**Cryomodule 2 Interconnect Installation Procedure**

V5.1/ 08 June 2012 / C. Baffes

Based on Version 4.4 / 07 June 2012 / A. Martinez and A. Klebaner

This is the procedure for installing Cryomodule 2 (RFCA002) in position CM1. The order of operations given here is influenced by a number of factors, including

* Current configuration of building and system
* Desire to start with easier-to-rework endcap welds
* Leak checking of the feedcap and endcap after CM1 removal was complicated by high helium backgrounds in the feedcap. As such, all endcap interconnect welding and leak checking is completed first to avoid this background

**Order of Operations**

1. Endcap welding and leak checking
	1. Valve configuration
	2. Install and weld gradient temperature sensor cables
	3. Weld Line B transition fittings
	4. 2K line welding
		1. Line H – warmup/cooldown
		2. Line G – 2K supply
		3. Line B – 2K return
	5. 2K line leak-checking
	6. 5K line welding
	7. 5K line leak-check
	8. 80K line welding
	9. 80K line leak-check
2. Endcap insulating vacuum work
	1. Route and terminate gradient temperature sensor cable
	2. Close endcap insulating vacuum
3. Feedcap welding and leak checking
	1. Valve configuration for welding
	2. 2K line welding
		1. Line H – warmup/cooldown
		2. Line B – 2K return
		3. Line G – 2K supply
	3. 5K line welding
	4. Valve configuration for leak checking
	5. 2K and 5K circuit pressure/leak testing
	6. 80K line welding
	7. Valve configuration for leak checking
	8. 80K circuit pressure/leak testing
4. Super-insulation and insulating vacuum work
	1. Install super-insulation and thermal shields
	2. Close feedcap insulating vacuum

**General Notes and Requirements**

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1. In-Process Inspection to be performed on all interconnect welds. In-process inspection forms shall be filled out by the person overseeing the fit up and welding process (Inspector). One form is to be filled out for each weld. A blank copy is attached at the end of this document.
2. Each weld shall be stamped with the welder ID
3. All lines shall be properly cleaned prior to fit up of interconnect pieces
4. Verify that Welding Procedure Specification (WPS) is in place for all welds to be made on the interconnects. Obtain a written copy
5. Verify welder is qualified to perform specific welding according to B31.3 Code rules (PQR). Obtain a written copy.
6. Record all relevant leak check data within this procedure.
7. Verify that all feedcap, endcap, and cryomodule sensors have been properly shorted before each welding operation. Be aware that work proceeding in parallel may result in shorting plugs being removed.
8. Any deviation from the procedure shall be agreed upon by the Lead Engineer and the Task Manager and documented in the comment section at the end of this report.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Task Manager (Welding) Date

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Task Manager (Leak Checking) Date

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Lead Engineer Date

**1 Endcap welding and leak checking**

1.1 Valve configuration

1. Open MV-892-H (to equalize conditions across DP90)
2. Close MV-891-H and MV-890H (to isolate endcap reservoir)
3. Open MV-894-H and MV-893-H (to vent transducer lines)
4. Blank off line leading to SV-895-H with pressure-capable flange (5K circuit)
5. Close MV-895-H (5K circuit)
6. Close MV-892-N (80K circuit)
7. (feedcap valves do not participate in this portion of the work)

Performed by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Verified by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**1 Endcap welding and leak checking**

1.2 Install and weld gradient temperature sensor cables

1. Insert cable assembly into the endcap 300mm flange
2. Bend cable as necessary to accomplish approximate preliminary routing

In order to avoid percolation effects, cable must run:

* horizontal or uphill from the transition flange to the 5K shield intercept
* uphill from the 5K shield to the 80K shield intercept
* downhill to interface flange only after the 80K shield intercept
1. Mate 12-pin hypertronics connectors inside 300mm pipe
2. Fit up 5K and 80K thermal shield, determine locations of any cutouts required. It must be possible to install shields around the cable after cable assembly is terminated
3. Implement any cutouts required in shield
4. Perform checkout of temperature sensors per “Cryomodule 300mm Helium Return Pipe RTD Installation/checkout procedure

Performed by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Result \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Use wire nut to short pigtail ends of cable assembly together. This shorts all gradient sensor RTDs

Performed by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Verified by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Confirm that all cryomodule and feedcap/endcap electrical connectors are shorted

Verified by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Insert wet rag into cable assembly cup to protect cable from weld heat
2. Confirm that all wires inside 300mm pipe are far from the area to be welded and will not be damaged by weld heating
3. Close off the large 6” openings at the upstream and downstream ends of the cryomodule line B. Establish an Argon purge, and purge until the oxygen concentration at the welding area falls below 0.2%
4. Weld the gradient temperature sensor cup to the transition flange around its circumference
5. Repeat RTD checkout procedure

Performed by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Result \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Use wire nut to short pigtail ends of cable assembly together.

Performed by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Verified by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Cable welding complete

Verified by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**1 Endcap welding and leak checking**

1.3 Weld Line B transition fittings

1. Confirm that all wires are away from area of Dia. 300mm weld interface. Cool cable cup and closest wires with a damp rag.

Performed by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Verified by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Confirm that all cryomodule and feedcap/endcap electrical connectors are shorted

Verified by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Close off the large 6” openings at the upstream and downstream ends of the cryomodule line B. Establish an Argon purge, and purge until the oxygen concentration at the welding area falls below 0.2%
2. Weld the downstream line B Dia. 300mm weld interface. Follow WPS and perform in-process inspections.
3. With purge still in place, weld the upstream line B Dia. 300mm weld interface. Follow WPS and perform in-process inspections.
4. Break purge in inspect interior of line B for weld quality and wire integrity

Performed by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Result \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Repeat RTD checkout procedure

Performed by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Result \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Use wire nut to short pigtail ends of cable assembly together.

Performed by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Verified by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Transition fitting welding complete

Verified by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**1 Endcap welding and leak checking**

1.4 2K line welding

1.4.1 Line H – warmup/cooldown

1. Compress bellows by the value given in the compression table
2. Measure and fit spool piece
3. Tack weld spool piece in place
4. Plug or blank off the following lines:

Line H on cryomodule upstream end (introduce purge here)

Line G on cryomodule upstream end

Line G on cryomodule downstream end

Line G on endcap

Line B on endcap (vent purge here)

1. Confirm that all cryomodule and feedcap/endcap electrical connectors are shorted

Verified by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Establish purge, and purge until the oxygen concentration at the highest point of the system falls below 0.2%
2. Weld the downstream line H. Follow WPS and perform in-process inspections.

1.4.2 Line G – 2K supply

1. Compress bellows by the value given in the compression table
2. Measure and fit spool piece (note that miter will be required)
3. Inspect CF flange interfaces to confirm that they are free from damage and likely to seal

Verified by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Seal CF flange interface to cryomodule
2. Tack weld spool piece in place
3. Plug or blank off the following lines:

Line H on cryomodule upstream end (introduce purge here)

Line G on cryomodule upstream end

Line B on endcap (vent purge here)

1. Confirm that all cryomodule and feedcap/endcap electrical connectors are shorted

Verified by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Establish purge, and purge until the oxygen concentration at the highest point of the system falls below 0.2%
2. Weld the downstream line G. Follow WPS and perform in-process inspections.

1.4.3 Line B – 2K return

1. Compress bellows by the value given in the compression table
2. Measure and fit spool piece
3. Tack weld spool piece in place
4. Plug or blank off the following lines:

Line H on cryomodule upstream end (introduce purge here)

Line G on cryomodule upstream end

Line B on feedcap (vent purge here)

1. Confirm that all cryomodule and feedcap/endcap electrical connectors are shorted

Verified by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Establish purge, and purge until the oxygen concentration at the highest point of the system falls below 0.2%
2. Weld the downstream line B. Follow WPS and perform in-process inspections.
3. 2K circuit endcap welding complete

Verified by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**1 Endcap welding and leak checking**

1.5 2K line leak-checking

1. Plug the following lines

Cryomodule Line G Feedcap end

Cryomodule Line B Feedcap end

Cryomodule Line H Feedcap end (install leak detector here if possible)

1. Perform leak check of all newly installed interconnects. No leaks shall be detected on the most sensitive scale of the leak detector with a minimum sensitivity of 10‐9 torr L/s.

Leak detector ID \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Background \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Result \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Notes:

1. Leak checking complete

Verified by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**1 Endcap welding and leak checking**

1.6 5K line welding

1. Compress line C and line D bellows by the amounts given in the compression table
2. Measure and fit spool pieces
3. Tack weld spool piece in places
4. Plug or blank off the following lines:

Line C on cryomodule upstream end (purge vent here)

Line D on cryomodule upstream end (introduce purge here)

1. Confirm that all cryomodule and feedcap/endcap electrical connectors are shorted

Verified by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Establish purge, and purge until the oxygen concentration at the vent falls below 0.2%
2. Weld the downstream line H. Follow WPS and perform in-process inspections.
3. 5K line welding complete

Verified by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**1 Endcap welding and leak checking**

1.7 5K line leak-check

1. Plug/seal the following lines

Cryomodule Line C Feedcap end

Cryomodule Line D Feedcap end

Cryomodule Line C mini-CF port (install leak detector here)

Cryomodule Line D mini-CF port

1. Perform leak check of all newly installed interconnects. No leaks shall be detected on the most sensitive scale of the leak detector with a minimum sensitivity of 10‐9 torr L/s.

Leak detector ID \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Background \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Result \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Notes:

1. 5K line leak checking complete

Verified by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**1 Endcap welding and leak checking**

1.8 80K line welding

**80K Supply – flanged spool installation**

1. Measure and record location of line E bellows relative to endcap. Sketch measurement and result below
2. Cut out line E bellows, trim squirm restraint per drawing requirements
3. Confirm that all cryomodule and feedcap/endcap electrical connectors are shorted

Verified by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Weld CF flange on endcap pipe per drawing requirements
2. Weld spool and CF flange on cryomodule per drawing requirements
3. Measure distance between newly installed CF flanges
4. Weld CF flanges to the bellows such that

-Free-length of assembly = flange-to-flange measurement + compression from table

-CF-to-squirm restraint distance is >=8mm to allow installation compression

1. Leak check bellows assembly
2. Install and seal flanged line E bellows spool piece

**80K Return – welded spool installation**

1. Compress line F bellows per compression table
2. Measure and fit required spool piece
3. Tack weld spool piece in places
4. Plug or blank off the following lines:

Line E on cryomodule upstream end (purge vent here)

Line F on cryomodule upstream end (introduce purge here)

1. Confirm that all cryomodule and feedcap/endcap electrical connectors are shorted

Verified by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Establish purge, and purge until the oxygen concentration at the weld area falls below 0.2%
2. Weld the downstream line F. Follow WPS and perform in-process inspections.
3. 80K line welding complete

Verified by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**1 Endcap welding and leak checking**

80K line leak-check

1. Plug/seal the following lines

Cryomodule Line E Feedcap end

Cryomodule Line F Feedcap end

Cryomodule Line E mini-CF port (install leak detector here)

Cryomodule Line F mini-CF port

1. Perform leak check of all 80K interconnects. No leaks shall be detected on the most sensitive scale of the leak detector with a minimum sensitivity of 10‐9 torr L/s.

Leak detector ID \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Background \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Result \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Notes:

1. 80K line leak checking complete

Verified by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**2 Endcap insulating vacuum work**

2.1 Route and terminate gradient temperature sensor cable

1. Remove 6” CF flange from relief/instrumentation port
2. Install CF Reducing Tee and re-install relief per drawing requirements
3. Feed wires through adapter assembly, and terminate at connector. Note that all copper gaskets must be installed and captive at this point.
4. Repeat RTD checkout procedure

Performed by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Result \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Seal all CF flanges in the feedthrough assembly
2. Install 32 pin shorting plug on warm connector
3. Gradient sensor routing complete

Verified by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**2 Endcap insulating vacuum work**

2.2 Close endcap insulating vacuum

1. Inspect insulating vacuum o-rings and sealing surfaces

Performed by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Result \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Close and seal endcap insulating vacuum
2. Endcap work complete

Verified by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**3 Feedcap welding and leak checking**

3.1 Valve configuration for welding

1. Maintain endcap valve states as defined in 1.1
2. Need input from Jerry M. for feedcap config

Performed by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Verified by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**3 Feedcap welding and leak checking**

3.2 2K line welding

3.2.1 Line H – warmup/cooldown

1. Compress bellows by the value given in the compression table
2. Measure and fit spool piece
3. Tack weld spool piece in place
4. Plug or blank off the following lines:

Line G on cryomodule upstream end

Line B on cryomodule upstream end (vent purge gas here)

1. Confirm that all cryomodule and feedcap/endcap electrical connectors are shorted

Verified by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Copied from CM1 procedure. Need input from Jerry M. Provide argon purge by connecting argon source to the 5K helium supply transfer line connection at the Feed Box. PVCD on the Feed Box will need to be open to provide flow to the welding area. All other Feed Box valves should be closed. Monitor oxygen level. When oxygen level is less than 0.2% as measured from the highest point, proceed. (Note, in order to reduce the time it takes to purge to the proper oxygen level, the circuit can be pumped and backfilled several times with argon prior to establishing the argon purge mentioned above).
2. Weld the upstream line H. Follow WPS and perform in-process inspections.

3.2.2 Line B – 2K return

1. Confirm alignment between flanges, adjust bellows restraint as required
2. Measure and fit spool piece
3. Tack weld spool piece in place
4. Plug or blank off the following lines:

Line G on cryomodule upstream end

1. Confirm that all cryomodule and feedcap/endcap electrical connectors are shorted

Verified by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Copied from CM1 procedure. Need input from Jerry M . In preparation for welding, provide argon purge by connecting argon source to the 5K helium supply transfer line connection at the Feed Box. The purge will be vented through the pumping header open connection on the cave roof above the Feed Box. This port will need to be partially sealed with only a port to allow purge gas to vent. PVCD and PV2K on the Feed Box will need to be open to provide an open path for the purge to vent. Cap the Line G circuit on both the Feed Cap and End Cap end of the Cryomodule with Conflat blank‐off flanges. Monitor oxygen level at the vent. When the oxygen level is less than 0.2%, proceed. (Note, in order to reduce the time it takes to purge to the proper oxygen level, the circuit can be pumped and backfilled several times with argon prior to establishing the argon purge
2. Weld the upstream line B. Follow WPS and perform in-process inspections.

3.2.3 Line G – 2K supply

1. Compress bellows by the value given in the compression table
2. Measure and fit spool piece
3. Inspect CF flange interfaces to confirm that they are free from damage and likely to seal

Verified by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Seal CF flange interface to cryomodule
2. Tack weld spool piece in place
3. Confirm that all cryomodule and feedcap/endcap electrical connectors are shorted

Verified by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Copied from CM1 procedure. Need input from Jerry M In preparation for final welding of Line G, provide argon purge by connecting argon source to the 5K helium supply transfer line connection at the Feed Box. PVJT, PVCD and PV2K on the Feed Box will need to be open to provide flow to the welding area. All other Feed Box valves should be closed. The purge will be vented through the pumping header opening on the cave roof. Monitor oxygen level. When oxygen level is less than 0.2% as measured from the highest point, proceed. (Note, in order to reduce the time it takes to purge to the proper oxygen level, the circuit can be pumped and backfilled several times with argon prior to establishing the argon purge mentioned above).
2. Weld the upstream line G. Follow WPS and perform in-process inspections.
3. 2K circuit feedcap welding complete

Verified by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**3 Feedcap welding and leak checking**

3.3 5K line welding

1. Compress line C and line D bellows by the amounts given in the compression table
2. Measure and fit spool pieces
3. Tack weld spool pieces in places
4. Confirm that all cryomodule and feedcap/endcap electrical connectors are shorted

Verified by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Establish Argon purge/vent through the mini-CF flanges on lines C and D. When oxygen level is less than 0.2% at the vent, proceed.
2. Weld lines C and D. Follow WPS and perform in-process inspections.
3. 5K line welding complete

Verified by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**3 Feedcap welding and leak checking**

3.4 Valve configuration for leak checking

1. Close endcap valves MV-893-H and MV-894-H (un-vent)
2. Open valves MV-890-H and MV-891-H (brings PT190, PT191 into volume under test)
3. What should MV-892-H be?
4. Need input from Jerry M. for feedcap config

Performed by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Verified by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**3 Feedcap welding and leak checking**

3.5 2K and 5K circuit pressure/leak testing

1. Install hose across unwelded lines E and F
2. Attach leak detectors to insulating vacuum, at each end of the cryomodule
3. Close insulating vacuum, evacuate volume
4. Establish stable background on leak detector

Leak Detector ID Location Initial Background

\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Step into pressure test permit/procedure here
2. Record any leak detector data and notes here
3. 5K line leak check complete

Verified by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**3 Feedcap welding and leak checking**

3.6 80K line welding

1. Compress line E and F bellows per compression table
2. Measure and fit required spool piece
3. Tack weld spool piece in places
4. Plug or blank off the following lines:

Line E mini CF flange (purge vent here)

Line F mini CF flange (introduce purge here)

1. Confirm that all cryomodule and feedcap/endcap electrical connectors are shorted

Verified by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Establish purge, and purge until the oxygen concentration at the weld area falls below 0.2%
2. Weld the upstream lines E and F. Follow WPS and perform in-process inspections.
3. 80K line welding complete

Verified by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**3 Feedcap welding and leak checking**

3.8 80K circuit pressure/leak testing

1. Attach leak detectors to insulating vacuum, at each end of the cryomodule
2. Close insulating vacuum, evacuate volume
3. Establish stable background on leak detector

Leak Detector ID Location Initial Background

\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Step into pressure test permit/procedure here
2. Record any leak detector data and notes here
3. 80K line leak check complete

Verified by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**4 Super-insulation and insulating vacuum work**

4.1 Install super-insulation and thermal shields

1. Install super-insulation on 2K and 5K lines
2. Install 5K thermal shields
3. Thermally intercept gradient sensor cable to the 5K shield
4. Install super-insulation over 5K thermal shields
5. Install super-insulation on 80K lines
6. Fit up 80K shield, implement notching as required for enlarged line E flanged interconnect
7. Install 80K shield
8. Route gradient temperature sensor cable through 80K shield, thermally intercept it to the shield
9. Complete super-insulation work
10. Super-insulation complete

Verified by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**4 Super-insulation and insulating vacuum work**

4.2 Close feedcap insulating vacuum

1. Confirm that all tools, scrap, and spurious material is out of the insulating vacuum.
2. Confirm cleanliness of O-rings and O-ring grooves
3. Close insulating vacuum
4. Procedure complete

Verified by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Bellows Compression Table**

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