



ENG-033 - CRR - CHIT RESOLUTION REPORT

NSTX-U Midplane Wire-Seal Flange Repair CHIT Resolution Report

NSTXU_1-4-1-22-3_CRR_100

Work Planning #: **3063**
Effective Date: **01/07/2020**
Prepared By: **Justin Bradley**

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|--------------------|---------------------------------------|---------------------------|
| Reviewed By | Robert A. Ellis, Responsible Engineer | 01/06/2020 17:54:03 PM |
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National Spherical Torus eXperiment Upgrade

NSTX-U Bays I, H, and F Diagnostic Wire-Seal Flange Repairs

CHIT Resolution Report

January 6th, 2020

NSTXU_1-4-1-22-3_CRR_100

Robert Ellis

Prepared By: Responsible Engineer

Yuhu Zhai

Reviewed By: Project Engineer

Tim Stevenson

Approved By: Chief Engineer



Seal Repair Structure

Record of Changes:

| Rev. | Date. | Description of Change |
|------|------------|--------------------------|
| 0 | 01/06/2020 | Initial Revision Drafted |
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Disposition Key:

3

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A = Actionable
NA = Not Actionable
O = Out of Scope
R = Redundant

CR-DIA-01 - Flange Supporting Stays

| Review | ID | CHIT |
|-------------|---------|---|
| Project CDR | SRCDR01 | Recommend adding some temporary stays to the vessel wall to be used when reinstalling the flange. |

R- The welding plan being implemented for reinstalling the replacement flanges will use temporary mounting clamps to hold the flange in place when welding. This is something that welders, and the welding engineer, will decide the best approach in the field, the most recent Drafts of the replacement procedure can be found [Here](#).

Commented [1]: Justin, could you provide a link to the welding plan? as reference.

Commented [2]: Inquiring with Morgan Styer whether a standard welding plan already exists for welding on wire-seal flanges for NSTX-U. If not, the welding plan may be tentative on the removal of the existing flanges and evaluation of the out-of-roundness of the Nozzle tubes that the new flanges would be welded too.

Commented [3]: Added Link to Replacement Procedure Folder

CR-DIA-02 - Leak-Check Nozzle Sealing

| Review | ID | CHIT |
|-------------|---------|---|
| Project CDR | SRCDR02 | The leak checking fixture is such that air pressure will try to open up the sealing putty. Can the putty be put on the side where the vacuum presses against it |

NA- Putty is already accessible from the inside of the vessel, which will be sucked in by the vacuum created by the vessel.

CR-DIA-03 - Nozzle Weld Loading

| Review | ID | CHIT |
|-------------|---------|--|
| Project CDR | SRCDR03 | The leak checking step has a port-cover like object installed on the new flange; ensure that the stiffness of the port cover is representative of the stiffness of the diagnostic port cover. Otherwise, the test of the new welds will not be under representative pre-load stress. (for Mike Kalish) |

A- A new leak-checking fixture is being designed utilizing 2 plates to close the flange and nozzle and leak-check the weld after installation. The design will also allow the nozzle plate to function with any female port covers after installation for leak-checking the wire-seal itself after the

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mating diagnostic flange is bolted on. Given that the mating female port covers have to sustain the same vacuum pressure during standard NSTX-U operation that we intend to leak-check the replacement too; it is assumed that the stiffness of the leak-checking fixture ports is sufficiently representative of the same loading evaluated for the mating female diagnostic flange. The new Leak-Checking fixture design drawings and assemblies can be found [Here](#).

Commented [4]: Provide a statement that the stiffness of the port cover for the leak checking fixture is sufficiently representative so to close this chit

Commented [5]: Added.

CR-DIA-04 - Design Review Plan Revision

| Review | ID | CHIT |
|-------------|---------|---|
| Project CDR | SRCDR04 | Prior to obtaining the remaining signatures on the Design Review Plan, please complete the "Revision" and "Category" fields at the top of page 1. |

A- The form has been revised and completed as directed following the completion of the CDR.

CR-DIA-05 - Bays H & F Work Scope

| Review | ID | CHIT |
|-------------|---------|---|
| Project CDR | SRCDR05 | Decision needs to be made before PDR for the work scope of bay H&F. |

A- A peer review was held on 11/07/2019 evaluating the deformation metrology results for bays H & F. Upon review, it has been concluded and set-forward that the most sensible and cost-effective solution for restoring proper vacuum functionality is the complete removal and replacement of all the deformed male wire-seal flanges at the Midplane flange Bays I, H, and F.

CR-DIA-06 - Stiffening Ring Consideration

| Review | ID | CHIT |
|-------------|---------|---|
| Project CDR | SRCDR06 | Consider bolting a stiffening ring to the flange at the time of welding to prevent deformation. |

A- We are exploring the possibility of bolting a mating flange to the replacement flange at the time of welding to maintain its shape and roundness and minimize potential thermal stresses from welding. Discussions held with the NSTX-U welding Engineer Morgan Styer determined that this step likely is not necessary for maintaining roundness during welding; specifically due to the type of weld connection being made generating a controlled and localized heat-affected

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zone. Given that this does not affect the difficulty of performing the work it is being considered nonetheless; However, space constraints at each bay may prevent this from being implemented in certain instances.

Commented [6]: This may not be sufficient to close this chit. If not possible to implement this recommendation, shall mention that deformation due to welding is not an issue.

Commented [7]: Added wording stating the implementation of this CHIT was not necessary as per Morgan Styer's experience, but it can't hurt to do it if it is easy to do so, therefore, we will do it if possible.

CR-DIA-07 - Diametral Tolerance Stack-Up

| Review | ID | CHIT |
|-------------|---------|---|
| Project CDR | SRCDR07 | Tolerance analysis needs to be done to make it clear how the total tolerance (roundness, flatness) can be split between the flanges before and after welding. |

A- A drawing of the mated Male and Female wire-seal flanges was created for the peer review held on 11/07/2019 displaying the diametral stack-up of the mated flanges. At any given point on the diameter, there are 2 sets of surfaces between the Male and Female flanges that have a 0.0075" clearance, this totals up to 0.015" clearance between the 2 sets of surfaces. Propagating this across the diameter represents an acceptable diametral out-of-roundness of no more than 0.030" or ± 0.015 " at any given point on the diameter.

CR-DIA-08 - Rubber O-Ring Seal Consideration

| Review | ID | CHIT |
|-------------|---------|---|
| Project CDR | SRCDR08 | Investigate the possibility of using rubber o-ring seal instead of metal wire seal. |

R- The existing design and operation do not facilitate the implementation of a rubber o-ring seal. Thermal stresses and expansion present in operation would compromise the rubber o-ring. It was determined in the CDR that this CHIT was rejected due to being out of scope.

Commented [8]: Did we reject this chit?

Commented [9]: Yes this CHIT was rejected, I have modified the wording to clarify this.

CR-DIA-09 - Bay H & F Internal Metrology

| Review | ID | CHIT |
|-------------|---------|--|
| Project CDR | SRCDR09 | Consider getting the Bay H/F out-of-round data ASAP by running the Romer arm (Faro arm??) around the weld from the INSIDE. |

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A- Metrology was conducted on 10/23/2019 using the Romer arm to take readings from inside the vacuum-vessel. The Romer arm was mounted from the inside of the vacuum vessel and took readings along the Nozzle tube ID, Male-Flange ID, and Inner flange face.

CR-DIA-10 - Leak-Fixture Reinforcement

| Review | ID | CHIT |
|-------------|---------|---|
| Project CDR | SRCDR10 | Proposed arrangement for leak testing on slide 14 will bend the thread rod and potentially violently collapse the sealed cover. Suggest to beef up the holding bars shown in slide 14 and make full width cross beam. |

A- The new leak-checking fixture design will be supported by structural members inside the vacuum area holding the flange and nozzle plates from collapsing inwards onto one another, this transforms the loading from bending into compression on the supporting members. The new Leak-Checking fixture design can be found [Here](#).

CR-DIA-11 - Flange Heat-Break Evaluation

| Review | ID | CHIT |
|-------------|---------|--|
| Project CDR | SRCDR11 | Consider increasing the heat-break size or add additional one to minimize weld distortion. Consider enhancing heat dissipation method during welding to minimize distortion. |

A- A weld relief groove will be cut into the replacement flange for ease of welding. Heat dissipation methods such as heat-sinks were explored, however space constraints at the midplane flange bays do not permit the usage of heat-sinks or dispersion methods. A stitch welding plan will be implemented to allow the heat from welding to cool between stitch welds and minimize thermal deformation.

CR-DIA-12 - Rigid Test Flange Evaluation

| Review | ID | CHIT |
|-------------|---------|---|
| Project CDR | SRCDR12 | Consider using rigid actual flange for leak check as opposed to less rigid test fixture / flange. This will be a more realistic test of the seal. |

R- Revisions to the leak-checking fixture no longer require the usage of a Test Flange for vacuum pumping. A front plate, or the mating diagnostic flange will be used for leak checking on

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the vessel. It was determined at project CDR that this CHIT was rejected due to being out of scope.

Commented [10]: Did we reject this chit?

Commented [11]: Yes, modified wording for clarity.

CR-DIA-13 - Reinstall Marginally Deformed Flanges

| Review | ID | CHIT |
|-------------|---------|--|
| Project CDR | SRCDR13 | If measurements and indications are marginal with respect to the need for cutting off and replacing the flange consider the cost benefit for trying to seal by removing and reinstalling flange first as compared to going straight to the cutting and replacing the flange. |

A- Deformation measurements indicated values greatly in excess of the allowable ± 0.015 " acceptable range therefore none of the Midplane Flange bays can have their vacuum functionality restored by trying to re-mate the male and female flanges with a new wire-seal. Attempts to do so through port jacking pose additional fixture and personnel safety concerns and as such were deemed unsafe.

CR-DIA-14 - Ensure Job Schedule Accuracy

| Review | ID | CHIT |
|-------------|---------|--|
| Project CDR | SRCDR14 | Review cost and schedule with technicians and others who will be working the job for accuracy. |

A- A Baseline change proposal was submitted at the end of Nov. 2019 after reviewing and updating the schedule with the RE and test-cell technicians that would be completing this work.

CR-DIA-15 - Consider Lip-Seal Weld

| Review | ID | CHIT |
|-------------|---------|------------------------|
| Project CDR | SRCDR15 | Consider Lip Seal Weld |

NA- Standard commercially available Lip-Seal/Weld-Ring Gasket configurations require, at minimum 3, and upwards of 5 welds applied to install and operate. The cause of leaking and deformation at Bays I, H, & F have been identified as a result of welding related heat deformation; additional CHITS have been raised (see SRCDR11) regarding heat distortion when welding on the replacement flange. Given that implementation of a Lip-Seal/Weld-Ring Gasket would require, at minimum 3 welds; it is highly unadvised to implement a solution which

Commented [12]: Do we have a reference report on this?

Commented [13]: Added link to a reference report



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introduces undue thermal stresses into the vacuum vessel. Additionally, the introduction of a Lip-Seal/Weld-Ring Gasket would constitute a change to the initial design and would require both design verification and analysis, of which the project does not have the time nor funds allocated for. Additional Research into this topic can be found [Here](#).

CR-DIA-16 - Expand Schedule Detail

| Review | ID | CHIT |
|-------------|---------|---|
| Project CDR | SRCDR16 | Need a more detailed schedule with bays H & F included. |

A- An updated schedule with greater detail was submitted under a baseline change proposal at the end of Nov. 2019. An up to date schedule can be found [Here](#).

Chit Resolution Report:NSTXU 1-4-1-22-3 CRR 100

List of chits closed in this report on the cover, details inside the report

Attach total log of chits, including all those previously closed and those not yet closed.

Cognizant Individual: _____ (sign and date)

Approver (*): _____ (sign and date)

(*) Up to and included FDR the DRC, after FDR the Main Approver (A-1: Chief Engineer, A-2 and A-3: DRC) DRC
=Design Review Chairperson