NCSX Specification for the Modular Coil Assembly Fixture (MCAF)
Comments, Observations, Questions on DRAFT Specification

1. ***Turning Fixture:*** Structurally, the Turning Fixture of the Modular Coil Assembly Fixture appears to be top heavy, meaning it has significant mass located high in the structure and it's stabilized with a relatively small base. Qualifying the equipment to meet the seismic requirements and maintaining deflections of the structure to within the very tight dimensional tolerances over the vacuum vessel may be extremely difficult and, most likely, it will require significant modification to the conceptual design in order to meet these criteria. The seismic load path (lateral load resisting load path) is very complex and it consists of multiple cantilevered members and potentially non-rigid connection points. However, since the assembly operation occurs during a short period of time, it may be an incredible event, from a safety or mission security standpoint, to have a seismic event concurrent with the assembly of the equipment. If this requirement holds fast, a detailed finite element model will be required to accurately model not only the stresses in the structure, but the displacements as well.

   Even if the seismic design criteria can be eliminated due to its improbability of occurrence, the acceleration and deceleration of the equipment is also a concern with this top heavy conceptual design. Sudden stops of the equipment may create acceleration forces in excess of the seismic forces if the velocities are high enough

   It is also not clear as to how the MCHP is fastened to the Turning Fixture to keep it from falling out of the Cradle under a sudden stop (e.g. Loss of power) or seismic event.

2. ***Gantry Crane:*** The load transfer of the MCHP from the Turning Fixture to the Gantry Crane can not occur without additional displacement of the Gantry Crane itself under the 25,000 lb loading. Section 3, Background indicates that the load transfer is to take place without degradation of the position of the modular coil. This is an impossible requirement to meet. However, Section 3.1.14 clarifies that the vertical deflection under the load transfer shall be less than 0.05 inches, which is reasonable to achieve.

   One of the bigger concerns with the load transfer is the rigidity of the pick points. If the Gantry Crane can't pick the MCHP through its exact center of gravity, a rotational moment will be induced that will have to be resisted by the Gantry Crane Support Points to the MCAF. Connections will have to be made to not allow slippage of the connection and the supports will have to be rigid enough to restrain the rotational moment without much distortion or deflection.

3. ***Seismic Criteria:*** Section 3.1.20 is not very specific. Please also note that the seismic requirements document, NCSX-CRIT-SEIS-00 was not available for review. Section 3.1.20 specifies a static seismic criteria factor of 0.11. This value alone has no real structural meaning since it is not associated with any of the common building codes and its definition is not specified (e.g. IBC 2003). Was it the intent to specify a single "g" force factor to be applied to the center of gravity of the equipment with that value being 0.11 g's? If an equivalent static seismic analysis is the intent, we suggest that you specify the design code that utilizes this approach such as IBC 2003. Through this design code, the seismic "g" force can be calculated with enough site specific information such as the longitude and latitude, soil profiles, Importance factors, and location within a structure.
4. ***General:*** It is difficult to determine or visualize how the MCHP's are supported in their final configuration. Does the Gantry Crane and the Turntable stay in place in the final configuration? It's difficult to determine what the intent is to hold everything up in place in the end.
5. If stainless steel is used, the specification may need to incorporate AWS D1.6 (for Stainless Steel).
6. Where are detailed requirements specified for: accuracy of dimensioning radii of weld fillets, marking of parts, cleaning, riveting, painting, and wiring, NDE, etc.? Will these be left up to the design authority?
7. Suggest allowing use of welding procedures qualified to AWS D1.1 or ASME Section IX. This will facilitate fabrication and reduce cost for additional welding procedure/welder qualification. Inspection and testing of welds can still be done to AWS D.1.
8. What acceptance criteria (from AWS D.1.1 Table 6.1) are to be used (e.g., criteria for statically loaded or cyclically loaded non-tubular connections)?
9. What edition of codes and standards are required for the design and fabrication of the MCAF?
10. Motion control can be done if the mechanical backlash can be reduced to meet the positional requirements. The movements are easy enough to make if the mechanical system is "tight" enough. Electrical Controls cannot make up for mechanical backlash.
11. Currently in section 3.2.4 the final position is stated as relative to three spherical seats. Figure 3.1-3 shows the locations of these spherical seats. It is assumed the designer is to create a fixture that mounts to the cradle and contains the three points in space so that they can be measured during testing. Merrick would need help from NCSX to translate these position accuracies to the spherical seats for all 248 movement steps (assuming 248 are used).
12. Table 3.1-1 appears to be position numbers for each axis of movement, and by the way then numbers change it appears that the top of the list is when the fixture is in it's final location and the end of the list is when it is at the zero point. Is this true? Would there be a second point list for the other half, or can

it be assumed that two axis would be identical and one would be negative of the other to accommodate the mirror image of each half? Is there a desired travel time for installation of each half period?

13. Section 3.1.11 discusses keeping the MCAF in position after a shear coupling has broken. This would require moving the motor brake off of the motor and placing it between the shear coupling and the MCAF drive. This makes the drive train larger and thus harder to work into the design. The motor brake will hold the MCAF in place even if the shear coupling has sheared. Is this type of system what NCSX had in mind?

14. Section 3.1.12 discusses using limit switches for travel stops. Merrick is assuming that this is for over-travel purposes only, encoders will be the means of positional feedback in the system and will therefore be the device that stops the motors at the desired positions, not limit switches. Is this true?

15. **Location Measurement:** It would be relatively easy to measure each movement in each axis for each step, but it is the accumulated error that must be overcome and accounted for. Does PPPL have preference in how this is accomplished? Measuring the absolute position of each of the spherical mounting points at each step using a Coordinate Measuring Machine (CMM) is a suggestion. This provides a common point of reference for all position movements, not a relative accumulated position. The larger challenge here is how to locate the cradle mounting points in space for the testing, AND how to locate the starting point during testing and final installation. A portable CMM would be the easier, faster way of doing this, but probably the most expensive. Transit measurements may be just as accurate with the right transit operator, but much more labor intensive. Sighting in 3 views for each of 3 axis points for 248 steps would take a long time. With the use of a CMM and a computer this can be made easier. In order to make the positioning at the factory and at the NCSX site feasible, a position on a fixed "base" point at NCSX is required so that the "zero" point or starting position can be located at NCSX AND at the fabrication facility.

16. Suggest adding required deliverables listing (e.g., drawings, O&M manuals, spare parts lists, installation/assembly procedure)

17. Suggest adding scheduling requirements in the specification. The 16 week design duration mentioned in the meeting may be too short. 20 weeks would be more accurate.

18. Suggest adding an interim informal design review(s). This can be accomplished with web meetings or some other method to avoid travel costs. Interim reviews will help avoid potential rework at the end of the project.

19. What type of project reporting does PPPL anticipate for the project?