ENGINEERING STANDARDS

FOR

GENERAL INSTRUMENTATION

0. INTRODUCTION

This Engineering Standard covers the minimum requirements of all engineering aspects of instrumentation which are common to various instruments. The Standard is contained in four parts as listed below:

Part One:	Hazardous Area Classification and Methods of Safeguarding
Part Two:	The Division of Responsibilities between Instrument and Engineering Disciplines
Part Three:	Instrument Engineering Procedures
Part Four:	Instrument Documents and Drawings

PART I

HAZARDOUS AREA CLASSIFICATION

AND

METHODS OF SAFEGUARDING

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SECTION TWO: METHODS OF SAFEGUARDING

APPENDICES:

1. SCOPE

This Standard provides general guidance for the safe installation of electrical instruments using appropriate means to prevent ignition of flammable gasses and vapors mixed with air under normal atmospheric conditions. It is intended to be applied in petroleum industries of Iran.

2. REFERENCES

In preparation of this Standard, the following standards and publications have been considered:

IEC (INTERNATIONAL ELECTROTECHNICAL COMMISSIONS)

79-0 "General Requirements"
79-2 "Electrical Apparatus-Type of Protection 'P' "
79-10 "Classification of Hazardous Areas" (1986)
79-13 "Construction and Use of Rooms or Buildings Protected by Pressurization"

IP (INSTITUTION OF PETROLEUM)

"Model Code of Safe Practice in the Petroleum Industry"

Part 1 "Electrical Safety Code" 6th Ed. (1991)

Part 2 "Storage and Handling of Petroleum Products
Part II: Design, Layout and Construction" (1990)

Part 15 "Area Classification Code for Petroleum Installations" (1990)

API (AMERICAN PETROLEUM INSTITUTE)

500 A "Classification of Areas for Electrical Installations at Petroleum Refineries" (1973)

500 B "Classification of Areas for Electrical Installations at Production Facilities"

500 C "Classification of Areas for Electrical Installations at Petroleum & Gas Pipeline Transportation Facilities"

ISA (INSTRUMENT SOCIETY OF AMERICA)

RP-12.1 "Electrical Instruments in Hazardous Atmosphere"
RP-12.2 "Intrinsically Safe and Non-Incentive Electrical Instruments"
RP-12.6 "Installation of Intrinsically Safe Systems for Hazardous (Classified) Locations" (1989)
S-12.4 "Instrument Purging for Reduction of Hazardous Area Classifications"

NFPA (NATIONAL FIRE PROTECTION ASSOCIATION)

NFPA 70 "Hazardous Classified Location" (1989)

SECTION ONE
HAZARDOUS AREA CLASSIFICATION

3. GENERAL CONSIDERATIONS

3.1 Electrical equipment in petroleum industries require special precautions to prevent or contain safely any explosion caused by ignition of vapors which have penetrated from outside into the equipment housing.

3.2 For electric instrumentation, the problem is aggravated because measuring elements containing flammable process fluids are often located in the housing for the electric components, a typical example is a pressure switch. Failure of the measuring element may mean an explosion, unless the electric components have been selected to prevent this.

3.3 Allowable techniques for coping with the above hazards, such as application of intrinsically safe circuits, flame-proof housings etc., depend on the area classification, as will further detailed in the following chapters.

3.4 For recommendation on area classification in Petroleum Industries or applications, reference should be made to the "Electrical Safety Code" Part I, "Model Code of Safe Practice in Petroleum Industry".

3.5 For determining the extent of the various types of dangerous area, such as distance in horizontal and vertical direction from potential sources of flammable gas and vapor, refer to the IP Code. The influence of future plant extensions on adjacent plots shall be taken into account, when plans are known in sufficient detail.

3.6 For each project, an area classification drawing which is made by the relevant specialists, shall form the basis for consideringinstrumentation-aspects.

3.7 The area classification drawing will only indicate the conditions around the instruments, but the situation inside the instrument housing may be more dangerous in case of failure of the measuring element. The more onerous of the two classifications should determine the appropriate execution.

4. AREA CLASSIFICATION OF PETROLEUM INSTALLATIONS FOR THE SELECTION OF ELECTRICAL EQUIPMENT

The following section outlines the procedures for the classification of areas for the selection and installation of electrical equipment. Unprotected electrical equipment would be a potential ignition hazard in certain areas of the installation. For the selection of appropriate and safe electrical equipment, and its sitting in any oil facility, control is exercised by means of 'Area Classification', a procedure whereby the different zones of an installation or plant are set out in accordance with the International Electrotechnical Commission nomenclature, IEC 79-10. The definition of hazardous area in this context, and its converse, is as follows:

4.1 Hazardous Area

An area in which explosive flammable gas-air mixtures are, or may be expected to be, present in quantities such as to require special precautions for the construction and use of electrical apparatus.

4.2 Non-Hazardous Area

An area in which explosive/flammable gas-air mixtures are not expected to be present in quantities such as to require special precautions for the construction and use of electrical apparatus.

4.3 Condition of Explosions

For an explosion to occur the following conditions must co-exist:

4.3.1 A flammable gas or vapor mixed with air in the proportions required to produce an explosive gas-air mixture.

4.3.2 A means of ignition

Only means of ignition related to electrical apparatus are taken into consideration. These are arcs or sparks or surfaces at a temperature sufficient to ignite the mixture. In order to facilitate the selection of appropriate electrical apparatus, hazardous areas may be divided into classified Zones.

5. CLASSIFICATION OF HAZARDOUS AREAS

5.1 Zones (Classification by IEC)

Hazardous areas are classified in zones based upon the frequency of the appearance and the duration of an explosive gas atmosphere as follows:

5.1.1 Zone 0

An area in which an explosive flammable gas-air mixture is present continuously or is present for long periods.

The vapor space of a closed process vessel or storage tank or above an oil-water separator basin is an example of this Zone.

5.1.2 Zone 1

An area in which an explosive gas-air mixture is likely to occur in normal operation.

The vicinity surrounding vents and gaging openings on a fixed-roof tank containing Class I petroleum products is an example of this category.

5.1.3 Zone 2

An area in which an explosive gas-air mixture is not likely to occur in normal operation and if it does occur, it will only exist for a short period.

An example is the whole area inside the bund wall of a fixed or floating-roof tank containing Class I petroleum products, and to the height of the bund wall.

Because of the lower probability of a Zone 2 occurrence, less stringent protection will be required for electrical equipment suitable for Zone 2 installation.

5.1.4 Classification of hazardous areas diagram

A block diagram represents schematically the zone classification of hazardous areas, is shown in Appendix A.

5.2 Divisions (Classification by NFPA)

The classification of hazardous areas in accordance to NFPA 70 Standards are as follows:

5.2.1 Division 1

The criterion for these locations is that; hazardous concentration of flammable gases or vapors continuously intermittently or periodically present under normal operating conditions.

5.2.2 Division 2

The criterion for these locations is that; volatile flammable liquids or flammable gases present, but normally confined within closed containers or system from which they can escape only under abnormal operating or fault conditions.

6. IP CLASSIFICATION OF PETROLEUM PRODUCTS

The Institute of Petroleum has revised its classification for petroleum products to be consistent with the system that is adopted within the Europe.

6.1 IP Classification Table

The IP classification is based on closed-cup flash points which has been shown in the Table 1 below: Flash point is the minimum liquid temperature at which, under certain standardized conditions, a liquid gives off sufficient vapors to form an explosive vapor/air mixture.

TABLE 1 - IP CLASSIFICATION

IP CLASSIFICATION	RANGE OF LIMITS	CORRESPONDING UK AND EEC LEGAL TERMINOLOGY
Class 0	Liquefied Petroleum Gas (LPG)	Liquefied Petroleum Gas
Class I	Liquids which have a flash point below 21°C	Highly Flammable Liquid
Class II	Liquids which have a flash point from 21°C up to and including 55°C	Flammable Liquid
Class III	Liquids which have a flash point above 55°C up to and including 100°C	Combustible
Unclassified	Liquids which have a flash point above 100°C	(No designation, but will burn under appropriate conditions.)

6.1.1 Effect of temperature

The extent of a hazardous area may increase with increase of temperature of process liquid provided the temperature is above the flash-point. It should be noted that the liquid or vapor temperature after the release may be increased or decreased by the ambient temperature or other factors (e.g. a hot surface).

6.1.2 Subdivision of the classification for high ambient temperatures and for heated products

For locations where ambient temperatures are high enough for the normal handling of products to rise above 21°C, e.g. in tankage, or in circumstances where products are handled artificially heated, it is necessary to introduce a further subdivision of the classification. For example, kerosene with a flash point, say, of 38°C, would be classified as ’Class II’ petroleum for ambient handling in a temperate climate, since its vapor would be too lean to create a flammable atmosphere; handled in a tropical location its temperature could rise to above the level of its flash point, creating a potential flammable condition e.g. in the vapor space of a fixed-roof storage tank.

For this reason, in the IP Codes Class II and Class III categories of petroleum are further subdivided in accordance with the circumstances as follows:

6.1.3 Subdivision of classes II and III liquids

Class II (1)	Liquids which have flash points from 21°C up to and including 55°C, handled below flash point.
Class II (2)	Liquids which have flash points from 21°C up to and including 55°C, handled at or above flash point.
Class III (1)	Liquids which have flash points above 55°C up to an including 100°C, handled below flash point
Class III (2)	Liquids which have flash points above 55°C up to and including 100°C, handled at or above flash point.

This subdivision is used as follows in conjunction with the IP Codes of Safe Practice:

Where liquids to be handled are in the category Class II (1) or Class III (1), i.e. at temperatures below their flash point, appropriately less stringent conditions of safety spacing and related precautions are given in the codes than are applicable for Class I products i.e. highly flammable liquids.

When Class II or III products fall into the Class II (2) or III (2) category, they are treated as though they were in Class I.

This system of classification enables requisite guidance to be given, and readily understood and followed in the codes, both for design and subsequent operation.

If the flash point is in excess of 100°C, then is called unclassified. "Unclassified" petroleum liquids should be considered as Class III (2) when handled under this condition.

6.2 Factors to be Considered for Area Classifications

Various factors must be taken into consideration when classifying an area. The main considerations are:

a) Source of hazard
b) Ventilation
c) Nature of hazard

6.2.1 Sources of hazards (or source of release)

The source of hazard is a point from which a flammable substance may be released into the atmosphere. There are three basic grades of source of release as listed below in order of decreasing likelihood of the release occurring:

- Continuous grade
- Primary grade
- Secondary grade

A source of release may be one of the above three grades, or may be a combination of two or three, in which case it is regarded as a multi-grade source of release.

6.2.1.1 Continuous grade source of release

A source which will release continuously or is expected to release for long periods or for short periods which occur frequently.

6.2.1.2 Primary grade source of hazard

a) Machinery and plant which can release a flammable substance into the atmosphere during normal operation.
b) Equipment containing a flammable substance and constructed of material liable to easy breakage.

6.2.1.3 Secondary grade source of hazard

Machinery or plant which can release a flammable substance into the atmosphere during abnormal (leakage or bursting) or infrequent operations for short periods. The source of releases are represented graphically as Figs. 1, 2 and 3.

6.2.2 Examples of sources of release

The following is a schedule or examples of recognized sources of release but in no way is it claimed to be complete as the design and development of new and modified equipment is a continuous process which frequently involves the use of new materials etc. A constant review of all equipment used is therefore absolutely necessary.

6.2.2.1 Fixed cone roof tanks-vents, manholes and dip hatches

When a tank is being filled vapor can be discharged-appropriate to the rate of filling-from any of the above referred to openings which are not sealed at the time.

Discharge of vapor can also occur at other times due to a change in temperature or, if a dip hatch is opened when a tank is above atmospheric pressure. Tank filling can occupy a relatively extended period of time and is a normal operation that gives rise to a primary grade source of release of flammable vapor to atmosphere.

6.2.2.2 Floating roof tanks

The roof-to-tank seal is normally vapor tight but vapor may accumulate above the roof within the tank shell when the tank is being emptied. Since the roof, when traveling downward, leaves a wetted area of shell so giving rise to a primary grade source of release. Normally there is sufficient wind to disperse such vapor but the source of release is nevertheless classed as primary.

6.2.2.3 Valves, flanges, pump glands and seals

In plants and installation where products are handled below their boiling point the above do not normally give rise to primary grade sources of release. A secondary grade source of release could occur where the valve stem or spindle passes through the packing gland or seal or where a flange gasket fails.

6.2.2.4 Loading arms

The external surface of the immersed length of the arm will be wet as it is withdrawn from the vessel which has been filled. The internal surface of the arm will also be wet. The wetted surfaces will drain so giving rise to other small wetted areas as the arm is returned to the "rest" position.

6.2.2.5 Relief valves

Relief valves do not create sources of release unless they vent to atmosphere.

6.2.2.6 Filters, sample points, air bleed points and pig traps

a) When filters are opened for cleaning, a wetted surface will be exposed and spillage may occur.

b) Sample points should be designed to prevent loss of constituents of the sample. The flow should, where practical, be restricted in order to limit the rate of loss if the sample point is accidentally left open. Samples should be small and delivered if possible into a closed system. Release of flammable vapor should consequently be small and infrequent.

c) Air bleed points are only fitted at high positions in piping systems and are normally in well-ventilated situations. Their use is infrequent, usually during commissioning and recommissioning and they should be plugged or blanked off when not required.

Leakage can occur if a valve is not properly re-seated. Flow rate during operation of such valves should be restricted but even so consideration should be given to the possible release of liquid and a consequent wetted area.

d) Pig traps give rise to three possible sources of release namely the air vent, the drain-line to a sump and the exposed wetted area of the internal surface of the trap, when opened. This includes the pig and any discharged debris. All the above are secondary grade sources of release.

6.2.2.7 Slop facilities, interceptors and sumps, drainage channels

In combination the above can form an oil/water effluent system and therefore require very careful consideration both separately and jointly since spillage in one area can be transmitted through to other areas. Slop facilities usually comprise a tundish-type entry to a closed piped system, leading in turn to a storage tank. Spillage may occur which gives rise to a secondary grade source of release.

6.2.2.8 Ground spillage

The initial rate of evaporation from ground spillage will be high with low flash point material and will then decrease assuming no replenishment by continued spillage. The area affected by the above secondary grade source of release will extend above and beyond the total surface area of the spillage.

6.2.3 Ventilation

The dilution of a flammable gas with air will depend upon the degree of ventilation and upon the amount of ignitible gas, or vapor available to replace the gas being diluted.

It follows from the above that there are two extreme conditions. A hazardous Zone 0 in which an explosive gas-air mixture can be present either continuously or for an appreciable time in an enclosed space, hence a source of ignition must be completely avoided; and a non-hazardous zone where a source of ignition is permissible because an explosive gas-air mixture is not expected to be present.

There are two intermediate hazardous zones:

a) Zone 1

In which an explosive gas-air mixture may be present under normal operating conditions (although every effort would normally be made to minimize such a likelihood).

This situation requires the installation of protected-type electrical equipment which will not give rise to a source of ignition (for a free flammable atmosphere) under normal or fault conditions.

b) Zone 2

In which an explosive gas-air mixture would only be present under abnormal conditions for a short time.

This situation requires the installation of protected-type electrical equipment which will not give rise to a source of ignition for a free flammable atmosphere in normal operation but which could do so in electrical fault conditions despite precautions to minimize the likelihood. In this case the probability or a flammable atmosphere and an electrical source of ignition being present simultaneously is very low.

Examination of the circumstances and total environment surrounding each possible source of release will indicate how quickly the flammable vapor can be expected to disperse. For example if ventilation is good a hazardous situation may remain for only the duration of the release and in this case a secondary grade source of release would give rise to a Zone 2 area, since the period of release would be short and infrequent.

6.2.4 Factors in considering the extent of hazardous zones

A release of flammable substance may occur as gas, liquid, vapor or a combination of three. It is necessary to decide at what distance from the source the vapor will have diffused in air to a mixture that cannot be ignited i.e., the distance at which it passes the lower explosive limit. Consideration must therefore be given to:

a) The quantity of material released, if over a short period, or the rate of release.

b) The conditions of the release. Namely temperature and properties of the product, local ambient temperatures and ventilation rate.

c) The rate of evaporation and the distance the vapor cloud will travel before dilution to below the lower explosion limit.

6.2.5 The nature of release i.e., liquid or vapor

An indication of the evaporation rate can be obtained from the vapor pressure of the product release as the evaporation rate-including that for a mixture of hydrocarbons-depends upon its volatility. It will also depend upon the temperature of the substance released and the temperature of the atmosphere into which it is released.

Dilution of the vapor from the flammable substance can occur due to:

a) Wind-which is the most significant.
b) Turbulence-caused by the velocity of the release.
c) Effect of gravity and thermal air currents on heavier than air material.

6.2.6 Requirements for electrical equipment in hazardous areas

All electrical equipment to be used in Zones 0, 1 and 2 must comply with the relevant standards for these Zones.

6.2.7 Requirements for ignition sources other than electrical

Whilst the classification described is for the selection of the correct electrical equipment and installation for each hazardous zone, the same classification will apply when ignition sources arising from other than electrical equipment are considered.

In Zone 0 and Zone 1 areas all items of equipment should be considered very carefully to establish if they could form an ignition source and if so they must be omitted.

In Zone 2 areas it is recommended that no plant, equipment or facilities should be used giving rise to fire, capable of producing sparks or generating temperatures higher than the auto-ignition temperature of the gas-air mixture present.

Full consideration must be given to all other factors which may influence the final classification for the purpose concerned.

6.3 Examples for Determination of Hazardous Areas Extents

6.3.1 Road tank vehicles-top loading

The analysis should be carried out in stages as follows:

The hazardous zones around all possible sources of release which could arise from the gantry equipment and slop facilities in the absence of a tank vehicle, should be assessed and a practical envelope devised.

Then with vehicles present and manlids open the additional zones which arise whilst vehicles are being filled should be determined. These zones are transient and will not exist when the manlids are closed and the loading arms have been returned to the parked position.

Spillages which could arise during tank vehicle filling and from other operations such as filter cleaning etc., should be considered and zones determined appropriate to the rate and duration when these could occur in practice, bearing in mind the degree of manual participation involved.

It is self evident that the whole arrangement must permit the movement of vehicles to and from the loading positions and this must take place with the loading gantry and vehicle in a hazard-free state.

A detailed analysis of each of the above stages is given below leading to the final classification of the loading area for the purpose of selecting the correct type of electrical equipment and installation.

a) Loading gantry facilities-no vehicle present

The loading arms are a primary grade source of release and consequently a hazardous zone will extend from the island base to a level above the walkway; the criteria being the height of the open end of the loading arm in the parked position.

b) Filling of vehicles

At all times whilst a vehicle is in service the internal spaces of the compartments should be classified Zone 0 (Division 1).

c) Spillage

Spillage, a secondary grade source of release, can occur from fillers during routine servicing, from the components of pipework systems, and overfilling of vehicle compartments.

The total hazardous area should include that within the means of containment plus an area beyond it for a horizontal distance equal to seventeenths (0.7) of that across the contained area, all to a height of 1 m, and a Zone 2 (Division 2) classification is recommended.

Where no means of containment exists around the area it is recommended that the extent of the hazardous area be determined on the basis detailed above as an extension beyond the maximum distance a spillage could be expected to run.

Typical installation-final classification shows the various hazardous areas derived from, (a, b and c), compounded to give a practical arrangement. The Zone 1 area around the vehicle has been extended to allow for drainage from the loading arm after it has been removed from the vehicle compartment to the parked position.

6.3.2 Road tank vehicles-bottom loading

A primary grade source of release will occur during the filling operation and if overfilling occurs there could be a secondary grade source of release. It is therefore recommended that the Zone 1 (Division 1) area around the vehicle be similar to that for top loading.

a) Rail cars-top loading

A primary grade source of release occurs whilst the rail car is being loaded due to vapor emission from the open or venting manlids.

Primary and secondary grade sources of release occur from the loading arms when being removed from the rail car to the parked position, from spillages due to overfilling and from filters and other associated equipment.

b) Rail cars-bottom loading

Sealed couplings are normally used from which a secondary grade source of release may occur due to leakage. Secondary grade sources of release can arise due to accidental spillage, when couplings are broken and from filters and associated equipment.

6.3.3 Tankage

a) Cone roof tanks

The tanks covered by this example are either free venting or low pressure fitted with pressure/vacuum valves. The ullage space should be classified Zone 0 (Division 1), irrespective of whether a floating or inert gas blanket is present.

b) Floating roof tanks

Primary grade source of release may occur above the tank roof and therefore the space above the roof and within the tank shell should be classified Zone 1 (Division 1). When the roof travels upwards, vapor will be displaced and diffusion will occur into the atmosphere above and around the tank. It is recommended therefore that an area above the tank shell for a distance of 2 m, extending 2 m horizontally beyond the tank shell and down to ground level should be classified Zone 2 (Division 2).

If the floating roof tank has a double wall, the outer wall acting as a bund, then the annular space between the walls should be classified Zone 1 (Division 1). The Zone 2 (Division 2) area above the tank should be extended horizontally to a point 2 m beyond the outer wall and then vertically downwards to the ground.

c) Pump platforms and open buildings

Pump platforms and open buildings are considered to be well ventilated situations. Any equipment installed usually gives rise to secondary grade sources of release.

A secondary grade source of release can occur from a flanged joint due to gasket failure. Flange joints most likely to leak include those subject to sharp changes in temperature, mechanical stress due to pipe movement, high pressure and those that are broken and remade at frequent intervals.

The extent of the hazardous area that can be expected from a flange gasket failure should be determined from a knowledge of all the pertinent conditions.

Pump suction strainers which are opened for servicing may involve some spillage and the wetted surfaces of the component parts and debris would give rise to secondary grade sources of release.

Provided that the sources of release are those associated with the pump platform or open building then it is recommended that the whole area of the platform or building be classified Zone 2 to a height of 2 m above the platform surface and, if an elevated platform, down to ground level irrespective of the type of flooring. The position of flanges and valves relative to the extremities of the above area must be considered and the Zone 2 (Division 2) area enlarged local to them.

d) Closed pump houses

The installation of pumps handling flammable materials within enclosed buildings is not recommended. However, when unavoidable the whole of the inside of the building should be classified Zone 1 (Division 1), since the continuous dilution of any flammable vapor cannot be guaranteed. Openings in the building to the outside atmosphere should be considered as secondary grade sources of release and an area extending 3 m in all directions and down to ground level from the edges of the opening should be classified Zone 2 (Division 2).

f) Manifolds

Manifolds in pipework systems such as those associated with pump platforms are usually in freely ventilated situations.

Secondary grade sources of release only are likely to occur from valves, flanged joints, vents and drain valves. Consequently a source of release can only be expected under abnormal conditions or under controlled conditions.

It is recommended that the manifold area, extended a distance of 2 m in all directions and down to ground level when measured from the extreme outer possible sources of release, should be classified Zone 2 (Division 2).

Pits and trenches below ground level within the above area should be classified Zone 1 (Division 1) as they cannot be considered freely ventilated and heavier than air vapors could accumulate within them.

If the manifold system contains line-pig or sphere reception facilities and has associated pit and open drainage system as may be employed at pipeline-supplied terminals, then the above constitute primary grade sources of release. It is recommended that the area extending 3 m horizontally from the open drainage system, 3 m upwards from the highest source of release and down to ground level should be classified Zone 1 (Division 1).

SECTION TWO
METHODS OF SAFEGUARDING

7. INTRINSIC SAFETY

7.1 An Intrinsically Safe (IS) instrument or circuit is an arrangement of instruments and wiring incapable (under normal or abnormal conditions) of releasing sufficient energy to cause ignition of a specific hazardous mixture in its most easily ignited form at atmospheric pressure.

7.2 Only those instruments shall be used, which carry a certificate of intrinsic safety for the type of gas to be expected in its intended location (refer to Appendix B). Moreover, it must be ensured that this certificate has been (or will be) accepted by the Company regulations

7.3 For process instrumentation, the certificate of intrinsic safety shall be valid for field mounted instruments and the related circuits extending to the control centers at safe areas.

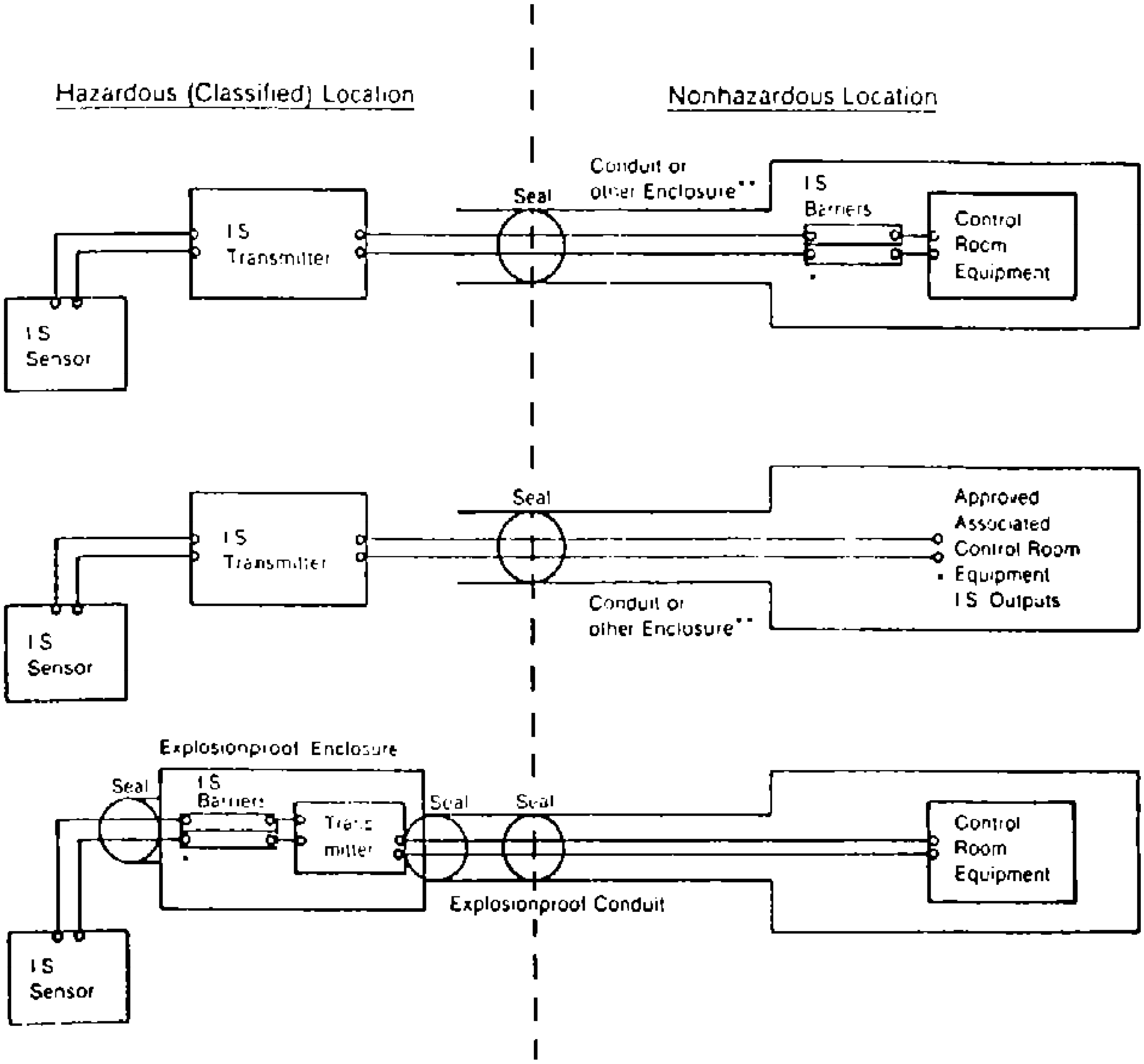
7.4 When instruments, data loggers, computers, etc., without an IS certificate are to be connected to instrumentation in hazardous areas, application of safety-barriers (with valid certificate) shall be considered to make the external circuit intrinsically safe.

These safety-barriers restrict the maximum possible spark-energy, and consequently have more in-line resistance for higher operating voltages.

Shunt-diode barriers are therefore only suitable for low-level signals, e.g., thermocouples, or electric signals in the milli-amp, range for electronic instrumentation. Where switches mounted in hazardous areas are required to control higher power, e.g., for operating relays in non-IS alarm and control systems, the use of other safety barriers, such as interposing relays with IS, certificate shall be considered.

7.5 The housing of IS field-mounted instruments, components, and the associated cable gland(s) shall be weather-proof and (where necessary) water-tight.

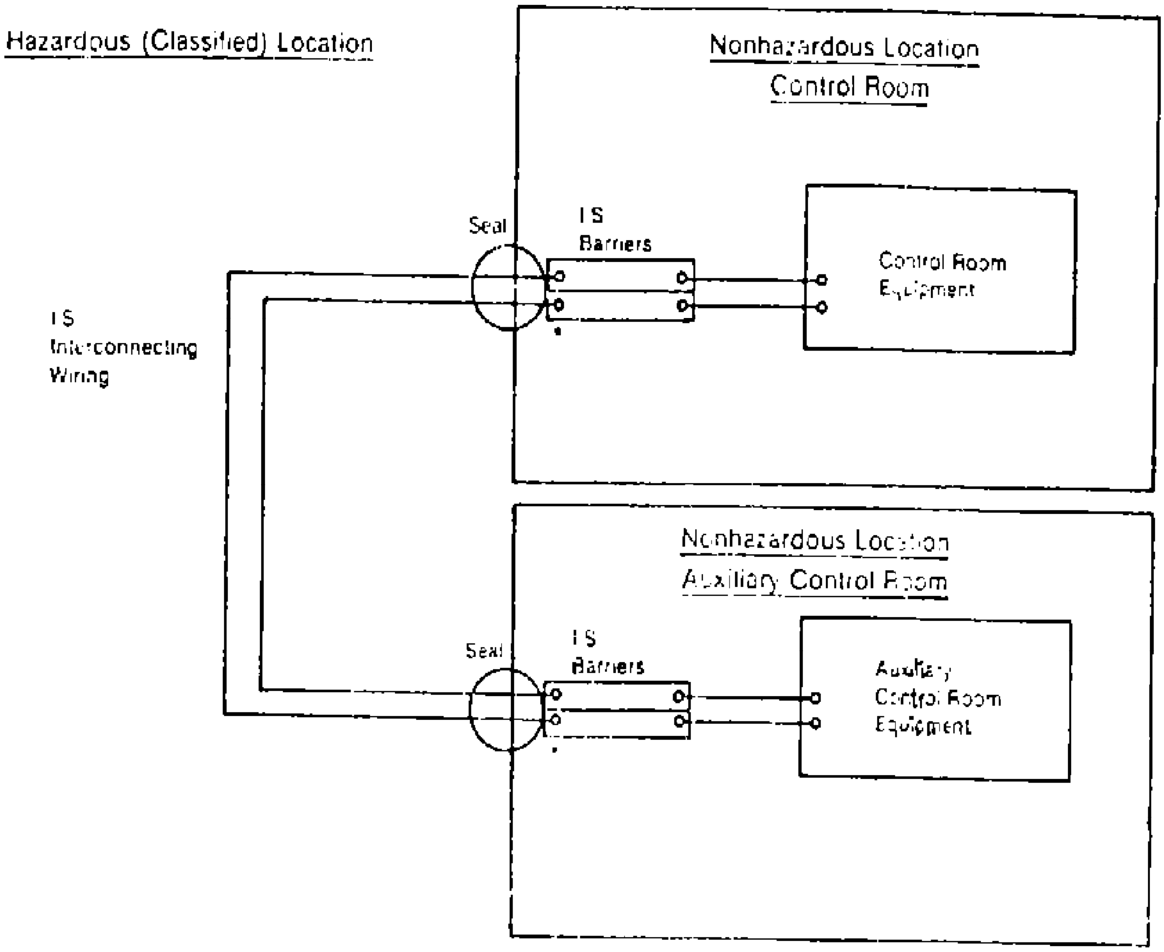
7.6 Some examples of the various configurations of intrinsically safe systems are given in Fig. 1.



VARIOUS CONFIGURATIONS OF INTRINSICALLY SAFE SYSTEMS
Fig. 1 (to be continued)

*** IS Intrinsically Safe terminals.**

**** Other enclosure may be shielded cable, metal-clad cable, or any mechanical or electrical protection that en-forces separation of intrinsically safe circuits from circuits that are not intrinsically safe.**

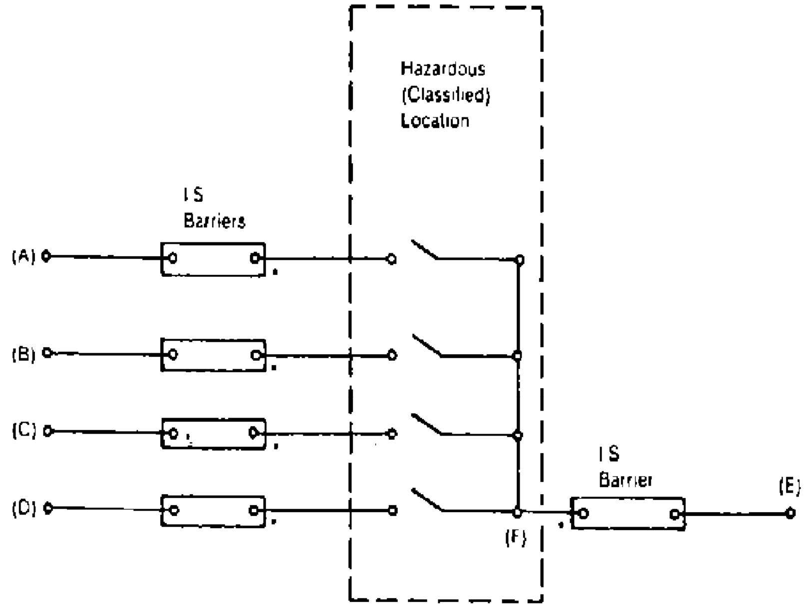


*** IS Terminals.**

VARIOUS CONFIGURATIONS OF INTRINSICALLY SAFE SYSTEMS
Fig. 1 (continued)

7.7 Hazardous (Classified) Location Apparatus

7.7.1 A switching device is shown in Fig. 2. If a common fault voltage occurs at Terminals A, B, C, and D when all the switch contacts are closed and if a simultaneous fault to ground occurs at point F, it is possible to get five times the maximum current of any one barrier. Unless the barrier control drawing permits five barriers to be paralleled, this circuit configuration is not acceptable.



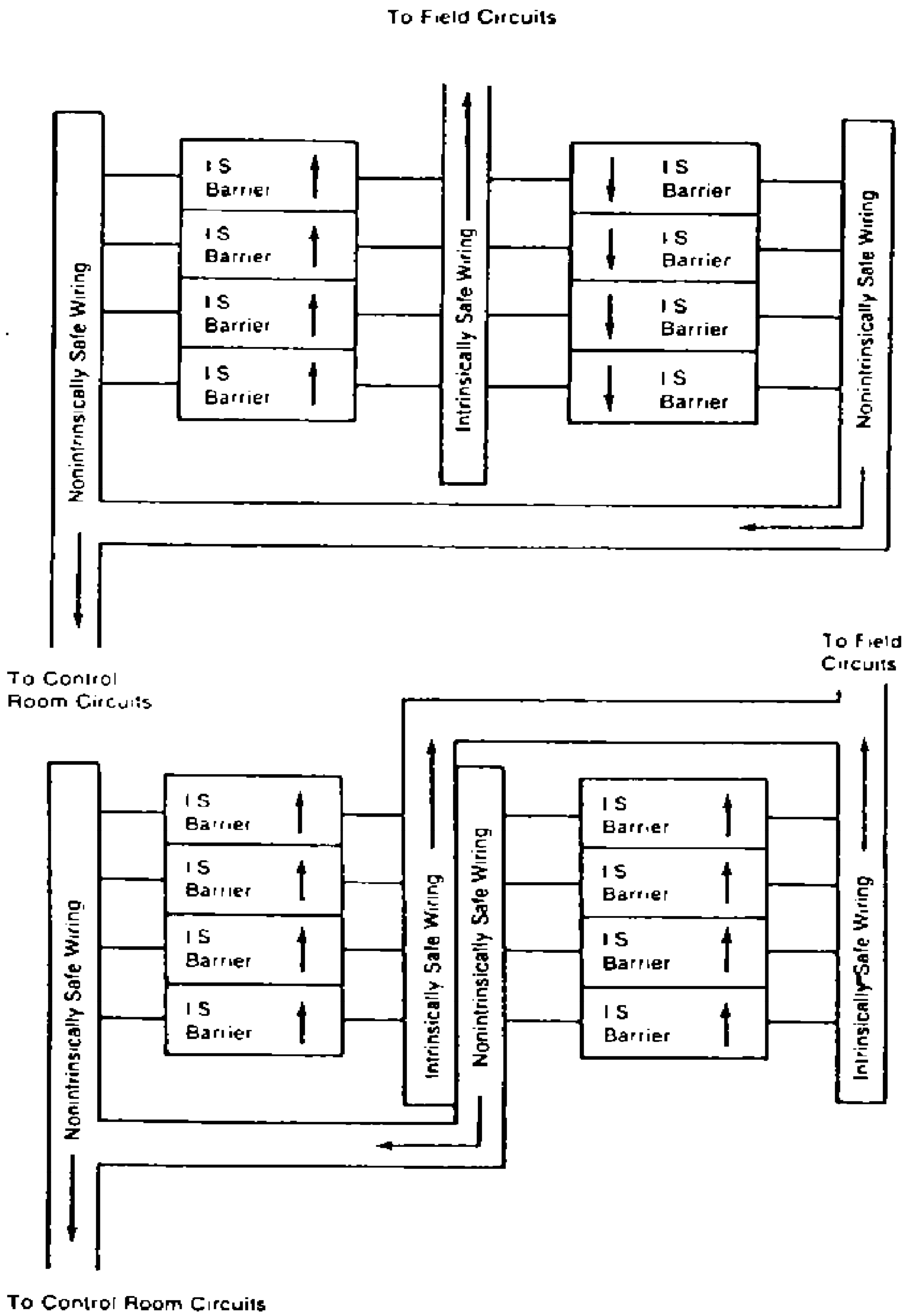
BINARY CODED DECIMAL SWITCHING DEVICE
Fig. 2

*** IS Terminals.**

7.8 Nonhazardous Location Wiring of Intrinsically Safe Circuits

7.8.1 Where intrinsically safe wiring may be exposed to disturbing magnetic or electric fields, it shall be twisted, shielded, or other suitable methods implemented to prevent the energy level of the intrinsically safe wiring from becoming ignition-capable.

7.8.2 When several devices having both intrinsically safe and nonintrinsically safe terminals are mounted in the same enclosure, attention must be given to the separation of circuits. An acceptable method of separation is shown in Fig. 3. Separate raceways are often used to provide greater assurance that separation of wiring will be maintained. Wire lacing, wire ties, or equivalent fasteners are also acceptable methods of separating wiring.



SUGGESTED PANEL ARRANGEMENT USING SEPARATE WIREWAYS
Fig. 3

8. FLAME-PROOF HOUSINGS

8.1 A flame-proof housing for electrical apparatus will withstand, without injury, any explosion of the prescribed flammable gas or vapor that may occur within it, and will prevent the transmission of flame such as will ignite the prescribed flammable gas or vapor which may be present in the surrounding atmosphere.

8.2 Flame-proof certificates are issued for separate groups of gases, according to the grade of risk. For segregation of groups refer to Appendix B.

In general apparatus certified for the higher group will cover situations where gases from the lower groups are present.

8.3 Flame-proof housings have been carefully designed for pressure release and flame-quenching openings, and consequently these housings are usually not weather-proof. Where weather-proofing is required for protection of the internals, this shall not interfere with the basic features. The use of gaskets is permissible only where these are applied to a joint additional to the flame-proof joint and do not interfere with its function.

A suitably constructed weather shield is usually the best solution.

8.4 All flame-proof housings shall be properly earthed.

9. PURGING FOR REDUCTION OF HAZARDOUS AREA CLASSIFICATION

The addition of air or inert gas (such as nitrogen) into the enclosure around the electrical equipment at sufficient flow to remove any hazardous vapors present and sufficient pressure to prevent their re-entry, shall be considered for hazardous area classification reduction.

9.1 Purging Classifications

9.1.1 Type Z purging

This covers purging requirements adequate to reduce the classification within an enclosure from Division 2 (normally non-hazardous-Zone 2) to non-hazardous.

9.1.2 Type Y purging

This covers purging requirements adequate to reduce the classification within an enclosure from Division 1 (hazardous-Zone 1) to Division 2 (normally non-hazardous).

9.1.3 Type X purging

This covers purging requirements adequate to reduce the classification within an enclosure from Division 1 (hazardous-Zone 1) to non-hazardous.

All type of purging systems shall be engineered and made to prevent flammable material from entering the enclosure by maintaining at least 2.5 mm of water, positive pressure inside the enclosure. All other requirements as specified in ISA/S 12.4 shall be fulfilled in purged systems.

Note:

For area classification equivalent of Division to Zone, refer to Appendix C.

9.2 General Requirements for Purging Applications

9.2.1 This Standard applies to instrument enclosures not exceeding 0.3 cubic meter.

9.2.2 In like manner for purposes of this Standard the ratio of the maximum internal dimension to the minimum shall not exceed 10 to 1.

9.2.3 An internal enclosure or an adjacent enclosure that is being considered as part of and purged with the main instrument enclosure must have nonrestricted top and bottom vents, common to the purged main enclosure, having a minimum size for each vent of 645 mm^2 per 6555 mm^3 of the volume of the internal or adjacent enclosure.

9.2.4 Enclosure shall be of non-combustible material and construction not likely to be broken under conditions to which it may be subjected.

9.2.5 Any window in a purged enclosure shall be of a material that is resistant to breakage such as 6.35 mm tempered glass or equivalent.

9.2.6 If hazardous gases or vapors have been collected within the enclosure, either because the door has been opened or the purge has failed, then enclosure must be purged before power is applied. Once purged of hazardous concentration, it is not obligatory to maintain any given flow rate. It is only necessary that positive pressure be maintained within the case.

9.2.7 Since the intent is to purge an enclosure to reduce the concentration of hazardous gases or vapors to an acceptably safe level, enclosures within the instrument or adjacent enclosures connected to the instrument must be considered separately.

- **a)** They may be adequately vented to the main enclosure.
- **b)** They may be separately purged.
- **c)** Equipment contained therein may be protected by other approved means.

9.2.8 If the enclosure is opened or if a failure occurs within the purging system, the purging system pressure may not be adequate to exclude the entrance of flammable gases or vapors. Suitable precautions such as indicators, interlocks, etc., must therefore be provided to safeguard the installation.

9.2.9 The purging supply shall be essentially clean and free of dust and liquids. It shall contain no more than trace amounts of flammable vapors or gases.

9.2.10 Instrument air is acceptable as well as other suitable gas such as inert gas. Ordinary plant compressed air is usually not suitable.

9.2.11 The compressor intake must be located in a non-hazardous area. The compressor suction line should preferably not pass through any area having hazardous atmospheres.

9.3 Specific Requirements for Purging Applications

9.3.1 Type Z-requirements

For the use of purging to reduce the classification of the area within an instrument from Zone 2 (Division 2 normally non-hazardous) to non-hazardous.

9.3.1.1 Before power is turned on, at least four enclosure volumes of purge gas must have passed through the enclosure while maintaining an internal enclosure pressure of at least 2.5 mm of water.

Exception:

Power may be turned on immediately if a pressure of at least 2.5 mm of water exists and if the atmosphere in the enclosure is known to be non-hazardous.

9.3.1.2 The enclosure must be maintained under a positive pressure of not less than 2.5 mm of water when the power is on.

9.3.1.3 Under normal operation and with 125 per cent of rated voltage applied to the instrument, the external enclosure temperature or the temperature of the engress air shall not exceed 80 percent of the ignition temperature of the vapor or gas involved.

9.3.1.4 Safety interlocks to remove power upon failure of purging supply are not required.

9.3.1.5 Acceptable installations are shown in Figs. 4.1, 4.2 and 4.3.

9.3.1.6 An alarm or indication of purge system failure must be provided. The audible or visual device may be mechanical, pneumatic or electric/electronic as follows:

a) If electrical, it must meet the requirements for its location.

b) To avoid plugging when a pneumatic device is used, any restrictions between the pneumatic device and the enclosure shall have passages no smaller than the smallest passage before the pneumatic device.

c) No valve between the alarm or indicator and the enclosure shall be permitted.

d) The pressure or flow device must be capable of indicating (or actuating an alarm) when the purging pressure or flow is inadequate to maintain a static pressure within the enclosure of 2.5 mm of water.

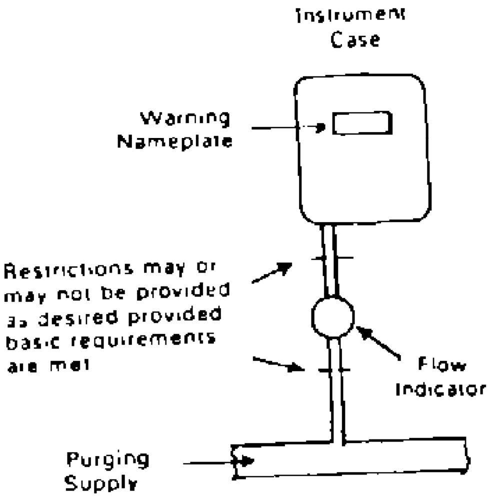


Fig. 4.1

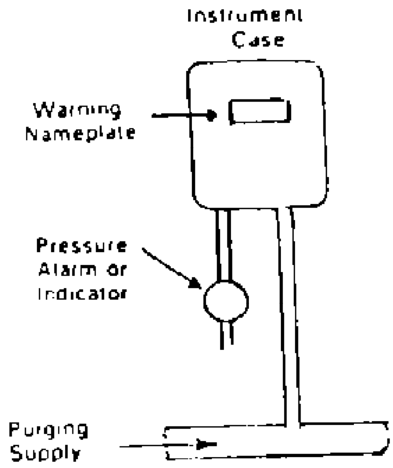


Fig. 4.2

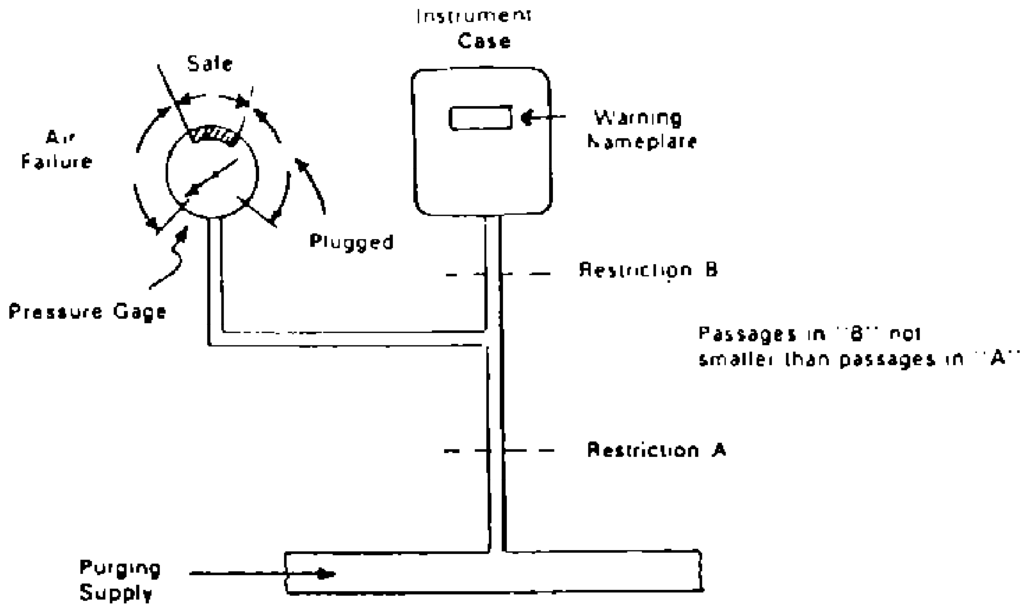


Fig. 4.3

ACCEPTABLE INSTALLATIONS FOR TYPES Y & Z PURGING
Fig. 4 (1, 2 and 3)

9.3.1.7 A red warning nameplate must be mounted on the instrument. The name-plate shall be mounted in a prominent location and be visible before the enclosure is opened. It shall state:

a) Enclosure shall not be opened unless area is known to be non-hazardous or unless the power has been removed from all devices within the enclosure.

b) Power shall not be restored after enclosure has been opened until enclosure has been purged for x minutes. (Period to be specified by manufacturer.)

9.3.1.8 The maximum operating temperature of any internal surface exposed to the atmosphere within the enclosure shall not exceed 80 percent of the ignition temperature (°C) of the gases or vapors involved under normal operating conditions and at 125 per cent of rated voltage. If any temperature exists over 80 per cent of the ignition temperature of the gases or vapors involved, then:

a) The warning nameplate shall contain a statement that such conditions exist and that power must be removed for x minutes (period to be determined and specified by the manufacturer to be sufficient to permit unit to cool to safe limit) before the door is opened unless the area is demonstrated to be non-hazardous at the time, or

b) The hot component may be separately housed so that the temperature of its housing is below safe limits. This housing shall be purged or sealed and provided with a warning name-plate that its cover may not be removed for x minutes (period to be determined and specified by manufacturer), unless the area is demonstrated to be non-hazardous at that time.

9.3.2 Type Y-requirements

For the use of purging to reduce the classification of the area within an instrument from Zone 1 (Division 1-hazardous) to Zone 2 (Division 2-normally non-hazardous).

9.3.2.1 All requirements of 9.3.1.1 to and including 9.3.1.7 must be met.

9.3.2.2 Precautions must be taken to insure that a malfunction (short circuit) between the power wiring and the enclosure walls shall not burn through the enclosure or otherwise raise the external surface temperature to 80 percent of the ignition temperature in °C of the gas or vapor involve a combination of fuse type (i.e., quick blow and medium blow), fuse rating and thickness of case wall. Conformance of aluminum or steel cases with this requirement can be determined by reference to Fig. 4.7. Other materials meeting the requirements will be equally acceptable.

9.3.3 Type X-requirements

For the use of purging to reduce the classification of the area with an instrument from Zone 1 (Division 1-hazardous) to non-hazardous.

9.3.3.1 A timing device must be incorporated to prevent power being applied until after the elapse of a time sufficient to permit at least four enclosure volumes of purge gas to have passed through the enclosure while maintaining an internal pressure of at least 2.5 mm (0.1 in.) of water. Timing device must meet the requirements of its location (timing to be specified by manufacturer).

9.3.3.2 The enclosure must be maintained under a positive pressure of not less than 2.5 mm of water when the power is on.

9.3.3.3 A device must be incorporated to automatically remove potential from all circuits or equipment within the enclosure not suitable for Zone 1 (Division 1), upon failure of the purging supply.

9.3.3.4 A door switch must be provided to remove potential automatically from all circuits, within the enclosure not suitable for Zone 1 (Division 1), if the enclosure can be readily opened without the use of a key or tools. The door switch, even though located within the enclosure must be suitable for Zone 1 (Division 1) locations.

9.3.3.5 The maximum operating temperature of any surface exposed to the atmosphere within the enclosure shall not exceed 80 percent of the ignition temperature in °C of the gases or vapors involved under normal operating conditions and at 125 per cent of rated voltage.

If any temperature exists over 80 percent of the ignition temperature in °C of the gases or vapors involved, the surface having this temperature shall be enclosed within a chamber hermetically sealed against the entrance of gases or vapors.

9.3.3.6 Precautions must be taken to insure that a malfunction (short circuit) between the power wiring and the enclosure walls shall not burn through the enclosure or otherwise raise the external surface temperature to 80 percent of the ignition temperature in °C of the gas or vapor involved. Precautions involve a combination of fuse type (i.e., quick blow, and medium blow) fuse rating and thickness of case wall. Conformance of aluminum or steel cases with this requirement can be determined by reference to Fig. 4.7. Other materials meeting the requirements will be equally acceptable.

9.3.3.7 Acceptable installations are shown in Figs. 4.4, 4.5 and 4.6.

9.3.3.8 The power cut-off switch provided to remove power upon failure of the purging system shall be either flow or pressure actuated, and;

a) It must conform to the requirements of its location;

b) the pressure of flow device must be capable of cutting off power when the purging pressure flow is inadequate to maintain a static pressure within the enclosure of 2.5 mm of water. If a pressure device (Fig. 4.6) is used, it must be capable of cutting off power if pressure exceeds predetermined safe limits;

c) to avoid plugging when a pneumatic device is used, any restrictions between the device and the enclosure shall have passages no smaller than the smallest passage before the device;

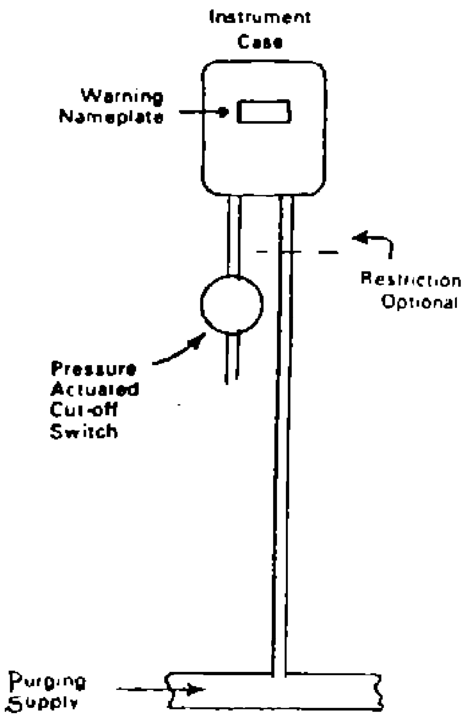
d) no valve between the alarm or indicator and the enclosure shall be permitted.

9.3.3.9 A red warning nameplate must be mounted on the instrument. The nameplate shall be mounted in a prominent location and be visible before enclosure is opened. It shall state:

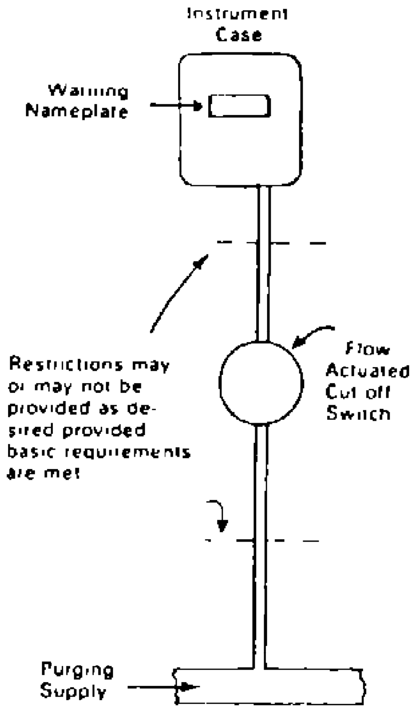
a) "Enclosure shall not be opened or any cover removed unless area is known to be non-hazardous or unless the power has been removed from all devices within the enclosure".

b) "Power shall not be restored after enclosure has been opened until enclosure has been purged for x minutes" (periods to be specified by manufacturer).

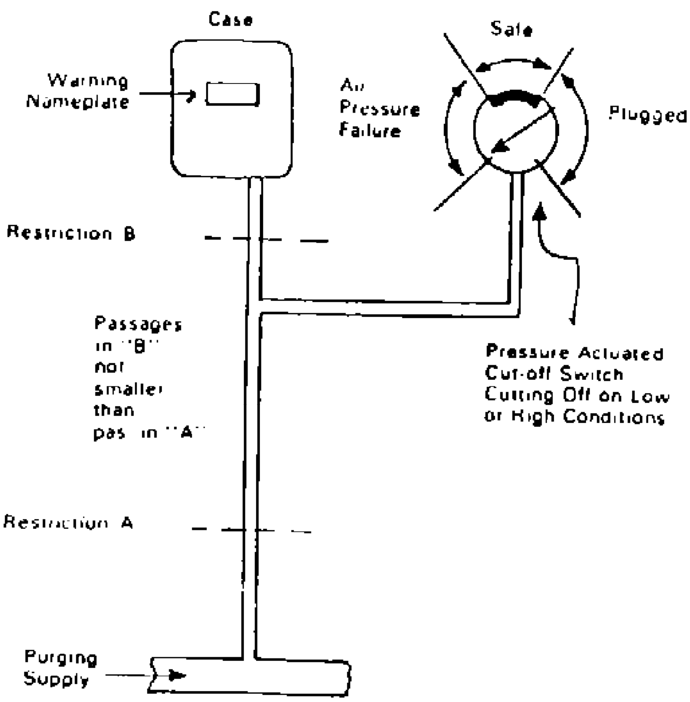
ACCEPTABLE INSTALLATIONS FOR TYPE X PURGING



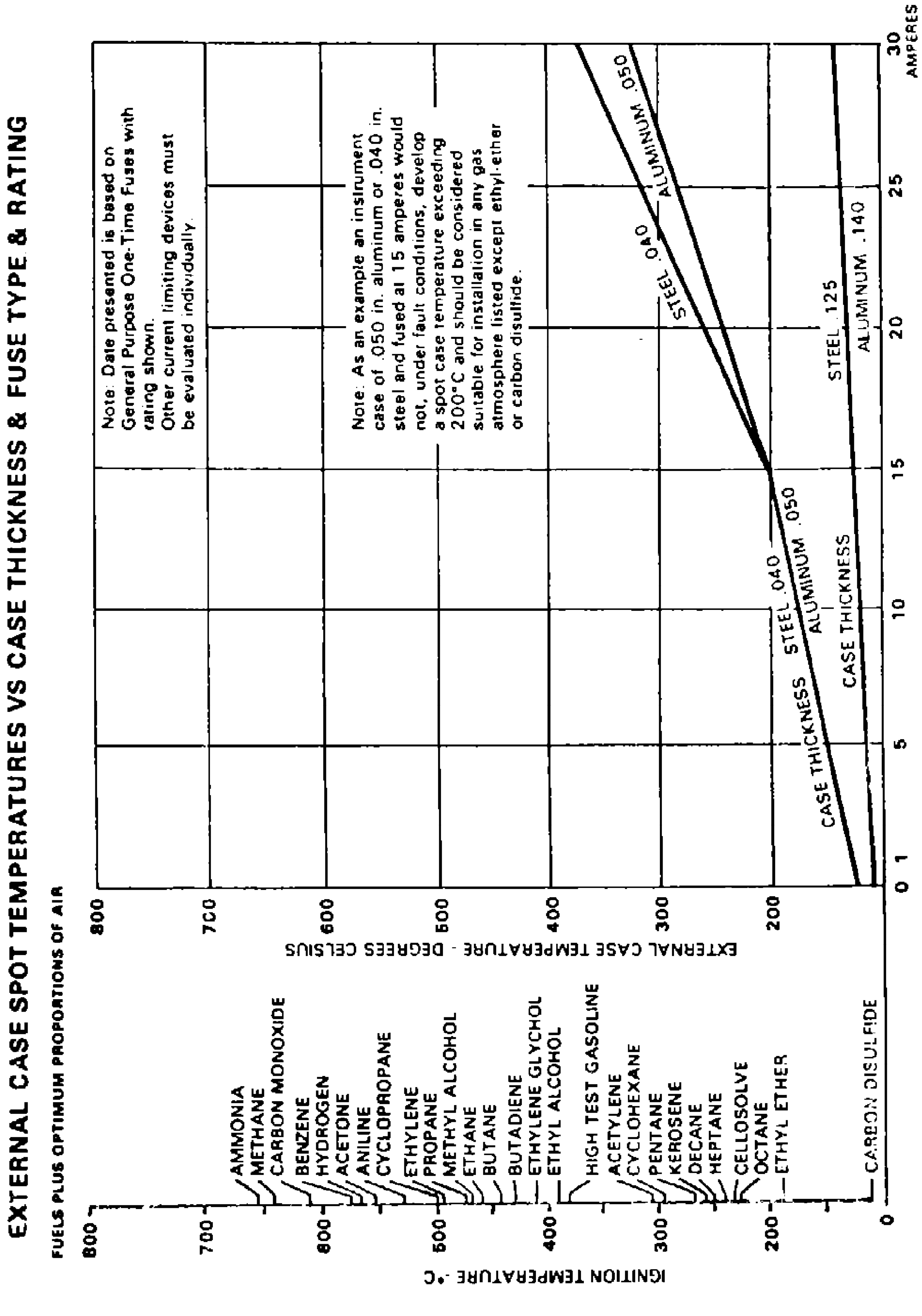
PREFERRED
Fig. 4.4



ALTERNATE
Fig. 4.5



ALTERNATE
Fig. 4.6

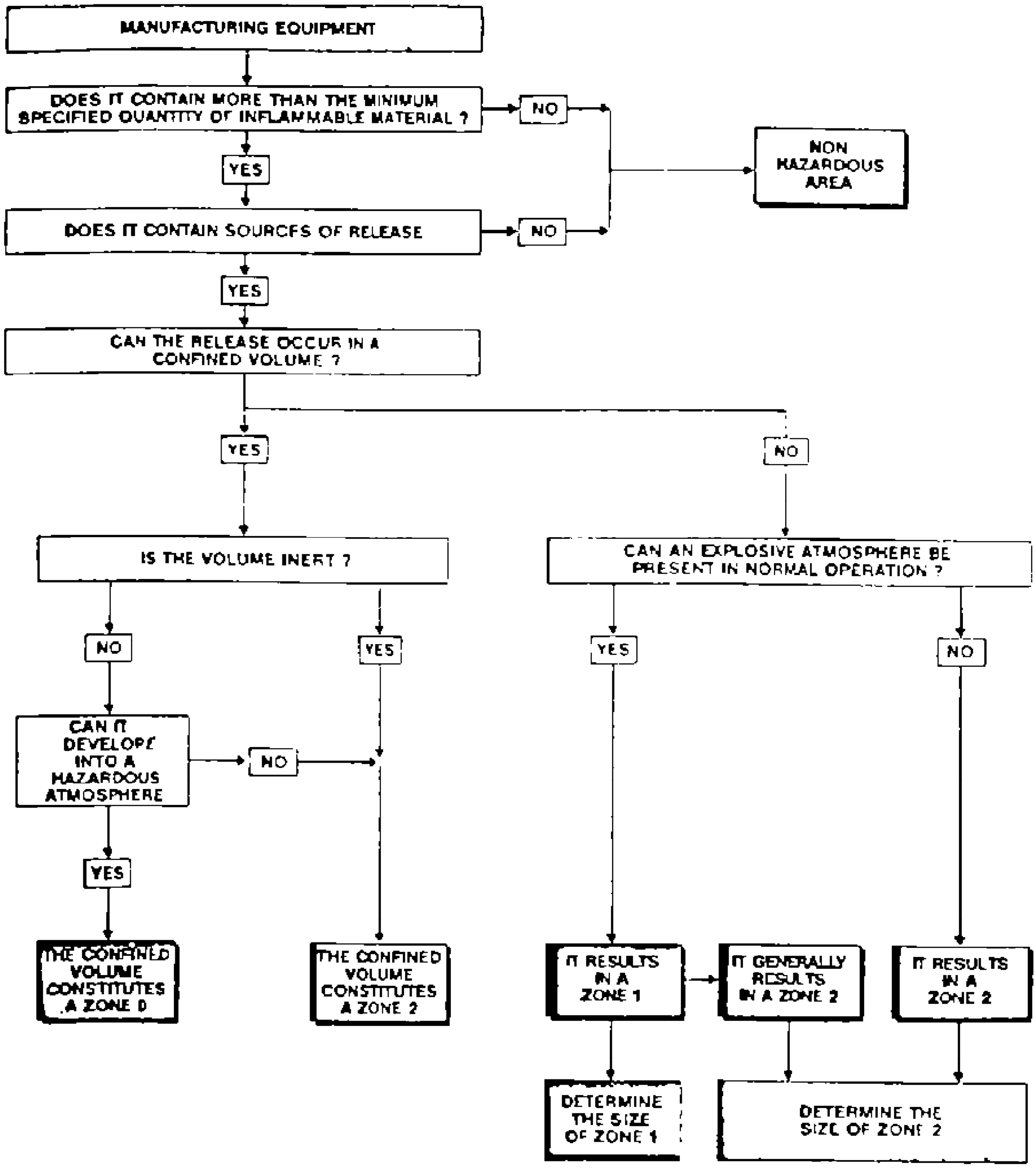


FUSE RATING GENERAL PURPOSE FUSE (CASE SHAWMUT TYPE OT)

Fig. 4.7

APPENDICES

APPENDIX A
CLASSIFICATION OF HAZARDOUS AREAS



*** This flow-chart is an extract from the leaflet by the Union o Chemical Industries is provided as a matter of interest only.**

APPENDIX B
COMPARISON OF APPARATUS GROUPS AND SUB-GROUPS IN BS/EN/IEC AND ANSI/CSA STANDARDS

TYPICAL HAZARD	GROUP/SUB-GROUP BS/EN/IEC	DESIGNATION ANSI/CSA
METHANE	I	CLASS I GROUP D
AMMONIA	IIA	CLASS I GROUP D
PROPANE	IIA	CLASS I GROUP D
ETHYLENE	IIB	CLASS I GROUP C
HYDROGEN	IIC	CLASS I GROUP B
ACETYLENE	IIC	CLASS I GROUP A

APPENDIX B.1
BRITISH CLASSIFICATION OF INTRINSICALLY SAFE APPARATUS AND CIRCUITS

Apparatus (and circuits) certified as being intrinsically safe are placed in one of two classes:

Class 1: Apparatus and circuits for mining applications (methane).
Apparatus and circuits for applications other than mining.

Class 2: Apparatus and circuits in Class 2 are subdivided according to the conditions of test for certification. The following table shows the classifications appropriate to the different gases in which the apparatus and circuits may be used.

Class 2a: Ammonia.

Class 2b: (reserved).

Class 2c:
1) Hydrocarbons (alkanes, benzenoid, alkenes, mixed).
2) Compounds containing oxygen (oxides, alcohols, phenols, aldehydes, ketones, esters, acids).
3) Compounds containing halogens.
4) Compounds containg nitrogen (amines, amides).
5) Compounds containing sulphur (mercaptans, organic sulphates).

Class 2d:
1) Hydrocarbons (cyclopropane, ethylene, butadiene).
2) Oxides (incl. ethers, ethylene oxide).
3) Compounds containing nitrogen.
4) Compounds containing sulphur (hydrogen sulphide).

Class 2e: Hydrogen, blue water gas, town gas, coke-oven gas.

Class 2f: Carbon di-sulphide, acetylene.

APPENDIX B.2
GERMAN SPECIFICATIONS FOR ELECTRIC EQUIPMENT IN HAZARDOUS AREA

Reference: Specifications for the Construction and Testing of Electrical Apparatus for use in Explosive Gas Atmospheres for the Mining Industry (VDE 0170).

For Industries other than Mining (VDE 0171).

Symbols for Marking of Equipment

General

Sch for the mining industry.
Ex for industry other than mining.

Type of Protection

d flameproof enclosure.
p plate protection (mining only).
o oil immersion.
f pressurized enclosure.
e increased safety.
I intrinsic safety.
s special protection.

Explosion Class

1 gap width above 0.6 mm for flameproof.
2 gap width 0.4-0.6 mm enclosures (d).
3 gap width below 0.4 mm only.

Note:

3 further subdivide 3a, 3b, etc. depending on type of gas used in test.

Ignition Group

G1 ignition temperature above 450°C.
G2 ignition temperature above 300°C, below 450°C.
G3 ignition temperature above 200°C, below 300°C.
G4 ignition temperature above 135°C, below 200°C.
G5 ignition temperature above 100°C, below 135°C.

Examples

1) flameproof enclosure in explosion class 3 only for acetylene: EX-d-3c-G2.
2) increased safety for acetylene: EX-e-G2.
3) intrinsically safe equipment for carbon disulphide: Ex-i-G5.

APPENDIX B.3
USA SPECIFICATIONS FOR ELECTRIC EQUIPMENT IN HAZARDOUS AREAS

Reference: National Electrical Code (NEC) Article 500.

Classification of Areas

a) **Class I:** Locations are those in which flammable gas or vapors are, or may be, present in the air in quantities sufficient to produce explosive mixtures. Under Class I, the code specifies 4 Groups:

Group A: Atmospheres containing acetylene.

Group B: Atmospheres containing hydrogen, or gases or vapors of equivalent hazard.

Group C: Atmospheres containing ethyl ether, ethylene, cyclopropane, or vapors of equivalent hazard.

Group D: Atmospheres containing gasoline, petroleum, naphtha, alcohols, acetons, lacquer solvents, natural gas.

b) **Class II:** Locations are those which are hazardous because of the presence of combustible dust.

Group E: Metal dust, including aluminum, magnesium, and their commercial alloys.

c) **Class III:** Locations in which easily ignitable fibres or materials producing combustible flyings are present.

Group G: Flour, starch on gram dust

Group F: Carbon black, charcoal, cool or coke dusts which have more than 8% total volatile material, or which have been sensitized by other materials.

All three classes are subdivided into:

Division 1: Normally hazardous
Division 2: Occasionally hazardous
Unclassified: Locations which cannot be classified Div. 1 or (safe area) Div. 2.

Extent of Areas

Refer American Petroleum Institute Recommended Practice RP-500 A, RP-500 B, RP-500 C, or NFPA-497 A as may be applicable.

APPENDIX C
INTRINSIC SAFETY PRINCIPLES, COMPARISON OF IEC, USA & CANADA

	IEC	USA & CANADA
Intrinsic safety (IS)	Technique that achieves safety by limiting the electrical-spark energy (and surface temperature) that can arise in hazardous areas to levels that are insufficient to ignite an explosive atmosphere.	
Categories	Ex la: explosion protection maintained with up to two component or other faults. IS apparatus may be located in, and associated apparatus may be connected into Zone 0, 1 and 2 hazardous areas (Germany requires galvanic isolation for Zone 0). Ex lb: explosion protection maintained with up to one component or other fault. IS apparatus may be located in, and associated apparatus may be connected into Zone 1 and 2 hazardous areas	One category only: safety maintained with up to two component or other faults. IS apparatus may be located in, and associated apparatus may be connected into Division 1 and 2 hazardous locations.
Area classification	Zone 0: explosive gas atmosphere is present continuously, or is present for long periods Zone 1: explosive gas atmosphere is likely to occur in normal operation. Zone 2: explosive gas atmosphere is not likely to occur in normal operation and, if it does occur, it will exist for a short period only. Zones Y & Z: being considered for dusts.	Division 1: hazardous concentrations of flammable gases or vapors - or combustible dusts in suspension - continuously, intermittently or periodically present under normal operating conditions. Division 2: volatile flammable liquids or flammable gases present, but normally confined within closed containers or systems from which they can escape only under abnormal operating or fault conditions. Combustible dusts not normally in suspension nor likely to be thrown into suspension.
Gas classification	Flammable gases, vapors and mists are classified according to the spark energy required to ignite the most easily ignitable mixture with air. Apparatus is grouped according to the gases that it may be used with Surface industries Group IIC: acetylene ↑ more Group IIC: hydrogen easily Group IIB: ethylene lighted Group IIA: propane Dusts under consideration Mining industry Group I: methane (firedamp)	Flammable gases, vapors and mists and ignitable dusts, fibres and flyings are classified according to the spark energy required to ignite the most easily-ignitable mixture with air. Surface industries Class l, Group A: acetylene ↑ more Class l, Group B: hydrogen easily Class l, Group C: ethylene lighted Class l, Group D: propane Class ll, Group E: metal dust Class ll, Group F: carbon dust Class ll, Group G: flour, starch, grain Class lll: fibres and flyings Mining industry Unclassified: methane (firedamp)
Temperature classification	Hazardous area apparatus is classified according to the maximum surface temperature produced under fault conditions at an ambien temperature of 40°C, or as otherwise specified. T1 450°C; T2 300°C; T3 200°C; T4 135°C; T5 100°C; T6 85°C	
Gas characteristics	Details of the classification (C) and the ignition temperatures (T) of commonly used gases and vapors are contained in: IEC 79-12 1978 (C) EN 50014 March 1977 } BS 5501: Part 1: 1977 } (C) VDE 0170/0171, Teil 1/05.78 } BS 5345: Part 1: 1989 (CT) VDE 0165: 1980 (CT)	NFPA 325M: 1984 (C) NFPA 497M: 1986 (includes dusts) (CT) CSA C22.1: 1986 (CT)
Approval	National certifying authorities issue certificates for approved equipment, defining how it may be used.	FM and UL (USA) and CSA (Canada) issue reports and publish listings of approved equipment defining how it may be used.
Standards	All countries in Western Europe work to CENELEC standards EN 50 020 (apparatus) and EN 50 039 (systems) EEC member countries issue Certificates of Conformity to these standards and accept products and systems certified by other members Other countries either work to their own standards based on IEC 79-11 (e.g. Australia, Brazil, Japan, USSR) or accept products and systems certified to European and/or North American standards.	FM and UL work to their own standards, FM 3610 based on the US national standard NFPA 493-1978, and UL 913, based on ANSI/UL 913-1988 Canada works to CSA C22.2, No. 157.
Codes of practice	IEC 79-14 1984 BS 5345: Part 4: 1977 VDE 0165 1980	ANSL/ISA-RP 12.6: 1987

PART II

THE DIVISION OF RESPONSIBILITIES

BETWEEN

INSTRUMENT AND ELECTRICAL ENGINEERING DISCIPLINES

CONTENTS :

PAGE No.

APPENDICES:

1. SCOPE

This Standard defines the division of responsibilities between instrument and electrical engineering disciplines and gives guidance for working at the interface between them.

2. GENERAL

In order to define the instrument and electrical interface clearly, the division of responsibilities should be based upon identified areas of responsibility for each discipline.

2.1 Objectives for Defining the Division of Responsibilities

A carefully defined division of responsibility for the instrument and the electrical disciplines is considered necessary in order to:

2.1.1 Achieve a clearly defined interface, without overlaps or gaps.

2.1.2 Ensure compatibility of equipment at the interface.

2.1.3 Minimize a duplication of expertise (specialist know-how) in two 'adjacent' disciplines.

2.1.4 Minimize personnel of different disciplines working on the same equipment.

2.1.5 Promote uniformity in the field of experience and training.

2.1.6 Enable each engineering discipline to be directly and singularly for matters assigned where qualifications of competance are required by authorities. Furthermore, the demarcation lines should be such that future developments can be easily adapted on either side.

2.2 Status for the Division of Responsibilities

By its very nature, this Standard can never be so complete as to cover all possible situations. Those not covered should be decided upon in line with the general objectives as stated above and with the principles as defined in the following sections.

It is highly desirable that the division of responsibilities as defined in this Standard is adopted for use by users for all instrument and electrical engineering activities.

2.3 Principles for Defining the Division of Responsibilities

In order to make areas of responsibility easily identifiable they are based upon a system division as opposed to an equipment division, the guiding principles being:

2.3.1 Instrument engineering shall be responsible for measurement and control systems of the operating variables in processing units, related utilities and facilities.

This shall include signal transmission systems, computer systems for process monitoring and control, and the related peripherals, e.g. data-loggers. DCS, etc.

2.3.2 Electrical engineering will be responsible for electrical power systems and their rotating equipment systems. This will include computers which monitor and control power generation equipment, power supply and distribution systems.

Note:

Rotating equipment systems in the context of this Standard refer only to electric-motor-driven equipment and to power generation equipment.

Typical examples of areas of responsibilities for instrument and electrical engineering are given in Appendix A.

3. THE INSTRUMENT AND ELECTRICAL INTERFACE

3.1 General

The interface between equipment forming part of instrument engineering (usually located in the plant control room) and equipment forming part of electrical engineering (usually located in a switch house or in the plant) is normally a matter of defining the demarcation lines for the interconnecting cabling.

In other situations, the demarcation lines are not so straightforward. For some typical cases demarcation lines have been defined in more detail.

3.2 Interface in Control and Signal Cabling

In order to achieve a well-defined interface in control and signal cabling between electrical and instrument engineering, an interface box shall normally be provided. The box shall contain an interface terminal strip-for instrument cable connections at one side and for electrical cable connections at the other side.

The interface box shall form part of instrument engineering, but shall be accessible to both instrument and electrical engineering disciplines.

The interface box should normally be located adjacent to the relevant switch room, however, subject to the geographical lay-out of the plant, it maybe located in other locations, e.g., control room basement, instrument auxiliary room, or close to the relevant equipment as agreed between instrument and electrical engineering.

The area in which the interface box is located may contain instrument equipment/facilities for instrument signal conversion and routing to and from the control center. The interposing relays which form part of instrument engineering may be included in the interface box.

Terminals accommodating on-off signal/command lines, or analogue instrument signal lines shall be fitted with isolating facilities. For a typical example of a signal line interface, see Appendix B.

Note:

The interface termination between instrument and electrical signal lines is normally the only area where the two disciplines shall work on the same item of equipment.

3.3 Electrical Equipment

The interface with instrument engineering for e.g., remote control shall be as described in 3.2. For motor-operated valves (see 3.8).

3.4 Mechanical Equipment

(Drives, luboil systems, cooling water systems, etc.)

All measurements, protection and controls. including systems for speed control (up to speed governor) and machine monitoring (bearing temperatures, vibration), etc., are part of instrument engineering.

Note:

For these facilities instrument engineering has an interface with mechanical engineering. However the subject of that interface is not part of this Standard.

3.5 Materials Handling Systems

3.5.1 General

In the context of this Standard, materials handling comprises:

- The filling of cans, bins, pails, bottles, drums, etc., with product (fluids, chemicals).

- The transportation of solid products (powder, nibs, flakes, lumps, bales) and associated filling of bags, drums, etc.

- The transportation of solid products on conveyers with hoisting and lifting equipment, in packing machines, palletizers, shrink wrapping machines, etc., including storage and dispatch.

- The handling with, e.g., conveyer bulk materials, catalysts, etc.

Equipment for these systems is often supplied as an approved package unit complete with inherent controls. Remote control with associated signal transmission to the control room is not normally required for this type of equipment. Where remote monitoring and control is required the measuring and control signals shall be routed via an interface box (see 3.2). The interface box should form part of the package.

3.5.2 The division of responsibilities

The division of responsibilities between instrument and electrical engineering for these systems shall be as follows:

3.5.2.1 Instrument engineering shall be responsible for:

- Overall system coordination of the automated materials handling systems;
- All equipment which has a measurement function (mass, volume, throughput);
- Process-integrated automation systems by computer of conventional controls.

3.5.2.2 Electrical engineering should be responsible for:

- All non-process-integrated individual power consumers for transport and handling, such as cranes, elevators, 'stand alone' packaged units, etc.

- Electric consumers (e.g. electric motors, heaters), control gear but excluding small drives (e.g. control drives, chart drives) for systems which are part of instrument engineering.

3.6 Signal Converters for Power Systems

Where electrical AC parameters such as current, power or power factor have to be presented in the control room as a process variable, these parameters shall be converted into a standard 4-20 mA DC transmission signal. These converters should form part of electrical engineering responsibilities and shall be installed in the electrical switch room. Attention shall be given to the provision of adequate isolation between input and output and to the arrangements for electricity supply; some types require an AC supply (from switch room) but others operate on a two-wire (24-V DC) system as is usual for other transmitters and signal converters. To avoid complications in further data handling, cable screening, etc., preference should be given to converters operating from an external 24-V DC supply, which will then form part of instrument engineering and be supplied via the interface strip.

The interconnecting cabling between converters and the interface box shall form part of electrical engineering, see also Appendix B.

3.7 Instrument Electricity Supply

3.7.1 General

Instrument engineering shall specify the basic requirements for instrument electricity supply, such as:

- required AC and DC voltages
- estimated consumption
- quality of supply
- allowable interruption time (if any)
- required back-up time in the case of power failure

Note:

The power requirements for air-conditioning systems to protect the instrument equipment, will be specified via air-conditioning engineering.

The division of responsibilities between instrument and electrical engineering shall be as defined in 3.7.2 and 3.7.3.

3.7.2 AC-powered instrument systems

Electrical engineering shall be responsible for the AC powering of instrument systems, including back-up and the AC distribution network.

From take-off points of this network instrument engineering shall arrange for the connections to the various instrument systems and racks located in a control room, basement or auxiliary room.

The AC supply for plant-mounted instruments or instrument racks form part of electrical engineering up to the AC termination point in the instrument or rack.

Instrument engineering shall be responsible for voltage inverters, conditioners and back-up arrangements as required for the individual instrument systems and racks, which form an integral part of the instrument or instrument system.

3.7.3 DC-powered instrument systems

For DC systems, including back-up, for powering the complete DC instrument systems of a plant, electrical engineering shall be responsible up to and including the DC power distribution board. The instrument-electrical interface shall lie at the DC terminal strip in the distribution board.

Instrument engineering shall be responsible for equipment, system, or rack-dedicated AC/DC systems (with battery back-up as required).

3.8 The Motor-Operated Valve (MOV)

The engineering of motor-operated valves (MOVs) requires an input from mechanical, instrument and electrical engineering as follows:

3.8.1 Mechanical engineering shall have overall responsibility for the MOV and will specify the details for the valve.

3.8.2 Instrument engineering will decide in consultation with mechanical and electrical engineering whether the actuator shall be electrically, pneumatically or hydraulically actuated.

Instrument engineering in cooperation with process engineering shall indicate the requirements for the associated measuring and control features of the valve and actuator.

3.8.3 Electrical engineering shall specify the actuator for electrically actuated MOVs. based on process design data (closing time, size of the valve, etc.) and the required measuring and control features advised by instrument engineering.

In all other cases instrument engineering shall specify the actuator and the required measuring and control features.

The interface between instrument and electrical engineering for the electric-operated actuator shall lie in an interface box, see 3.2, for the transfer of control signals to the actuator and valve status information from the actuator, see Appendix C.

3.9 Ignition Burners

Instrument engineering shall be responsible for the flame rod amplifier; electrical engineering will specify, install and maintain the HT transformer, if required.

Mechanical engineering shall be responsible for the ordering of the ignition burner package.

3.10 Soot Blower Control

A schematic control arrangement with interface lines for a soot blower system is given in Appendix D.

APPENDICES

APPENDIX A
TYPICAL ACTIVITIES OF INSTRUMENT AND ELECTRICAL ENGINEERING

A.1 Instrument Engineering

Consists of activities necessary for the specification, design, construction, testing, inspection, quality control, installation and maintenance of equipment and systems for the measurement and control of operating variables in processing units related utilities and facilities.

The equipment involved in instrument engineering activities comprises, but is not limited to:

- Measurement and control systems including analogue, digital, sequential, supervisory controls, DCS and PLC systems.

- Machine monitoring systems (vibration, displacement, torque, speed) and associated actuation of machine protection systems.

- Alarm annunciation and safeguarding systems.

- Detection systems and associated alarms for flammable and toxic gases, including those for buildings.

- Pollution detection systems and associated control systems including those for buildings.

- Earthing systems in electronic instrumentation and process control/monitoring computer systems.

- Instrument electricity supply and distribution systems as far as not forming part of electrical engineering.

- Instrument electricity supply systems incorporated in instrument systems.

- The selection of the type of actuator for control valves and remote operated on/off valves.

- Remote control and status signaling for pneumatically or hydraulically-operated valve actuators.

- Overvoltage protection systems for instrument circuits.

- Plant-mounted instruments and instrument impulse lines.

- Instrument air supply systems as far as not forming part of mechanical engineering.

A.2 Electrical Engineering

Electrical engineering consists of activities necessary for the specification, design, construction, installation, maintenance, measuring, protection and safeguarding, testing, inspection and quality control of electric power systems and rotating equipment systems. Operation of electric power systems forms part of electrical engineering.

The equipment involved in electrical engineering activities comprises, but is not limited to:

- Generation, transmission and distribution of electric power.

- Conversion of electric energy (e.g. transformers, frequency-converters, rectifiers, inverters).

- Electric drives (e.g. motors, variable-speed drives, constant-torque drives).

- Electric heating (e.g. process heating, compensation heating).

(to be continued)

APPENDIX A (continued)

- Electric heat tracing.

- Lighting including dimmer equipment.

- Electrostatic filters, desalters, etc.

- Equipment for electrolysis.

- Electric-motor-operated valve actuators including remote control and status signaling up to the interface terminal strip. Excluding torque and limit switches setting and maintenance.

- Instrument electricity supply systems up to the point where instrument engineering takes over.

- Safety circuits for personnel protection (e.g. emergency stops, pull chains, work safety switches).

- Earthing and bonding systems for electrical system earthing, protection against electrostatic charges, personnel protection.

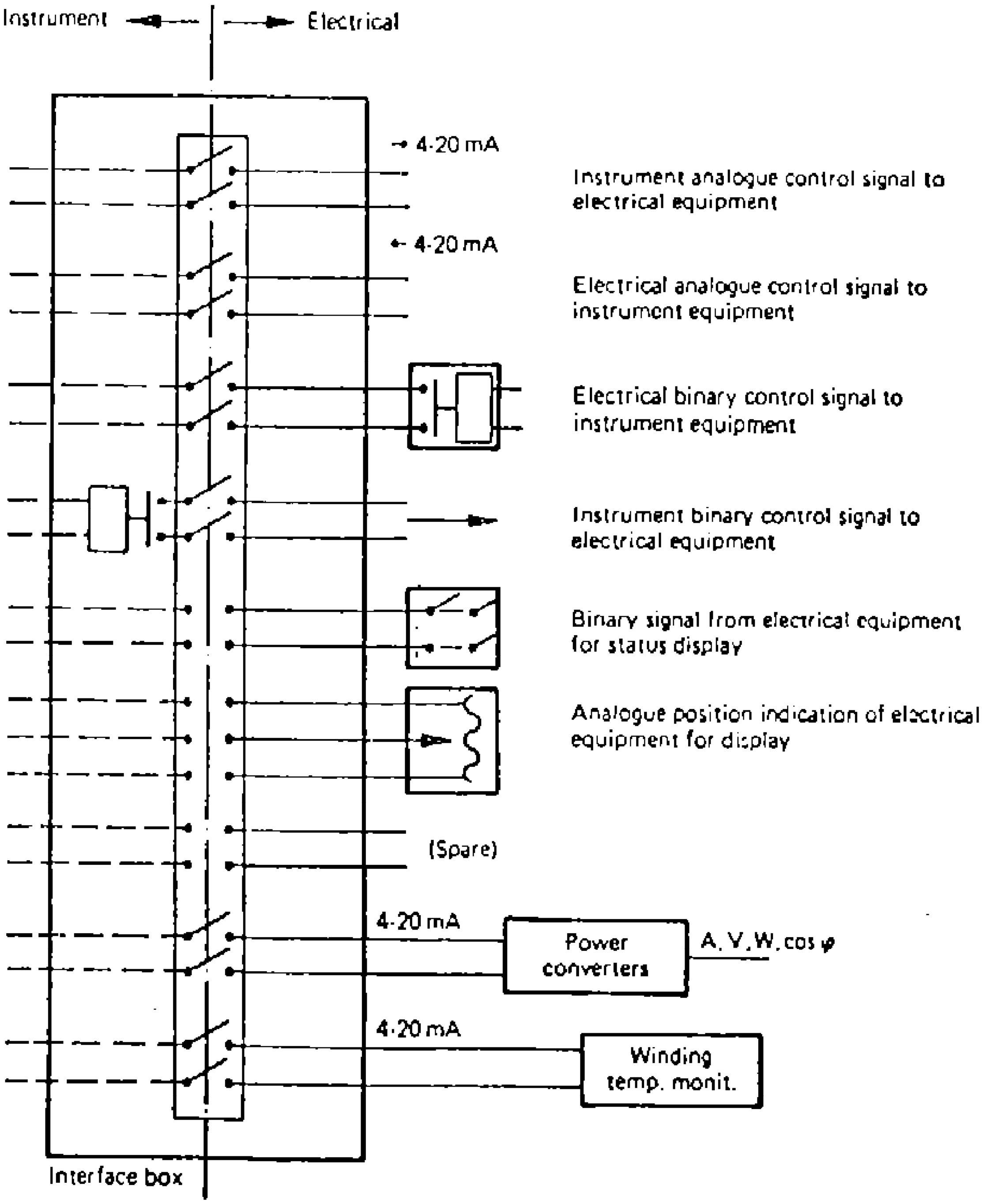
- Clean earth provisions for instrument systems.

- Lightning protection systems.

- Equipment for direct manual operation of above-mentioned items (e.g. remote control units, limit switches).

- Measurement and control systems, including inherent alarm annunciation and safeguarding systems for protection of electrical equipment, analogue, digital, sequential and supervisory controls for above-mentioned items.

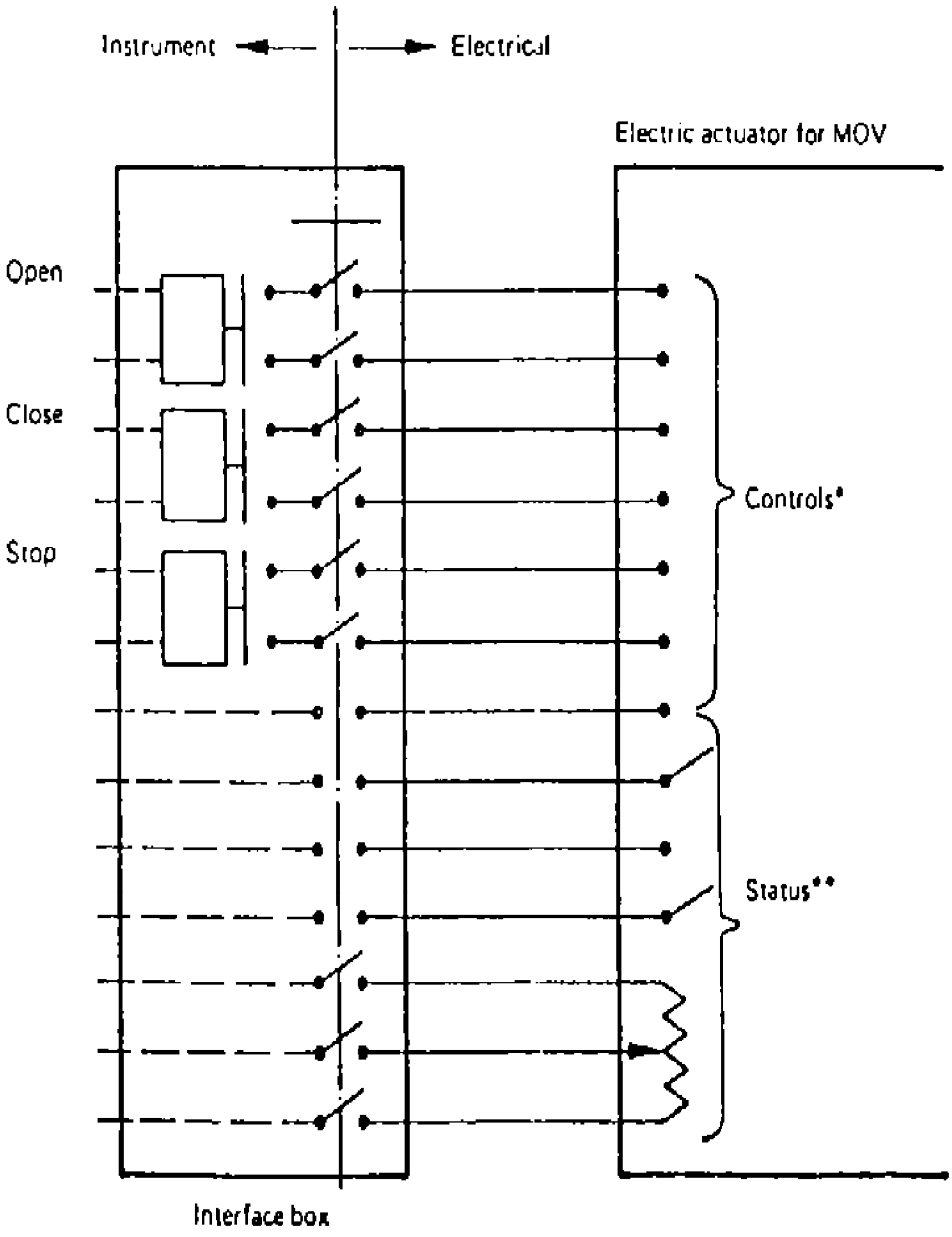
APPENDIX B
INSTRUMENT-ELECTRICAL SIGNAL LINE INTERFACE
(Typical Example)



———— **Electrical Signal Lines.**

------------ **Instrument Signal Lines.**

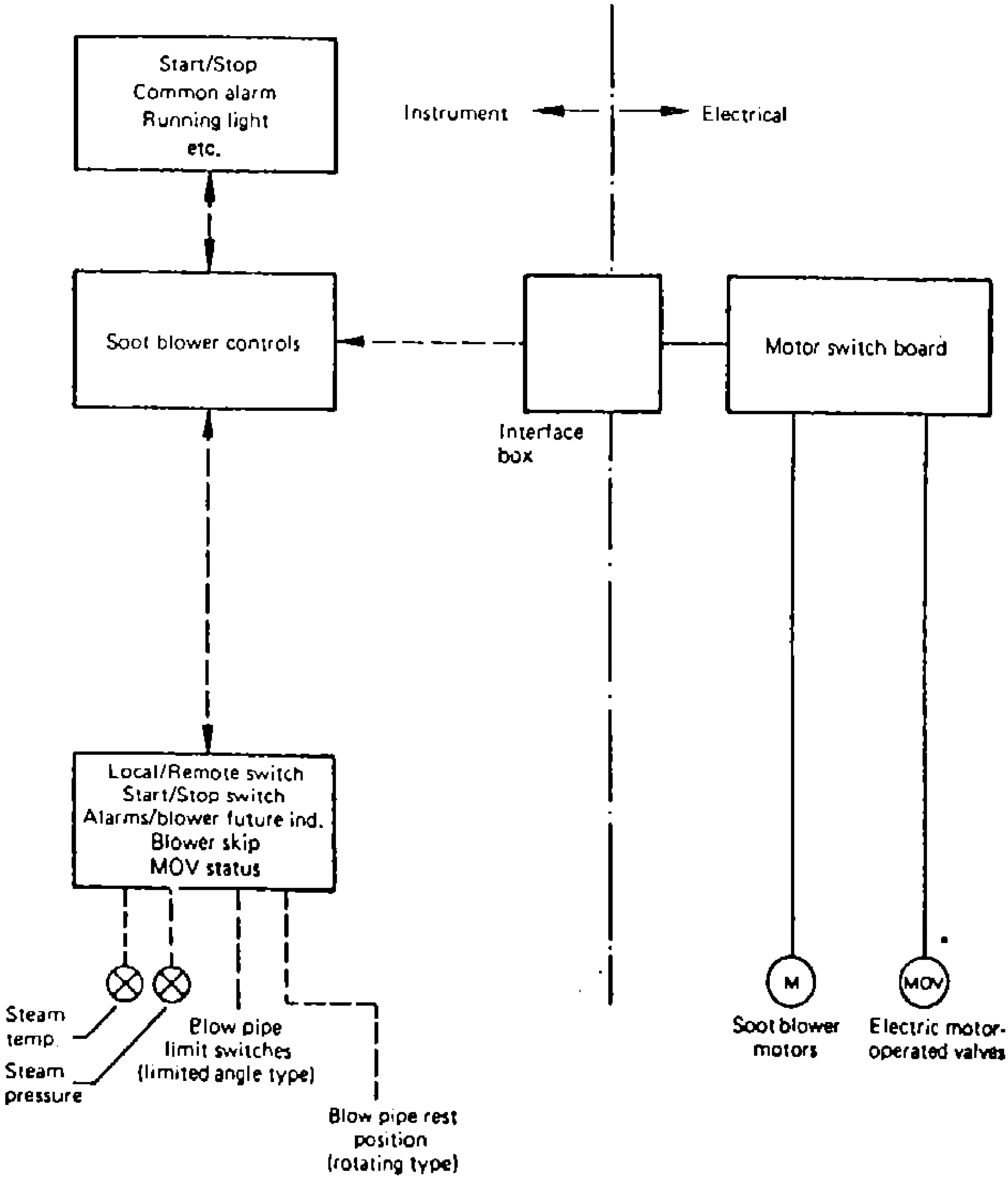
APPENDIX C
INSTRUMENT-ELECTRICAL INTERFACE FOR ELECTRIC MOVs



*** The motor contactors may also be located in the electrical switch house.**
**** Status contacts to be potential free.**

———— Electrical Signal Lines.
----------- Instrument Signal Lines.

APPENDIX D
INSTRUMENT-ELECTRICAL INTERFACE FOR A TYPICAL SOOT BLOWER SYSTEM



* See also Appendix C.

———— Electrical Signal Lines.
----------- Instrument Signal Lines.

PART III
INSTRUMENT ENGINEERING PROCEDURES

CONTENTS :

PAGE No.

APPENDICES:

1. SCOPE

This Standard describes project engineering procedures for the design, requisition, test and inspection of instruments. The procedures are intended for use in Petroleum Industries of Iran.

2. GENERAL

2.1 Instrument Engineering Activities

Unless otherwise specified, Instrument Engineering shall be responsible for carrying out the activities as mentioned hereafter. These activities comprise at least the following:

1) Planning and scheduling of the instrumentation work for the project within the overall project plan.

2) Checking of process engineering flow diagrams, utility engineering flow diagrams, functional logic diagrams and flow charts (functional description).

3) Preparation of Piping and Instrument Diagrams (P&IDs).

4) Preparing and updating instrument data sheets.

5) Calculations for flow measuring instruments, control valves and safety/relief valves.

6) Preparation of inquiries for all instruments, accessories and installation materials.

7) Evaluation of quotations, selection of suppliers from the list of approved manufacturers, checking copies of orders and suppliers data/drawings/documents.

8) Instrumentation and control: for detail refer to IPS-M-IN-100 "Factory Inspection".

9) Advising and assisting in the lay-out of instrument panels, operator consoles, control rooms, auxiliary instrument rooms, computer rooms and analyzer houses.

10) The design and engineering of alarm and trip systems.

11) The design of analyzer sample systems.

12) The configuration of distributed control system.

13) The preparation of detailed documents and drawings for the ordering and installation of the instruments, etc.

14) The checking of plant models, for instrument accessibility and location purposes.

15) Follow-up and progress control on all matters relating to instrument engineering.

16) The preparation and obtaining the necessary approvals of 'as-built' drawings.

The Designer shall be responsible for all instrumentation and related activities, and for the satisfactory design and correct implementation of instruments and control systems in accordance with Company's specifications.

For "split-phase" projects, responsibility shall be in accordance with the relevant section of the project specification.

2.2 Demarcations for Instrument Engineering

The interface between Instrument and Electrical Engineering, is given in Part 2 of this Standard IPS-E-IN-100.

Note:

The following items form part of mechanical engineering, for which the relevant engineering information shall be supplied by instrument engineering:

- **orifice flanges, orifice meter runs (made in accordance with Standard Drawings);**
- **level gage glasses, displacer chambers for level instruments;**
- **thermowells;**
- **safety/relief valves;**
- **instrument air compressors, coolers, dryers, buffer vessels and instrument air supply piping larger than ½ inches.**

2.3 Design Data for Instrument Engineering

2.3.1 All instrument engineering shall be based on the design data given in Instrument data sheets and process and utility engineering flow diagrams. Where necessary, additional information shall be provided in cooperation with relevant disciplines to explain such plant operational requirements as:

- Functional logic diagrams for (complicated) safeguarding systems;
- flow charts (functional description) for sequence control systems;
- functional diagrams for 'advanced' control.

2.3.2 The Designer shall continuously update the instrument data sheets if necessary and submit these at defined intervals for the Company's approval.

2.3.3 In addition to the instrumentation listed during the detailed engineering phase, all other instrumentation, such as those for equipment packages, shall be included in the instrument data sheets and engineering flow diagrams. Where these are not practicable, the additional instrumentation shall be shown on separate engineering flow diagrams and instrument data sheets.

Notes:

1) All process data shall be approved by the responsible process-control engineer before being used for instrument engineering.

2) The preliminary instrument data sheets as prepared in the basic design phase, shall normally only show the process data. Hardware (engineering) data shall be stated in a later revision by the Designer.

2.4 The Basis for Instrument Engineering

2.4.1 All instrument engineering work shall be based on the requirements given in the design package and latest amendments/revisions. In case of conflict between the referred to and the amendments, the latter shall over rule.

2.4.2 The Designer shall obtain the Company's written agreement for all deviations from the Project Specification, prior to carrying out the related engineering work.

2.4.3 Government and local authority requirements, laws and customs shall prevail if these are more stringent than those specified in the Project Specifications.

2.4.4 It is the Designer's responsibility that all the local legal obligations related to the scope of work and applicable to the realization of the project are complied with.

2.4.5 The Designer shall inform the user immediately of any such local requirements which are not covered by the specifications indicated above.

2.4.6 Should doubt arise in the interpretation of rules given in the design package referred to above, the Company shall be consulted.

2.4.7 Compliance with the requirements of this specification shall not relieve the Designer of his obligation to follow sound and safe engineering practice throughout.

2.4.8 If changes in the design are considered necessary by the Designer tractor for economic, safety, ease of operation, or other reasons they shall only be carried out after obtaining the Company's approval in writing.

2.5 Instrumentation of Equipment Packages

2.5.1 In general the instruments for equipment packages, such as boilers, incinerators, refrigeration equipment, compressors, etc., should be of exactly the same make and type as those used for the process units as far as possible.

2.5.2 The Equipment Package supplier shall be informed of the selected types and manufacturer's of the preferred instruments, in order that the instrument installation, including all materials, shall be in accordance with the overall requirements for the total project. This requirement shall then be clearly stated on the inquiry for the unit, and the equipment package supplier shall be provided with all pertinent documents and drawings.

3. TIME SCHEDULE

3.1 All phases of instrument engineering work shall be planned in detail and in accordance with the overall time schedule for the project. Special attention shall be given to the timing of the following:

For The preparation of:

- "The summary of instrumentation documents and drawings".
- "The summary of instrumentation inquiries".

These summaries shall indicate all expected engineering documents, drawings and inquiries together with the expected date of issue. The documents will then be used as the basis for the detailed instrument engineering planning.

- Required on site date, for equipment, documents and drawings etc.

- The finalization of computer input sheets for all calculations. This data shall be available at specified time before the planned date of plant commissioning.

- Plant Model Documents.

4. PREPARATION OF INQUIRIES

4.1 General

4.1.1 The inquiries of all instruments, instrument and control systems, auxiliary equipment, installation materials etc. shall be based on the relevant (process) data and on the makes and types specified by the Company.

4.1.2 When equipment or materials are free issue items to other suppliers, the Designer shall provide a clear description and all applicable cross references.

4.1.3 The Designer shall prepare separate inquiries for 'in line' instruments which have a pressure rating of various classes. They shall be segregated from inquiries which contain instruments of a lower pressure rating.

4.2 Inquiries Procedures

4.2.1 Inquiries shall be prepared for the purchase of all instruments shown in the Engineering P&IDs and listed in the instrument data sheets, including all auxiliary equipment and installation materials. These inquiries shall clearly state all the requirements and date necessary for the supply of correct equipment and materials.

4.2.2 The types of equipment specified on any inquiries should. ‘preferably’ be limited to those which can all be supplied by the same manufacturer.

4.3 Information in Inquiries

4.3.1 The inquiries shall only carry the information necessary for ensuring the proper supply of the equipment and/or services required.

4.3.2 When required, in addition to the operating conditions specified on the inquiry, the Designer shall also state requirements such as vacuum service, high pressure, low and high temperature, oxygen service, strongly varying process conditions, corrosive and abrasive conditions.

4.3.3 Furthermore, the specific requirements given in the Project Specification shall be stated on the inquiries and special attention shall be given to the following:

- Material certification of instruments and related components for pressure retaining parts, including the bolting of pressure retaining parts.

- Special testing and/or treatment of materials, e.g. leak, dye penetration, ultrasonic, magnetic particle, hardness, heat treatment, stress relieving, annealing/pickling, etc., shall be in accordance with the requirements given for the piping system or equipment in which the instruments are to be installed, and/or the Project Specification.

Note:

Pressure testing is mandatory for all pressure retaining instruments and/or installation materials.

- Requirements for the maximum allowable noise level, e.g. for control valves, control room equipment, etc.
- The ‘NACE Requirements’ for ’in line’ instruments used in sour service.

4.3.4 The Designer shall carefully check the supplier’s information to ensure the correct supply of equipment and/or services.

4.3.5 Complete tag numbers shall be stated on the inquiry for identifying instruments and accessories during installation. This is not necessary for installation materials which are identified, stored and used by indent/item numbers.

4.4 Comment/Approval by the Company

4.4.1 When the Designer is requested by the Company to submit all inquiries for comments and/or approval, the relevant up-to-date instrument data sheets and other relevant documents e.g. control valve calculation sheets shall be issued prior to, or simultaneously with the inquiry.

4.4.2 Quotations for approval shall be submitted with all relevant documents included, such as catalogues, intermediate correspondence and drawings, etc.

4.5 Project Spare Parts (Capital Spares)

4.5.1 The inquiries, especially initial inquiries, should include an amount of certain extra equipment as ’project spares’ to allow for losses of installation materials, or for late changes at site.

4.5.2 The Designer shall propose for each of the (initial) inquiries an amount of project spares. The amount of these spares requires the written approval of the Company.

4.6 Free Issue Items

If the inquiries for the main equipment contains free issue items, cross references shall be made between the inquiries for main equipment and free issue items, giving the inquiry number, make and type of instrument/equipment and quantities.

4.7 Preliminary Inquiries

4.7.1 To ensure timely delivery, preliminary inquiries shall be issued for certain equipments at an early stage of the detailed engineering, to allow the manufacturers to reserve manufacturing capacity and to order sub-assemblies and parts.

Such equipments may be:

- Control valves with components made from non-standard/special materials or Distributed Control Systems, etc.;

- panel instruments and flow transmitters when required in large quantities (with estimated quantities).

They shall be followed by updated revised inquiries at a later stage.

4.7.2 Initial inquiries for installation materials and cables should be issued with estimated quantities and average lengths of cable required for each instrument. The inquiries shall be revised and re-issued at a later date when final quantities and lengths are known, together with and approved amount of project spares materials and cables.

4.8 Factory Testing

Inquiries for equipment of 'Category B' and 'Category C', (see Clause 6), shall carry a note that the equipment will be inspected after factory-testing and before shipment.

4.9 Erection/Commissioning Assistance

Inquiries for factory assembled systems and items of equipment in 'Category B' Appendix A refers, shall specify whether erection and/or commissioning assistance and/or a 6 months or 1 year maintenance contract is required from the supplier, or as otherwise stated in the Project Specification.

5. COMPOSITE MANUALS

The Engineering Designer shall ensure that manufacturers/suppliers are instructed to supply to site, either by direct dispatch or via the Designer's office in accordance with the Project specification, complete sets of all instrument installation, commissioning and maintenance manuals, applicable to each type of equipment in their supply. Where practicable, these sets shall be assembled in loose-leaf binders.

For the larger systems, provided by the same supplier, the sets shall include all details of all the types of instruments supplied, e.g. for Distributed Control System, blender, metering station, etc.

6. FACTORY INSPECTION

6.1 Decision for Inspection

6.1.1 To facilitate the requirements for factory inspection, the instrumentation shall be separated into "Category A", "Category B" or "Category C" Items as appropriate, see Appendix A Page 55.

6.1.2 Equipment in Category A will not normally require a factory inspection.
Equipment in Category B shall be subjected to factory inspection.
Equipment in Category C should be inspected before dispatch.

Note:

The need for inspection of items in Category C shall be indicated.

6.1.3 Material in Category A, which forms an integral part of the equipment of Category B, will be inspected against the relevant requirements during the inspection of Category B material, e.g. controllers and recorders in a control desk will be checked against the requisition in the panel shop, during the acceptance test of the control desk. The requirements for factory inspection shall be clearly indicated in the inquiry for the particular equipment.

Factory inspection shall be carried out by:

- The Company or his representative; for non turnkey projects.
- The Designer; for turnkey projects, accompanied by a representative of Company.

6.2 Inspection Procedures

6.2.1 Prior to factory inspection by or on behalf of company the manufacturer shall carry out tests and if necessary take corrective measures, with the approval of company, in order to ensure that all equipment fulfills the requirements stated in the inquiry. This shall include equipment which is supplied with equipment packages or as free issue items.

The factory inspection, by or on behalf of company, shall include full loop and function tests for which floor space, simulation equipment and manpower assistance shall be provided by manufacturer. The inspection date shall be fixed at least four weeks in advance.

6.2.2 One set of approved, up-to-date vendors drawings, including test procedures, shall be supplied to the Company before the inspection is carried out.

6.3 Inspection Documents

For turnkey projects, the Designer shall establish, document and maintain, an effective quality assurance system to demonstrate compliance with the requirements for services and manufactured products, in accordance with the relevant section of the Project Specification.

7. DOCUMENTS AND DRAWINGS

For guidance as to which instruments and drawings should be made in the engineering stage, refer to IPS-E-IN-100/4 (Instrument Document and Drawings).

The engineering documents and drawings shall be processed and submitted to the Company in logical sequence for comments, or released in accordance with the requirements of the Project Specification, to ensure proper coordination of responsibilities and activities. If available, the Designer may use his own computerized system for handling documents and drawings, having first obtained the Company's approval in writing.

APPENDICES

APPENDIX A
INSPECTION REQUIREMENTS

A.1 Equipment Categories

A.1.1 Category A

Comprising individual items of equipment and separately mounted instruments. Typical items in this category are:

- transmitters
- recorders
- controllers (including indicating controllers)
- pressure/drought/receiving/temperature gages
- installation materials (except for impulse lines containing valves)
- solenoid valves
- plant mounted terminal/junction boxes
- switches (manual/receiver and process)
- push buttons
- cables (except system cables)
- variable-area meters (except for process applications)
- indicators (including receiving indicators)
- diaphragm seals
- manual loading stations
- howlers
- integrators
- pulse counters
- alarm light units
- computing/selecting/limiting/boosting/time relays
- air filter-reducers
- TC assemblies
- resistance thermometer elements/RTD's
- detectors
- tank gages
- gage glasses
- signal converters
- volume boosters
- load cells
- lock-up/quick exhaust devices
- control drives for dampers
- valve actuators/positioners.

A.1.2 Category B

Comprising instruments and equipment of a more complex nature, custom-built systems or equipment packages. Typical items of equipment in this category are:

1) Field equipment such as:

- local panels
- metering station
- meter provers

2) Analytical equipment such as:

- sampling systems for process stream analyzers
- process stream analyzers.

3) Piped and wired system cabinets or racks for:

- receiver switches
- signal converters
- signal amplifiers
- miscellaneous/auxiliary components.

4) Control room equipment such as:

- control desks
- alarm systems/alarm service units
- safeguarding systems
- interlock systems
- sequential control systems
- relay systems
- binary logic systems (all types)
- distributed control systems
- multiplexers
- operator consoles
- programmable logic controllers
- graphic panels
- prefabricated (system) cables
- interface systems
- computer systems
- close circuit systems
- tank gaging systems
- interposing cabinets
- monitoring systems
- fire and smoke detection systems
- distribution frames or cabinets
- weighing systems
- dosing systems
- blending systems
- sequential event recorder
- printers (used in data gathering or DCS/PLC Systems)
- gas detection systems
- multi point temperature systems (only for 100 points and complex systems)
- batch control units or counters.

Notes:

1) If the Designer considers it to be necessary, or when required by the Company and stated in the project specification, the more complicated instruments and equipment shall be commissioned by the manufacturer.

2) If doubt should arise regarding erection/commissioning assistance from the supplier, the Company shall be consulted.

A.1.3 Category C

Comprising in-line mounted instruments and items for instrument impulse lines. Typical items of equipment in this category are:

1) In line mounted instruments such as:

- orifice plates/restriction orifices
- variable area meters
- special meter runs. (e.g. for custody transfer)
- turbine/PD meters (including all accessories)
- venturi/dall/pitot tubes
- electromagnetic/vortex/impact/ultrasonic flow meters
- flow straighteners
- flow nozzles
- displacer level instruments
- probe-type level instruments
- control valves/safety valves
- pressure/self acting temperature regulators

2) Installation materials (for impulse lines) such as:

- manifold valves

Note:

All instruments installation materials in Category C which are to be inspected, shall be examined by a mechanical specialist to ensure compliance with the piping specification.

PART IV

INSTRUMENT DOCUMENTS AND DRAWINGS

CONTENTS :

PAGE No.

1. SCOPE

This Part of IPS-E-IN-100 gives minimum requirements for instrumentation documents and drawings which shall be prepared/completed during the basic design and detailed engineering stage of a project. In addition the requirements for documents and drawings in the "As Built" condition are given in Clause 3.

It is intended for use in Petroleum Industries of Iran. Where cross-references are made, the numbers of the section of sub-sections referred to, are shown in brackets.

2. GENERAL REQUIREMENTS

2.1 General

A set of instrumentation documents and drawings shall be prepared for each project, which shall include but not necessarily be limited to those specified in this Part.

These documents and drawings shall be issued such that sufficient time is allowed for realizing the instrument installation, taking into account the procedures and the time required for review and comment by the user.

The extent of detailing of each document and drawing shall be such that it will facilitate the installation of all instrumentation at the construction site and serve as a reference for future maintenance, changes and/or extension to the instrumentation.

The contents of these documents and drawings, the number of copies required, the need for additional documents and the procedures for commenting and/or approval, shall be in accordance with requirements which will be stated by the user.

The use of desk top computers, by the contractor, for document and drawing production requires the written approval of the Company. If documents and drawings are provided through software system the application of program must also be submitted.

Notes:

1) The release (date) of the above software packages shall be listed and submitted for approval by the Company.

2) The compatibility with computer equipment used on site should be verified by the Company if not compatible, the required computer equipment should be ordered with the project.

All parts and sections of any form, sheet or other document which requires ’filling in’ shall be completed. Where a particular part of any document is not applicable it shall be so indicated.

2.2 Identification

All documents and drawings shall be provided with a registration number from the series of numbers allocated to the project, together with a code number for classification and identification. The code number shall consist of a prefix, project number, group number.

All documents and drawings shall bear proper references to related project construction drawings, and indent numbers for the materials required, etc. The documents and drawings shall bear the titles as indicated in this part in addition, all instrument related layout drawings of control rooms, auxiliary rooms and analyzer houses, etc., shall indicate the building and room number as appropriate.

Where multi-sheet drawings (Clause 2.4) consist of a large number of sheets, each sheet may be revised, if required. For each revision, the cover sheet and the revision index sheet shall be re-issued together with the revised sheets. All the revised sheets shall bear the same revision letter irrespective of the last revision letter on the individual sheets, i.e., all revised sheets shall bear the same revision indicator as the cover sheet.

For multi-sheet drawings where signatures are applied for approval or checking, these shall be indicated on the cover sheet only. Where a full title block is applied this shall be used on the cover sheet only. Continuation sheets shall be sufficiently titled to link them clearly to the cover sheet and include project title, drawing title, project, drawing number and sheet number.

2.3 Drafting Techniques

The drafting techniques, drawing sizes, preparation, and when applicable the micro filming, of technical drawings shall be in accordance to the following instructions or company policy as instructed by the user. Drawings should be on A3 sized sheets. The basic format of each type of document produced by the Designer shall be submitted for review by the Company prior to large scale application. The following order of preference shall apply:

A4	297 mm × 210 mm
A3	420 mm × 297 mm
A2	594 mm × 420 mm
A1	841 mm × 594 mm
A0	1189 mm × 841 mm

Drawing size A0 may be used for instrument documents and drawings on special cases. Special attention shall be paid by the Designer to ensure a consistent drawing and documentation package, particularly for those documents which are associated with equipment package unit, (Clause 2.8). It is not acceptable to deviate from an agreed format and standards, and it is the Designer's responsibility to ensure rigid adherence to such procedures.

Copies of drawings issued for comments or information shall have a maximum size of A3. Consideration should be given to reducing by copying to A4 size before dispatch. Drafting techniques should then take into account clear readability of the reduced format.

Where it is anticipated that computer printouts will be employed, the dot matrix printers shall not be used for drawing preparation purpose. For the mechanical, instrument and electrical symbols and identification systems to be used on drawings, refer to the related symbols and legend drawings of these disciplines.

2.4 Multi-Sheet Drawings

Certain 'documents' shall be made in the format of a 'drawing' with a large number of sheets, consisting typically of:

- A cover sheet.
- Index to sheets, giving the applicable revision indicator of the sheets contained in the set.
- Listing of symbols and abbreviations used.
- Listing (by item number) of materials required.
- Detail sheets (as indicated on the index sheet) giving the required information.

Note:

For a typical example, refer to the multi-sheet drawing for instrument impulse lines, given in IPS-D-IN-104.

For the preparation of such drawings, standard forms A4 and A3 size shall be used. To facilitate reproduction and filing preference is given to the use of A4 size. All sheets of a multi-sheet drawing shall have the same size, mixing of A3 and A4 sizes in one multi-sheet drawing set is not allowed.

Where the subject cannot be arranged entirely on one sheet, as may be the case with logic diagrams, relay diagrams or instrument signal diagrams, the subject shall be continued on the following sheet(s) with proper cross references at the demarcation points. The arrangement shall then be such that a continuous presentation of the subject is formed when the separate sheets are laid side by side by the (ultimate) user.

2.5 Construction Drawings

Where constructional details are required to ensure the proper supply of instrumentation equipment, such details shall be shown on a separate construction drawing, to which references shall be made in the requisition.

For standard equipment, such drawings are available in the form of standard installation drawing. Where these standard drawings are used in an unmodified form they can be used by referring to the standard number, revision indicator and title. When, however, for a particular application, deviations from the standard drawing are necessary, the Designer shall prepare an engineering drawing based on the standard drawing. Under no circumstances shall a standard drawing be issued in a modified form.

For non-standard equipment, dedicated engineering drawings shall be prepared showing details and all requirements.

2.6 Technical Specifications

Where comprehensive descriptions, arrangement drawings and/or construction details are necessary for ensuring the proper supply of equipment, these requirements shall take the form of a technical specification, to which references shall be made in the requisition. For certain standard equipment, these specifications are available as an IPS publication (e.g., for control valves, control panels). Where this is not the case a dedicated technical specification shall be prepared in the form of a multi-sheet specification.

2.7 Manufacturer’s Drawings

Drawings received from manufacturer shall be identified as engineering drawings, see (2.2), and where applicable commented upon and incorporated into the detailed engineering stage of the project.

Manufacturer’s drawings shall be fully integrated into the overall project documentation package and incorporated into a dedicated ’Instrument Summary’, (see 3.2.1).

In addition to identification (2.2), manufacturer’s drawings shall carry a manufacturing schedule consisting of a table, listing the tag and/or equipment numbers with special requirements such as material, range, type number, labeling/engraving adjacent to the tags.

This will serve both as an acknowledgment and check on the additional requirements specified in the requisition.

Standard manufacturer’s manuals/bulletins shall indicate or delete inapplicable items and details, and highlight those which are applicable by underlining or arrowing, etc.

Note:

Where applicable, the above requirements shall be clearly stated under "Documentation" in each instrument equipment requisition.

Manufacturer’s drawings shall only be used to assist in the production of a comprehensive installation drawing package and shall not form a part of the installation package.

2.8 Equipment Package Drawings

Drawings of an equipment package shall be identified in accordance with Sub-clause 2.2. The drawings shall be commented upon and incorporated into the detailed engineering stage of the project. The drawings of an equipment package shall be arranged in separate sets for each equipment package unit.

3. THE PREPARATION OF INSTRUMENTATION DOCUMENTS AND DRAWINGS

3.1 As Built Requirements

The "As Built" preparation for the documents and drawings should be in accordance to the following table and categories:

- Category A Documents and drawings, should remain 'as built' during the life time of the plant for maintenance and safety audit purposes.

After commissioning, particularly in the case of plant changes, however small, plant management is responsible for the updating of the 'category A' documents and drawings concerned, and this function shall be defined clearly within the plant organization.

- Category B 'As-Built' documents and drawings, after construction shall include all changes/additions which have been made during the construction/commissioning phase of the project.

DOCUMENT/DRAWING TITLE	'AS-BUILT' CATEGORY	CROSS REFERENCE
General Instrumentation Documents:		(3.2)
- Summaries of instrumentation documents and drawings	A	(3.2.1)
- Summary of instrumentation inquiries	B	(3.2.2)
- Instrument engineering data sheets	A	(3.2.3)
- Composite instrument manuals		(3.2.4)
Instrumentation General Diagrams:	B	(3.3.1)
- System control diagrams	A	(3.3.2)
- Instrument loop diagrams	A	(3.3.3)
- Logic diagrams including relay diagrams	A	(3.3.4)
- Function descriptions	A	(3.3.5)
- Computer diagrams	B	(3.3.6)
- Alarm and trip settings	A	(3.3.7)
- Arrangements of system cabinets/auxiliary cabinets	B	(3.3.8)
- Instrument/Electrical interface cabinet	A	(3.3.9)
- Computing relay calculations	A	(3.3.10)
- Distributed control system (DCS)	A	(3.3.11)
- Instrument utility consumption calculations	B	(3.3.12)
- Heat dissipation calculation	B	(3.3.13)
- Noise calculation(CR)	B	(3.3.14)
Analyzers and Sundry Instruments:		(3.4)
- On-line process stream analyzers and sample systems	A	(3.21.1)
- Layout of the analyzer house	A	(3.21.2)
Flow Instruments:		(3.5)
- Flow meter calculations	A	
- Restriction orifice calculations	A	
- Construction drawings for special flow meters	B	
- Construction drawings for restriction orifices	B	
- Flow computer calculations	A	
Level Instruments:		(3.6)
- Calculations for differential pressure instruments	B	
- Calculations for radioactive sources	B	
- Construction drawings for special level instruments	B	

(to be continued)

DOCUMENT/DRAWING TITLE	'AS-BUILT' CATEGORY	CROSS REFERENCE
Pressure Instruments:		(3.7)
- Selection of diaphragm seals	B	
- Selection of over range protection	B	
Temperature Instruments:		(3.8)
- Construction drawings for special temperature measurement devices	B	
- Construction drawings for multiple temperature measuring elements	B	
Final Control Elements:		(3.9
- Control valve sizing calculations	B	
- Control valve noise calculations	B	
- Control valve stroking time calculations	B	
Instrument Installation:		(3.10)
- Summary of instrumentation cables	B	(3.10.1)
- Summary of instrument installation materials	B	(3.10.2)
- Summary of instrument process connections	B	(3.10.3)
- Instrument tag numbers and nameplates	B	(3.10.4)
- Layout of control room	A	(3.11.1)
- Computer system drawings	B	(3.11.2)
- Layout of auxiliary room	A	(3.12.1)
- Layout of cable supports and instruments signal cables in auxiliary room	B	(3.12.2)
- Instrument air/filter reducer stations in auxiliary room	B	(3.12.3)
- Arrangement for main marshaling cabinets cabinets	B	(3.12.4)
- Arrangement of instrument system earth	B	(3.12.5)
- Signal cabling diagram	B	(3.12.6)
- Layout of earthing in the auxiliary room	A	(3.12.7)
- Layout of instrument consoles	A	(3.13.1)
- Cutout dimensions for instrument consoles	B	(3.13.2)
- Construction of instrument consoles	B	(3.13.3)
- Alarm annunciator panels	A	(3.13.4)
- Fire and gas detection display panel	A	(3.13.5)
- Layout of local instrument panels	A	(3.14.1)
- Construction of local instrument panels	B	(3.14.2)
- Location of field instruments	B	(3.15.1)
- Trenches for instrument cables	B	(3.15.2)
- Layout of instrument cables in the plant	B	(3.15.3)
- Single-line diagrams for instrument power supply	A	(3.16.1)
- Layout of instrument power supply cables in the control building	B	(3.16.2)
- Layout of instrument power supply in analyzer house(s)	B	(3.16.3)
- Instrument air system details	B	(3.17)
- Instrument signal lines	B	(3.18)
Instrument Cable Terminations:		(3.19)
- For each junction box	A	(3.19.1)
- For pneumatic tubing distribution facilities	A	(3.19.2)
- For thermocouple extension cable distribution facilities	A	(3.19.3)
- For each electric signal cable distribution cabinet	A	(3.19.4)
Instrument Impulse Lines	B	(3.20)
Critical Instruments and Systems:	A	
- Depressurizing systems		
All documents and drawings such as layouts, installation details, fire proofing, etc., which are not already covered by 'As-Built' category A requirements.		

3.2 General Instrumentation Documents

The following sub-sections indicate the type of documents and drawings generally applied and give guidance on how they should be prepared.

3.2.1 Summaries of instrumentation documents and drawings

The summary shall consists of an index sheet and separate sheets for listing engineering drawings and manufacturer's drawings respectively.

The first issue shall be prepared at specified time after award of the contract and shall contain, in numerical order, listings of all instrumentation documents and engineering drawings, complete with the planned dates for the first issue indicated in the relevant columns.

Revisions of the summary shall be issued monthly and shall then be up to date and contain all known information. Each revision issued shall contain a complete set of sheets including non-revised sheet(s), the revision indicator used on the index sheet shall also be used on the attached summary sheets and in the 'issue' column of each revised item, irrespective of the previous revision indicator(s), if any, there-on. The revision shall include manufacturer's drawings as soon as these have been received.

3.2.2 Summary of instrumentation inquiries

This summary consists of an index sheet and a list(s) of inquiries for each group of instruments. The first issue shall be prepared at specified time after award of the contract and shall contain, in numerical order, a listing of all instrumentation requisitions, complete with the planned dates for the first issue indicated in the relevant columns.

Normally one line should be used for each requisition but where the requisition covers materials which are expected to have different delivery dates, one line should be used for each group of items which have the same delivery date. Revisions of the summary shall be issued periodically and shall then be up to date and contain all known information.

3.2.3 Instrument engineering data sheets

For each processing unit and/or major equipment package unit in the project, the design and engineering information for the instrumentation shall be listed on 'standard instrument engineering data sheets'. These sheets shall carry the process data which is defined by process engineering.

Notes:

1) The Actual operating data for the processing unit and/or major equipment package unit shall be entered on the instrument engineering data sheets. However, the values given for minimum/normal/maximum of flow/level/pressure/temperature etc., shall take into account the turn-down requirements and the operating/design limits of the processing and equipment package unit.

2) In addition to the instrumentation entered by the process engineers, all other instrumentation data, such as for utilities, etc., shall be included in the data sheets.

The tag numbers on the sheets shall be in numerical sequence 'Symbols and identification system instrumentation'.

These sheets shall comprise tag numbers in numerical sequence, the related process engineering (or utility) flow diagram (PFD) drawing number, and the location co-ordinates of the instrument concerned on the (PFD). Where a line has been revised the revision letter shall be placed in the left hand column.

Data sheets for each process unit and for each major equipment package shall be made up into separate sets and each set shall be supplied with a dedicated cover sheet. The set(s) of sheets of equipment package(s) shall be combined with and immediately follow the set of sheets for its associated process unit. However, the cover sheets from each set shall be placed at the front and the combined set shall be numbered accordingly. Tag numbers for a package unit shall be given in sequence and in a group.

The first issue shall be prepared at an early stage of the detailed engineering phase and shall specify the components for each instrument loop, with all additional information available at that time. During the detailed engineering period the instrument engineering data sheets shall be further completed with engineering and purchasing data.

Revisions of the instrument engineering data sheets shall be issued periodically and shall then be up to date and contain all known information.

The sequence of the data sheets as an engineering document and their numbering shall be as indicated on the cover sheet. The cover sheet shall list all the sheets and give the latest revision letter.

3.2.4 Composite instrument manuals

Composite instrument manuals shall be compiled as follows, but not necessarily limited to the examples given:

- For all in-line instruments such as control valves, positive displacement/turbine meters including accessories, level displacer instruments, etc.
- Equipment packages (including skid mounted units).
- Distributed Control System (DCS).
- Tank gaging, blending, dosing and weighing systems, etc.
- On-line process stream analyzers and sample systems.

The Composite instrument manuals shall incorporate all manufacturer's documents for the instrumentation designed/ordered against a particular project.

3.3 Diagrams

3.3.1 Instrumentation general diagrams

These diagrams shall be arranged as a multi-sheet 'drawing' (2.4), in one complete set for the particular project.

The diagrams shall show overall signal routing between field devices and all systems and cabinets, including the type of signal cabling, junction boxes, terminals, main distribution frame and system cabling, etc. For system cabinets, the type of power supply and the arrangement of system cabinet alarms, etc., shall be indicated. These drawings shall be in the form of block diagrams and, if applicable, detail all the battery limits delineating the scope of supply.

The diagrams shall be prepared at an early stage of the detailed engineering phase and shall be fully reviewed and approved by the Company before detailed design is started.

The instrumentation 'general' drawings shall be revised throughout the project to incorporate further requirements as they become apparent.

3.3.2 System control diagrams

These diagrams shall show in detail all active instrument components complete with instrument ranges, set points, controller settings, etc., for complicated systems such as HP/MP/LP steam systems, fuel gas systems and compressor surge control systems.

3.3.3 Instrument loop diagrams

Loop diagrams shall be arranged as a multi-sheet 'drawing' (2.4), in separate sets for each processing unit and for each major equipment package unit.

Each set of instrument loop diagrams shall have a drawing number. Where more than one processing unit and/or major equipment package unit is involved in the project, a group of consecutive drawing numbers shall be used for the various sets of diagrams.

3.3.4 Logic diagrams

Logic diagrams shall be arranged as a multi-sheet 'drawing' (2.4), in separate sets for each processing unit and for each major equipment package unit.

For each system for binary logic functions (including those in package units), a functional logic diagram shall be prepared by, or in close cooperation with, process design or process control engineering.

Each logic system as indicated on the process engineering, (or utility) engineering flow diagrams (P&IDs), shall have its own sheet or it may consist of several sheets.

Where it has been decided by the user that the logic functions will be realized by electro-mechanical relays, the functional logic diagrams shall be converted into relay diagrams. These conversions shall take into account system engineering aspects such as:

- Fail-safe provision.
- Provision for override, start-up, testing under operating conditions, etc.
- Identification of all components such as relays, circuit breakers, etc., terminals, sockets and pins, especially for incoming and outgoing signals.

The resulting relay diagrams or engineering logic diagrams shall be in such detail that proper hardware execution by the system supplier is ensured. The requisition for the system shall make reference to the applicable detailed hardware drawings, showing the position of and the interconnections between the applied modules for easy identification during installation, testing and maintenance. The format and layout of particular 'relay diagrams' shall be to requirements given by the user, and the proposed presentation shall be submitted for review and approval by the user.

Each set of logic diagrams, and relay diagrams (if applicable), shall have a drawing number. Where more than one processing unit and/or major equipment package unit is involved in the project, a group of consecutive drawing numbers shall be used for the various sets of logic diagrams and relay diagrams.

3.3.5 Function descriptions

Function descriptions, including basic logic diagrams and step charts, shall be made for sequence control or safeguarding systems and other complicated control systems. Function descriptions shall include test procedures for testing under operating conditions.

3.3.6 Computer diagrams

These diagrams and lists shall show all incoming and outgoing signals and control lines to computer equipment, operator consoles, interface equipment such as thermocouple selectors and signal line interconnections, junction boxes, cross boards, etc., as far as not covered in the documents and drawings for the 'normal' instrumentation.

3.3.7 Alarm and trip settings

Alarm and trip setting details shall be arranged as a multi-sheet drawing (2.4), in sets for each system cabinet. Each instrument having a binary logic function shall be listed on this ’drawing’. The ’drawings’ shall be prepared in such a way that instruments forming part of a system are grouped together on one or more sheets.

The alarm and trip setting ’drawing’ shall be set out to requirements given by the user. The format and layout to showing the intended presentation shall be submitted for review by the user.

Each set of listed alarm and trip settings shall have a drawing number. Where more than one set of listed alarm and trip settings is involved in the project, a group of consecutive drawing numbers shall be used for the various sets.

3.3.8 Arrangement of system cabinets/auxiliary cabinets

Drawings for each system cabinet or auxiliary cabinet shall show:

- The arrangement of all equipment in the cabinet with their tag numbers.
- The arrangement of terminals and sockets for the outside cabling with their identification.
- Assignment of each terminal and socket pin for the outside cabling.
- Facilities for earthing, outside cable supporting, ventilation and hoisting.
- Cabinet, equipment and socket/terminal row nameplate details.
- Cabinet installation details.

For guidance in the arrangement of system/auxiliary cabinets, refer to IPS-E-IN-220 "Control Center".

3.3.9 Instrument/electrical interface cabinets

This drawing shall show the construction and the layout of the interface cabinet, complete with the interface relays and cable termination details for the signals forming part of instrument engineering, and those forming part of electrical engineering. For the division of responsibilities between instrument and electrical engineering disciplines, refer to Part 2 of this Standard.

3.3.10 Computing relay calculations

The calculation sheets shall be arranged as a multi-sheet ’drawing’ (2.4), in sets for each processing unit. The calculations of the different computing relays (functions) shall be given in detail.

Each set of computing relay calculations shall have a drawing number. When more than one processing unit is involved in the project, a group of consecutive drawing numbers shall be used for the various sets of computing relay calculations.

3.3.11 Distributed control system (DCS) configuration

The system shall be shown in a multi-sheet ’drawing’ (2.4), arranged in sets for the configuration of the selected DCS.

These sets of ’drawings’ shall give information on the layout of the console, cabinets and the software function block configuration.

Software configuration information is not required for process multiplexer systems. For multiplexer systems, information on the tag number location in a cabinet is sufficient.

The function block configuration diagrams shall provide detailed software information, including an overview of the interrelations of the functional elements which constitute the controls and the interface with input/output circuitry, man/machine interface and supervisory controls as appropriate.

During the preparation of the DCS configuration drawings, care should be taken not to include "volatile" information in the drawing, such as proportional band setting, group display layouts, pictorials, etc. The type of information tends to change continuously during the lifetime of the plant, so that the drawing never reaches the "as built" status. This information shall be depicted on a separate drawing, and not included in the composite instrument manuals.

The DCS configuration drawing package shall be completed in detail so that proper configuration execution by the system supplier is ensured.

Certain parts of the DCS configuration, such as group display layout, pictorials, historical trend, alarm group listing, etc., shall be prepared in close cooperation with, Company's process design, process control and operation specialists.

Each set of DCS configuration drawing sheets shall have a drawing number. A group of consecutive drawing numbers shall be used for the various sets of DCS configuration 'drawings'.

3.3.12 Instrument utility consumption calculations

The calculation sheets shall be arranged as a multi-sheet 'drawing' (2.4), and for each required instrument utility, give a detailed calculation which shall include but not necessarily be limited to:

- Instrument air, which shall consider both the baseload and the maximum air consumption requirement and be ultimately based on selected equipment manufacturer's quoted consumption rates,
- Secured air supply buffer vessel capacity/sizing,
- Nitrogen, steam, cooling water, etc. consumption, e.g., for analyzers,
- Electrical power load requirements e.g., for Distributed Control System (DCS), Safeguarding Systems, Emergency Shutdown Systems (ESD), etc.,
- Purge fluid consumption, e.g., for instrument impulse lines,

The calculation shall indicate the required and the installed capacity,

During the detailed engineering stage, the instrument utility consumption calculations shall be updated and issued at regular intervals to ensure that the requirements can be met.

3.3.13 Heat dissipation calculation

This 'drawing' shall contain a detailed heat dissipation calculation for all electrically powered instrument equipment which will be installed in the instrument auxiliary room and/or satellite house and control room, in view of total heat load for the air-conditioning system(s).

During the detailed engineering stage, the heat dissipation calculation shall be updated and issued at regular intervals to ensure that the requirements can be met.

3.3.14 Noise calculation

This "drawing" shall contain a detailed noise calculation and/or spectrum for all instrument equipment which will be installed in the control room and contribute to a noise level higher than the allowed limit. Typical examples are printers, cooling fans of instrument equipment, etc.

3.4 Analyzers and Sundry Instruments

Documents and drawings are concerned with the selection, specification and ordering of on-line process stream analyzers, etc., and sundry instruments. For guidance on the preparation of such documents and drawings, refer to IPS-G-IN-230 "Analytical Instruments".

3.5 Flow Instruments

This Sub-section concerns the documents and drawings relating to the selection, specification and ordering of flow instruments. Typical examples are:

- Flow meter calculations.
- Restriction orifice calculations.
- Installation drawings for special flow meters.
- Construction drawings for restriction orifices.
- Flow computer calculations.
- Custody transfer flow metering stations.

Flow meter and restriction orifice calculations shall be arranged as a multi-sheet 'drawing' (2.4), in sets for each processing unit. Each set shall have a drawing number and, where more than one processing unit is involved in the project, a group of consecutive drawing numbers shall be used for the various sets of flow meter and restriction orifice calculations.

3.6 Level Instruments

This Section concerns documents and drawings relating to the selection, specification and ordering of level instruments. Typical examples are:

- Calculations for differential-pressure instruments.
- Calculations for radio-active sources.
- Installation drawings for special level measurement.

Calculations for differential-pressure transmitters shall be arranged as a multi-sheet 'drawing' (2.4), and show in detail all the required data such as transmitter elevation, type of leg and sealing fluid (if applicable), calculations of temperature effect on the sealing medium (if applicable), calibrated range and zero elevation/suppression, etc., for each application.

3.7 Pressure Instruments

This Section comprises all documents and drawings relating to the selection, specification and ordering of pressure instruments. Typical examples are:

- Selection of diaphragm seals.
- Selection of over-range protection devices.

3.8 Temperature Instruments

This Section comprises all documents and drawings relating to the selection, specification and ordering of temperature instruments. Typical examples are:

- Installation drawings for special temperature measurement devices.
- Installation drawings for multiple temperature measuring elements.

3.9 Final Control Elements

This Section concerns documents and drawings relating to the selection, specification and ordering of final control elements. Typical examples are:

- Control valve sizing calculations.
- Control valve noise calculations.
- Control valve stroking time calculations.

ISA Forms to be used for this purpose. Each set of control valve sizing and noise calculations shall have a drawing number. Where more than one processing unit is involved in the project, a group of consecutive drawing numbers shall be used for the various sets of control valve sizing and noise calculations sheets.

3.10 Instrument Installation

3.10.1 Summary of instrumentation cables

The summary consists of an index sheet and separate summary sheets for electric signal and supply cables (which form part of instrument engineering), thermocouple signal cables, system cables.

The summary shall contain a listing of all instrumentation cables (except single cables from individual plant instruments to plant junction boxes). The relevant sheets shall be completed at a later date, with the manufacturer's cable reel identification code.

The first issue of the summary shall be made as soon as possible after cable supplier selection, and henceforth it shall be revised at regular intervals, with the final issue at such a time that the cable deliveries are not endangered.

3.10.2 Summary of instrument installation materials

The summary consists of a table of contents and an index sheet together with sheets listing standard materials, sheets for specifying other materials and sheets for summarizing material quantities. The first issue of the summary shall be available two months after award of the contract.

Revisions of the summary shall be issued at regular intervals but at least once every two months. Each revision issued shall consist of a revised index sheet with summary sheet(s) attached.

3.10.3 Summary of instrument process connections

The summary 'sections' consist of a cover sheet, an index sheet, sheets indicating abbreviations, together with separate sheets for the different instrument groups, using Standard Forms.

During the detailed engineering stage, the summary of instrument process connections shall be updated and issued at regular intervals to ensure that the requirements can be met.

3.10.4 Instrument tag numbers and nameplates

Details of the type of tag numbers and nameplate and the description of the instrument service, etc., shall be arranged as a multi-sheet 'drawing' (2.4).

3.11 Control Room

3.11.1 Layout of the control room

The control room drawing shall show in detail, true to scale (using the same scale as for the auxiliary room (3.12.1)), the general arrangement and location of instrument consoles, computer consoles, supervision panels, printers, including console/panel numbering as applicable. It shall also show openings in the wall or floor between control room and auxiliary room, etc.

For projects where the auxiliary room and control room will be on the same elevation, the drawing shall indicate the grid of the cavity floor and openings required in this floor, for bottom entry into instrument consoles, etc.

3.11.2 Computer system drawings

When the project includes a digital computer for process supervision (and control), all details of the computer system shall be clearly covered in documents and drawings as follows:

- A layout of the computer room/computer auxiliary room

These drawings shall show the arrangement of computer equipment, cabinets, desks, etc., in the computer room and the computer auxiliary room respectively:

- Air-conditioning of computer and computer auxiliary rooms

This drawing shall show the layout of the air distribution ducting and the direction of the air flow,

- A layout of the cavity floor in the computer and computer auxiliary rooms

This drawing shall show the construction of the cavity floor, with an indication of the openings therein.

3.12 Auxiliary Room

3.12.1 Layout of the auxiliary room

The drawing of the auxiliary room shall show in detail, true to scale (using the same scale as for the control room (3.11.1)), the arrangement and identification of all equipment such as system cabinets, auxiliary, distribution and riser cabinets. For pneumatically controlled plants, the instrument air filter/reducer station(s), etc.

This drawing shall indicate the grid of the cavity floor and the openings required in this floor for bottom entry into cabinets, etc.

3.12.2 Layout of supports, and instrument signal cables

This drawing shall show:

- The arrangement of all cable supports under the ceiling and cavity floor of the auxiliary room.
- The plant instrument signal cable entries into the auxiliary room in the correct position together with the relevant cable numbers.
- The position of the plant instrument signal cable termination facilities, with their identification, and the routing of the plant instrument signal cables to these facilities.
- For pneumatically controlled plants, the routing of the instrument air supply piping complete with pipe sizes and branch-off points.
- The openings in the wall or floor between control room and auxiliary room.

3.12.3 Instrument air filter/reducer station(s) in the auxiliary room

For pneumatically controlled plants, the drawing shall show, in detail and true to scale, the actual arrangement of filter/reducer station(s) complete with detailed identification of the required hardware, supporting structure, etc. For general requirements see IPS-E-IN-200 "Instrument Air System".

3.12.4 Arrangement for main marshaling cabinets

Drawings for electrical instrument signal cables shall show:

- The arrangement of the terminal rows for outdoor cables, complete with row/terminal identification.
- The arrangement of the system cable termination boards for indoor cables, complete with row/terminal and socket identification.
- The facilities for interconnecting the cable screens.
- The facilities for earthing the armouring/lead sheathing of outdoor cables, if applicable.
- The facilities for supporting the indoor and outdoor cables.
- The facilities for routing/supporting the cross wiring.

Drawings required for thermocouple signal cables are similar to the above, but shall also include the arrangement of cold junction compensation boxes and their identification. Drawings for pneumatic signal tubing shall show:

- The arrangement of the terminal rows for outdoor and indoor cables, complete with row/terminal identification.
- The facilities for earthing the lead sheathing of outdoor cables, if applicable.
- The facilities for supporting the indoor and outdoor cables.
- The facilities for routing/supporting the cross tubing.

3.12.5 Arrangement of instrument system earth

The drawing shall show:

- The arrangement of earth bars for instrument system earth and safety earth of instrument equipment, complete with earth bar/terminal identification, choke and arrester.
- The facilities for supporting the indoor earthing cables.

3.12.6 Signal cabling diagram

This drawing shall show in diagrammatic form all signal cabling in the auxiliary room and its connection to equipment in the auxiliary room, to the consoles in the control room and to the plant. The drawing shall indicate the exact signal cabling routing, including cable crossing details, and generally follow the actual layout of equipment in the auxiliary room, but need not necessarily be true to scale.

The cable terminations shall be coded such that a clear distinction is made between cables terminating on rail-mounted terminals, plugs, and sockets, etc. The drawing shall also include the identification of the equipment, the cables, and the system cable sockets mounted in the equipment.

3.12.7 Layout of earthing in the auxiliary room

Separate drawings shall be prepared for DCS earth, computer earth, instrument system earth and safety earth of instrument equipment.

These drawings shall show in diagrammatic form all earth cabling from the system earth cabinet in the auxiliary room and its connections to equipment in the auxiliary room and consoles in the control room. They shall also include the identification of equipment and earth cables.

The drawing shall generally follow the actual layout of equipment in the auxiliary room, but need not necessarily be true to scale.

3.13 The Main Instrument Console

3.13.1 Layout of instrument consoles

Drawings shall show the layout (to scale) of the main instrument console(s), the location of each instrument or group of instruments and equipment in outline, with tag numbers(s) for each individual instrument or equipment such as visual display units, keyboards, alarm annunciator panel, manual switches, etc. The main dimensions of the complete console and the console sections shall be given and the console sections shall be numbered for identification.

3.13.2 Cut-out dimensions for instrument consoles

Drawing(s) shall show the cut-out dimensions for all console sections. Drawings for prefabricated instrument consoles shall be prepared by the console supplier based on the layout drawings and the detailed drawings for cut-out and bezel dimensions for equipment not forming part of the supply of the console manufacturer.

3.13.3 Construction of instrument consoles

Construction drawings shall give all information required for manufacturing and erecting the instrument consoles, including the supporting details of the equipment mounted in the consoles. They should also indicate facilities to allow maintenance personnel to reach from the rear of the console, equipment, installed in the front part.

3.13.4 Alarm annunciator panels

Drawings shall show the layout (full scale) of the semi-graphic panels (mimic panels). The display shall consist of a simplified plant flow diagrams with indication lights for valves states and controls if applicable.

For guidance in the preparation of the alarm annunciator panel, refer to IPS-E-IN-260 "Alarms and Shutdown Control Circuits".

3.13.5 Fire and gas detection display panel

Drawing(s) shall show the layout (full scale) of the fire and gas detection display panel, giving main dimensions. The display shall consist of a geographical plant representation for flammable gas, fire, smoke and hydrogen sulphide detection with indication lights for alarms, maintenance override status indication and manual call points.

For guidance in the preparation of the fire and gas detection display panel, refer to IPS-E-SF-260 "Automatic Fire and Gas Detection Panel".

3.14 Local Panels

3.14.1 Layout of local instrument panels

Drawings shall show the layout (to scale) of each local panel, with the instruments in outline and giving the tag number for each instrument.

3.14.2 Construction of local instrument panels

Construction drawings shall give all information required for manufacturing the local panels. Fully dimensioned cutouts for all instruments shall be included, either on the same drawing or presented separately.

3.15 Field Instrumentation

3.15.1 Location of field instruments

The location of instruments shall be shown, superimposed on sections of a simplified plot plan as follows:

- All field mounted instruments, including local indicators and temperature indicators.

- All local panels.

- All field-mounted junction boxes for instrument signal cabling.

- All trunking for instrument cabling and its riser points from (underground) trenches, complete with sizes, bends, branches and supporting points.

- All conduits between trunking and plant instruments.

- All instrument air supply piping from its demarcation points with mechanical engineering to the relevant (group of) consumers. Isolating valves, branch-off points and pipe sizes shall be clearly indicated.

Note:

Air filter/regulators shall not be shown in detail on these drawings.

In general, separate drawings shall be provided for the location of instruments relating to:

- Processing units.
- Flammable gas, fire and smoke detection and deluge systems.
- Toxic gas detection.

Each drawing shall contain a list of all instruments and junction boxes. Each list shall show, in sequence of tag number, the (plant) coordinates for location of the equipment and its elevation above plant grade level.

Where instrumentation installation in structures is involved, preference shall be given to the preparation of layout drawings for different levels, e.g., for each platform, and/or drawings showing such structures in sideview (elevation) containing all the above information.

Where one drawing showing all the information would become too congested, consideration should be given to:

- Changing the scale of the drawing, or where necessary covering the processing unit on several drawings, on the same scale.

- Showing relatively small congested areas on a separate drawing to a larger scale.

- Splitting the information over two drawings, with one drawing showing instruments and junction boxes, and the other showing junction boxes, cable trunking, conduits and air supply piping, this drawing shall then have the title 'Location of Cable Trunking and Air Supply Piping'.

Complicated cable trunking shall also be shown in isometric form if plan/elevation drawings would not be sufficiently clear for fabrication of trunking systems.

Where the cable trunking will be of fire resistant construction, it shall be shown on detailed construction drawings.

Where the cable trunking requires special supports, these shall be shown on detailed construction drawings, and a decision shall be taken whether they can form part of the installation activities or whether they should be requisitioned separately for prefabrication.

3.15.2 Trenches for instrument cables

Drawings shall show the location of trenches for instrument cables complete with indication of size, branch-off points, etc. Details of trench construction, methods of backfilling and trench closure shall also be indicated.

Note:

These drawings shall be prepared in close co-operation between instrument, electrical and civil engineering. the ultimate drawing(s) may form part of civil engineering, provided detailed references are made on the instrumentation drawings.

3.15.3 Layout of instrument cables in the plant

Drawings shall show the aboveground and underground routing of all instrumentation cables from their termination point in the plant to their termination point in the control building, complete with the laying pattern for cable segregation.

Cables for similar applications, such as for fire, gas and smoke detection and deluge systems shall also be indicated on the drawings.

Special attention shall then be paid to the need for additional branches and riser points in these power cable trenches for accommodating the instrument electricity supply cables.

All riser points for instruments power cables shall also be indicated on the drawings ’Layout of instrument cables in the plant’, complete with the aboveground cable routing to the individual consumers. Cross references shall then be made on both drawings.

3.16 Instrument Power Supply

3.16.1 Single-line diagram for instrument power supply

The instrument power supply shall be shown diagrammatically, from the electrical distribution switchboards to the consumers, and shall include:

- Arrangements for AC and DC supply.
- Special provisions for computer power supply.
- All instrument switchboards, switches, fuses including ratings and characteristics.
- Demarcation points at the interface between electrical engineering and instrument engineering.

For the division of responsibilities between instrument and electrical engineering disciplines, refer to Part 2, of this Standard.

3.16.2 Layout of instrument power supply cables in the control building

Drawing(s) shall show the layout of the instrument electricity supply cables, complete with the cable numbers, from the distribution board(s) forming part of electrical engineering, under the cavity floor and up into the system and auxiliary cabinets, and up through riser cabinets into the instrument panels of the control room, etc., and into the computer room.

3.16.3 Layout of instrument power supply in analyzer house(s)

The drawing shall show in detail, true to scale and on the same scale as ’Layout of an analyzer house’, the instrument electricity supply connections for the individual consumers. Complete with de-energizing facilities for each consumer, socket outlets for electrical tools and test equipment, and the cable routing from point of entry to the consumers.

3.17 Instrument Air System

Instrument air lines shall be prepared as a multi-sheet 'drawing' (2.4), showing in detail, the arrangement of the individual air supply for each pneumatically operated instrument, using the appropriate sheets of Standard form refer to IPS-C-IN-200 "Installation Standard for Instrument Air System".

Dedicated instrument air line details shall be provided for instruments related to fire detection facilities and deluge systems.

3.18 Instrument Signal Lines

Instrument signal lines, prepared as a multi-sheet 'drawing' (2.4), shall indicate:

- Cross sections of trenches showing the location and laying pattern of each group of cables.
- Procedures for laying cables in trenches, and methods of backfill.
- Procedures for laying cables in trunking, and methods for fixing the cables, etc.
- Details/procedures for termination of cables in cable joints, if applicable.
- Details/procedures for laying cables entering the auxiliary room with respect to their termination point.
- Details for covering/sealing/fire proofing of cable entries into the auxiliary and control room.
- Details/procedures for stripping length and finishing touch of cables in particular with respect to cable glands.
- Methods for identification of wires, pairs or quads in multielement cables.
- Procedures for termination of cables in thermocouple heads, transmitters, converters, solenoid valves, manual switches junction boxes, distribution cabinets, etc.
- Construction details of signal cabling crossings (bridges).

The 'drawing' shall also give dedicated earthing principles and details for instrument equipment such as:

- Instrument earthing, for signal cable screen continuity and earthing point, system cables, reference system earth bar, etc.
- Instrument earth star point.
- Safety earthing for signal cable armouring/lead sheathing, system cabinets, frames, instrument desks/consoles, recessed floor(s), instrument cable trunking, junction boxes, local panels, power distribution boards, etc.
- Safety earth distribution.
- Earthing of safety barriers, if applicable.

3.19 Instrument Cable Terminations

Instrument cable terminations in the form of a multi-sheet 'drawing' (2.4) shall be prepared. These drawings shall be set out to the requirements given by the user. The format and layout shall be submitted for review by the user prior to full scale application. The multi-sheet 'drawing' shall indicate the requirements of the following Sub-sections:

3.19.1 For each junction box

- Junction box number.
- The actual numbering of the terminals.

- The (multi-element) signal cable(s) connected to these terminals with full identification by cable number(s), pair/ quad number, color or number coding of wires, etc.

- The connections to plant instruments specified by the tag number.

If more than one signal is related to a tag number, the following code shall be added:

- TX in the case of a measured value signal.
- CV in the case of a controller output signal.

3.19.2 For pneumatic tubing distribution facilities

- The terminal rows for plant and indoor tubing, complete with row and terminal identification and tubing numbers.

- The cross tubing between the terminal rows.

- The direct tubing between the terminal rows for indoor cables.

3.19.3 For each thermocouple extension cable distribution cabinet

- The terminal rows and shunt diode safety barriers, if applicable, for plant cables, complete with row and terminal or barrier identification and cable numbers.

- The terminal rows for indoor cables, complete with row/terminal identification.

- The cross wiring between the terminal rows.

- The cross wiring between the terminal row(s) for plant cables via the cold junction compensation boxes, complete with row/terminal, box/terminal identification.

3.19.4 For each electric signal cable distribution cabinet

- The terminal rows for plant cables complete with row and terminal identification and cable numbers.
- Terminal rows for indoor cables complete with row/terminal identification.
- The cross wiring between the terminal rows.
- The direct wiring between the terminal rows for indoor cables.

3.20 Instrument Impulse Lines

Instrument impulse line details shall be prepared as a multi-sheet 'drawing' (2.4), in sets for each processing unit, using the appropriate 'Standard Forms'.

Each set of instrument impulse lines shall have a drawing number. Where more than one processing unit is involved in the project, a group of consecutive drawing numbers shall be used for the various sets of instrument impulse lines.

3.21 On-Line Process Stream Analyzers

3.21.1 On-line process stream analyzers and sample systems

Documents and drawings giving details of analyzer and sampling systems, etc., shall be prepared as follows, arranged in sets for each on-line analyzer:

- The sample take-off/return assembly, preconditioning and transport system.

- Sample transport system line size calculations.
- Sample lag time calculations.
- Calculations of the ratio of the sample line flow and the normal process line flow.
- Layout drawing(s) of analyzer sample transport system 'in isometric form' showing the routing of the sample transport lines from the sample take-off/return points in the plant, to the sample conditioning system at the analyzer house.
- The sample conditioning system.
- Calculations of the conditions at the inlet and outlet of the sample conditioning system.
- Calculations of the percentage of normal flow in the process line which is vented (flared) or drained.
- The analyzer and related equipment such as programmers, peak pickers (peak holders), recorders, convertors, etc.
- Calculations for auxiliary equipment such as heaters, coolers, pumps, tracing/lagging, etc., to obtain the required sample inlet conditions.

For guidance in the preparation of the above documents and drawings, refer to IPS-G-IN-230 "Analytical Instruments":

- Analyzer data sheet, using Standard Form for analyzer arrangements requiring a sample conditioning system.

Note:

The range of all instruments, in the above systems shall be specified in the requisition.

The range of the instruments shall also be specified on the appropriate documents and drawings. Each set of in-line analyzer documents and drawings shall have a drawing number. Where more than one analyzer is involved in the project, a group of consecutive drawing numbers shall be used for the various sets of documents and drawings.

3.21.2 Layout of the analyzer house(s)

A drawing, true to scale and on the same scale as the drawing 'Layout of instrument electricity supply in the analyzer house', shall show in detail the arrangement of all equipment in and around the analyzer house.

The equipment such as sample lines and conditioning systems, drain/vent systems, air conditioning, heating/ventilation systems, analyzers and their related equipment, junction boxes, initiating elements of safeguarding systems, sink, workbench, etc., shall where applicable be identified with line and/or tag numbers, etc.

For guidance in the preparation of the layout of analyzer house(s), refer to IPS-G-IN-230 "Analytical Instruments".