SECONDARY RECOVERY SECTION
GENERAL

Pressure maintenance in reservoirs is carried out in order to maintain the oil production for longer time and to achieve maximum ultimate recovery from the fields. It is carried out by injection of water, gas or air in the formation. In OIL, depending upon the reservoir, water injection is generally carried out at high pressure varying from 100 kg/cm² to 130 kg/cm². The path of water starts from Deep Tube Wells to Suction Manifold to Pumps to Delivery Manifolds to finally into Injection Wells.

So various SOP’s for specific sites are described as follows:

INJECTION WELLS

Procedure for injection of water in a well:

- Open both the tubing and casing valve of the injection well and allow the injected water to have a complete cycle of flushing to the nearby effluent pit before starting injection.
- After ensuring the return of clean water at the surface, close the casing valve slowly to start injection into the well.
- The above procedure to be followed if the injection is discontinued in the well for more than 2 hours.

While carrying out routine jobs on water injection wells following safety precautions should be taken.

- Use of personnel protective equipment is to be ensured.
- Calibrated pressure gauges and proper hand tools should be used.
- Status of valves both at the well and manifold should be confirmed prior to commencement of any rectification jobs on water injection flow line.
- Minimum two persons should be deployed for carrying out non routine jobs on water injection wells or high pressure flow lines.
**PUMPS**

High-pressure positive displacement pumps are used for water injection purpose.

**Following safety points must be ensured for safe operations of these high-pressure Pumps:**

- Floor area of pump house should be kept clean and dry. It is preferable to apply slip resistance coating on the passage of pump house.
- Coupling guards should be provided on high pressure water injection pumps.
- Lay out of the pump house should ensure accessible escape routes and unobstructed working space for free movement of operators.
- During maintenance of pumps corresponding section and discharge valves should be kept closed and motor should be de-energized from electrical sub-station.
- Before starting the pumps, corresponding section and discharge valves should be opened as required for particular type of pump.
- The pump should have pulsation dampener in the discharge line.

**Starting procedure of water injection pumps:**

The general procedure for running a water injection pump is given below:

- Ensure the level of POL in the prime mover and in the pump set.
- Ensure the disengagement of clutch of prime mover and the pump.
- Run the prime mover and observed for around 5-10 minutes.
- Ensure the proper setting of the Safety Relief Valve in the delivery line.
- Ensure the opening of all valves in the delivery/discharge stream (including well head valve of the injection well) except the pump delivery valve.
- To ensure sufficient pressure in the suction manifold by running adequate numbers of tube well.
- Open the suction valve of the pump.
- Open the By-Pass valve.
- Engaged the clutch of the pump set to run the pump.
Throttle the By-Pass valve very slowly and observe the pressure to develop to around 60kg/cm².

Open the delivery valve slowly. At this point, the water will enter the injection line/manifold.

Close the By-Pass valve completely.

Ensure the proper lubrication of all the lubrication points of the pump.

**Stopping of Water Injection Pump:**

- Disengage the clutch.
- After stopping of the pump shut the discharge valve.
- Open the By-pass valve to release the trapped pressure to the suction side.
- Shut the suction and By-Pass valve.
- Stop the Prime -mover.

**WATER INJECTION INSTALLATION**

**General guidelines to be followed in water injection installations are:**

- Non return valves should be provided at injection manifold.
- Since all the equipment and flow lines in water injection operations handle water on continuous basis. Painting jobs are to be planned and carried out regularly to avoid corrosion.
- Maintenance jobs on high pressure flow lines should be carried out after necessary isolation and depressurization.
- Disposal of unused chemicals should be carefully done to ensure safety of persons.

**Hydraulic Testing:**

- All manifolds, separators, connecting lines, valve flow lines etc. should be hydraulically tested to 1.5 times of maximum working pressure and the records to be kept in the installation.
- Thickness test of all the pressure vessels and piping to be done at least once in every three years.
**Safety Relief Valves (SRV)**
- The SRV set pressure should be 10% above the maximum allowable working pressure.
- SRV is to be installed on the pump delivery line and in any other discharged line of positive displacement pump.
- The discharged line of every safety valve should be connected to drain line for safe release of water from it.
- Safety valves should be tested at least once in every six month.

**Non Return Valve (NRV)**
- At the manifold header, a non-return valve should be provided in each flow line connected to well.
- NRV should be provided in the crude oil delivery line to avoid back-flowing.
- If two or more outlets operated in different operating pressures are connected to a common header/ line, NRV should be used in the low pressure outlets to avoid back flowing.

**DEEP TUBE WELLS**

**SAFE OPERATING PROCEDURE FOR STARTING AND BACKWASHING SOURCE WATER WELLS**
- Shut down the unit
- Close the bleed valve and outlet valve (delivery valve) of the source water well
- Fully open all the filter outlet valves (03 Nos.)
- Run / Start the unit. Then slowly open the tube well delivery valve. Bleed valve to remain fully closed at this time.
- Backwash the well till clear water is seen. If clean water is seen from the beginning, flush the well for minimum ½ hour.
- Then shut down the unit.
- Close all the filter outlet valves that were opened during backwashing job.
- Open the bleed valve and close delivery valve.
- Start the unit and check for delivery through the bleed line. Then close the bleed valve and open the delivery valve to the water injection pumps.
- Bleed line closing & delivery line opening to take place simultaneously.
HAZARDS

Injection of water into the formation involves handling of chemicals, distribution and injection of water under high pressure. So extreme care should be taken in handling the chemicals and also in working in high pressure lines.

SAFEGUARDS

The safeguards given below provide guidance. The operation manual/installation should be referred to detailers.

- A working platform, not less than 1 meter in width, should be provided over the water filter for service of the water cleaning installations.
- Personal protective equipment should be used for mixing chemicals.
- Automatic pressure recorder should be installed on discharge line of pump to ensure that the pressure does not exceed the rated capacity.

ACIDIZATION

GENERAL

This is a process in which oil bearing formation are treated with acid and chemicals to increase production of oil and gas. Hydrochloric acid, sometimes mixed with fluoboric acid also, is pumped down the well at high pressure. The hazards associated with the operation are similar to those connected with hydraulic fracturing and additional hazards are due to handling of acid and chemicals. In addition to the precautions mentioned in respect of fracturing, the following precautions are also recommended.
Safe handling of acid

- Acid container should be stored in a well-ventilated place. Chemicals which can react with acid should be stored separately. Acid storage tanks posted should conform to IS standards. See IS:6164-1971.
- Storage and container area of acid should be properly labeled and warning signs should prominently be displayed to denote “Danger-Acid”.
- Smoking should not be permitted at the place where acid is stored and suitable warning signs should be posted to this effect.
- Carboys or other containers of acid should be carefully lifted, preferably by mechanical means.
- Adequate quantity of lime should be kept readily available near the site where acid is stored to neutralize acid spills.
- Persons handling acid should be provided with suitable Personal Protective Equipment.
- Whenever it is required to dilute acid, the acid should be added to water. In no case water should be added to the acid.
- Fire tender should be stand-by during acidization job.
- Acid storing and mixing area should be barricaded with a fluorescent/brightly coloured ribbon.

No unauthorized person should be allowed inside the area.

First Aid
The first aid box and personnel trained in first aid should be available at the site. Adequate supply of clean and fresh water should also be available.

Acidization of wells:

- Prior to the acid job, a pit level meeting should be conducted wherein the responsibility of each person should be clearly told and the sign language to be used during the operation should be explained to each of the person concerned.
- The well site/working area should be temporarily fenced to restrict the entry of stray animal.
- A wooden ramp/platform with proper ladder should be erected at the backside of the acid mixing tank to facilitate storage and mixing of acid.
A pit is to be dug to collect the return fluid/unspent acid coming from the well. The bundh around the pit should be strong to avoid seepage of fluid to outside.

Prior to the acidization, the safety valves of the pumps delivery line should be tested hydraulically to avoid any seepage during the operation.

The units required for job should be placed at the safety distances from the well head.

The pump delivery line should be properly anchored.

Sufficient amount of lime should be kept at the site to neutralize the acid in case of any leakage during the operation.

After completion of the acidization, sufficient amount of lime should be added to the pilot pit to neutralize the acid so to avoid pollution hazards. The neutralization to be confirmed by testing (litmus test)

Prior to any acidization job pickling must be carried out to clean the tubing.

The unspent acid and the foreign materials produced during the acidization should be flushed out completely through reverse circulation/CTU prior to starting injection operation.

**PROCEDURE FOR WASHING EYES AND SKIN AFFECTED BY ACID**

If eyes, skin or other parts of body are affected by acids, wash it off with fresh and clean water at once. Remember that the first few minutes are most critical for washing of splashed acid. Do not use (except fresh water) any other solution to wash the eyes.

To wash the eyes, an eye wash bottle filled with fresh water should be used for at least 15 minutes. Use the thumb and forefinger of both hands to open the eye lids as wide as possible to permit free flow of water around the eyes. Do not attempt to close the eyelids or rub them. The injured should immediately be taken to a doctor and till that time, washing of eyes with eye wash bottle must continue. Reference may be made under head “First Aids Service”.
MOTORS & GENERATORS

Electric Motors are used in certain installations as a prime mover. Also we are using 125 KVA Generator sets for generating electric power to run Deep tube wells for adequate supply of source water and also for illumination requirements inside the Installation.

Motor (H.T and L.T)
The following shall be Inspection parameters:

- General Cleanliness
- Corrosion effect (external)
- Surface overheating/sparking
- Ventilation
- Vibration
- Abnormal noise
- External damages
- Load (Amperes)
- Lubrication
- Cooling System
- Effect of supply system disturbances such as voltage drop, power dip etc. (as given in the log entries at substation)
- Provision of Guards to moving parts
- Condition of commutator, brushes, and collector rings for slip ring and synchronous motors
- Any other inspection recommended by the manufacturer

Medium Voltage Motor Protection:

- The minimum protection requirement shall include fuses and thermal overload relay suitably co-ordinated with contactor characteristics as per applicable Indian Standards (BIS). However M.V. Motors controlled by circuit breakers may have either releases or relay for Motor Protection.

- Large MV Motors which are contactor fed (90 KW and above) may have core balance earth fault protection in addition to bimetal and fuse combination or composite motor protection relay.

- Bimetal relays shall be preferably with inherent protection against single phasing.
Generators

The following items shall be checked / tested, before start up:

- Cable connections
- Loose contacts in field circuit
- Open circuits in exciter/field coils
- Short circuits in the coils (exciter/stator/field)
- Blockage of ventilator openings
- Condition of bearings
- Turning of Oil rings
- Oil lubrication (adequacy & Oil quality)
- Alignment of coupled machines
- Grounding of coils (especially exciter)
- Brush spring pressure
- Earthing connections (body & neutral)
- Protection circuits (simulation tests)
- Auto/manual starting and changeover system.

The following items shall be checked after start up:

- Exciter voltage (whether low)
- Load on the generator
- Overheating of alternator/exciter/bearings
- Speed whether steady or hunting (growling)
- Sparking of brushes
- Commutator surface for uniformity (projection, if any)
- Carbon dust collection (whether consolidated between the commutator segments)
- Audio visual annunciation
- Noise
- Brush spring pressure.
**Generator Protection:**

The protecting generally used for generators are as under. However the actual protective requirements will vary from case to case, depending upon the rating, excitation system, operation, type of prime mover etc.

- Differential protection (87 G)
- Stator earth fault (51 N)
- Rotor earth fault (61)
- Voltage controlled over current (51V)
- Reverse power (32)
- Field failure (40)
- Unbalanced loading protection (46)
  - (Negative sequence current protection)
- Stator winding temperature protection (49 T)
- Under frequency protection (81)

When generator with unit transformers is employed besides individual equipment protection, the following additional protections are recommended:

i) Transformer over fluxing protection

ii) Overall generator unit transformer differential protection.

  o In installations where generator is operating in parallel with the grid, special protection such as out of step relay may be required.
  o It is recommended that synchronizing check relay for bus coupler may be provided on those switchboards having grid as well as in plant supply with manual transfer & momentary paralleling feature.
**Precautions during welding**

Welding Jobs are often required in the installation as well as the flow lines on account of various types of failures resulting from Corrosion, ageing equipments, miscreant activity etc. Depending on the job profile the types of Pre Cautions are taken are summarized below.

- No person other than a competent welder duly authorized in writing by the manager, installation manager or engineer (mines) shall carry out welding or cutting work requiring use of flame or electric welding apparatus.

- No welding or cutting work shall be undertaken by any welder in any classified hazardous area unless a written permit, called “Hot work permit” in the form specified in the second Schedule is issued to the welder by the manager or installation manager. Copies of hot work permits shall be entered in a bound paged book kept for the purpose.

- No welding or cutting work shall be undertaken in hazardous area unless the area is duly examined and found gas free by a competent person authorized for the purpose. A report of every such examination shall be recorded in a bound paged book kept for the purpose and shall be signed and dated by the person making the examination.

- During the welding and cutting operations, the welder shall see that –
  1. All flammable material, oil grease, oil-soaked earth are removed from the area;
  2. No matches, lighters or smoking apparatus or any other source capable of igniting flammable gas is present at or around his place of work. Provided that nothing in this clause shall be deemed to prohibit the use of any suitable apparatus for the purpose of lighting or re-lighting the welding torch.
  3. Adequate precautions are taken to prevent fires being started by sparks, slag or hot metal.
  4. Adequate number of foam type or dry-chemical type fire extinguishers are readily available for immediate use.
  5. When operations are carried out in confined space, adequate ventilation by mechanical means is constantly provided to prevent accumulation of flammable gas.
  6. When operations are carried out on pipeline which contained flammable fluid, the pipe is disconnected or blinded, the line is isolated, drained or purged with inert gas or water before hot work is undertaken and adequate precautions are taken against build-up of pressure in the line while hot work is in progress.