

Contents

Preface.....	IX
1. Introduction	1
1.1 Scope	1
1.2 Definitions of terms	1
2. Categorisation of storage systems	2
2.1 Definitions of containments.....	2
2.1.1 Single containment	2
2.1.2 Double containment.....	2
2.1.3 Full containment	2
2.1.4 Membrane tanks.....	3
2.2 Double concrete tanks.....	9
2.3 Refrigerated/cryogenic or pressurized storage	10
2.4 Risk assessment for tank Class/Type selection	12
3. Design considerations	13
3.1 Design	13
3.2 Safety requirements and special provisions.....	13
3.2.1 Typical considerations.....	13
3.2.2 Basic requirements for pressure and vacuum relief	16
3.3 Leakage and spillage	17
3.3.1 General.....	17
3.3.2 Risk of external leakage to atmosphere	18
3.3.3 Local internal leaks	18
3.3.4 Internal condensation	18
3.3.5 Overfilling	19
3.3.6 Other operational issues	19
3.3.7 Spillage.....	19
3.4 Lightning protection.....	20
3.5 Effect of radio transmissions, static electricity & cathodic protection systems	20
3.6 Earthquakes.....	20

4. Hydrostatic and leak testing 21

4.1 General..... 21

4.2 Inner tank testing..... 21

4.3 Testing of outer steel tanks of double and full containment 21

4.4 Filling rates and level checks..... 21

4.5 Outer concrete tank testing..... 21

4.6 Pneumatic testing 21

5. Tank Commissioning 22

5.1 Introduction 22

5.2 Status of tank at start of commissioning 22

5.3 Preparation for commissioning 23

5.3.1 Operating manual..... 23

5.3.2 General steps 23

5.3.3 Preparation of the tank..... 23

5.3.4 Installation of the pumps..... 24

5.4 Drying of tank 24

5.5 Purging 24

5.5.1 General 24

5.5.2 Types of inert gas 25

5.5.3 Purging tanks from air to inert atmosphere 25

5.5.4 Purging tanks from inert to hydrocarbon atmosphere..... 26

5.5.5 Drying and purging procedure..... 26

5.6 Commissioning of the tank heating system 26

5.7 Cool-down 27

5.7.1 General 27

5.7.2 Preparation for cool-down..... 27

5.7.3 Cool down rates..... 27

5.7.4 Cool down procedures 27

5.8 Commissioning of the submerged pumps..... 28

5.9 Completion of commissioning 28

6. Operations	29
6.1 Introduction	29
6.2 Prevention of overpressure	29
6.3 Prevention of vacuum	29
6.4 Tank heating system	29
6.5 Liquid in annulus	29
6.6 Prevention of rollover	30
6.7 Refilling after maintenance	31
6.8 Prevention of condensation	31
7. Maintenance and inspection	32
7.1 Introduction	32
7.2 Safety	32
7.3 Tank design and construction details	32
7.4 Operating history	32
7.5 External inspection	33
7.5.1 General	33
7.5.2 Inspection plan	33
7.6 Maintenance planning	34
7.7 Review of tank performance	34
7.8 Foundations	34
7.8.1 Visual inspection	35
7.8.2 Paving and drainage	35
7.8.3 Settlement	35
7.8.4 Foundation heaters	35
7.8.5 Product spillage collection sump (where provided)	35
7.8.6 Elevated bases	35
7.9 Wall	36
7.9.1 Visual inspection	36
7.9.2 Buttresses	36
7.9.3 Thermal imaging	36
7.10 Concrete roof	36
7.10.1 Visual inspection	36
7.10.2 Rain water drainage (where provided)	36
7.10.3 Operational fittings	37
7.10.4 Protective coating and spill protection (where provided)	37

7.10.5 Access and emergency egress.....	37
7.10.6 Roof platform.....	37
7.11 Equipment items.....	37
7.12 Inspection check list and suggested inspection frequency	37
7.13 Internal inspection.....	40
7.13.1 General	40
7.13.2 Initial inspection of suspended deck.....	40
7.13.3 Inspection from suspended deck.....	40
7.13.4 Inner tank inspection	41
8. De-commissioning	42
8.1 Introduction.....	42
8.1.1 Need for Decommissioning	42
8.1.2 Duration.....	42
8.1.3 Liquid removal.....	42
8.1.4 Purging.....	43
8.1.5 Warm-up.....	45
8.2 Decommissioning procedure.....	45
8.2.1 Outline of decommissioning.....	45
8.2.2 Procedure	45
8.2.3 Equipment and instruments.....	46
8.2.4 Liquid removal by pumping	46
8.2.5 Tank isolation (Stage 1)	47
8.2.6 Vaporisation of remaining liquid.....	47
8.2.7 Tank isolation (Stage 2)	47
8.2.8 Inerting and warm-up of tank.....	48
8.2.9 Simultaneous decommissioning of submerged pumps.....	48
8.2.10 Tank isolation (final stage)	49
References.....	50
Related standards.....	51
Bibliography	52
EEMUA Publication: Feedback Form	55
EEMUA Publications Catalogue	56

List of Figures

Figure 1 Scheme of tank categories for Refrigerated Liquefied Gas products..... 3

Figure 2 Scheme of tank categories for RLG products (cont.) 4

Figure 3 Scheme of tank types for RLG products (cont.) 5

Figure 4 Detail of a Type 2 above ground single containment storage tank..... 6

Figure 5 Detail of a Type 3 above ground double containment storage tank..... 6

Figure 6 Detail of a Type 4 above ground full containment storage tank..... 7

Figure 7 Detail of a Type 5/Type 8 above ground full containment storage tank 7

Figure 8 Detail of a Type 6/Type 7 above ground full containment storage tank 8

Figure 9 Typical detail of a Type 1 above ground membrane storage tank..... 8

Figure 10 Typical detail of a Type 11 in-ground membrane tank..... 9

Figure 11 Artist impression of a double concrete tank with no liner 10

Figure 12 Selection diagram refrigerated storage systems..... 11

Figure 13 LNG tank designed and constructed to best practice principle..... 15

Figure 14 Supported concrete foundation slab..... 15

Figure 15 Concrete foundation slab elevated from ground..... 16

Figure 16 Arrangement of pressure control valves to flare 17

Figure 17 Prevention of an overfill..... 19

Figure 18 Floating of the inner tank 30

Figure 19 Typical example of condensation in dome roof for butane gas 31

List of Tables

Table 1 Oxygen concentration end-points for purging from air..... 25

Table 2 Minimum temperature reached..... 26

Table 3 Summary of inspections..... 38

Table 4 Combustible gas and points for purging 44