LUSAIL DEVELOPMENT

Gas Distribution System
Design Guidelines for Mega-development and Sub-development

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CONTENTS

1 INTRODUCTION

The purpose of this document is to describe the works related to the supply, installation, testing, pre commissioning and commissioning of the buried gas pipelines for the gas distribution network at Lusail Development.

This guideline is applicable for the Mega-development and Sub-development.

2 SCOPE

Due to non-availability of Natural Gas the network shall be designed base on Synthetic Natural Gas with similar Wobbe index. Later in future when Natural Gas became available, the system will be converted to use Natural Gas without any major modification.

Marafeq is providing the guidelines for mega-development and sub-development whom undertaking the design and construction of synthetic natural gas distribution systems which will be connected to Marafeq's gas piping system within its supply areas which include:

2.1 Gas distribution systems

- Feeder Mains
- Distribution Pipelines
- Distribution Mains (MOP up to 4 bar)
- Gas Services (Gas Service Line)

2.2 Gas utilization systems:

- Pressure Reducing Station (Customer Primary Meter) Installations

The scope of this Design Guidelines is the design basis of Marafeq's synthetic natural gas distribution and associated utilization systems within its gas supply areas.

3 DEFINITIONS

- Client – The master developer Lusail Real Estate Development Company (LREDC) or its appointed representative.
- Contractor – The organization or its appointed representative, responsible for execution of the works
- Competency - The possession of a minimum level of knowledge, experience and proficiency required to collect appropriate information, make informed decisions, and physically take the needed actions to deliver the high-quality service of gas piping system installation.

- Customer – The owner/ sub-developer in-charge of the building.
- Engineer – Marafeq's supervision engineer or its appointed representative.
- Marafeq – The utility company which provides District Cooling, Gas supply and Waste Management services.
- Mega-developer – The owner of the district.
- Sub-developer – The owner of the building.
- Vendor – Any invited companies being fully eligible to submit the tender. The successful vendor will be the contractor or supplier.
- Supervising Consultant – Customer appointed representative.

4 COMPETENCY

Any contractor or person engaged in the design, construction, commissioning, inspection, operation, maintenance or alteration of a pipeline should be competent to carry out such work. This may achieved by an appropriate combination of education, training and practical experience.

5 OBJECTIVE

The Design Guidelines forms a part of a suite of technical documents and provides a platform for:

- Engineering instructions
- Management procedures
- Work Procedures
- Method statements
- Minimum functional specifications
- Material specifications

The objective of the Design Guidelines is to define the basis for the design of synthetic natural gas distribution and utilization systems.

6 DESIGN PRINCIPLES

The key design principles that shall be adhered to are:

- In all matters, the overriding goal is safety
- Adoption of the best international practices utilizing appropriate modern technology.
- In addition the design principles shall include:
- Protection of customers, public, property and environment from injury, damage or harm.

- Assurance of a safe, reliable, effective, efficient and secure supply of natural gas to consumers.
- Achievement of a financially viable investment.

These principles shall be achieved by:

- Making provisions to reasonably mitigate the risk and consequences of system failure, naturally occurring hazards or third party interference.
- Optimizing the use of the entire synthetic natural gas system during its operating life cycle.
- Ensuring that any design is appropriate to serve current demands yet is flexible enough to serve markets which are identified as being available during the design period.
- Ensuring that the scope of impact of failure of one or more components on the gas supply to consumers can be controlled and localized.
- Minimizing the complexity of the system from both the construction and operational stand points.
- Providing synthetic natural gas measurement data for gas system management and fiscal purposes.

7 DESIGN CRITERIA

The key design criteria that shall be adopted to are:

- The upstream synthetic natural gas supply shall be considered to be suitable, constant and adequate to supply the peak demand as stipulated in the gas purchase contract.
- To improve security of supply multiple sources shall be considered. Where possible, designs should allow for routine operation and maintenance without interruption of supply to consumers.
- Provision shall be made to incorporate means of control of synthetic natural gas flow within the distribution system including isolation of damaged facilities or components.
- The gas supply source pressure considered in design shall be determined based on the synthetic natural gas supply contract and upstream design conditions.
- The distribution system shall be designed without compression.
- The distribution system shall be adequate for the design load at each stage of its development.
- Distribution system shall be designed to supply a forecast hourly peak demand.
- Distribution system design shall be based on the predicted peak hour flows anticipated twenty five (25) years ahead.
- The load that shall be applied during design should be diversified. Considerations in determining the load diversity should include the nature of the facility being designed, the type of load and the number of consumers.

- The load diversities for pipelines, pressure reducing stations and mains shall be the same. However this load diversity is different from that used for gas services, meter sets and utilization piping systems.
- Designs should minimize the types and size range of materials and use only material items for which approved Material Specifications exist. All materials should be suitable for local climatic conditions.
- All materials, assemblies and installations shall assure correct functionality and full operability taking due account of ambient conditions of the location.
- The design shall allow construction to be undertaken using existing and/or reasonably available methods, tools and equipment. Where appropriate industry best practices shall be utilized.
- The design shall be prepared considering the location of other utilities plant or obstructions, where known.
- The design shall include provision for Gas Services to be installed to every plot and/or building.

8 DESIGN PARAMETER

The following design parameters have been adopted by MARAFEQ due to the nature of the specific local environment in which the synthetic natural gas distribution systems must be constructed.

Synthetic Natural Gas specification shall be based on the table below:-

In the assumption that the gas specification as given below:-

1. Propane Calorific Value at 2514 Btu/cf and Specific Gravity at 1.5
2. Butane Calorific Value at 3280 Btu/cf and Specific Gravity at 2.01
3. Natural Gas Calorific Value ranging from 960 Btu/cf to 1105 Btu/cf and Specific Gravity of 0.56 to 0.66

No.	LPG Source	Calorific Value	SNG Calorific Value	Wobbe Index	SNG Specific Gravity	Maximum Operating Pressure
1	*LPG	Net 2887 Btu/cf	1518 Btu/cf	1283	1.399	2 Bar
2	*LPG	Gross 3129 Btu/cf	1545 Btu/cf	1283	1.449	2 Bar
3	**Natural Gas	960 to 1050 Btu/cf		1283 – 1385	0.55 to 0.66	4 Bar

Notes: **LPG information from WOQOD LPG chemical composition table Appendix 2*

*** Natural Gas information for gas specification Appendix 3*

- Distribution and service line Maximum Operating Pressure (MOP) design shall be 2 bar and minimum operating pressure shall be at 1.2 Bar for SNG system.

- Distribution and service line Maximum Design Pressure shall be at 7 bar.
- Natural Gas Maximum Operating Pressure shall be at 4 bar.

9 CODES, STANDARD AND SPECIFICATIONS

The Gas Distribution Network to be installed at a minimum, to comply with the recommended standards and codes of practice listed below.

9.1 Institution of Gas Engineers & Managers (IGEM):

- IGE/TD/3 Edition 4; 2005 “Steel and PE pipelines for gas distribution”
- IGE/TD/4 Edition 4: PE and Steel gas services and service pipe work.
- IGE/TD/3 Edition 4 Supp1: Handling, transport and storage PE pipes and fittings
- IGE/GL/9: Guidance for large consumers in dealing with Natural gas supply emergencies
- IGE/SR/24: Risk assessment techniques
- IGE/SR/25: Hazardous area classification of Natural gas installations.
- IGEM/TD/13 Ed 2: Pressure regulating installations for Natural Gas, Liquefied Petroleum Gas and Liquefied Petroleum Gas/Air
- IGE/SR/22: Gas Purging and Commissioning Method.
- IGE/SR/23 2nd Imp: Venting of Natural Gas.
- IGE/GL/1; edition 2; 2005 “Planning of gas distribution systems of MOP not exceeding 16 bars”.
- IGE/GL/5; edition 2; 2005 “Procedures for managing new works, modifications and repairs”.
- IGE/GM/8 Part 1 Non domestic gas meter installation
- GBE/PL2 Technical Specification for Polyethylene Pipes and Fittings
- All IGE related Amendments and updates in September 2011.

9.2 British Standards Institute:

- BS EN 1555; Suite of European specifications for polyethylene pipe and fittings.
- BS EN 1295-1; Structural design of buried pipelines under various conditions of loading.

9.3 European Standards Institute:

- PrEN 1555-2: Plastics piping systems for the supply of gaseous fuels – Polyethylene (PE) – Part 2: Pipes.
- ISO 12007-2:2000; ”Gas supply systems – Pipelines for maximum operating pressure up to and including 16 bar – Part 2; Specific Functional recommendations for polyethylene (MOP up to and including 10 bar).

9.4 National Fire Protection Association:

- NFPA 58: Liquefied Petroleum Gas Code, 2011 Edition.
- NFPA 54: National Fuel Gas Code. 2011 Edition.

9.5 American Society of Mechanical Engineers

- ASME 31.8 Transmission and Distribution Piping System
- ASME 31.3 Process Piping
- ASME B16.5 Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard

9.6 Gas Industry Services, UK

- GIS V7 Specification for distribution valves - Part 1: Metal-bodied line valves for use at pressures up to 16 bar and construction valves for use at pressures up to 7 bar.
- GIS V7 Distribution valves Part 2: Plastics bodied valves of sizes up to and including 180 mm suitable for operation at pressures not exceeding 5.5 bar

9.7 Local Authority Regulations:

- WOQOD Gas Department Regulations.
- Qatar Construction Specification
- Qatar Civil Defense

10 DISTRIBUTION MAINS (MOP UP TO 4 BAR)

10.1 Design Standards

- IGE/TD/3 Edition 4 Steel and PE pipelines for gas distribution
- IGE/GL/1 Planning of Gas Distribution Systems Operating at Pressures not Exceeding 7 bar

10.2 Design Criteria

- Shall be buried.
- May be either polyethylene or steel.
- Within a contiguous network, one MOP pressure shall be utilized.
- Minimum pipe size for a main shall be 63mm for PE and 50mm for steel.
- 75mm, 200mm and 355mm PE are non-preferred pipe sizes.
- Maximum velocity as per IGE TD 3 requirement.
- Mains distribution pipe proximity limit shall be referred to IGE/TD/3 Table 5 (latest edition)

10.3 Feeder Mains

- Normally installed outside of sectors but may be installed through sectors.
- Supply small networks of mains installed within each sector.
- Extend from the outlet of a Primary Pressure Reducing Station (PPRS).
- If the gas distribution system is supplied by more than one Primary Pressure Reducing Station (PPRS) the feeder mains shall interconnect those Primary Pressure Reducing Station (PPRS). Where a gas distribution system is not back fed from another source then it should be looped
- May have branches
- Branches should be looped but may be single fed.
- Gas services should not be connected to feeder mains.

10.4 Sector Mains

- A sector should be served by one or more small networks of distribution mains installed within the sector.
- Gas services should be connected to sector mains in the network installed within the sector.
- The network shall allow for gas services to be installed to every residential and commercial premise in the sector.
- The network should be looped when serving more than 200 consumers.
- Looped networks may have single fed branches.
- Looped networks should have a dual supply from feeder mains outside the sector.

10.5 Mains Valves

- Strategic valves shall be installed per IGE/TD/3.
- Where expansion of the gas system is envisaged, provision for tie-ins shall be made. If the tie-in provision is a valve it shall be a strategic valve:

10.6 Feeder Mains Valves

- spacing should typically not exceed 800m
- should be installed on either side of special crossings and major river or estuary crossings
- should be installed at branch connections

10.7 Sector Mains Valves

- Not normally installed within a sector other than at the connection to feeder mains
- Strategic valves should be double block and bleed type and be installed with body bleed extended to a point near the ground surface to allow safe venting.

10.8 Design Parameters

- Network Maximum Incidental Pressure (MIP) shall be determined considering:
- Material selection.
- Proximity distances.
- Site conditions.
- Minimum design operating pressures for pipelines within the distribution network should be 1.2 bar.

11 GAS SERVICES DESIGN BASIS

The primary function of a gas service is to transport synthetic natural gas from a distribution main to service isolation valve (SIV). Each gas service shall be sized to deliver the quantity of synthetic natural gas that meets the connected customer requirements. A gas service is the takeoff from distribution line to each individual plot.

11.1 Design Standards

- IGE/TD/3 Steel and PE pipelines for gas distribution
- IGE/TD/4 Gas Services
- IGE/GL/1 Planning of Gas Distribution Systems Operating at Pressures not Exceeding 7 bar

11.2 Design Criteria

Functionality of a gas service shall include:

- For some installations, a flow limiting device (FLV) shall be installed near the main for automatic restriction of gas flow in situations where excessive quantities of gas flow through the pipe as a result of damage to the gas service.
- For some customers, multi-occupancy buildings and commercial or industrial installations, an underground service isolation valve (SIV) shall be installed for manually isolating the supply of synthetic natural gas from the connected customers.
- For all installations and customers, a riser shall be from below ground to above ground.
- For all installations and customers, above ground pipe shall be that is thermally stable at ambient temperatures.
- For all installations and customers, an above ground ECV for manually isolating the supply of synthetic natural gas from connected customers.

Considering the required functionality gas services:

- Shall consist of both buried and above ground components from the main to the outlet of the Service Isolation Valve (SIV) and Emergency Control Valve (ECV).

- Should install only one gas service to a plot. Conversely, a single gas service should not serve multiple plots.
- May be dual (i.e. two services from a single service tee).
- Above ground service pipe shall be designed to take into account local climatic conditions.
- Services should be external to buildings.
- Minimum pipe size shall be 25mm HDPE.
- Service tee from main line shall be reducing tee or equal tee with reducer, no tapping/ saddle tee is allowed.

Considerations in the gas service configuration are:

- Underground Routing - The gas service shall extend underground from a connection to a distribution main. The gas service should be routed perpendicular to the main directly towards the plot boundary, building or plot external wall where synthetic natural gas is to be provided. Also underground gas service piping shall not:
- directly entering a building
- be routed through cellars, car parks and unventilated voids
- Services to Vacant Plots - Where services are to be installed to vacant plots they shall terminate at a safe location.
- Above Ground Routing - Above ground section of the service shall be installed along a route external to the building. Piping shall not pass through unventilated voids.

11.3 Design Parameters

- Gas service size will be determined in accordance with the appropriate sections of IGEITD/4-Gas Services.
- Gas service sizing should be based on the diversified load, service length and minimum pressure at the inlet to the gas service:
- Design Load - The gas service shall deliver synthetic natural gas equivalent to the design load where the design load is the diversified load for all consumers receiving gas from the gas service.
- Diversity Factors - Diversity factors used in calculating the design load should be determined based on the type of consumer, the nature of gas utilization and the total connected load.
- For sizing the gas service length shall include the equivalent length of all valves and fittings, including the service tee and flow limiting device, that comprise the service.
- The maximum gas velocity within the gas service pipe shall be 15 m/s.
- The maximum pressure drop over the gas service length shall be limited to 20% of the minimum gas service inlet pressure.

12 PRESSURE REDUCING STATION (CUSTOMER PRIMARY METER)

It shall be referred to MARAFEQ Document for Pressure Reducing Station Guidelines No:

LUS-CPALL-MAQ-SPE-UT-0006.

13 RISK ASSESSMENT

Mega-developments shall comply with Marafeq requirements set out in the document no: LUS-CPALL-MAQ-SPE-UT-0007, all Risk Assessment shall be finalized with compliance statement to this Design Guidelines.

14 PRODUCTS (HDPE PIPES, VALVES AND ACCESSORIES)

14.1 HDPE High-density polyethylene pipe (Black Colour with Yellow Stripes)

All underground pipes are high density Polyethylene pipe of type PE 100, SDR 11 constructed according to code prEN 1555-2 or ASTM D 2513.

14.2 HDPE Fittings (Black Colour)

ASTM D 2683, socket-fusion type or ASTM D 3261, or UNI EN 1555-9:2004, Bar coded butt-fusion type with dimensions matching PE pipe.

14.3 HDPE Transition Fittings

Factory fabricated fittings with PE pipe complying with ASTM D 2513, or EN 1555, SDR 11 and steel pipe complying with ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B or ASTM A106 Grade B Schedule 40 or API 5 L Grade B Schedule 40.

14.4 Sleeves

For HDPE Pipe crossing under railway lines and sewage water lines) Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral water stop, unless otherwise indicated.

UPVC / GRP schedule 40 sleeves with 200mm concrete in casement as per normal practices.

14.5 PE Ball Valves

Polyethylene ball valve, with control bar constructed according to code UNI EN 1555-4:2004 or ASME B16.40.

Direct welding into PE pipe, by using socket fusion (125mm and below) or butt welding180mm and

above.

Full straight bore, no pressure loss

Ball polyethylene

Operating temperature -29º C to 60º

Operating pressure 7 bar

a. Body: PE.

b. Ball: PE.

c. Stem: Acetal / Galvanized Steel.

d. Seats and Seals: Nitrile.

e. Ends: Plain or fusible to match piping.

f. Operator: Nut or flat head for key operation.

g. Include plastic valve extension and or extension spindle for steel valve

h. Include tamperproof locking feature for valves.

15 JOINTING OF PIPES, FITTINGS AND VALVES

15.1 General

Only certified PE jointers shall be permitted to perform PE fusion jointing. Contractor shall provide original certificates of certified PE jointer from the issuing body to Supervising Consultant for approval.

A method statement of construction for PE fusion joints shall be submitted by Contractor for Supervising Consultant approval. Final approval shall be by Marafeq or its representative. This method statement of construction shall ensure that all fusion joints are of high integrity, and shall include, but not limited to:

a) Procedures for the operation, maintenance, periodic inspection and testing of fusion tooling and equipment.

b) A programme of update training for PE jointers, including the certification / re-certification of personnel to ensure their competency.

15.2 Electro-fusion Jointing

Electro-fusion in accordance with IGE/TD/3 standards shall be used for all PE jointing. Fully automatic butt fusion may be accepted by the Supervising Consultant and or Marafeq for use on special mains laying techniques e.g. directional drilling and large diameter pipes.

Barcode labeled or auto recognition electro-fusion jointing shall be used and all fittings shall incorporate fusion indicators.

The equipment used for joint construction shall provide fusion data in the form of a print out specific to each joint and shall in addition, include the operator identification reference. These print outs shall form part of the as laid records.

The electro-fusion control box shall deliver the correct fusion parameters to the electro-fusion fitting. A power generator shall provide the power requirements of the control box, taking into account the electrical characteristics of the control box.

Alignment clamps shall be used for all types of electro-fusion systems to minimize misalignment and movement during electro-fusion of the joint.

1) Pre-Joint Checks

a. Ensure that the correct jointing parameters for the machine and pipe being welded are checked with manufacturer's specifications.

b. Check the generator for sufficient fuel to complete the operation.

c. Check all welding equipment, in particular:

- The welding control box.
- The welding cables.
- The cable connectors.
- The fitting connections.

d. Pipe must be supported and well alignment.

e. Ensure pipe and fittings to be jointed are compatible with each other.

f. Fully scrapes pipe and/or spigot surfaces.

g. Clean equipment to ensure foreign particles do not contact pipe surfaces.

h. To control dust contamination, when possible welding will be carried out in a simple protective shelter. The floor or ditch should be covered by tarpaulin (or similar).

2) Jointing Process

a. Ensure correct fusion and cooling times are observed and adhere too.

b. Ensure all fusion indicators have raised. If not, cut out and make new weld.

c. Do not remove clamps from fittings until cooling time has elapsed.

d. Always ensure mark the completed joints with the numbers issued from the electro fusion

control box along with date, time, jointer number and machine number.

15.3 Butt-Fusion Jointing

Fully automatic butt fusion will be utilized only for 90mm pipes and larger. The butt fusion equipment provides an electronic record that will be printed and retained as part of the construction records and made available to Marafeq through Supervising Consultant for review.

Each butt fusion will be assigned a number that is recorded on the fusion as-built drawing. The number and date will also be marked using an appropriate marker, on the external surface of the pipe adjacent to the fusion.

Cleaning of the heater faces will be undertaken by aborting a joint after heating as required but, at minimum, will be done on the first joint of the day and for each change of diameter.

During fusing the alignment of the pipe will be checked and monitored. Additionally the joint will be protected from contaminants (e.g. water, oil, dust, blowing sand.)

Manufactures recommended joint cooling time will be extended depending on the ambient temperature.

Completed Fusions will be subjected to an external visual inspection assessment. In addition to visual inspection, the external fusion bead will be removed and some internal fusion beads may also be removed. The removal beads will be subjected to testing (Refer IGE/TD/3 Edition 4 Appendix 7). Removed beads shall be numbered and all pieces retained in storage.

Pre-Joint Checks

a. Ensure that the correct jointing parameters for the machine and pipe being welded are checked with manufacturer's specifications.

b. Check the generator for sufficient fuel to complete the operation.

c. Check all welding equipment. In particular:

- The clamps must be effective in holding pipe square.
- The trimmer blades must be clean and sharp and the trimmer must be square with power in reverse to ensure a clean cut.
- The heater plate must have a control system capable of maintaining a uniform temperature over the area in contact with the pipe.
- The hydraulic system must be effective and a gauge must be attached which can accurately resolve pressures to be used.

d. Pipe must be supported and well alignment.

e. Clean equipment to ensure oil and grease do not contact pipe surfaces.

f. To control dust contamination, welding is carried out in a simple protective shelter. The floor should be covered by tarpaulin (or similar).

g. To ensure that heater plate is fully clean a dummy weld every time the plate has been allowed to cool will be completed.

h. Dummy Welding: To ensure that contamination does not affect welds in installed pipes, it is necessary to make a dummy weld at the start of any welding session after the plate has been allowed to cool. It is only necessary to follow the welding cycle to the point where the pipe is snapped from the plate. Following cooling, the surfaces may be retimed to allow production welding to begin. Alternatively a scrap piece of pipe may be used and then discarded.

i. Do not remove clamps from fittings until cooling time has elapsed.

j. Always ensure mark the completed joints with the numbers issued from the electrofusion control box along with date, time, jointer number and machine number.

15.4 PE Welder Qualifications

The PE Welder shall have a test certificate including the following:

- Welder name, photo and nationality.
- Employer name.
- The third party name/ qualification.
- Welder qualification record number.
- Pipe material specifications.
- Date of test.
- Validity for the certificate.
- Type of qualification tests.
- Weld form.
- Welding position.
- Code/testing standards.
- Qualifying criteria/rating points.
- Pipe size of welding process.

16 STEEL PIPE, FITTINGS AND VALVES

There are some special cases where it is needed to use steel piping instead of the HDPE piping, some of these cases are the above ground crossings (Bridges) and in special cases were the use of steel is recommended by the standards and Marafeq. The use of steel material shall be Sch 40 minimum and all pipes, fittings and valves should be designed and installed as per the standards and installation requirements below:

16.1 Pipe and Fittings Codes and Standards:

The used steel pipe material and fittings shall be Schedule 40 minimum. Pipes and fittings such as elbows, tees & flanges shall comply with the following specifications

- ASTM A106 Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
- API 5 L Grade B Specification for Line Pipe
- A105/A105M- Standard Specification for Carbon Steel Forgings for Piping Applications
- ASTM A 234 WPB - Standard Specification for Piping Fittings
- ASME/ANSI B 16.5 - - Pipe Flanges & Flanged Fittings
- ASME/ANSI B 16.9 - Factory made wrought steel butt welded fittings
- ASME/ANSI B 16.25 - Butt welded ends
- ASME/ANSI B16.11 Forged Steel Fittings, Socket-Welding and Threaded
- ASME B31.3 :Main Reference Code - Process Piping
- ASME II Part A :Ferrous Material Specifications
- ASME II Part C :Specifications for Welding Rods, Electrodes, and Filler Metals
- ASME II Part D Properties (Customary) MATERIALS
- ASME V :Non-destructive Examination
- ASME IX :Welding and Brazing Qualifications
- ASTM A370 Rev A: Standard Test Methods and Definitions for Mechanical Testing of Steel Products
- API 1104 Welding of Pipelines and Related Facilities
- ASTM: All ASTM relevant materials standards.
- AWS D10.11M/ANSI D10.11 Guide for Root Pass Welding of Pipe without Backing Strip.
- AWS A2.4 :Standard Symbols for Welding, Brazing, and Non-destructive Examination
- AWS A3.0: Standard Welding Terms and Definitions.
- AWS A5.1/A5.1M :Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding
- AWS A5.5 :Specification for Low-Alloy Steel Electrodes for Shielded Metal Arc Welding
- AWS A5.17/A5.17M:Specification for Carbon Steel Electrodes and Fluxes for Submerged Arc Welding
- AWS A5.18/A5.18M :Specification for Carbon Steel Electrodes and Rods for Gas Shielded Arc Welding
- NACE MR 0175- 2001: Petroleum and natural gas industries — Materials for use in H2S-containing environments in oil and gas production
- AWS QC1: Standard for AWS Certification of Welding Inspectors (2007)
- AWS QC15: "Specification for the Certification of Radiographic Interpreters" (2008)

- API RP 2201: Safe Hot Tapping Practices in the Petroleum & Petrochemical Industries.
- API 570: Piping Inspection Code.
- ISO 3690: Welding and Allied Processes - Determination of Hydrogen Content in Ferrite Steel Arc Weld Metal.
- ISO 21809-2:2007, Petroleum and natural gas industries – External coatings for buried or submerged pipelines used in pipeline transportation systems - Part 2: Fusion-bonded epoxy coatings.

16.2 Steel Pipe

There are some special cases where it is needed to use steel piping instead of the HDPE piping, some of these cases are the above ground crossings (Bridges) and in special cases were the use of steel is recommended by the standards and the consultant. 3 mm corrosion allowance shall be considered when determining the pipe thickness.

Suitable 3 Layer Fusion Bonded Epoxy or Polyethylene coating shall be used for protection of pipe from corrosion. The details procedure of application the coatings to be submit by contractor.

16.2.1 Technical Details

Carbon steel pipes shall be either seamless or electric resistance weld.

The pipes shall be provided with mill certificates and shall contain at minimum all mechanical and chemical properties, heat number and production test results.

The wall thickness of the fittings shall match that of the pipe to which they will be welded.

Pipes with greater wall thickness will be acceptable provided the ends are counter bored to produce a wall thickness matching that of the fittings.

Pipe ends will be beveled for welding in accordance with ANSI B16.25.

Pipe shall be minimum ASTM A106 Grade B Schedule 40 or API 5L Grade B Schedule 40

Pipes ends shall be fitted with a protective dust cap prior to shipping.

16.2.2 Marking

Pipes shall be clearly and permanently marked with the following information:

- Manufacturer's name or trademark
- Size and wall thickness
- Schedule number or weight
- Material type number
- Heat number

16.3 Steel Fittings

Fittings such as elbows, tees, pipe support, bolt & nuts, gasket, flanges, hangers and expansion to be used shall be matching the material being used for steel pipes.

16.3.1 Technical Details

Fittings shall be manufactured from material with strength equal to or greater than that of the pipe and shall be suitable for welding to the line pipe. The wall thickness of the fittings shall match that of the pipe to which they will be welded.

Fittings with greater wall thickness will be acceptable provided the ends are counter bored to produce a wall thickness matching that of the pipe. Ends will be beveled for welding in accordance with ANSI B16.25. Flanges shall be welding neck with 1/16" raised face for Class 150 flanges. The material shall be of carbon steel.

16.3.2 Marking

Fittings and flanges shall be clearly and permanently marked with the following information:

- Manufacturer's name or trademark
- Size and wall thickness
- Schedule number or weight
- Material type number

16.3.3 Gasket, Bolt & Nuts

Gasket bolt & nuts shall comply with following specification:

- BS3381 – British Standard for gasket spiral wound
- ASTM A193 – American Society for Testing Materials Stud Bolts
- ASTM A194 – American Society for Testing Materials Nuts
- ASME/ANSI B16.21 – Non Metallic Flat Washers

16.4 Steel Valves

This specification details the minimum requirement for metallic ball valve or gate valve to be used for distribution mains and service line including aboveground valve suitable for maximum operating pressure (MOP) 4 bars.

16.4.1 Valve Codes and Standards:

- API 6D Specification for Pipeline Valves
- BS21 Pipe Threads for Tubes and Fittings Where Pressure - Tight Joints are Made on the Threads

- ANSI B16.34 Valves - Flanged, Threaded, and Welding End
- IGE/TD/3 Edition 4 2005 “Steel and PE pipelines for gas distribution”
- IGE/TD/4 Edition 4 PE and Steel gas services and service pipe work.
- API 607 Fire Test for Soft-Seated Quarter Turn Valves
- BS 5351 Specification for steel ball valves for the petroleum petrochemical and allied industries.
- ANSI B16.5 Pipe Flanges and Flanged Fittings
- API 6FA Specification for Fire Test for Valves
- API 598 Valve Inspection and Testing
- BS 6755 Part 1 Testing of valve, specification for production pressure testing requirement
- ASME B16.10 Face-to-Face and End-to-End Dimensions of Valves
- GIS V7 Part 1 Specification for Distribution Valves Part 1: Metal-bodied line valves for use at pressures up to 16 bar and construction valves for use at pressures up to 7 bar

16.4.2 Technical Details

All valves shall be non-lubricated type

All valves shall be turn clockwise to close, full bore and stop when fully open or close

All valves shall be metallic and manufactured with corrosion coated material

Valve shall be able to withstand 4 bar operating pressure and 7 bar test pressure

All valves shall have open and close indicators.

Valve shall be full bore type

Steel valve shall be used pipe size 200mm and above

Valve shall have feature of block and bleed facilities

Threaded purge valve shall be tapered according to BS21 standard

Flange end valve shall be according to ANSI B16.34 standard

Valve 50mm and below shall be lever operated and shall be capable being remove

Belowground valve material shall be off ductile iron material with corrosion coating

Belowground valve shall have downpipe adapter and or extension spindle for steel valve

Operating temperature from -29°C to 60°C

a. Body: Steel or Ductile Iron

b. Ball / Gate: Steel

c. Stem: Steel

d. Seats and Seals: Nitrile, NBR, for Secondary seat: Metal

e. Ends connection: Flange end to ASME B16.5 or PE pulp to GIS V7

f. Operator: Nut or flat head for key operation.

g. Include valve extension or street access down pipe adapter

h. Include tamperproof locking feature.

i. Specification for external painting and corrosion protection for belowground installation shall be incorporated

16.5 Cathodic Protection:

Cathodic protection is required for all underground steel piping and steel valves, the cathodic protection shall be installed as per the standards and the detailed drawings.

- NACE SP0169:2007 - Control of External Corrosion on Underground Metallic Piping Systems
- NACE TM 0497 - Measurement Techniques Related to Criteria for Cathodic Protection on Underground Metallic Piping Systems
- BS 7361-1:1991 - Cathodic Protection.

Cathodic Protection design shall have design life of 25 years as minimum.

16.6 Welding Qualification Record:

- The Procedure Qualification Record (PQR) sheets.
- The production Welder Procedure Specification (WPS).
- The WPS used for the qualification test.
- The procedure qualification data sheet, including dates & welders names, of the actual welding parameters applied to weld the test joint.
- The mechanical test results.
- The inspection and Non Destructive Test (NDT) results.
- The parent material test certificates indicating the chemical analysis and mechanical properties.
- Calibration certificates for the used equipment such as; thermometer, volt and ampere meters.
- Welder's certificates.

16.7 Steel Pipeline Welding Inspector Qualifications

- AWS QC1: Standard for AWS Certification of Welding Inspectors (2007).

- AWS QC15: "Specification for the Certification of Radiographic Interpreters" (2008).
- British Institute of Non-Destructive Testing (PCN) PCN Level 2 Weld Inspection.
- CSWIP-WI-6-92: Requirements for the Certification of Visual Welding Inspectors (Level 1), Welding Inspectors (Level 2) and Senior Welding Inspectors (Level 3) (fusion welding) in accordance with the requirements of BS EN ISO 17637:2011 (2011).

16.8 Inspection & Testing

Visual inspection will be done for fit-up, during welding and after welding.

The detail Non-Destructive Test (NDT) shall follow:

a. Production, field weld & repair weld - IGE/TD/3 (Operating pressure equal and more than 2 bar) – 100% Visual Inspection, Min 10% NDT of total weld joint and 100% for bridge crossing.

b. Production, field weld & repair weld - IGE/UP/1B (Operating pressure less than 2 bar) – 100% Visual inspection

Acceptance criteria for all welds shall be as per API 1104 - Welding of Pipelines and Related Facilities or as per the project specification and appropriately repaired and re-inspected. The results of the inspection shall be used to control the quality of welds.

The NDT for production welding will be done after the weld has cooled down to ambient temperature.

Welding requirement of pipeline shall also be referred to ASME B31.8 Transmission and Distribution Piping System.

16.9 Cost for NDT inspections and tests

The cost for welder qualifications and weld inspections shall be paid by the Contractor.

All costs for additional testing, or weld failure shall be paid by the Contractor. This includes costs for the testing firm and the Contractor’s own costs.

17 MATERIAL HANDLING AND STORAGE

The material transportation handling and storage is to be carried based on the IGE/TD/3 Edition 4.

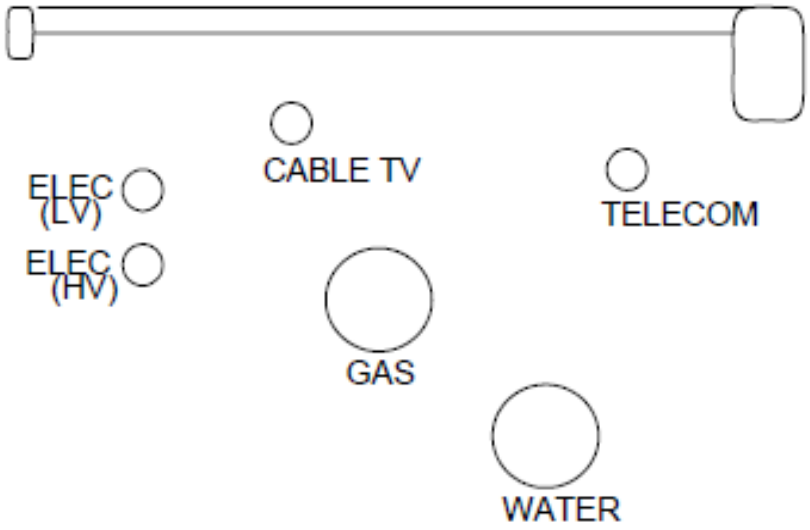
18 PIPE INSTALLATION

Mains pipe shall be laid to a minimum top cover of 1.00 m at all locations other than Special Crossings.

Marker tape and Tracer Wire shall be laid 400 mm above the pipe along the entire length of the mains.

Minimum clearance of the mains shall be 600 mm from electric cables, 500mm from sewage water

pipes, 250 mm from other utilities and 1200mm under roadway, railway lines in case of crossing and 1000mm in parallel with railway accessories. Where these minimum separation distances cannot be achieved, sleeve with concrete encasement or concrete slabs shall be installed between the mains and the cables utilities in question as per approved details.



The crossing on the railway groups with total width more than 20 meters is not allowed

The laying of the pipe and the making of connections shall be in accordance with IGE/TD/3.

During pipe laying operations the ends of pipes shall remain temporarily sealed with suitable stoppers.

The angle of intersection between a pipe crossing and the highway shall be as near to 90 degrees as practicable. In no case shall this be less than 30 degrees.

The minimum bend radius for the installation of PE pipe shall be 15D (D) = outside diameter of pipe). When a joint falls within the pipe bend section, then the minimum radius shall be 25 D.

The introduction of stresses shall be avoided during pipe installation, both in the polyethylene pipe or at joints.

During laying of pipes, the Contractor shall:

- Prevent the PE pipe from being damaged by contact with sharp materials during its installation.
- Ensure that the PE pipe is uniformly supported.
- Ensure that no rock or sharp object/stone impingement exists at the pipe soil interface.
- Ensure that when the pipe is laid within a sleeve, the sleeve ends to install pipe spacer in such a way that no stress or cutting effect can be transmitted to the HDPE pipe.

19 VALVE INSTALLATION

19.1 General

Full bore polyethylene ball valves / Ductile Iron Gate valves or Steel Ball valve shall be installed in the distribution mains system for the purpose of sectorisation and isolation where design requirements dictate and a service ball valve before each plot boundary. The installation of these valves shall comply with the following requirements:

19.2 Valve Locations

Valves incorporated into the HDPE distribution mains system shall be installed in compliance with IGE/TD/3 and as per approved shop drawings.

19.3 Pre-Installation

Prior to installation, all valves shall be checked for defects or damage.

All valves shall be thoroughly cleaned internally immediately prior to installation and all ends shall be kept closed with protective coverings when the valve is not being worked upon.

Following installation, and prior to commissioning, all valves shall be operated from open to closed and closed to open positions, respectively.

All parts or accessories shall be installed according to manufacturers' technical recommendations of this requirement.

19.4 Valve Installation Details

Valves shall be positioned so as to ensure unrestricted access and maintenance at all times. All valves should be installed as per the manufacturer's recommendations.

Purge points shall be installed either side of all main valves and these pressure points shall be 32 mm diameter reducing to 20 mm.

For valves of 200 mm diameter and above the valve shall include a gear assembly and for such valves a precast concrete blocks (PCC) or reinforcement cement concrete (RCC) chamber shall be provided so as to allow access to and operation of the valve/gear assembly. Valve size 200mm and above shall use Ductile Iron Gate valve with block and bleed capability.

For all service valves a surface box shall be provided 300 mm clear opening ductile iron cover while main valves shall have double triangular 600mm clear opening and also ductile iron cover. The surface boxes shall be installed flush with the ground surface and the valve spindle and pressure points shall terminate 100 mm below the underside of the cover. All ductile iron cover shall have client logo, "gas" marking and material standard stamp on it, refer to the Typical Manhole Cover Details drawing number LUS-CPALL-MAQ-DWG-UT-30306 in Appendix 4.

Security devices with valve identification markings shall be fitted to the spindle of valves to prevent un-authorized operation.

Aluminum or Stainless Steel marker plates shall be installed on either buildings or securely fixed posts adjacent to the location of all valves. The plates shall be coated with an epoxy type coating (colour white) and the required lettering shall be silk screened (colour black). The layout of the marker plate lettering and fixing arrangements shall be agreed with the Marafeq.

20 LABELING AND IDENTIFYING

20.1 Warning Tape

Acid and alkali-resistant PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of utility, coloured yellow at 400 mm above the top of the pipe a warning tape shall be laid along the length of the pipe.

20.2 Tracer wire

Metallic core encased in a protective jacket for corrosion protection detectable by metal detector. Contractor shall identify and supply suitable tracer wire metal detector. Minimum size for copper type tracer cable shall be 10 AWG. Warning tape could be incorporated with tracer wire or separated at 400 mm above the top of the pipe. A tracer wire shall be laid along the length of the pipe.

Completed installation of tracer wire should conduct a traceability and continuity test. The suitable machine shall be used to doing the test. Contractor to ensure all connection and tracer wire are in good condition and not damaged. If found any damage during testing, contractor to repair accordingly.

20.3 Marker Posts

Route marker posts complete with identification plates shall be installed each side of Special Crossings and at such other locations or where practicable, at changes in direction or as directed by Marafeq or its representative, for details refer to Typical Sign Board drawing no. LUS-CPALL-MAQ-DWG-UT-30302 and Typical Sign Board Details drawing no. LUS-CPALL-MAQ-DWG-UT-30303 in Appendix 5.

20.4 Stone marker

Stone marker for underground HDPE Pipe shall be installed for every 25 meter on any unmade areas, marker plate shall be installed on hardscape areas, marker pins for road crossing and where practicable, at any change of direction or as directed by Marafeq or its representative, for details refer to Typical Marking Pin drawing no. LUS-CPALL-MAQ-DWG-UT-30304 and Typical Stone Marker drawing no. LUS-CPALL-MAQ-DWG-UT-30304 and in Appendix 6.

21 TESTING AND COMMISSIONING OF PIPING

21.1 Scope

This specifies the minimum criteria to be adopted for pressure testing and commissioning of polyethylene and steel gas distribution mains and services operating at pressures up to 4 bar. Testing

and commissioning shall be in line with the requirement specify in IGE/TD/3, IGE/SR/22, IGE /TD/1.

21.2 Test pressure for Pneumatic Testing

The test pressure shall be 1.5 times the operating pressure of the system which is 4bar.

Prior to testing and commissioning, the pipes must be cleaned from any debris by carrying out pigging. Pigging procedure must be provided by Contractors doing the pipe installation for supervision consultant approval.

Intermediate pressure and low pressure testing criteria have been included in this specification to cover situations where the normal operating pressure of isolated sections of main must be reduced due to safety constraints.

The objective of the pneumatic test of polyethylene mains system and steel pipes is to prove the integrity of the system before commissioning.

The pneumatic test sets out to ensure that any leakage is within permissible limits (Permissible Pressure Loss).

The test shall take into account the fact that HDPE pipe creeps during the test, contributing towards any measured pressure loss.

21.3 Procedure for Testing

All Polyethylene mains and steel piping with a maximum operating pressure (MOP) of 4bar, shall be pressure tested in accordance with above mentioned codes but not less 1.5 MOP

Any part of the supply network which is constructed, diverted, altered or renewed and cannot be included in a sectional or overall pressure test i.e. a tie-in, shall be tested at the system Maximum Operating Pressure (MOP) using leak detection fluid. Such occurrences shall be minimized and shall be approved by the Supervising Consultant and final approval be by Marafeq or its representative.

Following a successful test, commissioning shall commence immediately or pressure to remain at certain level as directed by Marafeq or it representative.

21.4 Test Equipment

The minimum equipment shall be as given below:

- Suitable pressure instruments.
- Temperature thermometer.
- Pressure Gauges.
- Ball Valves.
- Barometer.
- Pressure & temperature recorder.

21.5 The criteria for testing are

a. That there will be a soak or stabilization period of at least 48 hours for the mains, before testing takes place,

b. The test duration shall be 24 hours or according to the volume calculations.

c. Pipe is SDR 11, PE 100 (HDPE) or carbon steel pipes Schedule 40 as minimum.

d. The reference test temperature is taken as 20ºC. (The temperature is likely to be higher than 20ºC in which case the creep allowance provided will be higher. Refer to IGE/TD/3 table A4.4).

The method of calculating the permissible pressure loss for a 24 hour test shall comply with section A4.2 of IGE/TD/3.

21.6 Safety Precautions

The precautions detailed below, shall be taken during the preparation and application of pneumatic tests.

- The piping system should be clean and free from any debris, dirt, waste particle and mud prior testing works. Suitable procedure to be taken consideration by contractor to implement the cleaning works.
- All caps, plugs, bends, tees and other fittings on mains incorporating flexible joints shall be restrained against any movement during the test.
- The trench shall be backfilled up to 200mm at least to secure the pipes in position before pneumatic pressure is applied.
- All temporary pipe, fittings and equipment fitted to the section of main under test shall be appropriately pressure rated.
- The stand pipe used for the purpose of pressurizing the main shall be fitted with a pressure relief valve to ensure over-pressurization of the main does not take place.
- Consideration shall be given to means of minimizing noise during pressurization and de-pressurization.
- Where the main is exposed and accessible to the public, notices warning that pressure testing is in progress shall be prominently displayed and the area securely cordoned off.
- Before final pressurisation commences a visual check shall be made to ensure that the test section is secure for pressurization.
- No person shall enter any excavation whilst the test pressure is being raised, the main is under test or the main is being depressurized.
- Throughout the duration of the test, the system shall be examined at regular intervals to ensure that all anchorage points are secure and that no hazards exist.

21.7 Testing Procedure

Testing and commissioning shall be carried out by competent person, and be

- Certified or approved by local authorities.
- Prior to pressure testing, the completed pipe work section shall be cleaned and free from construction debris and foreign matter.
- Mains to be tested shall generally be isolated into sections of and each section shall be tested individually unless there is no intermediate valve in between.
- Immediately upon satisfactory completion of the sectional tests, the whole of the main shall be subjected to a pneumatic soundness test at maximum working pressure 1.5 MOP.
- Following the satisfactory completion of the final tests, the main shall be purged and connected to the live main in accordance with IGE/TD/3 and the tie-in joints tested under operating conditions with leakage detection fluid.
- Mains which are not commissioned immediately following testing shall be de-pressurized and replaced with nitrogen at 2 bar for monitored appropriately. This pressure will maintain until commissioning works.
- Test instruments shall be fitted so that they can be read and operated without entering the trench or standing in line with the end of the main.
- Closed valves shall not be used as end caps. All valves shall be tested in their open position. Where a valve is fitted at the extremities of the main under test the valve shall be securely blanked and anchored against movement.
- Dry air shall be introduced under controlled conditions into the main or service until the appropriate test pressure is reached. Care shall be taken to ensure that the pipe-work is not subject to over pressurization.
- No person shall enter the trench whilst the test pressure is being raised, during the test or whilst the main is being depressurized.
- Before the start of the test period the temperature of the air in the pipe shall be allowed to stabilize before the test period is commenced. This shall be indicated by a stable pressure reading.
- When the test has been completed to the satisfaction of the Supervising Consultant and submitted to Marafeq or Engineer for final acceptance, the air pressure shall be released through suitable vents in a controlled manner until the whole of the main is at atmospheric pressure.
- The Supervising Consultant and or Marafeq or Engineer shall confirm by checking the gauges installed at all extremities that the pressure within the whole of the main has been reduced to atmospheric pressure. The Consultant shall record this information on the test certificate before authorizing further work to proceed.

21.8 Test Failure

Where the instrument reading after correction for barometric pressure and temperature readings shows a pressure loss greater than the calculated allowable pressure loss, investigations shall be carried out to find the leakage. All connections plugs and external fittings shall be re-examined for possible leakage by leak detection fluid.

If the leakage still happen after rectified all the visible connection and fittings, contractor to use other suitable method to find the leakages.

Any leakage on a HDPE fusion joint should not be repaired and the joint should be cut away and remade.

21.9 Pressure Test Certificate

Gas Contractor has to provide a Pressure test certificate as in appendix 1. The test certificates shall be certified or approved by Supervising Consultant and or Marafeq.

21.10 Commissioning

The purpose of commissioning is to gasifying the pipeline with fuel gas (SNG, NG or LPG). Therefore it is necessary to remove or purge the air, inert gas or nitrogen gas in the existing or new pipeline using the fuel gas. Two basic methods can be employed for the purging operation

a. Ram Purging- purge gas is fed continuously at one end of the pipe work and the gas mixture being vented off/flared at the other end under a steady and continuous condition until the total content of the pipe work is replaced by the purge gas

b. Cycle Purging (pressure and vent) – the content inside the closed pipe work system is diluted by introducing inert gas with minimum at 10% (Nitrogen) of the total pipe volume and then introduce the fuel gas into the pipeline. Once the pipeline is full with the inert gas and fuel gas, the mixture shall be vented off until gas percentage is 48 - 50% (SNG Gas) from the vented content (it shall be more than 95% for Natural Gas). This process is repeated until the required dilution off fuel gas/air is achieved or the replacement of the purge gas is completed.

The Gas contractor through their Supervising Consultant shall submit a detailed procedure with accompanying sketch(s) for all commissioning operations, 48 hours prior to the planned commissioning date. The procedures shall be subjected to the Marafeq approval.

The planning and execution of the commissioning of mains must avoid large networks and excessive lengths of feeder mains being commissioned at any one time.

The following criteria shall apply when planning and preparing a commissioning procedure:

- Looped sections of main shall be minimized and where the purge section contains a loop, it shall be physically isolated by closure of a valve
- Branch sections shall be purged simultaneously or sequentially.
- Flow stopping on live mains shall be by a double block and bleed system.
- Purge velocities shall not exceed 20 m/s
- All vent pipes shall be manned during purging operations and equipped with flame arrestors.
- Communications shall be set up to ensure safe co-ordination of activities.
- Pressures at all points shall be monitored throughout the commissioning operation and the minimum system requirements maintained.
- Tie in to existing gas pipes shall consider:
  a. Gasified system

b. Empty not in use system

c. Contractor to take consideration for tie-in works and submit the detailed procedure prior the activity.

22 CIVIL WORKS FOR PIPE LAYING

22.1 Design

Civil works for below ground service piping will be in accordance with:

- IGE/TD/3
- Project specifications
- The International codes, project requirements and requirements of the local approving authorities.

22.2 Existing Services, Utilities, etc.

Before commencement of any section of below ground works the Contractor shall identify the position of services, utilities, etc. on the proposed route. Utility location plans issued to the Contractor shall be studied carefully before digging operations are commenced. If necessary upon as directed by Marafeq, no objection certificates shall be acquired by the contractor from other utility services.

22.3 Trial Hole, Route survey, Excavation and Trenching

Trial hole by hand dig method shall be performed to verify the existing utilities and the below ground conditions.

Route survey should be conducted prior to the commencement of the construction.

Trench depths shall be sufficient to provide 1000 mm of cover to mains piping and service piping. Cover shall be measured to the top of the pipe. Trench widths shall be a minimum of 400 mm or pipe diameter plus 150 mm on each side of the pipe, whichever is the greater. However, where rapid trenching techniques are used the trench need only be of sufficient width to allow fine filling material to surround the pipe completely. The mains shall be protected against mechanical damage by means of concrete slabs or steel plates at a height of 150 mm above the gas pipes, be embedded in sand or soil and be compacted with backfill material firmly and evenly before making good of the road surface.

Excavation shall be by means of hand and/ or machine as expedient and it shall be the Contractor's responsibility to locate and protect all services, utilities, etc. encountered during excavation.

The width of the trench shall be maintained until commencement of backfilling and the Contractor shall be responsible for providing any necessary shoring and supports for such purpose, if required, and for ensuring the safety of workmen and other persons who may enter the excavated trench.

Excavations shall be kept free from water at all times and before commencement of excavation the

Contractor shall determine the water table level and, if considered necessary, install a well point dewatering system.

Trench bottoms shall be uniformly graded to provide a firm base for the pipe along its length. The bed and sides of the trench shall be free from loose stones and other sharp objects which may damage the pipe during or after installation. Pipe bedding should be free from stones minimum distance of stones away from pipe should be 150mm

22.4 Crossing

Sleeves and carrier pipes below roadway and railway shall be installed in accordance with the Authorities' requirements and shall have a minimum cover of 1,200 mm measured from the top of the pipe to the ground level.

Installation of road crossings by open cut methods shall be so scheduled to minimize interruption to site traffic and the Contractor shall co-ordinate such activities with the Supervising Consultant, Marafeq and other third party contractors.

Pipe crossing the road not meeting the minimum depth requirement shall be installed in sleeve with concrete encasement.

22.5 Proximity to other Services, Utilities, etc.

Minimum distances/spacing of 600 mm, 500mm and 250 mm shall be maintained between the mains and electric power cables, sewage water and other utilities/services/obstructions respectively and the Contractor shall be responsible for all additional excavation to ensure such distances/spacing are maintained. At locations where such separation distances are not physically achievable the Contractor shall provide and install precast concrete slabs between the mains and the cable(s) and the services/utilities in question, or sleeves with concrete encasement subject to the approval of the consultant. No other utilities are allowed to be laid in the Gas Corridor.

22.6 Backfilling and Reinstatement

Pipes shall be installed in a bedding, with consolidated stone free material (dune or wash sand), either selected from excavated materials or imported. The bedding shall be of 150 mm thickness.

The pipe surround shall apply 150mm on top of pipe by using stone free material. The sample of material shall submit in detail for Engineer's approval.

The trench shall be further backfilled and hand tampered, with stone free material (dune/wash) to a level 400 mm above the top of the pipe.

At this level a warning tape shall be laid along the length of the pipe. The tape shall be supplied in accordance with Warning Tape with tracer wire or as specified by the Marafeq. The trench shall be further backfilled to the finished level with the excavated material and compacted with a mechanical hand compactor. Backfill material should be well compacted to avoid trench settlement.

22.6.1 Surface Enclosure for Valves

The surface box should be constructed with either solid blocks or precast concrete. Blinding concrete

should be provided prior to installation of the pre-cast concrete/solid block. Bitumen coating should be provided on the surface of the plaster where it comes in contact with the soil.

22.7 Route Marking

Marker posts shall be installed at each side of Special Crossings and at other locations, specified by the Marafeq, where it is felt that the main could be susceptible to interference damage.

22.8 Reinforced Valve Chamber

The valve chamber shall be reinforcement cement concrete (RCC) type if falling under asphalt. Others than the road area precast concrete blocks (PCC) can be used. The standard chamber details shall be given by contractor to Marafeq for approval.

23 CONSTRUCTION RECORDS

The construction records shall include the following:

- Type and specifications of materials and fittings used with certifications.
- Test certification package.
- As-built drawings including details of surface construction, depth of cover, pipe protection, etc.
- Ground conditions (soil).
- Construction methods, including trenchless techniques.
- Welding procedure specification.
- Welder qualifications.
- NDT records.
- Quality control procedures and documentation.
- Inspection records.
- Pneumatic Pressure test records
- Soil compaction test results.
- Commissioning certificates.
- Handover documents.

24 DOCUMENTS TO SUBMIT PRIOR TO WORK

In order to assess the Contractor's proposal through Supervising Consultant , Marafeq, the Engineer's has the right to request the complete list of material, apparatus and various fittings that the Contractor envisages using for the execution of the work with the detailed manufacturers details associated with the selected materials and equipment.

During the work preparation period of 30 days, the Contractor, through its Supervising Consultant shall submit to the Marafeq or Engineer's:

- A detailed program for the work per construction phase. The work shall be in a multi-utility environment. The construction program should take into consideration the other utilities and adapt to this situation.
- Full set of shop drawings including layout plans and combined profiles.
- One set of complete detailed construction drawings for the work; these drawings shall provide all information necessary for their comprehension and verification.
- The design calculation notes, which may be supplied in different files for restitution to the Contractor after examination.
- If necessary, within a period of 15 (fifteen) days after return of the draft construction drawings accompanied by all observations by the Engineer, the drawing up of a new rectified drawing to take the observations into account.
- Detailed list of suppliers and specification of materials and equipment showing particularly the compliance with the Engineer specification.
- Method of statement including:
  - Description of the project.
  - Objectives-Execution of Work.
  - Scope and Major Activities needs to be completed before work start.
  - Reference Documents.
  - Personnel Responsibilities Matrix.
  - Material.
  - Material Storage, Transportation and Handling.
  - Instrument and Measurement Devices.
  - Methodology for Installation of Polyethylene Gas Pipe Network.
  - Objective, Pre Installation Check and Installation Works of the Network.
  - Health Safety and Environmental Plan.
  - Commissioning procedure included testing, cleaning, swabbing and or drying
  - Risk Assessment for the gas development work

This list is not exhaustive; the Engineer may ask the Contractor at any time for any specific construction or technical drawing.

25 QUALITY CONTROL

The Contractor should be able to document and demonstrate that all the activities relating to quality throughout the process from confirmation of order to design/development, purchasing, manufacturing and delivery to the customer have been carried out in a properly monitored and well organized fashion.

As a minimum, the Contractor should provide a quality manual in which the quality system is described. The areas of responsibility and authority with regard to quality should be clearly defined such that the performance of the system and the authority of the quality system manager can be assessed.

The quality system should be based on the requirements laid down in the international standard for quality systems, ISO 9001.

APPENDIX 1

TYPICAL PRESSURE TEST CERTIFICATES FORM IN: IGE/TD/3 Edition 4:

	Reference Number	Pneumatic Test Certificate Number
	.....	.....

GENERAL DETAILS
Project title:.....
Project reference: .....Drawing No.: .....
Start location: .....End location: .....
Pipework details (SDR-Pipe diameter- Length):.....
Design pressure:.....bar Test pressure: .....bar
MOP:.....bar
Test specification: .....
Associated hydrostatic pressure test certificate No.: .....

INITIAL PRESSURISATION
Witnessed by: .....Designation:.....
Date: .....Time: .....

TEST COMMENCED
Witnessed by: .....Designation: .....
Date: .....Time:.....

Conditioning time: .....hours Test period: .....hours
Creep allowance: .....mbar

PNEUMATIC REPORT	TEST 'ON'	INTERMEDIATE READINGS		TEST 'OFF'
Date/time				
Absolute pressure				
Ground/skin temperature				
Pressure correction				
Corrected pressure				

Gauge type: ..... Serial number: .....
Calibration date:..... Calibration expiry date:.....
Permissible loss: .....mbar Actual variance: .....mbar

Test Pass/Fail
(Delete as appropriate)
PASS
FAIL

Test accepted by: .....
Designation: .....Date: .....

TEST DE-PRESSURISATION
Witnessed by: .....Designation: .....
Date: .....Time: .....

APPENDIX 2

WOQOD LPG Gas Quality Report

وقود
WOQOD

LPG Chemical Composition

		% Gas Volume	% Liquid Volume
C2	Ethane	0.18	0.15
C3	Propane	18.35	16.27
iC4	Iso – Butane	19.85	20.90
nC4	Normal – Butane	60.75	61.65
iC5	Iso - Pentane	0.87	1.03
	Total	**100.00**	**100.00**

Heating Value	
Net Value Btu/Ft3	2886.87
Gross Value Btu/Ft3	3129.39
Net Value K. Cal/M3	25690.27
Gross Value K. Cal/M3	27848.41
Mol. Wt.	55.67

Ethyl Mercaptan injected into LPG at 1-2 LBS./10000 US Gals(12-24g/m3) liquid volume would provide sufficient Odorization for LPG to be detected in Air at less then 20% lel.

APPENDIX 3

Natural Gas Quality Report

GAS SPECIFICATIONS

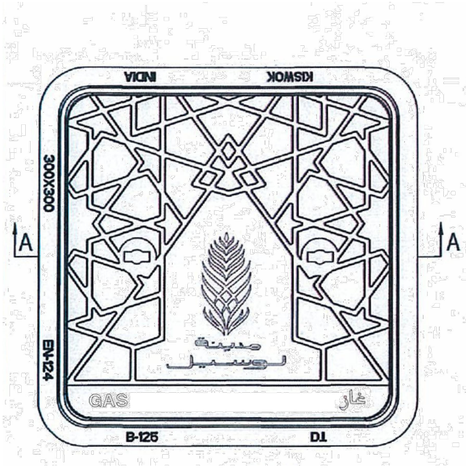
Parameter	Units	Minimum Specification	Maximum Specification
Gross Heating Value	BTU/scf	960	1105
Composition			
N2	mol %	None	5
CO2	ppmv	None	50
H_2S	ppmv	None	5
C_1	mol %	85	None
C_2	mol %	None	7
C_3+	mol %	None	4.85
Total Sulphur	ppmv	None	32
Water	ppmv	None	150
Mole Weight	Unitless	16.3	19
Wobbe Number	BTU/scf	1265	1385
Specific Gravity (Air = 1)	Unitless	0.56	0.66
Delivery Conditions:			
Pressure	Barg	1	5
Temperature	°C	5	50

Notes:

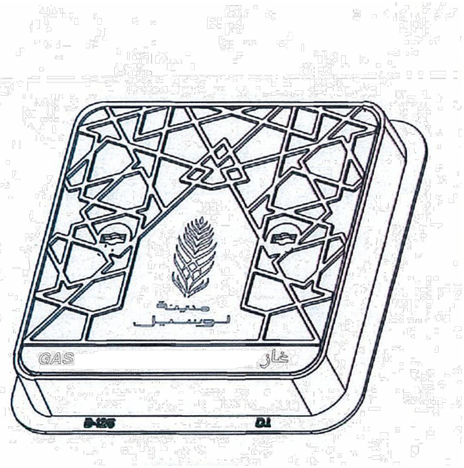
1. Under the "Minimum Specification" column, 'None' specification means any value between zero and the specified "Maximum Specification" value.
2. Under the "Maximum Specification" column, 'None' specification means any value between the "Minimum Specification" value and 100%.

APPENDIX 4

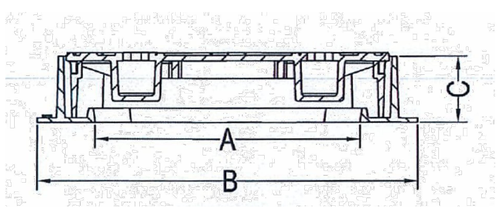
Typical Gas Manhole Cover drawing no. LUS-CPALL-MAQ-DWG-UT-30306



PLAN

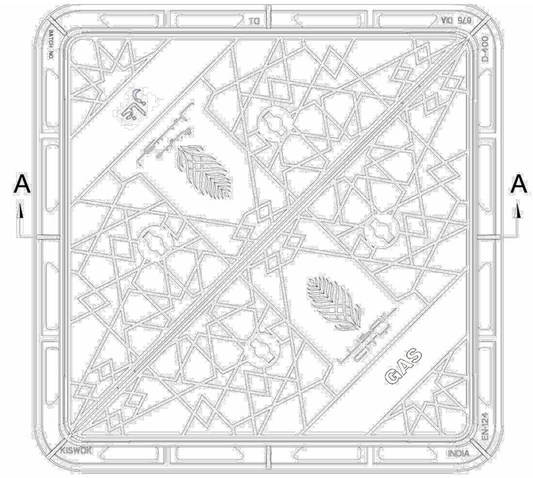


ISOMETRIC

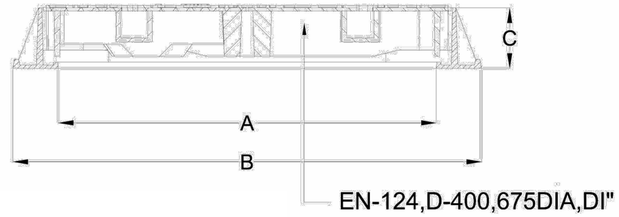


SECTION A-A

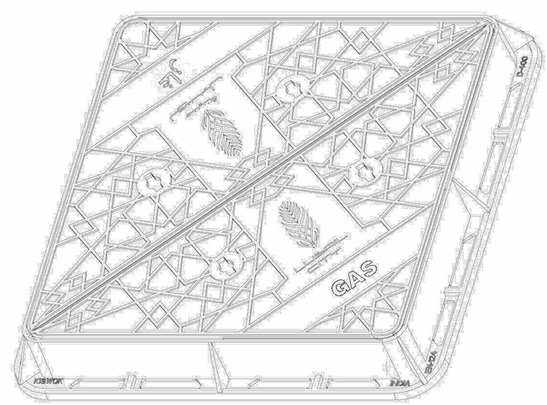
CLEAR OPENING (A)	OVER BASE (B)	DEPTH (C)
300 X 300	450 X450	75



TOP VIEW



SECTION A-A



ISOMETRIC

CLEAR OPENING (A)	OVER BASE (B)	DEPTH (C)
600 X 600	750 X750	100MM

KEYPLAN:

NOTES

1. ALL DIMENSION ARE IN MILLIMETERS AND LEVELS ARE IN METERS UNLESS OTHERWISE NOTED.
2. MARKING ON COVER AS PER COSTOMER'S REQUIREMENT

SPECIFICATIONS:-

TYPE: CLASS 'B' 125
LOADING - 125 KN
MATERIAL - DUCTILE IRON (500/7)
STANDARD - EN 124 D-400
PAINTING - 200 MICRON EPOXY COATING

FEATURES:-

NON-ROCK SEATING
CLOSED KEYHOLES
HEAVY DUTY FOR TRAFFIC LOADING
NON-SKID CHECKER DESIGN
PRY BAR SLOTS

DRAWING REFERENCE:

DRAWING NO.	DRAWING TITLE

REV	DATE	DESCRIPTION
0	09.04.12	ISSUED FOR INFORMATION

DRAWING TYPE:
DETAILED DESIGN

CLIENT:
QATARI DIARI
LUSAIL REAL STATE DEVELOPMENT COMPANY

UTILITIES PROVIDER:
Marafeq Qatar

PROJECT :
LUSAIL DEVELOPMENT

DRAWING NAME:
TYPICAL GAS MANHOLE COVER DETAILS

DRAWN BY:	P.K.S	DATE:	09.04.2012
CHECKED BY:	M.K.Y	DATE:	09.04.2012
REVIEWED BY:	A.ABUSHAIKHA	DATE:	09.04.2012
APPROVED BY:	D.R.PHILIPS	DATE:	09.04.2012

DRAWING NUMBER: LUS-CPALL-MAQ-DWG-UT-30306
REV 0

DRAWING SCALE:

APPENDIX 5

Typical Sign Board drawing no. LUS-CPALL-MAQ-DWG-UT-30302

Typical Sign Board Details drawing no. LUS-CPALL-MAQ-DWG-UT-30303

LUSAIL CITY

DANGER

GAS MAIN LINE

BURIED BELOW

BEFORE YOU DIG

CALL

XX-XXXXXXX

LUSAIL CITY

خطـــــر!

خط غاز رئيســـــي

مدفون في الأسفل

قبل أن تقوم بأعمال الحفر

اتصل بالرقم

XX-XXXXXXX

NOTES

DRAWING NO.	DRAWING TITLE

REV	DATE	DESCRIPTION
1	09.04.12	ISSUED FOR APPROVAL
0	30.04.12	ISSUED FOR COMMENTS

LUSAIL REAL STATE DEVELOPMENT COMPANY

مـــرافـق قـطـر
Marafeq Qatar

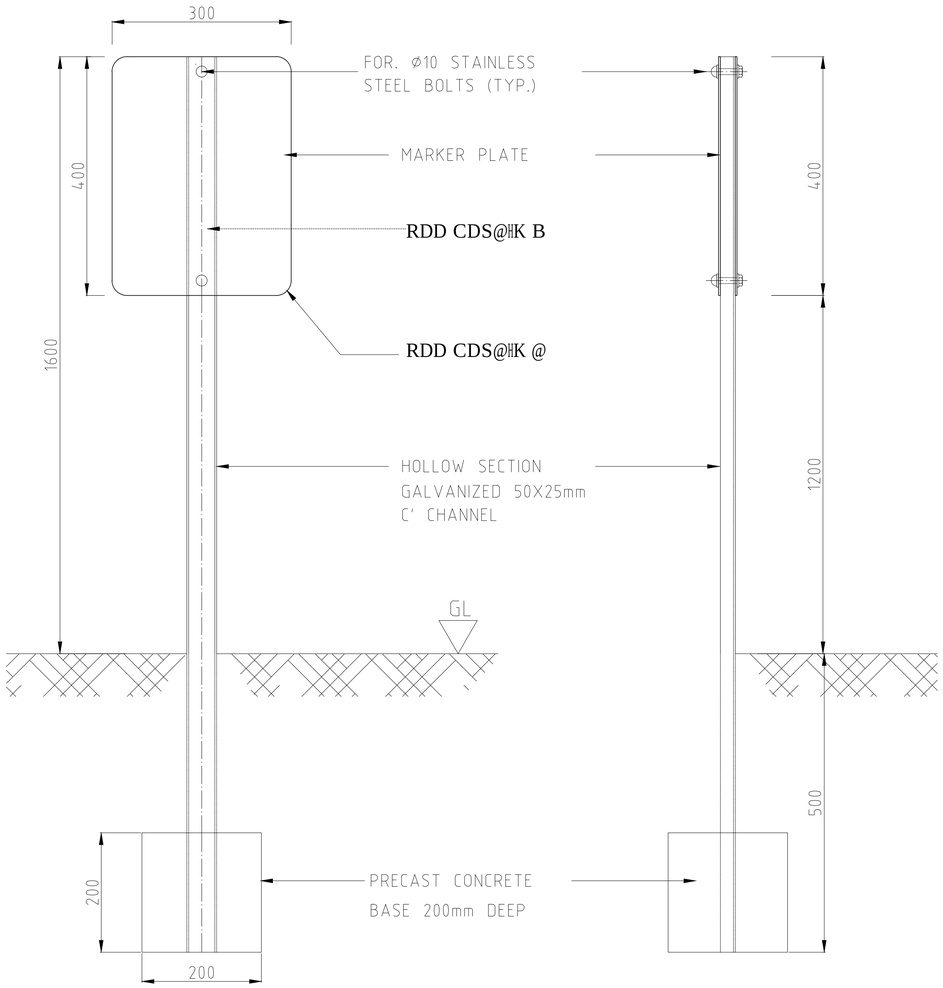
LUSAIL DEVELOPMENT
GAS DISTRIBUTION NETWORK

GAS PIPE LINE
TYPICAL SIGN BOARD

DRAWN BY:	P.K.S	DATE:	30.04.2012
CHECKED BY:	H. K	DATE:	30.04.2012
REVIEWED BY:	A.ABUSHAIKHA	DATE:	30.04.2012
APPROVED BY:	D.R.PHILIPS	DATE:	30.04.2012

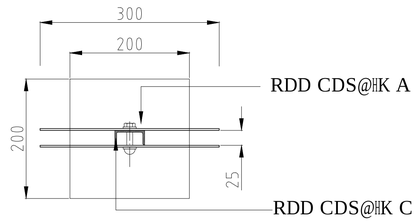
LUS-CPALL-MAQ-DWG-UT-30302 | REV 1

N.T.S @A1

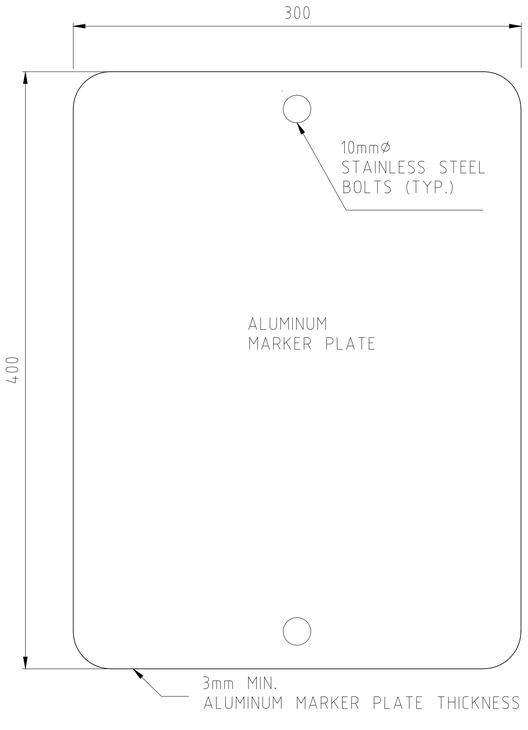


ELEVATION
SCALE 1:5

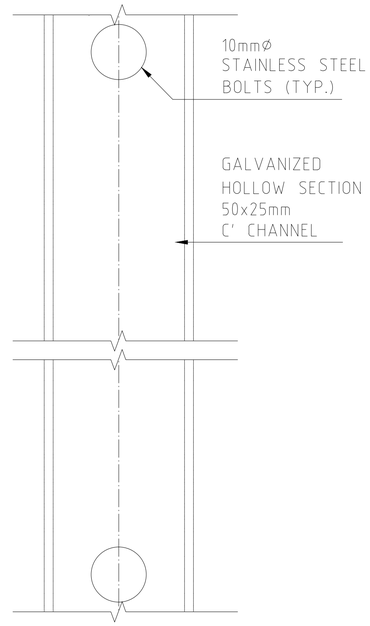
SIDE VIEW
SCALE 1:5



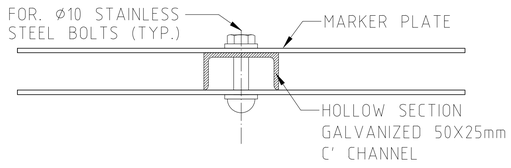
PLAN VIEW
SCALE 1:5



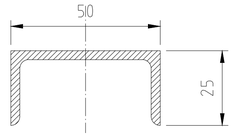
ENLARGED ELEVATION
SCALE 1:2 (DETAIL A)



ENLARGED ELEVATION
SCALE 1:1 (DETAIL C)



ENLARGED PLAN
SCALE 1:2 (DETAIL B)



ENLARGED PLAN
SCALE 1:1 (DETAIL D)

KEYPLAN:

NOTES

DRAWING REFERENCE:

DRAWING NO.	DRAWING TITLE

REV	DATE	DESCRIPTION
1	09.04.12	ISSUED FOR APPROVAL
0	30.04.12	ISSUED FOR COMMENTS

DRAWING TYPE:
DETAILED DESIGN

CLIENT:
LUSAIL REAL STATE DEVELOPMENT COMPANY

UTILITIES PROVIDER:
Marafeq Qatar

PROJECT :
LUSAIL DEVELOPMENT
GAS DISTRIBUTION NETWORK

DRAWING NAME:
GAS PIPE LINE
TYPICAL SIGN BOARD DETAILS

DRAWN BY:	P.K.S	DATE:	30.04.2012
CHECKED BY:	H. K	DATE:	30.04.2012
REVIEWED BY:	A.ABUSHAIKHA	DATE:	30.04.2012
APPROVED BY:	D.R.PHILIPS	DATE:	30.04.2012

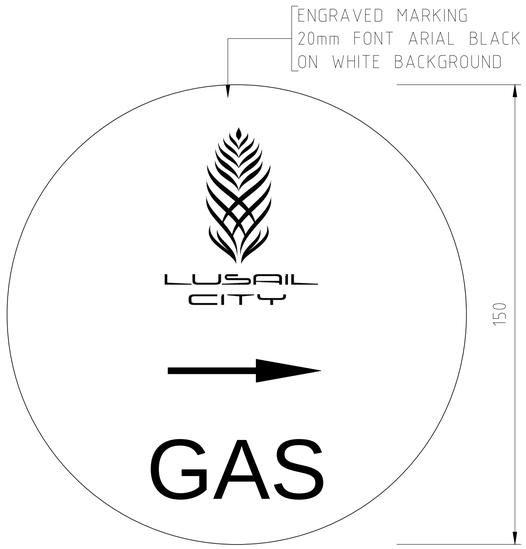
DRAWING NUMBER: LUS-CPALL-MAQ-DWG-UT-30303
REV: 1

DRAWING SCALE: AS SHOWN @A1

APPENDIX 6

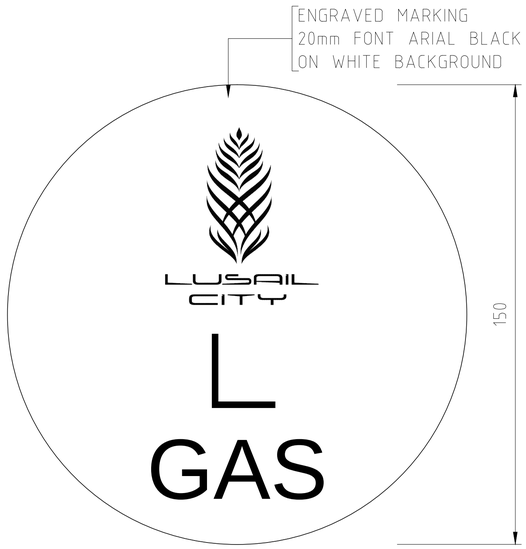
Typical Pin Marker drawing no. LUS-CPALL-MAQ-DWG-UT-30304

Typical Sign Board drawing no. LUS-CPALL-MAQ-DWG-UT-30305



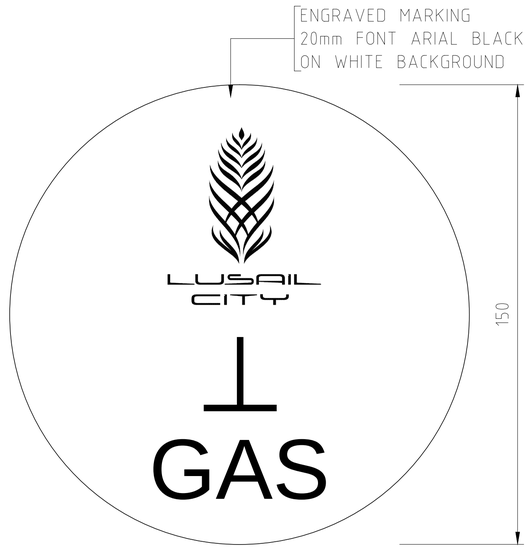
PLAN VIEW

STRAIGHT PIPE LINE



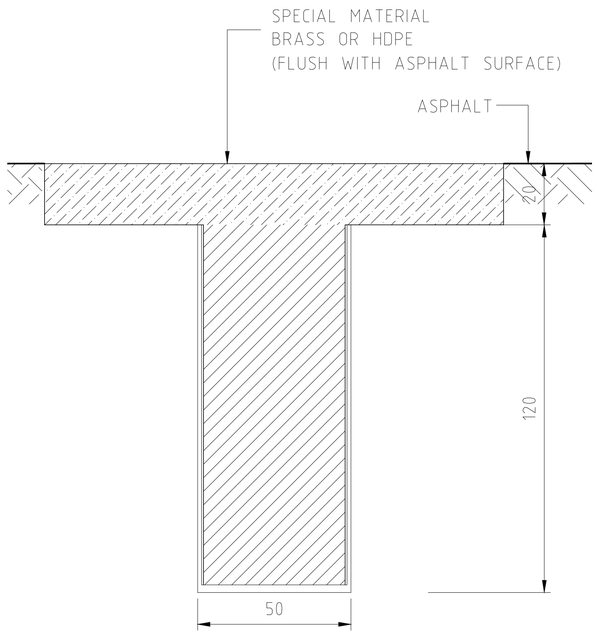
PLAN VIEW

TURN (CHANGE IN DIRECTION)



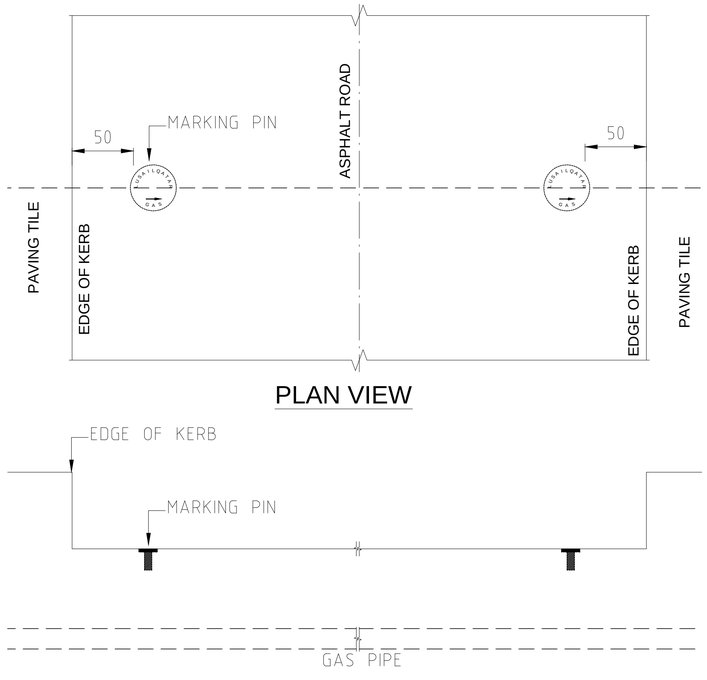
PLAN VIEW

T - CONNECTION



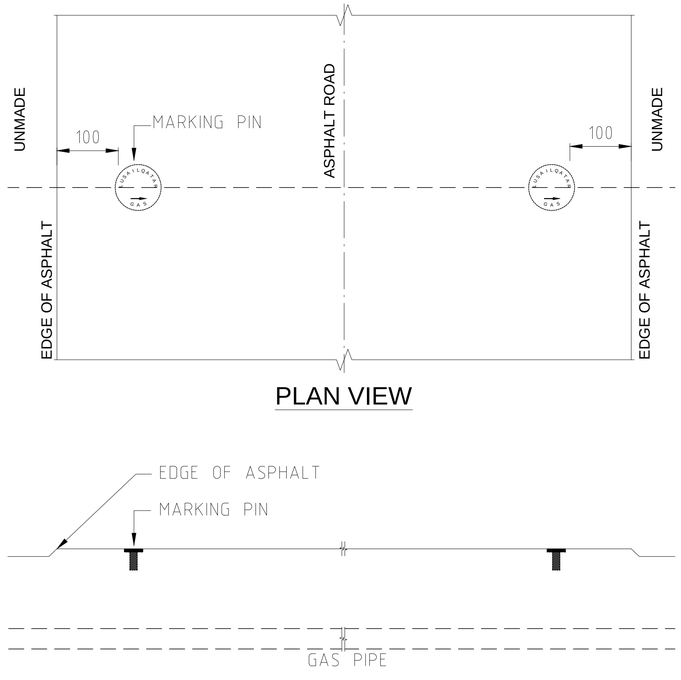
SECTION VIEW

DETAILS MARKING PIN



SECTION VIEW

POSITION OF MARKERS IN ROAD



SECTION VIEW

KEYPLAN:

NOTES

ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE STATED.

LEGEND

- STRAIGHT PIPE LINE
- T - CONNECTION
- TURN (CHANGE IN DIRECTION)

DRAWING REFERENCE:

DRAWING NO.	DRAWING TITLE

REV	DATE	DESCRIPTION
1	09.04.12	ISSUED FOR APPROVAL
0	30.04.12	ISSUED FOR COMMENTS

DRAWING TYPE:

DETAILED DESIGN

CLIENT:

LUSAIL REAL STATE DEVELOPMENT COMPANY

UTILITIES PROVIDER:

Marafeq Qatar

PROJECT :

LUSAIL DEVELOPMENT

GAS DISTRIBUTION NETWORK

DRAWING NAME:

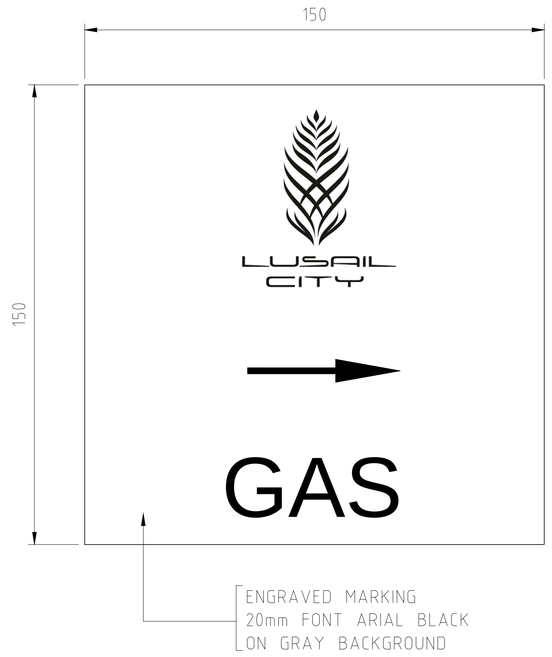
GAS PIPE LINE
SURFACE MARKER
(TYPICAL MARKING PIN)

DRAWN BY:	P.K.S	DATE:	30.04.2012
CHECKED BY:	H. K	DATE:	30.04.2012
REVIEWED BY:	A.ABUSHAIKHA	DATE:	30.04.2012
APPROVED BY:	D.R.PHILIPS	DATE:	30.04.2012

DRAWING NUMBER: LUS-CPALL-MAQ-DWG-UT-30304

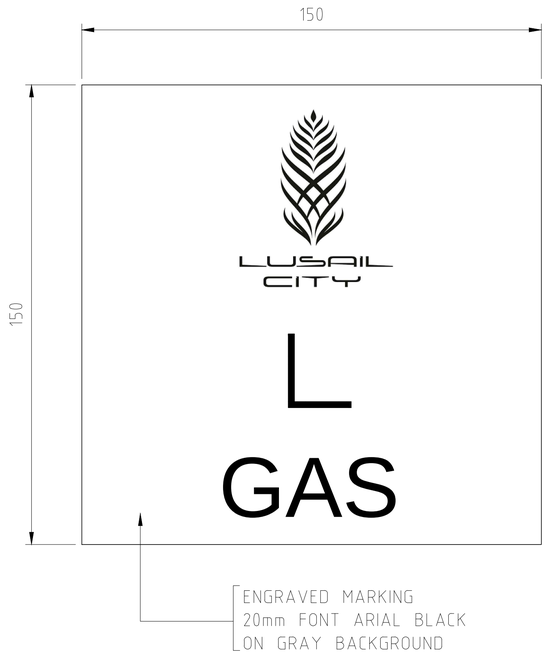
REV: 1

DRAWING SCALE: NTS @A1



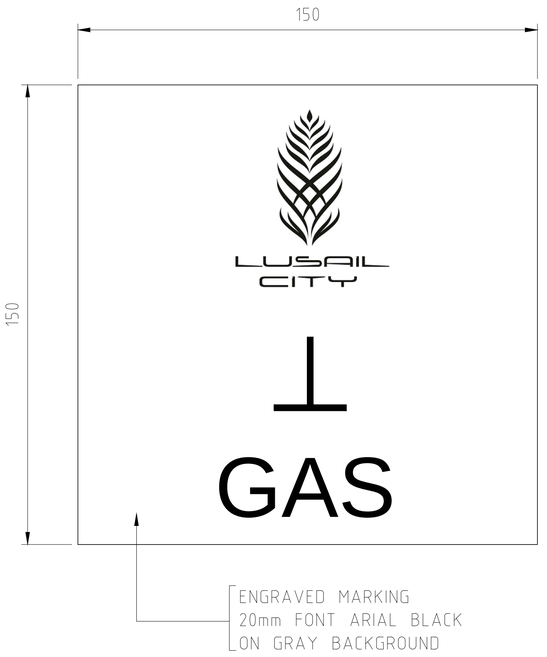
PLAN VIEW

STRAIGHT PIPE LINE



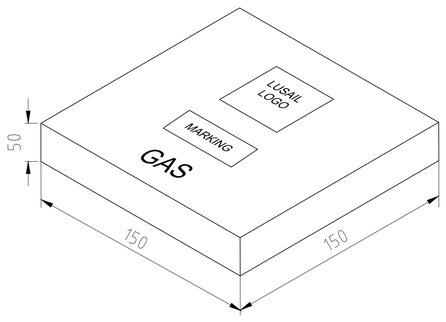
PLAN VIEW

TURN (CHANGE IN DIRECTION)



PLAN VIEW

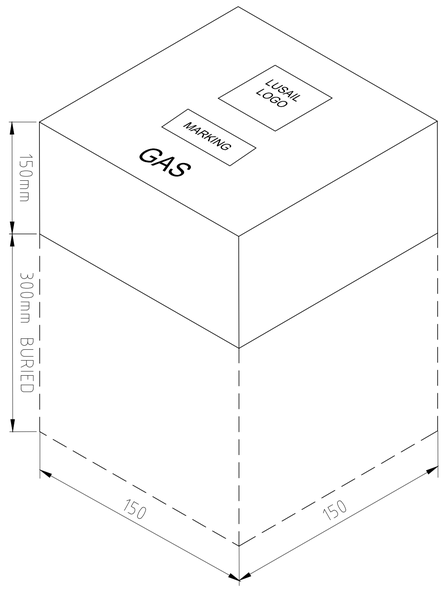
T - CONNECTION



ISOMETRIC VIEW

STONE MARKER FOR

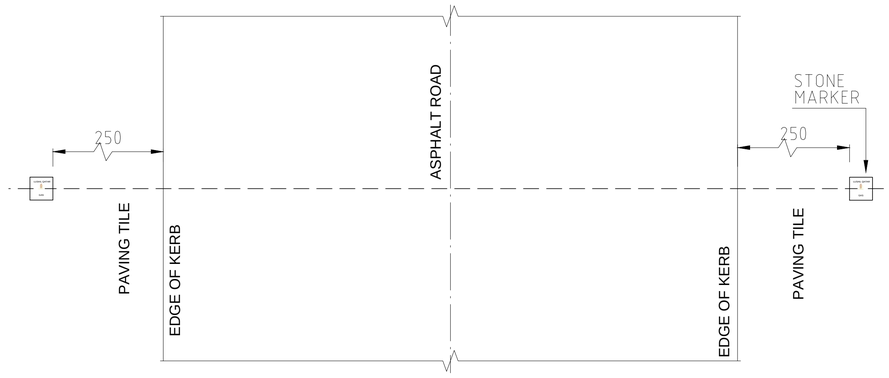
HARDSCAPE AREAS



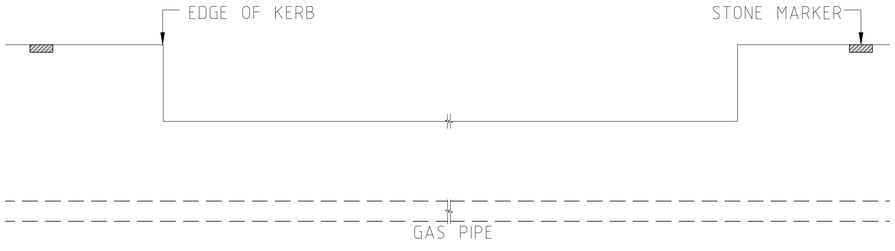
ISOMETRIC VIEW

STONE MARKER FOR

LANDSCAPE AREAS



PLAN VIEW



SECTION VIEW

POSITION ON MARKERS IN ROAD

KEYPLAN:

NOTES

ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE STATED.

LEGEND

- STRAIGHT PIPE LINE
- T - CONNECTION
- TURN (CHANGE IN DIRECTION)

DRAWING REFERENCE:

DRAWING NO.	DRAWING TITLE

REV	DATE	DESCRIPTION
1	09.04.12	ISSUED FOR APPROVAL
0	30.04.12	ISSUED FOR COMMENTS

DRAWING TYPE: DETAILED DESIGN

CLIENT: LUSAIL REAL STATE DEVELOPMENT COMPANY

UTILITIES PROVIDER: Marafeq Qatar

PROJECT : LUSAIL DEVELOPMENT
GAS DISTRIBUTION NETWORK

DRAWING NAME:
GAS PIPE LINE
SURFACE MARKER
(TYPICAL MARKING STONE)

DRAWN BY:	P.K.S	DATE:	30.04.2012
CHECKED BY:	H. K	DATE:	30.04.2012
REVIEWED BY:	A.ABUSHAIKHA	DATE:	30.04.2012
APPROVED BY:	D.R.PHILIPS	DATE:	30.04.2012

DRAWING NUMBER: LUS-CPALL-MAQ-DWG-UT-30305 REV 1

DRAWING SCALE: NTS @A1