Test Results for Evaluating Welding of Reinforcement Brackets to the Existing Passive Plate Support Brackets

Vacuum Vessel

CAT. A-3
NSTX-U-REC-166-00
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1. Test Purpose

The passive plate mounting brackets are not stiff enough to adequately support the passive plates during normal operation. Therefore supplementary stiffener brackets are being added, to strengthen the passive plate mounting brackets. These brackets are being designed to be welded to the passive plate mounting brackets.

Complicating matters is the fact that although all twenty-four brackets originally had the same design, weld distortion during installation, and/or distortion caused during operation has distorted the mounting brackets. This has caused some of the components in the individual mounting brackets to become bent or otherwise misaligned with respect to other components in the mounting bracket. These changes have resulted in no two brackets being quite the same.

The primary purpose of the testing is to evaluate how much welding will distort the brackets.

This record documents the results for test plan, NSTX-U-PLAN-034-00.

2. Test Condition

2.1 Test Date

The weld testing was conducted over a period of a month from April 8th to May 3rd.

2.2 Test Equipment

- GTAW welder with EN 12072 WZ 20 16 3 Mn NL at ER 316L filler material
- Permeability Tester
- Feeler gauges
- Protractor
- Various right angles blocks
- Air hammer

2.3 Test Sample

The test samples are the two brackets and test stand.

2.4 Test Preparation

Complete manufacturing of brackets and test stand.

This was completed as outlined below:

- Weld assembly of the test stand C-DB1501 (1)
- Weld assembly of two sets of the two designs of 316L weld test brackets C-DB1502 & C-DB1503 (1)
    - Set one done with larger fillet radius, as well has ER 316L filler material.
    - Set two done with smaller fillet radius along with EN 12702 LN filler material.
- Welding of weld test brackets (2) to test stand (1)

3. Test Procedure

For the complete test procedure, refer to document NSTX-U-PLAN-034-00

4. Test Results

The welding of the test stand was completed without issue (Figure 1).

Figure 1: Completed test stand C-DB1501

The initial welding of the test brackets resulted in some distortion and higher permeability. This was due to the combination of larger ¼” fillet welds as well as use of 316L filler rod. Placed next to a right angle block, the test brackets were visibly pulled away from flat by the large heat generated by the larger fillet weld.

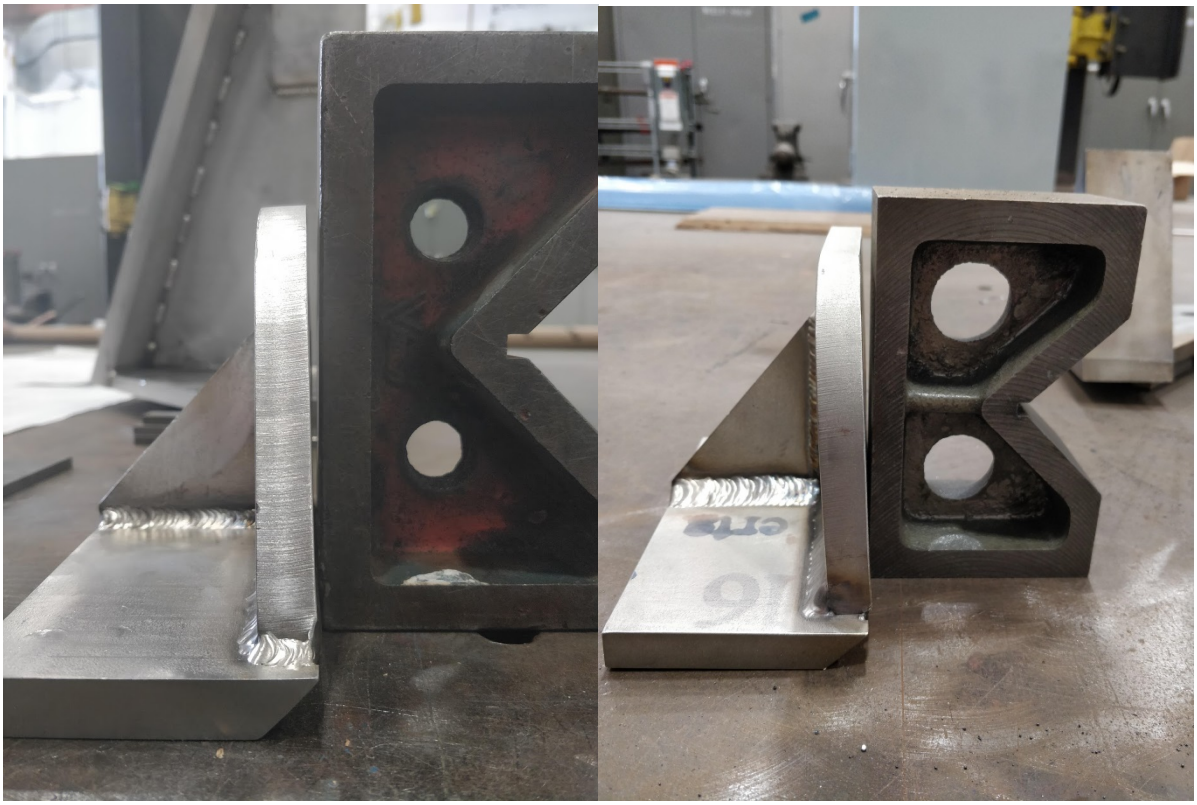
Figure 2: Initial test brackets, 1/8” fillet with bevel left, ¼” fillet right

The second sets of brackets were welded with 1/8” fillets on a bevel groove. This helped improve the right angle straightness of the part. The filler material used was of LN type, and the parts consistently returned a permeability of 1.2 or below over all surfaces including the weld areas.

As the first set of brackets (304) has higher distortion, they were not used on the test stand. The first welding of the second set of brackets (316L) to the test stand as defined in test procedure NSTX-U-PLAN-034-00 (with 1/8” fillets) was completed. Significant gaps were found (0.045”) when using feeler gauges between the free bracket surface and the test stand. The horizontal biscuit brackets have a spacer, the spacer blocks were welded with 1/8” fillet but this resulted in weld overlap as the spacer is quite small.

Figure 3: First trial of weld to test stand

The brackets were removed from the test stand via grinding, and a new weld test was conducted again with the same brackets, with special attention directed to changing the spacer welds from 1/8” to 3/16” along with heavy tack welds on the backside.

Figure 3: Spacer block weld on test stand (final). Upper weld changed to 3/18”

Weld sequencing was also optimized to reduce heat distortion of the parts. The welds were also peened using an air hammer. Use of an air hammer in NSTX is not allowed due to serious hearing damage concerns. This step shall not be part of the final

process.

The new weld sequencing resulted in a lower gap (0.020”). Inspection of all welds was conducted and all welds were of good quality. The complete assembly was checked for magnetic permeability and resulted in a consistent value of 1.2 or below.

Figure 4: Second trial of weld to test stand

The results of the angle and permeability measurements as defined in test procedure NSTX-U-PLAN-034-00 are below:

Drawing Number	Data from Step II	Data from Step III	Data from Step V	Data from Step VI
C-DB1502	91°			89°
	90.5°			90°
	90.5°			91°
C-DB1503		18.0°	18.0°	
		18.0°	18.0°	
		18.5°	18.5°	

Data Pre-weld on test stand

Drawing Number	Data from Step II	Data from Step III
C-DB1502	91°	
	90.5°	
	90.5°	
C-DB1503		18.0°
		18.0°
		18.4°

Data Post-weld on test stand

Drawing Number	Weld Location in the drawing	Magnetic Permeability μ
C-DB1501	1.2 μ	1.2 μ

5. Summary and Conclusions

There are some clear lessons learned from this weld test:

- For the brackets themselves, 1/8” fillet with bevel filler groove is preferred over ¼” and no filler groove.
- Filler material used for bracket to NSTX installation should be EN 12702 LN to ensure permeability is consistently low in the welds.
- The brackets with horizontal biscuit cut outs feature the spacer block. It was clear switching to a 3/16” weld fillet for the block would ensure no weld overlap. However, the spacer block will grow in height due to other findings and this should eliminate the issue.
- The straightness of the brackets using the lessons learned is considered satisfactory. The angle tolerance for C-DB1502 is at worst +1.0° pre welding on the stand, and identical afterwards. For C-DB1503 the angle tolerance is at worst -0.3° prior to welding on the stand, and almost identical afterwards. The total change (pre-weld to post weld) is negligible, with a maximum change of 0.1° for only one measurement made on C-DB1503.
- The permeability was acceptable for all welds.