National Radio Astronomy Observatory
Antenna Barn Inspection Memo Series – No. 1

Steven Tran

INSPECTION REPORT – VLA Site, July 18 – Sept 26, 2023

ENGINEERING INSPECTION

Work Summary

Engineers from engineering services at the VLA site worked in pairs to complete a structural inspection of the antenna assembly building, also known as the antenna barn. This was to understand and record the current structural integrity of the antenna barn.

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Introduction

Due to the age and surrounding environmental conditions of the structure, a structural inspection to determine and record the structural integrity was needed. All inspections completed in the past by internal and external groups were undocumented about the structural integrity. With the high-speed winds and sporadic downpours at this location, deterioration of the fasteners and structural members is expected over long periods of time. This report will cover a brief overview of what was found, accomplished during the inspection, and actions or concerns that should be completed or revisited.

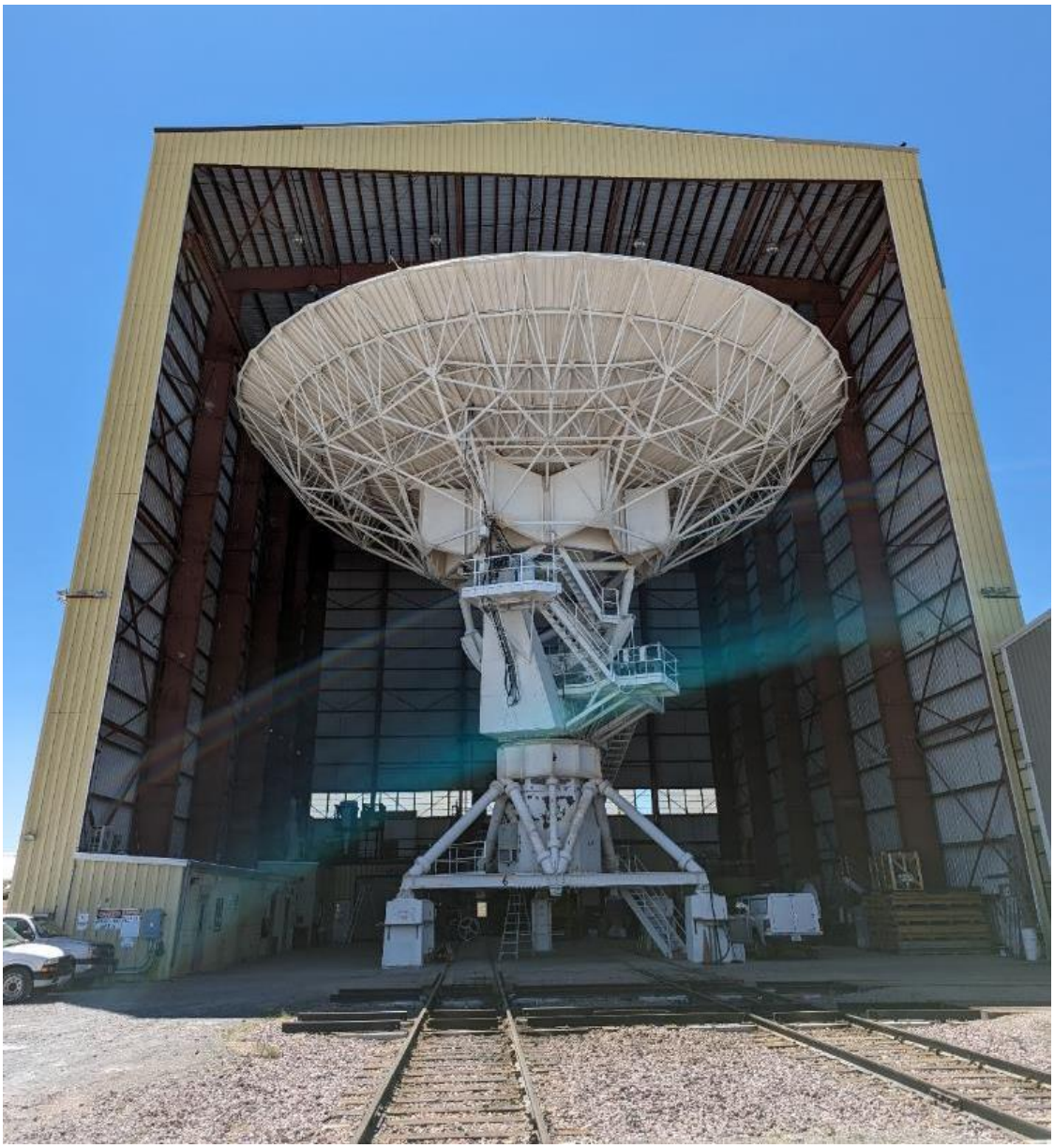

Figure 1: North entrance view of antenna barn

Priority List

The table below contains items that still need to be fixed or re-visited in the future. From lowest to highest priority, the respective color goes from green to light green to yellow, and finally red. There are no remaining items with enough concern to be rated as a red priority.

Table 1: Antenna Barn maintenance items to fix or re-visit

Item Number	Item / Member	Priority	Location(s)	What to fix or re-visit	Relevant Page(s)
1	Cross rods		R-B5	Cross rod member is no longer attached	13-14
2	Flange braces		Along roof truss 6	Loose & damaged bolts	12-13
3	1'' bolts		Bolt 18 (1b), bolt 3 (12b)	Heavily corroded and short bolts	7
4	Roof		Confirmed areas: above column 14, R-A2, R-D5	Rain leaking through roof holes or gaps	17-18
5	1'' bolts		6e	Column section with loose bolts pre-inspection	6-7
6	Window panels		Under 10b (And 7b)	Missing and damaged panels	18
7	¾'' bolts		7d – 10d	Loose & missing bolts pre-inspection	8-9
8	1'' bolts		Bolts 6 & 7 (4c)	Slightly loose bolts pre-inspection	7
9	Foundation		8a	Foundation crack under column	11-12
10	Columns		14d	High corrosion	16-17
11	Columns		Ladder, 11b, 12c, 16c	Clean debris build up from animals	6

Brief Terminology Overview

Findings in the report uses a condition state (CS) system to classify its concern level, where the rubric and examples can be found in appendix A on page 26. In short, CS1 is seen as normal, CS2 as something out of the ordinary but not alarming, CS3 as a larger concern, and CS4 as an emergency.

There are two main location referencing systems: One for the main column bolting sections, and one that covers the barn in grids. More detailed explanations and examples of all reference systems can be found in appendix A on page 20. Column bolting sections will be referred with a number and lowercase letter, representing the column and height it's located at. 6b would be the 6th column from left to right, starting on the east wall, and b would indicate the 2nd section from the bottom. Grid references typically start with the wall direction, followed by height, and distance from left to right. W-D3 would be the area on the west wall, 4 panels high, and 3rd from the left.

Figure 2: Inside view of Antenna Barn facing east wall with 6 columns.

The main members inspected were the 16 columns running vertically along the barn. Engineers performing the inspection would utilize a manlift to assist in observing for compromised members and abnormalities. If any bolts appeared to be in a suspicious condition or were quick to reach, a minimum of one bolt in that section were torqued to spec.

Figure 1: Typical column bolting section (12b)

To prevent bolts from loosening, they have to be tightened with enough preload. Typical column bolts were determined to be 1''-8 x 3¼'' A325 zinc coated bolts, which required 450 ft lbs. of torque to satisfy recommended preload. The torque required for other structural bolts of different sizes can be found in table A3 on page 30. The typical bolt tested has rotated 0-5 degrees, confirming that these bolts had previously been pretensioned to the equivalent of about 450 ft-lbs or higher. This falls within the tabulated torque ranges from multiple online sources for coated A325 fasteners seen in table A3.

Figure 2: Image of bolts with zinc coating (11c)

The overhead crane and antenna if present, can interfere with accessibility when using the manlift. The overhead crane usually prevents access to bolting sections d or higher, and the antenna will reduce access for higher sections in columns 1, 2, 15, and 16. Below shows the difference in room for maneuverability when the antenna is tilted and not tilted.

Figure 5: Left – Antenna before tilting. Right – Antenna after tilting.

Summary of Structural Inspection Findings

The antenna barn structure contains 16 main columns, with the east and west wall columns jointed by roof trusses. Including the anchor bolt sections, columns on the east and west wall have 5 bolting sections and 1 shared section, while the south wall columns have 4 bolting sections. There are multiple types of auxiliary support members that help distribute loads, while keeping the members and panels connected. The members identified include cross rods, X-braces, V braces, horizontal tube braces, flange braces, sag rods, purlins, and girts that run along the walls. Appendix A on page 20 shows the typical location for these different members.

Figure 6: Top – Typical debris found (10b). Bottom – Non-typical debris found (16c).

Main Bolting Sections

The majority of bolt sections passed torque check or visual inspection requirements to be qualified as CS1. Connections in 6e and 7d-9d classified as CS2, and the connections in section 10d as CS3. Section 6e was the only 1'' bolt section with concerningly loose bolts, with bolts requiring more than a full rotation before clicking. Some south column sections such as 7c had "loose" notation written nearby, but were already tightened and thread stick out appeared to be even across bolts. Column sections 7d-10d had many loose bolts, and a missing bolt at 10d. Visible gaps at column sections weren't concerning or uncommon, and usually contained tight bolts. Many of the visible gaps like

those found in figure 8, had likely formed during construction. The fillet welds binding the I beam column and plate would've slightly pulled the plates apart as the weld shrinks from cooling down.

Figure 7: Left – Threads of bolt 5 are visible in gap (6e). Right – Bolts 1-4 & 24 were tight but had visible gaps. (13b)

Figure 8: Left – Bolts 6 & 7 rotated about 15 degrees (4c). Right – (7c)

Bolt 18 (1b) and bolt 3 (12b) are compromised bolts that had previously been spray painted with a pink color, and should be replaced once spare A325 hot-dipped galvanized bolts, nuts, and flat washers arrive.

Figure 9: Bolt 18 (1b) found to be heavily corroded and short.

In figure 10 the connection between roof truss 6 and column 10 doesn't align properly, as the plate is misaligned. This is expected when considering the weight of the supported members pushing down, and the movement from high winds hitting the structure. As these bolts get worn their diameter decreases, resulting in the bolt hole to shift and close up. This makes it more difficult to simply insert a new bolt for replacement each time since new ones have a larger diameter than old ones.

Figure 10: Left & Middle - Loose, missing, and misaligned bolts in connection (10d). Right – After initial tightening.

Other south wall columns at this height visually appeared in good condition, such as having great alignment, minimal corrosion, and even threads. Figure 11 shows a comparison in conditions.

Figure 11: Visual comparison before tightening between 9d and 10d. Left – (9d). Right – (10d).

Further inspection showed bolts 1 and 4 from sections 7d - 10d, as well as bolts 2 from 8d and 9d were hand tightening loose despite looking good. While tightening bolts in section 9d to an initial torque of 150 ft lbs, we deduced bolts 1 and 4 to be compromised as they became hand tightening loose after tightening 3 and 2. Bolts 1 and 4 were replaced with new bolts before tightening the rest to 200 ft lbs, according to table A3. These replaced bolts can be seen in figure 12 along with bolt 1 at 10d, which had completely worn threads resulting in a smooth body between the head and nut interfaces.

A pneumatic die grinder was used to expand the holes for bolts 1 and 2 (10d), and bolt 4 (7d), which allowed the bolts and nuts to sit flat onto the flat washers after installation. This is a quick fix for the next few bolt replacements if needed, but installing a new tee joint will eventually be needed. In total, bolts 1 and 4 from 7d and 9d, and bolts 1 and 2 from 8d and 10d were replaced.

Figure 12: Left – SAE grade 5 bolt 1 (10d). Right – A325 bolt 1 (7d). Bottom – A325 bolt 4 (9d).

Figure 13 shows the misalignment of bolt hole 2 from 10d with bad alignment, compared to the alignment of bolt 1 of 9d which had a good fit. Figure 14 shows a visual difference after die grinding.

Figure 13: Left & Middle – Bolt hole 2 (10d). Right – Bolt hole 1 (9d).

Figure 14: Visual clearance of bolt 4 (7d) Left– Before die grinding. Right – After die grinding.

A few bolts across the barn had been replaced with A325 strength equivalent bolts, such as class 8.8 metric bolts, or SAE grade 5 bolts. The difference is that A325 bolts have a heavy head hex, resulting

in a thinner, but wider bolt head. A325 bolts also have more standardized thread lengths, and higher quality assurance and inspection requirements. Assuming proper preinstallation of any of these strength equivalent bolts with flat washers, strength equivalent bolts should suffice. Figure 12 also shows that replaced bolts of equivalent strengths experienced similar damage and wear. For these reasons, replacement of strength equivalent bolts was not considered unless they were compromised. But future bolt replacements should be done with A325 hot-dipped galvanized bolts with compatible heavy hex nuts and flat washers when possible.

Figure 15: Left – Bolt 12 (14c) replaced with SAE grade 5 bolt. Right – Class 8.8 metric replacement of bolt 21 (5b).

All f level bolting sections appeared to be in good condition, with no signs of looseness or damage.

Figure 16: Left – (5f). Right – (6f).

Many anchor bolt sections are unreachable or covered. Figure 17 shows exposed anchor bolt sections, while figure 18 shows anchor bolts in the welding shop with equipment around them, and figure 19 shows unobtainable anchor bolts. Defined by the American Institute of Steel Construction (AISC), a snug-tightened joint is when the members in a connection have achieved firm contact by the bolts in the joint, and the bolts have been tightened sufficiently to prevent removal of the nuts without a wrench. All anchor bolts appear to have a snug-tight condition, which satisfies pre-installment conditions.

Figure 17: Left – CS2 foundation crack (8a). Right – Exposed section (4a).

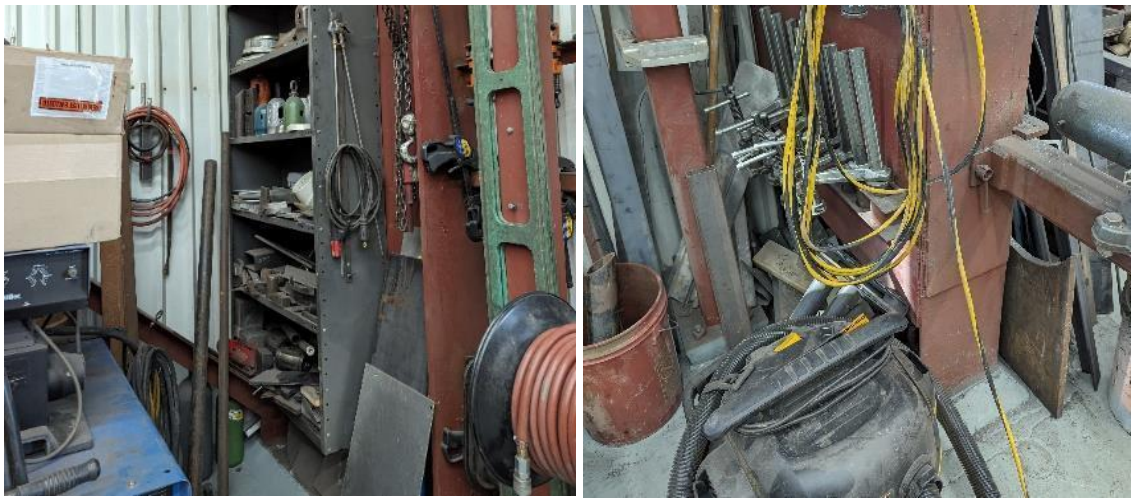

Figure 18: Covered anchor bolt sections in welding shop. Left – (6a). Right – (7a).

Figure 19: Section 5a unreachable. Left – Inside welding shop. Right – From welding shop roof.

Auxiliary Support Members

The majority of auxiliary members inspected have been within CS1 or lower, with less corrosion and cracking conditions than the columns. However, similar to the columns their connections are the usual concern with some found to be at CS2. This was more commonly found with the flange braces at the south wall, connecting roof truss 6 to the purlins. Most flange braces were found to be loose and could easily be shaken, or loose bolts could be seen moving when wind speeds were high. X bracings like at W-D3 would continue to wobble after an initial shake. However, these X bracings, cross rods, and other members are usually intended to keep the structure square, preventing it from tilting over. So absolute tightness of these members is not required.

Figure 20: Typical flange brace bolting. Left – Flange brace 9 on south wall. Right – Near bolt 11 (2e).

Flange brace 10 shows an example where flat washers would be highly beneficial. The head of the bolt is large enough to still work as intended, but doesn't have an ideal gripping area without a flat washer. This worsens the mechanism of sinking into the members known as embedding, resulting in preload loss in the bolts, and consequently loosening of bolts in shorter times.

Figure 21: Top bolt in flange brace 10. Left – View of head. Right – View of nut double match marked.

Figure 22: Left – Replaced from flange brace 12. Right – Replaced from flange brace 11.

One cross rod found in R-B5 had fallen out. Below shows one of the members still intact, while the other is unattached. Other cross rods across the roof are still intact, but the ones in the R-C5 and R-D5 are all sagging down with no tension. These cross rods should have some tension applied to bear intended loads. At the current state, they are just extra weight with no benefit.

Figure 23: Left – Member fell out (11e). Right – Member still intact (11e to 11f).

Below is a comparison between cross rods in better tension, and with the member in R-B5.

Figure 24: Top – Better tensioned cross rods (R-B1). Bottom – Members loose and fallen (R-B5).

Although not as concerning, a bolt was missing on a horizontal flange brace which classified as a CS3 connection. This was fixed by installing a new bolt with flat washers.

Figure 25: Missing ½" bolt for flange brace under 15d.

Some members were found to be modified and bent, such as one of the wall girt members intersecting with the fixed ladder. These members also appear to be non-structurally critical,

Figure 26: Slotted and bent member to run through ladder.

Column Conditions

The majority of column inspected has shown condition state levels of 1 and 2. Some minor concerns include corrosion, distortion, and the flaking or surface cracks found on column paint.

All flaking paint seen has been non-concerning at CS1. This was determined by physically inspecting the paint and revealed steel. Typically, cracking of the paint in situations like these signifies expansion or distortion of the members. However, the revealed steel's surface felt normally smooth to the touch, removing possible concerns relating to cracking paint.

Figure 27: Left – Between 6d and 6e. Right – Near horizontal flange brace under 5c.

There were some cases of CS2 distortion that can be seen in figure 28. Column 5 had appeared to have some slight buckling interfacing the wall girt, as well as on the column's flange. Whereas column 8 is undistorted, but instead distorting the wall girt in contact. These distortions likely occurred during structural erection to fit everything into its place.

Figure 28: Left – Column is pushing into wall girt near 8c. Middle – Wall girt pushing into column at 2nd ladder landing. Right – Slight buckling of column flange near 2nd ladder landing.

No cracks occurring in structural members were identified, figure 29 shows an example of non-critical surface cracks of paint.

Figure 29: Typical surface cracks of paint (5d).

Corrosion

Typical of most corrosion is found on the surface of the paint without penetration into the steel. Figures 31 shows areas with the highest corrosion seen at section 14d, classifying as a CS2 case.

Figure 30: Typical corrosion found. Left – 6d. Right – 5b.

Figure 31: Corrosion found at 14d.

Roof (& Panels / Other)

The antenna barn roof contains some defects, allowing for water to leak during downpours. All water leakages result in expedited, but preventable corrosive damage in the affected areas. The sources of leak areas that would be beneficial to patch up can be easily traced after a prolonged heavy downpour. These leaking areas can easily be fixed with caulking, butyl tape, silicone, or other common types of sealants. Example areas can be seen below.

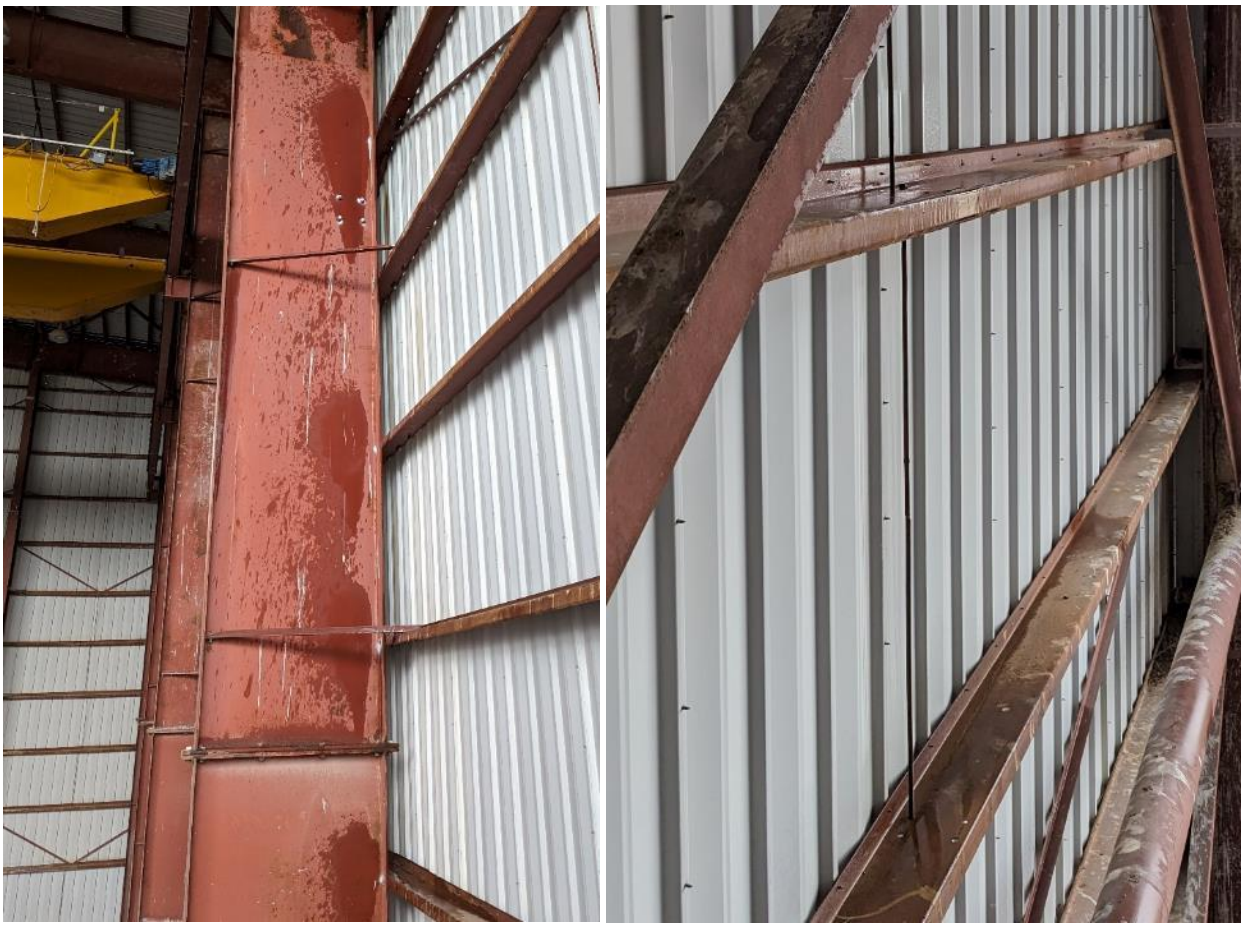

Figure 32: Left – Water dripping around column 14. Right – Slight puddling of water (W-D5).

Figure 33: Left – 3 small visible holes (8d bottom right of image). Right – 3 more holes (R-B5, between 5e & 5f).

Larger gaps between the roof and south wall may allow unwanted moisture to enter into the back. But at the same time, it may help with ventilation.

Figure 34: Large gap between roof and south wall (R-C5).

Figure 35: Left – Window panel missing (under 10b). Right – Window panel loose (under 7b).

Inspection conclusions

Overall, the barn's structural integrity is solid, with no remaining concerns requiring immediate attention. Although no concerns have been found with the columns themselves, most findings that should be brought to attention were related to the fasteners used to join the structure together. Most CS2 and CS3 findings can be traced back to the columns and additional members found at the south wall, typically closer to the roof. Similar members in other locations of the barns had been found to be in good condition such as tight flange brace bolts and members, versus loose and worn bolts at the south wall.

All areas identified in the inspection which required immediate action was resolved, while some areas require more attention and should be inspected semi-annually for the next year, and adjust frequency based on those findings. Following the inspection, all column sections including 7d-10 and 6e are currently satisfactory with no more loose or missing bolts. However, spare 1''- 8 x 3 ¾'' A325 hot-dipped galvanized bolts, respective heavy hex nuts and flat washers should be ordered preferably by the end of 2023 to replace bolt 18 (1b) and bolt 3 (12b). The mentioned sections above are the more concerning areas with a higher priority to re-visit in future maintenance inspections.

Not all compromised flange brace bolts had been replaced due to manlift and time limitations, but future replacements should implement flat washers. Cross rods at R-B5 should be re-installed if possible. The holes in the antenna barn roof should be further inspected and sealed before the next monsoon season starting June 2024, to prevent corrosive damage of the structural members and any items susceptible to water damage in the barn. Cleaning and repainting high corrosion areas such as section 14d, is another low priority item.

Appendix A

Location Referencing Systems

Height is separated by each horizontal tube braces shown in figure A1, and width is separated by columns. The columns are numbered left to right, starting on the east wall corner next to the break/meeting room. For the grid system, a folded visual shows the east, south, and west walls side by side, along with the height and column separations in figure A3. For the main column bolting sections, refer to figure A6. Examples on identifying locations can be found below in figure A7.

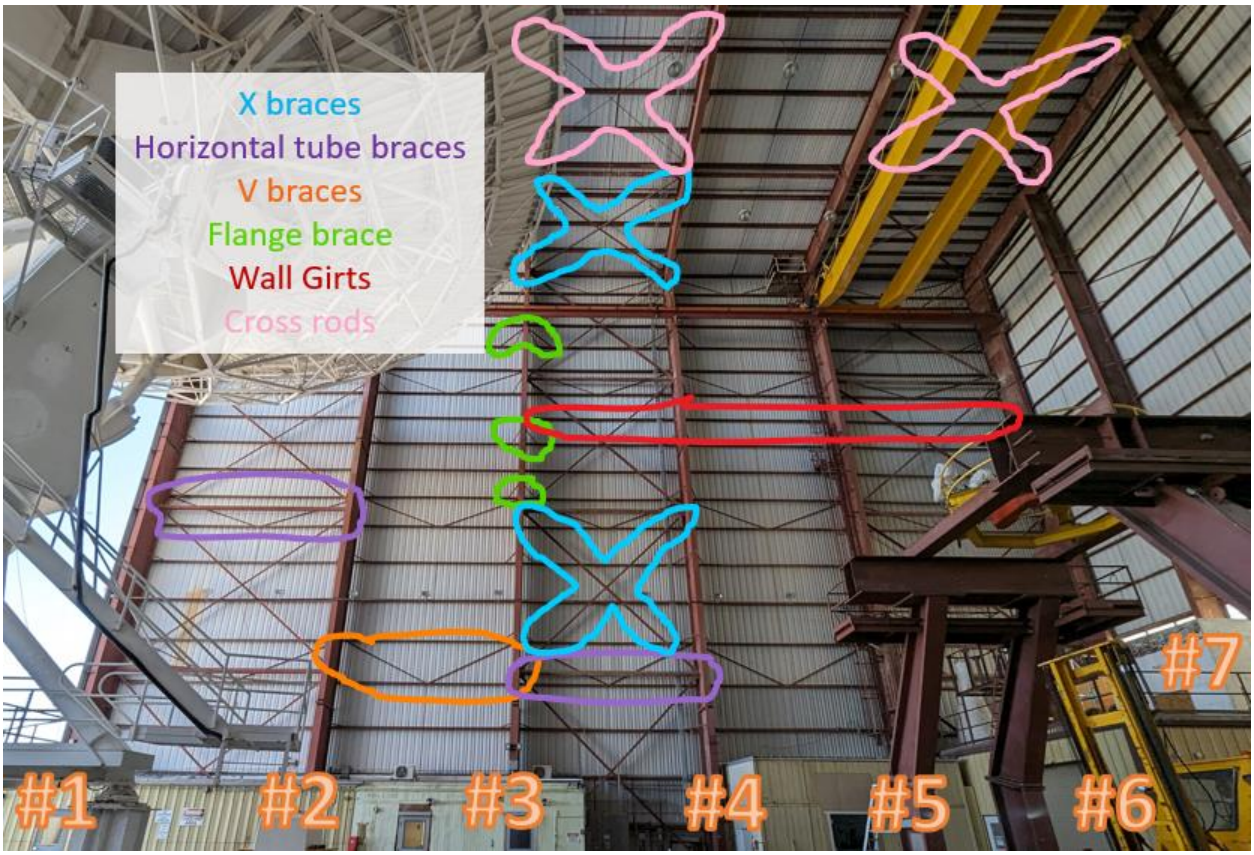

Figure A1: Support member locations.

Another small naming system involves the flange braces, usually for roof truss 6 that connects columns 6 and 11. There are 12 flange braces on each side of each roof truss, and will sometimes be counted from left to right, for a guaranteed way to distinguish where a problematic flange brace is. An example that uses this method can be found in figure A7.

Figure A2: More support member locations.

The numbers above represent the column numbers, and red markings indicate the general height for each column section for that wall. It should be noted that the true directions for the east, south, and west walls are facing the north east, south east, and south west. Their corners represent the true cardinal direction notated by the purple letters, with a top down view in figure A4.

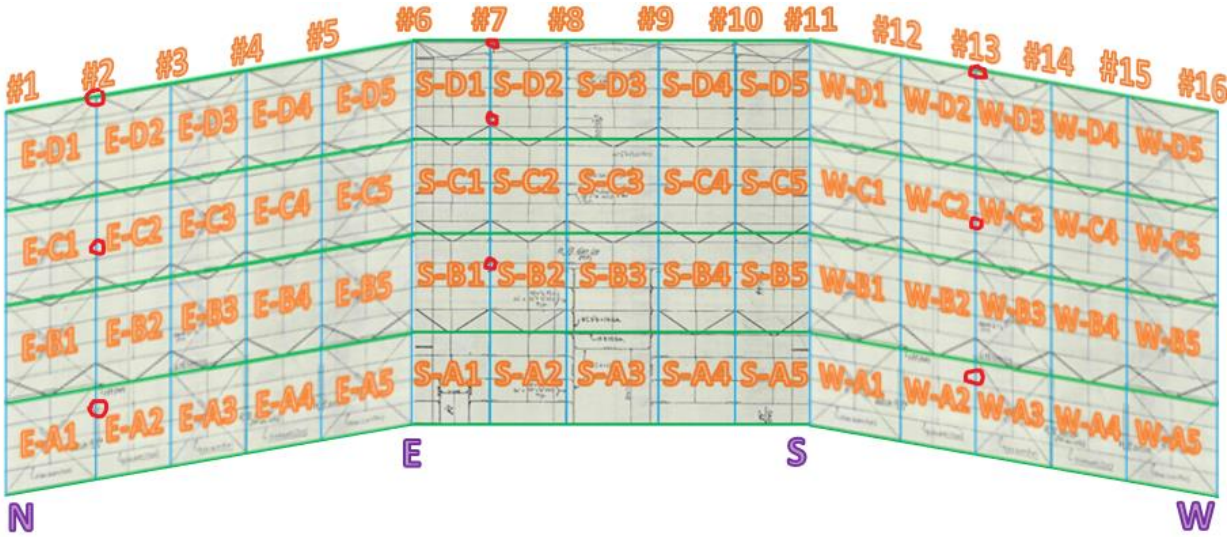

Figure A3: Grid reference system for Antenna Barn walls.

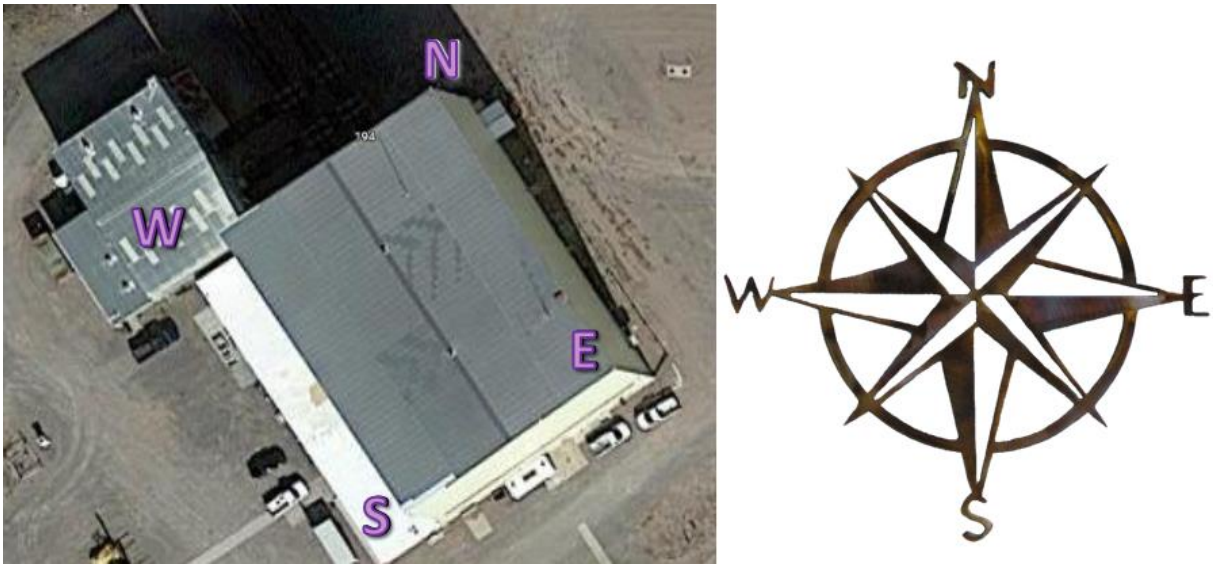

Figure A4: Top down view of barn for directional corners.

Figure A5: Roof labeling system.

Since the column bolting connections are a large focus, they have a separate naming convention from the grid. A column bolting section has two parts, the column number, and the height or section from the ground. Including the anchor bolts, columns 1-6, and 12-16 have 6 bolting sections, while columns 7-10 have 4. The height or section from the ground is indicated by a lowercase letter. 4a would be the anchor bolts on the fourth column, and 4f would be the bolts connecting columns 4 & 13 at the top of the barn, also referred to the center of the roof trusses. In figure A6, the light blue and green marks represent equivalent bolting section heights.

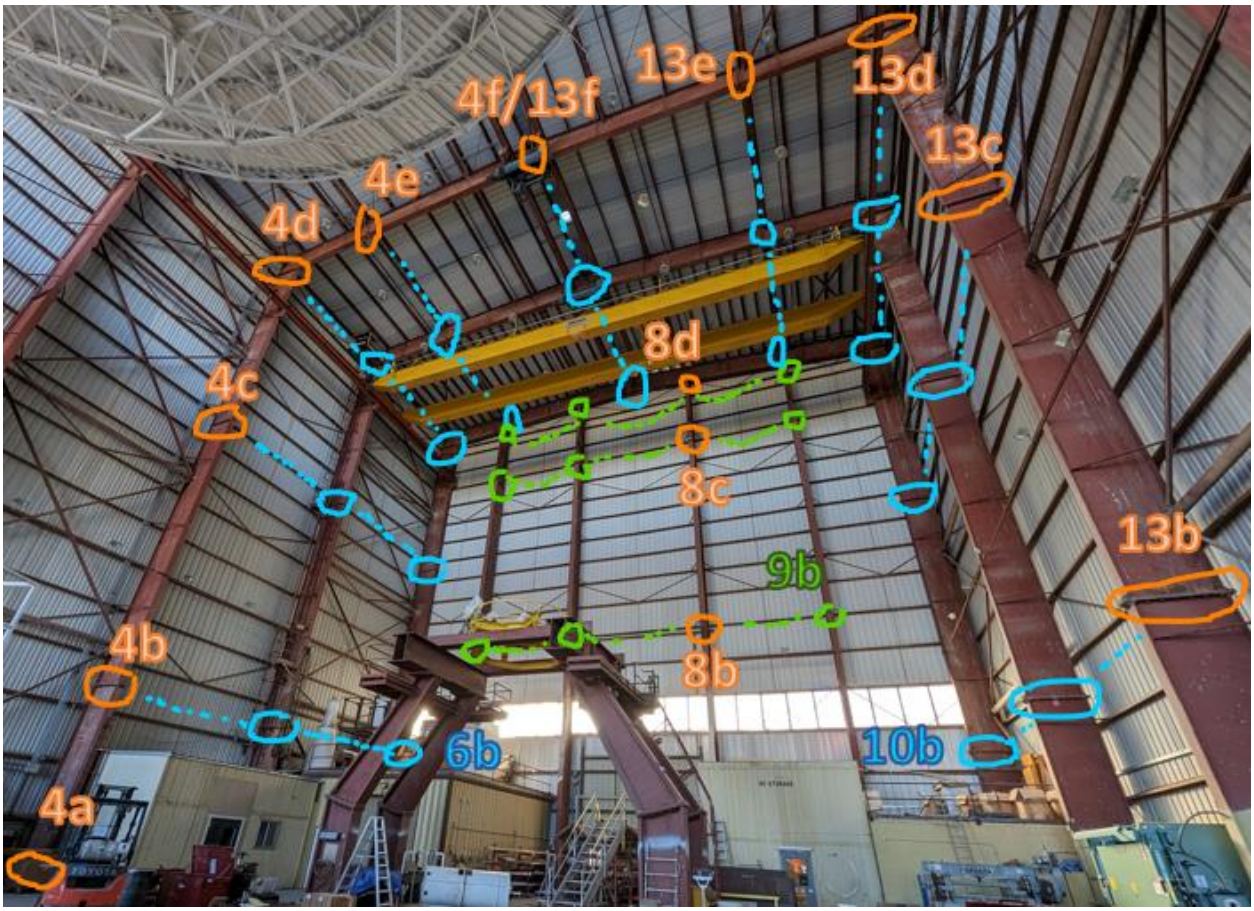

Figure A6: Main column bolting section location examples.

Figure A7: Examples of location callouts.

The vertical flange brace in blue can be referred as the flange brace 7 on roof truss 6, or the flange brace above section 8d. The horizontal flange brace in red can be referred as the flange brace under 9d or 11e, and the green X braces are located in R-A5.

Figure A8: More examples of location callouts.

Figure A9 shows the possible main bolting section configurations. Once at a bolting section, find the corresponding configuration and orientation to help identify which bolt is which.

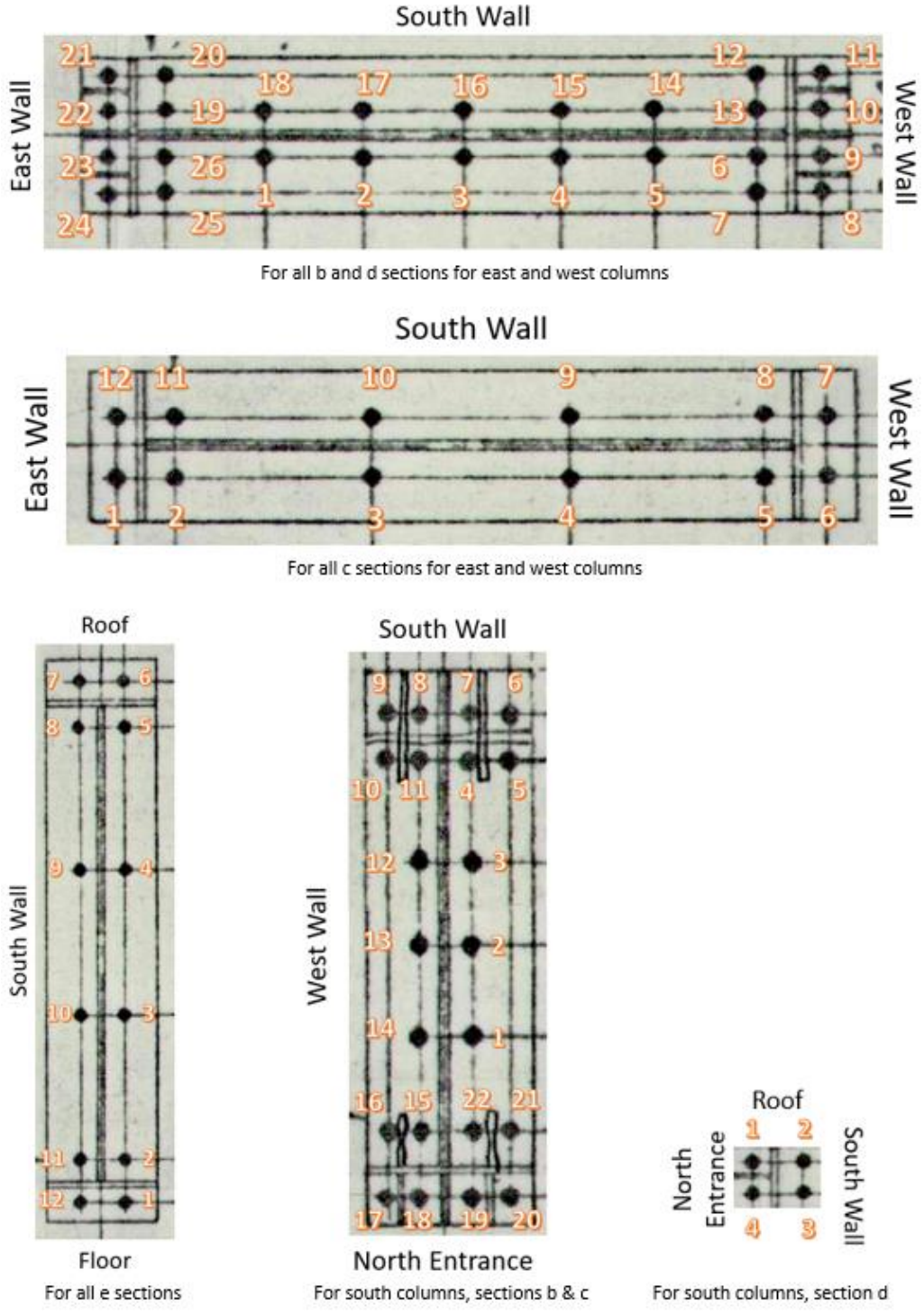

Figure A9: Bolt numbering for main sections.

Barn Severity Rubric

1. **Condition State X (Satisfied)** – Criteria is confirmed
2. **Condition State 1 (Good)** – Any deficiency is minor and has no impact on the performance of the element. These deficiencies would be expected for the material and construction used.
3. **Condition State 2 (Fair)** - The deficiency has advanced but with no impact on the performance of the element. Under continued exposure, the element will degrade further.
4. **Condition State 3 (Poor)** - The deficiency has advanced further and additional deterioration will ultimately impact the strength and/or serviceability of the element.
5. **Condition State 4 (Severe)** - The deficiency has advanced to the point where the strength or serviceability of the element may be affected and a structural review is necessary to determine the effect on strength or serviceability of the element or the bridge. A team discussion should take place to determine if any action is required. Structural reviews may include a review of the field inspection notes and photographs, review of as-built plans, or an analysis as necessary. If an evaluation determines strength or serviceability is not affected, then the Condition State can be changed to 3.

Table A1: Condition State Severity Rubric

Category	CS 1	CS 2	CS 3	CS 4
	Good	Fair	Poor	Severe
Material Defects				
Corrosion	None	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident, or pack rust is present but does not justify structural review	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking	None	Crack that has self-arrested or has been arrested with effective arrest holes, doubling plates, or similar.	Identified crack exists that is not arrested but doesn't justify structural review.	
Connections	Functions as intended	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended	Missing fasteners, broken welds, or pack rust with distortion, but doesn't justify structural review.	
Distortion	None	Distortion does not require mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but doesn't justify structural review.	

Figure A10: Corrosion and cracking examples.

Figure A11: Connection and distortion examples.

Figure A12: More corrosion and connection examples.

Bolting Tables

The table below shows the bolts that were confidently checked. All possible bolting sections at a minimum were visually inspected and skipped bolt checks based on patterns from previous sections. Bolded sections represent those found with CS2 conditions or higher, and underlined sections for those that were classified as CS1, but could be considered as CS2 conditions.

Table A2: Examples of location callouts

Section	Bolt #	Section	Bolt #	Section	Bolt #	Section	Bolt #
1a		2a		3a		4a	
1b		2b		3b	2, 4	4b	4, 8
1c	7	2c	4	3c	1, 4	4c	6, 7
1d	18	2d	13, 17	3d	2	4d	7
1e	10	2e		3e		4e	
1f		2f		3f		4f	
5a		6a		7a		8a	
5b		6b		7b	17, 20	8b	16
5c		6c	1, 7	7c		8c	
5d		6d		**7d**	**1 - 4**	**8d**	**1 - 4**
5e		**6e**	**4, 5**	---		---	
5f		6f		---		---	
9a		10a		11a		12a	
9b	5, 21	10b	13, 16	11b	3, 24	12b	25
9c	18	10c	17, 20	11c	3, 12	12c	2
9d	**1 - 4**	**10d**	**1 - 4**	11d	4, 26	12d	8
---		---		11e		12e	3
---		---		---		---	
13a		14a		15a		16a	
13b	1-4, 24	14b	17, 20	15b		16b	16
13c	1, 4	14c	10	15c	1, 12	16c	8
13d	2, 25	14d	15,16,19-21,22	15d	2	16d	16
13e	5	14e		15e		16e	
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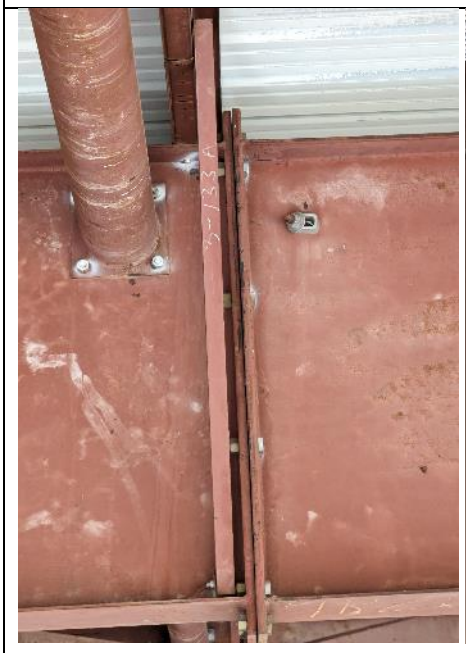
Table A3 – Torque Ranges and Head Sizes Based on Nominal Bolt Diameters

Nom. Bolt Dia. (in)	Head or Nut Size (in)	Torque for Pre-Installation Verification (lb-ft)					
		A307		A325		A490	
		Coated / Plain	Use	Coated / Plain	Use	Lubed / Plain	Use
1/2	7/8	37 – 40 / 29 - 32		50 – 58 / 100 - 116	55	63 – 75 / 125 - 150	80
5/8	1-1/16	-	-	~~99 – 120 / 2X~~		~~125 – 151 / 2X~~	
3/4	1-1/4	-	-	175 – 213 / 2X	200	~~219 – 263 / 2X~~	
7/8	1-7/16	208 - 209 / 166 - 167		~~284 – 343 / 2X~~		~~357 – 430 / 2X~~	
1	1-5/8	-	-	425 – 508 / 2X	450	~~533 – 642 / 2X~~	
1-1/8	1-13/16	-	-	~~600 – 722 / 2X~~		~~750 – 900 / 2X~~	
1-1/4	2	-	-	844 – 1021 / 2X		~~1063 – 1271 / 2X~~	
1-3/8	2-3/16	-	-	~~1111 – 1341 / 2X~~		~~1386 – 1661 / 2X~~	
1-1/2	2-3/8	1088 – 1091 / 870 - 873		~~1475 – 1788 / 2X~~		~~1850 – 2225 / 2X~~	

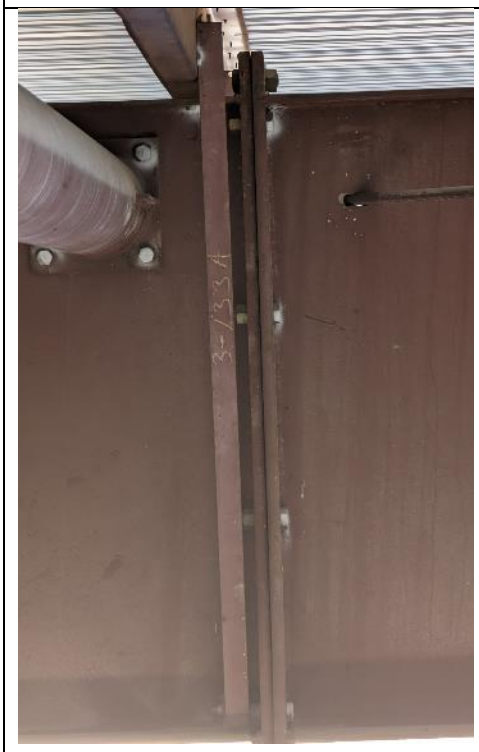
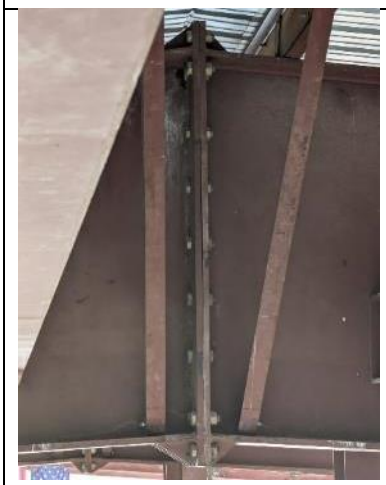
Column Bolting Sections Extras

	1b
	1d
	1e

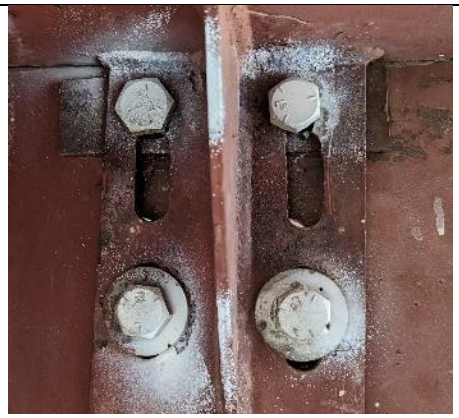
 	2b
	2d
 	2e Left - Bolts 9 & 10 Right – Bolts 1-6

 	3c
 	3e Left - Bolts 1-6 Right – Bolts 7-11
	4b

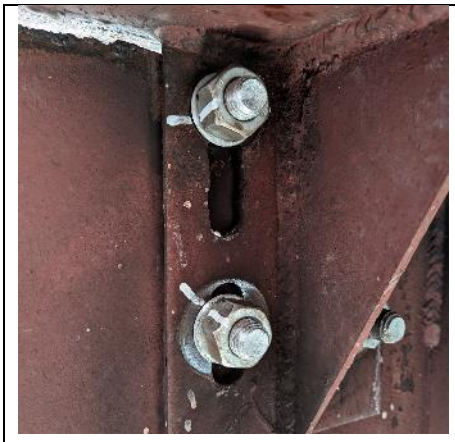
	4c
 	4e Left - bolts 7-11 Right – Near 4e, bolts are angled
	5b
	5c

	5d
	5e Bolts 7-11
 	5f

	6b
	6d
	6f
 	7d Left – Before Right - After

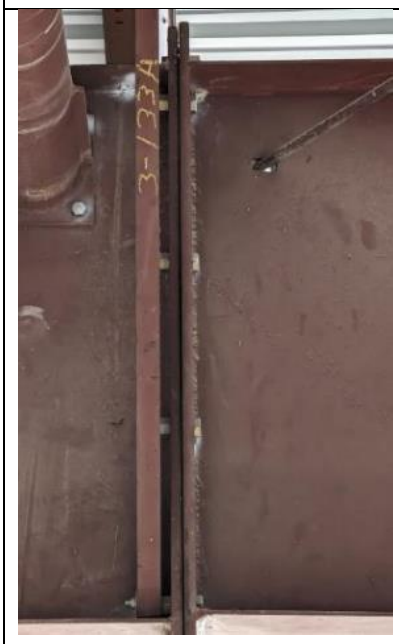
	8b and 9b
	8c
 	8d bolt clearance Left – Bolt 2 Right – Bolt 1 Member had extra steel plate as a spacer between joins.
 	8d Pre-Inspection

	9b
	9c
 	9d Had good clearance

	9d After replacement
	10b
	10c
 	10d

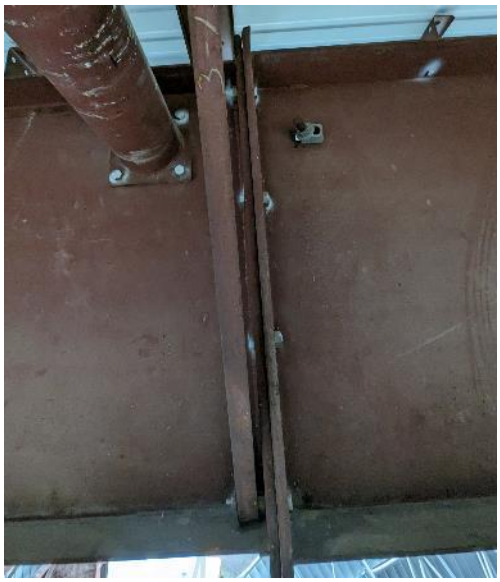
	
	11b
	11c
	11d

	11e
	12b
 	12c

 	12d (Top – Bolts 12-20)
	12e (Bolts 7-12)
	

 	13d (Top – Bolts 1-9 & 23-26)
	
 	14d

 	
	14e Bolt 10, tight with gap
	15b Bolts 10-22

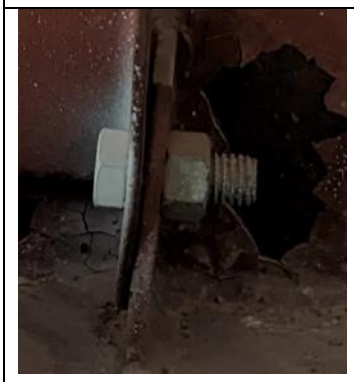
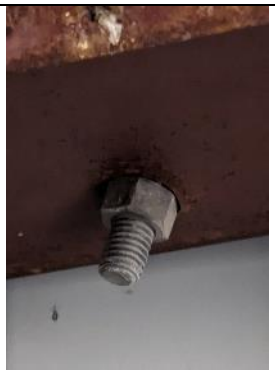
	15c Bolts 12 - 5
	15d Gap but tight Bolts 23-26, 1-9
 	15e Left – Bolts 1-6 Right – Bolts 7-12
	16c A lot of debris

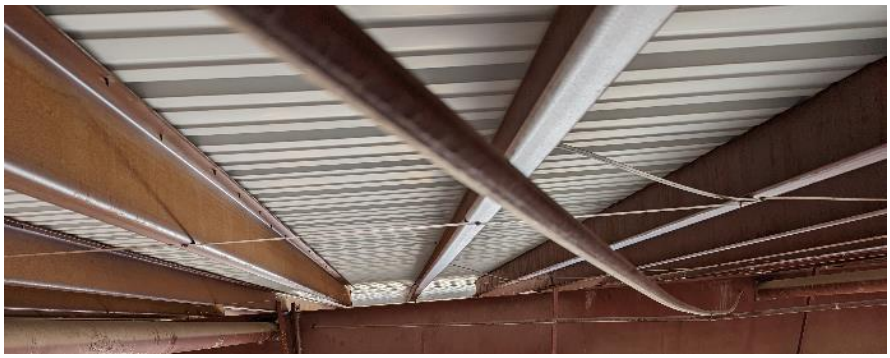
	16d
	16e
 	Bolt 1 (7d)
 	Bolt 1 (8d)

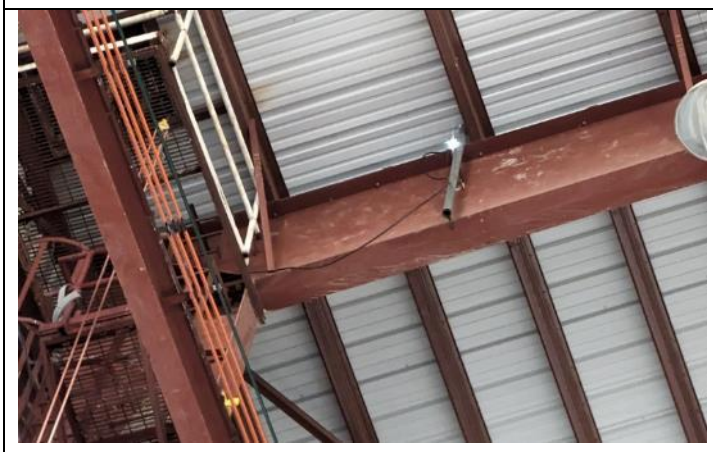
	Bolt 2 (8d)
	Bolt 1 (9d)
	Bolt 4 (9d)
	Bolt 1 (10d)
	2e Left - Next to bolt 11 Right – Next to bolt 8

	Under 8c
	8th flange brace near 9d
	9th flange brace between 9d and 10d
	10th flange brace near 11e

 	Bottom of 11th flange brace
	Top of 11th flange brace of south wall (2nd from right)
 	Near 11e

 	Under 15d Left – Missing bolt Right – Installed bolt
  	Near 15d Left – Tight flange brace Middle & Right – Visual bolt embedment resulting in misalignment
	Right – Near 15e
	Near 16d

	Loose sag rod nut in E-B2, E-C2 or E-D2
	X bracings at R-E1
 	Cross rods at R-B5

	View from 16e
	Visible hole near 5d
	Visible holes near 6f