FIRE CHITS, Superchits, and Comments
from Engineering Review of June, 2001

					11/20/2001, Feb 13, 2003 update by RJT, Feb 15 DMM	
	AREA					
	DESIGN PT - PHYSICS & TRADE STUDIES					
Schit #	**chit #**	**Reviewer**	**Reviewer Comment or Suggestion**	**FIRE Team Comment**	**FIRE Team Action by**	
PTS1	1	R. Parker	The baseline design fails to reach the Q>5 objective with H98 (y,z) = 1.0, even with optimistic assumptions about Zeff (Zeff = 1.4 including Helium). With more realistic assumptions about the level of Be and W, the performance would degrade well below the Q>5 goal. More margin must be incorporated into the baseline design. Raising the field does not seem as effective as increasing size, since substantially more MG capability is required. Also ICRF frequency would need to increase. Best approach: increase size to FIRE* or even a few cm more (2.2m) in major radius.	The 2002 Snowmass Fusion study reviewed the FIRE confinement projections and concluded that: "There is confidence that ITER and FIRE will achieve burning plasma performance in H–mode based on an extensive experimental database." "ITER and FIRE scenarios are based on standard ELMing H–mode and are reasonable extrapolations from the existing database."	Meade,Schultz	
PTS2	4	C.Bushnell	Too many options being looked at. Choose one and focus! Focus next immediate efforts on points or discontinuity (learn) tubes, cutouts, keys, etc.	In October, 01, the wedged configuration was selected for the baseline. A comparative overview may be found in the FY01 Engineering Report.	Meade, Thome, Heitzenroeder	
PTS3	14	R. Parker	The number of full power shots is limited by radiation damage of insulators. More shielding between plasma and inner base.	see Schit PTS3	Meade, Thome, Heitzenroeder	
PTS3	30	J. Irby & A. Pizzuto	Too few full performance shots. •Increase shielding in critical areas • Improve insulation • consider more DD operation	see Schit PTS3	Meade, Wesley	
	SChit PTS3 - The Snowmass Assessment concluded that the present number of shots was sufficient to satisfy the FIRE mission, and also noted that an increased allowed neutron yield would provide flexibility for advanced tokamak mode investigation would be desireable. As a result FIRE has encouraged the development of new insulators by CTD, and is investigating new insulator configurations that employ inorganic insulator cuffs in the high radiation dose/low stress locations.					
	R&D					
RD1	2	R. Parker	More R&D needs to be earmarked for diagnostics.	see Schit RD1	Young	
RD1	29	P.Mioduszewski	There should be some R&D funding for diagnostics, especially due to the harsh neutron environment and unique geometry. It is generic, but who will do it if not F.IR.E.?	see Schit RD1	Young	
	SChit RD1: An R&D plan has been outlined by K. Young in a memo, "FIRE Diagnostics Research & Development Plan", Aug 15, 2001					
RD2	9	F.Puhn	R&D is required to verify the design concept. Cost of R&D is a serious concern. Perform a complete survey of previous R&D to identify data and design solutions that can cut cost of FIRE R&D. ITER and Ignitor R&D seem most applicable to FIRE. Other fusion program R&D should be looked at.	see Schit RD2	Heitzenroeder, Thome	

RD2	12	C.Bushnell	The use of all OFHC copper is a simplifying move for R&D and downstream power and cooling costs etc. etc. - The allowable implies 50≥% cold work - Concern is this possible for plates this thick and this size? Get on with immediate R&D to demonstrate! - Feed back data to design criteria!	see Schit RD2	Thome, Heitzenroeder, Titus	
RD2	28	C.Bushnell	Will the copper (101-102) embrittle with radiation, will it creep at the stress levels indicated? Put these problems behind with immediate investigation / R&D!	see Schit RD2	Driemeyer, Titus, Zinkel	
	SChit RD2: The wedged configuration has been selected for the baseline. A comparative overview may be found in the FY01 Engineering Report. R&D plans are being evaluated to verify the availability of plates with the properties required in the sizes needed for FIRE.					
RD3	7	A. Pizzuto	It is urgent to confirm the design assumptions. CuBe and insulator properties not yet well assessed. Radiation resistance of insulator the main issue. Tests of: - Cu creep at R.T. -- Qualification of the impregnation process compatible with copper properties (curing T less than 200°C). -- CuBe and Cu of plate production in relevant thickness and dimension.	see Schit RD3	Action: Thome, Heitzenroeder	
RD3	15	C.Bushnell	The R&D level requires materials for insulation on the forefront of development. Get on with immediate R&D of available materials.	see Schit RD3	Meade, Thome, Heitzenroeder,Sawan	
RD3	27	F.Puhn	Radiation damage to insulator seems to limit total useful operating life. Selection of suitable insulation material is critical to getting full value from machine. Presently no insulation with supporting radiation damage data has been identified. As highest priority select candidate insulation materials and perform irradiation and testing as required. Make final selection. This task may take a long time so it should be started as soon as possible. Also investigate effect of local shielding (W) on VV inside wall.	see Schit RD3	Schultz, Titus	
	SChit RD3: R&D plans are being developed. Review of the design and experimental literature indicates that existing polyimide sheets may have adequate compressive strength and radiation-resistance. Promising new organic insulations are being developed through fusion SBIRs. A discussion of the design, data base, and necessary tests is given in NSO No WBS11_090701_ Review of Radiation-Resistant Insulation Development, Joel H. Schultz, "Review of Radiation-Resistant Insulation Development, Rev. 1" September 7, 2001					
RD4	24	C.Bushnell	The choice of castings could be a major cost driver if found not to be appropriate! Immediate R&D to prove one way or the other!	Information on castings being considered for NCSX should provide initial information. R&D is probably not possible this FY due to budget limitations.	Heitzenroeder, Thome	
	PFC's					
PFC1	3	Irby	Tiles are to be replaced 2-3 times during lifetime of machine. How will you know when to replace them. Will machine performance degrade slowly before changes are made. Make sure you have the diagnostics needed to monitor erosion.	Not critical to the conceptual design process. There are at least two good ideas of how to monitor the erosion without access to the vessel (IR and markers). In-vessel inspection may be enough also.	Ulrickson	
PFC2	46	Pizzuto	Divertor max. temperature in CuCrZr seems to exceed 550	see Schit PFC2	Ulrickson, Driemeyer	
PFC2	47	C.Bushnell	Baffle plates, first wall and inner divertor are in the minimal stage of P.C. design. Work on design immediately!	Work on the baffle and inner divertor design is part of FY03 effort. This will be completed by 2003. The first wall design is not as high priority and will be done after the baffle and inner divertor work.	Ulrickson, Driemeyer	

PFC2	50	F.Puhn,GA	Thermal gradient in divertor modules can cause excessive stress, distortion, and creep. These effects have not been assessed. Continue analysis to superimpose thermal loads with electromagnetic loads. Investigate creep behavior in copper.	see Schit PFC2	Ulrickson, Driemeyer	
PFC2	51	S. Majumdar	Thermal stress analysis of divertor structure is incomplete. Conduct thermal stress analysis and fatigue evaluation including creep effect. Also, need to satisfy design criteria for combined load effect, e.g., gravity + thermal + disruption etc.	see Schit PFC2	Ulrickson, Driemeyer	
PFC2	52	A. Pizzuto	Divertor thermal stresses: Divertor fingers are highly constrained so thermal stress could be very high.	see Schit PFC2	Ulrickson, Driemeyer	
PFC2	54	C.Bushnell	Outer divertor module needs much more work - on disruption loads/material and on copper finish that has high thermal stress. Work this soon with design effort and R&D as required!	Disruption analysis is in progress. This is a high priority activity. We will complete the analysis for the VDE, Radial inward and stationary disruption for the 2.0m machine in FY02. Scaling analyses will be used to estimate the disruption loads for the 2.14m machine.	Ulrickson, Driemeyer	
	SChit PFC2:The temperatures presented at the review did not exceed the allowables to CuCrZr. Iteration 2 of thermal stress analysis is examining the possibility of modifying the mounting pins to allow expansion of the fingers along their length. If this does not cure the stress issue additional degress of freedom will be added. This is a high priority task for FY03.					
PFC3	48	J. Irby	Can the disruptions really be predicted 30-50 ms ahead of time in FIRE? I don't think any engineering decisions should be made that depend on predictions. Reduce forces on plates by reducing size.	FIRE will follow disruption mitigation activities on current tokamaks - DIIID's massive gas puffs show promise that they can control energy deposition and current decay. This is not a conceptual design issue.	Ulrickson	
PFC4	49	J. Irby	Several kA/cm2 vacuum contacts are very risky. I suggest some other approach be found to deal with the toroidal disruption currents.	Only a backup if disruption forces prove to be too high; highly likely this will not be necessary.	Ulrickson, Driemeyer	
PFC5	53	A. Pizzuto	R.H. - Module to be refurbished is too heavy. Boom with limited operations area. Very long operation and complex out of vessel maintenance (3 full divertor plate refurbishments)	see Schit PFC5	Ulrickson, Driemeyer, Burgess	
PFC5	57	J. Irby	Size of divertor plates should be reduced.	see Schit PFC5	Ulrickson, Driemeyer	
PFC5	55	F.Puhn	Size of divertor module drives the design in several critical areas: •Weight of module impacts boom design and R&D requirements. •Size of module requires cut-outs in TF coil which creates critical section in coil and restricted space for leads. •Disruption loads are very high on large divertor module. Suggest changing from 16 to 32 divertor modules.	see Schit PFC5; Disruption loads are being assessed. If they are too high, other options exist.	Ulrickson, Driemeyer	
	SChit PFC5: No compelling need to change. Present module size OK for remote handling and divertor mounting. Water connections would be much more complex with a change to more, but smaller modules. This area will be reviewed again for the 2.14m machine.					
PFC6	56	A. Pizzuto	Divertor - The use of inconel back plates for fingers could have a big impact for waste and activation points of view.	Not expected to be a problem with our low fluence. However, if future stress analyses indicate SS can be used, Inconel will be eliminated.	Ulrickson, Driemeyer, Sawan	
PFC7	58	P. Mioduszewski	Need comparative study of single-versus double null configuration with respect to: connection length, temperature gradient, power disposition pattern.	see Schit PFC7	Ulrickson, Rognlien	

PFC7	59	P. Mioduszewski	Detached divertor operation needs to be studied with respect to: —plasma performance —He exhaust —Zeff —neutrals control	see Schit PFC7	Ulrickson - Rognlien, Brooks	
PFC7	60	P. Mioduszewski	It is not obvious that the short connection lengths in the SOL can support the need temperature gradients between divertor and separatrix/pedestal. What pedestal temperature is needed to achieve the desired H-mode confinement?	see Schit PFC7; Pedestal temperature required must be specified by physics.	Meade	
PFC7	61	P. Mioduszewski	CX - fluxes at the divertor entrance are usually fairly large. Sputtering of Be from the passive plate could lead to tungsten sputtering from the divertor surface and lead to unacceptable W-concentration in the plasma. Need plasma edge/neutrals modeling to evaluate erosion of the passive plates.	see Schit PFC7	Ulrickson/Brooks	
PFC7	62	P. Mioduszewski	Need to evaluate ranges for divertor loads; discussed was 80/20, should also look at performance of e.g. 70/30, 90/10 etc. The given loads are already at the limit. Partially detached.	see Schit PFC7	Ulrickson, Wesley, Rognlien	
	SChit PFC7: Many of these issues were also discussed at Snowmass. The general area of power deposition in the divertor due to Elms was identified at Snowmass as an important issue for both ITER and FIRE. Experience on JT-60U and ASDEX_U have shown reduced Elm size for near double null Double null experiments in support of FIRE have been proposed for both C-Mod and DIII-D. In addition, the primary limit to exploitation of AT modes on FIRE or ITER is the ability to remove the exhaust power at the high power densities produced by AT modes. A proposed work plan for analyzing the divertor and SOL will be worked out by Ulrickson and Rognlien.					
	TF/PF/STRUCTURES					
	·Stress Analysis					
TPS1	5	A. Pizzuto	Out of plane loads during disruption not yet considered. Could be the determining stress as far as shear is concerned	As measured in C-Mod and based on a transient electromagnetic disruption analysis of FIRE, the vessel shields the coils from any significant loading. See Memo NSO N0: WBS1.3.5_100501_TF_Disrupt_PHT.doc	Titus	
TPS2	17	J. Irby	Compression ring needs more R&D Allow time for study of non-metallic structure. Increase R&D in this activity.	see Schit TPS2	Titus	
TPS2	18	C.Bushnell	The loading rings (stiffness) and jack design need to be settled. Apply immediate design R&D as required.	see Schit TPS2	Titus	
TPS2	19	F.Puhn	Preload ring requires high strength and insulating breaks. To carry hoop load across insulating break requires special features, presently not defined. Consider use of a non-metallic filament wound preload ring. Stiffness is 5 to 10 times lower than metal and this results in less change in preload during temperature excursions.	see Schit TPS2	Titus	
	SChit TPS2:The compliance of non-metalics would probably make the opposed jack wedge system inadequate in terms of the displacement they could supply. The thermal contraction properties of non-metalics would have to be simulated and creep of the non-metalics needs to be quantified. Steel creep, on the other hand, is well characterized and is not a problem. The steel ring serves the purpose, and it is not clear if there is a substantial cost or assembly advantage for a non-metalic ring. Other materials will be characterized, and alternatives to steel will be considered, but R&D on this will be delayed until detailed design. Provision for electrical breaks has been made. The inner turn is "wrapped" to the outer turn and mechanically connected through an insulator. Cost was based on segmenting the ring into three "coils" to limit inner/outer turn voltage.					
	·Design Criteria					

TPS3	13	R. Parker	Copper embrittles at very low dpa and could lead to degradation of performance at or near end-of-life fluence. Carefully check data or Cu and BeCu if data exists. If data is inadequate or inconclusive, plan to explore in R&D program.	see Schit TPS3	Sawan,Nelson,Zinkle	
TPS3	32	S. Majumdar	(1) Treatment of low ductility material in the FIRE design criteria is absent. (2) Treatment of fatigue, creep/fatigue in the FIRE design criteria is incomplete. (1) First, conduct literature survey on low fluence embrittlement of copper/copper alloys. If embrittlement is a concern, use design rules from ITER structural design criteria as a starting point. (2) Use fatigue and creep-fatigue rules of ASME code or ITER structural design criteria for components like divertor,first wall, etc.	see Schit TPS3	Titus, Zatz	
	SChit TPS3: The peak cumulative end-of-life dpa values in the Cu components were calculated for the FIRE baseline design. The dpa values are very low (< 0.04 dpa). Although the damage levels are very low, some effects on physical and mechanical properties might occur. We reviewed the numerous studies performed over the past ~8 years as part of the ITER R&D program. A memo by Sawan, Zinkle, & Nelson was issued on 8/9/01 discussing in detail the status of existing data and the relevance to FIRE design. Based on the irradiation levels and operation conditions in FIRE and the available data on Cu alloys, we identified the R&D needs as follows: • Data on loss of ductility of BeCu (or OFHC) at temperatures between 80 and 373 K with doses < 0.01 dpa. • A small, relatively inexpensive irradiation program is needed to measure fatigue, fracture toughness and fatigue crack growth rate behavior in high-strength, high-conductivity copper alloys. • Thermal creep data for CuCrZr at temperatures up to 500°C. There is no need to perform irradiation creep measurements on Cu alloys for the low doses proposed in FIRE. A more detailed discussion is included in the neutronics section of the FY01 Engineering Report.					
TPS4	6	A. Pizzuto	12 T Operation. Baseline solution must have sufficient engineering margin to allow operation at maximum performance. ME=1.5 should be achieved.	see Schit TPS4	Titus	
TPS4	25	S.Majumdar	Safety factors for Sm in FIRE design criteria are unconservative compared to ASME Code. Magnet allowables should be separate from those for vacuum vessel and in-vessel components for which ASME Code or ISDC safety factors should be maintained.	see Schit TPS4	Zatz, Titus Section in FY01 rpt	
TPS4	31	S. Majumdar	Inelastic analysis rules in FIRE design criteria at present. If elastic analysis rules cannot be satisfied use either limit analysis rule (with flat top stress-strain curve with 1.5 SM as yield) of ISDC and show collapse load >3/2 design load or use inelastic analysis rule of ITER structural design criteria and satisfy strain limits.	see Schit TPS4	Zatz, Titus	
	SChit TPS4: The FIRE magnet design criteria is directly descended from CIT,BPX TPX and ITER magnet criteria. The issue of the non-conservative derivation of Sm being the lesser of 2/3 yield and 1/2 ult -rather than the ASME 1/3 Ult, has been discussed many times, and at least for magnets, has been accepted. One rationale is that, at present, a tokamak is an experimental device and a less conservative approach is acceptable for a component with limited public safety concerns. The present design criteria provides a margin of 2.0 against failure. Given the history of the criteria documents, additional margin for magnet systems would appear un-necessary, unless there is some uncertainty in the physics design point for the machine. We are using a factor of 2 against collapse consistent with our 1/2 Ult derivation of Sm.					

TPS5	33	S. Majumdar	Bucked & wedged design is justified by highly complex, nonlinear, contact stress analysis. Need to benchmark analysis technique by tests.	Both the Wedged and Bucked and Wedged configurations use the same non-linear analysis tools- gaps, plasticity etc.The predictive value of large, complex analysis models has been an issue and probably will remain an issue as long as we use state of the art analysis tools, that are substantially more advanced than the tools that were used to model the present operating tokamaks.Some benchmarks and qualification methods exist, eg- see memo# WBS1.3.5_101201_TF_Disrupt_PHT	Titus	
	·Configuration					
TPS6	16	J. Irby	B&W design: can you take it apart? Bucking arrangement should allow removal of CS w/o difficulty. Failure scenarios should be carefully considered.	The CS for both Wedged and B&W concepts needs to disconnect the case assembly for PF1 and 2 lower for the CS to be removed without disassembly of the TF. Passing LN2 through the CS cooling channels with the TF at room temp allows removal of the CS for the more tightly fit B&W configuration. The B&W approach is not the present baseline so this is not an issue.	Titus,Brown	
TPS7	21	R. Parker	Cooling of TF is too slow. Improve cooling by adding cooling of inner base of magnet.	see Schhit TPS7	Titus, Meade, Wesley, Brown	
TPS7	37	J. Irby	Between shot time too long @ 400 shots/year -- 7-8 years to get through the 3000 shots. Look at cooling both sides of TF. Look at cooling between TF & CS	see Schit TPS7	Titus, Meade	
	SChit TPS7: As a result of discussions at Snowmass we have decided to cool the TF from both sides as paret of the design modification for 2.14m. The pulse repetition time has been increased by a factor of 3. An extensive analysis of experimental scenarions was presented at Snowmass that produced 2500 shots per year which is in the range of today's tokamaks.					
TPS8	20	R. Parker	Cooling tube manifold presents a tricky design problem -- Tubes must be insulated from each other and no leak can be tolerated. Requires some R&D!	see Schit TPS8	Thome, Heitzenroeder; develop R&D Plan; Brown, Config. Study	
TPS8	22	J. Irby	Connections to magnets need to be analyzed/designed with high priority. Material - work hardened. Focus on these issues as soon as possible.	see Schit TPS8	Titus,Brown	
TPS8	23	F.Puhn	TF Coil lead is located in congested position next to midplane ports. Carrying TF coil load may require a thicker section adjacent to lead. Consider relocating TF coil leads to a position between ports to allow more space for structure.	see Schit TPS8	Brown, Titus See 22	
	SChit TPS8: The manifolds are an issue, but a leak is not a major concern since it will contribute to the gaseous nitrogen atmosphere within the cryostat. Our plan is to focus first on CS leads and terminals as these are in a high field region. The present lead and manifold design is considered appropriate for this stage of design. More detail will be generated as the design progresses.					
	REMOTE MAINTENANCE					
RM1	8	R. Parker	A single boom is risky since it could malfunction in machine or be unavailable when needed. Also, maintenance time (e.g., to replace divertor or substantial fraction of FW) would be needlessly long. Two booms should be part of baseline design.	see Schit RM1	Burgess	

RM1	35	F.Puhn	No rescue capability is identified for remote handling boom. Suggest requiring a second boom which has rescue capability. The training boom might be used in an emergency if another training boom can be obtained in a reasonable time.	see Schit RM1	Burgess	
	SChit RM1: The training/development boom is planned for back-up service.					
	SCHEDULE & COSTS					
SC1	10	C.Bushnell	In manufacturing, time is money! Could $$ be reduced by building it faster? By front loading in program more R&D and/or prototype? Trade offs or ….$$ need to be looked at -- soon.	Project costs could, indeed, be reduced by front loading R&D and compressing the construction schedule. The present strategy is based on an assumption for the fastest implementation schedule based on likely fiscal limitations. Our plan is to obtain feedback from the fusion community and DOE, and then revise the plan. Front loading R&D has many benefits, and we are persuing this possibility.	Simmons, Thome, Heitzenroeder	
	VV & CRYOSTAT					
VVC1	11	C.Bushnell	The purpose of the cryostat needs a crisp definition! Then we will know if the costs are correct. Define - Design - and Cost.	The requirements for the cryostat have been updated and can be found in the FY01 report.	Nelson,Petti	
VVC2	34	J. Irby	What happens if the vacuum vessel goes down to LN2 temps? What happens to outer cooling lines?	see Schit VVC4	Nelson	
VVC3	38	J. Irby	What are the vacuum properties of the Cu-Ss wall composite? •trapped volume •impurities. Inspection techniques. Prototype tests	see Schit VVC4	Nelson, Driemeyer	
VVC4	39	J. Irby	Pumping speed of cryopump @ 20 u\pT much too low for density control (Base p). Look at relocation of pump. Larger ports.	see Schit VVC4	Fisher, Gouge, Ulrickson	
	SChit VVC4: The design of the pumping system was revised to provide a high speed turbomolecular pump attached to a large, high conductance, mid-plane port and duct (~500 mm diameter) to enable faster pumpdown to base pressure prior to plasma operations or during vessel bakeout. This addition will provide a minimum pumping speed of 2000 l/s in the molecular flow region. The revised concept will use a sliding shield plug that will open a duct for pumping between shots, but close during a shot to avoid streaming and neutron activation outside the cryostat.					
VVC5	40	S. Majumdar	Vacuum vessel stress analyses have been conducted for thermal, gravity, etc. Disruption analysis is incomplete. Design criteria limits for combined loading effects have to be satisfied. Fatigue evaluation needed for regions of stress concentration. What are the stress limits for Cu/SS composite structure? Sufficient to show that primary stress limits can be satisfied and without any help from Cu.	see Schit VVC5	Nelson	
VVC5	41	A. Pizzuto	Vacuum Vessel - The stress analysis has to be also considering coherent disruption scenario.	see Schit VVC5	Nelson	
VVC5	42	F.Puhn	Vacuum Vessel and divertor design/analysis not complete. Stresses exceed allowables in some regions. Complete redesign and stress analysis. Include thermal stress and all loading conditions. Include thermal stress on divertor. Apply electromagnetic loading on VV.	see Schit VVC5	Ulrickson, Nelson	

VVC5	43	F.Puhn	Eddy current analysis does not include cut-outs for ports. Thus the poloidal current flow in port edges is not calculated. This current crosses toroidal field and produces loads on port walls. Perform more detailed eddy current analysis to include ports. Stress analyze ports for disruptions loads.	see Schit VVC5	Nelson, Ulrickson	
	SChit VVC5: Disruption analyses have begun and are considered appropriate for a pre-conceptual design phase. Further analyses are essential as indicated. This will be pursued further in FY03 and FY04.					
VVC6	44	F.Puhn	Vacuum vessel supports not fully analyzed for side loads. Load path relies on bending of slender tie rod. Shock loads or maldistribution will occur unless precise fit-up is ensured. Space and access is very restricted. Complete VV support design and analysis. As alternate concept consider supports on midplane ports using "watts linkage" or rollers. Watts lineage to ensure straight-line motion. Can place other linkages on top or bottom of ports to react side loads.	Support analyses have begun and are considered appropriate for a pre-conceptual design phase. Further analyses are essential as indicated. This will be pursued further in FY03 and FY04.	Nelson	
VVC7	45	F.Puhn	No obvious means to access fasteners connecting baffle modules to vacuum vessel. Remote handling requires large access holes and visibility. Design concept for remote assembly/disassembly of baffle modules. Analyze impact of cut-outs when subjected to peak heat loads.	Access and remote handling analyses have begun and are considered appropriate for a pre-conceptual design phase. Further analyses are essential as indicated. This will be pursued further in FY03 and FY04.	Ulrickson, Driemeyer, Burgess	
	NEUTRONICS					
N1	36	F.Puhn	Safety implications of activated nitrogen inside the cryostat is not addressed. This may be a problem due to neutron streaming. Perform 3D neutronics analysis. Address safety implications. Include off-normal events.	See FY01 Engineering report. Based on 1-D calculations, the total 13N production after each D-T pulse is only 0.9 Ci with only 1 micro Ci of 14C. These are generated mostly in the space between the IB magnet and the IB VV. Due to larger shielding, activity is about two orders of magnitude lower on OB side. Streaming is not expected to increase the OB activation by more than two orders of magnitude. Hence, streaming may double the estimated total activity in Nitrogen gas which remains very small. 3-D calculations are planned as the design details become available. In addition off-normal events will be analyzed as the design progresses.	Sawan	

N2		Y.Gohar	All the analyses and the results are produced with a one-dimensional toroidal model without including safety factors to account for engineering details, model assumptions, and other uncertainties.	Experience with toroidal 1-D calculations and 3-D calculations shows that peak nuclear parameters at midplane close to FW are overestimated by up to a factor of 1.6 when 1-D calculations are used. Since the worst conditions occur at midplane in FW/tiles and at front of lightly shielded (<10 cm) IB leg of TF coil, there is no need to increase these peak nuclear parameters by a safety factor. Engineering details, model assumptions and other uncertainties are not expected to counterbalance the overestimate in 1-D results at these locations. The main concern is for nuclear parameters outside the tokamak in the OB side where streaming and engineering details are important. The effect of an order of magnitude increase will be mainly to increase the cooling time needed before hands-on maintenance by a few hours. This will be indicated when 1-D results are	Sawan	
N3		Y.Gohar	The performance of the TF coils is sensitive to the nuclear heating load which impacts the operating pulse length. In addition, the peak IB insulator dose determines the allowable number of pulses based on the acceptable limit. Careful neutronics analyses are required to determine the peak nuclear parameters in coils based on a 3-D model.	The largest nuclear heating and insulator dose in TF coils occur in the IB leg on plasma side at midplane. 1-D calculations tend to overestimate results there compared to 3-D results with beter modeling of source distribution and geometry. Two-dimensional calculations are planned for FY03 assess the impact of plasma shape and neutron source profile on peak radiation effects in the inboard region at midplane. Shielding is primarily provided by the thin (5 cm) toroidally continuous VV and 5 cm FW/tiles. Tile heterogeneity and other details are not expected to counterbalance the overestimation in the results. Attenuation provided by tiles and VV at that location is only a factor of ~3. As more design details become available, we plan to perform multi-dimensional	Sawan	
N4		Y. Gohar	Biological dose during operation needs to be determined to define the shielding requirements for the building and to check the compliance with the site dose requirements.	These calculations will be planned in the conceptual design phase.	Sawan	
N5		Y. Gohar	Nuclear heating loads in the divertor ports based on the device geometry are required to provide input for sizing the cryoplant to achieve the operating scenario.	This requires 3-D calculations with details of geometrical configuration and arrangement of components and material in the divertor port. The effort is planned for the conceptual design phase.	Sawan	