		PROJECT	Standby SRU & Additional Tanks IOCL Paradip Refinery		
JOB SPECIFICATION FOR CHEMICAL CLEANING OF PIPING AND EQUIPMENT		CLIENT	INDIAN OIL CORPORATION LIMITED		
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JOB SPECIFICATION FOR CHEMICAL CLEANING OF PIPING AND EQUIPMENT

0	04/12/2019	ISSUED FOR IMPLEMENTATION	KMK	TNVS	TNVS	JMC
REV.	DATE	DESCRIPTION	PREPARED	CHECKED	APPROVED	AUTHORIZED

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1. Introduction:

INDIAN OIL CORPORATION LIMITED (IOCL) has awarded Fax of Acceptance (FOA) dated 29th August 2019 to M/s. Technip India Limited (TPIL) for Consultancy services (PMC/EPCM services) for overall project management, FEED Review / FEED, Detailed Engineering, Procurement & expediting services, Tendering & award, Construction Management & Supervision, Assistance in start-up, Commissioning & performance test runs for installation of a Standby SRU of 525 TPD capacity and execution of Additional tanks for Paradip Refinery, Odisha, India.

2. Definitions & Abbreviations

Abbreviation	Definition /Expanded form
IOCL/ CLIENT	Indian Oil Corporation Limited
PMC/ CONSULTANT	Technip India Limited
LICENSOR	Party selected by IOCL for process technology ownership for any UNIT
CONTRACTOR	Party whose services are obtained for performing the works specified as part of LSTK / packages.
EPCM	Engineering, Procurement & Construction Management Services.
LSTK	Lump Sum Turn Key portion of the work to be executed by CONTRACTOR
FEED	Front End Engineering Design
AUTHORISED REPRESENTATIVE	IOCL's/ CONSULTANT's representative authorized to act for and on behalf of them.
VENDOR	Any third party supplying the equipment/materials for setting up the Plant
PROJECT	Indicates Standby SRU and Additional tanks Project, Paradip Refinery
UNIT	Indicates any particular portion of the project to be built which can be Process related or Utilities/Offsites related
SRU	Sulphur Recovery Unit

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3. Scope

The scope of this procedure is to establish the guidelines for Chemical Cleaning of Piping and Equipment. For specific conditions and methods, Vendor/ service provider's procedures shall be referred.

4. Purpose

The purpose of chemical cleaning of steel equipment such as towers, exchangers, furnaces, boilers, tanks, transfer piping, etc., is:

- To remove oils or greases present in the system;
- To remove any unwanted iron oxides and scales;
- To provide a uniform protective layer during passivation stage.

The product will be a clean bare metal surface with a dark to grey passivation coating and the absence of any visible iron oxides.

Equipment and piping can be chemically cleaned provided:

- The material to be removed will react chemically with the solvent, or the solvent will disperse the deposit or scale;
- The solvent is not excessively corrosive to the materials of construction;
- The equipment being cleaned is not plugged to the point that circulation cannot be established.



Solvents used to chemically clean steel surfaces will vary from inhibited mineral or organic acids to caustic detergents. Choice of solvent will depend on the type of deposit or scale that must be removed and on steel composition.

Only competent personnel with proven experience should undertake chemical cleaning. Reliable chemical cleaning contractors are engaged for this purpose. In such case, chemical cleaning contractor operational procedures shall be applied.

5. Preliminary Operations

Prior to commencing chemical cleaning, several preliminary operations should be undertaken. These include the following:

- Study optimal arrangements for circulation and control of the system and/or piping loops to be cleaned, including any temporary piping, jump-overs, and bypasses required. Pumps, instrumentation and relief valves are normally removed before chemical cleaning;
- Install temporary bypasses, jump-overs, special chemical cleaning fittings, adaptors and flanges as required;

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- Move chemical cleaning equipment into position: skid mounted pumps, circulation tanks, flexible chemical hoses, filters, etc.;
- Ensure that all work areas are safely fenced off; HSE Norms of Owner shall be followed.
- Ensure that all personnel are acquainted with safety measures to protect human life and prevent environmental pollution;
- Prepare a specific procedure detailing stepwise all the activities to be performed considering the HSE requirements.

6. Chemical Cleaning Operations

Chemical cleaning is carried out in the following order:



- Flushing;
- Degreasing;
- Acid cleaning;
- Neutralization and Passivation;
- Conservation.

Some of the above listed steps may be omitted in some cases depending on the specific purpose of the operation.

6.1 Flushing

Flushing includes the following steps:

- Fill the circulation system with chloride free water and establish circulation in a closed loop with a recommended velocity of 1 to 4 m/sec inside piping;
- Vent off high points to verify fullness of system and elimination of air pockets;
- Perform leak checks under normal circulation condition;
- Apply pressure to the pump, temporary equipment and piping to be cleaned by restriction of return lines. Check again for leaks;
- By continuous addition of clean fresh water flush all lines to drain to remove loose dirt, debris and other foreign matter.

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- Flushing is considered complete when water exiting from the system contains no suspended solids.
- Air or steam blowing may be used in place of water flushing when convenient and feasible.
- Refer to specific procedures issued for water flushing, air and steam blowing;
- Stop circulation and drain the system to appropriate, approved discharge location as per the HSE requirements of the Owner.

6.2 Degreasing

An alkaline detergent solution is circulated vigorously throughout the system, and then heated to about 90°C for carbon steel equipment or to about 80°C for stainless steel equipment to remove rolling or drawing oils, greases, varnishes and other products. This step is necessary to remove the physical barrier of organic material and to allow subsequent acid steps full and complete contact with all internal surfaces and therefore promote solubilization of metal oxides present.

Degreasing includes the following steps:

- Fill system with clean fresh water;
- Circulate water at recommended velocity of 1 to 1.2 m/sec.;
- Heat circulating water to temperature of 80 to 90°C for carbon steel equipment or of 70°C to 80°C for stainless steel equipment;
- Vent at all high point vents to remove air from system;
- Check system regularly for leaks;
- Gradually dose circulating water with degreasing solution until following chemical strengths are reached:
- Caustic Soda 0.3% by weight.
- Trisodium Phosphate 0.2% by weight.
- Chemicals as Oil Dispersant and Wetting Agents may be added to improve operation according to Vendors recommended dosage;
- Maintain solution in circulation at 80 to 90°C for about 12 hours for carbon steel equipment or at 70°C to 80°C for about 5 hours for stainless steel equipment;
- During circulation, walk through the system and attentively check that all loops are circulating. If a loop lacks correct flow and/or has lower temperature, readjust valves accordingly;
- Measure flow rate and percentage of alkalinity every hour and record values in job log book;

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- After system is degreased, prepare to drain;
- Having verified that conditions are safe, Neutralize, drain waste chemical solution to a suitable sewer system or to approved receptacles by owner and start rinsing system with clean hot water;
- Repeat rinsing until water pH at outlet is approximately same as inlet water.

6.3 Acid Cleaning

A suitable chemical solution, chosen from one of several mineral or organic acids, is blended and inhibited to retard corrosion of the base metal, while allowing dissolution of metal oxides present (rust, scale, weld slag, etc). The concentration (%) of dissolved iron is monitored to determine when dissolution is complete.



Whenever mineral acid is used for carbon steel equipment, all acid cleaning operations should be carried out under nitrogen blanket to avoid metal surface oxidation upon contact with air.

Acid cleaning includes the following steps:

- Fill system with clean fresh water;
- Circulate water at recommended velocity of 1 to 1.2 m/s for carbon steel equipment or of 0.3 to 0.5 m/s for stainless steel equipment;
- Heat circulating water within a suitable temperature range that depends on the steel composition and on the solution used;
- Vent the system and check for leaks;
- Maintain water solution in circulation for about one hour to ensure that entire system has reached water temperature;
- Stop water heating; start dosing circulation water with acid solution;
- Typical solutions for acid cleaning and their relevant temperature range are reported here below, for carbon steel and stainless steel:

	CARBON STEEL	STAINLESS STEEL
Typical inorganic solution	- Inhibited hydrochloric acid 4% - 6%	- Nitric acid (65% solution) 10% by volume - Ammonium bifluoride (100%) 2.5% by volume - Sodium fluoride (100%) 3% by volume
Temperature range	60 to 70°C	40 to 50°C

- Carefully and gradually dose the acid solution;

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- Periodically check iron content and free acid content in the solution and record all readings in log book;
- When iron content and free acid content have stabilized, empty system and neutralize the discharge solution with caustic soda to prevent risk of accident or pollution;
- Start rinsing system with clean water until pH 7 of outlet water is reached. The effluents shall be disposed through Owner approved systems and records shall be made.
- Citric acid may also be used successfully both on carbon steel and stainless steel equipment.

In this case, typical required acid strength in circulating solution will be 4% to 10% and temperature 70 to 90°C for carbon steel equipment and 50 to 70°C for stainless steel equipment. Citric acid allows considerable savings in time and water use, because neutralization is not required nor is it necessary to drain under nitrogen blanket



6.4 **Neutralization And Passivation**

To neutralize all traces of acid left in the system and to confer residual corrosion protection to surfaces, all sections must be flushed with a neutralizing and passivating solution.

Neutralization/Passivation includes the following steps:

- Fill system with clean fresh chloride-free water (2ppm wt. max) which has been demineralized if possible;
- Circulate water at recommended velocity of 0.6 to 0.9 m/s for carbon steel equipment or of 0.3 to 0.5 m/s for stainless steel equipment;
- Heat circulating water to 50 to 60°C for carbon steel equipment or to 40 to 50°C for stainless steel equipment;
- Maintain hot water in circulation for about one hour to ensure that entire system has reached hot water temperature;
- Stop water heating and start dosing ammonia and passivating agent in the circulating water;
- Typical concentration for ammonia and passivating agent are reported here below, for carbon steel and stainless steel:

CARBON STEEL	STAINLESS STEEL
Ammonia and/or Sodium Nitrite 1% Passivating agent 0,8%	Trisodium Phosphate or Sodium Carbonate 2% by weight

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- Monitor solution pH and record readings in log book. If required add acid or alkaline to adjust pH;
- Maintain water solution in circulation for 4 to 6 hours to neutralize traces of acid in system and to confer residual corrosion protection to surfaces;
- Prepare to drain solution from system;
- Having verified that conditions are safe, after neutralization, drain waste chemical solution to suitable sewer system or to Owner approved receptacles; in case it will be not to discharge this chemical solution to the sewer system it will be disposed by contractor adhering the effluent norms of owner. Records of such disposal shall be submitted.
- Rinse system with clean chloride-free water (2ppm wt max) to remove residue or particulates remaining in system. This must be done carefully and not too vigorously, as the passive film is only 40-100 angstroms thick. It is also advisable to add a small amount of the passivation agent to rinse water.

6.5 Conservation



To remove remaining fluids, the system must be flushed with nitrogen, and low points purged.

When drying is over, system re-assembly is carried out. It is advised to light-flush the line with nitrogen during re-assembly. Risks of water infiltration in treated line must be avoided (condensation due to fog, rain, etc.). The system must then be maintained under nitrogen blanketing.

6.6 Quality Control

To maintain control of solvent solutions used in chemical cleaning, and to monitor both their effectiveness and progress of the cleaning process, the following quality control checks are required:

- Degreasing Solution.
- Monitor residence time and temperature.
- This solution operates by physical dissolution of oil and grease, and is not chemically consumed during degreasing. Time required to complete depends on temperature, circulation velocity, and level of contamination. Generally, 8-12 hours are recommended at 80 to 90°C for carbon steel equipment and 4-6 hours at 70 to 80°C for stainless steel equipment.
- Water Rinse
- Visually inspect for particulates and check pH of solution. A similar metal shall be used as a coupon for visual checks of the effectiveness.
- Water flush is performed to remove max amount of chemicals & materials before introduction of next solution.

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➤ Acid Cleaning Solution

Analyze acid and dissolved iron content of circulating solution hourly. Monitor temperature, flow rate, percentage of iron and pH.

Acid cleaning is completed when content of iron and free acid is quite constant, ignoring fluctuations caused by circulating and mixing factors. Time required to complete depends upon many variables, but generally 8-10 hours are adequate for carbon steel equipment and 5-6 hours for stainless steel equipment.

➤ Neutralization and Passivation Solution.

➤ Monitor pH, temperature, flow rate and residence time.

➤ This solution is prepared by adding neutralization chemicals and passivation agent to fresh water. pH is monitored during circulation while neutralization chemical (such as sodium bicarbonate) is added.

➤ Once a pH of 7.0 is obtained, the solution is chemically neutral.

➤ Further additions of neutralization chemicals are made during circulation, until a pH of 9 to 9.5 is obtained.

➤ Documentation.

Results of each test or inspection, and time of each result are recorded in log book. At end of each shift, logs are verified and signed by authorized Contractor and COMPANY Operation Inspectors. Test results shall be reported in the relevant Pre-commissioning Quality Control Form (refer to attachment 2) or attachment to it and it shall be integral part of the System Dossier.



7. HSE Precautions

During chemical cleaning, proper measures for safety and environmental control are required. Safety measures will safeguard personnel and prevent environmental pollution. In fact, the chemicals used (inhibited minerals, organic acids and caustic detergents) are usually hazardous for personnel, equipment and environment. All the potential risks of each substance are indicated on respective MSDS.

Besides this, the first phase of chemical cleaning is water flushing, so it's necessary to take all the precautions relevant to this operation. Furthermore, when operation is done under nitrogen atmosphere, precaution relevant to nitrogen purging shall be evaluated as well.



The following represent minimum precautions:

- Observe and enforce all local codes and regulations to safeguard plant, personnel and environment; Approved disposal of effluents generated with proper records.
- Inspect affected area to avoid conflict with other activities, special attention to be given for potential electrical hazards from flushing chemicals and other substances (e.g. water for water flushing or

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generic water based fluids);

- Verify suitability of water disposal facilities;
- Place warning signs and fence the entire cleaning area with strips of a colour distinguishable from those used for construction activities;
- Restrict entry into cleaning area to authorized personnel only;
- Product/Chemical Material Safety Data Sheet (MSDS) will be provided and specific precautions followed;
- Provide an emergency shower for personnel to wash off splashed hazardous chemicals;
- Provide adequate arrangement for concentrated chemicals;
- Arrange proper disposal of drum and any contaminated materials;
- Arrange for safe disposal of cleaning agents via a neutralization unit or disposal tank. Direct disposal to a safe sewer shall only be done after neutralization. Approved methods shall be followed.
- Define suitable area where discharge the chemicals;
- Instruct cleaning personnel how to safely stop cleaning actions immediately when required;
- Protective clothing, PVC aprons, gloves, boots, helmets, goggles and face shields shall be worn by cleaning personnel during cleaning and when handling cleaning agents;
- Prevent any persons from entering the exhaust blow area (if any), in order to obtain an high safety level;
- Transport all cleaning agents, inhibitors, and other chemicals in sealed containers, drums or tanks;
- System under blowing shall be properly isolated from connected systems on which other activities may be going on;
- Each valve isolating connecting lines or branches within the system under cleaning will be verified to be in the closed position by visually inspecting the valve stem and with the checking of the presence of the blind;
- Before (during water flushing operation) and during chemicals introduction walk down through the system to check its proper alignment and integrity (no major leaks);
- During cleaning an open bleeder or existing opening downstream of the isolation valve shall be monitored until it has been assured of positive shut off;
- Care should be taken if a leak occurs near electrical cables or distribution board;



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- Vent equipment to prevent pressure build-up by stored gases. Gas elimination through vent equipment shall be done during water filling for water flushing operation. If the chemical cleaning is conducted in heating/overheating condition, it's necessary to evaluate how chemicals volatility varies with temperature;
- Use gas-detecting instruments to check for presence and concentration of released gases.
- All the preventive measures identified in the JHA (Job hazard analysis) shall be followed.

8. Typical Arrangements For Chemical Cleaning

The following figures 1 through 5 show several typical arrangements for chemical cleaning of selected equipment and piping systems.

These attached figures are indicative, and should be adapted to meet the specific requirements of each chemical cleaning operation.

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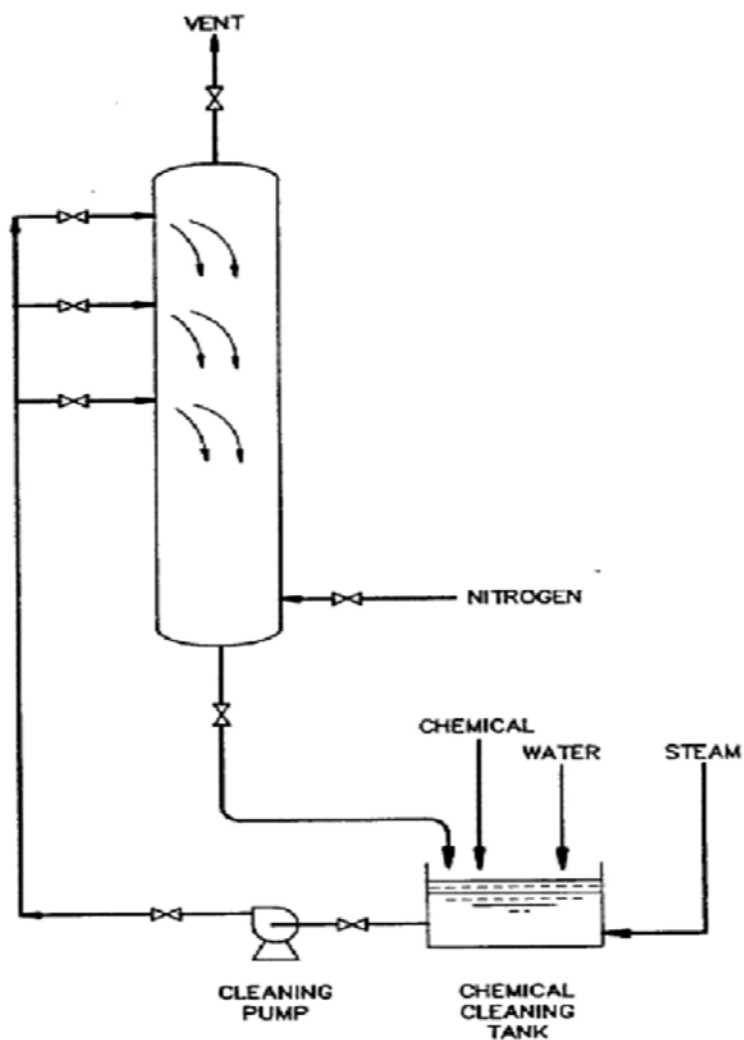




FIG. 1 : STANDARD ARRANGEMENT FOR CHEMICAL CLEANING OF LARGE TOWER (CASCADE METHOD)

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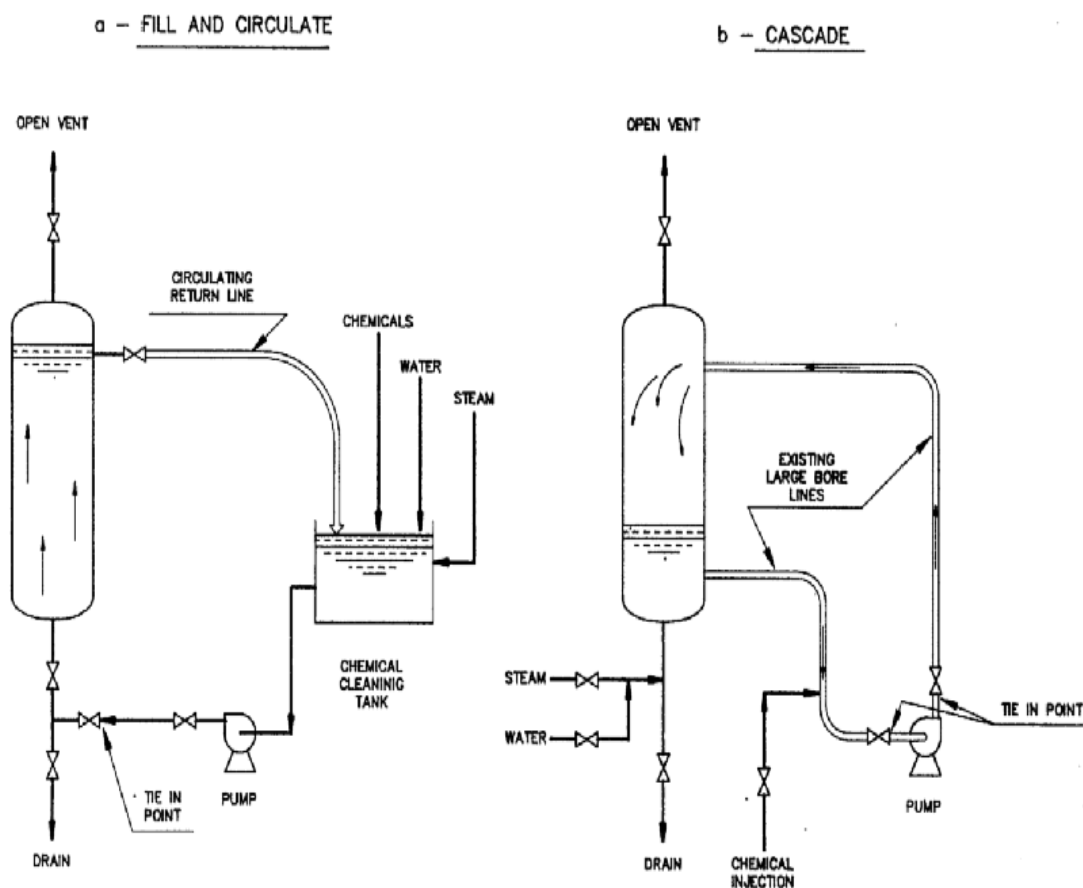




FIG. 2 : STANDARD ARRANGEMENTS FOR CHEMICAL CLEANING OF VESSELS
(a- FILL AND CIRCULATE METHOD; b- CASCADE METHOD)

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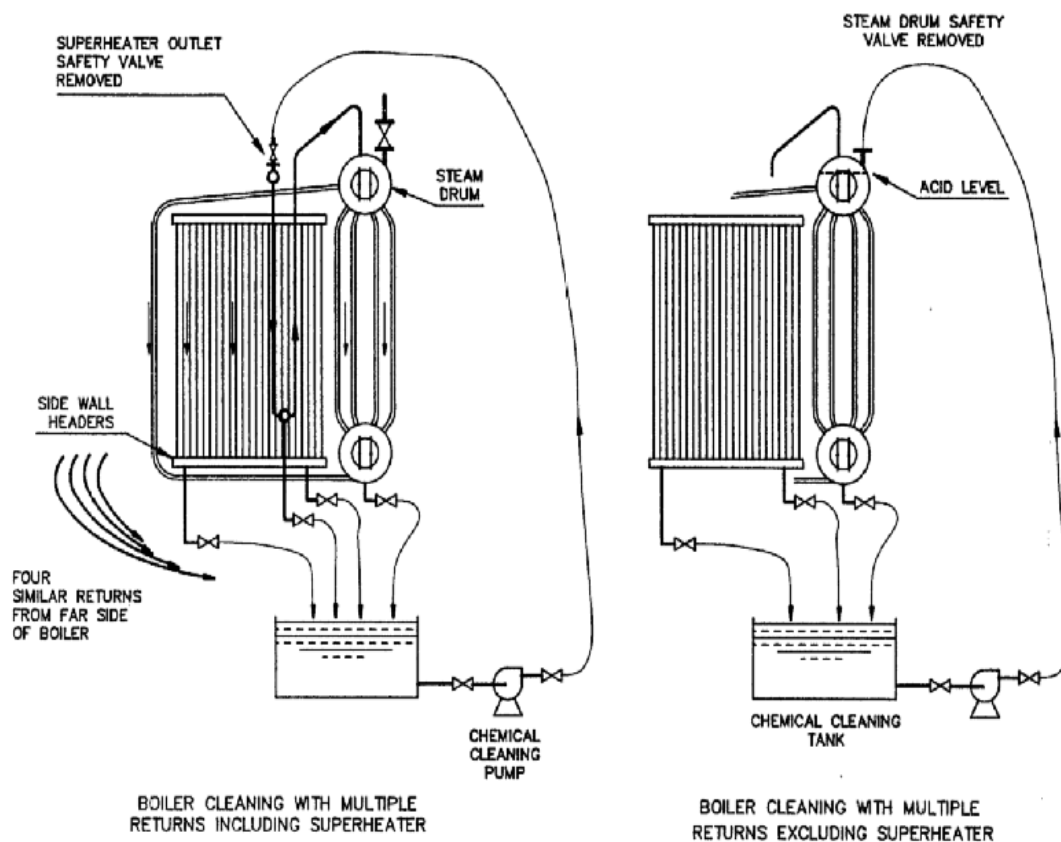




FIG. 3 : STANDARD ARRANGEMENT FOR CHEMICAL CLEANING OF BOILERS

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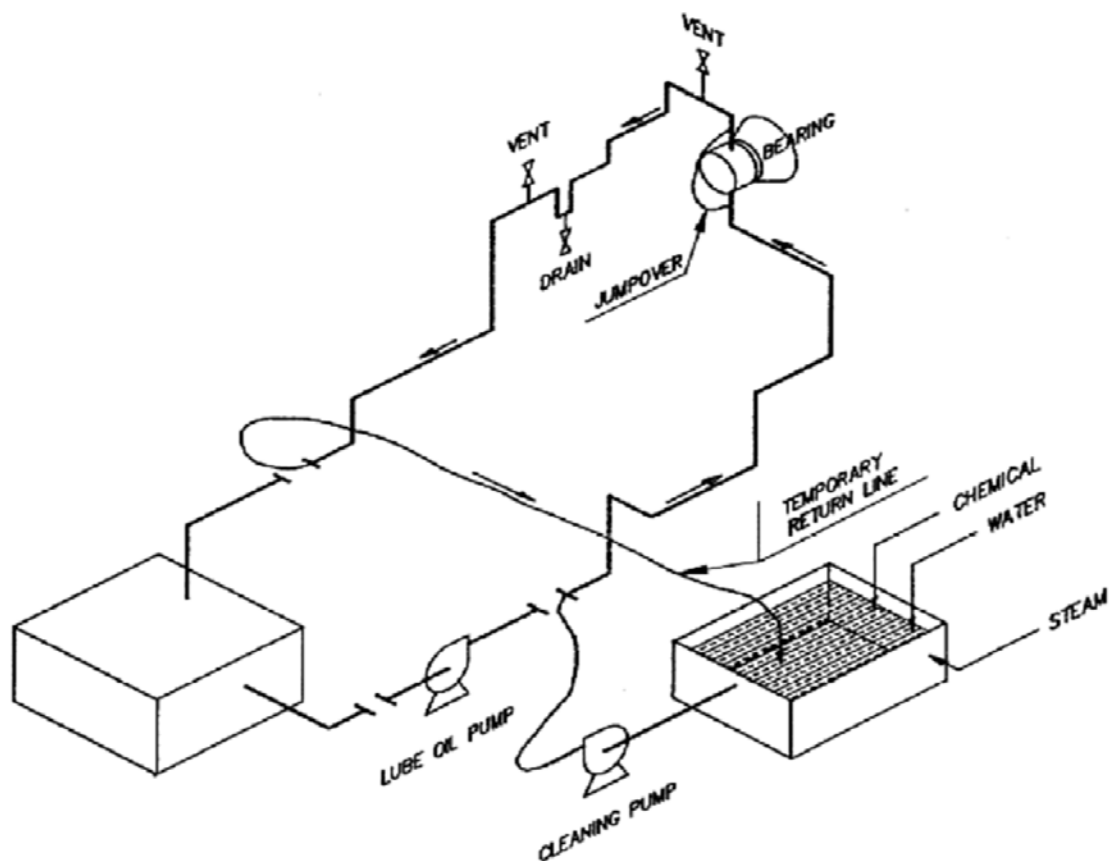




FIG. 4 : STANDARD ARRANGEMENT FOR CHEMICAL CLEANING OF LUBE OIL CIRCUIT

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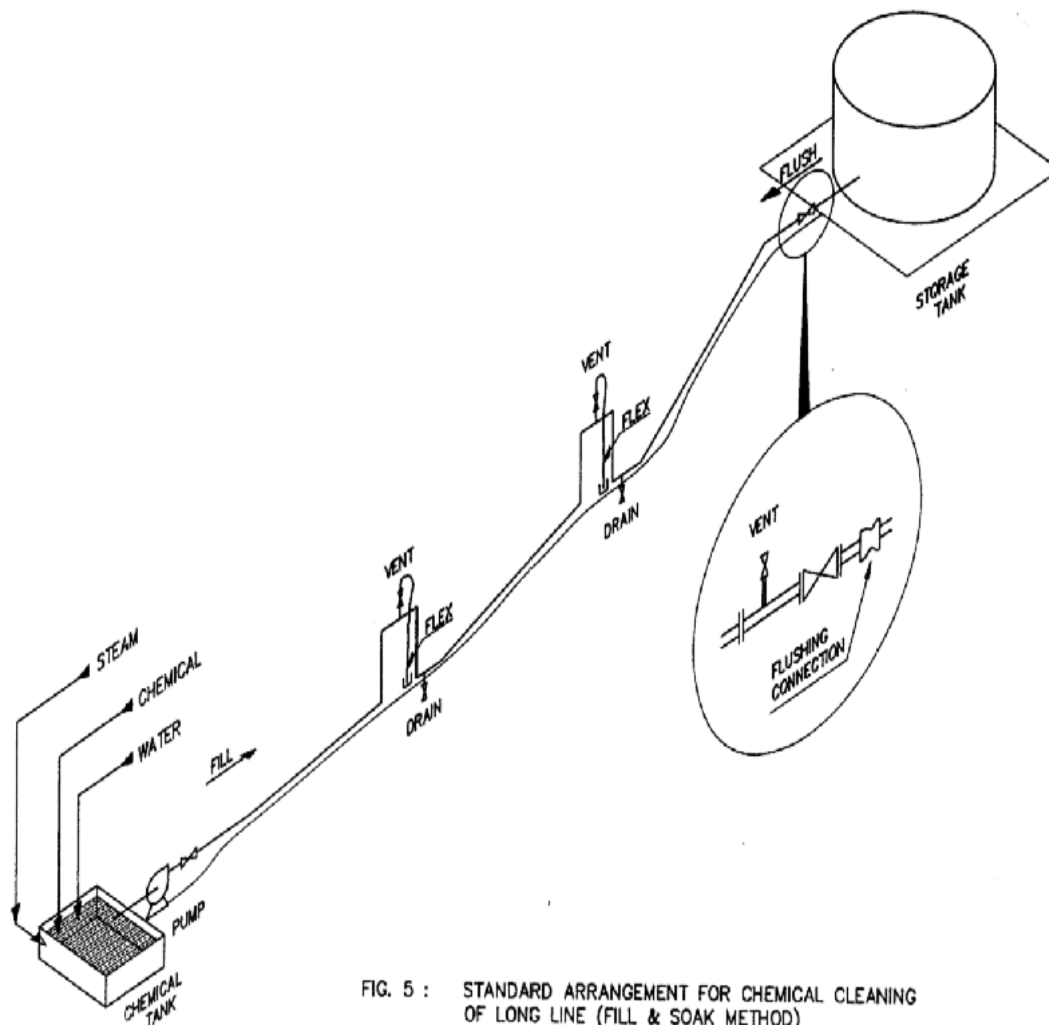




FIG. 5 : STANDARD ARRANGEMENT FOR CHEMICAL CLEANING OF LONG LINE (FILL & SOAK METHOD)

9. ATTACHMENTS



Attachment 1: Typical Job Hazard Analysis (JHA) for Chemical Cleaning of Piping Equipment

Attachment 2: Pre-commissioning chemical Cleaning Format



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ATTACHMENT 1
CHEMICAL CLEANING OF PIPING AND EQUIPMENT- Typical JHA



TASK	HAZARDS	CONTROLS
GENERAL RISKS	Poor Planning	<ul style="list-style-type: none"> Method statement and specific JHA available – application of the control measures hierarchy PTW available
	Poor Worksite - physical	<ul style="list-style-type: none"> Good means of access/egress – ladders Good work place - space available, illumination, housekeeping, scaffolding Weather conditions, surfaces status
	Poor Worksite – concurrent operations	<ul style="list-style-type: none"> Isolation of the Area with pre-commissioning tape during the operations Warning signs Coordinate with adjacent areas to ensure air blowing operation does not affect / conflict with other activities
	Poor Information	<ul style="list-style-type: none"> Orientation for Pre-commissioning phase of work Daily tool-box meeting – review of JHA and related PTW
	Poor Physical State	<ul style="list-style-type: none"> Workers fit for work Daily stretching
	Poor Logistics	<ul style="list-style-type: none"> Use appropriate working tools for the job; carry out material lifting using appropriate lifting devices, if handling weights above 20kg;
	Residual Risks	<ul style="list-style-type: none"> Full time fall protection PPE Area isolation (flagging, barricades). Barricade area with pre-commissioning tape Signals
	Emergency	<ul style="list-style-type: none"> Emergency instructions: phone/radio numbers, signals, muster point, actions to take Availability of first aid boxes
	Slips trips hazards	<ul style="list-style-type: none"> Housekeeping: keep work area clean Remove all trip hazards

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TASK	HAZARDS	CONTROLS
Preparation Secure Area	Slips Trips Falls Injury	<ul style="list-style-type: none"> Instruct involved personnel what to do, how to monitor operation, how to safe stop the activity if needed. Housekeeping: keep work area clean. Remove all trip hazards. Inspect affected area to ensure it does not conflict with other activities. Place warning signs and fence off both the points where nitrogen is introduced in the system and the nitrogen exhaust blow off area with pre-commissioning tape. Keep non-essential persons clear. Restrict access to authorized personnel only. Inspect affected area to ensure it does not conflict with other activities. Special attention to be given for potential electrical hazards from flushing water. Protect electrified equipment near flushing water outlets to prevent water contact with electric motors, instruments, electrical cable, power distribution boards, ecc. Appropriate PPE to be worn at all times (during all the steps of the job).
Install / Remove Spades / Blinds as required Open/Close Manway	Personnel Injury, Muscle Strains. Equipment Damage	<ul style="list-style-type: none"> Select correct tools for job. Mechanical lifting devices are to be used to prevent manual handling injuries. When manual handling is required, correct manual handling techniques is to be used. The use of two people or a team to lift heavy items should also be considered. Use proper scaffold or platform when working at height. A full body harness is to be worn at all times, with a lanyard attached securely to an anchor point. Positive isolate system under flashing from connected systems by means of double valves and bleed or valve plus blind.
Connection of Temporary Supplies	Personnel Injury	<ul style="list-style-type: none"> Temporary hoses shall be run in such a manner that they do not create a tripping hazard. All temporary line/hose must be rated for the working pressure and free from leaks. All valves isolated while making connection. All connections to be checked for tightness and security so fluid, with correct hose clamps and safety pins, cannot escape injuring personnel.

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Preparation for Cleaning	Contact with Chemicals Leak Personnel Injury	<ul style="list-style-type: none"> Any chemicals used for cleaning to be supplied with MSDS and all safety requirements adhered to. Transport all cleaning agents, inhibitors and other chemicals in sealed containers, drums or tanks. Provide adequate arrangement for concentrated chemicals. Arrange proper disposal of drum and any contaminated materials. Define suitable area where discharge the chemicals. Direct disposal to a sewer shall be done only after neutralization; arrange for safe disposal of cleaning agents via a neutralization unit or tank. Provide emergency shower for personnel to wash off splashed hazardous chemicals. Before cleaning, pressure test equipment to be cleaned and cleaning circuit. Instruct cleaning personnel to wear additional protective clothes (pvc parons, gloves, boots, goggles and face shields when handling cleaning agents).
Chemicals Introducing to System for Cleaning of Lines	Personnel Injury	<ul style="list-style-type: none"> During and/or before fluid introduction/pressurization, walk down through the system to check its proper alignment and integrity (no major visual leaks). During first water introduction, to verify the tight close of each isolation valve, an open bleeder or existing opening downstream of the isolation valve shall be monitored until it has been assured as positive shut off. Water to be introduced slowly to allow for close inspection for leaks. Vent equipment to prevent pressure build-up by stored gases. Gas elimination shall be done during water filling for water flushing operation. If the chemical cleaning is conducted in heating/overheating condition, it's necessary to evaluate how chemicals volatility varies with temperature Use gas detecting instruments to check for presence and concentration of released gases. Operation to be supervised by pre-commissioning engineer. Continuous monitoring to ensure the water from this operation does not pose hazard to other operation, especially electrical hazard. Care should be taken if a leak occurs near electric cables or distribution board.
Cleaning Complete Lock-out Tag- out Clean-up	Personnel Injury	<ul style="list-style-type: none"> All temporary chemicals supply to be removed in case someone turns on valve. Care is to be taken to ensure that the correct lock and tag are removed. Job site to be restored to original. Remove barricade when complete. Clean up for next worker is safe from injury. All hoses and electric cables and temporary equipment are to be removed once the task has been completed. The area is to be left clean and tidy with all rubbish and debris removed.

 	PROJECT	Standby SRU & Additional Tanks IOCL Paradip Refinery		
	CLIENT	INDIAN OIL CORPORATION LIMITED		
JOB SPECIFICATION FOR CHEMICAL CLEANING OF PIPING AND EQUIPMENT	Project No. 080557C001	Document No. 080557C-000- JSC-0093-011	Rev. No. 0	Page 21 of 21

Attachment 2: Pre-commissioning chemical Cleaning Format

<p align="center">PRECOMMISSIONING – QUALITY CONTROL REPORT</p> <p align="center">PIPING / EQUIPMENT</p> <p align="center">CHEMICAL CLEANING</p>

SYSTEM N°:	REPORT N°: PCR	PRECOM QC FORM : PCF-02P				
UNIT : _____						
LINE N°/ Equipment No.	REMARKS	DATE	SIGNATURE			
			SUB CONTRACTOR	CONTRACTOR	PMC	OWNER
NOTE :						
INSPECTORS	CONSTRUCTION CONTRACTOR	CONTRACTOR	PMC	OWNER		
NAME						
SIGNATURE						
DATE						

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