

NCSX
Field Period Assembly (FPA) Station 1 Sequence Plan

NCSX-Plan_FPA1SEQ-00

March 9, 2006

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**Field Period Assembly Stage 1 Sequence Plan
(NCSX-PLAN-FPA1SEQ-00)**

RECORD OF CHANGE

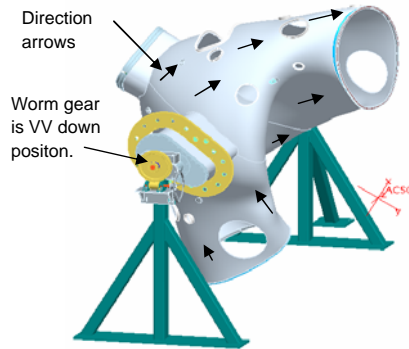
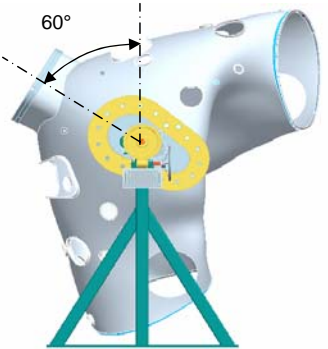

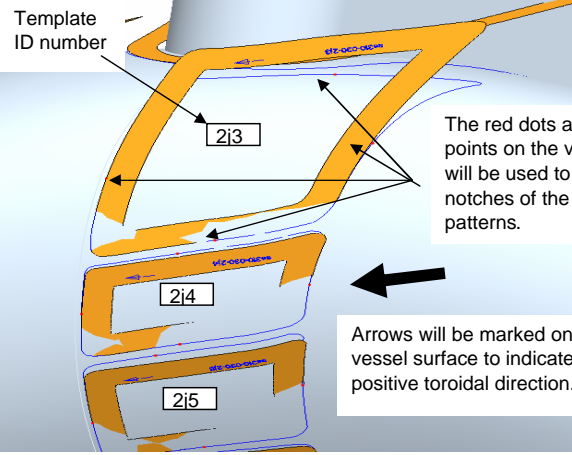
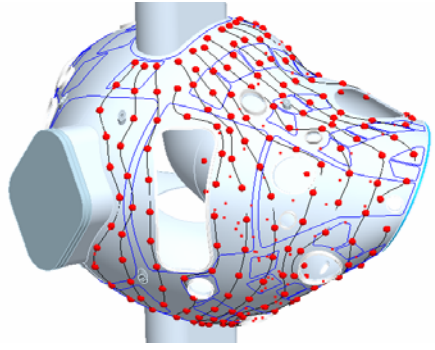
Revision	Date	Description of Change
0	3/9/2006	Initial release

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Stage 1 (Vacuum Vessel Preparation)

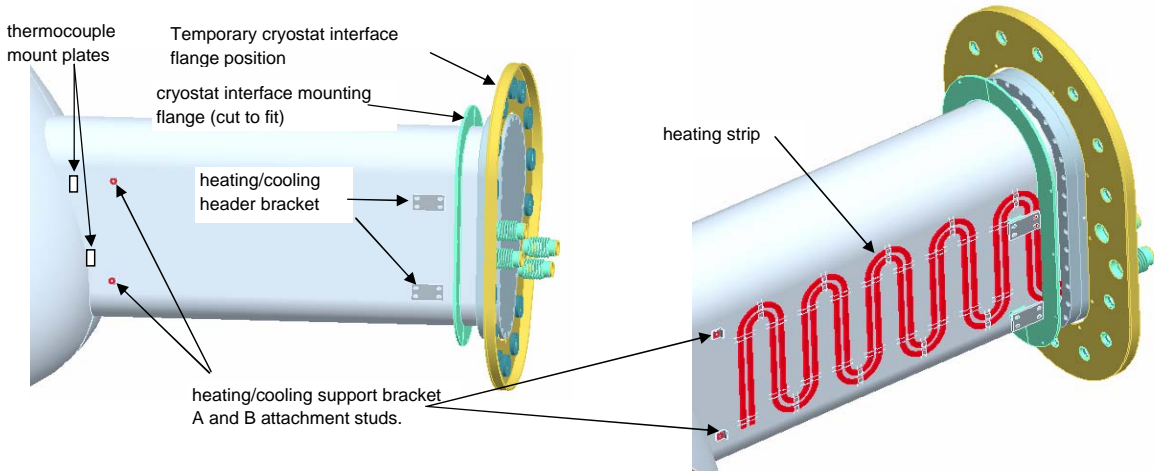
Item	Assembly Step	Comments
1.0	Receive VV and Inspect	Inspection Document: D-NCSX-FPA-QA1
1.1	Receive and perform visual inspection. Take metrology measurements. Resolve impact of out of tolerance conditions	Does it meet all specification and drawing requirements?
1.2	Verify all tooling ball locations with respect to MTM data and resolve any differences.	
1.3	Measure end flanges and compare with theoretical position. (practice for matching spacer)	
2.0	Replace port flange covers with Stage 1 assembly flanges	Reference drawing: se184-001
2.1	Remove two horizontal port flanges and hardware (if attached)	Horizontal ports have 32 bolt assemblies; bag hardware for future use
2.2	Remove NB port flange and hardware (if attached)	NB port has 34 bolt assemblies; bag hardware for future use. All sealing surfaces need to be protected
2.3	Slip VV heating/cooling cryostat interface flange over each vertical port.	The VV heating/cooling cryostat interface flanges need to be temporarily located on the vertical ports as the Stage 1 support fixture will inhibit there installation. Reference drawing: se123-164.
2.4	Attach Stage 1 port flanges.	The support axle Weldment and hoist rings should be preassembled to the vertical port flanges. It is assumed that the vessel will be cleaned at a later stage so vessel cleanliness is not an issue.
3.0	Check CG then mount on Prep fixture	Reference drawing: se184-001
3.1	Lubricate support axle and axle support cradle.	Add lubricate to the support axle Weldment and support axle cradle components (cradle top and cradle base) to reduce VV rotation friction.
3.2	Check VV CG	Using crane with attachment to hoist rings lift from a horizontal position and rotate vessel to a vertical position. Check to see if the part is in a near vertical position. Mark CG location.
3.3	Condition for resetting support axle Weldment	If CG is found to be off by a value greater than 2.0" return VV to its original position. Remove and relocate support axle Weldment to the proper CG location.
3.4	Mount VV on VV Prep fixture	Set VV on the Stage 1 Prep station support fixture in a horizontal position. Secure in place by bolting down support axle cradle top support blocks. Install quick release pin.
3.5	Install worm gear	Remove the hoist ring from the VV on the side with the worm gear support. Install worm gear axle Weldment and worm gear, engaging worm wheel.
3.6	Install	

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Item	Assembly Step	Comments
4.0	Metrology set-up and initial vessel settings	
4.1	Mark positive toroidal field direction	Using a marker mark the positive toroidal field direction on the front and back surface of the vacuum vessel. Note that the worm gear system is identified as the VV down direction. See figure below for field direction marking.
4.2	Set up measurement fiducials provided by MTM plus add additional monuments as specified in FP Dimensional Control Plan. Rotate vessel to convenient access positions	FP Dimensional Control Plan: NCSX-PLAN-FRAIDC Note that some monuments will be located on the body of the VV.
4.3	Perform a best fit to the fiducial measurements using the monuments on the VV body.	Settings will be made with the vessel NBI port at a +/- 60° off vertical position as indicated below. Secure vessel position by inserting release pin and tighten support axle cradle bolts. Verify that the mounting system is rigid enough to meet FP Dimensional Control Plan metrology requirements. Add additional bracing if required.
<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  <p>Direction arrows</p> <p>Worm gear is VV down position.</p> <p>Arrows mark toroidal field direction</p> </div> <div style="text-align: center;">  <p>60°</p> <p>60° off vertical position</p> </div> <div style="text-align: center;">  </div> </div>		
5.0	Magnetic loop and coolant line markings	FP Dimensional Control Plan: NCSX-PLAN-FRAIDC
5.1	Settings will be made with the vessel NBI port at a +/- 60° off vertical position	Secure vessel position by inserting release pin and tighten support axle cradle bolts.
5.2	Mark surface for 138 loop placement with the vessel NBI port at a +/- 60° off vertical position. It is expected that three Leica positions will be required on each side to accurately mark the vessel.	The Leica metrology system will be used to accurately define four marks (within +/- 0.040") for each of 138 loops except for the loops at the symmetry points which shall be positioned within +/- 0.010". The magnetic loop points shall be marked using an "X" to indicate the locating point. For ease of locating templates mark template number at the center of four points. See figure below.
5.3	Mark surface for coolant line stud placement with the vessel NBI port at a +/- 60° off vertical position.	The Leica metrology system will be used to locate 712 studs per half period at ~5" spacing. Fine accuracy is NOT important. The stud locations shall be marked with a circle with a name designation added (A1, A2, A3...) to define the stud series. An outline of the coolant hold-down bracket shall also be marked. See figure below and Reference drawing se121-008 sht. 4 for loop designation, point marking details.
<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;">  <p>Template ID number</p> <p>2i3</p> <p>2i4</p> <p>2i5</p> <p>The red dots are locating points on the vessel that will be used to align the notches of the loop flat patterns.</p> <p>Arrows will be marked on the vessel surface to indicate the positive toroidal direction.</p> </div> <div style="width: 45%; text-align: center;">  <p>Overlay of the coolant lines over the diagnostic loops with the red spheres indicating the size of the coolant line attachment brackets.</p> </div> </div>		

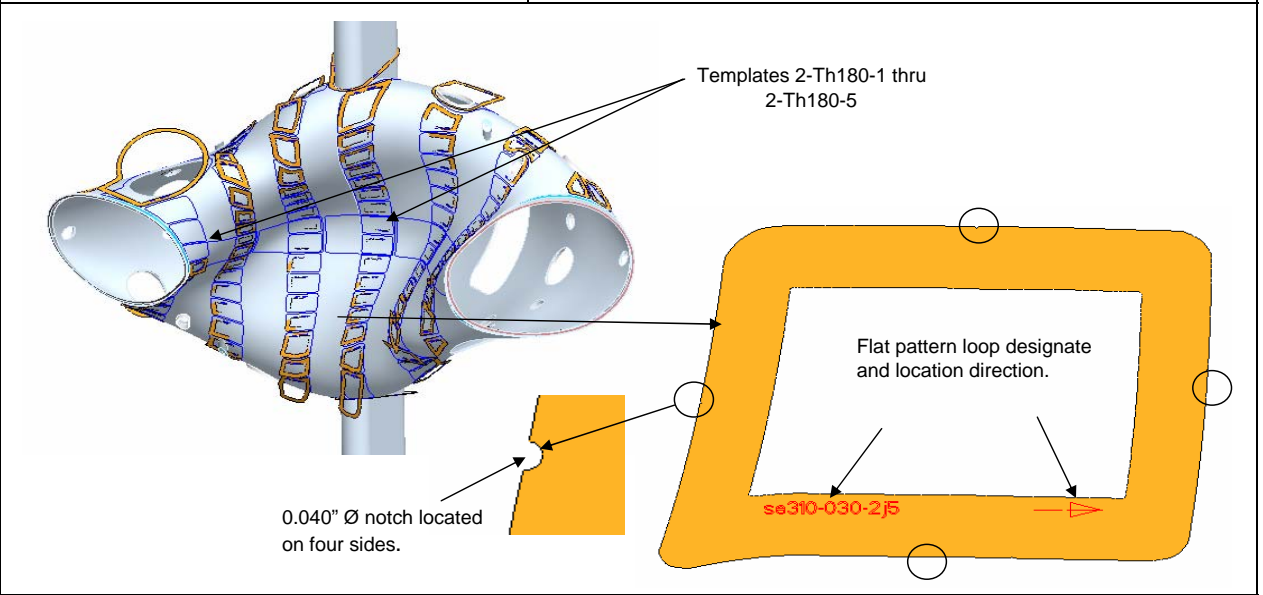
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Item	Assembly Step	Comments
6.0	Vertical port component installations	Reference drawings: se121-004, se121-008 and se121-009
6.1	Mark heating/cooling support bracket A and B attachment studs and mark bracket clip outline.	
6.2	Install cryostat interface mounting flange on vertical ports	Before welding the interface flange on the vertical ports the cryostat interface flange must be moved to the proper assembly position (see figure below).
6.3	Install cryostat interface flange on vertical ports	
6.4	Install heating/cooling header brackets	
6.5	Install thermocouple mount plates and thermocouples to VV vertical ports	Reference drawing: se121-004
6.6	Install heating strips on vessel vertical ports	



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Item	Assembly Step	Comments
7.0	Install magnetic flux templates and flux loops	Reference drawings: se121-004, se121-008 and se121-009
7.1	Rotate VVSA to convenient installation position for installing loop templates	Each loop template has four locating notches which shall be used to install loops to within ± 0.160 " of the marked locations, except for the loops at the symmetry points which shall be positioned within ± 0.020 ". The locating direction arrow should be aligned in the general direction of the positive toroidal field direction arrows marked on the vessel surface.
7.2	Template placement order	Templates 2-Th180-1 thru 2-Th180-5 need to be placed and the flux loop wires run before adjacent loops are placed because of local template interferences.
7.3	Install all remaining flux loop templates	Except for the above mentioned wire runs, all remaining templates shall be installed before any loop wires are run.
7.4	Mark vessel surface showing twisted pair leads path	
7.5	Install loop wires and then remove templates	A.) Use electrical color identifying code to mark wires as twisted wire leaves template, along its path and after it passes through the horse collar. B.) Lay I leads loosely to accommodate the installation of the H/C tube heat transfer bases. C.) Route excess lead lengths through the 2 3/4" CF and protect the excess length from damage.
7.6	Install voltage loops	



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Item	Assembly Step	Comments
8.0	Final loop measurement and H/C Installation	Reference drawings: se121-004, se121-008 and se121-009
8.1	Install H/C tube studs	The flux loops leads can be temporarily moved to facilitate this process
8.2	Attach H/C tube clamp hardware used for mounting coolant lines.	
8.3	Perform final flux loop lead tie down	Perform final routing of flux loop leads and hold down with spot-welded shim stock straps spaced approximately 4" apart. Note that the radial build of the twisted leads should not exceed 1/8", except in a few places (not under H/C tube paths) where it may be necessary for one set of leads to cross another.
8.4	Install remaining thermocouple mount plates and thermocouples to VV shell	Reference drawing: se121-004
8.5	Measure as-built paths of flux loops	Measure as-built paths of flux loops to within ± 0.25 mm (0.010"). This shall be done by tracing the groove between the two turns of each loop using a Laser Tracker probe with a small tip.
8.6	Install H/C tube support brackets	Install H/C support bracket Weldment A and B and tube mount strap. See figure below. Reference Drawing: se121-008
8.7	Secure H/C cryostat flange and H/C manifolds	See figure below. Reference Drawings: se121-008, se123-009
8.8	Install H/C flex tube	See figure below. Reference Drawings: se121-008, se123-009
8.9	Install H/C hard tubing	See figure below. Reference Drawings: se121-008, se123-009
9.0	Leak check coolant tubes	
9.0	Loop termination and verification check	
9.1	Final installation of twisted leads	A) Check continuity and resistance to ground of each pair. B) After H/C line bases are completed dress in cables and install hold down support.
9.2	Verify tagging and conductors	Verify tagging by physical check or use oscillator
9.3	Trim cable length	Cut excess length to 1 ft using diamond wheel to cut end flat
9.4	Install gas seal and partial junction box (JB)	A) Insert CF gasket. B) Route cables thru predrilled holes in CF blank. C) Route cables thru pre punctured holes of silicon rubber gasket. D) Route cables thru predrilled holes in JB base. E) Install CF threaded fasteners thru the JB base and torque to get metal to metal contact between JB base and CF ring. F) Check the cable configuration and condition in cryostat region.
9.5	Terminate cables	A) Determine length to terminal box (TB). B) Flat cut cable with diamond wheel. C) Strip back sheath with tool provided leaving xxxx of conductor exposed. D) Clean MgO from conductor. E) Apply moisture barrier seal to MgO. F) Install Teflon heat shrink tubing (4:1).
9.6	Strain relieve cables	Strain relieve cables inside JB using spot welded SS shim stk
9.7	Connect Cables to TB	A) Install TB/circuit boards into front panel of JB. B) Install conductors into TB.
9.8	Complete JB Assembly	A) Complete JB assembly. B) Add RF protection.
9.9	Protect D sub Connector	Place protective cover over the D Subminiature connector

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Item	Assembly Step	Comments
10.0	Prepare and transfer completed VV to holding area	
10.1	Install NB angle support bracket	This is done while the completed vessel is on the support stand. The temporary cover may be installed during step 2.4 if it has been fabricated. The NB angle support bracket can also be install at this stage.
10.2	Set for VV removal	Rotate VV to horizontal position. Secure in place by bolting down support axle cradle top support blocks. Install quick release pin. Remove worm gear and instal hoist ring.
10.3	Remove completed VV from support stand	Lift VV with crane and reposition to a vertical position with the worm gear side of the vessel in the down position.
10.4	While on the crane install base support plate	see figure below
11.0	Mount completed VV (period 2) on Stage 3 stand	see figure below.
11.1	Perform metrology alignment to orient the VV on Stage 3 stand.	Details of this step will be defined at a later time.

