

SAFETY CODE FOR IRON & STEEL SECTOR		
MINISTRY OF STEEL, GOVT. OF INDIA	HANDLING FUEL GAS	Doc. No: SC/21
		Rev no. : 00 Effective Date : --

1 OBJECTIVE

Objective of this safety code is to describe the recommended basic safety requirements in handling fuel gases such as BF gas (BFG), CO gas (COG), and LD gas (LDG) & their mixtures (MG) and Liquid Petroleum Gas (LPG)/ Propane. It describes briefly the precautions to be taken, safety appliances to be available and their use in working with above gas lines to prevent from their main hazards of fire, explosion & gas poisoning.

2 SCOPE

- 2.1 This code describes briefly the precautions to be taken and safety appliances available and their use while working with above gases inside and outside iron & steel industry.
- 2.2 Synonyms of Liquid Petroleum Gas are LPG, Propane, Butane, Propylene, Purofax, Bottled Gas. Handling of Propane gas is similar to that of LPG.

3 PROCEDURE

3.1 FOR BFG, COG, LDG & MG

Table 1 - Hazards of BFG, COG, LDG & MG				
Limit	BFG	COG	LDG	MG
Toxicity	Highly Toxic	Toxic	Extremely Toxic	Highly Toxic
Flammability	Inflammable	Inflammable	Inflammable	Inflammable
Carbon Monoxide %age in volume	23 - 27	6 – 10	60 – 70	10 – 60 Depending on composition
Explosiveness	Explosive	Explosive	Explosive	Explosive
Lower Explosive Limit (LEL)	35% in air	6 % in air	15 % in air	10 – 30% Depending on composition
Higher Explosive Limit (HEL)	73.5 % in air	31 % in air	72 % in air	35 – 70% Depending on composition
Identification of gases (by smell)	Odourless	Burning Tar Rotten Egg Or Rotten Fish	Odourless	Odourless

Other hazards include- Falling from height, Nitrogen exposure (barrier of oxygen).

3.2 Effect of Carbon Monoxide (CO) on Respiratory System

The carbon monoxide when breath in along with air is absorbed by the blood and deprives the blood of its oxygen carrying capacity and forms carboxy hemoglobin in place of oxyhemoglobin. Hemoglobin has 200 to 300 times more affinity for carbon monoxide than oxygen. The body tissues suffer from anoximia (lack of oxygen).

Symptoms of gas exposure: Headache, Nausea, Vomiting, Feeling of giddiness, difficulty in breathing

3.3 Effect of Various % of CO in blood

CO in Blood (%)	Effects
0-10	Shortness of breath on exertion
10-20	Increase in shortness of breath and slight headache
20-30	Headache is more pronounced, irritable, judgment impaired, vomiting
30-40	Becomes confused, faint
40-50	Above symptoms are intensified with increased pulse rate respiration
50-60	Unconsciousness
60-70	Respiration may fail, death may occur

3.4 Fire in gas lines



3.4.1 Fire due to fire source

It needs presence of ignition source in the vicinity from gas cutting welding spatters, electrical sparking, sparking from tools and tackles, or thunder etc. Standard practices to be taken for hot work in gas line.

i. Prevention

Before commencing and/or executing any work in and around the gas line one should ensure:

- a) There should not be any naked power cabling near gas lines.
- b) No leaky flammable gas lines nearby. Inform the owner of the gas lines if any leakage is found from the pipe, fittings or flanges. Start the job only

after the gas line owner attends the leakage.

- c) The tools and tackles to be used for gas line maintenance are non-sparking non-ferrous material.

3.4.2 Fire Due To Hot Work (Cutting/Welding/Grinding/Drilling Job) Near Charged Gas Line

i. Prevention

- a) Thorough analysis of the job to address the potential source of fire with meticulous prevention and mitigation plan.
- b) Check physically the pipe thickness for before start of welding job on gas line.
- c) Check for presence of CO% in the working area / vicinity of job less than equal to 50 ppm.
- d) Check for presence of explosive mixture before start of job.
- e) Put clay/ POP (plaster of paris) in the joints of all nearby gas line and cover with fireproof ceramic cloth.
- f) Gas cutting torch flame should not "hit" the charged gas pipelines.
- g) No inflammable material should be present below the working area.
- h) Do not use gas pipe/gas pipe supporting structure for earthing the welding m/c. Earthing should be near the welding spot.
- i) Continuous CO monitoring should be done throughout the job.
- j) Keep ready the fire hose with nozzle at the job point.
- k) Keep sufficient nos. of DCP/ CO₂ type fire Extinguisher at site (at least 2).
- l) If the presumed severity of fire is very high, make the fire tender stationed at the site.
- m) During welding on live gas line, % oxygen present in the gas to be monitored on regular basis and should be less than 1%.
- n) During the welding on live gas line the current should be kept under control all the time (70 – 100 amps). Suitable welding rod is to be used and the current should be adjusted so that the parent metal does not get punctured. The welding should not be done in continuous run rather it should be staggered.
- o) Falling of spatters from height must be prevented.
- p) While hot work on gas line, a positive pressure must always be maintained inside the gas line to prevent entry of atmospheric air. If required, Nitrogen shrouding at the welding tip must be arranged by providing N₂ in hose.
- q) Fire retardant cloth shall be wrapped over all the nearby joints.

3.4.3 Fire in COG lines even if there is no hot work

- i. At times, we experience spontaneous ignition (in the form of white smoke or fire of Coke Oven Gas (COG) deposits either on the ground or inside the pipe laid overhead.
- ii. Most commonly, this occurs during shutdowns when COG pipelines are opened for inspection or maintenance.
- iii. This happens due to presence of Pyrophoric Iron Sulfide (PIS), which is

formed by the conversion of iron oxide (rust or corrosion deposits) into iron sulfide in an oxygen-free atmosphere where hydrogen sulfide gas is present having concentration more than oxygen.

- iv. The PIS, when exposed to the atmospheric air, oxidizes exothermically. This results in the formation of excessive heat oxidation and which can ignite nearby flammable material, substances or fuel-air mixtures.



v. **Prevention**

PIS fires can be avoided by preventing the PIS from contacting air. This can be achieved by maintaining a continuous layer of liquid or inert gas between the material and the air.

- a) Always purge the gas line, preferably with Nitrogen, before dismantling it.
- b) Immediate after dismantling the pipes cover the open ends thoroughly to prevent the air ingress inside the pipe.
- c) Keep the deposits (inside the pipe) immersed in water, if end capping is not possible.
- d) If possible, maintain a positive pressure inside the pipe preferably with nitrogen supply.

3.5 Job Safety Analysis, Hazard Identification and Risk Mitigation Planning

- i. Define the scope of job with the help of P&ID or rough sketch
- ii. The P&ID or rough sketch must show all the components of the gas line like, branch connections, drip pots, water seals, isolating valves, vents, purge points and instruments etc.
- iii. Determine applicability of appropriate safety standards
- iv. List down the requirements of the applicable safety standards
- v. List down the hazards related to job
- vi. Carry out the site survey and identify site specific hazards
- vii. Assess the load of pipe, considering the muck inside the pipe, for proper selection of suitable crane.

- viii. Determine the positioning of crane with the consultation of crane operator & the area owner.
- ix. Barricading of the work site (if possible)
- x. Determine the counter measures to safeguard the workmen and the property damage against the identified hazards (Job specific as well as site specific) . HIRA (Hazard Identification and Risk Analysis) to be prepared.

3.6 **Preparation of Check List Based Standard Operating Practice (SOP)**

SOP to be made in details considering the following points:

- i. Sequence of activities
- ii. Isolation of pipe segment to be replaced with layout diagram
- iii. Gas isolation document and positive isolation process
- iv. Monitoring (preferably with the manometers) and controlling the line pressure during purging.
- v. Prepare the checklist as per Check List based Execution under clause no. 3.13
- vi. Proper protocol (For Def ref “ Glossary of terms related to safety & abbreviatins”) to be made before execution of the job.

3.7 **Training and Communication**

- i. All the persons working near or on the gas line must undergo General safety training and gas safety training conducted by Safety department.
- ii. A competent person of the department must explain the hazards and risk associated with the job (and site) to the Working agency supervisors through SOP.
- iii. Working agency supervisor will explain the similar thing to all their workmen before starting the job on daily basis.
- iv. Line Manager will hold the communication cum review meeting, preferably a day before the job execution, to communicate vital safety related points to all the Working agency employees and review the preparation for job execution.
- v. Line manager will hold the tool box meeting before starting the job.

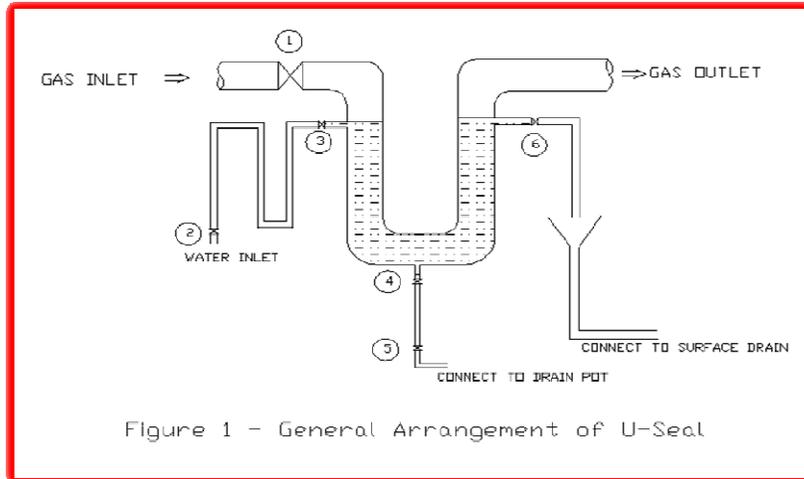
3.8 **Work permits and necessary clearances**

- i. Job shall only be started after getting all the clearances and work permits as per guidelines for permit to work under Doc. No.: DG/05, Rev. No.: 00.
- ii. The executing agency shall issue the written gas clearance as per protocol
- iii. Area clearance shall be given by the area owner as per protocol

3.9 **Isolation of gas mains**

- i. Means of Isolation
 - a) Water Seal (U Seal/ Quick Dump Seal)
 - b) Blanking
 - c) Goggle Valves (GV)

ii. **Isolation with Water Seals and Water sealing breaking**
(Refer Figure 1 - General arrangement of U Seal)



A. **Water Sealing**

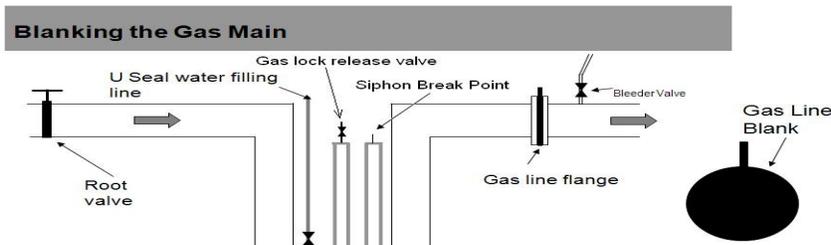
- Close the Gas isolating valve '1'.
- Close the drain valve '4' & '5' and additionally put a blank below the valve '4'.
- Ensure sufficient water pressure in the water inlet line.
- Open water inlet valves '2' and '3'.
- Open water overflow valve '6'.
- As soon as water starts coming from overflow line, adjust the water inlet valve '2' so as to ensure continuous trickling through water overflow line.
- Water sealing of U-seal is now complete.
- Watch from time to time the flow of water trickling from overflow line.

Note: To ensure the proper working of U-seal while maintenance works are ON, a man shall be posted there to check the water overflow

B. **Water Seal Breaking (after necessary purging of gas line)**

- Close the water inlet valves '2' and '3'.
- As soon as water trickling from overflow line stops, close the overflow valve '6'.
- Remove the blank below drain valve '4' and open the drain valve '4' & '5'.
- Ensure water supply to seal pot
- Open the gas isolating valve '1'.
- Water seal breaking is now complete.

iii. **Blanking**



(Figure 2 - Arrangement showing the blanking of COG main)

- a) Select an appropriate and safe location for putting the blank in the gas line preferably with Nitrogen flooding arrangement.
- b) Provide standard scaffolding with suitable platform, toe-guard, railing and proper approach
- c) Arrange for suitable gas mask / Breathing apparatus (as required) to be kept at site to meet any emergency situation. For doing any blanking job, blower type gas mask can be used as per site condition. One CO detector should be kept near the suction point of the blower during use to ensure that no CO is sucked in the blower.
- d) Arrange for fire brigade to be stationed near the blanking site.
- e) Check for any possible presence of ignition source in the vicinity, if there is any, it should be taken care of.
- f) Blank of the right size to be kept ready along with gasket/ceramic rope/ring joint.
- g) Close the gas line isolation valve after getting clearance from consumer.
- h) Do the water sealing of the respective gas line and depressurize the gas line by opening end bleeder at approachable safe location.
- i) Preferably N₂ purging of gas line must be done before doing blanking job to evacuate the toxic gas from the line (Follow steps for purging the gas line 6.6 below).
- j) Open out the nut-bolts by easing them. Never do gas cutting or chiselling instead use Nut-splitter.
- k) Ensure that isolation valves are fully closed, the amount of concentration of gas leakage if any should be under permissible limit (50ppm). In case the blanking is being done with gas leakage, it is to be done by using gas mask.
- l) All persons engaged for blanking / de-blanking job should wear fire-retardant cloth.
- m) Use non-ferrous tools for making gap between the flanges. Hydraulic Flange Spreader may also be used for this purpose.
- n) While putting blank, people working in the vicinity should untie their safety belt and stand away from the flange joint on the scaffolding platform. This is to ensure that they can flee away in case of any untoward fire.
- o) While blanking / de-blanking, plenty of water should be sprayed over the flange joint.
- p) After Blank is put inside the flange joint and nut bolt is put, the working people in the vicinity should tie their safety belt to do the further job.
- q) Gasket/rope should be put on both side of the blank.
- r) Same precautions are to be followed during removing of blank from gas line.
- s) Job to be done under and by the knowledgeable persons and supervisor.

iv. **Exemption for the job without blanking**

- a) Stringent SOP to be made for such job and approval to be taken

from Head of the dept. and safety

- b) Closing of the Isolating Valve & putting the tags/ locks, and Water sealing shall be considered as positive isolation with the condition that all the water seals will be manned (having a suitable means of communication) throughout the job execution. The deployed person shall ensure:
 - ✓ that water is continuously over-flowing from the U-Seal.
 - ✓ that make-up water valve for the U-Seal is open
 - ✓ that U-Seal drain valve is closed and locked/ tagged.
 - c) The blanking of nitrogen purge line and locking of the same after nitrogen purging is over.
 - d) If there is no Gas isolation valve before the U-Seal, operation in charge of Gas pipeline should ensure in writing that the design of U-Seal is such that it will not blow off in any abnormal condition or present operating condition.
 - e) The owner of the gas line should ensure that pressure downstream of the U Seal does not affect the overflow of U seal.
- v. **Gas main isolation with the help of Goggle Valves:** Refer SOP on Operation of Goggle Valve.

3.10 Purging of gas line (after positive isolation)

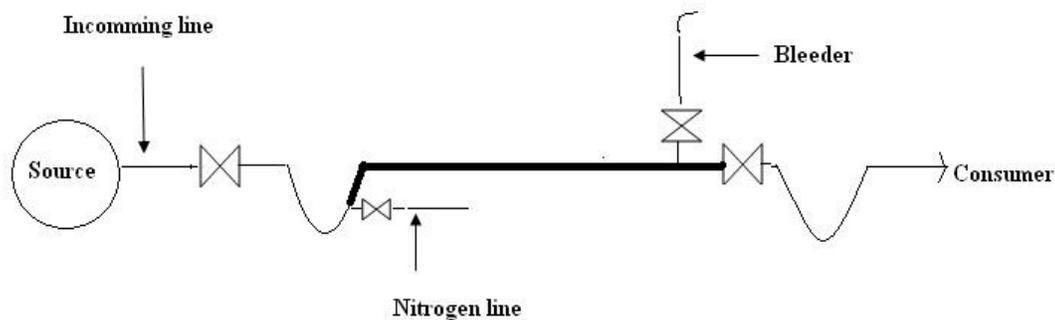


Figure 3: Purging with Nitrogen

- i. Close the gas incoming line valve, if provided.
- ii. Close the outlet gas line valve (consumer's side), if provided.
- iii. Do water sealing in incoming line as per 6.5.2 above.
- iv. Do water sealing in outlet line (consumer side) as per 6.5.2 above.
- v. Open the bleeder/ vent valve, just before 1st isolation device (valve or U seal) of downstream line of all consumers to depressurize the gas line & ensure the line is completely depressurized before purging preferably with N₂.
- vi. During purging the gas line preferably with nitrogen no person to be allowed to stay near the vicinity of end bleeders as high concentrations of nitrogen will not support life

- vii. Check and ensure the availability of nitrogen or other inert medium for purging.
- viii. Open purging valve nearest to the isolation point.
- ix. Monitor and control the line pressure by installing a manometer in one of the drip pots. The manometer should not be fixed very near to purge in and vent out point to ensure accurate monitoring. Line pressure must be controlled either by throttling the purge in or vent out valves. Drip pot where manometer is fixed should not be used as vent out for controlling the line pressure.
- x. Continue purging till CO concentration at bleeder becomes less than 50 ppm. During checking of CO concentration at bleeder, use suitable gas mask.
- xi. When CO concentration at bleeder becomes less than 50 ppm, close the N2 purging valve. Purging is now over and gas line job to be carried out from outside. No man should enter inside the gas line to perform the job.
- xii. If any job which require entry of man inside the gas line, trapped of the gas line to be purged out with air (with the help of suitable mechanical means (e.g. portable compressor or exhaust fan) till O2 comes above 20%. This is applicable especially for BFG & LDG mains only, as per the requirement of confined space safety standard.
- xiii. In no case man should enter inside CO gas line. However, for entering CO gas line, separate detailed SOP to be followed.

3.11 Job Execution

3.11.1 General

- i. Make a safe approach to working points by scaffolding.
- ii. Give prior information to all the consumers likely to be affected by the job.
- iii. On shutdown day take written clearance from all the consumers that they have isolated themselves with the affected mains.
- iv. Put equipment tags/locks to all the isolating points, including that of consumers.
- v. Keep calibrated CO detector with each working group.
- vi. Use Gas Mask if CO PPM is more than 50 PPM
- vii. Make adequate area illumination arrangement if job is to be continued after day light or in night
- viii. Workmen can anchor their safety harness at the working platform as long as hot work is not started. But, before starting any hot work or opening the gas line flanges, the harness should be untied so that workmen can leave the workplace unharmed, in case of any fire.
- ix. Keep capping arrangement ready at site to cover the open ends of the old pipes (dismantled pipes as well as the pipes left at height at their position).
- x. Keep ready the tarpaulin sheet of sufficient size at site to collect the gas line sludge.
- xi. Care must be taken that gas line effluent and contaminated water does not go into the drain or the soil to prevent ground water and land pollution.
- xii. Barricade the working area as well as the crane swing area.

- xiii. Take the road & track clearance if required
- xiv. A display board with emergency contact numbers (such as Fire Brigade, First Aid, Gas Safety, Energy centre, Job In-charge working agency etc.) should be kept at the site.
- xv. Make rain protection arrangement at the working point if the job is to done in the rainy season or the weather is cloudy and it is likely to be rained.
- xvi. The crane must be positioned on a rigid and leveled surface. If required use rigid wooden blocks and steel plate of sufficient size.
- xvii. If any muck/sludge/effluent is generated during job execution, same has to be collected on the tarpaulin, filled up in the gunny bags and disposed-off suitably.
- xviii. Any steel scrap (old pipes, drip pots, valves, stubs, structural etc.) generated during the job execution should be disposed-off suitably.
- xix. Clean the area with Water and sweeping, removing all the litters.

3.11.2 **Emergency Preparedness**

- i. Rescue arrangement to be used whenever anchoring point is possible for using rescue chair. Or, keep scissors' lift for emergency evacuation.
- ii. Ensure availability for the rescue arrangement
- iii. Key persons working on gas line should be trained, shall know how to wear breathing set and trained on rescue management conducted by Fire Brigade department.
- iv. Artificial respirators and gas mask to be kept at site.
- v. Proper accessibility and emergency escape route shall be there.
- vi. If the gas line is likely to catch fire during job execution, keep Fire tenders stationed at the job site or pre-inform the Fire Brigade department to be ready for any emergency call. Additionally keep water and Nitrogen hoses at the working points in ready to use condition.
- vii. Relevant clauses indicated in guidelines for fire safety (Doc. No.: DG/17, Rev No.:00) shall be used.
- viii. First aid & fire fighting arrangement (water, sand, and clay) should be there and people should know how to use it.
- ix. Mock drill shall be conducted periodically as per disaster plan of the plant unit.

3.11.3 **Off-line Patching/ Cladding**

- i. Isolate and purge the line.
- ii. Determine the size of plate depending up on the extent of damage and thickness of pipe where welding is to be done.
- iii. Fix the preformed patch plate and weld it. Avoid continuous run of the weld. (Should be staggered)
- iv. Soap bubble test at working pressure.
- v. In case of any leak, depressurize the line and rectify it.
- vi. In case of no leak, start post purging and charge the gas line.

3.11.4 **Online Leakage Repair of Gas Line**

(This is an indicative method, however other suitable methods can be

adopted)

- i. Using gas masks (preferably blower type); clean the affected surface by nonferrous tools (brush, scrapper or sand paper).
- ii. Plug the hole if leakage is more than pin hole with the help of wooden plug, piece of rubber, waste cloth soaked with cold-weld compound, etc.
- iii. Apply cold-weld compound all around the plugged hole.
- iv. Apply some pressure and hold the putty against the hole for some times till it gets cured.
- v. Tie ceramic rope over the pipe to hold the cold welding material tightly against the damage portion of the pipe.
- vi. Apply Plaster of Paris (POP).
- vii. If the leak is not repairable by plugging the hole, place a piece of rubber sheet followed by a metallic clamp to arrest the leakage. Apply cold-weld compound all around the rubber sheet to completely stop the leakage.
- viii. Check and ensure no leakage from the repair and repeat the above mentioned steps if required.

3.11.5 Replacement of Stubs/ spool piece of Vent valve/ Drain valve

- i. Isolate the line and purge the line.
- ii. Maintain a positive pressure in the gas line by throttling the purge medium.
- iii. Gas cut the defective stub piece.
- iv. Fix stub piece and weld it.
- v. Fix up the valve.
- vi. Soap bubbles test the weld joints at working pressure.
- vii. In case of any leak, depressurize the line and rectify it.
- viii. In case of no leak, proceed for gas charging in the line.

3.11.6 Inside cleaning of gas line

- i. Isolate the line either by operating the Goggle Valve or putting a blank at suitable location. THIS JOB SHOULD NOT BE DONE ONLY ON WATER SEAL ISOLATION.
- ii. Purge the line preferably with N₂ till CO ppm becomes nil.
- iii. Purge the line with Air till O₂ becomes >20%
- iv. Open the manhole cover or cut an opening in the pipeline at a suitable location for entry & exit of workmen.
- v. Take confined space clearance as per protocol.
- vi. Issue work permit for the workmen to carry out the job inside the gas line.
- vii. Depute one SAFETY PERSON with Safety Register, who is solely responsible for monitoring and recording of:
 - a) O₂ concentration, in %, inside the pipe, checked periodically.
 - b) Entry and exit time of each person going inside the pipe. No person should be allowed to work more than 30 min. inside the confined space.
 - c) Communicating continuously with the persons inside the confined space.
- viii. Clean the pipe manually or with the help of water jet.
- ix. Hot work inside the pipe is not allowed.
- x. After the job is over, close the manhole cover or patch weld the opening.

- xi. Soap bubble test at working pressure.
- xii. In case of any leak, depressurize the line and rectify it.
- xiii. In case of no leak, proceed for gas charging in the line.

3.11.7 **In-situ Maintenance of Valve (Goggle Valves, shut-off valves, control valves)**

- i. Isolate & purge the line and put blank on both side of the valve.
- ii. Purge the bonnet and body of the valve till CO at vent becomes nil.
- iii. Isolate the energy sources as per positive isolation procedure.
- iv. Carry out the maintenance job as per Standard Maintenance Practice (SMP) guidelines.
- v. Once the job is over revert back following above-mentioned steps in reverse order.
- vi. Leak test all the joints at working pressure and rectify the defect, if found any.
- vii. Charge the line.

3.11.8 **Pipe Replacement**

- i. Ease out flange bolt one day before to reduce shutdown duration.
- ii. Isolate and purge the line.
- iii. Position the crane appropriately.
- iv. Loosen and take out alternate flange bolts during crane placement.
- v. Hold the pipe with the help of crane and take out remaining flange bolts.
- vi. Dismantle the pipe, cap the open ends and keep it on the pre-decided location on the ground.
- vii. Lift the new fabricated pipe with the help of crane and position it between the flanges.
- viii. Rest the pipe on saddle after matching the hole of flange
- ix. Insert the flange bolts.
- x. Insert the sealing rope / gasket and tighten the fasteners with hand.
- xi. Tighten the fasteners with suitable torque wrench (Hydraulic / pneumatic / manual) in star pattern up to 50% of torque setting.
- xii. Torque the fasteners in star pattern, starting 180⁰ opposite to that followed in step xi above up to 75% of torque setting.
- xiii. Now torque the fasteners up to 100 % setting in star pattern that followed in step 'xi' above.
- xiv. Retighten the fasteners in clockwise direction till 100% uniform torqueing of all the fasteners is achieved.
- xv. Leak test, post purge and charge the line.

3.11.9 **Cleaning of Gas line without lowering**

- i. Isolate the line.
- ii. Make a suitable "water filling and quick draining" arrangement and fix up it directly either with drip pot drain pipe or down comer pipe.
- iii. Fix up a fire hose, connected with HP water system like fire hydrant, fire tender or HP water jetting m/c.
- iv. Fill the water in the gas line through drip pot and drain through adjacent drip pot, vent, and fittings or through the specially made arrangement.

- v. Continue till clean water starts coming out from the outlets.
- vi. Charge the line.

3.11.10 **Cleaning of Gas line after lowering the pipe**

For cleaning the pipe by lowering it follow the steps explained in 3.11.8 above

3.11.11 **Drip pot root valve poking online**

- i. Ease out the valve before poking activity.
- ii. Close the root valve and disconnect the down comer pipe.
- iii. Open the root valve, wearing suitable gas mask.
- iv. Ensure the gas line is not in negative pressure (suction or vacuum). Maintain a positive pressure inside the pipe preferably by injecting nitrogen.
- v. Poke the root valve with the help of long wooden stick or non-metallic rod.
- vi. Once all deposit material (Muck) gets clear, close the valve & connect the down comer pipe.

3.12 **Charging of gas lines**

- i. Once the job is over, get back all the work permits from the working agencies.
- ii. Pressurize the line preferably with Nitrogen to the working pressure. Pressure can be controlled by throttling Purge In valve, Vent or the drip pot drain valve.
- iii. Ask the working agencies to check all the points, with the help of soap solution to ensure leak-proof joints.
- iv. Hammer the weld joints with wooden mallets to remove any weld slag and expose the weld defects.
- v. If any defect is found, depressurize the line and rectify the defect.
- vi. Repeat the process till no defect is observed.
- vii. Reduce the pressure to throttling the Purge In valve, Vent or the drip pot drain valve.
- viii. Keep on monitoring the O₂ at the vent near isolation point. When O₂ reaches at <1 %, break the water seal from the other extreme end.
- ix. Close the Purging valve.
- x. Keep on monitoring the presence of gas with the help of CO detector at the vent near isolation point, wearing suitable gas mask. As soon as the CO reaches at 1000 ppm, close the vent.
- xi. Inform Energy Centre and return the clearance to all the consumers, asking them to charge the gas in their system.

3.12 **SPECIFIC SAFETY REQUIREMENTS FOR FUEL GASES (Blast Furnace Gas, Converter Gas, Coke Oven Gas and Mixed Gas)**

3.12.1 Following maintenance/ repair/ replacement works shall be carried out only in complete isolation of the portion under which work is to be taken up:

- i. Blanking & De-blanking
- ii. Valve, compensator repair/ replacement
- iii. Major repair/ replacement of part of the pipe

NOTE: Wherever, the chance of gases coming in contact with air/ ambient, work shall be carried out with complete isolation of the parts under subject

3.12.2 No personnel shall be allowed to work in or go to the area where fuel gases are present.

3.12.3 If the carbon monoxide content in that area is more than 50 PPM, use gas masks

- in such Emergency situation.
- 3.12.4 On line monitoring system with alarm for carbon monoxide concentration shall be provided in the areas around equipment/ process handling these gases. Performance of on-line monitoring system shall be checked once in a month for its proper operation and record maintained.
 - 3.12.5 Non sparking tools shall be used while working on charged pipeline and gas handling system.
 - 3.12.6 No personnel shall be allowed to work on charged system (where there is possibility of presence of fuel gases) without gas masks.
 - 3.12.7 Proper escape route and scaffolding shall be provided while working on charged system at height.
 - 3.12.8 The welding current shall not exceed 100A while welding on charged gas system.
 - 3.12.9 Cutting or welding job shall not be allowed on isolated system without analysis and written clearance of the competent person. It shall be done only by trained welders in presence of competent gas safety man. A minimum level of 19.5% oxygen shall be ensured.
 - 3.12.10 Proper electrical jumpers shall be provided between flanges and equipments before a gap is created between them.
 - 3.12.11 Platform and adjoining structures shall be covered with Ceramic blanket / Fire resistant clothes while blanking and de-blanking and the personnel working shall not be allowed to wear nylon or other synthetic fabric/garments.
 - 3.12.12 Fire brigade shall be kept as standby at the place of work in charged system, especially in case of Coke Oven Gas and Mixed Gases. Running steam line shall also be provided during welding.
 - 3.12.13 Lime water shall be poured after loosening the bolts of flanges in Coke Oven Gas lines/ equipments at the time of blanking or de-blanking or opening the manhole covers.
 - 3.12.14 The deposits/ incrustation in coke oven & other gas lines and associated equipments shall be kept wet either by steam or by water, after the system has been isolated and opened to atmosphere.
 - 3.12.15 Cutting in coke oven lines and associated equipments shall be carried out after cleaning of the deposits. In case, it is not possible, deposit shall be kept wet and a running steam hose shall be kept in readiness to prevent a fire. Also, ingress of fresh air shall be prevented by blanking the rejected gas lines.
 - 3.12.16 All jobs within a radius of 40 m which could be a source of fire/ignition shall be stopped and unauthorized persons shall not be allowed to remain in the area while shutting down the gas system.
 - 3.12.17 Lighting in enclosed area shall be done with portable spark proof electric lamp of 24 V or explosion proof fittings.
 - 3.12.18 All pipelines/systems shall be checked for leakage after completion of repair job as per IPSS-: 1-06-014-17 'Code of practice for laying and selection of moist fuel gas lines (third revision)'. The leakages shall be detected by soap solution and all leakages shall be rectified before charging the system. Steam shall be supplied along with compressed air while testing old coke oven and mixed gas lines/systems after repair of leakage.
 - 3.12.19 Blanking/de-blanking jobs on gas lines shall not be taken up at the time of extreme bad weather conditions when the possibility of thundering/ lightning exists.
 - 3.12.20 Drain pots and other auxiliaries of gas lines shall be inspected for proper

operation at least once a month and record maintained.

- 3.12.21 Permanent connections for purging by steam/ Nitrogen shall be blanked after purging requirements are over.
- 3.12.22 There shall not be any discontinuity in blanking/ deblanking. Once started it shall be completed at a stretch.
- 3.12.23 Testing of leaks of running mains of Coke Oven, Blast Furnace & Mixed Gases shall be done only by soap water.
- 3.12.24 Persons required to work in gaseous atmosphere shall be trained in First Aid and methods of giving artificial respiration.
- 3.12.25 Water seals/ Drip pots should be installed above ground level and continuous overflow of water should be monitored for ensuring its proper functioning.
- 3.12.26 The Drip Pot/ water seal area shall be fenced to avoid unauthorized entry.

3.13 **Check List based Execution**

3.13.1 **PPEs:**

- i. People are wearing "comfort fit" clothes (i.e. no loose cloths).
- ii. People are wearing cotton clothes.
- iii. People are wearing fire retardant jacket while working near or on gas line.
- iv. People are with good conditioned safety shoes, Safety glass. helmet with chinstraps hand gloves & Shin guards
- v. Gas Cutters are equipped with good conditioned long hand gloves.
- vi. Welders are equipped with good conditioned insulated hand gloves.
- vii. Welders are equipped with "hands-free" good conditioned welding screens.
- viii. Gas Cutters are equipped with good condition cutting goggles.
- ix. Welders / Gas Cutters are equipped with fire resistant aprons
- x. People are with calibrated Gas detectors.
- xi. Gas detectors are tested by Bump test before usage.
- xii. Artificial Respirators is made readily available at site. Artificial Respirators is must wherever gas clearance is required.
- xiii. Artificial Respirators must be full of oxygen.
- xiv. People must know how to use Artificial Respirators.
- xv. Suitable Gas mask& Breathing Apparatus needs to be used,

3.13.2 **Fire Safety & Process Safety**

- i. Relevant clauses indicated in guidelines for fire safety (Doc. No.: DG/17, Rev No.:00) and safety guidelines for energy isolation (Doc. No.: DG/23, Rev No.:00) shall be followed.
- ii. While carrying out gas cutting works, safety guidelines indicated in Gas cutting & Gas Welding (Doc. No.: DG/08, rev. No.: 00) shall be used.
- iii. Fire extinguisher has been kept at site with valid dates.
- iv. People know to operate the fire extinguishers ergonomically.
- v. Fire Hydrant hose pipes have been connected & crack opened for readily usage.
- vi. The trial of fire hydrant water pressure to be taken by opening of the valve so that water reaches at the destination
- vii. During Blanking/De-blanking, flange joints or gap at flange joints are being kept wet for elimination of chances of fire.
- viii. Anti-spark (non-sparking) tools are to be used for creating gap at flange

joints for elimination of chances of FIRE

- ix. Isolate the executing portion of gas lines completely from the process from all ends by putting blanks. So, not only the inlet line, but, the outlet line also needs to be blanked. There are cases where, many blanks are required to isolate completely from the system/ process.
- x. During erection / dismantling of Gas pipes, ensure the working pipes as “close ended” as there are potential of fire hazards. Ensure the “deposits/mucks (inside the pipes) wet” by spreading water and then the open ends are needed to be closed 100% to avoid any cross ventilation. One can use non-metals like ceramic clothes or metallic blanks to “eliminate” cross ventilation.
- xi. During dismantling of Gas pipes, ensure the dismantled pipes as “close ended” as there are potential of fire hazards. Ensure the “deposits/mucks (inside the pipes) wet” by spreading water and then the open ends are needed to be closed 100% to avoid any cross ventilation.
- xii. In the fire prone zone, or where there are every chances of fire, following things are to be done.
 - ✓ Keep fire hydrant hoses ready for use
 - ✓ Keep fire extinguishers
 - ✓ If the presumed severity of fire is very high, make the fire brigade stand at the site
 - ✓ Isolate the pipeline completely
 - ✓ An escape route to be ensured
 - ✓ Before this gas cutting, make sure of proper / perfect load distribution for enhancement of the mechanical integrity. As, this water filling will increase the weight.
 - ✓ Proper scaffolding/ working platform to be ensured
 - ✓ Proper barricading of area to be ensured

3.13.3 **Thumb Rules for Working At Height**

- i. Guidelines for working at height (Doc. No.: DG/03, Rev. No.: 00) shall be used.
- ii. People must climb up & down the ladder by using safety belts.
- iii. People must tie up all the hand tools & tackles with thin but strong threads to arrest their falling from height during usage.
- iv. People must use container to contain the spares, tools & tackles to arrest their falling from height.
- v. The area beneath the working zone must be barricaded to restrict people movement.

3.14 **FOR LIQUID PETROLEUM GAS (LPG)/ PROPANE**

3.14.1 Synonyms are **LPG, Propane, Butane, Propylene, Purofax, Bottled Gas**. LPG is a mixture of commercial butane and commercial propane having both saturated and unsaturated hydrocarbons. LPG marketed in India shall be governed by Indian Standard Code IS-4576 – 1999. Handling of Propane gas is similar to that of LPG.

3.14.2 **Physical & Chemical Characteristics**

Statement regarding the characteristics of LP Gas: LP gas is usually stored as a liquid under pressure. When released into the atmosphere at any temperature above its boiling point, -42° C for propane and 0° C for butane, it will change from a liquid to a vapor. LPG on bare skin causes frostbite. LPG is considered

to be nontoxic but may have some anesthetic effect if inhaled in high concentrations. LPG at atmospheric pressure and temperature is a gas which is 1.5 to 2.0 times heavier than air.

- i. **Combustion:** The combustion reaction of LPG increases the volume of products in addition to the generation of heat. LPG requires upto 50 times its own volume of air for complete combustion. Thus it is essential that adequate ventilation is provided when LPG is burnt in enclosed spaces otherwise asphyxiation due to depletion of oxygen apart from the formation of carbon-dioxide can occur.
- ii. **Odour:** LPG has only a very faint smell. Ethyl Mercaptan is normally used as stenching agent for this purpose.
- iii. **Toxicity:** LPG even though slightly toxic, is not poisonous in vapour phase, but can, however, suffocate when in large concentrations due to the fact that it displaces oxygen.
- iv. **Properties of Propane, Butane & LPG**

Sl. No.	Particulars	Propane	Butane	LPG
1.	Chemical Formulae	C ₃ H ₈	C ₄ H ₁₀	60% - Butane, 40% - Propane
2.	Max. Vapour Pressure Saturated in Kg/Cm ²	22.66	6.32	16.87
3.	Gross calorific value in Kcal/kg	11900	11800	11840
4.	Specific gravity (liquid) at 15 deg C Water =1	0.504	0.582	0.543
5.	Specific gravity (vapour) at 15 deg C air=1	1.50	2.01	1.75
6.	Ideal combustion Ratio (Air to Gas)	24 to 1	31 to 1	28 to 1
7.	Flammability limits (Upper)	9.60%	8.60%	9.1%
8.	Flammability limits (Lower)	2.15%	1.55%	1.90%
9.	Ignition Temperature (°C)	493-504	482-537	488-502
10.	Volume of gas produced per unit volume of liquid	274	233	250
11.	Volume of air required to burn unit volume of gas	23	30	26
12.	Volume of oxygen required to burn unit volume of gas	4.8	6.25	5.5
13.	Max. flame temperature (°C)	1980	1990	1985
14.	Percent Gas in air for Maximum Flame Temperature	4.4	3.5	3.9

3.14.3 Pre Requirement

When handling or there is potential exposure to LPG, safety glasses and rubber or leather gloves must be worn to protect the body from cold related injuries.

3.14.4 Precautions

When using LPG appliances or equipment, always follow manufacturer's directions and maintain appliances in a clean and undamaged condition. Before operating LPG equipment, be sure connections are tight.

- i. If leaks are present, turn off the equipment and check connections.
- ii. Do not operate until the leak is fixed.

- iii. Be aware that if a leak has occurred, LPG is heavier than air and will settle in low spots such as cellars or drains – ventilate well.
- iv. Keep vertical cylinders upright, even when empty, to ensure the pressure relief valve can operate effectively. A cylinder lying horizontally and involved in fire is more likely to burst.
- v. Except cylinders designed to operate horizontally they must be stored vertically so safety equipment will work properly.
- vi. LPG cylinders shall be stored outside of buildings or shops.
- vii. See the Compressed Gas Program for additional information regarding proper storage.
- viii. Ensure the pressure relief valve is pointed away from the structure supporting the cylinder, in case the relief valve operates and the discharge ignites.
- ix. When using a gas barbecue or other LPG equipment outdoors, be sure the area is clear and free from any ground fuel or litter that may ignite in the event of a fire.
- x. Protect cylinders from direct sun.
- xi. On extremely hot days, if the relief valve operates, cool the cylinder with water.
- xii. Keep cylinders clear of rubbish or brush.
- xiii. Any fire around the cylinder will increase the pressure within.
- xiv. Secure portable cylinders.
- xv. If the relief valve operates, unsecured cylinders could move about rapidly and erratically due to the jetting action.
- xvi. Shout and raise alarm / siren in case of unsafe conditions
- xvii. In case of leakage, stop all operations, close all isolation valves

3.14.5 **Handling & Storage**

- i. Stationary installation not exceeding 40 kg of LPG may be installed indoors on any floor. It is recommended to have a minimum floor area of 5 m³ for such installation.
- ii. Stationary installations each not exceeding 40kg of LPG may be installed indoors on any floor and within the same workspace provided the minimum distance between two such installations is 3 m, the proportion of such installations to floor area is one installation per Sq m and the aggregate quantity of gas of all such installations does not exceed 200 kg.
- iii. Refer IS: 6044 -2001 (Part-2) for capacity higher to above.
- iv. The storage tanks shall not be placed one above other.
- v. Number of storage tanks in one installation shall not exceed six. In case of more than one installation, the safe distance shall be maintained as per Table. 1 of IS: 6044 (Part-2).
- vi. Safe Handling:
 - a) Do not drag, drop or roll cylinders
 - b) The uncontrolled release of a gas under pressure may cause physical harm.
- vii. Conditions for Safe Storage:
 - a) Do not store near sources of ignition or incompatible materials
 - b) Cylinders should be stored upright, on a firm and stable surface.
 - c) Cylinders should be stored in an accessible, well-ventilated area.

3.14.6 **First Aid Measures**

1.	Swallowed	Due to high volatility of product, this is not likely to occur.
2.	Eyes	<ul style="list-style-type: none"> i. Do not delay– flood eyes gently with clean tepid water (not hot) for at least 15 minutes, or flush eyes for as long as possible with sterile saline solution ii. Remove contact lenses (if fitted) <p>Seek medical attention</p>
3.	Skin	<ul style="list-style-type: none"> i. Do not delay – handle patient carefully and Immerse in or flush the affected area with tepid water (not hot) for at least 20 minutes ii. Loosen any clothing that may restrict blood flow but do not remove iii. Thaw (defrost) out any frozen clothing with tepid water but do not remove. iv. Do not apply any form of direct heat v. Keep contaminated clothing away from ignition sources as some gas may be given off during thawing. vi. Loosely cover the affected area with a clean, dry dressing. vii. Do not allow smoking or drinking of alcohol as these reduce the blood flow to any affected area
4.	Inhaled	<ul style="list-style-type: none"> i. Allow fresh air to victim ii. Excessive exposure may cause unconsciousness or even death, due to asphyxiation (refers to vapour not liquid). If breathing has stopped, or irregular, apply artificial respiration iii. Seek medical attention

3.14.7

Fire Fighting Measures

1.	Fire/ Explosion Hazard	<ul style="list-style-type: none"> i. Evacuate area if required and remove ignition sources. ii. Cut off gas supply if safe to do so – do not endanger life. iii. Use Dry Chemical Powder only to extinguish the fire. iv. Drench and cool the LPG tank or cylinder with water spray from a safe distance v. Wait for Emergency Services at a safe distance. <p>Note: If ignition has occurred and water is not available or can't be sprayed on the tank or cylinder safely, the metal may weaken from the heat and explode. The potential affected area should be evacuated immediately, and emergency services notified from a safe location.</p>
2.	Combustion products	<ul style="list-style-type: none"> i. Carbon dioxide, water vapour, traces of carbon monoxide and nitrogen oxides ii. Fumes, smoke, carbon monoxide and aldehydes can be formed during incomplete

		<p>combustion.</p> <p>Note: Fire fighters may need self-contained breathing apparatus.</p>
3.	Advice to Firefighters	<ol style="list-style-type: none"> i. Temperatures in a fire may cause the tank or cylinder(s) pressure relief devices to open and release gas, or eventually rupture. ii. Cool the tank or cylinder(s) exposed to fire by applying water spray from a protected location
<p>Note:</p> <ol style="list-style-type: none"> 1. Fire fighting/protection facilities shall be as per Oil Industry Safety Directorate (OISD) norms/ American Petroleum Institute (API)/ National Fire Protection Association (NFPA)/ Institute of Petroleum (IP). 2. Water Sprinkler system shall be provided in vulnerable areas like storage tanks, column & hot pumps. Also semi-fixed foam system shall be provided in storage tank area 3. In order to detect leakages in advance hydrocarbon detectors shall be provided in vulnerable areas at all installations including LPG cylinder bank location. 		

3.14.8 **Accidental Release Measures**

1.	Personal precautions, Protective equipment and emergency procedures	<ol style="list-style-type: none"> i. Evacuate area if required and remove ignition sources. ii. Stop flow of gas/liquid if safe to do so – do not endanger life. iii. Move people from potential affected area, keep up-wind. iv. Notify emergency services. v. Stop flow of gas/liquid if safe to do so. vi. Spray water mist to disperse the gas cloud but avoid spraying water directly on leaking container as this may increase leakage. vii. Prevent spillage from spreading or entering underground drains by blocking with wetted cloths, sand or earth.
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3.14.9 **Engineering Controls/ Personal Protection**

1.	Ignition sources	<ol style="list-style-type: none"> i. Provide suitable ventilation to minimise an explosive environment ii. Do not bring sources of ignition into a potential hazardous area iii. Use only intrinsically safe electrical equipment. Do not bring items such as mobile phones, radios, cameras and other non-intrinsically safe electrical equipment into a potential hazardous area iv. Use only appropriate intrinsically safe (certified) tools and equipment in a potential hazardous area.
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		Note: Hazardous area atmosphere zones are not always easy to define or measure, these zone extents may need to be clarified by a competent person.
2.	Ventilation	LPG appliances can be hazardous when used in a poorly ventilated room. Maintain adequate ventilation

3.14.10 **Personal Protection:** To protect against accidental release of pressurised LPG when there is a possibility of LPG liquid release:

- i. Eyes/ Face: Wear full wrap-around safety glasses or goggles.
- ii. Hands: Wear appropriate thermal insulating gloves.
- iii. Body: Wear reduced static full body cover, cotton or other material with equivalent static and flame resistant properties
- iv. Respiratory: Where an inhalation risk exists, wear self-contained breathing apparatus.

3.14.11 **General Safety Requirements**

- i. Static Electricity & Lightning Protection:
 - a) Earthing and bonding, telecommunication & instrumentation shall conform to IS: 1913 (Part-1), IS: 2309 & IS: 3043.
 - b) Hand torches if used shall be of flame proof type.
 - c) All electrical installations within the safety zone shall be of flame proof type as per IS: 2148.
- ii. Grass & Weed Removal: Readily ignitable material such as weeds, long grass or any combustible materials shall be removed from an area within 3m from the shell of LPG tank of up to 2000 ltr. capacity and within 6m from the shell of larger tanks. For weed killers, chemical having no fire potential hazard shall be used.
- iii. Warning Signs: No smoking or naked flames shall be permitted within the safety zone of the installation. Prominent notices in this regard shall be displayed at access points.
- iv. During working at height refer clause no. 3.13.3 above.

REFERENCE:

1. IPSS: 1-11-030-17: Safety Standard for Working on Gas Lines in Steel Industry
2. IPSS: 1-11-002-19: Safety Procedure for Oxygen, Nitrogen & Fuel Gases
3. Safety Standard, Working on Gas Line from TATA Steel
4. Guidelines of IOCL for LPG
5. MSDS of LPG from Hindustan Petroleum
6. IS 6044 - 2001 (part-2): Code of Practice for LPG Storage Installations