This Code is based on accepted good practice and the appropriate standards for use in the industry. It should be regarded as complementary to the statutory requirements pertaining to the petroleum industry in different countries. It is hoped that the adoption of this Code will help reduce the risk of accidents.
Liquefied Petroleum Gas

Volume 1
LARGE BULK PRESSURE STORAGE AND REFRIGERATED LPG

Being the first of a two volume revision of Part 9 of the
Institute of Petroleum
Model Code of Safe Practice in the
Petroleum Industry

February
1987

A Code jointly prepared by The Institute of Petroleum,
The Institution of Gas Engineers and
The Liquefied Petroleum Gas Industry Technical Association (UK)

Published on behalf of
THE INSTITUTE OF PETROLEUM, LONDON

John Wiley & Sons
Chichester • New York • Brisbane • Toronto • Singapore
CONTENTS

Foreword .......................................................... x

1 Properties of Liquefied Petroleum Gas
   1.1 Liquefied Petroleum Gas (LPG) ......................... 1
   1.2 Properties and Characteristics ........................ 1
   1.3 Hazards ..................................................... 1
   1.4 Odorization ................................................ 2
   1.5 Prevention of Water Deposition ......................... 3

2 Pressure Storage at Refineries, Bulk Distribution Plants and Large Industrial Consumer Premises
   2.1 Scope ....................................................... 4
       2.1.1 Inclusions ........................................... 4
       2.1.2 Exclusions ........................................... 4
       2.1.3 Object ............................................... 4
   2.2 Requirements for the Layout Location and Spacing of LPG Pressure Storage Installations 4
       2.2.1 General layout principles .......................... 4
       2.2.2 Location and spacing ............................... 4
       2.2.3 Bunds and separation kerbs ......................... 5
       2.2.4 Ground conditions ................................... 6
       2.2.5 Pits and depressions in the storage area ........ 6
       2.2.6 Other hazardous storage ............................ 6
       2.2.7 Layout of storage ................................... 6
       2.2.8 Protection of facilities ............................ 6
   2.3 Pressure Storage ........................................... 6
       2.3.1 Design code ........................................... 6
       2.3.2 Design criteria ....................................... 6
       2.3.3 Fittings ............................................... 7
       2.3.4 Connections .......................................... 7
       2.3.5 Level gauging equipment ............................ 7
       2.3.6 Pressure relief ....................................... 7
       2.3.7 Shut-off valves ....................................... 8
       2.3.8 Emergency shut-off valves ........................ 8
       2.3.9 Excess flow valves .................................. 8
       2.3.10 Drain systems ....................................... 8
       2.3.11 Filling capacity .................................... 8
       2.3.12 Insulation ............................................ 8
CONTENTS

2.3.13 Icing of valves ........................................... 8
2.3.14 Protection—painting ...................................... 8
2.3.15 Marking ..................................................... 9
2.3.16 Identification ............................................ 9
2.3.17 Examination .............................................. 9

2.4 Piping, Valves and Fittings .................................. 9
2.4.1 Design code ................................................ 9
2.4.2 Materials .................................................. 9
2.4.3 Pipe thickness ............................................ 9
2.4.4 Pipe joints ............................................... 9
2.4.5 Welding .................................................... 9
2.4.6 Valves ..................................................... 10
2.4.7 Flanges and fittings ...................................... 10
2.4.8 Bolting .................................................... 10
2.4.9 Installation and flexibility ................................ 10
2.4.10 Thermal pressure relief .................................. 10
2.4.11 Insulation ............................................... 10
2.4.12 Articulated pipe connections .............................. 11
2.4.13 Inspection and testing .................................... 11
2.4.14 Hoses ..................................................... 11
2.4.15 Emergency shutdown ..................................... 11

2.5 Foundations and Supports for Vessels and Piping .......... 11
2.5.1 Codes and specifications ................................... 11
2.5.2 Ground conditions ........................................ 11
2.5.3 Materials ................................................ 11
2.5.4 Loadings ................................................ 11
2.5.5 Settlement ............................................... 12
2.5.6 Support systems ........................................... 12
2.5.7 Pipe supports ............................................. 12
2.5.8 Fireproofing .............................................. 12

2.6 Pumps, Compressors and Meters .............................. 12
2.6.1 Pumps .................................................... 12
2.6.2 Compressors .............................................. 12
2.6.3 Meters .................................................... 12
2.6.4 Protection of pumps, compressors and meters .............. 12
2.6.5 Transfer systems ......................................... 12

2.7 Road and Rail Loading and Unloading Facilities ............. 13
2.7.1 Location and layout ....................................... 13
2.7.2 Ground conditions ....................................... 13
2.7.3 Loading and unloading equipment .......................... 13
2.7.4 Stray currents, earthing and bonding ....................... 14

2.8 Electrical, Static Electricity, Lightning Protection .......... 14
2.8.1 Electrical apparatus, earthing and bonding ................ 14
2.8.2 Lightning protection ..................................... 14

2.9 Requirements for Fire Protection ............................ 14
2.9.1 Fire plan ................................................ 14
2.9.2 Control of fires .......................................... 14
2.9.3 Protection systems ....................................... 14
2.9.4 Access .................................................. 14
2.9.5 Communications/alarm .................................... 14
2.9.6 Cooling water ........................................... 14
2.9.7 Care and maintenance of fire-fighting equipment ........... 15
CONTENTS

2.9.8 Drainage .................................................. 15
2.9.9 Removal of combustible materials ....................... 15
2.9.10 Warning signs .......................................... 15

2.10 Operations .................................................. 15
2.10.1 Housekeeping .......................................... 15
2.10.2 Training .................................................. 15
2.10.3 Emergency procedures/plans .............................. 15
2.10.4 Emergency action ....................................... 15
2.10.5 Purging and filling of systems ........................... 16
2.10.6 Draining water in service ............................... 16
2.10.7 Transfer operations .................................... 16
2.10.8 Access to storage and operating areas ................. 17
2.10.9 Lighting of storage and operating areas ............... 17

2.11 Inspection of Pressure Storage ............................ 17
2.11.1 Permit to work systems .................................. 17
2.11.2 Preparation ............................................. 17
2.11.3 External inspection—above-ground vessels ............ 17
2.11.4 Internal inspection—above-ground vessels .............. 18
2.11.5 Buried/mounded vessels ................................ 18
2.11.6 Cracks ................................................... 18
2.11.7 Pressure relief valves ................................... 18

3 Refrigerated Liquefied Petroleum Gas Storage

3.1 Scope ................................................................ 19
3.1.1 Inclusions .................................................. 19
3.1.2 Exclusions .................................................. 19
3.1.3 Object ....................................................... 19

3.2 General Philosophy ........................................... 19
3.2.1 Definitions .................................................. 19
3.2.2 Level of safety ............................................ 20
3.2.3 Prudent provisions for spillage ............................ 20
3.2.4 Leakage ...................................................... 20
3.2.5 Vapour formation and fire ................................. 20

3.3 Requirements for Location and Spacing of Refrigerated LPG Tanks ................................................. 20
3.3.1 Limits for thermal radiation flux levels ................. 20
3.3.2 Rate of leakage .......................................... 21
3.3.3 Vapour travel ............................................. 21

3.4 Requirements for Bunds and Impounding Basins ......... 21
3.4.1 Individual tank bunding ..................................... 21
3.4.2 Bund capacity ............................................. 21
3.4.3 Bund design ................................................ 21
3.4.4 Bund safety ................................................ 22

3.5 Requirements for Low Pressure Refrigerated Storage Tanks ......................................................... 22
3.5.1 Design ....................................................... 22
3.5.2 Tank fittings ................................................. 23
3.5.3 Tank connections and appurtenances ..................... 23
3.5.4 Pressure/vacuum control and relief systems ............ 23
3.5.5 Insulation of tanks ....................................... 24
3.5.6 Corrosion protection of tanks ............................ 25
3.5.7 Marking of tanks ......................................... 25
### CONTENTS

3.6 Requirements for Piping, Valves and Fittings
  - 3.6.1 Piping code
  - 3.6.2 Materials
  - 3.6.3 Installation
  - 3.6.4 Thermal pressure relief

3.7 Requirements for Foundations for Tanks
  - 3.7.1 Foundation design
  - 3.7.2 Uplift

3.8 Requirements for Fire Protection/Loss Control Systems
  - 3.8.1 Fire plan
  - 3.8.2 Control of fires
  - 3.8.3 Protection systems

3.9 Inspection of Refrigerated Storage Tanks
  - 3.9.1 Permit to work systems
  - 3.9.2 General philosophy
  - 3.9.3 The possibility of internal corrosion
  - 3.9.4 Problems associated with internal inspection
  - 3.9.5 Requirements for internal inspection
  - 3.9.6 Requirements for external inspection
  - 3.9.7 Competent person/records

3.10 Requirements for the Initial Filling of Storage Tank or Re-commissioning After Inspection
  - 3.10.1 General
  - 3.10.2 Ice/hydrate formation
  - 3.10.3 Permit to work systems
  - 3.10.4 Removal of air—drying out
  - 3.10.5 Displacement of inerts by LPG vapour
  - 3.10.6 Cooling down and commissioning

3.11 Requirements for Taking Tank out of Service
  - 3.11.1 Permit to work systems
  - 3.11.2 Removal of liquid
  - 3.11.3 Purging
  - 3.11.4 Sources of inert gas
  - 3.11.5 Purging procedure
  - 3.11.6 Preparation for entry
  - 3.11.7 Entry into tanks

3.12 Operational Requirements
  - 3.12.1 Training
  - 3.12.2 Emergency procedures/plans
  - 3.12.3 Commissioning, gas freeing and entry into tanks
  - 3.12.4 Transfer operations

### Appendices
1. Thermal Radiation Flux Levels
2. Calculation of Thermal Radiation Flux Levels
3. Leak Sources and Typical Leak Rates from LPG Storage Systems
4. Vapour Dispersion
5. Cooling Water Requirements for the Protection of Refrigerated LPG Storage Tank Systems Exposed to Thermal Radiation
## CONTENTS

<table>
<thead>
<tr>
<th>Page</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Safe End Limits When Purging with Nitrogen vol. per cent</td>
<td>72</td>
</tr>
<tr>
<td>7</td>
<td>Glossary of Terms</td>
<td>73</td>
</tr>
<tr>
<td>8</td>
<td>Guidance on Work Permit Procedures</td>
<td>75</td>
</tr>
<tr>
<td>9</td>
<td>Some Codes of Practice, Specifications, Standards, etc., Relevant to the LPG Industry</td>
<td>84</td>
</tr>
<tr>
<td>10</td>
<td>List of Abbreviations</td>
<td>87</td>
</tr>
</tbody>
</table>

**Index**                                                                          | 88   |
1. This Code is Part 9 of The Institute of Petroleum Model Code of Safe Practice in the Petroleum Industry. It supersedes the edition published in 1967, the technical recommendations of which have both been amplified and brought up to date. Its purpose is to provide a general guide to safe practice in storing, handling and transport of Liquefied Petroleum Gas (LPG), and it gives, for the most part, recommendations for safe practice rather than a set of rigid rules. It is the intention that this approach should more easily allow the use of new methods, techniques, materials, etc., which may be developed in the future and which meet the requirements for safe practice given in this Code.

It must be stressed that in determining any required safe procedure the effect of any unusual circumstances, on which it is impossible to generalize, must receive due consideration and, further, that design, construction and operation of plant and equipment must be carried out only by suitably trained personnel.

Attention is drawn to the Institute’s Area Classification Code which should also be considered during the design of LPG facilities.

2. Attention is also drawn to the fact that in many countries there exist statutory requirements, both local and national, relating to LPG, and this Code should be regarded as being complementary to such requirements.

3. This Code is arranged as two volumes containing six separate chapters supported by a number of Appendices.

The volumes and chapters are as follows:

Volume 1
Chapter 1—General information applicable to LPG.
Chapter 2—Pressure storage at refineries, bulk distribution plants and also industrial consumer premises, where such storage is large.

Chapter 3—Refrigerated LPG.
This subject was previously dealt with in Clause 2.4 of Chapter 2 of the 1967 Code under the title Low Pressure Refrigerated Storage. However, because of the evolution of new techniques for handling refrigerated products, the increase in quantities being stored and handled and the resulting need for special safety considerations with respect to these large quantities, it has been decided to consider refrigerated storage separately.

Relevant Appendices

Volume 2
Chapter 1—Pressure storage at industrial, commercial and domestic premises (originally Chapter 3 of the 1967 Code).
Chapter 2—Plant for the filling, handling and storage of cylinders (originally Chapter 4 of the 1967 Code).
Chapter 3—Transport by road and rail (originally Chapter 5 of the 1967 Code).

For marine transport reference should be made to the International Safety Guide for Oil Tankers and Terminals (ISGOTT), and for pipeline transport to the IP Code of Practice for Petroleum Pipelines.

Relevant Appendices.

4. The Liquefied Petroleum Gas Sub-Committee, which prepared this Code, is a Sub-Committee of the Engineering Committee of the Institute. It comprises representatives of The Institute of Petroleum, The Institution of Gas Engineers and
FOREWORD

The Liquefied Petroleum Gas Industry Technical Association (UK).

5. For the purpose of this Code certain interpretations which are given in Appendix 7 apply irrespective of any other meaning the words may have in other connections. Where used in the Code such defined terms are printed in italics.

6. Although it is believed that adoption of the recommendations of the Code will help to reduce the risk of accident, The Institute of Petroleum, The Institution of Gas Engineers and The Liquefied Petroleum Gas Industry Technical Association (UK) cannot accept any responsibility, of whatever kind, for damage or alleged damage arising or otherwise occurring in or about premises, areas or vehicles to which this Code has been applied.