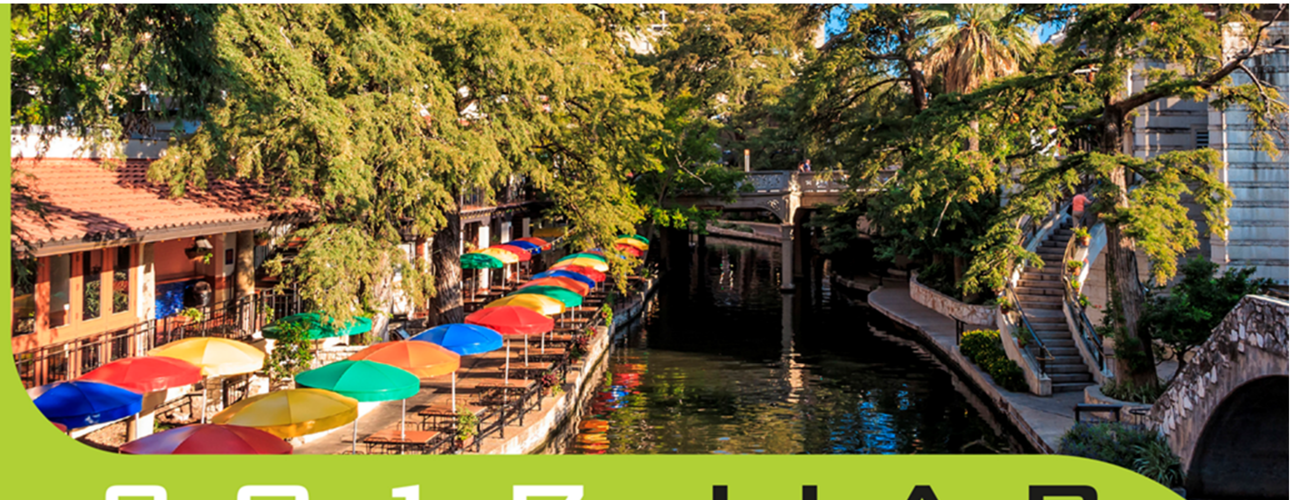

2017 IIAR

NATURAL REFRIGERATION

CONFERENCE & HEAVY EQUIPMENT EXPO

FEBRUARY 26 – MARCH 1

SAN ANTONIO, TX

Quality Assurance Statement

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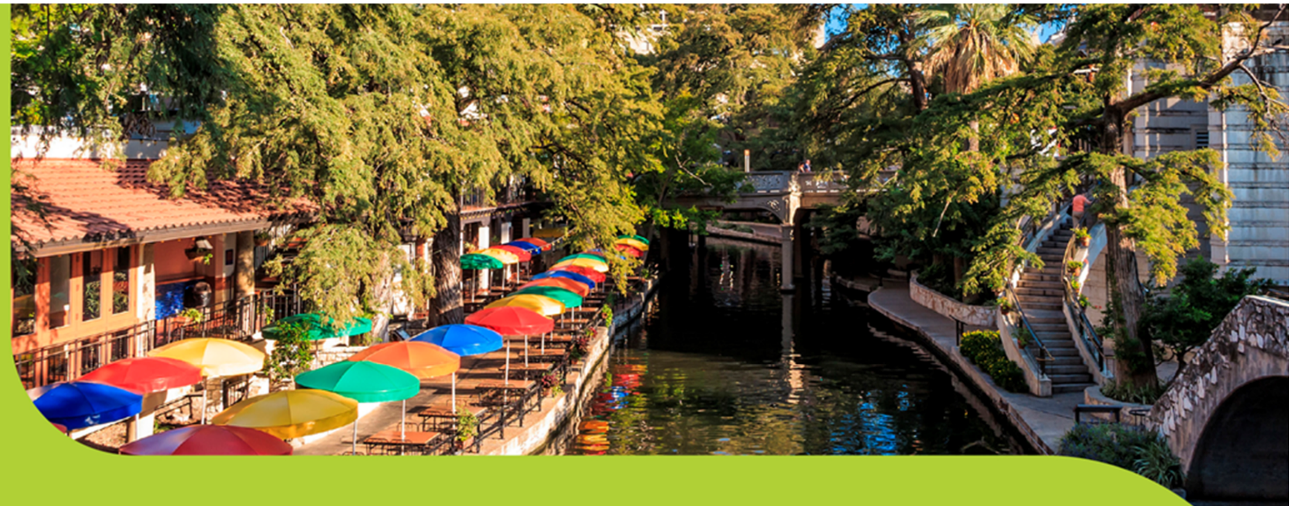
ENGINEERING RCEP REGISTERED CONTINUING EDUCATION PROGRAM



Rooftop Equipment Supports

iiar®

NATURAL REFRIGERATION CONFERENCE & HEAVY EQUIPMENT EXPO

FEBRUARY 26 – MARCH 1, 2017 • SAN ANTONIO, TEXAS

Learning Objectives

This IIAR Conference Session is intended to provide education regarding the safe and sustainable design, installation and operation of ammonia and other natural refrigerant systems.

During the course of this session, participants will learn:

- Learning Objective #1:

  When should rooftop equipment and supports be design for wind and seismic loading

- Learning Objective #2

  Understanding of how vertical and horizontal wind and seismic loads are determined and applied to rooftop equipment and supports.

Rooftop Equipment

Who is responsible for the design of Rooftop Supports?

- Building Owner
- Mechanical Engineer
- Structural Engineer
- Contractor
- Support supplier
- Architect
- Building Inspector
- Specialty Engineer

Rooftop Equipment

What Loading should be considered?

- Dead Load
- Service Loads
  - Start up
  - Thermal Expansion
  - Hammer
  - Component Stresses
- Wind loads (lateral and uplift)
- Seismic Loading
- Ice loading
- Snow Load
- Live Loads

Rooftop Equipment

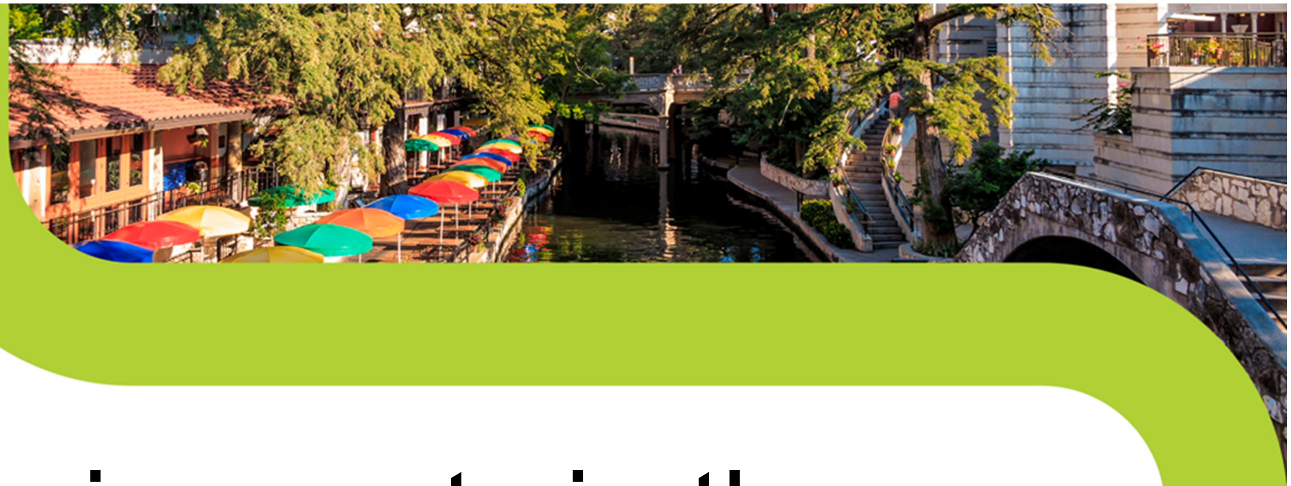
Who/what is affected by the rooftop supports?

- Equipment (chillers, condensers, etc.)
- Distribution Lines (Pipe, duct, etc.)
  - Connections
- Support Components
- Roofing Envelope
  - Membrane
  - Insulation
- Building Structure
  - Load transfer

Rooftop Equipment

Structural General Notes – Deferred Submittals

3. Deferred Submittals
   a. Deferred Submittals include those portions of the project that are furnished by the Contractor and designed by someone other than the Engineer of Record and are submitted at the time of application. Deferred Submittals shall be submitted to the Building Official prior to fabrication and installation.
   b. Submittal documents for Deferred Submittals:
      i. Shall be included in the Contractor's scope of services and shall be sealed by an Engineer licensed in the project state. Design of Deferred Submittals shall be in accordance with the governing Building Code.
      ii. Shall be submitted to the registered design professional in responsible charge who shall review them and forward to the Building Official with a notation indicating the deferred submittal documents have been reviewed and that they have been found in general conformance with the design of the building. Deferred submittal items shall not be installed until the design and submittal documents have been approved by the Building Official.
   c. The following shall be considered Deferred Submittals:
      i. Temporary/Permanent Shoring and Underpinning
      ii. Steel Connections – See "Structural Steel" Section
      iii. Cold-Formed Exterior Steel Stud Framing
      iv. Roof Top Unit Anchorage
      v. Curtainwall/Window Wall Systems
      vi. Slotted Channel Strut Framing



Requirements in the 2015 International Codes

NATURAL REFRIGERATION CONFERENCE & HEAVY EQUIPMENT EXPO
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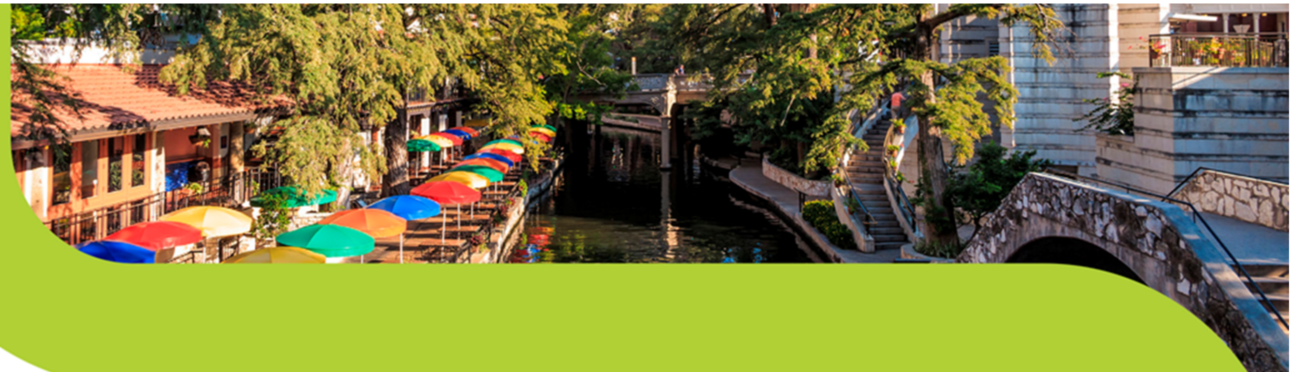

2015 International Mechanical Code

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FEBRUARY 26 – MARCH 1, 2017 • SAN ANTONIO, TEXAS

2015 IMC

Chapter 3 – General Regulations

<u>Section 301 - General</u>

301.1 Scope. This chapter governs the approval and installation of all *equipment* and appliances that comprise parts of the building mechanical systems regulated by this code in accordance with Section 101.2.

Specific to Rooftop Equipment Supports

- 301.15 Wind resistance

  Mechanical *equipment*, appliances and supports that are exposed to wind shall be designed and installed to resist the wind pressures determined in accordance with the *International Building Code.*

- 301.19 Seismic resistance

  Where earthquake loads are applicable in accordance with the *International Building Code*, mechanical system supports shall be designed and installed for the seismic forces in accordance with the *International Building Code.*

2015 IMC

Chapter 3 – Piping Support

<u>Section 305 Piping Support</u>

305.1 General. Mechanical system piping shall be supported in accordance with this section.

305.2 Materials. Adequate strength and compatible materials.

305.3 Structural attachment. Hangers and anchors shall be attached to the building construction in an *approved* manner.

305.4 Interval of support. Piping shall be supported at distances not exceeding the spacing specified in table 305.4 or in accordance with ANSI/MSS SP-58.

Steel pipe – Max horizontal spacing: 12 ft

Max vertical spacing: 15 ft

305.5 Protection against physical damage.

2015 IMC

Chapter 3 – Accessibility

Section 306 Access and Service Space

306.1 Access. Appliances, controls devices, heat exchangers and HVAC system components that utilize energy shall be accessible for inspection, service, repair and replacement without disabling the function of a fire-resistance-rated assembly or removing permanent construction, other appliances, venting systems or any other piping or ducts not connected to the appliance being inspected, serviced, repaired or replaced. A level working space not less than 30 inches deep and 30 inches wide shall be provided in front of the control side to service an appliance.

306.5 Equipment and appliances on roofs or elevated structures. Where *equipment* requiring access or appliances are located on an elevated structure or the roof of a building such that personnel will have to climb higher than 16 feet above grade to access such equipment or appliances, an interior or exterior means of access shall be provided. Such access shall not require climbing over obstructions greater than 30 inches in height or walking on roofs having a slope greater than 4 units vertical in 12 units horizontal (33% slope). Such access shall not require the use of portable ladders. Where access involves climbing over parapet walls, the height shall be measured to the top of the parapet wall.

2015 IMC

Chapter 3 – Accessibility

[OSHA 1910 Subpart D – Walking Working Surfaces]

2015 IMC

Accessibility?

2015 IMC

Chapter 11 – Refrigeration

<u>Section 1101 General</u>

1101.1 Scope. This chapter shall govern the design, installation, construction and repair of refrigeration systems that vaporize and liquefy a fluid during the refrigerating cycle. Refrigerant piping design and installation, including pressure vessels and pressure relief devices, shall conform to this code. Permanently installed refrigerant storage systems and other components shall be considered as part of the refrigeration system to which they are attached.

1101.3 Protection. Any portion of a refrigeration system that is subject to physical damage shall be protected in an approved manner.

1101.6 General. Refrigeration systems shall comply with the requirements of this code and, except as modified by this code, ASHRAE 15. Ammonia-Refrigerating systems shall comply with this code and, except as modified by this code, ASHRAE 15 and IIAR 2.

2015 IMC

Chapter 11 – Refrigeration

Section 1107 Refrigerant Piping

1107.1 General. The design of refrigerant piping shall be in accordance with ASME B31.5. Refrigerant piping shall be installed, tested and placed in operation in accordance with this chapter.

1107.2 Piping location.

1107.3 Pipe enclosures.

1107.4 Condensation.

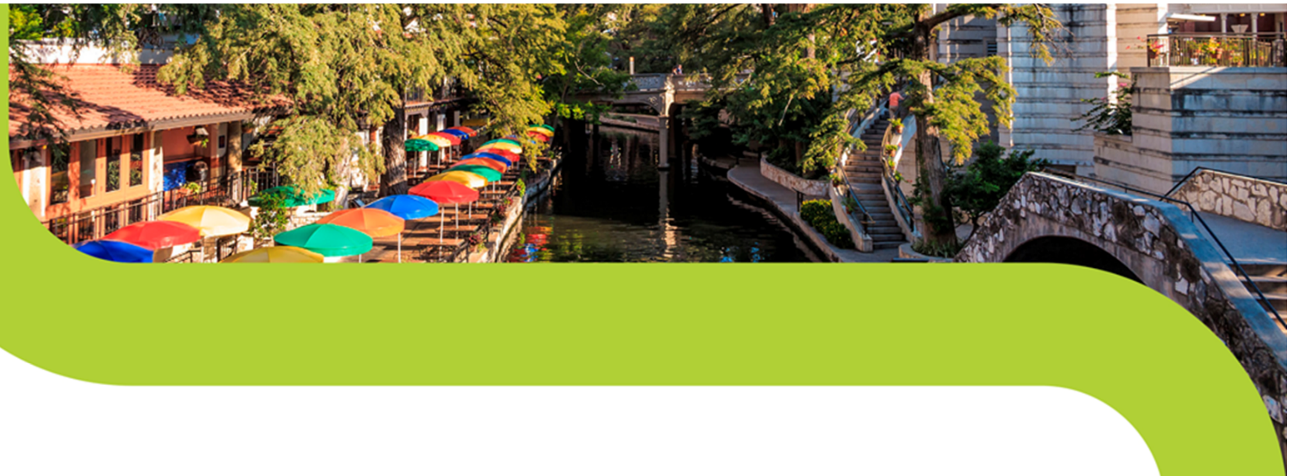
1107.5 Materials for refrigerant pipe and tubing.

1107.6 Joints and refrigerant-containing parts in air ducts.

1107.7 Exposure of refrigerant pipe joints.

1107.8 Stop valves.

***Nothing specific about supporting refrigerant piping.**



Failed

Examples of Rooftop Failures

Failed Rooftop Supports

Of the industries that utilize the roof space for distribution lines and equipment we have seen far fewer concerns with ammonia lines then with others.

Rooftop supports on a Texas Community College

Failed Rooftop Supports

Overturned supports

Failed Equipment

30’x10’x8’ 18,000 lb HVAC unit was attached to its curb with 16 straps (one screw per strap). Wind speeds were estimated to be only 85 to 95 mph (3-second peak just). Source – FEMA 489 “Mitigation Assessment Team report: Hurricane Ivan in Alabama and Florida” August 2005

Wind Screens?

Codes do not allow reductions in design wind loading due to apparent shielding from adjacent structures. Source - FEMA

Failed Equipment

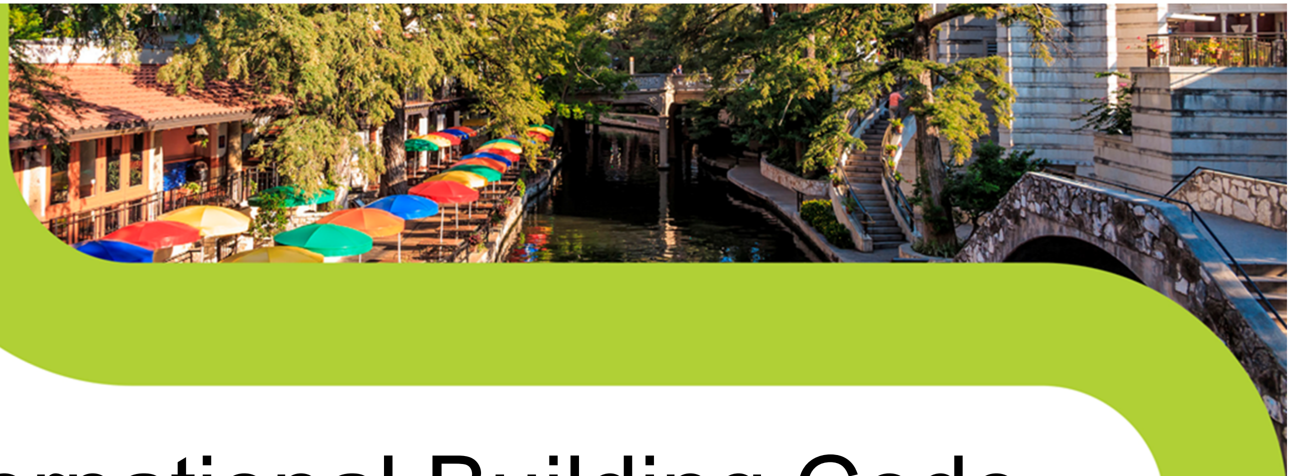
Photovoltaic Sail's (no longer cell's)

Roof Damage

Excessive loading causes ponding or puncture of the roof membrane.

Resourceful

Sometimes you have to use what's available.



2015 International Building Code & ASCE 7-10

Minimum Design Loads for Buildings and other Structures

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2015 IBC

Chapter 16 – Structural Design

Section 1601 - General

1601.1 Scope. The provisions of this chapter shall govern the structural design of buildings, structures and portions thereof regulated by this code.

Section 1604 – General Design Requirements

1604.5 Risk Category. Each building and structure shall be assigned a risk category (previously Occupancy Category) in accordance with Table 1604.5

- Category I – Low hazard to human life
- Category II – Building not assigned to Categories I, III or IV
- Category III – Substantial hazard to human life
- Category IV – Essential facilities

Section 1606 – Dead Loads

Section 1607 – Live Loads

2015 IBC

Chapter 16 – Structural Design

Section 1609 – Wind Loads

1609.1 Application. Buildings, structures and parts thereof shall be designed to withstand the minimum wind loads prescribed herein. Decreases in wind loads shall not be made for the effect of shielding by other structures.

1609.1.1 Determination of wind loads. Wind loads on every building or structure shall be determined in accordance with Chapters 26 to 30 of ASCE 7 or provisions of the alternative all-heights method in Section 1609.6. ……. Wind shall be assumed to come from any horizontal direction and wind pressures shall assume to act normal to the surface considered. (Alternative all-heights method is not applicable to rooftop equipment or supports per 1609.6.1-5)

Exceptions: (Rooftop equipment and supports do not qualify for any of the exceptions listed in the code.)

The wind speeds in Figure 1609.3(1 – 3) are ultimate design wind speeds, V_{ult}. (*Conversion to nominal design wind speed, V_{asd},* is not applicable for rooftop equipment and supports.)

2015 IBC

Chapter 16 – Structural Design

Section 1609 – Wind Loads Cont.

1609.6 Alternative all-heights method. The alternative wind design provisions in this section are simplifications of the ASCE 7 Directional Procedure.

> **1609.6.1 Scope.** As an alternative to ASCE 7 Chapters 27 and 30, the following provisions are permitted to be used to determine the wind effects on regularly shaped buildings that meet all of the following conditions:
>
> 5) For open buildings, ……….., and rooftop equipment, apply ASCE 7 provisions.

ASCE 7-10

Chapter 30

Wind Loads – Components and Cladding (C&C)

Section 30.1 – Scope.

30.1.1 Building Types. This chapter applies to the determination of wind pressures on components and cladding (C&C) on buildings.

6) Part 6 is applicable to building appurtenances such as roof overhangs and parapets and rooftop equipment.

30.1.4 Shielding. There shall be no reduction in velocity pressure due to apparent shielding afforded by buildings and other structures or terrain features.

Part 6: Building appurtenances and rooftop structures and equipment.

30.11 Rooftop Structures and equipment for buildings with h≤60 ft.

(Apply the procedures of Section 29.5 for wind loading on rooftop structures and equipment.

ASCE 7-10

Chapter 29

Wind Loads on other Structures and Building Appurtenances – MWFRS

<u>Section 29.1 – Scope.</u>

29.1.1 Structure Types. This chapter applies to the determination of wind loads on building appurtenances (such as rooftop structures and rooftop equipment) and other structures of all heights using the Directional Procedure.

29.1.4 Shielding. There shall be no reduction in velocity pressure due to apparent shielding afforded by buildings and other structures or terrain features.

29.5.1 Rooftop Structures and Equipment for Buildings with $h \le 60$ ft.
The lateral force F_h on rooftop structures and equipment located on buildings with a mean roof height $h \le 60$ ft shall be determined from Eq. 29.5-2

ASCE 7-10

Chapter 29

$F_h = q_h(GC_r)A_f$ (lb) *(Eq. 29.5-2)*

Where

- (GC_r) = 1.9 *(3.1 for Florida)* for rooftop structures and equipment with A_f less than (0.1Bh). (GC_r) shall be permitted to be reduced linearly from 1.9 to 1.0 as the value of A_f is increased from (0.1Bh) to (Bh)
- q_h = velocity pressure evaluated at mean roof height of the building
  - $q_h = 0.00256\, K_z K_{zt} K_d V^2 \left(lb/ft^2\right)$ (Eq. 29.3-1)

    Where
    - K_d = wind directionality factor defined in Section 26.6 (0.95 for round cross sectional members)
    - K_z = velocity pressure exposure coefficient defined in Section 29.3.1 (Depends on roof height and exposure category)
    - K_{zt} = topographic factor defined in Section 26.8.2 (Typically assume 1.0 unless directed otherwise)
    - V = basic wind speed from Section 26.5
    - The numerical coefficient 0.00256 shall be used except where sufficient climatic data are available to justify the selection of a different value of the factor for a design application.
- A_f = vertical projected area of the rooftop structure or equipment on a plane normal to the direction of the wind, in ft^2.

ASCE 7-10

Chapter 29

29.5.1 Continued. The vertical uplift force F_v on rooftop structures and equipment shall be determined from Eq. 29.5-3

$F_h = q_h(GC_r)A_r$ (lb) *(Eq. 29.5-3)*

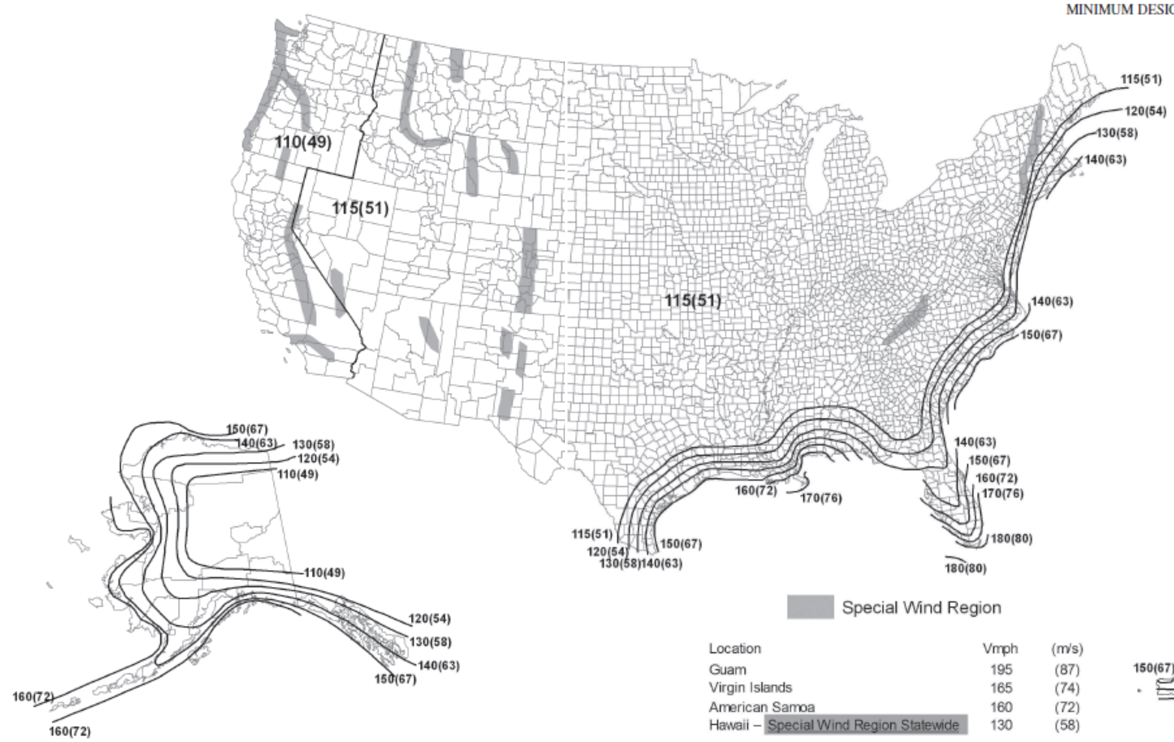
Where

- (GC_r) = 1.5 for rooftop structures and equipment with A_r less than (0.1BL). (GC_r) shall be permitted to be reduced linearly from 1.9 to 1.0 as the value of A_r is increased from (0.1BL) to (BL)
- q_h = velocity pressure evaluated at mean roof height of the building
- $q_h = 0.00256\, K_z K_{zt} K_d V^2\, (lb/ft^2)$ (Eq. 29.3-1)
  Same q_h previously used.
- A_r = Horizontal projected area of the rooftop structure or equipment on a plane normal to the direction of the wind, in ft^2.

(Previous editions of ASCE 7 did not include requirements for evaluating vertical uplift forces on rooftop structures and equipment inside the main body of the text.)

2015 IBC & ASCE 7-10

Basic Wind Speed Maps – Risk Category II



Location	Vmph	(m/s)
Guam	195	(87)
Virgin Islands	165	(74)
American Samoa	160	(72)
Hawaii – Special Wind Region Statewide	130	(58)

Figure 26.5-1A Basic Wind Speeds for Occupancy Category II Buildings and Other Structures.

Notes:

1. Values are nominal design 3-second gust wind speeds in miles per hour (m/s) at 33 ft (10m) above ground for Exposure C category.
2. Linear interpolation between contours is permitted.
3. Islands and coastal areas outside the last contour shall use the last wind speed contour of the coastal area.
4. Mountainous terrain, gorges, ocean promontories, and special wind regions shall be examined for unusual wind conditions.
5. Wind speeds correspond to approximately a 7% probability of exceedance in 50 years (Annual Exceedance Probability = 0.00143, MRI = 700 Years).

Figure 26.5-1A *(Continued)*

IBC Fig. 1609.3(1)
ASCE 7 Fig. 26.5-1A
(Risk Category II Buildings)

2015 IBC & ASCE 7-10

Basic Wind Speed Maps – Risk Category III and IV

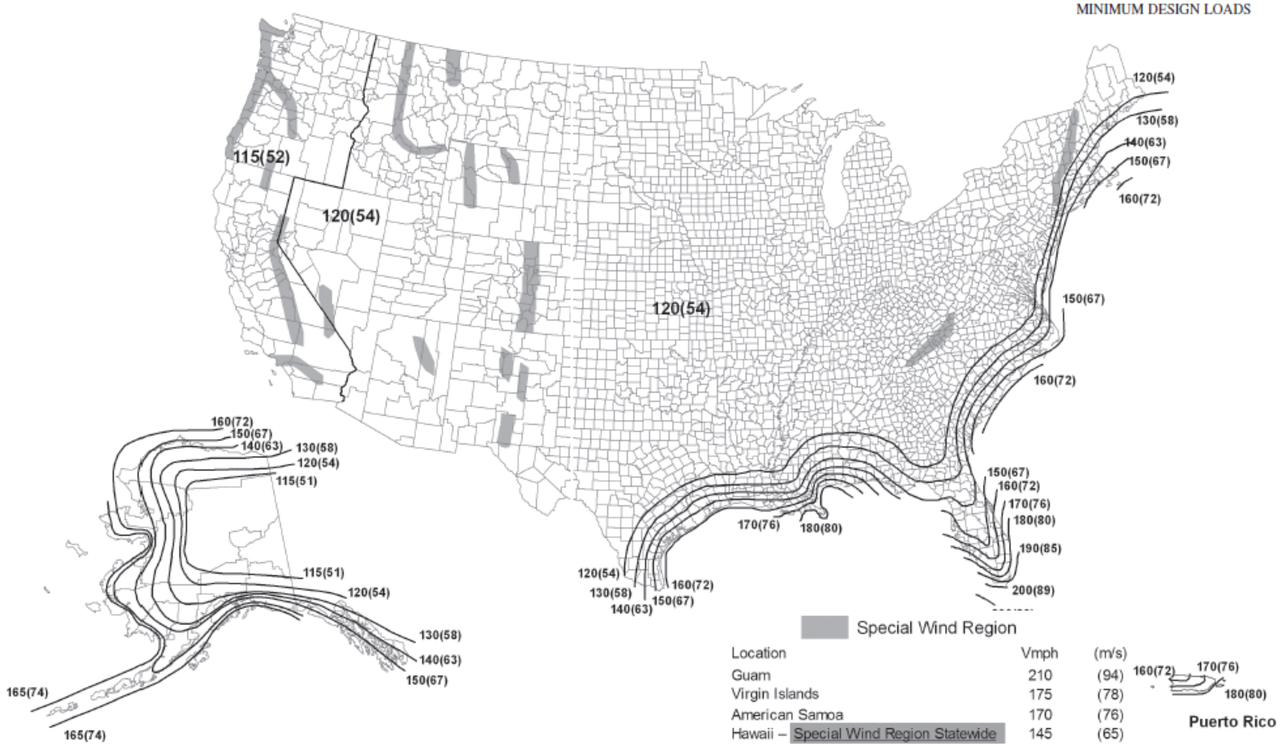


Figure 26.5-1B Basic Wind Speeds for Occupancy Category III and IV Buildings and Other Structures.

Figure 26.5-1B *(Continued)*

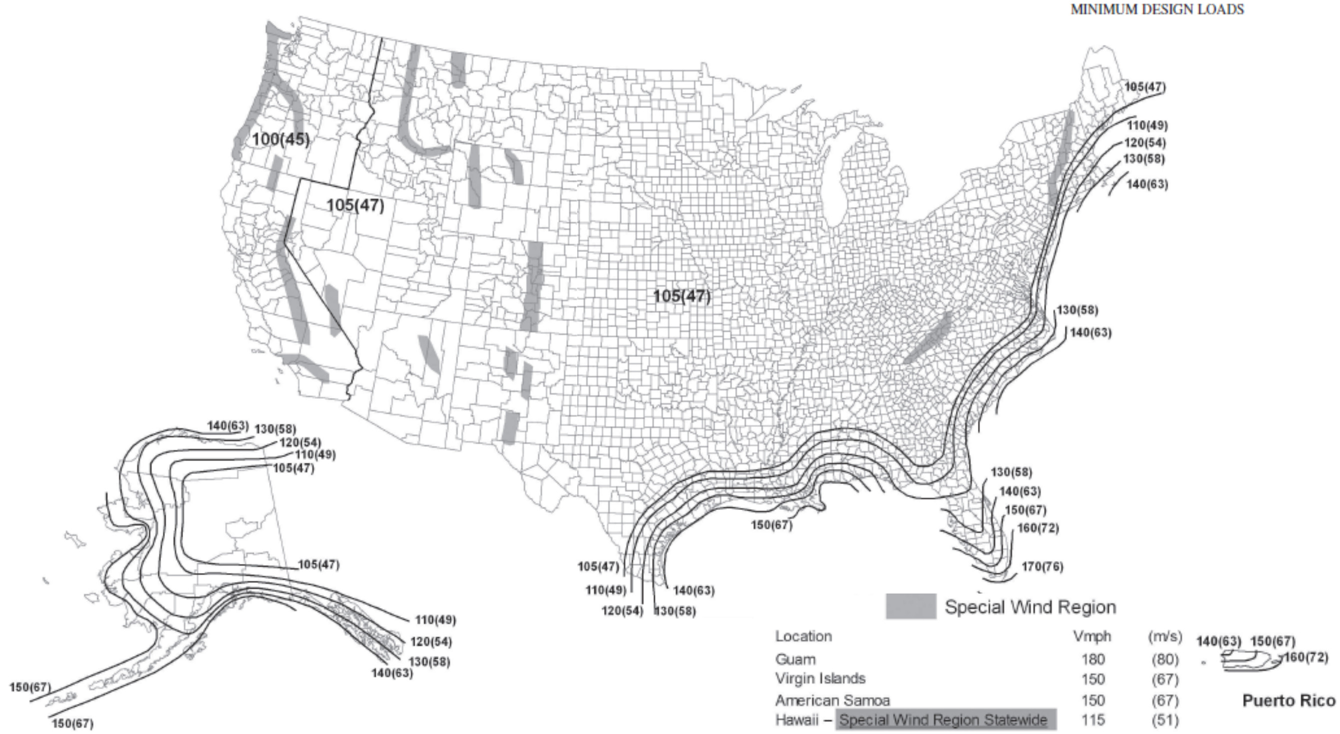
Notes:

1. Values are nominal design 3-second gust wind speeds in miles per hour (m/s) at 33 ft (10m) above ground for Exposure C category.
2. Linear interpolation between contours is permitted.
3. Islands and coastal areas outside the last contour shall use the last wind speed contour of the coastal area.
4. Mountainous terrain, gorges, ocean promontories, and special wind regions shall be examined for unusual wind conditions.
5. Wind speeds correspond to approximately a 3% probability of exceedance in 50 years (Annual Exceedance Probability = 0.000588, MRI = 1700 Years).

IBC Fig. 1609.3(2)
ASCE 7 Fig. 26.5-1B
(Risk Category III and IV Buildings)

2015 IBC & ASCE 7-10

Basic Wind Speed Maps – Risk Category I



Location	Vmph	(m/s)
Guam	180	(80)
Virgin Islands	150	(67)
American Samoa	150	(67)
Hawaii – Special Wind Region Statewide	115	(51)

Figure 26.5-1C Basic Wind Speeds for Occupancy Category I Buildings and Other Structures.

Notes:

1. Values are nominal design 3-second gust wind speeds in miles per hour (m/s) at 33 ft (10m) above ground for Exposure C category.
2. Linear interpolation between contours is permitted.
3. Islands and coastal areas outside the last contour shall use the last wind speed contour of the coastal area.
4. Mountainous terrain, gorges, ocean promontories, and special wind regions shall be examined for unusual wind conditions.
5. Wind speeds correspond to approximately a 15% probability of exceedance in 50 years (Annual Exceedance Probability = 0.00333, MRI = 300 Years).

Figure 26.5-1c *(Continued)*

IBC Fig. 1609.3(3)
ASCE 7 Fig. 26.5-1C
(Risk Category I Buildings)

ATC WINDSPEED BY LOCATION

WWW.WINDSPEED.ATCOUNCIL.ORG

ASCE 7 Windspeed | ASCE 7 Ground Snow Load | Related Resources | Sponsors | About ATC | Contact

Windspeed Website Information

The purpose of the "Windspeed Website" is to provide users with a site-specific windspeed that are used in the determination of design wind loads for buildings and other structures. On this website, users can obtain windspeeds compatible with ASCE 7-10, ASCE 7-05, and ASCE 7-93. Windspeeds are also provided for serviceability purposes for 10-, 25-, 50-, and 100-year return periods when using ASCE 7-10. Users are cautioned to be sure to use the correct windspeed associated with the edition of ASCE 7 being used in the design. Without providing too much detail, the design windspeeds are different because the basis for wind design was service-level, fastest mile windspeeds in ASCE 7-93, service-level, 3-second gust windspeeds in ASCE 7-05 and strength-level, 3-second gust windspeeds in ASCE 7-10. It is assumed that the users of this site have competency to understand how to calculate and apply design wind loads to structural models of buildings or other structures.

The reason this utility is needed is that the spatial resolution of the windspeed maps that are displayed in ASCE 7 are not sufficient to determine a site specific windspeed. There are no reference city or town locations on the ASCE 7 windspeed maps and while county boundaries are shown, the resolution is affected when the maps are expanded large enough to distinguish the boundaries and approximate the city locations.

- Decimal (Enter Decimal Value)

Latitude Longitude

- Address (Enter Complete Address Below)

Find

- US Virgin Islands
- Guam
- American Samoa
- Hawaii

Get Windspeed

ATC WINDSPEED BY LOCATION

WWW.WINDSPEED.ATCOUNCIL.ORG

ASCE 7 Windspeed | ASCE 7 Ground Snow Load | Related Resources | Sponsors | About ATC | Contact

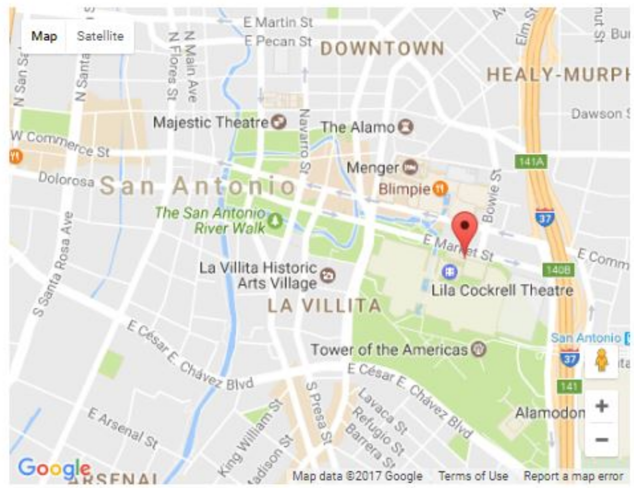
Search Results

Query Date: Thu Jan 26 2017
Latitude: 29.4218
Longitude: -98.4840

ASCE 7-10 Windspeeds
(3-sec peak gust in mph*):

Risk Category I: 105
Risk Category II: 115
Risk Category III-IV: 120
MRI 10-Year:** 76
MRI 25-Year:** 84
MRI 50-Year:** 90
MRI 100-Year:** 96

ASCE 7-05 Windspeed:
90 (3-sec peak gust in mph)
ASCE 7-93 Windspeed:
73 (fastest mile in mph)



*Miles per hour
**Mean Recurrence Interval

Users should consult with local building officials to determine if there are community-specific wind speed requirements that govern.

2015 IBC

Chapter 16 – Structural Design

Section 1613 – Earthquake Loads

1613.1 Scope. Every structure, and portion thereof, including nonstructural components that are permanently attached to structures and their supports and attachments, shall be designed and constructed to resist the effects of earthquake motions in accordance with ASCE 7, excluding Chapter 14 and Appendix 11A. The *seismic design category* for a structure is permitted to be determined in accordance with Section 1613 or ASCE 7.

ASCE 7 Chapter 13 must be used for determining seismic loading on rooftop equipment.

Seismic design parameters are typically provided in the structural general notes of the project documents when a Structural Engineer is involved. If a structural engineer is not involved the parameters can be obtained from the U.S. Geologic Survey Earthquake Hazards Program.

Earthquake.usgs.gov/designmaps/us/application.php

Earthquake Hazards Program

Earthquake.usgs.gov

For occasional announcements about this web tool, please visit our [U.S. Seismic Design Maps wiki](#).

There is currently a known issue running reports for the 2013 ASCE 41 design code reference document. There is no known timeline for this to be resolved, we apologize for the inconvenience.

Application | **Batch Mode** | **Help**

Design Code Reference Document
Consult your local design official if you need help selecting this.
2012/15 IBC ▼

Report Title (Optional)
This will appear at the top of the generated report.
IIAR 2017 - San Antonio

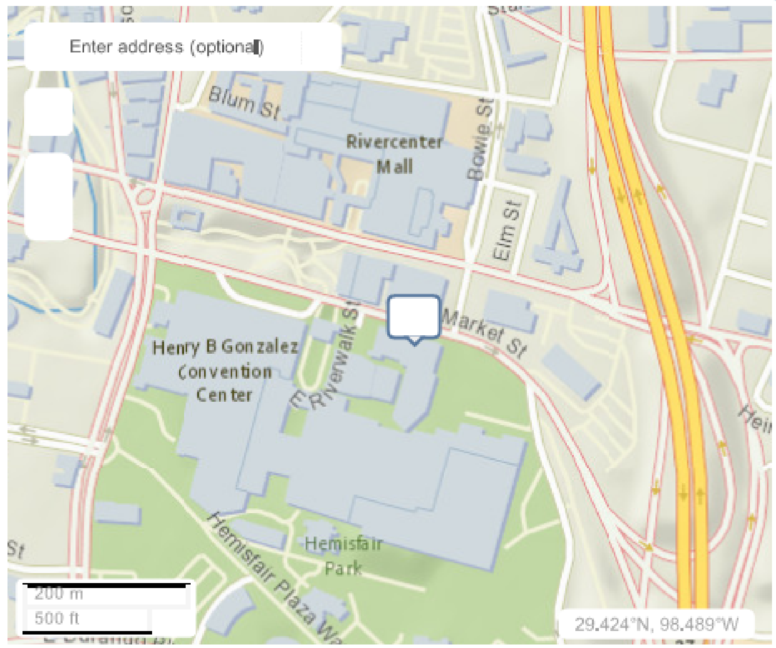
Site Soil Classification
This is not automatically selected based on site location.
Site Class D – "Stiff Soil" (Default) ▼

Risk Category
Used to compute the seismic design category.
I or II or III ▼

Site Latitude
Decimal degrees for the site location.
29.4218

Site Longitude
Decimal degrees for the site location.
-98.484

Compute Values



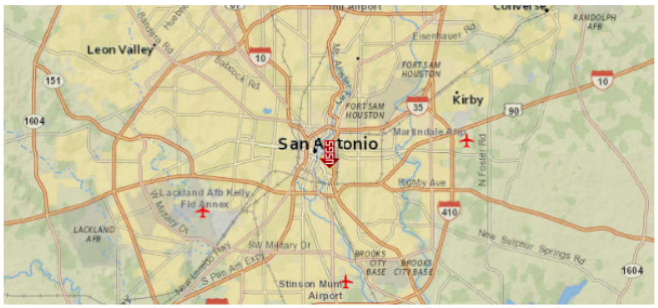
Powered by Leaflet — Content may not reflect National Geographic's current map policy. Sour

Earthquake Hazards Program

Earthquake.usgs.gov

User–Specified Input

Report Title	IIAR 2017 - San Antonio Tue February 14, 2017 16:20:49 UTC
Building Code Reference Document	2012/2015 International Building Code (which utilizes USGS hazard data available in 2008)
Site Coordinates	29.4218°N, 98.484°W
Site Soil Classification	Site Class D – "Stiff Soil"
Risk Category	I/II/III



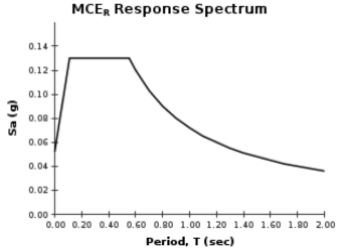
USGS–Provided Output

$S_S =$ 0.081 g $\quad S_{MS} =$ 0.130 g $\quad S_{DS} =$ 0.087 g

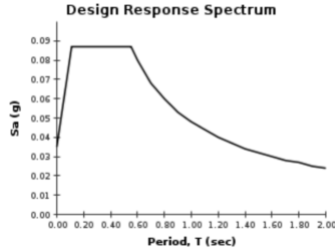
$S_1 =$ 0.030 g $\quad S_{M1} =$ 0.072 g $\quad S_{D1} =$ 0.048 g

For information on how the SS and S1 values above have been calculated from probabilistic (risk-targeted) and deterministic ground motions in the direction of maximum horizontal response, please return to the application and select the "2009 NEHRP" building code reference document.

MCE$_R$ Response Spectrum



Design Response Spectrum



Although this information is a product of the U.S. Geological Survey, we provide no warranty, expressed or implied, as to the accuracy of the data contained therein. This tool is not a substitute for technical subject-matter knowledge.

Section 1613.3.5 — Determination of seismic design category

TABLE 1613.3.5(1)
SEISMIC DESIGN CATEGORY BASED ON SHORT-PERIOD (0.2 second) RESPONSE ACCELERATION

VALUE OF S_{DS}	RISK CATEGORY		
	I or II	III	IV
$S_{DS} < 0.167g$	A	A	A
$0.167g \le S_{DS} < 0.33g$	B	B	C
$0.33g \le S_{DS} < 0.50g$	C	C	D
$0.50g \le S_{DS}$	D	D	D

For Risk Category = I and S_{DS} = 0.087 g, Seismic Design Category = A

TABLE 1613.3.5(2)
SEISMIC DESIGN CATEGORY BASED ON 1-SECOND PERIOD RESPONSE ACCELERATION

VALUE OF S_{D1}	RISK CATEGORY		
	I or II	III	IV
$S_{D1} < 0.067g$	A	A	A
$0.067g \le S_{D1} < 0.133g$	B	B	C
$0.133g \le S_{D1} < 0.20g$	C	C	D
$0.20g \le S_{D1}$	D	D	D

For Risk Category = I and S_{D1} = 0.048 g, Seismic Design Category = A

Note: When S_1 is greater than or equal to 0.75g, the Seismic Design Category is **E** for buildings in Risk Categories I, II, and III, and **F** for those in Risk Category IV, irrespective of the above.

ASCE 7-10

Chapter 13

Seismic Design Requirements for Nonstructural Components

Section 13.1 – General

13.1.1 – Scope. This chapter establishes minimum design criteria for nonstructural components that are permanently attached to structures and for their supports and attachments.

13.1.2 – Seismic Design Category. For the purposes of this chapter, nonstructural components shall be assigned to the same seismic design category as the structure that they occupy or to which they are attached.

13.1.3 – Component Importance Factor. All components shall be assigned a component importance factor as indicated in this section. The component importance factor, I_p, shall be taken as 1.5 if any of the following conditions apply:

1. Component is required to function for life safety purposes after an earthquake, including fire protection sprinkler systems and egress stairways.

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Chapter 13

13.1.3 – Component Importance Factor (Continued)

2. The component conveys, supports or contains toxic, highly toxic, or explosive substances **where the quantity of the material exceeds a threshold quantity established by the authority having jurisdiction and is sufficient to pose a threat to the public if released**.
3. The component is in or attached to a Risk Category IV structure and it is needed for continued operation of the facility or its failure could impair the continued operation of the facility.
4. The component conveys, supports, or otherwise contains hazardous substances and is **attached to a structure or portion thereof classified by the authority having jurisdiction as a hazardous occupancy**.

All other components shall be assigned a component importance factor, I_p, equal to 1.0.

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13.1.4 – Exemptions. The following nonstructural components are exempt from the requirements of this section:

1. Furniture.
2. Temporary or movable equipment.
3. Architectural Components……….
4. Mechanical and electrical components in Seismic Design Category B.
5. Mechanical and electrical components in Seismic Design Category C provided that component importance factor, I_P, is equal to 1.0
6. Mechanical and electrical components in Seismic Design Categories D, E, or F where all of the following apply:
   a. The component importance factor, I_P, is equal to 1.0;
   b. The component is positively attached to the structure;
   c. Flexible connections are provided between the component and associated ductwork, piping, and conduit; and either
      i. The component weights 400 lb or less and has a center of mass located 4 ft or less above the adjacent floor level; or
      ii. The component weights 20 lb or less or, in the case of a distributed system, 5 lb/ft or less.

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Chapter 13

13.2 General Design Requirements

13.2.1 Applicable Requirements for Architectural, Mechanical, and Electrical Components, Supports, and Attachments. Architectural, mechanical, and electrical components, supports and attachments shall be satisfied by one of the following methods:

1. Project-specific design and documentation submitted for approval to the authority having jurisdiction after review and acceptance by a registered design professional.
2. Submittal of the manufacturer's certification that the component is seismically qualified by at least one of the following:
   a) Analysis, or
   b) Testing in accordance with the alternative set forth in section 13.2.5, or
   c) Experience data in accordance with the alternative set forth in Section 13.2.6.

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13.2.3 Consequential Damage

The functional and physical interrelationship of components, their supports, and their effect on each other shall be considered so that the failure of an essential or nonessential architectural, mechanical, or electrical component shall not cause the failure of an essential architectural, mechanical, or electrical component.

13.2.4 Flexibility

The design and evaluation of components, their supports, and their attachments shall consider their flexibility as well as their strength.

13.2.7 Construction Documents

Where design of nonstructural components or their supports and attachments is required, such design shall be shown in construction documents **prepared by a registered design professional** for use by the owner, authorities having jurisdiction, contractors, and inspectors. ~~Such documents shall include a quality assurance plan if required by Appendix 11A~~. (The IBC Excludes Appendix 11A)

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13.3 SEISMIC DEMANDS ON NONSTRUCTURAL COMPONENTS

13.3.1 Seismic Design Force. The horizontal seismic design force (F_P) shall be applied at the component's center of gravity and distributed relative to the component's mass distribution and shall be determine in accordance with Eq. 13.3-1.

$$F_P = \frac{0.4 * a_p * S_{DS} * W_p}{\frac{R_p}{I_p}}\left(1 + 2\left(\frac{z}{h}\right)\right)$$

- F_P is not required to be taken greater than

$$F_P = 1.6 * S_{DS} * I_P * W_p$$

- F_P is not required to be taken less than

$$F_P = 0.3 * S_{DS} * I_P * W_p$$

- F_P = seismic design force
- S_{DS} = spectral acceleration, short period, as determined from section 11.4.4
- a_P = component amplification factor that varies from 1.00 to 2.50 (select appropriate value from Table 13.5-1 or 13.6-1)
- I_P = component importance factor that varies from 1.00 to 1.50 (see Section 13.1.3)
- W_P = component operating weight.
- R_P = component response modification factor that varies from 1.50 to 12 (select appropriate value from Table 13.5-1 or 13.6-1)
- z = height in structure of point of attachment of component with respect to the base. For items at or below the base, z shall be taken as 0. The value of z/h need not exceed 1.0
- h = average roof height of structure with respect to the base

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13.3.1 Seismic Design Force Continued.
The force (F_P) shall be applied independently in at least two orthogonal horizontal directions in combination with service loads associated with the component, as appropriate. For vertically cantilevered systems, however, the force F_P shall be assumed to act in any horizontal direction.

In addition, the components shall be designed for a concurrent vertical force

$$F_{VP} = \pm 0.2 * S_{DS} * W_p$$

13.3.2 Seismic Relative Displacements.
The effects of seismic relative displacements shall be considered in combinations with displacements caused by other loads as appropriate.

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Chapter 13

13.4 NONSTRUCTURAL COMPONENT ANCHORAGE

Nonstructural components and their supports shall be attached (or anchored) to the structure in accordance with the requirements of this section and the attachment shall satisfy the requirements for the parent material as set forth elsewhere in the standard.

Component attachments shall be bolted, welded, or otherwise positively fastened without consideration of frictional resistance produced by the effects of gravity. A continuous load path of sufficient strength and stiffness between the component and the supporting structure shall be provided. Local elements of the structure including connections shall be designed and constructed for the component forces where they control the design of the elements or their connections. The component force shall be those determined in Section 13.3.1. The design documents shall include sufficient information relating to the attachments to verify compliance with the requirements of this section.

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Chapter 13

<u>13.6 Mechanical and Electrical Components</u>

13.6.1 General

Mechanical and electrical components and their supports shall satisfy the requirements of this section. The attachment of mechanical and electrical components and their supports to the structure shall meet the requirements of section 13.4. Appropriate coefficients shall be selected from Table 13.6-1.

13.6.5 Component Supports

Mechanical and electrical component supports (including those with I_P=1.0) and the means by which they are attached to the component shall be designed for the forces in Section 13.3.1. Such supports include structural members, braces, frames, skirts, legs, saddles, pedestals, cables, guys, stays, snubbers, and tethers, as well as elements forged or cast as a part of the mechanical or electrical component.

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Chapter 13

13.6.8 Piping Systems

Unless otherwise noted in this section, piping systems shall be designed for the seismic forces and seismic relative displacements of Section 13.3. ASME pressure piping systems shall satisfy the requirements of Section 13.6.8.1. …..

13.6.8.1 ASME Pressure Piping Systems

Pressure piping systems, including their supports, designed and constructed in accordance with ASME B31 shall be deemed to meet the force, displacement, and other requirements of this section. In lieu of specific force and displacement requirements in ASME B31, the force and displacement requirements of Section 13.3 shall be used. Materials meeting the toughness requirements of ASME B31 shall be considered high-deformability materials.

Example Loading

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FEBRUARY 26 – MARCH 1, 2017 • SAN ANTONIO, TEXAS

Sample Loading

Design Criteria

1. Adopted Building Code: 2015 International Building Code & ASCE 7-10
2. Risk Category: IV
3. Wind Design Criteria:
   - Mean Roof Height: 40 Feet
   - Basic Wind Speed, V: 120 mph – 3 sec gust
   - Wind Exposure Category: C
4. Seismic Design Criteria:
   - Site Soil Classification: D (Assumed)
   - Short Period Spectral Acceleration, S_{DS}: 1.643 g
   - Seismic Design Category: D
   - Seismic Component Importance Factor, I_p: 1.5

For the seismic component amplification factor, a_p, and component response modification factor, R_p, from Table 13.6-1 of ASCE 7 we will assume the pipe is designed in accordance with ASME B31 with joints made by welding.

Component Amplification Factor, a_p: 2.5

Component Response Modification Factor, R_p: 12

Sample Loading

Design Criteria

ASCE 7-10 Wind Loading per Section 29.5.1 for Buildings with h ≤ 60 ft

Rooftop Structures and Equipment for Buildings with h ≤ 60 ft.

Building Risk Category:	IV	K_z =	1.04 (Table 29.3-1)
Mean Roof Height (h):	40 ft	K_{zt} =	1 (No Topographic Effects)
Roof Insulation Thickness:	4 in	K_d =	0.95 (Table 26.6-1)
Exposure Category:	C		
Design Wind Speed (V):	120 mph 3 sec gust		
Velocity Pressure (q_h):	$q_h = 0.00256K_zK_{zt}K_dV^2$= 36.42 psf		

Wind Design Load per Section 29.5.1

Lateral Force:	$F_h = q_h(GC_f)A_f$	**Vertical Uplift Froce:**	$F_v = q_h(GC_f)A_r$
G_{cr}:	1.9	**G_{cr}:**	1.5

ASCE 7-05 Seismic Design Loading per Chapter 13

Seismic Design Parameters:

Seismic Design Category:	D	
Spectral acceleration - S_{DS}:	1.643	
Component Importance Factor - I_p :	1.5	(Section 13.1.3)
Redundancy Factor, ρ:	1.3	(Section 12.3.4)

Seismic Design must be considered

Horizontal Seismic Design Factors:

a_p :	2.5	Component amplification factor (Table 13.6-1)
R_p :	12	Component response modification factor (Table 13.6-1)
z:	Avover Roof	Height in structure of point of attachment for component from the base.
h:	40 ft	Average roof height o f structure from the base.
z/h :	1	(Need Not Exceed 1.0)

Horizontal Force Component:

$$F_P = \frac{0.4 * a_p * S_{DS} * W_p}{\frac{R_p}{I_p}}\left(1 + 2\left(\frac{z}{h}\right)\right)$$

F_P shall not be taken greater than: $F_P = 1.6 * S_{DS} * I_P * W_p$

F_P shall not be taken less than: $F_P = 0.3 * S_{DS} * I_P * W_p$

Vertical Force Component:

$$F_{VP} = \pm 0.2 * S_{DS} * W_p$$

Sample Loading

Unfactored Loading

Design Wind and Seismic Loads

Pipe Content:	**Liquid Ammonia**		Insulation Thickness:	**2 in**			
Content Density:	**42.61 pcf**	@ -28°F	Support Spacing:	**12 ft**			
Pipe Type:	**Steel Pipe - Schedule 40**		Height off Roof:	**48 in**			
Youngs Modulus, E:	**29000000 psi**						
Trade Pipe Size:	**2 in**	**2-1/2 in**	**3 in**	**3-1/2 in**	**4 in**	**5 in**	**6 in**
Pipe ID:	2.067 in	2.469 in	3.068 in	3.548 in	4.026 in	5.047 in	6.065 in
Pipe OD:	2.375 in	2.875 in	3.5 in	4 in	4.5 in	5.563 in	6.625 in
Total OD:	6.375 in	6.875 in	7.5 in	8 in	8.5 in	9.563 in	10.625 in
Section Modulus, I (in^4):	0.627	1.45 in	2.85 in	4.52 in	6.82 in	14.3 in	26.5 in
Center Line Height:	51.1875 in	51.4375 in	51.75 in	52 in	52.25 in	52.7815 in	53.3125 in
Pipe Weight:	4.65 lb/ft	7.22 lb/ft	9.77 lb/ft	12.04 lb/ft	14.57 lb/ft	20.55 lb/ft	27.54 lb/ft
$A_f = A_r$ =	6.38 sf	6.88 sf	7.50 sf	8.00 sf	8.50 sf	9.56 sf	10.63 sf
Dead Load =	**55.791 lbs**	**86.582 lbs**	**117.245 lbs**	**144.520 lbs**	**174.808 lbs**	**246.613 lbs**	**330.487 lbs**
Horizontal Wind - F_h =	**441.157 lbs**	**475.758 lbs**	**519.008 lbs**	**553.609 lbs**	**588.209 lbs**	**661.770 lbs**	**735.262 lbs**
Wind Uplift - F_v =	**348.282 lbs**	**375.598 lbs**	**409.743 lbs**	**437.060 lbs**	**464.376 lbs**	**522.450 lbs**	**580.470 lbs**
Horizontal Seismic - F_P =	34.374 lbs	53.345 lbs	72.237 lbs	89.042 lbs	107.704 lbs	151.944 lbs	203.621 lbs
Max Horizontal - $F_{P, MAX}$ =	219.996 lbs	341.409 lbs	462.319 lbs	569.870 lbs	689.304 lbs	972.444 lbs	1303.175 lbs
Min Horizontal - $F_{P, MIN}$ =	**41.249 lbs**	**64.014 lbs**	**86.685 lbs**	**106.851 lbs**	**129.245 lbs**	**182.333 lbs**	**244.345 lbs**
Vertical Seismic - F_{VP} =	**18.333 lbs**	**28.451 lbs**	**38.527 lbs**	**47.489 lbs**	**57.442 lbs**	**81.037 lbs**	**108.598 lbs**

Sample Loading

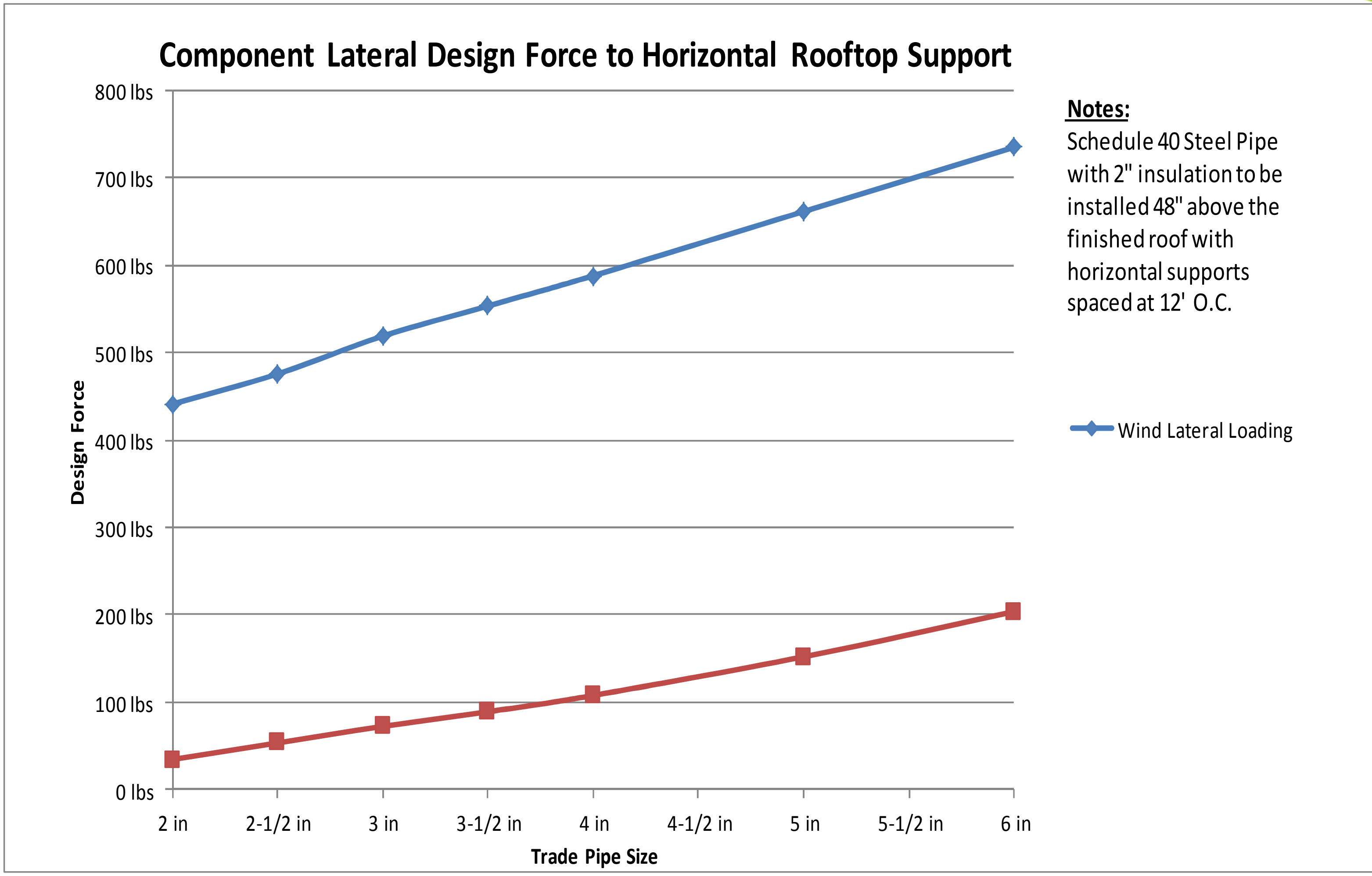
Factored Loading

ASCE 7 Section 2.3 - Strength Design Load Combinations - Vertical Loading							
Trade Pipe Size:	2 in	2-1/2 in	3 in	3-1/2 in	4 in	5 in	6 in
LC 1. -1.4D	-78.108 lbs	-121.214 lbs	-164.143 lbs	-202.327 lbs	-244.732 lbs	-345.258 lbs	-462.681 lbs
LC 4. -1.2D + 1.0W_y	281.332 lbs	271.700 lbs	269.050 lbs	263.636 lbs	254.606 lbs	226.515 lbs	183.886 lbs
LC 5. -(1.2+0.2S_{DS})D + ρQ_E	-40.596 lbs	-63.000 lbs	-85.312 lbs	-105.158 lbs	-127.197 lbs	-179.445 lbs	-240.475 lbs
LC 6. -0.9D + 1.0W_y	298.070 lbs	297.675 lbs	304.223 lbs	306.992 lbs	307.048 lbs	300.498 lbs	283.032 lbs
LC 7. -(0.9-0.2S_{DS})D + ρQ_E	12.808 lbs	19.876 lbs	26.915 lbs	33.176 lbs	40.129 lbs	56.613 lbs	75.867 lbs
Governing Downward Load:	-78.108 lbs	-121.214 lbs	-164.143 lbs	-202.327 lbs	-244.732 lbs	-345.258 lbs	-462.681 lbs
Governing Uplift Load:	298.070 lbs	297.675 lbs	304.223 lbs	306.992 lbs	307.048 lbs	300.498 lbs	283.032 lbs
Horizontal Wind Deflection:	0.9433 in	0.4399 in	0.2442 in	0.1642 in	0.1156 in	0.0620 in	0.0372 in
Horizontal Seismic Deflection:	0.0735 in	0.0493 in	0.0340 in	0.0264 in	0.0212 in	0.0142 in	0.0103 in
Vertical Uplift Deflection:	0.6374 in	0.2752 in	0.1431 in	0.0911 in	0.0604 in	0.0282 in	0.0143 in
Vertical Downward Deflection:	0.1670 in	0.1121 in	0.0772 in	0.0600 in	0.0481 in	0.0324 in	0.0234 in

ASCE 7 Section 2.4 - Allowable Stress Design Load Combinations - Vertical Loading							
Trade Pipe Size:	2 in	2-1/2 in	3 in	3-1/2 in	4 in	5 in	6 in
LC 1. -1.0D	-55.791 lbs	-86.582 lbs	-117.245 lbs	-144.520 lbs	-174.808 lbs	-246.613 lbs	-330.487 lbs
LC 5. -D + 0.6W_y	153.178 lbs	138.777 lbs	128.601 lbs	117.716 lbs	103.817 lbs	66.857 lbs	17.795 lbs
LC 5. -(1.0+0.14S_{DS})D + 0.7ρQ_E	-37.344 lbs	-57.953 lbs	-78.477 lbs	-96.734 lbs	-117.007 lbs	-165.069 lbs	-221.210 lbs
LC 6a. -D + 0.45W_y	100.936 lbs	82.437 lbs	67.140 lbs	52.157 lbs	34.161 lbs	-11.510 lbs	-69.275 lbs
LC 6b. -(1+0.1S_{DS})D + 0.525ρQ_E	-41.497 lbs	-64.399 lbs	-87.206 lbs	-107.493 lbs	-130.021 lbs	-183.429 lbs	-245.814 lbs
LC 7. -0.6D + 0.6W_y	175.494 lbs	173.410 lbs	175.499 lbs	175.524 lbs	173.741 lbs	165.502 lbs	149.990 lbs
LC 8. -(0.6-0.14S_{DS})D + 0.7ρQ_E	10.639 lbs	16.511 lbs	22.358 lbs	27.559 lbs	33.335 lbs	47.028 lbs	63.022 lbs
Governing Downward Load:	-55.791 lbs	-86.582 lbs	-117.245 lbs	-144.520 lbs	-174.808 lbs	-246.613 lbs	-330.487 lbs
Governing Uplift Load:	175.494 lbs	173.410 lbs	175.499 lbs	175.524 lbs	173.741 lbs	165.502 lbs	149.990 lbs
Horizontal Wind Deflection:	0.9433 in	0.4399 in	0.2442 in	0.1642 in	0.1156 in	0.0620 in	0.0372 in
Horizontal Seismic Deflection:	0.0735 in	0.0493 in	0.0340 in	0.0264 in	0.0212 in	0.0142 in	0.0103 in
Vertical Uplift Deflection:	0.3753 in	0.1603 in	0.0826 in	0.0521 in	0.0342 in	0.0155 in	0.0076 in
Vertical Downward Deflection:	0.1193 in	0.0801 in	0.0552 in	0.0429 in	0.0344 in	0.0231 in	0.0167 in

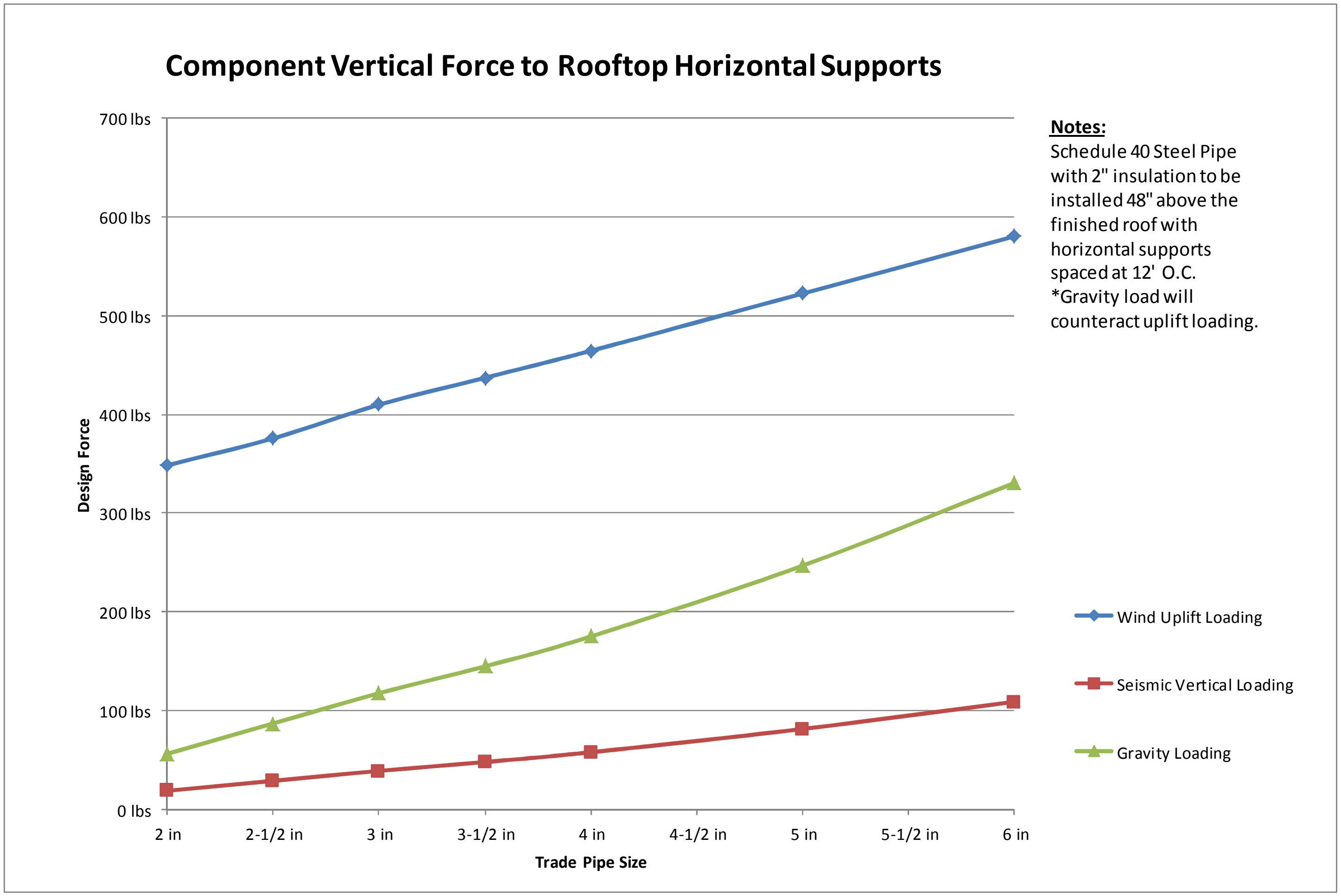
Sample Loading

Unfactored Lateral Force Design



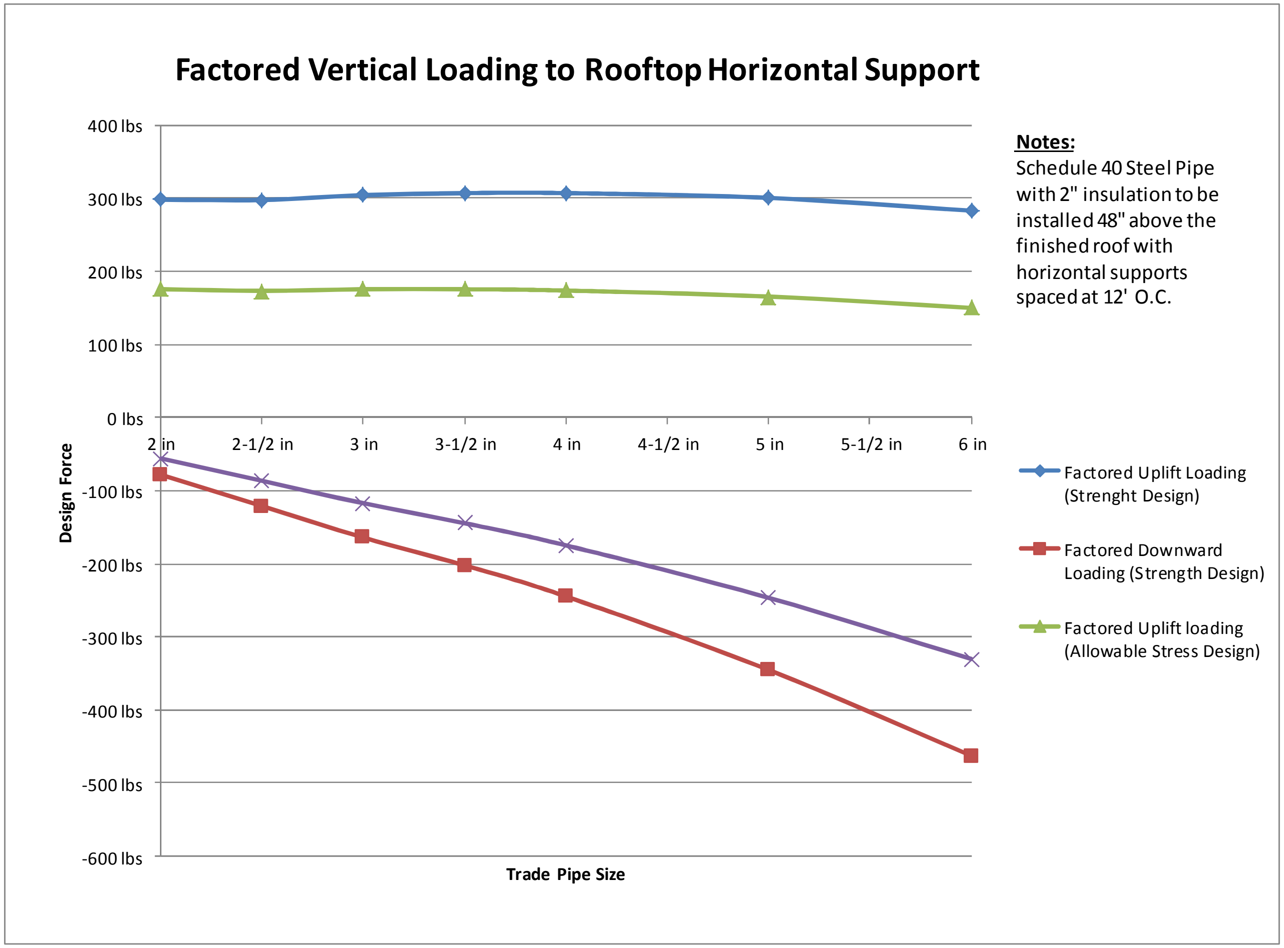
Sample Loading

Unfactored Vertical Force Design



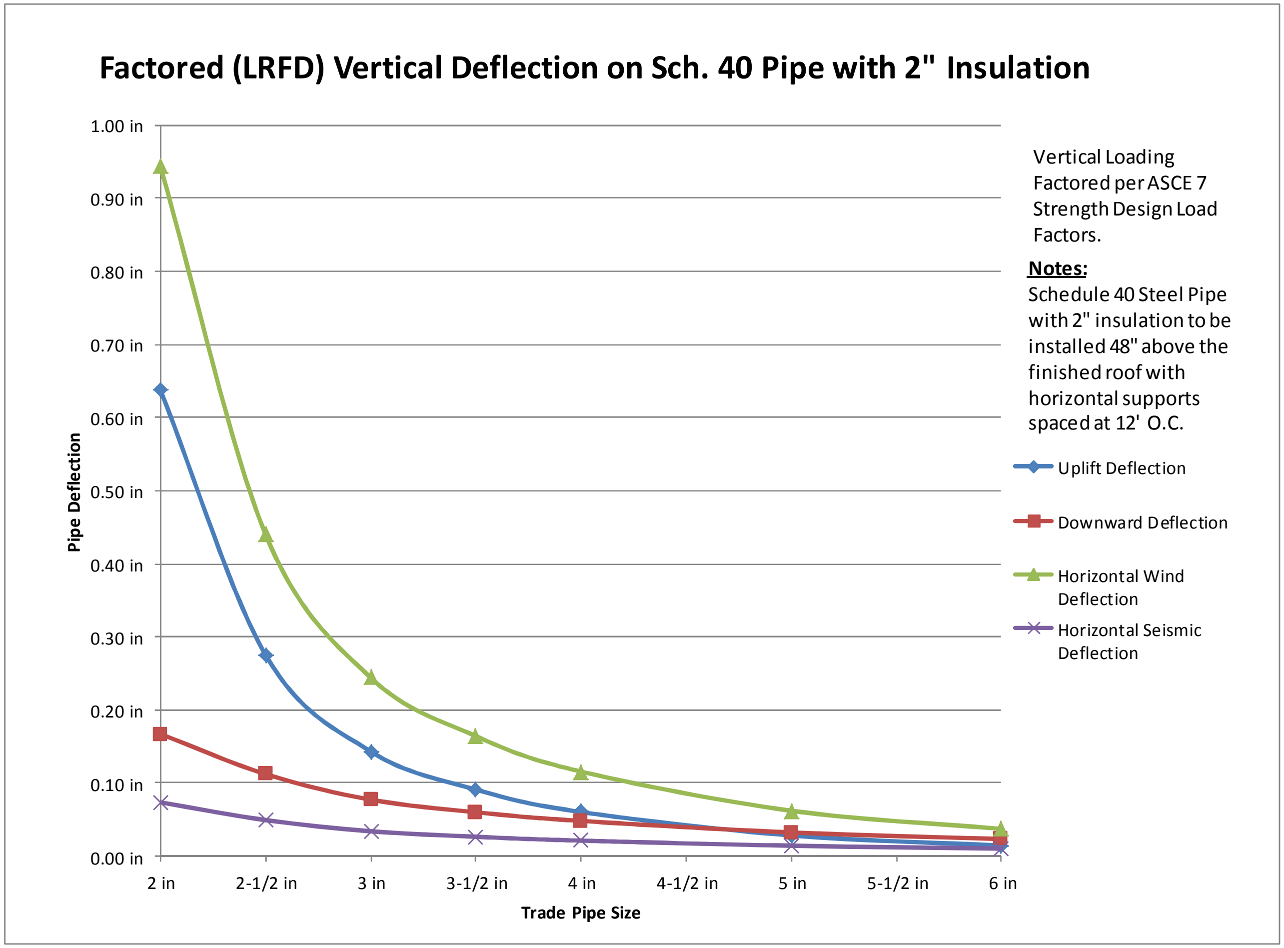
Sample Loading

Factored Vertical Force Design



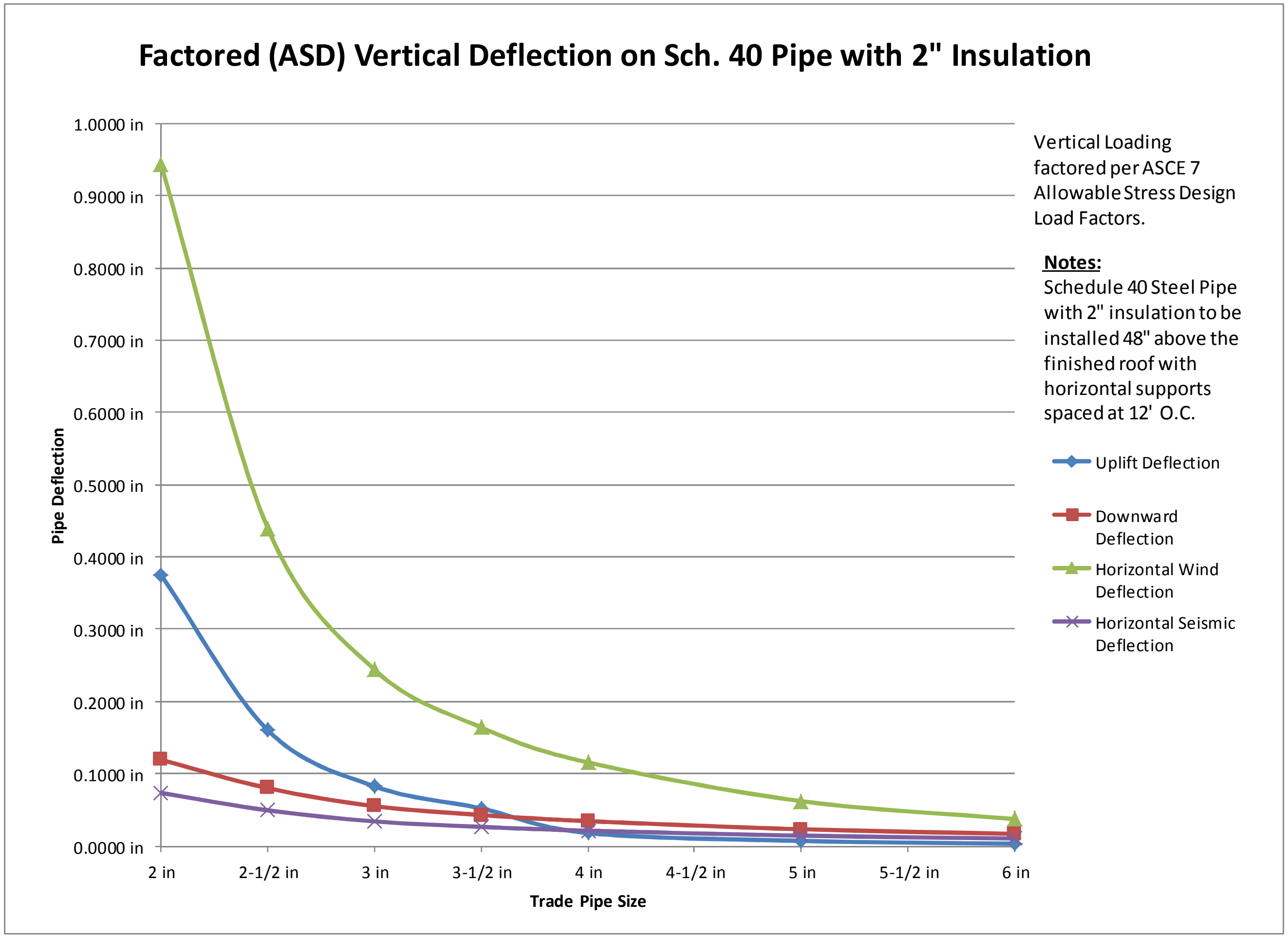
Sample Loading

LRFD Factored Load Pipe Deflections



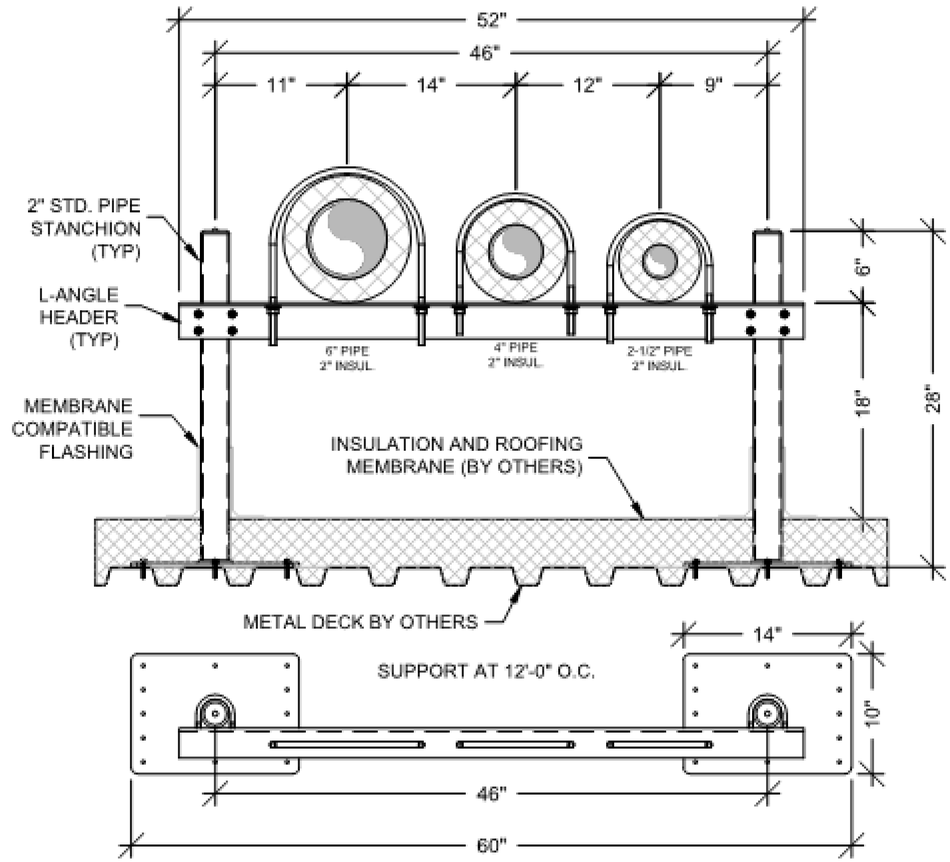
Sample Loading

ASD Factored Load Pipe Deflections



Example Design

Basic Layout



- Supports at 12’ O.C. (typ)

Example Design

Design Criteria

ASCE 7-10 Wind Loading per Section 29.5.1 for Buildings with h ≤ 60 ft

Rooftop Structures and Equipment for Buildings with h ≤ 60 ft.

Building Risk Category:	IV	K_z =	1.04	(Table 29.3-1)
Mean Roof Height (h):	40 ft	K_{zt} =	1	(No Topographic Effects)
Roof Insulation Thickness:	4 in	K_d =	0.95	(Table 26.6-1)
Exposure Category:	C			
Design Wind Speed (V):	120 mph 3 sec gust			
Velocity Pressure (q_h):	$q_h = 0.00256 K_z K_{zt} K_d V^2 =$ 36.42 psf			

Wind Design Load per Section 29.5.1

Lateral Force:	$F_h = q_h(GC_f)A_f$	**Vertical Uplift Froce:**	$F_v = q_h(GC_r)A_r$
G_{cr}:	1.9	**G_{cr}:**	1.5

ASCE 7-05 Seismic Design Loading per Chapter 13

Seismic Design Parameters:

Seismic Design Category:	D	
Spectral acceleration - S_{DS}:	1.643	
Component Importance Factor - I_p :	1.5	(Section 13.1.3)
Redundancy Factor, ρ:	1.3	(Section 12.3.4)

Seismic Design must be considered

Horizontal Seismic Design Factors:

a_p :	2.5	Component amplification factor (Table 13.6-1)
R_p :	12	Component response modification factor (Table 13.6-1)
z:	Avover Roof	Height in structure of point of attachment for component from the base.
h:	40 ft	Average roof height o f structure from the base.
z/h :	1	(Need Not Exceed 1.0)

Horizontal Force Component:

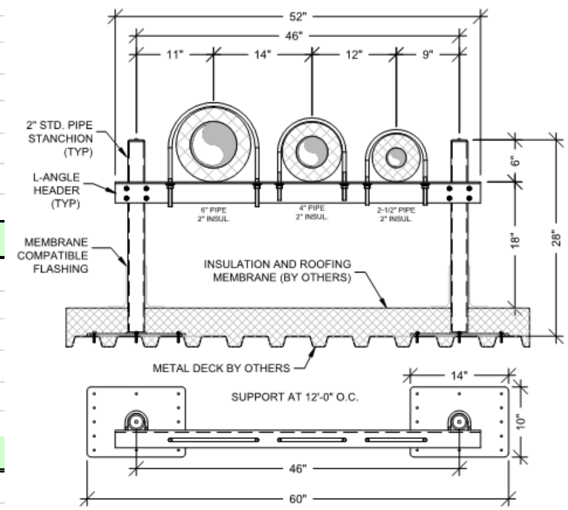
$$F_P = \frac{0.4 * a_p * S_{DS} * W_p}{\frac{R_p}{I_p}}\left(1 + 2\left(\frac{z}{h}\right)\right)$$

F_P shall not be taken greater than: $F_P = 1.6 * S_{DS} * I_P * W_p$

F_P shall not be taken less than: $F_P = 0.3 * S_{DS} * I_P * W_p$

Vertical Force Component:

$$F_{VP} = \pm 0.2 * S_{DS} * W_p$$



Example Design

Design Loading

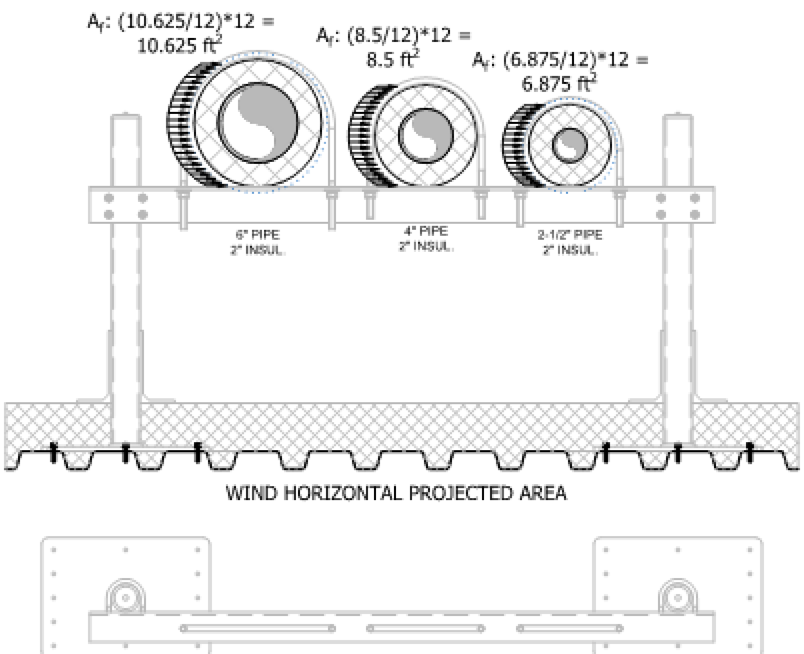
Design Wind and Seismic Loads

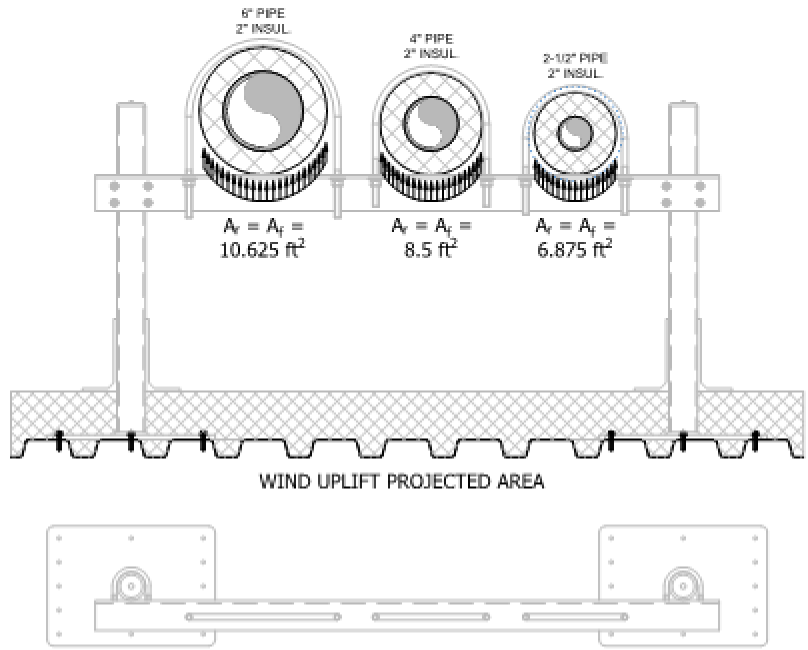
Pipe Content:	**Liquid Ammonia**		Insulation Thickness:	**2 in**
Content Density:	**42.61 pcf**	@ -28^{o}F	Support Spacing:	**12 ft**
Pipe Type:	**Steel Pipe - Schedule 40**		Height off Roof:	**18 in**
Youngs Modulus, E:	**29000000 psi**			

Trade Pipe Size:	**2-1/2 in**	**4 in**	**6 in**
Pipe ID:	2.469 in	4.026 in	6.065 in
Pipe OD:	2.875 in	4.5 in	6.625 in
Total OD:	6.875 in	8.5 in	10.625 in
Section Modulus, I (in^4):	1.45 in	6.82 in	26.5 in
Center Line Height:	21.4375 in	22.25 in	23.3125 in
Pipe Weight:	7.22 lb/ft	14.57 lb/ft	27.54 lb/ft
$A_f = A_r$ =	6.88 sf	8.50 sf	10.63 sf
Dead Load =	**86.582 lbs**	**174.808 lbs**	**330.487 lbs**
Horizontal Wind - F_h =	**475.758 lbs**	**588.209 lbs**	**735.262 lbs**
Wind Uplift - F_v =	**375.598 lbs**	**464.376 lbs**	**580.470 lbs**
Horizontal Seismic - F_P =	53.345 lbs	107.704 lbs	203.621 lbs
Max Horizontal - $F_{P, MAX}$ =	341.409 lbs	689.304 lbs	1303.175 lbs
Min Horizontal - $F_{P, MIN}$ =	**64.014 lbs**	**129.245 lbs**	**244.345 lbs**
Vertical Seismic - F_{VP} =	**28.451 lbs**	**57.442 lbs**	**108.598 lbs**

Example Design

Wind Projected Area

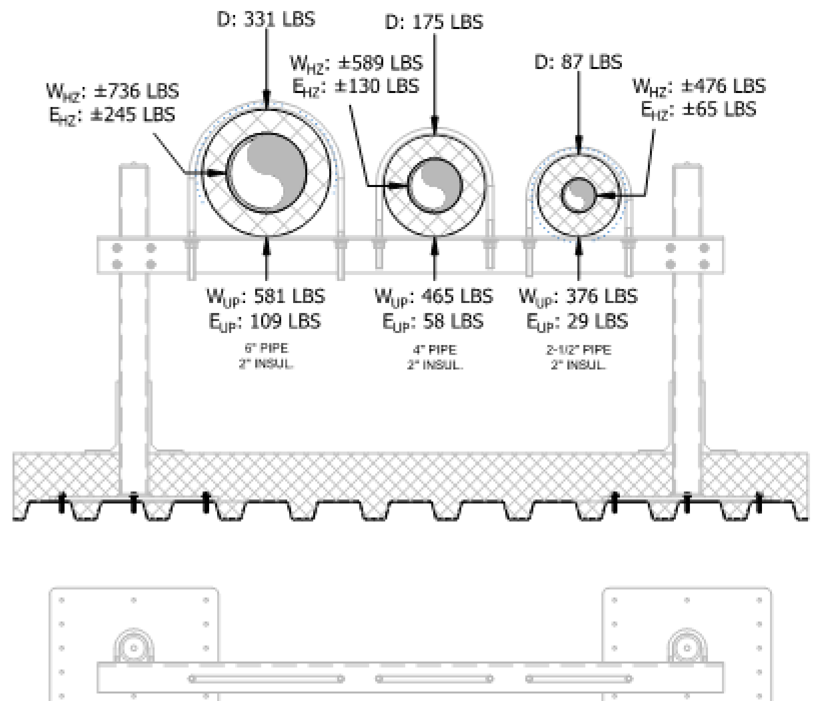




- Supports at 12' O.C. (typ)

Example Design

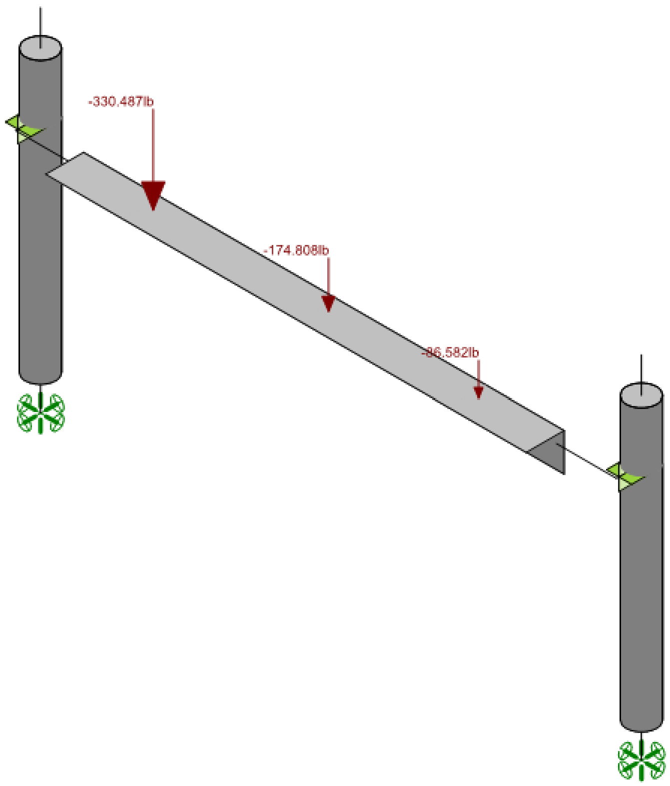
Loading

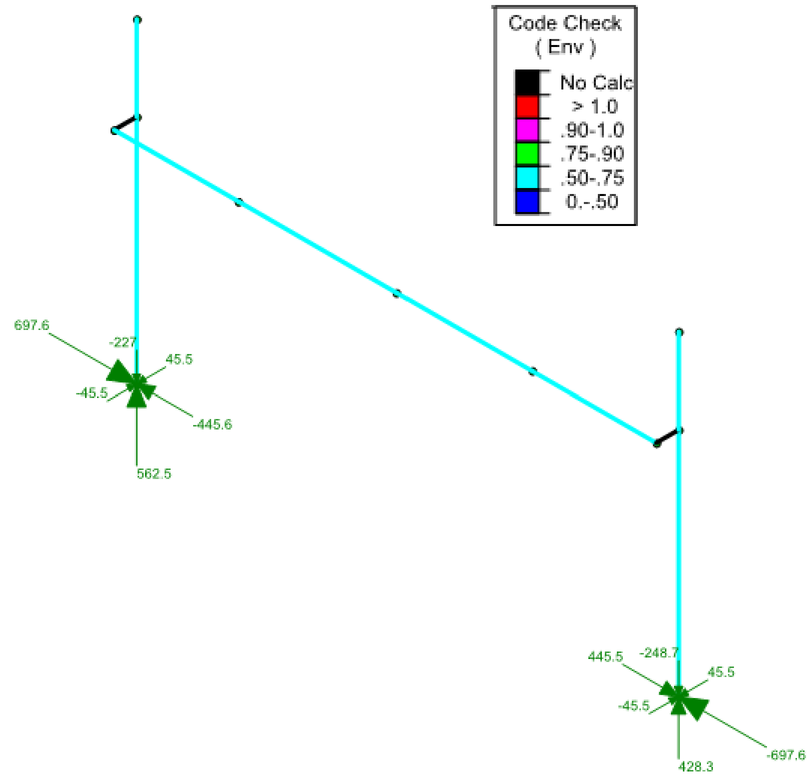


- Supports at 12' O.C. (typ)

Example Design

RISA 3D Analysis

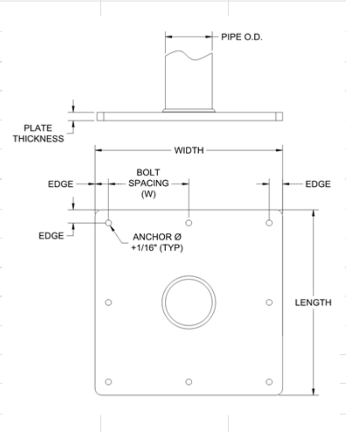




Example Design

Base Plate Design

Label:	Sample Base Plate			[OK]



Max Reactions from RISA 3D Analysis		Pipe Size:	2	
Max Shear in X Direction:	697.612 lb	Pipe Material:	A53 Gr B Galv	
Max Uplift in Y Direction:	562.532 lb	Inner Diameter, d:	2.07	in
Max Shear in Z Direction:	45.541 lb	Outer Diameter, D:	2.38	in
Max MX Moment:	1315.797 lb-in	Wall Thickness, t:	0.14	in
Max MZ Moment:	7744.035 lb-in	D/t:	16.64	
Base Plate				
Width:	14 in	Area, A:	1.00	in^2
Length:	10 in	Ix:	0.63	in^4
Thickness:	1/2	Sx:	0.53	in^3
Base Yield Strength, F_y:	36 ksi	rx:	0.79	in
Base Ultimate Strength, F_U:	58 ksi	Zx:	0.71	in^3
Typ. Bolt Edge Distance:	1 in	F_y:	35	ksi
Typical Bolt Spacing:	2 in	F_U:	60	ksi
		E:	29000	ksi

Base Plate to Pipe - Welded Connection

Weld Properties

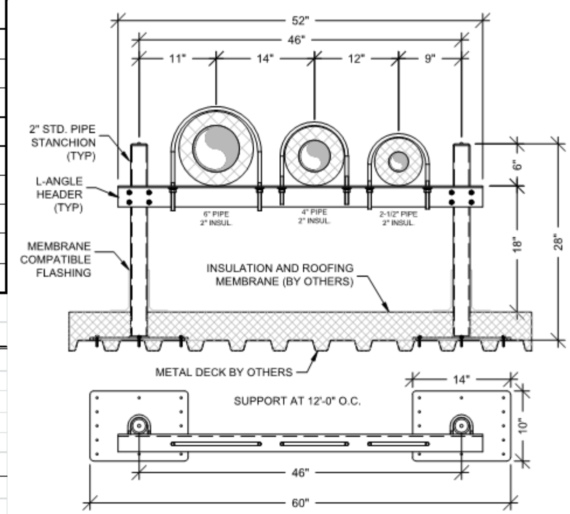
Moment, P_{UE}:	7.74 k-in	Pipe Diameter, D:	2.38 in	
Weld Size, a:	1/4	Pipe Radius, R:	1.19 in	
Weld Strength, F_{UW}:	70 ksi	Effective Weld Length, L:	7.477 in	$(L=2\pi R)$
(Ultimate Tensile Strength for E70XX Weld)				

Calculations (Eccentrically Loaded Weld Elastic Method)

Shear per inch of weld, r_p:	0.139 k/in	$(r_p = P_u / l)$	
Shear per inch of weld from moment, r_m:	1.741 k/in	$(r_m = (P_u\, e\, c) / I_x)$	
Resultant Force, r_u:	**1.746 k/in**	$r_u = \sqrt{r_p^2 + r_m^2}$	[OK]
Radial Distance from weld C.G. to most remote weld, c:	1.19 in	$(c = R)$	
Section Modulus, S_x:	4.45 in^2	$(S_x = \pi R^2)$	
Moment of Inertia of weld group, I_x:	5.29 in^3	$(I_x = \pi R^3)$	

ALLOWABLE WELD STRENGTH PER INCH (Using the lesser of the following)

$\emptyset R_n = \emptyset F_y A_g$	5.73 k	(AISC Eq. J4-1)	Φ:	0.90
			A_g:	0.18 in^2
$\emptyset R_n = \emptyset 0.6 F_y A_g$	3.82 k	(AISC Eq. J4-3)	Φ:	1.00
ΦRn:	**3.82 k**			



Example Design

Base Plate Design

STEEL BASE PLATE CHECK

PLATE INFORMATION

Effective Plate Length, L:	9.62 in	
Effective Plate Width, W:	5.62 in	
Plate Thickness, t:	0.5 in	[OK]

Plate Bending

Moment, M_x:	1.32	K-in.	
Moment, M_z:	7.74	K-in.	
Requires Section Modulus, S_x:	0.04	in^3	
Requires Section Modulus, S_z:	0.15	in^3	
Actual Section Modulus, S_{plx}:	0.23	in^3	[OK]
Actual Section Modulus, S_{plz}:	0.40	in^3	[OK]
Φ:	0.9		
Allowable Bending, ΦM_{px}:	7.59	K-in.	[OK]
Allowable Bending, ΦM_{pz}:	12.99	K-in.	[OK]

Base Plate Anchor Requirements

Roof Deck Description

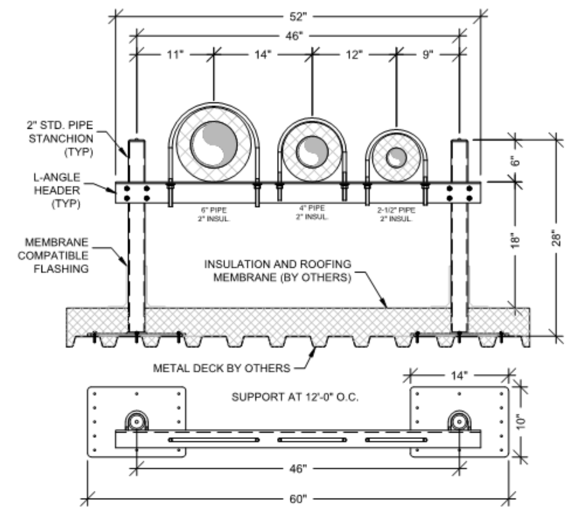
Deck:	1-1/2" x 20 ga. Type B Metal Deck (ASSUMED)
Screw Anchor:	Use 1/4-14 ELCO Drill Screw or Equivelant

Anchor Strength:

$V_{Ultimate}$:	1301 lbs	$V_{Allowable}$:	434 lbs
$P_{Ultimate}$:	571 lbs	$P_{Allowable}$:	190 lbs
Safety Factor:	3		

Max Reactions from RISA	Reaction	Total Anchors Req'd
Max Shear in X Direction:	697.612 lb	2
Max Uplift in Y Direction:	562.532 lb	3
Max Shear in Z Direction:	45.541 lb	1

Overturning		Moment Arm	Force @ Edge	Req'd Anchors/Side
Max MX Moment:	1315.797 lb-in	8 in	164.47 lb	1
Max MZ Moment:	7744.035 lb-in	12 in	645.34 lb	4



Conclusion

- International Code Council's International Codes are the most widely adopted codes. States typically either adopt the code in it's entirety, or use the codes as their base and make modifications as applicable their circumstances.
- Adopted codes establish minimum requirements with the goal to safeguard the public health and safety in all communities, large and small.
- Industry standards like IIAR 2 or ASHRE 15 are recognized in the codes and can be used in the design of systems on the condition that the minimum requirements outlined in the International Codes are met.
- There are currently no exemptions from evaluating equipment that is exposed to wind.
- Seismic exemptions exist, but are subject to site specific and other general requirements.
- Where wind and seismic must both be considered, wind loading will typically govern the design.

Conclusion

- The design of rooftop equipment supports requires coordination between multiple trades, and professions.
- Rooftop equipment supports are typically handled as a deferred submittal in the project documents. If not addressed in the project schedule, the rooftop support submittal can lead to delays project delays.
- Evaluation of wind and seismic loading on rooftop equipment can and has been overlooked by many industries, building officials and inspectors.
- A larger presence in the International Building Code and ASCE 7 will lead to stricter adherence and enforcement.
- Codes are always evolving and participation in code development can help ensure practical or realistic requirements are implemented.

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Q & A

Thank you for your time!

Questions?

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