DEPARTMENT OF PUBLIC WORKS

FIRE SECURITY

STANDARD TECHNICAL SPECIFICATION
FOR
AN INERT GAS AGENT
FIRE EXTINGUISHING SYSTEM

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STANDARD SPECIFICATION
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1. SECTION 1: GENERAL REQUIREMENTS

1.1 NOTICE

This Standard Specification forms part of. and shall be read in conjunction with, the Department's Supplementary Specification pertaining to a specific Inert Gas Agent fire extinguishing installation/service.

Any reference to "Contractor" or "Sub-contractor" shall be interpreted as the successful tenderer appointed to execute the contract of works specified in the Department's Supplementary Specification.

1.2 SCOPE AND OBJECTIVE

This Standard Specification shall apply to any fire protection or extinguishing installation containing an Inert Gas Agent, in accordance with the Standard on Clean Agent Fire Extinguishing Systems - NFPA 2001 latest edition, as issued by the National Fire Protection Association of the USA as extinguishing medium.

The Inert Gas Agent shall contain as primary components:

- Nitrogen (N_2), as well as one or more of the following gases:
- Helium (He)
- Neon (Ne)
- Argon (Ar)

The Inert Gas Agent may further contain Carbon Dioxide CO_2 as a secondary component.

The exact constitution and constituent tolerance of the Inert Gas Agent shall be in accordance with NFPA 2001 latest edition. Table 2-1.2(b) - Inert Gas Clean Agent Quality Requirements.

The objectives of an Inert Gas Agent discharge into any protected space shall be:

- Reduction of the oxygen (O_2) concentration in the protected space, by virtue of displacement of a significant part of the atmosphere, to a level which will not sustain fires of Classes A. B or C.
- To limit the reduction in oxygen concentration to a level which will still sustain human life at a fairly low rate of activity.
- Where Inert Gas Agents containing carbon dioxide (CO_2) are concerned, to limit the increase in CO_2 concentration in the protected space to a level which will not cause any related effects of toxicity in persons of reasonable health.

This Standard Specification shall apply to engineered fixed total flooding installations. This Standard Specification shall apply to systems with storage pressures of 150Bar to 200Bar. Systems with storage pressure lower than 150Bar shall not be acceptable. Where system storage pressure exceeds 200Bar. such system shall be suitably rated for safe operation at such higher pressure.

1.3 SYSTEM APPROVAL AND DESIGN RESPONSIBILITY

Every Inert Gas Agent installation shall comply with either of the following:

1.3.1 System Approval by an Approved Body

The entire system offered to the Department of Public Works, including physical equipment, as well as design algorithms and software, shall have complete, non-exclusive, system approval by a standards organisation or certification body acceptable to the Department of Public Works. such as

? South African Bureau of Standards (SABS)
? Underwriters Laboratory (UL) - United States of America
? Factory Mutual Research Corporation (FMRC) - United States of America
? Verband der Schadenversicherer (VdS) - Germany
? Germanischer Lloyds - Germany
? Loss Prevention Certification Board (LPCB) - United Kingdom
? Lloyds Register - United Kingdom
? Det Norske Veritas - Norway/Sweden

Or other body approved by the Department of Public Works from time to time.

Proof of compliance with this requirement shall be by means of certified copies of the original certificates.

1.3.2 System Design by Competent Individual

In cases where no system approval exists, the entire system offered to the Department of Public Works, including physical equipment, as well as design algorithms and software, shall be designed by a South African registered Professional Engineer, or other party acceptable to the Department.

In either case. such a design shall form part of an approved, integrated design, manufacture and testing process in compliance with IS09001. Proof of IS09001 certification shall be provided to the Department

Furthermore, every item of equipment shall carry individual approval by a body acceptable to the Department, such as:

? South African Burea of Standards (SABS)
? Underwriters Laboratory (UL) - United States of America
? Factory Mutual Research Corporation (FMRC) - United States of America
? Verband der Schadenversicherer (VdS) - Germany
? Germanischer Lloyds - Germany
? Loss Prevention Certification Board (LPCB) - United Kingdom
? Lloyds Register- United Kingdom
? Det Norske Veritas - Norway/Sweden

Or other body approved by the Department of Public Works from time to time.

The design of the fire protection layout detailed in the Supplementary Specification shall be done as part of an IS09001 certified design program. The technical interface as required by the IS09001 process, shall be the Engineer.

Final design verification, as called for by IS09001, shall be included in the scope of works unless otherwise specified in the Supplementary Specification.

1.4 COMPLIANCE & STANDARD SPECIFICATIONS

Unless specifically noted otherwise in the Supplementary Specification, all aspects of any Inert Gas Agent installation shall comply with the following regulations:

? Occupational Health and Safety Act (Act 85 of 1993. as amended) with Regulations.
? National Building Regulations Act of 1977 (SABS 0400 -1990) as amended.
? Local Municipal or other by-laws as applicable.
? Any applicable legislation imposed by any local or other authority.

Unless specifically noted otherwise in the Supplementary Specification, all aspects of any Inert Gas Agent installation shall meet or exceed the following specifications:

? NFPA 2001 Standard on Clean Agent Fire Extinguishing Systems - Latest Edition, as issued by the National Fire Protection Association of the USA.
? Department of Public Works F.P.O./82/5E Standard Technical Specification for an

Automatic Fire Alarm System - Latest Revision.

? Department of Public Works F.P.0.9E Standard Specification for Security Equipment - Latest Revision.

1.5 LIABILITY

All liability with respect to safety or other legislation regarding transport from manufacturer's premises, erection, storage on site. operation, etc. of any Inert Gas Agent installation shall rest with the Contractor until such time as the Department of Public Works has taken first delivery of such installation, and the Department or its representative has confirmed acceptance of such first delivery in writing.

1.6 STANDARD MEASURES

All dimensions, masses, volumes, etc. indicated on any drawings, schedules, submittals or other, shall be in accordance with the Sl system.

1.7 WORK BY OTHERS

All work necessary for successful completion of an installation shall be deemed to be included in the scope of works, except where it is specified in the Supplementary Specification as "by others".

1.8 DRAWINGS AND SUBMITTALS

Any drawings issued as part of the Department's Supplementary Specification are not working drawings, but are in essence schematic, and do not necessarily show the exact position, size. quantity or details of equipment construction, or pipe and other routes.

Tenderers should satisfy themselves that any equipment offered can indeed be accommodated as shown on the schematic drawings, without obstructing access for maintenance, repairs, or removal.

The successful tenderer shall submit Contractor's drawings, design calculations, and equipment samples, unless otherwise instructed by the Engineer. Drawings shall be prepared at the Contractor's expense, and shall be to a scale not less than 1:50 for plan layouts, and 1:20 for details. Drawings shall be submitted in sets of four to the Department or Engineer.

The Contractor shall at the time of submittal specifically point out in writing to the Department any deviations from this document or the Supplementary Specification. The Department may, at its discretion, require amendment and resubmittal prior to approval. Where items not requested by the Department are adjusted during amendment, these shall be pointed out in writing by the Contractor when resubmitting. No work shall commence until the relevant drawings or other documentation has been approved.

In the event of a Contractor failing to timeously provide equipment samples or final workshop drawings for approval, or if he fails to provide these at all. he shall be deemed to commence with any equipment or materials purchasing, manufacturing or installation or any other work at his own risk. and neither the Department, nor the Engineer shall be liable for any additional costs incurred to execute the contract works to the satisfaction of the Department and the Engineer. whether such costs be for redesign, remanufacture. scrapped material or equipment, or whatever, and regardless of whatever the reason/s for such failure.
Approval by the Department or Engineer of drawings or design calculations submitted by the Contractor shall in no way relieve the Contractor of his liability to complete the works in accordance with the requirements of the contract documents, and to the satisfaction of the Department and Engineer.

1.8.1 Builders Work Drawings

If required by the Supplementary Specification, the successful tenderer shall submit builders work drawings of all work by others required for this service within the time period specified

in the Department's Supplementary Specification. These drawings shall be dimensioned, and include the following:

- All builders items eg. bases, foundations, brickwork and concrete openings, cast-in items. etc.
- Electrical items such as chasing or recessed conduiting, electrical feeds, isolator or wall socket positions and rating, fire outputs if applicable, etc.
- Plumbers work if applicable.

1.8.2 Design Calculations

The successful tenderer shall submit for perusal by the Engineer copies of his detailed design calculations within the time period specified in the Department's Supplementary Specification. These shall include at least the following:

- System sizing calculations. Design concentration shall be clearly indicated for each and every zone or space, and whether such spaces are normally occupied or normally unoccupied.
- Distribution system detail design. All discharge pressures, both upstream and downstream of the main orifice shall be clearly indicated, together with proposed nozzle and pipe sizes, specifications, and allowable working pressures.
- Final discharge quantities for every protected space, design concentrations. 95% discharge time.

1.8.3 Working Drawings

The successful tenderer shall submit for approval copies of his complete working drawings within the time period specified in the Department's Supplementary Specification. As a minimum, these shall include the following:

- Plan layout of all equipment and distribution systems incorporating the latest architectural and structural layouts, to a scale of 1:50.
- Where any lights, air conditioning diffusers. grilles, public address systems or other ceiling mounted devices, as well as any dueling, piping, cable trays, trunking or other equipment which may interfere with the installation are to be installed, or are already installed in the same spaces, the extent and positions of these shall be clearly indicated on working drawings.
- Sections/elevations to a scale of 1:20 or larger indicating equipment details such as bracketing arrangements, enclosure details, construction details where these are not precisely as per the standard and supplementary drawings.

1.8.4 Electrical and Controls Schematics

The successful tenderer shall submit for approval copies of his electrical and controls schematics within the time period specified in the Department's Supplementary Specification. As a minimum, these shall include the following:

- Power supply single line diagrams indicating size of incomer feed, feed isolator requirement. standby batteries. UPS feeds, switchgear, fault levels, etc.
- Controls schematic indicating interfacing to detection system, details of actuation, detection alarms, and safety devices, etc.
- General arrangement drawings of all distribution boards, control panels and annunciator panels.

Wiring diagrams shall include numbers and sizes of conductors. The numbers of terminals and Corresponding conductors shall agree.

1.8.5 Equipment Samples

If required in the Supplementary Specification, samples of equipment, such as discharge valves, storage cylinders, actuation devices, direction valves, etc. proposed by a Contractor

shall be handed over to the Engineer for approval. The Contractor shall ensure that these are handed over in good time. i.e. at least 2 weeks before ordering or installation of every respective item commences.

1.8.6 As-Built Drawings and Schematics

As built drawings shall be handed over to the Department unless otherwise specified in the Department's Supplementary Specification. Draft Operational & Maintenance manuals shall be handed over at least 2 weeks prior to first delivery.

1.9 MATERIALS AND WORKMANSHIP

All equipment forming part of the works shall be of excellent quality with regard to material and finish, and of a standard acceptable by the Department. The Contractor shall employ the services of skilled personnel who are familiar with the high standard of workmanship required by the Department - Contractors are reminded that "normal industry practice" may not be acceptable by the Department.

1.10 DEVIATION FROM SPECIFICATION

Where a tenderer proposes any changes to the Departmental layout, these changes shall be marked in RED on the set of drawings returned with the tender, and offered as an alternative to the Departmental layout, and further detailed in a covering letter. The main tender shall nevertheless be to the letter of this specification and the Departmental layout.

1.11 PROGRAMMING OF WORK

The Contractor shall submit a program of works, in the form of a bar chart, within the time period specified in the Department's Supplementary Specification. This program shall make due allowance for the main building contract, if applicable, or any other activities which may require detailed scheduling to avoid delays or clashing of trades on site. The program shall include the following as a minimum requirement:

- Design stage
- Procurement of equipment
- First & final fixes - distribution system
- First & final fixes - electrical & controls
- Milestone events such as delivery of storage cylinders to site, any testing or inspections by relevant
- Authorities.
- Commissioning
- Handover

1.12 PERFORMANCE TOLERANCE

The Contractor shall at the time of first delivery hand over to the Department a certificate of confirmation that he guarantees actual Inert Gas Agent concentration of every protected space to be in accordance with the tolerances set out in SECTION 2 of this document. A copy of this certificate shall be bound into every Operation & Maintenance Manual, and the original shall be handed over to the Engineer or Department.

This certificate of confirmation shall include:

- Clear description of every protected space
- Volume of every protected space
- Total volume of agent piped to protected space
- Inert Gas Agent design concentration
- Guaranteed maximum Inert Gas Agent concentration
- Guaranteed minimum Inert Gas Agent concentration

1.13 NOTICES & SIGNAGE

All notices and signage associated with an Inert Gas Agent installation shall be supplied and installed as part of the installation. This shall include any temporary signage, which may be required.

1.14 COMMISSIONING & TESTING

Commissioning shall be done in a co-ordinated way in accordance with the requirements set out by the manufacturer of the equipment, and with the provisions of NFPA 2001.

The proper operation of the installation shall be demonstrated to the Engineer and a representative of the Department.

The Contractor shall bear the cost of all consumables, testing equipment, materials or extinguishing agent required for demonstration purposes.

1.15 GUARANTEE

The entire works shall be guaranteed by the Contractor for a period of no less than 12 months from date of first delivery. During this time. the Contractor shall repair or replace any defective equipment or materials, other than that obviously damaged by others, at his expense.

The Contractor shall maintain the entire works during this period, and he shall perform routine maintenance at his expense, inclusive of any consumables or incidental costs.

1.16 INSPECTIONS AND TEST CERTIFICATES

The Contractor shall obtain all required test certificates, and organize all necessary inspections, on behalf of the Department of Public Works as part of his scope of works. These shall include all certificates or inspections with regard to pressure testing of storage cylinders and other equipment as required in terms of Occupational Health and Safety Act or other as applicable.

1.17 APPLICATION FOR INSTALLATION & COMMISSIONING

Where any inspections or approvals of equipment or installations by inspection authorities or other are required before transport, erection, commissioning, operation, or any other action required for successful completion of the works may take place, these approvals or inspections shall be obtained by the Contractor.

1.18 DOCUMENTATION TO BE HANDED OVER

Refer to Clause 6.1 - Documentation Schedule, which forms part of this document.

The Contractor shall hand over to the Department at the indicated times all required documents as detailed at the required stages as indicated.

1.19 SERVICE ACCESS

The Contractor shall ensure that adequate access for service and removal of all items of equipment is allowed for.

1.20 SITE CLEARING

All scrap or loose materials associated with work done as part of this scope of works shall be removed from site by the Contractor before acceptance of first delivery by the Department.

2. SECTION 2: SYSTEM DESIGN

2.1 APPLICABILITY

This Standard Specification shall apply to any fire extinguishing installation containing an Inert Gas Agent, as described elsewhere in this document.

All Inert Gas Agent installations shall be engineered fixed full flooding systems.

Application of any Inert Gas Agent shall be limited to:

- Class A surface and deep seated fires
- Class B flammable liquid fires involving combustion of acetone, heptane, methane, or propane
- Class C energized electrical equipment fires, e.g. in computer rooms, control rooms, transformer rooms, substations, plantrooms containing rotating equipment, pumps, motors. etc.

Inert Gas Agents are not applicable where the following types of fires are involved, and these fires shall be excluded from their application:

- Class D combustible metal fires such as those involving magnesium, sodium, potassium, titanium, zirconium, etc.
- Chemicals, substances, or devices containing oxygen rendering them capable of sustaining their own combustion, such as cellulose nitrate and other explosives, incendiary devices. etc.
- Metal hydrides

Installations shall utilise an automatic fire detection system approved by the Department in line with the Departmental Standard Specification for Fire Detection Systems, and as detailed in this document and the Department's Supplementary Specification. Manual activation systems shall be allowable if called for in the Supplementary Specification.

2.2 DESIGN CODE

Any Inert Gas Agent installation shall be designed, erected and commissioned in accordance with or exceeding the following specifications, in order of preference:

- Department of Public Works Supplementary Specification.
- Department of Public Works Standard Specification for Inert Gas Agent Fire Extinguishing Systems (this document).
- NFPA2001 Standard on Clean Agent Fire Extinguishing Systems - latest edition.
- Manufacturer's specifications - latest edition.

Of these, the Departmental Supplementary Specification shall take preference over any other. Therefore, where anything contained in any of the Departmental Standard Specification (this document). NFPA2001. or the manufacturer's specification, is at variance with the Departmental Supplementary Specification, then the requirements of the Departmental Supplementary Specification shall take preference.

Any conflicts shall be referred to the Department for resolution before any action is taken.

2.3 PRELIMINARY DESIGN

The design as detailed in the Departmental Supplementary Specification with accompanying drawings is a preliminary design intended only to outline the scope of the works for tender purposes. Such a design, however detailed, shall under no circumstances be used as a final

layout for any Inert Gas Agent installation.

2.4 DETAILED DESIGN

Refer to clause 1.8.2 of this document.

The successful tenderer shall submit detailed design calculations of all aspects of every Inert Gas Agent installation. This shall include all aspects of an Inert Gas Agent installation as detailed in the design codes and specifications applicable.

It shall be assumed that any tenderer is completely familiar with the requirements of the applicable codes and standards as mentioned above, and that his design shall comply with all requirements of these, whether or not such requirements are specifically mentioned in this document or the Departmental Supplementary Specification.

2.4.1 Design by Competent Individual

Refer to clause 1.3 of this document.

2.4.2 Design Measurement

Exact dimensions of spaces shall be measured on site. Where this is not possible because building works have not been completed, exact dimensions shall be taken off architectural layouts. Under such circumstances, the Contractor shall verify before submittal of detail design that these dimensions have not changed.

2.4.3 Fire Divisions and Discharge Zoning

The Inert Gas Agent protection arrangement shall be designed in accordance with the fire divisioning of the protected area.

Unless otherwise specified in the Supplementary Specification, every individual protected space shall be served by a separate Inert Gas Agent protection system, which is capable of functioning in isolation from any other system. As a guideline, the following would constitute a **protected space:**

- A room or space constituting a fire division as intended by the National Building Regulations. and with no or few uncloseable penetrations in the envelope.
- A room or space enclosed by concrete slabs, masonry walls, drywall partitioning, or other physical barrier, with no or few uncloseable penetrations in the envelope, which is not necessarily a fire division, but which is indicated as a separate protected space in the Supplementary Specification.
- A combination of subdivisions such as access floor voids, occupied zones over, and ceiling voids over. which all form functional part of the same space, even though separated by physical barriers.
- A collection of functionally similar adjacent spaces that require combined gas discharge in order to achieve adequate protection against fire.

The Inert Gas Agent protection arrangement of any protected space shall be designed to effect simultaneous discharge of Inert Gas Agent in all parts of that particular protected space. If such a protected space contains subdivisions separated by any physical barrier, such as an access floor or ceiling, the Inert Gas Agent distribution system shall be designed to achieve a homogenous concentration of extinguishing gas in all parts of the space.

If the Supplementary Specification calls for a single Inert Gas Agent protection system to cover multiple spaces that would normally constitute separate protected spaces, such a protection system shall be designed to effect a single simultaneous discharge into all separate spaces. If the Supplementary Specification also calls for individual zoned discharge into the separate spaces, the distribution system shall be designed in accordance with clause 2.4.10 of this document.

2.4.4 Design Concentration

Design concentration shall depend on the nature and quantity of fuels contained in a protected hazard, as indicated in the Departmental Supplementary Specification.

Where Class B flammable liquid fires are concerned, and conditions exist which may result in subsequent reflash of a fire or explosion after agent discharge, ie:

- where sufficient fuel quantity is allowed in the protected space to achieve average concentration equal or in excess of the lower flammability limit. AND
- where, before agent discharge, ambient or fuel temperature is such that it would render the fuel volatile enough to reach lower flammability limit, or. where the detection system would permit a rate of temperature rise before extinguishing the fire which would cause the fuel to reach lower flammability level,

then the design concentration shall be the inerting design concentration applicable to the specific fuel contained in the protected space. Where flammable liquids cannot cause reflash or explosion, the design concentration shall be the flame extinguishing design concentration.

Inert Gas Agent minimum design concentrations for different classes of fire shall be as follows. unless otherwise stated in the Departmental Supplementary Specification:

Class A surface fires:	37.5%
Class A deep seated fires:	As tested in accordance with NFPA 2001
Class B flammable liquids - flame extinguishing concentrations:	
Acetone	In accordance with NFPA 2001
Heptane	In accordance with NFPA 2001
Methane	In accordance with NFPA 2001
Propane	In accordance with NFPA 2001
Other .	As tested in accordance with NFPA 2001 or by an IS09001 supplier
Class B flammable liquids - inerting concentrations:	
Methane	In accordance with NFPA 2001
Propane	In accordance with NFPA 2001
Other	As tested in accordance with NFPA 2001.or by an IS09001 supplier
Class C energised electrical equipment fires:	37.5%

Where any hazard contains a combination of Class B flammable liquid fuels, then the Inert Gas Agent protection system shall be designed for the fuel rendering the highest design concentration, unless the actual mixture has been tested in accordance with NFPA 2001.

For Class B flammable liquid fuels not listed above, the following shall apply:

- Flame extinguishing design concentration shall be the actual flame extinguishing concentration, obtained from reliable cup burner tests by an approved body to NFPA 2001. plus a 20% safety factor, all in accordance with NFPA 2001. Where reliable cup burner test data is not available, actual flame extinguishing concentrations obtained by means of full scale testing may be substituted. Such full scale testing shall be performed by an approved body, and as a minimum be in accordance with the fire test requirements of US Underwriters Laboratory UL1058 - Standard for Safety Halogenated Agent Extinguishing System Units - or other equivalent approved testing standard.
- Inerting design concentration shall be the actual inerting concentration obtained from testing plus a 10% safety factor. Testing of inerting concentration shall be performed by an approved body. and shall be in accordance with the enclosed sphere explosion testing procedure for inerting concentration prescribed in NFPA 2001, or other equivalent procedure.

2.4.5 Design Concentration Tolerance

The Contractor shall make provision in his design so that actual concentration of Inert Gas Agent during and after agent discharge in every protected space is within the following performance tolerances, unless otherwise stated in the Departmental Supplementary Specification:

- Normally unoccupied spaces - Inert Gas Agent concentration within ±5% of design
- Normally occupied spaces, which would under normal circumstances be evacuated before discharge - Inert Gas Agent concentration within ±5% of design, with maximum concentration not exceeding 52%, corresponding to the Lowest Observable Adverse Effect Level in accordance with NFPA2001. unless otherwise specified in the Department's Supplementary Specification
- Normally occupied spaces, which may under normal circumstances not be evacuated before or during discharge - Inert Gas Agent concentration within ±5% of design, with maximum concentration not exceeding 42.8%, corresponding to the No Observable Adverse Effect Level in accordance with NFPA2001. unless otherwise specified in the Department's Supplementary Specification

2.4.6 Discharge Time

The Inert Gas Agent distribution system shall be designed to achieve discharge of not less than 95% of-the total quantity of extinguishing agent in 60 seconds (slowest allowable discharge), but not more than 95% of the agent in 40 seconds (quickest allowable discharge).

2.4.7 Discharge Pressure and Pipe Specification

The Contractor shall perform a complete design calculation of distribution system parameters on both balanced and unbalanced systems, single zone or multi-zone installations, such as (among others):

- Manifold flow and maximum pressure.
- Pressure drop across main orifice.
- Actual branch flow rates.
- Actual maximum branch pressure.
- Actual nozzle flow and terminal pressure.
- Actual flooding factor (concentration) for every protected zone.
- Exact pipe and nozzle sizes, as well as nozzle orifice codes.
- Actual discharge time.

The Contractor shall verify that the pipe specifications per clauses 4.4 and 4.6 of this document are applicable for the pressures anticipated during a discharge of Inert Gas Agent. The Contractor shall assume maximum agent pressure for pipe design purposes, i.e. storage at elevated temperature (55°C per NFPA 2001), which is in excess of normal agent pressure at 21°C.

Any Inert Gas Agent distribution system shall be designed such that pressure downstream of main orifice does not exceed 80Bar, unless specifically indicated otherwise in the Department's Supplementary Specification. Where deviation from this rule is indicated, then the Contractor shall include in his detail design respecification of piping material and standard by a competent individual, and in accordance with the guidelines and requirements of NFPA 2001.

Regardless of actual discharge pressures, any piping used in an Inert Gas Agent distribution system shall have a minimum rating in excess of 69Bar, as required in NFPA2001.

2.4.8 Venting of Space Overpressure

The envelope of all protected spaces shall be assumed airtight for design purposes. Where there are known penetrations in the envelope, these will be specifically mentioned in the Supplementary Specification.

The Contractor shall during his detail design evaluate the airtightness of every space envelope. He shall calculate the vented area required to limit overpressure at any stage during an Inert Gas Agent discharge to 50Pa. specify an overpressure opening size. and supply a suitable overpressure venting louvre to be built in by others.

2.4.9 Provision for Standby Inert Gas Agent

If specified in the Supplementary Specification, a supply of standby Inert Gas Agent shall be provided for. Unless otherwise specified, such standby supply shall be permanently piped to the distribution system in accordance with the requirements of the Inert Gas Agent equipment manufacturer, and check valves shall be employed to avoid back pressure actuation of the standby cylinders during normal discharge.

The capacity of the standby supply shall be sufficient for the greatest single risk or group of risks to be protected at any one time. or as otherwise specified in the Supplementary Specification.

2.4.10 Zoned Discharge

Refer to clauses 2.4.3, 4.6.4. 4.6.5. and 4.6.7 of this document.

Zoned discharge shall only be allowable if specifically required in the Supplementary Specification, and shall not be allowable in a distribution system feeding an occupied space unless specifically requested in the Supplementary Specification. Under such circumstances. zoned discharge shall only be allowed if there is no possibility of exceeding maximum design concentration (42,8%) for occupied spaces. This requires, as a minimum guideline, that:

- The installation must incorporate metered discharge, i.e. actuation must be limited only to the number of cylinders required to attain design concentration in any particular space.
- Where an installation incorporates unmetered discharge, i.e. where all cylinders in an installation are discharged at once, any occupied spaces must be either the largest zones. or that occupied spaces be of exactly equal volume after structural allowance, volume reductions, etc.
- Where occupied spaces in an unmetered system are not the largest, the distribution system to such occupied spaces be fitted with waste nozzles to divert excess extinguishing gas outside the space.

Zoned discharge shall be arranged as shown in clauses 6.2 or 6.3 of this document.

2.5 REMEASUREMENT OF SPACES

The Contractor shall remeasure every space fitted with an Inert Gas Agent protection system prior to installation and commissioning of the system, and he shall not proceed with manufacture or installation until such time as he has confirmed in writing to the Department or Engineer that he has found the protected spaces to be in accordance with his approved design.

If at any stage during installation or commissioning periods, any protected space is changed, resulting in a space which does not conform to the approved design, be it with regard to room dimensions, vented area, volume reductions, etc. the Contractor shall inform the Engineer, and upon instruction, he shall without delay make the required alterations to the installation to comply with all aspects relating to the extinguishing gas requirements.

At first delivery, the Contractor shall confirm in writing to the Department or Engineer that every protected space has been remeasured. and found to be in accordance with the approved design. First delivery shall not be accepted without this written confirmation.

2.5.1 Uncloseable Openings

Where the envelope of any protected space includes uncloseable openings, e.g. open

gullies. chimneys, etc., such uncloseable openings will be listed in the Supplementary Specification. Upon taking up his detail design, the Contractor shall perform an inspection of any existing buildings, and survey the latest available architectural drawings to verify that there are no additional uncloseable openings.

The Contractor shall include adequate measures to ensure design concentration of Inert Gas Agent in such spaces. These measures shall be described in his detail design documentation submitted to the Department or Engineer.

Where screening nozzles are employed, the quantities of Inert Gas Agent required for such protection shall be in addition to the normal requirements for total flooding.

3. SECTION 3: GENERAL TECHNICAL REQUIREMENTS

3.1 ERECTION OF EQUIPMENT

Tenderers shal! allow for a complete installation, including provision of mobile cranes, air compressors, lifting and rigging tackle, measuring equipment, precision levels, and all other special or regular tools and equipment that may be needed to complete the entire installation in accordance with the specification, and to the satisfaction of the Department.

The Contractor shall be held responsible for any damage caused to building, equipment, etc. during the course of the erection of this equipment.

All distribution piping and fittings shall be installed in accordance with good commercial practice and the piping layout shall be such as to reduce frictional losses to a reasonable minimum. Care shall be taken to avoid possible restriction due to foreign matter and faulty fabrication.

3.2 CLEARANCES

All pipe runs and system components shall be so located so as to maintain a minimum clearance of 200mm from electrical conduiting or equipment, unless greater clearance is indicated in the Supplementary Specification or on Departmental drawings.

3.3 EQUIPMENT FIXING

The Contractor shall be responsible for the supply of all necessary anchor bolts or studs for fixing down of any equipment supplied by him.

Where equipment is to be bolted down on concrete plinths, anchor studs shall preferably be cast into concrete bases. In such instances, the thread of the anchor studs shall be suitably protected to readily facilitate repeated disassembly of fixing assemblies.

Where equipment is to be fixed to concrete or brickwork surfaces, and where building or casting in is not feasible or desirable, fixing shall be by means of approved expansion type anchor bolts. Due care shall be taken to ensure adequate penetration of any expansion bolt, to eliminate surface damage.

All pipelines shall be firmly bracketed to walls and ceilings to the satisfaction of the Department. Any piping system shall be securely supported with due allowance for expansion and contraction and shall not be subject to possible damage.

3.4 ASSEMBLY OF EQUIPMENT

The Contractor shall supply all bolts, fasteners, fittings, braces, supports, packings, gaskets, etc. necessary for assembling all equipment supplied by him. All such items required for assembly shall be supplied by the manufacturer of the Inert Gas Agent equipment, or alternatively approved by the manufacturer.

Assembly of equipment shall be done in accordance with the requirements of the Inert Gas Agent equipment manufacturer. Assemblies shall be neat and in accordance with the Department's requirements regarding quality of workmanship.

All pipe ends shall be reamed clean of any burrs before assembly. Contractors shall physically check the inner diametral tolerance of particularly smaller pipe sizes for conformity with the prescribed specification.

Contractors are advised to blow through all distribution pipework and nozzles to ensure that no blockages exist, prior to performing the full discharge test.

3.5 WELDING

Only coded welders in posession of a valid, approved certificate of competency shall be employed. The Contractor shall submit copies of the certificates of every coded welder employed to do welding on an Inert Gas Agent installation. Any welding shall be carried out in accordance with the current edition of SABS 044 Parts I to VII as applicable.

All welding shall be free from porosity, cavities and entrapped slag, and shall show proper fusion. Any joints in a weld run shall be smooth with no pronounced hump or crater in the weld surface. No grinding of any nature on welding shall be accepted.

The profile of the weld shall be uniform, of approximately equal leg length and free from overlap at the toe of the weld. Unless otherwise specified the surface shall be either flat or slightly convex in the case of fillet welds and with reinforcement of not more that 3mm in the case of butt welds. The weld face shall be uniform in appearance throughout its length.

Filler metal electrodes shall be of an approved type for the material being used and shall be kept in a dry condition. All electrodes shall conform to SABS 455.

3.6 PAINTING

The entire installation, other than brass cylinder valves or diverting valves, braided hose and associated couplings, brass nozzles, etc. shall be painted, unless otherwise specified in the Supplementary Specification.

Before any painting is applied, the surfaces shall be prepared in accordance with SABS 064. Code for Preparation of Steel Surfaces for Painting. All surfaces shall be moisture free, degreased and otherwise clean, and properly prepared.

All black piping, flat iron, angle iron. rods. etc. for supports, brackets, frames, etc, shall be painted on all sided with a red oxide primer to SABS standard, followed by two finishing coats of enamel paint to SABS 630 Grade 1.

All Inert Gas Agent equipment, with exception of those not to be painted, or items such as storage cylinders with manufacturer's painted finish, shall be painted in SABS C34 - Light Stone, in accordance with SABS 0140-3. All Inert Gas Agent distribution piping shall be labelled as "INERT GAS AGENT" in SABS A11 - Signal Red where any pipework enters or leaves a space. at no less than 3 metre intervals.

Name plates, labels, and notices on equipment shall not be painted, and be suitably masked to avoid overruns. Painted surfaces on proprietary manufactured items shall be adequately protected. Equipment on which the paintwork has been damaged during installation shall be repainted before first delivery of the installation.

During painting, the Contractor shall ensure that all the necessary fire prevention and fire fighting precautions have been taken.

3.7 ELECTRICAL EQUIPMENT & INSTALLATION

Supply and chasing of conduiting shall be included in the Contractors scope of works, unless specifically indicated as otherwise in the Supplementary Specification.

3.7.1 Cabling

Refer to F.P.O./82/5E - Standard Technical Specification for an Automatic Fire Alarm System -latest edition.

3.8 PIPE AND EQUIPMENT ANCHORING

Proper provisions shall be made in the fixing of all equipment to eliminate excessive transmission of vibration or noise to walls, etc. during discharge. All piping shall be supported at adequate intervals so as to eliminate generation of standing vibration or movement of any part of the installation during an Inert Gas Agent discharge.

4. SECTION 4: TECHNICAL REQUIREMENTS - EQUIPMENT & MATERIALS

4.1 GENERAL

4.1.1 Equipment Design and Manufacture

Refer to clause 1.3 of this document. All Inert Gas Agent equipment shall fully comply with these requirements.

All equipment shall be designed for the service they will encounter and shall not be readily rendered inoperative or susceptible to accidental operation. Equipment shall be normally designed to function properly from -10°C to 45°C or marked to indicate temperature limits. A tenderer offering equipment not suitable for this duty shall list such equipment as a tender deviation.

All equipment shall be located, installed and protected such that they will not be subject to mechanical, chemical, or other damage which would render them inoperative

4.2 INERT GAS AGENT STORAGE CYLINDERS

4.2.1 Cylinder Construction & Compliance

Any Clean Agent Inert Gas Agent storage cylinder shall be compliant with the requirements of the Occupational Health and Safety Act as amended, and shall further be designed and manufactured in accordance with a design code acceptable to the Department of Public Works. Every Inert Gas Agent storage cylinder shall be individually stamped with a unique serial number.

The Contractor shall provide written proof of compliance with such design code by the manufacturer.

All Inert Gas Agent storage cylinders shall be supplied new. and all cylinders forming part of an Inert Gas Agent installation shall be of identical size and design, and interchangeable without any modification whatsoever.

4.2.2 Submittal of Pressure Vessel Test Certificates

The Contractor shall submit test certificates for each and every storage cylinder before bringing them onto site. Where no certificates have been issued, the Contractor shall submit a list of cylinders, including manufacturer, serial number, and the date and test pressure of the latest hydrostatic test stamped on every cylinder.

4.2.3 Cylinder Shipping

Cylinder shipping shall be in accordance with the design code of the cylinders.

Storage cylinders shall be shipped fully charged, and with an approved protective cap over the Inert Gas Agent cylinder valve. Protective caps shall be removed only once cylinders have been finally bracketed into position.

Any Inert Gas Agent cylinder found, by the Engineer or any representative of the Department without a properly mounted valve cap. and which is not fixed into final position, shall be rejected by the Department, and replaced at his own expense by the Contractor.

4.2.4 Cylinder Charge

Charging of any Inert Gas Agent cylinder shall be done by a certified organisation, which carries the approval of the Inert Gas Agent equipment manufacturer or supplier.

The Contractor shall hand over a charging certificate for every charged cylinder before commissioning commences, which confirms that charge composition is within the allowable

tolerance. The charging certificate shall indicate the cylinder serial number, date of charge, location where charged, and charge contents.

4.2.5 Cylinder Installation & Bracketing

Storage cylinders shall be installed in banks:

- not exceeding three rows in depth, where clear access is limited to one side of the bank.
- not more than six rows deep, where clear access is available from both sides of the bank.

All cylinders shall be securely positioned by means of a rigid bracketing assembly, which eliminates any lateral movement of cylinders after installation.

Where cylinder banks are arranged against walls, provided that such walls shall be at least half brick masonry walls or heavier, the bracketing arrangement shall be securely anchored to the wall by means of expansion bolts of adequate size. penetration, and at intervals not exceeding 900mm.

Where cylinder banks are free standing, or walls are of construction which does not allow wall mounting, the bracketing arrangement shall be securely anchored to the floor by means of sectional steel channel with flanged support feet to take expansion bolts. Such expansion bolts shall be no less than M12x100. or as otherwise detailed in the Supplementary Specification.

4.2.6 Cylinder Enclosures

Inert Gas Agent storage cylinder banks, or single cylinders, shall be enclosed in lockable steel enclosures unless installed in dedicated, lockable rooms to which access can be limited to fire protection personnel.

Enclosures shall be brickwork enclosures as detailed in the Supplementary Specification, or constructed out of heavy sectional steel frame with expanded metal panels. Unless otherwise specified, enclosures shall be painted.

4.2.7 Pressure Testing Devices

Every Inert Gas Agent installation shall be supplied with pressure gauges on each and every cylinder. Pressure gauges shall indicate a green zone of pressures, which are acceptable, a red overpressure zone, and a yellow underpressure zone.

Every Inert Gas Agent installation shall be supplied with at least two removable pressure gauges indicating Bar pressure, and suitable for taking readings from the pressure port on every cylinder valve.

4.3 INERT GAS AGENT CYLINDER VALVES .

4.3.1 Valve Construction

Inert Gas Agent cylinder valve bodies and components shall be manufactured from brass; either die cast or machined from solid stock.

Every valve shall include the following features:

- Threaded neck matching storage cylinder.
- Threaded discharge port.
- Threaded back pressure actuation port if not incorporated into discharge port.
- Threaded fill & test port with check valve.
- Frangible safety disc.

The release mechanism employed shall hold the cylinder valve in the closed position and shall be designed to hold the valve opening devices firmly in the readiness position at all

times without the risk of metal fatigue or accidental operation through vibration or jarring, yet be sensitive to be instantly tripped by either manual or automatic operation as required, without undue force.

Inert Gas Agent cylinder valves shall be suitable for. electric solenoid or mechanical actuation. An adequate and reliable source of energy shall be used. NO DETONATORS SHALL BE ACCEPTABLE.

Valves shall be guaranteed to be leak proof for 5 years after handover. The Contractor shall hand over a certificate of guarantee from either manufacturer or supplier at the time of first delivery.

4.3.2 Electric Solenoid Valve Actuation

All Inert Gas Agent installations shall be discharged via electric solenoid actuation by a detection system, unless otherwise specified in the Supplementary Specification.

Electric actuation of Inert Gas Agent cylinder valves shall be accomplished by means of one of the following methods:

- Pre-discharge of Inert Gas Agent from the cylinder itself into the back-pressure actuation port of the cylinder valve.
- Direct solenoid actuation of plunger acting on main valve seat.

Solenoid input shall be 24V DC.

4.3.3 Manual Valve Actuation

Manual discharge of Inert Gas Agent installations shall be included only if requested in the Supplementary Specification.

Manual actuation shall be accomplished by cammed lever actuation of a direct acting plunger configured to lift the main seal off its seat. The assembly shall be configured such that the lever is locked in the open position once the system has been actuated, and shall be fitted with a removable locking pin tethered to the body of the mechanism with steel rope or chain.

Manual control for actuating discharge of Inert Gas Agent shall be located so as to be conveniently and easily accessible at all times, including time of fire. Such control shall cause the complete system to operate as for the normal automatic mode.

Any manual actuation arrangement shall be in accordance with the Inert Gas Agent equipment manufacturer's requirements, and to the satisfaction of the Department.

4.4 INERT GAS AGENT MANIFOLDS

For the purpose of this specification, a manifold shall be considered to be the common distribution header upstream of the main discharge orifice, to which storage cylinder hoses and other ancillary items of equipment are connected.

4.4.1 Manifold Construction

Inert Gas Agent manifolds shall be of welded construction throughout. Where sections of manifold need to be joined, these joints shall be flanged and bolted.

Threaded connections to cylinder hoses or ancillary equipment such as air vents, etc, shall be in the form of sockets welded to the manifold. No other threaded connections shall be acceptable.

Manifolds shall be single continuous manifolds or sectional flanged manifolds.

Manifolds shall be either manufactured by the IS09001 certified manufacturer of the Inert Gas Agent equipment, or fabricated by the Contractor.

Manifolds manufactured by Inert Gas Agent equipment manufacturers shall be certified suitable and tested by them. No manifold may be fabricated on site, or welded on site after pressure testing is complete.

Manifolds fabricated by Contractors shall be constructed of welded seamless carbon steel pipe to ASTM A106 Grade B (latest edition). Manifolds in 150Bar systems shall be fabricated from Schedule 80 piping. Any higher-pressure manifolds shall be fabricated from at least Schedule 160 piping. Such piping shall under no circumstances be bent or otherwise deformed, whether by hot or cold working. The Contractor shall hand over to the Department or Engineer certificates verifying the standard and grade of piping purchased.

All pipe fittings such as elbows, Tees. etc, shall be socket weld forged steel fittings to ANSI B16.11 Class 3000lb (latest edition). All threaded connections such as hose sockets shall conform to ANSI B1.20.1 (latest edition).

4.4.2 Welding

All welding on an Inert Gas Agent manifold shall conform to SABS 044. performed by coded welders, and preferably machine welded. Suitable approved electrodes shall be used.

The Department of Public Work retains the right to inspect, at any stage of manufacture, the welds on any manifold. This right of inspection, whether exercised or not, shall not in any way detract from the right of the Department to reject inferior equipment at any stage.

Where the Department, at its sole discretion, feels that welds may be of inferior quality, it may require of the Contractor that he performs or have performed X-ray testing of such welds, at the Contractor's expense.

4.4.3 Flexible Connection Hoses

Flexible connection hoses shall consist of flexible, steel reinforced hose. with swaged-on threaded connectors on either end. and shall incorporate a check valve to prevent agent loss in case of a discharge with any cylinder disconnected from the hose for any reason.

Flexible hoses shall be individually pressure tested before installation. Thereafter, flexible hoses shall be individually pressure tested at 5 year intervals, in accordance with NFPA2001. Contractors shall specifically include this requirement in the operating manuals.

4.4.4 Venting Requirements

In cases where a manifold or sections of manifold can be isolated from the open distribution system in such a manner as to allow pressure buildup inside such isolated sections, then every such isolated section shall be fitted with a vent plug.

Vent plugs shall be capable of venting gas resulting from leakage past cylinder valves, check valves, directional valves, or other, from the manifold to avoid buildup of pressure over prolonged periods. These vents shall close upon full discharge, eliminating loss of discharge gas through the vent.

4.4.5 Pressure Testing

All manifolds, sections of manifold, flexible connection hoses, and items of ancillary equipment open to manifold pressure shall be hydrostatically pressure tested to $1^{1/2}$ times normal working pressure.

All equipment supplied by IS09001 certified manufacturers or distributors shall be pressure tested by such manufacturer or distributor, and certificates from the manufacturer shall be handed over to the Department or Engineer.

Any equipment not tested by an IS09001 certified manufacturer or distributor, shall be inspected and pressure tested by a third party inspection authority, which carries the

approval of the Department of Labour, as part of the Contractor's scope of works.

Pressure test certificates shall be submitted before any equipment requiring pressure testing is brought onto site.

4.5 INERT GAS AGENT MAIN ORIFICE

Any Inert Gas Agent main orifice shall be either a clamped plate orifice or configured as a nipple. and connected on the upstream side to the manifold, and on the downstream side to the distribution pipe system. Contractors shall ensure that the orifice is installed for the right direction of flow.

All main orifices shall be supplied by the IS09001 certified manufacturer of the Inert Gas Agent equipment. No Contractor or other party shall under any circumstance be allowed to perform any drilling, machining, or other work or modification on an orifice assembly.

Any main orifice shall be certified by its manufacturer as suitable for the application intended. and a certificate to this end handed over to the Department or Engineer.

The main orifice shall be positively anchored to the building structure, in accordance with requirements of the equipment manufacturer, and to the satisfaction of the Department, to avoid pipe movement during discharge. The Contractor shall specifically detail his main orifice fixing arrangement on his drawing submittals for approval by the Department

4.5.1 Main Orifice Union

An orifice union shall incorporate a stainless steel orifice plate clamped between bolted clamping flanges or inside a threaded union. The orifice opening shall be drilled by the manufacturer, and the opening size clearly and indelibly stamped on the orifice assembly.

4.5.2 Main Orifice Nipple

An orifice nipple shall be brass construction, with center hex for assembly purposes. The orifice opening shall be drilled by the manufacturer, and the opening size clearly and indelibly stamped on the body of the nipple.

4.6 INERT GAS AGENT DISTRIBUTION SYSTEMS

For the purpose of this specification, an Inert Gas Agent distribution system shall be considered to be the entire distribution pipe system downstream of the main orifice, inclusive of all other ancillary items of equipment connected to it.

4.6.1 Distribution Piping Downstream of Main Orifice

All distribution piping shall be Schedule 40 seamless carbon steel pipe to ASTM A106 Grade B (latest edition). Distribution piping shall under no circumstances be bent or otherwise deformed, whether by hot or cold working. The Contractor shall hand over to the Department or Engineer certificates verifying the standard and grade of piping purchased.

All pipe fittings such as elbows, tees, etc. shall be forged steel fittings to ANSI B16.11 Class 3000lb (latest edition). All pipe flanges shall be steel flanges to ANSI B16.5 Class 600lb (latest edition). All threaded connections shall confirm to ANSI B1.20.1 (latest edition).

All distribution pipe and fittings of 065mm (2% inch) and smaller shall be threaded. Pipe fittings of 080mm (3 inch) and over shall be welded. No distribution pipe shall be sized larger than 0200mm (8 inch).

Distribution piping downstream of the main orifice shall be tested to *V/i* times full working pressure (120Bar) for 4 hours after assembly of the pipework, prior to installation of nozzles and venting fittings.

Distribution pipe shall continue in line with the main orifice for at least 10 pipe diameters

before any fittings or change in direction to allow flow stabilization.

4.6.2 Pipe Support and Fixing

Piping shall be hung by means of pipe hangers of appropriate dimensions as indicated in the Supplementary Specification, or as detailed on drawing. Floor support shall be heavy gauge mounting channel of minimum 2.0mm material thickness with appropriate pipe saddles of approved manufacture.

Maximum hanger spans shall be as follow:

Pipe Diameter	Maximum Span
<25mm	1.5m
<40mm	2.5m
< 65mm	3.0m
>65mm	3.5m

Hanger rod diameters shall be as follows:

Pipe Diameter	Hanger Rod Diameter
<40mm	? 8mm
40 - 80mm	? 10mm

Hanger rod lengths shall be kept as short as possible to facilitate rigid mounting. Where long hanger rods are unavoidable, then hanger rod diameter shall be increased to a suitable dimension, and additional lateral bracing of pipe runs shall be allowed for as part of the scope of works.

Floor or wall mounted pipes shall be mounted as follows

Pipe Diameter	Maximum Span
<25mm	1.5m
<40mm	2.5m
< 65mm	3.0m
>65mm	3.5m

All distribution piping shall be laterally braced to prevent lateral deflection under discharge conditions.

4.6.3 Cleaning of Piping

All piping shall be externally degreased and blown through before discharge nozzles are installed. The Contractor shall ensure that no metal filings or other matter able to block orifices or nozzles are left behind in piping after installation.

4.6.4 Directional Valves

Directional valves, as supplied by the certified manufacturer of the Inert Gas Agent equipment. shall be installed if requested in the Supplementary Specification.

The design of any directional valve shall allow removal of each valve from its pipeline without having to dismantle the line. The directional valves shall be of a straight through type and shall open fully within a 90° spindle movement.

Directional valves shall always be installed after a main orifice. Where system layout is such that directional valves are normally closed, the directional valves used shall be rated and tested to full system storage pressure. Where low pressure rated directional valves are used, these shall be rated for working pressure of no less than 80Bar, and tested to no less than 120Bar, unless otherwise specified in the Supplementary Specification.

Where high pressure rated directional valves are used. the manual or automatic operation of the Inert Gas Agent installation shall drive open the particular directional valve serving the hazard to be flooded, immediately prior to the release of gas. Where low pressure rated directional valves are used. these shall always be configured normally open. with valves to zones not requiring flooding driven closed immediately prior to discharge.

4.6.5 Check Valves

Check valves shall be as per the specification of the certified manufacturer of the Inert Gas Agent equipment.

4.6.6 Discharge Nozzles

Discharge nozzles shall be as supplied by the certified manufacturer of the Inert Gas Agent equipment, and shall be of adequate strength for use with the expected working pressures, able to resist normal mechanical damage, and constructed to withstand expected temperatures without deformation.

Discharge nozzles shall be brass with male threaded connections to ANSI B 1.20.1. and compatible with the pipe thread being used. The Contractor shall individually ensure that the thread on each and every nozzle matches pipe thread before commissioning.

Sufficient discharge nozzles shall incorporate frangible disc safety devices to limit pressure to 100Bar (1450psi), or other pressure indicated by the Inert Gas Agent equipment manufacturer, or alternatively separate rupture disk fittings shall be employed. These safety discs shall be designed to fracture in controlled manner without separating completely from the body of the nozzle or fitting to avoid possible injury.

All discharge nozzle orifices shall be pre-drilled by the certified manufactured of the Inert Gas Agent equipment, and the equivalent single orifice size clearly and indelibly stamped on the nozzle body, regardless of shape and number of orifices. This equivalent size shall refer to the size of standard single orifice type with rounded entry and a coefficient of discharge of not less than 0.98, having the same flow rate as the nozzle in question. No Contractor or any other party shall under any circumstance be allowed to modify in any way any pre-drilled nozzle orifice.

Where possible, a minimum of two nozzles shall be provided in every protected space, or any part or subdivision separated from the main part of the protected space by any physical barrier, such as access flooring or ceiling. Single nozzles shall only be used in spaces too small to accommodate two nozzles. Where single nozzles are installed, blind elbows shall be fitted.

All discharge nozzles shall be located to achieve the best results and shall be selected and so positioned that the discharge will not splash flammable liquids or create dust clouds that might spread a fire, create an explosion, or otherwise adversely affect the contents of the protected space. Nozzles vary in design and discharge characteristics and shall be selected on the basis of their suitability for the use intended.

Where any Inert Gas Agent nozzle is installed in dirty or dusty environment, it shall be fitted with a plastic protective cap, which shall be blown off on discharge of extinguishing gas without causing injury to anyone in its direct vicinity.

4.6.7 Venting of Pipework

All closed distribution pipework, ie. where directional valves, check valves, etc. have been employed, shall be ventilated by means of brass ventilation orifices of 00.4mm. or as

otherwise specified by the certified manufacturer of the Inert Gas Agent equipment. Such ventilation orifices shall nevertheless not be of any size that will cause noticeable leakage of extinguishing agent during discharge.

4.7 INERT GAS AGENT FIRE DETECTION & ACTUATION SYSTEMS

Refer to clause 2.4.3 of this document.

Every Inert Gas Agent installation shall incorporate an automatic fire detection system in accordance with F.P.O./82/5E - Standard Technical Specification for an Automatic Fire Alarm System.

Such fire detection system shall be an automatic fire detection system by an approved manufacturer, or as otherwise specified in the Supplementary Specification.

Inert Gas Agent fire detection systems may be either conventional or analog addressable. however:

- The function of any fire panel shall be limited to the conveyance of first and second knocks only to one or more gas control units.
- Monitoring of door status, alarm outputs etc. shall be gas control unit functions.
- The intelligence to actuate gas discharge based on 1st & 2nd knock status, door lock status, auto/manual/reset, etc. shall reside in the gas control unit.
- Every protected space shall be equipped with a single, unique gas control unit, which shall be mounted next to the main entrance door to the space. In cases where more doors allow access to a protected space, these entrances shall be fitted with either remote or status panels, as required in the Supplementary Specification.

4.7.1 Fire Detection Panel

Every Inert Gas Agent fire detection system shall incorporate at least one fire panel. All fire detectors and field devices, with the exception of monitored doorlocks, doorclosers, alarm devices associated with protected spaces, and gas actuation hardware shall be wired back to the fire panel/s.

Any conventional fire detection control panel shall support the following features:

- Every protected space shall be covered by at least two unique, independent detector circuits - these circuits shall not be used in any other protected space.
- Fire divisions in a protected space may be served by the same detector circuits.
- Every detector circuit shall contain at least two detectors per fire division.
- The panel shall be programmable to generate first knock on activation of any one detection device on any circuit, and second knock on activation of a detection device on another detector circuit in that protected space.
- Communication of 1st and 2nd knocks in any protected space shall be via distinct, separate digital outputs hardwired to the gas control unit for that particular space.
- The panel shall have at least two alarm output loops, and shall have adequate input/output capacity to allow all devices, interlocks and outputs required by the Supplementary Specification.

Any addressable fire detection control panel shall support the following features:

- Every fire division shall be covered by at least two independent addressable fire detectors. which may be on the same single circuit.
- All addressable detectors shall be logically linked to allow gas discharge zoning.
- The panel shall be programmable to generate first knock on activation of any single detection device in a protected space, and second knock on activation of any other detection device in the same protected space.
- Communication of 1 st and 2nd knocks in any protected space shall be via distinct output calls addressed to the gas control unit for that particular space.

? The panel shall have at least two alarm output loops, and shall have adequate input/output capacity to allow all devices, interlocks and outputs equired by the Supplementary Specification.

A detection device shall be interpreted to be:

? Any single smoke or heat detector
? Any manual call point other than the inegrated dual action call point on a gas control unit or remote panel - see clauses 4.7.2 & 4.7.3.
? Any other device specified in the Supplementary Specification.

4.7.2 Gas Control Unit

Unless otherwise specified in the Supplementary Specification, any gas control unit installed as part of an Inert Gas Agent installation shall incorporate the following:

? Dual LED's indicating automatic control of the detection system.-
? Dual LED's indicating manual control of the detection system.
? Dual LED's indicating gas isolation.
? Dual LED's indicating gas discharge activated (count-down timer).
? Dual LED's indicating fault condition.
? Key switch to select manual or automatic control of the gas control unit. The key shall be captive in the automatic position, and permanently tethered by means of a cord or chain.
? Key switch to select gas isolation. The key shall be captive in the gas isolation mode position, and permanently tethered by means of a cord or chain.
? Buzzer indicating violation of access door lock status or state of closure.
? Lamp test facility.
? Hardwired input for gas pressure switch for fault indication.
? Hardwired input for monitoring doorlocks.
? Manual dual action callpoint for manual discharge.
? Alarm outputs to alarm bells, sirens, strobes, and illuminated evacuation signage.
? Gas discharge activation timer capable of at least 60-second delay.

In automatic mode, the gas control unit shall automatically initiate gas discharge on the second knock, activate alarms, etc. In manual mode, the gas control unit will sound all alarms, but fail to discharge gas. In manual mode, gas discharge shall only be possible via the dual-action manual call point. Any switching between manual and automatic modes shall not reset knock and alarm status of the gas control unit.

Selection of gas isolation mode shall result in isolation of the physical hardwired outputs to gas actuation solenoid, as well as resetting of all gas control unit knock and alarm statuses.

The power supply and battery serving every gas control unit shall specifically be rated for the maximum inrush current of the electric gas discharge actuator solenoid.

4.7.3 Gas Remote Panel

Gas remote panels shall be mounted adjacent to secondary entrances to a protected space, as specified in the Supplementary Specification. Unless otherwise specified in the Supplementary Specification, any gas remote panel installed as part of an Inert Gas Agent installation shall incorporate the following:

? Dual LED's indicating automatic control of the detection system.
? Dual LED's indicating manual control of the detection system.
? Dual LED's indicating gas isolation.
? Dual LED's indicating gas discharge activated (count-down timer).
? Dual LED's indicating fault condition.
? Buzzer indicating violation of access door lock status or state of closure.
? Lamp test facility.
? Hardwired status feedback from gas control unit.

? Manual dual action callpoint for manual discharge.

Gas remote panel shall be wired back to gas control unit to mimic exactly all knock and alarm and operational statuses, and the manual callpoint shall allow manual gas discharge activation when in manual mode.

4.7.4 Gas Status Panel

Gas status panels shall be mounted adjacent to secondary entrances to a protected space, or any other location as indicated in the Supplementary Specification. Unless otherwise specified in the Supplementary Specification, any gas status panel installed as part of an Inert Gas Agent installation shall incorporate the following:

? Dual LED's indicating automatic control of the detection system.
? Dual LED's indicating manual control of the detection system.
? Dual LED's indicating gas isolation.
? Dual LED's indicating gas discharge activated (count-down timer).
? Dual LED's indicating fault condition.
? Buzzer indicating violation of access door lock status or state of closure.
? Lamp test facility.
? Hardwired status feedback from gas control unit.

Gas remote panel shall be wired back to gas control unit to mimic exactly all knock, alarm and operational statuses. No manual gas discharge activation shall be possible from a status panel.

4.7.5 Fire Detection Logic

The fire detection system shall be programmed to a double knock arrangement as follows:

First Knock:
Upon activation of any single detection device, as described in 4.7.1 above, the fire detection system shall:

? Activate alarm bells.
? Activate flashing Warning/Evacuation signage.
? Flash fire condition on relevant detector loop indicator on fire panel - this will change to steady light upon alarm acceptance.

Cancellation of evacuation tones shall be carried out via the gas control unit reset. On recurrence of activation the evacuation shall proceed again as before.

Second Knock:
Upon activation of any second detection device, the fire panel shall:

? Silence alarm bells
? Activate sirens inside and outside protected space.
? Activate strobes inside and outside protected space.
? Re-activate fire panel whistle alarm.
? Flash system activated on status panels.
? Light Warning/Evacuate signage (steady)
? Activate door closers.
? Fire signals to A/C & building electrical supplies.
? Initialise discharge timer on 60 seconds, or other interval specified in Supplementary Specification.

4.7.6 Audible and Visual Alarms

Bell alarms shall be 150mm in diameter and. unless specified otherwise in the Supplementary Specification, one bell alarm shall be installed in each protected space.

Sirens shall be installed inside and outside each protected space. Sirens shall, unless otherwise specified in the Supplementary Specification, be rated for 100dBA at 1m and shall incorporate an output stepping down facility. Siren starting frequency shall be 100Hz and the higher stabilised frequency 300Hz. or as otherwise specified in the Supplementary Specification.

Buzzers on gas control, remote and status panels shall be suitable to maintain a sound level of 70dBAat3m.

4.7.7 Fire Interlocks

Any Inert Gas Agent installation shall be fire interlocked with both air conditioning, and electrical distribution systems of all protected spaces. Fire interlock signals shall be in the form of 24 Volt switched and fused output, configured to supply 24V under normal circumstances, and 0V in a fire situation. If the fire output from the fire panel is integrated into the panel in such a manner that any damage can result to the fire panel in case of short circuit or external overvoltage. then the fire output shall be fed through an external fused interposing relay.

4.8 DOORS AND DOOR EQUIPMENT

Unless otherwise specified in the Supplementary Specification doors shall be provided by others, but door locks and door closers, as specified in the Supplementary Specification, shall form part of the scope of works.

4.8.1 Door Locks

Door locks shall comply with the requirements, of the most recent issue of the Department's Standard Specification for Security Equipment. F.P.0.9E.

Any access door to an Inert Gas Agent protected space or zone shall be provided with a two-way monitored lock type PWD Sample 24MS as S300.3.1.b of F.P.0.9E. and an approved door closer that will automatically close the door prior to discharge.

Any escape door shall be fitted with an alarm escape lock type PWD Sample 127 as S300.3.1.C of F.P.0.9E.

Should access to a protected space be through another space which is already protected, then the aforementioned door shall be fitted with a lock set of type PWD Sample 24MS as S300.3.1.b of F.P.0.9E.

4.8.2 Door Closers

Door closers shall be supplied if required in the Supplementary Specification. Door closers shall comply with the requirements of the Department's Standard Specification for Security Equipment. F.P.0.9E (latest edition).

Any access door to an Inert Gas Agent protected space or zone shall be fitted with an approved door closer that will automatically close the door upon discharge. Door closers shall not be required on strongroom doors within a protected space.

Mechanically operated door selectors shall be fitted to all double doors.

Should access to a protected space be through another space which is already protected, then the aforementioned door shall be fitted with a door closer activated by either of the detection systems in the two zones.

4.8.3 Door Monitoring

Where three or more doors with locks that can be monitored, as PWD Samples 23. 24. and 127 are used, a monitoring panel shall be provided in accordance with clause S330 of the Department's Standard Specification for Security Equipment. F.P.0.9E.

Approved magnetic switch type door monitors shall be installed to monitor status of escape and access doors.

4.9 BREATHING APPARATUS

Every entrance to an Inert Gas Agent protected space shall be supplied with two independent sets of approved breathing apparatus comprising face mask and compressed air supply system (cylinder and pressure regulator). Any such breathing apparatus shall be suitable for at least 10 minutes continuous use.

Breathing apparatus shall be located inside a single lockable break glass metal box per entrance, or as otherwise indicated in the Supplementary Specification. Supply and installation of breathing apparatus and mounting box shall be included in the Contractor's scope of works.

4.10 CLOSING OF FIXED OPENINGS

4.10.1 Automatic Shutters

Automatic closing shutters shall be provided, as part of the Contractor's scope of works, at all fixed ventilation openings not connected to air conditioning or ventilation dueling. These shall close automatically by means of fire interlock or other approved method.

4.10.2 Asbestos Blankets

Approved asbestos blankets shall be provided, as part of the Contractor's scope of works, on the inside of all louvered doors or other openings that cannot be protected by automatic closing shutters or dampers. Such asbestos blankets shall adequately seal the ventilation openings.

The asbestos blankets shall normally be rolled up above the door opening, but shall drop down immediately by means of fire interlock or other approved method.

4.10.3 Dampers

Unless otherwise specified in the Supplementary Specification, dampers to all ventilation or air conditioning dueling entering or leaving a protected space shall be supplied and installed by others.

If the Supplementary Specification does require supply of these dampers, then they shall be spring loaded SABS approved 4 hour fire rated dampers with external reset linkages, and with 24V solenoid actuation. Such dampers shall close on a fire signal from the fire detection system.

Damper operation shall be powered from a properly sized independent power source, and shall not be able to interfere with operation of fire panel or gas control units. All necessary power supplies, batteries, relays, etc, shall be provided as part of this scope of works, regardless of the origin of dampers.

Where an air-conditioning unit serves only the protected space, such A/C system shall be switched off upon discharge or upon a fire signal from the fire detection system.

4.11 OPERATION INSTRUCTIONS AND SIGNAGE

Full operating instructions and block plan shall be provided for every Inert Gas Agent installation in the form of directions for use in English, framed and mounted under perspex in close proximity to the fire and status panels. All signage shall be included in the scope of works.

Signage shall specifically (but not exclusively) include:

? Flashing illuminated Warning/Evacuation signs on the inside and outside of every

entrance to any protected space.

- “Inert Gas Agent Protection" warning signs inside protected space.
- “Inert Gas Agent Protection" entrance warning signs.
- “Inert Gas Agent Protection" warnings in all adjacent spaces, as well as plant room.
- Notice warning occupants of expected results of discharge, namely noise, possible breathing difficulty, and possible danger for individuals with pacemakers.
- All safety signage associated with Inert Gas Agent installations that may be required by any applicable legislation or NFPA.

5. SECTION 5: COMMISSIONING & MAINTENANCE

5.1 PRE-COMMISSIONING REQUIREMENTS

The following pre-commissioning requirements shall be met before the Contractor proceeds with commissioning.

5.1.1 Pressure Testing

All pressure test certificates, by the Inert Gas Agent equipment manufacturer or third party inspector shall be handed over to the Department.

5.1.2 Submittal of Approval Certificates

All approval certificates shall be handed over to the Department, including:

- Designer certificate of competency.
- Approval by IS09001 certified manufacturer of detail design.
- Storage cylinder test certificates.
- Distribution manifold test certificate.
- Materials certificates.

5.2 COMMISSIONING AND FIRST DELIVERY

The proper operation of the installation shall be demonstrated to the Engineer and a representative of the Department.

Where tests are conducted over areas in excess of the limits of normal speech, the Contractor shall make available at least 4 two way radios for proper communication.

The Contractor shall bear the cost of all consumables, materials or extinguishant required for demonstration purposes.

5.2.1 Fire Detection and Actuation System

Operation of the fire detection system shall be demonstrated as follows:

- Operation of the detection system with respect to the gas installation to be checked with extinguishing system isolated.
- All detectors to be triggered with ionisation aerosol or similar, and heat sources if applicable.
- Checking of all alarms and interlocks
- Checking of outputs to discharge actuation system.
- One zone shall be tested with a fire and accelerant.

Where any of the above items are not to the satisfaction of the Department or Engineer, such shortcomings shall be rectified before further commissioning is witnessed.

5.2.2 Full Discharge Test

The Department of Public Works requires that a full discharge test be performed on every Inert Gas Agent installation as part of the commissioning and handover procedure. The Contractor shall bear all costs associated with this test, whether for labour, equipment hiring, consumables, Inert Gas Agent extinguishing media, or other, as part of his scope of works.

Where directional valves are employed in an installation, every separate discharge zone shall be tested individually.

The Contractor shall arrange for concentration measurement and logging, during the discharge test, of O_2 and CO_2 levels in every protected space. Logging shall start when system discharge is triggered, and shall continue for a period not less than 30 minutes, with

measurement samples every 10 seconds during the first 5 minutes, and every minute thereafter.

5.2.3 Witnessing of Commissioning Tests & Simulations

All commissioning tests, including full discharge tests, shall be witnessed by a representative of the Department or Engineer. Where tests have for whatever reason not been witnessed, it shall be assumed for handover purposes that they have not been performed, and first delivery shall under such circumstances not be accepted by the Department.

5.3 OPERATING & MAINTENANCE MANUALS. AS-BUILT DOCUMENTATION

Refer to F.P.O./82/5E - Standard Technical Specification for an Automatic Fire Alarm System -clauses 6.3 and 6.4.

Unless otherwise specified in the Supplementary Specification, the Contractor shall hand over to the Engineer, as part of his scope of works. 2 weeks prior to first delivery being accepted by the Engineer, one full set of his as-built documentation, including:

- One set of transparancies of his up to date working drawings.
- All electrical and control schematics.
- Complete detail design calculations.

Two draft sets of operational and maintenance manuals, prepared in English, and written in layman's terms, shall be handed over for comments to the Departmental Representative and Engineer respectively at least 2 weeks before first delivery.

Paper copies of all as-built documentation shall be bound into every operating and maintenance manual unless otherwise specified in the Supplementary Specification. Manuals shall be properly bound in a durable hard cover. Material shall be clearly legible, well organised, and be provided with index. Drawings and diagrams A2 and larger shall be folded to A4 size, and included in thick clear plastic pockets.

The Contractor shall hand over four (4x) sets of approved O&M manuals. First delivery shall not be accepted before the complete sets of approved O&M manuals have been handed over.

5.3.1 Operating & Maintenance Manual Content

Operating and maintenance manuals shall include the following sections:

SECTION 1: GENERAL

- Clear description of the system, including system diagram and controls.
- Schematic diagrams of all systems with space volumes, structural and volume reductions. design flooding factors, detection & actuation thresholds, etc.
- Schedules of equipment, complete with model numbers, optional extras, modifications, electrical requirements if any, etc.

SECTION 2: OPERATING PROCEDURES

Operating procedures for all items of equipment, specifically including:
- Gas isolation procedure.
- Alarm acknowledge.
- Alarm reset.
- Gas actuation.
- Fault finding checklists.

SECTION 3: MAINTENANCE SCHEDULES

- Daily maintenance check sheets.

- Monthly maintenance check sheets.
- Annual maintenance check sheets.
- Maintenance schedules for each item of equipment.

SECTION 4: MAINTENANCE INSTRUCTIONS

- Detailed maintenance instructions for each item of equipment.

SECTION 5: PARTS LISTS AND SUPPLIERS. AS-BUILT DOCUMENTATION

- Detailed parts lists of all consumable items of equipment with full ordering details.
- Detailed parts lists of all wearing or items generally requiring replacement ie. relays and other switchgear.
- List of suppliers of all the above items with addresses, telephone, and fax numbers.
- Paper copies of as-built documentation.

5.3.2 General Requirements

Sections 1. 2 and 3 to be specifically prepared for the contract. No standard forms or manufacturers literature is acceptable.

Maintenance check sheets to refer to items of equipment by name (i.e. Inert Gas Agent storage cylinders) and not general descriptions.

Maintenance instructions may consist of manufacturers printed instructions where these are detailed and pertinent. Copies of general technical and sales literature are not acceptable.

5.4 MAINTENANCE & GUARANTEE

5.4.1 Contractual Maintenance & Guarantee Period

Unless otherwise specified in the Supplementary Specification, every Inert Gas Agent installation shall be covered, as part of the Contractor's scope of works, by a free maintenance and guarantee period.

The length of the free maintenance and guarantee period shall be at least 12 calendar months from date of acceptance of first delivery by the Department of Public Works.

5.4.2 Maintenance Requirements

During the free maintenance and guarantee period, the Contractor shall perform:

- Monthly/quarterly inspections and maintenance as applicable.
- Comprehensive maintenance service at the end of a period of 11 months verifying all commissioning setpoints, proper operation etc.

Maintenance shall consist of maintenance in accordance with the maintenance schedules, and actual maintenance performed shall be recorded on the maintenance check sheets and signed off by a representative of the Department.

All inspections and services shall be followed, within 7 days of such inspection or service, by reports outlining:

- The scope of the inspection.
- Any maintenance carried out.
- General state of installation & items requiring further attention.

Reports shall be completed in duplicate and forwarded to the Regional Manager and the Director General. Department of Public Works, Private Bag X65, Pretoria, 0001.

All items requiring replacement, repair or service within the 12 months maintenance and guarantee period, whether equipment or consumables, shall be repaired, replaced or

serviced by the Contractor at ins own expense as part of this contract.

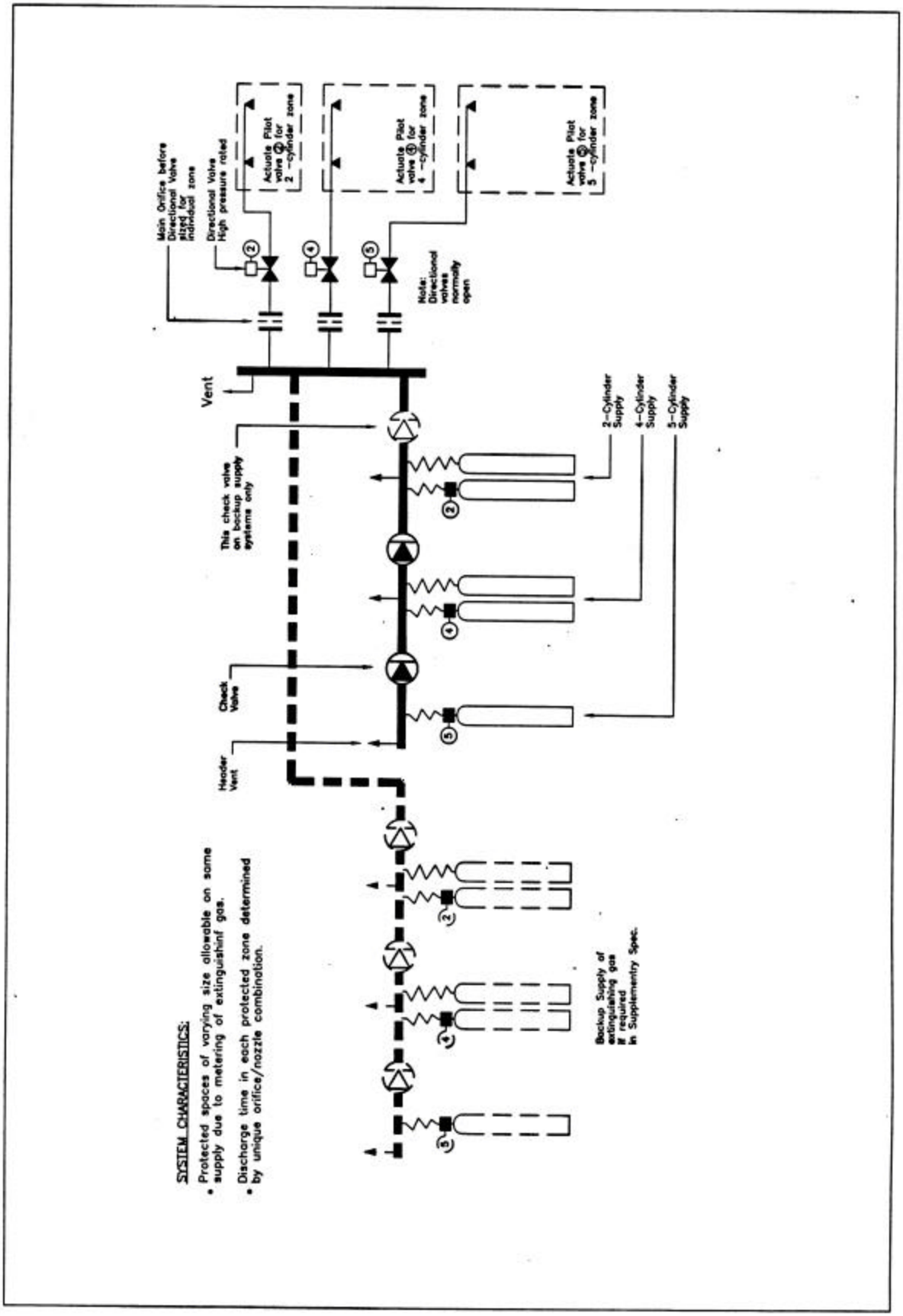
The system shall be fully guaranteed against all defects, and where a major defect occurs during the guarantee period, the item involved shall be guaranteed for a further 12 months from the date on which the defect was repaired, and the Department notified in writing.

6. SECTION 6: DRAWINGS. FIGURES & SCHEDULES

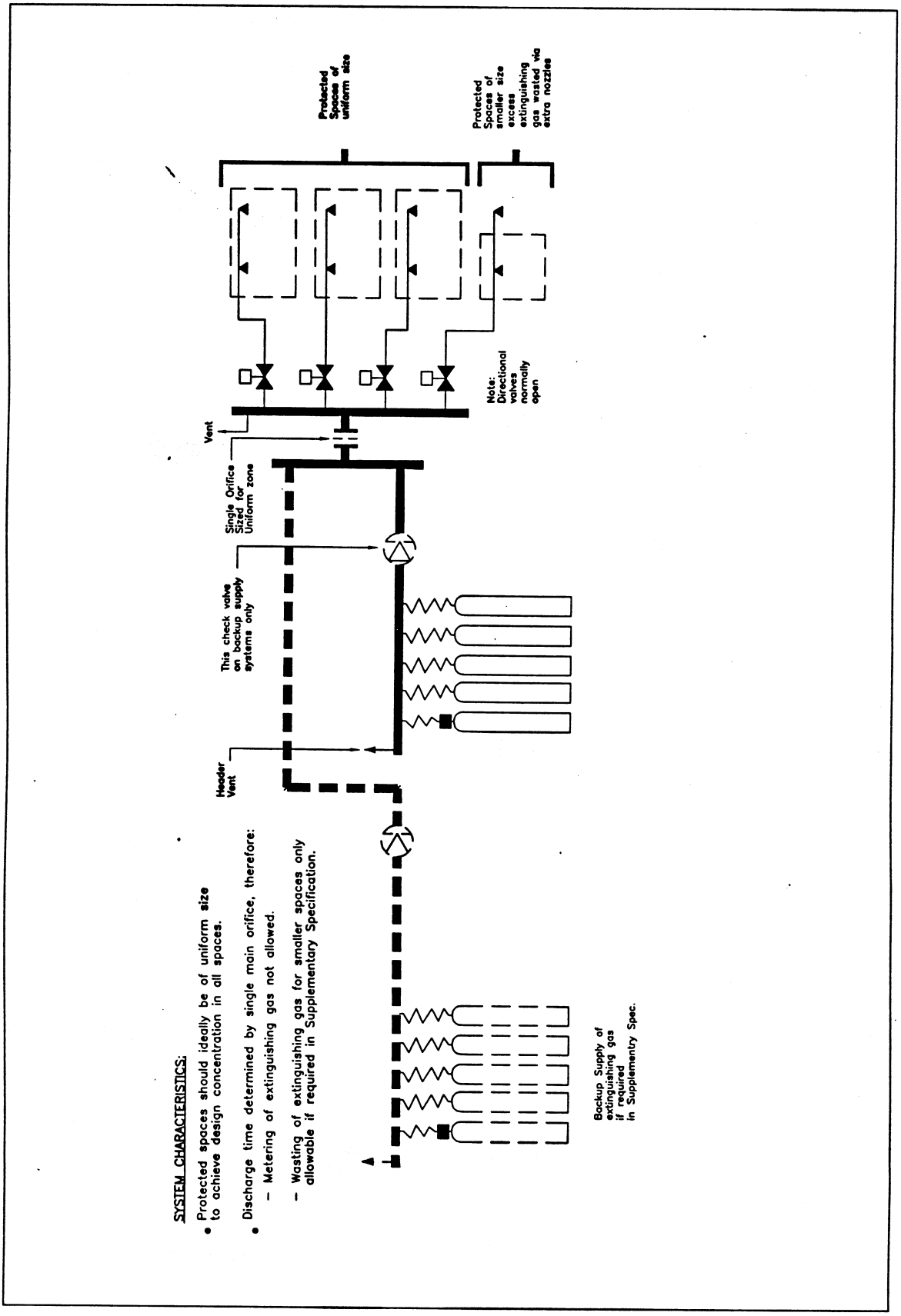
6.1.1 SCHEDULE 1 - DOCUMENTATION SCHEDULE

#	Documentation to be handed over	Special clause	Stage at which documentation is required				Notes:
			Tender	Design Submittals	Prior to Installation	First delivery & As built Docs	
6.1.1	System Approval	1.3.1	?				Required if system approval exists
6.1.2	Proof of ISO9001 certification	1.3.2	?				Required if no system approval exists
6.1.3	Person responsible for system design	1.3.1 & 1.3.2	?				
6.1.4	Component details & approvals	1.3.2	?				Required if no system approval exists
6.1.5	Builders work drawings	1.8.1		?			
6.1.6	System detail design calculations	1.8.2		?			
6.1.7	Working drawings	1.8.3		?			
6.1.8	Electrical and Controls Schematics	1.8.4		?			
6.1.9	Equipment samples	1.8.5			?		If required in the Supplementary Specification
6.1.10	As-built drawings & schematics	1.8.6				?	
6.1.11	Concentration performance tolerance certificate	1.12 & 2.4.5				?	
6.1.12	Confirmation of remeasurement	2.5			?		Prior to manufacture proceeding
6.1.13	Confirmation of remeasurement	2.5				?	Prerequisite for acceptance of first delivery
6.1.14	Coded welder certificates	3.5			?		Prior to manufacture proceeding
6.1.15	Confirmation of storage cylinder design code	4.2.1	?				
6.1.16	Storage cylinder pressure testing certificates	4.2.2			?		Prior to bringing onto site
6.1.17	Storage cylinder charging certificates	4.2.4			?		Prior to brining onto site
6.1.18	Cylinder valve leak guarantee certificates	4.3.1				?	Prerequisite for acceptance of first delivery
6.1.19	Piping material certificates	4.4.1 & 4.6.1			?		
6.1.20	Results of X-ray testing on welds	4.4.2			?		If required by the Department
6.1.21	Pressure testing certificates	4.4.5 & 4.6.1			?		Pre-commissioing requirement
6.1.22	Full discharge test results- time/concentration logs	5.2.2				?	Prerequisite for acceptance of first delivery
6.1.23	Draft O&M manuals	5.3				?	3 weeks prior to first delivery
6.1.24	Approved O&M manuals	5.3				?	Prerequisite for acceptance of first delivery
6.1.25	Monthly/quarterly maintenance reports	5.4.2					During 12 months guarantee period
6.1.26	Comprehensive maintenance service report	5.4.2					Before expiry of 12 months guarantee period

6.2 FIGURE 1 – TYPICAL ARRANGEMENT FOR METERED ZONED DISCHARGE



6.3 FIGURE 2 – TYPICAL ARRANGEMENT FOR UNMETERED ZONED DISCHARGE



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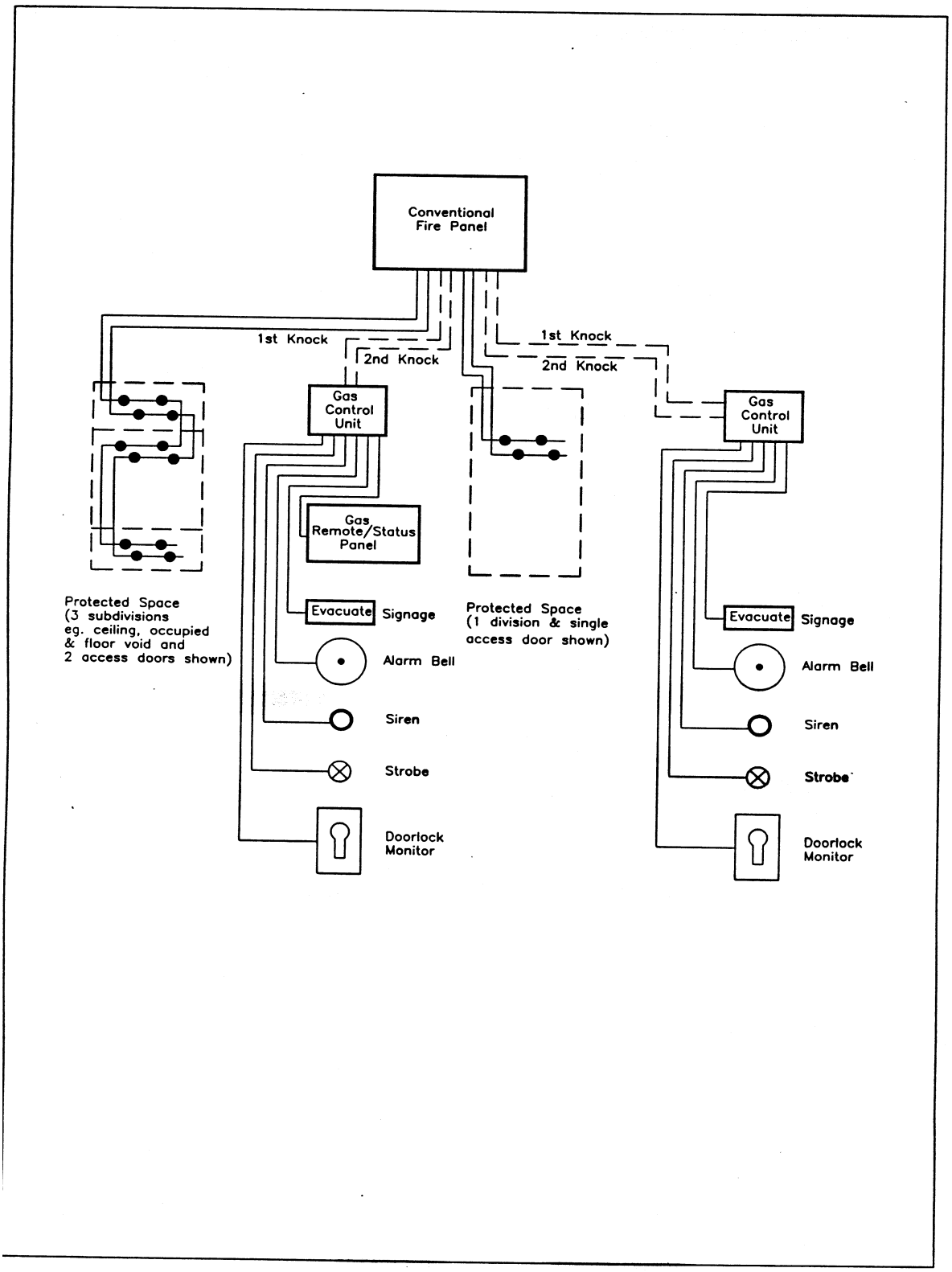
SECTION 6

6.4 FIGURE 3 – TYPICAL CONVENTIONAL DETECTION ARRANGEMENT



6.5 FIGURE 4 – TYPICAL ADDRESSABLE DETECTION ARRANGEMENT