Investigation of the February 1, 2014 Collapse of a Telecommunication Tower at the Summit Park Community in Clarksburg, WV

U.S. Department of Labor
Occupational Safety and Health Administration
Directorate of Construction

July 2014

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This report was prepared by
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Office of Engineering Services
Directorate of Construction

Introduction

On February 1, 2014, at approximately 11:37 a.m., a 340'-high guyed telecommunication tower (cell tower), suddenly collapsed during upgrading/construction activities. Four employees were working on the tower removing its diagonals. In the process, no temporary supports were installed. As a result of the tower's collapse, two employees were killed and two others were badly injured. The cell tower fell onto the guy wires of an adjacent smaller cell tower and caused it to collapse, killing a firefighter while he was rescuing the injured employees on the ground. The collapse of the smaller tower is not covered in this investigation.

The Occupational Safety and Health Administration's (OSHA) Regional Administrator, Region III, asked the Directorate of Construction (DOC) in OSHA's National Office in Washington, DC, to provide technical assistance in a causal determination and to provide engineering assistance to the OSHA Charleston Area Office in its investigation. A civil engineer from the DOC visited the incident site from February 5–7 to inspect the collapsed tower, examine the failed pieces, and discuss the sequence of events with representatives of the tower's owner.

DOC reviewed the following documents:

- Photographs of the incident taken by the OSHA Charleston Area Office.
- Notes and records (27 pages) from the West Virginia State Police (WVSP).
- Taped records of four witness interviews conducted by WVSP.
- Photographs of the incident taken by WVSP.
- Inspection report on Despard Tower 1, prepared by FDH Engineering, Inc., April 2013.
- Original design of Despard Tower 1, certified by Thomas W. Schepke, PE, UNR-ROHN, October 1990.
- Modification Drawings of Despard Tower 1, prepared by FDH Engineering, Inc., August 2013.
- ANSI/TIA-222-G-2005 Structural Standard for Antenna Supporting Structures and Antennas, Telecommunication Industry Association, August 2005 (Reaffirmed: December 20, 2012).
- ANSI/TIA-1019-A Standard for Installation, Alteration and Maintenance of Antenna Supporting Structures and Antennas, Telecommunication Industry Association, September 2012.

The Project

The project was to upgrade and modify an existing 340' guyed cell tower by replacing diagonals, adding angle leg reinforcements, and replacing guy wires (See Figure 1). The tower was located at the Summit Park Community, Harrison County, West Virginia. The site name was Despard (Tower 1). The site number was WV08612-A-02. The site address was 9141 Murphy's Run Road, Clarksburg, West Virginia.

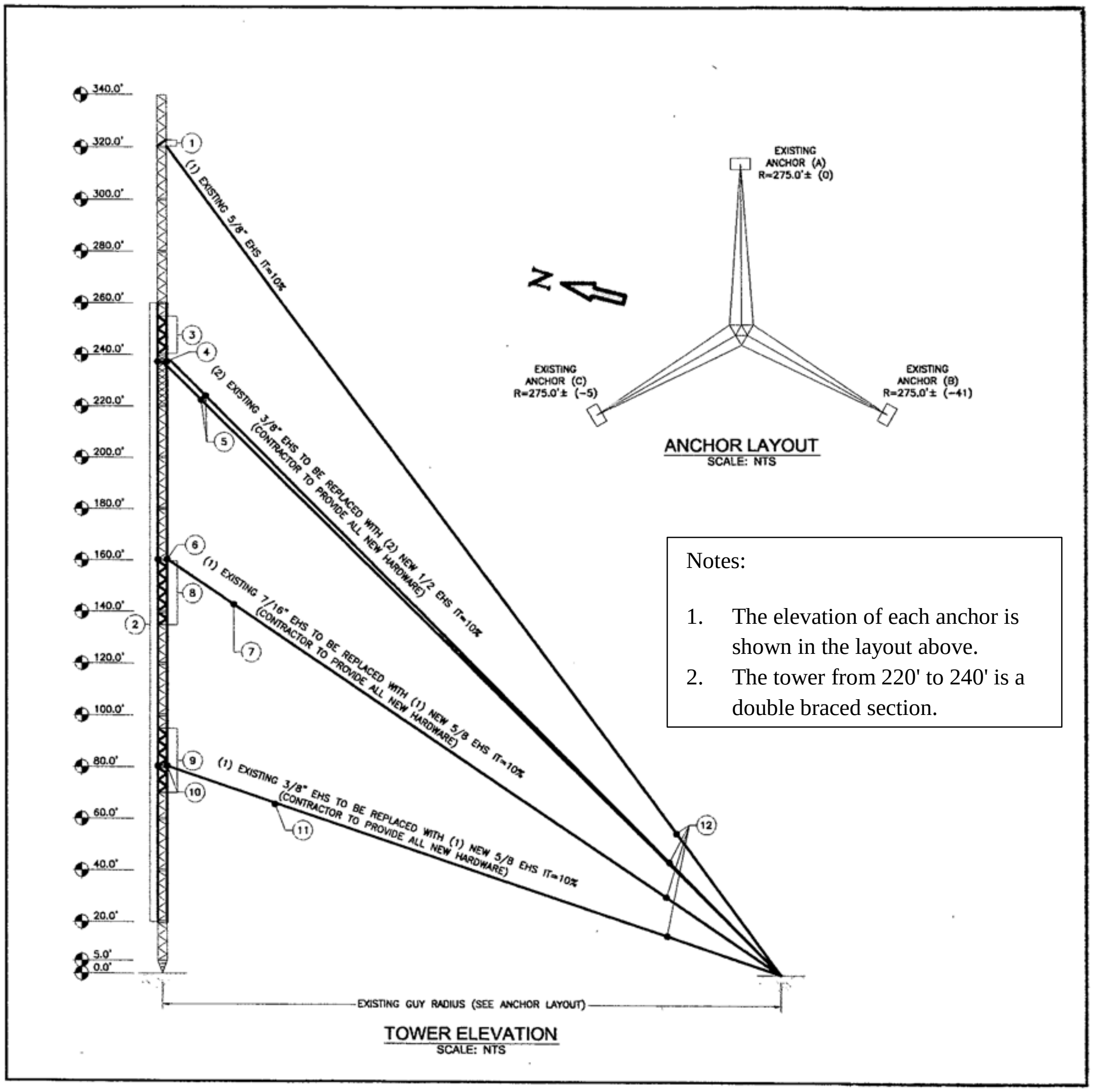

Figure 1. Plan and elevation of the cell tower and its anchors before the collapse (modified from the Modification Drawings, by FDH Engineering, Inc., August 2013).

The triangular tower was originally designed by UNR-ROHN of Peoria, IL in 1990 and was assembled with pre-fabricated ROHN 80 sections. SBA Network Services, Inc. (SBA) of Boca Raton, FL was the owner of the tower and the associated site. SBA retained FDH Engineering, Inc. (FDH) of Raleigh, NC as the structural engineer of record (SER) to provide engineering services to upgrade and modify the tower. FDH inspected the tower in April 2013, performed structural analysis of the tower and made recommendations in June 2013. FDH prepared modification drawings in August 2013.

FDH retained SNS Communication Specialists, Inc. (SNS) of Bokoshe, OK as the contractor (erector) to perform the required modifications to the tower. SNS started to mobilize equipment and materials at the site on January 27, 2014. SNS started the construction work by placing new guy wires on the ground and prepared to replace diagonals on the tower as identified by FDH.

The Incident

February 1, 2014, the day of the incident, was the first day SNS began construction activities on the tower. SNS had a foreman and five employees at the site. Three employees, one on each face of the tower, started to remove the existing diagonals from the tower legs at approximately 70' from the ground and progressed upward. The fourth employee was bringing the removed diagonals from the tower down to the ground and to the welder (the fifth employee) at the workstation approximately 50' away from the tower base. Based on the actual hole distance of the removed diagonals, the welder would cut new steel angle pieces, drill holes at its ends, paint and take pictures before sending them up as replacements.

The old diagonals were removed without installing any temporary supports to offset the loss of strength of the tower. The tower suddenly collapsed at approximately 11:37 a.m. At the time of the collapse, two old pipe diagonals and one old steel angle diagonal were identified at the workstation (Figure 2). One old pipe diagonal was located on the passageway near the tower (Figure 3). Another old diagonal that was wrapped with a rope remained in place on the way down from the tower (Figure 4). Thus, a total of five old diagonals were recovered at the site away from the tower. In addition, SBA safety personnel also recovered eight used (old) connecting bolts from the work bags of the injured employees. It is believed that these bolts were used to connect the diagonals at the lugs of the tower legs.

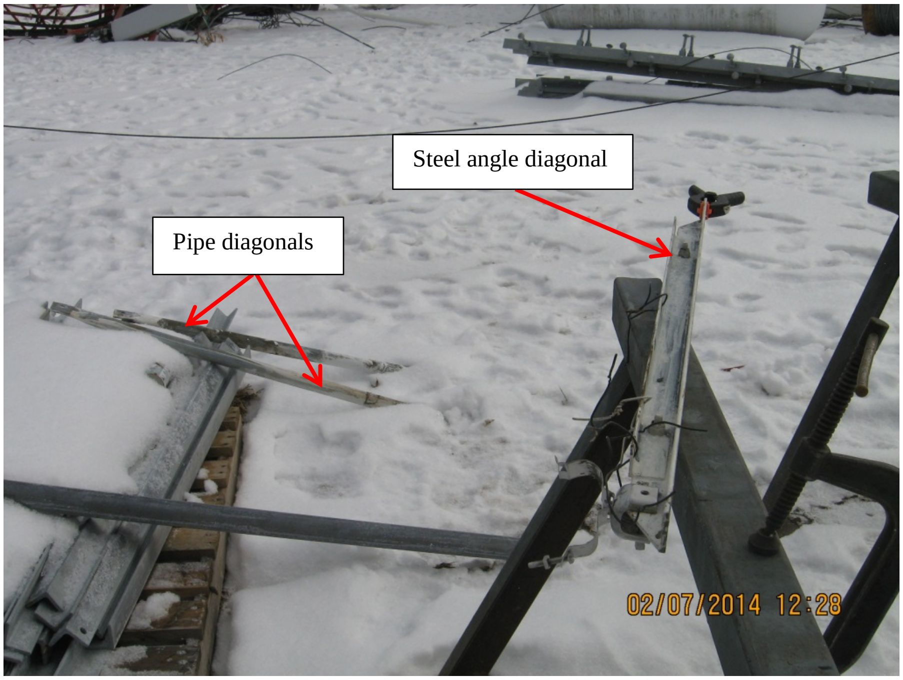

Figure 2. Two old pipe diagonals and one old steel angle diagonal were found at the workstation.

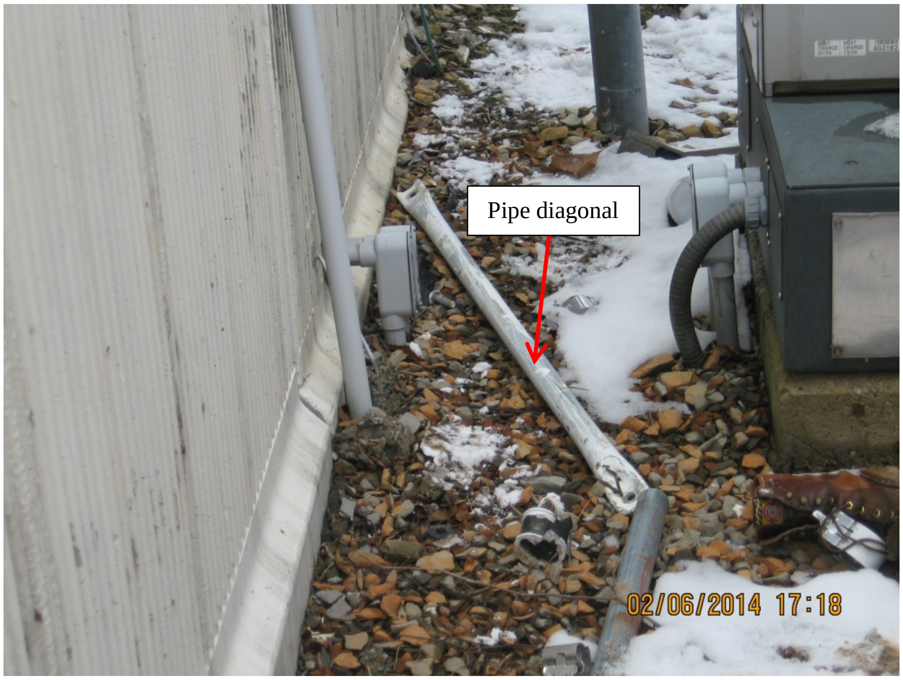

Figure 3. The fourth round diagonal, removed earlier from the tower, was found on the passageway near the tower.

Figure 4. The fifth round diagonal, still fastened to a rope, was found on the way down from the tower.

Observations of the Collapsed Tower

From observations of the collapsed tower, it appeared that the top 190' of the tower dropped nearly vertically to the ground. This portion of the tower then tilted and fell towards the northwest direction (see Figures 5, 6 and 7). The bottom 150' of the tower folded back-and-forth in the southwest and northeast directions like a folding ladder (Figures 8 through 12). In Figure 8, the bottom of the tower shifted only approximately 2' from its original position during the collapse. In Figure 12, the top of the lower portion of the tower, at approximately 150' from the base, fell to the ground within a 10' radius of the concrete foundation.

From the above description, it is believed that the top 190' of the tower was essentially intact before the collapse. The day of the incident was the first day the contractor did work on the tower. The contractor had removed five diagonals from the tower and disabled six diagonals (see explanations in Pages 13 and 14) without providing any temporary bracings to the tower between 70' to 80' from its base. This improper construction procedure would significantly increase the unbraced length and decrease the compressive capacity of the tower legs in this 10' length. As a result, the tower was subject to bending or folding at approximately 75' due to the existing vertical loads. The bending and folding of the tower proceeded downward to the base and upward to approximately 150'. Perhaps due to the lesser vertical loads and the effect of the upper guy wires, the bending and folding of the tower stopped at 150'. Thus, it is believed that the inadequate construction procedures initiated the collapse of the tower.

Figure 5. The upper portion of the collapsed tower, approximately from 150' to 190' above the ground (looking northeast).

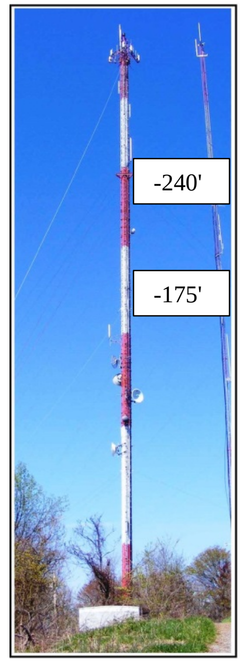

Figure 6. The upper portion of the collapsed tower, approximately from 175' to 240' above the ground (looking northeast).

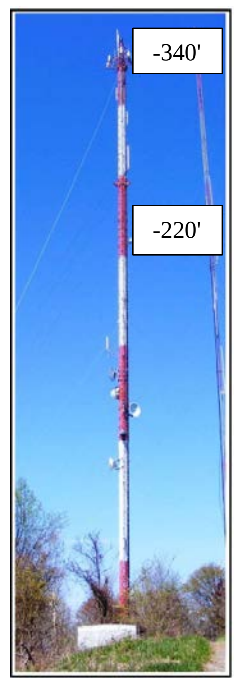

Figure 7. The upper portion of the collapsed tower, approximately from 220' to the top of the tower at 340' above the ground (looking northeast).

Figure 8. The lower portion of the folded and collapsed tower at its northwest end. Note that the 150' mark of the tower is at the lower-left corner of the photo and the base of the tower is at the lower-middle of the photo (WVSP Photo 5920, looking east).

Figure 9. The lower portion of the folded and collapsed tower at its southeast end (WVSP Photo 5924, looking northeast).

Figure 10. The lower portion of the folded and collapsed tower at its southeast end (WVSP Photo 5864, looking southwest).

Figure 11. The lower portion of the folded and collapsed tower at the middle of the collapsed pile (WVSP Photo 5868, looking southwest).

Figure 12. The lower portion of the folded and collapsed tower at its northwest end (WVSP Photo 5869, looking northwest).

Analysis

The guyed tower was a tall and slender structure designed primarily to support the axial compressive loads or the gravity loads arising from its own weight and the weights of antennas, dishes, coaxes, ice, etc., that were mounted or fell on it. The tower must be properly plumbed by the guy wires to minimize any flexural stresses. The bottom of the tower is usually pin connected to its foundation to eliminate any flexural stresses. All lateral forces from wind, earthquake, etc. applied to the tower were resisted by a series of pre-tensioned guy wires at different elevations.

The strength of a compressive member is determined by its unbraced length. It is, therefore, critical that the tower legs remain braced to maintain its capacity to carry the loads. The bracings must be placed in two different horizontal directions to ensure stability of the tower legs. The axial compressive capacity of a member is inversely proportional to the square of its unbraced length. In other words, if the unbraced length of the tower legs is doubled, the compressive capacity will be reduced to 25% of its original capacity.

In Figure 1, the tower in this project was constructed with seventeen sections of ROHN 80. Each section was 20' in length. The bottom section had a 5' tapered base. Except for the twelfth section, from 220' to 240' above ground, the tower was double braced to support the torque arm, while the remaining sixteen sections were single braced as shown in Figure 13. From this figure, the tower was triangular in shape. Each tower leg consisted of 2" diameter steel pipes. They were 41" apart. The unbraced length of the tower leg was approximately 4'-10" for the single-braced section and 2'-5" for the double-braced section.

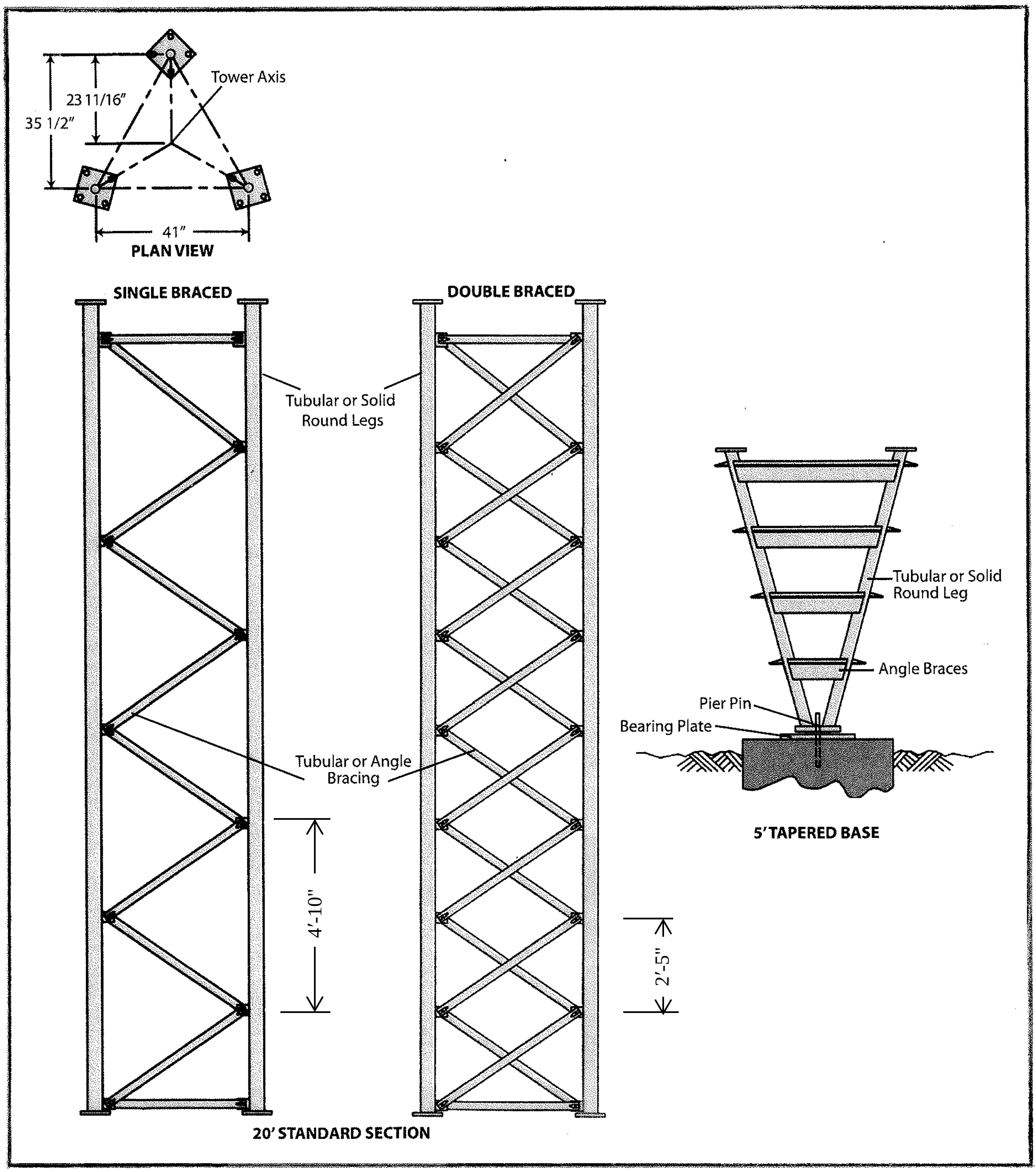

Figure 13. ROHN Standard 80 Series guyed tower section (modified from ROHN Products LLC, Product Catalog No. 3, Page 155, 2013).

In Figure 14, at each welded lug of the tower leg, there was one bolt connecting two diagonals. One diagonal had two holes for connection, one at each end. Thus, removing one bolt would disable two diagonals, although they would still be connected to the tower at the other ends. Figure 15 shows a disabled diagonal still attached to the collapsed tower.

Figure 14. Welded lug of the tower leg; one bolt connects two diagonals.

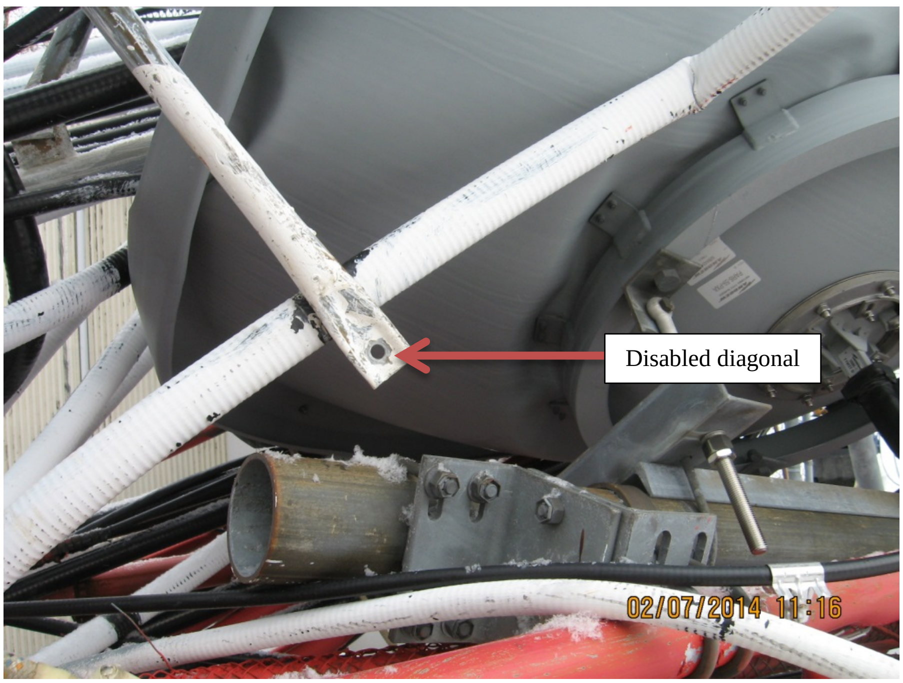

Figure 15. A diagonal disabled by being unbolted from the lug. It is still attached to the tower.

Removing bolts at each end of one diagonal would separate the diagonal completely from the tower but this would also disable two adjacent diagonals. For simplicity, three faces of the triangular tower are laid out in one plane as shown in the upper portion of Figure 16. In this figure, when eight bolts were removed, it produced six disabled diagonals (in dash lines) and five separated diagonals (in red lines). It should be noted that the numbers of removed bolts, disabled diagonals, and separated diagonals were consistent with the collections from the incident site.

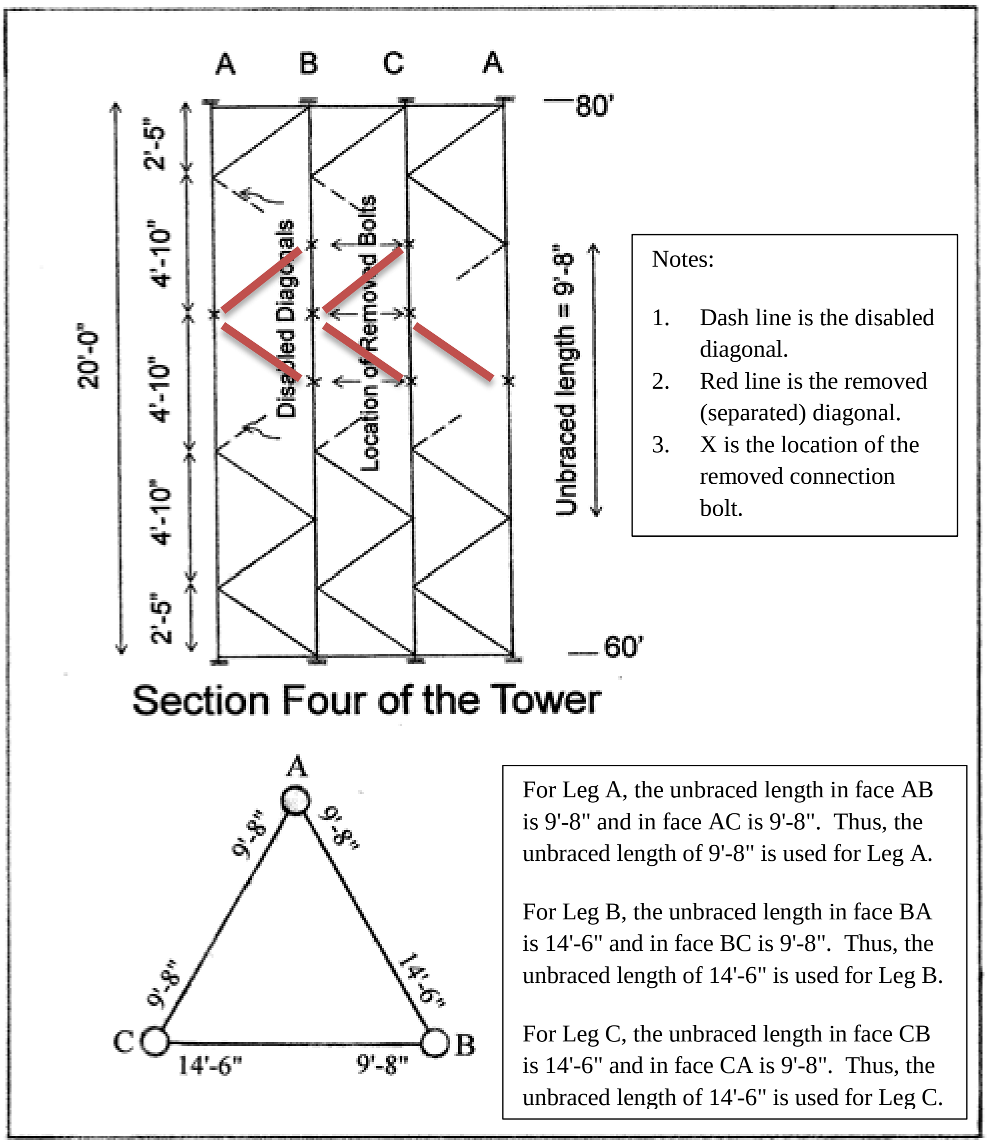

Figure 16. Determination of the Unbraced Length of the Tower Legs.

Principles of structural mechanics require that a column be laterally braced in two principal directions. When the unbraced lengths in the two directions are not equal, the longer unbraced length governs, if the sectional properties of the column are same in these two directions. Thus, from the configurations and explanations in Figure 16, the unbraced length of each tower leg was estimated to be 9'-8" for leg A, and 14'-6" for legs B and C.

Based on the unbraced length of 14'-6" and the section properties of the leg at a height of 70' above ground, the ultimate compressive capacity of leg B or C was calculated to be 6.78 kips per leg, disregarding any factor of safety. The vertical loads, including the weight of the tower above, the half weight of the guy wires and the vertical components of the tensile force in guy wires were computed to be 8.82 kips per leg. The actual vertical load was greater than the ultimate compressive capacity of the leg. Thus, the tower legs B and C failed as the diagonals were removed without installing any temporary supports. As a result, the tower collapsed. It should be noted that the above vertical load computations did not include the weight of antennas, dishes, coaxes, ice, etc.

Discussion

One of the recognized industry standards for “Installation, Alteration and Maintenance of Antenna Supporting Structures and Antennas” is ANSI/TIA -1019-A-2012. The industry standard requires that:

- Proposed activities shall be classified in accord with the Table 2-1 of the standard (Section 2.2).
- For Class II, III and IV construction, a written rigging plan shall be established showing the construction sequence, and *“procedures for the removal or reinforcing of structural members”* (Section 2.2.2, and Annex D).
- A qualified engineer shall be involved in establishing such a written plan (Section 2.2.1).
- Temporary member capable of supporting the loading condition shall be provided when removing a structural member, such as a diagonal (Section 2.7.1).

(It should be noted that a copy of the above mentioned sections is included in Attachment A.)

The contractor was engaged in removal of diagonals. ANSI/TIA-1019-2012 identifies diagonals as structural members; see Section 2.7.1 of the standard. Removal of a structural member falls under Class IV of Table 2-1 which establishes a minimum level of responsibility to a *“qualified person with qualified engineer.”* Section 2.2 of the standard requires that a written rigging plan be established. Section 2.2.1 further states that for Class III and IV construction, a qualified person shall coordinate the involvement of a qualified engineer when establishing rigging plans.

The contractor violated the industry standard ANSI/TIA-1019-A-2012 in that:

1. No written rigging plan was established showing the manner, sequence and number of diagonal to be removed at a time.
2. No qualified engineer was involved in establishing any rigging plan.
3. No temporary supports were provided when removing structural members.

Another industry standard is ANSI/TIA-222-G-2005 entitled “Structural Standard for Antenna Supporting Structures and Antennas”. Section 16.0 of the standard states that *“Rigging and* *temporary supports such as temporary guys, braces, false work, cribbing or other elements required for erection/modification shall be determined, documented, furnished and installed by the erector accounting for the loads imposed on the structure due to the proposed construction methods."* The contractor violated this standard by not providing any temporary supports while removing diagonals from the tower.

It should be noted that the Contact Drawing N-2, Contractor Qualification Note 1, requires that *"All repairs shall be performed by a tower contractor with a minimum 5 years experience in tower erection and retrofit and with working knowledge of the ANSI/TIA-222-G."* In addition, Contractor Qualification Note 4, requires that *"All construction to be in accordance with the ANSI/TIA-1019-A Standard."*

Figure 17 shows that the snap hook from one of the injured employees was attached and anchored to a horizontal bracing member of the tower. The horizontal bracing was a steel pipe with 1½" O.D. x 16 GA in size and 2'-10" in span (ROHN Commercial Products, Drawing No. C681228 R_5, 1981). The maximum vertical load at the mid span, based on the plastic flexural capacity of the pipe, was estimated to be approximately 600 pounds (see Attachment B). OSHA standard 1926.502(d)(15) requires that *"Anchorages used for attachment of personal fall arrest equipment shall be … capable of supporting at least 5,000 pounds (22.4 kN) per employee attached,* ***or*** *shall be designed, installed, and used as follows: (i) as part of a complete personal fall arrest system which maintains a safety factor of at least two; and…"*

Figure 17. The snap hook from one of the injured employees was anchored to a horizontal bracing member of the tower (WVSP Photo 5969).

Figure 17 also shows that the other end of the snap hook was connected to a shock-absorbing lanyard, which was typically capable of limiting the maximum fall arrest force to approximately 900 pounds. With the minimum required safety factor of two, the anchorage for the shock-absorbing lanyard must be capable of supporting a vertical load of at least 1,800 pounds without failure. But, the horizontal bracing member had a vertical load capacity of 600 pounds, much less than the required anchorage capacity. Thus, the contractor did not comply with OSHA standard 1926.502(d)(15).

From the witness accounts and the climatological data from the Harrison/Marion Regional Airport, at the time of the collapse, there was no measureable wind at the incident site. Therefore, wind was not a causal factor of the tower collapse.

Conclusions

1. The cause of the cell tower collapse was the simultaneous removal of multiple diagonals from different faces of the tower compromising the load carrying capacity of the tower legs. No temporary supports were provided prior to the diagonal removing process.

2. The contractor did not comply with the industry standard – ANSI/TIA-1019-A, Section 2.2. Rigging Plans and Section 2.7. Temporary Supports, when removing diagonals from the tower:
   - No written rigging plan was established showing the manner, sequence and number of diagonal to be removed at a time.
   - No qualified engineer was involved in establishing any rigging plan.
   - No temporary supports were provided when removing structural members.

   In addition, the contractor did not comply with the industry standard – ANSI/TIA222-G, Section 16.0 Installation; by not providing any temporary supports while removing diagonals from the tower.

   Thus, the contractor violated Occupational Safety and Health Act of 1970, Section 5(a)(1).

3. One of the personal fall arrest systems used by the employees was anchored to a horizontal bracing member of the tower. A shock-absorbing lanyard was used in this system. Under this condition, the maximum fall arrest force was limited to approximately 900 pounds. The minimum required anchorage capacity would need to have been approximately 1,800 pounds to achieve a safety factor of two. However, the horizontal bracing member had a capacity of 600 pounds less than the required anchorage capacity. Thus, the contractor did not comply with OSHA standard 1926.502(d)(15).

4. Wind was not a causal factor of the tower collapse.

ATTACHMENT A

SELECTED PAGES OF THE RELATED INDUSTRY STANDARDS

ADVANCING GLOBAL COMMUNICATIONS

ANSI/TIA-1019-A-2012
APPROVED: AUGUST 16, 2012

TIA STANDARD

Standard for Installation, Alteration and Maintenance of Antenna Supporting Structures and Antennas

TIA-1019-A **September 2012**

TELECOMMUNICATIONS
INDUSTRY ASSOCIATION

tiaonline.org

2. CONSTRUCTION CONSIDERATIONS

2.1. Scope

This section describes the considerations and processes to investigate strength and stability when installing, removing or altering antenna supporting structures or antennas and when adding or removing appurtenances and construction equipment.

2.2. Rigging Plans

All construction shall be classified in accordance with Table 2-1 based on the scope of the proposed construction work.

Proposed activities shall be outlined in a written rigging plan prior to implementation of Class II, III and IV construction.

The minimum level of responsibility for establishing a rigging plan is specified in Table 2-1.

2.2.1. Rigging Plan Requirements

An onsite Competent Rigger shall be identified for all classes of construction for identifying hazards and for authorizing prompt corrective measures as required. For Class III and IV Construction, a Qualified Person shall coordinate the involvement of a Qualified Engineer as required (i.e. satisfying Sections 2.7 Temporary Supports, Section 4 Supporting Structure Loading, etc.) when establishing rigging plans. A Qualified Engineer shall perform the analysis of structures and/or components for Class IV Construction.

2.2.2. Rigging Plan Considerations

The rigging plan shall consider the following in accordance with this Standard as applicable:

a) Operational and non-operational construction loads (refer to Section 4.3).

b) Construction equipment.

c) Supporting structure.

d) Construction sequence and duration.

e) Required load testing and field monitoring.

Note: Refer to Annex D for a rigging plan template.

2.3. Construction Equipment

2.3.1. General Considerations

The effects on the structure from heel (base) blocks, crown (top) blocks and other similar connection devices that apply horizontal and vertical forces to the structure shall be considered.

2.6.3. Hoist Mechanisms

Selection, use and operation of hoist mechanisms shall be in accordance with ANSI/ASME B30.7-2006, "Base-Mounted Drum Hoists", and in addition when lifting personnel NATE, "Base Mounted Hoist Mechanism Design and Use Standard for Lifting Personnel While Working on Telecommunications Structures", 2003.

2.6.4. Capstan Hoists

Anchorage of capstan hoists shall be in accordance with Section 2.6.1.

Capstan hoists shall not be used to raise or lower personnel or to lift loads directly over personnel.

The operator shall be properly trained on the operation of the capstan hoist. The number of wraps of rope on the capstan drum shall be consistent with the magnitude of the lift load and manufacturer's recommendation. The number of wraps on the drum shall be limited to prevent the rope from riding over the end of the drum. Precautions shall be taken to prevent entanglement of other lines with the capstan rope. A rope splice shall not be in contact with the capstan drum.

2.7. Temporary Supports

The potential for partial or complete collapse of a structure may exist when constructing, dismantling or altering structural components of a structure. A procedure defining critical steps in the process shall be provided and followed by the rigging crew during all phases of the work. Such a procedure shall take into consideration temporary reinforcing of members to support the structure while structural components are disconnected or altered and the potential of guy slippage. The procedure shall account for the loading conditions in Section 4.

2.7.1. Structural Members

Temporary members capable of supporting the loading conditions in Section 4. shall be provided when removing a structural member, such as a diagonal, horizontal or vertical member, refer to Figures 2-2 a, b, c, & d, except when a structural analysis indicates otherwise and is documented in the rigging plan.

2.7.2. Guy Replacement

Temporary guys capable of supporting the loading conditions referenced in Section 4. are required when replacing existing guys, refer to Figure 2-3, except when a structural analysis indicates otherwise and is documented in the rigging plan. Vertical alignment, reduction of initial guy tensions, local structure forces and eccentric connections at guy anchors shall be considered in the rigging plan. The strength requirements of temporary guys shall comply with Section 2.7.5.

2.7.3. Guy Anchorage Inspection, Replacement or Alteration

Temporary supports shall be considered throughout foundation inspection, replacement or alteration activities. Temporary supports shall meet the loading conditions of Section 4. When inspection of an anchorage determines degradation of the anchor may be significant, the use of temporary supports shall be considered.

Table 2-1: Construction Classifications

Class	Description	Minimum Level of Responsibility
I	The scope of work does not affect the integrity of the structure and the proposed rigging loads are minor in comparison to the strength of the structure, but not exceeding rigging forces greater than 650 lbs.	Competent Rigger
II	The scope of work involves the removal or the addition of appurtenances, mounts, platforms, etc. that involve minor rigging loads in comparison to the strength of the structure, but not exceeding rigging forces greater than 1,000 lbs.	Competent Rigger
III	Rigging plans that involve work outside the scope of Class I, II or IV construction.	Qualified Person
IV	The scope of work involves custom or infrequent construction methods, removal of structural members or unique appurtenances, special engineered lifts, and unique situations.	Qualified Person with Qualified Engineer

ANNEX D: RIGGING PLANS (NORMATIVE)

D1. Scope

The intent of this annex is to provide information required to develop a Rigging Plan.

A rigging plan is intended to ensure that the proper procedures, equipment and rigging is used for each operation and to ensure that the supporting structure can support the rigging loads.

A rigging plan may be very detailed and complex or very simple, depending on the type of job and the type of equipment necessary to complete the job.

D2. Rigging Plan

The following data shall be considered when completing a Rigging Plan:

A. General
1. Scope of work
2. Construction sequence
3. Duration of construction
4. Monitoring requirements
5. Rigging plan classification
6. Gross loads to be lifted
7. Height of lift
8. Operational and non-operational wind loadings
9. Load lifting restrictions

B. Gin Poles
1. Vertical or tilted position
2. Gin pole identification number
3. Load chart reference number
4. Maximum cantilever required
5. Maximum load line positioning angle
6. Load line size and number of parts

C. Basket and Bridle Attachments
1. Sling size, type, angle and connection details to the structure and to the gin pole

D. Jumping of a Gin Pole
1. Jump line size and number of parts
2. Block sizes and connection details
3. Gin pole attachment details
4. Track details and connections to the structure

E. Hoists
1. Load chart indicating line pull based on number of layers on the drum
2. Hoist line pull required
3. Cable sizes and breaking strengths
4. Hoist anchorage details
5. End connection efficiencies

6. Distance and orientation from tower base

F. Base Blocks
1. Block size and capacity
2. Sling size and applicable rigging hardware
3. Attachment details to the structure, foundation or other support

G. Crown Blocks
1. Block size and capacity
2. Sling size and applicable rigging hardware
3. Attachment details to the structure

H. Tag Lines
1. Straight or trolley
2. Size and type of tag line
3. Tag angle restrictions

I. Cranes
1. Main
2. Tailing
3. Pedestal
4. Chicago boom

J. Supporting Structure
1. Condition assessment
2. Temporary guys
3. Reinforcement to support the rigging loads
4. Procedures for the removal or reinforcing of structural members
5. Procedures for guy replacement
6. Procedures for guy tensioning
7. Guy slippage considerations

K. Miscellaneous
1. Headache ball
2. Condition of appurtenances to be removed
3. Interference with climbing facilities
4. Field welding and cutting procedures

D3. Rigging Plan Templates

The type of rigging plan created must be applicable to the proposed construction and/or maintenance and be classified in accordance with Section 2.2.

D3.1. General Data

The following template is intended to be generic and modified for site-specific applications:

Rigging Plan			
Site Information			
Date			
Site Location			
Customer			
Job Number			
Rigging Plan Class	☐ I ☐ II ☐ III ☐ IV		
Persons Responsible	**Name**	**Company**	**Phone**
Competent Rigger			
Qualified Person ☐ N/A			
Qualified Engineer ☐ N/A			
Type of Structure			
☐ Pole ☐ SST ☐ Guyed ☐ Rooftop ☐ Other			
Type of Work			
☐ Installation of New Structure	☐ Add or Remove Antennas		
☐ Add or Remove TX Lines	☐ Add or Remove Mounts		
☐ Replace Structural Members	☐ Add Reinforcement		
☐ Change Guys	☐ Other		
Construction Sequence			
Construction Duration			
Field Monitoring			

ANSI/TIA-222-G-2005
Approved: August 2, 2005

TIA STANDARD

Structural Standard for Antenna Supporting Structures and Antennas

EFFECTIVE JANUARY 1, 2006

TIA-222-G

(Revision of TIA/EIA-222-F)

August 2005

TELECOMMUNICATIONS INDUSTRY ASSOCIATION

Representing the telecommunications industry in association with the Electronic Industries Alliance

Electronic Industries Alliance

15.7 Modification of Existing Structures

15.7.1 Design

Modifications to existing structures shall be based on a rigorous structural analysis. A design document shall be prepared indicating the proposed reinforcement of existing members and/or connections and all proposed additional members.

Prior to implementation of the changed conditions and/or modifications, the data designated on the design document requiring verification shall be validated.

16.0 INSTALLATION

Rigging and temporary supports such as temporary guys, braces, false work, cribbing or other elements required for the erection/modification shall be determined, documented, furnished and installed by the erector accounting for the loads imposed on the structure due to the proposed construction method.

THE MODIFICATIONS DEPICTED ON THESE DRAWINGS ARE BASED ON THE RECOMMENDATIONS OUTLINED IN THE STRUCTURAL ANALYSIS COMPLETED BY FDH ENGINEERING, INC., PROJECT NO. 1317701400 (R1) DATED JUNE 14, 2013.

THIS REPORT WAS BASED ON A SPECIFIC ANTENNA AND COAX CONFIGURATION PROVIDED BY THE TOWER OWNER. ANY CHANGE TO THIS INFORMATION MUST BE REVIEWED BY FDH ENGINEERING, INC.

ALL DIMENSIONS, MEASUREMENTS, QUANTITIES, PART NUMBERS AND COAX/ANTENNA PLACEMENTS TO BE FIELD VERIFIED BY CONTRACTOR PRIOR TO MATERIAL ORDERS AND CONSTRUCTION.

FOR INQUIRIES REGARDING THE CONTENT OF THESE MODIFICATION DRAWINGS, PLEASE CONTACT STEVEN STRICKLAND WITH THE FDH CONSTRUCTION DEPARTMENT (919) 755-1012

PROJECT DESCRIPTION:

MODIFICATION DRAWINGS FOR A 340' GUYED TOWER

SBA

SITE NAME:

DESPARD (TOWER 1)

SITE NUMBER:

WV08612-A-02

SITE ADDRESS:

9141 MURPHY ROAD
CLARKSBURG, WV 26301

COORDINATES:

LATITUDE: 39.2981°
LONGITUDE: -80.2996°

SHEET INDEX

SHT. NO.	DESCRIPTION
T-1	TITLE SHEET
N-1	POST CONSTRUCTION INSPECTION NOTES
N-2	GENERAL NOTES & COAX LAYOUT
S-1	MODIFICATION SCHEDULE
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S-8	PULSE CHARTS

PREPARED BY:

FDH
6521 MERIDIEN DRIVE
RALEIGH, NC 27616
PHONE: 919-755-1012
FAX: 919-755-1031
ENGINEERING INNOVATION

PREPARED FOR:

SBA
5900 BROKEN SOUND PARKWAY, NW
BOCA RATON, FL 33487
(800) 487-SITE

NEIL J. KUPLIC REGISTERED STATE OF WEST VIRGINIA PROFESSIONAL ENGINEER

08/23/13

NEIL J. KUPLIC P.E.
WEST VIRGINIA LIC. NO. 13915

DRAWN BY:	PF
CHECKED BY:	SCG
ENG APPV'D:	NJK
PROJECT NO:	13F9C31400

SUBMITTALS

DATE	DESCRIPTION	REV
08/23/13	CONSTRUCTION	0

SITE NAME:
DESPARD (TOWER 1)

SITE NUMBER:
WV08612-A-02

SITE ADDRESS:
9141 MURPHY ROAD
CLARKSBURG, WV 26301

SHEET TITLE
TITLE SHEET

SHEET NUMBER
T-1

GENERAL NOTES:

1. ALL WORK SHALL BE DONE IN ACCORDANCE WITH ALL APPLICABLE FEDERAL, STATE AND LOCAL CODES AND ORDINANCES. IT IS THE CONTRACTOR'S RESPONSIBILITY TO OBTAIN ALL PERMITS NECESSARY TO COMPLETE THE PROJECT AND ABIDE BY ALL CONDITIONS AND REQUIREMENTS OF THE PERMITS.
2. THE CONTRACTOR SHALL BE RESPONSIBLE FOR VERIFICATION OF ALL DIMENSIONS, ELEVATIONS AND EXISTING CONDITIONS AT THE SITE BEFORE ORDERING ANY MATERIALS OR DOING ANY WORK. NO EXTRA CHARGE OR COMPENSATION SHALL BE ALLOWED DUE TO DIFFERENCE BETWEEN ACTUAL DIMENSIONS AND DIMENSIONS INDICATED ON THE CONSTRUCTION DRAWINGS. ANY SUCH DISCREPANCY IN DIMENSION WHICH MAY BE FOUND SHALL BE SUBMITTED TO FDH ENGINEERING FOR CONSIDERATION BEFORE THE CONTRACTOR PROCEEDS WITH THE WORK IN THE AFFECTED AREAS.
3. INCORRECTLY FABRICATED, DAMAGED, OTHERWISE MISFITTING, OR NON-CONFORMING MATERIALS AND CONDITIONS SHALL BE REPORTED TO FDH ENGINEERING PRIOR TO ANY REMEDIAL OR CORRECTIVE ACTION. ALL ACTIONS SHALL REQUIRE FDH ENGINEERING APPROVAL.
4. IT IS THE CONTRACTOR'S SOLE RESPONSIBILITY TO DETERMINE ERECTION PROCEDURE AND SEQUENCE TO ENSURE THE SAFETY OF THE STRUCTURE AND ITS COMPONENT PARTS DURING ERECTION AND/OR FIELD MODIFICATIONS. THIS INCLUDES, BUT IS NOT LIMITED TO, THE ADDITION OF TEMPORARY BRACING, GUYS OR TIE DOWNS THAT MAY BE NECESSARY. SUCH MATERIAL SHALL BE REMOVED AFTER THE COMPLETION OF THE PROJECT.
5. CONTRACTOR SHALL PROMPTLY REMOVE ANY & ALL DEBRIS FROM SITE AND RESTORE AS BEST AS POSSIBLE TO PRECONSTRUCTION CONDITION.

CONTRACTOR QUALIFICATION NOTES:

1. ALL REPAIRS SHALL BE PERFORMED BY A TOWER CONTRACTOR WITH A MINIMUM 5 YEARS EXPERIENCE IN TOWER ERECTION AND RETROFIT AND WITH WORKING KNOWLEDGE OF THE ANSI/TIA-222-G "STRUCTURAL STANDARD FOR ANTENNA SUPPORTING STRUCTURES AND ANTENNAS".
2. CONTRACTOR IS RESPONSIBLE FOR ALL CONSTRUCTION MEANS AND METHODS. SHOULD THE CONTRACTOR REQUIRE DIRECT CONSULTATION, FDH ENGINEERING, INC. IS WILLING TO OFFER SERVICES BASED UPON AN AGREED FEE FOR THE WORK REQUIRED.
3. ALL SUBMITTAL INFORMATION MUST BE SENT TO FDH ENGINEERING, INC. 6521 MERIDIEN DRIVE, RALEIGH NC. 27616, TEL. (919) 755-1012, FAX. (919) 755-1031, E-MAIL INFO@FDH-INC.COM. ANY VARIATION OF THESE SPECIFICATIONS OR DRAWINGS WITHOUT CONSENT FROM FDH ENGINEERING, INC. WILL VOID ANY RESPONSIBILITY OR LIABILITY FOR DAMAGE (MATERIAL OR PHYSICAL) TOWARDS FDH ENGINEERING, INC.
4. ALL CONSTRUCTION TO BE IN ACCORDANCE WITH THE TIA-1019-A STANDARD.

JOB SITE SAFETY & NOTES:

1. NEITHER THE PROFESSIONAL ACTIVITIES OF FDH ENGINEERING, INC. NOR THE PRESENCE OF FDH ENGINEERING, INC. OR EMPLOYEES AND SUB-CONSULTANTS AT THE CONSTRUCTION SITE, SHALL RELIEVE THE GENERAL CONTRACTOR AND OR SUBCONTRACTORS AND ANY OTHER ENTITY OF THEIR OBLIGATIONS, DUTIES AND RESPONSIBILITIES INCLUDING, BUT NOT LIMITED TO, CONSTRUCTION MEANS, METHODS, SEQUENCE, TECHNIQUES OR PROCEDURES NECESSARY FOR PERFORMING, SUPERINTENDING OR COORDINATING ALL PORTIONS OF THE WORK OF CONSTRUCTION IN ACCORDANCE WITH THE CONTRACT DOCUMENTS AND ANY HEALTH OR SAFETY PRECAUTIONS REQUIRED BY ANY REGULATORY AGENCIES. THE GENERAL CONTRACTOR AND OR SUBCONTRACTOR IS SOLELY RESPONSIBLE FOR JOB SAFETY, AND WARRANTS THAT THIS INTENT IS EVIDENT BY ACCEPTING THIS WORK.

STEEL:

1. ALL STRUCTURAL STEEL SHALL BE FABRICATED AND ERECTED IN ACCORDANCE WITH THE LATEST AISC CODE AND ASTM SPECIFICATIONS.

   *ALL STEEL ANGLE USED FOR LEG REINFORCEMENT SHALL BE ASTM A572-50 (Fy=50KSI) UNLESS OTHERWISE SPECIFIED.

   *ALL STEEL ANGLE USED FOR BRACING SHALL BE ASTM A36 (Fy=36KSI) UNLESS OTHERWISE SPECIFIED.

   *ALL V-BOLTS TO BE MADE OF ASTM A36 (Fy=36KSI) UNLESS OTHERWISE SPECIFIED.

   *ALL STEEL PLATE SHALL BE ASTM A36 (Fy=36KSI) UNLESS OTHERWISE SPECIFIED.

   *ALL GUY WIRE SHALL BE ASTM A475 UNLESS OTHERWISE SPECIFIED.

   *ALL BYPASS STEEL SHALL BE ASTM A572-50 (Fy=50KSI) UNLESS OTHERWISE SPECIFIED.
2. ALL CONNECTIONS OF STRUCTURAL STEEL MEMBERS SHALL BE MADE USING SPECIFIED WELDS WITH WELDING ELECTRODES E-70XX OR SPECIFIED HIGH STRENGTH BOLTS TO BE ASTM A325N, THREAD INCLUDED WITH SHEAR PLANE (UNLESS OTHERWISE NOTED).
3. ALL BOLTED CONNECTIONS TO BE INSTALLED TO A SNUG-TIGHTENED CONDITION IN ACCORDANCE WITH AISC 13 PART 16.2, "SPECIFICATION FOR STRUCTURAL JOINTS USING ASTM A325 OR A490 BOLTS", SECTION 8.1, UNLESS OTHERWISE SPECIFIED. WHEN "X" TYPE BOLTS ARE USED, CONTRACTOR MAY BE REQUIRED TO STACK ADDITIONAL WASHERS TO OBTAIN PROPER SNUG TIGHT INSTALLATION. ALL NUTS SHALL BE HEAVY HEX UNLESS OTHERWISE NOTED.
4. ALL STEEL, AFTER FABRICATION, SHALL BE HOT DIPPED GALVANIZED PER ASTM A-123. ALL DAMAGED SURFACES, WELDED AREAS AND AUTHORIZED NON-GALVANIZED MEMBERS OR PARTS (EXISTING OR NEW) SHALL BE PAINTED WITH MULTIPLE COATS OF ZRC COLD GALVANIZING COMPOUND ACHIEVING A MINIMUM OF 4 MILS DRY FILM PER ASTM A 780.
5. ALL SHOP AND FIELD WELDING SHALL BE DONE BY WELDERS QUALIFIED AS DESCRIBED IN THE "AMERICAN WELDING SOCIETY'S STANDARD QUALIFICATION PROCEDURE" TO PERFORM THE TYPE OF WORK REQUIRED. CONTRACTOR IS REQUIRED TO PROVIDE FDH ENGINEERING, INC. WITH A PASSING CERTIFIED WELDING INSPECTION FOR ALL WELDS.
6. STRUCTURAL STEEL MAY NOT BE TORCH CUT FOR FABRICATION. ALL STEEL FABRICATION MUST FOLLOW AISC STANDARDS.

MISC. NOTES:

1. ALL MODIFICATIONS ARE ASSUMED TO BE MADE ON AN EMPTY TOWER. CONTRACTOR IS RESPONSIBLE TO MAKE PROVISIONS TO SUPPORT OR WORK AROUND EXISTING ANTENNAS AND TRANSMISSION LINES. MODIFICATIONS MUST BE CONTINUOUS THROUGH ALL AREAS SHOWN.
2. CONTRACTOR FIELD VERIFY ALL DIMENSIONS PRIOR TO CONSTRUCTION.

FABRICATION NOTES:

1. ALL DIMENSIONS ARE PRELIMINARY UNTIL FIELD VERIFIED BY CONTRACTOR. ANY CHANGES MUST BE APPROVED BY ENGINEER OF RECORD IN WRITING PRIOR TO FABRICATION AND INSTALLATION.
2. NEW STEEL MEMBERS MUST HAVE SINGLE DRILLED HOLES. SLOTTED AND DOUBLE DRILLED HOLES ARE NOT ACCEPTABLE MEANS OF FABRICATION.

SUBSTITUTES AND/OR EQUALS:

1. IF CONTRACTOR WISHES TO FURNISH OR USE A SUBSTITUTE ITEM OF MATERIAL OR EQUIPMENT, CONTRACTOR SHALL FIRST MAKE WRITTEN APPLICATION TO ENGINEER OF RECORD FOR ACCEPTANCE THEREOF, CERTIFYING THAT THE PROPOSED SUBSTITUTE WILL PERFORM ADEQUATELY THE FUNCTIONS AND ACHIEVE THE RESULTS CALLED FOR BY THE GENERAL DESIGN, BE SIMILAR IN SUBSTANCE TO THAT SPECIFIED AND SUITED TO THE SAME USE AS THAT SPECIFIED. ALL VARIATIONS OF THE PROPOSED SUBSTITUTE FROM THAT SPECIFIED WILL BE IDENTIFIED IN THE APPLICATION AND AVAILABLE MAINTENANCE, REPAIR AND REPLACEMENT SERVICE WILL BE INDICATED. THE APPLICATION WILL ALSO CONTAIN AN ITEMIZED ESTIMATE OF ALL COSTS OR CREDITS THAT WILL RESULT DIRECTLY OR INDIRECTLY FROM ACCEPTANCE OF SUCH SUBSTITUTE INCLUDING COSTS OF REDESIGN AND CLAIMS OF OTHER CONTRACTORS AFFECTED BY THE RESULTING CHANGE, ALL OF WHICH WILL BE CONSIDERED BY ENGINEER OF RECORD IN EVALUATION OF THE PROPOSED SUBSTITUTE. ENGINEER OF RECORD MAY REQUIRE CONTRACTOR TO FURNISH ADDITIONAL DATA ABOUT THE PROPOSED SUBSTITUTE.

ANGLE LEG REINFORCEMENT NOTES:

1. CONTRACTOR MUST FIELD VERIFY ALL LENGTHS PRIOR TO CONSTRUCTION.
2. ALL DIMENSIONS ARE PRELIMINARY UNTIL FIELD VERIFIED BY CONTRACTOR. ANY CHANGES MUST BE APPROVED BY ENGINEER OF RECORD IN WRITING PRIOR TO FABRICATION AND INSTALLATION.

SURFACE PREPARATION:

1. PREPARE SURFACE TO BE WELDED BY REMOVING PAINT OR GALVANIZATION TO BARE METAL USING POWER WIRE BRUSHING IN ACCORDANCE WITH SSPC-SP11, (STEEL STRUCTURES PAINTING COUNCIL). FOLLOWING POWER WIRE BRUSHING CONTRACTOR SHALL POLISH METAL SURFACE WITH HIGH SPEED GRINDER WITH 400+ GRIT SANDPAPER.
2. BUTTER INTERIOR (SIDE IN CONTACT WITH LEG) OF REINFORCEMENT WITH SILICON GEL TO FORM GASKET BETWEEN CONTACT SURFACE.
3. AFTER NEW STEEL INSTALLATION CONTRACTOR TO BRUSH PAINT (2) COATS OF ZRC OR ZINGA COLD GALVANIZATION COMPOUND PER MANUFACTURER'S SPECIFICATIONS

ANGLE WELDING:

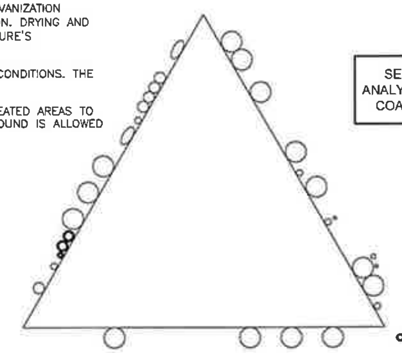
1. ALL WELDING TO THE EXISTING TOWER SHALL BE PERFORMED BY CERTIFIED WELDERS UTILIZING PROCEDURES QUALIFIED IN ACCORDANCE WITH AWS D1.1 AND AWS C5.4.
2. CONTRACTOR SHALL COMPLY WITH AWS D1.1 FOR PROCEDURES, APPEARANCE AND QUALITY OF WELDS AND FOR METHODS USED IN CORRECTING WELDING. ALL WELDERS AND WELDING PROCESSES SHALL BE QUALIFIED IN ACCORDANCE WITH AWS "STANDARD QUALIFICATION PROCEDURES". CONTRACTOR SHALL SUBMIT CERTIFICATION OF WELDERS TO THE ENGINEER PRIOR TO COMMENCEMENT OF THE WORK.
3. CONTRACTOR RESPONSIBLE FOR TEMPORARY HEAT SHIELDING AS REQUIRED DURING WELDING.
4. ALL WELDS TO BE VISUALLY INSPECTED BY A CERTIFIED WELD INSPECTOR PER AWS D1.1.
5. CONTRACTOR TO BE AWARE THAT EXISTING TOWER LEG THICKNESS IS EXTREMELY THIN. CONTRACTOR TO USE CAUTION WHEN WELDING TO PREVENT LEG BLOW OUT.
6. CONTRACTOR RESPONSIBLE FOR VIEWING EXISTING TOWER FOR LOOSE AND FLAMMABLE MATERIAL PRIOR TO WELDING FLAT PLATE.

COLD GALVANIZATION/SURFACE PREPARATION NOTES:

1. CONTRACTOR TO USE ZINGA OR ZRC COLD GALVANIZATION COMPOUNDS OR APPROVED EQUIVALENT.
2. PREPARE RUSTED/CORRODED SURFACE FOR TREATMENT ACCORDING TO MANUFACTURE'S RECOMMENDATIONS.
3. CONTRACTOR TO APPLY (2) COATS OF COLD GALVANIZATION COMPOUND PER MANUFACTURE'S RECOMMENDATION. DRYING AND CURING TIMES MUST BE UTILIZED PER MANUFACTURE'S RECOMMENDATION.
4. APPLY ALL COATINGS BY BRUSH IN CALM WIND CONDITIONS. THE USE OF AEROSOL IS NOT PERMITTED.
5. IF THE TOWER IS PAINTED, BRUSH PAINT ALL TREATED AREAS TO MATCH TOWER AFTER COLD GALVANIZATION COMPOUND IS ALLOWED TO CURE.

GUY WIRE SPECIFICATIONS:

1. ADJUST INITIAL TENSION AS REQUIRED FOR TEMPERATURE CONDITIONS UPON INSTALLATION OF GUY WIRES. CONTACT ENGINEER OF RECORD IF NECESSARY.
2. UPON INSTALLATION OF NEW GUY WIRES, CONTRACTOR IS RESPONSIBLE FOR ENSURING PLUMB AND TENSION OF ALL GUY WIRES ARE WITHIN ANSI/TIA-222-G SPECIFICATIONS.
3. ALL NEW GUY WIRE HARDWARE SHALL BE PROVIDED BY CONTRACTOR AS NOTED.
4. ANCHOR DROPOFFS AND RADII MAY VARY. CONTRACTOR TO PERFORM SITE VISIT PRIOR TO MATERIAL ORDERS.
5. CONTRACTOR MAY BE REQUIRED TO BORE EXISTING FAN PLATE AND/OR GUY LUG HOLES TO ENSURE PROPER FIT OF NEW HARDWARE. CONTRACTOR MUST CONTACT FDH PROJECT MANAGER PRIOR TO BORING FAN PLATE HOLES.



SEE STRUCTURAL ANALYSIS FOR DETAILED COAX INFORMATION.

COAX LAYOUT
SCALE: NTS

PREPARED BY:

FDH ENGINEERING INNOVATION
6521 MERIDIEN DRIVE RALEIGH, NC 27616 PHONE: 919-755-1012 FAX: 919-755-1031

PREPARED FOR:

SBA
5900 BROKEN SOUND PARKWAY, NW BOCA RATON, FL 33487 (800) 487-SITE

NEIL J. KUPLIC REGISTERED 13915 STATE OF WEST VIRGINIA PROFESSIONAL ENGINEER

NEIL J. KUPLIC P.E. 08/23/13
WEST VIRGINIA LIC. NO. 13915

DRAWN BY:	PF
CHECKED BY:	SCG
ENG APPV'D:	NJK
PROJECT NO:	13F9C31400

SUBMITTALS

DATE	DESCRIPTION	REV
08/23/13	CONSTRUCTION	0

THE INFORMATION CONTAINED IN THIS SET OF DOCUMENTS IS PROPRIETARY BY NATURE. REPRODUCTION OR CAUSING TO BE REPRODUCED THE WHOLE OR ANY PART OF THESE DRAWINGS WITHOUT THE PERMISSION OF FDH ENGINEERING, INC. IS PROHIBITED.

SITE NAME:
DESPARD (TOWER 1)

SITE NUMBER:
WV08612-A-02

SITE ADDRESS:
9141 MURPHY ROAD
CLARKSBURG, WV 26301

SHEET TITLE
GENERAL NOTES & COAX LAYOUT

SHEET NUMBER
N-2

ATTACHMENT B

EVALUATION OF THE CAPACITY OF THE HORIZONTAL BRACES AS THE ANCHORAGE FOR THE PERSONAL FALL ARREST SYSTEM

Evaluation of the capacity of the horizontal braces as the anchorage for the personal fall arrest system.

From: Rohn Drawing No. C681228 Rs (Page B-3)
UNR-ROHN Original Design Drawing No. D900798 (Page B-4)
Alro Steel Tubing & Pipe, Page No. 7-17 (Page B-5)
The size of the horizontal brace was steel tube TS 1½" O.D. x 16 gage with O.D. = 1.50 in., I.D. = 1.37 in. and the span length = 2'-10" = 34"

From AISC (2011), Page 2-48, $F_y = 35$ ksi for steel pipe.
From AISC (2011), Page 17-39, the gross plastic section modulus (Z)

$$Z = \frac{(O.D.)^3}{6} - \frac{(I.D.)^3}{6} = \frac{(1.50'')^3}{6} - \frac{(1.37'')^3}{6} = 0.5625\ in^3 - 0.4286\ in^3$$

$$= 0.1339\ in^3 \doteqdot 0.134\ in^3$$

From AISC (2011), Page 3-215, for simple beam - concentrated load at center

$$M_{max} = P_{max} \times L/4$$

From AISC (2011), Page 16.1-47, Yielding

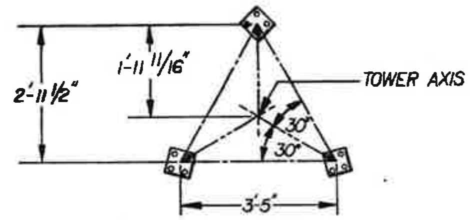
$$M_n = F_y Z_x$$

Assuming $M_n = M_{max}$, $Z_x = Z$. Thus, $F_y Z = P_{max} \times L/4$

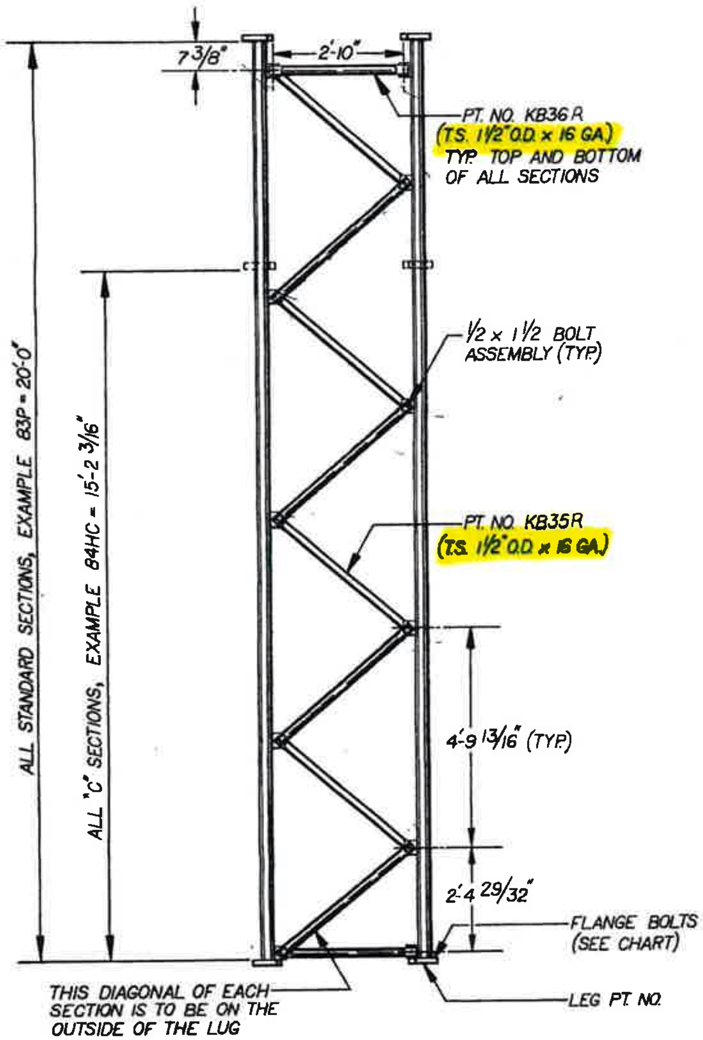
The vertical load capacity (P_{max}) of the horizontal bracing member is:

$$P_{max} = \frac{4 F_y Z}{L} = \frac{4 \times 35\,ksi \times 0.134\ in^3}{34\ in.} = 0.552\ kips = 552\ pounds,\ say\ 600\ pounds$$

From Pages B-6 and B-7, the maximum fall arrest force for a 6 ft long shock absorbing lanyard was approximately 900 pounds. With the minimum required safety factor of two, the anchorage for the shock-absorbing laynard must be capable of supporting a vertical load of at least 1,800 pounds.
900 pounds × 2 (Factor of safety) = 1,800 pounds > 600 pounds. NO GOOD.



PLAN VIEW



ELEVATION VIEW

TOWER SECTION SCHEDULE

SECTION	LEGS			FLANGE BOLTS		STEP BOLTS		BRACES		BRACE BOLTS	
** PT. NO.	PIPE SIZE	PT. NO.	QTY.	SIZE PT. NO.	QTY.	PT. NO.	QTY.	PT. NO.	QTY.	SIZE PT. NO.	QTY.
83P	2" STD.	KL56	3	3/4x2 1/2 210049GA	12			KB35R KB36R	24 6	1/2 x 1 1/2 210018GA	33
83PS	2" STD.	KL56 KL56S	2 1	3/4x2 1/2 210049GA	12	5/8 STEP	16	KB35R KB36R	24 6	1/2 x 1 1/2 210018GA	33
83PH	2" X-STR.	KL57	3	3/4x2 1/2 210049GA	12			KB35R KB36R	24 6	1/2 x 1 1/2 210018GA	33
83PHS	2" X-STR.	KL57 KL57S	2 1	3/4x2 1/2 210049GA	12	5/8 STEP	16	KB35R KB36R	24 6	1/2 x 1 1/2 210018GA	33
84	2 1/2" STD.	KL60	3	3/4x2 1/2 210049GA	12			KB35R KB36R	24 6	1/2 x 1 1/2 210018GA	33
84S	2 1/2" STD.	KL60 KL60S	2 1	3/4x2 1/2 210049GA	12	5/8 STEP	16	KB35R KB36R	24 6	1/2 x 1 1/2 210018GA	33
84H	2 1/2" X-STR.	KL61	3	3/4x2 1/2 210049GA	12			KB35R KB36R	24 6	1/2 x 1 1/2 210018GA	33
84HS	2 1/2" X-STR.	KL61 KL61S	2 1	3/4x2 1/2 210049GA	12	5/8 STEP	16	KB35R KB36R	24 6	1/2 x 1 1/2 210018GA	33
84HC	2 1/2" X-STR.	KL159	3	3/4x2 1/2 210049GA	12			KB35R KB36R	18 6	1/2 x 1 1/2 210018GA	27
84HCS	2 1/2" X-STR.	KL159 KL159S	2 1	3/4x2 1/2 210049GA	12	5/8 STEP	12	KB35R KB36R	18 6	1/2 x 1 1/2 210018GA	27
85	3" STD.	KL64	3	7/8x3 1/2 210063GA	12			KB35R KB36R	24 6	1/2 x 1 1/2 210018GA	33
85S	3" STD.	KL64 KL64S	2 1	7/8x3 1/2 210063GA	12	5/8 STEP	16	KB35R KB36R	24 6	1/2 x 1 1/2 210018GA	33
85H	3" X-STR.	KL65	3	7/8x3 1/2 210063GA	12			KB35R KB36R	24 6	1/2 x 1 1/2 210018GA	33
85HS	3" X-STR.	KL65 KL65S	2 1	7/8x3 1/2 210063GA	12	5/8 STEP	16	KB35R KB36R	24 6	1/2 x 1 1/2 210018GA	33
85HC	3" X-STR.	KL163	3	7/8x3 1/2 210063GA	12			KB35R KB36R	18 6	1/2 x 1 1/2 210018GA	27
85HCS	3" X-STR.	KL163 KL163S	2 1	7/8x3 1/2 210063GA	12	5/8 STEP	12	KB35R KB36R	18 6	1/2 x 1 1/2 210018GA	27
* 845H	2 1/2" X-STR.	KL68	3	7/8x3 1/2 210063GA	12			KB35R KB36R	24 6	1/2 x 1 1/2 210018GA	33
* 845HS	2 1/2" X-STR.	KL68 KL68S	2 1	7/8x3 1/2 210063GA	12	5/8 STEP	16	KB35R KB36R	24 6	1/2 x 1 1/2 210018GA	33

* TRANSITION SECTION WITH 7" FLANGE PLATES AT THE BOTTOM AND 6" FLANGE PLATES AT THE TOP. 7" FLANGE PLATES MUST BE BETWEEN NO. 85 SECTIONS AND ALL OTHER SECTIONS.

** SECTION PART NUMBERS ENDING WITH AN "S" INDICATE THAT THE SECTIONS WILL HAVE STEP BOLTS ON ONE LEG FOR CLIMBING.

GENERAL NOTES:

1. PAL NUTS ARE PROVIDED FOR ALL TOWER BOLTS.
2. FOR LEG FABRICATION, SEE DRAWINGS NUMBERED: C760013, C760014A, C760015, C760016, C760017, C760018, C760019, AND C760020.
3. FOR BRACE FABRICATION, SEE DRAWING NUMBER B660719.
4. FABRICATION DRAWINGS ARE FOR SHOP USE ONLY.

No.	Revision Description	Date	By
R5	REVISED TOWER SECTION SCHEDULE	11-29-90	WEB
R4	REVISED TOWER SECTION SCHEDULE	1-31-90	WEB
R3	REDRAWN	12-8-81	AJG

ROHN®

Title: MODEL NO. 80 TOWER STANDARD SECTIONS

Scale: NONE

Drawn by: AJG 12-8-81

Checked by: GPW 12-22-81

Approved by Engineering: TS 12-22-81

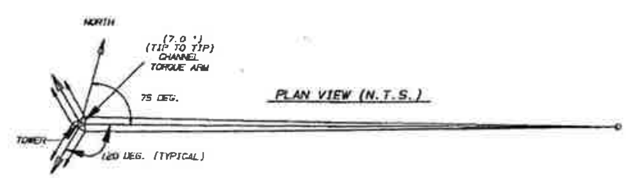
Approved by Production:

Approved by Sales: GR 12-22-81

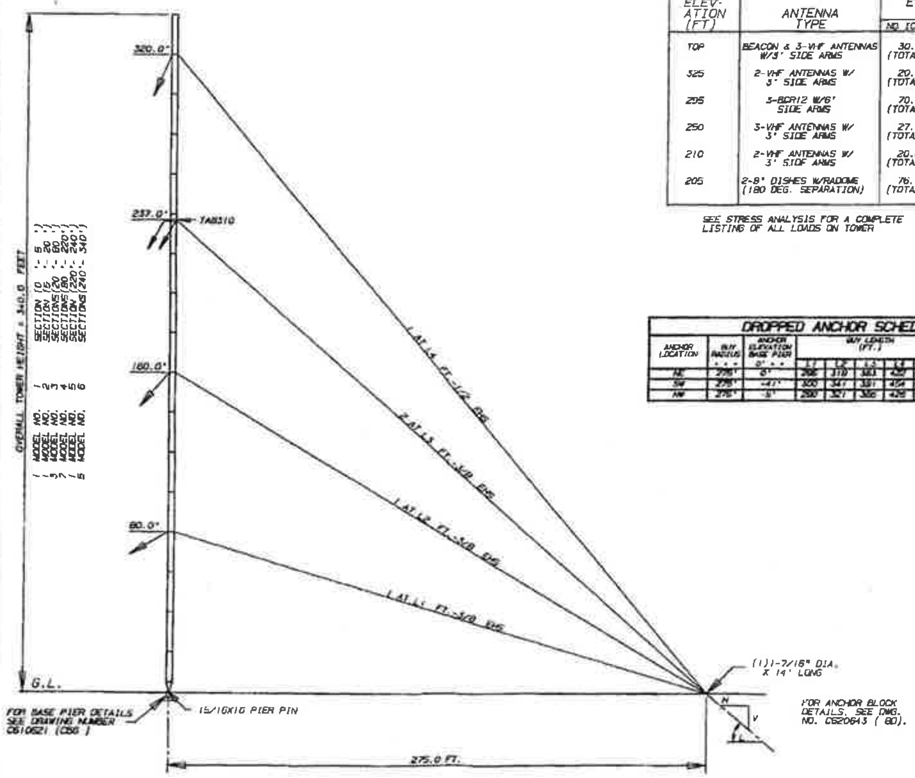
Unless otherwise specified, dimensions are given in inches.
Tolerances: Decimals ± Fractions ± Angles ±
Material / Finish / Weight

File Number

Drawing Number: C681228 R5



PLAN VIEW (N.T.S.)



ELEVATION VIEW

TOWER SITE: SUMMIT PARK HILL

TOWER DESIGN LOADING			
WIND LOAD = ANSI/EIA-222-D 1986, 70 MPH BASIC WIND SPEED (1/2" RADIAL ICE) ANSI A58.1-1982 EXPOSURE B			
THIS TOWER IS DESIGNED TO SUPPORT THE FOLLOWING LOADS			
ELEVATION (FT)	ANTENNA TYPE	E.P.A. (SF) NO ICE	E.P.A. (SF) W/ ICE
TOP	BEACON & 3-VHF ANTENNAS W/3' SIDE ARMS	30.0 (TOTAL)	41.3 (TOTAL)
325	2-VHF ANTENNAS W/ 3' SIDE ARMS	20.8 (TOTAL)	29.0 (TOTAL)
295	3-BCR12 W/6' SIDE ARMS	70.9 (TOTAL)	87.1 (TOTAL)
250	3-VHF ANTENNAS W/ 3' SIDE ARMS	27.6 (TOTAL)	38.9 (TOTAL)
210	2-VHF ANTENNAS W/ 3' SIDE ARMS	20.8 (TOTAL)	29.0 (TOTAL)
205	2-8' DISHES W/RADOME (180 DEG. SEPARATION)	76.5 (TOTAL)	76.6 (TOTAL)

SEE STRESS ANALYSIS FOR A COMPLETE LISTING OF ALL LOADS ON TOWER

DROPPED ANCHOR SCHEDULE										
ANCHOR LOCATION	GUY RADIUS * * *	ANCHOR ELEVATION BASE PIER 0' * *	GUY LENGTH (FT.) L1	L2	L3	L4		ANCHOR ROD SLOPE V	H	DEG
NE	275'	0'	296	319	383	422		9	12	37
SW	275'	-41'	300	341	391	454		10 1/2	12	41
NW	275'	-5'	290	321	386	426		9	12	37

TUBULAR MEMBER PROPERTIES		
MEMBER	SIZE O.D. (IN)	SIZE THICK. (IN)
TS1.50X16GA	1.500	0.065
PIPE 2 STD	2.375	0.154
PIPE 2 E.H	2.375	0.218
PIPE2.5E.H	2.875	0.276

SECTION MEMBER SCHEDULE											
		LEG					BRACE				
ELEVATION (FT)	SECTION	SIZE	MAX. TENS./COMP. LOAD (KIPS)	MIN. TENS./COMP. CAP. (KIPS)	BOLTED FLANGE CONNECTION NO.	SIZE	SIZE	MAXIMUM LOAD (KIPS)	MINIMUM CAPACITY (KIPS)	BOLTED END CONNECTION NO.	SIZE
0 - 5	1	PIPE2.5E.H	23.86	66.80	-	---	----------	----	----	---	---
5 - 20	2	PIPE2.5E.H	26.53	66.80	4	3/4	TS1.50X16GA.	0.57	4.83	1	1/2
20 - 80	3	PIPE 2 E.H	27.55	39.25	4	3/4	TS1.50X16GA.	1.10	4.83	1	1/2
80 - 220	4	PIPE 2 STD	27.18	28.87	4	3/4	TS1.50X16GA.	2.95	4.83	1	1/2
* 220 - 240	5	PIPE 2 E.H	27.36	31.58	4	3/4	TS1.50X16GA.	1.84	4.83	1	1/2
240 - 340	6	PIPE 2 STD	19.41	28.87	4	3/4	TS1.50X16GA.	2.54	4.83	1	1/2

NOTE : SECTION NUMBERS ARE FOR REFERENCE ONLY

* THESE SECTIONS ARE DOUBLE BRACED, ALL OTHERS ARE SINGLE BRACED.
BRACING PATTERN: TENSION COMPRESSION SYSTEM WITH 2'- 5" NOMINAL PANEL SPACING.
FACE WIDTH = 3' - 5"

TORQUE ARM SCHEDULE								
ELEVATION (FT)	* TYPE	MAX. GUY SIZE ALLOWED (IN)	MAIN MEMBERS SIZE	MAIN MEMBERS CONNECTION NO.	MAIN MEMBERS CONNECTION SIZE	SECONDARY MEMBERS SIZE	SECONDARY MEMBERS CONNECTION NO.	SECONDARY MEMBERS CONNECTION SIZE
237	TA8310	3/8	C10X15.3	4	5/8	--------	---	----

GUY WIRE DATA						
GUY ELEV. (FT)	SIZE (IN)	TYPE	ULT. STR. (KIPS)	MIN. CAP. (KIPS)	MAX. TENS. (KIPS)	PERCENTAGE ULT. STR.
80.0	3/8	EHS	15.40	7.70	5.13	33.31
160.0	3/8	EHS	15.40	7.70	6.87	44.61
237.0	3/8	EHS	15.40	7.70	7.31	47.47
320.0	1/2	EHS	26.90	13.45	11.52	42.83

GENERAL NOTES

1. ROHN COMMUNICATION TOWER DESIGNS CONFORM TO E.I.A.-222-D UNLESS OTHERWISE SPECIFIED UNDER TOWER DESIGN LOADING. TOWER DESIGN MAY OR MAY NOT CONFORM TO LOCAL, STATE, OR FEDERAL REQUIREMENTS.
2. TOWER MEMBER DESIGN DOES NOT INCLUDE STRESSES DUE TO ERECTION SINCE ERECTION EQUIPMENT AND CONDITIONS ARE UNKNOWN. DESIGN ASSUMES COMPETENT AND QUALIFIED PERSONNEL WILL ERECT THE TOWER.
3. WORK SHALL BE IN ACCORDANCE WITH E.I.A.-222-D, "STRUCTURAL STANDARDS FOR STEEL ANTENNA TOWERS AND ANTENNA SUPPORTING STRUCTURES".
4. THE MINIMUM YIELD STRENGTH OF STRUCTURAL STEEL MEMBERS SHALL BE 50 KSI, EXCEPT AS NOTED BELOW.
   TUBULAR BRACES SHALL BE 36 KSI.
   STRUCTURAL PLATES SHALL BE 36 KSI.
   CHANNELS FOR TORQUE ARMS SHALL BE 36 KSI.
5. FIELD CONNECTIONS SHALL BE BOLTED. NO FIELD WELDS SHALL BE ALLOWED.
6. STRUCTURAL BOLTS SHALL CONFORM TO ASTM A-325, EXCEPT WHERE NOTED.
7. PAL NUTS SHALL BE PROVIDED FOR ALL TOWER BOLTS.
8. STRUCTURAL STEEL AND CONNECTION BOLTS SHALL BE HOT-DIPPED GALVANIZED AFTER FABRICATION, IN ACCORDANCE WITH E.I.A.-222-D.
9. INITIAL TENSION OF GUY WIRES SHALL BE 10% OF THEIR ULTIMATE STRENGTHS.
10. THE FACTOR OF SAFETY OF GUYS AND THEIR CONNECTIONS SHALL NOT BE LESS THAN 2.0.
11. IT SHALL BE THE RESPONSIBILITY OF THE ERECTOR TO TEMPORARILY GUY THE STRUCTURE WHEN REQUIRED DURING ERECTION TO MAINTAIN THE STABILITY OF THE STRUCTURE AND TO PREVENT OVERLOADING ANY MEMBER OF THE STRUCTURE.
12. DESIGN ASSUMES VHF & BCR ANTENNAS SYMMETRICALLY MOUNTED TO MINIMIZE TORQUE.
13. DESIGN ASSUMES TRANSMISSION LINES EQUALLY DISTRIBUTED ON TWO TOWER FACES.
14. ROHN SHALL HAVE THE OPTION TO REVIEW FINAL DISH LOCATIONS, AZIMUTHS AND MOUNTS TO VERIFY THAT THE ASSUMED TORQUE VALUES AND LOCAL STRESSES ARE NOT EXCEEDED.
15. WAVEGUIDE BRACE BRACKETS PROVIDED ON TWO TOWER FACES FROM 5' TO TOP.
16. STEP BOLTS ARE PROVIDED FOR CLIMBING THE ENTIRE HEIGHT OF THE TOWER.
17. THE PURCHASER MUST VERIFY THAT ACTUAL SITE SOIL PARAMETERS MEET OR EXCEED E.I.A. "NORMAL" SOIL PARAMETERS.
18. TOWER ORIENTATION DETERMINED FROM CUSTOMER SUPPLIED SKETCH.
19. ALL HIGH STRENGTH BOLTS ARE TO BE TIGHTENED TO A "SNUG TIGHT" CONDITION AS DEFINED IN THE AUGUST 14, 1980 AISC "SPECIFICATION FOR STRUCTURAL JOINTS USING ASTM A325 OR A490 BOLTS".

REACTIONS		
AT	VERT. (+↓)	HORIZ. (→)
BASE 0.0 FT	72.0 KIPS	
275.0 FT	23.9 KIPS	27.7 KIPS

No. Revision Description — Date — Rev. By — Chk By — Appd By

R O H N

Scale: NONE	By	Date
Drawn:	ROBB	10/9/90
Checked:	RLH	10/11/90
App. Eng.:	TS	10-11-90
App. Sales:	SAK	10-11-90

Title: 340' 80 TOWER DESIGN FOR H.L. HEASTER, INC.

DWG. FILE: 263825K — DRAWING NO.: D900798

E.R.W. (ELECTRIC RESISTANCE WELD)
COLD DRAWN SEAMLESS (CDS)
D.O.M. (DRAWN-OVER-MANDREL)
HOT FINISHED SEAMLESS (HFS)

ERW - Electric Resistance Weld
CDS - Cold Drawn Seamless
DOM - Drawn Over Mandrel
HFS - Hot Finished Seamless

20' - ERW
x - Stock Size
17' - 24' Random Lengths DOM/CDS
12' - 24' - HFS

Outside Dimension (OD) & Gage (inches)	Wall Thickness Dec-In.	Inside Diameter (ID)	Weight (lbs./ft.)	ERW	CDS	DOM	HFS
1-3/8 OD							
20 ga	0.035	1.305	0.5009	-	-	-	-
18 ga	0.049	1.277	0.6939	-	-	X	-
16 ga	0.065	1.245	0.9094	X	-	X	-
14 ga	0.083	1.209	1.1450	X	-	X	-
13 ga	0.095	1.185	1.2990	-	-	X	-
12 ga	0.109	1.157	1.4740	-	-	X	-
11 ga	0.120	1.135	1.6080	X	-	X	-
1/8	0.125	1.125	1.6690	-	-	X	-
10 ga	0.134	1.107	1.7760	-	-	X	-
5/32	0.156	1.062	2.0310	-	-	X	-
11/64	0.172	1.031	2.2100	-	-	X	-
3/16	0.188	1.000	2.3830	-	-	X	-
7/32	0.219	0.937	2.7040	-	-	X	-
1/4	0.250	0.875	3.0040	-	-	X	-
9/32	0.281	0.813	3.2830	-	-	X	-
5/16	0.313	0.750	3.5500	-	-	X	-
3/8	0.375	0.625	4.0050	-	-	X	-
1-7/16 OD							
18 ga	0.049	1.339	0.7269	-	-	-	-
16 ga	0.065	1.308	0.9531	-	-	-	-
14 ga	0.083	1.271	1.2010	-	-	-	-
13 ga	0.095	1.247	1.3630	-	-	-	-
11 ga	0.120	1.197	1.6890	-	-	-	-
10 ga	0.134	1.170	1.8660	-	-	-	-
5/32	0.156	1.125	2.1360	-	-	-	-
3/16	0.188	1.062	2.5100	-	-	X	-
7/32	0.219	1.000	2.8510	-	-	-	-
1/4	0.250	0.937	3.1720	-	-	-	-
1-1/2 OD							
20 ga	0.035	1.430	0.5476	-	-	-	-
18 ga	0.049	1.402	0.7593	-	-	-	-
17 ga	0.058	1.384	0.8932	-	-	X	-
16 ga	0.065	1.370	0.9962	X	-	X	-
15 ga	0.072	1.356	1.0980	-	-	-	-
14 ga	0.083	1.334	1.2560	X	-	X	-
13 ga	0.095	1.310	1.4260	-	-	X	-
12 ga	0.109	1.282	1.6190	-	-	X	-
11 ga	0.120	1.260	1.7690	X	-	X	-
1/8	0.125	1.250	1.8360	-	-	X	-
10 ga	0.134	1.232	1.9550	-	-	X	-

Drawn over Mandrel (DOM) tubing is defined by 3 different dimensions:
• Inside Diameter (ID) • Outside Diameter (OD) • Wall Thickness

When ordering, only 2 of the 3 tolerances must be defined. Alro Steel purchases DOM tubing, for general inventory, to the outside diameter and inside diameter.

If you do not see a size listed, please contact your Alro representative.

Continued on next page ▶

LANYARDS

1 (800) 328-6374 – James

SALA

EZ-Stop™ Shock Absorbing Lanyard

Model: 1246011
6 ft. (1.8m) web single-leg with snap hooks at each end.

Share Share Email Print

Other Sizes / Lengths: 1246011: 6 ft. (1.8m)

Please login or register to add products to your list:
Log In Register

PRODUCT HIGHLIGHTS

- 6 ft. (1.8m) single-leg lanyard
- Extremely compact and lightweight
- Exclusive Hi-10™ Vectran™ energy absorption system
- Repel™ webbing
- User friendly self locking snap hooks at each end
- Built-in reflective materials
- Impact indicator
- Protected labels, equipped with i-Safe™

Overview Features Specifications Accessories

Capacity	130-310 lbs. (59-141kg)
Brand	DBI-SALA®
Sub Brand	EZ-Stop™
Size	6 ft. (1.8m)
Velocity Ship	Yes
iSafe Equipped	Yes
Anchor Connector Hook Type	Snap Hook
Energy Absorber Class	6 ft (1.8 m) Free Fall/MAAF 900 lbs. (4 kN)
Harness Connector Hook Type	Snap Hook
Lanyard Type	Fixed
Number Of legs	Single-Leg
Lanyard Length	6 ft. (1.8m)
Thread/Stitching	Polyester
Label	Vinyl
General Lanyard	Web
Harness Connection Hook	Zinc Plated Steel
Anchor Connection Hook	Zinc Plated Steel
Detailed Lanyard	3/4" (1.9cm) Polyester Web
Energy Absorber	Vectran™
Energy Absorber Cover	Nylon
Model	1246011
Physical Weight	0.00 lbs (0.0kg)
Product Styles	Standard
Product Types	Shock Absorbing Lanyard
Standards	OSHA 1910.66, OSHA 1926.502, Capital Safety Gen. Mfg. Req., ANSI A10.32, ANSI Z359.13

SIMILAR MODELS

SALA
EZ-Stop™ Adjustable Shock Absorbing Lanyard
6 ft. (1.8m) adjustable web single-leg with snap hooks at each end.
Model: 1246234

SALA
EZ-Stop™ Cable Shock Absorbing Lanyard
6 ft. (1.8m) cable single-leg with snap hooks at each end.
Model: 1246188

BUILD A FALL PROTECTION SOLUTION

A typical Personal Fall Arrest System (PFAS) incorporates three components often described as the ABC's of fall protection; The anchorage/anchorage connector, body support and connecting device. Don't forget about "D" either, the descent, rescue and retrieval of a fallen worker.

MILLER®
by SPERIAN

Potential Fall Arrest Forces

The following provides general information on fall arrest forces that could occur in free-falls at different distances.

Non-shock absorbing web lanyard with 220 pound steel weight
(Data shown to reinforce the importance of using shock-absorbing lanyards)

Distance of Drop	Average Force
6 inches	1100 pounds
3 feet	2500 pounds
4 feet	3200 pounds
5 feet	3800 pounds
6 feet	4000 pounds

Miller Shock absorbing web lanyard with 220 pound steel weight

Distance of Drop	Average Force	Extension
3 feet	820 pounds	21 inches
4 feet	810 pounds	22 inches
5 feet	822 pounds	28 inches
6 feet	872 pounds	33 inches
7 feet	877 pounds	38 inches
9 feet	1315 pounds	41 inches
10 feet	1654 pounds	42 inches
11.5 feet	2332 pounds	42 inches

Chuck Ziegler
Manager Technical Support

SPERIAN Fall Protection, Inc.
1345 15th Street - PO Box 271 - Franklin, PA 16323
Toll-Free: 800 873-5242 – Tel: 814 432-2118 – Fax: 800 892-4078
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