	Target Systems	
	The Committee recommends trying the following measures on the next few targets:	Response:
1	1. shift the stagnation point as far as possible from the window center by using different size orifices in the two inlet flow channels (a near term option for the next target)	Flow studies to accomplish this were done. The stagnation point could not be move out of the beam path; thermohydraulic solutions indicated excessive temperatures.
2	2. try to mimic a cross flow configuration by introducing a guide baffle in one of the inlet channels to split the flow (It might be possible to insert a tube carrying the baffle plate in one of the targets currently on order for manufacturing before the front window is welded on.)	T2 and T3 damage on the sides of the inner wall where flow velocity is ~ 1m/s indicate the stagnation point is not the only problem location. The chance that cross flow alone will solve problem seems less likely. Acceptable thermohydraulic solution for cross flow options were not found (high temperatures).
3	3. In the medium time scale a target applying the gas wall idea developed during the R&D work may provide additional -and possibly ultimate -protection (requires target re-design and some additions on the target trolley).	Development for gas-wall (and small gas bubbles) was making progres, but reduced resources resulted in this effort being suspended.
4	In the long run, raising the dpa-limit should be a goal, based on PIE results of used targets. PIE of spent targets must, therefore, be given high priority.	PIE has been given high priority and is continuing. Irradiated mechanical property data from T1 indicates ample ductility at ca. 6.5 dpa. Our current 10 dpa limit is reasonable and we are optimistic that future data can raise this.
5	Run the present target (Target 2) and the two following ones (Target 3 and 4) at the highest possible beam power until they fail. If, at the beginning of a scheduled maintenance shutdown any one of them has reached a dpa level (of the order of 10) which raises doubts that it will survive another scheduled operating period, exchange it during the shutdown. If necessary, announce an extension of the shutdown to the users before they arrive.	We are basically following this routine. T2 was run to 3145 MW-hrs / ca. 7 dpa; T3 leaked at 2791 MW-hrs / 6.0 dpa; T4 run to 3250 MW-hrs (est. 7.5 dpa).
6	For the next target (Target 3), try to establish a flow configuration (by tailoring the inlet flow orifices) which moves the stagnation region as far as possible from the window center in order to reduce the cavitation damage at this position and verify the importance of shear flow for damage mitigation.	Same as items 1 & 2
7	Try to interfere with the manufacturing process of one of the targets presently on order by introducing a flow baffle which directs part of the flow from one inlet channel all the way across the beam entrance window to establish shear flow on the whole entrance window. Use this as early as possible (Target 4?) to obtain conclusive evidence if a cross flow configuration is less prone to cavitation erosion than the present dual inlet flow.	Same as items 1 & 2

8	Based on the experience with Targets 2, 3 and 4, adjust the operations schedule to accommodate sufficiently long shutdown periods before the projected end of service life of each of the following targets. In the mean time, in order to minimize the number of unscheduled planned shutdowns, adjust the current operating schedule for bi-monthly target exchanges and perform an estimate of the tolerable beam power.	>2500 MW-hr life on T1-T4 should support 2 targets per year assuming 1MW damage rate not greatly increased
9	In parallel, continue to explore the potential of gas injection, in particular the gas wall concept, for its potential to mitigate cavitation damage in a realistic target configuration (curved window). At the same time continue the highly efficient collaboration with JSNS on the gas bubble injection technique.	See response to item 3. Further, collaboration with JSNS on mercury targets has been very strong. The WNR experiment on SGB was a major collaborative effort. Our contribution to collaboration in the future will suffer as a result of suspended development of gas mitigation approaches. But PIE remains strong.
10	Give high priority to PIE (post irradiation examination) of spent targets -including further work on Target 1 -in order to verify the validity of the conclusions drawn from the first examination of Target	PIE has been given high priority and this is continuing. Characterization of caviation damage in used targets remains very challenging with significant constraints, but improvements have been made. The leak in T3 has not been found, but we have clues. A removable shroud will be a significant aide in future leak locations. B&W completed detailed PIE on T1 disk specimens that provided excellent damage characterization, material properties, and disturbing indications of inclusions.
11	In addition examine the tensile and/or fatigue properties of specimens from high dpa regions not strongly affected by cavitation in order to explore the dpa limits the targets can be taken to in the long run. This should allow the development of a long term mitigation scheme which can be incorporated in the design of future targets and establish an irradiation dose which the targets can safely be taken to.	B&W completed detailed PIE on T1 disk specimens that provided irradiated mechanical property data indicating ample ductility at ca. 6.5 dpa. Our current 10 dpa limit is reasonable and we are optimistic that future data can raise this.
12	In the effort to add more diversity to the leak detection system for the target interspace, try to go for a system which has the capability of early warning (e.g. by analyzing the isotope content of the helium) rather than -or in addition to -a "post mortem" system which is activated by a rising mercury level in the interspace.	Funding not available to pursue the gas analyzer, but we have prepared a final design of an interstitial pressure detection system.
13	Continue improving the optical target inspection system with particular emphasis on long term reliability under the effect of irradiation. Ideally image processing software should be developed which corrects for the spatial and temporal change in emissivity of the fluorescent screen as it degrades under irradiation.	Significant improvements to TIS have been made. Reliability has been good and a repeatable pattern of intensity loss observed. Little spatial change observed with nearly uniform intensity loss. Software profile fitting is independent of absolute intensity. Further developments of TIS not funded.

14	Carry out an analysis to search for systems which are particularly vulnerable to short power losses and would create long down times as a consequence of such losses. Hook these systems up to an uninterrupted emergency power supply.	The issue of no UPS for the CMS remains unchanged. While its controls and instruments are under UPS, the power requirements of the equipment are too large for UPS. Redundant equipment is prohibitively expensive. As for an analysis / search throughout target systems for such vulnerabilities, no formal process has been performed or documented.
15	Carry out preventive maintenance during scheduled shutdown periods on systems which are known to degrade with time, such as the cryogenic heat exchanger and its adsorber.	Cryogenic heat exchanger problem has been fixed. Normal reventative maintenance is done during scheduled outages.
16	Re-examine all procedures on mercury-containing parts or systems with a view to minimizing spills and controlling contamination spread in the Service Bay.	We are doing this. Two examples: we've reviewed and made minor modifications to the target replacement procedure (specifically Catch Pot installation and handling) to minimize the chances of spillage from the target carriage mercury lines; we ensure PIE operational work instructions are written and reviewed to minimize mercury spillage in the Maintenance Bay (e.g. capping the Mercury Vent Line connection on Target #3 during horizontal rotation to prevent the escape of mercury).