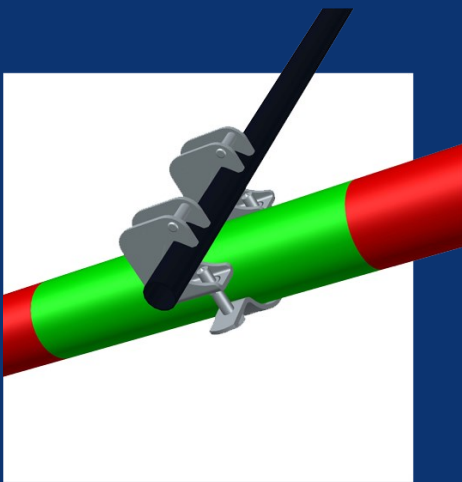




SEISMIC HANDBOOK

HANDBOOK FOR THE DESIGN AND
INSTALLATION OF SEISMIC PROTECTION
SYSTEMS FOR FIRE SPRINKLER



A COLLABORATION OF CADDY SEISMIC PROTECTION ENGINEERS
WITH THE SUPERVISION OF EXPERTS OF THE UNIVERSITY OF
UDINE IN A GLOBAL EFFORT TO PROTECT PEOPLE AND PROPERTY





SEISMIC HANDBOOK

**HANDBOOK FOR THE DESIGN AND INSTALLATION OF
SEISMIC PROTECTION SYSTEMS FOR FIRE SPRINKLER**

MAY 2017

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Olivier Braquet

CADDY Seismic Protection
Pentair Electrical & Fastening Solutions

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FOREWORD

The installation of sprinkler systems is becoming more widespread. Sprinkler systems are a very effective technology to defend against fires: to safeguard lives, to protect assets, to contain losses and to ensure business continuity. Very often such systems are installed in buildings or structures that are located in areas that are also seismic. One must therefore make sure that in case of earthquakes these services do not become themselves the cause of damage to the occupants due to their collapses or as a result of unwanted activations. When installed in strategic structures, or where it is imperative to maintain an efficient defense against fires, the fire sprinkler systems must be able to operate efficiently in the immediate aftermath of an earthquake.

Over the last decade, the earthquakes that hit Italy in L'Aquila (2009), in Emilia (2012) and more recently in Central Italy (2016) have shown that in a seismic zone, services too should be specifically designed or adjusted to resist a seismic event. This need has already emerged in other seismic countries, like the United States and Japan, where the installation of sprinkler systems is more widespread. Most observed seismic damage arises from the impact between (1) the sprinkler system and other services, (2) any distributed services and non-structural elements such as suspended ceilings and (3) any distributed services and structures. Therefore, the potential negative interaction between these distributed systems and components must be analyzed and prevented.

Hence, this highlights the need to consciously expand the design analysis to all types of construction, including non-structural elements and in particular distributed services.

Insurance companies and technical associations, especially those based in the US, leveraged such observations to issue specific recommendations for the design of sprinkler systems in seismic areas.

These standards set up the seismic design by focusing on the following key elements: (1) locating large mass elements as low as possible in the building's structure to reduce the stresses induced by the earthquake, (2) bracing the distributed services to control their oscillations, (3) ensuring clearance when crossings walls and floors to avoid destructive interactions, (4) intro-

ducing flexible joints between parts that can undergo relative movements, and (5) anchoring properly the various distributed services to avoid falls or unwanted movements.

Consequently, in seismic areas it is essential to operate in an integrated manner. Structural engineers, services designers, fire protection technicians, architects and contractors need to work together to define concerted solutions, shared with and accepted by the field engineers and inspectors of the insurance companies.

This handbook, designed and structured in that spirit, is intended to assist all those involved in the installation and the inspection of sprinkler systems in seismic areas. It also provides design guidelines using a graphical approach directly traceable to the requirements of the individual international standard followed. This particular document offers solutions using FM Approved CADDY's products.

This handbook can be used as a useful operational tool to design and implement solutions to protect activities located in areas with significant seismic activity (sites with expected ground acceleration greater than 0.125g). This is especially true in Italy where the National Fire Department issued specific measures for sprinkler systems in its technical guide *Guidelines for the reduction of firefighting equipment seismic vulnerability* (these guidelines are the most essential reference for installations subject to the control of the Fire Department). Additionally, the elements selected to provide the seismic protection must also conform to Italy's technical norms (building code) for construction.

Prof. Eng. Stefano Grimaz

Director of the Safety and Intersectorial Protection Laboratory
Politecnico Department of Engineering and Architecture
University degli Studi di Udine





TOPIC	SECTIONS
User consultation guide	CG 1 — CG 5
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Sway bracing installation overview	SB 1 — SB 4
Fire sprinklers system components	
Fire Pump installations	P A1— P B4, P fi
Risers	R A1 — R D4
Horizontal crossmains/feedmains	H A — H G2, H fi
Vertical crossmains/feedmains	V A — V D
Branch lines	B A — B F, B fi
Drops	D A1 — D C2
In-Rack systems	I A— I C5, I fi
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NOTES ON HOW TO USE THIS HANDBOOK

This HANDBOOK constitutes an aid to the design and to the verification of the installation of seismic protection systems for fire sprinklers as required by FM Global's Standard, FM Global Property Loss Prevention Data Sheet 2-8 *Earthquake Protection for Water-Based Fire Protection Systems*. As described in Data Sheet 1-2, *Earthquakes*, this handbook will address locations in FM Global 50-year through 500-year earthquake zones.

CADDY's handbook is organized in sections, inside of which are graphically represented requirements of the fire sprinkler system. The graphics include the identification of the sway bracing locations, the maximum intervals between sway bracing, the types of couplings required, etc. for the various situations presented in FM Global Property Loss Prevention Data Sheet 2-8. Each illustration is accompanied by a commentary that summarizes the requirements, quoting from time to time sections of the FM data sheets related to the situation detailed.

The sections are organized in two levels: at a first level are the major parts of the fire sprinkler system ("R" section for the risers, "H" section for the horizontal crossmains/feedmains, etc...). Each section identifies the requirements of the fire sprinkler system components. Subsections, identified with the subscript letter "D" in the encoding (e.g. R_D for riser, H_D for horizontal crossmains/feedmains, etc.), present detailed instructions for the proper design and installation of the seismic protection system at a second level.

Each section is introduced by an "overview", or diagram, which depicts this major part of the fire sprinkler subsections with the corresponding nomenclature, the corresponding section of the FM data sheet referenced, and the subsections to which to refer to find detailed instructions.

Following the sections about the fire sprinklers major parts, CADDY's sway bracing product range is presented with tables that contain information about the application(s) for which they have been designed and the pipe diameters that they can brace.

This handbook also contains suggestions of possible solutions using combinations of instructions from the FM data sheet for frequently

encountered situations such as obstacle avoidance, changes of directions etc.

This handbook does not cover the installation systems for vertical loads (hangers). Also, the instructions provided do not replace the structural calculation, which is necessary to comply with the local seismic regulations. In fact, the calculation results may lead to a greater number of sway braces than the minimum specified in the FM Global Property Loss Prevention Data Sheets.

The handbook provides a set of general information, not automatically transferable to the actual situations of specific job sites; the person in charge of the entire structural design, including verification of the sway braces and verification of the support structure of the building is still the engineer in charge, as provided by the local codes.

OVERVIEW PAGES

Letter code identifying the section covering this system component (e.g. H=Horizontal, R=Riser, etc.)



Fire sprinklers system component sec-

Color code identifying the Handbook's fire sprinkler code

HORIZONTAL CROSSMAIN/FEEDMAIN OVERVIEW **H**

START OF PIPE RUNS
2.2.1.1.4.D.1 HB

CONNECTIONS WITH PERPENDICULAR PIPE RUNS
2.2.1.1.4.D.2 HE
2.2.1.1.4.D.3

HORIZONTAL CHANGES OF DIRECTIONS
2.2.1.1.4.A HF
2.2.1.1.4.C.2

ENDS OF PIPE RUNS / SEISMIC SEPARATION JOINTS
2.2.1.1.4.B HC

STRAIGHT PIPE RUNS
2.2.1.1.4.D HA

WALL PENETRATIONS
2.2.1.1.4.D HG

RUNS WITH EXCESSIVE FLEXIBLE COUPLINGS
2.2.1.1.4.C.1 HD

Page release date

VERS. 05/2017

HANDBOOK FOR THE DESIGN AND INSTALLATION OF SEISMIC PROTECTION SYSTEMS FOR FIRE SPRINKLER
FM Global Property Loss Prevention Data Sheet 2-8 [May 2010]

Area of interest details:

Description of area of inte-

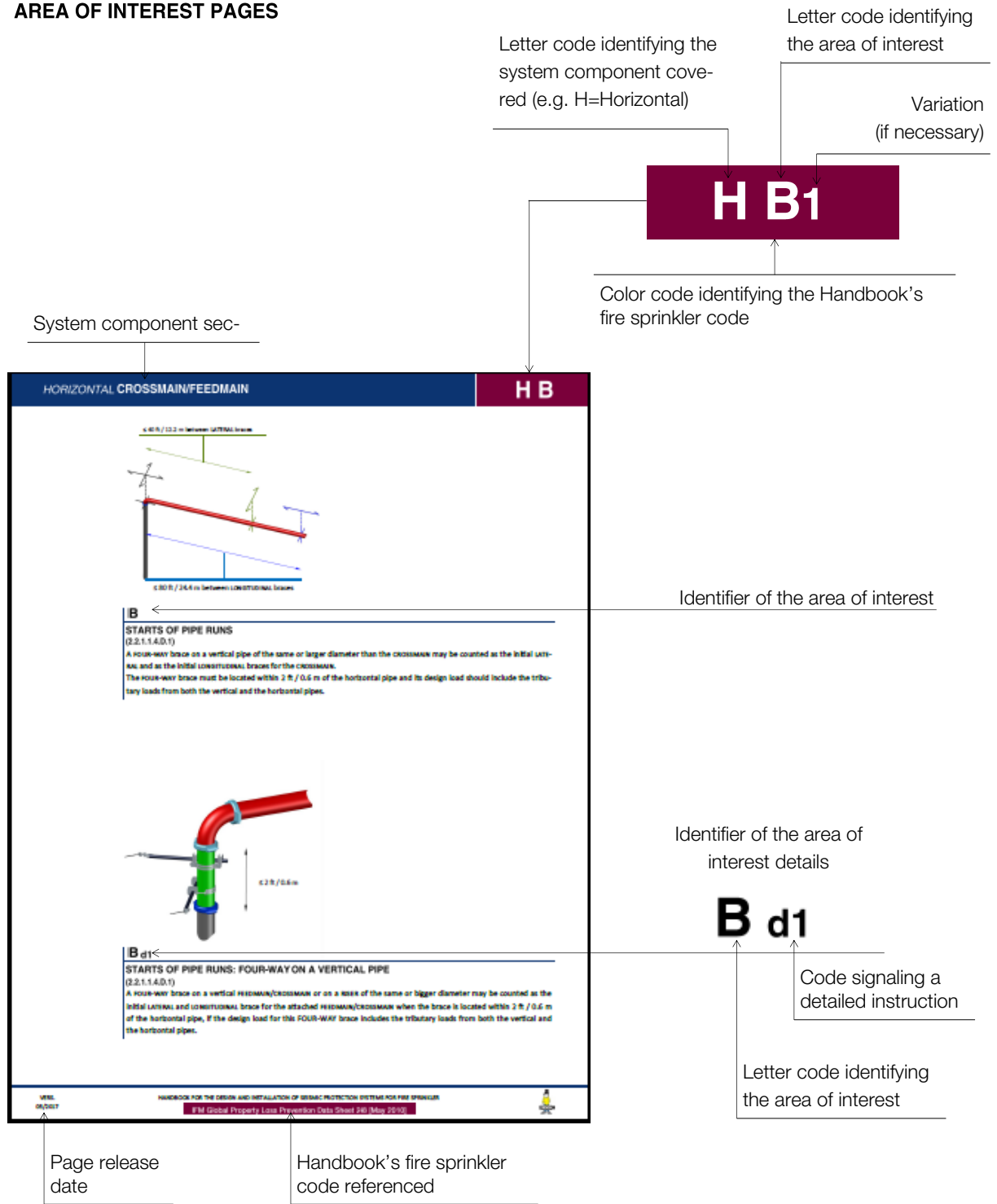
RUN WITH EXCESSIVE FLEXIBLE COUPLINGS
2.2.1.1.4.C.1 HD

Section(s) of the fire sprinkler code

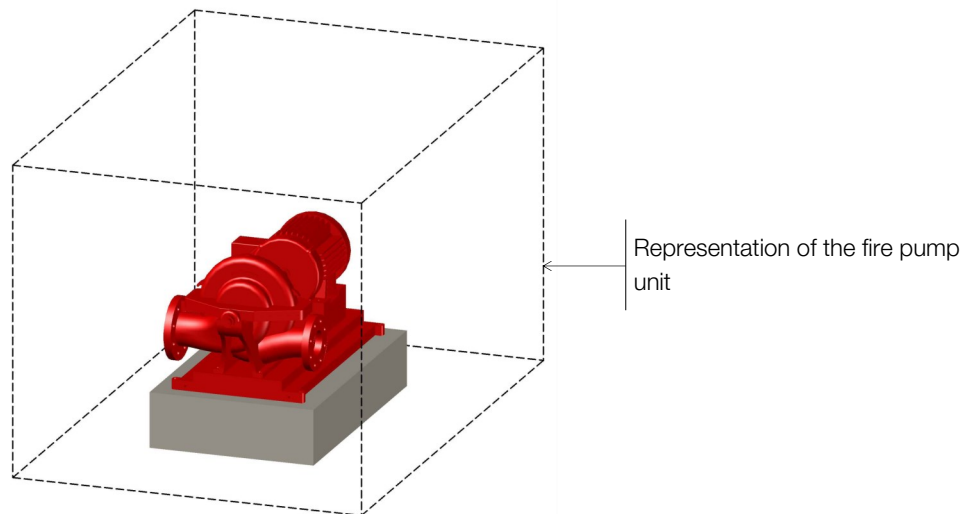
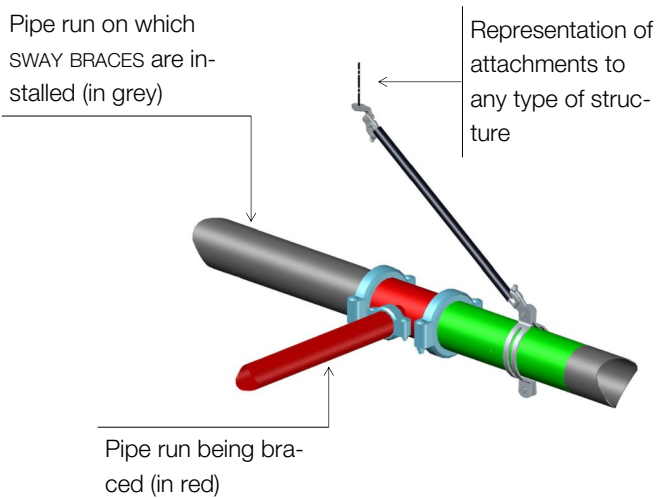
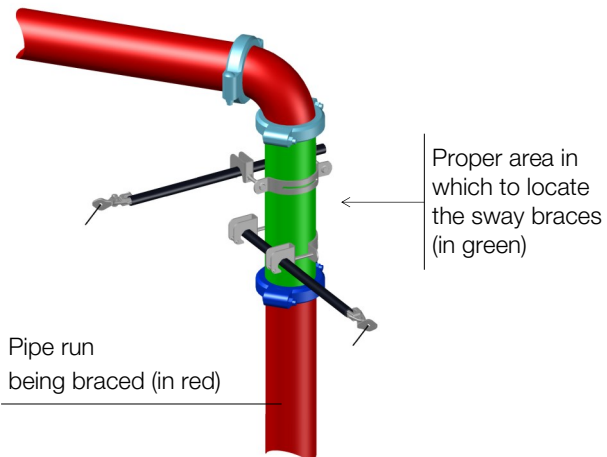
Handbook page(s) covering specific area of interest: the first letter identifies the system component; the second letter identifies the area of interest

Handbook's fire sprinkler code referenced

AREA OF INTEREST PAGES

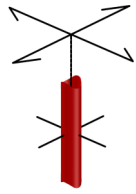


GRAPHICS AND SYMBOLS LEGEND



GRAPHICS AND SYMBOLS LEGEND

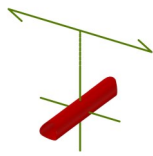
Sway braces



FOUR-WAY SWAY BRACE symbol and location



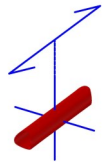
FOUR-WAY SWAY BRACE



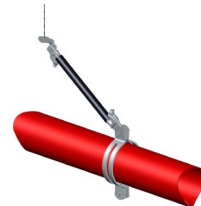
LATERAL SWAY BRACE symbol and location



LATERAL SWAY BRACE

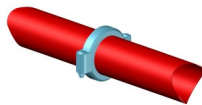


LONGITUDINAL SWAY BRACE symbol and location

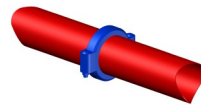


LONGITUDINAL SWAY BRACE

Couplings

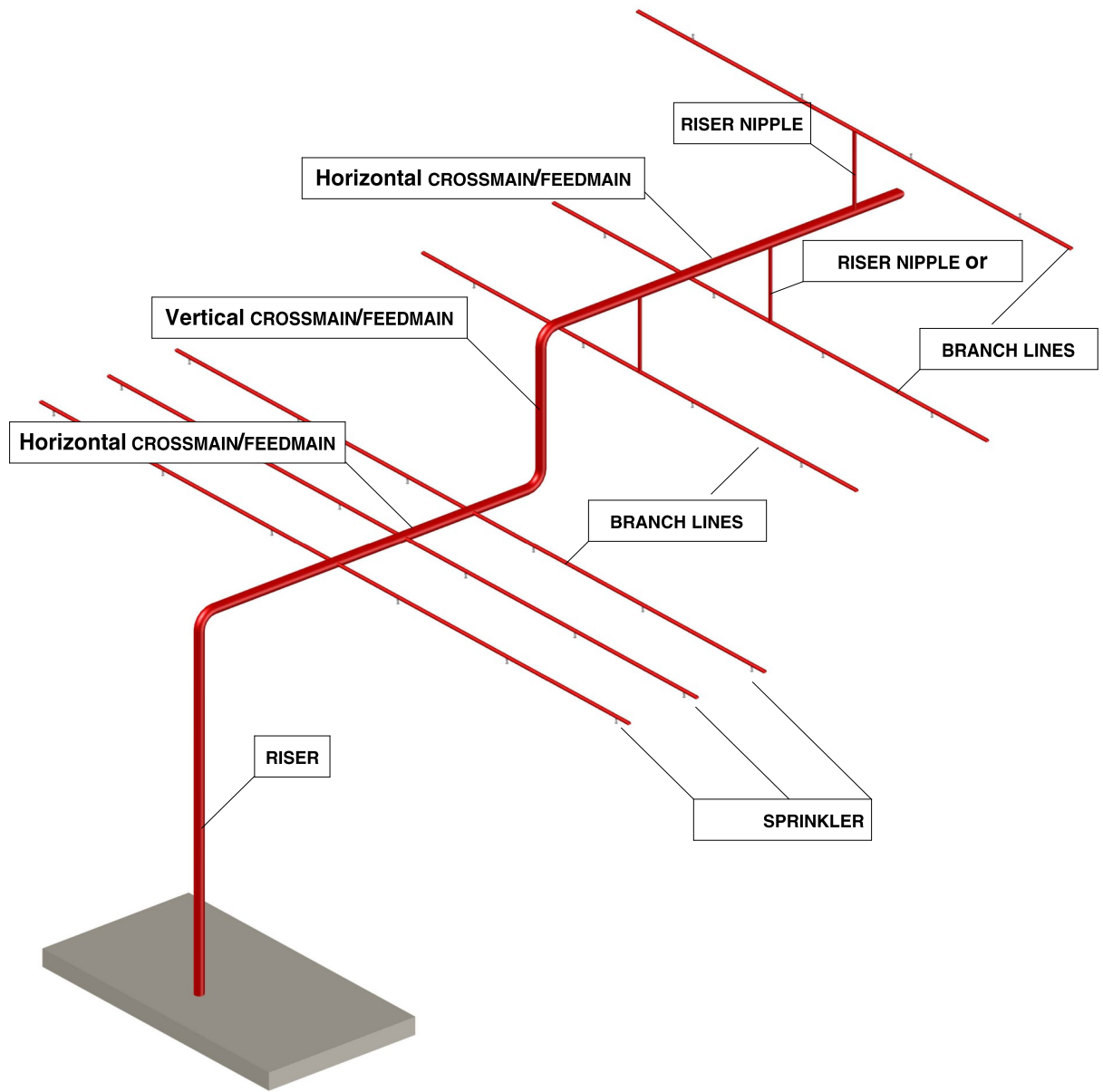


Rigid coupling



Flexible coupling

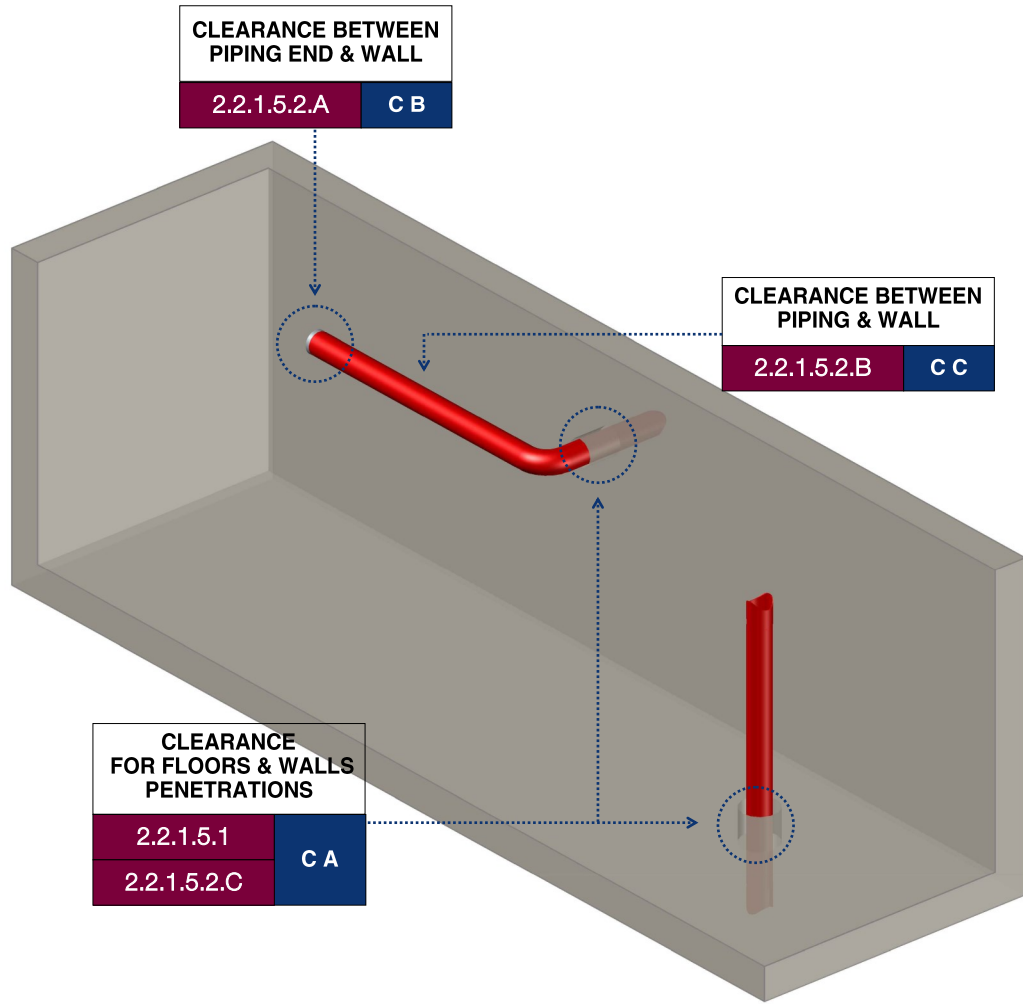


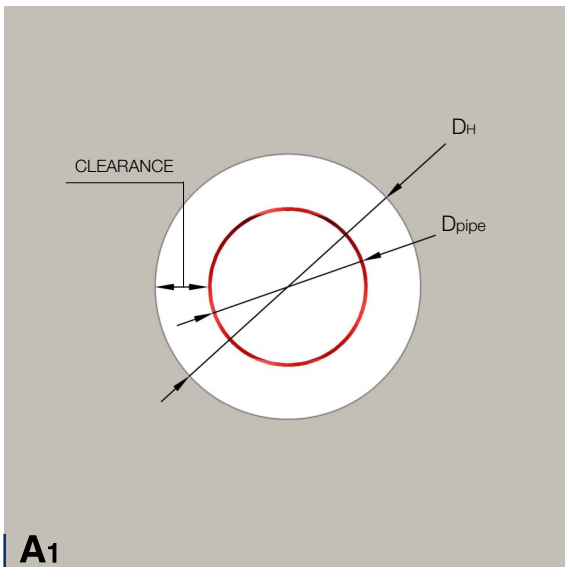


AUTOMATIC SPRINKLER	A device with a thermo-sensitive sealing element that opens to discharge water onto a fire.
BRANCH LINE	Pipes supplying sprinklers, either directly or through riser nipples (a.k.a. sprigs), drops, return bends, or arm-overs.
CLEARANCE	Space required so that pipes or other elements do not come into contact with walls or floors in case of earthquakes.
COUPLING	Connector used to join two or more pipe sections of the sprinkler system together.
CROSSMAIN	Pipe supplying the branch lines between the feedmain and the system's branch lines.
DROP	Pipe run of variable length descending from a main pipe or a branchline to feed a lower branchline.
FEEDMAIN	Pipes supplying cross mains and the distribution piping, either directly or through risers.
FOUR-WAY BRACE (FOUR-WAY)	Adjacent sway braces intended to resist differential movement of the system piping in all horizontal directions.
LATERAL BRACE (LATERAL)	A sway brace intended to resist a system piping movements perpendicular to its axis.
LONGITUDINAL BRACE (LONGITUDINAL)	A sway brace intended to resist a system piping movement parallel to its axis.
MANIFOLDED RISERS	Assembly consisting of more than one riser connected to a same supply pipe.
RISER	The vertical supply pipes in a sprinkler system.
RISER NIPPLE	Vertical piece of pipe between the main and a branch line.
SEISMIC SEPARATION ASSEMBLY	Assembly of fittings, pipe, flexible pipe, and/or couplings that permits movement in all directions to accommodate seismic differential movement across building seismic separation joints.
SPRINKLER SYSTEM	A system that consists of an integrated network of specially sized piping and all of the other necessary elements to provide sprinkler protection to a building, including one or more sprinkler grids, the distribution systems up to each grid and the water source.
SWAY BRACE	Assembly of rigid or flexible elements (cables) intended to be attached to the system piping in order to resist horizontal earthquake loads in two directions.
TWO-WAY BRACE	SWAY-BRACE that acts in both tension and compression.

Definitions provided above are adapted from NFPA13







A1

WALLS, FLOORS, ETC... PENETRATIONS

(2.2.1.5.1.A e 2.2.1.5.1.B)

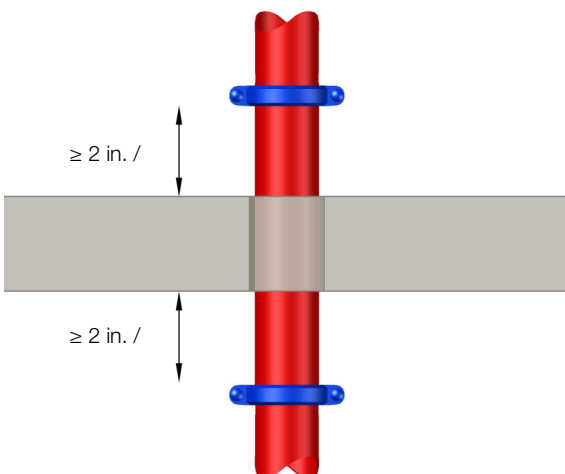
Where piping passes through walls, platforms, mezzanines, roofs, or floors, provide:

- a hole or sleeve with a nominal diameter $D_H = D_{\text{pipe}} + 2 \text{ in./}50\text{mm}$ for pipes 1 in./25mm diameter through 3-1/2 in./90mm

- a hole or sleeve with a nominal diameter $D_H = D_{\text{pipe}} + 4 \text{ in./}100 \text{ mm}$ 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.

CLEARANCE is not needed when the structural member crossed material is frangible, such as gypsum board, and the structural member crossed is not required to have a fire rating.

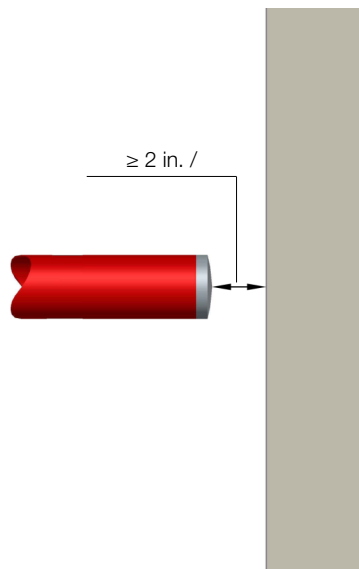


A2

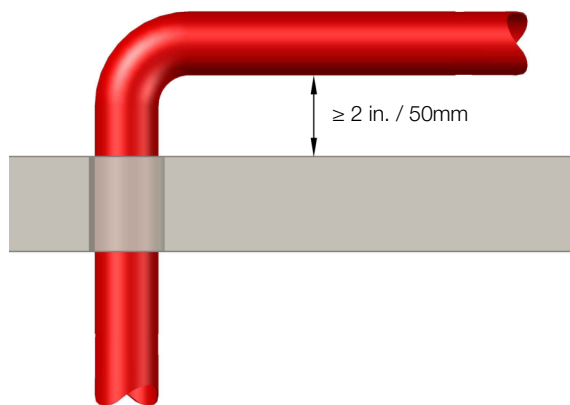
WALLS, FLOORS, ETC... PENETRATIONS

(2.2.1.5.2.C)

When piping passes through walls or structural members, provide at least 2 in. / 50 mm clearance between any flanges, fittings, or other devices on the piping and walls/structural members crossed.

**B****ENDS OF PIPING CLEARANCE****(2.2.1.5.2.A)**

Provide at least 2 in. / 50 mm CLEARANCE between ends of piping and walls or other structural members.

**C****PIPING PARALLEL TO A WALL / STRUCTURAL ELEMENT****(2.2.1.5.2.B)**

When piping passes through walls or structural members, then turns 90 degrees to run parallel to the wall, provide at least 2 in. / 50 mm clearance between the parallel pipe run and the wall/structural member.

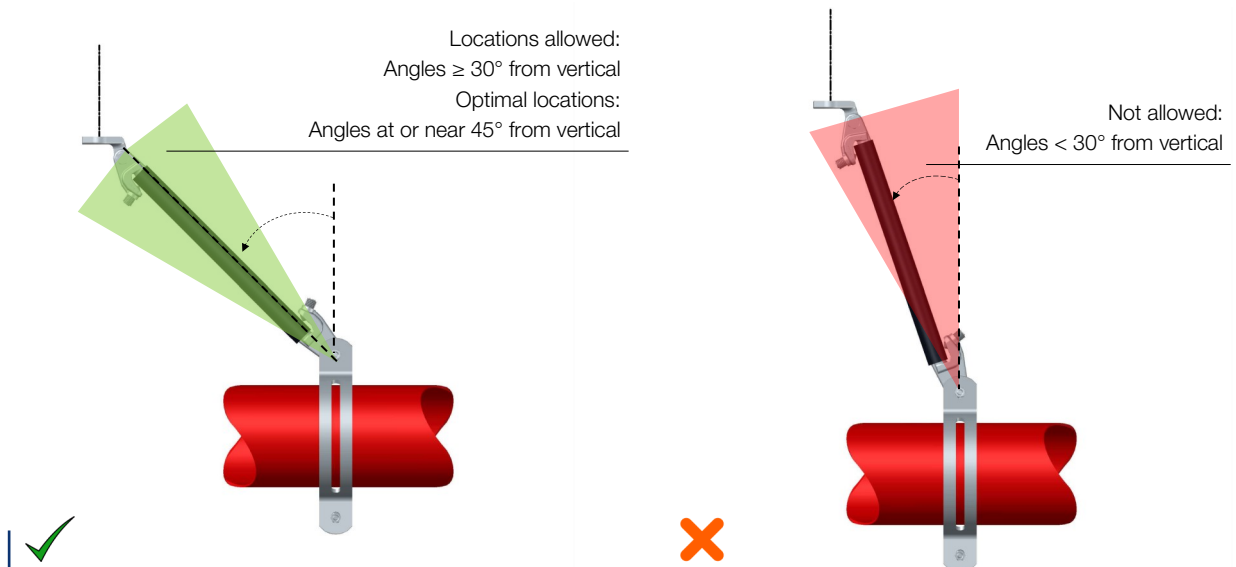
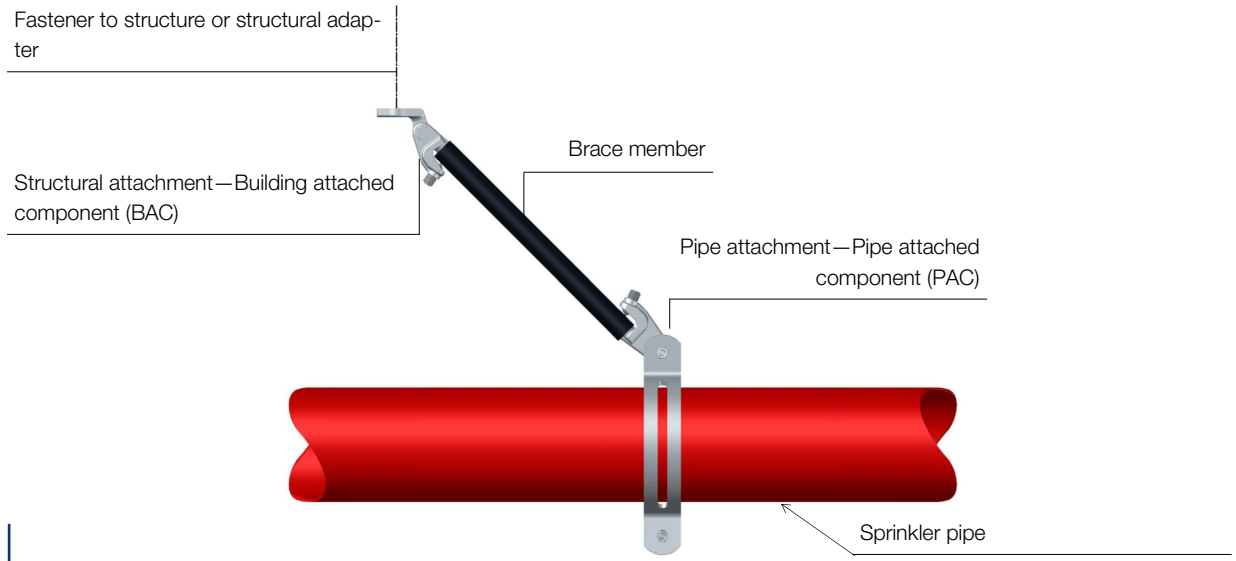
CLEARANCE - FURTHER INSTRUCTIONS**(2.2.1.5.3.A)**

For sprinklers (sprinkler heads) installed in suspended ceilings, if possible provide an oversize adapter through the ceiling tile to allow for free movement of 1 in. / 25 mm in all horizontal directions. If not possible, provide at least a 1/2 in. / 13 mm gap around ceiling penetrations for sprinklers.

(2.2.1.5.3.B)

For other sprinklers (sprinkler heads), 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 (head) and the object is expected or where the sprinkler (head) is protected from impact. Provide greater horizontal CLEARANCE (4–6 in. / 100–150 mm) to sprinklers (sprinkler heads) when possible.

Note: The minimum sprinkler head clearance is 2 in. / 50 mm but best practice would be 4-6 in. / 100-150 mm.



LONGITUDINAL 2-WAY SWAY BRACE

SWAY BRACE intended to resist movement parallel to the axis of the system piping.

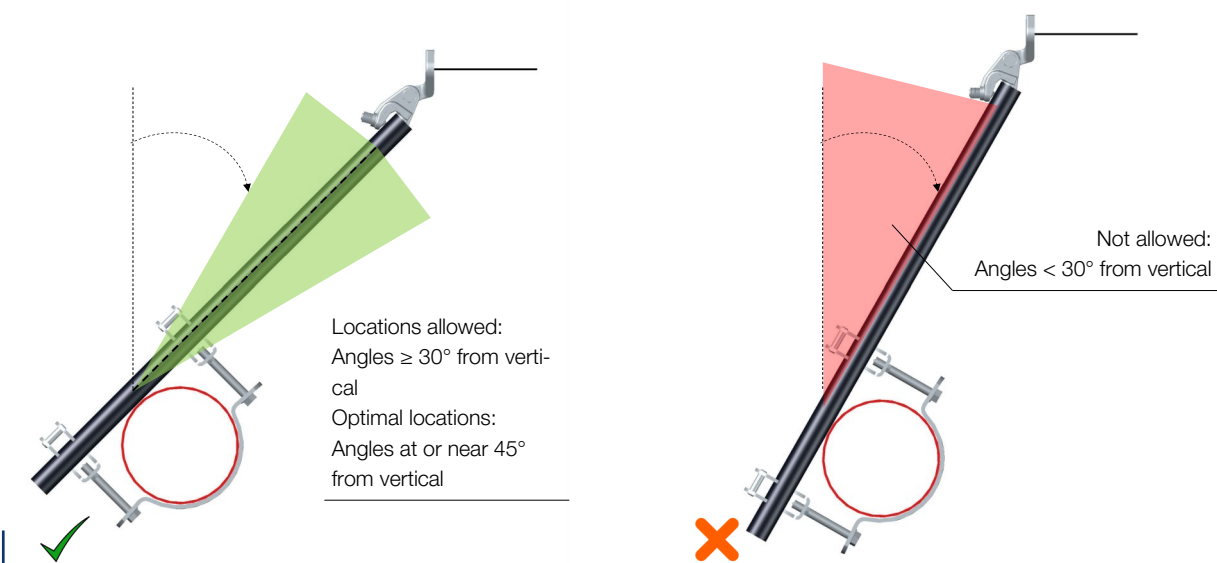
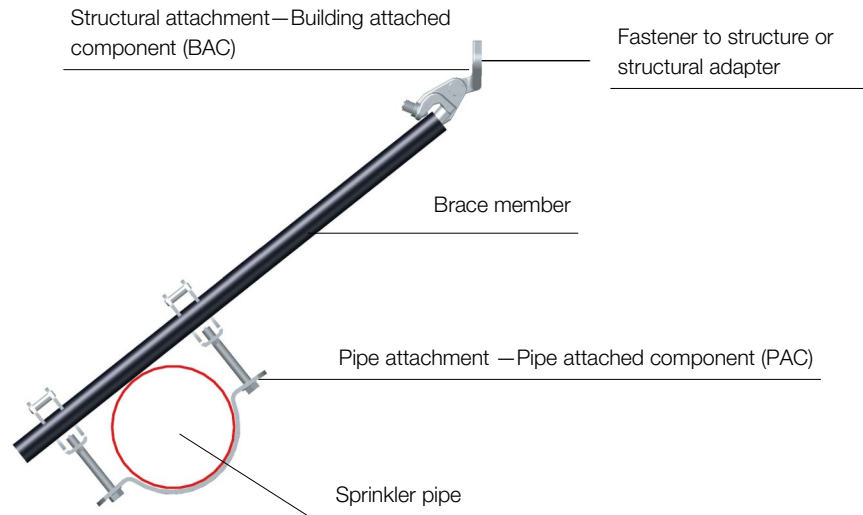
LONGITUDINAL BRACE elements shall be sized and configured according to the guidelines of section 2.2.1.3.5.

Braces can be steel pipe, steel angle, steel rods, or steel flats.

Section 2.2.1.3.5.A calls for positioning the diagonal brace element(s) at an angle of at least 30° from the vertical.

Note. It is recommended to target a brace angle as close to 45° from the vertical as possible.





LATERAL 2-WAY SWAY BRACE

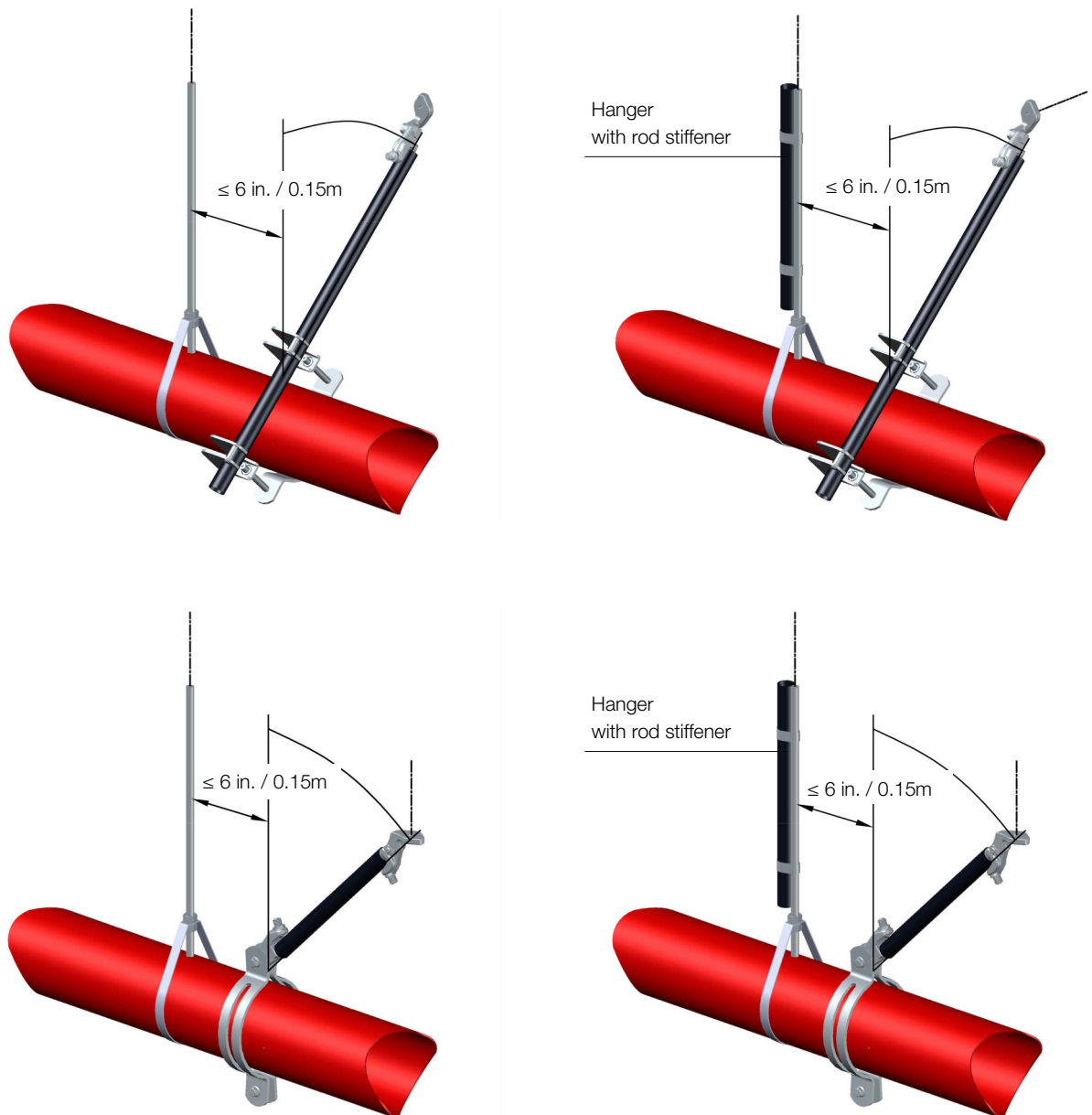
SWAY BRACE intended to resist movement perpendicular to the axis of the system piping.

LATERAL BRACE elements shall be sized and configured according to the guidelines of section 2.2.1.3.5.

Braces can be steel pipe, steel angle, steel rods, or steel flats.

Section 2.2.1.3.5.A calls for positioning the diagonal element(s) at an angle of at least 30° from vertical.

Note. It is recommended to target a brace angle as close to 45° from the vertical as possible.

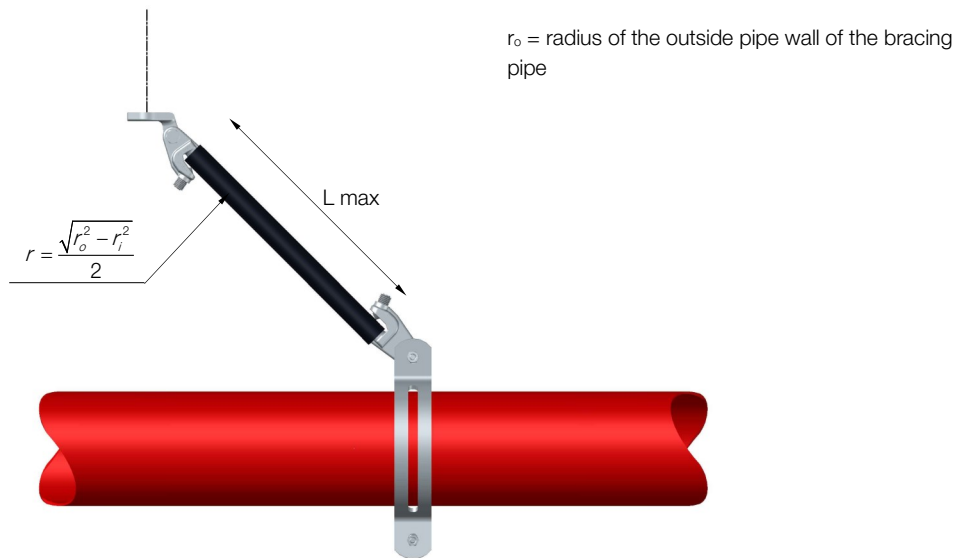


2-WAY SWAY BRACE WITH BRACE OR REINFORCED HANGER ROD TO RESIST VERTICAL UPLIFT FORCE

For the configurations illustrated above it is required to calculate the net vertical uplift force as described in section 2.2.1.3.5.D.1. If the net vertical lift force is greater than 0 (zero) it is necessary to add vertical reinforcement to resist the uplift force. The vertical brace, when needed, can either be a brace of the same shape and size of the LATERAL or LONGITUDINAL brace and connected to the pipe at the same point, without any further calculation, or it can be selected on the basis of the actual calculated net vertical uplift force.

Although less desirable, the vertical brace may be a hanger that is located no more than 6 in. / 0.15m from the point of attachment of the LATERAL or the LONGITUDINAL brace. In this case, the hanger must meet the following criteria:

- The hanger has been determined to be able to resist the net vertical resultant load uplift force (which may necessitate the use of a rod stiffener or other means, but in any case the slenderness ratio between length and least radius of gyration should not exceed 200),
- The hanger is capable of transferring vertical upward loads and is fastened to the structure by a positive means of mechanical attachment (such as through bolts, lag screws, or concrete anchors that are properly sized for the load, and
- The hanger attachment to the fire protection system piping is snug and concentric, with no more than 1/2 in. / 13mm between the top of the piping and the hanger so that excessive movement cannot occur.



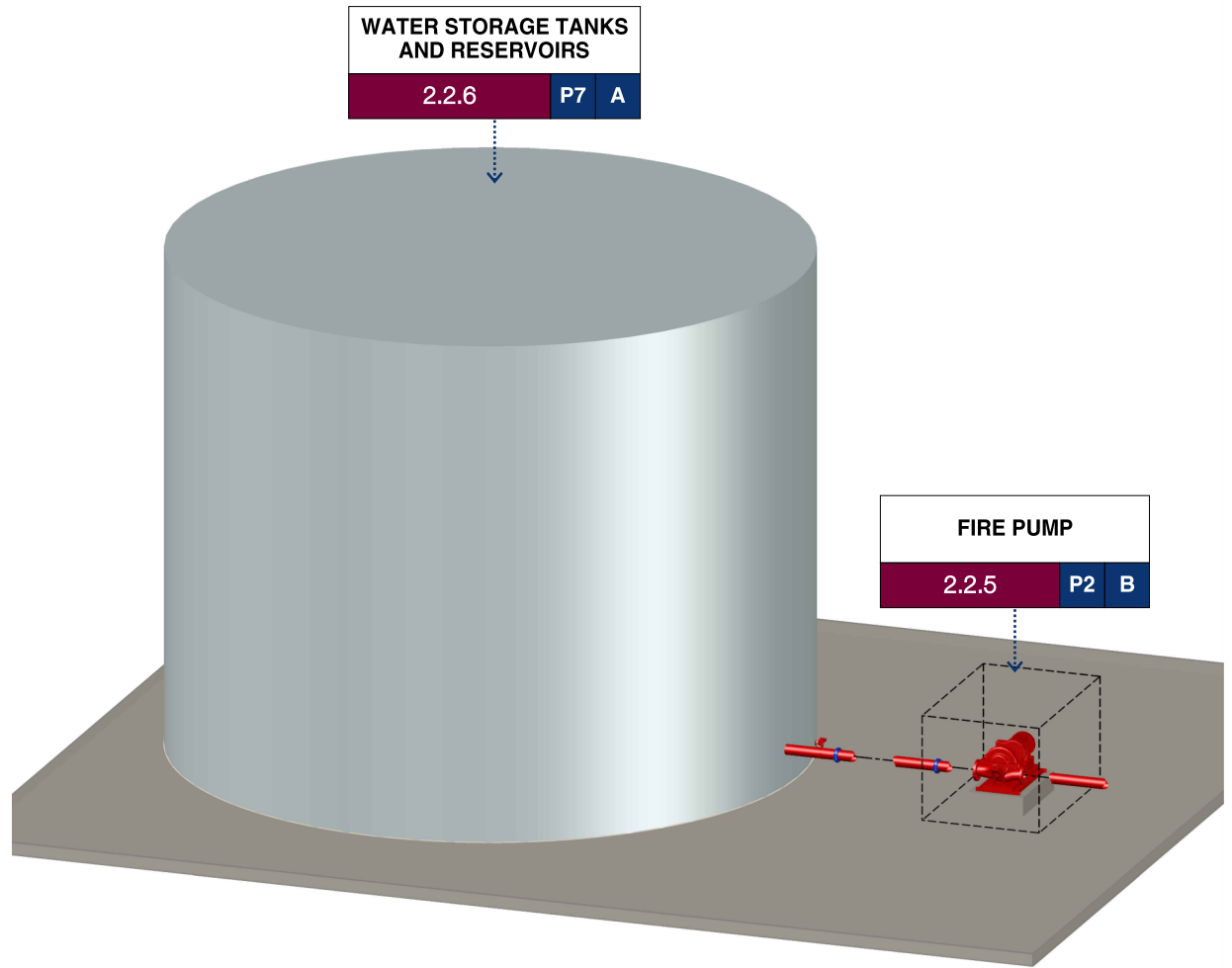
SLENDERNESS OF THE BRACING MEMBER

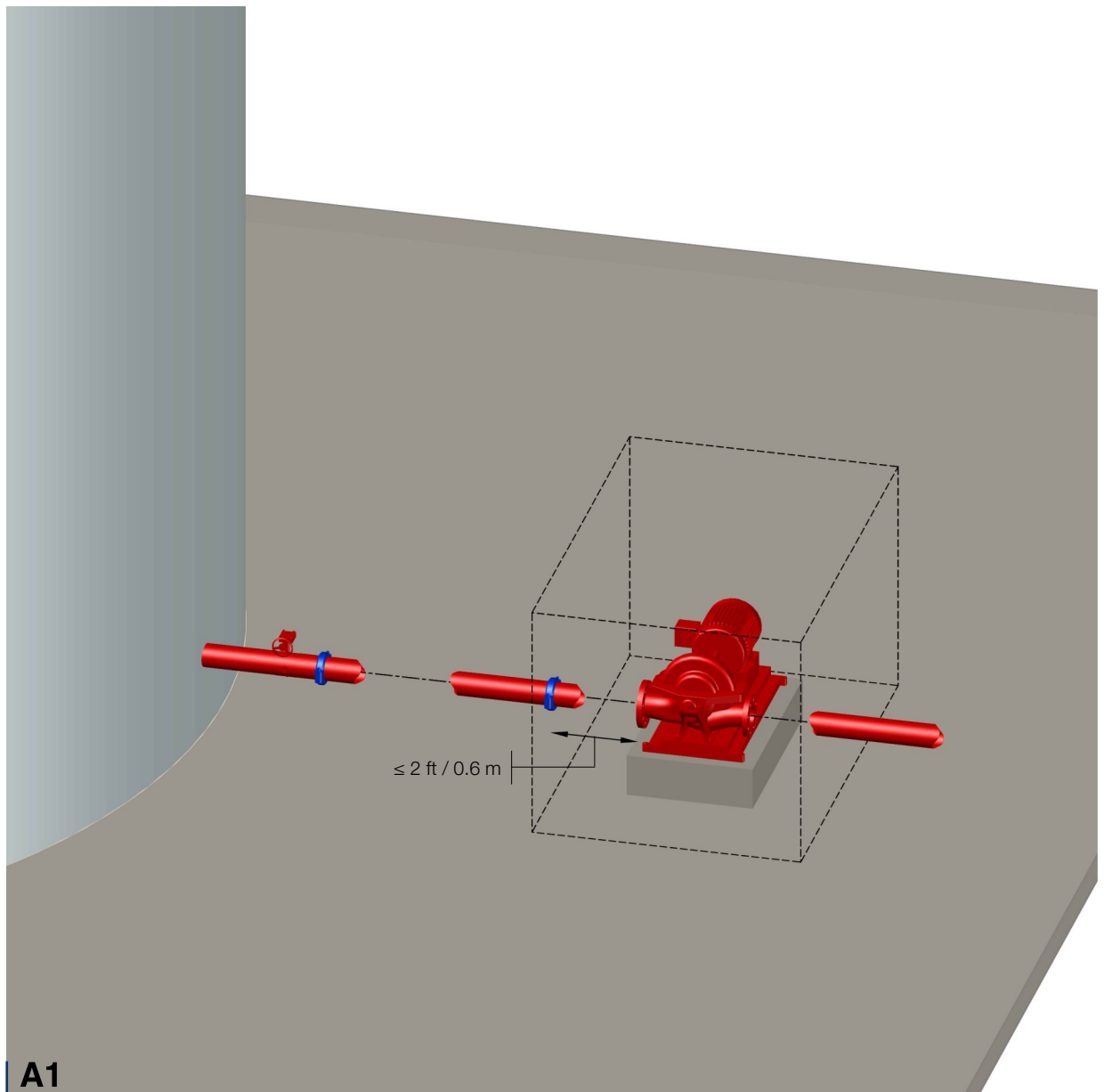
Section 2.2.1.3.5.B mandates that for braces used to resist both tension and compression the slenderness ratio L/r (ratio between the length of the brace and its least radius of gyration) does not exceed 200.

For braces used in tension only, (section 2.2.1.3.5.C) mandates the slenderness ratio not to exceed 300.

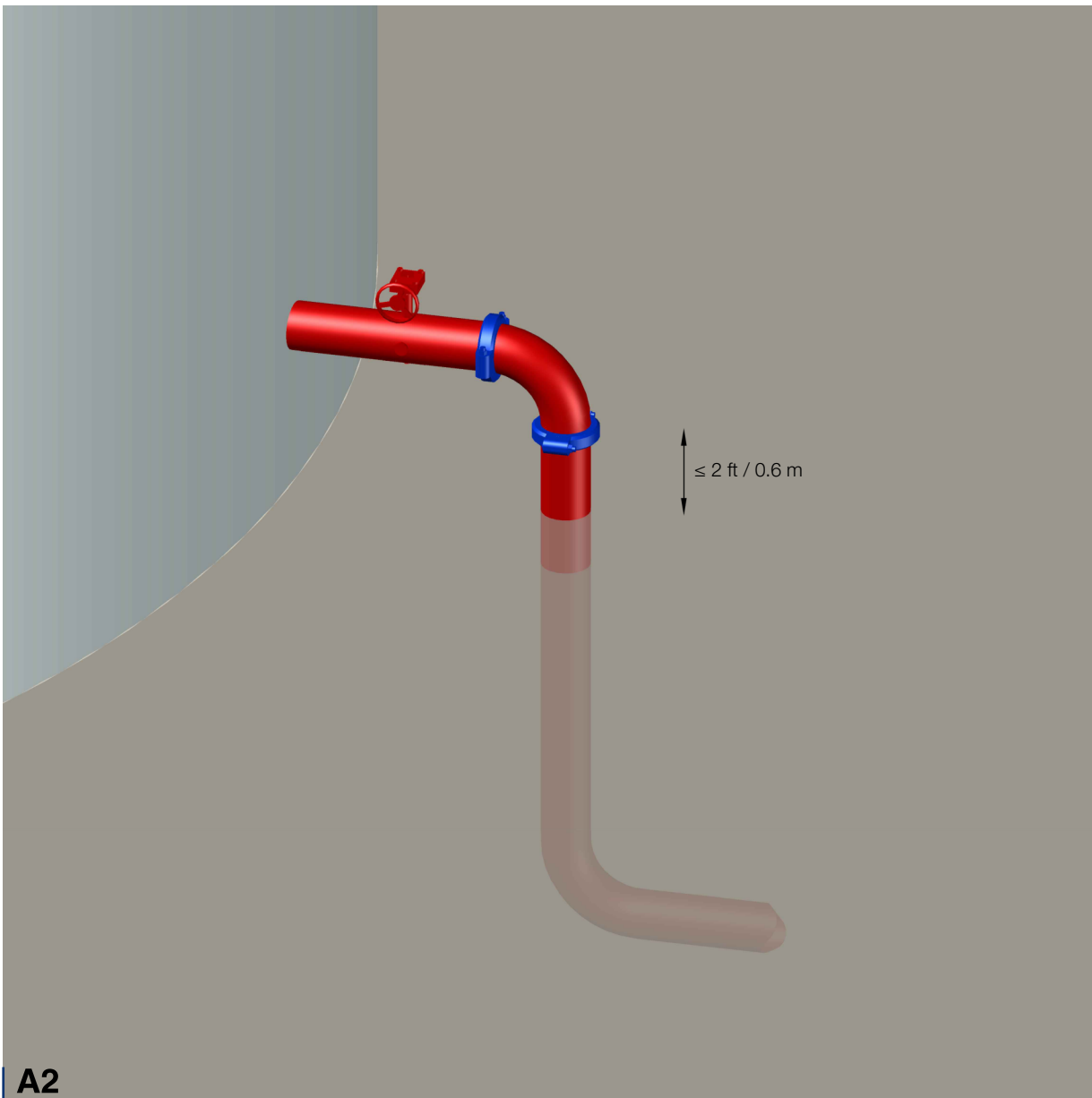
The table below gives the maximum length L_{max} for braces made of steel pipe based on the schedule and the nominal diameter of the pipe used:

NOMINAL DIAMETER (mm)	NOMINAL DIAMETER (inch)	LEAST RADIUS OF GYRATION r (mm)[in]	L max (m) [ft] SLENDERNESS 100	L max (m)[ft] SLENDERNESS 200	L max (m)[ft] SLENDERNESS 300
Schedule 10					
25	1	10.9 [0.43]	1.1 [3.61]	2.2 [7.22]	3.3 [10.83]
32	1 1/4	14.0 [0.55]	1.4 [4.59]	2.8 [9.19]	4.2 [13.78]
40	1 1/2	16.1 [0.63]	1.6 [5.25]	3.2 [10.50]	4.8 [15.75]
50	2	20.4 [0.80]	2.0 [6.56]	4.1 [13.45]	6.1 [20.01]
Schedule 30					
25	1	10.5 [0.41]	1.0 [3.28]	2.1 [6.89]	3.1 [10.17]
32	1 1/4	13.5 [0.53]	1.4 [4.59]	2.7 [8.86]	4.1 [13.45]
40	1 1/2	15.6 [0.61]	1.6 [5.25]	3.1 [10.17]	4.7 [15.42]
50	2	19.7 [0.78]	2.0 [6.56]	3.9 [12.80]	5.9 [19.36]
Schedule 40					
25	1	10.7 [0.42]	1.1 [3.61]	2.1 [6.89]	3.2 [10.50]
32	1 1/4	13.7 [0.54]	1.4 [4.59]	2.7 [8.86]	4.1 [13.45]
40	1 1/2	15.8 [0.62]	1.6 [5.25]	3.2 [10.50]	4.7 [15.42]
50	2	20.0 [0.79]	2.0 [6.56]	4.0 [13.12]	6.0 [19.69]

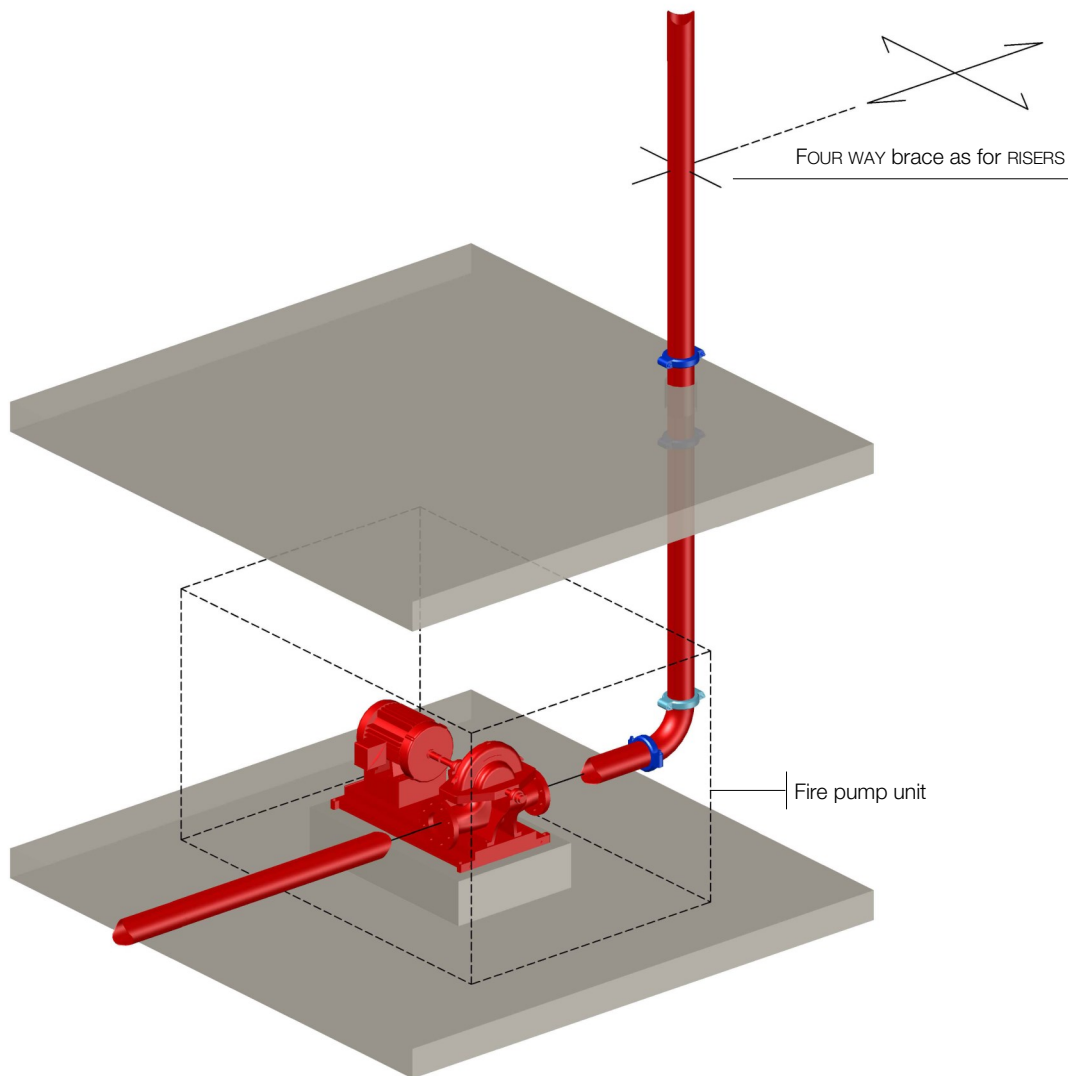


**A1****GROUND-SUPPORTED, FLAT-BOTTOM STEEL TANKS****(2.2.6.1.3.A)**

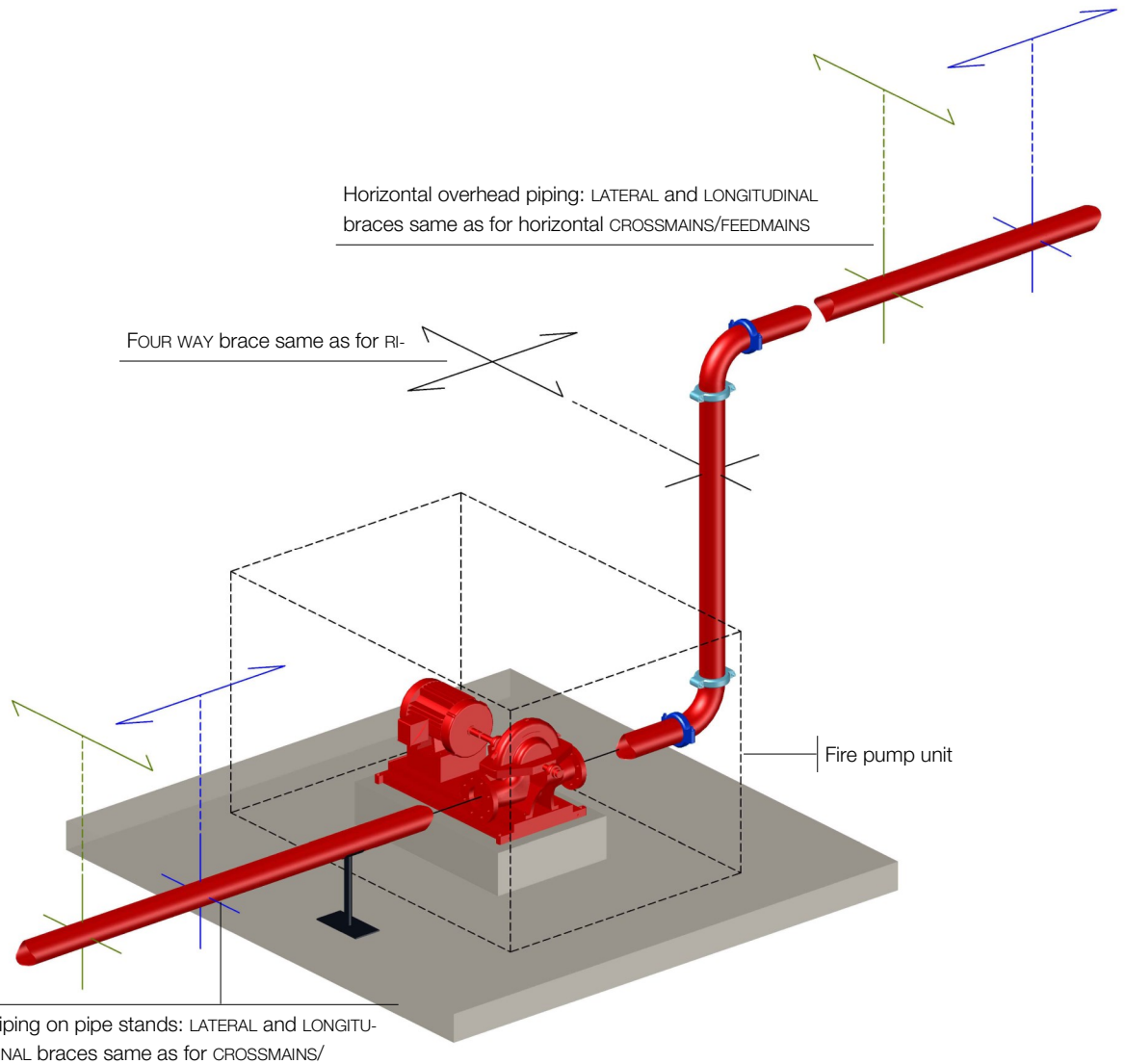
For anchored tanks, when the tank discharge pipe runs horizontally to a pump, provide two flexible couplings on the pipe between the tank and the pump. Locate one as close to the tank wall as possible and the other within 2 ft / 0.6 m of the pump.

**A2****GROUND-SUPPORTED, FLAT-BOTTOM STEEL TANKS****(2.2.6.1.3.B)**

For anchored tanks, when the tank discharge pipe feeds into an underground main, provide two flexible couplings between the tank and the ground entrance. Locate one as close to the tank wall as possible. Locate the other within 2 ft / 0.6 m of the ground entrance.

**B1****SWAY BRACING FOR RISERS AFTER PUMPS****(2.2.5.1.1)**

Provide FOUR-WAY sway bracing the same as for sprinkler system RISERS for any vertical RISER piping that extends from the pump to discharge through the ceiling to floors above (see section R of this handbook).

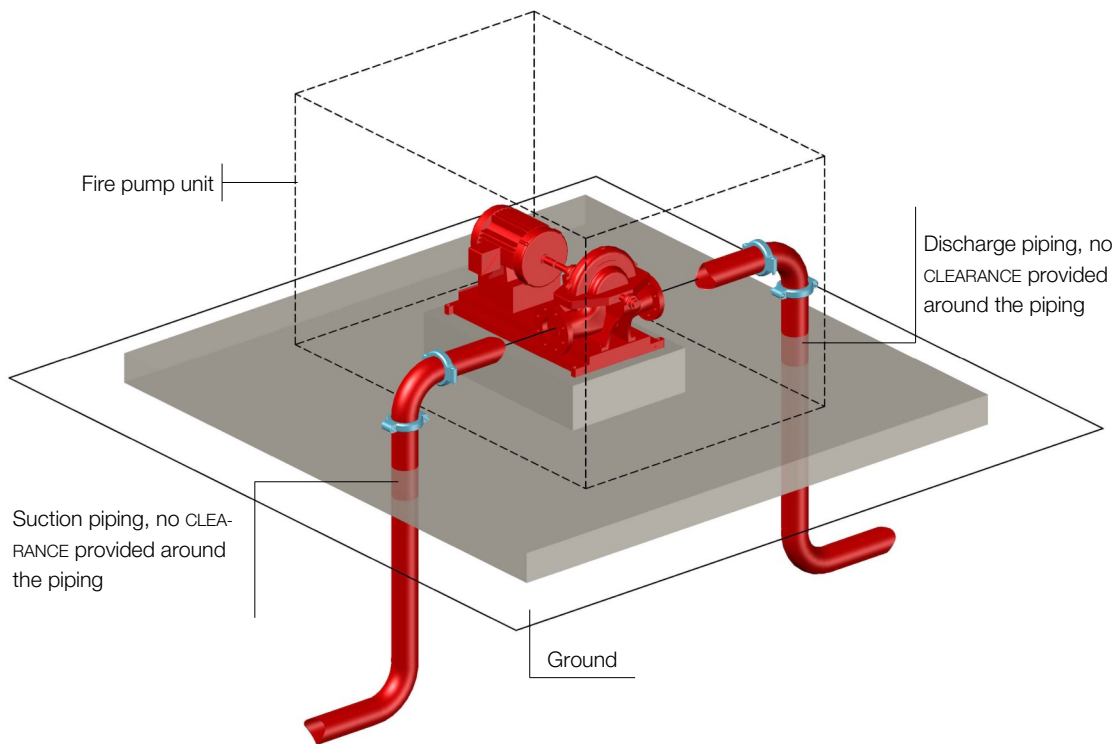


B2

SWAY BRACING FOR ALL HORIZONTAL PIPING

(2.2.5.1.2)

Provide horizontal overhead piping and piping on pipe stands with LATERAL and LONGITUDINAL sway bracing. Design sway bracing on the same basis as for sprinkler system piping. Make attachments for the sway bracing at structural elements capable of carrying the seismic loads. (see sections H and V of this handbook).

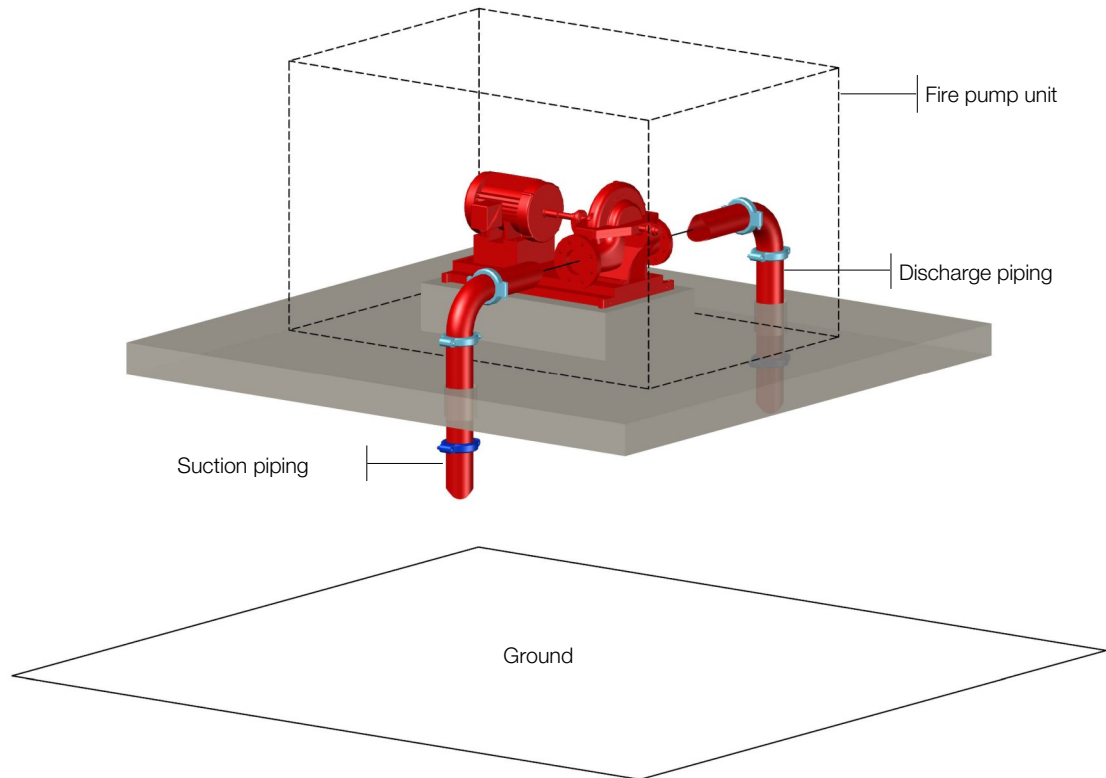


B3

FLEXIBILITY NEEDED FOR SUCTION AND DISCHARGE PIPING—SLAB ON GROUND

(2.2.5.2.1.A)

When the pump house rests directly on the ground and suction or discharge piping enters or exits through the floor, and no CLEARANCE around the piping is provided, flexible couplings are unnecessary because the pump house floor is not expected to move differentially from the ground.



B4

FLEXIBILITY NEEDED FOR SUCTION AND DISCHARGE PIPING—SLAB ABOVE GRADE/ GROUND

(2.2.5.2.1.B)

When the fire pump and driver, including suction and discharge piping, are located above grade/ground in a building, provide flexibility on the suction and discharge piping the same as for sprinkler system piping (See sections R and H of this handbook).

Note: Here, flexibility means providing flexible couplings

FIRE PUMPS INSTALLATIONS - FURTHER INSTRUCTIONS

FLEXIBILITY

(2.2.5.2.1.C)

Flexible couplings are not needed for pipe penetrations that feed hose headers or relief valve discharge outlets on an outside wall.

(2.2.5.2.2)

Provide flexibility on fuel line connections to both the fire pump drivers and the fuel tanks that supply fire pump drivers.

(2.2.5.2.3)

Flexibility for other equipment is usually unnecessary if proper anchorage and/or restraint against horizontal or vertical motion exists.

CLEARANCE

(2.2.5.3.1)

Provide CLEARANCE per section 2.2.1.5.1 around piping penetrations through walls, platforms, mezzanines, roofs, and floors. (see Section C of this handbook)

ANCHORAGE

(2.2.5.4.1)

Anchor the base plates for the fire pump and driver to the pump house floor.

(2.2.5.4.2)

Anchor the controller to the floor and/or to the wall to prevent damage to the controller itself, and to prevent breakage of piping or electrical connections between the controller and other equipment due to differential movements.

(2.2.5.4.3)

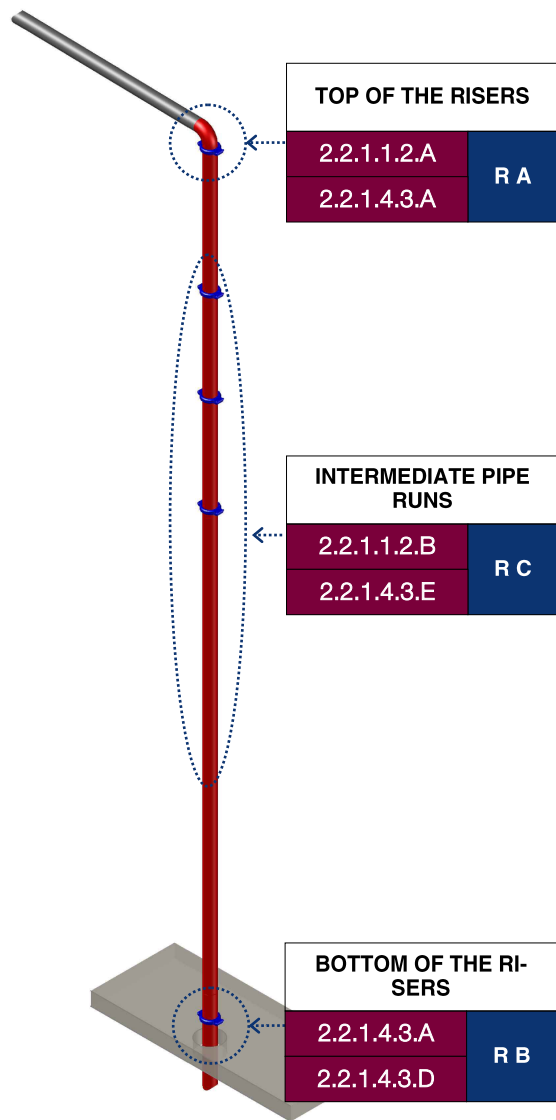
Anchor the fuel tanks for internal combustion engines to the support frames, if any, or directly to the supporting floor and/or wall. Brace the support frames to prevent buckling of the legs and also anchor the frames.

(2.2.5.4.4)

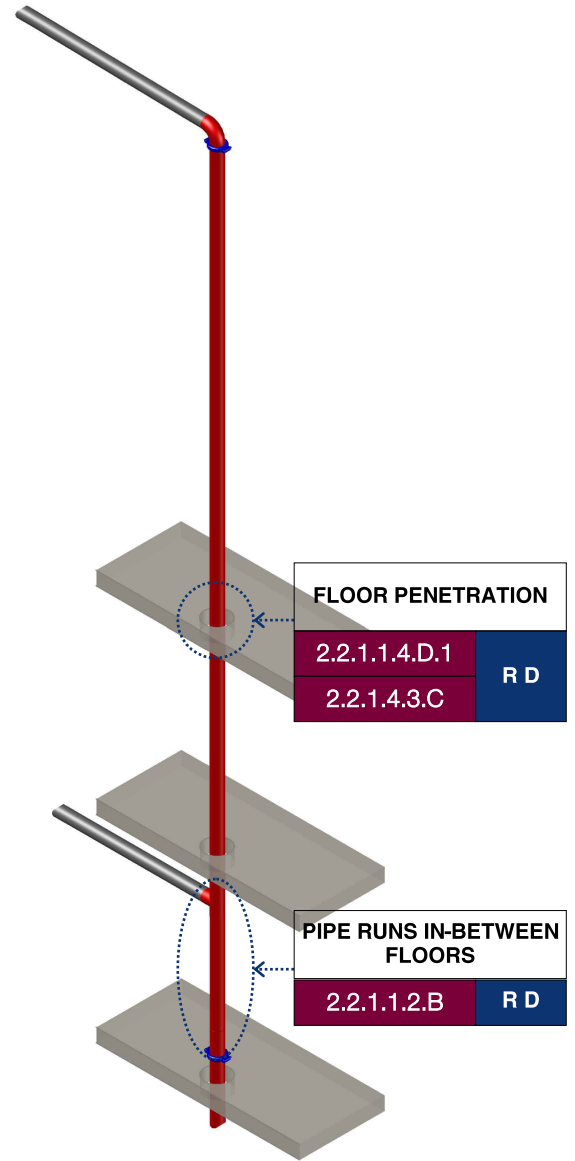
For internal combustion engines, restrain the starter battery sets, brace the battery racks to prevent buckling of the legs, and anchor the battery racks to prevent sliding and/or overturning that could damage the connections between batteries or from the battery set to the engine.

(2.2.5.4.5)

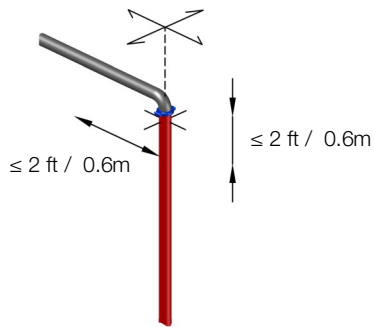
Anchor any other unrestrained equipment in the pump house if it exposes any of the fire pump equipment to damage from impact due to uncontrolled differential movement such as sliding, overturning, or swinging.



RISERS WITHOUT FLOOR PENETRATIONS

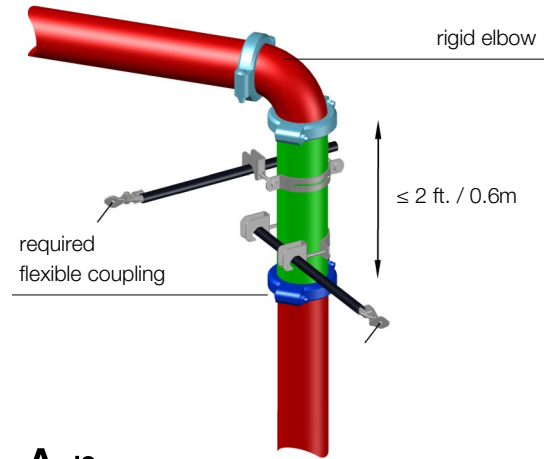
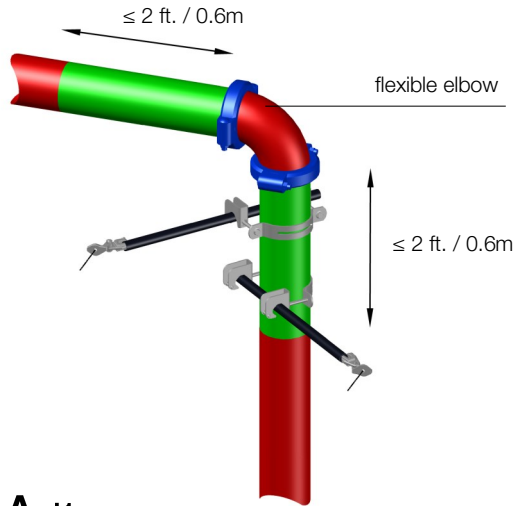


RISERS PENETRATION FLOORS (MULTISTORY BUILDINGS)

**A****TOP OF THE RISER****(2.2.1.1.2.A; 2.2.1.4.3.A)**

Provide a FOUR-WAY within 2 ft / 0.6 m of the top of the RISER.

For risers directly connected to underground piping, provide a flexible coupling within 2 ft / 0.6 m of the top of each individual RISERS. This applies to risers located outside and inside buildings.



A d1

A d2

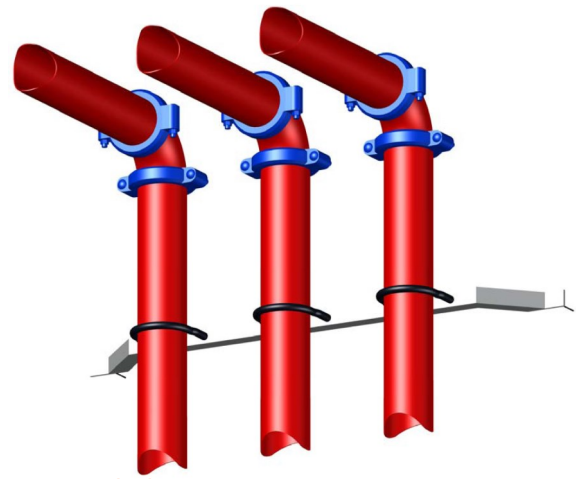
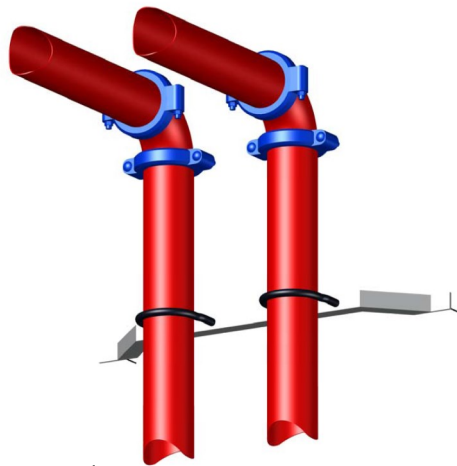
BRACE WITH FLEXIBLE OR RIGID COUPLINGS AT TOP OF THE RISER

(2.2.1.1.2.A; 2.2.1.4.3.A)

Provide a FOUR-WAY sway brace within 2 ft / 0.6 m of the top of the RISER. The FOUR-WAY brace may be located either on the RISER or on the main (see green pipe location in A1).

For risers directly connected to underground piping, provide a flexible coupling within 2 ft / 0.6 m of the top of each individual RISER. This applies to risers located outside and inside buildings.

Generally speaking a FOUR-WAY brace goes within 2 ft / 0.6 m from a flexible coupling on the RISER.



A d3 ✓

A d4 ✗

TOP OF MULTIPLE ADJACENT RISERS: NO MORE THAN 2 ADJACENT RISERS ARE ALLOWED

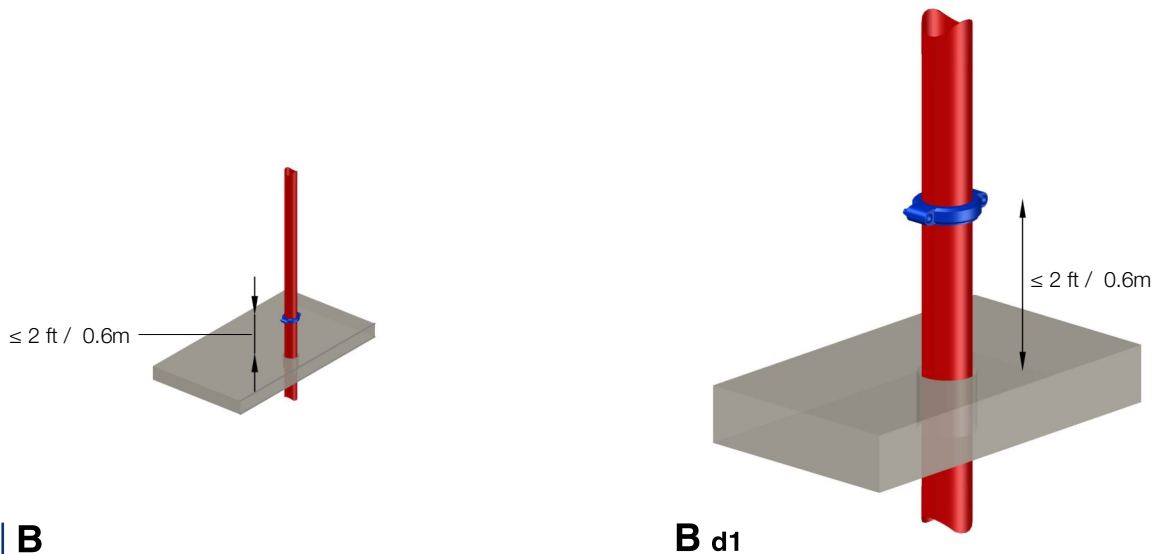
(2.2.1.1.2.A)

When possible, avoid the use of manifolded FOUR-WAY sway bracing at the top of multiple adjacent RISERS.

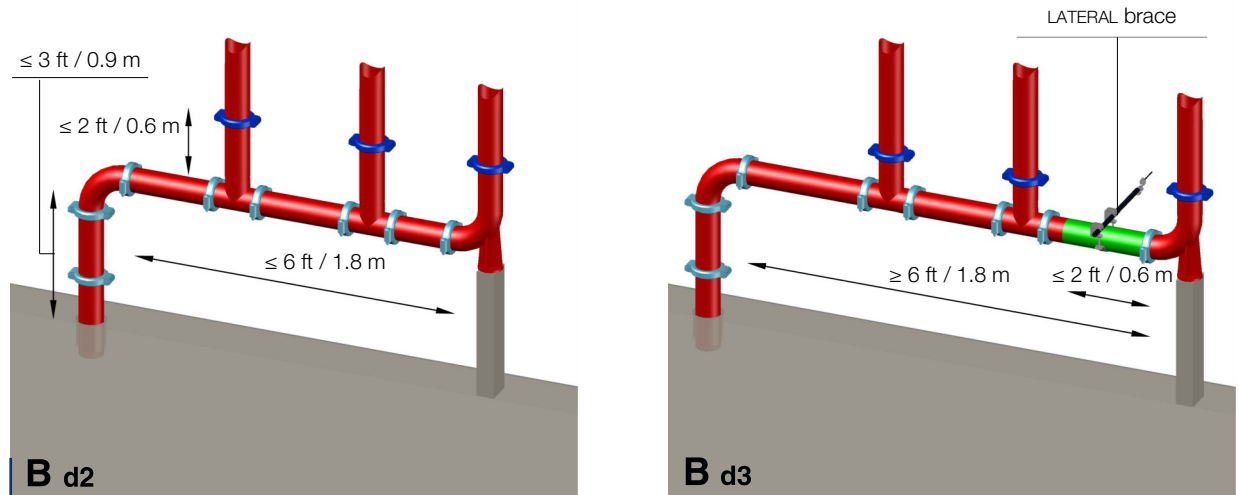
If used, limit the manifolded arrangement to two RISERS, and design an engineered FOUR-WAY bracing system to carry the total loads for both RISERS.

Note: individual FOUR-WAY sway braces are an acceptable solution.



**B****B d1****BOTTOM OF THE RISER****(2.2.1.4.3.A; 2.2.1.4.3.D)**

For RISERS directly connected to underground piping, provide a flexible coupling within 2 ft / 0.6 m of the bottom of each individual riser. This applies to RISERS located outside and inside buildings.

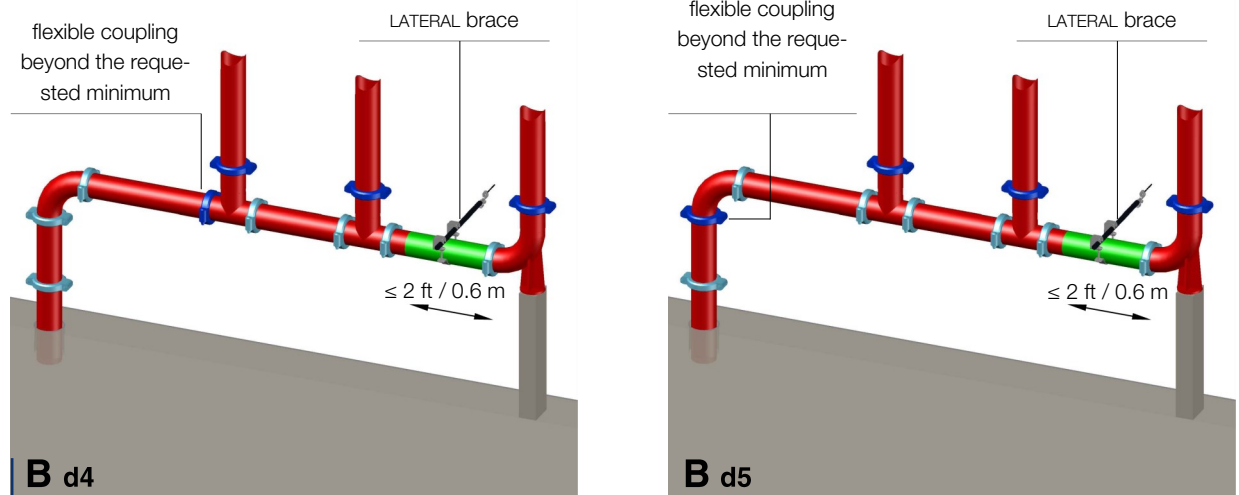


MANIFOLDED RISERS

(2.2.1.1.2.C; 2.2.1.4.3.B)

When multiple RISERS are supplied by a single MANIFOLD connection to an underground MAIN, provide each RISER with a flexible coupling at the top, and a flexible coupling at the bottom where connected to the MANIFOLD within 2 ft / 0.6 m of the horizontal piping. The horizontal MANIFOLD piping must be located no more than 3 ft / 0.9 m above floor level. The horizontal MANIFOLD must be connected to the main RISER coming from the underground supply at floor level via flanged or other rigid connections. Where welded piping systems exist from the riser through the crossmains, the flexible coupling at the top of the riser may be omitted.

If the section of horizontal pipe is longer than 6ft / 1.8m, place a LATERAL brace within 2 ft / 0.6m of the end of the horizontal section.

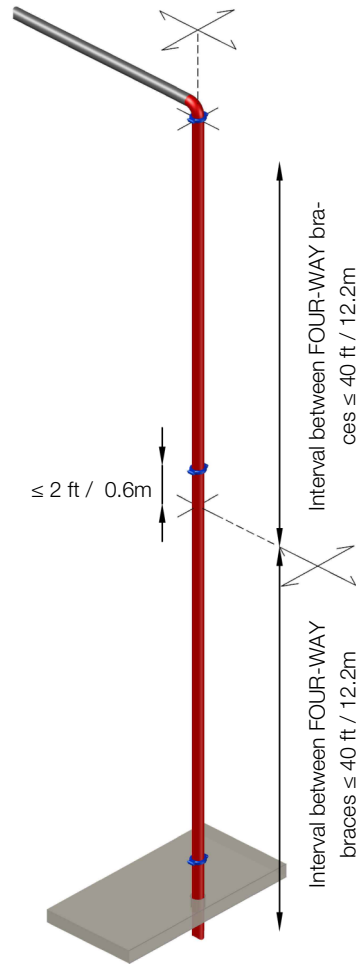
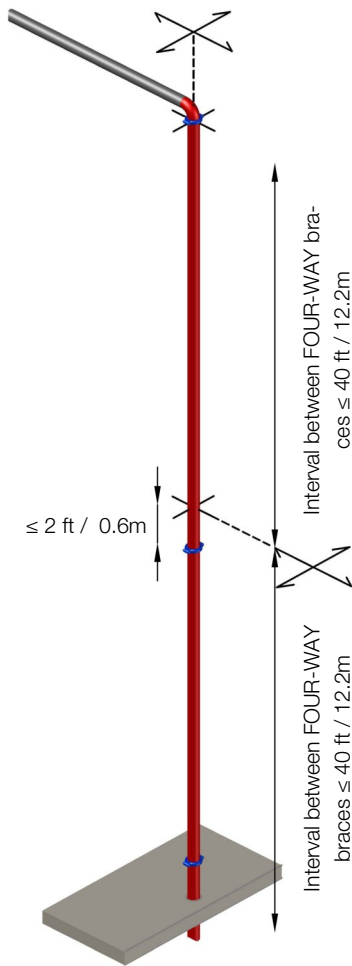


MANIFOLDED RISERS: FLEXIBLE COUPLING(S) BEYOND THE REQUESTED MINIMUM

(2.2.1.1.2.C; 2.2.1.4.3.B)

When there is one or more flexible coupling(s) on either the horizontal manifold piping (B₄) or along the vertical pipe section between the floor and the connection with the horizontal portion (B₅), place a LATERAL sway brace within 2 ft / 0.6m of the end of the horizontal section of the pipe.





C1

C2

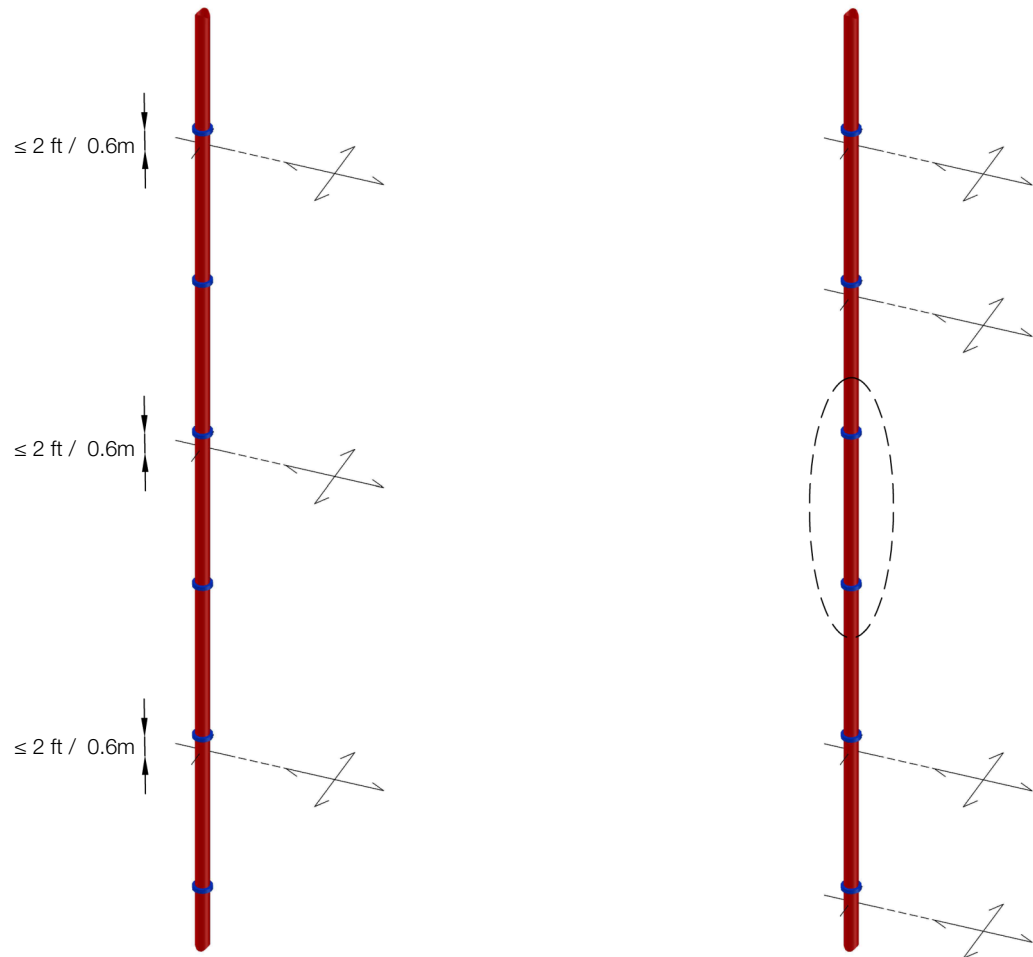
RISERS: INTERMEDIATE PIPING

(2.2.1.1.2.B; 2.2.1.4.3.E)

Position intermediate FOUR-WAY sway bracing at an interval not to exceed 40 ft / 12.2m.

Provide a flexible coupling within 2 ft / 0.6 m above or below any intermediate points of lateral restraint for RISERS.

Where welded piping systems exist from the RISER through the CROSSMAINS, these flexible couplings may be omitted.



C3 ✓

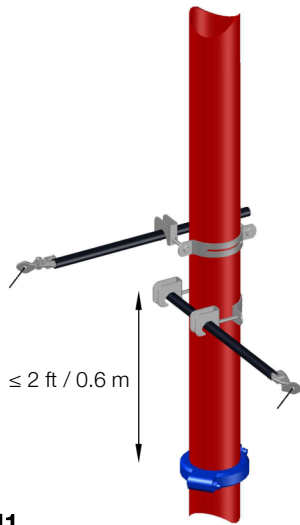
C4 ✗

FLEXIBLE COUPLINGS WITHIN INTERMEDIATE PIPING

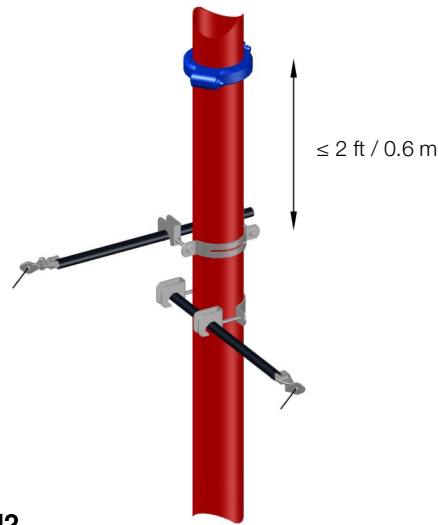
(2.2.1.1.2.B)

When flexible couplings are used on risers, provide FOUR-WAY sway bracing so a brace is provided within 2 ft / 0.6 m of every other flexible coupling.

Correct solution: C₂; Incorrect solution: C₃.



C1 d1



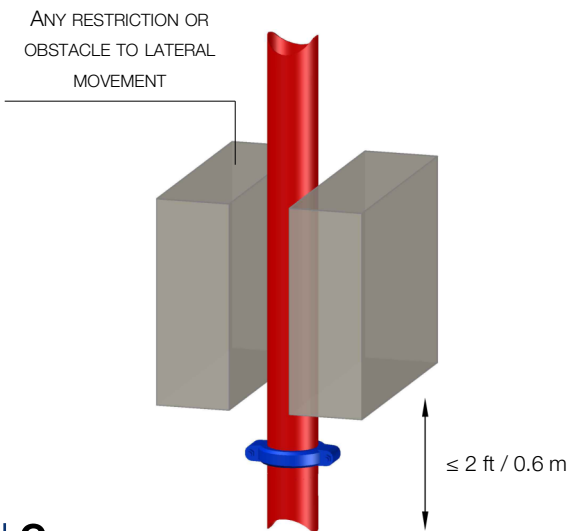
C1 d2

RISERS: INTERMEDIATE PIPING

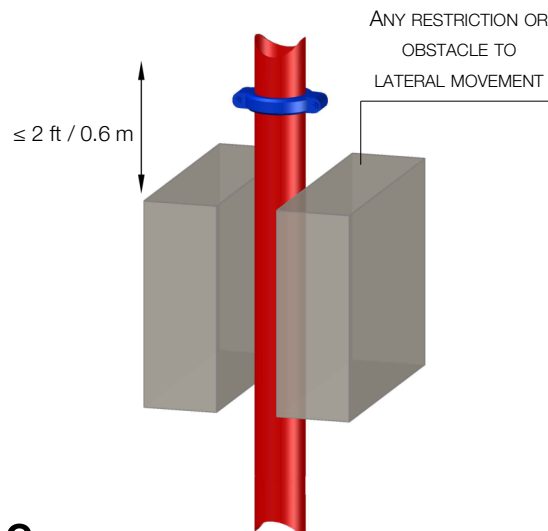
(2.2.1.1.2.B; 2.2.1.4.3.E)

Position intermediate FOUR-WAY sway bracing at an interval not to exceed 40 ft / 12.2 m. FOUR-WAY sway bracing consists of two LATERAL braces.

Provide a flexible coupling within 2 ft / 0.6 m below or above the intermediate FOUR-WAY sway bracing as the four-way bracing constitutes an intermediate point of lateral restraint for the risers.



C2 d1



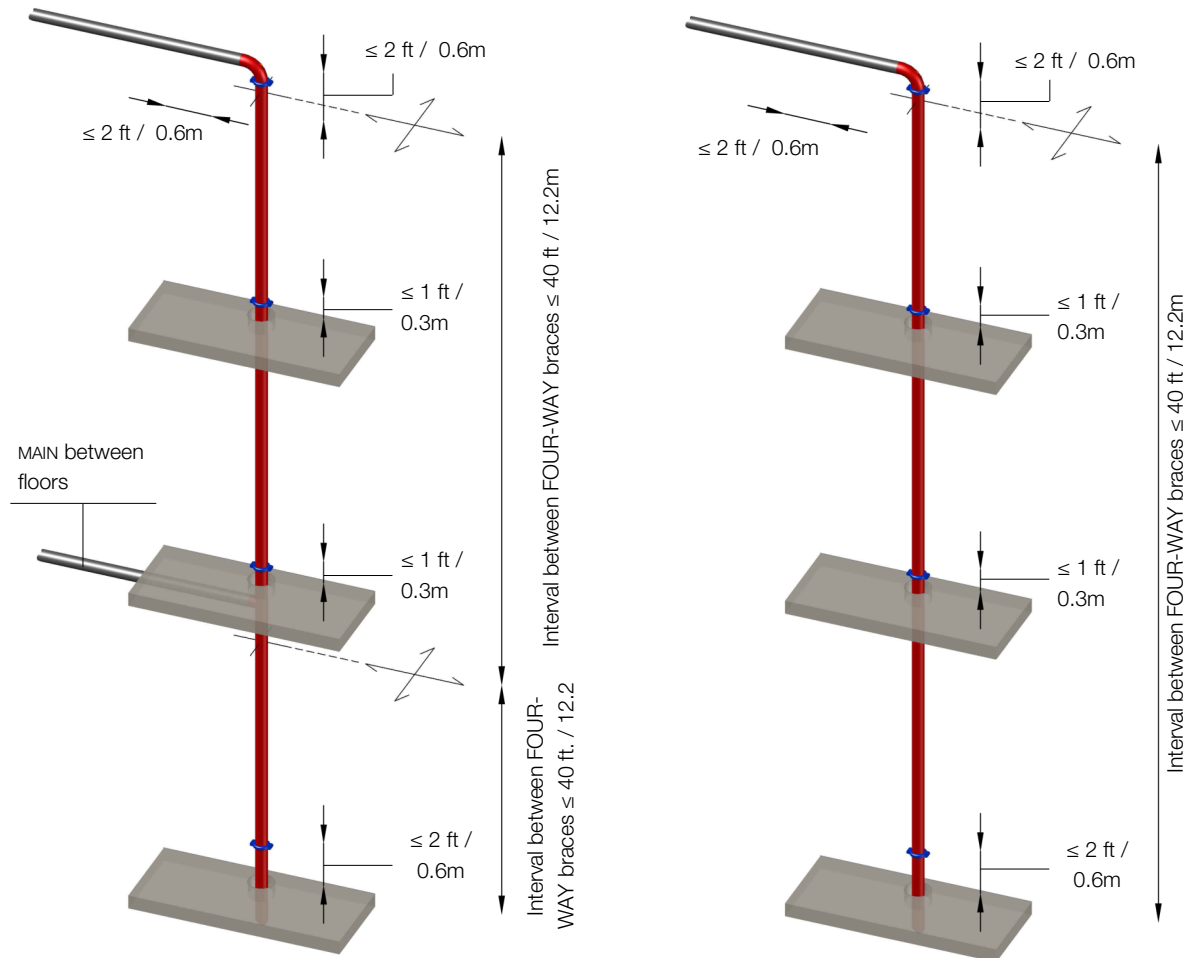
C2 d2

RISERS: INTERMEDIATE POINTS OF LATERAL RESTRAINT

(2.2.1.4.3.E)

Provide a flexible coupling within 2 ft / 0.6 m above or below any intermediate points of lateral restraint for RISERS.

Where welded piping systems exist from the RISER through the CROSSMAINS, these flexible couplings may be omitted.



D1

D2

MULTISTORY BUILDINGS WITH AND WITHOUT SUPPLY MAIN BETWEEN FLOORS

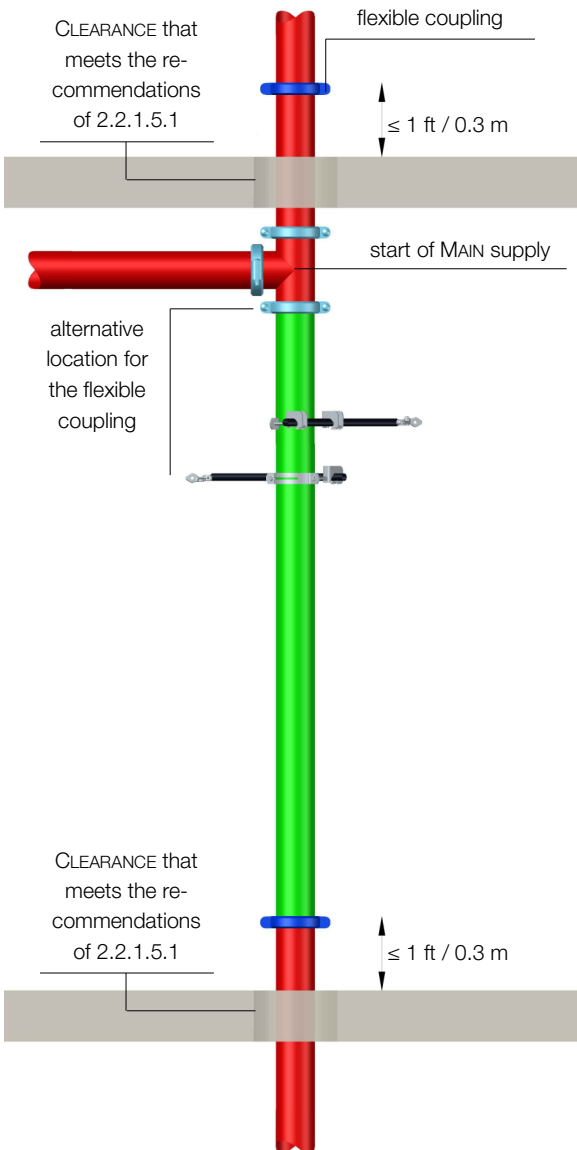
(2.2.1.1.2.B; 2.2.1.4.3.C)

In multistory buildings, provide a FOUR-WAY at each floor having a supply MAIN.

When a RISER passes through a structural floor, and CLEARANCES do not exceed the minimums per 2.2.1.5, a FOUR-WAY brace is considered to exist at this point (i.e. the floor is the four-way brace).

Provide intermediate FOUR-WAY way bracing at an interval not to exceed 40 ft / 12.2 m.

For multistory building RISERS where CLEARANCES meet the recommendations of 2.2.1.5.1, an additional flexible coupling is needed at each floor level within 1ft / 0.3 m of the floor (either above or below the floor).

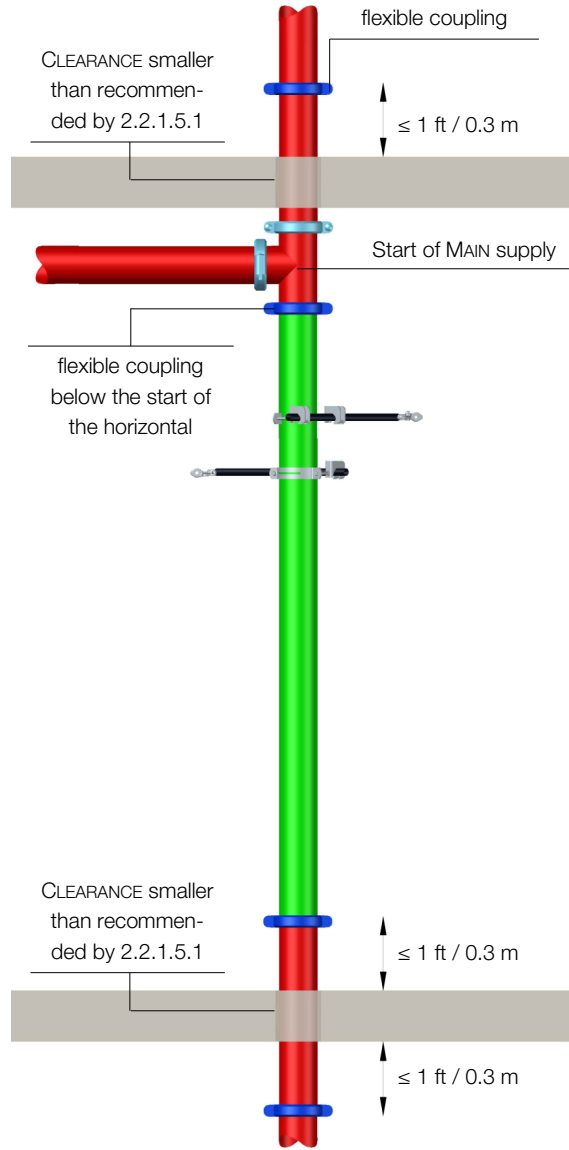
**D1 d1**

MULTISTORY BUILDINGS: START OF MAIN SUPPLY; CLEARANCE MEETS THE RECOMMENDATIONS OF 2.2.1.5.1 (2.2.1.4.3.C)

In multistory buildings, place a FOUR-WAY brace along the RISER at each floor where there is a MAIN.

FOR RISERS servicing multistory buildings, where clearances meet the recommendations of 2.2.1.5.1, provide an additional flexible coupling at each floor level within 1 ft / 0.3 m either above or below the floor.

When locating the flexible coupling below the floor, in the case of a MAIN supply under a floor, locate the flexible coupling below that MAIN (regardless of the distance from the floor above).

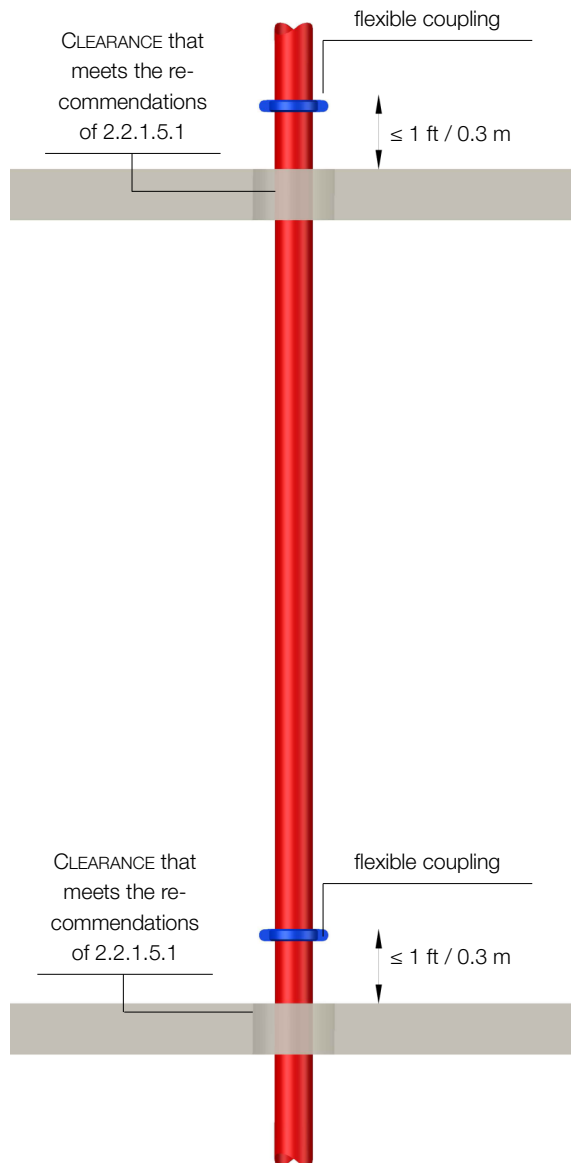
**D1 d2**

MULTISTORY BUILDINGS: START OF MAIN SUPPLY; CLEARANCE SMALLER THAN THE RECOMMENDATIONS OF 2.2.1.5.1 (2.2.1.1.2.B; 2.2.1.4.3.C)

In multistory buildings, place a FOUR-WAY brace along the RISER at each floor where there is a MAIN.

For RISERS servicing multistory buildings, where clearances do not meet the recommendations of 2.2.1.5.1, provide additional flexible couplings at each floor level within 1 ft / 0.3 m above and below the floor.

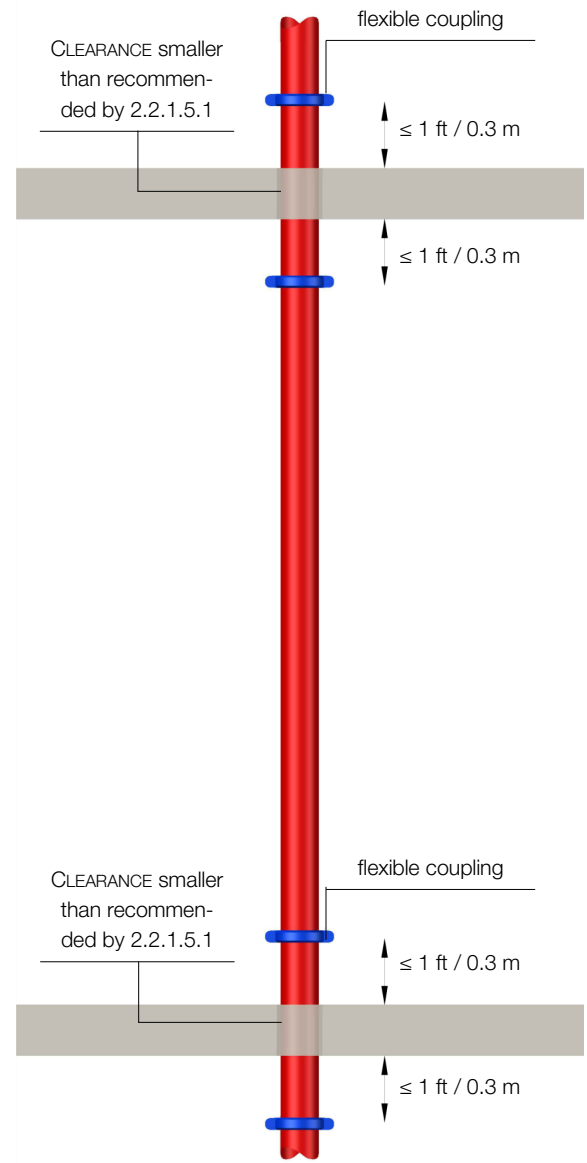
In the case of a MAIN supply under a floor, locate the flexible coupling below that MAIN (regardless of the distance from the floor).

**D2 d1**

MULTISTORY BUILDINGS: CLEARANCE MEETS THE RECOMMENDATIONS OF 2.2.1.5.1

(2.2.1.4.3.C)

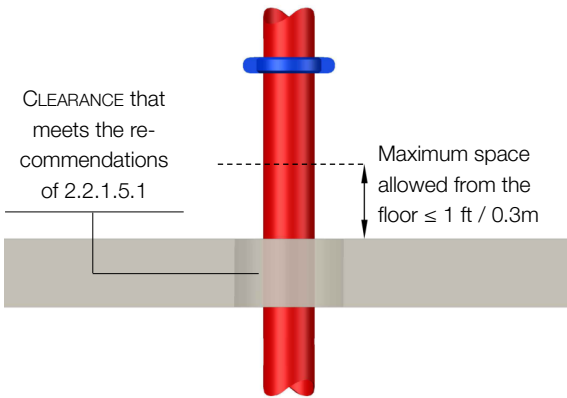
For RISERS servicing multistory buildings, where CLEARANCES meet the recommendations of 2.2.1.5.1, provide a flexible couplings at each floor level within 1 ft / 0.3 m either above or below the floor.

**D2 d2**

MULTISTORY BUILDINGS: CLEARANCE SMALLER THAN THE RECOMMENDATIONS OF 2.2.1.5.1

(2.2.1.4.3.C)

For RISERS servicing multistory buildings, where CLEARANCES do not meet the recommendations of 2.2.1.5.1, provide additional flexible couplings at each floor level within 1 ft / 0.3 m above and below the floor.

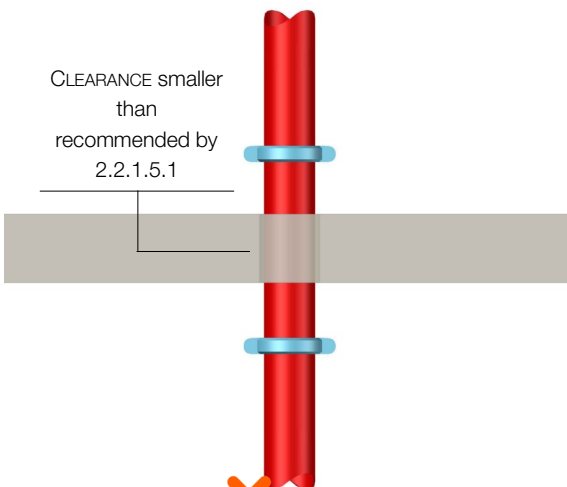


D1 d3 - D2 d3 ❌

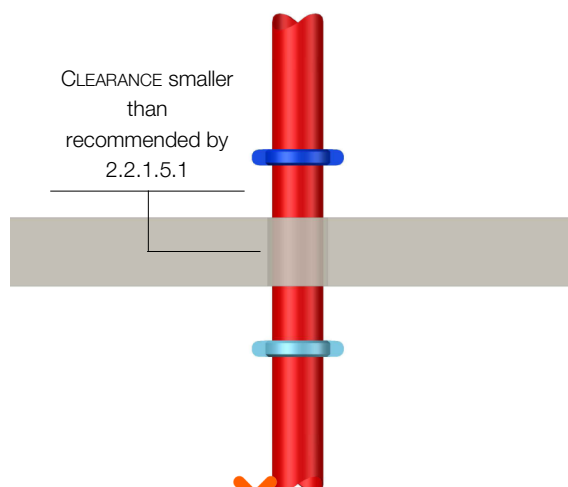
MULTISTORY BUILDINGS - INCORRECT SOLUTIONS: FLEXIBLE COUPLING BEYOND THE MAXIMUM ALLOWED DISTANCE FROM THE FLOOR

(2.2.1.4.3.C)

The CLEARANCE at the crossing of the floor meets the minimum required by 2.2.1.5.1, but the flexible coupling has been positioned at a distance of more than 1 ft / 0.3 m from the floor.



D1 d4 - D2 d4 ❌

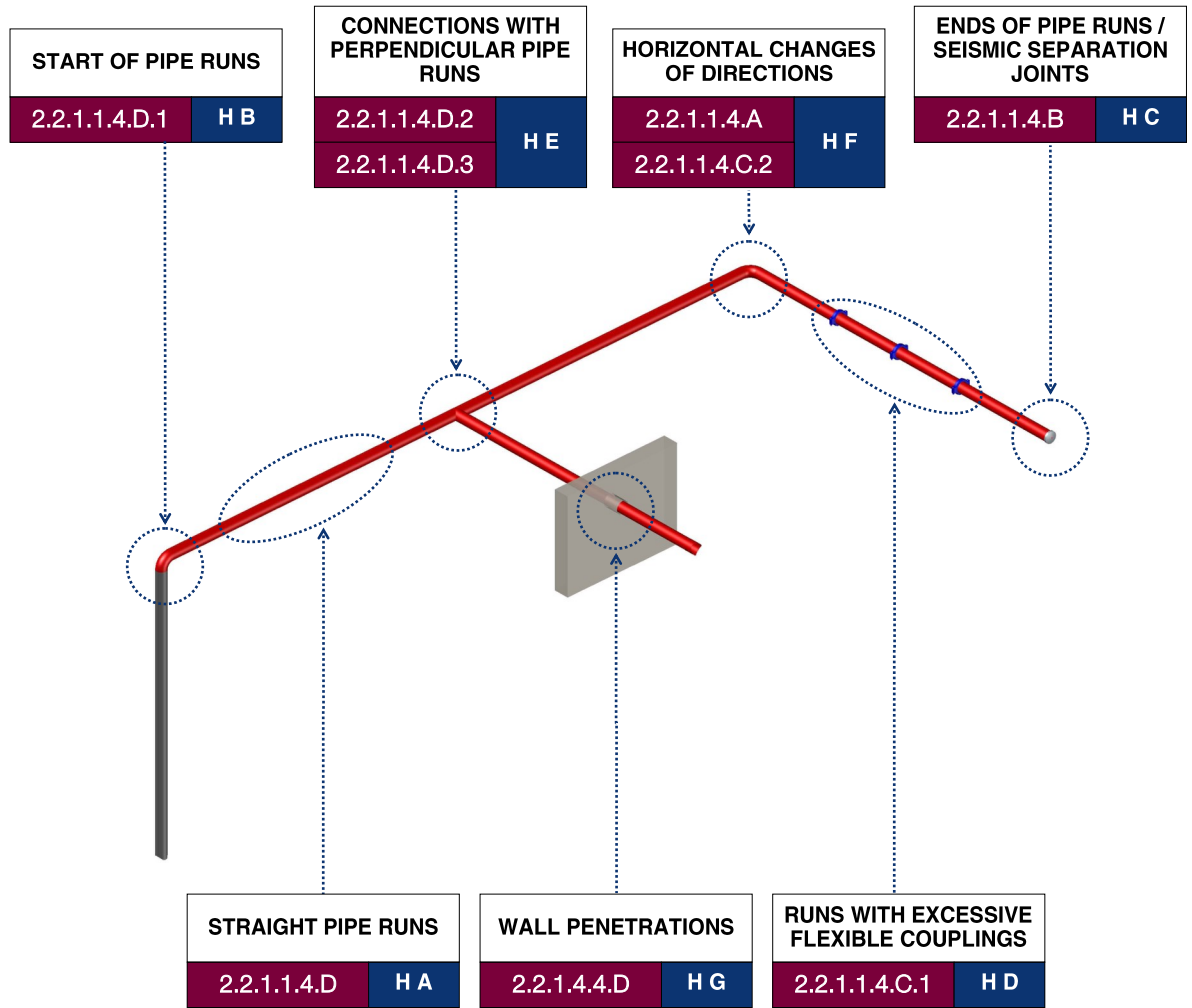


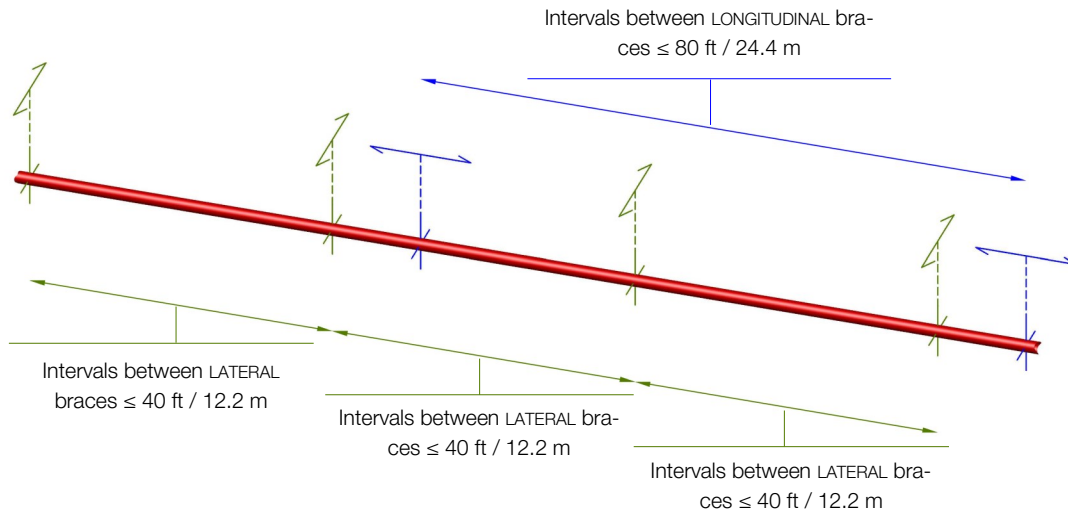
D1 d5 - D2 d5 ❌

MULTISTORY BUILDINGS - INCORRECT SOLUTIONS: FLEXIBLE COUPLING NOT USED AS REQUIRED

(2.2.1.4.3.C)

The CLEARANCE at the crossing of the floor does not meet the minimum requirement of 2.2.1.5.1 and the then mandated flexible couplings have not been provided (illustrations D₅ and D₆).





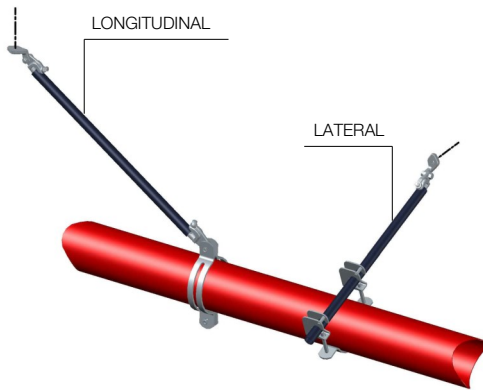
A

STRAIGHT PIPE RUNS

(2.2.1.1.4.D)

In straight runs, the SWAY BRACES must be positioned as follows:

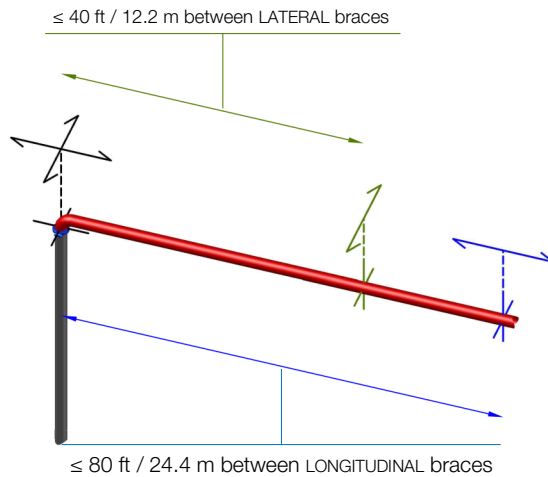
- maximum distance between two LATERAL BRACES $\leq 40 \text{ ft} / 12.2\text{m}$;
- maximum distance between two LONGITUDINAL BRACES $\leq 80 \text{ ft} / 24.4\text{m}$



A d

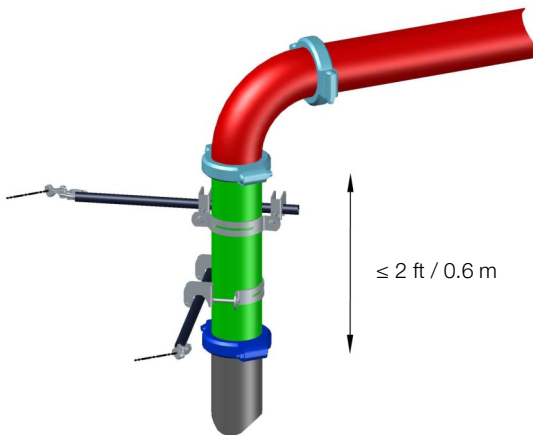
STRAIGHT PIPE RUNS

LONGITUDINAL and LATERAL SWAY BRACE.

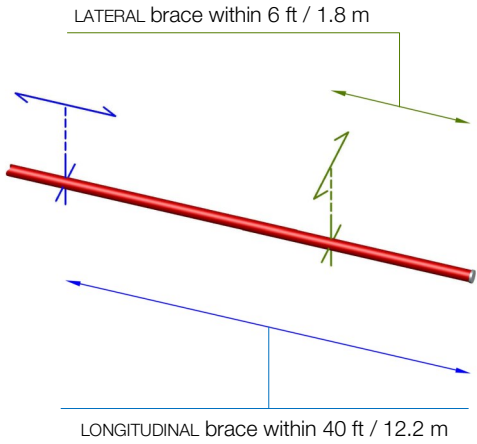
**B****STARTS OF PIPE RUNS****(2.2.1.1.4.D.1)**

A FOUR-WAY brace on a vertical pipe of the same or larger diameter than the CROSSMAIN may be counted as the initial LATERAL and as the initial LONGITUDINAL braces for the CROSSMAIN.

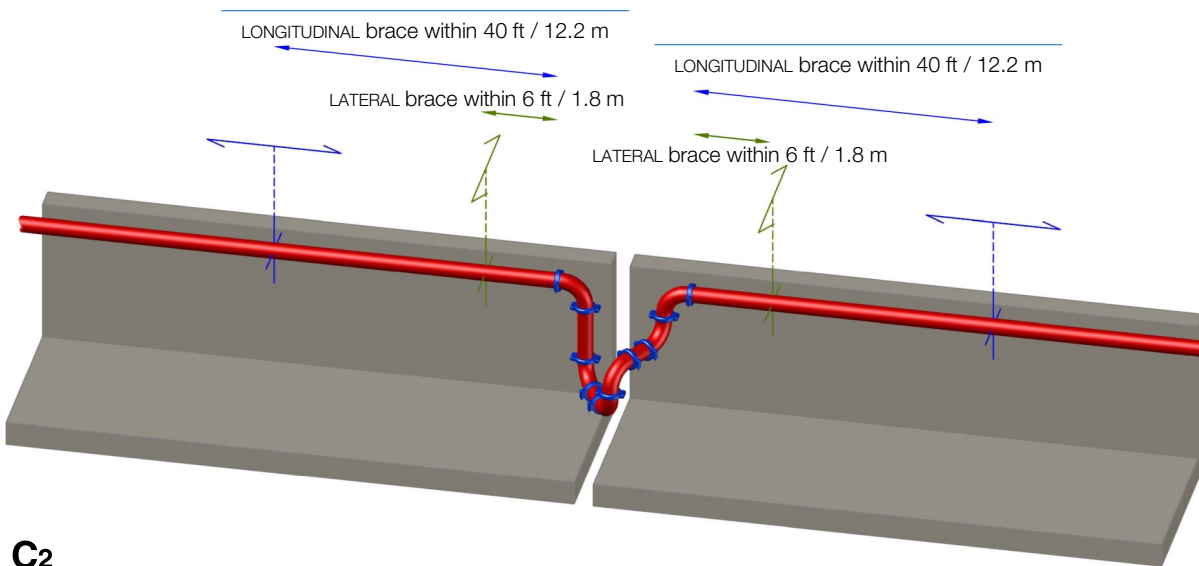
The FOUR-WAY brace must be located within 2 ft / 0.6 m of the horizontal pipe and its design load should include the tributary loads from both the vertical and the horizontal pipes.

**B d****STARTS OF PIPE RUNS: FOUR-WAY ON A VERTICAL PIPE****(2.2.1.1.4.D.1)**

A FOUR-WAY brace on a vertical FEEDMAIN/CROSSMAIN or on a RISER of the same or bigger diameter may be counted as the initial LATERAL and LONGITUDINAL brace for the attached FEEDMAIN/CROSSMAIN when the brace is located within 2 ft / 0.6 m of the horizontal pipe, if the design load for this FOUR-WAY brace includes the tributary loads from both the vertical and the horizontal pipes.



C1



C2

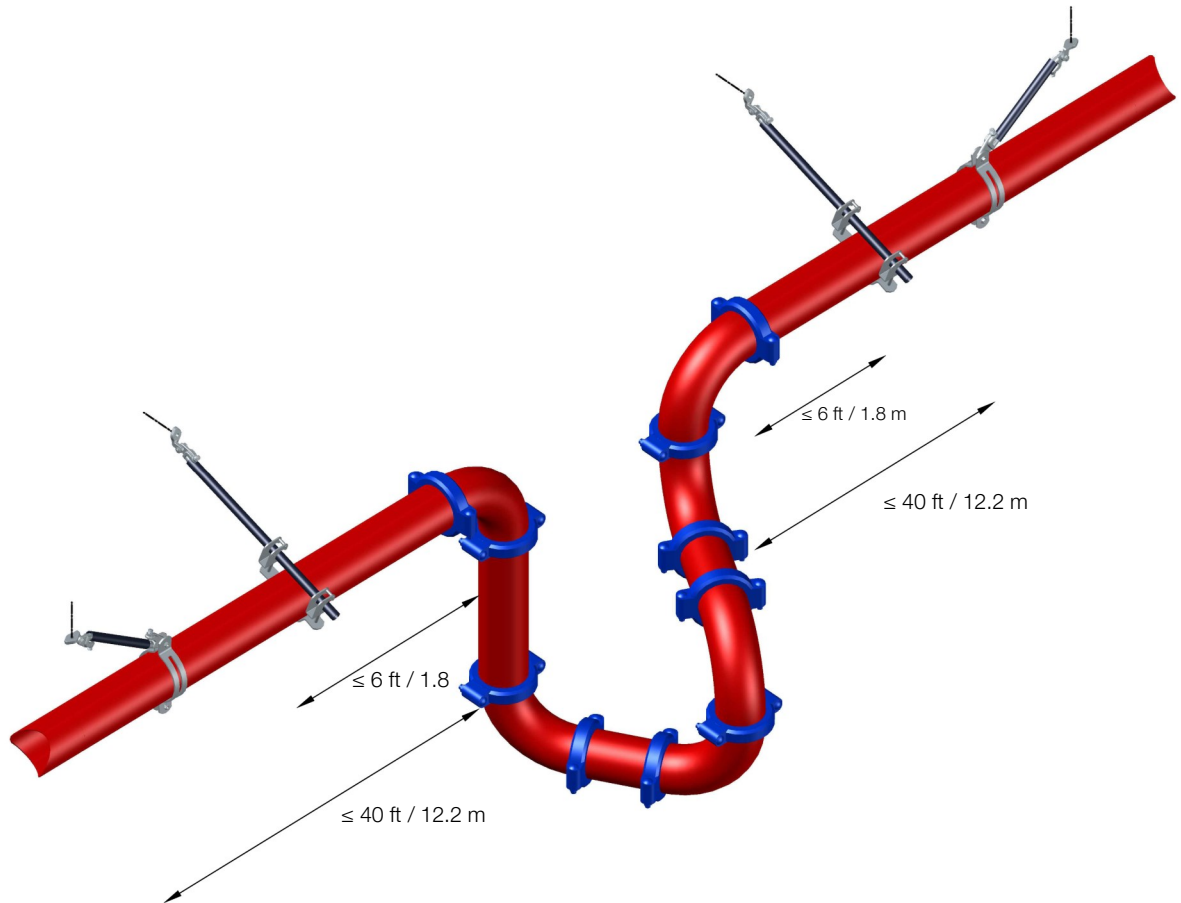
ENDS OF PIPE RUNS / SEISMIC SEPARATION JOINTS

(2.2.1.1.4.B)

At the end of a horizontal pipe run, there must be:

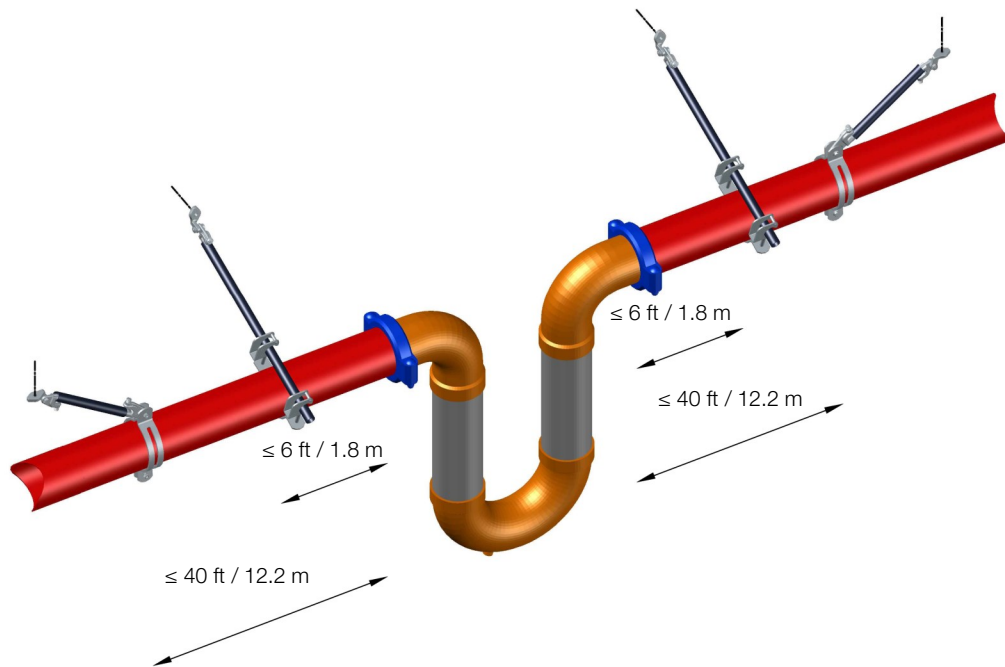
- One LATERAL brace within 6 ft / 1.8 m of the end of the pipe;
- One LONGITUDINAL brace within 40 ft / 12.2 m of the end of the pipe.

Seismic separation joints must be considered as ends of pipe.

**C2 d1****SEISMIC SEPARATION ASSEMBLY (SSA)****(2.2.1.1.4.B)**

Seismic separation assemblies are considered the end of the piping on both sides of the assembly.

Install a LATERAL sway brace within 6 ft / 1.8 m and a LONGITUDINAL sway brace within 40 ft / 12.2 m of both sides of the SEISMIC SEPARATION ASSEMBLY.



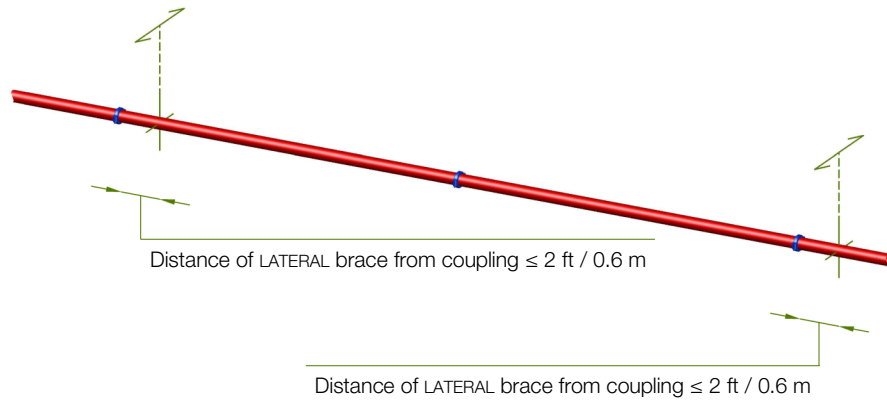
C2 d2

SEISMIC SEPARATION ASSEMBLY (SSA)

(2.2.1.1.4.B)

Seismic separation assemblies are considered the end of the piping on both sides of the assembly.

Install a LATERAL sway brace within 6 ft / 1.8 m and a LONGITUDINAL sway brace within 40 ft / 12.2 m of both sides of the SEISMIC SEPARATION ASSEMBLY.

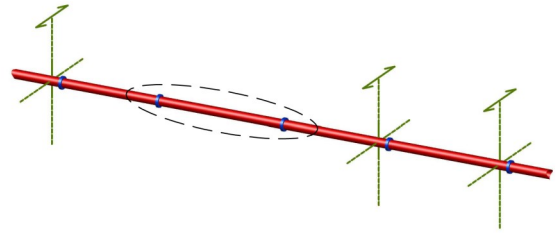
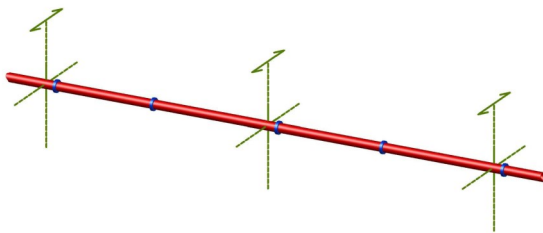


D1

RUNS WITH EXCESSIVE FLEXIBLE COUPLINGS

(2.2.1.1.4.C.1)

When more flexible couplings than recommended are installed on feedmains or crossmains, install an **additional** LATERAL brace at every other flexible coupling within 2 ft / 0.6 m of the flexible coupling.



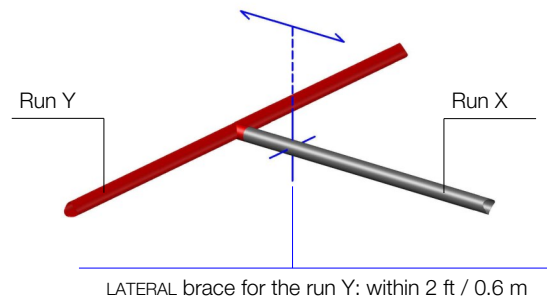
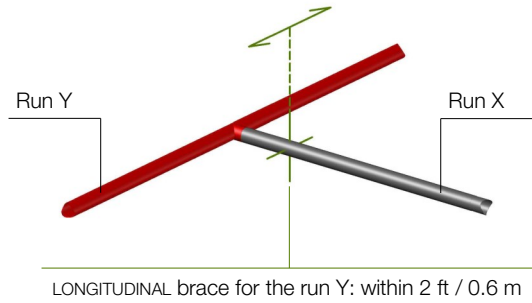
D2 ✓

D3 ✗

RUNS WITH EXCESSIVE FLEXIBLE COUPLINGS

(2.2.1.1.4.C.1)

Correct solution (D₂) and incorrect solution (D₃).



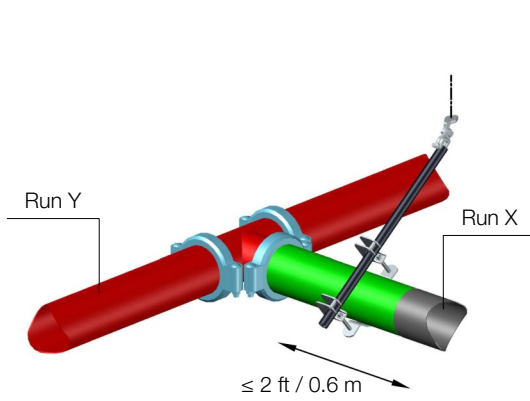
E1

E2

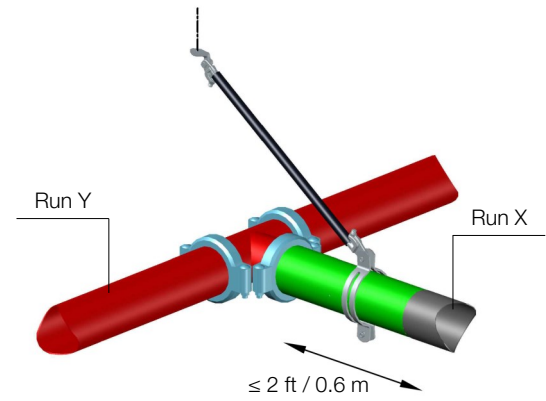
BRACING AT INTERSECTING PIPE CONNECTIONS

(2.2.1.1.4.D.2 e 2.2.1.1.4.D.3)

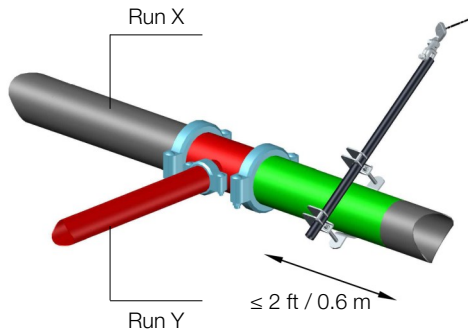
A LATERAL [LONGITUDINAL] brace within 2 ft. / 0.6 m of the end of a FEEDMAIN or CROSSMAIN piping connection (run X) to another main that is perpendicular and of the same or lesser diameter (run Y) may be used to also act as a LONGITUDINAL [LATERAL] brace for the perpendicular main.



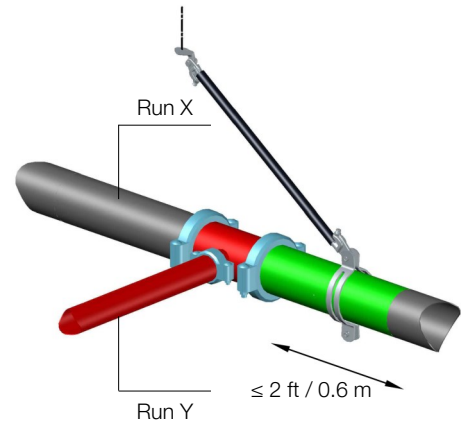
E1 d1



E2 d1



E1 d2



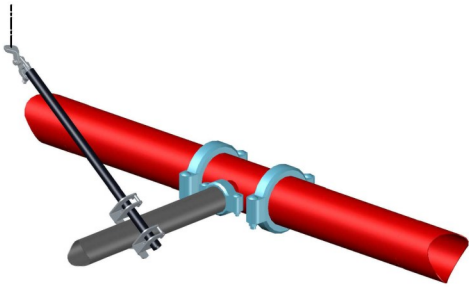
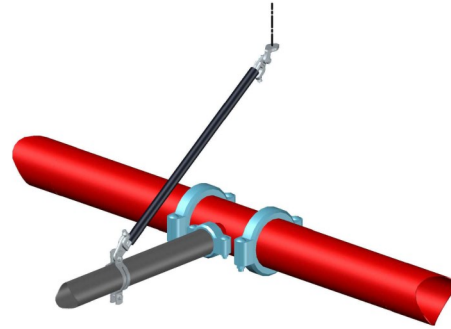
E2 d2

BRACING AT INTERSECTING PIPE CONNECTIONS

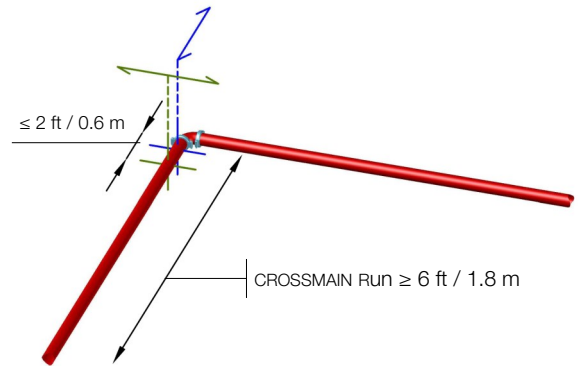
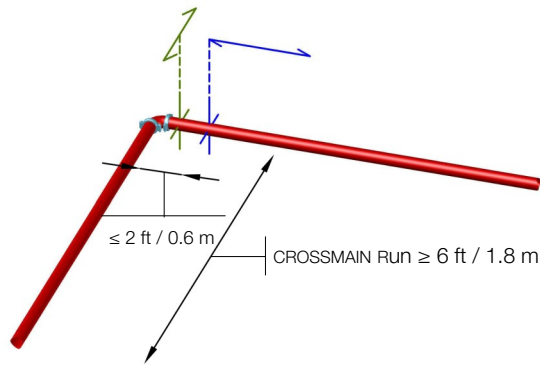
(2.2.1.1.4.D.2 e 2.2.1.1.4.D.3)

A LATERAL [LONGITUDINAL] brace within 2 ft. / 0.6 m of the end of a FEEDMAIN or CROSSMAIN piping connection (run X) to another main that is perpendicular and of the same or lesser diameter (run Y) may be used to also act as a LONGITUDINAL [LATERAL] brace for the perpendicular main.



**E1 d3** ✘**E2 d3** ✘**BRACING AT INTERSECTING PIPE CONNECTIONS: INCORRECT SOLUTIONS****(2.2.1.1.4.D.2: 2.2.1.1.4.D.3)**

Installing the SWAY BRACES on a FEEDMAIN/CROSSMAIN of smaller diameter than the one being braced is not allowed.



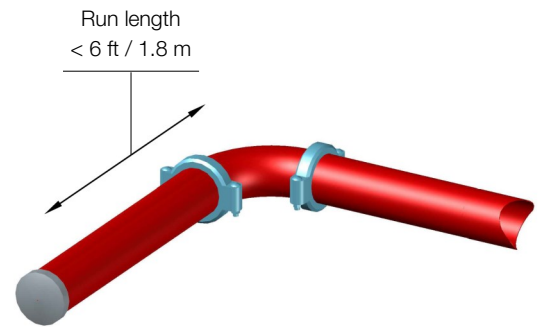
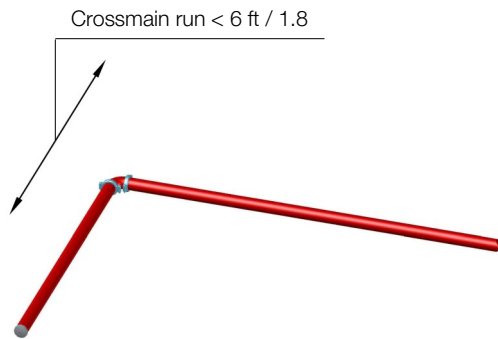
F1

F2

RUN ADJACENT TO THE CHANGE OF DIRECTION ≥ 6 ft. / 1.8 m

(2.2.1.1.4.A)

At a horizontal change of direction, when the CROSSMAIN run adjacent to the change of direction is 6 ft / 1.8 m or longer, a LATERAL and a LONGITUDINAL sway braces are required within 2 ft / 0.6 m of the change of direction.



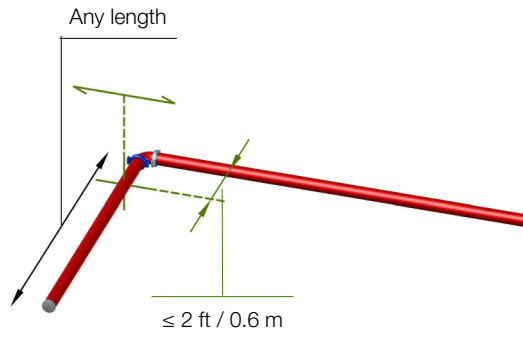
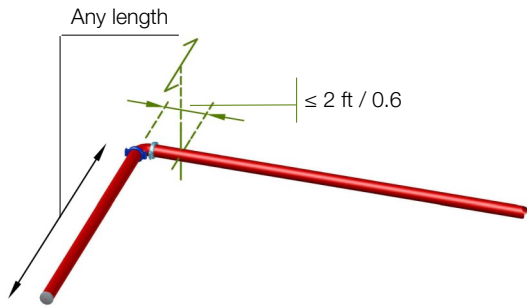
F3

RUN ADJACENT TO THE CHANGE OF DIRECTION < 6 ft. / 1.8 m

(2.2.1.1.4.A)

When the CROSSMAIN/FEEDMAIN runs adjacent to the horizontal direction change are shorter than 6 ft / 1.8 m, additional SWAY BRACE at the change of direction are not required.





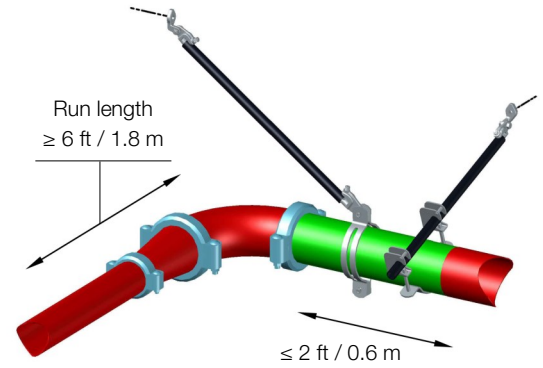
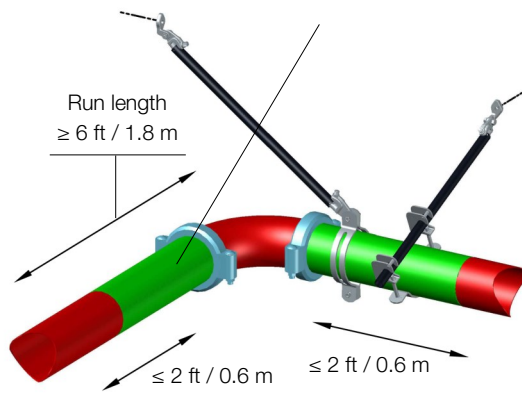
F4

F5

FLEXIBLE COUPLING USED AT CHANGE OF DIRECTION

(2.2.1.1.4.A; 2.2.1.1.4.C.2)

When flexible couplings are present at a horizontal change of direction, an **additional** LATERAL sway brace must be installed within 2 ft / 0.6 m of the change of direction, regardless of the length of the pipe run adjacent to the change in direction.



F1 d1

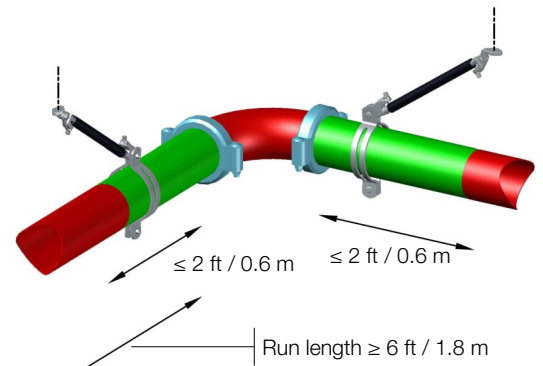
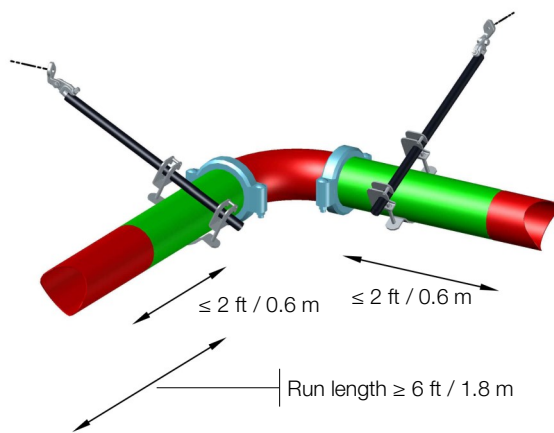
F1 d2

HORIZONTAL CHANGES OF DIRECTION: CONSTANT AND CHANGING MAIN SIZE

(2.2.1.1.4.A)

The CROSSMAIN/FEEDMAIN runs longer than 6 ft / 1.8 m adjacent to changes of direction are required to have a LATERAL and a LONGITUDINAL sway braces within 2 ft / 0.6 m of the change of direction.

If the CROSSMAIN/FEEDMAIN diameter decreases at the change of direction, locate the SWAY BRACES on the run with the larger diameter.



F1 d3

F1 d4

HORIZONTAL CHANGES OF DIRECTION: ALTERNATIVE SOLUTIONS

(2.2.1.1.4.A)

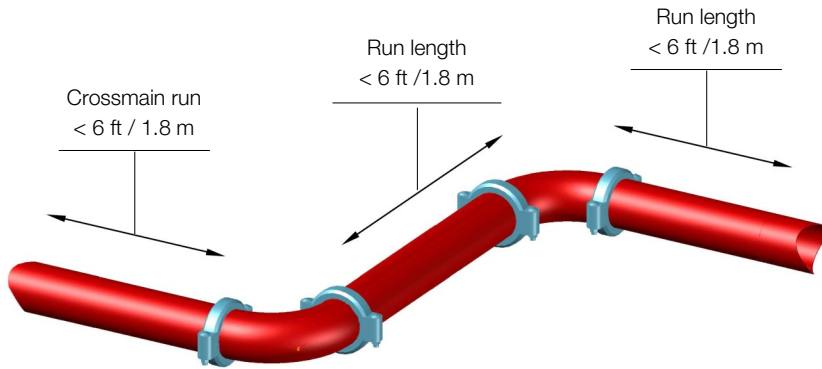
Alternative solutions made with two LATERAL braces, one of which works as a LONGITUDINAL brace for the perpendicular run.

HORIZONTAL CHANGES OF DIRECTION: ALTERNATIVE SOLUTIONS

(2.2.1.1.4.A)

Alternative solutions made with two LONGITUDINAL braces, one of which works as a LATERAL brace for the perpendicular run.



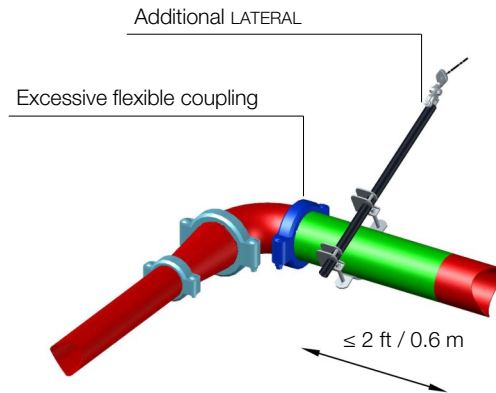
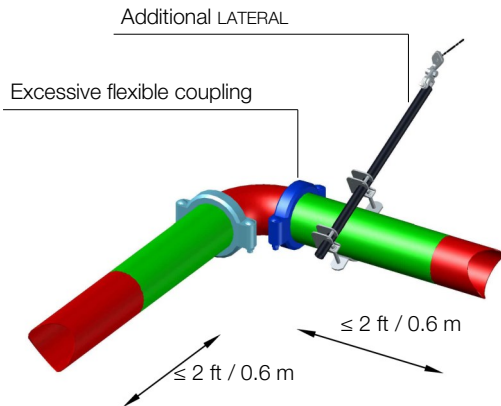


F3 d1

RUNS LESS THAN 6 FT. / 1.8m ADJACENT TO HORIZONTAL CHANGES OF DIRECTION

(2.2.1.1.4.A and 2.2.1.1.4.C.2)

When the CROSSMAIN/FEEDMAIN runs adjacent to horizontal direction changes are shorter than 6 ft / 1.8 m, additional SWAY BRACES at the changes of direction are not required.



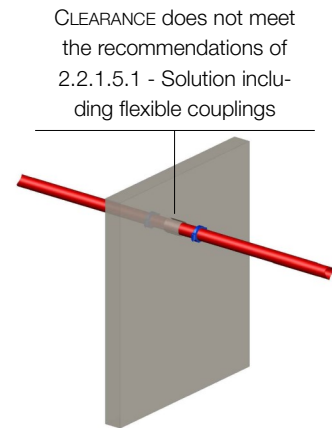
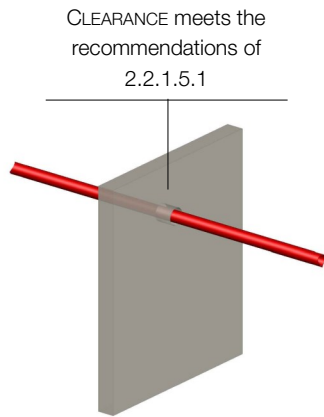
F4 d1

F4 d2

HORIZONTAL CHANGES OF DIRECTION: ACCEPTABLE SOLUTIONS WHEN FLEXIBLE COUPLING AT ELBOW

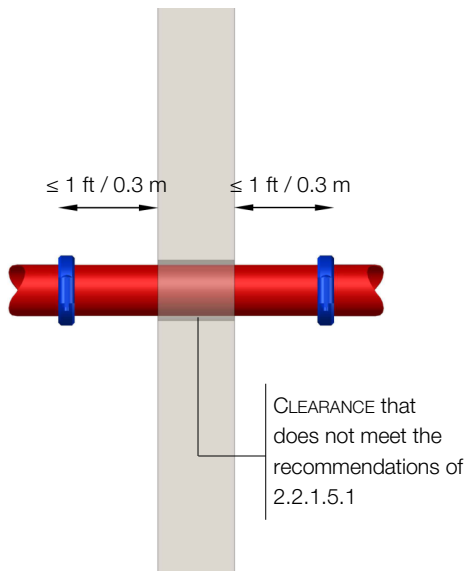
(2.2.1.1.4.A e 2.2.1.1.4.C.2)

When the pipe connection at changes in direction is made using flexible couplings, an **additional** LATERAL brace must be inserted within 2 ft / 0.6 m of the change of direction, regardless of the length of the adjacent pipe run. If there is no change in pipe diameter at the change of direction, the LATERAL brace can be indifferently located on either of the two runs as long as it is within 2 ft / 0.6 m limit from the change of direction. On the other hand, if there is a change in pipe diameter, then the LATERAL brace must be located on the pipe with the larger diameter.

**G1****G2****WALL PENETRATIONS: CLEARANCE REQUIREMENT MET OR NOT MET****(2.2.1.4.4.D)**

When the CROSSMAIN/FEEDMAIN penetrates through a wall made of non-breakable / frangible material and the CLEARANCE does not meet the recommendations indicated in Section 2.2.1.5.1, flexible couplings must be installed on both sides of the wall at a distance less than or equal to 1 ft / 0.3m from the wall itself.

Where the piping systems are welded from the RISERS through the CROSSMAINS, these flexible couplings may be omitted.



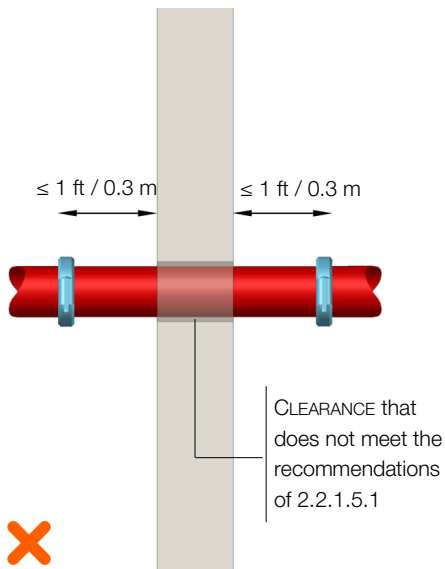
G2a

WALL PENETRATIONS

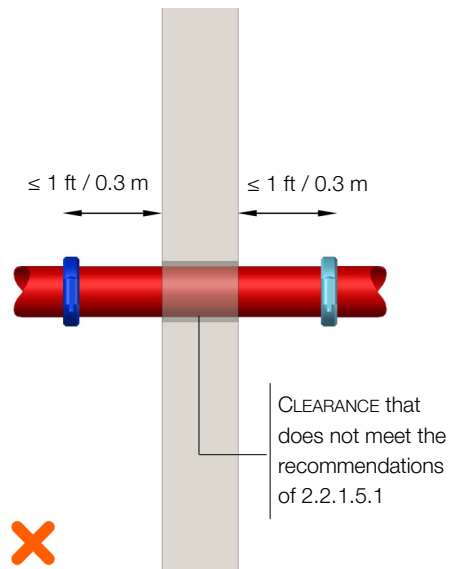
(2.2.1.4.4.D)

When the FEEDMAIN/CROSSMAIN crosses a wall made of non-breakable / frangible material and the CLEARANCE does not meet the recommendations indicated in Section 2.2.1.5.1, flexible couplings must be installed on both sides of the wall at a distance less than or equal to 1 ft / 0.3 m from the wall itself.

Where the piping systems are welded from the RISER through the CROSSMAINS, these flexible couplings may be omitted.



G2b ❌



G2c ❌

WALL PENETRATIONS: INCORRECT SOLUTIONS

(2.2.1.4.4.D)

FURTHER INSTRUCTIONS - STRAIGHT PIPE RUNS**(2.2.1.1.4.D.4)**

A properly sized and attached U-bolt that fastens the CROSSMAIN/FEEDMAIN directly to, and holds the CROSSMAIN/FEEDMAIN tightly against, a structural supporting member may be used as a LATERAL brace.

(2.2.1.1.4.D.5)

Do not use U-hangers, including wraparound types, as LATERAL brace for FEEDMAINS and CROSSMAINS.

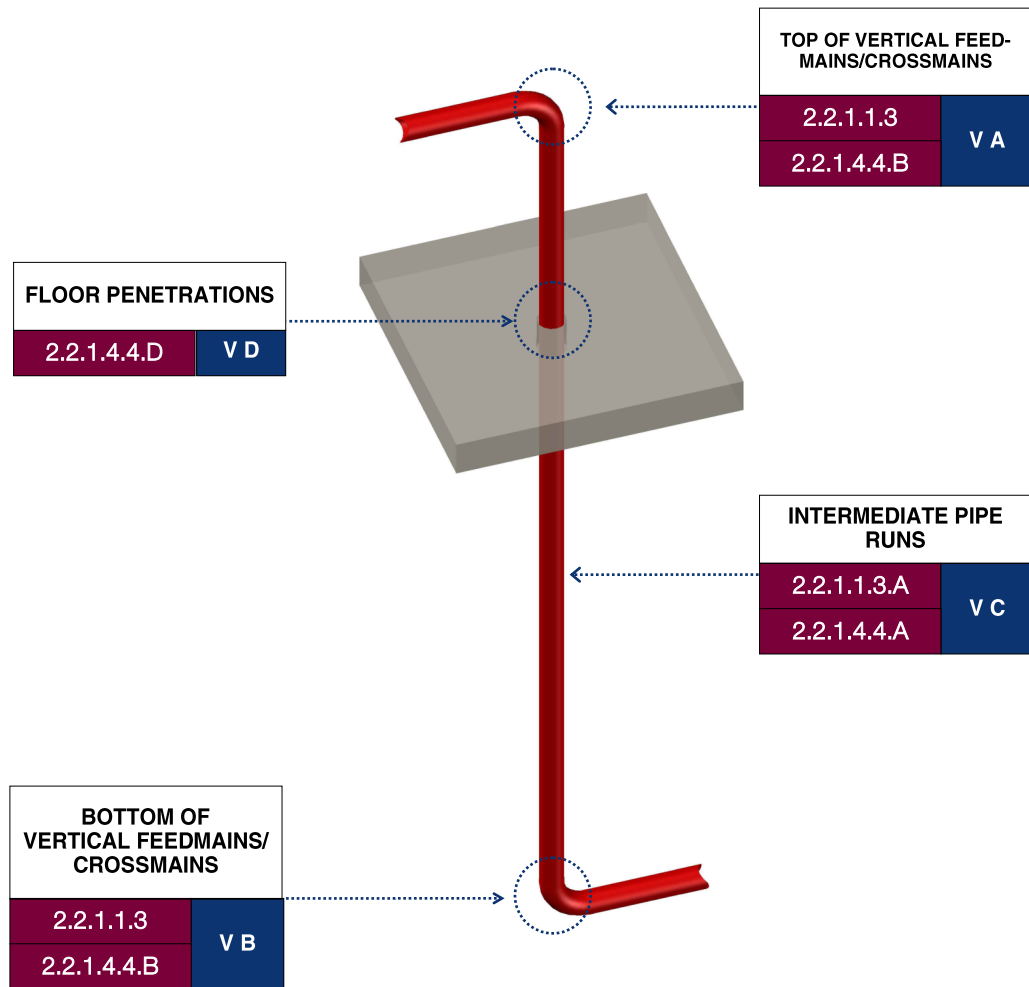
(2.2.1.1.4.D.6)

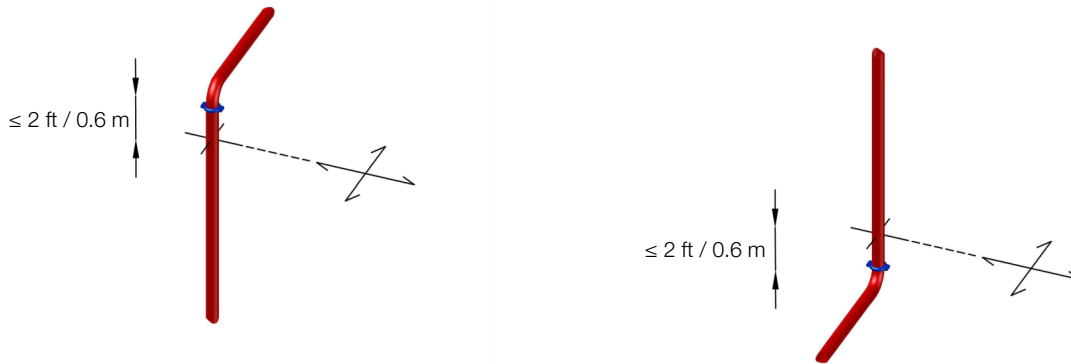
For FEEDMAINS and CROSSMAINS, do not omit LATERAL braces even if the pipes are individually supported by short hanger rods.

(2.2.1.1.4.D.7)

Do not consider any SWAY BRACE on the BRANCH LINES as providing LATERAL or LONGITUDINAL sway bracing to the FEEDMAINS and CROSSMAINS.





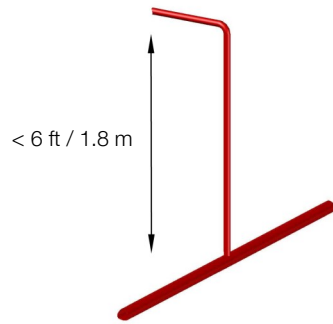
**A1****B1**

VERTICAL CROSSMAIN/FEEDMAIN: PIPE RUNS OF 6 ft / 1.8 m OR MORE

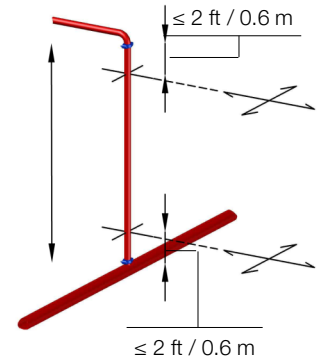
(2.2.1.1.3.A e 2.2.1.4.4.B)

For vertical CROSSMAINS or FEEDMAINS with pipe runs of 6 ft / 1.8 m or more, provide a FOUR-WAY brace at the top and at the bottom of the vertical run. The FOUR-WAY should be located on the pipe with the larger diameter within 2 ft / 0.6 m of the piping turn/connection.

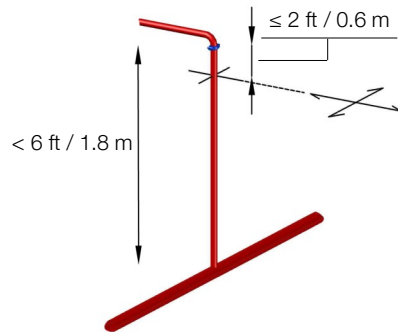
A flexible coupling should also be located at the top of the vertical pipe run within 2 ft / 0.6 m of the end of the pipe. Where welded piping systems exist from the RISER through the CROSSMAINS, these flexible couplings may be omitted.



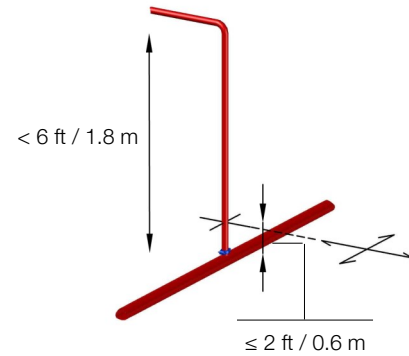
A2 - B2



A3 - B3



A4 - B4



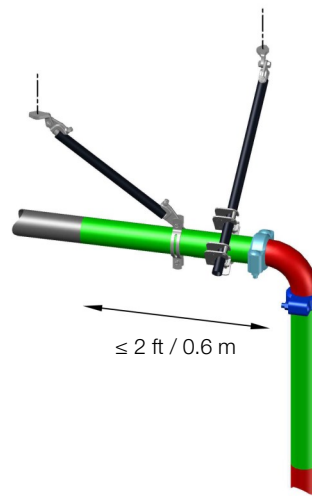
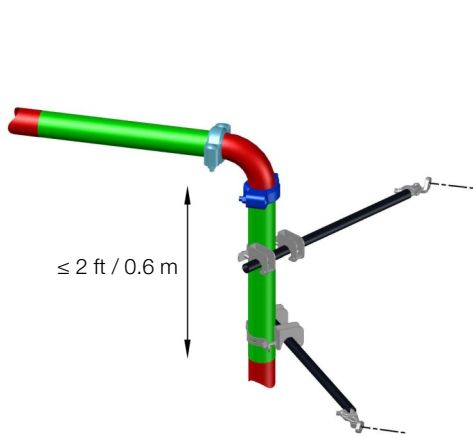
A5 - B5

VERTICAL CROSSMAIN/FEEDMAIN: PIPE RUNS LESS THAN 1.8 m LONG

(2.2.1.1.3.B)

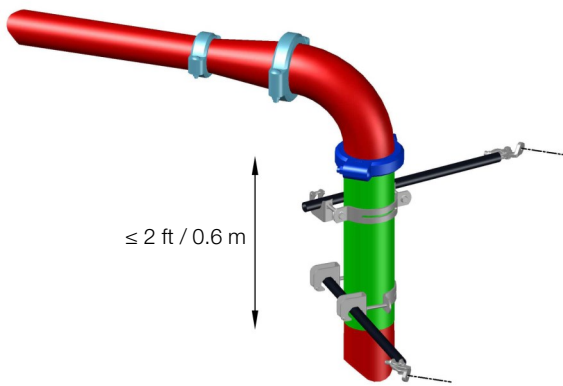
For vertical CROSSMAINS or FEEDMAINS less than 6 ft / 1.8 m long without FOUR-WAY brace, flexible couplings should not be present within the vertical pipe runs, piping turns/connections included.

If flexible couplings are used or needed to satisfy flexibility recommendations at one or both turns/connections, then provide FOUR-WAY bracing within 2 ft / 0.6 m of each turn equipped with flexible coupling(s).



A1 d1 - A3 d1 - A4 d1

A1 d2 - A3 d2 - A4 d2



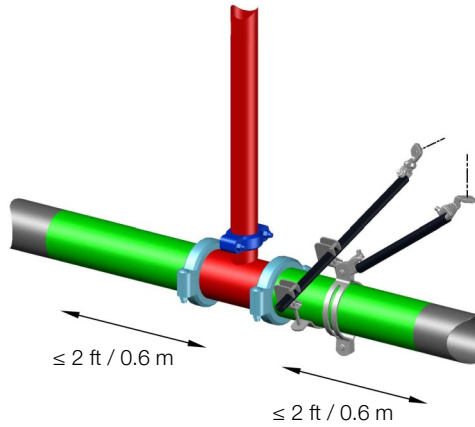
A1 d3 - A3 d3 - A4 d3

TOP OF VERTICAL FEEDMAINS/CROSSMAINS

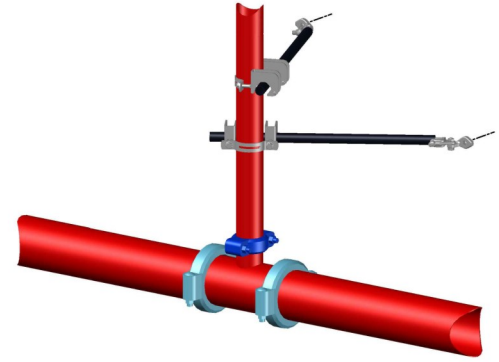
(2.2.1.1.3.A, 2.2.1.1.3.B, 2.2.1.4.4.B)

For vertical CROSSMAINS or FEEDMAINS with runs of 6 ft / 1.8 m or more, provide a FOUR-WAY brace at the top of the vertical run. The FOUR-WAY brace should be located on the pipe with the larger diameter within 2 ft / 0.6 m of the piping turn/connection.

Provide also a flexible coupling at the top of the vertical pipe run within 2 ft / 0.6 m of the end of the pipe. Where welded piping systems exist from the RISER through the CROSSMAINS, these flexible couplings may be omitted.

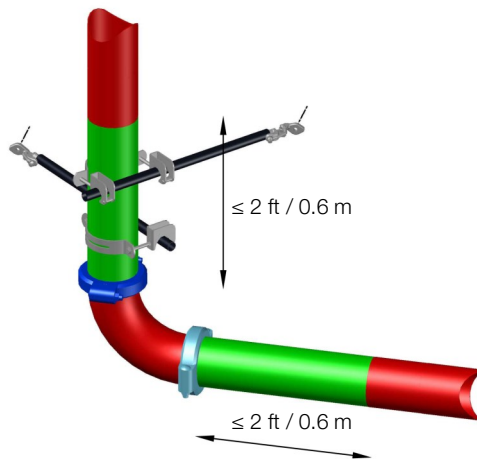


B1 d1 - B3 d1 - B4 d1



B1 d2 - B3 d2 - B4 d2 X

Note: Locating the FOUR-WAY on the smaller pipe is acceptable if the larger pipe load is not included in the zone of influence and the larger pipe is braced independently.



B1 d3 - B3 d3 - B4 d3

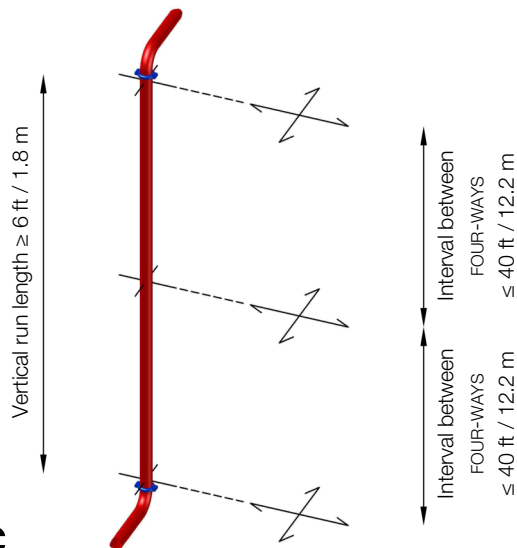
BOTTOM OF VERTICAL FEEDMAINS/CROSSMAINS

(2.2.1.1.3.A, 2.2.1.1.3.B, 2.2.1.4.4.B)

For vertical crossmains or feedmains with pipe runs of 6 ft / 1.8 m or more, provide a four-way brace at the bottom of the vertical run. Install the four-way brace on the pipe with the larger diameter within 2 ft / 0.6 m of the piping turn/ connection.

Provide also a flexible coupling at the bottom of the vertical pipe run within 2 ft / 0.6 m of the beginning of the pipe. Where welded piping systems exist from the riser through the crossmains, these flexible couplings may be omitted.





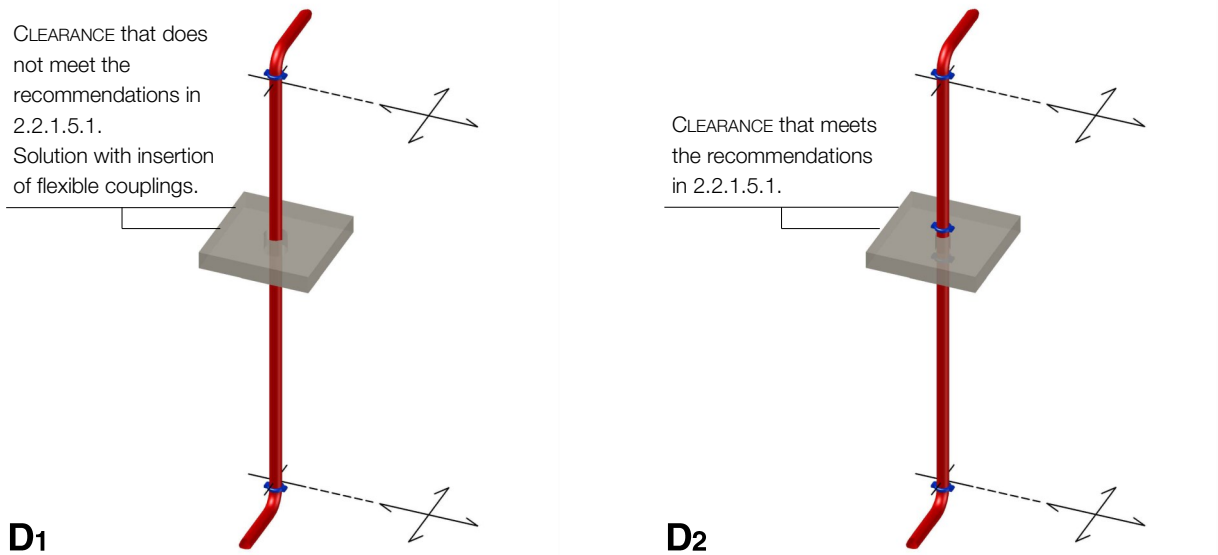
C

INTERMEDIATE PIPE RUNS

(2.2.1.1.3.A; 2.2.1.4.4.A)

Locate intermediate FOUR-WAY bracing like for RISERS: maximum distance between two FOUR-WAY braces not to exceed 40 ft / 12.2 m; When there are excessive flexible couplings, locate one FOUR-WAY brace every other flexible coupling; In multistory buildings, locate a FOUR-WAY brace at every floor in which a horizontal CROSSMAIN/FEEDMAIN branches out; When a RISER passes through a structural floor, and clearances do not exceed the minimum per 2.2.1.5.1., a FOUR-WAY brace is considered to exist at this point. (Refer to the R section of this handbook for further details.)

Install a flexible coupling within 2 ft / 0.6 m above or below intermediate points of lateral restraints for vertical pipe. Where the RISER through CROSSMAINS piping system is welded, this flexible coupling can be omitted.

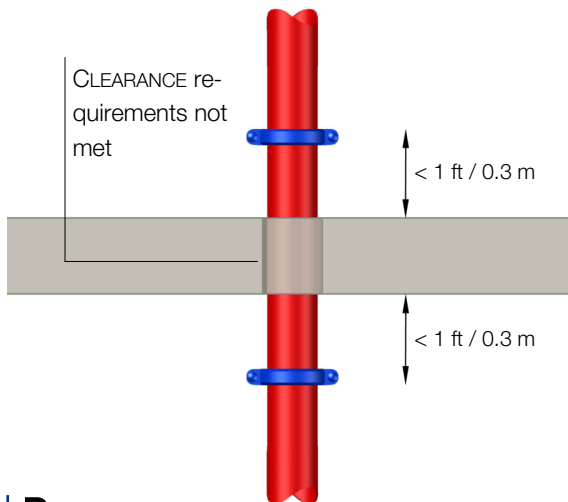


FLOOR PENETRATIONS: CLEARANCE REQUIREMENTS NOT MET AND MET

(2.2.1.4.4.D)

Where vertical FEEDMAINS/CROSSMAINS penetrate through a floor made of non-breakable material (structural floor) and CLEARANCES per Section 2.2.1.5.1 are not provided, install flexible couplings on both sides of the floor at no more than 1 ft / 0.3 m from the floor itself.

Where the piping systems is welded from the RISER through the CROSSMAINS , these flexible couplings may be omitted.



D2 d

FLOOR PENETRATIONS

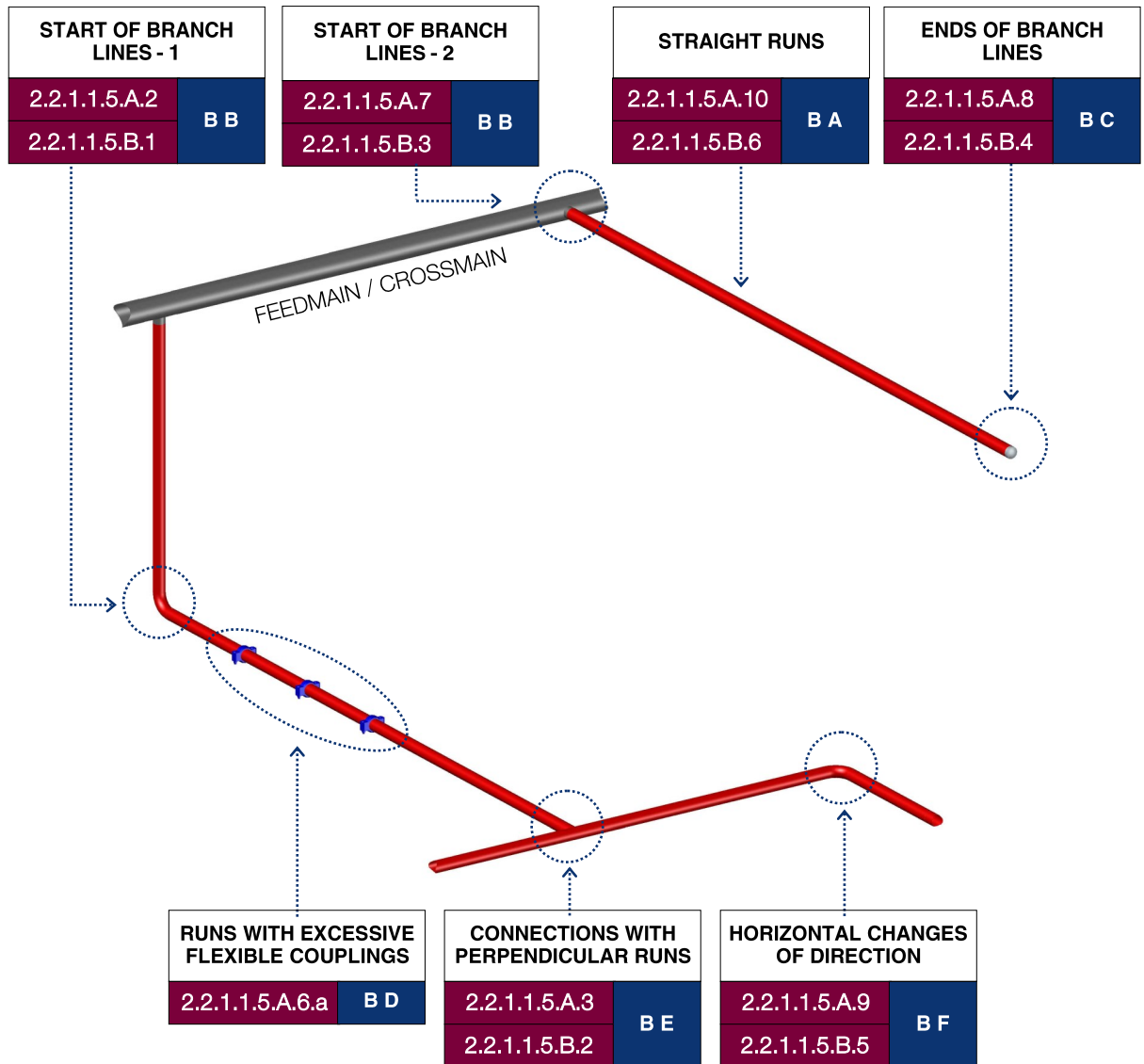
(2.2.1.4.4.D)

Where vertical FEEDMAINS/CROSSMAINS penetrate a floor made of non-breakable material and CLEARANCES per Section 2.2.1.5.1 are not provided, install flexible couplings ought on both sides of the floor at no more than 1 ft / 0.3 m from the floor itself.

Where the piping systems is welded from the RISER through the CROSSMAINS, these flexible couplings may be omitted.







BRANCH LINES SWAY BRACING– GENERAL INSTRUCTIONS

(2.2.1.1.5)

BRANCH LINES that are less than 2-1/2 in. / 65 mm in diameter do not require SWAY BRACES.

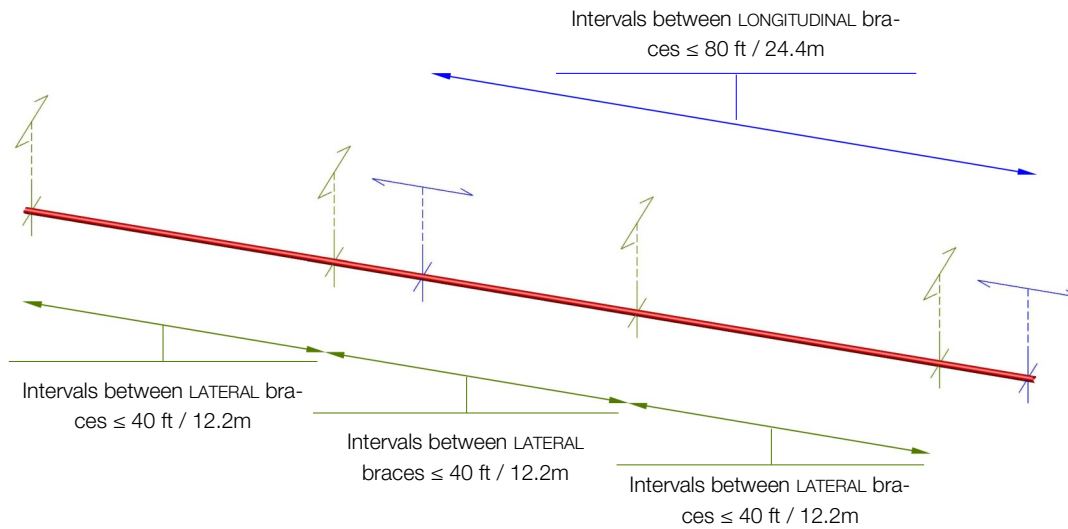
(2.2.1.1.5.A.1)

BRANCH LINES that are 2-1/2 in. / 65 mm or more in diameter do require SWAY BRACES.

For BRANCH LINES that are less than 4 in. / 100 mm in diameter, LATERAL sway bracing is not needed on pipes individually supported by rods that meet the following criteria:

- All rods have a length less than 6 in. / 150 mm from the supporting member attachment to the top of the branch line, and
- There is no more than 1/2 in. / 13 mm of space between the top of the BRANCH LINE piping and the bottom of the support rod.





A

STRAIGHT HORIZONTAL PIPE RUNS

(2.2.1.1.5.A.10 e 2.2.1.1.5.B.6)

Provide SWAY BRACES on straight runs of pipe spaced at the following maximum:

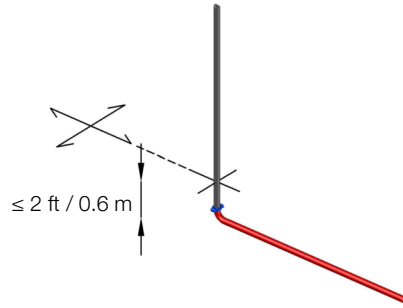
- Maximum interval between LATERAL braces ≤ 40 ft / 12.2 m;
- Maximum interval between LONGITUDINAL braces ≤ 80 ft / 24.4 m



A d

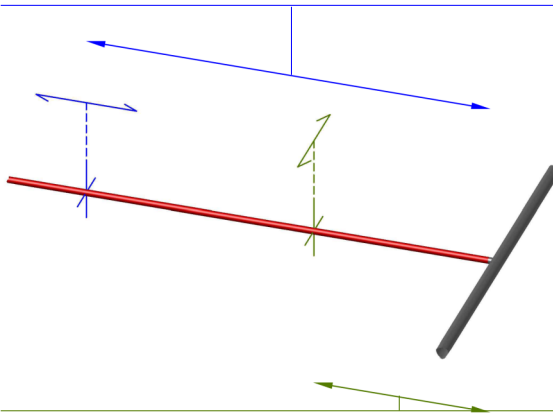
STRAIGHT HORIZONTAL PIPE RUNS

LONGITUDINAL and LATERAL SWAY BRACE.

**B1****START OF HORIZONTAL BRANCH LINES: CONNECTION WITH A DROP****(2.2.1.1.5.A.2; 2.2.1.1.5.B.1)**

A FOUR-WAY brace on a vertical pipe (e.g. at the bottom of a DROP) may be counted as the initial LATERAL and LONGITUDINAL braces for the attached horizontal branch line of the same or smaller diameter when the brace is located within 2 ft / 0.6 m of the horizontal pipe and when the design load for this FOUR-WAY brace includes the tributary loads from both the vertical and the horizontal pipes.

20 ft / 6.1 m \leq space to first LONGITUDINAL brace \leq 80 ft / 24.4m

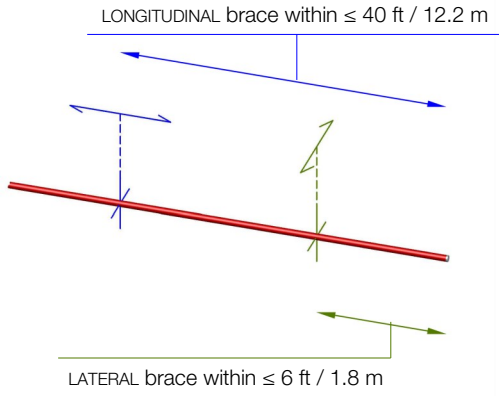


10 ft / 3.1 m \leq space to first LATERAL brace \leq 40 ft / 12.2 m

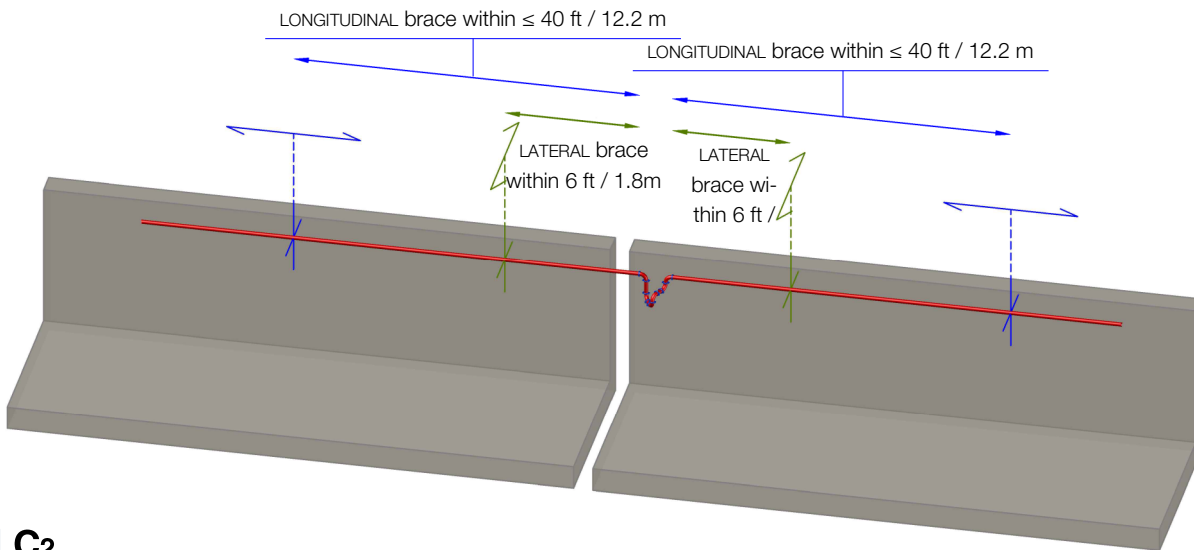
B2**START OF HORIZONTAL BRANCH LINES****(2.2.1.1.5.A.7; 2.2.1.1.5.B.3)**

Locate the first LATERAL sway bracing no closer than 10 ft / 3.1 m nor greater than 40 ft / 12.2 m from the branch line connection to the CROSSMAIN. This distance must be calculated including all vertical and horizontal BRANCH LINES section lengths.

Locate the first LONGITUDINAL sway bracing no closer than 20 ft / 6.1 m nor greater than 80 ft / 24.4 m from the branch line connection to the CROSSMAIN. This distance must be calculated including all vertical and horizontal BRANCH LINES section lengths starting from the connection with the CROSSMAIN.



C1



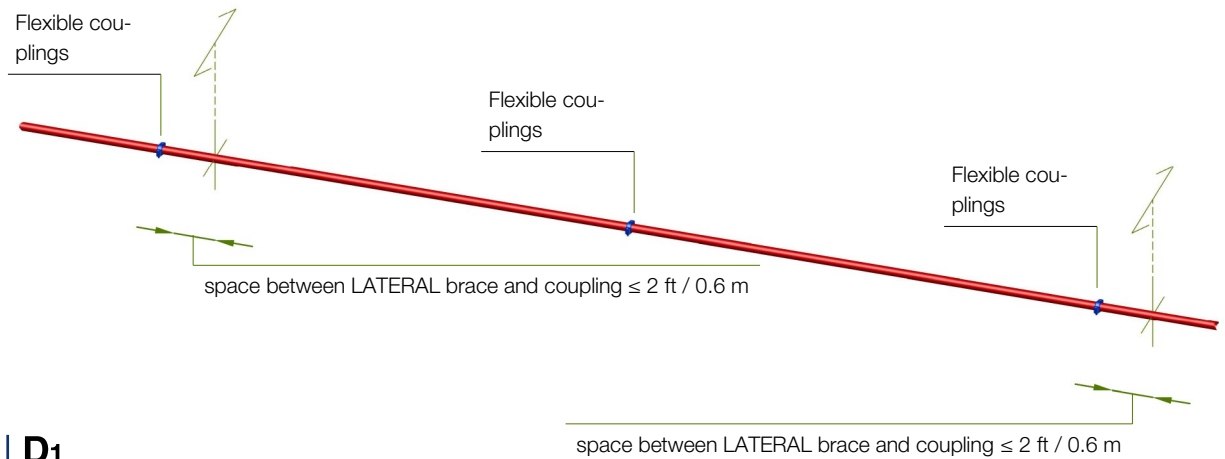
C2

ENDS OF LINES / SEISMIC SEPARATION ASSEMBLIES

(2.2.1.1.5.A.8 e 2.2.1.1.5.B.4)

For dead-end BRANCH LINES, locate the last LATERAL brace not more than 6 ft / 1.8 m from the end; Consider seismic separation assemblies as the end of the piping on both sides of the assembly.

Locate the last LONGITUDINAL brace not more than 40 ft / 12.2 m from the end; Consider seismic separation assemblies as the end of the piping on both sides of the assembly.

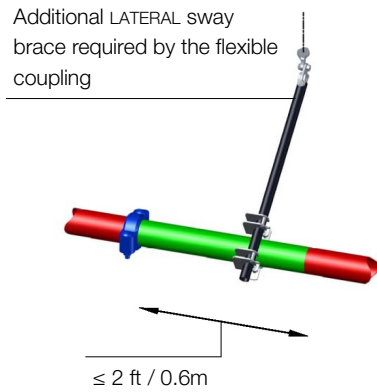


D1

PIPE RUNS WITH EXCESSIVE FLEXIBLE COUPLINGS

(2.2.1.1.5.A.6.a)

When more flexible couplings than recommended in Section 2.2.1.4 are installed on straight pipe runs, provide **additional** LATERAL sway bracing within 2 ft / 0.6 m of every other flexible coupling.



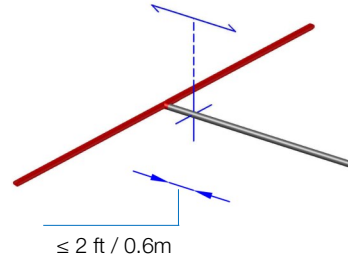
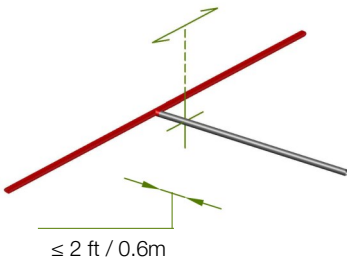
D1 d

PIPE RUNS WITH EXCESSIVE FLEXIBLE COUPLINGS

(2.2.1.1.5.A.6.a)

When more flexible couplings than recommended in Section 2.2.1.4 are installed on straight pipe runs, provide **additional** LATERAL sway bracing within 2 ft / 0.6 m of every other flexible coupling.





E1

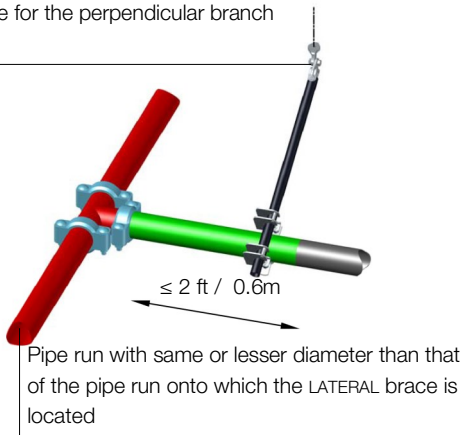
E2

BRACING AT INTERSECTING BRANCH LINES

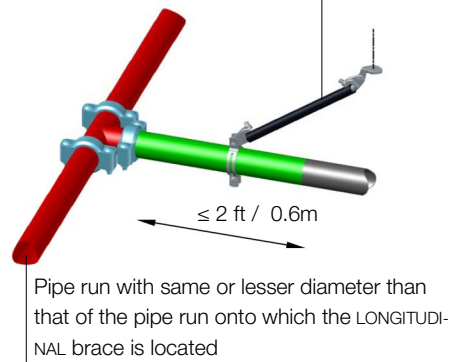
(2.2.1.1.5.A.3 e 2.2.1.1.5.B.2)

A LATERAL [LONGITUDINAL] brace located within 2 ft / 0.6 m of the end of a BRANCH LINE connection to another branch line that is perpendicular and of the same or lesser diameter may be used to also act as a LONGITUDINAL [LATERAL] brace for the perpendicular branch line as long as the sway brace design loads include the tributary lateral and longitudinal loads for the braced branch lines.

LATERAL brace used as acting LONGITUDINAL brace for the perpendicular branch line



LONGITUDINAL brace used as acting LATERAL brace for the perpendicular branch line



E1 d

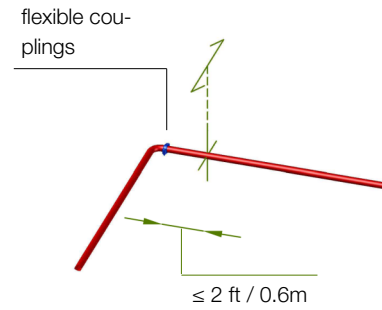
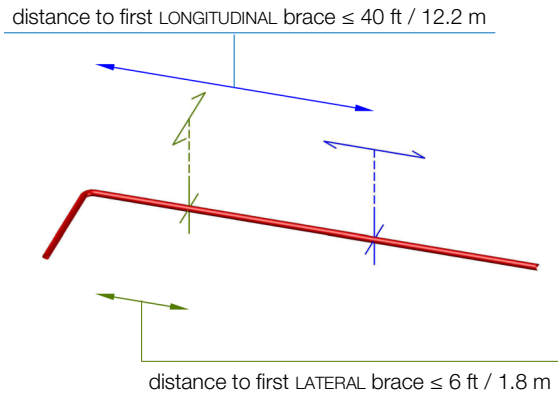
E2 d

BRACING AT INTERSECTING BRANCH LINES

(2.2.1.1.5.A.3, 2.2.1.1.5.B.2)

A LATERAL [LONGITUDINAL] brace located within 2 ft / 0.6 m of the end of a BRANCH LINE connection to another branch line that is perpendicular and of the same or lesser diameter may be used to also act as a LONGITUDINAL [LATERAL] brace for the perpendicular branch line as long as the sway brace design loads include the tributary lateral and longitudinal loads for the braced branch lines.





F1

HORIZONTAL CHANGES OF DIRECTION: NO FLEXIBLE COUPLING

(2.2.1.1.5.A.9 e 2.2.1.1.5.B.5)

Locate the first LATERAL brace not more than 6 ft / 1.8 m from horizontal changes in direction.

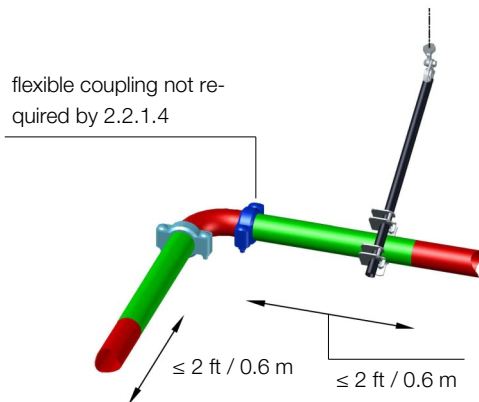
Locate a LONGITUDINAL brace not more than 40 ft / 12.2m from horizontal changes in direction.

F2

CHANGES OF DIRECTION: FLEXIBLE COUPLING

(2.2.1.1.5.A.6.b)

When more flexible couplings than recommended in Section 2.2.1.4 are installed at changes in horizontal pipe direction, provide an **additional** LATERAL sway bracing within 2 ft / 0.6 m of every flexible coupling installed.



F2 d

CHANGES IN HORIZONTAL PIPE DIRECTION WITH FLEXIBLE COUPLINGS

(2.2.1.1.5.A.6.b)

When more flexible couplings than recommended in Section 2.2.1.4 are installed at changes in horizontal pipe direction, provide an **additional** LATERAL sway bracing within 2 ft / 0.6 m of every flexible coupling installed.



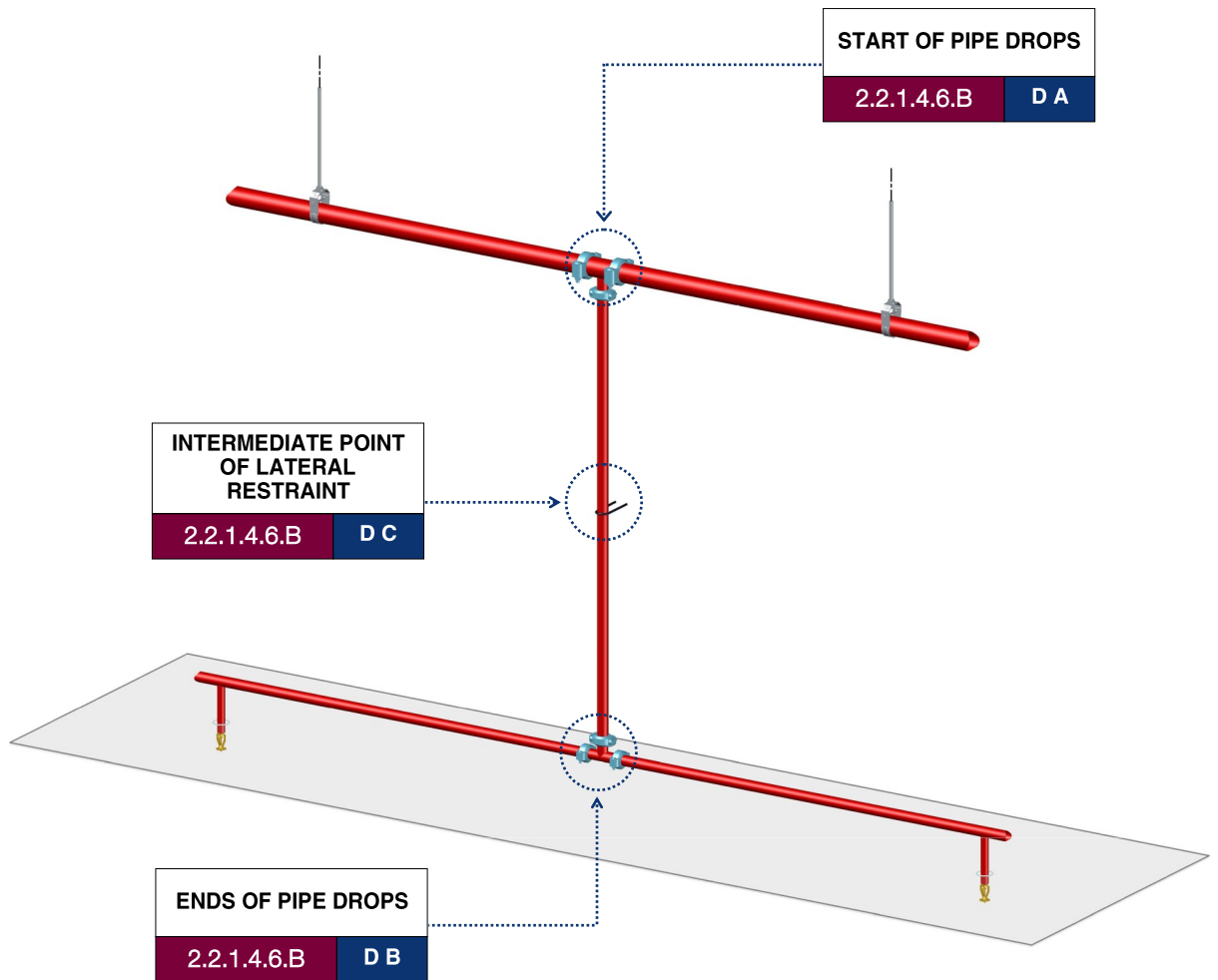
BRANCH LINES LATERAL SWAY BRACES - FURTHER INSTRUCTIONS**(2.2.1.1.5.A.4)**

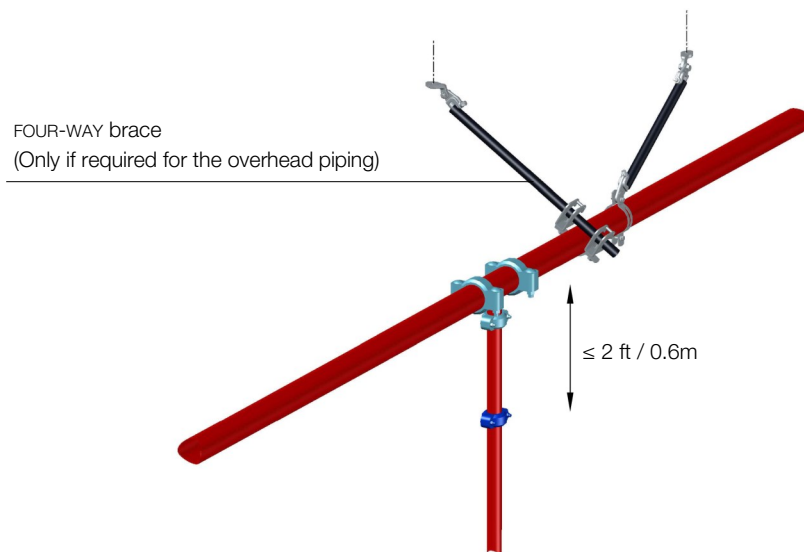
A properly sized and attached U-bolt that fastens the pipe directly to, and holds the pipe tightly against, a structural supporting member may be used as a LATERAL brace.

(2.2.1.1.5.A.5)

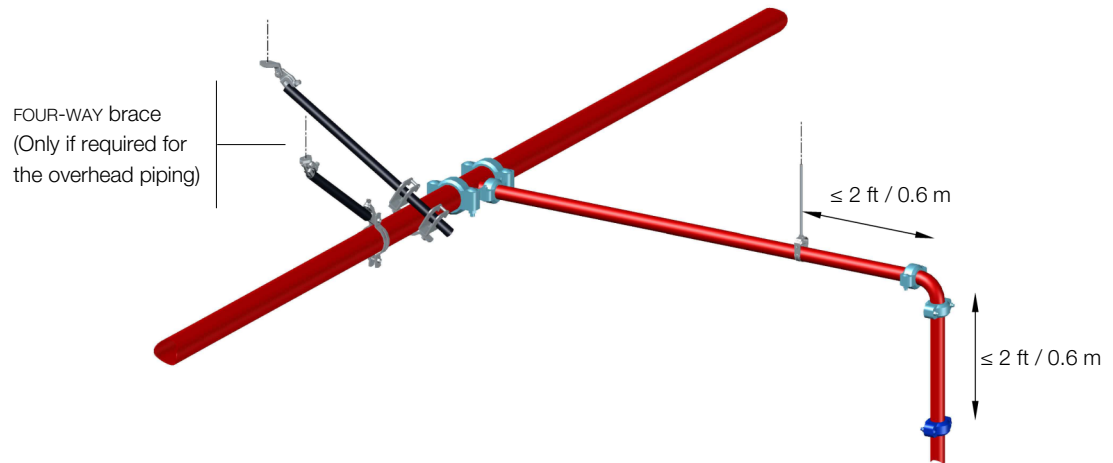
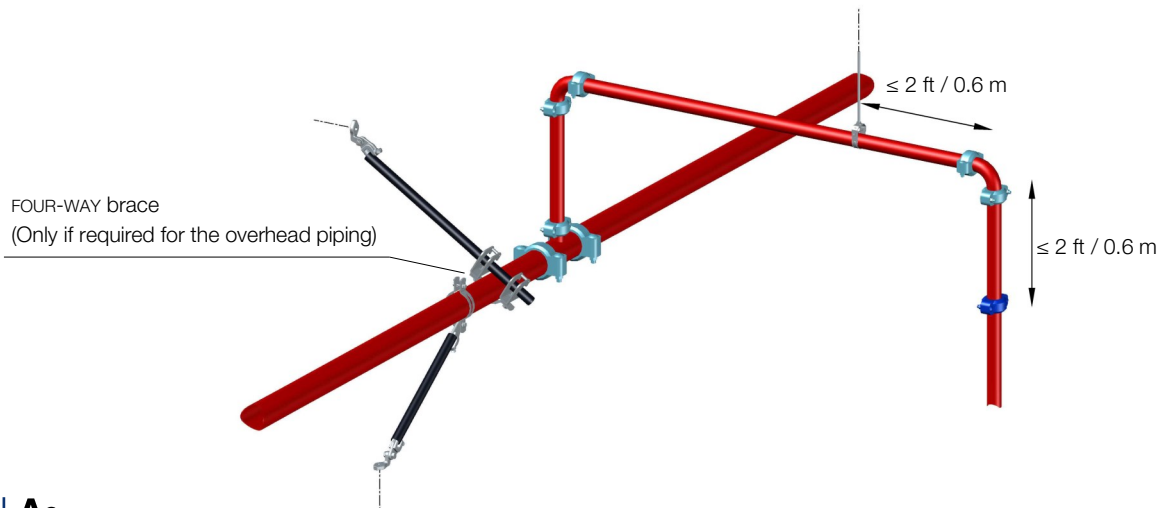
Wraparound U-hangers may be used as LATERAL sway bracing for BRANCH LINES if they meet the criteria per Section 2.2.1.3.4.





**A1****DROP THAT SUPPLY MORE THAN ONE SPRINKLER - CONNECTION STRAIGHT TO THE MAIN
(2.2.1.4.6; 2.2.1.4.6.A)**

For pipe DROPS that exceed 2 ft / 0.6 m in length, provide a flexible coupling within 2 ft / 0.6 m of the connection to overhead piping or armovers.

**A2****A3****ARMOVERS****(2.2.1.4.6; 2.2.1.4.6.A; 2.2.1.4.6.D)**

Provide a flexible coupling within 2 ft / 0.6 m of the connection to armovers for pipe DROPS that exceed 2 ft / 0.6 m in length.

No flexible couplings are needed on the armover itself.

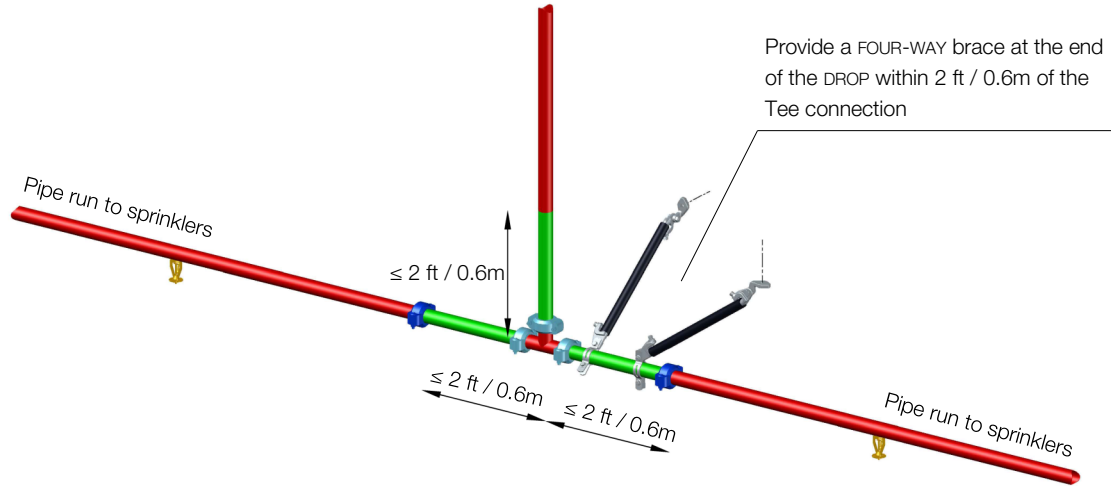
Provide hangers of the type that resist upward vertical movement as per 2.2.1.8.1.B.

HANGERS**(2.2.1.8.1.B)**

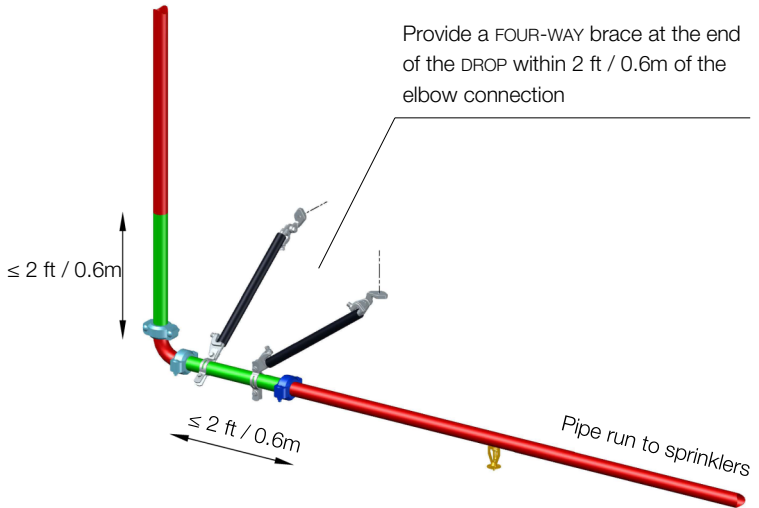
Provide hangers of the type that resist upward vertical movement at the following locations:

1. On all armovers to vertical pipe drops that supply more than one sprinkler, regardless of the length of the armover, located within 2 ft / 0.6 m of the drop.
2. On all armovers greater than 2 ft / 0.6 m long that supply one sprinkler, located within 2 ft / 0.6 m of the drop

Note that for very long armovers, hangers in addition to those recommended below will be needed when normal hanger spacing rules apply.



B1



B2

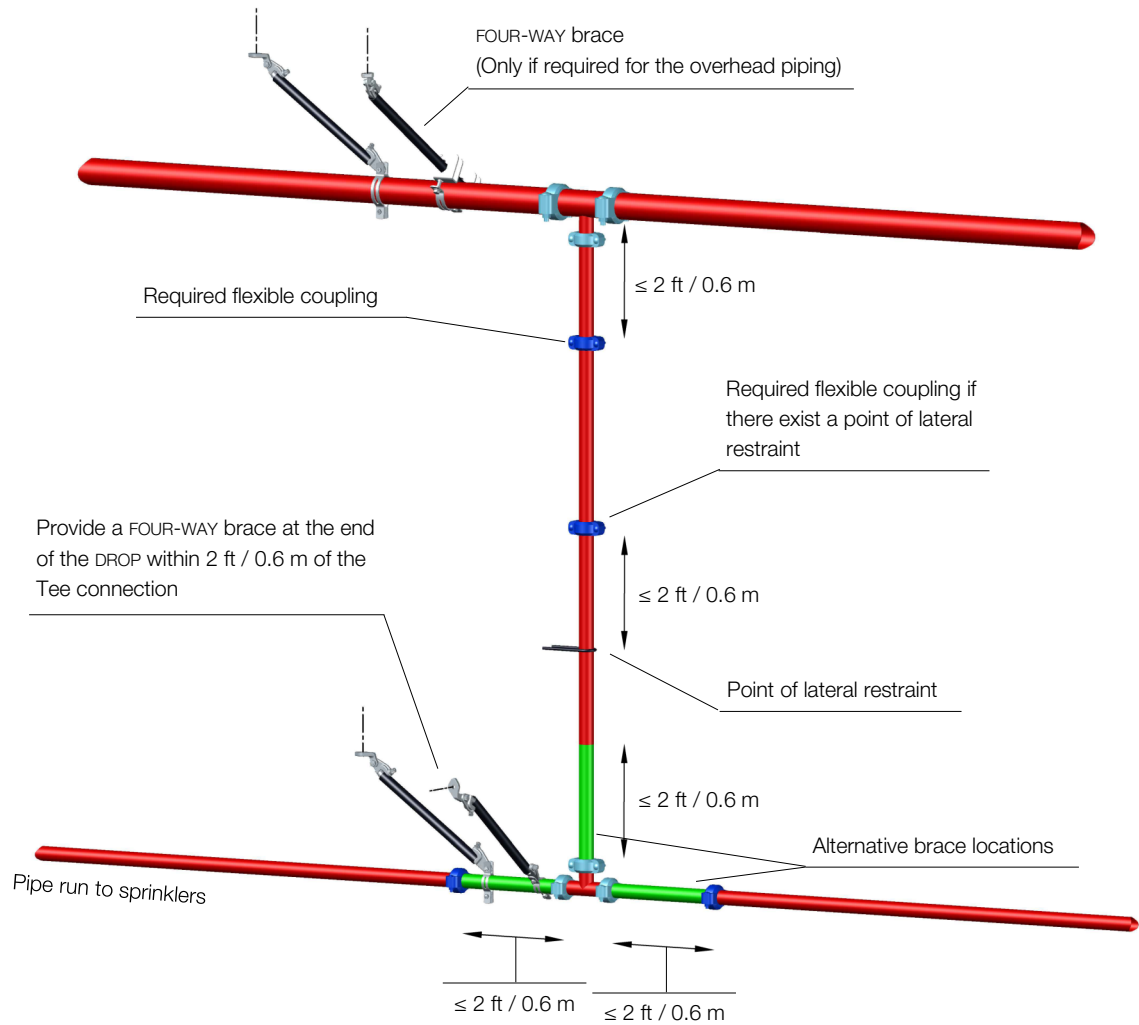
DROPS THAT SUPPLY MORE THAN ONE SPRIKLER - DROPS TO A TEE OR TO AN ELBOW

(2.2.1.4.6; 2.2.1.4.6.B)

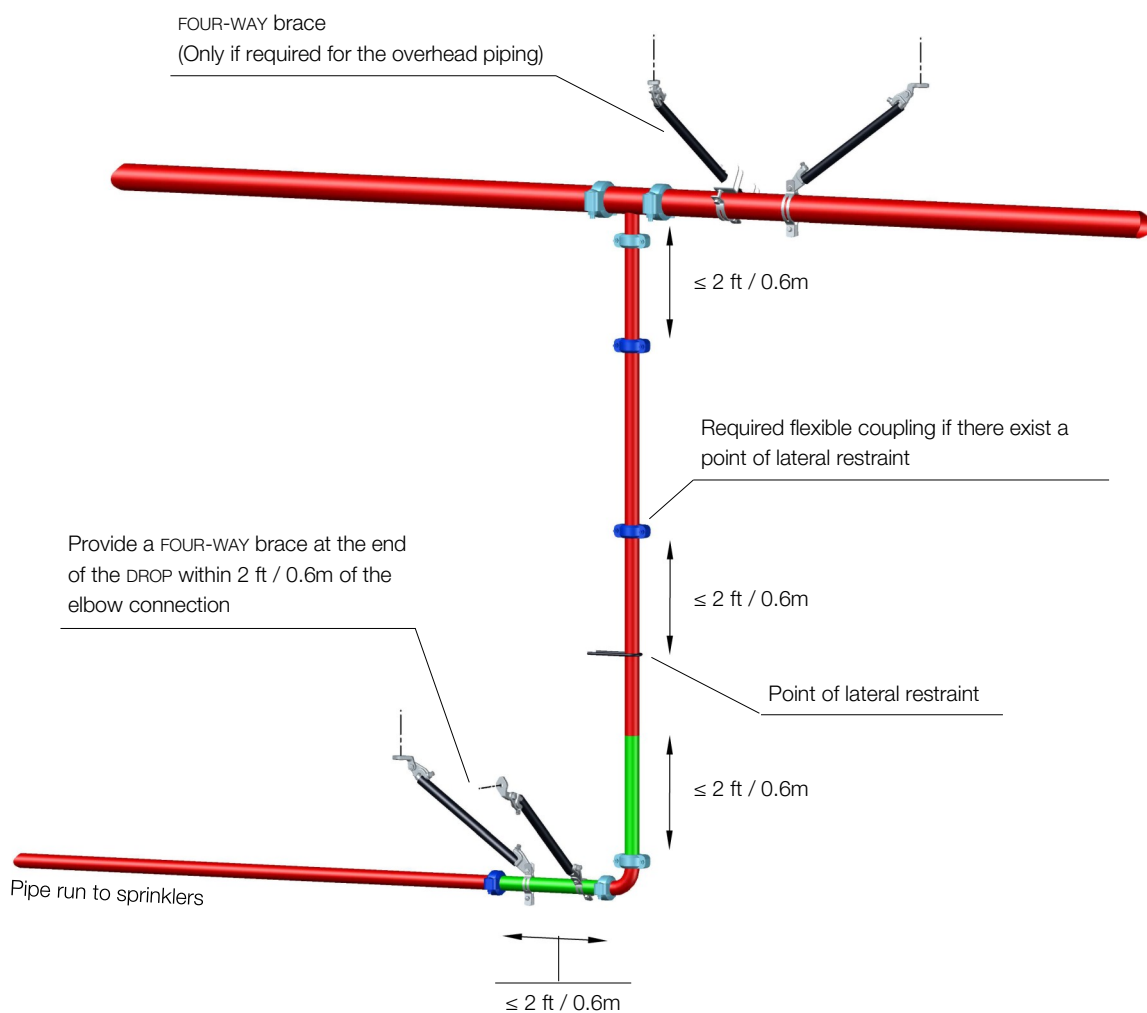
Provide flexible coupling(s) on the horizontal portion within 2 ft / 0.6 m of any tee or elbow connecting pipe DROPS to sprinkler piping.

Flexible couplings may be omitted on pipe DROPS that supply a single sprinkler.



**C1****DROPS TO A TEE: INTERMEDIATE POINT OF LATERAL RESTRAINT****(2.2.1.4.6.C)**

Provide a flexible coupling within 2 ft / 0.6 m above and/or below any intermediate points of lateral restraint to the pipe DROPS when needed to accommodate differential movement.

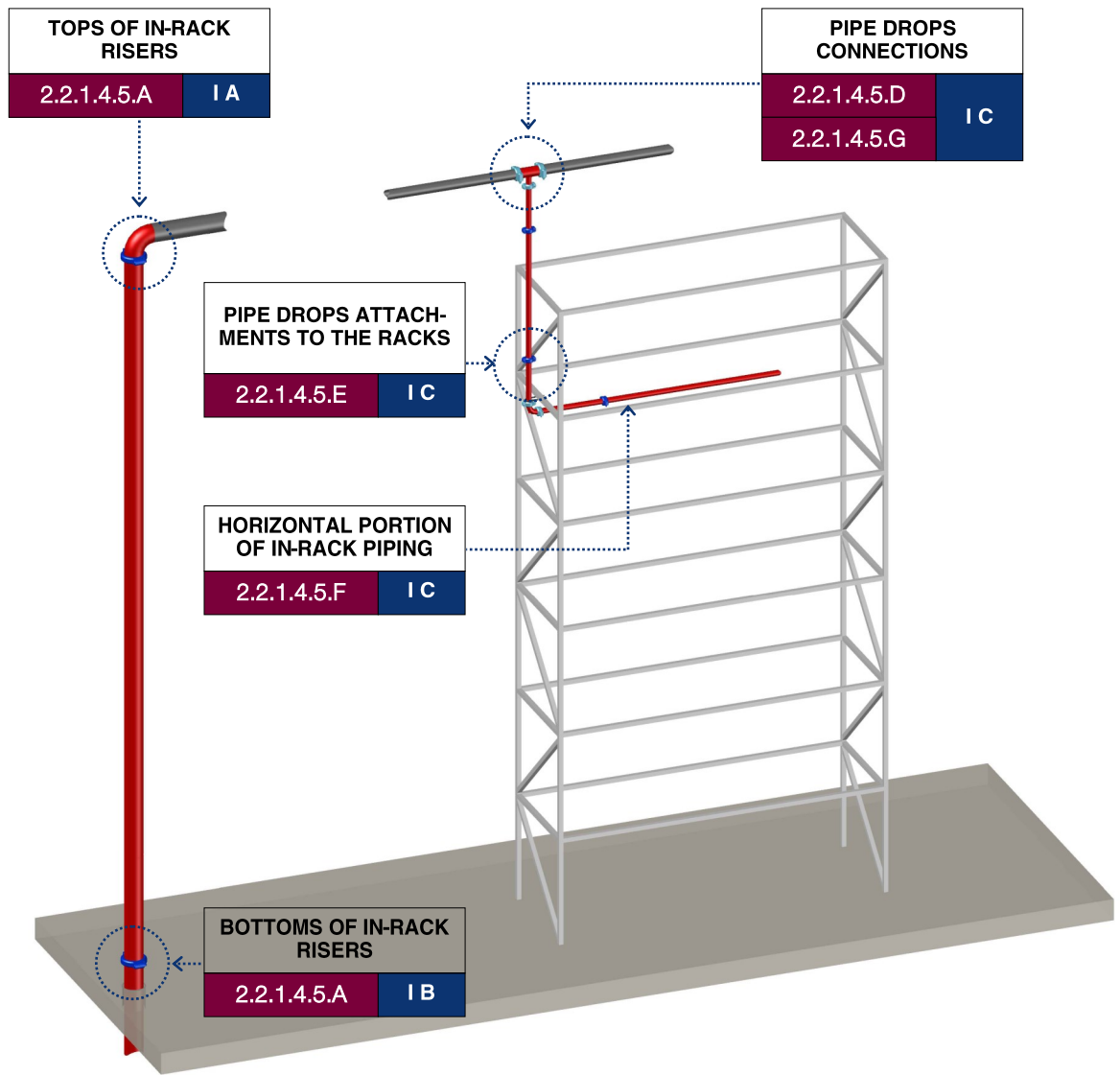


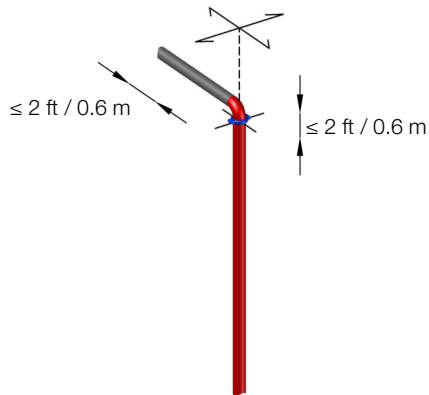
C2

DROPS TO AN ELBOW: INTERMEDIATE POINT OF LATERAL RESTRAINT

(2.2.1.4.6.C)

Provide a flexible coupling within 2 ft / 0.6 m above and/or below any intermediate points of lateral restraint to the pipe DROPS when needed to accommodate differential movement.

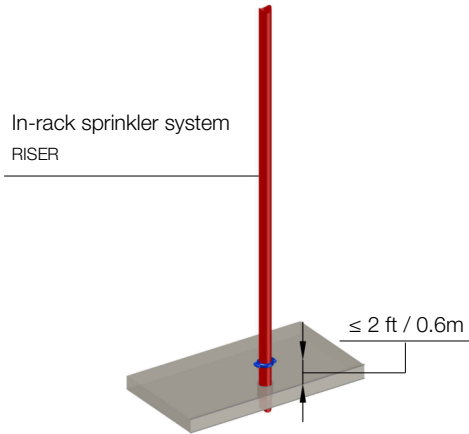


**A****TOPS OF IN-RACK RISERS****(2.2.1.4.5.A)**

Provide flexible couplings within 2 ft / 0.6 m of the top of each in-rack sprinkler system RISER, both in cases where the RISER is attached directly to the ceiling sprinkler system RISER, and where the in-rack sprinkler system RISER is attached directly to the underground piping.

Where the piping systems is welded from the RISER through the CROSSMAINS, the flexible coupling at the top of the riser may be omitted.

Refer to the R section of this handbook to locate the FOUR-WAY braces.

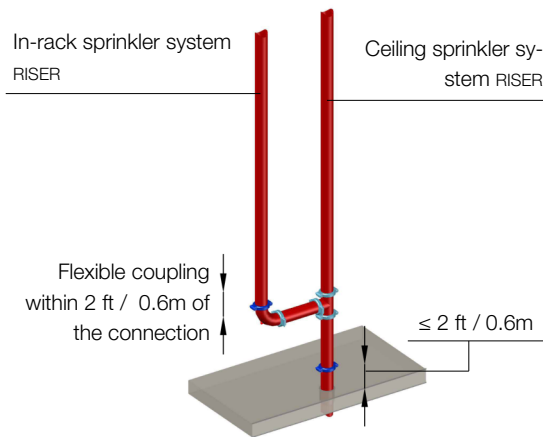


B1

BOTTOM OF IN-RACK SPRINKLER SYSTEMS RISERS ATTACHED DIRECTLY TO THE UNDERGROUND PIPING

(2.2.1.4.5.A)

In cases where the in-rack sprinkler system RISER is attached directly to the underground piping, provide flexible couplings within 2 ft. / 0.6 m of the bottom of each in-rack sprinkler system RISER.



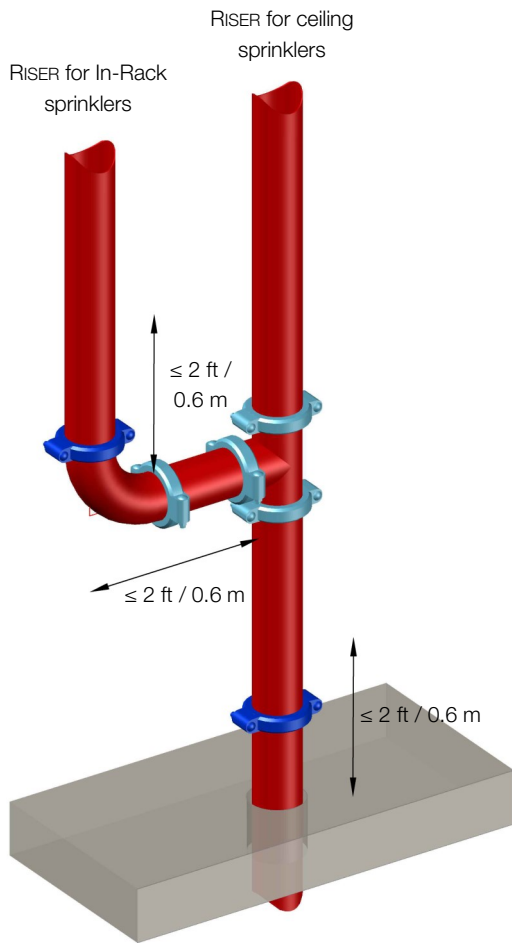
B2

BOTTOM OF IN-RACK SPRINKLER SYSTEMS RISERS ATTACHED DIRECTLY TO THE CEILING SPRINKLER SYSTEM RISER

(2.2.1.4.5.A)

In cases where the in-rack sprinkler system RISER is attached directly to the ceiling sprinkler system riser, provide flexible couplings within 2 ft. / 0.6 m of the connection of each in-rack sprinkler system RISER.

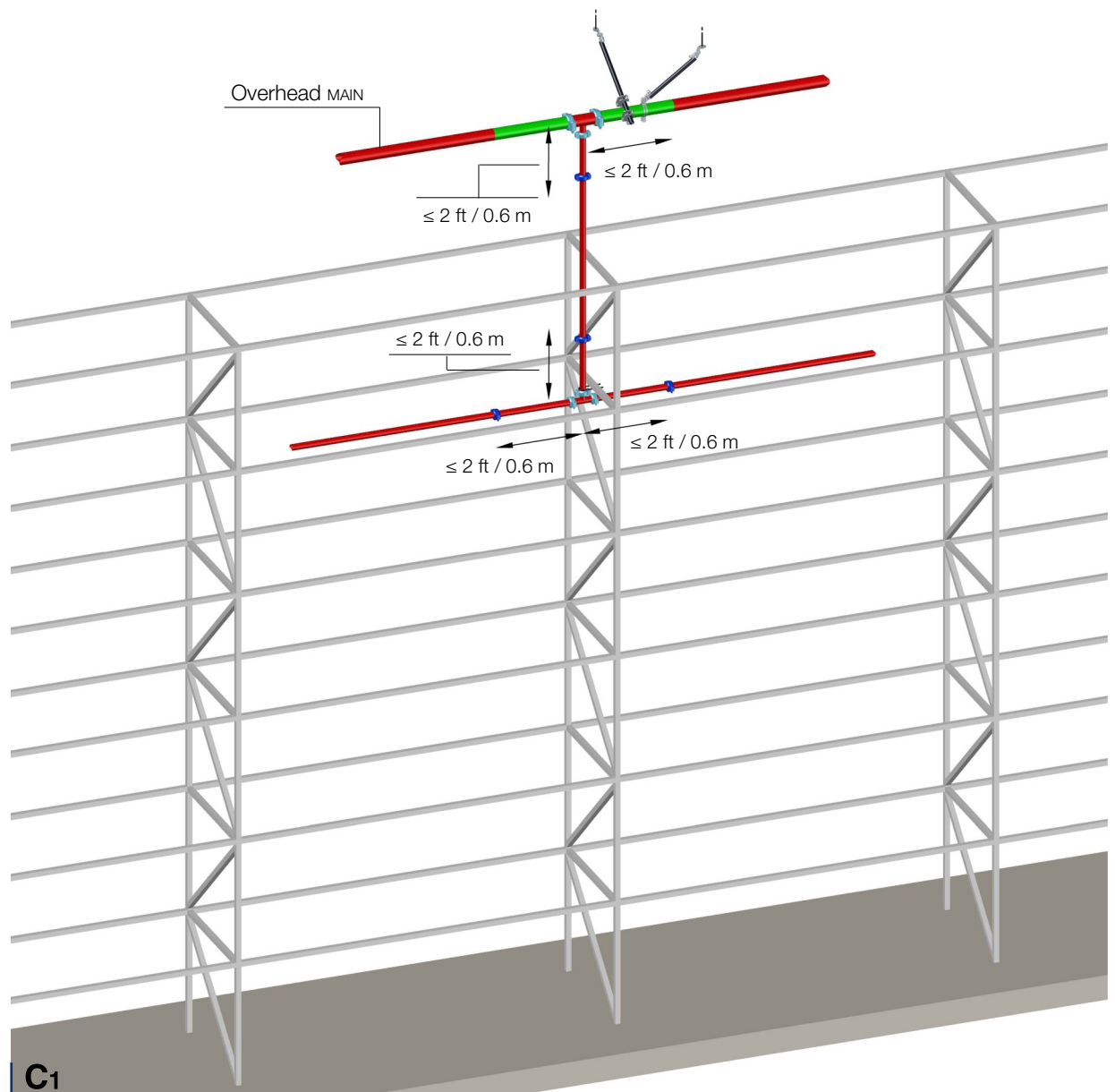


**B2 d****BOTTOM OF IN-RACK SPRINKLER SYSTEM RISER****(2.2.1.4.5.A)**

Provide flexible couplings within 2 ft / 0.6 m of the bottom of in-rack sprinkler systems RISERS, both in case where the RISER is attached directly to the underground piping and where it is attached directly to the ceiling sprinkler system RISER.

In cases where the in-rack sprinkler system RISER is attached to the ceiling sprinkler system RISER, provide a flexible coupling on the in-rack sprinkler system RISER within 2 ft / 0.6 m of the connection.

Provide also a flexible coupling within 2 ft / 0.6 m of the bottom of the RISER for the ceiling sprinkler system.



C1

IN-RACK SYSTEMS: FEED IN THE MIDDLE OF THE RACK

(2.2.1.4.5.D, 2.2.1.4.5.E, 2.2.1.4.5.F)

Provide a FOUR-WAY brace within 2 ft / 0.6 m of the connection of pipe DROPS to the overhead feed piping.

Provide a flexible coupling within 2 ft / 0.6 m of the connection of pipe DROPS to the overhead feed piping.

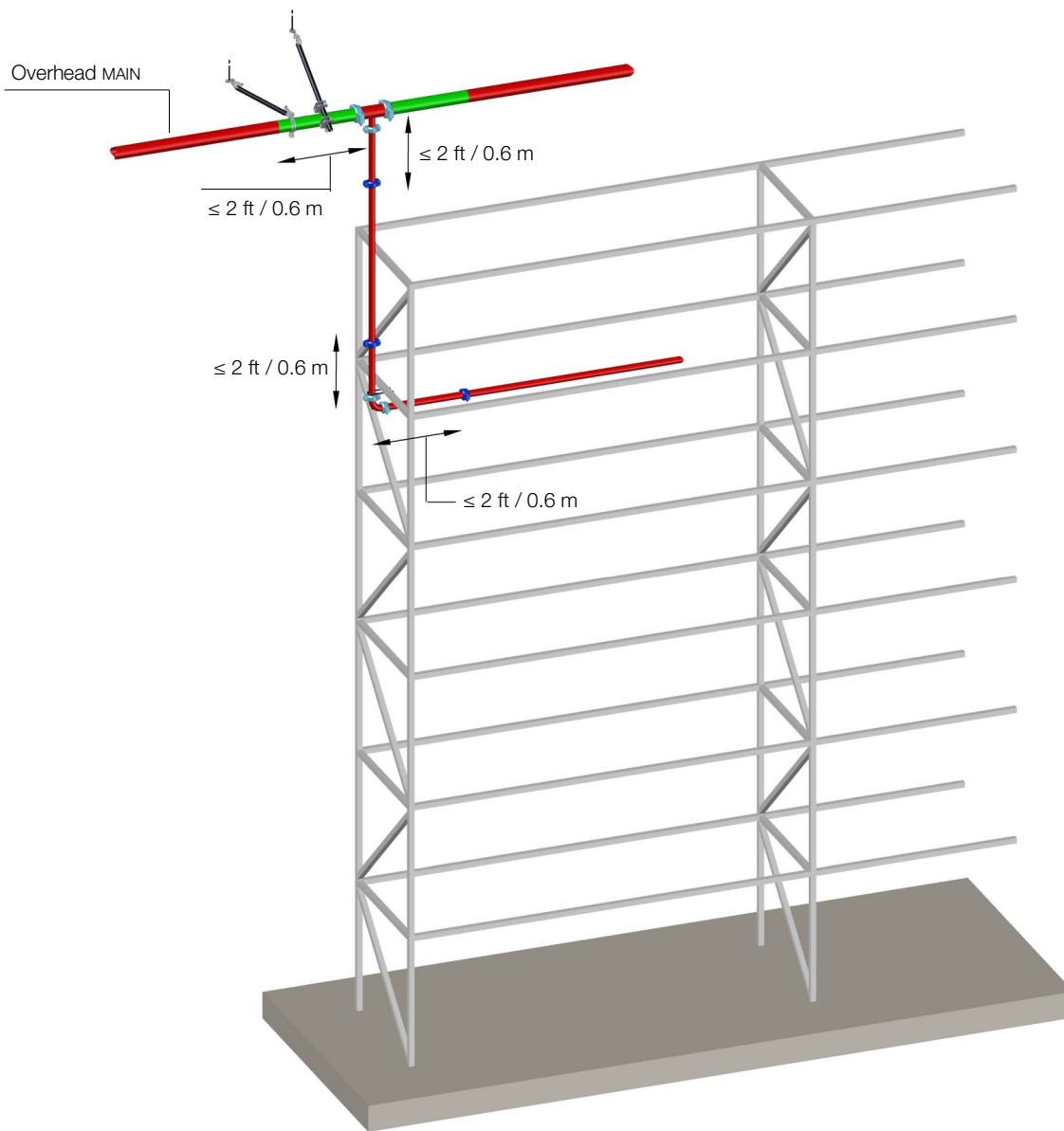
Provide a flexible coupling within 2 ft / 0.6 m above the initial in-rack sprinkler pipe DROP attachment to the rack.

Provide flexible coupling(s) on the horizontal portion of in-rack sprinkler piping within 2 ft / 0.6 m of the connections to vertical pipe DROPS .

Note: The pipe DROP attachments to the rack act as FOUR-WAY braces.

Note: The first pipe DROP attachment to the rack should be located as low as possible in order to allow for the maximum flexibility in the DROP.

Note: Bracing should be located along the in-rack horizontal sprinkler piping as for BRANCH LINES.



C2

IN-RACK SYSTEMS: FEED FROM AN END OF THE RACK

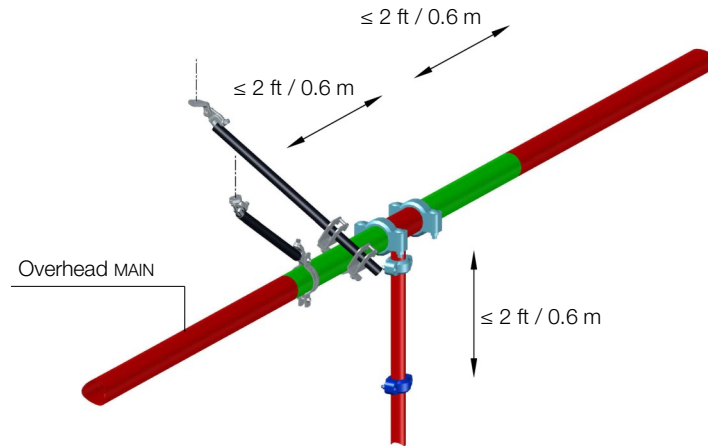
(2.2.1.4.5.D, 2.2.1.4.5.E, 2.2.1.4.5.F)

- Provide a FOUR-WAY brace within 2 ft / 0.6 m of the connection of pipe DROPS to the overhead feed piping.
- Provide a flexible coupling within 2 ft / 0.6 m of the connection of pipe DROPS to the overhead feed piping.
- Provide a flexible coupling within 2 ft / 0.6 m above the initial in-rack sprinkler pipe DROP attachment to the rack.
- Provide flexible coupling(s) on the horizontal portion of in-rack sprinkler piping within 2 ft / 0.6 m of the connections to vertical pipe DROPS.

Note: The pipe DROP attachments to the rack act as FOUR-WAY braces.

Note: The first pipe DROP attachment to the rack should be located as low as possible in order to allow for the maximum flexibility of the DROP.

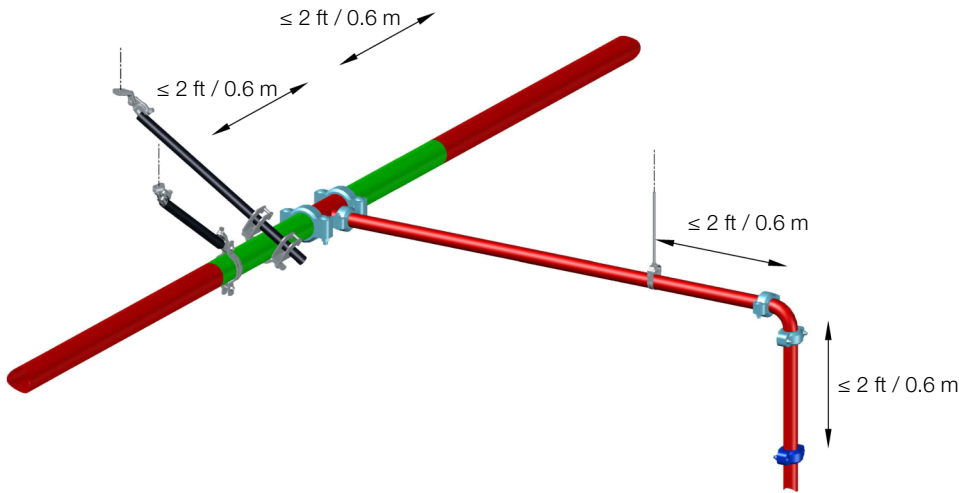
Note: Bracing should be located along the in-rack horizontal sprinkler piping as for BRANCH LINES.

**C1 d1 - C2 d1****IN-RACK FEED: VERTICAL DROP**

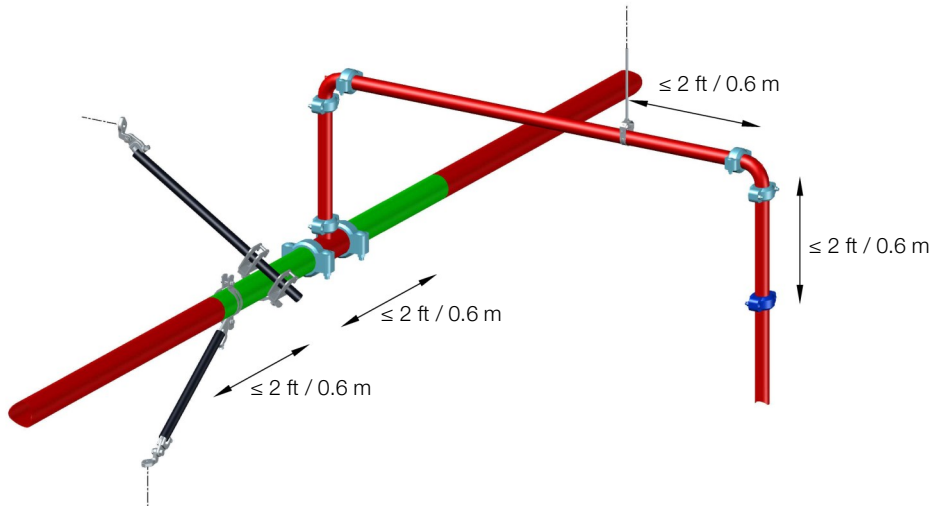
(2.2.1.4.5.D, 2.2.1.4.5.E, 2.2.1.4.5.F)

Provide a four-way brace within 2 ft / 0.6 m of the connection of pipe drops to the overhead feed piping.

Provide a flexible coupling within 2 ft / 0.6 m of the connection of pipe drops to the overhead feed piping.



C1 d2 - C2 d2



C1 d3 - C2 d3

IN-RACK FEED VIA AN ARMOVER

(2.2.1.4.5.D, 2.2.1.4.5.G)

Provide a FOUR-WAY brace within 2 ft / 0.6 m of the connection of pipe DROPS to the overhead feed piping.

When pipe DROPS supplying in-rack sprinklers are connected to overhead horizontal piping via an armover, provide a flexible coupling within 2 ft / 0.6 m of the connection of the pipe DROPS to the armover. No flexible couplings are needed on the armover.

However, provide a hanger of the type that will resist vertical upward movement per 2.2.1.8.1.B.

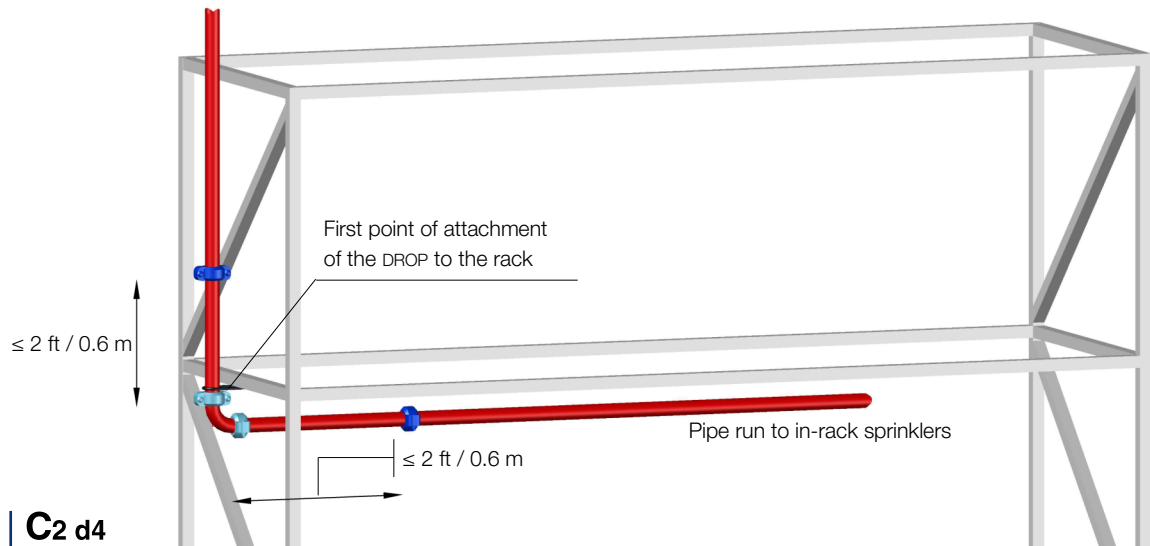
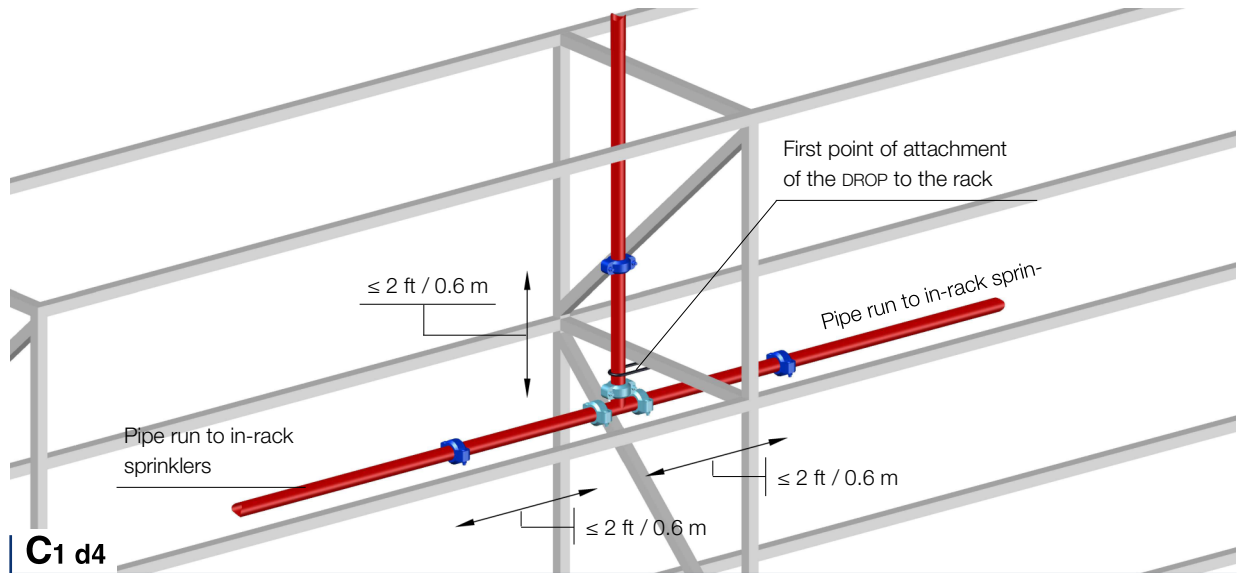
HANGERS

(2.2.1.8.1.B)

Provide hangers of the type that resist upward vertical movement at the following locations:

1. On all armovers to vertical pipe DROPS that supply more than one sprinkler, regardless of the length of the armover, located within 2 ft / 0.6 m of the DROP.
2. On all armovers greater than 2 ft / 0.6 m long that supply one sprinkler, located within 2 ft / 0.6 m of the DROP

Note that for very long armovers, hangers in addition to those recommended below will be needed when normal hanger spacing rules apply.



IN-RACK SPRINKLER: DROPS TO A TEE OR TO AN ELBOW

(2.2.1.4.5.E, 2.2.1.4.5.F)

Provide a flexible coupling within 2 ft / 0.6 m above the initial in-rack sprinkler pipe DROP attachment to the rack.

Provide flexible coupling(s) on the horizontal portion of in-rack sprinkler piping within 2 ft / 0.6 m of the connections to vertical pipe DROPS.

Note: The pipe DROP attachments to the rack act as FOUR-WAY braces.

Note: The first pipe DROP attachment to the rack should be located as low as possible in order to provide maximum flexibility in the DROP.

Note: Bracing should be located along the in-rack horizontal sprinkler piping same as BRANCH LINES (refer to section B of this handbook for further details)

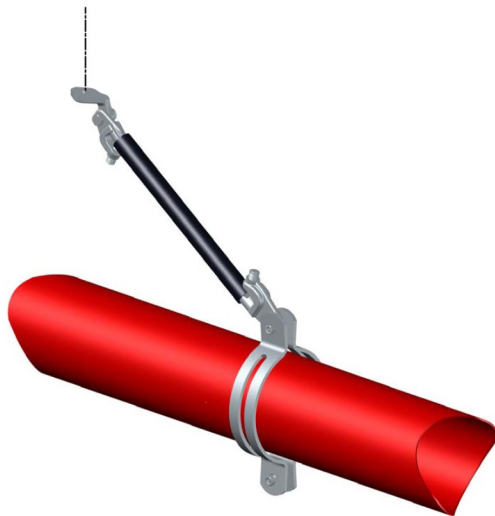
IN-RACK SPRINKLER SYSTEMS - FURTHER INSTRUCTIONS**(2.2.1.4.5.C)**

Provide a seismic separation assembly (SSA) where any piping crosses a building seismic expansion joint.





LATERAL SWAY BRACES
CSB_{LAT}



LONGITUDINAL SWAY BRACES
CSB_{LONG}



STRUCTURAL ATTACHMENTS
CSB_{STR}



CADDY SWAY BRACING

- All galvanized product line
- Works in conjunction with the CADDY bracing calculator for projects per FM guidelines and NFPA13 standard
- FM approved, all products tested and listed for FM projects world wide
- Innovative products minimize installation time
- Easy to inspect: snap-off bolt head enables easy installation and inspection
- Fastest to install sway braces
- Fewer tool changes: requires only one size wrench for installation on most products
- Minimized loose parts

USE WITH THE FOLLOWING BRACE PIPE TYPES

- ASTM SCH40
- AS1074 H
- EN 10255 H
- GBT 3091
- JIS 3454

USE TO BRACE THE FOLLOWING SPRINKLER / SERVICE PIPE TYPES

- | | | |
|--------------|--------------|--------------|
| • ASTM SCH40 | • ASTM SCH10 | • LIGHTWALL |
| • AS1074 H | • AS1074 M | • AS1074 L |
| • EN 10255 H | • EN 10255 M | • EN 10255 L |
| • GBT 3091 | • JIS 3452 | • EN 10220 |
| • JIS 3454 | | • GBT 8163 |

PART NUMBERS LEGEND

- CSB CADDY Sway Brace
- EZU, STU, QG, S1A, ETC. Product type: Easy Universal, STandard Universal, Quick Grip, Structural size 1 Assembly
- #### Pipe size, e.g. 0150 = 1 1/2" pipe
- EG, HD Finish (Electro-Galvanized / Hot Dipped galvanized)

For example, CSBEZU0400EG = CADDY Sway Brace Easy Universal 4" pipe ElectroGalvanized



UNIVERSAL SWAY BRACE—PART NUMBER CSB####, CSB####EG

Universal for lateral and longitudinal braces

Pipe to brace:

in.	1	1¼	1½	2	2½	3	4	5	6	8	10
DN	25	32	40	50	65	80	100	125	150	200	250

Brace pipe:

in.	1	1¼	1½	2
DN	25	32	40	50

Product information is available at erico.pentair.com

Available October 2017.





QUICK GRIP JR. LATERAL SWAY BRACE—PART NUMBER CSBQIKCL####EG

Pipe to brace:

in.	1	1¼	1½	2
DN	25	32	40	50

Brace pipe:

in.	1	1¼
DN	25	32

Product information is available at erico.pentair.com



QUICK GRIP LATERAL SWAY BRACE—PART NUMBER CSBQG####EG

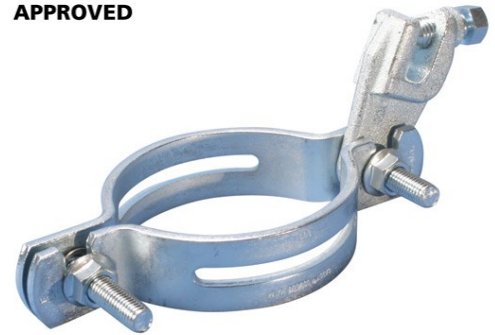
Pipe to brace:

in.	2½	3	4	6	8
DN	65	80	100	150	200

Brace pipe:

in.	1	1¼
DN	25	32

Product information is available at erico.pentair.com



EASY UNIVERSAL SWAY BRACE—PART NUMBER CSBEZU####EG

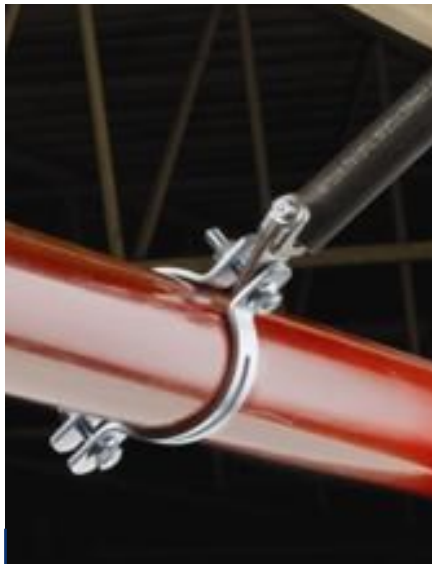
Pipe to brace:

in.	1	1¼	1½	2	2½	3	4	5	6
DN	25	32	40	50	65	80	100	125	150

Brace pipe:

in.	1	1¼	1½	2
DN	25	32	40	50

Product information is available at erico.pentair.com



STANDARD UNIVERSAL SWAY BRACE—PART NUMBER CSBSTU####EG

Pipe to brace:

in.	1	1¼	1½	2	2½	3	4	5	6	8	10
DN	25	32	40	50	65	80	100	125	150	200	250

Brace pipe:

in.	1	1¼	1½	2
DN	25	32	40	50

Product information is available at erico.pentair.com





UNIVERSAL SWAY BRACE—PART NUMBER CSB####, CSB####EG

Universal for lateral and longitudinal braces

Pipe to brace:

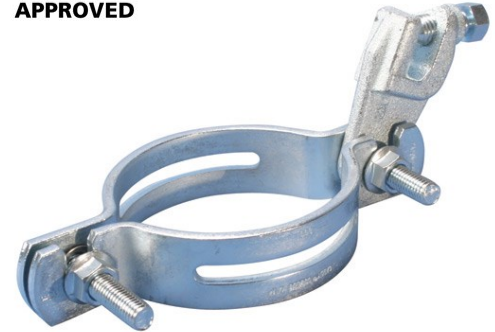
in.	1	1¼	1½	2	2½	3	4	5	6	8	10
DN	25	32	40	50	65	80	100	125	150	200	250

Brace pipe:

in.	1	1¼	1½	2
DN	25	32	40	50

Product information is available at erico.pentair.com

Available October 2017.



EASY UNIVERSAL SWAY BRACE —PART NUMBER CSBEZU####EG

Pipe to brace:

in.	1	1¼	1½	2	2½	3	4	5	6
DN	25	32	40	50	65	80	100	125	150

Brace pipe:

in.	1	1¼	1½	2
DN	25	32	40	50

Product information is available at erico.pentair.com



STANDARD UNIVERSAL SWAY BRACE —PART NUMBER CSBSTU####EG

Pipe to brace:

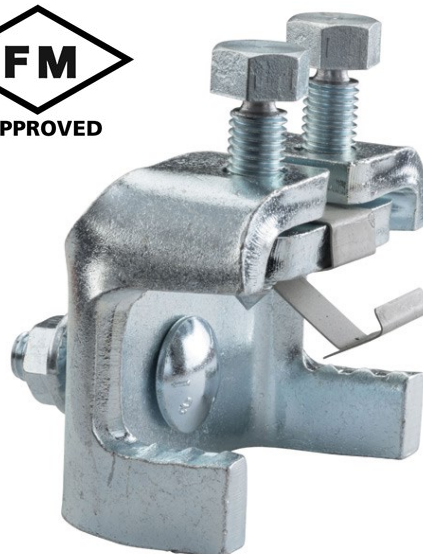
in.	1	1¼	1½	2	2½	3	4	5	6	8	10
DN	25	32	40	50	65	80	100	125	150	200	250

Brace pipe:

in.	1	1¼	1½	2
DN	25	32	40	50

Product information is available at erico.pentair.com



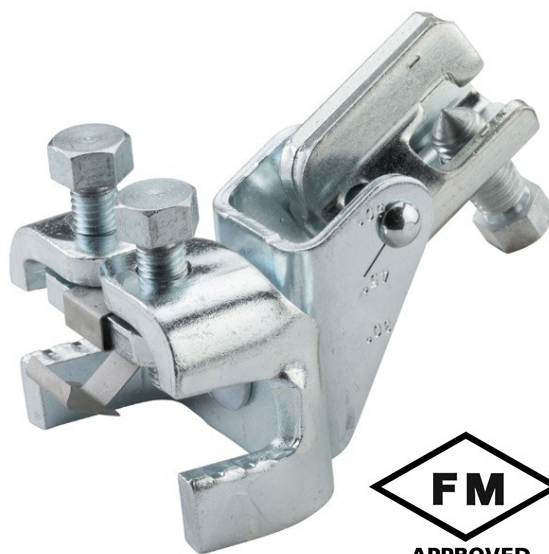


STEEL FLANGE ADAPTER —PART NUMBER CSBS#, CSBS#HD

Can be used on any structural flange including bar joists, beams, channels and angles.
 The brace can be orientated parallel or perpendicular to the direction of the structural element.

Product information is available at erico.pentair.com

Available October 2017.



STEEL FLANGE ADAPTER ASSEMBLY —PART NUMBER CSBS1A

Can be used on any structural flange including bar joists, beams, channels and angles.
 Preassembled to the Universal Structural Bracket.

Flange thickness: 1/4" - 3/4" / 6-19 mm

Product information is available at erico.pentair.com

Available October 2017.



BAR JOIST ATTACHMENT—PART NUMBER CSBBARJEG

Can be installed on bar joists or I-beams.

The brace can be oriented parallel or perpendicular to the direction of the structural element.

Flange thickness: 1/4" - 1/2" / 6.- 12 mm

Product information is available at erico.pentair.com



ADJUSTABLE I-BEAM ADAPTER—PART NUMBER CSBS#, CSBS#HD

The brace can be oriented parallel or perpendicular to the direction of the structural element.

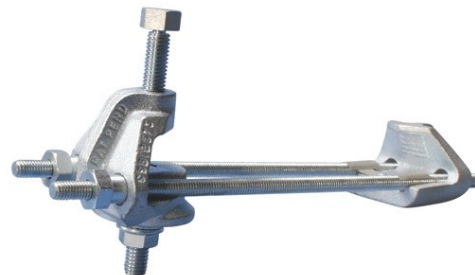
Range:

Flange thickness: 1/4" - 1 1/4" / 6 - 32 mm (3 PRODUCT SIZES)

Beam width: 4 " - 18" / 100 - 457 mm (3 PRODUCT SIZES)

Product information is available at erico.pentair.com

Available October 2017.



ADJUSTABLE I-BEAM ATTACHMENT—PART NUMBER CSBIB#####EG (FLANGE THICKNES AND MAX IBEAM SIZE)

The brace can be oriented parallel or perpendicular to the direction of the structural element.

Range:

Flange thickness: 1/4 INCH TO 1-1/4 INCH / 6- 32 mm (3 PRODUCT SIZES)

Beam width: 4 INCH—18 INCH / — 100 - 457 mm (3 PRODUCT SIZES)

Product information is available at erico.pentair.com





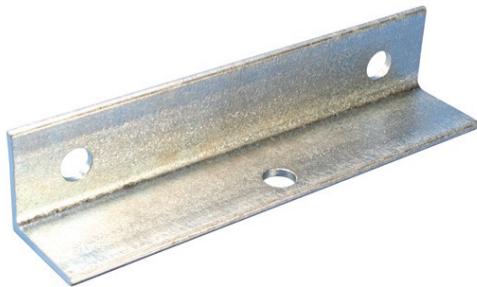
I-BEAM ATTACHMENT— PART NUMBER CSBBC075EG

Range:

Flange thickness: 1/4" - 3/4" / 6 - 12 mm

Product information is available at erico.pentair.com





MULTI ATTACHMENT — PART NUMBER CSBMA050050EG, CSBMA050075EG

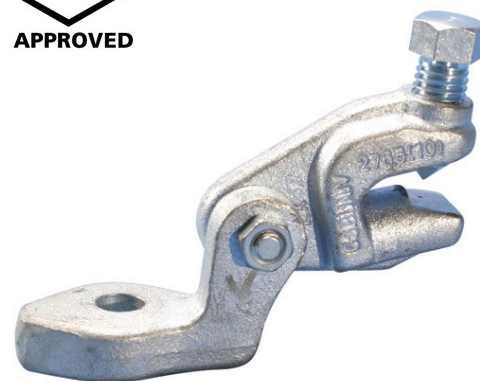
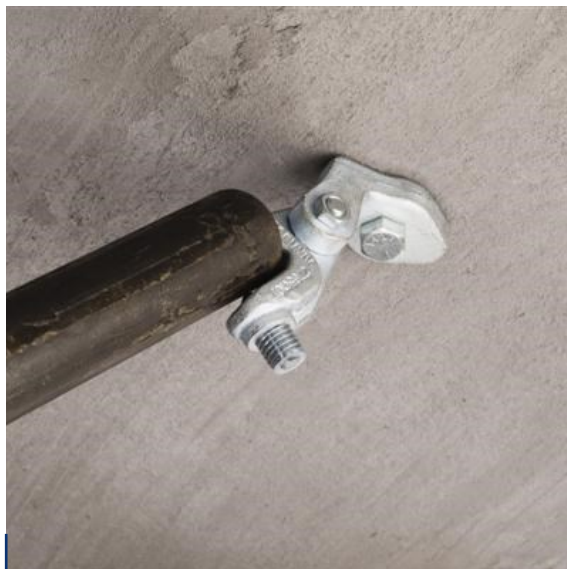
Enables to disperse the load over two anchors. Can be used for both LATERAL and LONGITUDINAL sway brace applications.

Attach to brace arm with Universal Structural Attachment Part Number CSBUNIV050EG or Stamped Universal Structural Attachment Part Number CSBU1, CSBU2, CSBU1HD and CSBU2HD

Range:

1/2" (M12) OR 3/4" (M20) STRUCTURAL CONNECTIONS

Product information is available at erico.pentair.com



UNIVERSAL STRUCTURAL ATTACHMENT—PART NUMBER CSBUNIV050EG, CSBUNIV075EG

Attaches directly to concrete, wood, bar joist or I-beam adapters.

Can be used for both LATERAL and LONGITUDINAL sway brace applications.

Equipped with snap-off bolt head which enable an easy installation and inspection of the SWAY BRACES.

Brace pipe:

in.	1	1¼	1½	2
DN	25	32	40	50

Product information is available at erico.pentair.com





UNIVERSAL STRUCTURAL BRACKET

Attaches directly to concrete, wood, bar joist, steel flange adapter, steel flange adapter assembly or I-beam adapters.

Can be used for both LATERAL and LONGITUDINAL sway brace applications.

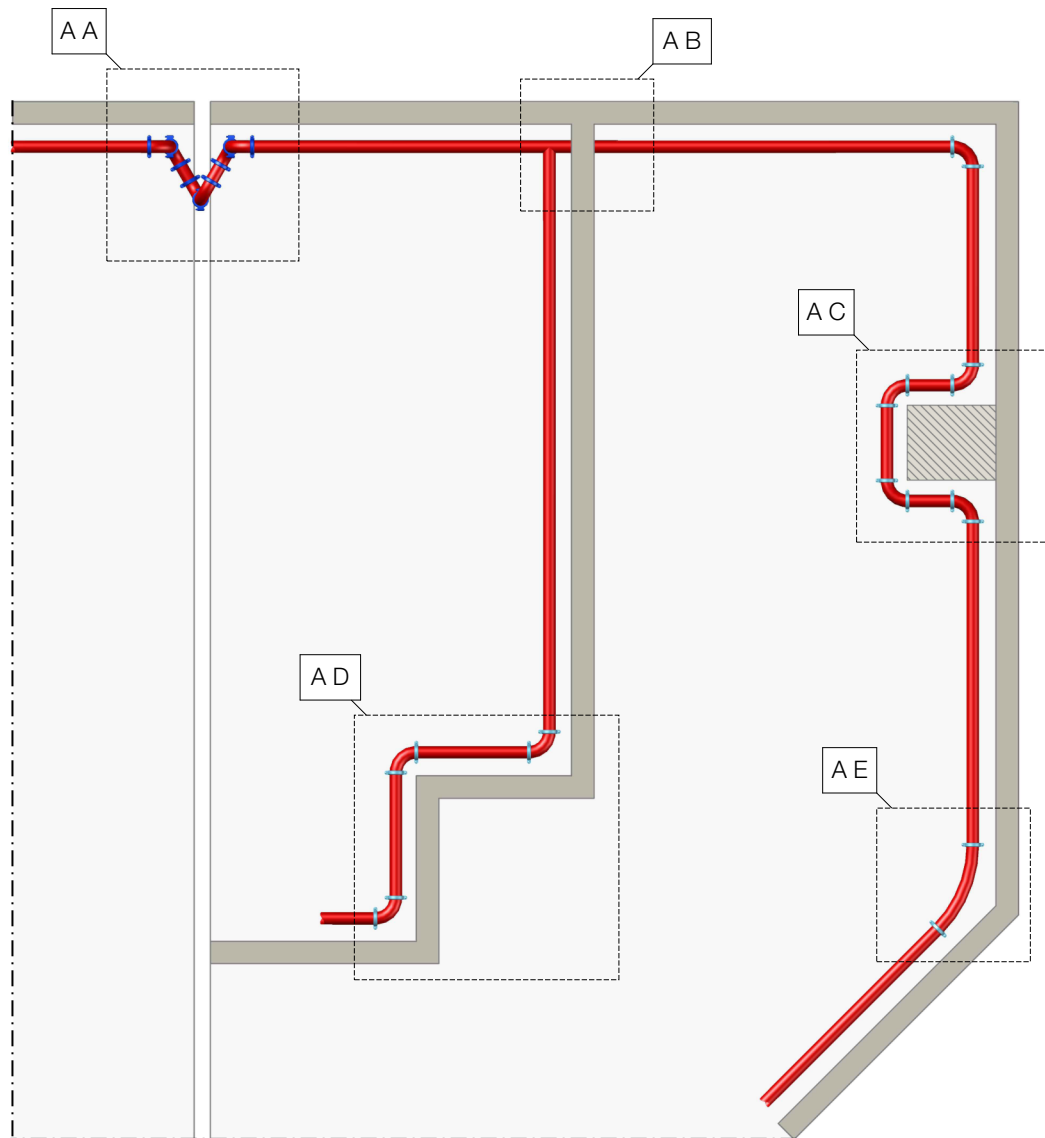
Equipped with snap-off bolt head which enable an easy installation and inspection of the SWAY BRACES.

Brace pipe:

in.	1	1¼	1½	2
DN	25	32	40	50

Product information is available at erico.pentair.com

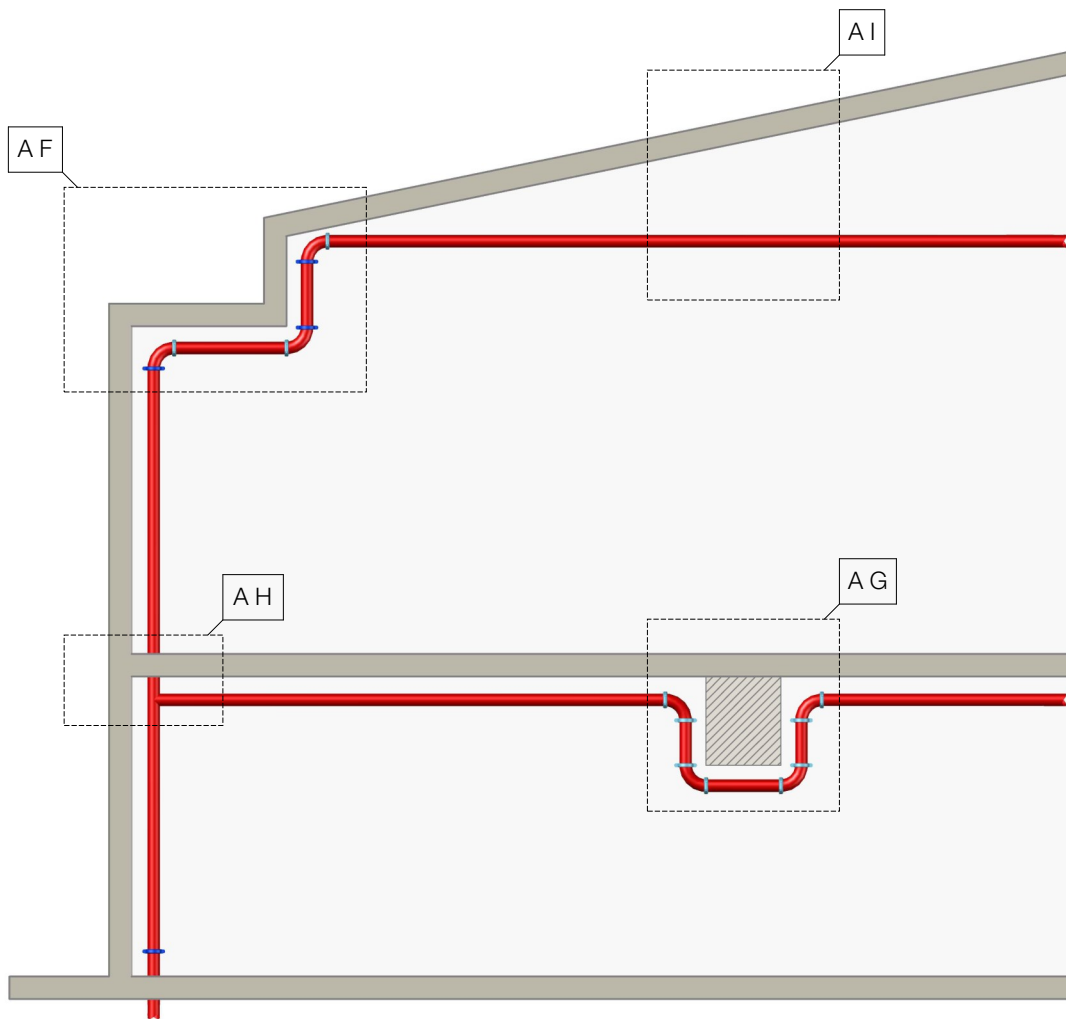
Available October 2017.



Plan view

APPLICATIONS

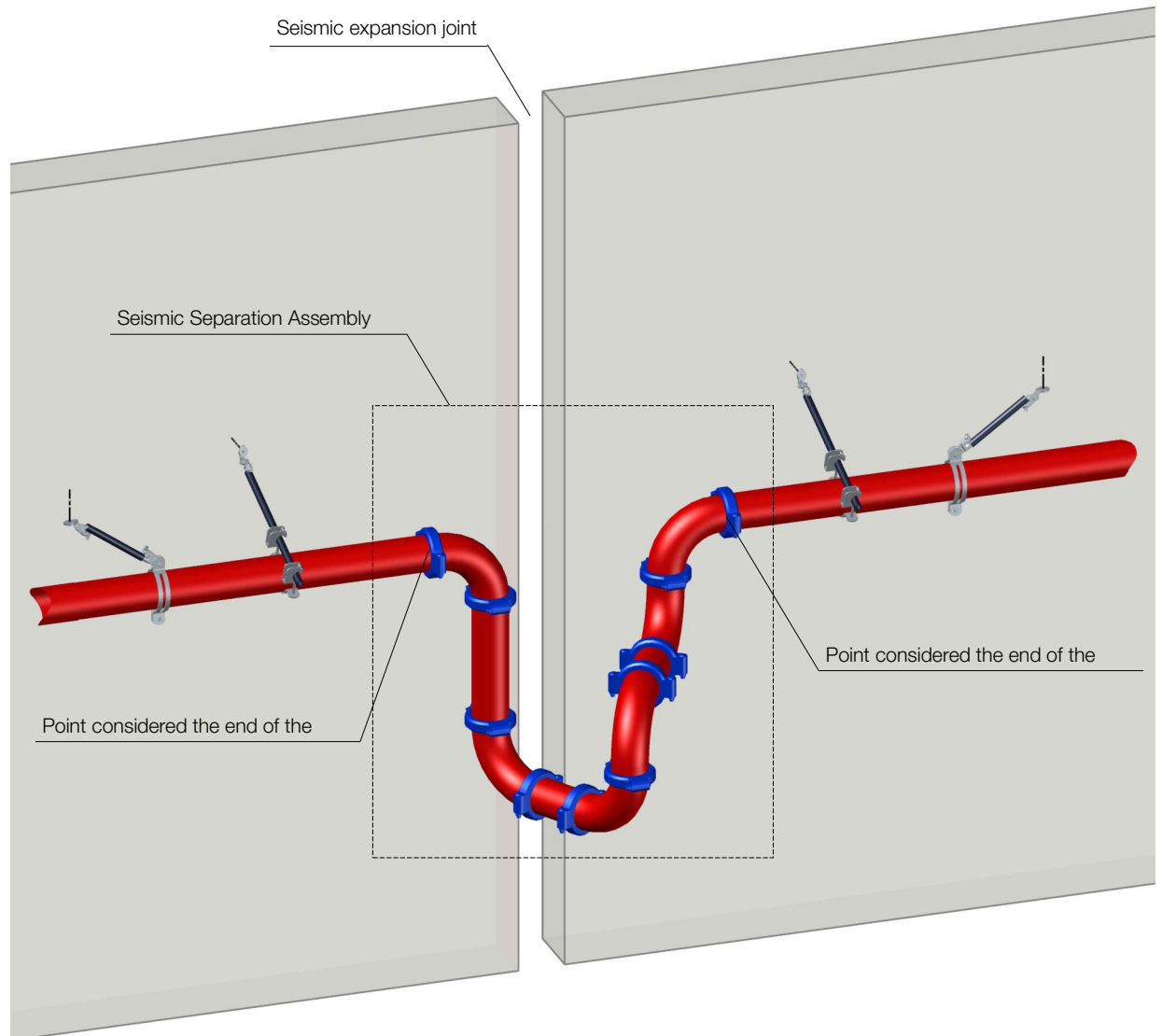
- A A) Crossings of seismic expansion joints
- A B) Wall penetrations
- A C) Obstacles avoidance
- A D) Horizontal changes of directions
- A E) Horizontal changes of directions: curves not at 90°



Section view

APPLICATIONS

- A F) RISERS with offsets, vertical changes of directions
- A G) Obstacles avoidance—Beams
- A H) Floor penetrations
- A I) Sloped ceilings



AA

CROSSINGS OF SEISMIC EXPANSION JOINTS

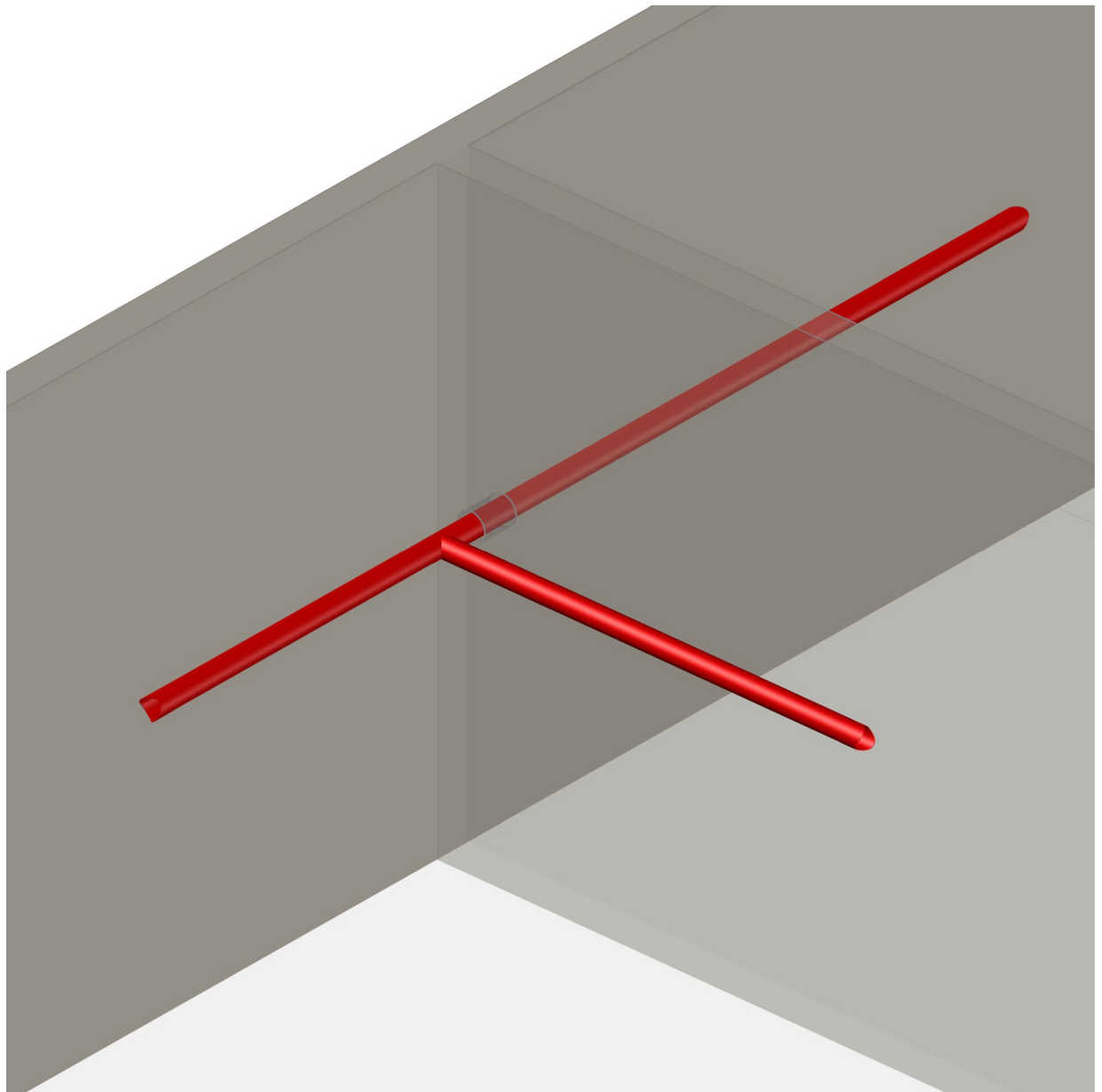
According to section 2.2.1.4.8, SEISMIC SEPARATION ASSEMBLIES (SSA) are to be installed on all fire protection system piping that crosses a building seismic expansion joint (including separations between two buildings) above ground level.

Each SEISMIC SEPARATION ASSEMBLY must be studied on a case by case basis taking under account the width of the joint so as to insure an appropriate degree of flexibility. Other engineered methods that provide an appropriate degree of flexibility in both the horizontal and the vertical planes are acceptable.

From a SWAY BRACE installation standpoint, as far as the CROSSMAINS/FEEDMAINS are concerned, section 2.2.1.1.4.B asks to consider seismic expansion joints and therefore SEISMIC SEPARATION ASSEMBLIES in CROSSMAINS/FEEDMAINS as the end of the piping on both sides of the assembly. Consequently, it is necessary to install a LATERAL sway brace within 6 ft / 1.8m of the end of the SSA and a LONGITUDINAL one within 40 ft / 12.2m of the end of the SSA. **(Please, refer to details C in the H section of this handbook)**

Sections 2.2.1.1.5.A.8 and 2.2.1.1.5.B.4 provide the same instructions for BRANCH LINES crossing seismic expansion joints.

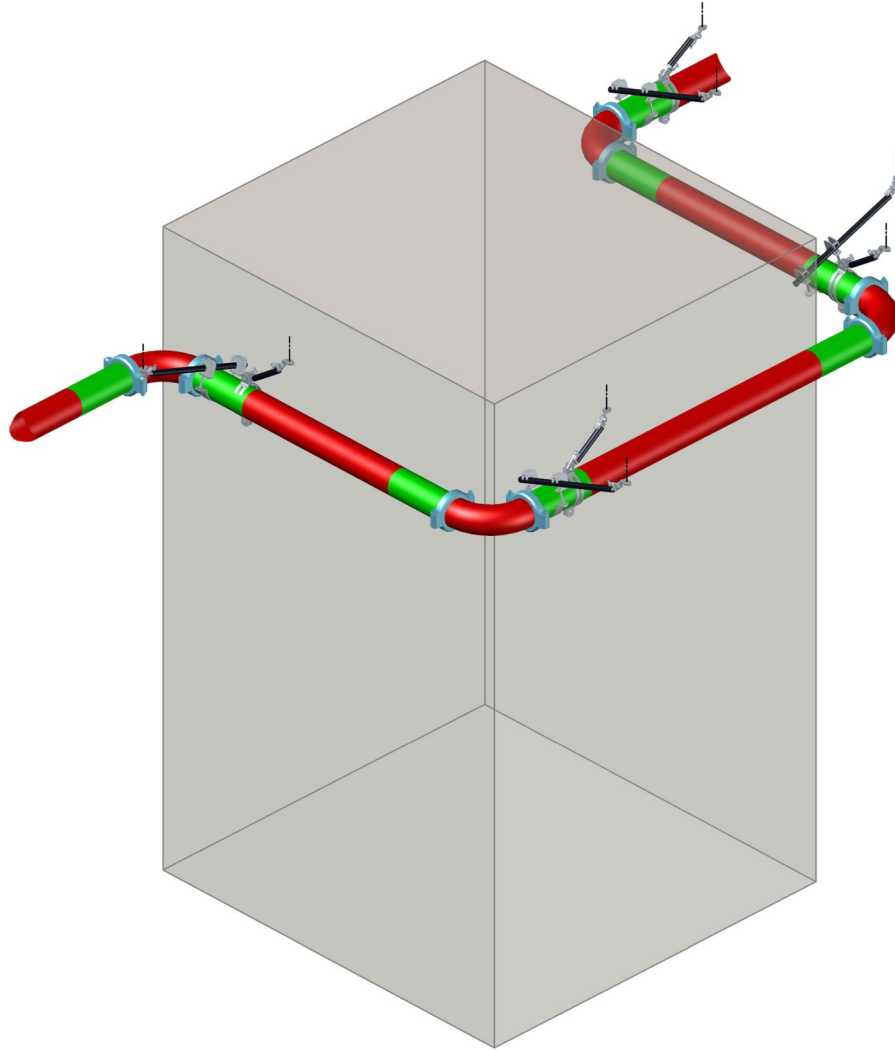


**WALLS PENETRATIONS**

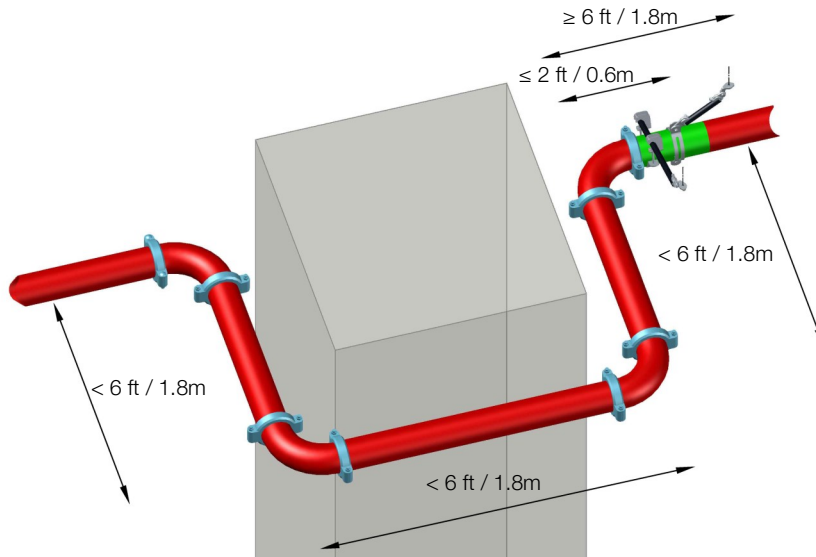
Please, refer to this Handbook:

- Section C for clearance specifications
- Sections H - details G for the horizontal feedmains/crossmains





**VERTICAL OBSTACLES AVOIDANCE
(SUCH AS PILLARS, STAIRWELLS, ELEVATORS, OR DISTRIBUTION SYSTEMS)**

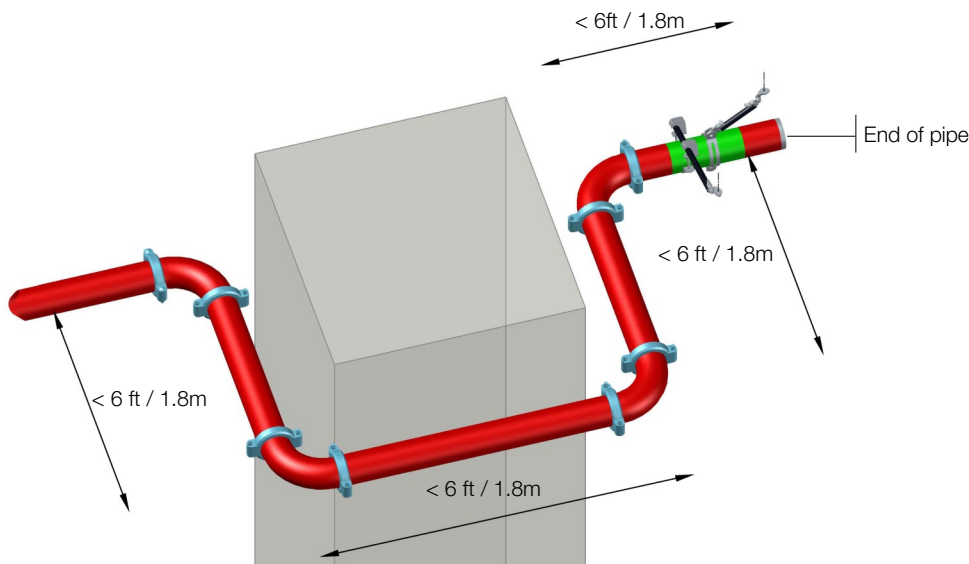


AC d1

HORIZONTAL CHANGES OF DIRECTION, OFFSET LESS THAN 6 ft / 1.8 m, RIGID COUPLINGS

When horizontal CROSSMAINS or FEEDMAINS need to avoid an obstacle (e.g. a pillar, a stairwell, elevator, or distribution systems), the instructions for horizontal CROSSMAINS or FEEDMAINS per 2.2.1.1.4.A may be applied.

When pipe runs adjacent to a horizontal change of direction are less than 6 ft / 1.8m, LATERAL and LONGITUDINAL sway bracing is not required as long as flexible couplings are not present in the change of direction. Conversely, when pipe runs adjacent to a horizontal change of direction are 6 ft / 1.8m long or more, both LATERAL and LONGITUDINAL sway bracing is required within 2 ft / 0.6m of the change of direction.

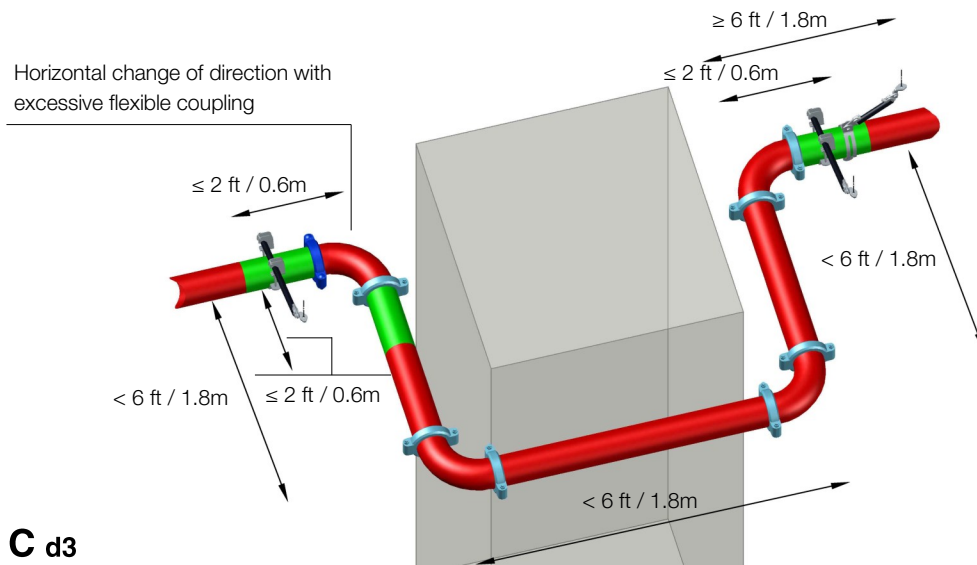


AC d2

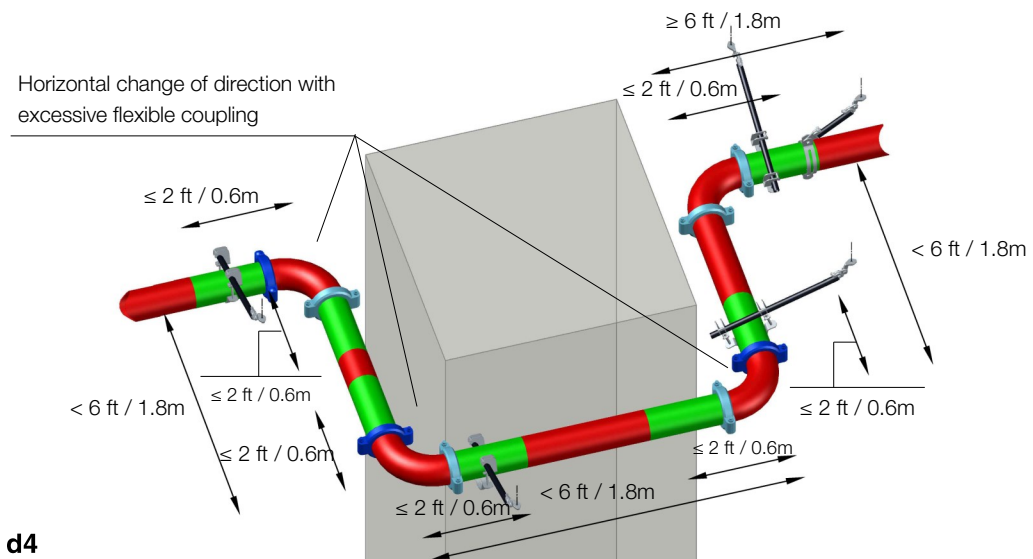
HORIZONTAL CHANGES OF DIRECTION AND END OF PIPE, OFFSET LESS THAN 6 ft / 1.8 m, RIGID COUPLINGS

When horizontal CROSSMAINS or FEEDMAINS need to avoid an obstacle (e.g. a pillar, a stairwell, elevator, or distribution systems), the instructions for horizontal CROSSMAINS or FEEDMAINS per 2.2.1.1.4.A may be applied.

When pipe runs adjacent to a horizontal change of direction are less than 6 ft / 1.8m, LATERAL and LONGITUDINAL sway bracing is not required as long as flexible couplings are not present in the change of direction. When the piping ends after avoiding the obstacle and the straight pipe run after the last curve is less than 6 ft / 1.8m, provide a LATERAL sway brace and a LONGITUDINAL sway brace respectively within within 6 ft / 1.8m and 40 ft / 12.2m of the end of the pipe.



A C d3



A C d4

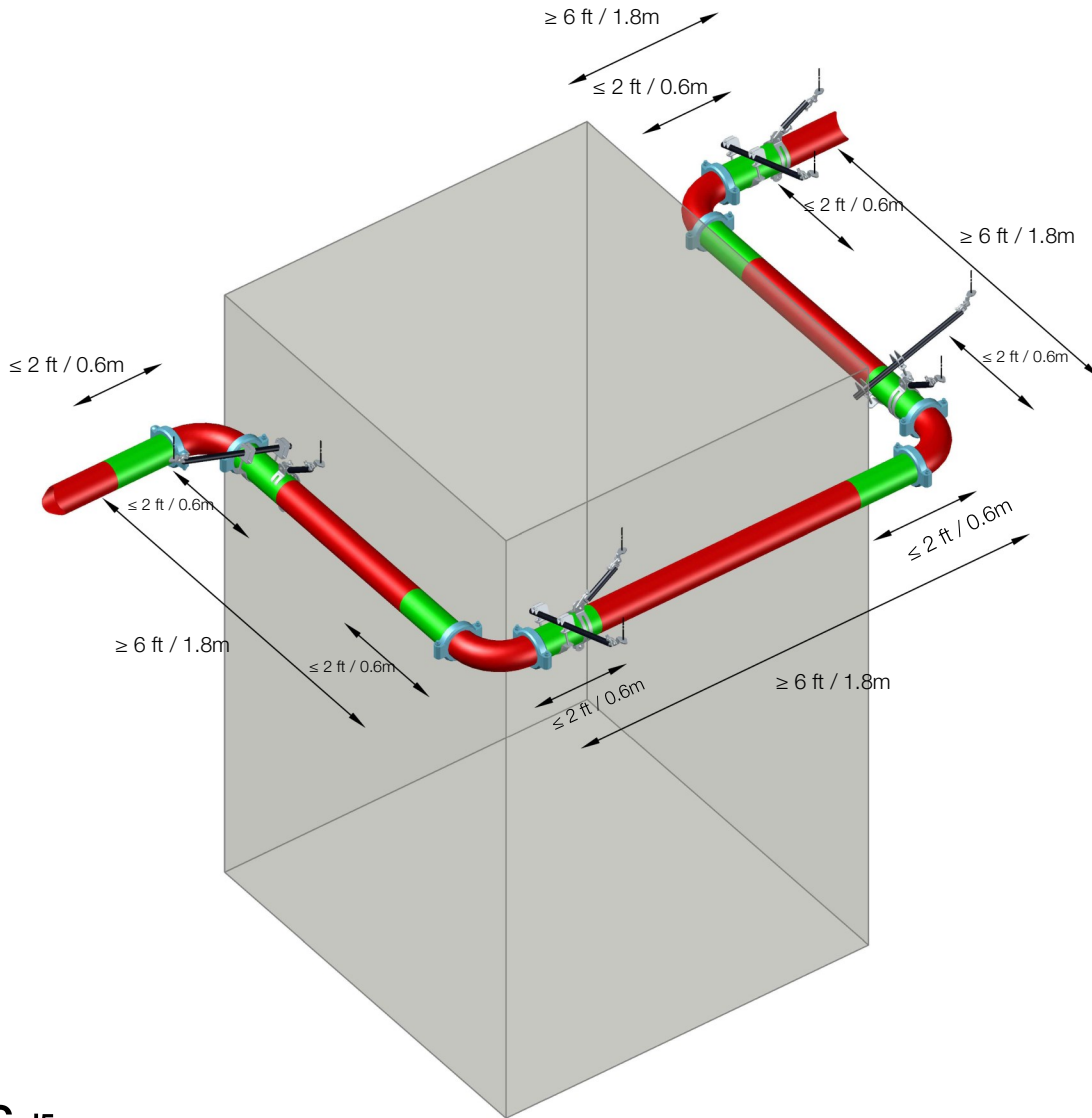
HORIZONTAL CHANGES OF DIRECTION, USE OF FLEXIBLE COUPLINGS, OFFSET LESS THAN 6 ft / 1.8 m

When horizontal CROSSMAINS or FEEDMAINS need to avoid an obstacle (e.g. a pillar, a stairwell, elevator, or distribution systems), the instructions for horizontal CROSSMAINS or FEEDMAINS per 2.2.1.1.4.A and 2.2.1.1.4.C may be applied.

When pipe runs adjacent to a horizontal change of direction are less than 6 ft / 1.8m, LATERAL and LONGITUDINAL sway bracing is not required as long as flexible couplings are not present in the change of direction. Conversely, when pipe runs adjacent to a horizontal change of direction are 6 ft / 1.8m long or more, both LATERAL and LONGITUDINAL sway bracing is required within 2 ft / 0.6m of the change of direction.

When flexible couplings are present within the changes of directions, for each flexible coupling present an additional LATERAL sway brace is to be located within 2 ft / 0.6m of the change of direction, no matter what is the length of the pipe run adjacent to the change of direction. When the piping diameter remains the same on both ends of the change of direction, the LATERAL sway brace may be indifferently located on one of the two runs as long as it is within 2 ft / 0.6m of the change of direction. On the other hand, when there is a change in piping diameter, place the LATERAL sway brace on the pipe run with the largest diameter.





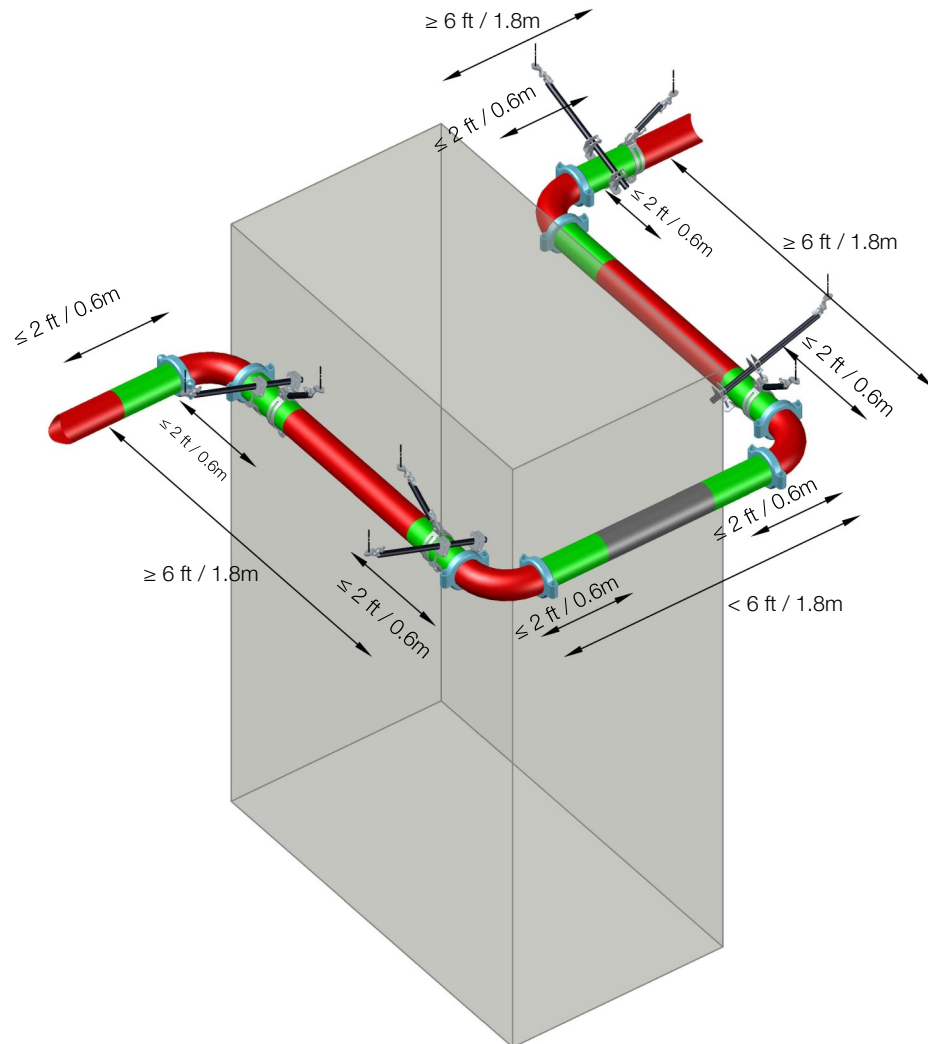
AC d5

HORIZONTAL CHANGES OF DIRECTIONS, OFFSET GREATER THAN 6 ft / 1.8 m, RUN GREATER THAN 6 ft / 1.8 m

When horizontal CROSSMAINS or FEEDMAINS need to avoid an obstacle (e.g. a pillar, a stairwell, elevator, or distribution systems), the instructions for horizontal CROSSMAINS or FEEDMAINS per 2.2.1.1.4.A may be applied.

Provide CROSSMAINS or FEEDMAINS piping with pipe runs of 6 ft / 1.8m or more adjacent to a horizontal change of direction with both LATERAL and LONGITUDINAL sway bracing within 2 ft / 0.6m of the change of direction.

Note: Bracing is required irrespective of type of coupling used in the system.

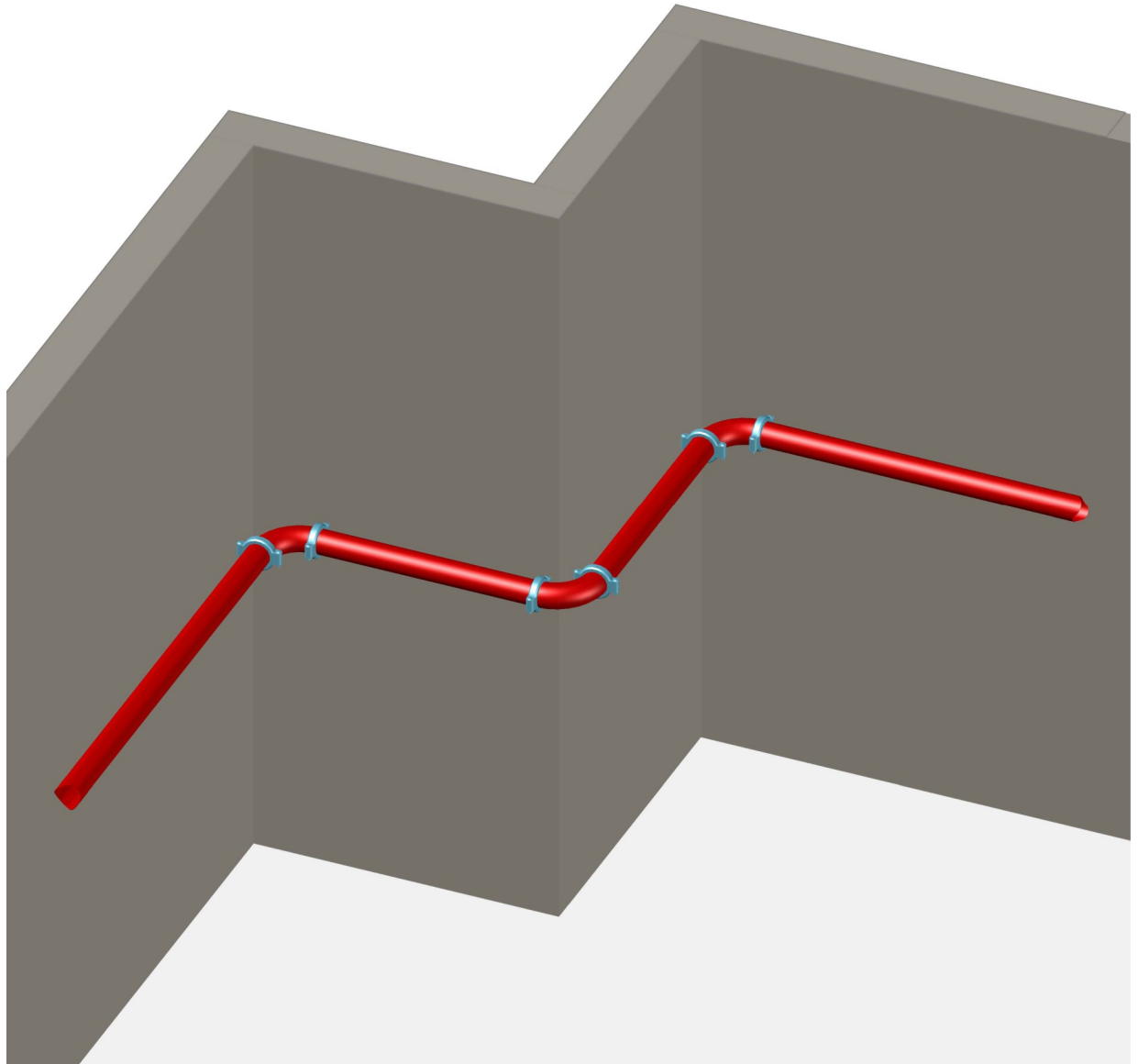
**A C d6****HORIZONTAL CHANGES OF DIRECTIONS, OFFSET GREATER THAN 6 ft, RUN LESS THAN 6 ft / 1.8 m**

When horizontal CROSSMAINS or FEEDMAINS need to avoid an obstacle (e.g. a pillar, a stairwell, elevator, or distribution systems), the instructions for horizontal CROSSMAINS or FEEDMAINS per 2.2.1.1.4.A may be applied.

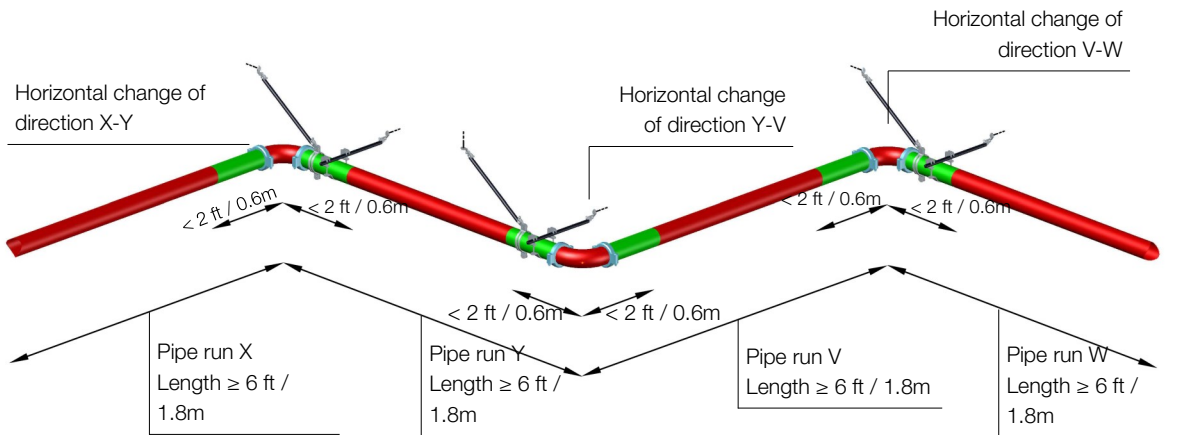
Provide CROSSMAINS or FEEDMAINS piping with pipe runs of 6 ft / 1.8m or more adjacent to a horizontal change of direction with both LATERAL and LONGITUDINAL sway bracing within 2 ft / 0.6m of the change of direction.

The required SWAY BRACES may also be located on the pipe run less than 6 ft / 1.8m long within 2 ft / 0.6m of the change of direction.





HORIZONTAL CHANGES OF DIRECTIONS AT 90° ANGLES



AD d1

HORIZONTAL CHANGES OF DIRECTIONS - 90° CURVES PIPE RUNS EQUAL OR GREATER THAN 6 ft / 1,8 m

The case presented uses the instructions from sections 2.2.1.1.4.A for the horizontal CROSSMAINS or FEEDMAINS and from sections 2.2.1.1.5.A.9 and 2.2.1.1.5.B.5 for the BRANCH LINES.

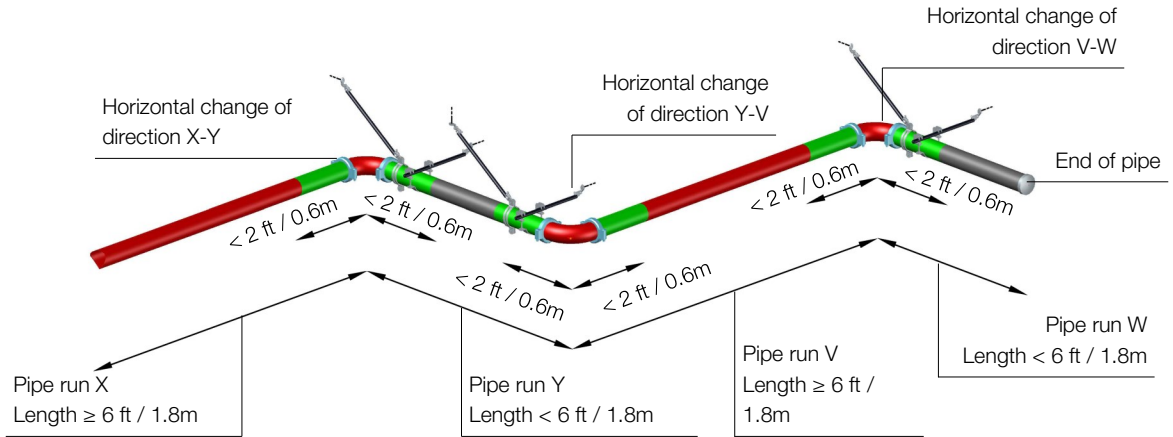
Pipe runs X and Y, adjacent to a horizontal change of direction, are 6 ft / 1.8m or more: providing LATERAL and LONGITUDINAL sway bracing within 2 ft / 0.6m of the change of direction X-Y itself is required. The SWAY BRACES may alternatively be located on the pipe run X or on the pipe run Y as long as they are within 2 ft / 0.6m of the change of direction.

Pipe runs Y and V, adjacent to a horizontal change of direction, are 6 ft / 1.8m or more: providing LATERAL and LONGITUDINAL sway bracing within 2 ft / 0.6m of the change of direction Y-V itself is required. The SWAY BRACES may alternatively be located on the pipe run Y or on the pipe run V as long as they are within 2 ft / 0.6m of the change of direction.

Pipe runs V and W, adjacent to a horizontal change of direction, are 6 ft / 1.8m or more: providing LATERAL and LONGITUDINAL sway bracing within 2 ft / 0.6m of the change of direction V-W itself is required. The SWAY BRACES may alternatively be located on the pipe run V or on the pipe run W as long as they are within 2 ft / 0.6m of the change of direction.

Please, note that a LATERAL [LONGITUDINAL] sway brace act as LONGITUDINAL [LATERAL] sway brace for the perpendicular pipe run.





A D d2

HORIZONTAL CHANGES OF DIRECTIONS - 90° CURVES PIPE RUNS LESS AND MORE THAN 6 ft / 1.8 m

The case presented uses the instructions from sections 2.2.1.1.4.A and 2.2.1.1.4.B for the horizontal CROSSMAINS or FEEDMAINS and from sections 2.2.1.1.5.A.8, 2.2.1.1.5.A.9, 2.2.1.1.5.B.4 and 2.2.1.1.5.B.5 for the BRANCH LINES.

Pipe run X is adjacent to an horizontal change of direction and is 6 ft / 1.8m or more, pipe run Y is less than 6 ft / 1.8m: providing LATERAL and LONGITUDINAL sway bracing is required within 2 ft / 0.6m of the X-Y change of direction itself. The SWAY BRACES may also be located on the pipe run Y within 2 ft / 0.6m of the change of direction. In that case, the LATERAL [LONGITUDINAL] sway brace must be sized as LONGITUDINAL [LATERAL] sway brace for the pipe run X.

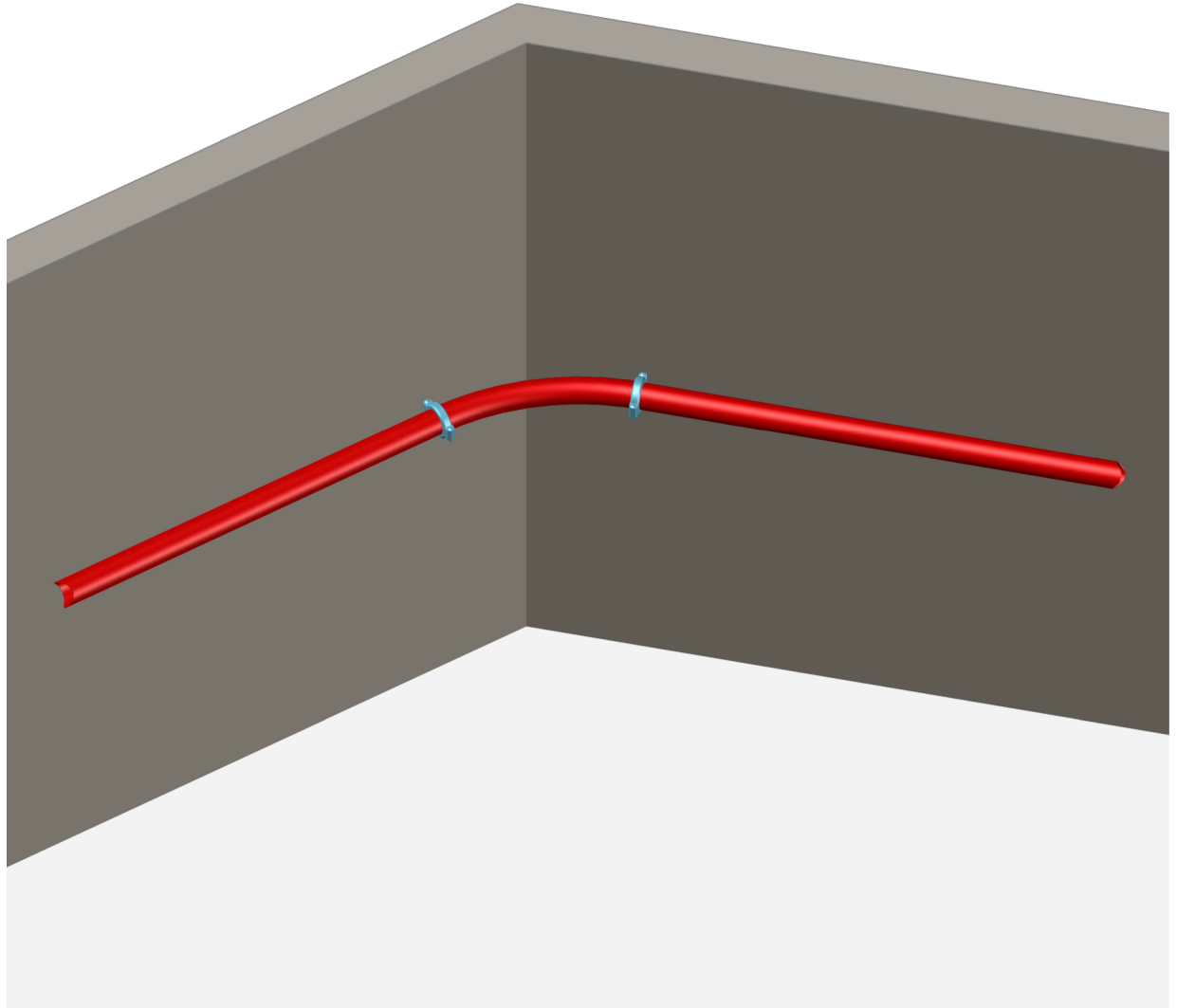
Pipe run Y is adjacent to a horizontal change of direction and is less than 6 ft / 1.8m, pipe run V is 6 ft / 1.8m or more: providing LATERAL and LONGITUDINAL sway bracing is required within 2 ft / 0.6m of the Y-V change of direction itself. The SWAY BRACES may also be located on the pipe run Y within 2 ft / 0.6m of the change of direction. In that case, the LATERAL [LONGITUDINAL] sway brace must be sized as LONGITUDINAL [LATERAL] sway brace for the pipe run V.

Pipe run V is adjacent to an horizontal change of direction and is 6 ft / 1.8m or more, pipe run W is less than 6 ft / 1.8m: providing LATERAL and LONGITUDINAL sway bracing is required within 2 ft / 0.6m of the V-W change of direction itself. The SWAY BRACES may also be located on the pipe run W within 2 ft / 0.6m of the change of direction. In that case, the LATERAL [LONGITUDINAL] sway brace must be sized as LONGITUDINAL [LATERAL] sway brace for the pipe run V.

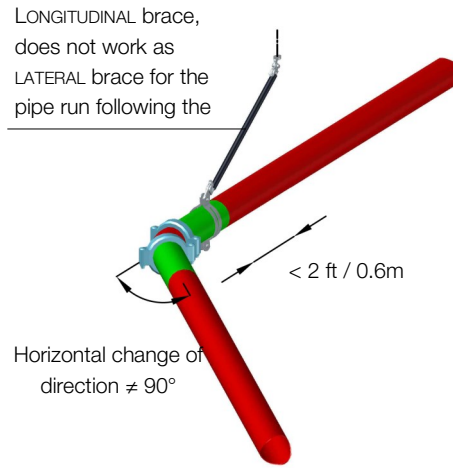
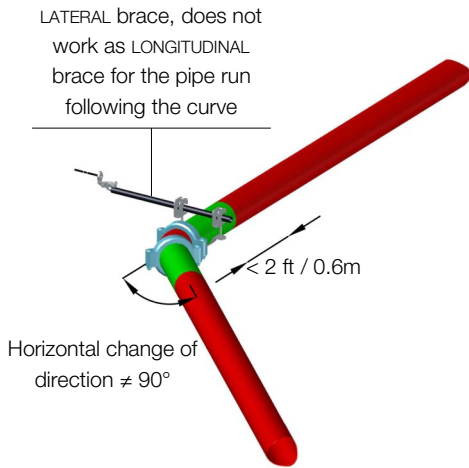
In any case, the last LATERAL sway brace is to be located within 6 ft / 1.8m of the end of the pipe and the last LONGITUDINAL within 40 ft / 12.2m of the end of the pipe.





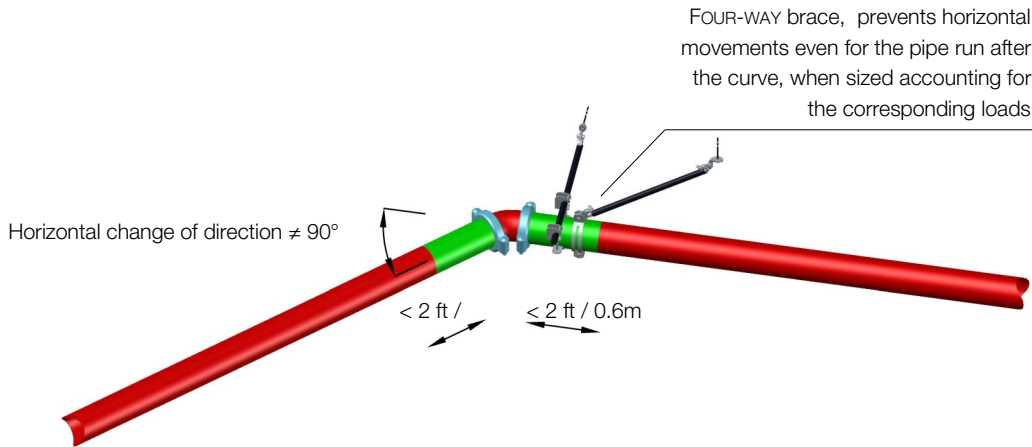


HORIZONTAL CHANGES OF DIRECTIONS, CURVES NOT AT 90 DEGREES



AE d1

AE d2



AE d3

HORIZONTAL CHANGES OF DIRECTIONS AT ANGLES OTHER THAN 90°

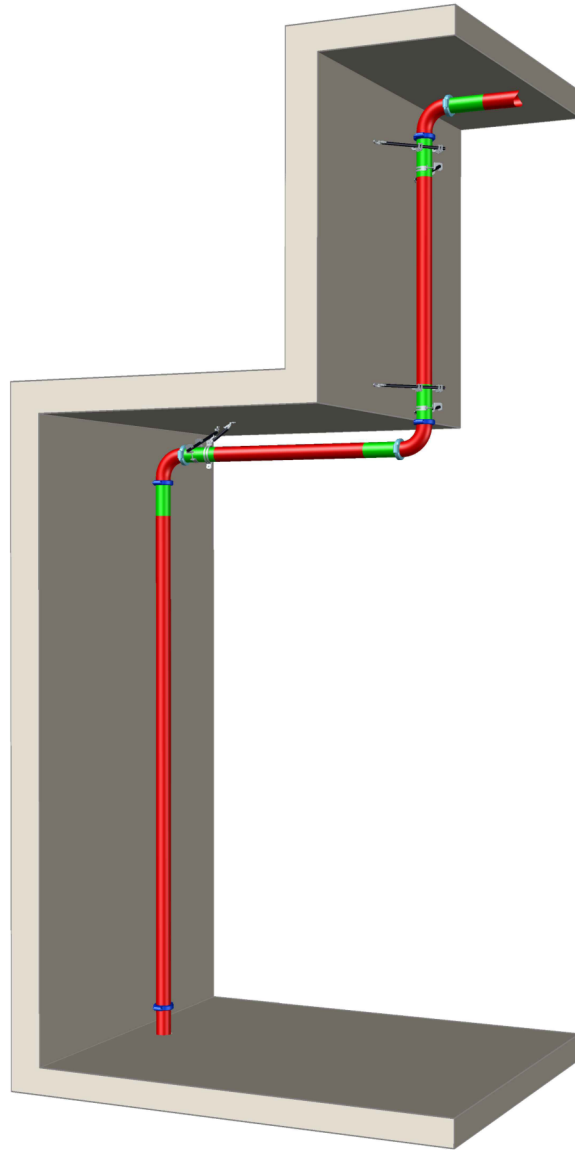
The case presented uses the provisions in section 2.2.1.1.4.A for the horizontal CROSSMAINS or FEEDMAINS and in sections 2.2.1.1.5.A.9 and 2.2.1.1.5.B.5 for the BRANCH LINES. **Please, refer respectively to sections H, and B, of the handbook for further information.**

As explained in Appendix C of FM Global Property Loss Prevention Data Sheet 2-8, for horizontal changes of directions at angles other than 90°, the use of a LATERAL [LONGITUDINAL] sway brace on the pipe run preceding the curve cannot act as LONGITUDINAL [LATERAL] sway brace for the pipe run that follows that curve.

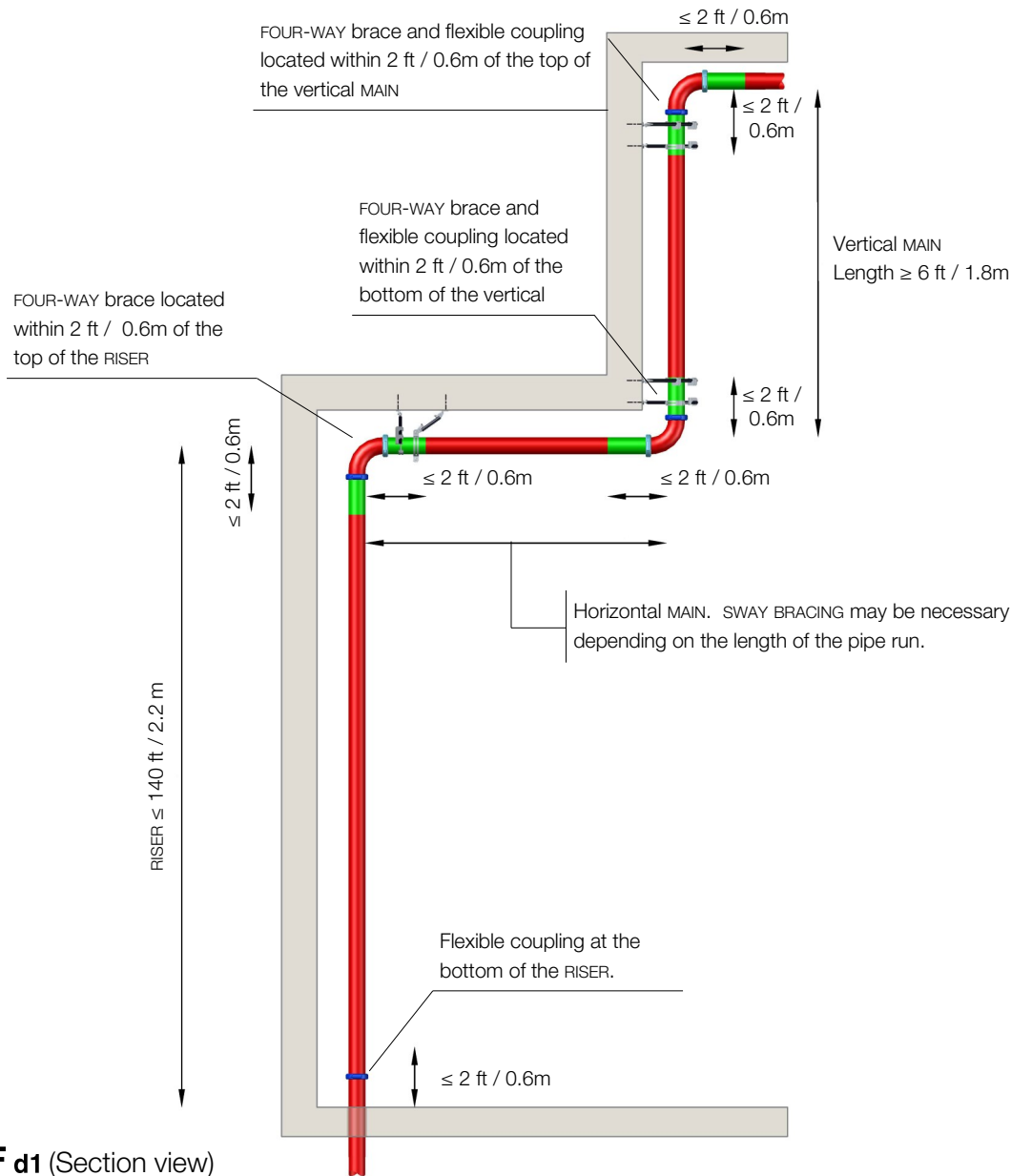
The use of a FOUR-WAY bracing, i.e. the combined use of a LATERAL and a LONGITUDINAL sway brace at the same point relative to a curve, ensures a bracing to movements in all horizontal directions, even for the run of pipe after the bend, provided it is sized taking under account the corresponding loads.

Note. FM Global Property Loss Prevention Data Sheet 2-0 allows bending sprinkler system piping to change horizontal direction. In such a case, the minimum radius of a bend is 12 pipe diameters. There are some exceptions relative to the minimum wall thickness in which case it is possible to reduce the radius of the bend to 6 pipe diameters (see FM Global Property Loss Prevention Data Sheet 2-0 — section 2.5.2.2).

The SWAY BRACES are to be located as previously indicated.



**RISERS WITH OFFSETS, VERTICAL CHANGES OF DIRECTIONS
(FOR INSTANCE A WALL PROJECTION)**



AF d1 (Section view)

RISERS WITH OFFSETS, VERTICAL CHANGES OF DIRECTIONS - VERTICAL MAIN GREATER THAN 6 ft / 1.8 m

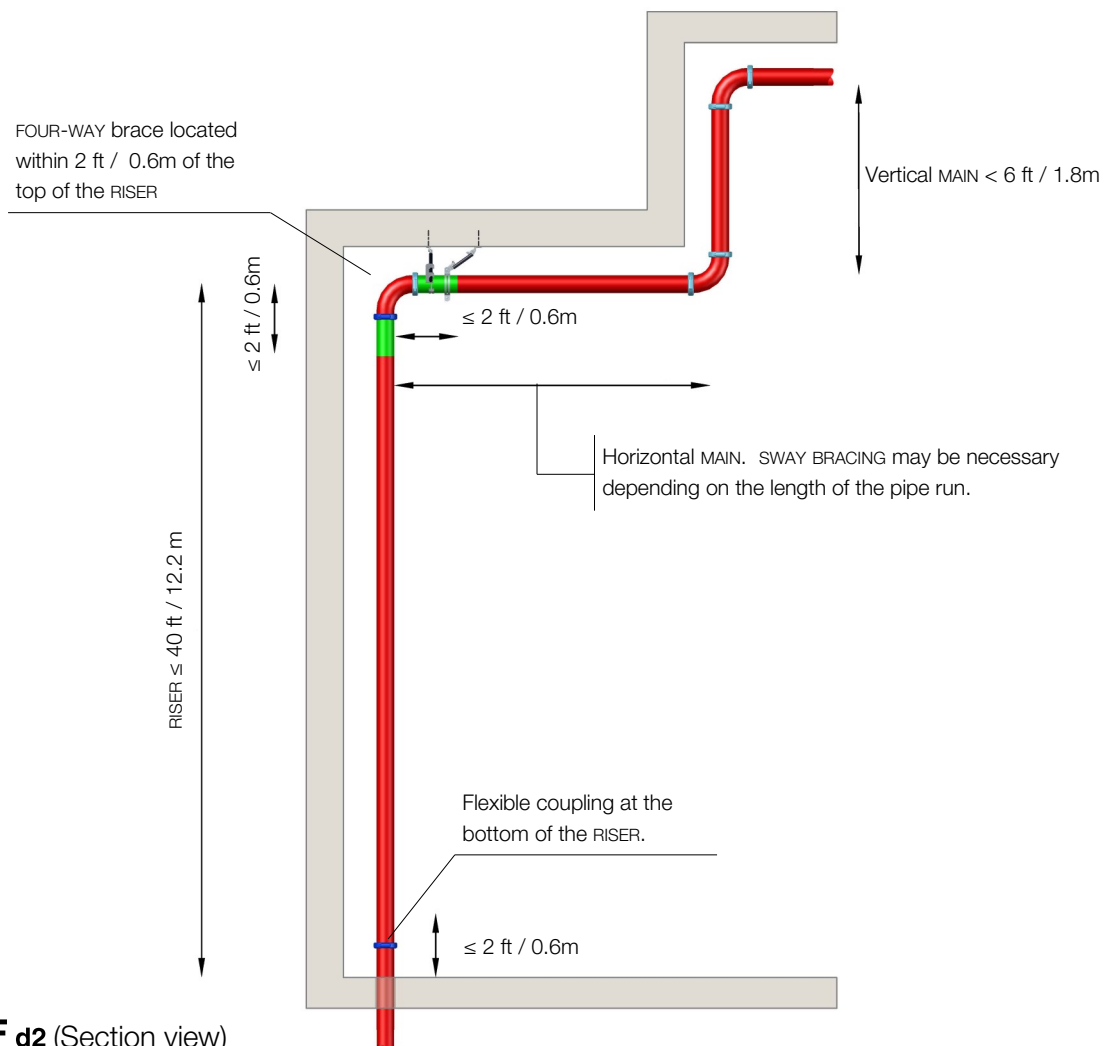
For the purpose of seismic bracing, the case in which RISERS need to overcome an obstacle may be divided into the succession of three elements: RISER—horizontal MAIN—vertical MAIN.

On RISERS, a flexible coupling is required within $2 \text{ ft} / 0.6 \text{ m}$ of the bottom and another flexible coupling and a FOUR-WAY brace are required within $2 \text{ ft} / 0.6 \text{ m}$ of the top. In the case presented the highest point of the vertical piping is considered the top of the RISER. (Refer to section R of the handbook for other instructions regarding RISERS.)

The FOUR-WAY brace located at the top of the RISER may be considered as the first LATERAL and the first LONGITUDINAL braces of the horizontal MAIN, as long as it is located within $2 \text{ ft} / 0.6 \text{ m}$ of the horizontal pipe run and is sized taking the loads from the horizontal piping also under account.

Depending on the length of the horizontal run, additional SWAY BRACES may be necessary. (Refer to section H of the handbook for further details.)

The next run of vertical piping is considered to be a vertical MAIN. If the length of this run is $6 \text{ ft} / 1.8 \text{ m}$ or more, a FOUR-WAY brace and a flexible coupling are required within $2 \text{ ft} / 0.6 \text{ m}$ of the top and the bottom of the pipe.

**A F d2** (Section view)**RISERS WITH OFFSETS, VERTICAL CHANGES OF DIRECTIONS - VERTICAL MAIN LESS THAN 6 ft / 1.8 m**

For the purpose of seismic bracing, the case in which RISERS need to overcome an obstacle may be divided into the succession of three elements: RISER—horizontal MAIN—vertical MAIN.

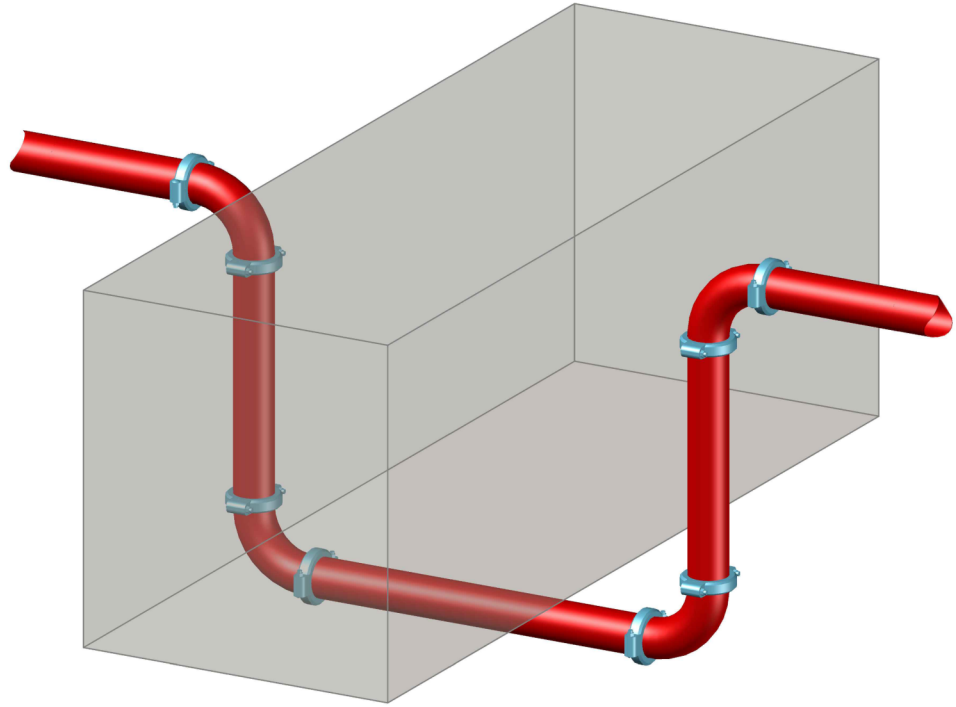
On RISERS, a flexible coupling is required within 2 ft / 0.6m of the bottom and another flexible coupling and a FOUR-WAY brace are required within 2 ft / 0.6m of the top. In the case presented the highest point of the first run of vertical piping is considered the top of the RISER. (Refer to section R of the handbook for other instructions regarding RISERS.)

The FOUR-WAY brace located at the top of the RISER may be considered as the first LATERAL and the first LONGITUDINAL braces of the horizontal MAIN, as long as it is located within 2 ft / 0.6m of the horizontal pipe run and is sized taking the loads from the horizontal piping also under account.

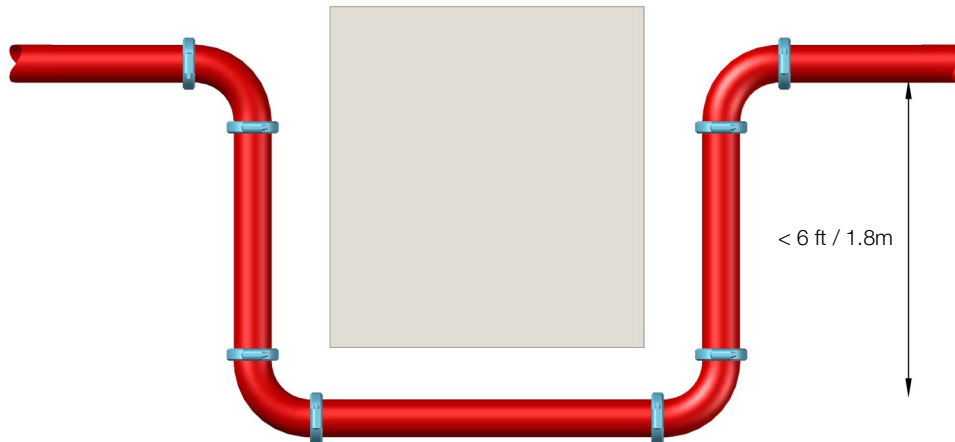
Depending on the length of the horizontal run, additional SWAY BRACES may be necessary. (Refer to section H of the handbook for further details.)

The next run of vertical piping is considered to be a vertical MAIN. If the length of this run is less than 6 ft / 1.8m and there are no flexible couplings at the bottom and at the top of the vertical run, FOUR-WAY bracing is not required at the bottom or at the top of the piping.





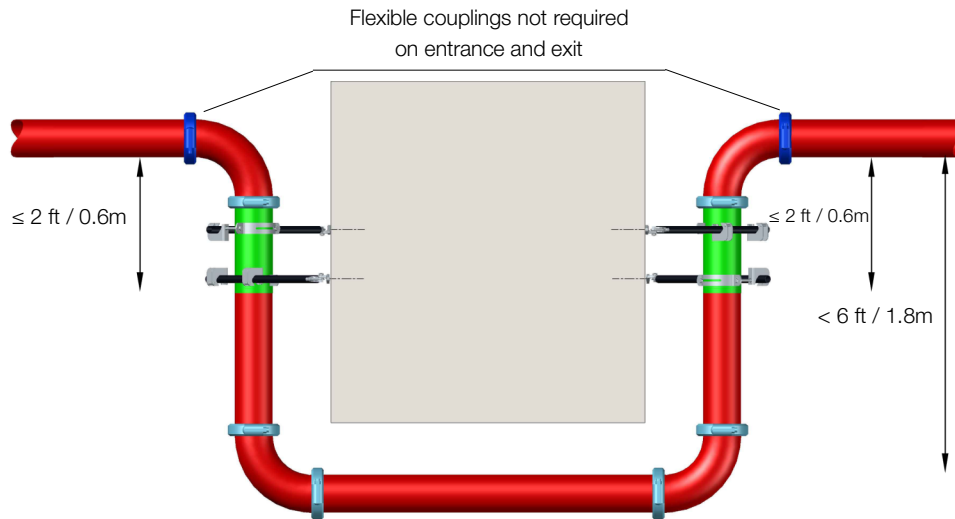
**NAVIGATING HORIZONTAL OBSTACLES
(FOR INSTANCE BEAMS, DISTRIBUTION SYSTEMS)**

**A G d1** (Section view)**VERTICAL OFFSET LESS THAN 6 ft / 1.8 m NO FLEXIBLE COUPLINGS**

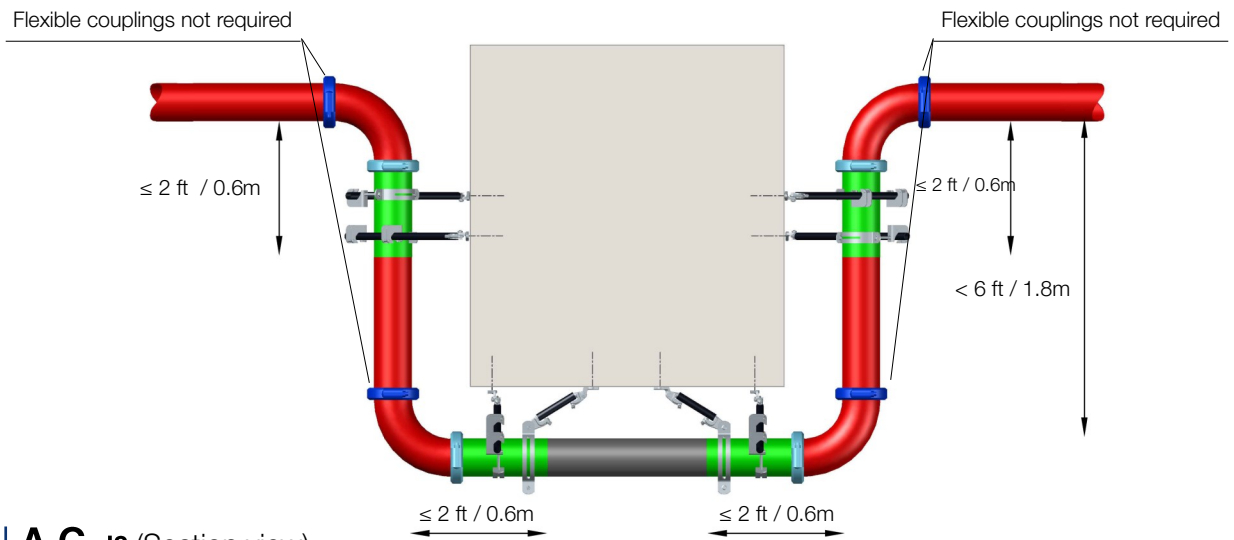
The case of CROSSMAINS or FEEDMAINS needing to avoid an obstacle (e.g. a wide beam or other piping systems) can be addressed using the provisions in section 2.2.1.1.3 for vertical CROSSMAINS or FEEDMAINS.

When the length of vertical pipe run necessary to go around the obstacle is less than 6 ft / 1.8m, FOUR-WAY bracing is not necessary at the bottom or at the top of the vertical run, as long as no flexible couplings are being used in connection with the horizontal piping.

The horizontal pipe run may require SWAY BRACING depending on its length, according to the provisions in section 2.2.1.1.4 for horizontal CROSSMAINS or FEEDMAINS.



AG d2 (Section view)



AG d3 (Section view)

VERTICAL OFFSET LESS THAN 6 ft / 1.8 m WITH FLEXIBLE COUPLINGS

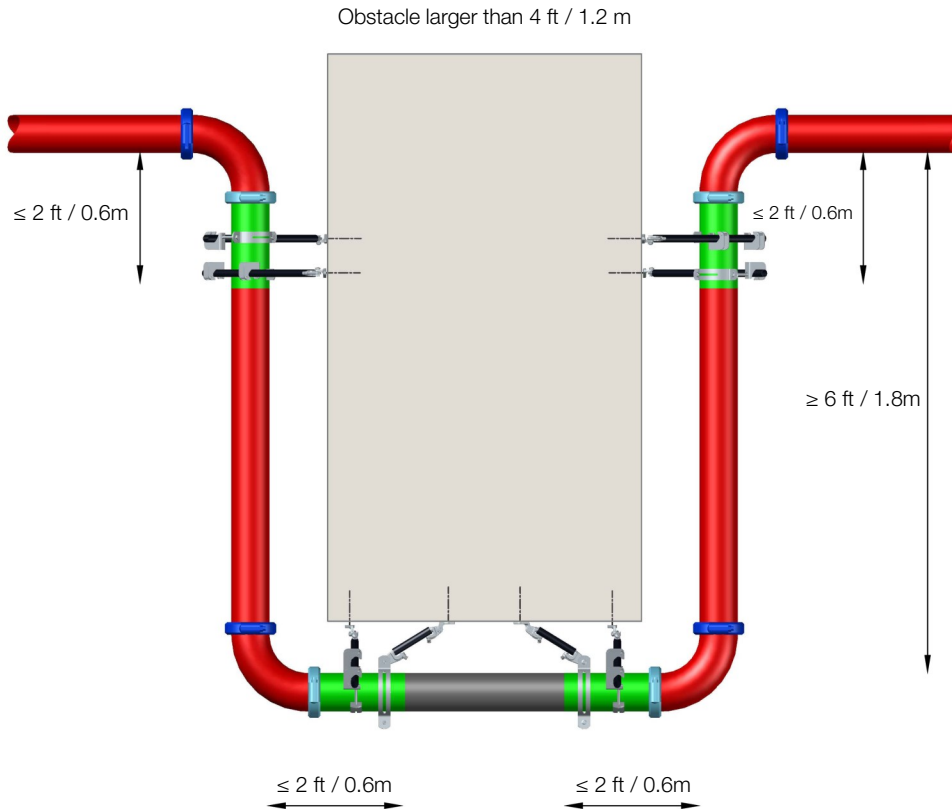
The case of CROSSMAINS or FEEDMAINS needing to avoid an obstacle (e.g. a wide beam or other piping systems) can be addressed using the provisions in section 2.2.1.1.3 for vertical CROSSMAINS or FEEDMAINS.

When the length of vertical pipe run necessary to go around the obstacle is less than 6 ft / 1.8m but flexible couplings are part of the connection to the horizontal piping, a FOUR-WAY brace is required at each of the connection in which there is a flexible coupling. Locate the FOUR-WAY brace within 2 ft / 0.6m of the connection.

The horizontal pipe run may require SWAY BRACING depending on its length, according to the provisions in section 2.2.1.1.4 for horizontal CROSSMAINS or FEEDMAINS.

Note. When it is not possible to attach the SWAY BRACES directly to the element avoided (in the case of non structural elements for instance), it is necessary to arrange for an auxiliary structure to which to anchor.





AG d4 (Section view)

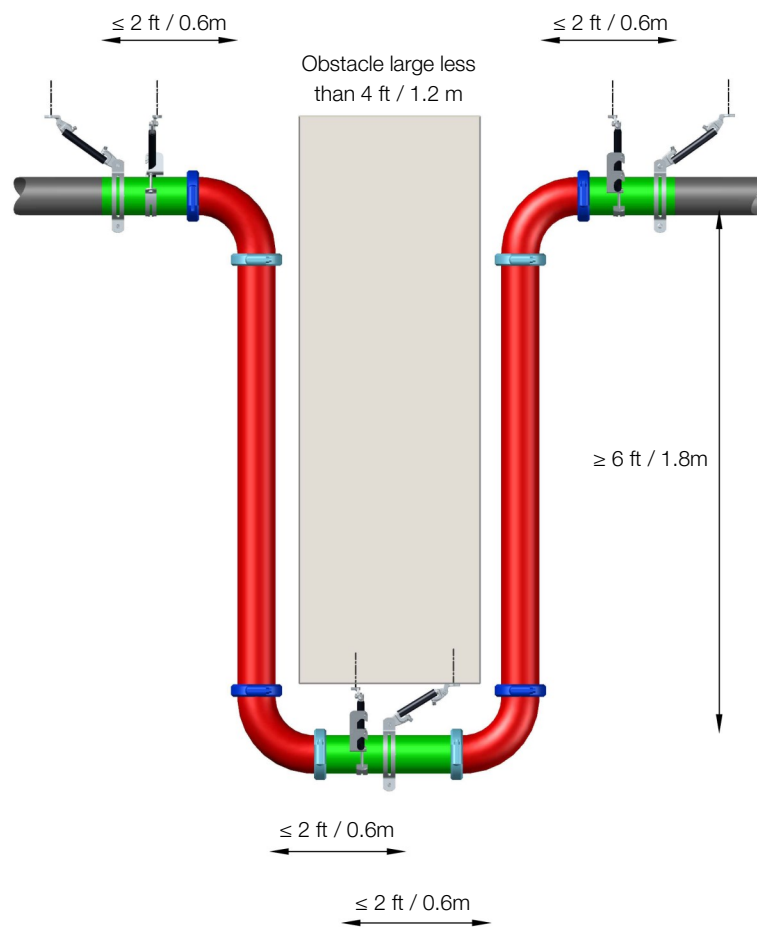
VERTICAL OFFSET GREATER THAN 6 ft / 1.8 m, WITH MULTIPLE FLEXIBLE COUPLINGS, HORIZONTAL RUN GREATER THAN 4 ft / 1.2 m

The case of CROSSMAINS or FEEDMAINS needing to avoid an obstacle (e.g. a wide beam or other piping systems) can be addressed using the provisions in section 2.2.1.1.3 e 2.2.1.4.4.B for vertical CROSSMAINS or FEEDMAINS.

When the length of vertical pipe run necessary to go around the obstacle is 6 ft / 1.8m or more, FOUR-WAY bracing is necessary at the bottom and at the top of the vertical pipe run. The FOUR-WAY brace is to be located within 2 ft / 0.6m of the bottom and of the top of the vertical pipe run. It is also necessary to locate a flexible coupling at the bottom and at the top of the vertical pipe run. These flexible couplings are to be located within 2 ft / 0.6m of the bottom and of the top of the vertical pipe run.

The run of horizontal piping that connects the two vertical pipe runs may require SWAY BRACING depending on its length, as per the provisions in section 2.2.1.1.4 for horizontal CROSSMAINS or FEEDMAINS.

Note. When it is not possible to attach the SWAY BRACES directly to the element avoided (in the case of non structural elements for instance), it is necessary to arrange for an auxiliary structure to which to anchor.



A G d5 (Section view)

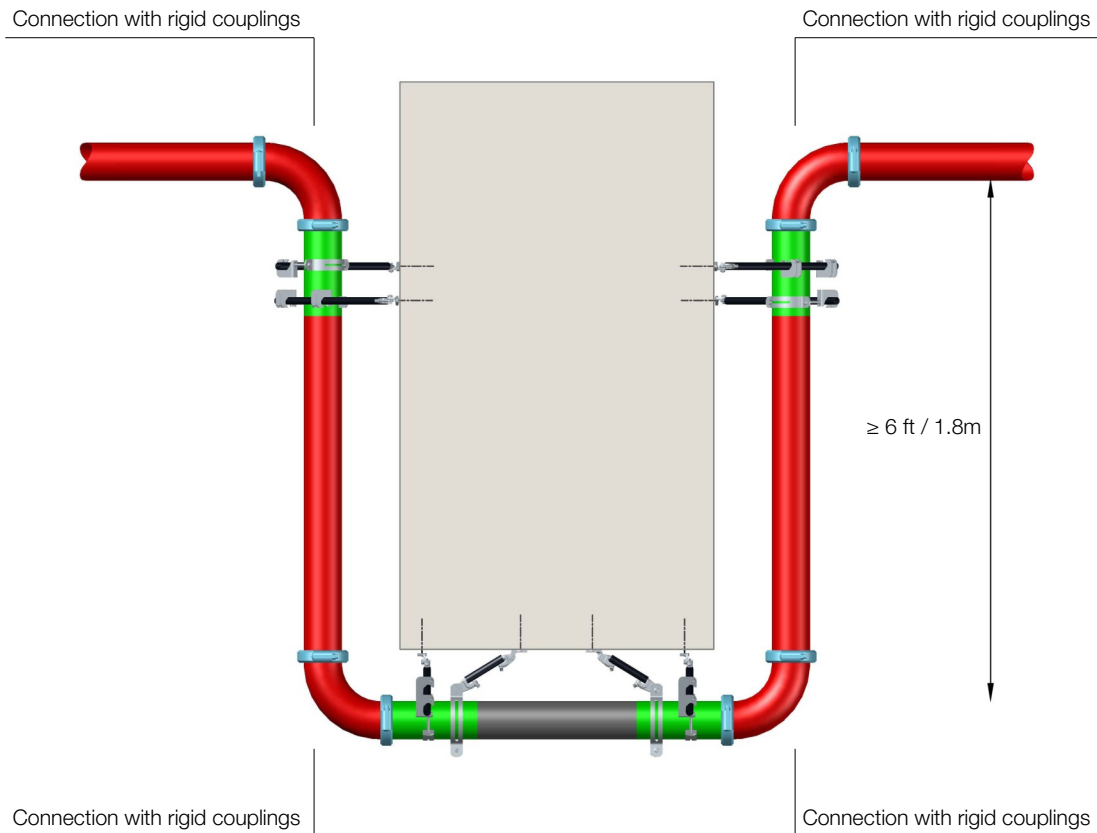
VERTICAL OFFSET GREATER THAN 6 ft / 1.8 m, WITH MULTIPLE FLEXIBLE COUPLINGS, HORIZONTAL RUN LESS THAN 4 ft / 1.2 m

The case of CROSSMAINS or FEEDMAINS needing to avoid an obstacle (e.g. a wide beam or other piping systems) can be addressed using the provisions in section 2.2.1.1.3 e 2.2.1.4.4.B for vertical CROSSMAINS or FEEDMAINS.

When the length of vertical pipe run necessary to go around the obstacle is 6 ft / 1.8m or more, FOUR-WAY bracing is necessary at the bottom and at the top of the vertical pipe run. The FOUR-WAY brace is to be located within 2 ft / 0.6m of the bottom and of the top of the vertical pipe run. It is also necessary to locate a flexible coupling at the bottom and at the top of the vertical pipe run. These flexible couplings are to be located within 2 ft / 0.6m of the bottom and of the top of the vertical pipe run.

When the width of the obstacle to avoid allows it, it is possible to use only one FOUR-WAY brace to brace both the vertical pipe runs, as long as it is sized to take under account the loads associated with both pipe runs.

Note. When it is not possible to attach the SWAY BRACES directly to the element avoided (in the case of non structural elements for instance), it is necessary to arrange for an auxiliary structure to which to anchor.



AG d6 (Section view) ✘

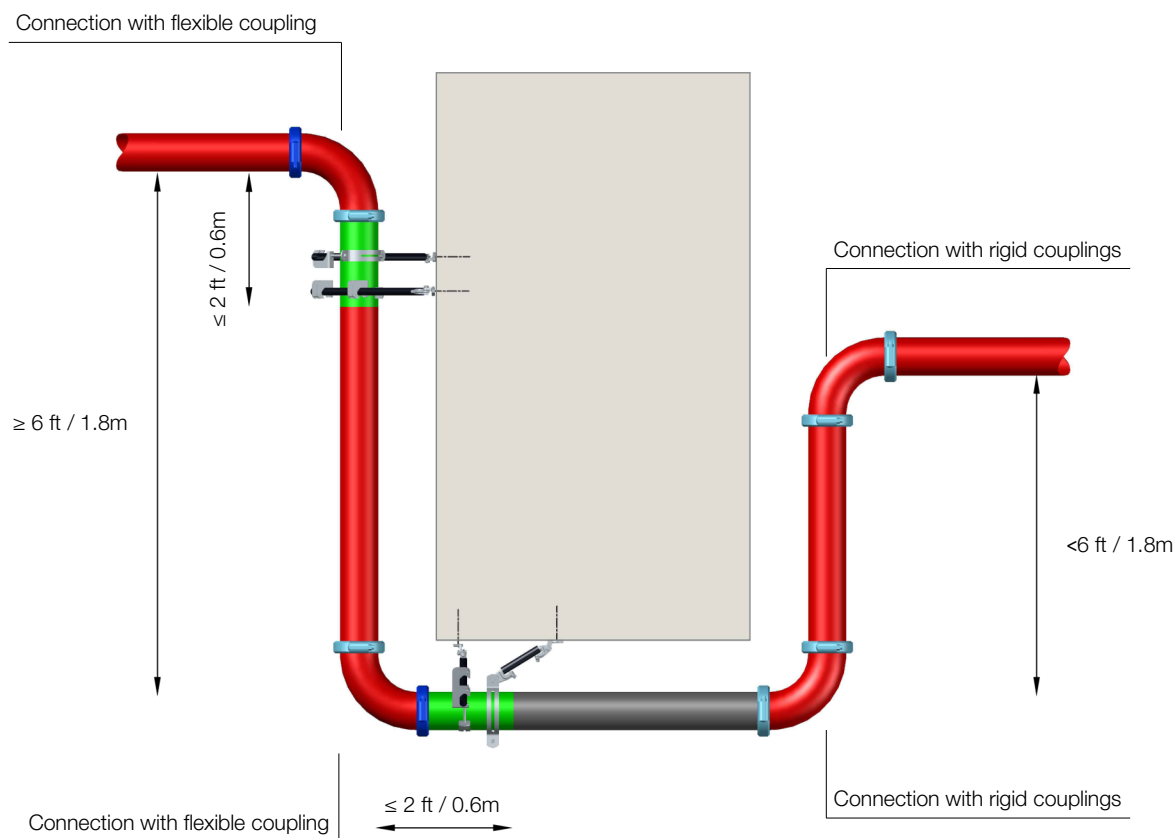
VERTICAL OFFSET GREATER THAN 6 ft / 1.8 m, WITH RIGID COUPLINGS

Solution not compliant with sections 2.2.1.1.3 and 2.2.1.4.4.B for vertical CROSSMAINS or FEEDMAINS.

The length of vertical piping necessary to avoid the obstacle is 6 ft / 1.8m or more, therefore it is necessary to locate a FOUR-WAY bracing at the bottom and at the top of the vertical pipe run within 2 ft / 0.6m of the bottom and of the top of the vertical pipe run. It is also necessary to locate a flexible coupling at the bottom of the vertical piping and another one at the top. These flexible couplings are to be located within 2 ft / 0.6m of the bottom and of the top of the vertical pipe run.

In the solution in illustration, the required flexible couplings have been omitted, thereby making the solution non-compliant with FM's requirements.

Note. When it is not possible to attach the SWAY BRACES directly to the element avoided (in the case of non structural elements for instance), it is necessary to arrange for an auxiliary structure to which to anchor.



A G d7 (Section view)

VERTICAL OFFSET ONE SIDE $\geq 6 \text{ ft} / 1.8 \text{ m}$ AND ONE $< 6 \text{ ft} / 1.8 \text{ m}$

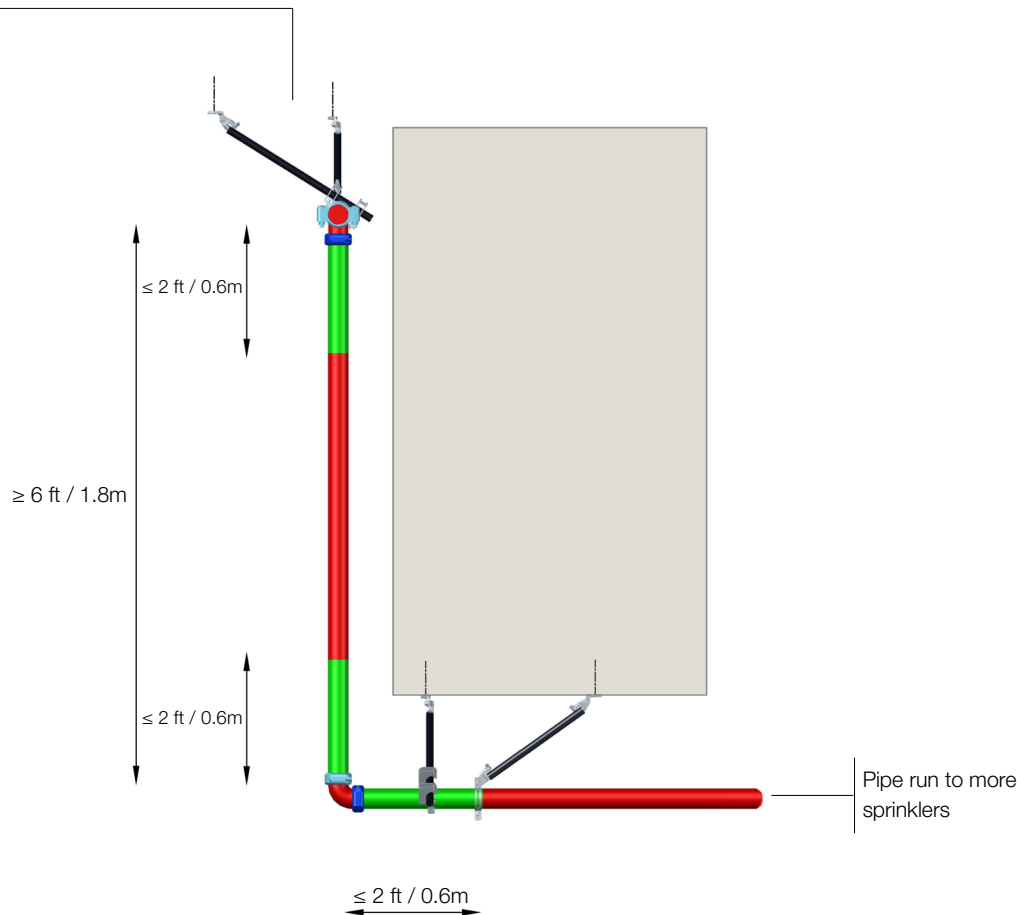
The case illustrated can be narrowed down to the provisions in sections 2.2.1.1.3 and 2.2.1.4.4.B for vertical CROSSMAINS or FEEDMAINS.

It is necessary to locate FOUR-WAY braces at the beginning and at the end of the vertical pipe run $6 \text{ ft} / 1.8 \text{ m}$ long or more required to avoid the obstacle. The FOUR-WAY braces are to be located within $2 \text{ ft} / 0.6 \text{ m}$ of the beginning and of the end of the vertical pipe run. It is also necessary to locate a flexible coupling at the beginning and at the end of the vertical pipe run. These flexible couplings are to be located within $2 \text{ ft} / 0.6 \text{ m}$ of the beginning and of the end of the vertical piping. FOUR-WAY is not required at the beginning and at the end of vertical pipe runs less than $6 \text{ ft} / 1.8 \text{ m}$, as long as there are no flexible couplings in the connections with the horizontal piping.

The run of horizontal piping that connects the two vertical pipe runs may require SWAY BRACING depending on its length, as per the provisions in section 2.2.1.1.4 for horizontal CROSSMAINS or FEEDMAINS.

Note. When it is not possible to attach the SWAY BRACES directly to the element avoided (in the case of non structural elements for instance), it is necessary to arrange for an auxiliary structure to which to anchor.

FOUR-WAY bracing located within 2 ft / 0.6m of the DROP on the pipe run with the largest diameter



AG d8 (Section view)

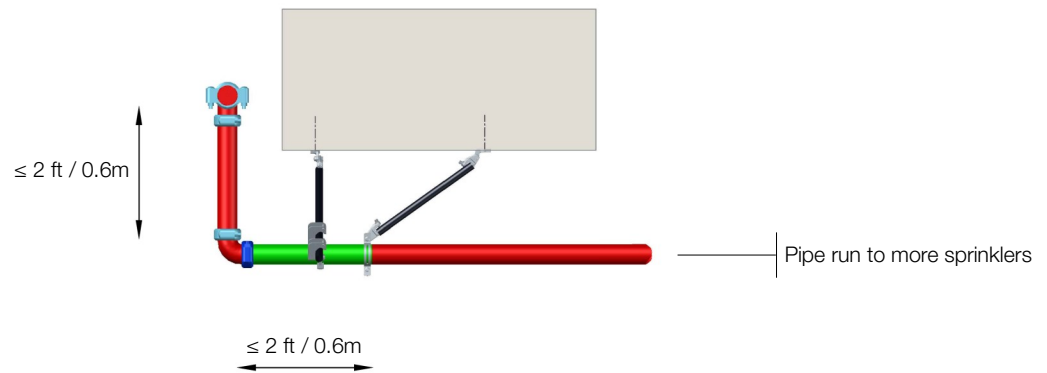
DROPS ≥ 6 ft / 1.8 m FEEDING MORE THAN ONE SPRINKLER WITH FLEXIBLE COUPLINGS

The case of pipe DROPS that feed more than one sprinkler needing to avoid an obstacle (e.g. a wide beam, other piping systems or other distribution systems) can be addressed using sections 2.2.1.1.3 and 2.2.1.4.6.

If the length of vertical piping necessary to avoid the obstacle is 6 ft / 1.8m or more, it is necessary to locate a FOUR-WAY brace at the beginning and at the end of the vertical pipe run. The FOUR-WAY braces are to be located on the piping with the largest diameter within 2 ft / 0.6m of the beginning and of the end of the vertical piping. It is also necessary to locate a flexible coupling at the beginning and at the end of the vertical pipe run within 2 ft / 0.6m of the connection with the horizontal piping and a flexible coupling on the horizontal piping that feeds the sprinklers within 2 ft / 0.6m of the connection with the pipe DROP.

The horizontal pipe run that feeds the sprinklers may require SWAY BRACING depending on its length, as per the provisions in section 2.2.1.1.4 for the horizontal CROSSMAINS or FEEDMAINS or in section 2.2.1.1.5 for the BRANCH LINES. (REFER TO SECTIONS H AND B.)

Note. When it is not possible to attach the SWAY BRACES directly to the element avoided (in the case of non structural elements for instance), it is necessary to arrange for an auxiliary structure to which to anchor.



A G d9 (Section view)

DROPS ≤ 2 ft / 0.6 m FEEDING MORE THAN ONE SPRINKLER

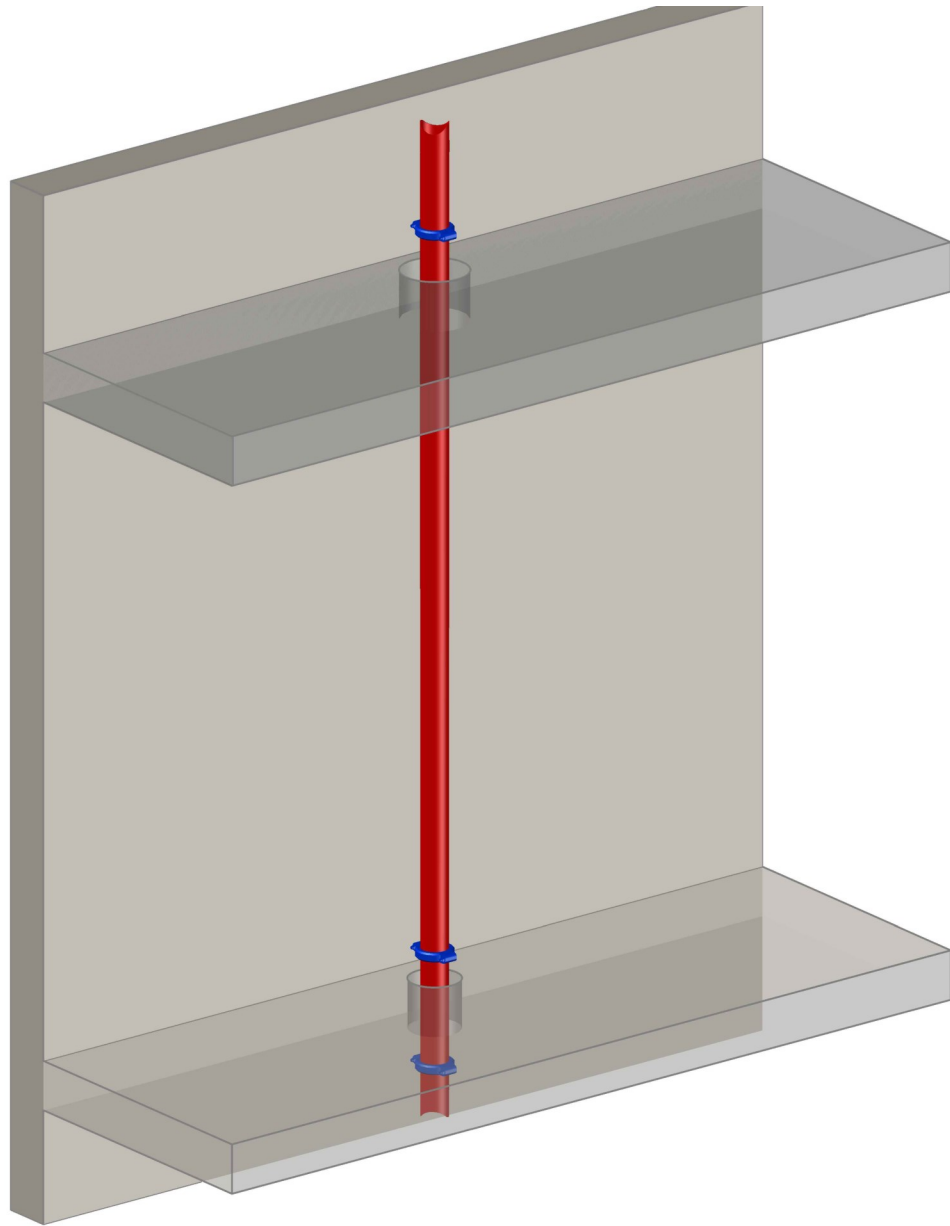
The case of pipe DROPS that feed more than one sprinkler needing to avoid an obstacle (e.g. a wide beam, other piping systems or other distribution systems) can be addressed using sections 2.2.1.1.3 and 2.2.1.4.6.

If the length of vertical piping necessary to avoid the obstacle is less than 0.6m, neither flexible couplings nor FOUR-WAY bracing are necessary at the beginning of the vertical piping. It is however necessary to locate a flexible coupling on the horizontal piping that feeds the sprinklers within 2 ft / 0.6m of the connection with the pipe DROP.

The horizontal pipe run that feeds the sprinklers may require SWAY BRACING depending on its length, as per the provisions in section 2.2.1.1.4 for the horizontal CROSSMAINS or FEEDMAINS or in section 2.2.1.1.5 for the BRANCH LINES. (REFER TO SECTIONS H AND B.)

Note. When it is not possible to attach the SWAY BRACES directly to the element avoided (in the case of non structural elements for instance), it is necessary to arrange for an auxiliary structure to which to anchor.



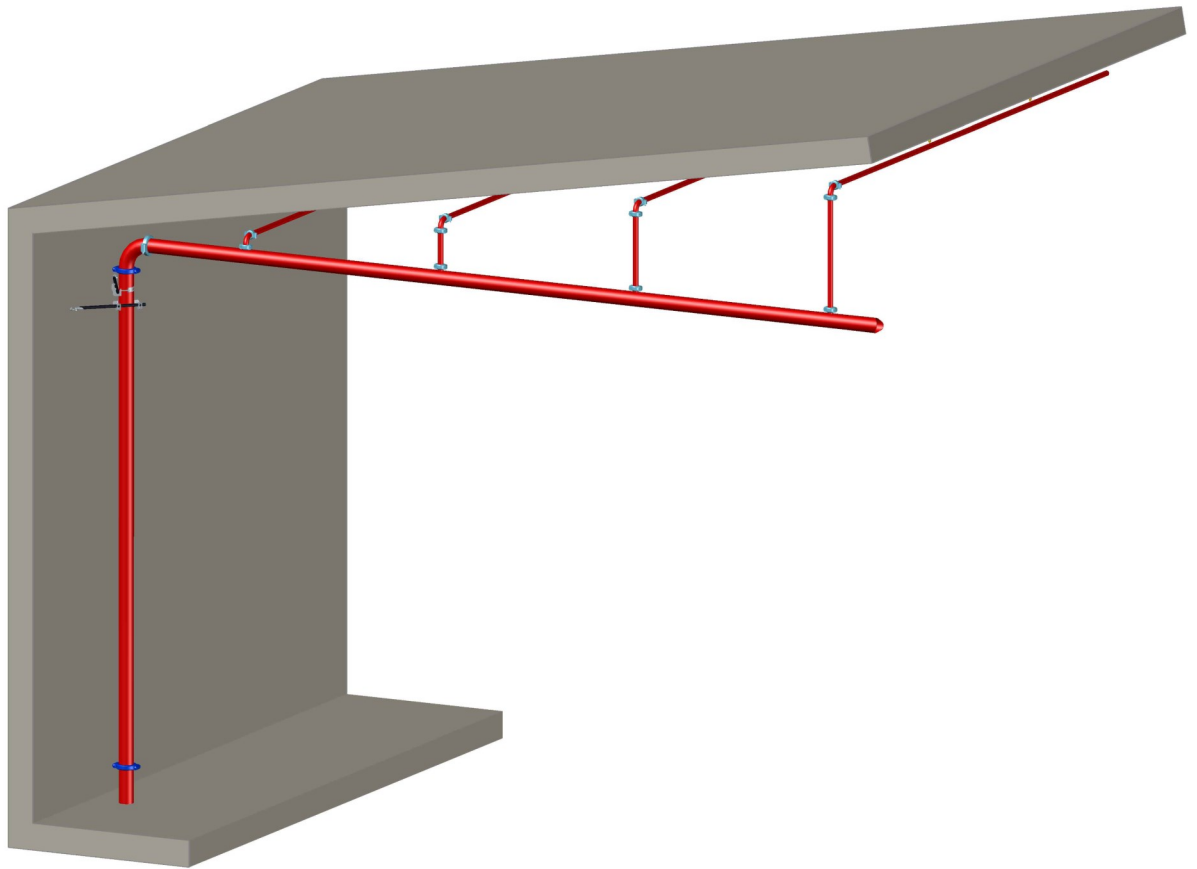


FLOORS PENETRATIONS

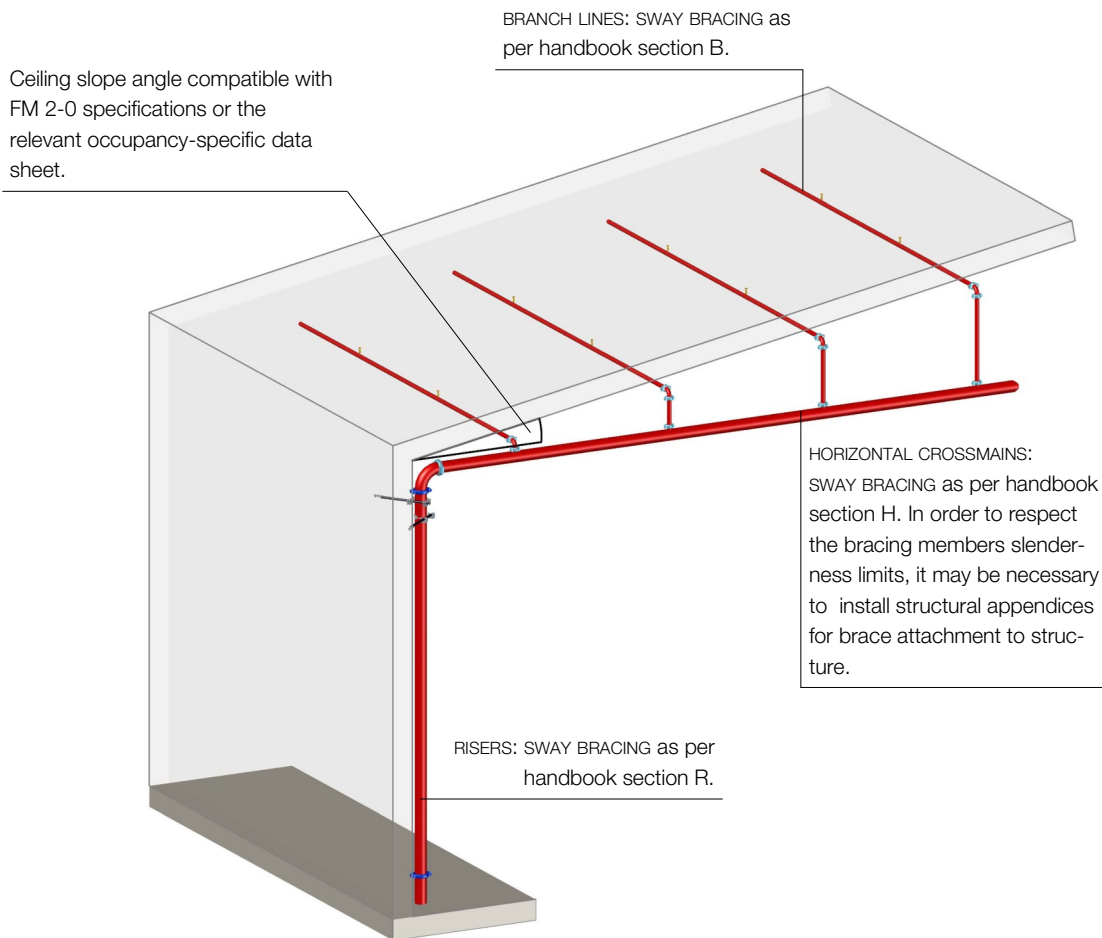
Please, refer to the following sections of the handbook:

- Section C for the clearance specifications
- section V - details D for the vertical CROSSMAINS
- section R - details D for the RISERS





BRACING OF FIRE SPRINKLER SYSTEMS UNDERNEATH SLOPED CEILINGS



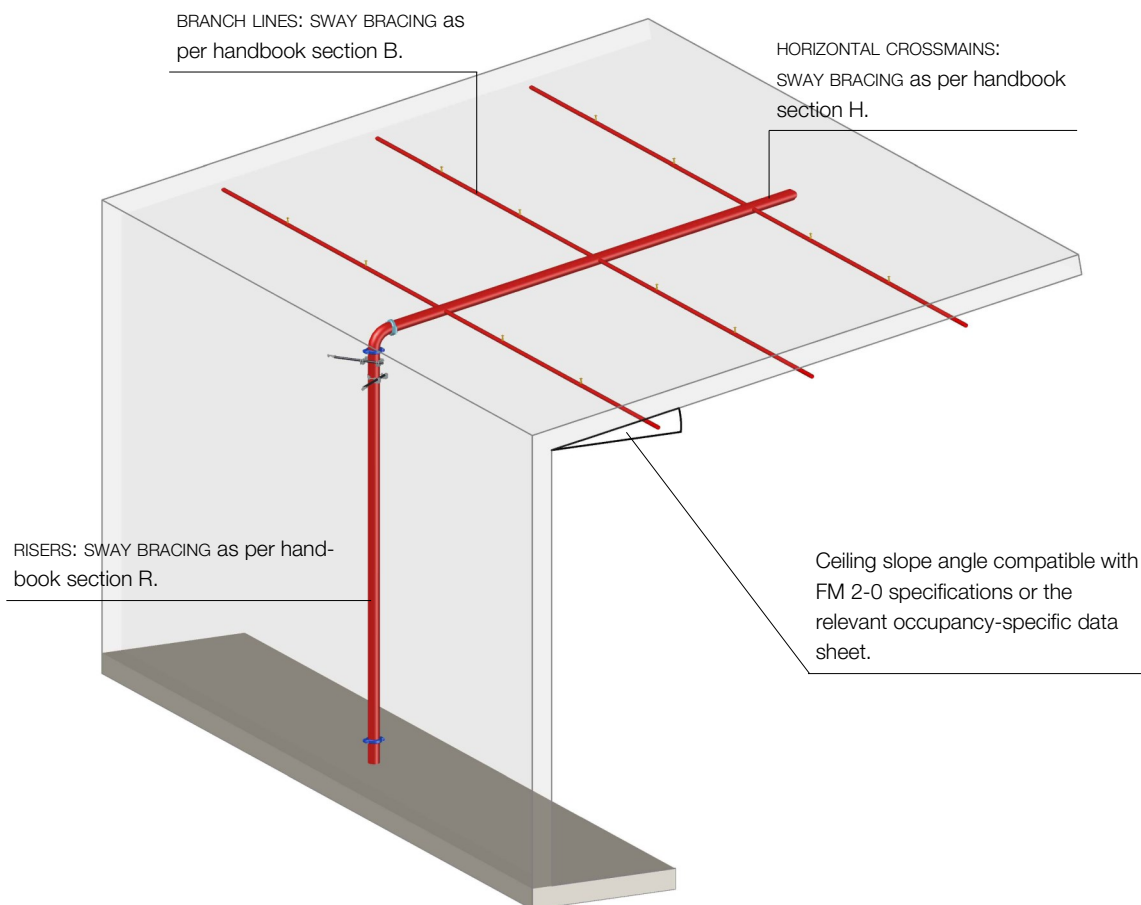
AI d1

BRACING UNDER A SLOPED CEILING WITH HORIZONTAL MAIN

In section 2.1.1.6 for nonstorage sprinklers and in section 2.2.1.6 for storage sprinklers, FM 2-0 specifies the cases in which installing a fire sprinkler system under a sloped ceiling is permitted unless recommended otherwise by the relevant occupancy-specific data sheet, and defines the specifications that the sprinkler system and the ceiling geometry must meet.

As far as the bracing of sprinkler systems installed under a sloped ceiling is concerned, FM 2-8 does not provide specific instructions. One must therefore turn to the provisions for individual pipe runs.

In the case in illustration, the BRANCH LINES are connected to the CROSSMAIN via RISER NIPPLES. Please note that, depending on the characteristics of the ceiling, it may be necessary to install structural appendices or structures especially designed to brace the CROSSMAIN and/or the BRANCH LINES in order to satisfy the brace members slenderness requirements.



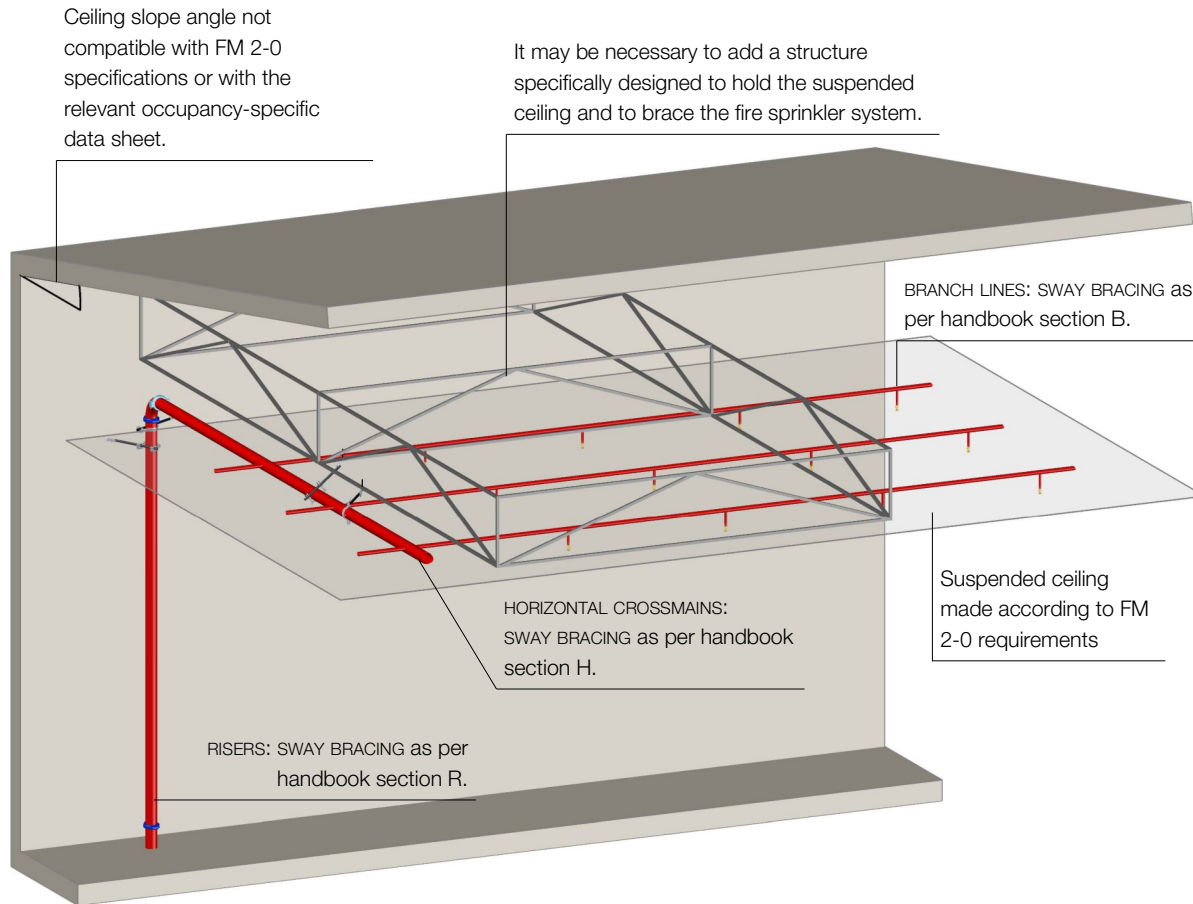
AI d2

BRACING WITH A MAIN PARALLEL TO THE SLOPED CEILING

In section 2.1.1.6 for nonstorage sprinklers and in section 2.2.1.6 for storage sprinklers, FM 2-0 specifies the cases in which installing a fire sprinkler system under a sloped ceiling is permitted unless recommended otherwise by the relevant occupancy-specific data sheet, and defines the specifications that the sprinkler system and the ceiling geometry must meet.

As far as the bracing of sprinkler systems installed under a sloped ceiling is concerned, FM 2-8 does not provide specific instructions. One must therefore turn to the provisions for individual pipe runs.

In the case in illustration, the CROSSMAIN runs parallel to the sloped ceiling and the BRANCH LINES are connected directly to the CROSSMAIN. Depending on the load capacity of structure making up the ceiling, the sway bracing may be attached directly to the ceiling; if the structural elements load capacity is not sufficient, it may be necessary to install an ad hoc structure in which to anchor the braces.



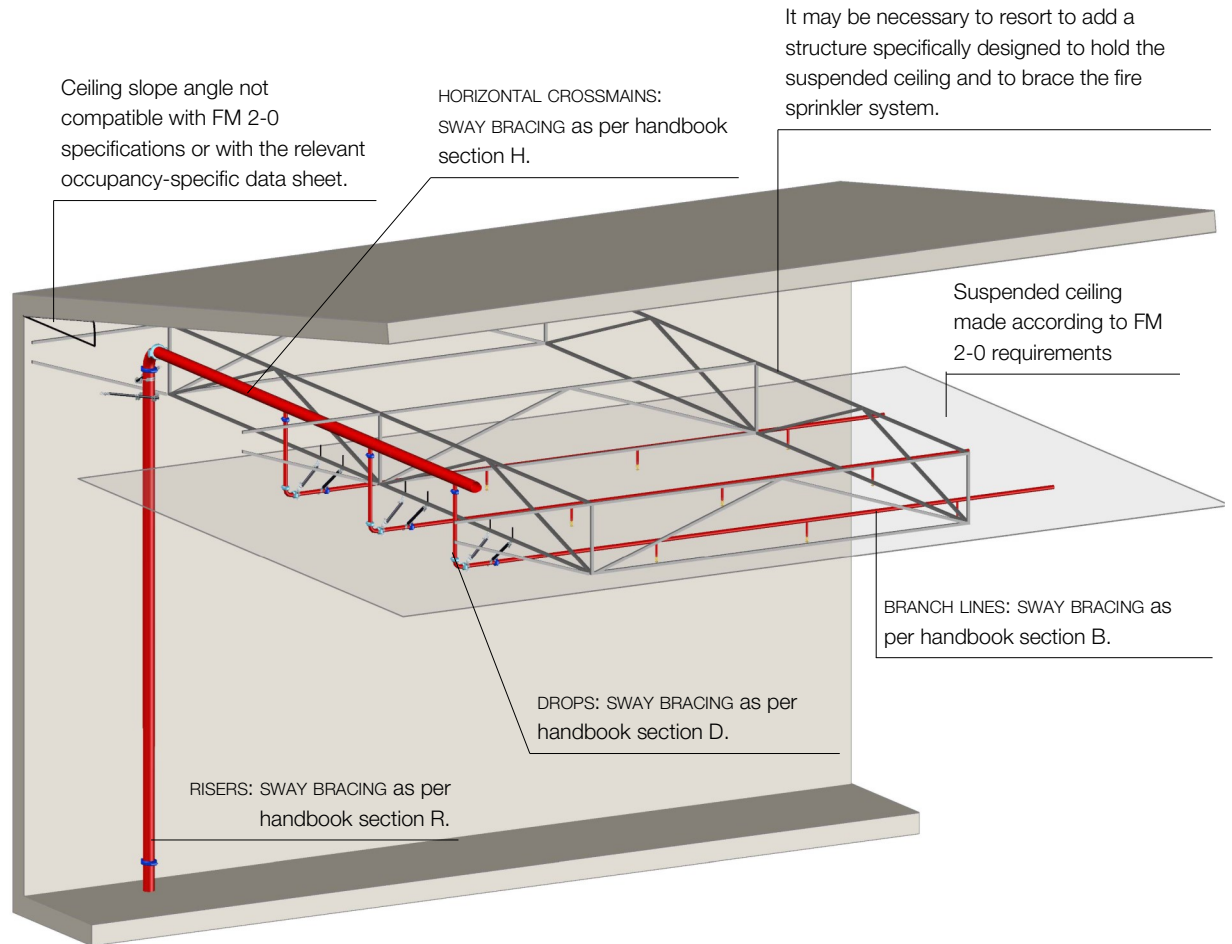
AI d3

STRUCTURE DESIGNED TO HANG AND BRACE THE SPRINKLER SYSTEM, RISER AT OR BELOW DESIGNED STRUCTURE

In section 2.1.1.6 for nonstorage sprinklers and in section 2.2.1.6 for storage sprinklers, FM 2-0 specifies the cases in which installing a fire sprinkler system under a sloped ceiling is permitted unless recommended otherwise by the relevant occupancy-specific data sheet, and defines the specifications that the sprinkler system and the ceiling geometry must meet. For ceiling slopes that exceed the maximum allowed, it is required to install a flat, continuous suspended ceiling over the protected area. The suspended ceiling must extend for 20 ft / 6.0m in all direction beyond the protected area. The suspended ceiling is to be designed according to the specifications of data sheet 1-12 *Ceilings and concealed spaces* and is to withstand a minimum uplift pressure of 3 lb/ft² — 14.4kg/m².

As far as the bracing of sprinkler systems installed under a sloped ceiling is concerned, FM 2-8 does not provide specific instructions. One must therefore turn to the provisions for individual pipe runs.

Depending on the characteristics of the ceiling, it may be necessary to install structural appendices or structures specifically designed to brace the CROSSMAIN and the BRANCH LINES in order to satisfy the brace members slenderness requirements.



AI d4

STRUCTURE DESIGNED TO HANG AND BRACE THE SPRINKLER SYSTEM, RISER ABOVE DESIGNED STRUCTURE

In section 2.1.1.6 for nonstorage sprinklers and in section 2.2.1.6 for storage sprinklers, FM 2-0 specifies the cases in which installing a fire sprinkler system under a sloped ceiling is permitted unless recommended otherwise by the relevant occupancy-specific data sheet, and defines the specifications that the sprinkler system and the ceiling geometry must meet. For ceiling slopes that exceed the maximum allowed, it is required to install a flat, continuous suspended ceiling over the protected area. The suspended ceiling must extend for 20 ft / 6.0m in all direction beyond the protected. The suspended ceiling is to be designed according to the specifications of data sheet 1-12 *Ceilings and concealed spaces* and is to withstand a minimum uplift pressure of 3 lb/ft² — 14.4kg/m².

As far as the bracing of sprinkler systems installed under a sloped ceiling is concerned, FM 2-8 does not provide specific instructions. One must therefore turn to the provisions for individual pipe runs.

Depending on the characteristics of the ceiling, it may be necessary to install structural appendices or structures specifically designed to brace the CROSSMAIN and the BRANCH LINES in order to satisfy the brace members slenderness requirements.

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