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SPALLATION NEUTRON SOURCE
SECOND TARGET STATION
CONCEPTUAL DESIGN REPORT
VOLUME 2: CONVENTIONAL FACILITIES

March 2020

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MANAGED BY UT-BATTELLE FOR THE US DEPARTMENT OF ENERGY

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SECOND TARGET STATION PROJECT

SPALLATION NEUTRON SOURCE
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March 2020

Prepared by
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UT-BATTELLE, LLC
for the
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ABBREVIATIONS, ACRONYMS, AND INITIALISMS

ACH	air changes per hour
ACI	American Concrete Institute
AFF	above finished floor
AHU	air-handling unit
AISC	American Institute of Steel Construction
ANSI	American National Standard for Ladders Institute
ASA	Acoustical Society of America
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASSE	American Society of Safety Engineers
ASSE	American Society of Sanitary Engineering
ASTM	American Society for Testing and Materials
ATS	automatic transfer switch
AV	audio-visual
AWS	American Welding Society
BAS	Building Automation System
BMP	Best Management Practices
BSC	biosafety cabinets
BTU	British Thermal Units
CAV	constant air volume
CDR	Conceptual Design Report
CEF	Central Exhaust Facility
CF	Conventional Facilities
cfm	cubic feet per minute
CFR	Code of Federal Regulations
CHW	chilled water
Ci	continuous insulation
CISPI	Cast Iron Soil Pipe Institute
CLO	Central Lab and Office
CMS	cryogenic moderator system
CMU	concrete masonry unit
CNMS	Center for Nanophase Materials Sciences
CUB	Central Utility Building
CY	cubic yard
DAS	distributed antenna systems
DDC	direct digital control
DI	deionized
DOE	Department of Energy
DWV	drain-waste-vent
EIA/TIA	Electronic Industries Alliance/Telecommunications Industry Association
EISA	Environmental Independence and Security Act
EO	Executive Order
EPICS	Experimental Physics and Industrial Control System

EPSS	Emergency Power Supply System
ERW	electric resistance welded
FACU	fire alarm control unit
FF	finished face
FGMA	Flat Glass Manufacturers Association
F&O	Facilities and Operations
fpm	feet per minute
fps	feet per second
FTS	First Target Station
gpm	gallons per minute
gsf	gross square footage
HDPE	high-density polyethylene
HEPA	high-efficiency particulate air
HOG	hot off-gas
HPV	hot process vault
HVAC	heating, ventilation, and air conditioning
HX	heat exchanger
IBC	International Building Code
IECC	International Energy Conservation Code
IEEE	Institute of Electrical and Electronics Engineers
IESNA	Illuminating Engineering Society of North America
IFC	International Fire Code
IMC	International Mechanical Code
IP	Internet Protocol
IT	information technology
LAN	local area network
LCD	liquid crystal diode
LED	light-emitting diode
LEED	Leadership in Energy and Environment Design
LSS	Laboratory Shift Superintendent
MERV	minimum efficiency reporting value
MPS	Machine Protection System
MUA	makeup air
MWP	maximum working pressure
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NRCA	National Roofing Contractors Association
nsf	net square footage
ORNL	Oak Ridge National Laboratory
OSHA	Occupational Safety and Health Administration
PBW	proton beam window

PCE	primary confinement exhaust
PID	proportional integral derivative
PLC	programmable logic controller
POTS	plain old telephone service
PPS	Personnel Protection System
PPU	Proton Power Upgrade
psf	pounds per square foot
PVC	polyvinyl chloride
PWM	pulse width modulation
RTBT	Ring to Target Beam Transport
RTST	Ring to Second Target
SCADA	supervisory control and data acquisition
SCE	secondary confinement exhaust
Sch	schedule
SDI	Steel Deck Institute
SF	square foot
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
SNS	Spallation Neutron Source
SPD	surge protection device
STS	Second Target Station
TPS	Target Protection System
Ufer	concrete-enclosed grounding electrode
UL	Underwriters Laboratories
UPS	uninterruptible power supply
VAV	variable air volume
VFD	variable-frequency drive
VOC	volatile organic compound
VoIP	voice over IP
VSD	variable-speed drive
WLAN	wireless local area network

APPLICABLE CODES AND STANDARDS

- ACI 318-14, American Concrete Institute, Building Code Requirements for Structural Concrete
- AISC 360-16, American Institute of Steel Construction, Inc, Specification for Structural Steel Buildings, 15th edition
- ANSI A14.3, American National Standard for Ladders, Fixed, Safety Requirements
- ANSI/ASSE Z359.6, Specifications and Design Requirements for Active Fall Protection Systems
- ANSI/ASA S12.2, Criteria for Evaluating Room Noise, 2008
- ASCE 7-16, American Society of Civil Engineers, Minimum Design Loads for Buildings and Other Structures
- ASHRAE 90.1
- ASHRAE, HVAC Applications—Noise and Vibration Control
- ASME A17.1a-2005, American Society of Mechanical Engineers, Safety Code for Elevators and Escalators
- ASME B30.11, American Society of Mechanical Engineers, Monorails and Underhung Cranes
- ASME B30.16, American Society of Mechanical Engineers, Overhead Hoists (Underhung)
- ASME B30.17, American Society of Mechanical Engineers, Overhead and Gantry Cranes, Top Running Bridge, Single Girder, Underhung Hoist
- ASME B30.2, American Society of Mechanical Engineers, Overhead and Gantry Cranes, Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist
- ASTM, American Society for Testing and Materials, 1592, 2012
- ASTM, American Society for Testing and Materials, 408, 2013
- ASTM, American Society for Testing and Materials, C1036-01, 2001
- AWS D1.1, American Welding Society, Structural Welding Code
- DOE O 420.1C, Facility Safety
- DOE O 420.2C Safety of Accelerator Facilities
- DOE-STD-1020-2016, Natural Phenomena Hazards Design and Evaluation Criteria for DOE Facilities
- DOE-STD-1066-2012, Fire Protection
- DOE, 10 CFR Part 429, Certification, Compliance, and Enforcement for Consumer Products and Commercial and Industrial Equipment
- DOE, 10 CFR Part 431. Energy Conservation Program for Certain Commercial and Industrial Equipment: Energy Conservation Standards for Distribution Transformers
- Facilities and Operation Performance Requirements, Master Design Criteria, August 4, 2017
- FGMA, Flat Glass Marketing Association’s Sealant and Glazing Manual, 1990
- FM Global Property Loss Prevention Data Sheets 5-1—Electrical Equipment In Hazardous (Classified) Locations, 2012
- FM Global Property Loss Prevention Data Sheets 5-4—Transformers, 2017
- Guiding Principles for Sustainable Federal Buildings, 2016
- IBC, International Building Code; International Code Council, Inc, 2015
- IBC, International Fire Code; International Code Council, 2012
- IBC, International Mechanical Code, 2012
- IBC, International Plumbing Code, 2012
- IECC, International Energy Conservation Code, 2012
- IEEE 80, IEEE Guide for Safety in AC Substation Grounding
- IEEE 141, Recommended Practice for Electric Power Distribution for Industrial Plants.
- IEEE 142, Recommended Practice for Grounding of Industrial and Commercial Power Systems

- IEEE 242, Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
- IEEE 446, Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications
- IEEE 551, Recommended Practice for Calculating AC Short-Circuit Currents in Industrial and Commercial Power Systems
- IEEE C2, National Electrical Safety Code
- IES Lighting Handbook
- IFC, International Fire Code, 2012
- NFPA 10, Standard for Portable Fire Extinguishers, 2018 edition; National Fire Protection Association, August 1, 2017
- NFPA 101, Life Safety Code, 2018 edition; National Fire Protection Association, 2018
- NFPA 13, National Fire Protection Association, Standard for the Installation of Sprinkler Systems, 2019 edition
- NFPA 14, National Fire Protection Association, Standard for the Installation of Standpipe and Hose Systems, 2019 edition
- NFPA 2, Hydrogen Technologies Code, 2016 edition; National Fire Protection Association, 2016
- NFPA 55, Compressed Gases and Cryogenic Fluids Code, 2016
- NFPA 70, National Electrical Code
- NFPA 70E, Standard for Electrical Safety in the Workplace
- NFPA 72, National Fire Alarm and Signaling Code, 2019 edition; National Fire Protection Association, 2019
- NFPA 780, Standard for the Installation of Lightning Protection Systems. 2017
- NFPA 80A Protection of Buildings from Exterior Fire Exposure (1996)
- NFPA 90A Standard for the Installation of Air Conditioning and Ventilating Systems, 2018
- NFPA 90B Standard for the Installation of Warm Air Heating and Air Conditioning Systems. 2018
- NFPA 110 Emergency and Standby Power Systems, 2019
- NFPA 110, Standard for Emergency and Standby Power Systems
- NFPA 111, Standard on Stored Electrical Energy Emergency and Standby Power Systems
- NFPA 220 Types of Building Construction, 2018
- NFPA 251 Standard Methods of Tests of Fire Endurance of Building, 2006
- NRCA, National Roofing Contractors Association Manual, 2018
- ORNL, Facilities and Operations Performance Requirements Master Design Criteria, MPO-DES-001 R2, August 4, 2017
- OSHA, 29 CFR 1910 Subpart D, Walk, Working Surfaces
- OSHA, 29 CFR 1910 Subpart S, Electrical
- OSHA, 29 CFR 1926 Subpart M, Fall Protection
- SDI, Steel Deck Institute, Design Manual for Composite Decks, Form Decks and Roof Decks

EXECUTIVE SUMMARY

The Spallation Neutron Source (SNS) facility at the Oak Ridge National Laboratory (ORNL) initially included a First Target Station (FTS) with 24 instrument beamlines. The SNS Campus Master Plan included provisions for a Second Target Station (STS) and was developed to accommodate growth and expansion of the accelerator facilities, target facilities, instrument buildings, laboratories, offices, and secondary supporting facilities. The STS project will fulfill the original master plan through the construction of ten new building structures that will comprise the STS facility. Figure ES.1 highlights the proposed new facilities within the context of the existing SNS site. Appendix A includes all drawings describing the STS Concept Design.

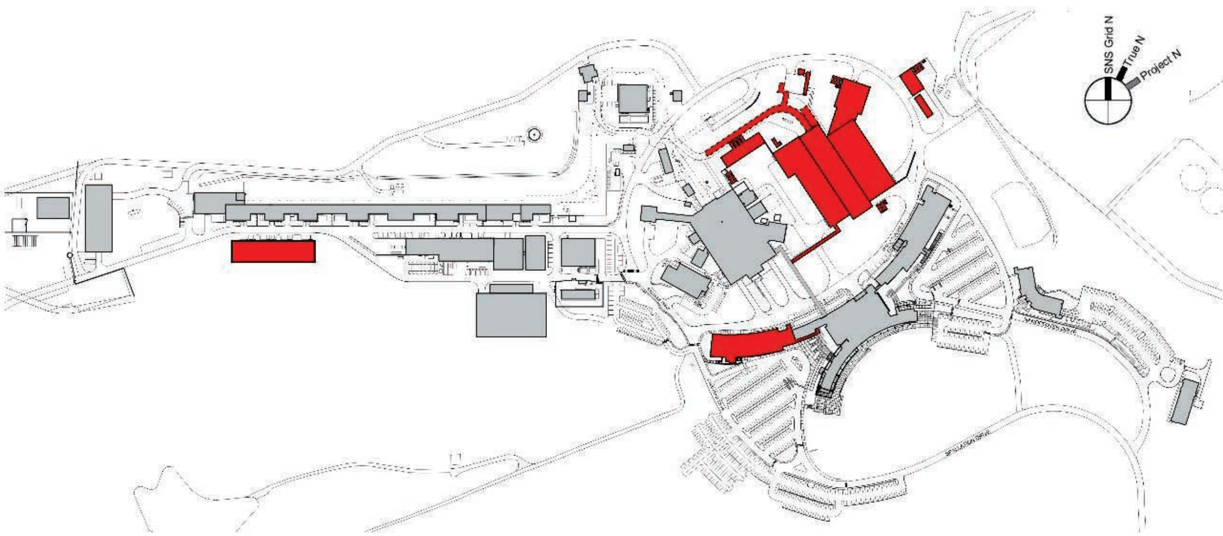


Figure ES.1. STS Site Plan showing the proposed new facilities in red.

The STS will include the capability to support 22 new beamlines. The entire complex will include 367,500 gsf of new construction. Table ES.1 summarizes the STS facilities and programmed areas. Appendix B includes the entire STS Preliminary Program.

Table ES.1. STS space program summary.

Buildings	GSF
RTST Tunnel	12,000
RTST Service Building	9,000
Target Building II	111,000
40M Instrument Building	45,000
50M Instrument Building	42,000
90M Instrument Building	17,000
Central Lab and Office Building II	96,000
Central Utilities Building II	9,000
Central Exhaust Facility II	500
Shop Building	26,000
Total (GSF)	**367,500**

The Ring to Second Target (RTST) Tunnel will house the proton beamline that extends from the existing Ring to Target Beam Transport (RTBT) Tunnel to Target Building II. The 12,000 gsf tunnel will include a dedicated truck access and overhead crane for the movement of beamline components. Because of radiological levels during operation of the proton beamline, the tunnel will be shielded with a combination of concrete and earth providing a minimum total shielding dimension of 18 ft. 6 in., measured from the interior tunnel surfaces to the exterior grade. Structurally, the RTST Tunnel will be designed to minimize settlement in relationship to the RTBT Tunnel and Target Building II.

The RTST Service Building will house utility systems, including magnet power supplies, magnet cooling systems, controls, diagnostics, and communication systems that support the RTST Tunnel and proton beamline. The single-story, 9,000 gsf facility will be located on the east side of the RTST Tunnel, accessible from the service courtyard between the FTS and STS.

Target Building II will house the second target monolith, at which the STS proton beamline terminates and 22 STS neutron beamlines originate. Target Building II will also house all utility systems necessary to support the target, space supporting long-term maintenance of the target, and numerous other functions that are critical to operation of the target facility. The 111,000 gsf facility includes four floor levels. The building includes extensive permanent and removable shielding. The second-floor high bay space is served by a 50-ton overhead bridge crane and interior tractor-trailer truck bay. Access to most of Target Building II will be restricted to STS scientific and technical operations staff.

The STS will include three instrument buildings. The 40M Instrument Building will house 11 instruments within 45,000 gsf; the 50M Instrument Building will house 9 instruments within 42,000 gsf; the 90M Instrument Building will house 2 instruments within 17,000 gsf. The 40M and 50M Instrument Buildings will include a perimeter mezzanine that provides upper-level access to individual instruments and links the entire STS complex with existing FTS facilities through a pedestrian bridge. The 40M and 50M Instrument Buildings will be served by 30 ton overhead cranes. The 90M Instrument Building will be served by a 10 ton overhead crane. The ST01 and ST02 (Zeeman’s Instrument), which are included in the 40 Instrument Building, will be served by a separate 10 ton overhead crane.

The Central Laboratory and Office Building (CLO) II will house laboratory space, STS scientific and technical staff offices/workstations, STS user staff offices/workstations, conference/collaboration areas, and general building support functions that will serve an increased campus population of approximately 170 people. The 4-story, 96,000 gsf building will be connected to the existing CLO in the vicinity of the existing SNS Control Room. The programming and design for CLO II incorporates ORNL and SNS space planning standards supporting goals for collaborative office/conference environments and flexible research laboratory space.

The STS will be served by a new Central Utilities Building (CUB) II and Central Exhaust Facility (CEF) II. CUB II will be a 2-story, 9,000 gsf building located along the perimeter ring road north of the STS complex. It will house chiller, boiler, compressed air, and pump systems and include an adjacent cooling tower. CEF II is primarily an exterior facility including exhaust fans, stacks, and associated utilities that will be located northwest of the STS complex within the perimeter ring road.

The Shop Building will house multiple workshop functions required to support FTS and STS operations, including the Cryogenics Shop, Pump Shop, RF Shop, and Modulator Shop. The single-story, 26,000 gsf building will be located along Los Alamos Drive near the west end of the SNS campus. The entire building will be a high bay space served by a 10 ton overhead crane.

The STS project will require substantial site development at the SNS campus. In addition to the individual building sites, the project will include underground site utilities, roadways and parking areas, stormwater management, and landscaping. The site design will also accommodate temporary construction staging, trailers, parking, and access roads. Significant mass grading will be required to support construction activities and the final site design.

The STS site and facilities are oriented using three grid systems referencing Project North, SNS Grid North, and True North. Typically, the narrative and drawings throughout the Conceptual Design Report reference Project North, which is an axis perpendicular to the longitudinal axis of Target Building II. The overall site drawings and narrative, in Section 8.1, reference SNS Grid North, which is organized relative to the SNS linear accelerator. True north, relative to the global coordinate system, is used for alignment of the accelerator technical systems. These orientations are illustrated in Figure ES.1, STS Site Plan.

The STS will comply with the *Guiding Principles for Sustainable Federal Buildings* issued by the Council on Environmental Quality in February 2016, according to Executive Order (EO) 13693, Planning for Federal Sustainability for the Next Decade. Although EO 13834 on May 17, 2018, superseded EO 13693, the 2016 *Guiding Principles for Sustainable Federal Buildings* are still in effect at the time this Conceptual Design Report is being written.

8. CONVENTIONAL FACILITIES

8.1 SITE CIVIL WORKS

8.1.1 Civil Site Land Improvements

8.1.1.1 Existing STS Area Stockpile

A stockpile made up of excess materials and spoils from construction of the Spallation Neutron Source (SNS) First Target Station (FTS) remains within the existing ring road at the proposed location for the Second Target Station (STS). This stockpile will be removed to allow construction of the Ring to Second Target (RTST) Tunnel and Building, Target II, and Instrument Buildings. The estimated volume of the existing stockpile is 194,000 CY. Much of this material will not be suitable as is for reuse as structural fill because of moisture concerns and therefore will have to be sorted, spread in lifts, and allowed to dry before compaction. The Construction Excavation Plan (Drawing 5.1.17) allows for this material to be spread and dried in structural and nonstructural fill areas to the south of the FTS Front-End Accelerator building, where the material can remain for development of the Shop Building area.

Alternatively, unsuitable structural material from the stockpile may be placed in fill areas to the east proposed for construction laydown, trailers, and parking. Geotechnical observation and testing services during construction will be required to manage proper placement of the unsuitable materials.

8.1.1.2 Construction Excavation Plan

The Construction Excavation Plan (Drawing 5.1.17) includes the excavation required for the RTST Tunnel, Target II, and Instrument buildings construction; eastern construction support area; and western haul road and spoil area. The overall cut volume for the Construction Excavation Plan, including the existing stockpile volume removal, is estimated at 430,000 CY (This volume excludes the Hawks Nest volume, discussed in Section 8.1.2). The cut materials will be placed as fill, as shown on the Construction Excavation Plan. The primary fill areas consist of the west spoil pile/shop area fill, eastern construction support area, and STS area cover stockpile. This plan provides the open pit excavations necessary to construct the extension of the RTST Tunnel and the Target Building II. Section 1 on Drawing 5.1.29 shows a typical cut section for the RTST Tunnel construction.

The Construction Excavation Plan (Drawing 5.1.17) allows for a west-to-east haul route separated from the facilities' existing roadway system for the movement of fill onsite. This route is established by constructing additional haul roads on the east and west ends of the site as shown on the Construction Excavation Plan and use of the existing North Perimeter Drive. The haul roads will be maintained as gravel roadways during construction.

The haul road connection from the extension of Spallation Drive to the temporary facility area will be graded to maintain less than 11 ft of fill over the existing 24 in. water line to avoid the expense of relocation or protection of the existing water line.

The Construction Excavation plan will require installation of appropriate best management practices (BMPs) (e.g., ponds, silt fence, check dams) during construction to minimize erosion and prevent silt from leaving the construction limits. Once final grades are achieved, topsoil, seed, and mulch will be used as stabilization measures to support grass establishment in areas not stabilized with gravel. Slopes of 3:1 and steeper will receive erosion control matting along with top soil and seed to support stabilization.

8.1.1.3 Finished Site Grading

Conceptual finished grades are shown on Drawings 5.1.18 through 5.1.20.

The STS area cover stockpile shown on Drawing 5.1.17 will be established to the east. It will consist of 180,000 CY of suitable cover material that is excavated and stored during construction excavation. The stockpile material will be used as backfill and cover material to establish finished grades in the areas excavated for the construction of the RTST Tunnel, Target II, and Instrument Buildings. As finished grading is completed, those areas will be seeded or paved as shown in the finished grading plan (Drawing 5.1.19).

The finished site grading areas will be protected by erosion and sedimentation control measures installed during the mass excavation. The installed BMPs (e.g., ponds, silt fence, check dams) will have to be maintained until site stabilization occurs. Once finished grades are achieved (in areas not stabilized by pavement, building areas, or gravel), topsoil, seed, and mulch will be used to support grass establishment. Slopes of 3:1 and steeper will receive erosion control matting along with top soil and seed to support stabilization.

8.1.1.4 Site Retaining Walls

Site retaining walls will be required to complete the site improvements. The wall locations shown in Table 8.1 are shown on Drawing 5.1.19. Typical wall sections are provided on Drawing 5.1.23.

Table 8.1. STS site wall summary.

Site wall	Wall type	Max height (ft)	Min height (ft)	Length	Approx. wall area (FF)
1	Cast in place concrete	20	10	85	1445
2	Cast in place concrete	34	–	30	1080
3	Cast in place concrete	10	1	190	1425
4	Cast in place concrete	34	1	260	4897.5
5	Cast in place concrete	16	1	300	3600
6	Cast in place concrete	21	1	100	1500
7	Cast in place concrete	2	1	110	385
8	Cast in place concrete	11	1	100	800
9	Cast in place concrete	13	11	55	770

8.1.1.5 Landscape/Hardscape

The landscape for the site will be in agreement with the current character of the FTS site. Plant selections will be in accordance with ORNL approved plant list and SNS's commitment to the use of native plant material to limit maintenance and water usage. Landscape focus areas shall be around building entrances, along heavily used pedestrian pathways, and at key roadway intersections. Trees shall be incorporated into parking lot design to reduce the heat island effect. Where possible, rain gardens and bio-swales will be used in the landscape to reduce stormwater runoff according to the Environmental Independence and Security Act (EISA) guidelines.

Hardscape elements will include sidewalks connecting parking areas and CLO II entrances and plaza spaces at key building entrances. All sidewalks shall be concrete and shall be a minimum of 4 ft wide, 6 ft in areas of heavier pedestrian traffic. Plaza space materials shall be a mix of concrete and concrete paver bands. Where possible, the use of permeable concrete pavers shall be used for larger plaza spaces.

8.1.1.6 Construction Support Area

Access to the construction support area will be via the Hawks Nest roadway construction access road discussed in Section 8.1.2.1. Because of the complex topography of the SNS site, limited area is available to support STS construction activities. During development of the STS Technical Design Report dated October 2014 and the STS Elevation Study dated October 20, 2016, it was determined that the area immediately to the east of the perimeter ring road is the most plausible location to support the construction space needs. Drawing 5.1.17 shows the 15 acres designated for construction needs, including haul roads and the STS area cover stockpile. It is proposed that the construction support area be graveled and designated for a trailer area, 350 construction craft parking spaces, and the construction laydown area. The project contractor will be responsible for temporary water and electrical utilities to serve the construction support area. During the STS Elevation Study, the team determined that 15 acres for construction support would be adequate based on a comparison of construction support areas used during the construction of FTS.

8.1.1.7 Karst/Sinkhole Considerations

Previous geotechnical explorations performed have identified the site as having a karst environment with a low to moderate chance for sinkhole development. Utility excavations and trenches should be backfilled and incomplete grading work should be maintained to adhere to recommendations of the geotechnical engineer.

8.1.2 Road and Transportation Improvements

8.1.2.1 Construction Access

The STS project encompasses eliminating or limiting construction traffic through the existing roadway network to avoid potential conflicts between FTS personnel, visitors, and existing facilities operations. Therefore, an alternative access plan for construction access to the STS site is included in the conceptual design. During previous studies, new construction access routes from Bethel Valley Road were analyzed. The two primary routes studied were the existing Walker Branch roadway and the unimproved Hawks Nest roadway. In the final analysis, the Hawks Nest access route was chosen to eliminate construction impacts to the Walker Branch environmental study area.

The proposed extension of Hawks Nest roadway shown on Drawing 5.1.16, Construction Access Route, is 1.0 mile. It will serve as the primary roadway for the construction activity because it has direct access to the construction support area east of the STS. The route shown is based on a preliminary analysis of the site topography. Further site studies are recommended to develop optimum road alignment.

The lower half of the proposed Hawks Nest access route alignment already exists and will be improved to a 22 ft wide gravel roadway. The upper portion of the alignment does not exist and will require more extensive clearing and grading to construct. The earthwork quantity for the proposed 22 ft gravel roadway is 75,000 CY of cut and fill placement.

8.1.2.2 Roads and Access Drives

The roads and access drives for the STS are depicted on Drawing 5.1.24, Roadway and Parking Improvement Plan.

Several new access roadways and access will be built as part of the Finished Site Plan. These roadways are shaded on Drawing 5.1.24 and labeled with numbers corresponding to the following list.

- Spallation Drive extension to SNS grid south, west, and north of Target II.
- Fire and Service access road between Target and Target II.
- STS basement access drive.
- STS first floor access drive.
- CUB II upper access drive.
- CUB II lower access roadway.
- 90M access drive.
- RTST Tunnel access roadway at CEF II.
- Truck and service access drive improvements at CLO II.
- RTST embankment area service drive.
- CLO II drop-off drive.
- Gravel roadway access to the construction support area and access to the existing booster pump station.

All new roadways are planned as asphalt, except for the driveway areas within 40 ft of buildings where concrete pavement is appropriate for loading operations. Curbing will be included when needed for traffic control and drainage collection. The access road from the extension of Spallation Drive to the construction support parking facility area will be graded to maintain a maximum fill height of 11 ft over the existing 24 in. water line to avoid the expense of relocation or protection of the existing water line. This roadway to the construction support area will be left in place at the completion of construction to serve as a gravel access road to the booster pump station.

8.1.2.3 Parking

The permanent roads and parking for the STS are depicted on Drawing 5.1.24, Roadway and Parking Improvement Plan.

All the additional parking for the proposed STS facilities, including the CLO II, are provided to the east (SNS grid) of the CLO II. Lot A includes 130 additional paved spaces in the area of an existing gravel lot. Lot B and C are east and northeast (SNS grid) of the FTS cooling towers and provide an additional 96 paved spaces. A small reduction in the existing CLO parking lot area D (29 spaces) will be required for the construction of the CLO II because of the realignment of the parking area for the CLO II footprint. Lot E North of CLO (55 spaces) is also being removed. Twelve additional spaces are proposed for the Shop Building area. All parking areas are proposed as asphalt parking with curbing for drainage and traffic control, as required.

A proposed layout and a summary of the parking count showing 154 additional paved parking spaces is provided on Drawing 5.1.24.

8.1.3 Site Utilities

Site utility improvements required for the STS included stormwater, electrical, sewer, domestic and fire water distribution, chilled water (CHW), heating water, tower water, and compressed air (CA).

8.1.3.1 Stormwater Management

Storm Drainage Collection

The stormwater runoff from the STS will be collected in the existing and new stormwater piping and inlets and conveyed to either the Main Pond or the East Pond. Some of the existing drainage inlets and pipe collection systems will have to be modified or relocated for the proposed development, as shown on Drawing 5.1.21 and Drawing 5.1.22. This plan shows demolition and rerouting of stormwater to the southeast (SNS grid) of Target II. This allows the project to route additional stormwater to the East Pond and remove some of the stormwater load to the Main Pond, which allows the increase in impervious parking areas described in the following Detention Ponds section.

Detention Ponds

Pond Improvements

The existing East Pond shown on Drawing 5.1.22 has a drainage watershed of approximately 35 acres. Currently about 5 ½ acres in the watershed are impervious, with an additional small amount of gravel improvements. Based on the current site layouts, the amount of impervious area may increase to 10 acres. Also, the watershed to the East Pond will increase by 5 acres because of the proposed rerouting of the stormwater collection southeast (SNS grid) of Target II.

Following new site improvements, the East Pond area will be required to maintain the existing stormwater flow rates for various storm events (10 year through 100 year). The pond will also have to retain the volume of the process cooling water for 24 hours and over detain the runoff from the 95th percentile storm (1.5 in.) for compliance with section 438 of the EISA.

Based on a preliminary review of construction drawings, the existing East Pond has a volume of between 150,000 and 180,000 cubic feet below elevation 1020.57 ft (top of overflow structure). It is anticipated, based on preliminary design model runs, that the pond outlet can be reconfigured to handle additional loads due to the process cooling water and the EISA requirements. However, the pond will need to be enlarged to meet these requirements and limit the peak discharges. The pond enlargement is anticipated to the north because the existing water line runs along the eastern edge of the pond. The pond volume has likely been impacted by silt accumulation from past construction activities. Therefore, the amount of silt accumulation in the pond will need to be evaluated as well.

An additional area of concern for the East Pond is that the only outlet to the pond is via the piping system and there is no emergency overflow from the pond. This situation will need to be further evaluated as design details are prepared.

The Main Pond to the southwest (SNS grid) of the site serves most of the SNS site. The CLO II, Shop Building, and parking improvements will all drain to the Main Pond. This pond is sufficient in size only for a small amount (approximately ½ acre) of additional building development (impervious surface). The proposed CLO II expansion, Shop Building area, and additional parking to the east of the current target will exceed the ½ acre allowance. Therefore, to eliminate the need for improvements to the Main Pond, the site improvements include rerouting drainage collection southeast (SNS grid) of Target II to the East Pond.

8.1.3.2 Electrical Systems

SNS Primary Substation Capacity

The SNS site primary substation is supplied from the Tennessee Valley Authority transmission system. The substation has two power transformers, both rated 165/13.8 kV, 42/56/70 MVA. The substation has an effective capacity of 70 MVA with one transformer out of service. The primary substation peak operating load is approximately 28 MVA when 1.4 MW of beam power is delivered to the First Target. The Proton Power Upgrade (PPU) is estimated to add an additional 3 MVA when 2.0 MW of beam power is delivered to the First Target. The STS is estimated to add an additional 12 MVA of load when 0.7 MW of beam power is delivered to the Second Target. The estimated total SNS load, summing up these loads, is 43 MVA. Therefore, no additional capacity is needed in the 70 MVA primary substation.

Normal Power Distribution

Normal power distribution will be supplied to the STS facilities from three existing 13.8 KV substation switchgears to unit substations near each building, as noted in Table 8.2. Specifically, the STS will be supplied from the existing 161/13.8 KV campus substation 13.8 KV switchgear spare metal-clad breakers 2034, 2054, and 3034 at Building 8912. Final terminations at the switchgear will be by campus facilities. Each feeder will be rated at 600 A using 3-1/C, 750 kcmil, EPR-MV-105, 3-phase, 3-wire cable plus a 600 V ground. The two feeders from bus A, 2034 and 2054, will first need to be extended overhead from the campus substation switchgear to enter into the southern new duct bank system. This three-source arrangement provides flexibility and reliability of service to the STS facility during outages and required system maintenance.

The three 13.8 KV service feeders will be extended in a new 2 ×2, 4-cell, 6-in., Sch 40 PVC concrete-encased duct bank with manholes to the south around Argonne Drive. The existing north duct bank system has limited spare conduits, and congested utilities in the area discourage adding a new duct bank in that area.

The feeders will be extended to exterior unit substations near the STS buildings with less-flammable fluid transformers and walk-in secondary enclosures to provide necessary secondary service voltages to service the loads of buildings. Substation primary switchgear will be sectionalized 600 A, 25 kAIC, S&C electric underground distribution switchgear (VISTA) type with fault interrupters serving the transformers. Bus B feeder 3034 will service substations dedicated to science loads, and bus A feeders will service non-science load substations. Buildings with two nonscience use substations at the Target, CLO II, and CUB II will be fed from different main feeders to further enhance the reliability of service to those buildings. The substation transformer primary cable will be standardized at 3-1/C, #2/0 EPR-MV-105 cable.

Refer to Appendix A for the drawings Proposed STS Medium Voltage Electrical Single-Line and Proposed Electrical Site Utilities Layout. Refer to Table 8.2 for the STS building normal power service summary for estimated peak demand loads by building and equipment type and associated generator sizes and capacity.

Table 8.2. STS building normal power services summary.

XFRMR served Buildings	Building SF	Estimated Peak Demand Load (kVA) LTG	GEN PWR	Science loads	Elev	Crane	HVAC	CUB plant	Total build	With 25% growth (kVA)	Estimated XFRMR Size (kVA)	Report USS ID	SEC WYE volts	SEC LV SWGR amps	Notes
Target Building II	108,421	152	108	660	50	50*	654	0	1624	2030	**1@2000**	**TA2-SS1**	480	3000	
Moderator helium compressors				2000						2000	**1@2000**	**TA2-SS2**	4160	2@200	No growth carried
RTST Tunnel	12,830	18	32	0	0	12.5	125	0	188	234					
RTST service	8,941	13	22	1375	0	0	274	0	1684	2105					
		30	54	1375	0	12.5	399	0	1871	2330	**1@2500**	**RS2-SS1**	480	4000	
				1000					1000	1000	**1@1000**	**RS2-SS2**	TBD		Septum power supplies
				920					920	1000	**1@1000**	**RS2-SS3**	TBD		Dipole power supply
				920					920	1000	**1@1000**	**RS2-SS4**	TBD		Dipole power supply
40M Instrument	45,259	63	113	360	0	30*	202	0	739	923					
Zeemans Instrument	0	0	0	80	0	10	0	0	90	113					
		63	113	440	0	40	202	0	829	1036	**1@1500**	**TA2-SS3**	480	2500	Sized for modularity
50M Instrument	42,447	59	106	360	0	30*	187	0	713	891					
90M Instrument	15,993	22	40	180	0	10	50	0	302	378					
		81	146	540	0	40	237	0	1015	1269	**1@1500**	**TA2-SS4**	480	2500	
CLO II	96,784	135	242	774	200	0	600	0	1952	2440	**2@2000/2500**	**CL2-SS1/SS2**	480	2@4000	Transformers rated KNAN/KNAF Manual secondary tie
CUB II	9,234	13	23	0	0	0	0	2460	2496	3120					
CEF II	370	1	1	0	0	0	140	0	141	177			480	600	Exhaust for Target Building II
		0	0	0	0	0	0	300	300	375			480	(2) 400	Two cooling towers
		14	24	0	0	0	780	2,760	2937	3672	**2@2000**	**CU2-SS1/SS2**	480	2@3000	
Shop	25,518	36	0	100	0	10	181	0	327	408	**N/A**	**N/A**	480	600	Feed from KG USS KL-SS1
TOTAL:	**365,797**														

* Indicates largest crane included when multiple.

A separate 600 A, 480 V feeder will be extended to the new Shop Building from unit substation USS-KLSS1 located south of the west end of the Klystron Gallery.

Temporary Electrical and Telecommunications Service Distribution

Temporary power and telecommunication for construction of the STS project will be provided via overhead pole line distribution. The overhead pole line will be supplied from 3104-SFG1to provide a power source located to the northwest near the construction staging area. The ORNL telecommunication provider Black Box will provide telecommunication service to the construction contractor's temporary offices.

Emergency Power Supply Systems (EPSS)

Local exterior diesel standby engine-generators will be provided at the buildings as noted in Table 8.3. Each generator will be in an exterior, weatherproof, sound-attenuated, reach-in enclosure with 24-hour sub-base fuel tanks. Each generator will be provided with a quick-connect feature to be used for load bank testing or portable generator back-up if the primary unit is down for maintenance.

Refer to Table 8.3 for the STS building standby power service summary for estimated peak demand loads by building and equipment type and associated generator size and capacity.

Uninterruptible Power Supply) Systems

Local science load, information technology (IT), and data center uninterruptible power supply (UPS) systems will be provided within each building as noted in Table 8.3. IT UPS systems will normally be located within the emergency power distribution rooms. Other UPS systems will be located near their loads. All UPS systems will be static (battery) type with maintenance bypass and 15-minute ride through capacity. Refer to Table 8.4 for the STS building UPS power service summary for UPS estimated size for each building.

Telecommunication Systems Distribution

Interconnecting fiber optic cabling between the new STS buildings and existing facilities will be provided using a new duct bank and manhole system essentially mirroring the power distribution raceway southern extension. A 3×3, 9-cell, 4-in., Sch 40 PVC, concrete-encased duct bank configuration is anticipated with raceway barriers in the manholes to isolate systems requiring this configuration.

STS IT systems, also known as ORNL networks, will connect to existing SNS IT hubs located in CLO IT rooms and will provide interconnection of the following building systems:

- VoIP, business computing, experimentation data, and so on
- Telephone (copper cables)

The new STS networking systems hardware and components will be provided to be compatible with existing SNS network systems, such as the ORNL Facilities and Operations (F&O) building systems distribution.

Table 8.3. STS building standby power services summary.

Buildings served	Building SF	Estimated Peak Demand Load (kVA) LTG	GEN PWR	Science loads	Elev	HVAC	IT UPS	CUB plant	Total build	With 25% growth (kVA)	Estimated generator size (kW/kVA)	Report GEN ID	SEC WYE volts	SEC SWBD amps	Notes
Target Building II	108,421	54	54	313	50	302	65	0	898	1123					
40M Instrument	45,259	23	23	0	0	0	0	0	45	57					
		77	77	313	50	302	65	0	944	1180	**1000/1250**	**TA2-EG1**	480	1600	
Moderator helium compressors		0	0	150	0	0	0	0	150	188					
50M Instrument	42,447	21	21	0	0	0	0	0	42	53					
90M Instrument	15,993	0	8	0	0	0	0	0	8	10					
		21	29	150	0	0	0	0	200	251	**300/375**	**TA2-EG2**	480	600	
RTST Tunnel	12,830	6	6	0	0	125	0	0	138	172					
RTST Service	8,941	4	4	120	0	0	80	0	209	261					
		11	11	120	0	125	80	0	347	433	**400/500**	**RS2-EG1**	480	800	
CLO II	96,784	48	48	387	100	63	200	0	847	1059	**800/1000**	**CL2-EG1**	480	1600	
CEF II	370	0	0	0	0	140	15	0	155	104					
CUB II	9,234	5	5	0	0	0	15	0	24	30					
		5	5	0	0	140	30	0	180	225	**300/375**	**CU2-EG1**	480	600	
Shop	25,518	13	13	0	0	0	15	0	41	51	**N/A**	**N/A**	480	60	Feed from KG KL-2DPE1
TOTAL:	**365,797**														

Table 8.4. STS Building UPS power services summary.

XFRMR served buildings	Building SF	Estimated UPS size (kVA) IT UPS Systems IT	With 25% growth	Estimated size (kVA)	Notes
RTST Tunnel	12,830	0			
RTST Service	8,941	80	100	**100**	Also serves science loads
Target Building II	108,421	10			
40M Instrument	45,259	10			
50M Instrument	42,447	10			
Moderator helium compressors		30			
90M Instrument	15,993	5			
TOTAL		65	81.25	**80**	Matches FTS size
CLO II	96,784	50	62.5	**75**	
		80	100	**100**	Dedicated to data center
CUB II	9,234	15	18.75	**25**	
CEF II	370	15	18.75	**25**	
Shop	25,518	0			
TOTAL:	**365,797**				

Note: All UPS systems will be static (battery) type with 15 minute backup.

Interconnecting fiber optic cabling between the new STS buildings and existing facilities will be provided using a new duct bank and manhole system essentially mirroring the power distribution raceway extension and ring topology. The following building systems/system owners will be interconnected with cables and raceways by SNS CF. The system owners will perform final tie-ins.

- Public Address/F&O Instrumentation and Controls
- Fire alarm (FIREWORKS network) F&O Laboratory Protection
- Access control/F&O Laboratory Protection
- Building automation system/(F&O Facilities Management (CLO II only—Siemens))
- Power monitoring (ION-Schneider) F&O electrical utilities (including central IT UPS systems monitoring)

The fire alarm systems will be proprietary Edwards Systems Technologies EST-3 manufacturer/series with communication platform links to the Building 8600 FIREWORKS fiber optic hub for compatible reporting to the existing Laboratory Shift Superintendent (LSS) office at Building 4512 and ORNL Fire Department at Building 2500.

Instrumentation and Control Systems Distribution

Interconnecting cabling between the new STS buildings and existing facilities will be provided using a new duct bank and manhole system, essentially mirroring the power distribution raceway extension and ring topology.

STS instrumentation and control systems for accelerator timing will connect to the existing hub in the Ring Service Building.

STS instrumentation and control systems will connect to existing SNS hubs located in the CLO Building and will provide site interconnection of the following systems:

- Machine Protection Systems (MPS)
- Accelerator Timing System (ATS)
- Target Protection System (TPS) (two conduits)
- Experimental Physics and Industrial Control System (EPICS)

8.1.3.3 Sanitary Sewer

Sanitary sewer service will be provided to the proposed Target Building II, RTST, CUB II, 90M Instrument Building, CLO II, and Shop Building by connecting to the existing SNS sanitary sewer collection system. See Drawings 5.1.25 through 5.1.28 as a reference. The existing SNS sanitary sewer collection system was originally designed with enough capacity to service both FTS and STS. SNS sanitary sewer flow measured from October 2017 through September 2018 totaled 8,711,000 gal, or 24,000 gal per day (gpd) or 17 gal per minute (gpm).

Gravity Sewers

The Target Building II, RTST, CUB II, and the 90M Instrument Building sanitary flow will be routed to the gravity sewer system east of the Center for Nanophase Materials Sciences (CNMS) at manhole M850. The sanitary sewer extensions for Target Building II, RTST, CUB II, and the 90M Instrument Building are shown on Drawing 5.1.27, Enlarged Sheet B–Utility Plan. Flow rates and pipe sizes will be calculated based on drainage fixture unit values and adjusted/increased to allow for projected wastewater discharges from various items of related equipment at the design stage. The sanitary sewer service needs to exit the Target Building II near the southeast corner at approximately the 1051 ft elevation so that it can flow by gravity into manhole M850. Wastewater flows by gravity from this manhole to lift station 8631 (LS8631). LS8631 is shown on Sheet 5.1.25–Overall Utility Plan. Capacity upgrades will be required to LS8631; they are discussed further in the following section, Lift Stations and Force Mains. The sanitary sewer components required to extend gravity sanitary sewage service from manhole M850 to the Target Building II, RTST, CUB II, and 90M Instrument Building consist of the following:

- 8-in. gravity sewer 1,200 linear feet
- 4-ft diameter manholes 4 each
- Sewer service lateral to RTST Building 170 linear feet
- Sewer service lateral to Target Building II 55 linear feet
- Sewer service lateral to CUB II 30 linear feet
- Sewer service lateral to 90M Instrument Building 130 linear feet

The CLO II sanitary sewer can be connected to SNS manhole M808, which is just upstream of LS8601. The sanitary sewer extension for the CLO II is shown on Drawing 5.1.27. The CLO II is projected to have 170 new offices/workstations and 25 guests per day, for an additional population of 195 people. At 25 gpd per capita, the average daily wastewater flow generated will be 4,875 gpd (10 gpm, calculated for an 8-hour shift). No additional downstream sewer system improvements are required for the CLO II. The sanitary sewer components required to extend sanitary sewage service to the CLO II consist of the following:

• Sewer service lateral	125 linear feet
• Connection to existing manhole M808	1 each

The Shop Building, located on the west side of the SNS campus, will connect to gravity sewer manhole M828 via a proposed grinder lift station located east of the Shop Building and 400 linear feet of force main. Flow rates and pipe sizes will be calculated based on drainage fixture unit values and adjusted/increased to allow for projected wastewater discharge from various related items of equipment at the design stage. The sanitary sewer extension for the Shop Building is shown on Drawing 5.1.26, Enlarged Sheet A–Utility Plan. No additional downstream sewer system improvements are required for the Shop Building. The sanitary sewer components required to extend sanitary sewage service to the Shop Building consist of the following:

• Grinder lift station	1 each
• Force main	400 linear feet
• Connection to existing manhole M828	1 each

Lift Stations and Force Mains

As noted previously, SNS receives an average wastewater flow of 24,000 gpd, or 17 gpm. Wastewater leaves SNS by being pumped by one of two lift stations, LS8601 and LS8631. The lift stations are manifolded into a 6-in. ductile iron force main that parallels Old Chestnut Ridge Road for discharge into the ORNL sewer system.

LS8601 has a measured capacity of 300 to 350 gpm (432,000 to 504,000 gpd). Compared with the overall SNS usage of 17 gpm, LS8601 and its 300 linear foot, 6-in. diameter force main can handle the additional flows generated from CLO II and the Shop Building without upgrades.

LS8631 currently handles wastewater generated by the Shull Wollan Center and the ORNL Guest House. The lift station is connected to the 6-in. force main along Old Chestnut Ridge Road with a 1,925 linear foot, 4-in. diameter PVC force main. LS8631 was designed for an average flow rate of 14 gpm and a peak flow rate of 68 gpm. Adding wastewater flows from Target Building II, RTST, CUB II, and 90M Instrument Building to LS8631 will exceed the lift station capacity. LS8631 will require larger-capacity pumps and properly sized electrical and control equipment to meet the additional needs, while the existing 4-in. force main size is adequate to convey the additional flow from the upgraded pumps.

System Design Criteria

The sanitary sewer system shall meet or exceed the requirements set forth in the Tennessee Department of Environment and Conservation's *Design Criteria for Sewage Works*, Chapter 2.

8.1.3.4 Water System

The water system serves several purposes. It provides (1) potable drinking water and water for sanitary purposes for the Chestnut Ridge employees and visitors, (2) process water (e.g., cleaning, filling of systems), (3) makeup water for the site cooling towers, and (4) water for fire suppression.

Water Usage and Demands

This section describes the additional water usage demand placed on the system by the STS. The existing SNS water system was designed using system demands for both FTS and STS. The existing water distribution system piping is sized to provide the design flows (potable, process, cooling water, and fire) at the required residual pressures. The potable, process, and cooling water demand capacity were designed for a peak day water system demand of 640 gpm. Peak water flow demands are influenced by operation of the accelerator and seasonal building cooling demands. Therefore, the highest water usage occurs when the accelerator is running during the summer. The highest FTS monthly usage of 9,171,000 gal (300,000 gpd) was recorded in July 2018.

The STS fire protection requirements, potable water demands, and line sizes will be determined as the facility buildings are further developed. Employees and visitors will contribute approximately 5,000 gpd based on the sewer demand calculation, and cooling tower makeup water demand will be approximately 250,000 gpd for a peak summer day based on the mechanical equipment demands referenced in this document. Therefore, STS peak day water demand is expected to be approximately 255,000 gpd.

Coupling these projected STS demands of 255,000 gpd with the FTS historical peak monthly demand of 300,000 gpd results in a peak day flow of 555,000 gpd (385 gpm). As previously noted, the potable, process and cooling water demand capacity were designed for a peak day water system demand of 640 gpm (1,045,000 gpd). The projected FTS and STS water demand is much less than the original design rate owing to decreased volumes of cooling tower makeup water. Therefore, the water distribution system is adequately sized to supply potable drinking water, process water, and cooling tower makeup water to both FTS and STS.

The design fire flow rate at SNS is based on the greatest demand for a suppression system on site. The hydraulic demand for the 2,500 SF area of the second floor of the Target Building is 1,621 gpm, including a 500 gpm hose stream allowance for a duration of 120 min. The required reserve using the 120-min duration is 195,000 gal. The fire protection volume required for Target Building II is assumed to be the same as for the existing Target Building I and not required during the same event. It is recommended that Target Building II be set near the same elevation as the Target Building to ensure adequate fire flow residual pressure.

Water flow tests performed by the ORNL Fire Department on an annual basis indicate the available water flow data for fire protection. The most recent test data are included in Table 8.5 and are provided for STS sprinkler design. The fire hydrant open outlets measured 2.5 in. in diameter, and the outlet coefficient of discharge was 0.9.

Table 8.5. Available water flow.

Hydrant numbers		Static pressure (psig)	Test: Single hydrant flowing (psig and gpm)	Test: Dual hydrants flowing (psig and gpm)
First (static/residual)	09–419	122	N/A	116
Second	09–417		N/A	1,453
Third	09–420		N/A	1,501
			Total flow:	2,954
Estimated available flow at 20 psig, according to the tests				13,641

Based on the available water flow measured at hydrants near Target Building II, the fire protection requirements are met with the existing water distribution system.

Water Supply and Distribution Infrastructure

This section discusses the adequacy of the existing system to meet the project water usage. Refer to Sheets 5.1.25 through 5.1.28 for conceptual site utility layouts.

Water to ORNL is supplied from the City of Oak Ridge via a single 24-in. cast iron water line that passes through the Y-12 National Security Complex site. The existing SNS water system has historically delivered all system demands with adequate flow and pressure. There have been no water system modifications since the initial system installation which would significantly affect the capacity of the SNS water system to deliver the design water demands to the site.

As shown on Drawing 5.1.28–Enlarged Sheet C, Utility Plan, the water booster pump station draws water from a 24-in. water line on the east side of the SNS site and pumps that water to an elevated water storage tank through a 12-in. dedicated transfer line connecting the pump station and storage tank. The multi-leg elevated storage tank has a storage capacity of 300,000 gal and is shown on Drawing 5.1.25. The storage tank feeds the site water distribution piping and fire protection system from existing 12-in. water line loops, which distribute water by gravity to all buildings on the site at the required flow and pressure.

The water booster pump station has three pumps of the same size. The pump station has a firm capacity (capacity with one pump out of service) of 1,100 gpm. The water booster station controls are configured to let only two pumps run at any time, as operating three pumps would cause cavitation damage due to low suction pressure. The original booster station capacity was calculated as the sum of (1) the normal peak day flow, (2) the flow rate calculated to refill the storage tank to the required fire storage volume in 8 h, and (3) a 100 gpm design contingency. Adjusting for a lower peak day flow of 385 gpm, and 410 gpm to fill the 195,000-gal fire storage reserve in 8 h (195,000 g/ (8 h · 60 min/h), the booster pump station contingency has increased to 305 gpm (1,100–385–410 gpm). Therefore, the water booster pump station is currently able to meet the needs of FTS and STS.

As FTS and STS are dependent on the water booster station, its reliability and resiliency should be addressed. “Reliability” means that since pumps will require maintenance and down time, a dedicated backup of the same size as the largest pump shall always be installed and operational. “Resiliency” is a measure of how quickly the water booster station can be brought back to full operation after an event that causes a pump failure. With a third pump installed and operational, the water booster station reliability is met for both FTS and STS. The Utilities Division maintains a fourth pump in inventory in case one of the three pumps must be removed from service. The new pump could be brought in quickly and installed to meet the resiliency needs for both FTS and STS. Having the pump in a separate but nearby location is advisable.

The 300,000 gal storage tank capacity is derived from the sum of the following volumes: (1) tank operating volume, which provides for adequate starting and stopping of booster pump station pumps; (2) a fire suppression volume, which is equal to the highest fire flow rate (1,621 gpm for a 120 min duration); and (3) an emergency operational storage volume, which provides the potable, cooling tower, and process flows for an original design period of 3 h. The fire protection volume is not required for multiple simultaneous events. Therefore, the elevated storage tank has adequate operational volume and fire protection volume to serve the addition of STS.

The emergency operational storage volume, which must be maintained in addition to the fire protection volume, is a minimum of 4 h for both FTS and STS when recalculating for the projected cooling demand.

This minimum of 4 h of operational storage is a vulnerability that needs to be addressed. Should an extended disruption to the SNS water supply occur, makeup water to the cooling towers would be impacted most, as it is the largest user, especially during summer months when demand is greatest.

Note that the existing booster pump station can provide the required operating pressures with the elevated storage tank out of service. Operating the system with the elevated tank out of service is currently a manual exercise and not desired by Utilities and Fire Protection staff.

Water service and fire protection lines will need to be extended to the STS buildings. Flow rates and pipe sizes will be calculated based on drainage fixture unit values and adjusted/increased to allow for projected water usage from various related equipment at the design stage. The following buildings require service:

- Shop Building
- RTST Building
- CLO II
- Target Building II
- CUB II
- 90M Instrument Building
- Construction support area

When grading operations interfere with existing water lines, new water lines should be relocated and operational before existing lines are taken out of service. As shown on Drawing 5.1.27, the grading and retaining wall 5 around the CUB II will require replacement of the following:

• 12-in. ductile iron water lines	725 linear feet
• Connections to pressurized lines	4 each
• 12-in. valves	3 each
• Fire hydrant	1 each

The site grading considers the 24-in. ORNL supply line as noted in Section 8.1.1.1, Construction Excavation. Depth of cover on the 24-in. waterline currently cannot exceed 11 ft, and proposed grading operations consider this requirement. Should the fill exceed 11 ft, or additional protection be desired because of construction traffic, special pipe bedding and/or encasement can be provided on the affected section to prevent disruption of water service on this vital line.

System Design Criteria

The water system shall meet or exceed the requirements set forth in the Tennessee Department of Environment and Conservation *Community Public Water Systems Design Criteria.*

8.1.3.5 Site Chilled Water

Site CHW will be generated at CUB II and distributed in an underground loop around the site to serve air handling units (AHUs) and for generating technical/sensible CHW as described in each of the building narratives. CHW will be provided to the following buildings:

• RTST Service Building	6-in. service
• Target Building II	12-in. service (east side) and 3-in. service (west side) (serving 40M and 50M Instrument Buildings)
• 90M Instrument Building	4-in. service

- CLO II Building — 8-in. service (from existing CUB generated site loop)
- CNMS Building — 8-in. service (transfer connection from existing to new mains)

Underground CHW piping will be distributed in factory-fabricated coated steel piping or insulated HDPE.

8.1.3.6 Site Heating Water

Site heating water will be generated at the CUB II and distributed in an underground loop around the site, to serve AHUs as described in each of the building narratives. Heating water will be provided to the following buildings:

- RTST Service Building — 4-in. service
- Target Building II — 6-in. service (east side) (also serving 40M and 50M Instrument Buildings)
- 90M Instrument Building — 2-in. service
- Shop Building — 4-in. service (from the existing CUB generated site loop)

Underground heating water piping will be distributed in a pre-insulated, factory-fabricated coated steel piping system.

8.1.3.7 Site Tower Water

Site tower water will be generated at the CUB II and distributed in an underground loop around the site, to provide technical cooling heat rejection as described in each of the building narratives. Tower water will be provided to the following buildings:

- RTST Service Building — 8-in. service
- Target Building II — 6-in. service (east side) and 4-in. service (west side) (also serving 40M and 50M Instrument Buildings)
- 40M Instrument Building — 3-in. service (separate service for Zeeman’s helium compressors)

Underground tower water piping will be distributed in a factory-fabricated coating piping system or HDPE.

8.1.3.8 Site Compressed Air

Site CA will be generated by a pair of redundant air compressors at the CUB II and distributed underground throughout the site at a minimum of 110 psig. The system will be routed from the CUB II to the Target and Instrument Buildings and CLO II and interconnected to the existing site distribution CA mains just outside the CNMS building. The distribution piping serving each building will be sized for the current building program with an additional 20% load provided to accommodate for renovation flexibility.

- RTST Service Building — 2 in.
- Target Building II — 4-in. service (east side) (also serving 40M and 50M Instrument Buildings)
- CLO II Building — 3-in. service (from existing CUB generated site loop)
- Shop Building — 3-in. service (from existing CUB generated site loop)

8.2 RTST TUNNEL AND SERVICE BUILDING

8.2.1 RTST Tunnel

8.2.1.1 Programming

Building Function

The RTST Tunnel will house the proton beamline that extends from the existing Ring to Target Beam Transport (RTBT) to Target Building II. Utility systems that support beam operation will be distributed throughout the length of the RTST Tunnel. The RTST Tunnel will also provide service access for regular maintenance to beam components and an 8 ft, 0 in. clear pedestrian/equipment passage along the entire length of the tunnel. During beam operation, the RTST Tunnel will be inaccessible for human activities because of elevated radiological levels. During periods of nonoperation, access to the tunnel is generally limited to scientific and technical staff.

Program Summary

The RTST Tunnel includes 9,920 nsf and has an estimated planning efficiency factor of 81%. This factor is based on analysis of the existing FTS tunnels and preliminary test-fit planning for the RTST Tunnel. The estimated gross area of the RTST Tunnel is 12,258 gsf. Table 8.6 summarizes the RTST Tunnel space program requirements. Detailed room data sheets and test-fit plans are included in Appendix B of the STS CF Conceptual Design Report.

Table 8.6. RTST Tunnel space program summary.

No.	Rooms	Qty.	Net SF	Total net ft^t
5.2.1.1	Tunnel	1	8,570	8,570
5.2.1.2	Egress stair labyrinth	1	260	260
5.2.1.3	Access tunnel labyrinth	1	300	300
5.2.1.4	Access tunnel	1	790	790
Total nsf				**9,920**
Total gsf				**12,258**
Total efficiency				**81%**

8.2.1.2 Site Planning

Location and Floor Elevations

The RTST Tunnel planning will be precisely coordinated with the layout of the proton beam components and location of the overall STS complex within the project site. The tunnel will be approximately 520 ft long. The RTST Tunnel does not include the RTBT Stub, which will be constructed as part of the PPU project. (See RTBT Stub Conceptual Design Study Revision 2, February 28, 2017.) The RTST Tunnel will link to the end of the RTBT Stub and terminate at Target Building II. The tunnel floor will be located at elevation 1076 ft. This corresponds to the proton beam centerline at elevation 1080 ft, which aligns with the existing proton beam elevation throughout the SNS complex. This elevation drives the vertical location of all technical equipment and conventional facilities (CF) throughout the STS complex. Figure 8.2 highlights the RTST Tunnel and the associated RTST Access Tunnel within the overall STS Site Plan.

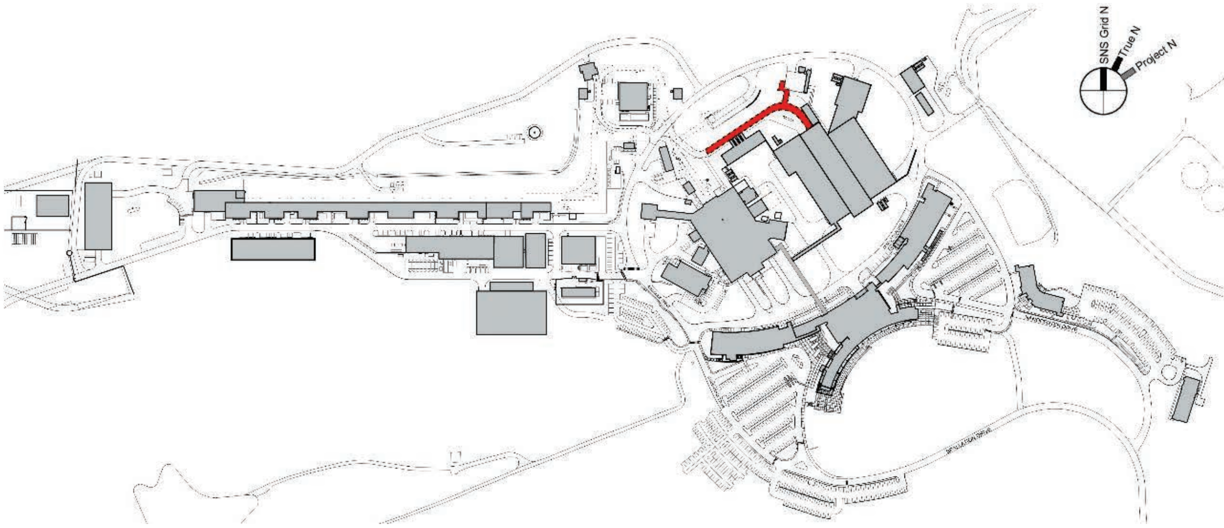


Figure 8.1. RTST Tunnel location within the STS Site Plan.

Truck Access

The primary tractor trailer truck access for the RTST Tunnel will be located where the tunnel bends by 90° to approach Target Building II. This will be an uncovered, flat dock condition, requiring the use of forklifts for movement of materials between the exterior and the tunnel. The exterior paved surface will be sized to accommodate truck maneuvering and storage of temporary shielding blocks that will placed at the end of the tunnel during normal accelerator operation. The loading dock will be connected to the RTST Tunnel by the RTST Access Tunnel, which is approximately 56 ft long. The access tunnel does not include an overhead crane. The RTST Tunnel will also be accessible by tractor trailer through the existing RTBT Access Tunnel. Use of this access point will be limited to time periods when the FTS proton beam is not in operation.

Pedestrian Access

Pedestrian access to the RTST Tunnel will be available from the RTST Access Tunnel and the RTBT Access Tunnel. Secondary pedestrian access will also be available through an egress stairwell located adjacent to Target Building II. All of these locations will include pedestrian radiological shielding labyrinths and restricted access controls.

8.2.1.3 Building Planning

Building Organization/Floor Planning

The RTST Tunnel will be a single-story, below-grade structure with a floor plan driven by the geometry and dimensions of the proton beamline components. Tunnel egress paths will be provided through the RTBT Stub, at the RTST Access Tunnel and into an egress stair with vertical discharge. This stair will be located adjacent to Target Building II.

Tunnel Cross Section

The RTST Tunnel will be comparable in size and construction to the existing RTBT Tunnel. The interior clear space of the tunnel will be approximately 17 ft wide and 13 ft high. The beam centerline will be located asymmetrically in the tunnel to allow for maintenance access and continuous passage along one side of the proton beam by scientific staff and technicians. The proton beam and magnets will be supported on steel lattice structures, provided as part of the technical equipment scope, that are anchored to the tunnel floor.

Utility Distribution

Utility systems supporting the proton beam will be distributed within the RTST Tunnel. Most utility systems, including power, technical cooling water, CA, fire protection water, and ventilation will be routed to the RTST Tunnel through underground chases linked to the RTST Service Building. These utilities will also be extended into the RTBT Stub. The RTST Tunnel process drain will be connected to the existing process drain in the RTBT Tunnel so it can be intercepted at the existing process waste diversion tanks located in Building 8918. It is anticipated that no utilities will be extended from the existing RTBT Tunnel into the RTST Tunnel.

8.2.1.4 Key Features and Requirements

Radiological Shielding

During normal operation, the RTST Tunnel will be exposed to elevated radiological levels. The RTST Tunnel will be shielded with a combination of concrete and earth providing a minimum total shielding dimension of 18 ft, 6 in. measured from the interior tunnel surfaces to exterior grade. Concrete shielding labyrinths will be installed at controlled access/egress locations.

Structural Requirements

The tunnel foundation and floor stability are critical for the alignment and operation of the proton beam. Geotechnical and structural design that limits settlement and vibration will be a critical consideration.

Materials Handling

A 12.5-ton overhead crane will be required throughout the entire RTST Tunnel. This crane will also be extended into the RTBT Stub. The RTST Access Tunnel will not include an overhead crane.

8.2.1.5 Life Safety/Code

Primary Occupancy Type

The primary occupancy type for the RTST Tunnel is Group F-2, Low Hazard Factory Industrial, according to the 2015 International Building Code (IBC), and Special–Purpose Industrial, according to National Fire Protection Association (NFPA) 101, 2018 edition.

Accessory Occupancies

The RTST Tunnel will not have any accessory occupancies.

Fire Protection Systems

The RTST Tunnel will be protected throughout by an automatic fire sprinkler system designed to protect an Ordinary Hazard–Group 2 occupancy in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems.* The RTST Tunnel will also be equipped with auxiliary 1.5-in. hose outlets fed from the sprinkler mains.

Portable fire extinguishers will be provided in the tunnel in accordance with the IBC and NFPA 10, *Standard for Portable Fire Extinguishers*.

The RTST Tunnel will be equipped with an addressable fire detection/alarm system consisting of the following:

- Manual fire alarm pull stations at all building exits
- Very Early Smoke Detection Apparatus (VESDA) system throughout the tunnel
- Duct smoke detectors on the supply and return sides of all AHUs having a design capacity greater than 2,000 cfm
- Audible/visual notification appliances installed through the building

All fire alarm, supervisory alarm, and trouble signals will be automatically transmitted to the ORNL Fire Department via the LSS fiber optics network.

All new fire alarm system equipment will be manufactured by Edwards Systems Technology to be compatible with the existing site-wide campus system.

The fire detection/alarm system will be designed and installed in accordance with the IBC and NFPA 72, *National Fire Alarm Code*.

Maximum Floor Area and Stories

The RTST Tunnel will be a single-level, underground structure approximately 500 ft in length and having an area of approximately 12,800 SF. The proposed area for the tunnel is within the limit established in IBC Section 506.

Travel Distances

The maximum travel distance within the RTST Tunnel will not exceed 400 ft as required by IBC Section 1016.2 and NFPA 101, Section 40.2.6.1. The maximum common path of travel distance will not exceed 100 ft as required by IBC Section 1014.3 and NFPA 101, Section 40.2.5.1. The maximum dead-end corridor will not exceed 50 ft as required by IBC Section 1018.4 and NFPA 101, Section 40.6.4.

Construction Type

The RTST Tunnel will be of Type IIB construction in accordance with IBC Section 602, except where modified in the Special Code Consideration section below.

Wall/Floor Ratings

The walls, floor, and roof of the RTST Tunnel will be of noncombustible construction. Fire resistance ratings are not required for buildings of Type IIB construction.

Special Code Considerations

Underground Building: If any portion of the RTST Tunnel is located more than 30 ft below the level of exit discharge, the provisions of the IBC, Sections 405.2 through 405.10, shall apply. These requirements include the provision of a smoke control system and smokeproof enclosures for the exit stairways.

8.2.1.6 Civil/Site Development

The RTST Tunnel will be constructed in the open cut excavation as described under Site Civil Works Section 8.1.1.2. The open cut for the RTST will extend from the proposed target excavation to the end of the RTBT Stub installed previously. The open cut is proposed to elevation 1072.75 ft with the bottom 2 ft vertically cut and the remainder of the cut sloped at 2 horizontals to 1 vertical back to existing grades. Typical section 1 on Drawing 5.1.29 shows a typical cut section for the RTST Tunnel construction. The contractor must incorporate all the protective measures required by OSHA 29 CFR Part 1926, Subpart P, for any worker access in the open cut during construction.

Infiltration into the existing structure will need to be controlled during construction. As part of the open excavation, a 6-in. diameter perforated foundation drain will be required to handle stormwater during construction and post-construction. The foundation drain will be extended to a new storm drain line extending from the existing storm drainage system off the southeast corner of the existing target (see Drawing 5.1.22 showing the storm drain extension to the south). The bedding material under the proposed stub will consist of 8 in. of compacted washed stone and 4 in. of roadway base stone. The washed stone provides a leveling base that is free-draining, allowing movement of any water during or after construction to the proposed foundation system. The roadway base stone is a well-graded material that provides a good working surface for equipment and personnel during construction. During construction, special care by the contractor to direct stormwater to the proposed drainage system will be critical to avoid any complications from stormwater runoff entering the existing base mat for the RTBT Stub area.

After completion of the structure, the RTST Tunnel will be backfilled to the finished grades on Drawing 5.1.19 and according to the typical section 2 on Drawing 5.1.29. An embankment liner will be installed according to the limits shown on Drawing 5.1.22 to prevent water from infiltrating to the tunnel area. The tunnel embankment liner is intended to act as an additional barrier to prevent site surface water from infiltrating into that area around the tunnels. The Typical Construction Fill Section on Drawing 5.1.29 shows the typical location of the tunnel embankment liner, which resides 1.5 ft’ below the top of the tunnel embankment. The upper layer of liner includes a drainage layer that discharges to the embankment slopes via a header and discharge pipe system.

The foundation drainage consists of small-diameter perforated piping below the floor elevations of the below-grade facilities installed during construction. See Section 2 on Drawing 5.1.29 for a typical section and Drawing 5.1.22 for the plan view layout of the foundation drainage pipes. The foundation drains are discharged by gravity flow via solid pipes to manholes designated as sampling points (not included in conceptual plans). The sampling points should be installed to test for radioactivity due to activation prior to discharge into the on-site piping system. From the sampling manholes, the discharge will be connected via piping to the on-site stormwater collection system that discharges into the site detention ponds.

8.2.1.7 Architecture

Exterior Wall

The RTST Tunnel will be constructed of reinforced concrete with waterproofing. The waterproofing membrane will be a hot-fluid-applied, two-layer 215 mil, polyester fabric–reinforced membrane, on all four sides. Drainage tile will be placed along the perimeter of the tunnel structure and gravity drained to the site stormwater system. Exterior walls below grade will be required to achieve R-7.5 ci. (continuous insulation) as according to 2012 International Energy Conservation Code.

Exterior Doors

Main exterior access doors will be 16-gauge, insulated-core, painted hollow metal doors with fully welded, 14-gauge metal frames and a U value of 0.61. An insulated-core overhead 14 ft, 0 in. by 4 ft, 0 in. door will be provided to bring large magnets into the tunnel. All exterior doors will be provided with proximity card reader hardware.

Thermal and Moisture Protection

Flashing and sheet metal will be provided as a positive water stop around all openings (e.g., head, jamb, and sill) in walls, such as windows, doors, and louvers.

Waterproofing will be provided at walls, floors, and other building elements that are subject to hydrostatic pressure, are liable to be immersed in water, or are below the water table. The waterproofing membrane will be a hot-fluid-applied, two-layer 215 mil, polyester fabric–reinforced membrane.

Exterior sealants will be a two-part composition with a 50% movement capacity.

Glazing

No glazing is anticipated for the RTST Tunnel.

Roof Construction

As stated previously, a waterproofing membrane will be provided around the tunnel with additional R7.5 ci to conform with energy code requirements.

Interior construction

Walls

Interior partitions are not anticipated for the RTST Tunnel.

Wall Finishes

All finish materials for walls, ceilings, and floors, will have a Class A rating, with a flame spread ≤ 25, a fuel contribution of ≤ 25, and smoke development of ≤ 450.

Typical interior concrete will receive a paint finish consisting of one primer coat and two finish coats. Epoxy paint will be applied to all wall and ceiling surfaces of the tunnel. All paints, including top coats and primers, will comply with the 2016 *Guiding Principles for Sustainable Federal Buildings*.

Floor Finishes

Flooring in the tunnel and support areas will receive epoxy coating over the new concrete. No vinyl wall base will be used in these areas.

Ceiling Finishes

The structure will be left exposed in the tunnel spaces. All exposed structure will receive epoxy paint finish consisting of one primer coat and two finish coats.

Interior Doors

All interior doors will be shop-primed, field-painted, 16-gauge hollow metal doors with 14-gauge fully welded metal frames.

Furnishings

Laboratory Casework

No requirements

Vertical circulation

Stairs

A 2-story enclosed egress stair will be located adjacent to the Target Building. The stair will be composed of a reinforced concrete structure with metal handrails mounted to the stair enclosure walls. Rubber treads, nosings, and landings will serve as the walking surface in the stair. Stairs will be designed in accordance with NFPA 100, Chapter 7. The stair enclosure will meet requirements for a 1-h fire barrier, including door(s).

Elevators

Not applicable

Specialty Equipment

Crane

A 12.5 ton overhead beam crane with hoists and wire ropes will be provided to facilitate the moving of large equipment within the RTST Tunnel and Access Tunnel.

8.2.1.8 Structure

Applicable Codes and Standards

See Sheets x–xii for complete list of applicable codes and standards

Design Loading

Superimposed Floor Loads

- Live loads:
  - Uniform loads: 1000 lb per square foot (psf)
  - Forklift loads: 10 ton

Superimposed Roof Loads

- Dead load: earth shielding weight
- Live load: 12.5-ton beam crane

Seismic Loading

- Risk category IV
- Importance factor Ie = 1.5

Crane Requirement

- Refer to the Crane section of Section 8.2.1.7 for information.

Building Structural System

Foundation System

The RTST Tunnel is a buried concrete structure 17 ft wide by 13 ft tall. Attached to the RTST Tunnel will be a truck access tunnel that is a buried concrete structure 14 ft wide by 12 ft tall. Typically, a minimum dimension of 18 ft, 6 in. measured from the inside face of the tunnel walls to the exterior grade is required in all directions to satisfy shielding requirements. It is anticipated that the tunnels will be supported on a 12 in. compacted gravel mat over undisturbed soils. It will be supported on 9 3/4-in. diameter micropile foundations in the vicinity of Target Building II to avoid post-construction settlement. The settlement criterion for the RTST Tunnel is 1 mm over 10 m.

Crane Support

Steel framing with embedded steel plate to the tunnel ceiling slab will be provided to support the crane runway.

Geotechnical Analysis

A review of historical geotechnical and geophysical surveys was performed that included the original campus development and additional structures. A detailed geotechnical exploration was performed by Law Engineering dated June 30, 2000, addressing the original development of the campus (Law 2000). The proposed tunnel structure should be supported on a combination of shallow foundations and micropiles. The stiff or better upper crust of residual soil should be sufficient to support the majority of the tunnel structure. Based on the current subsurface data on the site, we anticipate as much as 3,000 psf allowable bearing pressure will be available. However, at the transition from the soil-bearing support of the tunnel to the attachment to the target structure, special attention will be needed to prevent differential settlement between the tunnel and target structure. The tunnel should either attach to the target using a lintel, or bear on deep foundations such as micropiles. Additional micropiles may be installed beyond the area of excavation for the target structure footprint to support the tunnel. The micropiles should be capable of supporting 200 tons/pile when designed using a 9 ¾ in. steel casing. The axial capacity should be confirmed using a pile load test. If possible, the tunnel should be designed to be stiff enough to span between these sets of micropiles. Additional options may include using friction piles after grading of the area around the STS is completed, to help transition from the target to the shallow foundation supported section.

A review of geophysical data and shear wave velocities from the Law report (Law 2000) indicates that the tunnel structure would be located in a seismic site classification C as defined in IBC 2015 and ASCE 7. This is confirmed by the average shear wave velocities for multiple soil profiles tested during the original development.

A supplemental geotechnical report would be advisable once the final tunnel location and footprint have been determined. The density and pattern of the soil test borings should be selected to optimize the quality of geotechnical data. Additional geophysical testing is not anticipated for the design of the structure.

Vibration/Acoustics

The tunnel will support the ongoing maintenance of the beam components. In the interest of worker communications and comfort, the background noise design level should not exceed Noise Criteria (NC) 45 of ANSI/ASA S12.2-2008.[1] The NC curves are based on the average frequency response of human hearing. Calculated or measured octave band sound pressure levels can then be compared with those curves, allowing for the data as a function of frequency to be expressed as a single number. The NC level is determined by the highest of these curves that is reached by any of the eight octave band levels between 63 and 8000 Hz.

8.2.1.9 Mechanical

Air Handling/Ventilation

The AHU serving the RTST Tunnel will be located on the roof of the RTST Service Building. Supply air from the unit will be ducted underground into the tunnel, incorporating an ‘S’ bend, where it will cross over the crane in an elevated section of the tunnel and be distributed via ductwork along the west wall of the tunnel to provide cooling and ventilation. Return air will be gathered at a central point along the east wall of the tunnel and will be ducted back underground to the AHU in similar fashion.

The AHU will be sized for 10 air changes per hour (ACH), designed as heating-cooling, single zone, constant-air-volume (CAV) type to provide from minimum outside air supply to 100% for emergency purge mode. The unit will operate 24 h/day, 365 days/year. Supply fans and return fans will be plenum type, arranged in a multi-fan array. AHU supply air temperature will be modulated as required to suit the tunnel load.

Exhaust

As part of the heating, ventilation, and air-conditioning (HVAC) system, a grade-mounted exhaust fan will be provided to exhaust/ventilate the tunnel. The exhaust fan will connect to the return duct of the HVAC system, and control dampers will be provided to direct the air return to the RTST Tunnel AHU and/or direct the tunnel air flow to the exhaust fan. A control damper in the HVAC system will also allow the RTST Tunnel AHU to go to 100% outside air operation.

Emergency exhaust for the RTST Tunnel will be provided via a pair of new exhaust fans located at the Central Exhaust Facility II (CEF II). The tunnel emergency exhaust system will be ducted from an opening in the west side of the tunnel underground to the CEF II fans. The system will be manually activated if emergency ventilation of the tunnel is required. The RTST makeup AHU will be

[1] American National Standards Institute *Criteria for Evaluating Room Noise,* ANSI /ASA S12.2-2008. Note that this more recent standard extends the curves down to the 16 Hz band.

interconnected with the emergency exhaust fans and controlled to provide 100% outside air when the emergency exhaust fan is activated.

Technical Cooling Water

The magnet cooling water for the RTST Tunnel magnets will be supplied from the new RTST Service Building. Magnet cooling water supply and return pipe headers will be routed along the east wall of the tunnel. Valved connections will be provided at regular intervals for extension to the magnets in the tunnel. Fifty to sixty magnets are anticipated.

Controls

The RTST Tunnel shall be provided with controls through the EPICS. The building will be connected to an expansion of the existing EPICS. Instrumentation and wiring shall be connected to a new EPICS PLC in the building, and controls interfaces for the building will be provided. Programming and connection of the PLC to EPICS shall be completed and the control system commissioned to ensure proper operation.

Electric/pneumatic actuation will be used for all control valves and dampers for which instrument air is required. All control systems will be on UPS and emergency power. System software and firmware will provide the following functions:

- Control sequences to support the operation of the technical equipment
- Proportional, integral, and derivative (PID) control to allow faster, closer control to system set points
- Adaptive tuning to adjust PID loop constants to ensure that control system response remains accurate and reliable over a wide range of dynamic operating conditions
- Monitoring to read the value of measured variables; to read control loop set points, to monitor control signals to actuators; and to indicate status of equipment, alarms and overrides
- Energy management, including optimum start/stop, variable ACH rates in laboratories, duty cycling, supply air temperature reset, supply air static pressure reset, demand limiting, time totalization, and so on
- Data management, including continuous database updating, alarm reporting, trend logging, and report generation
- System programming to add, delete, or change points, set points, schedules, control algorithms, report formats, and so on
- System software to allow building operators to graphically monitor and control building operations and provide the functions listed. Graphics will include site plans, overall building plans, floor plans, and individual system graphics.

Equipment

Table 8.7 provides a listing of mechanical equipment servicing the RTST Tunnel and RTST Service Building.

Table 8.7. RTST Tunnel and Service Building mechanical equipment.

Use	Equipment	Size	Qty	Em pwr	Redund	Location	Remarks
Tunnel conditioning	CAV AHU	25,000 cfm	1	Y	–	On grade	
Tunnel smoke exhaust	Exhaust fan	25,000 cfm	1	Y	–	On grade	
Service Bldg. AHU	CAV packaged AHU	45,000 cfm	1	N	–	Service Bldg. roof	
Pump room ventilation	Exhaust fan	2,000 cfm	1	N	–	Service pump room	
Pump room ventilation	100% outside air intake	2,000 cfm	1	N	–	Service pump room	
Power supplies deionized (DI) water	Tech DI cooling skid	320 gpm @ 185 ft	1	N	–	Service pump room	Pumps, polisher, heat exchanger (HX)
Tunnel magnet DI water	Tech DI cooling skid	600 gpm @ 250 ft	1	N	–	Service pump room	Pumps, polisher, HX
Service Bldg. heating	Electric unit heaters	15 kw	4	N	–	Service pump room	

General

System Design Criteria

Outside Design Temperatures

- Summer: 92.8°F DB (dry bulb), 73.8°F MCWB (mean coincident wet bulb) (0.4% ASHRAE)
- Winter: 17.1°F (99.6% ASHRAE)
- Interior design donditions
- Conditioned spaces 75°F ± 4°F, 60% or lower RH (relative humidity)
- Ventilated spaces 60–100°F, no humidity control

Materials

Duct Distribution Systems

- Supply ductwork construction will be based on SMACNA (Sheet Metal and Air Conditioning Contractors National Association) 4 in. pressure class. All ductwork seams and joints shall be sealed, regardless of pressure rating.

- Return and general exhaust ductwork construction shall be based on SMACNA 2 in. pressure class.

- Above grade/interior air distribution ductwork will be G90 galvanized sheet metal.

- Underground supply ductwork and underground return ductwork shall be Schedule (Sch) 10 mild steel piping with external coal tar waterproofing or HDPE.

- Exterior (roof- or grade-mounted) supply or return ductwork shall be solid double-wall ductwork with a minimum of 2 in. thick insulation or single-wall duct with 2 in. duct board, vapor barrier, and aluminum jacket.

- Rectangular and round ductwork shall be fabricated in accordance with SMACNA standards. Spiral-wound ductwork shall be a prefabricated system with factory certifications. Spiral-wound ductwork shall not be used for laboratory exhaust systems or other systems that may be exposed to water intrusion.

- Lined ductwork shall not be used in any location.

- Ductwork shall be sized as shown in Table 8.9.

- Smoke detection will be provided in accordance with NFPA 90A and IMC (International Mechanical Code) requirements.

Table 8.8. RTST Tunnel ductwork sizing.

	Risers	Submains	Branches	Air distribution device neck velocity (ft/min)
Max P.D.	0.1 in./100 ft	0.08 in./100 ft	0.08 in./100 ft	450 ft/min

Piping

Technical Cooling Water (Deionized [DI] Water for Magnet Cooling)

- For sizes 2 in. and smaller, ASTM 312 Sch 10S, seamless, 304L stainless steel, plain ends (Victaulic Vic-Press system or butt-welded, as specified)

- For sizes 2½ in. and larger: ASTM 312 or ASTM 358, Sch 10 electric resistance–welded (ERW) 304L stainless steel, class 4. (Victaulic Vic-Groove system or butt-welded, as specified)

- For sizes ½ to ¾ in. outside diameter (OD) tubing, ANSI type 304L stainless steel, ASTM A213, grade TP304L, seamless, annealed, minimum 0.065 in. wall thickness

- Vents and drains: For sizes ½ to ¾ in. NPT, ANSI type 304L Sch 40 SST pipe

- Fittings:
  - Welded fittings: ASTM A403, Grade WP-S304L or WP-W304L, elbows: standard 1.5× radius. Full penetration butt weld
  - Welded flanges: ASTM A 182, Grade WP-S304L, raised face weld neck
  - Vic-Press or Vic-Groove 10S system, ASTM-312 304L SST
    - Plain end or grooved ends shall be ASTM A-312 304L SST
    - Vic-press flanges shall be ANSI class 150, 304L SST, Van Stone type, carbon steel raised face slip-on backing flange, Victaulic style 565

    - o Grooved couplings: galvanized coated ductile iron conforming to ASTM A-536, galvanized, stainless bolts, Victaulic style 89.
    - o Threaded outlets shall be ASTM A-312 or ASTM A-276 304L SST
    - o Seals shall be Grade H NBR, temperature range −20 to 210°F
  - Flange gaskets: Garlock Blue-Gard style 3000 gaskets (1/8 in. thick)

- Based on anticipated water temperatures, technical cooling water piping will not be insulated

Mechanical Calculations

Mechanical calculations are provided in Appendix C for both air side and cooling water side.

Sustainable Design Strategies

The following energy conservation measures will be incorporated into the HVAC design:

- Direct digital control (DDC) building automatic system for optimization of major HVAC equipment operation.
- Supply air temperature is to reset to minimize air conditioning of outside air and subsequent reheating of conditioned air.
- Variable-speed drives installed on all variable-air-volume (VAV) AHU supply and return fans to reduce fan horsepower requirements of non-peak conditions.
- Variable-speed drives installed on all pumps to reduce pump horsepower requirements at non-peak conditions.

8.2.1.10 Electrical

Site Power Distribution

The RTST Tunnel, Service Building, and makeup air structure will be considered one building with one electrical power supply servicing these structures.

Four exterior unit substations will be provided to service the buildings:

- Unit Substation RS2-SS1—2500 kVA serving
  - RTST Tunnel and Service Building
  - Make up air structure
- Unit substation RS2-SS2—1000 kVA serving
  - Septum power supplies
- Unit substation RS2-SS3—1000 kVA serving
  - Dipole power supply
- Unit substation RS2-SS4—1000 kVA serving
  - Dipole power supply

Building Power Distribution

The buildings will be provided with 480 Y/277 V secondary services from feeder duct banks from the outdoor substations to the RTST Electrical Room.

The RTST Tunnel makeup air structure will be provided with 480 Y/277 V secondary service from a 400A feeder duct bank from outdoor substation RS2-SS1 to a panelboard in the mechanical room.

4000 A, 480 Y/277 V low-voltage switchgear fed from RS2-SS1 in the RTST Electrical Service Room will distribute power to CF loads and instrument loads. The instrument loads will include magnet power supplies in the tunnel.

Service to a 12.5-ton crane will be provided.

All distribution and branch circuit panelboards will be located in the Service Building and makeup air structure with branch circuits extended to the tunnel. Empty duct banks will be provided between the service building and the tunnel. Cable trays, provided under another contract, will be located in the tunnel for extension of power conductors both east and west to the magnet power supplies, including west into the shelled RTBT Stub. Chases between are approximated at (56) 6-in. and (128) 3-in. conduits for transfer of power and controls to the tunnel. The northern chase D will extend to the north and swing in halfway up the north tunnel to alleviate cable congestion. These interconnecting conduits will be physically configured horizontally in an “S” shape to prevent tunnel beam exposure to the service building occupants.

Secondary Distribution

Building secondary distribution will generally be 480 V, 3-phase, 4-wire, plus ground. This will provide service to CF lighting, receptacles, and HVAC loads as well as building instrumentation loads. Further transformation down to 208 Y/120 V, 3-phase, 4-wire, plus ground will be provided for general use receptacles and other low-voltage equipment as necessary.

All conventional buildings use dry type transformers DOE 2016 rated for efficiency, 115° C rise, 220° C insulation class with six 2.5% taps. Consideration will be given to harmonic or K-rated transformers and oversized neutrals to handle the heating effects of the harmonic loading.

Circuit protection will be as follows.

- Where 480-V distribution is provided, the exterior unit substation secondary will be of low-voltage switchgear UL 1558 construction with electrically operated draw-out power circuit breakers with solid state adjustable trips.
- Generally molded case circuit breakers. Solid state adjustable trip units will be provided above 250 A.
- Bolt-in type molded case circuit breakers for branch circuit panelboards.
- 100% rated for service entrance main circuit breakers, 80% rated otherwise.

Devices will be fully rated. Series ratings of protective devices will not be acceptable.

Two levels of ground fault protective devices will be provided at the main and feeder breakers at service switchgear assemblies.

Every 100 ft, 60 A, 208 V welding receptacles will be provided in the tunnels, including the RTBT stub.

Emergency Power Supply System

EPSS Power Generation Plant

The RTST Tunnel, RTST Service Building, and makeup air structure will be provided with building and instrument standby power service from an exterior 400 kW/500 kVA, 480 Y/277 V diesel engine-generator RS2-EG1. It will provide emergency power for life safety systems, including egress lighting, and critical instrumentation and HVAC systems loads.

The exterior diesel standby engine-generator will be provided in an exterior, weatherproof, sound-attenuated, reach-in enclosure with 24-hour sub-base fuel tanks. The generator will be provided with a quick-connect feature to be used for load bank testing or portable generator backup if the primary unit is down for maintenance.

EPSS Power Distribution

The EPSS secondary distribution system will be separated into the following branches as required by code:

- Generator: This branch provides alternate source power from the generator set main circuits breaker(s) and associated distribution to the line side of each automatic transfer switch (ATS).

- Emergency (National Electrical Code [NEC] Article 700): This branch provides continuous (normal or generator) source power for the following equipment essential for safety to human life:
  - Interior building means of egress lighting and illuminated exit signs
  - Exterior building means of egress immediately adjacent to exit discharge doorways
  - Fire detection and alarm systems
  - Public address communication systems (when used for issuing emergency instructions)
  - Generator set location, task illumination, battery charger, emergency battery-powered lighting unit(s), and selected receptacles
  - Fire protection systems
  - Experimental processes where interruption would produce serious life safety health hazards, and similar functions

- Combined legally required and optional standby branch, designate as “optional branch” (NEC Article 701 and 702): This branch provides continuous (normal or generator) source power for the following equipment that, when stopped during any interruption of the normal electrical supply, could cause hazards or hamper rescue or firefighting operations; or (optional branch) to protect facilities or property where life safety is not dependent on system performance:
  - Control and alarm systems of major apparatus
  - Experimental processes where any power outage could cause serious interruption of the process or damage to the equipment
  - Ventilation and smoke removal systems
  - Access control systems
  - Telecommunication room lighting, equipment, and data processing systems
  - Electric and mechanical room lighting and selected receptacles
  - Mechanical equipment including boilers, condensate return pumps, hot water heating, and glycol circulating pumps
  - Plumbing equipment, including sewage ejectors and pumps

Generator distribution feeders will extend from the EPSS power generation plant to 480 Y/277 V, 4-pole isolation-bypass transfer ATSs with associated distribution panelboards located in the RTST Service Building Electrical Room. The following transfer switches are anticipated:

- 260 A: Life safety (sized large to meet required withstand ratings)
- 600 A: Optional branch—RTST Service Building and RTST Tunnel

An associated duct bank will be required for the makeup air structure for life safety systems.

Power Quality Systems

Uninterruptible Power Supply Systems

The tunnel UPS loads will be fed from the RTST Service Building's IT and science UPS system.

Electric Metering Systems

Electrical metering systems, according to ORNL standards, used to monitor and alarm, will be provided in the RTST Service Building for service to the RTST tunnel.

Grounding Systems

Ground Grid

All tunnel grounding systems must be bonded to a common earth ground in compliance with the NEC. Each building will be provided with a #4/0 direct buried copper ring encircling the perimeter of the building, which will provide a convenient means of connecting all metallic systems and equipment into a single equipotential grid that has a low resistance to ground.

Tunnel Grounding

Building steel, foundation rebar (Ufer ground), and metallic water supply piping will be bonded to the ground grid.

Electrical Power System Grounding

Separate green grounding conductors will be provided with all feeders and branch circuits to provide an intended grounding of the neutrals of the electrical power systems. Each will be bonded to the ground grid with grounding electrode conductors from the distribution system neutral source.

Interconnected bus bars in electrical rooms will collect electrical and electrical equipment grounding conductors to tie the ground ring at the electrical service entrance room.

Electrical Equipment Grounding

All non-current carrying metal parts of electrical equipment enclosures, raceways, boxes, cabinets, housings, frames of motors, luminaires, and so on, will be bonded and connected to electrical room ground buses where the associated system neutral is grounded. This allows for a safe ground path in an electrical fault condition.

Instrumentation Signal Reference Grounding

The bonding of instruments and instrument cabling pathways, as a low impedance signal reference system to a common equipment area bus and then to the ground grid, will be provided to minimize noise-induced voltages and reduce equipment malfunctions.

Lighting Systems

Interior Lighting

Tunnel lighting will be LED radiation-resistant, similar to Lithonia Type CLX.

LED interior lighting will be provided in compliance with Illuminating Engineering Society of North America (IESNA) lighting standards and ASHRAE 90.1 energy budgets.

Lighting Controls

The tunnel lighting will be provided 24/7 with breaker switching.

Facilities and Operations Building Systems

The Building Automation System (BAS) to monitor HVAC building systems will be site interconnected to SNS campus systems as described in Section 8.1.3 of this report, Site Utilities.

Fire Alarm System

The fire alarm system will be a microprocessor-based detection and notification control system installed and acceptance tested in compliance with NFPA 72, *National Fire Alarm Code*. The building system will include multiplex wiring techniques, a central processing unit (fire alarm control unit), annunciator units, and peripheral detection and alarm devices.

The tunnel system will

- Include smoke, heat, and smoke aspiration detection devices to suit environmental conditions
- Include audible horns and visual strobe notification devices
- Monitor building fire suppression systems and override HVAC functions in an alarm condition for fire and smoke containment
- Report fire, supervisory, and trouble alarms to the ORNL Fire Department in Building 2500 and LSS office in Building 4512 over a fiber optic network

Wiring will be supervised Class B installed in conduit. Multimode fiber optic cabling will be extended in conduit between the fire alarm control unit and the telecommunication room in each building.

The system will be Edwards/EST Fireworks manufacturer/series according to ORNL requirements to match the existing campus systems.

Public Address System

A public address system will be provided with amplification as an extension to the campus-wide Valcom mass notification system.

Wiring will be installed in conduit.

Access Control System

The building will be provided with an access control system with central equipment located in the main telecommunications room.

Alarm and supervisory conditions will be reported to the ORNL campus security monitoring location over a fiber optic network.

Components will match existing ORNL equipment for system compatibility.

Telecommunication Systems

Tunnel telecommunications systems will be extended to the Service Building.

ORNL F&O Building Systems Distribution

The following building systems/system owners will be interconnected with cables and raceways by SNS CF. The system owners will perform final tie-ins.

- Public address/F&O Instrumentation and Controls
- Fire alarm (FIREWORKS Network)/F&O Laboratory Protection
- Access control/F&O Laboratory Protection
- BAS/(F&O Facilities Management [CLO II only—Siemens])
- Power monitoring (ION-Schneider)/F&O Electrical Utilities (including central IT UPS systems monitoring)

Instrument and Control Systems

ORNL STS will provide building instrumentation and control systems cabling for interconnection of the following systems:

- Personnel Protection Systems (PPS)
- MPS
- ATS
- TPS (two conduits)
- EPICS

Pathway Systems

Ladder-type cable trays will be provided to support telecommunications and instruments and control systems cabling requirements with proper wire dropout devices, conduit sleeves, firestopping, grounding, and wire management components.

Cabling from wall box–type IT jacks will be in bushed conduits extended and grounded to the local cable tray system.

8.2.1.11 Plumbing

Drainage/Waste

Foundation Drainage

A perimeter foundation drainage system will be provided around the exterior of the tunnel. Groundwater collected by the foundation drainage system will be drained by gravity into the site storm sewer. A sampling manhole will be provided to allow for monitoring of the storm sewer flow for radioactivity.

Tunnel Interior Drainage System

The interior of the tunnel will be provided with a concrete trench along the west wall to collect interior water from leakage or condensation. This trench will serve as the collection point for pumping to the process waste system with portable pumps (as described below). Any water collected will be sampled and then manually pumped to a process waste discharge header.

Process Waste

A process waste header will be provided along the length of the tunnel routed to the existing process waste system in the RTBT. The 2-in., Sch 10 304 SS process waste header will be routed on the west wall of the tunnel and process waste connections will be provided on 100-ft centers along the length of the tunnel to allow for pumping of any process waste that might be required. Portable pumps will be used for this purpose. The header will connect to the existing process waste header in the RTBT Tunnel. Header will be installed with a positive slope so that it drains when not in use.

Storm Drainage

The RTST Tunnel is a below-grade structure that does not require exterior storm drainage (other than foundation drainage). See Section 1.2.7 Architecture – Thermal and moisture protection

Compressed Air

CA will be distributed throughout the RTST Tunnel along the west wall. Compressed air outlets on 100-ft centers will be provided. CA will be fed by the site CA system routed from the RTST Service Building. CA will enter the RTST Tunnel through the east wall and pass above the crane to the west wall.

System Design Criteria

Compressed Air

- Design CA pressure on incoming service—105 psi.
- Dew point of –40°F

Materials

Process Waste System

Process waste header: Sch 10 type 304 SS with pressfit couplings

Compressed Air System.

- Type K copper with brazed joints

8.2.1.12 Fire Protection

Sprinkler

The RTST Tunnel will be fully sprinkled, with exposed sprinkler piping feeding upright sprinklers. The sprinkler feed will enter the tunnel from the RTST Service Building, where a double check backflow preventer will be provided. The tunnel will be a single sprinkler zone, with a control valve located at in the RTST Service Building. The control valve will be provided with a tamper switch and a flow switch connected to the fire alarm system.

Standpipe

Interior 1½-in. hose connections fed from the fire sprinkler system will also be provided in the RTST Tunnel.

System Design Criteria

Fire sprinkler systems for the RTST Tunnel will be hydraulically designed to provide water densities that meet the requirements for Ordinary Hazard–Group 2 protection throughout the facilities.

The velocity shall not exceed 20 fps.

All calculations will assume a minimum of 10 psi deterioration in static and residual pressures in the hydrant flow test results.

The 1½-in. hose connections shall be provided so that all areas of the tunnels can be reached with 100 ft of hose.

Materials

- Pipe and fittings installed underground shall be Class 52 ductile iron cement lined with mechanical joints with a working pressure rating of 350 psig.

- Sprinkler piping installed above ground and sized 2 in. and smaller and all standpipe piping shall be Sch 40 black steel with threaded joints and fittings.

- Sprinkler piping installed above ground and sized 2½ in. and larger shall be Sch 40 black steel with roll or cut groove type connections and fittings. Pressure rating shall be 175 psig minimum.

- Fittings for grooved end steel pipe shall be cast of ductile iron conforming to ASTM A-536, malleable iron conforming to ASTM A-47, or forged steel conforming to ASTM A-234 (A-106, Gr. B), with grooved or shouldered ends for direct connection into grooved piping systems with steel pipe. They shall be UL-listed and FM-approved, rated for a minimum 300 psi maximum working pressure (MWP).

8.2.2 RTST Service Building

8.2.2.1 Programming

Building Function

The RTST Service Building will house utility systems that support the RTST Tunnel and proton beamline that extends from the existing RTBT Tunnel to Target Building II. The primary systems include magnet power supplies, magnet and power supply cooling systems, controls, diagnostics, and communication systems. The RTST Service Building also houses electrical infrastructure equipment associated with these systems. Access to the RTST Service Building will be limited to STS technical and facility operations staff.

Program Summary

The RTST Service Building includes 7,380 nsf and has an estimated planning efficiency factor of 88%. This factor is based on preliminary test-fit planning for the RTST Service Building. The estimated gross area of the RTST Service Building is 8,428 gsf. Table 8.9 summarizes the RTST Service Building space program requirements. Detailed room data sheets and test-fit plans are included in Appendix B of the STS CF Conceptual Design Report.

Table 8.9. RTST Service Building space program summary.

No.	Rooms	Qty.	NSF	Total NSF
5.2.2.1	Power Supply Room	1	3,050	3,050
5.2.2.2	Water Pump Room	1	2,040	2,040
5.2.2.3	Communications Room	1	330	330
5.2.2.4	Electrical Room	1	1,800	1,800
5.2.2.5	UPS Room	1	160	160
Total nsf				**7,380**
Total gsf				**8,428**
Total efficiency				**88%**

8.2.2.2 Site Planning

Location and Floor Elevations

The RTST Service Building will be located east of the RTST Tunnel and adjacent to the service courtyard between the FTS and STS facilities. The RTST Service Building is located near the center of the RTST Tunnel to minimize the length of the utility distribution runs within the tunnel. The RTST Service Building floor will be located at elevation 1074 ft. Figure 8.2 highlights the RTST Service Building within the overall STS Site Plan.

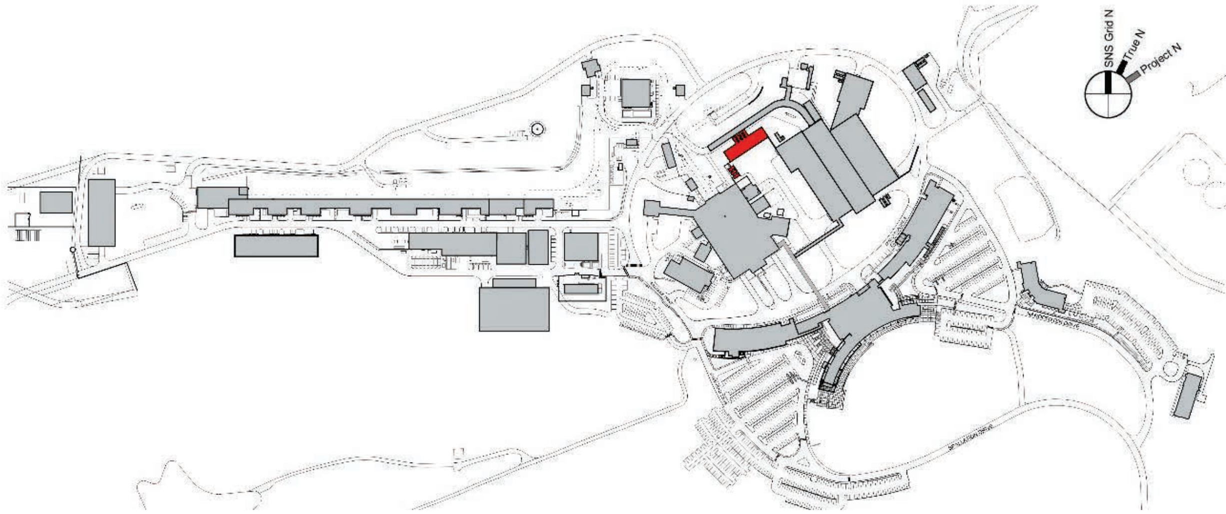


Figure 8.2. RTST Service Building location within the STS Site Plan.

Truck Access

Tractor-trailer truck access to the RTST Service Building is not required. Smaller 30 ft box trucks will approach the building from the service courtyard between the FTS and STS facilities. A loading dock is not required. Forklifts will be used to convey materials and equipment between the building and trucks through overhead service doors.

Pedestrian Access

Pedestrian access to the RTST Service Building will be available from the service courtyard located between the FTS and STS facilities. Pedestrian access to the RTST Service Building will not be restricted during beamline operation.

8.2.2.3 Building Planning

Building Organization and Floor Planning

The RTST Service Building will be a single-story utilitarian structure with a linear organization. The west side of the building will be entirely below grade and will be used to connect the utility chases that link the RTST Service Building and RTST Tunnel. The west wall of the building will be extended vertically above the roof elevation to hold back the grade associated with earth shielding above the RTST Tunnel. Air-handling systems serving the RTST Service Building and RTST Tunnel will be located on the roof. The east side of the building will be above grade with all access and egress doors located on this side of the building. The north and south sides of the building will also be below grade.

8.2.2.4 Key Features and Requirements

Radiological Shielding

The RTST Service Building will be shielded from the RTST Tunnel with a combination of concrete and earth fill construction equaling a minimum dimension of 18 ft, 6 in. This shielding will allow access to the RTST Service Building during beamline operation. The RTST Service Building utilities will be connected to the RTST Tunnel through underground chases, some of which may require an offset "S" configuration to prevent radiological "shine" between the RTST Tunnel and RTST Service Building. Four chases, each approximately 2 by 9 ft, are anticipated to be required. The final chase sizes and configurations will be based on detailed utility system design and neutronic calculations.

Roof Top Air Handling System

Two air-handling systems serving the RTST Service Building and Tunnel will be located on the roof of the building. These will be located at the south end of the building on a lower roof level above the Water Pump Room.

Ground Mounted Electrical Equipment

Exterior electrical equipment serving the RTST Service Building will be located adjacent to the east side of the building. This equipment will be located to coordinate with interior electrical equipment planning and intermittent access doors to be located along the east exterior wall of the building.

8.2.2.5 Life Safety/Code

Primary Occupancy Type

The primary occupancy type for the RTST Service Building is Group F-2, Low Hazard Factory Industrial, according to the 2015 IBC and Special-Purpose Industrial according to NFPA 101, 2018 edition.

Accessory Occupancies

The RTST Service Building will not have any accessory occupancies.

Fire Protection Systems

The RTST Service Building will be protected throughout by an automatic fire sprinkler system designed to protect an Ordinary Hazard–Group 2 occupancy in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems.*

Portable fire extinguishers will be provided throughout the building in accordance with the IBC and NFPA 10, *Standard for Portable Fire Extinguishers*.

The RTST Service Building will be equipped with an addressable fire detection/alarm system consisting of the following:

- Manual fire alarm pull stations at all building exits
- Area smoke detection throughout the building
- Duct smoke detectors on the supply and return sides of all AHUs having a design capacity greater than 2,000 cfm
- Audible/visual notification appliances installed throughout the building

All fire alarm, supervisory alarm, and trouble signals will be automatically transmitted to the ORNL Fire Department via the LSS fiber optics network.

All new fire alarm system equipment will be manufactured by Edwards Systems Technology to be compatible with the existing site-wide campus system.

The fire detection/alarm system will be designed and installed in accordance with the IBC and NFPA 72, *National Fire Alarm Code*.

Maximum Floor Area and Stories

The RTST Service Building will be a single-story, 7,658 SF building constructed of Type IIB construction. The proposed height and area for the building are within the limits established in IBC Sections 504 and 506.

Travel Distances

The maximum travel distance within the RTST Service Building will not exceed 400 ft, as required by IBC Section 1016.2 and NFPA 101, Section 40.2.6.1. The maximum common path of travel distance will not exceed 100 ft, as required by IBC Section 1014.3 and NFPA 101, Section 40.2.5.1. The maximum dead-end corridor distance will not exceed 50 ft, as required by IBC Section 1018.4 and NFPA 101, Section 40.6.4.

Construction Type

The RTST Service Building will be of Type IIB construction in accordance with IBC Section 602.

Wall/Floor Ratings

The walls, floor, and roof of the RTST Service Building will be of noncombustible construction. Fire resistance ratings are not required for buildings of Type IIB construction.

Special Code Considerations

There are no special code considerations associated with the RTST Service Building.

8.2.2.6 Civil/Site Development

The construction excavation described under the Site Civil Works section will be performed before construction of the RTST Service Building. The western wall of the Service Building will act as a retaining wall for the RTST Tunnel embankment backfill. The embankment liner will be attached to the western wall, and site grades will surface-drain water to the east away from the proposed RTST wall. Finished grading is shown on Drawing 5.1.19. Vehicular and pedestrian access will be provided to the west from the proposed roadway traveling between the existing target and the STS. Drawing 5.1.22 shows the site drainage concept. Roof drainage will be piped to the proposed storm sewer system. A foundation drainage system will be provided on the eastern, northern, and southern sides of the building to prevent standing water behind the proposed building walls. Sewer, fire and domestic water services to the building are shown on Drawing 5.1.27.

8.2.2.7 Architecture

Building Envelope

Exterior Wall

A striated face, 36-in.-wide insulated-core metal panel system, with a custom color to match the existing context, will be used as a major material component for the envelope of the RTST Building in keeping with the existing texture and materials used on the SNS campus. The metal panel cladding support backup system will consist of hanger rods and metal channel framing supported from the building structure. Metal window sills and wall caps will be used. Continuous through-wall flashing will be provided at the bottoms of all wall cavities, over all wall openings and metal copings. The metal panel wall systems will have an R-13 and R-13ci minimum requirement. Below-grade exterior walls will be constructed of reinforced concrete with a waterproof membrane, below-grade insulation board, and metal channel furring with a painted drywall finish on the interior side. Exterior walls below grade will be required to achieve R-7.5 ci according to the 2012 International Energy Conservation Code.

Exterior Doors

Exterior entrance doors and egress doors will be 16-gauge, insulated core painted hollow metal doors with fully welded 14-gauge frames, and a U value of 0.61. Overhead insulated coiling doors, 8 ft, 0 in. high by 8 ft, 0 in. wide, at the east side of the building will include factory-painted galvanized steel curtains with integral insulation achieving the required minimum R-value of 4.75. All exterior doors will be provided with proximity card reader hardware.

Thermal and Moisture Protection

Flashing and sheet metal will be provided as a positive water stop around all wall openings (e.g., head, jamb, and sill), such as windows, doors, and louvers. All copings and gravel stops will be ES-1 compliant as required by IBC.

Damp-proofing will be provided on all walls, floors, and other building components that are subject to high humidity, dampness, or frequent direct water contact.

Waterproofing will be provided at walls, floors, and other building elements that are subject to hydrostatic pressure, are liable to be immersed in water, or are below the water table. The waterproofing membrane will be a hot-fluid-applied, two-layer 215-mil, polyester fabric–reinforced membrane.

Because of the inherent moisture resistant properties of the insulated metal panel system, an air/vapor barrier will not be required where the system is installed.

Exterior sealants will be nonstaining, with a two-part composition and a 50% movement capacity, and will be compatible with the surfaces on which they are applied.

Insulation combustibility, including wrappings, inside the building skin will be limited to a flame spread of 25 and smoke development of less than 50.

Glazing

The RTST Service Building will not include glazed openings.

Roof Construction

The roofing system will be a 30-year, 80 mil minimum thickness, white thermoplastic (PVC) single-ply sheet with an integral fiberglass mat reinforcement roofing membrane over polyisocyanurate insulation on a sloping roof structure. Tapered insulation saddles will be used to provide drainage to roof drains and at roof equipment locations. All roof construction details and roof penetrations will comply with the guidelines established by the National Roofing Contractors Association (NRCA). Roof traffic pads will be adhered to the membrane along all roof maintenance traffic paths. All roofs with serviceable components beyond roof drains will be surrounded by a 42-in.-high parapet or provided with a fall protection system

Low-slope roofing will have a minimum 3-year aged solar reflectance of 0.55 and a minimum 3-year aged thermal emittance of 0.75 in accordance with the Cool Roof Rating Council Program. Roofing will be Energy Star rated with emissivity of at least 0.9 when tested in accordance with ASTM 408. The roof system shall have a minimum thermal resistance value of R-30.

The roofing system will meet or exceed UL class A fire exposure requirements and comply with FM Class I-90 for wind uplift according to ASTM 1592.

Interior construction

Walls

Interior walls will be constructed of concrete masonry units (CMUs) for durability and will extend to the structural deck above. All fire-rated walls will be constructed in accordance with the IBC code requirements and UL-listed assemblies.

Wall Finishes

All finish materials for walls, ceilings, and floors will have a Class A rating, with a flame spread of ≤25, a fuel contribution of ≤25, and smoke development of ≤450.

Typical interior CMU partitions will receive a paint finish consisting of one primer coat and two finish coats. Epoxy paint will be applied to all lab demising walls.

Floor Finishes

Flooring in the mechanical and support areas will receive concrete sealer over the new concrete. No vinyl wall base will be used in these areas.

Ceiling Finishes

The structure will be left exposed in some support spaces and all mechanical and utility areas. All exposed structures will receive a paint finish consisting of one primer coat and two finish coats.

Interior Doors

All interior doors will be shop-primed, field-painted, 16-gauge hollow metal doors with 14-gauge fully welded metal frames.

Furnishings

Laboratory Casework

Not applicable

Vertical Circulation

Stairs

Not applicable

Elevators

Not applicable

Specialty Equipment

Crane

Not applicable

8.2.2.8 Structure

Applicable Codes and Standards

See Sheets x–xii for complete list of applicable codes and standards

Design Loading

Slab-on-Grade Floor Loads

- Live loads: 500 psf
- Forklift load: 5000 lb

Superimposed Roof Loads

- Roof snow load:
  - Ground snow load: Pg = 10 psf
  - Snow exposure factor: Ce = 1.0
  - Snow importance factor: Is = 1.0

- Minimum roof live load = 20 psf + 20 psf collateral load

Wind Loads

- Risk category II
- Basic wind speed: V = 115 mph
- Exposure category B

Seismic Loading

- Risk category II
- Importance factor: Ie = 1.0

Building Structural System

Slab on Grade

The slab construction is anticipated to consist of an 8-in.-thick reinforced normal weight concrete slab. All construction joints between pours require smooth dowels across the joint. The floor slab will be placed over a vapor barrier, a compacted drainage base course, and a compacted subgrade.

Foundation System

A geotechnical investigation has not been performed. Until a geotechnical investigation and report have been completed, an accurate description of the building's foundation system cannot be provided. The RTST Service Building foundations are anticipated to consist of shallow spread footings bearing on soil with a minimum net allowable bearing capacity of 3,000 psf. Footings shall extend to the frost depth elevation at a minimum. Below-grade walls are anticipated to be constructed with reinforced normal weight concrete. It is anticipated that the north, west, and south below-grade walls will consist of counterfort retaining walls supported on battered micropiles. Water stops will be provided in construction joints to safeguard against water intrusion.

Superstructure

The RTST Service Building is anticipated to be a single-story conventional steel-frame structure. The building will support the exterior wall system with steel girts as required. The roof structural system is anticipated to consist of wide flange framing with roof deck meeting galvanizing G90 requirements.

Lateral System

Resistance to lateral loads resulting from wind and seismic forces on the building is anticipated to be provided by concentrically braced steel frames.

Geotechnical Analysis

A review of historical geotechnical and geophysical surveys was performed that included the original campus development and additional structures. A detailed geotechnical exploration was performed by Law Engineering dated June 30, 2000, addressing the original development of the campus (Law 2000). The proposed RTST should be supported on shallow foundations. The structure will be located at a sufficient distance beyond the STS excavation that additional support with deep foundations should not be necessary. The stiff or better upper crust of residual soil should be sufficient to support the RTST Service Building. Based on the current subsurface data available, as much as 3,000 psf of allowable bearing pressure is expected to be available.

A review of geophysical data and shear wave velocities from the Law report indicates that the RTST structure footprint would be located in a seismic site classification C as defined in IBC 2015 and ASCE 7 (Law 2000). This is confirmed by the average shear wave velocities for multiple soil profiles tested during the original campus development.

A supplemental geotechnical report would be advisable once the final tunnel and RTST location and footprint have been determined. The density and pattern of the soil test borings should be selected to optimize the quality of geotechnical data. Additional geophysical testing is not anticipated for design of the structure.

Vibration/Acoustics

The design will target the following average noise levels. These noise levels do not include noise from owner-furnished equipment or personnel located within these spaces. Actual noise levels may exceed the design noise levels as a result of the actual type of equipment purchased, installation compromises, workmanship, and so on.

- Room type NC
- Computer/server rooms 55
- Mechanical equipment rooms 65
- Electrical equipment rooms 60

8.2.2.9 Mechanical

Air Handling/Ventilation

The support areas of the RTST Service Building will include a utility space to house technical equipment control racks and power supplies, an electrical gear and UPS room, and a pump room housing mechanical equipment. The equipment and electrical spaces will be served by a roof-mounted constant air volume (CAV) AHU. The supply air to these areas will be recirculated to the units. The AHU serving the RTST Service Building will be located on the roof of the building above the pump room, along with the AHU serving the RTST Tunnel.

The AHU will be designed as a 4 cfm per square foot heating-cooling, single-zone, constant-volume type providing from minimum outside air supply to 100% outside air in economizer mode. The unit will operate 24 h/day, 365 days/year. Supply and return fans will be plenum type, arranged in a multi-fan array. AHU supply air temperature will be modulated as required to suit building loads.

Conditioning of the pump room/utility space housing the technical cooling water systems will be accomplished using a heating and ventilation approach. Ventilation will be achieved through the use of a single roof-mounted exhaust fan and associated wall-mounted intake louvers with motorized dampers. Heating for these spaces will be accomplished through the use of an electric unit heater located within the spaces.

Chilled Water

The CHW system for the RTST Service Building will be supplied from the new CUB II. CHW will enter the building from below grade at the utility room and will be routed to the cooling coil in the AHUs. Based on an estimated flow of 450 gpm to this building, the CHW branch line size to this building is expected to be 6 in.

Tower Water

The tower water system for the RTST Service Building will be supplied from the new CUB II. Tower water will enter the building from below grade at the utility room and will be routed to the heat exchangers for the technical cooling water systems. Based on an estimated flow of 700 gpm to this building, the tower water piping supplied to the building from the site distribution system is estimated to be 8 in.

Technical Cooling Water

Technical cooling water systems will be required to support technical equipment to be included in the RTST Service Building, as well as the RTST Tunnel. The technical cooling water system will provide DI water with a resistivity in the range of 1 to 3 megohm/cm, and a slip stream polishing loop. The pumps, heat exchanger (HX), conditioners, sterilizers, and filter components will be located in the pump room. One technical cooling water system will support the power supplies, and a second separate system will provide water to cool the magnets in the tunnel. Both systems will have heat rejected to the tower water system. The power supply cooling loop will be routed through the equipment and electrical rooms of the Service Building and will support a 300 KW load using 320 gpm of cooling tower water. Valved connections will be provided along the length of the loop to connect equipment cooling hose connections. The magnet cooling loop will be routed through the tunnel as described previously and will support a 1300 KW load using 600 gpm of cooling tower water. Pipe sizes for the power supply and magnet cooling loops are estimated at 5 in. and 6 in., respectively, and incoming service is anticipated to be 8 in. based on the flow.

Heating Water

The heating water system for the building will be supplied from the new CUB II. Based on an estimated flow of 150 gpm to this building, the heating water branch line size to this building is expected to be 4 in. The building's heating water distribution system will serve the AHU heating water heating coils.

Controls

The RTST Service Building shall be controlled by a new freestanding PLC processor that is interfaced with an extension of the EPICS. The building will be connected to an expansion of the existing EPICS. Instrumentation and wiring shall be connected to a new PLC in the building, and a controls interface for the building will be provided. Programming and connection of the PLC to EPICS shall be completed and the control system commissioned to ensure proper operation.

Electric actuation will be used for all control valves and dampers so that instrument air is not required. All control systems will be on UPS and emergency power. System software and firmware will provide the following functions:

- Control sequence development to support the operations of the technical equipment.

- PID control to allow faster and closer control to system set points.

- Adaptive tuning to adjust PID loop constants to ensure that control system response remains accurate and reliable over a wide range of dynamic operating conditions.

- Monitoring to read the value of measured variables; to read control loop set points, to monitor control signals to actuators; and to indicate status of equipment, alarms and overrides.

- Energy management, including optimum start/stop, variable ACH rates in laboratories, duty cycling, supply air temperature reset, supply air static pressure reset, demand limiting, time totalization, and so on.

- Data management, including continuous database updating, alarm reporting, trend logging, and report generation.

- System programming to add, delete, or change points, set points, schedules, control algorithms, report formats, and so on.

- System software to allow building operators to graphically monitor and control building operations and provide the functions listed. Graphics will include site plans, overall building plans, floor plans and individual system graphics.

Equipment

Air Handler

General

- All AHUs will be packaged, factory-fabricated and constructed with 4-in.-thick double walls, constructed of galvanized steel.

- Maximum allowable nominal face velocities:
  - Air intake louvers (through free area): 350 ft/min (fpm)
  - Heating water coils: 500 fpm
  - Cooling coils: 400 fpm
  - Filters: 400 fpm

AHU—Modular, Packaged, 4-in. Double-wall Construction Configured as Follows:

- Mixed air plenum
- Intake isolation damper
- Return/exhaust damper
- Relief fans (4- to 6-fan array)
- Variable-frequency drives (VFDs)
- Economizer section
- Merv 8 (30%) prefilter section
- Pipe vestibules
- Hot water preheat coil
- CHW coil
- Hot water reheat coil
- Supply fans (4- to 6-fan array)
- VFDs
- Merv 14 (95%) final filter section
- Supply plenum
- Isolation/smoke damper
- Access sections
- Doors: safety glass windows and quarter turn handles
- Marine light in each access section
- Vibration isolation in accordance with ASHRAE *HVAC Applications—Noise and Vibration Control*

General

System Design Criteria

Outside Design Temperatures

Summer: 92.8°F DB, 73.8°F MCWB (0.4% ASHRAE)

Winter: 17.1°F (99.6% ASHRAE)

Interior Design Conditions

Conditioned spaces	72°F ±2°F, 60% or lower RH
Ventilated spaces	60–100°F, no humidity control

Materials

Duct Distribution Systems

- Supply ductwork construction will be based on SMACNA 4 in. pressure class. All ductwork seams and joints shall be sealed, regardless of pressure rating.
- All supply ductwork shall be insulated with 2-in. foil-faced batts or foil-faced duct board with similar R-value.
- Return and general exhaust ductwork construction shall be based on SMACNA 2 in. pressure class.
- Return air duct shall be insulated with 1½-in. foil-faced batts or duct board.
- Above-grade/interior air distribution ductwork will be G90 galvanized sheet metal.
- Exterior supply or return ductwork shall be solid double-wall ductwork with a minimum 2-in.-thick insulation or single-wall duct with 2-in. duct board, vapor barrier, and aluminum jacket.
- Rectangular and round ductwork shall be fabricated in accordance with SMACNA standards. Spiral-wound ductwork shall be a prefabricated system with factory certifications. Spiral-wound ductwork shall not be used for laboratory exhaust systems or other systems that may be exposed to water intrusion.
- Lined ductwork shall not be used in any location.
- Ductwork shall be sized as shown in Table 8.10.
- Smoke detection will be provided in accordance with NFPA 90A and IMC requirements.

Table 8.10. RTST Service Building ductwork sizing.

	Risers	Submains	Branches	Air distribution device neck velocity (ft/min)
Max P.D.	0.1 in./100 ft	0.08 in./100 ft	0.08 in./100 ft	450 ft/min

Chilled Water/Tower Water

- Interior piping sizes 2 in. and smaller shall be Type L copper with brazed fittings.
- Interior piping 2.5 in. and larger shall be either Type L copper with brazed fittings or Sch 40 steel pipe with either welded and flanged joints or mechanical grooved fittings.
- Underground CHW piping serving the building will be distributed in a pre-insulated, factory-fabricated coated steel piping system or HDPE.
- Underground tower water piping serving the building will be distributed in a factory-fabricated coated piping system or HDPE.
- All piping will be tested at 1.5 times the design system pressure.
- All interior CHW piping shall be insulated with closed-cell elastomeric insulation. Properties shall meet or exceed the minimum energy code requirements.
- All piping in mechanical rooms and piping exposed below 8 ft above finished floor (AFF) shall have a PVC jacketing.
- All piping exposed to the exterior shall have an aluminum jacket.
- CHW and tower water services will be provided with a BTU meter at the building entry.

Heating Water

- Interior piping 2 in. and smaller shall be Type L copper with brazed fittings.
- Interior piping 2.5 in. and larger shall be either Type L copper with brazed fittings or Sch 40 steel pipe with welded and flanged joints.
- Underground hot water piping serving the building will be distributed in a pre-insulated, factory-fabricated coated steel piping system.
- Interior heating water piping shall be insulated with rigid glass fiber insulation.
- Piping exposed to the interior shall have a PVC or aluminum jacket. Piping exposed to the exterior shall have an aluminum jacket.
- Hot water service will be provided with a BTU meter at the building entry.

Mechanical Calculations

Mechanical calculations are provided in Appendix C for both air side and cooling water side.

Sustainable Design Strategies

The following energy conservation measures will be incorporated into the HVAC design:

- DDC building automatic system for optimization of major HVAC equipment operation.

- Supply air temperature is to reset to minimize air conditioning of outside air and subsequent reheating of conditioned air.

- Variable-speed drives installed on all VAV AHU supply and return fans to reduce fan horsepower requirements at non-peak conditions.

- Variable-speed drives installed on all pumps to reduce pump horsepower requirements at non-peak conditions.

- Full economizer control on all mixed AHUs to reduce consumption while maintaining appropriate indoor humidity levels.

8.2.2.10 Electrical

Site Power Distribution

The RTST Service Building, Tunnel, and makeup air structure will be considered one building with one electrical power supply servicing these structures.

Four exterior unit substations will be provided to service the buildings as follows:

- Unit substation RS2-SS1—2500 kVA serving
  - RTST Service Building and Tunnel
  - Makeup air structure

- Unit substation RS2-SS2—1000 kVA serving
  - Septum power supplies

- Unit substation RS2-SS3—1000 kVA serving
  - Dipole power supply

- Unit substation RS2-SS4—1000 kVA serving
  - Dipole power supply

Building Power Distribution

The buildings will be provided with 480 Y/277 V secondary services from feeder duct banks from the outdoor substations to the RTST Electrical Room.

The RTST Tunnel makeup air structure will be provided with 480 Y/277 V secondary service from a 400A feeder duct bank from outdoor substation RS2-SS1 to a panelboard in the mechanical room.

The 4000 A, 480 Y/277 V low-voltage switchgear fed from RS2-SS1 in the RTST Electrical Service Room will distribute power to CF loads and instrument loads. The instrument loads will include magnet power supplies in the tunnel.

All distribution and branch circuit panelboards will be located in the Service Building and makeup air structure with branch circuits extended to the tunnel and west shelled RTBT Stub. Distribution raceways for science cabling extension to initial beam entry magnets into the RTBT Stub will require routing through a trench cut in the existing tunnel floor. Empty duct banks will be provided between the Service

Building and the tunnel with cable trays located in the tunnel for extension of power conductors to the magnet power supplies under another contract.

Secondary Distribution

Building secondary distribution will generally be 480 V, 3-phase, 4-wire, plus ground. This will provide service to CF lighting, receptacles, and HVAC loads as well as building instrumentation loads. Further transformation down to 208 Y/120 V, 3-phase, 4-wire, plus ground will be provided for general use receptacles and other low-voltage equipment as necessary. Distribution panelboards fed from the 4000 A low-voltage switchgear located in the RTST Electrical Service Room will provide power to other than building septum and dipole power supply loads, which are fed directly from exterior substations RS2-SS2, RS2-SS3, and RS2-SS4 through individual 1600 A switchboards.

All conventional building use dry-type transformers will be DOE 2016 rated for efficiency, 115° rise, 220°C insulation class with six 2.5% taps. Consideration will be given to harmonic or K-rated transformers and oversized neutrals to handle the heating effects of the harmonic loading.

Circuit protection will be

- Where 480 V distribution is provided, the exterior unit substation secondary will be of low-voltage switchgear UL 1558 construction with electrically operated drawout power circuit breakers with solid state adjustable trips.

- Generally molded case circuit breakers. Solid state adjustable trip units will be provided above 250 A.

- Bolt-in type molded case circuit breakers for branch circuit panelboards.

- 100% rated for service entrance main circuit breakers, 80% rated otherwise.

Devices will be fully rated. Series ratings of protective devices will not be acceptable.

Two levels of ground fault protective devices will be provided at the main and feeder breakers at service switchgear assemblies.

Emergency Power Supply System

EPSS Power Generation Plant

The RTST Service Building, Tunnel, and makeup air structure will be provided with building and instrument standby power service from an exterior 400 kW/500 kVA, 480 Y/277 V diesel engine-generator RS2-EG1. It will provide emergency power for life safety systems including egress lighting and critical instrumentation and HVAC system loads.

The exterior diesel standby engine-generator will be provided in an exterior, weatherproof, sound attenuated, reach-in enclosure with 24-hour sub-base fuel tanks. The generator will be provided with a quick-connect feature to be used for load bank testing or portable generator backup if the primary unit is down for maintenance.

EPSS Power Distribution

The EPSS secondary distribution system will be separated into the following branches as required by code.

- Generator: This branch provides alternate source power from the generator set main circuits breaker(s) and associated distribution to the line side of each ATS.

- Emergency (NEC Article 700): This branch provides continuous (normal or generator) source power for the following equipment essential for safety to human life:
  - Interior building means of egress lighting and illuminated exit signs
  - Exterior building means of egress immediately adjacent to exit discharge doorways
  - Fire detection and alarm systems
  - Public address communication systems (when used for issuing emergency instructions)
  - Generator set location, task illumination, battery charger, emergency battery-powered lighting unit(s), and selected receptacles
  - Fire protection system.
  - Experimental processes where interruption would produce serious life safety health hazards, and similar functions

- Combined legally required and optional standby branch, designate as “optional branch” (NEC Article 701 and 702): This branch provides continuous (normal or generator) source power for the following equipment that, when stopped during any interruption of the normal electrical supply, could cause hazards or hamper rescue or firefighting operations; or (optional branch) to protect facilities or property where life safety is not dependent on system performance:
  - Control and alarm systems of major apparatus.
  - Experimental processes where any power outage could cause serious interruption of the processor damage to the equipment.
  - Ventilation and smoke removal systems.
  - Access control systems.
  - Telecommunication room lighting, equipment, and data processing systems.
  - Electric and mechanical room lighting and selected receptacles.
  - Selected mechanical and plumbing equipment. Generator distribution feeders will extend from the EPSS power generation plant to 480 Y/277 V, 4-pole isolation bypass transfer ATSs with associated distribution panelboards located in the RTST Electrical Room.

  - The following transfer switches are anticipated:

- 260 A: Life safety (sized large to meet required withstand rating)

- 600 A: Optional branch—RTST Service Building and Tunnel

An associated duct bank will be required for the makeup air structure for life safety systems and to maintain tunnel air.

Power Quality Systems

Uninterruptible Power Supply Systems

- A 100 kVA UPS system will be provided for the building and tunnel IT and science load distribution.

- The UPS system will be static (battery) type with maintenance bypass and 15-minute ride-through capacity.

Surge Protection Devices

Surge arrestors labeled for use with NFPA 780 lightning protection systems will be provided at all unit substation transformer primaries.

Transients (surges, lightning, switching events) can introduce harmful voltage or current spikes to electronic equipment.

Surge protection device (SPD) filtering devices will be installed on main low-voltage switchgear, distribution panelboards, and branch panelboards serving major electronic equipment and all emergency branch panelboards in compliance with current code requirements. Sensitive equipment may require multiple levels of protection to protect equipment not only from utility disturbances but also from other equipment.

Electric Metering Systems

Electrical metering systems, according to ORNL standards, will be used to monitor and alarm the RTST Service Building and RTST Tunnel:

- Electrical loading, harmonic loading, and protective device positions. Rail-mounted power quality PM 8214 DIN meters will be required at the unit substation building main service breakers.
- Service low-voltage switchgear mains and feeders.
- Medium-voltage interrupter switches, positions, and transformer status.
- Distribution panelboards on the load side of ATSs.
- Standby engine-generator plant and associated distribution equipment.
- ATS positions.

The system will be networked to the ORNL Power Operations supervisory control and data acquisition (SCADA) “SNO” network.

Grounding Systems

Ground Grid

All building grounding systems must be bonded to a common earth ground in compliance with the NEC. Each building will be provided with a #4/0 direct buried copper ring encircling the perimeter of the building, which will provide a convenient means of connecting all metallic systems and equipment into a single equipotential grid that has a low resistance to ground.

Building Grounding

Building steel, foundation rebar (Ufer ground), and metallic water supply piping will be bonded to the ground grid.

Building Lightning Protection

An NFPA 780 Faraday cage-type lightning protection system will be provided, to protect the building/structure and its occupants and contents from the electrical effects of a lightning strike to ground. The system will include independent down conductors in PVC from the rooftop to the ground grid.

Electrical Power System Grounding

Separate green grounding conductors will be provided with all feeders and branch circuits to provide an intended grounding of the neutrals of the electrical power systems. Each will be bonded to the ground grid with grounding electrode conductors from the distribution system neutral source.

Interconnected bus bars in electrical rooms will collect electrical and electrical equipment grounding conductors to tie the ground ring at the electrical service entrance room.

Electrical Equipment Grounding

All non–current carrying metal parts of electrical equipment enclosures, raceways, boxes, cabinets, housings, frames of motors, luminaires, and so on will be bonded and connected to electrical room ground buses where the associated system neutral is grounded. This allows for a safe ground path in an electrical fault condition.

Instrumentation Signal Reference Grounding

The bonding of instruments and instrument cabling pathways, as a low impedance signal reference system to a common equipment area bus and then to the ground grid, will be provided to minimize noise-induced voltages and reduce equipment malfunctions.

Telecommunications Signal Reference Grounding

Interconnected bus bars in telecommunication rooms will collect STS IT equipment and pathway grounding conductors and bond to the electrical service entrance room ground bus in compliance with Electronic Industries Alliance/Telecommunications Industry Association (EIA/TIA) and NEC requirements.

Lighting Systems

Exterior Lighting

Pole-mounted LED light standards with concrete bases will be provided along roadways and within parking lots.

Building-mounted perimeter LED luminaires will be provided at building exits, walkways, and vehicular circulation areas.

Interior Lighting

Tunnel lighting will be LED radiation-resistant similar to Lithonia Type CLX.

LED interior lighting will be provided in compliance with IESNA lighting standards and ASHRAE 90.1 energy budgets.

Lighting Controls

Exterior lighting will be provided with photocell and time clock controls.

Interior spaces will be provided with local automatic lighting sensor controls.

Facilities and Operations Building Systems

The building electrical metering system and BAS to monitor electrical and HVAC building systems will be site interconnected to SNS campus systems as described in Site Utilities, Section 8.1.3 of this report, and will also include the following systems.

Fire Alarm System

The fire alarm system will be a microprocessor-based detection and notification control system installed and acceptance tested in compliance with NFPA 72,*National Fire Alarm Code*. The building system will include multiplex wiring techniques, a central processing unit (fire alarm control unit [FACU]), annunciator units, and peripheral detection and alarm devices.

The tunnel system will

- Include smoke, heat, and smoke aspiration detection devices to suit environmental conditions.
- Include audible horns and visual strobe notification devices.
- Monitor building fire suppression systems and override HVAC functions in an alarm condition for fire and smoke containment.
- Report fire, supervisory, and trouble alarms to the ORNL Fire Department and LSS office in Building 4512 over a fiber optic network.

Wiring will be supervised Class B installed in conduit. Multimode fiber optic cabling will be extended in conduit between the fire alarm control unit and the telecommunication room in each building.

The system will be Edwards/EST Fireworks manufacturer/series according to ORNL requirements to match the existing campus systems.

Public Address System

A public address system will be provided with amplification as an extension to the campus-wide Valcom mass notification system.

Wiring will be installed in conduit.

Access Control System

The building will be provided with an access control system with central equipment located in the main telecommunications room.

Alarm and supervisory conditions will be reported to the ORNL campus security monitoring location over a fiber optic network.

Components will match existing ORNL equipment for system compatibility.

Telecommunication Systems

The building will be provided with a separate telecommunications service from the existing site telecommunications distribution system at the CLO to a building main distribution room. Design for the incoming POTS (plain old telephone service) and/or VoIP (voice over IP) telephone service, LAN (local area network), and wireless networking shall be coordinated with DOE’s prime subcontractor, Black Box. The STS project will provide the interconnecting fiber optic cabling. For more information, refer to Section 1.1.3.2 Electrical Systems—Telecommunication System Distribution, which outlines telecommunication service to the STS buildings.

Building IT systems for system networking hardware, including switches, routers, and patch panels, will be provided.

Building IT horizontal Category 6A cabling will be provided from telecommunication rooms located on each floor, stacked where possible. Building IT systems will be installed in compliance with EIA/TIA standards.

ORNL F&O Building Systems Distribution

The following building systems/system owners will be interconnected with cables and raceways by SNS CF. The system owners will perform final tie-ins.

- Public address/F&O Instrumentation and Controls
- Fire alarm (FIREWORKS network)/F&O Laboratory Protection
- Access control/F&O Laboratory Protection
- Building automation system/F&O Facilities Management (CLO II only—Siemens))
- Power monitoring (ION-Schneider)/F&O Electrical Utilities (including central IT UPS systems monitoring)

Instrument and Control Systems

ORNL STS will provide building instrumentation and control systems cabling for interconnection of the following systems:

- PPS
- MPS
- ATS
- TPS (two conduits)
- EPICS

Pathway Systems

Ladder-type cable trays will be provided to support telecommunications and instruments and control systems cabling requirements with proper wire dropout devices, conduit sleeves, firestopping, grounding, and wire management components.

Cabling from wall box type IT jacks will be in bushed conduits extended and grounded to the local cable tray system.

8.2.2.11 Plumbing

Drainage/Waste

Process Waste

The RTST Service Building will be provided with a process waste system to collect drainage from floor drains and equipment. Waste will be collected from floor drains and routed below the floor and conveyed by a gravity system to the underground sanitary waste drainage system outside the building. Flow rates and pipe sizes will be calculated based on drainage fixture unit values and adjusted/increased to allow for projected wastewater discharge from various related equipment at the design stage.

Floor drains will be provided at mechanical equipment spaces and other areas requiring drainage. Complete accessibility will be provided to all cleanouts. Floor drains that do not receive regular use will be provided with trap primers. Primers will consist of an automatic trap primer system that automatically discharges water at regular timed intervals.

Potable/Process Water

Potable water will enter the RTST Service Building from below grade shall be provided with a water meter and shall connect to the BAS. A branch from the incoming potable water service shall be converted to a process water stream through a Foundation for Cross-Connection Control and Hydraulic Research–approved duplex backflow prevention device. Water makeup for any mechanical equipment, for technical cooling water, and at hose bibs at the Service Building and Tunnel will be supplied through process water.

Storm Drainage

The primary storm drainage system for the Service Building will consist of gutters and exterior downspouts for any areas collecting water, routed to spill at grade.

Compressed Air

CA shall be provided to the RTST Service Building and distributed to the RTST Tunnel. CA will be used in the RTST Service Building for controls applications.

Equipment

System Design Criteria

Potable/Process water

- Potable water system is designed to provide a minimum of 40 psi at the furthest outlet.
- Process water system is designed to provide a minimum of 40 psi at the furthest outlet.
- Valves shall be placed to isolate individual fixtures within one room or a battery of fixtures within any one room.
- Hose outlets will be provided at all mechanical rooms and equipment spaces.

Process Waste

- The process waste system shall connect to each drain and will be provided with water seal traps. A vent system shall be provided for fixtures as required to ventilate the waste system and to prevent siphonage of fixture traps.

- Floor drains will be provided at all mechanical rooms and equipment spaces.

Storm Drainage

- Storm piping shall be sized based on a 100-year occurrence rainfall rate with a 60-minute duration.

Compressed Air

- Design CA pressure on incoming service—105 psi
- Design CA pressure at laboratory outlets—100 psi
- Dew point –40°F

Materials

Potable Water System

Above-ground potable water systems

Tubing is to be Type L hard temper with wrought copper fittings conforming to ASTM B88-and ASME B16.22. All joints shall be soldered with ASME AWS/A5.8 lead-free solder. The entire potable/process water distribution system will be fully insulated using closed-cell elastomeric foam insulation.

Process Water Systems

Above-ground process water systems

- Tubing is to be Type L hard temper with wrought copper fittings conforming to ASTM B88-and ASME B16.22. All joints shall be soldered with ASME AWS/A5.8 lead-free solder.

- Copper tubing with grooved ends and mechanical joints is acceptable for sizes 2½ to 6 in. only. Tubing is to be Type L hard temper with wrought grooved end fittings conforming to ASTM B88 and ASTM B75.

- The entire process water distribution system will be fully insulated using closed-cell elastomeric foam insulation.

Process Waste

Polypropylene pipe (fire retardant above grade) is to be Sch 40; drain-waste-vent (DWV) hub and spigot fittings; heat fusion joints above and below ground.

Compressed Air System

- Type K copper with brazed joints.

8.2.2.12 Fire Protection

Sprinkler

The RTST Service Building will be fully sprinkled, with exposed sprinkler piping feeding upright sprinklers. Sprinkler feed will enter the building from below grade into the pump room from the site potable/fire water main, and a double check backflow preventer will be provided. The Service Building will be a single sprinkler zone, with a control valve located at incoming service. The control valve will be provided with a tamper switch and a flow switch connected to fire alarm system.

General

System Design Criteria

Fire sprinkler systems for the RTST Service Building will be hydraulically designed to provide water densities that meet the requirements for Ordinary Hazard–Group 2 protection throughout the facilities.

Velocity shall not exceed 20 fps.

All calculations assume a minimum of 10 psi deterioration in static and residual pressures in the hydrant flow test results.

Materials

- Pipe and fittings installed underground shall be Class 52 ductile iron cement lined with mechanical joints with a working pressure rating of 350 psig.

- Sprinkler piping installed above ground and sized 2 in. and smaller and all standpipe piping shall be Sch 40 black steel with threaded joints and fittings.

- Sprinkler piping installed above ground and sized 2½ in. and larger shall be Sch 40 black steel with roll or cut groove type connections and fittings. Pressure rating shall be 175 psig minimum.

- Fittings for grooved end steel pipe shall be cast of ductile iron conforming to ASTM A-536 or malleable iron conforming to ASTM A-47, or forged steel conforming to ASTM A-234 (A-106, Gr. B), with grooved or shouldered ends for direct connection into grooved piping systems with steel pipe. They shall be UL listed and FM approved, rated for a minimum 300 psi MWP.

8.3 TARGET BUILDING

8.3.1 Target Building II

8.3.1.1 Programming

Building Function

Target Building II will be the center and the most complex structure of the STS facility. Major functions will include the second target monolith, neutron beamline bunker, service bay and high bay space. The target monolith will house the STS target and associated shielding. The neutron beam bunker will house the initial sections of the 22 STS neutron beamlines. The service bay will support removal, containment, and short-term storage of spent targets before off-site disposal. The Target Building II high bay will serve as a staging space for the initial construction and long-term maintenance of the target monolith and radial neutron beamlines that are located within the building. Alterations and maintenance to the monolith and beamlines will be an ongoing process for the life of Target Building II. Target Building II will also house all utility systems necessary to support the target, additional space supporting long-term maintenance of the target, and numerous other functions that are critical to operation of the target facility. Target Building II will be a restricted-access facility operated by STS scientists and technical staff. It will generally not be accessible by instrument users.

Program Summary

Target Building II includes 67,205 nsf and has an estimated planning efficiency factor of 60%. This factor is based on analysis of the existing FTS Target Building and preliminary test-fit planning for Target Building II. The estimated gross area of Target Building II 111,178 gsf. Table 8.11 summarizes Target Building II space program requirements. Detailed room data sheets and test-fit plans are included in Appendix B of the STS CF Conceptual Design Report.

Table 8.11. Target Building II space program summary.

No.	Rooms	Qty.	NSF	Total NSF
5.3.1.1	Communications Room	2	250	500
5.3.1.2	Instrument Maintenance	1	810	810
5.3.1.3	Instrument Maintenance Storage	1	610	610
5.3.1.4	Break Room/User Lounge	1	620	620
5.3.1.5	Computer Room	1	200	200
5.3.1.6	Controls Network	1	240	240
5.3.1.7	On-Shift Support	1	740	740
5.3.1.8	Neutron beamline bunker	1	2,600	2,600
5.3.1.9	Monolith	2	650	1,300
5.3.1.10	Truck Bay	1	2,100	2,100
5.3.1.11	Confinement Ventilation and Filtration Room	1	2,380	2,380
5.3.1.12	Receiving/Staging	1	335	335
5.3.1.13	Hot Process Vault	1	6,850	6,850
5.3.1.14	Bunker Electronics Room	1	0	0
5.3.1.15	UPS/Emergency Power Room	1	370	370
5.3.1.16	Target Maintenance Shop	1	1,100	1,100

Table 8.11. Target Building II Space program summary (continued)

No.	Rooms	Qty.	NSF	Total NSF
5.3.1.17	Hot Shop (Radiological)	1	470	470
5.3.1.18	Electrical (Research Mechanics)	1	1,030	1,030
5.3.1.19	Vacuum Workshop	1	1,110	1,110
5.3.1.20	Radiological Support Count Area	1	360	360
5.3.1.21	Activated Sample Lab	1	800	800
5.3.1.22	Activated Sample Storage	1	670	670
5.3.1.23	Survey and Alignment Storage	1	210	210
5.3.1.24	Active Storage Cages	1	790	790
5.3.1.25	Sample Environment Long Term Storage Cages	1	750	750
5.3.1.26	Target Control Room	1	800	800
5.3.1.27	Hydrogen Utility Room	1	600	600
5.3.1.28	CMS Control Room	1	400	400
5.3.1.29	Helium Compressor Room	1	2,080	2,080
5.3.1.30	Helium Refrigerator Room	1	1,000	1,000
5.3.1.31	Target Building Second Floor	1	15,100	15,100
5.3.1.32	Target Maintenance Storage	1	650	650
5.3.1.33	Service Cell	1	2,450	2,450
5.3.1.34	Storage Pit	1	75	75
5.3.1.35	Cask Loading Room	1	475	475
5.3.1.36	Mechanical Room	1	1,330	1,330
5.3.1.37	Toilets	2	550	1,100
5.3.1.38	Recycling/Trash	1	300	300
5.3.1.39	AHU Space	1	11,600	11,600
5.3.1.40	Instrument Vacuum Pump	1	400	400
5.3.1.41	Filter and Delay Tank Cavity	1	1,300	1,300
5.3.1.42	Gas Liquid Separator Cavity	1	650	650
5.3.1.43	Mockup room	1	500	500
Total nsf				**67,205**
Total gsf				**111,178**
Total efficiency				**60%**

8.3.1.2 Site Planning

Location and Floor Elevations

Target Building II and the attached 40M, 50M, and 90M Instrument Buildings are located within the SNS campus adjacent to the existing Target Building. In the north/south direction, the complex is located to allow placement of the 90M Instrument Building within the perimeter ring road, while maximizing the spacing between the FTS and STS facilities. This allows maximum future planning flexibility within the service courtyard. In the east/west direction, the Target Building II is located as far west as possible to reduce the length of the RTST Tunnel and to reserve the maximum area between Target Building II and the CLO/CNMS for future development.

The vertical elevation of the STS was evaluated extensively in previous design studies (see STS Elevation Study, page 5-346). Based on that analysis, the proton beam vertical centerline was set at elevation 1080 ft. This elevation drives the vertical location of all technical equipment and CF floor elevations of the STS complex located within the elliptical ring road. Correspondingly, the basement, first floor, and second floor elevations in Target Building II will be at elevations 1054 ft, 1074 ft, and 1094 ft, respectively. The second floor aligns with the mezzanine and pedestrian bridge levels that link the FTS and STS facilities. Figure 8.3 highlights Target Building II within the overall STS Site Plan.

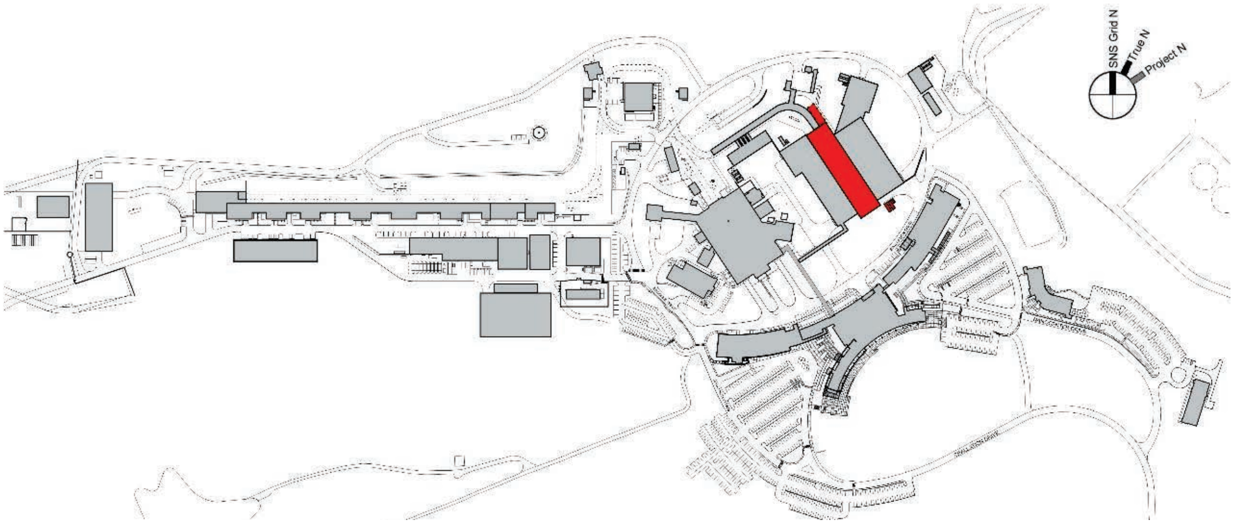


Figure 8.3. Target Building II within the STS Site Plan.

Truck Access

Tractor-trailer truck access for Target Building II will be located at the east end of the facility, within the building enclosure, at the first-floor level, elevation 1074 ft. Trucks will enter Target Building II from either the north through the 50M Building or the south through the 40M Building. The interior truck lane will allow single vehicle passage in either the north or south direction. Additional truck access to Target Building II will be provided at the east end of the building, basement floor level, elevation 1054 ft. This location will include a covered exterior dock. The pavement at this location will be depressed 4 ft from the loading dock elevation. Smaller trucks will be able to approach this dock through either forward or backing maneuvers. Larger trucks will be able to approach only through backing maneuvers.

Pedestrian Access

Pedestrian access to Target Building II will be provided at the first and second floor levels through adjacent facilities. The primary access will be provided through the mezzanine walkway system that will link Target Building II with the 40M, 50M and 90M Instrument Buildings. This mezzanine walkway will also link the STS complex with the existing FTS complex through an enclosed pedestrian bridge. First floor access will be provided through the adjacent 40M and 50M Buildings and at controlled exterior grade level access doors. Secondary exterior access to Target Building II will be possible at controlled pedestrian doors located at the egress stairs on the east and west sides of the building.

8.3.1.3 Building Planning

Building Organization/Floor Planning

Target Building II will be a four-level structure. The first floor, elevation 1074 ft, houses the target monolith and neutron beam bunker around which the STS complex is organized. All 22 STS neutron beamlines radiate from the center of the monolith. Horizontally, all beamlines are located approximately at elevation 1080 ft. The monolith and bunker areas are heavily shielded with permanent concrete construction and high-density shielding blocks, which can be removed to provide access to the target and beamlines. The outer diameter of the neutron beam bunker, which is approximately 86 ft, drives the width of Target Building II.

In addition to the monolith and bunker areas, the remainder of the first floor houses a service gallery, truck bay, and various target operation support functions. The monolith, bunker and service gallery are accessible through removable shielding and hatches from the second floor of the building, which is a high bay space with an overhead crane that extends over the entire footprint of Target Building II. The truck bay is open to the second floor and overhead crane above. The service gallery is also linked to spaces located on the basement floor through hatches that open through the first and second floors, which allow the overhead crane in the high bay to reach the basement floor. The basement floor primarily houses utility systems that serve the target and overall building. Minor space at the basement floor is dedicated to several labs and workshops. The third floor of the building is a mechanical room that houses air handling systems for Target Building II, 40M and 50M Instrument Buildings.

Vertical Circulation

Target Building II will include one freight elevator and two egress stairs, which will connect all four floor levels of the building. These vertical circulation elements will also serve the 40M and 50M Instrument Buildings. From a building code standpoint, Target Building II and the 40M, 50M, and 90M Instrument Buildings will make up one building. The freight elevator and one egress stair will be located in the southeast corner of the building directly adjacent to the truck bay and the mezzanine walkway. The other egress stair will be located in the northwest corner of the building. In addition to providing direct exterior egress from all four floor levels of Target Building II, this stair will provide egress from the RTST Tunnel.

Restricted Access

Access to Target Building II will be restricted to STS scientific and technical operations staff except in limited areas. Instrument users will have access to the first floor, east of the service bay and to the second-floor mezzanine walkway that connects the 40M and 50M Instrument Buildings. All other areas of Target Building II will be restricted to STS staff.

8.3.1.4 Features and Requirements

Radiological Shielding

Target Building II has multiple shielding requirements related to the spaces and components housed in the facility. The proton beam tunnel located within Target Building II requires permanent concrete and steel shielding on both sides, the top, and the bottom of the tunnel. The monolith and bunker each require permanent shielding on the sides and below the elements. Shielding above the monolith and bunker will be removable high-density concrete and steel blocks. The service bay and surrounding service gallery will require permanent shielding above, below, and on all sides of the spaces. The hot vault and hot vault mezzanine will require shielding between the vault and any occupied areas. The locations, materials, and preliminary sizes of the radiological shielding are shown in Target Building II floor plan and section drawings. Table 8.12 summarizes the shielding thickness requirements in Target Building II.

Table 8.12. Shielding thickness summary.

Description	Thickness (in)	Material	Information source	Reference number
Bunker				
Wall	60	High-density (HD) concrete	Beamline shielding analyses for STS instruments	STS04-41-TR0003-R01
Ceiling	50	HD concrete		
Floor	50	HD concrete		
Hot process vault (HPV)			Target Building basement shielding	SNS 106100200-TR0050-R00
All	30	Reg concrete	Approximated based on pipe chase shielding	
Cold process vault (CPV) (Mechanical Equipment Room)	Needs details		Target Building basement shielding	SNS 106100200-TR0050-R00
All	16		Approximated based on pipe chase shielding	
Proton beam entrance tunnel				
Side	100	Steel (could be Duratek)	RTBT shielding report	SNS-106100200-DA0009-R00
	18	Reg. concrete		
Top	75	Steel (could be Duratek)	RTBT shielding report	SNS-106100200-DA0009-R00
	24	Reg. concrete		
Bottom	100	Steel (could be Duratek)	Copied side thickness	
	18	Reg. concrete	Copied side thickness	
Service cell				
Floor	45	HD concrete	STS neutronics calculation, no formal document at present	
Walls/ceilings	40	HD concrete	STS neutronics calculation, no formal document at present	
Target drive room				
Walls	60	HD concrete	PPU reevaluation of FTS monolith biological shielding	SNS -106100200-TR0219-R00
Ceiling	60	HD concrete	PPU reevaluation of FTS monolith biological shielding	SNS -106100200-TR0219-R00
Filter and delay tanks vault				
All	45	HD concrete	PPU delay tank shielding reevaluation	PPUP-502-DA0001-R00

Table 8.12. Shielding thickness summary (continued).

Description	Thickness (in)	Material	Information source	Reference number
GLS tanks vault				
All	25	HD concrete	PPU delay tank shielding reevaluation	PPUP-502-DA0001-R00
Pipe chase—horizontal				
All	60	Reg concrete	Process water shielding requirements above the target monolith	SNS 106100200-TR0047-R00
Pipe chase—vertical				
All	30	Reg concrete	Process water shielding requirements above the target monolith	SNS 106100200-TR0047-R00
Target water loop (equipment protection in target drive room)	Unknown	unknown		
Monolith				
Steel	R172.00	Steel (could be Duratek)	PPU reevaluation of FTS monolith biological shielding	SNS -106100200-TR0219-R00
Concrete	45.00	HD concrete		
Neutron beamlines—outside bunker				
All	40	HD concrete	Beamline shielding analyses for STS instruments	STS04-41-TR0003-R01
	50	Reg concrete		
Bunker electronics room				
Walls adjacent to bunkers	12	HD concrete	Estimate	

Materials Handling

The second floor high bay will include a 50-ton bridge crane providing complete coverage of the Target Building II footprint. The crane will access the truck bay at the first floor and limited first and basement floor areas through removable floor hatches.

Technical Equipment

Extensive technical equipment will be integrated into Target Building II. This equipment is not included in the CF scope of work. Coordination of the technical equipment requirements with the CF will be necessary during subsequent design phases. A preliminary list of some technical equipment is provided in the Room Data Sheets and Test-Fit Plans included in Appendix B.

8.3.1.5 Life Safety/Code

Primary Occupancy Type

Target Building II and the 40M, 50M, and 90M Instrument Buildings will be constructed as a single building. The primary occupancy type for Target Building II and Instrument Buildings is Group F-2, Low Hazard Factory Industrial according to the 2015 IBC, and Special-Purpose Industrial according to NFPA 101, 2018 edition.

Accessory Occupancies

Accessory occupancies will include lab support rooms (Group B) and storage rooms (Group S-1). The lab support rooms and storage rooms can be considered accessory occupancies if the aggregate area of each use does not exceed 10% of the floor area of the story in which they are located. Otherwise, IBC Table 508.4 requires a 1-h fire-rated separation between the F-2 occupancy and the B and S-1 occupancies. Laboratory spaces with be separated by 1-h fire-resistive partitions, where practical, to allow for increased storage and use of hazardous materials.

The Hydrogen Utility Room will be an accessory occupancy (Group H-2) and will be enclosed by 2-h fire-rated construction as required by IBC Table 508.4.

Fire Protection Systems

Target Building II and the Instrument Buildings will be protected throughout by an automatic fire sprinkler system designed to protect an Extra Hazard—Group 1 occupancy for the main level and an Ordinary Hazard–Group 2 occupancy for the basement level in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems.*

Target Building II and the Instrument Buildings will be provided with a Class I standpipe system in accordance with NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*. Two and one-half inch fire department hose valves will be provided at each floor landing in each exit stairway.

Portable fire extinguishers will be provided throughout the building in accordance with the IBC and NFPA 10, *Standard for Portable Fire Extinguishers*.

Target Building II and the Instrument Buildings will be equipped with an addressable fire detection/alarm system consisting of the following:

- Manual fire alarm stations at all building exits
- Beam type smoke detectors in large, open high-bay areas
- Area smoke detectors in elevator lobbies and elevator machine rooms
- Duct smoke detectors on the supply and return sides of all AHUs having a design capacity greater than 2,000 cfm
- Audible/visual notification appliances installed through the building

All fire alarm, supervisory alarm, and trouble signals will be automatically transmitted to the ORNL Fire Department via the LSS fiber optics network.

All new fire alarm system equipment will be manufactured by Edwards Systems Technology to be compatible with the existing site-wide campus system.

The fire detection/alarm system will be designed and installed in accordance with the IBC and NFPA 72, *National Fire Alarm Code*.

Maximum Floor Area and Stories

Target Building II and the Instrument Buildings will be a 4-story, 214,800 SF building of Type IIA construction. The first floor will have the largest floor area at 113,294 SF. The maximum floor area permitted for any floor by IBC Table 506.2 for a fully sprinklered, multi-story, F-2 building of Type IIA construction, with the area increase for frontage, is 119,787 SF. The proposed height and area for the building are within the limits established in IBC Sections 504 and 506.

Travel Distances

The maximum travel distance within Target Building II and the Instrument Buildings will not exceed 400 ft, as required by IBC Section 1016.2 and NFPA 101, Section 40.2.6.1. The maximum common path of travel distance will not exceed 100 ft, as required by IBC Section 1014.3 and NFPA 101, Section 40.2.5.1. The maximum dead-end corridor will not exceed 50 ft, as required by IBC Section 1018.4 and NFPA 101, Section 40.6.4.

Construction Type

Target Building II and the Instrument Buildings will be of Type IIA construction in accordance with IBC Section 602.

Wall/Floor Ratings

The primary structural frame, floors, bearing walls, and roof will have a 1-h fire resistance rating as required for Type IIA construction. Interior non-bearing walls and partitions will be of noncombustible construction.

Special Code Considerations

The largest floor of Target Building II and the Instrument Buildings is the first floor, currently having an area of 113,294 SF. The maximum area permitted by IBC Table 506.2 for any story in a fully sprinklered, multi-story, F-2 building of Type IIA construction, without an increase for frontage, is 112,500 SF. Currently, the perimeter of the facility is 1,805 ft in length. The length of the perimeter that fronts on an open space at least 30 ft wide is 802 ft. This results in an area increase for frontage of 7,287 SF. Therefore, the maximum area permitted for any story would be increased to 119,787 SF. Should the area of any floor of Target Building II and the Instrument Buildings exceed 119,787 SF, the construction classification for the building will need to be upgraded to Type IB to permit an unlimited area building.

Hydrogen Utility Room: Target Building II will include a 600 SF Hydrogen Utility Room. This room will be equipped with a hydrogen gas detection system monitored by the building fire alarm system. All electrical equipment in this room will be classified for Class I, Division I locations in accordance with NFPA 70. The installation, storage, piping and use of hydrogen should comply with the *International Fire Code*, Chapter 58 and NFPA 2, *Hydrogen Technologies Code*.

Hazardous materials: The use and storage of hazardous materials shall be limited to the maximum allowable quantities indicated in IBC Tables 307.1(1) and 307.1(2). Where these quantities are exceeded, control areas shall be provided in accordance with IBC Section 414.2. The number of control areas per floor and their required fire resistance ratings shall be in accordance with IBC Table 414.2.2. Note that the floors of control areas are required to have a 2-h fire resistance rating for buildings over three stories in height.

8.3.1.6 Civil/Site Development

The construction excavation described under the Site Civil Works section will be performed before construction of Target Building II. The lower basement will be backfilled to the first-floor elevation except at the northeast corner, where vehicular access to the basement is shown. A site retaining wall will extend north from the northeastern corner to allow an upper drive access to the first floor and lower drive access to the basement. Finished grading is shown on Drawing 5.1.19. Drawing 5.1.22 shows the site drainage concept. Roof drainage will be piped to the proposed storm sewer system. A foundation drainage system will be provided around the entire basement area. The existing storm drainage to the east is deep enough to allow the foundation drainage system to discharge to gravity flow. Sewer, fire and domestic water services to the building are shown on Drawing 5.1.27.

8.3.1.7 Architecture

Building Envelope

Exterior Wall

A deep ribbed corrugated metal panel with exposed fasteners and a 2-in.-thick insulated liner panel will be used as the major façade material for Target Building II. The color will be custom to match the existing SNS campus. The metal panel cladding support backup system will consist of hanger rods and metal channel framing supported from the building structure. Metal window sills and wall caps will be used. Continuous through-wall flashing will be provided at the bottoms of all wall cavities, over all wall openings and metal copings. The metal panel wall systems will have an R-13 and R-13 ci minimum requirement. Below-grade exterior walls will be constructed of reinforced concrete with a waterproof membrane and below-grade insulation board. The interior side of the exterior below-grade walls will have metal channel furring with a painted drywall finish. Exterior walls below grade will be required to achieve R-7.5 ci according to the 2012 International Energy Conservation Code.

Exterior Doors

Exterior entrance doors and egress doors will consist of 16-gauge, insulated-core, painted hollow metal doors with 14-gauge, fully welded frames with a U value of 0.61. Overhead insulated coiling doors, 20 ft, 0 in. high by 14 ft, 0 in. wide will include factory-painted galvanized steel curtains with integral insulation achieving an energy code–required minimum R-value of 4.75. All exterior doors will be provided with proximity card reader hardware.

Thermal and Moisture Protection

Flashing and sheet metal will be provided as a positive water stop around all wall openings (head, jamb, and sill), such as windows, doors, and louvers. All copings and gravel stops will be ES-1 compliant as required by IBC.

Damp-proofing will be provided on all walls, floors, and other building components that are subject to high humidity, dampness, or frequent direct water contact.

Waterproofing will be provided at walls, floors, and other building elements that are subject to hydrostatic pressure, are liable to be immersed in water, or are below the water table. The waterproofing membrane will be a hot-fluid-applied, two-layer, 215 mil polyester fabric–reinforced membrane.

Because of the inherent moisture-resistant properties of the insulated metal panel system, an air/vapor barrier will not be required where the system is installed.

Exterior sealants will be nonstaining, with a two-part composition and50% movement capacity and will be compatible with the surfaces on which they are applied.

Insulation combustibility, including wrappings, inside the building skin will be limited to a flame spread of 25 and smoke development of less than 50.

Glazing

Windows will be limited to windows at the upper portion of the exterior wall. Typical vision glass will consist of 1-in.-thick, low U-value, insulated, low-E, argon fill glass units on a thermally broken frame. The windows/glazing systems are anticipated to have a U value of 0.38.

Glazing materials and methods will comply with the Flat Glass Marketing Association’s Sealant and Glazing Manuals. Glass will comply with ASTM C1036-01.

Roof Construction

The roofing system will be a 30-year, 80 mil minimum thickness, white thermoplastic (PVC) single-ply sheet with an integral fiberglass mat reinforcement roofing membrane over polyisocyanurate insulation on a sloping roof structure. Tapered insulation saddles will be used to provide drainage to roof drains and at roof equipment locations. All roof construction details and roof penetrations must comply with the guidelines established by the NRCA. Roof traffic pads will be adhered to the membrane along all roof maintenance traffic paths. All roofs with serviceable components beyond roof drains will be surrounded by a 42-in.-high parapet or provided with a fall protection system.

Low -slope roofing will have a minimum 3-year aged solar reflectance of 0.55 and a minimum 3- year aged thermal emittance of 0.75 in accordance with the Cool Roof Rating Council Program. Roofing will be Energy Star rated with emissivity of at least 0.9 when tested in accordance with ASTM 408.

The roofing system will meet or exceed UL class A fire exposure requirements and comply with FM Class I-90 for wind uplift according to ASTM 1592. The system will provide a minimum thermal resistance value of R-30.

Interior Construction

Walls

Interior walls at the Target Building will be constructed of CMUs for durability. The tunnel building entrance, bunker, monolith and hot process vault (HPV) spaces will be enclosed with concrete shielding walls. The height of the demising walls will be constructed to the underside of the structural deck. Sample environmental cages will be constructed of wire mesh fencing. All fire-rated walls will be constructed in accordance with the IBC code requirements and UL listed assemblies.

Painted metal guardrails and handrails will surround all floor openings and egress stairs.

Wall Finishes

All finish materials for walls, ceilings, and floors, will have a Class A rating, with a flame spread of ≤25, a fuel contribution of ≤25, and smoke development of ≤450.

Typical interior gypsum board and CMU partitions will receive a paint finish consisting of one primer coat and two finish coats. Epoxy paint will be applied to all lab demising walls. All paints, including top coats and primers, will comply with the 2016 *Guiding Principles for Sustainable Federal Buildings*.

Ceramic tile will be installed for the full height of all walls inside toilet rooms. Tile will be 12×24 in. in a brickwork pattern with a 1/3 offset. In areas where moisture is present, tile will be installed over a cementitious backer board.

Floor Finishes

The basement and the first-floor mezzanine levels in the HPV will receive a 1/8-in.-thick shielding, fully welded 304L stainless steel sheet liner, embedded within the concrete floor with all welds being vacuum box tested. Shielding will extend 1 ft up on surrounding walls.

Floors throughout the rest of the Target Building II will receive concrete sealer over new concrete. No vinyl wall base will be used in these areas.

Ceramic tile will be installed in toilet room floor areas. Tile will be 12×24 in. in a brickwork pattern with a 1/3 offset.

Ceiling Finishes

A suspended lay-in 2×4 ft acoustical tile ceiling will be provided at toilet rooms, control rooms, and break/lounge rooms that require ceilings. Acoustic and aesthetic requirements will be assessed for spaces requiring ceilings when selecting tile products, with consideration given to ceiling tile that contains recycled content. Vibration isolation requirements will be evaluated in determining whether isolation hangers will be used in any given space.

Structural elements will be left exposed in all other occupied spaces as well as all mechanical and utility areas. All exposed structure will receive an epoxy paint finish consisting of one primer coat and two finish coats.

Interior Doors

All interior doors will be shop-primed, field-painted, 16-gauge hollow metal, with 14-gauge fully welded metal frames. Doors serving the HPV will be radiation shielded and lead lined. Metal interior rolling doors and floor hatches will be provided at locations indicated in the drawings.

Tempered glass vision lights will be provided at all laboratory doors to facilitate safe egress. All laboratory access doors will be provided with proximity card reader hardware.

Furnishings

Laboratory Casework

Lab casework will be a modular system and include prefinished painted metal bases, wall cabinets, and shelving units with epoxy resin countertops. The modular system will be adaptable and flexible to accommodate the changing needs of lab research requirements.

Vertical Circulation

Stairs

Egress stairs will be metal pan concrete filled, with painted metal handrails, and will include rubber treads, nosings, and landings. Stair construction will comply with NFPA 101, Chapter 7. The stair enclosures, including the doors, will meet IBC requirements for fire barriers.

Elevators

A 50,000-lb capacity, hydraulic passenger/freight elevator will be provided.

Specialty Equipment

Fume hoods will be provided in the active sample lab and will be designed in accordance with the International Mechanical Code (IMC), the American Industrial Hygiene Association guidelines, and applicable DOE directives.

Combination emergency showers/eye wash units will be provided according to ANSI Z358.1 at lab areas where chemicals are being used or stored.

Crane

A 50-ton bridge crane with two 5-ton auxiliary hoists will serve the high bay area of the Target Building II, with a hook height of 434 ft at elevation 1094. A 10-ton crane will be required at the Helium Compressor Room. A 5-ton and a 10-ton bridge crane will be provided in the Target Maintenance Shop and Hot Shop (radiological) spaces, respectively. The Target Maintenance Shop and Hot Shop cranes will not be required if these spaces remain under the high bay crane coverage area.

8.3.1.8 Structure

Applicable Codes and Standards

See Sheets x – xii for complete list of Applicable Codes and Standards

Design Loading

Superimposed Floor and Roof Loads

- Figure 8.4 shows the basement floor loads.
- Figure 8.5 shows the first-floor loads.
- Figure 8.6 shows the second-floor loads.

- Figure 8.7 shows the truss level and moderator support floor loads.
- For elevated slabs, 20 psf collateral load, typical.

Wind Loads

- Risk Category IV
- Basic Wind Speed: V = 120 mph
- Exposure Category B

Seismic Loading

- Risk Category IV
- Importance Factor: Ie = 1.5

Crane Requirement

- Refer to the Crane section of Section 8.3.1.7 for information.

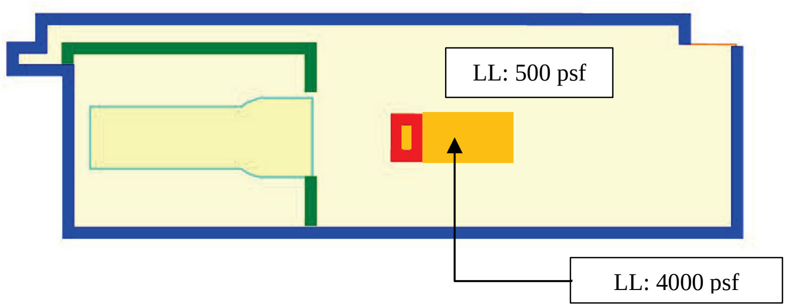


Figure 8.4. STS basement floor loading diagram.

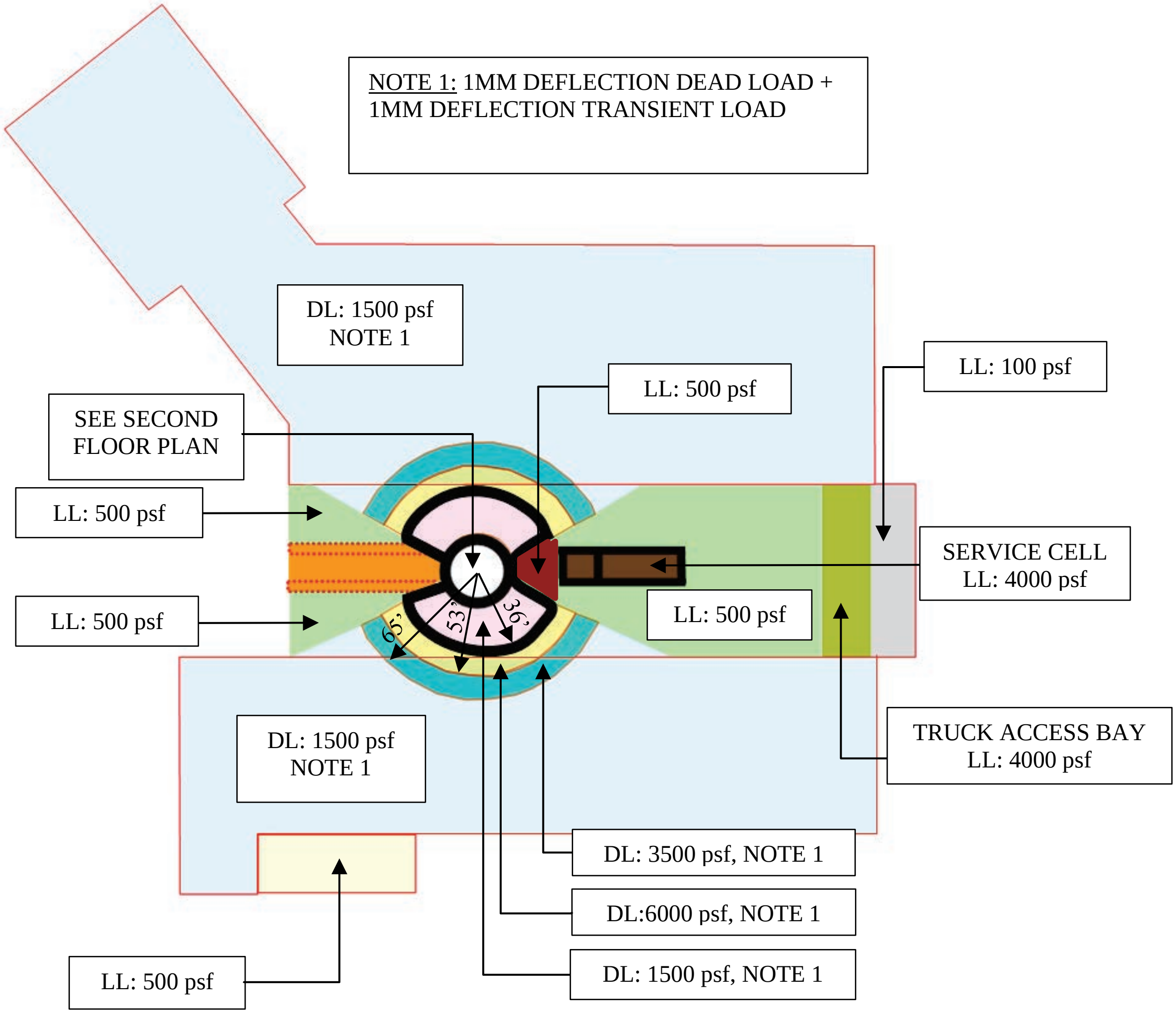


Figure 8.5. STS first floor loading diagram.

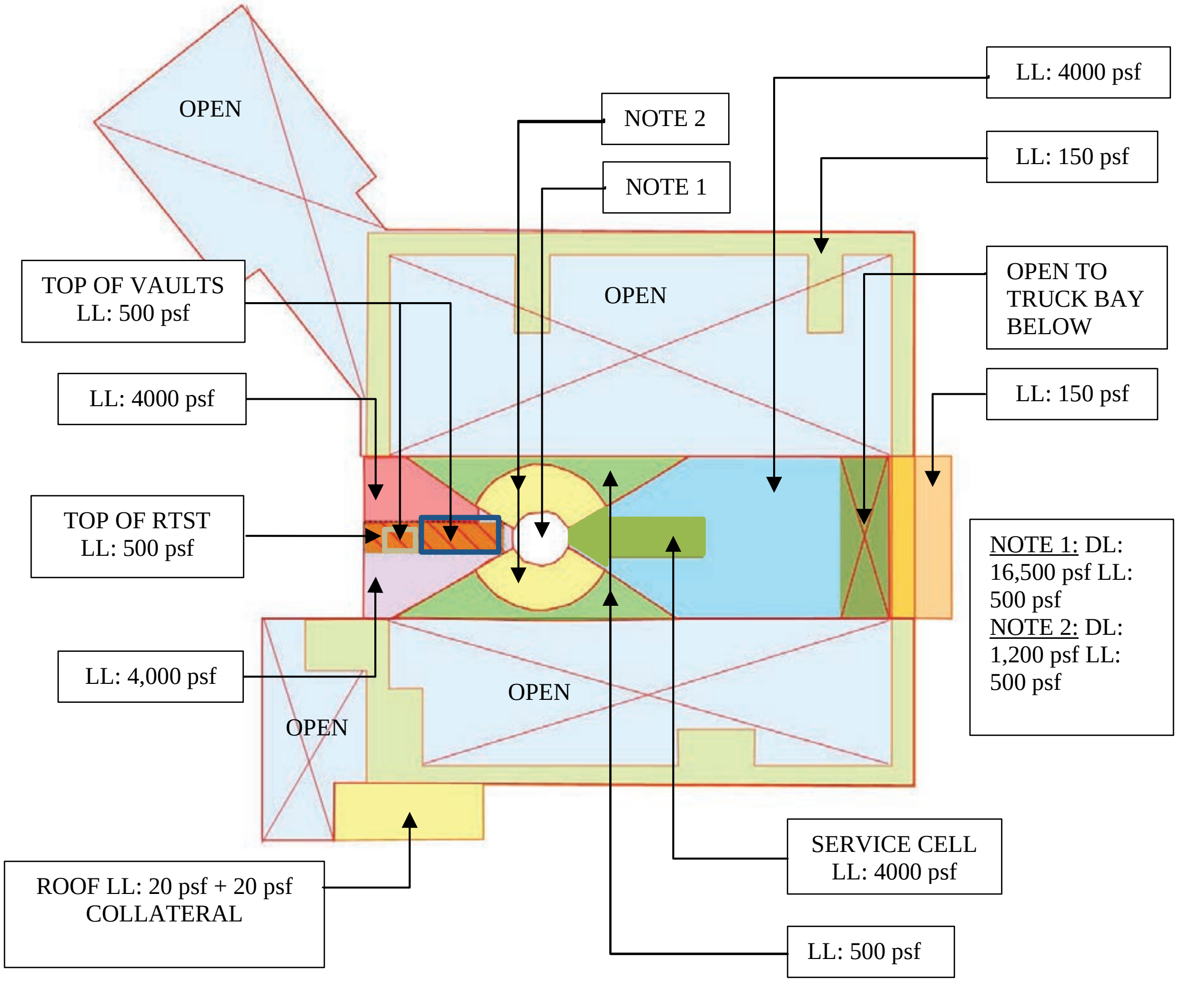


Figure 8.6. STS second floor loading diagram.

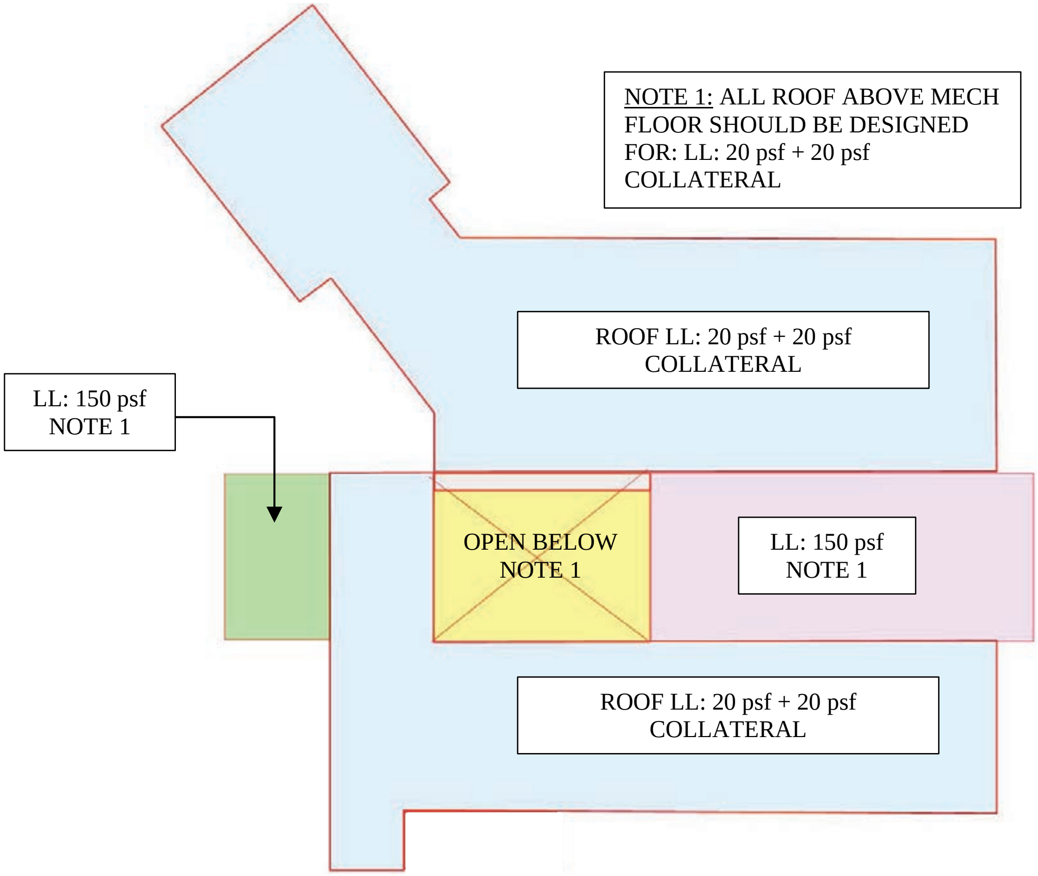


Figure 8.7. STS truss level and moderator support floor loading diagram.

Building Structural System

Slab on Grade

The slab construction is anticipated to consist of a structural reinforced normal weight concrete slab. The structural slab on grade is anticipated to be supported on 9¾-in. diameter micropile foundations, approximately 115 ft long, with a 200-ton capacity. The floor slab will be placed over a vapor barrier, a compacted drainage base course, and a compacted subgrade.

Foundation System

A geotechnical investigation has not been performed. Until a geotechnical investigation and report have been completed, an accurate description of the building's foundation system cannot be provided. The Target Building is anticipated to be supported on 9¾-in. diameter micropile foundations, approximately 115-ft long, with a 200-ton capacity. Below-grade walls are anticipated to be constructed with reinforced normal weight concrete. Water stops will be provided in construction joints to safeguard against water intrusion.

For Target Building II and the adjacent Instrument Buildings, there are three main components considered related to deflection and settlement concerns. The deflection component is slab deflection between pile supports. The settlement components are pile shortening and soil consolidation, differential settlement between Target Building II and the Instrument Buildings, and differential settlement between beamlines in the Instrument Buildings. A study was conducted to explore the implications of slab deflection between foundation supports. The results of this study show that the slab deflection levels out and is no longer a concern with a 36-in. slab thickness and a pile spacing of 10×10 ft; therefore the thickness of the slab can be reasonably designed to mitigate the impact of deflection. Another study was conducted to investigate the effect of load sequence on the 1-mm settlement criterion. This study showed that there will be minimal impact to the center of the beamline installed, but there could be roughly 1/3 mm of settlement at the boundaries of the adjacent beamline. If the loading sequence potentially causing up to 1/3 mm of settlement is a concern, the instrument floors should be pre-loaded to prevent settlement issues arising from the load being applied in sequences. Finally, differential settlement due to micropile shortening and soil consolidation shall be evaluated by the geotechnical engineer in the next phase of the project. On-site load testing for long-term settlement of micropiles and subgrade is recommended.

Superstructure

The Target Building is anticipated to be a 3-story structure and a basement. The superstructure for the third floor and roof will be a conventional steel frame structure. The building will support the exterior wall system with steel girts as required. The typical slab forming the instrument level above the basement is anticipated to be a 5-ft-thick reinforced normal weight concrete slab, supported by concrete columns in the basement. Figures 8.8 and 8.9 show the various slab and wall thicknesses on the basement floor and first floor, as well as the criteria governing the element design thickness.

The target monolith bulk shielding is a 45-in.-thick heavyweight concrete wall, and the bunker shielding is a 60-in.-thick heavyweight concrete wall. Figure 8.10 shows the various wall and slab thicknesses and governing design criteria for the second floor of Target Building II. Where wide column spacing is required for beamline clearance, a turnup deep transfer beam/truss will be used.

Figures 8.8 to 8.10 show the concrete type for each of the slabs and walls throughout Target Building II. “NWC” means normal weight concrete with a minimum density of 145 lb per cubic foot. “HWC” means heavyweight concrete with a minimum density of 245 lb per cubic foot.

The third floor is anticipated to be constructed using reinforced normal weight concrete on a galvanized composite metal deck. The third floor will be supported on the bottom chord of a deep steel truss. The truss will be supported by steel columns extending from the instrument floor to the roof.

The roof structural system is anticipated to consist of metal truss framing with a roof deck meeting galvanizing G90 requirements. The AHUs for the Target Building II and the Instrument Buildings will be located on the third floor of Target Building II. Concrete pads will be provided for each AHU. Target Building II will share a column line with both the 40M and the 50M Buildings.

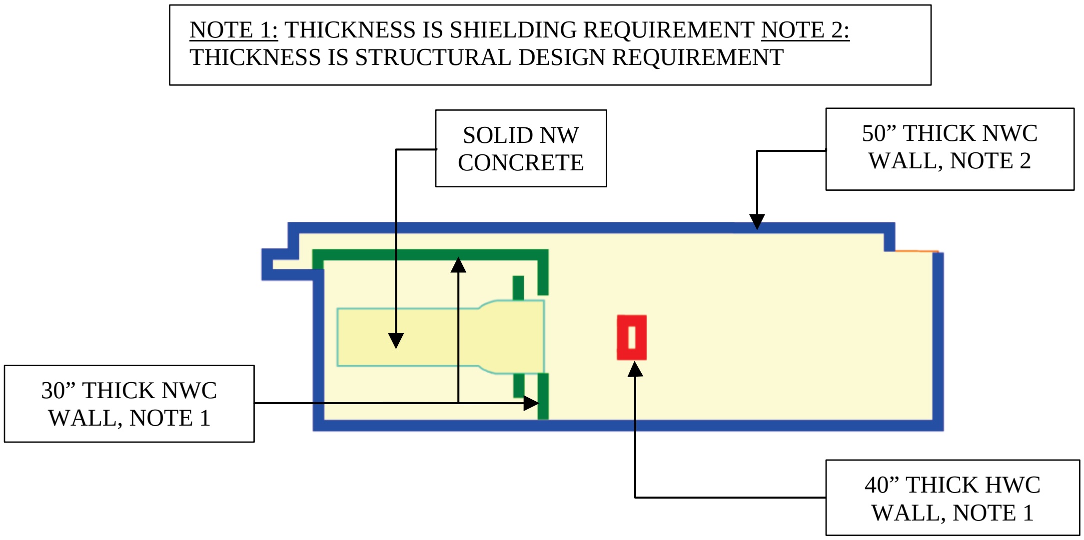


Figure 8.8. STS basement slab and wall thickness diagram.

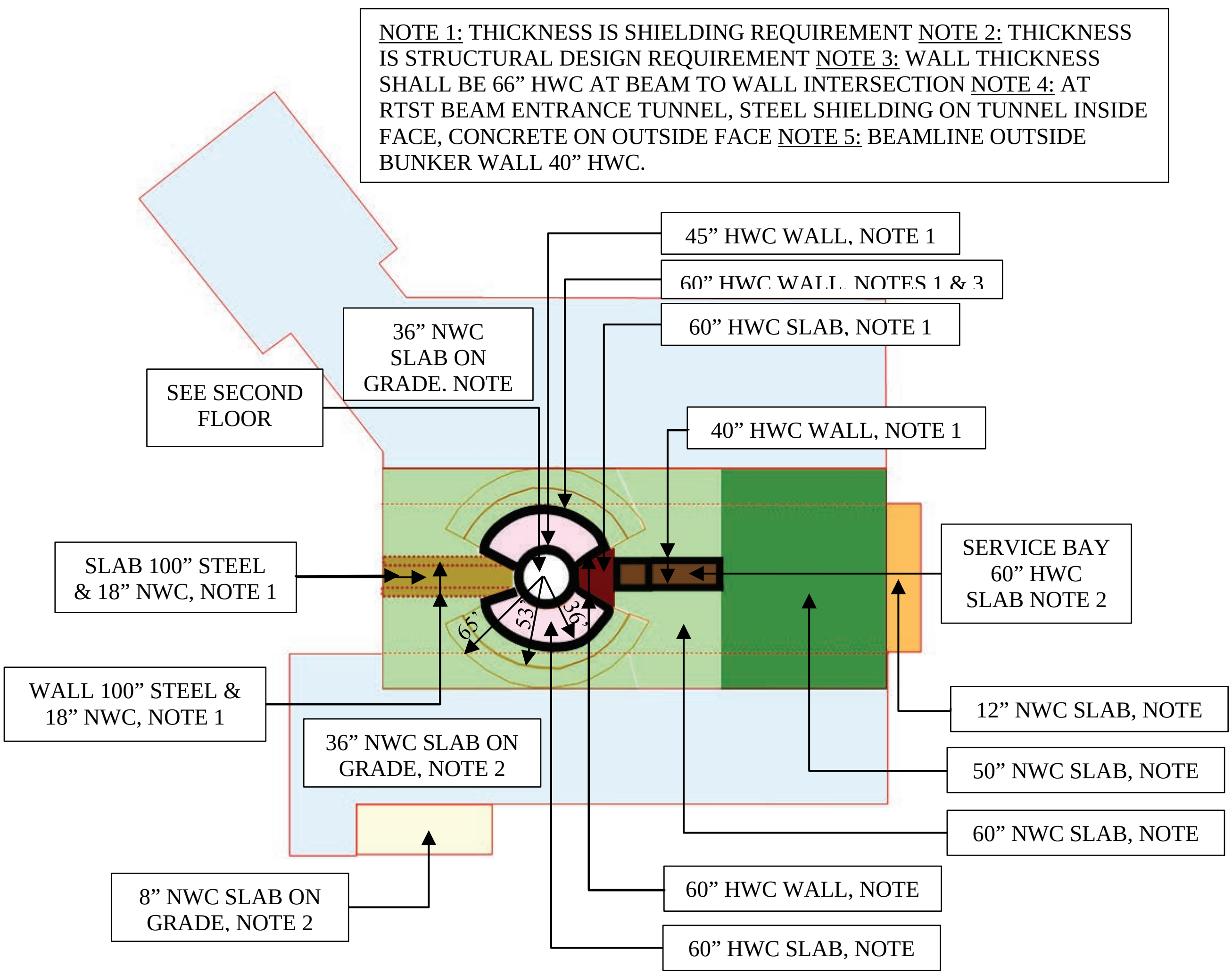


Figure 8.9. STS first floor slab and wall thickness diagram.

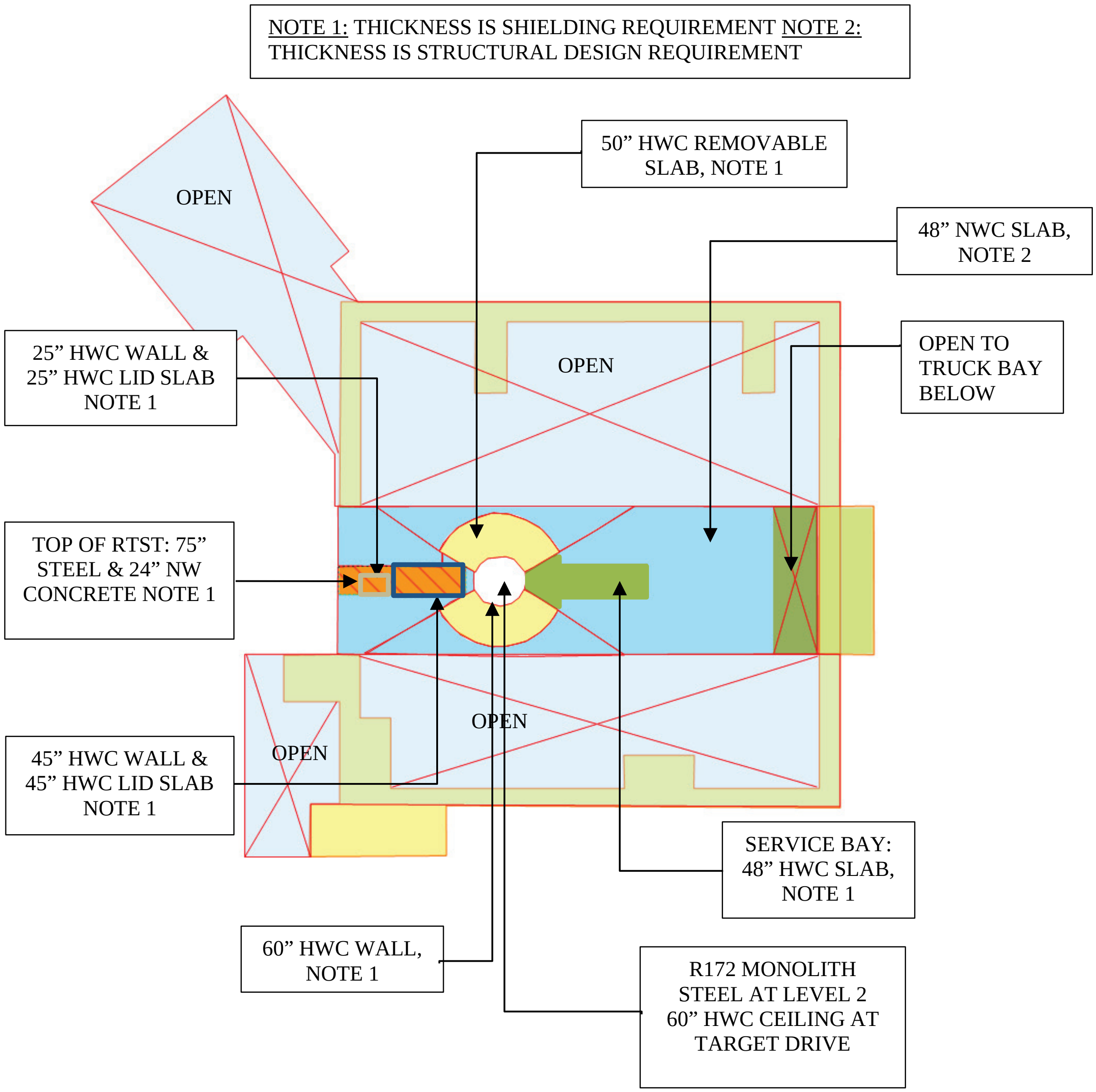


Figure 8.10. STS second floor slab and wall thickness diagram.

Lateral System

Resistance to lateral loads resulting from wind and seismic forces on the building are anticipated to be provided by concentrically braced steel frames and concrete shear walls.

Crane Supports

Steel framing will be provided to support the crane runways.

Geotechnical Analysis

A review of historical geotechnical and geophysical surveys was performed that included the original campus development and additional structures. A detailed geotechnical exploration performed by Law Engineering, dated June 30, 2000, addresses the original development of the campus (Law 2000). Two borings were drilled in the footprint of the proposed STS location and one boring in the vicinity of the possible STS location. The depth of soil in these borings ranged from 87.5 to 119.5 ft and indicated similar subsurface conditions as well as rock conditions to the FTS. It is anticipated that similar or greater loading conditions would be in service for the STS. The same deep foundation system used in the FTS, a micropile system, should support the STS. The potential for using drilled piers was considered; however, the average depth to rock as well as depth to competent rock would most likely exceed the capabilities of drilled pier rigs. Therefore, micropiles are the most suitable foundation system. The micropiles should be capable of supporting 200 tons/pile when designed using a 9¾ in. steel casing. The axial capacity should be confirmed using a pile load test.

A review of geophysical data and shear wave velocities from the Law report indicates that the target structure footprint would be located in a seismic site classification C as defined in IBC 2015 and ASCE 7 (Law 2000). This is confirmed by the average shear wave velocities for multiple soil profiles tested during the original campus development.

A supplemental geotechnical report would be advisable once the final target building location and footprint have been determined. The density and pattern of the soil test borings should be selected to optimize the quality of geotechnical data. Additional geophysical testing is not anticipated for the design of the structure.

Vibration Acoustics

The acoustical design will be consistent with achieving the following average noise levels. These noise levels do not include noise from owner-furnished equipment or personnel located within these spaces. Actual noise levels may exceed the design noise levels because of the actual type of equipment purchased, installation compromises, workmanship, and so on.

Room Type

- Break Room 40
- Controls 40
- Sample Lab 45
- Computer Room 50
- Maintenance Shop 55
- Computer/Server Rooms 55
- Mechanical Equipment Rooms 65

8.3.1.9 Mechanical

Air Handling/Ventilation

STS target and support spaces will be designated as building ventilation (tertiary), secondary confinement, or primary confinement, based upon usage with different ventilation strategies for each. Table 8.13 lists the ventilation criteria that apply to these areas.

Table 8.13. Target Building confinement space definitions and ventilation rates.

Space designation	Areas included	ACH	Notes
Building ventilation	All areas except as designated below[a]	8.0	Assume virtual/actual ceiling height of 10 ft for occupied spaces
Secondary confinement	Hot process vault Neutron beamline bunker Bunker Electronics Room GLS tank cavity Delay tank/full flow filter cavity Hot shop Activated sample lab hood Liquid low-level waste system Manipulator/service/charging areas High bay[b]	2.5(all)[2]	All spaces negative to building ventilation spaces
Primary confinement	Segmenting Area Crane Maintenance Bay Segmenting Bay Cask Loading Room Target Drive Room	4.0 4.0 2.5 2.5	All spaces negative to building ventilation and secondary confinement exhaust spaces

[a]See body of system description below for areas where conditions may vary.
[b]High bay area is primarily recirculated (at a rate of 2.5 ACH) through dedicated units with uncredited 99.9% filters, minimal exhaust of 0.25 ACH provided over entire space (exhausted through credited HEPA filters with balance of secondary confinement exhaust).

Pressure Relationships

All building areas containing potentially activated fluids will be exhausted using the primary or secondary exhaust systems and will be maintained at a negative pressure relative to the adjacent spaces.

Conditioned areas of building will be designed to be positive to ambient pressure. Pressure relationships within the buildings will be positive, negative or neutral to suit the functional requirement.

Unconditioned (ventilated only) areas of building that are conditioned using unit heaters and ventilation exhaust fans as described below will be negative to ambient pressure.

Indoor Air Quality Control Methods

There will be minimum filtration of outdoor/recirculated air: MERV 8 (30–35%) pre-filters and MERV 14 (90–95%) final filters at the building AHUs or as otherwise described below.

No fibrous media exposed to the airstream will be allowed in the ductwork downstream of any AHU's final filter bank.

Sound-attenuating flexible ducts at any office and support area diffusers will have woven nylon fabric type linings.

Outdoor air intakes for all AHUs will be located on opposite sides of the Target Building from the exhaust to minimize cross-contamination between intakes and exhaust air streams, and on the east side of the building to be downwind of the CEF II stack. A wind tunnel computer simulation is recommended for this project to corroborate the locations.

Target Building Central Air Handling Systems

The STS Target Building will be served by multiple CAV AHUs serving various portions of the facility. All units will be located in the truss space of the STS building, either within an enclosed mechanical room or on an open platform, as further described below.

High Bay Secondary Confinement Area

As shown in Table 8.13), the entire high bay space at the second level of the Target Building is a secondary confinement area. This space will be provided with a reduced ventilation rate, as described under the “Exhaust” subsection later in this section but will otherwise be conditioned through the use of two recirculating AHUs located on an open equipment platform within the truss space. The units will be manifolded together to provide partial redundancy (66% of the supply system design capacity through a single AHU) in the event of planned maintenance or unit failure, and will supply conditioned air through the truss space to the west end of the Target Building. The supply distribution system will consist of low-pressure ductwork to diffusers, and supply will be routed to the east and west ends of the building and introduced at the lowest levels of the high bay space. Sound attenuators at the air terminal devices will not be provided. Return air will be gathered at the center of the Target Building in a common return plenum located at the AHUs on the equipment platform and recirculated through return HEPA filters back to the units.

The recirculating AHUs will incorporate cooling coils and will contain a reheat coil for use in a dehumidification control cycle. Units are intended to operate 24 h/day, 365 days/year. Supply fans will be configured in a multi-fan array, plenum fan design. VFDs will be provided for setback control capability of the supply fan volume. The system will be designed for energy conservation adjustment with the potential to reduce ACHs (unoccupied setback change) controlled by the BAS. The recirculated air filtration system will consist of a 30% pre-filter rack and final 95% HEPA filter rack on the return side of the unit.

Primary and Secondary Support Area Makeup Air Handling System

The makeup air for primary and secondary support areas of the building on all floors will be served by two pairs of CAV 100% outside AHUs. Each of the AHU pairs will be housed independently, one in the enclosed mechanical equipment space located in the truss space at the east side of the Target Building (serving the east half of the high bay and east areas at the basement and first floors) and one on an open equipment platform within the truss space (serving the west half of the high bay and west areas at the basement and first floors). AHUs will be sized to be completely redundant; If one of the units should fail or have to be taken out of service for maintenance, the remaining unit will be able to provide 100% of the supply system design capacity.

All air supplied to these spaces will be exhausted using the primary or secondary confinement exhaust systems. The makeup AHUs will be designed as heating-cooling, single duct, reheat type. The units will operate 24 h/day, 365 days/year. Supply fans will be configured in a multi-fan array, plenum fan design. VFDs will provide the capability of simplified manual control of the supply fan volume for ease of balancing.

Ductwork will be routed at the sides and/or ends of the building to avoid conflict with the high bay crane. The supply distribution system will consist of low-pressure ductwork with pressure-independent electrically actuated supply CAV air terminal devices, reheat coils, and low-pressure ductwork downstream of air terminals to diffusers. Sound attenuators at the air terminal devices will not be provided.

Tertiary/Target Support Area Central Air Handling System (Building Ventilation)

The tertiary/target support portions of the building on all levels will be served by two CAV AHUs. The units will be manifolded together and will share a common discharge plenum to provide partial redundancy (66% of the supply system design capacity through a single AHU) in the event of planned service or a complete unit failure. The AHUs will be designed as heating-cooling, single duct, reheat type. The units will operate 24 h/day, 365 days/year. Supply fans will be configured in a multi-fan array, plenum fan design. VFDs will provide supply fan volume control in response to a signal from duct-mounted static pressure sensors and will allow for setback control capability of the supply fan volume. VFDs will also provide return fan volume control in response to a signal from air flow measuring stations used to establish volumetric offset between the return air and the supply air quantities. The system will be designed for energy conservation adjustment with the potential to reduce ACHs (unoccupied setback change) controlled by the BAS. The system will be designed to maintain minimum outside air quantities in order to maintain positive pressure in tertiary spaces but will also be capable of full economizer mode.

The AHUs will be housed in the enclosed mechanical equipment space located in the truss space at the east side of the Target Building. Ductwork will be routed at the east end of the building to avoid conflict with the high bay crane. The HVAC distribution system shall be pressure-independent, CAV control for all spaces. All terminal boxes and reheat coil valves shall be serviced from within the spaces they serve. All terminal units will be positioned for easy access with a minimum of 36-in. of service space on the panel/actuator side. All terminal reheat control valves serving the target support spaces shall fail closed.

Relief air from the tertiary areas will be routed through the mechanical equipment room in the truss space to provide a tempered environment within this space. Excess air in the penthouse will be relieved through wall-mounted louvers and associated barometric relief dampers.

The supply distribution system will consist of low-pressure ductwork with pressure-independent electrically actuated supply CAV air terminal devices, reheat coils, and low-pressure externally insulated ductwork downstream of air terminals and diffusers. Sound attenuators at the air terminal devices will not be provided. Sound-attenuating flexible duct used at diffusers will be limited to 6 ft in total length to minimize duct static pressure losses.

Hydrogen Utility Room HVAC System

The Hydrogen Utility Room will be designed with a 100% outside air, single pass, HVAC concept. Outside air will be drawn in through a roof-mounted intake hood. Hot water heating and CHW cooling coils will be provided in the intake ductwork to control space temperature while still maintaining an explosion-proof environment. All ventilation/purge air will be drawn through the space using roof-mounted exhaust fans as described under the “Exhaust” subsection later in this section.

Helium Compressor and Refrigeration Spaces

The Helium Compressor and refrigeration rooms will be ventilated only, with unit heaters provided for freeze protection. Ventilation will be achieved through the use of roof-mounted exhaust fans and associated wall-mounted intake air louvers with motorized dampers. Heating for these spaces will be accomplished using electric unit heaters located within the space.

Exhaust

Primary and Secondary Confinement Area Exhaust Systems

All building areas containing potentially activated fluids will be exhausted using the primary or secondary confinement exhaust systems and will be maintained at a negative pressure relative to the adjacent spaces. All air supplied to these spaces will be single pass (with the exception of the second floor high bay recirculation as noted earlier). Each space will be exhausted using the primary confinement or secondary confinement exhaust system, depending on designation (see Table 8.13). A hot-off gas exhaust system will also be provided for activated exhaust from equipment. These systems within the building will be constructed of welded type 304L stainless steel thin wall (Sch 10) piping. All exhaust air will be collected and routed through multistage nuclear-grade type HEPA filter banks located at the basement level. The exhaust discharge stream will be routed from the filter banks along the north side of the Target Building basement and underground to the CEF II. HDPE will be used for underground ducts.

The primary confinement exhaust filtration system is expected to consist of two 304L stainless steel, two-wide filter banks (eight filters total). Each filter bank will have butterfly isolation valves, two stacked pre-filters, test sections, two HEPA filter sections, test sections, two HEPA filter sections, a test section, and final butterfly isolation valves. Each of the two trains will also have a fire screen.

The secondary confinement exhaust filtration system is expected to consist of 4 304L stainless steel, 4-high filter banks (16 filters total). Each filter bank will have a butterfly isolation valve, pre-filter, test section, HEPA filter section, test section, and final butterfly isolation valve. The hot off-gas filtration system is expected to consist of two 304L stainless steel, two-high filter banks (eight filters total). Each filter bank will have a butterfly isolation valve, charcoal iodine adsorber, pre-filter, test section, HEPA filter section, test section, HEPA filter section, test section, and final butterfly isolation valve.

Primary and secondary confinement exhaust and hot off-gases will be gathered from all areas of the facility as indicated and routed through the HEPA filter banks at the basement-level filter room, and along an exhaust rack at the north side of the target building basement out to the CEF. Main duct headers will be 14-in. diameter for primary and 30-in. diameter for secondary confinement exhaust and 10-in. diameter for hot off-gases.

Hydrogen Utility Room Exhaust System

The exhaust system for the Hydrogen Utility Room will consist of a single ventilation exhaust fan with an estimated capacity of approximately 700 cfm (1 cfm/sf), as well as two roof-mounted purge exhaust fans with an estimated capacity of 10,000 cfm each (1 cfm/ft^3). The ventilation exhaust fan shall operate continuously. Purge exhaust fans shall operate if activated by hydrogen detection system. Purge fans will be completely redundant, with one purge fan operating as lead and the other as standby. All exhaust fans shall be of spark-free construction and provided with explosion proof motors.

Target Support Area General Exhaust System

Target support spaces requiring exhaust will be served by one combined exhaust system serving general exhaust requirements. General exhaust duct risers will be provided from each floor and will connect at a penthouse level to a roof-mounted common plenum exhausted by two vertical radial dilution fans. The general exhaust terminals served by the exhaust system will be constant-volume devices; therefore, the exhaust system will operate at constant volume. The system shall incorporate outside air bypass control technologies to maintain a stack discharge velocity of approximately 3500 fpm. The general exhaust fans will discharge at a minimum of 10 ft above the roof or as determined by wind tunnel testing. The exhaust system will operate 24 h/day, 365 days/year. A system is provided for connection of lab and instrument hoods.

Two fans will be provided to serve the common exhaust plenum, each sized at 100% of the load. If one of the fans fails, the remaining fan will be able to provide 100% of the common exhaust system design capacity. All the fans in the common exhaust plenum should be on emergency power to ensure continuous hazardous material containment but would be controlled to run at a reduced speed during a power outage to limit the negative pressure impact to the building.

General utility set exhaust fans will be provided to exhaust toilet rooms, janitor closets, and other rooms requiring ventilation at a minimum rate according to their code requirements. A total of ten fans will be distributed across the facility at the high bay roof to connect exhaust loads from throughout the Target Building.

Space Conditioning

Primary and Secondary Support Area Supplemental Cooling System

All primary and secondary confinement areas of the building (other than the second-floor high bay) will be provided with localized supplemental cooling to reduce the volume of air supplied to those spaces for ventilation requirements only. Supplemental cooling will be provided through local fan-coil units located within the spaces. To eliminate the need for treatment of potentially activated cooling coil condensate, the fan-coil units will be supplied with sensible cooling CHW that will be controlled to above the dew-point temperature of the spaces.

Fan coils will be provided at a maximum 1,500 SF spacing and a minimum of two per room in each primary/secondary confinement exhaust area to support sensible cooling.

Cryogenic Moderator System (CMS) Control Room

Supplemental cooling will be provided for the CMS Control Room through local fan-coil units located within the space. The fan-coil units will be supplied with CHW. Two fan coils will be provided for redundancy.

Chilled Water

The CHW system for the building will be supplied from CUB II. Based on an estimated flow of 3050 gpm to serve the Target Building, which includes CHW flow to air handlers (including Target Building-II, 40M, and 50M), sensible cooling HXs, hot off-gas condensing HXs, and the associated instrument areas except 90M, the CHW branch line size to this building is expected to be 12 in. CHW will be routed to cooling coils in all AHUs and HXs throughout the building from a point of entry at the east end of the lower level in the mechanical and maintenance storage area.

Tower Water

The tower water system for the building will be supplied from CUB II. Based on an estimated flow of 615 gpm to serve the Target Building, which includes tower water flow to technical cooling HXs, the tower water branch line size to this building is expected to be 6 in. Tower water will be routed to HXs throughout the building from a point of entry at the east end of the lower level in the mechanical and maintenance storage area, and a separate 4-in. service line will be routed separately to the Helium

Compressor Room as a second point of entry at the northwest side of the building. Tower water will be filtered before use in compressor cooling.

Technical Cooling Water

Secondary Technical Cooling Water Systems

Two secondary technical cooling water systems will be required to support the three primary technical equipment cooling water systems. These systems will be located in the target secondary containment support area (HPV) and will serve the target, proton beam window, inner reflector plug, and reflectors, moderators and core vessel inserts. The secondary technical cooling water systems will provide DI water with a resistivity in the range of 1 to 3 megohm/cm, using a slip stream polishing loop. The pumps, HX, conditioners, sterilizers, and filter components will be located in the basement level mechanical area. A higher-temperature technical cooling water system will provide secondary DI water using tower water, and a second system will provide lower-temperature secondary DI water using CHW. The higher-temperature cooling loop will support a 900 KW load using 800 gpm of cooling tower water for the target, target shroud, and beam stop. The lower-temperature cooling loop will support a 70 KW load using 18 gpm of CHW and will serve the moderators. Pipe sizes for the 800 gpm higher-temperature and 18 gpm lower-temperature cooling loops are estimated at 8 in. and 1½ in., respectively.

Two additional CHW cooling water systems will be provided to support space cooling in the instrument buildings. These CHW cooling systems will consist of independent loops distributing the building CHW. The loops will originate in the basement-level target support mechanical area and will be routed through each of the instrument buildings, with separate valved connections provided at each of the beamlines (22 total).

Sensible Cooling Water System

A sensible cooling water system will be provided to support fan-coil equipment in areas where condensate is to be avoided because of the potential for radiological activation. The sensible CHW cooling system will consist of an independent pumped loop that rejects heat to the building CHW through a plate-and-frame HX. The system will be designed to operate at a supply temperature of 55–60°F to reduce the potential for condensation. The tank, pumps, HX, filters, and chemical treatment components will be located in the basement-level target support mechanical area. Two variable-speed process cooling water pumps will be sized to provide 100% of the design flow rate each. If one of the booster pumps were to fail, the other remaining pump would provide 100% redundancy.

Two additional sensible cooling water systems will be provided to support instrument cooling in the instrument buildings. These sensible CHW cooling systems will consist of independent pumped loops that reject heat to the building CHW through plate-and-frame HXs. The system will be designed to operate at a supply temperature of 55–60°F to reduce the potential for condensation. The tank, pumps, HX, side stream filters, and chemical treatment components will be located in the basement-level target support mechanical area. Two variable-speed process cooling water pumps at each system will each be sized to provide 100% of the design flow rate. If one of the booster pumps were to fail, the other remaining pump would provide 100% redundancy.

Heating Water

The heating water system for the building will be supplied from the CUB II. Based on an estimated flow of 400 gpm to this building, the heating water branch line size to the building is expected to be 6 in. The building heating water distribution system will serve pre-heat and reheat heating water coils within the building. Hot water will be routed to heating coils in all AHUs and for pre-heat and reheat applications throughout the building from a point of entry at the east end of the lower level in the mechanical and maintenance storage area.

Controls

The STS Target Building shall be controlled by the EPICS. The building will be connected to an expansion of the existing EPICS. Instrumentation and wiring shall be connected to a new EPICS PLC in the building, and controls interface for the building will be provided at the target control room and on each floor. Programming and connection of the PLC to EPICS shall be completed and the control system commissioned to ensure proper operation.

Electric/pneumatic actuation will be used for all control valves and dampers on both systems so that instrument air is required. All control systems will be on UPS and emergency power. System software and firmware will provide the following functions:

- Control sequences shall be developed to support the operation of the technical equipment.
- PID control to allow faster and closer control to system set points.
- Adaptive tuning to adjust PID loop constants to ensure that the control system response remains accurate and reliable over a wide range of dynamic operating conditions.
- Monitoring to read the value of measured variables, read control loop set points, monitor control signals to actuators, and indicate status of equipment, alarms and overrides.
- Energy management including optimum start/stop, variable ACH rates in laboratories, duty cycling, supply air temperature reset, supply air static pressure reset, demand limiting, time totalization, and so on.
- Data management, including continuous database updating, alarm reporting, trend logging, and report generation.
- System programming to add, delete, or change points, set points, schedules, control algorithms, report formats, and so on.
- System software will allow building operators to graphically monitor and control building operations and provide the functions listed. Graphics will include site plans, overall building plans, floor plans and individual system graphics.

Equipment

Table 8.14 provides a listing of air side mechanical equipment servicing the Target Building.

Table 8.14. Target Building mechanical equipment air side.

Use	Equipment	Size	Qty	Em pwr	Redund	Location	Remarks
Tertiary support	CAV AHU	28,000 cfm	2	N	33%	Truss mech rm	
High bay recirc air	CAV AHU	30,000 cfm	2	N	33%	Truss platform	HEPA filtered

Table 8.14. Target Building mechanical equipment air side (continued).

Use	Equipment	Size	Qty	Em pwr	Redund	Location	Remarks
Primary/ second confinement exhaust support area	CAV makeup air (MUA)	16,000 cfm	2	N	33%	Truss platform	MUA unit
Primary/ second confinement exhaust support area	CAV MUA	13,000 cfm	2	N	33%	Truss mech rm	MUA unit
Hydrogen Utility Rm vent	100% outside air (OA) intake hood	10,000 cfm	1	N	–	Hydrogen utility roof	CC/HC included
Hydrogen Utility Rm vent	Exhaust fan	700 cfm	1	N	–	Hydrogen utility roof	Ventilation only (1 cfm/SF)
Hydrogen Utility Rm purge	Exhaust fan	10,000 cfm	2	Y	N+1	Hydrogen utility roof	Purge fans (1 CFV/ft^3)
Helium compressor vent	100% OA intake hood	4,000 cfm	1	N	–	Helium compressor roof	
Helium compressor vent	Exhaust fan	2,000 cfm	2	N	–	Helium compressor roof	Ventilation only
Helium refrigerator vent	100% OA intake hood	2,000 cfm	1	N	–	Helium ref. roof	
Helium refrigerator vent	Exhaust fan	1,000 cfm	2	N	–	Helium ref. roof	Ventilation only
Target Building II gen. exhaust	General exhaust fan	1,000 cfm	10	N	–	STS roof	
Target Building II fume exhaust	Radial exhaust fans	2,500 cfm	2	N	N+1	STS roof	Lab fume hood exhaust
Primary confinement support area	Primary confinement exhaust filter	2 HEPA/ train	4	N	–	Filter train rm	
Secondary confinement exhaust support area	Secondary confinement exhaust filter	1 HEPA/ train	16	N	–	Filter train rm	
Instrument exhaust	Hot off-gas exhaust filter	2 HEPA/ train	3	N	N+1	Filter train rm	

Air Handlers

General

- All AHUs will be semi-custom, factory-fabricated, and constructed with 2-in.-thick double walls, constructed of galvanized steel.
- Maximum allowable nominal face velocities:

- Air intake louvers (through free area): 350 fpm
- Heating water coils: 500 fpm
- Cooling coils: 400 fpm
- Filters: 400 fpm

AHUs

AHUs in mixed-use spaces where recirculation is allowed, modular, semi-custom, 2-in. double-wall construction configured as follows:

- Mixed air plenum
- Intake isolation damper
- Return/exhaust damper
- Supply fans (4 to 6 fan array)
- Relief fans (4 to 6 fan array)
- VFDs
- Economizer section
- Merv 8 (30%) prefilter section
- Hot water preheat coil
- CHW coil
- Hot water reheat coil
- Supply fans (4 to 6 fan array)
- VFDs
- Merv 14 (95%) final filter section
- Supply plenum
- Isolation/smoke damper
- Access sections
- Doors: safety glass windows and quarter turn handles
- Marine light in each access section
- Vibration isolation in accordance with ASHRAE HVAC Applications—Noise and Vibration Control

AHU

Makeup air units, 100% outside air, modular, semi-custom, 2-in. double-wall construction configured as follows:

- 100% outside air
- Intake isolation damper
- Outside air plenum
- Merv 8 (30%) prefilter section
- Energy recovery coil section
- Hot water preheat coil
- CHW coil
- Hot water reheat coil
- Supply fans (4 to 6 fan array)
- VFDs
- Merv 14 (95%) final filter section
- Supply plenum
- Isolation/smoke damper

- Access sections
- Doors: safety glass windows and quarter turn handles
- Marine light in each access section
- Vibration isolation in accordance with ASHRAE HVAC Applications—Noise and Vibration Control

100% recirculating AHUs, modular, semi-custom, 2-in. double-wall construction configured as follows:

- Return air plenum
- Return fans (4 to 6 fan array)
- VFDs
- Merv 8 (30%) prefilter section
- CHW coil
- Hot water reheat coil
- Supply fans (4 to 6 fan array)
- VFDs
- Merv 19 (99.9%) final filter section
- Supply plenum
- Isolation/smoke damper
- Access sections
- Doors: safety glass windows and quarter turn handles
- Marine light in each access section
- Vibration isolation in accordance with ASHRAE HVAC Applications—Noise and Vibration Control

Exhaust Fans

General/Lab Exhaust Fans

General/lab fans will be vertical, radial dilution exhaust fans with spark-proof construction with bearings and motors out of the airstream. Fans will have a baked epoxy air side chemical-resistant coating. The common plenum and outside air intake dampers will be of galvanized steel construction with a chemical-resistant coating. The system will consist of the following components:

- Common exhaust plenum
- Isolation damper at each fan inlet
- Vertical exhaust fans
- Exhaust stacks
- Bypass air inlet and bypass damper
- VFDs

Utility Set Exhaust

These will be backward-inclined, belt-driven centrifugal fans with spark-proof construction and bearings and motors out of the airstream. Fans will be single width, single inlet with a galvanized steel housing and wheel construction. The fan motor will be totally enclosed and fan cooled. The system will consist of the following components:

- Steel mounting rails with vibration isolators
- Isolation damper at the fan inlet
- Discharge ductwork with bird screen

- Weather cover
- VFDs

Water-Based Systems

Table 8.15 provides a listing of water side mechanical equipment servicing the Target Building.

Table 8.15. Target Building mechanical equipment water side.

Use	Equipment	Size	Qty	Em pwr	Redund	Location	Remarks
Target equipment cooling	Secondary technical cooling water pumps	800 gpm @ 100 ft	2	N	N+1	Mech rm	Higher-temp instrument cooling loop
Moderator building cooling	Secondary technical cooling water pumps	20 gpm @ 100 ft	2	N	N+1	Basement mech room	Lower-temp instrument cooling loop
Sensible instrument cooling	Sensible CHW pumps	500 gpm @ 100 ft	2	N	N+1	Mech rm	
Chilled water (CHW) to sensible CHW	Plate-frame HX with filtration skid	500 gpm	2	N	–	Mech rm	
Target equipment cooling	Technical DI water cooling skid with slip stream polisher	800 gpm	1	N	–	Mech rm	Higher-temp instrument cooling loop (tower water cooled)
Moderator building cooling	Technical DI water cooling skid with slip stream polisher	20 gpm	1	N	–	Mech rm	Lower-temp instrument cooling loop (chw cooled)
Stand-alone cooling	Fan coil units	2–3-ton units	16	N	–	Varies	Control rm/ elec/HVAC rms
Target Building II heating	Electric unit heaters	15 kw	6	N	–	Varies	Building heating

Sensible Cooling Water Systems

Sensible CHW cooling systems will consist of an independent pumped loop that rejects heat to the building CHW through a plate-and-frame HX. The tank, pumps, HX, filters, and chemical treatment components will be located in the basement-level target support mechanical area. The system will include the following equipment:

- Base-mounted, end suction, centrifugal pumps
- Pump VFDs
- CHW plate-and-frame HX
- Water filtration
- Automated chemical treatment system
- Makeup water assembly

- Appropriate valving and piping specialties
- CHW supply to HX

Technical Cooling Water Systems

Secondary technical cooling water systems will provide DI water with a resistivity in the range of 1 to 3 megohm/cm, using a slip stream polishing loop. All piping, valves, HX, expansion tanks, and equipment on the DI cooling water pump skids will be stainless steel. Each system will include the following equipment:

- Base-mounted, end suction, centrifugal pumps
- Pump VFDs
- Plate-and-frame HX
- Mixed bed deionizers
- Resin trap filtration
- Ultraviolet sterilizer
- Air separator and expansion tank
- Makeup water assembly
- Appropriate valving and piping specialties
- Tower or CHW supply to HX (see description for each building)

Motors

All motors shall be premium-efficiency type and built to National Electrical Manufacturers Association (NEMA) standards.

- Variable-speed motors shall be rated as inverter duty motors. All motors operating with VFDs shall be equipped with shaft grounding rings or insulated bearings to prevent the accumulated pulse width modulation (PWM) frequencies in the shaft from arcing across the bearing, causing pitting and premature bearing and motor failure.

- All VFDs shall be provided with power filters to improve the building power quality from the occurrence of multiple VFD installations.

General

System Design Criteria

Outside Design Temperatures

- Summer: 92.8°F DB, 73.8°F MCWB (0.4% ASHRAE)
- Winter: 17.1°F (99.6% ASHRAE)

Interior Design Conditions: Preliminary Load and Ventilation Assumptions

Table 8.16 provides a listing of Target Building preliminary load and ventilation assumptions.

Table 8.16. Target Building preliminary load and ventilation assumptions.

Space	Design set points	Cooling: BTU/SF	Heating: BTU/ SF	Airflow: cfm/SF or ACH	Ventilation
Mechanical/ electrical	60–85°F	80	40	2	Code-required
Second-level high bay	72–76°F, 60% >RH	40	40	0.25	Code-required
Office/office support/control areas	72–76°F, 60% >RH	40	40	1.25	Code-required
Laboratory	72–76°F, 30–60% RH	80	60	8 ACH	100% OA
Loading/service areas	60–85°F	–	40	2	Code-required
Toilets/shower	72–76°F, 60% >RH	40	40	10	Code-required

Notes:

Cfm/SF and values are schematic design-level assumptions. The final values of the project will be calculated based on code requirements or heating and cooling demand, whichever is greater.

Supply air rate in all laboratories will be a minimum of 8 ACH or as required for makeup of fume hood exhaust air. Additional cooling shall be provided by fan coil units if required to meet heat loads generated in the laboratories.

HEPA filtration will be provided as necessary for laboratory supply and exhaust systems to support individual space use.

Active humidity control will not be provided for any building. Therefore, HVAC units will not have a humidification capability. The maximum relative humidity should not exceed 60% because of moisture removal at the cooling coils.

Chilled Water

- Supply 42°F (to buildings), 44°F (to AHUs)
- Return 56–58°F

Sensible Technical Cooling Water (Chilled)

- Supply 55–60°F
- Return 5°F above supply

Technical Cooling Water (Tower Fed)

- Supply 87°F
- Return Dependent on mixed water temperature from equipment (generally 130°F maximum)

Tower Water

- Supply 80°F

- Return 100°F

Materials

Duct Distribution Systems

Ductwork Materials and Construction

- Supply ductwork construction will be based on SMACNA 4-in. pressure class and 2-in. pressure class. Four-inch pressure duct construction will be used upstream of VAV boxes on variable-volume units; 2 in. pressure class duct construction will be used downstream of VAV boxes on variable-volume units and for all ductwork on constant-volume units. All ductwork seams and joints shall be sealed, regardless of pressure rating. Maximum permissible leakage = 2%.

- All supply ductwork routed through unconditioned spaces shall be insulated with 2-in. foil-faced batts or foil-faced duct board with similar R-value.

- Return and general exhaust ductwork construction shall be based on SMACNA 2-in. pressure class.

- General laboratory exhaust ductwork shall be constructed to a 6-in. SMACNA pressure class.

- HEPA filtered laboratory exhaust ductwork shall be constructed to a 10-in. SMACNA pressure class.

- Return air duct shall be insulated with 1½-in. foil-faced batts or duct board. Laboratory exhaust ducts shall not have fire dampers.

- General air distribution ductwork will be G90 galvanized sheet metal.

- Wet laboratory and chemical storage exhaust will be welded 316L stainless steel.

- Primary and secondary confinement exhaust/hot off-gas shall be welded 304L stainless steel thin wall tube (Sch 10 or less) within building, HDPE underground.

- Exterior supply or return ductwork shall be solid double-wall ductwork with a minimum 2-in.-thick insulation or single-wall duct with 2-in. duct board, vapor barrier, and aluminum jacket.

- Rectangular and round ductwork shall be fabricated in accordance with SMACNA standards. Spiral-wound ductwork shall be a prefabricated system with factory certifications. Spiral-wound ductwork shall not be used for laboratory exhaust systems or other systems that may be exposed to water intrusion.

- Sound attenuation will be provided to meet the project requirements or in accordance with the direction of the project acoustician. Sound attenuation shall be by appropriate application of attenuators or duct design.

- Lined ductwork shall not be used, except for plenum return air-transfer boots for noise control. VAV air terminals shall be double-wall or have foil-faced inner surfaces.

- Flexible ductwork is limited to 5 ft and shall be used only downstream of VAV terminals. Flexible ductwork shall be limited to supply air systems only.

- Plenum return may be used for return air in all non-laboratory portions of buildings.
- Ductwork shall be sized as shown in Table 8.17.
- Spaces on VAV systems shall have conventional supply terminal boxes with hot water reheat coils and integral sound-attenuating characteristics.
- Smoke detection will be provided in accordance with NFPA 90A and IMC requirements.

Table 8.17. Target Building ductwork sizing.

	Risers	Submains	Branches	Air distribution device neck velocity (fpm)
Max P.D.	0.1 in./100 ft	0.08 in./100 ft	0.08 in./100 ft	450 fpm

Piping

Tower Water/Chilled Water/Sensible Chilled Water

- Interior piping, sizes 2 in. and smaller Type L copper with brazed fittings.
- Interior piping, 2½ in. and larger shall be either Type L copper with brazed fittings or Sch 40 steel pipe with either welded and flanged joints or mechanical grooved fittings.
- Underground CHW piping serving the building will be distributed in a pre-insulated, factory-fabricated coated steel piping system or HDPE.
- Underground tower water piping serving the building will be distributed in a factory-fabricated coated piping steel system or HDPE.
- All piping will be tested at 1.5 times the design system pressure.
- All interior CHW piping shall be insulated with closed-cell elastomeric insulation. Properties shall meet or exceed the minimum energy code requirements.
- All piping in mechanical rooms and piping exposed below 8 ft AFF shall have a PVC jacketing.
- All piping exposed to the exterior shall have an aluminum jacket.
- CHW and tower water services shall be provided with a BTU meter at building entry.

Technical Cooling Water (DI Water for Instrument Cooling Downstream of HXs)

- For sizes 2 in. and smaller, ASTM 312 Sch 10S, seamless, 304L stainless steel, plain ends. (Victaulic Vic-Press system or butt-welded, as specified)
- For sizes 2½ in. and larger: ASTM 312 or ASTM 358, Sch 10 ERW 304L stainless steel, Class 4. (Victaulic Vic-Groove system or butt-welded, as specified)

- For sizes ½ to ¾ in. OD tubing, ANSI Type 304L stainless steel, ASTM A213, Grade TP304L, seamless, annealed, minimum 0.065 in. wall thickness.

- Vents and drains: For sizes ½ to ¾ in. NPT, ANSI Type 304L Sch 40 SST pipe

- Fittings:
  - Welded fittings: ASTM A403, Grade WP-S304L or WP-W304L, elbows: standard 1.5× radius. Full penetration butt weld
  - Welded flanges: ASTM A 182, Grade WP-S304L, raised face weld neck
  - Vic-Press or Vic-Groove 10S system, ASTM-312 304L SST
    - Plain end or grooved ends shall be ASTM A-312 304L SST
    - Vic-press flanges shall be ANSI Class 150, 304L SST, Van Stone type, carbon steel raised face slip-on backing flange, Victaulic style 565
    - Grooved couplings: galvanized coated ductile iron conforming to ASTM A-536, galvanized, stainless bolts, Victaulic style 89.
    - Threaded outlets shall be ASTM A-312 or ASTM A-276 304L SST
    - Seals shall be Grade H NBR, temperature range –20 to 210°F

  - Flange gaskets: Garlock Blue-Gard style 3000 gaskets (1/8 in. thick)

- Based on anticipated water temperatures, technical cooling water piping will not be insulated.

Heating Water

- Interior piping 2 in. and smaller shall be Type L copper with brazed fittings.

- Interior piping 2½ in. and larger shall be either Type L copper with brazed fittings or Sch 40 steel pipe with welded and flanged joints.

- Underground hot water piping serving the building will be distributed in a pre-insulated, factory-fabricated coated steel piping system.

- Interior heating water piping shall be insulated with rigid glass fiber insulation.

- Piping exposed to the interior shall have a PVC or aluminum jacket. Piping exposed to the exterior shall have an aluminum jacket.

- Heating water will be provided with BTU meter at building entry.

Seismic Criteria

Referenced Standards and Design Criteria:

- Seismic bracing shall be in compliance with ASCE 7-10.

- Equipment mounted on isolators will be seismically braced using loose cables, telescoping pipes, or box sections, angles or flat plates used as limit stops or snubbers, either integral to or separate from the isolators.

- Nonrotating, fixed equipment will be bolted directly to the floor or structure.

Mechanical Calculations

Mechanical calculations are provided in Appendix C for both air side and cooling water side.

Sustainable Design Strategies

The following energy conservation measures will be incorporated into the HVAC design:

- DDC BAS for optimization of major HVAC equipment operation.
- Variable-volume supply and exhaust system in combination with stand-alone controllers to provide maximum flexibility in occupied/unoccupied space control scheduling, thus minimizing supply and exhaust air volumes.
- Supply air temperature is to reset to minimize air conditioning of outside air and subsequent reheating of conditioned air.
- Supply air volume from AHUs will be reduced to minimum levels without compromising safety. During occupied hours, room supply air volume is set at the maximum air flow required to provide exhaust makeup air, minimum required ventilation, or space cooling. This will be accomplished using the VAV air systems and DDC volumetric offset controls.
- Variable-speed drives (VSDs) installed on all VAV AHU supply and return fans to reduce fan horsepower requirements of non-peak conditions.
- VSDs installed on all pumps to reduce pump horsepower requirements at non-peak conditions.
- Full economizer control on all mixed AHUs to reduce consumption while maintaining appropriate indoor humidity levels.

8.3.1.10 Electrical

Site Power Distribution

Target Building II will be provided with 480 Y/277 V secondary service from a 3000 A feeder duct bank from 2000 kVA outdoor substation TA2-SS1 to the Electrical Service Room.

Building Power Distribution

The 3000 A, 480 Y/277 V low-voltage switchgear in the Target Building II outdoor substation will distribute power to CF loads and instrument loads. Two 800 A distribution panels located in both north and south science areas are anticipated for separation of services to instrument and CF building loads.

Two 200 A, 4160 V medium voltage feeders from the 4160 V substation will service the two helium compressors.

Separate transformers will be provided where possible to service instrument loads.

Service to the following cranes will be provided:

- 50-ton: second floor (high bay)

- 5-ton: maintenance shop
- 10-ton: hot shop
- 10-ton: helium compressor
- (2) 5-ton: Javelins

Equipment and raceways in the Hydrogen Utility Room will be rated Class 1, Division 2.

Secondary Distribution

- Building secondary distribution will generally be 480 V, 3-phase, 4-wire, plus ground. This will provide service to CF lighting, receptacles, and HVAC loads as well as building instrumentation loads. Further transformation down to 208 Y/120 V, 3-phase, 4-wire, plus ground will be provided for general use receptacles and other low-voltage equipment as necessary.

- All conventional building use dry type transformers will be DOE 2016 rated for efficiency, 115°C rise, 220°C insulation class with six 2.5% taps. Consideration will be given for harmonic or K-rated transformers and oversized neutrals to handle the heating effects of the harmonic loading.

- Circuit protection will be
  - Where 480-V distribution is provided, the exterior unit substation secondary will be of low-voltage switchgear UL 1558 construction with electrically operated drawout power circuit breakers with solid state adjustable trips.
  - Generally molded case circuit breakers. Solid state adjustable trip units will be provided above 250 A.
  - Bolt-in type molded case circuit breakers for branch circuit panelboards.
  - 100% rated for service entrance main circuit breakers, 80% rated otherwise.

- Devices will be fully rated. Series ratings of protective devices will not be acceptable.

- Two levels of ground fault protective devices will be provided at the main and feeder breakers at service switchgear assemblies.

- A contactor arrangement will be provided in main elevator feeders to comply with elevator shaft sprinkler code requirements.

Emergency Power Supply System

EPSS Power Generation Plants

The Target Building II and 40M Building will be provided with building and instrument standby power from an exterior 1000 kW/1250 kVA, 480 Y/277 V diesel engine-generator TA2-EG1. It will provide emergency power for life safety systems, including egress lighting, and critical instrumentation and HVAC systems loads.

The exterior diesel standby engine-generator will be provided in an exterior, weatherproof, sound-attenuated, reach-in enclosure with 24-h sub-base fuel tanks. The generator will be provided with a quick-connect feature to be used for load bank testing or portable generator backup if the primary unit is down for maintenance.

EPSS Power Distribution

The EPSS secondary distribution system will be separated into the following branches as required by code:

- Generator: This branch provides alternate source power from the generator set main circuits breaker(s) and associated distribution to the line side of each ATS.

- Emergency (NEC Article 700): This branch provides continuous (normal or generator) source power for the following equipment essential for safety to human life:
  - Interior building means of egress lighting and illuminated exit signs.
  - Exterior building means of egress immediately adjacent to exit discharge doorways.
  - Fire detection and alarm systems.
  - Public address communication systems (when used for issuing emergency instructions).
  - Elevator machine room lighting and receptacles; elevator cab lighting, control, signal, and communication systems.
  - Generator set location, task illumination, battery charger, emergency battery-powered lighting unit(s), and selected receptacles.
  - Fire protection systems.
  - Experimental processes where interruption would produce serious life safety health hazards, and similar functions.

- Combined legally required and optional standby branch, designate as “optional branch” (NEC Article 701 and 702): This branch provides continuous (normal or generator) source power for the following equipment that, when stopped during any interruption of the normal electrical supply, could cause hazards or hamper rescue or firefighting operations; or (optional branch) to protect facilities or property where life safety is not dependent on system performance:
  - Control and alarm systems of major apparatus
  - Experimental processes where any power outage could cause serious interruption of the processor damage to the equipment
  - Ventilation and smoke removal systems
  - Access control systems
  - Telecommunication room lighting, equipment, and data processing systems
  - Elevators (one at a time in each bank)
  - Electric and mechanical room lighting and selected receptacles
  - Mechanical equipment including boilers, condensate return pumps, hot water heating and glycol circulating pumps
  - Plumbing equipment including sewage ejectors and pumps

Generator distribution feeders will extend from the EPSS power generation plant to a 2000 A emergency distribution switchboard located in the Target Building II Emergency Electrical Service Room. This switchboard would serve 480 Y/277 V, 4-pole isolation-bypass transfer ATSs with associated distribution panelboards also located in the room. The following transfer switches are anticipated:

- 260 A: life safety branch (sized large to meet required withstand rating)
- 800 A: optional branch 1
- 800 A: optional branch 2

Power Quality Systems

Uninterruptible Power Supply Systems

An 80 kVA UPS system will be provided in the Target Building II for the STS target and Instrument Building IT distribution.

The UPS system will be static (battery) type with maintenance bypass and 15-minute ride through capacity.

Surge Protection Device

Surge arrestors labeled for use with NFPA 780 lightning protection systems will be provided at all unit substation transformer primaries.

Transients (surges, lightning, switching events) can introduce harmful voltage or current spikes to electronic equipment.

SPD filtering devices will be installed on main low-voltage switchgear, distribution panelboards, and branch panelboards serving major electronic equipment and all emergency branch panelboards in compliance with current code requirements. Sensitive equipment may require multiple levels of protection to protect equipment not only from utility disturbances but also from one another.

Electric Metering Systems

Electrical metering systems, according to ORNL standards, will be used to monitor and alarm:

- Electrical loading, harmonic loading, and protective device positions. Rail-mounted power quality PM 8214 DIN meters will be required at the unit substation building main service breakers.
- Service low-voltage switchgear mains and feeders.
- Medium voltage interrupter switches, positions, and transformer status.
- Distribution panelboards on the load side of ATSs.
- Standby engine generator plant and associated distribution equipment.
- ATS positions.

The system will be networked to the ORNL Power Operations SCADA “SNO” network.

Grounding Systems

Ground Grid

All building grounding systems must be bonded to a common earth ground in compliance with the NEC. Each building will be provided with a #4/0 direct buried copper ring encircling the perimeter of the building, which will provide a convenient means of connecting all metallic systems and equipment into a single equipotential grid that has a low resistance to ground.

Building Grounding

Building steel, foundation rebars (Ufer ground), exterior liquid and gaseous tanks, and metallic water supply piping will be bonded to the ground grid.

Building Lightning Protection

An NFPA 780 Faraday cage type lightning protection system will be provided to protect the building/structure and its occupants and contents from the electrical effects of a lightning strike to ground. The system will include independent down conductors in PVC from the rooftop to the ground grid.

Electrical Power System Grounding

Separate green grounding conductors will be provided with all feeders and branch circuits to provide an intended grounding of the neutrals of the electrical power systems. Each will be bonded to the ground grid with grounding electrode conductors from the distribution system neutral source.

Interconnected bus bars in electrical rooms will collect electrical and electrical equipment grounding conductors to tie the ground ring at the electrical service entrance room.

Electrical Equipment Grounding

All non–current carrying metal parts of electrical equipment enclosures, raceways, boxes, cabinets, housings, frames of motors, luminaires, and so on will be bonded and connected to electrical room ground buses where the associated system neutral is grounded. This allows for a safe ground path in an electrical fault condition.

Instrumentation Signal Reference Grounding

The bonding of instruments and instrument cabling pathways, as a low-impedance-signal reference system to a common equipment area bus and then to the ground grid, will be provided to minimize noise-induced voltages and reduce equipment malfunctions.

Telecommunications Signal Reference Grounding

Interconnected bus bars in telecommunication rooms will collect STS IT equipment and pathway grounding conductors and bond to the electrical service entrance room ground bus in compliance with EIA/TIA and NEC requirements.

Lighting Systems

Exterior Lighting

Pole-mounted LED light standards with concrete bases will be provided along roadways and within parking lots.

Building-mounted perimeter LED luminaires will be provided at building exits, walkways, and vehicular circulation areas.

Interior Lighting

LED interior lighting will be provided in compliance with IESNA lighting standards and ASHRAE 90.1 energy budgets.

Energy-efficient, heavy duty, specification-grade, high bay and industrial LED luminaires are generally anticipated in STS instrumentation areas.

Lighting Controls

Exterior lighting will be provided with photocell and time clock controls.

Interior spaces will be provided with automatic lighting controls in compliance with ASHRAE 90.1 energy budgets. High bay 24/7 areas will be breaker controlled.

Facilities and Operations Building Systems

The building Electrical Metering System and BAS to monitor electrical and HVAC building systems will be site interconnected to SNS campus systems as described in Site Utilities, Section 8.1.2.1 of this report and will also include the following systems.

Fire Alarm System

The fire alarm system will be a microprocessor-based detection and notification control system installed and acceptance tested in compliance with NFPA 72, *National Fire Alarm Code*. The building system will include multiplex wiring techniques, a central processing unit (FACU), annunciator units, and peripheral detection and alarm devices.

The system will

- Include smoke, heat, and smoke aspiration detection devices to suit environmental conditions.
  - High bay areas will be provided with beam smoke detection.
  - The Hydrogen Utility Room will include a hydrogen detection system, provided by others, monitored by the fire alarm system.
  - Both smoke and heat detection will be provided to the monolith area.

- Include audible horns and visual strobe notification devices.

- Monitor building fire suppression systems and override HVAC functions in an alarm condition for fire and smoke containment.

- Override elevator functions in an alarm condition to ensure safe passenger egress.

- Report fire, supervisory, and trouble alarms to the ORNL Fire Department and LSS office in Building 4512 over a fiber optic network.

Wiring will be supervised Class B installed in conduit. Multimode fiber optic cabling will be extended in conduit between the fire alarm control unit and the telecommunication room in each building.

The system will be Edwards/EST Fireworks manufacturer/series according to ORNL requirements to match the existing campus systems.

Public Address System

A public address system will be provided with building amplification as an extension to the campus wide Valcom mass notification system.

Wiring will be installed in conduit.

Access Control System

The building will be provided with an access control system with central equipment located in the main telecommunications room.

Alarm and supervisory conditions will be reported to the ORNL campus security monitoring location over a fiber optic network.

Components will match existing ORNL equipment for system compatibility.

Telecommunication Systems

The building will be provided with separate telecommunication service from the existing site telecommunication distribution system at the CLO to a building main distribution room. Design for the incoming POTS and/or VoIP telephone service, LAN, and wireless networking shall be coordinated with DOE's prime subcontractor, Black Box. The STS project will provide the interconnecting fiber optic cabling. Refer to the site utilities telecommunication distribution paragraphs, which outline telecommunication service to the STS buildings.

Building IT systems for systems networking hardware, including switches, routers, patch panels, distributed antenna systems (DAS), and wireless local area network (WLAN) components will be provided.

Building IT horizontal Category 6A cabling will be provided from telecommunication rooms located on each floor, stacked where possible. Building IT systems will be installed in compliance with EIA/TIA standards.

ORNL F&O Building Systems Distribution

The following building systems/system owners will be interconnected with cables and raceways by SNS CF. The system owners will perform final tie-ins.

- Public address/F&O Instrumentation and Controls
- Fire alarm (FIREWORKS network)/F&O Laboratory Protection
- Access control/F&O Laboratory Protection
- BAS/F&O Facilities Management (CLO II only—Siemens))
- Power monitoring (ION-Schneider)/F&O Electrical Utilities (including central IT UPS systems monitoring)

Instrument and Control Systems

ORNL STS will provide building instrumentation and control systems cabling for interconnection of the following systems:

- PPS
- MPS
- ATS
- TPS (two conduits)
- EPICS

Pathway Systems

Ladder-type cable trays will be provided to support telecommunication and instruments and control systems cabling requirements with proper wire dropout devices, conduit sleeves, firestopping, grounding, and wire management components.

Cabling from wall box type IT jacks will be in bushed conduits extended and grounded to the local cable tray system.

One 36-in. cable tray is anticipated for area coverage for each of the following systems:

- Instruments and control
- ORNL Networks Building IT

8.3.1.11 Plumbing

Drainage/Waste

Foundation Drainage

A perimeter foundation drainage system will be provided around the exterior of the Target Building II and the Instrument Buildings. Groundwater collected by the foundation drainage system will be drained by gravity into the site storm sewer. A sampling manhole will be provided to allow for monitoring of the storm sewer flow for radioactivity.

Target Interior Drainage System

The interior of Target Building II will be provided with a process waste drainage system to collect interior water from system leakage in potentially activated areas (HPV and other areas within the monolith). The drainage will be piped to a stainless steel process waste holding tank located at the lower level of the Target Building. The 8-ft diameter 5,000-gal tank will be located in a pit at the northwest side of the basement. Pump discharge will be via a manually activated pumping system discharging to the truck bay at the northeast corner of the lower level, for offsite disposal as needed. Any water collected will be sampled and then manually pumped to either the site sanitary sewer system or a transport vehicle for offsite treatment, as appropriate. A sump pump will be provided to collect any water that might collect in the recessed tank pit; discharge from the sump pump will be to the process waste holding tank.

Low-Level Liquid Waste and Other Tanks within HPV

There will be a total of five recessed tanks located in pits within the HPV. These include the two low-level liquid waste tanks and three tanks associated with the three activated water loops. These tanks are part of the technical equipment but will be located in recessed pits in the HPV.

The GLS loops incorporate two sets of off-gas delay/decay tanks that will be buried underground west of the Target Building. The main delay/decay tanks include six interconnected tanks, constructed of 24-in.

diameter Sch 10 stainless steel 78 ft long. The recombiner delay/decay tanks consist of three interconnected tanks, constructed of 24-in. diameter Sch 10 stainless steel 18 ft long. All of these tanks will be interconnected, with inlet/outlet piping routed to the west side of the HPV. A positively sloped drainage pipe will collect any liquid waste that might occur in the tanks and route that to the process waste holding tank.

These tanks will be installed as part of the CF scope, and piping to/from the tanks will be routed to the HPV for connection with the technical equipment installation.

Laboratory Waste

Laboratory waste from laboratory sinks, cup sinks, and laboratory-related equipment, will be collected separately below the lower level and conveyed by a gravity system to the underground sanitary waste drainage system outside the building. Any hazardous waste will not be discharged to the drains but will be bottled to be transported for processing; consequently, a lab waste treatment system will not be provided.

Lab waste from floor drains within lab spaces will be treated as process waste and routed to the process waste holding tank.

Unless required for specific equipment, floor drains will not be provided in laboratory rooms.

Complete accessibility will be provided to all cleanouts. Wall type cleanouts will be used within the laboratory spaces. Floor drains that do not receive regular use will be provided with trap primers. Primers will consist of an automatic trap primer system that automatically discharges water at regular timed intervals.

Sanitary Waste

Sanitary waste from pantry/break room sinks, lavatories, toilets, urinals, showers, mop sinks, and non-activated spaces will be collected below the lower level and conveyed by a gravity system to the underground sanitary waste drainage system outside the building. Flow rates and pipe sizes will be calculated based on drainage fixture unit values and adjusted/increased to allow for projected wastewater discharge from various laboratory related equipment at the design stage.

Floor drains will be provided at all toilet rooms, mechanical equipment spaces and other areas requiring drainage. Complete accessibility will be provided to all cleanouts. Wall type cleanouts will be used at the lower level. Floor drains that do not receive regular use will be provided with trap primers. Primers will consist of an automatic trap primer system that automatically discharges water at regular timed intervals.

Elevator pits shall be provided with an elevator sump pump that discharges to the sanitary drainage system through an open site waste connection. The elevator sump pump shall have an oil monitoring system that prevents the pump from operating when hydraulic oil is present and sends an alarm to the BAS.

Potable Water

Potable water will enter the building at the east end of the lower level in the mechanical and maintenance storage area, shall be provided with a water meter, and shall connect to the BAS. The incoming service shall split at the lower level into potable and process water streams through a Foundation for Cross-Connection Control and Hydraulic Research–approved duplex backflow prevention device. Potable hot and cold water will be distributed throughout the building to all fixtures and equipment requiring water. Water makeup to any mechanical equipment will be supplied through the process water system.

Potable use hot water will be generated by local point of use electric water heaters located adjacent to the areas where required.

Potable hot and cold water shall be distributed throughout the building to toilet rooms and break rooms.

A separate recirculating tempered water distribution system will include risers through the building to supply emergency safety equipment (eyewashes and showers). This water will originate from a centralized electric storage water heater located in the lower-level mechanical room. A thermostatic mixing valve will be provided to achieve 100ºF distribution temperatures. Tempered water will be distributed through a separate recirculating system.

Water velocity in distribution piping shall not exceed 8 ft/second for cold water, and 5 ft/second for hot water. Shock arrestors will be provided and shall comply with PDI-WH201 or ASSE-1010.

Process Water

Non-potable Water Service (Instrument Use)

A separate process water system will be provided for instrument water use. Process water shall emanate from the backflow preventer provided at the incoming potable water service and shall be routed around the perimeter of the Target Building and into the Instrument Buildings. Connections will be provided for instrument use and for makeup to technical cooling water and sensible cooling water systems.

Design of process water will be based on anticipated use and adjusted/increased to allow for projected water demand for instrument-related equipment at the design stage. Piping will be sized to maintain a minimum of 30 psi at the most remote laboratory equipment connection.

Water velocity in distribution piping shall not exceed 6 ft/second. Provisions shall be made to arrest waterhammer. Shock arrestors when installed shall comply with PDI-WH201 or ASSE-1010.

Storm Drainage

The primary storm drainage system will consist of roof drains for any areas collecting water, routed to downspouts that will collect below grade at the lower level and run to the site storm sewer.

A separate overflow storm drainage system will be provided, engineered to perform as a siphonic roof drainage system with the piping running level through the building and discharging through an above-grade connection to a velocity reduction tank located on the site. Velocities in the vertical piping shall be limited to 10 fps and in the horizontal piping the velocity shall be designed to 3.5 fps.

Compressed Air

CA shall be distributed throughout the Target Building and in the Instrument Buildings to supply instrument-related equipment and will be provided with local pressure reducing valves to permit each piece of equipment to use air of various pressures. CA will be fed by the site CA system routed from the air compressors in the CUB- II. CA will enter the Target Building at the east end of the lower level in the mechanical and maintenance storage area. The CA system shall be provided with a receiver tank located in the main mechanical room. Distribution will be routed around all perimeters of Instrument Building high bay spaces, with outlets provided for each beamline.

Specialty Gases

Nitrogen

A 6,000-gal vertical liquid nitrogen storage tank will be provided outside of the moderator area at the west side of Target Building II. Gaseous nitrogen will be distributed from an adjacent evaporator into the Target Building and around the Target Building basement and high bay spaces. Gaseous nitrogen will additionally be routed to the Instrument Buildings to supply nitrogen to instrument-related equipment.

Helium

A space will be allocated outside of the moderator area at the west side of the Target Building II for a helium tube trailer. The trailer will serve as the source for the helium used to cool the moderator hydrogen and will be connected to the helium compressor in the compressor room. Gaseous helium will be distributed from an adjacent evaporator into the Target Building and through the Target Building basement to the helium control panel located in the corridor north of the HPV.

Vacuum

Vacuum for the instrument beamlines will originate from the vacuum room at the Target Building II basement, where a vacuum pump will be installed as part of the technical equipment scope. A vacuum distribution manifold will be installed as part of the CF scope, providing a connection to the vacuum pump and 22 valved vacuum lines for future extension along the beamlines. Header will be located in the vacuum room with future connections routed through the bunker area.

Equipment

General

System Design Criteria

Potable/Process Water

- Potable water system is designed to provide a minimum of 40 psi at the furthest outlet.
- Process water system is designed to provide a minimum of 40 psi at the furthest outlet.
- Water piping shall be sized based on the number of water fixture units connected, and the minimum flow pressure required at each fixture or piece of equipment. Pipe velocities shall be maintained between 4 and 8 ft/second and shall not exceed 8 ft/second.
- Valves shall be placed to isolate individual fixtures within one room or a battery of fixtures within any one room.
- Wall hydrants shall be placed on the exterior of the building a maximum of 150 ft on center.
- Hose outlets will be provided at all mechanical rooms and equipment spaces.

Sanitary/Lab Waste

- The waste system shall connect to each fixture requiring connection and where required will be provided with water seal traps. A vent system shall be provided for fixtures as required to ventilate the waste system and to prevent siphonage of fixture traps.

- Floor drains will be provided at all mechanical rooms and equipment spaces.

- Waste and vent piping shall be sized based on the number of fixture units connected. Pipe shall be routed by gravity to maintain a positive slope with a maximum velocity of two ft/second.

Storm Drainage

- Storm piping shall be sized based on a 100-year occurrence rainfall rate with a 60-min duration.

- Roof drains will be provided for all roofs and areas receiving rainwater; maximum area per drains shall be 3,000 sf.

Compressed Air

- Design CA pressure on incoming service—105 psi.
- Design CA pressure at laboratory outlets—100 psi.
- Design flow at outlets—1.0 cfm.
- Dew point –40 ºF

Materials

Potable Water System

- Above-ground Potable Water Systems:
  - Tubing to be Type L hard temper with wrought copper fittings conforming to ASTM B88-and ASME B16.22. All joints shall be soldered with ASME AWS/A5.8 lead-free solder.
  - Copper tubing with grooved ends and mechanical joints is acceptable for sizes 2½ in. to 6 in. only. Tubing to be Type L hard temper with wrought grooved end fittings conforming to ASTM B88 and ASTM B75.
  - The entire potable hot and cold water distribution system will be fully insulated using closed-cell elastomeric foam insulation.

Process Water Systems

- Above-ground Process Water Systems
  - Tubing to be Type L hard temper with wrought copper fittings conforming to ASTM B88-and ASME B16.22. All joints shall be soldered with ASME AWS/A5.8 lead-free solder.
  - Copper tubing with grooved ends and mechanical joints is acceptable for sizes 2½ in. to 6 in. only. Tubing to be Type L hard temper with wrought grooved end fittings conforming to ASTM B88 and ASTM B75.
  - The entire process water distribution system will be fully insulated using closed-cell elastomeric foam insulation.

Sanitary/Storm System

- Above-ground Soil, Waste, Vent and Rainwater Piping:
  - Hubless cast iron soil pipe: no-hub pipe with Husky SD-4000 soil pipe coupling manufactured by Anaheim Foundry, 4-band clamp or Clamp-All Hi Torq 125 2-band clamp. Sealing gasket shall be neoprene in accordance with ASTM C564, CISPI 301-75.
  - Horizontal storm drainage piping will be fully insulated using closed-cell elastomeric foam insulation.

- Below-ground Soil, Waste, Vent and Rainwater Piping:
  - Asphaltum-coated, service weight, cast iron pipe and fittings with resilient neoprene push-on joints, ASTM A72, ASTM C564-70.

Process Waste

- Polypropylene pipe, (fire retardant above grade) (PP); Sch 40; PP DWV hub and spigot fittings; heat fusion joints above and below ground.

Compressed Air System

- Type K copper with brazed joints.

Plumbing Fixtures and Specialties

- All plumbing fixtures will be institutional grade, vitreous china or stainless steel as required.

- Floor sinks and floor drains in laboratory areas (if required) will be stainless steel, flush with finished floor, minimum 3-in. outlets.

- Hub drains and similar unsanitary fixtures will not be provided in lab spaces.

- Water closets: wall-hung, siphon jet type, high-efficiency 1.28 gal per flush maximum with hard-wired infrared sensor operation.

- Urinals: wall-hung siphon jet type, high-efficiency 0.125 gal per flush maximum with hard-wired infrared sensor operation.

- Lavatories: wall-hung or countertop type, 0.5 gal/min maximum with hard-wired infrared sensor operated faucets.

- Showers: high-efficiency 1.5 gal/min maximum.

- Safety showers, eyewashes and combination units: 30 psi minimum.

- Electric water coolers: recessed, self-contained.

- Interior hose bibbs: Chrome plated in finished areas, rough brass in mechanical rooms, wall mounted, furnished with vacuum breaker, ¾-in. hose threaded outlet.

- Wall hydrant: freeze-resistant type in recessed box, 3/4-in. hose threaded outlet.

8.3.1.12 Fire Protection

Sprinkler

The Target Building II will be provided with complete automatic fire protection systems as required by the IBC and/or DOE Order 420.1C, Facility Safety. The design, installation, and acceptance testing of automatic sprinkler protection will be in accordance with NFPA 13, Standard for the Installation of Sprinkler Systems and DOE-STD-1066-2012, Fire Protection. Building will be fully sprinkled, with exposed sprinkler piping feeding upright sprinklers for the majority of spaces or recessed pendent sprinklers in areas where ceilings are provided. Fire protection water will enter at the east end of the lower level in the mechanical and maintenance storage area from the site potable/fire water main, and a double check backflow preventer will be provided. Target Building fire protection water will incorporate a fire main routed to the exit stairs of the building, with separate sprinkler and standpipe risers feeding up through the stairs. Sprinkler zone control valves will be provided for each floor area, with control valves located in the exit stairwells. Control valves will be provided with a tamper switch and a flow switch connected to fire alarm system.

Incoming service will be hydraulically calculated and be sized for the maximum calculated flow at the design stage.

Standpipe

A full standpipe system will be provided for the Target Building. Standpipe risers with hose valves will be provided in all exit stairwells and elsewhere as required by IBC and/or DOE Order 420.1C, Facility Safety. The design, installation, and acceptance testing of standpipe systems will be in accordance with NFPA 14, Standard for the Installation of Standpipe and Hose Systems and DOE-STD-1066-2012, Fire Protection.

General

- Portable fire extinguishers will be provided throughout the Target Building in accordance with the IBC and NFPA 10, Portable Fire Extinguishers.

System Design Criteria

Sprinkler systems will be hydraulically designed to provide water densities that meet the requirements for Extra Hazard, Group 1 protection in all areas.

Fire sprinkler systems will be hydraulically designed. Velocity shall not exceed 20 fps. All calculations assume a minimum of 10 psi deterioration in static and residual pressures in the hydrant flow test results.

Materials

- Pipe and fittings installed underground shall be Class 52 ductile iron cement lined with mechanical joints with a working pressure rating of 350 psig.

- Sprinkler piping installed above ground and sized 2 in. and smaller and all standpipe piping shall be Sch 40 black steel with threaded joints and fittings.

- Sprinkler and standpipe piping installed above ground and sized 2½ in. and larger shall be Sch 40 black steel with roll or cut groove type connections and fittings. Pressure rating shall be 175 psig minimum.

- Fittings for grooved end shall be cast of ductile iron conforming to ASTM A-536 or malleable iron conforming to ASTM A-47, or forged steel conforming to ASTM A-234 (A-106, Gr. B), with grooved or shouldered ends for direct connection into grooved piping systems with steel pipe and shall be UL listed and FM approved, rated for a minimum 300 psi MWP.

8.4 INSTRUMENT BUILDINGS

8.4.1 40M Instrument Building

8.4.1.1 Programming

Building Function

The 40M Instrument Building will house beamlines 01–11, associated instruments, and user lab space. The maximum beamline length for an instrument located on ST06 in this building will be 40 M. The 40M Building will also serve as staging space for the construction of the beamlines, instrument hutches, and related lab support spaces. Instrument construction will occur progressively over successive years. Alterations and maintenance to existing instruments will be an ongoing process for the life of the 40M Instrument Building. Each instrument beamline is unique in terms of planning geometry, space requirements, and access. The design and coordination associated with the beamlines, instruments, and related shielding is generally not included in the CF scope. The instruments and beamlines will be accessible from the Instrument Building first floor and from a second-floor mezzanine. High bay space with full overhead crane coverage is a basic requirement of the 40M Instrument Building.

Program Summary

The 40M Instrument Building will include 33,890 nsf and have an estimated planning efficiency factor of 76%. This factor is based on analysis of the existing FTS Instrument Buildings and preliminary test-fit planning for the 40M Instrument Building. The estimated gross area of the 40M Instrument Building is 44,689 gsf. Table 8.18 summarizes the 40M Instrument Building space program requirements. Detailed room data sheets and test-fit plans are included in Appendix B, STS CF Conceptual Design Report.

Table 8.18. 40M Instrument Building space program summary.

No.	Rooms	Qty.	NSF	Total NSF
5.4.1.1	User support lab	2	620	1,240
5.4.1.2	Instrument/beamline space	1	21,100	21,100
5.4.1.3	Truck unloading set-down area	1	2,800	2,800
5.4.1.4	Sample environment cages	1	1,350	1,350
5.4.1.5	Bridge to 40M Instrument Building (exterior)	1	2,800	2,800
5.4.1.6	ZEEMANS—magnet utilities	1	2,200	2,200
5.4.1.7	ZEEMANS—beamline/chopper/optics crane access area	1	2,000	2,000
5.4.1.8	ZEEMANS—control room	1	300	300
5.4.1.9	ZEEMANS—computer room	1	100	100
Total nsf				**33,890**
Total gsf				**44,689**
Total efficiency				**76%**

8.4.1.2 Site Planning

Location and Floor Elevations

The 40M Instrument Building will adjoin the south side of Target Building II. The first floor will be located at elevation 1074 ft. Figure 8.11 highlights the 40M Instrument Building within the overall STS Site Plan.

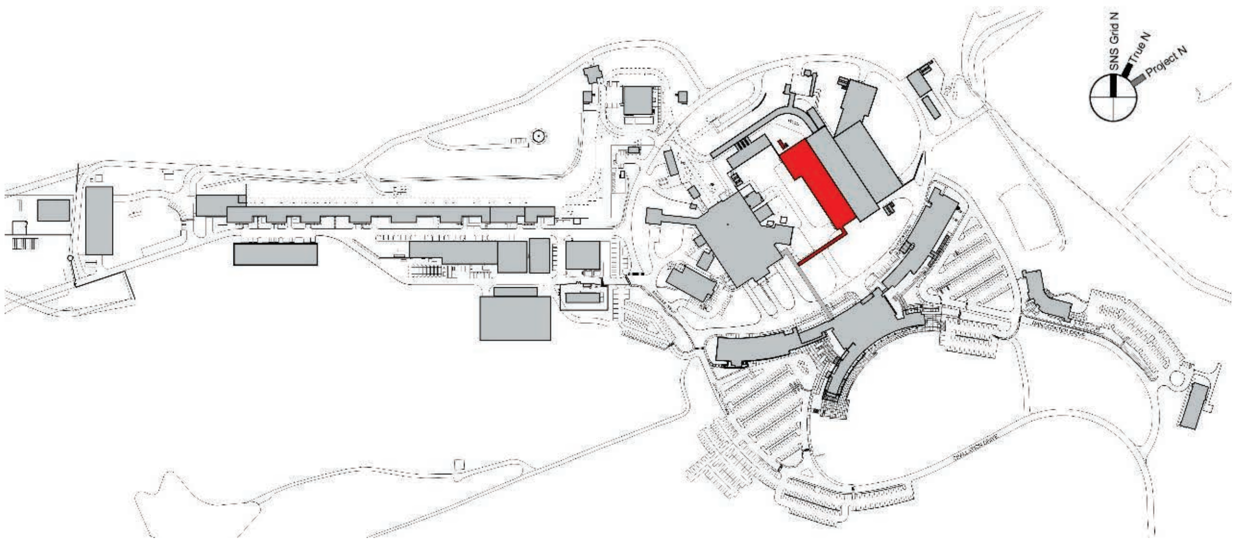


Figure 8.11. 40M Instrument Building location within the STS Site Plan.

Truck Access

Tractor-trailer truck access for the 40M Instrument Building will be located at the east end of the facility, within the building enclosure, at the first-floor level, elevation 1074 ft. Trucks will enter from the south side directly into the 40M Instrument Building or from the north side through the 50M Instrument Building and Target Building II. The interior truck lane will allow single vehicle passage in either the north or south direction.

Pedestrian Access

Pedestrian access to the 40M Instrument Building will be provided at the first and second floor levels of the facility. The primary access will be provided through the pedestrian bridge that will link the STS complex with the existing FTS complex. First-floor access will be provided from the adjacent Target II Building and at controlled exterior grade-level doors.

8.4.1.3 Building Planning

Building Organization/Floor Planning

The 40M Instrument Building will be a two-level structure. The first floor, elevation 1074 ft, will house the instruments associated with 11 beamlines and additional space for staging and sample environment preparation. This floor level will be open to a high bay space above. The entire floor area will be served by an overhead crane. The beamlines will radiate from the moderators located a few inches above and below the tungsten target located at elevation 1080 ft, which is 6 ft above the 40M Instrument Building first floor. Beamlines 01, 06, 11, 12, 17, and 22 will view the lower moderator, while the rest view the upper moderator. Nominally, the lower moderator neutron beams will be 8 in. closer to the 40M Instrument Building first floor (at elevation 1079 ft, 8 in.) than the upper moderator neutron beams (at elevation 1080 ft, 4 in.).

The second-floor mezzanine will provide access to the upper level of the instruments and general circulation throughout the 40M Building and STS complex. The mezzanine will be located at the perimeter of the 40M Instrument Building along the three exterior walls. The mezzanine level will link to Target Building II and the 50M Instrument Building. It will also link to the FTS and CLO through the pedestrian bridge.

Vertical Circulation

The 40M Instrument Building will be served by a freight elevator and two egress stairs located in Target Building II. These vertical circulation elements will serve the first floor and second floor mezzanine in the 40M Instrument Building. Two open, interior convenience stairs, connecting the first and second floor levels will be located near the southeast and southwest corners of the building. Additional open convenience stairs are anticipated to be constructed in support of individual instrument stations.

Utility Distribution

Instruments located within the 40M Instrument Building will be served by multiple utilities, including power, CHW, CA, potable water and nitrogen. These utilities will be distributed at the building perimeter above and below the second-floor mezzanine. The primary utility distribution is included in the CF scope. Extension of the utilities to the individual instruments is not included in the CF scope.

Zeemans Instrument

The Zeemans Instrument, which will be located on beamline ST02, will extend beyond the perimeter of the primary 40M Instrument Building. The Zeemans Instrument requires supporting spaces and utilities exceeding those of other instruments in the facility. As a result, the Zeemans Instrument will be located in an appendage structure constructed directly adjacent to the southwest corner of the primary 40M Instrument Building. The space housing the Zeemans Instrument is considered to be a part of the 40M Instrument Building. This space may also house a future instrument associated with beamline ST01. The high bay space will include mezzanine level access, a 10-ton overhead bridge crane and an exterior overhead access door.

8.4.1.4 Key Features and Requirements

Radiological Shielding

The beamlines will be shielded with removable high-density concrete blocks. The shielding at each beamline will be approximately 8 ft wide, centered on the beamline, and 10 ft high. Shielding configurations at each instrument will vary based on the instrument design and function. During construction or maintenance of the beamlines and instruments, shielding blocks will be staged within unassigned areas of the 40M Building first floor that will be located adjacent to the truck bay.

Structural Requirements

Optimum performance of the instruments requires a high degree of structural stability, including minimal deflection, vibration and settlement in the floor slab design. Maximized overhead crane coverage of the

40M Instrument Building will require a clear span roof structure and related structural design to support a 30-ton overhead bridge crane. See Structural Section 8.4.1.8 for additional information.

Instrument Pits

Individual instruments in the 40M Instrument Building may require depressed pits in the first-floor level. If required, the pits will be constructed as part of the CF scope.

8.4.1.5 Life Safety/Code

Primary Occupancy Type

The Target II Building and the 40M, 50M, and 90M Instrument Buildings will be constructed as a single building. The primary occupancy type for the Target II and Instrument Buildings is Group F-2, Low Hazard Factory Industrial, according to the 2015 IBC and Special-Purpose Industrial according to NFPA 101, 2018 edition.

Accessory Occupancies

Accessory occupancies will include lab support rooms (Group B) and storage rooms (Group S-1). The lab support rooms and storage rooms can be considered accessory occupancies if the aggregate area of each use does not exceed 10% of the floor area of the story in which they are located. Otherwise, IBC Table 508.4 requires a 1-h fire-rated separation between the F-2 occupancy and the B and S-1 occupancies. Laboratory spaces will be separated by 1-h fire partitions, where practical, to allow for increased storage and use of hazardous materials.

Fire Protection Systems

The Target Building II and Instrument Buildings will be protected throughout by an automatic fire sprinkler system designed to protect an Extra Hazard—Group 1 occupancy for the main level and an Ordinary Hazard–Group 2 occupancy for the basement level in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems.*

The Target Building II and Instrument Buildings will be provided with a Class I standpipe system in accordance with NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*. Two and one half-inch fire department hose valves will be provided at each floor landing in each exit stairway.

Portable fire extinguishers will be provided throughout the building in accordance with the IBC and NFPA 10, *Standard for Portable Fire Extinguishers*.

The Target Building II and Instrument Buildings will be equipped with an addressable fire detection/alarm system consisting of the following:

- Manual fire alarm pulls stations at all building exits
- Beam-type smoke detectors in large, open high-bay areas
- Area smoke detectors in elevator lobbies and elevator machine rooms
- Duct smoke detectors on the supply and return sides of all AHUs having a design capacity greater than 2,000 cfm
- Audible/visual notification appliances installed through the building

All fire alarm, supervisory alarm, and trouble signals will be automatically transmitted to the ORNL Fire Department via the LSS fiber optics network.

All new fire alarm system equipment will be manufactured by Edwards Systems Technology to be compatible with the existing site-wide campus system.

The fire detection/alarm system will be designed and installed in accordance with the IBC and NFPA 72, *National Fire Alarm Code*.

Maximum Floor Area and Stories

The Target Building II and Instrument Buildings will be a 4-story, 214,800 SF building constructed of Type IIA construction. The first floor will have the largest floor area at 113, 294 SF. The maximum floor area permitted for any floor by IBC Table 506.2 for a fully sprinklered, multi-story, F-2 building of Type IIA construction, with the area increase for frontage, is 119,787 SF. The proposed height and area for the building are within the limits established in IBC Sections 504 and 506.

Travel Distances

The maximum travel distance within the Target Building II and Instrument Buildings will not exceed 400 ft as required by IBC Section 1016.2 and NFPA 101, Section 40.2.6.1. The maximum common path of travel distance will not exceed 100 ft as required by IBC Section 1014.3 and NFPA 101, Section 40.2.5.1. The maximum dead-end corridor will not exceed 50 ft as required by IBC Section 1018.4 and NFPA 101, Section 40.6.4.

Construction Type

The Target Building II and Instrument Buildings will be of Type IIA construction in accordance with IBC Section 602.

Wall/Floor Ratings

The primary structural frame, floors, bearing walls, and roof will have a 1-h fire resistance rating as required for Type IIA construction. Interior nonbearing walls and partitions will be of noncombustible construction. Interior walls, where applicable/needed, will be constructed to provide 1-h fire barrier separation to support chemical quantity allowances.

Special Code Considerations

The largest floor area for the Target Building II and Instrument Buildings is the first floor, currently having an area of 113,294 SF. The maximum area permitted by IBC Table 506.2 for any story in a fully sprinklered, multi-story, F-2 building of Type IIA construction, without an increase for frontage is 112,500 SF. Currently, the perimeter of the facility is 1,805 ft in length. The length of the perimeter that fronts on an open space at least 30 ft wide is 802 ft. This results in an area increase for frontage of 7,287 SF. Therefore, the maximum area permitted for any story would be increased to 119,787 SF. Should the area of the Target Building II and Instrument Buildings exceed 119,787 SF on any level, the construction classification for the building will need to be upgraded to Type IB to permit an unlimited area building.

Hazardous materials: The use and storage of hazardous materials shall be limited to the maximum allowable quantities indicated in IBC Tables 307.1(1) and 307.1(2). Where these quantities are exceeded, control areas shall be provided in accordance with IBC Section 414.2. The number of control areas per floor and their required fire resistance ratings shall be in accordance with IBC Table 414.2.2. It should be noted that the floors of control areas are required to have a 2-h fire resistance rating for buildings over 3 stories in height.

Bridge: The new pedestrian bridge connecting the 40M Instrument Building to the existing pedestrian bridge will comply with IBC Section 3104 and the following:

- The pedestrian bridge will be constructed of noncombustible construction.
- The pedestrian bridge will have automatic fire sprinkler system protection.
- The walls separating the pedestrian bridge from the buildings will be smoke-resistant.

8.4.1.6 Civil/Site Development

The construction excavation described under the Site Civil Works Section will be performed before construction of the Instrument Buildings. The lower basement of the target will be backfilled to the first-floor elevation to establish the grades for construction of the instrument buildings. Finished grading is shown on Drawing 5.1.19. Drawing 5.1.22 shows the site drainage concept. Roof drainage will be piped to the proposed storm sewer system. Sewer, fire and domestic water services to the building are shown on Drawing 5.1.27.

8.4.1.7 Architecture

Building Envelope

Exterior Wall

A striated-face, 36-in.-wide insulated-core metal panel system, with a custom color to match the existing context, will be used as a major material component for the envelopes of the 40M, 50M and 90M Instrument Buildings in keeping with the existing texture and materials used on the SNS campus. The metal panel cladding support backup system will consist of hanger rods and metal channel framing supported from the building structure. Metal window sills and wall caps will be used. Continuous through-wall flashing will be provided at the bottoms of all wall cavities, over all wall openings and metal copings. The metal panel wall systems will have an R-13 and R-13ci minimum requirement. Below-grade exterior walls will be constructed of reinforced concrete with a waterproof membrane and below-grade insulation board. The interior walls will have metal channel furring with a painted drywall finish. Exterior walls below grade will be required to achieve R-7.5 ci according to the 2012 International Energy Code.

The elevated pedestrian bridge connecting the existing Target Building with the new 40M Building will be designed similarly to the existing bridges on the SNS campus.

Exterior Doors

Exterior entrance doors and egress doors will be 16-gauge, insulated-core painted hollow metal doors with 14-gauge, fully welded frames with a U value of 0.61. Overhead insulated coiling doors, 20 ft 0 in. high by 14 ft 0 in. wide will include factory-painted galvanized steel curtains with integral insulation achieving a minimum R-value of 4.75 requirement. All exterior doors will be provided with proximity card reader hardware.

Thermal and Moisture Protection

Flashing and sheet metal will be provided as a positive water stop around all wall openings (head, jamb, and sill) such as windows, doors, louvers, and so on. All copings and gravel stops will be ES-1 compliant as required by IBC.

Damp-proofing will be provided on all walls, floors and other building components that are subject to high humidity, dampness, or frequent direct water contact.

Waterproofing will be provided at walls, floors, and other building elements that are subject to hydrostatic pressure, are liable to be immersed in water, or are below the water table. The waterproofing membrane will be a hot-fluid-applied two-layer 215-mil, polyester fabric–reinforced membrane.

Because of the inherent moisture-resistant properties of the insulated metal panel system, an air/vapor barrier will not be required where the system is installed.

Exterior sealants will be nonstaining with a two-part composition and a 50% movement capacity and will be compatible with the surfaces on which they are applied.

Insulation combustibility, including wrappings, inside the building skin will be limited to a flame spread of 25 and smoke development of less than 50.

Glazing

Windows will be limited to the upper portions of the exterior walls. Typical vision glass will consist of a 1-in.-thick, low U-value insulated, low-E, argon-filled glass units on a thermally broken frame. The windows/glazing systems are anticipated to have a U value of 0.38.

Glazing materials and methods will comply with the Flat Glass Marketing Association's Sealant and Glazing Manuals. Glass will comply with ASTM C1036-01.

Roof Construction

The roofing system will be a 30-year, 80 mil minimum thickness, white thermoplastic (PVC) single-ply sheet with an integral fiberglass mat reinforcement roofing membrane over polyisocyanurate insulation on a sloping roof structure. Tapered insulation saddles will be used to provide drainage to roof drains and at roof equipment locations. All roof construction details and roof penetrations will comply with the guidelines established by the NRCA. Roof traffic pads will be adhered to the membrane along all roof maintenance traffic paths. All roofs with serviceable components beyond roof drains will be surrounded by a 42 in. high parapet or provided with a fall protection system

Low-slope roofing will have a minimum 3-year aged solar reflectance of 0.55 and a minimum 3- year aged thermal emittance of 0.75 in accordance with the Cool Roof Rating Council Program. Roofing will be Energy Star rated with emissivity of at least 0.9 when tested in accordance with ASTM 408.

The roofing system will meet or exceed UL class A fire exposure requirements and comply with FM Class I-90 for wind uplift according to ASTM 1592. It will provide a minimum thermal resistance value of R-30.

Interior Construction

Walls

Interior walls at the 40M Instrument will be constructed of CMUs for durability. The height of the demising walls will be constructed to the underside of the structural deck. All fire-rated walls will be constructed in accordance with the IBC code requirements and UL listed assemblies.

Painted metal guardrails and handrails will surround all floor openings and egress stairs. Painted metal guardrails and handrails will surround all floor openings and egress stairs.

Wall Finishes

All finish materials for walls, ceilings, and floors, will have a Class A rating, with a flame spread of ≤ 25, a fuel contribution of ≤ 25, and smoke development of ≤ 450.

Typical interior gypsum board and CMU partitions will receive a paint finish consisting of one primer coat and two finish coats. Epoxy paint will be applied to all lab demising walls. All paints, including top coats and primers, will comply with the 2016 *Guiding Principles for Sustainable Federal Buildings*.

Floor Finishes

The floor throughout the 40M Instrument Building will receive concrete sealer over the new concrete. No vinyl wall base will be used in these areas.

Ceiling Finishes

Structural elements will be left exposed in all regularly occupied spaces as well as all mechanical and utility areas. All exposed structure will receive an epoxy paint finish consisting of one primer coat and two finish coats.

Interior Doors

All interior doors will be shop-primed, field-painted, 16-gauge hollow metal doors with 14-gauge fully welded metal frames. In addition to passage doors, metal interior rolling doors and floor hatches will be provided in spaces as indicated in the drawings.

Tempered glass vision lights will be provided at all laboratory doors to facilitate safe egress. All laboratory access doors will be provided with proximity card reader hardware.

Furnishings

Laboratory Casework

Laboratory casework will be a modular system, with prefinished painted metal bases, wall cabinets, and shelving units with epoxy resin countertops. The modular system will be adaptable and flexible to accommodate the changing needs of lab research requirements.

Vertical Circulation

Stairs

Metal (painted steel) framed industrial stairs allowing convenience access from the first floor to the mezzanine level, will consist of steel grating treads, open risers, and painted metal handrails.

Elevators

Not applicable

Specialty Equipment

Combination emergency showers/eye wash units will be provided according to ANSI Z358.1, at lab areas where chemicals will be used or stored

Crane

A 10-ton bridge crane will be provided for the Zeeman's instrument with a hook height of 30 ft above the instrument floor. A 30-ton bridge crane will be provided for the 40M Instrument Building proper with a hook height of 40 ft above the instrument floor.

A 5-ton javelin crane will also be provided.

8.4.1.8 Structure

Applicable Codes and Standards

See Sheets x – xii for complete list of Applicable Codes and Standards

Design Loading

Superimposed Floor Loads on Instrument Floor

- Dead loads
  - Within 36 ft radius of target center: 1500 psf
  - 36–53 ft radius of target center: 6000 psf
  - 53–65 ft radius of target center: 3500 psf
  - Beyond 65 ft radius of target center: 1500 psf
  - At elevated deck: 20 psf collateral load, typical
  - See also Figures 8.6 through 8.8 in Section 8.3.1.8

- Live loads: 500 psf or HS20-44 truck loading
  - See also Figures 8.6 through 8.8 in Section 8.3.1.8

Superimposed Floor Loads on Mezzanine Floor

- Dead loads: 35 psf
- Live loads: 150 psf

Superimposed Roof Loads

- Roof snow load
  - Ground snow load: Pg = 10 psf
  - Snow exposure factor: Ce = 1.0
  - Snow importance factor: Is = 1.2

- Minimum roof live load = 20 psf + 20 psf collateral load

Wind Loads

- Risk category IV
- Basic wind speed: V = 120 mph
- Exposure category B

Seismic Loading

- Risk category IV
- Importance factor: Ie = 1.5

Crane Requirement

- Refer to the Crane section of Section 8.4.1.7 for information.

Building Structural System

Slab on Grade

The slab construction is anticipated to consist of a structurally reinforced normal weight concrete slab. The structural slab on grade is anticipated to be supported on 9¾-in. diameter micropile foundations, approximately 135 ft long, with a 200-ton capacity. The floor slab will be placed over a vapor barrier, a compacted drainage base course, and a compacted subgrade.

Foundation System

A geotechnical investigation has not been performed. Until a geotechnical investigation and report have been completed, an accurate description of the building’s foundation system cannot be provided. The 40M instrument building is anticipated to be supported on 9¾-in. diameter micropile foundations, approximately 135 ft long, with a 200-ton capacity. Below-grade walls are anticipated to be constructed with reinforced normal weight concrete. It is anticipated that the west below-grade wall will consist of counterfort retaining walls. Water stops will be provided in construction joints to safeguard against water intrusion.

For the 40M Instrument Building and the adjacent Target Building II, there are three main components considered related to deflection and settlement concerns. Refer to the Foundation System section of Section 8.3.1.8 for further discussion and information.

Superstructure

The 40M Instrument Building is anticipated to be a single-story conventional steel frame structure with a partial mezzanine level. The building will support the exterior wall system with steel girts as required.

The mezzanine floor is anticipated to be constructed using reinforced normal weight concrete on galvanized composite metal deck. The roof structural system is anticipated to consist of metal truss framing with roof deck meeting galvanizing G90 requirements. The 40M Instrument Building will share a column line with the Target Station Building. The 40M building will also include the Zeeman's instrument, which will require stainless steel reinforcing in areas near the magnet.

Lateral System

Resistance to lateral loads resulting from wind and seismic forces on the building is anticipated to be provided by concentrically braced steel frames.

Crane Support

Steel framing will be provided to support the crane runway.

Geotechnical Analysis

A review of historical geotechnical and geophysical surveys was performed that included the original campus development and additional structures. A detailed geotechnical exploration was performed by Law Engineering dated June 30, 2000, addressing the original development of the campus (Law 2000). No borings were drilled near the footprint of the proposed 40M Instrument Building (40M) location. Considering the consistency of the upper crust of soils at the site, we would anticipate similar subsurface conditions as well as rock conditions. The necessity to reduce and control differential settlement between the STS and the 40M will require a micropile system. The micropiles should be capable of supporting 200 tons/pile when designed using a 9¾ in. steel casing. The axial capacity should be confirmed using a pile load test.

A review of geophysical data and shear wave velocities from the Law report indicates that the 40M Building would be located in a seismic site classification C as defined in IBC 2015 and ASCE 7 (Law 2000). This is confirmed by the average shear wave velocities for multiple soil profiles tested during the original campus development.

A supplemental geotechnical report would be advisable once the final 40M location and footprint have been determined. The density and pattern of the soil test borings should be selected to optimize the quality of geotechnical data. Additional geophysical testing is not anticipated for design of the structure.

Vibration/Acoustics

The instrument floor and its foundations will be constructed so that beamline vibrations do not exceed a peak-to-peak value of 0.008 in. (±0.004 in. or ±0.1mm). Based on the current preliminary instrument floor design, which is driven by the instrument floor loading and settlement criteria, this vibration performance is considered to be readily achievable.

This building is located adjacent to the Target Building and will be designed for the following background noise levels:

- Room type — NC
- User support labs — 50
- Electrical equipment rooms — 60

8.4.1.9 Mechanical

The 40M Instrument Building will be served by two CAV AHUs. The units will be manifolded together and will share a common discharge plenum to provide partial redundancy (66% of the supply system design capacity through a single AHU) in the event of planned service or a complete unit failure. The AHUs will be designed as heating-cooling, single duct, reheat type. The units will operate 24 h/day, 365 days/year. Supply fans will be configured in a multi-fan array, plenum fan design. VFDs will provide supply fan volume control in response to a signal from duct-mounted static pressure sensors and will allow for setback control capability of the supply fan volume. VFDs will also provide return fan volume control in response to a signal from air flow measuring stations used to establish volumetric offset between the return air and the supply air quantities. The system will be designed for energy conservation adjustment with the potential to reduce ACHs (unoccupied setback change) controlled by the BAS. The system will be designed to maintain minimum outside air quantities to maintain positive pressure in the 40M building but will also be capable of full economizer mode.

The AHUs will be housed in the enclosed mechanical equipment space located in the truss space at the east side of the Target Building. Ductwork will be routed out over the roof of the 40M Building and enter the truss space above the 40M Building crane. Supply ductwork will be routed to the sides of the building to avoid the crane travel path and drop along the walls to introduce air at the lowest levels of the high bay space. Sound attenuators at the air terminal devices will not be provided. Return air will be gathered at the center of the 40M building truss space and will be recirculated through return ductwork back to the units. The HVAC distribution system shall be pressure-independent, CAV control for all spaces.

The supply distribution system will consist of low-pressure ductwork with pressure-independent electrically actuated supply CAV air terminal devices, reheat coils, low-pressure externally insulated ductwork downstream of air terminals, and diffusers. Sound attenuators at the air terminal devices will not be provided. The use of sound attenuating flexible duct at diffusers will be limited to 6 ft in total length to minimize duct static pressure losses.

Exhaust

The 40M Instrument Building will be provided with a general exhaust system for exhaust from lab hoods and similar areas. The general exhaust system will be located on the roof of the Instrument Area. The exhaust system will use duplex (one standby) vertical, radial dilution exhaust fans of spark-proof construction with bearings and motors out of the airstream. Two fans will be provided to serve the common exhaust plenum, each sized at 100% of the load. If one of the fans fails, the remaining fan will be able to provide 100% of the common exhaust system’s design capacity. All of the fans in the common exhaust plenum will be on emergency power to ensure continuous hazardous material containment but will be controlled to run at a reduced speed during a power outage to limit the negative pressure impact to the building. Ducts will be routed through the truss space of the facility for future connection of instrument exhaust.

The 40M Instrument Building will also be provided with a separate exhaust system for the instrument bunkers. The bunker exhaust fans will be located on the roof of the Instrument Area. The exhaust system will use duplex (one standby) vertical, radial dilution exhaust fans of spark-proof construction with bearings and motors out of the airstream. Two fans will be provided to serve the common exhaust plenum, each sized at 100% of the load. If one of the fans fails, the remaining fan will be able to provide 100% of the common exhaust system’s design capacity. All of the fans in the common exhaust plenum will be on emergency power to ensure continuous hazardous material containment but will be controlled to run at a reduced speed during a power outage to limit the negative pressure impact to the building. Ducts will be routed through the truss space of the facility for future connection of instrument exhaust.

Connections will be provided along each of the beamlines for future connection of instrument exhaust. A separate capped inlet will be provided at each beamline (11 total).

General utility set exhaust fans will be provided to exhaust toilet rooms, janitor closets, and other rooms requiring ventilation at a minimum rate according to their code requirements.

Space Conditioning

Bridge Air-Conditioning Systems

Heating and cooling for the bridges connecting to the FTS will be accomplished through the use of hot water, CHW fan-coil units located above the ceiling of the bridge. The fan-coil unit will supply conditioned air into a duct that will extend down the length of the bridge. Supply air diffusers along the length of the bridge will distribute conditioned air throughout the bridge. The air will then return through the bridge to a return air grille at the fan coil unit. Heating water and CHW will be routed to the fan-coil units from distribution in the 40M building.

Technical Cooling Water

Chilled Water System

A CHW cooling loop will be provided to support space cooling in the 40M Instrument Building. The CHW cooling system will consist of an independent loop of campus CHW originating in the Target Building lower level. CHW for future cooling use will be routed around the exterior of the 40M Building, with valved connections provided along each beamline (11 total).

Sensible Chilled Water System

A sensible CHW cooling loop will be provided to support equipment cooling in the 40M Instrument Building. The sensible CHW cooling system will consist of an independent pumped loop that will reject heat into the Target Building CHW through a plate-and-frame HX. The system will be designed to operate at a supply temperature of 55–60°F to reduce the potential for condensation. The tank, pumps, HX, filters and chemical treatment components will be located in the mechanical equipment room at the Target Building lower level. Sensible CHW for future instrument use will be routed around the exterior of the 40M building, with valved connections provided along each beamline (11 total).

Tower Water

An independent tower water service entry for the Zeeman’s Instrument Helium Compressors will be supplied from the new CUB-II. A separate 3-in. service will be routed to the Helium compressor room at the southwest side of the building. Tower water will be filtered prior to use in compressor cooling.

Heating Water

Heating water for AHUs will be extended from the target building lower level to the truss level mechanical room at the target building.

Controls

The 40M Building shall be controlled by the EPICS. The building will be connected to an expansion of the existing EPICS. Instrumentation and wiring shall be connected to a new EPICS PLC in the building, and controls interface for the building will be provided at the target control room and on the instrument floor. Programming and connection of the PLC to EPICS shall be completed and the control system commissioned to ensure proper operation.

Electric/pneumatic actuation will be used for all control valves and dampers on both systems so that instrument air is required. All control systems will be on UPS and emergency power. System software and firmware will provide the following functions:

- Control sequences shall be developed to support the operations of the technical equipment.
- PID control to allow faster and closer control to system set points.
- Adaptive tuning to adjust PID loop constants to ensure that control system response remains accurate and reliable over a wide range of dynamic operating conditions.
- Monitoring to read the value of measured variables; to read control loop set points, to monitor control signals to actuators; and to indicate status of equipment, alarms and overrides.
- Energy management, including optimum start/stop, variable ACH rates in laboratories, duty cycling, supply air temperature reset, supply air static pressure reset, demand limiting, time totalization, and so on.
- Data management, including continuous database updating, alarm reporting, trend logging and report generation.
- System programming to add, delete, or change points, set points, schedules, control algorithms, report formats, and so on.
- System software will allow building operators to graphically monitor and control building operations and provide the functions listed. Graphics will include site plans, overall building plans, floor plans and individual system graphics.

Equipment

Table 8.19 provides a listing of mechanical equipment servicing the 40M Instrument Building.

Table 8.19. 40M Instrument Building mechanical equipment.

Use	Equipment	Size	Qty	Em pwr	Redund	Location	Remarks
40M AHU	VAV AHU	25,000 cfm	2	N	33%	Target bldg. Truss mech rm	
40M exhaust	Radial exhaust fans	2,500 cfm	2	N	N+1	40M roof	Lab fume hoods
40M instrument bunker exhaust	Radial exhaust fans	7,500 cfm	2	Y	N+1	40M roof	
40M Exhaust	Utility exhaust fan	Varies	10	N	–	40M roof	
Instrument cooling	Sensible CHW pumps	220 gpm @ 100 ft	2	N	N+1	Target mech rm	

Table 8.19. 40M Instrument Building mechanical equipment (continued).

Use	Equipment	Size	Qty	Em pwr	Redund	Location	Remarks
CHW to sensible CHW	Plate-frame HX	220 gpm	1	N	–	Target mech rm	
Zeeman's Instrument cooling	Tech cooling water pumps	15 gpm @ 100 Ft	2	N	N+1	Target mech rm	
Zeeman's Instrument cooling	Tech Di water cooling skid w/ slip stream polisher	20 Gpm	1	N	–	Target mech rm	
Sensible instrument cooling	Fan coil units	2-3 tons	11	N	–	Varies	
40M bridge cooling/heating	4-pipe fan coil units	1-2 tons	12	N	–	40M bridge	

Air Handlers

General

- All AHUs will be semi-custom, factory-fabricated, and constructed with 2-in.-thick double walls, constructed of galvanized steel.

- Maximum allowable nominal face velocities:
  - Air intake louvers (through free area): 350 fpm
  - Heating water coils: 500 fpm
  - Cooling coils: 400 fpm
  - Filters: 400 fpm

- AHU: modular, semi-custom, 2-in. double-wall construction configured as follows:
  - Mixed air plenum
  - Intake isolation damper
  - Return/exhaust damper
  - Supply fans (4 to 6 fan array)
  - Relief fans (4 to 6 fan array)
  - VFDs
  - Economizer section
  - Merv 8 (30%) prefilter section
  - Hot water preheat coil
  - CHW coil
  - Hot water reheat coil
  - Supply fans (4 to 6 fan array)
  - VFDs
  - Merv 14 (95%) final filter section
  - Supply plenum
  - Isolation/smoke damper
  - Access sections
  - Doors: safety glass windows and quarter turn handles.
  - Marine light in each access section.

- Vibration isolation in accordance with ASHRAE HVAC Applications—Noise and Vibration Control

Exhaust Fans

General/Lab Exhaust Fans

Vertical, radial dilution exhaust fan with spark-proof construction with bearings and motors out of the airstream. Fans will have a baked epoxy airside chemical-resistant coating. The common plenum and outside air intake dampers will be of galvanized steel construction with a chemical-resistant coating. The system will consist of the following components:

- Common exhaust plenum
- Isolation damper at each fan inlet
- Vertical exhaust fans
- Exhaust stacks
- Bypass air inlet and bypass damper
- VFDs

Utility Set Exhaust

The exhaust system will consist of backward-inclined, belt-driven centrifugal fans with spark-proof construction and bearings and motors out of the airstream. Fans will be single width, single inlet with a galvanized steel housing and wheel construction. The fan motor will be totally enclosed and fan cooled. The system will consist of the following components:

- Steel mounting rails with vibration isolators
- Isolation damper at the fan inlet
- Discharge ductwork with bird screen
- Weather cover
- VFDs

Water-Based Systems

Technical Cooling Water Systems

Secondary technical cooling water systems will provide DI water with a resistivity in the range of 1 to 3 megohm/cm, using a slip stream polishing loop. All piping, valves, HX, expansion tanks, and equipment on the DI cooling water pump skids will be stainless steel. Each system will include the following equipment:

- Base mounted, end suction, centrifugal pumps
- Pump VFDs
- Plate-and-frame HX
- Mixed bed de-ionizers
- Resin trap filtration
- UV sterilizer
- Air separator and expansion tank
- Makeup water assembly
- Appropriate valving and piping specialties

- CHW supply to HX (using Target Building CHW)

Motors

- All motors shall be premium efficiency type and built to NEMA standards.

- Variable-speed motors shall be rated as inverter duty motors. All motors operating with VFDs shall be equipped with shaft grounding rings or insulated bearings to prevent the accumulation of PWM frequencies in the shaft, which could arc across the bearing, causing pitting and premature bearing and motor failure.

- All VFDs shall be provided with power filters to improve the building power quality from the occurrence of multiple VFD installations.

General

System Design Criteria

Outside Design Temperatures

- Summer: 92.8°F DB, 73.8°F MCWB (0.4% ASHRAE)
- Winter: 17.1°F (99.6% ASHRAE)

Interior Design Conditions: Preliminary Load and Ventilation Assumptions

Table 8.20 provides a listing of preliminary load and ventilation assumptions for the 40M Building.

Table 8.20. 40M Instrument Building preliminary load and ventilation assumptions.

Space	Design Set Points	Cooling: BTU/sf	Heating: BTU/sf	Airflow: cfm/ sf or ACH	Ventilation
Mechanical/electrical	60–85°F	80	40	2	Code required
High bay	72–76°F, 60% >RH	40	40	8 ACH	Code required
Loading	60–85°F	–	40	2	Code required
Ventilated spaces	60–100°F, no humidity control				

Notes:
Cfm/sf and values are schematic design level assumptions. The final values of the project will be calculated based on code requirements or heating and cooling demand, whichever is greater.
Active humidity control will not be provided for any building. Therefore, HVAC units will not have a humidification capability. The maximum relative humidity should not exceed 60% due to moisture removal at the cooling coils.

Sensible Technical Cooling Water (Chilled)

- Supply 55–60°F
- Return 5°F above supply

Materials

Duct Distribution Systems

- Supply ductwork construction will be based on SMACNA 4-in. pressure class and 2-in. pressure class. Four-in. pressure duct construction will be used upstream of VAV boxes on variable-volume units; 2 in. pressure class duct construction will be used downstream of VAV boxes on variable-volume units and for all ductwork on constant-volume units. All ductwork seams and joints shall be sealed, regardless of pressure rating. Maximum permissible leakage = 2%.

- All supply ductwork routed through unconditioned spaces shall be insulated with 2-in. foil-faced batts or foil-faced duct board with similar R-value.

- Return and general exhaust ductwork construction shall be based on SMACNA 2-in. pressure class.

- Return air duct shall be insulated with 1½-in. foil-faced batts or duct board. Laboratory exhaust ducts shall not have fire dampers.

- General air distribution ductwork will be G90 galvanized sheet metal.

- General exhaust will be welded 316L stainless steel.

- Secondary confinement exhaust/hot off-gas shall be welded 304L stainless steel duct/thinwall tube (Sch 10 or less).

- Exterior supply or return ductwork shall be solid double-wall ductwork with a minimum 2-in.-thick insulation or single-wall duct with 2-in. duct board, vapor barrier, and aluminum jacket.

- Rectangular and round ductwork shall be fabricated in accordance with SMACNA standards. Spiral-wound ductwork shall be a prefabricated system with factory certifications. Spiral-wound ductwork shall not be used for laboratory exhaust systems or other systems that may be exposed to water intrusion.

- Provide sound attenuation to meet the project requirements or in accordance with the direction of the project acoustician. Sound attenuation shall be by appropriate application of attenuators or duct design.

- Lined ductwork shall not be used, except for plenum return air-transfer boots for noise control. VAV air terminals shall be double-wall or have foil-faced inner surface.

- Flexible ductwork is limited to 5 ft and shall be used only downstream of VAV terminals. Flexible ductwork shall be limited to supply air systems only.

- Plenum return may be used for return air in all non-laboratory portions of buildings.

- Ductwork shall be sized as shown in Table 8.21.

- Spaces on VAV systems shall have conventional supply terminal boxes with hot water reheat coils and integral sound-attenuating characteristics.

- Smoke detection will be provided in accordance with NFPA 90A and IMC requirements.

Table 8.21. 40M Building ductwork sizing.

	Risers	Submains	Branches	Air distribution device neck velocity (fpm)
Max P.D.	0.1 in./100 ft	0.08 in./100 ft	0.08 in./100 ft	450 fpm

Piping

Chilled Water

- Interior piping sizes 2 in. and smaller Type L copper with brazed fittings.
- Interior piping 2½ in. and larger shall be either Type L copper with brazed fittings or Sch 40 steel pipe with either welded and flanged joints or mechanical grooved fittings.
- All piping will be tested at 1.5 times the design system pressure.
- All interior CHW piping shall be insulated with closed-cell elastomeric insulation. Properties shall meet or exceed the minimum energy code requirements.
- All piping in mechanical rooms and piping exposed below 8 ft AFF shall have a PVC jacketing.
- All piping exposed to the exterior shall have an aluminum jacket.

Technical Cooling Water (DI Water for Instrument Cooling Downstream of HXs)

- For sizes 2 in. and smaller, ASTM 312 10S, seamless, 304L stainless steel, plain ends. (Victaulic Vic-Press system or butt-welded, as specified)
- For sizes 2½ in. and larger: ASTM 312 or ASTM 358, Sch 10 ERW 304L stainless steel, Class 4. (Victaulic Vic-Groove system or butt-welded, as specified)
- For sizes ½ in. to ¾ in. OD tubing, ANSI Type 304L stainless steel, ASTM A213, Grade TP304L, seamless, annealed, minimum 0.065 in. wall thickness.
- Vents and drains: For sizes ½ to ¾ in.es NPT, ANSI Type 304L Sch 40 SST pipe
- Fittings:
  - Welded fittings: ASTM A403, Grade WP-S304L or WP-W304L, elbows: standard 1.5× radius. Full penetration butt weld.
  - Welded flanges: ASTM A 182, Grade WP-S304L, raised face weld neck
  - Vic-Press or Vic-Groove 10S system, ASTM-312 304L SST
    - Plain end or grooved ends shall be ASTM A-312 304L SST
    - Vic-press flanges shall be ANSI Class 150, 304L SST, Van Stone type, carbon steel raised face slip-on backing flange, Victaulic style 565
    - Grooved couplings: galvanized coated ductile iron conforming to ASTM A-536, galvanized, stainless bolts, Victaulic style 89.
    - Threaded outlets shall be ASTM A-312 or ASTM A-276 304L SST
    - Seals shall be Grade “H” NBR, temperature range –20 to 210°F

- Flange gaskets: Garlock Blue-Gard style 3000 gaskets (1/8 in. thick)

- Based on anticipated water temperatures, technical cooling water piping will not be insulated.

Heating Water

- Interior piping 2 in. and smaller shall be Type L copper with brazed fittings.
- Interior piping 2½ in. and larger shall be either Type L copper with brazed fittings or Sch 40 steel pipe with welded and flanged joints.
- Interior heating water piping shall be insulated with rigid glass fiber insulation.
- Piping exposed to the interior shall have a PVC or aluminum jacket. Piping exposed to the exterior shall have an aluminum jacket.

Seismic Criteria

Referenced Standards and Design Criteria:

- Seismic bracing shall be in compliance with ASCE 7-10.
- Equipment mounted on isolators will be seismically braced using loose cables, telescoping pipes, or box sections, angles or flat plates used as limit stops or snubbers, either integral to or separate from the isolators.
- Nonrotating, fixed equipment will be bolted directly to the floor or structure.

Mechanical Calculations

Mechanical calculations are provided in Appendix C for both air side and cooling water side.

Sustainable Design Strategies

The following energy conservation measures will be incorporated into the HVAC design:

- DDC BAS for optimization of major HVAC equipment operation.
- Variable-volume supply and exhaust system in combination with stand-alone controllers to provide maximum flexibility in occupied/unoccupied space control scheduling, thus minimizing supply and exhaust air volumes.
- Supply air temperature is to reset to minimize air conditioning of outside air and subsequent reheating of conditioned air.
- Supply air volume from AHUs will be reduced to minimum levels without compromising safety. During occupied hours, room supply air volume is set at the maximum air flow required to provide makeup air, minimum required ventilation, or space cooling. This will be accomplished using the VAV air systems and DDCs.

- VSDs installed on all VAV AHU supply and return fans to reduce fan horsepower requirements of non-peak conditions.

- VSDs installed on all pumps to reduce pump horsepower requirements at non-peak conditions.

- Full economizer control on all mixed AHUs to reduce consumption while maintaining appropriate indoor humidity levels.

8.4.1.10 Electrical

Site Power Distribution

The 40M Instrument Building will be supplied from outdoor unit substation TA2-SS3.

The 40M Instrument Building will be provided with 480 Y/277 V secondary service from duct bank feeders from 1500 kVA outdoor substation TA2-SS3 to interior distribution equipment in the science areas. The building's interior distribution will also service the adjacent new pedestrian bridge that connects to the existing pedestrian bridge.

The Zeeman's instruments will be provided with 480 Y/277 V secondary service from an 225 A feeder duct bank from outdoor substation TA2-SS3 to the building main distribution panel.

New Pedestrian Bridge

Systems for the new pedestrian bridge connection from the 40M Instrument Building to the existing pedestrian bridge will be extended from the 40M Instrument Building.

Building Power Distribution

2500 A, 480 Y/277 V low-voltage switchgear located at exterior substation TA2-SS3 will distribute power to CF loads and instrument loads. Two 400 A distribution panels located in both north and south science areas are anticipated for separation of services to instrument and CF building loads.

An 800 A, 480 Y/277 V distribution panel in the 40M Building will distribute power to CF loads and instrument loads.

Service to a 30-ton high bay crane and 5-ton javelin crane in the 40M Building and a 10-ton crane in the Zeeman's instrument area will be provided.

Separate transformers will be provided where possible to service instrument loads.

Secondary Distribution

- Building secondary distribution will generally be 480 V, 3-phase, 4-wire, plus ground. This will provide service to CF lighting, receptacles, and HVAC loads as well as building instrumentation loads. Further transformation down to 208 Y/120 V, 3-phase, 4-wire, plus ground will be provided for general use receptacles and other low-voltage equipment as necessary.

- All conventional building dry-type transformers will be DOE 2016 rated for efficiency, 115°C rise, 220°C insulation class with six 2.5% taps. Consideration will be given for harmonic or K-rated transformers and oversized neutrals to handle the heating effects of the harmonic loading.

- Circuit protection will be
  - Where 480-V distribution is provided, the exterior unit substation secondary will be of low-voltage switchgear UL 1558 construction with electrically operated drawout power circuit breakers with solid state adjustable trips.
  - Generally molded case circuit breakers. Solid state adjustable trip units will be provided above 250 A.
  - Bolt-in type molded case circuit breakers for branch circuit panelboards.
  - 100% rated for service entrance main circuit breakers, 80% rated otherwise.

- Devices will be fully rated. Series ratings of protective devices will not be acceptable.

- Two levels of ground fault protective devices will be provided at the main and feeder breakers at service switchgear assemblies.

Emergency Power Supply System

EPSS Power Generation Plants

The 40M Building and Target Building II will be provided with building and instrument standby power from an exterior 1000 kW/1250 kVA, 480 Y/277 V diesel engine-generator TA2-EG1. It will provide emergency power for life safety systems, including egress lighting, and critical instrumentation and HVAC systems loads.

The exterior diesel standby engine-generator will be provided in an exterior, weatherproof, sound-attenuated, reach-in enclosure with 24-h sub-base fuel tanks. The generator will be provided with a quick-connect feature to be used for load bank testing or portable generator backup if the primary unit is down for maintenance.

EPSS Power Distribution

The EPSS secondary distribution system will be separated into the following branches as required by code:

- Generator: This branch provides alternate source power from the generator set main circuits breaker(s) and associated distribution to the line side of each ATS.

- Emergency (NEC Article 700): This branch provides continuous (normal or generator) source power for the following equipment essential for safety to human life:
  - Interior building means of egress lighting and illuminated exit signs
  - Exterior building means of egress immediately adjacent to exit discharge doorways
  - Fire detection and alarm systems
  - Public address communication systems (when used for issuing emergency instructions)
  - Generator set location, task illumination, battery charger, emergency battery-powered lighting unit(s), and selected receptacles
  - Fire protection systems
  - Experimental processes where interruption would produce serious life safety health hazards, and similar functions

- Combined legally required and optional standby branch, designate as “optional branch” (NEC Article 701 and 702): This branch provides continuous (normal or generator) source power for the following equipment that, when stopped during any interruption of the normal electrical supply, could cause hazards or hamper rescue or firefighting operations; or (optional branch) to protect facilities or property where life safety is not dependent on system performance:

- Control and alarm systems of major apparatus
- Experimental processes where any power outage could cause serious interruption of the processor damage to the equipment
- Ventilation and smoke removal systems
- Access control systems
- Telecommunication room lighting, equipment, and data processing systems
- Electric and mechanical room lighting and selected receptacles
- Mechanical equipment including boilers, condensate return pumps, hot water heating and glycol circulating pumps
- Plumbing equipment including sewage ejectors and pumps

Generator distribution feeders will extend from the EPSS power generation plant to 480 Y/277 V, 4-pole isolation-bypass transfer ATSs with associated distribution panelboards located in the Target Building Electrical Service Room. The following transfer switches are anticipated at that location:

- 260 A: Life safety branch (sized large to meet required withstand rating)
- 800 A: Optional branch 1
- 800 A: Optional branch 2

Associated branch feeders will extend to the 40M Building.

Power Quality Systems

Uninterruptible Power Supply Systems

An 80 kVA UPS system will be provided in Target Building II which will also serve the 40M Building IT distribution.

Surge Protection Devices

Surge arrestors labeled for use with NFPA 780 lightning protection systems will be provided at all unit substation transformer primaries.

Transients (surges, lightning, switching events) can introduce harmful voltage or current spikes to electronic equipment.

SPD filtering devices will be installed on main low-voltage switchgear, distribution panelboards, and branch panelboards serving major electronic equipment and all emergency branch panelboards in compliance with current code requirements. Sensitive equipment may require multiple levels of protection to protect items of equipment not only from utility disturbances but also from one another.

Electric Metering Systems

Electrical metering systems, according to ORNL standards, will be used to monitor and alarm

- Electrical loading, harmonic loading, and protective device positions. Rail-mounted power quality PM 8214 DIN meters will be required at the unit substation building main service breakers.

- Service low-voltage switchgear mains and feeders.

- Medium-voltage interrupter switches, positions, and transformer status.
- Distribution panelboards on the load side of ATSs.
- Standby engine generator plant and associated distribution equipment.
- ATS positions.

The system will be networked to the ORNL Power Operations SCADA “SNO” network.

Grounding Systems

Ground Grid

All building grounding systems must be bonded to a common earth ground in compliance with the NEC. Each building will be provided with a #4/0 direct buried copper ring encircling the perimeter of the building, which will provide a convenient means of connecting all metallic systems and equipment into a single equipotential grid that has a low resistance to ground.

Building Grounding

Building steel, foundation rebars (Ufer ground), and metallic water supply piping will be bonded to the ground grid.

Building Lightning Protection

An NFPA 780 Faraday cage type lightning protection system will be provided to protect the building/structure and its occupants and contents from the electrical effects of a lightning strike to ground. The system will include independent down conductors in PVC from the rooftop to the ground grid.

Electrical Power System Grounding

Separate green grounding conductors will be provided with all feeders and branch circuits to provide an intended grounding of the neutrals of the electrical power systems. Each will be bonded to the ground grid with grounding electrode conductors from the distribution system neutral source.

Interconnected bus bars in electrical rooms will collect electrical and electrical equipment grounding conductors to tie the ground ring at the electrical service entrance room.

Electrical Equipment Grounding

All non–current carrying metal parts of electrical equipment enclosures, raceways, boxes, cabinets, housings, frames of motors, luminaires, and so on will be bonded and connected to electrical room ground buses where the associated system neutral is grounded. This allows for a safe ground path in an electrical fault condition.

Instrumentation Signal Reference Grounding

The bonding of instruments and instrument cabling pathways, as a low-impedance-signal reference system to a common equipment area bus and then to the ground grid, will be provided to minimize noise induced voltages and reduce equipment malfunctions.

Telecommunications Signal Reference Grounding

Interconnected bus bars in telecommunication rooms will collect STS IT equipment and pathway grounding conductors and bond to the electrical service entrance room ground bus in compliance with EIA/TIA and NEC requirements.

Lighting Systems

Exterior Lighting

Pole-mounted LED light standards with concrete bases will be provided along roadways and within parking lots.

Building-mounted perimeter LED luminaires will be provided at building exits, walkways, and vehicular circulation areas.

Interior Lighting

LED interior lighting will be provided in compliance with IESNA lighting standards and ASHRAE 90.1 energy budgets.

Energy-efficient, heavy-duty, specification-grade, high bay and industrial LED luminaires are generally anticipated in STS instrumentation areas.

Lighting Controls

Exterior lighting will be provided with photocell and time clock controls.

Interior spaces will be provided with automatic lighting controls in compliance with ASHRAE 90.1 energy budgets. High bay 24/7 areas will be breaker controlled.

Facilities & Operations Building Systems

The building electrical metering system and BAS to monitor electrical and HVAC building systems will be site interconnected to the SNS campus systems as described in Site Utilities, Section 8.1.3 of this report and will also include the following systems.

Fire Alarm System

The fire alarm system will be a microprocessor-based detection and notification control system installed and acceptance tested in compliance with NFPA 72, *National Fire Alarm Code*. The building system will include multiplex wiring techniques, a central processing unit (FACU), annunciator units, and peripheral detection and alarm devices.

The system will

- Include smoke, heat, and beam smoke detection devices to suit environmental conditions
  - High bay areas will be provided with beam smoke detection.
  - Both smoke and heat detection will be provided to other areas.

- Include audible horns and visual strobe notification devices

- Monitor building fire suppression systems and override HVAC functions in an alarm condition for fire and smoke containment

- Report fire, supervisory, and trouble alarms to the ORNL Fire Department and LSS office in Building 4512 over a fiber optic network

Wiring will be supervised Class B installed in conduit. Multimode fiber optic cabling will be extended in conduit between the fire alarm control unit and the telecommunication room in each building.

The system will be Edwards/EST Fireworks manufacturer/series according to ORNL requirements to match the existing campus systems.

Public Address System

A public address system will be provided with building amplification as an extension to the campus-wide Valcom mass notification system.

Wiring will be installed in conduit.

Access Control System

The building will be provided with an access control system with central equipment located in the main telecommunications room.

Alarm and supervisory conditions will be reported to the ORNL campus security monitoring location over a fiber optic network.

Components will match existing ORNL equipment for system compatibility.

Telecommunication Systems

The building will be provided with separate telecommunications service from the existing site telecommunications distribution system at the CLO to a building main distribution room. Design for the incoming POTS and/or VoIP telephone service, LAN, and wireless networking shall be coordinated with DOE's prime subcontractor, Black Box. The STS project will provide the interconnecting fiber optic cabling. Refer to the site utilities telecommunication distribution paragraphs, which outline telecommunications service to the STS buildings.

Building IT systems for systems networking hardware, including switches, routers, patch panels, DAS, and WLAN components, will be provided.

Building IT horizontal Category 6A cabling will be provided from telecommunications rooms located on each floor, stacked where possible. Building IT systems will be installed in compliance with EIA/TIA standards.

ORNL F&O Building Systems Distribution

The following building systems/system owners will be interconnected with cables and raceways by SNS CF. The system owners will perform final tie-ins.

- Public address/F&O Instrumentation and Controls

- Fire alarm (FIREWORKS Network)/F&O Laboratory Protection
- Access control/F&O Laboratory Protection
- BAS/(F&O Facilities Management (CLO II only—Siemens))
- Power monitoring (ION-Schneider)/F&O electrical utilities (including central IT UPS systems monitoring)

Instrument and Control Systems

ORNL STS will provide building instrumentation and control systems cabling for interconnection of the following systems:

- PPS
- MPS
- ATS
- TPS (two conduits)
- EPICS

Pathway Systems

Ladder-type cable trays will be provided to support telecommunications and instruments and control systems cabling requirements with proper wire dropout devices, conduit sleeves, firestopping, grounding, and wire management components.

Cabling from wall box–type IT jacks will be in bushed conduits extended and grounded to the local cable tray system.

One 36-in. cable tray is anticipated for area coverages for each of the following:

- Instruments and control
- 480-V instrument power
- 120-V instrument power
- ORNL Networks Building IT

8.4.1.11 Plumbing

Drainage/Waste

High Bay Interior Drainage System

The interior of the 40M building high bay will be provided with a process drainage system to collect interior water from system leakage. The drainage will be piped to a duplex sewage ejector with pit located below grade. Any water collected will be pumped to the process waste holding tank in the basement of the Target Building II. Drains will be provided for each of the beamlines (11 total).

Laboratory Waste

Laboratory waste from laboratory sinks, cup sinks, and laboratory-related equipment will be collected separately below the lower level and conveyed by a gravity system to the underground sanitary waste drainage system outside the building. Any hazardous waste will be bottled to be transported for processing, consequently a lab waste treatment system will not be provided.

Lab waste from floor drains within lab spaces will be treated as process waste.

Unless required for specific equipment, floor drains will not be provided in laboratory rooms.

Complete accessibility will be provided to all cleanouts. Wall-type cleanouts will be used within the laboratory spaces. Floor drains that do not receive regular use will be provided with trap primers. Primers will consist of an automatic trap primer system that automatically discharges water at regular timed intervals.

Process Water

Non-potable Water Service (Instrument Use)

A separate process water system will be provided for instrument use water. Process water shall emanate from the backflow preventer provided at the incoming potable water service at the Target Building and shall be routed around the perimeter of the Target Building and into the Instrument Buildings. Connections will be provided for instrument use and for makeup to technical cooling water and sensible cooling water systems.

Design of process water will be based on anticipated use and adjusted/increased to allow for projected water demand for instrument-related equipment at the design stage. Piping will be sized to maintain a minimum of 30 psi at the most remote laboratory equipment connection.

Water velocity in distribution piping shall not exceed 6 ft/second. Provisions shall be made to arrest waterhammer. Shock arrestors when installed shall comply with PDI-WH201 or ASSE-1010.

Storm Drainage

The primary storm drainage system will consist of roof drains for any areas collecting water, routed to downspouts that will collect below grade at the lower level and run to the site storm sewer.

A separate overflow storm drainage system will be provided; it will be engineered to perform as a siphonic roof drainage system with the piping running level through the building and discharging to a velocity reduction tank located on the site. Velocities in the vertical piping shall be limited to 10 fps, and in the horizontal piping, the velocity shall be designed to 3.5 fps.

Compressed Air

CA shall be distributed from incoming service at the Target Building and around the Instrument Buildings to supply CA to instrument-related equipment and will be provided with local pressure-reducing valves to permit each piece of equipment to use air of various pressures. CA will be fed by a site CA system routed from the air compressors in the CUB. CA will enter the Target Building at the lower-level mechanical room. Distribution will be routed around all perimeters of Instrument Building high bay spaces, with outlets provided for each beamline (11 total).

Specialty Gases

Nitrogen shall be distributed from incoming service at the Target Building and around the Instrument Buildings to supply nitrogen to instrument-related equipment. Nitrogen will be fed by the liquid nitrogen tank located west side of Target Building II. Nitrogen will enter the Target Building at the lower level.

Distribution will be routed around all perimeters of Instrument Building high bay spaces, with outlets provided for each beamline (11 total).

Equipment

General

System Design Criteria

Process Water

- Process water system is designed to provide a minimum of 40 psi at the furthest outlet.

- Water piping shall be sized based on the minimum flow pressure required at each fixture or piece of equipment. Pipe velocities shall be maintained between 4 and 8 ft/second and shall not exceed 8 ft/second.

- Valves shall be placed to isolate individual fixtures within one room or a battery of fixtures within any one room.

- Hose outlets will be provided at all mechanical rooms and equipment spaces.

Lab Waste

- The waste system shall connect to each fixture requiring connection and where required will be provided with water seal traps. A vent system shall be provided for fixtures as required to ventilate the waste system and to prevent siphonage of fixture traps.

- Floor drains will be provided at all mechanical rooms and equipment spaces.

- Pipe shall be routed by gravity to maintain a positive slope with a maximum velocity of 2 ft/second.

Storm Drainage

- Storm piping shall be sized based on a 100-year occurrence rainfall rate with a 60-min duration.

- Roof drains will be provided for all roofs and areas receiving rainwater; maximum area per drains shall be 3,000 sf.

Compressed Air

- Design CA pressure on incoming service—105 psi
- Design CA pressure at laboratory outlets—100 psi
- Design flow at outlets—1.0 cfm
- Dew point −40 °F

Materials

Process Water Systems

- Above-ground process water systems

  - Tubing to be Type L hard temper with wrought copper fittings conforming to ASTM B88-and ASME B16.22. All joints shall be soldered with ASME AWS/A5.8 lead-free solder.
  - Copper tubing with grooved ends and mechanical joints is acceptable for sizes 2½ in. to 6 in. only. Tubing to be Type L hard temper with wrought grooved end fittings conforming to ASTM B88 and ASTM B75.
  - The entire process water distribution system will be fully insulated using closed-cell elastomeric foam insulation.

Storm System

- Above-ground rainwater piping
  - Hubless cast iron soil pipe: no-hub pipe with Husky SD-4000 soil pipe coupling manufactured by Anaheim Foundry, 4-band clamp or Clamp-All Hi Torq 125 2-band clamp. Sealing gasket shall be neoprene in accordance with ASTM C564, CISPI 301-75.
  - Horizontal storm drainage piping will be fully insulated using closed-cell elastomeric foam insulation.

- Below-ground rainwater piping
  - Asphaltum-coated, service weight, cast iron pipe and fittings with resilient neoprene push-on joints, ASTM A72, ASTM C564-70.

Process Waste

- Polypropylene pipe, (fire retardant above grade) (PP); Sch 40; PP DWV hub and spigot fittings; heat fusion joints above and below ground.

Compressed Air/Nitrogen Systems

- Type K copper with brazed joints

8.4.1.12 Fire Protection

Sprinkler

The 40M Instrument Building will be provided with complete automatic fire protection systems as required by the IBC and/or DOE Order 420.1C, *Facility Safety*. The design, installation, and acceptance testing of automatic sprinkler protection will be in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems* and DOE-STD-1066-2012, *Fire Protection*. Building will be fully sprinkled, with exposed sprinkler piping feeding upright sprinklers, or recessed pendent sprinklers where ceilings are provided. Sprinkler feed will enter at the east side of the Target Building in the lower-level mechanical and maintenance storage room from the site potable/fire water main, and a double check backflow preventer will be provided. The 40M Building will have multiple sprinkler zones limited to 30,000 sf maximum, with control valves located in exit stairwell at the east end of the building. Control valves will be provided with a tamper switch and a flow switch connected to the fire alarm system.

Incoming service will be hydraulically calculated and will be sized for the maximum calculated flow at the design stage.

General

- Portable fire extinguishers will be provided throughout the 40M building in accordance with the IBC and NFPA 10, *Portable Fire Extinguishers*.

System Design Criteria

Sprinkler systems will be hydraulically designed to provide water densities that meet the requirements for Extra Hazard, Group 1 protection and will be provided throughout the building.

Fire sprinkler systems will be hydraulically designed. Velocity shall not exceed 20 fps. All calculations assume a minimum of 10 psi deterioration in static and residual pressures in the hydrant flow test results.

Materials

- Pipe and fittings installed underground shall be Class 52 ductile iron cement lined with mechanical joints with a working pressure rating of 350 psig.

- Sprinkler piping installed above ground and sized 2 in. and smaller and all standpipe piping shall be Sch 40 black steel with threaded joints and fittings.

- Sprinkler piping installed above ground and sized 2½ in. and larger shall be Sch 40 black steel with roll or cut groove type connections and fittings. Pressure rating shall be 175 psig minimum.

- Fittings for grooved end shall be cast of ductile iron conforming to ASTM A-536 or malleable iron conforming to ASTM A-47, or forged steel conforming to ASTM A-234 (A-106, Gr. B), with grooved or shouldered ends for direct connection into grooved piping systems with steel pipe and shall be UL listed and FM approved, rated for a minimum 300 psi MWP.

8.4.2 50M Instrument Building

8.4.2.1 Programming

Building Function

The 50M Instrument Building will house beamlines 12–22, associated instruments, and user lab space, except for instruments to be located on beamlines 20 and 21, which are located in the 90M Instrument Building. The maximum beamline length for an instrument located on ST17 in this building will be 50 M. The 50M Building will also serve as a staging space for the construction of the beamlines, instrument hutches, and related lab support spaces. Instrument construction will occur progressively over successive years. Alterations and maintenance to existing instruments will be an ongoing process for the life of the 50M Instrument Building. Each instrument beamline will be unique in terms of planning geometry, space requirements and access. The design and coordination associated with the beamlines, instruments and related shielding is generally not included in the CF scope. The instruments and beamlines will be accessible from the Instrument Building main floor and from an upper-level mezzanine. High bay space with full overhead materials handling is a basic requirement of the 50M Instrument Building.

Program Summary

The 50M Instrument Building will includes 27,540 nsf and will have an estimated planning efficiency factor of 65%. This factor is based on analysis of the existing FTS instrument buildings and preliminary test-fit planning for the 50M Instrument Building. The estimated gross area of the 50M Instrument Building is 42,150 gsf. Table 8.22 summarizes the 50M Instrument Building space program requirements. Detailed room data sheets and test-fit plans are included in Appendix B.

Table 8.22. 50M Instrument Building space program summary.

No.	Rooms	Qty.	NSF	Total NSF
5.4.2.1	Instrument/beamline space	1	20,000	20,000
5.4.2.2	User support lab	2	620	1,240
5.4.2.3	Truck unloading set-down area	1	4,250	4,250
5.4.2.4	Sample environment cages	1	1,350	1,350
5.4.2.5	Staging and prep area	1	400	400
5.4.2.6	Emergency electrical room	1	300	300
Total nsf				**27,540**
Total gsf				**42,150**
Total efficiency				**65%**

8.4.2.2 Site Planning

Location and Floor Elevations

The 50M Instrument Building will adjoin the north side of Target Building II. The first floor will be located at elevation 1074 ft. Figure 8.12 highlights the 50M Instrument Building within the overall STS Site Plan.

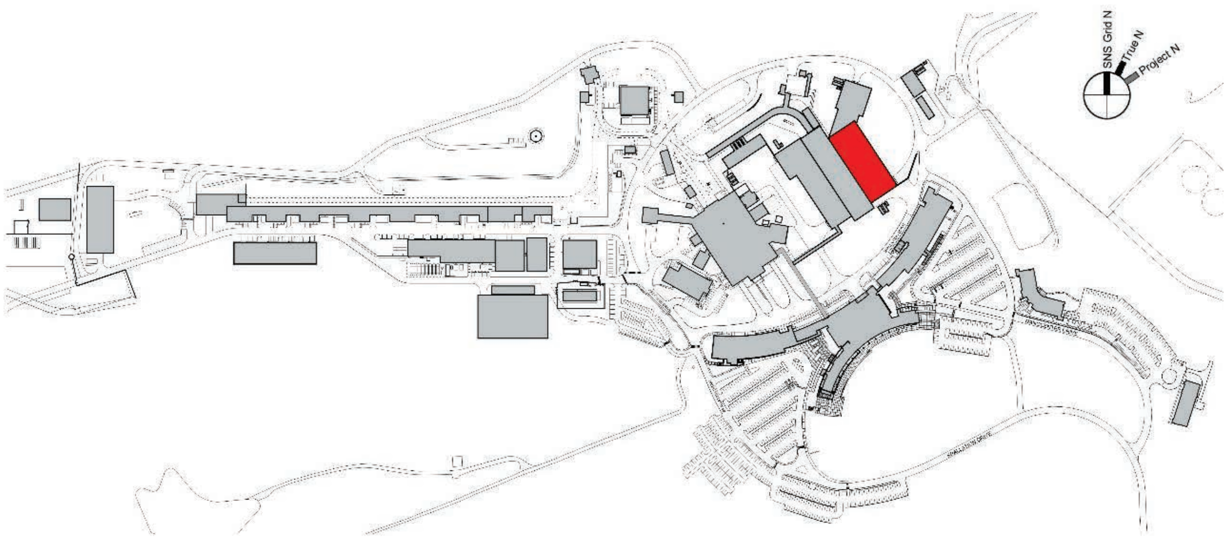


Figure 8.12. 50M Instrument Building location within the STS Site Plan.

Truck Access

Tractor-trailer truck access for the 50M Instrument Building will be located at the east end of the facility, within the building enclosure, at the first-floor level, elevation 1074 ft. Trucks will enter from the north directly into the 50M Building or from the south through the 40M Building and Target Building II. The interior truck lane will allow single vehicle passage in either the north or south direction.

Pedestrian Access

Pedestrian access to the 50M Instrument Building will be provided at the first and second floor levels of the facility. The primary access will be provided through the second-floor mezzanine walkway system that will link the STS complex with the existing FTS complex. First floor access will be provided from the adjacent Target Building II and at controlled exterior-grade level doors.

8.4.2.3 Building Planning

Building Organization/Floor Planning

The 50M Instrument Building will be a two-level structure. The first floor, elevation 1074 ft, will house the instruments associated with up to nine beamlines and additional space for staging and sample environment preparation. This floor level will be open to a high bay space above. The entire floor area will be served by an overhead crane. The beamlines will radiate from the moderators slightly above and below the tungsten target at elevation 1080 ft, which will be 6 ft above the 50M Instrument Building first floor.

The second-floor mezzanine will provide access to the upper level of the instruments and general circulation throughout the 50M Building and STS complex. The mezzanine will be located at the perimeter of the 50M Instrument Building along the three exterior walls. The mezzanine level will link to Target Building II and the 40M Instrument Building. It will also link to the FTS and CLO through the pedestrian bridge.

Vertical Circulation

The 50M Instrument Building will be served by a freight elevator and two egress stairs located in Target Building II. These vertical circulation elements will serve the first-floor and second-floor mezzanine in the 50M Instrument Building. Two open, interior convenience stairs, connecting the first- and second-floor levels will be located near the northeast and northwest corners of the building. Additional open convenience stairs are anticipated to be constructed in support of individual instrument stations.

Utility Distribution

Instruments located within the 50M Instrument Building will be served by multiple utilities, including power, CHW, CA, potable water, and nitrogen. These utilities will be distributed at the building perimeter above and below the second-floor mezzanine. The primary utility distribution is included in the CF scope. Extension of the utilities to the individual instruments is not included in the CF scope.

8.4.2.4 Key Features and Requirements

Radiological Shielding

The beamlines will be shielded with removable high-density concrete, regular weight concrete, or steel blocks. The shielding at each beamline will be approximately 8 ft wide, centered on the beamline, and 10 ft high. Shielding configurations at each instrument will vary based on the instrument design and function. During construction or maintenance of the beamlines and instruments, shielding blocks will be staged within unassigned areas of the 50M Building first floor that is located adjacent to the truck bay.

Structural Requirements

Optimum performance of the instruments requires a high degree of structural stability, including minimal deflection, vibration, and settlement in the floor slab design. Maximized overhead crane coverage of the 50M Instrument Building will require a clear span roof structure and related structural design to support a 30-ton overhead bridge crane. See Structural section, Section 8.4.2.8, for additional information.

Instrument Pits

Individual instruments in the 50M Instrument Building may require depressed pits in the first-floor level. If required, the pits will be constructed as part of the CF scope.

8.4.2.5 Life Safety/Code

Primary Occupancy Type

Target Building II and the 40M, 50M, and 90M Instrument Buildings will be constructed as a single building. The primary occupancy type for the Target Building II and Instrument Buildings is Group F-2, Low Hazard Factory Industrial, according to the 2015 IBC, and Special-Purpose Industrial according to NFPA 101, 2018 edition.

Accessory Occupancies

Accessory occupancies will include lab support rooms (Group B) and storage rooms (Group S-1). The lab support rooms and storage rooms can be considered accessory occupancies if the aggregate area of each use does not exceed 10% of the floor area of the story in which they are located. Otherwise, IBC Table 508.4 requires a 1-h fire-rated separation between the F-2 occupancy and the B and S-1 occupancies. Laboratory spaces will be separated by 1-h fire-resistive partitions, where practical, to allow for increased storage and use of hazardous materials.

Fire Protection Systems

The Target Building II and Instrument Buildings will be protected throughout by an automatic fire sprinkler system designed to protect an Extra Hazard – Group 1 occupancy for the main level and an Ordinary Hazard–Group 2 occupancy for the basement level in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems.*

The Target Building II and Instrument Buildings will be provided with a Class I standpipe system in accordance with NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*. Two and one half-in. fire department hose valves will be provided at each floor landing in each exit stairway.

Portable fire extinguishers will be provided throughout the building in accordance with the IBC and NFPA 10, *Standard for Portable Fire Extinguishers*.

The Target Building II and Instrument Buildings will be equipped with an addressable fire detection/alarm system consisting of the following:

- Manual fire alarm pull stations at all building exits
- Beam-type smoke detectors in large, open high-bay areas

- Area smoke detectors in elevator lobbies and elevator machine rooms
- Duct smoke detectors on the supply and return sides of all AHUs having a design capacity greater than 2,000 cfm
- Audible/visual notification appliances installed through the building

All fire alarm, supervisory alarm, and trouble signals will be automatically transmitted to the ORNL Fire Department via the LSS fiber optics network.

All new fire alarm system equipment will be manufactured by Edwards Systems Technology to be compatible with the existing site-wide campus system.

The fire detection/alarm system will be designed and installed in accordance with the IBC and NFPA 72, *National Fire Alarm Code*.

Maximum Floor Area and Stories

Target Building II and the Instrument Buildings will constitute a 4-story, 214,800 SF building of Type IIA construction. The first floor will have the largest floor area at 113,294 SF. The maximum floor area permitted for any floor by IBC Table 506.2 for a fully sprinklered, multi-story, F-2 building of Type IIA construction, with the area increase for frontage, is 119,787 SF. The proposed height and area for the building are within the limits established in IBC Sections 504 and 506.

Travel Distances

The maximum travel distance within Target Building II and the Instrument Buildings will not exceed 400 ft, as required by IBC Section 1016.2 and NFPA 101, Section 40.2.6.1. The maximum common path of travel distance will not exceed 100 ft, as required by IBC Section 1014.3 and NFPA 101, Section 40.2.5.1. The maximum dead-end corridor will not exceed 50 ft, as required by IBC Section 1018.4 and NFPA 101, Section 40.6.4.

Construction Type

Target Building II and the Instrument Buildings will be constructed of Type IIA construction in accordance with IBC Section 602.

Wall/Floor Ratings

The primary structural frame, floors, bearing walls, and roof will have a 1-hour fire resistance rating as required for Type IIA construction. Interior non-bearing walls and partitions will be of noncombustible construction. Interior walls, where applicable/needed, will be constructed to provide a 1-hour fire separation to support chemical quantity allowances.

Special Code Considerations

The largest floor area for the Target Building II and Instrument Buildings is the first floor, currently planned to have an area of 113,294 SF. The maximum area permitted by IBC Table 506.2 for any story in a fully sprinklered, multi-story, F-2 building of Type IIA construction, without an increase for frontage is 112,500 SF. Currently, the perimeter of the facility is 1,805 ft in length. The length of the perimeter that fronts on an open space at least 30 ft wide is 802 ft. This results in an area increase for frontage of

7,287 SF. Therefore, the maximum area permitted for any story would be increased to 119,787 SF. Should the area of the Target Building II and Instrument Buildings exceed 119,787 SF on any level, the construction classification for the building will need to be upgraded to Type IB to permit an Unlimited Area building.

Hazardous materials: The use and storage of hazardous materials shall be limited to the maximum allowable quantities indicated in IBC Tables 307.1(1) and 307.1(2). Where these quantities are exceeded, control areas shall be provided in accordance with IBC Section 414.2. The number of control areas per floor and their required fire resistance ratings shall be in accordance with IBC Table 414.2.2. Note that the floors of control areas are required to have a 2-h fire resistance rating for buildings over 3 stories in height.

8.4.2.6 Civil/Site Development

The construction excavation described under the Site Civil Works Section will be performed before construction of the Instrument Buildings. The lower basement of the target will be backfilled to the first-floor elevation to establish the grades for construction of the instrument buildings. Finished grading is shown on Drawing 5.1.19. Drawing 5.1.22 shows the site drainage concept. Roof drainage will be piped to the proposed storm sewer system. Sewer, fire and domestic water services to the building are shown on Drawing 5.1.27.

8.4.2.7 Architecture

Building Envelope

Exterior Wall

A striated-face, 36 in. wide insulated-core metal panel system, with a custom color to match the existing context, will be used as a major material component for the envelope of the 40M, 50M, and 90M Instrument Buildings in keeping with the existing texture and materials used on the SNS campus. The metal panel cladding support backup system will consist of a hanger rods and metal channel framing supported from the building structure. Metal window sills and wall caps will be used. Continuous through-wall flashing will be provided at the bottoms of all wall cavities, over all wall openings and metal copings. The metal panel wall systems will have an R-13 and R-13ci minimum requirement. Below-grade exterior walls will be constructed of reinforced concrete with a waterproof membrane and below-grade insulation board. The interior walls will have metal channel furring with a painted drywall finish. Exterior walls below grade will be required to achieve R-7.5 ci according to the 2012 International Energy Code.

Exterior Doors

Exterior entrance doors and egress doors will be 16-gauge, insulated-core painted hollow metal doors with 14-gauge, fully welded frames with a U value of 0.61. Overhead insulated coiling doors, 20 ft, 0 in. high by 14 ft, 0 in. wide will include factory-painted galvanized steel curtains with integral insulation achieving a minimum R-value of 4.75 requirement. All exterior doors will be provided with proximity card reader hardware.

Thermal and Moisture Protection

Flashing and sheet metal will be provided as a positive water stop around all openings (head, jamb, and sill) in walls such as windows, doors, louvers, and so on. All copings and gravel stops will be ES-1 compliant as required by IBC.

Damp-proofing will be provided on all walls, floors and other building components that are subject to high humidity, dampness, or frequent direct water contact.

Waterproofing will be provided at walls, floors, and other building elements that are subject to hydrostatic pressure, are liable to be immersed in water, or are below the water table. The waterproofing membrane will be a hot-fluid-applied, two-layer 215-mil, polyester fabric–reinforced membrane.

Because of the inherent moisture-resistant properties of the insulated metal panel system, an air/vapor barrier will not be required where the system is installed.

Exterior sealants will be nonstaining with a two-part composition and 50% movement capacity and will be compatible with the surfaces on which they are being applied.

Insulation combustibility, including wrappings, inside the building skin will be limited to a flame spread of 25 and smoke development of less than 50.

Glazing

Windows will be limited to the upper portion of the exterior walls. Typical vision glass will consist of 1-in.-thick, low U-value insulated, low-E, argon-filled glass units on a thermally broken frame. The windows/glazing system are anticipated to have a U value of 0.38.

Glazing materials and methods will comply with the Flat Glass Marketing Association's Sealant and Glazing Manuals. Glass will comply with ASTM C1036-01.

Roof Construction

The roofing system will be a 30-year, 80 mil minimum thickness, white thermoplastic (PVC) single-ply sheet with an integral fiberglass mat reinforcement roofing membrane over polyisocyanurate insulation on a sloping roof structure. Tapered insulation saddles will be used to provide drainage to roof drains and at roof equipment locations. All roof construction details and roof penetrations must comply with the guidelines established by the NRCA. Roof traffic pads will be adhered to the membrane along all roof maintenance traffic paths. All roofs with serviceable components beyond roof drains will be surrounded by a 42-in.-high parapet or provided with fall protection system.

Low-slope roofing will have a minimum 3-year aged solar reflectance of 0.55 and a minimum 3-year aged thermal emittance of 0.75 in accordance with the Cool Roof Rating Council Program. Roofing will be Energy Star rated with emissivity of at least 0.9 when tested in accordance with ASTM 408.

The roofing system will meet or exceed UL class A fire exposure requirements and comply with FM Class I-90 for wind uplift per ASTM 1592. It will provide a minimum thermal resistance value of R-30

Interior Construction

Walls

Interior walls at the 50M Instrument Building will be constructed of CMUs for durability. The height of the demising walls will be constructed to the underside of the structural deck. All fire-rated walls will be constructed in accordance with the IBC code requirements and UL-listed assemblies.

All metal guard railing and handrails at all openings and egress stairs will have a painted metal finish.

Wall Finishes

All finish materials for walls, ceilings, and floors, will have a Class A rating, with a flame spread ≤ 25, a fuel contribution of ≤ 25, and smoke development ≤ 450.

Typical interior gypsum board and CMU partitions will receive a paint finish consisting of one primer coat and two finish coats. Epoxy paint will be applied to all lab demising walls. All paints, including top coats and primers, will comply with the 2016 *Guiding Principles for Sustainable Federal Buildings*.

Floor Finishes

The floor throughout the 50M Instrument Building will receive concrete sealer over the new concrete. No vinyl wall base will be used in these areas.

Ceiling Finishes

The structural elements will be left exposed in all spaces and all mechanical and utility areas. All exposed structures will receive an epoxy paint finish consisting of one primer coat and two finish coats.

Interior Doors

All interior doors will be shop-primed, field-painted, 16-gauge hollow metal doors with 14-gauge fully welded metal frames. Metal interior rolling doors and floor hatches will be provided.

Tempered glass vision lights will be provided at all laboratory doors for safe egress. All laboratory access doors will be provided with proximity card reader hardware.

Furnishings

Laboratory Casework

Lab casework will be a modular system, prefinished painted metal base, wall cabinets, and shelving units with an epoxy resin countertop. The modular system will be adaptable and flexible to accommodate the changing needs of lab research.

Vertical Circulation

Stairs

Metal (painted steel) framed industrial stairs, allowing convenience access from the first floor to the mezzanine level, will include steel grating treads, open risers, and painted metal handrails

Elevators

Not applicable

Specialty Equipment

Combination emergency showers/eye wash units will be provided according to ANSI Z358.1 at lab areas where chemicals will be used or stored.

Crane

A 30-ton bridge crane will be provided with a hook height of 40 ft above the instrument floor.

A 5 -ton javelin crane will be provided.

8.4.2.8 Structure

Applicable Codes and Standards

See Sheets x – xii for a complete list of Applicable Codes and Standards

Design Loading

Superimposed Floor Loads on Instrument Floor

- Dead loads
  - Within 36 ft radius of target center: 1500 psf
  - 36–53 ft radius of target center: 6000 psf
  - 53–65 ft radius of target center: 3500 psf
  - Beyond 65 ft radius of target center: 1500 psf
  - At elevated deck: 20 psf collateral load, typical
  - See also Figures 8.6 through 8.8 in Section 8.3.1.8

- Live loads: 500 psf or HS20-44 truck loading
  - See also Figures 8.6 through 8.8 in Section 8.3.1.8

Superimposed Floor Loads on Mezzanine Floor

- Dead loads: 15 psf + 20 psf collateral load
- Live loads: 150 psf

Superimposed Roof Loads

- Roof snow load
  - Ground snow load: Pg = 10 psf
  - Snow exposure factor: Ce = 1.0
  - Snow importance factor: Is = 1.2

- Minimum roof live load = 20 psf + 20 psf collateral load

Wind Loads

- Risk category IV
- Basic wind speed: V = 120 mph
- Exposure category B

Seismic Loading

- Risk category IV
- Importance factor: Ie = 1.5

Crane Requirement

- Refer to the Crane section of Section 8.4.2.7 for information.

Building Structural System

Slab on Grade

The slab construction is anticipated to consist of a structurally reinforced normal weight concrete slab. The structural slab on grade is anticipated to be supported on 9¾-in. diameter micropile foundations, approximately 135 ft long, with a 200-ton capacity. The floor slab will be placed over a vapor barrier, a compacted drainage base course, and a compacted subgrade. In the CHESS Instrument space, stainless steel rebar will be provided within 6 ft of the sample position.

Foundation System

A geotechnical investigation has not been performed. Until a geotechnical investigation and report have been completed, an accurate description of the building's foundation system cannot be provided. The 50M instrument building is anticipated to be supported on 9¾-in. diameter micropile foundations, approximately 120 ft long, with a 200-ton capacity. Below-grade walls are anticipated to be constructed with reinforced normal weight concrete. It is anticipated that the east below-grade wall will consist of counterfort retaining walls supported on battered micropiles. Water stops will be provided in construction joints to safeguard against water intrusion.

For the 50M Instrument Building and the adjacent 90M Instrument Building and Target Building II, there are three main components considered related to deflection and settlement concerns. Refer to the Foundation System section of Section 8.3.1.8 for further discussion and information.

Superstructure

The 50M Instrument Building is anticipated to be a single-story conventional steel-frame structure with a partial mezzanine level. The building will support the exterior wall system with steel girts as required. The mezzanine floor is anticipated to be constructed using reinforced normal weight concrete on galvanized composite metal deck. The roof structural system is anticipated to consist of metal truss framing with roof deck meeting galvanizing G90 requirements. The 50M Instrument Building will share a column line with the Target Station Building.

Lateral System

Resistance to lateral loads resulting from wind and seismic forces on the building are anticipated to be provided by concentrically braced steel frames.

Crane Support

Steel framing will be provided to support the crane runway.

Geotechnical Analysis

A review of historical geotechnical and geophysical surveys was performed that included the original campus development and additional structures. A detailed geotechnical exploration was performed by Law Engineering dated June 30, 2000, addressing the original development of the campus (Law 2000).

No borings were drilled near the footprint of the proposed 50M Instrument Building location. Considering the consistency of the upper crust of soils at the site, we would anticipate similar subsurface conditions as well as rock conditions. The necessity to reduce and control differential settlement between the STS and the 50M will require a micropile system. The micropiles should be capable of supporting 200 tons/pile when designed using a 9¾-in. steel casing. The axial capacity should be confirmed using a pile load test.

A review of geophysical data and shear wave velocities from the Law report indicates that the 50M Building footprint would be located in a seismic site classification C as defined in IBC 2015 and ASCE 7 (Law 2000). This is confirmed by the average shear wave velocities for multiple soil profiles tested during the original campus development.

A supplemental geotechnical report would be advisable once the final 50M Building location and footprint have been determined. The density and pattern of the soil test borings should be selected to optimize the quality of geotechnical data. Additional geophysical testing is not anticipated for design of the structure.

Vibration/Acoustics

The instrument floor and its foundations will be constructed so that beamline vibrations do not exceed a peak-to-peak value of 0.008 in. (± 0.004 in. or ±0.1mm). Based on the current preliminary instrument floor design, which is driven by the instrument floor loading and settlement criteria, this vibration performance is considered to be readily achievable.

The available information does not indicate any spaces that will require acoustical criteria.

8.4.2.9 Mechanical

Air Handling/Ventilation

The 50M Instrument Building will be served by two CAV AHUs. The units will be manifolded together and will share a common discharge plenum to provide partial redundancy (66% of the supply system design capacity through a single AHU) in the event of planned service or a complete unit failure. The AHUs will be designed as heating-cooling, single duct, reheat type. The units will operate 24 h/day, 365 days/year. Supply fans will be configured in a multi-fan array, plenum fan design. VFDs will provide supply fan volume control in response to a signal from duct-mounted static pressure sensors and will allow for setback control capability of the supply fan volume. VFDs will also provide return fan volume control in response to a signal from air flow measuring stations used to establish volumetric offset between the return air and the supply air quantities. The system will be designed for energy conservation adjustment with the potential to reduce ACHs (unoccupied setback change) controlled by the BAS. The system will be designed to maintain minimum outside air quantities to maintain positive pressure in tertiary spaces but will also be capable of full economizer mode.

The AHUs will be housed in the enclosed mechanical equipment space located in the truss space at the east side of the Target Building. Ductwork will be routed out over the roof of the 50M building and enter the truss space above the 50M Building crane. Supply ductwork will be routed to the sides of the building to avoid the crane travel path and drop along the walls to introduce air at the lowest levels of the high bay space. Sound attenuators at the air terminal devices will not be provided. Return air will be gathered at the center of the 50M Building truss space and will be recirculated through return ductwork back to the units. The HVAC distribution system shall be pressure-independent, CAV control for all spaces.

The supply distribution system will consist of low-pressure ductwork with pressure-independent electrically actuated supply CAV air terminal devices, reheat coils, low-pressure externally insulated ductwork downstream of air terminals, and diffusers. Sound attenuators at the air terminal devices will not be provided. The use of sound attenuating flexible duct at diffusers will be limited to 6 ft in total length to minimize duct static pressure losses.

Exhaust

The 50M Instrument Building will be provided with a general exhaust system for lab hoods and similar uses. The general exhaust system will be located on the roof of the instrument area. The exhaust system will use duplex (one standby) vertical, radial dilution exhaust fans of spark-proof construction with bearings and motors out of the airstream. Two fans will be provided to serve the common exhaust plenum, each sized at 100% of the load. If one of the fans fails, the remaining fan will be able to provide 100% of the common exhaust system's design capacity. All of the fans in the common exhaust plenum will be on emergency power to ensure continuous hazardous material containment but will be controlled to run at a reduced speed during a power outage to limit the negative pressure impact to the building. Ducts will be routed through the truss space of the facility for future connection of instrument exhaust.

The 50M Instrument Building will also be provided with a separate exhaust system for the instrument bunkers. The bunker exhaust fans will be located on the roof of the Instrument Area. The exhaust system will use duplex (one standby) vertical, radial dilution exhaust fans of spark-proof construction with bearings and motors out of the airstream. Two fans will be provided to serve the common exhaust plenum, each sized at 100% of the load. If one of the fans fails, the remaining fan will be able to provide 100% of the common exhaust system's design capacity. All of the fans in the common exhaust plenum will be on emergency power to ensure continuous hazardous material containment but will be controlled to run at a reduced speed during a power outage to limit the negative pressure impact to the building. Ducts will be routed through the truss space of the facility for future connection of instrument exhaust. Connections will be provided along each of the beamlines for future connection of instrument exhaust. A separate capped inlet will be provided at each beamline (nine total).

General utility set exhaust fans will be provided to exhaust toilet rooms, janitor closets, and other rooms requiring ventilation at a minimum rate according to their code requirements.

Technical Cooling Water

Chilled Water System

A CHW cooling loop will be provided to support space cooling in the 50M Instrument Building. The CHW cooling system will consist of an independent loop of campus CHW originating in the Target Building lower level. CHW for future cooling use will be routed around the exterior of the 50M building, with valved connections provided along each beamline (nine total).

Sensible Chilled Water System

A sensible CHW cooling loop will be provided to support equipment cooling in the 50M Instrument Building (and extended to the 90M Building). The sensible CHW cooling system will consist of an independent pumped loop that will reject heat into the Target Building CHW through a plate-and-frame HX. The system will be designed to operate at a supply temperature of 55–60°F to reduce the potential for condensation. The tank, pumps, HX, filters, and chemical treatment components will be located in the mechanical support area of the Target Building lower level. Sensible CHW for future instrument use will be routed around the exterior of the 50M building (and 90M building), with valved connections provided along each beamline (11 total).

Heating Water

Heating water for AHUs will be extended from the Target Building lower level to the truss mechanical room where the AHUs are located.

Controls

The 50M Building shall be controlled by the EPICS. The building will be connected to an expansion of the existing EPICS. Instrumentation and wiring shall be connected to a new EPICS PLC in the building, and controls interface for the building will be provided at the target control room and on the instrument floor. Programming and connection of PLC to EPICS shall be completed and the control system commissioned to ensure proper operation.

Electric/pneumatic actuation will be used for all control valves and dampers on both systems so that instrument air is required. All control systems will be on UPS and emergency power. System software and firmware will provide the following functions:

- Control sequences shall be developed to support the operations of the technical equipment.
- PID control to allow faster and closer control to system set points.
- Adaptive tuning to adjust PID loop constants to ensure that control system response remains accurate and reliable over a wide range of dynamic operating conditions.
- Monitoring to read the value of measured variables, to read control loop set points, to monitor control signals to actuators, and to indicate status of equipment, alarms and overrides.
- Energy management, including optimum start/stop, variable ACH rates in laboratories, duty cycling, supply air temperature reset, supply air static pressure reset, demand limiting, time totalization, and so on.
- Data management, including continuous database updating, alarm reporting, trend logging and report generation.
- System programming to add, delete, or change points, set points, schedules, control algorithms, report formats, and so on.
- System software will allow building operators to graphically monitor and control building operations and provide the functions listed. Graphics will include site plans, overall building plans, floor plans and individual system graphics.

Equipment

Table 8.23 provides a listing of the mechanical equipment specifications for the 50M Building.

Table 8.23. 50M Instrument Building mechanical equipment.

Use	Equipment	Size	Qty	Em pwr	Redund	Location	Remarks
50M AHU	CAV AHU	25,000 cfm	2	N	33%	Target Bldg. truss mech rm	
50M exhaust	Radial exhaust fans	2,500 cfm	2	N	N+1	50M roof	Lab fume hood exhaust
50M instrument bunker exhaust	Radial exhaust fans	7,500 cfm	2	Y	N+1	50M roof	
50M exhaust	Utility exhaust fan	Varies	10	N	–	50M roof	
Instrument cooling	Sensible CHW pumps	220 gpm @ 100 Ft	2	N	N+1	Target mech rm	Includes 90M sensible CHW
CHW To Sensible CHW	Plate-frame HX w/ filtration skid	220 gpm	1	N	–	Target mech rm	
Sensible instrument cooling	Fan coil units	2–3 tons	9	N	–	Varies	

Air Handlers

General

- All AHUs will be semi-custom, factory-fabricated, and constructed with 2-in.-thick double walls, constructed of galvanized steel.

- Maximum allowable nominal face velocities:
  - Air intake louvers (through free area): 350 fpm
  - Heating water coils: 500 fpm
  - Cooling coils: 400 fpm
  - Filters: 400 fpm

- AHUs: modular, semi-custom, 2-in. double-wall construction configured as follows:
  - Mixed air plenum
  - Intake isolation damper
  - Return/exhaust damper
  - Supply fans (4 to 6 fan array)
  - Relief fans (4 to 6 fan array)
  - VFDs
  - Economizer section
  - Merv 8 (30%) prefilter section
  - Hot water preheat coil
  - CHW coil
  - Hot water reheat coil
  - Supply fans (4 to 6 fan array)
  - VFDs
  - Merv 14 (95%) final filter section
  - Supply plenum
  - Isolation/smoke damper

- Access sections
- Doors: safety glass windows and quarter turn handles
- Marine light in each access section
- Vibration isolation in accordance with ASHRAE HVAC Applications—Noise and Vibration Control

Exhaust Fans

General/ Lab Exhaust Fans

Vertical, radial dilution exhaust fan with spark-proof construction with bearings and motors out of the airstream. Fans will have a baked epoxy airside chemical-resistant coating. The common plenum and outside air intake dampers will be of galvanized steel construction with a chemical-resistant coating. The system will consist of the following components:

- Common exhaust plenum
- Isolation damper at each fan inlet
- Vertical exhaust fans
- Exhaust stacks
- Bypass air inlet and bypass damper
- VFDs

Utility Set Exhaust

Exhaust fans will be backward-inclined, belt-driven centrifugal fans with spark-proof construction and bearings and motors out of the airstream. Fans will be single width, single inlet with a galvanized steel housing and wheel construction. The fan motor will be totally enclosed and fan cooled. The system will consist of the following components:

- Steel mounting rails with vibration isolators
- Isolation damper at the fan inlet
- Discharge ductwork with bird screen
- Weather cover
- VFDs

Water-Based Systems

Technical Cooling Water Systems

Secondary technical cooling water systems will provide DI water with a resistivity in the range of 1 to 3 megohm/cm, using a slip stream polishing loop. All piping, valves, HXs, expansion tanks, and equipment on the DI cooling water pump skids will be stainless steel. Each system will include the following equipment:

- Base-mounted, end suction, centrifugal pumps
- Pump VFDs
- Plate-and-frame HX
- Mixed bed deionizers
- Resin trap filtration
- UV sterilizer

- Air separator and expansion tank
- Makeup water assembly
- Appropriate valving and piping specialties
- CHW supply to HX (using Target Building CHW)

Motors

- All motors shall be premium efficiency type and built to NEMA standards.

- Variable-speed motors shall be rated as inverter duty motors. All motors operating with VFDs shall be equipped with shaft grounding rings or insulated bearings to prevent the accumulation of PWM frequencies in the shaft, which could arc across the bearing, causing pitting and premature bearing and motor failure.

- All VFDs shall be provided with power filters to improve the building power quality from the occurrence of multiple VFD installations.

General

System Design Criteria

Outside Design Temperatures

- Summer: 92.8°F DB, 73.8°F MCWB (0.4% ASHRAE)
- Winter: 17.1°F (99.6% ASHRAE)

Interior Design Conditions: Preliminary Load and Ventilation Assumptions

Table 8.24 provides a listing of the preliminary load and ventilation assumptions for the 5M Building.

Table 8.24. 50M Instrument Building preliminary load and ventilation assumptions.

Space	Design set points	Cooling: BTU/sf	Heating: BTU/sf	Airflow: cfm/sf or ACH	Ventilation
Mechanical/ electrical	60–85°F	80	40	2	Code required
High bay	72–76°F, 60% >Rh	40	40	8 Ach	Code required
Loading	60–85°F	–	40	2	Code required
Ventilated spaces	60–100°F, no humidity control				

Notes:
Cfm/sf and values are schematic design level assumptions. The final values of the project will be calculated based on code requirements or heating and cooling demand, whichever is greater.

Active humidity control will not be provided for any building. Therefore, HVAC units will not have a humidification capability. The maximum relative humidity should not exceed 60% as a result of moisture removal at the cooling coils.

Sensible Technical Cooling Water (Chilled)

- Supply 55– 60°F

- Return 5°F above supply

Materials

Duct Distribution Systems

- Supply ductwork construction will be based on SMACNA 4-in. pressure class and 2-in. pressure class. Four-in. pressure duct construction will be used upstream of VAV boxes on variable-volume units; 2-in. pressure class duct construction will be used downstream of VAV boxes on variable-volume units and for all ductwork on constant-volume units. All ductwork seams and joints shall be sealed, regardless of pressure rating. Maximum permissible leakage = 2%.

- All supply ductwork routed through unconditioned spaces shall be insulated with 2-in. foil-faced batts or foil-faced duct board with similar R-value.

- Return and general exhaust ductwork construction shall be based on SMACNA 2-in. pressure class.

- Return air duct shall be insulated with 1½-in. foil-faced batts or duct board. Laboratory exhaust ducts shall not have fire dampers.

- General air distribution ductwork will be G90 galvanized sheet metal.

- General exhaust will be welded 316L stainless steel.

- Secondary confinement exhaust/hot off-gas shall be welded 304L stainless steel duct/thin wall tube (Sch 10 or less).

- Exterior supply or return ductwork shall be solid double-wall ductwork with a minimum 2-in.-thick insulation or single wall duct with 2-in. duct board, vapor barrier, and aluminum jacket.

- Rectangular and round ductwork shall be fabricated in accordance with SMACNA standards. Spiral-wound ductwork shall be a prefabricated system with factory certifications. Spiral-wound ductwork shall not be used on laboratory exhaust systems or other systems that may be exposed to water intrusion.

- Provide sound attenuation to meet the project requirements or in accordance with the direction of the project acoustician. Sound attenuation shall be by appropriate application of attenuators or duct design.

- Lined ductwork shall not be used, except for plenum return air-transfer boots for noise control. VAV air terminals shall be double-wall or have foil-faced inner surface.

- Flexible ductwork is limited to 5 ft and shall be used only downstream of VAV terminals. Flexible ductwork shall be limited to supply air systems only.

- Plenum return may be used for return air in all non-laboratory portions of buildings.

- Ductwork shall be sized as shown Table 8.25

- Spaces on VAV systems shall have conventional supply terminal boxes with hot water reheat coils and integral sound-attenuating characteristics.

- Smoke detection will be provided in accordance with NFPA 90A and IMC requirements.

Table 8.25. 50M Instrument Building ductwork sizing.

	Risers	Submains	Branches	Air distribution device neck velocity (fpm)
Max P.D.	0.1 in./100 ft	0.08 in./100 ft	0.08 in./100 ft	450 fpm

Piping

Chilled Water

- Interior piping sizes 2 in. and smaller, Type L copper with brazed fittings.
- Interior piping 2½ in. and larger shall be either Type L copper with brazed fittings or Sch 40 steel pipe with either welded and flanged joints or mechanical grooved fittings.
- All piping will be tested at 1.5 times the design system pressure.
- All interior CHW piping shall be insulated with closed-cell elastomeric insulation. Properties shall meet or exceed the minimum energy code requirements.
- All piping in mechanical rooms and piping exposed below 8 ft AFF shall have a PVC jacketing.
- All piping exposed to the exterior shall have an aluminum jacket.
- Technical cooling water (DI water for instrument cooling downstream of HXs)
- For sizes 2 in. and smaller, ASTM 312 Sch 10S, seamless, 304L stainless steel, plain ends. (Victaulic Vic-Press system or butt-welded, as specified)
- For sizes 2½ in. and larger, ASTM 312 or ASTM 358, Sch 10 electric ERW 304L stainless steel, Class 4. (Victaulic Vic-Groove system or butt-welded, as specified)
- For sizes ½ in. to ¾ in. OD tubing, ANSI Type 304L stainless steel, ASTM A213, Grade TP304L, seamless, annealed, minimum 0.065 in. wall thickness.
- Vents and drains: For sizes ½ to ¾ in. NPT, ANSI Type 304L Sch 40 SST pipe
- Fittings:
  - Welded fittings: ASTM A403, Grade WP-S304L or WP-W304L, elbows: standard 1.5× radius. Full penetration butt weld.
  - Welded flanges: ASTM A 182, Grade WP-S304L, raised face weld neck
  - Vic-Press or Vic-Groove 10S system, ASTM-312 304L SST
    - Plain end or grooved ends shall be ASTM A-312 304L SST
    - Vic-press flanges shall be ANSI Class 150, 304L SST, Van Stone type, carbon steel raised face slip-on backing flange, Victaulic style 565
    - Grooved couplings: galvanized coated ductile iron conforming to ASTM A-536, galvanized, stainless bolts, Victaulic style 89.
    - Threaded outlets shall be ASTM A-312 or ASTM A-276 304L SST

    - Seals shall be Grade H NBR, temperature range –20 to 210°F

  - Flange gaskets: Garlock Blue-Gard style 3000 gaskets (1/8 in. thick)

- Based on anticipated water temperatures, technical cooling water piping will not be insulated.

Heating Water

- Interior piping 2 in. and smaller shall be Type L copper with brazed fittings.
- Interior piping 2.5 in. and larger shall be either Type L copper with brazed fittings or Sch 40 steel pipe with welded and flanged joints.
- Interior heating water piping shall be insulated with rigid glass fiber insulation.
- Piping exposed to the interior shall have a PVC or aluminum jacket. Piping exposed to the exterior shall have an aluminum jacket.

Seismic Criteria

Referenced Standards and Design Criteria:

- Seismic bracing shall be in compliance with ASCE 7-10.
- Equipment mounted on isolators will be seismically braced using loose cables, telescoping pipes, or box sections, angles or flat plates used as limit stops or snubbers, either integral to or separate from the isolators.
- Nonrotating, fixed equipment will be bolted directly to the floor or structure.

Mechanical Calculations

Mechanical calculations are provided in Appendix C for both air side and cooling water side.

Sustainable Design Strategies

The following energy conservation measures will be incorporated into the HVAC design:

- DDC building automatic system for optimization of major HVAC equipment operation.
- Variable-volume supply and exhaust system in combination with stand-alone controllers to provide maximum flexibility in occupied/unoccupied space control scheduling, thus minimizing supply and exhaust air volumes.
- Supply air temperature is to reset to minimize air conditioning of outside air and subsequent reheating of conditioned air.
- Supply air volume from AHUs will be reduced to minimum levels without compromising safety. During occupied hours, room supply air volume will be set at the maximum air flow required to provide makeup air, minimum required ventilation, or space cooling. This will be accomplished using VAV air systems and DDCs.

- VSDs installed on all VAV AHU supply and return fans to reduce fan horsepower requirements of non-peak conditions.
- VSDs installed on all pumps to reduce pump horsepower requirements at non-peak conditions.
- Full economizer control on all mixed AHUs to reduce consumption while maintaining appropriate indoor humidity levels.

8.4.2.10 Electrical

Site Power Distribution

The 50M Instrument Building, helium compressor area, and 90M Instrument Building will be supplied from the same outdoor substation TA2-SS4.

The 50M Instrument Building will be provided with 480 Y/277 V secondary service from a duct bank from 1500 kVA outdoor substation TA2-SS4 providing two 400 A distribution panels located in both north and south science areas for separation of services to instrument and CF building loads.

The 50M Instrument Building will also be provided with two secondary services from 2000 kVA unit substation TA-SS2 to service N+1 helium compressors.

Building Power Distribution

Service to a 30-ton high bay crane and 5-ton javelin crane will be provided.

Separate transformers will be provided where possible to service instrument loads.

Secondary Distribution

- Building secondary distribution will generally be 480 V, 3-phase, 4-wire, plus ground. This will provide service to CF lighting, receptacles, and HVAC loads as well as building instrumentation loads. Further transformation down to 208 Y/120 Vs, 3-phase, 4-wire, plus ground will be provided for general use receptacles and other low-voltage equipment as necessary.
- All conventional building use dry-type transformers will be DOE 2016 rated for efficiency, 115°C rise, 220°C insulation class with six 2.5% taps. Consideration will be given for harmonic or K-rated transformers and oversized neutrals to handle the heating effects of the harmonic loading.
- Circuit protection will be
  - Where 480-V distribution is provided, the exterior unit substation secondary will be of low-voltage switchgear UL 1558 construction with electrically operated drawout power circuit breakers with solid state adjustable trips.
  - Generally molded case circuit breakers. Solid state adjustable trip units will be provided above 250 A.
  - Bolt-in type molded case circuit breakers for branch circuit panelboards.
  - 100% rated for service entrance main circuit breakers, 80% rated otherwise.
- Devices will be fully rated. Series ratings of protective devices will not be acceptable.

- Two levels of ground fault protective devices will be provided at the main and feeder breakers at service switchgear assemblies.

Emergency Power Supply System

EPSS Power Generation Plants

The 50M Instrument Building, 90M Instrument/tunnels, and helium compressor area buildings will be provided with building and instrument standby power from an exterior 300 kW/375 kVA, 480 Y/277 V diesel engine-generator TA2-EG2. It will provide emergency power for life safety systems, including egress lighting, and critical instrumentation and HVAC system loads.

The exterior diesel standby engine-generator will be provided in an exterior, weatherproof, sound-attenuated, reach-in enclosure with 24-h sub-base fuel tanks. The generator will be provided with a quick-connect feature to be used for load bank testing or portable generator backup if the primary unit is down for maintenance.

EPSS Power Distribution

The EPSS secondary distribution system will be separated into the following branches as required by code:

- Generator: This branch provides alternate source power from the generator set main circuit breaker(s) and associated distribution to the line side of each ATS.

- Emergency (NEC Article 700): This branch provides continuous (normal or generator) source power for the following equipment essential for safety to human life:
  - Interior building means of egress lighting and illuminated exit signs
  - Exterior building means of egress immediately adjacent to exit discharge doorways
  - Fire detection and alarm systems
  - Public address communication systems (when used for issuing emergency instructions)
  - Generator set location, task illumination, battery charger, emergency battery-powered lighting unit(s), and selected receptacles
  - Fire protection systems
  - Experimental processes where interruption would produce serious life safety health hazards, and similar functions

- Combined legally required and optional standby branch, designate as “optional branch” (NEC Article 701 and 702): This branch provides continuous (normal or generator) source power for the following equipment that, when stopped during any interruption of the normal electrical supply, could cause hazards or hamper rescue or firefighting operations; or (optional branch) to protect facilities or property where life safety is not dependent on system performance:
  - Control and alarm systems of major apparatus
  - Experimental processes where any power outage could cause serious interruption of the processor damage to the equipment
  - Ventilation and smoke removal systems
  - Access control systems
  - Telecommunication room lighting, equipment, and data processing systems
  - Electric and mechanical room lighting and selected receptacles
  - Mechanical equipment including boilers, condensate return pumps, hot water heating and glycol circulating pumps

- Plumbing equipment including sewage ejectors and pumps

Generator distribution feeders will extend from the EPSS power generation plant to 480 Y/277 V, 4-pole isolation-bypass transfer ATSs with associated distribution panelboards located in the 50M Instrument Building Electrical Service Room. The following transfer switches are anticipated at that location:

- 260 A: Life safety branch (sized large to meet required withstand rating)
- 600 A: Optional branch
- Associated branch circuits and feeders will extend to the 90M Instrument/tunnels, helium compressor area, CEF II, and CUB II buildings.

Power Quality Systems

Uninterruptible Power Supply Systems

An 80 kVA UPS system will be provided in Target Building II which will also serve the 50M Building IT distribution.

Surge Protection Devices

Surge arrestors labeled for use with NFPA 780 lightning protection systems will be provided at all unit substation transformer primaries.

Transients (surges, lightning, switching events) can introduce harmful voltage or current spikes to electronic equipment.

SPD filtering devices will be installed on main low-voltage switchgear, distribution panelboards, and branch panelboards serving major electronic equipment and all emergency branch panelboards in compliance with current code requirements. Sensitive equipment may require multiple levels of protection to protect items of equipment not only from utility disturbances but also from one another.

Electric Metering Systems

Electrical metering systems, according to ORNL standards, will be used to monitor and alarm

- Electrical loading, harmonic loading, and protective device positions. Rail-mounted power quality PM 8214 DIN meters will be required at the unit substation building main service breakers.

- Service low-voltage switchgear mains and feeders.

- Medium-voltage interrupter switches, positions, and transformer status.

- Distribution panelboards on the load side of ATSs.

- Standby engine generator plant and associated distribution equipment.

- ATS positions.

The system will be networked to the ORNL Power Operations SCADA “SNO” network.

Grounding Systems

Ground Grid

All building grounding systems must be bonded to a common earth ground in compliance with the NEC. Each building will be provided with a #4/0 direct buried copper ring encircling the perimeter of the building, which will provide a convenient means of connecting all metallic systems and equipment into a single equipotential grid that has a low resistance to ground.

Building Grounding

Building steel, foundation rebars (Ufer ground), and metallic water supply piping will be bonded to the ground grid.

Building Lightning Protection

An NFPA 780 Faraday cage-type lightning protection system will be provided to protect the building/structure and its occupants and contents from the electrical effects of a lightning strike to ground. The system will include independent down conductors in PVC from the rooftop to the ground grid.

Electrical Power System Grounding

Separate green grounding conductors will be provided with all feeders and branch circuits to provide an intended grounding of the neutrals of the electrical power systems. Each will be bonded to the ground grid with grounding electrode conductors from the distribution system neutral source.

Interconnected bus bars in electrical rooms will collect electrical and electrical equipment grounding conductors to tie the ground ring at the electrical service entrance room.

Electrical Equipment Grounding

All non–current carrying metal parts of electrical equipment enclosures, raceways, boxes, cabinets, housings, frames of motors, luminaires, and so on will be bonded and connected to electrical room ground buses where the associated system neutral is grounded. This allows for a safe ground path in an electrical fault condition.

Instrumentation Signal Reference Grounding

The bonding of instruments and instrument cabling pathways, as a low-impedance-signal reference system to a common equipment area bus and then to the ground grid, will be provided to minimize noise induced voltages and reduce equipment malfunctions.

Telecommunications Signal Reference Grounding

Interconnected bus bars in telecommunication rooms will collect STS IT equipment and pathway grounding conductors and bond to the electrical service entrance room ground bus in compliance with EIA/TIA and NEC requirements.

Lighting Systems

Exterior Lighting

Pole-mounted LED light standards with concrete bases will be provided along roadways and within parking lots.

Building-mounted perimeter LED luminaires will be provided at building exits, walkways, and vehicular circulation areas.

Interior Lighting

LED interior lighting will be provided in compliance with IESNA lighting standards and ASHRAE 90.1 energy budgets.

Energy-efficient, heavy-duty, specification-grade, high bay and industrial LED luminaires are generally anticipated in STS instrumentation areas.

Lighting Controls

Exterior lighting will be provided with photocell and time clock controls.

Interior spaces will be provided with automatic lighting controls in compliance with ASHRAE 90.1 energy budgets. High bay 24/7 areas will be breaker controlled.

Facilities & Operations Building Systems

The building electrical metering system and BAS to monitor electrical and HVAC building systems will be site interconnected to SNS campus systems as described in Site Utilities, Section 8.1.3 of this report and will also include the following systems:

Fire Alarm System

The fire alarm system will be a microprocessor-based detection and notification control system installed and acceptance tested in compliance with NFPA 72, *National Fire Alarm Code*. The building system will include multiplex wiring techniques, a central processing unit (FACU), annunciator units, and peripheral detection and alarm devices.

The system will

- Include smoke, heat, and beam detection devices to suit environmental conditions
  - High bay areas will be provided with beam smoke detection.
  - Both smoke and heat detection will be provided to other areas.

- Include audible horns and visual strobe notification devices

- Monitor building fire suppression systems and override HVAC functions in an alarm condition for fire and smoke containment

- Override elevator functions in an alarm condition to ensure safe passenger egress

- Report fire, supervisory, and trouble alarms to the ORNL Fire Department and LSS office in Building 4512 over a fiber optic network

Wiring will be supervised Class B installed in conduit. Multimode fiber optic cabling will be extended in conduit between the fire alarm control unit and the telecommunication room in each building.

The system will be Edwards/EST Fireworks manufacturer/series according to ORNL requirements to match the existing campus systems.

Public Address System

A public address system will be provided with building amplification as an extension to the campus wide Valcom mass notification system.

Wiring will be installed in conduit.

Access Control System

The building will be provided with an access control system with central equipment located in the main telecommunications room.

Alarm and supervisory conditions will be reported to the ORNL campus security monitoring location over a fiber optic network.

Components will match existing ORNL equipment for system compatibility.

Telecommunication Systems

The building will be provided with separate telecommunications service from the existing site telecommunications distribution system at the CLO to a building main distribution room. Design for the incoming POTS and/or VoIP telephone service, LAN, and wireless networking shall be coordinated with DOE's prime subcontractor, Black Box. The STS project will provide the interconnecting fiber optic cabling. Refer to the site utilities telecommunication distribution paragraphs, which outline telecommunications service to the STS buildings.

Building IT systems for systems networking hardware, including switches, routers, patch panels, DAS, and WLAN components, will be provided.

Building IT horizontal Category 6A cabling will be provided from telecommunications rooms located on each floor, stacked where possible. Building IT systems will be installed in compliance with EIA/TIA standards.

ORNL F&O Building Systems Distribution

The following building systems/system owners will be interconnected with cables and raceways by SNS CF. The system owners will perform final tie-ins.

- Public address/F&O Instrumentation and Controls
- Fire alarm (FIREWORKS Network)/F&O Laboratory Protection
- Access control/F&O Laboratory Protection
- BAS/(F&O Facilities Management [CLO II only—Siemens])

- Power monitoring (ION-Schneider)/F&O electrical utilities (including central IT UPS systems monitoring)

Instrument and Control Systems

ORNL STS will provide building instrumentation and control systems cabling for interconnection of the following systems:

- PPS
- MPS
- ATS
- TPS (two conduits)
- EPICS

Pathway Systems

Ladder-type cable trays will be provided to support telecommunications and instruments and control systems cabling requirements with proper wire dropout devices, conduit sleeves, firestopping, grounding, and wire management components.

Cabling from wall box–type IT jacks will be in bushed conduits extended and grounded to the local cable tray system.

One 36-in. cable tray is anticipated for area coverages for each of the following:

- Instruments and control
- 480-V instrument power
- 120-V instrument power
- ORNL Networks Building IT

8.4.2.11 Plumbing

Drainage/Waste

High Bay Interior Drainage System

The interior of the 50M Building high bay will be provided with a process waste drainage system to collect interior water from system leakage. The drainage will be piped to a duplex sewage ejector in recessed pit located below grade. Any water collected will be pumped to the process waste holding tank in the basement of the Target Building II.

Laboratory Waste

Laboratory waste from laboratory sinks, cup sinks, and laboratory-related equipment will be collected separately below the lower level and conveyed by a gravity system to the underground sanitary waste drainage system outside the building. Any hazardous waste will be bottled to be transported for processing; consequently, a lab waste treatment system will not be provided.

Lab waste from floor drains within lab spaces will be treated as process waste.

Unless required for specific equipment, floor drains will not be provided in laboratory rooms.

Complete accessibility will be provided to all cleanouts. Wall-type cleanouts will be used within the laboratory spaces. Floor drains that do not receive regular use will be provided with trap primers. Primers will consist of an automatic trap primer system that automatically discharges water at regular timed intervals.

Process Water

Non-potable Water Service (Instrument Use)

A separate process water system will be provided for instrument use water. Process water shall emanate from the backflow preventer provided at the incoming potable water service at the Target Building and shall be routed around the perimeter of the Target Building and into the Instrument Buildings. Connections will be provided for instrument use and for makeup to technical cooling water and sensible cooling water systems.

Design of process water will be based on anticipated use and adjusted/increased to allow for projected water demand for instrument-related equipment at the design stage. Piping will be sized to maintain a minimum of 30 psi at the most remote laboratory equipment connection.

Water velocity in distribution piping shall not exceed 6 ft/second. Provisions shall be made to arrest waterhammer. Shock arrestors when installed shall comply with PDI-WH201 or ASSE-1010.

Storm Drainage

The primary storm drainage system will consist of roof drains for any areas collecting water, routed to downspouts that will collect below grade at the lower level and run to the site storm sewer.

A separate overflow storm drainage system will be provided; it will be engineered to perform as a siphonic roof drainage system with the piping running level through the building and discharging to a velocity reduction tank located on the site. Velocities in the vertical piping shall be limited to 10 fps, and in the horizontal piping, the velocity shall be designed to 3.5 fps.

Compressed Air

CA shall be distributed from incoming service at the Target Building around the 50 M Instrument Building perimeter and into the 90M Instrument Building to supply CA to instrument-related equipment and will be provided with local pressure-reducing valves to permit each piece of equipment to use air of various pressures. CA will be fed by the site CA system routed from the air compressors in the CUB II building. CA will enter the Target Building at the lower-level mechanical room. Distribution will be routed around all perimeters of Instrument Building high bay spaces, with outlets provided for each beamline (11 total).

Specialty Gases

Nitrogen shall be distributed from incoming service at the Target Building around the Instrument Buildings to supply nitrogen to instrument-related equipment. Nitrogen will be fed by the liquid nitrogen tank located west side of the Target Building II. Nitrogen will enter the Target Building at the lower level. Distribution will be routed around all perimeters of the 50M Instrument Building and into the 90M Instrument Building high bay spaces, with outlets provided for each beamline (11 total).

Equipment

System Design Criteria

Process water

- Process water system is designed to provide a minimum of 40 psi at the furthest outlet.

- Water piping shall be sized based on the minimum flow pressure required at each fixture or piece of equipment. Pipe velocities shall be maintained between 4 and 8 ft/second and shall not exceed 8 ft/second.

- Valves shall be placed to isolate individual fixtures within one room or a battery of fixtures within any one room.

- Hose outlets will be provided at all mechanical rooms and equipment spaces.

Lab Waste

- The waste system shall connect to each fixture requiring connection and where required will be provided with water seal traps. A vent system shall be provided for fixtures as required to ventilate the waste system and to prevent siphonage of fixture traps.

- Floor drains will be provided at all mechanical rooms and equipment spaces.

- Pipe shall be routed by gravity to maintain a positive slope with a maximum velocity of 2 ft/second.

Storm Drainage

- Storm piping shall be sized based on a 100-year occurrence rainfall rate with a 60-min duration.

- Roof drains will be provided for all roofs and areas receiving rainwater; maximum area per drains shall be 3,000 sf.

Compressed Air

- Design CA pressure on incoming service—105 psi.
- Design CA pressure at laboratory outlets—100 psi.
- Design flow at outlets—1.0 cfm.
- Dew point –40°F

Materials

Process Water Systems

- Above-ground process water systems

- Tubing to be Type L hard temper with wrought copper fittings conforming to ASTM B88-and ASME B16.22. All joints shall be soldered with ASME AWS/A5.8 lead-free solder.

- Copper tubing with grooved ends and mechanical joints is acceptable for sizes 2½ in. to 6 in. only. Tubing to be Type L hard temper with wrought grooved end fittings conforming to ASTM B88 and ASTM B75.

- The entire process water distribution system will be fully insulated using closed-cell elastomeric foam insulation.

Storm System

- Above-ground rainwater piping
  - Hubless cast iron soil pipe: no-hub pipe with Husky SD-4000 soil pipe coupling manufactured by Anaheim Foundry, 4-band clamp or Clamp-All Hi Torq 125 2-band clamp. Sealing gasket shall be neoprene in accordance with ASTM C564, CISPI 301-75.
  - Horizontal storm drainage piping will be fully insulated using closed-cell elastomeric foam insulation.

- Below-ground rainwater piping
  - Asphaltum-coated, service weight, cast iron pipe and fittings with resilient neoprene push-on joints, ASTM A72, ASTM C564-70

Process Waste

- Polypropylene pipe, (fire retardant above grade) (PP); Sch 40; PP DWV hub and spigot fittings; heat fusion joints above and below ground.

Compressed Air/Nitrogen Systems

- Type K copper with brazed joints

8.4.2.12 Fire Protection

Sprinkler

The 50M Instrument Building will be provided with complete automatic fire protection systems as required by the IBC and/or DOE Order 420.1C, *Facility Safety*. The design, installation, and acceptance testing of automatic sprinkler protection will be in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems* and DOE-STD-1066-2012, *Fire Protection*. Building will be fully sprinkled, with exposed sprinkler piping feeding upright sprinklers, or recessed pendent sprinklers where ceilings are provided. Sprinkler feed will enter at the east side of the lower level of the Target Building in the mechanical and maintenance storage room from the site potable/fire water main, and a double check backflow preventer will be provided. The 50M building will have sprinkler zones limited to 30,000 sf maximum, with control valves located in the exit stairwell at the east end of the building. Control valves will be provided with a tamper switch and a flow switch connected to the fire alarm system.

Incoming service will be hydraulically calculated and be sized for the maximum calculated flow at the design stage.

General

- Portable fire extinguishers will be provided throughout the 50M Building in accordance with the IBC and NFPA 10, *Portable Fire Extinguishers*.

System Design Criteria

- Sprinkler systems will be hydraulically designed to provide water densities that meet the requirements for

- Extra Hazard, Group 1 protection will be provided throughout.

- Fire sprinkler systems will be hydraulically designed. Velocity shall not exceed 20 fps. All calculations assume a minimum of 10 psi deterioration in static and residual pressures in the hydrant flow test results.

Materials

- Pipe and fittings installed underground shall be Class 52 ductile iron cement lined with mechanical joints with a working pressure rating of 350 psig.

- Sprinkler piping installed above ground and sized 2 in. and smaller and all standpipe piping shall be Sch 40 black steel with threaded joints and fittings.

- Sprinkler piping installed above ground and sized 2½ in. and larger shall be Sch 40 black steel with roll or cut groove type connections and fittings. Pressure rating shall be 175 psig minimum.

- Fittings for grooved end shall be cast of ductile iron conforming to ASTM A-536 or malleable iron conforming to ASTM A-47, or forged steel conforming to ASTM A-234 (A-106, Gr. B), with grooved or shouldered ends for direct connection into grooved piping systems with steel pipe and shall be UL listed and FM approved, rated for a minimum 300 psi MWP.

8.4.3 90M Instrument Building

8.4.3.1 Programming

Building Function

The 90M Instrument Building will house beamlines ST20 and ST21, associated instruments, and user lab space. The maximum beamline length for instruments in this building will be 90 M. The 90M Building will also serve as staging space for the construction of the beamlines, instrument hutches, and related lab support spaces. Alterations and maintenance to existing instruments will be an ongoing process for the life of the 90M Instrument Building. Each instrument beamline is unique in terms of planning geometry, space requirements, and access. The design and coordination associated with the beamlines, instruments, and related shielding is generally not included in the CF scope. The instruments and beamlines will be accessible from the Instrument Building main floor. The 90M Instrument Building does not require a mezzanine. High bay space with full overhead crane coverage is a basic requirement of the 90M Instrument Building.

Program Summary

The 90M Instrument Building includes 12,800 nsf and has an estimated planning efficiency factor of 76%. This factor is based on analysis of the existing FTS Instrument Buildings and preliminary test-fit planning for the 90M Instrument Building. The estimated gross area of the 90M Instrument Building is 16,856 gsf. Table 8.26 summarizes the 90M Instrument Building space program requirements. Detailed room data sheets and test-fit plans are included in Appendix B, STS CF Conceptual Design Report.

Table 8.26. 90M Instrument Building space program summary.

No.	Rooms	Qty.	NSF	Total NSF
5.4.3.1	EWALD/MENUS—instrument/beamline space	1	11,850	11,850
5.4.3.2	Electrical room	1	400	400
5.4.3.3	Sample prep	2	130	260
5.4.3.4	Control cabin	2	145	290
Total nsf				**12,800**
Total gsf				**16,856**
Total efficiency				**76%**

8.4.3.2 Site Planning

Location and Floor Elevations

The 90M Instrument Building will adjoin the northwest side of the 50M Instrument Building to provide interior space for long instruments located on beamlines ST20 and ST21. The 90M Instrument Building first floor will be located at elevation 1074 ft. Figure 8.13 highlights the 90M Instrument Building within the overall STS Site Plan.

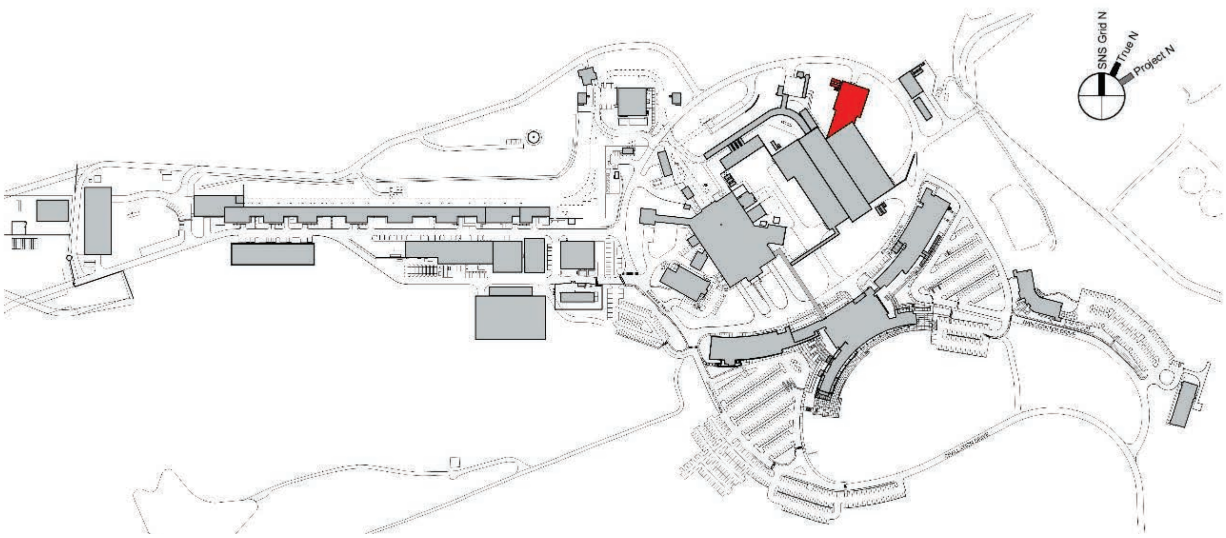


Figure 8.13. 90M Instrument Building location within the STS Site Plan.

Truck Access

Tractor-trailer truck access for the 90M Instrument Building will be located on the northeast side of the facility at the first-floor level, elevation 1074 ft. This location will include a covered, flat exterior dock. Forklifts will be used to convey materials and equipment between the building and trucks through overhead service doors.

Pedestrian Access

Pedestrian access to the 90M Instrument Building will be provided at the first floor from the adjacent 50M Instrument Building and at controlled exterior-grade level doors.

8.4.3.3 Building Planning

Building Organization/Floor Planning

The 90M Instrument Building will be a single-level structure. The first floor, elevation 1074 ft, will house the instruments associated with beamlines 20/21 and additional space for staging and lab support. The first-floor level will be open to a high bay space above. The entire floor area will be served by an overhead crane. The beamlines will radiate from the tungsten target at elevation 1080 ft, which is 6 ft above the 90M Instrument Building first floor.

Vertical Circulation

The 90M Instrument Building will be indirectly served by a freight elevator located in Target Building II, which will provide access to the mezzanine level, pedestrian bridge, and all floor levels of Target Building II.

Utility Distribution

Instruments located within the 90M Instrument Building will be served by multiple utilities, including power, CHW, CA, potable water, and nitrogen. These utilities will be distributed at the building perimeter. The primary utility distribution is included in the CF scope. Extension of the utilities to the individual instruments is not included in the CF scope.

8.4.3.4 Key Features and Requirements

Radiological Shielding

The beamlines will be shielded with removable high-density concrete blocks. The shielding at each beamline will be approximately 8 ft wide, centered on the beamline, and 10 ft high. Shielding configurations at each instrument will vary based on the instrument design and function. During construction or maintenance of the beamlines and instruments, shielding blocks will be staged within unassigned areas of the 90M Instrument Building floor.

Structural Requirements

Optimum performance of the instruments requires a high degree of structural stability, including minimal deflection, vibration, and settlement in the floor slab design. Maximized overhead crane coverage of the 90M Instrument Building will require a clear span roof structure and related structural design to support a 10-ton overhead bridge crane. See the Structural section of Section 8.4.3.8 for additional information.

Instrument Pits

Individual instruments in the 90M Instrument Building may require depressed pits in the first-floor level. If required, the pits will be constructed as part of the CF scope.

8.4.3.5 Life Safety/Code

Primary Occupancy Type

Target Building II and the 40M, 50M, and 90M Instrument Buildings will be constructed as a single building. The primary occupancy type for Target Building II and the Instrument Buildings is Group F-2, Low Hazard Factory Industrial, according to the 2015 IBC, and Special-Purpose Industrial according to NFPA 101, 2018 edition.

Accessory Occupancies

Accessory occupancies will include lab support rooms (Group B) and storage rooms (Group S-1). The lab support rooms and storage rooms can be considered accessory occupancies if the aggregate area of each use does not exceed 10% of the floor area of the story in which they are located. Otherwise, IBC Table 508.4 requires a 1-h fire-rated separation between the F-2 occupancy and the B and S-1 occupancies. Laboratory spaces will be separated by 1-h fire-resistive partitions, where practical, to allow for increased storage and use of hazardous materials.

Fire Protection Systems

Target Building II and the Instrument Buildings will be protected throughout by an automatic fire sprinkler system designed to protect an Extra Hazard—Group 1 occupancy for the main level and an Ordinary Hazard–Group 2 occupancy for the basement level in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems.*

Target Building II and the Instrument Buildings will be provided with a Class I standpipe system in accordance with NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*. Two and one half-inch fire department hose valves will be provided at each floor landing in each exit stairway.

Portable fire extinguishers will be provided throughout the building in accordance with the IBC and NFPA 10, *Standard for Portable Fire Extinguishers*.

Target Building II and the Instrument Buildings will be equipped with an addressable fire detection/alarm system consisting of the following:

- Manual fire alarm pull stations at all building exits
- Beam type smoke detectors in large, open high-bay areas
- Area smoke detectors in elevator lobbies and elevator machine rooms
- Duct smoke detectors on the supply and return sides of all AHUs having a design capacity greater than 2,000 cfm
- Audible/visual notification appliances installed through the building

All fire alarm, supervisory alarm, and trouble signals will be automatically transmitted to the ORNL Fire Department via the LSS fiber optics network.

All new fire alarm system equipment will be manufactured by Edwards Systems Technology to be compatible with the existing site-wide campus system.

The fire detection/alarm system will be designed and installed in accordance with the IBC and NFPA 72, *National Fire Alarm Code*.

Maximum Floor Area and Stories

Target Building II and the Instrument Buildings will constitute a 4-story, 214,800 SF building of Type IIA construction. The first floor will have the largest floor area at 113,294 SF. The maximum floor area permitted for any floor by IBC Table 506.2 for a fully sprinklered, multi-story, F-2 building of Type IIA construction, with the area increase for frontage, is 119,787 SF. The proposed height and area for the building are within the limits established in IBC Sections 504 and 506.

Travel Distances

The maximum travel distance within Target Building II and the Instrument Buildings will not exceed 400 ft, as required by IBC Section 1016.2 and NFPA 101, Section 40.2.6.1. The maximum common path of travel distance will not exceed 100 ft, as required by IBC Section 1014.3 and NFPA 101, Section 40.2.5.1. The maximum dead-end corridor will not exceed 50 ft, as required by IBC Section 1018.4 and NFPA 101, Section 40.6.4.

Construction Type

Target Building II and the Instrument Buildings will be of Type IIA construction in accordance with IBC Section 602.

Wall/Floor Ratings

The primary structural frame, floors, bearing walls, and roof will have a 1-h fire resistance rating as required for Type IIA construction. Interior non-bearing walls and partitions will be of noncombustible construction. Interior walls, where applicable/needed, will be constructed to provide a 1-h fire separation to support chemical quantity allowances.

Special Code Considerations

The largest floor area for Target Building II and the Instrument Buildings will be the first floor, currently planned to have an area of 113,294 SF. The maximum area permitted by IBC Table 506.2 for any story in a fully sprinklered, multi-story, F-2 building of Type IIA construction, without an increase for frontage, is 112,500 SF. Currently, the perimeter of the facility is 1,805 ft in length. The length of the perimeter that fronts on an open space at least 30 ft wide is 802 ft. This results in an area increase for frontage of 7,287 SF. Therefore, the maximum area permitted for any story would be increased to 119,787 SF. Should the area of Target Building II and the Instrument Buildings exceed 119,787 SF on any level, the construction classification for the building will need to be upgraded to Type IB to permit an unlimited area building.

<u>Hazardous materials</u>: The use and storage of hazardous materials shall be limited to the maximum allowable quantities indicated in IBC Tables 307.1(1) and 307.1(2). Where these quantities are exceeded, control areas shall be provided in accordance with IBC Section 414.2. The number of control areas per floor and their required fire resistance ratings shall be in accordance with IBC Table 414.2.2. Note that the floors of control areas are required to have a 2-h fire resistance rating for buildings over 3 stories in height.

8.4.3.6 Civil/Site Development

The construction excavation described under the Site Civil Works Section will be performed before construction of the Instrument Buildings. The lower basement of the target will be backfilled to the first-floor elevation to establish the grades for construction of the instrument buildings. Vehicular access will be provided from the ring road to the Instrument Building. Finished grading is shown on Drawing 5.1.19. Drawing 5.1.22 shows the site drainage concept. Roof drainage will be piped to the proposed storm sewer system. Sewer, fire, and domestic water services to the building are shown on Drawing 5.1.27.

8.4.3.7 Architecture

Building Envelope

Exterior Wall

A striated-face, 36 in. wide insulated core metal panel system, with a custom color to match the existing context, will be used as a major material component for the envelope of the 40M, 50M, and 90M Instrument Buildings in keeping with the existing texture and materials used on the SNS campus. The metal panel cladding support backup system will consist of hanger rods and metal channel framing supported from the building structure. Metal window sills and wall caps will be used. Continuous through-wall flashing will be provided at the bottoms of all wall cavities, over all wall openings and metal copings. The metal panel wall systems will have an R-13 and R-13ci minimum requirement. Below-grade exterior walls will be constructed of reinforced concrete with a waterproof membrane and below-grade insulation board. The interior walls at below-grade locations will have metal channel furring with a painted drywall finish. Exterior walls below grade will be required to achieve R-7.5 ci according to the 2012 International Energy Code.

Exterior Doors

Exterior entrance doors and egress doors will be 16-gauge, insulated-core painted hollow metal doors with 14-gauge, fully welded frames with a U value of 0.61. Overhead insulated coiling doors, 20 ft, 0 in. high by 14 ft, 0 in. wide will include factory-painted galvanized steel curtains with integral insulation achieving a minimum R-value of 4.75 requirement. All exterior doors will be provided with proximity card reader hardware.

Thermal and Moisture Protection

Flashing and sheet metal will be provided as a positive water stop around all openings (head, jamb, and sill) in walls such as windows, doors, louvers, and so on. All copings and gravel stops will be ES-1 compliant as required by IBC.

Damp-proofing will be provided on all walls, floors and other building components that are subject to high humidity, dampness, or frequent direct water contact.

Waterproofing will be provided at walls, floors, and other building elements that are subject to hydrostatic pressure, are liable to be immersed in water, or are below the water table. The waterproofing membrane will be a hot-fluid-applied, two-layer 215-mil, polyester fabric–reinforced membrane.

Because of the inherent moisture-resistant properties of the insulated metal panel system, an air/vapor barrier will not be required where the system is installed.

Exterior sealants will be two-part composition with a 50% movement capacity. Sealants will be compatible with the surfaces on which they are being applied and nonstaining.

Insulation combustibility, including wrappings, inside the building skin will be limited to a flame spread of 25 and smoke development of less than 50.

Glazing

Windows will be limited to windows at the upper portion of the exterior wall. Typical vision glass will consist of 1-in.-thick, low U-value insulated, low-E, argon fill glass units on a thermally broken frame. The windows/glazing system are anticipated to have a U value of 0.38.

Glazing materials and methods will comply with the Flat Glass Marketing Association's Sealant and Glazing Manuals. Glass will comply with ASTM C1036-01.

Roof Construction

The roofing system will be a 30-year, 80 mil minimum thickness, white thermoplastic (PVC) single-ply sheet with an integral fiberglass mat reinforcement roofing membrane over polyisocyanurate insulation on a sloping roof structure. Tapered insulation saddles will be used to provide drainage to roof drains and at roof equipment locations. All roof construction details and roof penetrations must comply with the guidelines established by the NRCA. Roof traffic pads will be adhered to the membrane along all roof maintenance traffic paths. All roofs with serviceable components beyond roof drains will be surrounded by a 42-in.-high parapet or provided with a fall protection system.

Low-slope roofing will have a minimum 3-year aged solar reflectance of 0.55 and a minimum 3- year aged thermal emittance of 0.75 in accordance with the Cool Roof Rating Council Program. Roofing will be Energy Star rated with emissivity of at least 0.9 when tested in accordance with ASTM 408.

The roofing system will meet or exceed UL class A fire exposure requirements and comply with FM Class I-90 for wind uplift according to ASTM 1592. It will provide a minimum thermal resistance value of R-30.

Interior Construction

Walls

Interior walls at the 90M Instrument Building will be constructed of CMUs for durability. The height of the demising walls will be constructed to the underside of the structural deck. All fire-rated walls will be constructed in accordance with the IBC code requirements and UL listed assemblies.

All metal guard railing and handrails at all openings and egress stairs will have a painted metal finish.

Wall Finishes

All finish materials for walls, ceilings, and floors, will have a Class A rating, with a flame spread ≤ 25, a fuel contribution of ≤ 25, and a smoke development of ≤ 450.

Typical interior gypsum board and CMU partitions will receive a paint finish consisting of one primer coat and two finish coats. Epoxy paint is to be applied to all lab demising walls. All paints, including top coats and primers, will comply with the 2016 *Guiding Principles for Sustainable Federal Buildings*.

Floor Finishes

Floor will receive concrete sealer over the new concrete. No vinyl wall base will be used in these areas.

Ceiling Finishes

The structural elements will be left exposed in all spaces and all mechanical and utility areas. All exposed structure will receive an epoxy paint finish consisting of one primer coat and two finish coats.

Interior Doors

All interior doors will be shop-primed, field-painted, 16-gauge hollow metal doors with 14-gauge fully welded metal frames. Metal interior rolling doors and floor hatches will be provided.

Tempered glass vision lights will be provided at all laboratory doors for safe egress. All laboratory access doors will be provided with proximity card reader hardware.

Furnishings

Laboratory Casework

Lab casework will be a modular system, prefinished painted metal base, wall cabinets, and shelving units with an epoxy resin countertop. The modular system will be adaptable and flexible to accommodate the changing needs of the lab research.

Vertical Circulation

Stairs

Not applicable

Elevators

Not applicable

Specialty Equipment

Crane

A 10-ton bridge crane will be provided with a hook height of 40 ft above the instrument floor.

MENUS Instrument Pit

Instrument ST21(MENUS) will require an 8-ft-deep pit for locating hydraulic hoses and power units along with a removable precast reinforced concrete cap above the pit. An additional 10-ton crane will be required in the instrument's shield cave surrounding the pit. This 10-ton crane will be provided by the instrument and is not part of CF scope.

8.4.3.8 Structure

Applicable Codes and Standards

See Sheets x – xii for complete list of Applicable Codes and Standards.

Design Loading

Superimposed Floor Loads on Instrument Floor

- Dead loads: 1500 psf
  - At elevated deck: 20 psf collateral load, typical
  - See also Figures 8.6 through 8.8 in Section 8.3.1.8

- Live loads: 500 psf typical, 1500 psf at MENUS pit
  - See also Figures 8.6 through 8.8 in Section 8.3.1.8

Superimposed Roof Loads

- Roof snow load
  - Ground snow load: Pg = 10 psf
  - Snow exposure factor: Ce = 1.0
  - Snow importance factor: Is = 1.2

- Minimum roof live load = 20 psf + 20 psf collateral load

Wind Loads

- Risk category IV
- Basic wind speed: V = 120 mph
- Exposure category B

Seismic Loading

- Risk category IV
- Importance factor: Ie = 1.5

Crane Requirement

- Refer to the Crane section of Section 8.4.3.7 for information.

Building Structural System

Slab on Grade

The slab construction is anticipated to consist of a structural reinforced normal weight concrete slab. The structural slab on grade is anticipated to be supported on 9¾-in. diameter micropile foundations, approximately 135 ft long, with a 200-ton capacity. The floor slab will be placed over a vapor barrier, a compacted drainage base course, and a compacted subgrade. In the VERDI Instrument Building and EWALD Instrument Building, stainless steel rebar will be provided within 6 ft of the sample position.

Foundation System

A geotechnical investigation has not been performed. Until a geotechnical investigation and report have been completed, an accurate description of the building's foundation system cannot be provided. The 90M Instrument Building is anticipated to be supported on 9¾-in. diameter micropile foundations, approximately 135 ft long, with a 200-ton capacity. Below-grade walls are anticipated to be constructed with reinforced normal weight concrete. It is anticipated that the diagonal south–west below-grade wall will consist of counterfort retaining walls. Water stops will be provided in construction joints to safeguard against water intrusion.

For the 90M Instrument Building and the adjacent 50M Instrument Building and Target Building II, there are three main components considered related to deflection and settlement concerns. Refer to the Foundation System section of Section 8.3.1.8 for further discussion and information.

Superstructure

The 90M Instrument Building is anticipated to be a single-story conventional steel-frame structure. The building will support the exterior wall system with steel girts as required. The roof structural system is anticipated to consist of metal truss framing with a roof deck meeting galvanizing G90 requirements. The 90M Instrument Building will share a wall with the 50M Instrument Building.

Lateral System

Resistance to lateral loads resulting from wind and seismic forces on the building are anticipated to be provided by concentrically braced steel frames.

Crane Support

Steel framing will be provided to support the crane runway.

Geotechnical Analysis

A review of historical geotechnical and geophysical surveys was performed that included the original campus development and additional structures. A detailed geotechnical exploration was performed by Law Engineering dated June 30, 2000, addressing the original development of the campus (Law 2000). No borings were drilled near the footprint of the proposed 90M Instrument Building location. Considering the consistency of the upper crust of soils at the site, we would anticipate similar subsurface conditions as well as rock conditions. The necessity to reduce and control differential settlement between the STS and the 90M Building will require a micropile system. The micropiles should be capable of supporting 200 tons/pile when designed using a 9¾-in. steel casing. The axial capacity should be confirmed using a pile load test.

A review of geophysical data and shear wave velocities from the Law report indicates that the 90M Building footprint would be located in a seismic site classification C as defined in IBC 2015 and ASCE 7 (Law 2000). This is confirmed by the average shear wave velocities for multiple soil profiles tested during the original campus development.

A supplemental geotechnical report would be advisable once the final 90M location and footprint have been determined. The density and pattern of the soil test borings should be selected to optimize the quality of geotechnical data. Additional geophysical testing is not anticipated for design of the structure.

Vibration/Acoustics

The instrument floor and its foundations will be constructed so that beamline vibrations do not exceed a peak-to-peak value of 0.008 in. (±0.004 in. or ±0.1mm). Based on the current preliminary instrument floor design, which is driven by the instrument floor loading and settlement criteria, this vibration performance is considered to be readily achievable.

The available information does not indicate any spaces that will require acoustical criteria.

8.4.3.9 Mechanical

Air Handling/Ventilation

The 90M Instrument Building will be served by two CAV roof-mounted AHUs. The units will be manifolded together and will share a common discharge plenum to provide partial redundancy (66% of the supply system design capacity through a single AHU) in the event of planned service or a complete unit failure. The AHUs will be designed as heating-cooling, single duct, reheat type. The units will operate 24 h/day, 365 days/year. Supply fans will be configured in a multi-fan array, plenum fan design. VFDs will provide supply fan volume control in response to a signal from duct-mounted static pressure sensors and will allow for setback control capability of the supply fan volume. VFDs will also provide return fan volume control in response to a signal from air flow measuring stations used to establish volumetric offset between the return air and the supply air quantities. The system will be designed for energy conservation adjustment with the potential to reduce ACHs (unoccupied setback change) controlled by the BAS. The system will be designed to maintain minimum outside air quantities to maintain positive pressure in tertiary spaces but will also be capable of full economizer mode.

The AHUs will be on the lower roof of the 90M Building above the beamlines. Ductwork will be routed into the 90M building truss space above the 90M building crane. Supply ductwork will be routed to the sides of the building to avoid the crane travel path and drop along the walls to introduce air at the lowest levels of the high bay space. Sound attenuators at the air terminal devices will not be provided. Return air will be gathered at the high ceiling area of the 90M building truss space and will be recirculated through return ductwork back to the units on the roof. The HVAC distribution system shall be pressure-independent, CAV control for all spaces.

The supply distribution system will consist of low-pressure ductwork with pressure-independent electrically actuated supply CAV air terminal devices, reheat coils, low-pressure externally insulated ductwork downstream of air terminals, and diffusers. Sound attenuators at the air terminal devices will not be provided. The use of sound-attenuating flexible duct at diffusers will be limited to 6 ft in total length to minimize duct static pressure losses.

Exhaust

The 90M Instrument Building will be provided with a general exhaust system for lab hoods and similar uses. The general exhaust system will be located on the lower roof of the beamline area. The exhaust system will use duplex (one standby fan) vertical, radial dilution exhaust fans of spark-proof construction with bearings and motors out of the airstream. Two fans will be provided to serve the common exhaust plenum, each sized at 100% of the load. If one of the fans fails, the remaining fan will be able to provide 100% of the common exhaust system design capacity. All of the fans in the common exhaust plenum will be on emergency power to ensure continuous hazardous material containment but will be controlled to run at a reduced speed during a power outage to limit the negative pressure impact to the building. Ducts will be routed through the truss space of the facility for future connection of instrument exhaust.

The 90M Instrument Building will also be provided with a separate exhaust system for the instrument bunkers. The bunker exhaust fans will be located on the roof of the instrument area. The exhaust system will use duplex (one standby fan) vertical, radial dilution exhaust fans of spark-proof construction with bearings and motors out of the airstream. Two fans will be provided to serve the common exhaust plenum, each sized at 100% of the load. If one of the fans fails, the remaining fan will be able to provide 100% of the common exhaust system design capacity. All of the fans in the common exhaust plenum will be on emergency power to ensure continuous hazardous material containment but will be controlled to run at reduced speed during a power outage to limit the negative pressure impact to the building. Ducts will be routed through the truss space of the facility for future connection of instrument exhaust. Connections provided along each of the beamlines for future connection of instrument exhaust. A separate capped inlet will be provided at each beamline (2 total).

Chilled Water

The CHW system for the 90M building will be supplied from the CUB II. CHW will enter the building from below grade at the utility room and will be routed to the cooling coil in the AHU. Based on an estimated flow of 170 gpm to this building, the CHW branch line size to this building is expected to be 4 in.

Heating Water

The heating water system for the building will be supplied from the CUB II. Based on an estimated flow of 20 gpm to this building, the heating water branch line size to this building is expected to be 2 in.. Hot water supply and return will enter the building from below grade. The heating water distribution system will serve heating and preheat coils at the air handler.

Technical Cooling Water

Chilled Water System

A CHW cooling loop will be provided to support space cooling in the 90M Instrument Building. The CHW cooling system will consist of an independent loop of campus CHW. CHW for future cooling use will be routed around the exterior of the 90M Building, with valved connections provided along each beamline (2 total).

Sensible Chilled Water System

A sensible CHW cooling loop will be provided to support equipment cooling in the 90M Instrument Building (extended through the 50M Building). The sensible CHW cooling system will consist of an independent pumped loop that will reject heat into the Target Building CHW through a plate-and-frame HX. The system will be designed to operate at a supply temperature of 55–60°F to reduce the potential for condensation. The tank, pumps, HX, filters, and chemical treatment components will be located in the mechanical support area of the Target Building lower level. Sensible CHW for future instrument use will be routed around the exterior of the 90M Building (and 50M Building), with connections provided along each beamline (2 total).

Controls

The 90M Building shall be controlled by the EPICS. The building will be connected to an expansion of the existing EPICS. Instrumentation and wiring shall be connected to a new EPICS PLC in the building, and controls interface for the building will be provided at the target control room and on the instrument floor. Programming and connection of the PLC to EPICS shall be completed and the control system commissioned to ensure proper operation.

Electric actuation will be used for all control valves and dampers (with the exception of larger valves which may be pneumatic) on both systems so that instrument air is generally not required. All control systems will be on UPS and emergency power. System software and firmware will provide the following functions:

- Control sequences shall be developed to support the operations of the technical equipment.
- PID control to allow faster and closer control to system set points.
- Adaptive tuning to adjust PID loop constants to ensure that control system response remains accurate and reliable over a wide range of dynamic operating conditions.
- Monitoring to read the value of measured variables, to read control loop set points, to monitor control signals to actuators, and to indicate the status of equipment, alarms and overrides.
- Energy management, including optimum start/stop, variable ACH rates in laboratories, duty cycling, supply air temperature reset, supply air static pressure reset, demand limiting, time totalization, and so on.
- Data management, including continuous database updating, alarm reporting, trend logging, and report generation.
- System programming to add, delete, or change points, set points, schedules, control algorithms, report formats, and so on.
- System software will allow building operators to graphically monitor and control building operations and provide the functions listed. Graphics will include site plans, overall building plans, floor plans and individual system graphics.

Equipment

Table 8.27 provides a listing of mechanical equipment servicing the 90M Building.

Table 8.27. 90M Instrument Building mechanical equipment.

Use	Equipment	Size	Qty	Em pwr	Redund	Location	Remarks
90M AHU	CAV AHU	9,000 cfm	2	N	33%	90M roof	
90M exhaust	Radial exhaust fans	1,500 cfm	2	N	N+1	90M roof	Lab fume hood exhaust
90M instrument bunker exhaust	Radial exhaust fans	3,500 cfm	2	Y	N+1	90M roof	
90M exhaust	Utility exhaust fan	Varies	2	N	–	90M roof	
Sensible instrument cooling	Fan coil units	2-3 tons	2	N	–	Varies	

Air Handlers

General

- All AHUs will be semi-custom, factory-fabricated, and constructed with 2-in.-thick double walls, constructed of galvanized steel.

- Maximum allowable nominal face velocities:
  - Air intake louvers (through free area): 350 fpm
  - Heating water coils: 500 fpm
  - Cooling coils: 400 fpm
  - Filters: 400 fpm

- AHUs: modular, 4-in. double-wall construction configured as follows:
  - Mixed air plenum
  - Intake isolation damper
  - Return/exhaust damper
  - Supply fans (4 to 6 fan array)
  - Relief fans (4 to 6 fan array)
  - VFDs
  - Economizer section
  - Merv 8 (30%) prefilter section
  - Hot water preheat coil
  - CHW coil
  - Hot water reheat coil
  - Pipe vestibules
  - Supply fans (4 to 6 fan array)
  - VFDs
  - Merv 14 (95%) final filter section
  - Supply plenum
  - Isolation/smoke damper
  - Access sections
  - Doors: safety glass windows and quarter turn handles.
  - Marine light in each access section.
  - Vibration isolation in accordance with ASHRAE HVAC Applications—Noise and Vibration Control

Exhaust Fans

General/Lab Exhaust Fans

Exhaust fans will be vertical, radial dilution exhaust fans with spark-proof construction with bearings and motors out of the airstream. Fans will have a baked epoxy airside chemical-resistant coating. The common plenum and outside air intake dampers will be of galvanized steel construction with a chemical-resistant coating. The system will consist of the following components:

- Common exhaust plenum
- Isolation damper at each fan inlet
- Vertical exhaust fans
- Exhaust stacks
- Bypass air inlet and bypass damper

- VFDs

Utility Set Exhaust

Exhaust fans will be backward-inclined, belt-driven centrifugal fans with spark-proof construction and bearings and motors out of the airstream. Fans will be single width, single inlet with a galvanized steel housing and wheel construction. The fan motor will be totally enclosed and fan cooled. The system will consist of the following components:

- Steel mounting rails with vibration isolators
- Isolation damper at the fan inlet
- Discharge ductwork with bird screen
- Weather cover
- VFDs

Motors

- All motors shall be premium efficiency type and built to NEMA standards.

- Variable-speed motors shall be rated as inverter duty motors. All motors operating with VFDs shall be equipped with shaft grounding rings or insulated bearings to prevent the accumulation of PWM frequencies in the shaft, which could arc across the bearing, causing pitting and premature bearing and motor failure.

- All VFDs shall be provided with power filters to improve the building power quality from the occurrence of multiple VFD installations.

General

System Design Criteria

Outside Design Temperatures

- Summer: 92.8°F DB, 73.8°F MCWB (0.4% ASHRAE)
- Winter: 17.1°F (99.6% ASHRAE)

Interior Design Conditions: Preliminary Load and Ventilation Assumptions

Table 8.28 provides a listing of the preliminary load and ventilation assumptions for the 90M Building.

Table 8.28. 90M Instrument Building preliminary load and ventilation assumptions.

Space	Design set points	Cooling: BTU/sf	Heating: BTU/sf	Airflow: cfm/sf or ACH	Ventilation
Mechanical/electrical	60–85°F	80	40	2	Code required
High bay	72–76°F, 60% >RH	40	40	8 ACH	Code required
Loading	60–85°F	–	40	2	Code required
Ventilated spaces	60–100°F, no humidity control				

Notes:

Cfm/sf and values are schematic design-level assumptions. The final values of the project will be calculated based on code requirements or heating and cooling demand, whichever is greater.

Active humidity control will not be provided for any building. Therefore, HVAC units will not have a humidification capability. The maximum relative humidity should not exceed 60% because of moisture removal at the cooling coils.

Sensible Technical Cooling Water (Chilled)

- Supply 55–60°F
- Return 5°F above supply

Materials

Duct Distribution Systems

- Supply ductwork construction will be based on SMACNA 4-in. pressure class and 2-in. pressure class. Four-in. pressure duct construction will be used upstream of VAV boxes on variable-volume units; 2-in. pressure class duct construction will be used downstream of VAV boxes on variable-volume units and for all ductwork on constant-volume units. All ductwork seams and joints shall be sealed, regardless of pressure rating. Maximum permissible leakage = 2%.

- All supply ductwork routed through unconditioned spaces shall be insulated with 2-in. foil-faced batts or foil-faced duct board with similar R-value.

- Return and general exhaust ductwork construction shall be based on SMACNA 2 in. pressure class.

- Return air duct shall be insulated with 1½ in. foil-faced batts or duct board. Laboratory exhaust ducts shall not have fire dampers.

- General air distribution ductwork will be G90 galvanized sheet metal.

- General exhaust will be welded 316L stainless steel.

- Secondary confinement exhaust/hot off-gas shall be welded 304L stainless steel duct/thinwall tube.

- Exterior supply or return ductwork shall be solid double-wall ductwork with a minimum 2-in.-thick insulation or single-wall duct with 2-in. duct board, vapor barrier, and aluminum jacket.

- Rectangular and round ductwork shall be fabricated in accordance with SMACNA standards. Spiral-wound ductwork shall be a prefabricated system with factory certifications. Spiral-wound ductwork shall not be used for laboratory exhaust systems or other systems that may be exposed to water intrusion.

- Sound attenuation will be provided to meet the project requirements or in accordance with the direction of the project acoustician. Sound attenuation shall be by appropriate application of attenuators or duct design.

- Lined ductwork shall not be used, except for plenum return air-transfer boots for noise control. VAV air terminals shall be double-wall or have foil-faced inner surface.

- Flexible ductwork is limited to 5 ft and shall be used only downstream of VAV terminals. Flexible ductwork shall be limited to supply air systems only.

- Plenum return may be used for return air in all non-laboratory portions of buildings.

- Ductwork shall be sized as shown in Table 8.29.

- Spaces on VAV systems shall have conventional supply terminal boxes with hot water reheat coils and integral sound-attenuating characteristics.

- Smoke detection will be provided in accordance with NFPA 90A and IMC requirements.

Table 8.29. 90M Instrument Building ductwork sizing.

	Risers	**Submains**	**Branches**	**Air distribution device neck velocity (fpm)**
Max P.D.	0.1 in./100 ft	0.08 in./100 ft	0.08 in./100 ft	450 fpm

Piping

Chilled Water

- Interior piping sizes 2 in. and smaller Type L copper with brazed fittings.

- Interior piping 2½ in. and larger shall be either Type L copper with brazed fittings or Sch 40 steel pipe with either welded and flanged joints or mechanical grooved fittings.

- Underground CHW piping serving the building will be distributed in a pre-insulated, factory-fabricated coated steel piping system or HDPE.

- All piping will be tested at 1.5 times the design system pressure.

- All interior CHW piping shall be insulated with closed-cell elastomeric insulation. Properties shall meet or exceed the minimum energy code requirements.

- All piping in mechanical rooms and piping exposed below 8 ft AFF shall have a PVC jacketing.

- All piping exposed to the exterior shall have an aluminum jacket.

- CHW will be provided with a BTU meter at the service entry.

Technical Cooling Water (DI Water for Instrument Cooling Downstream of HXs)

- For sizes 2 in. and smaller: ASTM 312 Sch 10S, seamless, 304L stainless steel, plain ends. (Victaulic Vic-Press system or butt-welded, as specified)

- For sizes 2½ in. and larger: ASTM 312 or ASTM 358, Sch 10 ERW 304L stainless steel, Class 4. (Victaulic Vic-Groove system or butt-welded, as specified)

- For sizes 1/2 in. to ¾ in. OD tubing: ANSI Type 304L stainless steel, ASTM A213, Grade TP304L, seamless, annealed, minimum 0.065 in. wall thickness.

- Vents and drains: for sizes ½ to ¾ in.es NPT, ANSI Type 304L Sch 40 SST pipe

- Fittings:
  - Welded fittings: ASTM A403, Grade WP-S304L or WP-W304L, elbows: standard 1.5× radius. Full penetration butt weld
  - Welded flanges: ASTM A 182, Grade WP-S304L, raised face weld neck
  - Vic-Press or Vic-Groove 10S system, ASTM-312 304L SST
    - Plain end or grooved ends shall be ASTM A-312 304L SST
    - Vic-press flanges shall be ANSI Class 150, 304L SST, Van Stone type, carbon steel raised face slip-on backing flange, Victaulic style 565
    - Grooved couplings: galvanized coated ductile iron conforming to ASTM A-536, galvanized, stainless bolts, Victaulic style 89.
    - Threaded outlets shall be ASTM A-312 or ASTM A-276 304L SST
    - Seals shall be Grade H NBR, temperature range –20 to 210°F
  - Flange gaskets: Garlock Blue-Gard style 3000 gaskets (1/8 in. thick)

- Based on anticipated water temperatures, technical cooling water piping will not be insulated.

Heating Water

- Interior piping 2 in. and smaller shall be Type L copper with brazed fittings.

- Interior piping 2.5 in. and larger shall be either Type L copper with brazed fittings or Sch 40 steel pipe with welded and flanged joints.

- Underground hot water piping serving the building will be distributed in a pre-insulated, factory-fabricated coated steel piping system.

- Interior heating water piping shall be insulated with rigid glass fiber insulation.

- Piping exposed to the interior shall have a PVC or aluminum jacket. Piping exposed to the exterior shall have an aluminum jacket.

- Heating water will be provided with a BTU meter at the service entry.

Seismic Criteria

Referenced Standards and Design Criteria:

- Seismic bracing shall be in compliance with ASCE 7-10.
- Equipment mounted on isolators will be seismically braced using loose cables, telescoping pipes, or box sections, angles or flat plates used as limit stops or snubbers, either integral to or separate from the isolators.
- Nonrotating, fixed equipment will be bolted directly to the floor or structure.

Mechanical Calculations

Mechanical calculations are provided in Appendix C for both air side and cooling water side.

Sustainable Design Strategies

The following energy conservation measures will be incorporated into the HVAC design:

- DDC BAS for optimization of major HVAC equipment operation.
- Variable-volume supply and exhaust system in combination with stand-alone controllers to provide maximum flexibility in occupied/unoccupied space control scheduling, thus minimizing supply and exhaust air volumes.
- Supply air temperature is to reset to minimize air conditioning of outside air and subsequent reheating of conditioned air.
- Supply air volume from AHUs will be reduced to minimum levels without compromising safety. During occupied hours, room supply air volume will be set at the maximum air flow required to provide fume hood makeup air, minimum required ventilation, or space cooling. This will be accomplished using the VAV air systems and DDCs.
- VSDs installed on all VAV AHU supply and return fans to reduce fan horsepower requirements of non-peak conditions.
- VSDs installed on all pumps to reduce pump horsepower requirements at non-peak conditions.
- Full economizer control on all mixed AHUs to reduce consumption while maintaining appropriate indoor humidity levels.

8.4.3.10 Electrical

Site Power Distribution

The 50M Instrument Building, helium compressor area, and 90M Instrument Building will be supplied from the same outdoor substation TA2-SS4.

The 90M Instrument Building will be provided with 480 Y/277 V secondary service from 1500 kVA outdoor substation TA-SS4. Two 400 A service to distribution panels is anticipated to provide separation of services to instrument and CF building loads.

Building Power Distribution

Service to a 10-ton crane will be provided.

Separate transformers will be provided where possible to service instrument loads.

Secondary Distribution

- Building secondary distribution will generally be 480 V, 3-phase, 4-wire, plus ground. This will provide service to CF lighting, receptacles, and HVAC loads as well as building instrumentation loads. Further transformation down to 208 Y/120 V, 3-phase, 4-wire, plus ground will be provided for general use receptacles and other low-voltage equipment as necessary.

- All conventional building use dry-type transformers will be DOE 2016 rated for efficiency, 115°C rise, 220°C insulation class with six 2.5% taps. Consideration will be given for harmonic or K-rated transformers and oversized neutrals to handle the heating effects of the harmonic loading.

- Circuit protection will be
  - Where 480-V distribution is provided, the exterior unit substation secondary will be of low-voltage switchgear UL 1558 construction with electrically operated drawout power circuit breakers with solid state adjustable trips.
  - Generally molded case circuit breakers. Solid state adjustable trip units will be provided above 250 A.
  - Bolt-in type molded case circuit breakers for branch circuit panelboards.
  - 100% rated for service entrance main circuit breakers, 80% rated otherwise.

- Devices will be fully rated. Series ratings of protective devices will not be acceptable.

- Two levels of ground fault protective devices will be provided at the main and feeder breakers at service switchgear assemblies.

Emergency Power Supply System

EPSS Power Generation Plants

The 90M Instrument, 50M Instrument, and helium compressor area buildings will be provided with building and instrument standby power from an exterior 300 kW/375 kVA, 480 Y/277 V diesel engine-generator TA2-EG2. It will provide emergency power for life safety systems, including egress lighting, and critical instrumentation and HVAC systems loads.

The exterior diesel standby engine-generator will be provided in an exterior, weatherproof, sound-attenuated, reach-in enclosure with 24-h sub-base fuel tanks. The generator will be provided with a quick-connect feature to be used for load bank testing or portable generator backup if the primary unit is down for maintenance.

EPSS Power Distribution

The EPSS secondary distribution system will be separated into the following branches as required by code:

- Generator: This branch provides alternate source power from the generator set main circuits breaker(s) and associated distribution to the line side of each ATS.

- Emergency (NEC Article 700): This branch provides continuous (normal or generator) source power for the following equipment essential for safety to human life:
  - Interior building means of egress lighting and illuminated exit signs
  - Exterior building means of egress immediately adjacent to exit discharge doorways
  - Fire detection and alarm systems
  - Public address communication systems (when used for issuing emergency instructions)
  - Generator set location, task illumination, battery charger, emergency battery-powered lighting unit(s), and selected receptacles
  - Fire protection systems
  - Experimental processes where interruption would produce serious life safety health hazards, and similar functions

- Combined legally required and optional standby branch, designate as “optional branch” (NEC Article 701 and 702): This branch provides continuous (normal or generator) source power for the following equipment that, when stopped during any interruption of the normal electrical supply, could cause hazards or hamper rescue or firefighting operations; or (optional branch) to protect facilities or property where life safety is not dependent on system performance:
  - Control and alarm systems of major apparatus
  - Experimental processes where any power outage could cause serious interruption of the processor damage to the equipment
  - Ventilation and smoke removal systems
  - Access control systems
  - Telecommunication room lighting, equipment, and data processing systems
  - Electric and mechanical room lighting and selected receptacles
  - Mechanical equipment including boilers, condensate return pumps, hot water heating and glycol circulating pumps
  - Plumbing equipment including sewage ejectors and pumps

Generator distribution feeders will extend from the EPSS power generation plant to 480 Y/277 V, 4-pole isolation-bypass transfer ATSs with associated distribution panelboards located in the 50M Instrument Building Electrical Service Room. The following transfer switches are anticipated at that location:

- 260 A: Life safety branch (sized large to meet required withstand rating)

- 600A: Optional branch

- Associated branch circuits and feeders will extend to the 90M Instrument, helium compressor area, CEF II, and CUB II buildings.

Power Quality Systems

Uninterruptible Power Supply Systems

An 80 kVA UPS system will be provided in Target Building II, which will also serve the 90M Building IT distribution.

Surge Protection Devices

Surge arrestors labeled for use with NFPA 780 lightning protection systems will be provided at all unit substation transformer primaries.

Transients (surges, lightning, switching events) can introduce harmful voltage or current spikes to electronic equipment.

SPD filtering devices will be installed on main low-voltage switchgear, distribution panelboards, and branch panelboards serving major electronic equipment and all emergency branch panelboards in compliance with current code requirements. Sensitive equipment may require multiple levels of protection to protect items of equipment not only from utility disturbances but also from one another.

Electric Metering Systems

Electrical metering systems, according to ORNL standards, will be used to monitor and alarm:

- Electrical loading, harmonic loading, and protective device positions. Rail-mounted power quality PM 8214 DIN meters will be required at the unit substation building main service breakers.
- Service low-voltage switchgear mains and feeders.
- Medium voltage interrupter switches, positions, and transformer status.
- Distribution panelboards on the load side of ATSs.
- Standby engine generator plant and associated distribution equipment.
- ATS positions.

The system will be networked to the ORNL Power Operations SCADA “SNO” network.

Grounding Systems

Ground Grid

All building grounding systems must be bonded to a common earth ground in compliance with the NEC. Each building will be provided with a #4/0 direct buried copper ring encircling the perimeter of the building, which will provide a convenient means of connecting all metallic systems and equipment into a single equipotential grid that has a low resistance to ground.

Building Grounding

Building steel, foundation rebars (Ufer ground), and metallic water supply piping will be bonded to the ground grid.

Building Lightning Protection

An NFPA 780 Faraday cage type lightning protection system will be provided to protect the building/structure and its occupants and contents from the electrical effects of a lightning strike to ground. The system will include independent down conductors in PVC from the rooftop to the ground grid.

Electrical Power System Grounding

Separate green grounding conductors will be provided with all feeders and branch circuits to provide an intended grounding of the neutrals of the electrical power systems. Each will be bonded to the ground grid with grounding electrode conductors from the distribution system neutral source.

Interconnected bus bars in electrical rooms will collect electrical and electrical equipment grounding conductors to tie the ground ring at the electrical service entrance room.

Electrical Equipment Grounding

All non–current carrying metal parts of electrical equipment enclosures, raceways, boxes, cabinets, housings, frames of motors, luminaires, and so on will be bonded and connected to electrical room ground buses where the associated system neutral is grounded. This allows for a safe ground path in an electrical fault condition.

Instrumentation Signal Reference Grounding

The bonding of instruments and instrument cabling pathways, as a low-impedance-signal reference system to a common equipment area bus and then to the ground grid, will be provided to minimize noise induced voltages and reduce equipment malfunctions.

Telecommunications Signal Reference Grounding

Interconnected bus bars in telecommunication rooms will collect STS IT equipment and pathway grounding conductors and bond to the electrical service entrance room ground bus in compliance with EIA/TIA and NEC requirements.

Lighting Systems

Exterior Lighting

Pole-mounted LED light standards with concrete bases will be provided along roadways and within parking lots.

Building-mounted perimeter LED luminaires will be provided at building exits, walkways, and vehicular circulation areas.

Interior Lighting

LED interior lighting will be provided in compliance with IESNA lighting standards and ASHRAE 90.1 energy budgets.

Energy-efficient, heavy-duty, specification-grade, high bay and industrial LED luminaires are generally anticipated in STS instrumentation areas.

Lighting Controls

Exterior lighting will be provided with photocell and time clock controls.

Interior spaces will be provided with automatic lighting controls in compliance with ASHRAE 90.1 energy budgets. High bay 24/7 areas will be breaker controlled.

Facilities & Operations Building Systems

The building electrical metering system and BAS to monitor electrical and HVAC building systems will be site interconnected to SNS campus systems as described in Site Utilities, Section 8.1.2.1, of this report and will also include the following systems.

Fire Alarm System

The fire alarm system will be a microprocessor-based detection and notification control system installed and acceptance tested in compliance with NFPA 72, *National Fire Alarm Code*. The building system will include multiplex wiring techniques, a central processing unit (FACU), annunciator units, and peripheral detection and alarm devices.

The system will

- Include smoke, heat, and beam smoke detection devices to suit environmental conditions
  - High bay areas will be provided with beam smoke detection.
  - Both smoke and heat detection will be provided to other areas.

- Include audible horns and visual strobe notification devices

- Monitor building fire suppression systems and override HVAC functions in an alarm condition for fire and smoke containment

- Report fire, supervisory, and trouble alarms to the ORNL Fire Department and LSS office in Building 4512 over a fiber optic network

Wiring will be supervised Class B installed in conduit. Multimode fiber optic cabling will be extended in conduit between the fire alarm control unit and the telecommunication room in each building.

The system will be Edwards/EST Fireworks manufacturer/series according to ORNL requirements to match the existing campus systems.

Public Address System

A public address system will be provided with building amplification as an extension to the campus-wide Valcom mass notification system.

Wiring will be installed in conduit.

Access Control System

The building will be provided with an access control system with central equipment located in the main telecommunications room.

Alarm and supervisory conditions will be reported to the ORNL campus security monitoring location over a fiber optic network.

Components will match existing ORNL equipment for system compatibility.

Telecommunication Systems

The building will be provided with separate telecommunications service from the existing site telecommunications distribution system at the CLO to a building main distribution room. Design for the incoming POTS and/or VoIP telephone service, LAN, and wireless networking shall be coordinated with DOE's prime subcontractor, Black Box. The STS project will provide the interconnecting fiber optic cabling. Refer to the site utilities telecommunication distribution paragraphs, which outline telecommunications service to the STS buildings.

Building IT systems for systems networking hardware, including switches, routers, patch panels, DAS, and WLAN components will be provided.

Building IT horizontal Category 6A cabling will be provided from telecommunications rooms located on each floor, stacked where possible. Building IT systems will be installed in compliance with EIA/TIA standards.

ORNL F&O Building Systems Distribution

The following building systems/system owners will be interconnected with cables and raceways by SNS CF. The system owners will perform final tie-ins.

- Public address/F&O Instrumentation and Controls
- Fire alarm (FIREWORKS Network)/F&O Laboratory Protection
- Access control/F&O Laboratory Protection
- BAS/(F&O Facilities Management (CLO II only—Siemens))
- Power monitoring (ION-Schneider)/F&O electrical utilities (including central IT UPS systems monitoring)

Instrument and Control Systems

ORNL STS will provide building instrumentation and control systems cabling for interconnection of the following systems:

- PPS

- MPS
- ATS
- TPS (two conduits)
- EPICS

Pathway Systems

Ladder-type cable trays will be provided to support telecommunications and instruments and control systems cabling requirements with proper wire dropout devices, conduit sleeves, firestopping, grounding, and wire management components.

Cabling from wall box–type IT jacks will be in bushed conduits extended and grounded to the local cable tray system.

One 36-in. cable tray is anticipated for area coverages for each of the following:

- Instruments and Control
- ORNL Networks Building IT

8.4.3.11 Plumbing

Drainage/Waste

High Bay Interior Drainage System

The interior of the 90M Building high bay will be provided with a process waste drainage system to collect interior water from system leakage. The drainage will be piped to a duplex sewage ejector in a pit located below grade. Any water collected will be pumped to the process waste holding tank in the basement of Target Building II.

Laboratory Waste

Laboratory waste from laboratory sinks, cup sinks, and laboratory-related equipment will be collected separately below the lower level and conveyed by a gravity system to the underground sanitary waste drainage system outside the building. Any hazardous waste will be bottled to be transported for processing; consequently, a lab waste treatment system will not be provided.

Lab waste from floor drains within lab spaces will be treated as process waste.

Unless required for specific equipment, floor drains will not be provided in laboratory rooms.

Complete accessibility will be provided to all cleanouts. Wall-type cleanouts will be used within the laboratory spaces. Floor drains that do not receive regular use will be provided with trap primers. Primers will consist of an automatic trap primer system that automatically discharges water at regular timed intervals.

Process Water

Non-potable Water Service (Instrument Use)

A separate process water system will be provided for instrument use water. Process water shall emanate from the backflow preventer provided at the incoming potable water service at the Target Building and shall be routed around the perimeter of the Target Building and into the Instrument Buildings. Connections will be provided for instrument use and for makeup to technical cooling water and sensible cooling water systems.

Design of process water will be based on anticipated use and adjusted/increased to allow for projected water demand for instrument-related equipment at the design stage. Piping will be sized to maintain a minimum of 30 psi at the most remote laboratory equipment connection.

Water velocity in distribution piping shall not exceed 6 ft/second. Provisions shall be made to arrest waterhammer. Shock arrestors when installed shall comply with PDI-WH201 or ASSE-1010.

Storm Drainage

The primary storm drainage system will consist of roof drains for any areas collecting water, routed to downspouts that will collect below grade at the lower level and run to the site storm sewer.

A separate overflow storm drainage system will be provided; it will be engineered to perform as a siphonic roof drainage system with the piping running level through the building and discharging above grade to a velocity reduction tank located on the site. Velocities in the vertical piping shall be limited to 10 fps, and in the horizontal piping, the velocity shall be designed to 3.5 fps.

Compressed Air

CA shall be distributed from incoming service at the Target Building and around the Instrument Buildings to supply CA to instrument-related equipment and will be provided with local pressure-reducing valves to permit each piece of equipment to use air of various pressures. CA will be fed by a site CA system routed from the air compressors in the CUB. CA will enter the Target Building at the lower-level mechanical room. Distribution will be routed around all perimeters of Instrument Building high bay spaces, with outlets provided for each beamline.

Specialty Gases

Nitrogen shall be distributed from incoming service at the Target Building and around the Instrument Buildings to supply nitrogen to instrument-related equipment. Nitrogen will be fed by the liquid nitrogen tank located west side of the Target Building II. Nitrogen will enter the Target Building at the lower level. Distribution will be routed around all perimeters of the 50M building and into the 90M Instrument Building high bay spaces, with outlets provided for each beamline (11 total).

Equipment

General

System Design Criteria

Process Water

- Process water system is designed to provide a minimum of 40 psi at the furthest outlet.

- Water piping shall be sized based on the minimum flow pressure required at each fixture or piece of equipment. Pipe velocities shall be maintained between 4 and 8 ft/second and shall not exceed 8 ft/second.

- Valves shall be placed to isolate individual fixtures within one room or a battery of fixtures within any one room.

- Hose outlets will be provided at all mechanical rooms and equipment spaces.

Lab Waste

- The waste system shall connect to each fixture requiring connection and where required will be provided with water seal traps. A vent system shall be provided for fixtures as required to ventilate the waste system and to prevent siphonage of fixture traps.

- Floor drains will be provided at all mechanical rooms and equipment spaces.

- Pipe shall be routed by gravity to maintain a positive slope with a maximum velocity of 2 ft/second.

Storm Drainage

- Storm piping shall be sized based on a 100-year occurrence rainfall rate with a 60-min duration.

- Roof drains will be provided for all roofs and areas receiving rainwater; maximum area per drain shall be 3,000 sf.

Compressed Air

- Design CA pressure on incoming service—105 psi.
- Design CA pressure at laboratory outlets—100 psi.
- Design flow at outlets—1.0 cfm.
- Dew point –40°F

Materials

Process Water Systems

- Above-ground process water systems
  - Tubing to be Type L hard temper with wrought copper fittings conforming to ASTM B88-and ASME B16.22. All joints shall be soldered with ASME AWS/A5.8 lead-free solder.

- Copper tubing with grooved ends and mechanical joints is acceptable for sizes ½ in. to 6 in. only. Tubing to be Type L hard temper with wrought grooved end fittings conforming to ASTM B88 and ASTM B75.
- The entire process water distribution system will be fully insulated using closed-cell elastomeric foam insulation.

Storm System

- Above-ground rainwater piping
  - Hubless cast iron soil pipe: no-hub pipe with Husky SD-4000 soil pipe coupling manufactured by Anaheim Foundry, 4-band clamp or Clamp-All Hi Torq 125 2-band clamp. Sealing gasket shall be neoprene in accordance with ASTM C564, CISPI 301-75.
  - Horizontal storm drainage piping will be fully insulated using closed-cell elastomeric foam insulation.

- Below-ground rainwater piping:
  - Asphaltum-coated, service weight, cast iron pipe and fittings with resilient neoprene push-on joints, ASTM A72, ASTM C564-70.

Process Waste

- Polypropylene pipe, (fire retardant above grade) (PP); Sch 40; PP DWV hub and spigot fittings; heat fusion joints above and below ground.

Compressed Air/Nitrogen Systems

- Type K copper with brazed joints

8.4.3.12 Fire Protection

Sprinkler

The 90M Instrument Building will be provided with complete automatic fire protection systems as required by the IBC and/or DOE Order 420.1C, *Facility Safety*. The design, installation, and acceptance testing of automatic sprinkler protection will be in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems* and DOE-STD-1066-2012, *Fire Protection*. The building will be fully sprinkled, with exposed sprinkler piping feeding upright sprinklers, or recessed pendent sprinklers where ceilings are provided. Sprinkler feed will enter the at the east end of the lower level of the Target Building from the site potable/fire water main, and a double-check backflow preventer will be provided. The 90M Building will have a single sprinkler zones, with control valves located at the incoming service. Control valve will be provided with a tamper switch and a flow switch connected to fire alarm system.

Incoming service will be hydraulically calculated and be sized for the maximum calculated flow at the design stage.

Portable fire extinguishers will be provided throughout the 90M building in accordance with the IBC and NFPA 10, *Portable Fire Extinguishers*.

System Design Criteria

Sprinkler systems will be hydraulically designed to provide water densities that meet the requirements for Extra Hazard, Group 1 protection throughout.

Fire sprinkler systems will be hydraulically designed. Velocity shall not exceed 20 fps. All calculations assume a minimum of 10 psi deterioration in static and residual pressures in the hydrant flow test results.

Materials

- Pipe and fittings installed underground shall be Class 52 ductile iron cement lined with mechanical joints with a working pressure rating of 350 psig.
- Sprinkler piping installed above ground and sized 2 in. and smaller and all standpipe piping shall be Sch 40 black steel with threaded joints and fittings.
- Sprinkler piping installed above ground and sized 2½ in. and larger shall be Sch 40 black steel with roll or cut groove type connections and fittings. Pressure rating shall be 175 psig minimum.
- Fittings for grooved end shall be cast of ductile iron conforming to ASTM A-536 or malleable iron conforming to ASTM A-47, or forged steel conforming to ASTM A-234 (A-106, Gr. B), with grooved or shouldered ends for direct connection into grooved piping systems with steel pipe and shall be UL listed and FM approved, rated for a minimum 300 psi MWP.

8.5 CENTRAL LAB AND OFFICE BUILDING

8.5.1 Central Lab and Office Building II

8.5.1.1 Programming

Building Function

The CLO II will house laboratory space, STS scientific and technical staff offices/workstations, STS user staff offices/workstations, conference/collaboration areas, and general building support functions that will serve an added campus population of approximately 170 people. Effectively, the CLO II will expand the office and laboratory activities of the existing CLO. The existing CLO food service and auditorium functions will serve CLO II and will not be expanded. The CLO II will be generally accessible to all STS scientific staff, technical staff and users.

Program Summary

The CLO II includes 63,671 nsf and has an estimated planning efficiency factor of 66%. This factor is based on analysis of the existing CLO and preliminary test-fit planning for the CLO II. The program requirements for the CLO II were defined during a series of programming workshops attended by FTS and STS research program leaders and scientists. The original workshops were held in 2016. The programming was supported by a review of existing space concluding that the existing CLO and CNMS office and lab spaces were fully utilized. Office and laboratory space needs for CLO II were established based on information provided by the program leaders and scientists regarding projected increases in research, administrative, and operations staff, plus additional user requirements. The space needs developed in 2016 were reviewed again in 2018, incorporating minor revisions. The estimated gross area of the CLO II is 96,060 gsf. Table 8.30 summarizes the CLO II space program requirements. Detailed room data sheets and test-fit plans are included in Appendix B, STS CF Conceptual Design Report.

Table 8.30. CLO II space program summary.

No.	Rooms	Qty.	NSF	Total NSF
	Office Space			**14,030**
5.5.1.1	Private office—single occupancy	66	110	7,260
5.5.1.2	Private office—double occupancy	17	110	1,870
5.5.1.3	Workstation	70	70	4,900
	Shared Space			**7,620**
5.5.1.4	Unassigned office/conference	10	120	1,200
5.5.1.5	Small conference	6	250	1,500
5.5.1.6	Medium conference	2	500	1,000
5.5.1.7	Large conference	1	1,400	1,400
5.5.1.8	Coffee/kitchen/vending	5	100	500
5.5.1.9	Common space/café	1	1,000	1,000
5.5.1.10	Printing room	6	120	720
5.5.1.11	Catering kitchen	1	300	300
	Laboratory space			**20,410**
5.5.1.12	Synthesis Lab I	2	730	1,460

Table 8.30. CLO II space program summary (continued).

No.	Rooms	Qty.	NSF	Total NSF
5.5.1.13	Synthesis Lab II	3	730	2,190
5.5.1.14	Synthesis Lab III	3	730	2,190
5.5.1.15	Characterization Lab	3	730	2,190
5.5.1.16	BSL-2	2	730	1,460
5.5.1.17	Lab support	2	730	1,460
5.5.1.18	Sample receiving	1	480	480
5.5.1.19	Data acquisition lab and storage	3	730	2,190
5.5.1.20	Detector lab	2	970	1,940
5.5.1.21	Detector storage	2	730	1,460
5.5.1.22	Light mechanical instrument support	1	970	970
5.5.1.23	Blast lab	1	480	480
5.5.1.24	Metrology guide alignment	2	970	1,940
	Building Support			**20,130**
5.5.1.25	General building storage	1	2,000	2,000
5.5.1.26	Lobby	1	870	870
5.5.1.27	Janitor closet	4	80	320
5.5.1.28	Server room	1	500	500
5.5.1.29	Electrical distribution room	4	120	480
5.5.1.30	IT communications room	4	120	480
5.5.1.31	Switchgear	1	1,200	1,200
5.5.1.32	Fire riser room	1	450	450
5.5.1.33	Mechanical room	1	500	500
5.5.1.34	Mechanical penthouse	1	10,431	10,431
5.5.1.35	Toilets	8	250	2,000
5.5.1.36	Recycling/trash	1	150	150
5.5.1.37	Entrance vestibule	1	130	130
5.5.1.38	Electrical normal distribution room	1	1,200	1,200
5.5.1.39	Boiler room	1	500	500
5.5.1.40	Electrical gen/UPS distribution room	1	400	400
Total nsf				**63,671**
Total gsf				**96,060**
Total efficiency				**66%**

8.5.1.2 Site Planning

Location and Floor Elevations

The CLO II will adjoin the southwest corner of the existing CLO adjacent to the existing SNS control room. All floor levels of CLO II will align with the existing floor levels of the CLO. Figure 8.14 highlights the CLO II Building within the overall STS Site Plan.

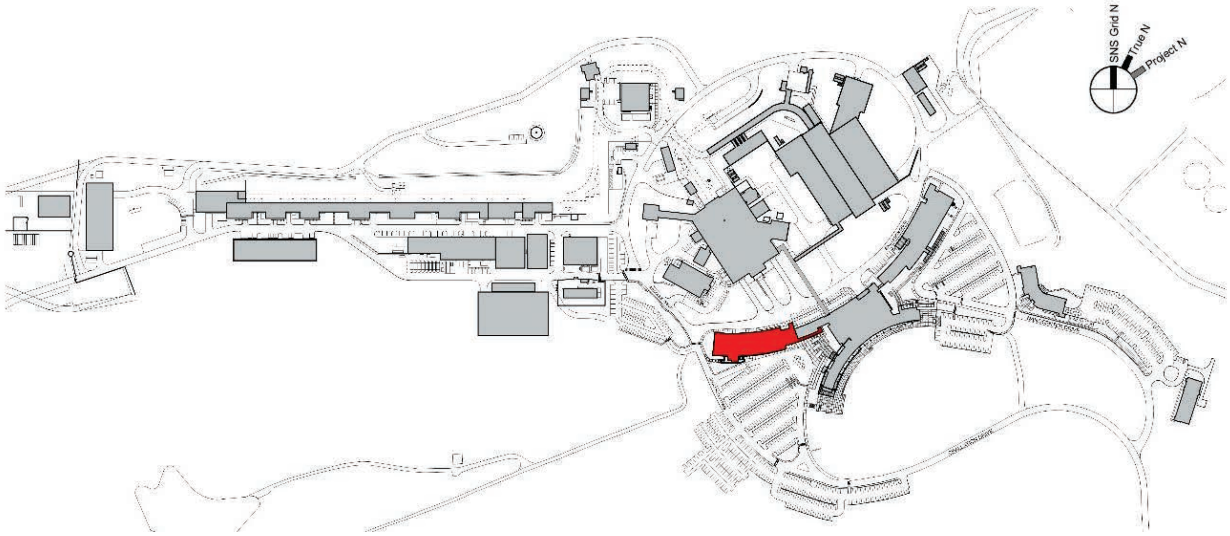


Figure 8.14. CLO II Building location within the STS Site Plan.

Truck Access

The CLO II will use the existing CLO loading dock facilities for primary deliveries requiring tractor-trailer truck access. This will require modifying existing CLO shop areas to establish an access aisle or corridor between the CLO and CLO II at the ground floor level, elevation 1057 ft. A secondary receiving door will also be included at the northwest corner of the CLO II ground floor, which will allow deliveries involving smaller truck types. At this location, handcarts will be used to convey materials and equipment between the building and trucks through double-wide service doors.

Pedestrian Access

The primary exterior access will be the main entrance located at the south end of the first floor. The building will be accessible directly from the existing CLO at all four existing floor levels. The facility will also be accessible through controlled exterior grade-level doors located adjacent to the loading area at the ground floor.

8.5.1.3 Building Planning

Building Organization/Floor Planning

The CLO II will be a four-level structure with an enclosed penthouse housing mechanical air handling equipment. All floor levels of CLO II will align with the floor levels of the existing CLO. Because of the narrow site, the building will be organized in a linear manner with central laboratories flanked by perimeter office and support areas. The first, second and third floors will be entirely above grade. The ground floor, at elevation 1057 ft, will be below grade along the southeast side and above grade on the northwest side, adjacent to the service ring road. The CLO II will be constructed adjacent to the existing SNS control room, which must remain in full operation throughout construction activities. From a building code standpoint, the CLO II will be considered a separate building from the existing CLO.

The CLO II plan will be anchored by two building cores located near the north and south ends of the building. These cores will include stairs, elevators, toilets, vertical shafts, and utility distribution closets. The central laboratory areas are planned on a nominal 10 ft, 6 in. by 10 ft, 6 in. two-directional grid.

Laboratories will be planned to maximize future flexibility, collaboration, and visual openness. Vibration-sensitive characterization labs will be located at the ground floor level.

Vertical Circulation

The CLO II will include one freight elevator and two egress stairs which will connect all five floor levels of the building, including the mechanical penthouse. Two passenger elevators will serve the four occupied floors of the building, but not the mechanical penthouse. Stairs, stair enclosures, and exit discharge shall be designed in accordance with NFPA 101.

8.5.1.4 Key Features and Requirements

Laboratory Casework and Fume Hoods

Mobile laboratory casework will be provided throughout the laboratory space employing a 5 ft or 6 ft bench module based on the specific lab planning. Overhead service carriers or flexible, ceiling-mounted utility drops will provide power, CA, vacuum, and nitrogen to bench tops. Other gases will be locally supplied. To the extent possible, sink basins and fume hoods will be located in fixed, permanent locations. All casework and hoods will be provided as part of the CF scope.

Office and Workstation Furnishings

Private office, shared office, workstation, conference room and other public area furnishings will be provided as part of the CF scope.

8.5.1.5 Life Safety/Code

Primary Occupancy Type

The primary occupancy type for the CLO II is Group B, Business, according to the 2015 IBC, and New Business according to NFPA 101, 2018 edition.

Accessory Occupancies

Accessory occupancies will include shops (Group F-1) and storage rooms (Group S-1). The shops and storage rooms can be considered accessory occupancies if the aggregate area of each use does not exceed 10% of the floor area of the story in which they are located. IBC Table 508.4 does not require a fire-rated occupancy separation between Groups B, F-1, and S-1 occupancies.

Fire Protection Systems

The CLO II will be protected throughout by automatic fire sprinkler systems designed and installed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems.* The fire sprinkler systems protecting office areas, conference rooms, corridors, and lobbies will be designed to protect an Ordinary Hazard–Group 1 occupancy. Sprinkler systems protecting laboratories, shops, and storage rooms will be designed to protect an Ordinary Hazard–Group 2 occupancy.

The building will be provided with a Class I standpipe system with a fire standpipe located within each of the two exit stairways in accordance with NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*. Two and one half-in. fire department hose valves will be provided at each floor landing in each exit stairway.

Portable fire extinguishers will be provided throughout the building in accordance with the IBC and NFPA 10, *Standard for Portable Fire Extinguishers*.

The CLO II will be equipped with an addressable fire detection/alarm system consisting of the following:

- Manual fire alarm pull stations at all building exits
- Area smoke detectors in elevator lobbies and elevator machine rooms
- Duct smoke detectors on the supply and return sides of all AHUs having a design capacity greater than 2,000 cfm
- Audible/visual notification appliances installed through the building

All fire alarm, supervisory alarm, and trouble signals will be automatically transmitted to the ORNL Fire Department via the LSS fiber optics network.

All new fire alarm system equipment will be manufactured by Edwards Systems Technology to be compatible with the existing site-wide campus system.

The fire detection/alarm system will be designed and installed in accordance with the IBC and NFPA 72, *National Fire Alarm Code*.

Maximum Floor Area and Stories

The CLO II will be a 5-story building of Type IIA construction. IBC Table 503 limits the height of a fully sprinklered, Group B building of Type IIA construction to a maximum of 65 ft and 6 stories.

The CLO II will have a gross area of approximately 93,736 SF. IBC Table 503 and Section 506 limit the area of a fully sprinklered, Group B building of Type IIA construction to 112,250 SF per story up to a maximum of 4 stories (or 450,000 SF). The proposed height and area for the building are within the limits established in IBC Sections 503, 504, and 506.

Travel Distances

The CLO II will have two exit stairways enclosed by 2-h fire-rated construction. The maximum travel distance to an exit will not exceed 300 ft, as required by IBC Section 1016.2 and NFPA 101, Section 38.2.6.3. The maximum common path of travel distance will not exceed 100 ft, as required by IBC Section 1014.3 and NFPA 101, Section 38.2.5.3.1. The maximum dead-end corridor will not exceed 50 ft, as required by IBC Section 1018.4 and NFPA 101, Section 38.2.5.2.1.

Construction Type

The CLO II will be of Type IIA construction in accordance with IBC Section 602.

Wall/Floor Ratings

The primary structural frame, floors, bearing walls, and roof of the CLO II will have a 1-h fire resistance rating as required for Type IIA construction. Interior non-bearing walls and partitions will be of noncombustible construction.

Special Code Considerations

The CLO II should be separated from any new or existing building by a 3-h fire wall constructed in accordance with IBC Section 706.

Hazardous materials: The use and storage of hazardous materials shall be limited to the maximum allowable quantities indicated in IBC Tables 307.1(1) and 307.1(2). Where chemicals are used or stored, hazardous material control areas shall be provided in accordance with IBC Section 414.2. The number of control areas per floor and their required fire resistance ratings shall be in accordance with IBC Table 414.2.3. Note that the floors of control areas are required to have a 2-h fire resistance rating for buildings over 3 stories in height.

8.5.1.6 Civil/Site Development

The CLO II will extend off the southwest wing of the existing CLO. The development of this area involves realignment of the southern CLO parking facility and removal of the existing control room parking. Walkways will be provided from the additional parking installed to the south and east for the CLO II area. Finished grading is shown on Drawing 5.1.19. Drawing 5.1.22 shows the site drainage concept. Roof drainage will be piped to the proposed storm sewer system. Sewer, fire, and domestic water services to the building are shown on Drawing 5.1.27.

8.5.1.7 Architecture

Building Envelope

Exterior Wall

The exterior enclosure will incorporate basic concepts; a solid expression that will enclose the majority of the lab areas of the building; and a glazed expression that will surround the office, conference, collaboration and commons space, providing views to the exterior and welcoming in ample daylight. A striated-face, 24-in.-wide insulated-core metal panel system, with a custom color to match existing context, will be used as major material component for the envelope of the CLO II building that will be compatible with the existing texture and materials used on the SNS campus. Consistent with the project’s sustainable goals, the preferred solid wall construction will function as a rain screen. The metal panel cladding support backup system will be a light gauge metal framing wall with glass mat gypsum board sheathing, fluid-applied air barrier, and mineral wool insulation with a gypsum board interior finish. Metal window sills and wall caps will be used. Continuous through-wall flashing will be provided at the bottoms of all wall cavities, over all wall openings and metal copings. Below-grade exterior walls will be constructed of reinforced concrete with a waterproof membrane and below-grade insulation board. The interior side of the below-grade walls will have metal channel furring with a painted drywall finish. Exterior walls below grade will have a requirement of R-7.5 ci.

A deep-ribbed, corrugated metal panel with exposed fasteners with a 2-in.-thick insulated liner panel will be used at the penthouse enclosure. The metal panel backup system will be a light-gauge metal framing wall with glass mat gypsum board sheathing, air barrier, and rigid insulation with a gypsum board interior finish. The metal panel wall systems will have an R-13 and R-13 ci minimum requirement. Exterior walls below grade will have a requirement of R-7.5 ci.

Exterior Doors

Main exterior entrance doors will be pre-finished, wide-style aluminum doors with low-E, insulated, and tempered glazing with a U value of 0.77. They will be provided with egress/entry hardware. Egress doors at loading dock areas will be 16-gauge, insulated-core painted hollow metal doors with fully welded, 14-gauge frames with a U value of 0.61. All exterior doors will be provided with proximity card reader hardware.

Thermal and Moisture Protection

Flashing and sheet metal will be provided as a positive water stop around all openings (head, jamb, and sill) in walls such as windows, doors, louvers, and so on. All copings and gravel stops will be ES-1 compliant as required by IBC.

Damp-proofing will be provided on all walls, floors, and other building components that are subject to high humidity, dampness, or frequent direct water contact.

Waterproofing will be provided at walls, floors, and other building elements that are subject to hydrostatic pressure, are liable to be immersed in water, or are below the water table. The waterproofing membrane will be a hot-fluid-applied, two-layer 215-mil polyester fabric–reinforced membrane.

Exterior sealants will be nonstaining with two-part composition and a 50% movement capacity, and will be compatible with the surfaces on which they are being applied.

Insulation combustibility, including wrappings, inside the building skin will be limited to a flame spread of 25 and smoke development of less than 50.

Glazing

Owing to the building orientation and environmental and daylighting needs, the exterior glazing will use several types of window systems. A standard vision glass will consist of a thermally broken frame with 1-in.-thick, low e-coated insulated units. Fixed horizontal shading devices will be used at all glazing locations. The aluminum curtain wall and storefront systems will be high-performance, 1-in.-thick, low U-value insulated, low-E, argon-filled glass units on a thermally broken frame to the north of the building to provide optimal thermal protection while allowing the highest transfer of visible light. The windows/glazing systems are anticipated to have a U value of 0.38.

Glazing materials and methods will comply with the Flat Glass Marketing Association's Sealant and Glazing Manuals. Glass will comply with ASTM C1036-01.

Roof Construction

The roofing system will be a 30-year, 80 mil minimum thickness, white thermoplastic (PVC) single-ply sheet with an integral fiberglass mat reinforcement roofing membrane over polyisocyanurate insulation on a sloping roof structure. Tapered insulation saddles will be used to provide drainage to roof drains and at roof equipment locations. All roof construction details and roof penetrations must comply with the guidelines established by the NRCA. Roof traffic pads will be adhered to the membrane along all roof maintenance traffic paths. All roofs with serviceable components beyond roof drains will be surrounded by a 42-in.-high parapet or provided with a fall protection system.

Low-slope roofing will have a minimum 3-year aged solar reflectance of 0.55 and a minimum 3- year aged thermal emittance of 0.75 in accordance with the Cool Roof Rating Council Program. Roofing will be Energy Star rated with emissivity of at least 0.9 when tested in accordance with ASTM 408.

The roofing system will meet or exceed UL class A fire exposure requirements and comply with FM Class I-90 for wind uplift according to ASTM 1592. It will provide a minimum thermal resistance value of R-30.

Interior Construction

Walls

Interior partitions will be constructed of metal studs with 5/8 in. gypsum board on each side. The height of the new walls will vary as needed to accommodate sound attenuation requirements, HVAC compartmentation requirements, and required laboratory control areas. All walls defining chemical control areas are to be 1-HR rated. Walls constructed at office and conference areas will be constructed to the underside of the ceiling grid to allow for future flexibility. The enclosing and demising walls at the laboratories and toilet rooms are to be constructed to the underside of the structural deck. Sound mineral wool batts will be installed in the walls enclosing mechanical rooms, offices, conference rooms, toilet rooms, and laboratories. All fire-rated walls will be constructed in accordance with the IBC code requirements and UL-listed assemblies.

Interior storefront systems with 3 5/8-in. frame and ¼-in.-thick tempered glazing system will be provided at huddle room and conference room areas.

All metal guardrails and handrails at openings and egress stairs will be painted metal.

Wall Finishes

All finish materials for walls, ceilings, and floors, will have a Class A rating, with a flame spread ≤ 25, a fuel contribution of ≤ 25, and a smoke development of ≤ 450.

Typical interior gypsum board partitions will receive a paint finish consisting of one primer coat and two finish coats. Epoxy paint is to be applied to all lab demising walls. All paints, including top coats and primers, will comply with the 2016 *Guiding Principles for Sustainable Federal Buildings*.

Ceramic tile will be installed for the full height of all walls in toilet rooms. Tile will be 1 × 24 in. in a brickwork pattern with a 1/3 offset. In areas where moisture is present, tile will be installed over a cementitious backer board.

Floor Finishes

Commercial-grade carpet tile and 4-in.-high vinyl wall base is to be installed in the enclosed offices, open offices, and conference areas. Carpet systems must meet or exceed the Carpet and Rug Institutes Green Label Plus Program, and all carpet adhesives will not exceed the volatile organic compounds limits of LEED Gold v4 or will meet the 2016 *Guiding Principles for Sustainable Federal Buildings*.

Commercial-grade vinyl composition tile with a 4-in.-high vinyl wall base is to be installed at all lab support areas and main corridors. Seamless chemical-resistant sheet vinyl with integral coved base is to be installed in all laboratories. An epoxy floor with an integral coved base will be provided at the synthesis labs, characterization labs, detector labs, blast lab, and H occupancy rooms for durability.

The main corridor and lobby areas on the first floor will receive a thin-set epoxy terrazzo finish.

Ceramic tile will be installed in toilet room floor areas. Tile will be 12×24 in. in a brickwork pattern with a 1/3 offset.

Porcelain tile will be provided at the café/kitchen area, and quarry tile will be provided at the food preparation areas.

Static-dissipative floor tile will be provided in the server room.

Flooring in the mechanical areas is to receive concrete sealer over the new concrete. No vinyl wall base will be used in these areas.

Ceiling Finishes

The main lobby ceiling will have a metal ceiling panel system. A suspended lay-in 2×4 ft ceiling will be provided in laboratories that require ceilings. A 2×4 ft suspended acoustical ceiling system with lay-in panels will be installed in office and conference areas with a noise reduction coefficient rating greater than 0.9. All ceiling tile products will contain recycled content. A gypsum board ceiling on a suspended drywall system is to be installed in the toilet rooms.

The structure will be left exposed in some laboratory spaces and all mechanical and utility areas. All exposed structure will receive paint finish consisting of one primer coat and two finish coats.

Interior Doors

All interior doors, except stairwell doors, will be solid-core wood, natural finish, with fully welded hollow metal frames. Stairwell, mechanical rooms, and other support areas will be hollow metal doors with fully welded metal frames.

Tempered glass vision lights will be provided at all laboratory and office doors. Labeled doors will also be provided at rated walls and stairwells in accordance with NFPA 101. Glass lights will be provided at labeled doors for safe egress. Doors to laboratories requiring light control will be equipped with light-tight blackout shades.

All laboratory access doors will be provided with proximity card reader hardware.

Furnishings

Roller shade window coverings will be provided to control sun intake in normally occupied areas. Electrically operated shades will be provided for conference rooms.

Millwork will conform to the Architectural Woodwork Institute Quality Standards, Guide Specifications, and Quality Certification Program, latest edition.

A janitor closet will be provided on each floor of the building, easily accessible for cleaning, and near the elevator. Closet will include mop sink, faucet with bucket hook, storage for supplies, storage for vacuum and mop bucket trolley, and a hanging apparatus for mops and brooms.

Laboratory Casework

Laboratory casework will be a modular system with prefinished painted metal bases, wall cabinets, and shelving units, with epoxy resin countertops. The modular system will be adaptable and flexible to accommodate the changing needs of the lab research. The casework will be provided with flammable/acid storage base cabinets, full height storage cabinets, and full height storage racks as required for the lab functions.

Mobile base cabinets with epoxy resin tops will be provided in limited areas with overhead service carriers.

Vertical Circulation

Stairs

Stairs will be constructed of concrete-filled metal pans and metal handrails, with rubber treads, nosings, and landings. The stair will extend to the roof for maintenance access and egress.

Elevators

Elevators will comply with the requirements of ASME A17.1, NFPA 70, *Safety Code for Elevators and Escalators*, and the requirements of the State of Tennessee Elevator Code.

There will be one 2500-lb capacity passenger and a 4500-lb capacity passenger/freight elevator. All elevators will be hydraulic. Elevator machine rooms will be in the first floor adjacent to or near the elevator shaft.

The final sizes of the elevators will be determined during preliminary design to support any large equipment that may need to be transported through the building vertically.

Specialty Equipment

Combination emergency showers/eye wash units will be provided, according to ANSI Z358.1, at lab areas where chemicals will be used or stored.

8.5.1.8 Structure

Applicable Codes and Standards

See Sheets x – xii for complete list of Applicable Codes and Standards

Design Loading

Superimposed Floor Loads

- Dead loads:
  - Ceilings: 5 psf
  - Mechanical and lighting: 10 psf

- Live loads:
  - Typical floor load: 100 psf
  - Office floor load: 50 psf + 20 psf partition load

- Laboratory floor load: 150 psf
- Mechanical/equipment room floor load: 150 psf or actual equipment load
- Auditorium stage floor load: 125 psf
- Auditorium seating floor load: 50 psf + 20 psf partition load
- Library stack floor load: 125 psf
- Library reading floor load: 60 psf + 20 psf partition load
- Ground floor load: 500 psf or 6000 lb forklift

Superimposed Roof Loads

- Roof snow load:
  - Ground snow load: Pg = 10 psf
  - Snow exposure factor: Ce = 1.0
  - Snow importance factor: Is = 1.0

- Minimum roof live load = 20 psf + 20 psf collateral load

Wind Loads

- Risk category II
- Basic wind speed: V = 115 mph
- Exposure category B

Seismic Loading

- Risk category II
- Importance factor: Ie = 1.0

Building Structural System

Slab on Grade

The slab construction is anticipated to consist of an 8-in.-thick reinforced normal weight concrete slab. All construction joints between pours will require smooth dowels across the joint. The floor slab will be placed over a vapor barrier, a compacted drainage base course, and a compacted subgrade.

Foundation System

A geotechnical investigation has not been performed. Until a geotechnical investigation and report have been completed, an accurate description of the building's foundation system cannot be provided. The CLO II is anticipated to be supported on shallow foundation with a 3,000 psf allowable bearing pressure. Some site preparation to remove unsuitable soils will be required. Below-grade walls are anticipated to be constructed with reinforced normal weight concrete. There will be a walk-out ground level as one of the four stories, requiring retaining walls. Water stops will be provided in construction joints to safeguard against water intrusion.

Superstructure

The CLO II is anticipated to be a 4-story conventional steel-frame structure. The building will support the exterior wall system with steel girts as required. The elevated floors are anticipated to be constructed using reinforced normal weight concrete on galvanized composite metal deck. The roof structural system is anticipated to consist of wide flange framing with roof deck meeting galvanizing G90 requirements. There will be a walk-out ground level as one of the four stories.

Lateral System

Resistance to lateral loads resulting from wind and seismic forces on the building are anticipated to be provided by concentrically braced steel frames.

Floor Vibration Design

The floor structure will meet VC-A, 2000 μin/sec velocity, under a moderate walking speed of 75 steps/minute.

Geotechnical Analysis

A review of historical geotechnical and geophysical surveys was performed that included the original campus development and additional structures. A detailed geotechnical exploration was performed by Law Engineering dated June 30, 2000, addressing the original development of the campus. A detailed geotechnical report was performed by Shield Engineering Inc. dated November 4, 2010, for the proposed Chestnut Ridge Office Building, which was not constructed. The proposed office building was to be located in the footprint of the proposed CLO II. The proposed CLO II may be supported on shallow foundations. According to the recommendations of the 2010 Shield report, the footprint area of the proposed CLO II addition will require some site preparation to remove unsuitable soils (Shield 2010). Once the site is prepared according to the 2010 Shield report, a 3,000 psf allowable bearing pressure will be available.

A review of geophysical data and shear wave velocities from the Law report indicates that the CLO II footprint would be located in a seismic site classification C as defined in IBC 2015 and ASCE 7 (Law 2000). This is confirmed by the average shear wave velocities for multiple soil profiles tested during the original campus development.

A supplemental geotechnical report may be needed in the area between the east edge of the unbuilt office building footprint and the existing CLO. The density and pattern of the soil test borings should be selected to optimize the quality of geotechnical data. Additional geophysical testing is not anticipated for design of the structure.

Vibration/Acoustics

The acoustical design will be consistent with achieving the following average noise levels. These noise levels do not include noise from owner-furnished equipment or personnel located within these spaces. Actual noise levels may exceed the design noise levels because of the actual type of equipment purchased, installation compromises, workmanship, and so on.

- Room type NC
- Mechanical rooms 65
- Electrical rooms 60
- Computer/server rooms 55
- Maintenance shops 55
- Corridors and public circulation areas 45
- Lab support spaces 45
- Laboratories with fume hoods 45

- Laboratories without fume hoods 40
- Open-plan offices 40
- Private offices 35
- Conference rooms 25

Sound attenuators at the air terminal devices will not be provided. Instead, sound-attenuating flexible ductwork with woven nylon fabric type lining will be provided at the supply diffusers to control noise. The use of sound-attenuating flexible duct at diffusers and grilles will be limited to 6 ft in total length to minimize duct static pressure losses.

The design will target a vibration criterion of VC-A (50 μm/s or 2000 μin/s RMS amplitude in 1/3 octave bands) in laboratory areas. This will govern structural design of floors and the level of vibration isolation hardware provided for rotating mechanical equipment.

8.5.1.9 Mechanical

Air Handling/Ventilation

CLO spaces shall be designated as laboratory, office, or support based upon usage, with different requirements for each. The ventilation criteria in Table 8.31 apply to these areas.

Table 8.31. CLO II space definitions and ventilation rates.

Space designation	Areas included	ACH		Notes
		Occ	Unocc [b]	
Laboratory [a]	Wet laboratory Dry/instrumentation laboratory Laboratory support Laboratory prep	8.0	3.0	Assume virtual/actual ceiling height of 10 ft all spaces negative to surroundings
Office	Offices Open office Corridors Conference rooms Break rooms/amenity spaces Copy rooms Lobby	4.0	0.0	All spaces positive to laboratory
Support [c]	Shop areas Maintenance rooms Toilets/janitor closets	4.0 4.0 10.0	2.0	All spaces negative to surroundings

[a] Designed as 100% outside air.
[b] Unoccupied mode ACH dependent on temperature stability requirements.
[c] Designed as 100% outside air or recirculation depending on hazardous material use.

Laboratory ACH rates will be at a minimum as listed in Table 8.31 but otherwise dependent on temperature stability requirements of the installed equipment and exhaust flow rates above and beyond general exhaust. The following criteria have been used to size exhaust systems:

Fume Hoods

All hoods will be of VAV type for energy reduction and improved safety. Hood exhaust system will be sized based on an average 100 fpm face velocity (measured over the entire face) at an 18 in. sash height at the chemical fume hoods. These criteria correspond to the following exhaust rates at the listed fume hood types:

- 6 ft chemical fume hood (18 in. sash height) 900 cfm
- 8 ft chemical fume hood (18 in. sash height) 1200 cfm
- Any hoods in nano labs will be provided with a local HEPA filtration system.

The current design assumes a maximum of two 6 ft chemical hoods per designated lab space.

Other Laboratory Exhaust Devices

Other exhaust devices in the building will include the following:

- Canopy hoods: 100 cfm/SF(two assumed in the building at 6×4 ft).

- Downdraft surfaces: 100 cfm/SF downdraft velocity at table surface for 100% smoke capture 12 in. above the table. (Two assumed in the building at 3×5 ft).

- Snorkel (6 in. ±) 150 cfm (three per designated lab space)

- Equipment vent (4 in. ±) 50 cfm (two per designated lab space)

Biosafety Cabinets

- Biosafety cabinets classifications are as follows for the project:

- Class II, Type B2 biological safety cabinets (100% exhaust) will require dedicated exhaust system because of high static pressure of 1.4–2.0 in. WC for 6 ft unit or 1.0–1.4 in. WC for 4 ft unit. Two 6 ft II/B2 biological safety cabinets assumed in the building.

- Class II, Type A2 biological safety cabinets (30% exhaust) shall be canopy connected to the exhaust system. Two 6 ft II/A2 biological safety cabinets assumed in the building.

Pressure Relationships

The following typical pressure relationships are assumed for the similar facilities.

- Building: Positive to ambient
- Wet laboratories and shops: negative to adjacent spaces
- Corridors: positive to laboratories and shops
- Offices: neutral or positive to adjacent spaces
- Toilet rooms: negative to adjacent spaces

Pressure relationships will be maintained by volumetric offsets between supply and exhaust/return air flow rates.

Outdoor Air Quality Control Methods

Minimum filtration of outdoor/recirculated air—MERV 8 (30–35%) pre-filters and MERV 14 (90–95%) final filters at the building AHUs or as otherwise described below.

No fibrous media exposed to the airstream will be allowed in the ductwork downstream of any AHU's final filter bank.

Ventilation for all laboratory spaces and lower-level shops will be 100% exhausted using separate laboratory ventilation AHUs and exhaust fans. Office ventilation will be recirculated, with a minimum of 15% outside air provided during occupied mode. Additional outside air will be provided as required to offset exhaust and maintain pressure relationships between spaces.

Outdoor air intakes for all AHUs will be located on opposite sides of the mechanical penthouse from exhaust and lab exhaust to minimize cross-contamination between intakes and exhaust air streams, and on the east side of the penthouse to be downwind of the CEF II and other buildings. A wind tunnel simulation is recommended for this project to corroborate the locations and determine minimum exhaust stack height for lab exhaust equipment. Fume exhaust stacks will be a minimum of 10 ft above the roof. Fume exhaust fans will be designed to be capable of exhausting a constant volume of air at a stack discharge velocity of approximately 3500 fpm. If wind analysis shows a lower stack velocity is acceptable, VFDs provided for the exhaust fans can be adjusted using the control system to allow the stack velocity to be lowered as an energy savings measure.

Supply/Ventilation Air

The CLO II building will be served by multiple VAV AHUs serving various portions of the facility. All units will be located in the enclosed mechanical penthouse.

Wet Laboratory/Support Central Air Handling System

The wet laboratory and some shop support portions of the building will be served by three VAV AHUs. The units will be manifolded together and will share a common discharge plenum to provide full redundancy in the event of a complete unit failure. If one of the units should fail or be required to be taken out of service for maintenance, the remaining two units will be able to provide 100% of the maximum supply system design capacity. The AHUs will be designed as heating, cooling, single-duct, reheat type. The units will operate 24 h/day, 365 days/year. Supply fans will be configured in a multi-fan array, plenum fan design. VFDs will provide supply fan volume control in response to a signal from duct-mounted static pressure sensors. The HVAC distribution system shall be pressure-independent, VAV with minimum and maximum ACHs established for laboratory spaces. Setback adjustments will maintain minimum outside air quantities to meet exhaust air requirements but will also include an air side economizer control scheme (ambient enthalpy driven).

The system will be designed for energy conservation/pressurization adjustment. The potential to reduce ACHs, go to an unoccupied setback in a particular room (or rooms), or change pressurization shall be accommodated. ACH reduction, unoccupied setback, or pressurization change shall be controlled by the BAS based on a time-clock adjustment and overridden by an air quality monitoring system.

An energy recovery system will be provided between the lab and general exhaust streams and the laboratory ventilation air handlers, using a piped run-around loop extending between the exhaust air stream and the incoming outside air stream. Energy recovery/reheat section will be provided with an upstream filter and by-pass damper to minimize fan static pressure when not in use during shoulder seasons/economizer mode operation.

The supply distribution system will consist of medium-pressure laboratory supply air distribution risers located in shafts on either end of the central laboratory bay and interconnected across this bay at each floor to provide redundancy of supply and minimize horizontal duct sizing. Terminal boxes and reheat coil valves shall be located within the laboratory space. Terminal devices shall be pressure-independent venturi-actuated supply air valves, with reheat coils, feeding low-pressure externally insulated ductwork downstream. Sound attenuators at the air terminal devices will be provided based on determination of sound levels. All terminal units will be positioned for easy access with a minimum of 36 in. of service space on the panel/actuator side. All terminal reheat control valves serving the laboratory spaces shall fail closed.

Controls to maintain pressure gradients shall be accomplished by an active volumetric offset (tracking) control concept, with supply air valves interconnected with exhaust air valves for tracking.

Spaces within the shop and support areas that are using hazardous materials will be fed by the laboratory air supply systems and exhausted.

Office/Support Area Central Air Handling System

The office and some portions of the shop support areas of the building will be served by a single VAV AHU. Air delivered to these areas will be recirculated to the unit, with a minimum of 15% outside air provided during occupied mode. The AHU will be designed as heating-cooling, single-duct, reheat type to provide from minimum outside air to 100% outside air economizer on a VAV basis. The unit will operate only during occupied periods of the day, or cycle on as required to maintain night setback temperature settings. Supply fans will be configured in a multi-fan array, plenum fan design. VFDs will provide supply fan volume control in response to a signal from a duct-mounted static pressure sensor. VFDs will provide return fan volume control in response to a signal from air flow measuring stations used to establish volumetric offset between the return air and the supply air quantities. AHU supply fan speed will be modulated as required by building load.

The supply distribution system will consist of medium-pressure supply air distribution risers located in shafts on the north end of the central laboratory bay and a medium-pressure loop in the main circulation corridor at each floor. Terminal boxes and reheat coil valves shall be located within the spaces they serve or immediately adjacent. Terminal devices shall be pressure-independent electrically actuated supply VAV boxes with reheat coils, feeding low-pressure externally insulated ductwork downstream. Sound attenuators at the air terminal devices will not be provided. Instead, sound-attenuating flexible ductwork with woven nylon fabric type lining will be provided at the supply diffusers to control noise. The use of sound-attenuating flexible duct at diffusers and grilles will be limited to 6 ft in total length.

All terminal units will be positioned for easy access with a minimum of 36 in. of service space on the panel/actuator side.

The control system for this AHU will include local thermostats for all VAV boxes and CO_2 sensors located in high-occupancy spaces, such as conference or meeting rooms, to achieve demand-based ventilation control.

Spaces within the shop and support areas that are not using hazardous materials will be served from this fan system.

Return from each floor shall be through and above a ceiling return air plenum routed to a return air inlet at the duct shaft. The return air duct riser will connect at a penthouse return/relief fan. VFDs will provide return fan volume control in response to a signal from duct-mounted static pressure sensors. The return air system will have the capability to either return the air from the spaces for recirculation or relieve the air from the building to allow for ventilation or as part of the air side economizer operation.

Exhaust

Laboratory and Shop Area Central Exhaust System

The wet laboratory and areas containing hazardous material in the shop spaces will be served by one combined central exhaust system serving fume hood exhaust, snorkel exhaust, and general exhaust requirements. Combined fume and general exhaust duct risers from each floor will connect at a penthouse level to a roof-mounted common plenum exhausted by three vertical radial dilution fans. The general exhaust and fume hood/snorkel exhaust terminals served by the central exhaust system will be variable-volume devices; therefore, the central exhaust system will operate at variable-volume. To achieve operational flexibility, the system shall incorporate both VFD and outside air bypass control technologies. Under outside air bypass operation, the system shall have the ability to maintain a stack discharge velocity of approximately 3500 ft/min (fpm). Under favorable wind conditions the system will have the capability to close the outside air bypass damper and operate the fans under VFD fan speed control, allowing the stack discharge velocity to drop. Minimum stack velocity will need to be confirmed by the wind tunnel test. A static pressure sensor in the exhaust ductwork will provide a control signal to adjust the speed of the exhaust fans, or to control an outside air bypass damper that allows makeup air into the fume exhaust plenum. The control system will interface with a building wind sensing (direction and speed) system to produce higher stack discharge velocities during times of unfavorable wind speed or wind direction.

Three fans will be provided to serve the common exhaust plenum, each sized at 50% of the load. If one of the fans fails, the remaining fans will be able to provide 100% of the common exhaust system’s design capacity. All of the three fans in the common exhaust plenum should be on emergency power to ensure continuous hazardous material containment, but they would be controlled to run at a reduced speed during a power outage to limit the negative pressure impact to the building. Fans will be located exterior to the mechanical penthouse in a screened area on the roof. The fume exhaust fan stacks for the combined fume and general exhaust fans will discharge at a minimum of 10 ft above the roof or as determined by wind tunnel testing. The exhaust system will operate 24 h/day, 365 days/year.

Pressure-independent venturi exhaust air valves will be provided to serve general exhaust grilles, each fume hood, and all snorkels with a single lab space. Low-pressure/low-velocity exhaust ductwork will be used between the exhaust air terminal devices and the laboratory exhaust risers located in shafts on either end of the central laboratory bay, interconnecting across this bay at each floor to provide redundancy of exhaust and minimize horizontal duct sizing. Exhaust systems will not be provided with smoke/fire dampers but will use a sub-duct concept for protection at the fire-rated shaft penetrations. Terminal boxes and reheat coil valves shall be located within the laboratory space. Exhaust fan duct construction shall be 304 stainless steel with fully welded seams and joints. Sound attenuators at the air terminals may be provided, pending acoustical review.

Biosafety Cabinet Exhaust System

A system of independent exhaust risers and fans will be provided to serve the biological safety cabinet lab loads. The design for this system shall be similar to that described for the lab general exhaust but will incorporate two 100% capacity exhaust fans in lieu of three 50% capacity fans, and fans will be equipped with HEPA filtration. Fans will be located exterior to the mechanical penthouse in a screened area on the roof. Ductwork associated with this system shall be all welded 304 stainless steel construction.

Exhaust risers for the biological safety cabinet exhaust will be provided adjacent to the lab general exhaust risers at either and of the lab bays, and at four intermediate points adjacent to columns within the lab bays.

General Exhaust System

General exhaust fans will be provided to exhaust toilet rooms, janitor closets, and other rooms requiring ventilation at a minimum rate according to their code requirements.

Atrium Smoke Exhaust System

The central atrium, extending between the first and third floors, will be served by a mechanical smoke exhaust system. The smoke exhaust system will be designed to remove smoke from the atrium and the associated floor levels in the event of a fire to maintain a safe means of egress for the building occupants. The design for this system will consist of two 50% capacity exhaust fans that will be located exterior to the mechanical penthouse.

Exhaust risers for the smoke exhaust will be located around the perimeter of the atrium with combination fire/smoke dampers. Ductwork associated with this system will be galvanized steel construction designed to withstand the increased air temperatures.

This exhaust system will be activated by the fire alarm control panel and will be interlocked with the building air handling systems to maintain a negative pressurization.

Space Conditioning

Telecommunications Room and Electrical Equipment Room

All telecommunications rooms and electrical equipment rooms will be served by CHW-cooled, fan-coil units located within the spaces. Units shall normally operate 24 h/day, 365 days/year. Local humidifiers shall be provided. Provisions will be made to provide some conditioned air from one of the constantly running AHUs as backup to the space should a fan-coil unit fail.

Data Center Equipment Room

The data center equipment room will be served by CHW, computer room AHUs (CRAH) located on the floor within the space. The space will be served by two units each designed to meet 70% of the full load. Units shall operate 24 h/day, 365 days/year and shall be supplied with emergency power. Airflow will be designed for under-floor distribution. Humidifiers will be provided with each CRAH.

Chilled Water

The CHW system for the building will be supplied from the existing CUB. Based on an estimated flow of 875 gpm to this building, the CHW branch line size to this building is expected to be in the range of 8 in. CHW will be distributed to the CLO Building from the CUB from the underground CHW loop. CHW supply and return will enter the building at the lower level.

Within the building, CHW will be routed to cooling coils in all AHUs, to the data center CRAHs and telecommunications room fan coils, and to the HX of the process CHW system. As a means of addressing high heat rejection potential from laboratory equipment power usage beyond the capacity provided by the AHUs, CHW lines risers with connections at each laboratory floor will be provided for extension to fan coil units that would be installed in the future to provide additional in-room cooling if required.

Technical Cooling Water

Process Cooling Water System

A process cooling water system will be provided to support any equipment that might be water cooled included in the CLO II building. A piped process cooling water system will be extended throughout the laboratory floors, with risers located along columns at four points within the lab bays. Equipment to be cooled will include such items as process and instrumentation equipment. The process cooling water system will consist of an independent pumped loop that rejects heat to the building CHW through a plate-and-frame HX. The system will be designed to operate at a supply temperature of 55–60°F to reduce the potential for condensation (temperature to be coordinated with any night setback supply air temperature reset). The tank, pumps, HX, filters, and chemical treatment components will be located in the lower-level mechanical area.

Three variable-speed process cooling water pumps will be sized at 50% of the design flow rate each. If one of the booster pumps were to fail, the other remaining pumps would provide 100% redundancy. If determined to be necessary for minimizing backpressure at the equipment, the system will be designed to incorporate an atmospheric tank and low-pressure loss return pipe system. The process cooling water pumping system will be on emergency power, since it must provide continuous service to critical laboratory equipment.

Heating Water

The heating water system for the building will be supplied from three condensing boilers located at the lower-level mechanical room. Boilers will be designed to be 100% redundant, with any single boiler capable of handling 50% of the entire load. Hot water supply and return will distribute from the lower level through redundant hot water pumps, up through risers to the penthouse. The hot water distribution system will serve heating and preheat coils at the air handlers and reheat heating water coils at the terminal units. A variable primary heating water pumping scheme will be used, incorporating three hot water distribution pumps each sized to handle 50% of the design load.

Natural Gas

Natural gas piping will be routed to the CLO II from the existing site gas service. Medium-pressure gas will enter the building at the lower level and will be distributed to the water heaters and boilers located at the lower level. Separate pressure regulators will be provided for the water heaters and boilers.

Controls

The mechanical and process support systems in the CLO will be controlled and monitored through a DDC-based BAS with distributed processing at the local level. The DDC system will be designed around an open protocol BACnet communication network. The basis of design is expected to a JCI Metasys system.

Electric actuation will be used for all control valves and dampers on both systems so that instrument air is generally not required. Pneumatic actuation will be provided for the largest valves only. All control systems will be on UPS and emergency power. System software and firmware will provide the following functions:

- Control sequences shall be developed to support the operations of the technical equipment.
- PID control to allow faster and closer control to system set points.
- Adaptive tuning to adjust PID loop constants to ensure that control system response remains accurate and reliable over a wide range of dynamic operating conditions.
- Monitoring to read the value of measured variables, to read control loop set points, to monitor control signals to actuators, and to indicate status of equipment, alarms and overrides.
- Energy management, including optimum start/stop, variable ACH rates in laboratories, duty cycling, supply air temperature reset, supply air static pressure reset, demand limiting, time totalization, and so on.
- Data management, including continuous database updating, alarm reporting, trend logging, and report generation.
- System programming to add, delete, or change points, set points, schedules, control algorithms, report formats, and so on.
- System software will allow building operators to graphically monitor and control building operations and provide the functions listed. Graphics will include site plans, overall building plans, floor plans and individual system graphics.

Laboratory Fume Hood Airflow Control Systems

Fume hood type: variable-volume types with horizontal sash. Each fume hood shall be provided with a low-airflow alarm (audible and visual) by the fume hood manufacturer. Each fume hood shall be provided with a variable-volume exhaust air valve and face velocity control system to achieve constant face velocity into the hoods. Fume hood controls will be monitored by the BAS and will interface with the supply and exhaust air terminals for the lab where they are located.

Equipment

Table 8.32 provides a listing of mechanical equipment servicing the CLO II.

Table 8.32. CLO II mechanical equipment.

Use	Equipment	Size	Qty	Em pwr	Redund	Location	Remarks
Wet lab and shop areas	100% outside air VAV AHU	20,000 cfm	3	N	N+1	Penthouse	
Office and admin areas	VAV AHU	45,000 cfm	1	N	-	Penthouse	
Wet lab and shop areas	Lab exhaust fan	17,000 cfm	3	Y	N+1	Penthouse	

Table 8.32. CLO II mechanical equipment (continued).

Use	Equipment	Size	Qty	Em pwr	Redund	Location	Remarks
Wet lab biological safety cabinets	Lab exhaust fan	4,000 cfm	2	Y	N+1	Penthouse	HEPA filtered
Toilet/jan closet exhaust	General exhaust fan	3,500 cfm	1	N	–	Penthouse	
Atrium smoke exhaust	Utility set exhaust fan	50,000 cfm	2	Y	–	Penthouse	
Instrument sensible chilled water	Sensible chilled water pumps	30 gpm @ 100 ft	3	N	N+1	Mech room	
Sensible chilled water storage	Storage tank	500 gal	1	N	–	Mech room	
CHW to process CHW	Plate-frame HX w/ filtration skid	60 gpm	1	N	–	Mech room	
Elec/telecom cooling	Fan coil units	2-3 tons	8	N	–	Varies	
CLO II data center cooling	CRAH units	5 tons	2	Y	70%	IT rooms	
CLO II heating water	Gas-fired condensing boilers	1.5 MMBH	3	N	N+1	Boiler room	STS heating hot water (LWT = 140–18°F; Δ = 40°F)
CLO II heating water	Primary heating pumps	75 gpm @ 60 ft	3	N	N+1	Boiler room	Vari-prime system
CLO II heating	Electric unit heaters	Varies	8	N	–	Mech room	

Air Handlers

General

- All AHUs will be semi-custom, factory-fabricated and constructed with 2-in.-thick double walls, constructed of galvanized steel.

- Maximum allowable nominal face velocities:
  - Air intake louvers (through free area): 350 fpm
  - Heating water coils: 500 fpm
  - Cooling coils: 400 fpm
  - Filters: 400 fpm

- AHU (mixed-use spaces where recirculation is allowed): modular, semi-custom, 2-in. double-wall construction configured as follows:
  - Mixed air plenum
  - Intake isolation damper
  - Return/exhaust damper
  - Supply fans (4 to 6 fan array)
  - Relief fans (4 to 6 fan array)

- VFDs
- Economizer section
- MERV 8 (30%) prefilter section
- Hot water preheat coil
- CHW coil
- Hot water reheat coil
- Supply fans (4 to 6 fan array)
- VFDs
- MERV 14 (95%) final filter section
- Supply plenum
- Isolation/smoke damper
- Access sections
- Doors: safety glass windows and quarter turn handles.
- Marine light in each access section.
- Vibration isolation in accordance with ASHRAE HVAC Applications—Noise and Vibration Control

- AHU (laboratory spaces—100% outside air): modular, semi-custom, 2-in. double-wall construction configured as follows:
  - 100% outside air
  - Intake isolation damper
  - Outside air plenum
  - MERV 8 (30%) prefilter section
  - Energy recovery/pre-heat coil section
  - CHW coil
  - Hot water reheat coil
  - Supply fans (4 to 6 fan array)
  - VFDs
  - MERV 14 (95%) final filter section
  - Supply plenum
  - Humidifier section
  - Isolation/smoke damper
  - Access sections
  - Doors: safety glass windows and quarter turn handles.
  - Marine light in each access section.
  - Vibration isolation in accordance with ASHRAE HVAC Applications—Noise and Vibration Control

Energy Recovery Systems Description:

- A glycol/water energy recovery loop will be provided to transfer sensible heat between the major laboratory supply and exhaust systems.

- The energy recovery loop will include two pumps (one active, one standby) operating at constant volume, and an exhaust coil frost prevention bypass valve.

- Supplemental heat will be added to the heat recovery loop as necessary to meet the preheat requirements of the supply AHUs (combined energy recovery/preheat system). The supplemental preheat system will consist of three HXs, each sized for 50% of the anticipated peak load (assuming no heat recovery).

- Energy recovery system sizing criteria:
  - Energy recovery system temperatures and flow rates will be sized to optimize sensible heat transfer between laboratory/vivarium supply and exhaust air flows.
  - Energy recovery system will be 40% propylene glycol/water solution by weight.
  - Energy recovery coils will be sized for maximum face velocity of 600 fpm and maximum 6 rows and 10 fins/in.

Exhaust Fans

General/Lab Exhaust Fans

The fans will be vertical, radial dilution exhaust fans with spark-proof construction with bearings and motors out of the airstream. Fans will have a baked epoxy airside chemical-resistant coating. The common plenum and outside air intake dampers will be of galvanized steel construction with a chemical-resistant coating. The system will consist of the following components:

- Common exhaust plenum
- Isolation damper at each fan inlet
- Vertical exhaust fans
- HEPA filters (where indicated)
- Exhaust stacks
- Bypass air inlet and bypass damper
- VFDs

Utility Exhaust Fans

Exhaust fans will be backward-inclined, belt-driven centrifugal fans with spark-proof construction and bearings and motors out of the airstream. Fans will be single width, single inlet with a galvanized steel housing and wheel construction. The fan motor will be totally enclosed and fan cooled. The system will consist of the following components:

- Steel mounting rails with vibration isolators
- Isolation damper at the fan inlet
- Discharge ductwork with bird screen
- Weather cover
- VFDs

Water-Based Systems

Process Cooling Water Systems

Process CHW cooling systems will consist of an independent pumped loop that rejects heat to the building CHW through a plate-and-frame HX. The tank, pumps, HX, filters, and chemical treatment components will be located in the ground floor level mechanical area. The system will include the following equipment:

- Base-mounted, end-suction, centrifugal pumps
- Pump VFDs
- CHW plate-and-frame HX
- Water filtration

- Automated chemical treatment system
- Makeup water assembly
- Appropriate valving and piping specialties
- CHW supply to HX

Boilers

Packaged gas-fired, condensing boilers will be provided for generating the campus hot water. The boilers will be factory-fabricated with Type 316L stainless steel HX, flue gas vent, combustion air intake, water pipe connections, and controls. The system will include the following equipment:

- Stand-alone, microprocessor-based control panel
- Condensate neutralizer
- Centrifugal blower
- Intake and exhaust mufflers

Pumps

Pumps will be separately coupled, base-mounted, end-suction centrifugal pumps. The system will include the following equipment:

- VSD and motor
- Rated for 175 psig (1204 kPa) minimum working pressure and a continuous water temperature of 225°F (107°C)
- Horizontally split, cast iron casing
- stainless steel shaft
- Mechanical seal

Motors

- All motors shall be premium efficiency type and built to NEMA standards.
- Variable-speed motors shall be rated as inverter duty motors. All motors operating with VFDs shall be equipped with shaft grounding rings or insulated bearings to prevent the accumulation of PWM frequencies in the shaft, which could arc across the bearing, causing pitting and premature bearing and motor failure.
- All VFDs shall be provided with power quality filters to improve the building power quality from the occurrence of multiple VFD installations.

General

System Design Criteria

Outside Design Temperatures

- Summer: 92.8°F DB, 73.8°F MCWB (0.4% ASHRAE)

- Winter: 17.1°F (99.6% ASHRAE)

Interior Design Conditions: Preliminary Load and Ventilation Assumptions

Table 8.33 provides a listing of the preliminary load and ventilation assumptions for the CLO II Building.

Table 8.33. CLO II Building preliminary load and ventilation assumptions.

Space	Design set points	Cooling: BTU/sf	Heating: BTU/sf	Airflow: cfm/sf or ACH	Ventilation
Mechanical/electrical	60–85°F	80	40	2	Code required
Office/office support	72–76°F, 60% >Rh	40	40	1.25	Code required
Laboratory	72–76°F, 30–60% RH	80	60	8 ACH	100% OA
Loading	60–85°F	–	40	2	Code required

Notes:

Cfm/sf and values are schematic design-level assumptions. The final values of the project will be calculated based on code requirements or heating and cooling demand, whichever is greater.

Supply air rate in all laboratories will be a minimum of 6–8 ACH or as required for makeup of fume hood exhaust air. Additional cooling shall be provided by fan coil units if required to meet heat loads generated in the laboratories. HEPA filtration will be provided as necessary for laboratory supply and exhaust systems to support individual space use.

Active humidity control will not be provided for any building. Therefore, HVAC units will not have a humidification capability. The maximum relative humidity should not exceed 60% due to moisture removal at the cooling coils.

Noise Criteria

The design will target the following average noise levels. Actual noise levels may exceed the design noise levels because of the actual type of equipment purchased, installation compromises, workmanship, and so on.

- Laboratory areas with fume hoods: NC = 50–55
- Laboratory areas without fume hoods: NC = 45–50
- Laboratory support areas: NC = 50–55
- Open offices: NC = 40–45
- Private offices: NC = 30–35
- Conference rooms: NC = 30 – 35
- Circulation space, lobby: NC = 40

Water Systems

Chilled Water

- Supply 42°F (to buildings), 44°F (to AHUs)
- Return 56–58°F

Process Cooling Water (Chilled)

- Supply 55–60°F

- Return 5°F above supply

Hot Water

- Supply 180°F
- Return 100°F

Materials

Duct Distribution Systems

Ductwork Materials and Construction

- Supply ductwork construction will be based on SMACNA 4-in. pressure class and 2-in. pressure class. Four-in. pressure duct construction will be used upstream of VAV boxes on variable-volume units; 2-in. pressure class duct construction will be used downstream of VAV boxes on variable-volume units and for all ductwork on constant-volume units. All ductwork seams and joints shall be sealed, regardless of pressure rating. Maximum permissible leakage = 2%.

- All supply ductwork routed through unconditioned spaces shall be insulated with 2-in. foil-faced batts or foil-faced duct board with similar R-value.

- Return and general exhaust ductwork construction shall be based on SMACNA 2-in. pressure class.

- General laboratory exhaust ductwork shall be constructed to a 6-in. SMACNA pressure class.

- HEPA filtered laboratory exhaust ductwork shall be constructed to a 10-in. SMACNA pressure class.

- Return air duct shall be insulated with 1½-in. foil-faced batts or duct board. Laboratory exhaust ducts shall not have fire dampers.

- General air distribution ductwork will be G90 galvanized sheet metal.

- Wet laboratory and chemical storage exhaust will be welded 316L stainless steel.

- Exterior supply or return ductwork shall be solid double wall ductwork with a minimum 2-in.-thick insulation or single-wall duct with 2-in. duct board, vapor barrier, and aluminum jacket.

- Rectangular and round ductwork shall be fabricated in accordance with SMACNA standards. Spiral-wound ductwork shall be a prefabricated system with factory certifications. Spiral-wound ductwork shall not be used for laboratory exhaust systems or other systems that may be exposed to water intrusion.

- Provide sound attenuation to meet the project requirements or in accordance with the direction of the project acoustician. Sound attenuation shall be by appropriate application of attenuators or duct design.

- Lined ductwork shall not be used, except for plenum return air-transfer boots for noise control. VAV air terminals shall be double-wall or have foil-faced inner surface.

- Flexible ductwork is limited to 5 ft and shall be used only downstream of VAV terminals. Flexible ductwork shall be limited to supply air systems only.
- Plenum return may be used for return air in all non-laboratory portions of buildings.
- Ductwork shall be sized as shown in Table 8.34.
- Laboratory supply and exhaust control air devices shall be with laboratory-style, high-speed actuation, constant-volume supply valves with downstream sound attenuators and hot water reheat coils.
- Non-laboratory spaces on VAV systems shall have conventional supply terminal boxes with hot water reheat coils and integral sound-attenuating characteristics.
- Smoke detection will be provided in accordance with NFPA 90A and IMC requirements.

Table 8.34. CLO II Building ductwork sizing.

	Risers	Submains	Branches	Air distribution device neck velocity (fpm)
Max P.D.	0.1 in./100 ft	0.08 in./100 ft	0.08 in./100 ft	450 fpm

Piping

Tower Water/ Chilled Water/ Process Chilled Water

- Interior piping sizes 2 in. and smaller, Type L copper with brazed fittings.
- Interior piping 2.5 in. and larger shall be either Type L copper with brazed fittings or Sch 40 steel pipe with either welded and flanged joints or mechanical grooved fittings.
- Underground CHW piping serving the building will be distributed in a pre-insulated, factory-fabricated coated steel piping system or HDPE.
- Underground tower water piping serving the building will be distributed in a factory-fabricated coated steel piping system or HDPE.
- All piping will be tested at 1.5 times the design system pressure.
- All interior CHW piping shall be insulated with closed-cell elastomeric insulation. Properties shall meet or exceed the minimum energy code requirements.
- All piping in mechanical rooms and piping exposed below 8 ft AFF shall have a PVC jacketing.
- All piping exposed to the exterior shall have an aluminum jacket.
- CHW will be provided with a BTU meter at the service entry.

Heating Water

- Interior piping 2 in. and smaller shall be Type L copper with brazed fittings.

- Interior piping 2.5 in. and larger shall be either Type L copper with brazed fittings or Sch 40 steel pipe with welded and flanged joints.

- Underground hot water piping serving the building will be distributed in a pre-insulated, factory-fabricated coated steel piping system.

- Interior heating water piping shall be insulated with rigid glass fiber insulation.

- Piping exposed to the interior shall have a PVC or aluminum jacket. Piping exposed to the exterior shall have an aluminum jacket.

- Heating water will be provided with a BTU meter at the service entry.

Natural Gas

- Interior Sch 40 steel pipe with welded and flanged joints.
- Underground piping HDPE with heat fused joints.
- Meter will be provided on the natural gas at the incoming service.

Seismic Criteria

Referenced Standards and Design Criteria:

- Seismic bracing shall be in compliance with ASCE 7-10.

- Equipment mounted on isolators will be seismically braced using loose cables, telescoping pipes, or box sections, angles or flat plates used as limit stops or snubbers, either integral to or separate from the isolators.

- Nonrotating, fixed equipment will be bolted directly to the floor or structure.

Mechanical Calculations

Mechanical calculations are provided in Appendix C for both air side and cooling water side.

Sustainable Design Strategies

The following energy conservation measures will be incorporated into the HVAC design:

- DDC BAS for optimization of major HVAC equipment operation.

- Variable-volume supply and exhaust system in combination with stand-alone controllers to provide maximum flexibility in occupied/unoccupied space control scheduling, thus minimizing supply and exhaust air volumes.

- Supply air temperature is to reset to minimize air conditioning of outside air and subsequent reheating of conditioned air.

- VAV fume hood controls, where applicable, will be applied to reduce exhaust flow to fume hoods when not required.

- Supply air volume from AHUs will be reduced to minimum levels without compromising safety. During occupied hours, room supply air volume will be set at the maximum air flow required to provide fume hood makeup air, minimum required ventilation, or space cooling. This will be accomplished using the VAV air systems and DDC volumetric off-set controls.

- Glycol run-around energy recovery loops for the laboratory systems will be installed. Heating and cooling energy expended to condition supply air will be recovered from the building exhaust air.
  - An added benefit of energy recovery is the reduction of peak heating and cooling design requirements for the HVAC system. This allows major HVAC equipment to be downsized.

- VSDs will be installed on all VAV AHU supply and return fans to reduce fan horsepower requirements of non-peak conditions.

- VSDs will be installed on all pumps to reduce pump horsepower requirements at non-peak conditions.

- Full economizer control will be used on all mixed AHUs to reduce consumption while maintaining appropriate indoor humidity levels.

8.5.1.10 Electrical

Site Power Distribution

The CLO II Building will be provided with 480 Y/277 V secondary service from two 4000 A feeder duct banks, each from 2000/2500 KNAN/KNAF kVA outdoor substations CL2-SS1 AND CL2-SS2 to the Electrical Service Room.

The medium-voltage transformers will have integral fans providing 33.3% spare capacity to handle the entire building load should there be an outage or should one need to be taken down for maintenance.

Building Power Distribution

Two 4000 A, 480 Y/277 V low-voltage switchgears in the CLO II Building Electrical Service Room will distribute power to CF loads and instrument loads. The switchgears will have a main tie–main breaker arrangement with key interlock so only two may be closed at the same time. 1200 A, 480 Y/277 V distribution panels at the bases of vertical north and south electrical rooms will service lighting panelboards and 208 Y/120 V transformers and panelboards located on each floor.

Separate transformers will be provided where possible to service instrument loads.

Secondary Distribution

- Building secondary distribution will generally be 480 V, 3-phase, 4-wire, plus ground. This will provide service to CF lighting, receptacles, and HVAC loads as well as building instrumentation loads. Further transformation down to 208 Y/120 V, 3-phase, 4-wire, plus ground will be provided for general use receptacles and other low-voltage equipment as necessary.

- All conventional building use dry-type transformers will be DOE 2016 rated for efficiency, 115°C rise, 220°C insulation class with six 2.5%t taps. Consideration will be given for harmonic or K-rated transformers and oversized neutrals to handle the heating effects of the harmonic loading.

- Circuit protection will be
  - Where 480-V distribution is provided, the exterior unit substation secondary will be of low-voltage switchgear UL 1558 construction with electrically operated drawout power circuit breakers with solid state adjustable trips.
  - Generally molded case circuit breakers. Solid state adjustable trip units will be provided above 250 A.
  - Bolt-in type molded case circuit breakers for branch circuit panelboards.
  - 100% rated for service entrance main circuit breakers, 80% rated otherwise.

- Devices will be fully rated. Series ratings of protective devices will not be acceptable.
- Two levels of ground fault protective devices will be provided at the main and feeder breakers at service switchgear assemblies.

- A contactor arrangement will be provided in main elevator feeders to comply with elevator shaft sprinkler code requirements.

- A 208 Y/120-V panelboard will be dedicated to each laboratory.

Emergency Power Supply System

EPSS Power Generation Plant

The CLO II Building will be provided with building and instrument standby power from an exterior 800 kW/1000 kVA, 480 Y/277 V diesel engine-generator CL2-EG1. It will provide emergency power for life safety systems, including egress lighting, and critical instrumentation and HVAC systems loads.

The exterior diesel standby engine-generator will be provided in an exterior, weatherproof, sound-attenuated, reach-in enclosure with 24-h sub-base fuel tanks. The generator will be provided with a quick-connect feature to be used for load bank testing or portable generator backup if the primary unit is down for maintenance.

EPSS Power Distribution

The EPSS secondary distribution system will be separated into the following branches as required by code:

- Generator: This branch provides alternate source power from the generator set main circuits breaker(s) and associated distribution to the line side of each ATS.

- Emergency (NEC Article 700): This branch provides continuous (normal or generator) source power for the following equipment essential for safety to human life:
  - Interior building means of egress lighting and illuminated exit signs
  - Exterior building means of egress immediately adjacent to exit discharge doorways
  - Fire detection and alarm systems
  - Public address communication systems (when used for issuing emergency instructions)
  - Elevator machine room lighting and receptacles; elevator cab lighting, control, signal, and communication systems

- Generator set location, task illumination, battery charger, emergency battery-powered lighting unit(s), and selected receptacles
- Fire protection systems
- Experimental processes where interruption would produce serious life safety health hazards, and similar functions

- Combined legally required and optional standby branch, designate as “optional branch” (NEC Article 701 and 702): This branch provides continuous (normal or generator) source power for the following equipment that, when stopped during any interruption of the normal electrical supply, could cause hazards or hamper rescue or firefighting operations; or (optional branch) to protect facilities or property where life safety is not dependent on system performance:
  - Control and alarm systems of major apparatus
  - Experimental processes where any power outage could cause serious interruption of the processor damage to the equipment
  - Ventilation and smoke removal systems
  - Access control systems
  - Telecommunication room lighting, equipment, and data processing systems
  - Elevators (one at a time in each bank)
  - Electric and mechanical room lighting and selected receptacles
  - Mechanical equipment, including data center cooling, boilers; condensate return pumps; hot water heating and glycol circulating pumps
  - Plumbing equipment including sewage ejectors and pumps

Generator distribution feeders will extend from the EPSS power generation plant to 480 Y/277 V, 4-pole isolation-bypass transfer ATSs with associated distribution panelboards located in the CLO II Building Electrical Service Room. The following transfer switches are anticipated:

- 260 A: Life safety branch (sized large to meet required withstand rating)
- 600 A: Optional branch 1
- 600 A: Optional branch 2

Power Quality Systems

Uninterruptible Power Supply Systems

- A 75 kVA UPS systems will be provided for the building IT distribution.

- A 100 kVA UPS system will be provided for the data center loads.

- The UPS systems will both be static (battery) type with maintenance bypass and 15-minute ride through capacity.

Surge Protection Devices

Surge arrestors labeled for use with NFPA 780 lightning protection systems will be provided at all unit substation transformer primaries.

Transients (surges, lightning, switching events) can introduce harmful voltage or current spikes to electronic equipment.

SPD filtering devices will be installed on main low-voltage switchgear, distribution panelboards, and branch panelboards serving major electronic equipment and all emergency branch panelboards in compliance with current code requirements. Sensitive equipment may require multiple levels of protection to protect items of equipment not only from utility disturbances, but also from one another.

Electric Metering Systems

Electrical metering systems, according to ORNL standards, will be used to monitor and alarm

- Electrical loading, harmonic loading, and protective device positions. Rail-mounted power quality PM 8214 DIN meters will be required at the unit substation building main service breakers.
- Service low-voltage switchgear mains and feeders.
- Medium-voltage interrupter switches, positions, and transformer status.
- Distribution panelboards on the load side of ATSs.
- Standby engine generator plant and associated distribution equipment.
- ATS positions.

The system will be networked to the ORNL Power Operations SCADA “SNO” network.

Grounding Systems

Ground Grid

All building grounding systems must be bonded to a common earth ground in compliance with the NEC. Each building will be provided with a #4/0 direct buried copper ring encircling the perimeter of the building, which will provide a convenient means of connecting all metallic systems and equipment into a single equipotential grid that has a low resistance to ground.

Building Grounding

Building steel, foundation rebars (Ufer ground), and metallic water supply piping will be bonded to the ground grid.

Building Lightning Protection

An NFPA 780 Faraday cage type lightning protection system will be provided, to protect the building/structure and its occupants and contents from the electrical effects of a lightning strike to ground. The system will include independent down conductors in PVC from the rooftop to the ground grid.

Electrical Power System Grounding

Separate green grounding conductors will be provided with all feeders and branch circuits to provide an intended grounding of the neutrals of the electrical power systems. Each will be bonded to the ground grid with grounding electrode conductors from the distribution system neutral source.

Interconnected bus bars in electrical rooms will collect electrical and electrical equipment grounding conductors to tie the ground ring at the electrical service entrance room.

Electrical Equipment Grounding

All non–current carrying metal parts of electrical equipment enclosures, raceways, boxes, cabinets, housings, frames of motors, luminaires, and so on will be bonded and connected to electrical room ground buses where the associated system neutral is grounded. This allows for a safe ground path in an electrical fault condition.

Laboratory Equipment Reference Grounding

A ground bus will be provided in electronics laboratories as an equipment and cable pathway common ground point.

Telecommunications Signal Reference Grounding

Interconnected bus bars in telecommunication rooms will collect STS IT equipment and pathway grounding conductors and bond to the electrical service entrance room ground bus in compliance with EIA/TIA and NEC requirements.

Lighting Systems

Exterior Lighting

Pole-mounted LED light standards with concrete bases will be provided along roadways and within parking lots.

Building-mounted perimeter LED luminaires will be provided at building exits, walkways, and vehicular circulation areas.

Interior Lighting

LED interior lighting will be provided in compliance with IESNA lighting standards and ASHRAE 90.1 energy budgets.

Energy-efficient, heavy-duty, specification-grade, high bay and industrial LED luminaires are generally anticipated in STS instrumentation areas.

Lighting Controls

Exterior lighting will be provided with photocell and time clock controls.

Interior spaces will be provided with automatic addressable lighting controls in compliance with ASHRAE 90.1 energy budgets. Wireless type room sensors and controls with a wired backbone will be used. The system will be an extension to the CLO N-Light system.

Facilities & Operations Building Systems

The building electrical metering system and BAS to monitor electrical and HVAC building systems will be site interconnected to SNS campus systems as described in Site Utilities, Section 8.1.2.1 of this report, and will also include the following systems.

Fire Alarm System

The fire alarm system will be a microprocessor-based detection and notification control system installed and acceptance tested in compliance with NFPA 72, *National Fire Alarm Code*. The building system will include multiplex wiring techniques, a central processing unit (FACU), annunciator units, and peripheral detection and alarm devices.

The system will

- Include campus backbone communications link to the adjacent CLO fire alarm system.
- Include smoke, heat, and beam detection devices to suit environmental conditions.
  - High ceiling areas will be provided with beam detection.
- Include audible horns and visual strobe notification devices.
- Monitor building fire suppression systems and override HVAC functions in an alarm condition for fire and smoke containment.
- Override elevator functions in an alarm condition to ensure safe passenger egress.
- Report fire, supervisory, and trouble alarms to the ORNL Fire Department and LSS office in Building 4512 over a fiber optic network.

Wiring will be supervised Class B installed in conduit. Multimode fiber optic cabling will be extended in conduit between the fire alarm control unit and the telecommunication room in each building.

The system will be Edwards/EST Fireworks manufacturer/series according to ORNL requirements to match the existing campus systems.

Public Address System

A public address system will be provided with building amplification as an extension to the campus-wide Valcom mass notification system.

Wiring will be installed in conduit.

Access Control System

The building will be provided with an access control system with central equipment located in the main telecommunications room.

Alarm and supervisory conditions will be reported to the ORNL campus security monitoring location over a fiber optic network.

Components will match existing ORNL equipment for system compatibility.

Telecommunication Systems

The building will be provided with a separate telecommunications service from the existing site telecommunications distribution system at CLO to a building main distribution room. Design for the incoming POTS and/or VoIP telephone service, LAN, and wireless networking shall be coordinated with DOE's prime subcontractor, Black Box. The STS project will provide the interconnecting fiber optic cabling. Refer to the site utilities telecommunication distribution paragraphs, which outline telecommunications service to the STS buildings.

Building IT systems for systems networking hardware, including switches, routers, patch panels, DAS, and WLAN components, will be provided.

Building IT horizontal Category 6A cabling will be provided from telecommunications rooms located on each floor, stacked where possible. Building IT systems will be installed in compliance with EIA/TIA standards.

Audio Visual Systems

The building will be provided with audio/visual (AV) systems consisting of conference room presentation systems for control and distribution of several forms of sources and media. These systems will be tied to central source CLO AV systems with rooms consisting of projection, whiteboards, and LCD or LED displays; audio amplifiers, touch screen controllers, source equipment with DVD player, camera inputs, inputs from equipment such as laptops, and interconnecting cables.

ORNL F&O Building Systems Distribution

The following building systems/system owners will be interconnected with cables and raceways by SNS CF. The system owners will perform final tie-ins.

- Public address/F&O instrumentation and controls
- Fire alarm (FIREWORKS Network)/F&O Laboratory Protection
- Access control/F&O Laboratory Protection
- BAS/(F&O Facilities Management (CLO II only—Siemens))
- Power monitoring (ION—Schneider)/F&O electrical utilities (including central IT UPS systems monitoring)

Instrument and Control Systems

ORNL STS will provide building instrumentation and control systems cabling for interconnection of the following systems through the building from the site duct bank system to associated CLO central equipment hubs:

- PPS
- MPS
- ATS
- TPS (two conduits)
- EPICS

Pathway Systems

Ladder-type cable trays will be provided to support telecommunications and instrument and control systems cabling requirements with proper wire dropout devices, conduit sleeves, firestopping, grounding, and wire management components.

Cabling from wall box–type IT jacks will be in bushed conduits extended and grounded to the local cable tray system.

8.5.1.11 Plumbing

Laboratory Waste

Laboratory waste from laboratory sinks, cup sinks, and laboratory-related equipment will be collected separately below the lower level and conveyed by a gravity system to the underground sanitary waste drainage system outside the building. Any hazardous waste will be bottled to be transported for processing; consequently, a lab waste treatment system will not be provided.

Six lab waste and vent stacks will be provided at columns on either side of the designated lab bays. Flow rates and pipe sizes will be calculated based on drainage fixture unit values and adjusted/increased to allow for projected wastewater discharge from various laboratory-related equipment at the design stage.

Unless required for specific equipment, floor drains will not be provided in laboratory rooms.

Complete accessibility will be provided to all cleanouts. Wall-type cleanouts will be used within the laboratory spaces. Floor drains that do not receive regular use will be provided with trap primers. Primers will consist of an automatic trap primer system that automatically discharges water at regular timed intervals.

Sanitary Waste

Sanitary waste from pantry/break room sinks, lavatories, toilets, urinals, mop sinks, and non–laboratory-related equipment will be collected below the lower level and conveyed by a gravity system to the underground sanitary waste drainage system outside the building. Flow rates and pipe sizes will be calculated based on drainage fixture unit values and adjusted/increased to allow for projected wastewater discharge from various laboratory related equipment at the design stage.

Floor drains will be provided at all toilet rooms, mechanical equipment spaces, and other areas requiring drainage. Complete accessibility will be provided to all cleanouts. Wall-type cleanouts will be used at the lower level. Floor drains that do not receive regular use will be provided with trap primers. Primers will consist of an automatic trap primer system that automatically discharges water at regular timed intervals.

Elevator pits shall be provided with an elevator sump pump that discharges to the sanitary drainage system through an open site waste connection. Elevator sump pump shall have an oil monitoring system that prevents the pump from operating when hydraulic oil is present and sends an alarm to the BAS.

Potable Water

Potable water will enter the building at the lower level and shall be provided with a water meter that shall connect to the BAS. The incoming service shall split at the lower level into potable and process water streams through a Foundation for Cross-Connection Control and Hydraulic Research–approved backflow preventer. Potable hot and cold water will be distributed throughout the building to all fixtures and equipment requiring water. Water makeup and mechanical equipment will be supplied through local backflow preventers.

Potable use hot water will be generated at 140°F by a gas-fired water heater located at the mechanical penthouse. A thermostatic mixing valve will be provided to achieve 120°F distribution temperatures. Hot water will be distributed through a separate recirculating system designed to provide hot water to the points of use.

Potable hot and cold water shall be distributed throughout the building above the ceiling to risers located adjacent to toilet rooms and break rooms.

A separate recirculating tempered water distribution system, including risers through the designated lab bays, will be provided to supply emergency safety equipment (eyewashes and showers).

Water velocity in distribution piping shall not exceed 8 ft/second for cold water, and 5 ft/second for hot water. Shock arrestors will be provided and shall comply with PDI-WH201 or ASSE-1010.

Process Water

Non-potable Water Service (Laboratory Use)

A separate process water system will be provided for laboratory use water.

Process water shall emanate from the backflow preventer provided at the incoming potable water service and shall be routed to all laboratory sinks, cup sinks, fume hoods, glass-washing equipment, and other laboratory-related equipment in lab areas. Six process water risers (hot and cold) will be provided at columns on either side of the designated lab bays.

Laboratory hot water will be generated at 140°F by a natural gas–fired water heater located in the mechanical penthouse. Each heater will be sized for 75% of the laboratory hot water demand. A thermostatic mixing valve will be provided to achieve 120°F distribution temperature. Laboratory hot water will be distributed through a separate recirculating system designed to provide hot water to the points of use.

Design of laboratory-use cold and hot water will be based on fixture unit values and adjusted/increased to allow for projected water demand for laboratory-related equipment at the design stage. Piping will be sized to maintain a minimum of 30 psi at the most remote laboratory equipment connection.

Water velocity in distribution piping shall not exceed 6 ft/second. Provisions shall be made to arrest water hammer. Shock arrestors when installed shall comply with PDI-WH201 or ASSE-1010.

Storm Drainage

The primary storm drainage system will consist of roof drains for any areas collecting water, routed to downspouts that will collect below grade at the lower level and run to the site storm sewer.

A separate overflow storm drainage system will be provided; it will be engineered to perform as a siphonic roof drainage system with the piping running level through the building and discharging above grade into a velocity reduction tank located on the site. Velocities in the vertical piping shall be limited to 10 fps and in the horizontal piping the velocity shall be designed to 3.5 fps.

Compressed Air

CA shall be distributed throughout the building to supply CA to laboratory-related equipment and will be provided with local pressure-reducing valves to permit each piece of equipment to use air of various pressures. CA will be fed by the site CA system routed from the air compressors in the existing CUB. CA will enter the building at the lower level. The CA system shall be provided with a buffer tank located in the main mechanical room with dual filtration of the air prior to distribution to the laboratory air system. Distribution will be routed to all lab spaces via six CA risers that will be provided at columns on either side of the designated lab bays.

Specialty Gases

Most specialty gases (e.g., gaseous oxygen, helium, argon) will be supplied from local cylinders and manifolds provided by the local gas supply company. Nitrogen will be centralized, with gas cylinder manifolds installed at the lower level. Centralized nitrogen risers will be distributed up through the building at every other column around the lab bays, with valved connections provided for extension as needed by lab users. Manifolds will be duplex six-tank variety.

Pressure in distribution system will be as required by program.

Piping material will be brazed Type K copper.

Equipment

System Design Criteria

Potable/Process water

- Potable water system is designed to provide a minimum of 40 psi at the furthest outlet.
- Process water system is designed to provide a minimum of 40 psi at the furthest outlet.
- Water piping shall be sized based on the number of water fixture units connected and the minimum flow pressure required at each fixture or piece of equipment. Pipe velocities shall be maintained between 4 and 8 ft/second and shall not exceed 8 ft/second.
- Valves shall be placed to isolate individual fixtures within one room or a battery of fixtures within any one room.
- Wall hydrants shall be placed on the exterior of the building a maximum of 150 ft on center.
- Hose outlets will be provided at all mechanical rooms and equipment spaces.

Sanitary/Lab Waste

- The waste system shall connect to each fixture requiring connection and, where required, will be provided with water seal traps. A vent system shall be provided for fixtures as required to ventilate the waste system and to prevent siphonage of fixture traps.
- Floor drains will be provided at all mechanical rooms and equipment spaces.

- Waste and vent piping shall be sized based on the number of fixture units connected. Pipe shall be routed by gravity to maintain a positive slope with a maximum velocity of 2 ft/second.

Storm Drainage

- Storm piping shall be sized based on a 100-year occurrence rainfall rate with a 60-minute duration.

- Roof drains will be provided for all roofs and areas receiving rainwater; maximum area per drain shall be 3,000 sf.

Compressed Air

- Design CA pressure on incoming service—105 psi.
- Design CA pressure at laboratory outlets—100 psi.
- Design flow at outlets—1.0 cfm.
- Dew point −40°F

Vacuum

- Design vacuum level at vacuum skid—24 in. Hg.
- Design vacuum level at laboratory inlets—19 in. Hg.
- Design flow at inlets—0.5 cfm.

Piping mains will be sized for the maximum calculated flow at the design stage and limit velocities to 5,000 fpm with a maximum pressure drop to the farthest inlet of not more than 5 in. Hg at estimated peak flow conditions.

Materials

Potable Water System

- Above-ground potable water systems:
  - Tubing to be Type L hard temper with wrought copper fittings conforming to ASTM B88-and ASME B16.22. All joints shall be soldered with ASME AWS/A5.8 lead-free solder.
  - Copper tubing with grooved ends and mechanical joints is acceptable for sizes 2½ in. to 6 in. only. Tubing to be Type L hard temper with wrought grooved end fittings conforming to ASTM B88 and ASTM B75.
  - The entire potable hot and cold water distribution system will be fully insulated using closed-cell elastomeric foam insulation.

Process Water Systems

- Above-ground process water systems
  - Tubing to be Type L hard temper with wrought copper fittings conforming to ASTM B88-and ASME B16.22. All joints shall be soldered with ASME AWS/A5.8 lead-free solder.
  - Copper tubing with grooved ends and mechanical joints is acceptable for sizes 2½ in. to 6 in. only. Tubing to be Type L hard temper with wrought grooved end fittings conforming to ASTM B88 and ASTM B75.
  - The entire process hot and cold water distribution system will be fully insulated using closed-cell elastomeric foam insulation.

Sanitary/Storm System

- Above-ground soil, waste, vent and rainwater piping:
  - Hubless cast iron soil pipe: no-hub pipe with Husky SD-4000 soil pipe coupling manufactured by Anaheim Foundry, 4-band clamp or Clamp-All Hi Torq 125 2-band clamp. Sealing gasket shall be neoprene in accordance with ASTM C564, CISPI 301-75.
  - Horizontal storm drainage piping will be fully insulated using closed-cell elastomeric foam insulation.

- Below-ground soil, waste, vent and rainwater piping:
  - Asphaltum-coated, service-weight, cast iron pipe and fittings with resilient neoprene push-on joints, ASTM A72, ASTM C564-70.

Process Waste

- Polypropylene pipe, (fire retardant above grade) (PP); Sch 40; PP DWV hub and spigot fittings; heat fusion joints above and below ground.

Compressed Air/Specialty Gas System

- Type K copper with brazed joints.

Plumbing Fixtures and Specialties

- All plumbing fixtures will be institutional-grade, vitreous china or stainless steel as required.

- Floor sinks and floor drains in laboratory areas (if required) will be stainless steel, flush with finished floor, minimum of three 3-in. outlets.

- Hub drains and similar unsanitary fixtures will not be provided in lab spaces.

- Water closets: wall-hung, siphon jet type, high-efficiency 1.28 gal per flush maximum with hard-wired infrared sensor operation.

- Urinals: wall-hung siphon jet type, high-efficiency 0.125 gal per flush maximum with hard-wired infrared sensor operation.

- Lavatories: wall-hung or countertop type, 0.5 gal per minute maximum with hard-wired infrared sensor operated faucets.

- Showers: high-efficiency 1.5 gal/min maximum.

- Safety showers, eyewashes and combination units: 30 psi minimum.

- Electric water coolers: recessed, self-contained.

- Interior hose bibbs: chrome plated in finished areas, rough brass in mechanical rooms, wall mounted, furnished with vacuum breaker, ¾-in. hose threaded outlet.

- Wall hydrant: freeze resistant type in recessed box, ¾-in. hose threaded outlet.

8.5.1.12 Fire Protection

Sprinkler

The CLO building will be provided with complete automatic fire protection systems as required by the IBC and/or DOE Order 420.1C, *Facility Safety*. The design, installation, and acceptance testing of automatic sprinkler protection will be in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems* and DOE-STD-1066-2012, *Fire Protection*. Building will be fully sprinkled, with exposed sprinkler piping feeding upright sprinklers, or recessed pendent sprinklers where ceilings are provided. Sprinkler feed will enter at the lower level from the site potable/fire water main, and a double check backflow preventer will be provided. The CLO building will have a separate sprinkler zone for each floor, with control valves located in the exit stairwell at the north end of the building. Control valves will be provided with a tamper switch and a flow switch connected to fire alarm system.

Incoming service will be hydraulically calculated and be sized for the maximum calculated flow at the design stage.

Standpipe

A full standpipe system will be provided for the CLO Building. Standpipe risers with hose valves will be provided in all exit stairwells and elsewhere as required by IBC and/or DOE Order 420.1C, *Facility Safety*. The design, installation, and acceptance testing of standpipe systems will be in accordance with NFPA 14, *Standard for the Installation of Standpipe and Hose Systems* and DOE-STD-1066-2012, *Fire Protection*.

General

Portable fire extinguishers will be provided throughout the CLO building in accordance with the IBC and NFPA 10, *Portable Fire Extinguishers*.

System Design Criteria

Sprinkler systems will be hydraulically designed to provide water densities that meet the requirements for Ordinary Hazard–Group 1 protection in office areas and general corridors.

Ordinary Hazard–Group 2 protection will be provided in laboratories, shop areas, supporting tunnels, and utility structures.

Fire sprinkler systems will be hydraulically designed. Velocity shall not exceed 20 fps. All calculations assume a minimum of 10 psi deterioration in static and residual pressures in the hydrant flow test results.

Materials

- Pipe and fittings installed underground shall be Class 52 ductile iron cement lined with mechanical joints with a working pressure rating of 350 psig.

- Sprinkler piping installed above ground and sized 2 in. and smaller, and all standpipe piping, shall be Sch 40 black steel with threaded joints and fittings.

- Sprinkler and standpipe piping installed above ground and sized 2½ in. and larger shall be Sch 40 black steel with roll or cut groove type connections and fittings. Pressure rating shall be 175 psig minimum.

- Fittings for grooved end shall be cast of ductile iron conforming to ASTM A-536 or malleable iron conforming to ASTM A-47, or forged steel conforming to ASTM A-234 (A-106, Gr. B), with grooved or shouldered ends for direct connection into grooved piping systems with steel pipe and shall be UL listed and FM approved, rated for a minimum 300 psi MWP.

8.6 CENTRAL UTILITIES BUILDING

8.6.1 Central Utilities Building II

8.6.1.1 Programming

Building Function

The CUB II will house the primary mechanical utility systems supporting the STS facility. The primary systems include CHW, heating water, tower water, and CA. The facility will include an associated exterior cooling tower. Ancillary functions supporting the primary systems and facility staff are also included. The CUB II is functionally independent of the existing CUB. Access to CUB II will be limited to STS technical and facility operations staff.

Program Summary

The CUB II includes 7,850 nsf and has an estimated planning efficiency factor of 85%. This factor is based on analysis of the existing CUB and preliminary test-fit planning for CUB II. The estimated gross area of the CUB II is 9,244 gsf. Table 8.35 summarizes the CUB II space program requirements. Detailed room data sheets and test-fit plans are included in Appendix B, STS CF Conceptual Design Report.

Table 8.35. CUB II space program summary.

No.	Rooms	Qty.	NSF	Total NSF
5.6.1.1	Boiler systems	1	1,050	1,050
5.6.1.2	Pump room/chem treatment	1	1,700	1,700
5.6.1.3	Chiller room	1	1,700	1,700
5.6.1.4	Compressed air system	1	1,050	1,050
5.6.1.5	Control room	1	300	300
5.6.1.6	Communications room	1	200	200
5.6.1.7	Break room	1	150	150
5.6.1.8	Workshop	1	1,250	1,250
5.6.1.9	Technician work area	1	150	150
5.6.1.10	UPS/emergency electrical room	1	300	300
Total nsf				**7,850**
Total gsf				**9,244**
Total efficiency				**85%**

8.6.1.2 Site Planning

Location and Floor Elevations

The CUB II will be located on the outer perimeter of the ring road directly north of the STS complex. The CUB II first floor will be located at elevation 1074 ft and the basement floor level will be located at elevation 1056 ft. The sloped grade at the building site will allow grade level access to both the first and basement floor levels. Figure 8.15 highlights the CUB II within the overall STS Site Plan.

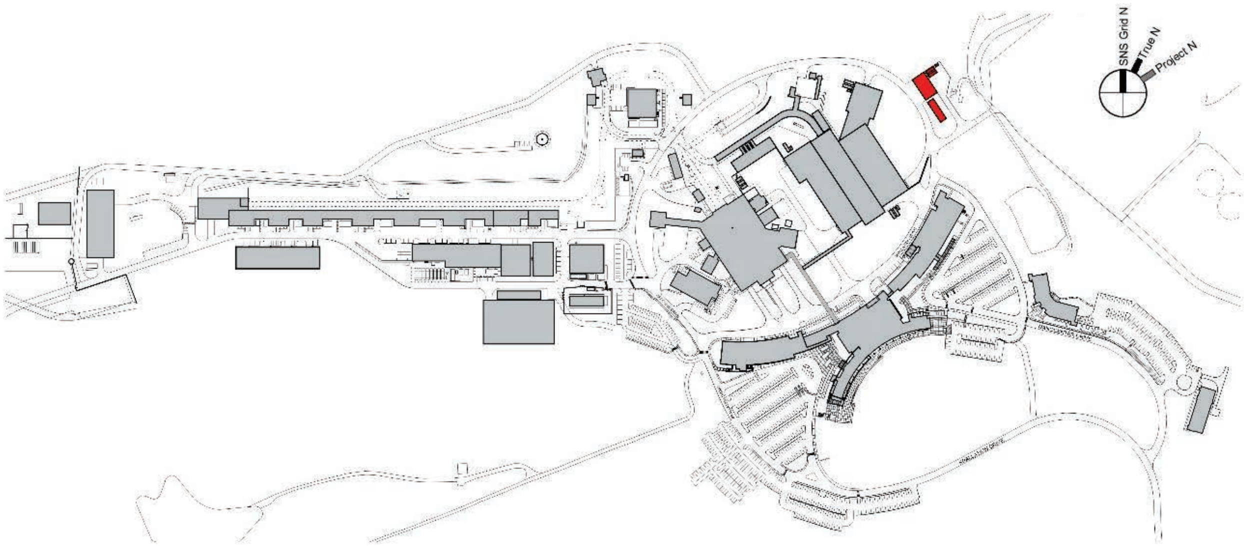


Figure 8.15. CUB II location within the STS Site Plan.

Truck Access

Tractor-trailer and smaller truck access for the CUB II will be located on the south side of the facility at the first-floor level, elevation 1075 ft. Additional truck access will be available on the north side of the building at the basement floor level from a secondary service road. A loading dock is not required at these locations. Forklifts will be used to convey materials and equipment between the building and trucks through overhead service doors.

Pedestrian Access

Pedestrian access to the CUB II will be provided at the first and basement floor levels of the facility. First floor access will be from the ring road on the south side of the building. Additional pedestrian access will be provided at the basement floor level on the north side of the building. All access locations will be at controlled grade-level exterior doors.

8.6.1.3 Building Planning

The CUB II will be a 2-story utilitarian structure, planned in a relatively narrow configuration to conform to the steeply sloped site. The south side of the building will be one story above the grade of the ring road. The north side of the building will be two stories above grade, as a result of the site slope. The first floor will house boiler and CA systems. Chillers, pump systems, and chemical treatment will be located at the basement floor. Secondary spaces for supporting activities are located at the east end of the building on both floor levels. Multiple cooling towers will be located on the east side of CUB II. They will be mounted on an integrated foundation/common sump assembly to be partially embedded in the sloped topography.

Vertical Circulation

A single open, interior stair will serves both floor levels of the building. Building egress will be provided separately at each floor level.

8.6.1.4 Key Features and Requirements

None

8.6.1.5 Life Safety/Code

Primary Occupancy Type

The primary occupancy type for the CUB II is Group F-1, Moderate Hazard Factory Industrial, according to the 2015 IBC, and Special-Purpose Industrial, according to NFPA 101, 2018 edition.

Accessory Occupancies

The CUB II will not have any accessory occupancies.

Fire Protection Systems

The CUB II will be protected throughout by an automatic fire sprinkler system designed to protect an Ordinary Hazard–Group 2 occupancy in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*.

Portable fire extinguishers will be provided throughout the building in accordance with the IBC and NFPA 10, *Standard for Portable Fire Extinguishers*.

The CUB II will be equipped with an addressable fire detection/alarm system consisting of the following:

- Manual fire alarm pull stations at all building exits
- Duct smoke detectors on the supply and return sides of all AHUs having a design capacity greater than 2,000 cfm
- Audible/visual notification appliances installed through the building

All fire alarm, supervisory alarm, and trouble signals will be automatically transmitted to the ORNL Fire Department via the LSS fiber optics network.

All new fire alarm system equipment will be manufactured by Edwards Systems Technology to be compatible with the existing site-wide campus system.

The fire detection/alarm system will be designed and installed in accordance with the IBC and NFPA 72, *National Fire Alarm Code*.

Maximum Floor Area and Stories

The CUB II will be a 2-story, 9,283 SF building of Type IIB construction. The proposed height and area for the building are within the limits established in IBC Sections 504 and 506.

Travel Distances

The maximum travel distance within the CUB II will not exceed 250 ft, as required by IBC Section 1016.2. The maximum common path of travel distance will not exceed 100 ft, as required by IBC Section

1014.3. The maximum dead-end corridor will not exceed 50 ft, as required by IBC Section 1018.4 and NFPA 101, Section 40.6.4.

Construction Type

The CUB II will be of Type IIB construction in accordance with IBC Section 602.

Wall/Floor Ratings

The walls, floor, and roof of the CUB II will be of noncombustible construction. Fire resistance ratings are not required for buildings of Type IIB construction.

Special Code Considerations

A refrigerant detection system will be provided for the chiller refrigeration room in accordance with the International Mechanical Code. Upon detection, the refrigerant detection system will active a purge fan ducted to the low-level intakes in the refrigeration room. The refrigerant detection system will be connected to the EPICS.

8.6.1.6 Civil/Site Development

The CUB II is proposed to the north of the STS facility on the outside edge of the ring road. The development of this area will require excavation for the first-floor level. This excavation will be done as part of the building construction and is not proposed as part of the initial construction excavation. Vehicle access to the second floor will be provided from ring road and an access to the lower elevation will be developed as shown on Drawing 5.1.19. The lower drive will require a retaining wall to protect site grades from impacting the existing booster pump station. Drawing 5.1.22 shows the site drainage concept. Roof drainage will be piped to the proposed storm sewer system. Sewer, fire, and domestic water services to the building are shown on Drawing 5.1.27. A significant relocation of the utilities extending from the booster pump station will be required to develop this area.

8.6.1.7 Architecture

Building Envelope

Exterior Wall

A-striated face, 36 in. wide insulated-core metal panel system, with a custom color to match the existing context, will be used as a major material component for the envelope of the CUB in keeping with the existing texture and materials used on the SNS campus. The metal panel cladding support backup system will consist of hanger rods and metal channel framing supported from the building structure. Metal window sills and wall caps will be used. Continuous through-wall flashing will be provided at the bottoms of all wall cavities, over all wall openings and metal copings. The metal panel wall systems will have an R-13 and R-13ci minimum requirement. Below-grade exterior walls will be constructed of reinforced concrete with a waterproof membrane and below-grade insulation board. The interior walls will have metal channel furring with a painted drywall finish. Exterior walls below grade will be required to achieve an R-7.5 ci as according to 2012 International Energy Code.

Exterior Doors

Exterior entrance doors and egress doors will be 16-gauge, insulated-core painted hollow metal doors with fully welded 14-gauge frames and a U value of 0.61. Overhead insulated coiling doors, 14 ft, 0 in.

high by 14 ft, 0 in. wide, at the east side of the building and 10 ft, 0 in. high by 14 ft, 0 in. wide at the west side of the building, will include factory-painted galvanized steel curtains with integral insulation achieving a minimum R-value of 4.75 requirement. All exterior doors will be provided with proximity card reader hardware.

Thermal and Moisture Protection

Flashing and sheet metal will be provided as a positive water stop around all openings (head, jamb, and sill) in walls such as windows, doors, louvers, and so on. All copings and gravel stops will be ES-1 compliant as required by IBC.

Damp-proofing will be provided on all walls, floors, and other building components that are subject to high humidity, dampness, or frequent direct water contact.

Waterproofing will be provided at walls, floors, and other building elements that are subject to hydrostatic pressure, are liable to be immersed in water, or are below the water table. The waterproofing membrane will be a hot-fluid-applied, two-layer 215-mil, polyester fabric–reinforced membrane.

Because of the inherent moisture-resistant properties of the insulated metal panel system, an air/vapor barrier will not be required where the system is installed.

Exterior sealants will be non-staining with a two-part composition and a 50% movement capacity, and will be compatible with the surfaces on which they are applied.

Insulation combustibility, including wrappings, inside the building skin will be limited to a flame spread of 25 and smoke development of less than 50.

Glazing

Windows will be limited to the control room to allow views to the exterior. Typical vision glass will consist of 1-in.-thick, low U-value insulated, low-E, argon-filled glass units on a thermally broken frame. The windows/glazing system is anticipated to have a U value of 0.38.

Glazing materials and methods will comply with the Flat Glass Marketing Association’s Sealant and Glazing Manuals. Glass will comply with ASTM C1036-01.

Roof Construction

The roofing system will be a 30-year, 80 mil minimum thickness, white thermoplastic (PVC) single-ply sheet with an integral fiberglass mat reinforcement roofing membrane over polyisocyanurate insulation on a sloping roof structure. Tapered insulation saddles will be used to provide drainage to roof drains and at roof equipment locations. All roof construction details and roof penetrations must comply with the guidelines established by the NRCA. Roof traffic pads will be adhered to the membrane along all roof maintenance traffic paths. All roofs with serviceable components beyond roof drains will be surrounded by a 42-in.-high parapet or provided with a fall protection system.

Low-slope roofing will have a minimum 3-year aged solar reflectance of 0.55 and a minimum 3- year aged thermal emittance of 0.75 in accordance with the Cool Roof Rating Council Program. Roofing will be Energy Star rated with emissivity of at least 0.9 when tested in accordance with ASTM 408.

The roofing system will meet or exceed UL class A fire exposure requirements and comply with FM Class I-90 for wind uplift according to ASTM 1592. It will provide a minimum thermal resistance value of R-30.

Interior construction

Walls

Interior walls will be constructed of CMUs for durability and will extend up to structure deck above. All fire-rated walls will be constructed in accordance with the IBC code requirements and UL-listed assemblies.

Painted metal guardrails and handrails will surround all floor openings and egress stairs.

Wall Finishes

All finish materials for walls, ceilings, and floors, will have a Class A rating, with a flame spread ≤ 25, a fuel contribution of ≤ 25, and a smoke development of ≤ 450.

Typical interior CMU partitions will receive a paint finish consisting of one primer coat and two finish coats. Epoxy paint is to be applied to all lab demising walls. All paints, including top coats and primers, will comply with the 2016 *Guiding Principles for Sustainable Federal Buildings*.

Floor Finishes

Flooring in the mechanical and support areas is to receive concrete sealer over the new concrete. No vinyl wall base will be used in these areas.

Ceiling Finishes

The structure will be left exposed in some support spaces and all mechanical and utility areas. All exposed structure will receive paint finish consisting of one primer coat and two finish coats.

Interior Doors

All interior doors will be shop-primed, field-painted, 16-gauge hollow metal doors with 14-gauge fully welded metal frames.

Furnishings

Laboratory Casework

Not applicable

Vertical circulation

Stairs

Stairs will be constructed of concrete-filled metal pans and metal handrails, with rubber treads, nosings, and landings.

Elevators

Not applicable

Specialty Equipment
A trolley beam assembly will be provided over each chiller for equipment maintenance purposes. Combination emergency showers/eye wash units will be provided, according to ANSI Z358.1, at areas where chemicals will be used or stored.

8.6.1.8 Structure

Applicable Codes and Standards

See Sheets x–xii for a complete list of Applicable Codes and Standards

Design Loading

Superimposed Floor Loads

- Dead loads:
  - Ceilings: 5 psf
  - Mechanical and lighting: 10 psf

- Live loads: 500 psf or equipment weight

Superimposed Roof Loads

- Roof snow load:
  - Ground snow load: Pg = 10 psf
  - Snow exposure factor: Ce = 1.0
  - Snow importance factor: Is = 1.0

- Minimum roof live load = 20 psf + 20 psf collateral load

Wind Loads

- Risk category II
- Basic wind speed: V = 115 mph
- Exposure category B

Seismic Loading

- Risk category II
- Importance factor: Ie = 1.0

Building Structural System

Slab on Grade

The slab construction is anticipated to consist of an 8-in.-thick reinforced normal weight concrete slab. At pumps with a motor larger than 10 HP, the foundation/housekeeping pad will be sized for five times the mass of the pump. All construction joints between pours will require smooth dowels across the joint. The floor slab will be placed over a vapor barrier, a compacted drainage base course, and a compacted subgrade.

Foundation System

A geotechnical investigation has not been performed. Until a geotechnical investigation and report have been completed, an accurate description of the building's foundation system cannot be provided. The CUB II foundations are anticipated to consist of shallow spread footings bearing on soil with a minimum net allowable bearing capacity of 3,000 psf. Footings shall extend to the frost depth elevation at a minimum. Below-grade walls are anticipated to be constructed with reinforced normal weight concrete. It is anticipated that the south below-grade wall will consist of counterfort retaining walls. Water stops will be provided in construction joints to safeguard against water intrusion.

Superstructure

The CUB II is anticipated to be a 2-story conventional steel-frame structure. The building will support the exterior wall system with steel girts as required. The elevated floors are anticipated to be constructed using reinforced normal weight concrete on a galvanized composite metal deck. The roof structural system is anticipated to consist of wide flange framing with a roof deck meeting galvanizing G90 requirements.

Lateral System

Resistance to lateral loads resulting from wind and seismic forces on the building are anticipated to be provided by concentrically braced steel frames.

Geotechnical Analysis

A review of historical geotechnical and geophysical surveys was performed that included the original campus development and additional structures. A detailed geotechnical exploration was performed by Law Engineering dated June 30, 2000, addressing the original development of the campus (Law 2000). The proposed CUB II should be supported on shallow foundations. The structure will be located at a sufficient distance beyond the STS excavation that additional support with deep foundations should not be necessary. The stiff or better upper crust of residual soil should be sufficient to support the CUB II Building. Based on the current subsurface data on the site, as much as 3,000 psf allowable bearing pressure will be available.

A review of geophysical data and shear wave velocities from the Law report indicates that the CUB II would be located in a seismic site classification C as defined in IBC 2015 and ASCE 7 (Law 2000). This is confirmed by the average shear wave velocities for multiple soil profiles tested during the original campus development.

A supplemental geotechnical report would be advisable once the final CUB II location and footprint have been determined. The density and pattern of the soil test borings should be selected to optimize the quality of geotechnical data. Additional geophysical testing is not anticipated for design of the structure.

Vibration/Acoustics

It is recommended that spaces within the CUB II that will be occupied for extended time periods (such as an office) be designed for a background noise criterion of NC 40.

8.6.1.9 Mechanical

Air Handling/Ventilation

At the CUB II, only the occupied control room, electrical, communications, and instrument spaces will be conditioned. Heating and cooling for conditioned spaces will be accomplished using a packaged roof-mounted VAV AHU. The AHU will be designed as a 4 ACH, heating-cooling, single-zone, constant-volume type providing from minimum outside air to 100% outside airside in economizer mode. The unit will operate only during occupied periods of the day, or cycle on as required to maintain night setback temperature settings. Supply and return fans will be plenum type, arranged in a multi-fan array. AHU supply air temperature will be modulated as required to suit building load.

Mechanical, pump room, and utility spaces housing plant equipment treated using a heating and ventilation approach. Ventilation will be achieved through the use of four roof-mounted exhaust fans for the upper level and two wall-mounted exhaust fans for the lower level, with associated wall-mounted intake louvers with motorized dampers. Heating for these spaces will be accomplished through the use of electric unit heaters located within the space.

Exhaust

General utility set exhaust fans will be provided for ventilation of the equipment spaces as indicated above, and a separate fan to exhaust toilet room and janitor closet.

A purge fan ducted to low-level intakes will be provided in the chiller refrigeration machinery room, connected to a refrigerant detection system.

Space Conditioning

Telecommunications Room and Electrical Equipment Room

The telecommunications room and electrical equipment room will be served by CHW-cooled, fan-coil units located within the spaces. Units shall normally operate 24 h/day, 365 days/year. Local humidifiers shall be provided. Provisions will be made to provide some conditioned air from one of the constantly running AHUs, as backup to the space should a fan-coil unit fail.

Chilled Water

The CHW system and all associated pumps would be located at the lower level of the CUB II. A dedicated refrigeration machinery room will be provided for the chillers, and a separate room for the pumps. A refrigerant detection and exhaust system will be provided for the chiller room. The CHW plant will incorporate four water-cooled centrifugal chiller units and four variable primary CHW pumps. The entire CHW plant will be designed in an N+1 configuration, with one chiller and one CHW primary pump, one condenser water pump, and one cooling tower cell being a standby unit. A variable primary pumping distribution scheme will be used for the CHW campus distribution. Multiple pressure differential sensors in the CHW loop at each major building will vary the VFD pump speed of the CHW pumps to maintain the required pressure differential across the CHW system.

CHW system will include appropriate valving and piping specialties, expansion tank and air separator, makeup water assembly, and automated chemical treatment systems. A trolley beam will be provided above each chiller to facilitate maintenance. CHW from the plant will be distributed at 42°F and delivered to the building air-handling units at 44°F; return water temperature will be optimized but is expected to be operated with a 12 to 16°F temperature rise. Based on the minimum temperature differential stated above, the CHW piping mains would be 16-in.in diameter.

System sizing will be such that three chillers and three cooling tower cells will incorporate capacity to meet the total estimated building load and 20% allowance for future growth. Three primary pumps and three condenser water pumps will be sized to provide 100% of the design flow rate, with the fourth pumps acting as a standby.

Condenser/Tower Water

Condenser water will be supplied from four cooling tower cells dedicated to the CHW plant. Cooling towers will be located west of the CUB II, mounted on a field fabricated concrete sump. The sump will incorporate two separate compartments to facilitate maintenance and reduced winter flow operation. The entire sump will be recessed below grade to allow for underground routing of piping to the plant while still maintaining an outlet level that provides positive suction head at the condenser water pumps. Four FM-approved factory-fabricated cross flow cells will be provided. A tower sump will be piped to the lower level of the CUB II, where associated four condenser water pumps will be located to supply the chiller units. Four base-mounted condenser water pumps, with one pump as a standby, will draw the condenser water from the sump and deliver it to the chillers in the CUB II. To regulate the condenser water temperature, each tower will be provided with variable-speed operation. Additionally, each cell shall be provided with a 3-way diverting valve to send the return water directly back to the sump. A low-temperature cooling tower bypass valve will be provided in the mechanical room.

A separate cooling tower water system will be provided as the source of heat rejection for the technical equipment DI water cooling loops. Tower water will be supplied from two cooling tower cells dedicated to the tower water system. Towers will be located west of the CUB II, with a sump assembly fabricated in similar fashion to the condenser water sump. Two FM-approved factory-fabricated cross flow cells will be provided. The tower sump will be piped to the lower level of the CUB II where associated two tower water pumps will be located to supply the tower water loop (one standby). To regulate the tower water temperature, each tower will be provided with variable-speed operation. Additionally, each cell shall be provided with a 3-way diverting valve to send the return water directly back to the sump. A low-temperature cooling tower bypass valve will be provided in the mechanical room.

Condenser and tower water systems will include appropriate valving and piping specialties, automated water fill assembly, and automated chemical treatment systems.

Heating Water

Heating water for preheat and reheat at the buildings will be generated using a boiler plant located in the upper level of CUB II. The plant will consist of four condensing boilers and heating water distribution pumps. Boiler plant capacity will be in the range of 12 MMBH. Four boilers at 4 MMBH input will provide N+1 redundancy for the system. Heating water supply temperature will be 180°F with a 40°F delta between supply and return temperatures. The heating water supply temperature will be reset lower based on outside air temperature in the summer months. Total heating water flow is estimated at 600 gpm, provided by four 200 gpm pumps configured in an N+1 arrangement.

Heating water system will include appropriate valving and piping specialties, expansion tank and air separator, makeup water assembly, and automated chemical treatment systems. Heating water distribution will use a variable primary pumping scheme to distribute the heating water to buildings. Base-mounted variable-volume pumps will be used for the circulation loop, with a VFD provided for each pump. Distribution pumps will be sized at 100% of the design flow rate of each boiler, in an N+1configuration.

If one pump fails, the remaining pumps will be able to provide 100% of the design capacity of the piped loop.

Natural Gas

Natural gas piping will be routed to the CUB II from the existing site gas service. Medium-pressure gas will enter the building at the upper level and be distributed to the boilers. A separate pressure regulator will be provided for each boiler. A gas meter will be provided for each boiler.

Controls

The CUB II shall be controlled by the EPICS. The building will be connected to an expansion of the existing EPICS. Instrumentation and wiring shall be connected to a new EPICS PLC in the building, and controls interface for the building will be provided. Programming and connection of the PLC to EPICS shall be completed and the control system commissioned to ensure proper operation.

Electric actuation will be used for most control valves and dampers so that instrument air is generally not required. Larger valves will be provided with pneumatic actuation. All control systems will be on UPS and emergency power. System software and firmware will provide the following functions:

- Control sequences shall be developed to support the operations of the technical equipment.
- PID control to allow faster and closer control to system set points.
- Adaptive tuning to adjust PID loop constants to ensure that control system response remains accurate and reliable over a wide range of dynamic operating conditions.
- Monitoring to read the value of measured variables, to read control loop set points, to monitor control signals to actuators, and to indicate status of equipment, alarms and overrides.
- Energy management, including optimum start/stop, variable ACH rates in laboratories, duty cycling, supply air temperature reset, supply air static pressure reset, demand limiting, time totalization, and so on.
- Data management, including continuous database updating, alarm reporting, trend logging, and report generation.
- System programming to add, delete, or change points, set points, schedules, control algorithms, report formats, and so on.
- System software will allow building operators to graphically monitor and control building operations and provide the functions listed. Graphics will include site plans, overall building plans, floor plans and individual system graphics.

The refrigerant detection system provided for the refrigeration room in accordance with the requirements of the IMC will be connected to the EPICS.

Equipment

Table 8.36 provides a listing of the mechanical equipment servicing the CUB II.

Table 8.36. CUB II mechanical equipment.

Use	Equipment	Size	Qty	Em pwr	Redund	Location	Remarks
CUB II AC	Packaged AHU	5 ton	1	N	–	Roof	Occupied space conditioning
CUB II Vent	General exhaust fan	1,500 cfm	5	N	–	Roof	Building ventilation
Site CHW	Water cooled chiller	900 ton *(20% growth)*	4	N	N+1	Chiller room	STS CHW *(Δ = 12f)*
Site CHW	Primary CHW pumps	1,800 gpm @ 135 ft	4	N	N+1	Chiller room	CHW Vari-Prime
Chiller Condenser Water	Condenser water pumps	2,700 gpm @ 70 ft	4	N	N+1	Pump room	Chiller condenser pumps *(Δ = 10f)*
Tower Water Tech Cooling	Cooling tower water pumps	2,000 gpm @ 150 ft	2	N	N+1	Pump room	Technical DI cooling water loop
Chiller condenser water	Cross flow cooling tower (condenser water)	1,100 ton *(20% growth)*	4	N	N+1	Outside	Chiller condenser water
Tower water tech cooling	Cross flow cooling tower (tower water)	1,650 ton *(20% growth)*	2	N	N+1	Outside	Technical DI cooling water loop
Site heating water	Gas-fired condensing boilers	4 MMBH	4	N	N+1	Boiler room	STS heating hot water (LWT = 140–180°F; Δ = 40°F)
Site heating water	Primary heating pumps	200 gpm @ 95 ft	4	N	N+1	Boiler room	Vari-Prime system
CUB II heating	Electric unit heaters	15 kw	8	N	–	Boiler room	General building heating

Air Handler

General

- All AHU will be packaged, factory-fabricated, and constructed with 4-in.-thick double walls, constructed of galvanized steel.
- Maximum allowable nominal face velocities:
  - Air intake louvers (through free area): 350 fpm
  - Heating water coils: 500 fpm
  - Cooling coils: 400 fpm

  - Filters: 400 fpm

AHU: Modular, Packaged, 4-in. Double-wall Construction Configured as Follows:

- Mixed air plenum
- Intake isolation damper
- Return/exhaust damper
- Relief fans
- VFDs
- Economizer section
- MERV 8 (30%) prefilter section
- Pipe vestibules
- Hot water preheat coil
- CHW coil
- Hot water reheat coil
- Supply fans
- VFDs
- MERV 14 (95%) final filter section
- Supply plenum
- Isolation/smoke damper
- Access sections
- Doors: safety glass windows and quarter turn handles.
- Marine light in each access section.
- Vibration isolation in accordance with ASHRAE HVAC Application—Noise and Vibration Control
  - Exhaust fans
  - Utility set fans

Fans will be backward-inclined, belt-driven centrifugal fans with spark-proof construction and bearings and motors out of the airstream. Fans will be single width, single inlet with a galvanized steel housing and wheel construction. The fan motor will be totally enclosed and fan cooled. The system will consist of the following components:

- Steel mounting rails with vibration isolators
- Isolation damper at the fan inlet
- Discharge ductwork with bird screen
- Weather cover
- VFDs

Water-Based Systems

Chillers

Packaged centrifugal, water-cooled chillers with microprocessor-based controls will be provided. The compressors will be variable displacement with direct-drive, hermetically sealed motors. Evaporator and condenser will be of the shell-and-tube design consisting of carbon steel shells and copper tube construction. The system will include the following equipment:

- Pressure relief valve
- Stand-alone, microprocessor-based control panel

- Unit mounted VFDs
- Closed-cell, flexible elastomeric thermal insulation
- Appropriate valving and piping specialties

Boilers

Packaged gas-fired, condensing boilers will be provided for generating the campus hot water. The boilers will be factory-fabricated with Type 316L stainless steel HX, flue gas vent, combustion air intake, water pipe connections and controls. The system will include the following equipment:

- Stand-alone, microprocessor-based control panel
- Condensate neutralizer
- Centrifugal blower
- Intake and exhaust mufflers

Factory-fabricated, open-circuit, induced-draft, crossflow cooling towers will be provided for the condenser and tower water systems. The system will include the following equipment:

- Fan assembly including fan, VSD, and motor
- Vibration switch for the fan drive
- PVC fill material
- Drift eliminator
- Air intake louvers
- Integral, microprocessor-based controller
- Field-fabricated collection basin

Pumps

Pumps will be separately coupled, base-mounted, double-suction centrifugal pumps. The system will include the following equipment:

- VSD and motor

- Rated for 175-psig (1204-kPa) minimum working pressure and a continuous water temperature of 225° F (10°C)

- Horizontally split, cast iron casing

- Stainless steel shaft

- Mechanical seal

Motors

- All motors shall be premium efficiency type and built to NEMA standards.

- Variable-speed motors shall be rated as inverter duty motors. All motors operating with VFDs shall be equipped with shaft grounding rings or insulated bearings to prevent the accumulation of PWM frequencies in the shaft, which could arc across the bearing, causing pitting and premature bearing and motor failure.

All VFDs shall be provided with power filters to improve the building power quality from the occurrence of multiple VFD installations.

General

System Design Criteria

Outside Design Temperatures

- Summer: 92.8°F DB, 73.8°F MCWB (0.4% ASHRAE)
- Winter: 17.1°F (99.6% ASHRAE)

Interior Design Conditions: Preliminary Load and Ventilation Assumptions

- Conditioned spaces 72°F ±2°F, 60%>RH
- Ventilated spaces 60–100°F, no humidity control

Chilled Water

- Supply 42°F (to buildings), 44°F (to AHUs)
- Return 56–58°F

Tower Water

- Supply 80°F
- Return 100°F

Materials

Duct Distribution Systems

Ductwork Materials and Construction

- Supply ductwork construction will be based on SMACNA 4-in. pressure class and 2-in. pressure class. Four-in. pressure duct construction will be used upstream of VAV boxes on variable-volume units; 2-in. pressure class duct construction will be used downstream of VAV boxes on variable-volume units and for all ductwork on constant-volume units. All ductwork seams and joints shall be sealed, regardless of pressure rating. Maximum permissible leakage = 2%.

- All supply ductwork routed through unconditioned spaces shall be insulated with 2-in. foil-faced batts or foil-faced duct board with similar R-value.

- Return and general exhaust ductwork construction shall be based on SMACNA 2-in. pressure class.

- Refrigerant exhaust ductwork shall be constructed to a 6-in. SMACNA pressure class.

- Return air duct shall be insulated with 1½ in. foil-faced batts or duct board. Laboratory exhaust ducts shall not have fire dampers.

- General air distribution ductwork will be G90 galvanized sheet metal.

- Rectangular and round ductwork shall be fabricated in accordance with SMACNA standards. Spiral-wound ductwork shall be a prefabricated system with factory certifications. Spiral-wound ductwork shall not be used for laboratory exhaust systems or other systems that may be exposed to water intrusion.

- Provide sound attenuation to meet the project requirements or in accordance with the direction of the project acoustician. Sound attenuation shall be by appropriate application of attenuators or duct design.

- Lined ductwork shall not be used, except for plenum return air-transfer boots for noise control. VAV air terminals shall be double-wall or have foil-faced inner surface.

- Flexible ductwork is limited to 5 ft and shall be used only downstream of VAV terminals. Flexible ductwork shall be limited to supply air systems only.

- Plenum return may be used for return air in all non-laboratory portions of buildings.

- Ductwork shall be sized as shown in Table 8.37.

- Non-laboratory spaces on VAV systems shall have conventional supply terminal boxes with hot water reheat coils and integral sound-attenuating characteristics.

- Smoke detection will be provided in accordance with NFPA 90A and IMC requirements.

Table 8.37. CUB II Building ductwork sizing.

	Risers	**Submains**	**Branches**	**Air distribution device neck velocity (fpm)**
Max P.D.	0.1 in./100 ft	0.08 in./100 ft	0.08 in./100 ft	450 fpm

Piping

Tower Water/ Chilled Water/ Condenser Water

- Interior piping sizes 2 in. and smaller Type L copper with brazed fittings.

- Interior piping 2.5 in. and larger shall be either Type L copper with brazed fittings or Sch 40 steel pipe with either welded and flanged joints or mechanical grooved fittings.

- Underground CHW piping serving the building will be distributed in a pre-insulated, factory-fabricated coated steel piping system or HDPE.

- Underground tower water piping serving the building will be distributed in a factory-fabricated coated steel piping system or HDPE.

- All piping will be tested at 1.5 times the design system pressure.

- All interior CHW piping shall be insulated with closed-cell elastomeric insulation. Properties shall meet or exceed the minimum energy code requirements.

- All piping in mechanical rooms and piping exposed below 8 ft AFF shall have a PVC jacketing.

- All piping exposed to the exterior shall have an aluminum jacket.

Heating Water

- Interior piping 2 in. and smaller shall be Type L copper with brazed fittings.

- Interior piping 2½ in. and larger shall be either Type L copper with brazed fittings or Sch 40 steel pipe with welded and flanged joints.

- Underground hot water piping serving the building will be distributed in a pre-insulated, factory-fabricated coated steel piping system.

- Interior heating water piping shall be insulated with rigid glass fiber insulation.

- Piping exposed to the interior shall have a PVC or aluminum jacket. Piping exposed to the exterior shall have an aluminum jacket.

Natural Gas

- Interior Sch 40 steel pipe with welded and flanged joints
- Underground piping HDPE with heat fused joints
- Gas will be metered at incoming service and individually at each boiler

Seismic Criteria

Referenced Standards and Design Criteria:

- Seismic bracing shall be in compliance with ASCE 7-10.

- Equipment mounted on isolators will be seismically braced using loose cables, telescoping pipes, or box sections, angles or flat plates used as limit stops or snubbers, either integral to or separate from the isolators.

- Nonrotating, fixed equipment will be bolted directly to the floor or structure.

Mechanical Calculations

Mechanical calculations are provided in Appendix C for both air side and cooling water side.

Sustainable Design Strategies

The following energy conservation measures will be incorporated into the HVAC design:

- DDC BAS for optimization of major HVAC equipment operation.

- Variable-volume supply and exhaust system in combination with stand-alone controllers to provide maximum flexibility in occupied/unoccupied space control scheduling, thus minimizing supply and exhaust air volumes.

- Supply air temperature is to reset to minimize air conditioning of outside air and subsequent reheating of conditioned air.

- Supply air volume from AHUs will be reduced to minimum levels without compromising safety. During occupied hours, room supply air volume will be set at the maximum air flow required to provide fume hood makeup air, minimum required ventilation, or space cooling. This will be accomplished using the VAV air systems and DDCs.

- Heating water temperature is to reset during summer to reduced temperature suitable for reheat.

- VSDs installed on all VAV AHU supply and return fans to reduce fan horsepower requirements of non-peak conditions.

- VSDs installed on all pumps to reduce pump horsepower requirements at non-peak conditions.

- Full economizer control on all mixed AHUs to reduce consumption while maintaining appropriate indoor humidity levels.

8.6.1.10 Electrical

Site Power Distribution

The CUB II Building and CEF II will be provided with 480 Y/277 V secondary service from 2000 kVA outdoor substations CU2-SS1 and CU2-SS2.

Building Power Distribution

Two 3000 A, 480 Y/277 V low-voltage switchgears in the CUB II outdoor substations will distribute power to CF loads and cooling towers. Similar loads will be split and serviced from the two exterior substations to provide a level of redundancy (i.e., two 800-ton chillers will be fed from each of the substations, each with a 1000 A breaker).

Secondary Distribution

- Building secondary distribution will generally be 480 V, 3-phase, 4-wire, plus ground. This will provide service to CF lighting, receptacles, and HVAC loads as well as building instrumentation loads. Further transformation down to 208 Y/120 V, 3-phase, 4-wire, plus ground will be provided for general use receptacles and other low-voltage equipment as necessary.

- All conventional building use dry-type transformers will be DOE 2016 rated for efficiency, 115°C rise, 220°C insulation class with six 2.5% taps. Consideration will be given for harmonic or K-rated transformers and oversized neutrals to handle the heating effects of the harmonic loading.

- Circuit protection will be as follows:
  - Where 480-V distribution is provided, the exterior unit substation secondary will be of low-voltage switchgear UL 1558 construction with electrically operated drawout power circuit breakers with solid state adjustable trips.
  - Generally molded case circuit breakers. Solid state adjustable trip units will be provided above 250 A.
  - Bolt-in type molded case circuit breakers for branch circuit panelboards.
  - 100% rated for service entrance main circuit breakers, 80% rated otherwise.

Devices will be fully rated. Series ratings of protective devices will not be acceptable.

Two levels of ground fault protective devices will be provided at the main and feeder breakers at service switchgear assemblies.

Emergency Power Supply System

EPSS Power Generation Plant

The CUB II and CEF II buildings will be provided with building and instrument standby power from an exterior 300 kW/375 kVA, 480 Y/277 V diesel engine-generator CU2-EG1 located at the CUB II building. It will provide emergency power for life safety systems, including egress lighting, and critical instrumentation and HVAC systems loads.

The exterior diesel standby engine-generator will be provided in an exterior, weatherproof, sound-attenuated, reach-in enclosure with 24-h sub-base fuel tanks. The generator will be provided with a quick-connect feature to be used for load bank testing or portable generator backup if the primary unit is down for maintenance.

EPSS Power Distribution

The EPSS secondary distribution system will be separated into the following branches as required by code.

- Generator: This branch provides alternate source power from the generator set main circuits breaker(s) and associated distribution to the line side of each ATS.

- Emergency (NEC Article 700): This branch provides continuous (normal or generator) source power for the following equipment essential for safety to human life:
  - Interior building means of egress lighting and illuminated exit signs
  - Exterior building means of egress immediately adjacent to exit discharge doorways
  - Fire detection and alarm systems
  - Public address communication systems (when used for issuing emergency instructions)
  - Generator set location, task illumination, battery charger, emergency battery-powered lighting unit(s), and selected receptacles
  - Fire protection systems
  - Experimental processes where interruption would produce serious life safety health hazards, and similar functions

- Combined legally required and optional standby branch, designate as “optional branch” (NEC Article 701 and 702): This branch provides continuous (normal or generator) source power for the following equipment that, when stopped during any interruption of the normal electrical supply, could cause hazards or hamper rescue or firefighting operations; or (optional branch) to protect facilities or property where life safety is not dependent on system performance:
  - Control and alarm systems of major apparatus
  - Experimental processes where any power outage could cause serious interruption of the processor damage to the equipment
  - Ventilation and smoke removal systems
  - Access control systems
  - Telecommunication room lighting, equipment, and data processing systems
  - Electric and mechanical room lighting and selected receptacles

  - Mechanical equipment including boilers, condensate return pumps, hot water heating and glycol circulating pumps
  - Plumbing equipment including sewage ejectors and pumps

- Generator distribution feeders will extend from the EPSS power generation plant to 480 Y/277 V, 4-pole isolation-bypass transfer ATSs with associated distribution panelboards located in the CUB UPS/generator distribution room. The following transfer switches are anticipated:
  - 260 A: Life safety branch (sized large to meet required withstand rating)
  - 600 A: Optional branch

- Associated feeders will extend in a separate duct bank to the CEF II Building.

Power Quality Systems

Uninterruptible Power Supply Systems

A 25 kVA UPS system will be provided for the building IT distribution.

The UPS system will be static (battery) type with maintenance bypass and 15-minute ride through capacity.

Surge Protection Devices

Surge arrestors labeled for use with NFPA 780 lightning protection systems will be provided at all unit substation transformer primaries.

Transients (surges, lightning, switching events) can introduce harmful voltage or current spikes to electronic equipment.

SPD filtering devices will be installed on main low-voltage switchgear, distribution panelboards, and branch panelboards serving major electronic equipment and all emergency branch panelboards in compliance with current code requirements. Sensitive equipment may require multiple levels of protection to not only protect equipment from utility disturbances, but also from one another.

Electric Metering Systems

Electrical metering systems, according to ORNL standards, will be used to monitor and alarm CUB II and CEF II:

- Electrical loading, harmonic loading, and protective device positions. Rail-mounted power quality PM 8214 DIN meters will be required at the unit substation building main service breakers.

- Service low-voltage switchgear mains and feeders

- Medium-voltage interrupter switches, positions, and transformer status

- Distribution panelboards on the load side of ATSs

- Standby engine generator plant and associated distribution equipment

- ATS positions

The system will be networked to the ORNL Power Operations SCADA “SNO” network.

Grounding Systems

Ground Grid

All building grounding systems must be bonded to a common earth ground in compliance with the NEC. Each building will be provided with a #4/0 direct buried copper ring encircling the perimeter of the building, which will provide a convenient means of connecting all metallic systems and equipment into a single equipotential grid that has a low resistance to ground.

Building Grounding

Building steel, foundation rebars (Ufer ground), and metallic water supply piping will be bonded to the ground grid.

Building Lightning Protection

An NFPA 780 Faraday cage type lightning protection system will be provided to protect the building/structure and its occupants and contents from the electrical effects of a lightning strike to ground. The system will include independent down conductors in PVC from the rooftop to the ground grid.

Electrical Power System Grounding

Separate green grounding conductors will be provided with all feeders and branch circuits to provide an intended grounding of the neutrals of the electrical power systems. Each will be bonded to the ground grid with grounding electrode conductors from the distribution system neutral source.

Interconnected bus bars in electrical rooms will collect electrical and electrical equipment grounding conductors to tie the ground ring at the electrical service entrance room.

Electrical Equipment Grounding

All non–current carrying metal parts of electrical equipment enclosures, raceways, boxes, cabinets, housings, frames of motors, luminaires, and so on will be bonded and connected to electrical room ground buses where the associated system neutral is grounded. This allows for a safe ground path in an electrical fault condition.

Telecommunications Signal Reference Grounding

Interconnected bus bars in telecommunication rooms will collect STS IT equipment and pathway grounding conductors and bond to the electrical service entrance room ground bus in compliance with EIA/TIA and NEC requirements.

Lighting Systems

Exterior Lighting

Pole-mounted LED light standards with concrete bases will be provided along roadways and within parking lots.

Building-mounted perimeter LED luminaires will be provided at building exits, walkways, and vehicular circulation areas.

Interior Lighting

LED interior lighting will be provided in compliance with IESNA lighting standards and ASHRAE 90.1 energy budgets.

Energy-efficient, heavy-duty, specification-grade, high bay and industrial LED luminaires are generally anticipated in STS instrumentation areas.

Lighting Controls

Exterior lighting will be provided with photocell and time clock controls.

Interior spaces will be provided with local automatic lighting sensor controls.

Facilities and Operations Building Systems

The building electrical metering system and BAS to monitor electrical and HVAC building systems will be site interconnected to SNS campus systems as described in Site Utilities, Section 8.1.2.1 of this report, and will also include the following systems:

Fire Alarm System

The fire alarm system will be a microprocessor-based detection and notification control system installed and acceptance tested in compliance with NFPA 72, *National Fire Alarm Code*. The building system will include multiplex wiring techniques, a central processing unit (FACU), annunciator units, and peripheral detection and alarm devices.

The system will

- Include smoke, heat, and beam detection devices to suit environmental conditions.
  - High bay areas will be provided with beam smoke detection.

- Include audible horns and visual strobe notification devices.

- Monitor building fire suppression systems and override HVAC functions in an alarm condition for fire and smoke containment.

- Report fire, supervisory, and trouble alarms to the ORNL Fire Department and LSS office in Building 4512 over a fiber optic network.

Wiring will be supervised Class B installed in conduit. Multimode fiber optic cabling will be extended in conduit between the fire alarm control unit and the telecommunication room in each building.

The system will be Edwards/EST Fireworks manufacturer/series according to ORNL requirements to match the existing campus systems.

Public Address System

A public address system will be provided with building amplification as an extension to the campus-wide Valcom mass notification system.

Wiring will be installed in conduit.

Access Control System

The building will be provided with an access control system with central equipment located in the main telecommunications room.

Alarm and supervisory conditions will be reported to the ORNL campus security monitoring location over a fiber optic network.

Components will match existing ORNL equipment for system compatibility.

Telecommunication Systems

The building will be provided with separate telecommunications service from the existing site telecommunications distribution system at CLO to a building main distribution room. Design for the incoming POTS and/or VoIP telephone service, LAN, and wireless networking shall be coordinated with DOE’s prime subcontractor, Black Box. The STS project will provide the interconnecting fiber optic cabling. Refer to the site utilities telecommunication distribution paragraphs, which outline telecommunications service to the STS buildings.

Building IT systems for systems networking hardware, including switches, routers, patch panels, DAS, and WLAN components, will be provided.

Building IT horizontal Category 6A cabling will be provided from telecommunications rooms located on each floor, stacked where possible. Building IT systems will be installed in compliance with EIA/TIA standards.

ORNL F&O Building Systems Distribution

The following building systems/system owners will be interconnected with cables and raceways by SNS CF. The system owners will perform final tie-ins.

- Public address/F&O Instrumentation and Controls
- Fire alarm (FIREWORKS Network)/F&O Laboratory Protection
- Access control/F&O Laboratory Protection
- BAS/(F&O facilities management (CLO II only—Siemens))
- Power monitoring (ION—Schneider)/F&O electrical utilities (including central IT UPS systems monitoring)

Instrument and Control Systems

ORNL STS will provide building Instrumentation and Control systems cabling for interconnection of the following systems:

- PPS

- MPS
- ATS
- PS) (two conduits)
- EPICS

Pathway Systems

Ladder type cable tray will be provided to support telecommunications and instruments and control systems cabling requirements with proper wire dropout devices, conduit sleeves, firestopping, grounding, and wire management components.

Cabling from wall box type IT jacks will be in bushed conduits extended and grounded to the local cable tray system.

8.6.1.11 Plumbing

Drainage/Waste

Sanitary waste from pantry/break room sinks, lavatories, toilets, urinals, mop sinks, and equipment on the upper level will be collected at the lower level ceiling and routed by gravity to the site sewer. All waste from floor drains at the lower level will be collected below the lower level and conveyed by a gravity system to a duplex ejector in fiberglass pit. Ejector will pump drainage to the underground sanitary waste drainage system outside the building. Flow rates and pipe sizes will be calculated based on drainage fixture unit values and adjusted/increased to allow for projected wastewater discharge from various equipment at the design stage.

Floor drains will be provided at all toilet rooms, mechanical equipment spaces and other areas requiring drainage. Complete accessibility will be provided to all cleanouts. Wall type cleanouts will be used at the lower level. Floor drains that do not receive regular use will be provided with trap primers. Primers will consist of an automatic trap primer system that automatically discharges water at regular timed intervals.

Potable Water

Potable water will enter the building at the lower level and shall be provided with a water meter and. shall connect to the BAS. The incoming service shall split at the lower level into potable and process water streams through a foundation for cross-connection control and hydraulic research approved duplex backflow prevention device. Potable hot and cold water will be distributed throughout the building to all fixtures and equipment requiring water. Water make-up any mechanical equipment will be supplied through the process water system. Cooling tower make-up water will be separately metered.

Potable use hot water will be generated at 140°F by a gas fired water heater located at the boiler room. A thermostatic mixing valve will be provided to achieve 120ºF distribution temperatures. Hot water will be distributed through a separate recirculating system designed to provide hot water to the points of use.

Potable hot and cold water shall be distributed throughout the building to toilet rooms and break rooms.

A separate tempered water connection through a thermostatic mixing valve will be provided to supply emergency safety equipment (eyewashes and showers).

Water velocity in distribution piping shall not exceed 8 ft/second for cold water, and 5 ft/second for hot water. Shock arrestors will be provided and shall comply with PDI-WH201 or ASSE-1010.

Process Water

Non-potable Water Service (Mechanical System Makeup)

A separate process water system will be provided for mechanical makeup to CHW system, heating water system and cooling towers. Process water shall emanate from the backflow preventer provided at the incoming potable water service and shall be routed to equipment.

Storm Drainage

The primary storm drainage system will consist of gutters and exterior downspouts for any areas collecting water, routed to spill at grade.

Compressed Air

The central CA system for the STS buildings will be located within the CUB II. The new CA system will have a capacity of 700 SCFM at 150 psig. The system will be located within a separate heated and ventilated space in the CUB and will consist of two 420 SCFM water-cooled oil free rotary screw compressors. Cooling water for the units will be provided from the tower water system. The system will also be provided with duplex, dual tower desiccant dryers designed to handle the capacity of each compressor and dry the air stream to a -40 °F pressure dew-point (minimum). The system will be furnished with a series of moisture separators, prefilters, after filters and final filters. An ASME rated and stamped receiver tank with a capacity of 4,000 Gal will be co-located near the compressor room. A pressure regulating valve will be installed in the CA main supply line to control the site-wide distribution pressure. A control panel with interface to the site EPICS will provide status and alarm conditions. The system controls for the compressors and dryers will operate to alternate each compressor for even wear on the system.

The CA will be distributed throughout the site at a minimum of 100 psig. The new CA piping system will be looped and interconnected to the existing system in the existing Target Building and Tunnels. Each of the compressors will be sized to handle two-thirds of the load. Each compressor will serve as a partial backup in case of failure of a single compressor. The distribution piping serving each building will be sized for the current building program with an additional 20% load provided to accommodate for renovation flexibility.

Equipment

System Design Criteria

Potable/Process water

- Potable water system is designed to provide a minimum of 40 psi at the furthest outlet.
- Process water system is designed to provide a minimum of 40 psi at the furthest outlet.
- Water piping shall be sized based on the number of water fixture units connected, and the minimum flow pressure required at each fixture or piece of equipment. Pipe velocities shall be maintained between 4 and 8 ft/second and shall not exceed 8 ft/second.
- Valves shall be placed to isolate individual fixtures within one room or a battery of fixtures within any one room.

- Wall hydrants shall be placed on the exterior of the building a maximum of 150 ft on center.

- Hose outlets will be provided at all mechanical rooms and equipment spaces.

Sanitary/Waste

- The waste system shall connect to each fixture requiring connection and where required will be provided with water seal traps. A vent system shall be provided for fixtures as required to ventilate the waste system and to prevent siphonage of fixture traps.

- Floor drains will be provided at all mechanical rooms and equipment spaces.

- Waste and vent piping shall be sized based on the number of fixture units connected. Pipe shall be routed by gravity to maintain a positive slope with a maximum velocity of 2 ft/second.

Storm Drainage

- Storm piping shall be sized based on a 100-year occurrence rainfall rate with a 60-min duration.

Compressed Air

- Design CA pressure on outgoing service—110 psi
- Design CA pressure at point of delivery to outlets—100 psi
- Design flow at outlets—1.0 cfm
- Dew point –40°F

Materials

Potable Water System

- Above-ground potable water systems
  - Tubing to be Type L hard temper with wrought copper fittings conforming to ASTM B88-and ASME B16.22. All joints shall be soldered with ASME AWS/A5.8 lead-free solder.
  - Copper tubing with grooved ends and mechanical joints is acceptable for sizes 2½ in. to 6 in. only. Tubing to be Type L hard temper with wrought grooved end fittings conforming to ASTM B88 and ASTM B75.
  - The entire potable hot and cold-water distribution system will be fully insulated using closed-cell elastomeric foam insulation.

Process Water Systems

- Above-ground process water systems
  - Tubing to be Type L hard temper with wrought copper fittings conforming to ASTM B88-and ASME B16.22. All joints shall be soldered with ASME AWS/A5.8 lead-free solder.
  - Copper tubing with grooved ends and mechanical joints is acceptable for sizes 2½ in. to 6 in. only. Tubing to be Type L hard temper with wrought grooved end fittings conforming to ASTM B88 and ASTM B75.
  - The entire process water distribution system will be fully insulated using closed-cell elastomeric foam insulation.

Sanitary System

- Above-ground soil, waste, vent piping
  - Hubless cast iron soil pipe: no-hub pipe with Husky SD-4000 soil pipe coupling manufactured by Anaheim Foundry, 4-band clamp or Clamp-All Hi Torq 125 2-band clamp. Sealing gasket shall be neoprene in accordance with ASTM C564, CISPI 301-75.
  - Horizontal storm drainage piping will be fully insulated using closed-cell elastomeric foam insulation.

- Below-ground soil, waste, vent piping
  - Asphaltum-coated, service-weight, cast iron pipe and fittings with resilient neoprene push-on joints, ASTM A72, ASTM C564-70.

Compressed Air

- Below-ground factory-coated steel pipe
- Above-ground Type K copper with brazed joints.

Plumbing Fixtures and Specialties

- All plumbing fixtures will be institutional grade, vitreous china or stainless steel as required.

- Floor sinks and floor drains in laboratory areas (if required) will be stainless steel, flush with finished floor, minimum of three 3-in. outlets.

- Hub drains and similar unsanitary fixtures will not be provided in lab spaces.

- Water closets: wall-hung, siphon jet type, high-efficiency 1.28 gal per flush maximum with hard-wired infrared sensor operation.

- Urinals: wall-hung siphon jet type, high-efficiency 0.125 gal per flush maximum with hard-wired infrared sensor operation.

- Lavatories: wall-hung or countertop type, 0.5 gal per minute maximum with hard-wired infrared sensor operated faucets.

- Showers: high-efficiency 1.5 gal/min maximum.

- Safety showers, eyewashes and combination units: 30 psi minimum.

- Electric water coolers: recessed, self-contained.

- Interior hose bibbs: chrome plated in finished areas, rough brass in mechanical rooms, wall-mounted, furnished with vacuum breaker, ¾-in. hose threaded outlet.

- Wall hydrant: freeze-resistant type in recessed box, ¾-in. hose threaded outlet.

8.6.1.12 Fire Protection

Sprinkler

CUB II will be fully sprinkled, with exposed sprinkler piping feeding upright sprinklers. Sprinkler feed will enter the building from below grade into the lower level from the site potable/fire water main, and a double check backflow preventer will be provided. Service building will be a single sprinkler zone, with control valve located at incoming service. Control valve will be provided with tamper switch and flow switch connected to fire alarm system.

General

System Design Criteria

Fire sprinkler systems for the CUB will be hydraulically designed to provide water densities that meet the requirements for Ordinary Hazard–Group 1 protection throughout the facilities.

Velocity shall not exceed 20 fps.

All calculations assume a minimum of 10 psi deterioration in static and residual pressures in the hydrant flow test results.

Materials

- Pipe and fittings installed underground shall be Class 52 ductile iron cement lined with mechanical joints with a working pressure rating of 350 psig.

- Sprinkler piping installed above ground and sized 2 in. and smaller and all standpipe piping shall be Sch 40 black steel with threaded joints and fittings.

- Sprinkler piping installed above ground and sized 2½ in. and larger shall be Sch 40 black steel with roll or cut groove type connections and fittings. Pressure rating shall be 175 psig minimum.

- Fittings for grooved end shall be cast of ductile iron conforming to ASTM A-536 or malleable iron conforming to ASTM A-47, or forged steel conforming to ASTM A-234 (A-106, Gr. B), with grooved or shouldered ends for direct connection into grooved piping systems with steel pipe and shall be UL listed and FM approved, rated for a minimum 300 psi MWP.

8.6.2 Central Exhaust Facility II

8.6.2.1 Programming

Building Function

The CEF II will consist primarily of non-enclosed exterior space that includes exhaust fans and a central exhaust stack that serve Target Building II, the 40M, 50M and 90M Instrument Buildings, and the RTST Tunnel. The CEF II will not serve the CLO II or CUB II, which will have independent exhaust systems. The facility also will include a small building that houses electrical and control systems associated with the CEF II. Access to the CEF II will be limited to STS technical and facility operations staff.

Program Summary

The CEF II includes primarily exterior equipment which is not programmed as net area. The CEF II includes one small, 300 nsf, Control Building. It has an estimated planning efficiency factor of 79%. The estimated gross area of the building is 380 gsf. Table 8.38 summarizes the CEF II space program requirements. Detailed room data sheets and test-fit plans are included in Appendix B.

Table 8.38. CEF II space program summary.

No.	Rooms	Qty.	NSF	Total NSF
5.6.2.1	Central Exhaust Fan Control Building	1	300	300
Total nsf				**300**
Total gsf				**380**
Total efficiency				**79%**

8.6.2.2 Site Planning

Location and Floor Elevations

The CEF II will be located within the perimeter of the ring road northeast of the STS complex. The CEF II exterior service court area will be located at elevation 1078 ft. Figure 8.16 highlights the CEF II within the overall STS Site Plan.

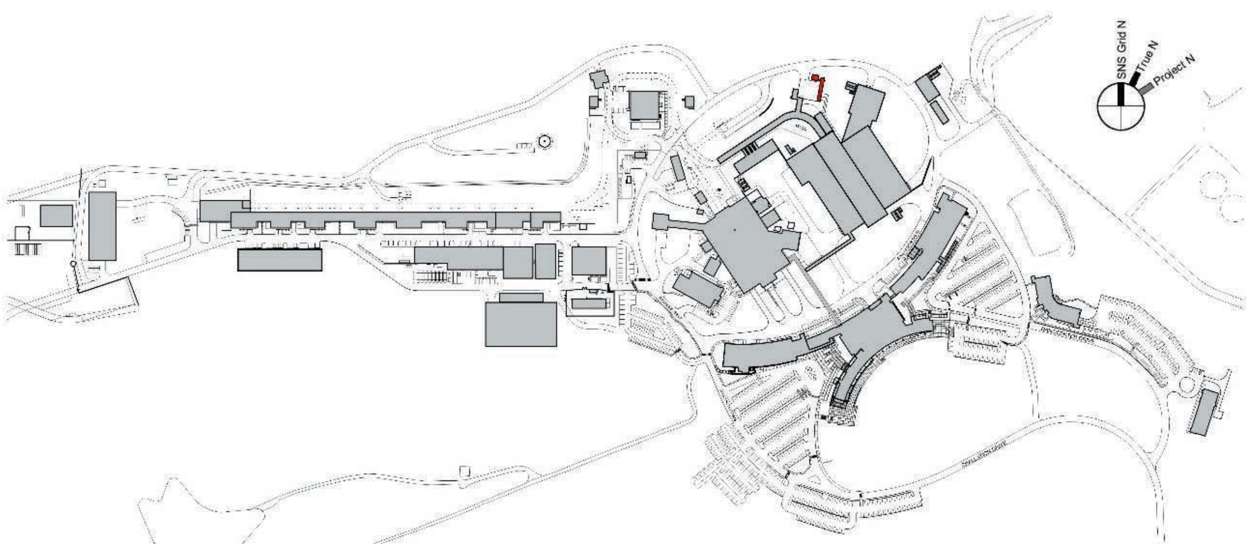


Figure 8.16. CEF II location within the STS Site Plan.

Truck Access

Tractor-trailer and smaller truck access for the CEF II will be located on the northwest side of the facility at elevation 1078 ft. A loading dock is not required. Forklifts will be used to convey materials and equipment between the facility and trucks.

Pedestrian Access

Pedestrian access to the CEF II will be at grade through a perimeter-controlled security fence and at the first floor of the Control Building through a controlled access door.

8.6.2.3 Building Planning

Building Organization/Floor Planning

The CEF II planning will be integrated with planning for the RTST Access Tunnel. Both functions will share an exterior service court for vehicular access. The service court will be partially enclosed by retaining walls. The retaining walls will allow a grade transition between the service court and other exterior service access area into the west end of Target Building II, approximately 25 ft above. Large exhaust ducts, serving Target Building II and the RTST Tunnel, will be located below the elevated grade and terminate at the CEF II exterior service court area. Eight exhaust fans serving four separate exhaust systems will be located adjacent to the vehicular area and will manifold together to exhaust through a single stack.

8.6.2.4 Key Features and Requirements

Central Exhaust Stack

The grade-supported exhaust stack is estimated to be approximately 100 ft tall to allow the discharge elevation to sufficiently clear surrounding structures. Analysis of the stack height and exhaust system performance will require air dispersion modeling during future design phases.

8.6.2.5 Life Safety/Code

Primary Occupancy Type

The primary occupancy type for the CEF II is Group F-2, Low Hazard Factory Industrial, according to the 2015 IBC, and Special-Purpose Industrial according to NFPA 101, 2018 edition.

Accessory Occupancies

The CEF II will not have any accessory occupancies.

Fire Protection Systems

Portable fire extinguishers will be provided throughout the building in accordance with the IBC and NFPA 10, *Standard for Portable Fire Extinguishers*.

The CEF II will be equipped with an addressable fire detection/alarm system consisting of the following:

- Manual fire alarm pull station at the building exit,
- Audible/visual notification appliances installed through the building

All fire alarm, supervisory alarm, and trouble signals will be automatically transmitted to the ORNL Fire Department via the LSS fiber optics network.

All new fire alarm system equipment will be manufactured by Edwards Systems Technology to be compatible with the existing site-wide campus system.

The fire detection/alarm system will be designed and installed in accordance with the IBC and NFPA 72, *National Fire Alarm Code*.

Maximum Floor Area and Stories

The CEF II will be a single-story, 432 SF building constructed of Type IIB construction. The proposed height and area for the building are within the limits established in IBC Sections 504 and 506.

Travel Distances

The CEF II will have a single exit with travel distances in accordance with the IBC and NFPA 101.

Construction Type

The CEF II will be constructed of Type IIB construction in accordance with IBC Section 602.

Wall/Floor Ratings

The walls, floor, and roof of the CEF II will be of noncombustible construction. Fire resistance ratings are not required for buildings of Type IIB construction.

Special Code Considerations

There are no special code considerations associated with the CEF II.

8.6.2.6 Civil/Site Development

The CEF II is proposed to the west of STS facility near the RTST Tunnel entrance. Vehicle access to this area can be accomplished from the ring road. Finished grading is shown on Drawing 5.1.19. Drawing 5.1.22 shows the site drainage concept. It is assumed that any required sewer, fire, or domestic water services to this building will be served from the target or RTST Tunnel.

8.6.2.7 Architecture

Building Envelope

Exterior Wall

The majority of the walls surrounding CEF II will be concrete counterfort retaining walls with a parge-coated finish. A striated-face, 36 in. wide insulated-core metal panel system, with a custom color to match existing context, will be used as for the envelope of the CEF II Fan Control Room in keeping with the existing texture and materials used on the SNS campus. The metal panel cladding support backup system will consist of a hanger rod and metal channel framing supported from the building structure. Continuous through-wall flashing will be provided at the bottoms of all wall cavities, over all wall openings and metal copings. The metal panel wall systems will have an R-13 and R-13ci minimum requirement.

Exterior Doors

Exterior entrance doors and egress doors will be 16-gauge, insulated-core painted hollow metal doors with fully welded 14-gauge frames and a U value of 0.61. All exterior doors will be provided with proximity card reader hardware.

Thermal and Moisture Protection

Flashing and sheet metal will be provided as a positive water stop around all openings (head, jamb, and sill) in walls such as windows, doors, louvers, and so on. All copings and gravel stops will be ES-1 compliant as required by IBC.

Damp-proofing will be provided on all walls, floors, and other building components that are subject to high humidity, dampness, or frequent direct water contact.

Waterproofing will be provided at walls, floors, and other building elements that are subject to hydrostatic pressure, are liable to be immersed in water, or are below the water table. The waterproofing membrane will be a hot-fluid-applied, two-layer, 215-mil, polyester fabric–reinforced membrane.

Because of the inherent moisture-resistant properties of the insulated metal panel system, an air/vapor barrier will not be required where the system is installed.

Exterior sealants will be nonstaining, with a two-part composition and 50% movement capacity, and will be compatible with the surfaces on which they are applied.

Insulation combustibility, including wrappings, inside the building skin will be limited to a flame spread of 25 and smoke development of less than 50.

Glazing

Not applicable

Roof Construction

The roofing system will be a 30-year, 80 mil minimum thickness, white thermoplastic (PVC) single-ply sheet with an integral fiberglass mat reinforcement roofing membrane over polyisocyanurate insulation on a sloping roof structure. Tapered insulation saddles will be used to provide drainage to roof drains and at roof equipment locations. All roof construction details and roof penetrations must comply with the guidelines established by the NRCA. Roof traffic pads will be adhered to the membrane along all roof maintenance traffic paths. All roofs with serviceable components beyond roof drains will be surrounded by a 42-in.-high parapet or provided with a fall protection system.

Low-slope roofing will have a minimum 3-year aged solar reflectance of 0.55 and a minimum 3- year aged thermal emittance of 0.75 in accordance with the Cool Roof Rating Council Program. Roofing will be Energy Star rated with emissivity of at least 0.9 when tested in accordance with ASTM 408.

The roofing system will meet or exceed UL class A fire exposure requirements and comply with FM Class I-90 for wind uplift according to ASTM 1592. It will provide a minimum thermal resistance value of R-30

Interior Construction

Walls

Not applicable

Wall Finishes

Not applicable

Floor Finishes

The flooring will receive concrete sealer over the new concrete with no vinyl wall base required.

Ceiling Finishes

The structure will be left exposed in the CEF II and will receive a paint finish consisting of one primer coat and two finish coats.

Interior Doors

Not applicable

Furnishings

Laboratory Casework

Not applicable

Vertical Circulation

Stairs

Not applicable

Elevators

Not applicable

Specialty Equipment

Not applicable

8.6.2.8 Structure

Applicable Codes and Standards

See Sheets x – xii for complete list of Applicable Codes and Standards

Design Loading

Slab on Grade Floor Loads

- Live loads: 500 psf

Superimposed Roof Loads

- Roof snow load:

  - Ground snow load: Pg = 10 psf
  - Snow exposure factor: Ce = 1.0
  - Snow importance factor: Is = 1.0

- Minimum roof live load = 20 psf + 20 psf collateral load

Wind Loads

- Risk category II
- Basic wind speed: V = 115 mph
- Exposure category B

Seismic Loading

- Risk category II
- Importance factor: Ie = 1.0

Building Structural System

Slab on Grade

The slab construction is anticipated to consist of an 8-in.-thick reinforced normal weight concrete slab. All construction joints between pours will require smooth dowels across the joint. The floor slab will be placed over a vapor barrier, a compacted drainage base course, and a compacted subgrade.

It is anticipated that there will be an exterior grade-level slab for support of equipment. The slab will be used as the foundation for the equipment.

Foundation System

A geotechnical investigation has not been performed. Until a geotechnical investigation and report have been completed, an accurate description of the building’s foundation system cannot be provided. The CEF II foundations are anticipated to consist of shallow spread footings bearing on soil with a minimum net allowable bearing capacity of 3,000 psf. Footings shall extend to the frost depth elevation at a minimum. Below-grade walls are anticipated to be constructed with reinforced normal weight concrete. Water stops will be provided in construction joints to safeguard against water intrusion.

Superstructure

The CEF II is anticipated to be a single-story conventional steel-frame structure. The building will support the exterior wall system with steel girts as required. The roof structural system is anticipated to consist of wide flange framing with roof deck meeting galvanizing G90 requirements.

Lateral System

Resistance to lateral loads resulting from wind and seismic forces on the building are anticipated to be provided by concentrically braced steel frames.

Geotechnical Analysis

A review of historical geotechnical and geophysical surveys was performed that included the original campus development and additional structures. A detailed geotechnical exploration was performed by Law Engineering dated June 30, 2000, addressing the original development of the campus (Law 2000). The proposed CEF II should be supported on shallow foundations. The structure will be located at a sufficient distance beyond the STS excavation that additional support with deep foundations should not be necessary. The stiffer or better upper crust of residual soil should be sufficient to support CEF Building. Based on the current subsurface data on the site, we anticipate as much as 3,000 psf allowable bearing pressure will be available.

A review of geophysical data and shear wave velocities from the Law report indicates that the target structure footprint would be located in a seismic site classification C as defined in IBC 2015 and ASCE 7 (Law 2000). This is confirmed by the average shear wave velocities for multiple soil profiles tested during the original campus development.

A supplemental geotechnical report would be advisable once the final CEF location and footprint have been determined. The density and pattern of the soil test borings should be selected to optimize the quality of geotechnical data. Additional geophysical testing is not anticipated for design of the structure.

Vibration/Acoustics

This building has no acoustical or vibration criteria.

8.6.2.9 Mechanical

Exhaust

The project technical exhaust air streams handled by the CEF II will consist of Target Building primary confinement exhaust, Target Building secondary confinement exhaust, Target Building hot off-gas exhaust and RTST Tunnel emergency exhaust. The CEF II will house separate fans for each of these systems on an equipment pad located to the west of the STS building. Fan systems will be arranged in a duplex configuration, with one fan in each set a full standby. Each fan will be provided with a shutoff damper on the suction side and a motorized shutoff damper on the fan discharge. All above-round ductwork will be 304 SS. All underground ductwork will be HDPE.

The Target Building primary confinement exhaust will collect exhaust from the potentially highly activated areas of the Target Building. System capacity is expected to be 4,000 cfm. Ductwork size is estimated to be 14-in. diameter.

The Target Building secondary confinement exhaust will collect exhaust from the potentially activated areas of the Target Building. System capacity is expected to be 16,000 cfm. Ductwork size is estimated to be 30-in. diameter.

The Target Building hot off-gas exhaust will collect exhaust from highly activated areas of the target system. System capacity is expected to be 2,000 cfm. Ductwork size is estimated to be 10-in. diameter.

The RTST Tunnel emergency exhaust will collect exhaust from the tunnel in the event that the tunnel requires emergency ventilation as a result of contamination. System capacity is expected to be 3,000 cfm. Ductwork size is estimated to be 12-in. diameter.

An exhaust header manifold will be used to combine the exhaust streams of the three fan systems. The manifold is expected to be 36 in. The manifold will extend into a vertical stack that will also be mounted on the equipment pad. The stack will be 40 in. or less, as required to achieve a 3,000 fpm stack discharge velocity. The height of the stack is anticipated to be approximately 100 ft. Final stack height will be based on input from the ORNL Environment, Safety, and Health Directorate and as verified by wind tunnel testing.

Space Conditioning

An instrument and control building will be provided for the CEF II. Conditioning in this building will be provided through two localized heat pumps. Heat pumps will be sized for 100% of the anticipated load, N+1 configuration, with supplemental electric heating coil for sub-freezing conditions.

Controls

The CEF II shall be controlled by the EPICS. The facility will be connected to an expansion of the existing EPICS. Instrumentation and wiring shall be connected to a new EPICS PLC in the central exhaust building, and controls interface for the building will be provided at the target control room. Programming and connection of the PLC to EPICS shall be completed and the control system commissioned to ensure proper operation.

Electric actuation will be used for all dampers on both systems so that instrument air is not required. All control systems will be on UPS and emergency power. System software and firmware will provide the following functions:

- Control sequences shall be developed to support the operations of the technical equipment.
- PID control to allow faster and closer control to system set points.
- Adaptive tuning to adjust PID loop constants to ensure that control system response remains accurate and reliable over a wide range of dynamic operating conditions.
- Monitoring to read the value of measured variables, to read control loop set points, to monitor control signals to actuators, and to indicate status of equipment, alarms and overrides.
- Energy management, including optimum start/stop, variable ACH rates in laboratories, duty cycling, supply air temperature reset, supply air static pressure reset, demand limiting, time totalization, and so on.
- Data management, including continuous database updating, alarm reporting, trend logging and report generation.
- System programming to add, delete, or change points, set points, schedules, control algorithms, report formats, and so on.
- System software will allow building operators to graphically monitor and control building operations and provide the functions listed. Graphics will include site plans, overall building plans, floor plans and individual system graphics.

Equipment

Table 8.39 provides a listing of the mechanical equipment servicing the CEF II.

Table 8.39. CEF II mechanical equipment.

Use	Equipment	Size	Qty	Em pwr	Redund	Location	Remarks
Primary confinement exhaust	Exhaust fan	4,000 cfm @ 25 in. Wg	2	Y	N+1	Outside	Target primary confinement exhaust
Secondary confinement exhaust	Exhaust fan	16,000 cfm @ 15 in. wg	2	Y	N+1	Outside	Target/Inst. Bldg secondary confinement exhaust
Hot off-fas exhaust	Exhaust fan	2,000 cfm @ 40 in. wg	2	Y	N+1	Outside	Target/Inst. Bldg hot off-gas
RTST exhaust	Exhaust fan	3,000 cfm @ 5 in. wg	2	Y	N+1	Outside	RTST emergency exhaust
CEF II air conditioning	Heat pumps with electric heat	5 ton	2	Y	N+1	Fan VFD/ elec	

- Two primary confinement exhaust fans with VFDs
- Two secondary confinement exhaust fans with VFDs
- Two hot off-gas exhaust fans with VFDs
- Two RTST Tunnel exhaust fans with VFDs
- Ductwork manifold (40-in. 304L SS).
- Vertical stack (100 ft high)
- Fan isolation dampers
- Controls and instrumentation
  - Exhaust fans
  - Scroll blowers

Fans will be centrifugal, direct-drive scroll blowers with spark-proof construction and bearings and motors out of the airstream. Fans will be constructed with 304 stainless steel welded housing and wheel construction. The fan motor will be totally enclosed and fan cooled. The system will consist of the following components:

- VFDs
- Mounting base

General

System Design Criteria

Outside Design Temperatures

- Summer: 92.8°F DB, 73.8°F MCWB (0.4% ASHRAE)
- Winter: 17.1°F (99.6% ASHRAE)

Interior Design Conditions (Central Exhaust Building)

- 72°F ±2°F, 60% >RH
- Stack discharge velocity 3,000 fpm minimum

Each exhaust fan system will be designed in an N+1 configuration with two full-capacity fans. Should one fan fail or be shut down for maintenance, the second fan will be capable of meeting the full airflow requirement. All exhaust fans will be served by emergency power.

Materials

Primary and second confinement, hot off-gas, and RTST Tunnel exhaust shall be welded 304L stainless steel thinwall tube within the building, HDPE underground.

Mechanical Calculations

Mechanical calculations are provided in Appendix C for both air side and cooling water side.

8.6.2.10 Electrical

Site Power Distribution

The CEF II Building and CUB II will be provided with 480 Y/277 V secondary services from 2000 kVA outdoor substation CU2-SS1 and CU2-SS2.

The CEF II will be provided with 480 Y/277 V secondary normal service from a duct bank to the building from CUB II distribution.

Building Power Distribution

Secondary Distribution

Building secondary distribution will generally be 480 V, 3-phase, 4-wire, plus ground. This will provide service to CF lighting, receptacles, and HVAC loads as well as building instrumentation loads. Further transformation down to 208 Y/120 V, 3-phase, 4-wire, plus ground will be provided for general use receptacles and other low-voltage equipment as necessary.

All conventional building use dry-type transformers will be DOE 2016 rated for efficiency, 115°C rise, 220°C insulation class with six 2.5% taps. Consideration will be given for harmonic or K-rated transformers and oversized neutrals to handle the heating effects of the harmonic loading.

Circuit protection will be as follows:

- Where 480-V distribution is provided, the exterior unit substation secondary will be of low-voltage switchgear UL 1558 construction with electrically operated drawout power circuit breakers with solid state adjustable trips.

- Generally molded case circuit breakers. Solid state adjustable trip units will be provided above 250 A.

- Bolt-in type molded case circuit breakers for branch circuit panelboards.

- 100% rated for service entrance main circuit breakers, 80% rated otherwise.

Devices will be fully rated. Series ratings of protective devices will not be acceptable.

Two levels of ground fault protective devices will be provided at the main and feeder breakers at service switchgear assemblies.

Emergency Power Supply System

EPSS Power Generation Plants

The CUB II and CEF II Buildings will be provided with building and instrument standby power from an exterior 300 kW/375 kVA, 480 Y/277 V diesel engine-generator CU2-EG1 located at the CUB II Building. It will provide emergency power for life safety systems, including egress lighting, and critical instrumentation and HVAC systems loads.

The exterior diesel standby engine-generator will be provided in an exterior, weatherproof, sound-attenuated, reach-in enclosure with 24-h sub-base fuel tanks. The generator will be provided with a quick-connect feature to be used for load bank testing or portable generator backup if the primary unit is down for maintenance.

EPSS Power Distribution

The EPSS secondary distribution system will be separated into the following branches as required by code.

- Generator: This branch provides alternate source power from the generator set main circuits breaker(s) and associated distribution to the line side of each ATS.

- Emergency (NEC Article 700): This branch provides continuous (normal or generator) source power for the following equipment essential for safety to human life:
  - Interior building means of egress lighting and illuminated exit signs
  - Exterior building means of egress immediately adjacent to exit discharge doorways
  - Fire detection and alarm systems
  - Public address communication systems (when used for issuing emergency instructions)
  - Generator set location, task illumination, battery charger, emergency battery-powered lighting unit(s), and selected receptacles
  - Fire protection systems
  - Experimental processes where interruption would produce serious life safety health hazards, and similar functions

- Combined legally required and optional standby branch, designate as “optional branch” (NEC Article 701 and 702): This branch provides continuous (normal or generator) source power for the following equipment that, when stopped during any interruption of the normal electrical supply, could cause hazards or hamper rescue or firefighting operations; or (optional branch) to protect facilities or property where life safety is not dependent on system performance:
  - Control and alarm systems of major apparatus
  - Experimental processes where any power outage could cause serious interruption of the processor damage to the equipment
  - Ventilation and smoke removal systems
  - Access control systems

- Telecommunication room lighting, equipment, and data processing systems
- Electric and mechanical room lighting and selected receptacles
- Mechanical equipment including boilers, condensate return pumps, hot water heating, and glycol circulating pumps
- Plumbing equipment including sewage ejectors and pumps

Generator distribution feeders will extend from the EPSS power generation plant to 480 Y/277 V, 4-pole isolation-bypass transfer ATSs with associated distribution panelboards located in the CUB II Building UPS/generator distribution room. The following transfer switches are anticipated at that location:

- 260 A: Life safety branch (sized large to meet required withstand rating)
- 600 A: Optional branch

Associated feeders will extend in a separate duct bank to the CEF II Building.

Power Quality Systems

Uninterruptible Power Supply Systems

A 25 kVA UPS system will be provided for the building IT distribution.

The UPS system will be static (battery) type with maintenance bypass and 15-minute ride through capacity.

Surge Protection

Surge arrestors labeled for use with NFPA 780 lightning protection systems will be provided at all unit substation transformer primaries.

Transients (surges, lightning, switching events) can introduce harmful voltage or current spikes to electronic equipment.

SPD filtering devices will be installed on main low-voltage switchgear, distribution panelboards, and branch panelboards serving major electronic equipment and all emergency branch panelboards in compliance with current code requirements. Sensitive equipment may require multiple levels of protection to protect items of equipment not only from utility disturbances but also from one another.

Grounding Systems

Ground Grid

All building grounding systems must be bonded to a common earth ground in compliance with the NEC. Each building will be provided with a #4/0 direct buried copper ring encircling the perimeter of the building, which will provide a convenient means of connecting all metallic systems and equipment into a single equipotential grid that has a low resistance to ground.

Building Grounding

Building steel, foundation rebars (Ufer ground), and metallic water supply piping will be bonded to the ground grid.

Building Lightning Protection

An NFPA 780 Faraday cage type lightning protection system will be provided to protect the building/structure and its occupants and contents from the electrical effects of a lightning strike to ground. The system will include independent down conductors in PVC from the rooftop to the ground grid.

Electrical Power System Grounding

Separate green grounding conductors will be provided with all feeders and branch circuits to provide an intended grounding of the neutrals of the electrical power systems. Each will be bonded to the ground grid with grounding electrode conductors from the distribution system neutral source.

Interconnected bus bars in electrical rooms will collect electrical and electrical equipment grounding conductors to tie the ground ring at the electrical service entrance room.

Electrical Equipment Grounding

All non–current carrying metal parts of electrical equipment enclosures, raceways, boxes, cabinets, housings, frames of motors, luminaires, and so on will be bonded and connected to electrical room ground buses where the associated system neutral is grounded. This will allow for a safe ground path in an electrical fault condition.

Telecommunications Signal Reference Grounding

Interconnected bus bars in telecommunication rooms will collect STS IT equipment and pathway grounding conductors and bond to the electrical service entrance room ground bus in compliance with EIA/TIA and NEC requirements.

Lighting Systems

Exterior Lighting

Pole-mounted LED light standards with concrete bases will be provided along roadways and within parking lots.

Building-mounted perimeter LED luminaires will be provided at building exits, walkways, and vehicular circulation areas.

Interior Lighting

LED interior lighting will be provided in compliance with IESNA lighting standards and ASHRAE 90.1 energy budgets.

Energy-efficient, heavy-duty, specification-grade, high bay and industrial LED luminaires are generally anticipated in STS instrumentation areas.

Lighting Controls

Exterior lighting will be provided with photocell and time clock controls.

Interior spaces will be provided with local automatic lighting sensor controls.

Communication and Signaling Systems

Fire Alarm System

The fire alarm system will be a microprocessor-based detection and notification control system installed and acceptance tested in compliance with NFPA 72, *National Fire Alarm Code*. The building system will include multiplex wiring techniques, a central processing unit (FACU), annunciator units, and peripheral detection and alarm devices.

The system will

- Include smoke and heat detection devices to suit environmental conditions
- Include audible horns and visual strobe notification devices
- Monitor building fire suppression systems and override HVAC functions in an alarm condition for fire and smoke containment
- Report fire, supervisory, and trouble alarms to the ORNL Fire Department and LSS office in Building 4512 over a fiber optic network

Wiring will be supervised Class B installed in conduit. Multimode fiber optic cabling will be extended in conduit between the fire alarm control unit and the telecommunication room in each building.

The system will be Edwards/EST Fireworks manufacturer/series according to ORNL requirements to match the existing campus systems.

Public Address System

A public address system will be provided with building amplification as an extension to the campus-wide Valcom mass notification system.

Wiring will be installed in conduit.

Access Control System

The building will be provided with an access control system with central equipment located in the main telecommunications room.

Alarm and supervisory conditions will be reported to the ORNL campus security monitoring location over a fiber optic network.

Components will match existing ORNL equipment for system compatibility.

Telecommunication Systems

The building will be provided with a separate telecommunications service from the existing site telecommunications distribution system at CLO to a building main distribution room. Design for the incoming POTS and/or VoIP telephone service, LAN, and wireless networking shall be coordinated with DOE’s prime subcontractor, Black Box. The STS project will provide the interconnecting fiber optic cabling. Refer to the site utilities telecommunication distribution paragraphs, which outline telecommunications service to the STS buildings.

Building IT systems for systems networking hardware and cabling, including switches, routers, patch panels, backbone cabling, and components will be provided.

Building IT horizontal Category 6A cabling will be provided from telecommunications rooms located on each floor, stacked where possible. Building IT systems will be installed in compliance with EIA/TIA standards.

ORNL F&O Building Systems Distribution

The following building systems/system owners will be interconnected with cables and raceways by SNS CF. The system owners will perform final tie-ins.

- Public address/F&O Instrumentation and Controls
- Fire alarm (FIREWORKS Network)/F&O Laboratory Protection
- Access control/F&O Laboratory Protection
- BAS/(F&O Facilities Management (CLO II only—Siemens))
- Power monitoring (ION—Schneider)/F&O Electrical Utilities (including central IT UPS systems monitoring)

Instrument and Control Systems

ORNL STS will provide building instrumentation and control systems cabling for interconnection of EPICS.

Pathway Systems

Ladder-type cable trays will be provided to support telecommunications and instruments and control systems cabling requirements with proper wire dropout devices, conduit sleeves, firestopping, grounding, and wire management components.

Cabling from wall box–type IT jacks will be in bushed conduits extended and grounded to the local cable tray system.

8.7 SHOP BUILDING

8.7.1 Shop Building

8.7.1.1 Programming

Building Function

The Shop Building will house multiple workshop functions required to support FTS and STS operations including a cryogenics, pump, radio frequency, and modulator shops. The Shop Building will replace functions that were removed from the Klystron Gallery to allow construction of the PPU Klystron Galley Upgrade project. The Shop Building will include a flexible, open plan that is readily adaptable to variable technical needs and operational requirements. Access to this facility will be limited to STS technical and facility operations staff.

Program Summary

The Shop Building will include 21,090 NSF and has an estimated planning efficiency factor of 83%. This factor is based on preliminary test-fit planning for the Shop Building. The estimated gross area of the Shop Building is 25,518 gsf. Table 8.40 summarizes the Shop Building space program requirements. Detailed room data sheets and test-fit plans are included in Appendix B, STS CF Conceptual Design Report.

Table 8.40. Shop Building space program summary.

No.	Rooms	Qty.	NSF	Total NSF
5.7.1.1	Cryogenics shop	1	6,000	6,000
5.7.1.2	Pump shop	1	2,400	2,400
5.7.1.3	RF shop	1	6,000	6,000
5.7.1.4	Modular shop	1	6,300	6,300
5.7.1.5	Electrical room	1	130	130
5.7.1.6	Telecom room	1	130	130
5.7.1.7	Single-user toilets	2	65	130
5.7.1.8	Mechanical room	1	520	520
Total nsf				**21,090**
Total gsf				**25,518**
Total efficiency				**83%**

8.7.1.2 Site Planning

Location and Floor Elevations

The Shop Building will be located west of the existing Central Helium Liquification Plant along Los Alamos Drive. The Shop Building first floor will be located at elevation 1084 ft. Figure 8.17 highlights the Shop Building within the overall STS Site Plan.

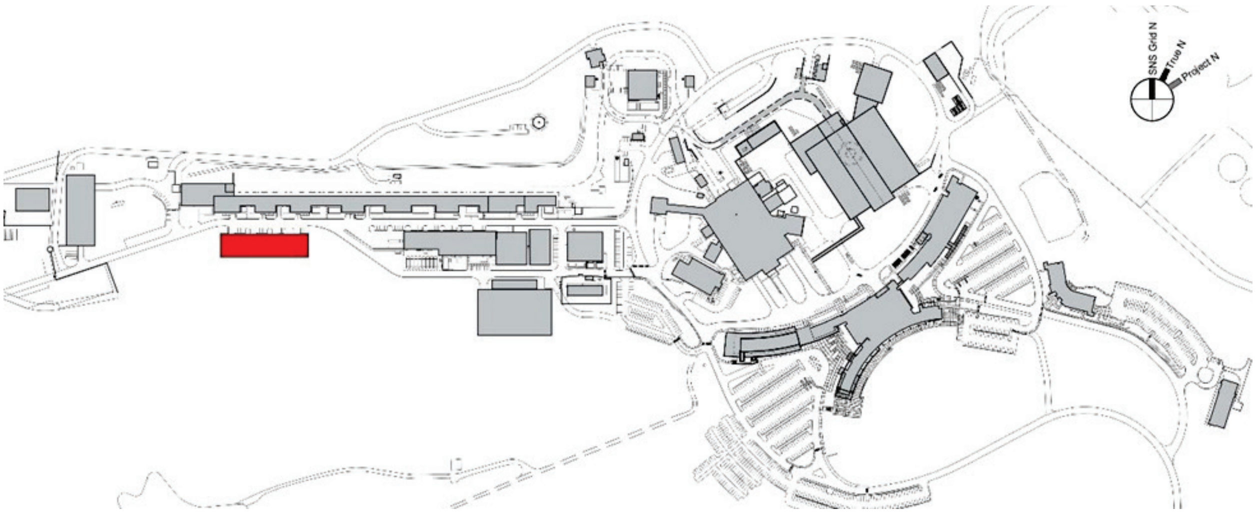


Figure 8.17. Shop Building location within the STS Site Plan.

Truck Access

Tractor-trailer and smaller truck access for the Shop Building will be located on the west side of the facility at the first-floor level, elevation 1079 ft. A loading dock is not required. Forklifts will be used to convey materials and equipment between the building and trucks through overhead service doors.

Pedestrian Access

Pedestrian access to the Shop Building will be provided at the first-floor level from the adjacent service road. Multiple controlled grade-level doors will be provided along the length of the facility.

8.7.1.3 Building Planning

Building Organization/Floor Planning

The Shop Building will be a single-story structure with an elongated linear floor plan. Four primary shop areas will be organized along an internal circulation aisle located adjacent to the west exterior wall of the facility. All access and egress doors will be located on this side of the building. Separations between shop areas will be wire or low-height solid partitions. An overhead crane will travel above these partitions and provide coverage to the entire open shop area.

8.7.1.4 Key Features and Requirements

Structural Requirements

The Shop Building will require a clear span roof structure and related structural design to support a 10-ton overhead crane.

8.7.1.5 Life Safety/Code

Primary Occupancy Type

The primary occupancy type for the Shop Building is Group F-1, Moderate Hazard Factory Industrial, according to the 2015 IBC, and General Industrial according to NFPA 101, 2018 edition.

Accessory Occupancies

The Shop Building will not have any accessory occupancies.

Fire Protection Systems

The Shop Building will be protected throughout by an automatic fire sprinkler system designed to protect an Ordinary Hazard–Group 2 occupancy in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems.*

Portable fire extinguishers will be provided throughout the building in accordance with the IBC and NFPA 10, *Standard for Portable Fire Extinguishers*.

The Shop Building will be equipped with an addressable fire detection/alarm system consisting of the following:

- Manual fire alarm pull stations at all building exits
- Duct smoke detectors on the supply and return sides of all AHUs having a design capacity greater than 2,000 cfm
- Audible/visual notification appliances installed through the building

All fire alarm, supervisory alarm, and trouble signals will be automatically transmitted to the ORNL Fire Department via the LSS fiber optics network.

All new fire alarm system equipment will be manufactured by Edwards Systems Technology to be compatible with the existing site-wide campus system.

The fire detection/alarm system will be designed and installed in accordance with the IBC and NFPA 72, *National Fire Alarm Code*.

Maximum Floor Area and Stories

The Shop Building will be a single-story, 25,518 SF building of Type IIB construction. The proposed height and area for the building are within the limits established in IBC Sections 504 and 506.

Travel Distances

The maximum travel distance within the Shop Building will not exceed 250 ft, as required by IBC Section 1016.2 and NFPA 101, Section 40.2.6.1. The maximum common path of travel distance will not exceed 100 ft, as required by IBC Section 1014.3 and NFPA 101, Section 40.2.5.1. The maximum dead-end corridor will not exceed 50 ft, as required by IBC Section 1018.4 and NFPA 101, Section 40.6.4.

Construction Type

The Shop Building will be of Type IIB construction in accordance with IBC Section 602.

Wall/Floor Ratings

The walls, floor, and roof of the Shop Building will be of noncombustible construction. Fire resistance ratings are not required for buildings of Type IIB construction.

Special Code Considerations

There are no special code considerations associated with the Shop Building.

8.7.1.6 Civil/Site Development

The construction excavation described under the Site Civil Works Section will be performed before construction of the Shop Building. Vehicular access will be provided from Los Alamos Drive. Finished grading is shown on Drawing 5.1.18. Drawing 5.1.21 shows the site drainage concept. Roof drainage will be piped to the proposed storm sewer system. Sewer, fire, and domestic water service to the building are shown on Drawing 5.1.26.

8.7.1.7 Architecture

Building Envelope

Exterior Wall

A deep-ribbed corrugated metal panel with exposed fasteners and a 2-in.-thick insulated liner panel will be used as the major façade material for the Shop Building. The color will be custom to match the existing SNS campus. The metal panel cladding support backup system will consist of hanger rods and metal channel framing supported from the building structure. Metal window sills and wall caps will be used. Continuous through-wall flashing will be provided at the bottoms of all wall cavities, over all wall openings and metal copings. The metal panel wall systems will have an R-13 and R-13ci minimum requirement.

Exterior Doors

Exterior entrance doors and egress doors will be 16-gauge, insulated-core painted hollow metal doors with 14-gauge, fully welded frames with a U value of 0.61. Overhead insulated coiling doors, 14 ft, 0 in. high by 14 ft, 0 in. wide will include factory-painted galvanized steel curtains with integral insulation achieving a minimum R-value of 4.75 requirement. All exterior doors will be provided with proximity card reader hardware.

Thermal and Moisture Protection

Flashing and sheet metal will be provided as a positive water stop around all openings (head, jamb, and sill) in walls such as windows, doors, louvers, and so on. All copings and gravel stops will be ES-1 compliant as required by IBC.

Damp-proofing will be provided on all walls, floors and other building components that are subject to high humidity, dampness, or frequent direct water contact.

Waterproofing will be provided at walls, floors, and other building elements that are subject to hydrostatic pressure, are liable to be immersed in water, or are below the water table. The waterproofing membrane will be a hot-fluid-applied, two-layer, 215-mil, polyester fabric–reinforced membrane.

Because of the inherent moisture-resistant properties of the insulated metal panel system, an air/vapor barrier will be required where the system is installed.

Exterior sealants will be of two-part composition with a 50% movement capacity. Sealants will have low VOCs within the LEED Gold v4 limits or will meet the 2016 *Guiding Principles for Sustainable Federal Buildings*. Sealants will be compatible with the surfaces on which they are being applied and will be nonstaining.

Insulation combustibility, including wrappings, inside the building skin will be limited to a flame spread of 25 and smoke development of less than 50.

Glazing

Not applicable

Roof Construction

The roofing system will be a 30-year, 80 mil minimum thickness, white thermoplastic (PVC) single-ply sheet with an integral fiberglass mat reinforcement roofing membrane over polyisocyanurate insulation on a sloping roof structure. Tapered insulation saddles will be used to provide drainage to roof drains and at roof equipment locations. All roof construction details and roof penetrations must comply with the guidelines established by the NRCA. Roof traffic pads will be adhered to the membrane along all roof maintenance traffic paths. All roofs with serviceable components beyond roof drains will be surrounded by a 42-in.-high parapet or provided with a fall protection system.

Low-slope roofing will have a minimum 3-year aged solar reflectance of 0.55 and a minimum 3-year aged thermal emittance of 0.75 in accordance with the Cool Roof Rating Council Program. Roofing will be Energy Star rated with emissivity of at least 0.9 when tested in accordance with ASTM 408.

The roofing system will meet or exceed UL class A fire exposure requirements and comply with FM Class I-90 for wind uplift, according to ASTM 1592. It will provide a minimum thermal resistance value of R-30

Interior Construction

Walls

Interior walls will be constructed of CMUs for durability and will extend up to the structure deck above. All fire-rated walls will be constructed in accordance with the IBC code requirements and UL-listed assemblies.

Wall Finishes

All finish materials for walls, ceilings, and floors, will have a Class A rating, with a flame spread of ≤ 25, a fuel contribution of ≤ 25, and smoke development of ≤ 450.

Typical interior CMU partitions will receive a paint finish consisting of one primer coat and two finish coats. Epoxy paint is to be applied to all lab demising walls. All paints, including top coats and primers, will comply with the 2016 *Guiding Principles for Sustainable Federal Buildings*.

Ceramic tile will be installed for the full height of all walls in toilet rooms. Tile will be a 12×24 in. brickwork pattern with a 1/3 offset. In areas where moisture is present, tile will be installed over a cementitious backer board.

Floor Finishes

Flooring in the mechanical and support areas is to receive concrete sealer over the new concrete. No vinyl wall base will be used in these areas.

Ceramic tile will be installed in toilet room floor areas. Tile will be a 12×24 in. brickwork pattern with 1/3 offset.

Ceiling Finishes

The structure will be left exposed in some support spaces and all mechanical and utility areas. All exposed structures will receive paint finish consisting of one primer coat and two finish coats.

Interior Doors

All interior doors will be shop-primed, field-painted, 16-gauge hollow metal doors with 14-gauge fully welded metal frames

Furnishings

Laboratory Casework

No requirements

Vertical Circulation

Stairs

No requirements

Elevators

No requirements

Specialty Equipment

Combination emergency showers/eye wash units will be provided according to ANSI Z358.1 at lab areas where chemicals will be used or stored.

Bridge Crane

A 10-ton bridge crane will be provided with a hook height of 20 ft above the finish floor.

8.7.1.8 Structure

Applicable Codes and Standards

See Sheets x – xii for complete list of Applicable Codes and Standards

Design Loading

Slab on Grade Floor Loads

- Live loads: 500 psf
- Fork lift load: 8000 lb

Superimposed Roof Loads

- Roof snow load
  - Ground snow load: Pg = 10 psf
  - Snow exposure factor: Ce = 1.0
  - Snow importance factor: Is = 1.0

- Minimum roof live load = 20 psf + 20 psf collateral load

Wind Loads

- Risk category II
- Basic wind speed: V = 115 mph
- Exposure category B

Seismic Loading

- Risk category II
- Importance factor: Ie = 1.0

Crane Requirement

- Refer to the Crane section of Section 8.7.1.7 for information.

Building Structural System

Slab on Grade

A geotechnical investigation was previously performed by Shield Engineering Inc. for a warehouse/maintenance building in the area of the proposed Shop Building. The results of that report, dated December 11, 2009, indicated a layer of unsuitable soils and uncompacted fill (Shield 2009). The recommendations of the report were to perform an undercut and replace the soils. Once the site has been remediated or a foundation option selected to address the unsuitable soils, the slab construction will be anticipated to consist of an 8-in.-thick reinforced normal weight concrete slab. All construction joints between pours will require smooth dowels across the joints. The floor slab will be placed over a vapor barrier, a compacted drainage base course, and a compacted subgrade.

Foundation System

A geotechnical investigation was previously performed for a warehouse/maintenance building in the area of the proposed Shop Building. The results of that report indicated a layer of unsuitable soils and uncompacted fill. As a result, it is anticipated that the Shop Building foundations will consist of shallow spread footings bearing on remediated soil with a minimum net allowable bearing capacity of 2,500 psf. Footings shall extend to the frost depth elevation at a minimum. Below-grade walls are anticipated to be constructed with reinforced normal weight concrete. Water stops will be provided in construction joints to safeguard against water intrusion.

Superstructure

The Shop Building is anticipated to be a single-story conventional steel-frame structure. The building will support the exterior wall system with steel girts as required. The roof structural system is anticipated to consist of wide flange framing with roof deck meeting galvanizing G90 requirements.

Lateral System

Resistance to lateral loads resulting from wind and seismic forces on the building is anticipated to be provided by concentrically braced steel frames.

Crane Support

Steel framing will be provided to support the crane runways.

Geotechnical Analysis

A review of historical geotechnical and geophysical surveys was performed that included the original campus development and additional structures. A detailed geotechnical exploration was performed by Law Engineering, dated June 30, 2000, addressing the original development of the campus (Law 2000). An additional geotechnical investigation was previously performed by Shield Engineering Inc., dated October 26, 2009, for a warehouse/maintenance building in the area of the proposed Shop Building, which was not constructed (Shield 2009). The results of that report indicated a layer of unsuitable soils and uncompacted fill located in the footprint of the proposed Shop Building location. The recommendations of the report were to perform an undercut and to replace the soils (Shield 2009). If the recommendations of the report are followed, the Shop Building foundations can consist of shallow spread footings bearing on soil with a minimum net allowable bearing capacity of 2,500 psf. Other options may include deep foundations (e.g., micropiles) or compacted stone columns (i.e., vibropiers or Geopiers) that have been treated to reduce collection of water to reduce the risk of sinkhole development.

A review of geophysical data and shear wave velocities from the Law report indicates that the Shop Building would be located in seismic site classification C, as defined in IBC 2015 and ASCE 7 (Law 2000). This is confirmed by the average shear wave velocities for multiple soil profiles tested during the original campus development.

A supplemental geotechnical report would be advisable once the final Shop Building location and footprint have been determined. The density and pattern of the soil test borings should be selected to optimize the quality of geotechnical data. Additional geophysical testing is not anticipated for design of the structure.

Vibration/Acoustics

The design will target the following average noise levels. These noise levels do not include noise from equipment or personnel located within these spaces. Actual noise levels may exceed the design noise levels due to the actual type of equipment purchased, installation compromises, workmanship, and so on.

- Room type NC
- Enclosed office spaces 40

- Light maintenance shops 55
- Corridors and public circulation areas 45

The building has no vibration criterion.

8.7.1.9 Mechanical

Air Handling/Ventilation

At the Shop Building, the shops, break room, electrical, communications, and instrument spaces will be conditioned. Heating and cooling for conditioned spaces will be accomplished using a packaged roof-mounted VAV direct expansion AHU. The AHU will be designed as an eight-ACH, heating-cooling, variable-volume type providing from minimum outside air to 100% outside airside in economizer mode. The unit will operate only during occupied periods of the day, or cycle on as required to maintain night setback temperature settings. Supply and return fans will be plenum type, arranged in a multi-fan array. AHU supply air temperature will be modulated as required to suit building occupancy status.

Mechanical and equipment rooms will be treated using a heating and ventilation approach. Ventilation will be achieved through the use of roof-mounted exhaust fans, with associated wall-mounted intake louvers with motorized dampers. Heating for these spaces will be accomplished through the use of electric unit heaters located within the space.

Exhaust

General utility set exhaust fans will be provided for ventilation of the equipment spaces as indicated above, and a separate fan to exhaust the toilet room and janitor closet.

Provisions will be made for shop area exhaust systems to accommodate welding fumes, duct collection, and spot exhaust of fumes from painting or other applications.

Tower Water

The tower water system for the Shop Building will be supplied from the existing CUB. Tower water will enter the building from below grade and will be routed to the technical cooling water skid. Based on an estimated flow of 50 gpm to this building, the tower water piping supplied to the building from the site distribution system is estimated to be 2.5 in.

Technical Cooling Water

Technical cooling water systems will be required to support technical equipment maintenance to be performed in the Shop Building. The technical cooling water system will provide DI water with a resistivity in the range of 1 to 3 megohm/cm, and a slip stream polishing loop. The pumps, HX, conditioners, sterilizers, and filter components will be located in the mechanical room.

Heating Water

The heating water system for the building will be supplied from the existing CUB loop. Based on an estimated flow of 50 gpm to this building, the heating water branch line size to this building is expected to be 2.5 in. Hot water supply and return will enter the building from below grade. The heating water distribution system will serve heating and preheat coils at the air handler.

Controls

The CUB shall be controlled by an extension of the existing DDC-based BAS at the Klystron Gallery with distributed processing at the local level. The DDC system will be designed around an open protocol BACnet communication network. The basis of design is expected to be a JCI Metasys system. The building will be connected to an expansion of the existing BAS system. Instrumentation and wiring shall be connected to a new BAS system PLC in the building, and controls interface for the building will be provided. Programming and connection of the PLC to the existing system shall be completed and the control system commissioned to ensure proper operation.

Electric actuation will be used for all control valves and dampers so that instrument air is not required. All control systems will be on UPS and emergency power. System software and firmware will provide the following functions:

- Control sequences shall be developed to support the operations of the technical equipment.
- PID control to allow faster and closer control to system set points.
- Adaptive tuning to adjust PID loop constants to ensure that control system response remains accurate and reliable over a wide range of dynamic operating conditions.
- Monitoring to read the value of measured variables, to read control loop set points, to monitor control signals to actuators, and to indicate status of equipment, alarms, and overrides.
- Energy management, including optimum start/stop, variable ACH rates in laboratories, duty cycling, supply air temperature reset, supply air static pressure reset, demand limiting, time totalization, and so on.
- Data management including continuous database updating, alarm reporting, trend logging and report generation.
- System programming to add, delete, or change points, set points, schedules, control algorithms, report formats, and so on.
- System software will allow building operators to graphically monitor and control building operations and provide the functions listed. Graphics will include site plans, overall building plans, floor plans, and individual system graphics.

Equipment

Table 8.41 provides a listing of the mechanical equipment servicing the Shop Building.

Table 8.41. Shop Building mechanical equipment.

Use	Equipment	Size	Qty	Em pwr	Redund	Location	Remarks
Shop building AHU	Packaged AHU (VAV)	30,000 cfm	1	N	–	Roof	Direct expansion heat/cool
Mech/elec rms vent	Exhaust fans	Varies	3	N	–	Roof	
Mech/elec rms heat	Unit heaters	Varies	4	N	–	Varies	

Air Handler

General

- All AHUs will be packaged, factory-fabricated, and constructed with 4-in.-thick double walls of galvanized steel.

- Maximum allowable nominal face velocities:
  - Air intake louvers (through free area): 350 fpm
  - Heating water coils: 500 fpm
  - Cooling coils: 400 fpm
  - Filters: 400 fpm

- AHU—modular, packaged, 4 in. double-wall construction configured as follows:
  - Mixed air plenum
  - Intake isolation damper
  - Return/exhaust damper
  - Relief fans (4 to 6 fan array)
  - VFDs
  - Economizer section
  - MERV 8 (30%) prefilter section
  - Pipe vestibules
  - Hot water preheat coil
  - Direct expansion cooling coil (air cooled)
  - Supply fans (4 to 6 fan array)
  - VFDs
  - MERV 14 (95%) final filter section
  - Supply plenum
  - Isolation/smoke damper
  - Access sections
  - Doors: safety glass windows and quarter turn handles
  - Marine light in each access section
  - Vibration isolation in accordance with ASHRAE HVAC Applications—Noise and Vibration Control

Exhaust Fans

Utility Set Exhaust

Exhaust fans will be backward-inclined, belt-driven centrifugal fans with spark-proof construction and bearings and motors out of the airstream. Fans will be single width, single inlet with a galvanized steel housing and wheel construction. The fan motor will be totally enclosed and fan cooled. The system will consist of the following components:

- Steel mounting rails with vibration isolators
- Isolation damper at the fan inlet
- Discharge ductwork with bird screen
- Weather cover
- VFDs

General

System Design Criteria

Outside Design Temperatures

- Summer: 92.8°F DB, 73.8°F MCWB (0.4% ASHRAE)
- Winter: 17.1°F (99.6% ASHRAE)

Interior Design Conditions: Preliminary Load and Ventilation Assumptions

- Conditioned spaces 72°F ± 2°F, 60%>RH
- Ventilated spaces 60–100°F, no humidity control

Materials

Duct Distribution Systems

Ductwork Materials and Construction

- Supply ductwork construction will be based on SMACNA 4-in. pressure class and 2-in. pressure class. Four-in. pressure duct construction will be used upstream of VAV boxes on variable-volume units; 2-in. pressure class duct construction will be used downstream of VAV boxes on variable-volume units and for all ductwork on constant-volume units. All ductwork seams and joints shall be sealed, regardless of pressure rating. Maximum permissible leakage = 2%.

- All supply ductwork routed through unconditioned spaces shall be insulated with 2-in. foil-faced batts or foil-faced duct board with a similar R-value.

- Return and general exhaust ductwork construction shall be based on SMACNA 2-in. pressure class.

- Refrigerant exhaust ductwork shall be constructed to a 6-in. SMACNA pressure class.

- Return air duct shall be insulated with 1½-in. foil-faced batts or duct board. Laboratory exhaust ducts shall not have fire dampers.

- General air distribution ductwork will be G90 galvanized sheet metal.
- Rectangular and round ductwork shall be fabricated in accordance with SMACNA standards. Spiral-wound ductwork shall be a prefabricated system with factory certifications. Spiral-wound ductwork shall not be used for laboratory exhaust systems or other systems that may be exposed to water intrusion.
- Sound attenuation will be provided to meet the project requirements or in accordance with the direction of the project acoustician. Sound attenuation shall be by appropriate application of attenuators or duct design.
- Lined ductwork shall not be used, except for plenum return air-transfer boots for noise control. VAV air terminals shall be double-wall or have foil-faced inner surface.
- Flexible ductwork is limited to 5 ft and shall only be used downstream of VAV terminals. Flexible ductwork shall be limited to supply air systems only.
- Plenum return may be used for return air in all non-laboratory portions of buildings.
- Ductwork shall be sized as shown in Table 8.42.
- VAV systems shall have conventional supply terminal boxes with hot water reheat coils and integral sound-attenuating characteristics.
- Smoke detection will be provided in accordance with NFPA 90A and IMC requirements.

Table 8.42. Shop Building ductwork sizing.

	Risers	Submains	Branches	Air distribution device neck velocity (fpm)
Max P.D.	0.1 in./100 ft	0.08 in./100 ft	0.08 in./100 ft	450 fpm

Piping

Tower Water

- Interior piping sizes 2 in. and smaller Type L copper with brazed fittings.
- Interior piping 2½ in. and larger shall be either Type L copper with brazed fittings or Sch 40 steel pipe with either welded and flanged joints or mechanical grooved fittings.
- Underground tower water piping serving the building will be distributed in a factory-fabricated coated steel piping system or HDPE.
- All piping will be tested at 1.5 times the design system pressure.
- All interior CHW piping shall be insulated with closed-cell elastomeric insulation. Properties shall meet or exceed the minimum energy code requirements.
- All piping in mechanical rooms and piping exposed below 8 ft AFF shall have PVC jacketing.

- All piping exposed to the exterior shall have an aluminum jacket.
- BTU meter will be provided on tower water at incoming service.

Heating Water

- Interior piping 2 in. and smaller shall be Type L copper with brazed fittings.
- Interior piping 2½ in. and larger shall be either Type L copper with brazed fittings or Sch 40 steel pipe with welded and flanged joints.
- Underground hot water piping serving the building will be distributed in a pre-insulated, factory-fabricated coated steel piping system.
- Interior heating water piping shall be insulated with rigid glass fiber insulation.
- Piping exposed to the interior shall have a PVC or aluminum jacket. Piping exposed to the exterior shall have an aluminum jacket.
- BTU meter will be provided on heating water at incoming service.

Mechanical Calculations

Mechanical calculations are provided in Appendix C for both air side and cooling water side.

Sustainable Design Strategies

The following energy conservation measures will be incorporated into the HVAC design:

- DDC BAS for optimization of major HVAC equipment operation.
- Supply air temperature is to reset to minimize air conditioning of outside air and subsequent reheating of conditioned air.
- VSDs will be installed on all VAV AHU supply and return fans to reduce fan horsepower requirements of non-peak conditions.
- VSDs will be installed on all pumps to reduce pump horsepower requirements at non-peak conditions.
- Full economizer control will be provided on all mixed AHUs to reduce consumption while maintaining appropriate indoor humidity levels.

8.7.1.10 Electrical

Site Power Distribution

The Shop Building will be provided with 600 A, 480 Y/277 V secondary service from a new duct bank extended to existing unit substation KL-SS1.

Building Power Distribution

Secondary Distribution

- Building secondary distribution will generally be 480 V, 3-phase, 4-wire, plus ground. This will provide service to CF lighting, receptacles, and HVAC loads as well as building instrumentation loads. Further transformation down to 208 Y/120 V, 3-phase, 4-wire, plus ground will be provided for general use receptacles and other low-voltage equipment as necessary.

- All conventional building use dry type transformers will be DOE 2016 rated for efficiency, 115°C rise, 220°C insulation class with six 2.5% taps. Consideration will be given for harmonic or K-rated transformers and oversized neutrals to handle the heating effects of the harmonic loading.

- Service to a 10-ton crane will be provided.

- Circuit protection will be
  - Generally molded case circuit breakers. Solid state adjustable trip units will be provided above 250 A.
  - Bolt-in type molded case circuit breakers for branch circuit panelboards.
  - 100% rated for service entrance main circuit breakers, 80% rated otherwise.

- Devices will be fully rated. Series ratings of protective devices will not be acceptable.

- Two levels of ground fault protective devices will be provided at the main and feeder breakers at service switchgear assemblies.

Emergency Power Supply System

The Shop Building will be provided with a standby power feeder from a new duct bank extended to existing emergency panel KL-2DPE1 in the Klystron Gallery.

EPSS Power Distribution

The EPSS secondary distribution system will be separated into the following branches as required by code.

- Generator: This branch provides alternate source power from the generator set main circuit breaker(s) and associated distribution to the line side of each ATS.

- Emergency (NEC Article 700): This branch provides continuous (normal or generator) source power for the following equipment essential for safety to human life:
  - Interior building means of egress lighting and illuminated exit signs
  - Exterior building means of egress immediately adjacent to exit discharge doorways
  - Fire detection and alarm systems
  - Public address communication systems (when used for issuing emergency instructions)
  - Experimental processes where interruption would produce serious life safety health hazards, and similar functions

- Combined legally required and optional standby branch, designate as “optional branch” (NEC Article 701 and 702): This branch provides continuous (normal or generator) source power for the following equipment that, when stopped during any interruption of the normal electrical supply, could cause hazards or hamper rescue or firefighting operations; or (optional branch) to protect facilities or property where life safety is not dependent on system performance:

- Control and alarm systems of major apparatus
- Experimental processes where any power outage could cause serious interruption of the processor damage to the equipment
- Ventilation and smoke removal systems
- Access control systems
- Telecommunication room lighting, equipment, and data processing systems
- Electric and mechanical room lighting and selected receptacles
- Mechanical equipment including boilers, condensate return pumps, hot water heating and glycol circulating pumps
- Plumbing equipment including sewage ejectors and pumps

Power Quality Systems

Uninterruptible Power Supply Systems

Required UPS circuits will be extended to the Klystron Gallery for the building IT distribution.

Electric Metering Systems

Electrical metering systems, according to ORNL standards, will be used to monitor and alarm

- Electrical loading and harmonic loading. Rail-mounted power quality PM 8214 DIN meters will be required at the unit substation building main service breakers.

The system will be networked to the ORNL Power Operations SCADA "SNO" network.

Grounding Systems

Ground Grid

All building grounding systems must be bonded to a common earth ground in compliance with the NEC. Each building will be provided with a #4/0 direct buried copper ring encircling the perimeter of the building, which will provide a convenient means of connecting all metallic systems and equipment into a single equipotential grid that has a low resistance to ground.

Building Grounding

Building steel, foundation rebar (Ufer ground), and metallic water supply piping will be bonded to the ground grid.

Building Lightning Protection

An NFPA 780 Faraday cage type lightning protection system will be provided to protect the building/structure and its occupants and contents from the electrical effects of a lightning strike to ground. The system will include independent down conductors in PVC from the rooftop to the ground grid.

Electrical Power System Grounding

Separate green grounding conductors will be provided with all feeders and branch circuits to provide an intended grounding of the neutrals of the electrical power systems. Each will be bonded to the ground grid with grounding electrode conductors from the distribution system neutral source.

Interconnected bus bars in electrical rooms will collect electrical and electrical equipment grounding conductors to tie the ground ring at the electrical service entrance room.

Electrical Equipment Grounding

All non–current carrying metal parts of electrical equipment enclosures, raceways, boxes, cabinets, housings, frames of motors, luminaires, and so on will be bonded and connected to electrical room ground buses where the associated system neutral is grounded. This allows for a safe ground path in an electrical fault condition.

Lighting Systems

Exterior Lighting

Pole-mounted LED light standards with concrete bases will be provided along roadways and within parking lots.

Building-mounted perimeter LED luminaires will be provided at building exits, walkways, and vehicular circulation areas.

Interior Lighting

LED interior lighting will be provided in compliance with IESNA lighting standards and ASHRAE 90.1 energy budgets.

Energy-efficient, heavy-duty, specification-grade, high bay and industrial LED luminaires are generally anticipated in STS instrumentation areas.

Lighting Controls

Exterior lighting will be provided with photocell and time clock controls.

Interior spaces will be provided with local automatic sensor lighting controls.

Facilities & Operations Building Systems

The building electrical metering system and BAS to monitor electrical and HVAC building systems will be site interconnected to SNS campus systems as described in Site Utilities in Section 8.1.2.1 of this report and will also include the following systems:

Fire Alarm System

The fire alarm system will be a microprocessor-based detection and notification control system installed and acceptance tested in compliance with NFPA 72, *National Fire Alarm Code*. The building system will include multiplex wiring techniques, a central processing unit (FACU), annunciator units, and peripheral detection and alarm devices.

The system will

- Include smoke, heat, and beam smoke detection devices to suit environmental conditions
  - High bay areas will be provided with beam smoke detection.
- Include audible horns and visual strobe notification devices
- Monitor building fire suppression systems and override HVAC functions in an alarm condition for fire and smoke containment
- Report fire, supervisory, and trouble alarms to the ORNL Fire Department and LSS office in Building 4512 over a fiber optic network

Wiring will be supervised Class B installed in conduit. Multimode fiber optic cabling will be extended in conduit between the fire alarm control unit and the telecommunication room in each building.

The system will be Edwards/EST Fireworks manufacturer/series, according to ORNL requirements, to match the existing campus systems.

Public Address System

A public address system will be provided with building amplification as an extension to the campus-wide Valcom mass notification system.

Wiring will be installed in conduit.

Access Control System

The building will be provided with an access control system with central equipment located in the main telecommunications room.

Alarm and supervisory conditions will be reported to the ORNL campus security monitoring location over a fiber optic network.

Components will match existing ORNL equipment for system compatibility.

Telecommunication Systems

The building will be provided with separate telecommunications service from the existing site telecommunications distribution system at the CLO to a building main distribution room. The design for the incoming POTS and/or VoIP telephone service, LAN, and wireless networking shall be coordinated with DOE’s prime subcontractor, Black Box. The STS project will provide the interconnecting fiber optic cabling. Refer to the site utilities telecommunication distribution paragraphs, which outline telecommunications service to the STS buildings.

Building IT systems for systems networking hardware and cabling, including switches, routers, patch panels, backbone cabling, components, will be provided.

Building IT horizontal category 6A cabling will be provided from telecommunications rooms located on each floor, stacked where possible. Building IT systems will be installed in compliance with EIA/TIA standards.

ORNL F&O Building Systems Distribution

The following building systems/system owners will be interconnected with cables and raceways by SNS CF. The system owners will perform final tie-ins.

- Public address/F&O Instrumentation and Controls
- Fire alarm (FIREWORKS Network)/F&O Laboratory Protection
- Access control/F&O Laboratory Protection
- BAS/F&O Facilities Management (CLO II only—Siemens)
- Power monitoring (ION-Schneider)/F&O electrical utilities (including central IT UPS systems monitoring)

Instrument and Control Systems

ORNL STS will provide building instrumentation and control systems cabling for interconnection of the following systems:

- EPICS

Pathway Systems

Cabling from wall box–type ORNL Networks Building IT jacks and instrument and control systems will be in bushed conduits extended and grounded to the Comm Room.

8.7.1.11 Plumbing

Drainage/Waste

Sanitary waste from pantry/break room sinks, lavatories, toilets, urinals, mop sinks, and equipment will be collected below the floor and conveyed by a gravity system to the underground sanitary waste drainage system outside the building. Flow rates and pipe sizes will be calculated based on drainage fixture unit values and adjusted/increased to allow for projected wastewater discharge from various equipment at the design stage.

Floor drains will be provided at all toilet rooms, mechanical equipment spaces, and other areas requiring drainage. Complete accessibility will be provided to all cleanouts. Wall type cleanouts will be used at the lower level. Floor drains that do not receive regular use will be provided with trap primers. Primers will consist of an automatic trap primer system that automatically discharges water at regular timed intervals.

Potable Water

Potable water will enter the building at the lower level and shall be provided with a water meter and shall connect to the BAS. The incoming service shall split at the lower level into potable and process water streams through a Foundation for Cross Connection Control and Hydraulic Research approved duplex backflow prevention device. Potable hot and cold water will be distributed throughout the building to all fixtures and equipment requiring water. Water makeup to any mechanical equipment will be supplied through local backflow preventers.

Potable hot water will be generated at 140°F by an electric water heater located in the utility room. A thermostatic mixing valve will be provided to achieve 120°F distribution temperatures. Hot water will be distributed through a separate recirculating system designed to provide hot water to the points of use.

Potable hot and cold water shall be distributed throughout the building above the ceiling to risers located adjacent to toilet rooms and break rooms.

A separate tempered water connection through a thermostatic mixing valve will be provided to supply emergency safety equipment (eyewashes and showers).

Water velocity in distribution piping shall not exceed 8 ft/second for cold water, and 5 ft/second for hot water. Shock arrestors will be provided and shall comply with PDI-WH201 or ASSE-1010.

Process Water

Non-potable Water Service (Mechanical System Makeup)

A separate process water system will be provided for mechanical equipment flushing and hose outlets. Process water shall emanate from the backflow preventer provided at the incoming potable water service and shall be routed to equipment.

Storm Drainage

The primary storm drainage system will consist of gutters and exterior downspouts for any areas collecting water, routed to spill at grade.

Compressed Air

CA shall be distributed throughout building to supply CA to service outlets and will be provided with local pressure-reducing valves to permit each outlet to use air of various pressures. CA will be fed by a site CA system routed from the air compressors in the CUB. CA will enter the building from below grade.

Equipment

System Design Criteria

Potable/Process water

- The potable water system is designed to provide a minimum of 40 psi at the furthest outlet.
- The process water system is designed to provide a minimum of 40 psi at the furthest outlet.
- Water piping shall be sized based on the number of water fixture units connected and the minimum flow pressure required at each fixture or piece of equipment. Pipe velocities shall be maintained between 4 and 8 ft/second and shall not exceed 8 ft/second.
- Valves shall be placed to isolate individual fixtures within one room or a battery of fixtures within any one room.
- Wall hydrants shall be placed on the exterior of the building a maximum of 150 ft on center.
- Hose outlets will be provided at all mechanical rooms and equipment spaces.

Sanitary/Waste

- The waste system shall connect to each fixture requiring connection and where required will be provided with water seal traps. A vent system shall be provided for fixtures as required to ventilate the waste system and to prevent siphonage of fixture traps.

- Floor drains will be provided at all mechanical rooms and equipment spaces.

- Waste and vent piping shall be sized based on the number of fixture units connected. Pipe shall be routed by gravity to maintain a positive slope with a maximum velocity of 2 ft/second.

Storm Drainage

- Storm piping shall be sized based on a 100-year occurrence rainfall rate with a 60-min duration.

Compressed Air

- Design CA pressure on incoming service—105 psi
- Design CA pressure at laboratory outlets—100 psi
- Design flow at outlets—1.0 cfm
- Dew point –40 ºF

Materials

Potable Water System

- Above-ground potable water systems
  - Tubing to be Type L hard temper with wrought copper fittings conforming to ASTM B88-and ASME B16.22. All joints shall be soldered with ASME AWS/A5.8 lead-free solder.
  - Copper tubing with grooved ends and mechanical joints is acceptable for sizes 2½ to 6 in. only. Tubing to be Type L hard temper with wrought grooved end fittings conforming to ASTM B88 and ASTM B75.
  - The entire potable hot and cold water distribution system will be fully insulated using closed-cell elastomeric foam insulation.

Process Water Systems

- Above-ground process water systems
  - Tubing to be Type L hard temper with wrought copper fittings conforming to ASTM B88-and ASME B16.22. All joints shall be soldered with ASME AWS/A5.8 lead-free solder.
  - Copper tubing with grooved ends and mechanical joints is acceptable for sizes 2½ to 6 in. only. Tubing to be Type L hard temper with wrought grooved end fittings conforming to ASTM B88 and ASTM B75.
  - The entire process water distribution system will be fully insulated using closed-cell elastomeric foam insulation.

Sanitary System

- Above-ground soil, waste, vent piping

  - Hubless cast iron soil pipe: no-hub pipe with Husky SD-4000 soil pipe coupling manufactured by Anaheim Foundry, 4-band clamp or Clamp-All Hi Torq 125 two-band clamp. Sealing gasket shall be neoprene in accordance with ASTM C564, CISPI 301-75.
  - Horizontal storm drainage piping will be fully insulated using closed-cell elastomeric foam insulation.

- Below-ground soil, waste, vent piping
  - Asphaltum-coated, service weight, cast iron pipe and fittings with resilient neoprene push-on joints, ASTM A72, ASTM C564-70

Compressed Air

- Below-ground factory-coated steel pipe
- Above-ground Type K copper with brazed joints

Plumbing Fixtures and Specialties

- All plumbing fixtures will be institutional-grade, vitreous china or stainless steel as required.

- Floor sinks and floor drains in laboratory areas (if required) will be stainless steel, flush with finished floor, minimum of three 3-in. outlets.

- Hub drains and similar unsanitary fixtures will not be provided in lab spaces.

- Water closets: wall-hung, siphon jet type, high-efficiency 1.28 gal per flush maximum with hard-wired infrared sensor operation.

- Urinals: wall-hung siphon jet type, high-efficiency 0.125 gal per flush maximum with hard-wired infrared sensor operation.

- Lavatories: wall-hung or countertop type, 0.5 gal per minute maximum with hard-wired infrared sensor operated faucets.

- Showers: high-efficiency 1.5 gal per minute maximum.

- Safety showers, eyewashes and combination units: 30 psi minimum.

- Electric water coolers: recessed, self-contained.

- Interior hose bibbs: Chrome plated in finished areas, rough brass in mechanical rooms, wall mounted, furnished with vacuum breaker, ¾-in. hose threaded outlet.

- Wall hydrant: freeze-resistant type in recessed box, ¾-in. hose threaded outlet.

8.7.1.12 Fire Protection

Sprinkler

The Shop Building will be fully sprinkled with exposed sprinkler piping feeding upright sprinklers. Sprinkler feed will enter the building from below grade into the utility room from the site potable/fire water main, and a double check backflow preventer will be provided. The shop building will be a single sprinkler zone, with a control valve located at incoming service. The control valve will be provided with a tamper switch and a flow switch connected to the fire alarm system.

General

System Design Criteria

Fire sprinkler systems for the Shop Building will be hydraulically designed to provide water densities that meet the requirements for Ordinary Hazard–Group 2 protection throughout the facilities.

Velocity shall not exceed 20 fps.

All calculations assume a minimum of 10 psi deterioration in static and residual pressures in the hydrant flow test results.

Materials

- Pipe and fittings installed underground shall be class 52 ductile iron cement lined with mechanical joints with a working pressure rating of 350 psig.

- Sprinkler piping installed above ground and sized 2 in. and smaller and all standpipe piping shall be Sch 40 black steel with threaded joints and fittings.

- Sprinkler piping installed above ground and sized 2½ in. and larger shall be Sch 10 black steel with roll groove type connections and fittings. Pressure rating shall be 175 psig minimum.

- Fittings for grooved end steel pipe shall be cast of ductile iron conforming to ASTM A-536 or malleable iron conforming to ASTM A-47, or forged steel conforming to ASTM A-234 (A-106, Gr. B), with grooved or shouldered ends for direct connection into grooved piping systems with steel pipe. They shall be UL listed and FM approved, rated for a minimum 300 psi MWP.

8.8 CONVENTIONAL FACILITIES MAJOR PROJECT RISKS

8.8.1 Risk Summary

8.8.1.1 If the micro-piles do not perform according to the design basis, then an alternate foundation system would have to be designed, increasing cost and schedule.

Micro-piles have historically been used at SNS to support high-load critical foundations and equipment, and they are the design basis in the conceptual design. If the piles do not perform according to their design basis, then associated foundations would be unable to meet their specifications. That situation would result in a redesign effort, which would increase CF costs and negatively impact the construction schedule. To mitigate this risk, CF will perform verification of the pile design supported by site geotechnical analysis during the preliminary design phase, and the design will be validated by load testing piles in the field as early as is feasible.

8.8.1.2 If the CF systems requirement documents were not agreed upon and approved by the CF preliminary design (e.g., neutronics calculation, drain tanks, central exhaust facility), then CD-3a could not proceed and design would be extended, resulting in additional cost and time.

If there were significant changes to, or a lack of, verified facility requirements after the start of final design then the CF final design would be extended in time, resulting in increased costs and potential delays to the construction schedule. To mitigate this risk, CF will establish interface control documents with the technical systems teams before the start of final design.

8.8.1.3 If local major projects were delayed beyond our project CD-3, then CF (craft) estimate assumptions would be wrong, resulting in increased costs and schedule delays.

Craft labor rates and associated construction cost estimates have been developed based upon assumptions of local availability. If other major construction projects in the region were delayed beyond the start of STS construction, the delays may create local labor shortages, which could drive up construction manager/general contractor construction costs. To mitigate this risk, CF will perform national market outreach to increase competition during bidding by prospective construction managers/general contractors.

8.8.1.4 If the global market for hematite should be impacted by a significant event, then the project would have to pay additional costs or carry out redesign, resulting in cost and scheduling impacts.

Hematite has historically been used as the aggregate in high-density cast-in-place concrete at SNS. Any market events that impact the global availability and price stability for this aggregate may significantly impact the design of associated structures, which in turn would pose risks to the construction cost and schedule. To mitigate this risk, CF will investigate the feasibility of using alternate similar materials during preliminary design, as well as determine if alternate sources for the aggregate are available.

REFERENCES

Shield 2010. *Final Report of Geotechnical Exploration Rev. 1*, Chestnut Ridge Office Building, Oak Ridge, Tennessee, Shield Engineering, Inc, November 4.

Shield 2009. *Report of Geotechnical Exploration, SNS Shop/Maintenance Facility Building, Spallation Neutron Source Campus*, Oak Ridge, Tennessee, Shield Engineering Inc, December 11.

Law 2000. *Report of Phase Ill Geotechnical Study, Spallation Neutron Source*, Oak Ridge, Tennessee, LAW Engineering and Environmental Services Inc, June 28.

WORKS CONSULTED

Spallation Neutron Source, RTBT Stub Conceptual Design Study Revision 2, PPU-P06-TD0001, R02, Oak Ridge National Laboratory, February 28, 2017

Spallation Neutron Source, Second Target Station, Elevation Study, STS05-51-TD0002, R00, Oak Ridge National Laboratory, October 20, 2016

Spallation Neutron Source, Second Target Station, Programming Study, STS05-51-TD0001, R00, Oak Ridge National Laboratory, October 20, 2016

Technical Design Report, Second Target Station, ORNL/TM-2015/24, Oak Ridge National Laboratory, January 2015

Spallation Neutron Source, Second Target Station, Conventional Facilities, Technical Design Report, Oak Ridge National Laboratory, October 2014

JR DeVore, STS Ventilation Systems [PowerPoint presentation], Oak Ridge National Laboratory, Oak Ridge, Tennessee, October 2018.

JR DeVore, Hot Offgas System [PowerPoint presentation], Oak Ridge National Laboratory, Oak Ridge, Tennessee, November 2018.

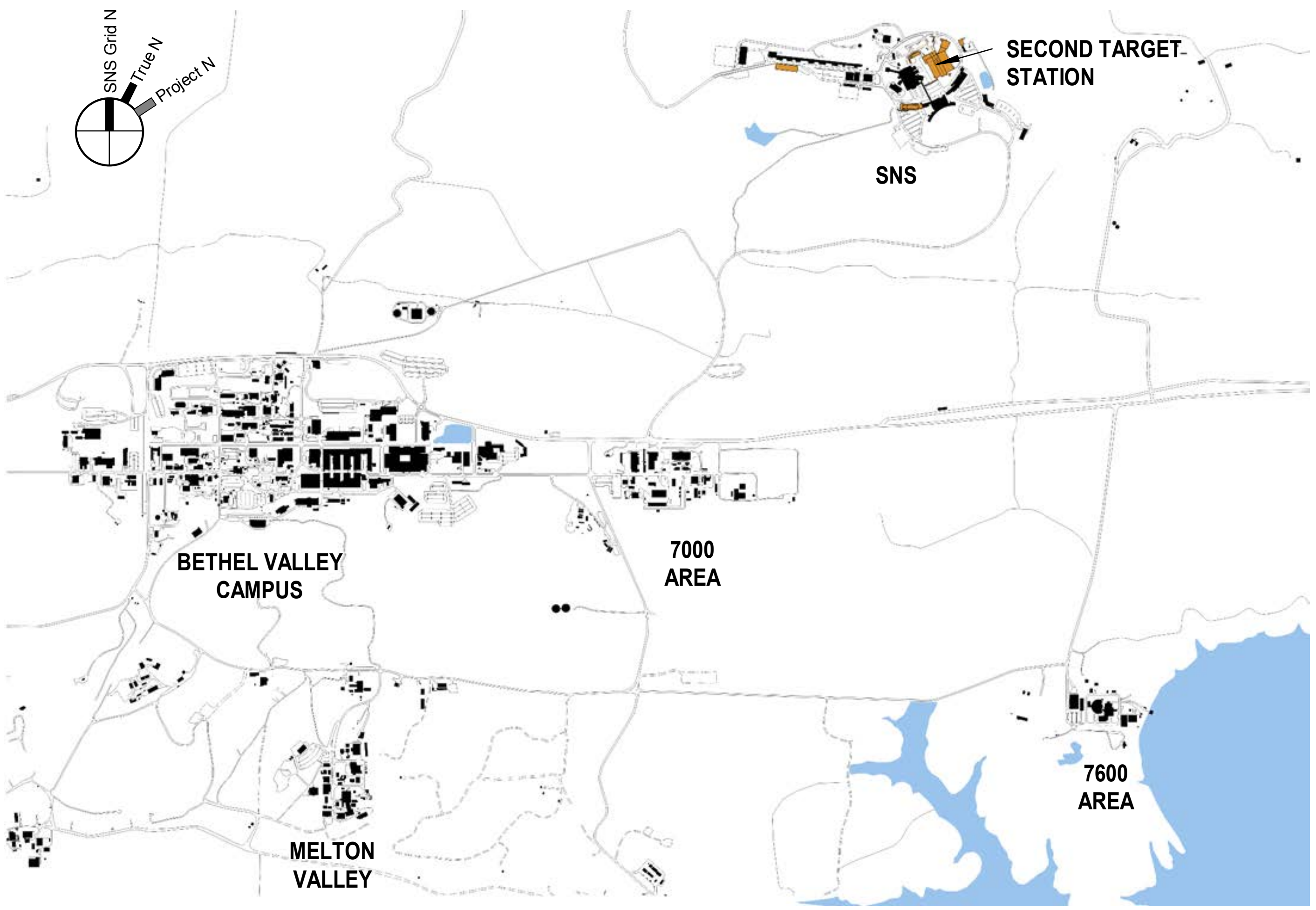
FY 2018 SNS Water Use Data, Oak Ridge National Laboratory, Oak Ridge, Tennessee, September 2018.

APPENDIX A. DRAWINGS

SPALLATION NEUTRON SOURCE
SECOND TARGET STATION CONVENTION FACILITIES

CONCEPTUAL DESIGN REPORT
100% SUBMISSION

FEBRUARY 8, 2019



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5.0 RENDERINGS

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SHEET NAME **NORTHEAST AERIAL PERSPECTIVE**
SHEET NUMBER **5.0.1**
DATE FEBRUARY 8, 2019

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SHEET NAME	**NORTHWEST AERIAL PERPSPECTIVE**
SHEET NUMBER	**5.0.2**
DATE	FEBRUARY 8, 2019

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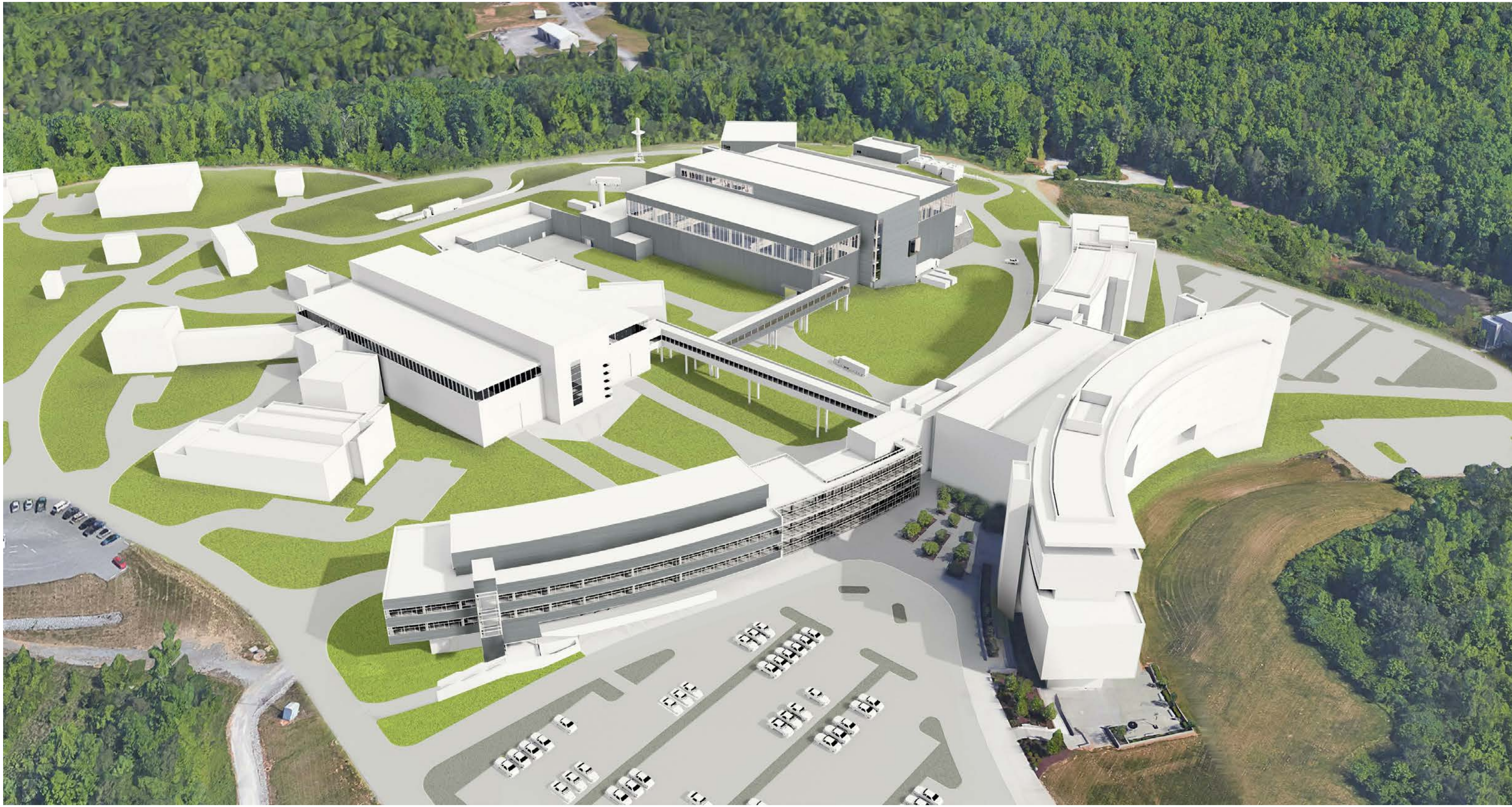

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SHEET NAME	**SOUTHEAST AERIAL PERSPECTIVE**
SHEET NUMBER	**5.0.3**
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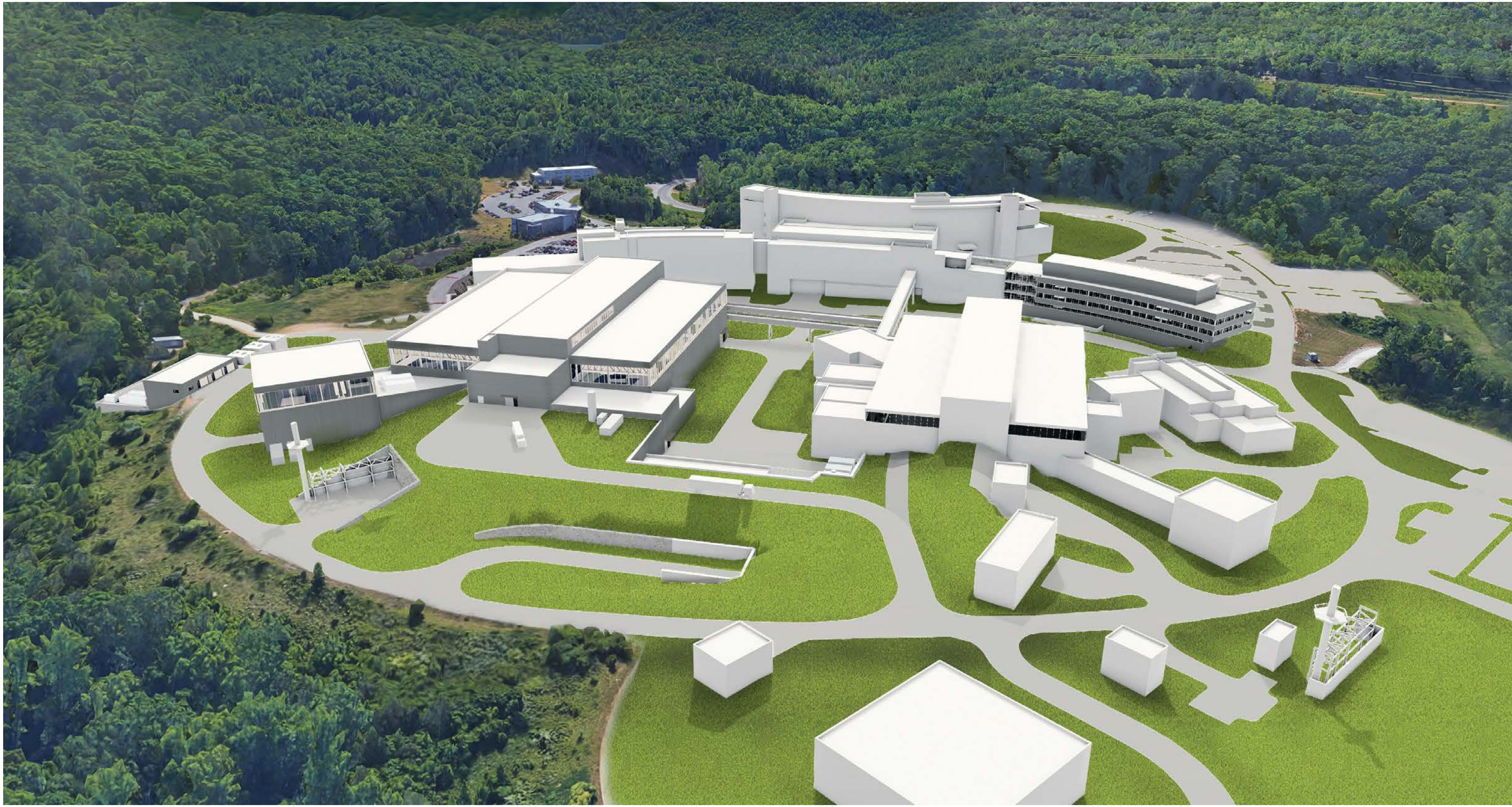

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SHEET NAME	**SOUTHWEST AERIAL PERSPECTIVE**
SHEET NUMBER	**5.0.4**
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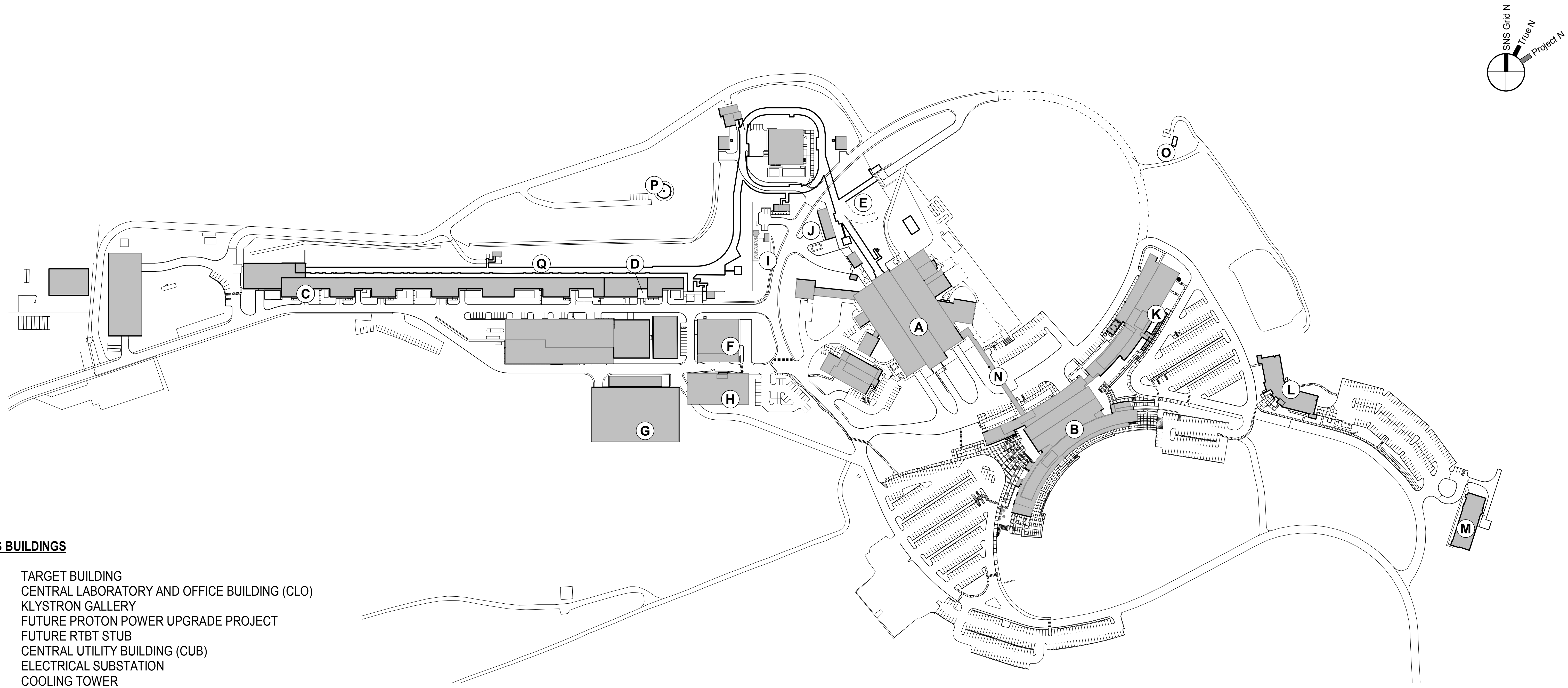

SNS BUILDINGS

A. TARGET BUILDING
B. CENTRAL LABORATORY AND OFFICE BUILDING (CLO)
C. KLYSTRON GALLERY
D. FUTURE PROTON POWER UPGRADE PROJECT
E. FUTURE RTBT STUB
F. CENTRAL UTILITY BUILDING (CUB)
G. ELECTRICAL SUBSTATION
H. COOLING TOWER
I. CENTRAL EXHAUST FACILITY
J. RTBT SUPPORT BUILDING
K. CENTER FOR NANOSCALE MATERIALS SCIENCES (CNMS)
L. JOINT INSTITUTE FOR NETRON SCIENCE (JINS)
M. ORNL GUEST HOUSE
N. PEDESTRIAN BRIDGE
O. WATER PUMPING STATION
P. WATER TOWER
Q. RTBT TUNNEL

SCALE: 1" = 300'-0"

0 150 300 600

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SHEET NAME **SPALLATION NEUTRON SOURCE - EXISTING SITE PLAN**
SHEET NUMBER **5.1.1**
DATE FEBRUARY 8, 2019

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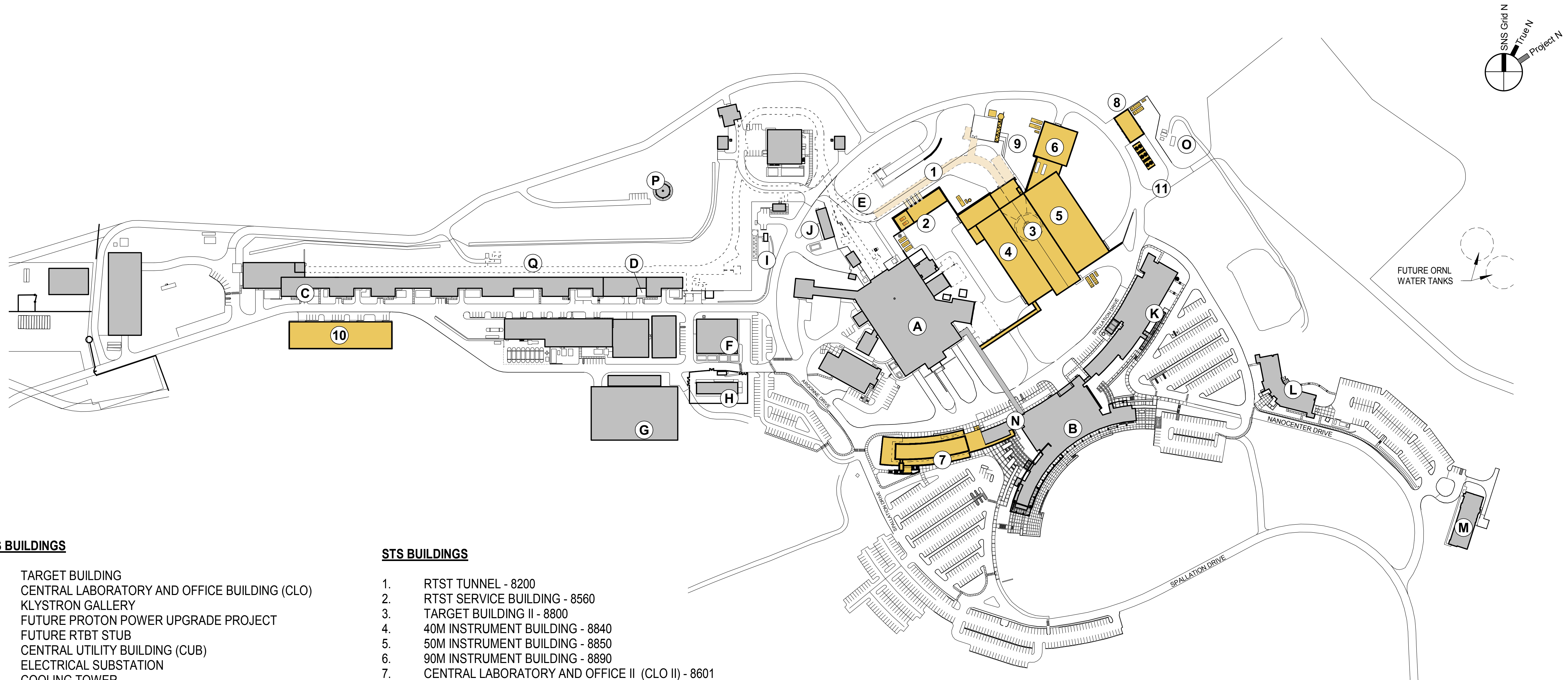

SNS BUILDINGS

A. TARGET BUILDING
B. CENTRAL LABORATORY AND OFFICE BUILDING (CLO)
C. KLYSTRON GALLERY
D. FUTURE PROTON POWER UPGRADE PROJECT
E. FUTURE RTBT STUB
F. CENTRAL UTILITY BUILDING (CUB)
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I. CENTRAL EXHAUST FACILITY
J. RTBT SUPPORT BUILDING
K. CENTER FOR NANOSCALE MATERIALS SCIENCES (CNMS)
L. JOINT INSTITUTE FOR NETRON SCIENCE (JINS)
M. ORNL GUEST HOUSE
N. PEDESTRIAN BRIDGE
O. WATER PUMPING STATION
P. WATER TOWER
Q. RTBT TUNNEL

STS BUILDINGS

1. RTST TUNNEL - 8200
2. RTST SERVICE BUILDING - 8560
3. TARGET BUILDING II - 8800
4. 40M INSTRUMENT BUILDING - 8840
5. 50M INSTRUMENT BUILDING - 8850
6. 90M INSTRUMENT BUILDING - 8890
7. CENTRAL LABORATORY AND OFFICE II (CLO II) - 8601
8. CENTRAL UTILITY BUILDING II (CUB II) - 8917
9. CENTRAL EXHAUST FACILITY II (CEF II) - 8921
10. SHOP BUILDING - 8960
11. COOLING TOWERS - 8919

SCALE: 1" = 300'-0"

0 150 300 600

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SHEET NAME: SECOND TARGET STATION - PROPOSED SITE PLAN
SHEET NUMBER: 5.1.2
DATE: FEBRUARY 8, 2019

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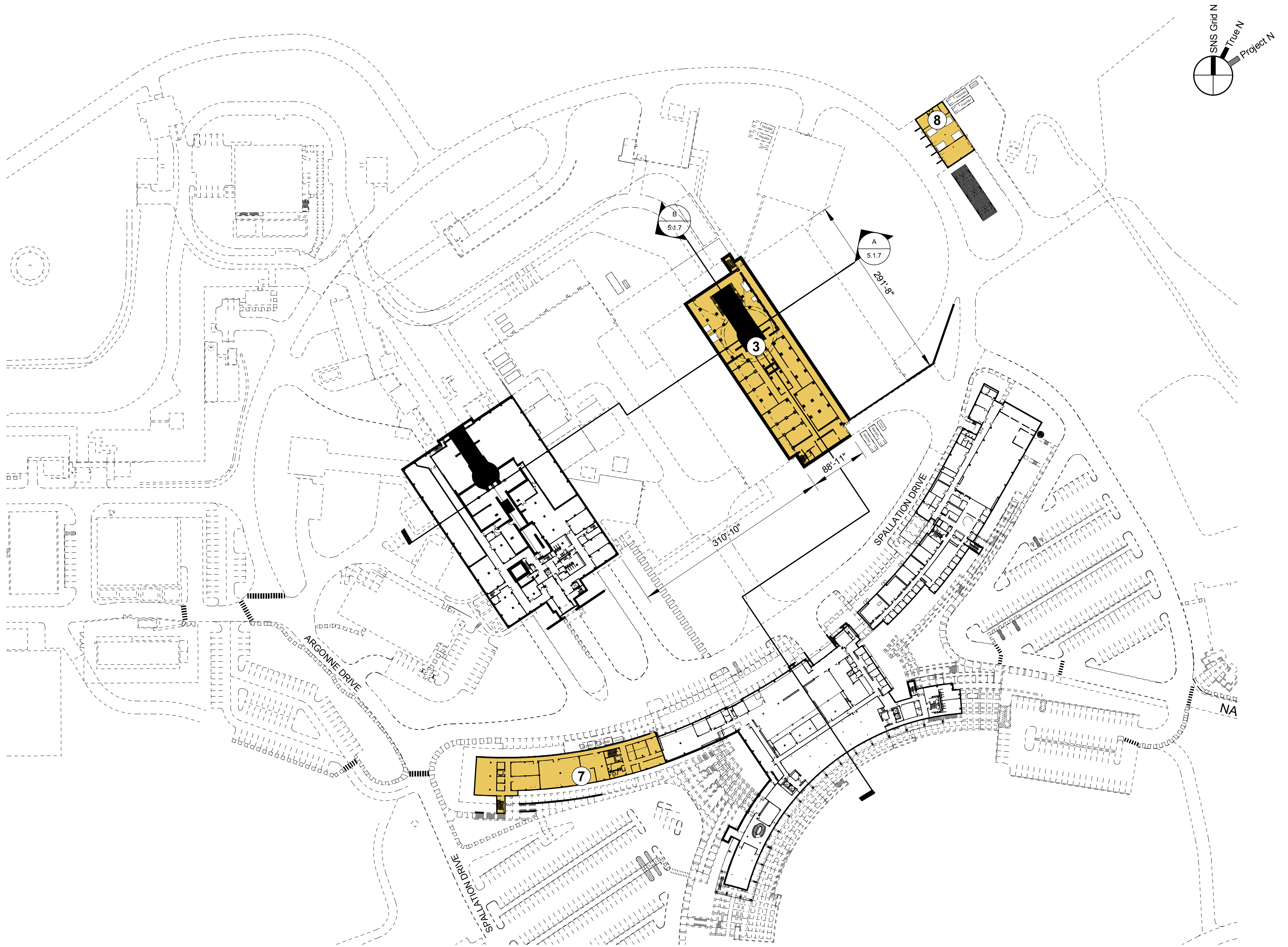

STS BUILDINGS

1. RTST TUNNEL - 8200
2. RTST SERVICE BUILDING - 8560
3. TARGET BUILDING II - 8800
4. 40M INSTRUMENT BUILDING - 8840
5. 50M INSTRUMENT BUILDING - 8890
6. 90M INSTRUMENT BUILDING - 8601
7. CENTRAL LABORATORY AND OFFICE II (CLO II) - 8917
8. CENTRAL UTILITY BUILDING II (CUB II) - 8921
9. CENTRAL EXHAUST FACILITY II (CEF II) - 8960
10. SHOP BUILDING -8919
11. RTBT STUB

SCALE: 1" = 300'-0"

0 150 300 600

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SHEET NUMBER	**5.1.3**
DATE	FEBRUARY 8, 2019

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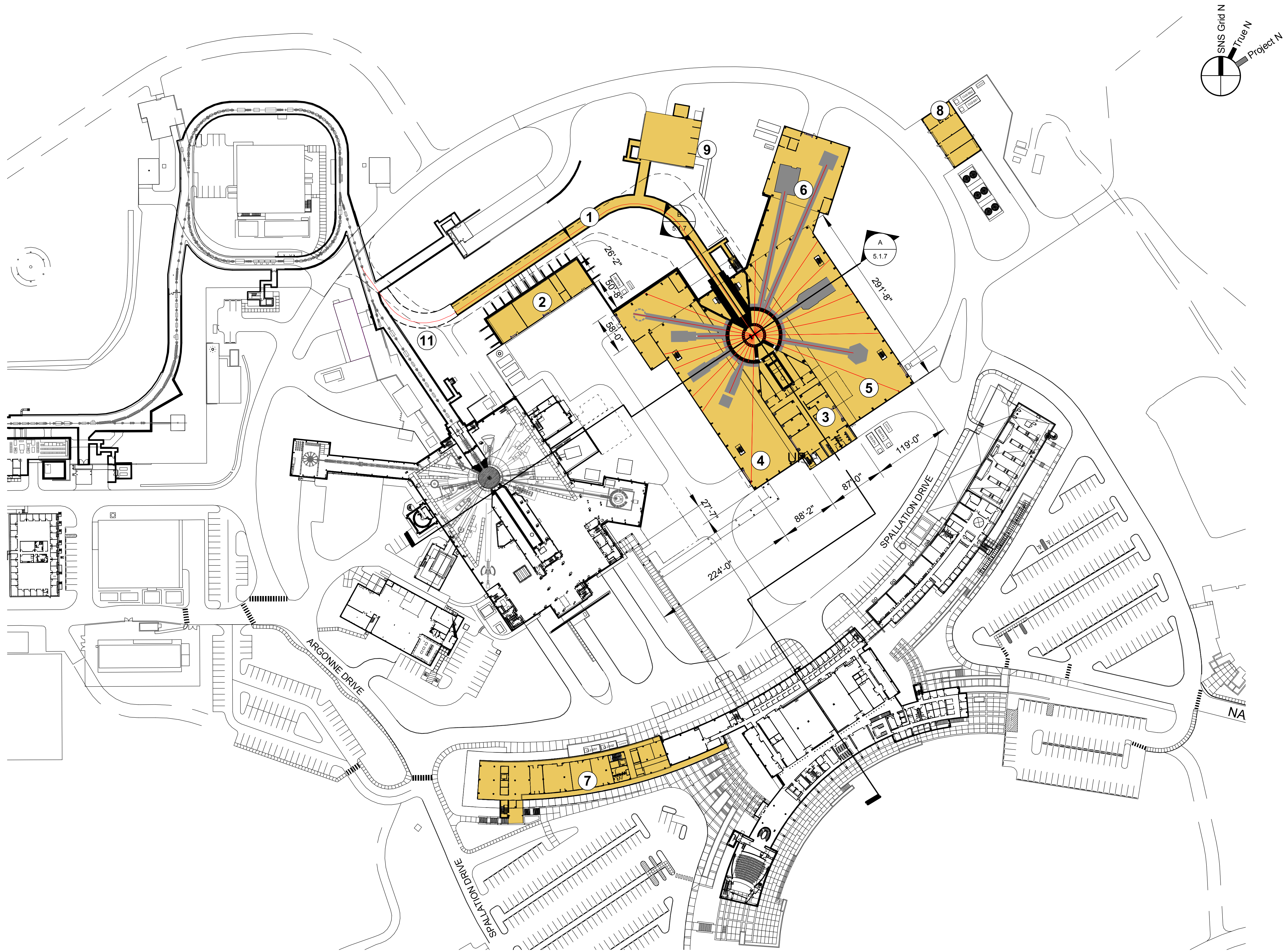

STS BUILDINGS

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2. RTST SERVICE BUILDING - 8560
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5. 50M INSTRUMENT BUILDING - 8890
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9. CENTRAL EXHAUST FACILITY II (CEF II) - 8960
10. SHOP BUILDING -8919
11. RTBT STUB

SCALE: 1" = 300'-0"

0 150 300 600

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SHEET NAME	**SITE FLOOR PLAN LEVEL 1074**
SHEET NUMBER	**5.1.4**
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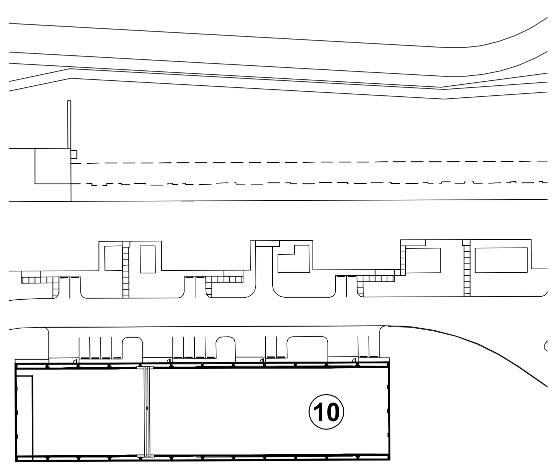

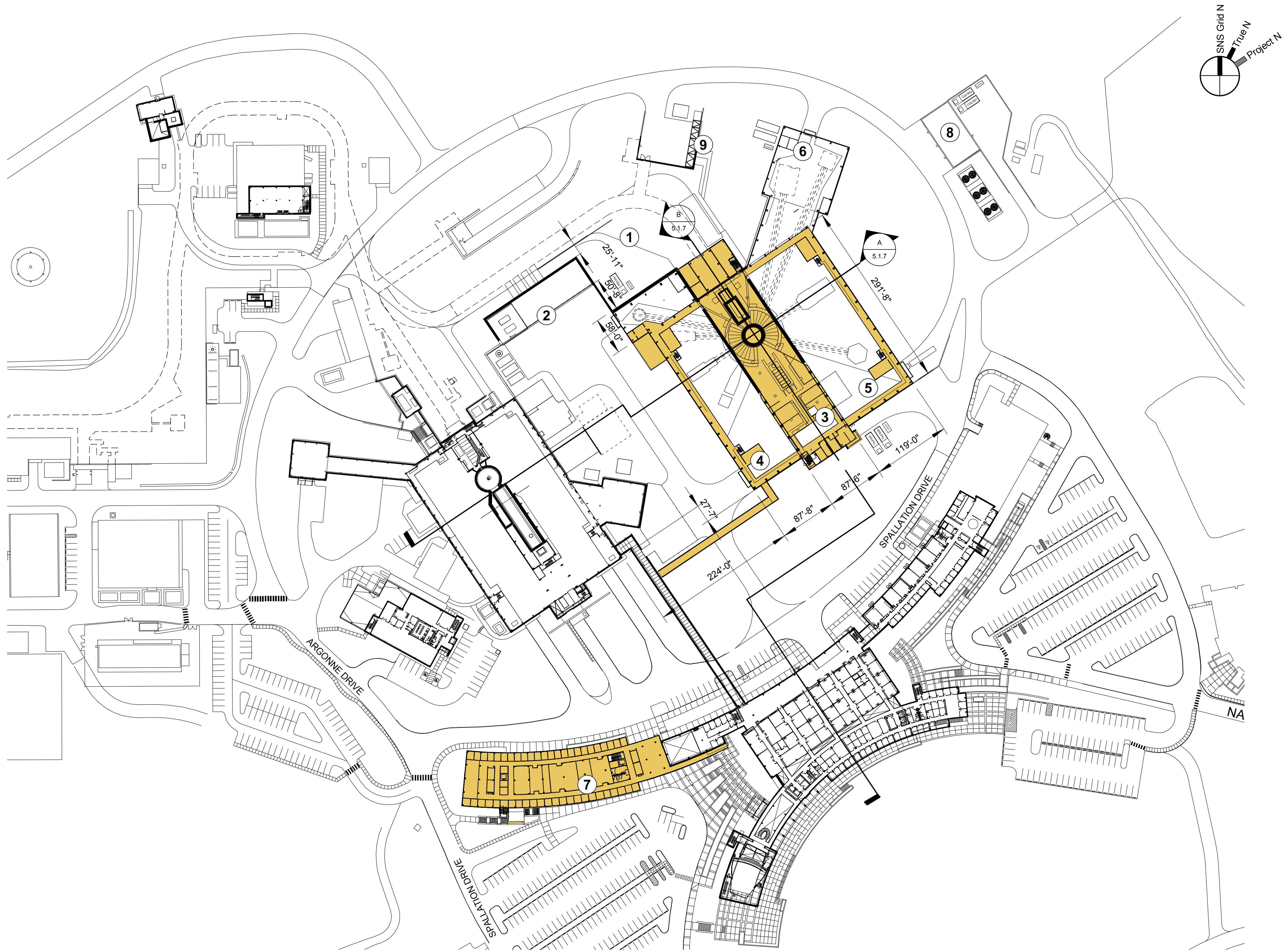

STS BUILDINGS

1. RTST TUNNEL - 8200
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9. CENTRAL EXHAUST FACILITY II (CEF II) - 8960
10. SHOP BUILDING -8919
11. RTBT STUB

SCALE: 1" = 300'-0"

0 150 300 600

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SHEET NAME	**SITE FLOOR PLAN LEVEL 1094**
SHEET NUMBER	**5.1.5**
DATE	FEBRUARY 8, 2019

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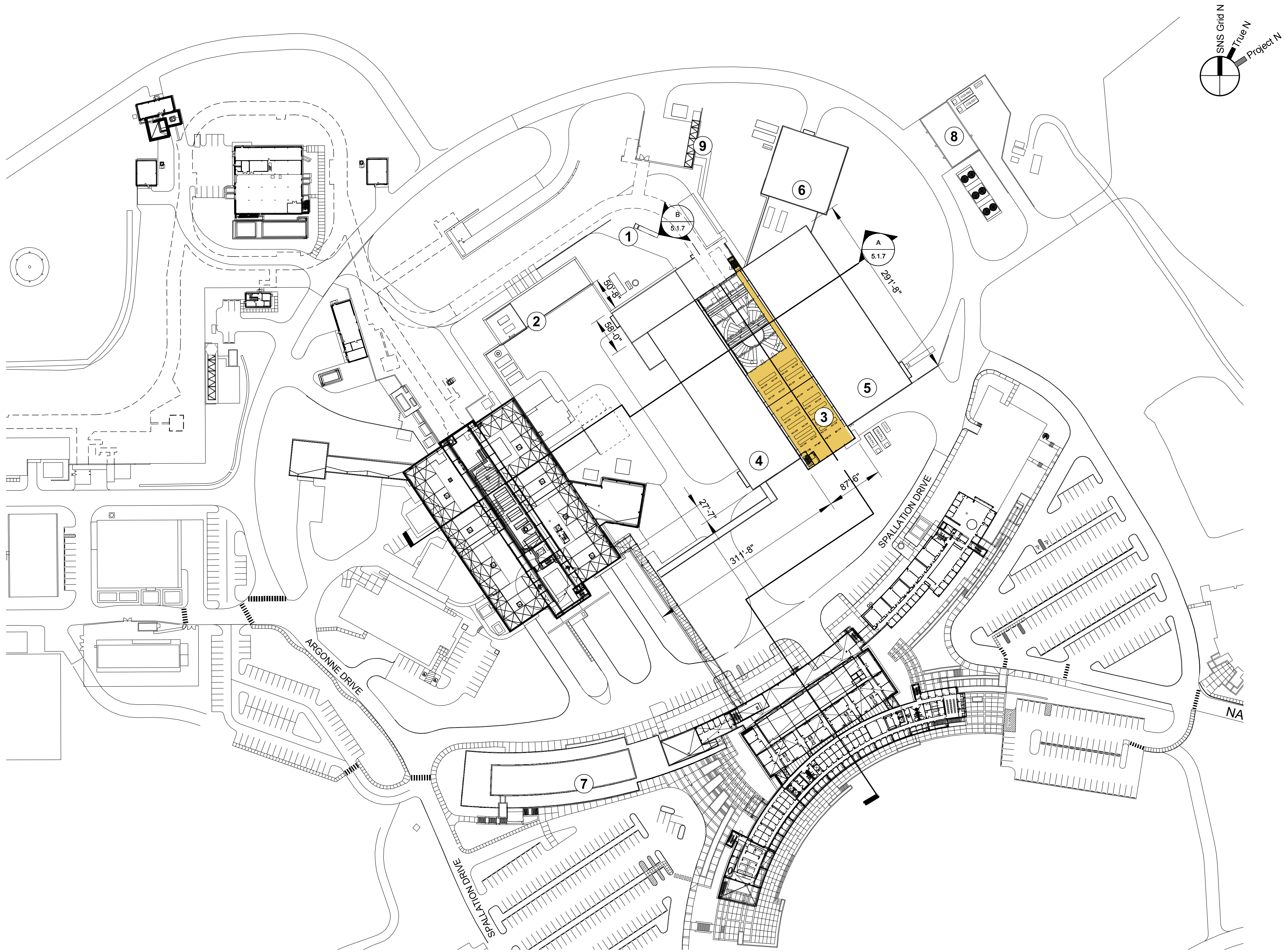

STS BUILDINGS

1. RTST TUNNEL - 8200
2. RTST SERVICE BUILDING - 8560
3. TARGET BUILDING II - 8800
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8. CENTRAL UTILITY BUILDING II (CUB II) - 8921
9. CENTRAL EXHAUST FACILITY II (CEF II) - 8960
10. SHOP BUILDING -8919
11. RTBT STUB

SCALE: 1" = 300'-0"

0 150 300 600

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SHEET NAME	**SITE FLOOR PLAN LEVELS 1120 & 1138**
SHEET NUMBER	**5.1.6**
DATE	FEBRUARY 8, 2019

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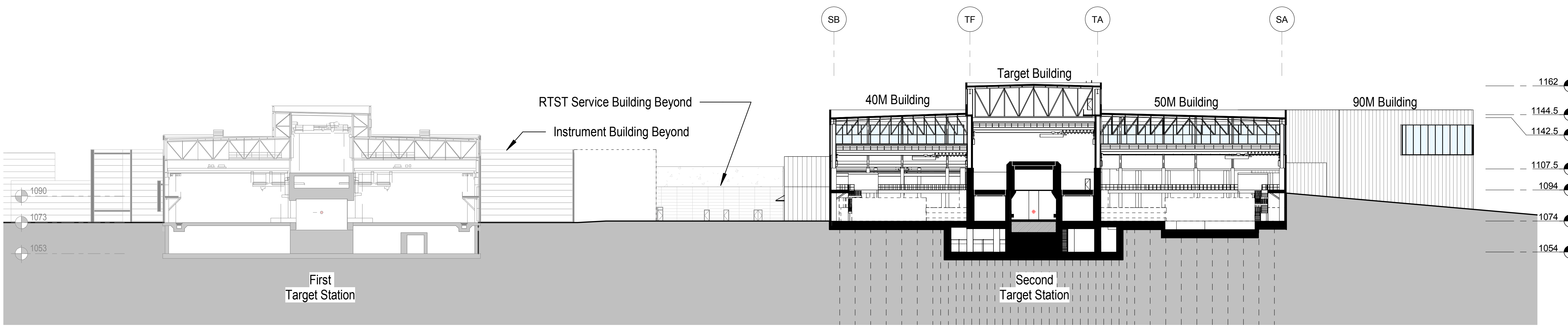
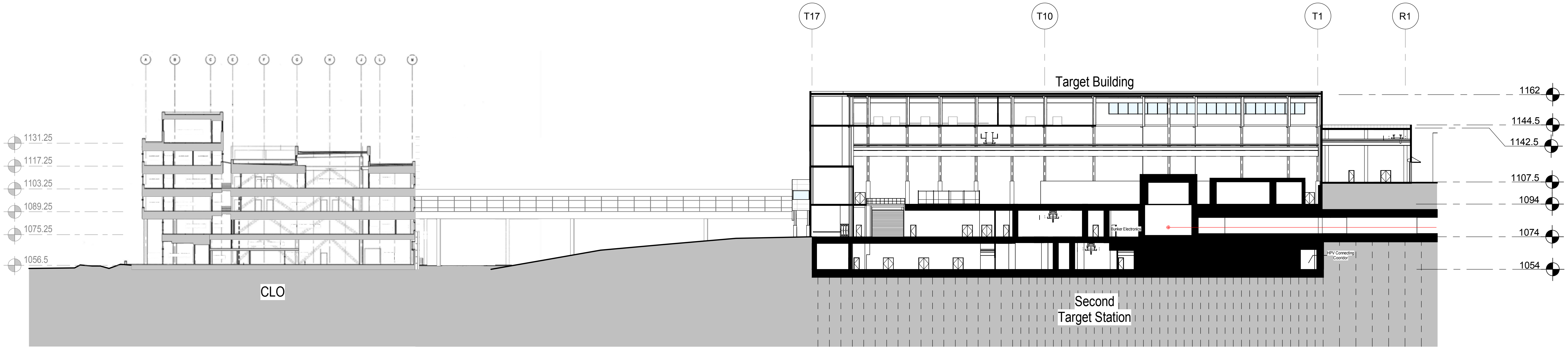


SITE SECTION A



SITE SECTION B

SCALE: 1/64" = 1'-0"

0 16 32 64 128

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SHEET NAME	**SITE SECTIONS**
SHEET NUMBER	**5.1.7**
DATE	FEBRUARY 8, 2019

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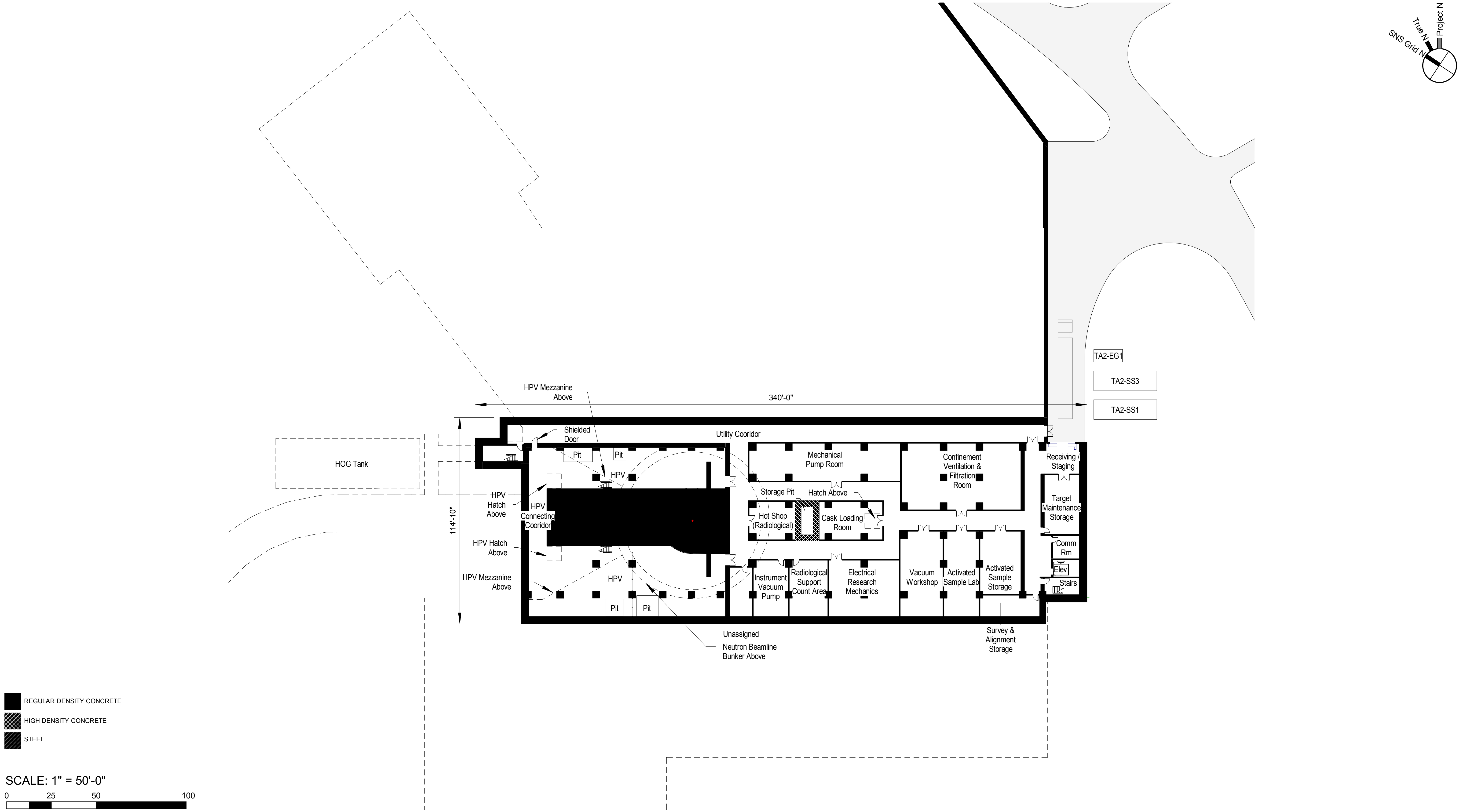

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PROJECT TITLE
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SHEET NAME **TARGET/INSTRUMENT STS BASEMENT PLAN**

SHEET NUMBER **5.1.8**

DATE FEBRUARY 8, 2019

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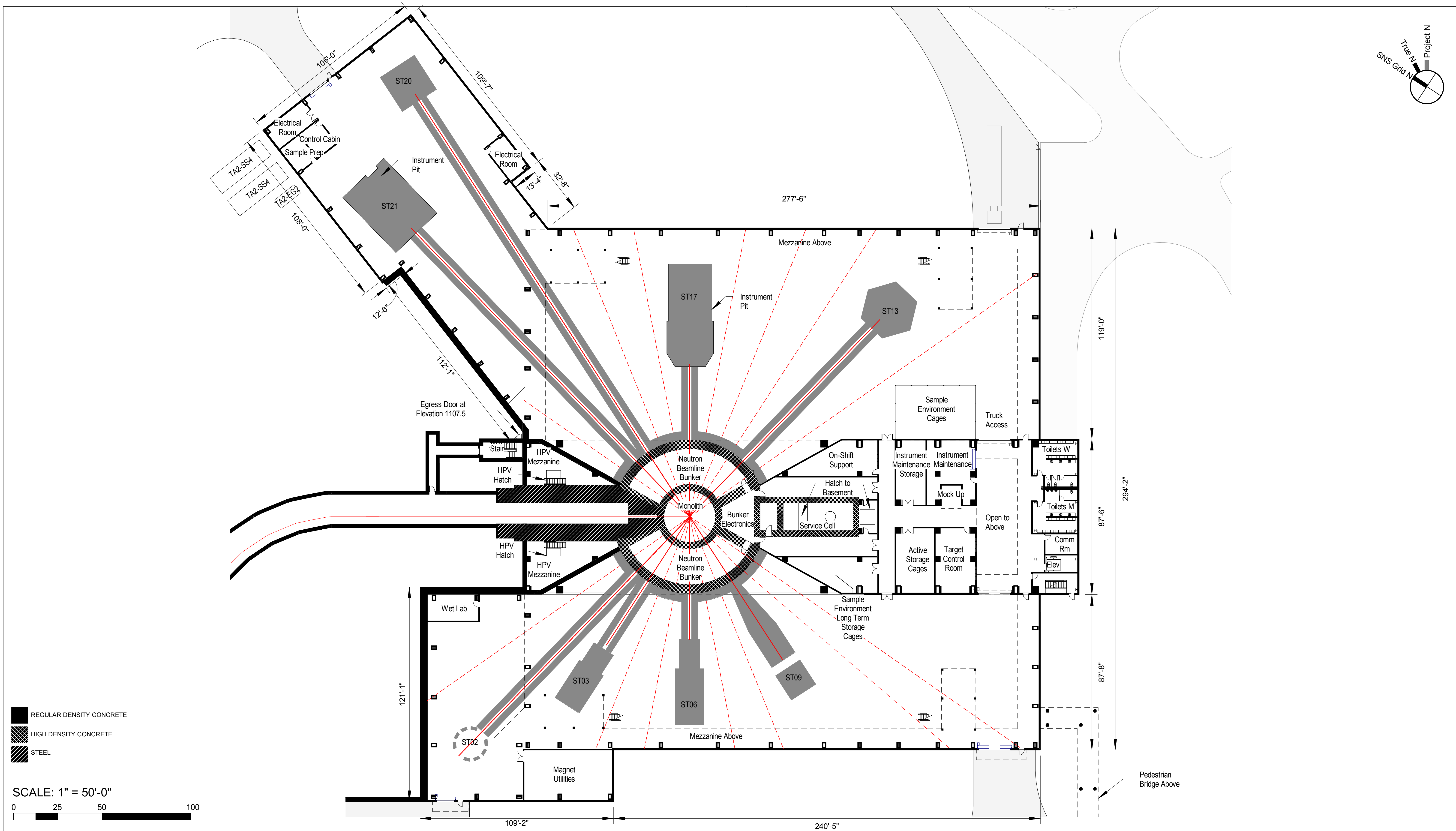

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SHEET NAME: TARGET/INSTRUMENT STS FIRST FLOOR PLAN
SHEET NUMBER: 5.1.9
DATE: FEBRUARY 8, 2019

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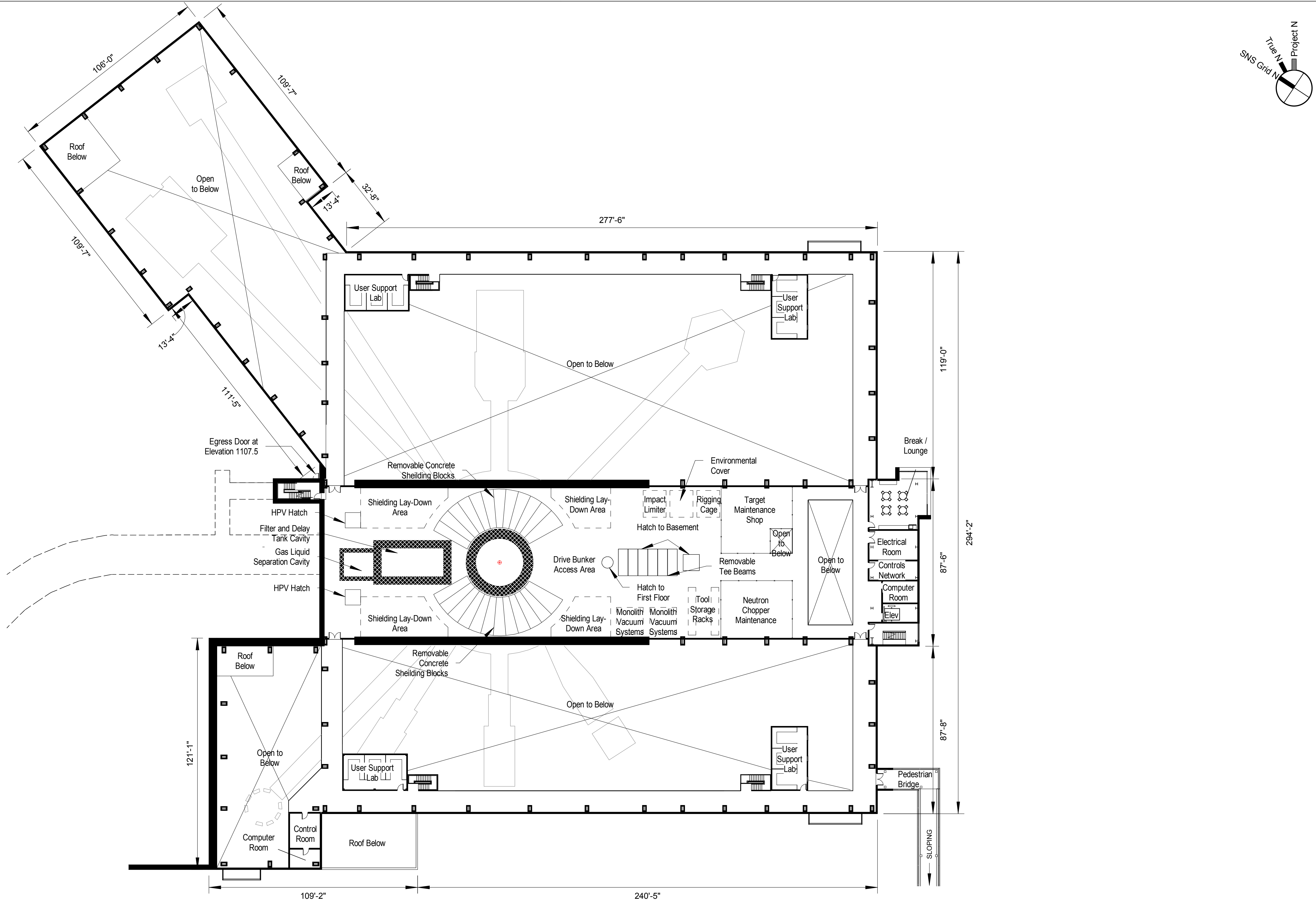

REGULAR DENSITY CONCRETE

HIGH DENSITY CONCRETE

STEEL

SCALE: 1" = 50'-0"

0 25 50 100

REV. NO.	DESCRIPTION	BY	APVD	DATE

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SHEET NAME	**TARGET/INSTRUMENT STS SECOND FLOOR PLAN**
SHEET NUMBER	**5.1.10**
DATE	FEBRUARY 8, 2019

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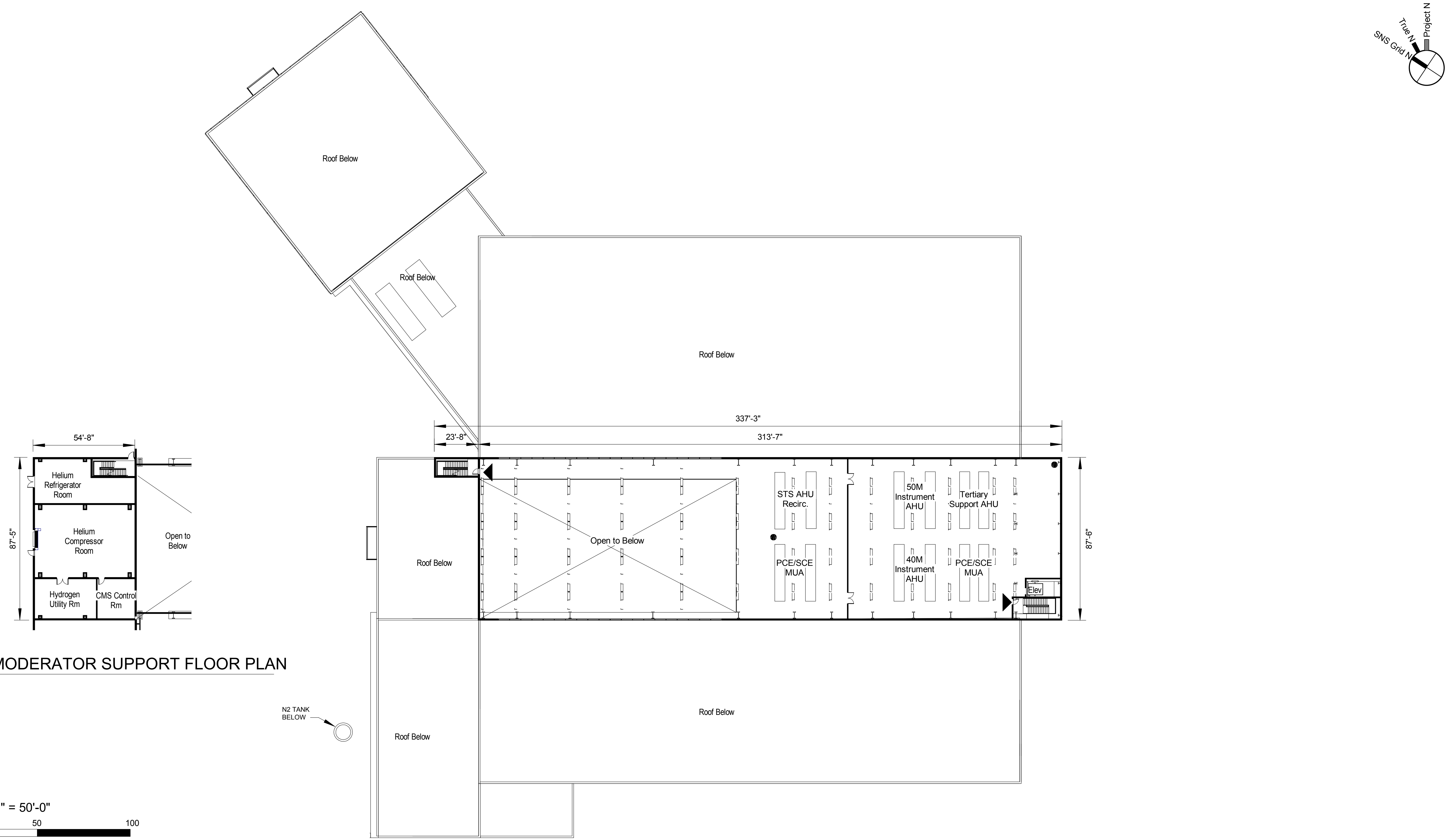

MODERATOR SUPPORT FLOOR PLAN

SCALE: 1" = 50'-0"

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SECOND TARGET STATION CONVENTIONAL FACILITIES

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SHEET NAME	**TARGET/INSTRUMENT STS TRUSS LEVEL & MODERATOR SUPPORT FLOOR PLANS**
SHEET NUMBER	**5.1.11**
DATE	FEBRUARY 8, 2019

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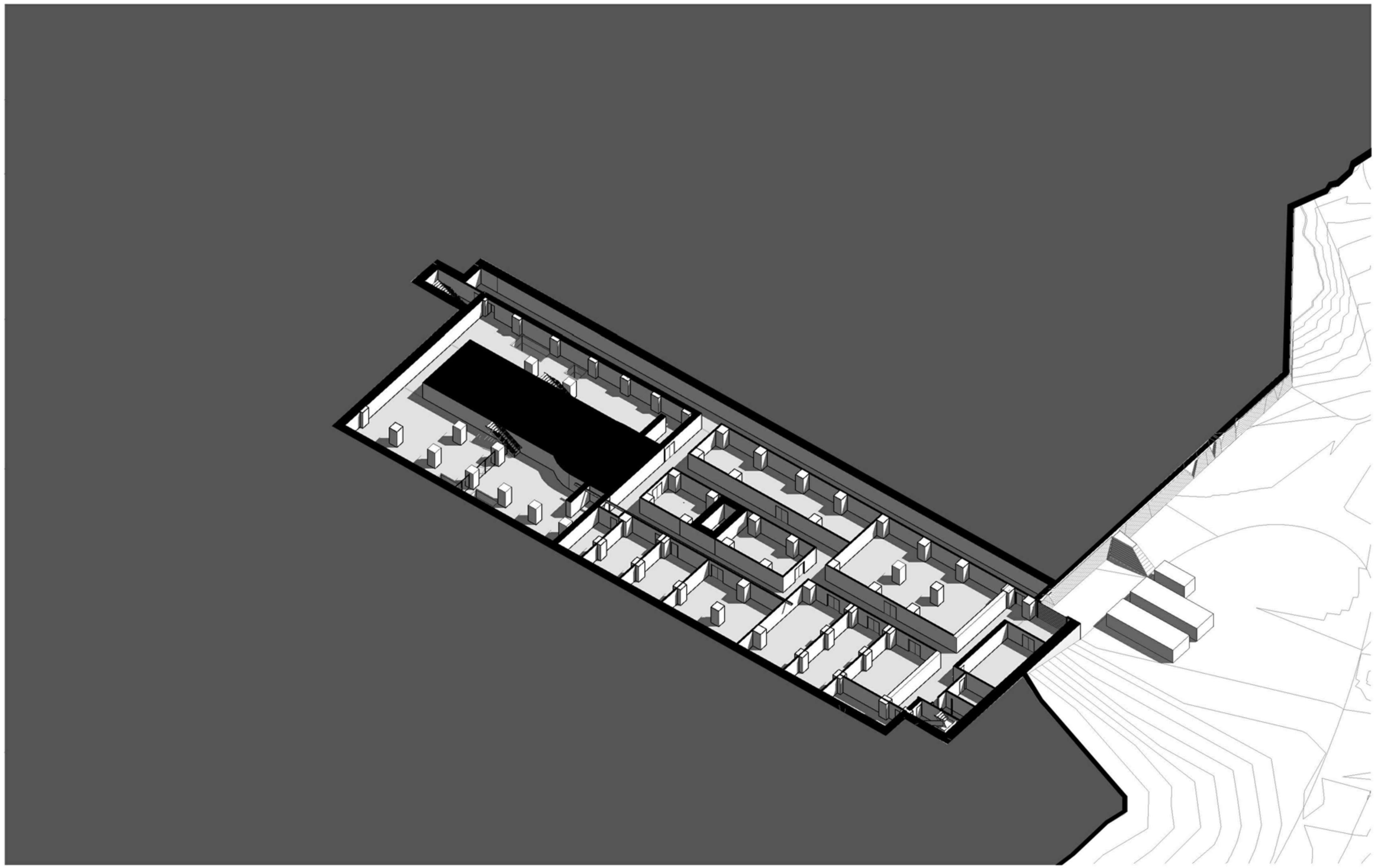

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PROJECT TITLE
SECOND TARGET STATION CONVENTIONAL FACILITIES

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SHEET NAME	**TARGET / INSTRUMENT STS BASEMENT AXONOMETRIC**
SHEET NUMBER	**5.1.12**
DATE	FEBRUARY 8, 2019

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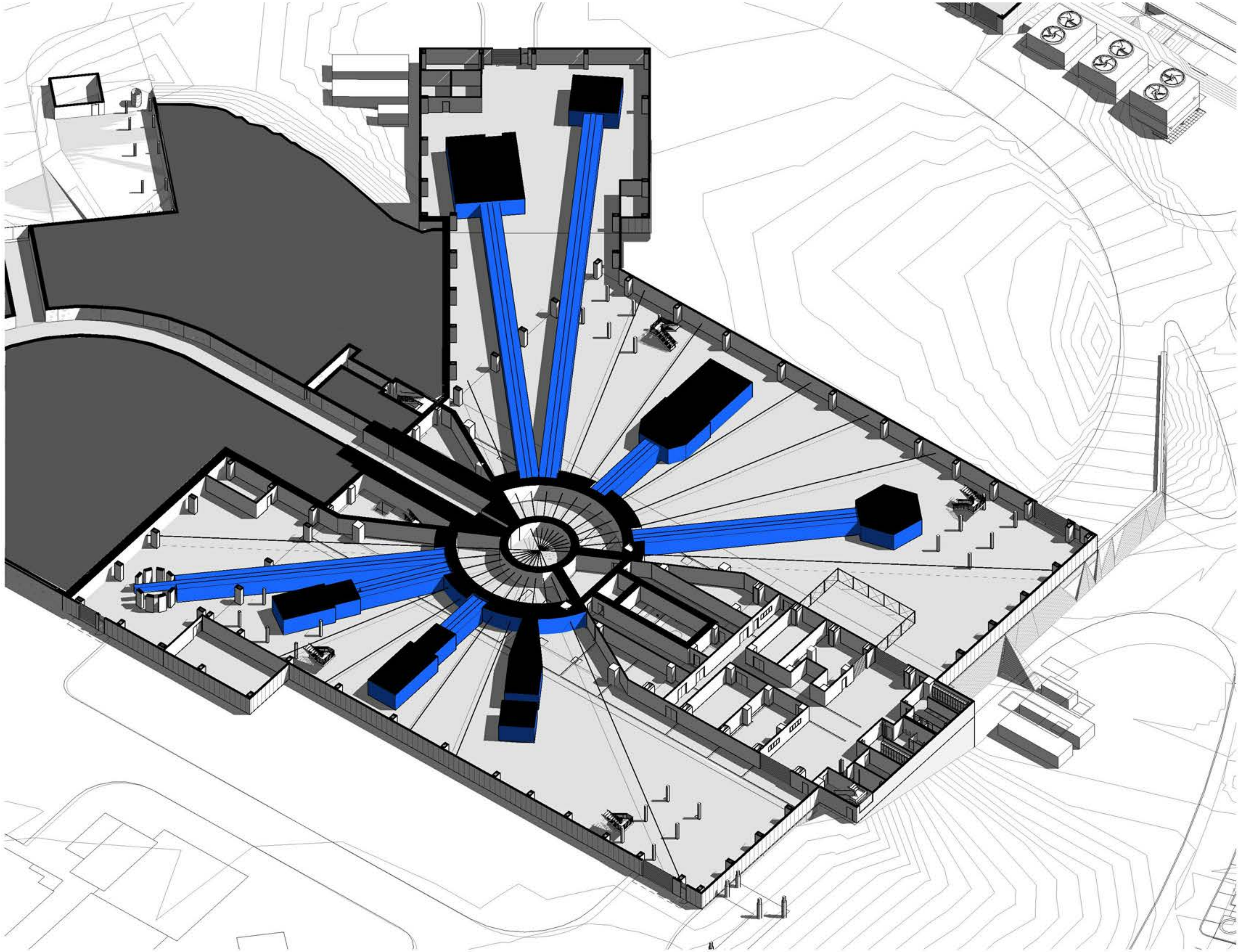

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SHEET NAME **TARGET / INSTRUMENT STS FIRST FLOOR AXONOMETRIC**

SHEET NUMBER **5.1.13**

DATE FEBRUARY 8, 2019

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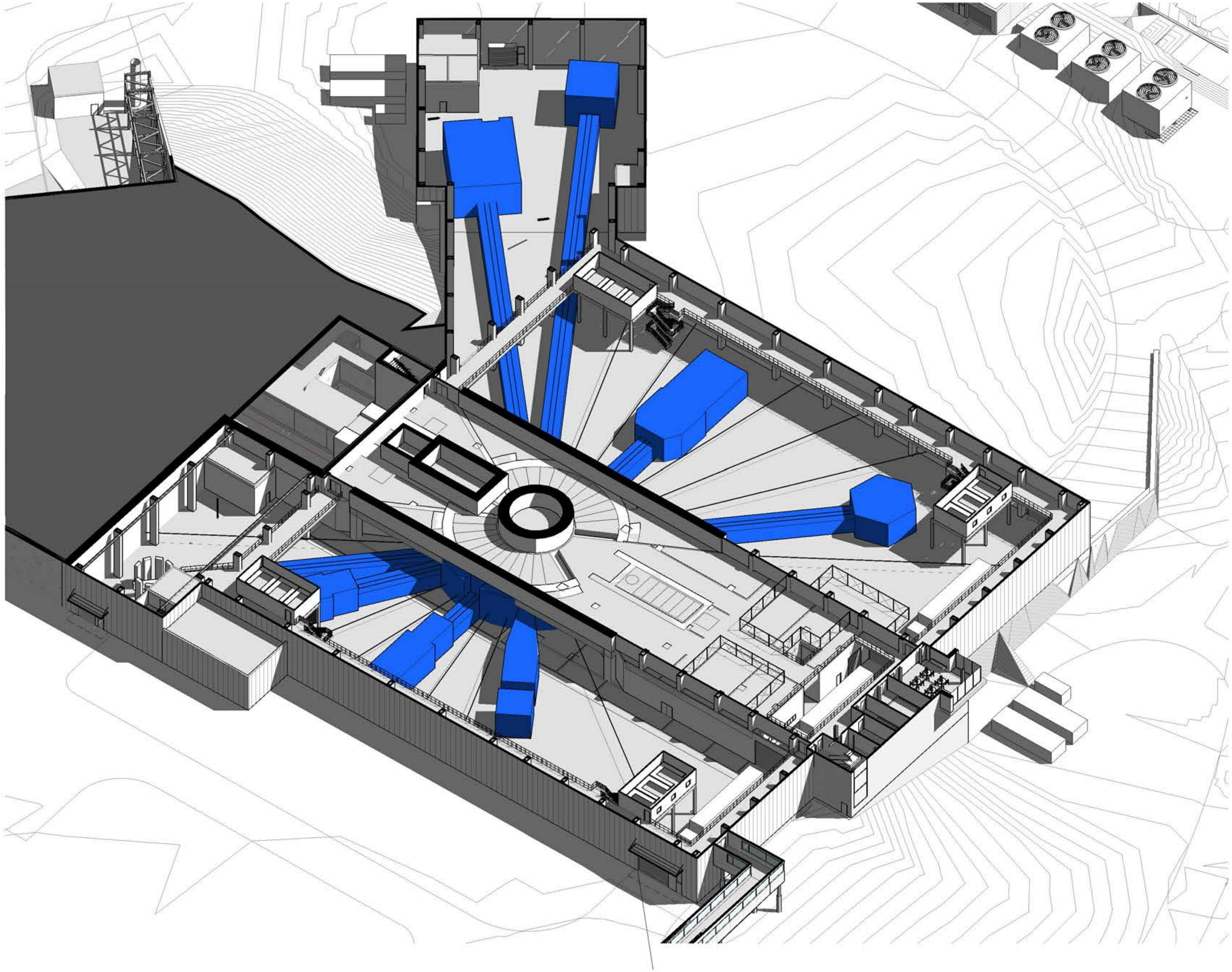

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SHEET NAME **TARGET / INSTRUMENT STS SECOND FLOOR AXONOMETRIC**

SHEET NUMBER **5.1.14**

DATE FEBRUARY 8, 2019

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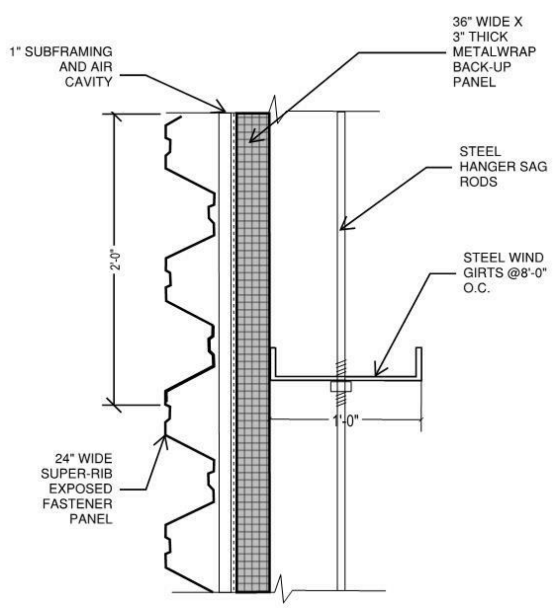
BUILDING	AREA (SF)
40M	**42,274**
Below Grade Concrete	3,651
Glazing	6,419
Metal Panel IA	2,778
Metal Panel II	29,426
50M	**34,788**
Above Grade Concrete	2,376
Below Grade Concrete	9,10
Glazing	10,920
Metal Panel II	20,582
90M	**31,324**
Below Grade Concrete	3,203
Metal Panel III	28,121
CEF II	**1,164**
Metal Panel III	1,164

BUILDING	AREA (SF)
CLO II	**58,222**
Above Grade Concrete	3,892
Below Grade Concrete	7,294
Glazing	20,947
Metal Panel IA	25,653
Metal Panel IB	436
CUB II	**9,251**
Above Grade Concrete	2,121
Below Grade Concrete	2,636
Glazing	112
Metal Panel III	4,382
RTST ACCESS TUNNEL	**24,943**
Above Grade Concrete	2,100
Below Grade Concrete	22,843

BUILDING	AREA (SF)
RTST SERVICE BLDG	**12,900**
Above Grade Concrete	6,033
Below Grade Concrete	3,022
Metal Panel III	3,382
Perforated Metal Screen Wall	463
SHOP BLDG	**27,456**
Metal Panel III	27,456
TARGET BLDG	**53,388**
Above Grade Concrete	810
Below Grade Concrete	21,518
Glazing	1,319
Metal Panel III	29,741
GRAND TOTAL	**295,710**

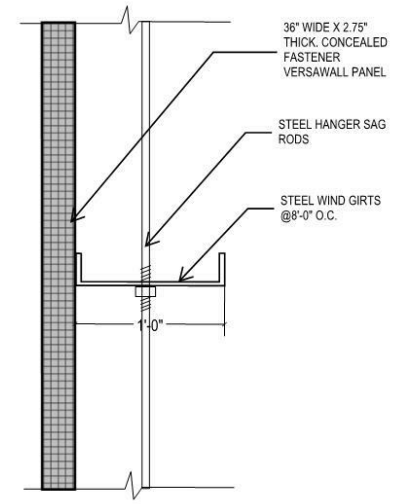
MATERIAL	AREA (SF)
Above Grade Concrete	17,332
Below Grade Concrete	65,077
Glazing	39,717
Metal Panel IA	28,431
Metal Panel IB	436
Metal Panel II	50,008
Metal Panel III	94,246
Perforated Metal Screen Wall	463
GRAND TOTAL	**295,710**



TYPE III: MR3-36 EXPOSED FASTERNER PANEL WITH METAL WRAP BACK-UP PANEL

TYPE III

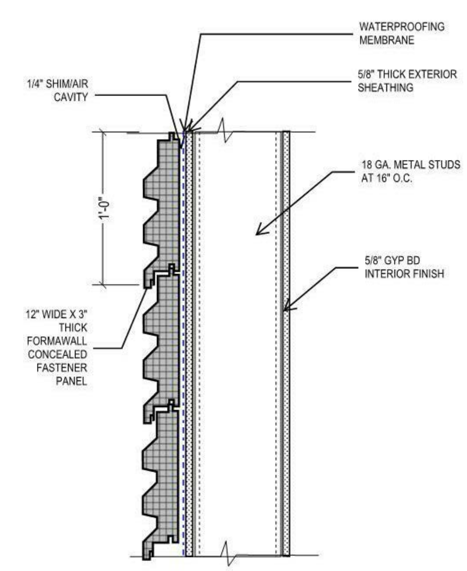
3/4" = 1'-0"



TYPE II: VERSAWALL 36" WIDE X 2" THICK STRIATED PANEL

TYPE II

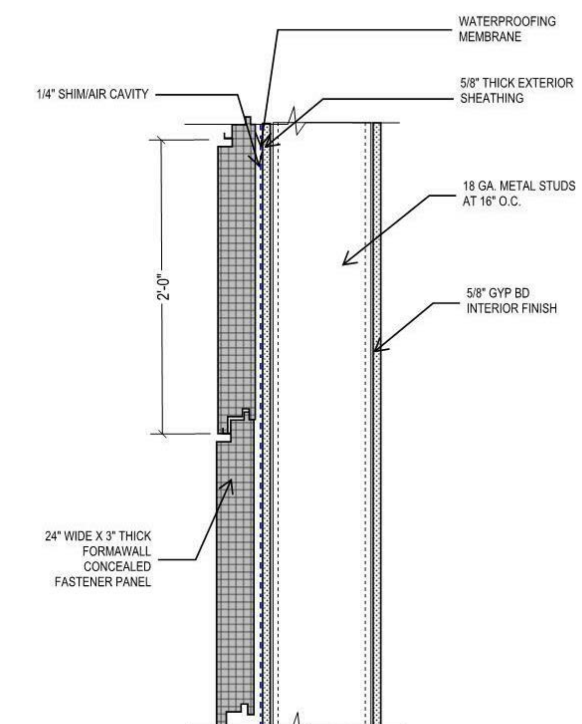
3/4" = 1'-0"



TYPE 1B: FORMAWALL DS60 24" WIDE PANEL

TYPE 1B

3/4" = 1'-0"



TYPE IA: FORMAWALL 24" WIDE PANEL

TYPE IA

3/4" = 1'-0"

REV. NO.	DESCRIPTION	BY	APVD	DATE

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T: 312.332.9600
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PROJECT TITLE
SECOND TARGET STATION CONVENTIONAL FACILITIES

100% CONCEPTUAL DESIGN REPORT SUBMISSION

SHEET NAME **METAL PANEL DETAILS & ESTIMATED EXTERIOR MATERIAL AREA TAKEOFFS**

SHEET NUMBER **5.1.15**

DATE FEBRUARY 8, 2019

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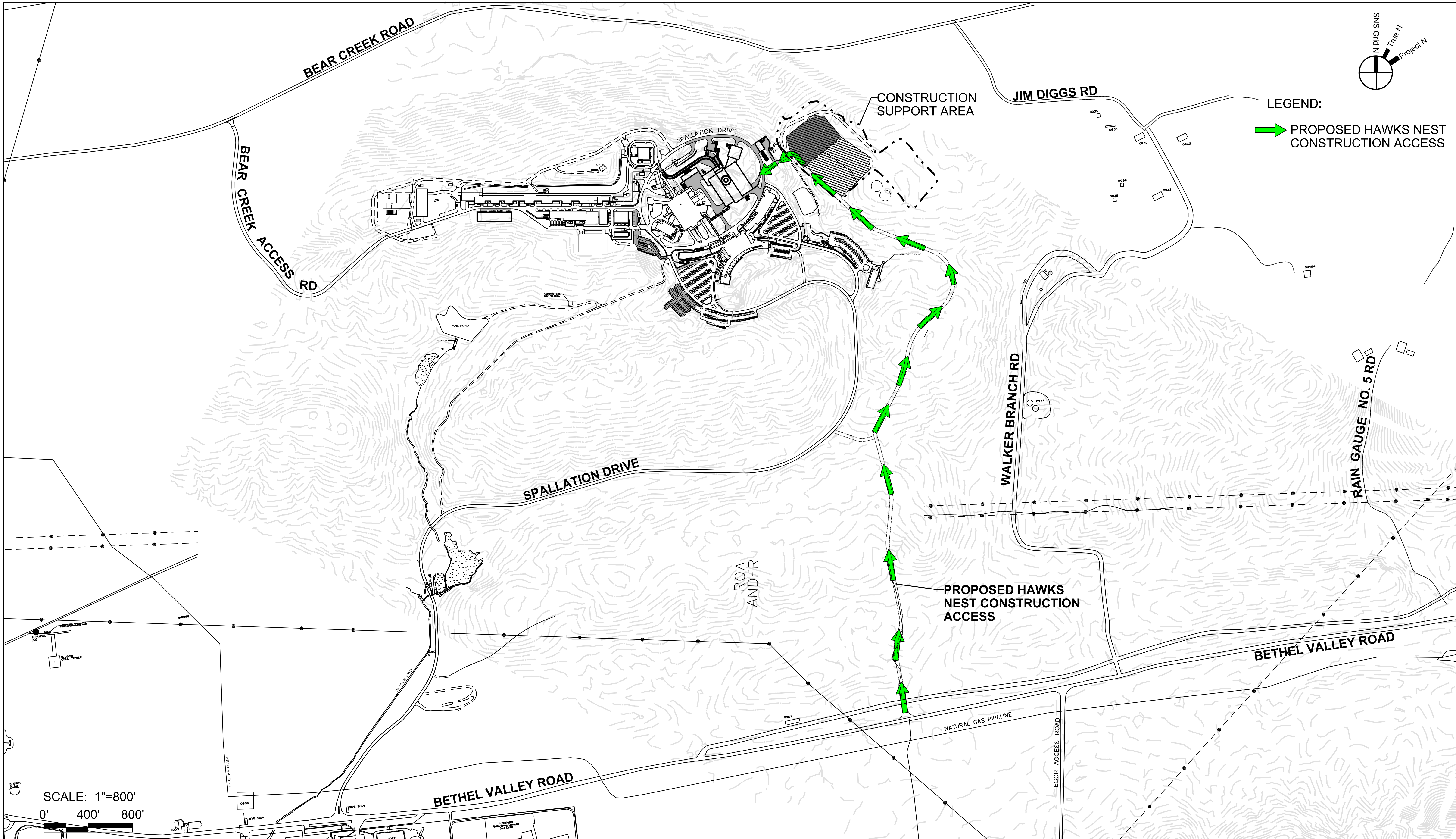

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PROJECT TITLE
SPALLATION NEUTRON SOURCE SECOND TARGET STATION CONVENTIONAL FACILITIES
CONCEPTUAL DESIGN REPORT, 100% SUBMISSION

SHEET NAME	**CONSTRUCTION ACCESS ROUTE**
SHEET NUMBER	**5.1.16**
DATE	FEBRUARY 8, 2019

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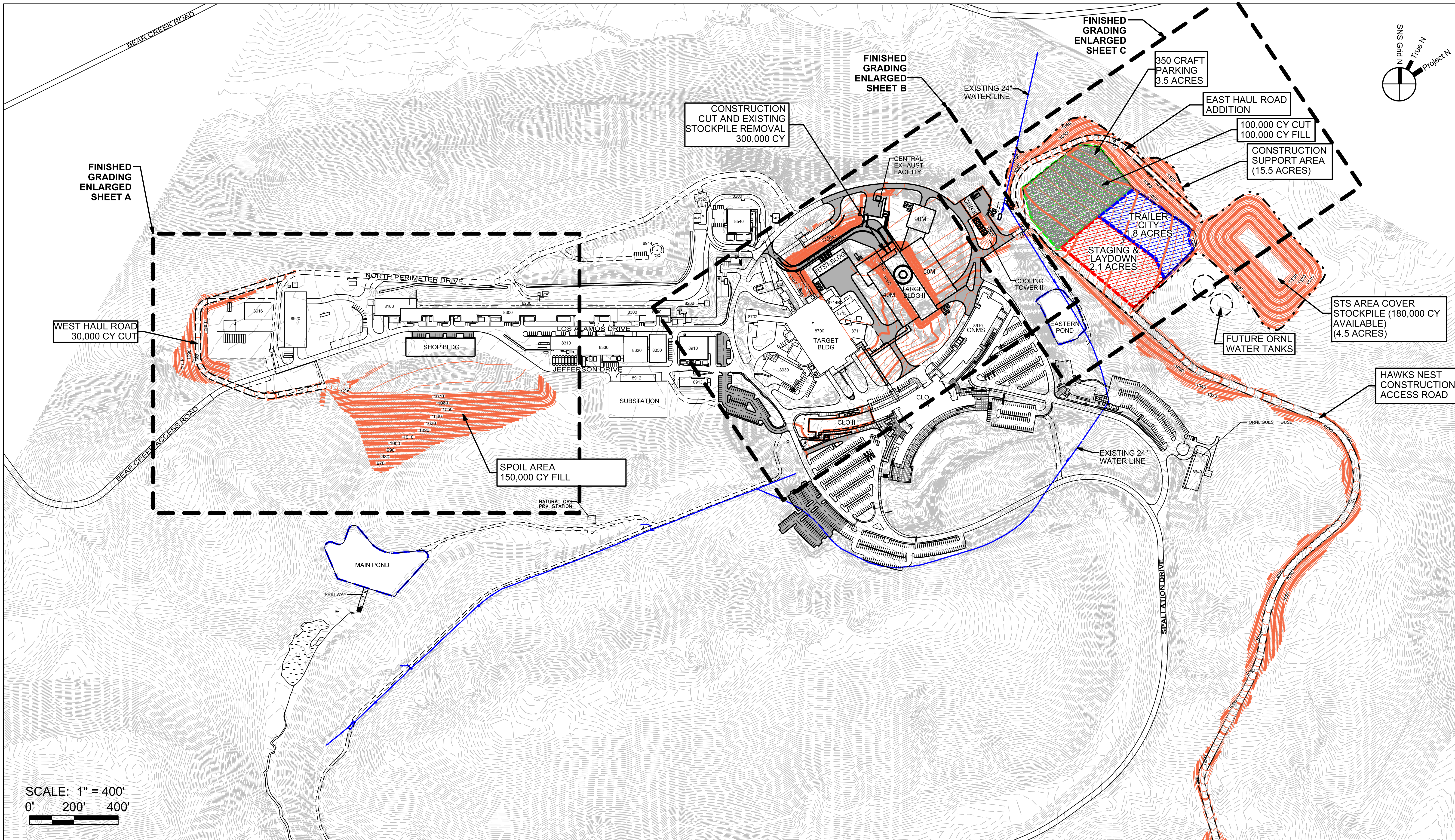

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PROJECT TITLE
SPALLATION NEUTRON SOURCE SECOND TARGET STATION CONVENTIONAL FACILITIES
CONCEPTUAL DESIGN REPORT, 100% SUBMISSION

SHEET NAME	**CONSTRUCTION EXCAVATION & SUPPORT AREA PLAN**
SHEET NUMBER	**5.1.17**
DATE	FEBRUARY 8, 2019

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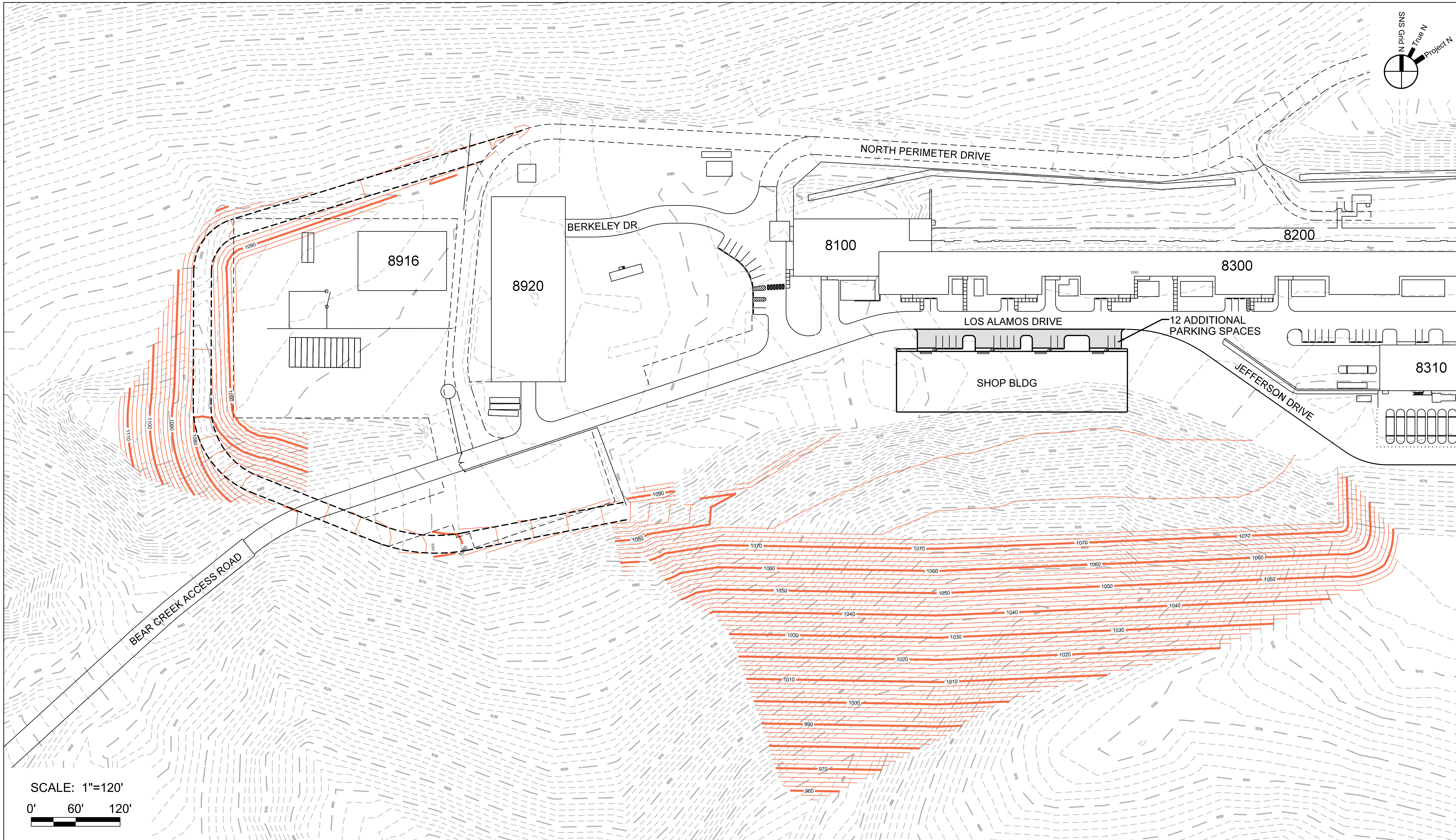

REV. NO.	DESCRIPTION	BY	APVD	DATE

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PROJECT TITLE
SPALLATION NEUTRON SOURCE SECOND TARGET STATION CONVENTIONAL FACILITIES
CONCEPTUAL DESIGN REPORT, 100% SUBMISSION

SHEET NAME	**ENLARGED SHOP BLDG AREA FINISH GRADING**
SHEET NUMBER	**5.1.18**
DATE	FEBRUARY 8, 2019

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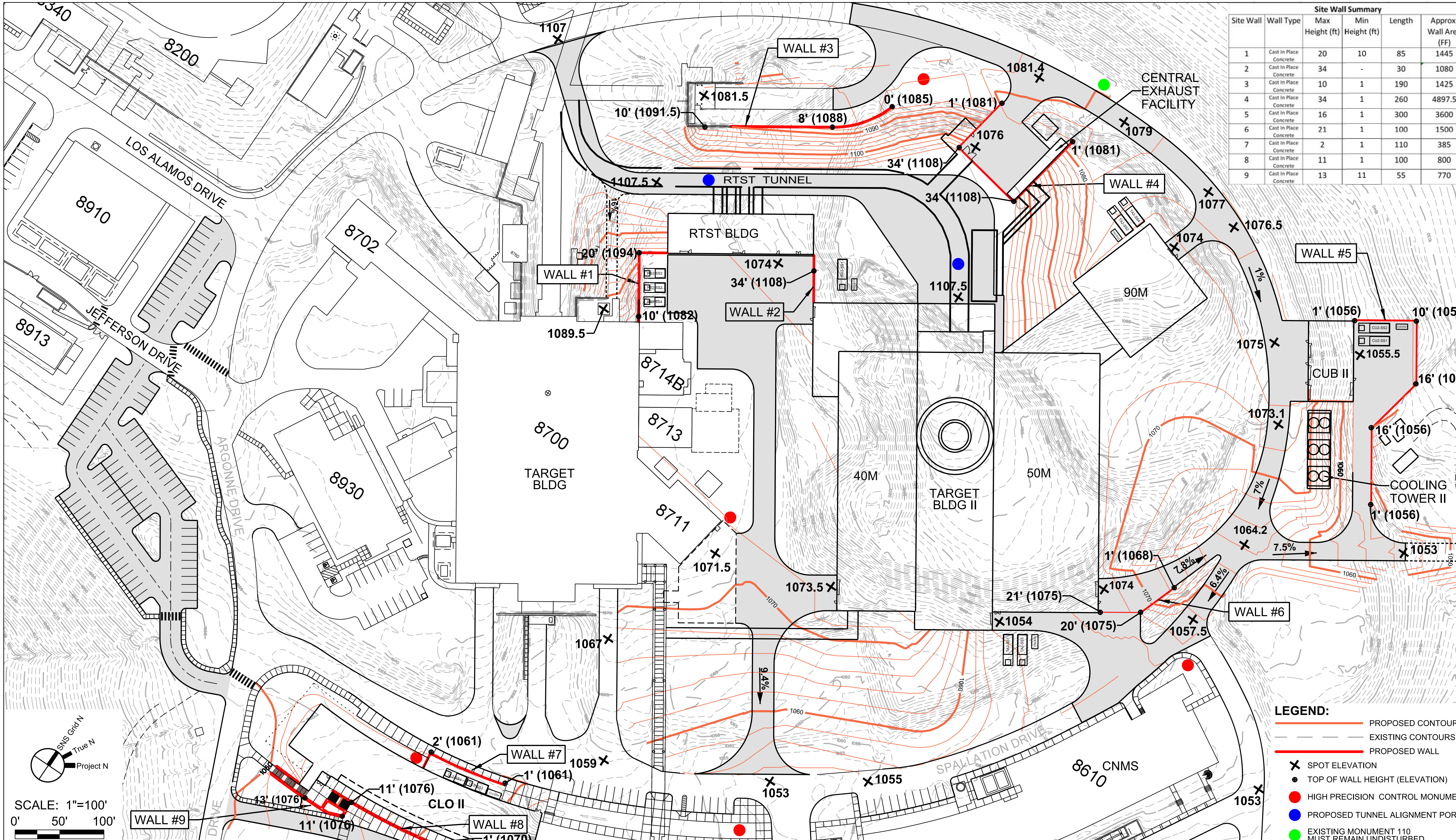

Site Wall Summary					
Site Wall	Wall Type	Max Height (ft)	Min Height (ft)	Length	Approx. Wall Area (FF)
1	Cast In Place Concrete	20	10	85	1445
2	Cast In Place Concrete	34	-	30	1080
3	Cast In Place Concrete	10	1	190	1425
4	Cast In Place Concrete	34	1	260	4897.5
5	Cast In Place Concrete	16	1	300	3600
6	Cast In Place Concrete	21	1	100	1500
7	Cast In Place Concrete	2	1	110	385
8	Cast In Place Concrete	11	1	100	800
9	Cast In Place Concrete	13	11	55	770

LEGEND:

- PROPOSED CONTOURS
- EXISTING CONTOURS
- PROPOSED WALL
- SPOT ELEVATION
- TOP OF WALL HEIGHT (ELEVATION)
- HIGH PRECISION CONTROL MONUMENT
- PROPOSED TUNNEL ALIGNMENT PORT
- EXISTING MONUMENT 110 MUST REMAIN UNDISTURBED

REV. NO.	DESCRIPTION	BY	APVD	DATE

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PROJECT TITLE
SPALLATION NEUTRON SOURCE SECOND TARGET STATION
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CONCEPTUAL DESIGN REPORT, 100% SUBMISSION

SHEET NAME	**ENLARGED TARGET II AREA FINISH GRADING**
SHEET NUMBER	**5.1.19**
DATE	FEBRUARY 8, 2019

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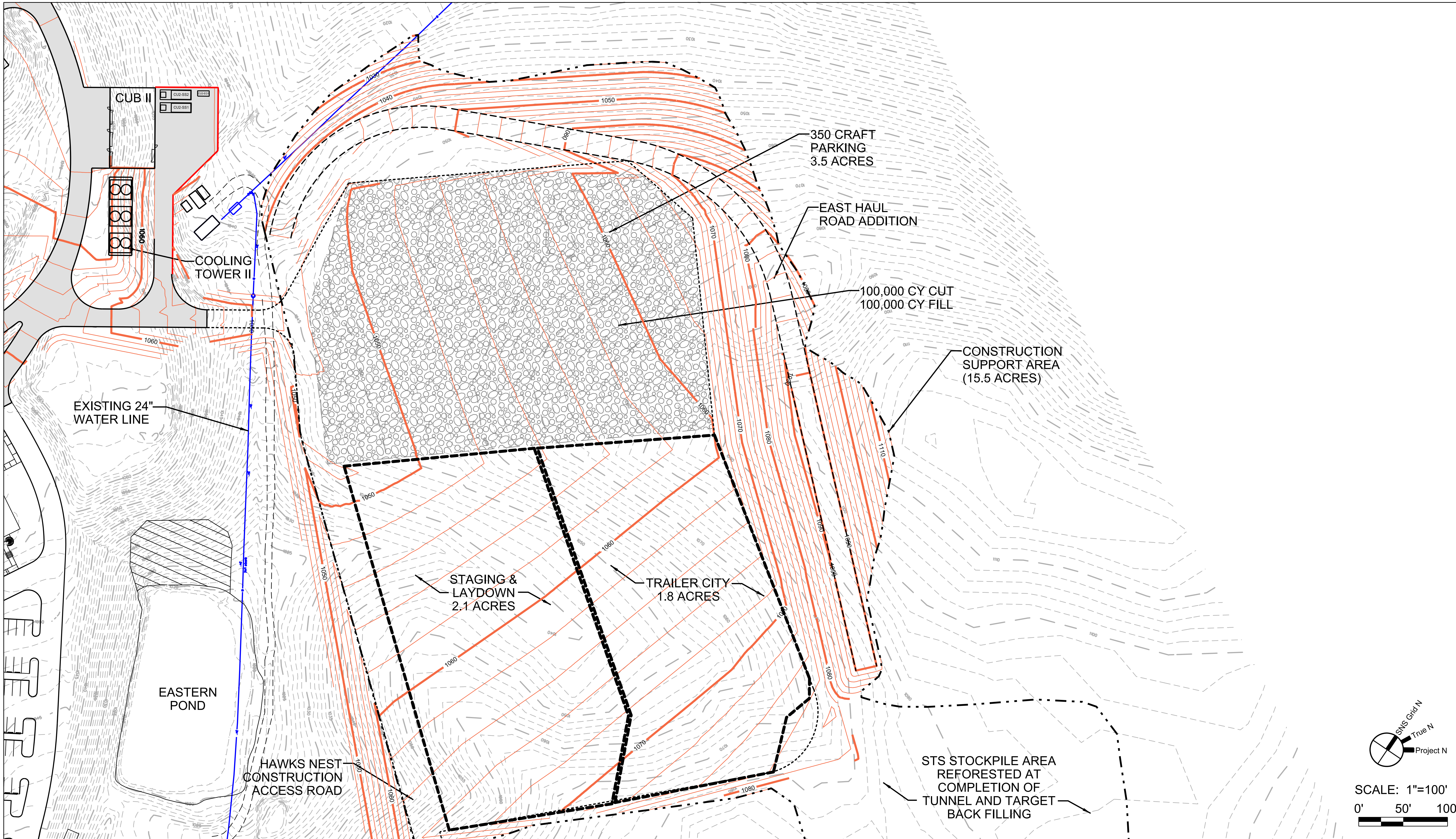

REV. NO.	DESCRIPTION	BY	APVD	DATE

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SHEET NAME: **ENLARGED SUPPORT AREA FINISH GRADING**
SHEET NUMBER: **5.1.20**
DATE: FEBRUARY 8, 2019

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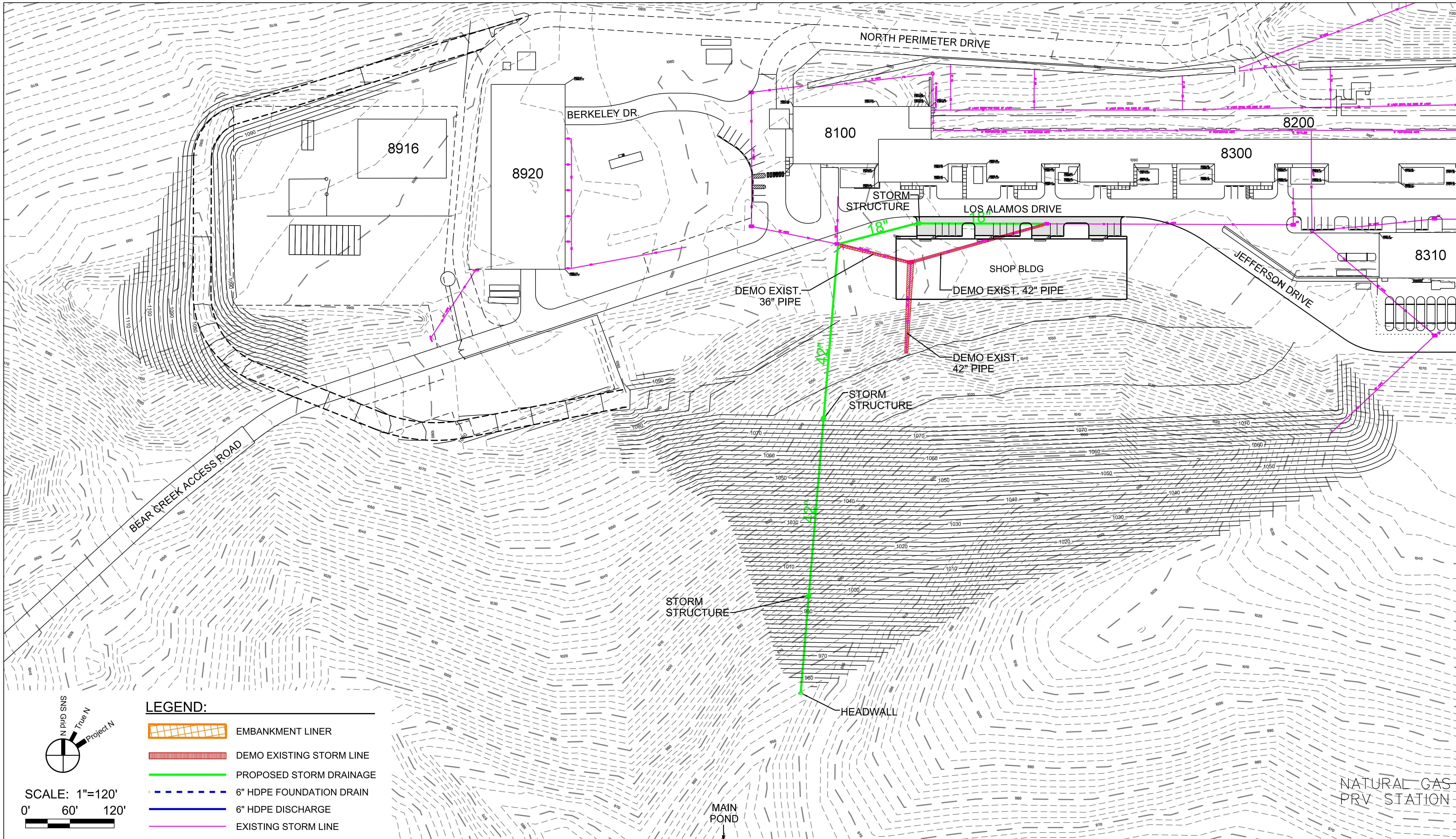

REV. NO.	DESCRIPTION	BY	APVD	DATE

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PROJECT TITLE
SPALLATION NEUTRON SOURCE SECOND TARGET STATION CONVENTIONAL FACILITIES
CONCEPTUAL DESIGN REPORT, 100% SUBMISSION

SHEET NAME **CONCEPTUAL DRAINAGE PLAN**
SHEET NUMBER **5.1.21**
DATE FEBRUARY 8, 2019

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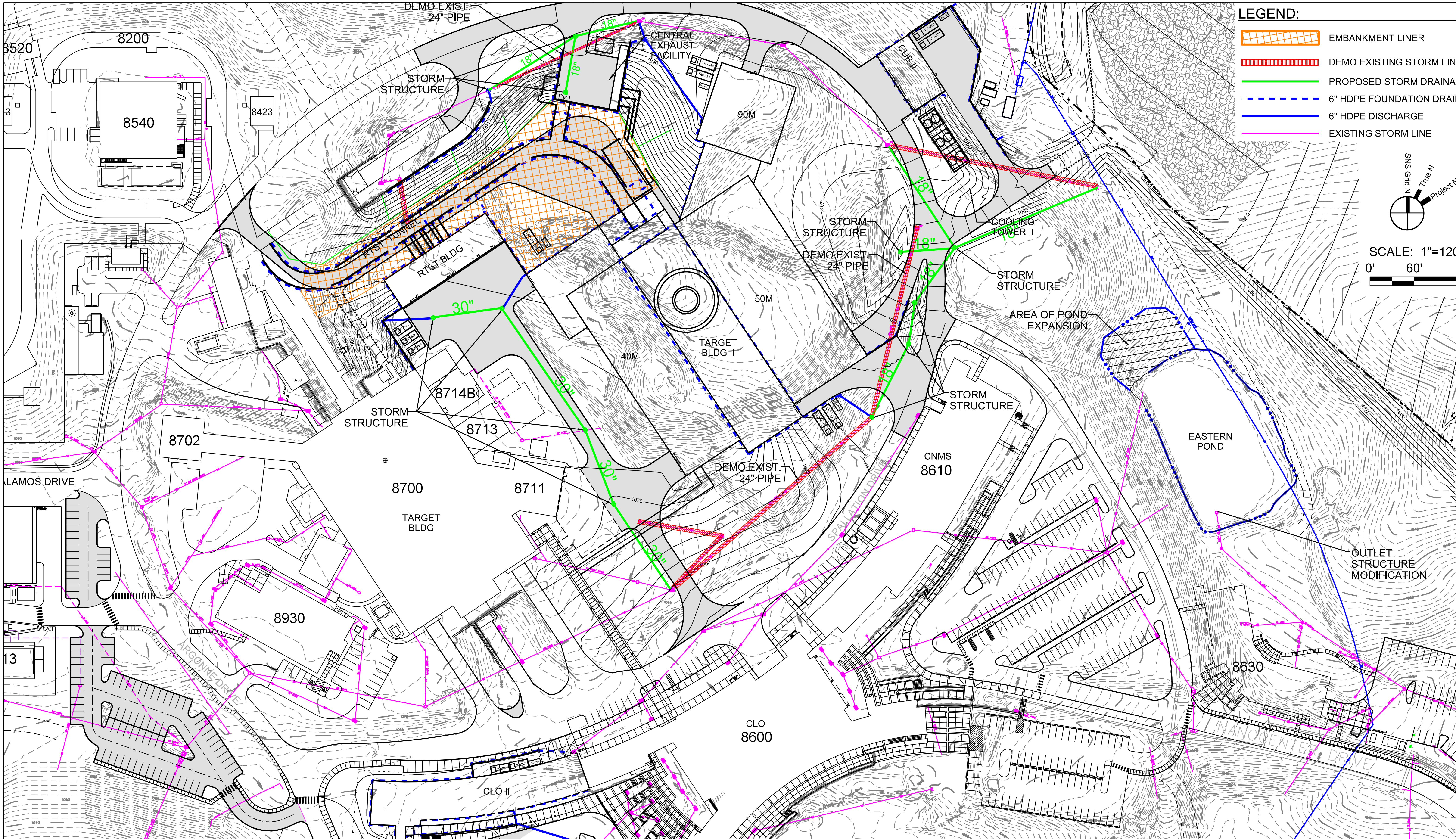

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SHEET NAME: **CONCEPTUAL DRAINAGE PLAN**
SHEET NUMBER: **5.1.22**
DATE: FEBRUARY 8, 2019

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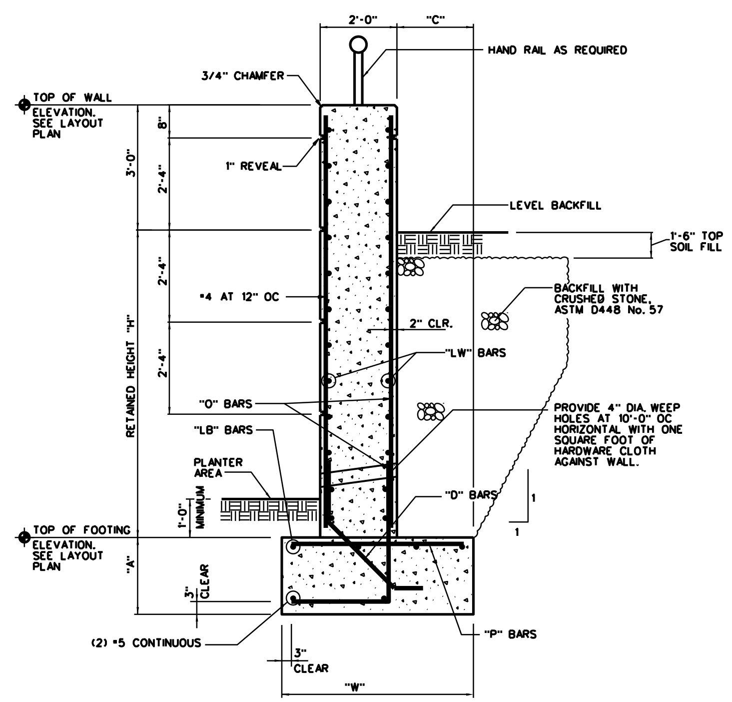
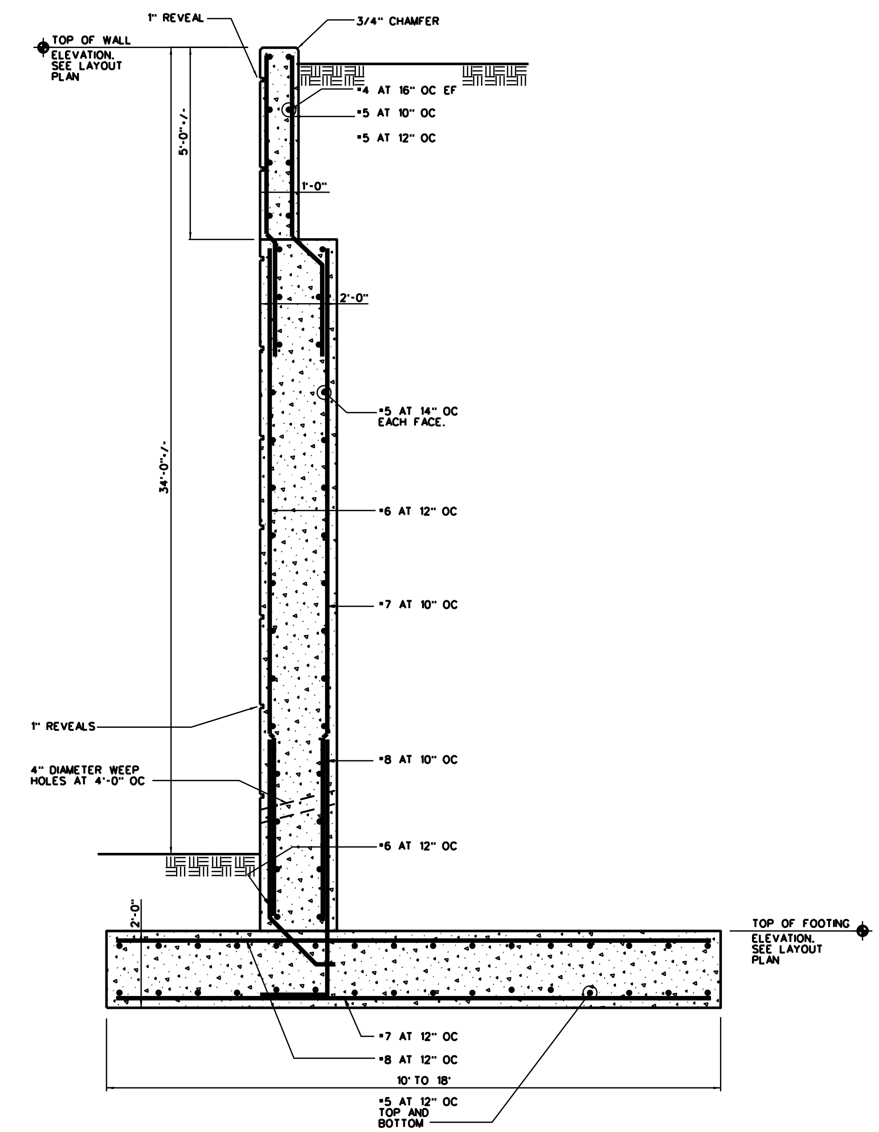
BACKFILL : LEVEL				SOIL : EQUILIVENT FLUID PRESSURE 35 POUNDS PER CUBIC FOOT				
"H"	"A"	"C"	"W"	"O"	"D"	"LB"	"P"	"LW"
<4'-0"	24"	1'-0"	3'-6"	#5 AT 12"	#5 AT 12"	(4) #5	#5 AT 12"	#5 AT 14"
6'-0"	24"	1'-0"	4'-0"	#5 AT 12"	#5 AT 12"	(5) #5	#5 AT 12"	#5 AT 14"
8'-0"	24"	2'-0"	5'-0"	#5 AT 12"	#5 AT 12"	(6) #5	#4 AT 12"	#5 AT 14"
10'-0"	24"	3'-0"	6'-6"	#6 AT 12"	#6 AT 12"	(7) #5	#5 AT 12"	#5 AT 14"
12'-0"	24"	4'-0"	8'-0"	#6 AT 12"	#6 AT 12"	(8) #5	#5 AT 12"	#5 AT 14"
14'-0"	24"	5'-0"	9'-6"	#7 AT 12"	#6 AT 12"	(10) #5	#6 AT 12"	#5 AT 14"



B RETAINING WALL DETAIL FOR 2' WALL
NTS



C WALLS GREATER THAN 14'
SCALE : 1/2" = 1'-0"

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SPALLATION NEUTRON SOURCE SECOND TARGET STATION
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SHEET NAME	**CONCEPTUAL SITE RETAINING WALL SECTIONS**
SHEET NUMBER	**5.1.23**
DATE	FEBRUARY 8, 2019

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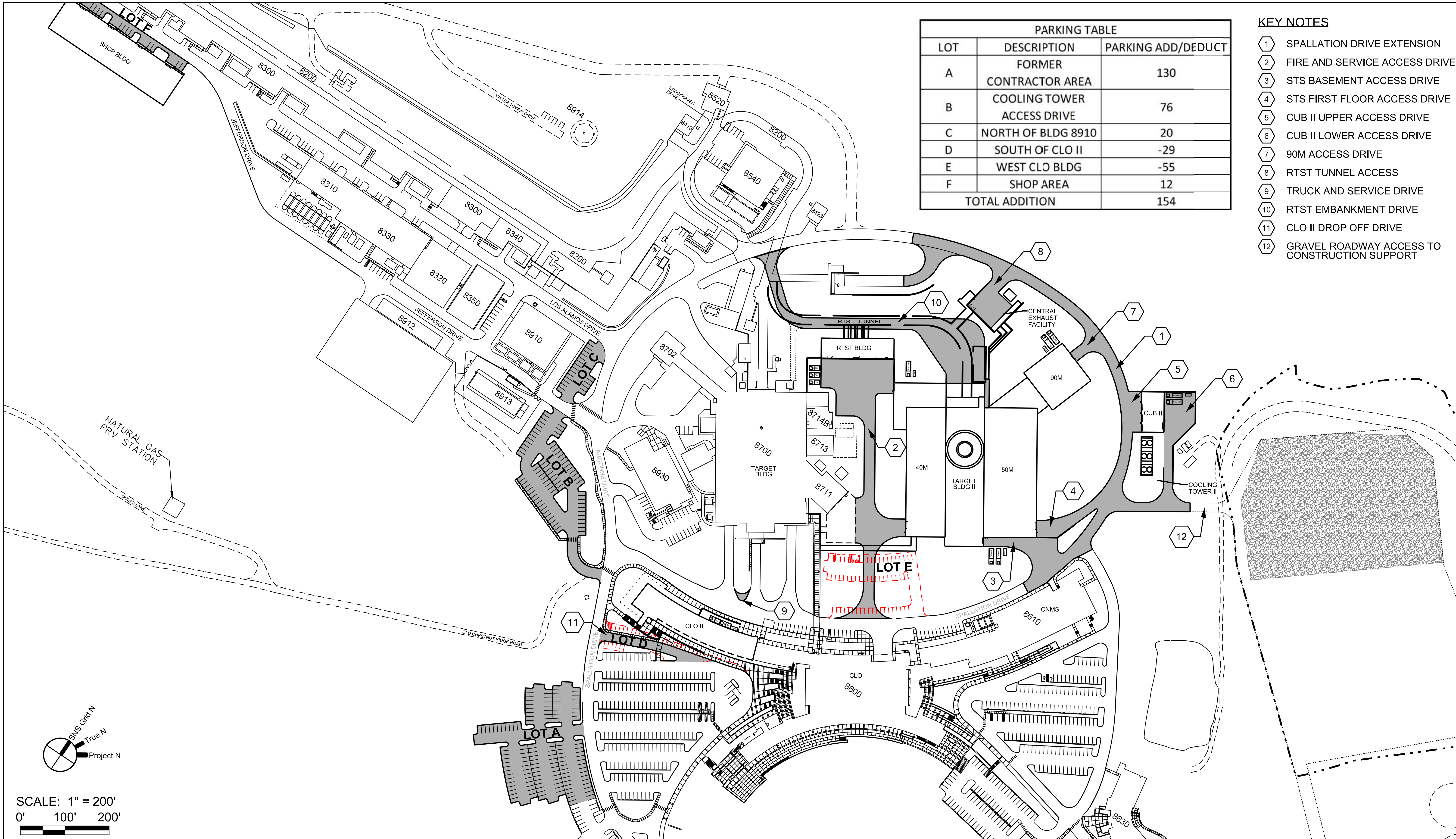
PARKING TABLE		
LOT	DESCRIPTION	PARKING ADD/DEDUCT
A	FORMER CONTRACTOR AREA	130
B	COOLING TOWER ACCESS DRIVE	76
C	NORTH OF BLDG 8910	20
D	SOUTH OF CLO II	-29
E	WEST CLO BLDG	-55
F	SHOP AREA	12
TOTAL ADDITION		154

KEY NOTES

1. SPALLATION DRIVE EXTENSION
2. FIRE AND SERVICE ACCESS DRIVE
3. STS BASEMENT ACCESS DRIVE
4. STS FIRST FLOOR ACCESS DRIVE
5. CUB II UPPER ACCESS DRIVE
6. CUB II LOWER ACCESS DRIVE
7. 90M ACCESS DRIVE
8. RTST TUNNEL ACCESS
9. TRUCK AND SERVICE DRIVE
10. RTST EMBANKMENT DRIVE
11. CLO II DROP OFF DRIVE
12. GRAVEL ROADWAY ACCESS TO CONSTRUCTION SUPPORT



REV. NO.	DESCRIPTION	BY	APVD	DATE

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PROJECT TITLE
SPALLATION NEUTRON SOURCE SECOND TARGET STATION CONVENTIONAL FACILITIES
CONCEPTUAL DESIGN REPORT, 100% SUBMISSION

SHEET NAME	**ROADWAY & PARKING IMPROVEMENT PLAN**
SHEET NUMBER	**5.1.24**
DATE	FEBRUARY 8, 2019

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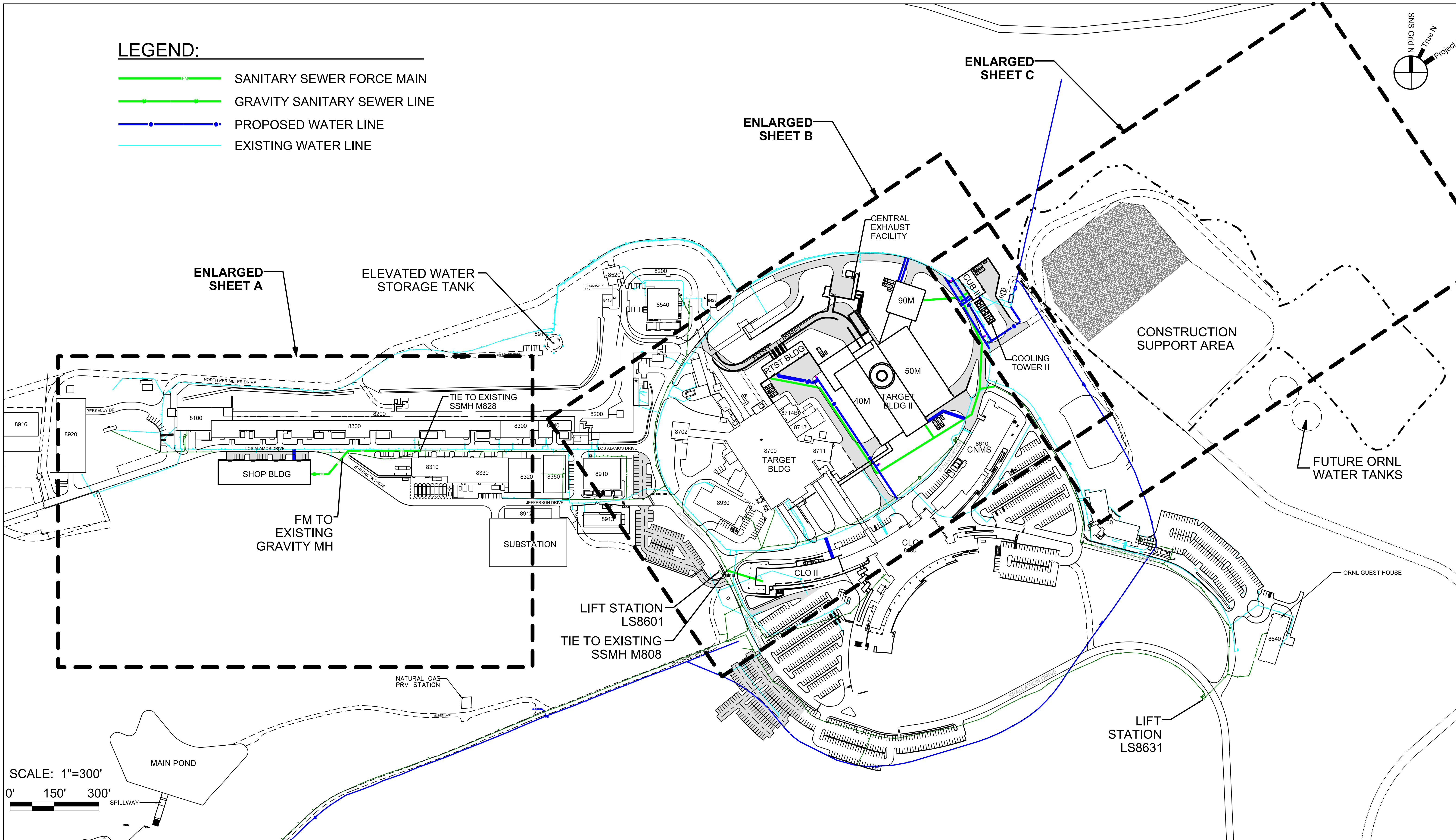

REV. NO.	DESCRIPTION	BY	APVD	DATE

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PROJECT TITLE
SPALLATION NEUTRON SOURCE SECOND TARGET STATION CONVENTIONAL FACILITIES
CONCEPTUAL DESIGN REPORT, 100% SUBMISSION

SHEET NAME	**OVERALL UTILITY PLAN**
SHEET NUMBER	**5.1.25**
DATE	FEBRUARY 8, 2019

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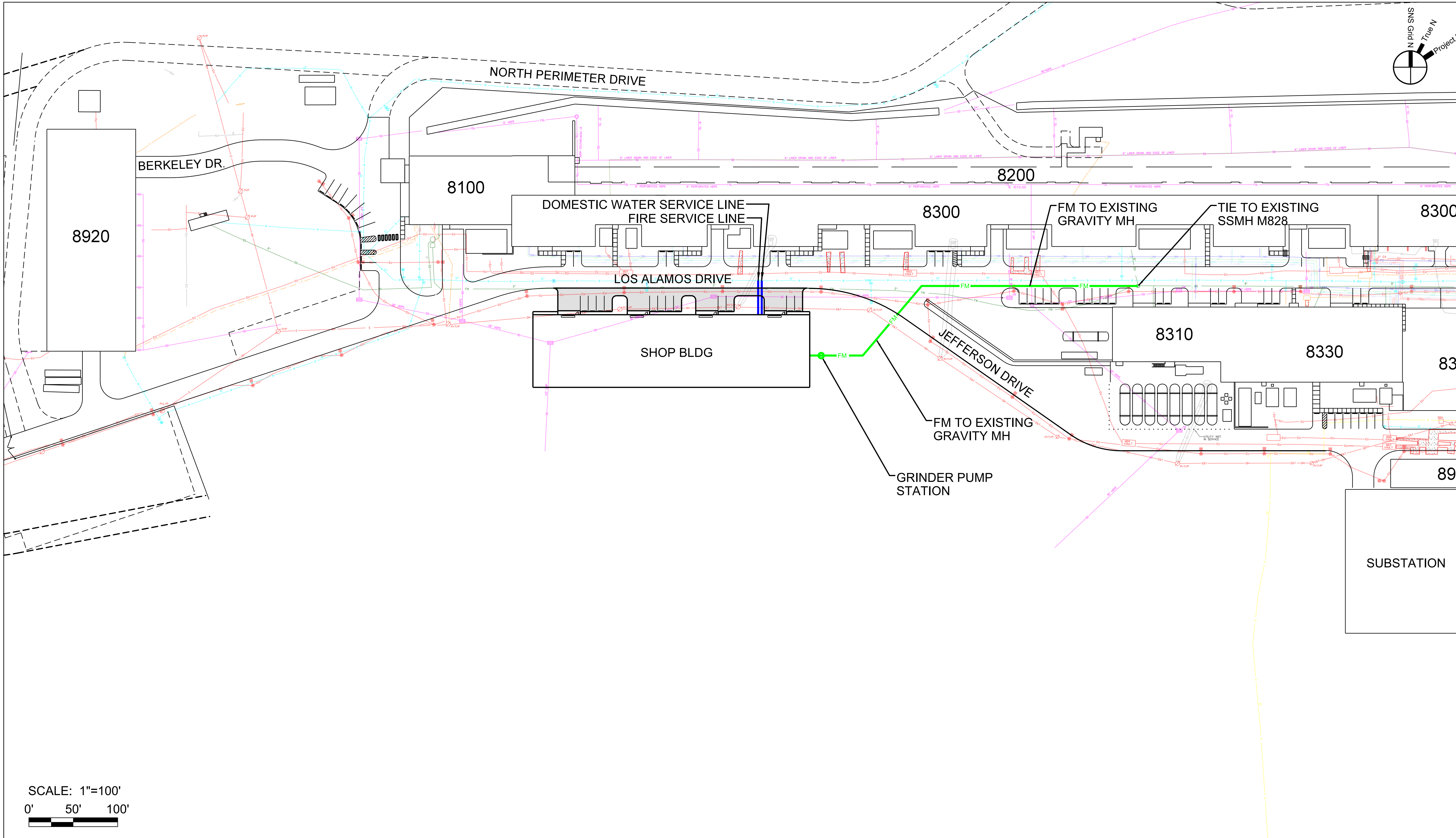

REV. NO.	DESCRIPTION	BY	APVD	DATE

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PROJECT TITLE
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SHEET NAME	**ENLARGED SHEET A UTILITY PLAN**
SHEET NUMBER	**5.1.26**
DATE	FEBRUARY 8, 2019

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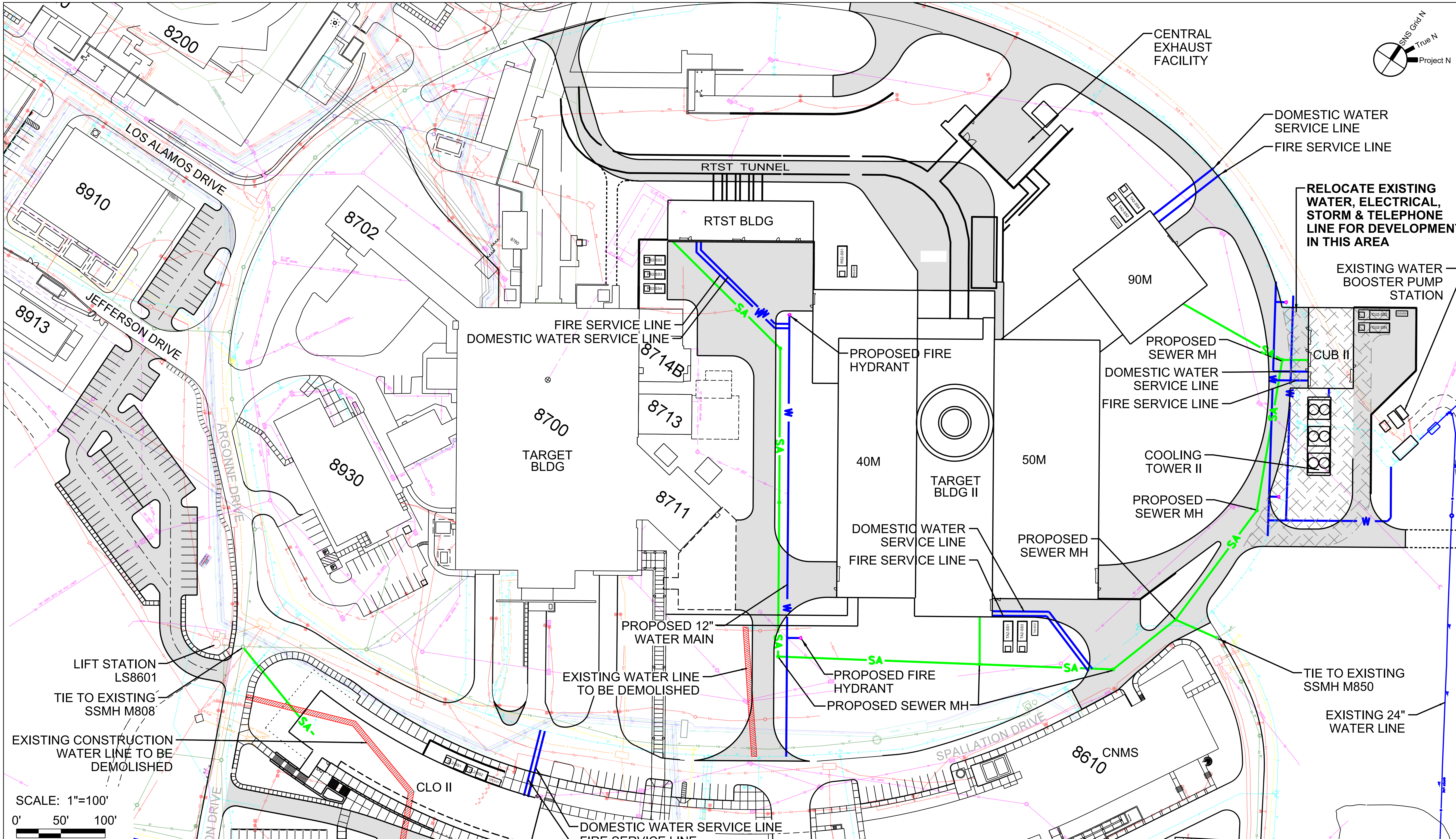

REV. NO.	DESCRIPTION	BY	APVD	DATE

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SHEET NAME	**ENLARGED SHEET B UTILITY PLAN**
SHEET NUMBER	**5.1.27**
DATE	FEBRUARY 8, 2019

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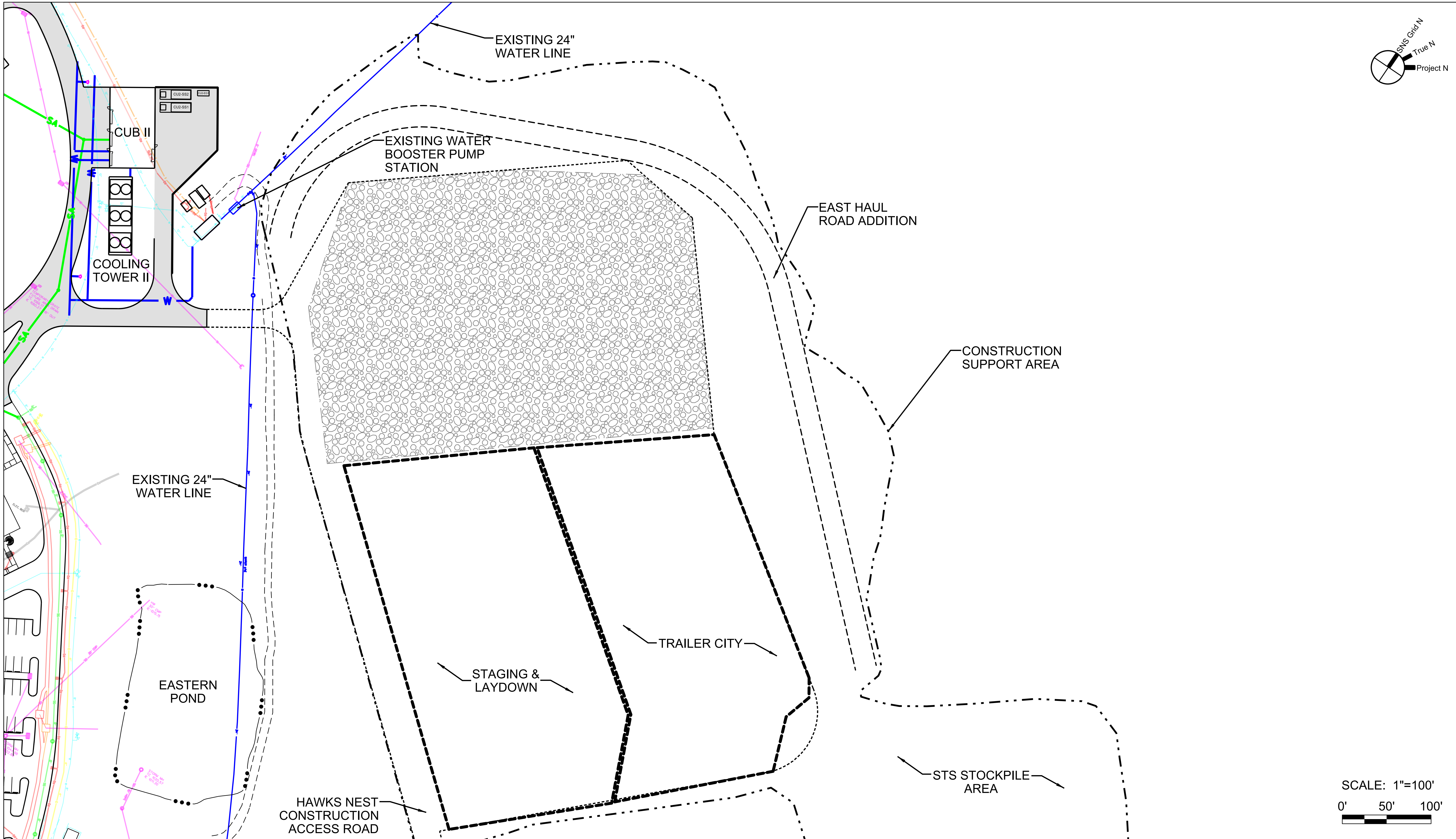

REV. NO.	DESCRIPTION	BY	APVD	DATE

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SHEET NAME	**ENLARGED SHEET C UTILITY PLAN**
SHEET NUMBER	**5.1.28**
DATE	FEBRUARY 8, 2019

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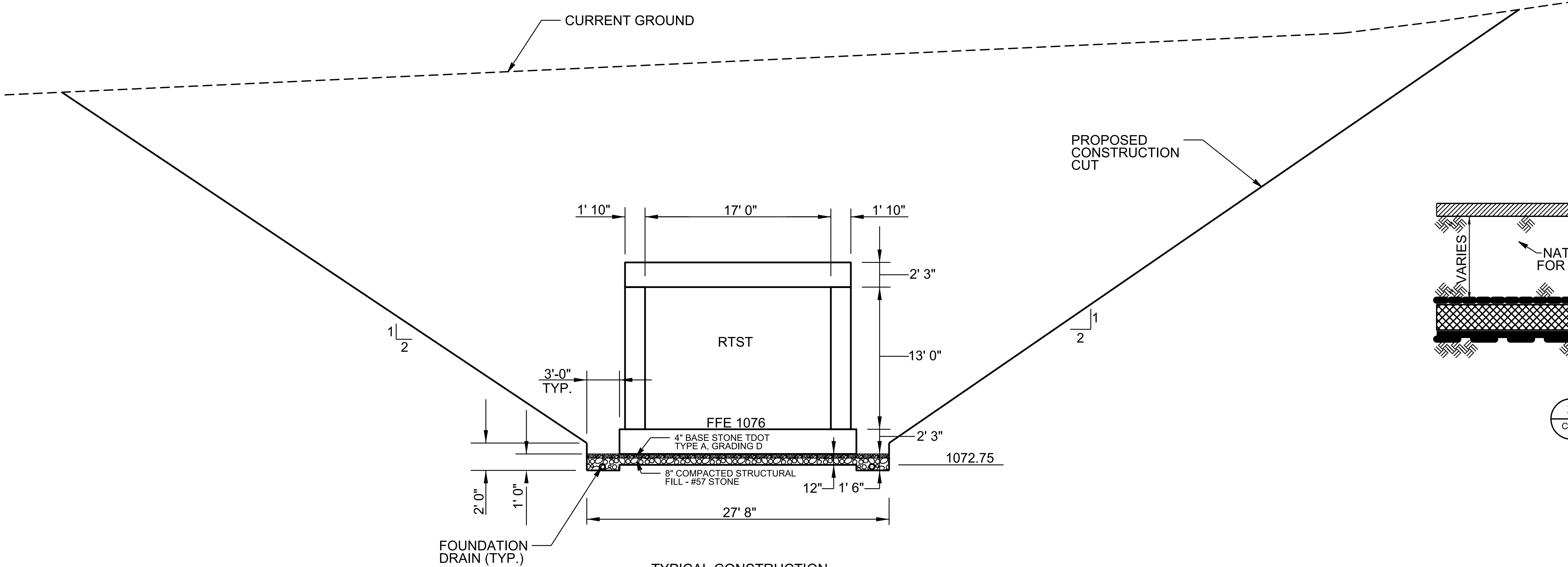
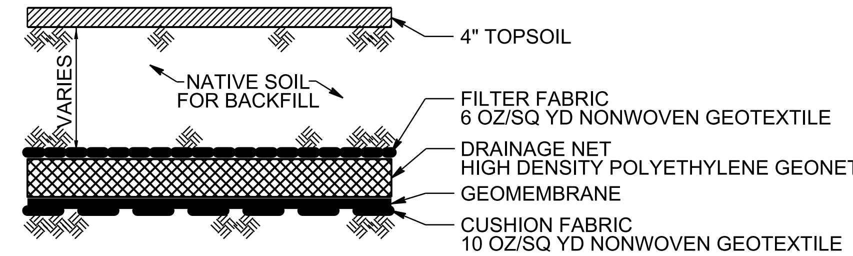
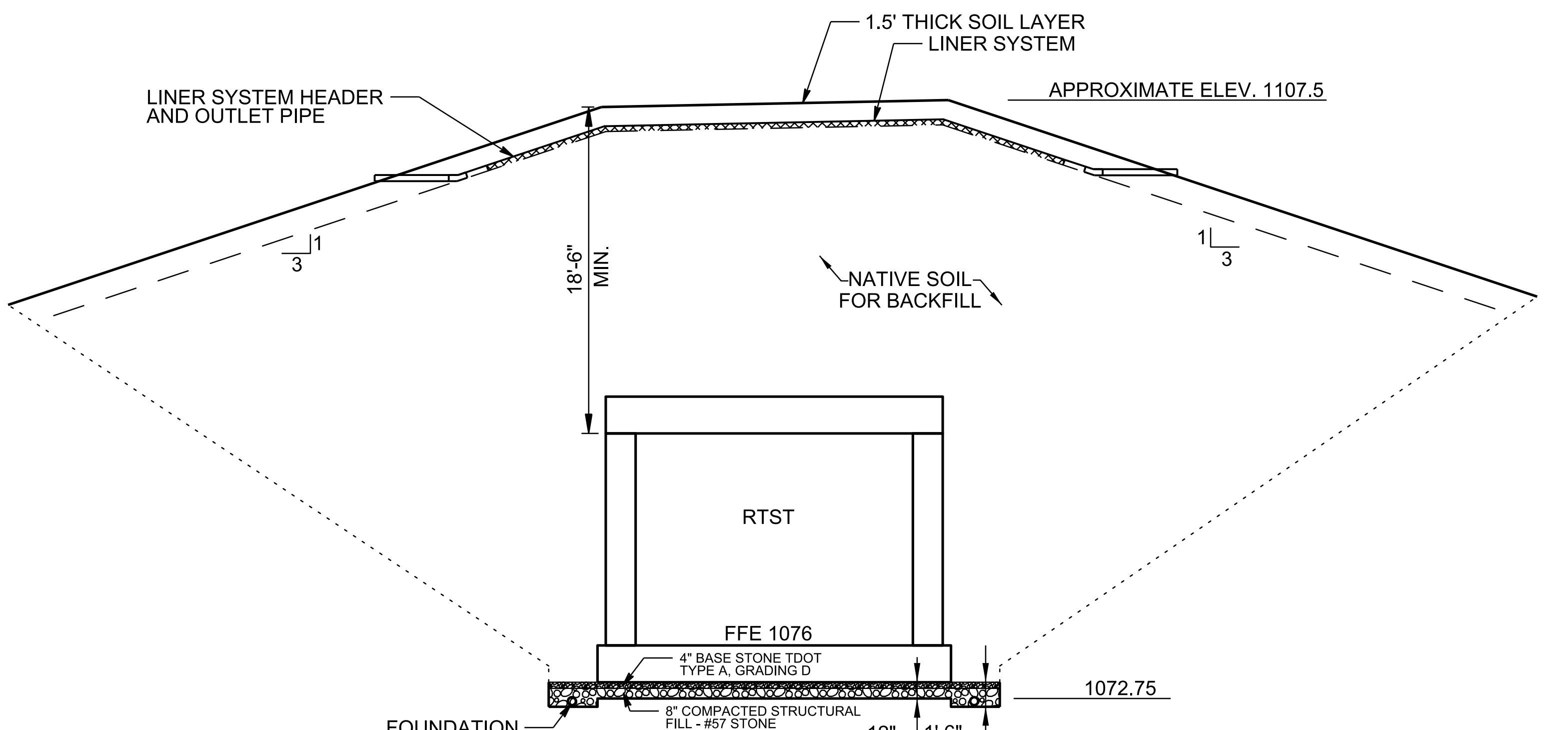


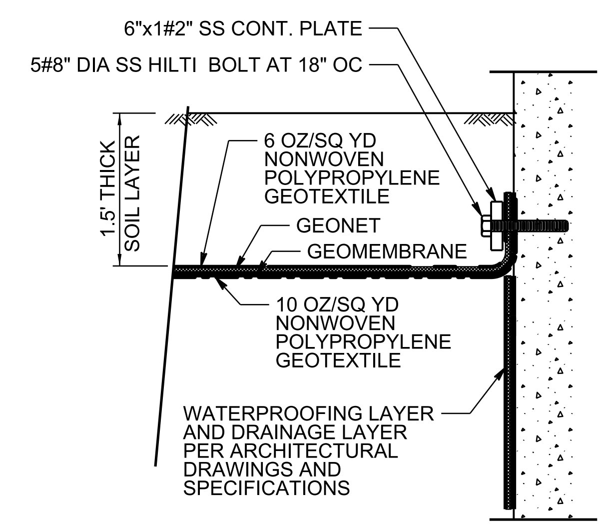
1 C 03 TYPICAL CONSTRUCTION EXCAVATION SECTION
SCALE: NTS



3 C 03 LINER SYSTEM DETAIL
SCALE: NTS



2 C 03 RTST EMBANKMENT FILL SECTION
SCALE: NTS



4 C 03 WALL CONNECTION DETAIL
SCALE: NTS

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SPALLATION NEUTRON SOURCE SECOND TARGET STATION CONVENTIONAL FACILITIES
CONCEPTUAL DESIGN REPORT, 100% SUBMISSION

SHEET NAME	**TYPICAL RTST EXCAVATION & FILL SECTION**
SHEET NUMBER	**5.1.29**
DATE	FEBRUARY 8, 2019

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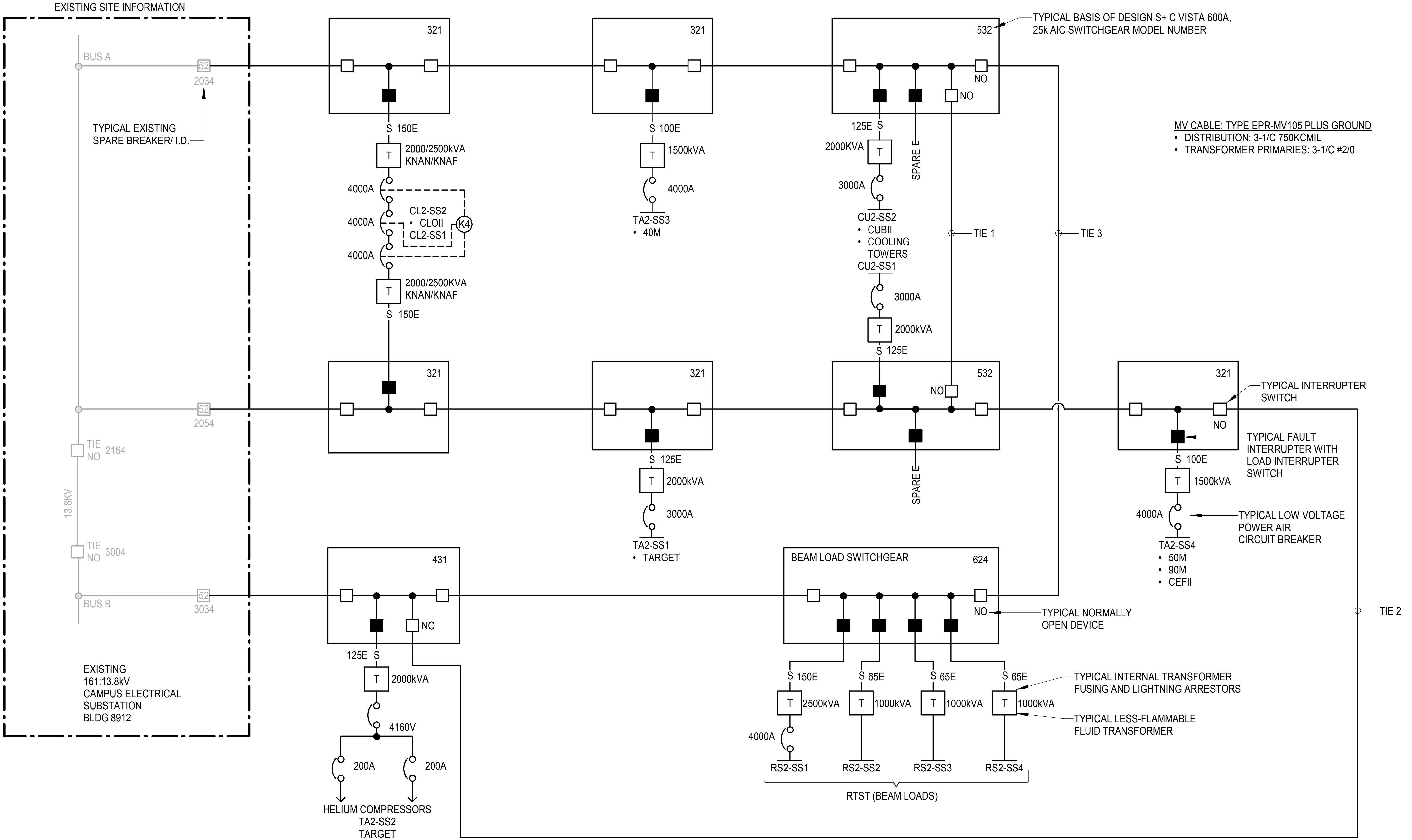

No

PROPOSED STS MEDIUM VOLTAGE ELECTRICAL SINGLE LINE

CANNONDESIGN

Issue Date:

Project No.: 000000.00

Sheet Ref No.:

SDE001

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PROPOSED ELECTRICAL SITE UTILITIES LAYOUT

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Issue Date:

Project No.: 000000.00

Sheet Ref No.:

SDE002

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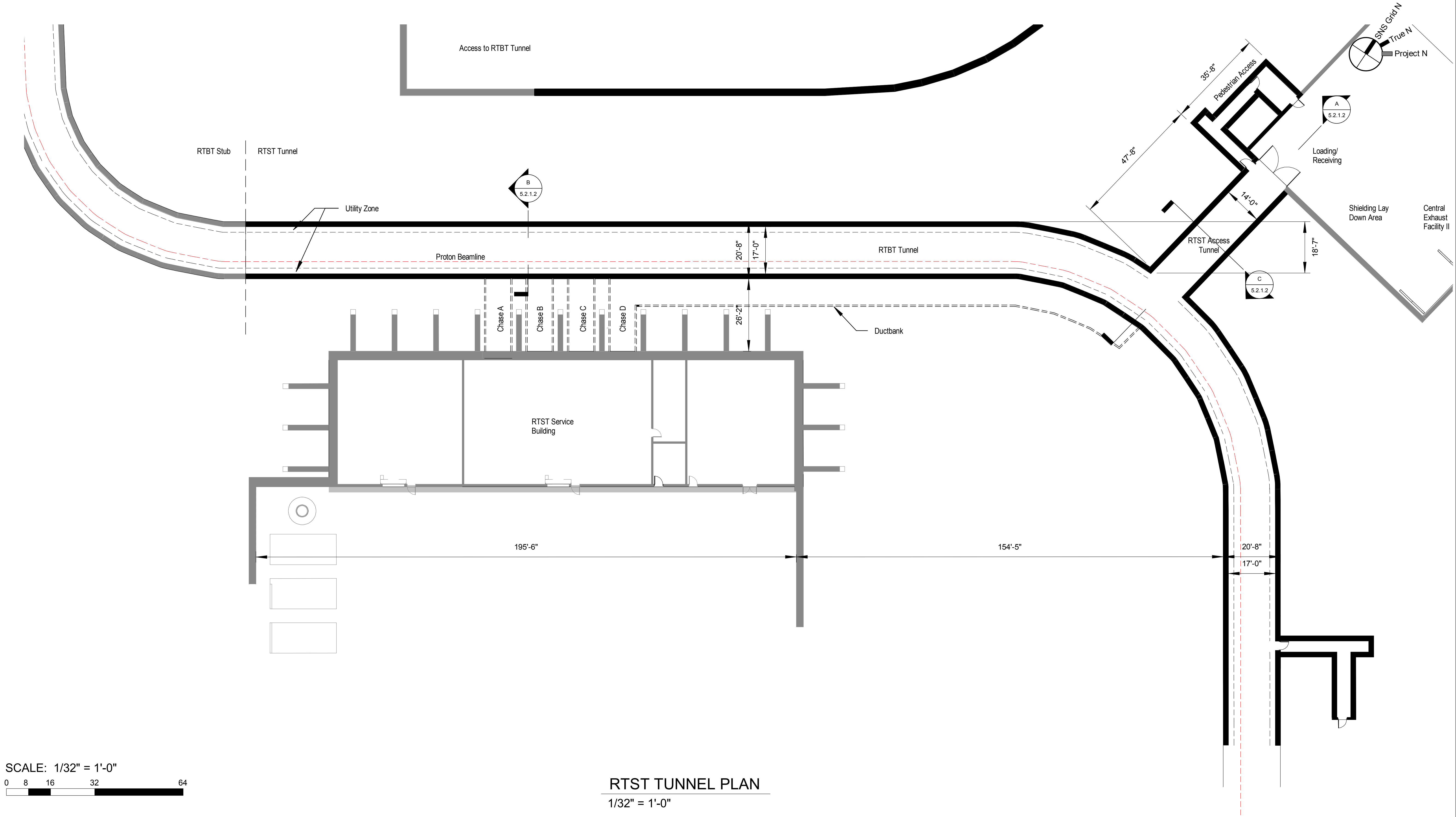

SCALE: 1/32" = 1'-0"

0 8 16 32 64

RTST TUNNEL PLAN

1/32" = 1'-0"

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PROJECT TITLE
SECOND TARGET STATION CONVENTIONAL FACILITIES
SPALLATION NEUTRON SOURCE
100% CONCEPTUAL DESIGN REPORT SUBMISSION

SHEET NAME	**RTST TUNNEL PLAN**
SHEET NUMBER	**5.2.1.1**
DATE	FEBRUARY 8, 2019

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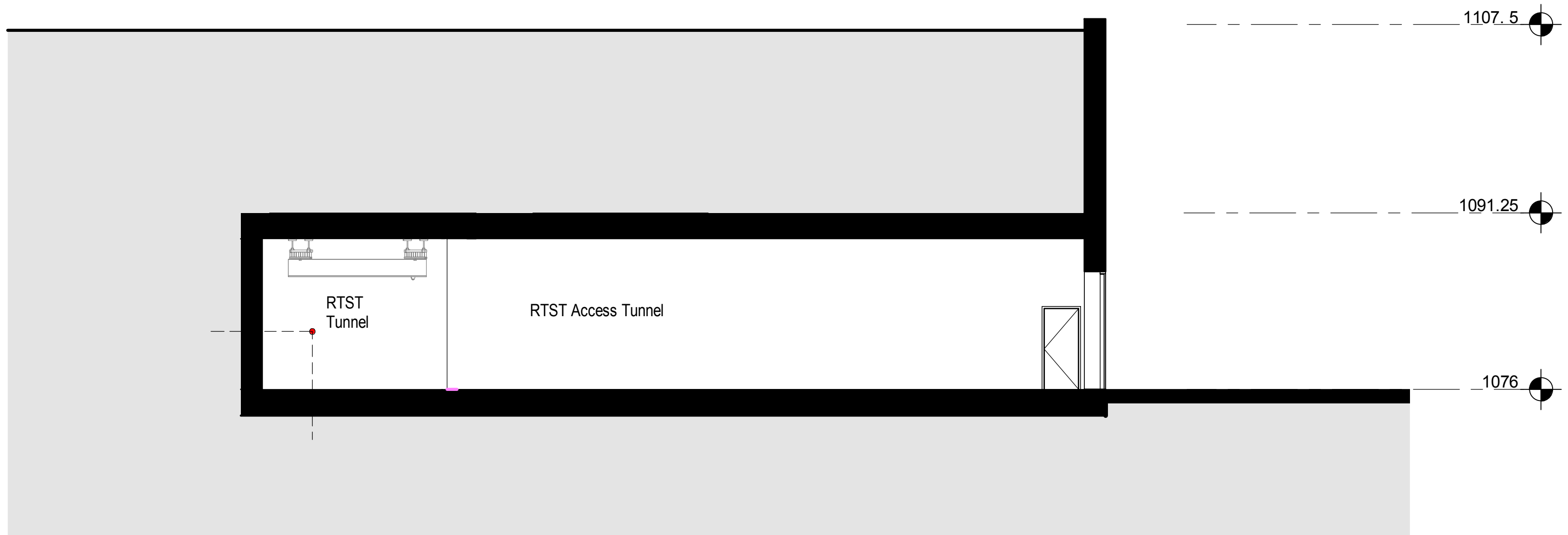
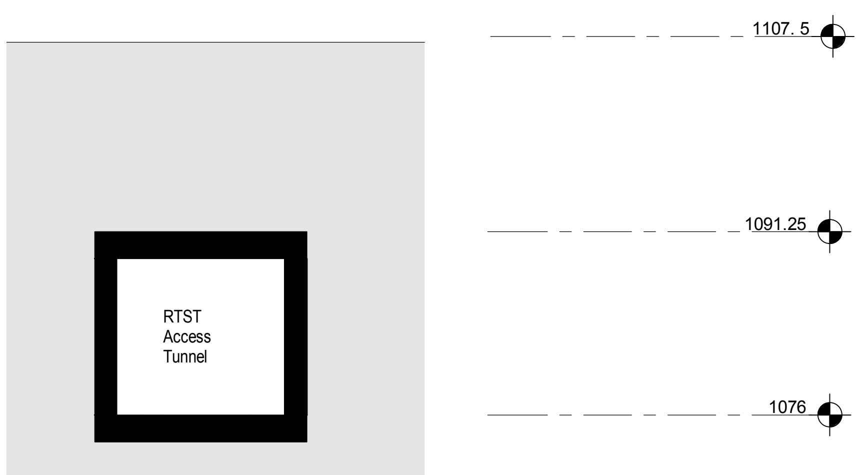


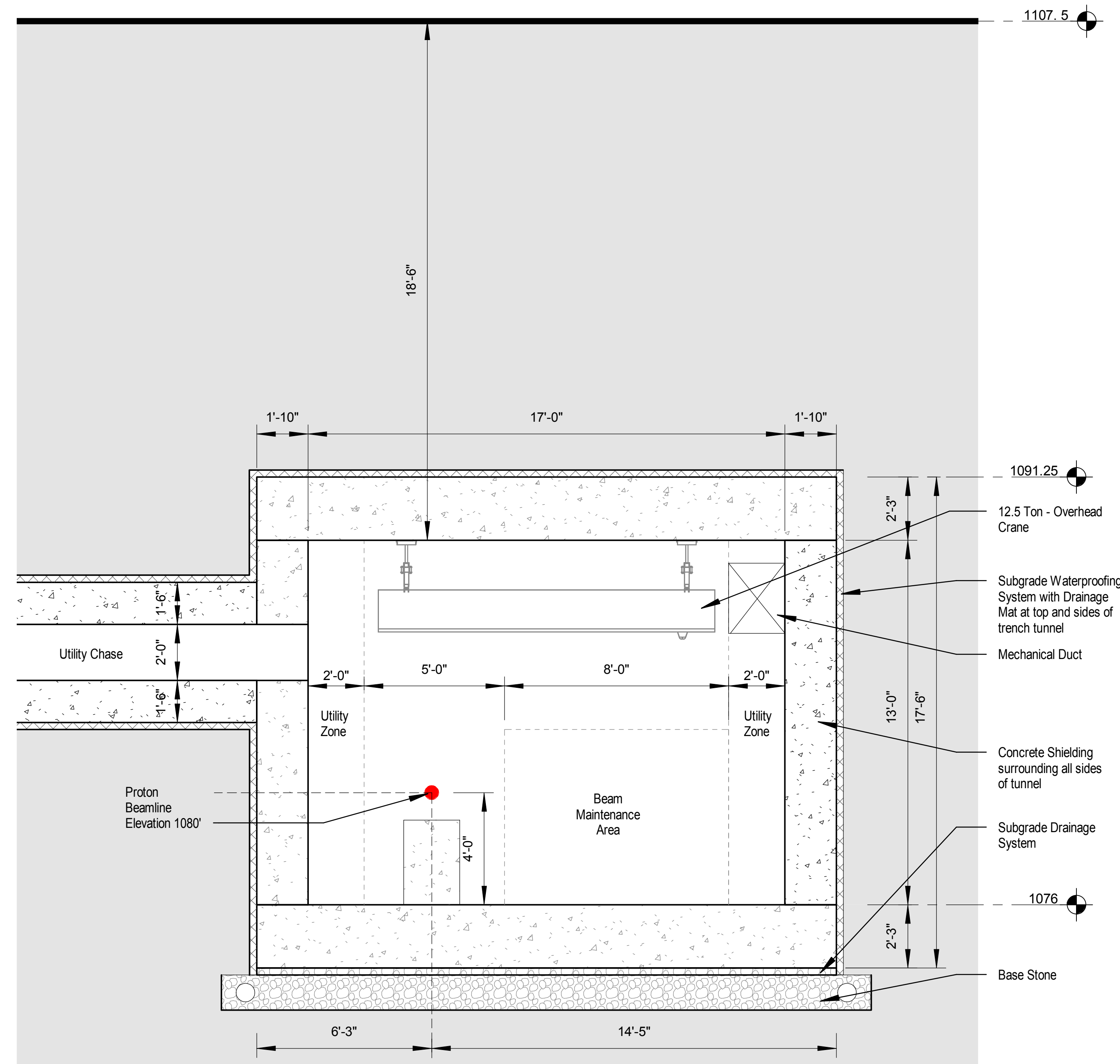
RTST ACCESS TUNNEL - SECTION A

1/16" = 1'-0"



RTST TUNNEL SECTION C

1/16" = 1'-0"



RTST TUNNEL - SECTION B

3/16" = 1'-0"

REV. NO.	DESCRIPTION	BY	APVD	DATE
1	2	4		8

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SHEET NAME	**RTST TUNNEL SECTIONS**
SHEET NUMBER	**5.2.1.2**
DATE	FEBRUARY 8, 2019

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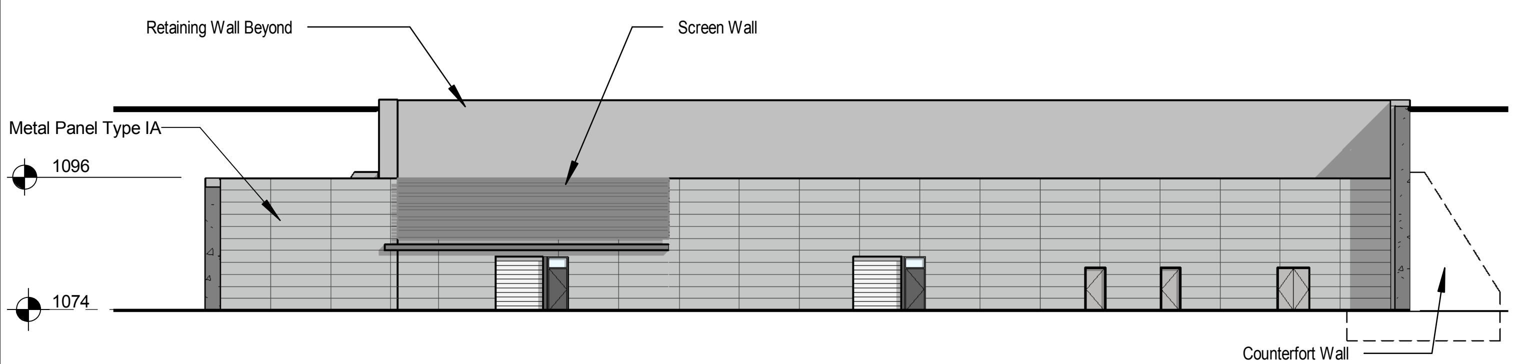
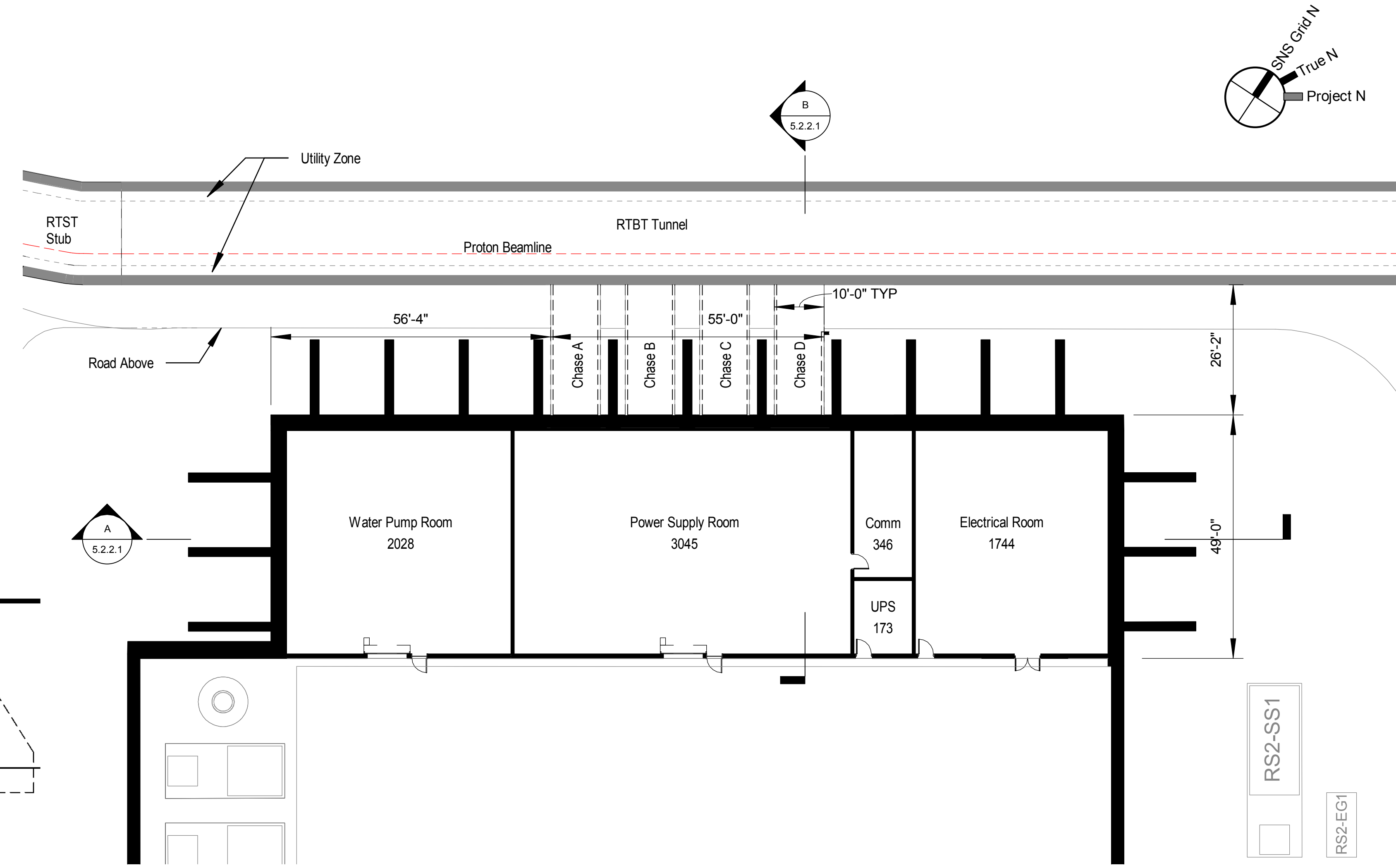


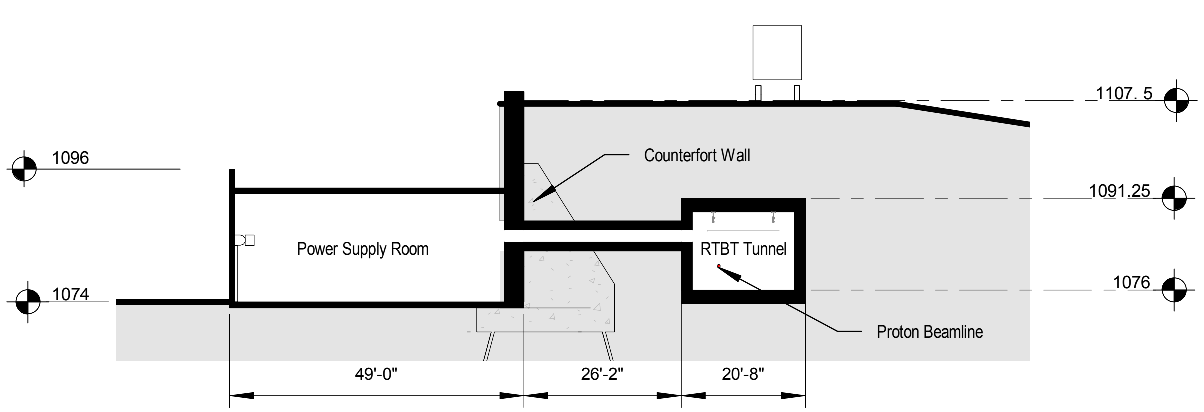
RTST SERVICE BUILDING - EAST ELEVATION

1/32" = 1'-0"



RTST SERVICE BUILDING - FLOOR PLAN

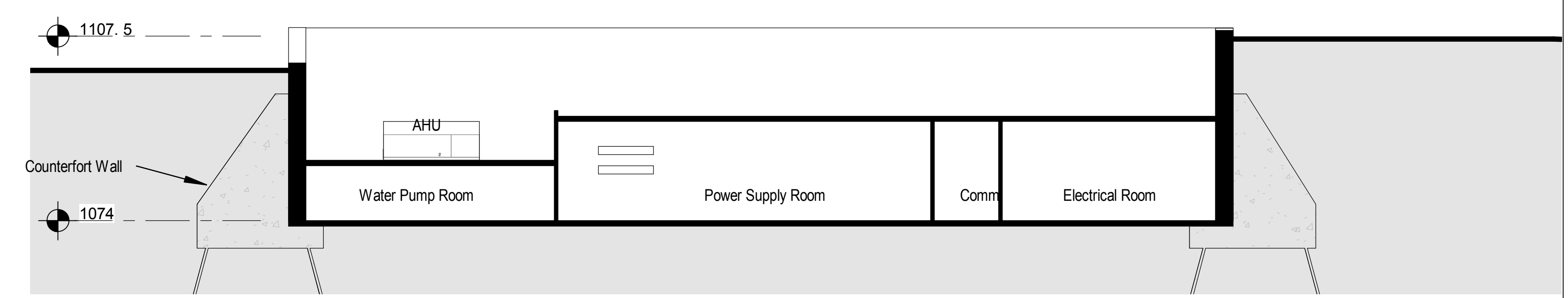
1/32" = 1'-0"



RTST SERVICE BUILDING - SECTION B

1/32" = 1'-0"

0 8 16 32 64



RTST SERVICE BUILDING - SECTION A

1/32" = 1'-0"

REV. NO.	DESCRIPTION	BY	APVD	DATE

OAK RIDGE NATIONAL LABORATORY
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CANNONDESIGN
225 North Michigan Avenue, Suite 1100
Chicago, Illinois 60601
T: 312.332.9600
F: 312.332.9601

PROJECT TITLE
SECOND TARGET STATION CONVENTIONAL FACILITIES
SPALLATION NEUTRON SOURCE
100% CONCEPTUAL DESIGN REPORT SUBMISSION

SHEET NAME: **RTST SERVICE BUILDING PLAN, SECTIONS, ELEVATIONS**
SHEET NUMBER: **5.2.2.1**
DATE: FEBRUARY 8, 2019

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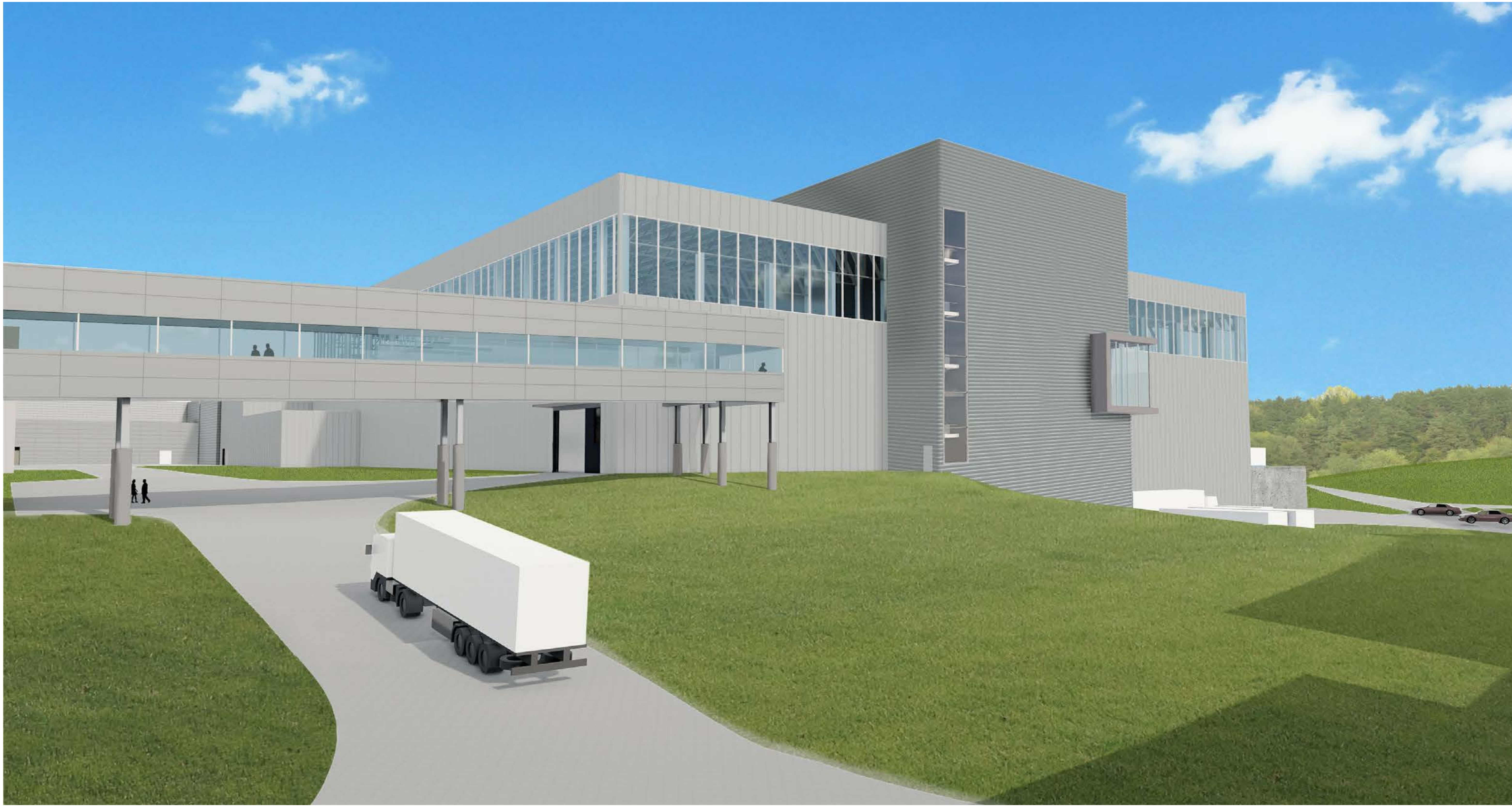

REV. NO.	DESCRIPTION	BY	APVD	DATE

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PROJECT TITLE
SECOND TARGET STATION CONVENTIONAL FACILITIES

100% CONCEPTUAL DESIGN REPORT SUBMISSION

SHEET NAME	**TARGET BUILDING - SOUTHEAST VIEW**
SHEET NUMBER	**5.3.1.1**
DATE	FEBRUARY 8, 2019

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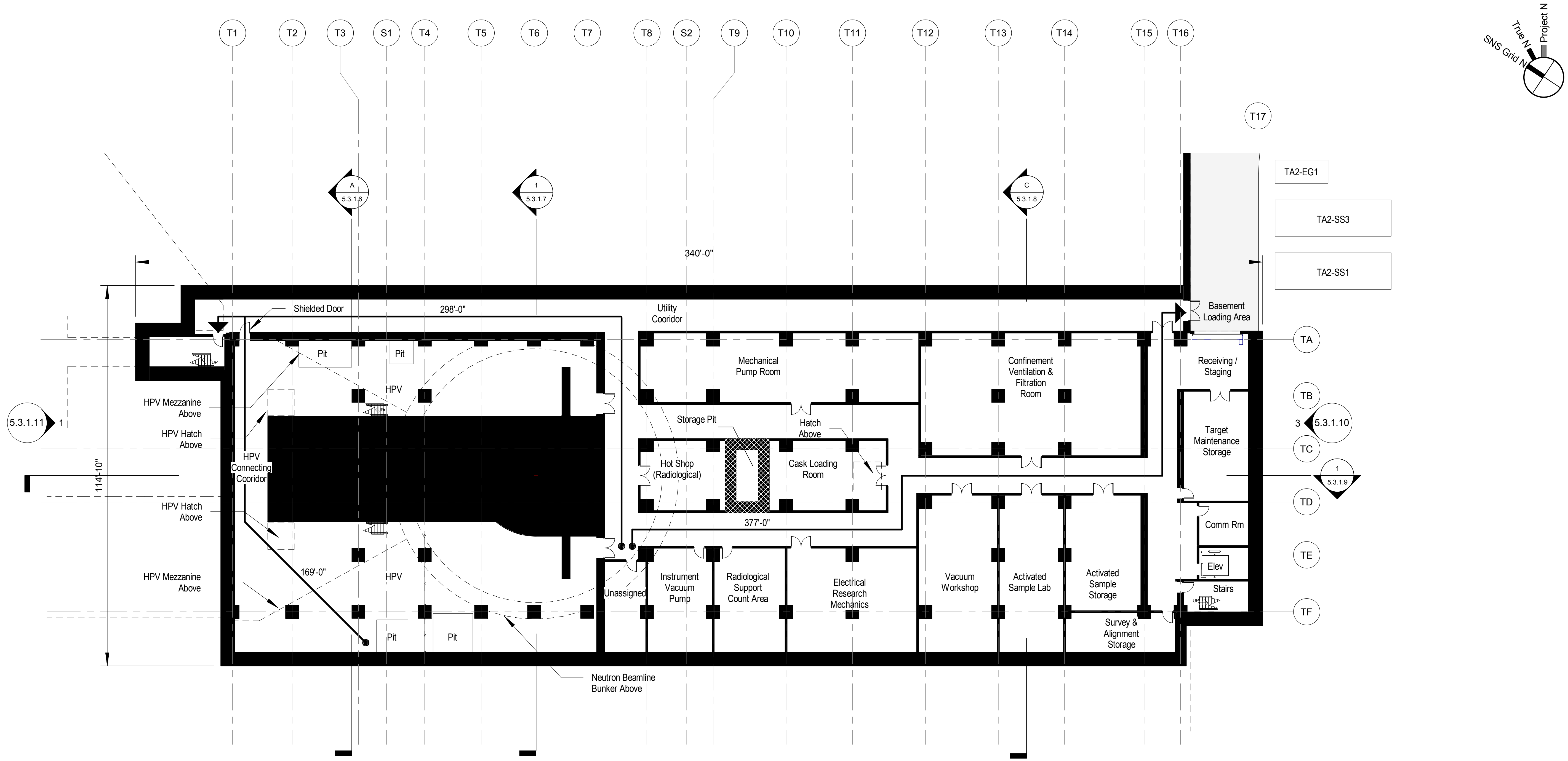

REGULAR DENSITY CONCRETE

HIGH DENSITY CONCRETE

STEEL

Egress Route and Travel Distance:

XX'-X"

Longest Travel Distance: 377'-0"

Max Travel Distance: 400'-0"

SCALE: 1/32" = 1'-0"

0 8 16 32 64

REV. NO.	DESCRIPTION	BY	APVD	DATE

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PROJECT TITLE
SECOND TARGET STATION CONVENTIONAL FACILITIES

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SHEET NAME	**TARGET BUILDING BASEMENT PLAN**
SHEET NUMBER	**5.3.1.2**
DATE	FEBRUARY 8, 2019

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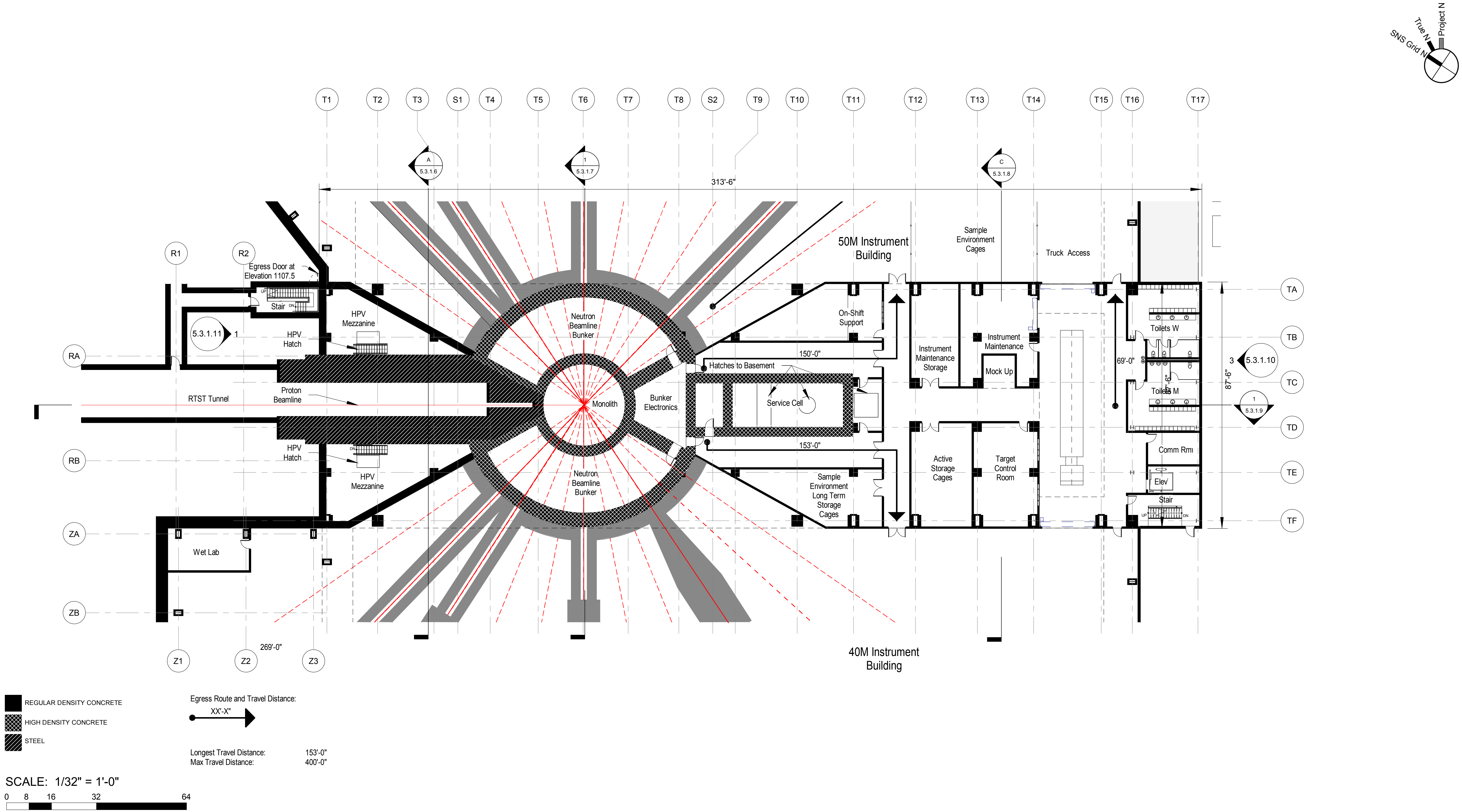

REV. NO.	DESCRIPTION	BY	APVD	DATE

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PROJECT TITLE
SECOND TARGET STATION CONVENTIONAL FACILITIES

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SHEET NAME	TARGET BUILDING FIRST FLOOR PLAN
SHEET NUMBER	5.3.1.3
DATE	FEBRUARY 8, 2019

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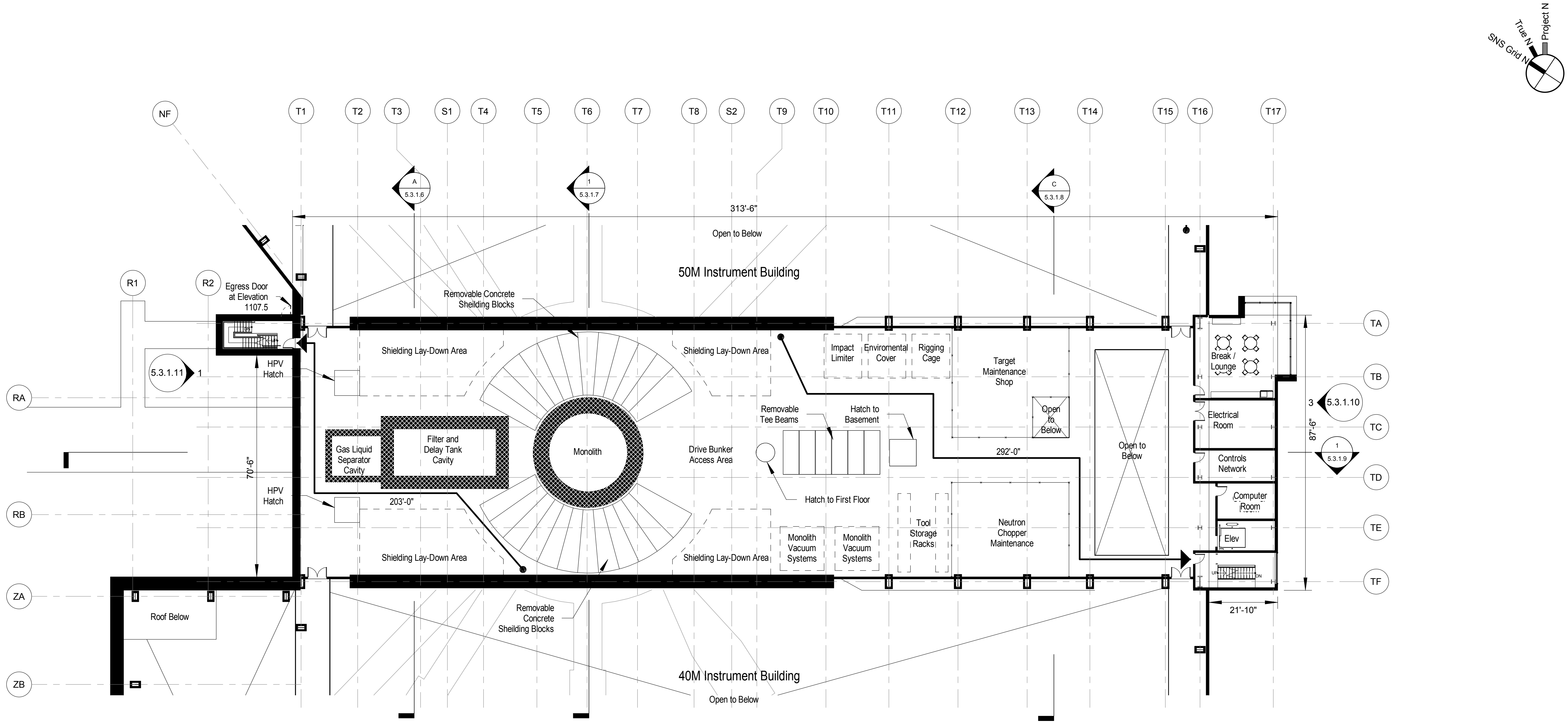

REGULAR DENSITY CONCRETE

HIGH DENSITY CONCRETE

STEEL

Egress Route and Travel Distance:

XX'-X"

Longest Travel Distance: 292'-0"

Max Travel Distance: 400'-0"

SCALE: 1/32" = 1'-0"

0 8 16 32 64

REV. NO.	DESCRIPTION	BY	APVD	DATE

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PROJECT TITLE

SECOND TARGET STATION CONVENTIONAL FACILITIES

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SHEET NAME	**TARGET BUILDING SECOND FLOOR PLAN**
SHEET NUMBER	**5.3.1.4**
DATE	FEBRUARY 8, 2019

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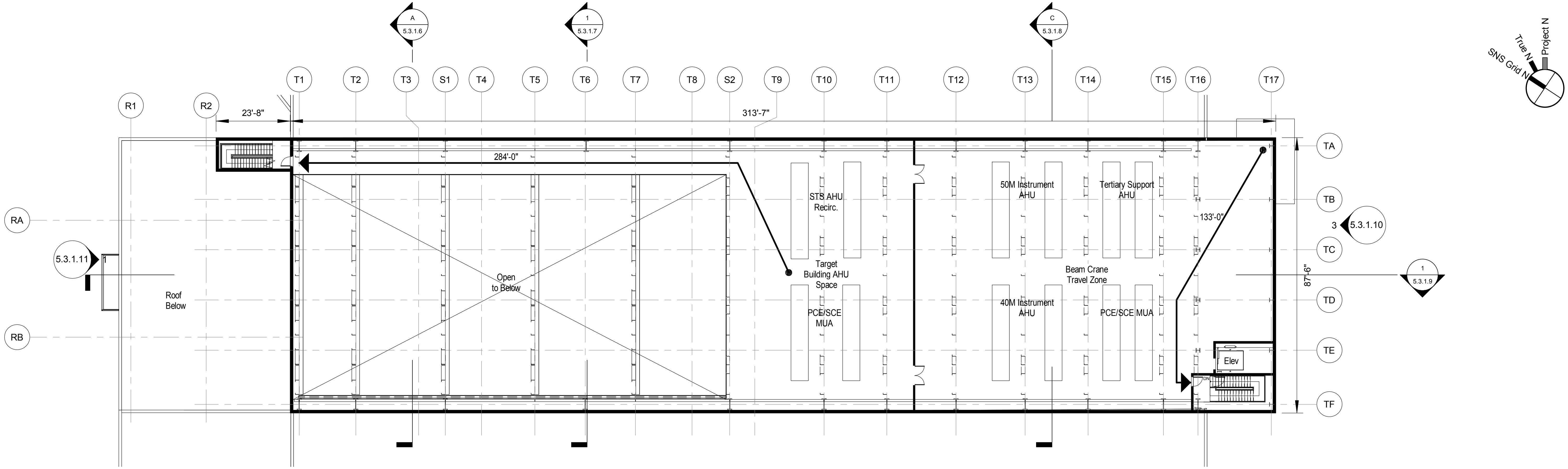
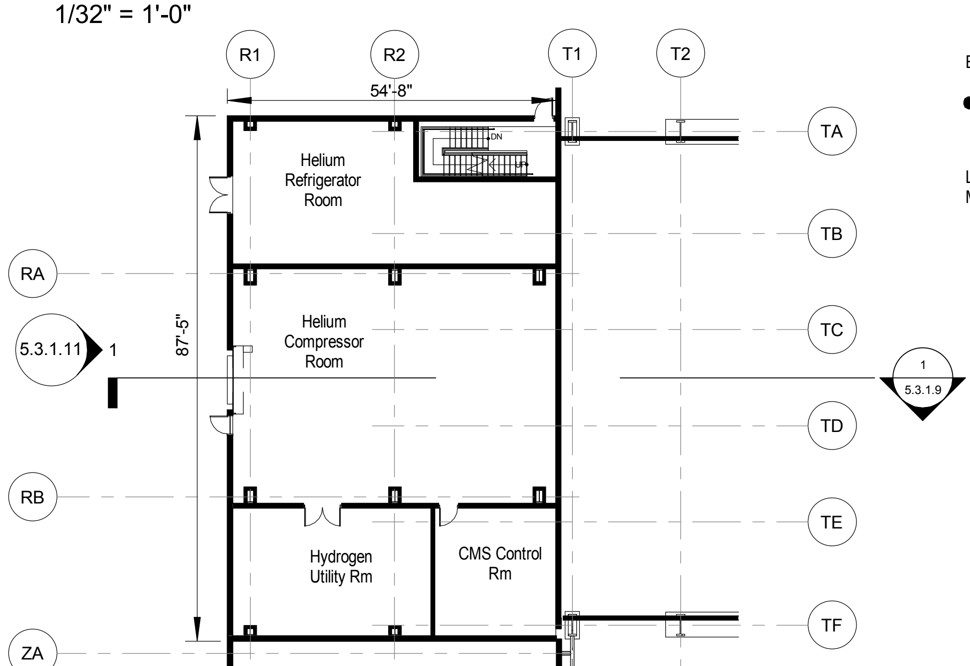


TARGET BUILDING TRUSS LEVEL 1138

1/32" = 1'-0"



Egress Route and Travel Distance:

XX'-X"

Longest Travel Distance: 284'-0"
Max Travel Distance: 400'-0"

MODERATOR SUPPORT FLOOR PLAN LEVEL 1107

1/32" = 1'-0"

0 8 16 32 64

REV. NO.	DESCRIPTION	BY	APVD	DATE

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PROJECT TITLE
SECOND TARGET STATION CONVENTIONAL FACILITIES

100% CONCEPTUAL DESIGN REPORT SUBMISSION

SHEET NAME	**TARGET BUILDING TRUSS LEVEL & MODERATOR SUPPORT**
SHEET NUMBER	**5.3.1.5**
DATE	FEBRUARY 8, 2019

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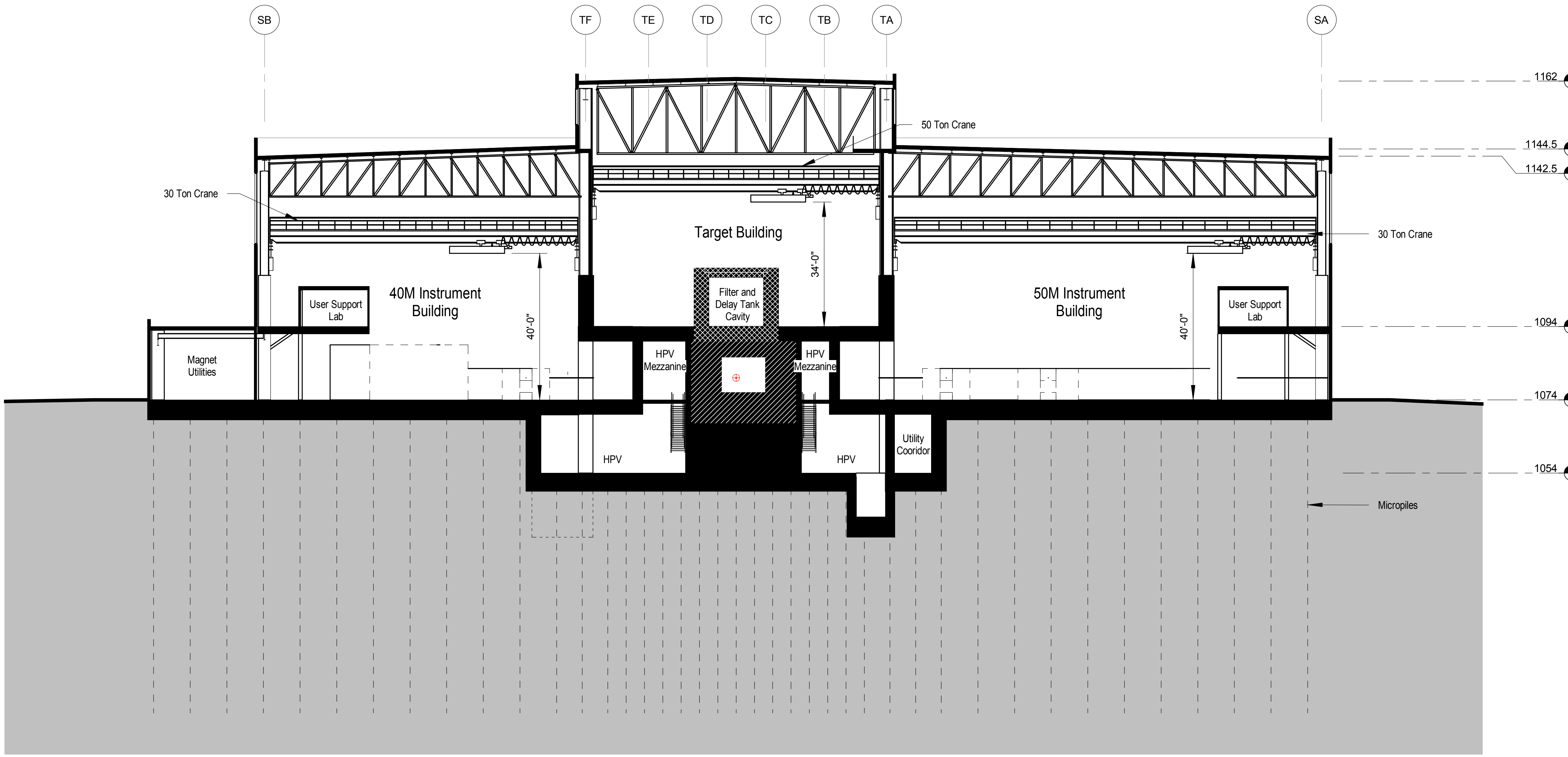

REGULAR DENSITY CONCRETE

HIGH DENSITY CONCRETE

STEEL

SCALE: 1/32" = 1'-0"

0 16 32 64 128

REV. NO.	DESCRIPTION	BY	APVD	DATE

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PROJECT TITLE
SECOND TARGET STATION CONVENTIONAL FACILITIES

100% CONCEPTUAL DESIGN REPORT SUBMISSION

SHEET NAME	**TARGET BUILDING SECTION A**
SHEET NUMBER	**5.3.1.6**
DATE	FEBRUARY 8, 2019

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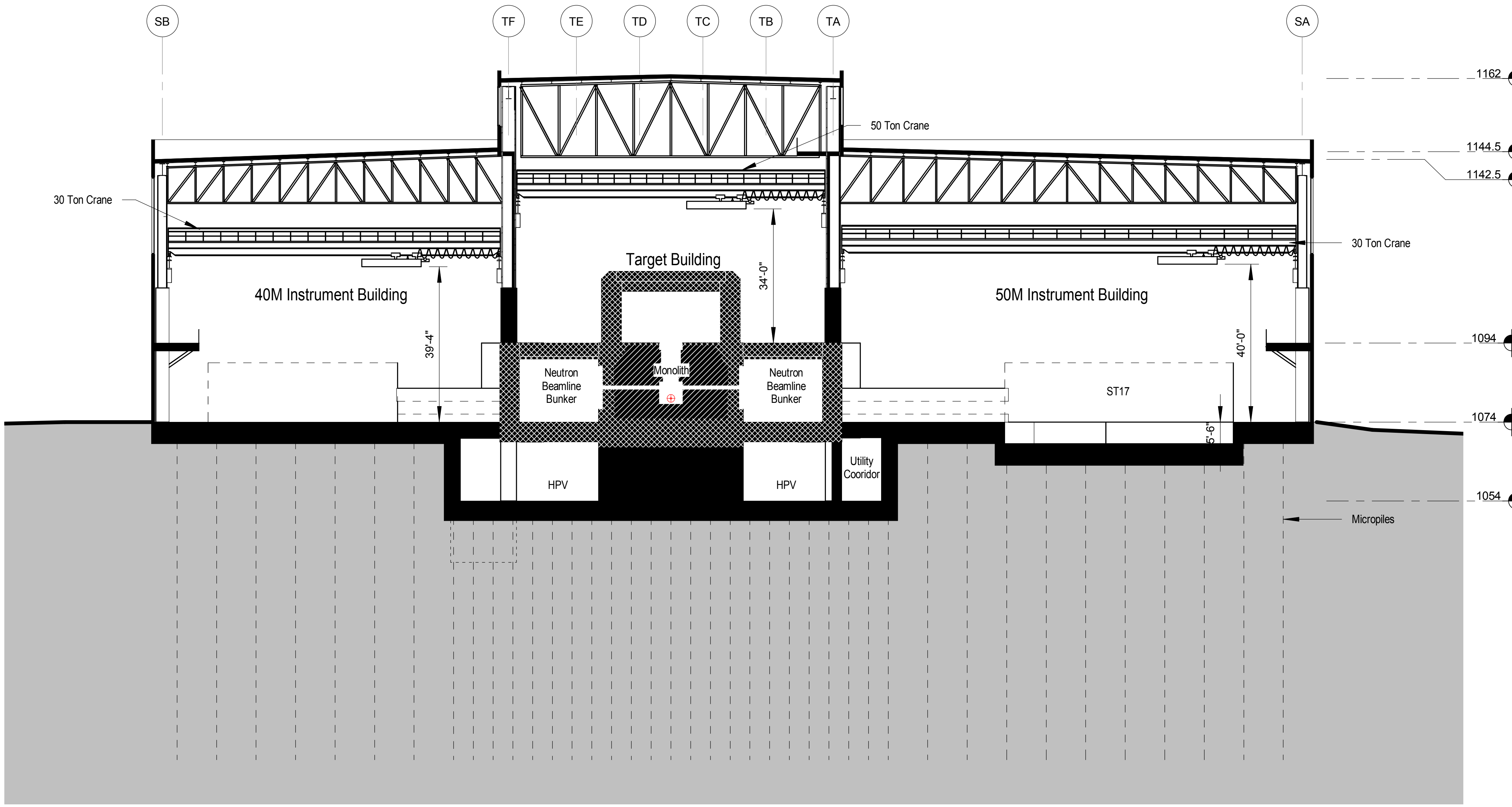

REGULAR DENSITY CONCRETE

HIGH DENSITY CONCRETE

STEEL

SCALE: 1/32" = 1'-0"

0 16 32 64 128

REV. NO.	DESCRIPTION	BY	APVD	DATE

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PROJECT TITLE
SECOND TARGET STATION CONVENTIONAL FACILITIES

100% CONCEPTUAL DESIGN REPORT SUBMISSION

SHEET NAME **TARGET BUILDING SECTION B**

SHEET NUMBER **5.3.1.7**

DATE FEBRUARY 8, 2019

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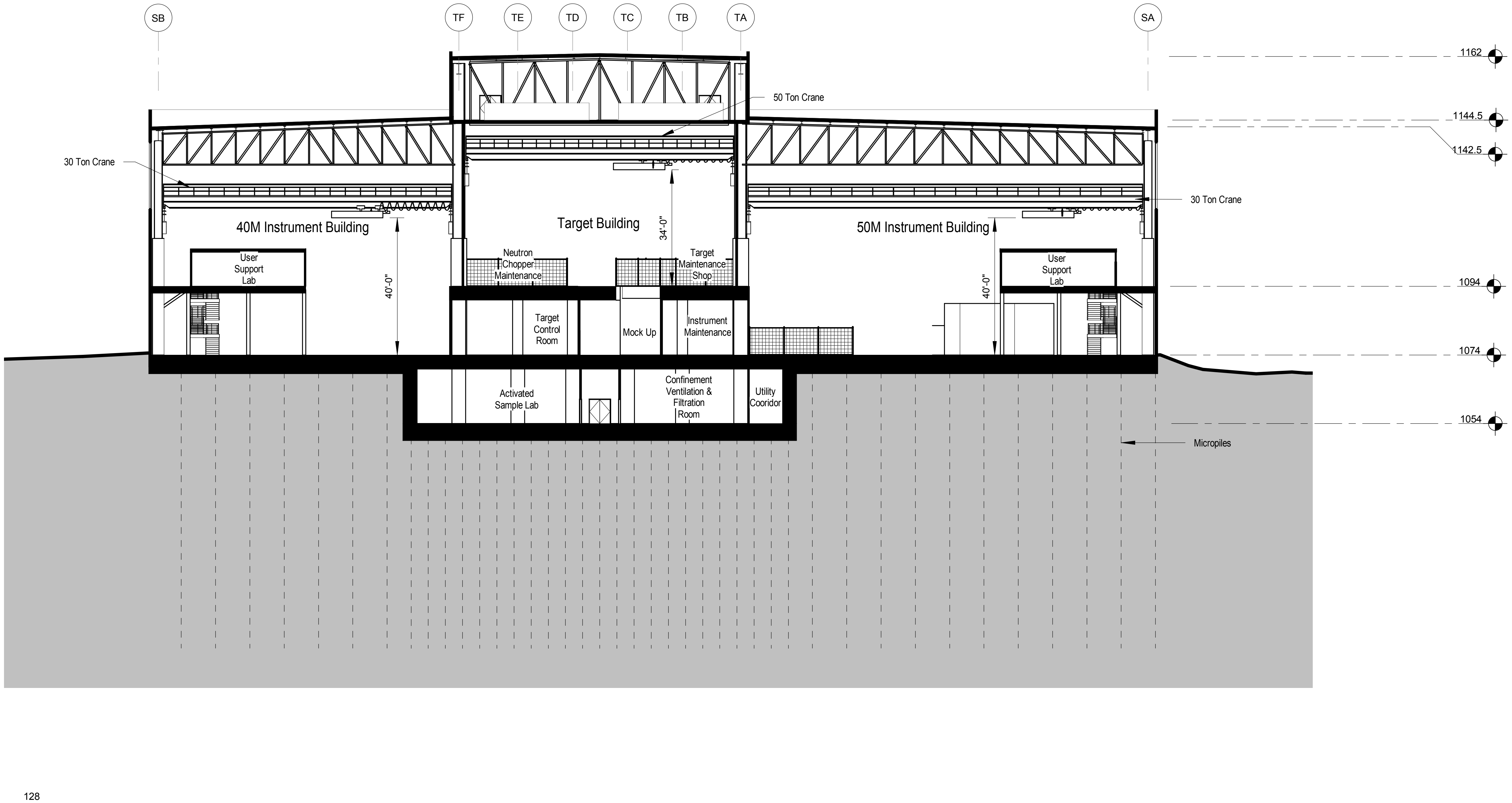

SCALE: 1/32" = 1'-0"

0 16 32 64 128

REV. NO.	DESCRIPTION	BY	APVD	DATE

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PROJECT TITLE
SECOND TARGET STATION CONVENTIONAL FACILITIES

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SHEET NAME	**TARGET BUILDING SECTION C**
SHEET NUMBER	**5.3.1.8**
DATE	FEBRUARY 8, 2019

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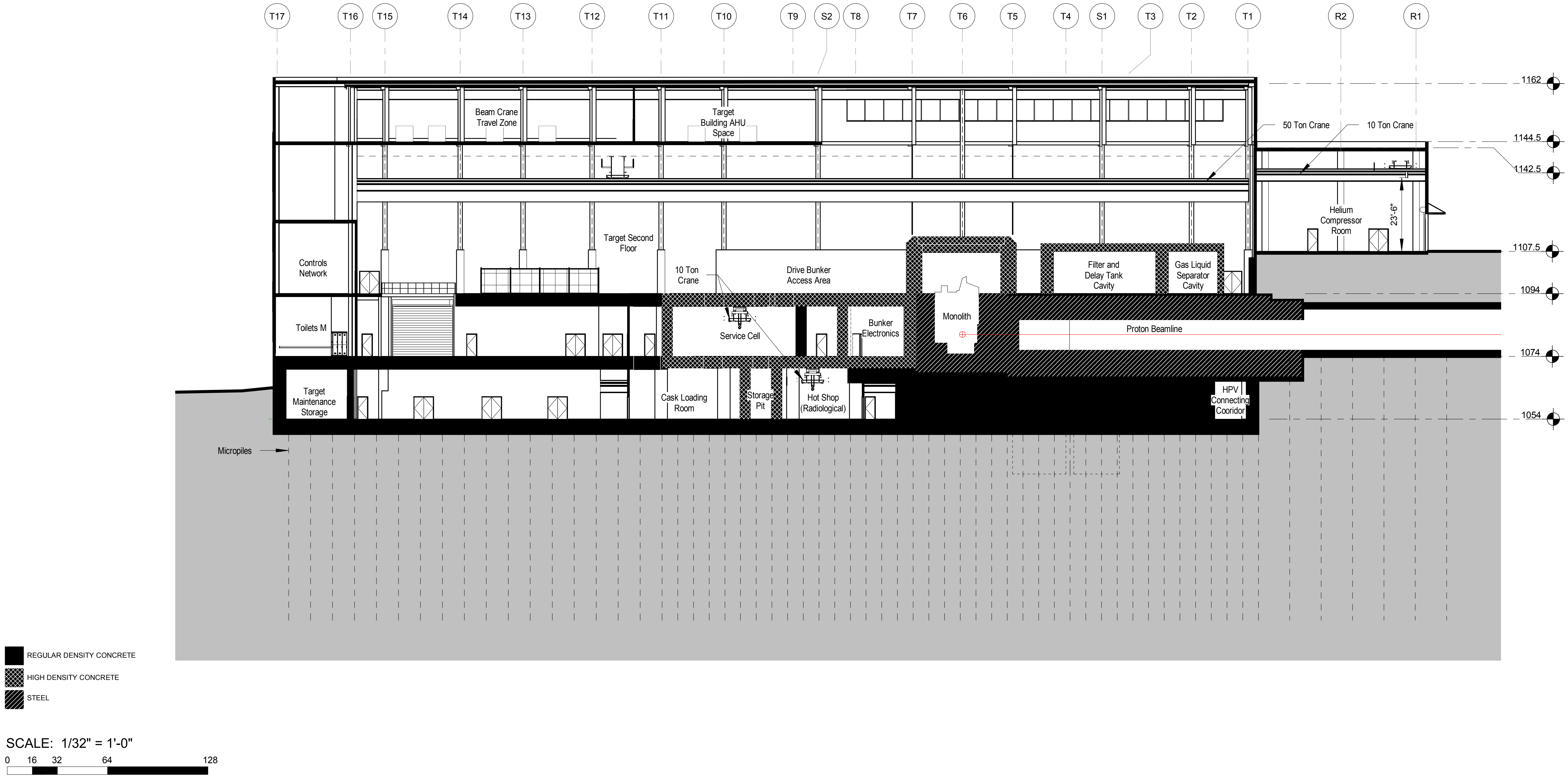

REV. NO.	DESCRIPTION	BY	APVD	DATE

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PROJECT TITLE
SECOND TARGET STATION CONVENTIONAL FACILITIES

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SHEET NAME **TARGET BUILDING SECTION D**

SHEET NUMBER **5.3.1.9**

DATE FEBRUARY 8, 2019

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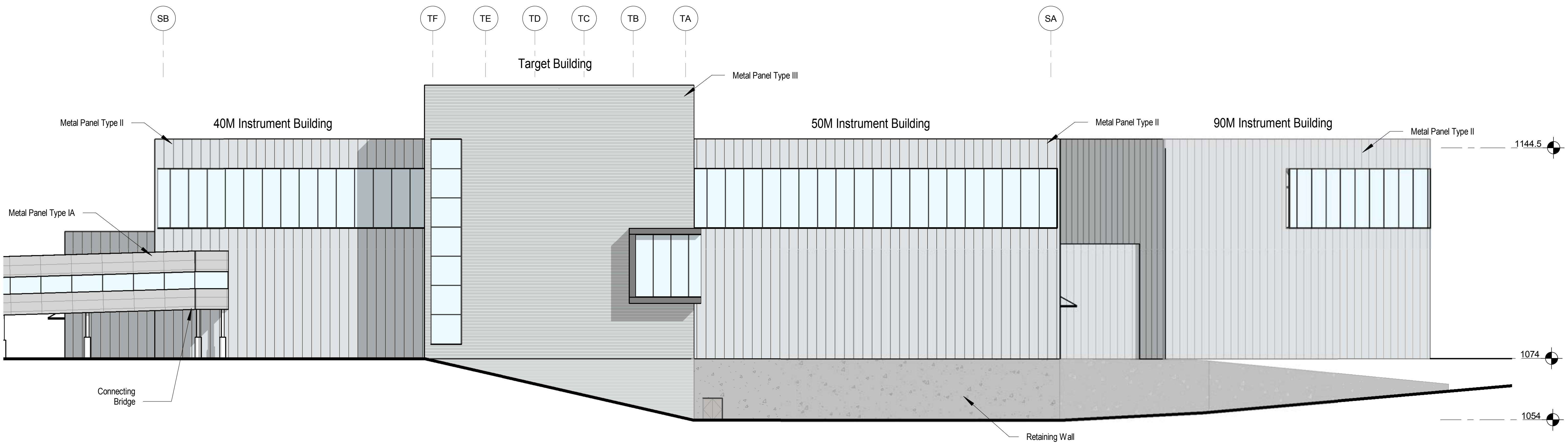

SCALE: 1/32" = 1'-0"

0 16 32 64 128

REV. NO.	DESCRIPTION	BY	APVD	DATE

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PROJECT TITLE
SECOND TARGET STATION CONVENTIONAL FACILITIES

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SHEET NAME	**TARGET BUILDING EAST ELEVATION**
SHEET NUMBER	**5.3.1.10**
DATE	FEBRUARY 8, 2019

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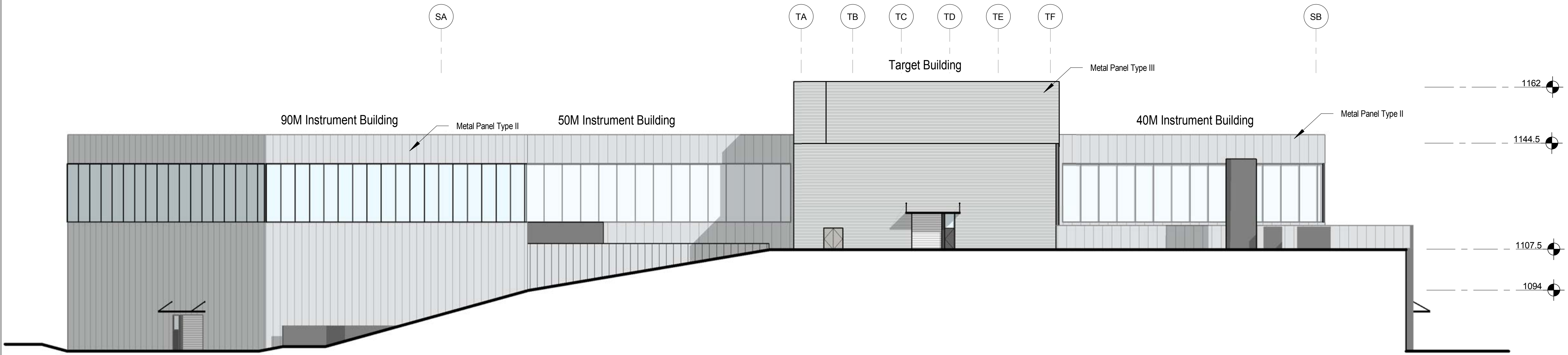

SCALE: 1/32" = 1'-0"

0 8 16 32 64

REV. NO.	DESCRIPTION	BY	APVD	DATE

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PROJECT TITLE
SECOND TARGET STATION CONVENTIONAL FACILITIES

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SHEET NAME	**TARGET BUILDING WEST ELEVATION**
SHEET NUMBER	**5.3.1.11**
DATE	FEBRUARY 8, 2019

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PROJECT TITLE
SECOND TARGET STATION CONVENTIONAL FACILITIES

100% CONCEPTUAL DESIGN REPORT SUBMISSION

SHEET NAME	**TARGET BUILDING - HIGH BAY - INTERIOR VIEW**
SHEET NUMBER	**5.3.1.12**
DATE	FEBRUARY 8, 2019

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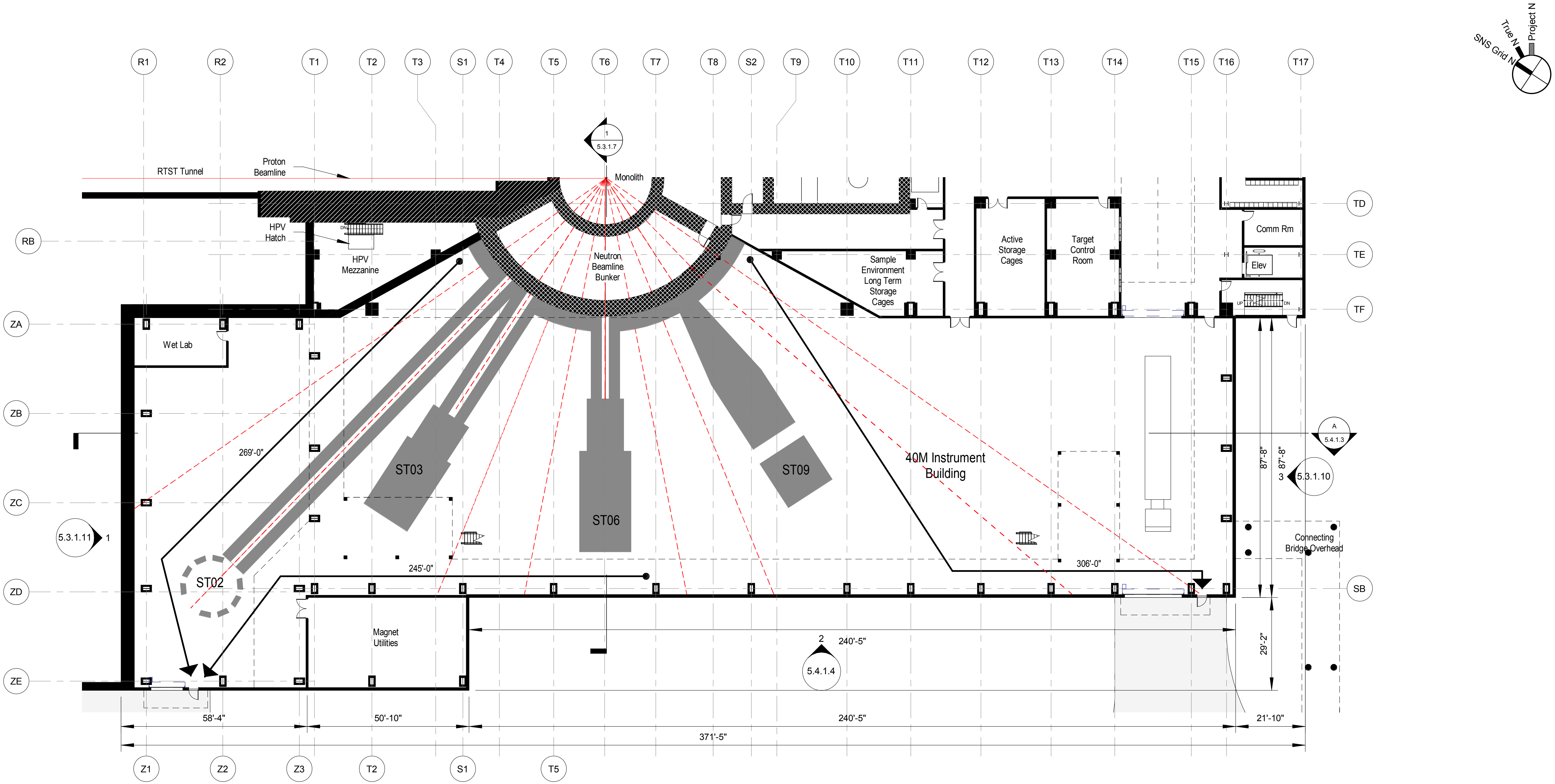

Egress Route and Travel Distance:

XX'-X"

SCALE: 1/32" = 1'-0"

0 8 16 32 64

Longest Travel Distance: 306'-0"

Max Travel Distance: 400'-0"

REV. NO.	DESCRIPTION	BY	APVD	DATE

OAK RIDGE NATIONAL LABORATORY
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F: 312.332.9601

PROJECT TITLE
SECOND TARGET STATION CONVENTIONAL FACILITIES

100% CONCEPTUAL DESIGN REPORT SUBMISSION

SHEET NAME	**40M INSTRUMENT BUILDING FIRST FLOOR PLAN**
SHEET NUMBER	**5.4.1.1**
DATE	FEBRUARY 8, 2019

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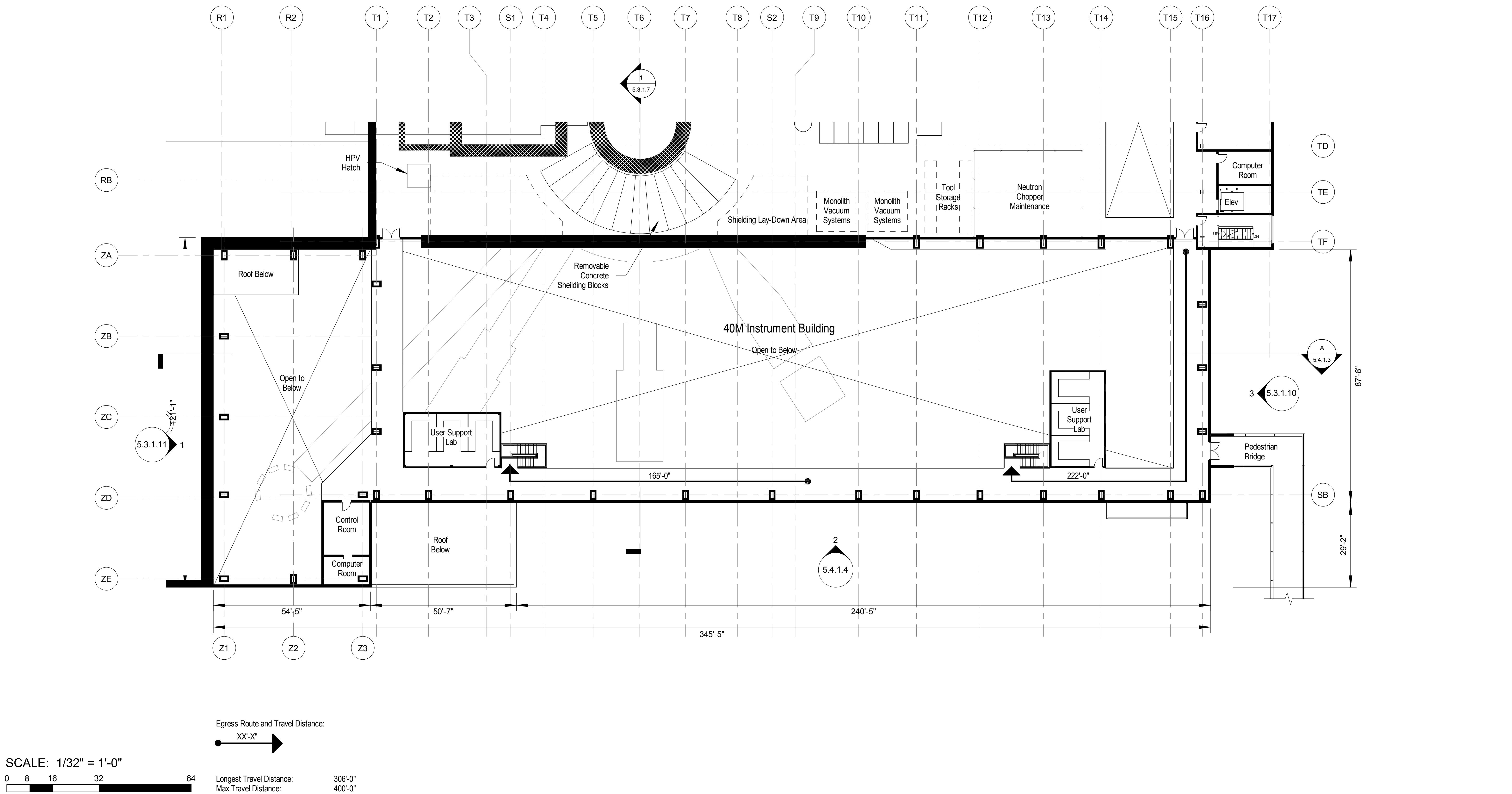

REV. NO.	DESCRIPTION	BY	APVD	DATE

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F: 312.332.9601

PROJECT TITLE
SECOND TARGET STATION CONVENTIONAL FACILITIES

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SHEET NAME **40M INSTRUMENT BUILDING MEZZANINE PLAN**

SHEET NUMBER **5.4.1.2**

DATE FEBRUARY 8, 2019

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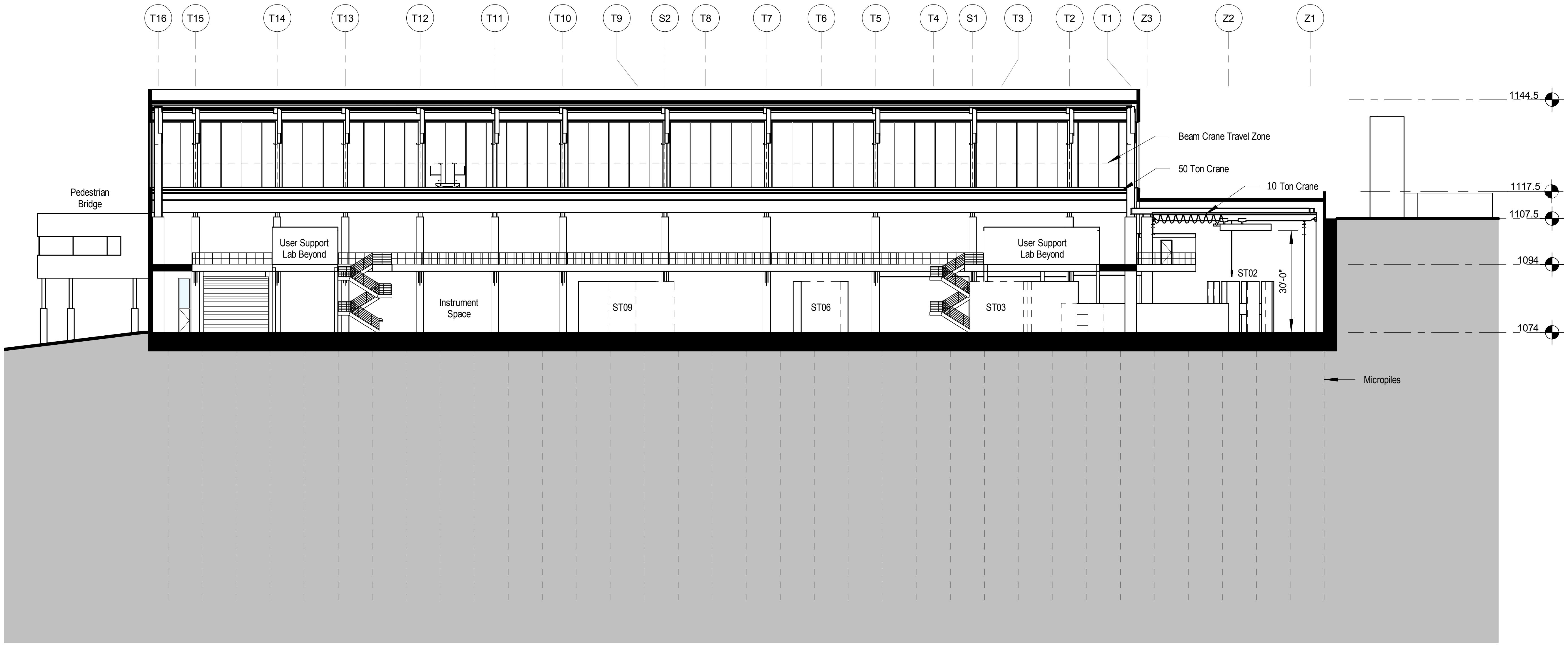

SCALE: 1/32" = 1'-0"

0 16 32 64 128

REV. NO.	DESCRIPTION	BY	APVD	DATE

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PROJECT TITLE
SECOND TARGET STATION CONVENTIONAL FACILITIES

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SHEET NAME	**40M INSTRUMENT BUILDING SECTION A**
SHEET NUMBER	**5.4.1.3**
DATE	FEBRUARY 8, 2019

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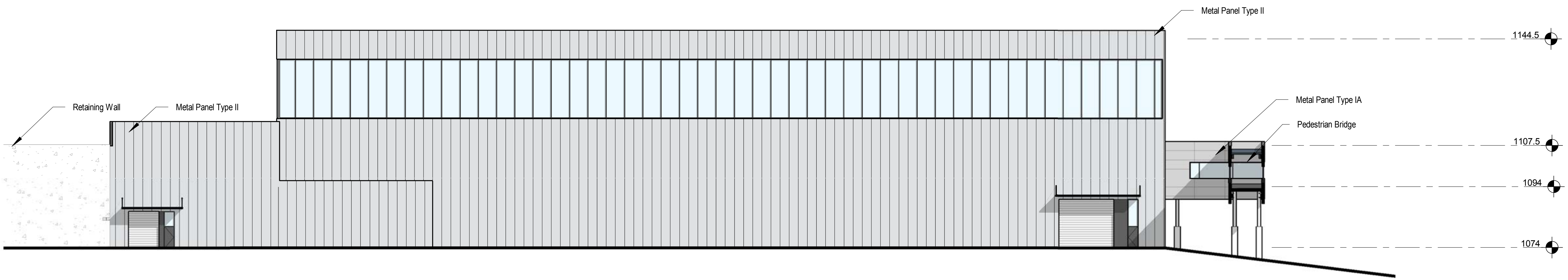

SCALE: 1/32" = 1'-0"

0 16 32 64 128

REV. NO.	DESCRIPTION	BY	APVD	DATE

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PROJECT TITLE
SECOND TARGET STATION CONVENTIONAL FACILITIES

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SHEET NAME	**40M INSTRUMENT BUILDING EXTERIOR ELEVATION**
SHEET NUMBER	**5.4.1.4**
DATE	FEBRUARY 8, 2019

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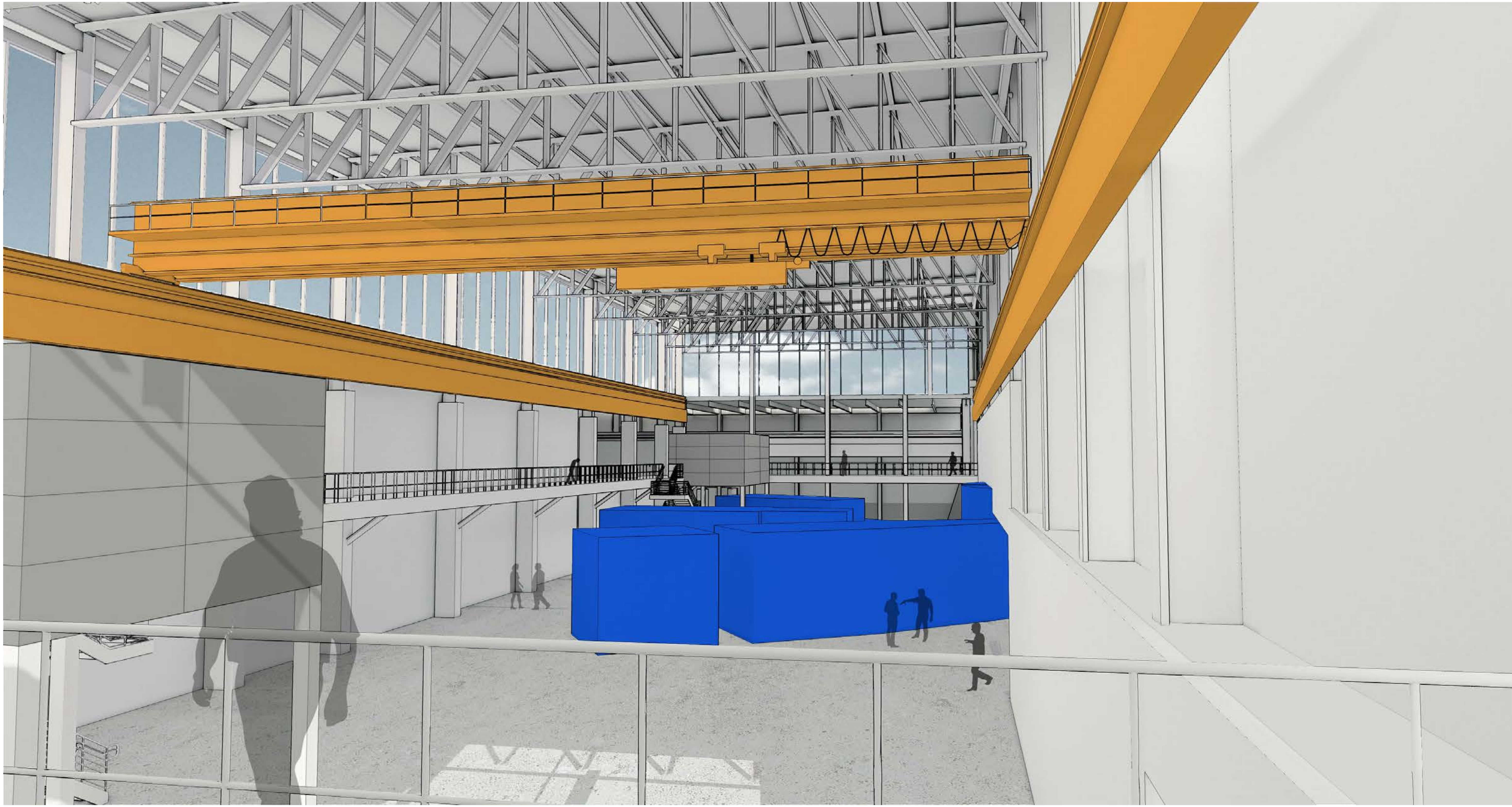

REV. NO.	DESCRIPTION	BY	APVD	DATE

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PROJECT TITLE
SECOND TARGET STATION CONVENTIONAL FACILITIES

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SHEET NAME **40M INSTRUMENT BUILDING - MEZZANINE - INTERIOR VIEW**

SHEET NUMBER **5.4.1.5**

DATE FEBRUARY 8, 2019

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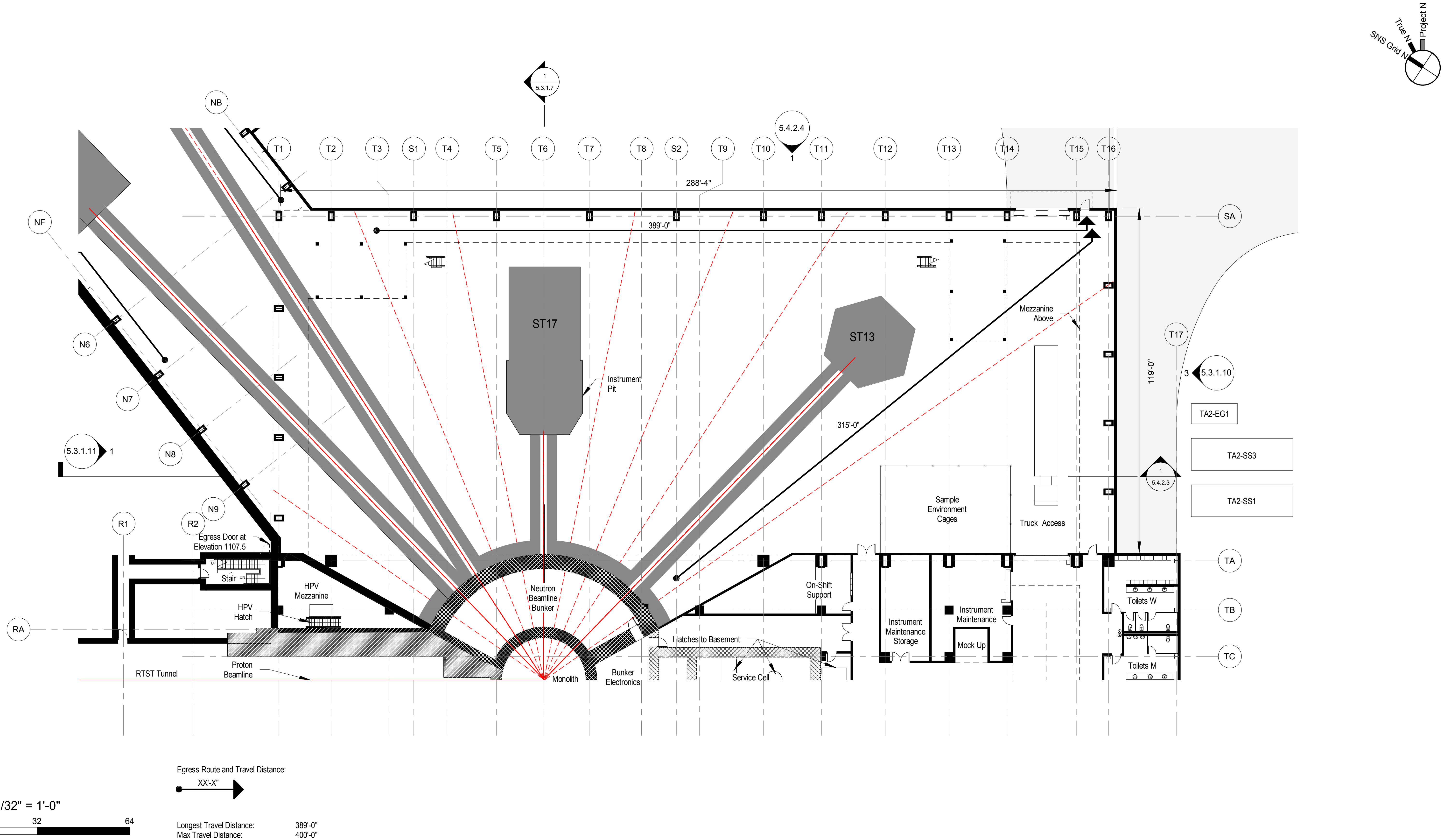

REV. NO.	DESCRIPTION	BY	APVD	DATE

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PROJECT TITLE
SECOND TARGET STATION CONVENTIONAL FACILITIES

100% CONCEPTUAL DESIGN REPORT SUBMISSION

SHEET NAME **50M INSTRUMENT BUILDING FIRST FLOOR PLAN**

SHEET NUMBER **5.4.2.1**

DATE FEBRUARY 8, 2019

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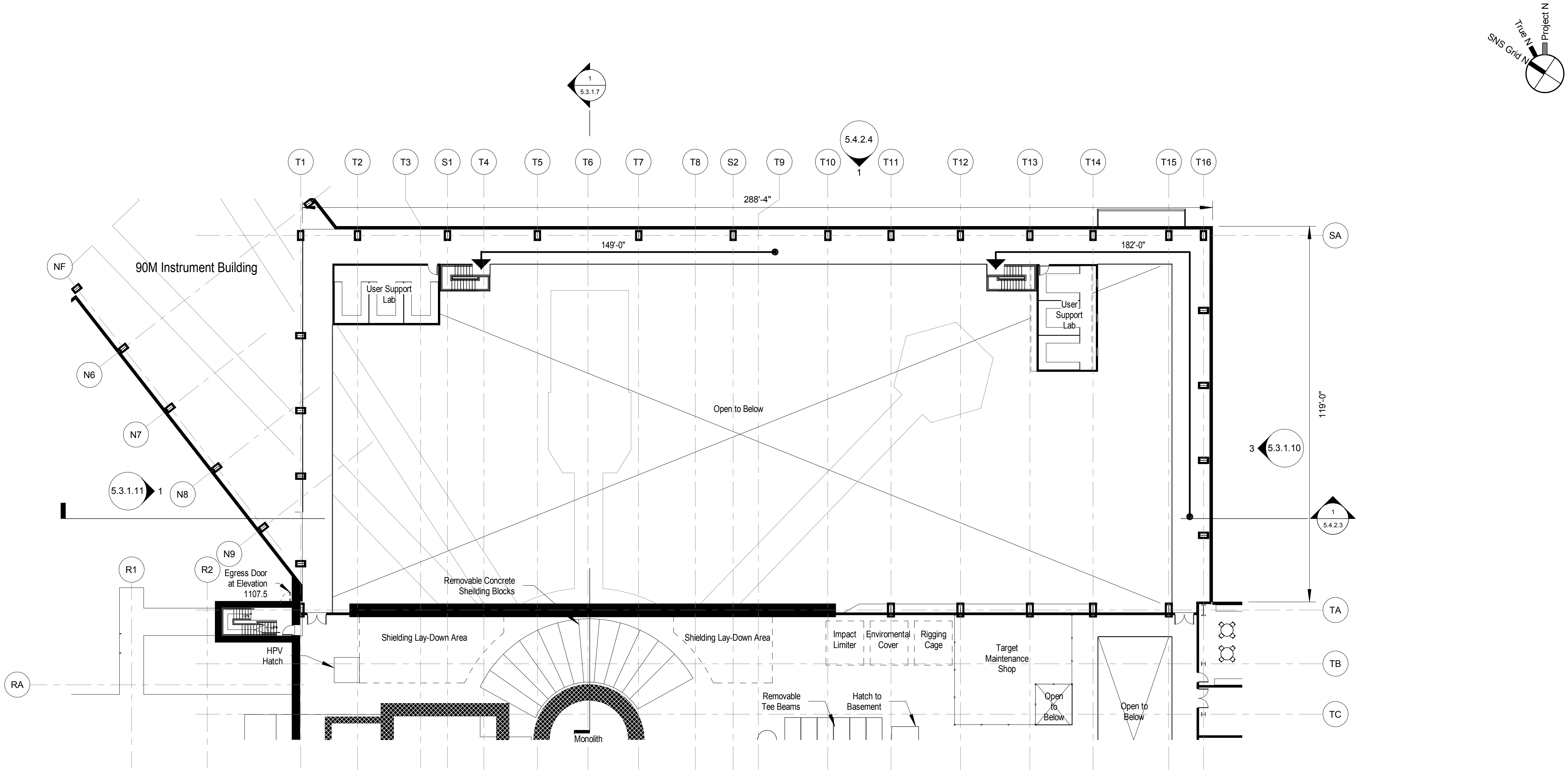

Egress Route and Travel Distance:

XX'-X"

SCALE: 1/32" = 1'-0"

0 8 16 32 64

Longest Travel Distance: 182'-0"

Max Travel Distance: 400'-0"

REV. NO.	DESCRIPTION	BY	APVD	DATE

OAK RIDGE NATIONAL LABORATORY

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PROJECT TITLE

SECOND TARGET STATION CONVENTIONAL FACILITIES

100% CONCEPTUAL DESIGN REPORT SUBMISSION

SHEET NAME	**50M INSTRUMENT BUILDING MEZZANINE PLAN**
SHEET NUMBER	**5.4.2.2**
DATE	FEBRUARY 8, 2019

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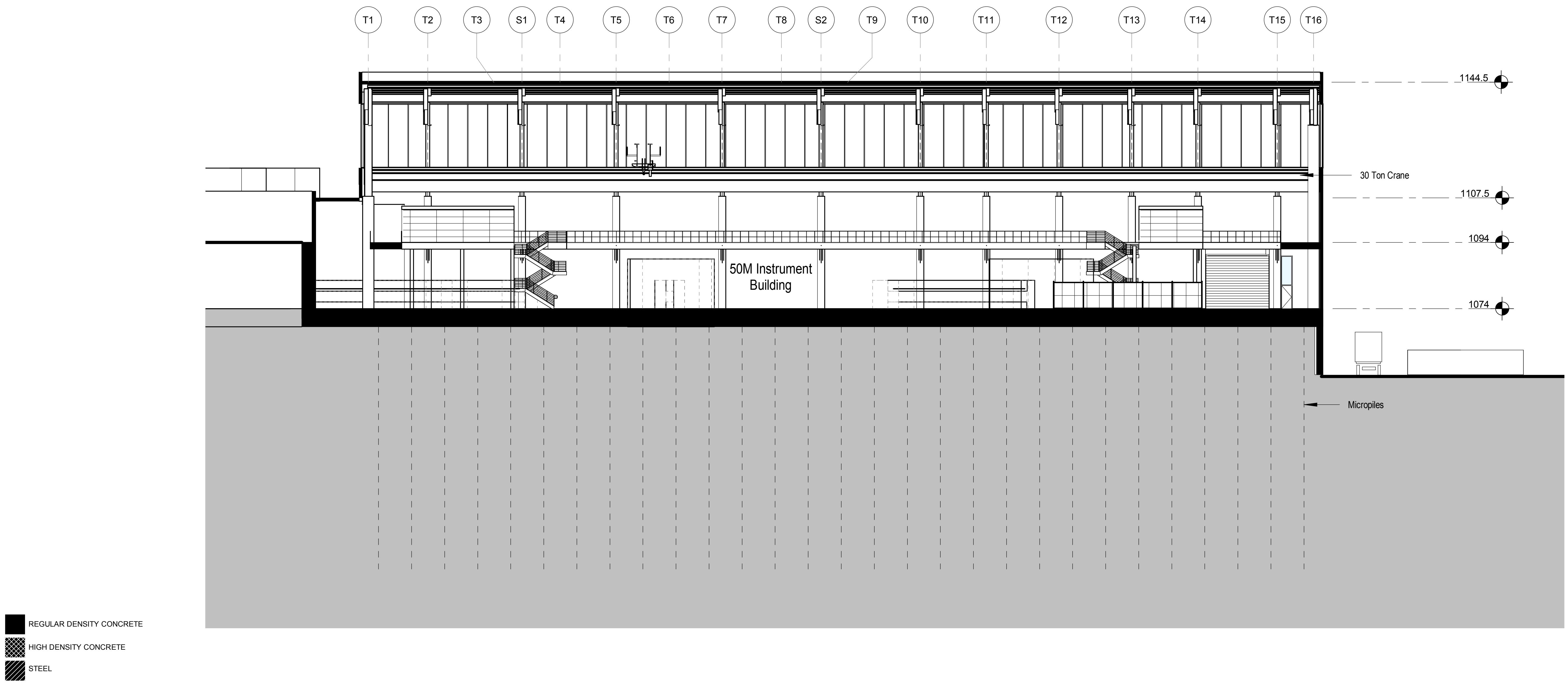

SCALE: 1/32" = 1'-0"

0 8 16 32 64

REV. NO.	DESCRIPTION	BY	APVD	DATE

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PROJECT TITLE
SECOND TARGET STATION CONVENTIONAL FACILITIES

100% CONCEPTUAL DESIGN REPORT SUBMISSION

SHEET NAME	**50M INSTRUMENT BUILDING SECTION A**
SHEET NUMBER	**5.4.2.3**
DATE	FEBRUARY 8, 2019

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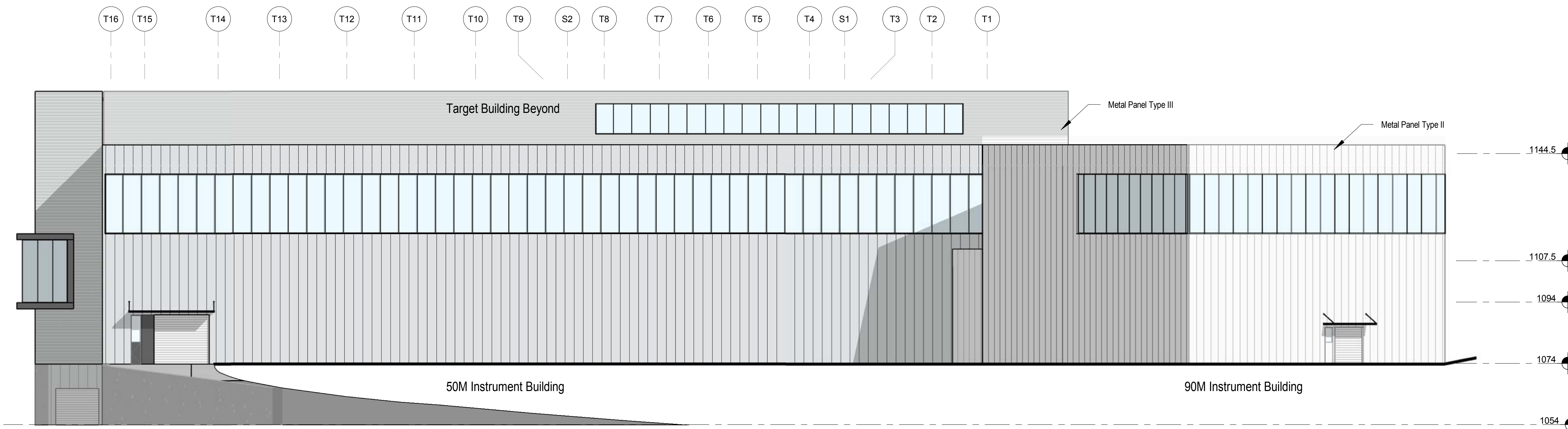

SCALE: 1/32" = 1'-0"

0 16 32 64 128

REV. NO.	DESCRIPTION	BY	APVD	DATE

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PROJECT TITLE
SECOND TARGET STATION CONVENTIONAL FACILITIES

100% CONCEPTUAL DESIGN REPORT SUBMISSION

SHEET NAME	**50M INSTRUMENT BUILDING EXTERIOR ELEVATION**
SHEET NUMBER	**5.4.2.4**
DATE	FEBRUARY 8, 2019

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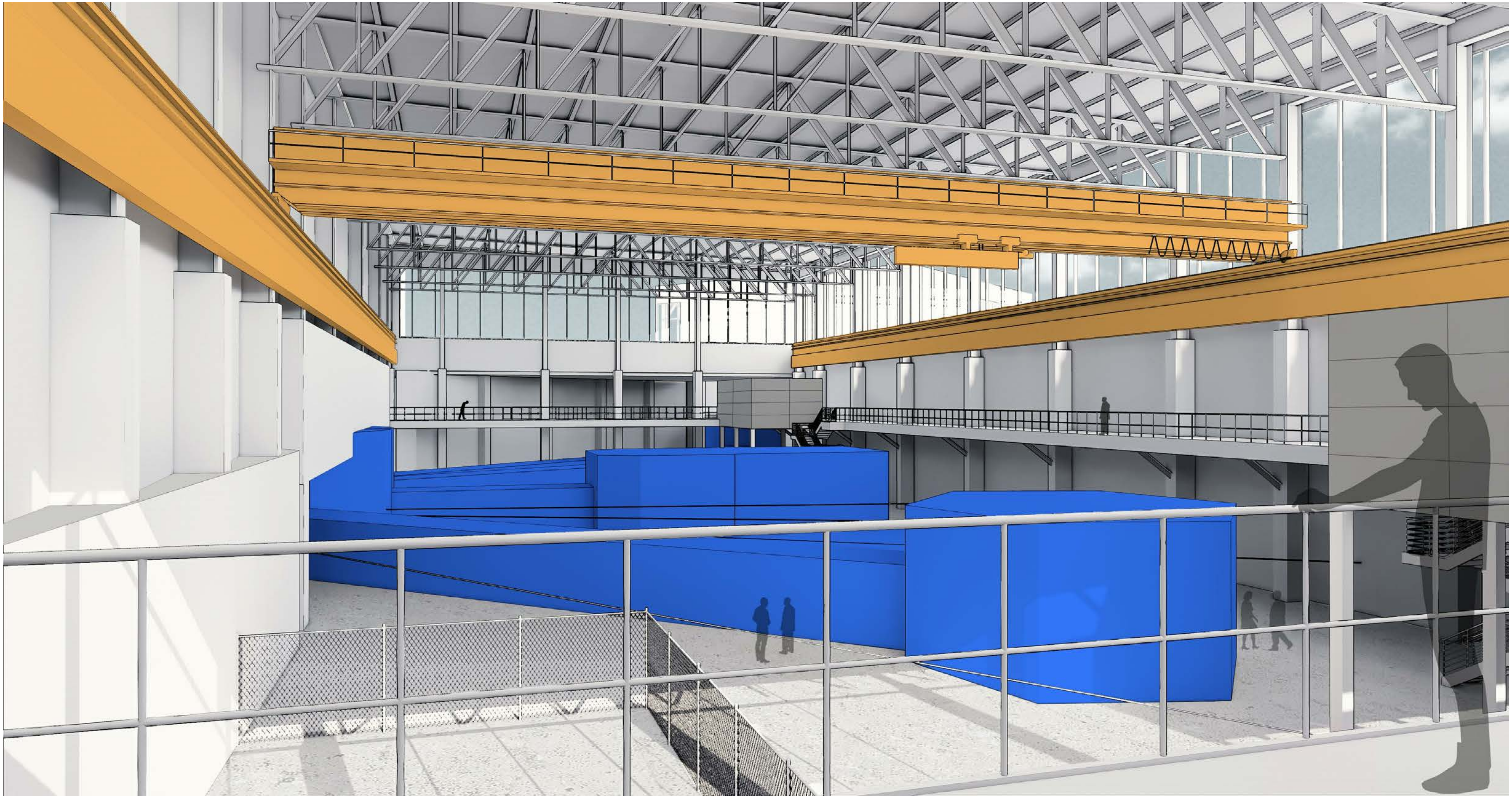

REV. NO.	DESCRIPTION	BY	APVD	DATE

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PROJECT TITLE
SECOND TARGET STATION CONVENTIONAL FACILITIES

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SHEET NAME **50M INSTRUMENT BUILDING - MEZZANINE - INTERIOR VIEW**

SHEET NUMBER **5.4.2.5**

DATE FEBRUARY 8, 2019

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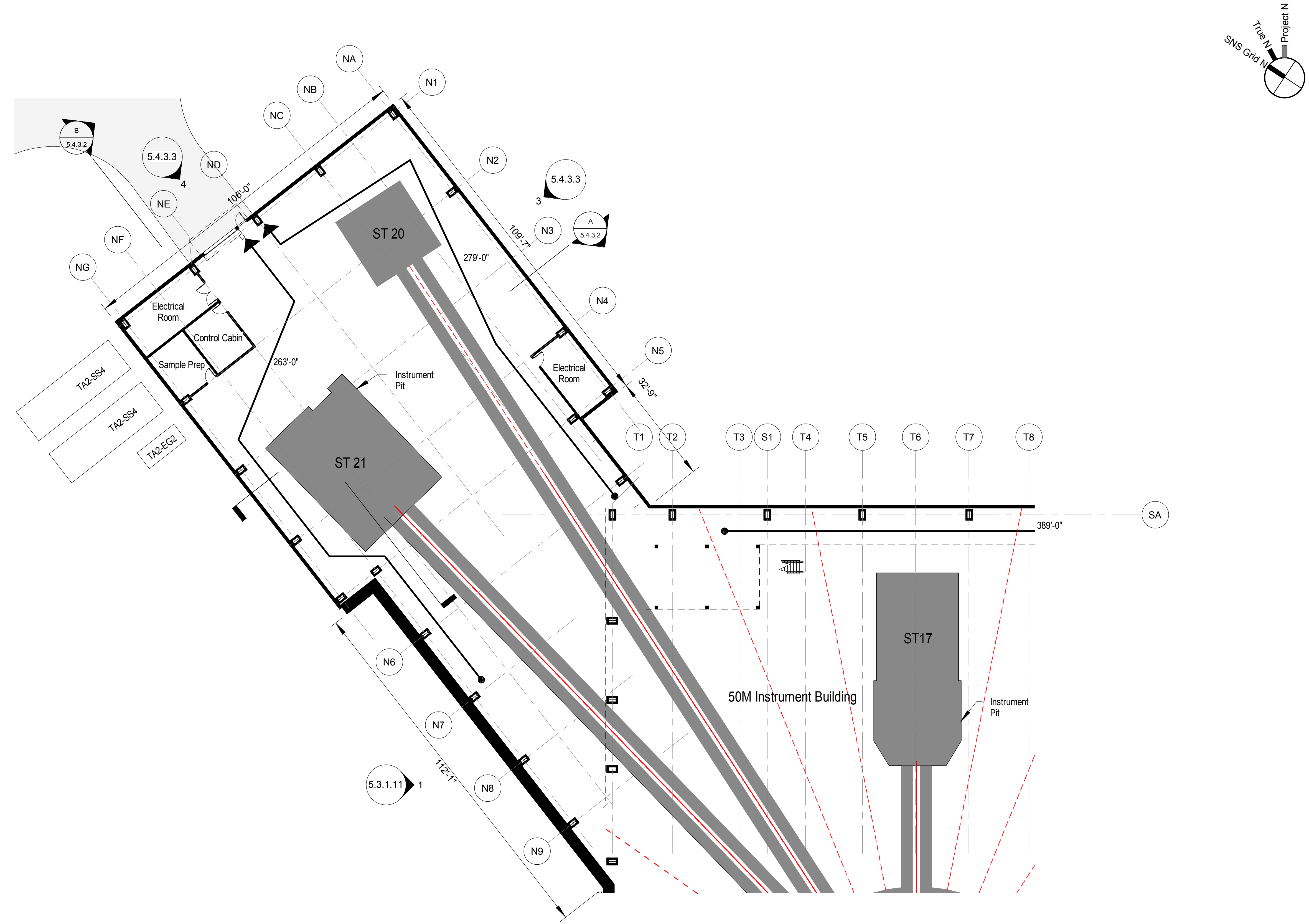

Egress Route and Travel Distance:

XX'-X"

SCALE: 1/32" = 1'-0"

0 8 16 32 64

Longest Travel Distance: 279'-0"

Max Travel Distance: 400'-0"

REV. NO.	DESCRIPTION	BY	APVD	DATE

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PROJECT TITLE

SECOND TARGET STATION CONVENTIONAL FACILITIES

100% CONCEPTUAL DESIGN REPORT SUBMISSION

SHEET NAME	**90M INSTRUMENT BUILDING FIRST FLOOR PLAN**
SHEET NUMBER	**5.4.3.1**
DATE	FEBRUARY 8, 2019

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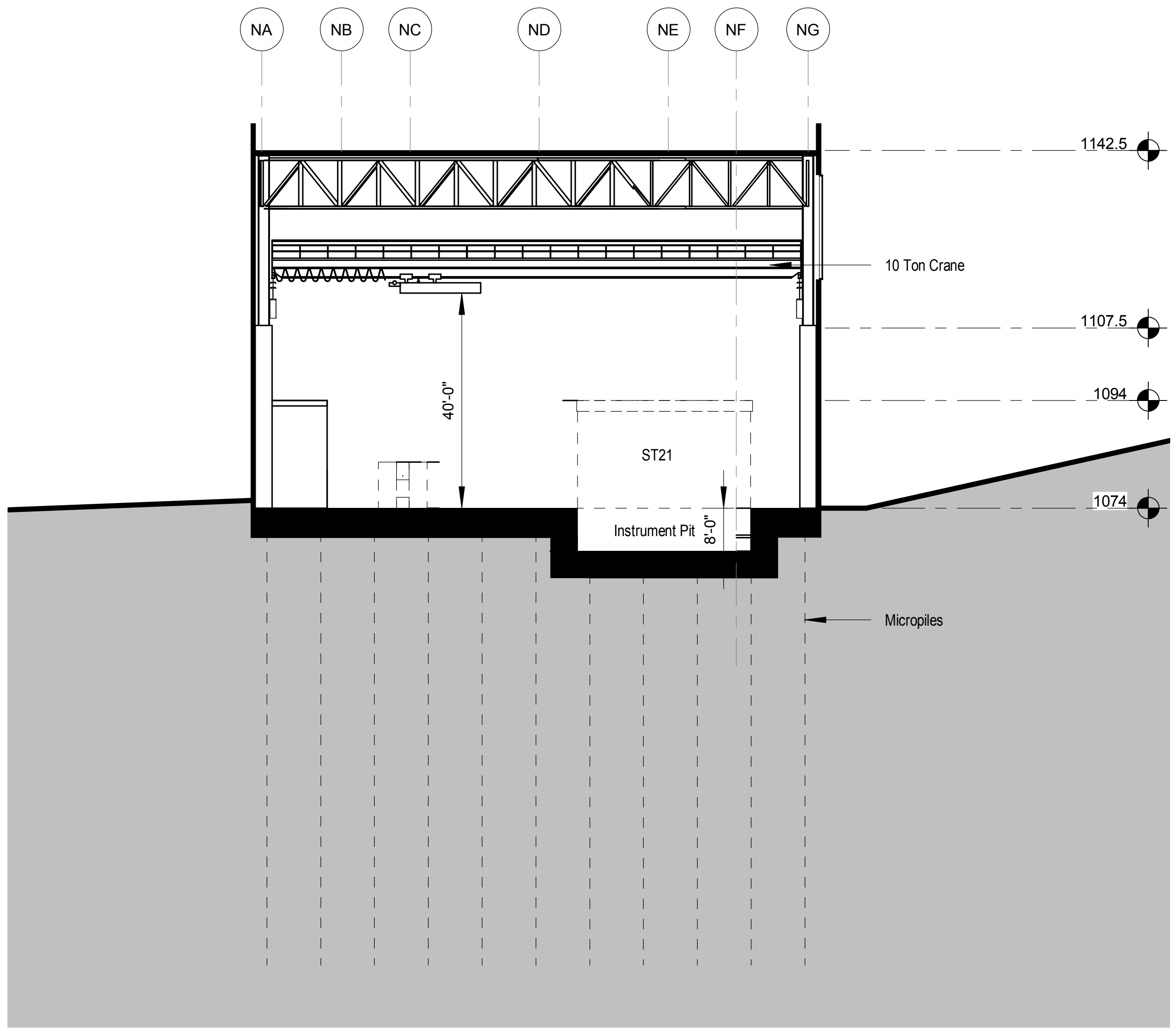
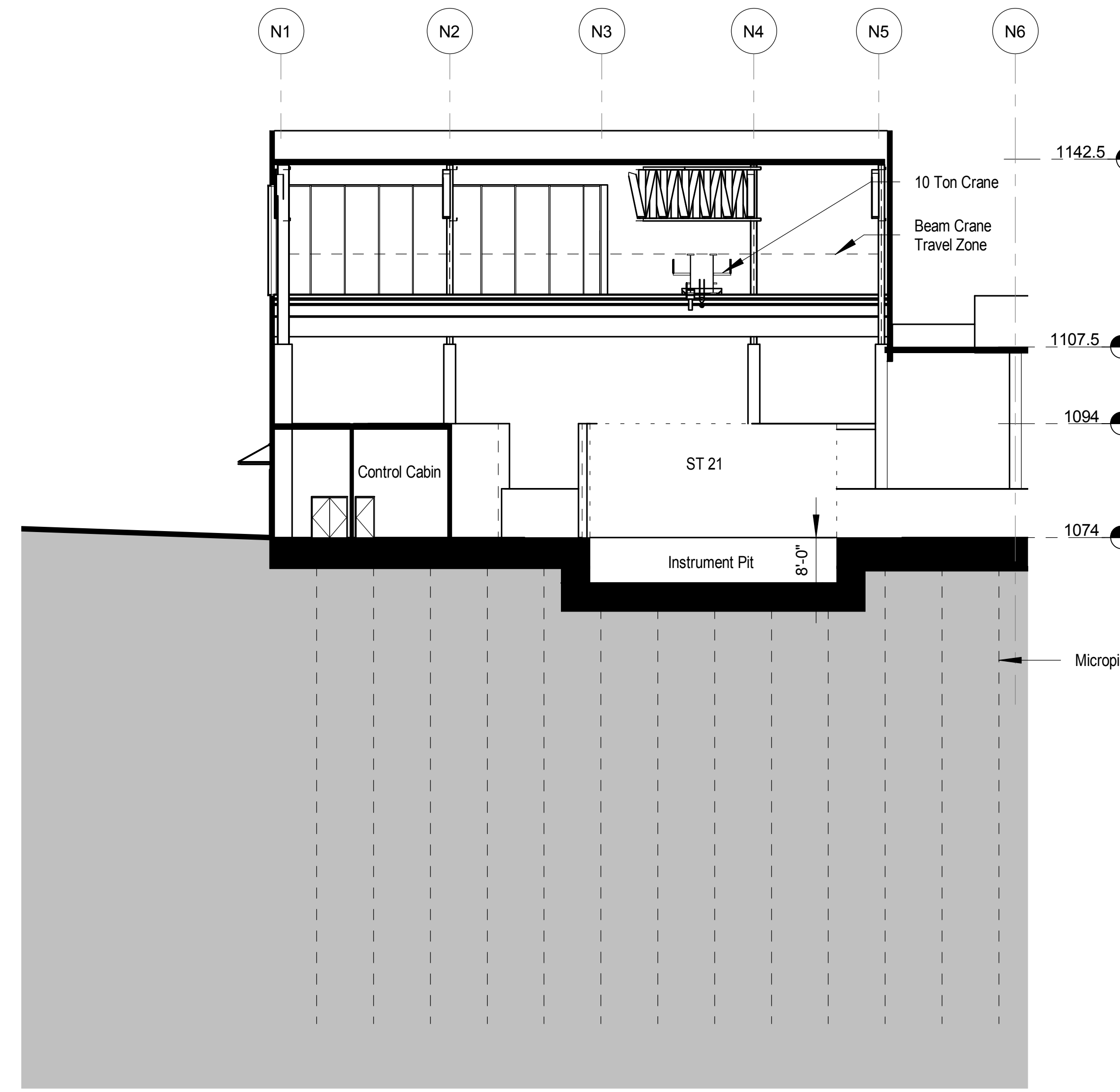


90M INSTRUMENT BUILDING SECTION A

1/32" = 1'-0"



90M INSTRUMENT BUILDING SECTION B

1/32" = 1'-0"

REGULAR DENSITY CONCRETE

HIGH DENSITY CONCRETE

STEEL

0 8 16 32 64

REV. NO.	DESCRIPTION	BY	APVD	DATE

OAK RIDGE NATIONAL LABORATORY

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PROJECT TITLE

SECOND TARGET STATION CONVENTIONAL FACILITIES

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SHEET NAME	**90M INSTRUMENT BUILDING SECTIONS**
SHEET NUMBER	**5.4.3.2**
DATE	FEBRUARY 8, 2019

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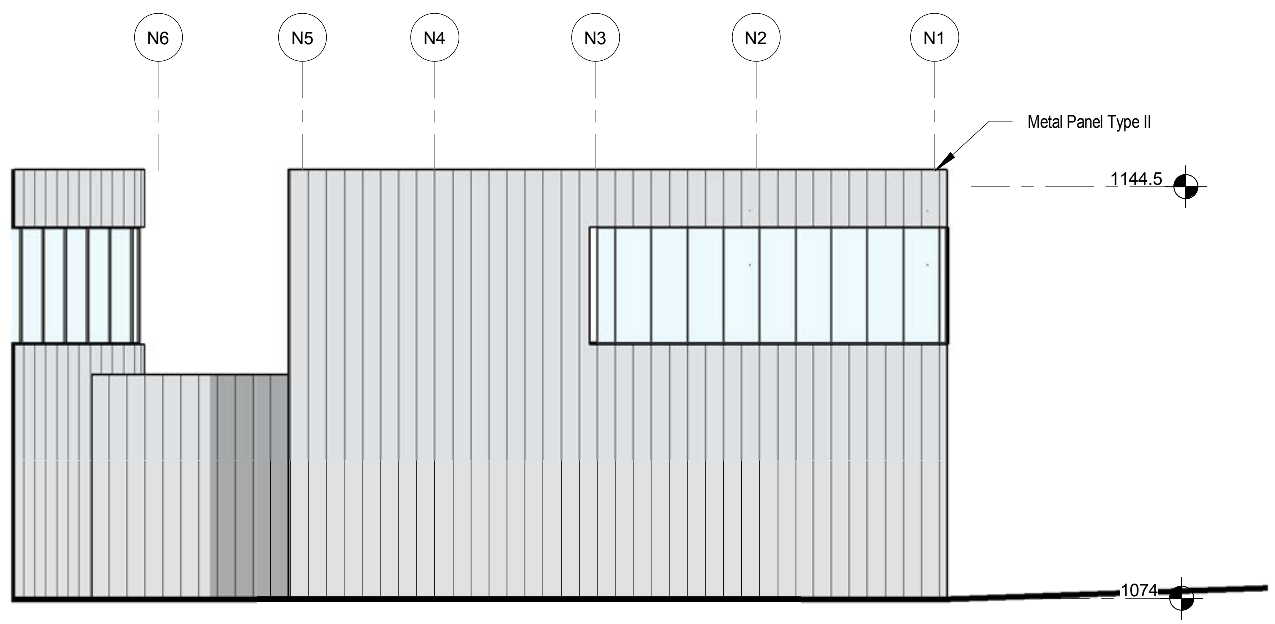
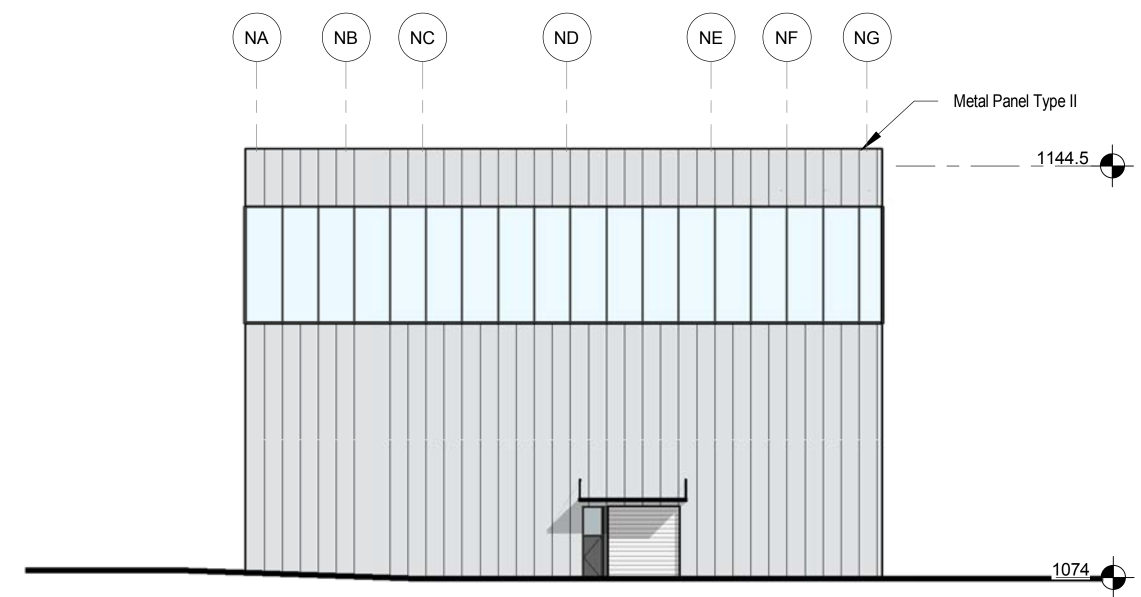


90M INSTRUMENT BUILDING NORTHEAST ELEVATION
1/32" = 1'-0"



90M INSTRUMENT BUILDING NORTHWEST ELEVATION
1/32" = 1'-0"

0 8 16 32 64

REV. NO.	DESCRIPTION	BY	APVD	DATE

OAK RIDGE NATIONAL LABORATORY
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225 North Michigan Avenue, Suite 1100
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PROJECT TITLE
SECOND TARGET STATION CONVENTIONAL FACILITIES

100% CONCEPTUAL DESIGN REPORT SUBMISSION

SHEET NAME **90M INSTRUMENT BUILDING EXTERIOR ELEVATIONS**
SHEET NUMBER **5.4.3.3**
DATE FEBRUARY 8, 2019

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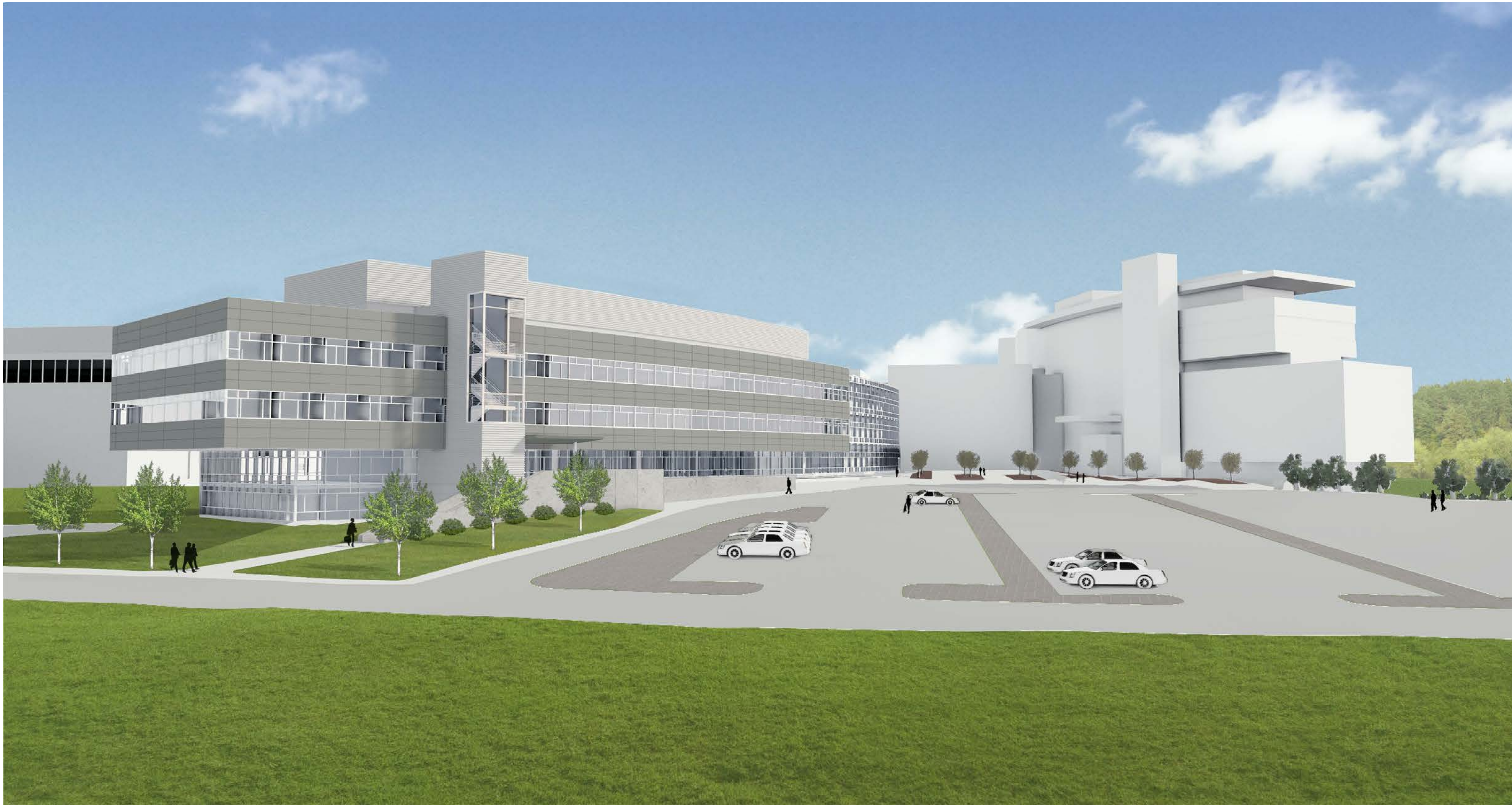

REV. NO.	DESCRIPTION	BY	APVD	DATE

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PROJECT TITLE
SECOND TARGET STATION CONVENTIONAL FACILITIES
SPALLATION NEUTRON SOURCE
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SHEET NAME	CLO II - SOUTHWEST VIEW
SHEET NUMBER	5.5.1.1
DATE	FEBRUARY 8, 2019

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Egress Route and Travel Distance:

XX'-X"

Longest Travel Distance: 226'-0"
Max Travel Distance: 300'-0"

SCALE: 1/32" = 1'-0"

0 8 16 32 64

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PROJECT TITLE
SECOND TARGET STATION CONVENTIONAL FACILITIES
SPALLATION NEUTRON SOURCE
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SHEET NAME	**CLO II - GROUND FLOOR PLAN**
SHEET NUMBER	**5.5.1.2**
DATE	FEBRUARY 8, 2019

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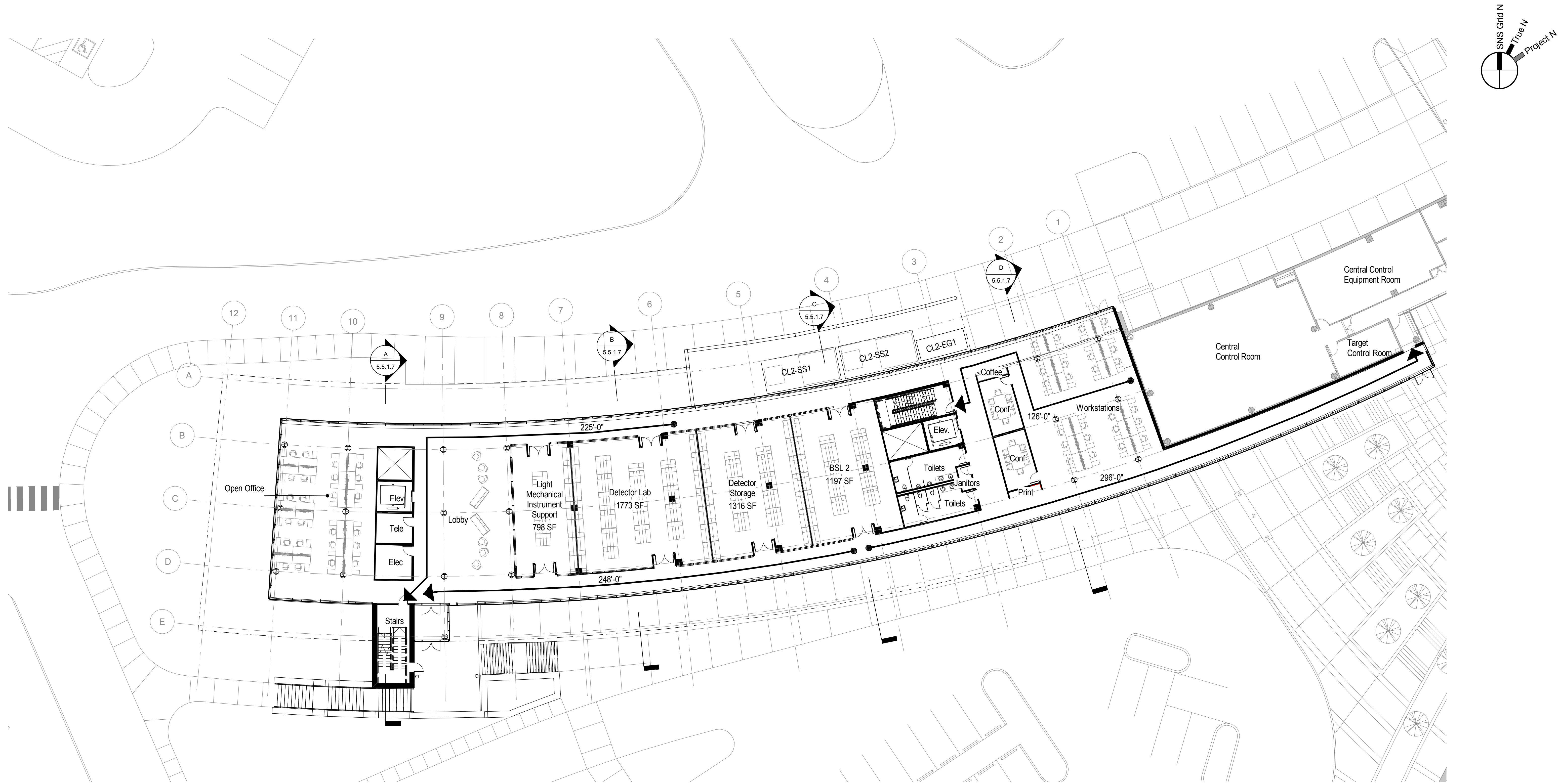

Egress Route and Travel Distance:

XX'-X"

SCALE: 1/32" = 1'-0"

0 8 16 32 64

Longest Travel Distance: 296'-0"
Max Travel Distance: 300'-0"

REV. NO.	DESCRIPTION	BY	APVD	DATE

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PROJECT TITLE
SECOND TARGET STATION CONVENTIONAL FACILITIES
SPALLATION NEUTRON SOURCE
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SHEET NAME **CLO II - FIRST FLOOR PLAN**
SHEET NUMBER **5.5.1.3**
DATE FEBRUARY 8, 2019

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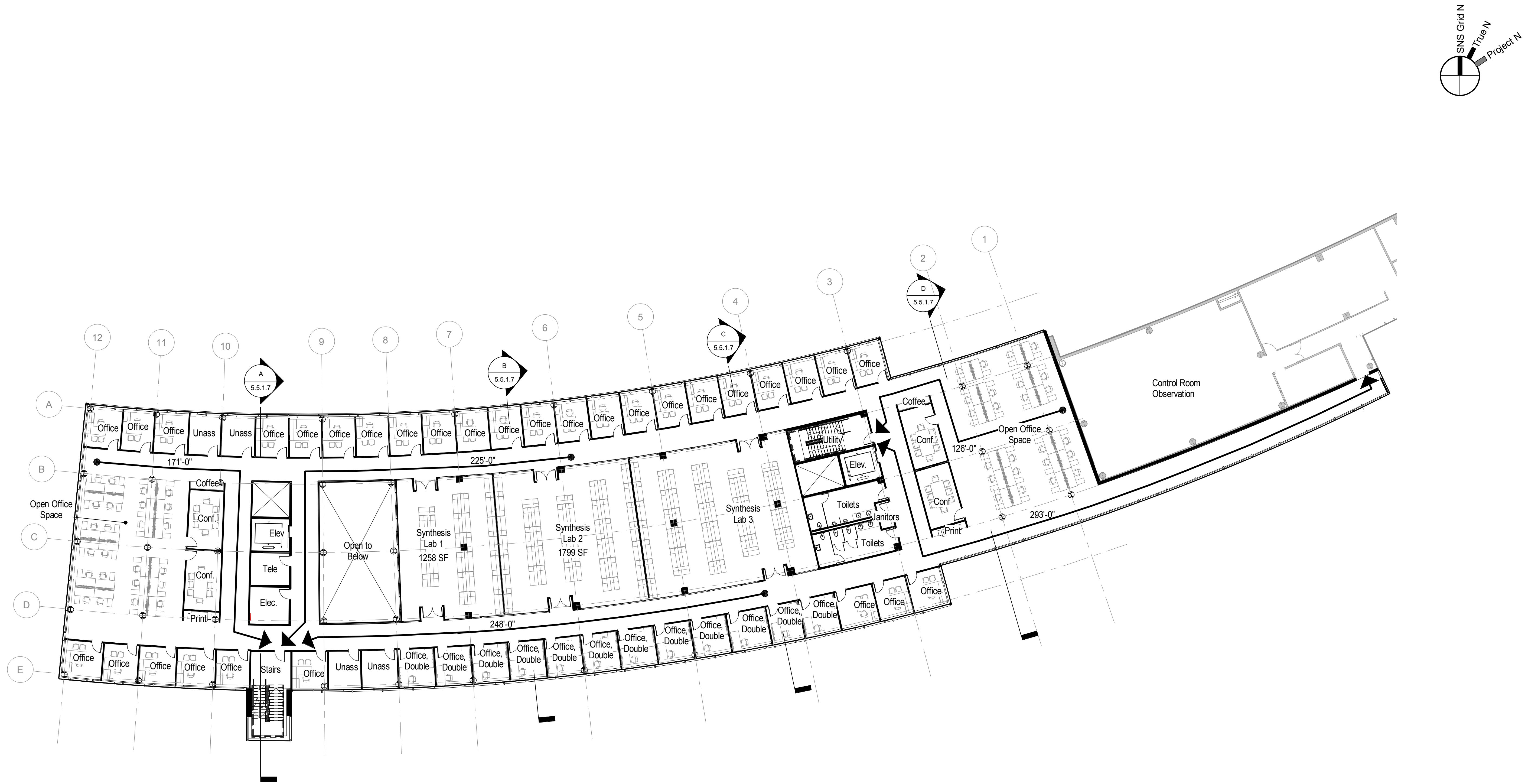

SCALE: 1/32" = 1'-0"

0 8 16 32 64

XX'-X"

Longest Travel Distance: 293'-0"

Max Travel Distance: 300'-0"

REV. NO.	DESCRIPTION	BY	APVD	DATE

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PROJECT TITLE
SECOND TARGET STATION CONVENTIONAL FACILITIES
SPALLATION NEUTRON SOURCE
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SHEET NAME	**CLO II - SECOND FLOOR PLAN**
SHEET NUMBER	**5.5.1.4**
DATE	FEBRUARY 8, 2019

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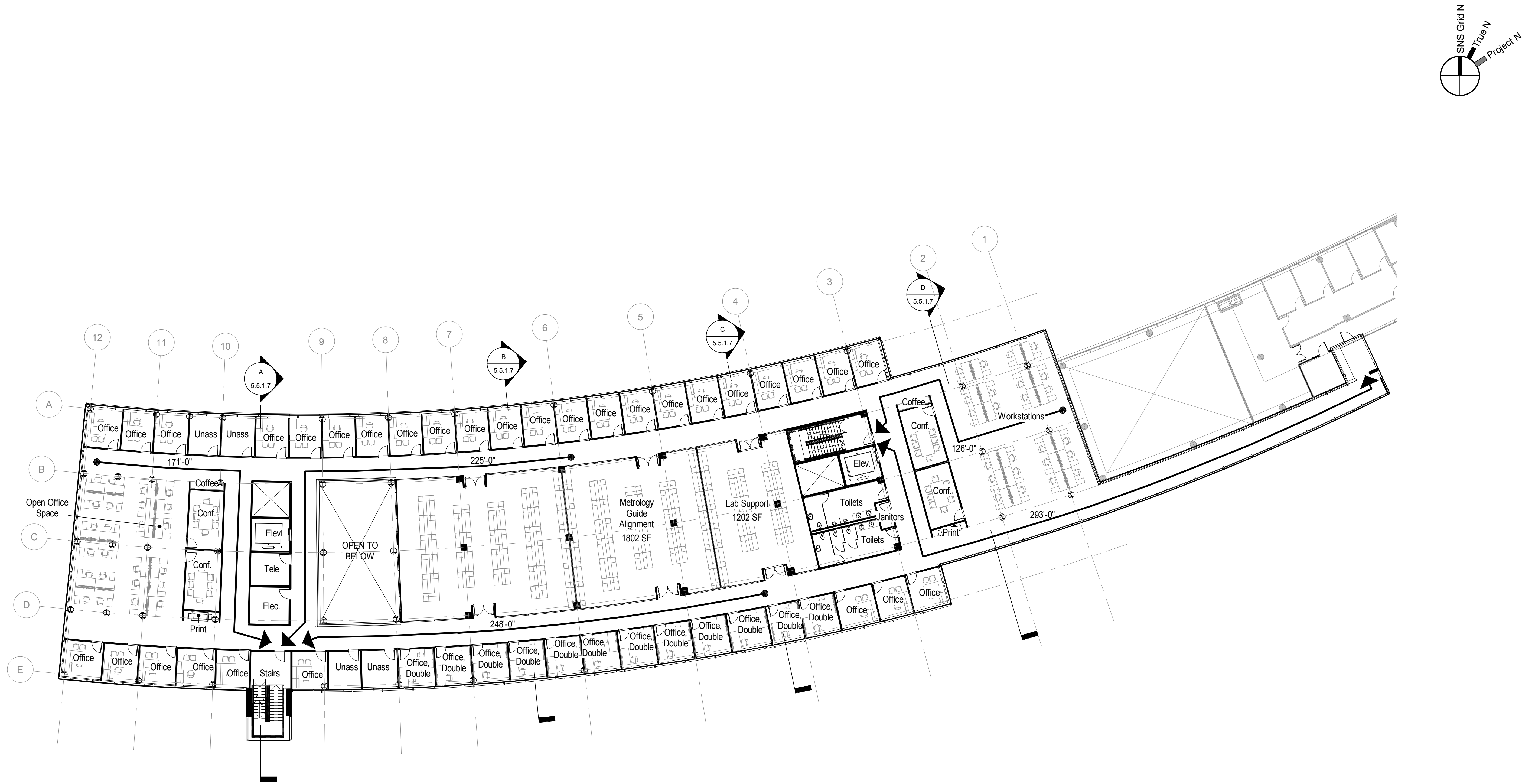

Egress Route and Travel Distance:

XX'-X"

Longest Travel Distance: 293'-0"
Max Travel Distance: 300'-0"

SCALE: 1/32" = 1'-0"

0 8 16 32 64

REV. NO.	DESCRIPTION	BY	APVD	DATE

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PROJECT TITLE

SECOND TARGET STATION CONVENTIONAL FACILITIES
SPALLATION NEUTRON SOURCE

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SHEET NAME	**CLO II - THIRD FLOOR PLAN**
SHEET NUMBER	**5.5.1.5**
DATE	FEBRUARY 8, 2019

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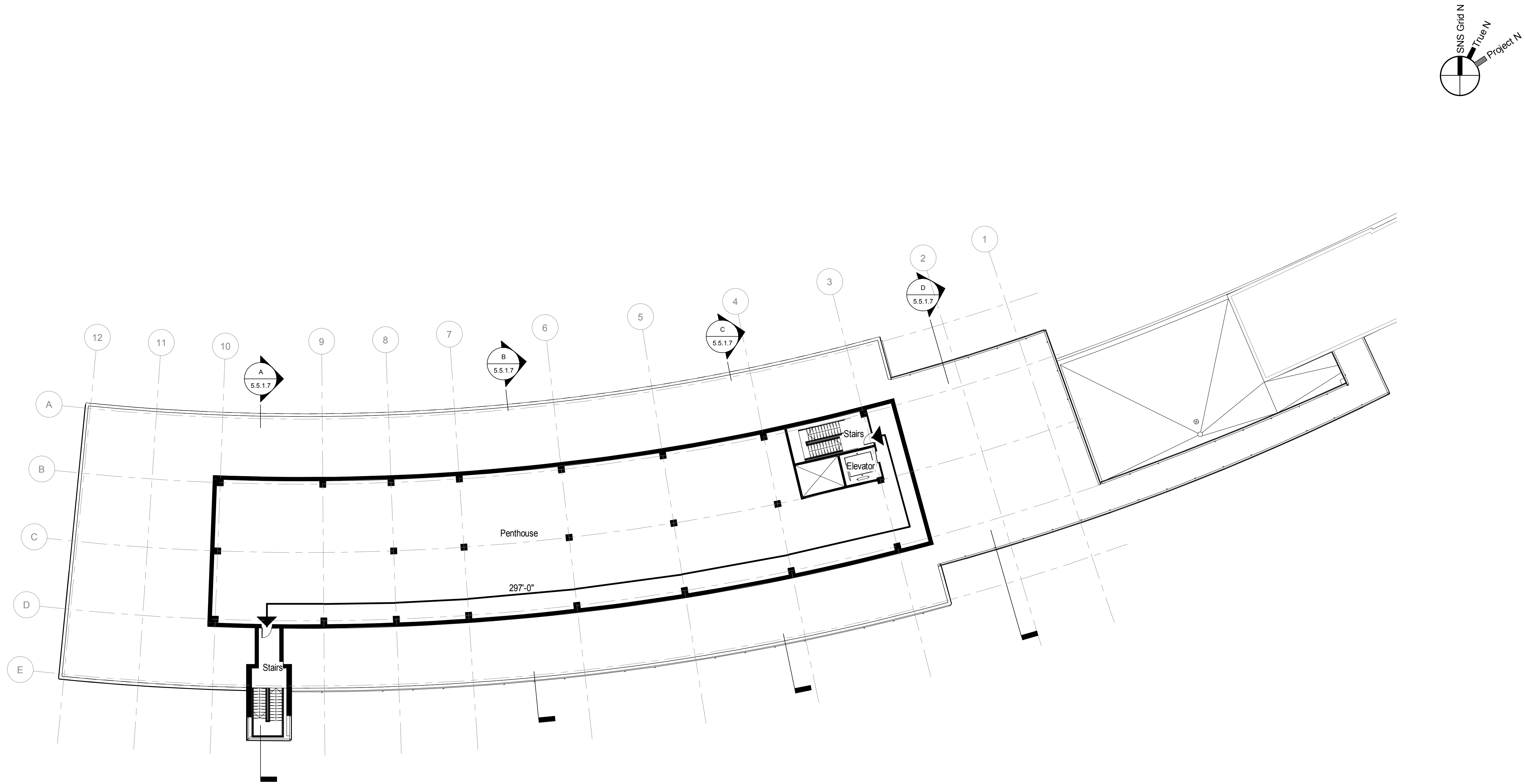

Egress Route and Travel Distance:

XX'-X"

SCALE: 1/32" = 1'-0"

0 8 16 32 64

Longest Travel Distance: 297'-0"
Max Travel Distance: 300'-0"

REV. NO.	DESCRIPTION	BY	APVD	DATE

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PROJECT TITLE
SECOND TARGET STATION CONVENTIONAL FACILITIES
SPALLATION NEUTRON SOURCE
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SHEET NAME	**CLO II - FOURTH FLOOR PLAN**
SHEET NUMBER	**5.5.1.6**
DATE	FEBRUARY 8, 2019

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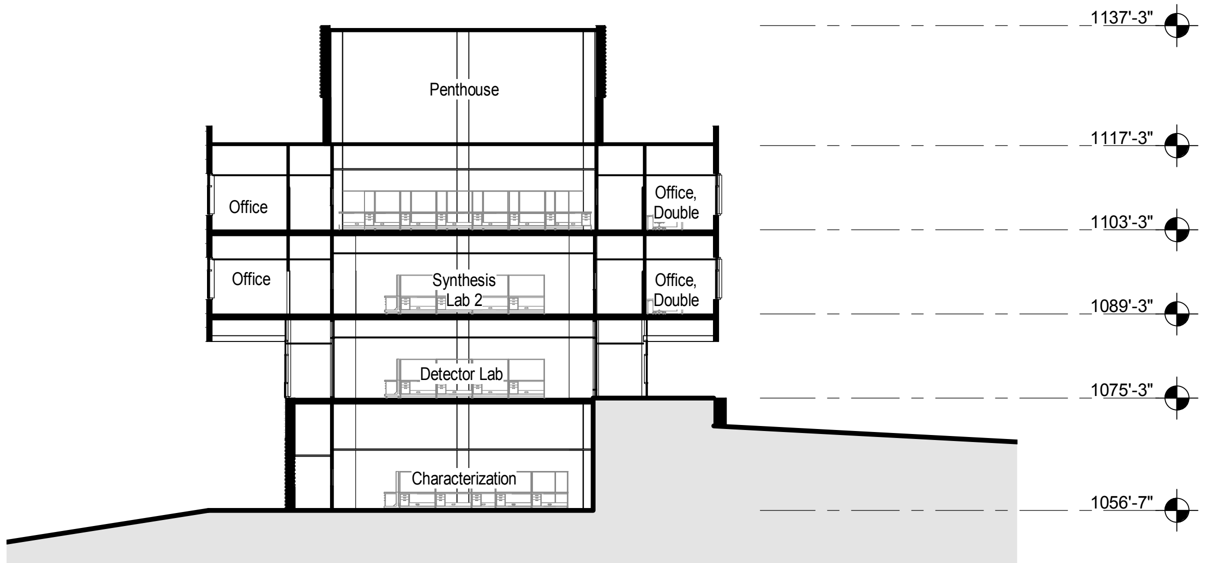
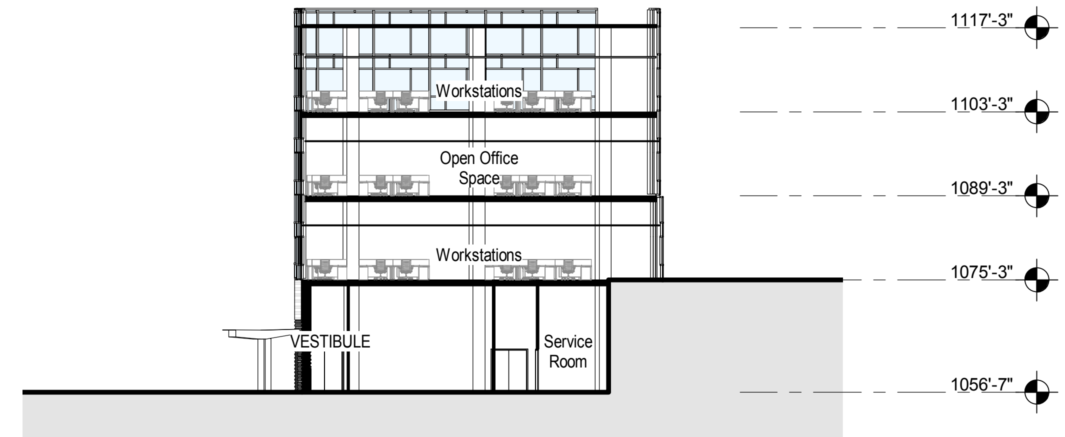
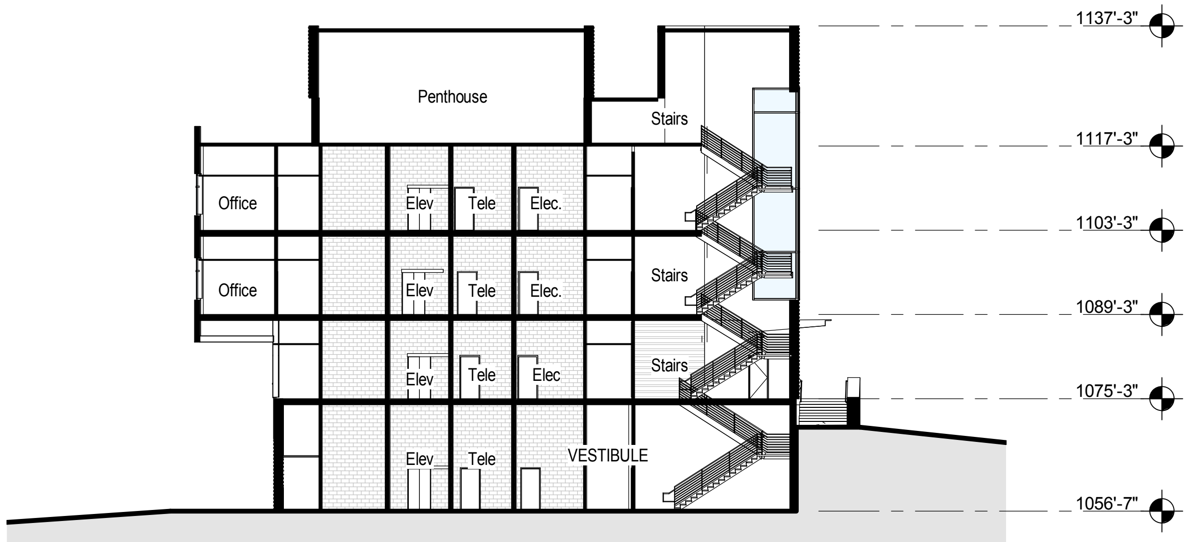


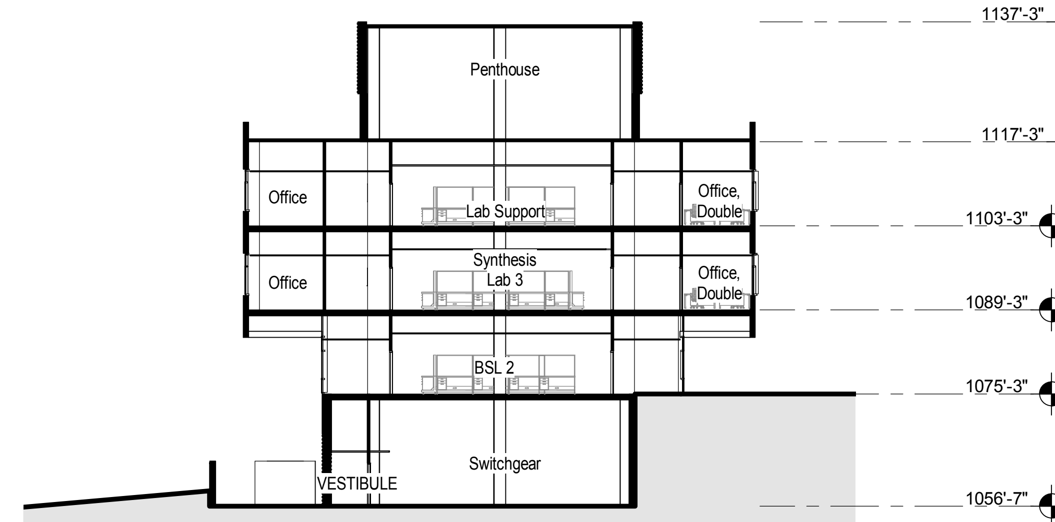
BUILDING SECTION - B
1/32" = 1'-0"



BUILDING SECTION - D
1/32" = 1'-0"



BUILDING SECTION - A
1/32" = 1'-0"



BUILDING SECTION - C
1/32" = 1'-0"

SCALE: 1/32" = 1'-0"
0 8 16 32 64

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SHEET NAME	**CLO II - SECTIONS**
SHEET NUMBER	**5.5.1.7**
DATE	FEBRUARY 8, 2019

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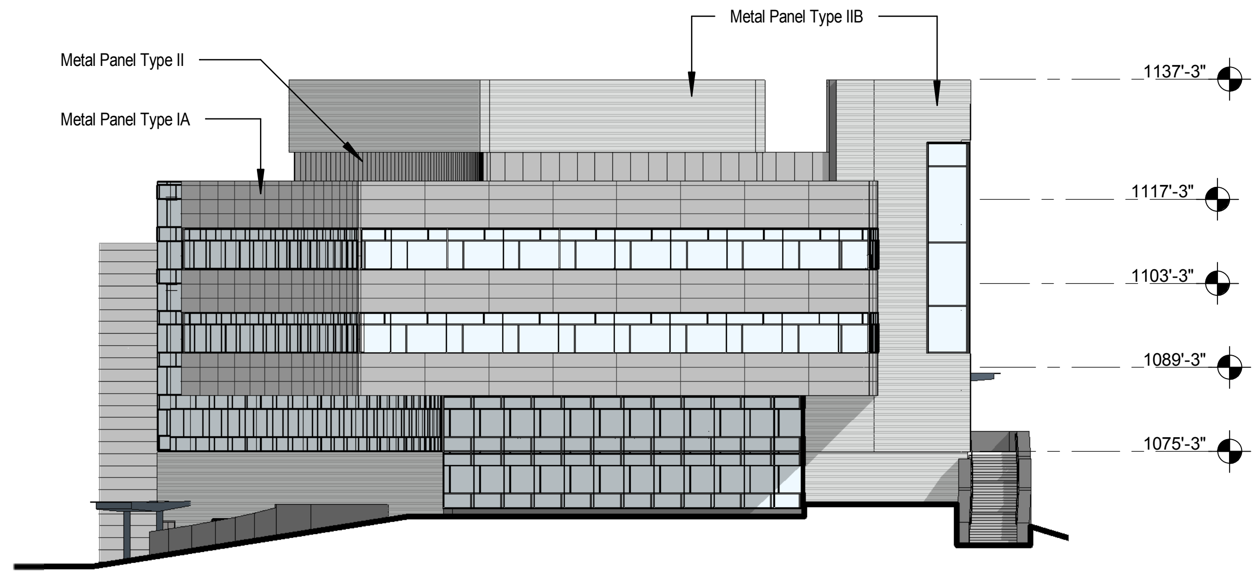
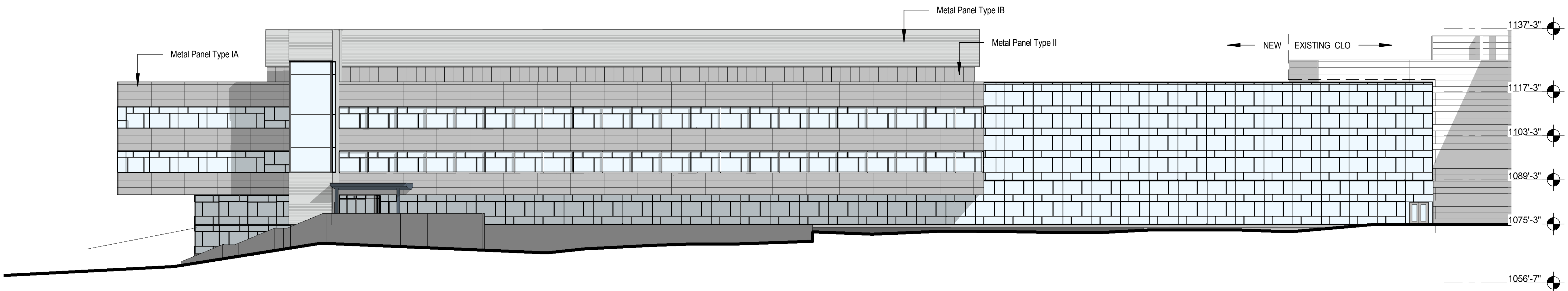


WEST ELEVATION

1/32" = 1'-0"



SOUTH ELEVATION

1/32" = 1'-0"

SCALE: 1/32" = 1'-0"

0 8 16 32 64

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SHEET NAME	**CLO II - EXTERIOR ELEVATIONS**
SHEET NUMBER	**5.5.1.8**
DATE	FEBRUARY 8, 2019

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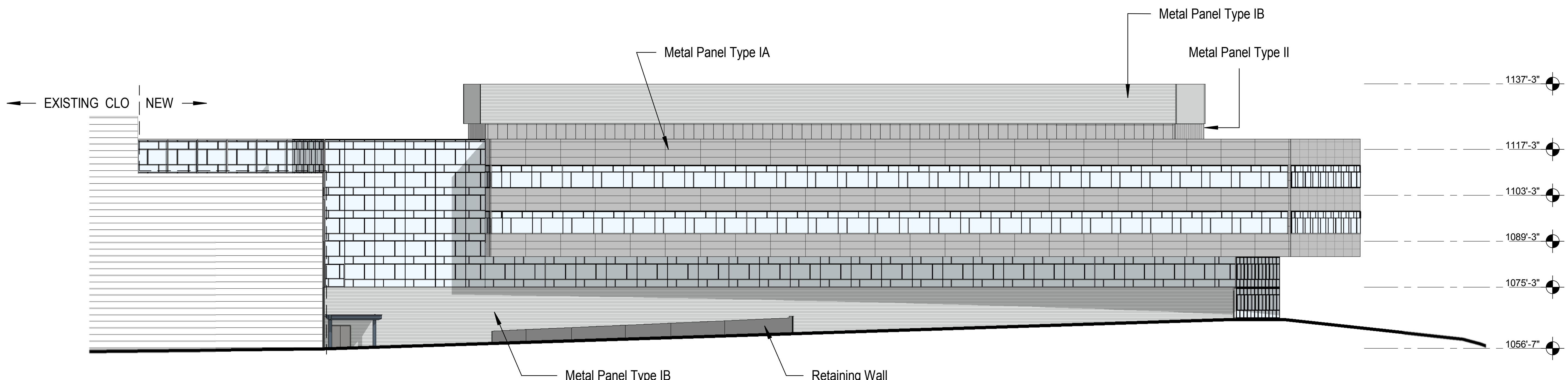

NORTH ELEVATION

1/32" = 1'-0"

SCALE: 1/32" = 1'-0"

0 8 16 32 64

REV. NO.	DESCRIPTION	BY	APVD	DATE

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PROJECT TITLE

SECOND TARGET STATION CONVENTIONAL FACILITIES
SPALLATION NEUTRON SOURCE

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SHEET NAME	**CLO II - EXTERIOR ELEVATIONS**
SHEET NUMBER	**5.5.1.9**
DATE	FEBRUARY 8, 2019

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PROJECT TITLE
SECOND TARGET STATION CONVENTIONAL FACILITIES
SPALLATION NEUTRON SOURCE
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SHEET NAME	**CLO II - INTERIOR VIEWS**
SHEET NUMBER	**5.5.1.10**
DATE	FEBRUARY 8, 2019

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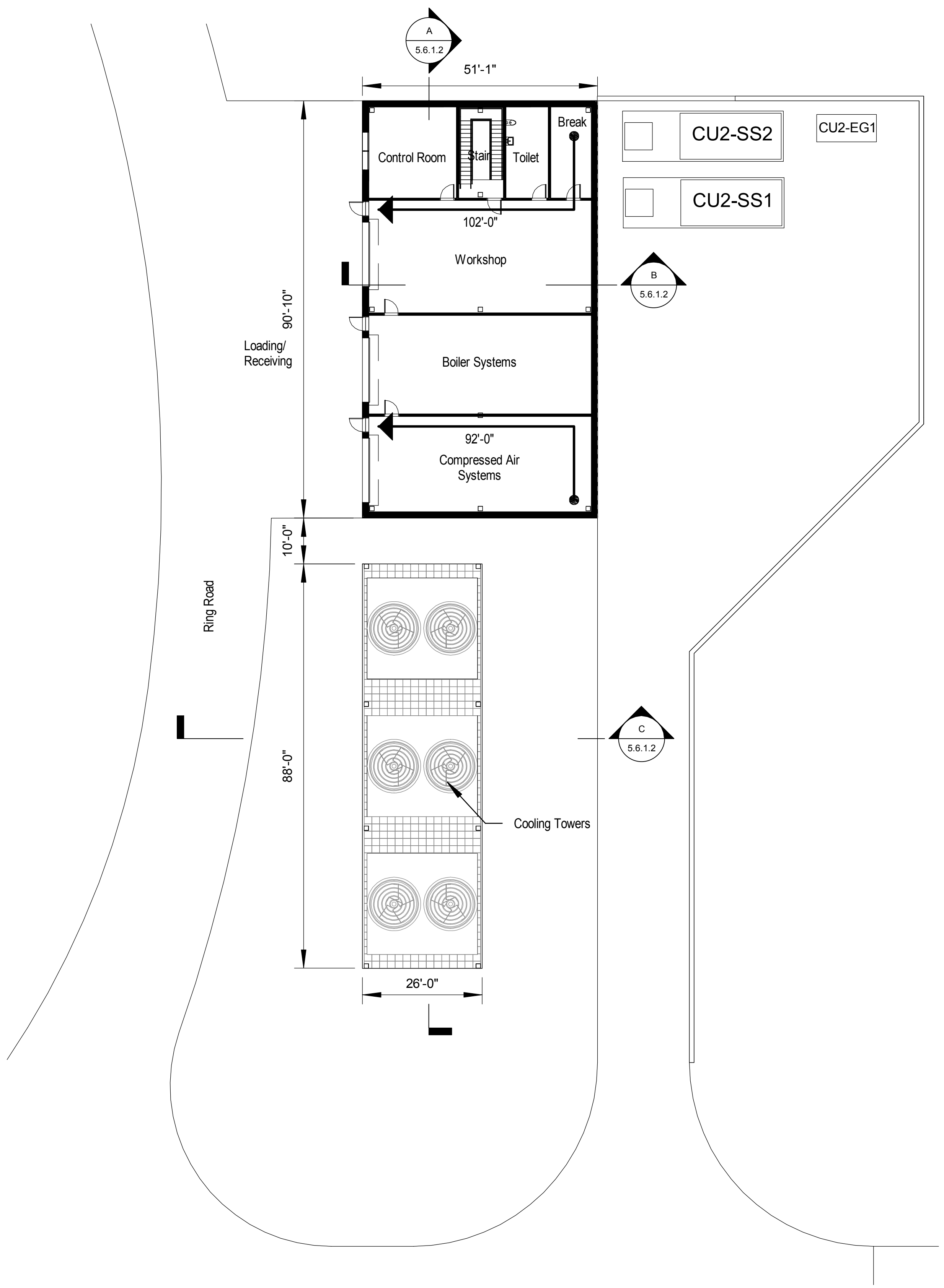


Egress Route and Travel Distance:

XX'-X"

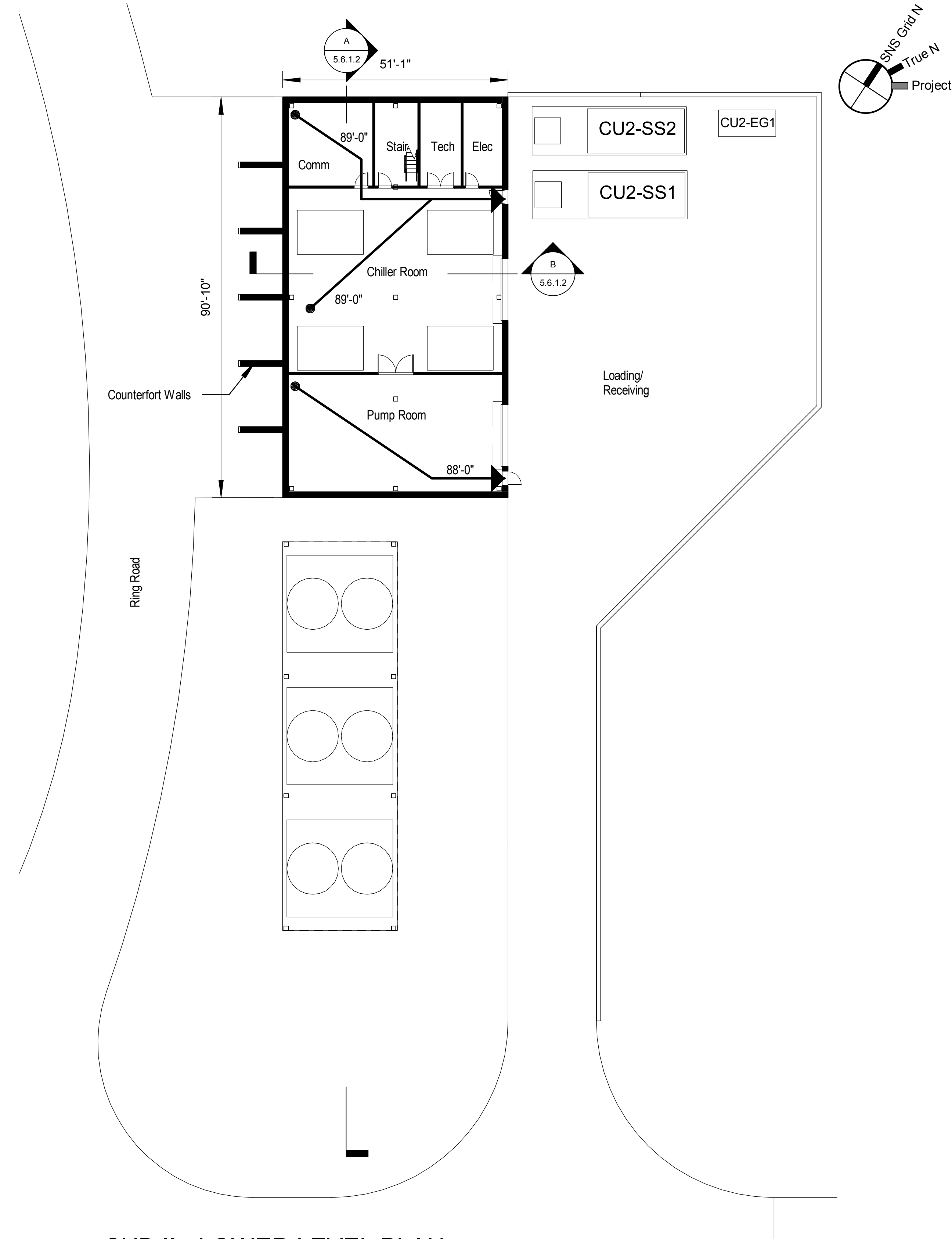
GREATEST TRAVEL DISTANCE: 102'-0"
MAX TRAVEL DISTANCE: 250'-0"

SCALE: 1/32" = 1'-0"

0 8 16 32 64

CUB II - UPPER LEVEL PLAN

1/32" = 1'-0"



CUB II - LOWER LEVEL PLAN

1/32" = 1'-0"

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PROJECT TITLE
SECOND TARGET STATION CONVENTIONAL FACILITIES
SPALLATION NEUTRON SOURCE
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SHEET NAME	**CUB II FLOOR PLANS**
SHEET NUMBER	**5.6.1.1**
DATE	FEBRUARY 8, 2019

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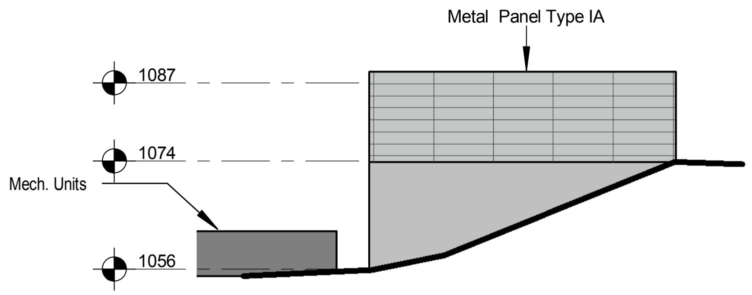
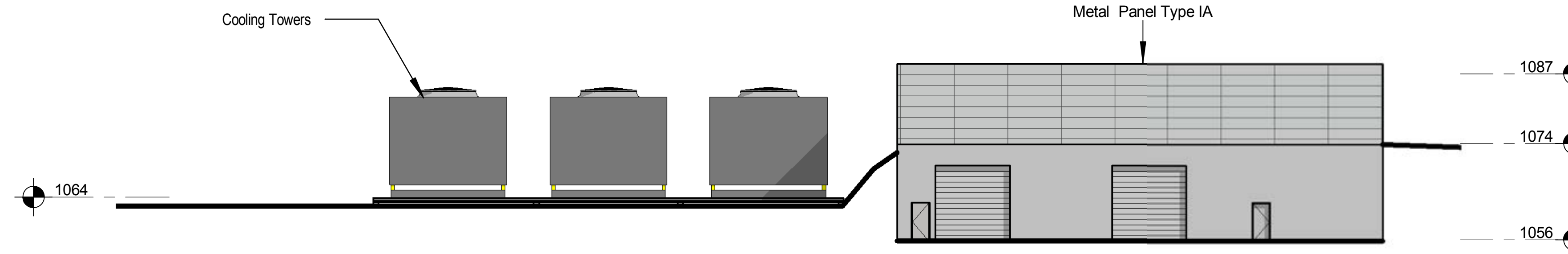


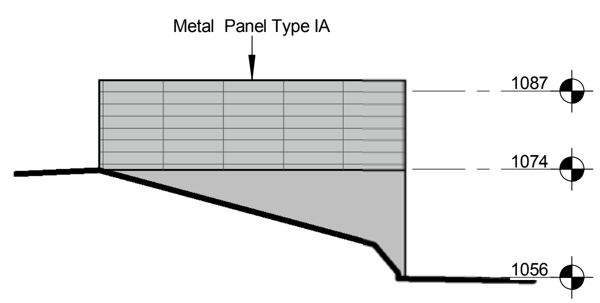
CUB II - WEST ELEVATION

1/32" = 1'-0"



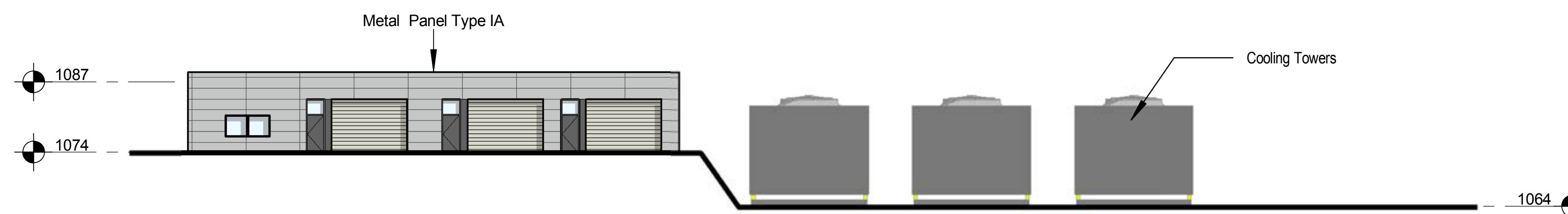
CUB II - NORTH ELEVATION

1/32" = 1'-0"



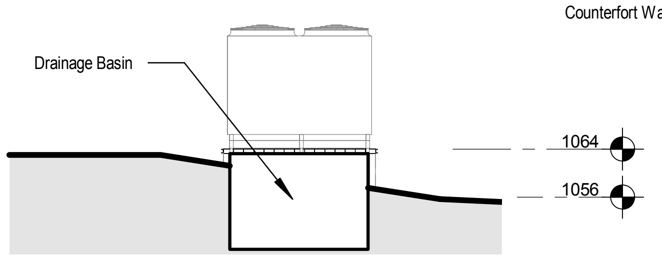
CUB II - EAST ELEVATION

1/32" = 1'-0"



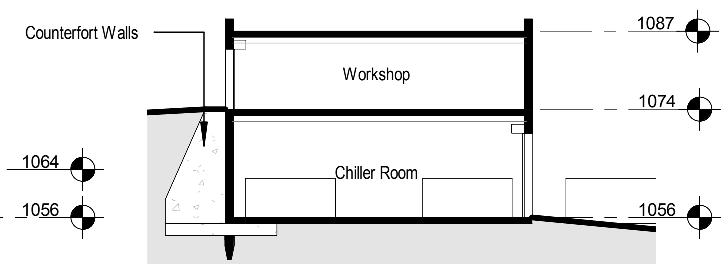
CUB II - SOUTH ELEVATION

1/32" = 1'-0"



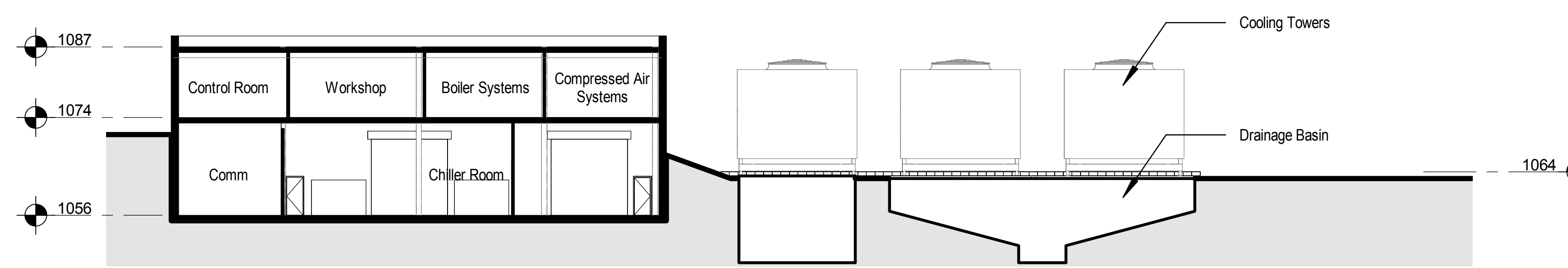
COOLING TOWER - SECTION C

1/32" = 1'-0"



CUB II - SECTION B

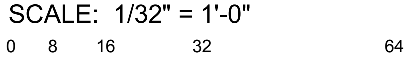
1/32" = 1'-0"



CUB II - SECTION A

1/32" = 1'-0"

SCALE: 1/32" = 1'-0"



REV. NO.	DESCRIPTION	BY	APVD	DATE

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PROJECT TITLE
SECOND TARGET STATION CONVENTIONAL FACILITIES
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SHEET NAME	**CUB II SECTIONS, ELEVATIONS**
SHEET NUMBER	**5.6.1.2**
DATE	FEBRUARY 8, 2019

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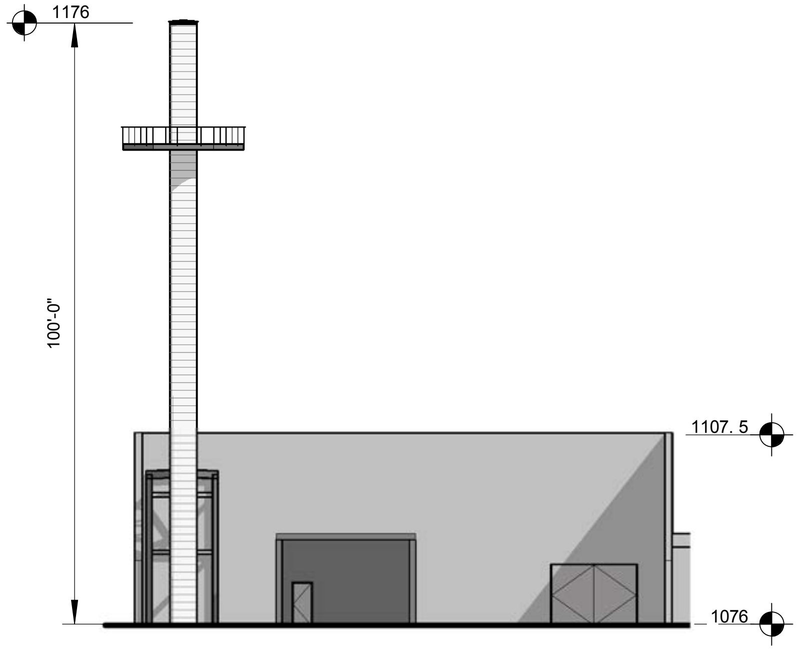
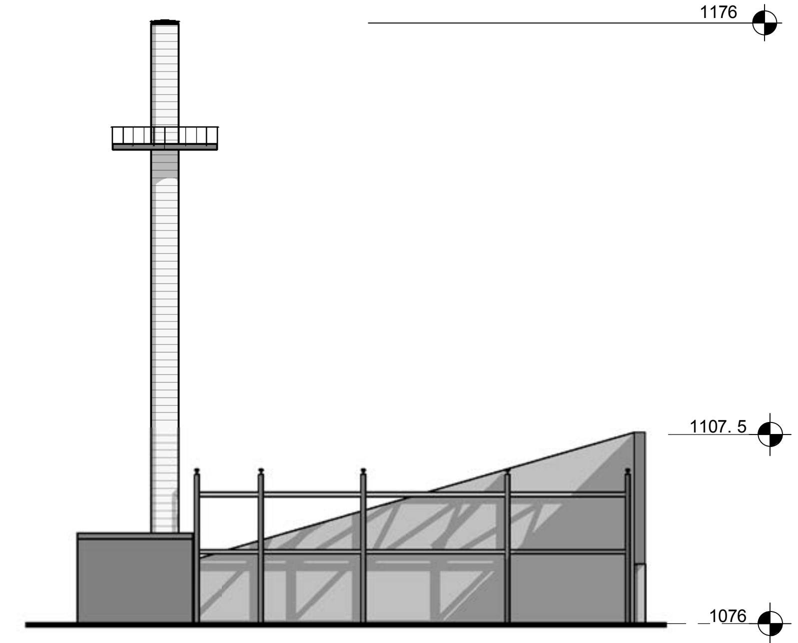
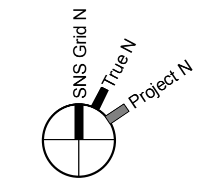
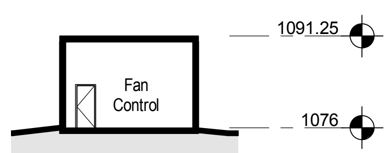


CEF II - NORTH
1/32" = 1'-0"

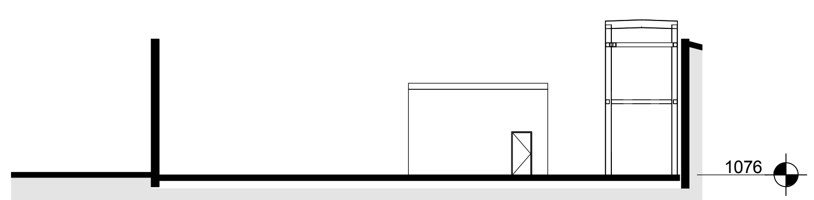


CEF II -WEST
1/32" = 1'-0"

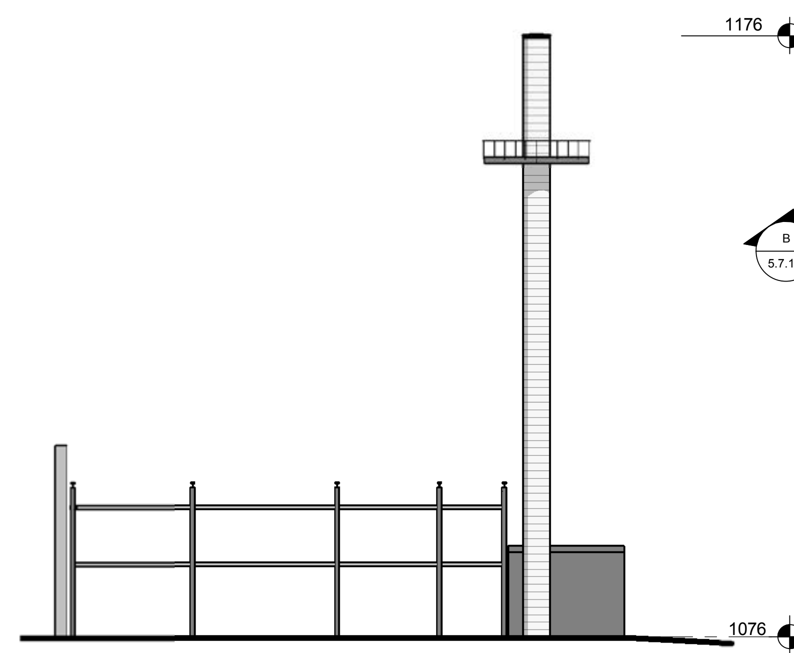




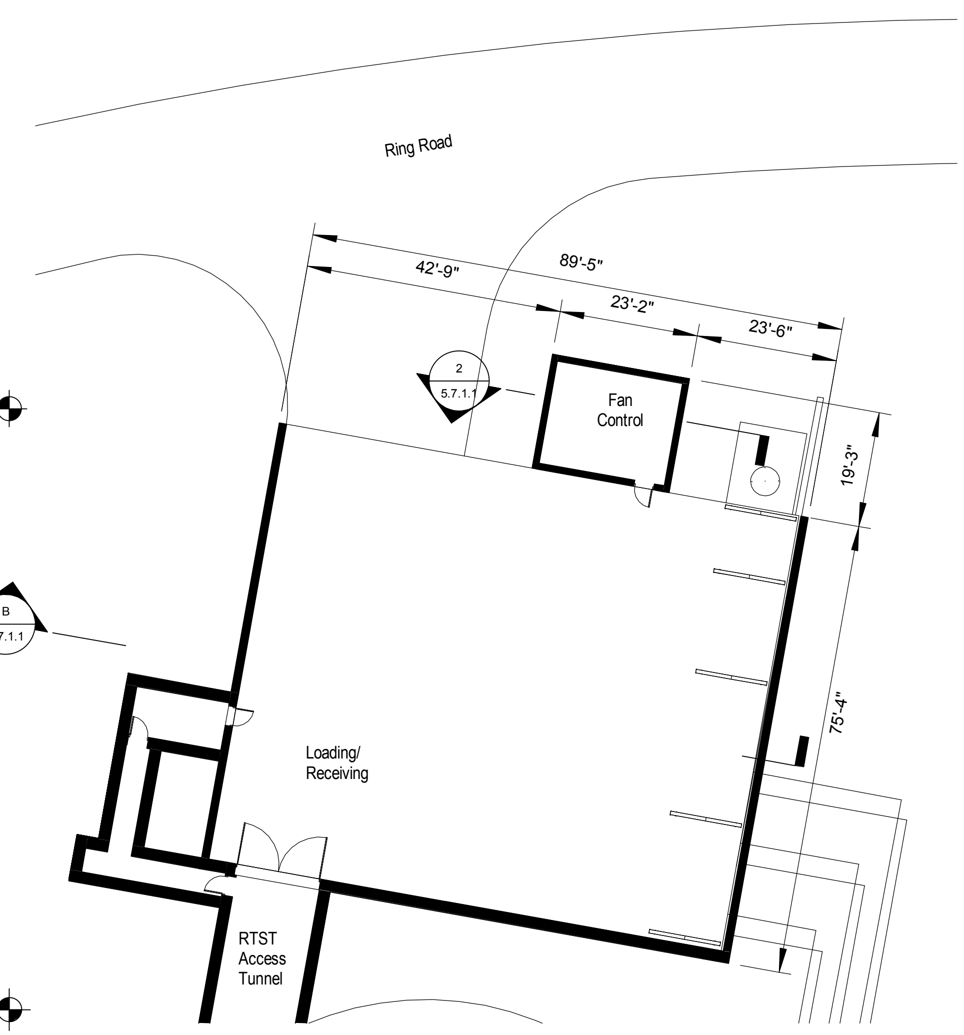
CEF II - SECTION A
1/32" = 1'-0"



CEF II - SECTION B
1/32" = 1'-0"



CEF II - EAST
1/32" = 1'-0"



CEF II - PLAN
1/32" = 1'-0"

SCALE: 1/32" = 1'-0"

0 8 16 32 64

REV. NO.	DESCRIPTION	BY	APVD	DATE

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PROJECT TITLE
SECOND TARGET STATION CONVENTIONAL FACILITIES
SPALLATION NEUTRON SOURCE
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SHEET NAME	**CEF II FLOOR PLAN, SECTIONS, ELEVATIONS**
SHEET NUMBER	**5.7.1.1**
DATE	FEBRUARY 8, 2019

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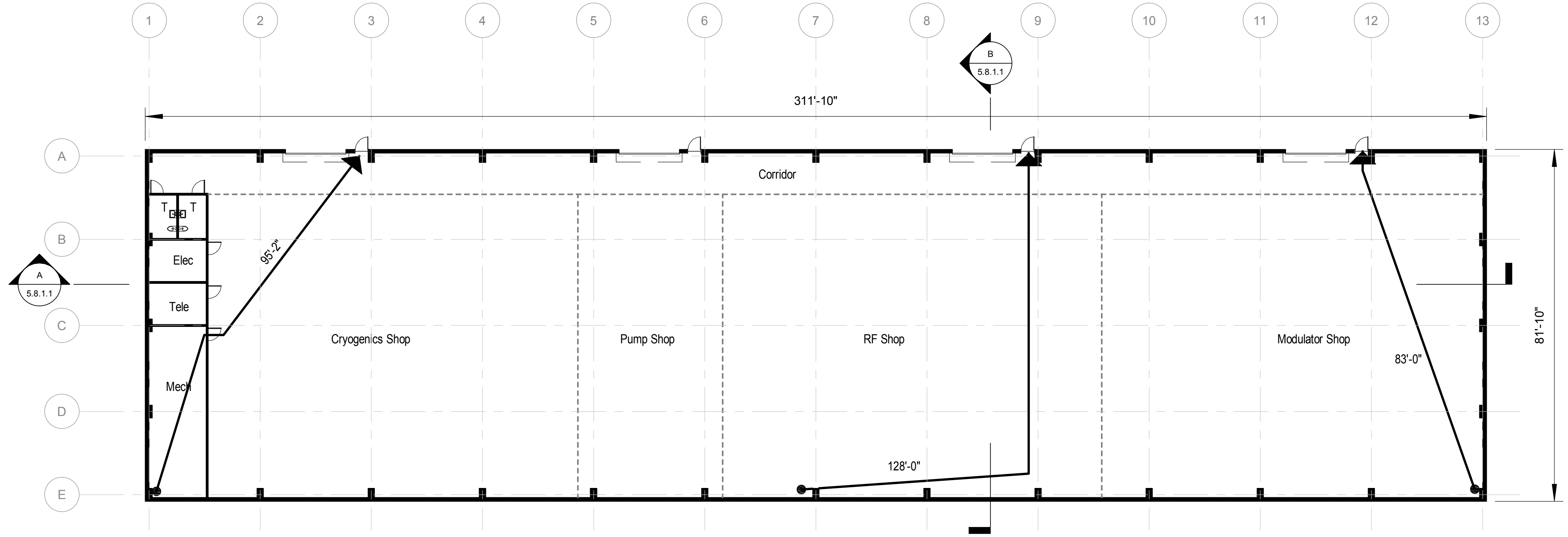
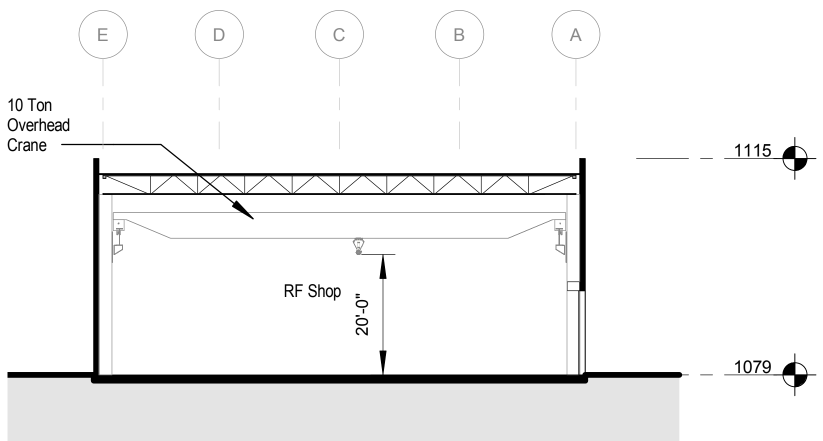


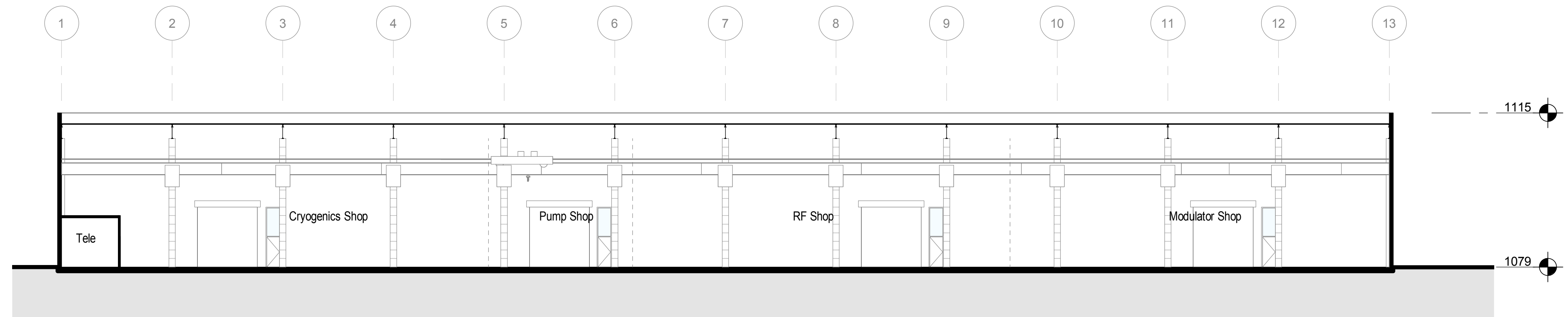
SHOP BUILDING - PLAN

1/32" = 1'-0"



SHOP BUILDING - SECTION B

1/32" = 1'-0"



SHOP BUILDING - SECTION A

1/32" = 1'-0"

SCALE: 1/32" = 1'-0"

0 8 16 32 64

Egress Route and Travel Distance:

XX'-X"

GREATEST TRAVEL DISTANCE: 128'-0"
MAX TRAVEL DISTANCE: 250'-0"

REV. NO.	DESCRIPTION	BY	APVD	DATE

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SHEET NAME **SHOP BUILDING FLOOR PLAN, SECTIONS**

SHEET NUMBER **5.8.1.1**

DATE FEBRUARY 8, 2019

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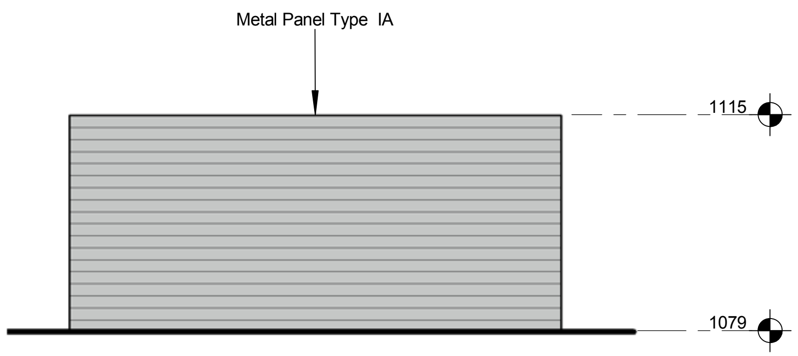
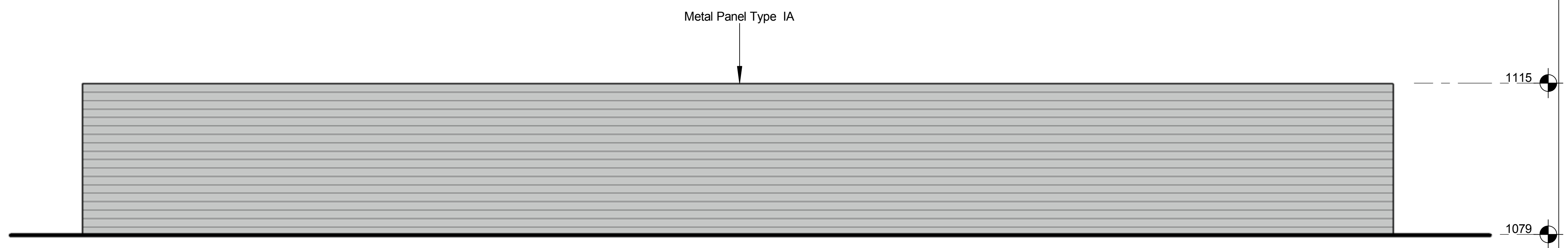


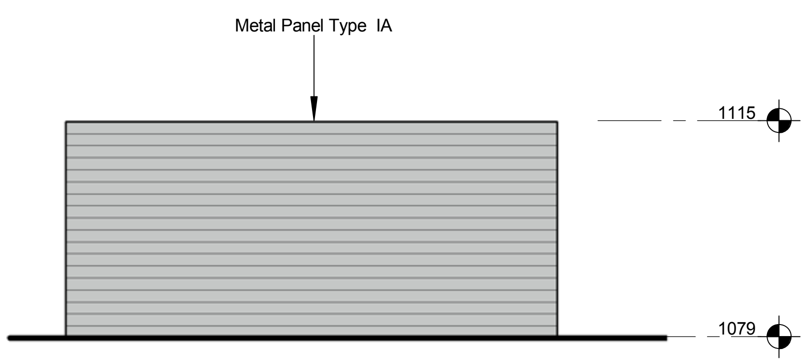
SHOP BUILDING - WEST

1/32" = 1'-0"



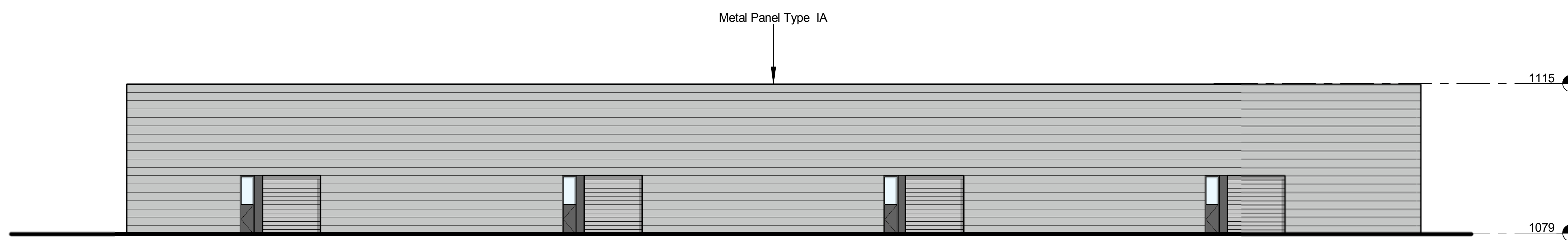
SHOP BUILDING - SOUTH

1/32" = 1'-0"



SHOP BUILDING - EAST

1/32" = 1'-0"



SHOP BUILDING - NORTH

1/32" = 1'-0"

SCALE: 1/32" = 1'-0"

0 8 16 32 64

REV. NO.	DESCRIPTION	BY	APVD	DATE

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PROJECT TITLE

SECOND TARGET STATION CONVENTIONAL FACILITIES
SPALLATION NEUTRON SOURCE

100% CONCEPTUAL DESIGN REPORT SUBMISSION

SHEET NAME	**SHOP BUILDING ELEVATIONS**
SHEET NUMBER	**5.8.1.2**
DATE	FEBRUARY 8, 2019

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APPENDIX B. SPACE PROGRAM

Second Target Station Conventional Facilities

Conceptual Design Program

February 08, 2019

CANNONDESIGN

TABLE OF CONTENTS

EXECUTIVE SUMMARY

The Second Target Station Conventional Facilities Concept Design Program includes preliminary space programming information for the proposed Second Target Station at the Oak Ridge National Laboratory Spallation Neutron Source. This program document is part of a Conceptual Design Report, executed over a four-month period between September of 2018 and February of 2019, and builds upon previous studies completed in 2014 and 2016.

The proposed STS complex will include approximately 251,646 NSF and 367,380 GSF of new construction in 10 primary facilities. The summary net and gross areas for each of the primary facilities are listed in the Space Program Summary below. The planning and design images of the STS complex are shown in the Conceptual Design Report.

STS Space Program Summary

No.	Buildings	NSF	GSF	Eff.
		251,646	366,761	69%
5.2.1	RTST Tunnel	9,920	12,258	81%
5.2.2	RTST Service Building	7,380	8,428	88%
5.3.1	Target Building II	67,205	111,178	60%
5.4.1	40M Instrument Building	33,890	44,689	76%
5.4.2	50M Instrument Building	27,540	42,150	65%
5.4.3	90M Instrument Building	12,800	16,856	76%
5.5.1	Central Lab and Office Building II	63,671	96,060	66%
5.6.1	Central Utilities Building II	7,850	9,244	85%
5.6.2	Central Exhaust Facility II	300	380	79%
5.7.1	Shop Building	21,090	25,518	83%

Percentage of Building GSF to Total GSF (Per Building)

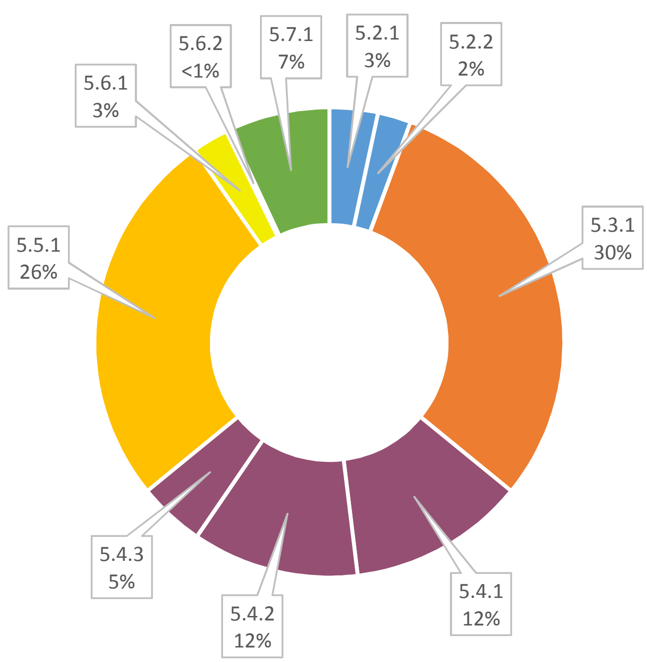
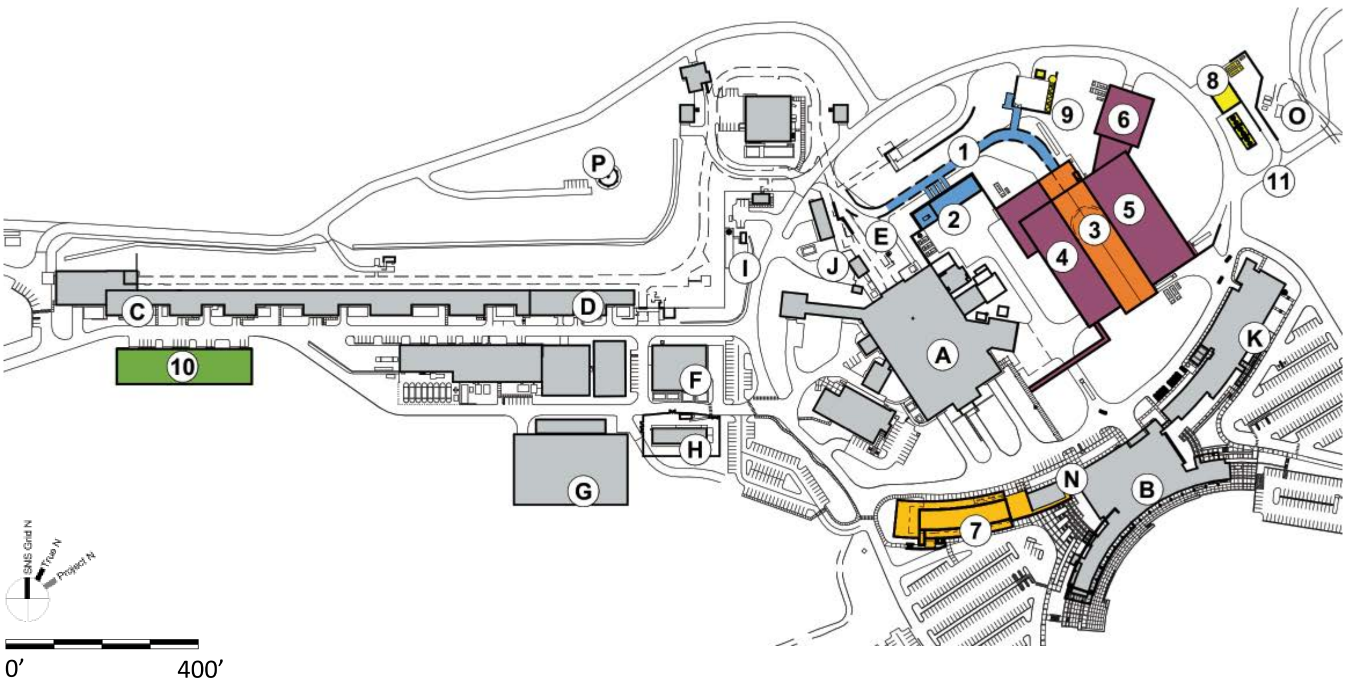


Chart groups individual buildings by WBS Structure

The gross areas for each of the 10 facilities is based on the preliminary building planning included in the STS Conceptual Design Report.

This document includes a preliminary room data sheet and test fit plan for each of the specific spaces comprising the net area of the STS. Required spaces not included in the net area are identified for each facility as Additional Program Space Requirements and are included in the summary page for each facility. The room data sheets also identify Key Design Requirements. In general, these requirements are significant design drivers considered essential to facility design and performance. In most cases these requirements will require further attention during future programming and design activities.



Proposed STS Complex

SNS BUILDINGS

A. Target Building
B. Central Laboratory And Office Building (CLO)
C. Klystron Gallery
D. Future Proton Power Upgrade Project
E. Future RTBT Stub
F. Central Utility Building
G. Electrical Substation
H. Cooling Tower
I. Central Exhaust Facility
J. RTBT Support Building
K. Center For Nanoscale Materials Sciences (CNMS)
L. Joint Institute For Netron Science (not shown)
M. ORNL Guest House (not shown)
N. Pedestrian Bridge
O. Water Pumping Station
P. Water Tower

STS BUILDINGS

1. RTST Tunnel
2. RTST Service Building II
3. Target Building II
4. 40M Instrument Building
5. 50M Instrument Building
6. 90M Instrument Building
7. Central Laboratory And Office II (CLO II)
8. Central Utility Building II (CUB II)
9. Central Exhaust Facility II (CEF II)
10. Shop Building
11. Cooling Towers

5.2.1 RTST Tunnel

STS Space Program | Lead: Sarah Cousineau

5.2.1	**RTST Tunnel NSF**			**9,920**
	RTST Tunnel GSF			**12,258**
	RTST Tunnel Efficiency			**81%**
No.	**Rooms**	**Qty.**	**NSF**	**Total NSF**
5.2.1.1	Tunnel	1	8,570	8,570
5.2.1.2	Egress Stair Labyrinth	1	260	260
5.2.1.3	Access Tunnel Labyrinth	1	300	300
5.2.1.4	Access Tunnel	1	790	790

Additional Program Space Requirements

Egress Stairs

Loading/Receiving (Exterior)

Shielding Laydown Area (Exterior)

Air Handling Unit (On RTST Service Building Roof)

5.2.1.1 Tunnel

RTST Tunnel

Lead: Sarah Cousineau

Room Data	
Space Number	5.2.1.1
Space Name	Tunnel
Net Area Requirement (NSF)	8,570
Number of spaces required	1
Population	0 during operation
Space Activities/Functional Description	Houses Proton Beam Line
Adjacency Requirements	RTST Support Building, RTBT, Target Building II
Vehicular Access Requirements	Truck access
Key Design Requirements	Overhead crane, shielding. Survey access chase located along tunnel length (number to be determined).

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	46 - 21Q40 Quadrupole magnets	40cm Long	3 in existing RTBT Tunnel	☐	☑
2	1 - 26Q40 Quadrupole magnet	40cm Long	Replaces RTBT QV09 in existing RTB Tunnel	☐	☑
3	1 - Septum magnets	2m Long	Estimated size. Like Ring Ext Spt type 17ELS224	☑	☑
4	16 - Using Ring Magnet design	55" x 47" x 24"	Number and size may change after redesign for lighter-weight magnets, but overall length will be about the same. (Size is based on RTBT DH13)	☐	☑
5	Vertical kicker magnets	82cm long	Size may change after design optimization	☐	☑
6	Overhead crane	12.5 Ton		☑	☐
7	Shielding maze	17' x 13' x 24'	Fits around beam line components. Assumes same size as HEBT maze.	☐	☑

Note: Test Fit Plan on following page

CF: Conventional Facilities
TS: Technical Systems

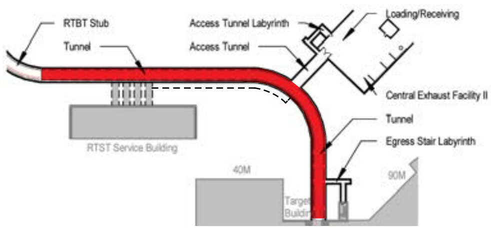
5.2.1.1 RTST Tunnel

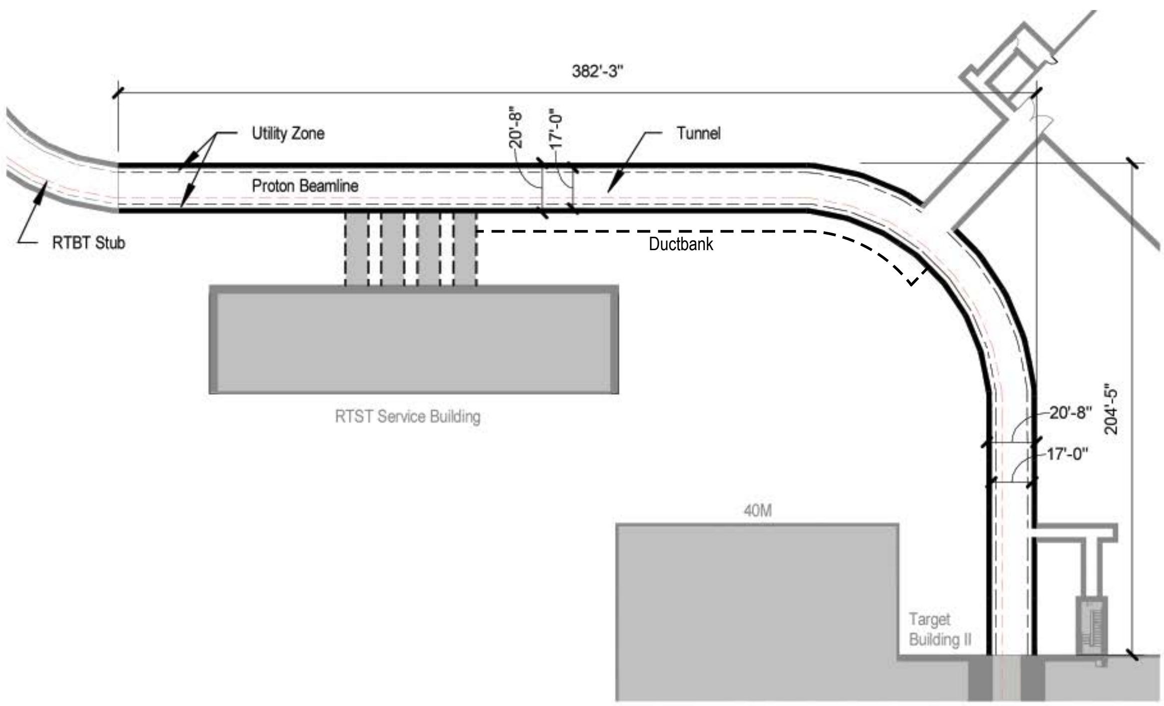
RTST Tunnel

Lead: Sarah Cousineau

Test-fit Plan

RTST Tunnel Key Plan - Not to Scale





Preliminary space plan

Scale 1” = 80’-0”

0’ 80’ 160’

5.2.1.2 Egress Stair Labyrinth

RTST Tunnel

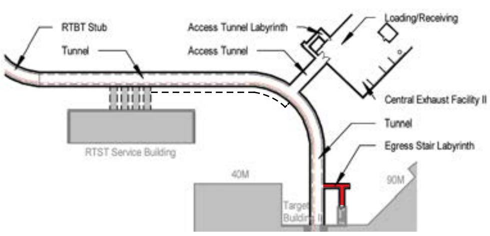
Lead: Sarah Cousineau

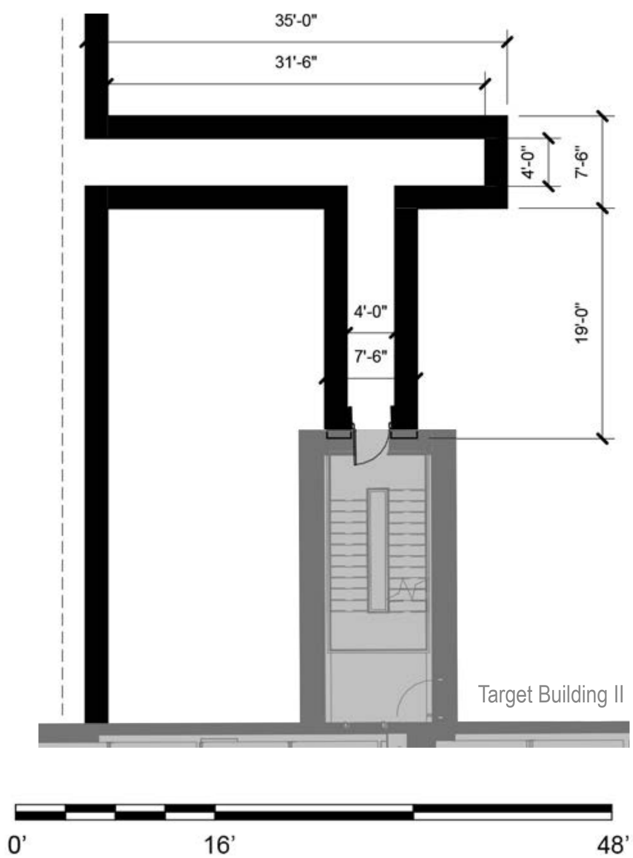
Room Data	
Space Number	5.2.1.2
Space Name	Egress Stair Labyrinth
Net Area Requirement (NSF)	260
Number of spaces required	1
Population	0
Space Activities/Functional Description	Egress/circulation and radiation containment
Adjacency Requirements	Egress stair and RTST tunnel
Vehicular Access Requirements	None
Key Design Requirements	Radiation shielding wall construction

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 None			☐	☐

Test-fit Plan

RTST Tunnel Key Plan - Not to Scale





Preliminary space plan

Scale 1/16" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.2.1.3 Access Tunnel Labyrinth

RTST Tunnel

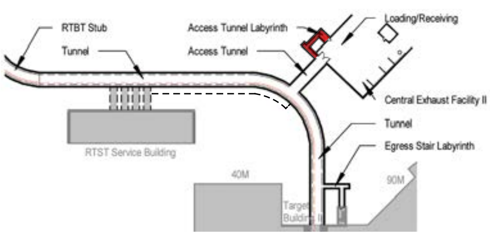
Lead: Sarah Cousineau

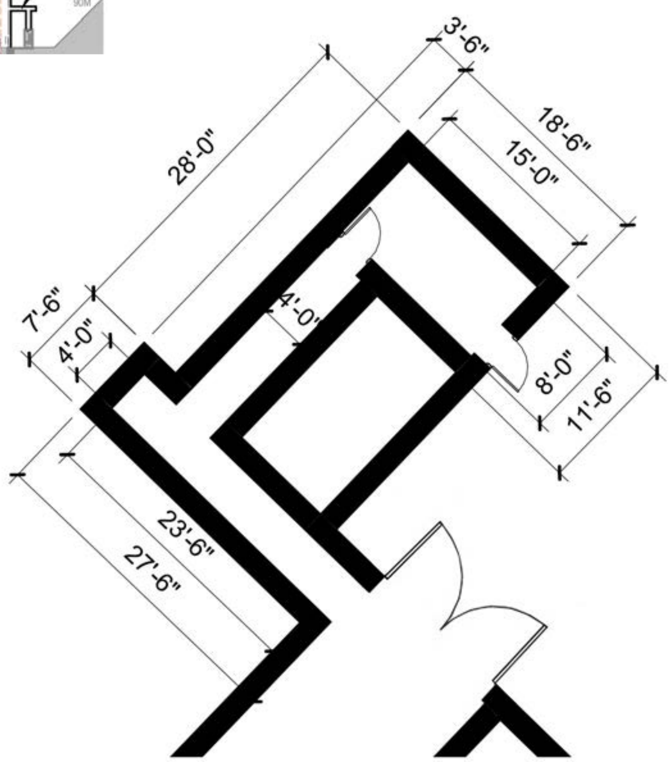
Room Data	
Space Number	5.2.1.3
Space Name	Access Tunnel Labyrinth
Net Area Requirement (NSF)	300
Number of spaces required	1
Population	0
Space Activities/Functional Description	Circulation and radiation containment
Adjacency Requirements	RTST Access Tunnel
Vehicular Access Requirements	None
Key Design Requirements	Radiation shielding wall construction

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 None			☐	☐

Test-fit Plan

RTST Tunnel Key Plan - Not to Scale





Preliminary space plan

Scale 1/16" = 1'-0"

0' 16' 48'

CF: Conventional Facilities
TS: Technical Systems

5.2.1.4 Access Tunnel

RTST Tunnel

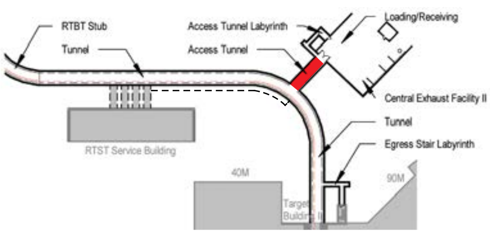
Lead: Sarah Cousineau

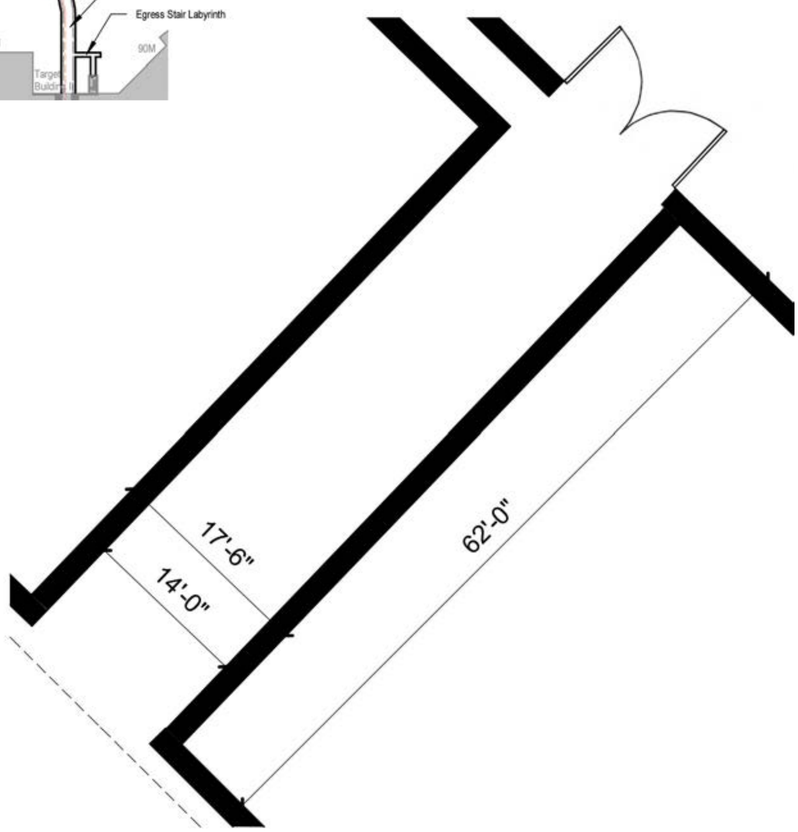
Room Data	
Space Number	5.2.1.4
Space Name	Access Tunnel
Net Area Requirement (NSF)	790
Number of spaces required	1
Population	0
Space Activities/Functional Description	Service access to RTST Tunnel
Adjacency Requirements	RTST Tunnel
Vehicular Access Requirements	Truck loading/receiving, Shielding laydown area
Key Design Requirements	14' Wide double door, portable gantry

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 None			☐	☐

Test-fit Plan

RTST Tunnel Key Plan - Not to Scale





Preliminary space plan

Scale 1/16" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.2.2 RTST SERVICE BUILDING

5.2.2 RTST Service Building

STS Space Program — Lead: Sarah Cousineau

5.2.2	**RTST Service Building NSF**			**7,380**
	RTST Service Building GSF			**8,428**
	RTST Service Building Efficiency			**88%**
No.	**Rooms**	**Qty.**	**NSF**	**Total NSF**
5.2.2.1	Power Supply Room	1	3,050	3,050
5.2.2.2	Water Pump Room	1	2,040	2,040
5.2.2.3	Communications Room	1	330	330
5.2.2.4	Electrical Room	1	1,800	1,800
5.2.2.5	UPS Room	1	160	160

Additional Program Space Requirements

RTST-Tunnel Piping Spacing

Air Handling Unit (On Building Roof)

RS2-SS1, RS2-SS2, RS2-SS3, RS2-SS4 Electrical Substations (Exterior Pad)

Smoke Exhaust Fan (Exterior Pad)

RS2-EG1 Emergency Generator (Exterior Pad)

5.2.2.1 Power Supply Room

RTST Service Building

Lead: Sarah Cousineau

Room Data	
Space Number	5.2.2.1
Space Name	Power Supply Room
Net Area Requirement (NSF)	3,050
Number of spaces required	1
Population	0
Space Activities/Functional Description	DIWS&R headers located above the power supplies but below the cable trays to provide drops to each of the water cooled power supplies.
Adjacency Requirements	RTST Tunnel Utility Chases
Vehicular Access Requirements	Truck Access, 8' Overhead rolling door
Key Design Requirements	Offset power path to RTST Tunnel

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	30 - 900A51V Quadrupole magnet power supplies	45" x 36" x 66.5"	36" keep out area front and back for maintenance	☐	☑
2	6 - 1300A125V Quadrupole magnet power supplies	45" x 56" x 66.5"	36" keep out area front and back for maintenance	☐	☑
3	2 - Horizontal dipole power supplies	48" x 80" x 80"	36" front and 72" back keep out area for maintenance. 24 x 535 kcmil cables from each supply. These require large transformers and switch gear external to the building.	☐	☑
4	1 - Septum power supply	56" x 44" x 80"	36" front and back keep out area for maintenance. 10 x 55 kcmil cables from supply.	☐	☑
5	5 - Kicker power supplies	56" x 80" x 80"	36" front and back keep out area for maintenance.	☐	☑
6	40 - Standard electrical racks for diagnostics, vacuum, controls, steering supplies, PSI's, etc.	37" x 22" x 88"	Racks need front and back access. This is the 22" dimension. Racks may be placed side by side along the 37" edges.	☐	☑
7	9 - 480v => 208/110 VAC transfromers	36" x 36" x 36"	These were forgotten in the RTBT and need to have space allocated in the RTST.	☑	☐
8	3 - Transformers and switch gear external to building	17' x 20'	For dipole power supplies and other power supplies	☑	☐

Note: Continued on following page

CF: Conventional Facilities
TS: Technical Systems

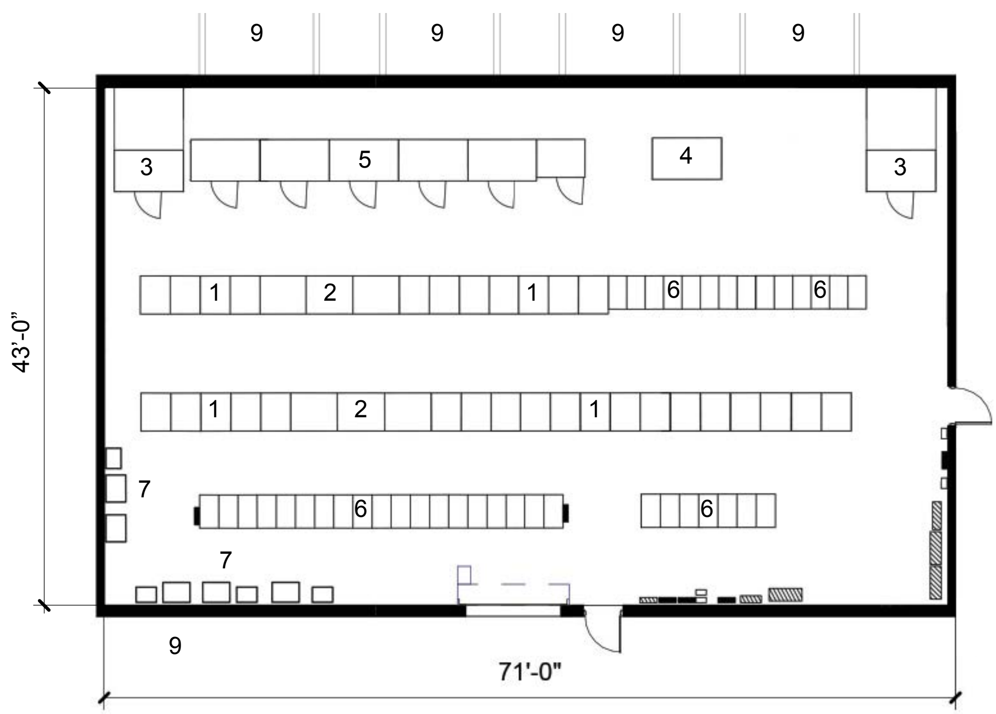
5.2.2.1 Power Supply Room

RTST Service Building

Lead: Sarah Cousineau

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
9 4 - Chase from RTST Service Bilding to Tunnel	A- 18x 6" conduits, 24x3" conduits. B- 10x 6" conduits, 40x3" conduits. C- 10x 6" conduits, 40x3" conduits. D- 18x 6" conduits, 24x3" conduits	Mag. Ps: 34 pf 3", 54 pf 6" Controls/ICU: 3 OF 6" Controls/Vacuum: 4 of 3" Beam Instrumentation: 8 of 3" Fire Department 10 of 3"	☐	☐

Test-fit Plan



Preliminary space plan

Scale 1/16" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.2.2.2 Water Pump Room

RTST Service Building

Lead: Sarah Cousineau

Room Data	
Space Number	5.2.2.2
Space Name	Water Pump Room
Net Area Requirement (NSF)	2,040
Number of spaces required	1
Population	0 to 4
Space Activities/Functional Description	Provide space for cooling systems PS-R2-01 (RTST Tunnel Magnet Cooling System); cooling system PS-R2-02 (RTST-SB Magnet Power Supply Cooling System); RTST Tunnel Waste Collection System; MCC for building equipment, chase access to RTST tunnel, storage, maintenance equipment storage, equipment access for maintenance and equipment access to/from outside.
Adjacency Requirements	Need Chase access to RTST Tunnel for piping. Can be next to or in basement of building, but need access for equipment in and out of the area.
Vehicular Access Requirements	Truck access. Need access for equipment installation, cylinder access (14" Dia X 48" tall), pump assemblies, motors, etc.
Key Design Requirements	Water spill area. Potentially contaminated water from the tunnel, need to berm or floor trench to assure all water goes to waste collection system. Provide space for wall penetrations to connect water pump room systems to RTST Tunnel. 8' high overhead door. Process waste pumped to existing tunnel.

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	2 -Pump skids (PS-R2-O1)	15' x 13'		☐	☑
2	Polishing Panel/Bottle (FS-R2-01)	3' x 10'		☐	☑
3	2 - Pump Skids (PS-R2-02)	12' x 11'		☐	☑
4	Polishing Panel/ Bottle (FS-R2-02)	3' x 10'		☐	☑
5	Makeup Water Panel/Bottle	6' x 3'		☐	☑
6	MCC/VFD	6' x 3'	On curbed riser to avoid standing water problems	☑	☐
7	Waste Sump	4' x 4'		☐	☑
8	Waste Pump Lift	4' x 5'		☐	☑
9	Storage Rack	4' x 8'		☐	☐
10	Portable Hoist storage area	4' x 6'		☑	☐
11	Transformer	30" x 60"		☑	☐
12	2 - Distribution panels	16" x 36"		☑	☐
13	DIWS-x"	4"	Info from K. Magda & J. Schubert	☐	☑
14	DIWR-x"	4"	Info from K. Magda & J. Schubert	☐	☑

Note: Test Fit Plan on following page

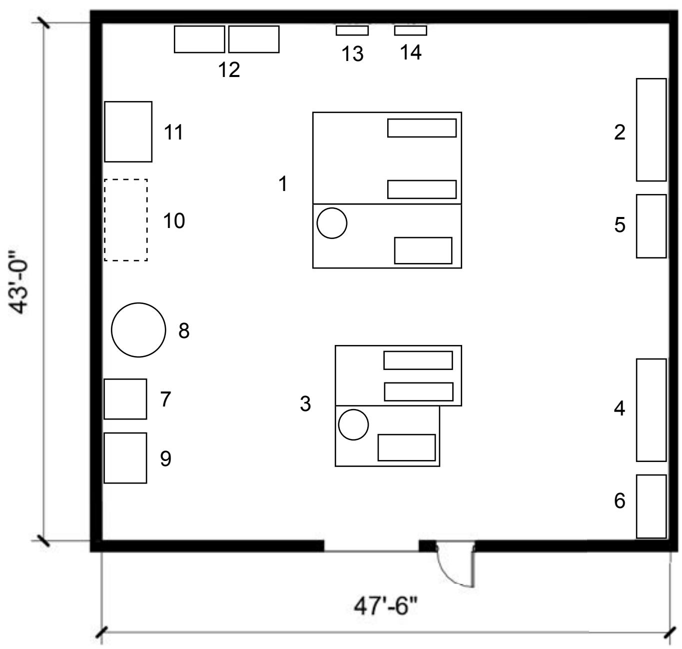
CF: Conventional Facilities
TS: Technical Systems

5.2.2.2 WATER PUMP ROOM

RTST Service Building

Lead: Sarah Cousineau

Test-fit Plan



Preliminary space plan

Scale 1/16" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.2.2.3 Communications Room

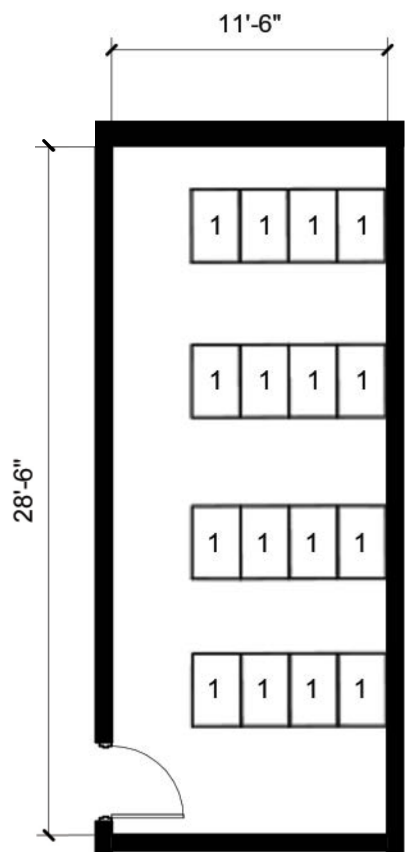
RTST Service Building

Lead: Sarah Cousineau

Room Data	
Space Number	5.2.2.3
Space Name	Communications Room
Net Area Requirement (NSF)	330
Number of spaces required	1
Population	0
Space Activities/Functional Description	House communication equipment
Adjacency Requirements	Electrical and UPS rooms
Vehicular Access Requirements	None
Key Design Requirements	Area should be about the same as the RTBT

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	16 - Standard electrical racks for diagnostics, vacuum, controls, steering supplies. PSI's etc.	37" x 22" x 88"	Racks need front and back access along the 22" dimension. Racks may be placed side by side along the 37" edges.	☐	☑

Test-fit Plan



Preliminary space plan

Scale 1/8” = 1’-0”

CF: Conventional Facilities
TS: Technical Systems

5.2.2.4 Electrical Room

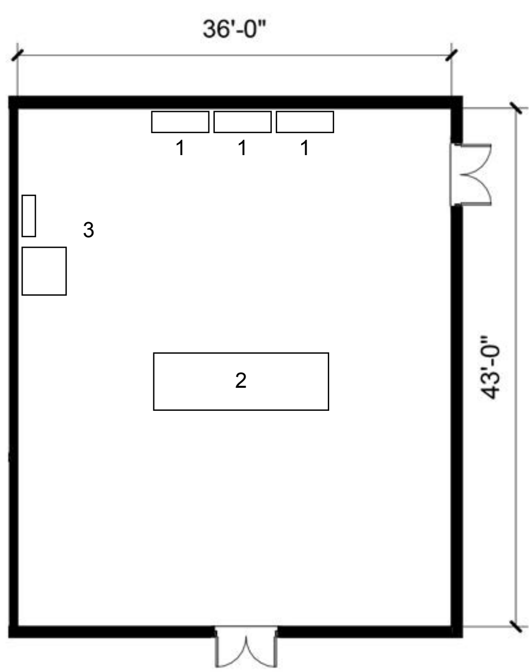
RTST Service Building

Lead: Sarah Cousineau

Room Data	
Space Number	5.2.2.4
Space Name	Electrical Room
Net Area Requirement (NSF)	1,800
Number of spaces required	1
Population	0
Space Activities/Functional Description	House electrical equipment
Adjacency Requirements	UPS Room
Vehicular Access Requirements	None
Key Design Requirements	Double door for equipment access/movement

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 3 - Power supply 1600A switchboards	6' x 2'	Possible relocation to Power Supply Room - TBD	☐	☑
2 RS2-SS1 4000A Switchgear	14' x 5'		☐	☑
3 Secondary Panels and Transformers	TBD		☐	☑
4 RS2-SS1 2500 KVA substation	72" x 88" x 96"	Exterior	☑	☐
5 RS2-EG1 Generator	20' x 12'	Exterior	☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/16" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.2.2.5 UPS Room

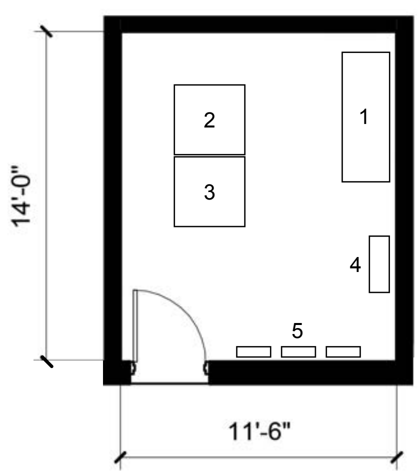
RTST Service Building

Lead: Sarah Cousineau

Room Data	
Space Number	5.2.2.5
Space Name	UPS Room
Net Area Requirement (NSF)	160
Number of spaces required	1
Population	0
Space Activities/Functional Description	House uninterrupted power system equipment
Adjacency Requirements	Electrical Room
Vehicular Access Requirements	None
Key Design Requirements	Door wide enough to accommodate equipment

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 UPS	8' x 4'		☑	☐
2 400A BATS	3' x 3'	Verify Size	☑	☐
3 260A Emergency UPS	3' x 3'	Verify Size	☑	☐
4 400A Dist Panel	1' x 4'		☑	☐
5 3-Related branch circuit panels	6" x 24"	Step down Tansformers	☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/8” = 1’-0”

CF: Conventional Facilities
TS: Technical Systems

5.3.1 TARGET BUILDING II

5.3.1 Target Building II

STS Space Program | Lead: Peter Rosenblad

No.	Rooms	Qty.	NSF	Total NSF	Truss	Second Floor	First Floor	Basement
5.3.1	**Target Building II NSF**			**67,575**	**11,600**	**24,030**	**15,320**	**16,625**
	Target Building II GSF			**111,178**	**21,340**	**26,027**	**27,713**	**36,098**
	Target Building II Efficiency			**61%**				
5.3.1.1	Communications Room	2	250	500			250	250
5.3.1.2	Instrument Maintenance	1	810	810			810	
5.3.1.3	Instrument Maintenance Storage	1	610	610			610	
5.3.1.4	Break Room/User Lounge	1	620	620		620		
5.3.1.5	Computer Room	1	200	200		200		
5.3.1.6	Controls Network	1	240	240		240		
5.3.1.7	On-Shift Support	1	740	740			740	
5.3.1.8	Neutron Beamline Bunker	1	2,600	2,600			2,600	
5.3.1.9	Monolith	2	650	1,300			650	650
5.3.1.10	Truck Bay	1	2,100	2,100			2,100	
5.3.1.11	Confinement Ventilation & Filtration Room	1	2,380	2,380				2,380
5.3.1.12	Receiving/Staging	1	335	335				335
5.3.1.13	Hot Process Vault (HPV)	1	6,850	6,850			1,420	5,430
5.3.1.14	Bunker Electronics Room	1	0	0			0	
5.3.1.15	Electrical Room	1	370	370		370		
5.3.1.16	Target Maintenance Shop	1	1,100	1,100		1,100		
5.3.1.17	Hot Shop (Radiological)	1	470	470				470
5.3.1.18	Electrical (Research Mechanics)	1	1,030	1,030				1,030
5.3.1.19	Vacuum Workshop	1	1,110	1,110				1,110
5.3.1.20	Radiological Support Count Area	1	360	360				360
5.3.1.21	Activated Sample Lab	1	800	800				800
5.3.1.22	Activated Sample Storage	1	670	670				670
5.3.1.23	Survey and Alignment Storage	1	210	210				210
5.3.1.24	Active Storage Cages	1	790	790			790	
5.3.1.25	Sample Environment Long Term Storage Cages	1	750	750			750	
5.3.1.26	Target Control Room	1	800	800			800	
5.3.1.27	Hydrogen Utility Room	1	600	600		600		
5.3.1.28	CMS Control Room	1	400	400		400		
5.3.1.29	Helium Compressor Room	1	2,080	2,080		2,080		
5.3.1.30	Helium Refrigerator Room	1	1,000	1,000		1,000		
5.3.1.31	Target Building Second Floor	1	15,100	15,100		15,100		
5.3.1.32	Target Maintenance Storage	1	650	650				650
5.3.1.33	Service Cell	1	2,450	2,450			2,450	
5.3.1.34	Storage Pit	1	75	75				75

5.3.1 Target Building II

STS Space Program

Lead: Peter Rosenblad

No.	Rooms	Qty.	NSF	Total NSF	Truss	Second Floor	First Floor	Basement
5.3.1	**Target Building II NSF**			**67,575**	**11,600**	**24,030**	**15,320**	**16,625**
	Target Building II GSF			**111,178**	**21,340**	**26,027**	**27,713**	**36,098**
	Target Building II Efficiency			**61%**				
5.3.1.35	Cask Loading Room	1	475	475				475
5.3.1.36	Mechanical Room	1	1,330	1,330				1,330
5.3.1.37	Toilets	2	550	1,100			550	
5.3.1.38	Recycling/Trash	1	300	300			300	
5.3.1.39	Electric Room	1	370	370		370		
5.3.1.40	AHU Space	1	11,600	11,600	11,600			
5.3.1.41	Instrument Vacuum Room	1	400	400				400
5.3.1.42	Filter and Delay Tank Cavity	1	1,300	1,300		1,300		
5.3.1.43	Gas Liquid Separator Cavity	1	650	650		650		
5.3.1.44	Mockup room	1	500	500			500	

Additional Program Space Requirements
1 - Elevator
2 -Egress Stairs
Janitor’s Closet
Circulation
Receiving/Staging
Fire Riser
50T Crane
Electrical Substations (Exterior Pad)
Electrical Generator (Exterior Pad)
Shielding

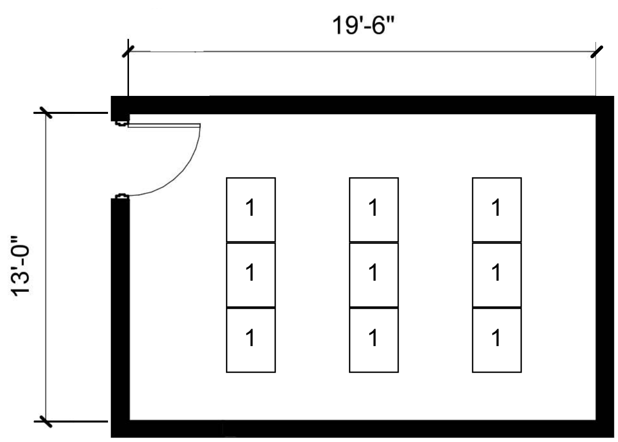
5.3.1.1 Communications Room

Target Building II - Building Utilities | Lead: Peter Rosenblad

Room Data	
Space Number	5.3.1.1
Space Name	Communications Room
Net Area Requirement (NSF)	250
Number of spaces required	2
Population	0
Space Activities/Functional Description	Equipment room
Adjacency Requirements	STS Basement and First Floor locations
Vehicular Access Requirements	None
Key Design Requirements	None

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	8 - Standard size electrical racks	37" x 22" x 88"		☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.3.1.2 Instrument Maintenance

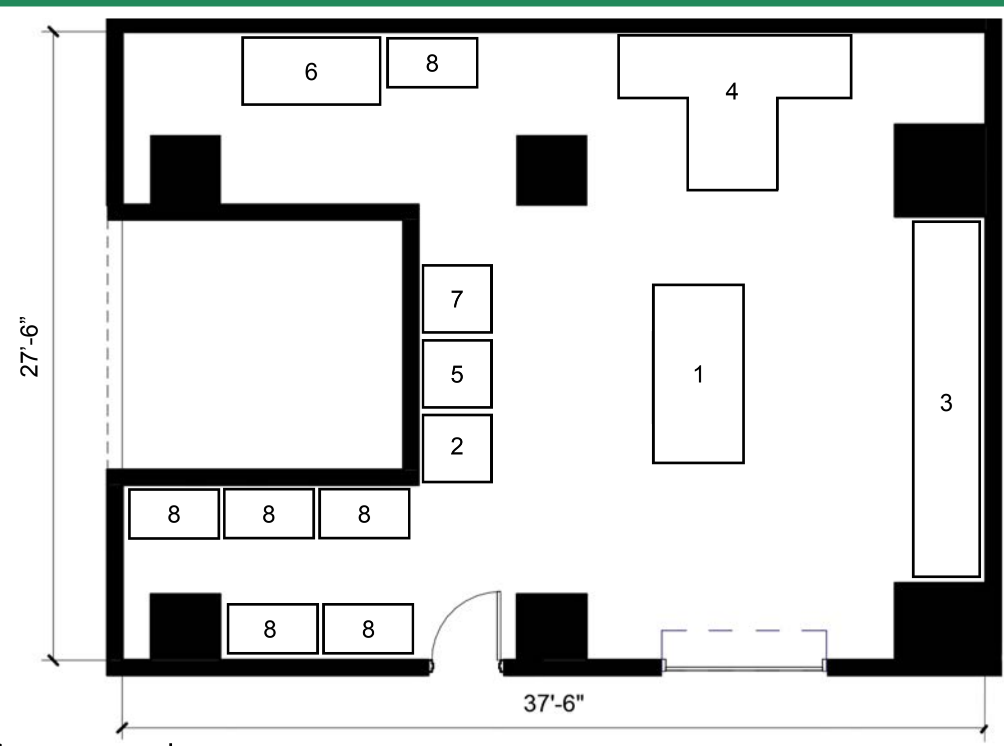
Target Building II - Instrument Support

Lead: Peter Rosenblad

Room Data	
Space Number	5.3.1.2
Space Name	Instrument Maintenance
Net Area Requirement (NSF)	810
Number of spaces required	1
Population	2
Space Activities/Functional Description	Maintenance, fabrication, and repair. Hot work.
Adjacency Requirements	STS Basement location
Vehicular Access Requirements	Fork lift
Key Design Requirements	Roll-up door to facilitate access of large equipment. 208 /480 VAC required. Process water connection. 8' high overhead door.

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	Large fabrication table	4' x 8' x 3'		✓	
2	Drill press	3' x 3'			✓
3	Tool boxes	20' x 3'			✓
4	2 - Desks w/ computers	35 SF		✓	
5	Welder	3' x 3'			✓
6	Pump filter station	6' x 3'			✓
7	Bench grinder, sander, cutoff saw	3' x 3'			✓
8	3 - Storage cabinets	2' x 4'		✓	

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.3.1.3 Instrument Maintenance Storage

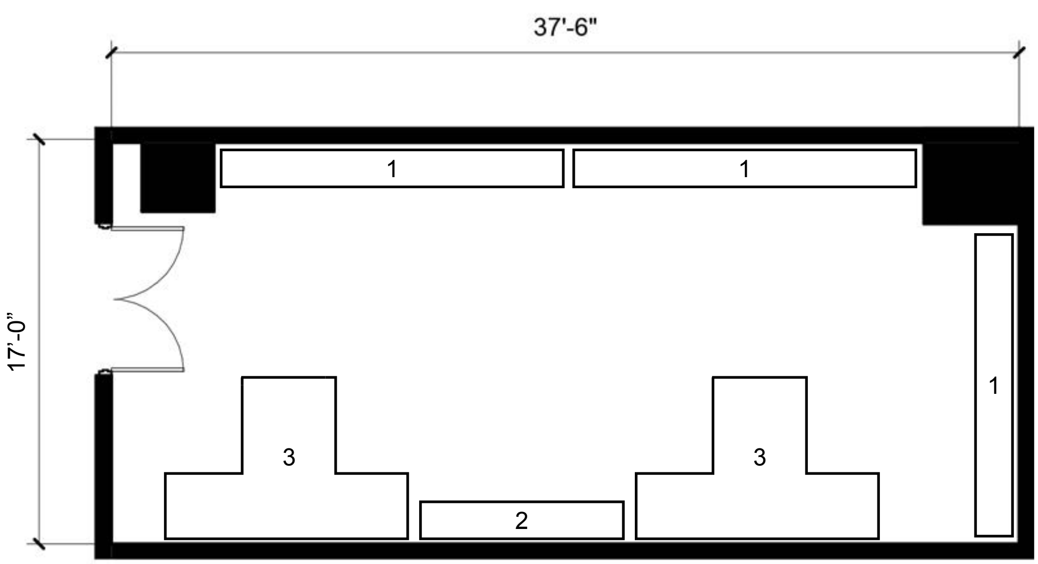
Target Building II - Instrument Support

Lead: Peter Rosenblad

Room Data	
Space Number	5.3.1.3
Space Name	Instrument Maintenance Storage
Net Area Requirement (NSF)	610
Number of spaces required	1
Population	No permanent occupancy
Space Activities/Functional Description	Spares storage
Adjacency Requirements	STS Basement location
Vehicular Access Requirements	Fork lift and/or crane access
Key Design Requirements	8' high overhead door

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 Pipe racks	16' Long		☑	☐
2 Shelving	2' x 8'		☑	☐
3 2 - Desks w/ computers	35 SF		☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.3.1.4 Break Room/User Lounge

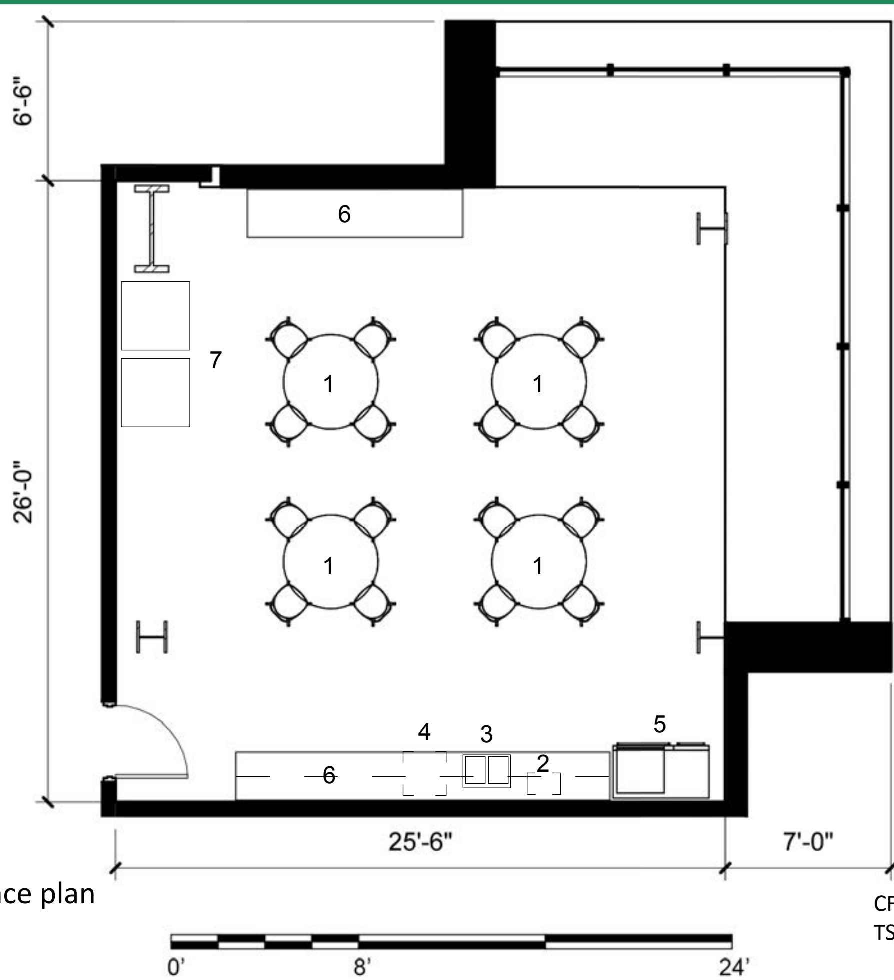
Target Building II - Instrument Support

Lead: Ken Herwig

Room Data	
Space Number	5.3.1.4
Space Name	Break Room/User Lounge
Net Area Requirement (NSF)	620
Number of spaces required	1
Population	6 to 8
Space Activities/Functional Description	Supports Instrument staff
Adjacency Requirements	STS Second Floor location
Vehicular Access Requirements	None
Key Design Requirements	Kitchen area and vending machine support

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 4 - Tables w/ chairs	42" x 42"		☑	☐
2 Microwave	2' x 2'		☑	☐
3 Sink	2' x 2'		☑	☐
4 Dishwasher	3' x 2'		☑	☐
5 Refrigerator	3' x 3'		☑	☐
6 Counter surface	2' x 10'		☑	☐
7 2 - Vending machines	3' x 3'		☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.3.1.5 Computer Room

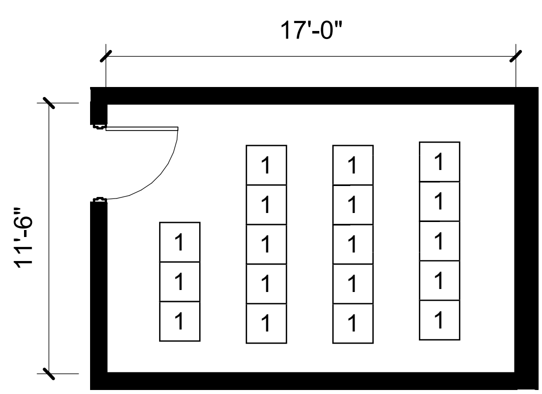
Target Building II - Instrument Support

Lead: Peter Rosenblad

Room Data	
Space Number	5.3.1.5
Space Name	Computer Room
Net Area Requirement (NSF)	200
Number of spaces required	1
Population	0
Space Activities/Functional Description	Instrument computing servers, data storage and networking
Adjacency Requirements	Communication fiber backbone
Vehicular Access Requirements	None
Key Design Requirements	Forced air cooling (possibly by raised floor); dual AC. Computing racks, cooling system, AC power, network and fiber backbone

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 18 - Computer racks	19" x 19"		☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.3.1.6 Controls Network

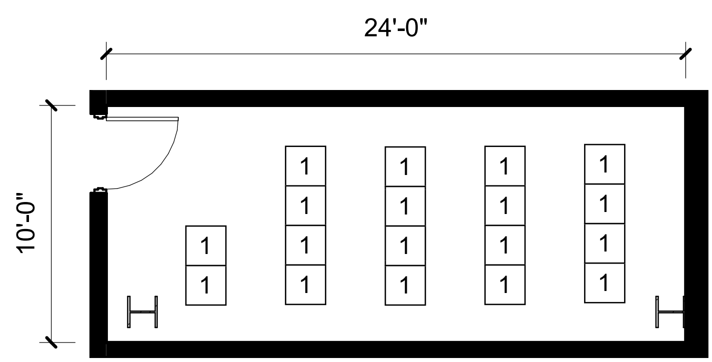
Target Building II - Instrument Support

Lead: Peter Rosenblad

Room Data	
Space Number	5.3.1.6
Space Name	Controls Network
Net Area Requirement (NSF)	240
Number of spaces required	1
Population	0
Space Activities/Functional Description	Network and timing signal distribution
Adjacency Requirements	Located to provide comm links to instruments, computer room, and communications infrastructure.
Vehicular Access Requirements	None
Key Design Requirements	Communication and network fiber cabling. Dual AC power feed (normal and UPS)

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 18 - Computer racks	12" x 19"		☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.3.1.7 On-Shift Support

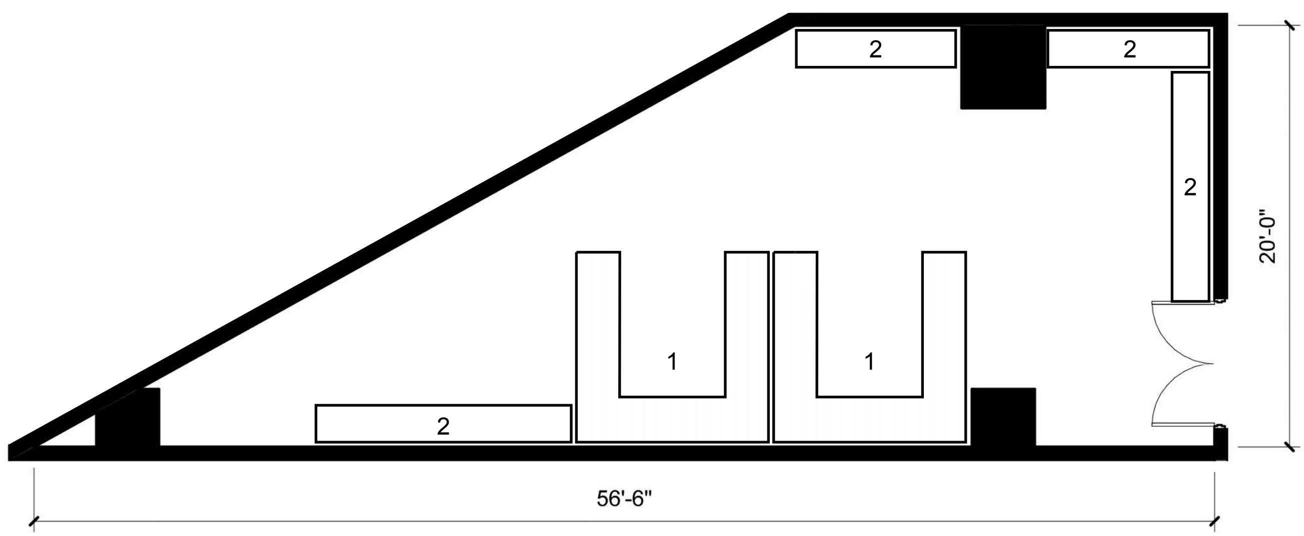
Target Building II - Instrument Support

Lead: Peter Rosenblad

Room Data	
Space Number	5.3.1.7
Space Name	On-Shift Support
Net Area Requirement (NSF)	740
Number of spaces required	1
Population	2
Space Activities/Functional Description	Office
Adjacency Requirements	None
Vehicular Access Requirements	None
Key Design Requirements	Shared workspace btw SE & IS workstations and printing space

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 2 - Workstations	8' x 8'		☑	☐
2 Shelving	2' x 16'		☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.3.1.8 Neutron Beamline Bunker

Target Building II - Target Operations

Lead: Ken Herwig

Room Data	
Space Number	5.3.1.8
Space Name	Neutron Beamline Bunker
Net Area Requirement (NSF)	2,600
Number of spaces required	1
Population	0
Space Activities/Functional Description	Beamline guide components
Adjacency Requirements	STS First Floor location
Vehicular Access Requirements	None
Key Design Requirements	Provide utility services to instrument components such as power, instrumentation, cooling water, vacuum, helium, compressed air, etc. Generally, the utilities associated with the shutters and monolith inserts will be distributed around the inner diameter of the bunker, while those associated with the choppers and alignment systems will be distributed around the outer diameter. Wall-mounted cable trays will be required and possibly a walkway or other means of getting over beamlines. A trench around the inner diameter will be required for potentially activated cooling water leaks from the monolith inserts. Detailed design of these utilities will require an interface sheet between CF and Instrument Systems. Add walk-in access (door or labyrinth) from Bunker Electronics Room required. Bunker wall thickness: 66” HWC at intersection with upturn beam, 60” HWC rest of wall. Add a column in the shielding spread sheet for structural requirement.

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 Power			☑	☐
2 HVAC		SCE	☑	☐
3 Compressed Air			☑	☐
4 Beamline Equipment			☐	☑

Note: Test Fit Plan on following page

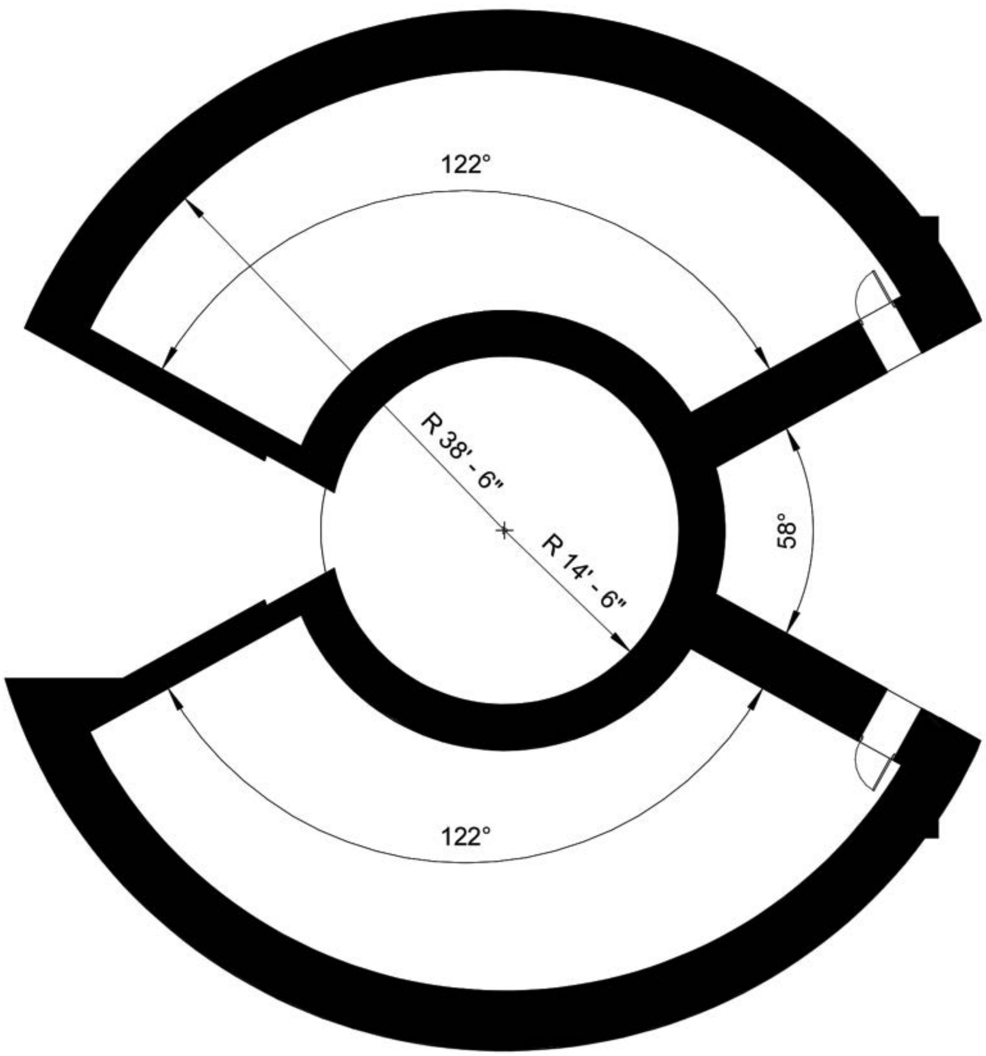
CF: Conventional Facilities
TS: Technical Systems

5.3.1.8 Neutron Beamline Bunker

Target Building II - Target Operations

Lead: Peter Rosenblad

Test-fit Plan



Preliminary space plan

Scale 1/16" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.3.1.9 Monolith

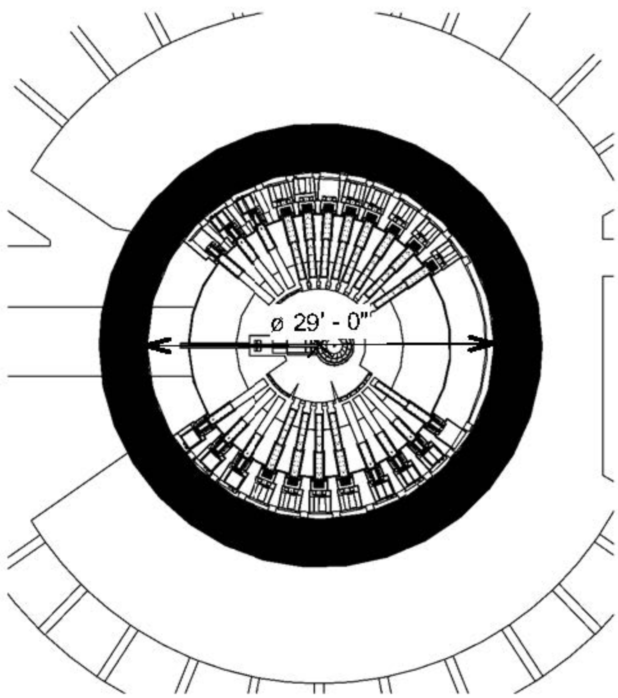
Target Building II - Target Operations

Lead: Peter Rosenblad

Room Data	
Space Number	5.3.1.9
Space Name	Monolith
Net Area Requirement (NSF)	650
Number of spaces required	2
Population	0
Space Activities/Functional Description	Contains target systems and related shielding
Adjacency Requirements	STS First and Second Floor locations
Vehicular Access Requirements	None
Key Design Requirements	Contains target drive bunker, which has once through ventilation

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 Target System Components			☐	☑

Test-fit Plan



Preliminary space plan

Scale 1/16" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.3.1.10 Truck Bay

Target Building II - Target Utilities

Lead: Peter Rosenblad

Room Data	
Space Number	5.3.1.10
Space Name	Truck Bay
Net Area Requirement (NSF)	2,100
Number of spaces required	1
Population	0
Space Activities/Functional Description	Loading/Unloading
Adjacency Requirements	STS First Floor location
Vehicular Access Requirements	Tractor/Trailer
Key Design Requirements	Overhead crane, roll up door

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 Tractor/Trailer	70' x 8'		☐	☑

Note: Test Fit Plan on following page

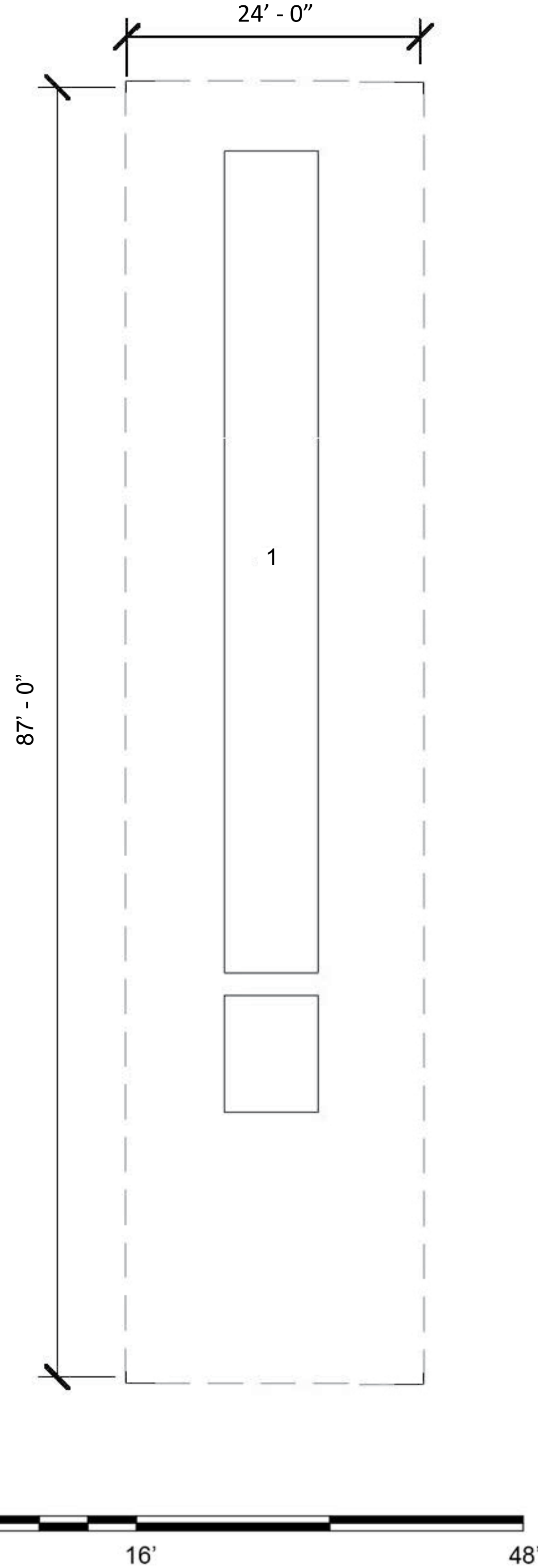
CF: Conventional Facilities
TS: Technical Systems

5.3.1.10 Truck Bay

Target Building II - Target Utilities

Lead: Peter Rosenblad

Test-fit Plan



Preliminary space plan

Scale 1/16" = 1'-0"

5.3.1.11 Confinement Ventilation & Filtration Room

Target Building II - Target Utilities

Lead: Peter Rosenblad

Room Data	
Space Number	5.3.1.11
Space Name	Confinement Ventilation/HOG HEPA Filter Train
Net Area Requirement (NSF)	2,380
Number of spaces required	1
Population	0
Space Activities/Functional Description	Provides confinement for areas where a potential for contamination exists. Provides single HEPA filtration of confinement areas. Provides double HEPA filtration of core vessel and cask loading room.
Adjacency Requirements	STS Basement location
Vehicular Access Requirements	None
Key Design Requirements	ASME N509/ASME AG1 CV spaces - 2 air changes/hr. CV spaces maintained at -0.3"WG negative pressure. Core vessel/cask loading room filters need to be adjacent to core vessel/cask loading room. HOG delay tanks located minimum 8' below grade for shielding, external to Target building. All inlets for the sce, pce, and hog are sized at 1,000 cfm per filter train (8" round). Confinement exhaust pipes from filter train room racked along wall in Utility Corridor.

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 Filter Trains			☑	☐
6 - Secondary confinement filter trains	11' x 3' x 10' ea	4 filters stacked		
19 - pre-filter				
19 - HEPA filter housings				
1 - Secondary confinement filter train	11' x 3' x 7.5' ea	3 filters stacked		
3 - pre-filter				
3 - HEPA filter housings		Pre and post test sections		
2 Duct chases	3' x 6'	Assume 24" duct size at filters; minimum of 10" elsewhere	☑	☐
3 Filter change access area	11' x 4' x 10'	Needs to be adjacent to one long side of the filter trains	☑	☐
4 2 - Hot Off Gas Filter Trains	16' x 3' x 6'	1 filter stacked	☑	☐
2 - charcoal iodine absorbers		Pre and post test sections and a fire screen for each train		
2 - pre-filters				
4 - HEPA filters		Pre and post test sections		
5 Filter change access area	16' x 4' x 6'	Needs to be adjacent to one long side of the filter trains	☑	☐
6 Ductwork chases	3' x 4'	Assume 12" duct size at filters	☑	☐

Note: Test Fit Plan on following page

CF: Conventional Facilities
TS: Technical Systems

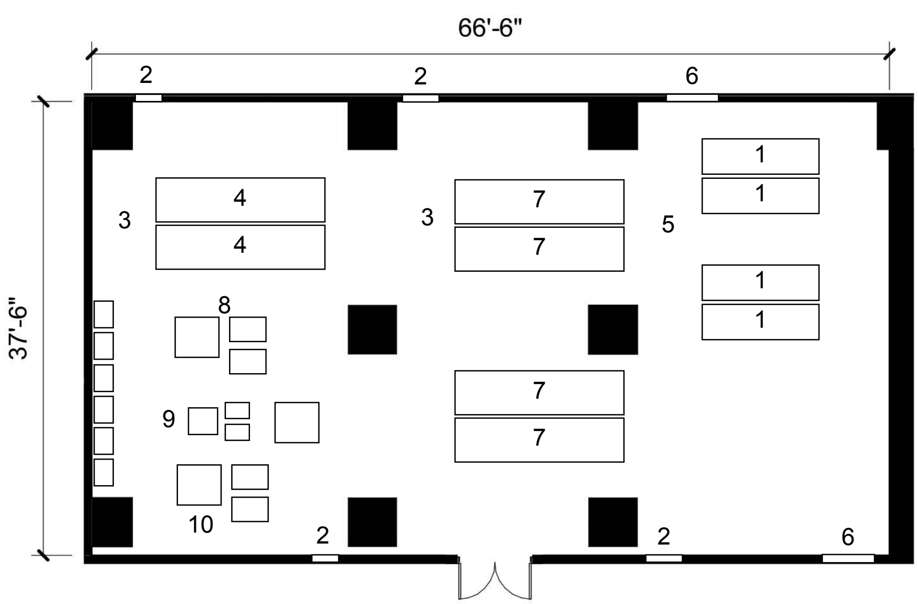
5.3.1.11 Confinement Ventilation & Filtration Room

Target Building II - Target Utilities

Lead: Peter Rosenblad

Primary Equipment/Furnishings List	Size (LxWxH)	Notes		
7 PCE			☑	☐
4- Primary confinement filter trains	16’x3’x6’	1 filter stacked		
4 - pre-filter				
8 - HEPA filter housings		Pre and post test sections		
Filter change access area	16' x 4' x 6'	Needs to be adjacent to one long side of the filter trains		
8 50M SCHW	6' x 4'		☑	☐
9 ZEEMANS DI tech CHW	9' x 3'		☑	☐
10 40M SCHW	6' x 4'		☑	☐
11 Nitrogen & helium distribution panels	60' x 4'	Located in Utility Corridor	☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/16” = 1’-0”

0’ 16’ 48’

CF: Conventional Facilities
TS: Technical Systems

5.3.1.12 Receiving/Staging

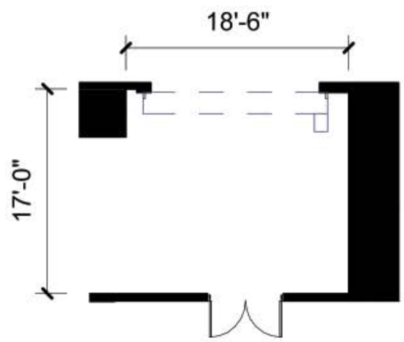
Target Building II - Target Utilities

Lead: Peter Rosenblad

Room Data	
Space Number	5.3.1.12
Space Name	Receiving/Staging
Net Area Requirement (NSF)	335
Number of spaces required	1
Population	0
Space Activities/Functional Description	Loading/Unloading
Adjacency Requirements	STS First Floor location
Vehicular Access Requirements	Tractor/Trailer
Key Design Requirements	Roll up door

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 None			☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/16” = 1’-0”

CF: Conventional Facilities
TS: Technical Systems

5.3.1.13 Hot Process Vault (HPV)

Target Building II - Target Utilities

Lead: Peter Rosenblad

Room Data	
Space Number	5.3.1.13
Space Name	Hot Process Vault (HPV)
Net Area Requirement (NSF)	6,850
Number of spaces required	1
Population	0
Space Activities/Functional Description	Utility support systems
Adjacency Requirements	STS Basement location, I & C racks
Vehicular Access Requirements	Access required for ~5' wide Utility Cart used to transport shielded IX columns and Filters.
Key Design Requirements	30" shielding required around HPV, SSTL liners in all areas that enclose equipment and piping containing activated heavy and light water. HPV and Mezzanine lined with 12 gauge SSTL. Entire floor and tank cavities of the Hot Process Vault and Mezzanine require a welded stainless-steel plate extend 1’ up on surrounding walls.

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	Labyrinth Entrance			☐	☐
2	High Bay Hatch Access	6' x 6'	Access to mezzanine only	☐	☐
3	2 - Stairway	4' W x 46' L	Length includes 5 ' clear both ends	☐	☐
4	Low Level Liquid Waste (LLLW) Tanks	6' OD x 8' OAH	OAH doesn’t include vessel leg height or nozzle extensions; in tank pit below floor	☐	☐
5	LLLW Evaporator	6' OD x 7' OAH	South Mezzanine	☐	☐
6	LLLW Feed Tank	6' OD x 7' OAH	South Mezzanine	☐	☐
7	LLLW Condensate Tank	6' OD x 7' OAH	South Mezzanine	☐	☐
8	LLLW Evaporator Condenser	6" OD x 9' OL	South Mezzanine	☐	☐
9	LLLW Filter and sampling station	4' x 6' x 6' H	South HPV	☐	☐
10	HOG Condenser	6" OD x 9' OL	Main Target Loop 1 - South Mezzanine	☐	☐
11	HOG Condenser	6" OD x 9' OL	Reflector D2O Loop 2- North Mezzanine	☐	☐
12	HOG Condenser	6" OD x 9' OL	Shielding Loop 3 - South Mezzanine	☐	☐
13	2 - Loop 1 Pumps	1.5' x 5' EA	South HPV	☐	☐
14	2 - Loop 2 Pumps	1.5' x 5' EA	North HPV	☐	☐
15	2 - Loop 3 Pumps	1.5' x 5' EA	South HPV	☐	☐

CF: Conventional Facilities
TS: Technical Systems

5.3.1.13 Hot Process Vault (HPV)

Target Building II - Target Utilities

Lead: Peter Rosenblad

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
16 2 - LLLW Pumps	1.5' x 5' EA	North HPV	☐	☐
17 2 - CV Drain Tank Pump	1.5' x 5' EA	North HPV	☐	☐
18 2 - Bulk Shield Tank Pump	1.5' x 5' EA	North HPV	☐	☐
19 Loop 1 Heat Exchanger	2.3' x 5' x 6'T	South HPV	☐	☐
20 Loop 2 Heat Exchanger	2.3' x 5' x 6'T	North HPV	☐	☐
21 Loop 3 Heat Exchanger	2.3' x 5' x 6'T	South HPV	☐	☐
22 Loop 1 Clean Up Loop	5' x 20' envelope		☐	☐
23 Loop 2 Clean up Loop	5' x 20' envelope	Each clean up loop includes 1 Pre-Filter, 2 IX columns and 1 Post Filter; all shielded; ~34" dia on 5' 2" Centers		
24 Loop 3 Clean up Loop	5' x 20' envelope			
25 Vacuum Pre-Condenser	10" OD x 9' OAL	North Mezzanine	☐	☐
26 Loop 1 Drain Tank - H2O	10' OD x 8'10" OAH	5' 5" straight side doesn’t include vessel leg height; in tank pit below floor	☐	☐
27 Loop 2 Drain Tank - D2O	5' OD x 7'-8" OAH	6' straight side doesn’t include vessel leg height; in tank pit before floor	☐	☐
28 Loop 3 Drain Tank - H2O	8'6" OD x 8'-10" OAH	8' 10" straight side doesn’t include vessel leg height; in tank pit below floor	☐	☐
29 Bulk Shielding Drain Tank	4' OD x 6' OAH	May need to be in tank pit below floor	☐	☐
30 Core Vessel Drain Tank	4' OD x 6' OAH	May need to be in tank pit below floor	☐	☐
31 Vacuum pump for drying loop 2	3' OD x 8' L	For temporary use in D2O Loop 2	☐	☐
32 Condensate Collection Tank	5' x 5' x 4' H	For temporary use in D2O Loop 2	☐	☐
33 Vacuum Valve Panel	4' x 6' x 6' H	For temporary use in D2O Loop 2	☐	☐
34 Recombiner System Equipment	6 ' x 20' x 8' H	To support D2O recovery from HOG; may not be contiguous	☐	☐
35 Loop 3 Control Valve Manifold	7' x 16' x 8'H	Manifold envelope	☐	☐
36 4 - Pipe Chases	4' x 5' EA	Location driven by layout of High Bay tank cavities	☐	☐
37 3 - Sample Panels	2' x 2'	One for each cooling loop	☐	☐

Note: Test Fit Plan on following page

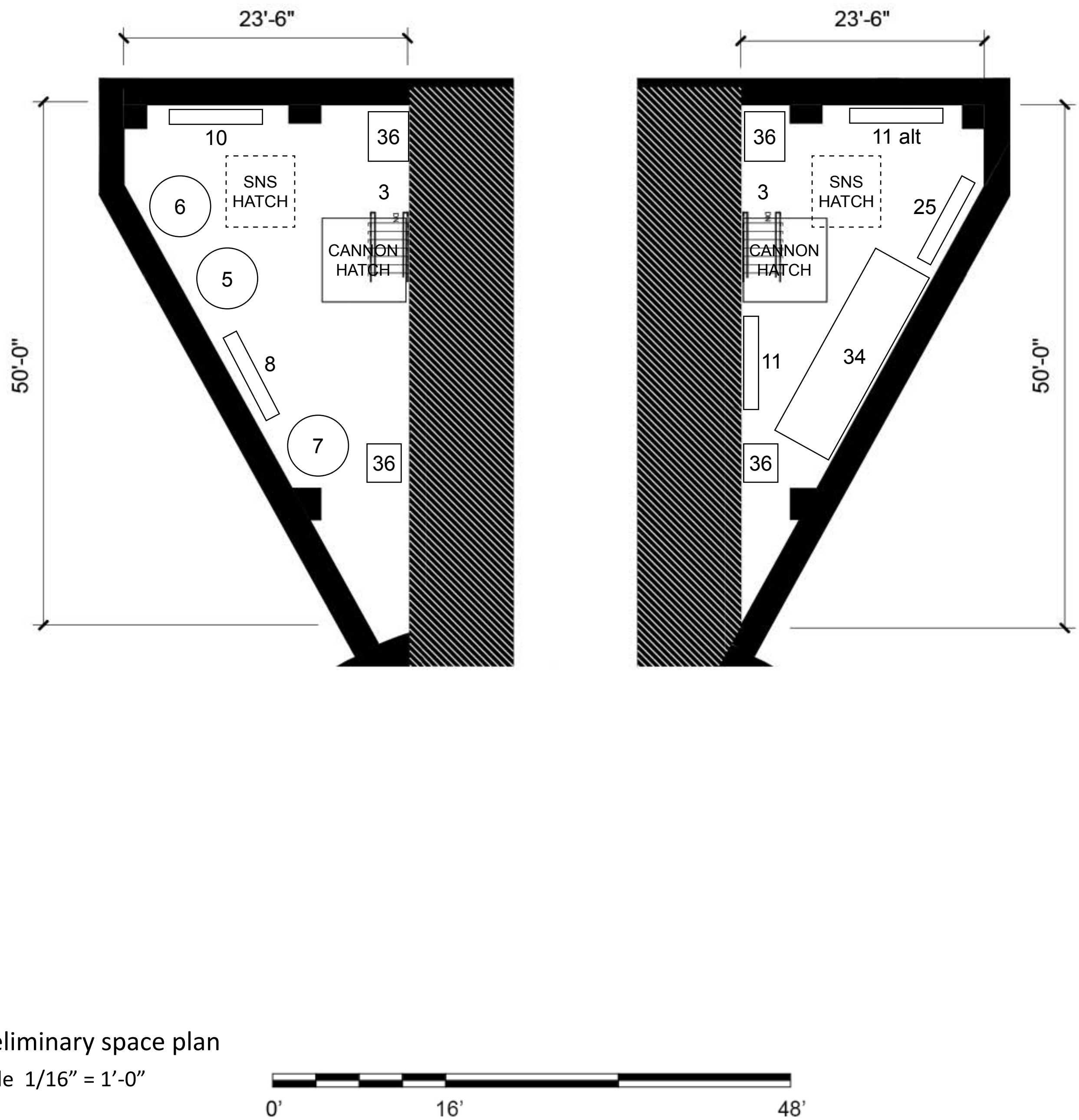
CF: Conventional Facilities
TS: Technical Systems

5.3.1.13 Hot Process Vault (HPV)

Target Building II - Target Utilities

Lead: Peter Rosenblad

HPV Mezzanine

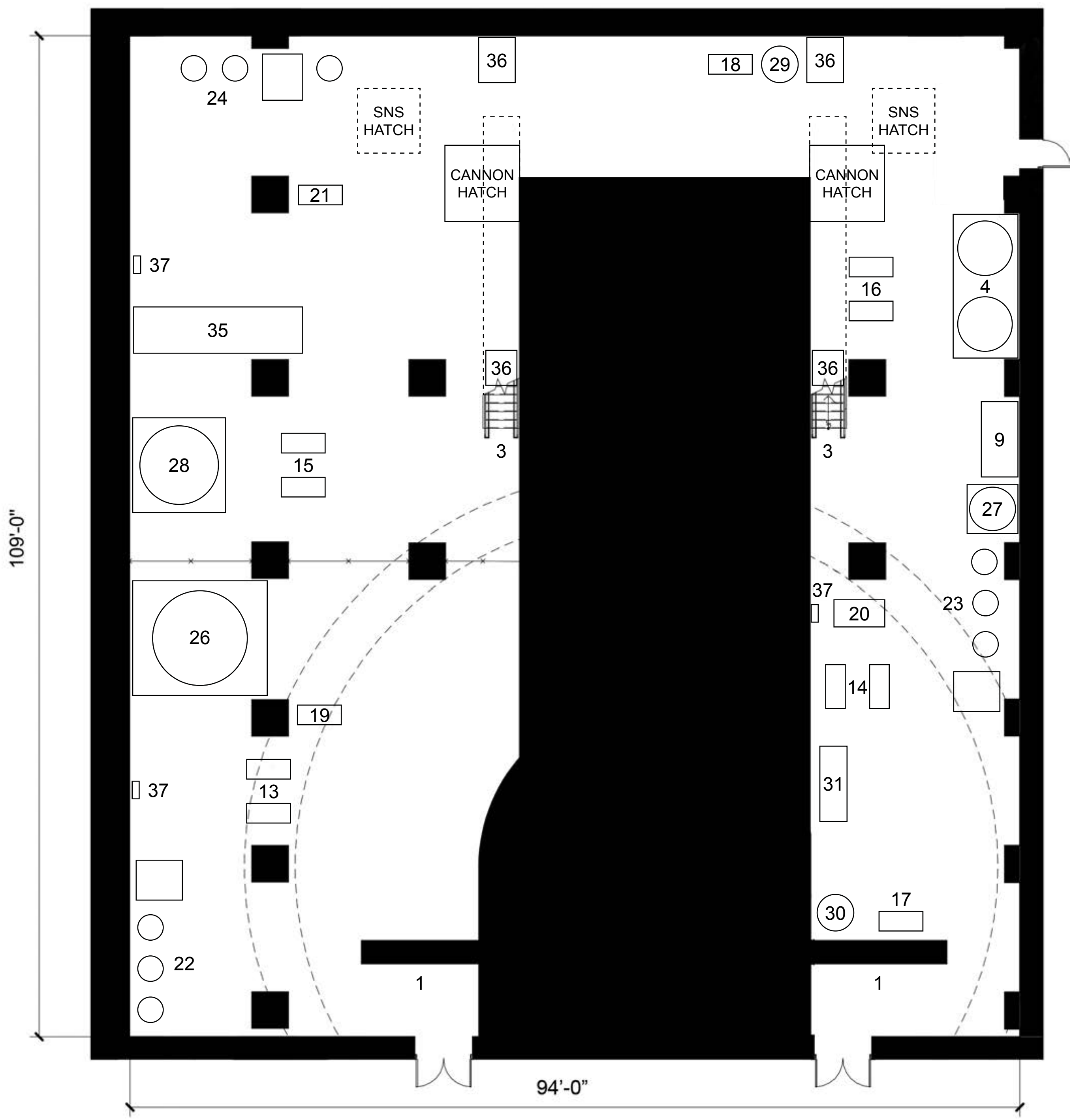


5.3.1.13 Hot Process Vault (HPV)

Target Building II - Target Utilities

Lead: Peter Rosenblad

Test-fit Plan



Preliminary space plan

Scale 1/16" = 1'-0"

5.3.1.14 Bunker Electronics Room

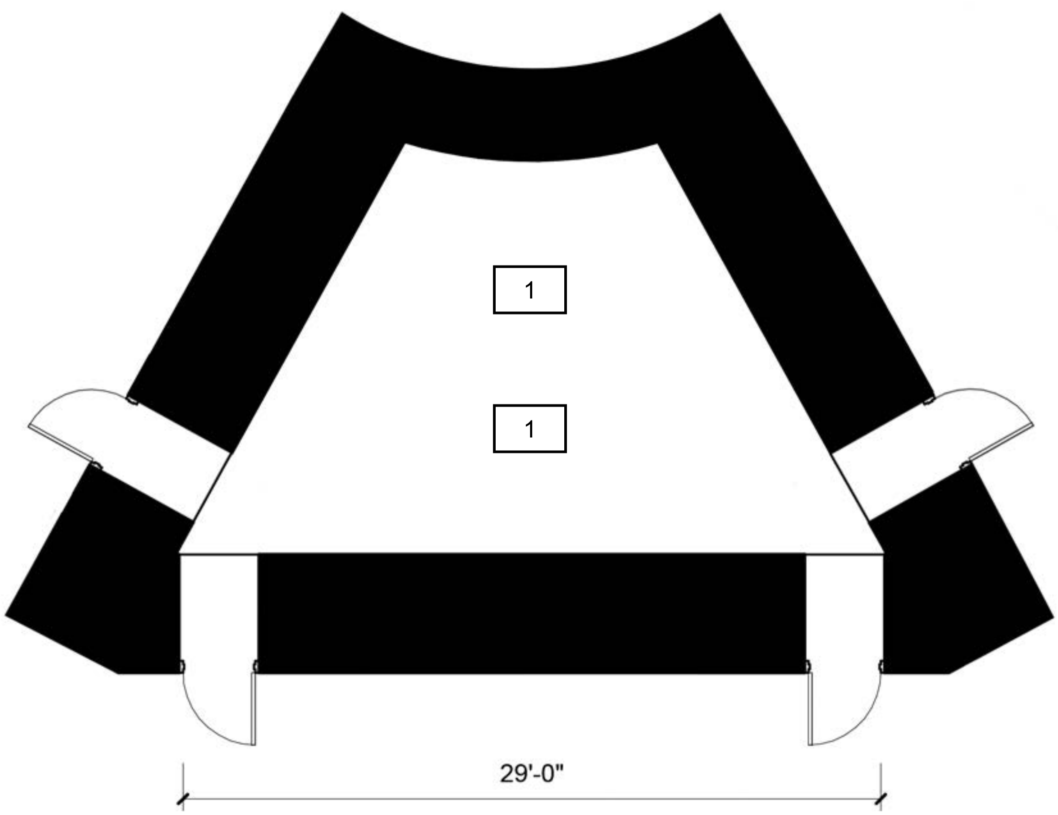
Target Building II

Lead: Ken Herwig

Room Data	
Space Number	5.3.1.14
Space Name	Bunker Electronics Room
Net Area Requirement (NSF)	
Number of spaces required	1
Population	0
Space Activities/Functional Description	Houses electronics racks for bunker equipment.
Adjacency Requirements	Monolith
Vehicular Access Requirements	None
Key Design Requirements	Electrical power and lighting, conditioned space, SCE. Door height must accommodate transport and installation of electronics racks using pallet jacks. Walk-in access (doors or labyrinths) to the bunkers.

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	2 - electronics racks	36x24x84	Dual access doors on 24" ends	☐	☑

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

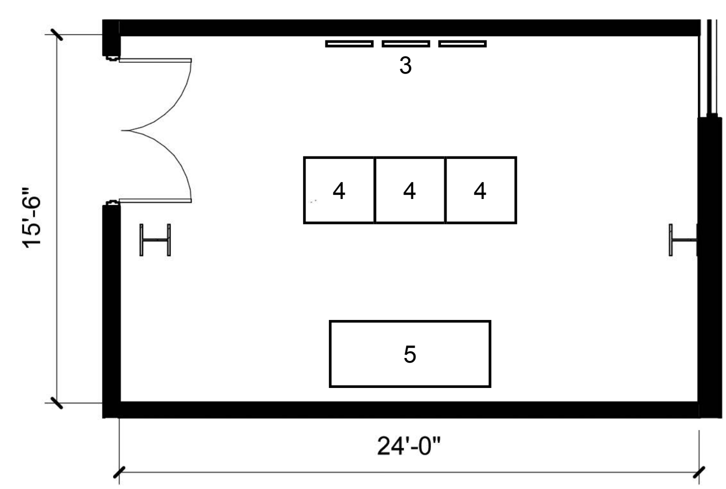
5.3.1.15 UPS / Emergency Power Room

Target Building II - Building Utilities — Lead: Peter Rosenblad

Room Data	
Space Number	5.3.1.15
Space Name	UPS / Emergency Power Room
Net Area Requirement (NSF)	370
Number of spaces required	1
Population	0
Space Activities/Functional Description	
Adjacency Requirements	STS Second Floor location
Vehicular Access Requirements	Indirect access
Key Design Requirements	Cooling, emergency lighting, double doors for emergency egress and equipment placement & maintenance. Assure 2nd floor room perimeter location allows short duct bank run to TA2-EG1 generator.

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 TA2-SS1 Substation	72” x 88" x 96”	Exterior	☑	☐
2 TA2-EG1 generator	3' x 3' x 3'	Exterior	☑	☐
3 3 - Panelboards	30" x 8" x 42"		☑	☐
4 4 - Automatic Transfer Switch	3' x 3 ' x 6'-6"		☑	☐
5 80 KW UPS	3' x 7'		☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/8” = 1’-0”

CF: Conventional Facilities
TS: Technical Systems

5.3.1.16 Target Maintenance Shop

Target Building II - Building Utilities

Lead: Peter Rosenblad

Room Data	
Space Number	5.3.1.16
Space Name	Target Maintenance Shop
Net Area Requirement (NSF)	1,100
Number of spaces required	1
Population	2
Space Activities/Functional Description	Perform maintenance ,fabrication and repair. Hot work capable
Adjacency Requirements	STS Second Floor locations
Vehicular Access Requirements	Fork truck accessible
Key Design Requirements	Needs 208/480, ventilation, over head crane ,vertical storage mezzanine, roll up door,process water, compressed air, welding hood, welding gas manifold. 8' high overhead door

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 Large fabrication table	4' x 8' x 3'		✓	
2 Drill press	3' x 3'			✓
3 Tool boxes	20' x 3'			✓
4 2 - Desks w/ computers	35 SF		✓	
5 Welder	3' x 3'			✓
6 Pump filter station	6' x 3'			✓
7 Bench grinder, sander, cutoff saw	3' x 3'			✓
8 3 - Storage cabinets	2' x 4		✓	
9 Overhead crane	5 Ton	Will likely use the Target building 2nd Floor crane	✓	

Note: Test Fit Plan on following page

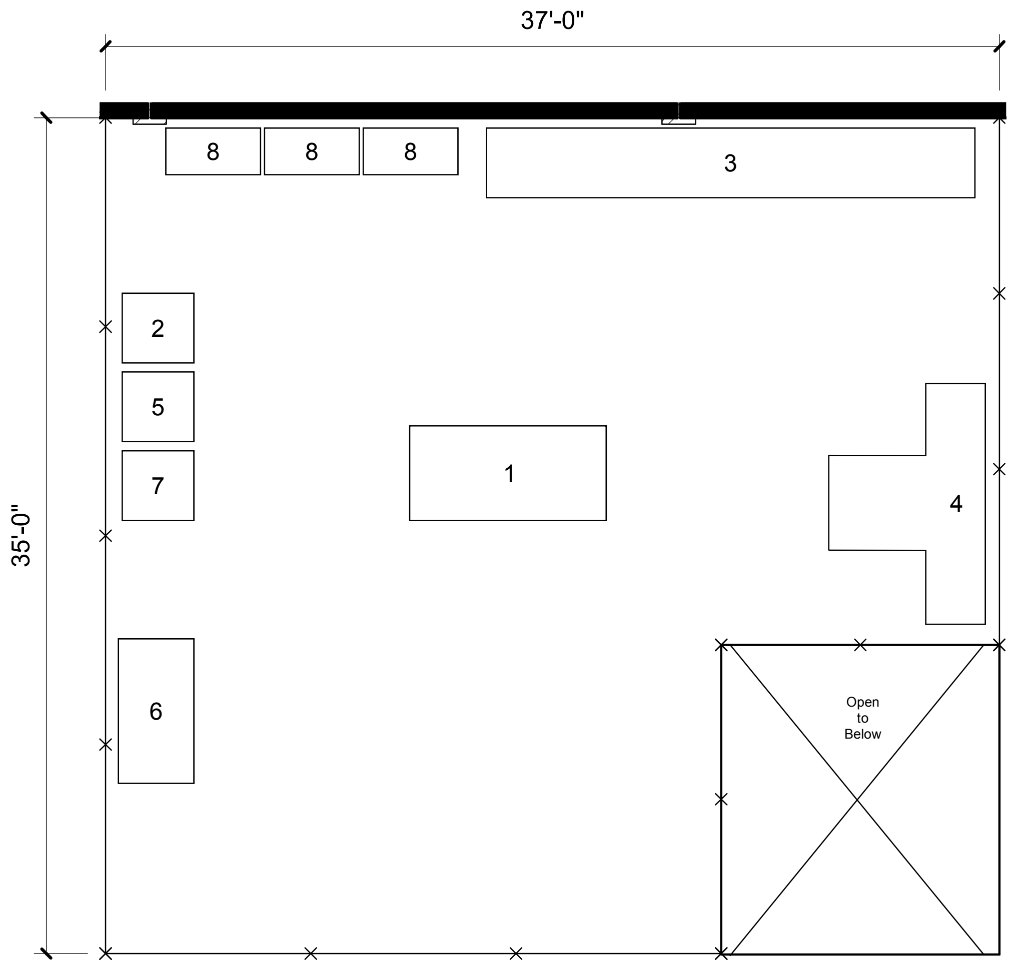
CF: Conventional Facilities
TS: Technical Systems

5.3.1.16 Target Maintenance Shop

Target Building II - Target Utilities

Lead: Peter Rosenblad

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

5.3.1.17 Hot Shop (Radiological)

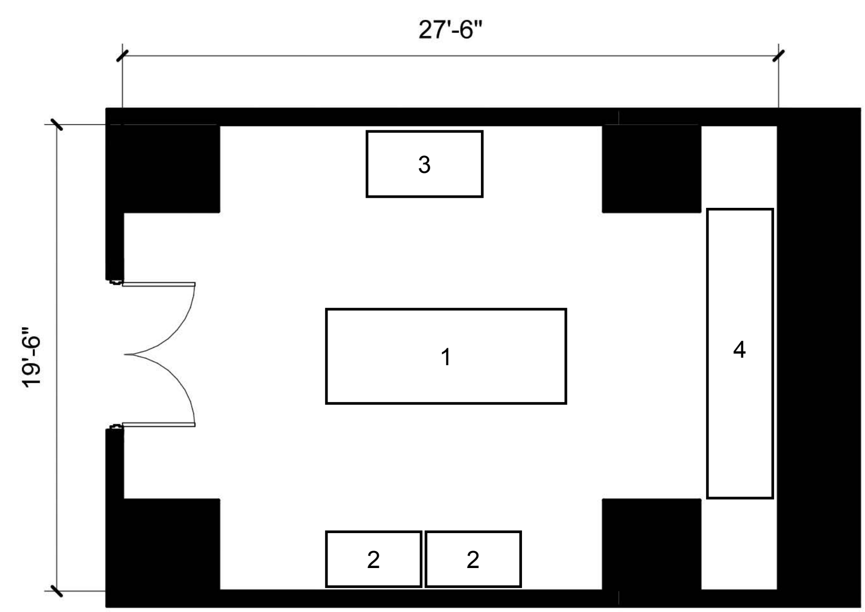
Target Building II - Instrument Support

Lead: Peter Rosenblad

Room Data	
Space Number	5.3.1.17
Space Name	Hot Shop (Radiological)
Net Area Requirement (NSF)	470
Number of spaces required	1
Population	Up to 4, as dictated by workload. No permanent occupancy
Space Activities/Functional Description	Shared space to work on equipment (rebuild pumps) that is potentially contaminated.
Adjacency Requirements	STS Basement location
Vehicular Access Requirements	Fork lift access. Overhead crane
Key Design Requirements	Needs 208/480, filtered ventilation, LLLW drain, overhead crane, vertical storage mezzanine. 8' high overhead door. Hot off gas, compressed air, and nitrogen required.

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	Fabrication table	4' x 10' x 3'		✓	
2	2 - Storage cabinets	30" x 48"		✓	
3	Toolbox	3' x 5'			✓
4	Workstation	3' x 12'		✓	
5	Overhead Crane	10 Ton		✓	
6	Overhead Door	8' H.			

Test-fit Plan



Preliminary spa

Scale 1/8" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.3.1.18 Electrical (Research Mechanics)

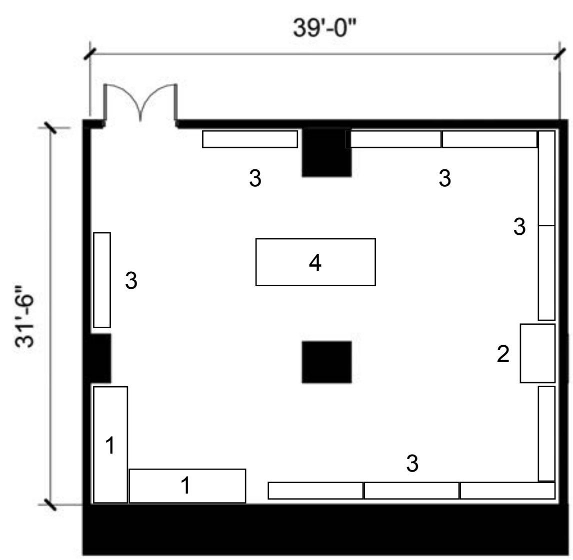
Target Building II - Instrument Support

Lead: Peter Rosenblad

Room Data	
Space Number	5.3.1.18
Space Name	Electrical (Research Mechanics)
Net Area Requirement (NSF)	1,030
Number of spaces required	1
Population	2 (permanent occupancy not required)
Space Activities/Functional Description	Fabrication and repair of electrical equipment and components
Adjacency Requirements	STS Basement location
Vehicular Access Requirements	None
Key Design Requirements	208 VAC

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 2 - Workstations	3' x 10"		✓	
2 Toolbox	3' x 5'			✓
3 Shelving	2' x 10'		✓	
4 Fabrication table	4' x 10' x 3'		✓	

Test-fit Plan



Preliminary space plan

Scale 1/16” = 1’-0”

CF: Conventional Facilities
TS: Technical Systems

5.3.1.19 Vacuum Workshop

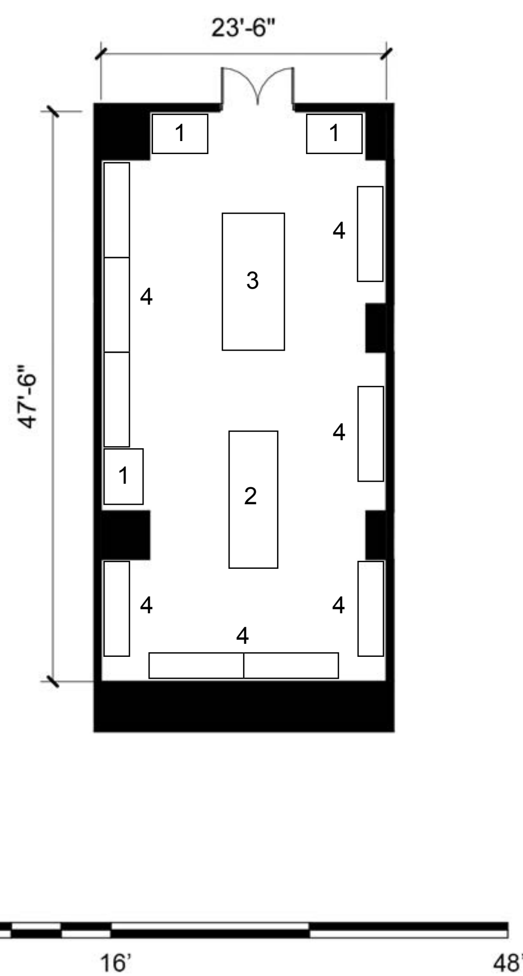
Target Building II - Instrument Support

Lead: Peter Rosenblad

Room Data	
Space Number	5.3.1.19
Space Name	Vacuum Workshop
Net Area Requirement (NSF)	1,110
Number of spaces required	1
Population	No permanent occupancy
Space Activities/Functional Description	Maintenance for Vacuum systems
Adjacency Requirements	STS Basement location
Vehicular Access Requirements	Fork lift or crane access
Key Design Requirements	208 VAC. 8' high overhead door

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	3 - Storage cabinets	30" x 48"		☑	☐
2	Work table	3' x 10'		☑	☐
3	Fabrication Table	4' x 10'		☑	☐
4	Shelving	2' x 8'		☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/16" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.3.1.20 Radiological Support Count Area

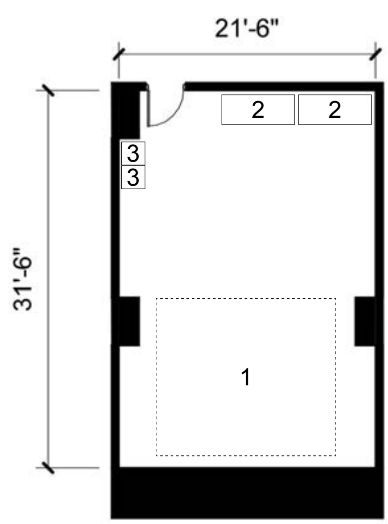
Target Building II - Instrument Support

Lead: Peter Rosenblad

Room Data	
Space Number	5.3.1.20
Space Name	Radiological Support Count Area
Net Area Requirement (NSF)	360
Number of spaces required	1
Population	No permanent occupancy
Space Activities/Functional Description	Count radiological samples
Adjacency Requirements	STS Basement location
Vehicular Access Requirements	None
Key Design Requirements	Low Radiological Background Area. Epoxy floor for easy cleaning.

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	Detectors and count room equipment	Approx. 200 SF		☐	☑
2	2 - Storage lockers	2' x 2'		☑	☐
3	2 - Desks	30" x 6'		☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/16" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.3.1.21 Activated Sample Lab

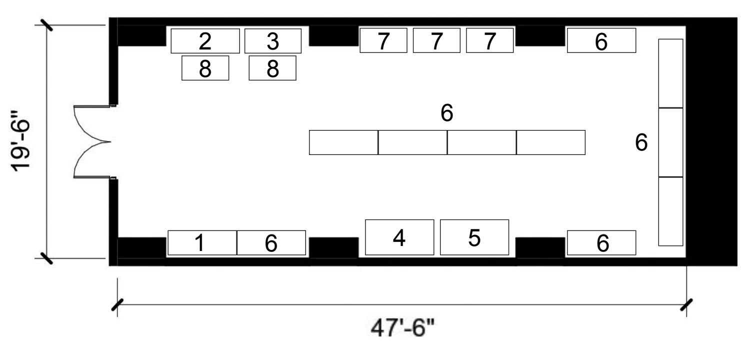
Target Building II - Instrument Support

Lead: Ken Herwig

Room Data	
Space Number	5.3.1.21
Space Name	Activated Sample Lab
Net Area Requirement (NSF)	800
Number of spaces required	1
Population	No permanent occupancy
Space Activities/Functional Description	Sample preparation. Toxic chemicals, nano material and radiological samples
Adjacency Requirements	STS Basement location
Vehicular Access Requirements	None
Key Design Requirements	Space will require ventilation connections to hoods, sink, compressed air, and nitrogen. HEPA filtered ventilation. Provide emergency eyewash based on regulatory requirements.

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 Desk/computer	70 SF		✓	
2 Large fume hood	8' Long		✓	
3 Small fume hood	6' Long		✓	
4 Glove box	4' x 8'			✓
5 Dry storage box	4' x 8'			✓
6 Shelving	2' x 6'		✓	
7 3 - Storage cabinets	30" x 48"		✓	
8 2 - Work tables	3' x 5'		✓	

Test-fit Plan



Preliminary space plan

Scale 1/16” = 1’-0”

CF: Conventional Facilities
TS: Technical Systems

5.3.1.22 Activated Sample Storage

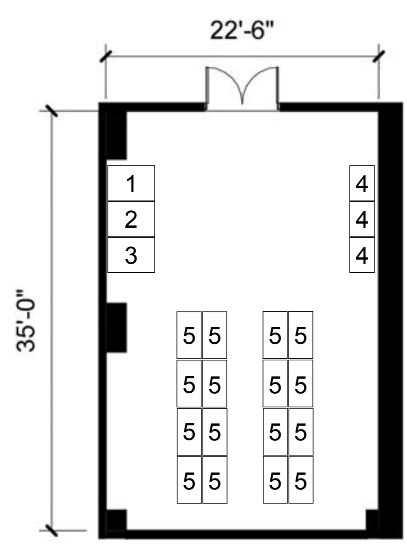
Target Building II - Instrument Support

Lead: Ken Herwig

Room Data	
Space Number	5.3.1.22
Space Name	Activated Sample Storage
Net Area Requirement (SF)	670
Number of spaces required	1
Population	No permanent occupancy
Space Activities/Functional Description	Storage of irradiated samples
Adjacency Requirements	STS Basement location, near radiological support count area
Vehicular Access Requirements	None
Key Design Requirements	Nitrogen

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 Nitrogen dry box	3' x 3'		☐	☑
2 Refrigerator w/ -20 freezer	3' x 3'		☐	☑
3 Freezer (-80)	3' x 3'		☐	☑
4 3 - Storage bins/cabinets	30" x 48"		☑	☐
5 Activated samples	Varies		☐	☑

Test-fit Plan



Preliminary space plan

Scale 1/16" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.3.1.23 Survey and Alignment Storage

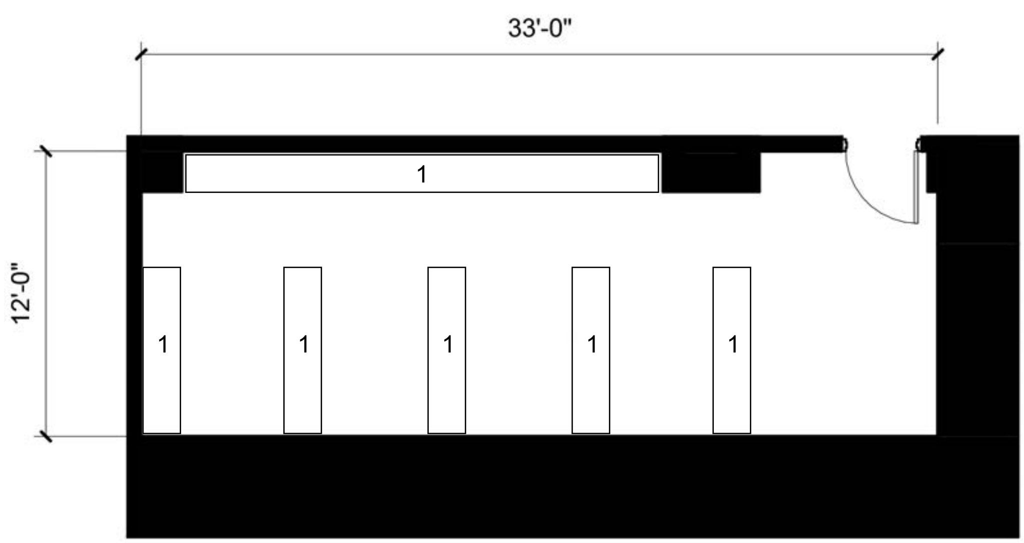
Target Building II - Instrument Support

Lead: Ken Herwig

Room Data	
Space Number	5.3.1.23
Space Name	Survey and Alignment Storage
Net Area Requirement (NSF)	210
Number of spaces required	1
Population	No permanent occupancy
Space Activities/Functional Description	Storage of equipment and small experiment area
Adjacency Requirements	None
Vehicular Access Requirements	None
Key Design Requirements	Delicate equipment. Needs to be able to be rolled to instruments from the storage area

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 Shelving	18" Deep		☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.3.1.24 Active Storage Cages

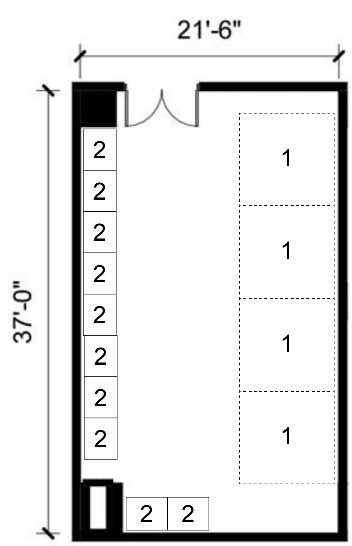
Target Building II - Sample Environment

Lead: Ken Herwig

Room Data	
Space Number	5.3.1.24
Space Name	Active Storage Cages
Net Area Requirement (NSF)	790
Number of spaces required	2
Population	0 - only accessed to retrieve equipment
Space Activities/Functional Description	Storage of sample environment equipment prior
Adjacency Requirements	STS First Floor location
Vehicular Access Requirements	None
Key Design Requirements	Caged and locked, access to overhead crane would be useful (but optional), level smooth transport to maintenance cages required.

Primary Equipment/Furnishings List	**Size (LxWxH)**	**Notes**	**CF**	**TS**
1 Sample environment equipment	4' X 4'	Stored relatively compactly	☐	☑
2 10 - Storage cabinets	3' x 2' x 7'		☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/16" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.3.1.25 Sample Environment Long Term Storage Cages

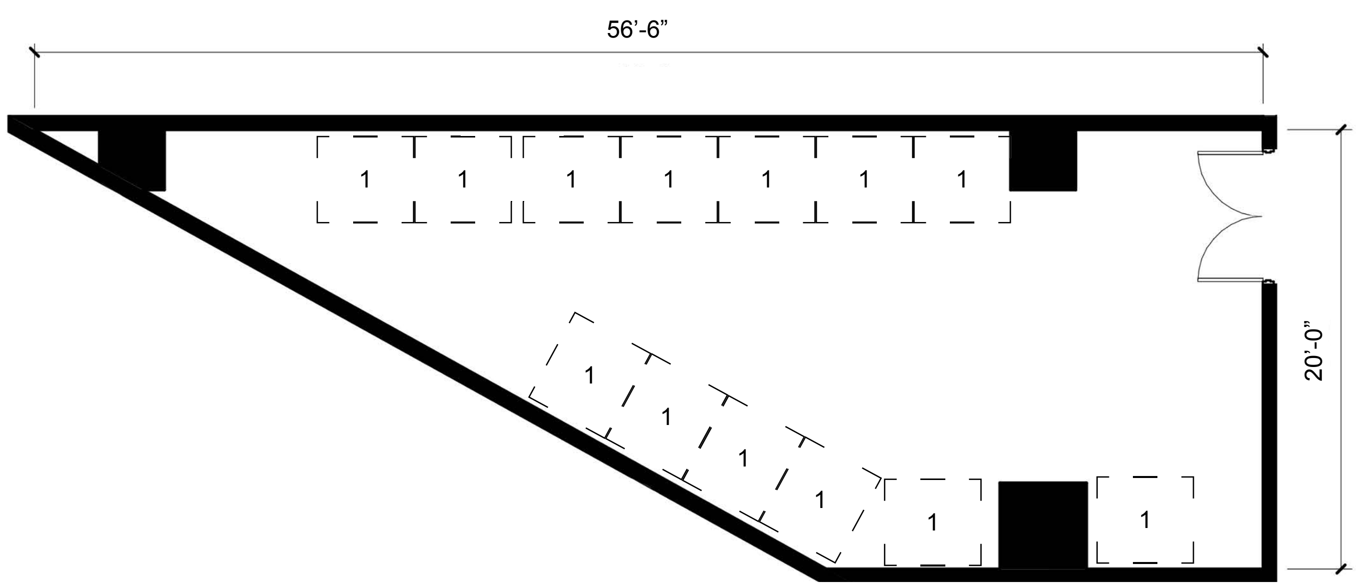
Target Building II - Sample Environment

Lead: Ken Herwig

Room Data	
Space Number	5.3.1.25
Space Name	Sample Environment Long Term Storage Cages
Net Area Requirement (NSF)	750
Number of spaces required	1
Population	0
Space Activities/Functional Description	Storage equipment used infrequently on order a few times per year
Adjacency Requirements	STS Second Floor location
Vehicular Access Requirements	Indirect access
Key Design Requirements	Smooth, level access to maintenance area, could be on separate floor with elevator access to main floor

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 Storage cages	4' x 4'		☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.3.1.26 Target Control Room

Target Building II - Target Operations

Lead: Peter Rosenblad

Room Data	
Space Number	5.3.1.26
Space Name	Target Control Room
Net Area Requirement (NSF)	800
Number of spaces required	1
Population	8 operations support & 1 rotating shift personnel
Space Activities/Functional Description	
Adjacency Requirements	Same level as restroom; as close as possible. I & C
Vehicular Access Requirements	None
Key Design Requirements	Should be made a comfortable, quiet place for operations staff to work. Could include housing for operations staff. Needs to accommodate 24/7 operations and include a refrigerator, microwave storage cabinets, sink, and lockers. Restrooms on same floor preferred

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	Computer control consoles	10' x 10'	To accommodate 3 workstations w/ min. 6 -24" monitors per station	☑	☐
2	4 - Personnel workstations	8' x 8'	Includes desk, chairs, hutch, & drawers	☑	☐
3	Kitchenette	3' x 10'	To include cabinets, refrigerators, microwave, and sink	☑	☐
4	10 - Lockers	2' x 2'	For personnel storage	☑	☐

Note: Test Fit Plan on following page

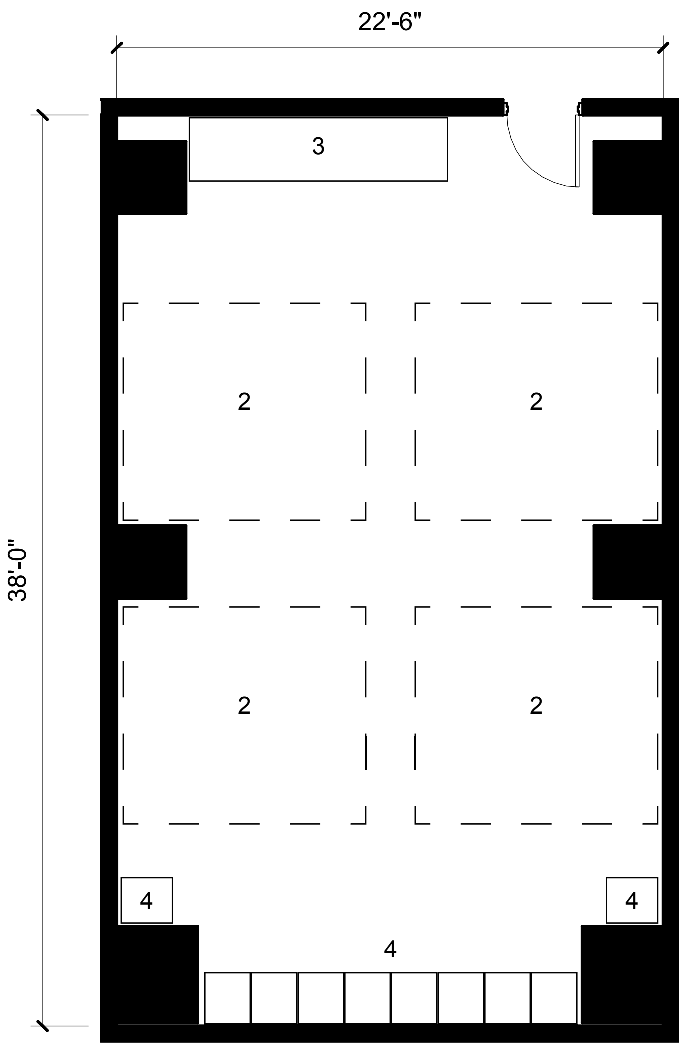
CF: Conventional Facilities
TS: Technical Systems

5.3.1.26 Target Control Room

Target Building II - Target Operations

Lead: Peter Rosenblad

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

5.3.1.27 Hydrogen Utility Room

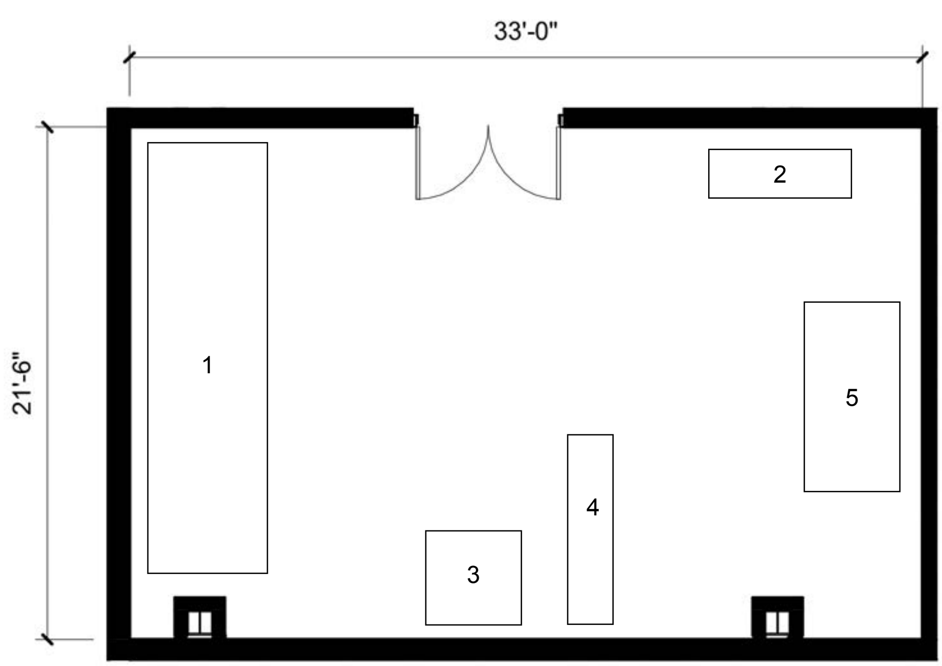
Target Building II - Target Operations

Lead: Peter Rosenblad

Room Data	
Space Number	5.3.1.27
Space Name	Hydrogen Utility Room
Net Area Requirement (NSF)	600
Number of spaces required	1
Population	0
Space Activities/Functional Description	House equipment for liquid hydrogen system
Adjacency Requirements	Near monolith, adjacent to CMS control room, helium compressor and helium refrigerator; STS Second Floor location
Vehicular Access Requirements	Forklift access, 8' roll-up door
Key Design Requirements	Class 1 Div 2 Group B, Hydrogen safety

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 H2 pump module	18' x 5' x 7'		☐	☑
2 H2 gas management	6' x 2' x 10'		☐	☑
3 Vacuum system	4' x 4' x 4'		☐	☑
4 Inert gas system	8' x 2' x 8'		☐	☑
5 H2 control PLC cabinet	8' x 4' x 8'		☐	☑

Test-fit Plan



Preliminary space plan

Scale 1/8″ = 1′-0″

CF: Conventional Facilities

TS: Technical Systems

5.3.1.28 CMS Control Room

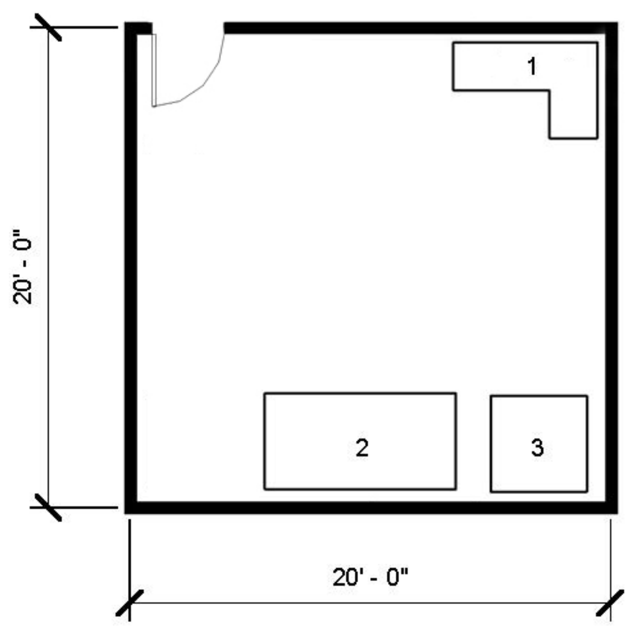
Target Building II - Target Operations

Lead: Peter Rosenblad

Room Data	
Space Number	5.3.1.28
Space Name	CMS Control Room
Net Area Requirement (NSF)	400
Number of spaces required	1
Population	2
Space Activities/Functional Description	Control moderator system, perform maintenance on moderator components
Adjacency Requirements	Near Hydrogen Utility Room; STS Second Floor
Vehicular Access Requirements	None
Key Design Requirements	Isolated from the hydrogen equipment room. Do not require explosion proof electrical installation

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 Control panel (L-shape)	6' x 4' x 5'		☐	☑
2 He Control PLC Cabinet	8' x 4' x 8'		☐	☑
3 Diode Control cabinet	4' x 4' x 8'		☐	☑

Test-fit Plan



Preliminary space plan

Scale 1/8” = 1’-0”

CF: Conventional Facilities
TS: Technical Systems

5.3.1.29 Helium Compressor Room

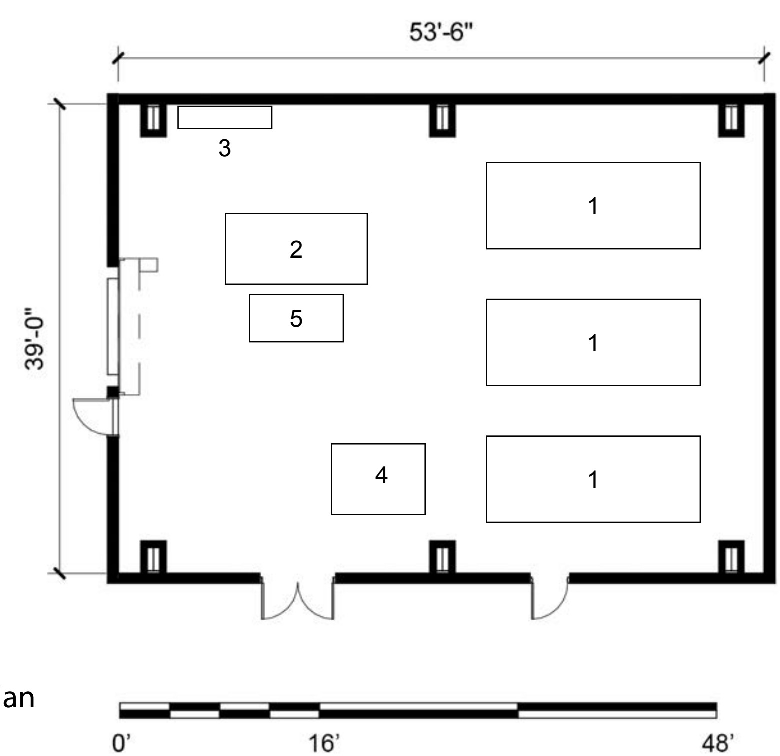
Target Building II - Target Operations

Lead: Peter Rosenblad

Room Data	
Space Number	5.3.1.29
Space Name	Helium Compressor Room
Net Area Requirement (NSF)	2,080
Number of spaces required	1
Population	0
Space Activities/Functional Description	House equipment from the helium compressor
Adjacency Requirements	STS Second Floor location
Vehicular Access Requirements	Flatbed truck access
Key Design Requirements	Sound insulated, ventilated, heated but not necessarily air conditioned, helium compressor weight - 18,000 lbs., compressors oriented lengthwise to facilitate heat exchanger removal, Exterior location. 8' high overhead door at truck access.

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 3 - Helium compressors	18' x 7' x 10'		☐	☑
2 Oil removal System	12' x 6' x 10'		☐	☑
3 He gas management	8' x 2' x 8'		☐	☑
4 Helium purifier	8' x 6' x 12'		☐	☑
5 Oil purifier	8' x 4' x 8'		☐	☑
6 Overhead crane	10 Ton		☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/16″ = 1′-0″

CF: Conventional Facilities
TS: Technical Systems

5.3.1.30 Helium Refrigerator Room

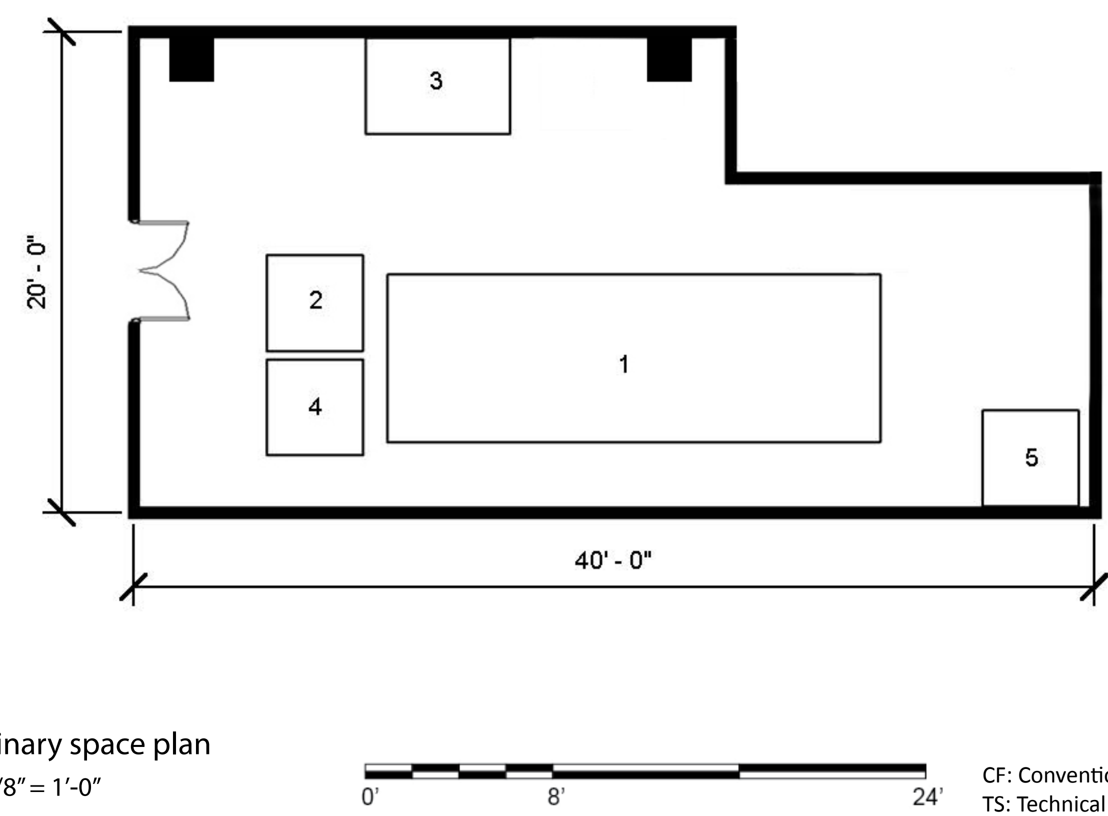
Target Building II - Target Operations

Lead: Peter Rosenblad

Room Data	
Space Number	5.3.1.30
Space Name	Helium Refrigerator Room
Net Area Requirement (NSF)	1,000
Number of spaces required	1
Population	0
Space Activities/Functional Description	House equipment for liquid hydrogen system
Adjacency Requirements	Near hydrogen utility room and monolith; STS Second Floor location
Vehicular Access Requirements	Forklift access
Key Design Requirements	Exterior Location. 8' high overhead door

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 Helium refrigerator	20' x 7' x 10'		☐	☑
2 Vacuum System	4' x 4' x 4'		☐	☑
3 Vaporizer	6' x 4' x 10'		☐	☑
4 Contamination monitor	4' x 4' x 8'		☐	☑
5 Control PLC Cabinet	4' x 4' x 8'		☐	☑

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.3.1.31 Target Second Floor

Target Building II - Target Operations

Lead: Peter Rosenblad

Room Data	
Space Number	5.3.1.31
Space Name	Target Second Floor
Net Area Requirement (NSF)	15,100
Number of spaces required	1
Population	0
Space Activities/Functional Description	Multi-purpose, monolith/bunker maintenance, chopper maintenance
Adjacency Requirements	None
Vehicular Access Requirements	Crane access
Key Design Requirements	To be designed as a high-load/capacity floor. Overhead crane access to transition building floor level. Convenient access to both instrument floors. 5T javelins to the primary crane required.

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	Mock-Up	15' x 15'		☐	☑
2	Environment Cover	160 SF		☐	☑
3	Impact Limiter	50 SF		☐	☑
4	Neutron Chopper Maintenance	1300 SF		☑	☐
5	Drive Bunker Access Area	320 SF		☑	☐
6	Beam Tunnel	1800 SF		☑	☐
7	2 - Monolith Vacuum Systems	300 SF	Adjacent to monolith	☐	☑
8	Shielding Lay-Down	1250 SF		☑	☐
9	2 - HPV Hatches	100 SF		☑	☐
10	2 - Tool storage racks	5' x 25'	For long tool storage	☑	☐
11	12 - Beam Line Hatches	varies	Slot hatches over extreme angle beam lines for installation of beamline shielding and optical components	☑	☐
12	Overhead crane	50 ton	34' hook ht. from elevation 1094'	☑	☐

Note: Test Fit Plan on following page

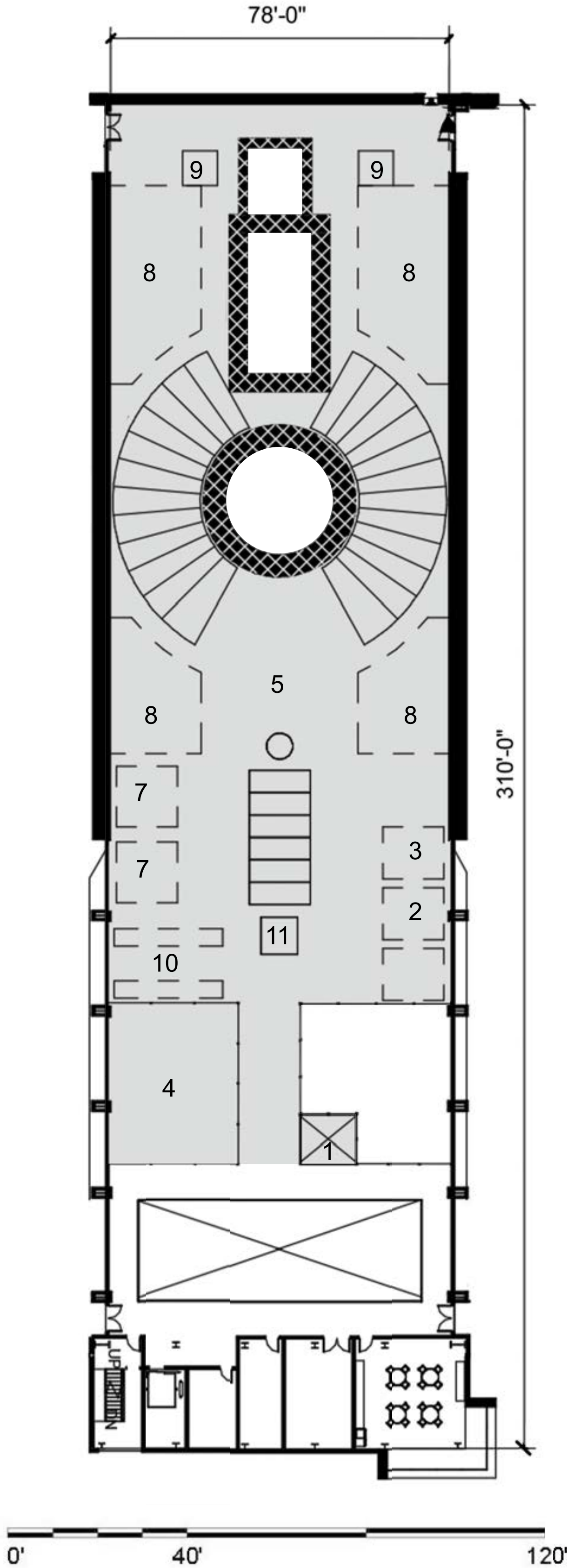
CF: Conventional Facilities
TS: Technical Systems

5.3.1.31 Target Second Floor

Target Building II - Target Operations

Lead: Peter Rosenblad

Test-fit Plan



Preliminary space plan

Scale 1” = 40’-0”

5.3.1.32 Target Maintenance Storage

Target Building II - Target Operations

Lead: Peter Rosenblad

Room Data	
Space Number	5.3.1.32
Space Name	Target Maintenance Storage
Net Area Requirement (NSF)	650
Number of spaces required	1
Population	No permanent occupancy
Space Activities/Functional Description	Spare storage
Adjacency Requirements	STS Basement location
Vehicular Access Requirements	Fork truck accessible
Key Design Requirements	8' high overhead door

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	8 - High capacity shelves	2' X8'		☑	☐
2	8 - Storage lockers	4' x2'		☑	☐
3	Pipe rack	16' x 6'		☑	☐
4	Overhead Door	8' H.		☐	☐

Note: Test Fit Plan on following page

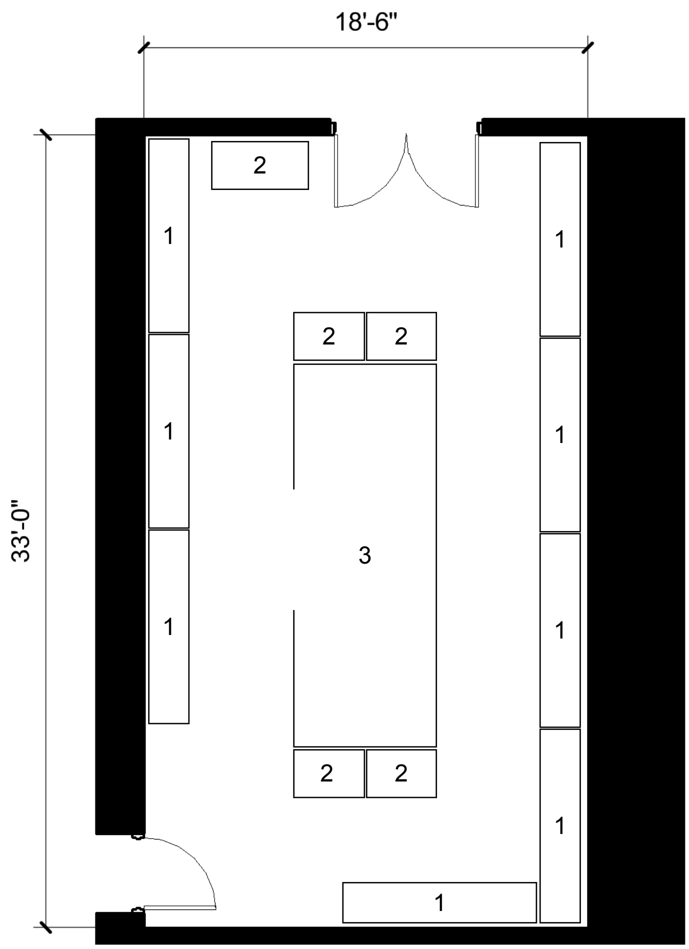
CF: Conventional Facilities
TS: Technical Systems

5.3.1.32 Target Maintenance storage

Target Building II - Target Operations

Lead: Peter Rosenblad

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

5.3.1.33 Service Cell

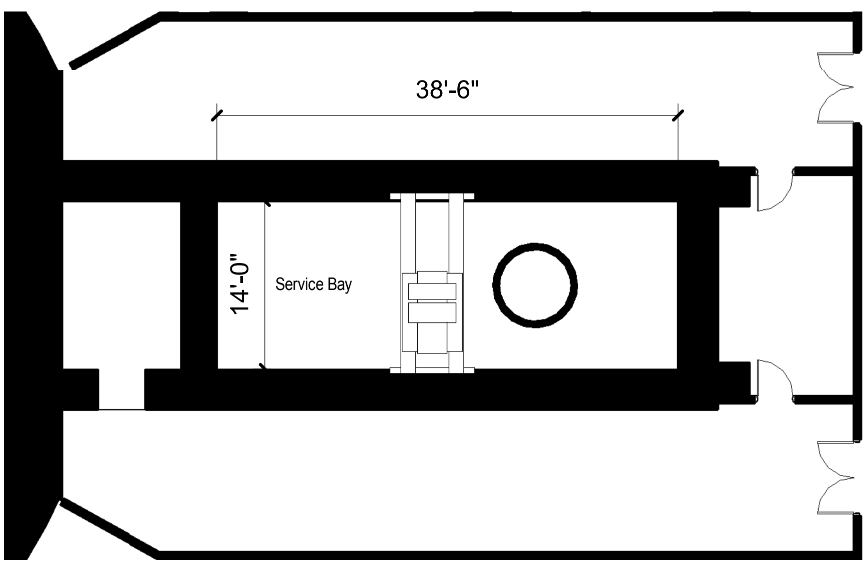
Target Building II

Lead: Peter Rosenblad

Room Data	
Space Number	5.3.1.33
Space Name	Service Bay
Net Area Requirement (NSF)	2,450
Number of spaces required	1
Population	0
Space Activities/Functional Description	For material handling
Adjacency Requirements	STS First Floor Location, close to target
Vehicular Access Requirements	none
Key Design Requirements	Hatches from second floor to basement, crane

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 Overhead crane	TBD		☐	☑
2 In-cell lights			☑	☐
3 Fan coil units			☑	☐
4 LLWS drains			☑	☐
5 penetrations			☑	☐
6 Floor pan			☑	☐
7 Fire suppression			☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.3.1.34 Storage Pit

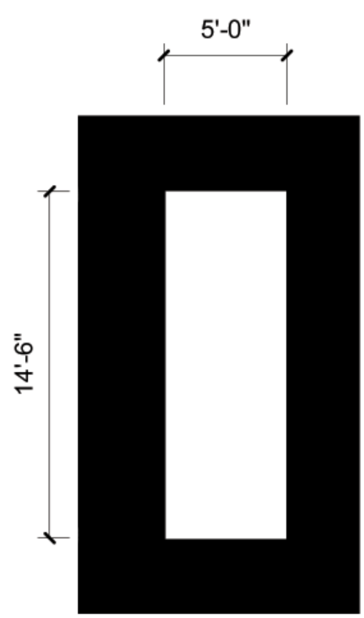
Target Building II

Lead: Peter Rosenblad

Room Data	
Space Number	5.3.1.34
Space Name	Storage Pit
Net Area Requirement (NSF)	75
Number of spaces required	1
Population	0
Space Activities/Functional Description	material handling
Adjacency Requirements	STS Basement location below service bay
Vehicular Access Requirements	none
Key Design Requirements	Containment enclosure

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	None				

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.3.1.35 Cask Loading Room

Target Building II - Remote Handling

Lead: Peter Rosenblad

Room Data	
Space Number	5.3.1.35
Space Name	Cask Loading Room
Net Area Requirement (NSF)	475
Number of spaces required	1
Population	2
Space Activities/Functional Description	Installing and removing lids from shipping casks
Adjacency Requirements	Basement
Vehicular Access Requirements	None
Key Design Requirements	Hatch on Second floor, stair to second floor level

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	Two-High filter train	11' x 3' x 5'	2 filters stacked (core vessel and cask loading room; locate near source)	☐	☑
2	Duct chases	3' x 6'	Assume 24" duct size at filters; minimum of 10" elsewhere	☑	☐
3	Chopper control cabinet	4' x 10'		☐	☑
4	Shutter control cabinet	4' x 10'		☐	☑
5	Bunker monitoring control cabinets	4' x 10'	Gas sensors, radiation sensors, temperature sensors, and audio sensors	☐	☑
6	Beam monitor control cabinet	4' x 10'		☐	☑
7	Cask Cart/Rail System	TBD		☑	☐

Note: Test Fit Plan on following page

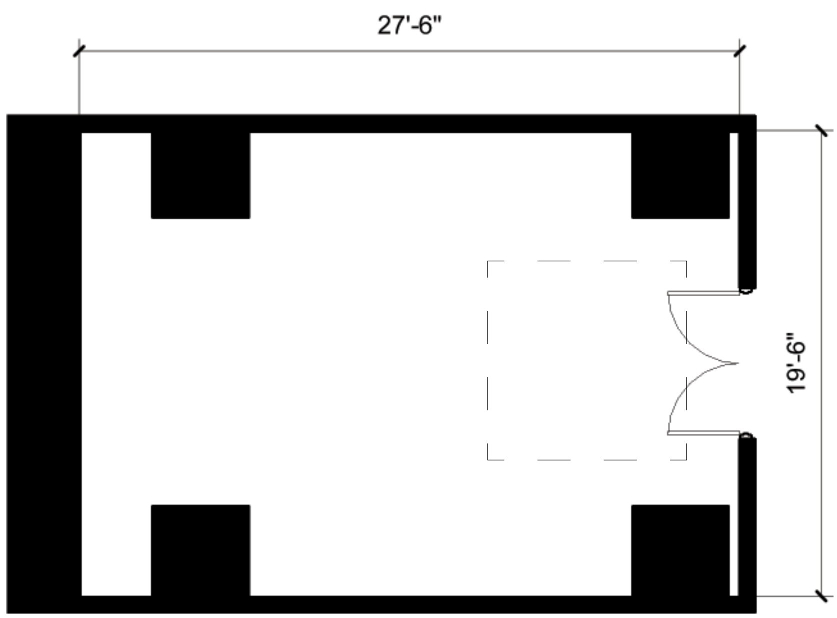
CF: Conventional Facilities
TS: Technical Systems

5.3.1.35 Cask Loading Room

Target Building II - Remote Handling

Lead: Peter Rosenblad

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

5.3.1.36 Mechanical Room

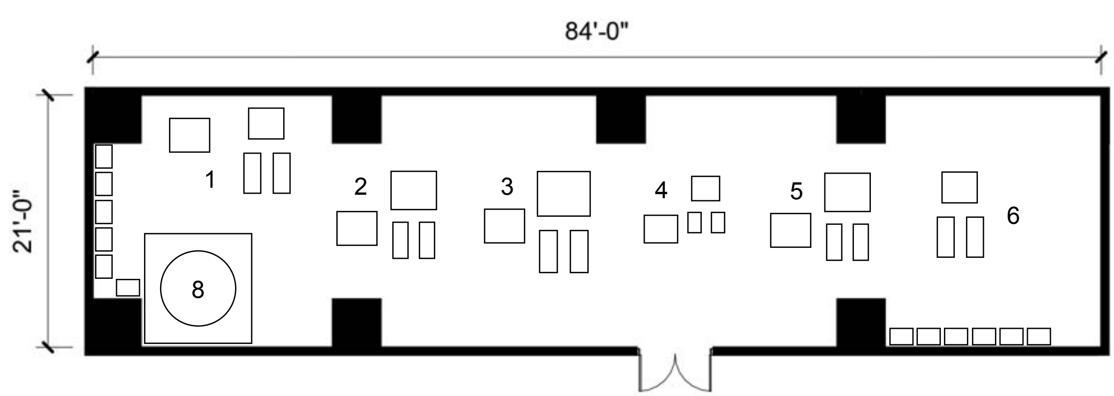
Target Building II

Lead: Peter Rosenblad

Room Data	
Space Number	5.3.1.36
Space Name	Mechanical Room
Net Area Requirement (NSF)	1,330
Number of spaces required	1
Population	0
Space Activities/Functional Description	Equipment room for mechanical equipment
Adjacency Requirements	none
Vehicular Access Requirements	none
Key Design Requirements	Double door to accommodate equipment installation and change.

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 CPV DI Make up water	10' x 8'		☑	☐
2 CPV CHW DI Cooling	10' x 10'		☑	☐
3 CPV TW DI Cooling	10' x 12'		☑	☐
4 Moderator DI Tech CHW	10' x 8'		☑	☐
5 Target Equipment DI Tech CHW	10' x 10'		☑	☐
6 STS Instrument SCHW	8' x 5'		☑	☐
7 3 - WAG for I & C racks	20' x 3'	For basement instrument racks	☑	☐
8 Process waste tank space	300 SF	Basement location	☐	☑
9 Nitrogen & helium distribution panels	60' x 4'	Located in Utility Corridor	☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/16”= 1’-0”

CF: Conventional Facilities
TS: Technical Systems

5.3.1.37 Toilets

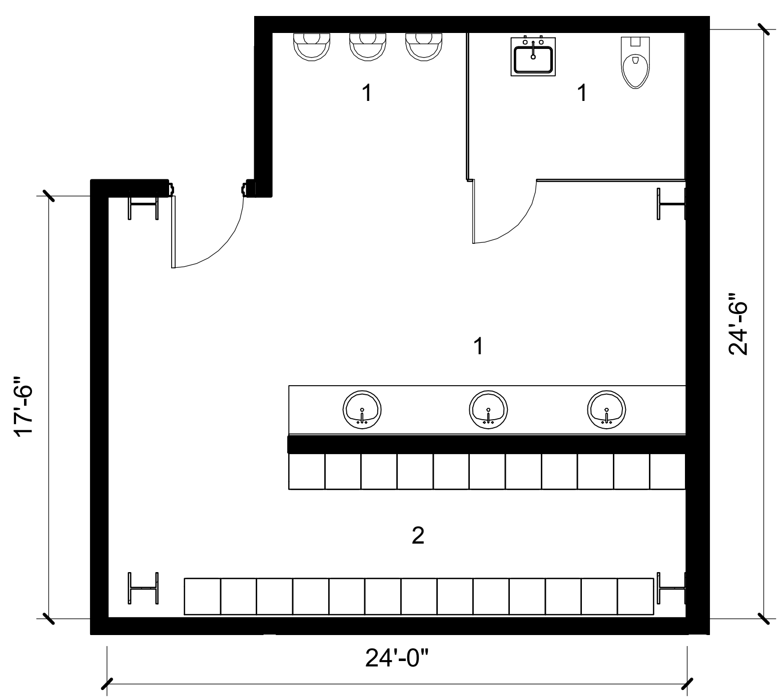
Target Building II

Lead: Peter Rosenblad

Room Data	
Space Number	5.3.1.37
Space Name	Toilets
Net Area Requirement (NSF)	550
Number of spaces required	2
Population	Non-permanent
Space Activities/Functional Description	Support occupants
Adjacency Requirements	none
Vehicular Access Requirements	none
Key Design Requirements	Make accessible

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 Plumbing Fixtures		Verify quantity	✓	
2 Lockers		Verify quantity	✓	

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

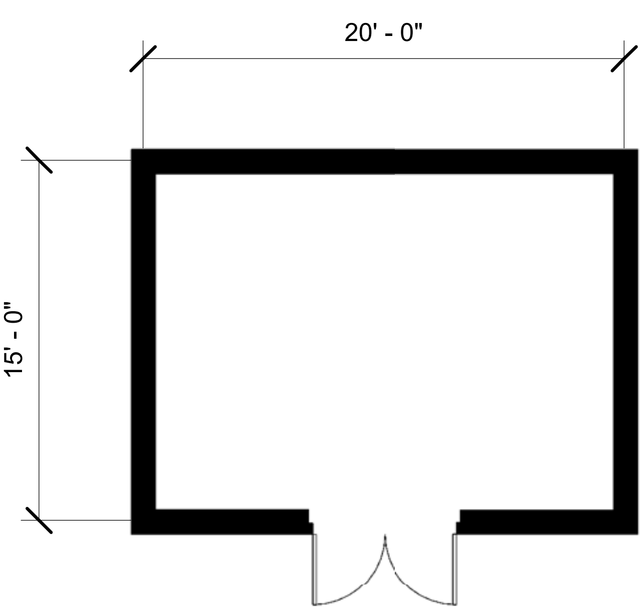
5.3.1.38 Recycling/Trash

Target Building II — Lead: Peter Rosenblad

Room Data	
Space Number	5.3.1.38
Space Name	Recycling/Trash
Net Area Requirement (NSF)	300
Number of spaces required	1
Population	
Space Activities/Functional Description	Recycling/Trash
Adjacency Requirements	Loading Dock
Vehicular Access Requirements	None
Key Design Requirements	

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 None			☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.3.1.39 AHU Space

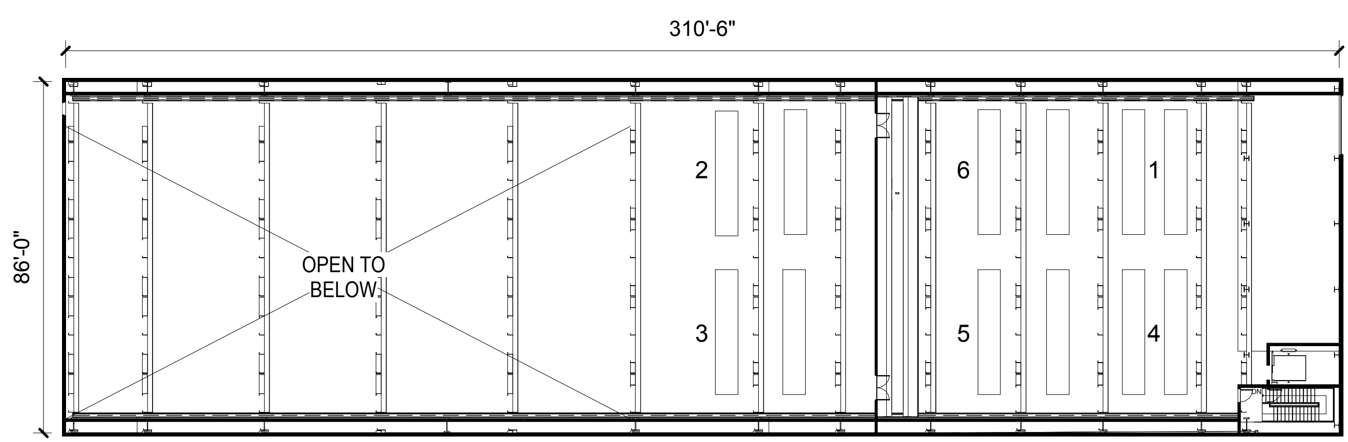
Target Building II

Lead: Peter Rosenblad

Room Data	
Space Number	5.3.1.39
Space Name	AHU Space
Net Area Requirement (NSF)	11,600
Number of spaces required	1
Population	none
Space Activities/Functional Description	Equipment Space
Adjacency Requirements	Located in Truss Space at third floor
Vehicular Access Requirements	none
Key Design Requirements	Need rated separation from lower floor

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	2-Tertiary Support AHU	30’ x 8’ x 5’ ea		☑	☐
2	2-High Bay Recirculation AHU	32’ x 11’ x 10’ ea		☑	☐
3	2-PCE/SCE Support Area MUA	26’ x 8 ’x 10’ ea		☑	☐
4	2-PCE/SCE Support Area MUA	26’ x 8’ x 10’ ea		☑	☐
5	2-40M AHU	30’ x 10’x 10’ ea		☑	☐
6	2-50M AHU	30’ x 10’ x 10’ ea		☑	☐

Test-fit Plan



Preliminary space plan

Scale 1” = 40’-0”

CF: Conventional Facilities
TS: Technical Systems

5.3.1.40 Instrument Vacuum Pump

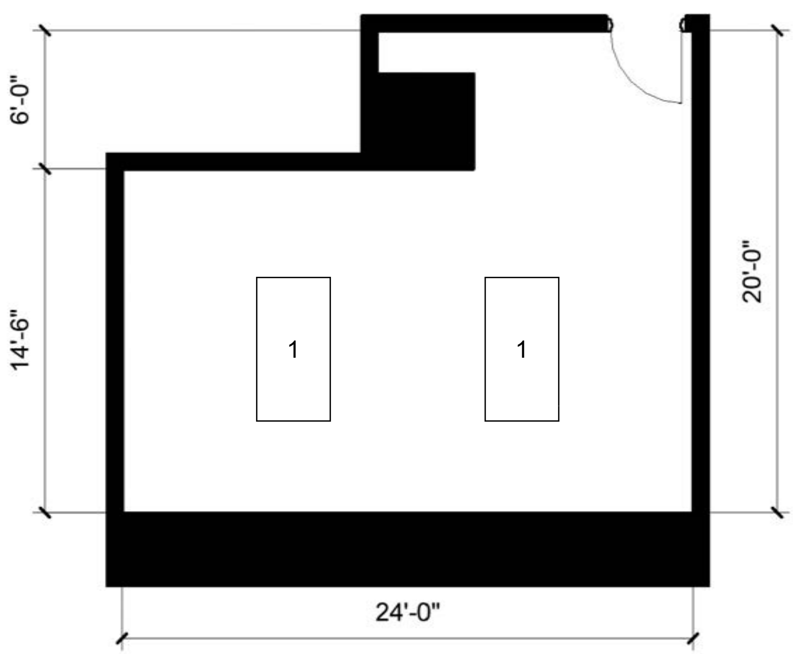
Target Building II

Lead: Ken Herwig

Room Data	
Space Number	5.3.1.40
Space Name	Instrument Vacuum Pump
Net Area Requirement (NSF)	400
Number of spaces required	1
Population	none
Space Activities/Functional Description	House vacuum pumps for the instrument beam lines
Adjacency Requirements	Monolith
Vehicular Access Requirements	None
Key Design Requirements	Vacuum pumps tied into SCE or locally exhausted through HEPA filters.

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	2-Vacuum Pump	3' x 6' x 4'	One primary and one backup	☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.3.1.41 Filter and Delay Tank Cavity

Target Building II

Lead: Peter Rosenblad

Room Data	
Space Number	5.3.1.41
Space Name	Filter and Delay Tank Cavity
Net Area Requirement (NSF)	1,300
Number of spaces required	1
Population	0
Space Activities/Functional Description	
Adjacency Requirements	Second Floor
Vehicular Access Requirements	None
Key Design Requirements	1) Three (3) full flow filter housings (in parallel) and associated piping and instruments for Target water loop 2) Three (3) delay tanks tanks and associated piping and instruments for 3 activated water loops. 3) Two (2) vertical pipe chases down to and through the Mezzanine levels to the Target basement, one on each side of the beam line. 4) Two horizontal pipe chases; one with "S" bend penetrations: One (with "S" bend penetrations) to the adjacent GLS tank cavity and one to the Core Vessel. 5) Cavity lined with SSTL on floor and 1 foot up all sides. 6) Removable cover block over each filter housing to facilitate remote filter media removal into shield cask for disposal. 7) Removable cover "T" block required for personnel access to maintain/replace instruments.

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	Loop 1 Full flow filter housings	3' diam, 7.5 ft tall		☐	☑
2	Loop 1 delay tank	3' dia x 8' OAL		☐	☑
3	Loop 2 delay tank	2' diam, 5'-8" OAL		☐	☑
4	Loop 3 delay tank	2'-8" diam, 7' OAL		☐	☑
5	Liner Plate	1300 sq ft		☑	☐
6	2 vertical pipe chases			☐	☑
7	2 horizontal pipe chases			☑	☐

Note: Test Fit Plan on following page

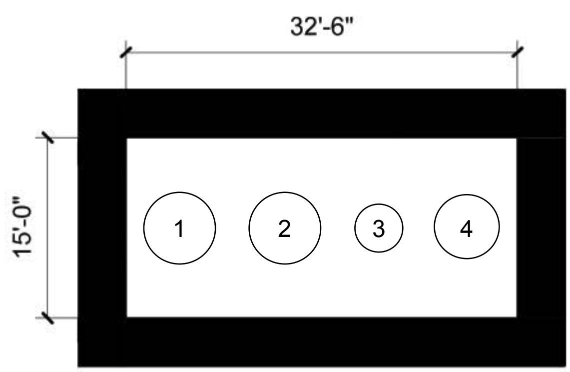
CF: Conventional Facilities
TS: Technical Systems

5.3.1.41 Filter and Delay Tank Cavity

Target Building II

Lead: Peter Rosenblad

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

5.3.1.42 Gas Liquid Separator Cavity

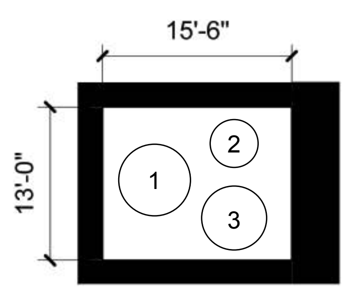
Target Building II

Lead: Peter Rosenblad

Room Data	
Space Number	5.3.1.42
Space Name	Gas Liquid Separator Cavity
Net Area Requirement (NSF)	650
Number of spaces required	1
Population	0
Space Activities/Functional Description	
Adjacency Requirements	Second Floor
Vehicular Access Requirements	None
Key Design Requirements	1) Three (3) GLS tanks and associated piping and instruments for 3 activated water loops 2) Two (2) vertical pipe chases down to and through the Mezzanine levels to the Target basement, one on each side of the beam line 3) Two horizontal pipe chases with "S" bend penetrations: One to the adjacent Filter and Delay tank cavity and one out back of Target Building through CMS Building 4) Cavity lined with SSTL on floor and 1 foot up all sides. 5) Removable cover "T" blocks required for personnel access to maintain/replace instruments

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 Loop 1 GLS tank	3' dia x 8' OAL		☐	☑
2 Loop 2 GLS tank	2' diam, 5'-8" OAL		☐	☑
3 Loop 3 GLS tank	2'-8" diam, 7' OAL		☐	☑
4 Liner Plate	650 sq ft		☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.3.1.43 Mockup room

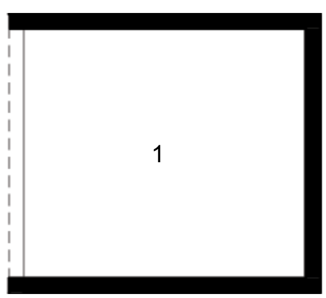
Target Building II

Lead: Ken Herwig

Room Data	
Space Number	5.3.1.43
Space Name	Mockup room
Net Area Requirement (NSF)	500
Number of spaces required	1
Population	0
Space Activities/Functional Description	This space will house a mock-up of the core vessel. It will be used to simulate remote handling operations.
Adjacency Requirements	Double height space on both First and Second floor
Vehicular Access Requirements	
Key Design Requirements	Access to the mock-up along the full height and full perimeter. For this reason, it is most convenient to locaet this space with an open wall adjacent to the truck bay. From above, the area shall have full coverage from the 50 ton crane.

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 Target Core vessel mockup	24' x 12' x 22'		☐	☑

Test-fit Plan



Preliminary space plan

Scale 1/8” = 1’-0”

CF: Conventional Facilities
TS: Technical Systems

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5.4.1
40M INSTRUMENT BUILDING

5.4.1 40M Instrument Building

STS Space Program

Lead: Ken Herwig

No.	Rooms	Qty.	NSF	Total NSF	Mezzanine	First Floor
5.4.1	**40M Instrument Building NSF**			**33,890**	**4,440**	**29,450**
	40M Instrument Building GSF			**44,689**	**34,119**	**10,570**
	40M Instrument Building Efficiency			**76%**		
No.	**Rooms**	**Qty.**	**NSF**	**Total NSF**	**Mezzanine**	**First Floor**
5.4.1.1	User Support Lab	2	620	1,240	1,240	
5.4.1.2	Instrument/Beam Line Space	1	21,100	21,100		21,100
5.4.1.3	Truck unloading set-down area	1	2,800	2,800		2,800
5.4.1.4	Sample Environment Cages	1	1,350	1,350		1,350
5.4.1.5	Bridge to 40M Instrument Building (Exterior)	1	2,800	2,800	2,800	
5.4.1.6	ZEEMANS - Magnet Utilities	1	2,200	2,200		2,200
5.4.1.7	ZEEMANS - Beam Line/Chopper/Optics Crane Access Area	1	2,000	2,000		2,000
5.4.1.8	ZEEMANS - Control Room	1	300	300	300	
5.4.1.9	ZEEMANS - Computer Room	1	100	100	100	

Additional Program Space Requirements

Circulation/Mezzanine

2 - Open stairs

Substation TA2-SS2 & TA2-SS3 (Exterior Pad)

Generator TA2-EG1 (Exterior Pad)

Note: Test Fit Plan on following page

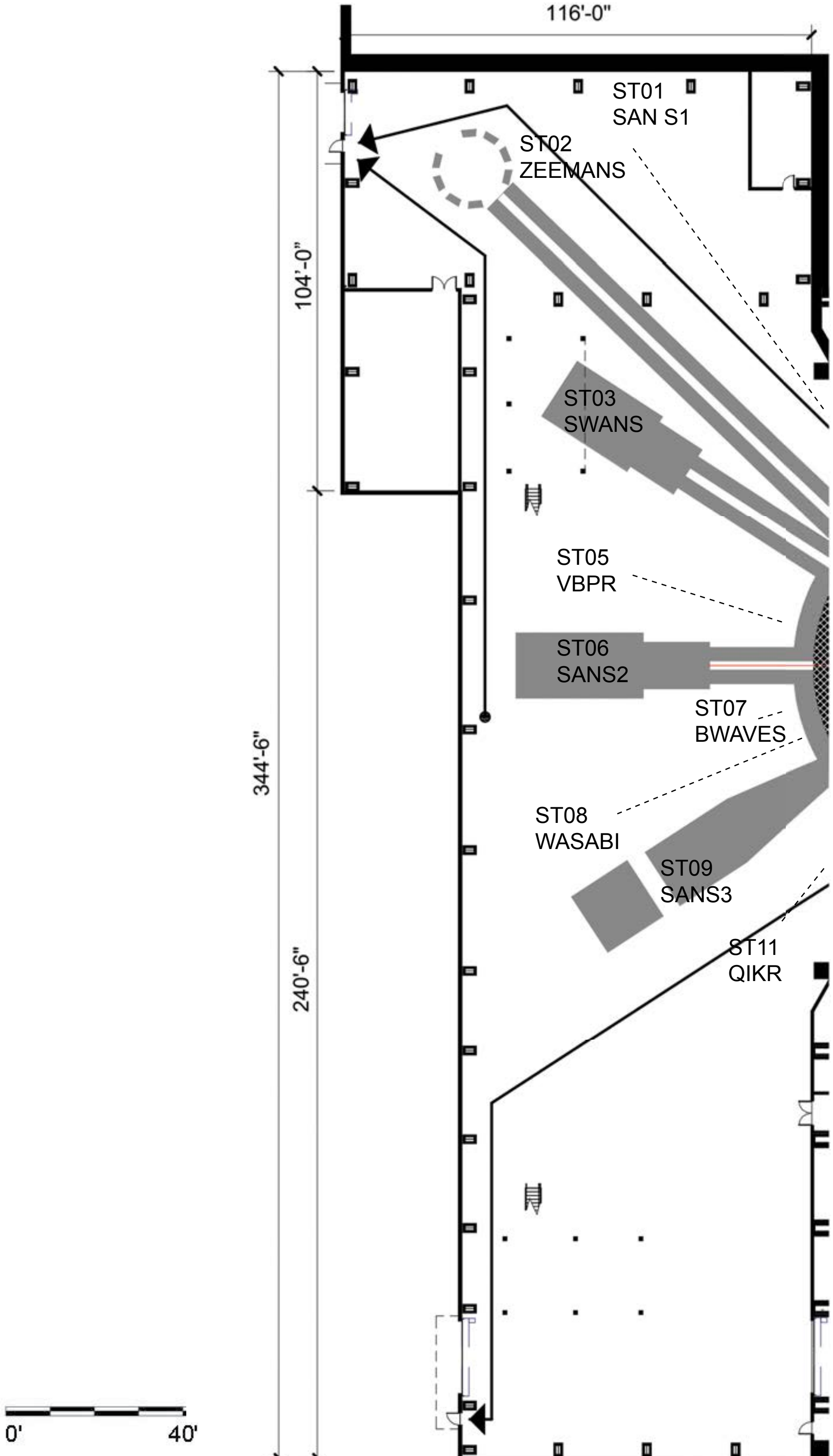
CF: Conventional Facilities
TS: Technical Systems

5.4.1 40M Instrument Building

40M Instrument Building

Lead: Ken Herwig

Test-fit Plan



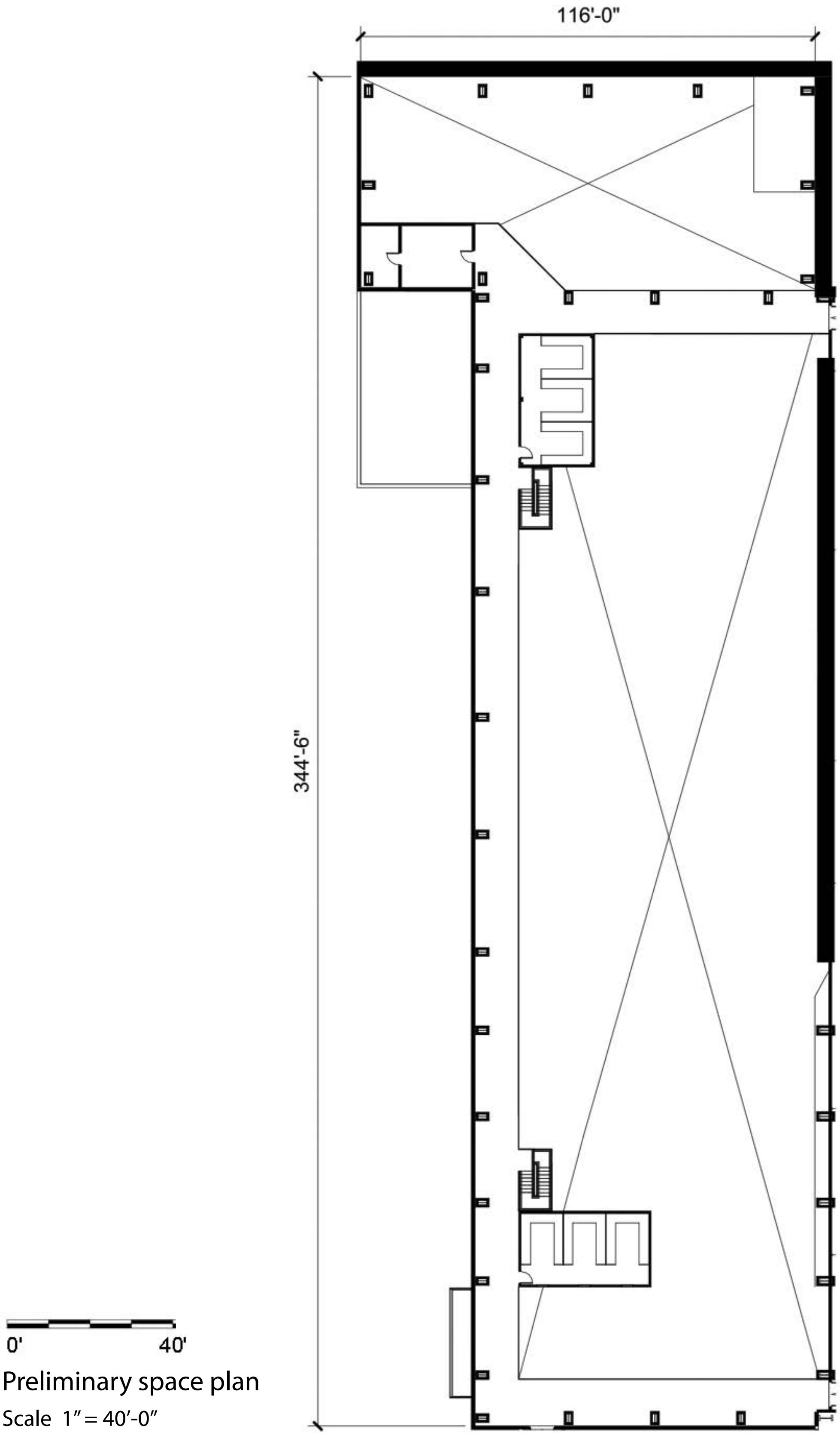
Preliminary space plan

Scale 1" = 40'-0"

5.4.1 40M Instrument Building

40M Instrument Building | Lead: Ken Herwig

Test-fit Plan



Preliminary space plan

Scale 1″ = 40′-0″

5.4.1.1 User Support Lab

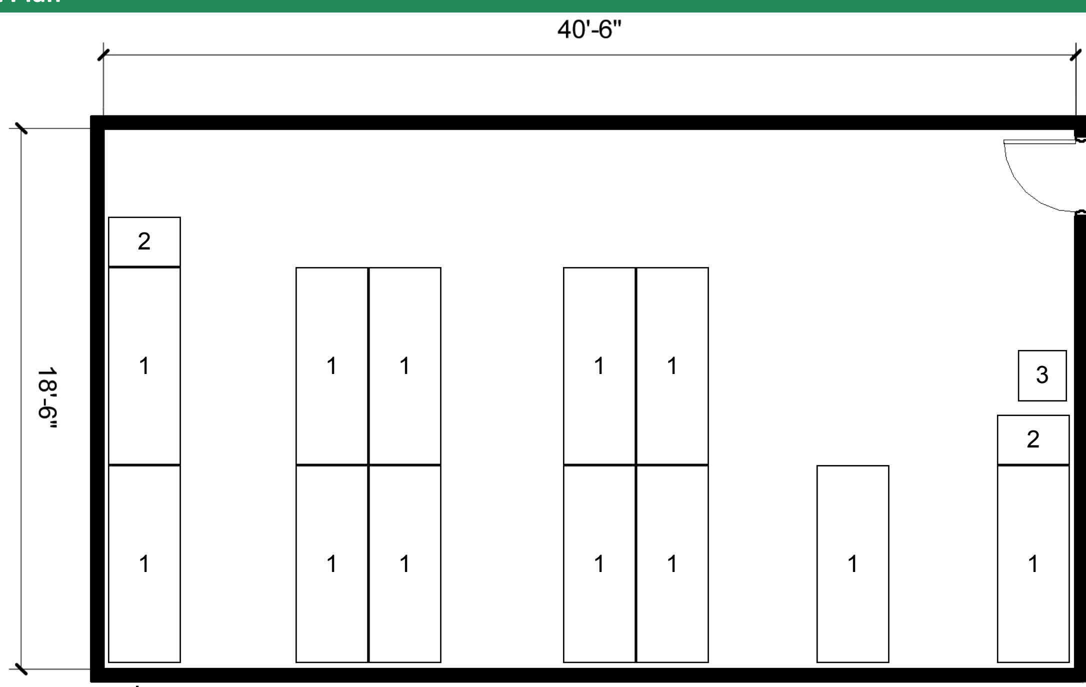
40M Instrument Building

Lead: Ken Herwig

Room Data	
Space Number	5.4.1.1
Space Name	User Support Lab
Net Area Requirement (NSF)	620
Number of spaces required	2
Population	2 - 4
Space Activities/Functional Description	General lab supporting instrument users
Adjacency Requirements	Mezzanine level, instruments
Vehicular Access Requirements	None
Key Design Requirements	All labs designed as chemistry labs with nitrogen, vacuum. Needs people access to instrument end stations. Provide emergency eyewash based on regulatory requirements.

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 8 - Lab benches	3' x 8' x7'	Essentially back to back filling floor space but leaving enough room for equipment and moving people around	☑	☐
2 2 - Fumehoods	3' x 6' x 8'	Standard hoods - one for solvent/chemicals, the second for nano-particles	☑	☐
3 Sink	2' x 2'		☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.4.1.2 Instrument/Beam Line Space

40M Instrument Building

Lead: Ken Herwig

Room Data	
Space Number	5.4.1.2
Space Name	Instrument/Beam Line Space
Net Area Requirement (NSF)	21,100
Number of spaces required	1
Population	6 per instrument
Space Activities/Functional Description	Houses Neutron Beams, shielding and instruments
Adjacency Requirements	Monolith, User Support Labs, mezzanine, control room
Vehicular Access Requirements	Tractor/Trailer
Key Design Requirements	30 T Overhead beam crane, mezzanine level access. 40ft hook height from floor elevation. 10T 30ft Hook height from floor elevation for ZEEMANS only. Instrument crane. Egress stair

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	ST01 - SANS1 Instrument Space	TBD		☐	☑
2	ST01 - SANS1 Beam Line Space	TBD		☐	☑
3	ST02 - ZEEMANS Instrument Space	TBD	30ft Crane hook height	☐	☑
4	ST02 - ZEEMANS Beam Line Space	TBD	30ft Crane hook height	☐	☑
5	ST03 - SWANS Instrument Space	TBD		☐	☑
6	ST03 - SWANS Beam Line Space	TBD		☐	☑
7	ST04 - TBD Instrument Space	TBD		☐	☑
8	ST04 - TBD Beam Line Space	TBD		☐	☑
9	ST05 - VBPR Instrument Space	TBD		☐	☑
10	ST05 - VBPR Beam Line Space	TBD		☐	☑
11	ST06 - SANS2 Instrument Space	TBD		☐	☑
12	ST06 - SANS2 Beam Line Space	TBD		☐	☑
13	ST07 - BWAVES Instrument Space	TBD		☐	☑
14	ST07 - BWAVES Beam Line Space	TBD		☐	☑
15	ST08 - WASABI Instrument Space	TBD		☐	☑
16	ST08 - WASABI Beam Line Space	TBD		☐	☑
17	ST09 - SANS3 Instrument Space	TBD		☐	☑
18	ST09 - SANS3 Beam Line Space	TBD		☐	☑
19	ST10 - TBD Instrument Space	TBD		☐	☑
20	ST10 - TBD Beam Line Space	TBD		☐	☑
21	ST11 - QIKR Instrument Space	TBD		☐	☑
22	ST11 - QIKR Beam Line Space	TBD		☐	☑
21	Wet lab for BL 1	400 SF	With exhgaust hood support. Will be suppied by BL1, out space allocation should be shown along retaining wall.	☐	☑
22	Overhead crane	30 Ton	40’ from elevation 1074’. Include 5 ton javelin crane	☑	☐
24	Overhead crane (ZEEMANS)	10 Ton	30’ from elevation 1074’	☑	☐

Note: Test Fit Plan on following page

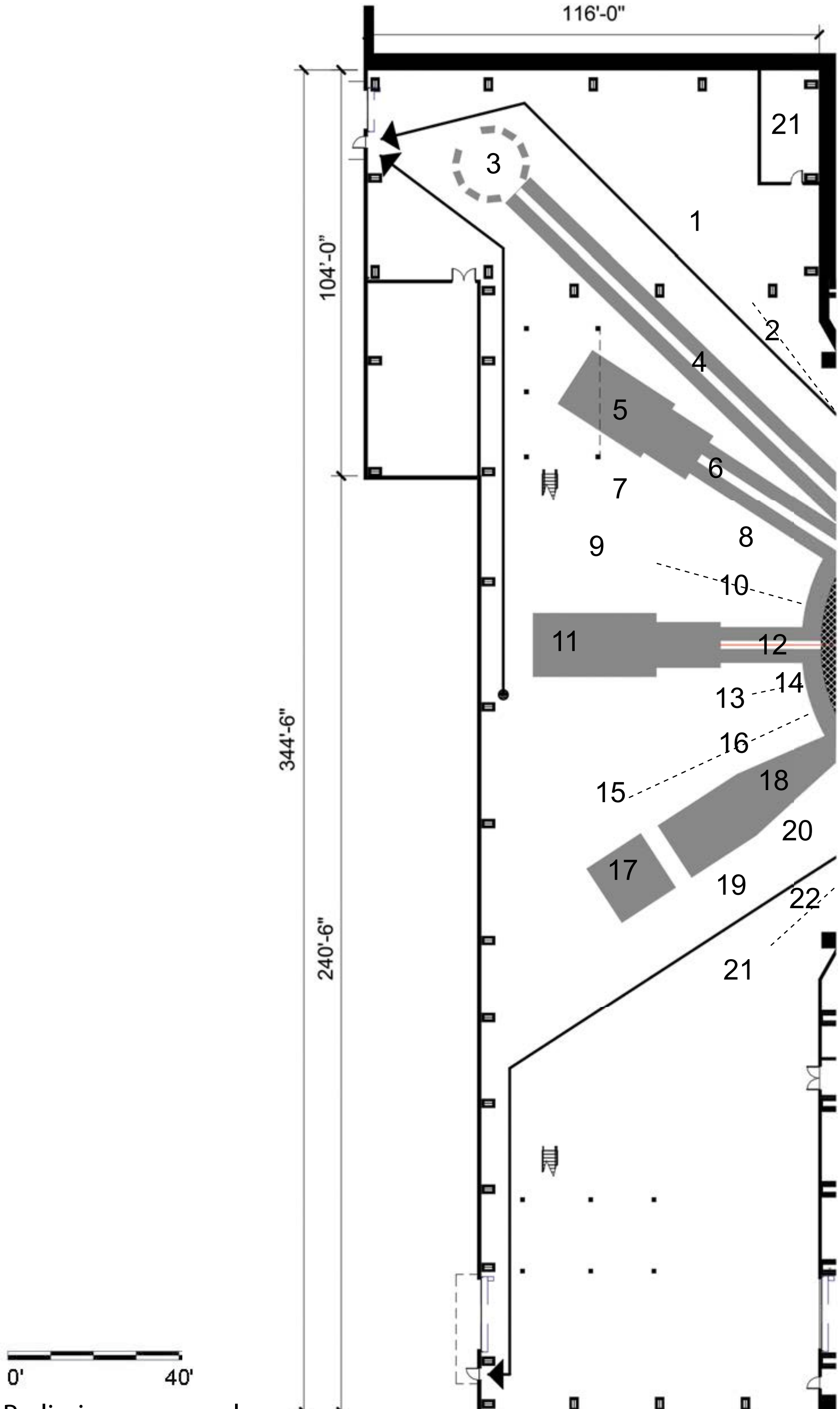
CF: Conventional Facilities
TS: Technical Systems

5.4.1.2 Instrument/Beam Line Space

40M Instrument Building

Lead: Ken Herwig

Test-fit Plan



Preliminary space plan

Scale 1" = 40'-0"

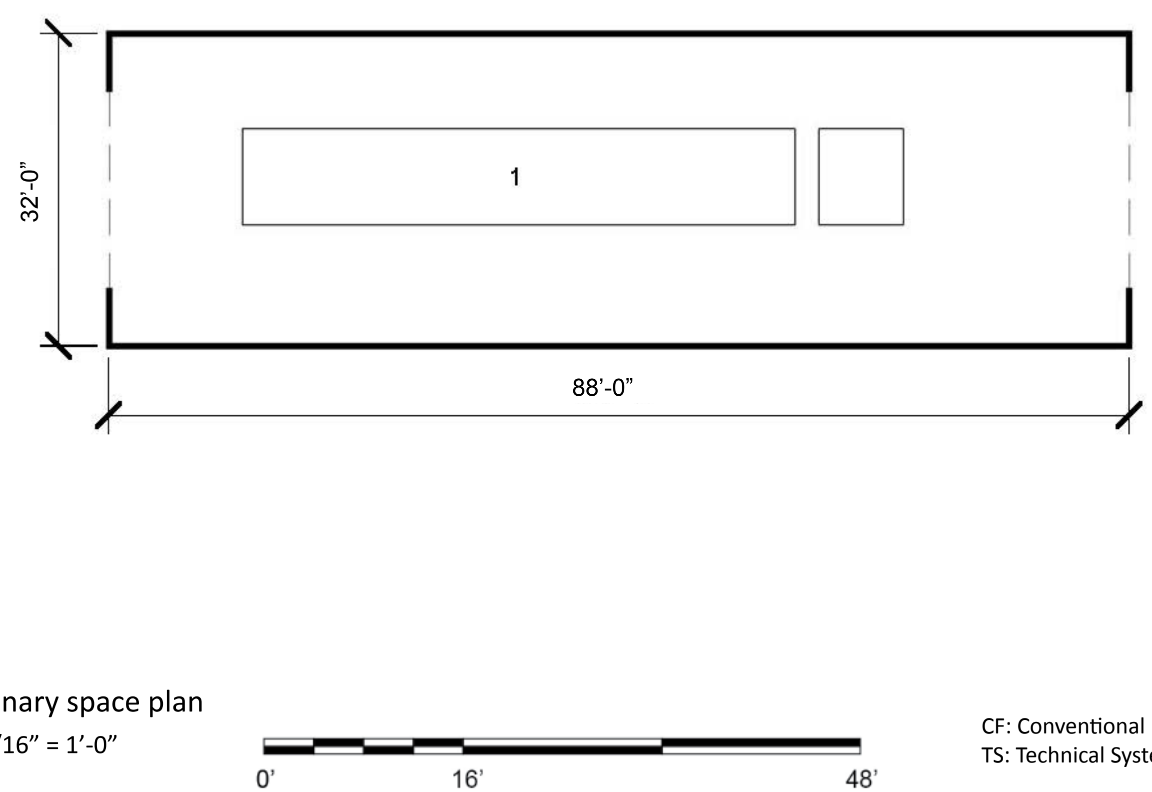
5.4.1.3 Truck Unloading Set-Down Area

40M Instrument Building | Lead: Ken Herwig

Room Data	
Space Number	5.4.1.3
Space Name	Truck unloading set-down area
Net Area Requirement (NSF)	2,800
Number of spaces required	1
Population	0
Space Activities/Functional Description	Loading/Unloading
Adjacency Requirements	Instruments
Vehicular Access Requirements	Tractor/Trailer
Key Design Requirements	Overhead crane hook height requirement is 40'. 14' high overhead door at truck access

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 Trailer	46' x 8'		☑	☐

Overall Plan



Preliminary space plan

Scale 1/16" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.4.1.4 Sample Environment Cages

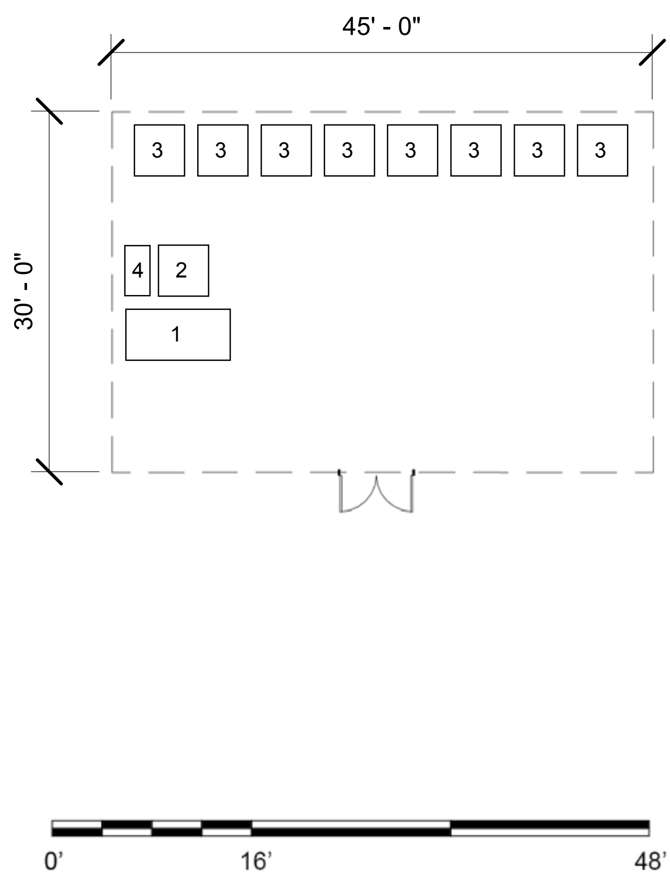
40M Instrument Building

Lead: Ken Herwig

Room Data	
Space Number	5.4.1.4
Space Name	Sample Environment Cages
Net Area Requirement (NSF)	1,350
Number of spaces required	1
Population	5
Space Activities/Functional Description	Development, sample preparation pre-install,
Adjacency Requirements	PIT, crane access
Vehicular Access Requirements	None
Key Design Requirements	None

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 Sample temperature control	5' x 10' x 5'		☐	☑
2 Pumps for samples	5' x 5' x 5'		☐	☑
3 8 - Sample environment inserts	5' x 5' x 5'		☐	☑
4 Small sample plumbing manifold	5' x 3' x 10'		☐	☑

Test-fit Plan



Preliminary space plan

Scale 1/16" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.4.1.5 Bridge to 40M Instrument Building

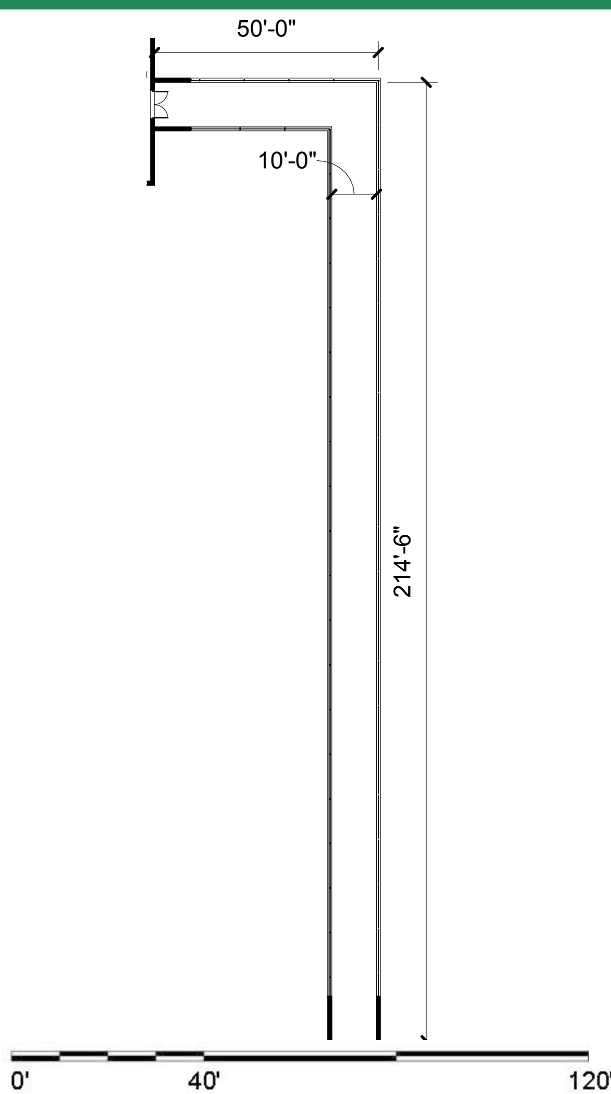
40M Instrument Building

Lead: Ken Herwig

Room Data	
Space Number	5.4.1.5
Space Name	Bridge to 40M Instrument Building
Net Area Requirement (NSF)	2,800
Number of spaces required	1
Population	Transient
Space Activities/Functional Description	Enclosed elevated pedestrian connection between existing FTS bridge and 40M Building
Adjacency Requirements	Connect to existing FTS bridge and 40M Building
Vehicular Access Requirements	none
Key Design Requirements	Match design of existing bridge between CLO and

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	None			☐	☐

Test-fit Plan



Preliminary space plan

Scale 1” = 40’-0”

CF: Conventional Facilities

TS: Technical Systems

5.4.1.6 ZEEMANS - Magnet Utilities

40M Instrument Building | Lead: Ken Herwig

Room Data	
Space Number	5.4.1.6
Space Name	ZEEMANS - Magnet Utilities
Net Area Requirement (NSF)	2,200
Number of spaces required	1
Population	5
Space Activities/Functional Description	Utility support systems for magnet alone
Adjacency Requirements	Must be in close proximity to ZEEMANS magnet (sample position)
Vehicular Access Requirements	Forklift access. Rolling door access to outside
Key Design Requirements	Sound proofing. High purity helium bottles located exterior and adjacent. 14' high overhead door at truck access, Sensible Chilled water

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	1 - Helium Liquification Plant	20' x 40' x 12' shared room		☐	☑
2	Gas Recovery System	20' x 40' x 12' shared room	Houses 8x Cold heads (3x3x3 ea) & compressor	☐	☑
3	Gas Bag	40m^3 (1.5m dia x 20m long)	In truss space. suspended from the ceiling of Magnet Utility Room. Locate close to ZEEMANS instrument.	☐	☑
4	400 A fused disconnects to helium compressors		local LTV (Lock, Tag, Verify) for electrical service to compressors. Locate close to ZEEMANS instrument.	☐	☑

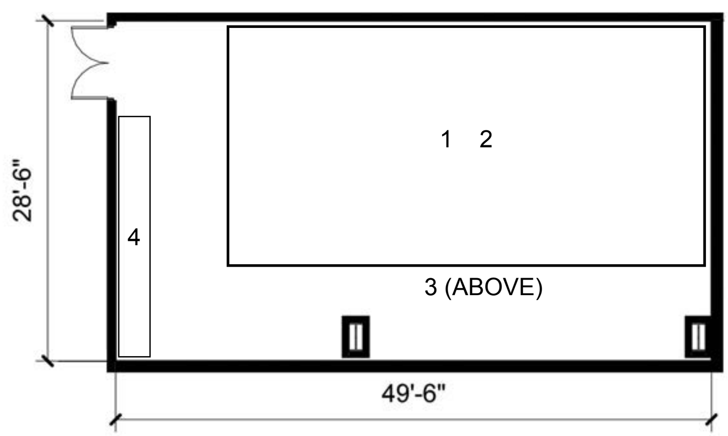
Note: Test Fit Plan on following page

CF: Conventional Facilities
TS: Technical Systems

5.4.1.6 ZEEMANS - Magnet Utilities

40M Instrument Building Lead: Ken Herwig

Test-fit Plan



Preliminary space plan

Scale 1/16” = 1’-0”

5.4.1.7 ZEEMANS - Beam Line/Chopper/Optics Crane Access Area

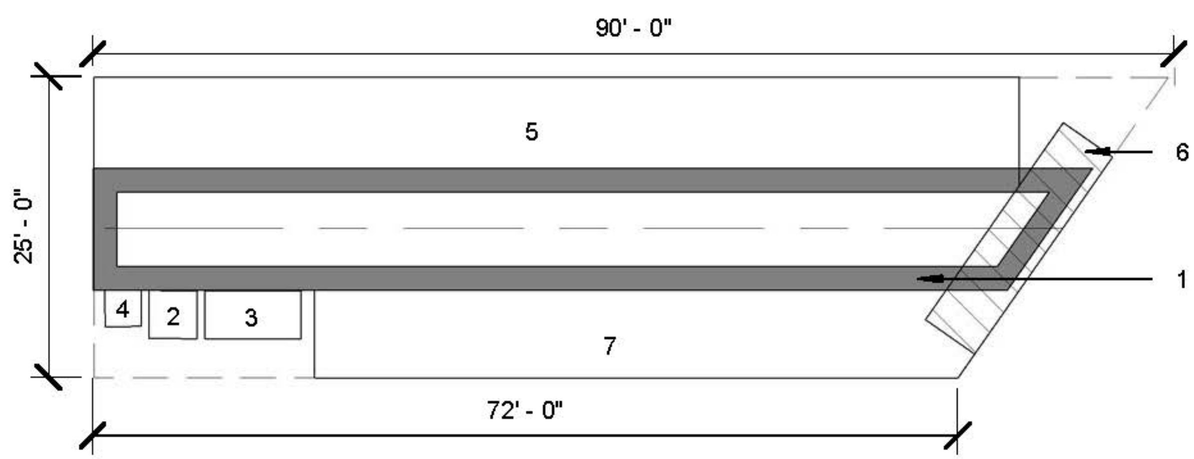
40M Instrument Building

Lead: Ken Herwig

Room Data	
Space Number	5.4.1.7
Space Name	ZEEMANS - Beam Line/Chopper/Optics Crane Access Area
Net Area Requirement (SF)	2,000
Number of spaces required	1
Population	5
Space Activities/Functional Description	Utility support systems
Adjacency Requirements	Instrument
Vehicular Access Requirements	None
Key Design Requirements	10T crane 30' hook hieght. Non-magnetic construction 10ft around sample center

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 Beamline with shielding	800 SF		☐	☑
2 Chopper Rack	4' x 4' x 10'		☐	☑
3 Chopper Chiller	4' x 8' x 4'		☐	☑
4 Chopper pumps	3' x 3' x 3'		☐	☑
5 Sample environment pick-up area	400 SF		☑	☐
6 Vacuum pumps	5' x 10' x 5'		☐	☑
7 Utility manifold wall	3' x 30' x 10'	All support equipment here needs cabling or flexible piping close to and leading to the top of the magnet, and appropriate routing, manifolds, valves for easy maintenance	☐	☑
8 Quench protection	3' x 20' x 3'	200 cubic feet	☐	☑

Test-fit Plan



Preliminary space plan

Scale 1/16" = 1'-0"

0' 16' 48'

CF: Conventional Facilities
TS: Technical Systems

5.4.1.8 ZEEMANS - Control Room

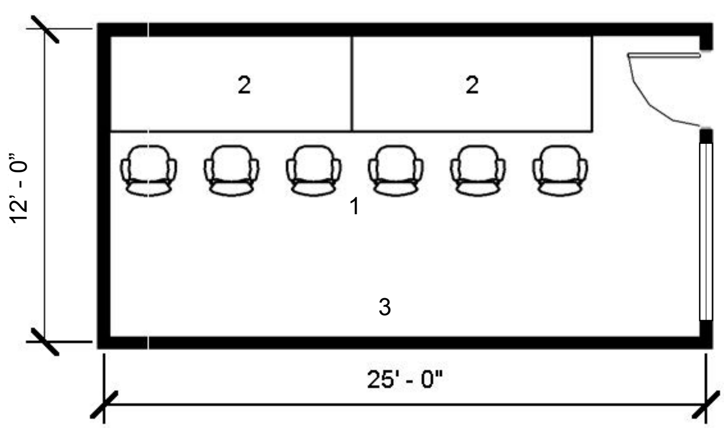
40M Instrument Building

Lead: Ken Herwig

Room Data	
Space Number	5.4.1.8
Space Name	ZEEMANS - Control Room
Net Area Requirement (NSF)	300
Number of spaces required	1
Population	6
Space Activities/Functional Description	Houses tables, chairs and terminals for
Adjacency Requirements	Computer room, SE lab space, PIT
Vehicular Access Requirements	None
Key Design Requirements	Prefabricated hutch. Procured as part of the instrument scope. Include window.

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	6 - Chairs	3' x 3' x 4'		☐	☐
2	2 - Long table with terminals	4' x 10' x 4'		☐	☐
3	Whiteboard	3' x 10' x 8'		☐	☐

Test-fit Plan



Preliminary space plan

Scale 1/16" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

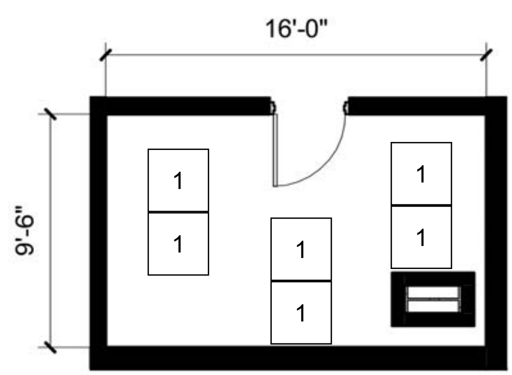
5.4.1.9 ZEEMANS - Computer Room

40M Instrument Building

Lead: Ken Herwig

Room Data	
Space Number	5.4.1.9
Space Name	ZEEMANS - Computer Room
Net Area Requirement (NSF)	100
Number of spaces required	1
Population	1
Space Activities/Functional Description	Electronics, computers and racks for instrument
Adjacency Requirements	Control room
Vehicular Access Requirements	None
Key Design Requirements	Sufficient AC to handle 3 tall racks/heat load. Prefabricated hutch. Procured as part of the instrument scope.

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 6 - Racks	30" x 30"		☐	☐



Preliminary space plan

Scale 1/8" = 1'-0"

0' 8' 24'

CF: Conventional Facilities
TS: Technical Systems

5.4.2
50M INSTRUMENT BUILDING

5.4.2 50M Instrument Building

STS Space Program — Lead: Ken Herwig

No.	Rooms	Qty.	NSF	Total NSF	Mezzanine	First Floor
5.4.2	**50M Instrument Building NSF**			**27,540**	**1,240**	**26,300**
	50M Instrument Building GSF			**42,150**	**7,456**	**34,694**
	50M Instrument Building Efficiency			**65%**		
No.	**Rooms**	**Qty.**	**NSF**	**Total NSF**	**Mezzanine**	**First Floor**
5.4.2.1	Instrument/Beam Line Space	1	20,000	20,000		20,000
5.4.2.2	User Support Lab	2	620	1,240	1,240	
5.4.2.3	Truck unloading set-down area	1	4,250	4,250		4,250
5.4.2.4	Sample Environment Cages	1	1,350	1,350		1,350
5.4.2.5	Staging and Prep Area	1	400	400		400
5.4.2.6	Emergency Electrical Room	1	300	300		300

Additional Program Space Requirements

Circulation/Mezzanine

2 - Open stairs

Electrical Substations (Exterior Pad)

Electrical Generator (Exterior Pad)

5.4.2.1 Instrument/Beam Line Space

50M Instrument Building

Lead: Ken Herwig

Room Data	
Space Number	5.4.2.1
Space Name	Instrument/Beam Line Space
Net Area Requirement (NSF)	20,000
Number of spaces required	1
Population	0
Space Activities/Functional Description	Houses Neutron Beams, shielding and instruments
Adjacency Requirements	Target Building, Sample Environment
Vehicular Access Requirements	Tractor/Trailer
Key Design Requirements	30 T Overhead beam crane, mezzanine level access. 40ft hook height from floor elevation. Egress stair. Instrument crane.

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	ST12 - NSE Instrument Space	TBD		☐	☑
2	ST12 - NSE Beam Line Space	TBD		☐	☑
3	ST13 - VERDI Instrument Space	TBD		☐	☑
4	ST13 - VERDI Beam Line Space	TBD		☐	☑
5	ST14 - HERTZ Instrument Space	TBD		☐	☑
6	ST14 - HERTZ Beam Line Space	TBD		☐	☑
7	ST15 - TBD Instrument Space	TBD		☐	☑
8	ST15 - TBD Beam Line Space	TBD		☐	☑
9	ST16 - NESCRY Instrument Space	TBD		☐	☑
10	ST16 - NESCRY Beam Line Space	TBD		☐	☑
11	ST17 - CHESS Instrument Space	TBD	Pit required	☐	☑
12	ST17 - CHESS Beam Line Space	TBD		☐	☑
13	ST18 - TBD Instrument Space	TBD		☐	☑
14	ST18 - TBD Beam Line Space	TBD		☐	☑
15	ST19 - TBD Instrument Space	TBD		☐	☑
16	ST19 - TBD Beam Line Space	TBD		☐	☑
17	ST22 - IMAGING Instrument Space	TBD		☐	☑
18	ST22 - IMAGING Beam Line Space	TBD		☐	☑
19	Overhead crane	30 Ton	40’ from elevation 1074’. Include 5 ton javelin crane	☑	☐

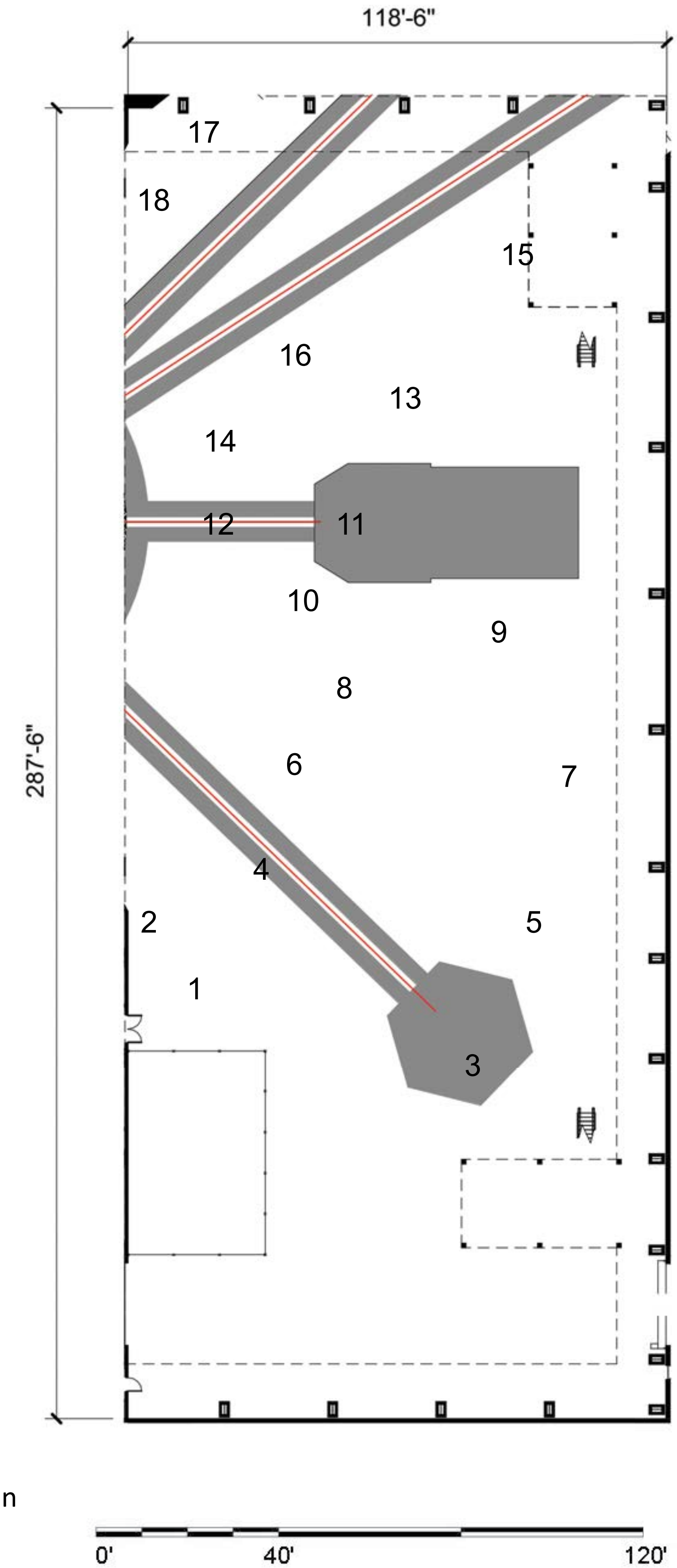
Note: Test Fit Plan on following page

5.4.2.1 Instrument/Beam Line Space

50M Instrument Building

Lead: Ken Herwig

Test-fit Plan



Preliminary space plan

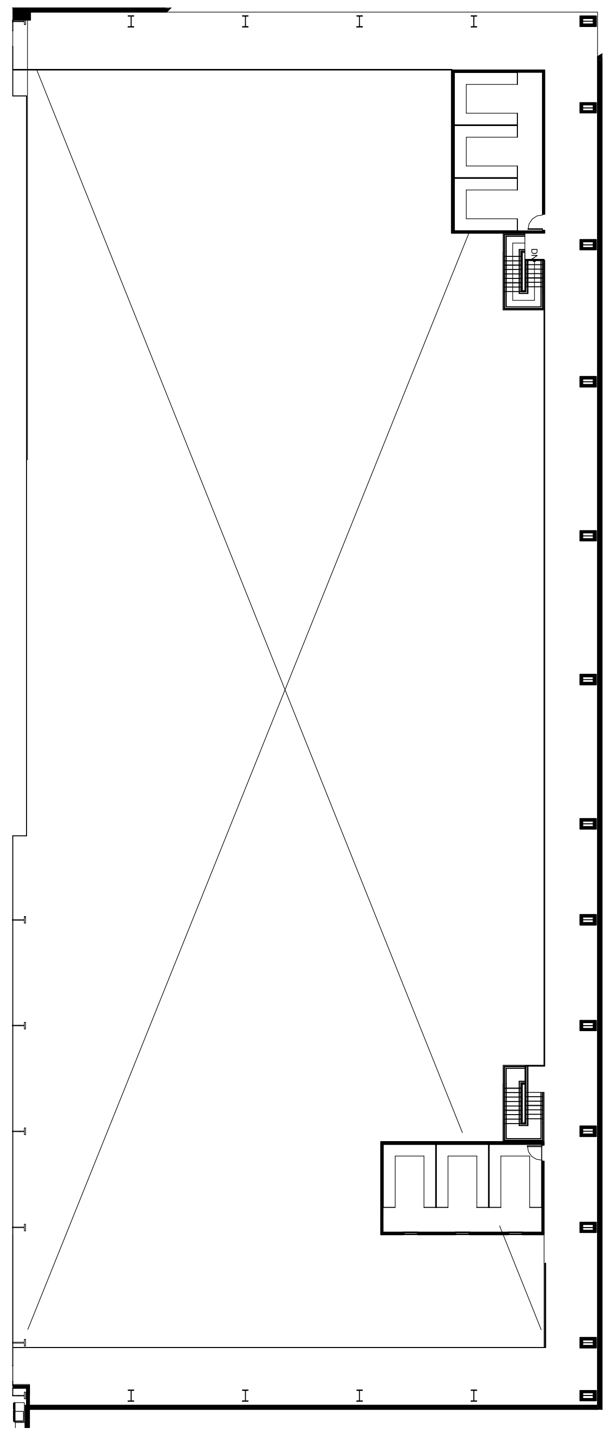
Scale 1" = 40'-0"

5.4.2.1 Instrument/Beam Line Space

50M Instrument Building

Lead: Ken Herwig

Test-fit Plan



Preliminary space plan

Scale 1” = 40’-0”

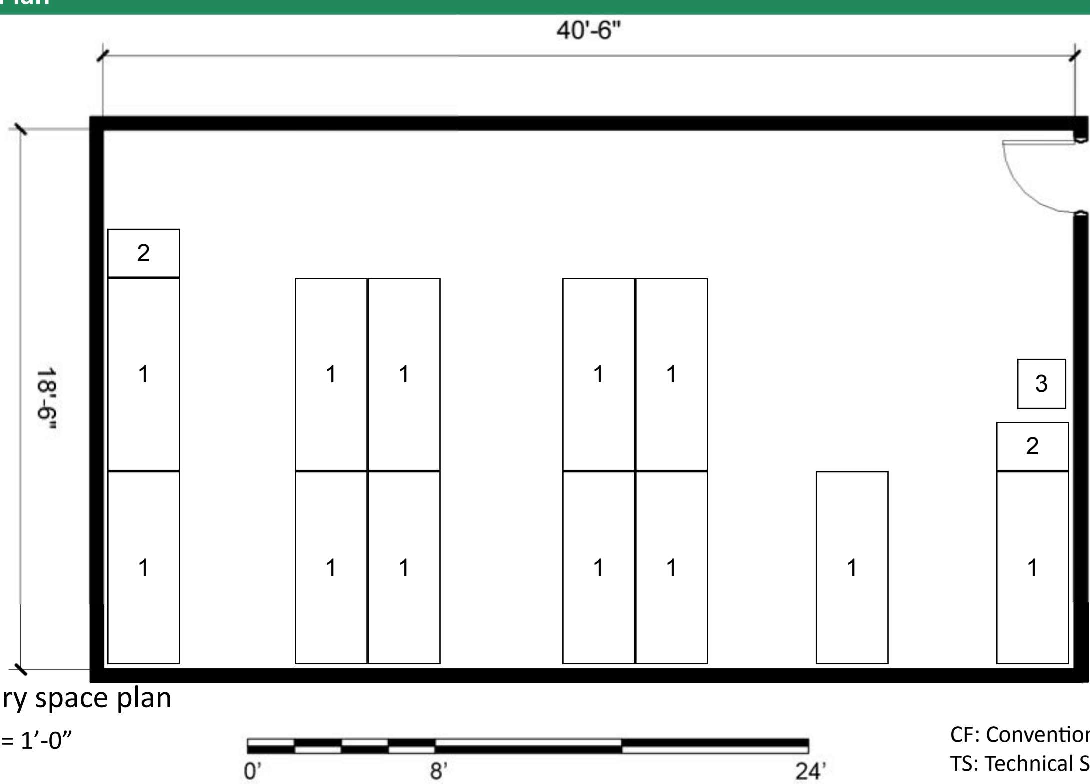
5.4.2.2 User Support Lab

50M Instrument Building | Lead: Ken Herwig

Room Data	
Space Number	5.4.2.2
Space Name	User Support Lab
Net Area Requirement (NSF)	620
Number of spaces required	2
Population	2 - 4
Space Activities/Functional Description	General lab supporting instrument users
Adjacency Requirements	Instruments
Vehicular Access Requirements	None
Key Design Requirements	All labs designed as chemistry labs with nitrogen, vacuum. Needs people access to instrument end stations.

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 8 - Lab benches	3' x 8' x7'	Essentially back to back filling floor space but leaving enough room for equipment and moving people around	☑	☐
2 2 - Fumehoods	3' x 2' x 8'	Standard hoods - one for solvent/chemicals, the second for nano-particles	☑	☐
3 Sink	2' x 2'		☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.4.2.3 Truck Unloading Set-Down Area

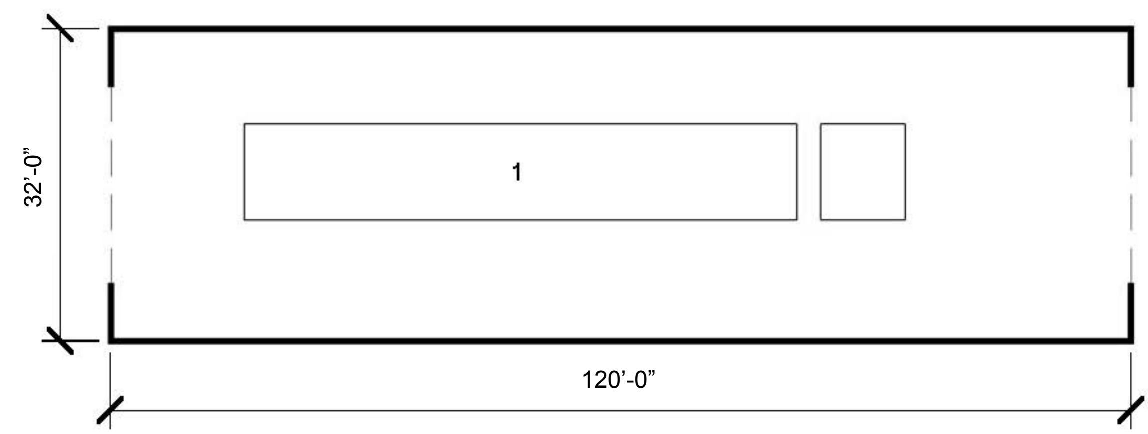
50M Instrument Building

Lead: Ken Herwig

Room Data	
Space Number	5.4.2.3
Space Name	Truck Unloading Set-Down Area
Net Area Requirement (NSF)	4,250
Number of spaces required	1
Population	0
Space Activities/Functional Description	Loading/Unloading
Adjacency Requirements	Instruments
Vehicular Access Requirements	Tractor/Trailer
Key Design Requirements	Overhead crane hook height requirement is 40'. 14' high overhead door at truck access

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	Trailor	46' x 8'		☐	☐

Test-fit Plan



Preliminary space plan

Scale 1/16" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

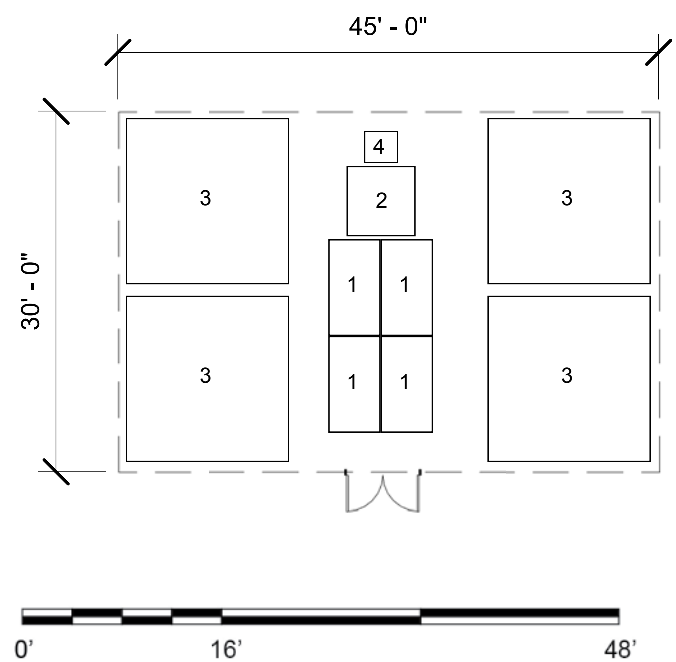
5.4.2.4 Sample Environment Cages

50M Instrument Building | Lead: Ken Herwig

Room Data	
Space Number	5.4.2.4
Space Name	Sample Environment Cages
Net Area Requirement (NSF)	1,350
Number of spaces required	1
Population	4 people continuously
Space Activities/Functional Description	Technician work on sample environment
Adjacency Requirements	STS First Floor location
Vehicular Access Requirements	Access to loading zone required
Key Design Requirements	5 T overhead crane, power/utilities distribute to 4 working bays, compressed air, sensible chilled water. Level/smooth transport to equipment loading zone and to 40 M instrument bay and long instruments enclosures; need open space to minimize ODH concerns with cryogens, space needs to be caged to restrict access.

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	4 - Work tables	3' x 8'		☐	☑
2	Sample environment equipment	3' x 3' x 8'	space for staging 10 at a time	☐	☑
3	4 - Working bays	14' x 14' x 10'	each equipped w/ standard utility distribution	☐	☑
4	Cryogen dewars	3' x 3' x 7'	up to 10 at a time	☐	☑

Test-fit Plan



Preliminary space plan

Scale 1/16" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.4.2.5 Staging and Prep Area

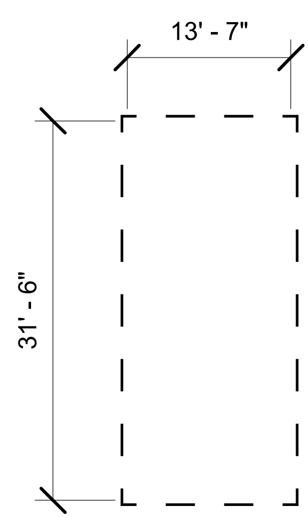
50M Instrument Building

Lead: Ken Herwig

Room Data	
Space Number	5.4.2.5
Space Name	Staging and Prep Area
Net Area Requirement (NSF)	400
Number of spaces required	1
Population	none
Space Activities/Functional Description	Support of instrument space
Adjacency Requirements	Instrument Space
Vehicular Access Requirements	none
Key Design Requirements	none

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 None			☐	☐

Test-fit Plan



Preliminary space plan

Scale 1/16" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.4.2.6 Emergency Electrical Room

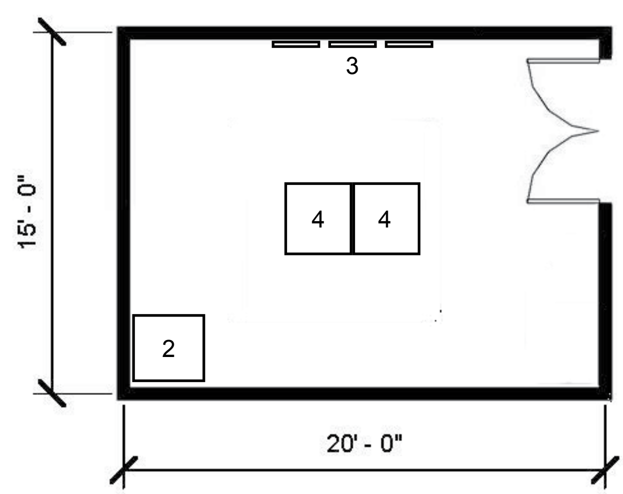
50M Instrument Building

Lead: Ken Herwig

Room Data	
Space Number	5.4.2.6
Space Name	Emergency Electrical Room
Net Area Requirement (NSF)	300
Number of spaces required	1
Population	0
Space Activities/Functional Description	Equipment Room
Adjacency Requirements	none
Vehicular Access Requirements	none
Key Design Requirements	Rated enclosure, provide paired doors for equipment installation. Double doors for emergency egress and equipment placement & maintenance.

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 TA2-SS4 Switchgear	72" x 88” x 96”	Exterior	☑	☐
2 Transformer	3' x 3' x 3'		☑	☐
3 3 - Panelboards	30" x 8" x 42"		☑	☐
4 2 - Automatic Transfer Switch	3' x 3 ' x 6'-6"		☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/8” = 1’-0”

CF: Conventional Facilities
TS: Technical Systems

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5.4.3
90M INSTRUMENT BUILDING

5.4.3 90M Instrument Building

STS Space Program

Lead: Ken Herwig

No.	Rooms	Qty.	NSF	Total NSF
5.4.3	**90M Instrument Building NSF**			**12,800**
	90M Instrument Building GSF			**16,856**
	90M Instrument Building Efficiency			**76%**
No.	**Rooms**	**Qty.**	**NSF**	**Total NSF**
5.4.3.1	EWALD/MENUS - Instrument/Beam Line Space	1	11,850	11,850
5.4.3.2	Electrical Room	1	400	400
5.4.3.3	Sample Prep	2	130	260
5.4.3.4	Control Cabin	2	145	290

Additional Program Space Requirements

TA2-SS4 Substation (Exterior Pad)

Generator TA2-EG2 (Exterior Pad)

5.4.3.1 EWALD/MENUS - Instrument/Beam Line

90M Instrument Building

Lead: Ken Herwig

Room Data	
Space Number	5.4.3.1
Space Name	EWALD/MENUS - Instrument/Beam Line Space
Net Area Requirement (NSF)	11,850
Number of spaces required	1
Population	0 - 5
Space Activities/Functional Description	Houses instruments, neutron beam and choppers, and supporting operations.
Adjacency Requirements	50M Instrument Building
Vehicular Access Requirements	Tractor/Trailer
Key Design Requirements	Crane Hook Height - 40', MENUS Cave 13' H. Hook Height, lift, beam shielding, stairway to level 2. Plans for a mezzanine level 2 will need to be incorporated, add space for electrical services and other utilities. Stainless steel re-bar in vicinity (within 6' of the sample position), non-magnetic construction materials within 6' of sample position. 14' high overhead door at truck access. Pit required for MENUS. Instrument crane.

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	ST20 - EWALD Instrument Space			☑	☐
	Shielded area enclosing detectors	375 SF	Will have concrete walls 30-50cm thick	☐	☑
	Beam stop	3' x 3' x 3'	Centered on beam, downstream of shielded enclosure	☐	☑
	4 - Equipment staging areas	7' x 7'		☐	☑
2	ST20 - EWALD Beam Line Space			☑	☐
	Choppers			☐	☑
	Alignment Equipment			☐	☑
3	ST21 - MENUS Instrument Space	TBD	Pit Required	☑	☐
4	ST21 - MENUS Beam Line Space	TBD		☑	☐
5	Overhead Crane	10 Ton	40’ from elevation 1074’	☑	☐

Note: Test Fit Plan on following page

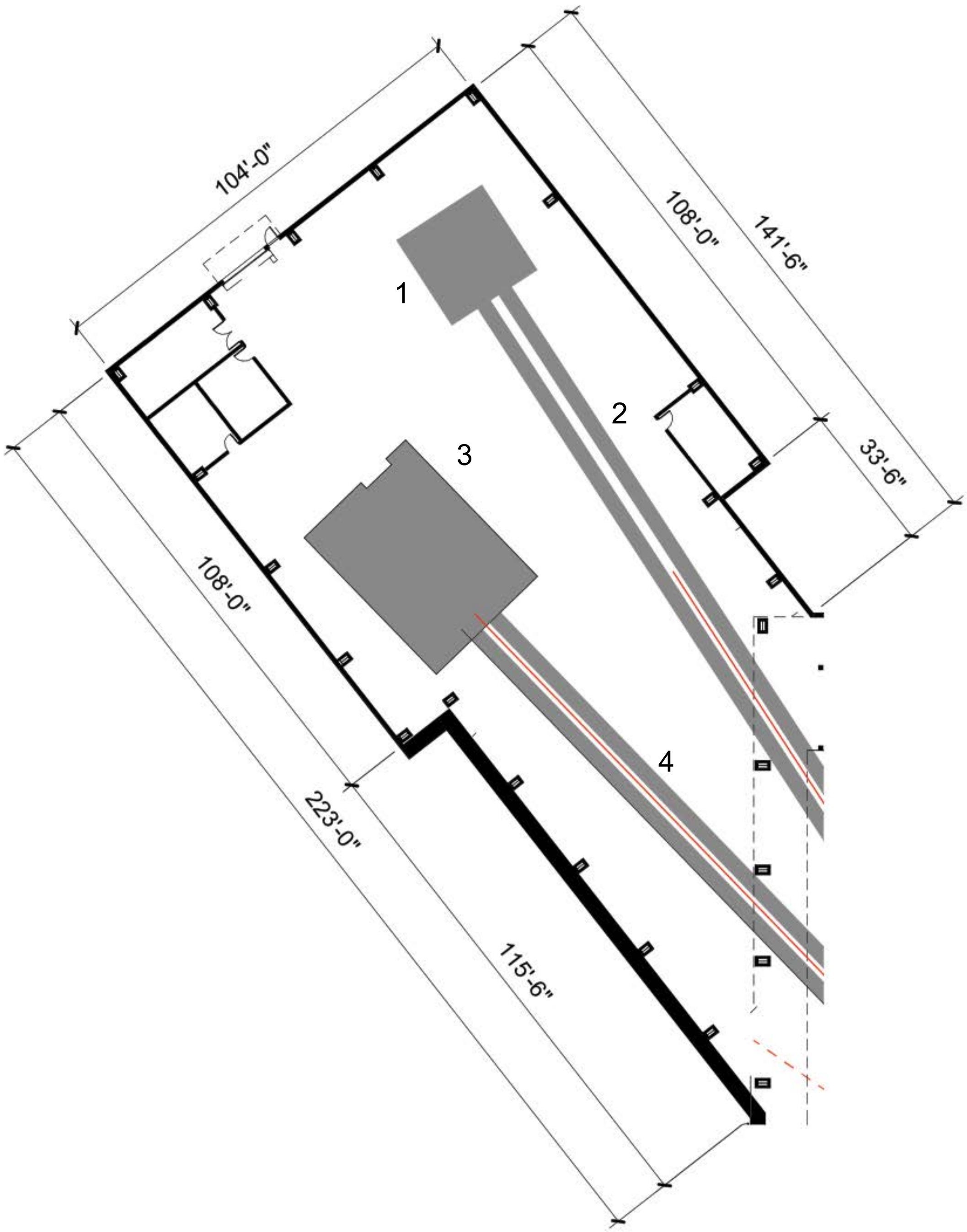
CF: Conventional Facilities
TS: Technical Systems

5.4.3.1 EWALD/MENUS - Instrument/Beam Line Space

90M Instrument Building Lead: Ken Herwig

Test-fit Plan

Beamline Spaces



Preliminary space plan

Scale 1" = 40'-0"

5.4.3.2 Electrical Room

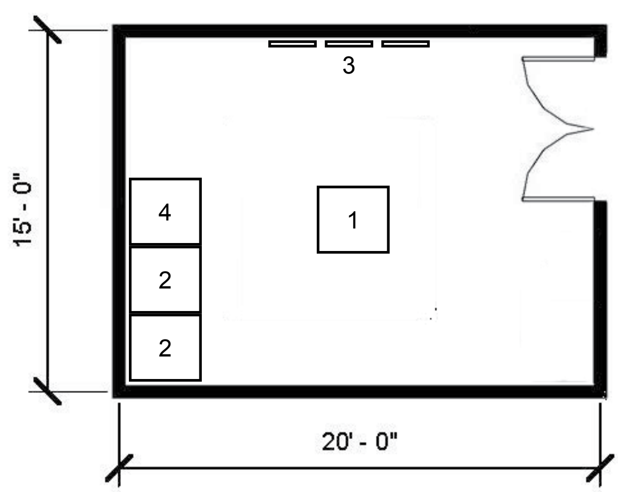
90M Instrument Building

Lead: Ken Herwig

Room Data	
Space Number	5.4.3.2
Space Name	Electrical Room
Net Area Requirement (NSF)	400
Number of spaces required	1
Population	0
Space Activities/Functional Description	Equipment Room
Adjacency Requirements	none
Vehicular Access Requirements	none
Key Design Requirements	Rated enclosure. Doors for emergency egress and equipment placement & maintenance.

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 TA2-SS4 Switchgear	72" x 88" x 96"		☑	☐
2 Transformer	3' x 3' x 3'		☑	☐
3 3 - Panelboards	30" x 8" x 42"		☑	☐
4 Automatic Transfer Switch	3' x 3 ' x 6'-6"		☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.4.3.3 Sample Prep

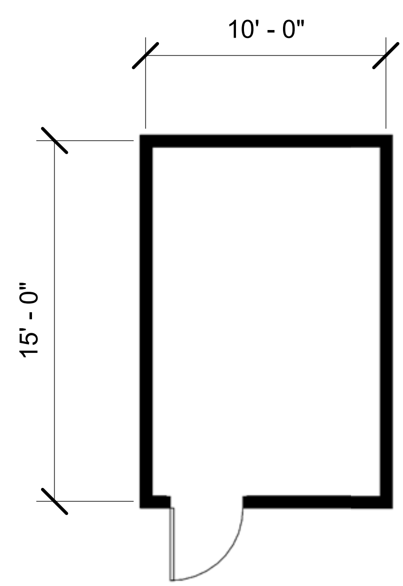
90M Instrument Building

Lead: Ken Herwig

Room Data	
Space Number	5.4.3.3
Space Name	Sample Prep
Net Area Requirement (NSF)	130
Number of spaces required	2
Population	Transient
Space Activities/Functional Description	Prepare samples
Adjacency Requirements	Instrument space
Vehicular Access Requirements	none
Key Design Requirements	

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	TBD			☐	☑

Test-fit Plan



Preliminary space plan

Scale 1/16″ = 1′-0″

CF: Conventional Facilities
TS: Technical Systems

5.4.3.4 Control Cabin

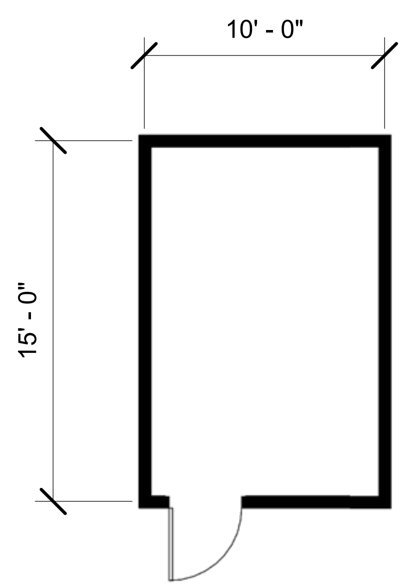
90M Instrument Building

Lead: Ken Herwig

Room Data	
Space Number	5.4.3.4
Space Name	Control Cabin
Net Area Requirement (NSF)	145
Number of spaces required	2
Population	2
Space Activities/Functional Description	Control room
Adjacency Requirements	Instrument space
Vehicular Access Requirements	none
Key Design Requirements	Acoustical and shielding enclosure supplied by instruments

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	TBD			☐	☑

Test-fit Plan



Preliminary space plan

Scale 1/16" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.5.1
CLO II

5.5.1 Central Laboratory and Office Building II

STS Space Program Lead: Gary Bloom

No.	Rooms	Qty.	NSF	Total NSF
5.5.1	**Central Lab and Office Building II NSF**			**62,190**
	Central Lab and Office Building II GSF			**96,060**
	Central Lab and Office Building II Efficiency			**65%**
No.	**Rooms**	**Qty.**	**NSF**	**Total NSF**
	Office Space			**14,030**
5.5.1.1	Private Office - Single Occupancy	66	110	7,260
5.5.1.2	Private Office - Double Occupancy	17	110	1,870
5.5.1.3	Workstation	70	70	4,900
	Shared Space			**7,620**
5.5.1.4	Unassigned Office/Conference	10	120	1,200
5.5.1.5	Small Conference	6	250	1,500
5.5.1.6	Medium Conference	2	500	1,000
5.5.1.7	Large Conference	1	1,400	1,400
5.5.1.8	Coffee/kitchen/Vending	5	100	500
5.5.1.9	Common Space/Café	1	1,000	1,000
5.5.1.10	Printing Room	6	120	720
5.5.1.11	Catering Kitchen	1	300	300
	Laboratory space			**20,410**
5.5.1.12	Synthesis Lab I	2	730	1,460
5.5.1.13	Synthesis Lab II	3	730	2,190
5.5.1.14	Synthesis Lab III	3	730	2,190
5.5.1.15	Characterization Lab	3	730	2,190
5.5.1.16	BSL-2	2	730	1,460
5.5.1.17	Lab Support	2	730	1,460
5.5.1.18	Sample Receiving	1	480	480
5.5.1.19	Data Acquisition Lab and Storage	3	730	2,190
5.5.1.20	Detector Lab	2	970	1,940
5.5.1.21	Detector Storage	2	730	1,460
5.5.1.22	Light Mechanical Instrument Support	1	970	970
5.5.1.23	Blast Lab	1	480	480
5.5.1.24	Metrology Guide Alignment	2	970	1,940
	Building Support			**20,130**
5.5.1.25	Shipping/Receiving	1	800	800
5.5.1.26	General Building Storage	1	2,000	2,000
5.5.1.27	Lobby	1	870	870
5.5.1.28	Janitor's Closet	4	80	320
5.5.1.29	Server Room	1	500	500
5.5.1.30	Electrical Distribution Room	4	120	480

5.5.1 Central Laboratory and Office Building II

STS Space Program Lead: Gary Bloom

5.5.1	Central Lab and Office Building II NSF			63,671
	Central Lab and Office Building II GSF			96,060
	Central Lab and Office Building II Efficiency			66%
No.	**Rooms**	**Qty.**	**NSF**	**Total NSF**
5.5.1.31	Switchgear	1	1,200	1,200
5.5.1.32	Fire Riser Room	1	450	450
5.5.1.33	Mechanical Room	1	500	500
5.5.1.34	Mechanical Penthouse	1	10,431	10,431
5.5.1.35	Toilets	8	250	2,000
5.5.1.36	Recycling/Trash	1	150	150
5.5.1.37	Entrance Vestibule	1	130	130
5.5.1.38	Electrical Normal Distribution Room	1	1,200	1,200
5.5.1.39	Boiler Room	1	500	500
5.5.1.40	Electrical Gen/UPS Distribution Room	1	400	400

Additional Program Space Requirements

Elevators

Freight Elevator

Egress Stairs

Circulation

Electrical Substations (Exterior Pad)

Electrical Generator (Exterior Pad)

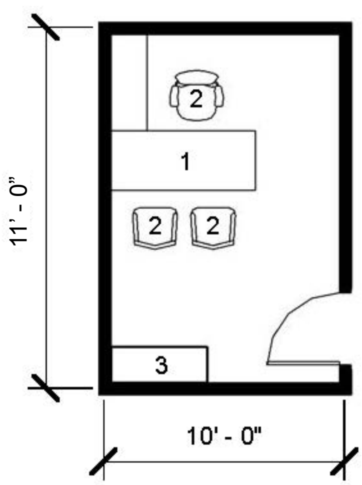
5.5.1.1 Private Office - Single Occupancy

Central Laboratory and Office Building II — Lead: Gary Bloom

Room Data	
Space Number	5.5.1.1
Space Name	Private Office - Single Occupancy
Net Area Requirement (NSF)	110
Number of spaces required	66
Population	1
Space Activities/Functional Description	Single occupant private office
Adjacency Requirements	None
Vehicular Access Requirements	None
Key Design Requirements	Daylighting. Include a tackable surface and whiteboard.

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 Adaptable systems furnishings	6' x 6'		☑	☐
2 3 - Chair	2' x 2'		☑	☐
3 Storage cabinets	18" x 4'		☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.5.1.2 Private Office - Double Occupancy

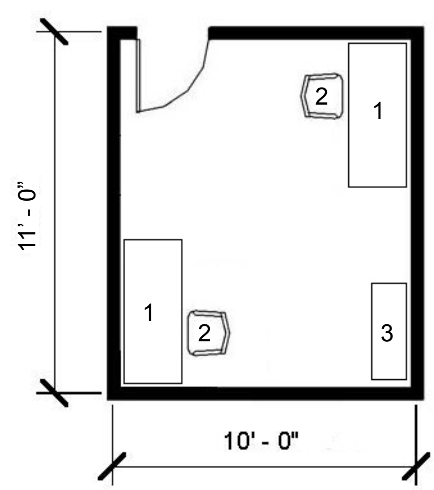
Central Laboratory and Office Building II

Lead: Gary Bloom

Room Data	
Space Number	5.5.1.2
Space Name	Private Office - Double Occupancy
Net Area Requirement (NSF)	110
Number of spaces required	17
Population	2
Space Activities/Functional Description	Multiple occupant private office
Adjacency Requirements	None
Vehicular Access Requirements	None
Key Design Requirements	Daylighting. Include a tackable surface and whiteboard.

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	2 - Adaptable systems furnishings	6' x 6'		☑	☐
2	2 - Chairs	2' x 2'		☑	☐
3	Storage cabinets	18" x 4'		☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

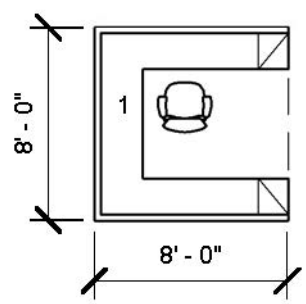
5.5.1.3 Workstation

Central Laboratory and Office Building II — Lead: Gary Bloom

Room Data	
Space Number	5.5.1.3
Space Name	Workstation
Net Area Requirement (NSF)	60
Number of spaces required	70
Population	1
Space Activities/Functional Description	Open workstation
Adjacency Requirements	None
Vehicular Access Requirements	None
Key Design Requirements	Daylighting

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	Adaptable systems furnishings	8' x 8'		☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/8” = 1’-0”

CF: Conventional Facilities

TS: Technical Systems

5.5.1.4 Unassigned Office/Conference

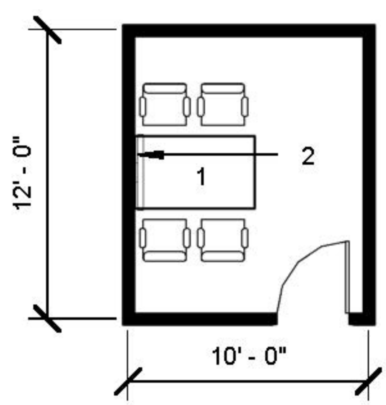
Central Laboratory and Office Building II

Lead: Gary Bloom

Room Data	
Space Number	5.5.1.4
Space Name	Unassigned Office/Conference
Net Area Requirement (NSF)	120
Number of spaces required	10
Population	3 to 4
Space Activities/Functional Description	Small open or enclosed space for secluded
Adjacency Requirements	None
Vehicular Access Requirements	None
Key Design Requirements	Daylighting

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	Movable table w/ chairs	3' x 5'		☑	☐
2	Monitor	40"		☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.5.1.5 Small Conference

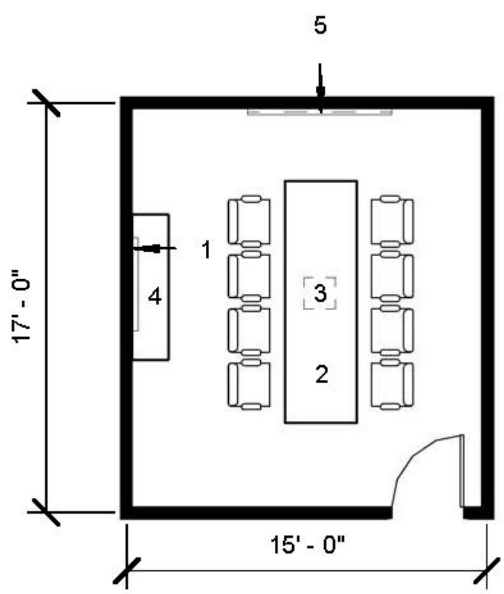
Central Laboratory and Office Building II

Lead: Gary Bloom

Room Data	
Space Number	5.5.1.5
Space Name	Small Conference
Net Area Requirement (NSF)	250
Number of spaces required	6
Population	8
Space Activities/Functional Description	This is a dedicated workroom for a project team of 8 people. Either open or enclosed, typically furnished with a large table or clustered tables, one or more video displays, mobile and wall mounted whiteboards, and fexible seating options.
Adjacency Requirements	None
Vehicular Access Requirements	None
Key Design Requirements	None

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 Monitor	50"		☑	☐
2 Conference table w/ chairs	3' x 10'	Table w/ power data	☑	☐
3 Overhead video projector	16" x 16"		☑	☐
4 Storage unit	18" x 6'		☑	☐
5 Projection screen	6' Wide		☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/8″ = 1′-0″

CF: Conventional Facilities
TS: Technical Systems

5.5.1.6 Medium Conference Room

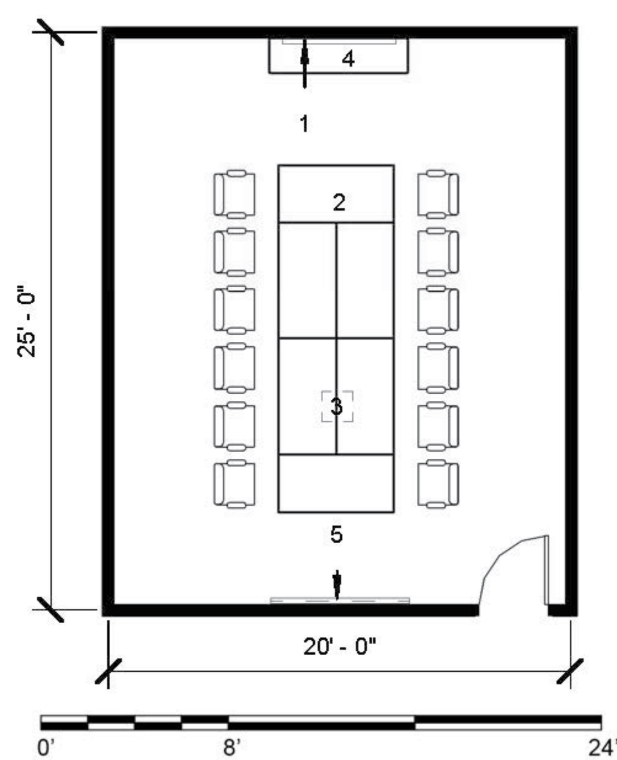
Central Laboratory and Office Building II

Lead: Gary Bloom

Room Data	
Space Number	5.5.1.6
Space Name	Medium Conference Room
Net Area Requirement (NSF)	500
Number of spaces required	2
Population	10+
Space Activities/Functional Description	Enclosed group space for planned interaction, equipped with multiple display surfaces (tackable, whiteboard and video), credenzas for storage, and counters for refreshments and catering. Sized for groups of 10 or more, it includes formal meeting spaces for presentations and training.
Adjacency Requirements	None
Vehicular Access Requirements	None
Key Design Requirements	None

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 Monitor	65"		☑	☐
2 6 - Conference tables w/ chairs	30" x 5'	Reconfigurable with power/data	☑	☐
3 Ceiling mounted video projector	16" x 16"		☑	☐
4 Storage unit	18" x 6'		☑	☐
5 Projection screen	6' Wide		☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.5.1.7 Large Conference

Central Laboratory and Office Building II — Lead: Gary Bloom

Room Data	
Space Number	5.5.1.7
Space Name	Large Conference
Net Area Requirement (NSF)	1,400
Number of spaces required	1
Population	25+
Space Activities/Functional Description	Enclosed group space for planned interaction, equipped with multiple display surfaces (tackable, whiteboard and video), credenzas for storage, and counters for refreshments and catering. Sized for groups of 25 or more, it includes formal meeting spaces for presentations and training.
Adjacency Requirements	None
Vehicular Access Requirements	None
Key Design Requirements	None

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 2 - Monitors	70"		☑	☐
2 6 - Conference tables w/ chairs	30" x 5'	Reconfigurable with power/data	☑	☐
3 Ceiling mounted video projector	16" x 16"		☑	☐
4 3 - Storage units	18" x 6'		☑	☐
5 Projection screen	12' Wide		☑	☐

Test-fit Plan

Note: Test Fit Plan on following page

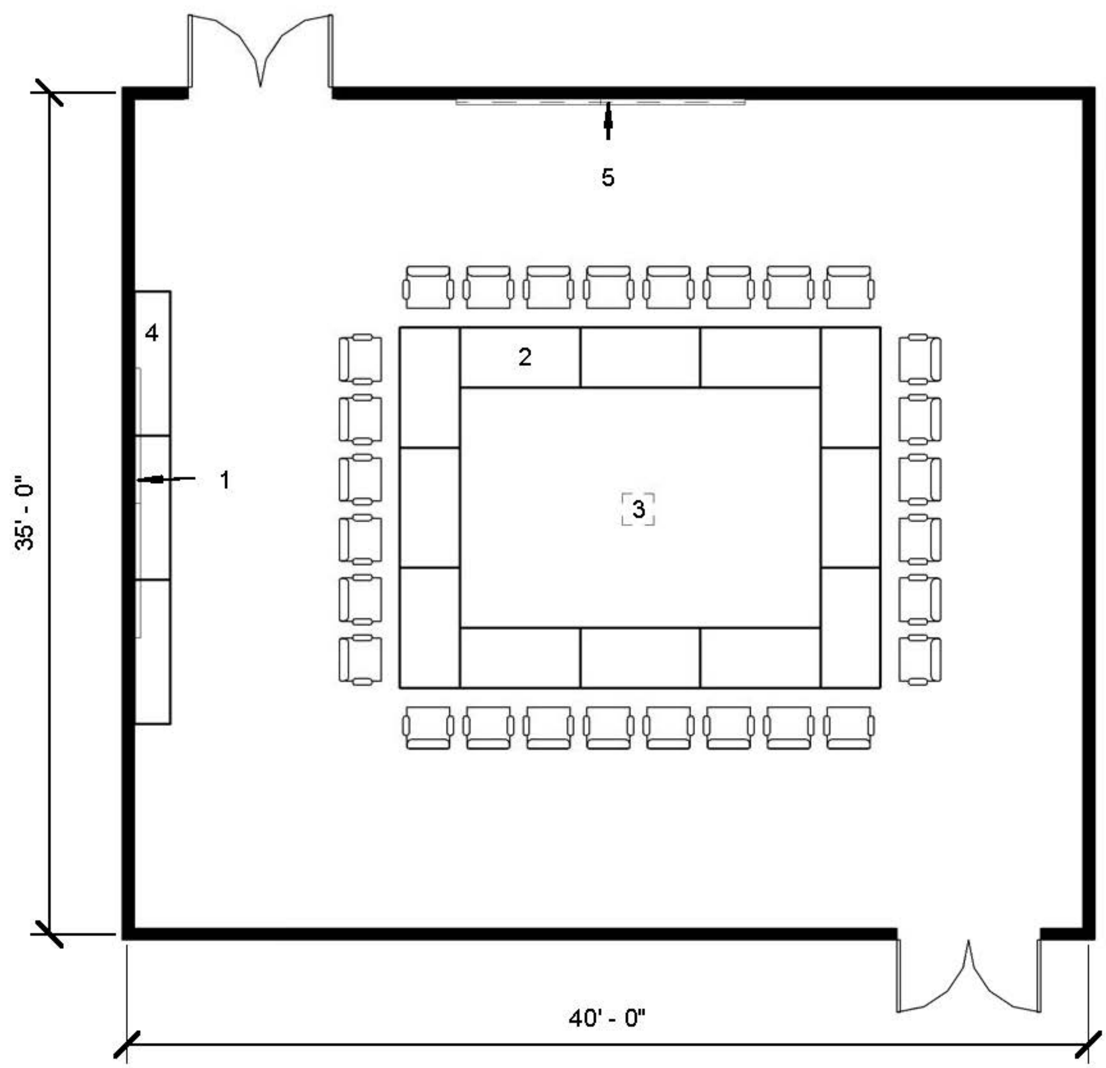
CF: Conventional Facilities
TS: Technical Systems

5.5.1.7 Large Conference

Central Laboratory and Office Building II

Lead: Gary Bloom

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

5.5.1.8 Coffee/Kitchen/Vending

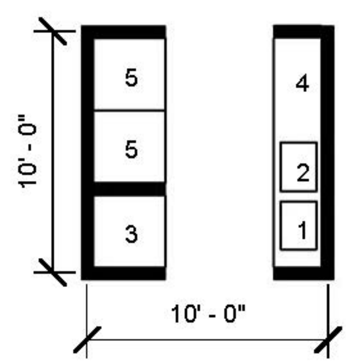
Central Laboratory and Office Building II

Lead: Gary Bloom

Room Data	
Space Number	5.5.1.8
Space Name	Coffee/Kitchen/Vending
Net Area Requirement (NSF)	100
Number of spaces required	5
Population	0 - 2
Space Activities/Functional Description	Small open kitchenette
Adjacency Requirements	Office space
Vehicular Access Requirements	None
Key Design Requirements	None

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 Microwave	2' x 2'		☑	☐
2 Sink	2' x 2'		☑	☐
3 Refrigerator	3' x 3'		☑	☐
4 Counter surface	2' x 10'		☑	☐
5 2 - Vending machines	3' x 3'		☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

0' 8' 24'

CF: Conventional Facilities

TS: Technical Systems

5.5.1.9 Common Space/Cafe

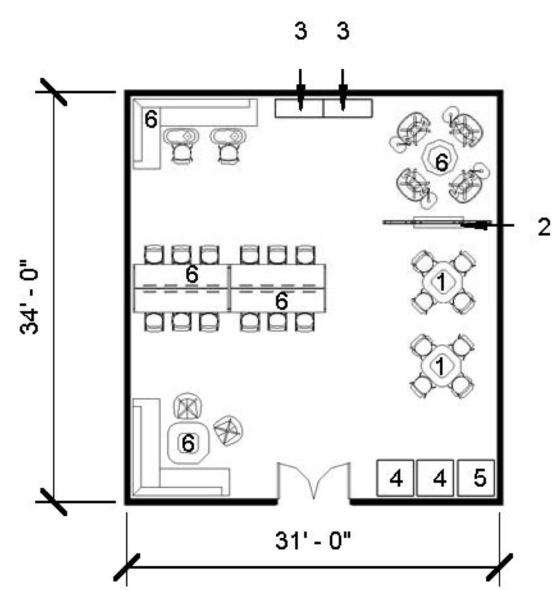
Central Laboratory and Office Building II

Lead: Gary Bloom

Room Data	
Space Number	5.5.1.9
Space Name	Common Space/Cafe
Net Area Requirement (NSF)	1,000
Number of spaces required	1
Population	20+
Space Activities/Functional Description	Designed to encourage both casual and planned interactions. Furnishings range from informal seating and small tables, to lounge furniture groupings, to standing height counters with stools. This space can be used for social events and activities.
Adjacency Requirements	Office space
Vehicular Access Requirements	None
Key Design Requirements	Daylighting. Include whiteboards

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 2 - Small tables w/ chairs	3' x 3'		☑	☐
2 2 - Monitors	32"		☑	☐
3 2 - Storage units	18" x 4'		☑	☐
4 2 - Vending machines	3' x 3'		☑	☐
5 Ice machine	3' x 3'		☑	☐
6 Lounge furniture	Varies		☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/16" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.5.1.10 Printing Room

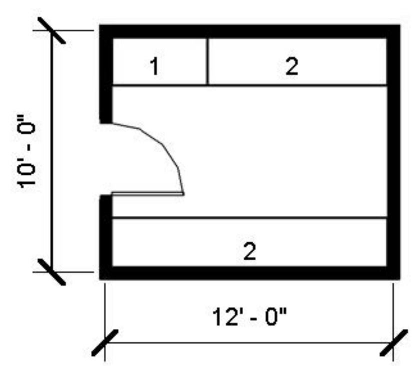
Central Laboratory and Office Building II

Lead: Gary Bloom

Room Data	
Space Number	5.5.1.10
Space Name	Printing Room
Net Area Requirement (NSF)	120
Number of spaces required	6
Population	0 - 2
Space Activities/Functional Description	Office support
Adjacency Requirements	Office space
Vehicular Access Requirements	None
Key Design Requirements	Space for mail deliveries

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	Printer/scanner/fax	4' x 2' x 3'		☑	☐
2	Counter space w/ cabinets	2' Deep		☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/8″ = 1′-0″

CF: Conventional Facilities
TS: Technical Systems

5.5.1.11 Catering Kitchen

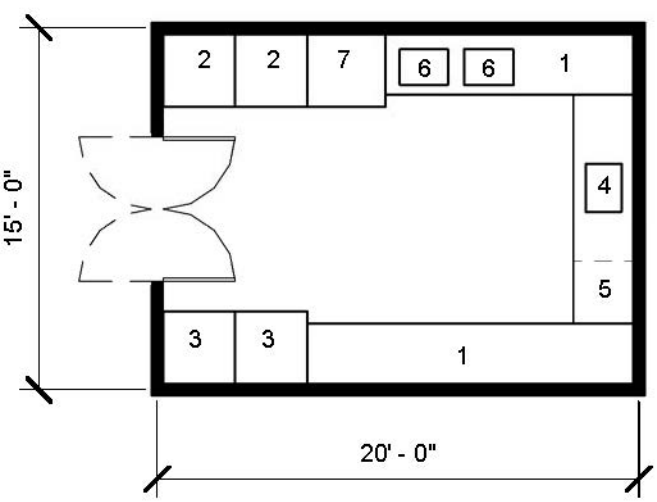
Central Laboratory and Office Building II

Lead: Gary Bloom

Room Data	
Space Number	5.5.1.11
Space Name	Catering Kitchen
Net Area Requirement (NSF)	300
Number of spaces required	1
Population	0 to 4
Space Activities/Functional Description	Support catering activities
Adjacency Requirements	Near conference area
Vehicular Access Requirements	Box delivery truck, indirect
Key Design Requirements	None

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	Counter space & cabinets	2' Deep		☑	☐
2	2 - Refrigerators	3' x 3'		☑	☐
3	2 - Warming ovens	3' x 3'		☑	☐
4	Sink	2' x 2'		☑	☐
5	Dishwasher	2' x 2'	Undercounter	☑	☐
6	2 - Microwaves	2' x 2'		☑	☐
7	Ice maker	3' x 3'		☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.5.1.12 Synthesis Lab I

Central Laboratory and Office Building II

Lead: Gary Bloom

Room Data	
Space Number	5.5.1.12
Space Name	Synthesis Lab I
Net Area Requirement (NSF)	730
Number of spaces required	2
Population	6-7
Space Activities/Functional Description	Supports staff and user research
Adjacency Requirements	Staff offices
Vehicular Access Requirements	Indirect
Key Design Requirements	Designed as chemistry labs with CA/N2 gas. Provide emergency eyewash based on regulatory requirements.

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	10 - Lab benches	60" x 30" x 36"		✓	
2	2 - Fume hoods	6' Long		✓	
3	Sink	2' x 2'		✓	
4	Safety shower/eye wash	2' x 2'	Standard in all labs	✓	
5	2 - Storage racks	48" x 30" x 36"		✓	
6	Floor model centrifuge	4' x 4'			✓
7	Glove box - solvent handling	4' x 3'	Can be in room center		✓
8	Rack for lab coats, ppe, etc...	3'	Linear space	✓	
9	Desk	6' Long		✓	
10	Chromatography Refrigerator	4' x 3'			✓
11	Freezer (-20)	4' x 4'			✓
12	Refrigerator	3' x 3'			✓

Note: Test Fit Plan on following page

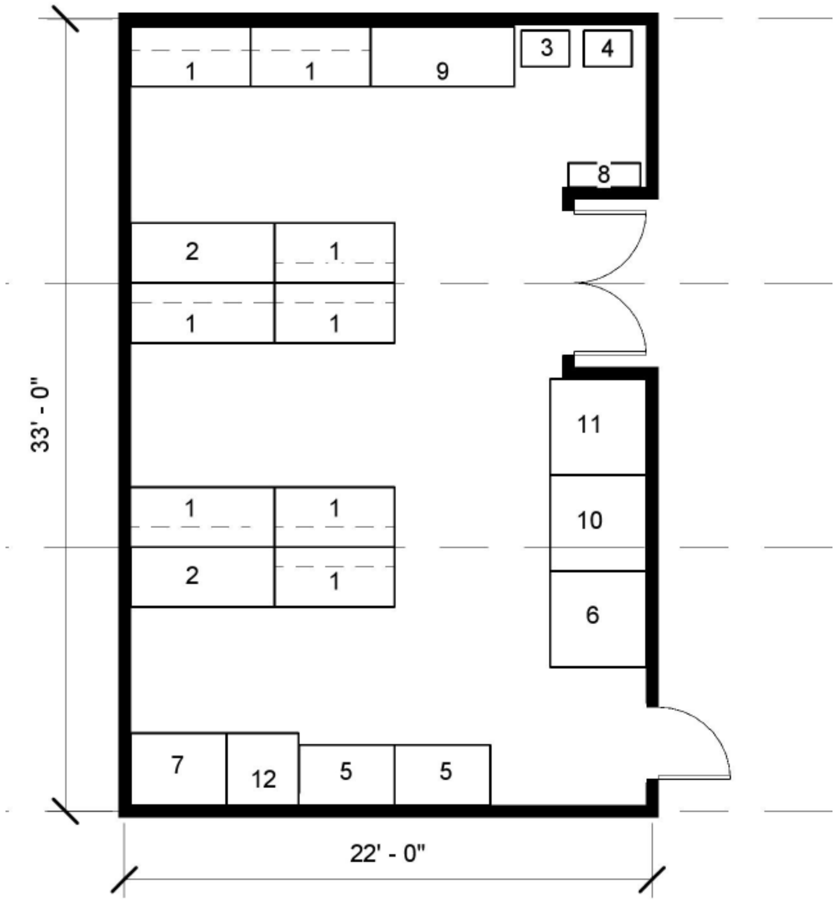
CF: Conventional Facilities
TS: Technical Systems

5.5.1.12 Synthesis Lab I

Central Laboratory and Office Building II

Lead: Gary Bloom

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

5.5.1.13 Synthesis Lab II

Central Laboratory and Office Building II

Lead: Gary Bloom

Room Data	
Space Number	5.5.1.13
Space Name	Synthesis Lab II
Net Area Requirement (NSF)	730
Number of spaces required	3
Population	6-7
Space Activities/Functional Description	Supports staff and user research
Adjacency Requirements	Staff offices
Vehicular Access Requirements	Indirect
Key Design Requirements	Designed as chemistry labs with nitrogen. Provide active ventilation over benches. Provide emergency eyewash based on regulatory requirements.

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	6 - Lab benches	60" x 30" x 36"		✓	
2	2 - Fume hood	8' Long		✓	
3	2 - Sinks	2' x 2'	At opposite ends of room	✓	
4	Safety shower/eye wash	2' x 2'	Standard in all labs	✓	
5	4 - storage racks	48" x 30" x 36"		✓	
6	3 - Flammable gas cabinets	2' x 2'		✓	
7	Glove box - dry	8' x 4'	Can be in room center		✓
8	Glove box - solvent handling	8' x 4'	Can be in room center		✓
9	Rack for lab coats, ppe, etc...	3'	Linear space	✓	
10	Desk	6' Long		✓	
11	Refrigerator	3' x 3'	Explosion proof		✓

Note: Test Fit Plan on following page

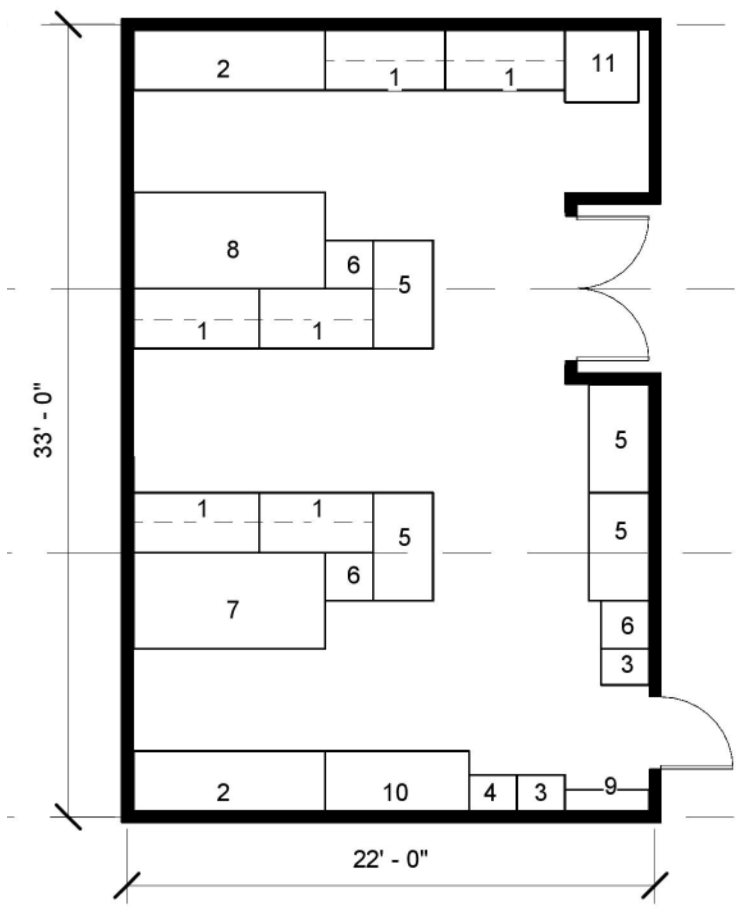
CF: Conventional Facilities
TS: Technical Systems

5.5.1.12 Synthesis Lab II

Central Laboratory and Office Building II

Lead: Gary Bloom

Test-fit Plan



Preliminary space plan

Scale 1/8” = 1’-0”

5.5.1.14 Synthesis Lab III

Central Laboratory and Office Building II | Lead: Gary Bloom

Room Data	
Space Number	5.5.1.14
Space Name	Synthesis Lab III
Net Area Requirement (NSF)	730
Number of spaces required	3
Population	6-7
Space Activities/Functional Description	Supports staff and user research
Adjacency Requirements	Staff offices
Vehicular Access Requirements	Indirect
Key Design Requirements	Designed as chemistry labs with CA/N2 gas. Provide active ventialtion over benches. Possibly 2(lab) + 1(storage) or 3(lab+storage). Provide emergency eyewash based on regulatory requirements.

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 5 - Lab benches	60" x 30" x 36"		☑	☐
2 2 - Fume hoods	8 ft long		☑	☐
3 2 - Sinks	2' x 2'	At opposite ends of room	☑	☐
4 Safety shower/eye wash	2' x 2'	Standard in all labs	☑	☐
5 5 - Storage racks	48" x 30" x 36"		☑	☐
6 Floor model centrifuge	4' x 4'		☐	☑
7 Glove box - dry	8' x 4'	Can be in room center	☐	☑
8 Glove box - solvent handling	8' x 4'	Can be in room center	☐	☑
9 Rack for lab coats, ppe, etc...	3'	Linear space	☑	☐
10 Desk	6' Long		☑	☐
11 Refrigerator	3' x 3'	Explosion proof	☐	☑
12 3 - Flammable gas cabinets	2' x 2'		☑	☐

Note: Test Fit Plan on following page

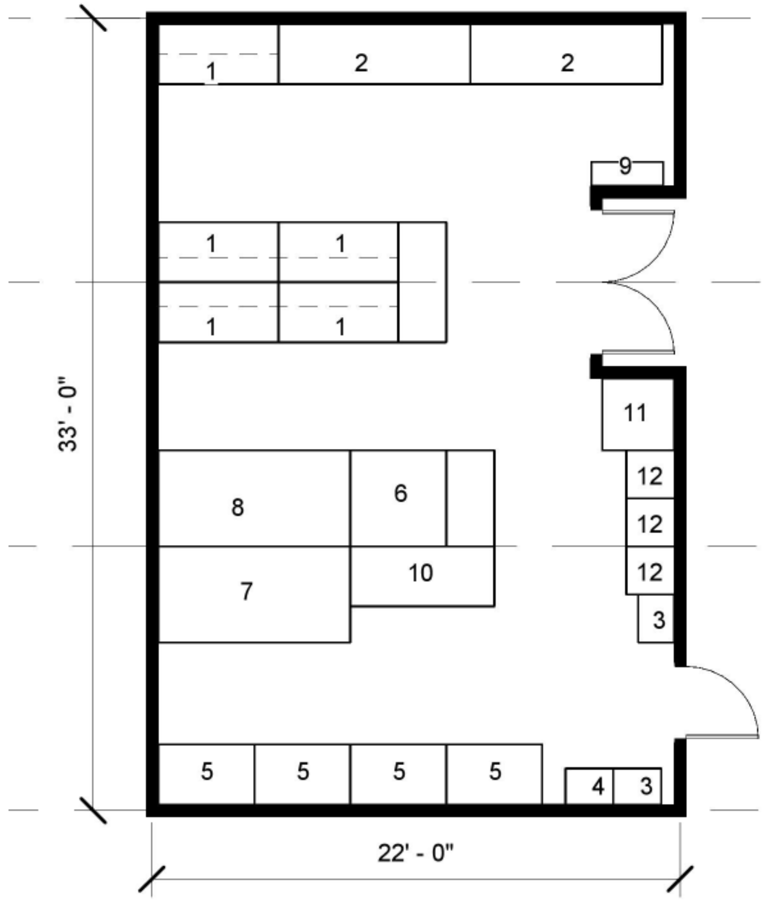
CF: Conventional Facilities
TS: Technical Systems

5.5.1.12 Synthesis Lab III

Central Laboratory and Office Building II

Lead: Gary Bloom

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

5.5.1.15 Characterization Lab

Central Laboratory and Office Building II | Lead: Gary Bloom

Room Data	
Space Number	5.5.1.15
Space Name	Characterization Lab
Net Area Requirement (NSF)	730
Number of spaces required	3
Population	6-7
Space Activities/Functional Description	Supports staff and user research
Adjacency Requirements	Staff offices
Vehicular Access Requirements	Indirect
Key Design Requirements	Designed as chemistry labs with CA/N2 gas. (This lab could be divided into two labs: one for large analytical equipment and one for laser work). Provide emergency eyewash based on regulatory requirements.

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	6 - Lab benches	60" x 30" x 36"		☑	☐
2	Fume hood	6' Long		☑	☐
3	Sink	2' x 2'		☑	☐
4	Safety shower/eye wash	2' x 2'	Standard in all labs	☑	☐
5	3 - Storage racks	48" x 30" x 36"		☑	☐
6	Rack for lab coats, ppe, etc...	3'	Linear space	☑	☐
7	Desk	6' Long		☑	☐
8	2 - Optics table	48" x 96" x 40"		☐	☑
9	2 - Large equipment	48" x 96" x 40"	(e.g. diffractometer)	☐	☑

Note: Test Fit Plan on following page

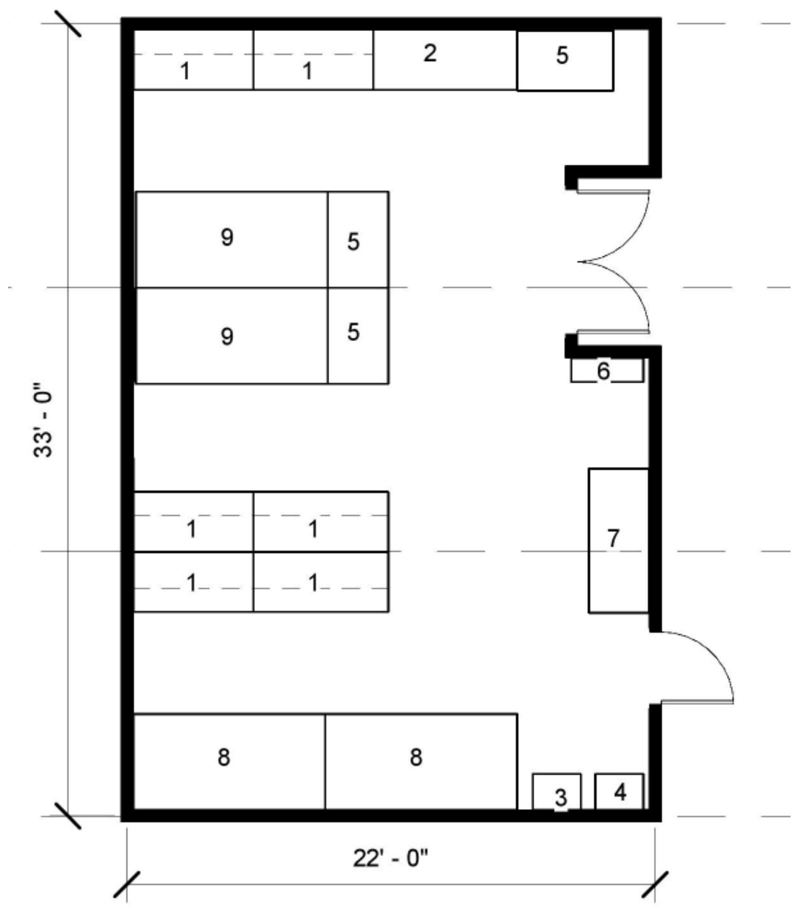
CF: Conventional Facilities
TS: Technical Systems

5.5.1.15 Characterization Lab

Central Laboratory and Office Building II

Lead: Gary Bloom

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

5.5.1.16 BSL-2

Central Laboratory and Office Building II

Lead: Gary Bloom

Room Data	
Space Number	5.5.1.16
Space Name	BSL-2
Net Area Requirement (NSF)	730
Number of spaces required	2
Population	4-6
Space Activities/Functional Description	Supports staff and user research
Adjacency Requirements	Staff offices
Vehicular Access Requirements	Indirect
Key Design Requirements	Designed as chemistry labs with CA/N2 gas. Provide emergency eyewash based on regulatory requirements.

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	10 - Lab benches	60"x 30" x 36"		☑	☐
2	Fume hood	6' Long		☑	☐
3	Sink	2' x 2'		☑	☐
4	Safety shower/eye wash	2' x 2'	Standard in all labs	☑	☐
5	3 - Storage racks	48" x 30" x 36"		☑	☐
6	Floor model centrifuge	4' x 4'		☑	☐
7	Rack for lab coats, ppe, etc...	3'	Linear space	☑	☐
8	3 - Stacked incubators	4' x 4'		☐	☑
9	Freezer (-20)	4' x 4'		☐	☑
10	Refrigerator	3' x 3'		☐	☑
11	2 - Biosafety cabinets	4' Long		☐	☑

Note: Test Fit Plan on following page

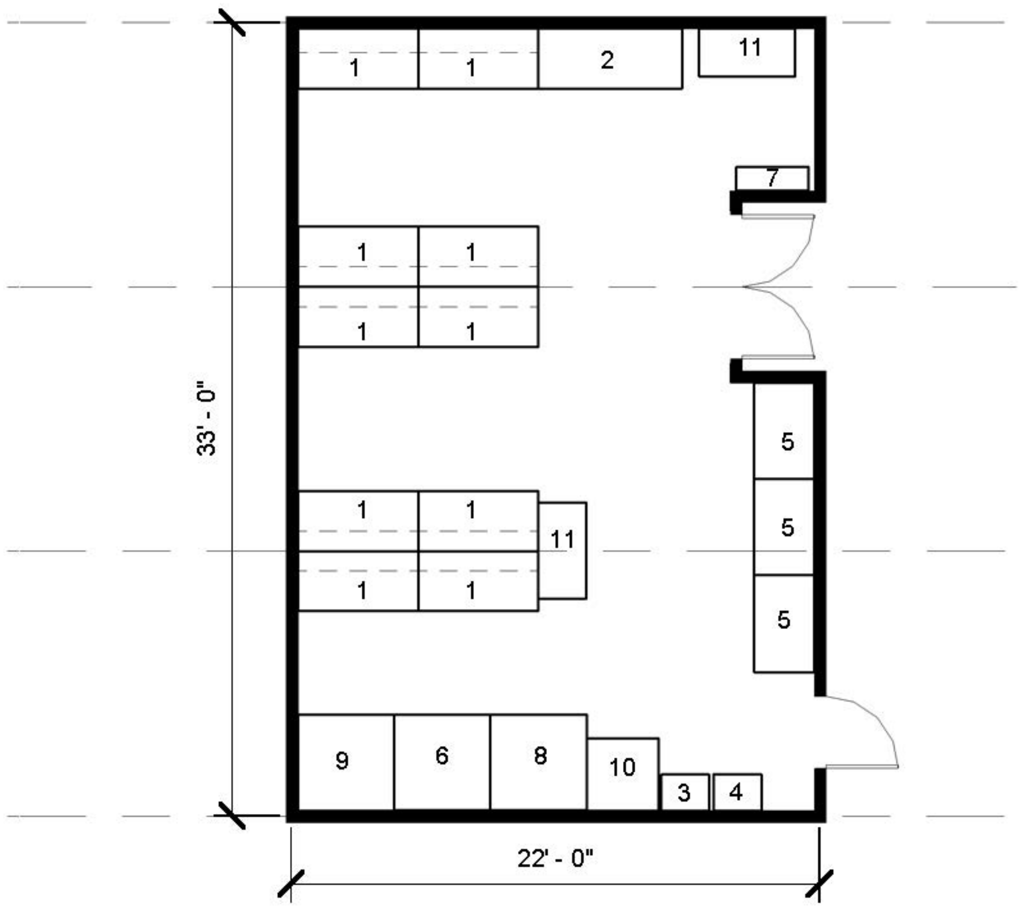
CF: Conventional Facilities
TS: Technical Systems

5.5.1.16 BSL-2

Central Laboratory and Office Building II

Lead: Gary Bloom

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

5.5.1.17 Lab Support

Central Laboratory and Office Building II — Lead: Gary Bloom

Room Data	
Space Number	5.5.1.17
Space Name	Lab Support
Net Area Requirement (NSF)	730
Number of spaces required	2
Population	2 - 4
Space Activities/Functional Description	Supports staff and user research
Adjacency Requirements	Lab space
Vehicular Access Requirements	Indirect
Key Design Requirements	This area would be used to store common consumables as well as samples. This space will need enough 120V outlets to support the various storage environments for samples. Provide emergency eyewash based on regulatory requirements.

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	6 - Lab benches	60" x 30" x 36"		☑	☐
2	7 - Storage racks	48" x 30" x 36"		☑	☐
3	Small fume hood	4' Long	(if bleaching media, etc)	☑	☐
4	Freezer (-80)	3' x 3'		☐	☑
5	2 - Freezers (-20)	3' x 3'		☐	☑
6	2 - Refrigerators	3' x 3'		☐	☑
7	Nitrogen dry box	3' x 3'	(nitrogen line?)	☐	☑
8	2 - Flammable cabinets	3' x 2' x 6'		☑	☐
9	Acid/base cabinet	3' x 2' x 6'		☐	☑
10	3 - Dishwashers	3' x 3' x 3'		☑	☐

Note: Test Fit Plan on following page

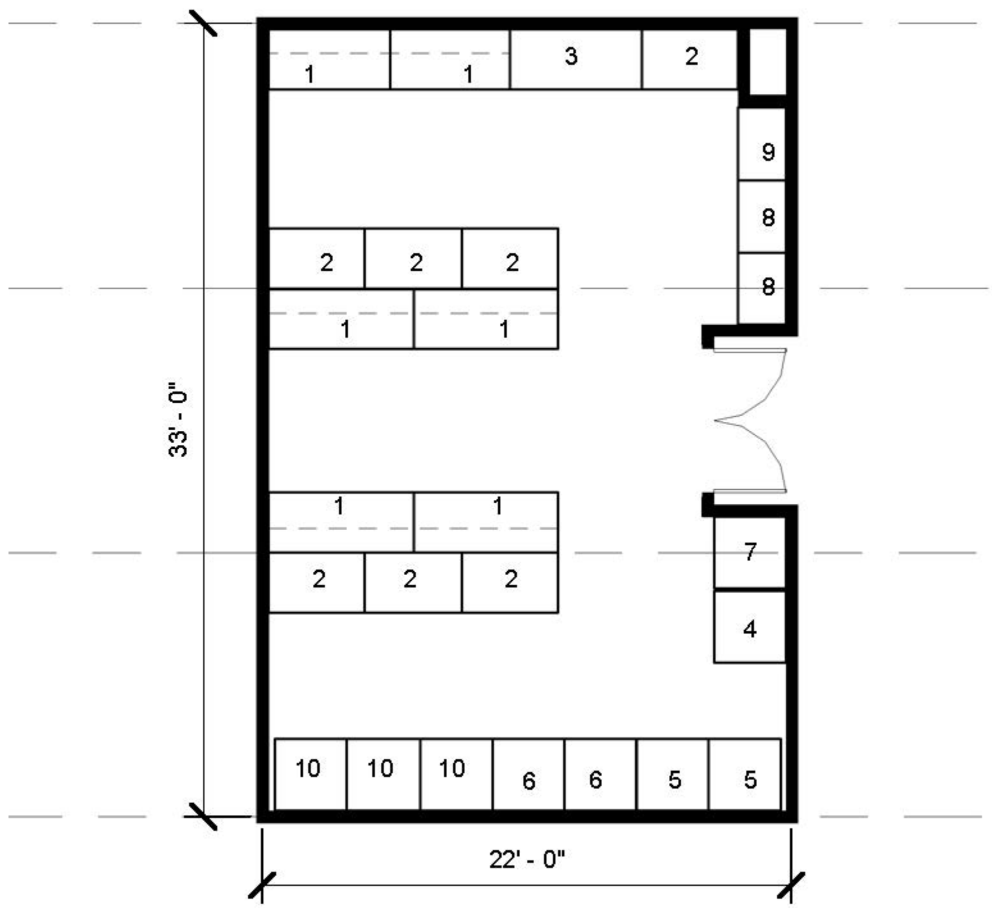
CF: Conventional Facilities
TS: Technical Systems

5.5.1.17 Lab Support

Central Laboratory and Office Building II

Lead: Gary Bloom

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

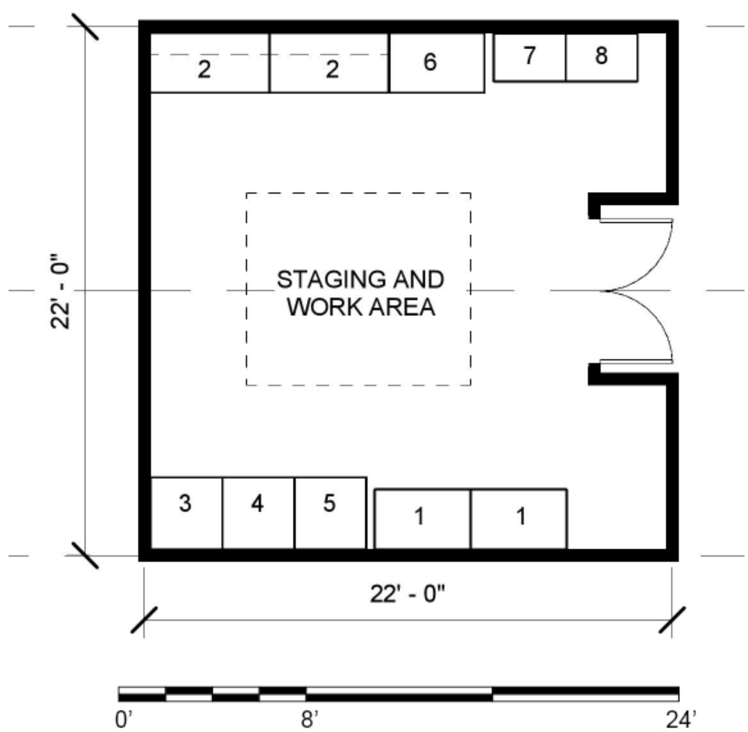
5.5.1.18 Sample Receiving

Central Laboratory and Office Building II | Lead: Gary Bloom

Room Data	
Space Number	5.5.1.18
Space Name	Sample Receiving
Net Area Requirement (NSF)	480
Number of spaces required	1
Population	2
Space Activities/Functional Description	Receiving/processing/holding
Adjacency Requirements	Loading dock, laboratories
Vehicular Access Requirements	T/T, direct
Key Design Requirements	This area will need good ventilation. Walls must be appropriate to house a variety of hazardous chemicals long-term. No hood is necessary if this space is used for storage ONLY. Provide emergency eyewash based on regulatory requirements.

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	2 - Storage racks	48" x 30" x 36"		✓	
2	2 - Lab benches	60" x 30" x 36"		✓	
3	Refrigerator	3' x 3'	For samples		✓
4	Small Freezer (-20)	3' x 3'	For samples		✓
5	Freezer (-20)	3' x 3'	For samples		✓
6	Fume hood	4' Long	For pour ups	✓	
7	Flammables cabinet	3' x 2' x 6'		✓	
8	Acid/base cabinet	3' x 2' x 6'			✓

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.5.1.19 Data Acquisition Lab and Storage

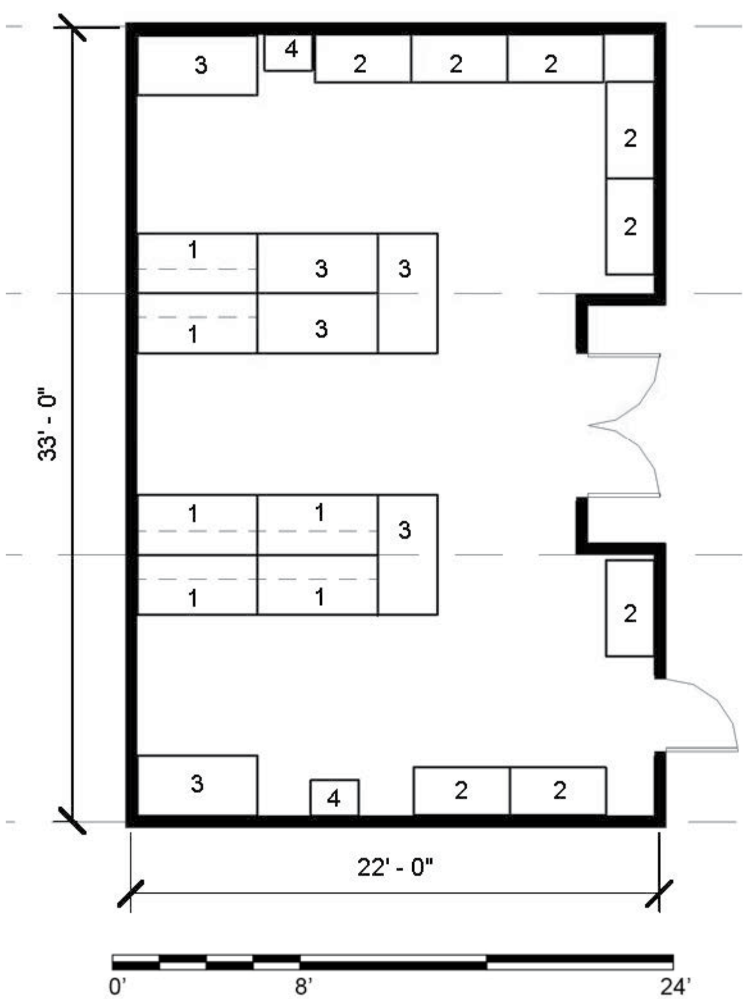
Central Laboratory and Office Building II

Lead: Gary Bloom

Room Data	
Space Number	5.5.1.19
Space Name	Data Acquisition Lab and Storage
Net Area Requirement (NSF)	730
Number of spaces required	3
Population	4 - 6
Space Activities/Functional Description	Staff offices
Adjacency Requirements	none
Vehicular Access Requirements	None
Key Design Requirements	Include a whiteboard

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 6 - Lab benches	60" x 30" x 36"		☑	☐
2 8 - Storage cabinets	4' x 2' x 6'		☑	☐
3 6 - Work Tables	60" x 30" x 36"		☑	☐
4 2 - Sinks	2' x 2'		☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.5.1.20 Detector Lab

Central Laboratory and Office Building II — Lead: Gary Bloom

Room Data	
Space Number	5.5.1.20
Space Name	Detector Lab
Net Area Requirement (NSF)	970
Number of spaces required	2
Population	4 - 6
Space Activities/Functional Description	Staff offices
Adjacency Requirements	TBD
Vehicular Access Requirements	None
Key Design Requirements	House compressed air supply, 120 VAC outlets spaced every 6 to 8 feet. Include a whiteboard.

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	2 - Sinks	2' x 2'		☑	☐
2	Radiation source and buffer area	20' x 20'	Shielded Cf-252 source	☐	☐
3	12 work benches	6' L x 3' W		☑	☐
4	4 - Storage shelves	5' W x 8' H		☑	☐
5	3 - Cabinets	4' W x 8' H		☑	☐

Note: Test Fit Plan on following page

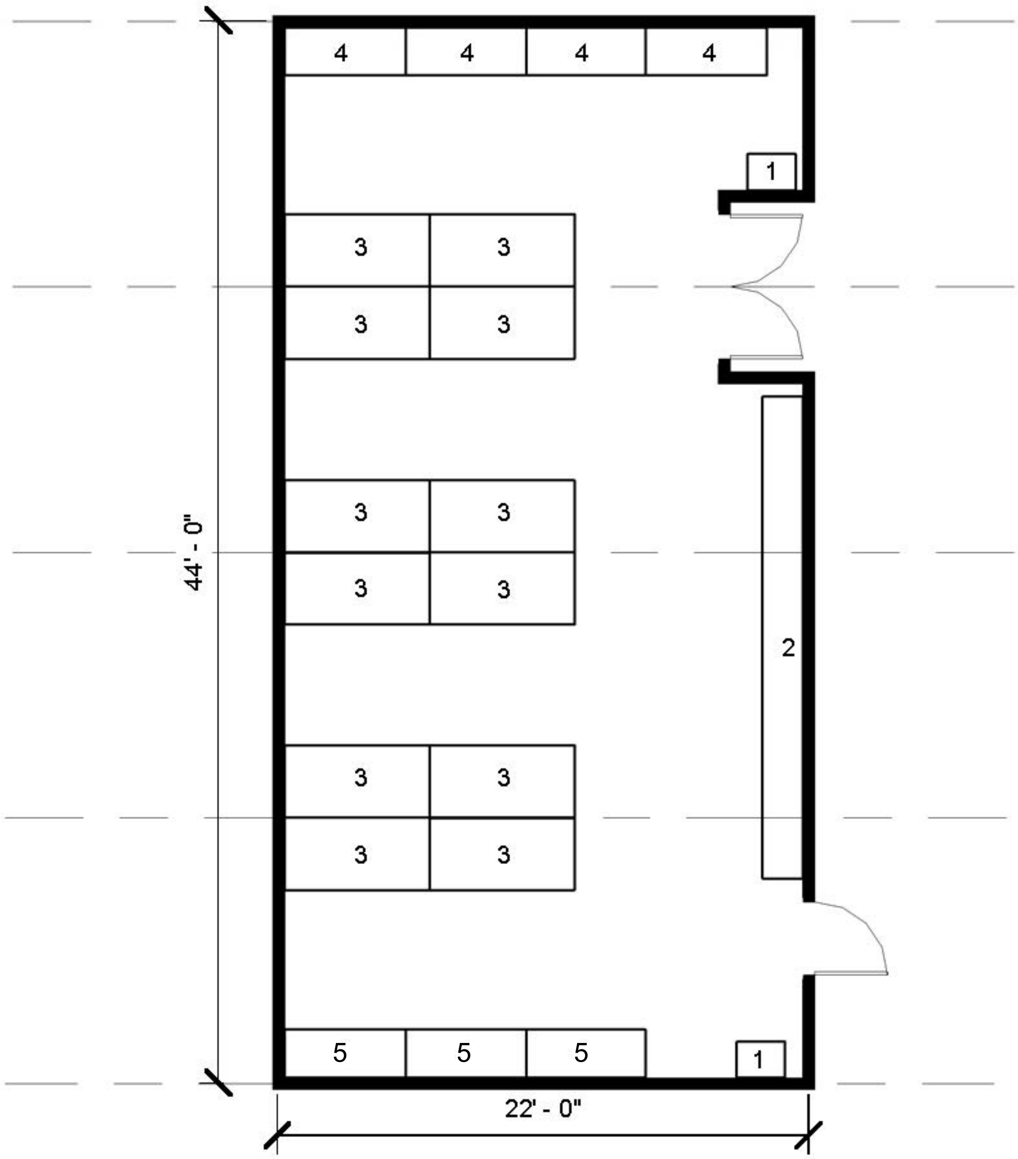
CF: Conventional Facilities
TS: Technical Systems

5.5.1.20 Detector Lab

Central Laboratory and Office Building II

Lead: Gary Bloom

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

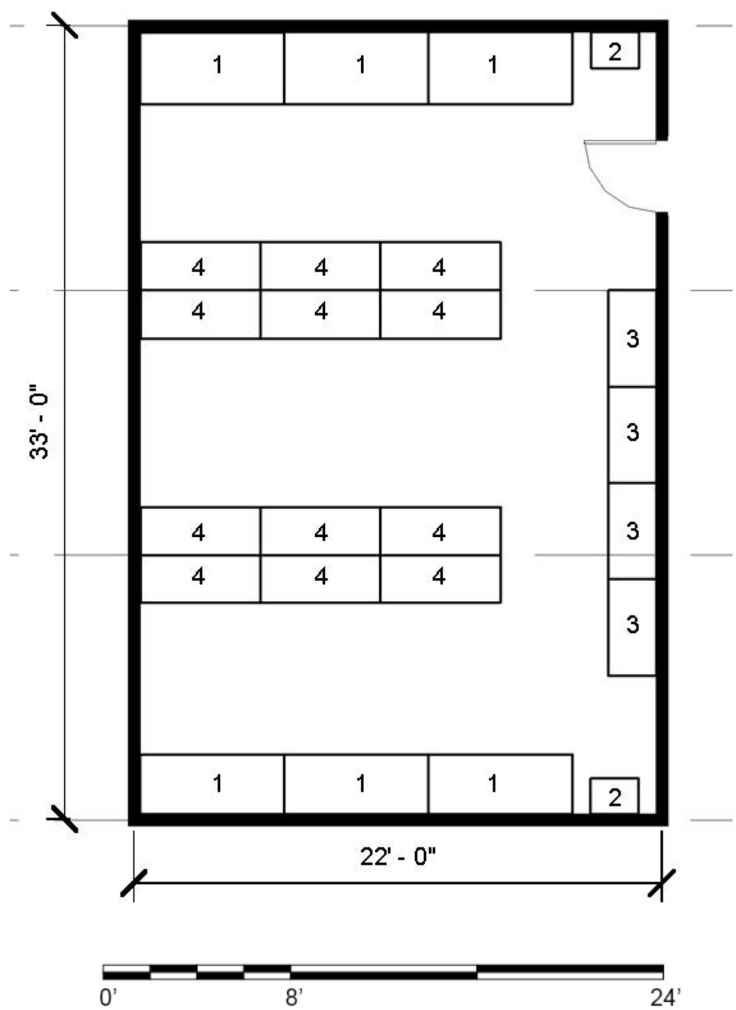
5.5.1.21 Detector Storage

Central Laboratory and Office Building II | Lead: Gary Bloom

Room Data	
Space Number	5.5.1.21
Space Name	Detector Storage
Net Area Requirement (NSF)	730
Number of spaces required	2
Population	4 - 6
Space Activities/Functional Description	Staff offices
Adjacency Requirements	TBD
Vehicular Access Requirements	None
Key Design Requirements	None

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	6 - Work Tables	60" x 30" x 36"		☑	☐
2	2 - Sinks	2' x 2'		☑	☐
3	4 - Storage cabinets	4' Wide		☑	☐
4	12 - Shelving racks	5' Wide		☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.5.1.22 Light Mechanical Instrument Support

Central Laboratory and Office Building II

Lead: Gary Bloom

Room Data	
Space Number	5.5.1.22
Space Name	Light Mechanical Instrument Support
Net Area Requirement (NSF)	970
Number of spaces required	1
Population	4 - 6
Space Activities/Functional Description	Staff offices
Adjacency Requirements	None
Vehicular Access Requirements	None
Key Design Requirements	House compressed air supply, 120 VAC outlets spaced every 6 to 8 feet

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	2 - Sinks			☑	☐
2	Radiation source and buffer area	20' x 20'	Shielded Cf-252 source	☐	☐
3	12 - Work benches	6' L x 3' W		☑	☐
4	7 - storage shelves	5' W x 8' H		☑	☐

Note: Test Fit Plan on following page

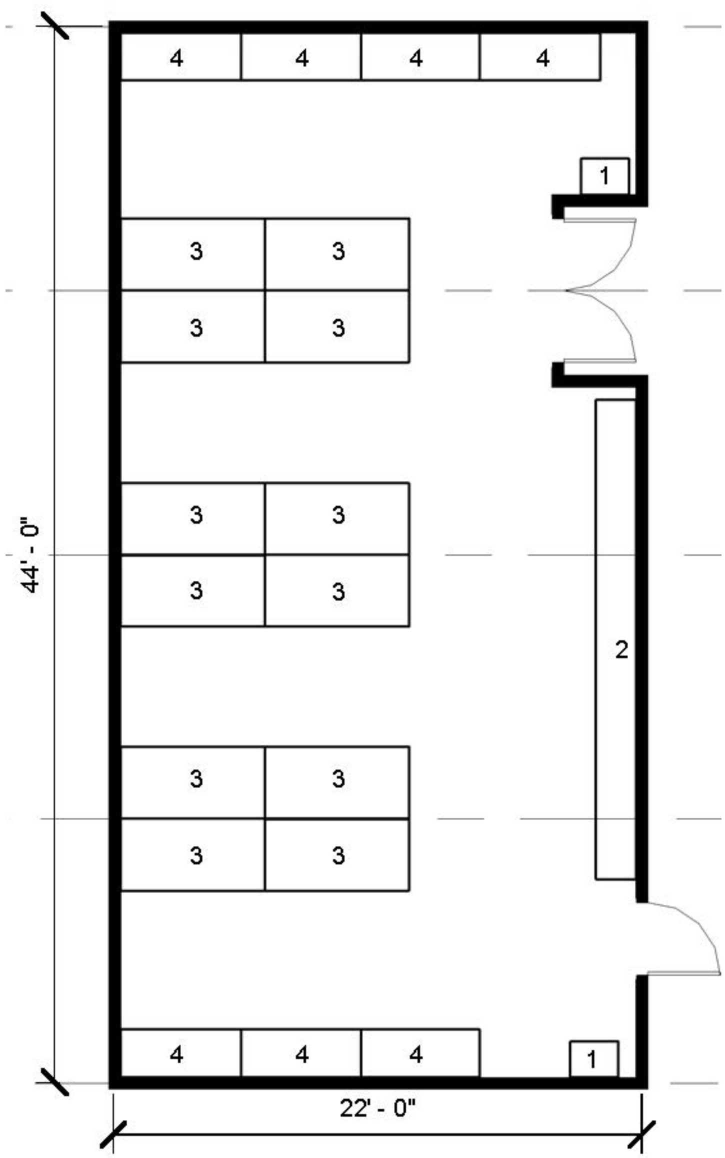
CF: Conventional Facilities
TS: Technical Systems

5.5.1.22 Light Mechanical Instrument Support

Central Laboratory and Office Building II

Lead: Gary Bloom

Test-fit Plan



Preliminary space plan

Scale 1/8″ = 1′-0″

5.5.1.23 Blast Lab

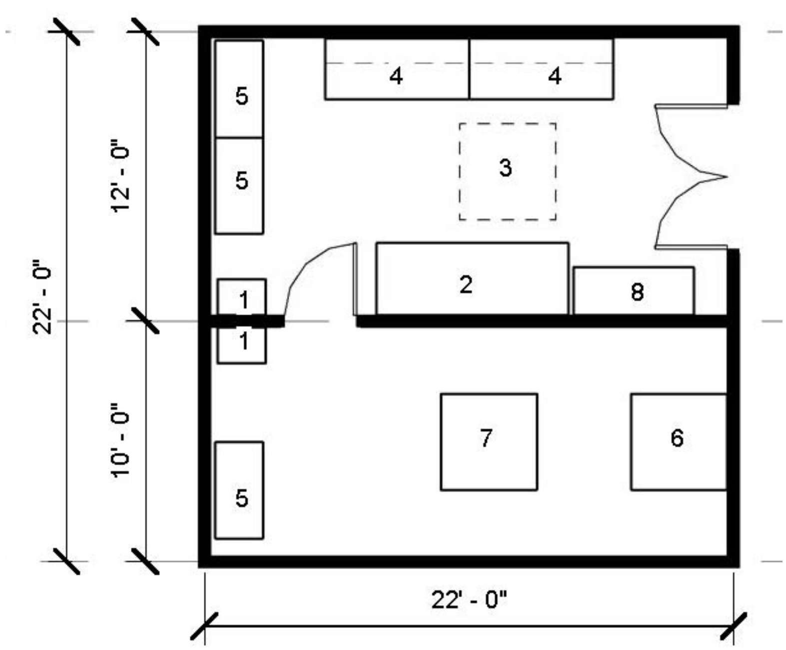
Central Laboratory and Office Building II

Lead: Gary Bloom

Room Data	
Space Number	5.5.1.23
Space Name	Blast Lab
Net Area Requirement (NSF)	480
Number of spaces required	1
Population	4-6
Space Activities/Functional Description	Staff offices
Adjacency Requirements	TBD
Vehicular Access Requirements	None
Key Design Requirements	Should be located on ground floor.

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	2 -Sinks	2' x 2'		✓	
2	Gas panel	8' x 3' x 6'			✓
3	Gas intesifier	4' x 4'	Portable		✓
4	2 - Lab benches	60" x 30" x 36"		✓	
5	3 - Cabinets	4' W x 8' H		✓	
6	Hydrogen intensifier	4' x 4'			✓
7	Lab Table	4' x 4'			✓
8	Desk	5' Long		✓	

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.5.1.24 Metrology Guide Alignment

Central Laboratory and Office Building II | Lead: Gary Bloom

Room Data	
Space Number	5.5.1.24
Space Name	Metrology Guide Alignment
Net Area Requirement (NSF)	970
Number of spaces required	2
Population	6-Apr
Space Activities/Functional Description	Metrology Lab precision fiducialization, charcterization and dimensional inspection of project and experimental components.
Adjacency Requirements	Indirect
Vehicular Access Requirements	Van, indirect
Key Design Requirements	Thick slab on ground floor, no basement below, acces to loading dock to facilitate moving heavy components into lab. Floor needs to stabily support several heavy surface plates (9000 lbs, 7040 lbs, ~7000 lbs) can not bridge slabs. There are several smaller/lighter plates and an optic table. Compressed air required for CMM operation. Standard AC power access on all walls. Independent climate and access controlled area required for accurate measurements. Sufficient spacing to allow lifting fixtures, pallet jacks and possibly fork lifts to move equipment for work.

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 Surface plate (7040 lbs)	48" x 96" x 40"		☐	☑
2 Optics table	48"x 96" x 40"		☐	☑
3 CMM (9000 lbs)	48" x 96" x 120"		☐	☑
4 CMM (~2000 lbs)	48" x 48" x 120"		☐	☑
5 Surface plate (7000 lbs)	48" x 120" x 40"		☐	☑
6 10 - Equipment cabinets	36" x 36" x 72"		☑	☐
7 3 - Work benches	48" x 96" x 36"		☑	☐

Note: Test Fit Plan on following page

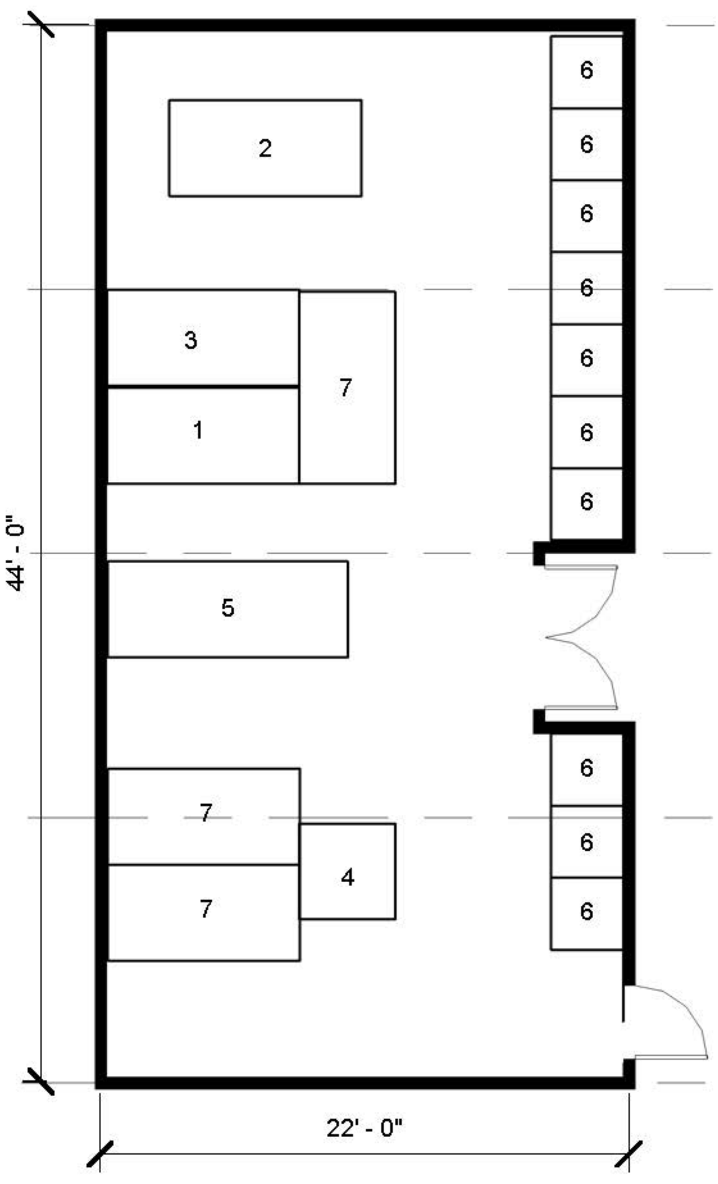
CF: Conventional Facilities
TS: Technical Systems

5.5.1.24 Metrology Guide Alignment

Central Laboratory and Office Building II

Lead: Gary Bloom

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

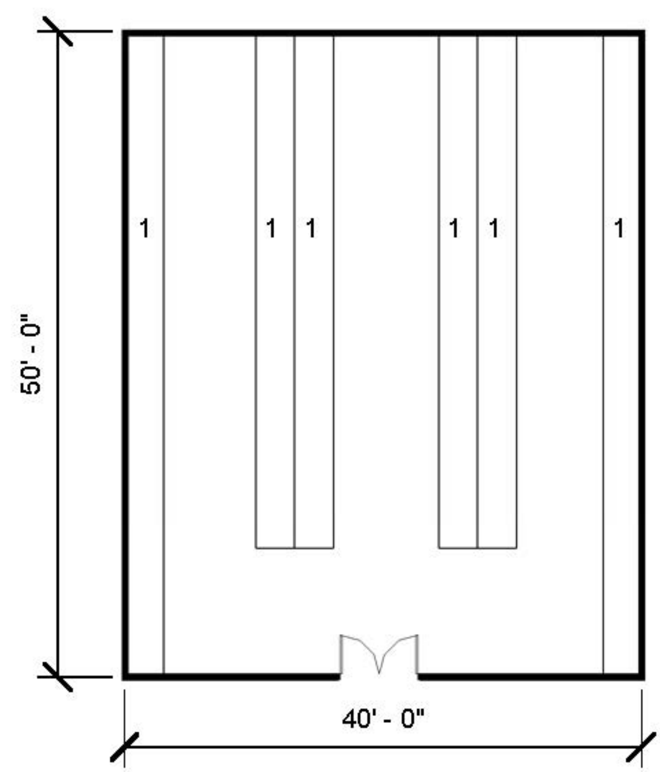
5.5.1.25 General Building Storage

Central Laboratory and Office Building II — Lead: Gary Bloom

Room Data	
Space Number	5.5.1.25
Space Name	General Building Storage
Net Area Requirement (NSF)	2,000
Number of spaces required	1
Population	0
Space Activities/Functional Description	General storage
Adjacency Requirements	Loading dock, freight elevator
Vehicular Access Requirements	Tractor/Trailer
Key Design Requirements	Conditioned space, floor drain(s)

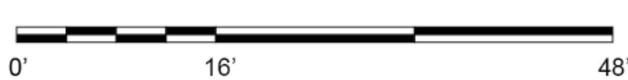
Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 Staged excessed furniture/spares	Estimated size		☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/16" = 1'-0"



CF: Conventional Facilities
TS: Technical Systems

5.5.1.26 Lobby

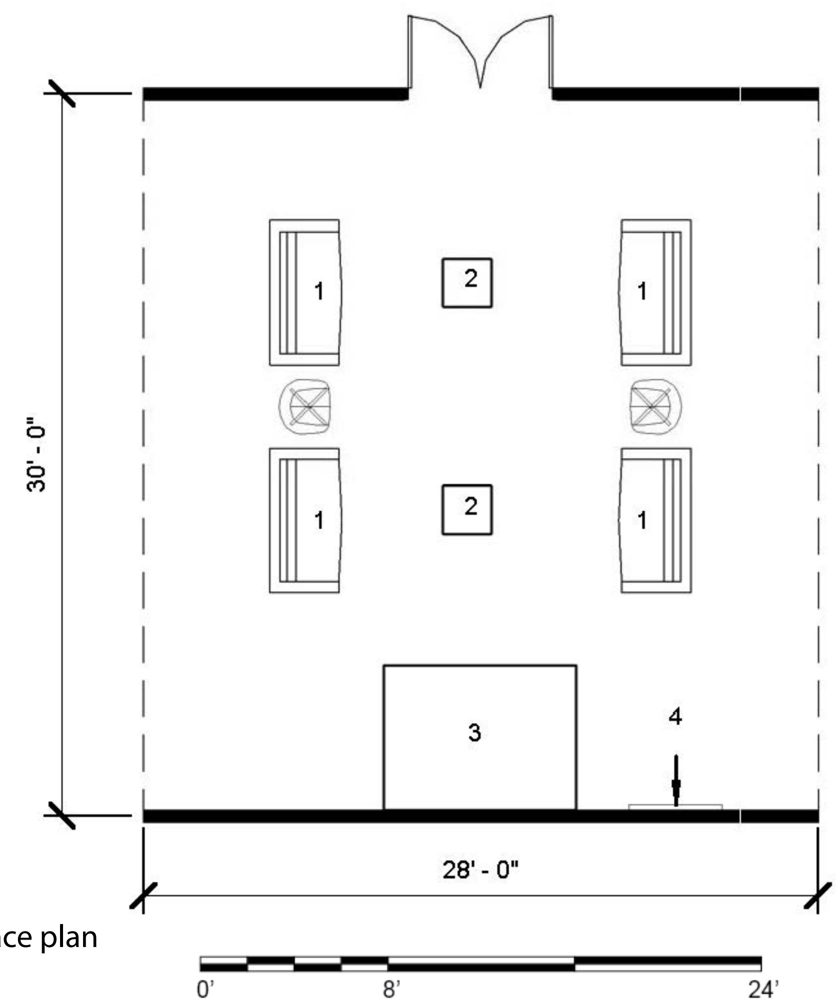
Central Laboratory and Office Building II

Lead: Gary Bloom

Room Data	
Space Number	5.5.1.26
Space Name	Lobby
Net Area Requirement (NSF)	870
Number of spaces required	1
Population	0 - 40
Space Activities/Functional Description	Orientation, short-term gathering, special events
Adjacency Requirements	Conference, breakout areas, restrooms
Vehicular Access Requirements	None
Key Design Requirements	Daylighting

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 Lounge chairs	2' x 2'		☑	☐
2 Coffee tables	18" x 18"		☑	☐
3 Orientation kiosk	6' x 8'		☑	☐
4 Flat screen monitor	50"	(operations status etc.)	☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.5.1.27 Janitor's Closet

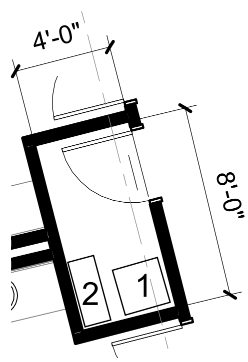
Central Laboratory and Office Building II

Lead: Gary Bloom

Room Data	
Space Number	5.5.1.27
Space Name	Janitor's Closet
Net Area Requirement (NSF)	80
Number of spaces required	4
Population	0
Space Activities/Functional Description	Equipment and maintenance
Adjacency Requirements	None
Vehicular Access Requirements	None
Key Design Requirements	None

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 Floor sink	2' x 2'		☑	☐
2 Shelving	1' x 3'		☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.5.1.28 Server Room

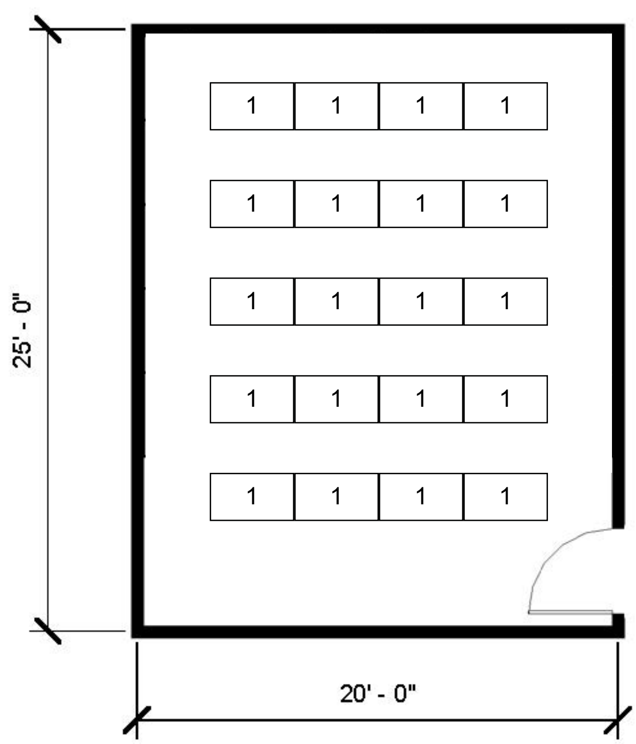
Central Laboratory and Office Building II

Lead: Gary Bloom

Room Data	
Space Number	5.5.1.28
Space Name	Server Room
Net Area Requirement (NSF)	500
Number of spaces required	1
Population	0
Space Activities/Functional Description	Houses processor and data servers for engineering applications. It incorporates blade and GPU servers of different types in the same facility housed in 6 double-sided floor to ceiling
Adjacency Requirements	None
Vehicular Access Requirements	None
Key Design Requirements	Stand alone HVAC (for energy efficiency), no labs or restrooms above to prevent water damage

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	20 - Server racks	Estimated size		☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

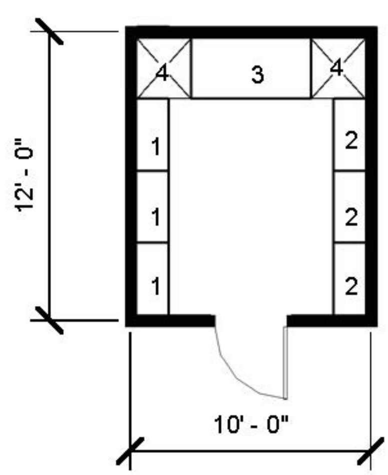
5.5.1.29 Electrical Distribution Room

Central Laboratory and Office Building II — Lead: Gary Bloom

Room Data	
Space Number	5.5.1.29
Space Name	Electrical Distribution Room
Net Area Requirement (NSF)	120
Number of spaces required	4
Population	0
Space Activities/Functional Description	Houses electrical panels
Adjacency Requirements	One per floor
Vehicular Access Requirements	None
Key Design Requirements	Stacked vertically. Stand alone HVAC (for energy efficiency), no labs or restrooms above to prevent water damage. 1200 SF normal distribution room; 600 SF Gen/UPS distribution room on north perimeter at east end.

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 3 - Distribution switchboards	16" x 36"		☑	☐
2 3 - Panelboards	16" x 36"		☑	☐
3 Transformer	30" x 60"		☑	☐
4 2 - Riser space	27" x 30"		☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/8″ = 1′-0″

CF: Conventional Facilities
TS: Technical Systems

5.5.1.30 IT Communications Room

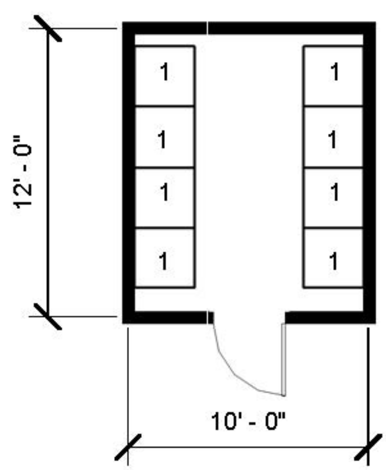
Central Laboratory and Office Building II

Lead: Gary Bloom

Room Data	
Space Number	5.5.1.30
Space Name	IT Communications Room
Net Area Requirement (NSF)	120
Number of spaces required	4
Population	0
Space Activities/Functional Description	Houses electrical panels
Adjacency Requirements	One per floor
Vehicular Access Requirements	None
Key Design Requirements	Stacked vertically. Stand alone HVAC (for energy efficiency), no labs or restrooms above to prevent water damage. Racks need rear access.

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	8 - Communications cabinets	30" x 30"		☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.5.1.31 Switchgear

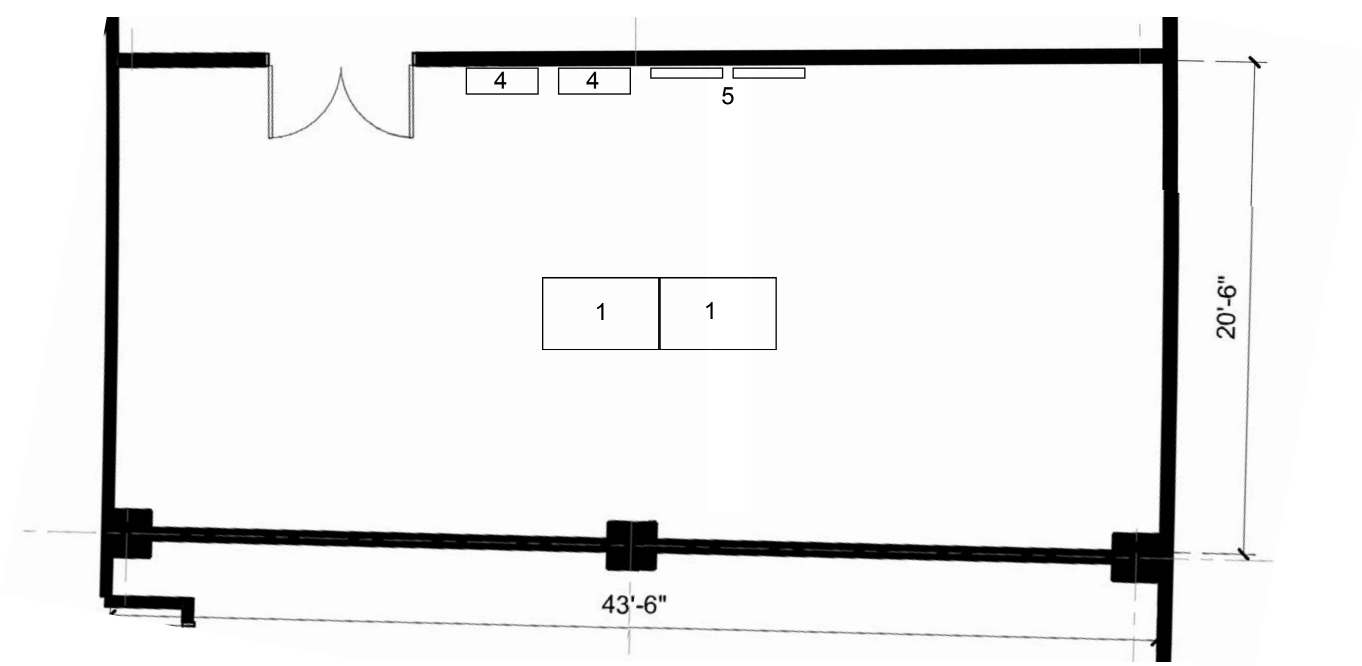
Central Laboratory and Office Building II

Lead: Gary Bloom

Room Data	
Space Number	5.5.1.31
Space Name	Switchgear
Net Area Requirement (NSF)	1,200
Number of spaces required	1
Population	0
Space Activities/Functional Description	Houses main building switchgear
Adjacency Requirements	Ground floor
Vehicular Access Requirements	Indirect
Key Design Requirements	Floor drain needed. Double doors for emergency egress and equipment placement.

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	2 - 480V Substations	72" x 88" x 96"		☑	☐
2	2 - DC power supply	30" x 30"	TBD	☑	☐
3	SCADA	30" x 30"	TBD	☑	☐
4	2 - Distribution boards	TBD		☑	☐
5	2 - Panel boards	TBD		☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

CF: Conventional Facilities

TS: Technical Systems

5.5.1.32 Fire Riser Room

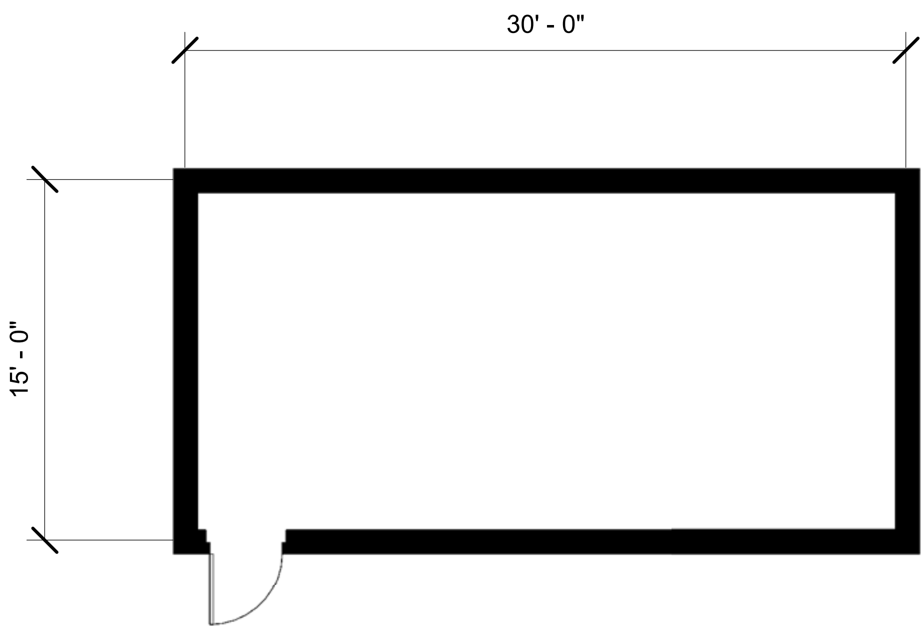
Central Laboratory and Office Building II

Lead: Gary Bloom

Room Data	
Space Number	5.5.1.32
Space Name	Fire Riser Room
Net Area Requirement (NSF)	450
Number of spaces required	1
Population	0
Space Activities/Functional Description	
Adjacency Requirements	
Vehicular Access Requirements	
Key Design Requirements	

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 TBD			☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

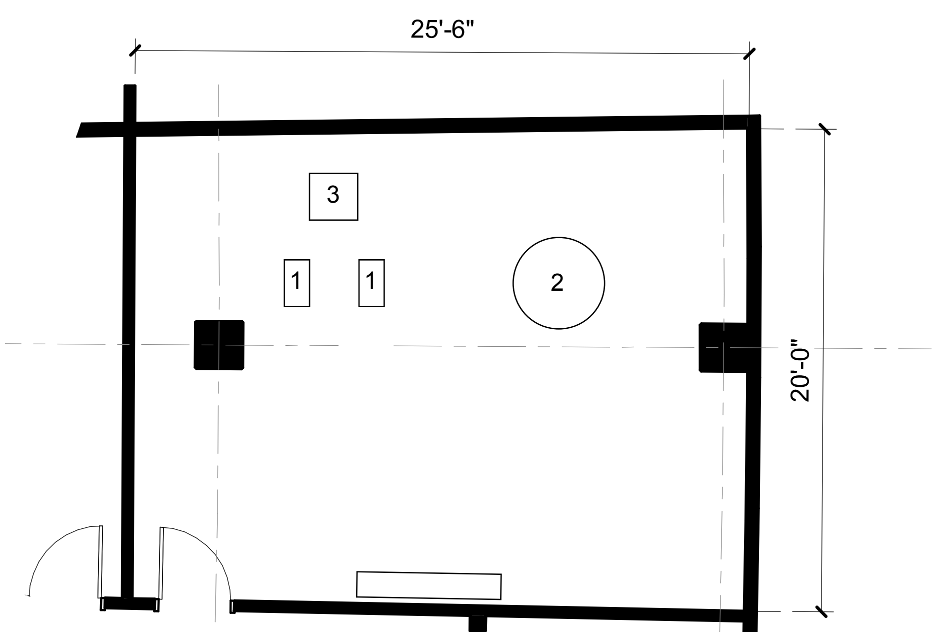
5.5.1.33 Mechanical Room

Central Laboratory and Office Building II — Lead: Gary Bloom

Room Data	
Space Number	5.5.1.33
Space Name	Mechanical Room
Net Area Requirement (SF)	500
Number of spaces required	1
Population	0
Space Activities/Functional Description	Equipment room
Adjacency Requirements	none
Vehicular Access Requirements	none
Key Design Requirements	Rated enclosure

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 2-Sensible Chilled Water Pumps	2’ x 1’ each		☑	☐
2 500 Gallon Sensible Chilled Water Storage Tank	4’ dia. x 6’ h.		☑	☐
3 Plate-Frame Heat Exchanger	2’ x 2’ x 4’		☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/8” = 1’-0”

0’ 8’ 24’

CF: Conventional Facilities
TS: Technical Systems

5.5.1.34 Mechanical Penthouse

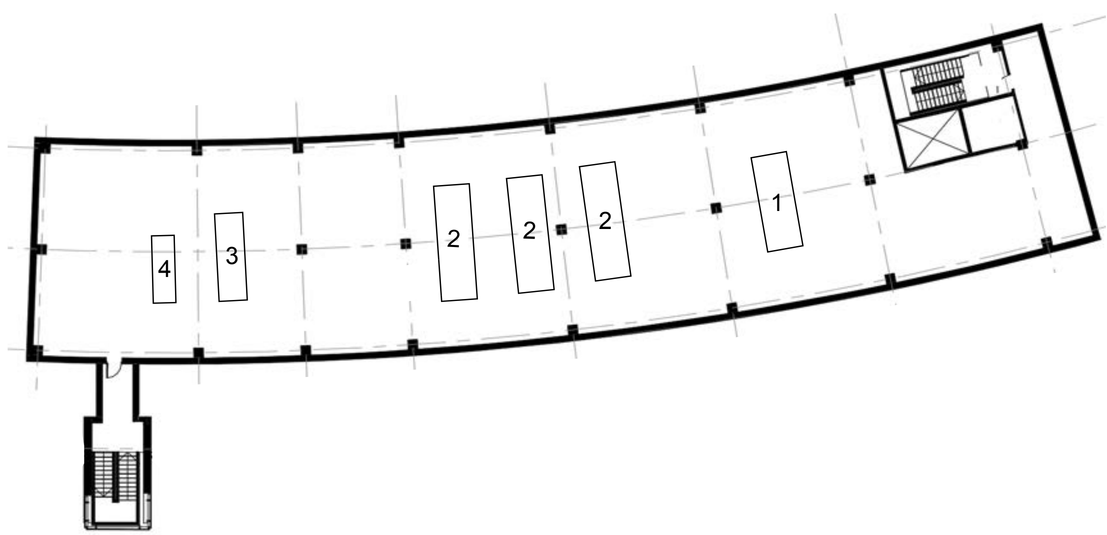
Central Laboratory and Office Building II

Lead: Gary Bloom

Room Data	
Space Number	5.5.1.34
Space Name	Mechanical Penthouse
Net Area Requirement (NSF)	8,150
Number of spaces required	1
Population	0
Space Activities/Functional Description	Equipment Space
Adjacency Requirements	Roof
Vehicular Access Requirements	None
Key Design Requirements	None

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	Office AHU	20’ x 9’ x 8’		☑	☐
2	3-Lab & Shop AHUs	24’ x 9’ x 10’ each		☑	☐
3	3-Wet Lab Exhaust Fans	18’ x 6’ total dimension		☑	☐
4	2-Bio Safety Cabinet Exhaust Fans	10’ x 5’ total dimension		☑	☐

Test-fit Plan



Preliminary space plan

Scale 1” = 40’-0”

0' 40' 120'

CF: Conventional Facilities
TS: Technical Systems

5.5.1.35 Toilets

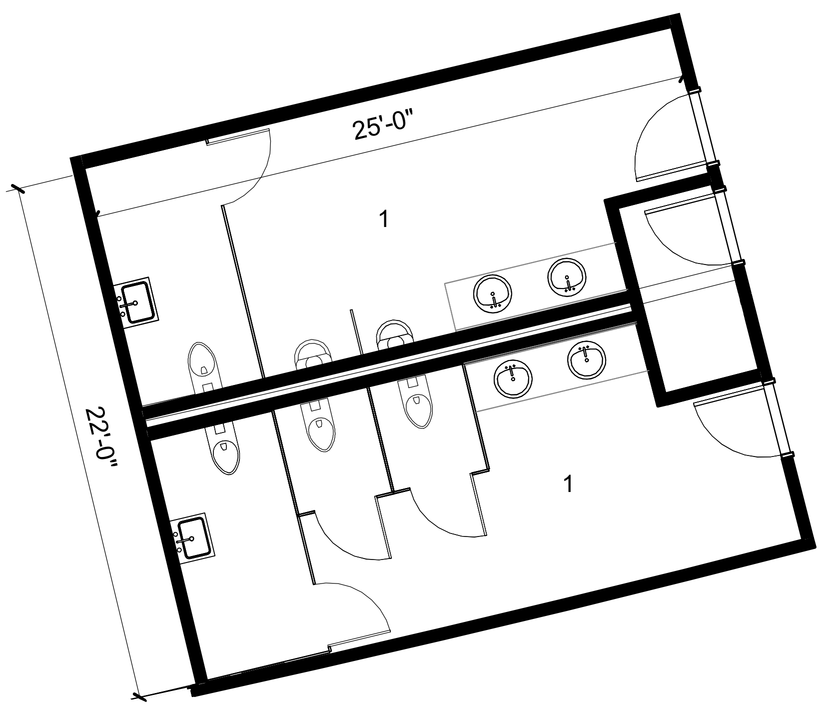
Central Laboratory and Office Building II

Lead: Gary Bloom

Room Data	
Space Number	5.5.1.35
Space Name	Toilets
Net Area Requirement (SF)	250
Number of spaces required	8
Population	0-4
Space Activities/Functional Description	Toilets
Adjacency Requirements	None
Vehicular Access Requirements	None
Key Design Requirements	Accessible

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 Toilet Fixtures		Verify QuantityVerify Quantity	☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.5.1.36 Recycling/Trash

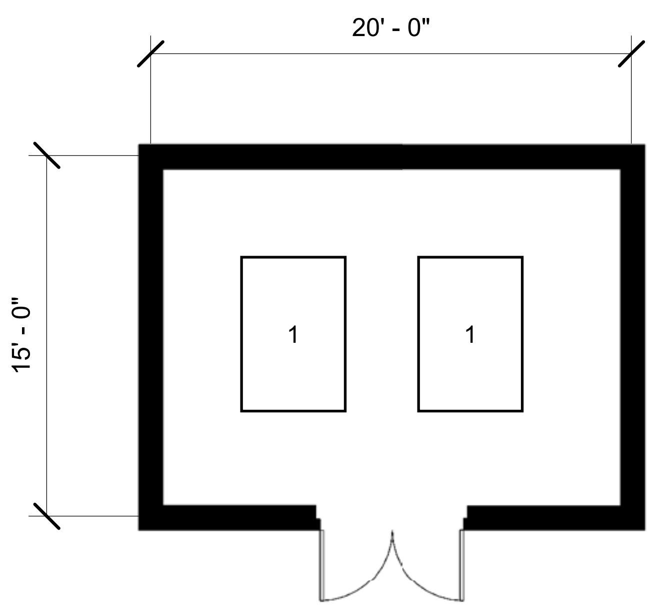
Central Laboratory and Office Building II

Lead: Gary Bloom

Room Data	
Space Number	5.5.1.36
Space Name	Recycling/Trash
Net Area Requirement (NSF)	150
Number of spaces required	1
Population	0
Space Activities/Functional Description	Receive, store and organize disposables
Adjacency Requirements	
Vehicular Access Requirements	Yes, provide truck access and overhead door
Key Design Requirements	

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 Recycling/Trash Dumpster			☑	☐

Test-fit Plan



Preliminary space plan
Scale 1/8" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.3.1.37 Toilets

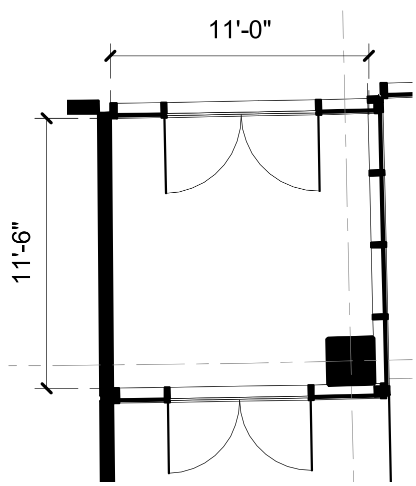
Target Building II

Lead: Peter Rosenblad

Room Data	
Space Number	5.3.1.37
Space Name	Toilets
Net Area Requirement (NSF)	550
Number of spaces required	2
Population	Non-permanent
Space Activities/Functional Description	Support occupants
Adjacency Requirements	none
Vehicular Access Requirements	none
Key Design Requirements	Make accessible

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 Plumbing Fixtures		Verify quantityVerify quantity	☑	☐
2 Lockers		Verify quantityVerify quantity	☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.5.1.38 Electrical Normal Distribution Room

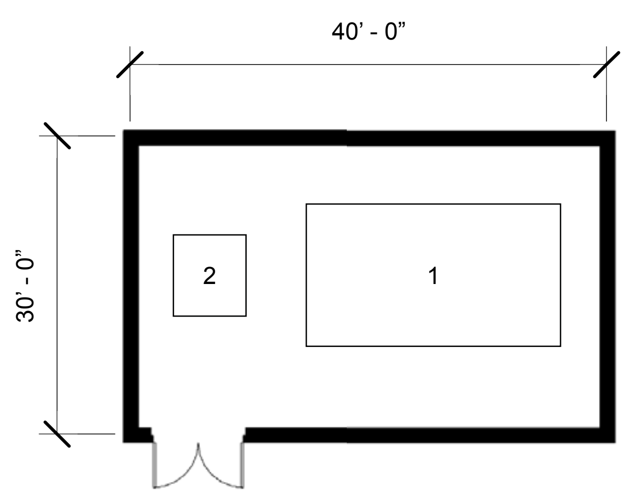
Central Laboratory and Office Building II

Lead: Gary Bloom

Room Data	
Space Number	5.5.1.38
Space Name	Electrical Normal Distribution Room
Net Area Requirement (NSF)	1,200
Number of spaces required	1
Population	0
Space Activities/Functional Description	Houses electrical panels
Adjacency Requirements	One per floor
Vehicular Access Requirements	None
Key Design Requirements	Stacked vertically. Stand alone HVAC (for energy efficiency), no labs or restrooms above to prevent water damage. 1200 SF normal distribution room; 600 SF Gen/UPS distribution room on north perimeter at east end.

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	Two 1500 KVA exterior substations (CL2-SS1 & CL2-SS2)	20' x 12' pad each	Exterior	☑	☐
2	4000A low voltage switchgear assembles with secondary distribution (CL2-SS1 & CL2-SS2)	72" x 88" x 96"		☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/16" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.5.1.39 Boiler Room

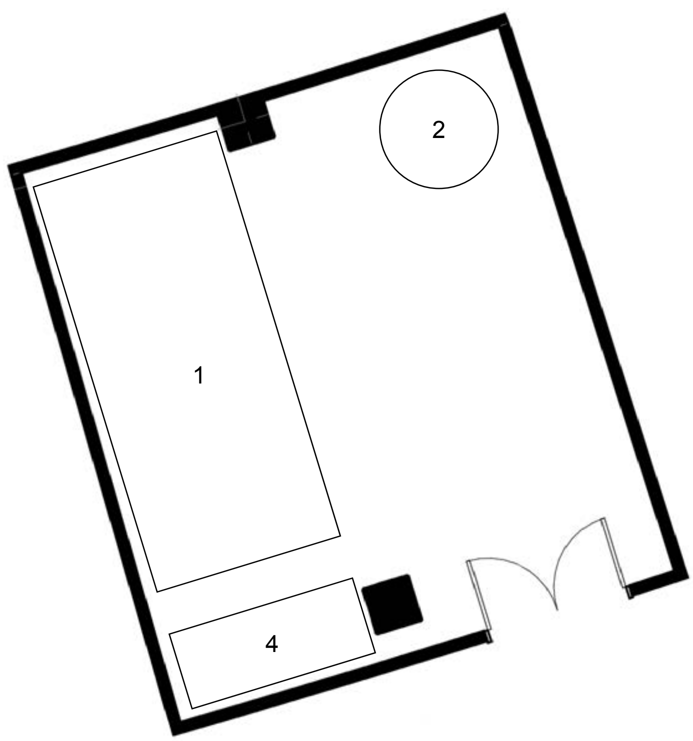
Central Laboratory and Office Building II

Lead: Gary Bloom

Room Data	
Space Number	5.5.1.39
Space Name	Boiler Room
Net Area Requirement (NSF)	500
Number of spaces required	1
Population	0
Space Activities/Functional Description	
Adjacency Requirements	Basement level
Vehicular Access Requirements	None
Key Design Requirements	

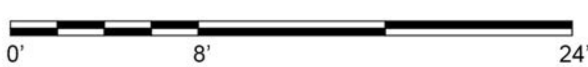
Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 Heating water Boilers	18' x8'		☑	☐
2 Expansion tanks	5' Dia		☑	☐
3 Naterial gas reducing station		Exterior	☑	☐
4 Heating water pumps	4' x 8'		☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/8″= 1′-0″



CF: Conventional Facilities

TS: Technical Systems

5.5.1.40 Electrical Gen/UPS Distribution Room

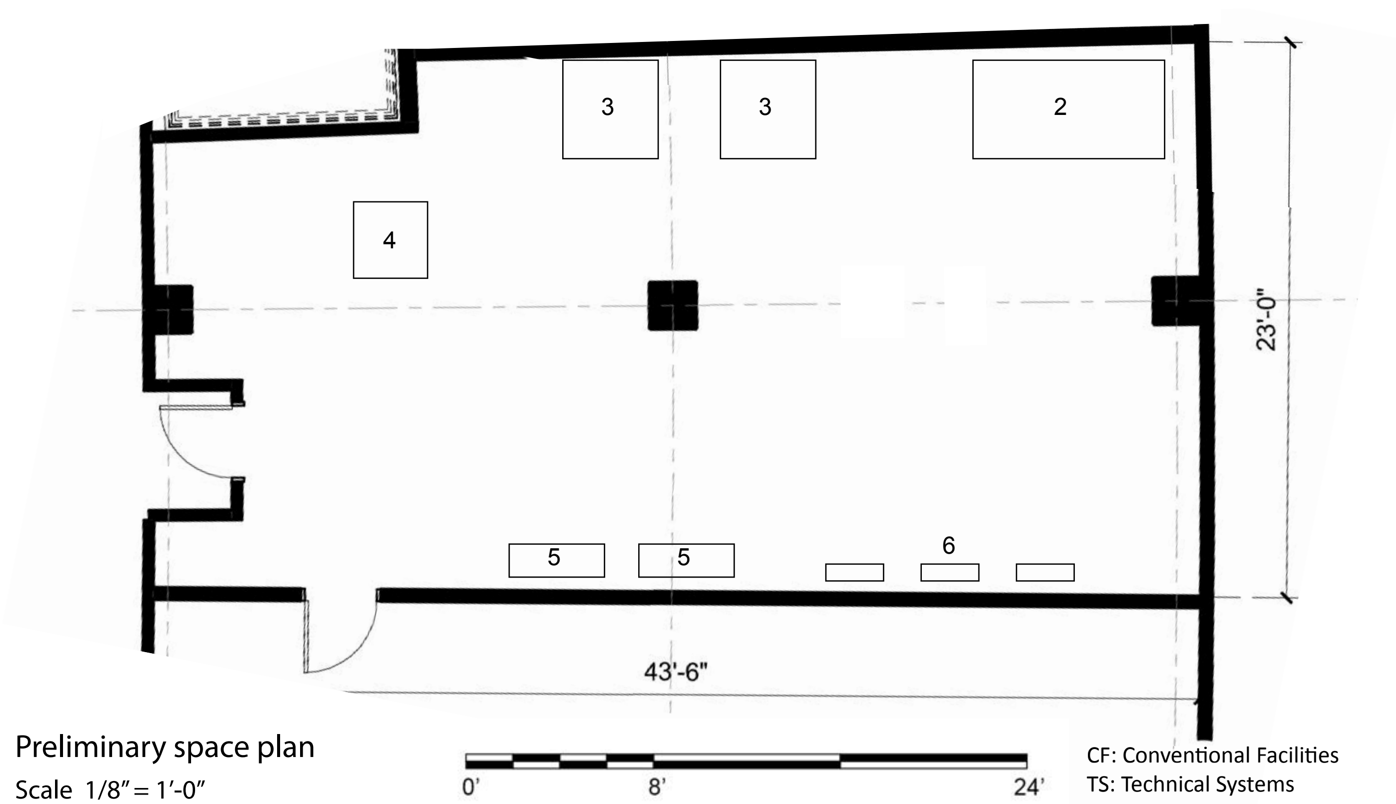
Central Laboratory and Office Building II

Lead: Gary Bloom

Room Data	
Space Number	5.5.1.40
Space Name	Electrical Gen/UPS Distribution Room
Net Area Requirement (NSF)	400
Number of spaces required	1
Population	0
Space Activities/Functional Description	Houses electrical panels
Adjacency Requirements	One per floor
Vehicular Access Requirements	None
Key Design Requirements	Distribution from is stacked vertically. Stand alone HVAC (for energy efficiency), no labs or restrooms above to prevent water damage. 1200 SF normal distribution room; 400 SF Gen/UPS distribution room on north perimeter at east end.

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 CL2-EG1 Generator	20' x 12' pad	Exterior	☑	☐
2 UPS	8' x 4'		☑	☐
3 2-600A BATS	4' x 4' each		☑	☐
4 260A ATS	3' x 3'		☑	☐
5 2-600A Dist Panel	1' x 4'		☑	☐
6 3-related branch circuit panels	6" x 24" each		☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.6.1
CUB II

5.6.1 Central Utilities Building II

STS Space Program Lead: TBD

5.6.1	Central Utilities Building II NSF			7,850
	Central Utilities Building II GSF			9,244
	Central Utilities Building II Efficiency			85%

No.	Rooms	Qty.	NSF	Total NSF
5.6.1.1	Boiler Systems	1	1,050	1,050
5.6.1.2	Pump Room / Chem Treatment	1	1,700	1,700
5.6.1.3	Chiller Room	1	1,700	1,700
5.6.1.4	Compressed Air System	1	1,050	1,050
5.6.1.5	Control Room	1	300	300
5.6.1.6	Communications Room	1	200	200
5.6.1.7	Breakroom	1	150	150
5.6.1.8	Workshop	1	1,250	1,250
5.6.1.9	Technician Work Area	1	150	150
5.6.1.10	UPS/Emergency Electrical Room	1	300	300

Additional Program Space Requirements

Cooling Tower (Exterior Location)

- CNDW filtration - sand filter or alternate selection
- TWR filtration - sand filter or alternate selection
- CNDW & TWR - acid neutralization diked area 12' x 18'

Circulation

Egress Stairs

Exterior Loading at both Levels

Spare pump storage - 4' x 16' (four 4' x 4' pallets)

Receiving area at upper roll up door - 10' x 10'

Diked chemical treatment areea - 16' x 20'

CHW filtration 6' x 6'

5.6.1.1 Boiler Systems

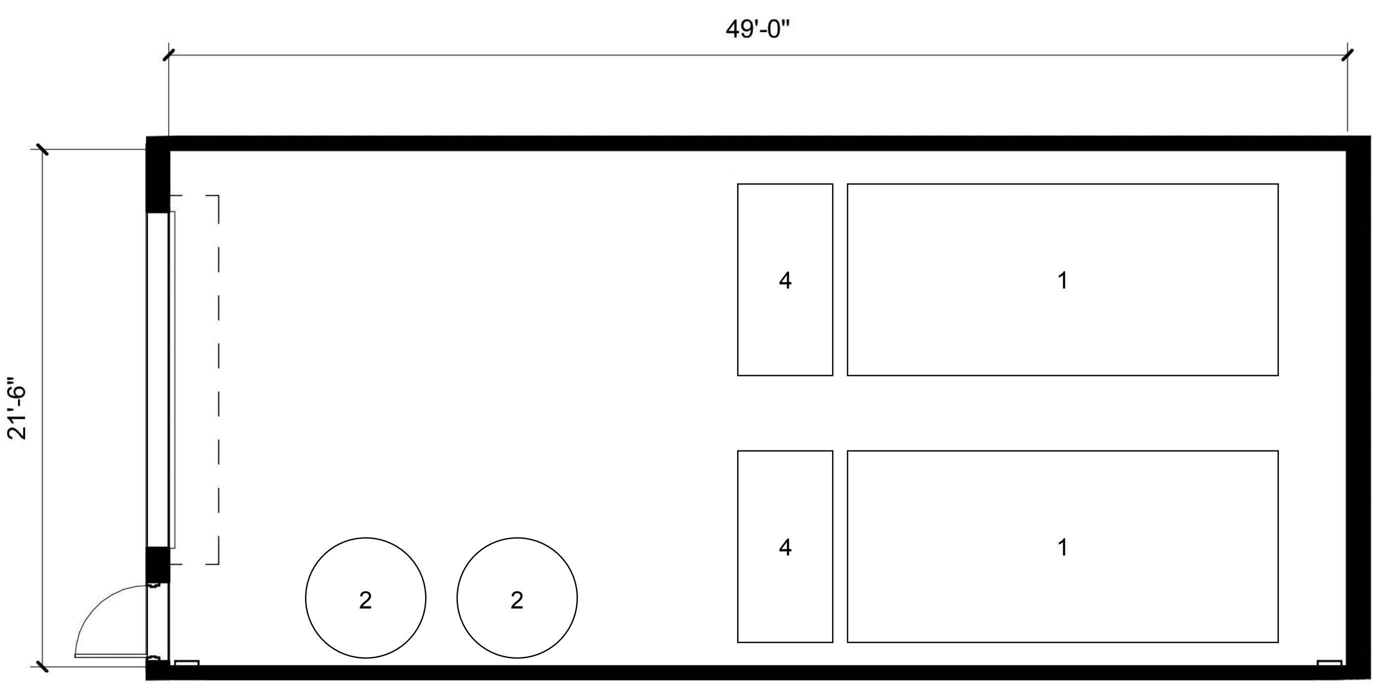
Central Utilities Building II

Lead: TBD

Room Data	
Space Number	5.6.1.1
Space Name	Boiler Systems
Net Area Requirement (NSF)	1,050
Number of spaces required	1
Population	0
Space Activities/Functional Description	Utility support
Adjacency Requirements	Ground floor
Vehicular Access Requirements	Tractor/Trailer
Key Design Requirements	Take into consideration: fire protection issues, combustion air, combustion gases, and high temps. Gas train requires exterior wall.

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	3 -Heating water boilers	18' x 8' x 10'	Need davit swing space both	☑	☐
2	2 - Expansion tanks (air separator)	5' Diameter		☑	☐
3	Natural gas reducing station		Exterior location	☑	☐
4	2 - Heating water pumps	4' x 8'		☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

CF: Conventional Facilities

TS: Technical Systems

5.6.1.2 Pump Room / Chem Treatment

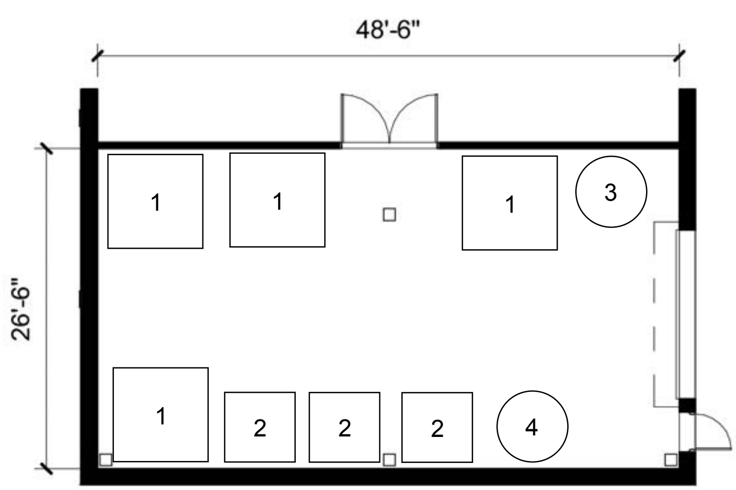
Central Utilities Building II

Lead: TBD

Room Data	
Space Number	5.6.1.2
Space Name	Pump Room / Chem Treatment
Net Area Requirement (NSF)	1,700
Number of spaces required	1
Population	0
Space Activities/Functional Description	Utility support
Adjacency Requirements	Ground floor
Vehicular Access Requirements	Tractor/Trailer
Key Design Requirements	Crane coverage over chillers. Refrigerant hazard

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	4 - Primary chilled water pumps	8' x 8'		☑	☐
2	4 -Secondary chilled water pumps	6' x 6' x 6'		☑	☐
3	CHW Air separator	6' Diameter		☑	☐
4	CHW Expansion Tank	6' Diameter		☑	☐
5	Condenser water pumps	TBD		☐	☐
6	Tower water pumps	TBD		☐	☐
7	Chemical treatment	TBD		☐	☐
8	Local motor control center	TBD	For water pumps	☐	☐

Test-fit Plan



Preliminary space plan

Scale 1/16” = 1’-0”

CF: Conventional Facilities
TS: Technical Systems

5.6.1.3 Chiller Room

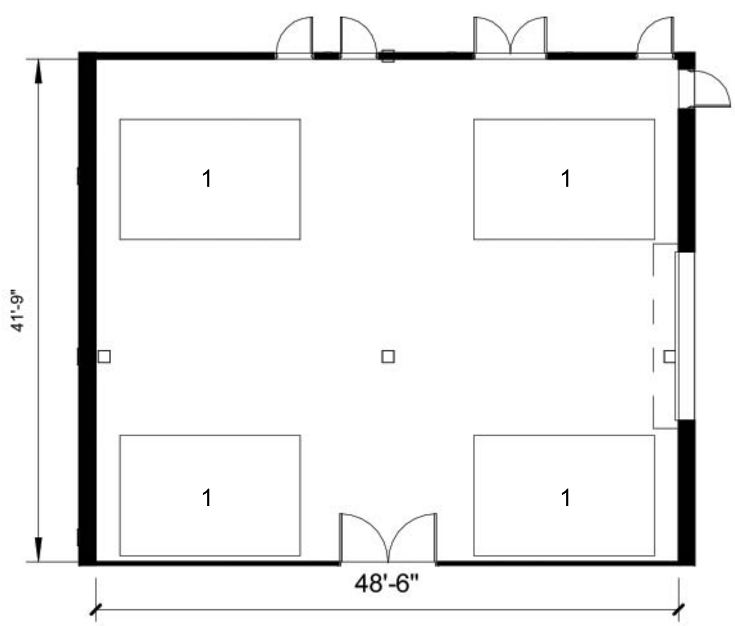
Central Utilities Building II

Lead: TBD

Room Data	
Space Number	5.6.1.3
Space Name	Chiller Room
Net Area Requirement (NSF)	1,700
Number of spaces required	1
Population	0
Space Activities/Functional Description	Utility support
Adjacency Requirements	Ground floor
Vehicular Access Requirements	Tractor/Trailer
Key Design Requirements	Crane coverage over chillers. Refrigerant hazard

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	4 - Water cooled centrifugal chillers	18' x 10' x 12'	Refrigerant discharge stack through roof must preserve lifting/rigging and head removal space both ends, tube pull space one end. Life safety hazard - 1 hr. fire rated separation required.	☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/16” = 1’-0”

CF: Conventional Facilities
TS: Technical Systems

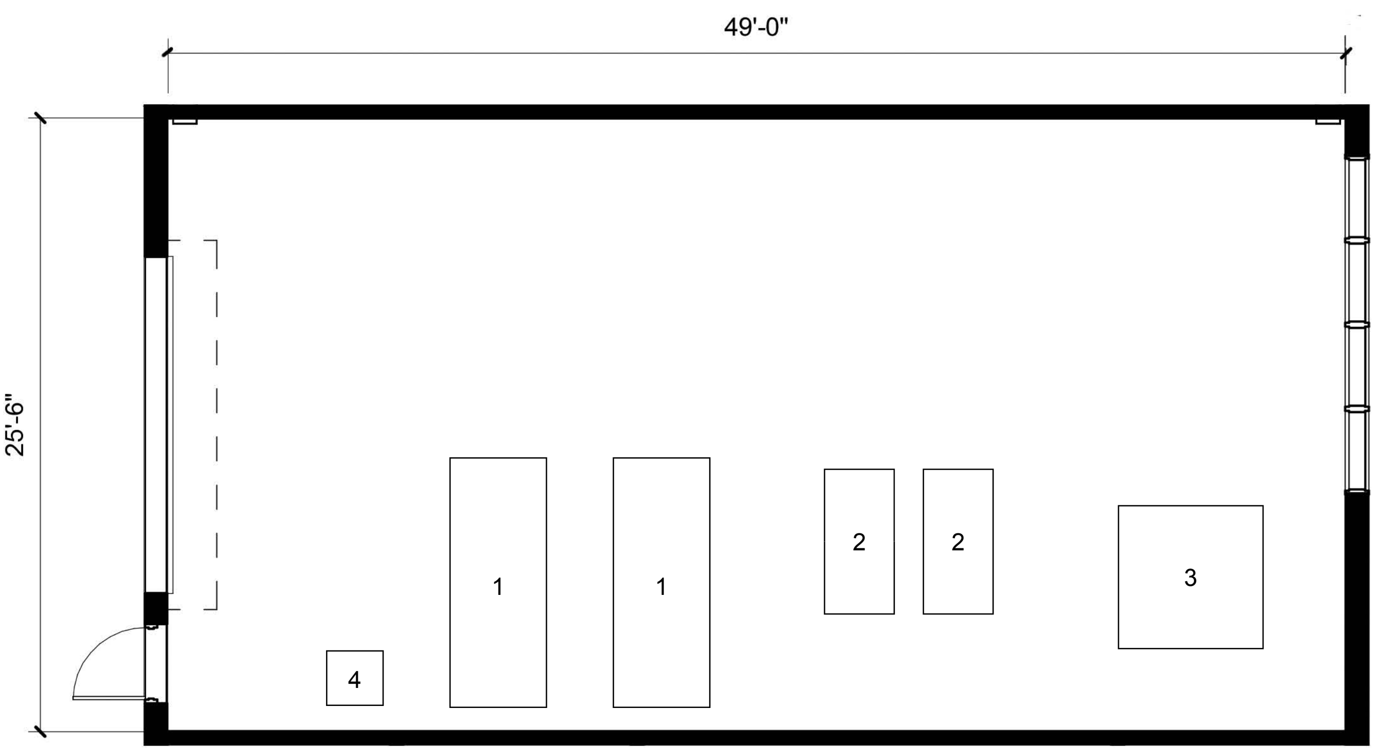
5.6.1.4 Compressed Air System

Central Utilities Building II — Lead: TBD

Room Data	
Space Number	5.6.1.4
Space Name	Compressed Air System
Net Area Requirement (NSF)	1,050
Number of spaces required	1
Population	0
Space Activities/Functional Description	Utility support
Adjacency Requirements	Ground floor
Vehicular Access Requirements	Tractor/Trailer
Key Design Requirements	Noise hazard. Gas train requires exterior wall

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	2 - Water cooled, oil-free, rotary screw air compressors	10' x 4' x 6'	Requires generous access, all sides condensate disposal	☑	☐
2	2 - Regenerative dessicant dryers	6' x 3' x 8'		☑	☐
3	Air Receiver	6' x 6' x 20'	5000 gallon	☑	☐
4	Moisture separator	2' x 2' x 6'		☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.6.1.5 Control Room

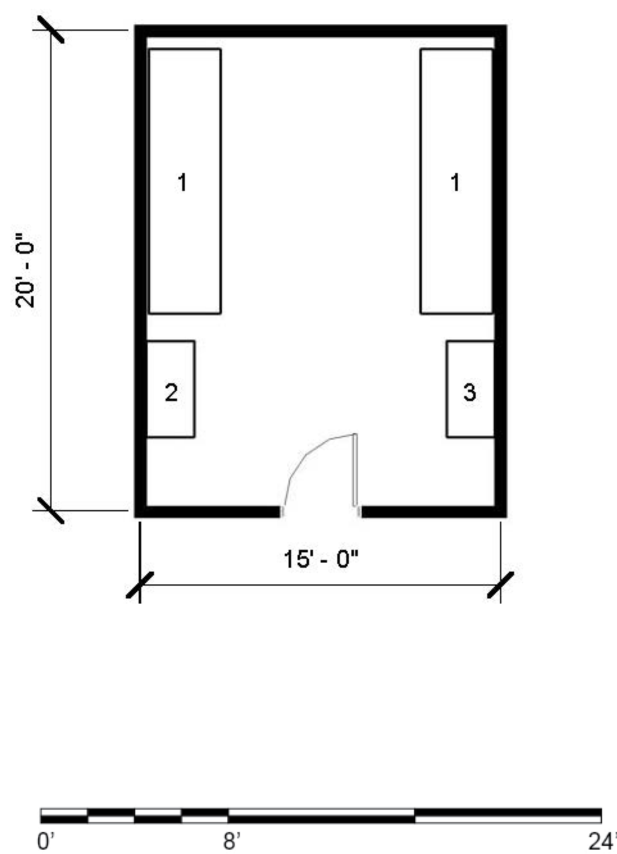
Central Utilities Building II

Lead: TBD

Room Data	
Space Number	5.6.1.5
Space Name	Control Room
Net Area Requirement (NSF)	300
Number of spaces required	1
Population	0 - 2
Space Activities/Functional Description	Houses computer, monitoring and diagnostics
Adjacency Requirements	Restroom
Vehicular Access Requirements	None
Key Design Requirements	Space conditioning

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	2 - Operator work stations	3' x 10'	Computer, 6 monitors	☑	☐
2	Security monitoring work station	2' x 4'	Computer, 2 monitors	☑	☐
3	General computer access station	2' x 4'	Computer, 2 monitors	☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

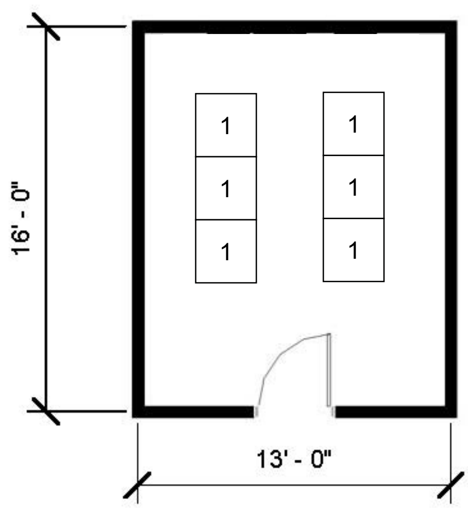
5.6.1.6 Communications Room

Central Utilities Building II | Lead: TBD

Room Data	
Space Number	5.6.1.6
Space Name	Communications Room
Net Area Requirement (NSF)	200
Number of spaces required	1
Population	0
Space Activities/Functional Description	Equipment/Maintenance
Adjacency Requirements	None
Vehicular Access Requirements	None
Key Design Requirements	Space conditioning

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	6 - Electronics cabinets	30" x 30"	Cabling access to top of cabinets	☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.6.1.7 Breakroom

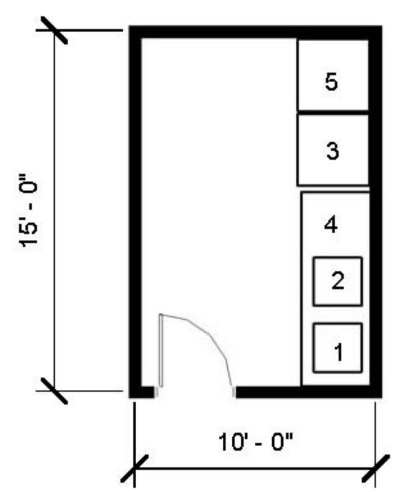
Central Utilities Building II

Lead: TBD

Room Data	
Space Number	5.6.1.7
Space Name	Breakroom
Net Area Requirement (NSF)	150
Number of spaces required	1
Population	5
Space Activities/Functional Description	Kitchen/Vending
Adjacency Requirements	Office
Vehicular Access Requirements	None
Key Design Requirements	Space conditioning

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 Microwave	2' x 2'		☑	☐
2 Sink	2' x 2'		☑	☐
3 Refrigerator	3' x 3'		☑	☐
4 Counter surface	2' x 10'		☑	☐
5 Vending machine	3' x 3'	Vendor	☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.6.1.8 Workshop

Central Utilities Building II

Lead: TBD

Room Data	
Space Number	5.6.1.8
Space Name	Workshop
Net Area Requirement (NSF)	1,250
Number of spaces required	1
Population	2
Space Activities/Functional Description	Tool/workshop area
Adjacency Requirements	None
Vehicular Access Requirements	Tractor/Trailer
Key Design Requirements	Space conditioning

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	6 - Toolbox	2' x 4'		☑	☐
2	3 - Workstations	50SF		☑	☐
3	Welding/brazing cart	2' x 3'		☑	☐
4	Bench grinder			☑	☐
5	Drill press			☑	☐
6	Sand blaster			☑	☐
7	Belt sander			☑	☐
8	Mobile crane	4' x 10'		☑	☐
9	10 storage cabinets	2' x 4'		☑	☐
10	Used oil station	4' x 8'	Two 4' x 4' pallets	☑	☐
11	Pipe rack	20' long	Two sides, easily accessible	☑	☐
12	Spare pump storage	4' x 16'	Four 4' x 4' pallets	☑	☐
13	Receiving area at upper roll up door	10' x 10'		☑	☐
14	Diked chemical treatment area	16' x 20'		☑	☐
15	CHW filtration	6' x 6'		☑	☐

Note: Test Fit Plan on following page

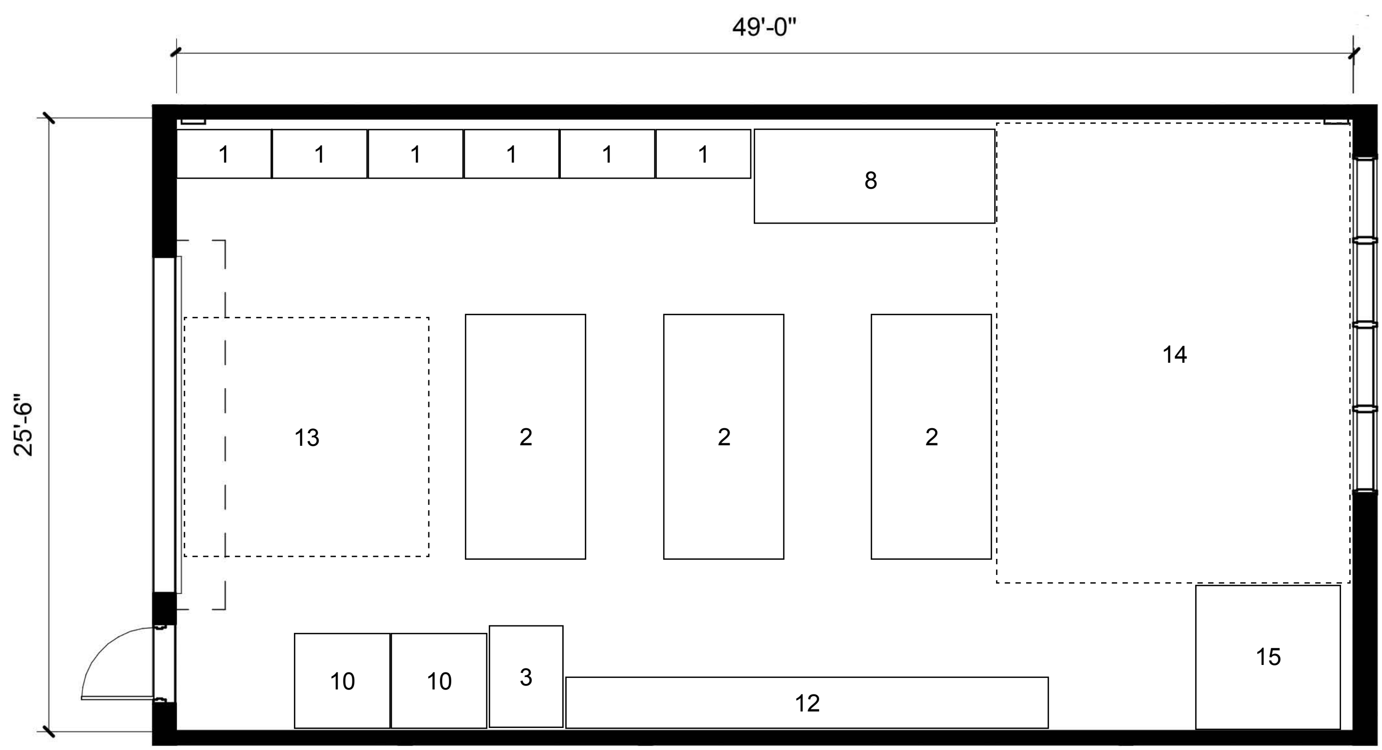
CF: Conventional Facilities
TS: Technical Systems

5.6.1.8 Workshop

Central Utilities Building II

Lead: TBD

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

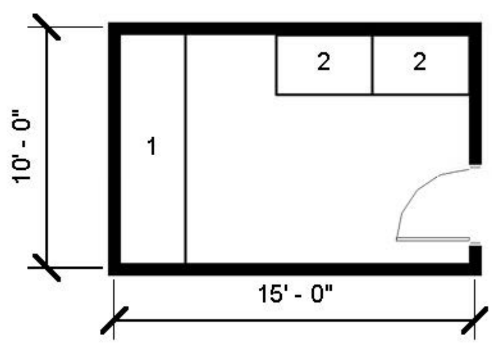
5.6.1.9 Technician work area

Central Utilities Building II — Lead: TBD

Room Data	
Space Number	5.6.1.9
Space Name	Technician work area
Net Area Requirement (NSF)	150
Number of spaces required	1
Population	1
Space Activities/Functional Description	Benchtop work area
Adjacency Requirements	None
Vehicular Access Requirements	None
Key Design Requirements	Office space. Quiet, well-lit, w/ space

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	Work bench	3' x 10'		☑	☐
2	Storage cabinets	2' x 4'		☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/8″ = 1′-0″

CF: Conventional Facilities
TS: Technical Systems

5.6.1.10 UPS/Emergency Electrical Room

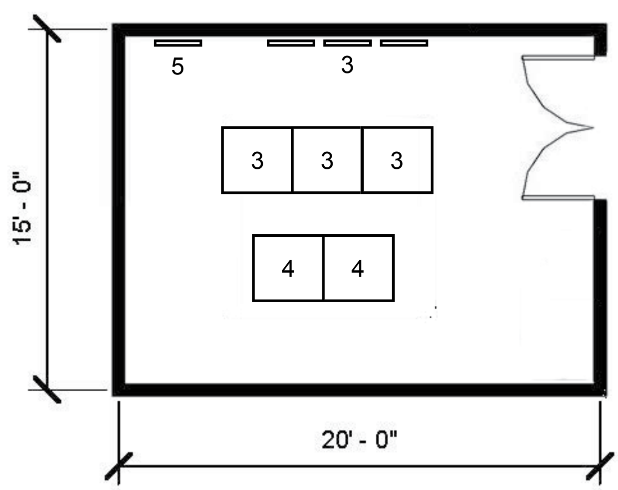
Central Utilities Building II

Lead: TBD

Room Data	
Space Number	5.6.1.10
Space Name	UPS/Emergency Electrical Room
Net Area Requirement (NSF)	300
Number of spaces required	1
Population	0
Space Activities/Functional Description	Equipment room
Adjacency Requirements	none
Vehicular Access Requirements	none
Key Design Requirements	Rated enclosure. Doors for emergency egress and equipment placement & maintenance.

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 CU2-SS1 & CU2-SS2 Switchgear	72" x 88" x 96"	Exterior	☑	☐
2 CU2-EG1 Transformer	3' x 3' x 3'	Exterior	☑	☐
3 3 - Panelboards	30" x 8" x 42"		☑	☐
4 2 - Automatic Transfer Switch	3' x 3 ' x 6'-6"		☑	☐
5 25 KVA UPS	3' x 7"		☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/8” = 1’-0”

CF: Conventional Facilities
TS: Technical Systems

5.6.2 CEF II

5.6.2 Central Exhaust Facility II

STS Space Program Lead: TBD

5.6.2	**Central Exhaust II Facility NSF**			**300**
	Central Exhaust Facility II GSF			**380**
	Central Exhaust Facility II Efficiency			**79%**
No.	**Rooms**	**Qty.**	**NSF**	**Total NSF**
5.6.2.1	Central Exhaust Fan Control Building	1	300	300

Additional Program Space Requirements

Central Exhaust Fan Systems and Stack

2 HOG Exhaust Fans and 2 Confinement Ventilation Exhaust Fans

Transformer Pads

2 Tunnel Exhaust Fans

5.6.2.1 Central Exhaust Fan Control Building

Central Exhaust Facility II

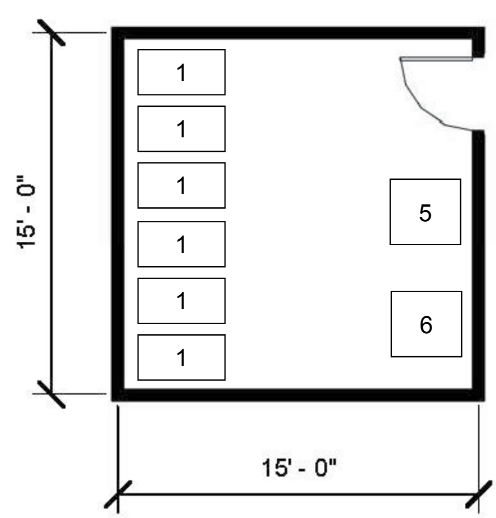
Lead: TBD

Room Data

Space Number	5.6.2.1
Space Name	Central Exhaust Fan Control Building
Net Area Requirement (NSF)	300
Number of spaces required	1
Population	0
Space Activities/Functional Description	Houses fan control equipment
Adjacency Requirements	Exhaust Fans and Stack
Vehicular Access Requirements	Direct
Key Design Requirements	UPS powered controls. The hot offgas (HOG) Decay tank consists of 350 linear feet of 24” dia. Pipe, buried underground as required for shielding outside of the target building.

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 6-Exhaust Fan VFDs	40” x 20” x 12”		☑	☐
2 Backup Generator	TBD	Exterior Location	☑	☐
3 Lift Stations	TBD	Exterior Location	☑	☐
4 Underground HOG Decay Tanks	80' x 28'	Exterior Location	☑	☐
5 Electrical service entrance equipment	TBD		☑	☐
6 VFD interface rack	TBD		☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/8” = 1’-0”

CF: Conventional Facilities
TS: Technical Systems

5.7.1
SHOP BUILDING

5.7.1 Shop Building

STS Space Program Lead: TBD

5.7.1	**Shop Building NSF**			**21,090**
	Shop Building GSF			**25,518**
	Shop Building Efficientcy			**83%**
No.	**Rooms**	**Qty.**	**NSF**	**Total NSF**
5.7.1.1	Cryogenics Shop	1	6,000	6,000
5.7.1.2	Pump Shop	1	2,400	2,400
5.7.1.3	RF Shop	1	6,000	6,000
5.7.1.4	Modular Shop	1	6,300	6,300
5.7.1.5	Electrical Room	1	130	130
5.7.1.6	Telecom Room	1	130	130
5.7.1.7	Single User Toilets	2	65	130
5.7.1.8	Mechanical room	1	520	520

Additional Program Space Requirements

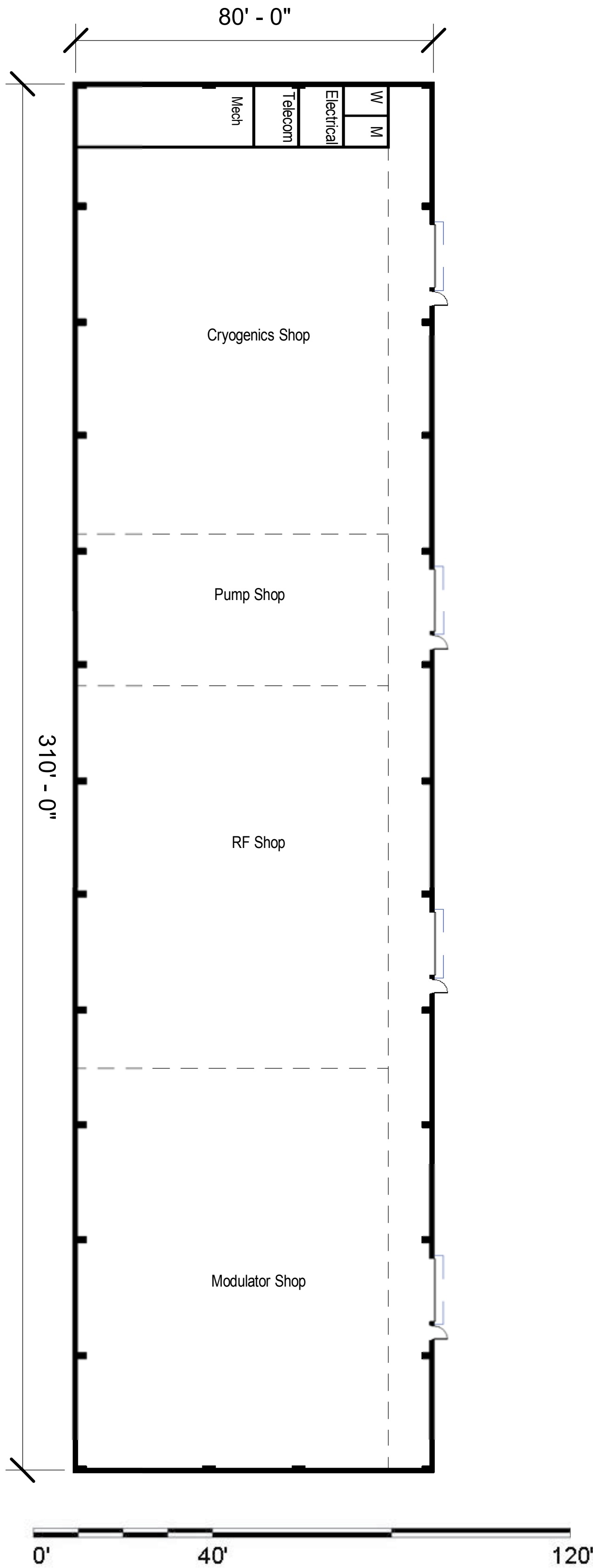
Circulation

5.7.1 Shop Building

Shop Building

Lead: TBD

Test-fit Plan



Preliminary space plan

Scale 1” = 40’-0”

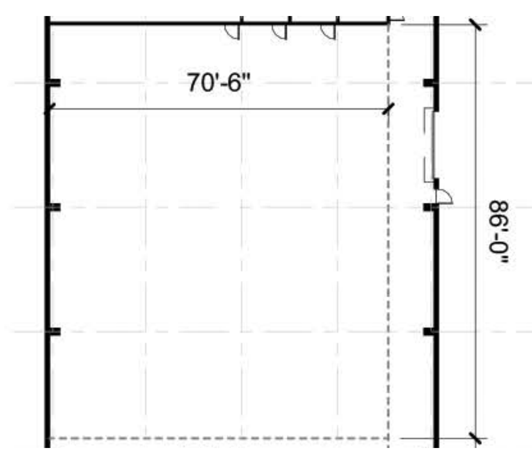
5.7.1.1 Cryogenics Shop

Shop Building | Lead: TBD

Room Data	
Space Number	5.7.1.1
Space Name	Cryogenics Shop
Net Area Requirement (NSF)	6000
Number of spaces required	1
Population	0
Space Activities/Functional Description	Equipment and Shop Space
Adjacency Requirements	None
Vehicular Access Requirements	None
Key Design Requirements	

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 Workbench			☑	☐
2 Shelving				

Test-fit Plan



Preliminary space plan
Scale 1" = 40'-0"

CF: Conventional Facilities
TS: Technical Systems

5.7.1.2 Pump Shop

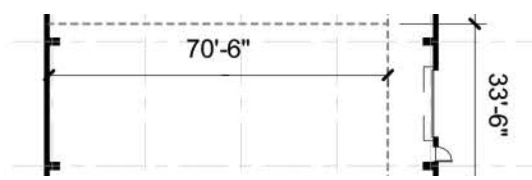
Shop Building

Lead: TBD

Room Data	
Space Number	5.7.1.2
Space Name	Pump Shop
Net Area Requirement (NSF)	2400
Number of spaces required	1
Population	Transient
Space Activities/Functional Description	Pump shop repair
Adjacency Requirements	None
Vehicular Access Requirements	None
Key Design Requirements	None

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 Workbench			☑	☐
2 Shelving				

Test-fit Plan



Preliminary space plan

Scale 1″ = 40′-0″

CF: Conventional Facilities
TS: Technical Systems

5.7.1.3 RF Shop

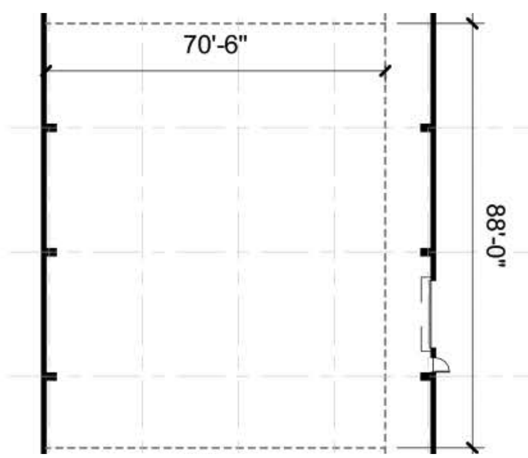
Shop Building

Lead: TBD

Room Data	
Space Number	5.7.1.3
Space Name	RF Shop
Net Area Requirement (NSF)	6000
Number of spaces required	1
Population	Transient
Space Activities/Functional Description	RF shop and repair
Adjacency Requirements	None
Vehicular Access Requirements	None
Key Design Requirements	None

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 Workbench			☑	☐
2 Shelving				

Test-fit Plan



Preliminary space plan

Scale 1″ = 40′-0″

CF: Conventional Facilities

TS: Technical Systems

5.7.1.4 Modular Shop

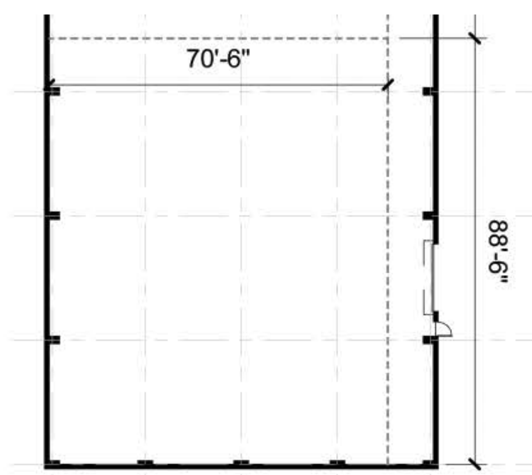
Shop Building

Lead: TBD

Room Data	
Space Number	5.7.1.4
Space Name	Modular Shop
Net Area Requirement (NSF)	6300
Number of spaces required	1
Population	Transient
Space Activities/Functional Description	Shop and repair
Adjacency Requirements	None
Vehicular Access Requirements	None
Key Design Requirements	None

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 Workbench			☑	☐
2 Shelving				

Test-fit Plan



Preliminary space plan

Scale 1″ = 40′-0″

CF: Conventional Facilities
TS: Technical Systems

5.7.1.5 Electrical Room

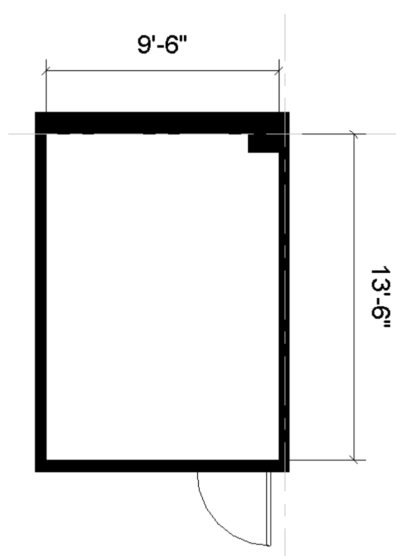
Shop Building

Lead: TBD

Room Data	
Space Number	5.7.1.5
Space Name	Electrical Room
Net Area Requirement (NSF)	130
Number of spaces required	1
Population	0
Space Activities/Functional Description	Equipment room
Adjacency Requirements	None
Vehicular Access Requirements	None
Key Design Requirements	Rated enclosure

	Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1	TBD			☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

0' 8' 24'

CF: Conventional Facilities
TS: Technical Systems

5.7.1.6 Telecom Room

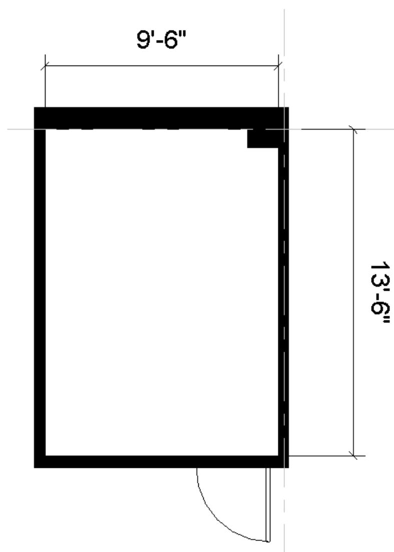
Shop Building

Lead: TBD

Room Data	
Space Number	5.7.1.6
Space Name	Telecom Room
Net Area Requirement (NSF)	130
Number of spaces required	1
Population	0
Space Activities/Functional Description	Equipment room
Adjacency Requirements	None
Vehicular Access Requirements	None
Key Design Requirements	None

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 TBD			☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.7.1.7 Single User Toilets

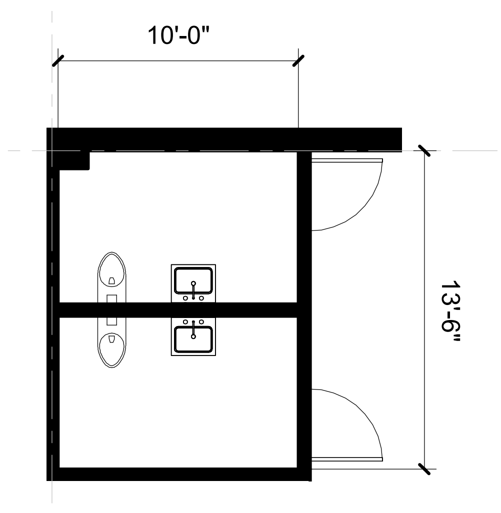
Shop Building

Lead: TBD

Room Data	
Space Number	5.7.1.7
Space Name	Single User Toilets
Net Area Requirement (NSF)	65
Number of spaces required	2
Population	Transient
Space Activities/Functional Description	Toilet room
Adjacency Requirements	None
Vehicular Access Requirements	None
Key Design Requirements	Accessible design

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 Plumbing Fixtures			☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

5.7.1.8 Mechanical Room

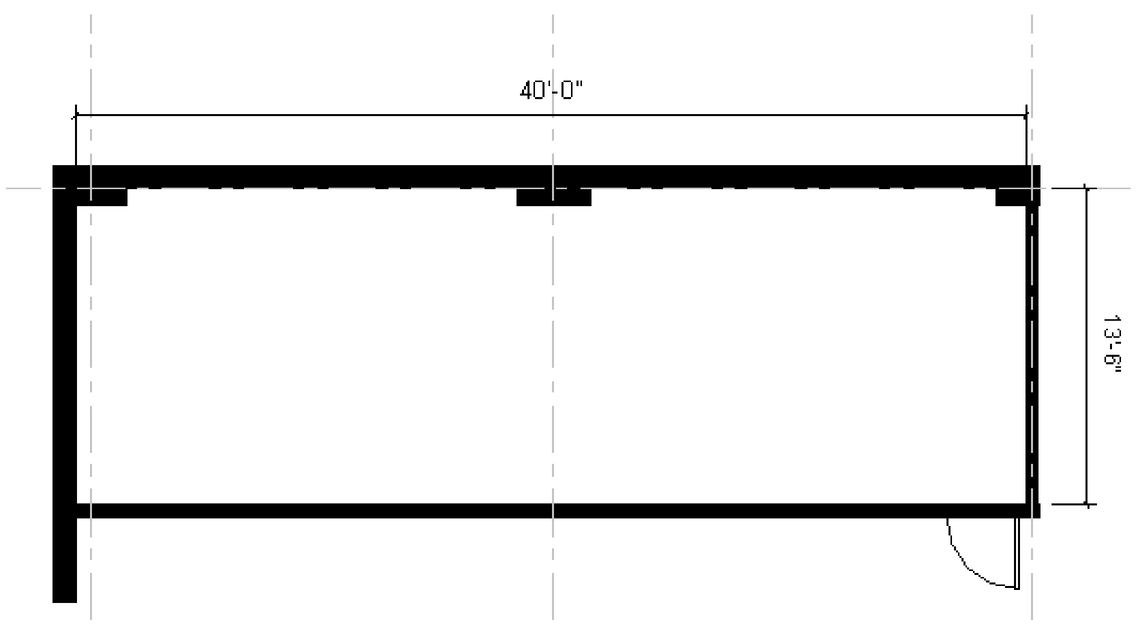
Shop Building

Lead: TBD

Room Data	
Space Number	5.7.1.8
Space Name	Mechanical Room
Net Area Requirement (NSF)	520
Number of spaces required	1
Population	0
Space Activities/Functional Description	Equipment room
Adjacency Requirements	None
Vehicular Access Requirements	None
Key Design Requirements	None

Primary Equipment/Furnishings List	Size (LxWxH)	Notes	CF	TS
1 TBD			☑	☐

Test-fit Plan



Preliminary space plan

Scale 1/8" = 1'-0"

CF: Conventional Facilities
TS: Technical Systems

APPENDIX C. MECHANICAL CALCULATIONS

RTST & SERVICE BUILDING OVERVIEW						
ROOM NAME	**AREA (SF)**	**HEIGHT (FT)**	**VOLUME (CF)**	**CFM/SQ. FT.**	**AIRFLOW (CFM)**	**REMARKS**
ELECTRICAL ROOM	1,488	18	26,784	4	5,952	
COMM	313	18	5,634	4	1,252	
UPS	161	18	2,898	4	644	
POWER SUPPLY ROOM	2,876	18	51,768	10	30,000	200 KW LOAD
TOTAL SERVICE BUILDING AIRFLOW (CFM)					37,848	
			SF	1.2	**45,418**	20% growth factor
PUMP ROOM	1,855	10	18,550	1	1,855	VENTILATION ONLY
TOTAL PUMP ROOM AIRFLOW (CFM)					1,855	
ROOM NAME	**AREA (SF)**	**HEIGHT (FT)**	**VOLUME (CF)**	**ACH**	**AIRFLOW (CFM)**	**REMARKS**
RTST	9,369	13	121,797	10	20,300	
TOTAL RTST TUNNEL AIRFLOW (CFM)					20,300	
			SF	1.2	**24,359**	20% growth factor

STS BUILDING OVERVIEW						
ROOM NAME	**AREA (SF)**	**HEIGHT (FT)***	**VOLUME (CF)**	**ACH**	**AIRFLOW (CFM)**	**REMARKS**
BASEMENT CORRIDOR / UTILITY CORRIDOR	7,173	10	71,730	8	9,564	*VIRTUAL HEIGHT
CONFINEMENT VENTILATION & FILTRATION ROOM	2,358	10	23,580	8	3,144	*VIRTUAL HEIGHT
INSTRUMENT VACUUM PUMP	580	10	5,800	8	773	*VIRTUAL HEIGHT
VACUUM WORKSHOP	1,069	10	10,690	8	1,425	*VIRTUAL HEIGHT
RADIOLOGICAL SUPPORT COUNT AREA	650	10	6,500	8	867	*VIRTUAL HEIGHT
ELECTRICAL (RESEARCH MECHANICS)	1,204	10	12,040	8	1,605	*VIRTUAL HEIGHT
BASEMENT COMMUNICATIONS	192	10	1,920	8	256	*VIRTUAL HEIGHT
MECHANICAL PUMP ROOM	1,646	10	16,460	8	2,195	*VIRTUAL HEIGHT
RECEIVING / STAGING	337	10	3,370	8	449	*VIRTUAL HEIGHT
SURVEY & ALIGNMENT STORAGE	383	10	3,830	8	511	*VIRTUAL HEIGHT
TARGET MAINTENANCE STORAGE	644	10	6,440	8	859	*VIRTUAL HEIGHT
1ST FLOOR CORRIDOR	4,196	10	41,960	8	5,595	*VIRTUAL HEIGHT
ACTIVE STORAGE CAGES	765	10	7,650	8	1,020	*VIRTUAL HEIGHT
SAMPLE ENVIRONMENT LONG TERM STORAGE CAGES	743	10	7,430	8	991	*VIRTUAL HEIGHT
TARGET CONTROL ROOM	768	10	7,680	8	1,024	*VIRTUAL HEIGHT
1ST FLOOR COMMUNICATION ROOM	207	10	2,070	8	276	*VIRTUAL HEIGHT
ON SHIFT SUPPORT	743	10	7,430	8	991	*VIRTUAL HEIGHT
INSTRUMENT MAINTENANCE	798	10	7,980	8	1,064	*VIRTUAL HEIGHT
INSTRUMENT MAINTENANCE STORAGE	589	10	5,890	8	785	*VIRTUAL HEIGHT
MOCK-UP	130	10	1,300	8	173	*VIRTUAL HEIGHT
BREAK/LOUNGE	809	10	8,090	8	1,079	*VIRTUAL HEIGHT
CONTROLS NETWORK	250	10	2,500	8	333	*VIRTUAL HEIGHT
TOTAL TERTIARY AIRFLOW (CFM)					34,979	
			SF	1.2	**41,974**	20% growth factor
HIGH BAY RECIRCULATION AIR	22,443	40	897,720	2.5	37,405	SECONDARY CONFINEMENT
TOTAL HIGH BAY RECIRCULATION AIRFLOW (CFM)					37,405	
			SF	1.2	**44,886**	20% growth factor
HIGH BAY MAKE-UP AIR	22,443	40	897,720	0.25	4,489	SECONDARY CONFINEMENT
HOT PROCESS VAULT	6,925	16	110800	2.5	4,617	SECONDARY CONFINEMENT
HOT PROCESS VAULT MEZZANINE	1,548	16	24768	2.5	1,032	SECONDARY CONFINEMENT
NEUTRON BEAMLINE BUNKER	2,443	16	39088	2.5	1,629	SECONDARY CONFINEMENT
MONOLITH (1074)	660	20	13200	4	880	PRIMARY CONFINEMENT
MONOLITH (1094)	487	13	6331	4	422	PRIMARY CONFINEMENT
INSTRUMENT BEAM TERMINATION DOMES	n/a	n/a	n/a	n/a	7,000	SECONDARY CONFINEMENT
TOTAL WEST PCE/SCE MUA AIRFLOW (CFM)					20,068	
			SF	1.2	**24,082**	20% growth factor
HIGH BAY MAKE-UP AIR	22,443	40	897,720	0.25	4,489	SECONDARY CONFINEMENT
ACTIVATED SAMPLE STORAGE	772	16	12352	2.5	515	SECONDARY CONFINEMENT
ACTIVATED SAMPLE LAB	875	16	14000	3	700	SECONDARY CONFINEMENT
HOT SHOP	488	16	7808	2.5	325	SECONDARY CONFINEMENT
LLLW SYSTEM	329	16	5264	2.5	219	SECONDARY CONFINEMENT
FILTER AND DELAY TANK CAVITY	489	13	6357	2.5	265	SECONDARY CONFINEMENT
GAS LIQUID SEPARATOR CAVITY	201	13	2613	2.5	109	SECONDARY CONFINEMENT
CASK LOADING ROOM	687	16	10992	2.5	458	PRIMARY CONFINEMENT
STORAGE PIT	105	16	1680	2.5	70	PRIMARY CONFINEMENT
SERVICE CELL	616	16	9856	4	657	PRIMARY CONFINEMENT
CRANE MAINTENANCE BAY	52	16	832	4	55	PRIMARY CONFINEMENT
SERVICE, CHARGING AREAS	1,536	16	24576	2.5	1,024	SECONDARY CONFINEMENT
INSTRUMENT BEAM TERMINATION DOMES	n/a	n/a	n/a	n/a	7,000	SECONDARY CONFINEMENT
TOTAL EAST PCE/SCE MUA AIRFLOW (CFM)					15,886	
			SF	1.2	**19,063**	20% growth factor
HELIUM REFRIGERATOR ROOM	1,034	15	15510	8	2,068	*VIRTUAL HEIGHT
TOTAL VENTILATION AIRFLOW (CFM)					**2,068**	
HELIUM COMPRESSOR ROOM	2,061	15	30915	8	4,122	*VIRTUAL HEIGHT
TOTAL VENTILATION AIRFLOW (CFM)					**4,122**	
CMS CONTROL ROOM	429	15	6435	8	858	*VIRTUAL HEIGHT
TOTAL FAN COIL UNITAIRFLOW (CFM)					**858**	
HYDROGEN UTILITY ROOM	694	15	10410	4	694	*VIRTUAL HEIGHT
TOTAL VENTILATION AIRFLOW (CFM)					**694**	

CONFINEMENT EXHAUST OVERVIEW						
ROOM NAME	**AREA (SF)**	**HEIGHT (FT)**	**VOLUME (CF)**	**ACH**	**AIRFLOW (CFM)**	**REMARKS**
HOT PROCESS VAULT	6925	16	110800	2.5	4,617	SECONDARY CONFINEMENT
HOT PROCESS VAULT MEZZANINE	1548	16	24768	2.5	1,032	SECONDARY CONFINEMENT
NEUTRON BEAMLINE BUNKER	2443	16	39088	2.5	1,629	SECONDARY CONFINEMENT
BUNKER ELECTRONICS	440	16	7040	2.5	293	SECONDARY CONFINEMENT
HIGH BAY EXHAUST AIR	22443	40	897720	0.25	3,741	SECONDARY CONFINEMENT
ACTIVATED SAMPLE STORAGE	772	16	12352	2.5	515	SECONDARY CONFINEMENT
ACTIVATED SAMPLE LAB	875	16	14000	2.5	583	SECONDARY CONFINEMENT
HOT SHOP	488	16	7808	2.5	325	SECONDARY CONFINEMENT
LLLW SYSTEM	329	16	5264	2.5	219	SECONDARY CONFINEMENT
FILTER AND DELAY TANK CAVITY	489	13	6357	2.5	265	SECONDARY CONFINEMENT
GAS LIQUID SEPARATOR CAVITY	201	13	2613	2.5	109	SECONDARY CONFINEMENT
SERVICE, CHARGING, MANIPULATOR GALLERY	1536	16	24576	2.5	1,024	SECONDARY CONFINEMENT
TOTAL SCE EXHAUST AIRFLOW (CFM)					14,352	
MONOLITH (1074)	660	20	13200	4	880	PRIMARY CONFINEMENT
MONOLITH (1094)	487	13	6331	4	422	PRIMARY CONFINEMENT
CASK LOADING ROOM	687	16	10992	2.5	458	PRIMARY CONFINEMENT
STORAGE PIT	105	16	1680	2.5	70	PRIMARY CONFINEMENT
SERVICE CELL	616	16	9856	4	657	PRIMARY CONFINEMENT
CRANE MAINTENANCE BAY	52	16	832	4	55	PRIMARY CONFINEMENT
TOTAL PCE EXHAUST AIRFLOW (CFM)					2,543	
INSTRUMENT BEAM TERMINATION DOMES	n/a	n/a	n/a	n/a	2,000	HOT OFF-GAS
TOTAL HOG EXHAUST AIRFLOW (CFM)					2,000	

40M INSTRUMENT BUILDING OVERVIEW						
ROOM NAME	**AREA (SF)**	**HEIGHT (FT) ***	**VOLUME (CF)**	**ACH**	**AIRFLOW (CFM)**	**REMARKS**
1ST FLOOR - 40M	16578	10	165,780	8	22,104	*VIRTUAL HEIGHT (50% OCC. SPACE)
2ND - MEZZANINE	5256	10	52,560	8	7,008	*VIRTUAL HEIGHT
2ND - CONTROL ROOM	287	9	2583	8	344	
2ND - COMPUTER RM	153	9	1377	8	184	
2ND - USER SUPPORT LAB	605	10	6050	8	807	
2ND - USER SUPPORT LAB	596	10	5960	9	894	
			40M TOTAL AIRFLOW (CFM)		31,341	
			SF	1.2	**37,609**	20% growth factor

40M BUILDING LAB EXHAUST				
ROOM NAME	**EQUIPMENT**	**CFM**	**QTY**	**AIRFLOW (CFM)**
USER SUPPORT LAB	6' FUME HOOD (18" SASH HEIGHT)	900	2	1,800
ZEEMAN'S BEAMLINE 1 WET LAB	6' FUME HOOD (18" SASH HEIGHT)	900	2	1,800
	TOTAL 40M LAB EXHAUST AIRFLOW (CFM)			**3,600**

50M INSTRUMENT BUILDING OVERVIEW						
ROOM NAME	**AREA (SF)**	**HEIGHT (FT) ***	**VOLUME (CF)**	**ACH**	**AIRFLOW (CFM)**	**REMARKS**
1ST FLOOR - 50M	17251	10	172,510	8	23,001	*VIRTUAL HEIGHT (50% OCC. SPACE)
2ND - MEZZANINE	5526	10	55,260	8	7,368	*VIRTUAL HEIGHT
2ND - USER SUPPORT LAB	605	10	6,050	8	807	
2ND - USER SUPPORT LAB	599	10	5,990	8	799	
				TOTAL AHU AIRFLOW (CFM)	31,975	
			SF	1.2	**38,370**	20% growth factor

50M BUILDING LAB EXHAUST				
ROOM NAME	**EQUIPMENT**	**CFM**	**QTY**	**AIRFLOW (CFM)**
USER SUPPORT LAB	6' FUME HOOD (18" SASH HEIGHT)	900	2	1,800
			TOTAL 50M LAB EXHAUST AIRFLOW (CFM)	**1,800**

90M INSTRUMENT BUILDING OVERVIEW						
ROOM NAME	**AREA (SF)**	**HEIGHT (FT) ***	**VOLUME (CF)**	**ACH**	**AIRFLOW (CFM)**	**REMARKS**
1ST FLOOR - 90M	7,478	10	74,780	8	9,971	*VIRTUAL HEIGHT (50% OCC. SPACE)
1ST - SAMPLE PREP	217	10	2,170	8	289	
1ST - CONTROL CABIN	220	10	2,200	8	293	
TOTAL AHU AIRFLOW (CFM)					10,553	
			SF	1.2	**12,664**	20% growth factor

CLO II BUILDING OVERVIEW						
ROOM NAME	AREA (SF)	HEIGHT (FT)	VOLUME (CF)	ACH	AIRFLOW (CFM)	REMARKS
CHARACTERIZATION	2,732	10	27,320	8	3,643	
SAMPLE RECEIVING	895	10	8,950	8	1,193	
BLAST LAB	921	10	9,210	8	1,228	
BSL 2	1,197	10	11,970	8	1,596	
DETECTOR STORAGE	1,316	10	13,160	8	1,755	
DETECTOR LAB	1,773	10	17,730	8	2,364	
LIGHT MECHANICAL INSTRUMENT SUPPORT	798	10	7,980	8	1,064	
SYNTHESIS LAB 1	1,258	10	12,580	8	1,677	
SYNTHESIS LAB 2	1,799	10	17,990	8	2,399	
SYNTHESIS LAB 3	2,200	10	22,000	8	2,933	
DATA ACQUISITION AND STORAGE LAB	2,215	10	22,150	8	2,953	
METROLOGY GUIDE ALIGNMENT	1,802	10	18,020	8	2,403	
LAB SUPPORT	1,202	10	12,020	8	1,603	
TOTAL LABORATORY AIRFLOW (CFM)					26,811	
			SF	1.2	**32,173**	20% growth factor
ROOM NAME	**AREA (SF)**	**HEIGHT (FT)**	**VOLUME (CF)**	**CFM/ SQ. FT.**	**AIRFLOW (CFM)**	**REMARKS**
BASEMENT - RECYCLING/ TRASH	146	10	1460	1	146	
BASEMENT - GEN. BUILDING STORAGE	266	10	2660	0.5	133	
BASEMENT - OPEN OFFICE	1,328	9	11952	1.25	1,660	
BASEMENT - CIRCULATION	3,291	9	29619	0.6	1,975	
1ST FLOOR - CONF	380	9	3420	1.25	475	
1ST FLOOR - OPEN OFFICE	1,385	9	12465	1.25	1,731	
1ST FLOOR - WORKSTATIONS	2,019	9	18171	1.25	2,524	
1ST FLOOR - LOBBY	1,366	9	12294	0.6	820	
1ST FLOOR - CIRCULATION	5,544	9	49896	0.6	3,326	
2ND FLOOR - OPEN OFFICE	3,459	9	31131	1.25	4,324	
2ND FLOOR - OFFICES	5,305	9	47745	1.25	6,631	
2ND FLOOR - CONFERENCE	761	9	6849	1.25	951	
2ND FLOOR - CIRCULATION	6,503	9	58527	0.6	3,902	
3RD FLOOR - OPEN OFFICE	3,485	9	31365	1.25	4,356	
3RD FLOOR - OFFICES	5,305	9	47745	1.25	6,631	
3RD FLOOR - CONFERENCE	760	9	6840	1.25	950	
3RD FLOOR - CIRCULATION	6,503	9	58527	0.6	3,902	
TOTAL OFFICE AIRFLOW (CFM)					**44,158**	

CLO II BUILDING TOILET EXHAUST					
ROOM NAME	AREA (SF)	HEIGHT (FT)	VOLUME (CF)	ACH	AIRFLOW (CFM)
TOILETS/JC BASEMENT FLOOR	550	9	4950	10	825
TOILETS/JC FIRST FLOOR	550	9	4950	10	825
TOILETS/JC SECOND FLOOR	550	9	4950	10	825
TOILETS/JC THIRD FLOOR	550	9	4950	10	825
TOTAL TOILET EXHAUST AIRFLOW (CFM)					**3,300**

CLO II BUILDING LAB EXHAUST					
EQUIPMENT	AREA (SF)	CFM/SF	CFM	QTY	AIRFLOW (CFM)
CANOPY HOODS	24	100	2400	2	4,800
DOWN DRAFT SURFACES	15	100	1500	2	3,000
SNORKEL (6")	-	-	150	36	5,400
EQUIPMENT VENT (4")	-	-	50	24	1,200
6 FT. FUME HOOD (18" SASH)	-	-	900	12	10,800
TOTAL LAB EXHAUST AIRFLOW (CFM)					**25,200**

CLO II BUILDING NANO LAB EXHAUST				
ROOM NAME	EQUIPMENT	CFM	QTY	AIRFLOW (CFM)
SYNTHESIS LAB I	6' FUME HOOD (18" SASH HEIGHT)	900	2	1,800
SYNTHESIS LAB II	8' FUME HOOD (18" SASH HEIGHT)	1200	2	2,400
SYNTHESIS LAB III	8' FUME HOOD (18" SASH HEIGHT)	1200	2	2,400
CHARACTERIZATION LAB	6' FUME HOOD (18" SASH HEIGHT)	900	1	900
LAB SUPPORT	4' FUME HOOD (18" SASH HEIGHT)	600	1	600
SAMPLE RECEIVING	4' FUME HOOD (18" SASH HEIGHT)	600	1	600
TOTAL NANO LAB EXHAUST AIRFLOW (CFM)				**8,700**

CLO II BUILDING BIOSAFETY LAB EXHAUST				
ROOM NAME	EQUIPMENT	CFM	QTY	AIRFLOW (CFM)
BSL-2	6' FUME HOOD (18" SASH HEIGHT)	900	1	900
BSL-2	4' BSC (8" SASH HEIGHT)	735	2	1,470
TOTAL BSL EXHAUST AIRFLOW (CFM)				**2,370**

SHOP BUILDING OVERVIEW					
ROOM NAME	**AREA (SF)**	**HEIGHT (FT)**	**VOLUME (CF)**	**CFM/ SQ.FT.**	**AIRFLOW (CFM)**
CRYOGENICS SHOP	6,000	20	120,000	1.2	7,200
PUMP SHOP	2,371	20	47,420	1.2	2,845
RF SHOP	6,204	20	124,080	1.2	7,445
MODULATOR SHOP	6,238	20	124,760	1.2	7,486
CORRIDOR	2,971	20	59,420	0.25	743
TOTAL AHU AIRFLOW (CFM)					**30,862**

CUB II BUILDING OVERVIEW					
ROOM NAME	**AREA (SF)**	**HEIGHT (FT)**	**VOLUME (CF)**	**CFM/ SQ.FT.**	**AIRFLOW (CFM)**
PUMP SYSTEM / CHEM TREAT	1,284	18	23,112	0.5	642
CHILLER SYSTEMS	2,018	18	36,324	0.5	1,009
CONTROL ROOM	380	18	6,840	1.5	570
COMM	360	18	6,480	1.5	540
TECH WORK	175	18	3,150	1.5	263
BREAKROOM	176	18	3,168	1.5	264
BOILER SYSTEMS	1,034	18	18,612	0.5	517
WORKSHOP	1,186	18	21,348	0.5	593
COMPRESSED AIR SYSTEMS	1,005	18	18,090	0.5	503
				TOTAL AHU AIRFLOW (CFM)	**5,880**

CEF II BUILDING OVERVIEW					
ROOM NAME	**AREA (SF)**	**HEIGHT (FT)**	**VOLUME (CF)**	**CFM/ SQ. FT.**	**AIRFLOW (CFM)**
CEF II	364	14	5,096	8	2,912
				TOTAL AIRFLOW (CFM)	**3,494**

RTST & SERVICE BUILDING OVERVIEW

SYSTEM	TOTAL AIRFLOW (CFM)	OUTSIDE AIR CFM	OUTSIDE AIR TEMP (F)	OUTSIDE AIR ENTHALPY (BTU/lb)	RETURN AIR CFM	RETURN AIR TEMP (F)	MIXED AIR TEMP (F)	MIXED AIR ENTHALPY (BTU/lb)	COIL LAT (F)	COIL ENTHALPY (BTU/lb)	COIL CAPACITY (KW)	COIL CAPACITY (MBH)	EWT (F)	LWT (F)	FLOW (GPM)	REMARKS
TOWER WATER											300	1,024	80	90.2	200	POWER SUPPLIES
TOWER WATER											1300	4,436	80	97.7	500	MAGNET COOLING LOOP
DI COOLING WATER											300	1,024	87	93.4	320	POWER SUPPLIES
DI COOLING WATER											1300	4,436	87	101.8	600	MAGNET COOLING LOOP
RTST AHU CHW	25000	5000	92.8/73.8	37.205	20,000	78/65	80.9/66.9	31.361	53/52	21.392	329	1,122	44	56	187	
SERVICE BLDG. AHU CHW	45000	9000	92.8/73.8	37.205	36,000	72/60.5	76.2/63.4	28.717	53/52	21.392	435	1,483	44	56	247	
RTST AHU HW	25000	25000	17	-	-	-	17	-	75	-	467	1,595	180	140	80	SIZED FOR EMERGENCY SMOKE MODE
SERVICE BLDG. AHU HW	45000	9000	17	-	36,000	65	55.4	-	85	-	429	1,465	180	140	73	

STS BUILDING OVERVIEW

SYSTEM	TOTAL AIRFLOW (CFM)	OUTSIDE AIR CFM	OUTSIDE AIR TEMP (F)	OUTSIDE AIR ENTHALPY (BTU/lb)	RETURN AIR CFM	RETURN AIR TEMP (F)	MIXED AIR TEMP (F)	MIXED AIR ENTHALPY (BTU/lb)	COIL LAT (F)	COIL ENTHALPY (BTU/lb)	COIL CAPACITY (KW)	COIL CAPACITY (MBH)	EWT (F)	LWT (F)	FLOW (GPM)	REMARKS
TOWER WATER											800	2,730	80	98.2	300	
TOWER WATER											800	2,730	80	98.2	300	
TOWER WATER											500	1,706	80	100.1	170	MODERATOR COMPRESSOR
DI COOLING WATER											900	3,071	87	94.7	800	HIGH TEMP TECH WATER
DI COOLING WATER											70	239	60	83.9	20	LOW TEMP TECH WATER
CHILLED WATER (DI WATER HX)											70	239	44	56.0	18	LOW TEMP TECH WATER
CHILLED WATER (SENSIBLE HX)											700	2,388	44	56.0	398	
SENSIBLE CHILLED WATER											700	2,388	55	64.6	500	
CHILLED WATER (INSTRUMENTS)											700	2,388	44	56.0	398	INSTRUMENT DOMES
RECIRC. AHU CHW	30000	0	0	0	30000	78/65	78/65	29.903	53/52	21.392	337	1,149	44	56	191	
RECIRC. AHU CHW	30000	0	0	0	30000	78/65	78/65	29.903	53/52	21.392	337	1,149	44	56	191	
TERTIARY AHU CHW	28000	5600	92.8/73.8	37.205	22400	78/65	80.9/66.9	31.361	53/52	21.392	368	1,256	44	56	209	
TERTIARY AHU CHW	28000	5600	92.8/73.8	37.205	22400	78/65	80.9/66.9	31.361	53/52	21.392	368	1,256	44	56	209	
MUA CHW	16000	16000	92.8/73.8	37.205	-	-	92.8/73.8	37.205	53/52	21.392	334	1,139	44	56	190	
MUA CHW	16000	16000	92.8/73.8	37.205	-	-	92.8/73.8	37.205	53/52	21.392	334	1,139	44	56	190	
MUA CHW	13000	13000	92.8/73.8	37.205	-	-	92.8/73.8	37.205	53/52	21.392	271	925	44	56	154	
MUA CHW	13000	13000	92.8/73.8	37.205	-	-	92.8/73.8	37.205	53/52	21.392	271	925	44	56	154	
RECIRC. AHU HW	30000	0	0	-	30000	55	55	-	85	-	290	990	180	140	50	REHEAT COILS
RECIRC. AHU HW	30000	0	0	-	30000	55	55	-	85	-	290	990	180	140	50	REHEAT COILS
TERTIARY AHU HW	28000	5600	17	-	22400	70	59.4	-	85	-	231	788	180	140	39	
TERTIARY AHU HW	28000	5600	17	-	22400	70	59.4	-	85	-	231	788	180	140	39	
MUA HW	16000	16000	17	-	0	0	17	-	85	-	351	1,197	180	140	60	
MUA HW	16000	16000	17	-	0	0	17	-	85	-	351	1,197	180	140	60	
MUA HW	13000	13000	17	-	0	0	17	-	85	-	285	972	180	140	49	
MUA HW	13000	13000	17	-	0	0	17	-	85	-	285	972	180	140	49	
HYDROGEN CHW COIL	10000	10000	92.8/73.8	37.205	0	0	92.8/73.8	37.205	75/68	32.297	65	221	44	56	37	SIZED FOR EMERGENCY OPERATION
HYDROGEN HW COIL	10000	10000	17	-	0	0	17	-	40	-	74	253	180	140	13	SIZED FOR EMERGENCY OPERATION

40M INSTRUMENT BUILDING OVERVIEW

SYSTEM	TOTAL AIRFLOW (CFM)	OUTSIDE AIR CFM	OUTSIDE AIR TEMP (F)	OUTSIDE AIR ENTHALPY (BTU/lb)	RETURN AIR CFM	RETURN AIR TEMP (F)	MIXED AIR TEMP (F)	MIXED AIR ENTHALPY (BTU/lb)	COIL LAT (F)	COIL ENTHALPY (BTU/lb)	COIL CAPACITY (KW)	COIL CAPACITY (MBH)	EWT (F)	LWT (F)	FLOW (GPM)	REMARKS
TOWER WATER											100	341	80	100.0	34	
DI COOLING WATER											100	341	87	132.5	15	HELIUM LIQUIFIER COOLING
CHILLED WATER (SENSIBLE HX)											322	1,100	44	56.0	183	
SENSIBLE CHILLED WATER											322	1,100	55	65.0	220	INCLUDES ZEEMAN'S BEAMLINES
AHU CHW	25000	5000	92.8/73.8	37.205	20000	78/65	80.9/66.9	31.361	53/52	21.392	329	1,122	44	56	187	
AHU CHW	25000	5000	92.8/73.8	37.205	20000	78/65	80.9/66.9	31.361	53/52	21.392	329	1,122	44	56	187	
AHU HW	25000	5000	17	-	20000	70	59.4	-	75	-	126	429	140	100	21	
AHU HW	25000	5000	17	-	20000	70	59.4	-	75	-	126	429	140	100	21	

50M INSTRUMENT BUILDING OVERVIEW

SYSTEM	TOTAL AIRFLOW (CFM)	OUTSIDE AIR CFM	OUTSIDE AIR TEMP (F)	OUTSIDE AIR ENTHALPY (BTU/lb)	RETURN AIR CFM	RETURN AIR TEMP (F)	MIXED AIR TEMP (F)	MIXED AIR ENTHALPY (BTU/lb)	COIL LAT (F)	COIL ENTHALPY (BTU/lb)	COIL CAPACITY (KW)	COIL CAPACITY (MBH)	EWT (F)	LWT (F)	FLOW (GPM)	REMARKS
CHILLED WATER (SENSIBLE HX)											264	900	44	56.0	150	
SENSIBLE CHILLED WATER											264	900	55	65.0	180	
AHU CHW	25000	5000	92.8/73.8	37.205	20000	78/65	80.9/66.9	31.361	53/52	21.392	329	1,122	44	56	187	
AHU CHW	25000	5000	92.8/73.8	37.205	20000	78/65	80.9/66.9	31.361	53/52	21.392	329	1,122	44	56	187	
AHU HW	25000	5000	17	-	20000	70	59.4	-	75	-	126	429	180	140	21	
AHU HW	25000	5000	17	-	20000	70	59.4	-	75	-	126	429	180	140	21	

90M INSTRUMENT BUILDING OVERVIEW

SYSTEM	TOTAL AIRFLOW (CFM)	OUTSIDE AIR CFM	OUTSIDE AIR TEMP (F)	OUTSIDE AIR ENTHALPY (BTU/lb)	RETURN AIR CFM	RETURN AIR TEMP (F)	MIXED AIR TEMP (F)	MIXED AIR ENTHALPY (BTU/lb)	COIL LAT (F)	COIL ENTHALPY (BTU/lb)	COIL CAPACITY (KW)	COIL CAPACITY (MBH)	EWT (F)	LWT (F)	FLOW (GPM)	REMARKS
CHILLED WATER (SENSIBLE HX)											59	200	44	56.0	33	
SENSIBLE CHILLED WATER											59	200	55	65.0	40	
AHU CHW	9000	1800	92.8/73.8	37.205	7200	78/65	80.9/66.9	31.361	53/52	21.392	118	404	44	56	67	
AHU CHW	9000	1800	92.8/73.8	37.205	7200	78/65	80.9/66.9	31.361	53/52	21.392	118	404	44	56	67	
AHU HW	9000	1800	17	-	7200	70	59.4	-	75	-	45	154	180	140	8	
AHU HW	9000	1800	17	-	7200	70	59.4	-	75	-	45	154	180	140	8	

CLO II BUILDING OVERVIEW																
SYSTEM	TOTAL AIRFLOW (CFM)	OUTSIDE AIR CFM	OUTSIDE AIR TEMP (F)	OUTSIDE AIR ENTHALPY (BTU/lb)	RETURN AIR CFM	RETURN AIR TEMP (F)	MIXED AIR TEMP (F)	MIXED AIR ENTHALPY (BTU/lb)	COIL LAT (F)	COIL ENTHALPY (BTU/lb)	COIL CAPACITY (KW)	COIL CAPACITY (MBH)	EWT (F)	LWT (F)	FLOW (GPM)	REMARKS
CHILLED WATER (SENSIBLE HX)											88	300	44	56.0	50	
SENSIBLE CHILLED WATER											88	300	60	70.0	60	
LAB DOAS AHU CHW	20,000	20000	92.8/73.8	37.205	-	-	92.8/73.8	37.205	53/52	21.392	417	1,423	44	56	237	
LAB DOAS AHU CHW	20,000	20000	92.8/73.8	37.205	-	-	92.8/73.8	37.205	53/52	21.392	417	1,423	44	56	237	
OFFICE AHU CHW	45000	6750	92.8/73.8	37.205	38250	78/65	82.4/67.4	31.749	53/52	21.392	615	2,097	44	56	350	
LAB DOAS AHU HW	20000	20000	17	-	-	-	17	-	70	-	342	1,166	180	140	58	
LAB DOAS AHU HW	20000	20000	17	-	-	-	17	-	70	-	342	1,166	180	140	58	
OFFICE AHU HW	45000	6750	17	-	38250	70	54.1	-	70	-	231	787	180	140	39	

SHOP BUILDING OVERVIEW																
SYSTEM	TOTAL AIRFLOW (CFM)	OUTSIDE AIR CFM	OUTSIDE AIR TEMP (F)	OUTSIDE AIR ENTHALPY (BTU/lb)	RETURN AIR CFM	RETURN AIR TEMP (F)	MIXED AIR TEMP (F)	MIXED AIR ENTHALPY (BTU/lb)	COIL LAT (F)	COIL ENTHALPY (BTU/lb)	COIL CAPACITY (KW)	COIL CAPACITY (MBH)	EWT (F)	LWT (F)	FLOW (GPM)	REMARKS
TOWER WATER											289	987	80	100.0	99	PROVIDED FROM CUB I
AHU DX	30000	6000	92.8/73.8	37.205	24000	80/64.5	82.6/65.8	30.484	56/55	23.176	289	987	n/a	n/a	n/a	
AHU HW	30000	6000	17	-	24000	70	59.4	-	80	-	199	680	180	140	34	PROVIDED FROM CUB I