NCSX
System Requirements Document (SRD)
for the
Base Support Structure (WBS 17)

NCSX-BSPEC-172-00

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Record of Revisions

Revision	Date	ECP	Description of Change
Rev. 0	5/9/2008	-	Initial issue

Table of Contents

Table of Figures

1 Scope

This document covers the design and functional requirements for the NCSX Base Support Structure.

1.1 Applicable Documents

The following documents form a part of this specification to the extent specified herein. In the event of a conflict, the contents of this specification shall be considered a superceding requirement.

1.2 NCSX Project Documents

Structural and Cryogenic Design Criteria

Seismic Design Criteria NCSX-CRIT-SEISPPPL Proc.# ENG-037

General Requirements Document (NCSX-ASPEC-GRD)

Stellarator Core Systems (WBS 1) WBS Dictionary (NCSX-WBS1)

Reliability, Availability, and Maintainability (RAM) Plan (NCSX-PLAN-RAM-00)

1.2.2 Project Drawings

SE172-201 Top Assembly

SE172-203 Inboard Base Frame

SE172-207 Outboard Base Frame

SE172-240 Outboard C-C Joint Column

SE172-243 Inboard Pedestal

SE172-247 Inboard A-A Joint Short Column

SE172-252 Inboard Base Beam Weldment

SE172-253 Inboard A-A Joint Column

SE172-254 Outboard Angle Brace

1.2.3 Reference Drawings

SE172-219

SE172-244

SE172-245

SE172-250

1.3 Non-Project Documents

AWS D1.6

ASTM A479

ASTM A484

DOE-STD-1020-02

DOE-STD-1021-93

DOE-STD-1024-92

IBC-2000

2 Subsystem Requirements

2.1 Subsystem Definition

The base support structure consists of six (6) columns with welded base and top end plates. Three outboard columns are bolted to 3 wide A-frame style weldments which spread approximately 50% of the stellarator core gravity loading to the top of the reinforced concrete test cell floor. Three inboard columns attach via bolts to a triangular hub weldment which spreads and transfers the remaining gravity load from the core. Both the inboard and outboard beam weldments span rectangular openings in the test cell floor and are anchored to the floor by means of stainless steel concrete wedge stud anchors. All structural materials are fabricated from solution annealed, 300 series, austenitic stainless steel with low relative magnetic permeability.

Figure 2-1 illustrates the main features of the base supports and their orientation to the utility bay floor openings.

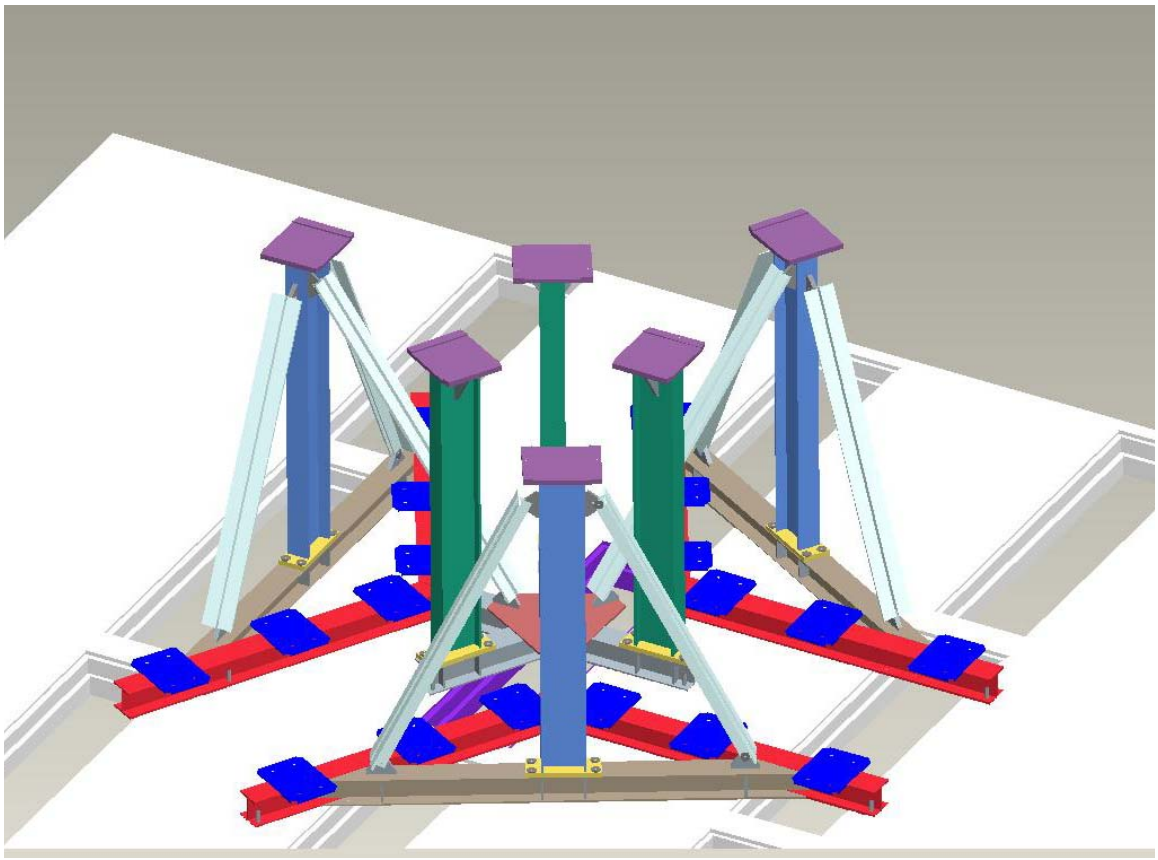

Figure 2-1 Base Support Structure and a Portion Of The Test Cell Floor

The top plates (as shown in purple in the above figure provide the horizontal mounting surfaces for the stellarator core. These top plates provide mounting holes for the lateral load retainer brackets and the mounting surface and retainer threaded holes for the low friction base slides. The spherical bearing assemblies and slide mounts (which are not considered part of the base support) are shown in Figure 2-2 and Figure 2-3. These assemblies separate the base supports from the core, and will ride on the low friction base slides in the radial direction while being restrained in the circumferential direction by the lateral load retainers. These lateral load retainers also will vertically capture the spherical bearing housing base plates.

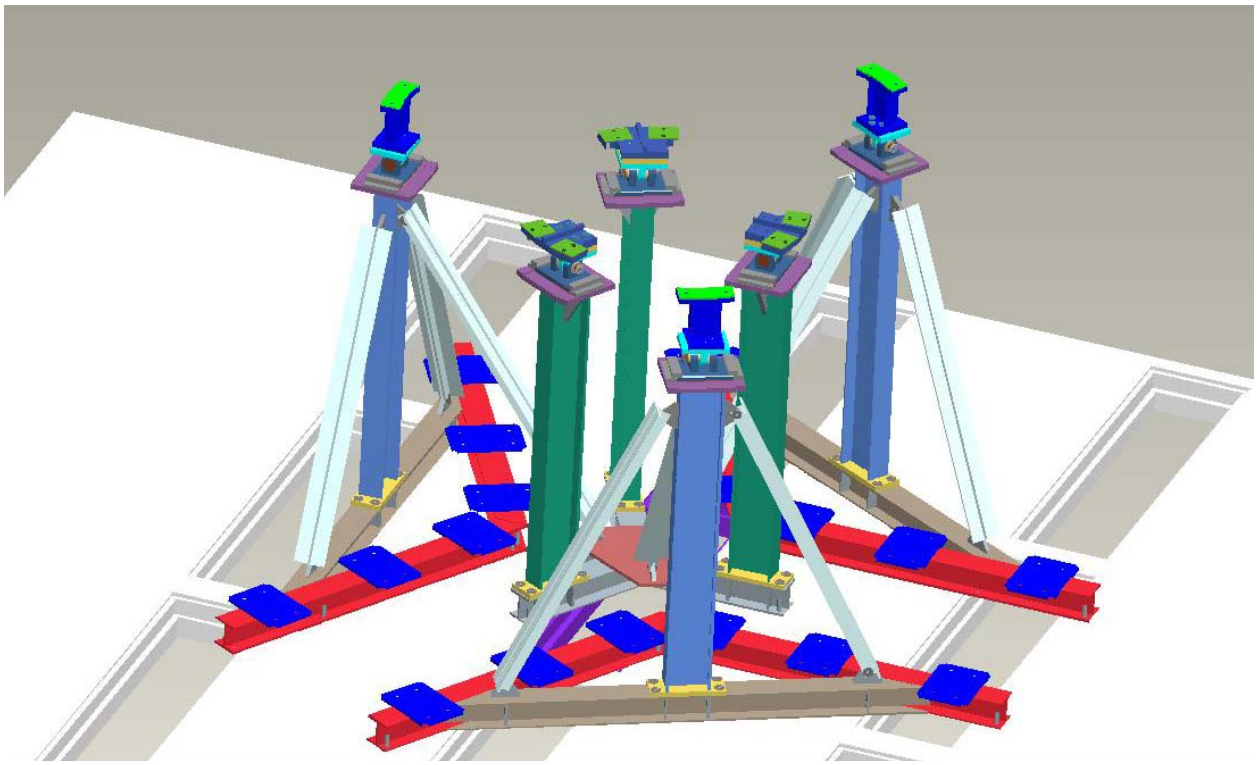

Figure 2-2 Base Support Structure and Spherical Bearing Assemblies

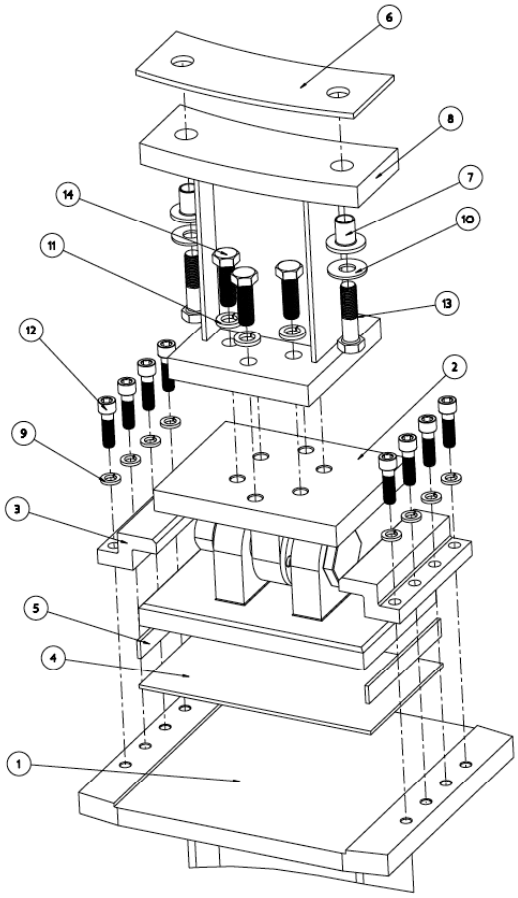

Figure 2-3 Spherical Bearing Assembly Interface with Stellarator Core

2.2 Subsystem Diagrams

2.2.1 Functional Relationships

A block diagram of the base support structure and it's environment is illustrated in Figure 2-4 below (the base support system is outlined in red). As noted the main direct functional connections are with the coil support structure, test cell floor, and cryostat systems.

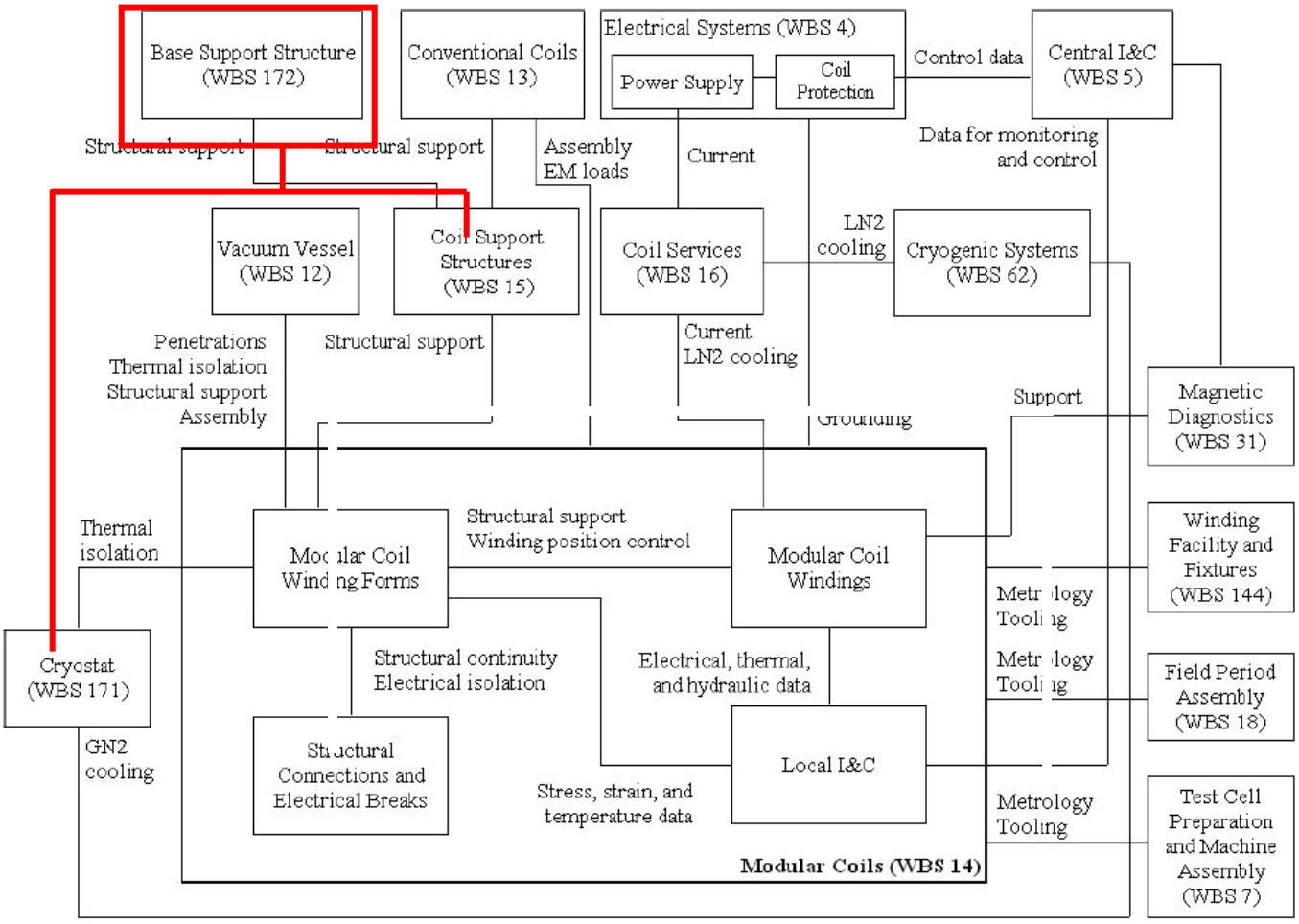

Figure 2-4 Base Support Structure Functional Relationship

2.2.2 Interface Definition

The base support structure interfaces the NCSX stellarator core and cryostat with the test cell floor.

2.2.3 Major Components

The major components of the base support structure are:

1. Outboard A-frame base beam weldments (3), Dwg. SE172-207
2. Inboard base hub weldment (1), Dwg. # SE172-203
3. Outboard C-C joint column weldments (3), Dwg. # SE172-240
4. Inboard A-A joint column weldments (3), Dwg. # SE172-253

2.3 Characteristics

2.3.1 General Performance Requirements

The NCSX base support structure shall provide the gravity load path from the bottom of the modular coil winding form (MCWF) to the C-site test cell floor (El.98'-6"), for all NCSX core systems which

include the vacuum vessel, modular coils (MCWF), TF coils, PF coils, Trim coils, coil support structures, buswork, and cryostat. The estimated dead load for all systems is 300,000 lbs. The nominal height of the machine core center of mass is 184" above the test cell floor.

The design shall be in compliance with the NCSX structural and Cryogenic Design Criteria (rev0). In addition to the gravity load, the support structure shall provide adequate resistance to vertical and horizontal seismic loading conditions as specified in the NCSX Seismic Design Criteria (rev 0).

The base support structure shall be rigid enough to limit relative vertical displacements of the stellarator core to 0.040" (1mm).

The maximum rated test cell floor loading of 4,500 lbs/sq.ft shall not be exceeded.

2.3.2 Magnetic Permeability Requirements

Structural components are to be fabricated from non-magnetic materials with an over-all relative magnetic permeability of 1.05 or less (ref.GRD para.3.3.1.1.b).

2.3.3 Assembly Requirements

Support weldments and assemblies that exceed two man manual lift limits shall include provisions for lifting eyes or other sling attachment provisions. The Three outer column supports are required to support, on their own, the full period assembly weight of 80 kips per column during the initial three-period machine assembly.

2.3.4 Fabrication Requirements

All welding shall be in accordance with AWS D1.6 and PPPL Proc.# ENG-037. All weld filler material shall be ER316L-Mn (Stellalloy alloy). No filler is required for fusion welded (laser welded), commercially procured, structural shapes.

2.4 Subsystem Interfaces

2.4.1 Test Cell

The interfaces shall be at the test cell floor at an elevation of 98'-6", and with the NCSX stellarator core at El.114'- 11 3/8" for the C-C joint (outer support) location, and 101' to the ¼" thick G10 thermal insulating plates at the A-A joints. The A-A joint interface will traverse the two adjacent inner TF support brackets on either side of the joint. The centerline of the inner columns will be located at a radius of 29.5". The base support assemblies are to be anchored to the test cell floor with a provision for full radial compliance with vertical and circumferential restraint of the stellarator core assembly at the top. At the test cell floor level anchors must be located in areas that avoid the concrete re-bar and the utility bay floor openings and cutout re-enforcing angles.

2.4.2 Assembly Tooling

Space must also be provided between supports and shall be sufficient to accommodate the three period assembly carts.

The base support structure will have interfaces with the tooling and metrology equipment required for field period assembly, which may include lifting points and monuments to facilitate position measurements.

2.4.3 Field Coil Supporting Structure

The main interface with the machine core is at the six top support pedestals on the inboard and outboard columns. These top plates provide the mounting holes for the lateral load retainer brackets and the mounting surface and retainer threaded holes for the low friction base slides. The spherical bearing housing assemblies which are attached to the lower TF coil support brackets, will ride on these base slides in the radial direction while being restrained in the circumferential direction by the lateral load retainers which also will capture the spherical bearing housing base plate to insure no possible vertical displacements if the machine is ever subjected to seismic over-turning moments.

It is anticipated that subsequent to the station 5 pre-fit-up of the three field periods, appropriately sized shims will be fabricated to position the field periods in their proper vertical height based on the metrology results of the fit-up. These shims will be fitted between the top surface of the upper spherical bearing housing and the core interface connecting short column base plates.

2.4.4 Cryostat

The cryostat interfaces with the base supports at the upper connecting short columns which separate the 6 spherical bearing assemblies from the TF coil support brackets and MCWF shell mounts. This is also the transition point from 77 K to room temperature. Cryostat seals must be provided around/above these penetrations. An interface is also required for the cryostat support scheme.

2.4.5 Instrumentation

Thermocouples will be required at the top of each column to monitor the integrity of the cryostat seals and the thermal isolation of the base structure from the cold stellarator core. Strain gages (12 total) will also be required at the column base outer flange surfaces to determine the load distribution, any potential bending, and to monitor any load re-distribution during cooldown and operations.

2.4.6 Grounding

The base support shall be electrically isolated from the cryostat and stellarator core and grounded to the test cell building steel.

2.4.7 Heaters

Heating elements will be provided with integral thermostatic control switches to maintain the base support columns at room temperature (50 to 80 F).

2.5 Documentation

The Primary documentation for the base support structure will be provided by the Pro-E CAD models and drawings. Documentation for procured parts such as stainless structurals and materials will require full certifications and specs from suppliers sufficient to properly establish the material chemistry and process history (ie. Full solution annealing of plates).

3 Quality Assurance Provisions

3.1 Purchased components and Materials

Receipt inspection of the pre-fabricated stainless structurals will be required.

Material certifications must be checked.

These checks should also include checks for compliance with straightness, flatness and warping tolerances as per ASTM A484 – Table 16, and relative magnetic permeability.

3.2 In-process Fabrication inspection

A visual weld inspection and acceptance criteria for all welds shall be shall be conducted per AWS D1.6 and PPPL Proc.# ENG-037.