Nonstructural Bracing

2012 INTERNATIONAL BUILDING CODE

PNW-AWWA 2015 Conference

wrk engineers

Presented by
Brian Knight, PE, SE

SUMMARY

- Historical Performance
- Seismic Hazard
- Expected Performance
- Code Bracing Requirements

Historical Performance

LACK OF BRACING & ANCHORAGE

Historical Performance

CONDUIT

Historical Performance

CONTROL EQUIPMENT

Historical Performance

UTILITIES INTO BUILDING

Historical Performance

DUCTS

Historical Performance

FIRE SPRINKLER

Historical Performance

PIPING

Historical Performance

PARTITION WALLS

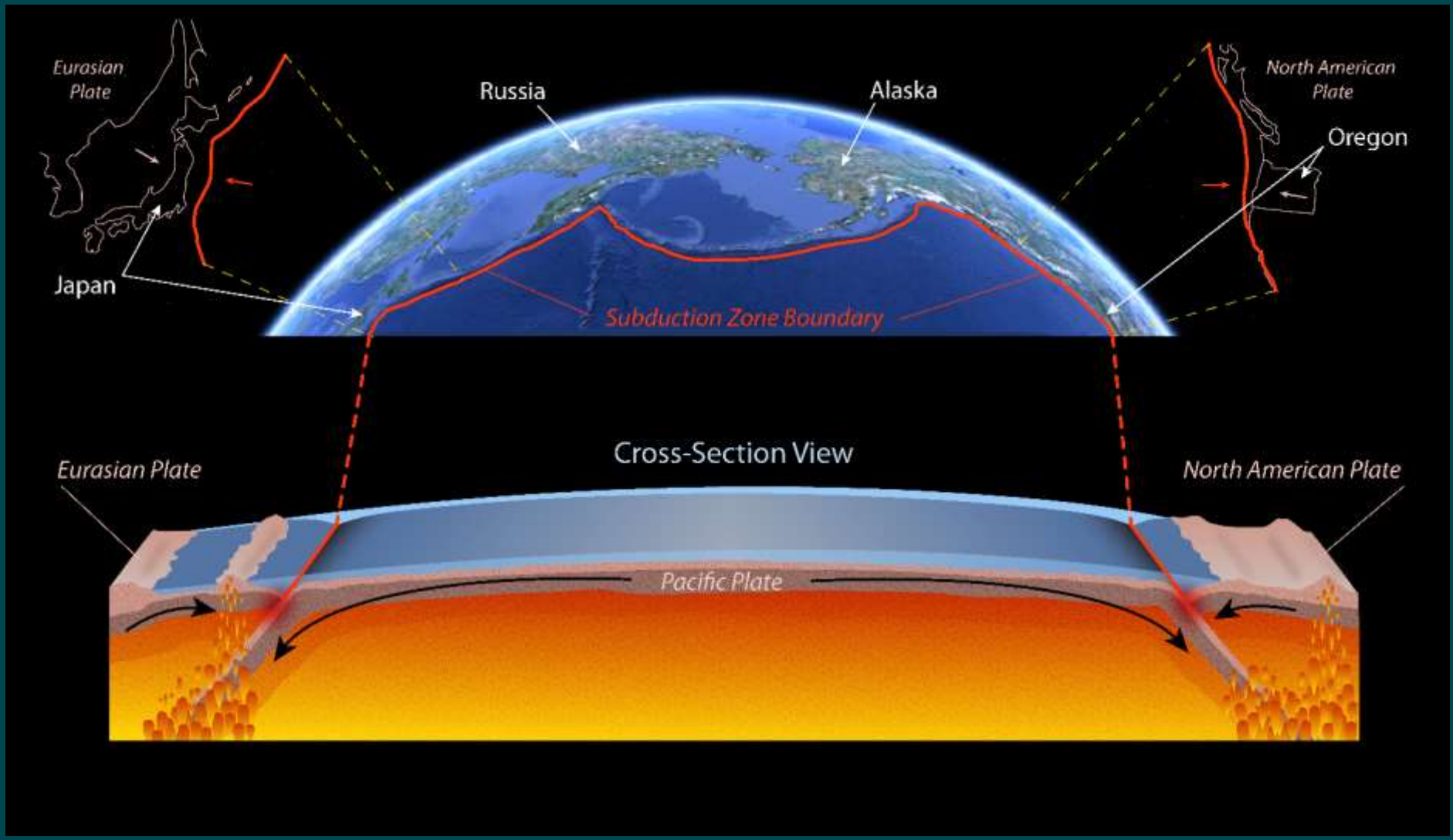
Historical Performance

SUSPENDED CEILING SYSTEMS

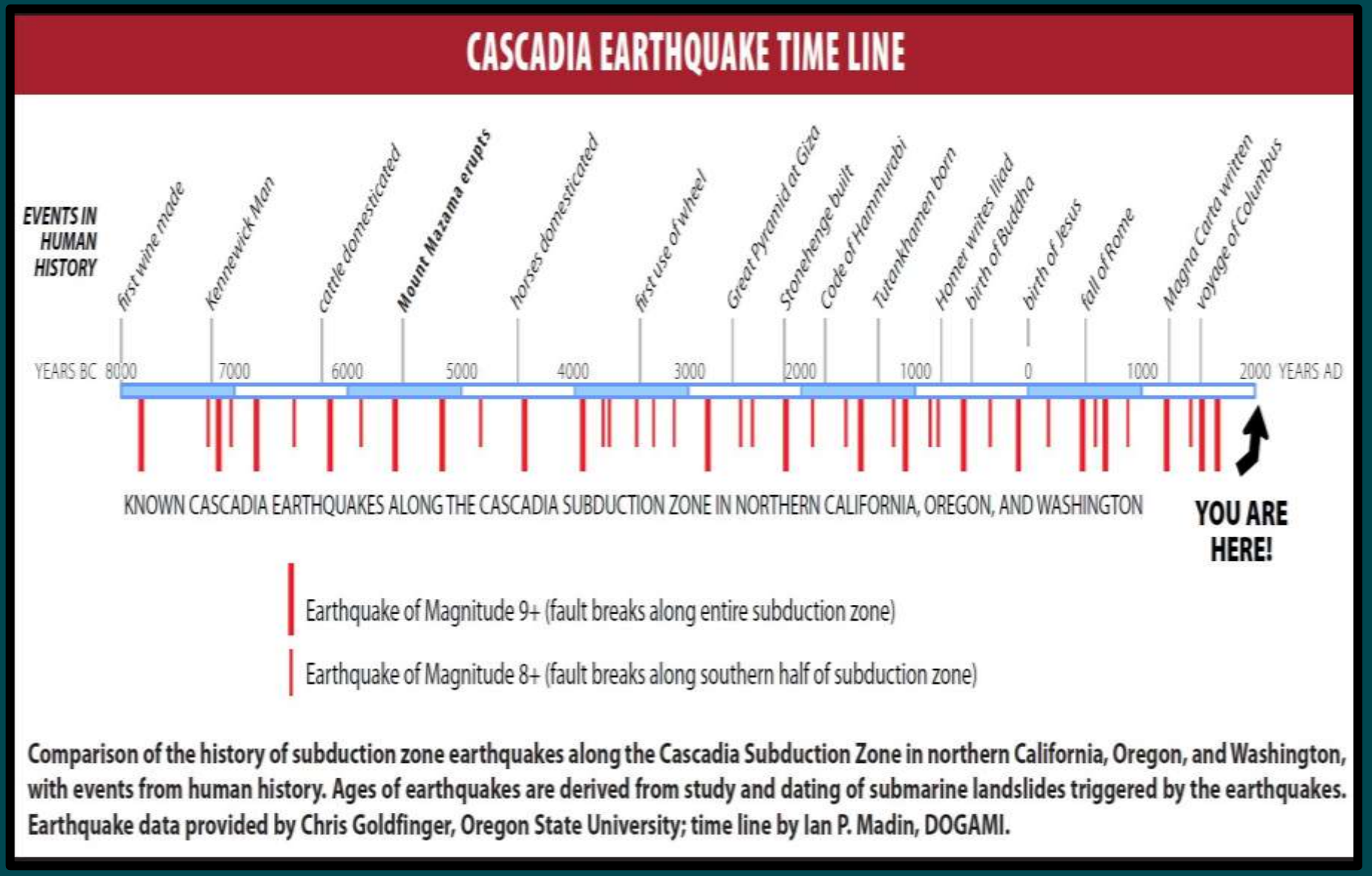
Historical Performance

STAIRS

Pacific Northwest Hazard



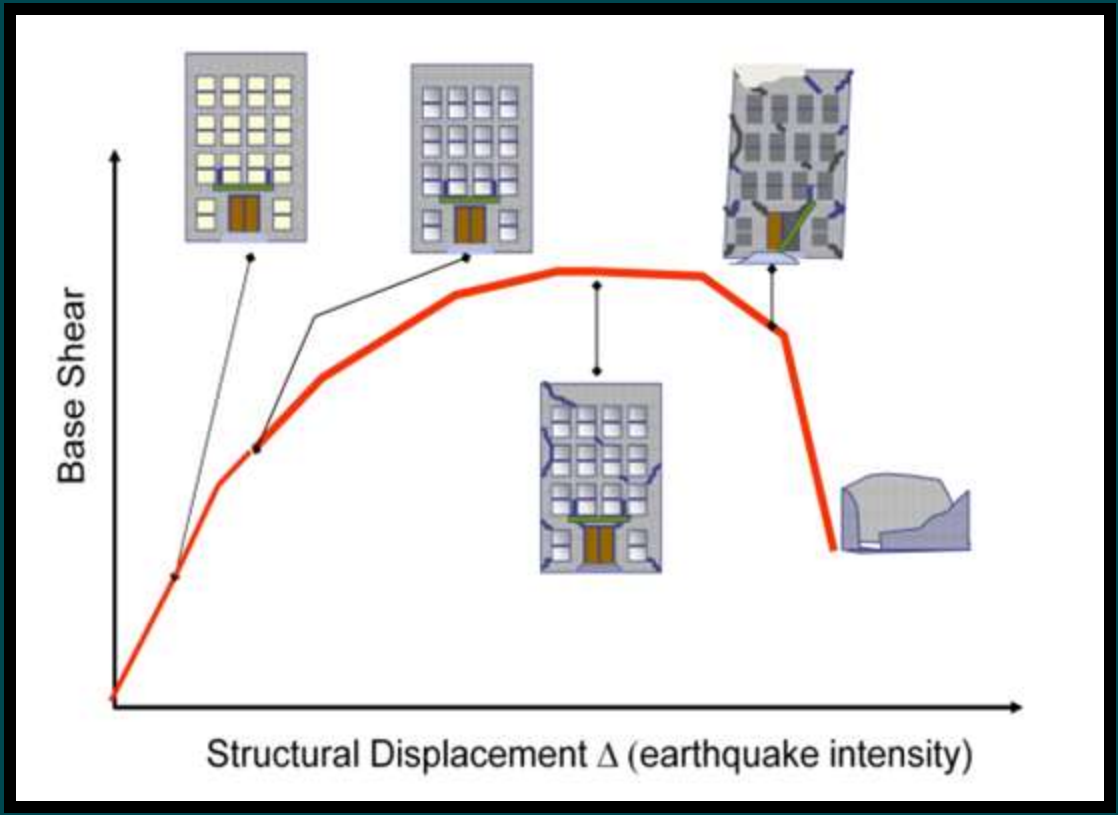
Pacific Northwest Hazard



Expected Performance

Q

What **performance** does the **building code** provide?



Expected Performance

Q How does the code **differentiate** between different **levels of performance**?

Scope

Size

Weight considerations for nonstructural components

IMPORTANCE FACTOR

General Requirements

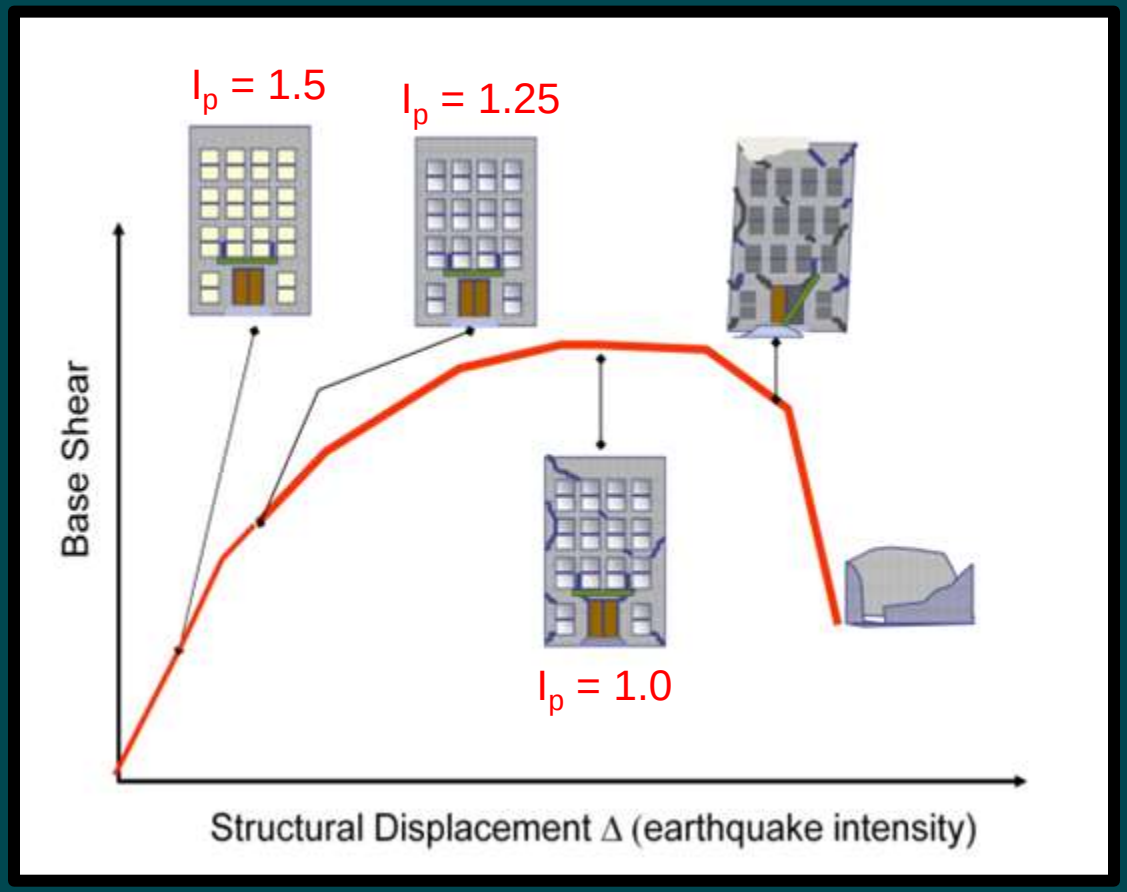
Q

How does the code define **demands** for nonstructural components?

SEISMIC DESIGN FORCE

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

Expected Performance



Building Code Requirements

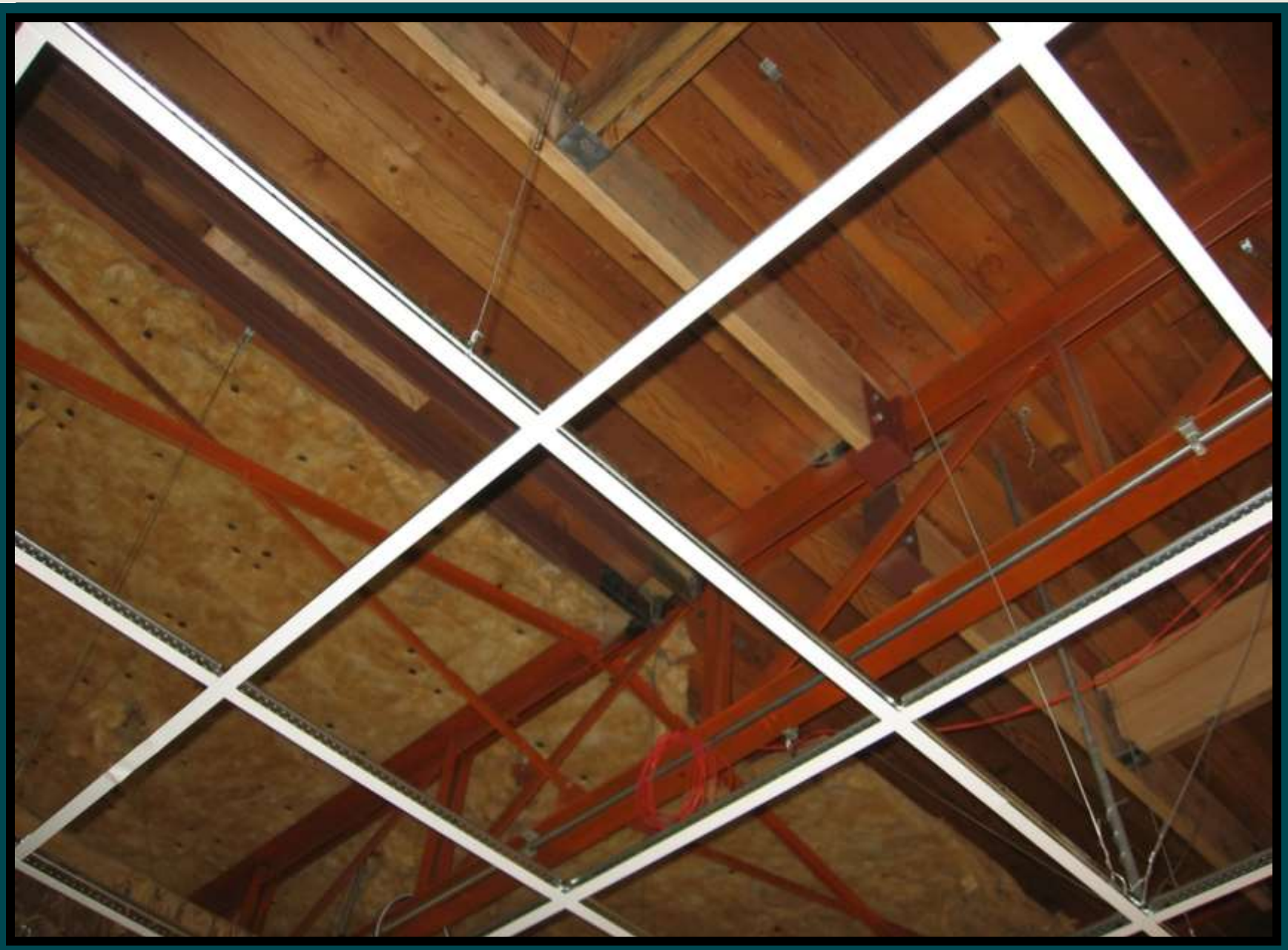
Table 13.6-1 Seismic Coefficients for Mechanical and Electrical Components

Mechanical and Electrical Components	a_p[a]	R_p[b]
Air-side HVAC, fans, air handlers, air conditioning units, cabinet heaters, air distribution boxes, and other mechanical components constructed of sheet metal framing	2.5	6.0
Wet-side HVAC, boilers, furnaces, atmospheric tanks and bins, chillers, water heaters, heat exchangers, evaporators, air separators, manufacturing or process equipment, and other mechanical components constructed of high-deformability materials	1.0	2.5
Engines, turbines, pumps, compressors, and pressure vessels not supported on skirts and not within the scope of Chapter 15	1.0	2.5
Skirt-supported pressure vessels not within the scope of Chapter 15	2.5	2.5
Elevator and escalator components	1.0	2.5
Generators, batteries, inverters, motors, transformers, and other electrical components constructed of high deformability materials	1.0	2.5
Motor control centers, panel boards, switch gear, instrumentation cabinets, and other components constructed of sheet metal framing	2.5	6.0
Communication equipment, computers, instrumentation, and controls	1.0	2.5
Roof-mounted stacks, cooling and electrical towers laterally braced below their center of mass	2.5	3.0
Roof-mounted stacks, cooling and electrical towers laterally braced above their center of mass	1.0	2.5
Lighting fixtures	1.0	1.5
Other mechanical or electrical components	1.0	1.5

Building Code Requirements

Vibration Isolated Components and Systems[b]		
Components and systems isolated using neoprene elements and neoprene isolated floors with built-in or separate elastomeric snubbing devices or resilient perimeter stops	2.5	2.5
Spring isolated components and systems and vibration isolated floors closely restrained using built-in or separate elastomeric snubbing devices or resilient perimeter stops	2.5	2.0
Internally isolated components and systems	2.5	2.0
Suspended vibration isolated equipment including in-line duct devices and suspended internally isolated components	2.5	2.5
Distribution Systems		
Piping in accordance with ASME B31, including in-line components with joints made by welding or brazing	2.5	12.0
Piping in accordance with ASME B31, including in-line components, constructed of high or limited deformability materials, with joints made by threading, bonding, compression couplings, or grooved couplings	2.5	6.0
Piping and tubing not in accordance with ASME B31, including in-line components, constructed of high-deformability materials, with joints made by welding or brazing	2.5	9.0
Piping and tubing not in accordance with ASME B31, including in-line components, constructed of high- or limited-deformability materials, with joints made by threading, bonding, compression couplings, or grooved couplings	2.5	4.5
Piping and tubing constructed of low-deformability materials, such as cast iron, glass, and nonductile plastics	2.5	3.0
Ductwork, including in-line components, constructed of high-deformability materials, with joints made by welding or brazing	2.5	9.0
Ductwork, including in-line components, constructed of high- or limited-deformability materials with joints made by means other than welding or brazing	2.5	6.0
Ductwork, including in-line components, constructed of low-deformability materials, such as cast iron, glass, and nonductile plastics	2.5	3.0
Electrical conduit and cable trays	2.5	6.0
Bus ducts	1.0	2.5
Plumbing	1.0	2.5
Manufacturing or process conveyors (nonpersonnel)	2.5	3.0

SUSPENDED CEILINGS



Architectural Components

SUSPENDED CEILINGS

- 2" oversize ring around sprinkler head

Mechanical Components

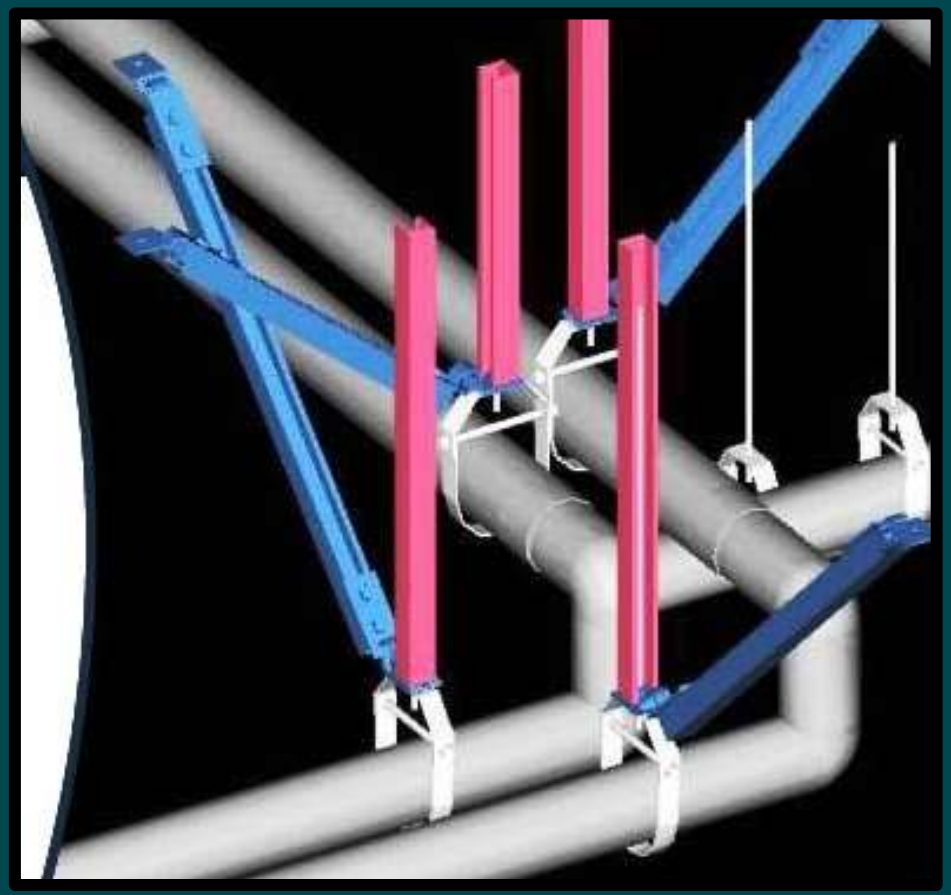
HVAC EQUIPMENT

Plumbing Components

FIRE SPRINKLERS

Piping Components

NON FIRE SPRINKLERS



OTHER COMPONENTS

COMMUNICATION EQUIPMENT

HAZARDOUS MATERIALS

FURNISHING ANCHORAGE

Specifying Nonstructural Requirements

Q **When** the does the Code require **certification** of **equipment?**

A *When equipment is required to remain operable after design level earthquake*

Components with hazardous substances shall be certified as maintaining containment

Specifying Nonstructural Requirements

Q What does **certification** entail?

Testing

Specifying Nonstructural Requirements

Q What does **certification** entail?

- *Testing*
  - *Experience Data*
    - *Inherently Rugged + Analysis*

HOW DO I ADDRESS BRACING ???

Design Options for Nonstructural Bracing

Prescriptive Method

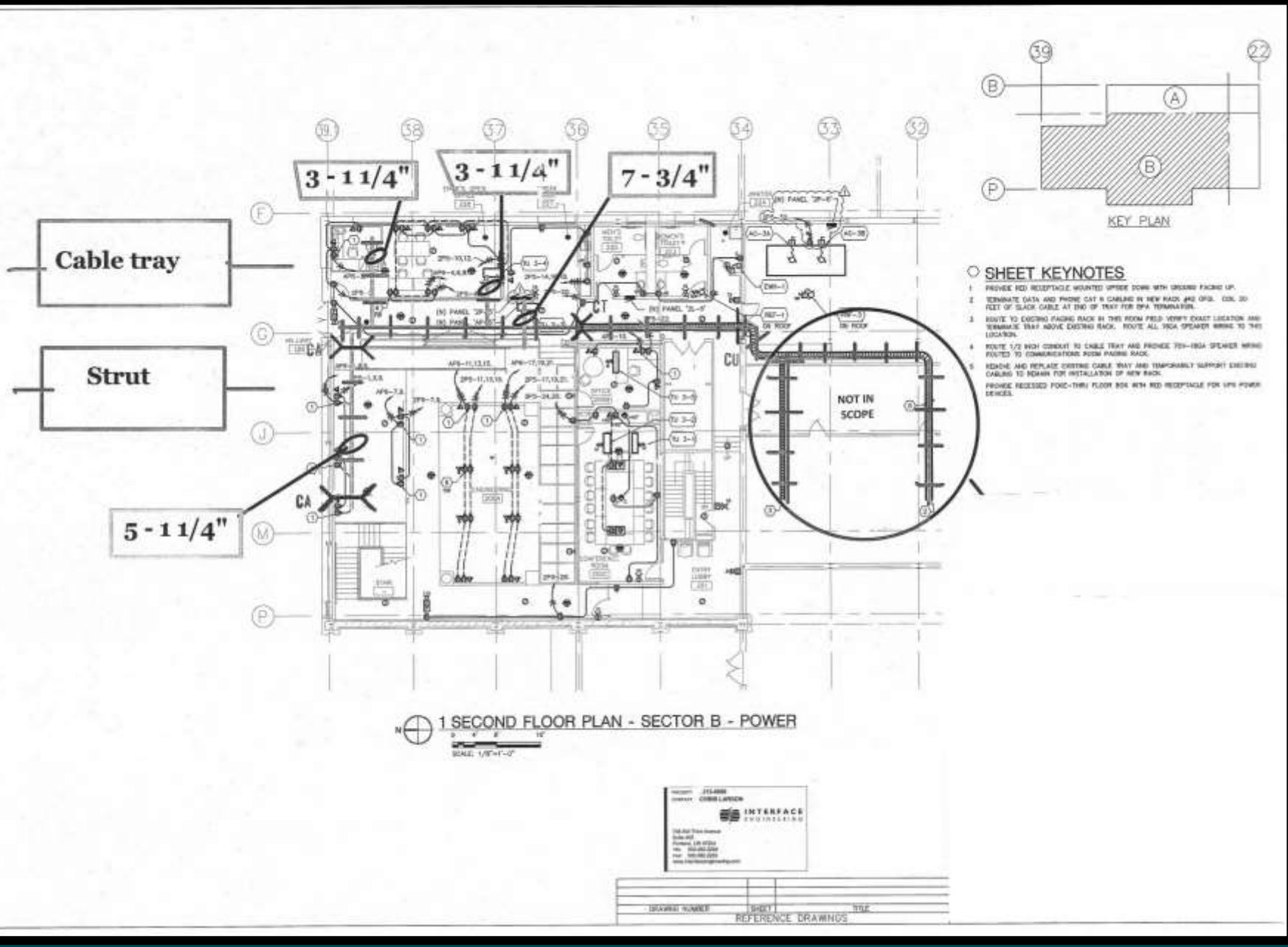
- Pre-engineered designs for nonstructural bracing w/o consideration of local conditions.
- Design Professional often does not visit project site.
- May not include provisions for pipe thrust restraint or thermal expansion

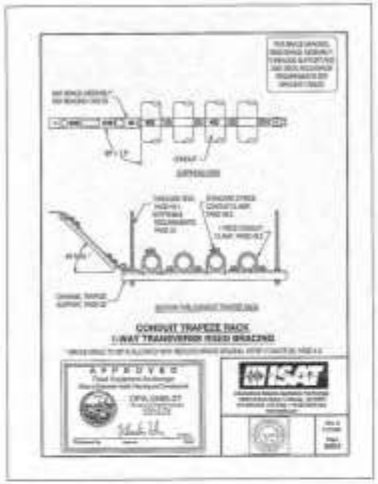
HOW DO I ADDRESS BRACING ???

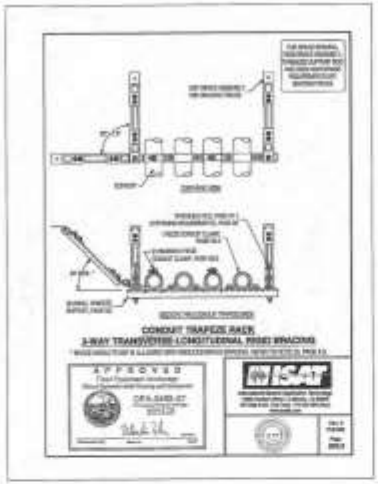
Design Options for Nonstructural Bracing

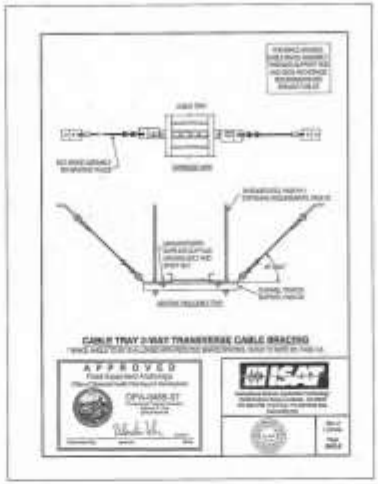
Prescriptive Method

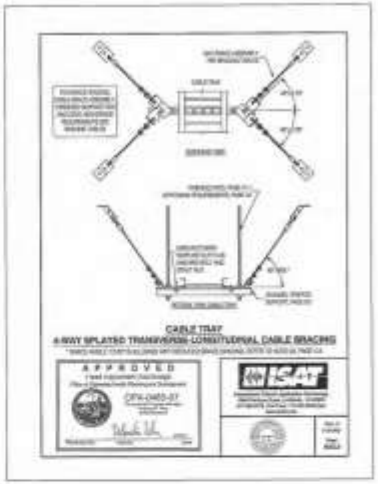
- Provides generic bracing details and connection details to structure (may not be constructible)
- Method often neglects existing conditions (i.e. conflicts)
- Some limitations to MEP configurations and materials of construction
- Difficult to use with congested systems/spaces.


3 - 1 1/4"
3 - 1 1/4"
7 - 3/4"
Cable tray
Strut
5 - 1 1/4"
NOT IN SCOPE
KEY PLAN
SHEET KEYNOTES
1 SECOND FLOOR PLAN - SECTOR B - POWER
INTERFACE ENGINEERING
DRAWING NUMBER
SHEET
TITLE
REFERENCE DRAWINGS

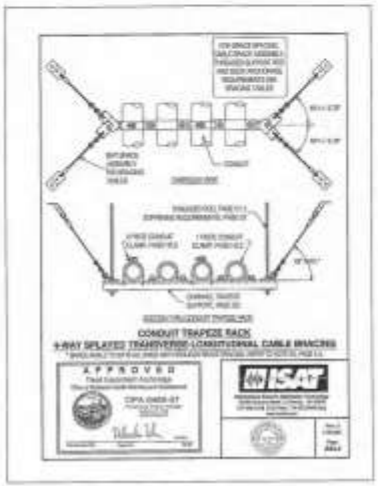


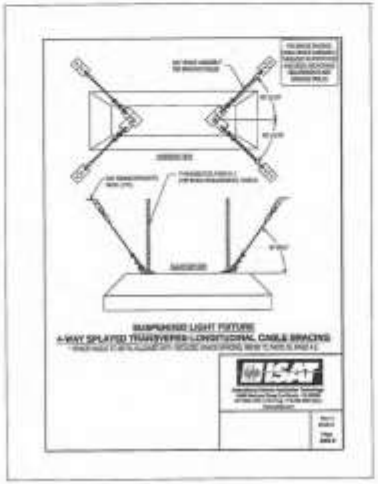


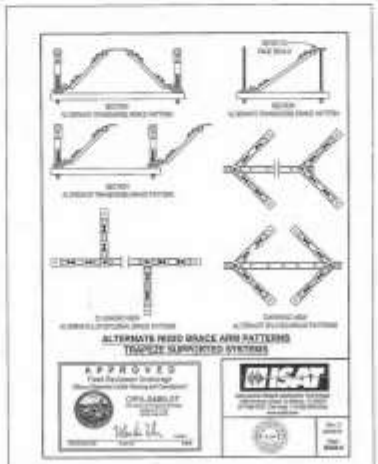


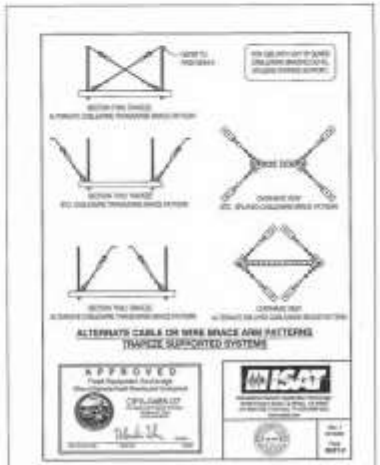


For Rod Stiffining Requirements
See Detail G1 on Drawing SB3.1









ISAT

ISSUED FOR:	Date
COMPLETED	8/12/16

Drawn By: KE
Checked By: KE
Project #: ELECTRICAL
Date: 8/12/16
Scale: NTS

Sheet Title:
ELECTRICAL INSTALLATION DETAILS

Sheet No.
SBH2.1

HOW DO I ADDRESS BRACING ???

Design Options for Nonstructural Bracing

Custom Engineered Designs

- More cost-effective than Prescriptive Method
- Custom designs include seismic brace locations, bracing details, and connection details to structure
- Designed to local design criteria

HOW DO I ADDRESS BRACING ???

Design Options for Nonstructural Bracing

Custom Engineered Designs

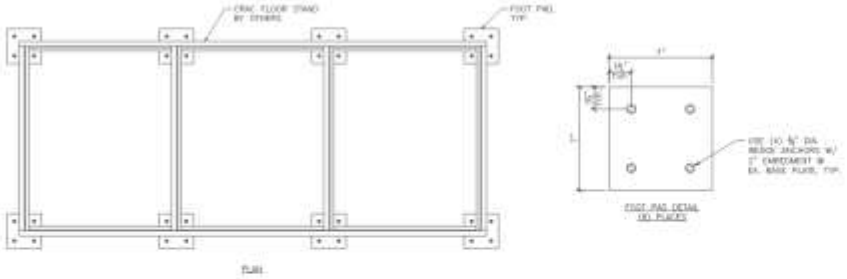
- Custom designs can include provisions for thrust restraint and thermal expansion
- No limitations to MEP configurations or materials of construction
- Eliminate installation conflicts with other systems

HOW DO I ADDRESS BRACING ???

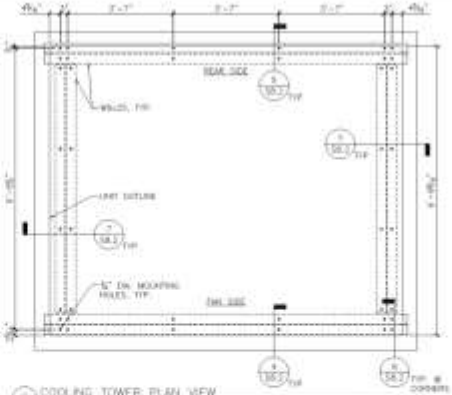
Design Options for Nonstructural Bracing

Custom Engineered Designs

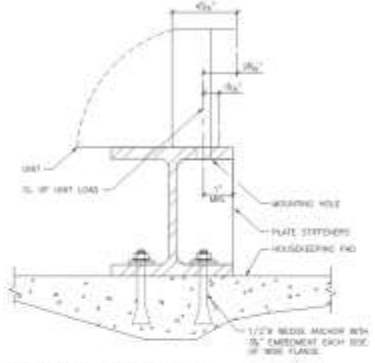
- Address structural support design & alterations (pads/support structures/etc.)
- Use for both New and Existing
- Only use Custom for Existing



1 TYPICAL CRAC FLOOR STAND ANCHORAGE DETAIL

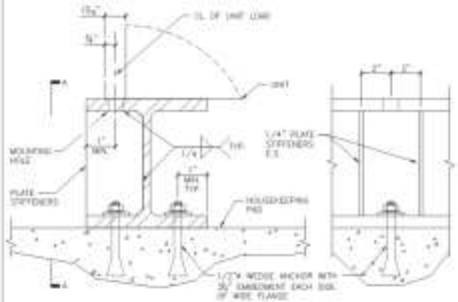


3 COOLING TOWER PLAN VIEW



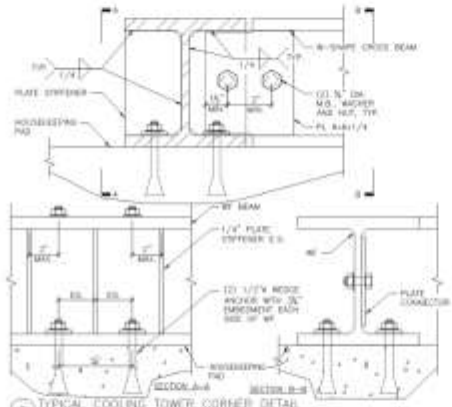
NOTE: SEE 3/– FOR BALANCE OF INFORMATION

4 TYPICAL COOLING TOWER FAN INLET SIDE ANCHORAGE DETAIL

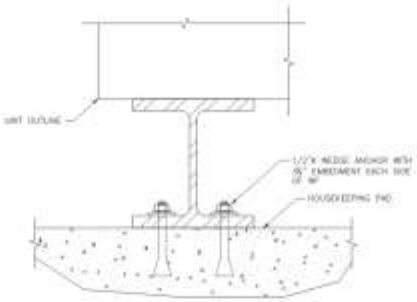


NOTE: SEE 3/– FOR BALANCE OF INFORMATION

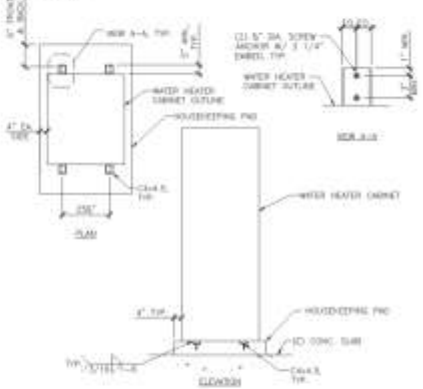
5 TYPICAL COOLING TOWER REAR SIDE ANCHORAGE DETAIL



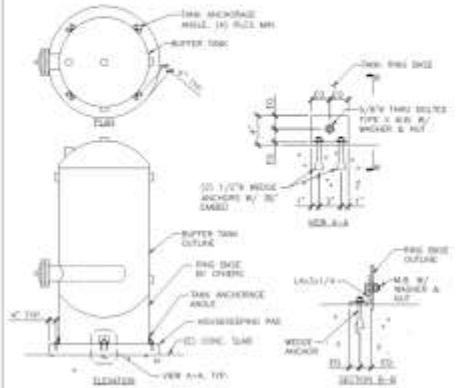
6 TYPICAL COOLING TOWER CORNER DETAIL



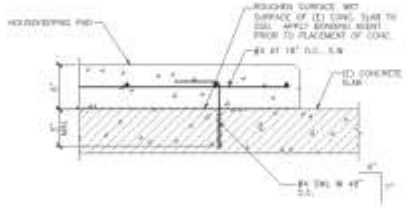
7 TYPICAL COOLING TOWER W/ ANCHORAGE DETAIL



8 TYPICAL WATER HEATER ANCHOR DETAIL

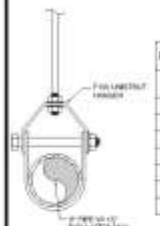


9 TYPICAL BUFFER TANK ANCHOR DETAIL



NOTE:
REFER TO MECH. UNIT DETAIL FOR SIZE INFORMATION

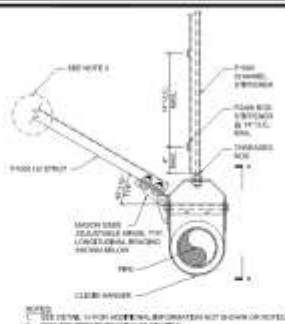
10 TYPICAL HOUSEKEEPING PAD DETAIL



PIPE HANGER RODS AND SUPPORT SPACING		
PIPE DIA. (INCHES)	ROD DIA. (INCHES)	MAX. SUPPORT SPACING
2 AND LESS	3/8	7'-0"
2½ TO 3½	1/2	10'-0"
4 TO 5	5/8	10'-0"
6	3/4	10'-0"
8	7/8	10'-0"
10	7/8	10'-0"
12	7/8	10'-0"

NOTES:
1. FOR SEISMICALLY RESISTANT PIPE SUPPORT, PROVIDE SEISMIC BRACING AT SPACING:
   TRANSVERSE : 20'-0" O.C. MAX.
   LONGITUDINAL : 20'-0" O.C. MAX.
2. SEE DETAIL 2 FOR SEISMIC BRACING DETAIL.

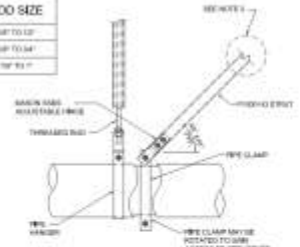
1 TYP. PIPE SUPPORT



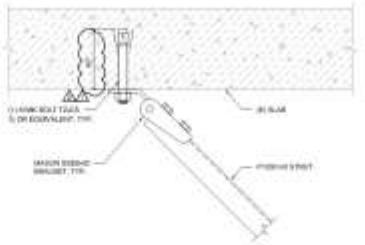
SSBS SIZE	ROD SIZE
SSBS#1	3/8" TO 1/2"
SSBS#2	3/8" TO 3/4"
SSBS#3	7/8" TO 1"

NOTES:
1. SEE DETAIL 1/S FOR ADDITIONAL INFORMATION NOT SHOWN OR NOTED.
2. PROVIDE SEISMIC BRACING AT SPACINGS:
   TRANSVERSE : 20'-0" O.C. MAX.
   LONGITUDINAL : 20'-0" O.C. MAX.
3. SEE DETAIL 3/-/S FOR BRACE TO CEILING CONNECTION DETAIL.

2 TYP. SINGLE PIPE SUPPORT WITH SEISMIC BRACING

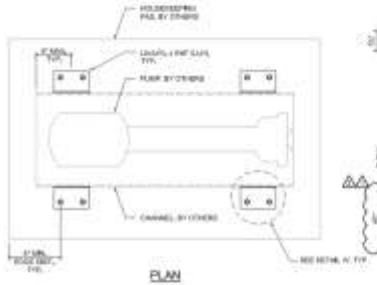


SECTION AA

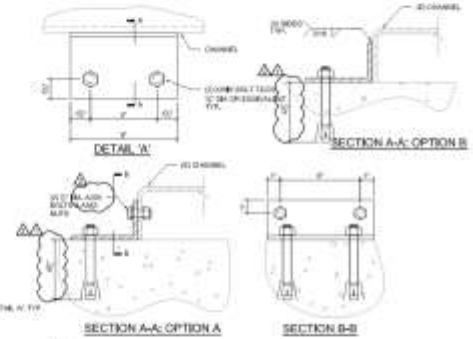


NOTE:
SLOPED ASSUMED TO BE A 1" SLAB AS SHOWN IN CITY OF ARBOVALE CONSTRUCTION EXPANSION DRAWING SET - SHEET S4.1 DATED JANUARY 2014

3 TYP. BRACE CONNECTION TO CEILING OR FLOOR SLAB



PLAN



DETAIL 'A'

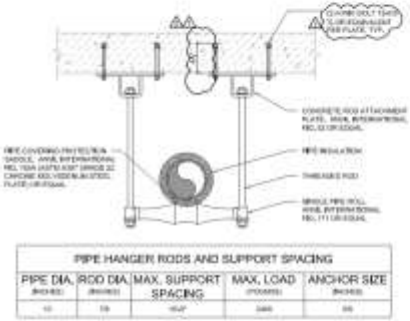
SECTION A-A: OPTION B

SECTION A-A: OPTION A

SECTION B-B

NOTE:
CONTRACTOR CAN CHOOSE EITHER OPTION A OR OPTION B AS DESIRED.
ALL CONNECTIONS MUST USE THE SAME OPTION.

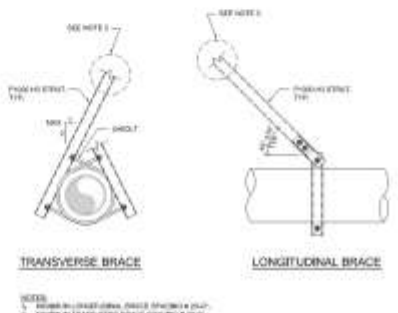
4 PUMP ANCHORAGE PLAN



PIPE HANGER RODS AND SUPPORT SPACING				
PIPE DIA. (INCHES)	ROD DIA. (INCHES)	MAX. SUPPORT SPACING	MAX. LOAD (POUNDS)	ANCHOR SIZE (INCHES)
10	7/8	10'-0"	3,865	3/8

NOTES:
1. ALL THREADED ROD IS ACCEPTABLE FOR ROD LENGTHS LESS THAN 24".
2. SEE S/S/S FOR SEISMIC BRACING DETAIL.

5 ENGINE EXHAUST PIPE HANGER

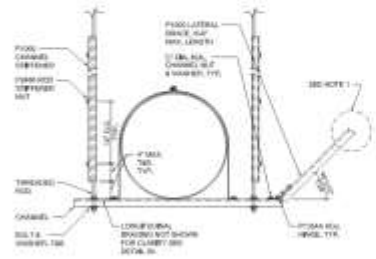


TRANSVERSE BRACE

LONGITUDINAL BRACE

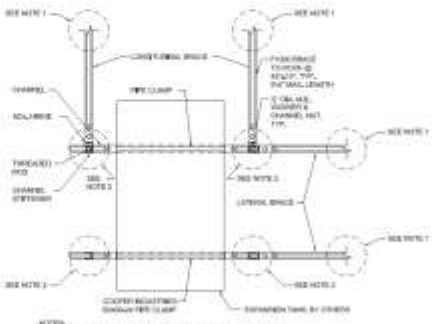
NOTES:
1. MAXIMUM UNBRACED LONG. BRACE SPACING IS 20'-0".
2. MAXIMUM TRANSVERSE BRACE SPACING IS 20'-0".
3. SEE S/S/S FOR ROOF CONNECTION.
4. AT BELOW CONCRETE, RUN BRACES TO THE FLOOR.

6 SINGLE PIPE BRACING W/O VERTICAL HANGER



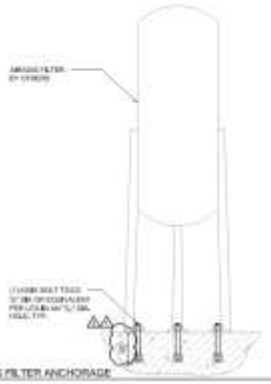
NOTES:
1. SEE DETAIL 3/S/S FOR BRACE TO CEILING CONNECTION DETAIL.

7 TRAPEZE HANGER

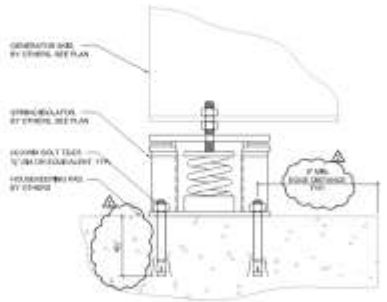


NOTES:
1. SEE DETAIL 3/S/S FOR BRACE TO CEILING CONNECTION DETAIL.
2. PLACE (2) TRANSVERSE BRACES IN ANY TWO OF THE LOCATIONS NOTED.

8 TRAPEZE SEISMIC BRACING



9 AIR/GAS FILTER ANCHORAGE



10 STRING ISOLATOR ANCHORAGE

wrk

REVISION		
NO.	DATE	
1	8/15/14	
2	9/17/14	

DATE: 9/17/14
JOB #: WRK1403.00
DRAWN BY: MM
CHECKED BY: SH
APPROVED BY: BK

SHEET NO.

S8.0

Nonstructural Bracing

2012 INTERNATIONAL BUILDING CODE

PNW-AWWA 2015 Conference

wrk engineers

Presented by
Brian Knight, PE, SE