LUSAIL DEVELOPMENT

District Cooling Distribution System Design Guidelines for Mechanical Works for Mega-development

Document No.: LUS-CPALL-MAQ-SPE-UT-00003

REV NO.	REASON FOR ISSUE	DATE	DOCUMENT HISTORY	STATUS	PREPARED BY	CHECKED BY	APPROVED BY
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REASON FOR ISSUE:	STATUS
IFR Issued for Review/Comment(s)	**PFC** Preliminary for Comment
IFI Issued for Information	**A** Approved
IFA Issued for Approval	**SS** Superseded
IFT Issued for Tender	
IFC Issued for Construction	

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CONTENTS

1 INTRODUCTION

1.1 General

This document and the attached files define the technical requirements to furnish pipe and materials for the portion of the district cooling system referred to as Mega-Development. For ease in understanding, these documents are prepared as if the project was broken into three separate contracts, but in fact they are all components of a single contract between the Client and one contracting party.

In the end, the contracting party is responsible for all aspects of the project and that all tools, equipment, and devices are suitable and reliable for the intended use and in the ambient conditions expected at the construction site. He shall be responsible for all documents and procedures requested by authorities for the official inspection and acceptance of the works.

In general the technical tender documents are described as:

- LUS-CPALL-MAQ-SPE-UT-00001 Pre-insulated Pipes: The scope of supply is described as pipe and materials including delivery to a lay down area designated by Client, but the scope does NOT include fabrication or installation of pipe (mechanical works) or trenches (civil works)
- LUS-CPALL-MAQ-SPE-UT-00002 Civil Works: The scope of supply is the civil portion of the underground piping system and thus does NOT include pipe materials or mechanical installation
- LUS-CPALL-MAQ-SPE-UT-00003 Mechanical Works: The scope of supply includes mechanical installation of pipe and materials, but does not include furnishing materials or preparing the trenches.

1.2 Tender documents package

This document is part of the total tender package and ultimately will be incorporated into the project Agreement.

1.2.1 Technical Requirements Mechanical works – documents package

This document specifies technical requirements for mechanical works and is a part of the total Technical requirements for Mechanical works package.

The Scope of Works is defined by:

- This document.
- Appendices and drawings in accordance with Drawings/Documents List form (DLF).

1.3 Scope of Works

Scope of works is defined as the design, detailed workshop engineering, fabrication, welding, testing, transportation, handling, installation, site testing, commissioning and documentation for carrying out mechanical works as defined in the tender documents.

The Contractor shall include in its scope all the works, material and services necessary for a complete, safe and prudent underground pipe system as described herein.

Works shall be carried out in accordance with good industry practice, notwithstanding certain essential items not being expressly stated in these requirements or elsewhere in the RFP.

The Scope of Works shall include, but not be limited to:

1. Transportation and handling of pre-insulated pipes with HDPE outer jacket from the local storage area to the trench.
2. Supply and placing out temporary supports on the prepared trench's sand bed.
3. Lifting the pre-insulated pipes and pipe components down into the trench including placement on the temporary supports.
4. Adjustment of pipes into final positions, preparation and welding of pipes, valves and other pipe components together.
5. Removal of temporary supports.
6. Carry out cleaning, pigging, flushing, testing and control. (Separate quotation required, work might be done at a later stage).
7. Installing, testing and commissioning the surveillance system in all pipe casing joints.
8. Jointing of outer casings including foaming.
9. Documentation.

Civil works, supply of pre-insulated pipes and components will be carried out by other parties and are **not** a part of this Scope of Works, for the Mechanical Contract.

Drawings showing the pipe route, dimensions and a typical trench section are attached.

The Contractor is responsible for extra costs associated with any changes of plot connection locations carried out without approval from the Engineer.

2 DEFINITIONS, ABBREVIATIONS AND REFERENCES

2.1 Definitions

The following expressions shall, where the context so permits, have the meaning hereby respectively assigned to them.

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.
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/Supplier.

Works	Means work, products, materials, computer software and documentation, as called for in the Agreement.
Agreement	Means the contract or other written agreement entered into between the Client and a contracting party regarding supply of the Works, including appendices, amendments and additions agreed in writing.
For Information only	Means information only is indicative and not under responsibility of the Client. Vendor has to control, verify and be responsible for any such information in the same manner as other submittals.
Must	This is a minimum requirement.
Shall	Indicates a mandatory requirement.
Should	Indicates a preferred method or material.
Request for Proposal	Means the document prepared and issued by the client which includes this document and other general and particular requirements.

2.2 Abbreviations

DP	Design pressure
ID	Internal diameter
OD	Outer diameter
WT	Wall thickness
QCP	Quality Control Plan
FAT	Factory Acceptance Test
SAT	Site Acceptance Test
RFP	Request For Proposal
WPS	Welding Procedure Specification

2.3 Reference documents

2.3.1 Codes, standards and specifications

Material supplied by the Contractor or its sub-contractor, shall, at a minimum, confirm to the requirements of the codes listed below.

Work, work methods, testing and actions carried out by the Contractor shall, at a minimum, confirm the requirements of the codes listed below.

When an edition date is not indicated for a code or standard, the latest edition in force at the time of contract award shall apply.

EN253	Pre-insulated bonded pipe systems for directly buried hot water networks.
EN448	Pre-insulated fittings for bonded pipe systems
EN488	Pre-insulated valves for bonded pipe systems
EN489	Joints and connections for pre-insulated bonded pipe systems
EN13941	Design and installation for bonded pre-insulated pipe systems.
EN14419	Surveillance systems for bonded pre-insulated pipe systems

EN10216-2	Seamless steel tubes
EN10217-2, -5	Welded steel tubes
EN10253-2	Butt welded steel fittings
EN13480	Metallic industrial piping
P235GH	Steel quality
EN 12517	Non-destructive testing of welds. Radiographic testing of welded joints
EN12613	Plastic warning devices for underground cables and pipelines with visual characteristics
EN ISO 5817	Fusion welded joints in steel and alloys. Quality levels for imperfections.
EN206-1	Concrete: Specification, performance, production and conformity.
EN287-1	Qualification test of welders. Fusion welding – Part 1: steels.
E 287-3	Welding procedures tests.
EN288-2	Specification and approval of welding procedures for metallic materials. Welding procedures specification for arc welding of steels.
EN288-3	Specification and approval of welding procedures for metallic materials. Welding procedures specification for arc welding.
EN ISO 9692-1	Welding and allied procedures – Recommendations for joint preparation
EN ISO 11970	Specification and approval of welding procedures for production welding of steel castings.
ISO 12096	Submerged arc-welding steel tubes for pressure purposes – Radiographic testing of the weld seam for the detection of imperfections.
EN ISO 15607	Specification and qualification of welding procedure for metallic materials. General rules.
EN ISO 3834	Quality requirements for fusion welding of metallic materials.
EN ISO 15614-1	Specification and qualification of welding procedures for metallic materials -- Welding procedure test -- Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys
EN 10253-1,-2	Butt welding pipe fittings
QCS	Qatar Construction Specifications
Kahramaa	Water and Electricity Components
QCD	Qatar Civil Defense
Other standards	Mentioned or referred to in the complete package of Tender documents.

2.4 Document precedence

The Contractor shall notify the Engineer of any conflict between this specification, the related requirements and/or data sheets, the codes and standards and any other

specifications noted herein. Resolution and/or interpretation precedence shall be obtained from the Engineer in writing before proceeding with the design or manufacture.

In case of conflict, the order of precedence shall be:

1. Material narrative specifications.
2. Project specifications and standards.
3. Industry and official codes and standards.

3 TECHNICAL REQUIREMENTS AND SPECIFICATIONS

3.1 General

The piping system will consist of two pipes (supply and return) parallel in the trench. The pipes are pre-insulated bonded carbon steel pipes with PUR polyurethane foam insulation and with HDPE outer jacket.

Works, pipes and components shall meet the technical and environmental requirements of the applicable directives and harmonised standards.

Health and safety requirements and the function of safety related systems must be fulfilled.

3.2 Basic design conditions

Design pressure	1600 kPa
Operating temperature range	4.0 – 16°C
Soil temperature range	10 – 50°C
Ambient design temperature	50°C; maximum outdoor temperature during installation
Water quality	See table in paragraph 3.3.
Calculated life-time	Pipes, works and components shall be designed for a calculated life-time of 40 years.

3.3 Distributed water quality

The Client intends to maintain the circulated water quality as noted in the table below.

Parameter	Data
pH-value	8.0 +/-1.0
TH (°F)	2 - 20
Punctual TH (°F)	8 - 20
TAC (°F)	35 +/- 10
Total copper	0.2 +/- 0.1 mg/l
Total iron	2.0 +/- 0.5 mg/l
Conductivity	471 +/- 251 µs/cm
Chlorides	10 +/- 2 mg/l
CO_2	> 30 mg/l
O_2	1.0 +/- 0.1 mg/l

4 PRE-INSULATED PIPES

4.1 General

Pre-insulated bonded pipe systems for directly buried water networks. Pipes assembled by carbon steel service pipe, polyurethane thermal insulation and outer casing of high density polyethylene (HDPE).

The pre-insulated bonded piping will comply with standard EN253 as minimum.

The pre-insulated pipe system shall, for the main part, be directly buried in trenches without any duct, concrete cover or similar. However, some drain valves and venting valves will be needed to be installed in concrete valve chambers.

Civil work, excavation and backfill will be carried out by others and is not a part of this contract.

Pre-insulated pipes and fittings material will be supplied by others and is not a part of this scope.

Installation works welding, lifting, handling and local transportation are included in the Scope of Works. For installations in drainage & venting valve chambers is also supply of pipes, fittings, flanges and other pipe components included in Scope of Works.

Pipe ends on straight pipe sections and fittings are delivered free from foam insulation at a length of approx. 250 mm for welding in the field. For cutting of pipes and removal of foam insulation, see clause 5.7.

Pipe ends or other openings in pipe sections shall always be covered in order to prevent inside of pipes from debris and other foreign objects.

Insulation of the free pipe joints and joining of the outer casing pipe after welding and testing are included in the Scope of Works.

A surveillance system consisting of copper wires is included in the pre-insulated piping system; jointing of detection wires and installation of detection units shall be carried out by the Mechanical Contractor in accordance with the supplier's specifications.

4.1.1 Chilled water service carbon steel pipes

The service carbon steel pipes are a part of the pre-insulated pipe and fitting material scope. The service carbon steel pipe will conform to dimensions in accordance with DIN 2458 and steel quality P235GH in accordance with standard EN10216-2, EN10217-2 and 10217-5.

Elbows, reducers, tees and other fittings will fulfil requirements in accordance with standard EN10253-2 type B.

Pipes will be delivered from factory in 12 m length sections.

Seamless steel tubes in accordance with EN10216-2 for dimensions up to DN350.

Welded steel tubes in accordance with EN10217-2 (ERW) or EN10217-5 (SAW) from dimension DN400 and larger.

Following dimensions will apply for the service carbon steel pipe:

Dimension	Outer diameter	Nominal Wall thickness
DN100	114,3 mm	3,6 mm
DN125	139,7 mm	3,6 mm

Dimension	Outer diameter	Nominal Wall thickness
DN150	168,3 mm	4,0 mm
DN200	219,1 mm	4,5 mm
DN250	273,0 mm	5,0 mm
DN300	323,9 mm	5,6 mm
DN400	406,4 mm	6,3 mm
DN450	457,0 mm	6,3 mm
DN500	508,0 mm	6,3 mm
DN600	610,0 mm	7,1 mm
DN700	711,0 mm	8,0 mm
DN800	813,0 mm	8,8 mm
DN900	914,0 mm	10,0 mm
DN1000	1016,0 mm	11,0 mm
DN1100	1120,0 mm	11,0 mm
DN1200	1220,0 mm	12,5 mm
DN1300	1320,0 mm	12,5 mm

4.1.2 Thermal insulation

The thermal insulation is a part of the pre-insulated pipes material scope. The pre-insulated pipes and fittings will be delivered with hard polyurethane foam applied at factory. The polyurethane foam is bonded to the service pipe and the outer casing jacket pipe.

Minimum insulation requirements

Property	Min. requirement
Closed cell content	> 90,0 %
Size of cells	< 0,3 mm
Core density	≥ 60 kg/m3 **Note1**
Thermal conductivity at 50°C (λ50)	< 0,03 W/mK
Water absorption	< 5 % (volume)
Compression strength	> 0,30 MPa
Axial shear strength, 23 deg C new	> 0,12 MPa
Axial shear strength, 23 deg C aged	> 0,12 MPa

Note 1: Not defined in present EN253:2009. However for securing the handling of pipes of large dimensions this is required. (It was included in the previous EN253:2003. Requirements are considered by CEN/TC 107, to be included again in next EN253 standard version.)

Thickness of insulation varies depending of pipe dimension, see dimensions of outer casing jacket pipe in paragraph 4.1.3.

4.1.3 Outer casing jacket pipe

The outer casing jacket pipe works as the condenser barrier and is a part of the pre-insulated pipes material scope. The outer casing pipe will be manufactured in UV-stabilized HDPE in accordance with EN253 or equal.

Materials	High density polyethylene (HDPE) bimodal minimum PE80, ISO 12162
Density	Min. 944 kg/m3
Pipe wall thickness	According to EN253 or equal

Following dimensions apply for the outer casing jacket pipe:

Dimension	Outer diameter casing pipe	Minimum casing wall thickness (mm)
DN100	200 mm	3,2
DN125	225 mm	3,4
DN150	250 mm	3,9
DN200	315 mm	4,5
DN250	400 mm	4,8
DN300	450 mm	5,2
DN350	500 mm	5,6
DN400	520 mm	5,7
DN450	560 mm	6,6
DN500	630 mm	7,2
DN600	780 mm	7,9
DN700	900 mm	8,7
DN800	1000 mm	9,4
DN900	1100 mm	10,2
DN1000	1200 mm	11,0
DN1100	1300 mm	11,8
DN1200	1400 mm	12,5
DN1300	1500 mm	15,9

4.1.4 Surveillance system

Surveillance system materials are supplied by the pre-insulated pipe supplier. All pre-insulated pipes and fittings are delivered with three copper alarm wires moulded into the foam insulation.

Connecting and joining the alarm wires is the Mechanical Contractor's responsibility, but must be carried out by a specialized sub-contractor. Connections shall be done to existing cabinets.

5 PIPE WORKS

5.1 Pipe works – underground pipes

Pipe works shall include following main phases and activities which are further described in these Technical requirements.

- Transportation of pipes and components from the local storage to the working area (trenches)
- Supply and install of temporary supports in the trenches.

- Lifting down pipes and components into the trench including adjustment of positions including handling of temporary supports.
- Preparation and welding of pre-insulated steel pipe joints.
- Jacket pipe jointing including connections of surveillance wires.
- Insulation of joints.
- Carry out control, tests and inspection.
- Cleaning, pigging and flushing
- Documentation

5.1.1 Temporary supports in trenches

Contractor will be notified when civil works have been approved and the prepared sand bed is ready for the pipes.

Contractor shall supply and put temporary supports on the sand bed in order to make the total circumference of the pipe joint reachable for welding.

For pipe DN400 and smaller, the supporting length shall be at least 200 mm and spaced no farther than 5 m apart. For pipe DN450 and larger, the supporting length shall be at least 300 mm and spaced no farther than 3 m apart.

Temporary supports shall be fabricated from wooden timbers or sandbags. If the Contractor prefers another material or type of temporary support, he shall describe it in the offer.

Before backfilling is started all temporary supports must be removed by the Contractor.

5.1.2 Temporary supports – alternative

As an alternative to temporary supports may local excavation being accepted, the Contractor is allowed to use this alternative method only after a written approval from the Engineer:

Local excavation alternative

As an alternative for temporary supports described above, the Contractor may place pipes directly on the sand bed and excavate a pit locally under each joint. The size of the pit must allow room for welding, insulation and application of outer jacket pipe sleeves. Minimum length is 2.0 m and minimum depth is 200 mm measured from the outer jacket.

Since this alternate method may require extra work for the Civil Contractor for embedment and compaction, this alternate must be coordinated between the Mechanical and Civil Contractors such that there is no variance to the Client.

5.1.3 Lifting down and laying pipes in the trenches

Pipes may be lifted into the trench only after the temporary supports are in place.

Pipe bends and other fittings are marked by others with a position number for individual identification and these numbers must match with the drawings for each location.

Straight pipe sections shall be installed with the pre-fabricated leak detection wires on top of the pipe.

Pipe position shall then be adjusted so the pipe ends are aligned. Pipes centre to centre positions and distances from trench wall, etc shall be maintained in accordance with the “Typical trench section” drawing.

5.2 Pipe works - valve chambers

Pre-insulated shut-off valves, drain valves and venting valves shall be installed in manholes in accordance with the drawings. (If required)

Manholes are furnished and installed by the Civil Contractor and thus are not included in the Scope of Works.

All mechanical installations, except the concrete manhole and manhole cover, shall be included in the Contractors Scope of Works.

5.3 Local storage and transportation of pipes

Pre-insulated pipes and components will be locally stored in the area and shall be transported by the Contractor to the trench.

The Contractor will receive the material, providing written evidence of any defects detected during visual inspection. After this inspection the Contractor will be held responsible for any damages on the pipes.

The Contractor is responsible for protection of the pipes during storage, in local storages as well as pipes in trenches/compartment. Sun protection is required; overheating by the sun will lead to cracks in the jacket pipe casing and separation of the insulation foam from the carrier steel pipe.

Damaged pipes and fittings will be rejected at the Contractor's cost.

During loading, transport and unloading the material should be handled in such a way that prevents damage, in accordance with pipe supplier's recommendations.

Flat type fabric band straps shall be used for lifting, Chains, wires, ropes or other round lifting equipment are not allowed. A fork lift can be used to lift fittings and components, provided that flat forks are used.

T-piece branches shall not be lifted by the branch pipe only.

During transportation and handling the temporary end caps must be in place.

In any case shall instructions from the pipe supplier always be considered by the Contractor.

5.4 Applying jacket pipe joint casings

The tubular joint casings must be applied before the pipes are welded together.

Joint kits of the following types are supplied by the pipe material supplier:

- For pipe dimension DN150 and smaller: a tubular PE-shell jacket piece, sealing sleeves and a foam kit.
- For larger dimensions: electro welded band joint jacket and a foam kit.

Contractor shall slip on the tubular shell jacket on a pipe next to each joint before welding is carried out.

5.5 Welding of pipes and pipe systems

Welding shall be carried out by certified contractor or certified sub-contractor with welder's qualifications as stated below.

Copy of certificate shall be submitted to the Engineer before the works are started.

5.5.1 General rules

The welding procedures shall follow EN ISO 15607 and EN 13480.
Welds quality levels shall be in accordance with EN ISO 5817 Grade B.

All welding of pipes shall be butt welding of pipe end against pipe end, no socket welding shall be carried out. Preferred welding method is arc-welding or arc-welding combined with first pass TIG-welding.

Preparation of pipe ends prior to welding, measurements, number of passes, etc are described in standards referred to.

5.5.2 Contractor's certification

The welding contractor shall be certified in accordance with EN ISO 3834 or equivalent to be approved by the Engineer.

5.5.3 Welding Procedures Specifications (WPS)

The Contractor shall submit to the Engineer for approval welding procedures (WPS) for each method intended to use in this project.

The welding procedure inspection shall follow the EN ISO 15614-1.

Each welded joint shall also be marked with the welder's name (initials) and the date for the work, hand written marking with a permanent marking pen is sufficient

5.5.4 Welder's qualification

Welder approval test shall be carried out in accordance with EN 287-1 before the actual welder starts working in this project.

The first three (3) welds by each welder will be radiographed and judged by the Engineer's approved testing agent. The welder will be approved to work in this project only after completing three successive welds.

All costs with re-testing, after the first three joints, until three successive welds have been completed shall be at the Contractor's cost. The Engineer has the right to reject a welder after multiple tries.

5.5.5 Marking and identification

Each welded joint shall be marked with the welder's name (initials) and the date for the work, hand written marking with a permanent marking pen is sufficient.

5.6 Cutting of pre-insulated pipes

The outer jacket PE-pipe shall be cut and foam insulation removed at a length of approx. 250 mm from the intended steel pipe end, it is most practical to cut a length of 2x250 mm with the steel pipe cut in centre when cutting a pipe section.

At cutting of the outer jacket PE-pipe it is important to start with tangential cuts to avoid scratches or damages in axial direction since a small crack tends to grow.

It is important to remove all foam insulation completely from the pipe end before welding starts. Polyurethane foam insulation generates toxic fumes when heated.

5.6.1 Cutting of pre-insulated fittings

Normally, pre-insulated fittings shall not be cut. The Contractor shall receive approval from the Engineer prior to cutting pre-insulated fittings.

5.7 Pipe angles and changes of direction

Pre-insulated elbows will be delivered to the amount specified in the Bill of Quantity. Deliveries comply with the requirements in EN448.

Changes of direction are made in 3 different ways as described below.

5.7.1 Pre-insulated elbow

For directional changes greater than 10 deg, pre-insulated elbows will be furnished and by others.

A pre-insulated elbow is made with two pipe ends for welding and shall be welded, by the Contractor between other pipe components. The pre-insulated elbow requires two joint kits for insulation.

5.7.2 Uninsulated steel pipe elbow

For directional changes from 0 to 10 deg for piping DN400 and larger, uninsulated fittings will be furnished and delivered by others. An uninsulated steel pipe elbow is made from a section of a bend and shall be welded, by the Contractor, between two perpendicular steel pipe ends within a common casing pipe joint and requires one joint kit for insulation.

5.7.3 Mitered pipe ends

For field adjustments of 0 to 10 deg directional changes for DN350 and smaller, pipe ends shall be mitered.

Contractor shall cut the two meeting pipe ends in equal angles and weld together as one weld; thermal insulation plus HDPE jacket shall also be jointed together by the Contractor.

For field adjustments of plot connection service pipes in vertical direction, as shown on profile drawings, pipe ends shall be mitered.

5.8 Branches and T-pieces

Branches and T-pieces will be delivered to the amount specified in Bill of Quantity.

Deliveries comply with the requirements in EN448.

Branches will be delivered as pre-insulated branches or site made branches in accordance with the table below:

Main pipe	Pre-insulated branch	Site made branch
DN500	DN250 and larger	DN200 and smaller
DN600 and larger	DN350 and larger	DN300 and smaller

5.8.1 Pre-insulated branches

Branches in larger dimensions (see table above) will be delivered as pre-insulated, by others.

Welding of a branch T-piece to the main pipe shall be carried out after careful adjustment of the branch pipe vertical direction. Normally is the branch direction horizontal or slightly upwards but this must be double checked.

5.8.2 Site made branches

Special site made branches are required in combinations as defined in paragraph 5.8.

Following branch details will be supplied by the pipe supplier:

- One 90 degree steel pipe elbow
- One steel pipe stub piece
- One special joint kit
- Detailed instructions for the welding contractor.

The Contractor shall cut main pipe casing and insulation and weld the branch pipe as a tie-in into to the main pipe.

Measurements and detailed drawings issued by the pipe supplier must be considered.

5.9 Reducers

Pre-insulated reducers will be delivered by the pipe supplier and shall be installed by the Contractor.

5.10 Pre-insulated valves

All valves will be pre-insulated and put directly in the trenches. Pre-insulated valves will be delivered by the pipe supplier and shall be installed by the Contractor in accordance with the drawings.
The pre-insulated valves are designed for operation from the ground level. It is very important that the valves are installed and welded with the stem in straight vertical position.

For valves buried deeper than 2 meters, the Contractor shall install hydraulic operators, hoses and auxiliaries furnished by others.

Installation shall be done in accordance with the suppliers recommendations.

5.11 Outer casing pipe jointing

Installation of supplied joint kits is included in the Scope of Works.

Joint kits for the outer casing HDPE pipe will be furnished by others to the amount specified in Bill of Quantity.

Delivery will comply with the requirements in EN489.

Joint kits of the following types will be supplied by the pipe material supplier:

- For pipe dimension DN150 and smaller: a tubular PE-shell jacket piece, sealing sleeves and a foam kit.
- For larger dimensions: electro welded band joint jacket and a foam kit.

Not all joint kits will be installed at completely straight pipe joints, it is therefore of great importance that joints kits are designed to overcome small angles of deviation.

Others will supply information on:
1. Maximum allowed deviation-angle for a “standard” joint kit.
2. Special joint kits for deviation-angles larger than the standard joint kit.
3. Training of fitters for each type of delivered joints.

No fitter will be allowed to perform casing joints without participating in pipe supplier’s training program. Personal certificates of this education shall be issued for all fitters.

5.12 Mounting of end-seals

The pipe system will be constructed and finalized before the connection into the buildings are ready for the DC pipe connection. The boundary of the delivery will then be a sectioning valve and a welded end-cap after each valve.

Mounting of insulation end seals are included in the Scope of work.

5.13 Surveillance system

All pre-insulated pipes and fittings are delivered (by others) with a surveillance system consisting of 3 copper wires moulded into the foam insulation together with a sufficient number of surveillance units.

Connections and jointing of the surveillance wires are included in the Contractor’s Scope of works. The wires shall be jointed in accordance with the supplier’s specifications, creating loops of pipe sections, each connected to a surveillance unit.

The works must be commenced by a special sub-contractor with documented experiences within this field.

6 TESTING, CONTROL AND COMMISSIONING

All pipe systems shall be tested in presence of the Engineer or its representative.

Contractor shall repair all failures discovered and carry out re-tests after the repair.

A testing program shall be agreed upon before the starting the works.

6.1 Radiography tests

The Engineer intends to carry out non-destructive tests by visual examination and gamma ray radiography (hereinafter referred to as “radiography”).

Welds quality will be checked by radiography inspection carried out by a company specialized for the task and hired by the Client.

The Engineer will nominate the testing firm with approval from the Contractor and such approval shall not be unreasonably withheld.

100% radiographic inspection of 10% of butt welds completed by each welder will be carried out. The frequency of test moments, when the testing company will appear on site, will be decided by the Engineer.

6.1.1 Approval of welds

Approval of welds will be in accordance with EN 12517 acceptance level 1, EN ISO 5817 grade B In order to reduce the costs for radiographic inspections, the 10 - 20 % inspection level is chosen.

The testing firm will inspect all welds visually or any other methods of inspection necessary to assure the welds are proper.

The Engineer shall have the right to reject any weld not meeting the requirements of this specification.

6.1.2 Weld quality failures

If inspections and/or tests of welds show disapproved welding, additional 10 % of actual welder's works shall radiographies.

If all of the additional radiographies welds are approved, no additional testing is required.

If any failure in additional testing is discovered shall all welds of actual welder's work be radiographies.

All failed welds shall be repaired and tested after the repair.

6.1.3 Costs for radiography inspections and tests

The cost for welder qualifications in accordance with clause 5.5.4 and weld inspections shall be paid by the Contractor.

All costs for additional testing, as stated in paragraph 6.1.2, shall be paid by the Contractor. This includes costs for the testing firm and the Contractor's own costs.

6.2 Leak detection

All pipe systems shall initially be tested for leaks in pipes, pipe-joints, flanges and installed components.

Leak detection shall be carried out with air as a first test before the pipe system is filled with water for the pressure test.

Pipe sections shall be filled with slightly over pressured air (1-5 kPa), and joints treated with soap water in order to locate possible leaks.

Air-pressure holding time is as long as it takes to inspect the welds.

6.3 Pressure tests with water

Pressure test shall be carried out with water. Water for fill-up and testing will be provided by the Contractor.

Contractor shall fill-up the pipe system to be tested, release air and pump up pressure to specified level.

Test pressure, 23 bar (2300 kPa)

Pressure holding time, 6 hours before inspection of welds.

6.4 Cleaning by pigging and/or flushing

Cleaning by pigging and/or flushing of the pipe system is included in the Contractor's Scope of work.

A sub-contractor with special competence in this field is required and a Method statement shall be submitted to the Engineer for approval prior to starting the cleaning process.

6.4.1 Pigging

Pigging shall be carried out by running a foam type of plug covered with brush through the pipeline system a sufficient number of times until the pipe is clean. The plug is pushed by compressed air with a limited quantity of water added.

The number of times and types of plug's to be used are dependent of the actual pipeline conditions.

Butterfly valves must be removed and temporarily replaced with spool pieces before pigging can be carried out.

Generally, pigging shall be carried out as briefly described below:

- Insertion of a soft type of plug in the pipeline launching end for the first run. Applying compressed air mixed with a small quantity of water pushing the plug through the pipeline and out at the receiving end.
- Examination of the used plug before decision about what type of plug (hardness, coarse) to be used for the second run.
- Running the chosen plug through, the required number of times, until the added small amount of water is clean and free from debris and loose material.

6.4.2 Flushing, the Air-Water Cleaning Method

Where pigging not is possible flushing must be carried out.

Due to the large pipe dimensions flushing must be carried out with the Air-Water Cleaning Method. Air and water is mixed proportionally in accordance to the pipeline dimension thus creating a turbulent flow in the pipeline which removes dirt and debris from the pipeline.

The air-water mixture shall be injected in one end of the pipeline and the speed of the air-water turbulent flow is controlled by the operator by the amount of air injected.

The air-water cleaning is considered finished when the outlet water at the other end is clean and do not show any signs of debris and dirt.

7 DOCUMENTATION

The Contractor shall submit all documentation from quality control, inspection and test reports.

The Welding procedure Specification (WPS) should be delivered 4 weeks before the construction work of each system part.

Welder's qualification certificates from welding of pipe components shall be submitted, 2 weeks before each construction part.

Pipes and pipe components shall be marked for identification.

The as-built-drawings shall be delivered continuously during the progress of the project.

All documentation shall be delivered in minimum 5 sets hard copies and 1 set soft copy as a minimum.

8 APPENDICES

Appendices and applicable drawings are listed in the Drawings/Documents List form (DLF).

9 DRAWING / DOCUMENT LIST FORM

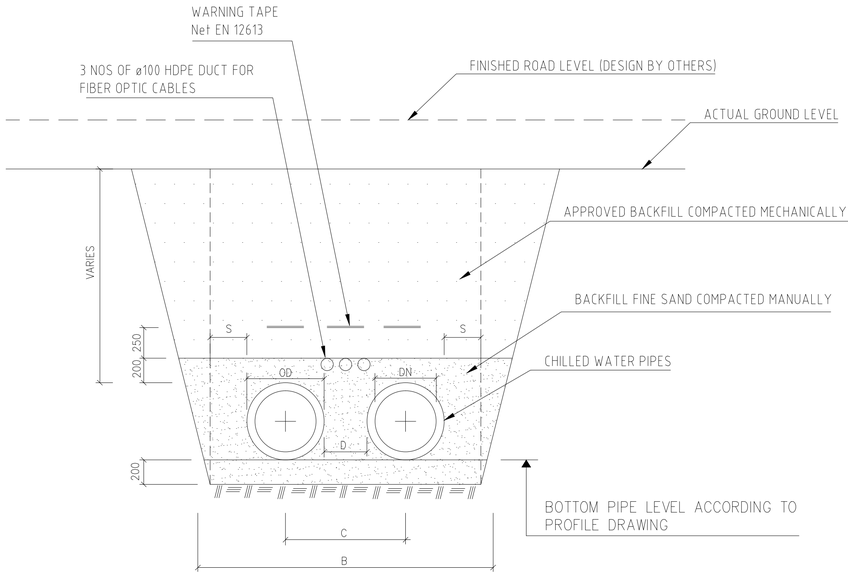
DRAWINGS/DOCUMENTS LIST FORM (DLF)			
ITEM	**DRAWING/DOCUMENT NUMBER**	**DRAWING/DOCUMENT TITLE**	**Revision**
01	LUS-CPALL-MAQ-DWG-UT-10301	DISTRICT COOLING-TYPICAL TRENCH AND TUNNEL SECTION	0
02	LUS-CPALL-MAQ-DWG-UT-10302	DISTRICT COOLING-VALVE WITH HYDRAULIC ACTUATOR	0

SCHEDULE OF TRENCH DIMENSIONS CW PIPES

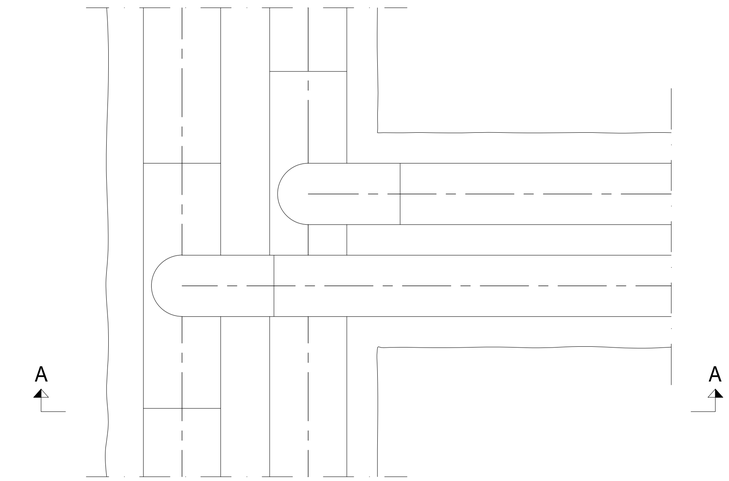
DN	OD Serie 0	OD Serie 1	CENTERLINE DISTANCE C	BOTTOM WIDTH B	DIST. D	DIST. S
100	180	200	380	960	200	200
125	200	225	450	1150	250	250
150	225	250	475	1200	250	250
200	280	315	530	1310	250	250
250	355	400	605	1460	250	250
300	400	450	650	1550	250	250
350	450	500	700	1650	250	250
400	500	520	750	1750	250	250
450	520	560	810	1870	250	250
500	560	630	1030	2260	400	300
600	710	780	1110	2420	400	300
700	800	900	1300	2800	500	300
800	900	1000	1400	3000	500	300
900	1000	1100	1500	3200	500	300
1000	1100	1200	1600	3400	500	300
1100	1200	1300	1800	4000	600	400
1200	1300	1400	1900	4200	600	400
1300	1400	1500	2000	4400	600	400
1400	1500	1600	2100	4600	600	400
1500	1600	1700	2300	4800	600	400

(ALL DISTANCES IN mm)

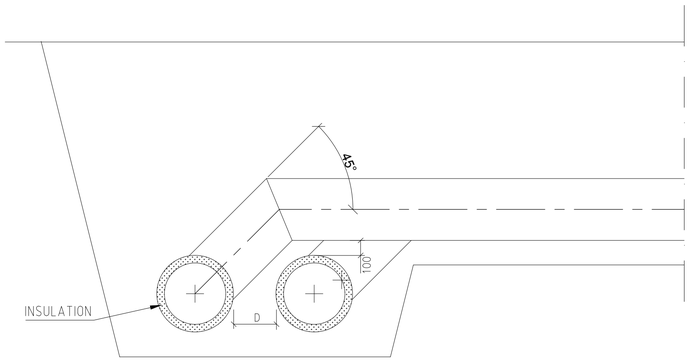
* OD is depending of the pipe provider and can be different



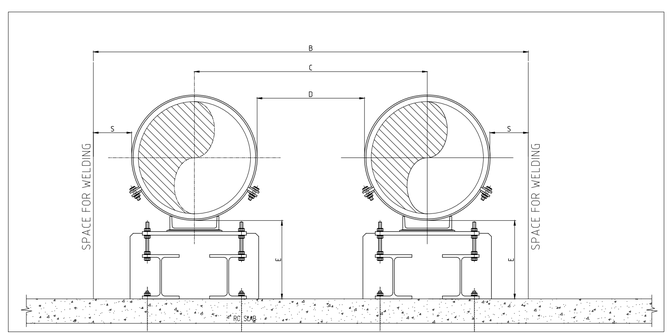
TYPICAL TRENCH CROSS SECTION
NOT TO SCALE



PREINSULATED BRANCH
NOT TO SCALE



A - A



TYPICAL TUNNEL CROSS SECTION
NOT TO SCALE

SCHEDULE OF DIMENSIONS FOR DC PIPES IN TUNNEL

DN	OD Serie 0	OD Serie 1	CENTERLINE DISTANCE C	OVERALL WIDTH B	DIST. D	DIST. E	DIST. S
100	180	200	380	1200	200	650	300
125	200	225	450	1300	250	650	300
150	225	250	475	1350	250	650	300
200	280	315	530	1310	250	650	300
250	355	400	605	1480	250	650	300
300	400	450	650	1650	250	650	300
350	450	500	700	1750	250	650	300
400	500	520	750	1850	250	650	300
450	520	560	810	1890	250	650	300
500	560	630	1030	2120	400	650	300
600	710	780	1110	2420	400	650	300
700	800	900	1300	2700	500	650	300
800	900	1000	1400	2900	500	650	300
900	1000	1100	1500	3100	500	650	300
1000	1100	1200	1600	3300	500	650	300
1100	1200	1300	1800	3800	600	650	300
1200	1300	1400	1900	4000	600	650	300
1300	1400	1500	2000	4200	600	650	300
1400	1500	1600	2100	4400	600	650	300
1500	1600	1700	2200	4600	600	650	300

(ALL DISTANCES IN mm)

* OD IS DEPENDING OF THE PIPE PROVIDER AND CAN BE DIFFERENT

GENERAL NOTES

1. THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE TECHNICAL REQUIREMENT FOR CIVIL WORKS.

2. DO NOT USE MECHANICAL COMPACTORS OR WHEEL OR TRACKED VEHICLES FOR COMPACTION UNTIL A MINIMUM OF 300mm OF COMPACTED SOIL IS ABOVE THE TOP OF THE INSULATION JACKET.

DRAWING REFERENCE:

DRAWING NO.	DRAWING TITLE

Rev	By	Chkd	Rvewd	Apprvd	Date	Description
0	PKS	H.K.	A.A.	D.R.	2.4.12	REVIEW

Client:

LUSAIL REAL ESTATE DEVELOPMENT COMPANY

Utilities Provider:

Marafeq Qatar

Project :

LUSAIL DEVELOPMENT

Drawing Name:

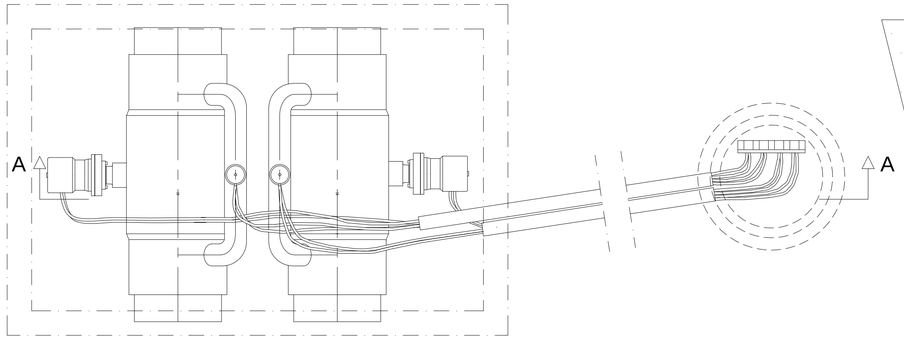
DISTRICT COOLING
TYPICAL TRENCH AND TUNNEL SECTION

Drawn by:	NJB	Date:	02–Apr–2012
Checked by:	H.K.	Date:	02–Apr–2012
Reviewed by:	Abdullah Abushaikha	Date:	02–Apr–2012
Approved by:	D. R. PHILLIPS	Date:	02–Apr–2012

Drawing No:

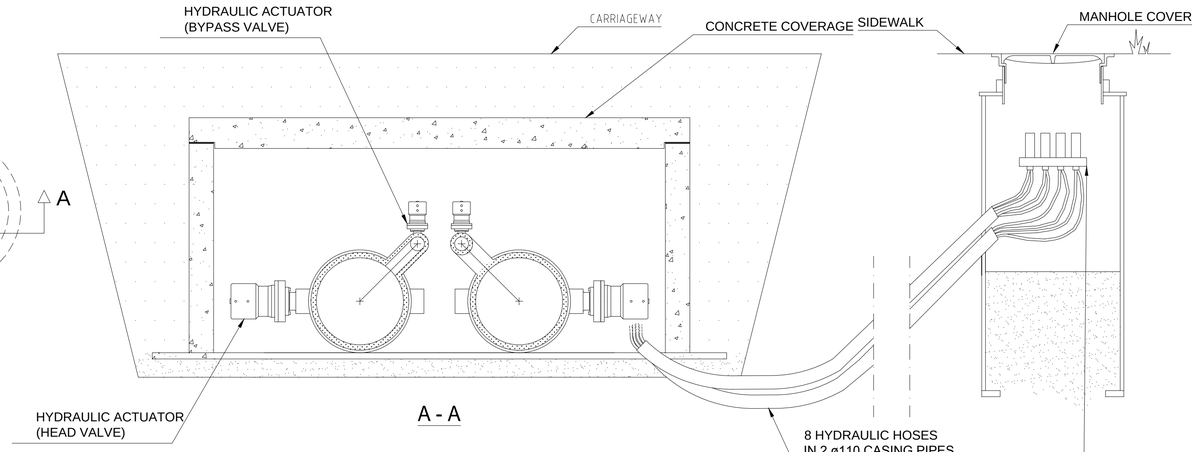
LUS-CPALL-MAQ-DWG-UT-10301 Rev.: 0

Drawing Scale: NTS



PREINSULATED VALVE WITH HYDRAULIC ACTUATOR AND BYPASS VALVE

ALTERNATIVE 1
NOT TO SCALE



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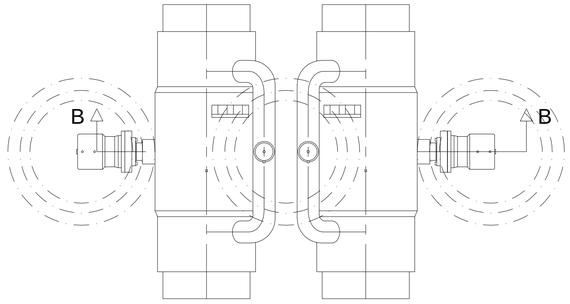

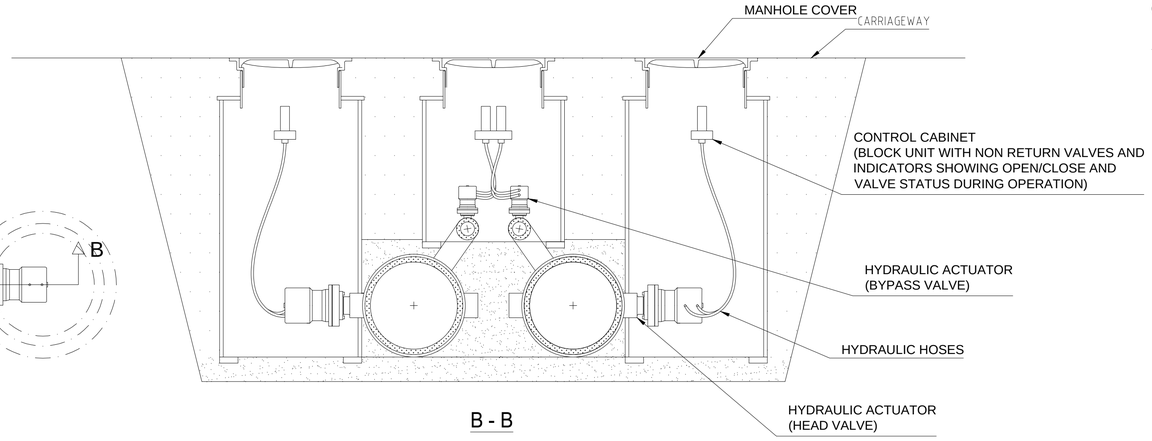

B - B

PREINSULATED VALVE WITH HYDRAULIC ACTUATOR AND BYPASS VALVE

ALTERNATIVE 2
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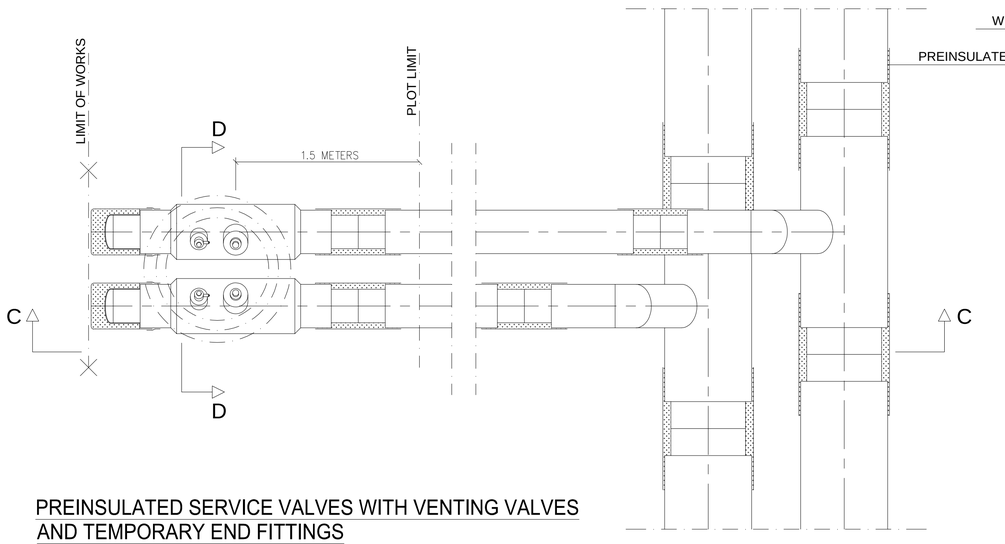
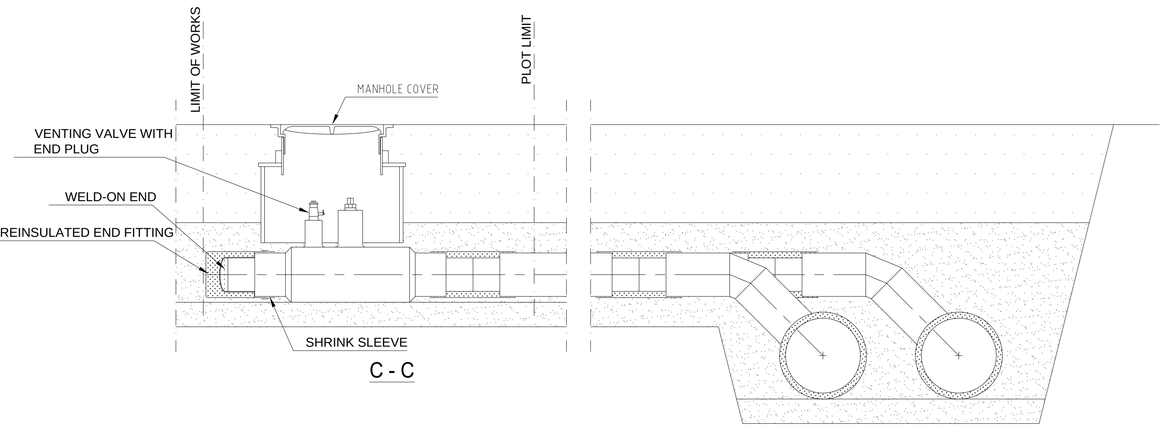
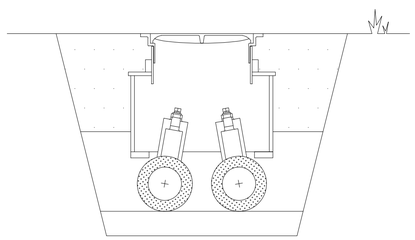




C - C



D - D

PREINSULATED SERVICE VALVES WITH VENTING VALVES AND TEMPORARY END FITTINGS

NOT TO SCALE

GENERAL NOTES

1. THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE TECHNICAL REQUIREMENT FOR CIVIL WORKS.

2. FOR TYPICAL TRENCH SECTION REFER TO DWG. LUS-CPALL-MAQ-DWG-UT-10301.

DRAWING REFERENCE:

DRAWING NO.	DRAWING TITLE

Rev	By	Chkd	Rvewd	Apprvd	Date	Description
0	PKS	H.K.	A.A.	D.R.	2.4.12	REVIEW

Client:

LUSAIL REAL ESTATE DEVELOPMENT COMPANY

Utilities Provider:

Marafeq Qatar

Project :

LUSAIL DEVELOPMENT

Drawing Name:

DISTRICT COOLING
VALVE WITH HYDRALIC ACTUATOR

Drawn by:	NJB	Date:	02-Apr-2012
Checked by:	H.K.	Date:	02-Apr-2012
Reviewed by:	Abdullah Abushaikha	Date:	02-Apr-2012
Approved by:	D. R. PHILLIPS	Date:	02-Apr-2012

Drawing No:

LUS-CPALL-MAQ-DWG-UT-10302 Rev.: 0

Drawing Scale: NTS