

Chit No.	Joint Design	Comment/Recommendation/ Concern	Originator	Board Disposition	Review Board Comment / Recommendation
▼ All					
1	All	The evaluation form seemed much more detailed than warranted for the presentations. In bolted electrical connections, the devil is in the details and other than Neumeyer's presentation, the details were pretty light. Clearly, they all had merit.	Reiersen		
2	All	I am concerned about the assumed current distribution in the analyses. It should change as the current ramps up, as it soaks in, as the temperature rises, and as the current is dumped. If you optimize for a steady state, constant temperature condition, you need to make sure that the solution is robust to the current distribution at other points in time. It was not apparent that this had been considered.	Reiersen	Concur	Will be considered in design. Titus has begun to look at this.
3	All	I am also concerned about the allowable stresses. The strength of copper drops pretty quickly with temperature. Creep becomes a concern. There did not appear to be clear criteria for allowable stresses in the copper as a function of temperature.	Reiersen	Concur	Need to specify criteria as part of Conceptual and Preliminary Design process
4	All	Cost was never quantitatively discussed.	Reiersen	Other	Cost will be estimated as designs are downselected and detailed
5	All	Forces on the joint are due to EM load, thermal loads and the relative deformations of TF inner leg and outer leg. The relative deformations are the results of structural displacements, in the vertical, toroidal and radial directions, primarily caused by thermal expansion and EM loads.	Fan	Concur	
6	All	Umbrella cover is an effective rigid diaphragm to match the IB and OB toroidal displacements.	Fan	Concur	
7	All	For the relatively vertical displacements (about 8mm by Bob), the shape and flexibility of the TF flag determines the structural responses. Analysis is needed unless very flexible conductor is used.	Fan	Concur	
8	All	The radial displacement is considered to be much smaller.	Fan	Concur	
9	All	In-plan EM loads are influenced by the conductor shape and the flux lines. The effects on joints are tension, shear and bending, depending on the designs, but will not be critical one on all four designs.	Fan	Disagree	Inplane and OOP loads need to be considered, however the effects on the design will vary.
10	All	Out-of-plan EM loads induce shear, bending and torsion on the joint, among them the bending moment may be the most serious because of small width. Magnitude of bending depends on the span that Phil's design has shortest span. Joint design should be checked to preserve the joint integrity and maintain proper joint pressure.	Fan	Other	Need to factor in the loads in the joint which don't necessarily correspond to the span. (Flex could alleviate liftoff problem)
11	All	I think through some modifications, all designs can make it to work. Therefore the cost and ease of implementation and maintenance is important factors for consideration.	Fan	Concur	Will be considered in design as it evolves.
▼ Heitzenroeder					
12	Heitzenroeder	On joint concept #4, lower joint resemble existing concept and will have similar problems (well known, not listed here)	Neumeyer	Concur	Similar but with different proportions so restraint is improved.
13	Heitzenroeder	On joint concept #4, there appears to be a bolt access problem where u-shaped flex pieces bolt on to inner leg extensions.	Neumeyer	Concur	
14	Heitzenroeder	Option-4 is more of a brute force approach to get the joint away from high field but it also gives you an attractive way of making the OH coil.	Williamson	Concur	
15	Heitzenroeder	Phil's approach for expanding the radius of the joints looks attractive. It should reduce the loads and produce spatial flexibility.	Schmidt	other	
16	Heitzenroeder	I would review Phil's conclusions that trapping the OH would not cause significant problems. If it does not cause problems I would tend to implement this option even though at this point it may not seem needed.	Schmidt	Concur	Launching loads and preload need to be addressed
17	Heitzenroeder	Can the upper leads be shortened to allow more access for maintenance?	Chrzanowski	Concur	
18	Heitzenroeder	Could be difficult tightening lower bolts on bundle side with last several jumpers.	Chrzanowski	Concur	
19	Heitzenroeder	The bottom connection in Heitzenroeder's up:down asymmetric concept seems to be the weak link in that approach, but it may be fine. Taking advantage of the allowed asymmetry seemed very reasonable.	Reiersen	Other	If loads in the lower joint are acceptable asymetry may be eliminated.
56	Heitzenroeder	The Heitzenroeder concept is very good. Electron beam welding should be considered the baseline.	Perry		
61	Heitzenroeder	Access to the upper OH connections and PF Connections will be difficult on top. Consider using the lower design on the bottom to make access easier.	Dudek	Concur	
▼ Neumeyer					
20	Neumeyer	If calculations of magnetic loading + bolt loading are marginal the design must account for less than the simple addition of the two. The magnetic loading will off load the bolting preload and the resultant load will be less than the simple sum.	Kalish	Concur	
21	Neumeyer	Lid shear reaction at the outer diameter would require large diameter deeply engaged shoulder bolts	Kalish	Concur	
22	Neumeyer	Match drilling shear pins difficult and maybe impossible for more than one shear pin. Shear pin should be carefully considered and properly analyzed. Maybe replaced with some kind of block?	Kalish	Concur	
23	Neumeyer	Option-1 makes good use of the constant tension connector approach and though it seems like a complicated asm, Bruce has some good ideas re match drilling, shear pins, and other asm techniques.	Williamson	Other	
24	Neumeyer	Charlie has given a lot of thought to the details of supporting the loads. I would review each of his approaches and integrate them into the design if they pass muster.	Schmidt	Other	
25	Neumeyer	Trapped nut blocks are a concern. If they get gnawed or a stud breaks off, there is no reliable way up correcting the problem.	Chrzanowski	Concur	Needs more thought. Could use a rod inserted from above which could be repaired easily
26	Neumeyer	Having multiple shoulder bolts with close fit up tolerance in the same part could be very difficult to achieve.	Chrzanowski	Concur	
27	Neumeyer	Lining up all of the blocks with the ring may be difficult. Could the flag box attachment ring be broken in several sections? This may improve any fit-up issues.	Chrzanowski	Concur	Will be considered in design.
28	Neumeyer	Neumeyer's concept seemed like an incremental improvement over the baseline. It used EM loads to keep the joint closed (+). The bolts tied into SS rather than inserts threaded into copper (+). Because it is close to something we understand and have experience with, it might be the least risky path forward - not necessarily the one with the greatest upside potential, but the one that might be least likely to have a nasty surprise. It ensures a positive electrical connection between the flag and the CP conductor.	Reiersen	Other	
29	Neumeyer	7) The lateral support can carry some out-of-plane load to the umbrella cover and thus reduce the loads passing to the joint. It is particularly useful for flexible one. I prefer the continuous flange box in Charles' design.	Fan	other	
54	Neumeyer	The Neumeyer concept is quite good, but it will require replacing the trapped steel "nuts" with a removable rod that has tapped holes so repairs can be made easily when the threads become damaged. Also, the use of shoulder bolts is not advisable because the tolerance build-ups will make the overall assembly very difficult if not impossible.	Perry	concur	
62	Neumeyer	Too many precisely fitting parts will make assembly difficult (or impossible) and cost high.	Dudek	Other	
63	Neumeyer	The arched OOP flex joint is new design (looks rigid) needs to be proven.	Dudek	Concur	Needs to be detailed and analyzed further.
65	Neumeyer	Replace steel inserts with standard threaded inserts or redesign steel inserts so they can be replaced after being put in service.	Dudek	Concur	
▼ Titus					
30	Titus	On joint concept #2, concern about interfaces between radial flag structures and inner leg turns, which have some finite dimensional tolerance	Neumeyer	Concur	
31	Titus	On Joint concept #2, concern about load carrying capacity of outer leg ends (brazed tabs and aluminum blocks and wet lay-up which must carry ~ 112 of load.	Neumeyer	Other	Would require more structure on outer leg.
32	Titus	R&D and large factors of safety should be employed if we rely on friction to react the primary loads.	Kalish	Concur	
33	Titus	Analysis should consider a "reasonable" worst case non symmetric loading of the jackscrews to determine if there is a danger of damaging the turn insulation in the TF Core.	Kalish	Concur	
34	Titus	R&D to determine Felt Metals ability to account for manufacturing tolerances and imperfections	Kalish	Concur	Some data exists from MIT experience but it's new to PPPL
35	Titus	How to keep the turns from sliding side to side	Winston	Concur	Shear Key or rabbet needed
36	Titus	A solid group of three may not mate with the outer TF well thus making each bundle custom	Winston	Concur	
37	Titus	Option-2 seems to have some inboard alignment issues,	Williamson	Concur	
38	Titus	I liked Peter's compression ring. It looks much better than screws and bolts into the joints.	Schmidt	Other	
39	Titus	How is the ring supported?	Chrzanowski	Concur	Weight of ring will be an issue for assemblers. May need some sort of fixture to asm during asm.
40	Titus	What prevents over loading opposite side during torquing operation?	Chrzanowski	Concur	Could use springs to load evenly
41	Titus	If one joint loosens, could this cause additional loosing in the other joints?	Chrzanowski	Concur	See chit 40
42	Titus	Difficult access to mid lead of Outer TF coils.	Chrzanowski	Concur	Shimming required not only in the thickness direction but also angular alignment.
43	Titus	There is no flexibility for bus fit up. The jumpers appear quite stiff.	Chrzanowski	Concur	
44	Titus	Titus' ring and jack screw approach with the simple arched connector element also had appeal.	Reiersen	Other	
45	Titus	Jacking ring in Peter's design is more reliable than the shoulder bolt with thread insert because of the thermal effects on the long bolt that change the preload.	Fan	Other	During pulse the joint force increases in long bolt joint because bolts don't heat immediately
55	Titus	The Titus concept is good, but will require Belleville washers to eliminate the need for an overly restrictive bolt tightening sequence and frequent checking of the bolt torques to assure they remain uniformly loaded. Access to the jacking bolts during assembly/ disassembly must be worked out before this concept is adopted.	Perry	Other	Needs to be detailed and analyzed further, may be able to implement spring loaded mechanism to support evenly. Access to bolts looks reasonable (Winston)
58	Titus	Concerned about tolerances using the "Jack Bolt Ring". Should consider using some sort of spring loaded ring to allow for uneven joint height.	Dudek	Concur	
59	Titus	Ability to lift jack ring up into position from above and to accurately place it will be difficult.	Dudek	Concur	
60	Titus	Access to jack bolts from above may be difficult	Dudek	Other	See chit 55
66	Titus	Move the 90 degree bends on the outside connections to the outer TF to allow access to the middle connection bolts	Dudek	Concur	
▼ Woolley					
46	Woolley	Careful review of effort required to shim connections to make up for low compliance of the buss work should consider assembly and machinist cost.	Kalish	Concur	
47	Woolley	Braided cable? We had failures on PLT with this type of flex (broke and started fire)	Winston	Concur	
48	Woolley	Like idea of flexible bus extensions	Winston	Other	
49	Woolley	Option-3 doesn't appear to have the same out of plane stiffness as the other concepts. Those issues could likely be resolved, however.	Williamson	Other	Would need to be addressed as part of further design.
50	Woolley	Rings rely on precise location of TF joints and bus assembly for uniform load to be applied. This is highly unlikely.	Chrzanowski	Concur	Would need to be addressed as part of further design.
51	Woolley	We have had difficulty with braided connections in high field area in the past. [PLT]	Chrzanowski	Other	See Chit 47
52	Woolley	Shims for outer TF coils would have to be customized. Electrical flags are bent and out of plane.	Chrzanowski	Concur	In both directions.
53	Woolley	Woolley's analysis was very interesting but I did not understand what design he was proposing other than the arched connector. Details of the mechanical design were sorely lacking.	Reiersen	concur	
57	Woolley	The Woolley concept does not appear to be practical for actual implementation by the machine technicians. The required tolerances are not achievable and the required use of long handled tools for installing the last pieces is not advisable.	Perry	Other	The basic principle of shaping the connection to benefit from the EM fields is sound, but the details of the connection the haven't been worked out.
64	Woolley	Collet needs to be rethought. Tolerances will prevent even tightening. Some sort of spring loaded joint may be a way to get visual indication and to take care of the loads.	Dudek	Concur	