



ENTUITIVE

STRUCTURAL ASSESSMENT REPORT

**FORT SASKATCHEWAN UTILITY SERVICES
WATER TOWER STRUCTURAL CONDITION
ASSESSMENT**

FOR: THE CITY OF FORT SASKATCHEWAN | DATE: NOVEMBER 28, 2016

C016.1488



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1. EXECUTIVE SUMMARY

As part of the Utility Services – Structural Engineering Assessments project, Entuitive was retained by the City of Fort Saskatchewan to perform a visual inspection of the Water Tower support structure located at 9421 101 Street Fort Saskatchewan, Alberta. This report outlines the results of our observations and recommendations are provided. The site visit was conducted by Mohammad Moayyed, P.Eng., and Dean Amundson, C.E.T., of Entuitive on September 28, 2016.

Based on our observation of the existing support structure (excluding the water tank), it is our opinion that the structure is generally in good condition. However, there are some repair and modifications that have been recommended in this report based on our observations.

Modification of the existing vertical ladder and addition of the lifeline for access ladder to top of the tank is required. Other repairs include: minor paint repair in various structural steel components, the riser pipe cladding repair and sealing, catwalk floor coating,

Some cracks were observed on the foundation piers. It is recommended to remove the pier plasters and repair all cracks prior reinstating the plaster or other type of waterproofing coating.

Based on our evaluation, the wind impact due to the existing antennas is negligible in comparison to the total wind load on the water tank. However, the number of antennas shall be limited to 4 per column. Also, no antenna shall be attached to the catwalk handrail.

The opinion of probable costs for required repairs and upgrades are provided for immediate and deferred maintenance actions. No lifecycle replacement is recommended at this time.

Immediate Repair/Replacement	Deferred Maintenance	Lifecycle Replacement
\$22,000	\$36,000	\$0

2. INTRODUCTION

Constructed in 1956 the Water Tower stands about 150ft from grade and is an essential component of water distribution for the City, along with being a city landmark. The Water Tower is composed of a steel structure supported off of concrete foundations. Directly beneath the tower resides the heater house. The steel super-structure of the tower is comprised of six 30" diameter tubular columns, brace rods and horizontal struts. The columns are positioned in a hexagon configuration and are supported by concrete pier foundations. Due to the existing site conditions, we were unable to confirm pier depths and footing dimensions. Our assumptions pertaining to the buried foundations are based on the existing foundation drawings by Associated Engineering Services, dated 1956.

The steel support structure consists of three levels, two of which are intermediate struts perpendicularly supported between the tubular columns by bolted connection. The third level pertains to the catwalk around the tank. Vertical cross brace rods are found connected at the strut and column interfaces as well as the foundation and catwalk interfaces. Turnbuckles for the brace rods are located at the bottom. Horizontal rod bracing (stay rods) are connected between two columns opposite of each other and are located at the two intermediate strut levels to provide lateral support of the riser. Access to the Catwalk from grade level can be achieved by using the ladder which is affixed to one of the tubular columns. The ladder is equipped with a lifeline and starts at approximately 23ft above grade elevation extending to the Catwalk. Approximately 125ft from the column base, the catwalk circulates the entire tank and provides additional access to the tank roof via ladder welded to the outer shell of the tank. It must be noted that this ladder does not provide any fall protection system.

Entuitive was retained by the City of Fort Saskatchewan to perform a visual inspection of the tower support structure and evaluate the impact of the existing and future antennas pertaining to the wind stability of the tower. The following documents were made available for this assessment:

- Fort Saskatchewan Horton Water Tower, Tower Report, by Century Towers Ltd., dated 2015
- 250 M U.S. Gals. Elevated Tank, Steel Drawings, by Horton Steel Works Limited, dated 1956
- 250 M U.S. Gals. Elevated Tank, Foundation Drawings, by Associated Engineering Services Ltd., dated 1956
- Antennas on Water Tower, Antenna Chart and Drawings, by FC Telec Consultants, dated 2016
- Radio Installation on Water Tower, Plan and Elevation Drawings, by clear NET, dated 2000

Encore Trucking & Transport Ltd. was sub-contracted by Entuitive. In order to access the elevated height, a crane with man-lift bucket was provided. Initially the crane was stationed west of the Water Tower on 101 St., due to height restrictions; the crane operator had to relocate and reposition to the east side of the tower to enable us to inspect the complete structure.

2.1 SCOPE OF WORK AND METHODOLOGY

The scope of work for this structural condition assessment included the following:

- Visual review of the tower structure including columns, brace rods, struts, stay rods, connections, anchor rods, and piers
- Collection of pertinent data and recording of observations related to existing conditions found at the site
- Evaluate the fixed ladder, catwalk (balcony) and handrail
- Analyze the impact of the existing antenna and foreign hardware on the tower wind load stability

- Evaluate capacity for future antenna and related hardware additions
- Identify remedial and repair works and provide opinion of probable costs

The review was based on a visual observation of the visible and accessible components. The assessment did not include an intrusive investigation or non-destructive testing. No physical tests were conducted and no samples of component materials were collected. The inspection of the water tank, coating systems condition, sanitary conditions, security conditions, riser cylinder, and control-room/heater-house was excluded.

Preparation of a report, including an overall summary of the inspection and assessment findings, and photographs of salient observations made during the assessment. Selected photographs referred in this report are provided.

The existing conditions of the structural components are rated within a range as listed below:

- Excellent: Component is new and meets present and foreseeable requirements
- Good: Component is performing well and meets all present requirements with minor deterioration or negligible deficiencies
- Acceptable: Component meets present requirements but there are some deterioration and minor deficiencies need repairing
- Poor: Component meets minimum requirements and has extensive deficiencies
- Critical: Component is unacceptable and unsafe, requiring immediate attention

The condition rating “Critical” requires immediate action to prevent further deterioration to the component to prevent possible failure, unsafe causing damage and injury.

Deferred maintenance includes the condition rating “Poor”, where physical damage or deferred maintenance was observed or expected to recur. This requires action to restore component performance. Typically, it is recommended that the deferred maintenance should be completed within two years.

The lifecycle category includes recommended events for components that have a condition rating that is “Excellent, Good and Acceptable”, where the component has already exceeded or will exceed its expected useful life. It may require replacement to maintain component performance. It should be noted some components have been assumed to have indefinite life expectancy such as structural elements. From time to time localized repairs may be required due to deterioration or vandalism, which are assumed to be handled as part of ongoing maintenance.

2.2 OPINION OF PROBABLE COSTS

Our opinions of probable replacement costs which correspond with recommended events are based on local experience gained by Entuitive. Event costs are expressed as “order of magnitude” (+/-

25%). The quantities associated with each event have been estimated during the site visit and do not represent exact measurements or quantities.

Any opinions of probable costs are intended for global budgeting purposes only. The scope of work and the actual costs of the work recommended can only be determined after a detailed examination of the site element in question, understanding of the site restrictions, understanding of the effects on the ongoing operations of the site/buildings, definition of the construction schedule, and preparation of tender documents. Entuitive expressly waives any responsibilities for the effects of any action taken as a result of these endeavors unless Entuitive is specifically advised of prior to, and participate in the action, at which time, Entuitive's responsibility will be negotiated.

2.3 LIMITATIONS

- This report, including its information and opinions, has been prepared for the exclusive and sole use of the Water Tower located at 9421 101 Street in the City of Fort Saskatchewan.
- This report shall not be relied upon for any purpose other than intended for the City of Fort Saskatchewan within the scope of services negotiated between Entuitive and the City of Fort Saskatchewan without the express prior written consent of Entuitive.
- This report may not be relied upon by any other person or entity without the express written consent of Entuitive and the City of Fort Saskatchewan. Any reliance on this report by a third party, any decisions that a third party makes based on this report, or any use at all of this report by a third party without the prior written consent of Entuitive is the sole responsibility of such third parties. Entuitive accepts no responsibility for damages, if any, suffered by a third party as a result of decisions made or actions based on this report.
- No party shall distribute this report, in its final or preliminary form, or any portion or copy thereof without the express written permission of Entuitive, except that the City of Fort Saskatchewan may make copies of this report as are reasonable for its own use and consistent with the intended purposes of this report.
- Opinions of probable costs expressed in this report are partially based on consultation with industry-recognized publications on probable costs for materials and labour. While Entuitive uses information available to us combined with our judgment and past experience, the specific rationale and conditions forming the basis of contractors' bids, material or equipment pricing are beyond our knowledge and control. Entuitive can therefore not be held responsible if the final costs vary from these opinions of probable cost.
- Entuitive's work did not include intrusive testing/investigation, destructive testing, testing of life safety systems or quantitative testing. As such, any recommendations and opinions of probable costs associated with these recommendations, as presented in this report, are based on walkthrough non-invasive observations of the parts of the buildings which were readily accessible during a visual review. Conditions may exist that are not as per the general condition of the system being observed and reported in this report.

- Opinions of probable costs presented in this report are also based on information received during interviews with site representatives, operations and/or maintenance staff. Entuitive cannot be held responsible for incorrect information received during the interview process. Should additional information become available with respect to the condition of the buildings and/or site elements, Entuitive requests that this information be brought to our attention so that Entuitive may reassess the conclusions presented herein.
- No detailed engineering calculations, geotechnical assessments, wind (except as stipulated for antenna) or seismic assessments have been made. No responsibility, therefore, is assumed concerning these matters. Entuitive will not be held responsible for the impact of any design or construction defects, whether or not described in this report. No guarantee or warranty, expressed or implied, with respect to the property, tower, building, or any other physical aspect of the property is made.
- The assessments outlined in this report generally captured conditions that existed at the time of the site visit. Our opinions and recommendations presented in this report are rendered in accordance with generally accepted professional standards. The opinions and recommendations are not to be construed as a warranty or guarantee regarding existing or future physical conditions or regarding compliance of systems/components and procedures/operations with the various regulating codes, standards, regulations, ordinances, etc.

3. OBSERVATIONS

During the site visit, we performed a visual observation of the Water Tower structure as described above. These observations were limited to elements which were visible to view and were within the allowable zone of maneuvering of the crane. To document our findings we assigned a number to each tubular column and the same number was assigned to the piers. A plan illustrating the number sequence has been provided in Figure A-1 (Appendix A). In the following sections, our findings are summarized with reference to selected photos taken during our site visits. Selected photographs are provided in Appendix B.

3.1 FOUNDATION PIERS

- Piers are generally in good condition; cracking was observed on piers #4, #5 and #6. Refer to photo S-1.
- Plaster around all six of the exposed column piers appeared to have cracking and delamination; generally all in poor condition. Refer to photo S-2.
- Signs of partial deteriorated grout underneath the base plate of column #4 were evident. Refer to photo S-3. Grout among the remainder of base plates appear to be in good condition.

- No separation between the column base plate and grout was evident at any of the six columns.

3.2 ACCESS LADDER

- The access ladder attached to Water Tower column #1 was observed that the lower portion had been removed at some point. The distance from grade up to the first rung was measured at approximately 23ft. Refer to photo S-4.
- A vertical lifeline is provided for the fall protection system. The cable and connectors were visually inspected and appeared to be in good condition.
- Based on our visual observations, the ladders structural integrity was in good condition.

3.3 COLUMNS

- Each of the six columns has experienced wear from the cable strapping which has resulted in spot rusting and stripping of the paint. Refer to photos S-5 and S-6.
- Column welds appeared to be intact with a few rust spots in areas where paint as flaked off leaving the unprotected steel exposed to the elements.
- No major concerns were observed at gusset plate connections for the bracing welded to the columns.
- Anchor bolts at the base plate showed signs of general corrosion around base plate hole. Through visual inspection no cracks were observed. Refer to photo S-7.
- The columns were deemed in good condition.
- Column paint appeared to be in acceptable condition, except as listed above.

3.4 VERTICAL AND HORIZONTAL BRACINGS

- Brace rods observed were deemed in good condition with minor areas of spot rusting due to paint flaking.
- Horizontal bracing rods (stay rods) located at two levels were in good condition with signs of slight spot rusting.
- Turnbuckles observed for both the brace and stay rods show very minor spot rusting and therefore they were deemed in good condition.

3.5 RISER PIPE

- Cladding around the riser showed signs of paint deterioration and rusting.
- At multiple elevations the cladding was observed to be disconnected to the structure, which creates access points for not only the elements but animals to penetrate easily. Refer to photo S-8.

It should be noted that we were unable to maneuver through the vertical bracings with the crane.

3.6 CATWALK

- Catwalk (balcony) and its handrail appeared to be in good condition.
- Sporadic signs of rusting were found both on the catwalk floor as well as the handrails. Refer to photo S-9.
- Antennas were observed to be attached to the catwalk handrail at various locations. Refer to Antenna observations.
- The top of the tank is accessible from the catwalk level via a fixed ladder which is welded to the tank shell. However no fall protection system is in place on the ladder making it unsafe to climb. Refer to photo S-10.

3.7 ANTENNAS

- Antennas, cables and the hardware associated were present on all of the six columns except for column number 1. Refer to photo S-11 and S-12.
- Besides the columns, the catwalk handrail also acted as a host to multiple antennas. There were a few locations in which the connections were loose. Refer to photo S-13.

4. EVALUATION OF WIND LOAD IMPACT DUE TO ANTENNAS

There are various types of antenna and hardware supported by the tower structure. Based on the available information, the antennas were added over years. It is also possible that number of antennas be increased in the future. We understood that the City of Fort Saskatchewan is also considering potential future addition to the current number of antennas. Partial information of the existing antennas were, as listed earlier, were reviewed for obtaining the required parameters. No information for future antenna was provided for this assessment.

We verified the dimensions of the selected antennas during the tower inspection. Therefore, the wind calculations were performed based on the verified information. In order to evaluate the wind load impact due to antennas, we utilized a rationalization method, in which we compared the total additional wind load caused by the antennas with the total wind load against the water tower (structure and tank). The calculations were based on the design data specified by the Alberta Building Code (ABC 2014). The water tower original wind design information was not available; therefore, the wind load on the water tower was also determined by using ABC 2014 design data. It should be emphasized that our evaluation is limited to the requirement of ABC 2014 and especial events such as tornado has not been considered.

The results of the evaluation can be summarized as follows:

- The additional wind load of the existing antennas is less than 5% of the total wind load on the water tank. It is our opinion that the increase is negligible.

- The number of antennas shall be limited to 4 per column. These antennas shall be oriented in different angles to reduce the additional wind projected area.
- The dimensions of future antennas shall be less than the existing. The largest existing antenna assumed in this evaluation is 6'-6" Long x 1'-2" Wide x 12" Deep.
- No antenna shall be fastened into the catwalk handrail.

5. RECOMMENDATIONS

The following recommendations are provided based on the observations and evaluations mentioned above. The main purpose of the report is to address concerns related to the overall structural integrity of the Water Tower.

5.1 WATER TOWER STRUCTURE

- Cracking in the piers will only worsen overtime as water is able to penetrate the concrete. The plaster coating of the piers is already showing signs of delamination and therefore we recommend removal of all the plasters. This will expose any additional cracking on the piers which shall be remediated. Depends of the extent of the cracks an epoxy injection can be utilized for the repairing of the piers. Piers shall be protected by reinstating the plaster or applying a waterproof coating.
- Grout deterioration at column 4 should be repaired.
- After cleaning the rusted anchor bolts at the gap between anchor bolt and base plate holes, the gap shall be filled with elastomeric sealant to prevent water penetration.
- To control the rusting on the columns and bracing, it is recommended to patch/repaint the columns.
- Disconnected cladding around the riser pipe should be repaired and properly sealed to remediate the water and potential animal penetrations.
- To control the sporadic rusting on the catwalk handrails, it is recommended to patch/repaint the handrails.
- To create a safer floor on the catwalk it is recommended to apply a slip resistant coating.
- A fall protection system is recommended to be installed for the access ladder on the catwalk to tank hatch.

5.2 ACCESS LADDERS

According to Alberta Occupational Health and Safety Code (OHS 2009), a fixed ladder equipped with an integral fall protection system that meets the requirements of CSA 2259.2.1 shall be used for climbing the Water Tower. As noted previously in this document, the lower portion of the existing

fixed ladder had been removed. It is our opinion that the current arrangement does not conform to the OHS 2009 requirements. Therefore the following recommendations are provided:

- The lower portion of the fixed ladder shall be designed, installed and tested in accordance with OHS 2009 and PIP Standard STF05501. The bottom of the ladder shall not be higher than 150mm above the concrete foundation.
- The existing vertical lifeline shall be extended to the bottom of the fixed ladder. The vertical lifeline shall be designed, installed and tested in accordance with CSA 2259.2.1.
- To prevent unauthorized personnel climbing the ladder, a ladder guard as shown in Figure A-1 is recommended.
- A lifeline system shall be installed on the access ladder to top of the water tank.
- The record drawings of the fixed ladder and fall protection system shall be certified by a professional engineer registered in the province of Alberta.

5.3 ANTENNAS

Below is the list of the recommendations that shall be considered and pertain to the antennas and potential future antenna/hardware:

- Existing antennas attached to catwalk handrail to be relocated. Connection to catwalk girder plate with additional new post is acceptable.
- Future antennas can be installed as per evaluation summary provided in Section 4.

5.4 NEXT INSPECTION

In determining inspection frequency a risk assessment approach should be used, taking into account all relevant matters, including the following factors:

- The structure affects a large number of people.
- After recommended repairs and replacement noted in the report, there will not be any issues of concern which need to be inspected for.
- The structure will regularly be inspected by the facility management team and the structural engineer will be advised for any issues of concern noted during such inspections. It is assumed such inspections will be carried out every six month.

Accordingly, we recommend the next structural inspection to be done within five years.

6. OPINION OF PROBABLE COSTS

The following table provides a summary of opinion of probable cost identified based on the recommendations in the preceding sections outlined above.

Component	Immediate Repair/Replacement	Deferred Maintenance	Lifecycle Replacement
Foundation Pier Crack and Plaster Repairs	\$7,000		
Base Plate Grout and Anchor Rod Hole Repairs	\$2,000		
Column, Struts, Rods and Connection Paint Repairs		\$27,000	
Fixed Ladder, Guard, Lifeline Extension and Certification	\$10,000		
Lifeline for Ladder from Catwalk to Top of the Tank	\$3,000		
Catwalk Handrail Repainting		\$5,000	
Catwalk Floor Coating		\$4,000	
Total	\$22,000	\$36,000	\$0

7. CLOSURE

Trusting the above addresses your immediate requirements; we remain available to answer any questions or to proceed with the recommendations presented above.

Sincerely,

Entuitive
APEGA Permit to Practice No. P11274

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APPENDIX A

Figure A-1: Water Tower Plan – Column/Pier Numbering

Figure A-2: Ladder Guard Example

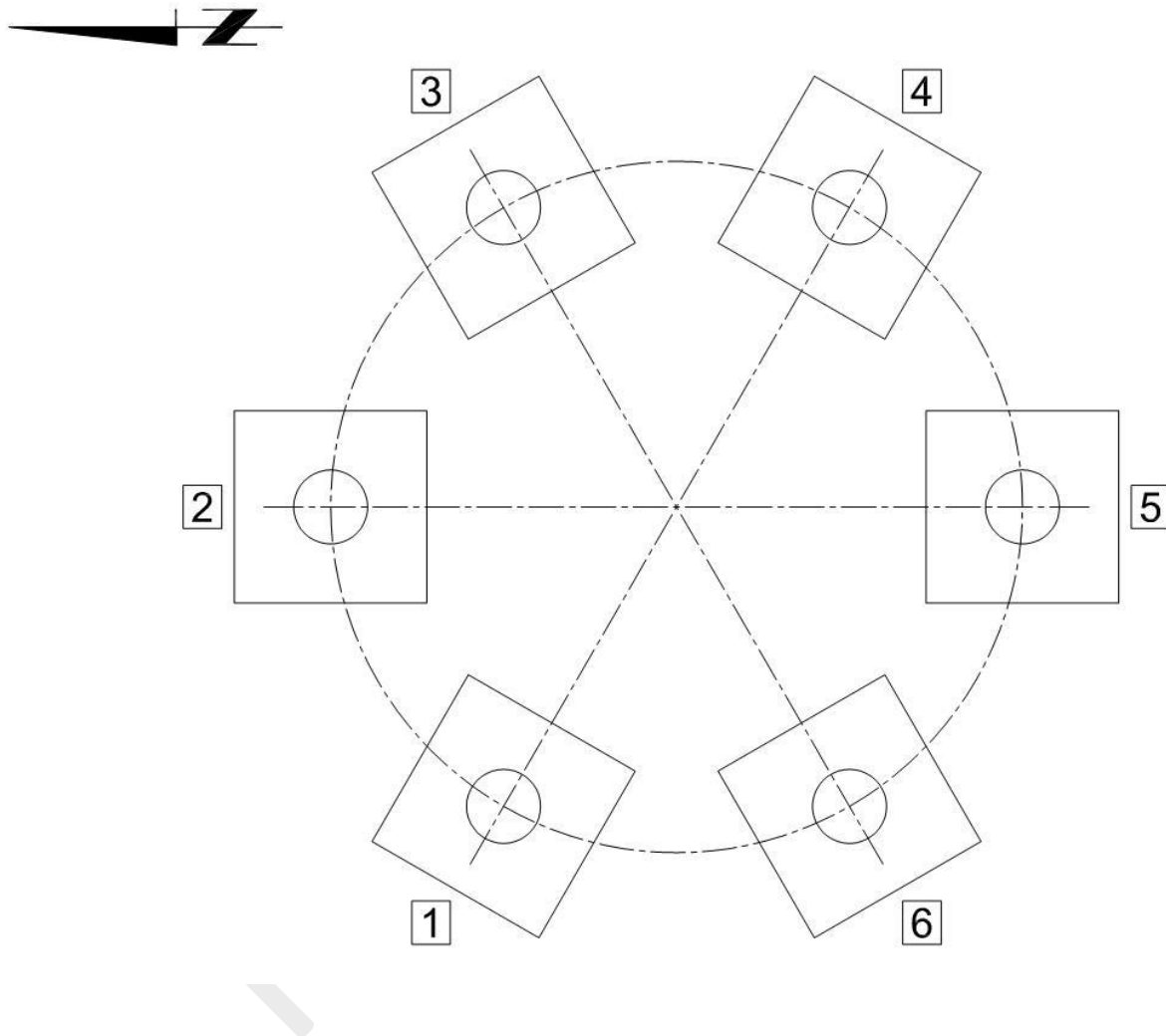


Figure A-1: Water Tower Plan – Column/Pier Numbering

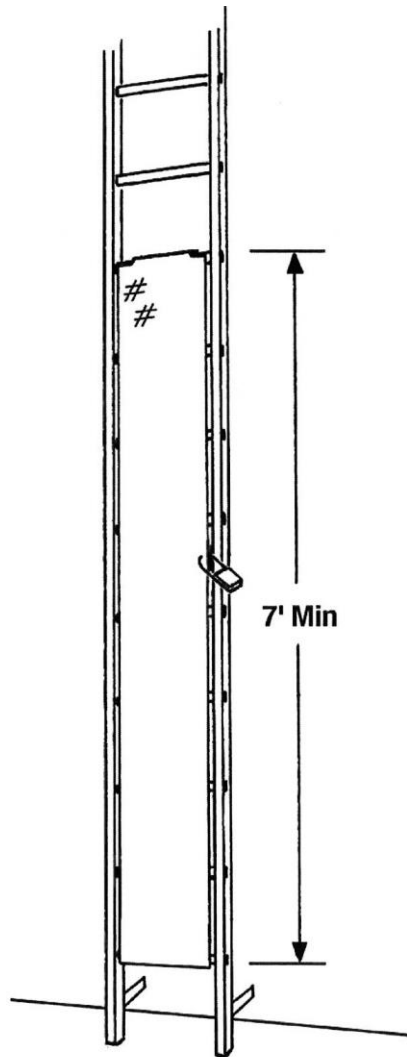


Figure A-2: Ladder Guard Example

APPENDIX B

Site Visit Photographs



Photo S-1: Cracking evident at column pier #1



Photo S-2: Plaster has thin cracking throughout and delamination is evident (Pier #3)



Photo S-3: Deteriorated grout at the underside of the column baseplate (Pier #4)



Photo S-4: Access ladder's lower portion has been removed (Column #1)



Photo S-5: Rusting and paint wear (Column #2)



Photo S-6: Rusting and paint wear (Column #2)



Photo S-7: Anchor bolts at column baseplate (Pier #5)



Photo S-8: Openings in the riser cladding



Photo S-9: Spot rusting on handrail and catwalk floor



Photo S-10: Access ladder to top of tank does not have a vertical lifeline



Photo S-11: Antennas and hardware connected to column #4



Photo S-12: Antenna hardware connected to column #6



Photo S-13: Antenna hardware connected to catwalk handrail