Installation of Mounded Bullet:

PREFACE

Numaligarh Refinery Limited, (NRL) presently operates a 3 MMTPA refinery at Numaligarh, District Golaghat, and Assam. The refinery commenced commercial production in October, 2000.

This document presents the design basis to be used for the Preparation of BEDP for Mounded Bullets at Numaligarh Refinery Limited (NRL).

Mounded bullets provide intrinsically passive & safe environment & eradicates the possibility of Boiling Liquid Expanding Vapor Explosion (BLEVE), through LPG handling possess many challenges, due to its inherent dangerous properties, modern state of art safety features has been taken into consideration while designing the facilities using different OISD codes.

As handling of LPG in above ground vessel has many challenges due to its inherent dangerous properties, NRL proposed to replace the old aboveground vessels with mounded bullets of suitable capacity. New statues / guidelines suggest for mounded bullets which proves to be safer compared to above ground storage vessels. The project envisages construction of 4 nos. of mounded bullets of capacity 1760.56 m$^3$ (1000MT) each and upon successful completion / construction of mounded bullets existing 03 nos. of LPG Spheres and 01 LPG bullet will be dismantled up to ground level.

PLANT DESIGN BASIS

LPG Composition

<table>
<thead>
<tr>
<th>Composition</th>
<th>Mole %</th>
</tr>
</thead>
<tbody>
<tr>
<td>C3</td>
<td>65.58</td>
</tr>
<tr>
<td>C4</td>
<td>34.42</td>
</tr>
<tr>
<td>H2S</td>
<td>&lt; 10 ppm</td>
</tr>
</tbody>
</table>

Properties of LPG

<table>
<thead>
<tr>
<th>Designation</th>
<th>LPG (At 7.5 Kg/cm$^2$g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Sp. Gravity</td>
<td>0.5293 (Simulated)</td>
</tr>
<tr>
<td>Vapour pressure at 30/35/40 OC, kg/cm$^2$</td>
<td>8.66/9.822/11.07 (Simulated)</td>
</tr>
</tbody>
</table>
LPG Mounded Storage Facilities

- System Design as per OISD -150
- Four (4) Mounded bullets of 7,042.24 m³ capacity total

Bullet Details

- Operating LPG storage capacity of each Bullet 1760.56 m³
  (Operating capacity considered as 85% level of the volumetric capacity of bullet)
- Size: Length (TL-TL) 52m X Diameter 7 m
- Operating / Design Pressure: 14.5 kg/cm²g
- Design Temperature: (-) 27 to 55 °C
- Material: ASTM A 516 Gr.60,( IT) or equiv.
  (Refer to clause no. 5.1 ,ii,(a) OISD-150)
- Internal bottom surface up to 90 degree shall be provided with a coating suitable for caustic, water, and H₂S dissolve in LPG.
- Pump out Rate (max): 291 m³/hr

Normal Bullet Operation

- One mounded bullet is receiving mode,
- One dispatch mode
- Two for recirculation & certification mode

Odorization

- The existing odorant system to be used.
- One mercaptan vessel having capacity of 200 L which is maintained by positive pressure with N₂.
- The dosing rate is around 20 ppm.
- Two nos. (1W+1S) mercaptan dosing pump.
Very Dilute Caustic Draining From Bullet

- No. of Drain vessel: 1 no (Vertical cylindrical vessel)
- Design Pressure: 14.5 kg/cm²g
- Design Temperature: (-27) °C to 55 °C
- MOC: CS
- Capacity: 0.5 m³

LPG Pump Details

- Four nos. of LPG forwarding pump to be used.
- Two nos. (1W+1S) for loading gantry & two nos. (1W+1S) pump for bottling plant

Corrosion Allowance

Internal Corrosion Allowance: 3 mm (minimum).

Pressure Safety Valve

- Each vessel shall have at-least two Safety Relief Valves (SRV).
- The full flow capacity of each SRV on mounded vessel(s) shall be minimum 30 % of the capacity required for an equivalent size of above ground vessel.
- The discharge of SRVs shall be connected to existing flare system.

Gas Detection System

- Suitable gas detectors shall be placed at critical locations in the LPG storage area such as near the ROVs, in inspection tunnel or dome connection, near water draining/sampling points.
- First level alarm shall be set at 20% of Lower Explosive Limit (LEL) and second level alarm at 60 % of LEL

Noise Criteria

a) Nearby equipment
The maximum allowable noise level nearby equipment shall be 85 dB within one meter from the equipment, during normal operation and with control valves in line.

b) **Near Working Environment**

Overall noise level in the working environment shall be below 85dB at 1m.

c) **Outside plant limit**

The average noise level shall be 60 dB at 100 m from the boundary of plant.

**Effluent Criteria**

- **Gaseous Effluent**
  - Details of existing flare header (Bullet header to be connected with existing header)
  - Size of existing flare header 24”
  - All PSV/TSV discharge shall be routed to the new flare header which will be connected to existing flare header

- **Liquid Effluents**
  - Very Dilute caustic solution is released from the system through drain vessel, to a Shallow Sump (RCC) & finally to the storm sewer.
  - LPG pump drain is to be connected to flare header.

**HAZARDOUS AREA CLASSIFICATION**

Hazardous Area classified as Zone 1: Gas Group IIA/IIB, Temp. Class-T3

**TECHNICAL SPECIFICATION:**

<table>
<thead>
<tr>
<th>Project</th>
<th>BEDP FOR MOUNDED BULLETS, NUMALIGARH REFINERY LTD. NUMALIGARH.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment</td>
<td>LPG Mounded Bullets</td>
</tr>
<tr>
<td>Code No.</td>
<td><strong>V-101/102/103/104</strong></td>
</tr>
<tr>
<td>No. of units</td>
<td>Four (4)</td>
</tr>
<tr>
<td>Service</td>
<td>LPG STORAGE</td>
</tr>
<tr>
<td>Size</td>
<td>mm (ID)7000 x 52000 (TL-TL)</td>
</tr>
<tr>
<td>Position</td>
<td>Horizontal Cylindrical with dished ends</td>
</tr>
<tr>
<td>MATERIAL OF CONSTRUCTION</td>
<td><strong>DESIGN DATA</strong></td>
</tr>
</tbody>
</table>
**Fluid:** LPG  
**Shell:** ASTM-AS169 r 60 or Equiv. (Refer. Clause no 5.1, ii (a)) or OISD-150

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity Type $m^3$:</td>
<td><strong>2071.3</strong> (water Capacity)</td>
</tr>
<tr>
<td>Capacity (Max. Stored)$m^3$:</td>
<td><strong>1760.56</strong> (85% Capacity)</td>
</tr>
<tr>
<td>Flow (INLET) m3/hr:</td>
<td>Lining if any:</td>
</tr>
<tr>
<td><strong>Pump-Out</strong> m3/hr:</td>
<td><strong>291</strong> (Max.) Nozzle Neck</td>
</tr>
<tr>
<td>Working pressure kg/cm²g:</td>
<td>6.5-12</td>
</tr>
<tr>
<td>Design Pr. Kg/cm²g (Internal):</td>
<td><strong>14.5 + Static head</strong></td>
</tr>
<tr>
<td>Design Pr. kg/cm²g (External):</td>
<td><strong>Full Vacuum + Wt of Mound</strong></td>
</tr>
<tr>
<td>Working temp $^\circ$C:</td>
<td><strong>15-45</strong></td>
</tr>
<tr>
<td>Design temp $^\circ$C:</td>
<td><strong>(-) 27 TO 55</strong></td>
</tr>
<tr>
<td>Specific Gravity:</td>
<td><strong>0.50-0.57</strong></td>
</tr>
<tr>
<td>Design SG:</td>
<td><strong>0.5293 (Simulated)</strong></td>
</tr>
<tr>
<td>Outlet (Vapour) / (Liquid) Kg/m³:</td>
<td>Additional Attachments Internals:</td>
</tr>
<tr>
<td>Corrosion Allowance (mm):</td>
<td>3</td>
</tr>
<tr>
<td>Internal Attachments:</td>
<td>-</td>
</tr>
</tbody>
</table>

1. *All process data are indicated in Bold & italic.*
2. As per OISD STD-150 Internal Bottom portion of the Vessel (90$^\circ$C Angle) shall be coated with anticorrosive coating suitable for CAUSTIC.
3. Two nos. of PSV will be provided on Different Nozzle for each Bullet. One will be in line and other shall be spare.
4. Vessel will be sloped towards the bottom outlet @ 1:200.
5. The top and side soil cover to be of neutral material which is well compacted to prevent water and air erosion. The mound should have good drainage to prevent any water accumulation on the mound. Material should be free from abrasive material or particles likely to damage the equipment.
6. The entire nozzle to be outside the earth level/mound, suitable coating for external surface to be provided.
7. Vessel to be designed for the external loading.
8. The fire proofing to the exposed vessel, bottom outlet line inside tunnel, nozzles & pipe shall be done up to the first ROV.
<p>| | |</p>
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<th></th>
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<tbody>
<tr>
<td>9.</td>
<td>All drawings, documents, design calculation, stage inspection &amp; certification shall be got approved by chief controller of explosives</td>
</tr>
<tr>
<td>10.</td>
<td>Inspection tunnel shall be provided for bottom outlet nozzle (N2) as per OISD-150</td>
</tr>
<tr>
<td>11.</td>
<td>Hydrocarbon Leak detector in the Liquid Outlet Line Tunnel &amp; near ROV’s to be provided.</td>
</tr>
<tr>
<td>12.</td>
<td>Vortex breaker shall be provided in the bullet Outlet.</td>
</tr>
<tr>
<td>13.</td>
<td>Fire fighting facilities shall be considered as per code.</td>
</tr>
<tr>
<td>14.</td>
<td>H2S in LPG &lt; 10 ppm</td>
</tr>
<tr>
<td>15.</td>
<td>All nozzles except N2 shall be located on the dome.</td>
</tr>
<tr>
<td>16.</td>
<td>Manholes with staircase shall be provided on the Bullet top. Access platform shall be provided at the Top for accessing of Instrument / maintenance along with hand rail. Matching flange with ROV’s (Bottom Outlet nozzle N2) on bullet and piping side shall be RTJ type.</td>
</tr>
<tr>
<td>17.</td>
<td>Remote operated valves (ROV) shall be provided on inlet and outlet LPG nozzle from Bullet, Recycle liquid LPG &amp; vapour return line. These valves shall be fire safe design.</td>
</tr>
<tr>
<td>18.</td>
<td>Radar &amp; Servo Gauge, Temperature measurement shall be with stilling well. Perforations/slots shall be as per Instrumentation requirement.</td>
</tr>
<tr>
<td>19.</td>
<td>Safety valve set pressure shall be 14.50 kg/cm²; it shall be designed for 21% over pressure (fire sizing). The full flow capacity of each safety valve shall be minimum 30% of the capacity required for an equivalent size of above ground vessel.</td>
</tr>
<tr>
<td>20.</td>
<td>During LPG filling in bullet, the bullet shell shall expand due to pressure. The RCC wall design shall be able to take care of the thrust.</td>
</tr>
<tr>
<td>21.</td>
<td>Bullet &amp; mounding shall be designed as per OISD-STD-150.</td>
</tr>
<tr>
<td>22.</td>
<td>Suitable cathodic protection shall be provided for each bullet to guard against corrosion. Proper electrical isolation with isolation joint/flange to be provided suitably for all bullet flanges.</td>
</tr>
<tr>
<td>24.</td>
<td>Bottom draw off line shall have slope angle 1.5° minimum distance of 3 m from vessel tangent line to ROV at nozzle N2 shall be maintained as per OISD-150</td>
</tr>
<tr>
<td>25.</td>
<td>Bullet end shall be hemispherical</td>
</tr>
<tr>
<td>26.</td>
<td>Further detailing by detailed Engineer Consultants / LSTK Vendor.</td>
</tr>
</tbody>
</table>
Facility Up-gradation of LPG Bottling Plant:

Modernization & Capacity Augmentation of LPG Bottling Plant at NRMT, NRL

1. Background:

1.1 NRL is producing around 2.2% of its throughput as LPG which is equivalent to 60 TMT against a crude throughput of 2.8 MMTPA. Initially, after commissioning of the refinery in the year 2000, NRL was supplying its entire LPG production to OMCs (Oil Marketing Companies) in the bulk form by roads in LPG Bullets. In 2002, based on request from BPCL and HPCL for packed LPG hospitality assistance for their distribution network of domestic LPG cylinder in NE (North East), NRL built and commissioned a 10 TMTPA capacity LPG bottling plant within the premises of the Marketing Terminal (NRMT).

1.2 The said bottling plant is still in operation, which has a semi automatic carousel with 12 filling heads which was designed in line with BPCL’s bottling plants operated during that time. The bottling plant has a designed capacity of filling 32.05 MT per day which is equivalent to 2257 nos. of 14.2 KG cylinders with single shift operation.

1.3 Over the last five years, there has been continuous increase in capacity utilization of the bottling plant and is presently operated above its designed capacity of 10 TMTPA. Higher capacity utilization of the bottling plant is primarily driven by BPCL’s expansion of the LPG distribution in NE. NRL is the single supply source for packed LPG for BPCL in NE.

1.4 Presently, the bottling plant is supplying packed LPG to BPCL and HPCL only with BPCL’s share at 90%. In the last FY2013-14, BPCL sourced 14.759 TMT of packed LPG from NRL against total filling of 16.445 TMT.

2. LPG Demand in NE Market:

2.1 NE market has a huge supply deficit in LPG. Against production of 145 TMT of LPG from all the four refineries in NE, the market demand stands at 354 TMT during the year 2013-14. On the other hand, there is tremendous potential for growth in the market considering a very low house hold penetration in NE to the tune of 20% only.

2.2 In the FY2013-14, BPCL achieved a growth of 30.1% in Packed LPG sales in NE region with LPG sales volume of 16.6 TMT. However, compared to total industry sales of 354 TMT of packed LPG in NE, BPCL’s market share stands at 4.6% only.

3. Technical requirements of modernization:

3.1 The semi automatic carousel system used in the bottling plants is now being phased out by oil companies and replaced by electronic carousel system. Electronic carousel system has the distinct advantages over the semi automatic carousels in terms of better accuracy, less manual involvement, higher rate of filling, better safety standards etc.

3.2 As most of the oil companies in the country have already phased out semi automatic carousels, availability of spares from the Original Equipment Manufacturer (OEM) has become an issue during maintenance. Maintenance requirement of the existing bottling plant at NRL, which was commissioned in 2002, has also increased many folds due to aging of the equipments.

3.3 An electronic carousel system with 24 filling heads has a capacity of 1400 cylinders per hour as compared 1000 cylinder per hour in case of semi automatic carousels. A single shift operation
considering 6 Hrs of bottling operations will be able to produce 119 MT of packed LPG per day or 3.0 TMT per month or 36 TMT per year without any additional manpower.

3.4 Some of the distinct opportunities associated with the modernisation are as follows:
- Providing secured supply of packed LPG to BPCL as a group refinery and strategic partner to consolidate and enhance their market share in NE.
- Reduction of repair & maintenance cost and increase plant reliability at NRL.
- Reduction on overtime and realization of additional revenue from filling of additional quantity of packed LPG.
- Higher safety standards, accuracy of metering allowing compliance to latest safety standards etc.

**PROJECT PROFILE**

1. **FILLING /EMPTY CYLINDER SHED**

Filling of LPG cylinder (14.2 kg & 19.0 kg) will be done with 24/24 station Electronic Type Carousel (including production data management with UPS).

Following equipments shall be housed in the filling cum filled cylinder storage shed.

2. Telescopic Conveyors (2+2 for filling & storage shed).
3. Online electronic type check weighing scale having least count 5 gm (capacity 50 kg).
4. On line Weight correction unit with electronic type scale having least counts 5 gm (capacity 50 kg).
5. On line automatic Valve and bung leak detector system.
6. On line automatic O-ring leak detection machine.
7. On line automatic valve changing unit.
8. Auto Cap fixer.
9. In line test bath (for 14.2 kg and 19 kg cylinders).
10. On line automatic purging unit.
11. Driving Units.
12. Chain & Roller conveyors system / all related sections & accessories.
14. SQC unit for 14.2 kg & 19.0 cylinders.
15. Vapour extraction (Blower) system, interlocking with LPG Carousel Machine, Auto valve changing machine, evacuation unit and purging unit.
16. Filling Machine for higher capacity cylinders (35.0 kg & 47.5 kg) along with conveyor system.
17. On line test bath for higher capacity cylinders (35.0 kg & 47.5 kg).
18. Valve changing unit for higher capacity cylinders (35.0 kg & 47.5 kg).
19. LPG Evacuation system for higher capacity cylinders (35.0 kg & 47.5 kg).
20. SQC unit for higher capacity cylinders.
21. Separate conveyor for BMCG cylinder for additive dosing.
22. Adequate cross-over.
23. Air Compressor & all related accessories.
24. Conveyor system for unloading & loading of higher capacity cylinders in/out from filling point.
25. Air Dryer System & all related accessories.
26. LPG Pumps (2 nos.) & all related accessories.
27. All related civil jobs including mastic flooring.
28. Provision for filling of 5.0 kg cylinders including all facilities.
29. The length of shed used for vehicle during loading and unloading to be increased to accommodate full length of the vehicle.
30. Modification of the existing MCC room as per requirement.
31. Air receiver between air compressor house and filling shed inside the license area. In order to maintain continuous air pressure.
32. Auto/manual water drain valve for the pneumatic line inside the shed.
33. Any other points not exclusively covered but required for the complete upgradation should be covered.

2. **FILLED CYLINDER STORAGE SHED**

   The size of shed has been attached in the layout drawing and approximate 6400 nos. of filled cylinder will be stored.

   Filling shed and filled cylinder shed are interconnected with 15 x 3 M gangway with conveyors. Similarly gangway is provided (at present) between filling shed and valve changing shed. Statistical quality control loop (SQC) with roller conveyor will be provided with an inline check scale and CVT for domestic, commercial & industrial cylinders.

3. **VALVE CHANGE SHED/ ON LINE VALVE CHANGE MACHINE**

   For valve changing ON-LINE VALVE CHANGE MACHINE is being provided in the filling shed.

4. **CHAIN CONVEYOR SYSTEM**

   Adequate conveyors shall be provided as per attached drawing for automatic movement of cylinders inside the shed.

5. **LPG PUMP/COMPRESSOR SHED**

   Shed for LPG pump and compressor is already existed. Adequate capacity of 2 nos. LPG pump (1 standby) shall be provided to fill LPG into cylinders.

6. **PIPING**

   Process, instrumentation and utility piping as per requirement shall be provided.

7. **AIR COMPRESSOR/RECEIVER/DRYER**

   Two nos. of adequate air-compressor along with air receiver and refrigerated type air dryer shall be provided to cater to the requirement of instrument air for carousel, pneumatics, ROV, fire protection system etc. Shed for compressor and dryer already exists.