

GENERAL SPECIFICATION

FOR

LIQUEFIED PETROLEUM GAS INSTALLATION

IN

GOVERNMENT BUILDINGS

OF

THE HONG KONG SPECIAL ADMINISTRATIVE REGION

2007 EDITION



ARCHITECTURAL SERVICES DEPARTMENT
THE GOVERNMENT OF THE HONG KONG SPECIAL ADMINISTRATIVE REGION

PREFACE

This General Specification aims to lay down the technical requirements of materials and equipment, the standards of workmanship, the requirements on testing and commissioning as well as requirements on document submissions for liquefied petroleum gas installation in Government Buildings of the Hong Kong Special Administrative Region (HKSAR).

The 2007 edition of this General Specification was developed based on its 2000 edition by the Fire Service, LPG, Catering and Plumbing Specialist Support Group that was established under the Building Services Branch Technical Information and Research & Development Committee. Apart from the adoption of a new arrangement which gives the document a more compact and well-defined structure, this new edition comprises revisions to incorporate updated international standards and covers technological developments which find applications in Hong Kong. The other emphasis is on green initiatives, e.g. reduction of construction waste and enhancement of client satisfaction on completed projects. This is in line with the department's endeavour to reduce the environmental burden on our neighbours and help to preserve common resources while improving the quality of our service.

With the benefit of information technology, electronic version of this new edition is to be viewed on and free for download from the Architectural Services Department (ArchSD) Internet homepage. As part of the Government's efforts to limit paper consumption, hard copies of this General Specification will not be put up for sale.

The draft of this edition has been circulated to stakeholders within and external to the Government before finalization. Nevertheless, the Architectural Services Department welcomes comments on its contents at anytime since the updating of this General Specification is a continuous process for the inclusion of any developments that can help meeting the needs of our community.

DISCLAIMER

This General Specification is solely compiled for a Liquefied Petroleum Gas installation carried out for or on behalf of the ArchSD in Government buildings of the HKSAR.

There are no representations, either expressed or implied, as to the suitability of this General Specification for purposes other than that stated above. Users who choose to adopt this General Specification for their works are responsible for making their own assessments and judgement of all information contained here. The ArchSD does not accept any liability and responsibility for any special, indirect or consequential loss or damage whatsoever arising out of or in connection with the use of this General Specification or reliance placed on it.

The materials contained in this document may not be pertinent or fully cover the extent of the installation in non-government buildings and there is no intimated or implied endorsement of the sales, supply and installation of the materials and equipment specified in this General Specification within the territory of the HKSAR.

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PART A – SCOPE AND GENERAL REQUIREMENTS

SECTION A1

SCOPE OF SPECIFICATION

A1.1 INSTALLATION TO COMPLY WITH THIS GENERAL SPECIFICATION

The liquefied petroleum gas installation shall comply with this General Specification which details the intrinsic properties (including materials and workmanship) of the installation, in so far as it is not overridden by the General Conditions of Contract, Special Conditions of Contract, Particular Specification for the Works, Drawings and/or written instructions of the Architect.

A1.2 SCOPE OF THE WORKS

This General Specification, Particular Specification, Tender Equipment Schedule and Drawings detail the performance requirements of the Works. The Works to be carried out in accordance with this General Specification shall include the whole of the installation and supply of all materials necessary to form a complete installation including any necessary tests, adjustments, commissioning and maintenance as prescribed and all other incidental sundry components together with the necessary labour for installing such components, for the proper operation of the installation.

Unless otherwise specified, the Work also includes the initial supply of sufficient quantity of Liquefied Petroleum Gas for testing and commissioning, the specified quantity of Liquefied Petroleum Gas as indicated in the Particular Specification and Drawings, and the loan of Liquefied Petroleum Gas bottles. Subsequent replacement of the liquefied petroleum gas after the initial supply has been exhausted, will be provided by others. The Contractor shall be responsible for taking back his on loan bottles after the replacement has been made.

A1.3 TERMS AND DEFINITIONS

In this General Specification, the following words or expressions shall have the meanings assigned to them except when the context otherwise requires: -

A1.3.1 Terms and Definitions

Architect	The Architect or the Maintenance Surveyor or the Supervising Officer as defined in the Contract
Building Contractor	The Contractor employed by the Employer for the execution of the Works as defined in the Contract or the contractor separately employed by the Employer to execute the builder's work associated with the Works as appropriate.

Competent Person	The person who has been recognised by the Gas Authority under Gas Safety Ordinance (Cap 51), Laws of the Hong Kong Special Administrative Region to perform or supervise or inspect or certify Liquefied Petroleum Gas installation, testing and maintenance work.
Contract	The Contract defined in the General Conditions of Contract for the Works or the Sub-contract defined in the Specialist Sub-contract for the Works or the Sub-contract defined in the Nominated Sub-contract for the Works as appropriate.
Contractor	The contractor employed by the Employer or the Specialist Sub-contractor employed by the Building Contractor or the Nominated Sub-contractor nominated by the Architect for the execution of the Works as appropriate
Fire Resisting Period	The period of time during which the material can withstand fire as defined by the Buildings Department of the Hong Kong Special Administrative Region.
High Pressure Stage	That part of the installation between the valve of the bulk storage vessel/cylinder and the inlet of the pressure regulator; the pressure range is exceeding 69 kPa.
Low Pressure Stage	That part of the installation between the second stage regulator (or the outlet of the high pressure regulator if no medium stage is used) and the inlet of the appliance, the pressure range is up to 6.9 kPa.
Medium Pressure Stage	That part of the installation between a first stage regulator and a second stage regulator; the pressure range is from exceeding 6.9 kPa to 69 kPa.
Notifiable Gas Installation	LPG installation with either a storage capacity exceeding 130 litre water capacity or a liquid draw-off arrangement irrespective of the capacity or as defined by the Gas Authority is classified as notifiable gas installation. Construction approval, type approval of gas container and approval of use from Gas Authority are required for the notifiable gas installation.
Or Equal or Or Similar or Or Equivalent	Having similar characteristics and specification as regards type of construction, performance, safety provision, general appearance and standard of quality of manufacture and approved by the Architect.
Tender	The Contractor's tender for the Works Contract or the Specialist Sub-contractor's tender for the Works Specialist Sub-contract or the Nominated Sub-contractor's tender for the Works Nominated Sub-contract as appropriate.

ANSI	American National Standards Institute
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Material
BGC	Centrica Plc / BG Plc of United Kingdom (previously known as British Gas Corporation of United Kingdom)
BS EN	European Standard adopted as British Standard
BS	British Standards, including British Standard Specifications and British Standard Codes of Practice, published by the British Standard Institution
BSB	Building Services Branch, Architectural Services Department of the Hong Kong Special Administrative Region
CGA	Canadian Gas Association
EE_TCP	Testing and Commissioning Procedure for Electrical Installation in Government Buildings of the Hong Kong Special Administrative Region issued by the Architectural Services Department
EMSD	Electrical and Mechanical Services Department of the Hong Kong Special Administrative Region
FSD	Fire Services Department of the Hong Kong Special Administrative Region
GasSO	Gas Standards Office of the Electrical and Mechanical Services Department of the Hong Kong Special Administrative Region
HKSAR	Hong Kong Special Administrative Region
IP	Institute of Petroleum
ISO	International Operation for Standardisation Publication
JIS	Japanese Industrial Standards
LPG	Liquefied Petroleum Gas as defined under the Gas Safety Ordinance (Cap 51)
LPGA	Liquefied Petroleum Gas Association of United Kingdom (previously known as Liquefied Petroleum Gas Industry Technical Association)

LPG_TCP Testing and Commissioning Procedure for Liquefied Petroleum Gas Installation in Government Buildings of the Hong Kong Special Administrative Region issued by the Architectural Services Department

NFPA National Fire Protection Association of United States

A1.4 SINGULAR AND PLURAL

Words importing the singular only also include the plural and vice versa where the context requires.

A1.5 DESIGN RESPONSIBILITY

Where design is specified for any part of the Works, the Contractor shall design the liquefied petroleum gas installation to comply with the statutory requirements as well as the requirements in the Specification. Where design is not specified, the Contractor shall still develop the design shown in the Drawings or in the Particular Specification, complete the detailed design and installation details of the whole liquefied petroleum gas installation and select the most appropriate equipment design to comply with the statutory requirements and all other requirements of the Specification. All design drawings, calculation and installation details shall be submitted to the Architect for approval.

All design shall be checked and endorsed by a qualified and experienced staff of the Contractor approved by the Architect before submission.

SECTION A2

STATUTORY OBLIGATIONS AND OTHER REGULATIONS

A2.1 STATUTORY OBLIGATIONS AND OTHER REQUIREMENTS

The LPG installation shall comply with the statutory obligations stipulated in the following Laws of the HKSAR and other documents currently in force:

A2.1.1 Statutory Obligations

- (a) Gas Safety Ordinance, Chapter 51, Laws of the Hong Kong Special Administrative Region and all the Gas Safety Regulations;
- (b) Building Regulations, Chapter 123, Laws of the Hong Kong Special Administrative Region;
- (c) Dangerous Goods Ordinance, Chapter 295, Laws of the Hong Kong Special Administrative Region;
- (d) Electricity Ordinance, Chapter 406, Laws of the Hong Kong Special Administrative Region and the associated Electricity (Wiring) Regulations and Code of Practice;
- (e) Water Works Regulations, Chapter 102, Laws of the Hong Kong Special Administrative Region;
- (f) Fire Service (Installation and Equipment) Regulations, Fire Services Ordinance, Chapter 95, Laws of the Hong Kong Special Administrative Region;
- (g) Water Pollution Control Ordinance, Chapter 358, Air Pollution Control Ordinance, Chapter 311, Noise Control Ordinance, Chapter 400, Laws of the Hong Kong Special Administrative Region and all the statutory regulations related to the environmental protection;
- (h) Waste Disposal Ordinance, Chapter 354 and other subsidiary legislation made under the Ordinance; and
- (i) Environmental Impact Assessment Ordinance, Chapter 499 and other subsidiary legislation made under the Ordinance.

A.2.1.2 Other Requirements

- (a) Code of Practice for the Electricity (Wiring) Regulations published by the Electrical and Mechanical Services Department of the Hong Kong Special Administrative Region;
- (b) Codes of Practice for Minimum Fire Service Installations and Equipment and Inspection, testing and Maintenance of Installations and Equipment published by Fire Services Department of the Hong Kong Special Administrative Region;
- (c) Requirements and Circular Letters of the Fire Services Department of the Hong Kong Special Administrative Region;
- (d) Code of Practice for Hong Kong LPG Industry published by the Gas Standards Office of the Hong Kong Special Administrative Region;
- (e) Gas Utilisation Code of Practice GU03, GU05, GU06 and GU09 published by the Gas Standards Office of the Hong Kong Special Administrative Region;
- (f) Other Codes of Practice published by the Gas Standards Office of the Hong Kong Special Administrative Region;
- (g) Codes of Practice published by the Liquefied Petroleum Gas Association, United Kingdom or acceptable equivalent;
- (h) General Specification for Electrical Installation in Government Buildings of the Hong Kong Special Administrative Region issued by the Architectural Services Department;
- (i) General Specification for Air Conditioning, Refrigeration, Ventilation and Central Monitoring and Control System Installation in Government Building of the Hong Kong Special Administrative Region issued by the Architectural Services Department;
- (j) General Specification for Fire Service Installation in Government Buildings of the Hong Kong Special Administrative Region issued by the Architectural Services Department;
- (k) Codes and Standards published by the National Fire Protection Association (NFPA), American National Standards Institute (ANSI), American Society of Mechanical Engineers (ASME), American Society of Material Association (ASTM), United States; and

- (l) Equivalent standard that is acceptable to the Architect and the Gas Standards Office when a code or standard is specified in the Specification.

A2.1.3 Safety Requirements

- (a) Construction Sites (Safety) Regulations;
- (b) Factories and Industrial Undertakings Ordinance, Chapter 59, Laws of the Hong Kong Special Administrative Region and other subsidiary legislation made under the Ordinance;
- (c) Factories and Industrial Undertakings (Electrical) Regulations;
- (d) Factories and Industrial Undertakings (Safety Officers and Safety Supervisors) Regulations;
- (e) Factories and Industrial Undertakings (Confined Spaces) Regulations;
- (f) Public Health and Municipal Service Ordinance, Chapter 132, and other subsidiary legislation made under the Ordinance;
- (g) Construction Site Safety Manual issued by the Environment, Transport and Works Bureau, the Government of the Hong Kong Special Administrative Region; and
- (h) Occupation Safety and Health Ordinance, Cap 509, Laws of the Hong Kong Special Administrative Region.

A2.1.4 Technical Standards

BS, BS EN, ISO Standards, IEC Standards and Codes of Practice, etc., and other technical standards, quality standards, rules, design manuals, guidelines, technical requirements and specifications in this General Specification shall be deemed to include all amendments, revisions and standards superseding the standards listed herein, which are current at the closing date of the tender of the Contract, unless otherwise specified or unless the latest amendments are not approved or allowed by relevant authorities under the statutory regulations. Equivalent International Standards may be used if approved by the Architect.

Materials, equipment and products that comply with equivalent technical standards and demonstrated to be equivalent in overall technical substitute on the type of construction, functions, performance, general appearance and standard of quality of manufacture to the standards and requirements listed herein may be submitted for approval by the Architect.

A summary of technical standards quoted in this General Specification to which the Works shall comply is listed in Annex I.

A2.2 CASE OF CONFLICT

The documents forming the Contract are to be taken as mutually explanatory of one another but in case of ambiguities or discrepancies the same shall be explained by the Architect who shall issue to the Contractor instructions clarifying such ambiguities or discrepancies.

SECTION A3

EXECUTION OF WORKS

A3.1 THE INTERNATIONAL SYSTEM OF UNITS (SI)

The International System of Units (System International d'Unites) of weights and measures shall be used for all materials, equipment and measurements.

A3.2 PROGRAMME OF WORKS

The Contractor shall submit to the Architect a detailed programme of the Works within 4 weeks from the acceptance of his Tender showing the intended method, stages and order of work execution in coordination with the building construction programme, together with the duration he estimated for each and every stage of the Works. The programme shall include at least the following:

- (a) Dates for the placement of orders for equipment and materials;
- (b) Expected completion dates for builder's work requirements, i.e. when work site needs to be ready;
- (c) Delivery dates of equipment and materials to Site;
- (d) Dates of commencement and completion of every stage of the Works in line with the building construction programme, i.e. each floor level and/or zone area;
- (e) Dates of documents/drawings submissions to relevant Government departments to obtain the necessary approvals;
- (f) Dates of requirement of temporary facilities necessary for testing & commissioning, e.g. electricity supply, water and town gas;
- (g) Dates of completion, testing and commissioning; and
- (h) Short term programmes showing the detailed work schedules of coming weeks and months shall also be provided to the Architect. Programmes shall be regularly updated to reflect the actual progress and to meet the obligations under the Contract.

In addition, detailed submission schedules for installation drawings, equipment and testing and commissioning shall be submitted to the Architect for approval. The formats and information to be included in the schedules shall be as required by the Architect.

A3.3 BUILDER'S WORK

All builder's work including pipework openings or holes through building structure or partition walls; trenches, ducts and cutting; and all plinths, concrete bases, supports, ducts etc. required for the installation will be carried out as part of the building works by the Building Contractor at the expense of the Employer provided that the Contractor has submitted full details of such requirements within a reasonable time to the Architect for approval, so that due consideration may be given before the Building Contractor commences the building works in accordance with the building programme in the areas concerned.

After obtaining the said approval of the Architect, the Contractor is required to mark out at the relevant locations of the Site the exact positions and sizes of all such works and to provide detailed information of such works to the Building Contractor to facilitate him to carry out the builder's works as the works proceed. Builder's work shall include civil work in Section B9 of this General Specification unless otherwise specified.

All 'cutting-away' and 'making-good' as required to facilitate the Contractor's works will be carried out by the Building Contractor, except for minor provisions required for the fixing of screws, raw plugs, redhead bolts, etc. which shall be carried out by the Contractor. The Contractor shall mark out on Site and/or supply drawings of all 'cutting-away' to the Building Contractor within a reasonable time.

All expenses properly incurred and losses suffered by the Employer as a result of the Contractor's failure to comply with the above requirements are recoverable by the Employer from the Contractor.

The Contractor shall ensure that such works are essential for the execution of the Works. In the event that any of such works is proved to be non-essential, unnecessary and/or abortive, the Contractor shall bear the full cost of such works including but not limited to any unnecessary or incorrect cutting-away and making-good and shall reimburse the Employer for all cost incurred in this connection.

Upon completion of the builder's works by the Building Contractor, the Contractor shall forthwith check and examine that all builder's works so executed have been completed in accordance with his requirements. If at any time it becomes apparent to the Contractor that any builder's works completed by the Building Contractor does not comply with his requirements in any respect whatsoever, the Contractor shall forthwith give notice in writing to the Architect and specify in details the extents and effects of such non-compliance in that notice. The Contractor is deemed to have satisfied with the builder's works after a period of 14 days from the date of completion of the builder's works if the above notice is not served to the Architect within such period. All additional expenditure properly incurred and all loss suffered in this connection by the Employer in having such works re-executed and rectified shall be recoverable by the Employer from the Contractor.

A3.4 COORDINATION OF CONTRACT WORKS

The Contractor shall coordinate the Works with those works of the Building Contractor and any other contractors and sub-contractors.

The Contractor shall note that the Drawings supplied to him only indicate the approximate location of his work. He shall make any modification reasonably required of his programme, work sequence and physical deployment of his work to suit the outcome of work coordination or as necessary and ensure that all cleaning, adjustment, test and control points are readily accessible while keeping the number of loops, cross-overs and the like to a minimum.

The programme of work shall also be coordinated to the satisfaction of the Architect and adhere to the approved overall construction programme.

Any significant problems encountered during the coordination work, which are beyond the Contractor's control shall promptly be reported to the Architect for advice and/or decision.

A3.5 COOPERATION WITH OTHER CONTRACTORS

The Contractor shall cooperate at all times with the Building Contractor and all other contractors and sub-contractors in order to achieve efficient workflow on Site.

Any significant problems beyond the Contractor's control shall promptly be reported to the Architect for advice and/or decision. No extra claim for delay either financially or extension of the Contract Period will be allowed if the Contractor fails to properly and adequately co-ordinate and programme the work at all times.

A3.6 SITE SUPERVISION

The Contractor shall keep on the Site a competent and technically qualified site supervisor to control, supervise, co-ordinate and manage all his Works on Site. The supervisor shall be vested with suitable powers to receive instructions from the Architect.

The site supervisor shall be technically competent and have adequate site experience for the Works. The Contractor shall also refer to the Particular Specification for other specific requirements, if any, on site supervision.

Approval by the Architect shall be obtained prior to the posting of the supervisor on Site. The Contractor shall immediately replace any site supervisor whose experience, skill or competency is, in the opinion of the Architect, found to be inadequate for the particular work.

The LPG installation including the maintenance works shall be carried out by a Registered Gas Installer or by a trainee under the direct (on site) supervision of a Registered Gas Installer in accordance with Gas Safety Ordinance, Cap 51, Laws of the Hong Kong Special Administrative Region. Such Registered Gas Installer shall be registered in the appropriate class of work with the Gas Authority under the registration scheme.

All Works shall be carried out in such a manner so as to comply with the Gas Safety Ordinance (Cap 51), the Construction Site Safety Regulations and the Factories & Industrial Undertakings under Laws of the Hong Kong Special Administrative Region.

The Contractor shall implement a work permit system where work is required to be carried out on the installation in which LPG has been loaded (Annex 3.1 and 3.2). The Contractor shall be responsible to take every fire precautionary measures. He shall also be responsible for putting up warning signs at prominent positions on site to warn other contractors of the existence of the inflammable gases.

A3.7 SAMPLE BOARD

Within 6 weeks of the award of the Contract and prior to the commencement of installation work, the Contractor shall submit to the Architect for approval in good time a sample board of essential components proposed to be used in the Contract. However, the Contractor may request the Architect in writing for an extension of time, if 6 weeks are practically insufficient.

Items displayed shall be deemed to be adequate for the whole Works unless otherwise clearly indicated. Each sample, with clear numbering and labelling, shall be firmly fixed onto a rigid wooden or metal board. A list shall also be affixed on the sample board to show the item description, make and brand, country of origin and locations of installation (if not generally used). Samples rejected by the Architect shall be replaced as soon as possible. Upon approval of all items, the Architect will endorse the list on the sample board and the Contractor shall deliver the board to the site office for reference.

The following items shall be included in the sample board as a minimum. Additional items may be required by the Architect and/or specified in the Particular Specification.

- (a) pipework, fitting and support;
- (b) flexible rubber hose and tubing

A3.8 ADVICE OF ORDER PLACED

The Contractor shall submit copies of all orders placed for major items of equipment and materials to the Architect for record.

A3.9 RECORD OF MATERIALS DELIVERY

For the purpose of assessing interim payment, all materials delivered to Site shall be accurately listed and recorded in the site record books maintained by the representatives of the Architect on Site.

Materials and equipment delivered to Site and paid for in interim payment shall be the Employer's property. Such materials and equipment shall not be removed from Site without the approval of the Architect in writing and appropriate deduction shall be made in the next interim payment in accordance with the Contract.

Where the Building Contractor is in overall control of the Site, the Building Contractor may also be required to record details of all incoming/outgoing materials. In this case, the Contractor shall comply with the Building Contractor's arrangements.

A3.10 PROTECTION OF MATERIALS AND EQUIPMENT

Unless the responsibility is clearly defined in the Contract that the protection on Site for delivered equipment, materials and installation is solely by other contractors, the Contractor shall be responsible for the safe custody of all materials and equipment as stored or installed by him until finally inspected, tested and accepted. In addition, the Contractor shall protect all work against theft, fire, damage or inclement weather and carefully store all materials and equipment received on Site but not yet installed in a safe and secure place unless otherwise specified.

All cases of theft and fire must immediately be reported to the police, the Building Contractor, the Architect and the Architect's representatives on Site with full details.

Where necessary the Contractor shall provide lockable steel container or other equally secure enclosures placed within a securely fenced-in compound provided by the Building Contractor on Site for the storage of materials and equipment.

The Contractor shall co-ordinate and arrange with the Building Contractor who shall provide clean, reasonably finished and lockable secure accommodation for the storage of sensitive and/or expensive items before installation. If the Building Contractor fails to concede to the request, the Contractor shall report the shortcomings of the accommodation to the Architect.

If there is no Building Contractor, all the storage facilities and spaces shall be provided by the Contractor.

SECTION A4

DRAWINGS AND MANUALS

A4.1 STANDARD DRAWINGS

There are standard abbreviations, symbols and standard drawings prepared by BSB to show details of the common standard installations. The Contractor shall refer to these standards and drawings whenever such are mentioned or specified in the Drawings or the Particular Specification. The same standards shall also be used in the Contractor's "as-built" drawings, etc., whenever applicable.

A4.2 DRAWINGS IN ELECTRONIC FORMAT

The Contractor shall provide drawings in electronic format as required in the following clauses. These drawings shall conform to the latest version of CAD Standard of Works Projects (CSWP) as posted in the web site of the Works Branch, Development Bureau and in accordance with the latest version of CAD Manual for Architectural Services Department Projects. Should any technical conflict between the CSWP and the CAD Manual arise, the CSWP shall take precedence.

A4.3 INSTALLATION DRAWINGS

A4.3.1 Drawing Submission Schedule

The Contractor shall submit a detailed installation drawing submission schedule and programme to the Architect. The Contractor shall allow reasonable time in the programme for vetting of the installation drawings by the Architect and for drawing resubmissions as necessary.

The Contractor shall submit to the Architect a comprehensive "Submission Schedule" of installation drawings and builder's work drawings within 2 weeks after the acceptance of Tender, taking into account of the overall programme of the Works including any Specialist Works and works by the utility undertakings. No equipment shall be delivered to the Site and no work shall be executed until the installation drawings have been approved by the Architect. The Contractor shall ensure that the installation drawings and builder's work drawings are progressively submitted in accordance with the approved "Submission Schedule".

The Contractor shall provide at least 6 hard copies and one electronic copy, unless otherwise specified in the Contract, of the approved installation drawings to the Architect for distribution.

A4.3.2 Size of Installation Drawings

Drawings submitted by the Contractor shall only be of standard sizes from A0 to A4 or B1 size as stipulated in ISO 5457:1999.

A4.3.3 Contents of Installation Drawings

The Contractor shall ensure all installation drawings are accurate representation of the Works, before submitting them to the Architect. All installation drawings shall be fully dimensioned and suitably scaled showing construction, sizes, weights, arrangements, operating clearances and performance characteristics.

Installation drawings including manufacturer's shop drawings shall be prepared and submitted to the Architect for perusal by the Contractor in sequence with the Building Contractor's construction programme. They shall contain plan layouts, sectional drawings (elevations and plans), vertical schematic line diagrams, schematic wiring diagrams, installation details, etc. and shall show the following particulars:

- (a) Service routings and levels relative to the structure and other services;
- (b) Plant and equipment locations with dimensions and weights; and
- (c) Service joints, supports and fixing details together with their locations,

Maintenance accesses, facilities and all necessary details relating to the proper operation and maintenance of the systems.

A4.3.4 Builder's Work Drawings

Unless otherwise approved by the Architect, the Contractor shall submit to the Architect in accordance with the approved "Submission Schedule", 6 copies of drawings showing details of all builder's work required e.g. the weight and the load on each support of equipment. Such drawings shall clearly indicate the details and positions of all holes, trenches, ducts and cutting required and construction details for plinths and equipment bases.

A4.3.5 Manufacturer's Shop Drawings

The manufacturer's shop drawings are drawings for equipment or plant to be manufactured by a specialist manufacturing supplier in their own workshops and places away from the Site.

The drawings shall show detailed construction, principal dimensions, weights and clearances for maintenance, etc. Immediately after placing of any order or at any event within 4 weeks unless otherwise approved in writing by the Architect, the Contractor shall forward to the Architect for comment, 4 copies of manufacturer's shop drawings, indicating detailed construction, principal dimensions and weights, clearances for withdrawals and/or cleaning, etc. No work shall proceed on or off the Site unless drawings requiring approval are so approved in writing by the Architect.

A4.3.6 Drawings for Submission to Other Authority (FSD / GasSO / EMSD / WSD etc)

The Contractor shall ensure that construction approval where necessary from the Gas Authority has been obtained prior to commencing construction work of the LPG installation on Site. The Contractor shall submit installation drawings and other necessary information to the Gas Standards Office for construction approval.

A4.4 AS-BUILT DRAWINGS

A4.4.1 Submission of As-built Drawings

The Contractor shall submit 3 sets of the first draft prints of as-built drawings within 28 days of the issuance of the certification of completion. The Architect after checking the above draft prints shall return one set of the marked up copies of these as-built drawings to the Contractor within 42 days from the date of submission of the Contractor's draft prints with comments. The Contractor shall within a further 28 days from the date of receiving the Architect's comments on the draft as-built drawings re-submit to the Architect for his approval another 3 sets of the second draft prints of as-built drawings with the Architect's comments incorporated. This process of submission and approval shall continue until the final approval of the Architect on these as-built drawing is obtained.

The final approved as-built drawings shall be in 3 sets of hard copy and 3 sets of electronic copies. These shall be submitted within 21 days from the date of final approval. Each electronic copy shall be in the form of CD-ROM, labelled, with cross reference to a printed list of files explaining the contents and purpose of each file and supplied in sturdy plastic containers.

The detailed requirements and the media of as-built drawings set out in the Preliminaries of the Bills of Quantities or the Specification Preliminaries shall be followed as appropriate.

A4.4.2 Size of As-built Drawings

As-built drawings shall only be of standard sizes of A0, A1 or B1 size as stipulated in ISO 5457:1999. Smaller size (A2 to A4) is accepted for installation drawings.

A4.4.3 Content of As-built Drawings

The Contractor shall ensure all as-built drawings are accurate representation of the Works, before submitting them to the Architect. The as-built drawings required to be provided by the Contractor for various types of BS/E&M installations shall include, but not limited to the followings:-

- (a) Building services layout plans such as ducting arrangement, trunking arrangement, piping arrangement, etc.;
- (b) System schematic diagrams, control diagrams and wiring diagrams;
- (c) Concealed work layout plan such as concealed conduit routing, etc.; and
- (d) Installation details and assembly drawings such as bulk LPG vessel, LPG vaporizer, etc.

A4.4.4 Framed Drawings

On completion and before the acceptance of the LPG installation, the Contractor shall provide a framed drawing with glass cover and fix it on the wall of all the LPG stores/vaporiser rooms. The drawing shall indicate schematically all the pipe routes, positions of main controls and all sectional cocks or valves, meters, pressure testing points, etc and site layout plan to the approval of the Architect. A log book shall be provided and kept on site recording all operational checks and maintenance.

A4.5 OPERATION AND MAINTENANCE (O&M) MANUAL AND USER MANUAL

A4.5.1 General

The Contractor shall provide two types of manuals to the Architect with all changes made to the installation during the course of the Contract suitably incorporated.

The O&M Manual is for use by the maintenance agent of the completed installation. It shall contain detailed technical information covering both operation and maintenance aspects of the installation.

The User Manual seeks to enable the user of the completed installation an overview of the essential information of the installation. The contents of the manual should be concise and succinct for ease of comprehension by people with a non-technical background.

A4.5.2 Checking and Approval

The Contractor shall supply 3 sets of the first draft of O&M Manuals together with a list of recommended spare parts for one year's operation and a list of special tools, both complete with prices to the Architect for comment at least 56 days prior to the testing and commissioning of the plant and equipment or within 28 days of the issuance of the certification of completion.

The Contractor shall submit 3 sets of the first draft of the User Manual to the Architect for comment at least 56 days before the date of completion.

The Architect will check the drafts and return them to the Contractor within 42 days from the date of submission by the Contractor with comments necessary for final and approved set of document. The Contractor shall then make all necessary amendments to the documents and resubmit them to the Architect within 21 days from the date of receipt of comments.

The Contractor shall submit 3 sets of hard copies (one of which shall be the original) and one set of electronic copy of the final approved O&M manuals in CD-ROM, labelled, with cross reference to a printed list of files explaining the contents and purpose of each file and supplied in sturdy plastic containers, within 21 days from the date of approval by the Architect.

A4.5.3 Structure and Content of O&M Manual

The detailed requirements, structure and contents of the O&M manual shall be as specified in the Contract Preliminaries or shall include the following information under separate sections where appropriate:

(a) Project Information

The following information shall be included:-

Project title, site address, contract no., contract title, contractor/sub-contractor name, address, contact persons and their telephone/fax nos., contract commencement date, substantial completion date and end date of maintenance period.

(b) System Description

- (i) Type(s) of system(s) and equipment installed;
- (ii) Design criteria, design data and parameters;

- (iii) Locations of the system and major equipment, and what they serve;
 - (iv) Description of operation and functions of the system and equipment; and
 - (v) General operating conditions, expected performance and energy and resources consumption where applicable.
- (c) List of Installed Equipment
- Schedule of all items of equipment and plant stating the location, name, model no., manufacturer's serial or reference no., manufacturer's design duties and data.
- (d) Spare Parts and Special Tools Lists
- (i) List of Spare Parts supplied by Contractors:
Item descriptions, supplied quantities, model nos., manufacturer's serial or reference nos. and storage locations.
 - (ii) Recommended Spare Parts List and Special Tools List:
Manufacturers'/suppliers' recommendations for spare parts and special tools with item description, unit rate, recommended stock quantities as well as the agents for the spare parts and special tools.
- (e) Manufacturers' Certificates/Guarantees
- (i) Manufacturers' certificates such as factory test certificate, laboratory test reports, guarantees and any others where required for the equipment and plants etc.;
 - (ii) Originals of Statutory Inspection Certificate for various installations, including :-
 - Construction approval and use approval issued by Gas Standards Office;
 - Surveyor certificate of the bulk LPG vessels.
 - (iii) Testing records & commissioning data (other than the types prescribed above), which are required under the contract such as the T&C procedures, etc to verify the compliance of the BS/E&M system's/equipment's performance with the contract requirements, are checked and endorsed separately by the Architect and do not form part of the O&M manuals.

(f) Safety Precautions for Operation & Maintenance

State, where applicable, hazard warnings and safety precautions of which the operation and maintenance staff need to be aware:

- (i) mandatory requirements relating to safety;
- (ii) known hazards against which protection measures shall be taken; and
- (iii) known features or operational characteristics of the installed equipment or systems which may cause hazard and the related safety precautions.

(g) Operation Instructions

Instructions for the safe and efficient operation, under both normal and emergency conditions, of the installed system which shall comprise :

- (i) an outline of the operating mode;
- (ii) control logic and data (sequence, effect, limits of capability, modes and set points);
- (iii) procedures and sequences for start-up and shut-down;
- (iv) interlocks between equipment/system;
- (v) calling on of stand-by equipment;
- (vi) precautions necessary to overcome known hazards;
- (vii) means by which any potentially hazardous equipment can be made safe;
- (viii) estimation of energy consumption and energy costs;
- (ix) forms for recording plant running hours, energy consumption and energy costs; and
- (x) operating data such as running current, operating pressure, operating flow rates etc.

(h) Maintenance

(i) Maintenance instructions

Manufacturers' and contractor/ subcontractor's recommendations and instructions for the maintenance of the installed equipment. Clear distinction should be made between planned tasks (preventive maintenance) and fault-repair tasks (corrective maintenance). Instructions shall be given on each of the following, as appropriate :

- nature of deterioration, and the defects to be looked for;
- isolation and return to service of plant and equipment;
- dismantling and reassembly;
- replacement of components and assemblies;
- dealing with hazards which may arise during maintenance;
- adjustments, calibration and testing; and
- special tools, test equipment and ancillary services.

(ii) Maintenance schedules

Proposed maintenance schedules for all the preventive maintenance tasks identified above. The schedules shall be based on both manufacturers' recommendations and other authoritative sources (e.g. statutory or mandatory requirements) and shall include :

- routine servicing;
- inspections;
- tests and examinations;
- adjustments;
- calibration; and
- overhaul.

The frequency of each task may be expressed as specific time intervals, running hours or number of completed operations as appropriate. Collectively, the schedules will form a complete maintenance cycle, repeated throughout the whole working life of the installation.

(i) Drawing Lists

- (i) A complete list of as-built drawings identified with drawing number/reference;

- (ii) A complete list of manufacturers' shop drawings with drawing number/reference, where applicable; and
 - (iii) A brief description of CD-ROM for these drawings.
- (j) Technical Literatures
- A complete set of manufacturers' literatures for all the plant and equipment installed in the system. The contents of these literatures shall cover the following areas where applicable:
- (i) description of equipment with model numbers highlighted;
 - (ii) performance - behavioural characteristics of the equipment;
 - (iii) applications - suitability for use;
 - (iv) factory/laboratory test reports, detailed drawings, circuit diagrams;
 - (v) methods of operation and control;
 - (vi) operation instructions;
 - (vii) cleaning and maintenance requirements;
 - (viii) plants, materials and space required for maintenance;
 - (ix) protective measures and safety precautions for operation & maintenance; and
 - (x) part lists.
- (k) Contact addresses and telephone numbers of suppliers of major equipment.

A4.5.4 Structure and Content of User Manual

The detailed requirements, structure and contents of the User Manual shall include, where applicable, the following information:

- (a) Project Information

The following information shall be provided:

Project title, site address, contract no., contract title, contract commencement date, substantial completion date and end date of maintenance period.

(b) System Description

- (i) Type(s) of system(s) and equipment installed, and their purposes;
- (ii) Location of major plant rooms and riser ducts;
- (iii) Brief description of the operation and functions of the systems and equipment; and
- (iv) Listing of set points which can be adjusted by the user to suit their operation needs.

(c) Schedule of Major Plant Rooms and Installed Equipment

- (i) Schedule of major plant rooms and riser ducts including their locations;
- (ii) Schedule of major equipment and plants including their locations and serving areas.

(d) Safety Precautions for Operation

Any safety precautions and warnings signals in the daily operation of the various systems and equipment in the installation including:

- (i) mandatory requirements relating to safety;
- (ii) features or operational characteristics of the installed systems or equipment which may cause hazard and the related safety precautions;
- (iii) protective measures and safety precautions for operation; and
- (iv) list of warning signals and the related meanings that the user shall be aware of;

(e) Operation Instructions

Instructions for the safe and efficient operation, under both normal and emergency conditions, of the installed system which shall comprise :

- (i) an outline of the operating mode;
- (ii) step by step operation instructions for systems and equipment that are to be operated by the user, including at least procedures for start-up and shut-down;

- (iii) means by which any potentially hazardous situation can be made safe; and
- (iv) cleaning and basic maintenance procedures;

(f) List of Statutory Periodic Inspections and Tests

A schedule of periodic inspections and tests that owner and/or user of the installation have to arrange to achieve compliance with the requirements stipulated in the relevant Laws of the Hong Kong. The frequency of such inspections and tests shall be expressed in specific time intervals.

(g) Drawings

A set of selected as-built drawings which shall be able to illustrate to the user the general layout of the completed installation.

(h) Photographs

A set of photographs with suitable captions to illustrate to the user the appearance and locations of devices which require their setting and operation.

A4.5.5 Presentation

All manuals shall be written in English, unless otherwise specified. The text of descriptive parts shall be kept concise while at the same time ensure completeness. Diagrammatic materials shall also be supported by comprehensive descriptions. The overall aim of the manuals is to provide clarity in conjunction with brevity on a “need to know” basis.

The manuals shall comprise A4 size loose-leaf, where necessary, A3 size folded loose-leaf. The loose-leaves shall be of good quality paper that is sufficiently opaque to avoid “show-through”. Unless otherwise specified in the Contract, the manuals shall be bound in durable loose-leaf four ring binders with hard covers. The manuals shall have labels or lettering on the front cover and spine. The Architect’s approval shall be obtained on this at the draft manual stage. The electronic copy of manuals including the technical literatures, shall be in PDF format readable by Acrobat Reader Freeware.

A4.6 INTELLECTUAL PROPERTY RIGHTS

The Government shall become the absolute and exclusive owner of the Operation and Maintenance Manuals and the User Manual and all intellectual property rights subsisting therein free from all encumbrances.

In the event that the beneficial ownership of any intellectual property rights subsisting in the above Manuals are vested in anyone other than the Contractor, the Contractor shall procure that the beneficial owner shall grant to the Employer a transferable, non-exclusive, royalty-free and irrevocable licence (carrying the right to grant sub-licences) to utilize the intellectual property rights in the manuals for the purposes contemplated in the Contract. For the avoidance of doubt such purposes shall, but not limited to, include providing free copying of the material in the manuals by any subsequent owner or user of the installation, and/or any party responsible for the operation and maintenance of the installation in connection with any subsequent alteration, extension, operation and maintenance of the installation.

A4.7 CHECKING BEFORE SUBMISSION

All installation drawings, builder's works drawings, manufacturers' shop drawings, design drawings, as-built drawings, O&M manuals and User manuals shall be checked and endorsed by a qualified and experienced staff of the Contractor approved by the Architect before submission.

SECTION A5

GENERAL REQUIREMENTS OF THE WORKS

A5.1 TRADESMEN

All tradesmen must be experienced in the trade and the work carried out shall be consistent with good practice in Hong Kong and to the satisfaction of the Architect. The Contractor shall employ not less than one competent foreman on Site for each trade during installation. All trade foremen shall be registered tradesmen of the relevant trade.

The Contractor shall immediately replace any trade foreman or labour whose experience, skill or competency is, in the opinion of the Architect, found to be inadequate for the particular work.

A5.2 TRAINING OF EMPLOYER'S STAFF

The Contractor shall provide adequate training to the Employer's staff at completion of the Works after commissioning of the installation until they are fully familiar with the operation, routine testing and maintenance of the installation.

The training shall include all training facilities, material and handouts etc. The Contractor shall submit a training schedule and proposal at least 3 months prior to completion of the Works for the Architect's Approval.

A5.3 SPARES AND TOOLS

The Contractor shall also supply all the spare parts and special tools required for the whole Maintenance Period for operation and maintenance of the plant and installation. All consumable parts except fuel and water supply shall be included.

Unless otherwise specified, the Contractor shall submit before the certified completion date of the Works a price list for itemized spares and consumables pertaining to all the equipment offered as recommended by the manufacturers for a period of one year's operation and maintenance following the completion of the contract Maintenance Period. The prices listed shall be fixed and open for acceptance up to the end of the maintenance period.

In addition, the Contractor shall submit before the certified completion date of the Works a complete list of all the replaceable parts with model number, part number and price which shall be for purchase and use after the expiration of the Maintenance Period. The list shall be complete with suggested prices.

A5.4 SAFETY FACILITIES

Facilities for operational and maintenance safety shall be supplied and installed to comply with the Occupational Safety and Health Ordinance and with the requirements of Labour Department. All moving parts shall be appropriately covered and emergency stops shall be supplied and installed where necessary. Adequate spaces and facilities shall be allowed for maintenance and access.

A5.5 QUALITY ASSURANCE STANDARDS

The Contractor in supplying a specific item of equipment or appliance, whether specified herein by name or whether of a make selected by the Contractor, shall be deemed to warrant its satisfactory performance under all local working conditions.

In the event of anything described in the Specification or shown in the tender drawings being, in the Contractor's opinion, unsuitable for or inconsistent with the Contractor's guarantee or responsibilities, the Contractor shall draw the Architect's attention thereto at the time of tendering.

A5.6 GENERAL DESIGN REQUIREMENTS

All liquefied petroleum gas installations, materials, equipment and systems provided by the Contractor shall meet with the following design objectives: -

- (a) Comply with the statutory requirements;
- (b) Serve the functional and performance requirements for the storage and supply of liquefied petroleum gas to cater for the usage;
- (c) Be adequate, safe, efficient and convenient;
- (d) Allow and provide adequate maintenance facilities and accesses;
- (e) Provide reliable and durable materials and equipment with a reasonably long operating life;
- (f) Allow easy monitoring of system performance and equipment status;
- (g) Minimize future maintenance and replacement of parts;
- (h) Allow adequate standby and spare facilities to cater for the failure of any part of the installation;
- (i) Select and use equipment with optimum performance and with good efficiency;
- (j) Reduce noise, vibration and other nuisances to the occupants and neighbours;
- (k) Comply with all the safety requirements in future operation and maintenance with particular attention on the occupational safety and health of the workers;
- (l) Use durable materials as well as equipment having a steady and reliable supply of parts and spares;
- (m) Be aesthetically acceptable for all installations in exposed positions;
- (n) Minimise the environmental impact and social effect as appropriate; and
- (o) Be flexible to cater for future modification and expansion as appropriate.

The Contractor shall submit documentary evidence and demonstrate to the satisfaction and approval of the Architect that all the above design objectives as relevant are satisfied and complied with reasonably satisfactory solution. Where selection of the brand and model of equipment and material is done by the Contractor, the Contractor shall ensure and may be required to demonstrate to the satisfaction of the Architect that the design, configuration and installation details of equipment and material so selected shall meet with all the relevant design objectives as necessary.

A5.7 GENERAL REQUIREMENTS ON OPERATION AND MAINTENANCE PROVISIONS

All liquefied petroleum gas equipment shall be provided with facilities, permanent accesses and sundries for its proper operation, maintenance, inspection, repair, overhaul, testing and servicing after installation. Liquefied petroleum gas equipment without consideration of the maintenance and related provisions to the satisfaction of the Architect shall not be accepted.

The Contractor shall provide and allow in the equipment installation adequate facilities for future inspection, monitoring, operation, maintenance, testing, overhaul and replacement. Such facilities shall be built-in during equipment installation. All heavy equipment shall be provided with lifting eyebolt or the like for lifting. All equipment that has a limited operating life shall be accessible and shall be easily removed for maintenance or replacement. Adequate and safe access shall be provided to all parts of the equipment. Adequate special tools shall be provided where necessary. The Contractor shall ensure that access to the plant and equipment is adequate to allow for its removal and/or ultimate replacement. Where this is considered not possible or necessary, the Architect shall be consulted for alternative arrangements in the plant room.

The Contractor shall submit and use equipment that has a reliable and steady supply of spares and parts. The installation and equipment shall be provided with adequate gauges, meters, measuring devices and monitoring facilities for indicating all the essential or necessary parameters for quick inspection and monitoring. All such measuring and monitoring facilities shall be deemed to include in the Works whether they are shown in the Drawings or not. Where necessary measuring and monitoring facilities are found missing or not provided during testing and commissioning stage or in the Maintenance Period, the Contractor shall make such alterations or additions as in the opinion of the Architect as necessary to remedy such non-compliance at the Contractor's own expense. No approval given by the Architect of the drawings and material submission shall absolve the Contractor from liability for this aspect.

Warning notices, operating instructions and working/maintenance instructions shall be provided as necessary adjacent to or near to the equipment. Adequate protective guards shall be provided.

Adequate facilities shall be allowed in the installation for carrying out tests during future inspection and maintenance of equipment.

PART B – GENERAL TECHNICAL REQUIREMENTS

SECTION B1

BULK LPG STORAGE VESSELS

B1.1 GENERAL

This section covers fixed LPG storage vessels of capacity in excess of 450 litres water capacity which are normally refilled on site.

B1.2 STORAGE VESSELS

Vessels shall be designed and constructed of steel in accordance with a recognised Pressure Vessel Code such as PD 5500:2000, AS1210, or ANSI/ASME Boiler and Pressure Vessel Code Section VIII or equivalent. The Contractor shall be responsible to obtain the approval from the Gas Authority and submit the manufacturer's test certificates to prove that these standards have been fully complied with. Use of partial standards shall not be allowed.

Vessels shall be post-weld heat treated in accordance with the respective design codes and shall be subject to 100% radiography examination and a satisfactory "charpy" test at minimum design temperature.

Bulk tanks shall be designed to minimum pressure of 1.725 MPa and a minimum design temperature of -10 °C.

Each vessel shall be provided with a permanently fixed and clearly visible data plate that shall include as a minimum the following information:

- (a) the Pressure Vessel Code;
- (b) the manufacturer's name and serial number;
- (c) the water capacity in kilolitres;
- (d) the maximum working pressure in kPa;
- (e) the date of manufacture;
- (f) design temperature range in °C – minimum and maximum;
- (g) date of test, pressure applied, inspection authority, and its symbol; and
- (h) provision of sufficient space for subsequent re-test marking.

The vessel supports shall be of adequate design with due consideration of the vessel shell stressing and transmission of loading to the ground.

Saddles, bearing or corrosion plates shall be designed in accordance with the Pressure Vessel Code to which the vessel is designed and shall be of steel. Where saddles are not welded to the vessel, bearing and/or corrosion plates shall be used. The latter shall also be used whenever there is likely to be severe corrosion between the vessel and the supporting structure.

Saddles shall project downward more than any other projection on the lowest part of the vessel. Where saddles are not used, the vessel supports shall be shaped to conform to the vessel shell.

For above ground vessels above 5000 litres water capacity or where piers are used as part of the vessel support, provision shall be made for securing the vessel at one end, the other being free to move as required. The end so secured shall be that to which the principal liquid and vapour lines are attached.

Underground vessels shall be secured at both ends against flotation and they shall also be secured against movement at the end to which the connections are made.

Skirts for vertical vessels shall be provided with at least two vents to prevent the accumulation of liquid or vapour.

Horizontal vessels shall be sloped slightly towards the drain connection; alternatively the liquid withdrawal connection shall be at a slightly higher level than the drain connection.

Vessels exceeding 5000 litres water capacity shall have a manhole of minimum diameter of 450 mm. The manhole in the form of extruded nozzles shall be of not less than 550 mm internal diameter. Above ground vessels of less than 5000 litres water capacity and not fitted with a manhole shall be fitted with inspection openings accessible from the top.

In addition to inlet and outlet connections, each bulk storage LPG vessel shall be provided with at least one of each of the following fittings:

- (a) pressure relief valve connected directly to the vapour space;
- (b) plugged shut-off valve for connection;
- (c) a fixed maximum liquid level device and a contents gauge;
- (d) a pressure gauge connected to the vapour space; and
- (e) a suitable earthing connection.

All fittings on an underground vessel shall be accessible above ground level and shall be either on the manholes or on welded extensions.

B1.3 PRESSURE RELIEF VALVES

Pressure relief valves shall be of tamper-proof, direct spring loaded type, and designed to start to discharge and attain full flow at pressure in accordance with the Pressure Vessel Code of the vessel. Weight loaded relief valves shall not be used. The pressure relief valve shall have the following information stamped on the valve or on a separate metal plate securely fixed to it: -

- (a) the manufacturer's identification including name and catalogue or type number; and
- (b) the start to discharge pressure. Space shall be provided on the valve or the metal plate for subsequent stamping of periodic retest dates.

In the case of multiple pressure relief valves, provision made for isolating any one relief valve for testing or servicing shall ensure that the remaining relief valves provide the full capacity. In the case of vessels fitted with single relief valves, provision shall be made for their removal for testing or servicing by the use of an automatic shut-off valve which shall be fully open by the presence of the relief valve and shall close before the relief valve is completely removed.

For above ground vessels the rate of discharge of the pressure relief valve(s) at full flow shall not be less than 300 litres/s air or that calculated according to the formula, whichever is the greater:

$$\text{Flow rate, litres/s air} = 177.637 \times (\text{Surface Area, m}^2)^{0.82}$$

For underground vessels the full flow capacity of the pressure relief valves may be reduced to not less than 30% of the capacity derived for above ground vessels.

Excess flow valves shall not be installed between the vessel and any pressure relief valve.

B1.4 VENT PIPES

For above ground vessels over 5000 litres water capacity and for all underground vessels, the relief valves shall be fitted with vent pipes adequately supported and having outlets at least 2 m above the top of the vessels to which they are fitted and at least 3 m above ground level. Vent pipe outlet shall be located away from fixed sources of ignition at a minimum distance of 4.5 m. Electrical fittings within this area shall be in accordance with section B7.

Vent pipes shall be designed for the full flow characteristic of the relief valves, to allow for drainage of water and to ensure that in the case of ignition of discharging products, flame impingement on the vessel or on any adjacent vessels, piping or equipment is avoided.

Vent pipes shall be provided with loose fitting captive rain caps.

In case of vessels fitted with protective covers, the vent shall be provided to direct the discharged LPG through the relief valve away from the vessel shell.

B1.5 SHUT OFF VALVES AND EMERGENCY VALVES

All liquid and vapour connections on vessels other than those for relief valves, plugged openings and those where the connection through the vessel shell is not greater than 1.4 mm, shall have fire resistant shut-off valves conforming to BS EN 12266-1:2003 and BS EN 12266-2:2002 or API 607:1993 or equivalent, capable of manual operation located as close as practicable to the vessel. Particularly, liquid and vapour withdrawal connections shall be fitted with shut-off valve completed with integral excess flow valves. Filling connection shall be fitted with shut-off valve and check valve in accordance with clause B1.8.

Other connections to the vessel greater than 3 mm diameter for liquid and 8 mm diameter for vapour with the exception of those for relief valves and drain connections shall also be protected with an emergency valve.

Remotely controlled emergency valve shall be provided for large size connections of 40 mm or above. The emergency valve manual control shall be operated from a safe area and be of the “fail-safe” type.

B1.6 FILLING CONNECTIONS

All filling connections of a storage vessel shall be equipped with:

- (a) an emergency valve, e.g. an excess flow valve, back check valve; and
- (b) a shut-off valve preferably capable of manual operation.

Filling connections shall be easily accessible, preferably within the storage fenced area, and as close to the vessel as is practical, but not directly underneath.

Filling connections shall be located so that the safe positioning of the delivery vehicle and its quick removal in an emergency are facilitated.

Offset/Remove filling connections including vapour returns, shall be clearly labelled “liquid” or “vapour” as appropriate and shall terminate about 1 m above ground and shall allow a horizontal connection to be made with the delivery hose(s).

B1.7 DRAIN CONNECTIONS

Drain connections designed to permit drainage to atmosphere shall be provided with a shut-off valve which is preferably not more than 50 mm nominal size. The outlet of the drain valves shall be provided with a length of piping terminating with second shutoff valve, preferably not more than 25 mm nominal size. A sufficient length of piping shall be provided downstream of the second valve to ensure that discharge will not take place beneath the vessel. The drain valve adjacent to the vessel connection shall be quick action type.

No drain or blow-off line shall discharge into or be in the proximity of any public drainage system or any other drainage system where this would be liable to create a hazard.

The outlet of the drain valve system shall be blank-flanged, plugged or otherwise secured against tampering when not in use.

Pipework between the drain system valves and between any valve and a blank-flange or plug etc. shall be protected by hydrostatic pressure relief valve.

B1.8 GAUGES

The content gauges shall clearly indicate whether they read in % water capacity, % rated LPG capacity or actual contents in litres, tonnes, etc. Each bulb tank shall be equipped with at least two gauges for indicating the quantity of content, one of which shall be of a fixed liquid level type.

Any content gauge which relies on bleeding to atmosphere shall be such that: -

- (a) The bleed hole maximum opening is not larger than 1.4 mm otherwise it shall be protected by a shut-off valve and a suitable emergency valve;
- (b) It shall not be completely withdrawn in normal gauging operation; and
- (c) The gland shall be capable of being repacked without withdrawing the vessel from service.

The setting of the maximum level devices shall be suitable for the grade of LPG being stored and shall indicate a maximum product level for the designed usage at a temperature of 42.5 °C.

Temperature gauges shall be of the indirect type comprising pockets merged in contact with the vessel contents.

Pockets if temperature gauges shall be in the form of blind tubes suitable length, oil filled, permanently welded to the vessel and constructed in accordance with the Pressure Vessel Code of the vessel.

Pressure gauges shall be provided for all fixed storage vessels and connected to the vapour space of the vessel and easily readable from ground level. Pressure gauge mounting connection shall be protected either by a tapping reduced internally to a bleed hole not larger than 1.4 mm or by a suitable excess flow valve and shut off valve.

B1.9 MAXIMUM PERMITTED FILLING VOLUME

The maximum permitted filling volume should be reference to the legal requirements for filling of cylinders as prescribed in the Gas Safety (Gas Supply) Regulations 10(2).

No person shall fill a tank or cylinder with LPG other than such that, at temperature of: -

- (a) 47.5 °C, the tank will not be more than 97%, and the cylinder will not be more than 95%, full of LPG in liquid form; and
- (b) 52.5 °C, the tank or cylinder will not be full of LPG in liquid form.

B1.10 LOCATION AND SAFETY DISTANCE

No underground storage vessels shall be installed in basements or open pits. Storage vessels, whether at ground level or underground shall be spaced and located in accordance with Appendix 2 of LPGA Code No. 1 in which the distances given are the minimum recommended and refer to the horizontal distance in plan between the vessel and the nearest point of a specified feature, e.g. an adjacent storage vessel, building, property line, fixed point of ignition, any point of the LPG installation boundary up to which the general public legitimately have access. For underground vessels, distance from the vessel is measured from the valve assembly on the manhole cover.

The distance from the valve assembly on the manhole cover and the loading/unloading point to the LPG installation boundary up to which the general public legitimately have access must be at least 3 m.

For underground storage vessels, the distance between the vessel and the LPG installation boundary must be at least 1.5 m and the concrete chamber around the underground storage vessel must be wholly within the LPG installation boundary.

B1.11 ARRANGEMENT AND SEPARATION

Above ground storage vessels shall not be installed one above the other. In the case of multiple vessel installations, and where vessels are interconnected in the liquid phase, precautions must be taken to prevent both overfilling and the unintentional transfer of liquid from one vessel to another.

An LPG storage vessel shall not be installed nearer than 7 m to any vessel or bund wall of vessels containing any other inflammable liquid with a flash point below 65 °C.

The number of storage vessels in one group shall not exceed six, subject to the maximum total capacity of a group given in Appendix 2 of the LPG Code No. 1. Any vessel in one group shall be at least 8 m from any vessel in another group unless a radiation wall is erected between the groups, or adequate fixed water drenching systems are provided.

Separation kerbs for directing spillage away from vessels and other important areas shall not be higher than 380 mm.

Suitable protection must be provided to prevent possible damage to the above ground vessels and associated equipment valves, etc. by the use of crash barriers, bollards or a non-continuous kerb of not more than 380 mm in height.

Individual underground vessels of a multi-vessel system shall each be enclosed by a separate Concrete Chamber.

Underground vessels shall be protected from above ground loadings due to vehicular traffic or other cause, either by fencing off the area under which the vessels are buried or protecting them with reinforced concrete slab or other adequate cover. If the vessel area is not fenced off, the vessel manhole cover and the vessel fittings shall be protected against damage and tampering. The perimeter of the area under which the vessels are buried shall be permanently marked.

B1.12 FINISHES AND COATING

The exterior of an underground vessel shall be covered with a coating material which shall be strongly bonded to all external surfaces of the vessel. The coating material shall have the following properties:

- (a) be electrically insulating;
- (b) be inert;
- (c) be impervious to water;
- (d) possess high dielectric strength;
- (e) possess adequate mechanical strength to resist damage during handling of the vessel; and
- (f) have sufficient flexibility to allow for any damage due to expansion or contraction of bulk tank.

After coating of the vessel is completed, “holiday” test shall be carried out in accordance with Section D of this Specification.

B1.13 CATHODIC PROTECTION

Every semi-underground or underground vessel shall be provided with a cathodic protection system complete with test point (Gas Safety (Gas Supply) Regulation 12(1)). Tests on the cathodic protection system shall be made after completion of the installation and at 6 month intervals thereafter. The test results shall include the following data and shall be recorded and retained for the life of the vessel.

- (a) quantity, size and location of anodes;
- (b) date of installation;
- (c) type of backfill material; and
- (d) resistivity measurement of electrolyte.

SECTION B2
LPG CYLINDERS

B2.1 GENERAL

This section covers LPG installation using transportable, refillable cylinders, each not exceeding 130 litre water capacity but excludes the coverage of disposable cartridges.

The LPG installation may not ask for the supply of LPG cylinders. However, the LPG supplied by the Contractor shall be contained in cylinders which must have complied with the relevant British Standard Specifications or other recognized pressure vessel codes and approved by the appropriate authority of Government of Hong Kong Special Administrative Region.

Refilling the transportable cylinders shall not be carried out locally at the LPG installation.

B2.2 LIQUID-DRAW SYSTEM

Installation using liquid-draw LPG cylinders shall be incorporated with a vaporiser for the production of vapour LPG, which shall subsequently be conveyed to the appliance through pressure regulator(s).

Hydrostatic pressure relief valve shall be installed on each liquid piping that can be isolated by valves.

All liquid-draw cylinder shall be conspicuously marked for clear distinction from vapour-draw cylinders.

B2.3 VAPOUR-DRAW SYSTEM

Installation having vapour-draw LPG cylinder may direct feed the installation through pressure regulator(s).

B2.4 MULTI-CYLINDERS SYSTEM

Multi-cylinders in cylinder banks shall be manifold together by a permanent header, which shall be linked together through changeover device to enable that only one bank cylinder will supply LPG to appliances at any one time.

Manual and automatic changeover device shall be equipped with indication for the particular bank of cylinders being in operation, and may be complete with pressure regulation device should it be used in a vapour-draw system. The operation of the changeover device shall avoid GAS ON-GAS OFF-GAS ON situation.

Connection of the cylinders to a manifold shall be made by flexible hose and of sufficient length as specified in Clause 4.4 for easy manoeuvring of the cylinders. A flexible hose connecting to a manifold shall not be left unconnected after commissioning.

Safety Devices

- (a) Provision shall be incorporated into a manifold system to ensure that failure of a flexible hose connecting a cylinder to the manifold will not cause the complete loss of content from other cylinders.
- (b) When more than one cylinder supplying LPG to a piped gas system by means of flexible hose to a manifold system, appropriate safety devices shall be incorporated in accordance with Gas Safety (Gas Supply) Regulation 11(e) as described in B2.4.3.
- (c) The device consisting of a stop valve with check function shall be installed between the flexible hose and the manifold system for all cylinders. In the case of liquid withdrawal cylinders, one particular cylinder of each bank shall be installed with a stop valve with excess flow device to allow liquid LPG to flow back from the vaporiser.
- (d) By-pass pipework in addition to changeover device may be provided to ensure continuity of supply during maintenance. By-pass valves shall be kept closed throughout the normal operation.

B2.5 SIMPLE DOMESTIC INSTALLATION

For domestic installation using LPG cylinder of 15 kg or less, a clip-on regulator may be connected directly to the cylinder for drawing vapour LPG to the appliance through flexible hose, rubber tubing and/or metal piping. Clip-on regulator shall be of approved type acceptable to the Gas Authority.

B2.6 STORAGE OF LPG CYLINDERS

The storage of LPG cylinders and the minimum separation distance to boundary building or fixed ignition source from the nearest cylinder shall be in accordance with the current issue of Code of Practice for Hong Kong LPG Industry Module 1 published by the Gas Authority.

Within a single storage, all LPG cylinders are considered to be full irrespectively of the state of their contents for the purpose of calculating the minimum separation distance.

The maximum capacity of a piped cylinder store shall be 1000 kg.

Wherever practicable LPG cylinders shall be stored in open air with top cover of non-combustible material for weather protection and shading from direct sunshine. Where an open storage is not practicable, a purpose-built storage room shall be provided and constructed in accordance with the ventilation and explosion relief requirements in section B9 of this Specification.

The storage arrangement of cylinders in standby cylinder stores shall conform to the following:-

- (a) The gangway between palletised stacks shall be not less than 2.5 m while that between unpalletised stacks shall be not less than 1.5m; and
- (b) The maximum height of a stack shall not exceed 1.6 m.

SECTION B3

VAPORISERS

B3.1 TYPES

Vaporisers shall be of indirect heated type without naked flame or red-heated element, and utilising water as the heating medium. All electric elements and components installed within the vaporiser, shall be of flameproof design with enclosure to BS EN 50018:2000 or equivalent, unless they are being installed elsewhere and are physically separated at least 1 m from the vaporiser.

Vaporisers of direct fuel/heated type with naked flame or of non-flameproof electrical type shall not be used.

Heating coil shall not be installed inside bulk tanks as means of vaporisation.

B3.2 CAPACITY

The vaporiser shall have sufficient capacity to convert the liquid LPG at minus 10 °C to vapour at a temperature above the dew point at the maximum inlet pressure to the vaporiser and at the maximum demand rate from the installation.

B3.3 CONSTRUCTION

Pressure containing component of the vaporisers shall be designed, manufactured and factory tested in accordance with a recognized Pressure Vessel Code. The design pressure of the LPG containing component shall meet the highest pressure and temperature in service. The Contractor shall be responsible for producing certificates to verify the standard of construction.

Each vaporiser shall be permanently labelled on the outer surface of the casing to display the following data: -

- (a) The design Pressure Vessel Code;
- (b) The manufacturer's name, serial number and the date of manufacture;
- (c) The maximum LPG working pressure and temperature;
- (d) The outside surface area of the pressure vessel in m²;
- (e) The vaporising capacity in litre per minute or kg per hour; and
- (f) The heat exchanger area in contact with liquid LPG in m².

Extra space shall be provided in the metal plate for subsequent periodic stamping of retest dates.

B3.4 FUNCTIONAL COMPONENTS AND SAFETY DEVICES

Each vaporiser shall be equipped with at least the following facilities so as to ensure proper functioning and safe operation: -

- (a) Pressure relief valve in direct communication with the vapour side for an immediate and effective discharge of vapour to atmosphere at full flow conditions in case of excess vapour pressure. The relief pressure shall be in accordance with the Pressure Vessel Code to which the vaporiser is designed and constructed, and the relief capacity shall be 3.33 times the values in clause B1.3 using the surface area of the vaporiser shell and that of the heat exchanger that is directly in contact with LPG as the total surface area;
- (b) Liquid control device (such as a magnetic valve or float valve) to prevent liquid LPG from penetrating through the vaporiser to the vapour discharge pipe during heat input failure, overloading and any other abnormal condition;
- (c) Non-bimetal heat input control to prevent overheating and the pressure in the vaporiser vessel from reaching the start-to-discharge pressure of the pressure relief valves. Large vaporisers with multiple heating elements may be controlled by stages by more than one thermostat for regulating the temperature;
- (d) A drain off point for the LPG circuit complete with an intentionally operated control valve for the periodic drain off of oil and residue collected at the vaporiser. End of the connection shall be blanked or plugged;
- (e) Water level indicator and a low water level cut off to protect the vaporiser against damage due to low water level;
- (f) Gauges or other indication devices to accurately monitoring the state of liquid and vapour LPG within the vaporisation system and to keep track of the water temperature during operation;
- (g) A drain valve for the water chamber;
- (h) Shut-off valves at both the liquid and vapour LPG lines connecting the vaporiser to the storage vessel in accordance with Gas Safety (Gas Supply) Regulation 13. The emergency shut-off valves (Clause B5.6) provided upstream of the vaporisers shall be installed at a location as close to the vaporisers room entrance and as far away from the bulk tank as possible for access in the event of fire. Emergency shut-off valves shall be of fire-resistant type; and
- (i) Fusible plugs and frangible discs shall not be installed in the vaporisation system.

B3.5 LOCATION OF VAPORISERS

Minimum Distance from Vaporiser to Storage Vessel

Table 3.5A

Type of Vaporiser	Storage Vessel	
	Above ground with no radiation wall	Underground or mounded storage vessel up to 60 tonnes
Indirect heated or flameproof electric	1.5m	1.5m

For above ground storage vessel with radiation walls which are constructed as specified in Section C1, the minimum distance shall be the same as in the table 3.5A, but the distance may be measured round the ends of the radiation wall. The distance between the storage vessel and the wall shall be at least 1 m but not more than 2 m. The distance between the vaporiser and the wall shall be as follows: -

Table 3.5B

Water Capacity of Storage Vessel (litre)	Minimum Distance of Vaporiser from Radiation Wall (metre)
Over 1125 to 2250	1
Over 2250 to 9000	2.5
Over 9000	Radiation wall inappropriate

Minimum Distance from Vaporiser to Building or Boundary Lines of Adjoining Property

Table 3.5C

Type of Vaporiser	Minimum Distance
Indirect heated or flameproof electric	3 m

Electrical wiring and lighting for vaporiser room shall be designed and constructed in accordance with zone 1 electrical classification.

Pressure relief valves, pressure regulators and control equipment installed near the vaporiser shall not be located at where the ambient temperature is in excess of 60°C unless they are specifically designed for higher temperature.

B3.6 DRAIN AND VENT

Liquid LPG drain valve shall be permanently connected to pipe of sufficient length and running away from the vaporiser so that discharge of liquid LPG will not take place near to the vaporiser. The pipe outlet shall be fitted with another intentional operated shut-off valve but of one size smaller than the drain valve. The point of discharge of the liquid LPG shall be so selected that the possibility of creating a hazard is minimal.

Vapour from the pressure relief valve shall be piped upward and away from the adjacent LPG storage vessels for free discharge to the atmosphere. Vent pipes shall be designed for the full flow characteristic of the pressure relief valve.

SECTION B4
PIPING AND FITTINGS

B4.1 MATERIAL

All materials shall be compatible for use with LPG under the service conditions to which they are subjected. Pipes shall be of steel construction complying with Code of Practice for Hong Kong LPG Industry published by the Gas Authority. Materials such as cast iron, aluminium or its alloys, copper, rubber and plastic other than those specially designed for LPG shall not be used.

B4.2 STEEL PIPES

All liquid pipelines shall be Schedule 80 seamless steel pipes conforming to BS EN 10216-1:2002, BS EN 10217-1:2002 or API 5L:2004, and of a design working pressure of 2.75 MPa.

All vapour pipelines at high pressure stage shall be Schedule 80 seamless steel pipe conforming to BS EN 10216-1:2002, BS EN 10217-1:2002 or API 5L:2004 or ASTM A53:2006 or equivalent.

All vapour pipelines at medium pressure stage and below shall be of heavy grade steel construction and conform to BS EN 10255:2004 or ISO 65:1981 heavy grade or equivalent.

B4.3 FLEXIBLE RUBBER HOSE AND TUBING

The flexible hoses shall conform to BS 3212 (type 2):1991 or equivalent. It shall be designed to withstand a minimum bursting pressure of four times the maximum operating pressure or 5200 kPa whichever is higher. Corrosion resistant braiding shall be used. Each flexible hose shall be marked with "LPG" and be tagged with a label indicating the date of next replacement.

Emergency valves shall be installed in all liquid pipelines and in vapour pipelines at high pressure stage to which the flexible rubber hose are connected, to prevent discharge of LPG Gas in the event of hose failure. A manual shut-off valve shall be used for vapour lines designed to operate at medium pressure stage or below.

The flexible rubber tubing shall conform to BS 3212 (type 1):1991 for installations up to 5 kPa. The tubing shall be of minimum practicable length and shall not exceed 2 metre. The flexible tubing shall not extend from one room to another nor pass through wall or ceiling etc. and shall be easily accessible for inspection.

The end fitting of the flexible rubber hose or rubber tubing shall comply with BS 5315:1991 or the equivalent of applicable codes.

The clips, clamps or spigots used to secure flexible rubber hose or rubber tubing on the fittings shall be free from burrs and rough edges and shall not be over-tightened.

B4.4 PIPE JOINTS

Joints in steel pipes of 50 mm nominal bore and smaller shall be welded, or where approved flanged or screwed. Steel pipe joints over 50 mm nominal bore shall be welded, or where approved welded flanged. LPG pipes shall be of welded construction as far as practicable. LPG pipes of flanged or screwed construction shall have the prior approval of the Architect before installation.

Jointing of steel pipes by gas welding shall be in accordance with BS 2640:1982 and welding by electric arc shall be in accordance with BS 2971:1991. Electric arc welding shall only be used on pipes of 125 mm nominal bore or larger.

Jointing compounds for screwed connections shall be resistant to LPG and shall comply with BS 6956-1:2005, BS 6956-5:2005, BS EN 751-1:1997 and BS EN 751-2:1997. The use of PTEE tape is preferable but lead or hemp shall not be used.

All underground LPG pipe joints shall be welded unless otherwise approved by the Architect. Flanged connections shall be kept to a minimum.

B4.5 PIPE FITTINGS

Steel flanges and flanged fittings shall be to ANSI B 16.5 or BS EN 1759-1:2004 on liquid lines or vapour lines at high pressure stage. Flanges on vapour lines operating at medium pressure stage or below shall conform to BS1515-1:2000, BS EN 10921-1:2002. Bolting shall comply with BS EN 1515-1:2000, BS EN 1515-3:2005 or BS 4882:1990 or the equivalent of applicable codes.

Steel butt-welded fittings shall be to BS EN 10253-1:1999 or at least the same schedule thickness as the pipes for use at high pressure stage.

Steel socket-welded and screwed fittings and screwed coupling shall be to BS 3799:1974 or equivalent standard for use at high pressure stage.

Screwed fittings for use with steel pipes to BS EN 10255:2004 or ISO 65:1981 on vapour lines operating at medium pressure or below shall conform to BS 143 & 1256:2000 or BS EN 10241:2000 or the equivalent of applicable codes.

Gaskets shall be resistant to LPG and natural rubber shall not be used.

Screwed union or compression fittings for piping installation within LPG compound and cylinder store shall be avoided and shall not be used without the prior approval of the Architect.

B4.6 ALLOWABLE PRESSURE DROPS

Piping shall be sized that the pressure drop along the medium pressure stage shall not exceed 7 kPa, and that along the low pressure stage shall not exceed 0.15 kPa.

B4.7 PIPING INSTALLATION

Only lateral pipework inside the premises feeding the gas appliances may be allowed to be buried in floor slab. They shall be protected against corrosion and mechanical damage. Installation risers shall be carried external to the building and exposed or may be enclosed in ducts complying with BS 8313:1997.

All pipework shall be properly supported with strong hangers, anchors, brackets, saddles, guides etc. Pipe supports shall be arranged as near as possible to joints and changes of direction and each support shall take its share of load.

Supports for steel pipes shall be of mild steel, malleable iron or galvanised steel. Copper pipes shall be fixed by gunmetal or brass pipe clip. Brackets screwed to walls shall be secured by expanding plugs or other approved methods. The top half of the pipe clip shall be detachable without disturbing the fixing. The maximum distances of pipe supports shall be as shown in Table 4.7A.

Table 4.7A: Spacing of Support for Steel Pipe

Nominal Pipe Size (mm)	Maximum Distance between Supports (m)	
	Vertical runs	Horizontal runs
20	3	2.5
25	3	2.5
32	3	2.7
40	3.5	3
50	3.5	3
80	4.5	3
100	4.5	3
150	4.5	3
200	4.5	3

Vertical pipe risers shall be adequately supported at the base to withstand the total weight of the risers and shall be protected against mechanical damage to a minimum height of 2 metres from ground level.

All vertical and horizontal pipe runs shall have adequate flexibility and facilities to compensate for thermal expansion and contraction of pipes, or mechanical stress at branch pipes.

Insulation shall be provided in the pipe support for those section of piping where cathodic protection has been provided.

All pipes shall be thoroughly cleaned and wirebrushed to remove all grease, dirt, rust, scale, and other defects before installation; and shall be protected against corrosion by wrapping, galvanising or painting as appropriate.

During the installation work in progress, all open ends of the pipework shall be blanked off with purposely made plugs or caps to keep foreign matters from entering the finished system.

Pipework laid in floor slab shall be protected by factory-bonded sheath or wrapping. The piping shall be covered to a depth of not less than 12 mm. The channel shall be cleaned of all debris, sharp edges, rubbish and surplus moisture before the pipe is embedded.

Pipework passing through wall or floors of a building, shall be wrapped and enclosed in metal sleeve for complete length through the walls or floors and sealed with a non-combustible sealing agent at both ends. The annular space between the sleeve and the pipe shall be of sufficient width to allow for the maximum movement of the pipe due to thermal expansion and contraction. No joint shall be located within the sleeve. The sleeve shall be of same material as the LPG piping. Where sleeve passes through a floor that may be wetted or a wall on which water or corrosive material may condense, the sleeve shall project at least 25 mm beyond the floor or wall finished surfaces.

A minimum clearance of 150 mm shall be maintained between the LPG pipe and electric conduits or cables.

Pipework buried underground shall be adequately protected against corrosion and mechanical damage. Pipework shall be treated with two coats of bituminous paint and wrapped with corrosion and water resistance self-amalgamating tapes and mastics, or other equal and approved wrapping for protection against corrosion. The pipeline channel shall be cleaned of all debris, rubbish and surplus moisture, and the pipe shall be supported to ensure that it is completely surrounded by crack free mortar.

Underground pipework outside the premises shall be buried at a depth of not less than 800 mm. In the case where gas pipes and underground electric cables are running in a common trench, a minimum clearance of 200 mm shall be maintained between the two services. Pipe markers shall be fixed to indicate the route of the buried pipelines.

Underground pipework at road crossing shall have sufficient mechanical protection to prevent crushing. The Contractor shall submit the detail of protection for approval before installation.

SECTION B5

VALVES AND ACCESSORIES

B5.1 GENERAL

Pressure containing metal parts of valves (except appliance valves), including manual positive shut-off valves, excess-flow check valves, back-flow check valves, emergency shut-off valves and remotely controlled valves (either manually or automatically operated), used in piping systems shall be of steel, ductile iron, malleable iron or brass. Ductile iron shall meet the requirements of ASTM A 395:1999 or equivalent and malleable iron shall meet the requirements of ASTM A 47:1999 or equivalent. All materials used, including valve seat discs, packing, seals and diaphragms, shall be resistant to the action of LPG under service conditions.

All diaphragm valves shall be fitted with renewable diaphragms. Back seating shall be provided to isolate the gland packing when the valve is open for repair or inspection. Screwed ends shall be to BS EN 10241:2000. Taper threads and flanged end shall be to BS EN 1759-1:2004 or BS EN 1092-1:2002.

All valves shall be fitted in accessible positions and shall carry clear indication of the direction of operation required to open and to close the valve. Clockwise rotation of the lever or spindle shall close the valve.

B5.2 EXCESS FLOW VALVES

Excess flow valves or emergency valves shall be installed in the correct flow direction and shall intend to close upon excessive discharge of vapour or liquid resulting from a downstream rupture in hoses and piping system. The flow rate for closure of the valve shall be substantially above normal service flow rate to prevent premature closing, but shall in no case exceed 1.5 time the normal service flow rate.

B5.3 NON-RETURN VALVES

Non-return valves shall be suitable for liquid or vapour use in LPG cylinders/bulk tanks or in-line application. The valve shall be fitted with soft seat for tight shut-off so that piping can be blowdown for maintenance without leakage.

B5.4 ISOLATING VALVES

Isolating valves shall be of globe type with ductile iron bodies and stainless steel stems to resist corrosion. The valve seat shall be suitable for long-lived leakproof service. Steel ball valves shall be to BS EN ISO 17292:2004.

B5.5 QUICK-ACTING SHUT-OFF VALVES

Quick-acting shut-off valves shall be of lever operation and shall design to close tight in the direction of arrow.

B5.6 EMERGENCY SHUT-OFF VALVES

A shut-off valve incorporating thermal and manual means of closing provide for remote means of closing. Emergency shut-off valves shall be provided and incorporate all of the following means of closing: -

- (a) Automatic shut-off through thermal (fire) actuation. When fusible elements are used they shall have a melting point not exceeding 121 °C.
- (b) Manual shut-off from a remote location.
- (c) Manual shut-off at the installation.

B5.7 PRESSURE RELIEF VALVES

Pressure relief valves shall be spring-loaded and be fully automatic in operation. The valves shall have an effective rate of upward discharge to protect a system against excess pressure. The outlet vent connection shall terminate vertically with a self-detachable weatherproof cap complete with chain at least 3 m above ground level with an ultimate vertical section of minimum 2 m in length. Clause B1.3 shall also be referred for pressure relief valves for bulk LPG storage vessel.

Each pressure relief valve shall be plainly and permanently marked with the following: -

- (a) manufacturer's identification including catalogue or type number;
- (b) start to discharge pressure;
- (c) certified capacity in terms of air at Standard Temperature and Pressure (STP).

B5.8 HYDROSTATIC RELIEF VALVES

Hydrostatic relief valves shall be installed in pipelines and hoses located between isolating valves or blank flanges when liquid LPG can be trapped to protect a system against excessive pressure caused by thermal expansion of contents. The pressure relieving device shall be fixed in such a way that it will not discharge excessive pressure endangering personnel or equipment. The valve shall have a pressure setting in the range of 2.4 MPa to 2.75 MPa and be fitted with a self-detachable weatherproof cap complete with chain. The pressure setting shall not be higher than the weakest element in the system.

B5.9 PRESSURE GAUGES

Pressure gauges shall have stainless steel case and burden tube with dials not less than 75 mm diameter. They shall be installed at high, medium and low pressure stages to indicate the service pressures. Calibration shall be in kPa. Pressure gauge connections shall be protected by a tapping reduced internally to a bleed hole not larger than 1.4 diameter or by a suitable excess flow valve and shut-off valve.

B5.10 METERS

The design, material and construction of meters shall be suitable for the grade of LPG and the pressure and flow which they are to handle. The meter shall comply with the relevant parts of BS EN 12405-1:2005, BS EN 1359:1999, BS EN 12261:2002 and BS EN 12480:2002 and have corrosion resistant body and shall be of maintenance-free construction. If the meter is enclosed in a box for mechanical protection, the box shall be provided with sufficient ventilation.

SECTION B6

PRESSURE REGULATION

B6.1 PRESSURE RANGES

The ranges of high pressure stage, medium pressure stage and low pressure stage are as defined in Clause A1.3.

B6.2 CONSTRUCTION OF PRESSURE REGULATORS/GOVERNORS

Pressure regulators/governors shall be compatible for use with LPG in Hong Kong and designed in accordance with Gas Safety (Gas Supply) Regulation 21. The material, construction, performance and testing requirements for regulators of different pressure stages shall conform to BS EN 12864:2001, BS EN 13785:2005 & BS EN 13786:2004 except otherwise specified.

All pressure regulators/governors shall be sealed and locked against unauthorized adjustment after final testing and commissioning.

B6.3 PRIMARY PRESSURE REGULATOR

The primary pressure regulator is used for reducing the system pressure from high pressure stage to medium pressure stage or directly to low pressure stage.

The medium pressure of the LPG system shall be as specified in the Particular Specification. The pressure chosen shall not enable the LPG to re-condense due to fluctuation of ambient temperature. Thermal insulation may be used to prevent the re-condensation and the insulation shall be impervious to the ingress of water, resistance to fire and sufficiently robust to withstand minor mechanical damage.

If active-monitor regulator is used, the active regulator shall be of the fail open type. The monitor regulator shall be of a fail shut type or equivalent and equipped with an external static connection and shall be set at a slightly higher pressure than that of the active regulator downstream. The external static connection shall be connected at a point free of turbulence and preferably at a minimum of 5-pipe diameter downstream.

All first stage pressure regulating devices shall be located as close as practicable to the storage vessel or vaporiser and shall also be adequately supported and easily accessible.

Isolating valves shall be provided to facilitate removal of regulator(s) and shall be installed as close as practicable to the regulator(s).

B6.4 SECONDARY PRESSURE REGULATOR

The secondary pressure regulator is used for reducing the system pressure from medium pressure stage to low pressure stage and shall be capable of maintaining an outlet pressure of not exceeding 6.9 kPa. The installation shall be fully protected against effects of both over-pressure and under-pressure downstream with a need to ensure adequate reliability and continuity of supply.

If the primary pressure regulator is not of the active-monitor type, the secondary pressure regulator shall be equipped with slam-shut valve, under pressure shut off (UPS0) and over pressure shut off (OPSO) devices for protection against regulator malfunctioning.

All secondary pressure regulators and associated protective devices shall be suitable for outdoor use. They shall be able to work well at overpressure and underpressure condition and shall normally be installed outside building except otherwise specified.

B6.5 SERVICE GOVERNOR

The service governor is used to reduce the system pressure from low pressure stage to the operating pressure of the gas appliances connecting to it and shall be of spring-loaded type. The outlet pressure of the service governor shall be adjustable by means of a tool and shall normally be set at 3 kPa except otherwise specified. The service governor shall be capable of maintaining its outlet pressure with a maximum fluctuation of 10%.

The service governor shall be suitable for installation on horizontal or vertical pipe lines.

B6.6 REGULATORS WITH OVER PRESSURE AND/OR UNDER PRESSURE SHUT OFF DEVICES

The over pressure shut off (OPSO) device shall prevent excessive pressure from entering a building. The OPSO device shall close automatically and require manually reset if the regulator outlet pressure rises above a maximum set point.

The under pressure shut off (UPS0) device shall prevent any abnormal low inlet pressure and/or too great downstream demand. The device shall close automatically and require manual reset.

The OPSO and/or UPS0 device(s) may be integral with a regulator.

B6.7 REGULATORS/GOVERNORS WITH FULL CAPACITY OF INTERNAL RELIEF

Regulators/governors equipped with full capacity internal relief valve shall be capable of limiting the increase of outlet pressure of not more than 7 kPa or the maximum acceptable operating pressure of gas appliances downstream, whichever is the lower, even if the regulator is blocked open at full inlet pressure. The relief valve shall begin to operate at a pressure increase of 2 kPa at the regulator outlet and shall remain open until the over pressure condition is relieved.

Vent pipes shall be used to discharge the gas through the internal relief valve to freely ventilated locations when the escaping gas may constitute a hazard. Obstruction-free tubing or piping of at least 20 mm diameter shall be used and a screened vent shall be installed at the end of the vent pipe. On all installation, the bent or the end of the vent pipe must be protected from anything that may clog it.

SECTION B7

HAZARD PRECAUTION AND FIRE PREVENTION

B7.1 ELECTRICAL & ELECTROSTATIC HAZARD PRECAUTIONS

Area Classification shall be in accordance with Code of Practice for HKLPG Industry module 1, Section 5 of Code of Practice No. 1 and Section 7 of Code of Practice No. 7 of the LPGA.

All electrical equipment, apparatus and luminaries to be used in the designed hazardous area shall comply with the recommendations of BS EN 60079-14:2003 & BS EN 60079-10:2003 and shall be of a type suitable for the intended use in the appropriate zones. The Contractor shall be responsible for providing the certificates from the appropriate authority for approval before installation. All electrical equipment shall indicate clearly the type of service for which the equipment is designed, i.e. intrinsically safe or flameproof, etc.

Electrical wiring for flameproof installations and earthing of the power supply system shall be in accordance with the General Specification for Electrical Installation in Government Buildings of the Hong Kong Special Administrative Region issued by the Architectural Services Department.

With the exception of the insulation which is required to break the continuity of piping to meet the cathodic protection requirement, the Contractor shall ensure that all other LPG piping and equipment shall be electrical continuous and earthed. Continuity tests shall be carried out by the Contractor to the satisfaction of the Architect.

LPG piping shall not be used as electrical circuit protective conductor or earth electrode for other systems although their bonding to the circuit protective conductor may be necessary.

Whenever it is not contradict to the cathodic protection requirement, all bulk storage vessels shall be electrically earthed to protect against the accumulation of static electricity.

An earthing terminal shall be provided near the LPG filling point for the connection of the bulk tanker vehicles. The earthing resistance of the earthing terminal shall not exceed 1×10^6 ohm for dissipation of static electricity from the bulk tanker vehicles.

Identification of conductors and cables on LV power circuits shall be in accordance with New Cable Colour Code for Fixed Electrical Installations : Installation Guidelines published by the Electrical and Mechanical Services Department. Colour tracers may be used, in addition, to distinguish cables one from another.

B7.2 FIRE PREVENTION AND CONTROL

Fire prevention and control shall be in accordance with LPGA Code of Practice No. 3.

Provision of fire fighting equipment/system e.g. fire extinguishers, water drencher, etc., shall be as advised by the Director of Fire Services. The installation of these equipment/system shall be in accordance with the General Specification for Fire Service Installation in Government Buildings of the Hong Kong Special Administrative Region issued by the Architectural Services Department.

Fire extinguishers if required to be provided shall be of the type of 3 kg dry powder fire extinguishers or equivalent at suitable locations in accordance to the table, unless otherwise specified.

Minimum Number of Fire Extinguishers Required for LPG Compound, Cylinder Store and Vaporiser Room

Table B7.2A

LPG Storage Capacity (Tonnes)	Minimum Number of Fire Extinguishers Required
LPG Compound (excluding vaporiser room)	
Up to 25	2
Above 25	3
LPG Cylinder Store (excluding vaporiser room)	
Up to 1	1
1 – 2.5	2
Above 2.5	3
Vaporiser room	1

Vessel supports excluding those 450 mm or less in height shall be constructed or protected to have a standard of fire resistance of at least two hours.

Weeds, long grass and any combustible material should be kept clear from an area within 3 m of any LPG vessel of up to 2250 litres water capacity and 6 m of larger vessels. Weed killers containing chemicals such as sodium chlorate, which are a potential source of fire danger, shall not be selected for this purpose.

SECTION B8

MISCELLANEOUS

B8.1 GAS DETECTION

Gas leakage or suspected gas leakage shall be checked by the use of a gas detector, soapy water or by smell BUT NEVER WITH A NAKED FLAME.

Work in the affected or suspected gas leakage areas shall only be resumed subject to satisfactory gas detector readings.

Inflammable gas detectors shall be used only by Competent Persons.

B8.2 LPG TRANSFER PROCEDURES

The following procedures shall be applied before LPG is transferred from road tankers to bulk storage vessels: -

Any driving unit or electrical equipment not required and not specifically designed for the transfer operation shall not be used and be isolated.

Fire extinguishers shall be located in easily accessible positions and temporary warning notice displayed prominently.

Any accumulated static electricity on a road tanker shall be safely discharged to the earth terminal provided for this purpose before the LPG transfer connections are made.

A responsible person of the oil company shall remain both in attendance and control during all transfer operations to ensure that all the safety operation measures established by the oil company are enforced.

The road tanker shall be parked in the unloading space and shall be directly under the water sprinkler or drenching system, if provided.

B8.3 INSTRUCTION, LABELS, SIGNS AND NOTICES

Adequate and appropriate identification labels, emergency instructions, warning signs and line diagrams shall be provided.

The Contractor shall provide “NO SMOKING”, “LPG HIGHLY FLAMMABLE” and “LPG STORE” signs in 120 mm minimum English and Chinese characters and shall prominently display them on or adjacent to each point of entry to the LPG installation.

At the bulk storage vessels, at least TWO sets of the above mentioned signs shall be provided. The warning signs shall be made of sandwich plastic material with white outer layers and a black or red inner layer as required. Lettering shall be engraved on the plastic material by cutting away one of the outer layers to outline the required letters, and exposing the inner underneath. Details shall be submitted to the Architect for approval prior to engraving.

The Contractor shall provide and install adequate warning signs, emergency notices, operating instructions and framed schematic and line diagram in accordance with the requirement of the Gas Authority.

The Contractor shall identify all LPG piping with a colour band in accordance with BS 1710:1984. The basic identification colour shall be yellow ochre with black letters and signs on top to show the word "LPG", the "liquid" or "vapour" phase where the piping are inside the storage compound and the direction of flow.

All emergency control/valves shall be labelled to show their ON and OFF positions. The label may be in the form of a continuous roll of self-adhesive material or a permanent notice clearly marked "LPG Emergency Valve" and prominently displayed near such control/valves. Similarly, a permanent notice marked "LPG Main Control Valve" for the LPG main control valve outside the building shall also be provided.

Operating instructions shall be provided at appropriate locations to ensure safe, continuing and reliable operations. The operating instructions shall be made on a durable material and be properly fixed.

Labels shall be provided to all pipeworks, valves, electric circuits, indicators, cables, and all other equipment to facilitate operation and proper maintenance of the installation.

Labels and notices required by statutory requirements shall be inscribed accordingly whereas other labels shall indicate name and purpose of the equipment together with ratings where applicable. All labels shall be in both Chinese and English.

Labels and notices shall be fixed by screws. Where drilling and tapping is impracticable, approved adhesive may be used subject to prior approval by the Architect.

Warning notice sufficiently durable and legible throughout the life of the equipment shall be fixed in a prominent position drawing the attention of the operator to any potential hazard.

B8.4 PAINTING

Unless otherwise specified or not allowed by the statutory regulations, all equipment, pipeworks, hangers, brackets, supports, etc. which form part of the works shall be painted after erection. Painting shall be done in accordance with the latest edition of "General Specification for Buildings issued by the Architectural Services Department of the Hong Kong Special Administrative Region".

All finishing to factory assembled appliances shall be factory applied in accordance with the manufacturer's normal practice and to a standard suitable for the duty and location of the appliances.

Where factory applied finishes are approved, the Contractor must obtain from the manufacturer touch-up paint kits and detailed instructions for making good after completion any damage to finishes which may occur during transportation, storage, installation or commissioning.

All surfaces, unless otherwise specified, shall be finished in first class paint work. All metallic surfaces shall be wire-brushed and cleaned to make it free from rust, scale, dirt and grease prior to painting. All work shall be carried out by qualified tradesmen. Water based paints with reduced volatile and preservative content or paints with reduced solvent content formulated for minimal volatile organic compound emissions complying with reputable international standards shall be used in occupied areas and renovated areas without good natural ventilation. In addition, all paints shall contain no mercury, lead, hexavalent chromium or cadmium compounds. All painting works shall be completed and left in ventilated environment for at least one week, or the curing period recommended by the paint manufacturer whichever is longer, before occupation or handover of the renovated area to minimize volatile organic compound exposure. All surfaces shall be painted and finished as specified in the Particular Specification to meet and match the aesthetic architectural design as required.

Painting shall be of approved type and shall be generally to CP 231 and as described below: -

- (a) Do not carry out painting work in wet, humid or foggy weather or on surface that is not thoroughly dry or if there is excessive dust in the air;
- (b) Ensure that all holes, cracks and other defects in surface have been made good prior to painting;
- (c) Ensure the surface is thoroughly clean and dry prior to painting. Loose material shall be removed by dry brushing with stiff broom or brush;
- (d) Keep surface clean and free from dust during coating and drying; and
- (e) Protection freshly applied surface coating from damage.

Primer shall be applied to metal surface before the application of under and finishing coats of paint. Primer for non-galvanised metal surface shall be metallic zinc-rich primer to BS 4652: 1995, Type 2, and for galvanised surface shall be calcium plumbate primer or approved etch primer.

The primer, under coat and finishing coat of paint shall be from the same manufacturer. The painting procedure shall be strictly in accordance with the manufacturer's instruction.

For anti-corrosion paint and primer, the correct type of thinner/activator shall be used and the mixing method shall follow the manufacturer's instructions.

The volatile organic compound (VOC) content, in grams per litre, of all paint applied on surfaces of liquefied petroleum gas installation and any installations/equipment inside semi-enclosed/ enclosed areas of the building shall not exceed :

Type of Internal Paint

Type of External Paint

Water-based Paint : 50g/litre

Water-based Paint : 80g/litre

Solvent-based Paint : 400g/litre

Solvent-based Paint : 400g/litre

The testing method of the VOC content of paint shall be determined by the US EPA Method 24.

All finishing to factory assembled appliances shall be factory applied in accordance with the manufacturer's normal practice and to a standard suitable for the duty and location of the appliances.

Where factory applied finishes are approved, the Contractor must obtain from the manufacturer touch-up paint kits and detailed instructions for making good after completion any damage to finishes which may occur during transportation, storage, installation or commissioning.

SECTION B9

CIVIL WORK

B9.1 LPG COMPOUND

To prevent trespassing or tampering, the LPG compound which houses the storage vessels, vaporisers, regulators, etc. shall be enclosed by fence with two means of exit preferably positioned at opposite end of the compound. The fence shall be of industrial type, at least 1800 mm high and perforated to maintain good ventilation. The solid concrete kerb for supporting the perforated fence shall form a bund to a height of not less than 150mm and not be higher than 380 mm above finished floor level.

The floor of the LPG compound shall be concreted and those parts underneath the storage vessels shall be sloped. The vicinity of the vessels shall also be free from pits and depressions other than those necessary for drainage or the containment of spillage.

Water drains, where provided, shall be of the U shape with water seal preferably situated well away from the storage area.

The support for above ground storage vessels shall be of concrete, masonry or structural steel. Supports which are higher than 380 mm shall have a fire resisting period of at least 2 hours.

A sterile area of at least 1m shall be provided and paved with concrete around the LPG compound and conspicuously marked with yellow lines on the floor.

B9.2 ENCLOSURE FOR LPG CYLINDER/PLANT

Rooms containing LPG cylinders/plant shall be well ventilated and made of non-combustible materials. The floor shall be raised with a higher level than the surrounding and shall be concreted and sloped down towards an external door which shall not be provided with kerb. The door shall be open outwards and shall not be self-locking. The walls, ceilings, roofs and doors (including door frame and hinge assembly) shall be able to withstand a static pressure of 4.8 kPa. Those parts common with other structure shall be imperforated and have a fire resisting period of 2 hours minimum. Drain shall not be provided in the room and should be avoided in the immediate vicinity i.e. within 3 m of the room. A sterile area of at least 1 m shall be provided around the cylinder room and conspicuously marked on the floor with yellow lines.

B9.3 VENTILATION AND EXPLOSION RELIEF APERTURES

The natural ventilation and explosion relief requirements of the room with one external wall to 4 external walls are provided in Code of Practice for Hong Kong

LPG Industry Module 1. The apertures shall be situated as uniformly as practicable in the external walls.

If the requirement for natural ventilation cannot be met, mechanical ventilation shall be provided.

LPG installations shall be provided with explosion relief apertures located in external walls, the explosion relief area shall be at least 0.07 m^2 per m^3 of enclosed volume for open vents, or at least 0.1 m^2 per m^3 of enclosed volume for louvered vents. A louvered angle shall not be in excess of 45° to horizontal. The method for calculating the “effective area of ventilation/explosion relief” shall be in accordance with Code of Practice for HK LPG Industry Module 1.

Imperforated explosion relief panels shall be used. Ventilation apertures may be included as explosion relief apertures.

LPG cylinders and/or equipment shall not be located within 150mm of ventilation apertures. Suitable measures shall be taken to prevent blockage of ventilation apertures.

B9.4 TRENCHES

Trenches for underground pipe works shall have a minimum depth of not less than 800 mm. There shall be no pebble or small stones at the bottom of the trench. Electric cables and other services are not permitted to share the same trench.

B9.5 WALLS, CEILING OR FLOORS

Sleeves of the same material of the LPG piping shall be embedded in holes for the whole length through walls or slabs. Wall, ceilings, roofs and doors shall be designed such that if imperforated, they shall be capable of withstanding a static pressure of at least 4.8 kPa.

B9.6 RADIATION WALLS

Radiation walls for separating the vaporisers and storage vessels /cylinders shall be substantially constructed of concrete, brick or other suitable material having a fire resisting period of not less than 2 hours in accordance with BS476 Part 20 – 24:1987. The wall shall not be more than 2.5 m high.

B9.7 WARNING SIGNS AND LABELS

Warning signs and emergency instructions in both English and Chinese shall be posted by the Contractor near each entrance on the outside wall/fence of the installation. The size of the letters shall be of 120 mm minimum in height.

PART C – TECHNICAL REQUIREMENTS FOR APPLIANCES

SECTION C1

LPG GAS APPLIANCES

C1.1 SCOPE OF GAS APPLIANCES

The “Gas appliances” covered in this Section are appliances designed for use by a consumer of gas for domestic, catering and commercial purposes such as heating, cooking, hot water supply, lighting, motive power or other ordinary purposes for which LPG can be used.

C1.2 GENERAL REQUIREMENTS

A gas appliance to be supplied and installed in Hong Kong and submitted to Gas Authority for approval shall be approved in accordance with Codes of Practice issued by the Gas Authority including GU03, GU05, GU06, GU09 and other codes.

The gas appliance shall be suitable for operation with LPG of minimum pressure of 3 kPa unless otherwise specified. All materials used for the construction of the appliance shall be fire and heat resistance, non-flammable, strong and durable for the expected conditions of intended service.

The gas appliance shall be robust in construction, reliable and efficient in performance and shall meet the heat output with respect to the fuel input as specified in the Particular Specification. Apart from the locally fabricated custom-built cooking appliances, all imported appliances shall comply with the safety requirements as specified in one of or an equivalent to the following standards: -

- (a) British Standards (BS);
- (b) Japanese Industrial Standards (JIS);
- (c) Deutscher Verein des Gas and Wasserfaches e.v. (DVGW); and
- (d) The safety requirements for the locally fabricated units will be specified in the Particular Specification or otherwise.

The gas appliance shall incorporate adequate means for the removal of products of combustion as necessary.

The gas appliance shall incorporate facilities for drawing sufficient permanent supply of air for proper and efficient combustion.

The gas appliance and its associated gas fittings shall be stabilized in a secure position free from damage as effected by the foreseeable environmental dynamic conditions and accidental factors.

The gas appliance shall incorporate a fine control over the initial release of gas during ignition phase and shall also be capable of withstanding any undue explosion within the combustion chamber without damage to any part of the appliance in the event of ignition delay.

Any gas appliance requiring the supply of water and electricity shall be suitable for operation under the local supply conditions particularly with respect to the water pressure at the uppermost floor of the building and electrical voltage, viz. 380 V 3 phase or 220 V single phase 50 Hz.

C1.3 BURNERS AND ASSOCIATED PARTS

Burners shall be made of robust and durable metallic alloy and capable of producing the maximum heat capacity as specified with the proper mixing of gas and air.

The burner shall be designed for maximum efficiency, even flame distribution and generating as little noise as practically allowed.

The main and pilot flames shall be protected against draughts.

The products of combustion when tested in accordance with BS 7977-1:2002 shall not result in a CO/CO₂ ratio in excess of 0.02. The CO/CO₂ ratio shall not exceed 0.004 after 5 minutes of operation at normal gas rate.

Ignition may be manual or automatic sparks ignition by means of battery power, mains electricity, piezo-electric device or electronic device as indicated in the Particular Specification.

Combustion chamber and heat exchanger if applicable shall be constructed of high grade thermal conductivity alloy with high heat transfer efficiency.

C1.4 OUTER CASING

The outer casing of the gas appliance shall be smooth with no sharp edges and insulated from heat transfer such that the contact temperature at any position shall not exceed the maximum allowable values as specified in BS EN 297:1994.

C1.5 CONTROL AND REGULATING DEVICES

The gas appliance shall incorporate regulating devices for supply of gas, air and water as applicable.

The inlet gas and air shall be adequately filtered from dirt and dust before being mixed for combustion. Non-return valves shall be incorporated in the separate gas and air stream such that no mixing shall be possible in either supply stream.

C1.6 FORCED DRAUGHT COMBUSTION

If mechanically forced draught is employed for combustion, the flow rate of air shall be carefully designed and adjusted such that optimum combustion efficiency is achieved.

The Contractor shall be required to submit calculation verifying his selection of the blowers, fans, etc. with respect to the burners used in the offered gas appliance.

Ignition, combustion and air supply shall be properly sequenced for automatic combustion system for safe and proper purging and such as to avoid the extinguishments of the pilot or main flame during the course of operation.

C1.7 SAFETY DEVICES

The gas appliance shall incorporate a reliable safety shut-off valve to the gas supply.

Suitable flame failure device shall be provided to shut off the gas supply by actuating a relay or solenoid valve if no flame is detected.

Where a thermostat is specified to control the temperature attained in a compartment of the gas appliance, a back-up overheat protective device shall also be provided to shut-off the gas supply in the event of failure of the thermostat.

A gas water heating appliance shall be provided with the low water pressure automatic gas shut-off device.

If a gas appliance is constructed with a built-in power operated flue extract system, it shall be prevented from operation if the draught fails to operate.

Wherever applicable for a gas heating appliance, safety guards shall be provided to prevent accidental contact of clothing or inflammable materials with the heat surfaces.

C1.8 FLAME FAILURE DEVICES AND ASSOCIATED SAFETY SHUT-OFF VALVES

The flame failure device shall be manufactured to an international acceptable standard such as JIS2103:1991.

Wherever a flame failure device is required, the type of device and its coupling safety shut-off valves shall be incorporated in the following manner: -

- (a) Below 45 kW, thermo-electric type flame failure device may be used;
- (b) 45 kW to 600 kW, electronic type flame failure device coupled with one safety shut-off valve shall be provided;
- (c) 600 kW to 3 MW, electronic type flame failure device coupled with two safety shut-off valves in line shall be provided;
- (d) Above 3 MW, electronic type flame failure device coupled with two safety shut-off valves in line together with a vent in between the valves shall be incorporated.

The electronic type flame failure device specified in this Section shall operate on the principle of current rectification of the flame which in this application shall rectify an alternating current flowing between an electrode and the burner as the opposing electrode connected to the ground potential. The rectified signal so generated shall be amplified to control the operation of a gas relay or solenoid valve.

The flame failure device shall be installed in a proper position suitable for performing the required function and sheltered from over-spilling and over-heating as the circumstances prevail.

C1.9 ASSOCIATED GAS INSTALLATION

All the gas pipework in association with the gas appliance installation shall be carried out in accordance with Section B4 of this Specification.

All appliance with a fixed flue shall be connected to the gas supply by means of a permanently fixed rigid pipe.

Flexible rubber tubing complying with Clause B4.4 of this Specification may only be used for connecting unflued or portable appliances. Each length of connection shall not exceed 2 m. It shall not extend from one room to another nor passing through walls, ceilings etc. and shall be easily accessible for inspection and replacement. Connection to gas pipe by means of integral threaded metal ends or secured to a gas supply nozzle by crimping or using suitable hose clip as acceptable. Flexible rubber tubing shall not be exposed to temperature exceeding 50 °C.

A gas shut-off valve shall be provided at a readily accessible position at the gas inlet of the appliance.

C1.10 FLUES

Where a flue is required to be connected to a gas appliance, it shall be constructed and installed in conformity with BS5440-1:2000 for a rated input of up to 70 kW. Flues shall be so designed and constructed as to conduct away the products of combustion in an efficient manner.

A flue shall be readily accessible for inspection and maintenance. If it enters a brick or masonry chimney, access shall be made for inspection and maintenance of the seal between the flue pipe and the chimney.

Where a flue passes through a tiled or slated roof, the joint shall be weather-proof by using a purpose-made metal plate with a 150 mm upstand.

Where a flue passes through a ceiling, it shall be fitted with an insulating sleeve.

A flue, if required to be insulated against combustible materials, the surface temperature shall not reach 65 °C. The annular space between the metal sheets shall be packed with an approved non-combustible material not less than 25 mm thick.

A flue system incorporating electric powered exhaust draught shall have the control integrated with the gas appliance such that it shall be prevented from operation if the draught fails to operate.

If a manually operated damper is incorporated with a flue, it shall always be maintained in the fixed open position. An automatically operated damper for a flue shall be interlocked with the gas supply to the burner such that the burner shall be prevented from ignition in the event of failure of the damper when not in the open position.

C1.11 TESTING OF GAS APPLIANCE

Gas appliance shall be tested and commissioned in accordance with regulation 30 of Gas Safety (Installation and Use) Regulations and Code of Practice issued by the Gas Authority.

The Contractor upon completion of the installation of a gas appliance shall test the gas connection pipework for soundness. He shall examine the appliance, the gas fittings and other associated works, flue system, condition of ventilation of the room etc. for the purpose of ascertaining whether

- (a) the appliance has been installed to the required standard and regulations;
- (b) the appliance has been installed in accordance with the manufacturer's instructions;
- (c) the safety controls of the appliance are in proper working order; and
- (d) the supply gas pressure, water pressure, electrical voltage and frequency etc. are within the operating range of the gas appliance.

When testing the performance of the appliance, the Contractor shall verify its satisfactory operation condition with regard to the following aspects: -

- (a) the safe functioning of all protective controls;
- (b) the heat output of the appliance as specified in compatible with the fuel input;
- (c) the correct gas/air ratio for proper combustion; and
- (d) the effectiveness of the flue extract system

C1.12 DOMESTIC INSTANTANEOUS TYPE WATER HEATERS

Instantaneous water heaters shall be room sealed, balanced flue type and shall be so constructed that the combustion air shall be drawn from and the flue gas conducted away outside the room by means of a concentric wallcase flue duct.

The water heater shall be of modern, compact design and pleasant appearance. It shall be capable of providing instantaneous hot water with a temperature rise of 25 °C at a minimum flow rate as specified in the Particular Specification.

The water heater shall be manufactured to the reputable international standards such as BS EN 26:1998 or JIS S2109:2004. Test certificates issued by an independent regulatory authority in the country of origin shall be required unless otherwise approved for use by the Gas Authority.

The water heater shall be approved by the Water Supplies Department for direct connection to the town mains. Appropriate inlet and outlet pipe fittings shall be provided for connection to the external pipes. The minimum water supply pressure required for the water heater shall not be excessive such that it allows the installation of the water heater at the uppermost floor of the building without problem.

The water heater shall be equipped with built-in temperature regulator, flame failure detector, automatic gas shut-off valve, manual regulation valves, pilot burner and an automatic piezo-electric ignition device unless otherwise specified. The heat exchanger and combustion chamber shall be constructed of high thermal conductivity alloy with high heat transfer efficiency.

The fan shape burner shall give even flame distribution with as little noise as practically allowed.

The outer casing shall be made of heavy gauge sheet metal, properly treated to prevent rusting and corrosion and finished in high quality white stoved enamel or equivalent. Any insulation materials used shall be free of asbestos.

The inlet pipe connections shall be arranged in such manner that the gas pipe shall be preferably positioned between the hot and cold water pipes.

Balanced flue/room-sealed water heaters shall be installed in purpose built flue aperture, the location of which shall comply with the Building (Planning) Regulation 35A and the Practice Note to Authorized Persons issued by the Building Authority.

The water heater shall be installed on the wall by means of a number of substantial bolts and nuts. The process of fixing the heater in position shall not impair the supporting structure. The indoor portion of the appliance shall be installed to allow sufficient clearance from the side walls, ceiling and other structures for maintenance or replacement. The flue duct shall be adjusted to allow effective rejection of flue gases and, if for balanced flue, to allow also sufficient inlet vents for the intake air for combustion. The portion of flue duct passing through the external wall shall be thermally insulated and sealed for weather proofing. All ducts and pipes shall be checked for cleanliness and clearance of obstacle prior to commissioning.

Fan assisted room sealed instantaneous water heater shall be provided where specified in the Particular Specification. The fan assisted heater shall be complete with built-in flue fan. The flue fan shall have an over-run time before the ignition and after shutting down of the burner in accordance with the applicable design code. The electric fan, wirings and all parts of electrical installation of the heater shall comply with the requirements of the Electricity (Wiring) Regulation and suitable for electricity supply of 220V a.c., 50 Hz. The heater shall either have a viewing window for the user to check at any time that the heater is in operation by visual observation of the flame or have an indication lamp indicating the heater is on.

Terminals for earthing or equipotential bonding shall be provided where applicable.

C1.13 DOMESTIC TYPE GAS COOKER

The gas cooker shall be of modern design, pleasant appearance and suitable for installation in domestic kitchen. Facilities shall contain an oven, hot plates and a grill of various ratings as specified in the Particular Specification.

The gas cooker shall comply with BS5386: Part 3:1980 and Code of Practice GU06 relevant for use with LPG.

Unless otherwise specified, the cooker shall comprise open ring burners for the hot plates and jet burners for both the oven and grill.

All burners shall give low noise level in operation and a minimum noise in turning off to extinguish. All burners shall be regulated by "push and turn" control knobs; stable flames shall be maintained at all knob's position. All burners shall be suitable for simmering by adjusting the control knobs.

Unless otherwise specified, the oven shall be of the internally heated type with side hinged door. The oven shall be equipped with a temperature control regulator by means of thermostat with back-up overheat gas shut-off device. A

flame failure device shall be fitted to shut-off the gas supply in the event of failure of the pilot or main flame.

Solid top hot plates if specified shall be fitted with flame failure device.

Unless otherwise specified, the grill shall be of the open-fired type with the source of heat radiated from a metal fret above the food.

Ignition means to the various cooking facilities shall be specified in the Particular Specification or otherwise it will be assumed to be all manual without the use of a spark gun and to the manufacturer's standard product. Battery if required shall be included.

Means shall be provided to cater for spillage from the burner and the spill receivers shall be designed for easy cleaning.

A storage compartment with door beneath the oven shall be provided. Means of levelling the cooker shall also be available.

The casing shall be made of heavy gauge sheet metal properly treated to prevent rusting and corrosion and finished in high quality white or cream vitreous enamel or acceptable equivalent. The casing shall be insulated internally.

The cooker shall be supplied with a standard baking tray, a roasting tin and a ring type wok adaptor suitable for 300 mm diameter nominal size Chinese Wok.

The cooker shall be positioned at sufficient distance from the adjacent wall, overlaying shelves or other appliances or structures to prevent overheating of the surrounding. It shall be installed and commissioned all in accordance with the manufacture's instructions.

PART D – INSPECTION, TESTING AND COMMISSIONING

SECTION D1

INSPECTION, TESTING AND COMMISSIONING

D1.1 General

After the installation work is completed, the Contractor shall test and commission the whole installation for proper and safe operation.

The testing and commissioning of the installation shall be carried out by Competent Persons of the Contractor according to the Specification and the manufacturer's instruction and manuals. The Contractor shall follow relevant approved standards, procedures, guidelines in the testing and commissioning works. They shall include but not limited to :

- (a) Statutory Obligations and other requirements, Specifications and Standards specified in Part A;
- (b) Testing and Commissioning Procedure for Liquefied Petroleum Gas installation in Government Buildings of the Hong Kong Special Administrative Region;
- (c) Code of Practice for HKLPG Industry Module 1.
- (d) Detailed inspection, testing and commissioning methods and procedures approved by the Architect;
- (e) Manufacturers' recommendation and specifications; and
- (f) Test requirements under various standards including British Standards, European Standards, ISO Standards and other International Standards on liquefied petroleum gas installation.

The Contractor shall submit detailed testing and commissioning procedures and programme for approval by the Architect prior to the testing and commissioning of the LPG installation. The procedures include all the requirements in LPG_TCP with other additional requirements for the installation.

The Contractor shall carry out safety test and functional test for the installation. The Contractor shall commission the installation and carry out complete performance tests for all equipment and systems installed by him in accordance with the manufacturer's instructions, the requirements of the statutory rules and regulations and to the satisfaction of the Architect. The tests shall include, but not limited to :-

- (a) factory tests where required;
- (b) visual inspection and checking;

- (c) safety tests;
- (d) commissioning, tuning and adjustment;
- (e) functional tests; and
- (f) performance tests.

All tests mentioned in Clauses from D1.2 to D1.12 shall be witnessed and certified by a "Competent Person" as defined in Section A1. The Contractor shall despatch competent and experienced commissioning engineers and technicians to carry out the testing and commissioning of the installation.

The Contractor is required to appoint a competent and experienced commissioning engineer responsible for the overall planning, organizing, coordinating, supervising and monitoring of the testing and commissioning works and also certifying all results and reports from the testing and commissioning works. The Contractor shall submit, at the commencement of the contract, information detailing the qualification and experience of the commissioning engineer for the Architect's approval. The commissioning engineer shall be a "Competent Person" as defined in Section A1 and has minimum 3 years on-site experience in similar type and scale of testing and commissioning works.

All labour, instrument, fuel and materials necessary for carrying out the tests and for commissioning shall be provided by the Contractor.

Before the testing and commissioning of the LPG installation, the Competent Person shall check and ensure that the fire protection system for the LPG installation, if provided, should have been tested and accepted by Fire Services Department and put into operation.

The Contractor shall ensure Approval of Use has been obtained from Gas Authority before filling up the LPG storage tank or supplying LPG cylinders for commissioning of the LPG installation. The Contractor shall submit relevant information, test certificates and drawings to the Architect for applying Approval of Use from the Gas Authority well before commissioning of the LPG installation. All submission fees, if any, shall be borne by the Contractor. The Contractor shall ensure all tests are completed and certified by the Competent Person before forwarding the relevant information to the Architect for applying Approval of Use.

Prior to testing and commissioning, the Contractor shall submit detailed procedures and a programme for testing and commissioning to the Architect for approval.

The Contractor shall make arrangement with the Gas Authority for inspection and witness of the tests, including the pressure test and 'holiday test' for the underground pipeline and storage tanks, prior to cover up/back-filling.

Prior to the test, the Contractor shall carry out commissioning which shall include but not limited to :-

- (a) All equipment, joints, valves, etc. shall be checked for leakage, integrity and proper function;
- (b) Pressure regulators shall be set to their lowest outlet pressure initially and gradually adjusted to their required operating pressures. The regulators shall be checked for their pressure control function over the entire range of the design conditions including shut-off capability;
- (c) LPG trap shall be checked to ensure it is filled with water;
- (d) Active and monitor regulators shall be set for the designed function; and
- (e) Vaporiser including the heat and level controls shall be checked for satisfactory operation.

D1.1.1 Master Programme of Testing and Commissioning Works

The Contractor is required to submit a programme for testing and commissioning works which shall be submitted at the commencement of the contract, usually within the first three months. The programme shall indicate the tentative dates of all tests and commissioning works that will be carried out throughout the whole contract and all necessary submissions and approval relating to testing and commissioning and ensure that the testing and commissioning programme matches the master programme for construction and that all testing and commissioning works are complete before the completion date of the contract.

A detailed checklist of all the equipment and installation of the Works to be commissioned and tested shall be submitted at the same time. The checklist will be used for progress monitoring and shall be updated from time to time as the Works progress towards completion.

The testing and commissioning programme submitted by the Contractor shall detail the type of testing and commissioning works required, the breakdown of the programme into area-by-area basis, the tests that are required during construction and before completion of the Works, the period of each test with float time allowed, and the proposed programme for the completion of builder's works. Critical path programme shall be submitted. The Contractor shall plan the programme so as to minimise the overlapping of different tests arranged simultaneously in different locations of the Site.

D1.1.2 Inspection, Testing and Commissioning Methods and Procedures

The Contractor is required to submit detailed inspection, testing and commissioning methods and procedures together with report formats for reporting inspection, testing and commissioning results for the Architect's approval at least 4 months before commencement of testing and commissioning works, or 4 months after the commencement of the

contract, whichever is earlier.

Submission for works to be tested and commissioned during the construction period shall be made in good times matching with the construction programme for approval. For tests that have to be done satisfactorily before subsequent construction work, such tests shall be completed to the approval of the Architect before new construction work is to be carried out.

The Contractor shall submit detailed inspection, testing and commissioning methods and procedures following the format in LPG_TCP adding additional pages and details in accordance with the manufacturers' recommendation and relevant standards, and adding testing and commissioning procedures for systems and equipment not covered in LPG_TCP.

D1.1.3 Labour and Materials

The Contractor is required to be responsible for provision of all labour and both consumable and non-consumable materials for carrying out testing and commissioning works at their expenses. Electricity supply, water, LP gas, town gas and other fuel for carrying out of testing and commissioning works shall also be arranged and provided by the Contractor at no cost to the Employer. Where specified, Building Contractor may supply electricity and water.

The Contractor shall provide, at no cost to the Employer, all necessary equipment, apparatus, tools and materials for carrying out of testing and commissioning works.

The Contractor shall properly drain the water and exhaust the gases during and after the test as required. The Contractor shall provide and adopt measures to avoid damage to the building, installations, decorations and fixtures during the tests.

The Contractor shall allow labour, materials and fuel for carrying out overall acceptance test with the users and maintenance agents, and to provide training to the users and operators on the use and operation of the equipment.

D1.1.4 Supply of Inspection, Measuring and Testing Equipment

The Contractor is required to supply the calibrated equipment and instrument for testing and commissioning works in accordance with the requirements as specified in the Particular Specification.

D1.1.5 Readiness for Testing and Commissioning

The Contractor is required to check the completion of the works to be tested or commissioned, the associated builder's works and the associated building services installations to ensure that testing and commissioning can be proceeded in a safe and satisfactory manner without obstruction.

D1.1.6 "Type-test" Certificate

"Type-test" for equipment shall be carried out at the manufacturers' works or elsewhere appropriate in order to demonstrate their compliance with the Regulation or requirements. "Type-test" certificates together with the corresponding drawings, sketches, reports and any other necessary documents shall be submitted to the Architect for approval before delivery of the equipment.

D1.1.7 Notice of Inspection, Testing and Commissioning Works

The Contractor is required to provide advanced notice for inspection, testing and commissioning works as follows:

(a) Off-site Inspection and Testing

An advanced notice of at least one week before commencement of the inspection or test shall be provided.

(b) On-site Inspection, Testing and Commissioning

An advanced notice of at least 4 days before commencement of inspection, testing or commissioning shall be provided.

The Contractor shall plan the testing and commissioning programme to enable the Architect or his representatives to witness all the tests. Unless otherwise approved by the Architect, testing and commissioning works carried out by the Contractor in the absence of the Architect or the Architect's representatives shall not be accepted as the approved contract test record

D1.1.8 Documentation and Deliverables

The Contractor shall record all commissioning information and testing results at the witness of the Architect or his representatives. Testing and commissioning shall be properly checked and certified by Contractor's commissioning engineer and signed by the Architect or his representative who has witnessed the testing or commissioning before submission to the Architect. The Contractor shall submit full testing and commissioning report to the Architect within 14 days after completion of testing and commissioning of the installation.

Immediately after each test, the commissioning engineer shall sign the test/data record sheet, and obtain the endorsement of the Architect's representative who has witnessed the test on site, irrespective of whether the test is successful or not, and submit a copy of the test/data record sheet to the Architect. For testing that is required during the construction period, the Contractor shall also submit a formal testing and commissioning report endorsed by the commissioning engineer within 14 days after the completion of the whole test for any part of the installation.

3 copies of the results of tests for all appliances and certificate of tests for pressure type appliances and certificates for gas appliances signed by authorised or competent person shall be submitted before the hand-over inspection and shall be included in the related operation and maintenance manuals.

D1.2 BULK LPG STORAGE VESSELS

LPG storage vessels should be tested and certified by a Competent Person to prove that the vessel is up to the required standard: -

- (a) Ultrasonic/radiographic tests for examining internal flaws in accordance with the applicable design code; and
- (b) Magnetic particle or penetrant tests for examining surface flaws in accordance with BS EN 1290:1998 and BS EN 1291:1998.

In addition, the following tests shall be carried out on site by the Contractor: -

- (a) Hydraulic test at testing pressure 1.5 times of the design pressure of the storage vessels;
- (b) Commissioning pneumatic test at 700 kPa or 90% of design pressure, whichever is lower;
- (c) Paint thickness test (400µm minimum);
- (d) For underground vessels, "holiday" test after the vessel is coated; and
- (e) Leak test for the connections up to a minimum pressure of 689 kPa.

Format of the test certificate shall follow Code of Practice for Hong Kong LPG Industry Module 1 issued by the GasSO.

D1.3 VAPORISERS

Vaporisers and associated relief valves shall be hydraulic tested and certified by a Competent Person at 1.5 times of the design pressure. The components of the vaporiser not capable of accepting the test pressure shall be isolated or removed whichever appropriate during the hydraulic test.

Satisfactory operation of liquid control and heat input control device shall be checked.

Flame failure devices, pilot and main burner systems shall be checked and adjusted to give satisfactory and safe operation.

For indirect heated vaporiser using water as heating medium, water level safety controls shall be checked for proper operation.

Format of the test certificate shall follow Code of Practice for Hong Kong LPG Industry Module 1 issued by the GasSO.

D1.4 PIPEWORK TESTING

All pipework shall be tested after construction and before being placed in operation to ensure that it is structurally sound and gas-tight. In carrying out the test, precautions shall be taken to protect against any dangers which may arise if such pipe fails the test. : -

- (a) the person carrying out the test;
- (b) any persons working in the vicinity; and
- (c) members of the public.

All pipework shall be pressure tested as follows: -

- (a) All liquid lines shall be hydraulically tested at 1.1 times the HRPV setting after isolation of elements that could be damaged by the test pressure. Pressure test certificates shall state HRPV setting in addition to hydraulic test pressure. After the hydraulic test is completed, all isolated elements shall be properly installed and the whole system shall be tested pneumatically at a minimum pressure of 689 kPa.
- (b) High pressure vapour lines shall be tested either pneumatically or hydraulically at a minimum pressure of 1034 kPa.
- (c) Medium and low pressure vapour lines shall be tested either pneumatically or hydraulically at a minimum pressure of 103 kPa and 69 kPa respectively.

Time shall be allowed for temperature stabilization during pressure testing. The line pressure shall be adjusted to the test pressure after stabilization.

Note: The time allowing for temperature stabilization depends on the ambient temperature, test medium, pipe size and length. Generally this shall not be less than 15 minutes.

For pneumatic testing, the test shall be undertaken in phases as follows: -

- (a) Initially pressurize the system to 140 kPa and hold it for sufficient time to ensure that all fittings have been adequately fastened.
- (b) The pressure shall then be raised in stages until the required test pressure is reached.
- (c) After each pressure increase, sufficient time shall be allowed to ensure system integrity.

All exposed pipework shall be subject to annual visual examination and leak test using soap solution.

For hydraulic and pneumatic pressure test, the test period shall be of a minimum of 30 minutes and there shall be no sign of pressure decay during this period.

Note: Pressure decay indicates leakage and leaks shall then be identified by sight and sound or soap solution.

All open ends of a piping system shall be suitably blanked before testing.

Pipework pressure tests shall be recorded and the test report shall include the following: -

- (a) name of Contractor, and signature of the Competent Person who supervise the tests;
- (b) test date;
- (c) maximum working pressure;
- (d) test pressure, medium and duration;
- (e) test results; and
- (f) material, rating and specification of pipework and fittings.

The pressure of the pipework shall be reduced to zero as soon as is practicable after the pressure tests (see Gas Safety (Gas Supply) Regulation 20). Upon satisfactory completion of pressure tests, the pipework shall be purged into service in accordance with Section D1.12 prior to commissioning and operation of the LPG installation.

Format of the test certificate shall follow Code of Practice for Hong Kong LPG Industry Module 1 issued by the GasSO.

D1.5 REGULATORS

Regulators shall be checked for the required pressure control functioning over the required range of flows and for tight shut-off at zero flow.

D1.6 EMERGENCY VALVES

All emergency valves shall be checked for proper functioning.

D1.7 PRESSURE RELIEF VALVES

- (a) Pressure relief valves shall be calibrated and sealed by the manufacturer of the Competent Person before installation.
- (b) Check shall be carried out to ensure that relief valve vent caps are in place and mobile.

D1.8 VESSEL CONTENT GAUGES AND FIXED MAXIMUM LIQUID LEVEL DEVICES

Vessel content gauges and fixed maximum liquid level devices shall be checked for correct functioning and accuracy.

D1.9 GAUGES

Gauges shall be checked for accuracy and proper functioning.

D1.10 EARTHING

Installation earthing shall be tested and test results shall be submitted.

D1.11 CATHODIC PROTECTION SYSTEM

The cathodic protection system shall be tested and test results shall be submitted. It shall be checked at intervals not exceeding 6 months.

D1.12 PURGING/GAS FILLING OF VESSELS AND SYSTEMS

The method and procedure for purging or gas filling of vessels and systems shall be in accordance with the Code of Practice for HKLPG Industry Module 1.

D1.13 THE GAS AUTHORITY INSPECTIONS AND WITNESS OF TESTS

Additional tests and inspections, where not specified above, shall also be carried out to meet the statutory requirements to the satisfaction of the Gas Authority. The Contractor shall make all necessary applications to the Gas Authority and attend to the inspections conducted by their representatives for the purpose of these tests and inspections.

D1.14 TESTING AND COMMISSIONING REPORT

A testing and commissioning report shall be forwarded to the Architect within 14 days after completion of testing and commissioning the installation.

PART E – INSPECTION, ATTENDANCE, OPERATION AND MAINTENANCE DURING MAINTENANCE PERIOD

SECTION E1

MAINTENANCE

E1.1 GENERAL MAINTENANCE REQUIREMENTS

The Contractor shall furnish maintenance at no cost to the Employer for the complete LPG installation in the Contract for the whole Maintenance Period or any section or part thereof certified by the Architect. This maintenance shall include the following services: -

- (a) Emergency inspection, testing and repair;
- (b) Routine maintenance including preventive maintenance services;
- (c) Quarterly inspection, testing and servicing;
- (d) Annual and final inspection, testing and servicing; and
- (e) All the services and requirements in Section E1

The maintenance of the LPG installation shall be carried out by Competent Person of the Contractor in accordance with the Code of Practice for HKLPG Industry Module 1, this specifications and the manufacturers' instructions and manuals. All inspections, tests, servicing and repairs shall be carried out to the satisfaction of the Architect.

The Contractor shall despatch competent and experienced engineers and technicians equipped with appropriate testing instruments, tools, equipment, etc. to inspect, service, test, adjust and maintain the LPG installation in a satisfactory and safe operating condition.

The Contractor shall allow for carrying out 24-hour emergency and routine maintenance work at a time outside normal office hours including general holidays whenever necessary. The Contractor shall allow and prepare to provide a high level of service for the prompt rectification of the faults especially those related to safety issues.

All labour and materials necessary and transportation required for carrying out routine and emergency inspections, tests, repairs, replacements and maintenance services shall be included in the Contract. During the Maintenance Period, the Contractor shall supply and install at no cost to the Employer replacements for all equipment and parts which in the opinion of the Architect become unserviceable where such unserviceability is due to faulty materials, workmanship, design or installation or inadequate performance, rating and size of the Work provided by the Contractor. The Contractor shall also be responsible to replace all liquefied petroleum gas which may be lost by leakage or become unserviceable due to the aforesaid reasons.

The Contractor shall allow all necessary expendable materials such as cleaning fluid, oil, grease, jointing materials, abrasive anti-corrosive, touch-up paints, etc. required for the maintenance work.

The Contractor shall be responsible for all repairs necessary to maintain the LPG installation in a safe, reliable and operative condition at all times. The Contractor shall ensure that his servicing staff shall carry out the necessary repairs by utilising manufacturer's original replacement parts. Any component taken down for services shall be reinstated within 2 hours or otherwise replaced by a spare unit at the Contractor's expenses.

The Contractor shall ensure minimum interruption to the functioning of the LPG installation during each inspection, testing, repair or maintenance service. Where any part of the LPG installation is out of service temporarily during the progress of work, the Contractor shall notify the client in advance and to place a suitable notice in a prominent position. This is, however, not to be construed as an authority to leave any part inoperative for an undue length of time.

The Contractor shall, as and when instructed by the Architect, repair or replace at his own cost any part of the system proved to be defective by reason of Contractor's negligence, faulty design, inadequate routine maintenance and supervision, workmanship or materials. No claim whatsoever shall be made by the Contractor for such repair or replacement if it is within the scope of the Contractor's responsibility.

After each routine inspection, testing and maintenance service, the Contractor shall furnish to the Architect within 14 days a detailed report with details including date and time, persons carrying out the task, details of work done, follow-up actions and other requirements as stipulated below and in the Appendices.

The Contractor shall, at his own expenses, make all suitable arrangements to avoid damage to property or installations provided by others during the course of his work. The Contractor shall be responsible for all losses and claims for injury or damage to any person or property arises out of or in consequence of the execution of the maintenance and repair work.

E1.2 EMERGENCY INSPECTION, TESTS AND REPAIRS

Emergency service including overtime work for minor repairs and adjustment shall be included under the Contract. The Contractor shall make suitable arrangements whereby Competent Person shall be dispatched for emergency works at any time during the day or night including public holidays, whether true or false, and attending to such calls in the shortest possible time and using the quickest means of transport. In general a response time of less than one hour will be expected.

Such emergency service shall be rendered if the report involves gas leakage, explosion, fire hazard, human safety or incidental disruption of gas supply. Notification to the Contractor of the required emergency service will normally be by telephone from the Architect, his representative, or the user.

The Contractor shall submit a list with at least two names, office telephone numbers, mobile telephone numbers and addresses of his representatives to whom emergency service calls should be directed.

Following response to an emergency call the Contractor shall on the next working day submit a written "Emergency Service Report" to the Architect.

The Contractor shall keep a clear and legible record of all fault callout which shall indicate the date, time of callout, persons attending, brief description of the fault and subsequent time of rectification for each occasion. The record shall be submitted to the Architect for inspection within 3 days upon request by the Architect and will be returned to the Contractor after perusal by the Architect but shall subsequently be submitted and kept by the Architect at the end of the Maintenance Period during the handover inspection of the installation.

For safety reason, the Employer reserves the right to call upon the Fire Services Department and/or the Government employed LPG Maintenance Contractor to make safe the installation. However, if this is the case, the Contractor shall be responsible for all follow-up action and for payment of all incidental costs if such remedial action is caused by the defects of the installation.

All necessary repairs shall be carried out with the most practicably expeditious means to ensure minimum interruption to the user.

E1.3 ROUTINE MAINTENANCE – GENERAL

Before routine maintenance is carried out on site the Contractor shall obtain the Architect's agreement on the programme of routine maintenance, such as date and time taken.

After the routine maintenance, the Contractor shall furnish to the Architect within 14 days a test report.

E1.4 QUARTERLY INSPECTION, TESTING AND SERVICING

The Contractor shall carry out regular, quarterly and annual inspection, testing and servicing to the installation including all statutory maintenance requirement.

Operational checks such as house keeping, conditions of regulators and pressure gauges, inventory level and water level of certain vaporisers, etc. shall be carried out and logged on site as appropriate to ensure safety and proper function of the system.

E1.5 ANNUAL INSPECTION, TESTING AND SERVICING

The annual inspection, testing and servicing shall be witnessed and certified by a Competent Person. In addition, the Competent Person shall carry out test and submit the Annual Inspection Report.

E1.6 HANDOVER OF LIQUEFIED PETROLEUM GAS INSTALLATION

The LPG installation will not be deemed as acceptable for handover to the Architect until the installation is in good working order and all as-built drawings, instruction and maintenance manuals, spare part list, test reports, test certificates, etc. have been submitted to the Architect.

ANNEX I

LIST OF TECHNICAL STANDARDS AND QUALITY STANDARDS QUOTED IN THIS GENERAL SPECIFICATION

The following is a list of the technical standards and quality standards quoted in this General Specification. The technical standards and quality standards indicate the basic requirements. The Contractor may offer products, materials and equipment complying with alternative internationally recognized equivalent standards acceptable to the Architect and demonstrated to be equivalent in terms of construction, functions, performance, general appearance and standard of quality to the relevant standards or other standards specified in this General Specification to the Architect for approval.

Standard	Description
API 5L: 2004	Specification for Line Pipe
API 607:1993	Fire Test for Soft-Seated Quarter-turn Valves
AS1210:1998	Pressure Vessels
ASTM A 395/A 395M:1999	Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures
ASTM A 47/A 47M:1999	Standard Specification for Ferritic Malleable Iron Castings
ASTM A 53/A 53M:2006	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM B16.5: 2003	Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
BS 143 & 1256:2000	Threaded pipe fittings in malleable cast iron and cast copper alloy
BS 1515-1:2000	Flanges and their joints – Bolting – Part 1: Selection of Bolting.
BS 2640:1982	Class II Oxy-acetylene welding of carbon steel pipework for carrying fluids
BS 2971:1991	Class II Arc Welding of carbon steel pipework for carrying fluids

Standard	Description
BS 3212 (Type 1):1991 BS 3212 (Type 2):1991	Flexible rubber tubing, rubber hose and rubber hose assemblies for use in LPG vapour phase and LPG/Air installation
BS 3799:1974	Steel pipe fittings, screwed and socket-welding for the petroleum industry
BS 476- 20 – 24:1987	Fire Tests on Building Materials and Structures Part 20: Method for Determination of the Fire Resistance of Elements of Construction
BS 4882:1990	Bolting for flanges and pressure containing purposes
BS 5315:1991	Hose clamps (worm drive type) for general purpose use (Metric Series)
BS 5386-3:1980	Gas burning appliances Part 3: Domestic cooking appliances burning gas
BS 5440-1:2000	Installation and maintenance of flues and ventilation for gas appliances of rated input not exceeding 70 kW net (1 st , 2 nd and 3 rd family gas) Part 1: Specification for installation and maintenance of flues
BS 6956-1:2005	Jointing Materials and Compounds Part 1: Corrugated Metal Joint Rings
BS 6956-5:2005	Jointing Materials and Compounds Part 5: Specification for Jointing Compounds for Use with Water, Low Pressure Saturated Steam, 1st Family Gases (Excluding Coal Gas) and 2nd Family Gases
BS 7977-1:2002	Specification for safety and rational use of energy of domestic gas appliances Part 1
BS 8313:1997	Code of Practice for Accommodation of Building Services in Ducts
BS EN 10216-1:2002	Seamless steel tubes for pressure purposes: Technical delivery conditions Part 1: Non-alloy steel tube with specified room temperature properties
BS EN 10217-1:2002	Welded steel tube for pressure purposes: Technical delivery conditions Part 1: Non-alloy steel tube with specified room temperature properties
BS EN 10241:2000	Steel threaded pipe fittings

Standard	Description
BS EN 10253-1:1999	Butt welding pipe fittings – Part 1: Wrought carbon steel for general use and without general specific inspection requirements
BS EN 10255:2004	Non-alloy steel tubes suitable for welding and threading technical delivery conditions
BS EN 10255:2004	Non-alloy steel tubes suitable for welding and threading Technical delivery conditions
BS EN 1057:2006	Copper and copper alloys – Seamless, round copper tubes for water and gas in sanitary and heating applications
BS EN 1092-1:2002	Flanges and Their Joints - Circular Flanges for Pipes, Valves, Fittings and Accessories, PN Designated - Part 1: Steel Flanges
BS EN 1092-1:2002	Flanges and their joints – Circular flanges for pipes, valves, fittings and accessories, PN designated - Part 1 : Steel flanges
BS EN 12261:2002	Gas meters - Turbine gas meters
BS EN 12266-1:2003	Industrial Valves – Testing of Valve Part 1 : Pressure tests; test procedures and acceptance criteria - mandatory requirements
BS EN 12266-2:2002	Industrial Valves – Testing of Valve Part 2 : Pressure tests; test procedures and acceptance criteria - supplementary requirements
BS EN 12405-1:2005	Gas meters Conversion devices Part 1: Volume conversion
BS EN 12480:2002	Gas Meters - Rotary Displacement Gas Meters
BS EN 1254-1:1998	Copper and copper alloys – Plumbing Fittings – Part 1: Fitting with ends for capillary soldering or capillary blazing to copper tubes
BS EN 1254-2:1998	Copper and copper alloys – Plumbing Fittings – Part 2: Fittings with compression ends for use with copper tubes
BS EN 12864:2001	Low-Pressure Non Adjustable Regulators Having a Maximum Outlet Pressure of Less Than or Equal to 200 mbar, with a Capacity of Less Than or Equal to 4 kg/h, and Their Associated Safety Devices for Their Mixtures
BS EN 1290:1998	Non-destructive examination of welds - Magnetic particle examination of welds

Standard	Description
BS EN 1291:1998	Non-destructive testing of welds Magnetic particle testing of welds Acceptance levels
BS EN 1359:1999	Gas Meters - Diaphragm Gas Meters
BS EN 13785:2005	Regulators with a capacity of up to and including 100 kg/h, having a maximum nominal outlet pressure of up to and including 4 bar, other than those covered by EN 12864 and their associated safety devices for butane, propane or their mixtures
BS EN 13786:2004	Automatic change-over valves having a maximum outlet pressure of up to and including 4 bar with a capacity of up to and including 100 kg/h
BS EN 1515-1:2000	Flanges and their joints, Bolting Part 1: Selection of bolting-AMD 16534: August 31, 2006
BS EN 1515-3:2005	Flanges and their joints – Bolting – Part 3: Classification of bolt materials for steel flanges, class designated
BS EN 1759-1: 2004	Flanges and their joints Circular flanges for pipes, valves, fittings and accessories, Class designated Part 1: Steel flanges, NPS 1/2 to 24
BS EN 1759-1:2004	Flanges and their joints Circular flanges for pipes, valves, fittings and accessories, Class designated Part 1: Steel flanges, NPS 1/2 to 24
BS EN 26:1998	Gas-Fired Instantaneous Water Heaters for the Production of Domestic Hot Water, Fitted with Atmospheric Burners
BS EN 297:1994	Gas-fired central heating boilers Type B11 and B11BS boilers fitted with atmospheric burners of nominal heat input not exceeding 70 kW
BS EN 50018:2000	Electrical apparatus for potentially explosive atmospheres - Flameproof enclosure
BS EN 60079-10:2003	Electrical Apparatus for Explosive Gas Atmospheres Part 10: Classification of Hazardous Areas
BS EN 60079-14:2003	Electrical Apparatus for Explosive Gas Atmospheres Part 14: Electrical Installations in Hazardous Areas (Other than Mines)

Standard	Description
BS EN 751-1:1997	Sealing Materials for Metallic Threaded Joints in Contact with 1st, 2nd and 3rd Family Gases and Hot Water Part 1: Anaerobic Jointing Compounds
BS EN ISO 17292:2004	Metal ball valves for petroleum, petrochemical and allied industries
ISO 5457:1999	Technical Product Documentation - Sizes and Layout of Drawing Sheets-Second Edition
ISO 65: 1981	Carbon Steel Tubes Suitable for Screwing in Accordance with ISO 7/1-Second Edition
JIS S 2103:1991	Gas Burning Cooking Appliances for Domestic Use
JIS S 2109:2004	Gas Burning Water Heaters for Domestic Use-JIA
PD 5500:2000	Specification for Unfired fusion welded pressure vessels