Handbooks for the design, installation and verification of seismic protection for fire sprinkler systems

nVent CADDY
We Make Seismic Simple

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Thursday 9 May 2024

Seismic damage to/from a fire sprinkler system without seismic sway bracing

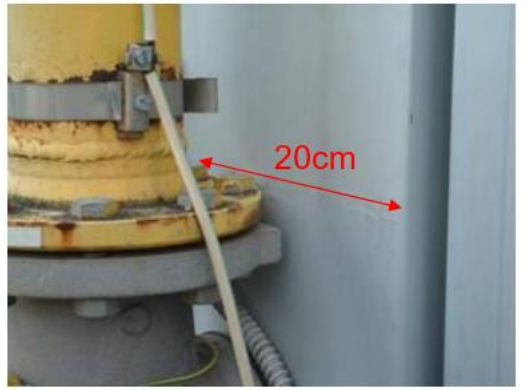
Seismic damage to a piping system

No clearance

Seismic damage to not anchored equipment

Tip over

Seismic damage to not anchored equipment



Glissement

A changing world

Worldwide
(installations)

New technologies

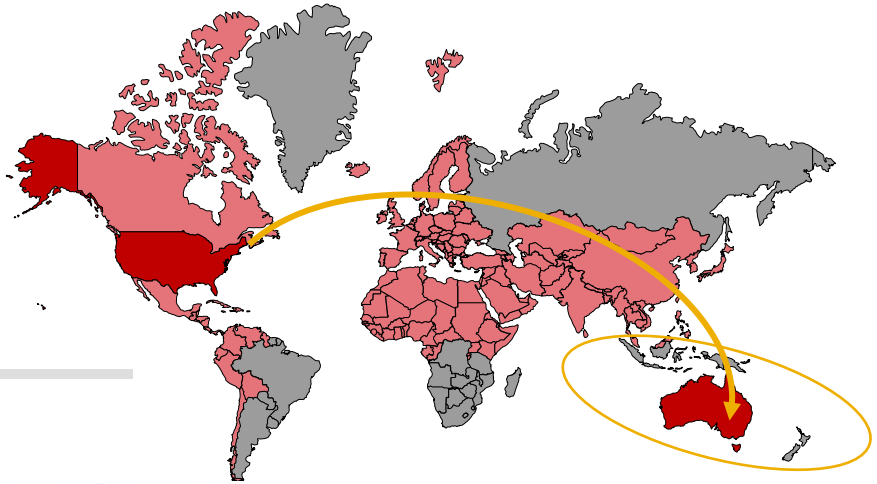
Care facilities

High rise buildings

The world and what to protect against fires are changing

Fire protection systems and seismic protection

1 **Fire Protection**
Fire Sprinkler Standards
(from USA)
NFPA 13
FM Global

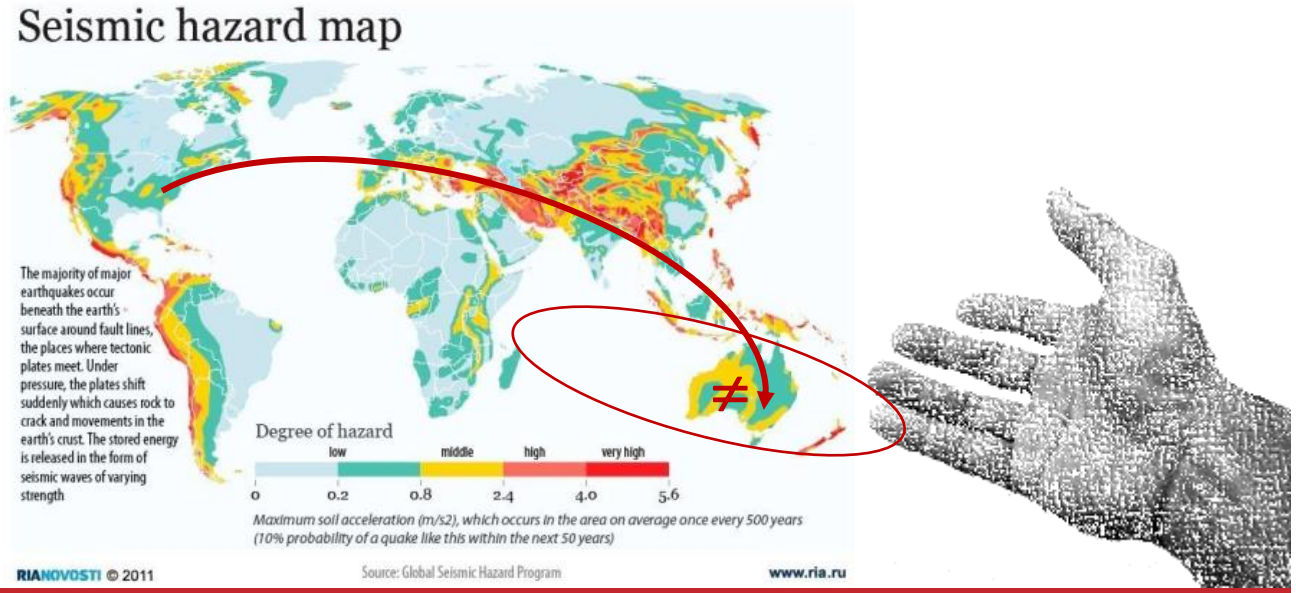


2 **Seismic protection**
Seismic standard
AS 1170.4
Performance based

Operability of strategic infrastructures
Immediately after and earthquake

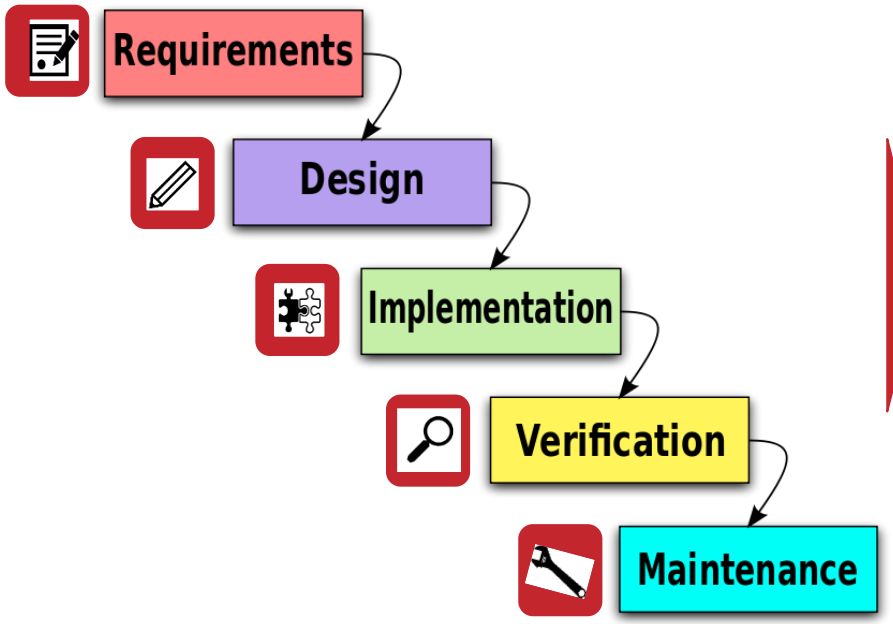
Operability of life-safety systems
(fire protection systems)

Seismic protection of life-safety systems
(seismic protection of sprinkler systems)

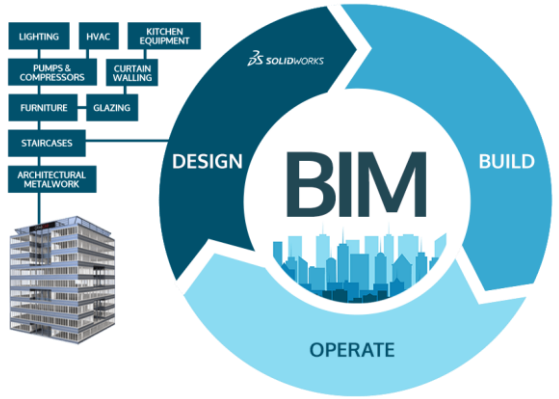


"Extension" of the use of fire sprinkler standards but different seismic standards contexts

The system realization process



Advanced approach



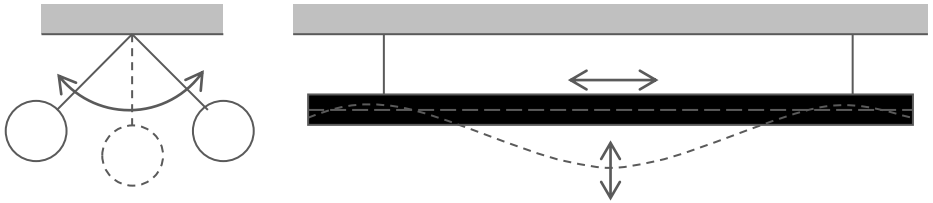
Protection

Multiple players

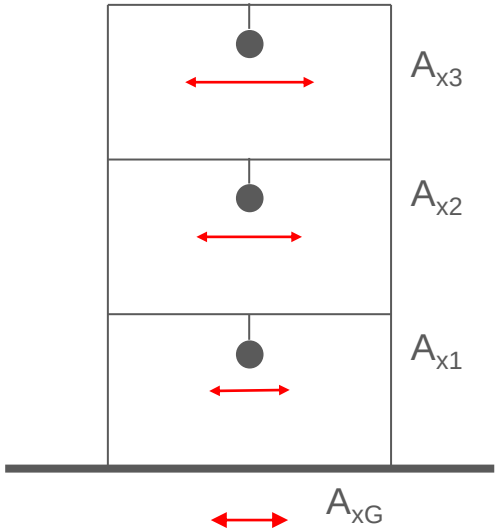
Piping systems seismic challenges

System seismic response

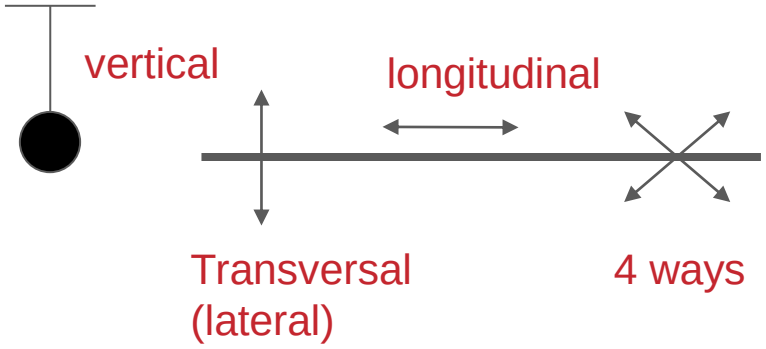
Potential problems: Lateral and Longitudinal sway



Seismic force



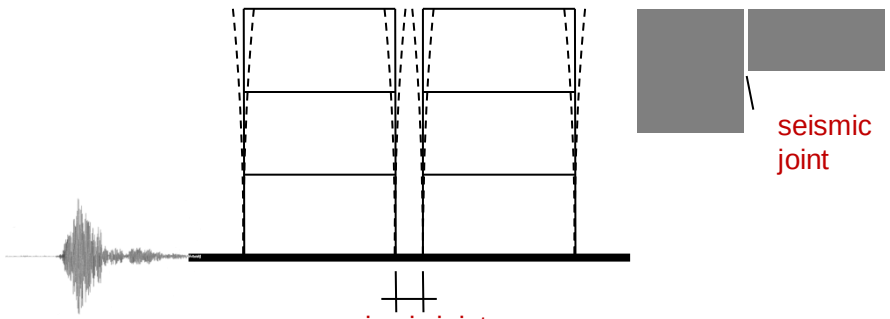
Seismic protection

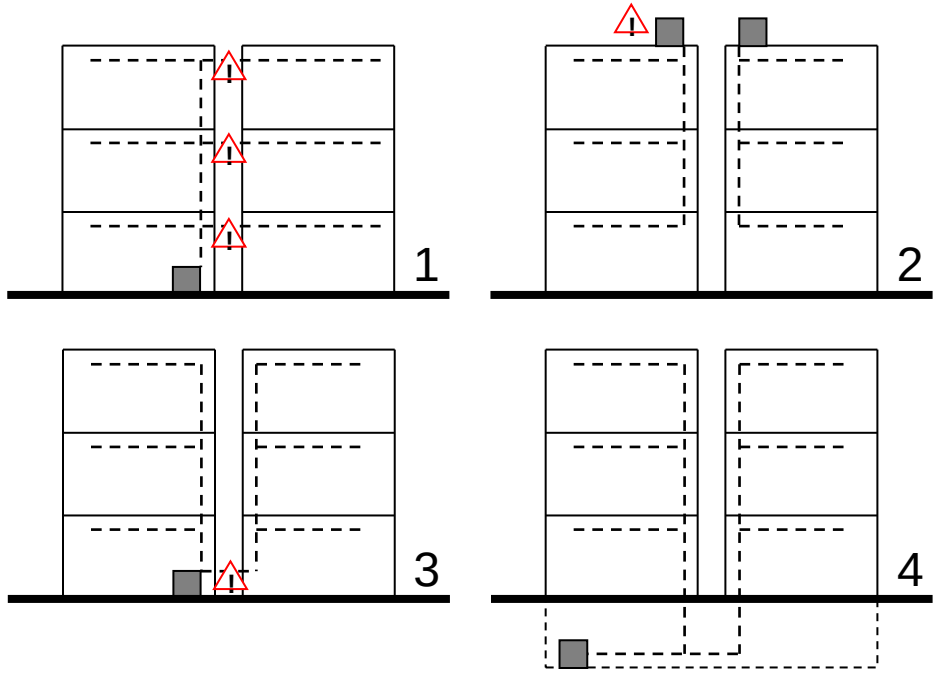


Layout and sizing of seismic protection systems

Motion and rupture, worsened by height of installation

Integrated seismic design





Structural Design

To eliminate or reduce the configuration-related problems/weaknesses

- **Regularization**
- **Introduction of seismic joints**

Systems Design

To eliminate or reduce the configuration-related problems/weaknesses

- **Reduce the number of joint crossings (1→ 2, 3 or 4)**

- **Cross at lower/est level (1 and 2 → 3 or 4)**

Smart seismic structural design and seismic system design choices reduce the seismic risk

Many players

Requirements → Design → Installation → Verification

Customer

Design: Layout, Sizing

Protection systems *(type/location)*

Architects
Engineers
- Structural
- Mechanical

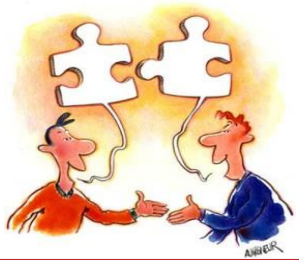
Installers

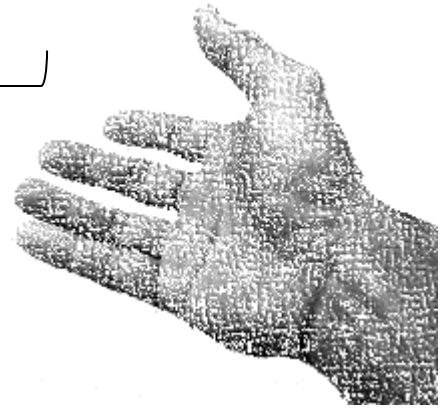
System components
Protection devices (correct installation)

Inspectors

Plurality of players with different languages and different approaches

Interface support and common reference tools could play an important role





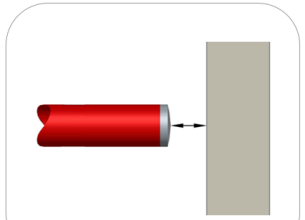
The 4 aspects of an effective seismic protection

SWAY BRACING

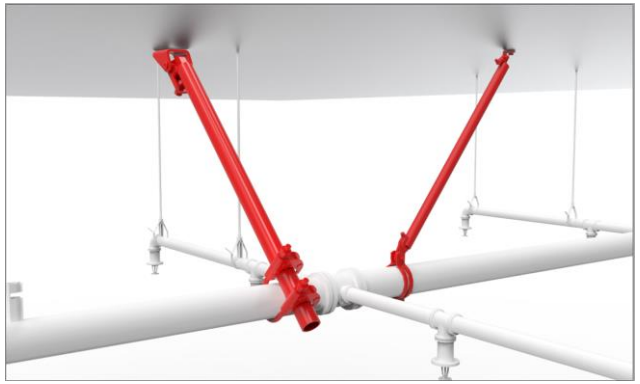
FLEXIBILITY

EQUIPMENT ANCHORING

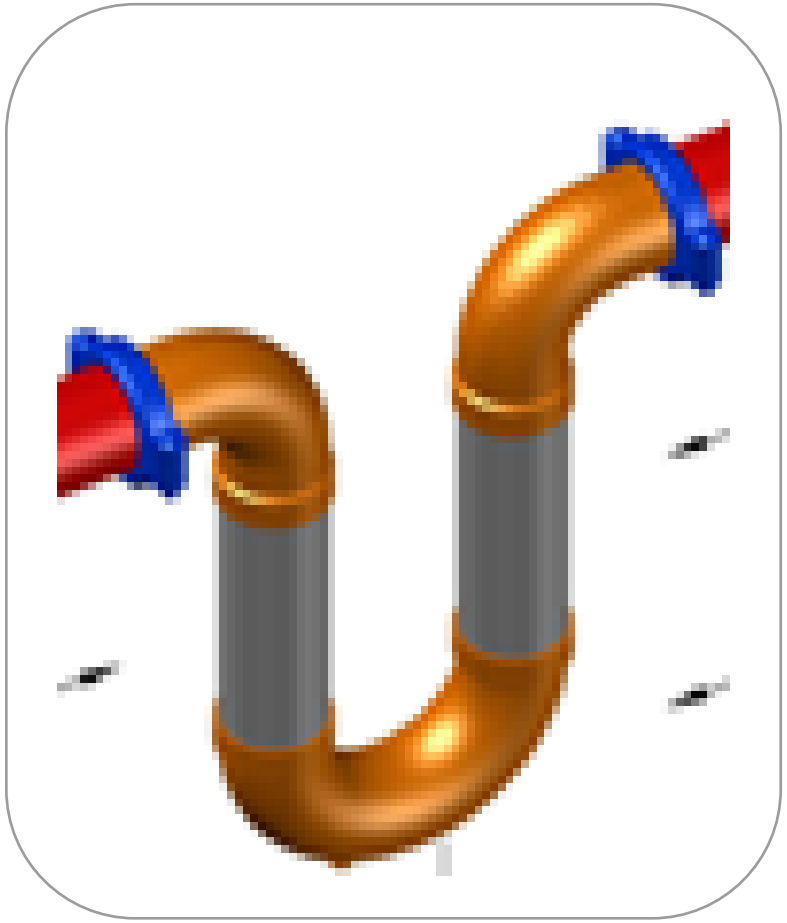
CLEARANCE



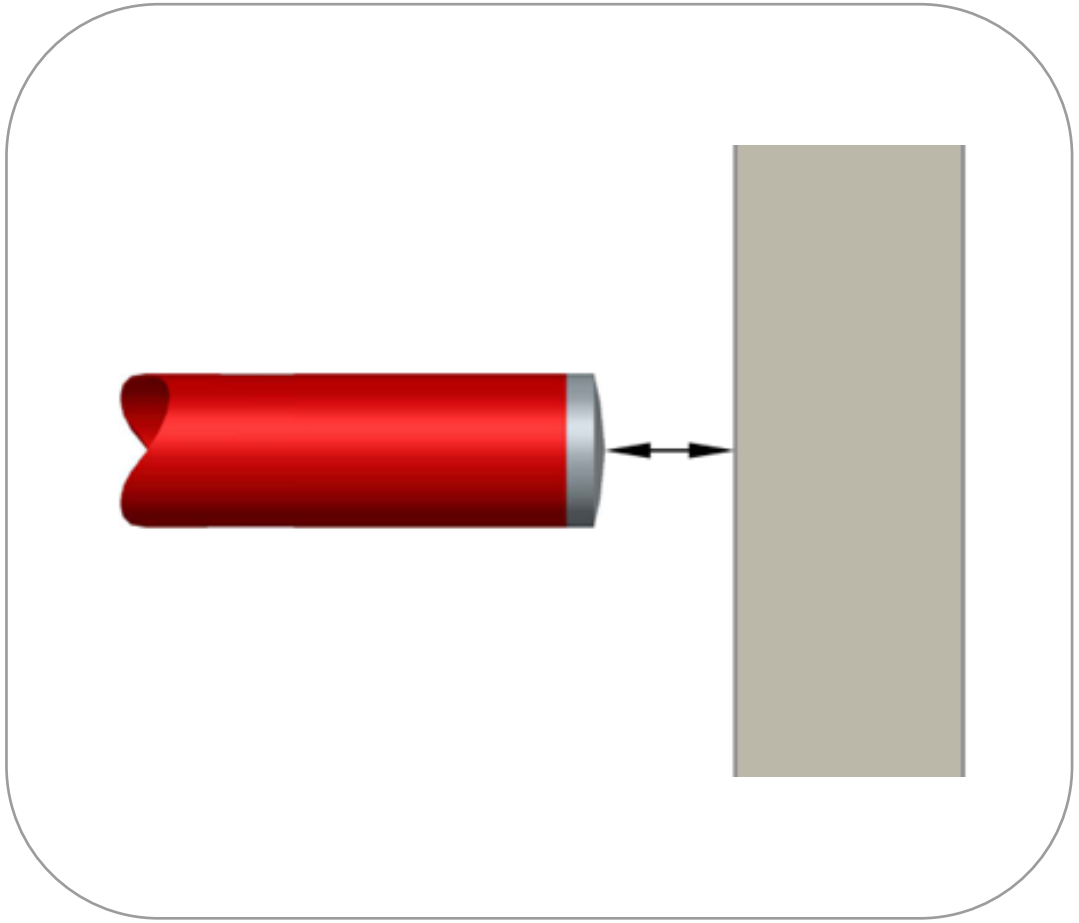
SWAY BRACING



FLEXIBILITY



CLEARANCE



EQUIPMENT ANCHORING

The 4 pillars of a sound seismic protection

The 4 pillars of a sound seismic protection

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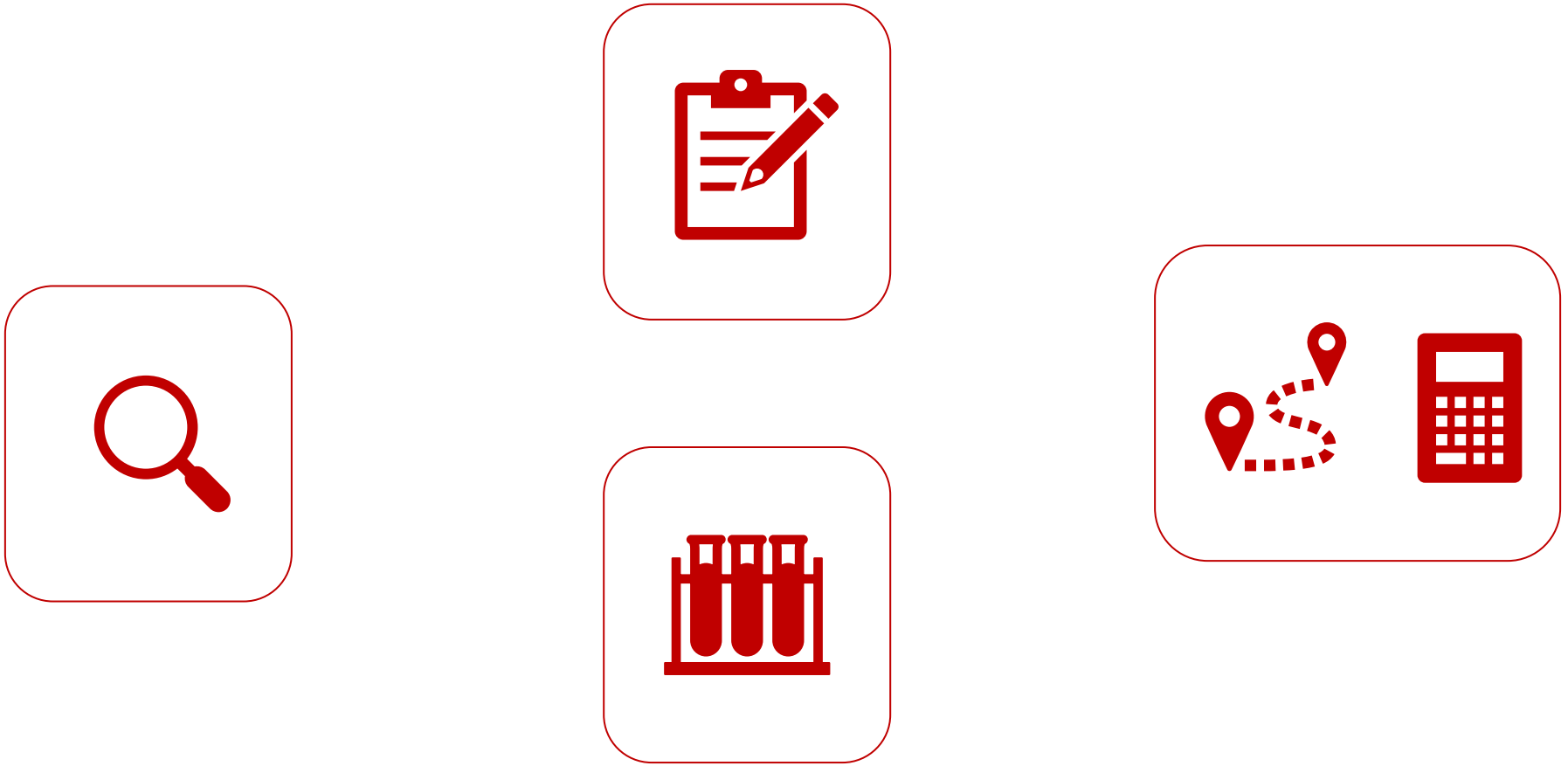

1. Agreed upon requirements – 2. Load path calculation –
3. Use products tested for seismic protection application – 4. Independent verification of the installation

Seismic protection for fire sprinkler: an example

Manifolded Risers

Seismic protection for fire sprinkler: an example

Manifolded Risers

1 | Start from «Sway bracing» section

2.2.1.1 Sway Bracing Locations for Steel Piping

Guidance in this section applies to steel pipe. See 2.2.1.9 for other pipe materials.

2.2.1.1.1 At a minimum, locate and space sway bracing for sprinkler system (ceiling and in-rack) and hose system steel piping per this section. Braces and their attachments must also be sized to resist design forces per 2.2.1.2 and configured per 2.2.1.3. Provide additional sway braces when necessary to reduce the tributary load so the brace capacity is not exceeded or so sway bracing locations will coincide with adequate structural members to which the sway braces will be attached. Also see further commentary in Section 3.1.2.

2.2.1.1.2 Provide adequately sized and configured bracing on sprinkler system risers, whether they are single or manifolded type and regardless of size, in accordance with the following guidelines. Also see further commentary in Section 3.1.3.

2.2.1.1.2.1 Provide a four-way sway brace within 2 ft (0.6 m) of the top of each riser. When possible, avoid the use of a single manifolded sway bracing assembly at the top of multiple adjacent risers. If used, limit the manifolded arrangement to two risers.

2.2.1.1.2.2 In multistory buildings, provide a four-way brace on the riser within 2 ft (0.6 m) of each building floor level. A four-way brace can be considered to exist when the riser passes through a structural floor and clearances do not allow more than ½ in. (13 mm) movement in any horizontal direction (note: this arrangement will require additional flexible couplings on the riser; see 2.2.1.4.3.3).

2.2.1.1.2.3 Provide additional intermediate four-way sway bracing on risers at an interval not to exceed 40 ft (12.2 m). Where flexible couplings are used, arrange this intermediate four-way sway bracing so a brace is provided within 2 ft (0.6 m) of **every other** flexible coupling (adding four-way braces if necessary). For risers in multistory buildings or towers that have attached feed or cross mains not located at floor levels, add four-way braces if necessary such that a brace is provided within 2 ft (0.6 m) of these mains.

2.2.1.1.2.4 For risers fed from horizontal manifold piping, provide a two-way lateral sway brace within 2 ft (0.6 m) of the end of any horizontal manifold piping longer than 6 ft (1.8 m), or when any flexible couplings are used on either the horizontal manifold piping or on the riser stub between the floor and the connection to the horizontal manifold piping. See Fig. 2.2.1.1.2.

Seismic protection for fire sprinkler: an example

Manifolded Risers

1 Start from «Sway bracing» section

2 Continue with the “Flexibility” section

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2.2.1.4 Flexibility Needed to Allow Differential Movement

2.2.1.4.1 Provide adequate flexibility between portions of properly braced, welded and non-welded sprinkler systems, regardless of pipe size, that are expected to move differentially with respect to each other using the following guidelines and techniques.

Guidance in this section applies to steel pipe. See 2.2.1.9 for other pipe materials.

2.2.1.4.2 If more flexible couplings are installed than recommended in this section, provide additional lateral sway bracing to prevent excessive movement of piping per 2.2.1.1.2.3, 2.2.1.1.4.3 and 2.2.1.1.5.1.E.

2.2.1.4.3 Provide flexibility for sprinkler risers per the following recommendations.

2.2.1.4.3.1 Provide a flexible coupling within 2 ft (0.6 m) of the top and bottom of each individual riser that is connected directly to underground piping (see Fig. 3.1.3 in the Section 3.1.3 commentary for details). This applies to risers located outside and inside buildings. Where welded piping systems exist from the riser through the cross mains, the flexible coupling at the top of the riser may be omitted.

2.2.1.4.3.2 When multiple risers are supplied by a single manifold connection to an underground main, provide each riser with a flexible coupling within 2 ft (0.6 m) of the top, and a flexible coupling within 2 ft (0.6 m) of the bottom where connected to the manifold. Locate the horizontal manifold piping 3 ft (0.9 m) or less above floor level and brace manifold piping when needed (see 2.2.1.1.2.4). Connect the horizontal manifold to the main riser and the main riser to the riser stub at floor level with flanged or other rigid connections (see Fig. 2.2.1.1.2). Where welded piping systems exist from the riser through the cross mains, the flexible coupling at the top of the riser may be omitted.

2.2.1.4.3.3 For multistory building risers, additional flexible coupling(s) are needed at each floor level. When the pipe doesn’t penetrate a floor slab, steel plate, etc. (e.g., is in an open tower), or when it does penetrate one of these elements and clearances meet the recommendations of 2.2.1.5.1, locate the flexible coupling within 1 ft (0.3 m) of the floor (either above or below the floor; see Fig. 2.2.1.4.3). Where clearances per 2.2.1.5.1 are not provided, install flexible couplings within 1 ft (0.3 m) both above and below the floor. (Exception: the flexible coupling below the floor should be located below any main supplying that floor.)

2.2.1.4.3.4 Flexible couplings are not needed on riser piping beneath floors that rest directly on the ground; however, a flexible coupling is needed above the ground floor as recommended in 2.2.1.4.3.1 and 2.2.1.4.3.2.

2.2.1.4.3.5 Provide a flexible coupling within 2 ft (0.6 m) above or below any intermediate points of bracing for risers. Where welded piping systems exist from the riser through the cross mains, these flexible couplings may be omitted.

Seismic protection for fire sprinkler: an example

Manifolded Risers

1 | Start from **sway bracing** section

2 | Continue with the **flexibility** section

3 | Then, look at the **clearance** section

2.2.1.1 Sway Bracing Locations for Steel Piping

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2.2.1.4.3 Provide flexibility for sprinkler risers per the following recommendations.

2.2.1.5 Clearance

2.2.1.5.1 Provide clearance around piping through walls or floors per the following guidelines.

2.2.1.5.1.1 Except as allowed in 2.2.1.5.1.2, where piping passes through walls, platforms, mezzanines, roofs, or floors, provide a hole or sleeve with a nominal diameter 2 in. (50 mm) larger than the pipe for pipes 1 in. (25 mm) diameter through 3½ in. (90 mm), and 4 in. (100 mm) larger than the pipe for pipe sizes 4 in. (100 mm) and larger. Openings may be sealed with mastic or a weak, frangible mortar. If the pipe passes through a fire separation, the space can be filled with mineral wool held in place with a pipe collar.

2.2.1.5.1.2 Clearance is not needed when wall material is frangible, such as gypsum board, and the wall is not required to have a fire rating, or when flexible couplings are provided on both sides of the penetration per 2.2.1.4.3.3 or 2.2.1.4.4.4.

2.2.1.5.2 Provide at least 2 in. (50 mm) clearance between piping and walls/structural members in the following locations:

A. Between ends of piping and walls/structural members

B. When piping passes through walls/structural members, then turns 90 degrees to run parallel to the wall, between the parallel pipe run and the wall/member

C. When piping passes through walls/structural members, between any flanges, fittings, or other devices on the piping and the wall

2.2.1.5.3 Provide clearance to sprinklers per the following guidelines.

2.2.1.5.3.1 For sprinklers installed in suspended ceilings, provide an oversize adapter through the ceiling tile to allow for free movement, in all horizontal directions, of not less than 1/2 in. (13 mm), and preferably not less than 1 in. (25 mm) (i.e., a hole diameter that is 1 in. [25 mm] to 2 in. [50 mm] larger than the diameter of the sprinkler or pipe through the ceiling). Alternatively, accommodate differential movement by connecting to overhead pipe using FM Approved flexible sprinkler hose (for this alternative, the suspended ceiling must meet the requirements of the FM Approval and must be seismically designed per 2.2.1.6.2).

2.2.1.5.3.2 For other sprinklers, provide vertical and horizontal clearance of at least 2 in. (50 mm) to structural or nonstructural elements. A smaller clearance is acceptable where the system is arranged so that less relative movement between the sprinkler and the object is expected (e.g., by providing hangers that limit upward vertical movement per 2.2.1.8.1 or by accommodating the movement with FM Approved flexible sprinkler hose) or where the sprinkler is protected from impact. Provide greater horizontal clearance (4-6 in. [100-150 mm]) to sprinklers when possible.

Seismic protection for fire sprinkler: an example

Manifolded Risers

1 | Start from **sway bracing** section

2 | Continue with the **flexibility** section

3 | Then, look at the **clearance** section

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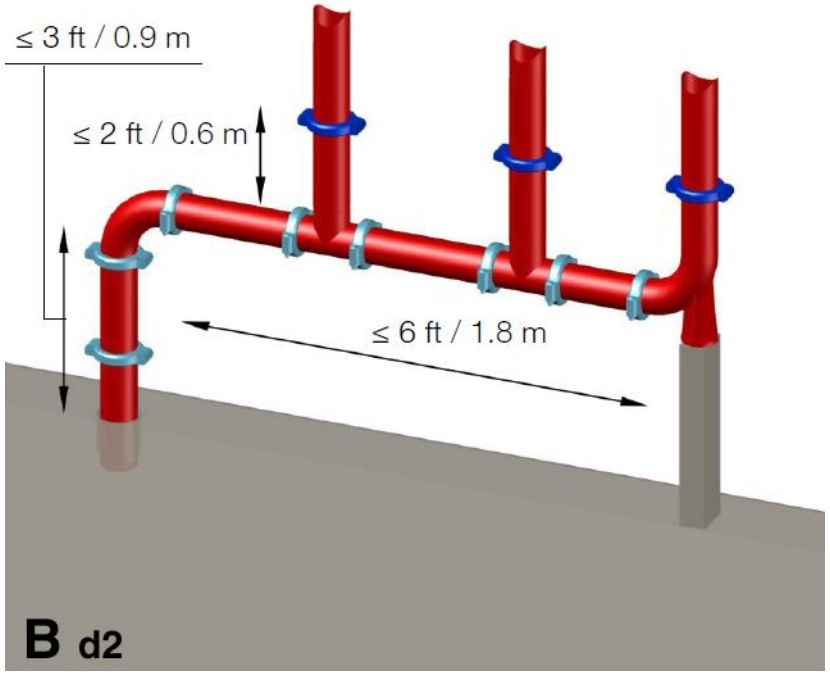
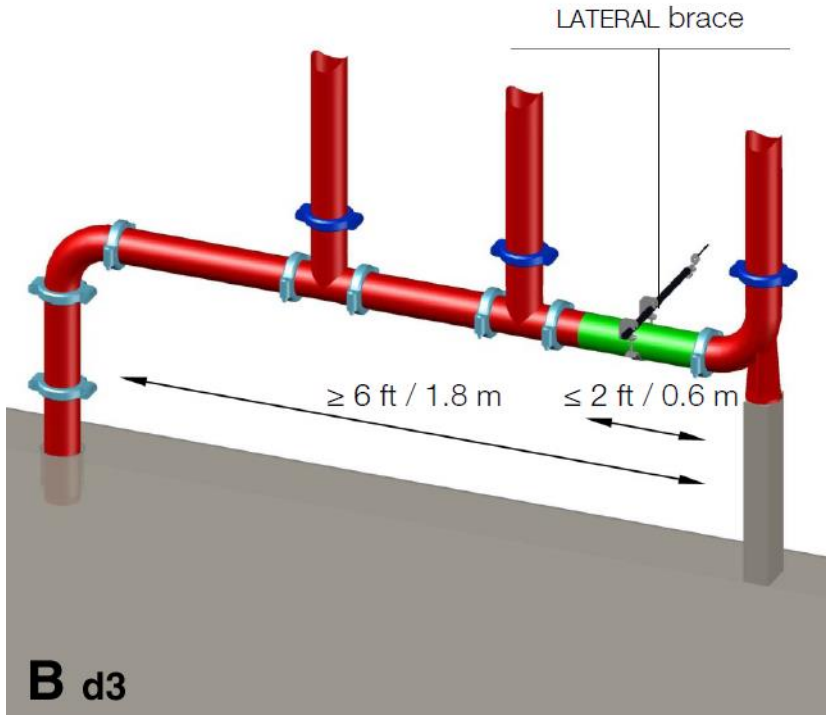
How to explain to a non-expert? How do the multiple players get on the same page?

Seismic protection for fire sprinkler: an example

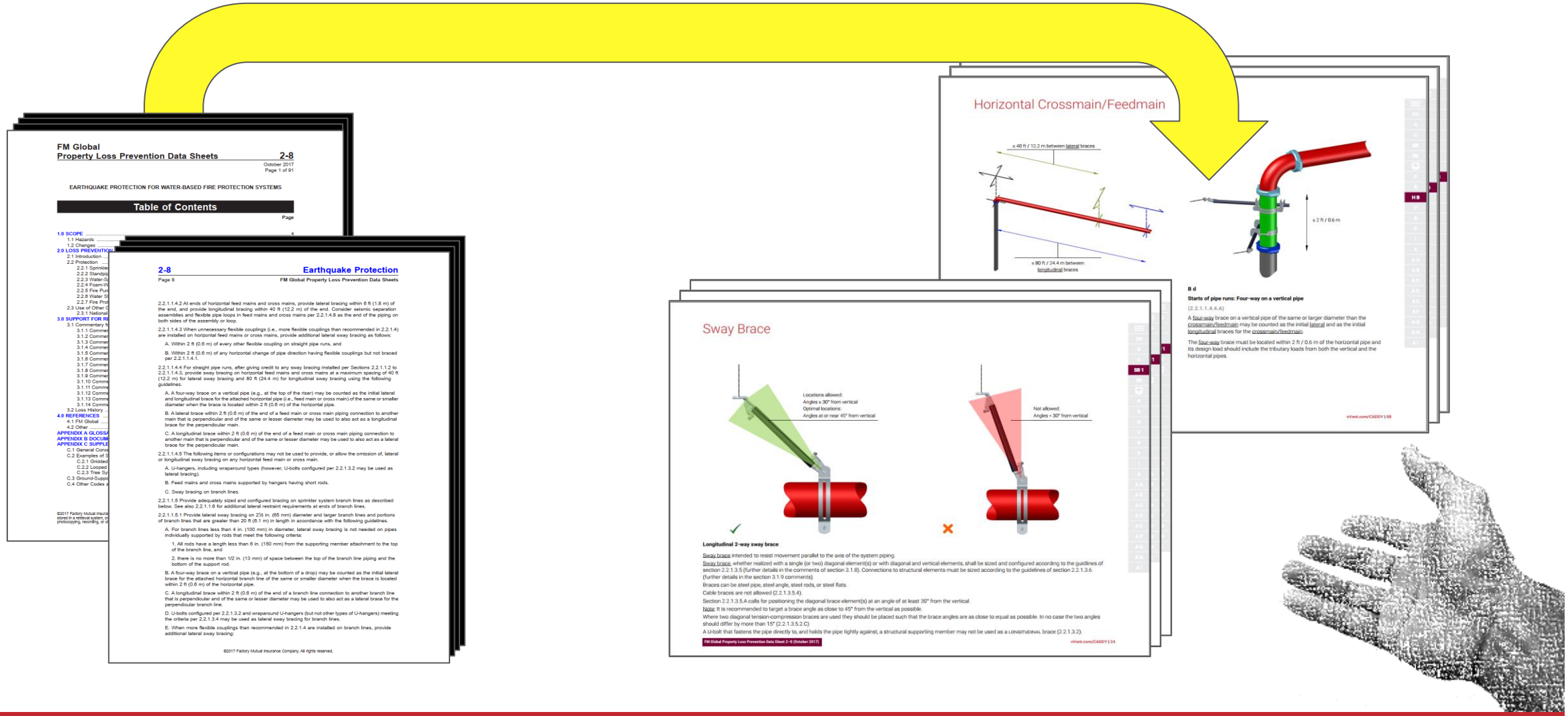
Manifolded Risers





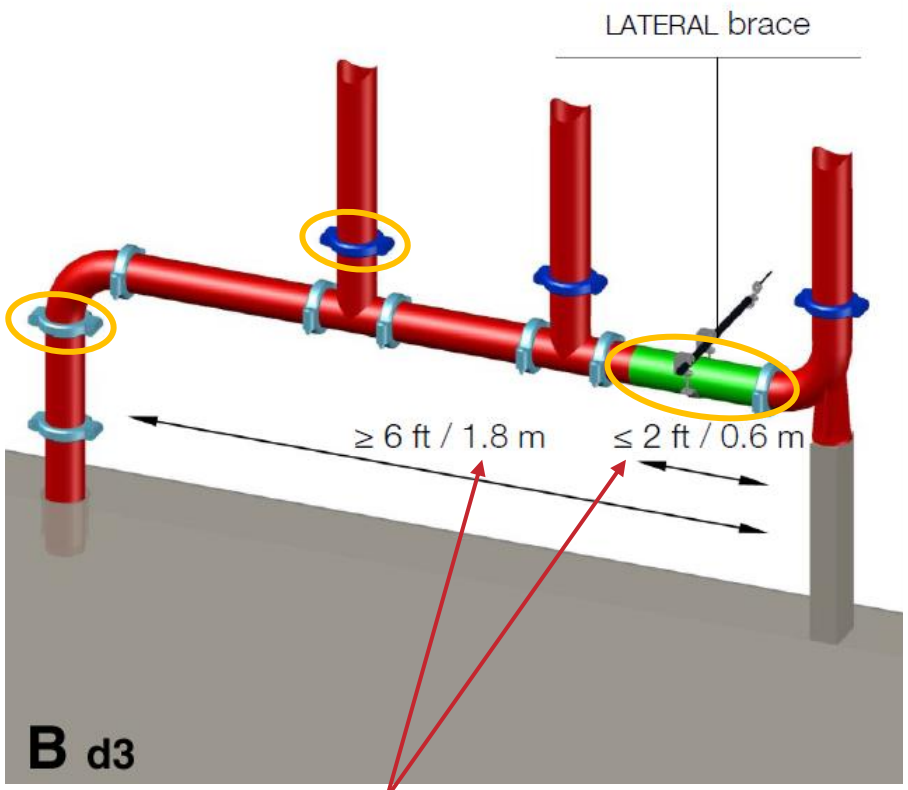
Illustrations is the answer

“Translation” into a visual language

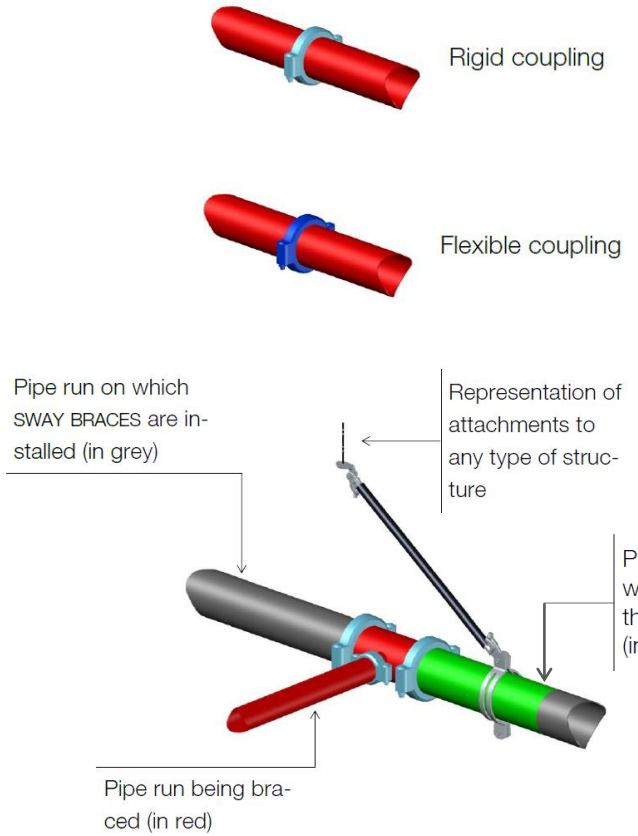


A picture is worth 1000 words

Color coding



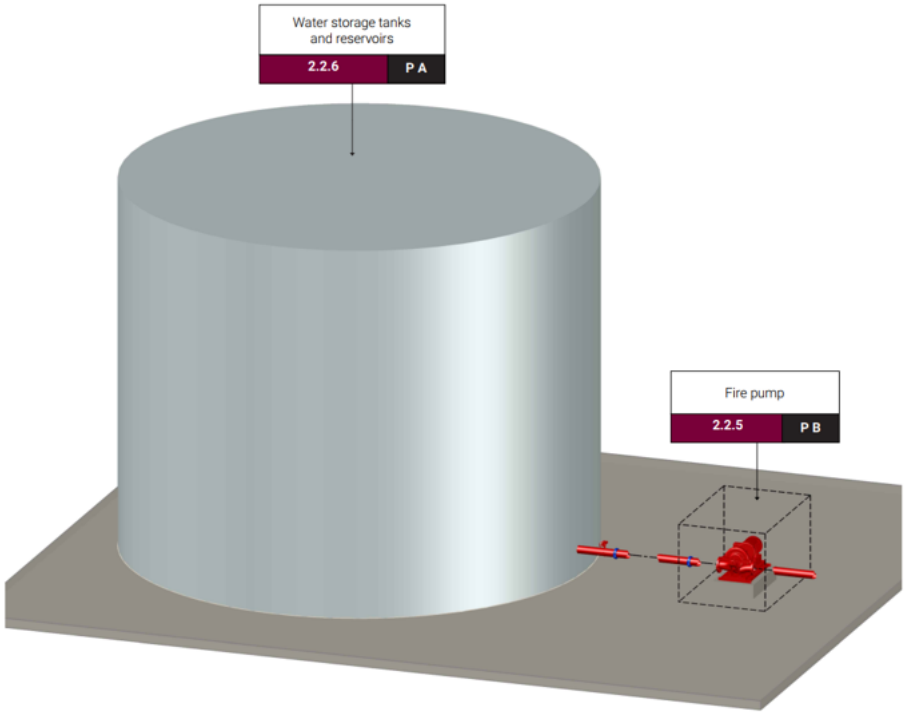
Measurements that drive requirements for seismic protection components

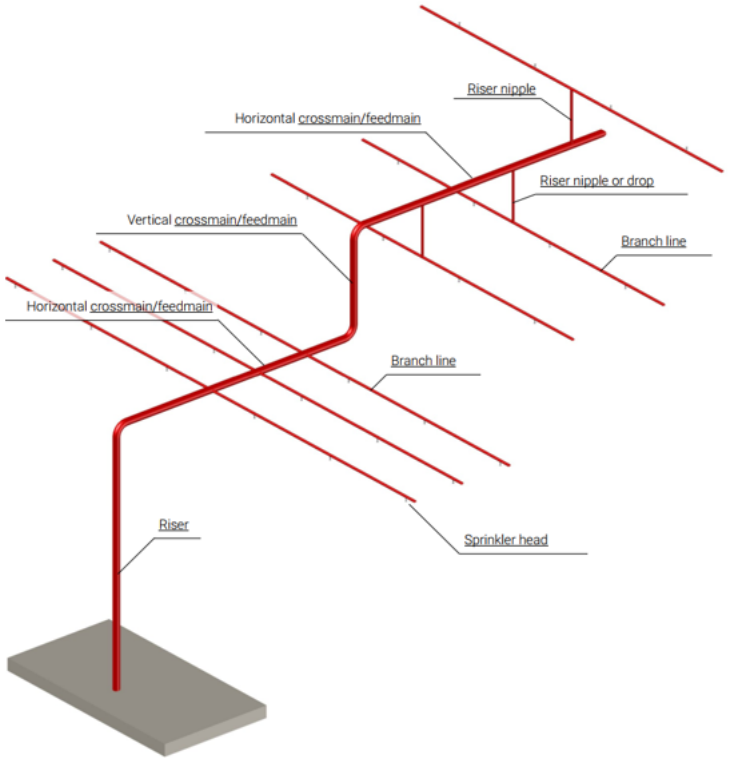


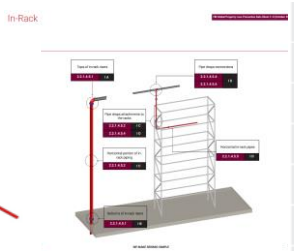
Color codes that identify:

- The seismic protection components
- Proper area of installation

Logically ordered





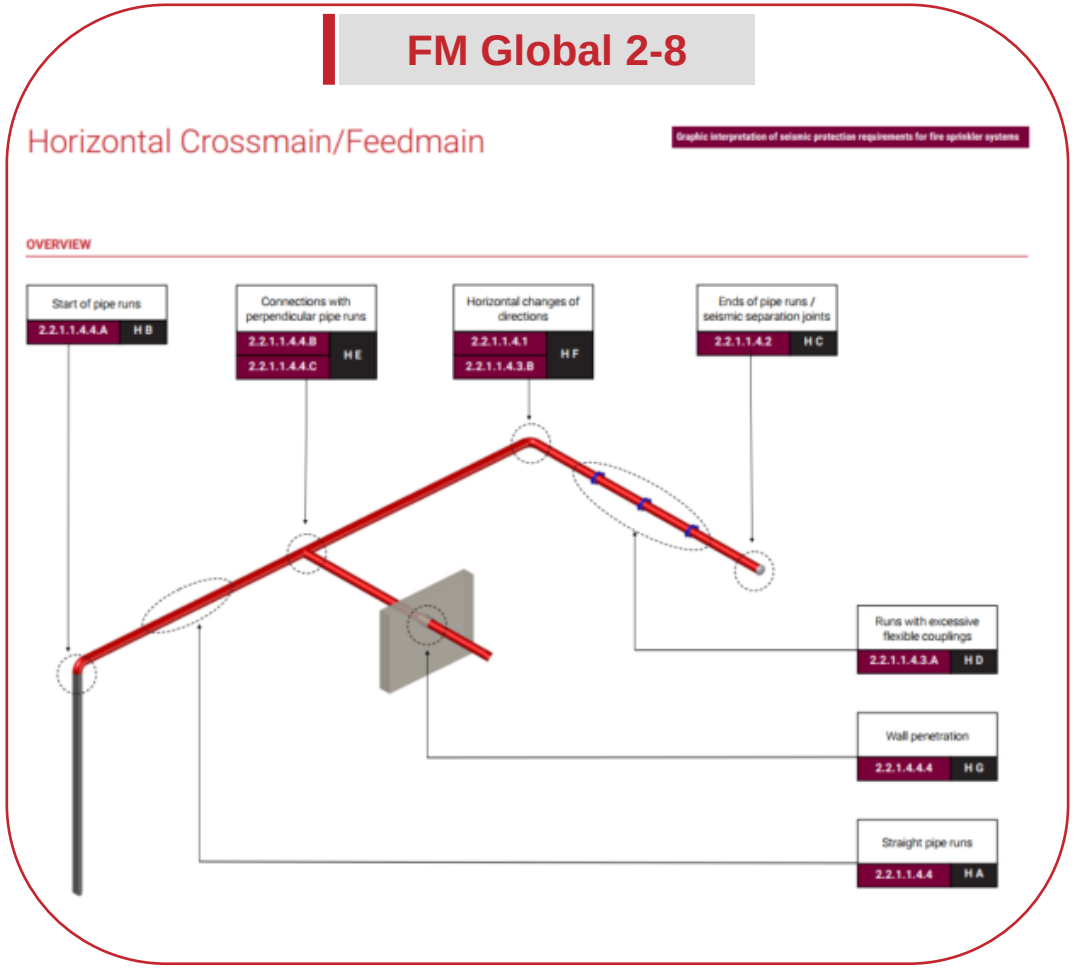


Easy "click" navigation

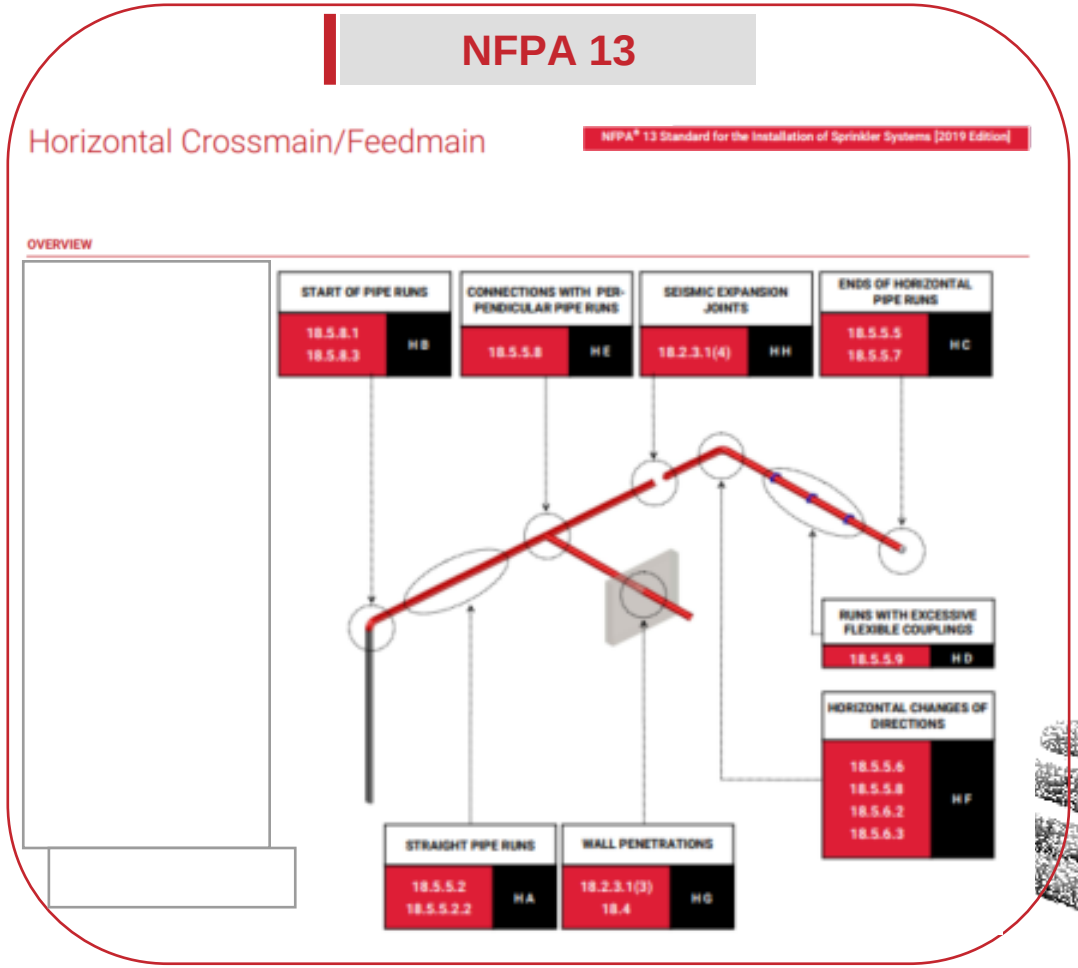
Easy to Navigate

Layout of seismic protection components

FM Global 2-8

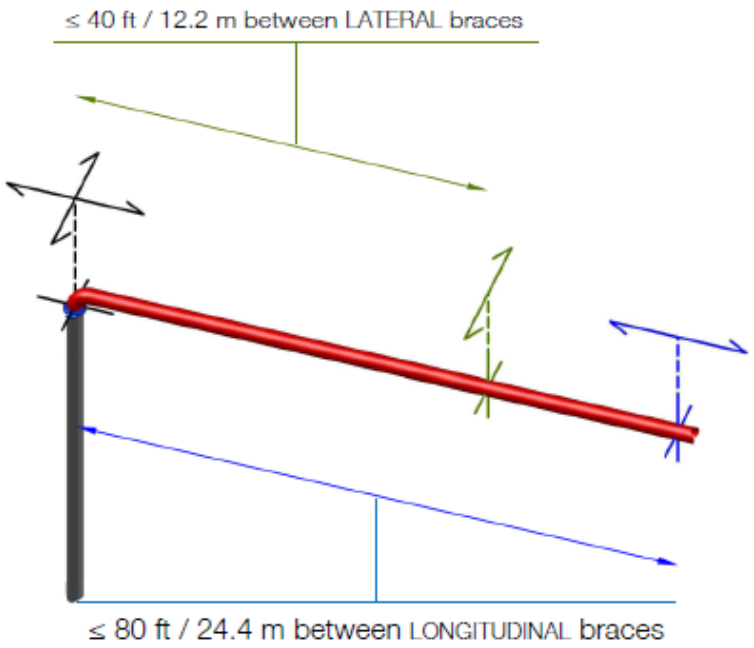


NFPA 13



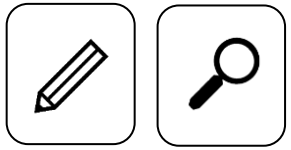
The prescription location is visibly made simple

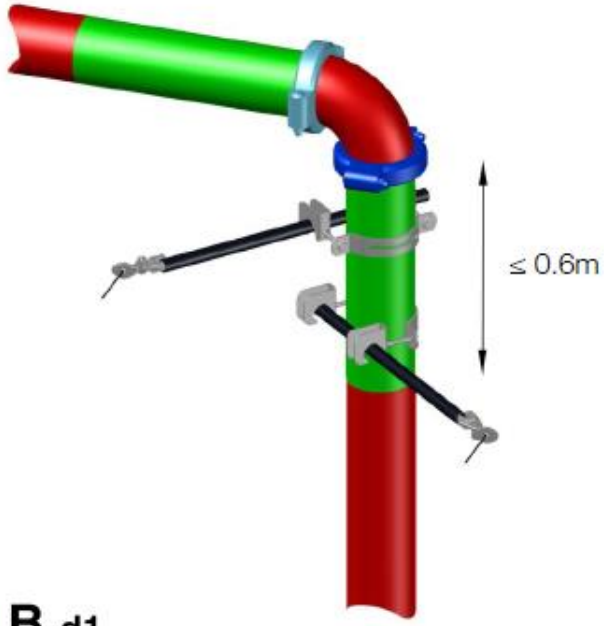
Illustrations for the layout & illustrations for the installation



B

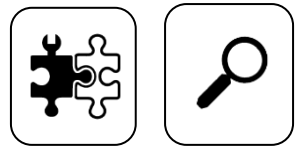
Drawings focusing on **layout**





B d1

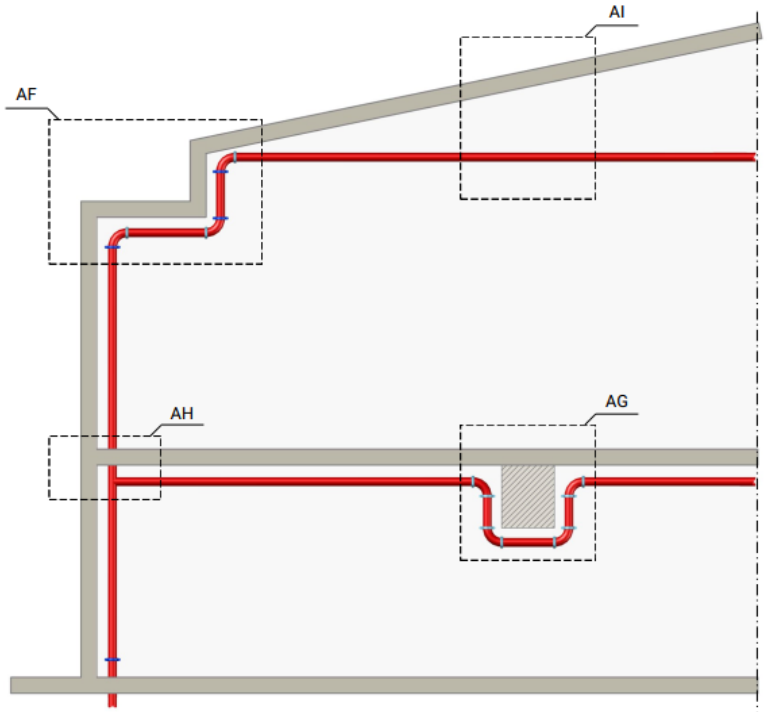
Drawings focusing on **installation**



Jobsite complex situations

Not detailed in standards

Complex applications



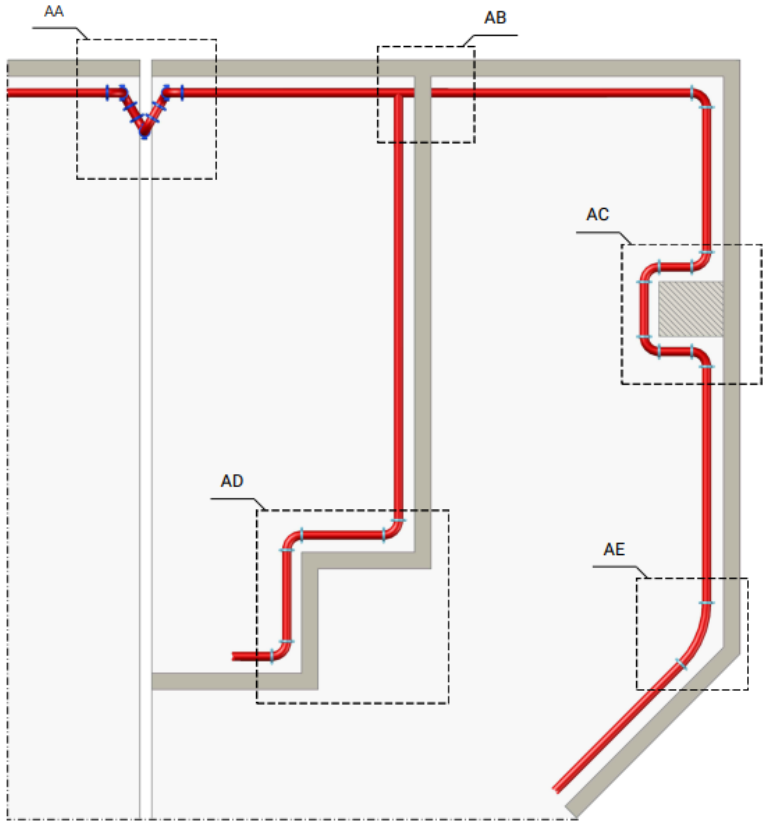
Section view

AF) Riser with offsets, vertical changes of directions

AG) Obstacles avoidance—Beams

AH) Floor penetrations

AI) Sloped ceilings



Plan view

AA) Crossing of seismic expansion joints

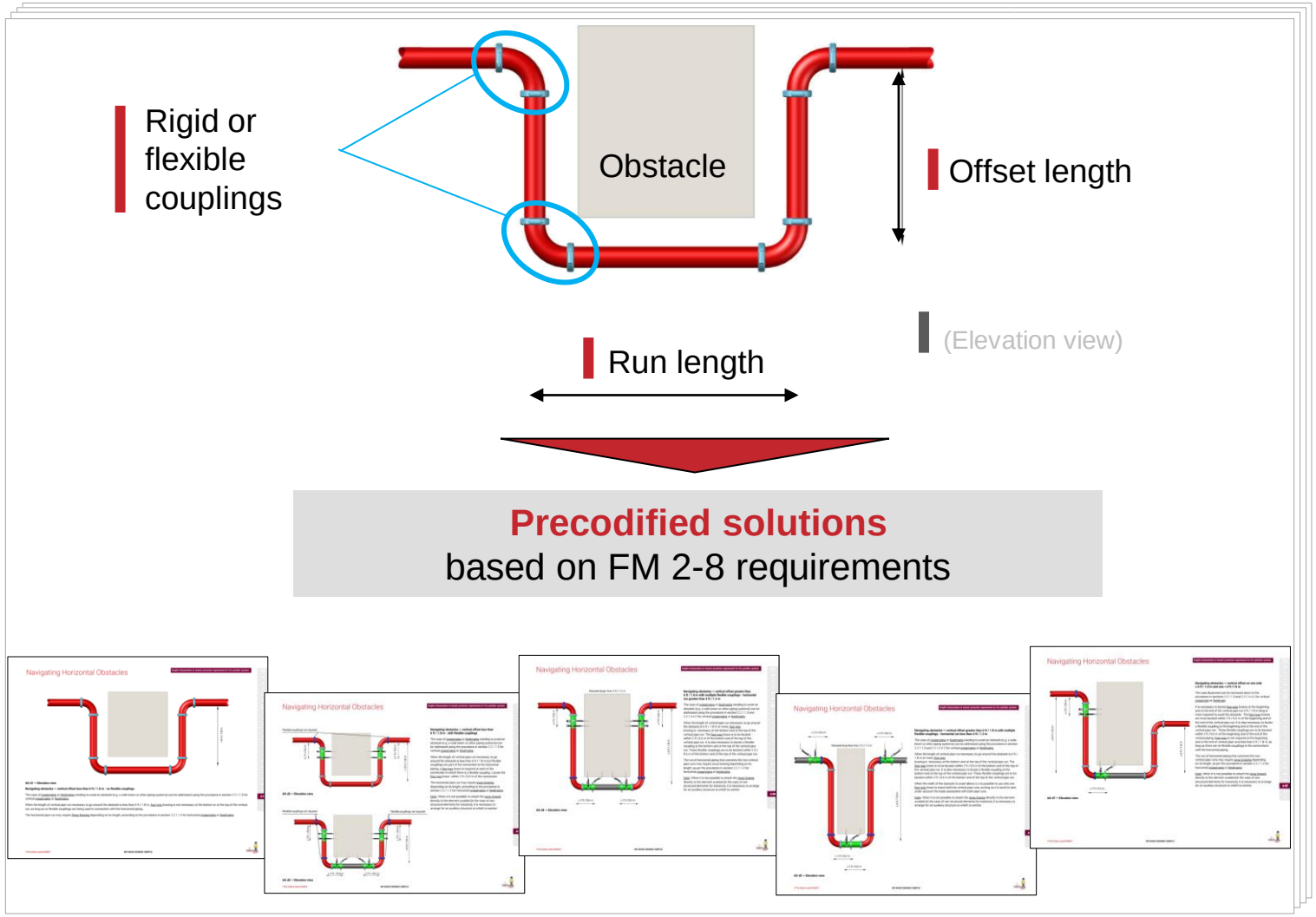
AB) Wall penetrations

AC) Obstacles avoidance

AD) Horizontal changes of directions: 90°

AE) Horizontal changes of directions: not at 90°

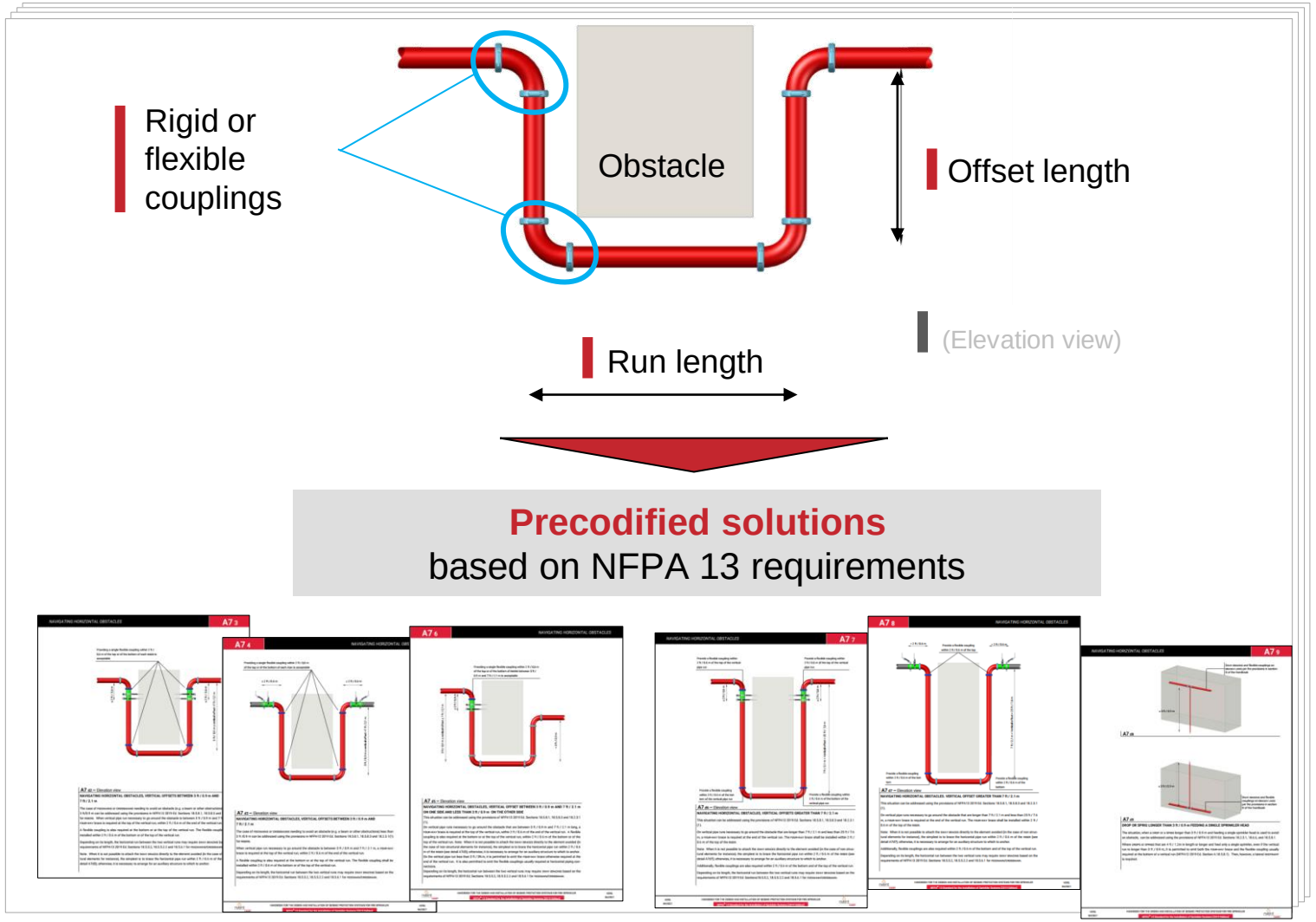
Complex applications



Precodified solutions
based on FM 2-8 requirements

Compliant solutions made simple

Complex applications

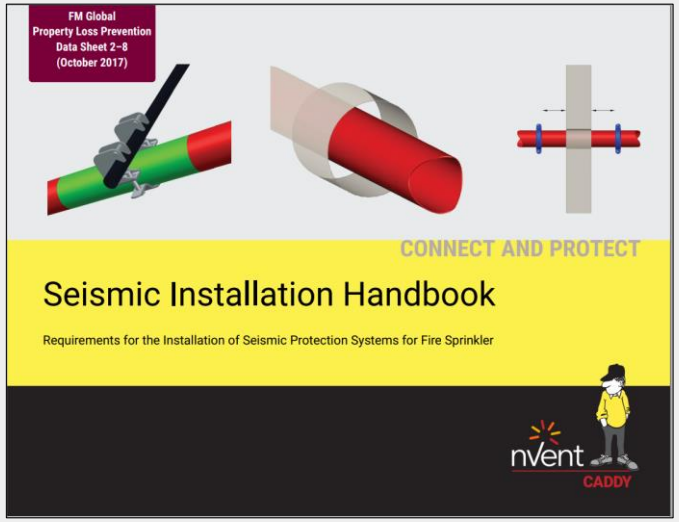


Precodified solutions
based on NFPA 13 requirements

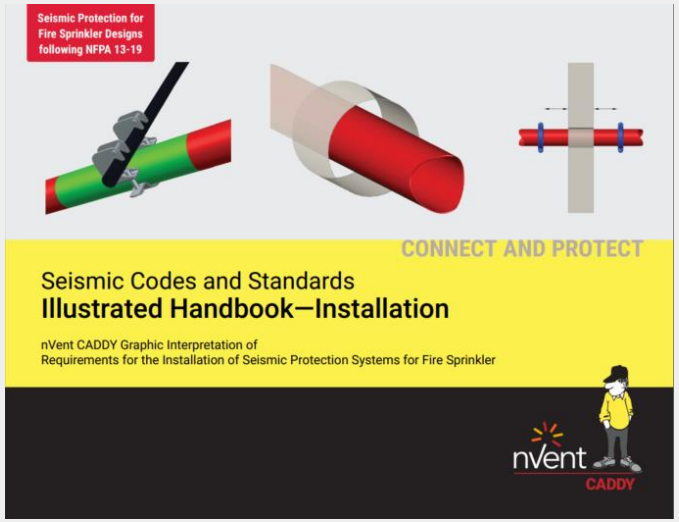
Compliant solutions made simple

Handbooks for different standards

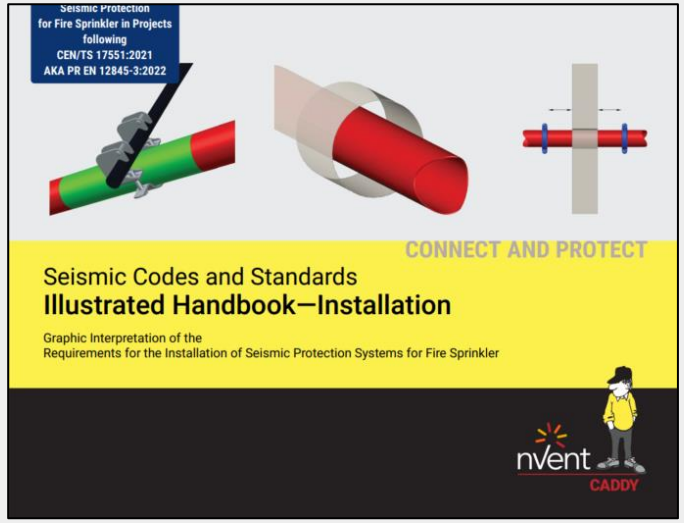
For projects insured by FM Global



For projects per NFPA 13



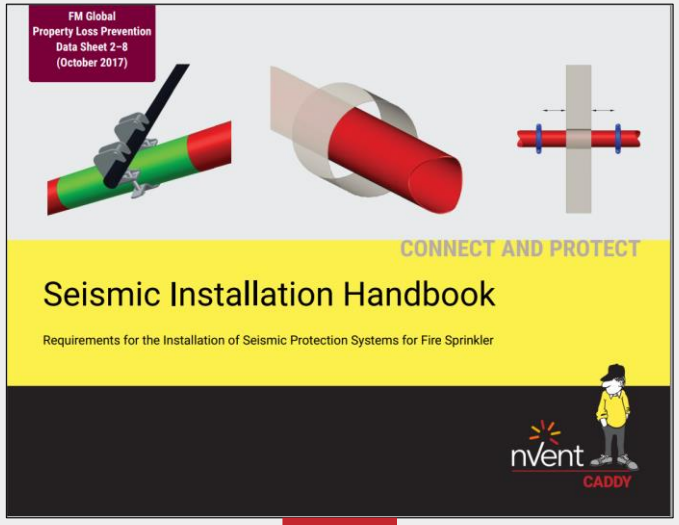
For projects per EN 12845



For recognized standards around the world

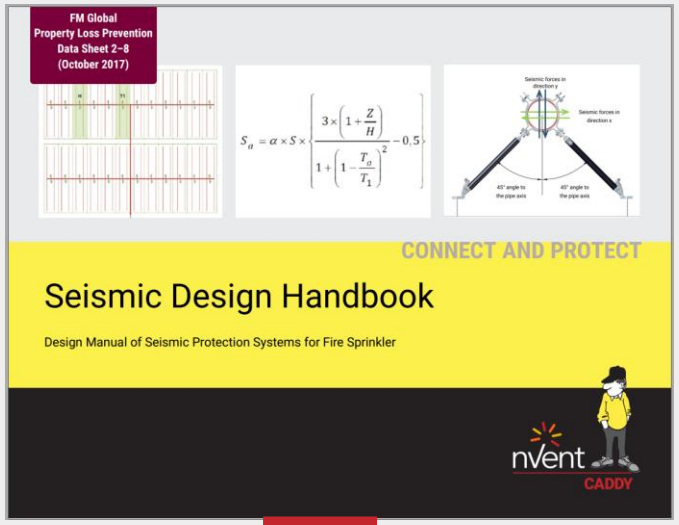
3-Contents per standard

nVent CADDY Seismic Installation Handbooks



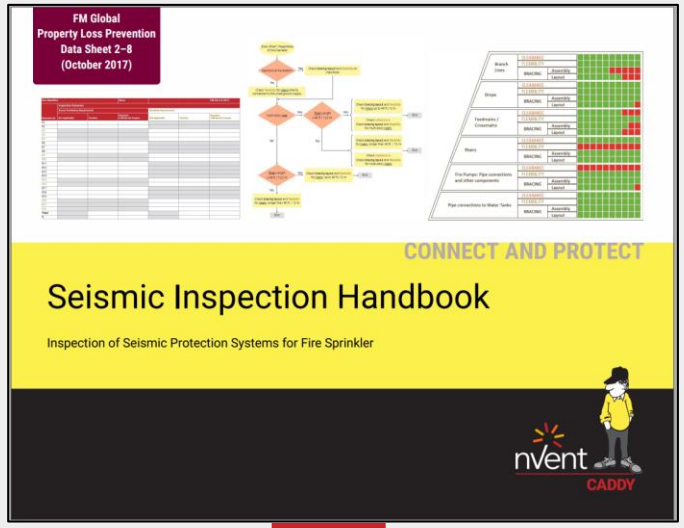
1 The focus is on the **layout** and **installation** of the seismic protection

nVent CADDY Seismic Design Handbooks



2 The focus is on the **load path calculation** and the **sizing** of the seismic protection

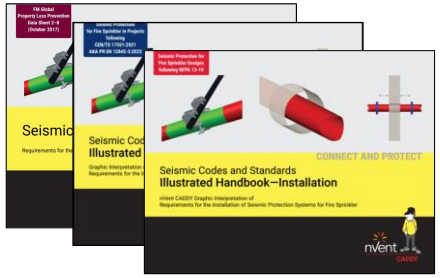
nVent CADDY Seismic Inspection Handbooks

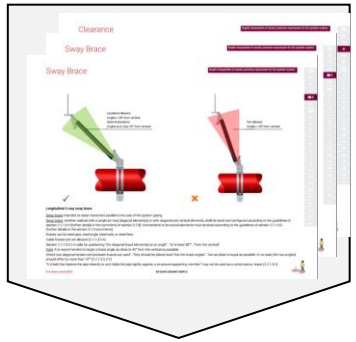


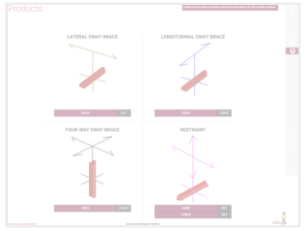
3 The focus is on the **verification** and the **quality** of the seismic protection

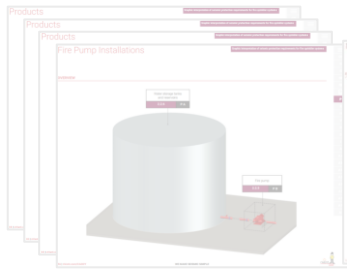
3 books per standard / multiple standard per content

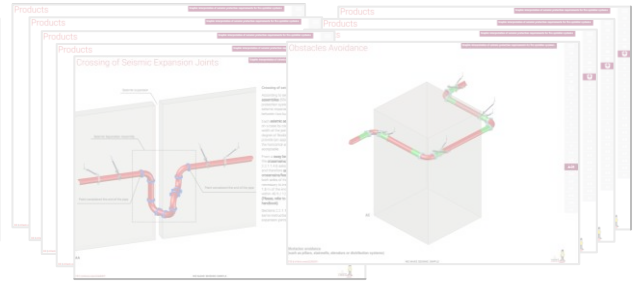
Installation instructions

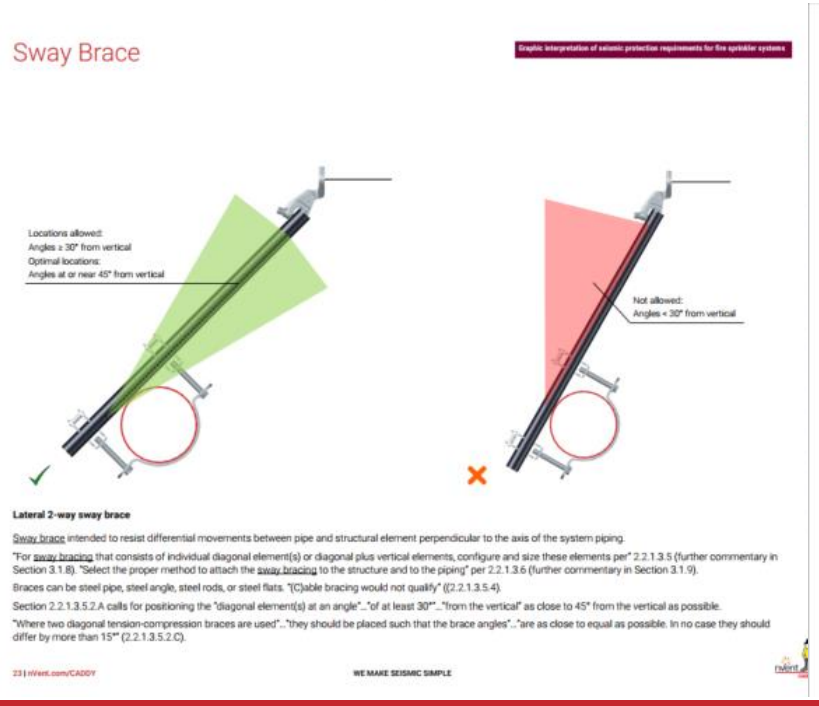


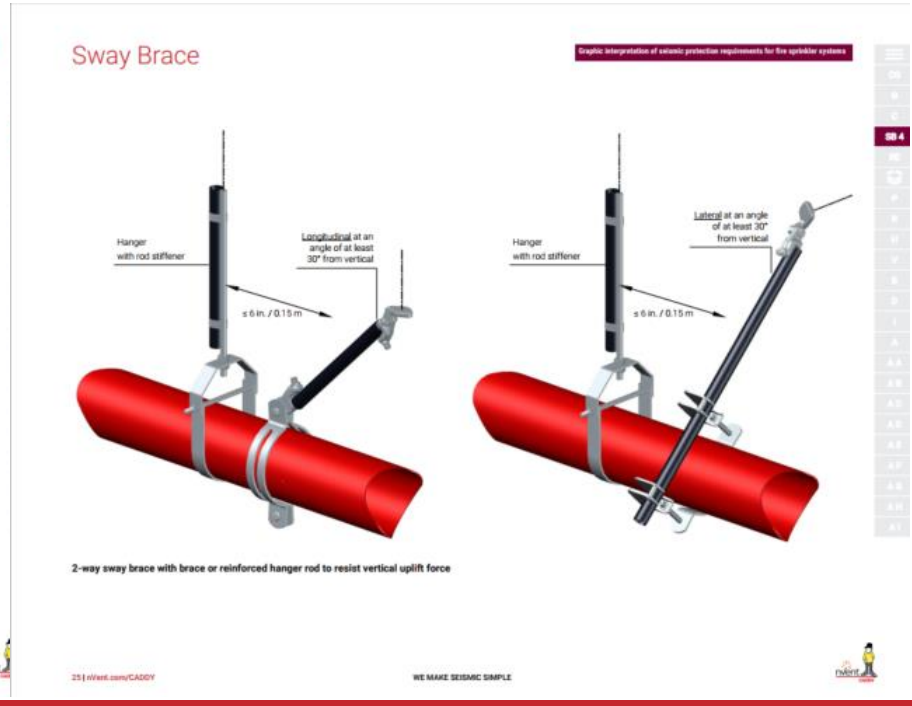


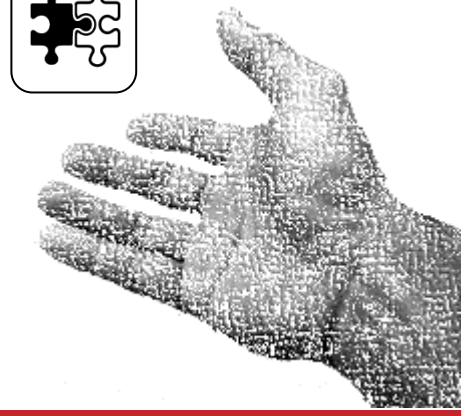






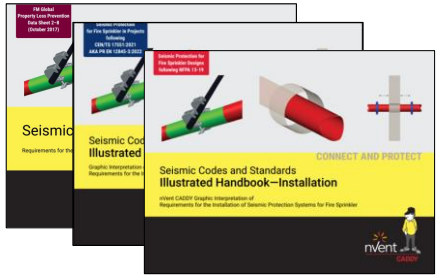


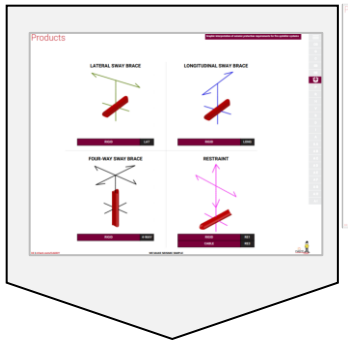


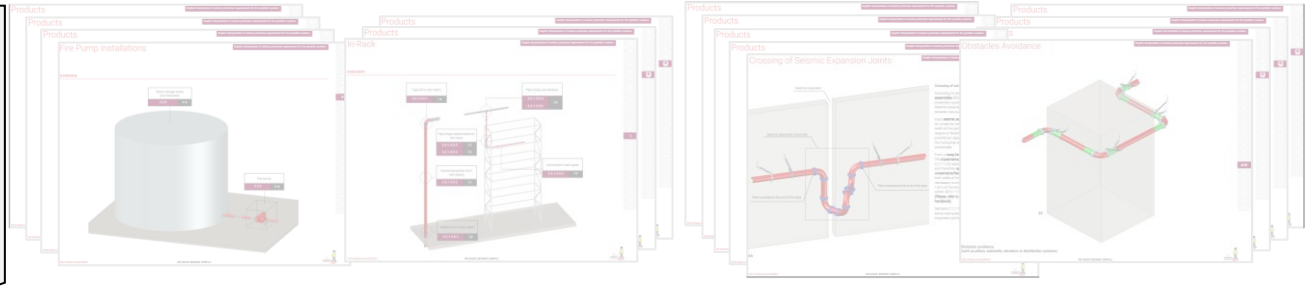


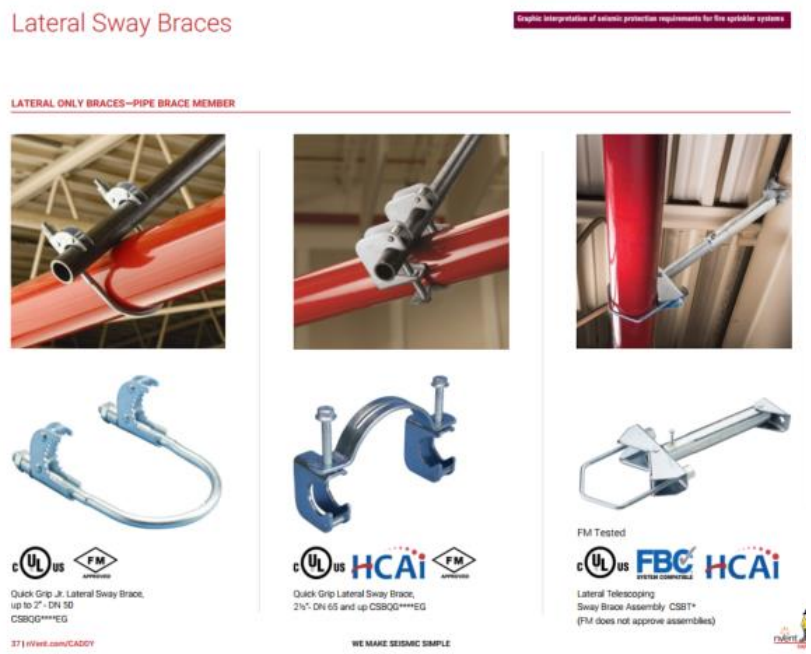
Clearance, sway bracing, restraints

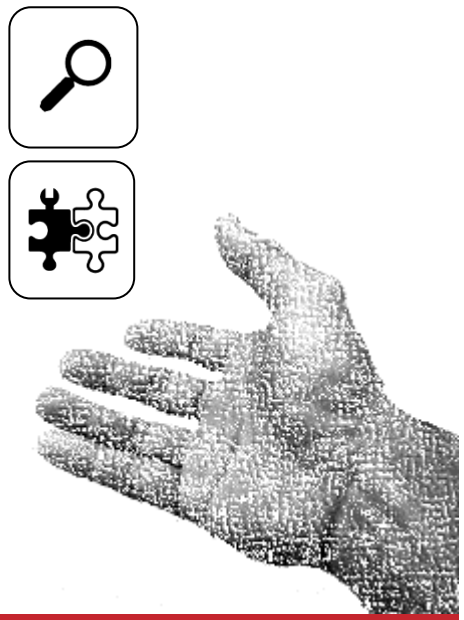
Products and assemblies





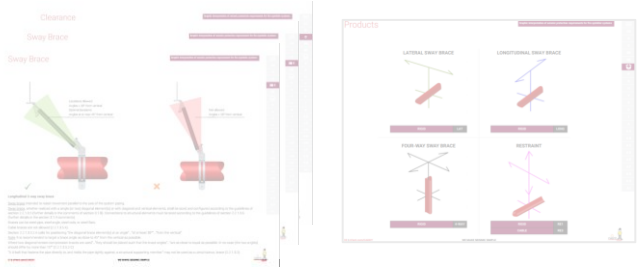


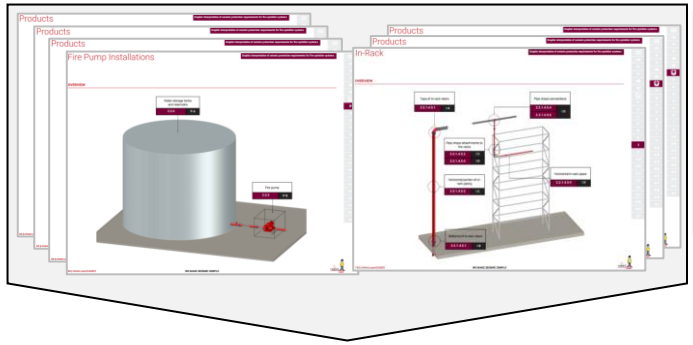


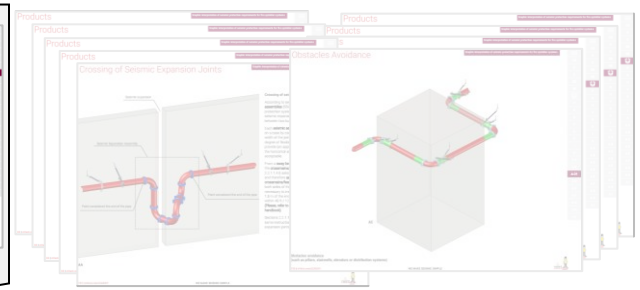


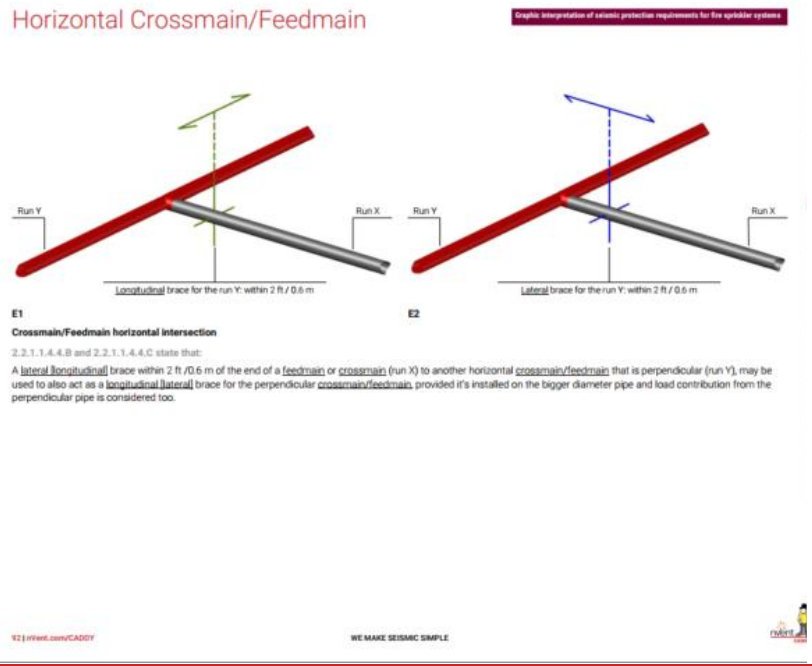
For sway bracing and for restraining

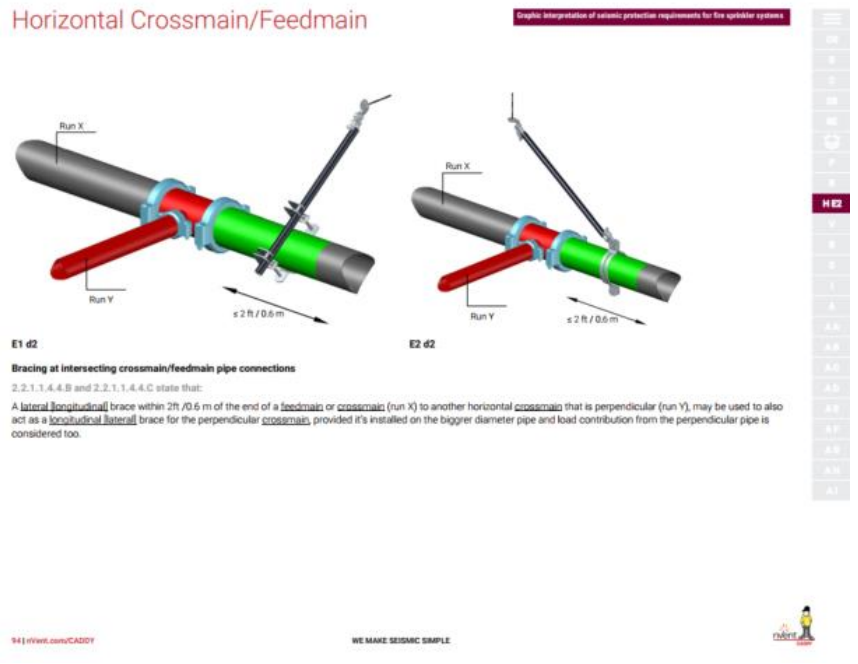
Requirements per major portions of the sprinkler system

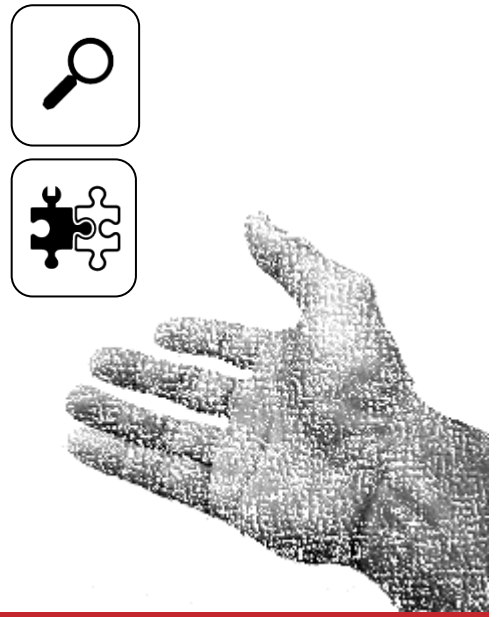






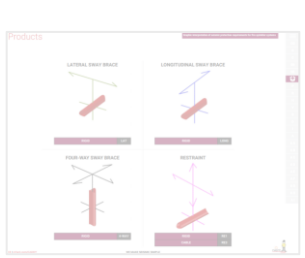


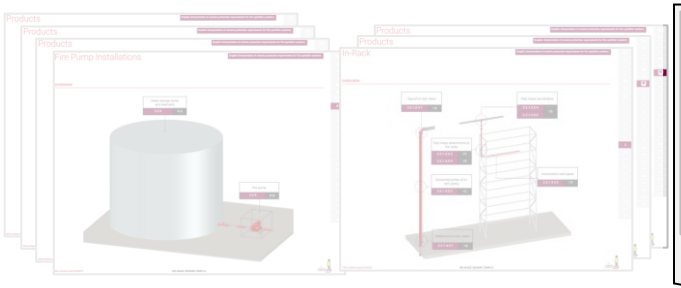


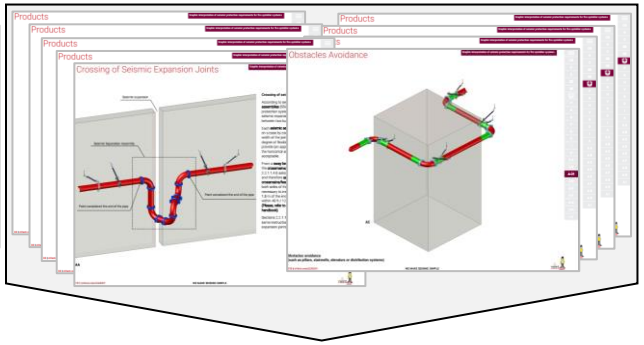


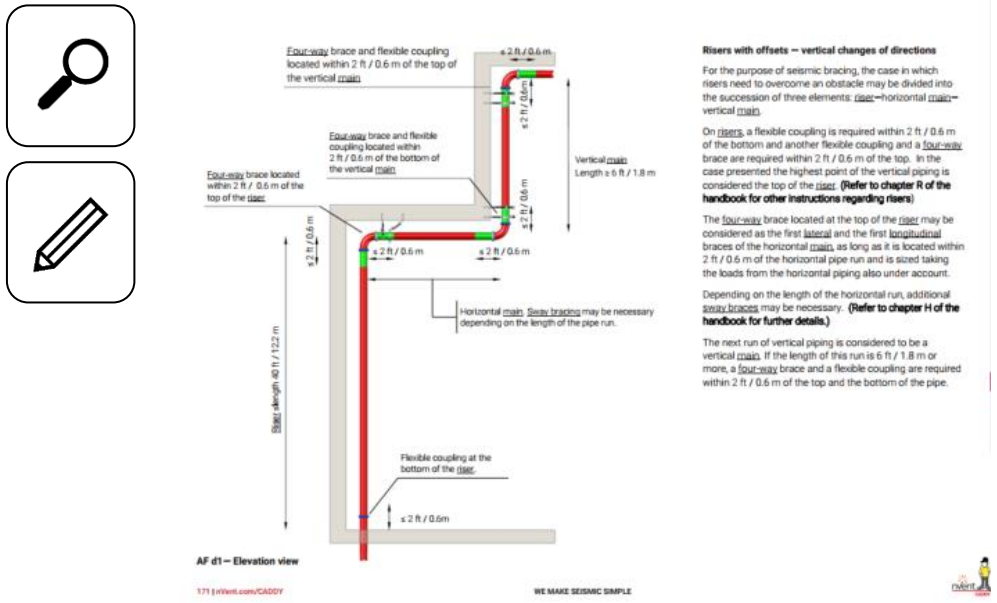
Water source, pump room, risers, mains, drops, branch lines, in-rack

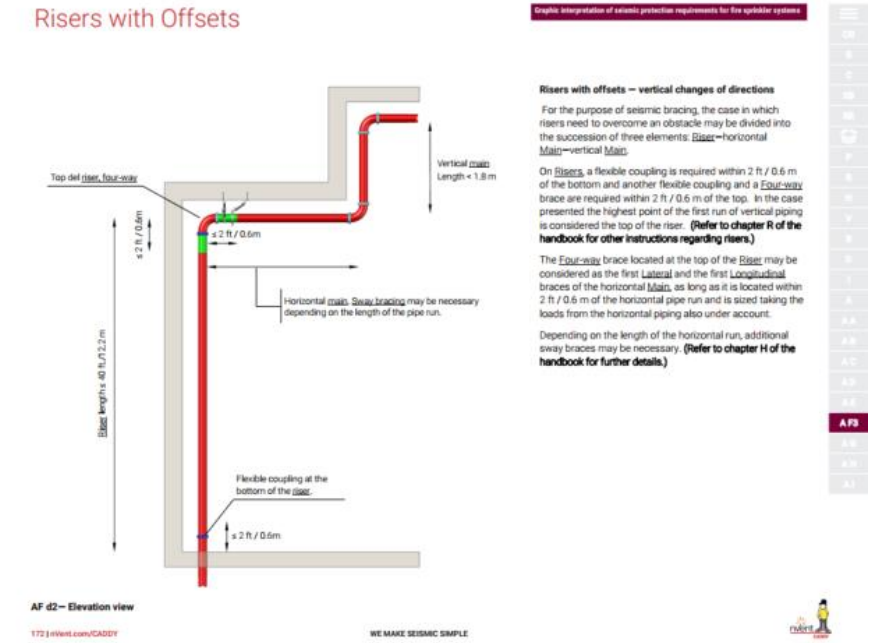
“Turn-key” compliant solutions to complex applications





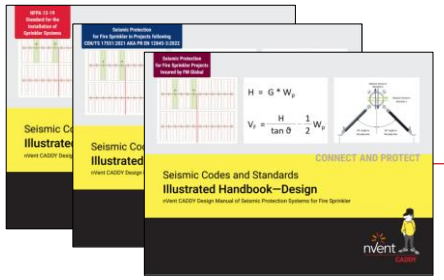






Obstacles, changes of direction, seismic expansion joints, floor & wall penetration, slopped ceilings…

Sway bracing design



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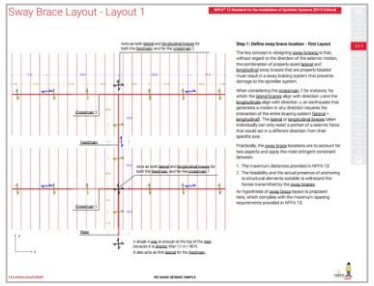

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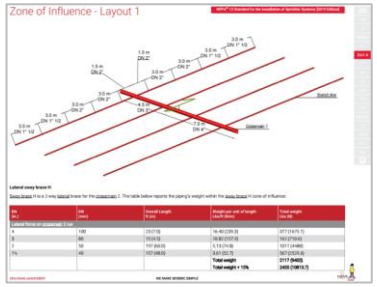

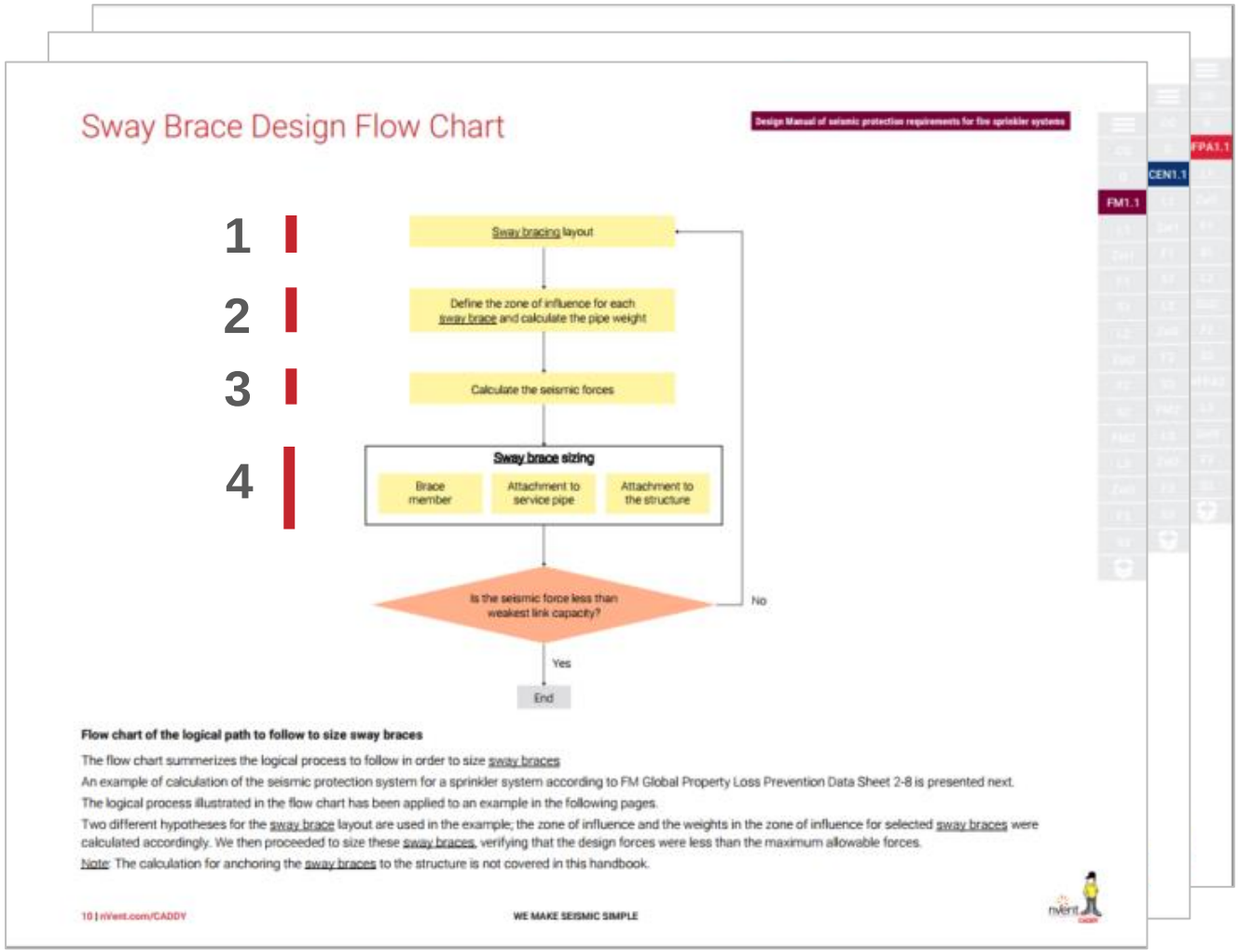

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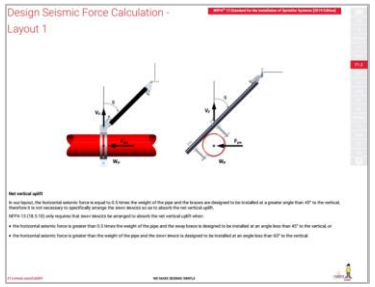

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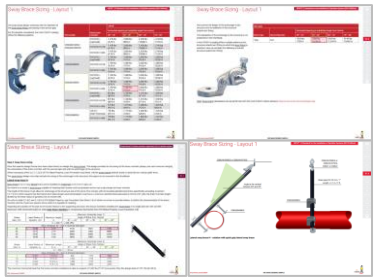
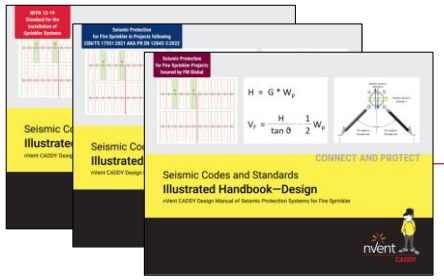


Layout – zone of influence – design seismic force calculation – assembly products selection

Verification: do the branch lines require sway bracing?



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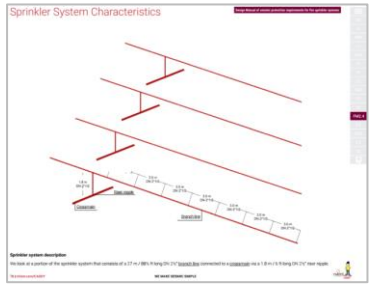

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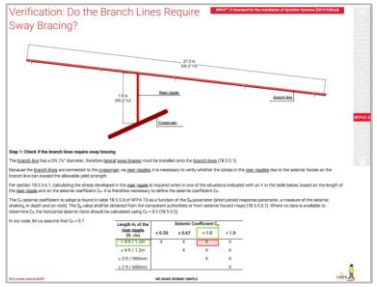

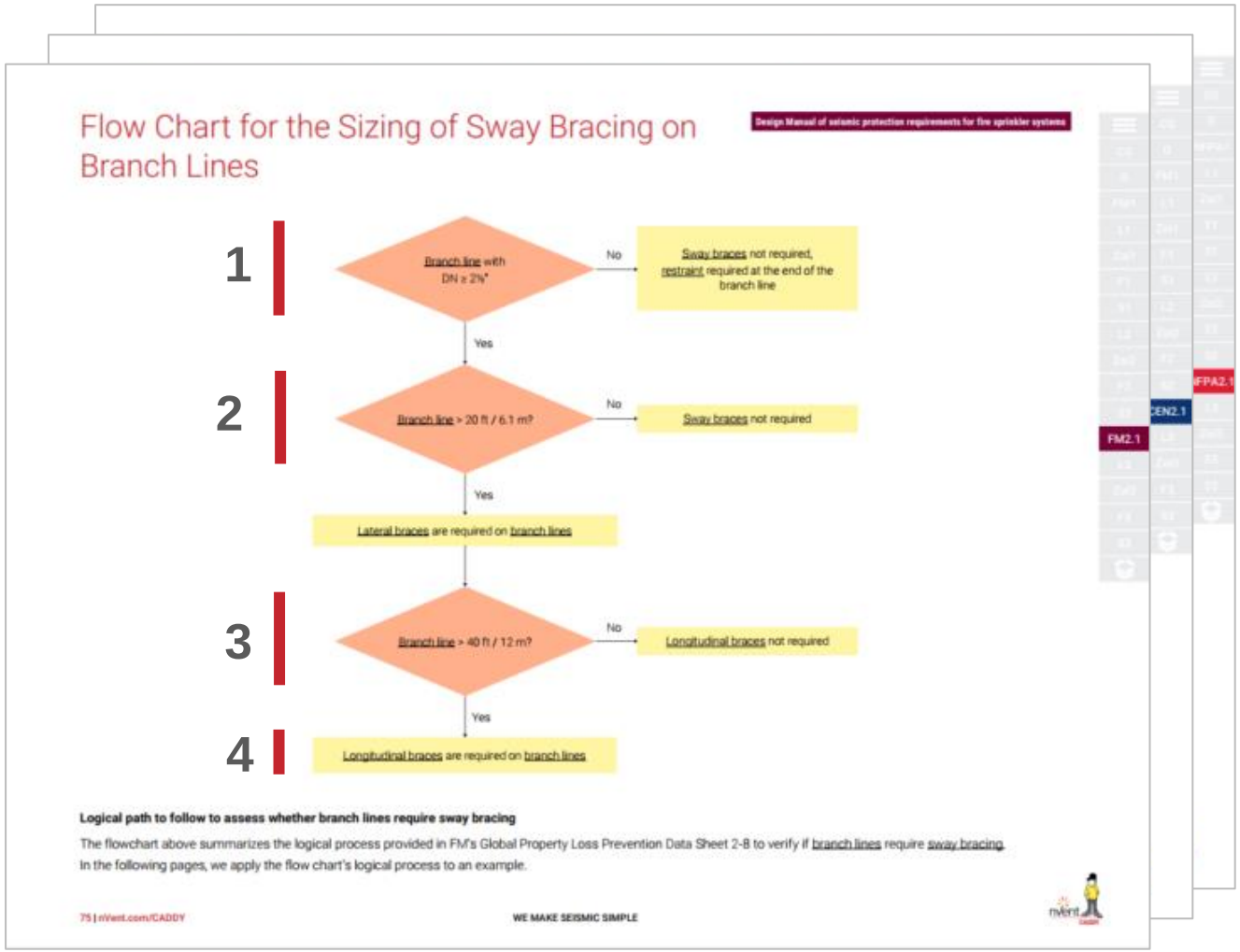

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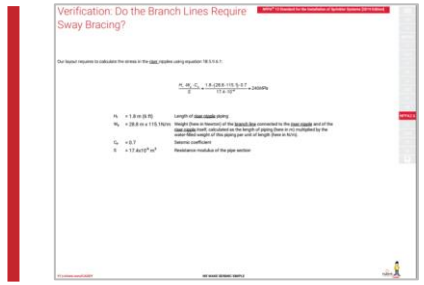

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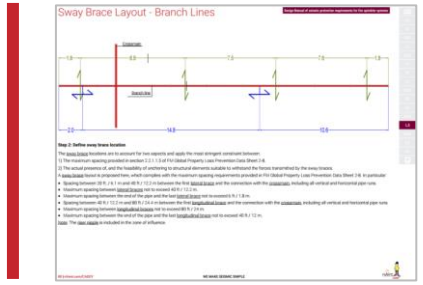
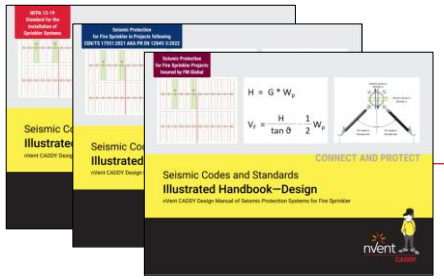
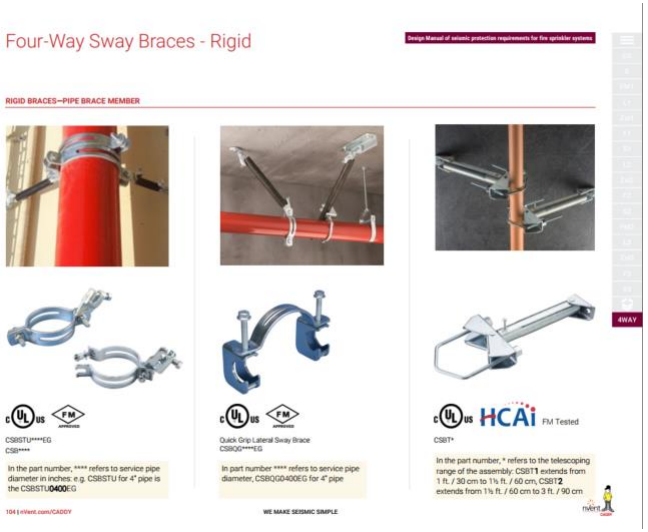
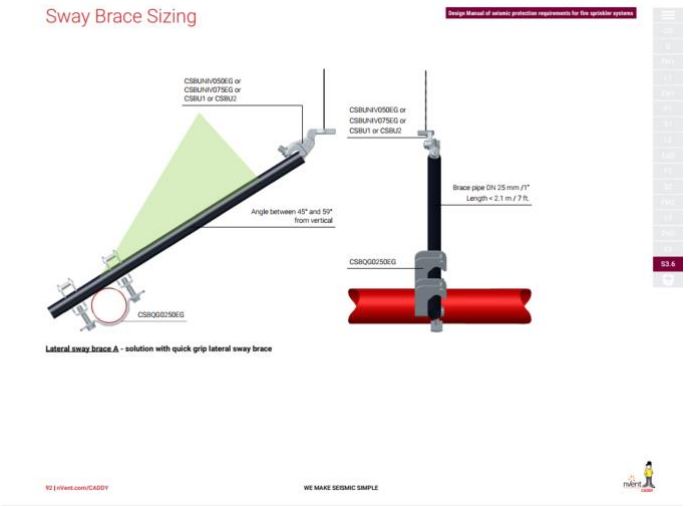


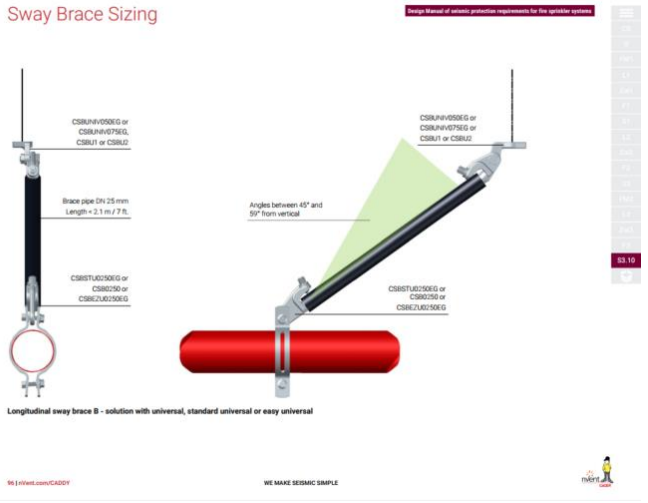
Flow chart, example



Visualization

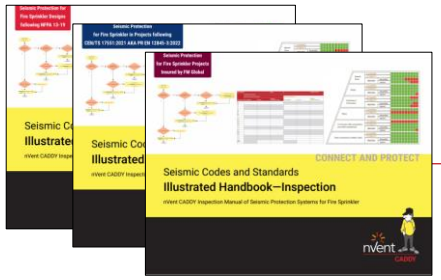


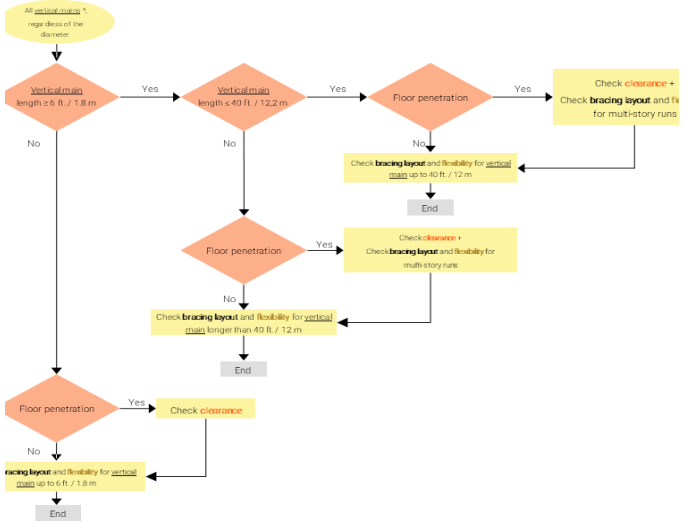




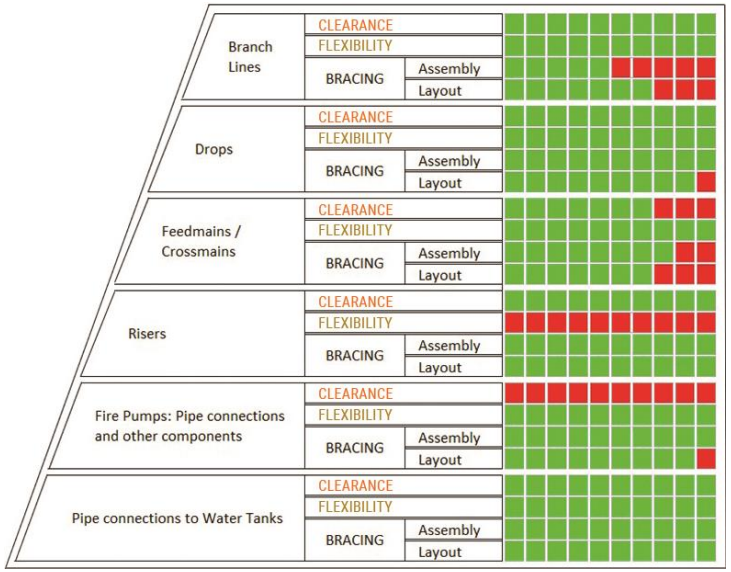
Four-way, lateral (transverse), longitudinal sway braces, and restraints

Verification





Run Identifier:			Riser			FM DS 2-8 2017
	Inspection Outcomes					
	Braces Positioning Requirements			Flexibility Requirements		
Requirement	Not Applicable	Positive	Negative Indicate the Causes	Not Applicable	Positive	Negative Indicate the Causes
R1						
R2						
R3						
R4						
R5						
R6						
R7						
R8						
R9						
R10						
R11						
R12						
R13						
R14						
R15						
R16						
R17						
R18						
R19						
R20						
R21						
R22						
Total						
%						



Flow charts, collection charts, proprietary pyramid to evaluate compliance and quality

Final considerations

Requirements

Customer

Design

Layout

Sizing

Protection systems *(type/location)*

Architects
Engineers
- Structural
- Mechanical

Installation

Installers

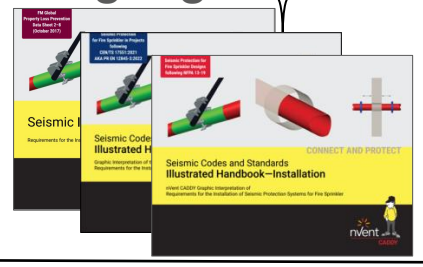
System components
Protection devices (correct installation)

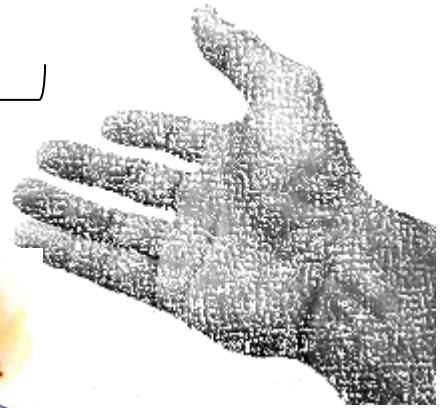
Verification

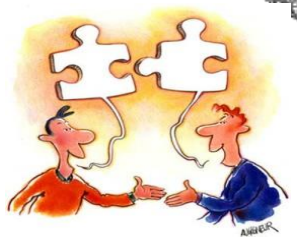
Inspectors

Plurality of actors

Different languages - different approaches







Interface support and
common reference tools

Final considerations

Handbook: a **facilitator** for the **dissemination** of a

Worldwide (installations)

culture of **Integrated / Contextualized Protection**

Requests for Handbooks can be submitted at https://go.nvent.com/Seismic-Handbook-FM2017.html

Facilitator of integrated and contextualized fire and seismic protection

Thank you for your attention

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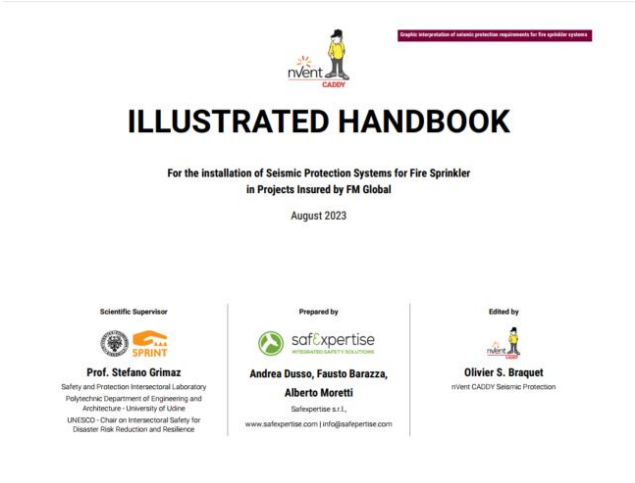

ILLUSTRATED HANDBOOK

For the installation of Seismic Protection Systems for Fire Sprinkler in Projects Insured by FM Global

August 2023

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UNIVERSITÀ DEGLI STUDI DI UDINE

- Founded in 1978
- Founded as part of the reconstruction plan from the Friuli earthquake in 1976

The authors all have a personal history with the consequences of earthquakes