MAYAKS SERVICES LIMITED

QUALITY ASSURANCE AND QUALITY CONTROL MANUAL

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MAYAK SERVICES LIMITED QUALITY ASSURANCE AND QUALITY CONTROL

1.1 GENERAL

1.1.1 The quality control assumes all the more importance where more than one grade of LPG is stored at the same plant / location. Presently, at any bottling plant, only one grade of LPG is being stored / handled. It is likely that in the coming years, it may be required to handle more than one grade of LPG at the same plant.It is with this background that the details of various aspects of quality control of LPG are covered below. Many of the measures described relate to the plants handling single grade LPG also.

1.1.2 Although LPG is stored and handled in a closed and pressurized system, it may still become contaminated by air, water, other petroleum fractions and even with other grades of LPG, if sufficient care is not taken. Any such contaminant can affect its quality or safe handling as LPG with high vapour pressure when mixed with LPG with low vapour pressure for instance, will lead to over filling and over pressurization of containing systems.

1.1.3 This chapter covers not only the quality control of bulk LPG but also random quality control of filled LPG cylinders which is very vital both from safety as well as customers' satisfaction point of view.

1.1.4 Quality Control and the procedures related to its achievement / retention are thus necessary not only to safeguard the quality of the product but also for safety reasons.

1.2 OBJECTIVES

1.2.1 Uniform Quality Control procedures are to be evolved for handling LPG at following places:

1.2.1.1 Refinery Locations
1.2.1.2 Fractionators Locations
1.2.1.3 LPG Import / Coastal Movement Terminals.
1.2.1.4 LPG Loading Terminals
1.2.1.5 LPG Bottling Plants.

1.3 PURPOSE

1.3.1 The purpose of the procedures outlined is to ensure:

1.3.1.1 that LPG produced indigenously at Refineries / Fractionators and received through Imports and coastal movement is in accordance with the standard specification.

1.3.1.2 that the commercial propane, commercial butane and predominant mixture of two (LPG) enter the marketing and distribution system in accordance with the specification.

1.3.1.3 that the commercial propane, commercial butane and predominant mixture of two (LPG) are delivered from various storage points by different modes of transportation in good condition and conforming to specification.

1.3.1.4 that a well-defined system of quality control checks and documentation exists to achieve the purpose and has traceability and transparency.

1.4 QUALITY CONTROL RESPONSIBILITIES

1.4.1 The primary responsibility of implementation of Quality Control manual and procedures will be of Plant Manager. However, the overall responsibility for ensuring proper quality control in various import terminals and LPG bottling plants rests with the LPG Operations Department at Head Office. Each terminal and LPG bottling plant shall identify an Officer as a Quality Control Co-ordinator, who will be responsible for the implementation of quality control guidelines at that location.

1.4.2 The responsibility for ensuring proper quality control in Refineries and Fractionators rests with the production sources.

1.4.3 Quality Control Implementation Officers of the LPG Operations Department / Controlling Offices shall carry out inspection to ensure proper implementation of the laid down quality control

procedures. Such inspection shall be carried out at least once in a year for each location.

1.4.4 All those associated with the delivery of LPG bear the responsibility to ensure that the product is delivered in a clean and good condition meeting the relevant quality standards. Delivery of "Off Specification / contaminated Product" should not be made.

1.4.5 Plant Manager shall maintain quality control of the productperfectly at all stages starting from the receipt of the product tostorage, loading, unloading, filling etc. and thus ensure delivery of the product from the plant as per the specification. Necessary facilities and apparatus are to be provided at the plant.

1.4.6 Plant Manager should ensure that all personnel engaged inhandling of LPG are thoroughly familiar with LPG quality control procedures.

1.5 QUALITY AUDIT INSPECTIONS

1.5.1 Officers of the Quality Control Department / LPG Operations Department from State Office / Regional Office / Head Office shall carry out quality audit inspections. Such inspections shall be carried out at all production centers and import locations at least once in a year and the observations be entered in quality control check form.

1.6 DOCUMENTATION

1.6.1 All quality control activities are to be documented and duly reviewed by the Plant Manager and the documents are to be preserved for a period of one year for the next annual inspection.

1.7 PRODUCT QUALITY & SPECIFICATIONS

1.7.1 IMPORT SPECIFICATIONS

Import specifications of the commercial butane, commercial propane and commercial butane-propane mixture are given in

Annexure Nos. 16, **17** and **18** respectively and shall be binding for all imports

1.7.2 SPECIFICATIONS FOR INDIGENOUS LPG PRODUCTION

The specifications for commercial butane, commercial Propane and butane-propane mixture should conform to IS: 4576-1979.

1.7.3 QUALITY ASSURANCE AT REFINERIES AND FRACTIONATOR LOCATIONS

1.7.3.1 Quality of LPG produced at Refineries & Fractionator locations shall be tested / certified batch wise in line with SON AND ASME Specification No. IS: 4576-1999 as per Annexure No. 21.

1.7.3.2 A copy of the Quality Certificate shall be issued to Marketing Division/Pipeline Division, which shall also indicate the densityof the product at 15^0C temperature.

1.7.3.3 (In case the quality of LPG fails in any of the characteristics,the same shall not be released for dispatch. The quality ofthe product must be corrected by re-processing, before releasing the product.

1.7.3.4 Before dispatch, the product shall be doped with mercaptan and ensured that 18-20 ppm of mercaptan is present with a view to have distinct odour and the same is recorded in the Quality Certificate. Subject to the agreement between the purchaser and the supplier, the odour requirements of LPG may be changed for certain application, when un-odourised LPG is required to be supplied.

1.7.3.5 The water from the storage vessel shall be drained off daily to ensure that the product is free of water and the observationshall be recorded.

1.7.4 TANK TRUCK LOADING

Whenever bulk loading is involved i.e., transfer of the product to tank trucks, the following checks are necessary:

1.7.4.1 The product is to be loaded / transferred as per the product grade indicated in the relevant indent / challan after ensuring that the tank truck is fit for loading.

1.7.4.2 The tank truck in which the product is to beloaded shall be checked for compatibility of the same e.g. the vessel in which propane is to be loaded should be of propane rating. However, presently in LPG bottling plants,propane alone is not handled.

1.7.4.3 After loading, vapour pressure, density and temperature ofthe product in the transport vessel shall be checked for acceptable limits and recorded on the invoice.

1.7.5 TANKER LOADING (Coastal Movement)

1.7.5.1 Procedures are to be followed in line with "TANK TRUCK LOADING" mentioned above. Prior to loading, the quality certificate shall be scrutinized to ensure that all characteristics as per SON AND ASME specification are tested and certified by the loading Refinery. The surveyor shall ensure fitness of the tanker before loading and necessary fitness certificate shall be issued.

1.7.5.2 After loading the product, the sample shall be drawn from the individual tank of the tanker for retention and conducting tests, if required, in case of any dispute in the quality. Two setsof each sample shall be drawn as follows:

1.7.5.2.1 From the loading arm jointly with the representative ofRefinery. One set of the sample shall be retained by theRefinery and another set shall be with Marketing Company.

1.7.5.2.2 From the individual tanks of the tanker jointly taken withthe Master of the tanker. One set shall be retained withthe Marketing Company and the second set shall be handed over to the Master of the tanker for handing over to the receiving company at the disport.

1.7.5.3 All the sample(s) shall be retained, till the quality of the product is established at the disport or maximum up to 30 days, whichever is earlier. In case of failure in the quality ofthe product either in the pre-discharge test or batch formation test, the sample shall be retained till further advice from the Controlling Office.

1.8 QUALITY CONTROL AT LPG IMPORT/COASTAL MOVEMENT TERMINALS

1.8.1 IMPORT RECEIPTS

1.8.1.1 Quality Control Checks are to be made before the dischargeof the tanker.

1.8.1.2 Before discharging the import cargoes, the load port quality certificate shall be verified with contractual specification.

(i) For C&F Cargoes (Cost and freight): If the load port quality certificate shows that the product is not meeting the contractualspecification, the cargo is to be rejected and a report to be sent to the Controlling Office / HO Shipping Department for further necessary action.

(ii) For FOB Cargoes: If the load port quality certificate meets the contractual specification, the sample from the individual tank(s) shall be drawn and tested as per the following characteristics in line with the contractual specification:

1) Vapour Pressure
2) Copper strip corrosion
3) Volatility* (See Note No. 1&2)
4) Density

Note 1: In case the load port quality certificate indicates the test only for the gas composition, the volatility test shall be carried out in line with SON AND ASME specification IS: 4576-1999 and the test method. If the product meets the limit of this specification, the product shall be discharged.

Note 2: If in the load port quality certificate and the test report, the volatility and the gas composition are reported, then the sample shall be tested for volatility and the result be compared with the contractual specification of volatility. If the sample meets the specification, the product shall be discharged.

1.8.1.3 In case the product fails in the volatility and the supplier has certified in respect of gas composition only, the laboratory shall carry out the gas composition test as per either of thefollowing test methods:

(I) ASTM D 2163/IP: 264: Analysis of liquefied petroleum gases and propane concentrates by Gas Chromatography

OR

(II) ISO 7941:1988/IP 405-94: Commercial propane and Butane analysis by Gas Chromatography

Note 1: If the product meets the specification in respect of the gas composition in line with the contractual specification, the product shall be discharged.

Note 2: If the product does not meet the specification in respect of the gas composition in line with the contractual specification, the product shall not be discharged.

1.8.1.4 If the product is not cleared for discharge, the detailed test results along with pertinent information shall be communicated to the Controlling Office and HO Shipping Department immediately for necessary advice. Meanwhile,without loss of time, 3 sets of fresh samples shall be drawnjointly with the representatives from the concerned agencies.

One set should be immediately tested as per the contractual specification in the presence of above representatives. The balance two sets of samples shall be retained till further advice from Shipping Department.

1.8.2 QUALITY CONTROL BEFORE DESPATCH

1.8.2.1 After tanker discharge, the product shall be tested in line with SON AND ASME specification. In case the product does not meet the specification, necessary corrective action shall be taken in consultation with Controlling Office/ Quality Control Department to ensure release of the product to the market as per SON AND ASME specification. In case dosing is done on-line during the despatch of the certified product, a sample has to be drawn after dosing for odour test. The testing of the product is to be done shift-wise and the record of the same shall be maintained.

1.8.2.2 Mercaptan content of 18-20 ppm must be ensured to maintain the odour level 2 before despatch of the product tothe bottling plant.

1.8.3 TANK TRUCK UNLOADING

Quality control procedures as outlined in the "TANK TRUCK LOADING" is to be followed.

1.9 QUALITY CONTROL AT BOTTLING PLANT

1.9.1 PRODUCT TESTING

1.9.1.1 The frequency of testing and types of tests required for LPG quality control depend upon the local conditions. Excessive sampling and testing add to operating costs, involve productloss and introduce hazard on account of venting of the product to the atmosphere. It should, therefore, be ensured that the instructions regarding sampling and testing are closely followed and sampling should be done whenever required only.

1.9.1.2 Quality control operations at the plant are generally restricted to the following:

(i) Reading Pressures.
(ii) Reading Temperatures.
(iii) Checking appearance visually,
(iv) Checking odour
(v) Determining the density.
(vi) Determining the presence of water and other contaminants such as air, rusted particles, etc. and dealing with them.

1.9.1.3 Samples MUST be representative of the whole product parcel from which they are obtained and correctly and legibly identified.

1.9.2 VAPOUR PRESSURE / TEMPERATURE

For routine plant operations, the vapour pressure determination does not require any special equipment or procedure. It is necessary only to read the pressure gauges and the temperature sensing Instruments of the vessel.

1.9.3 COLOUR AND APPEARANCE

a) The colour and appearance of LPG can be established satisfactorily only by sampling of the product.

b) LPG is colourless whether it is in liquid or vapour form. However, the cooling effect of evaporating LPG on the surrounding area condenses water vapour causing a visible white cloud.

c) Liquid LPG should be bright and water-white in appearance. Cloudiness or dis-colouration should be taken as a possible indication of contamination.

d) The contents of LPG storage vessels should be sampled and checked for correct colour and appearance whenever contamination is suspected.

1.9.4 DENSITY

1.9.4.1 The density of the liquid phase of LPG is useful guide for the quality of the product and is indispensable for converting volumes to weight and vice-versa.

1.9.4.2 The density of liquid LPG can be readily determined by using standard procedures and equipment. At the plant level, the density communicated by the supply source should be usedas reference for calculations. Density through physical sampling should be checked, only if it is required for any otherspecific purpose. In that case, the sampling must be done under the supervision of a competent person specifically trained for the purpose.

1.9.4.3 The product temperature is an essential measurement in connection with the density and also to study the relative vapour pressure.

1.9.4.4 For comparison with Quality Certificates, observed data should be converted to density at standard temperature (15^0C).

1.9.5 ODOUR

1.9.5.1 Pure LPG is odourless, but the commercial product marketedfor the use of consumers is odourised as per statutory requirements. Unless odourless gas is needed, it is normal practice to stench LPG sufficiently to make it detectable in concentration with air of one-fifth the lower explosive limit.

1.9.5.2 The distinctive odour of commercial LPG should be used as quality control check to distinguish from other gases (and from odourless LPG) and all personnel should be familiar withthe odour of the odouring agent used.

1.9.5.3 (If LPG, during the draining operation involving venting to the atmosphere, fails to produce a distinctive odour, the product (unless known to be odourless grade) shall not be

released. A sample shall be taken for further testing, causes be investigated and corrective action be taken.

1.9.5.4 Odourless product shall not be allowed to leave the plant unless an odourless grade is specified.

1.9.6 SOLID CONTAMINANTS

1.9.6.1 LPG may become contaminated by solids such as rusted particles during transportation, handling or processing and this must be removed. Storage vessels, pipeline systems and transport media must be kept clean.

1.9.6.2 As solid contaminants are detrimental to pumps, meters, etc., product must be strained / filtered before reaching them. The filters/strainers, etc. must be inspected and cleaned regularly as per the guidelines given In Chapter No. 10. The conditionand appearance of the effluent from the storage vessel drains, give an indication of the cleanliness of the product and the associated storage and handling system.

1.9.6.3 The presence of contaminants in the strainers and drained effluent is the evidence that the vessel requires cleaning.

1.9.7 WATER AND OTHER CONTAMINANTS

1.9.7.1 Contaminants such as water, other petroleum products, rusted particles etc., can be detected during the routine draining operation and should be removed at once. Solid contaminants also accumulate in the filters. The filters/ strainers should, therefore, be periodically checked and cleaned.

1.9.7.2 Water may be present in LPG in its free state i.e. as droplets orin solution. Water in solution at one temperature can be precipitated as free water by a fall in temperature. Hence, the routine draining operation should be preferably carried out early in the morning.

1.9.8 PRESENCE OF AIR

1.9.8.1 Before any LPG system is made operational, air in the vessels, pipelines and equipment, etc., are to be replaced by LPG. Detailed procedures for purging the storage vessels and the cylinders are outlined in the Annexure No. 8. Checking and testing of the product for contamination by air are, therefore, non-routine procedures and are necessary only during and after the initial commissioning or after the plant is opened for maintenance, etc.

1.9.8.2 Air must be removed from all LPG cylinders because its presence creates a flammability hazard. The presence of aircan also lead to over-pressurization of LPG system.

1.9.9 DRAINING

1.9.9.1 The purpose of draining is to remove water, heavier petroleum fractions and other contaminants, whose presence will affect the product quality. The procedure of draining operation is given in Chapter No. 6

1.9.9.2 Water or other contaminants found in the storage vessels during routine draining operation should be removed as completely as possible. Care is essential, as otherwise LPG may escape with water or other contaminants.

1.9.9.3 Water and other contaminants should be removed through drain valves (a double valve system is required) and piped away from the immediate vicinity of the vessel

1.9.9.4 Responsible person MUST be present throughout the draining operation

1.9.9.5 As far as practicable, the stocks should be arranged in such a way that the cargo can be received in one vessel or a groupof vessels, while the normal operation continues from anothervessel. This provides settling time for the new stock, facilitating drainage of water, etc

1.9.9.6 The frequency of draining should be minimized to reduce the hazard arising out of LPG escaping through water, but daily draining is recommended following any product receipt.

1.9.9.7 In order to prevent the escape of spilled LPG into the main drainage system, surface water from the storage area shallbe directed to the main drainage through a water seal to avoid the spread of Hydrocarbon.

1.9.10 RECOMMENDED MINIMUM REQUIREMENTS

1.9.10.1 Many of the checks and tests, necessary for satisfactory quality control of LPG product are also applicable to the quantity control and safety. Safety is the most important consideration and governs the timing of the combinedchecks but unnecessary duplication should be avoided,whenever possible.

1.9.10.2 The frequency and extent of the need for the quality control checks and tests vary with local circumstances.

1.10 RANDOM QUALITY CONTROL OF LPG CYLINDERS

1.10.1 EMPTY CYLINDERS

1.10.1.1 It must be ensured that the new empty cylinders and the empty cylinders received from Statutory Testing Plants / HotRepairers and other cylinders containing air are purged before filling operations.

1.10.1.2 A batch of new cylinders received at the plant should be checked at random for the presence of water. If water is observed in the cylinders, all the cylinders in the batch shouldbe checked and corrective action be taken by referring the matter to the supplier through State Office / Regional Office /Head Office. In any case, no cylinder, where presence of water is detected, should be taken up for filling, unless the water is completely drained off.

1.10.2 CYLINDER FILLING

The ultimate objective of the plant is to ensure that the cylinders while leaving the plant are 100% safe, correctly filled and are genuine. This calls for strict adherence to all checks for leakage / weighment / visual inspection and compliance of all statutory requirements and manualised instructions on the subject. While various checks to achieve this objective are broadly covered in Chapter No. 8 and Chapter No.10, further specific guidelines for these checks are detailed below for adhering to strict quality control of filled cylinders.

1.10.3 Before each and every filled cylinder leaves the plant, it shall be critically examined for the following aspects:

1.10.3.1 Cylinder is genuine (not spurious) and fit for filling as per SON AND ASME norms.

1.10.3.2 Correct quantity is filled within specified limits.

1.10.3.3 There is no leakage

1.10.3.4 The 'O' ring is present in the Self Closing valve and is not defective.

1.10.3.5 It complies with statutory requirements such as, not ST due, proper colour, safety cap, neck label, sealing etc.,

1.10.4 For ensuring that the cylinder is genuine and fit for filling as per SON AND ASMEnorms, following action shall be taken:

1.10.4.1 Each and every incoming empty cylinder should be critically examined externally as per IS: 15966: 2013. For details Chapter No. 8 may be referred. Primarily, it must be ensured that the cylinders which are badly rusted, dented, pitted, having burnmarks and spurious are not taken up for filling.

1.10.4.2 Spurious cylinders can be classified into three categories:

1.10.4.2.1 Those which can be easily identified visually e.g. cylinders having different dimensions, having patch welding, having more than one number of circumferential welds, having vertical welding, having different colour, etc.

All such cylinders shall be withdrawn from the circulation during the course of visual inspection. The source of such cylinders shall be identified and corrective action shall be taken to prevent recurrence.

1.10.4.2.2 Cylinders having non-standard markings such as ISI monogram, non-standard manufacturer's symbol etc.

All such cylinders shall also be withdrawn from the circulation through the process at crucial visual inspection of the markings.

1.10.4.2.3 Cylinders which cannot be easily identified as spurious through visual inspection and checking of the markings
e.g. cylinders having patches /additional welds which are covered with putty/thick paint.

All such cylinders normally get detected during the process of filling due to leakage of the product through the additional weld points.

Each bottling plant should evolve a method to identify the source of receipt of such spurious cylinders.

1.10.5 If the adequacy of any cylinder to accept the product involved isin doubt, the cylinder should be removed from the filling system for subsequent investigations.

Where different grades of LPG are filled into the cylinders, cylinders are properly identified (colour, shape or other markings) as suitable for the particular grade of LPG being filled.

1.10.6 For monitoring accuracy of the quantity of LPG in the cylinder, following steps shall be taken:

1.10.6.1 With the type of filling equipment installed in most of the plants, the accuracy of quantity of the product filled in the cylinder is a function of correct tare weight marked on the cylinder. Therefore, the tare weight of incoming cylinder shallbe verified as under:

(i) Tare weight of 10% new (virgin) cylinder shall be verified at random and records be maintained for the same. Weighing scale shall have least count of at least 10 gram. Cylinders with variation between stenciled and actual tare more than +/- 50 grams subsequent to rounding off as per Nigerian Standard code IS 2 shall notbe acceptable,. All such cylinders shall be kept aside and the matter shall be taken up with the concerned manufacturer through HO LPG Department for corrective action while carrying out the tare weight checks, the accuracy of the weighing machine must be established. The weighing scale shall have verification scale interval of 10 gms and not more.

(ii) Similarly each and every cylinder returned after hot repairs / statutory testing shall be verified for accuracy of the tare weight in the same manner as explained in paragraph (i) above. In the event of variations observed, if any, observations are to be recorded in the proforma given in **Annexure No. 21** and the matter to be taken up with the concerned party to identify the cause and take corrective action before revising the tare weight markings (both stencil as well as punch marks). Old tare weight of the cylinder must be retained on the stay plate

(iii) The new tare weight of the cylinders shall be stenciled on the shoulder as well as inside portion of one of the vertical stays of the cylinder. The height of the figures should of 40mm and the colour of the paint to be used for stenciling shall be white.

1.10.6.2 The accuracy of each electronic filling machine shall be established at the beginning of each shift and at the intervalof every four hours as detailed in Chapter No. 8 using checkscales. The findings of such checks shall be recorded in theproforma given in **Annexure No. 22** or alternatively print out of filling machine accuracy can be taken from control room PC for review and corrective action, However, ifdata logging is not provided/working the format has to be maintained manually for corrective action.

1.10.6.3 The accuracy of the check scales shall be established minimum four times in each shift as follows:

1st check: at the beginning of the shift.
2nd check: in the third hour after beginning of the shift.
3rd check: in the fifth hour after beginning of the shift.
4th check: in the seventh hour after beginning of the shift.

The checks shall be carried out by using standard weights duly certified by the Legal Metrology Department. The weights shall be available with the weight equal to or slightly greater than the maximum weight of the filled cylinder being handled. Immediate corrective action for the variations observed must be taken. The record of the checks, the observations and corrective action taken shall be maintained in the proforma given **Annexure No. 23**.

1.10.6.4 Correctness of the standard weights used for checking the accuracy of the weighing scales shall be verified through the Legal Metrology Department at periodical intervals specifiedin the relevant Act.

1.10.6.5 100% check weighing of filled cylinders shall be ensured. The permissible margin for the net quantity of 14.2 Kg LPG cylinderis minus 100 gm and plus 200 gm. Presently, Legal Metrology Department allows a variance of ± 150 gm for 14.2 Kg. cylinders and +/- 190 gram (1% of net weight) for 19 kg

cylinders and ± 75 gm (1.5% of net weight) for 5 Kg cylinders with average net weight of the sample greater than or equal to declared net weight of the respective cylinders.

1.10.6.6 Record of total number of under filled / overfilled cylinders generated in each shift vis-a-vis total number of cylinders filled during the shift shall be maintained as per proforma given in **Annexure No. 24** and the trend should be watchedcarefully.

Efforts shall be made to have a decreasing trend. Causes for increasing trend shall be investigated and immediate corrective action shall be taken.

1.10.6.7 To minimize the possible human errors, persons at the following work stations shall be rotated every two hours at theoperational convenience of plants :

- Marking of the tare weight of cylinders
- Tare weight setting on the carousel
- Check weighing of the filled cylinders (if available)
- Tightness testing in the water bath (if available)
- Compact Valve Tester (CVT) (if available)
- Bung leak checks (if available)

1.10.7 For monitoring tightness (leakage) test of the filled cylinders, following steps shall be ensured :

1.10.7.1 All the filled cylinders shall be checked for bung leak in the 'in-line' bath / Electronic bung leak detector.

1.10.7.2 Cylinder leakage test through water bath shall be properly supervised by the experienced staff. While the sensitivity ofCVT is limited to 0.5 gm of gas per hour, by testing the filledcylinders in the 'in-line' test bath, the leaks can be detecteddown to 0.1 gm of escaped gas per hour which will clearly manifest during the visual inspection. The limit of possible escape of gas from an accepted cylinder after tightness water bath test will not cause any danger to its surroundings.

1.10.7.3 The record of total number of bung leak / valve leak cylinders and cylinders with missing / defective 'O' rings should be maintained in the proforma given in **Annexure No. 25** and the trend will be monitored.

Causes for increasing trend, whenever occurs, should be thoroughly analysed and corrective action be taken immediately. Efforts should be constantly made to achieve decreasing trend in all categories.

1.10.7.4 Soap solution should never be used under any circumstances for checking leakage through valve seat/spindle of SC typevalve.

1.10.8 From the consumer point of view, it is extremely important that the filled cylinders, while leaving the plant, must have 'O' rings in the SC type valve outlets and that the 'O' rings fixed are not defective. Towards this objective, the following steps shall be taken:

1.10.8.1 All incoming empty cylinders shall be visually examined forthe presence of 'O' rings before they reach the carousel or unit filling machine. Cylinders not having 'O' rings shall befixed with new 'O' rings immediately.

1.10.8.2 With the help of Compact Valve Tester (CVT)/ AVTS/ Pressure transmitter, test must be conducted to check each and everyfilled cylinder for effectiveness of 'O' ring (as per the manufacturer's instructions). Sufficient time as prescribed by the manufacturer shall be given for the test. Presently permissible limit of leakage is 0.5 gm per hour.

1.10.8.3 In case of leakage through CVT, it must be established thatthe leakage is not through the valve seat before changing the 'O' ring.

1.10.8.4 (The effectiveness of the CVT unit shall be checked at the beginning of shift and every one hour thereafter by using a dummy SC valve fitted with defective 'O' ring, close to CVTunit in operation. In case of AVTS, the test shall be conductedwith the help of test cylinder.

1.10.8.5 Defective 'O" rings of the filled cylinders should be immediately replaced with new 'O' rings and cylinders are to be again subjected to CVT test.

1.10.8.6 The record of missing / defective 'O' rings noticed at the plant level and also in respect of cylinders returned by the Distributors as defective shall be maintained in a proforma given in **Annexure No. 26**.

1.10.8.7 EVERY CASE OF MISSING 'O' RING CYLINDERS RETURNED AS "MARKET RETURN" SHOULD BE T INVESTIGATED TO IDENTIFY THE SOURCE AND THE CAUSES FOR FUTURE COURSE OF ACTION.

1.10.9 DRAINING OF WATER

1.10.9.1 In case any cylinder is returned by the Distributor because of presence of water in the filled cylinder, the same is to be treated seriously and thorough investigation should be carried out with concerned Area Office and State Office to identify the source and take corrective action

1.10.9.2 10 out of every 100 incoming empty cylinders from each of the following category shall be lifted and turned upside down to detect the presence of any foreign matter inside the cylinder such as, water/rust particles/sludge particles, etc.

Categories

- New cylinder
- Cylinder received after statutory testing
- Cylinder received after hot repairs

In the case of suspected presence of any foreign materials inside the cylinder, the cylinder valve is to be removed, the contents are to be collected in a clean tray and examined. The matter is to be taken up with the concerned for corrective action.

1.10.9.3 Besides checking the correctness of the tare weight markings on the new cylinders, cylinders received after hot repairs and cylinders received after statutory testing, as prescribed in Clause No. 12.10.5 above, the quality of workmanship in the following area shall also be checked:

- Body leak
- Leakage through weld joint (bung/circumferential)
- Bung leak
- Valve leak
- Details beyond permissible limit as per IS 15966: 2013 (IS:13258- in the case of cylinders received after hot repairs & IS16054 for cylinders received after statutory testing. In the case of new cylinders there should not be any dent)
- Quality of the punch mark
- Quality of stenciling (tare weight and due date of testing)

In case any deficiency is noticed, the same is to berecorded in a separate register to be maintained for the purpose. The matter shall be referred to HO LPG Department for corrective action by the concerned party inthe case of new cylinders and through the State Office in the case of other two categories.

1.10.10 RANDOM QUALITY CONTROL CHECKS (RQC)

1.10.10.1 Filled cylinders ready for dispatch after sealing shall be picked up at random for random quality control checks. These random checks shall be carried out by the Plant Manager and any other Officer authorized by the Plant Manager. Visiting officers from the State Office/Regional Office / Head Office shall also undertake such surprise checks and record the observation in the register provided at the plant for the purpose.

1.10.10.2 The minimum frequency of the random quality control checks on daily basis in each operating shift at the rate of 10 out of1000 cylinders should be as under:

1.10.10.2.1 1st Check- Minimum 10 cylinders or more, whichever In the 1st hour from the beginning of the shift

1.10.10.2.2 2nd Check- Minimum 10 cylinders or more In the 3rd hourfrom the beginning of the shift.

1.10.10.2.3 3rd Check Minimum 10 cylinders or more In the 5th hourfrom the beginning of the Shift.

1.10.10.2.4 4th Check- Minimum 10 cylinders or more-In the last hour from the beginning of the Shift.

1.10.10.3 The total number of filled cylinders picked up for random quality control checks in the manner as indicated in the clause No. 12.10.10 (b) above should not be less than 0.5% ofthe net filling on daily basis.

1.10.10.4 Cylinders picked up for random quality control checks shallbe checked for:

1.10.10.4.1 Fitness of the cylinder as per visual inspection accordingto SON AND ASME norms IS15966: 2013.

1.10.10.4.2 Due date of cylinder for re-testing as per statutoryregulations.

1.10.10.4.3 Correct weight and the extent of under/over filling.

1.10.10.4.4 Cylinder valve / bung leak.

1.10.10.4.5 'O' ring defect/missing in the case of SC type valves.

1.10.10.4.6 (Absence of water/dust in the outlet of SC type valves.

1.10.10.4.7 Safety cap properly fixed.

1.10.10.4.8 (Cylinder properly sealed.

1.10.10.4.9 (Any other defect.

1.10.10.5 The record of surprise checks as above shall be kept in a separate register to be maintained for the purpose togetherwith the details of the corrective action taken in the proforma given in **Annexure No. 27**. In effect the record of random quality control checks should work as a parameter for the various checks exercised at the plant for correct filing /tightness testing of the filled cylinders.

1.11 BULK RECEIPTS

1.11.1 Certificate of Quality, Bill of Lading (in case of tanker receipts), delivery challan, pipeline transfer advices etc., must tally with the requirements and indicate that the incoming parcel is compatible with the product in the receiving facilities.

1.11.2 In the case of pipeline transfers, verification should be made through the dispatching location to ensure that the line contents and the planned LPG parcel are identical or compatible.

1.11.3 The vapour pressure and temperature of each incoming bulk vessel shipments (road, rail, pipeline or tanker) should be checked individually to ensure that it is in accordance with the requirements and with the dispatch advice and that it is compatible with the contents of receiving facilities. If quality variation or contaminationis suspected, the transferring and receiving tanks should be isolated and pipeline transfer delayed/suspended. The sampling and testing of suspected product parcels should be done to investigate the causes and initiate corrective measures.

1.11.4 Samples of the product should be taken from the tank trucks (or pipelines) before receiving the product into the plant only when this prescribed procedure is specifically authorized. Such samples should be checked/tested for vapour pressure, temperature, odour, colour, appearance and density. Presently, the system of checking of tank truck or pipeline samples, before the receipt should not be followed as a routine, but should be adopted in specific cases only where contamination is suspected. The sampling must be done by a competent person trained for the purpose with the help ofapproved apparatus.

1.11.5 During the receipt of any shipment, designated receiving vessels are to be checked regularly i.e. level and pressure gauges and temperature readings, to ensure that the correct product is received into the nominated vessels.

1.11.6 In the case of tanker discharge when two or more grades are carried, individual tank of the tanker is to be checked regularly

(i.e. ullage) to ensure that only the required grade is being discharged.

1.11.7 When a common line is used and the product grade change is tobe made, representative line samples should be taken at intervals before and after switching over in order to detect the stop interface and to confirm the change and the quality of the product switched over to the new vessel.

1.11.8 When switching for a common line, grade change is done on a calculated speed of flow-time basis. Sampling and checking should be carried out on the receiving vessel or its individual supplypipe after the switching over as soon as possible in order to checkthe absence of the contaminants.

1.11.9 For all forms of receipt, if contamination or quality of the product being received is suspected, receipt must be stopped and the receiving lines and the vessels be isolated. Samples should be checked and operations should be resumed, only if the results of samples are satisfactory. If the samples are unsatisfactory, State Office / Regional Office /Head Office should be consulted for further instructions.

1.11.10 After the receipt of shipment and settling time of minimum one hour, the following checks/tests should be carried out:

(i) Pressure and temperature readings are to be noted for checking their correctness.
(ii) Receiving vessel is to be drained and checked for water or any other contaminants.

1.12 BULK LOADING

1.12.1 Whenever bulk loading is involved i.e. transfer of the product to the tank truck or tanker, the following checks are necessary:

1.12.1.1 The product is to be loaded/transferred as per the productgrade indicated in the relevant indent/Challan.

1.12.1.2 The vapour pressure/temperature of the products in the supplying and receiving vessels indicate that the products are compatible.

1.12.1.3 After the transfer (loading), it is to be checked that thevapour pressure and the temperature of the contents of thetransport vessel are within the acceptable limits for the product.

1.12.1.4 The vapour pressure and the temperature are checked forthe bulk supplying vessels.

1.13 BULK DELIVERIES TO CUSTOMERS' PREMISES

1.13.1 The following checks should be made while making deliveries to customers' premises by means of tank trucks.

1.13.1.1 Before discharging the product into customers' storagevessels, the contents of the line should be checked to ensurethat it meets the customers' requirements.

1.13.1.2 Before the discharge is made, the vapour pressure and the temperature of the product in both the delivery vehicles andthe receiving vessel, must be checked to ensure that they are within the acceptable limits and that the products arecompatible. If not, the delivery must be deferred till full investigation is carried out.

1.13.1.3 After the discharge is completed, the vapour pressure and the temperature of the product in the customer's storage vessels should be rechecked to ensure that it is within the acceptable range.

1.14 INTER VESSEL TRANSFERS

1.14.1 Inter vessel transfers should be minimised in the interest of safety, product loss and product quality. In the case of such transfers, the following checks/tests should be carried out:

1.14.1.1 Before the transfer is undertaken (while checking the ullage capacity), it should be checked that the temperature and the pressure in both the vessels are within the requirements and indicate that the products are compatible.

1.14.1.2 After completion of the transfer, the pressure and the temperature of the product in the receiving vessels should be re-checked and draining operation be started after minimum settling time of one hour to ensure that the contents are free from water and other contaminants.

1.14.2 When transfers occur in the multi-product plant and/or involve common lines, the compatibility of the transfer parcel must be checked both with the contents of the common lines and the receiving vessels. It is advisable to test the sample from the receiving vessel after completing the transfer.

1.15 DORMANT STORAGE

1.15.1 As it is contained in a closed pressurised system, clean LPG will remain as per specification indefinitely, if it is stored in clean segregated vessels. During the prolonged storage, i.e. , while there are no receipts, but deliveries may be taking place, the following checks should be carried out:

1.15.1.1 Daily checks for the liquid level, pressure and temperature.

1.15.1.2 Check for draining water should be made daily until no water or contamination is found on successive tests. Draining should then be stopped till the receipt of next replenishment, unless climatic conditions (colder days) might cause soluble water in LPG to be precipitated.

1.16 COMMISSIONING OF NEW PLANT AND RE-COMMISSIONING OF EXISTING PLANTS

1.16.1 When an LPG plant is newly commissioned or when the modifications etc., are carried out to the existing plant, the following minimum quality checks/tests should be carried out for the first receipt of the product:

1.16.1.1 Storage vessels and filling/loading points are to be drained carefully checking the presence of water or other contaminants. The drainage operations should be repeated daily until no water/contaminant is found in successive operations.

1.16.1.2 Storage vessel and pipelines are checked for the presence of water, if any and properly purged to ensure air is not present.

1.17 PRECAUTIONS

1.17.1 MOVEMENT OF LPG

1.17.1.1 To prevent the product contamination, sufficient care is necessary during loading / unloading operations.

1.17.1.2 Competent person in charge of the operation should plan in advance each operation from start to finish.

1.17.1.3 All Lines, Pumps, Valves and Storage Vessels must beidentified and checked by physical tracing before starting the operation. Checks should be repeated when switching over from one storage vessel to another or when changing the product grades especially where the pipeline manifolds are involved.

1.17.1.4 Before loading or receiving the product from any vehicle or vessel, it should be ensured that the product in the receivingand delivery vessels and the inter-connecting pipelines are similar. A check on pressure and temperature is normally sufficient.

1.17.1.5 If the product grade is changed, the contents of the receiving vessel and inter-connecting pipelines must be checked so that the mixture formed will not send the inter-connecting product (off-spec) to the receiving vessel.

1.17.2 IDENTIFICATION OF PIPELINES

To ensure correct identification of the pipeline contents, all pipelines should be properly colour coded at valves, Flange joints, Tee, elbows and every ten meters in a straight section. The details of colour coding of pipelines are given in **Annexure No. 28**.

1.17.3 IDENTIFICATION OF STORAGE VESSELS

Storage vessels should be identified by means of serial numbers e.g. 1,2,3 etc. painted prominently on the shell in bold block figures. In addition, the contents should be clearly indicated by means of bold figures. Product identification markings should also be prominently located next to the receipt and withdrawal connections.

1.17.4 IDENTIFICATION OF STORAGE VESSEL FITTINGS

All fittings on the storage vessels should be clearly marked for easier identification and correct use.

1.18 HANDLING OF CONTAMINATED PRODUCT

1.18.1 IDENTIFICATION OF SUSPECT GRADES

If during the initial testing at the plant {refer Clause No. 12.9.1(b)} it does not remove the doubt regarding the quality of LPG, the suspect stocks should be frozen and State Office / Regional Office / Head Office be informed immediately. At the same time samples should be taken, marked for identification and submitted to the nominated laboratory for testing.

1.18.2 CHANGING OF LPG GRADES

Changing from one grade of LPG to another grade (having different vapour pressures) should not be undertaken without the authorization from State Office/Regional Office/Head Office, unless the change is a part of the established procedure.

1.18.3 DEALING WITH CONTAMINATED PRODUCT

1.18.3.1 If testing at the plant before, during and after the receipt ofLPG shows that the vapour pressure/temperature and/or thedensity are found to be outside the accepted range for the grade, State Office / Regional Office/Head Office should be consulted for further instructions.

1.18.3.2 Bulk storage vessels suspected or known to be contaminated e.g., with air and/or water, should be frozen, if practicable. Other vessels should be used until the contamination is dealt with. If there are no other vessels, the contaminated vessel should be drained before the liquid LPG is taken in it and the LPG vapour should be vented from it before it is connected to the vapour phase of any other static or mobile vessel.

1.18.4 REPORTING OF LPG CONTAMINATION

1.18.4.1 The Plant Manager should report all the cases of product contamination to State Office / Regional Office / Head Office giving full details of the grade and storage vessel involved and additional stock and ullage available in the plant. The causes of the contamination should also be indicated, if known, together with the proposal for dealing with it and toprevent its recurrence.

1.18.4.2 Similar reports should be made for any complaint received from bulk customers for quality problems related to LPG

1.19 SAMPLING

1.19.1 PURPOSE

1.19.1.1 Sampling is very important aid to the quality control

1.19.1.2 Samples are drawn for the purpose of ascertaining the conformity of the stock to the relevant specifications

1.19.2 SAMPLING STANDARD

1.19.2.1 Bureau of Nigerian Standard IS 1447(Part 2) describes the method of sampling representative of Liquefied Petroleum Gases such as propane, butane or mixtures thereof, in containers other than those used in the laboratory testing apparatus. These procedures are considered adequate for obtaining representative samples for all routine tests as per IS4576 Specification.

1.19.2.2 A liquid sample is transferred from the source into a sample container by purging the container and filling it with liquid LPG to 80% of the capacity.

1.19.2.3 Different sampling bombs are to be used for drawing samples for different tests like vapour pressure, density, volatility and copper corrosion.

1.19.3 TYPES OF SAMPLES

1.19.3.1 Sample for pre-discharge tests: The sample is to be drawn from the manifold of the vessel grade-wise representing thegroup-wise product.

1.19.3.2 Sample for during discharge tests: The sample is to be drawn from the sampling arrangement provided on the shoreline /manifold of the tanker.

1.19.3.3 Sample before despatch of the product: The representative sample shall be drawn from the system after dosing of mercaptan. In case of dosing of mercaptan is done before the storage vessel, sample is to be drawn from the storagevessel.

1.19.3.4 In the case of dosing of mercaptan online before despatch, representative sample shall be drawn from the loading line.

1.19.4 SAMPLING PROCEDURE

Observance of the correct sampling procedure is of utmost importance, since the quality of the product is very much dependent on the test results of the representative sample. The following procedures should be followed while sampling:.

1.19.4.1 Before taking the sample, the product must be in equilibrium.

1.19.4.2 The sampling bomb should be properly closed and it shouldbe confirmed that there is no leak.

1.19.4.3 Sample details should be entered in the prescribed form and attached to the container.

1.19.4.4 Sampling and filling of sampling bomb should be personally supervised by an Officer well conversant with the procedures.

1.19.5 PRECAUTIONS DURING SAMPLING

1.19.5.1 Careful testing and analysis is of little use, if sufficient care isnot exercised in sampling.

1.19.5.2 LPG presents a particular hazard because it is heavier than airand is highly inflammable and appropriate precautions must, therefore, be taken.

1.19.5.3 Sampling normally involves venting of the product into the atmosphere and the absence of source of ignition must always be checked before and during the sampling.

1.19.5.4 Liquid LPG causes serious cold burns on contact with the skin. Protective gloves and goggles should, therefore, be worn during the sampling.

1.19.5.5 Breathing of LPG vapours during the sampling should be avoided.

1.19.5.6 If samples are to be sent through a public transport, the appropriate regulations must be complied with.

1.19.5.7 The discharge of LPG from a sampling bomb can cause static electricity. Sampling bomb must, therefore, be earthed effectively before and during the discharge.

1.19.5.8 The condition of sampling bomb must be examined before use. It should be hydraulically tested at an interval of 12 months, while its control valve should also be checked and serviced.

1.19.5.9 Each bomb should be marked with its tare weight, working pressure, test pressure and the dates on which it was originallyand last tested. The markings are to be etched on the bomb or stamped on the metal plate attached securely to it.

1.19.6 SAMPLE COLLECTION PROCEDURE

The size of the sample should be related to the test and analysis to be carried out on it and will influence the size and type of the sampling container used. The sampling procedure as under shall be followed:

1.19.6.1 The liquid content in the bomb is vented out after checkingthat there is no source of ignition in the vicinity.

1.19.6.2 Holding the bomb vertically and connecting to the sampling point, it should be at least 10cm. below the liquid level. The connections should be made to the bottom of the bomb, which should be the end to which the ullage tube is connected.

1.19.6.3 The outlet and inlet valves on the bomb are opened.

1.19.6.4 The sample source valve is opened and the outlet valve on the bomb is closed to minimize boiling of Liquid LPG in thebomb.

1.19.6.5 When the liquid appears, the liquid outlet valve is closed followed by the inlet valve and the sample source valve.

1.19.6.6 The connection is loosened sufficiently to enable the bomb to be inverted. After re-tightening the connection, the outlet valve is opened, and the liquid LPG contents are allowed to vent out so as to ensure that any contamination from the previous sample is removed and that the bomb is chilled.

1.19.6.7 When the liquid ceases to flow, the outlet valve is closed, andthe bomb is re-inverted by slackening and re-tightening the connection.

1.19.6.8 Sample source valve is opened followed by the bomb inlet valve and liquid is allowed to flow into the bomb.

1.19.6.9 Outlet valve of the bomb is opened momentarily from time to time until the liquid appears.

1.19.6.10 The outlet valve is closed, followed by quick closing of inletand sample source valves quickly in that order.

1.19.6.11 The union is slackened, and bomb is inverted so that the ullage tube is at the top. The union is tightened and then thetop needle valve is cracked until the liquid ceases to emerge,
i.e., when appropriate ullage is made in the bomb.

1.19.6.12 The needle valve is closed, and the union is slackened to bleed off the liquid from the bomb connection tube.

1.19.6.13 The bomb, the connection tube and the seal/plug sampling point are disconnected.

1.19.6.14 The sampling bomb is removed to the test/analysis point, ensuring that it is not overheated.

1.19.7 LABORATORY SUPPORT

1.19.8 PURPOSE

Quality control laboratories are conveniently located at all Refineries, Fractionators units, LPG Import Terminals, selected Terminals and Depots for the tests to be carried out on various samples, as required. These laboratories shall be manned by

qualified Laboratory Officers, who are familiar with the standard procedures for testing LPG. The laboratories shall be properly equipped with the standard apparatus in line with the relevant specifications. Laboratory shall issue suitable test reports for the samples tested.

1.19.9 FIELD LABORATORIES

Quality Control Laboratories are located at the indigenous sourcelocations and at Import locations as given at xxxxx

2

ANNEXURES

ANNEXURE 1

GLOSSARY OF TERMS

ABSOLUTE PRESSURE
See under "Pressure"

ATMOSPHERIC PRESSURE
See under "Pressure"

BAROMETRIC PRESSURE
See under "Pressure"

BLOW DOWN PRESSURE
I See under "Pressure"

BOILING

This is the action which takes place when a liquid changes its state from a liquid into a gas or vapour. The heat required to bring this change of state is called Latent Heat.

BOILING POINT

The Boiling Point of a liquid is defined as the temperature at which the vapour pressure is one atmospheric absolute.

BOYLE'S LAW

See under "Gas Laws"

BULLET

A horizontal pressure vessel designed for storage of LPG. Horizontal tanks mounted on pedestals at the Plants, mounted on a truck chassis or a rail chassis are also known as Bullets.

CO-EFFICIENT OF EXPANSION

It is defined as the increase in volume of unit volume of a substance when its temperature rises by 1°C.

COMMERCIAL BUTANE

Butane used as a fuel or for other purposes. It is not a chemically

pure product but the impurities are adjoining members of the hydrocarbon series and small amounts of other impurities which do not materially affect its use as a fuel.

COMMERCIAL PROPANE

Same as commercial butane except the primary component is propane.

COMPETENT PERSON

A person in officer's grade having the necessary ability for particular operation or type of Plant and equipment to which the text refers, such as to render him capable of the work involved, and who has been duly authorized to undertake this work.

COMPETENT STAFF

Staff of 'competent persons' trained for the job.

COMPRESSED GAS

Any permanent gas, liquefiable gas or gas dissolved in liquid under pressure or gas mixture which in a closed gas cylinder exercises a pressure either exceeding 2.5 Kgf/Cm^2 abs (1.5 Kgf/Cm^2 gauge) at + 15°C or a pressure exceeding 3 Kgf/Cm^2 abs (2 Kgf/Cm^2 gauge) at 50°C or both

CONDENSATION

This is evaporation in reverse. If a vapour becomes supersaturated, condensation takes place and heat is surrendered.

CONTAINER

The term includes all vessels such as tanks, cylinders or bullets used for the transportation or storage of LPG.

CONVERSION

Converting LPG from the liquid phase to the vapour phase or vice versa.

CORROSION

All forms of wastage, and includes oxidation, scaling, mechanical abrasion and erosion.

CRITICAL TEMPERATURE

The critical temperature of a gas is the temperature above which itcannot be liquefied regardless of pressure.

CRITICAL PRESSURE

See under 'Pressure'.

DESIGN

Includes drawings, calculations, specifications, models, codes & all other details necessary for the complete description of the pressure vessel and its construction.

DESIGN PRESSURE

See under 'Pressure'.

DENSITY OF LIQUIDS

Density of a liquid is defined as mass of the liquid occupying unit volume at a given temperature.

DENSITY OF VAPOURS

Density of a liquid is defined as the mass of the liquid occupying unit volume at a given temperature.

EVAPORATION

This is the process of converting a liquid into a vapour, and it requires latent heat to do this.

FILLING OF CARGO TANKS

The correct maximum volume of liquid that should be loaded in a cargo tank is such a quantity that after allowance for the product to warm up and expand to a temperature the saturated vapour pressure of which would lift the safety valves, prescribed percentages, of the space would remain. A tank so filled is described as 'Full'. A tank filled above this level is described as 'Overfull'. A tank completely filled with liquid is described as 'one hundred per cent – full'.

FILLING DENSITY

The per cent ratio of weight of liquefied gas allowed in a pressure vessel to the weight of water that the vessel will hold at 15°C.

FILLING PRESSURE

See under 'Pressure'.
liquid.

FILLING RATIO

The ratio of weight of liquefied gas allowed in a pressure vessel to the weight of water that the vessel will hold at 15°C.

FLAMMABLE COMPRESSED GAS

Gas, 13 per cent or less of which when mixed with air forms a flammable mixture or whose flammable range with air is greater than 12 per cent.

FLAMMABLE

The term is synonymous with 'Inflammable'. It refers to any substance, solid. liquid, gas or vapour which is easily ignited. The addition of the prefix " non" indicates that the substance is not readily ignited, but does not necessarily indicate that it is non• combustible. The use of term "flammable" is preferred to ''inflammable" to avoid ambiguity.

FLAMMABLE GAS

Any gas which, if either a mixture of 13 per cent or less (by volume) with air forms a flammable mixture or the gas which has flammability range greater than 12 per cent regardless of the lower limits. These limits shall be determined at atmospheric temperature and pressure.

FLAMMABILITY RANGE

The term is synonymous with "Inflammability Range·· The difference between the minimum and maximum percentage by volume of the ·gas in mixture with air that forms a flammable mixture at atmospheric pressure and ambient temperature.

FLASH VAPOURISATION

The instantaneous and complete conversion of liquid to gas

FOG NOZZLE

A water nozzle which produces a fine fog-like spray It is very effective in cooling and

controlling fires.

FREEZING POINT

The temperature at which liquid changes to a solid state : solidifies

GAS CYLINDER OR CYLINDER

Any closed metal container intended for the storage and transport of compressed gas. designed not to be fitted to a special transport or under-carriage. and having a volume exceeding 500 ml. but not exceeding 1000 liters.

GAS LAWS

(a) AVOGADRO'S HYPOTHESIS

Equal volumes of different gases at the same pressure and temperature contain the same number of molecules.

(b) BOYLE'S LAW

The volume occupied by a given mass of gas varies inversely with the absolute pressure if the temperature IS not allowed to change.

(c) CHARLE'S LAW

The volume of a given mass of gas varies directly with the absolute temperature provided the pressure remains constant Volume at t°C = (273+t)/273 x Volume at 0°C

Density at t^0 C= 273/(273+t) x Density at 0^oC

(d) CLERK MAXWELL'S KINETIC THEORY

A gas may be imagined as a vast number of molecules moving inall directions at irregular velocities, colliding with one another and with the walls of the containing vessel. The path of a molecule is zigzag in three dimensions and the mean free path is defined as the average length between collisions, the denser the gas, the shorter will be the mean free path. This theory co-relates Avogadro's Hypothesis, Boyle's Law & Gay Lussac's Law.

(e) DALTON'S LAW OF PARTIAL PRESSURES

The pressure of a mixture of gases is the sum of the pressures each would exert if it alone were to occupy the containing vessel.

(f) GAY LUSSAC'S LAW .

The density of a gas at standard pressure and temperature is proportionalto its molecular weight. This is a corollary of Avogadro's Hypothesis.

(g) JOULE'S LAW

When a perfect gas expands without doing external work and without taking in or giving out heat and therefore, without changing its stock of internal energy, its temperature does not change.

GAS FREE

In relation to a pressure vessel means concentration of flammable or toxic gases or both in case of such pressure vessel is within the safe limits specified for persons to enter and carry out hot work in such vessels.

HEAT

(a) LATENT HEAT

This is the heat used up in changing the state of a substance without changing its temperature. In the case of changing the state of a substance from solid into a liquid (melting), it is called the latent heat of fusion, and in the case of heat changing the state of a liquid into a gas or vapour (boiling), it is called the latent heat of vaporization. The value of latent heat of vaporization varies with . temperature and pressure.

(b) SENSIBLE HEAT

This is the heat used in raising the temperature of a substance without changing its state. 1 calorie is used to raise the temperature of 1 gram of water by 1°C.

HORTON SPHERE

Spherical pressure vessel designed for storage of LPG. These are usually of capacities above 400 cubic meters.

HIGH PRESSURE LIQUEFIABLE GASES

A liquefiable gas having a critical temperature between – 10°C + 70°C.

HYDROCARBON

An organic compound consisting primarily of hydrogen and carbon. All petroleum products are hydrocarbons.

HYDROSTATIC STRETCH TEST
Subjecting the cylinder to a hydrostatic pressure equal to the test pressure of the cylinder and recording the permanent stretch undergone by the cylinder.

HYDROSTATIC TEST
The test in which a cylinder is subjected to a hydrostatic pressure equal to the test pressure of the cylinder

INERT GAS
A gas which will not support combustion and normally does not react with other compounds under normal conditions and temperature (e.g. Nitrogen)

INFLAMMABLE
See "Flammable".

INFLAMMABILITY RANGE
See "Flammability Range".

INLET PRESSURE
See under 'Pressure'.

INSTALLATION
Any premises wherein any place has been specially prepared for the manufacture
(filling) or storage of compressed gas in cylinder.

INSPECTOR
A person authorized by the licensing authority for the purpose of inspecting vessels i n accordance with the approved design & specification and code.

LATENT HEAT
See under "Heat".

LATENT HEAT OF VAPOURISATION
The quantity of heat absorbed by a unit mass when changing from the liquid to gaseous phase while remaining at the same temperature.

LIQUEFIED PETROLEUM GAS

A material having a vapour pressure not exceeding that allowed for commercial propane composed predominantly of the following hydro carbons, either by themselves or as mixtures : Propane, Propylene, Butane (Normal Butane or Iso-Butane) and Butylenes including Isomers. "Liquefied Petroleum Gas" is also expressed by terms 'LP-Gas' and 'LPG'.

LIQUEFIABLE GAS

Any gas that may be liquefied by pressure above 0 °C. but will be completely vaporized when in equilibrium with normal atmospheric pressure (760 mm Hg) at 30°C.

LIQUID CARRY OVER

This occurs when vapour moves swiftly over the surface of a liquid and droplets of liquid become entrained with the vapour and are earned over with it.

LIQUID LEVEL INDICATOR

A fixed liquid level gauge, a rotary gauge. a magnetic gauge. or other type of gauge which will indicate the quantity or the level ofa liquid in a container.

LIQUEFACTION

Converting a gas into the liquid phase by compression or cooling ora combination of both.

LOW PRESSURE LIQUEFIABLE GAS

A liquefiable gas having critical temperature higher than + 70°C.

MAGNETIC GAUGES

A gauge in which a float, through mechanical means, causes a magnet to revolve as the float rises or falls with the liquid level. The magnet causes a magnetized needle to follow and indicate the liquid contents of the container on a suitable scale.

MANUFACTURE OF GAS

Filling of a cylinder with any compressed gas and also includes transfer of compressed gas from one cylinder to any other cylinder.

MAXIMUM ALLOWABLE WORKING PRESSURE

The pressure for which a storage container is designed or the maximum pressure allowable according to the condition of the tank when it is designed.

MERCAPTANS

A family of petroleum Sulphur compounds having a disagreeable odour. Some of them are used to odourise LP-Gas so that it can be detected in case of gas leaks.

METER

A device for measuring the flow of fluids.

NAKED LIGHTS

Naked lights include all unconfined flames. fires, exposed incandescent material, lamps of an unapproved pattern, electric welding arcs and. portable hand or power operated equipment liable to cause incendiary sparks.

NATURAL GAS

The term applied to gas as commonly associated with petroliferous geologic formations. The main combustion constituent is methane but varying amounts of ethane are usually present with small percentages of propane and butane. Some natural gases contain helium, carbon dioxide, nitrogen and sulphide in varying quantities.

PURGING

Removing an unwanted substance from the container. pipeline or other enclosure.

PRESSURE

(a) ABSOLUTE PRESSURE

The absolute or total pressure of a gas is the sum of the gauge pressure plus the barometric pressure of the atmosphere. In other words this is the pressure above a vacuum. Thus a pressure of 7 psi absolute, is really a suction pressure of 7 7

psi at atmospheric pressure (atmospheric pressure equals 14.7 psi)

(b) ATMOSPHERIC PRESSURE

This is the pressure exerted at sea level. This pressure varies from

place to place and from time to time The standard atmospheric pressure is 1012.5 millibars. corresponding to 29.90 inches or 760 mm of mercury (Hg)

(c) BAROMETRIC PRESSURE

The pressure due to the weight of the earth's atmosphere as indicated by a barometer.

(d) BLOW DOWN PRESSURE

The term IS applicable to pressure relief valve. The pressure at which the seat of the valve closes tight after release of excessive pressure IS known as 'Blow Down Pressure'. This value is generally lower than the set 'Start to Discharge Pressure'.

(e) DESIGN PRESSURE.

Design pressure means the pressure used in the design calculations of a vessel for the purpose of determining the minimum thickness of the various component parts of the vessel. This should not be lower than the 'Working Pressure'.

(f) FILLING PRESSURE

The maximum permissible gauge pressure, converted to + 15°C, at which a gas cylinder for permanent gas or gas dissolved under pressure can be filled.

(g) INLET PRESSURE

The pressure at the inlet side of a regulator, pump, meter or entrance to a system or **process** cycle.

(h) PRESSURE RELIEF VALVE

See 'Safety Relief Device' (Valve)

(i) PRESSURE VESSEL

Any closed metal container of whatever shape, intended for the storage or transport of any compressed gas which is subjected to internal pressure and whose water capacity exceeds one thousand liters and includes interconnecting parts and components thereof up to the first point of connection to the connected piping and fittings.

(j) START TO DISCHARGE

The term is related to pressure relief valve also known as safety relief valve. The set pressure at which the valve seat is designed to lift slightly and start releasing the excessive vapour pressure. At this stage the valve will open slightly and not full. This pressure MUST be

less than 110% of the working pressure of the vessel on which it is mounted.

(k) TEST PRESSURE

The internal pressure required for the hydrostatic test or hydrostatic stretch test of the cylinder. This is indicated on all the pressure vessels.

(I) VAPOUR PRESSURE

The vapour pressure of liquid at a given temperature is defined as the equilibrium pressure developed at that temperature in a closed vessel containing the liquid and its vapour only. The vapour pressure of LP-Gas depends upon the temperature of the liquid and the composition in terms of primary hydrocarbons present.

(m) WORKING PRESSURE

The maximum saturated vapour pressure at which the vessel shouldbe operated in actual service. For un-insulated storage and transport pressure vessels this is based on the maximum temperature of 55°C, where as for LPG cylinders it is based on the maximum temperature of 65°C. Working Pressure is· indicated on all the pressure vessels·

(Note : For the values of saturated vapour pressure of different gases refer IS : 3710)

PERMANENT GAS

A gas whose critical temperature is below (-) 10°C that is to say a gas which cannot be liquefied under any pressure at a temperature above(-) 10°C.

QUICK CLOSING VALVE

A valve which can be closed quickly by the movement of release of a lever instead of by the rotation of a stem.

RECEIVING TANK

A storage tank into which liquid is loaded.

REGULATOR

A device used to reduce the pressure of a fluid from a higher pressure to a lower controlled pressure.

RELIEF DEVICE

·A device used to prevent a dangerous condition of pressure or temperature from occurring in an enclosed space. Refer 'Safety Relief Device'.

RELIEF VALVE MANIFOLD
A manifold containing two or more relief valves but with only one connection to the container. Some manifolds are designed to permit the removal of one relief device without impairing the relieving capacity required by the container.

TEST PRESSURE
See under 'Pressure'.

VALVE, AUTOMATIC CUT·OFF
A valve either pressure or electrically energized which automatically closes when certain undesirable conditions such as an abnormal low or high pressure are experienced.

VALVE, BACK FLOW CHECK
A valve which permits flow of fluid in one direction but closes automatically to prevent flow in the opposite direction.

VALVE, BALL CHECK
A form of check valve which utilizes a ball as a medium to stop the flow.

VALVE, DIFFERENTIAL
A special valve used in liquid metering systems to create a back pressure on the liquid stream as it passes through the meter and prevent vapour formation in the meter.

VALVE, EXCESS FLOW CHECK
A valve which permits uninterrupted flow in one direction but when flow in the opposite direction exceeds a predetermined rate or a predetermined differential pressure across the valve. the valve closes and stops the flow.

VAPOUR
A gaseous form of substances which are normally in the solid or liquid state.

VAPOUR PRESSURE
See under 'Pressure'.

VEHICLE
A mechanically propelled carriage designed to transport by land. compressed gas in a pressure vessel mounted thereon. and shall not

7include a vessel forming the barrel of a rail tank wagon.

VESSEL
A pressure vessel used for storage or transport (road/rail) of LPG.

VISCOSITY
The internal friction or resistance of a fluid to flow.

WATER CAPACITY
The volume of water in liters a vessel will hold at 15'C.

WEATHERING
Venting vapour to atmosphere or vaporization of a liquid at atmospheric pressure.

WORKING PRESSURE
See under 'Pressure'.

WORKING PRESSURE FOR LOW PRESSURE LIQUEFIABLE GASES
See under 'Pressure'

YIELD STRENGTH
The stress corresponding to a permanent strain of 0.2 per cent of the original gauge length in. a tensile test. For practical purposes it may be taken as a stress at which elongation first occurs in the test piece without the increase of load in a tensile test

ANNEXURE 2

Statutory Licenses and Approvals/Documentation

(A)		***PESO Related***
	1	Conveyor Layout- Proposed and also for as built
	2	Plant Layout-Proposed and also for as built
	3	License to Fill compressed gas in cylinder (Form E).
	4	License to store compressed gas in Cylinders (form F).
	5	License to store compressed gas in pressure vessel or vessels.) Form-III
	6	License to store Diesel in Diesel tank for Consumer pump
	7	Endorsement for degassing of cylinders
	8	Endorsement for filling of cylinders & storage vessels after sunset and also for unloading/loading of Bulk as applicable
	9	NDT & Hydro test of LPG Pressure vessels
	10	SRV Testing of Storage vessels and also air receivers/POP action valve test records
(B)		**Factory License-Related**
	1	Approval for ERDMP vetted by PNGRB accredited 3rd Party
	2	Approval for on site emergency plan
	3	Copy of Off Site emergency plan
	4	Endorsement on factory license regarding change of occupier.
	5	Plant Layout-Proposed and also for as as built
	6	Building drawings-Proposed and as built
	7	NDT & Hydro test of other Pressure vessels , Suction and discharge bottles/air receivers
	8	Stability Certificate for buildings
	9	Safety Audit report- external agency-as required by Factories dpt.
	10	First Aid Training and certificates
	11	Risk analysis as and when changes in filling/storage system/risk
	12	TT Parking area exclusion from Plant layout

	13	Report of examination of Pressure Vessel as reqd by Factories dept
©		**PCB RELATED**
	1	AIR CONSENT
	2	WATER CONSENT
	3	Hazardous Waste (MHIHC) Rule 1989
	4	Water test (Potability)
	5	Air quality monitoring Test
	6	Water quality monitoring Test
	7	Noise Monitoring Test
	8	DG sets approvals as required from EB/ERC as applicable.
(D)		***W&Ms Certificates***
	1	Certificate of Registration Under Legal Metrology (Packaged Commodities) Rules 2011)
	2	Certificate of Registration [Under Rule 17 of Standards of Weights & Measures 1985]
	3	Certification of verification of Stamping Weights & Measures for Carousal Filling M/c, Check Scales, Weigh Bridge, Standards Weights, 5 ltr measure & HSD Dispensing Pump and any other weighing scales
(E)		**Prohibited area/place declaration**
(F)	1	License from Labor Department for engaging labors for various works
	2	Intimation regarding change/commencement/completion of contract and change of occupier for amendment of license
(E)		***General***
	1	Hydro Test of LPG Pipeline- Above ground-Every Five years
	2	RTO Approval for Motor Driving Institute-Hazardous endorsement for Cyl TTs and BTs
	3	LPG Hose Testing record- Every four months
	4	Electrical Audit - Internal-Every year
	5	Electrical Audit - External-Every four years

	6	Earth Resistance Testing-Every six months
	8	Emergency Response Drill-Every six months
	9	Fire Hose Testing-Every six months
	10	CEA Inspection- Before commissioning of any new facilities and period not exceeding five years/as per IE rules
	11	Bomb Threat Contingency Plan- Approved by corporate office
	12	Security Contingency Plan- Approved by Corporate office and then by district administration
	13	Fire Water Tank Inspection, Thickness testing, cleaning and painting- Cleaning Every 5 years & Wall thickness every three years & as Per OISD 129
	14	Fire Extinguisher Inspection visual every month and servicing-every three months
	15	Hydro - Test of DCP Fire Extinguishers-Every three years
	16	Public Liability Insurance-Validity-Copy to be kept
	17	Testing of Transformer Oil-Every year
	18	Relay Calibrations-Every year
	20	Torque Wrench Calibration-Every year
	21	Electrical Hand Gloves 33 KVA-Every six months- To have valid test certificate
	22	Explosive meter calibration-Every year
	25	Cable Insulation Resistance Test-Every year and corrective actions if insulation value less than 1 mega ohm.
	26	VHF License- for base stations and walkie talkies- Every year-To be kept valid from DOT

ANNEXURE 3

Sr.No.	Characteristic	Auto LPG as per IS 14861	Domestic LPG as per IS 4576
1	Vapour Pressure at 40 C, kPa	Min 520 Max 1050	Comml. Butane 520, Mix 1050 Comml.Propane 1550
2	C5 Hydrocarbons & Heavier, Max (Liquid Vol. %)	2.0	Comml.Butane 2.5, Mix 2.5 Comml.Propane 0.2
3	Dienes, mole %, max	0.5	Report
4	Total Volatile Sulphur ppm	150	150
5	Motor Octane Number MON	88	-
6	Cu Strip Corrosion at 38 C	Class 1	Not worse than no. 1
7	Evaporation Residue, mg/kg, max	100	-
8	**Volatility** :Evaporation temperature in °C for 95 percent by volume at 760 mm Hg pressure, Max.		Comml.Butane 2 , Mix 2 Comml.Propane (-)38
9	Free water content	Nil	Nul
10	Hydrogen Su;phide	Pass the test	Pass the test

ANNEXURE 4

TYPICAL PROPERTIES OF COMMERCIAL PROPANE & BUTANE

Specification

	Commercial Propane	Commercial Butane
Formula	C_3H_8 (Propane)	C_4H_{10} (Butane)
Boiling Point ^{0}C	- 45	-7 to -0.5
Freezing Point ^{0}C	-186	-150
Critical Temperature °C	97	152
Critical Pressure at (Kg/cm2)	43	39

(a) Liquid at Vapout Pressure , 15^{0}C

a.	Density kg/l	0.51	0.575	
b.	Specific volume, l/kg	1.96	1.73	
c.	Sp. Gravity (w.r.t water=1)	0.510		0.575
d.	Vapour Pressure, kg/cm^2(g)	6.65		1.4
e.	Absolute Viscosity , cP	0.10	0.15	
f.	Co-eff.of Vol. expansion,(10-40^{0}C)	0.00324		0.00230
g.	Latent Heat, Kcal/Kg (1 atm)	95	90	
h.	Specific Heat, Kcal/Kg/^{0}C	0.60	0.57	
i.	Calorific Value (Gross),Kcal/Kg	11900	11800	
j.	Calorific Value (net),Kcal/Kg	11000	10900	

(b) Saturated vapour, 15^{0}C

a.	Density, Kg/m^3	15.3	5.62
b.	Specific Volume m^3/tonne	65	178

(c) Vapour at 1 atm, 15^{0}C

a.	Density, Kg/m^3	2.0	2.6
b.	Specific Volume, m^3/kg	0.5	0.38
c.	Sp. Gravity (air=1)	1.5	2.0
d.	Sp. Heat, Kcal/kg/^{0}C		
	i. Cp	0.38	0.39
	ii. Cv	0.34	0.35
e.	Calorific Value (gross), Kcal/m^3	24000	30700

f.	Calorific Value (net), Kcal/m^3	22600	29000
g.	Ignition Temp. In air ^0C	450-500	420-490
h.	Flame Temp. In air, ^0C max	1970	1975
i.	Combustion air Required Stoichiometric Prop., m^3/m^3	24	30
j.	Limits of Flammability, Vol % of vapour in air gas mixture		
	Lower	2.0	1.8
	Upper	10	8.5

* Whereas LPG marketed would conform to IS 4576. the composition is not guaranteed since the % varies for different crudes and even for same crude from batch to batch. The composition should, therefore, be taken only as a general guide.

ANNEXURE 5

WORKING OF SAFE-FILLING QUANTITIES FOR LPG CONTAINERS

1.0 GENERAL

1.1 One of the most important safety aspects at LPG bottling plant is to ensure that the LPG containers are not over-filled. LPG containers should be so filled that there is always sufficient vapour space left to allow the liquid LPG to expand with the expected maximum increase in temperature as stipulated in relevant statutory rules.

1.2 On account of safety considerations, statutory regulations stipulate basis for arriving at maximum quantity that can be filled in an LPG container. For storage vessels, tank wagon bullets and tank truck bullets, the stipulations laid under 'The Static and Mobile Pressure Vessels (Unfired) Rules, 1981" are applicable. whereas for LPG cylinders the rules covered in 'The Gas Cylinder Rules, 2004 are applicable.

1.3 "The Static & Mobile Pressure Vessels (Unfired) Rules 1981" pertaining to safe-filling of bulk LPG containers, reads as under .

"Filling capacity and filling pressure

(1) Maximum quantity of liquefiable gas filled into any vessel shall be limited by the filling density of the gas, and shall be such that the vessel shall not be liquid full due to expansion of the contents with rise of temperature to 55°C, if vessel is uninsulated or to the highest temperature which the contents are likely to reach in service, it the vessel is refrigerated or insulated. This requirement shall be applicable irrespective of the ambient temperature of the product at the time of filling."

1.4 "The Gas Cylinder Rules, 1981" reads as under 'Cylinders charged with liquefiable gases shall not be filled in excess of the filling ratios specified in IS 3710 for low pressure liquiefiable gases and IS 8866 for high pressure liquefiable gases'.

(Note LPG cylinders fall into category of low-pressure liquefiable gases).

1.5 A vapour space or OUTAGE must be left above the liquid to permit room for expansion under any temperature conditions. In Nigeria Design Pressure or Maximum Working Pressure for filling LPG in cylinders has been fixed at 65°C. Since LPG in liquid form has relatively high co-efficient of expansion (10 times more in case of Butane and 15 times in case of Propane compared to water) and in case sufficient outage is not left in LPG cylinder due to defective cut-oil system/weighing machine, the hydrostatic pressure inside the cylinder would shoot up by 14 to 15 Kg/cm' per 1°C rise in temperature once the container becomes liquid full. This would cause great strain over cylinder body which could burst with normal increase in ambient temperature and release LPG in the surrounding areas, This in turn could instantly form flammable mixture which could spread and get ignited if it reaches a source of ignition which may otherwise be away at a safer distance in the un-licensed premises or even outside the plant area. This could lead . worst possible disaster and the catastrophe that could be caused by such a mishap could well be imagined. It is therefore, imperative. that all possible care Is exercised to avoid overfilling of containers beyond prescribed safe limits.

1.6 Minimum data required to work out safe-filling capacity of a container consists of:

(a) Water capacity ol the container.

(b) Density of liquid LPG to be stored

(c) Filling density as per statutory rules.

The safe capacity of a container depends upon the density of the product to be stored, which in turn depends upon the composition of the LPG to be stored. It is, therefore, imperative that whenever there is change in composition of LPG to be stored, safe tilling quantities should be reworked out and safety gadgets such as fixed-level gauges and high level alarm re-adjusted as per revised safe quantity. This is particularly most important in case of switch over from heavier grade to lighter

grade. It is however assumed that the container in question is designed to suit the vapour pressure of the lighter grade whenever switch-over from heavier grade to lighter grade is made.

1.7 The safe-filling quantities can be worked out either in terms of weight (Kg or MT) or volume (Lts. or KL). Weight method should be used if the container is designed and equipped to be filled by weight (e.g. cylinders, LPG tank truck or LPG tank wagon), using following formula:

W = FR x WC where
W = Safe-filling weight in Kg,
FR = Filling Ratio,
WC = Water capacity of the container in litres.

1.8 Whenever LPG tank wagons or tank trucks are required to be filled on volumetric basis, 'it must be ensured that the quantity so filled is not in excess of the maximum permitted filling density on weight basis when the liquid LPG reaches the temperature of 55°C. Maximum volume of liquid LPG that can be "filled in a vessel at given temperature can be worked out using the following formula

$$V = \frac{FR \times WC}{D \times VRF} \text{ where}$$

Vl = safe maximum volume in Litres at temp. t°C,
FR = Filling Ratio (Refer Table J-2),
WC=Water Capacity of the vessel in Litres,
D =Density@15°C of liquid LPG in Kgs/Litre,
VRF = Volume Reduction Factor for Density D at temp t°C using ASTM - table 54
Based on the above formula, safe maximum volume for a container could be worked out in terms of "percent volume" of the container as under

$$\%Vl = \frac{Vl}{WC} \times 100$$

$$\text{or} = \frac{FR}{D \times VRF} \times 100$$

1.9 To comply with the requirement set out In clause 1.8 above, It is essential to ascertain temperature of liquid LPG at the time of tilling when working out safe filling volume at any particular temperature.

1.10 For the purpose ot computing safe-tilling quantities, insulated vessels to be treated as uninsulated vessels as *far* as IOC's vessels are concerned.

1.11 Various calculations for safe-filling of LPG cylinders/vessels are best understood through the examples given in Clause-1.13.

TABLE J-1

FILUNG RATIOS FOR LPG TO BE FILLED IN LPG CYLINDERS

Liquid LPG Density g/m I @15°C	Filling atio	Liquid LPG Density Filling g/ml Ratio @15°C	Filling Ratio
0.500	0.388	0.560	0.467
0.505	0.396	0.565	0.475
0.510	0.402	0,570	0.480
0.515	0.409	0.575	0.486
0.520	0.415	0.580	0.491
0.525	0.421	0.585	0.498
0.530	0.428	0.590	0.504
0.535	0.435	0.595	0511
0.540	0.442	0.600	0.510
0.545	0.448	0.605	0.520
0.550	0.454	0.610	0.525
0.555	0.462	---	---

NOTE:1. Filling Ratio is based on assumed maximum temperature of 65°C as laid down for LPG Cylinders as per statutory rules.

2. Filling Ratios given above are as per IS 3710-1978 (Filling Ratios for Low Pressure Liquefiable Gases contained in cylinders).

3. In case density of liquid LPG is observed at a temperature other than 15.0°C, it should be converted to 15.0°C with the help of ASTM table 53 before using above table.

TABLE .J-2

MAXIMUM FILLING DENSITIES AND CORRESPONDING MAXIMUM LIQUID CONTENTS IN TERMS OF PERCENTAGE VOLUME OF THE CONTAINER FOR LPG OF VARIOUS DENSITIES AND ABOVEGROUND UNINSULATED CONTAINERS ABOVE 5000 LITERS CAPACITY.

Liquid LPG Density g/Mi @ 15.5°C	Fiiling Ratio	Filling Density`	Maximum LPG volume at 15.5 °C **(%** water capacity)
0.496 - 0.503	0,41	41	81.5
0.504 - 0.510	0.42	42	82.3
0.511 - 0.519	0.43	43	82.8
0.520 - 0.527	0.44	44	83.5
0.528 - 0.536	0.45	45	83.9
0.537 - 0.544	0.46	46	84.3
0.545 - 0.552	0.47	47	85.1
0.553 - 0.560	0.48	48	85.7
0.561 - 0.568	0.49	49	86.3
0.569 - 0.576	0.50	50	86.7
0.577 - 0.584	0.51	51	87.4
0.585 - 0.592	0.52	52	87.8
0.593 - 0.600	0.53	53	86.3

NOTE: 1. Above figures are based on IS 6044 (Part-Il) — 1972.
2. Filling Ratios under column-2 and Filling Density under column-3 are based on assumed maximum temperature of 55°C as laid down for uninsulated above ground containers under statutory rules.
(FD = FR x 100).
3. In case density of liquid LPG is observed at a temperature other than 15.5°C, it should be converted to 15.5°C using ASTM table 53.
4. Density (6D 15.5°C (Density @ 15.0°C 0.0001) approx.

1.12 EXAMPLES :

EXAMPLE: 1

If volumetric capacity of a Horten Sphere is 1418 M3 and LPG to be stored has a density of 0.5430 Kg/Litre @ 15°C, calculate the safe filling capacity for the Horton Sphere in terms of
(a) Metric Tons,
(b) % volume of the total volumetric capacity of the Horton Sphere, at 15°C.

STEP—1
Density of 0.5430 @ 15°C is equal to 0.5429 D 15.5°C.
STEP — 2
As per clause 1.8 of the annexure
W = FR x WC, where;
W = safe-filling weight in Kgs. (to be ascertained),
FR = Filling Ratio; 0.46 (as per table J-2),
WC = Water capacity in Litres, 1418 x 1000 (given),

Therefore, W = 0.46x 1418 x 1000
= 652280 Kgs
or 652.280 MTs. (1000 kgs 1 MT)

STEP—3:
% safe-filing volume against the density of 0.5429 @ 15.5°C (or 0.5430 @ 15°C) is already given in table J-2 as 84 *5%o.*
STEP — 4
% safe-filling volume at 15°C can alternatively be worked out by dividing the safe-filling capacity in MT with the density @ **15°C.**

%V15 = FD FD = 46 from table J-2
D15 D15 = 0.5430 (given)

=46/05430
=84.7%

NOTE **: %** safe-filling volume worked out as per step-4 is more accurate as it takes into account the actual density of the product instead of range of density as is the case for the figures in Table J-2.

EXAMPLE — **2**

An LPG tank wagon having a gross weight of 34.0 MT, tare-weight of 18.8 MT and 33 M3 water capacity is to be loaded on volumetric basis at a temperature of 25°C. The density of LPG to be loaded is 0.5450 Kgs/Litre **@** 15°C. Calculate safe-filling volume at 25°C and safe-filling quantity in MT for the tank wagon.

STEP—i:
Maximum carrying capacity of LPG tank wagon, as permitted by the railways, is the difference of gross weight and tare weight of the tank wagon subject to maximum limit of 15.4 MT. In the present case maximum carrying capacity as per railways would be 15.2 MT (34.0 gross wt. 18.8 tare weight).

STEP — 2

Using formula in clause 1.8 of the annexure it must be verified that the filling ratio for the tank wagon bullet is not exceeded, if the LPG is loaded as per carrying capacity worked out on the basis of Step-i above. In case filling ratio is exceeded based on the carrying capacity, the loading should be limited to safe- filling quantity worked out on the basis of formula in clause 1.8 of the annexure.

Filling ratio in the present case, based on carrying capacity of 15.2 MT

works out to 0.46 (15.2 MT CC ÷ 33 M3 water capacity). This is within the FR of 0.47 shown in table J-2., safe. Filling capacity for the tank wagon, therefore, can be considered as 15.2 MT.

STEP — 3

Using formula given in clause 1,9 of the annexure, safe filling volume at 25°C can be worked out as under

$$V1 = \frac{FR \times WC}{D \times VRF}$$ where;

V1 = Safe max. volume in Litres at 25°C (to be ascertained),
FR = Filling Ratio; 0.47 (from table J-2)
WC = Water Capacity in Litres 33 x 1000 (given),
D = Density @ 15°C; 0.5450 (given),
VRF= Volume Reduction Factor for Density of 0.5450 @ 15°C and temperature 25°C; 0.9760 (from ASTM table — 54).

$$\text{Therefore, VI} = \frac{0.47 \times 33 \times 1000}{0.5450 \times 0.9760} = 29158 \text{ Litres.}$$

EXAMPLE — 3

Volumetric capacity of an LPG tank truck bullet is 22 M3 . LPG having liquid density of 0.5440 Kg/Litre @ 15°C is to be loaded in the tank truck. Calculate the safe vapour space in terms of percentage volume for fixing the fixed level gauge.

STEP—i:

For the purpose of working out safe maximum volume for a "fixed level gauge", the minimum operating temperature should be considered. LPG tank truck bullets are designed for operating temperature range of — 6°C, to (+)55°C, therefore, safe maximum volume should be calculated for **(—)** 6°C in the present case.

STEP — 2

As per formula in clause 1.9 of the annexure

$$Vi = \frac{FR \times WC}{D \times VRF}$$ where;

V1 = Safe max. volume in Litres at temp. (—)6°C, (to be ascertained),
FR = Filling Ratio; 0.46 (from table J-2),
WC = Water Capacity in Litres 22 x 1000 (given),
D = Density @ 15°C; 0.5440 (given),
VRF = Volume Reduction Factor for Density of 0.5440 @15°C and temperature (—)6°C; 1.048 (from ASTM table — 54).

$$\text{Therefore, } V1 = \frac{0.46 \times 22 \times 1000}{0.5450 \times 1.048} = 17751 \text{ Litres.}$$

$$\text{Or \% } V1 = \frac{17751 \times 100}{22 \times 1000} = 80.6\%$$

STEP — 3

Percentage safe vapour space ((-) 6°C would therefore, be

100 — 80.6 = 19.4%

NOTE : In case the "actual" minimum operating temperature is different than the minimum "designed" operating temperature, the % volume could also be worked out as above for the "actual" minimum operating temperature. It must however, be ensured that the "actual" minimum operating temperature is within the temperature range as per design of the bullet.

EXAMPLE — 4:

Calculate the minimum water capacity required for LPG tank truck bullet for carrying 10 MT of LPG, with the assumption that the lowest density of LPG to be transported would be 0.5280 @ 15°C.

STEP— 1:

As per formula given in clause 1.8 of the annexure

W = FRxWC, or,
WC = W / FR ; where
WC = Water capacity in Litres, (to be ascertained),
W = Safe maximum capacity in Kgs; 10 x 1000 (given),
FR = Filling Ratio, 0.45 (as per table J-2).

Therefore, WC $\frac{10 \times 1000}{0.45}$ = 22,222 Litres or 22.3 m3

EXAMPLE — 5:

An LPG tank truck is having a bullet with a volumetric capacity of 13,200 Litres. If it is required to be filled on volumetric basis, calculate the percentage setting for Rotogauge it liquid *LPG* with density of 0.5400 Kg/Litre is to be titled at a temperature of 28°C.

STEP — I

As per formula given in clause 1.9 of the annexure

$V1 = \frac{FR \times WC}{D \times VRF}$; where

V1 = Safe maximum volume in Litres; (to be calculated),
FR = Filling Ratio; 0.46 (as per table J-2),
WC = Water capacity in Litres; 13,200 (given)
D = Density of LPG at 15°C; 0.5400 (given)
VRF = Volume Reduction Factor, based on density of 0.5400 at 15°C and temperature 25°C; 0.967 (from ASTM table 54),

Therefore, $v1 = \frac{0.46 \times 13200}{0.54 \times 0.967}$ = 11628 Litres

or $\%V1 = \frac{11{,}628 \times 100}{13{,}200}$ = 88

NOTE :

(1) As a normal practice, LPG tank trucks are filled on weight basis only.

(2) Whenever the tank truck is filled on volumetric basis, care must be exercised to ensure that

(a) Correct volumetric capacity of the tank truck bullet is known.

(b) The temperature of the product in the tank truck is identical to the temperature for which the safe maximum volume has been calculated. In any case the actual temperature of the product should not be less than the temperature for which the safe maximum volume has been calculated.

(c) The Rotogauge on the tank truck is correctly calibrated and iS in working order. This could be checked against the setting of fixed level-gauge mounted on the tank truck bullet. Further, if the Roto-gauge is functioning properly, readings on left-hand side as well as right hand side of the gauge would be identical when quantity filled in the tank truck is checked.

(3) Even though the tank truck is filed on volumetric basis it is advisable to determine through weigh bridge, the weight of the product loaded to ensure that the weight does not exceed the safe filling weight. This also helps to work out transit loss at unloading point.

EXAMPLE — 6

Calculate safe-filling quantity for cylinder of 33.3 Litres water capacity @ 15.0°C. assuming that the density of LPG to be filled in is 0.550 Kg/Litres @ 15.0°C.

STEP — 1:

As per formula given in clause 1.8 of the annexure
W = FR x WC ; where ;
W = Safe filling quantity in Kgs; (to be ascertained),
FR = Filling Ratio; 0.454 (from Table J-1),
WC = Water capacity in Litres, 33.3 (given),
Therefore, W = 0.454 x 33.3,
= 15.1182 Kg. (say 15 kg.).

ANNEXURE 6

LIST OF DOs AND DON'Ts

	DOs	DON'T's
1.	Adhere to the Dos listed below.	Do not ignore points listed below
2.	Get familiarised with the Glossary of Terms **(Annexure No. 3)**	Do not ignore Statutory Rules and Regulations.
3.	Understand Properties, Characteristics and Hazards of LPG **(Chapter No. 3)**	Do not undertake modifications without proper approvals.
4.	Ensure that all relevant licensees as per Statutory Regulations are available, valid and renewed in time.	Do not undertake any operation without competent supervision.
5.	Comply with the conditions of applicable licenses.	Do not carry out hot work without adequate precautions and hot work permit.
6.	Avoid presence of water and air in LPG system including cylinders. Purge wherever necessary **(Annexure No. 8)**	Do not start any LPG operation without proper grounding and bonding arrangement.
7.	Wear protective gloves / clothing at vulnerable points of liquid exposure.	Do not enter into a storage vessel until all connecting lines are disconnected, blanked-off, vessel thoroughly purged of residual gases and certified Gas Free' in writing by a competent person.
8.	Familiarise with (i) Common sources of leakage; (ii) Common sources of ignition; (iii) Common sources of fire.	Do not commission plant or a facility without detailed inspection and all applicable licenses and certificates.
9.	Avoid venting of LPG to	Do not use LPG system for the grade

	DOs	DON'T's
	atmosphere	having higher vapour pressure than that of the grade for which it was designed.
10.	Drain water from storage vessels regularly and carefully.	Do not fill any container beyond its safe filling capacity.
11.	Ensure good house-keeping	Do not use LPG system for the grade having higher vapour pressure than that of the grade for which it was designed.
12.	Strictly enforce "NO SMOKING" within the plant area.	Do not use pressurized system beyond its due date of re-testing
13.	Discontinue operation at the first sign of major leak.	Do not place any part of the body over a slip tube device nor over the discharge end of a pressure relief valve.
14.	Ensure all plant personnel are familiar with the knowledge of action in emergencies.	Do not expose hands, face or any part of the body to liquid
15.	Report accidents as per laid down procedures and investigate causes.	LPG without protective clothing / equipment.
16.	Conduct regular Safety Audit of the Plant to eliminate hazards.	Do not carry out any operation after daylight unless adequate flame-proof lighting arrangement is provided,
17.	Prepare and display 'Fire Fighting Organization Plan' at prominent	Do not drain water from storage vessel without provision of double valve on the water drain.
18.	locations in the plant ensuring that all concerned understand their role and responsibility clearly.	Do not bang or roll the cylinders during loading / unloading and handling operations.
19.	Check fire protection and safety devices regularly.	Do not store filled cylinders or cylinders containing LPG vapour in open.
20.	Maintain liaison with Local Fire Brigade and involve them in regular exercises.	Do not vent out cylinder contents to atmosphere at plant.
21.	Maintain proper records of fire drills, checks, incidents, accidents etc.	Do not dispose off condemnedcylinders as scrap unless they are de- shaped by pressing and marked as de-faced.
22.	Ensure periodic checking of	Do not store empty and filled cylinders

	DOs	DON'T's
	pressure relief valves	beyond stacking or the licensed capacity, whichever is less.
23.	Before filling LPG tank truck, ensure that valid CCOE's license is available and the receiving location has a storage license.	Do not throw cylinders from a height.
24.	Check tightness of hose connections for tank wagon and tank truck operations with soap solution by only cracking the valve initially.	Do not send cylinders to the repairers without making them gas-free.
25.	Always replace caps and plugs of transfer connections ensuring that they are leak free.	Do not leave any over-filled / leaky cylinder at the close of working hours.
26.	Ensure that the receiving vessel has sufficient ullage before discharging tank wagons or tank trucks.	Do not transport filled cylinders by rail.
27.	Apply chock blocks on tank wagons and tank trucks during operation.	Do not use stake trucks for
28.	Disconnect LPG hoses from tank wagons and tank trucks during prolonged suspension of operation.	cylinder transportation which do not meet basic safety requirements.
29.	Place caution signs on railway siding, whenever theoperation is on.	Do not transport leaky cylinders.
30.	Keep the sealing material away	Do not transport LPG cylinders with other goods.
31.	from the end of the threads, while making any threaded connection.	Do not use lifting magnet for loading of cylinders.
32.	Maintain operating log for commissioning /decommissioning of storage	Do not fill a cylinder whose due date of testing has expired.

	DOs	DON'T's
	vessels and all other important operations within the plant.	
33.	Educate tank truck drivers for over the road procedure, parking during transit, vehicle parking in the plant, vehicle garaging, vehicle repairing, emergencies in transit, accident reporting	Do not dip cylinder valve threads into a sealing compound.
34.	Ensure strict checks for segregation of cylinders due for statutory testing.	Do not use LPG hose beyond its due date of testing.
35.	Ensure correct tare weight marking and check for presence of water, at random, specifically in case of new cylinders, cylinders returning from testing plants and repairers.	Do not attempt sampling of LPG unless proper sampling arrangement exists, concerned person is trained for the job, sampling is required for a specific purpose and authorized by SO/RO/HO.
36.	Ensure test for 'O'-ring of filled cylinders with SC type valve, using dummy regulators or CVT.	Do not continue operations if safety / fire protection devices are rendered ineffective.
37.	Ensure that water / dust from the cavity of the 'SC' type valve outlet is blown using air pressure.	Do not allow entry of vehicles not conforming to statutory requirements.
38.	Ensure use of conveyor system to the maximum.	Do not release the truck loaded with filed cylinders unless check is carried out with Explosimeter and readings are within permissible limits.
39.	Ensure 100% check weighing of filled LPG cylinders.	Do not compromise on any norm governing safety.
40.	Use portable trolleys within the plant for transporting cylinders in vertical position and to avoid rolling wherever use of conveyor is not practicable.	Do not allow unauthorised / untrained persons when unsafe condition is noticed.

	DOs	DON'T's
41.	Ensure cylinders are evacuated before filling in case of filling through machines operating on 'Tare-Off' system.	Do not leave any LPG operation unattended.
42.	Use evacuation units for evacuating contents from leaky / defective cylinders.	Do not continue LPG operation, if any leak or unsafe condition is noticed
43.	Ensure security nut on the cylinder valve outlet is fixed at all times except for the duration when removal is necessary for any specific operation.	Do not allow weed / vegetation to grow in yard area.
44.	Leave adequate pathways around stacks of cylinders for easy detection and removal of leaky cylinders.	Do not stack filled cylinders horizontally.
45.	Minimise manual handling of cylinders as far as practicable.	Do not allow rough handling or filled / empty cylinders.
46.	Earmark storage areas for different categories of cylinders and provide proper sign boards for identification of each stack.	Do not despatch any filled cylinder without proper valve protection seal and neck-label.
47.	Stack filled cylinders vertically only.	Do not ignore liquid-equivalent of vapor quantities while accounting LPG bulk stocks.
48.	Evacuate leaky and overfilled cylinders on priority.	Do not allow accumulation of vapour in plant area, especially in low lying areas such as drains, sumps, etc.,
49.	De-pressure the cylinder before valve removal.	Do not carry out cylinder repairs in the filling- shed.
50.	Use proper clamp / vice for holding the cylinder at the time of valve removal / fixing	Do not carry out water draining operation in dark hours.
51.	Inspect critical area around internal periphery of the foot	Do not open back cover of the truck and cross bars used in the truck for

	DOs	DON'T's
	ring during visual inspection and painting operation of LPG cylinders.	supporting the cylinders prior to parking of the truck.
52.	Verify the due date of testing at the test plant, before undertaking the testing operations.	Do not roll cylinders on belly for faster unloading of cylinders.
53.	Examine defective valves carefully for retrieval-worthy condition before sending for retrieval.	Do not start unloading operation, without counting the numbers by supervisor.
54.	Maintain proper records at all stages of operations.	Do not drop cylinders from a height during unloading operations .
55.	Ensure test certificate is issued for cylinders tested at the Statutory testing plant.	Do not start the truck till the back cage cover is closed and locked.
56.	Follow inspection and maintenance schedules strictly.	Do not attempt lubrication of carousel filling guns when carousel is in operation as it may lead to oil spillage.
57.	Test LPG hoses at stipulated intervals.	Do not lubricate the running rail.
58.	Measure, calculate andrecord all stocks care-fully, accurately, regularly and in conformity with standard procedures.	Do not tamper with speed of rotation of carousel.
59.	Investigate promptly, any abnormal loss or gain.	Do not bypass gas stop valve under any circumstances.
60.	Keep close watch on pressure and temperature in the storage / transport vessels during operation.	Do not remove or introduce cylinders either after encoding or before check
61.	Ensure training for all regular employees within the plant and all others associated with the plant working such as truck crew/ contract labourers.	scale in electronic carousal system as it disturbs the sequence

	DOs	DON'T's
62.	Ensure strict security checks at the gate to prevent unauthorised entry and carrying of match box, cigarette lighters or any other source of ignition.	Incase of cylinders struck up at check scale platform do not forcibly pull or drag the cylinders.
63.	Ensure display of identity badge for each person within the plant.	No jet of water/air should be used to clean the surrounding floor which may lead to water seepage to load cell check scale and junction boxes.
64.	Place proper caution signs at the gate and all other vulnerable locations within the plant.	Do not tamper settings of electronic check scale.
65.	Enforce random checks by frisking of persons by authorised officers to ensure that they are not in possession of any items which may provide a source of ignition.	Do not allow dust accumulation around electronic parts.
66.	Maintain copies of all Manuals, applicable Statutory rules, manufacturers instructions for operations/ maintenance / inspection, etc. Secure them in plant library.	Do not increase the rejection range from 0.5 gm/hr
67.	Keep fire fighting equipment in good order and condition, ready for immediate use at all times.	Do not allow air leaks from the pneumatic hoses.
68.	Conduct fire drills atleast once in a month.	Do not use oil other than Kerosene.
69.	Conduct checks for gas leakage through Explosimeter at all vulnerable points within the plant on daily basis.	Do not allow gap between cylinders while entering test bath, to avoid falling of cylinder.
70.	Ensure periodic earthling test.	Do not allow filling of evacuation vessel more than 85%.

	DOs	DON'T's
71.	Ensure proper colour coding of pipelines and valves.	Do not keep leaky cylinders unevaluated at the end of the shift.
72.	Ensure daily draining of 'air compressor' tanks.	Do not use non standard tools for evacuating cylinders having pin struck / broken valves
73.	Ensure proper cushioning on cylinder storage / filling shed flooring.	Do not remove valves with out properly clamping the cylinders.
74.	Provide and maintain first-aid kits at strategic locations.	Do not keep cylinders haphazardly near the valve ON/OFF screw machine.
75.	Conduct hydrostatic stretch test instead of hydrostatic test at the time of third Statutory re-testing. Ensure supports of Horton Sphere are encased in cement concrete.	Do not over tighten the valve.
76.	Ensure one of the ends of bullet supports has provision for sliding.	Do not use worn out head for screw and unscrewing of valves as it may damage hexagonal portion of the valves.
77.	Provide effective communication system (PA/Paging) in the plant, ensuring that the system is Flame-Proof within licensed area.	Do not leave any serviceable cylinderwith open bung after removal of the valve.
78.	Replace dirty water in cylinder test baths with clean water.	Do not roll the cylinders on belly.
79.	Paint interior surface of test baths with white paint and provide adequate lighting (FLP) for better visibility of leaks.	Do not store filled cylinders beyond the licensed capacity.
80.	Keep the water drain connection of storage vessels locked and sealed when not in us.	Do not stack filled cylinders horizontally.
81.	Do set maximum inventory levels for the stocks of filled	Do not allow rough handling of filled cylinders.

	DOs	DON'T's
	and empty cylinders individually as well as maximum inventory level for combined stock of filled and empty cylinders as per norms.	
82.	Unloading of serviceable empty cylinders should be made at unloading platforms only.	
83.	Trucks should be securely parked with hand brake and gear.	
84.	Engine should be put off and master cut off switch should be isolated prior to any unloading operations.	
85.	The unloading contract labourers should wear shoes and hand gloves.	
86.	Telescopic conveyers should be used to unload the cylinders.	
87.	Cylinders while unloading should be handled carefully without dropping or rolling.	
88.	Ensure oil level in FRL & Hydraulic oil tank prior to starting the carousel.	
89.	Ensure filling heads are properly earthed.	
90.	Any leak of LPG from filling head to be attended immediately.	
91.	Monitor pressure of LPG &Air for the accuracy of filling.	
92.	Ensure carousel is interlocked with vapour extraction unit.	
93.	Accuracy of the electronic	

	DOs	DON'T's
	filling machine are to be checked in intervals of every four hours & maintain records.	
94.	Filling hoses should be tested periodically, once in four months.	
95.	Only stamped and certified scales by Dept. of Legal Metrology should be used.	
96.	Accuracy of check scaleshould be checked at aninterval of every 2 Hrs by standard weight.	
97.	Adequate air pressure should be maintained	
98.	FRL need to be checked for oil level and cleaning of the filter element.	
99.	The maximum limit of rejection at check scale should be within +200/-100 grams.	
100	Always keep the kerosene chamber clean in CVT. Replace if required.	
101	Ensure CVT Clamping properly on the cylinder valve.	
102	CVT should be periodically checked with the CVT verifier and also after any repair to the CVT.	
103	AVTS/GD-PD should be calibrated weekly with comparator and checked for functioning at both rejection level of 0.5 gm/hr and also at acceptable level say 0.3 gm/hr	
104	Ensure air pressure between 5-6 Kg/sq cm.	

	DOs	DON'T's
105	Re-check 'O' ring effectivenss after replacement.	
106	Ensure the water level in the bath for complete immersionup to the bung level of cylinders.	
107	Ensure clean water in the bath. Evacuate the leaky cylinders immediately.	
108	Use cold flare line to vent out residual LPG.	
109	Ensure proper earthing of evacuation adopters.	
110	Ensure proper stacking of leaky cylinders.	
111	Ensure capping of cylinders before and after the evacuation Handle the cylinders in vertical position at all stages of loading .	
112	Attend leaky adapters immediately.	
113	LPG hoses should be tested periodically once in 4 months.	
114	Ensure cylinders are depressurised before removing the valve.	
115	Do not change the valve for bung defect cylinders unless the valve thread found to be damaged.	
116	Check the torque setting ofthe machine in the beginning of the shift and also every two hours with a torque wrench.	
117	Ensure bung cleaning and checking before fixing of	

	DOs	DON'T's
	valve .	
118	Ensure proper application of thread sealant.	
119	Use portable trolley for cylinder movement inside the plant, if conveyor is not available.	
120	Store cylinders vertically only, within the plant shed.	
121	Ensure safety cap is fitted on all cylinders stored in the plant.	
122	Ensure different categories of cylinderslike(filled, serviceable empty /ST due, new etc), with Identity Boards.	
123	Separate tags should be maintained for 14.2 Kg, 19 Kg, , 5 Kg and 47.5 Kg cylinders.	
124	Ensure de-gassing of unserviceable cylinders.	
125.	Handle the cylinders in vertical position at all stages of loading .	
126.	Trucks should be properly parked keeping on the gear and hand brake with ignition 'OFF' and key removed.	
127.	Fire extinguishers of the trucks should be taken out of the cabin and position suitably for easy access, in case of emergency .	
128.	Use of personal protective clothing like hand gloves, shoes, helmets etc should be ensured.	
129	Use Telescopic conveyer for loading cylinders on to the	

	DOs	DON'T's
	truck.	
130	Ensure positioning of wooden crossbars for supporting of cylinders and back cover are closed and locked prior to movement of the truck from the loading platform.	

ANNEXURE 7

BAY WISE CHECKLIST BEFORE START & AFTER COMPLETION OF TLD/TLF OPERATION

Date: Batch No. Name Of Plant

PART-1 BEFORE START

For Part 1- S.No 3-10 & Part 2 S.No 2-9 If OK-"Y" Not OK-N"

S.	CHECKPOINT	BAY1	BAY2	BAY3	BAY4	BAY5	BAY6
1	TT NO						
2	Record Pressure (psi) / Temp ^{o}C						
3	Rotogauge Readiing						
4	Master cut-off switch in Off Position & Hand Brakes applied						
5	TT Fire Extinguisher placed in front of the vehicle						
6	Wheel chokes placed at front and back tyre						
7	Ignition Keys of TT handed over by driver to workman and kept in the key box under lock and key by the Workman						
8	Earthing connectors connected to chassis and Tank						
9	Unloading arms/ Hoses connected to TT flange through SS metallic gaskets and eight nos. studs and nuts and bonding of flange done. No CAF/Rubber/Non metallic gaskets used						
10	No LPG leakage from flange/coupling/swivel joint.						

Unloading/Loading started at (in 24 hr. format						
Driver Signature						
Signature of Workman						

PART-2- AFTER COMPLETION AND BEFORE HANDING OVER THE KEYS

S.No	CHECKPOINT	BAY-1	BAY-2	BAY-3	BAY-4	BAY5	BAY-6
1	Record Pressure in psi / Temp (^{o}C)						
2	TT valve and manifold valves closed						
3	Unloading/Loading arm/hoses depressurized						
4	Arm/Hoses and couplings disconnected and kept at designated place. Open ends are capped						
5	Earthing cables disconnected and placed/fixed at designated place						
6	Choke Blocks removed and kept at designated place						
7	TT Fire extinguishers put back on the TT						
8	Gaskets & studs issued by Plant, if any, are returned						
9	The Area around the Vehicle is Gas Free						

Keys handed over at (Time in 24 hr. format)						
Driver Signature						
Signature of Workman						

ANNEXURE 8

PURGING

8.1 GENERAL

8.1.1 Presence of air in any LPG system; be it a storage vessel, pipeline, transport vessel, or a Cylinder; is undesirable. Therefore, necessary to remove air from LPG systems before filling it with LPG. The process of replacement of air in a closed containers/system by LPG vapour, using safe methods, is known as 'purging into service" commonly referred as "purging".

8.1.2 Presence of LPG vapour in a container/system is equally undesirable from safely point of view if it is to be opened up for inspection, maintenance or repair. In this case LPG vapour has to be displaced by water followed by air or directly by inert gas. This process is known as "purging out of service".

8.1.3 The objective of purging containers/systems "into service" or "out of service" is to reach "end-point" where the concentration in percentage by volume of LPG vapour in the closed system being purged "into service" or of inert substance if "purging out of service" will not result in the formation of an explosive mixture.

8.1.4 "Purging into service" is normally required in the following cases
(a) Commissioning new containers/systems.
(b) Re-commissioning containers/systems after repairs or pneumatic test,
(c) Any eventuality when the container/system is de-pressurised and exposed to atmosphere.

8.1.5 As the term itself suggests, "purging out of service" is required when LPG container/system is required to be taken out of service for inspection, maintenance, repairs or any other purpose.

8.1.6 Purging procedures for following systems are covered
(a) Storage vessels and connected pipelines.
(b) LPG tank trucks.
(c) LPG tank wagons.
(d) LPG cylinders.

8.2 PURGING OF LPG TANK WAGONS

8.2.1 PURGING INTO SERVICE

8.2.1.1 Once new tank wagons are ready they are sent to refinery points for loading. However, before actual loading, they are required to be "purged into service",

8.2.1.2 The normal method of "purging" using water to displace air and LPG vapour to displace water is not practicable in case of LPG tank wagons in drain connection at bottom of the tank wagon bullet. In view of this, the procedure described in Clause 8.2.1.3. below is followed.

8.2.1.3 Approximately 50 Kg. of liquid LPG is tilled into the tank wagon initially and vapour released to the atmosphere gradually using sate venting means. Again 200 kg. of liquid LPG is tilled thereafter and similarly released to the atmosphere using safe venting means. The tank wagon is thereafter ready for loading.

8.3 PURGING OUT OF SERVICE

8.3.1 Inspection, maintenance and repair of LPG tank wagons is done by the railways who take care to purge the tank wagons "out of service" before attempting inspection, maintenance or repair.

8.4 PURGING OF LPG CYLINDERS

8.4.1 (a) A set of cylinders to be purged(the number can vary depending upon the requirement) is connected to air-line manifold which in turn is connected to suction side of a vacuum pump.
(b) Vacuum pump is started. The air is sucked from all the connected cylinders simultaneously. The delivery side of the vacuum pump is connected to a suitable sate venting system.
a) As soon as pressure on the suction side of the vacuum pump reaches the level of (- 0.65 kg/cm?/(-)494 mm Hg (indicated through pressure gauge mounted on the air-line manifold. This gauge pressuire is equivalent to 0.35 kg/cm^2 absolute) air-line connections are closed and vacuum pump suction switched over to next batch of cylinders which are kept connected.
(d) Control valve on LPG vapour line is opened to allow entry of LPG vapours into the cylinders from filled LPG cylinder connected to LPG line (or LPG vapour line directly). Once positive pressure (minimum 1.0 kg/cm2) is attained

within the cylinders, LPG vapour supply is cut-off and the cylinders are disconnected which can thereafter be used for LPG filling. (e) The cycle is repeated for the next batch of cylinders.

8.5 PURGING OUT OF SERVICE

8.5.1 Cylinders must be purged out of service under following circumstances
(a) Before sending for hot repairs
(b) Before statutory testing
(c) Before de-shaping scrapped cylinders.

8.5.2 In case of hot repairs. assurance must be gained that the cylinder is "gas-free" before attempting the repairs.

8.5.3 Most common method for purging the cylinders 'out of service" is to remove the cylinder valve, fill the cylinder with water allowing to over-flow and keep the water filled for minimum one hour before draining.

As an alternative method, inert gas (e.g. Nitrogen) could be used to purge the cylinders out of service. The equipment and procedure would be similar to the one for "purging into service" described in clause 8.2.1 above with the exception that the nitrogen cylinder is connected to gas-line instead for LPG cylinder. Further, after completion of introduction of Nitrogen into the cylinders, the cylinders are inverted, and the cylinder valve slightly opened to allow escape of remnant LPG vapours, if any.

ANNEXURE 9

1. CALIBRATION CHART FOR TANK WAGONS (4 – WHEELER)

Overall Length of Wagon ... 8350
Diameter of Wagon ... 2300
Length of cylindrical portion ... 7200
Density of LPG ... 0.540

CALIBRATION CHART FOR TANK WAGONS

Dip (mm)	Volume (in m3)	Mass (in MT)	Dip (mm)	Volume (in m3)	Mass (in MT)
0	0.0000	0.000	2300	32.5007	17.550
10	0.0147	0.008	2290	32.4860	17.542
20	0.0413	0.022	2280	32.4594	17.528
30	0.0759	0.041	2270	32.4248	17.509
40	0.1163	0.063	2260	32.3844	17.488
50	0.1626	0.088	2250	32.3381	17.463
60	0.2138	0.115	2240	32.2869	17.435
70	0.2695	0.146	2230	32.2312	17.405
80	0.3293	0.178	2220	32.1714	17.373
90	0.3930	0.212	2210	32.1077	17.338
100	0.4603	0.249	2200	32.0404	17.302
110	0.5310	0.287	2190	31.9697	17.264
120	0.6050	0.327	2180	31.8957	17.224
130	0.6821	0.368	2170	31.8186	17.182
140	0.7622	0.412	2160	31.7385	17.139
150	0.8452	0.456	2150	31.6555	17.094
160	0.9309	0.503	2140	31.5698	17.048
170	1.0194	0.550	2130	31.4813	17.000
180	1.1104	0.600	2120	31.3903	16.951
190	1.2039	0.650	2110	31.2968	16.900
200	1.2998	0.702	2100	31.2009	16.848
210	1.3981	0.755	2090	31.1026	16.795
220	1.4987	0.809	2080	31.0020	16.741

Dip (mm)	Volume (in m3)	Mass (in MT)	Dip (mm)	Volume (in m3)	Mass (in MT)
230	1.6015	0.865	2070	30.8992	16.686
240	1.7065	0.922	2060	30.7942	16.629
250	1.8136	0.979	2050	30.6871	16.571
260	1.9228	1.038	2040	30.5779	16.512
270	2.0339	1.098	2030	30.4667	16.452
280	2.1482	1.160	2020	30.3525	16.390
290	2.2633	1.222	2010	30.2374	16.328
300	2.3802	1.285	2000	30.1205	16.265
310	2.4990	1.349	1990	30.0017	16.201
320	2.6195	1.415	1980	29.8812	16.136
330	2.7418	1.481	1970	29.7589	16.070
340	2.8659	1.548	1960	29.6348	16.003
350	2.9915	1.615	1950	29.5092	15.935
360	3.1189	1.684	1940	29.3818	15.866
370	3.2478	1.754	1930	29.2529	15.797
380	3.3783	1.824	1920	29.1224	15.726
390	3.5103	1.896	1910	28.9904	15.655
400	3.6439	1.968	1900	28.8568	15.583
410	3.7789	2.041	1890	28.7218	15.510
420	3.9154	2.114	1880	28.5853	15.436
430	4.0532	2.189	1870	28.4475	15.362
440	4.1925	2.264	1860	28.3082	15.286
450	4.3331	2.340	1850	28.1676	15.210
460	4.4751	2.417	1840	28.0256	15.134
470	4.6184	2.494	1830	27.8823	15.056
480	4.7629	2.572	1820	27.7378	14.978
490	4.9087	2.651	1810	27.5920	14.900
500	5.0558	2.730	1800	27.4449	14.820
510	5.2040	2.891	1780	27.1473	14.660
530	5.5040	2.972	1770	26.9967	14.578
540	5.6557	3.054	1760	26.8450	14.496
550	5.8085	3.137	1750	26.6922	14.414
560	5.9624	3.220	1740	26.5383	14.331
570	6.1173	3.303	1730	26.3834	14.247
580	6.2733	3.472	1710	26.0704	14.078
600	6.5883	3.558	1700	25.9124	13.993
610	6.7473	3.644	1690	25.7534	13.907

Dip (mm)	Volume (in m3)	Mass (in MT)	Dip (mm)	Volume (in m3)	Mass (in MT)
620	6.9072	3.730	1680	25.5935	13.820
630	7.0681	3.817	1670	25.4326	13.734
640	7.2299	3.904	1660	25.2708	13.646
650	7.3925	3.992	1650	25.1082	13.558
660	7.5561	4.080	1640	24.9446	13.470
670	7.7205	4.169	1630	24.7802	13.381
680	7.8840	4.257	1620	24.6167	13.293
690	8.0500	4.347	1610	24.4507	13.203
700	8.2169	4.437	1600	24.2838	13.113
710	8.3844	4.528	1590	24.1163	13.023
720	8.5528	4.618	1580	23.9479	12.932
730	8.7218	4.710	1570	23.7788	12.841
740	8.8916	4.801	1560	23.6091	12.749
750	9.0621	4.894	1550	23.4386	12.657
760	9.2333	4.986	1540	23.2674	12.564
770	9.4051	5.079	1530	23.0956	12.472
780	9.5776	5.172	1520	22.9231	12.378
790	9.7506	5.265	1510	22.7501	12.285
800	9.9243	5.359	1500	22.5764	12.191
810	10.0986	5.453	1490	22.4021	12.097
820	10.2735	5.548	1480	22.2272	12.003
830	10.4489	5.642	1470	22.0518	11.908
840	10.6248	5.737	1460	21.8759	11.813
850	10.8012	5.833	1450	21.6995	11.718
860	10.9782	5.928	1440	21.5225	11.622
870	11.1556	6.024	1430	21.3451	11.526
880	11.3335	6.120	1420	21.1672	11.430
890	11.5118	6.216	1410	20.9889	11.334
900	11.6906	6.313	1400	20.8101	11.237
910	11.8698	6.410	1390	20.6309	11.141
920	12.0493	6.507	1380	20.4514	11.044
930	12.2293	6.604	1370	20.2714	10.947
940	12.4096	6.701	1360	20.0911	10.849
950	12.5903	6.799	1350	19.9104	10.752
960	12.7712	6.896	1340	19.7295	10.654
970	12.9525	6.994	1330	19.5482	10.556
980	13.1341	7.092	1320	19.3666	10.458
990	13.3160	7.191	1310	19.1847	10.360

Dip (mm)	Volume (in m3)	Mass (in MT)	Dip (mm)	Volume (in m3)	Mass (in MT)
1000	13.4981	7.289	1300	19.0026	10.261
1010	13.6805	7.387	1290	18.8202	10.163
1020	13.8631	7.486	1280	18.6376	10.064
1030	14.0459	7.585	1270	18.4548	9.966
1040	14.2289	7.684	1260	18.2718	9.867
1050	14.4121	7.783	1250	18.0886	9.768
1060	14.5955	7.882	1240	17.9052	9.669
1070	14.7790	7.981	1230	17.7217	9.570
1080	14.9626	8.080	1220	17.5381	9.471
1090	15.1464	8.179	1210	17.3543	9.371
1100	15.3302	8.278	1200	17.1705	9.272
1110	15.5141	8.378	1190	16.9866	9.173
1120	15.6981	8.477	1180	16.8026	9.073
1130	15.8821	8.576	1170	16.6186	8.974
1140	16.0662	8.676	1160	16.4345	8.875
1150	16.2503	8.775	1150	16.2503	8.775

ANNEXURE 9 (cont'd)

2. CALIBRATION CHART FOR TANK WAGONS (8 – WHEELER)

Overall Length of Wagon ... 17960
Diameter of Wagon ... 2400
Length of cylindrical portion ... 16760
Density of LPG ... 0.540

Dip (mm)	Volume (in m3)	Mass (in MT)	Dip (mm)	Volume (in m3)	Mass (in MT)
0	0.0000	0.000	2400	78.7571	42.529
10	0.0348	0.019	2390	78.7223	42.510
20	0.0982	0.053	2380	78.6590	42.476
30	0.1800	0.097	2370	78.5771	42.432
40	0.2757	0.149	2360	78.4814	42.380
50	0.3852	0.208	2350	78.3719	42.321
60	0.5062	0.273	2340	78.2509	42.256
70	0.6375	0.344	2330	78.1196	42.185
80	0.7785	0.420	2320	77.9787	42.108
90	0.9283	0.501	2310	77.8288	42.028
100	1.0866	0.587	2300	77.6705	41.942
110	1.2527	0.676	2290	77.5044	41.852
120	1.4264	1.074	2250	76.7681	41.455
160	2.1896	1.182	2240	76.5676	41.346
170	2.3961	1.294	2230	76.3610	41.235
180	2.6086	1.409	2220	76.1485	41.120
190	2.8267	1.526	2210	75.9304	41.002
200	3.0503	1.647	2200	75.7069	40.882
210	3.2791	1.771	2190	75.4780	40.758
220	3.5132	1.897	2180	75.2439	40.632
230	3.7522	2.026	2170	75.0049	40.503
240	3.9961	2.158	2160	74.7610	40.371
250	4.2448	2.292	2150	74.5124	40.237
260	4.4980	2.429	2140	74.2591	40.100
270	4.7557	2.568	2130	74.0014	39.961
280	5.0204	2.711	2120	73.7367	39.818
290	5.2868	2.855	2110	73.4703	39.674

Dip (mm)	Volume (in m3)	Mass (in MT)	Dip (mm)	Volume (in m3)	Mass (in MT)
300	5.5574	3.001	2100	73.1997	39.528
310	5.8320	3.149	2090	72.9251	39.380
320	6.1106	3.300	2080	72.6465	39.229
330	6.3931	3.452	2070	72.3641	39.077
340	6.6793	3.607	2060	72.0778	38.922
350	6.9692	3.763	2050	71.7879	38.765
360	7.2628	3.922	2040	71.4943	38.607
370	7.5599	4.082	2030	71.1972	38.446
380	7.8605	4.245	2020	70.8966	38.284
390	8.1645	4.409	2010	70.5927	38.120
400	8.4717	4.575	2000	70.2854	37.954
410	8.7823	4.742	1990	69.9749	37.786
420	9.0960	4.912	1980	69.6611	37.617
430	9.4128	5.083	1970	69.3443	37.446
440	9.7327	5.256	1960	69.0245	37.273
450	10.0555	5.430	1950	68.7016	37.099
460	10.3813	5.606	1940	68.3758	36.923
470	10.7099	5.783	1930	68.0472	36.745
480	11.0414	5.962	1920	67.7157	36.566
490	11.3756	6.143	1910	67.3815	36.386
500	11.7125	6.325	1900	67.0446	36.204
510	12.0520	6.508	1890	66.7051	36.021
520	12.3941	6.693	1880	66.3630	35.836
530	12.7388	6.879	1870	66.0183	35.650
540	13.0859	7.066	1860	65.6712	35.462
550	13.4355	7.255	1850	65.3216	35.274
560	13.7874	7.445	1840	64.9697	35.084
570	14.1417	7.637	1830	64.6154	34.892
580	14.4982	7.829	1820	64.2589	34.700
590	14.8570	8.023	1810	63.9001	34.506
600	15.2180	8.218	1800	63.5391	34.311
610	15.5811	8.414	1790	63.1760	34.115
620	15.9463	8.611	1780	62.8108	33.918
630	16.3136	8.809	1770	62.4436	33.720
640	16.6828	9.009	1760	62.0743	33.520
650	17.0541	9.209	1750	61.7031	33.320
660	17.4272	9.411	1740	61.3299	33.118

Dip (mm)	Volume (in m3)	Mass (in MT)	Dip (mm)	Volume (in m3)	Mass (in MT)
670	17.8022	9.613	1730	60.9549	32.916
680	18.1753	9.815	1720	60.5818	32.714
690	18.5540	10.019	1710	60.2031	32.510
700	18.9344	10.225	1700	59.8228	32.304
710	19.3165	10.431	1690	59.4406	32.098
720	19.7002	10.638	1680	59.0569	31.891
730	20.0857	10.846	1670	58.6715	31.683
740	20.4727	11.055	1660	58.2845	31.474
750	20.8612	11.265	1650	57.8959	31.264
760	21.2513	11.476	1640	57.5058	31.053
770	21.6429	11.687	1630	57.1143	30.842
780	22.0359	11.899	1620	56.7213	30.629
790	22.4303	12.112	1610	56.3269	30.417
800	22.8260	12.326	1600	55.9311	30.203
810	23.2231	12.540	1590	55.5340	29.988
820	23.6215	12.756	1580	55.1356	29.773
830	24.0212	12.971	1570	54.7360	29.557
840	24.4220	13.188	1560	54.3351	29.341
850	24.8241	13.405	1550	53.9330	29.124
860	25.2273	13.623	1540	53.5298	28.906
870	25.6316	13.841	1530	53.1255	28.688
880	26.0370	14.060	1520	52.7201	28.469
890	26.4434	14.279	1510	52.3137	28.249
900	26.8509	14.499	1500	51.9063	28.029
910	27.2593	14.720	1490	51.4978	27.809
920	27.6686	14.941	1480	51.0885	27.588
930	28.0789	15.163	1470	50.6782	27.366
940	28.4900	15.385	1460	50.2671	27.144
950	28.9020	15.607	1450	49.8551	26.922
960	29.3148	15.830	1440	49.4423	26.699
970	29.7284	16.053	1430	49.0287	26.476
980	30.1427	16.277	1420	48.6144	26.252
990	30.5577	16.501	1410	48.1994	26.028
1000	30.9734	16.726	1400	47.7837	25.803
1010	31.3897	16.950	1390	47.3674	25.578
1020	31.8066	17.176	1380	46.9505	25.353
1030	32.2241	17.401	1370	46.5330	25.128

Dip (mm)	Volume (in m3)	Mass (in MT)	Dip (mm)	Volume (in m3)	Mass (in MT)
1040	32.6421	17.627	1360	46.1150	24.902
1050	33.0607	17.853	1350	45.6964	24.676
1060	33.4797	18.079	1340	45.2774	24.450
1070	33.8992	18.306	1330	44.8579	24.223
1080	34.3191	18.532	1320	44.4380	23.997
1090	34.7394	18.759	1310	44.0177	23.770
1100	35.1600	18.986	1300	43.5971	23.542
1110	35.5810	19.214	1290	43.1761	23.315
1120	36.0022	19.441	1280	42.7549	23.088
1130	36.4237	19.669	1270	42.3334	22.860
1140	36.8453	19.896	1260	41.9118	22.632
1150	37.2673	20.124	1250	41.4898	22.405
1160	37.6894	20.352	1240	41.0678	22.177
1170	38.1114	20.580	1230	40.6457	21.949
1180	38.5336	20.808	1220	40.2236	21.721
1190	38.9560	21.036	1210	39.8011	21.493
1200	39.3786	21.264	1200	39.3786	21.264

ANNEXURE 10

FORMAT FOR GAUGE BOOK

PAGE NO.

TOTAL NO OF PAGES IN THE GAUGE BOOK

DATE : MONTH :

YEAR : PRODUCT : LPG

Time	Storage Vessel	Opening Gauge Reading	LPG Liquid – Qty (MT)	Pressure	Temp	Density	Remarks
	1.						
	2						
	3						
	4						
	5						
	6						

Note : Water draining should be carried out before the commencement of operation and should be recorded in "Remarks" column.

Separate Gauge book to be maintained for every month, duly serially numbered.

Shift Officer's Signature

Plant Manager Signature

ANNEXURE 11

QUANTITY OF LPG IN A 14.2 KG CYLINDER

What is the quantity of LPG required for vapour filling inside a cylinder of 33.3 ltrs. capacity having a vapour content at a temperature of 30.°C and a pressure of 2 Kgs/ cm^2

Find the liquid equivalent of the vapour. Density of liquid LPG is 0.56 kg/litres.

Step : 1

Vapour volume = 33.3 litres.

Step : 2

Convert the vapour volume at 30°C and 1.5 Kg/ cm^2 pressure to NTP (i.e. Normal Temperature and pressure where normal temp. = 15°C and normal pressure = 0) using the following formulae.

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

Where P_1 = Observed gauge pressure + Atmospheric pressure

T_1 = Observed temperature + 273^0C.

P_2 = Zero pressure in gauge + Atmospheric pressure (1.0335 Kgs/Cm^2)

V_2 = Volume of vapour @ 15^0C and zero pressure

T_2 = 15^0C (Standard Temp) + 273^0C = 288^0C

Therefore, $V_2 = \frac{P_1 x V_1 x T_2}{T_1 x P_2}$

$$\frac{(2+1.0335)x(33.3)x(15^0C+273^0C)}{(30^0+273^0C)x(0+1.0335)}$$

= 92.90 litres.

Step : 3

Using liquid / vapour ratio of 247.7: 92.90 litres of vapour volume at zero gauge pressure and 15^0C would work out to liquid equivalent of :

92.90 - 247.7 = 0.375 litre at 15^0C

Step:4

Density of LPG of 0.560 kg/litres at 15 degrees cent.

Hence the weight of LPG i= 0.21 kg. say 200 gms

ANNEXURE 12

CALIBRATION CHART FOR 14 MT DIA HORTON SPHERE INCLUDING LEV

OBSERVED TEMP.	35
OBSERVED PR.	6
DENSITY	0.54
HORTON DIA.	14

	LIQ. LEVEL	LIQ. VOL.	LIQ. QTY.	VAP. SPACE	VAP. VOL	LEV	PRODUCT
	0	0.00	0.00	14	1437.33	19.94	19.94
	0.5	5.37	2.90	13.5	1431.96	19.87	22.76
	1	20.95	11.31	13	1416.38	19.65	30.96
	1.5	45.96	24.82	12.5	1391.37	19.30	44.12
	2	79.62	42.99	12	1357.71	18.84	61.83
	2.5	121.13	65.41	11.5	1316.20	18.26	83.67
	3	**169.71**	**91.65**	**11**	**1267.62**	**17.59**	**109.23**
	3.5	224.58	121.28	10.5	1212.75	16.82	138.10
	4	284.95	153.87	10	1152.38	15.99	169.86
	4.5	350.04	189.02	9.5	1087.30	15.08	204.10
	5	419.05	226.29	9	1018.29	14.13	240.41
	5.5	491.20	265.25	8.5	946.13	13.13	278.37
	6	565.71	305.49	8	871.62	12.09	317.58
	6.5	641.80	346.57	7.5	795.54	11.04	357.61
	7	718.67	388.08	7	718.67	9.97	398.05
	7.5	795.54	429.59	6.5	641.80	8.90	438.49
	8	871.62	470.67	6	565.71	7.85	478.52
	8.5	946.13	510.91	5.5	491.20	6.81	517.73
	9	1018.29	549.87	5	419.05	5.81	555.69
	9.5	1087.30	587.14	4.5	350.04	4.86	592.00
	10	1152.38	622.29	4	284.95	3.95	626.24
	10.5	**1212.75**	**654.89**	**3.5**	**224.58**	**3.12**	**658.00**
	11	1267.62	684.51	3	169.71	2.35	686.87

	11.5	1316.20	710.75	2.5	121.13	1.68	712.43
	LIQ. LEVEL	**LIQ. VOL.**	**LIQ. QTY.**	**VAP. SPACE**	**VAP. VOL**	**LEV**	**PRODUCT**
	12	1357.71	733.17	2	79.62	1.10	734.27
	12.5	1391.37	751.34	1.5	45.96	0.64	751.98
	13	1416.38	764.85	1	20.95	0.29	765.14
	13.5	1431.96	773.26	0.5	5.37	0.07	773.34
	14	1437.33	776.16	0	0.00	0.00	776.16

ANNEXURE 13

TANK BEHAVIOUR - CONTRIBUTOR OF APPARENT STOCK LOSSES

As per BS 5500, the tolerance allowed in the circularity of the vessels is based on the following Formula :

Tolerance in circularity (Variation in actual inner Dia. from std. Dia.) = +/- (0.5+625/D)% OR 1% whichever is lower. where D = diameter in mm.

FOR 600 MT. HORTON SPHERES

Tolerance = +/-(0.5 + 625/ 14000) %
= +/- 0.54%
(Inner dia. may vary from 14.076m. to 13.924m,)

Variation in Water Capacity due to variation in diameter when diameter is taken as D = 14.07 m.

= 4/3x22/7x(d/2)3
= 4/3x22/7x14.076x14.076x14.076/8
= **1460 cum.**

When diameter is taken as D = 13.924 m.

Water capacity = 4/3x22/7x(d/2)3
= 4/3x22/7x13.924x13.924x13.924/8
= **1414.0 cum.**

Water capacity of the vessel is taken as 1437 cum. as per the manufacturer's recommendation.

Hence variation in water capacity = (1460-1437) to (1437-1414)
= +/- 23 cum.
= **+/- 12.42 MT(taking LPG density as 0.54)**

Variation in Qty.for 600 MT capacity used = +/-600/(1437x0.54)x12.42
= +/- 9.60 MT

FOR 1200 MT. HORTON SPHERES

Tolerance = +/-(0.5 + 625/ 17000) %
= +/- 0.536%

Inner dia may vary from 17.091m. to 16.908 m.

Variation in Water Capacity due to variation in diameter :

When diameter is taken as D = 17.091 m.

Water capacity = 4/3x22/7x(d/2)3
= 4/3x22/7x17.091x17.091x17.091/8
= 2615 cum.

When diameter is taken as D = 16.908 m

Water capacity = 4/3x22/7x(d/2)3
= 4/3x22/7x16.908x16.908x16.908/8
= 2531 cum.

Water capacity of vessel is taken as 2573 cum.

Hence variation in water capacity = (2615-2573) to (2573-2531)
= +/- 42 cum.
= **+/- 22.68 MT(taking LPG density as 0.54)**

Variation in QTY.for1200 MT capacity used = +/-1200/(2573x0.54)x22.68
= +/- 19.58 MT

ANNEXURE 14

STOCK LOSS/GAIN DAILY ANALYSIS REGISTER

Date :

Name of Officer : A: B: C:

VESSEL READING

Time	#1	#2	#3	#4	#5	#6	#7	#8	Total Qty.
0600									
Qty.									
1400									
Qty.									
2200									
Qty.									

BULK RECEIPT BY TANK TRUCKS

Time	Vessel	Opening Qty.	AC-5 Qty.	Book Balance	HS Reading Closing	Physical Balance	Loss/ Gain	No. of TT Decantat	Remarks
Total									

BOTTLING

Shift	Vessel	Opening Qty.	Bottling (No of cyl)		Total no. of cyls.	Qty. (MT)	Book balance	Vessel Readin	Physical Balance	Loss/ Gain
			14.2 Kg	19 kg						
Total										

OVER ALL ANALYSIS

Opening Qty :
Receipt Qty. :
Issue Qty. :
VD Adj. Qty. :
B. Balance :
P. Balance :
Day's Loss/Gain:
Cum Loss/Gain :
Cum Loss/Gain :
Month
Cum Loss/Gain :
Year

2200 Hrs. to 0600 Hrs.
2200 Hrs. Qty. :
0600 Hrs. Qty. :
Loss/Gain :
Remarks :

Signature of Officer

Signature of Location In-charge

RAIL RECEIPT

Date & Hrs.	Vessel Used	Opening Reading	Opening Qty.	Date & Hrs.	Closing reading	Qty.	Recd .Qty.	CC/ AC-5 Qty.	Loss/ gain	Remarks

	A Shift HS #	B Shift HS #
Evacuation by pass open in		
Pump by pass & crousel by pass open in		

A Shift Stock Loss/Gain Analysis

Over All Analysis Horton Sphere Wise

ANNEXURE 15

INSPECTION CHECKLIST ON QC FOR LPG STORAGE/HANDLING LOCATIONS

LOCATION DATE OF INSPECTION BY/ON LAST INSPECTED BY/ON

QUALITY CONTROL MANUAL AND CIRCULARS

YES / NO

a. Is QC Manual on LPG available ?

b. Are all QC circulars/bulletin available properly filled ?

QC APPARATUS

Is the following apparatus available in proper working condition ?

a. Vapour pressure sampling bomb.
b. Density bomb.
c. Volatility test apparatus.
d. H_2S test apparatus.
e. Copper corrosion test apparatus.

PRODUCT MONITORING

a. Vapour pressure carried out as per requirement and record maintained.
b. Monitoring of mercaptan dosing maintained.
c. PPM level of mercaptan dosing in product.
d. Water draining done regularly and record maintained.
e. Are the test report available.

FAILURES

a. Has there been a failure of any product during receipt/storage/ despatch at the location ? How was the product released ? Confirmif the instructions as per manual followed.

COMPLIANCE

a. What is status of compliance of the last inspection ?

SUGGESTIONS

a. As per location in-charge, are there any impediments in carrying outthe manualised QC procedures ?

TANKERS RECEIPT

a. Are the Load port test report available ?
b. Pre-discharge test/during discharge test carried out and record maintained.
c. After receipt complete analysis of the product received done and in line with IS:4576 specifications.

TANK TRUCK / TANK WAGON LOADING

a. Is the product release only after the lab? Conformed that the product meets IS specifications.
b. Is the test report sent to respective receiving locations ?

INSPECTING OFFICER **LOCATION INCHARGE**

NAME

SIGNATURE

ANNEXURE 16

IMPORT SPECIFICATION OF COMMERCIAL BUTANE

Sl. No.	Characteristics	Commercial Butane	Method of Test Ref. to ASTM :
(1)	(2)	(3)	(4)
i	Vapour pressure at 37.8°C/100 °F, kPa (psi), gauge, Max.	483 (70)	D 1267 D 2598
ii	Composition, liquid, mole/vol percentage a) C2 Hydrocarbons b) C3 Hydrocarbons c) C4 Hydrocarbons d) C5 Hydrocarbons & heavier e) Unsaturated hydrocarbons OR Volatility : Evaporation Temp. In deg C for 95% by vol. at 760 mm HG pressure	 ----- Report Report 2.5 max Report 2.0 max	D 2163 IP 405-94 ISO 7941-88 D 1837
iii	Total volatile sulphur ppm max.	150	D 2784 D 3246
iv	Copper Strip Corrosion at 38°C for 1 hour	Not worse than No. 1	D 1838
v	Hydrogen Sulphide	Pass	D 2420(Note 1)
vi	Free water content	None	Visual(Note 2)

Note 1 :
Hydrogen Sulphide by UOP 212.77 test method is also acceptable, with limit for Hydrogen Sulphide Max 5 ppm. "Pass" test as per test method D 2420 indicates Hydrogen Sulphide not more than 5 ppm.

Note 2 :
Water content by ASTM E-700 test method is also acceptable, with limit of max. 10 ppm.

ANNEXURE 17

IMPORT SPECIFICATION OF COMMERCIAL PROPANE

Sl. No.	Characteristics	Commercial Propane	Method of Test Ref. to ASTM :
(1)	(2)	(3)	(4)
i	Vapour pressure at 37.8^{O}C/100 ^{O}F, kPa (psi), gauge, Max.	**1380** (200)	D 1267 D 2598
ii	Composition, liquid, mole/vol percentage a) C2 Hydrocarbons b) C3 Hydrocarbons c) C4 Hydrocarbons d) C5 Hydrocarbons & heavier e) Unsaturated hydrocarbons OR Volatility : Evaporation Temp. In deg C for 95% by vol. at 760 mm HG pressure	 Report 95.0 min 4.0 max 0.2 max Report -38.0 max	D 2163 ISO 7941-88 IP 405-94 D 1837
Iii	Total volatile sulphur, ppm max.	150	D 2784 D 3246
Iv	Copper Strip Corrosion at 38^{O}C for 1 hour	Not worse than No. 1	D 1838
v	Hydrogen Sulphide	Pass	D 2420 (Note 1)
vi	Free water content	None	Visual (Note 2)

Note 1 :
Hydrogen Sulphide by UOP 212.77 test method is also acceptable, with limit for Hydrogen Sulphide Max 5 ppm. "Pass" test as per test method D 2420 indicates Hydrogen Sulphide not more than 5 ppm.

Note 2 :
Water content by ASTM E-700 test method is also acceptable, with limit of max. 10 ppm.

ANNEXURE 18

IMPORT SPECIFICATION OF COMMERCIAL BUTANE - PROPANE MIXTURE

Sl. No.	Characteristics	Commercial Propane – Butane mixture	Method of Test Ref. to ASTM :
(1)	(2)	(3)	(4)
i	Vapour pressure at 37.8°C/100 °F, kPa (psi), gauge, Max.	520 – 890 (75-130)	D 1267 D 2598
ii	Composition, liquid, mole/vol percentage a) C2 Hydrocarbons b) C3 Hydrocarbons c) C4 Hydrocarbons d) C5 Hydrocarbons & heavier e) Unsaturated hydrocarbons OR Volatility : Evaporation Temp. In deg C for 95% by vol. at 760 mm HG pressure	 ----- Report Report 2.5 max Report 2.0 max	D 2163 ISO 7941-88 IP 405-94 D 1837
Iii	Total volatile sulphur, ppm max.	150	D 2784 D 3246
Iv	Copper Strip Corrosion at 38°C for 1 hour	Not worse than No. 1	D 1838
v	Hydrogen Sulphide	Pass	D 2420 (Note 1)
vi	Free water content	None	Visual (Note 2)

Note 1 :
Hydrogen Sulphide by UOP 212.77 test method is also acceptable, with limit for Hydrogen Sulphide Max 5 ppm. "Pass" test as per test method D 2420 indicates Hydrogen Sulphide not more than 5 ppm.

Note 2 :
Water content by ASTM E-700 test method is also acceptable, with limit of max. 10 ppm.

ANNEXURE 19

REQUIREMENT FOR LIQUIFIED PETROLEUM GASES AS PER IS 4576 1999

Sl. No.	Characteristics	Requirement for Commercial			Method of Test Ref. to:
		Butane	Butane Propane mixture	Propane	
(1)	(2)	(3)	(4)	(5)	(6)
i	Vapour pressure at 40^{O}C, kPa, gauge, Max (Note 1)	520	1050 (Note 2)	1550	D 1267
ii	Composition, liquid mole percentage				
	a) C2 Hydrocarbons	--	Report	Report	D 2163
	b) C3 Hydrocarbons	Report	Report	95.0 min	
	c) C4 Hydrocarbons	Report	Report	4.0 max.	
	d) C5 Hydrocarbons & heavier	2.5 Max.	2.5 max.	0.2 max.	
	e) Unsaturated hydrocarbons	Report	Report	Report	
	OR				
	Volatility :				
	Evaporation Temp. In ^{O}C for 95% by vol. at 760 mm Hg pressure, max.	2.0	2.0	-38.0	D 1837
iii	Total volatile sulphur ppm, Max.	150	150	150	D 2784 D 3246
iv	Copper Strip Corrosion at 38^{O}C for 1 hour	Not worse Than		No.1	D 1838
v	Hydrogen Sulphide	Pass	Pass	Pass	D 2420 (Note 3)
vi	Free water content	None	None	None	Visual

ASTM Test Methods can be followed till "P" of IS 1448 method under revision are finalised

Note 1 – Vapour pressure may be determined at any other temperature and converted to 40^{O}C by means of suitable vapour pressure – temperature graph. The same can also be determined by analysing the gas by means of a gas chromatograph and then using the composition, the vapour pressure can be calculated at 40^{O}C from the standard values of vapour pressures at various temperatures.

Note 2 – Each consignment of commercial butane-propane mixture shall be designated by its maximum vapour pressure in kPa at 40^{O}C. Further, if purchaser and the supplier agreed, the minimum vapour pressure of that mixture shall be not lower than 200 kPa gauge compared to the designated maximum vapour pressures and in any case the minimum for the mixture shall be not lower than 520 kPa at 40^{O}C.

Note 3 - 'Pass' test indicates Hydrogen Sulphide not more than 5 ppm.

Note 4 – Subject to agreement between the purchaser and the supplier, odour requirements of LPG may be changed for certain applications when unodourized LPG is required.

Note 5 - Product shall contain 20 ppm minimum ethyl mercaptan at the first despatching location to ensure the detection of odour.

To detect the odour, the following procedures may be adopted :

5 ml Doctor Solution + 8 ml Iso-Octane + Pinch of Sulphur powder in 25 ml stopped cylinder. Shake and add 2 ml LPG (Aq). Shake slowly by releasing pressure.

Odour is adequate if sulphur turns yellowish brown.

P:75, Odour test method is also acceptable as an alternate method.

ANNEXURE 20

TANKER TANKS FITNESS CERTIFICATE

The tanker tanks_____nominated to carry the product (Propane, Butane or admixture of two) bulk heads / manifolds, etc. has / have been jointly inspected and it is certified that the tank (s), bulk heads / manifolds, etc. are clean and fit to carry the product to be loaded into the tanker tank.

Signature	Signature
(Name)	(Name)
Surveyor	Master

*Tanker tank fitness certificate to be issued either by the master and surveyors, wherever surveyor has been appointed.

ANNEXURE 21

CYLINDER TARE WEIGHT CORRECTNESS CONTROL RECORD

TARE WEIGHT INSPECTION AND REPORTING

Sr. No.	MRN No. and Date	Category (New/ HR/ST)	Manufacturer / Party	Cylinder Sr. No.	Observed Tare Weight Data			Difference with Actual		Cylinders found to be not meeting quality	Details of defects
					Actu	Pun	sten	Pun	Ste		
DATE		LOCATION	OPS OFFICER							PLANT MANAGER	

ANNEXURE 22

FILLING MACHINE ACCRACY CHECK RECORD

LOCATION : _____ **DATE** : _____ **SHIFT :** _____

CHECK NO	CHECK -1		CHECK -2		CHECK -3		CHECK -4		CHECK -5	
Time of checking										
Filling Machine no.	Observed variation	Checked by	Observed variation	Checked by	Observed variation	Checked by	Observed variation	Checked by	Observed variation	Checked by
FM –1										
FM -2										
FM -3										
FM -22										
FM -23										
FM -24										
LPG PRESSURE KG/CM2										
AIR PRESSURE (KG/CM2)										
hecked by										

Shift in Charge

Plant Manager

ANNEXURE 23

CHECK SCALES ACCURACY CHECKS RECORD

LOCATION : / DATE : / SHIFT :			CHECK SCALE -1		CHECK SCALE -2		CHECK SCALE -3		CHECK SCALE –4	
			Observed	Chkd	Observed	Chkd	Observed	Chkd	Observed	Chkd
CHECK -1	TIME	1/4 LOAD								
		1/2 LOAD								
		3/4 LOAD								
		FULL LOAD								
CHECK -2	TIME	1/4 LOAD								
		1/2 LOAD								
		3/4 LOAD								
		FULL LOAD								
CHECK -3	TIME	1/4 LOAD								
		1/2 LOAD								
		3/4 LOAD								
		FULL LOAD								
CHECK -4	TIME	1/4 LOAD								
		1/2 LOAD								
		3/4 LOAD								
		FULL LOAD								
CHECK -5	TIME	1/4 LOAD								
		1/2 LOAD								
		3/4 LOAD								
		FULL LOAD								

ANNEXURE 24

FILLED CLINDERS WEIGHT CONTROL RECORD

Date	Shift	Total No. of Cylinders Filled	Generation of O/F, U/F Cylinders			% Generation of O/F, U/F Cylinders				
			Over Filled	Under Filled	Total	Over Filled	Under Filled	Total	Analysis of the Probable Causes for Weight Variation and Remedial Measures Taken	Initials of Plant Manager
Average for previous month										
generation O/F, Lowest achieved C/F cylinders										

ANNEXURE 25

FILLED CYLINDER TIGHTNESS CONTROL RECORD

Date	Shift	Total No.of Cylinder sFilled	Category wise Details of Defective Cylinders										Analysis of Probable Causesand Remedial Measures Taken	Initials of Plant Manage r
			Valve	%	Bung	% Bung	Body	% Body	O-Ring	% O-Ring	O-Ring	% O-Ring		
Previous month's average generation Lowest achievedgeneration														

ANNEXURE 26

RECORD OF CYLINDERS RECEIVED WITHOUT O-RING

Date	Name of the Transporter	Truck No.	Erv. No. and Date	Name of the Distributor	No. of Cyls Without O-Ring	Remedial measures Taken	Initials of PM

BACK

ANNEXURE 27

DAILY RECORD OF RANDOM QUALITY CHECKS OF FILLED CYLINDERS

DATE:

Sr.	Observed Weight				Observed Defects							
	Gross wt. in Kg	Tare wt	Net wt	Difference in wt	Valve leak	Bung leak	Body leak	O-Ring Missing	O –Ring defect	Due for 5yr test/ Hot repair	Others	Remarks

LOCATION : **COMMENTS:**

Details	Inspecting Officer	on-in-charge
Signature		
Name		
Designation		
Time		

n.b. Data to be recorded by the officer concerned in his / her own handwriting.

ANNEXURE 28

COLOUR CODING OF PIPELINES AND VALES

1.0 GENERAL

1.1 All pipelines, valves and fittings at LPG plant should be colour-coded as per details given below.

1.2 Colour-coding is adapted to cover liquid LPG lines, LPG vapour lines, Pressure Relief Valves, other valves/fittings, compressed air lines for pneumatic operations and water service lines.

1.3 Colour scheme for fire-hydrant and fire-protection facilities to be adopted as per "HS&E Manual".

1.4 Colour scheme to be adopted as under :

Service Grade	Background colour	ISI No.	Colour for Lettering
Liquid LPG	Yellow	356	Black
LPG vapour	Green	284	White
Compressed air	Grey	632	White
Pressure Relief Valves	Blue	—	—
Service Water	Black	695	White
Auto LPG Liquid	Yellow with 2 Red oxide bands		
Auto LPG Vapour	Green with 2 Red oxide bands		
Propylene Liquid	Yellow with 2 Oxford Blue bands		
Propylene Vapour	Green with 2 Oxford Blue bands		

1.5 Pipeline, valves and fittings mounted on IOC's LPG tank trucks should also be colour coded as per above colour scheme.

2.0 COLOUR-CODE FOR PIPELINES

2.1 All pipelines to be painted with white/aluminium paint.

2.2 One colour band of 500 mm width with lettering for service grade to be painted as per colour scheme detailed in Clause 1.3 above. For illustration, refer enclosed diagram.

2.3 Colour band on the pipelines should be provided at following places :

(a) Every 10 meters along the pipeline.
(b) The points where the lines go under-ground.
(c) Near the operating valves, at Elbows, bends and T-joints
(d) Any other location considered necessary for ease of identification.

2.4 Direction of flow also to be indicated on the pipelines with the help of arrows. Arrows to be marked close to the colour bends.

2.5 The width of the additional bands for auto LPG and Propylene shall be 50 mm each and spaced 25mm apart i.e from the center of the base colour band two bands of 50 mm width on either side shall be provided and the same shall be at a distance of 12.5 mm from the center of the base colour band.

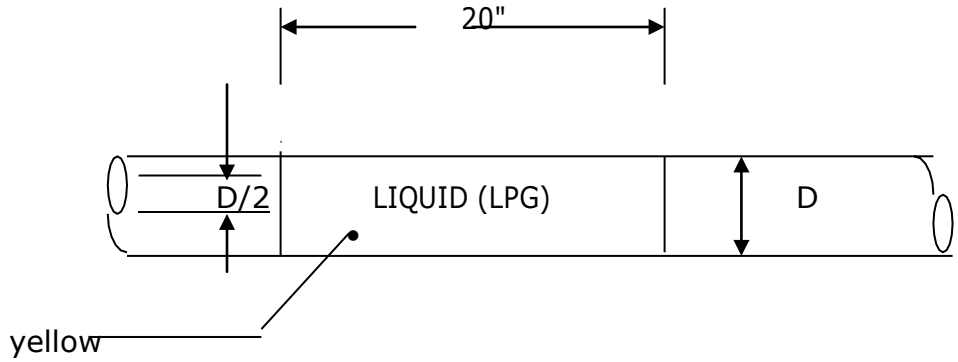
3.0 COLOUR-CODE FOR VALVES/FITTINGS

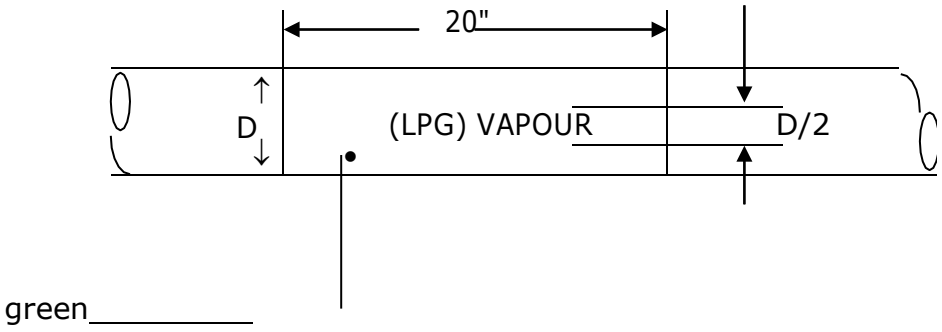
3.1 Valves/fittings fixed on the respective lines to be painted as per colour scheme described in clause 1.4 above.

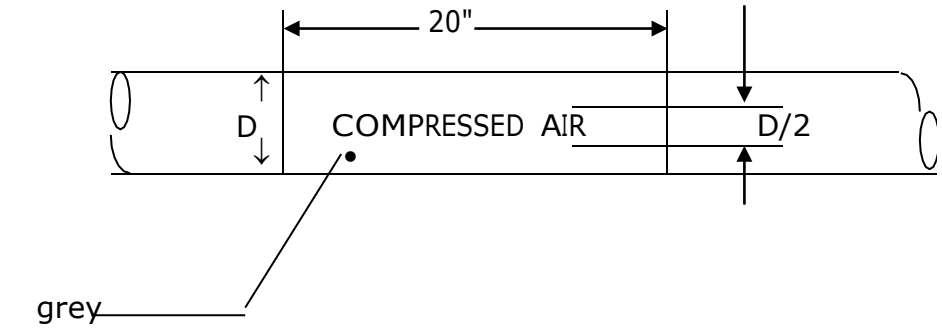
4.0 COLOUR-CODE FOR PRESSURE RELIEF VALVES

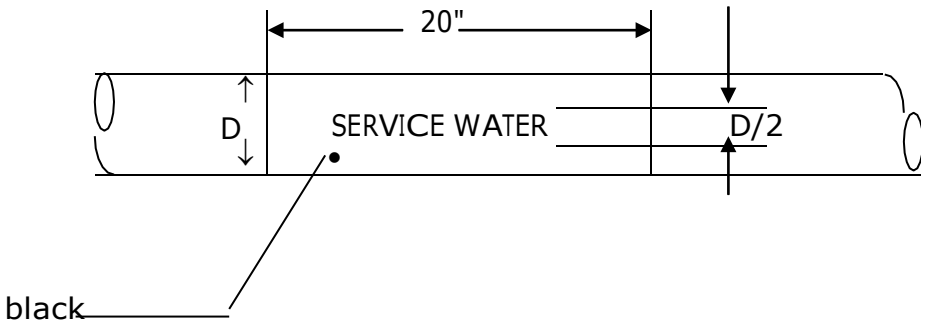
4.1 Pressure Relief Valves on vessels as well as on pipelines to be painted blue including the vent pipes, wherever provided.

COLOUR CODING OF PIPELINES AND VALVES









NOTES

- ☐ All valves and fittings on respective line to be painted as per colour scheme described in clause-13
- ☐ Direction of flow to be shown by an arow
- ☐ Lettering in black/white colour as per clause-13

ANNEXURE 29

SAMPLE DETAILS TAG :

Performa for labelling samples is given hereunder :

Serial number -
Name of location -
Date sample drawn -
Time sample drawn -
Type of product -
Sample drawn from -