

**IGEM/SR/4 Edition 3
Communication 1752**

Variable volume gasholders storing lighter than air gases



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Royal Charter 1929
Patron: Her Majesty the Queen*



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Communication 1752**

Variable volume gasholders storing lighter than air gases



Price Code: C5S
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SECTION 1 : INTRODUCTION

- 1.1 This Standard supersedes IGE/SR/4 Edition 2, Communication 1624, which is obsolete.
- 1.2 This Standard has been drafted by a Panel appointed by the Institution of Gas Engineers and Managers' (IGEM's) Gas Transmission and Distribution Committee and published by the authority of the Council of IGEM.
- 1.3 This Standard applies to the design, inspection, maintenance, operation, repair, modification and demolition of gasholders. It is not retrospective but where existing practices do not comply it is recommended that such practices are reviewed and brought into line where practicable. Any deviation from this Standard needs to be subject to risk assessment and cost benefit analysis.
- 1.4 Significant amendments to Edition 2 have been made in this edition. These include:
- updating the definitions for gasholders (see IGE/G/4)
 - revision of the requirements for electrical apparatus
 - additional information on purging
 - further guidance on control systems
 - inclusion of advice for the demolition of gasholders
 - updating of numerous references to legislation and Standards
 - revised and additional drawings of the different types of gasholders and their seals.
- 1.5 This Standard sets out general requirements for water-sealed, dry (Wiggins) and waterless (M.A.N.) gasholders. Due to the individuality of these gasholder types, however, they each have specific considerations which are made apparent in the following sections:
- design
 - entry for inspection and maintenance
 - isolation and purging
 - inspection
 - maintenance and repair
 - demolition.

The following flow chart will assist in using this Standard:

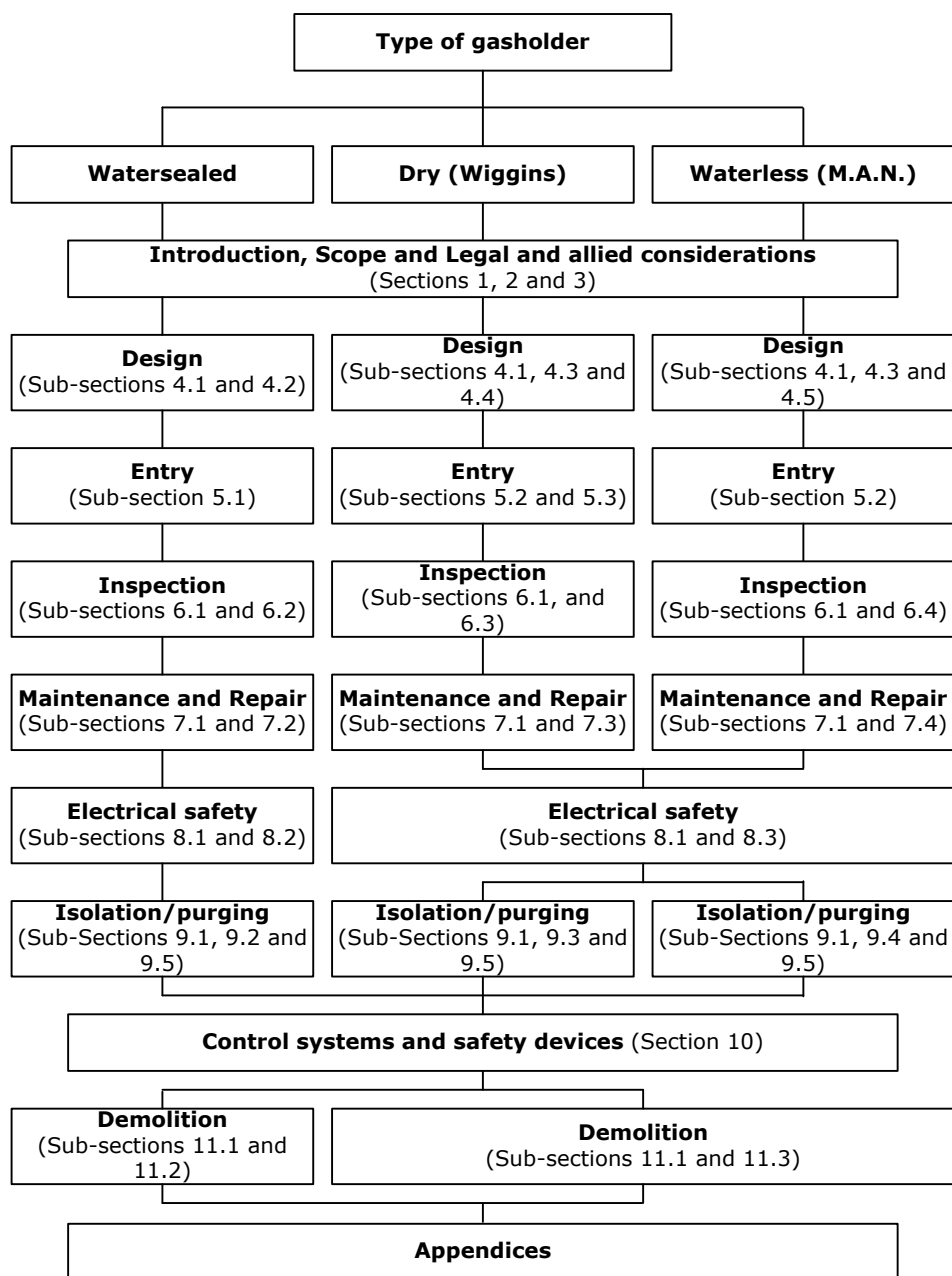


FIGURE 1 - LAYOUT OF IGEN/SR/4

- 1.6 Requirements for fixed volume gas storage storing lighter than air gases can be obtained from IGEN/SR/14.
- 1.7 This Standard makes use of the terms “must”, “shall” and “should”. Notwithstanding Sub-Section 1.9:
- the term “must” identifies a requirement by law in Great Britain (GB) at the time of publication
 - the term “shall” prescribes a requirement which, it is intended, will be complied with in full and without deviation
 - the term “should” prescribes a requirement which, it is intended, will be complied with unless, after prior consideration, deviation is considered to be acceptable.

Such terms may have different meanings when used in legislation, or Health and Safety Executive (HSE) Approved Codes of Practice (ACoPs) or Guidance, and reference needs to be made to such statutory legislation or official guidance for information on legal obligations.

- 1.8 The primary responsibility for compliance with legal duties relating to health and safety at work rests with the employer. The fact that certain employees, for example "responsible engineers" are allowed to exercise their professional judgement does not allow employers to abrogate their primary responsibilities. Employers must:
- have done everything to ensure, so far as is reasonably practicable, that there are no better protective measures that can be taken other than relying on the exercise of professional judgement by "responsible engineers"
 - have done everything to ensure, so far as is reasonably practicable, that "responsible engineers" have the skills, training, experience and personal qualities necessary for the proper exercise of professional judgement
 - have systems and procedures in place to ensure that the exercise of professional judgement by "responsible engineers" is subject to appropriate monitoring and review
 - not require "responsible engineers" to undertake tasks which would necessitate the exercise of professional judgement that is not within their competence. There should be written procedures defining the extent to which "responsible engineers" can exercise their professional judgement. When "responsible engineers" are asked to undertake tasks which deviate from this they should refer the matter for higher review.
- 1.9 Notwithstanding Sub-Section 1.7, This Standard does not attempt to make the use of any method or specification obligatory against the judgment of the responsible engineer. Where new and better techniques are developed and proved, they should be adopted without waiting for the modification of this Standard. Amendments to this Standard will be issued when necessary and their publication will be announced in the Journal of the Institution and other publications as appropriate.
- 1.10 It is now widely accepted that the majority of accidents in industry may be attributable to human as well as technical factors. People may initiate actions that cause or contribute towards accidents.
- To assist in the control of risk and proper management of these human factors, due regard should be taken of both HSG65 and HSG48.
- 1.11 Requests for interpretation of this Standard in relation to matters within their scope, but not precisely covered by the current text, should be either:
- addressed to Technical Services, IGEN, IGEN House, High Street, Kegworth, Derbyshire, DE74 2DA; or
 - emailed to technical@igem.org.uk.
- These will be submitted to the relevant Committee for consideration and advice, but in the context that the final responsibility is that of the engineer concerned. If any advice is given by or on behalf of IGEN, this does not imply acceptance of liability for the consequences and does not relieve the responsible engineer of any of his or her obligations.
- 1.12 This Standard was published in May 2011.

SECTION 2 : SCOPE

- 2.1 This Standard highlights those aspects of gasholder design, inspection, maintenance, operation, repair, modification and demolition which may put the gasholder or persons working on the gasholder, or members of the public, at risk.
- 2.2 Ancillary fittings, such as measurement controls etc., have not been covered in detail as it is considered that they come within the purview of "instrumentation controls". However, the combination of measurement and control into a logical system is discussed at some length.
- 2.3 This Standard refers to the safety of gasholders and where matters of design are mentioned, these relate to the safety features and not to the design of gasholders as a whole.
- 2.4 This Standard refers specifically to storage of gases having a density less than air. If heavier than air gases are stored in variable volume gasholders, consideration has to be given to the effects of the escape of gas during purging operations and accidental escapes of gas during operation. It is expected that the responsible engineer will identify problems and provide his or her own safe solutions.
- 2.5 All references to gas pressure are gauge pressure unless otherwise stated.
- 2.6 Italicised text is informative and does not represent formal requirements.
- 2.7 Appendices are informative and do not represent formal requirements unless specifically referenced in the main sections via the prescriptive terms "must", "shall" or "should".

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SECTION 3 : LEGAL AND ALLIED CONSIDERATIONS

This Standard is set out against a background of legislation in force in Great Britain at the time of publication. Similar considerations are likely to apply in other countries and reference to the appropriate national legislation is necessary.

All relevant legislation must be applied and relevant ACoP's, official Guidance Notes and referenced codes, standards etc. shall be taken into account.

Where British Standards, etc. are quoted, equivalent national or international standards, etc. equally may be appropriate.

Note: Appendix 2 is relevant in this respect.

3.1 NOTIFICATION OF SITES

Sites storing appreciable quantities of specified hazardous substances must be notified to the Health and Safety Executive under the Notification of Installations Handling Hazardous Substances Regulations (NIHHS) (see clause 3.3.17). Installations storing larger quantities of specified substances require a more detailed report under the Control of Major Accident Hazards (COMAH) Regulations (see clause 3.3.18). The duty on operators under the COMAH Regulations is to take all measures necessary to prevent major accidents and limit their consequences to persons and the environment. Where new storage is planned, controls set out in the Planning (Hazardous Substances) Act are applicable.

3.2 PRIMARY LEGISLATION

3.2.1 Health and Safety at Work etc. Act (HSWA)

HSWA applies to all persons involved with work activities, including employers, the self-employed, employees, designers, manufacturers, suppliers, etc. as well as the owners of premises. It places general duties on such people to ensure, so far as is reasonably practicable, the health, safety and welfare of employees and the health and safety of members of the public who may be affected by the work activity.

3.2.2 Factories Act

3.2.2.1 The Factories Act and the Regulations made there under remain in force under the HSWA. The expression 'factory' includes premises in which persons are employed in manual labour and (inter-alia) any premises used for the storage of gas in a gasholder having a storage capacity of not less than 140 m³ (5000 ft³). The whole Act will apply to such premises. Specifically, Section 39 of the Act requires that watersealed gasholders must:

- be of sound construction and be properly maintained
- be thoroughly examined externally by a competent person at least once in every period of two years. A record containing the prescribed particulars must be attached to the general register

Note 1: Alternatively, a suitable place may be agreed with the HSE for the location of the record.

Note 2: The Gasholders (Record of Examinations) Order gives details of the information to be recorded in the 2 yearly examination. Appendix 3 provides records to satisfy these requirements.

- have the internal state of the sheeting examined at least once in every period of ten years by a competent person if any lift of the gasholder has been in use for more than twenty years. The resulting report of this examination must be available for inspection. The examination can be carried out by cutting samples from the crown and sides of the gasholder.

Note: Although more modern methods are available to measure the thickness of gasholder sheeting, appropriate precautions need to be in place when applying these techniques to gasholders known or suspected to have heavy deposits on the lifts.

- have a record signed by the occupier of the factory, or by a responsible official authorised in that behalf available for inspection. Specifically it will detail the date of the construction, as nearly as it can be ascertained, of the oldest lift of every gasholder in the factory
- be marked in a conspicuous position with a distinguishing number or letter where there is more than one gasholder in the factory
- not be repaired or demolished except under the direct supervision of a competent person.

Note: Section 39 of the Factories Act does not apply to dry (Wiggins) or waterless (M.A.N.) gasholders.

3.2.2.2 Whereas the Act (Section 31 (4)) prohibits the application of heat to a vessel containing gas for the purposes of repair or demolition, a gasholder containing towns gas, natural gas or gases used in the manufacture of towns gas at a pressure above atmospheric may be repaired by electric arc welding, providing the precautions given in clause 7.1.8 are observed.

3.2.3 **Control of Pollution Act**

The Control of Pollution Act places duties on disposal authorities to ensure arrangements for the disposal of controlled waste are adequate and plans are in place for the import and export of waste into/out of their area. Special provisions must be made for controlled waste which is dangerous or difficult to dispose of and this duty is fulfilled under the Control of Pollution (Special Waste) Regulations.

3.2.4 **Environmental Protection Act (EPA)**

3.2.4.1 EPA imposes a Duty of Care on any person who produces, imports, carries, keeps, treats or disposes of controlled waste.

3.2.4.2 All waste is classified as 'controlled waste' and can be disposed of only to approved facilities. It must be accompanied by a detailed description of the waste.

3.2.4.3 Controlled waste which is also classified as 'special waste' must be disposed in accordance with the Special Waste Regulations.

Note: The Special Waste Regulations provides details of what constitutes 'special waste'.

3.2.5 **Occupier's Liability Act**

The Occupier's Liability Act places a duty on the occupier, or any person having effective control of the premises, to take such care as is necessary and reasonable to ensure that visitors and trespassers are safe in using the premises.

3.3 **SECONDARY LEGISLATION**

3.3.1 **Management of Health and Safety at Work Regulations (MHSWR)**

MHSWR impose a duty on employers and the self-employed to make assessments of risks to the health and safety of employees, and non-employees affected by their work. They also require effective planning and review of protective measures.

3.3.2 **Workplace (Health, Safety and Welfare) Regulations, as amended by the Health and Safety (Miscellaneous Amendments) Regulations**

These Regulations apply to most workplaces, exceptions include construction sites. It places duties on employers for the Health, Safety and Welfare of employees at work.

3.3.3 **Construction (Design and Management) Regulations (CDM)**

CDM place duties on clients, designers, contractors and the CDM Co-ordinator to ensure that health and safety is taken into account and managed effectively throughout all stages of a construction project.

3.3.4 **Personal Protective Equipment at Work Regulations**

Personal protective equipment (PPE) includes protective clothing, gloves, safety footwear, high visibility waistcoats, eye protectors, respirators, safety equipment etc. An employer is required to provide suitable PPE to any employee who may be exposed to risk at work.

3.3.5 **Provision and Use of Work Equipment Regulations (PUWER)**

PUWER place duties on employers in relation to the selection, suitability, maintenance, inspection, installation, instruction and training, prevention of danger and control of work equipment.

3.3.6 **Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR)**

3.3.6.1 RIDDOR require employers, self employed people or those in control of work premises to report certain work related accidents, diseases and dangerous occurrences.

3.3.6.2 Other people have duties to report certain gas incidents which may not appear to be work related:

- Death or major injury arising out of the distribution, filling, import or supply of Natural Gas must be reported by the conveyer
- Dangerous gas fittings (as defined in RIDDOR) must be reported by a "member of a class of persons".

3.3.6.3 Major injuries, death and dangerous occurrences must be notified immediately, for example by telephone, to the enforcing authority by the "responsible person" as defined by RIDDOR.

3.3.6.4 Uncontrolled releases of:

- 10 kg or more of a flammable gas inside a building
- 500 kg or more of a flammable gas in the open air

must be reported under RIDDOR.

Note: The above list is not exhaustive.

3.3.7 **Confined Spaces Regulations**

These Regulations apply to places which are substantially enclosed, though not necessarily entirely, and which may pose a risk of injury from hazardous substances or conditions within the space or nearby. The supplier or designer of an enclosure and equipment within it is required to perform a risk assessment of the enclosure with respect to safe access and egress and to give clear instructions to operators on access/egress as well as to what actions to take in the event of any emergency or a gas alarm occurring. Employers and the self employed should prevent entry into confined spaces unless avoidance is not reasonably practicable and unless there is a system of work which renders the work safe. They are also required to have specific emergency arrangements in place.

3.3.8 **Control of Substances Hazardous to Health Regulations (COSHH)**

COSHH, reinforce existing statutory obligations under HSWA and impose a duty on employers to protect employees against risks to their health, whether immediate or delayed, arising from exposure to substances hazardous to health, either used or encountered, as a result of a work activity. They also impose certain duties on employees.

Under COSHH, work must not be carried out which is liable to expose employees to hazardous substances as specified in COSHH unless the employer has made a suitable and sufficient assessment of the risk created by the work and the steps needed to be taken to comply with COSHH. After assessing the risk, it is necessary to inform employees of the risks and carry out the appropriate training and instruction to ensure that risks are minimised. In certain cases, control measures such as ventilation or PPE may be necessary and, where provided, they must be used.

3.3.9 **Dangerous Substances and Explosive Atmospheres Regulations (DSEAR)**

DSEAR is the UK implementation of the European Union ATEX (Atmosphere Explosibles) directive. DSEAR require employers to assess the risks of fire and explosions that may be caused by dangerous substances in the workplace and to record the significant findings of assessments. These risks must then be eliminated or reduced so far as reasonably practicable.

Emergency plans and procedures must be prepared where appropriate and made available to emergency services to enable them to develop their own plans if necessary.

DSEAR places additional duties on employers where potentially explosive atmospheres may occur, including:

- identifying and classifying (zoning) areas where potentially explosive atmospheres may occur
- avoiding ignition sources in zoned areas
- if appropriate, identifying the entrance to zoned areas.

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3.3.10 **Work at Height Regulations**

These Regulations replace all earlier regulations about working at height and address minimum safety requirements for the use of equipment for work at height.

The Regulations require that the Duty Holder:

- provides a safe means of access and egress
- does all that is reasonably practicable to prevent anyone falling
- avoids work at height where they can
- uses work equipment or other measures to prevent falls when working at height cannot be avoided
- uses work equipment or other measures to minimise the distance and consequences in the event of a fall.

3.3.11 **Control of Lead at Work Regulations**

These Regulations apply where work involving lead based substances is to be carried out. Such work includes:

- scraping, welding, grit blasting, high pressure water jetting, burning or demolition of surfaces/structures which have been painted with lead based paints
- painting using lead based paints.

When undertaking work involving lead based substances employees must be advised of the risks and appropriate precautions to take.

3.3.12 **Control of Asbestos at Work Regulations**

Before carrying out work involving asbestos or asbestos products, precautions must be taken to protect persons against inhaling asbestos dust, or allowing such dust to endanger other persons. The protective measures required are given in the Control of Asbestos at Work Regulations.

3.3.13 **Control of Noise at Work Regulations**

The aim of The Noise at Work Regulations is to reduce the risks of occupational hearing damage to as low as reasonably practicable.

There are, among others, legal duties to:

- protect the hearing of those at work and of others
- carry out a noise assessment if employees are exposed to noise levels exceeding 80 dB(A)
- take measures to reduce noise levels to the lowest level reasonably practicable
- use warning signs to indicate where hearing protection must be worn
- inform workers about risks to hearing.

3.3.14 **Electricity at Work Regulations**

These regulations are concerned with the prevention of danger from electric shock, electric burn, electrical explosion or arcing, or from fire or explosion initiated by electrical energy.

They impose duties on every employer, employee and self-employed person and require that persons engaged in electrical work be competent or be supervised by competent persons.

3.3.15 **Manual Handling Operations Regulations**

These Regulations seek to reduce the incidence of injury and ill-health arising from the manual handling of loads at work.

The Regulations place duties upon employers in respect of their own employees. Identical duties are placed on the self-employed in respect of their own safety.

3.3.16 **Gas Safety (Management) Regulations (GS(M)R)**

GS(M)R apply to Natural Gas only.

GS(M)R place specific duties on gas transporters (GTs), or their emergency service providers (ESPs), for dealing with gas escapes from pipes on their networks. Their primary duty is to make the situation safe. They are responsible not only for dealing with escapes from their own pipes, but also for dealing with escapes from gas fittings supplied with gas from pipes on their network. In GS(M)R, the term "gas escapes" includes escapes of fuel gas and emissions of carbon monoxide (CO) from gas fittings.

3.3.17 **Notification of Installations Handling Hazardous Substances Regulations (as Amended)**

These Regulations require that the HSE be notified of any installation which stores more than 15 tonnes of "gas or any mixture of gas which is flammable in air and is held in the installation as a gas".

This quantity includes any gas held in a pipeline operating at pressure not less than 8 bar absolute which is within 500 metres of the site and is connected to it.

The particulars are:

- name and address of the person making the notification
- postal address and map reference of site
- area of site
- date of commencement of activity or statement that it has already started
- general description of activities carried out at the site
- name and address of planning authority
- name and maximum quantity of substances(s) stored on site.

The HSE must be informed at the earliest opportunity of changes which affect any of these particulars. If the maximum quantity of hazardous substances(s) is increased to an amount three or more times that originally notified, the application must be re-submitted at least three months before making the increase.

3.3.18 **Control of Major Accident Hazard Regulations (as Amended)**

3.3.18.1 COMAH apply to industrial installations where certain quantities of specified substances are stored and to the measures in place in order to identify, control and mitigate the risks involved in storing such substances.

The Amendment to the Regulations makes changes to the schedule of substances and qualifying thresholds. Changes are also made to the aggregation rule for determining operator status under COMAH.

COMAH require:

- notification to the Competent Authority of quantities of substances stored and status under COMAH
- preparation of a Major Accident Prevention Policy (MAPP) Document
- taking necessary measures to prevent major accidents.

3.3.18.2 For sites storing more than 50 tonnes but less than 200 tonnes (Lower tier) of 'flammable gases' (substances which have a boiling point at atmospheric pressure of 20°C or less and which become flammable when mixed with air) evidence must be provided to show that the site operator has a MAPP which includes:

- identifying the major hazards
- taking adequate steps to:
 - prevent major accidents and limit their consequences to persons and the environment
 - provide persons working on site with the information, training and equipment necessary to ensure their safety.

3.3.18.3 For sites storing more than 200 tonnes (Top tier) of flammable gases, operators are required to submit a Safety Report to the HSE providing:

- information about the hazardous substance(s) including a brief description of the hazards which may be created
- information about the site, quantity of material(s) stored, conditions of storage, and numbers of people on and off site who may be affected by an incident
- details of the management system for controlling the industrial activity
- information relating to the potential major accidents, including an estimate of the number of people who may be exposed to the hazard(s).

The operator must prepare an on-site emergency plan. They must also inform persons off-site who may be affected by an incident of the safety measures at the site and on the actions they need to take in the event of a major accident.

The Local Authority is responsible for the preparation and updating of an adequate off-site emergency plan.

3.3.19 **Planning (Hazardous Substances) Regulations, as amended by the Planning (Control of Major Accident Hazards) Regulations**

3.3.19.1 *General*

These Regulations control the planning process for the establishment of new facilities to store hazardous material in bulk.

For natural gas, the controlled quantity is 15 tonnes. This does not include gas held in pipelines.

Note: For gas of specific gravity 0.6, 1 tonne occupies approximately 1350m³ at Standard Temperature and Pressure (STP).

3.3.19.2 *Developments adjacent to low pressure gasholders*

Where developments are planned in the vicinity of low pressure gasholders, the planning authority is obliged to consult the Health and Safety Executive for advice in advance of consent, the provision of advice by HSE enables authorities to control proposed development in the vicinity of major accident hazards.

SECTION 4 : DESIGN

4.1 DESIGN - GENERAL

4.1.1 The design of the main structural features of any gasholder will be the responsibility of the designers but attention shall be paid to the following clauses that make an important contribution to safety and which may be overlooked.

4.1.2 All gasholders should be so situated or protected as to prevent the possibility of damage by road or rail vehicles and a minimum surrounding distance of 6 m should be kept clear of obstruction and corrosive or flammable materials.

Due consideration shall be given where the 6 m zone extends beyond the site boundary.

4.1.3 Site security arrangements shall be such that unauthorised persons, and particularly children, do not have access to a gasholder or any inground tank or valve pit, where applicable. As far as reasonably practicable, gates should be provided on tank ladders or staircases and be kept locked.

Note: Examples such as a closed meshed door or a steel door in a smooth fronted plate which extends 0.6 m out from and below a staircase at about 3.6 m from the ground are effective.

4.1.4 IGEM/SR/25 should be used to determine the extent of any hazardous area where gas may be present. Specific consideration shall be given to a hazardous area which extends beyond the site boundary.

Where electrical equipment is to be installed on site, it shall be suitable for the zone in which it is installed.

4.1.5 Provision should be made at ground level for depositing articles such as matches and lighters in a safe place. For possible sources of ignition, such as electrical equipment, see Section 8.

4.1.6 Limit switches or signalling apparatus used shall not interfere with the free movement of the gasholder and should themselves be protected against inadvertent movement.

Where suspended flexible electric cabling or pipework is used to interconnect apparatus upon the moving parts of a gasholder, it shall not interfere with movement, even in periods of high wind.

4.1.7 Guide tracks on a gasholder shall be kept free from obstruction.

4.1.8 For all gasholders:

- safe means of access and a safe place of work shall be provided for all work on the gasholder
- where new gasholders are planned, consideration shall be given to the provision of means for suspending cradles or similar equipment for maintenance purposes.
- access should be by staircase and/or lift
- handrails, together with toeboards, should be provided and fitted to the guardrail or dip tops wherever access to antifreeze, walkways, carriages or other equipment is necessary
- handrails should be 30 mm diameter solid bar or other suitable section of equal strength.

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- 4.1.9 Monitoring and control equipment should be installed in accordance with Section 10.

Arrangements shall be made to prevent damage which can be caused if a vacuum is created in a gasholder by the associated gas extraction plant. Such control equipment or other devices should be suitably protected against accidental operation.

- 4.1.10 Inlet and outlet connections should be arranged so that a gasholder can be completely isolated from gas ingress by the removal of pipework and not merely by reliance upon valves or hydraulic water seals.

- 4.1.11 A formal process for appraisal and approval of modifications to gasholders should be employed when required to ensure that designs are 'fit for purpose'.

Note: IGE/GL/5 or similar could be used for this purpose.

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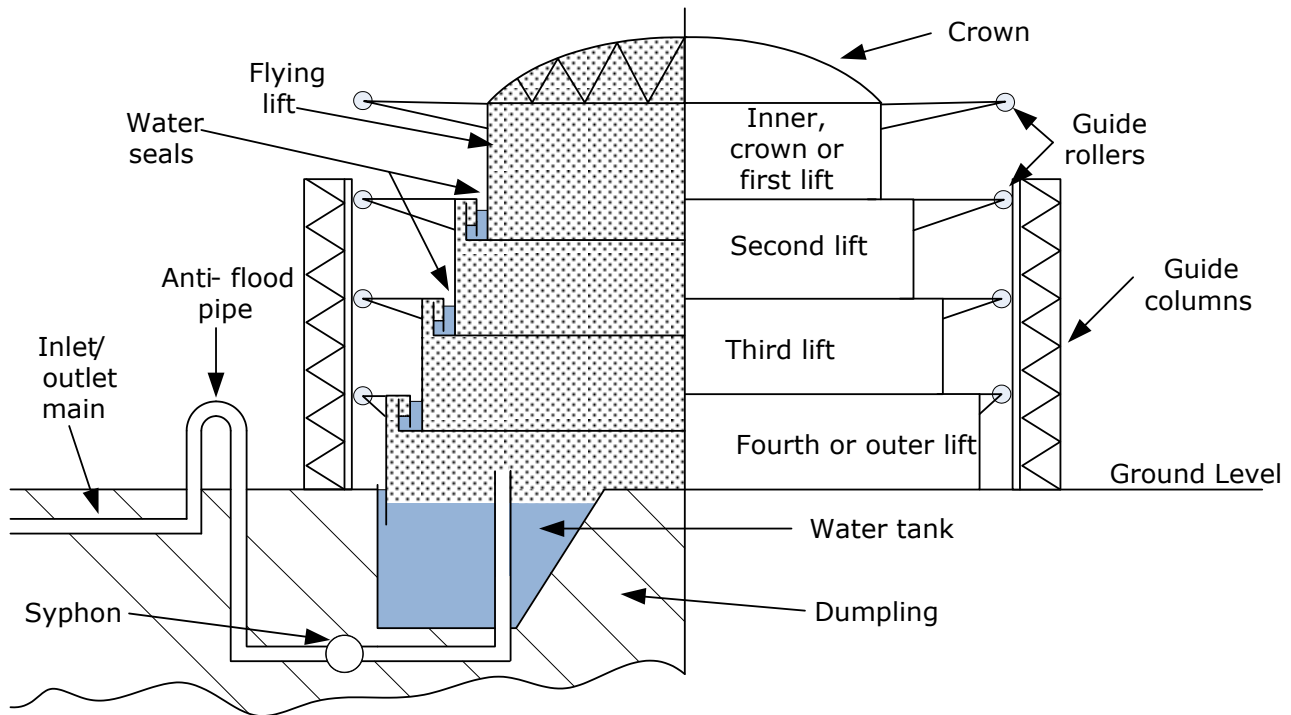


**FIGURE 2 - TYPICAL WATERSEALED GASHOLDER (COLUMN GUIDED).
BELOW GROUND TANK**

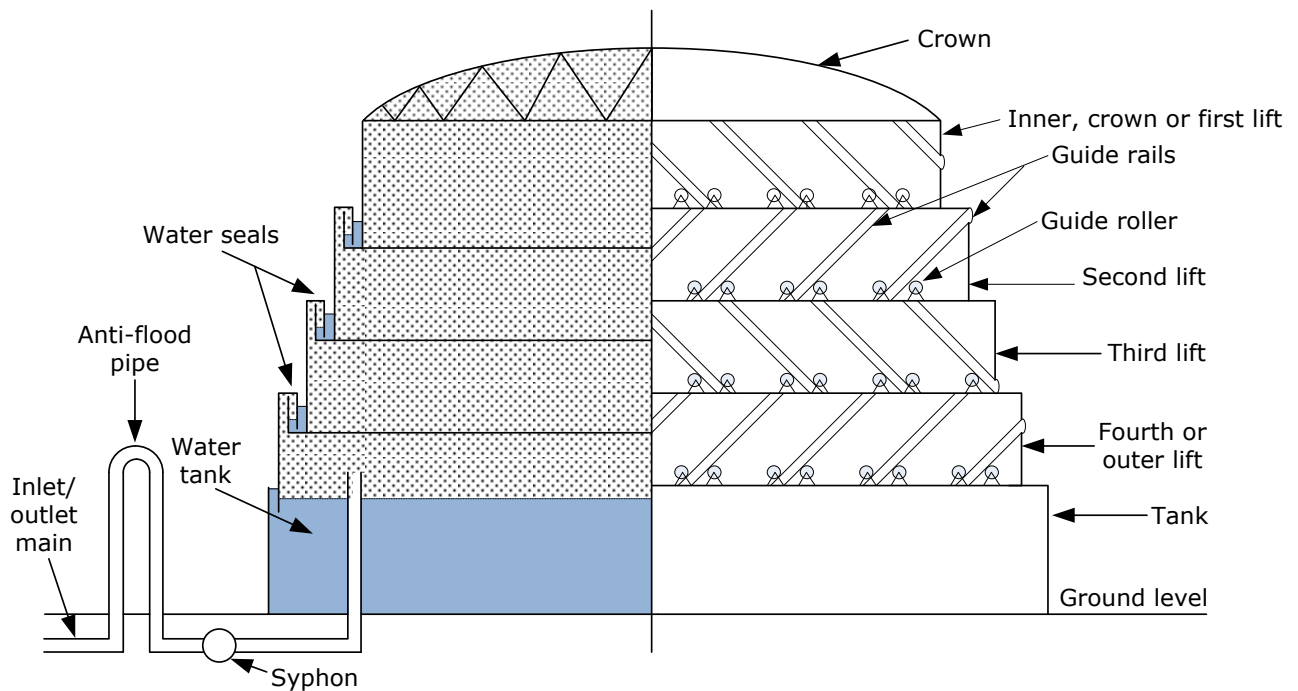


**FIGURE 3 - TYPICAL WATERSEALED GASHOLDER (SPIRAL GUIDED).
ABOVE GROUND TANK**

4.2.1 Design - watersealed gasholders - general

4.2.1.1 Above ground gasholder tanks should be fully exposed. Earth filling and concrete fillets or shoulders, etc., should not conceal the bottom curb in order that the entire side plates and bottom angle can be inspected when necessary. Such tanks require earthing as a protection against lightning and consideration shall be given to BS EN 62305.

4.2.1.2 Any tank connection, downcomer or earth electrode pit shall be available for inspection and test.

4.2.1.3 It is fundamental to the operation of this type of gasholder that an adequate waterseal is maintained in the cups.

Normal practice is to design in a safety margin in excess of 150 mm extra seal depth above that required for the maximum gas pressure. This is to cater for losses due to evaporation, out-of-level etc., (see clause 7.2.2.2).

Some older gasholders may not have this amount of safety margin. Therefore, consideration shall be given to fitting a dip extension plate. However, care shall be taken to ensure that any alteration to the gasholder does not impair the cup/dip seal. Competent advice should be sought before any modifications to seals are undertaken (see clause 4.1.11).

4.2.1.4 The minimum safe depth of seal in the cups and tanks should be determined, recorded and displayed on the site.

4.2.1.5 Permanent purge valves of adequate size should be provided on the crown of the gasholder (at least one at the centre and at least one at the periphery) to facilitate purging. At least three additional purge points, should be fitted to each dip in order to purge the dips.

Note: For additional information on purging, see Section 9.

4.2.1.6 Inlet and outlet connections should be so arranged that any leakage of the tank water into the internal stand pipes and gasholder mains cannot flood the gas distribution system to or from the gasholders.

Note: A receptacle such as a syphon will collect any liquids in the gasholder mains, which allows the gas to flow freely. Liquid is removed from the syphon by pumping, often with fixed syphon pumps.

4.2.1.7 Drain connections are sometimes fitted to gasholder tanks during construction. Where there is any possibility of these freezing, they should be removed and the opening blanked before the gasholder is taken into use.

Note: Trace heating of the drains can be considered as an alternative.

4.2.1.8 A notice shall be displayed on site if a gasholder is oil filmed since filming oil can be displaced from the cups during operation.

4.2.1.9 An alternative to vertical ladders built into the side sheeting of some spiral guided gasholders should be provided and the use of the ladders prevented. The use of such ladders shall be forbidden on gasholders that are treated with non-drying paint and/or where filming oil comes to the outside of the gasholder.

4.2.1.10 For spiral guided gasholders, which have more than one lift and are fitted with staircases, means should be provided whereby a person can pass the base of a staircase safely.

4.2.1.11 For column guided gasholders access ladders should be fitted with half back guards where practicable, but their requirement may be assessed in association with any personal fall protection systems in use and their impact on emergency response and rescue procedures (see clause 7.1.6).

4.2.1.12 The height of a ladder should not exceed 9 m. Where the vertical height to be climbed is over 9 m rest platforms should be provided at suitable intervals. Where more than one ladder is used the flights should be staggered where practicable.

4.2.2 **Design - watersealed gasholders - prevention of ice formation in cups and above ground tanks (anti-freeze systems)**

4.2.2.1 *General*

4.2.2.1.1 The hazards associated with the formation of ice in water sealed gasholders include the possibility of damage to cups, lifts, guide mechanisms, internal inlet and outlet gas pipes. Anti-freeze equipment should be installed at each cup seal and at tank top level to provide the necessary heat to prevent the water from freezing during winter.

Note: It may be electrical, use steam or hot water, or consist of a water circulation system (with or without additional heating).

4.2.2.1.2 The heat produced by an anti-freeze system shall prevent the water in the cups of gasholders from freezing. The relatively low thermal capacity of the water in the cups means that the rate of heat loss in cold conditions may be rapid.

Note: Details of the method of calculating heat input required to gasholder cups and tank is given in Appendix 4.

4.2.2.1.3 Experience has shown that heating the water in the tanks of gasholders is rarely necessary except during prolonged spells of very cold weather. This is especially so for large gasholders. Small gasholders shall be given special consideration with regard to their heating requirements.

4.2.2.1.4 Consideration shall be given to the benefit of local tank water circulation with particular regard to protecting the tank annulus from low temperature effects during periods where lifts are down.

Note: Inground tanks are very unlikely to freeze, except under extreme conditions.

4.2.2.1.5 An external means of tank heating for use in extreme conditions may be incorporated in the circulating system. The level of heat input for this emergency, and for heating smaller gasholder tanks, should be taken from the heat input per metre of circumference given by the cup heat requirements described in the Appendix 4.

4.2.2.1.6 Figure 10 provides guidance on the heat losses from the gasholder water seals. In assessing the size of the heat source to make good these losses, due consideration shall be given to the efficiency of the selected method of providing the heat and the uncertainty of operating conditions.

4.2.2.2 *Methods of heating*

4.2.2.2.1 Consideration shall be given to the types of systems in general use, as follows:

- (a) Hot water circulation (open circuit)
 - The tank water is pumped through an external heater, a proportion being distributed to the cups and the remainder returned direct to the tank. The surplus water from the cups is returned through appropriate channels to the tank.
- (b) Hot water circulation (closed circuit)
 - Water is continuously circulated from a heater through small bore pipes fixed below the water surfaces in the cups and tank annulus
 - Loss of water in the system is corrected by either having a balance and make up tank at the highest point of the system or providing a pumped make up system near to the lowest point of the system.

(c) Steam injection

- The cup and tank water is heated by means of injectors fixed below the water surfaces
- Such a system should be designed so that the velocity and pressure in the pipework between the boiler and the injectors is sufficient to eliminate an undue accumulation of condensate, particularly in the flexible pipes to lift injectors.

Note: Particular attention needs to be given to safety systems which maintain the integrity of a steam system when it is in operation.

(d) Electric (heating elements)

- Mineral insulated metal sheathed cables or other suitably designed heating elements are fixed below the water surfaces in the cups and sometimes in the tank annulus
- Flexible cables, supported and guided, connect supplies from tank level to junction boxes at cup levels
- The design of these cables shall be such that any section exposed to the atmosphere cannot exceed a temperature of 350°C (660°F).

(e) Electric (modular pumps)

- A number of modular pump units are fitted around the circumference of each cup. The actual number required on each depends on the gasholder circumference and other local conditions
- Flexible cables supply power to each modular unit which contains a pump, an electric heater and temperature control equipment
- Cup water is pumped through the unit and is also heated as required
- Each unit operates independently.

Note: Modular pumps may require regular operation to prevent impellers from seizing.

(f) Circulation pumps

- Circulation pumps are fitted to circulate the water in a gasholder tank to prevent ice formation. No heating is involved.

4.2.2.2.2

Precautions shall be taken, in the design and operation of steam injection and water circulatory systems, to prevent syphoning of cup water, reverse flow and internal freezing of pipework. Examples would be:

- limiting the depth of steam injectors so that they operate within the safety margin of the seal
- inserting non-return valves in steam or water lines
- fitting anti-vacuum valves
- making a pin-hole 'drilling' in pipe or injector to prevent a vacuum forming.

4.2.2.2.3

For all methods of heating, consideration shall be given to the position of immersed equipment as cup water levels can vary according to the lift engagement.

Note: For fixed position heaters, injectors or temperature sensors, the lowest normal cup water level will determine the position of immersed equipment.

4.2.2.3

Heating Control

4.2.2.3.1

Control of heating should be by means of air or water thermostats or a combination of the two, for example, hot water circulation system in which circulation is initiated by an air thermostat and heating by a water thermostat.

4.2.2.3.2

Air thermostats should be sited by considering prevailing winds and located away from sunlight and buildings to prevent an incorrect reading of temperature.

4.2.2.3.3

Consideration shall be given to providing a means of indicating the state of the gasholder heating to the control centre, i.e. an anti-freeze failure alarm.

4.3 **DESIGN – DRY (WIGGINS) AND WATERLESS (M.A.N.) GASHOLDERS**

4.3.1 Ventilation openings should be protected so as to prevent the entry of birds.

4.3.2 Where windows are fitted they should be plastic or other suitable material. Consideration shall be given to placing these in the roof of the gasholder, rather than the walls, to facilitate repairs and they should be protected so as to prevent any person from falling through them.

4.3.3 A method of communication shall be provided between the gas operatives inside, at the top and at ground level of the gasholder, for the purpose of giving alarm in the event of any accident inside the gasholder.

4.3.4 A suitable stretcher, chair or other means of lifting a casualty from difficult situations should be readily available.

4.3.5 A minimum of two sets of breathing apparatus, of a type that can be used effectively in the particular gasholder, should be stationed at, or taken to, the point where entry is made and on the piston. Self contained breathing apparatus is the most suitable type.

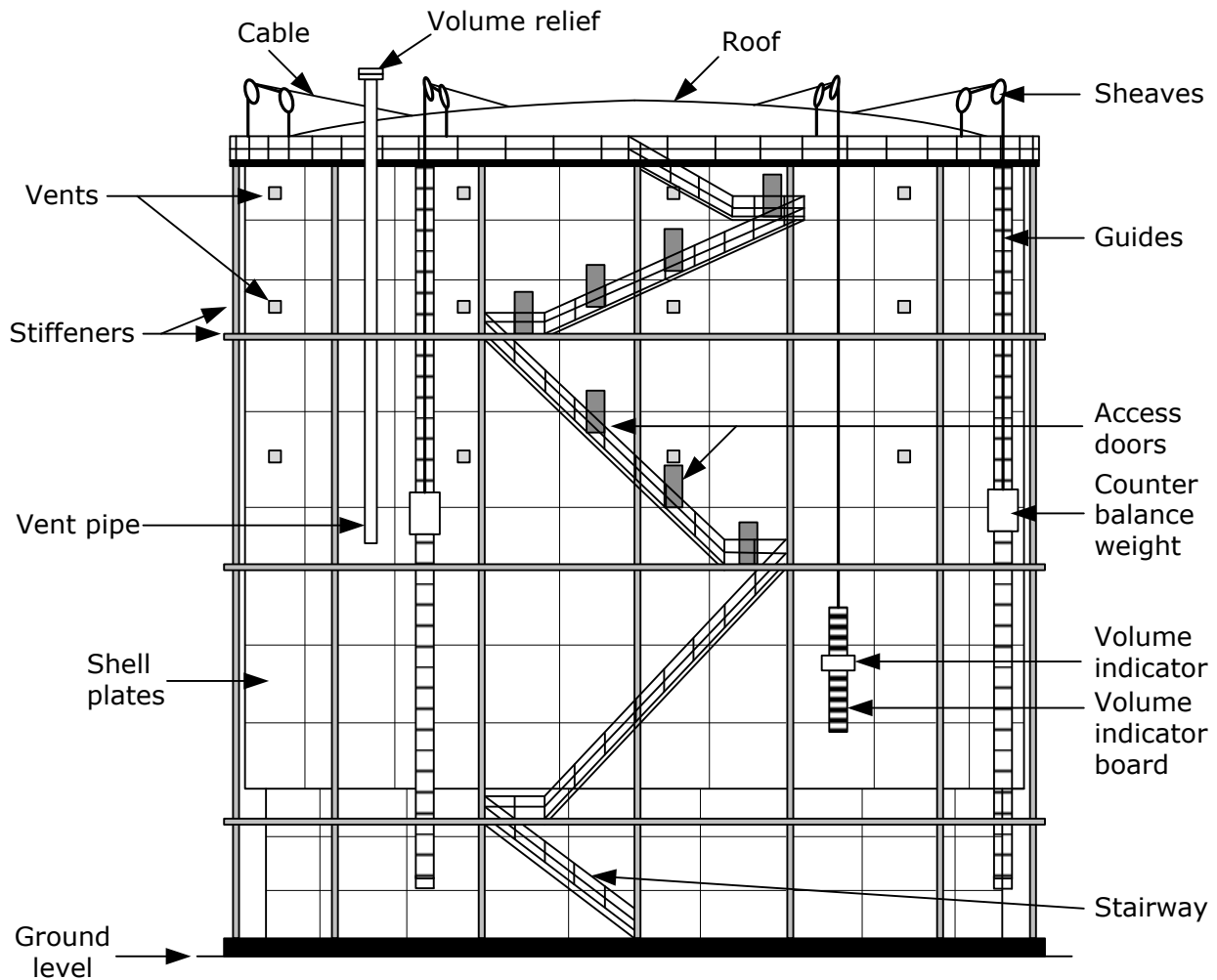
Oxygen sets shall not be used as the presence of pure oxygen may create a hazard in such a situation.

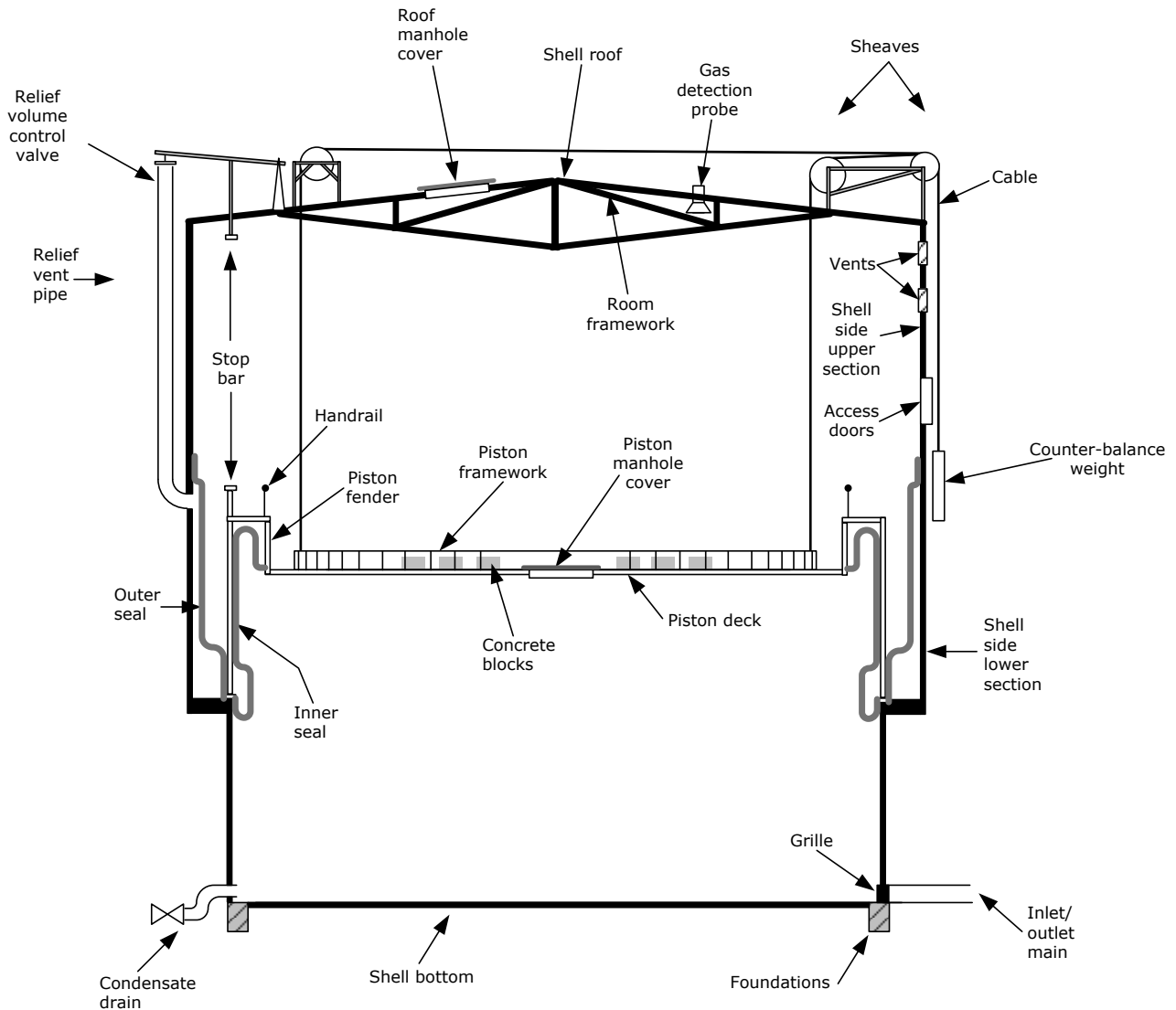
4.3.6 Guard rails and toeboards should be fitted to walkways on the:

- piston
- fender top
- piston framing, where the framing is higher than 0.7 m.

Where ladders descend through walkways, suitable barriers should be provided to prevent persons from falling through the opening.

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DESIGN - DRY (WIGGINS) GASHOLDER**FIGURE 4 - TYPICAL DRY (WIGGINS) GASHOLDER**



Note: This view shows the point where the piston fender has just made contact with the telescoping fender.

FIGURE 5 - CROSS-SECTION OF A TYPICAL DRY (WIGGINS) GASHOLDER

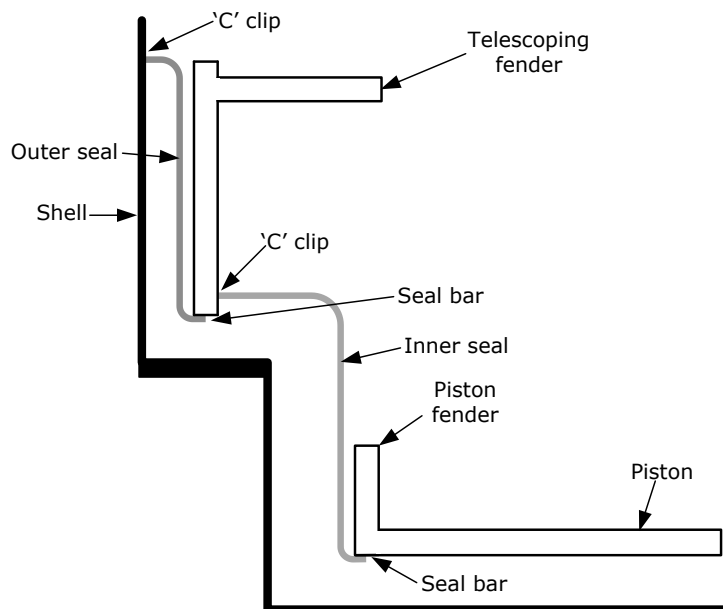


FIGURE 6 - TYPICAL SEAL OF A DRY (WIGGINS) GASHOLDER

4.4.1 Fabric seals should be specifically designed to suit the gas stored; thus care should be taken not to adulterate the gas by allowing it to become mixed with substances which could have a deleterious effect upon the fabric seals.

4.4.2 Side doors should have slots near the bolts so arranged that any bolt can be opened from inside the gasholder; this will permit escape through a previously closed doorway if piston movement renders this necessary. The slots will also permit the seal to be seen where this is overlying the door.

The bolts should be padlocked when the gasholder is in operation.

4.4.3 A large diameter, valved purging connection should be fitted as low as possible to the shell of the gasholder or to the gas inlet connection on the gasholder side of the main gasholder valve to facilitate purging.

Note: By this means, inert gas can be passed into the empty gasholder, inflating the seal and raising the piston, then passing out from the gasholder via the volume control valve which can be manually raised, or by special purge valves on the emergency gas vents and piston top.

If nitrogen is used as the purge gas, one of the drain valves at the base of the gasholder shell may be used, but in all cases care should be exercised to ensure that the temperature and contents of the purge gas will not cause damage to the seals.

Note: For additional information on purging, see Section 9.

4.4.4 Before the gasholder is taken into use, all plate edges, welds, etc., over which the seal may lie should be smoothed off so as to prevent damage to the seal.

4.4.5 The emergency gas vents should be designed for maximum instantaneous inlet flow plus a 10% margin.

Consideration shall be given to the provision of automatically operated flare stacks initiated by the position of the piston and other methods of diverting gas feed to prevent excessive system pressure, to avoid the accidental venting of gas through the emergency gas vents during normal operation.

If deposits are likely to build up in the volume relief valve pipes, appropriate actions should be taken to clean these when required.

4.4.6 The space through which any balance-weight travels should be fenced to a height of 2.4 m above ground level.

DESIGN – WATERLESS (M.A.N.) GASHOLDERS

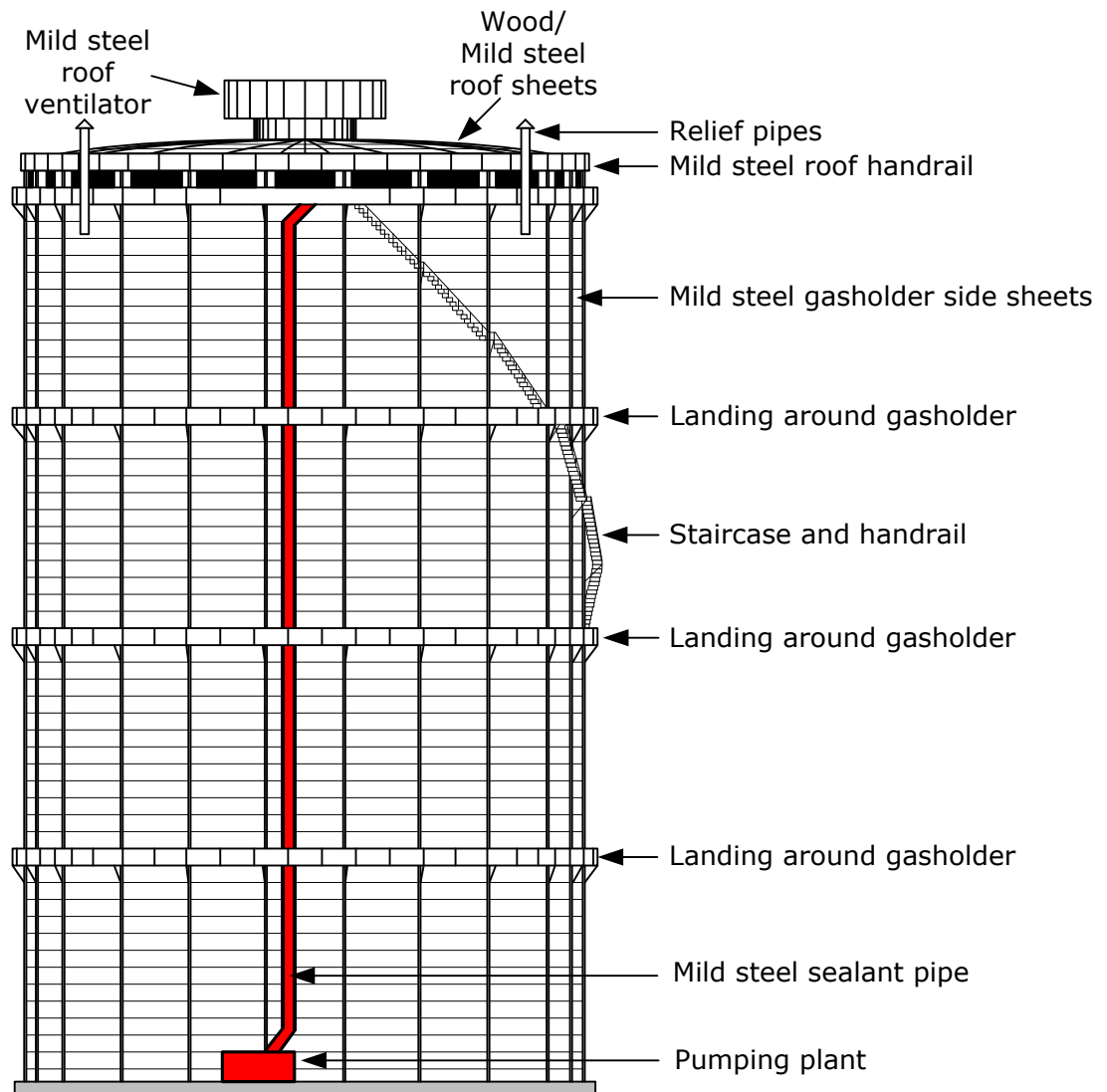


FIGURE 7 – TYPICAL WATERLESS (M.A.N.) GASHOLDER

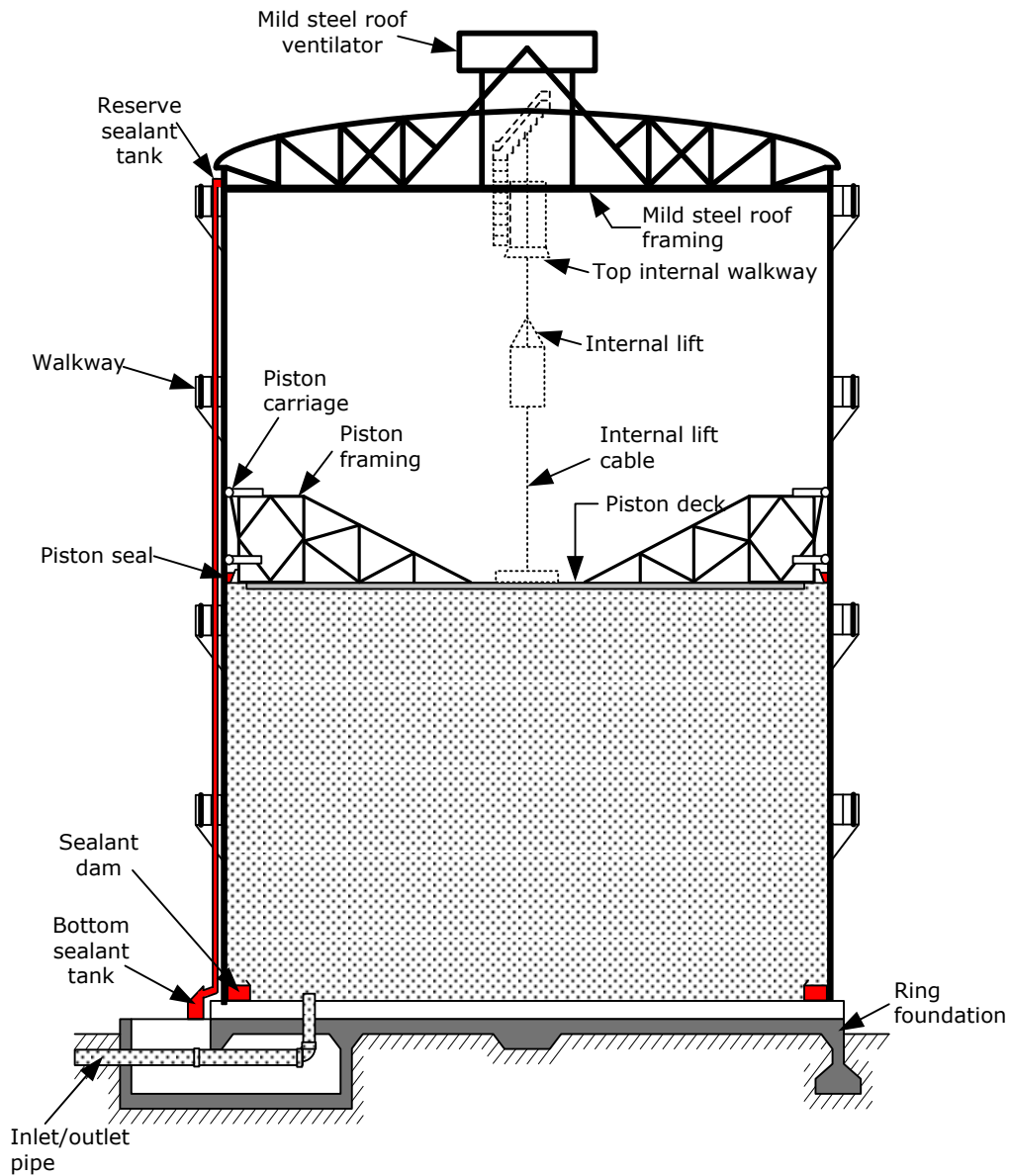
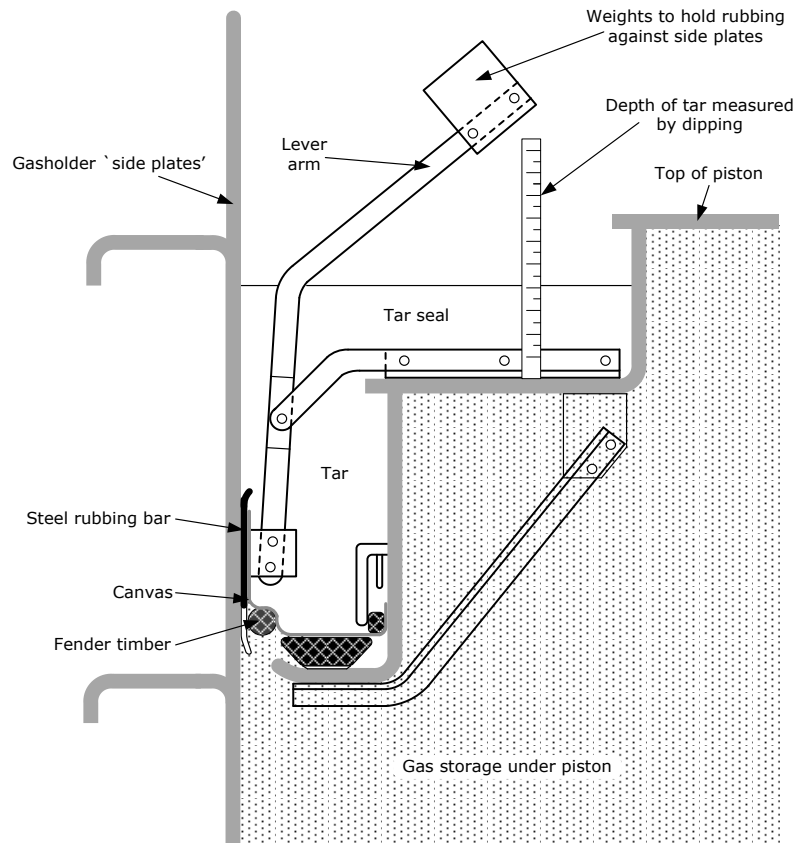
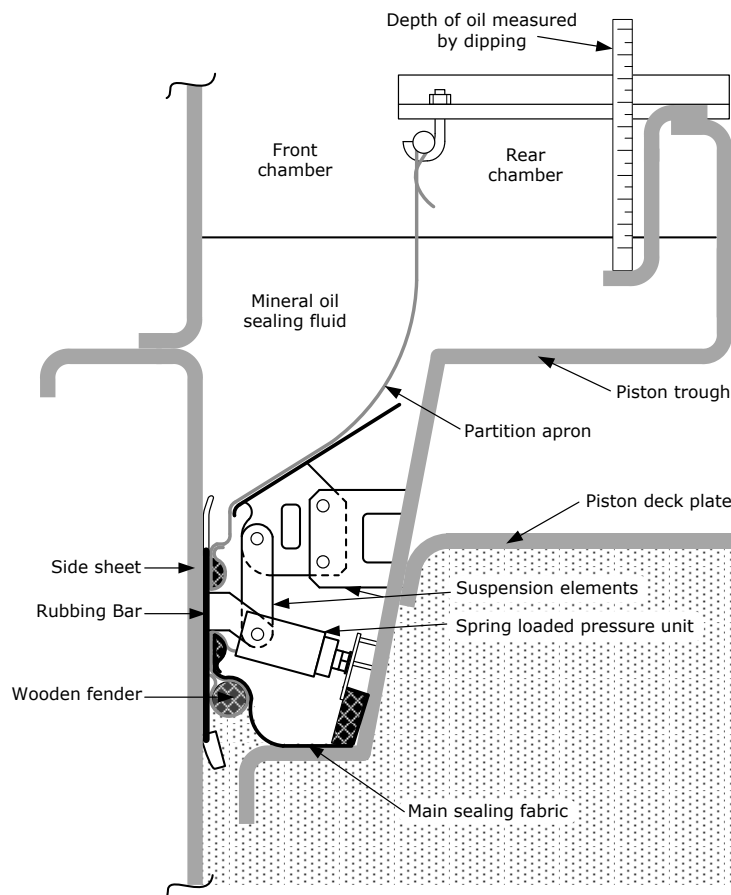


FIGURE 8 - CROSS-SECTION OF A TYPICAL WATERLESS (M.A.N.) GASHOLDER



Tar seal of a waterless (M.A.N.) gasholder



Oil seal of a waterless (M.A.N.) gasholder

FIGURE 9 - TYPICAL TAR AND OIL SEALS FOR WATERLESS (M.A.N.) GASHOLDER