Guidance Note

Fire Industry Association

Pipework for Gaseous Fixed Fire Fighting Systems

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1. SCOPE

This FIA guidance sets out a generic industry best practice for practitioners that install pipework for gaseous fixed fire-fighting systems.

2. SAFETY

Pipework is used to convey the extinguishing agent from its storage to distribution nozzles within a protected space. It should be noted that should there be a major failure of any pipe and/or fitting, a number of hazards may arise:

- Projectiles
- Release of toxic agents (eg CO2) or asphyxiants in confined spaces
- Pressure effects/structural damage
- Consequential compromise of extinguishing capability

Therefore, it is important that piping from the container storage location to the protected space is professionally installed by trained personnel, who have experience with the installation of gaseous fixed fire fighting systems. They should also be fully conversant with the manufacturer's requirements, to ensure the integrity and stability of piping during discharge and aware of the forces generated. Where agent storage containers are located outside the protected space, then the pipe routing should be the shortest route possible to the protected space.

Post-discharge condensate

In the event of a system discharge, condensation may form on the external surface of the pipework which could then accumulate and drip. Where this itself may have an impact, such as on sensitive or energised equipment, precautionary measures may be necessary in the form of insulation, drip trays or pipework re-routing to prevent this occurring or mitigate its impact.

3. PIPE SPECIFICATION

The relevant British Standards state the basic criteria with which pipe materials must comply – ie metallic, not cast iron etc and whereas BS 5306 part 4 specifies suitable pipe materials, BS EN 15004 does not.

Carbon steel is most commonly used for fixed extinguishing system pipework and this guide primarily focuses on this pipe material. Stainless steel or copper alloy may be used where the pipe is to be installed in harsh or corrosive environments, and the user of such materials must verify the suitability of such materials using the methodology contained in this guide.

Pipe sizes are referred to as nominal bore (NB), or nominal diameter (DN), or nominal pipe size (NPS). This set range of size increments are used whatever the specification the pipe complies with, and the increments are the same for either designation. The pipe size is a nominal number and does not correlate exactly to any physical dimension.

Physically, for each pipe specification and each nominal pipe size, the outside diameter of the pipe is a constant size – ie the outside diameter of a DN 25 pipe to BS EN 10255 is the same as that of an ASTM A106 DN25 pipe.

Pipes are available in different pressure ratings, based on differing material strengths and wall thicknesses. Given that for any nominal pipe size, the outside diameter is constant for that size, the effect of changing the wall thickness changes the actual bore of the pipe. Depending on the Standard, wall thicknesses for pipe are defined by a 'schedule' number (higher numbers being thicker wall), physical thickness, or in the case of BS EN 10255, as either 'light', 'medium' or 'heavy'.

The following is a non-exhaustive summary and intended use of some tubular products:

ASTM A106 grade B	line pipe – US spec widely available in UK
API 5L grade B	line pipe – US spec widely available in UK
BS EN 10255 (replaces BS 1387)	non-alloy steel tube for welding and threading
BS EN 10217	line pipe
BS EN ISO 3183 (replaces BS EN 10208)	line pipe ('grade A' is equivalent to API 5L).
BS 3601 / 3602 / 3604	boiler tube
BS EN 10216	seamless steel tubes
BS EN 13480	metallic industrial piping

Notes

1. *Where some pipe specifications are similar, the pipe may be certified and marked to both standards: dual certification. This is common for ASTM A106 and API 5L and used for BS EN 10255 and BS EN 10217.*

2. *It should be noted that although the above listed pipe standards exist, not all are frequently stocked or available in the UK, pipeline suppliers may not necessarily stock 'boiler tube'.*

4. MANUFACTURING PROCESS

Pipe or tube can be made by one of two basic methods:

1. Extruded or drawn as a single piece of material without a join – ie seamless.
2. Longitudinal welded – a strip of flat material is rolled into a single wall tube and the longitudinal join welded to form a tube.

For any grade of steel, seamless pipe construction results in a 'stronger' product than longitudinally welded pipe; any tubular material referred to as 'longitudinally' welded, or with designations 'W' (welded), 'ERW' (electric resistance welded), 'SAW' (submerged arc weld), or 'FW' (furnace welded) has been made by this process.

It should be noted that some Standards allow the use of either manufacturing process. Whereas with BS EN 10255 pipe, the resulting mechanical properties are applicable for either, with API 5L the physical properties vary with the type of manufacturing process. Whilst some of the larger pipe sizes in API 5L are only manufactured by a welding process, the smaller diameters may be made by any process. The user of API 5L pipe needs to be aware that the defined properties vary with the mode of manufacture, the welded grades (ERW, SAW, FW) each having different and lower strength properties than seamless (S).

The degree of external heating used in the manufacturing process also affects the finished product strength – the higher the temperature the easier the forming process becomes, but material formed at a lower temperature will have increased mechanical strength. Where this makes a difference, this may be identified in some Standards (particularly 'boiler tube') by additional grade designations such as CFS, CD (cold formed) or HFS, HF (hot formed).

The key issue is that it must be recognised that there may be variations in the strength of a pipe within a common Standard, the user shall check the exact/full grade designation of the pipe selected and ensure that the correct material properties are used in strength calculations, to assess the suitability of the pipe for the required duty.

5. PIPE PRESSURE RATINGS

The pressure rating of a pipe is determined by both its internal pressure resistance (hoop stress) and the method (strength) of joining sections of pipe together.

The pipe Standards may not specifically state any pressure ratings for the pipes included; frequently pipe suppliers will state maximum working pressures, but often the methodology by which these are calculated is not stated, or make any allowance for the method of joining (as this has an effect on the maximum working pressure of a given pipe material).

The maximum working pressure of any given pipe can be calculated using the methods stated in ASME B31.1 or BS EN 13480 – 3. Both use the same basic formula, but have different base stress levels used in the calculation. The BS EN method results in a higher allowable working pressure for a given pipe size. But:

- The BS EN requires another safety factor be added if the pipe doesn't have a BS EN 10204 type 2.2 or greater cert.

The methodology in BS EN 13480-3 is the same as ASME B31.1, but in a different format – the latter is easier for the layperson to understand and follow, so for that reason ASME B31.1 is used as the basis for the tables in Annex A.

Maximum working pressures for common pipe materials are stated in the tables and example calculations contained in Annex A.

6. WORKING PRESSURES FOR GASEOUS FIXED FIRE FIGHTING SYSTEMS

The developed pressure in a container and pipe network is related to the temperature. Any determination of the pressure retaining capability of a pipe must be based on the maximum working pressure (ie the developed pressure of the agent at the maximum temperature – typically 50°C). The user should refer to the physical properties of the specific agent to verify the maximum developed pressures based on maximum temperature and where applicable, the container fill ratio (eg the developed pressure for a 25 bar halocarbon system could be as high as 35 bar at 50°C). The user should always seek guidance from the system manufacturer.

7. PIPE FITTINGS SPECIFICATION

As with pipe, BS 5306 part 4 defines suitable fitting types and grades; BS EN 15004 does no more than cover the basic material requirements.

Pipe fittings are available in a range of materials and construction methods, with a corresponding variety of stated pressure criteria. The selection of fittings having the correct rating is therefore essential to ensure the pressure integrity of the pipe network.

Pipe fittings are available in a range of ferrous and non-ferrous materials for compatibility with the pipe material.

The following table lists the commonly available fittings for use with mild or carbon steel pipe and the maximum working pressures are based on compatible materials (ie malleable iron, wrought iron/ steel, forged steel etc).

TABLE 1 PIPE FITTING SPECIFICATIONS

Fitting specification	Type	Material	Maximum working pressure	
			Screwed	Welded
BS 1640-1	Butt weld	Wrought carbon and ferritic alloy steel	N/A	As per pipe of same diameter and schedule
BS 3799	3000 lb. Screwed/ socket weld	Forged steel	Equivalent to schedule 80 pipe in corresponding diameter.	Equivalent to schedule 80 pipe in corresponding diameter
BS 3799	6000 lb. Screwed/ socket weld	Forged steel	Equivalent to schedule 'double extra strong (XXS)' pipe in corresponding diameter.	Equivalent to schedule 160 pipe in corresponding diameter
BS EN 10241	Screwed	Steel – seamless or fabricated construction	(1	N/A
BS EN 10242	Screwed	Malleable cast iron	25 bar (1	N/A
BS EN 10253-2 (2	Butt weld, Type A	Wrought carbon and ferritic alloy steel	N/A	Reduced strength compared to equivalent pipe and schedule (3
BS EN 10253-2 (2	Butt weld, Type B	Wrought carbon and ferritic alloy steel	N/A	As per pipe of same diameter and schedule

Notes:

1) BS EN 10241 does not state any maximum working pressure. It does state the material shall have a minimum UTS of 320 N/mm² (and yield stress for fabricated fittings of 195 N/mm²). These values render the fittings of low pressure duty suitability. This standard replaces BS 1740 fittings which had a stated test pressure of 50 bar. Test pressure is often 1.5x maximum working pressure, which infers a maximum working pressure of 33 bar. BS EN 10242 fittings with a maximum working pressure of 25 bar have a test pressure of 100 bar, but these fittings can be type rated for use at higher pressures if specified at the time of ordering from the manufacturer. Such fittings are usually colour coded. The use of non-type rated BS EN 10242 fittings is not recommended, as in most instances the developed pressure in the system could exceed the maximum working pressure of the fitting.

2) BS EN 10253 is published in four parts: part 1 covers fittings which are used where the system does not comply with the Pressure Equipment Regulations – fittings of this part are therefore not usable with fixed extinguishing systems. Parts 3 and 4 apply to stainless steel fittings and are therefore beyond the scope of this document.

3) BS EN 10253-2 Type A fittings are of reduced strength compared to the equivalent pipe schedule. BS EN 10253-2 provides a means of calculating the reduced strength (or conversely increased wall thickness required to match the strength of the pipe); the user of BS EN 10253-2 fittings is recommended to use Type B, or where Type A are used, refer to the supplier for guidance.

Notes on the use of type rated fittings

Although using low specification fittings which have been type rated for use at a higher pressure may be attractive and can be a suitable solution, the user should not forget to allow for the additional costs of type testing the fittings; depending on market prices, higher rated fittings may be more economical. It shall also be made clear to installers using type rated fittings that they are not 'standard', such that if they need additional fittings, they are unlikely to be able to purchase these from their normal pipe supplier with the essential type rating.

The pressure rating of BS EN 10242 fittings which have been type rated will be stated on the BS EN 10204 certification documentation supplied with the fittings.

Type rated fittings will each also be individually marked to provide a visual indication – usually a red or yellow ink or paint spot. If the pipe network is entirely painted on completion, such identification marks on these fittings will be obliterated. This may have consequences for future servicing of the system, as visually the system will appear to have the wrong type of fittings used. It is therefore recommended that where type rated fittings are used, that this is clearly documented on the drawings.

8. CONNECTION METHODOLOGIES

Fittings are intended to be attached by means of screw threads, by welding or grooved joints.

8.1. Screwed fittings

Screwed thread connections are common for pipes in fixed extinguishing systems. Commonly used screw threads are detailed elsewhere in the guide; the relevant Standard for each kind of fitting will state the thread combinations/permutations available.

It should be noted that BS 3799 is based on US specification ANSI B16.11 and as such, this British Standard specifies threads that are NPT. However, these fittings are also widely available manufactured with BS EN 10226 R series (BSP taper) threads. The purchaser of such fittings should verify or specify which thread form is required.

The type of thread used has a bearing on the maximum working pressure of the pipe network; deep cut threads (eg NPT) result in lower maximum working pressures.

Where joining pipes of dissimilar sizes, the use of a reducing bush or concentric reducer shall be in accordance with the system manufacturer's instructions.

8.2. Welded fittings

Fittings intended for welding to the pipe are available, these being either 'butt weld' (where the outside diameter and bore of the fitting are the same as the pipe) or 'socket weld' (essentially similar to screwed fittings, but where the female thread is replaced by a plain bore (socket) into which the pipe is inserted).

Butt weld fittings require more operator care during the fabrication process, whereas socket weld fittings lend themselves to more convenient site fabrication.

Welded pipe assemblies are superior to threaded assemblies in terms of permitting a thinner wall pipe to be used and resulting leak tightness. The latter is advantageous for long sections of closed section pipe, where the high hydraulic test pressure, with no loss of pressure test criteria, is far less likely to result in test failure compared to threaded pipe fittings for such service.

Where welded fittings are used, these and the pipe must have a black (non-galvanised) finish. The former practice of grinding off any galvanising local to the weld prior to welding is banned, due to health and safety implications. The completed pipe assembly should then be externally painted or galvanised after fabrication/test to provide corrosion resistance.

All companies providing welding services should have third party approved welding procedures to EN 15614-1 2004:+A2:2012 for arc and gas welding of steels and arc welding of nickel alloys, to cover the diameter range and wall thicknesses of their contracts.

Welders should be tested to an approved welding procedure in BS EN 9606-1: 2013.

Welding should be overseen by a qualified CSWIP welding inspector or an approved responsible welding coordinator (RWC) operating as detailed in BS EN 3834 and EN ISO 14731.

8.3. Flanged connections

Where flanged connections are to be used, refer to the system manufacturer.

8.4. Grooved fittings
These fittings clamp externally onto the outside of the pipe and engage a groove formed in the outside diameter of the pipework; the groove may be formed by rolling, or machining.

If such fittings are to be used, the supplier should be consulted to verify the maximum working pressure. Where the groove is machined, the depth of groove must be allowed for in the wall thickness calculation.

9. COMPATIBILITY OF THREADS

9.1. Taper v parallel
Pipe threads may either seal on the thread from the physical assembly of the mating parts (taper threads) or by means of a separate seal (parallel threads); it is important that the correct thread compatibility is used to ensure adequate sealing. For any given thread size, the profile and pitch of the male and female threads should match, so the two can be physically assembled and be tightened up. An effective thread seal will never be achieved if incompatible threads are mixed.

On pipe threads where pressure tight joints are made on the threads, British Standard Pipe Taper – R Series (BSPT) and National Pipe Taper (NPT), both the male and female threads are normally tapered. However, with BSPT male threads, the mating female may be a parallel thread, as found on some pipe fittings and pipeline valves.

On pipe threads where pressure tight joints are not made on the threads, British Standard Pipe Parallel – G series (BSPP) and National Pipe Straight (NPS), both the male and female threads are parallel. Such thread forms provide the means of mechanical assembly only and require the use of a seal (such as a bonded seal, O-ring, copper washer or metal to metal cone seat) to achieve pressure integrity. Such fittings therefore, feature profiles to suit the applicable sealing arrangement, either flat face sealing or O-ring grooves etc. Thread sealants must not be used with these threads.

10. JOINTING AND SEALING
For the most suitable application method refer to the system manufacturer.

10.1. Taper pipe threads
For taper pipe threads where sealing is achieved on the thread, the use of an appropriate jointing compound or sealant is essential to achieve a pressure tight joint; the following details current thread sealing methodologies.

10.1.1. Thread compound and hemp
Ensure the thread is clean and dry. Cover the male thread with a thin coat of jointing compound, making sure that the compound is a minimum of two threads away from the end of the pipe, which will provide grip for the hemp. Wind the hemp clockwise onto the male thread when viewing from the end of the pipe. Start two threads from the end of the pipe and ensure that no hemp overlaps the end of the pipe. With the hemp in place cover the thread with a thin coat of jointing compound, making sure that the compound is a minimum of two threads from the end of the pipe.

10.1.2. Liquid thread sealant

Ensure the thread is clean and dry. Follow the manufacturer's application instructions for the particular type of sealant. Avoid the application of excessive sealant.

Care should be taken when installing 'threaded pipe' into selector valves, to ensure any liquid sealant does not drip onto the internal part of the valve which may prevent successful operation.

10.1.3. Sealing with Tape

Only use tape rated suitable for use with gas.

Wire brushing the male thread will clean it and provide grip for the tape. Wind the tape tightly clockwise onto the male thread when viewing from the end of the pipe, starting two threads from the end of the pipe

TABLE 2 TAPE SEALS

Pipe diameter	Tape thickness	Number of tape turns
DN6 to DN15	0.075mm	4
DN20 to DN50	0.2mm	1.5

10.2. Parallel

Parallel threads require the use of a separate seal which can be as given in table 2 below; the threads serve to draw the sealing faces together.

TABLE 3 SEALING PARALLEL THREADS

Sealing Parallel threads	Diameters
Bonded seal (Steel washer with rubber insert)	Generally between M3 and M20, G15 and G50
Specialist taper cone with 'O' ring	Generally between M3 and M20, G15 and G50
Specialist threads with 'O' ring	Any diameter

11. PROTECTIVE FINISHES

Piping should be galvanised inside and out, unless it is intended to be welded.

Special corrosion resistant materials or coatings should be used in severely corrosive atmospheres.

Copper, brass or stainless steel tube may be used without additional corrosion protection.

12. PIPE SUPPORTS

12.1. General

Pipe support saddles or straps normally used for supporting sprinkler system pipework must not be used, as such supports cannot withstand the forces generated by gaseous fixed fire fighting systems.

The piping should be securely supported to prevent movement under the reaction forces at pipe fittings during the rapid filling of the pipework upon system actuation.

a) The maximum spacing between hangers must not exceed those listed in the Hanger Spacing Table 4.

TABLE 4 HANGER SPACINGS

Nominal Pipe Size (mm)	Maximum Spacing Between Hangers (m)
6	.5
10	1.0
15	1.5
20	1.8
25	2.1
32	2.4
40	2.7
50	3.4
65	3.5
80	3.7
100	4.3
125	4.8
150	5.2
200	5.8

b) Fixings should ideally be within 300mm of an elbow.

c) Adequate bracing and support should be provided for nozzles and their reactive forces, such that in no case shall the distance from the last support be greater than as follows:

- ≤25mm pipe: ≤100mm;
- >25mm pipe: ≤250mm.

d) Movement of pipework, caused by temperature fluctuations arising from the environment or the discharge of extinguishant, may be considerable particularly over long lengths and should be taken into account when deciding support fixing methods.

12.2. Pipe support types

a) Threaded rod and Munsen rings

Consisting of a length of threaded rod (typically M10 or M12), with one end fixed into the building structure and a two part ring fitted to the other, in which the pipe is supported. This type of support provides very little bracing where long lengths of threaded rod are employed. Where this support type is used as the sole means of support, the length of unsupported threaded rod should not exceed 100mm. It should also be ensured that the threaded rod is screwed through the Munsen ring to ensure when the two parts of the ring are assembled, that the ring will grip the pipe.

b) Cantilever beams (sectional structural systems)

Proprietary channel section cantilever beams, with corresponding pipe clips or clamps are widely available. These provide greater rigidity than long threaded rod supports and are therefore more suited where the pipe has to be mounted some distance off the fixing surface. The cantilever beams can be installed in the vertical or horizontal attitude, however care should be taken with vertical installation, as the weight of the pipe may only be retained by the friction between the pipe clip and channel. A mix of horizontal and vertical cantilever beams, or interspersed threaded rod and Munsen rings (where these are not the only means of support, thus enabling long lengths of threaded rod to be used) should be employed.

c) DIN 3015 clamps

Consisting of a steel base plate, two part split inner clamp block (plastic or aluminium) and steel top clamp with two through bolts. The base plate is either fixed to the mounting surface with screws/bolts or can be welded onto a structure. With the pipe located between the clamp blocks and the top plate bolted in position, a very secure clamp is achieved. The advantage of this clamp type over traditional U-bolts is that the pipe fixing nuts are on the top of the clamp and so are readily and easily accessible.

d) Fabricated steel brackets

Fabricated from traditional structural steel members (eg angle iron), these are invariably designed and fabricated to suit each individual installation, but some standard designs may be available off the shelf. These brackets are used in conjunction with traditional U-bolts or DIN 3015 clamps. Brackets of this type do provide a very secure means of supporting pipework, but may not be as convenient as beams available in the ranges of sectional structural systems products.

e) Pipe hangers

Other commercially available pipe hangers which do not grip the pipe are not suitable for gaseous fixed fire fighting systems so shall not be used.

13. ACTUATION LINES

Where pneumatic actuation of a gaseous fixed fire fighting system is required between a pilot or master container and the slave container bank, tubing is commonly used in addition to hoses (connectors).

Actuation lines shall be of material having physical and chemical characteristics such that its integrity under stress can be predicted with reliability. The line and fittings shall be suitable for service at the anticipated pressure, at both the minimum and maximum system temperatures.

The actuation line is available in both metric and imperial sizes; 6mm and ¼" tube is commonly used.

The fire industry tends to use either copper nickel pipe (CN102) which is suitable for bending supplied by coil or half hard copper pipe (BS6017 grade Cu-DHP) which is not suitable for bending, and is generally supplied in 3m straight lengths. Alternatively, steel tube in accordance with EN 10305-1 seamless cold drawn tubes or EN 10305-2 welded cold drawn tubes can be utilised.

Connections are made to the actuation tubing using appropriate configured compression fittings. However, when compression fittings are used, steel fittings with steel ferrules (olives) are to be used with steel pipes and brass fittings with brass ferrules (olives) are to be used with copper pipes.

Expansion loops such as 'pigtails' or pilot hoses should be used where appropriate.

14. GASEOUS FIXED FIRE FIGHTING PIPEWORK CORROSION

Corrosion of Gaseous Fixed Fire Fighting pipework, its adverse effects (if no avoidance measures are taken) on both the integrity of the fixed extinguishing system and the protected area/asset, and appropriate avoidance measures shall be considered in the pipework design from the outset. Where corrosion may be a problem, there are propriety methods for detecting corrosion degradation of pipework which include ultrasonic, radiographic, magnetic flux and infra-red.

14.1. Thermal

Wherever a temperature differential may exist resulting in the formation of condensate, for example pipework running through different areas (plant space to a controlled environment)

14.1.1. Galvanic corrosion

This arises from dissimilar metals either in direct contact or in the presence of an electrolyte.

Note: The electrical potential difference between the materials creates a transfer of metallic ions from the anode to the cathode, just like in a battery, thus creating accelerated corrosion of the anode material and reduced corrosion of the cathode. For instance, if stainless steel and carbon steel are in contact, the carbon steel will exhibit significantly increased corrosion and explains why alloys (eg steel) exhibit a faster rate of corrosion than a pure metal (eg iron).

14.2. Pipe internal

Unless the application requires the use of blow off caps or other devices to prevent the ingress of the product or atmosphere from the pipework, it can reasonably be anticipated that the atmosphere of the protected area will encroach into the open ends of the pipework through the nozzles.

Pipework may be exposed internally to condensation by the pipework being partially or wholly routed through an unheated or outdoor area, where condensation is likely to form on the cold pipe material.

Where internal condensation is formed, as there is no free air movement within the pipe, it can be expected that the moisture may be present inside the pipework for some time, therefore consideration should be given to using corrosion resistant materials/finishes, or lagging and/or trace heating of pipework to mitigate this.

14.3. Pipe external

Condensation can also be expected on the pipe exterior following a discharge, no matter how warm or controlled the environment.

External corrosion is also more likely if the pipework is installed in an outdoor environment.

14.4. Effects of corrosion

The deterioration of the external surface of the pipework and its supports is obvious.

What is not obvious is the internal state of the pipework, particularly where installed in outdoor or unheated indoor areas, where condensation can routinely be expected to form on the inside of the pipe.

Under these conditions, some internal surface corrosion can be expected, which will be greater if black pipe is used. It should be noted that the galvanising used to provide corrosion resistance with carbon steel pipe is itself sacrificial, so corrosion of the zinc will occur where any bare steel is exposed – eg at cut ends of the pipe.

Corrosion of the pipe will reduce its wall thickness and ultimately its ability to retain pressure. The speed with which this becomes significant depends on the protection provided to the pipework and the nature of the environment. Ultimately, any corrosion prevention slows down the rate at which corrosion occurs, such that the life of the pipe can normally be expected to be significantly longer than the life of the system.

On discharge, any corrosion present on the internal surface of the pipe is likely to become dislodged, which could be lodged in the nozzles and/or discharged into the protected area. The fitting of dirt traps to the pipework should mitigate this.

14.5. Corrosion avoidance

Hot dip galvanised pipe has superior corrosion resistance compared to black pipe and is therefore preferred; entirely externally painting such pipe will provide additional corrosion prevention.

Where black pipe is used, it should be entirely painted externally. Black pipe should not be used where the regular formation of internal condensation is likely.

Where installed in adverse environments, pipe of higher corrosion resistance (eg stainless steel for outdoor offshore installation) may be essential. For such applications, guidance should be sought to determine the appropriate material/grade for the application.

The use of dissimilar metals in contact should be avoided, especially those combinations with significant electro potential differences, such as carbon steel and stainless steel.

However, where dissimilar metals in contact cannot be avoided, then a means should be employed to insulate the materials. For use with pipework, galvanic insulators may be used, whereby the pipe materials, including union nuts, flanges and flange bolts, are separated by electrically non-conductive material. The use of PTFE tape or similar on screw threads does not provide the degree of insulation required for joining dissimilar metals. Consideration shall also be given to the pipe clamps and supports where these may be of a dissimilar metal to the pipework – eg using plastic lined clamps.

15. PIPE MARKING

Pipe service identification is required (in accordance with BS 1710). Customarily this is a yellow ochre ‘gas’ label installed on both sides of the red band. Flow arrows and gas name labels should be mounted on the yellow ochre bands.

See Table 6 below.

TABLE 6 PIPE IDENTIFICATION

	Band	
Pipe diameter nb	**Safety**	**Basic identification**
< 50	30mm wide	50mm wide
50-100	75mm wide	100mm wide
>100	150mm wide	150mm wide
Colour	red	Yellow ochre
BS4800 colour code	04E53	08C35

FIGURE 1 PIPE MARKING

3	**1**	**2**	**1**	**3**

Key

1 Basic identification colour
2 Safety or code colours (equal widths)
3 Decorative or natural colour

16. PRESSURE TESTING

Pipework should be tested as described below. The type of testing required will be determined by the position of the pipework in the system, relative to devices that could affect the developed pressure in the pipework section.

Unless the total piping contains not more than one change in direction fitting between the storage container and the discharge nozzle, and unless all piping has been physically checked for tightness, the following tests shall be carried out.

Open-ended piping shall be pneumatically tested in a closed circuit for a period of 10 minutes at 3 bar. At the end of 10 minutes, the pressure drop shall not exceed 20% of the test pressure. The test equipment shall be disconnected or isolated (eg by means of a valve) from the pipework for the duration of the test.

WARNING: Pneumatic pressure testing creates a potential risk of injury to personnel in the area, as a result of airborne projectiles if rupture of the piping system occurs. Prior to conducting the pneumatic pressure test, the protected area shall be evacuated and appropriate safeguards shall be provided for test personnel.

Closed-section pipework and pipework upstream of pressure-reducing devices shall be hydrostatically tested to a minimum of 1.5 times the maximum working pressure for two minutes during which there shall be no leakage.

The working pressure is the developed pressure of the agent at the maximum operating temperature which should not be less than 50°C.

Note: It is recommended that hydrostatic testing is carried out at the manufacturer's works where practicable.

In the case of regulated non-liquefied systems, the working pressure shall be taken as the maximum pressure that could be present in the pipework, under both flow and no flow conditions.

On completion of the test, the pipework shall be purged to remove moisture.

17. ELECTROSTATIC PRECAUTIONS

The primary reason for taking precautions against electrostatic charging when deploying extinguishing agents through manifolds and pipework, is to militate against consequence of electrostatic discharge. These discharges can represent an ignition risk to flammable vapours or flammable airborne particulates – leading to fire or explosion.

Electrostatic discharges do not represent any other injurious threat, but the consequent electrical interference also has the propensity to interfere with radio transmissions and damage sensitive electronic components.

More detail on electrostatic hazards and their mitigation can be found in NFPA 77, IEC 61340-4-4, EN 60079-32-1 and EN 60079-32-2.

18. EARTH BONDING

All metallic piping that carries a medium, either liquid, gas or a combination of the two shall be connected to a common earth.

Any fittings, joints or devices that break the continuity of the earth path should have a separate earth connection or a continuation device in place.

Additionally, procedures should be in place for the periodic testing of the continuity to earth of pipework where necessary.

For sizing of earth conductors please refer to BS 7671.

ANNEX A – EXAMPLE CALCULATION OF PIPE MAXIMUM WORKING PRESSURE

Determination of pipe wall thickness for any given maximum working pressure or the maximum working pressure for any given pipe, are determined by calculation. ASME B31.1 or BS EN 13480 – 3.

The following is an example of how to calculate maximum working pressure of a pipe using the ASME B31.1 Power Piping Code method.

The formula used to calculate the maximum working pressure of a given pipe is given by:

$$\text{Pressure } P = \frac{20SE(t-A)}{D}$$

Where:

- P = maximum working pressure (bar)
- S = maximum allowable stress (N/mm^2)
- E = pipe seam efficiency factor
- t = wall thickness (mm)
- A = connection allowance factor

The maximum allowable stress is defined as whichever is the lower of two thirds of the yield stress or one quarter of the tensile strength.

The pipe seam efficiency factor relates to the construction of the pipe. The following factors are used:

Seamless pipe	–	1.00
ERW pipe	–	0.85
Furnace butt weld pipe	–	0.60

The connection factor allowance factor relates to the strength of joint between the pipe and fittings. The following factors are used:

Threaded fittings	–	A = depth of thread (mm)
Welded fittings	–	A = 0
Compression fittings	–	A = 0
Cut grooved connections	–	A = depth of groove (mm)
Rolled groove connections	–	A = 0

Example calculation

Consider ASTM A 106 grade B pipe, DN 25, schedule 40.

Material properties: Yield stress Re/t = 240 N/mm^2

Ultimate tensile stress $R_{m/20}$ = 415 N/mm^2

Both above are based on non-extreme temperature.

For the purposes of the calculations: 2/3 $R_{e/t}$ = 159.84 N/mm^2

1/4 Rm/20 = 103.75 N/mm^2

The limiting stress value is the lower of these figures – ie 103.75 N/mm^2

ASME B31.1 permits the minimum stress value to be increased by a factor of 20% where the pipe is predominantly unpressurised for defined periods; fixed extinguishing system pipework falls into this category, the minimum stress used in these calculations can be increased by 20%, therefore,

S = 124.5 N/mm^2

ASTM A 106 pipe is seamless	E = 1	
Nominal wall thickness	= 3.38mm	

The stated tolerance on wall thickness for ASTM A106 grade B pipe is +0%, -12.5%; the thinnest possible wall thickness must be used in these calculations.

Minimum wall thickness,	= 3.38 – 12.5%,	∴t = 2.96mm
Outside diameter of pipe	D = 33.4mm	

For screwed fittings, connection allowance factor, A = depth of thread.

Depth of 1” NPT thread	A = 1.77mm

Note – if there is any other reduction in wall thickness, or allowance for reduction (due to thinning, corrosion etc), this value must be added to A above in the calculations.

Therefore, maximum working pressure of pipe, $P = \frac{20SE(t-A)}{D}$

$= \frac{20 \times 124.5 \times 1 \times (2.96 - 1.77)}{33.4}$

= <u>89 bar</u>

Calculations based on BS EN 13480 – 3 are equally valid producing a very similar result.

THE STANDARD PIPE TABLES ARE GIVEN BELOW

TABLE A.1 PIPE TABLE API 5L ERW

Nominal size	Schedule	Maximum pressure (bar)		
		NPT screwed fittings	BSP screwed fittings	Welded fittings
40	40	63	77	141
	80	117	130	195
	160	193	206	271
50	40	57	68	119
	80	106	116	168
	160	204	214	266
65	40	58	89	131
	80	103	134	177
	160	167	197	240
80	40	54	79	114
	80	97	123	158
	160	170	195	230
100	40	50	70	97
	80	92	111	139
	160	171	190	218
125	40	48	64	86
	80	86	102	124
	160	170	185	207
150	40	46	59	78
	80	89	102	120
	160	169	182	200

TABLE A.2 PIPE TABLE API 5L GRADE B SEAMLESS

Nominal size	Schedule	Maximum pressure (bar)		
		NPT screwed fittings	BSP screwed fittings	Welded fittings
15	40	117	150	285
	80	208	241	376
	160	320	354	489
20	40	101	128	236
	80	182	209	317
	160	320	347	455
25	40	89	111	221
	80	160	182	292
	160	284	306	415
32	40	81	98	185
	80	147	165	252
	160	224	242	329
40	40	75	90	166
	80	138	153	229
	160	228	243	319
50	40	67	80	140
	80	125	137	198
	160	240	252	313
65	40	68	104	154
	80	122	158	208
	160	196	232	282
80	40	63	93	134
	80	115	144	185
	160	200	230	271
100	40	59	82	114
	80	108	131	163
	160	201	224	256
125	40	57	75	101
	80	101	120	146
	160	199	218	244
150	40	54	70	91
	80	104	120	142
	160	198	214	236

TABLE A.3 PIPE TABLE ASTM A 106 GRADE B

Nominal size	Schedule	Maximum pressure (bar)		
		NPT screwed fittings	BSP screwed fittings	Welded fittings
15	40	114	148	283
	80	212	246	382
	160	320	353	489
20	40	99	126	234
	80	184	211	319
	160	319	345	454
25	40	88	110	220
	80	164	187	297
	160	282	304	414
32	40	79	97	184
	80	146	163	250
	160	223	241	328
40	40	74	90	166
	80	137	153	229
	160	230	246	322
50	40	68	80	141
	80	127	139	200
	160	242	255	316
65	40	67	104	154
	80	123	159	209
	160	198	234	284
80	40	63	93	135
	80	116	145	187
	160	202	231	273
100	40	59	83	115
	80	108	131	163
	160	202	225	257
125	40	56	75	101
	80	102	121	147
	160	200	219	245
150	40	54	70	92
	80	104	120	142
	160	199	215	236

TABLE A.4 PIPE TABLE BS EN 10255 HEAVY SERIES

Nominal size	Maximum pressure (bar)		
	NPT screwed fittings	BSP screwed fittings	Welded fittings
15	65	78	131
20	52	62	104
25	52	61	103
32	42	48	82
40	36	42	72
50	36	41	65
65	19	33	52
80	21	33	49
100	20	29	41
125	16	23	34
150	14	20	28

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