Safe Practices

For

Workover and Well Stimulation Operations

Prepared by:

Committee on “Safe Practices for

Workover and Well Stimulation Operations”

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FOREWORD

The Oil Industry in India is more than 100 years old. Because of various collaboration agreements, a variety of international codes, standards and practices have been in vogue. Standardization in design philosophies and operation and maintenance practices at a national level was hardly in existence. This coupled with feedback from some serious accident that occurred in the recent past in India and abroad, emphasized the need for the industry to review the existing state-of-the-art in designing, operating and maintaining oil and gas installations.

With this in view, the Ministry of Petroleum and Natural Gas in 1986 constituted a Safety Council assisted by the Oil Industry Safety Directorate (OISD) staffed from within the industry in formulating and implementing a series of self regulatory measures aimed at removing obsolescence, standardizing and upgrading the existing standards to ensure safe operations. Accordingly, OISD constituted a number of functional committees of experts nominated from the industry to draw up standards and guidelines on various subjects.

The present guidelines were first published in the year 2000. These were taken up for revision by the functional committee, in the year 2007. Additional inputs have been provided related to offshore operations, besides complete revision of the existing document. The document has been re-titled as “Safe Practices for Workover and Well Stimulation Operations”

The document is based on the accumulated knowledge and experience and the various national and international codes and practices.

These guidelines are meant to be used as supplement and not as a replacement for existing codes and practices.

The purpose of these guidelines is to assist the oil well servicing industry in prevention of accidents.

It is recognized that these guidelines cannot possibly cover all the problems which may arise in the operation and maintenance of oil well servicing equipment. Owners of servicing equipment and their employees should constantly be alert to unforeseen hazards and realize that changing conditions will present new hazardous exposures which must be met with appropriate precautions. These guidelines should, however, assist each individual worker to improve his work methods and reduce accidents.
The recommendations should be used only when applicable and with modifications as necessary due to operating conditions, type of equipment, etc. Nothing herein shall be deemed to constitute the setting up of minimum or maximum standards for the oil well servicing operations, or to regulations.

Suggestions are invited from the users after it is put into practice to improve the document further. Suggestions for amendments to this document should be addressed to:

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These Guidelines in no way supersede the statutory requirements of bodies like DGMS, PESO or any other Government Body which must be followed, as applicable.
**FUNCTIONAL COMMITTEE ON “RECOMMENDED SAFE PROCEDURES AND GUIDELINES FOR WORKOVER AND WELL STIMULATION OPERATIONS” (2000)**

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In addition to the above, several other experts from the industry contributed in the preparation, review and finalization of this document.
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SAFE PRACTICES FOR WORKOVER AND WELL STIMULATION OPERATIONS

1.0 INTRODUCTION

Workover operations are carried out on wells during life of well for purpose of maintaining, restoring or increasing the productivity /injectivity of well and also for the abandonment of well.

Workover operation includes:

1. Repairing/replacing downhole completion equipment and surface equipment
2. Repairing liner/casing
3. Water and gas control
4. Sand clean out/gravel pack
5. Zone transfer
6. Change of completion (single, dual, commingle etc.)
7. Installing/servicing of artificial lift
8. Side tracking/drain hole drilling
9. Fishing
10. Well abandonment

During workover operations following jobs may be required to be performed:

- Rig building /dismantling (onshore rigs)
- Well subduing
- Perforation and logging
- Running in /pulling out of tubular
- Cementing
- Well activation/ well testing
- Stimulation

Well stimulation includes:

- Acidization
- Hydraulic fracturing
- Surfactant/solvent treatment
- Coiled tubing assisted operations
- Hot oil services
- Nitrogen application

Safe practices related to personnel, equipment, operations and maintaining well integrity, during workover and well stimulation operations, both onshore and offshore, have been covered in these guidelines.

2.0 SCOPE

This document provides guidelines on safe practices for workover and well stimulation operations, both onshore and offshore.

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3.0 DEFINITIONS

1. ACID FRACTURING
   A hydraulic fracturing treatment performed in carbonate formation to etch the open faces of induced fractures using hydrochloric acid and additives.

2. ARTIFICIAL LIFT
   Any method used to lift oil to the surface after well ceases to flow on self.

3. CEMENTING
   The application of liquid slurry of cement and additives to various points of interest inside or outside the well casing and related operations.

4. COILED TUBING SERVICES (CTU)
   The coil tubing services is a second-generation workover system employing continuous string tubing to carry out various workover and well maintenance jobs on live wells. The continuous tubing is stored on a ‘reel’ and coiled upon itself in the same manner as the flexible cable of a logging unit. The tubing is straightened and lowered in the hole by an ‘injector’, installed directly on the well head through a ‘stripper’ which allows lowering and pulling out of coiled tubing under pressure.

5. HOT OIL SERVICES
   This service involves pumping of hot crude oil or water through the well flow line or production tubing, partially or completely choked due to wax deposition.

6. HYDRAULIC FRACTURING
   The objective of hydraulic fracturing in well stimulation is to increase well productivity by creating a highly conductive path from the well bore deep into the formation. The fractures are created by use of hydraulic force and the conductivity is maintained by propping with sand / proppant to hold the fracture faces apart.

7. MATRIX ACIDISING
   It is the technique of injecting acid into the formation below the pressure at which fracture is created. This technique is applied primarily to stimulate by dissolving acid soluble material in the formation to remove skin damage caused by drilling, completion, workover operations or plugging caused by precipitation of deposits from produced water or oil.

8. MODULAR WORKOVER RIG:
   Offshore Modular rigs are platform mounted workover rigs and consists of light weight components that can be installed on the well platform piece by piece.

9. PULLING OUT
   To pull the tubulars including tubing/drill string, sucker rods etc. out of the wellbore.

10. RIGGING UP/DOWN
    To assemble a workover rig and place auxiliary equipment at appropriate location to start the workover operation. Rig down is to dismantle a workover rig and auxiliary equipment following the completion of workover operation.

11. RUNNING IN
    To lower the tubulars including tubing/drill string, sucker rods etc. into the wellbore.

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12. **SAND CONTROL**
Sand control is the technique of arresting the movement of formation sand during production from oil or gas wells. The sand control techniques include gravel packing, installation of pre packed liners, and consolidation.

13. **SECONDARY CEMENTATION** – are mainly classified as plug cementing and squeeze cementing.
Plug Cementing – a cement plug of specified length when placed across a selected interval in a well.
Squeeze Cementing- The forcing of cement slurry by the application of pressure to specified points in a well to cause seals at the points of squeeze. It is used to re-cement channeled areas or to block off an un-cemented zone, to isolate a producing formation, seal off water, repair casing leaks and so forth.

14. **SQUEEZE POINT**
The depth in a wellbore at which cement is to be squeezed.

15. **STIMULATION**
A process undertaken to remove formation damage / enlarge old channels or to create new ones in the producing formation for enhancing productivity/injectivity of as well.

16. **SURFACTANT/SOLVENT TREATMENT**
It is a wellbore treatment to remove wellbore damage caused by water-blocks, wettability alteration, wellbore plugging with heavier deposits etc which can occur during production or workover jobs. Surfactant acts as a surface active agent and its function as an emulsifier or dispersant depends on the application requirements.

17. **SWABBING**
It is the act of taking out fluid from the wellbore so as to reduce the head, thereby inducing influx into the well. Swabbing equipment includes a swabbing assembly, lubricator with an oil saver, wireline BOP and shut-off valve on the well, also called a Swabbing valve.

18. **WATER SHUT OFF**
Water shut off techniques involves pumping of the cement slurry/chemicals/polymer systems to arrest / prevent water coning near water oil contact and breakthrough of water through high permeability streaks in water drive reservoirs.

19. **WELL INTEGRITY**
It is defined as prevention of uncontrolled release of formation fluids throughout the life cycle of a well.

20. **WORKOVER RIG**
The derrick / mast, drawworks, engines, pumps and necessary surface equipment of workover unit.

4.0 **SAFETY OF PERSONNEL**

For training requirements refer OISD-STD-154 and 176 on ‘Safety Aspects in Functional Training’ and ‘Safety, Health & Environment Training for Exploration & Production (Upstream) Personnel’ respectively.

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4.1 PERSONNEL PROTECTIVE EQUIPMENT

4.1.1 HEAD PROTECTION

i) Approved safety helmets shall be worn by all personnel at all times while working within working areas, outside accommodation and offices.

4.1.2 CLOTHING

i) Overalls shall be worn by all personnel during workover and stimulation operations (preferably cotton). For increased safety use of fire retardant overall should be considered.

ii) Unreasonably loose, poorly fitted or torn clothing should not be worn.

iii) Personnel clothing which gets saturated with flammable or toxic substances or spillage/spray, should not be worn until it is thoroughly cleaned.

4.1.3 HAND PROTECTION

i) Safety gloves shall be provided to all personnel and worn as appropriate, for the work.

ii) Rubber gloves shall be available and worn by electrician while working.

4.1.4 FOOT PROTECTION

Approved safety shoes or safety boots shall be worn by personnel in working areas.

4.1.5 EYE PROTECTION

i) Eye protection equipment appropriate for the work being done shall be worn by personnel where there is reasonable probability of injury to eyes from flying objects, or injurious light, fluid or heat.

ii) Safety glasses, shields and goggles should be worn when eye hazard exists like when chipping, grinding, hammering, cutting wire line, changing tong dies, scrapping paint, using a drill machine, operating a press, a lathe machine, and for any other activity which may cause foreign body entering the eye.

iii) In addition to the safety goggles, a face shield shall be worn when handling corrosive or harmful products (solids or liquids).

iv) Welding helmet or hand-held shield shall be used when performing arc welding rather than welding goggles.

v) Welding goggles should be worn when using a cutting torch.

vi) Provision for eye wash with potable water shall be available at chemical handling areas.

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4.1.6 HEARING PROTECTION

Protection against effect of noise exposure should be ensured when the sound levels exceed the maximum permissible noise exposure as given in the table below:

**MAXIMUM PERMISSIBLE NOISE EXPOSURE**

<table>
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<td>HOURS</td>
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<tr>
<td>1/2</td>
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<td>1/4 or less</td>
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When the daily noise exposure is composed of two or more periods of noise exposure of different levels, their combined effect should be considered rather than individual effect of each. Exposure to impulsive or impact noise should not exceed 140dBA peak sound level.

i) No person shall enter or be allowed to enter without appropriate ear protection, an area in which the sound level is 115 dBA or more.

ii) No person shall enter or be allowed to enter an area in which the sound level is 140 dBA or more.

iii) Hearing conservation programme should be considered, as appropriate, to protect the hearing of personnel.

4.1.7 RESPIRATORY PROTECTION

i) An industrial hygiene assessment of work area should be done to identify the potential hazards that may require respiratory protection.

ii) Approved self contained or supplied air breathing equipment shall be used for those atmospheres where tests indicate toxic or hazardous gases presence in quantities immediately dangerous to health or oxygen content is less than necessary to sustain life.

iii) Air from the rig utility system should not be used as the source for breathing air supply.

iv) Personnel should be trained in the use and operation of breathing equipment available at site.

v) Personnel should be advised of the potential dangers of flammable, hazardous gases and insufficient oxygen atmosphere.

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For further details refer OISD-STD-155 and 184 on ‘Personnel Protective Equipment’ and ‘Standard on Replacement of Personal Protective Equipment and Life Saving Appliances’ respectively.

4.2 PERSONNEL SAFETY EQUIPMENT

4.2.1 FALL PROTECTION

All personnel, when engaged in work 3 mts. above the rig floor or other working surfaces, shall be protected at all times from falling by guardrails system, safety net system, or personal fall arrest system (PFAS).

i) PFAS includes a full body harness and connecting devices between the harness and the anchorage connector. Connecting devices may consist of a lanyard, energy (shock) absorber or shock absorbing lanyard, fall arrestor or deceleration device (i.e. rope grab), lifelines (horizontal or vertical), or a self-retracting lanyard or lifeline. Suitable combination of these may be used to provide a complete system.

ii) The lanyard shall be adjusted to permit a maximum drop of 1.8 mts. in case of a fall.

iii) Personnel should be trained in use of PFAS.

iv) PFAS should be inspected prior to each use.

v) Manufacturer’s instructions for inspection and replacement should be followed

4.2.2 SAFETY BELT

i) While working at any unguarded area at an elevation, safety belt shall be worn.

ii) Safety belt, a travel-resistant system, keeps the person from getting too close to unprotected edge.

iii) Safety belt is not recommended for use as a fall arrest device as it provides suspension from one part of the body only (this would restrict freedom of movement during a fall).

4.2.3 TOP MAN ESCAPE DEVICE

On onland rigs, the mast shall have an auxiliary means of escape installed prior to personnel working in the mast.

i) The escape route shall use a specially rigged and securely anchored escape line attached to the mast so as to provide a ready and convenient means of escape from the topman’s (also called derrickman) working platform.

ii) The escape line route should be kept clear of obstructions.

iii) A safety buggy equipped with an adequate braking or controlled descent device should be installed on the escape line, kept at the topman’s working platform, and secured in a manner that will release it when weight is applied.

iv) Tension on the escape line should be periodically checked and adjusted to enhance safe landing of the user.

v) The landing point area onland should be covered with soft cushioning material to ensure ‘soft’ landing.

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vi) It is recommended that the ground anchor point of the escape line should be located a minimum lateral distance from the mast equal to two times the height of the work platform.

vii) Personnel should be trained in the proper procedure(s) for escaping from the mast.

In offshore rigs, suitable means, for escape of topman, should be provided.

4.3 OFFSHORE RELATED

Safety in offshore is of prime importance due to hostile environment and severe constraints of operations.

i) The system and equipment provided in offshore should be designed for safe and reliable operations.

ii) All personnel concerned with the operation and maintenance should be suitably qualified and familiar with the details and operating conditions/characteristics of equipment and systems.

iii) Each person shall know where the safety and fire suppression equipment is placed and how to operate it.

iv) Escape route shall be prominently displayed at the strategic locations. Primary and Secondary escape routes to muster stations (emergency station) shall be clearly indicated by proper safety signs. The escape routes shall be clear of any obstruction.

v) Personnel shall be aware of abandonment procedure, abandonment/emergency station, emergency signals and water entry procedures. Visitors should also be made familiar with signals and action required to be taken.

vi) A basket stretcher capable of being hoisted safely with an injured person should be provided and maintained in an accessible place and designated personnel should be instructed in its correct use.

vii) When a crane is being used to transfer personnel over water, personnel shall wear approved personal flotation devices and should not ride on anything other than personnel net or a device specifically designed for that purpose.

viii) Load should not exceed basket manufacturer’s specifications. Personnel basket should be inspected at frequent intervals. Personnel basket should be used only for the transfer of personnel. Equipment, materials, or supplies should not be lifted in personnel baskets.

ix) Tag lines should be used to guide and steady all loads being lifted.

x) Transfer of man & material to and from boat to rig and vice- versa should be done with extreme care, taking into consideration the weather conditions and such transfers should be stopped during adverse/unsuitable weather conditions.

xi) Adequate means of communication between crane operator and signal man should be available.

xii) The working area of the crane should have adequate illumination and free of any obstruction which may interfere with operations.

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xiii) Helideck rules should be pasted at entrance and strictly followed. When helicopter landings and takeoffs are in progress, crane operations should cease and the boom be safely positioned. A competent person should be designated to be in control of helideck operations.

xiv) During workover at a well platform, there are generally more than one well. It is therefore likely that at any given time, oil and gas are being produced from some of the wells and other works may also be taken up simultaneously. In such cases, prior to undertaking any job, job safety analysis should be carried out to ensure that all the hazards related to the proposed operations are identified and assessed. For further details refer OISD-STD-186 on “Simultaneous operations in Exploration & Production Industry”.

xv) Personnel should undertake offshore related safety trainings, which include:
   - Personnel survival techniques
   - Fire fighting
   - First aid
   - Personnel safety and social responsibility
   - Helicopter underwater escape training

xvi) All installations shall be equipped with necessary life saving appliances / equipment which should be regularly inspected and maintained in constant state of readiness. These include:
   - Life boats
   - Inflatable life raft
   - Life jacket
   - Work vest
   - Life buoys
   - Personnel basket
   - Scramble net
   - Jumping rope
   - Fire blankets
   - Fire suits
   - Breathing apparatus

xvii) A plan showing the position of all life saving appliances (except lifejackets issued to individuals) on the installation should be ensured.

4.4 MEDICAL

As workover jobs are frequently done at remote areas in onland where medical aid is not readily available, it is strongly recommended that all employees undergo training in first aid.

i) All occupational injuries, no matter how small, shall be reported promptly to the shift in-charge. He is to make out a full report at the end of the shift on an approved accident form and handover to the Rig Incharge.

ii) The information regarding availability of first aid kit should be known to all personnel.

iii) An adequate and approved first aid kit shall be provided on each rig and should be conspicuously located. The first aid kit should have all medicines, as recommended.

iv) At least one person who is trained and certified in first aid and basic rescue techniques shall be available in each shift.

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v) Posters demonstrating techniques (like cardiopulmonary resuscitation, stopping bleeding) and first aid should be displayed at work place.

vi) Emergency contingency plan shall be available at site.

vii) Telephone numbers, location and other related information pertaining to availability of medical personnel, transportation and medical facilities shall be available at the site.

viii) Emergency vehicle at onland site should have the provision to shift injured person on stretcher to nearby medical centre.

ix) Well stimulation team shall also be equipped with necessary first aid kit and trained personnel, to take care of eventualities when it is working on stand-alone basis at onland sites.

x) In offshore, Health emergency preparedness should be incorporated into the general emergency preparedness of the installation.

For further details refer OISD-GDN-204 on 'Medical Requirements, Emergency Evacuation and Facilities (for Upstream).

4.5 CHEMICAL HAZARDS

Hydrocarbon industry uses a variety of chemicals. These chemicals are used as absorbents, solvents, additives, catalysts, coloring agents, laboratory reagents etc. All such chemicals, along with petroleum, pose health hazards to the operating personnel.

Chemicals have properties to cause personal injury due to contact with or entry into the body via inhalation, ingestion, skin contact or eye contact. Health hazard may result from repeated, chronic and long term exposure to even low concentration of such chemicals (for further details refer OISD-GDN-166 on ‘Guidelines for Occupational Health Monitoring in Oil and Gas Industry).

Material safety data sheet (MSDS) shall be available for the chemicals being used. Besides properties of a particular substance, MSDS should also contain information on procedures for handling and working with that substance in a safe manner, potential hazards, health effects, first aid, spill handling etc. in line with OISD-STD-114 on “Hazardous Chemicals and their Handling”.

Relevant portion of MSDS in local language shall be prominently displayed in the working areas. Personnel should be made aware of the first aid actions required to be taken for routinely used chemicals and necessary facilities required (to take first aid actions) should be provided. Use of appropriate PPE should be ensured.

4.6 COMMUNICATION

The means of communication shall be selected based on the need for communication in anticipated scenarios including emergencies, and taking into consideration the operational conditions under which they are to function like, noise, ambient conditions and susceptibility to damage.

i) Signals between supervisors, personnel and other involved in the operation should be agreed upon and fully understood.
ii) All equipment should be located so that equipment operators can see the personnel involved in the operation; or alternate specific arrangements should be made to assure adequate communication.

iii) Communication equipment should be in good working condition.

iv) Minimum two independent communication systems should be provided at site.

v) The communication equipment situated in classified hazardous zones should be of a type suitable for use in such zones.

vi) In offshore, suitable means of communication should be ensured at all times for communicating internally as well as externally with other stations. Also, emergency communication system should be ensured. The source of power of this (emergency communication) system should be independent of the normal current sources of the installation.

vii) Good communication should be ensured between the well platform personnel and rig crew throughout the workover activities in offshore.

4.7 EMERGENCY RESPONSE PLANNING

The objective of emergency response planning is to have clear written procedures for expected actions during anticipated emergencies. Emergency response plan includes operational and procedural requirements for various emergency scenarios.

4.7.1 EMERGENCY DRILLS AND EXERCISES

The effectiveness of emergency response should be demonstrated through a programme of drills and exercises. Evacuation, escape and rescue procedures shall be tested during the drills to verify their efficacy (for details refer OISD-GDN-227 on ‘Emergency Response and Preparedness in E&P Industry’).

The drills need to address the readiness of personnel and their familiarity/proficiency with emergency equipment and procedures.

All personnel involved, including contractor’s employees, should participate in the drills. Scenarios should be varied to avoid drills being perceived as monotonous.

Drills (Fire, Pit and Rig Abandonment) should be regularly held with the purpose of training/making persons aware in the correct use, handling and operation of emergency equipment and also to examine, clean, recharge or replace such equipment. During abandonment exercises, personnel must practice the use of both escape routes.

A muster list should be available indicating:

- the station to which each person should proceed in the event of an emergency.
- the duties to be carried out by specified persons in an emergency.
- the persons appointed to be “incharge” of emergency stations.

Safety should be of prime consideration while carrying out these exercises and management judgment should be exercised to ensure that unnecessary risks are avoided.

An analysis and critique of each drill and exercise has to be documented to identify and correct weaknesses.

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Emergency response plan shall be reviewed and revised as appropriate in line with the findings from drills and exercises.

4.8 JOB SAFETY ANALYSIS (JSA)

JSA is a very effective means of helping reduce incidents and injuries in the workplace. Any job that has hazards or potential hazards is a candidate for a JSA. An uncommon or seldom-performed job is also a candidate for a JSA.

Considering the potential hazards, necessary actions to eliminate, control, or minimize hazards that could lead to accidents, injuries, damage to the environment, or possible occupational illness should be decided. Each safe job procedure or action must correspond to the job steps and identified hazards.

The JSA should be reviewed, approved, and signed by the supervisor before the task is started. Understanding every job step is very important. Whenever a job step changes or a new step is introduced, the JSA must be reviewed and updated.

4.9 PRE-OPERATION & SAFETY MEETINGS

4.9.1 PRE-OPERATION MEETING

i) Prior to commencing of any workover, stimulation job operation, a meeting should be held with all personal involved, covering procedure for operation, hazards associated and emergencies.

ii) Matters relating to the safety of crew personnel, prevention of equipment damage or similar subjects should be discussed.

iii) Thorough safety inspection should be made of the equipment including its anchoring and foundation, before commencing operations.

iv) Pre-workover checklist (for onland workover rig) is given at Annexure-I. For offshore rig checklist refer OISD-RP-190.

4.9.2 SAFETY MEETINGS

4.9.2.1 Regular safety meetings, in addition to pre-operation meeting, should be conducted periodically and various safety aspects of operation should be discussed therein.

Safety meeting should focus on specific topics like:

i) Personal protective equipment (safety helmets, safety shoes, face protection etc.)

ii) Operation of new equipment

iii) Fire extinguisher use and maintenance

iv) First aid procedures

v) Equipment inspection procedures

vi) Well control methods/procedures

vii) Permit to work system

Records of meetings should be maintained.

4.9.2.2 On the job safety meeting should be held whenever the workover job changes to the extent that fresh instructions are necessary or when extenuating circumstances exist that warrant a meeting. The meeting should cover safe procedures for operation, hazards associated & emergencies.

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The shift-in-charge should instruct other crew members on proper use of any new equipment on the rig.

4.10 HYDROGEN SULPHIDE (H₂S)

Although Hydrogen Sulphide (H₂S) is a dangerous, deadly gas, its effects are controllable and generally reversible, provided appropriate action is taken in time.

EXPOSURE LIMITS

Permissible Exposure Limit (PEL) is defined as the maximum concentration of substance of interest that you can be exposed to in an 8 hour period, 40 hours week, without respiratory protection. PEL for H₂S is 10 ppm (as per OSHA)

Immediately Dangerous to life and health (IDLH) is 100 ppm.

Short Term Exposure Limit, (STEL) based on 15 minutes time period is 15 ppm for H₂S.

The danger of exposure to H₂S can not be eliminated altogether but the potential of danger can be minimized, in H₂S prone areas, by:

- Providing adequate safety equipment on location.
- Proper training to personnel before posting, including first aid training for H₂S environment.
- Establishing strict operating and emergency procedures
- Creating general awareness of potential hazards of H₂S

i) Hydrogen Sulfide concentrations for each location shall be determined. The detector shall be available for determining level of H₂S present in gas.

ii) Personnel working in a location where atmospheric concentration of H₂S is greater than 10 PPM should wear proper breathing equipment.

iii) Active monitoring for Hydrogen Sulfide gas, good planning and training programs for workers besides use of required PPE are the best ways to prevent injury and death.

i) Wind direction indicators should be installed at strategic locations at the well site.

ii) Protective breathing apparatus should be maintained at the well site as required.

iii) Employees with facial hair in the form of beards, long side burns, etc. that could interfere with the seal of a facemask should not be allowed to work at exposed site.

iv) Automatic hydrogen sulfide detection and alarm equipment that should warn the crew of the presence of H₂S should be installed on the rig. Portable detection equipment should also be made available.

v) Poison gas signs should be provided and properly placed.

vi) Safe briefing areas should be established prior to the beginning of the work. All employees should be informed to report to the briefing area in case of a hydrogen sulfide emergency. The briefing areas must be established upwind from the well.

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Prior to entering a potentially hazardous area, visitors and other non regularly assigned personnel should be briefed on routes of egress, emergency assembly areas, applicable warning signs, and how to respond in the event of emergency, including use of PPE, if required.

The contingency plan should be available to all persons responsible for implementation, regardless of their normal location assignment. It should also incorporate community warning and protection plan.

**4.10.1 FIRST AID FOR H₂S**

i) Move the victim into fresh air at once (upwind from the source). Never attempt to rescue a victim without first donning appropriate breathing apparatus.

ii) If the victim is unconscious and not breathing, immediately apply mouth-to-mouth artificial resuscitation and continue until normal breathing is restored. If available, oxygen should be given through an inhaling apparatus by an employee trained in the use and operation of such equipment.

iii) Summon emergency help as quickly as possible and transport the victim to nearest medical centre if necessary.


**5.0 WORKOVER OPERATIONS**

The following content though mainly for onland workover operations, is relevant for offshore workover operations, as applicable. As workover operations in offshore are mostly carried out by drilling rigs, OISD-RP-190(revised edition) on safe drilling operations may also be referred.

Offshore Modular workover rig operation is covered in section 5.4.

**5.1 SAFETY OF EQUIPMENT**

Rig and equipment cause safety hazards mainly due to

- Dynamic, instantaneous and fatigue loading
- Continuous wear and tear
- Hazardous environment and fluids.

Every rig site should have one copy each of operating, repairs, and safety check manuals prepared and supplied by manufacturer.

Safety checks should be carried out for the rig and equipment at pre-determined frequency as per manufacturer’s supplied check list.

**5.1.1 SELECTION OF RIG** –It is an important factor to accomplish workover jobs safely. The following factors should be considered for selection of rig:

a) Well depth
b) Requirement of drilling/milling
c) Fishing

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5.1.2 RIG FLOOR AND MAST

Rig floor and mast are also known as derrick floor and derrick, respectively.

i) Mast, rig floor and its auxiliary parts shall be constructed conforming to good engineering practice and maintained in safe condition.

ii) Mast should have a permanent name plate attached to the structure indicating name of manufacturer, safe load capacity with number of lines and recommended guy pattern.

iii) Carrier mounted mast should not be moved while in a raised position.

iv) Bolts, nuts, and pins on elevators, wire rope, and catlines, as well as sheave and other anchor bolts in the rig sub-structure and mast, should be secured.

v) During instances of unusual loading of the mast, such as during unusually hard pull, only the shift in-charge or other essential supervisory personnel should be on the rig floor and no one should be on the mast or in cellar area.

vi) Guyropes and anchors should be under continuous vigil during unusual loading of mast (like stuckup; fishing).

vii) Personnel should not work on the rig floor under the mast while repair work is in progress overhead unless their help is necessary for accomplishing the overhead job.

viii) Except for the ladder opening, no unguarded opening large enough to permit a person to fall through should exist between the beams or main supports of the crown block.

ix) Load bearing leveling jacks shall have a safety lock device.

x) No mast should be subjected to a compression load greater than the safe load as per the manufacturer's guidelines/ recommendations.

xi) Mast guying and foundations should comply with the standards for guylines, anchors and foundation bases, as per manufacturer's recommendations. Before any load is put on the mast all crown guys should be properly tightened.

xii) Crown block should be equipped with guards which should prevent the casing/drill lines from being displaced from the sheaves.

xiii) The rig carrier should be properly placed and leveled before raising the mast. It should be ensured that transmission is shifted from road to hoist and it is locked.

xiv) Unattached tools or material of any kind should not be kept in the mast above the rig floor unless there is occasion for their immediate use.

xv) All masts should be equipped with locking devices with sufficient strength to prevent the mast from bending at the hinge points. The locking device should be approved by the rig manufacturer. The mast will be locked as soon as the mast is in position and remain locked until the mast is to be lowered. Locking shall be verified.

xvi) On every mast, a platform shall be provided on at least one side of the crown block. The platform shall be equipped on its outer edges with a railing and toe-board.

xvii) The working edge of monkey board platforms shall be so placed that there is adequate clearance for safe passage of traveling block.

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xviii) Platforms, floors and walkways shall be kept free of dangerous projections or obstructions and shall be so maintained that adequate protection against slipping is provided.

xix) The rig floor area and drawworks area shall have not less than two escape exits on opposite sides to give unobstructed escape.

5.1.3 HOISTING LINES (CASING LINES)

i) Dead-line anchor for hoisting line should be so constructed, installed and maintained that its strength should be at least equal to the working strength of the hoisting line. Inspect dead line anchor on a daily basis for weld failure, metal fatigue, or other signs of possible failure.

ii) All hoisting lines shall be visually inspected when in use by a qualified person and a record made of any defects noted. Slip and cut procedure should be followed, as per OISD-STD-187 on ‘Care and Use of Wire Rope’.

iii) Also, hoisting line or sand line shall be removed from service when any of the following condition exists:

- When marked corrosion appears
- When there is evidence of kinking, crushing.

For guidelines with respect to replacement of wire rope, refer OISD-STD-187 on ‘Care and Use of Wire Rope’.

iv) On any drum on which a hoisting line is wound, the end of the hoisting line should be fastened securely to the drum and there must be a reasonable number of wraps of the line on the drum to eliminate any strain on the fastening to the drum.

v) Use right size of rope with right size of sheave to avoid deformation of rope.

vi) Rope should be kept tightly and evenly wound on the drum.

vii) Excessive speeds when blocks are running up, and sudden severe stresses may damage wire rope.

For further details on care and use of wire rope, refer OISD-STD-187.

5.1.4 TRAVELING BLOCK

i) Traveling block shall be properly guarded.

ii) Traveling block should be reasonably free of projecting bolts, nuts, pins or other parts upon which clothing of workmen may be caught.

iii) Traveling block should be inspected and maintained in good working condition and the applied load should never exceed the manufacturer's listed rating.

iv) Traveling block safety device, crown-o-matic and floor-o-matic, shall be installed in order to prevent the block hitting the crown block and rig floor accidentally.

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v) Traveling block when not in use, should be kept as near as possible to the rotary table/rig floor and brake of drawworks should be securely locked to prevent any inadvertent movement of traveling block.

5.1.5 WEIGHT INDICATORS

i) Every rig shall be equipped with a reliable weight indicator.

ii) Weight indicator should be safely secured and should be easily visible to the operator.

iii) The manufacturer's rated load capacity should not be exceeded.

iv) The weight indicator system should be checked for calibration periodically by comparing its reading with the calculated one.

5.1.6 DRAWWORKS AND CATHEAD

i) A visual inspection of the drawworks and its working parts shall be made each day/shift before operations begin.

ii) All guards and covers shall be in place before operations begin.

iii) If lubrication fittings are not outside of guards, machinery shall be completely stopped for oiling and greasing.

iv) When it becomes necessary to remove a guard, the drawworks shall be completely stopped and engine shut off.

v) A double (auxiliary) braking system should be installed on the drawworks.

vi) Shutdown switches for drawworks shall be installed at driller’s console/panel.

vii) The brake system of the drawworks should be inspected prior to start of operation in each shift.

viii) The operator shall not leave the brake without tying the brake down or securing it with a catch lock.

ix) The operator should not leave the brake while hoisting drum is in motion.

x) Catheads on which rope is manually operated shall have a rope guide to hold the on-running rope alignment with its normal running position against the inner flange.

xi) When a rope or line is in use on a cathead, all other ropes or lines should be placed so as not to come in contact with the cathead or with the rope or lines used on the cathead.

xii) When the cathead is unattended, no rope or line shall be left wrapped on or in contact with the cathead. Cathead should be stopped if provision exists.

xiii) When the cathead is in use there shall be an authorized person at the driller’s control.

xiv) The friction surface of a cathead on which a rope is manually operated should be reasonably smooth.

xv) Cathead operation being a hazardous one, alternate means should be adopted, so as to minimize use of cathead.

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5.1.7 TONGS

i) Make up and break out tongs shall be used in pairs for tightening and loosening of pipe joints.

ii) Positioning of jaws of the tongs round the pipe should be such that these are properly fastened to avoid slipping when the pull is exerted.

iii) Tongs should be fitted with safety line of sufficient length to gain full benefit of pull, but should not be too long to prevent complete rotation of the tongs (in that event the crew may be caught, in the arc of swing of the tong and sustain serious injuries). Worker should be in the right position when carrying out these operations, since he runs a risk of serious injury.

iv) The strength of safety line of tong should be more than the pull line strength of the tong. The ends of tong’s safety line and pull line should be secured with at least three wire line clamps. The safety line should preferably be snubbed to anchor post attached to substructure.

v) Tong counter balance weight and lines shall be adequately guarded to prevent accidental contact.

vi) Power tong pressure lines shall be equipped with a safety relief valve and pressure shall never exceed the manufacturer’s specifications.

vii) The tong latches should be clean and lubricated; its dies should be checked for wear. If tong dies are worn out, these should be immediately replaced.

viii) Welded tongs shall not be used.

ix) When not in use, tongs should be hooked back to a corner on the rig floor.

5.1.8 SLIPS/SPIDERS

i) Rotary slips shall be set using handles. It is forbidden to kick the slips into the rotary table bowl.

ii) Use proper stance and slip-lifting techniques.

iii) When slips are taken out they should be set back well clear of rotary table.

iv) While tripping, slip should be taken out from master bush of rotary table.

v) Correct size slip should be used.

vi) Regular inspection of slip and dies should be carried out.

vii) Slip should not be used / applied when the string is in motion.

viii) Grease handle hinges and slips’ segments connections.

Sl.no. v-viii are relevant to spiders also.

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5.1.9 ELEVATORS

i) Elevator links should be reasonably free of projecting bolts, nuts, pins or other parts upon which clothing of workmen may be caught.

ii) Correct size elevator should be used.

iii) Regular inspection of elevator should be carried out and worn or damaged parts replaced so as to reduce the possibility of malfunction and accidental release of load.

iv) Personnel shall not ride on elevator.

5.1.10 WIND GUY LINES AND ANCHORING

i) Any mast designed to utilize guy wires for mast stability should have all applicable guy wires in position prior to commencing work. The number, placement and size of guy wires should meet mast manufacturer’s recommendations.

ii) In no case should a guy line be extended above or below a power line unless power is turned off and locked out.

iii) All chains clamps and tensioning devices used should have safe working load capacities that meet or exceed 40% of the breaking strength of the guy wire. The guy line should be properly secured with U-bolts or fist grip clamps of proper size, at both ends as recommended by manufacturer.

iv) A thorough inspection of all guy lines in use should be made prior to each installation and no guy lines should be spliced.

v) Anchors should be used to secure the guy lines, except when other means or methods of anchoring the guy lines are recommended by the manufacturer.

vi) Concrete anchors, or other approved techniques should be used.

vii) All anchors should be inspected for damage or deterioration prior to rigging up and during unusual loading of mast. Anchors should be easily accessible, for inspection.

For guidelines with respect to clamping of wire rope, refer OISD-STD-187 on ‘Care and Use of Wire Rope’.

5.1.11 PUMPING UNIT AND PRESSURE LINES

i) The mud pumps shall be fitted with safety pressure relief valve and pressure gauge. The safety valves must be checked and calibrated as per OEM’s guidelines.

ii) The valve shall be set at a pressure which should not exceed working pressure of the pump, pipes and fittings.

iii) No valve shall be installed between the pump and its safety pressure relief valve.

iv) Ensure that protective cap of safety relief valve is in place to prevent the shearing pin from flying when sheared and to prevent accidental contact.

v) Only shear pin of correct rating should be used when replacement is necessary / required.

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vi) Bleed off valve should be installed on discharge line of the pump, to allow the residual pressure, after isolation of the high pressure circuit, to be safely relieved.

vii) The discharge line from the pressure relief valve shall be anchored and routed to a place where it will not endanger persons.

viii) All exposed moving parts shall have proper guard.

ix) The discharge line from the pump and return line from the well shall be properly anchored.

x) All hammer unions shall be made of compatible halves having same pressure rating.

xi) High pressure warning signs should be displayed.

5.1.12 TANKS

i) Tanks shall be so designed and installed as to provide positive suction to mud pumps.

ii) All fixed mud guns used for jetting shall be pinned or hobbled when unattended.

iii) Hoses used for jetting operations should be manned, and there should be an employee stationed at the pump controls to shut down the pump in the event of emergency.

iv) Portable tanks should be located where there is no possibility for personnel or equipment to come into contact with overhead power lines.

v) All portable tanks in excess of 2 mts. in height used in testing and treating, should be equipped with a fixed metal ladder.

vi) An effective ventilation system should be ensured at all enclosures containing mud pumps and circulation tanks in order to ensure continuous removal of gases or vapours. A safety device, to give an alarm in case there is failure in the ventilation system should be provided.

5.1.13 ELECTRICAL

i) Rig generators on land locations should be located at least 30 mts. from the wellhead upwind. Electrical equipment should be placed according to hazardous area classification.

ii) All generators should have an overload / short circuit protection device that will provide protection from shorting and burnout. Also the system to have sufficient protection against electric shock during normal operations and in the event of power failure, ignition of explosive gas atmosphere, health injury from electromagnetic fields and power failure etc.

iii) All electrical equipment including electric motors, generators and panels shall be properly earthed.

iv) All electrical wires shall be properly secured, insulated and plugs shall be in good condition. Joints, if any, shall be placed in safe area and be located such that it does not pose hazard due to accidental contact.

v) All lights should be properly protected and adequate illumination should be ensured.

vi) Rig lighting and fixtures shall conform to corresponding area electrical classification.

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vii) Repair of electrical equipment shall not be performed until the power source has been isolated and control has been locked out/tagged out (appropriate permit should be issued before taking up the job) and the person making the repairs is authorized to do so.

viii) Aviation warning lights shall be fixed on top of the mast through a separate circuit.

ix) Electric shock treatment chart shall be displayed in generator/electrical control room.

x) Emergency lighting system shall be available.

xi) A competent person shall be designated to be responsible for the electrical system of the installation.

For further details, refer OISD-STD-216 on ‘Electrical Safety in Onshore Drilling and Workover Rigs’.

xii) In offshore

- Electrical equipment should be suitable for marine environment. All electrical equipment and power sources provided on the deck in open areas should be adequately protected.

- An emergency source of electrical power capable of catering to the emergency load i.e. power required for equipment and systems that must function in the event of main power failure shall be available.

- Emergency generator including its starting arrangement should be function-tested regularly.

- The emergency power supply system should be independent of the main power supply system and if the normal generator trips, the emergency generator should takeover automatically.

- There shall be an emergency lighting system which ensures necessary lighting of the facility if the main lighting fails.

5.1.14 MATERIAL AND EQUIPMENT LIFTING

i) Use proper lifting means.

ii) Hoist slowly to limit equipment momentum.

iii) Seek assistance when moving awkward and heavy guards and covers.

iv) Use mechanical lifting aids, proper lifting techniques, and team lifting where appropriate.

v) Use proper hand and body positioning.

vi) It shall be ensured that personnel do not come under suspended load.

vii) Hook used for lifting should be equipped with a safety latch.

Wire rope slings should be used and maintained as per OISD-STD-187 on ‘Care and Use of Wire Rope’. Webbing strop slings’ use and maintenance should be as per manufacturer’s recommendations.

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5.1.14.1 PIPE HANDLING

i) When pipe is lifted, lowered and carried, team work is essential. Pipe should be lifted and lowered only after receiving signal.

ii) Pipe should be rolled from ends or from behind in order to be out of the way if the pipe movement gets out of control.

iii) No employee shall go between loading or unloading skids unless necessary. If the work necessitates getting between skids, notify fellow workman in order that pipe will not be released.

iv) When unloading pipe, make sure that skids are securely fastened.

v) Stacking strips should be used as spacers, during pipe stacking. These strips should not protrude out, excessively.

vi) Pipe racks shall be fitted with stoppers at both ends to prevent pipe accidentally rolling off the racks.

vii) Always keep your hands and feet clear of any pipe that is suspended in the mast.

5.1.15 PIPE PROTECTION

i) Damage to threads resulting from protectors loosening and falling off should be avoided.

ii) Hammering the coupling to break the joint should be avoided. When tapping is required, use the flat face of the hammer, and tap lightly at the middle and completely around the coupling to avoid damage.

iii) Care should be taken not to use worn-out and wrong type of equipment related to pipe operations like hand slip, spider and tongs.

iv) Do not drop a string, even a short distance. This may loosen the couplings at the bottom of the string. If the string is dropped for any reason, the string should be pulled and rerun, examining all joints very carefully.

v) Proper selection of pipe should be done for strength and life required.

5.1.16 HAND TOOLS

i) Wrenches should be inspected frequently to ensure they are fit for use.

ii) Inspect driving faces of hammers, chisels, drift pins, bars, and similar tools frequently to eliminate mushroomed heads, broken faces and other defects.

iii) In applying force to a wrench take a position so that balance is not lost in case the nut or joint suddenly loosens or the wrench slips.

iv) Do not carry tools in hands, while going up or down the ladder. Always keep both hands free for climbing.

v) All tools used in mast shall be secured to prevent them from falling.

vi) Hands tools shall never be left on ladders or elevated places.

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vii) Tools being used by topman should be brought down as soon as topman has finished using these and kept at proper place.

viii) Fit for purpose tools, in good conditions, shall be used for the job being performed.

ix) Non-spark producing hammers (brass) shall be used in a flammable environment.

x) The wooden handles of hand tools should be kept free of splinters and cracks and should be kept securely attached to the tools.

xi) Do not use hand tools, which have become dull.

xii) Hand tools shall not be used after being subjected to intense heat.

xiii) Electrical cords of powered tools should be checked and replaced if worn.

xiv) Before rolling up or coiling pneumatic hoses, electrical cords or hydraulic hoses, disconnect from the power source.

xv) Disconnect air and electrical tools from the power source before changing bits, sockets and blades.

5.1.17 LADDER, STAIRWAYS, FLOORS & PLATFORMS

i) Every scaffold, stage, walkway, working platform, stairway and ladder, whether temporary or permanent, should be constructed and maintained in safe condition and should not be altered or moved while in use.

ii) Work areas should be clean and free of debris.

iii) Every stairway, ladder, ramp, runway, floor and platform should be kept reasonably free of objects and substances which may create a slipping or tripping hazard, or prevent or hinder the escape of workmen in an emergency.

iv) With the exception of exit and entrance openings, and loading and unloading areas, a standard guardrail with mid-rail and toe board shall be installed at the outer edge of any floor, platform, walkway, ramp or runway which is four feet above the ground, or above another floor or working level. Where guardrails are not feasible, chains, or wire rope may be used.

v) A guardrail used for the purpose of actual or potential containment of equipment or material should be of such construction and strength as to effectively contain the full load or stress which may be anticipated to be applied upon it.

vi) Access from ladder to working platforms shall be properly secured with railings and toe-boards.

vii) The top end of each ladder section shall extend above the platform.

viii) Landing platforms or cages shall be provided on ladders as specified in OMR, 1984, as amended from time to time.

ix) Any temporary stabbing board, or other temporary boards, placed in mast should be securely fastened.
x) A stairway with handrails shall be installed beside the inclined walk which should extend from the ground to the rig floor.

xi) Floor and deck openings shall not be left unguarded/uncovered.

xii) Rig floor, catwalk or engine room floor shall not be used as a storage platform for equipment or material that is not required for immediate use unless the material or equipment

- is properly racked / stored, and
- does not cause congestion of work areas/ walkways.

xiii) Mast ladder should be provided with safety loop cage.

xiv) In offshore, ladder should be provided inside the truss legs of the jack up rig which should extend below the surface of the sea in low tide. Such a ladder can be used by any person who has accidentally fallen into the sea to reboard the installation or by persons while abandoning the rig.

5.1.18 FIRE PREVENTION, PROTECTION AND FIRE- FIGHTING EQUIPMENT

The following should be adhered to:

i) Fire fighting equipment shall not be tampered with or removed for other than its intended purpose.

ii) Fire- fighting equipment, suitable for fire hazards involved are suitably located and plainly labeled as to their type and method of operation. All fire protection equipment shall be maintained in ready to use condition and shall be easily accessible at all times. Records be kept showing the date fire extinguishers were last inspected, tested or refilled and by whom.

iii) Used cleaning rags and combustible waste materials are kept to a minimum, stored in a metal container and disposed of regularly.

iv) Access to exits or fire extinguishers is not blocked or obscured by laundry, materials or equipment.

v) Well cellars, rig floors and ground areas adjacent to rig floor are kept reasonably free from accumulation of oil which might create or aggravate fire hazards.

vi) Carbon tetrachloride extinguishers are not permitted.

vii) During welding operation, keep suitable portable fire extinguishers in the vicinity. A person shall be designated as a fire watch.

viii) Any engine being refueled should be shut off during refueling.

ix) Smoking shall not be allowed within 30 mts. of any flammable storage area, or within 30 mts. of the handling of flammable liquids.

x) There should be an adequate number of "NO SMOKING" signs conspicuously displayed at each well location while well service work is in progress.

xi) No open flames shall be allowed within 30 mts. from the well or well bore.

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xii) Personnel shall be instructed on the use of fire-fighting equipment during fire drills and training exercises.

xiii) Live drills as per ERP scenarios should be carried out. Personnel should be aware of fire-fighting techniques to fight various types of fires.

Refer OISD-STD-189 for requirements of fire fighting equipment. For requirements for inspection of fire fighting equipment and systems, refer OISD-STD-142.

5.1.18.1 FIRE DETECTION AND SUPPRESSION SYSTEM (IN OFFSHORE)

Fire detection and suppression system should be capable of automatic actuation.

Fire detection system should include:
- Gas detectors: Fixed & Portable.
- UV detectors
- Thermal and Smoke detectors
- Fusible loops
- Paging/communication

Fire suppression system should include:
- Water system-spray, sprinklers
- Foam system
- DCP
- Gaseous systems (CO₂/clean agent)
- Portable extinguishers

In addition, external fire-fighting support by multi-support vessel, fire-fighting support vessel etc. should be available.

5.1.19 INSPECTION AND MAINTENANCE

For details regarding requirements of inspection and maintenance of workover rig equipment refer OISD-RP-190 and OISD-GDN-202&203.

5.2 SAFETY OF OPERATIONS

5.2.1 GENERAL SAFE OPERATING PRACTICES (DURING WORKOVER)

i) Personnel should receive instructions about correct work methods to reduce chance of injury to themselves or fellow personnel.

ii) Good housekeeping is essential for successful accident control and fire prevention. Keeping everything in its place promotes efficiency, quality and good work. Tools, equipment and working areas should be kept clean, neat and orderly.

iii) Thorough safety inspection should be made of well servicing equipment and foundation before starting job.

iv) When drinking water is transported and stored for use by crew on location, it should be in a clean container, labeled “drinking water”. Water potability should be ensured.

v) Riding catline is prohibited.

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vi) Unsafe or otherwise dangerous conditions no matter how small should immediately be reported to in charge for corrective action. Correction of unsafe condition may take one of three forms - remove, guard or warn.

vii) Upon completion of job, clean tools/equipment and store in its assigned location.

viii) If there exists any hazard on adjoining roads/passageways due to workover operation, then signs, flags, lights etc. should be used to give warning.

ix) Scuffing, practical joking, or horseplay of any nature among employees on duty is inconsistent with safety and is positively prohibited.

x) An area within 30 mts. of the wellhead shall be treated as danger zone in which no smoking or open flame shall be permitted.

xi) Control to the extent possible must be maintained over leaks and spills; however, if they occur, they should be cleaned up promptly to eliminate slipping hazard to personnel as well as fire hazard.

xii) Do not leave timbers or planks, embedded with nails, lying around.

xiii) All employees are responsible for prevention of accidents to men working with them. Any employee using unsafe tools or work practices or encouraging other employees to do so should be prohibited.

xiv) Lift weights properly, with correct body posture. If the load is beyond individual’s safe capacity, get help.

xv) Hair of such length that it might become entangled in moving or rotating machinery should be contained in a suitable manner. Beards and sideburns of employees should be kept in such conditions so as not to interfere with the proper use of gas masks, air masks, or other safety apparel or equipment.

xvi) Personnel should not wear jewellery or other adornments subject to snagging or hanging and causing injury while in the work area

xvii) Drinking alcohol/use of intoxicating substance on the job or to and fro from the work is prohibited.

xviii) It is the responsibility of all employees to train men under their supervision, in the safest and most efficient way to work. New person/topman starting to work for the first time at the rig/monkey-board should be assisted by an experienced person/topman.

xix) An employee should never operate any machinery, including a cathead, until he is well acquainted with the operation, equipment.

xx) Unauthorized personnel should not be permitted at the work location.

xxi) Smoking shall be prohibited at the well site. Use of Mobile phone in the well site area is not to be allowed. Cigarettes, matches, lighters, mobile phones etc., are to be left in a pre-determined safe area.

xxii) Warning signs to be placed around the equipment, having potential hazards, which are close to well site area.

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xxiii) The off going supervisor should inform the incoming supervisor of any known special hazards or work in progress that may affect the safety of crew. Incoming tour personnel should be alerted to work in progress that could affect their safety.

xxiv) On land locations vehicles not involved in the immediate rig operations should be located a minimum distance of 100 ft. from the well bore or a distance equal to the ht. of mast including attachments whichever is more. Appropriate safety measures should be taken where terrain, location or other conditions do not permit such spacing.

xxv) Hardening, leveling and fencing of well site area & availability of hygienic utility area should be ensured.

xxvi) Appropriate PPE, including fall protection and respiratory protection devices (as applicable) to be used.

5.2.2 TRANSPORTATION

In onland:

i) Route survey should be conducted prior to rig inter-location movement. It should be ensured that road and drill site has been properly prepared.

ii) Drive slowly & cautiously, taking into consideration hazards due to shifting weight.

iii) Load should be inspected with respect to its proper securing before loading/unloading and during transportation.

iv) Preparation before transporting the rig:

- Secure mast to the carrier
- Proper pads should be available at mast rest.
- Secure all matting boards, cables, etc.
- Secure traveling block in its cradle
- Check air pressure of tyres
- Ensure that jacks are retracted to maximum.

In offshore:

i) Moving a jack up rig from and to an oil / gas production well platform is a critical operation due to safety and environmental hazards associated with it.

ii) Suitability of rig should be ensured during re entry at the same location with respect to spud indentations.

iii) Prior to rig move to platform, the pre-operations meeting with all concerned should be held to ensure that all preparatory activities have been completed; various scenarios during rig move, where simultaneous activities may take place are to be taken into consideration.

iv) All wells should be kept closed during rig approach, rig skidding and pull away.

v) Sea bed conditions should be examined to ensure that the location is suitable for jacking up the rig.

vi) Debris observed during sea bed survey, which may be detrimental to rig shall be cleared before rig move.

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vii) Latest layout of pipeline drawing should be available on board. Pipelines should be buoyed prior to arrival of rig at location as per the requirement.

viii) Weather forecast for next 48 hrs. before moving should be available on board.

ix) Life boat drill to be carried out before rig move. Ensure life boats are ready to use in case of emergency.

x) Ensure availability of standby vessel in case of emergency to take all personnel on board.

xi) Water-tight integrity should be maintained. Suitable equipment for deflooding should be checked before making the rig afloat.

xii) Radio and the other communication facilities should be so arranged that all concerned can maintain contact with one another at all times during operations, without leaving their locations.

xiii) The towing lines integrity should be ensured. The tension of the various towing lines should be constantly watched. Suitable device should be provided so that the lines can be quickly disconnected in case of an emergency.

xiv) Any obstruction on the platform should be checked and cleared prior to docking.

xv) All the rig equipment should be well secured.

xvi) Approach to platform should be made in slack water.

xvii) The operation should be planned, to be safely completed during day light hours.

5.2.3 RIGGING UP/DOWN

i) All personnel should be briefed about the safety procedures and job hazards.

ii) A thorough visual inspection of the mast and raising or lowering mechanism shall be made by the person in charge prior to raising or lowering of mast.

iii) Raising and lowering of mast should be done in day light.

iv) Prior to raising or lowering of the mast, all tools and material not secured shall be removed from the mast.

v) Check leveling of unit, foundation and supports for correct placement before erecting operation. Level the unit in accordance with manufacturer’s recommendations.

vi) Wire rope, including operating lines, raising lines, and guylines, shall be inspected for kinks, broken wires, or other damage. Make certain that guylines are not fouled and that other lines are in place in sheave grooves before and during each raising or lowering operation.

vii) Make sure that mast and guylines will not come within close proximity to power lines.

viii) Follow the manufacturer’s instructions in checking hydraulic circuits of raising mechanism before operation. Make sure of adequate supply of hydraulic fluid.

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ix) An experienced person shall be made in charge of raising or lowering a mast; allow only the operator raising the mast to be on the rig floor. No employee should be allowed in the vicinity when it is being raised or lowered except personnel essentially required.

x) Manufacture’s instructions specific to the rig for raising or lowering mast safely should be followed.

xi) Mast should be raised/ lowered at safe speed. Application of brakes at any stage should not create any jerk.

xii) After raising of mast visually inspect load latches are engaged and properly locked. Tighten load guys, space out crown wind guys according to manufacturer’s recommendations.

xiii) Before lowering of mast, release all guy lines to allow easy retraction of load. Uncouple all electric and air lines in mast and free all other lines.

xiv) Park automobiles out of fall lines of the mast.

 xv) For skidding of Cantilever Substructure in offshore:

- Proper cleaning and greasing of all moving parts like bearing surfaces, rack and pinions and skidding unit etc. should be ensured.

- Ensure load on both (port and starboard) side cantilever deck is equal.

- All equipment like cable trays, hoses and supply line etc. should be properly positioned before starting operation.

Refer OISD-GDN-218 on ‘Guidelines for Safe Rig-Up and Rig-Down of Drilling and Workover Rigs’ for further details with regard to onland rigs.

5.2.4 WELL KILLING/SUBDUIING: can be achieved by

- Bullheading
- Circulation

Well servicing/workover plan should be prepared well in advance and circulated to all concerned; it should include the following information:

- Present status of well
- Brief history of earlier workover done including details of perforations(existing; earlier ones, with their present status)
- Complications encountered during drilling /earlier workover(s)
- Mud/kill fluid parameters during drilling/previous workovers
- Details of downhole equipment , tubing and X-mas tree
- Casing and cementing details
- Bottom hole pressure of existing layer and expected bottom hole pressure (if new layer is to be opened) after workover job

i) The kill line shall be tested to rated working pressure.

ii) No hammering shall be done on pressurized line.

iii) Check the parameters of kill fluid including fluid weight. Kill fluid should include the following characteristics:

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- Non damaging to formation
- Non-corrosive
- Stability at expected downhole temperature range.
- Solid suspension and carrying capacity
- Fluid loss control
- Safe in handling, with respect to personnel and environment.

iv) Monitor pump pressure during subduing and also check for short circulation or quick pressure buildup during subduing operation.

v) Monitor & check the parameters of return fluid during circulation till well is properly subdued, conditioned & stabilized.

vi) In offshore wells additional precaution should be taken by installing back pressure valve in the tubing hanger. SCSSV should be in closed condition while X-mas tree is nipped down.

5.2.5 PULLING OUT AND RUNNING IN OPERATIONS

A) BEFORE STARTING OPERATIONS

i) Monitor that there is no activity in the well and well fluid is homogeneous.

ii) The monkey-board shall remain visible to the shift incharge, or be monitored by the shift incharge using a TV system.

iii) The travelling block shall not be moved until the shift incharge ensures that the topman has the safety harness on and properly secured. The topman should confirm this to the driller by suitable means.

iv) The equipment to be checked/inspected prior to starting operations include:

   - Power tongs/tongs and pull & safety lines
   - Spider/slip
   - Elevators
   - Weight indicator
   - FOSV

B) DURING OPERATIONS

i) Keep an eye on weight indicator while commencing pulling out of string.

ii) Carry out the initial pulling out only in singles so that the threads of each tubing (single) can be checked. Defective ones should be discarded. Alternatively, if initial pulling out is done in doubles, during the second pulling out, sequence should be shifted by one single, to enable checking of threads of remaining singles.

iii) Ensure that the hole is filled with kill fluid regularly during pulling out. Also ensure that there is no swabbing action during pulling out.

iv) During running in the quality/quantity of the return fluid is to be observed cautiously so that any early sign of well's abnormal behavior can be detected, to take remedial action immediately.

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As a well control measure, trip tank should be installed on workover rig deployed for servicing of high pressure/gas wells, to monitor gain/loss of workover fluid during tripping operations.

v) When tripping in or out of the hole, hands shall never be placed on or around the link eyes where elevators can pinch. Workers should stay away from swing path of elevator & link. Workers on floor should know latching procedure.

vi) Floor should be kept clean through regular cleaning and should not be slippery. Appropriate non-slip material should be used around the rotary table.

vii) The driller’s view of the rotary table and set back areas shall not be obstructed at any time.

viii) Pipe should be racked by pushing against the outer face of the pipe when setting it back. Feet should be kept away from the pipe resting place.

ix) While picking up, laying down tubulars, the stairs near the cat slope/vee door should not be used by personnel.

x) Rotary table should not be used for makeup or breakout of a pipe connection.

xi) After release of stuck string by back off, all joints pulled out should be retightened.

xii) Tubings stacked in the rigfloor should be set on a firm wooden platform and without the bottom thread protector (design of most protectors is not meant to support the joint or stand without damage to the thread).

xiii) The length of each of tubing should be measured prior to running in. Also it should be go gauged with proper size gauge.

xiv) Make sure threads are undamaged, clean, and apply thread compound on pin end before rerunning.

 xv) In order to avoid leaks, all joints should be retightened occasionally.

xvi) Clean protectors should be placed on the tubing before it is laid down.

**DURING WELL SCRAPING:**

i) Proper size scraper should be used.

ii) Scraper should be physically checked before running in.

iii) Spring action of the blades should be checked.

iv) Direction of blades should be ascertained so that it does not get stuck.

**DURING USE OF OTHER DOWNHOLE EQUIPMENT**

While running in packer, bridge plug, cement retainers etc special attention should be given to the setting procedure in order to avoid premature setting.

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5.2.6 WIRELINE OPERATIONS

All wireline operations require special precautions. Operations completed through the use of wire line include logging, perforation, setting of down hole tools, fishing, bailing and swabbing.

i) The wire line supervisor should hold a pre-job meeting with the crew and other involved personnel to review responsibilities and to coordinate the operations to be performed.

ii) Keep all non-essential workers out of the immediate work area.

iii) Inspect wire line, rope sockets, cable heads and stuffing box packing for defects before use.

iv) Operate the wire line at a safe speed.

v) Inspect all slings, chains, pins or other attachment devices before lifting or suspending tools or equipment.

vi) Minimize manual handling of lubricator and other equipment. Use proper hand placement and tag lines to avoid pinch points. Hands, rags and other objects should be kept clear of the sheaves while the line is in motion.

vii) Guide the lubricator assembly during rig up/down to prevent hitting of any wellhead fittings.

viii) If a ginpole is used, it should be secured to the well and should be as near to vertical as possible.

ix) Use proper fall protection device.

x) Position the unit properly with respect to wind direction and distance from potential gas or vapor sources.

xi) Before rigging of surface equipment, the wire line truck onland shall be securely blocked so that it will not move.

xii) Install a pressure release valve in the lubricator assembly. Bleed pressure from lubricator assembly before breaking connections.

xiii) The rated working pressure of all sections of the lubricator, including stuffing box, wire line valve connections and adaptors should be higher than the expected wellhead pressure.

xiv) Check for an unusually tight connection that may indicate that pressure has not been released.

xv) Install foundation, outriggers, and guy ropes according to the manufacturer's recommendations in order to avert toppling wire line mast or boom.

xvi) In offshore, the winch of wireline should be secured to the main deck of the platform to prevent it from skidding.

xvii) The main deck of the wellhead platform should be kept reasonably clean of oil, mud, grease etc. & unnecessary materials so as to provide safe work area and escape.

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xviii) Adequate number of persons should be available at the platform during wireline operation, at the controls & at the well.

A. LOGGING & PERFORATION

In addition to the guidelines under wire line operations, as applicable, refer OISD-STD-183 and OISD-STD-191 for detail safety requirements during logging and perforation.

5.2.7 SECONDARY CEMENTATION

i) During pre-job safety meeting, cementing incharge must outline the job procedure, define pressure limits and discuss safety measures. He should specify the sequence and volume in which fluid will be pumped and at what pumping rate and total time involved. Also duties of each person during cementing job including equipment operation, mixing of chemicals and operation of valves should be spelled out. He should also cover additional emergency procedures required to be followed, in the event of abnormal situation(s).

ii) Cementing Incharge should also review communication system which plays an important role in monitoring cementing job execution.

iii) The cementing in-charge must supervise line hook up work and thoroughly inspect, prior to testing lines.

iv) Equipment locations should be preplanned and equipment be positioned accordingly, upwind of vapor and gas sources.

v) Use mechanical lifting aids, proper lifting techniques, and team lifting where appropriate.

vi) Conduct a pre-job and post-job inspection to minimize hazardous situations due to spillage etc.

vii) All non-essential personnel to stand clear of the work area.

viii) Secure/ hobble all elevated, high-pressure lines properly.

ix) Pump operator should stay near the controls.

x) Conduct pressure tests on pump(s) and lines before pumping. It should be carried out at a pressure not less than the maximum expected cementing pressure, but not to exceed the rated working pressure of the equipment with the lowest rating.

xi) During equipment checking, include checking of rating and matching threads of hammer unions.

For details refer OISD-STD-175 on “Cementing operations”

The above guidelines for secondary cementation are also applicable for water shut off operations by cementation.

5.2.8 HOT WORK / WELDING

i) Use a written permit system to document authorization to enter, the work to be performed, and the results of the gas monitoring where there is a potential for toxic, flammable, or oxygen-deficient atmosphere. Both a hot work and confined entry permit may be required for welding, cutting or brazing within a confined space.
ii) Perform hot work in a safe location, or with fire hazards removed or covered. Use guards to confine the heat, sparks, and slag, and to protect immovable fire hazards.

iii) Do not perform hot work where flammable vapors or combustible materials exist.

iv) Inspect the work area to ensure that it is safe for carrying out hot work.

v) A competent welder should perform welding or flame cutting operations.

vi) During hot work monitor the atmosphere with a gas detector. If a flammable or combustible gas exceeds prescribed limit of the lower explosive level (LEL), the work must be stopped. Identify the source of the gas and repair the leakage, where the hazards exist. Hot work permit should be re-validated in such cases.

vii) A portable gas detector shall be available, which shall be regularly inspected, maintained and calibrated.

viii) Make suitable fire extinguishing equipment available in the vicinity. Such equipment may consist of pails of water, buckets of sand and portable extinguishers.

ix) Assign additional personnel (fire watch) to guard against fire while hot work is being performed. Fire watchers shall have fire-extinguishing equipment readily available and be trained in its use and familiar with facilities for sounding an alarm in the event of a fire.

x) Maintain the fire watch at least a half hour after completion of a welding or cutting job.

xi) Ensure adequate ventilation from toxic welding and cutting fumes. Mechanical ventilation shall be provided when doing hot work in confined spaces.

xii) Inspect welding, cutting and grinding equipment before use. Leak test gas torches, gauges, and hoses. Oxygen and acetylene torches should be equipped with flash-back arrestors.

xiii) Ensure cylinders are properly stored in an upright position and chained in separate racks.

xiv) Store full and empty cylinders separately. Store cylinders in a dry, well-ventilated location; avoid storing flammable substances in the same area as gas cylinders.

xv) Terminals from welding lead shall be protected from accidental contact by person or metal.

xvi) The frame of electrically driven arc welding machine shall be grounded.

Prior to carrying out any job (cold/hot work) on an equipment connected with an electrical device/equipment, positive isolation of electrical power by electrical personnel shall be ensured through electrical isolation permit.

5.2.9 WORK PERMIT SYSTEM

Based on the nature of work to be performed, the following minimum type of work permits should be used.

- Cold work permit
- Hot work permit

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5.2.10 WORKING IN CONFINED SPACE

A confined space is one that:

- Has limited openings for entry and / or exit.
- Could contain known or potential hazards.
- Is not intended for continuous occupation
- Has insufficient natural ventilation

i) Any confined space that is going to be entered should be isolated and entry prohibited until the following conditions are met:

- Completion of internal atmospheric testing, prior to entry, to determine:
  - Oxygen content is in acceptable range
  - Acceptable level of flammable gases/vapors
  - Potential toxic air contaminants
- Activation of a confined space entry permit system where hazardous atmosphere exists or has the potential to exist.

ii) Ensure proper and accessible means of exit before entry inside confined space.

iii) When the work is going on in the confined space, there should always be one man standby at the nearby manway.

iv) Depending upon need, necessary respirator system, gas masks and suits shall be worn by everyone entering confined space.

v) Safety helmet, safety shoes and safety belt shall be worn by everyone entering confined space.

vi) Don’t wear loose clothing while working in confined space.

vii) The gas cylinder used for cutting/welding shall be kept outside.

viii) Only non-sparking tools and flameproof hand lamps protected with guard and safety torches should be used inside such confined space or area for initial inspection, cleaning or other work required to be done for making the area safe.

ix) Communication should always be maintained between the worker and the attendant.

x) Declassification of confined space can be done subject to removal of all hazards, or control of hazards through adequate ventilation.

xi) When it is not necessary to maintain a cellar, the cellar should be filled to eliminate a possible confined space hazard.

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5.2.11 WELL TESTING

The final stage of well completion operation is the testing of well. The purpose of the test is to ascertain the potential of the perforated horizon to produce hydrocarbons.

i) Pre-job meeting should be conducted about operation & safety procedures to be adopted in case of fire or uncontrolled flow.

ii) Before testing, X-mas tree and flow lines including the associated fittings shall be subjected to a maximum pressure that is likely to be encountered.

iii) No operation to activate the well shall be done during night time.

iv) The activation tank and test flare should be located at a distance not less than 30 mts. from the wellhead.

v) The separator should be located at a distance of not less than 15 mts. from the well head.

vi) Ensure that the separator is in good working, with all its instruments operational.

vii) Well should be tested at a rate not above the capacity of gas/oil separator.

viii) The gate valve should be opened fully. It may get damaged due to throttling and may leak thereafter.

ix) Adequate fire fighting arrangements should be made available. It should be ensured that personnel deployed for well testing are conversant with the use of fire extinguishers.

x) Temporary flow line from well to activation tank shall be anchored properly to avoid any accident in case of sudden jerking of the line caused by flow of gas. All the joints in the temporary line shall be properly tightened.

xi) A bend should be fitted to the end of pipe line so that flow is always directed downward into the activation tank.

xii) If the well is to be unloaded through the permanent flow line connected to an installation, concerned incharge /shift incharge shall be informed beforehand to avoid process upset in the separation / fluid handling facilities.

xiii) In offshore

- Appropriate safe distance between various equipment should be maintained.

- Flow line should be connected to burner through test choke manifold.

- Adequate water sprinklers to be provided in the surrounding area while well is being flared.

- Environment protection should be given prime importance.

5.2.12 ACTIVATION

Activation involves reducing the hydrostatic head in the well (i.e. creating negative overbalance), thereby inducing the formation fluids to flow into the wellbore. Displacing

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the workover fluid with lighter fluid (water, oil, diesel) may be sufficient to create necessary drawdown (formation pressure minus wellbore pressure) to enable the well to flow. However when higher drawdown is required to activate the well, one of the activation methods is used.

A) COMPRESSOR APPLICATION

In this operation compressed air is introduced into the well (which displaces well fluids), thereafter released, thereby reducing the hydrostatic head acting on the formation.

In wells completed with gas lift valves, compressed air can be used instead of lift gas, for activation.

In this operation the main hazards are due to blow out and fire.

i) Compressor should have safety features such as pressure relief valves, pressure & temperature gauges, engine shut off valves etc.

ii) A pressure gauge should be provided on the discharge line. The discharge line should be securely anchored to the ground.

iii) Discharge line of the compressor should be provided with a gate valve and also a non return valve to prevent back flow of fluids from well into the compressor.

iv) The pipeline should be pressure tested at the rated working pressure. The joints and hammer union should not be opened or tightened unless the pressure in the line is released.

v) In case of any interruption in injection of compressed air, the well should be closed immediately.

vi) The compressors should be located at a safe distance from the wellhead on the upwind side.

vii) Adequate arrangements for fire fighting should be made available.

viii) Use only steel flow lines for compressed air injection and release lines.

ix) Release compressed air, after the application, slowly through a bean at a safe distance.

x) Do not place parts of your body in front of bleed off or sample valves.

B) SWABBING

It is carried out on onland rigs. However, it being an inherently hazardous operation, is normally not resorted to, unless other means of activation are not available.

i) Conduct swabbing operations during daylight hours. It should be carried out at a steady rate to avoid surges. It should not be done in gas wells.

ii) Keep all personnel clear of the mast, rig floor and wellhead during swabbing operations. Avoid approaching, walking over or standing near well flow lines.

iii) Locate swab tanks at least 30 mts. from the wellhead.

iv) Place fire extinguishers at accessible locations.

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v) Use appropriate equipment, rated for the maximum expected pressure, to shut in the well.

vi) Inspect lubricators, swages, and unions before use. Use a lubricator that will allow removal of the swab or other tools with the well shut in (valve closed).

vii) Train all personnel in emergency evacuation procedures.

viii) Make provisions to contain spilled flammable liquids. Remove all spillage of flammable liquids from equipment, cellars, rig floor, and ground area adjacent to the wellhead periodically.

ix) Securely anchor pressurized lines to prevent whipping or bouncing caused by pressure surges.

x) Close the shut-off valve and bleed the pressure from the lubricator before removing swab assembly.

xi) Minimize manual handling of the equipment. Use a winch line, where available, not the swab line, to handle the lubricator.

xii) The wireline should be flagged using a strip of leather or rubber at least 50 feet above the rope socket.

If SRP/ESP is installed in the well during workover, the well can be activated by unloading the well by operating SRP/ESP.

Nitrogen application, for well activation is used when heavy drawdown is required to be imposed. It is covered in section 6.2.5.

5.2.12 ARTIFICIAL LIFT INSTALLATION

A) GAS LIFT:

i) Care should be taken that gas lift valves are not dropped from height or hit against any object.

ii) The gas passage holes in GLV should always be covered during transportation and storage, to avoid plugging by foreign material/dust.

iii) It should be ensured that calibrated valves are tagged properly indicating the set-pressures, depths and well number before either transporting them to the well or sending them for temporary storage.

iv) Threads of mandrel should also be checked before lowering to avoid complications later on.

v) In the case of tubing retrievable conventional mandrel, ensure that GLVs are guarded by protector to avoid damage to GLV by friction / abrasion with the casing wall while lowering the valves.

vi) During storage of wire line retrievable valve mandrels, holes in the mandrel should be covered properly so that no foreign material enters inside the mandrel and plug the holes as well as damage the polished bore of mandrel.

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vii) In order to ensure smooth passage of GLV and wire line tools into the well, tubing clearance should be checked and ensured by dummy run prior to lowering of GLV with wire line tool.

viii) To prevent blowing up of the tool, pressures in the tubing and annulus should be equalized before de-plugging GLV from any mandrel.

ix) Gas injection line should be provided with choke control device.

Please refer to OISD-GDN-193 on ‘Guidelines for Gas Lift Operations and Maintenance’ for more information.

B) SUCKER ROD PUMP

i) Electrical motor should be disconnected before SRP unit is disassembled and caution sign should be displayed.

ii) Keep fingers and hands away from pinch points during making and breaking rod connections. Also ensure that workers are instructed in proper latching procedures while pulling and running rods.

iii) Tubings should be gauged before running in to ensure smooth lowering of rods/pump.

iv) Threads of the rod should be inspected before use.

v) For breaking of sucker rods connections, the joints should never be hammered. Proper coupling and rod wrenches should be used.

vi) Rod elevators, hooks, wrenches and other tools should be inspected regularly for suitability of their use.

vii) After pulling out the downhole pump from the well to the surface, depressurizing of the pump should be ensured, against trapped gas and any other well fluid, before it is opened.

C) ELECTRICAL SUBMERSIBLE PUMP

i) Speed of lowering the pump to be controlled, to avoid damage to the cable.

ii) For clamping of cable with the tubing, distance between the clamps should be as per the cable manufacturer’s recommendations.

iii) Ensure that the cable is suitably guided from the drum so that it unwinds uniformly without overlap and is not damaged by the movement of the elevator during running in or pulling out operation.

iv) Care shall be taken to avoid damage to electrical cable while closing and opening of slips.

v) When connecting/disconnecting tubings, the electrical cable should be safely held by a metallic hook connected to the mast.

vi) While pulling out pump from the well, it should be ensured that the hydrostatic head in the well overbalances the bottom hole pressure.

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vii) Reel of the cable should be in the rig operators direct line of vision.

viii) Electrical continuity and insulation resistance of the cable should be checked periodically while running in the well, at pump setting depth and when termination or splices are made.

5.3 WELL INTEGRITY

There are many aspects to well integrity like well operation/service processes, hardware (tubing, casing, X-mas tree and well head) integrity and testing of surface and sub surface systems.

Well Operating Processes: This includes processes such as personnel competency, well startup-operating-shut down procedures, process to report anomalies, corrosion/erosion control, etc.

Well Service Processes: This includes processes such as personnel competency, intervention procedures, etc.

Tubing Integrity: This refers to the integrity of the well tubing. Common threats to tubing integrity are erosion and corrosion by production/injection fluids. The other threat is pressure differential between the tubing and the annulus. If it exceeds the rated pressure of the tubing, there is a risk of tubing burst or tubing collapse.

Annulus Integrity: This refers to the integrity of the casing strings, which bound the annuli. All annuli will naturally be filled to some level with brine or other fluids from the completion, though the annulus may have gas down to the lowest gas lift valve if the well is gas lifted. The major integrity issues come from the differential pressure across the casings due to the weight of brine. To protect well integrity, each annulus will have specified maximum allowable annulus surface pressure, which should not be exceeded at any time.

X-Mas Tree and Wellhead Integrity: This refers to the integrity of the surface (or sub sea) equipment. The wellhead and the tree are engineered to be able to withstand the normal operating pressures. The major integrity issues for these components surround the operation of the valves, which are prone to leaking. For this reason, valves must be routinely maintained.

Testing of Safety Systems: This refers to testing of surface and subsurface safety systems.

The above mentioned aspects of well integrity are to be addressed, through checking and repair, as required.

The checks should be carried out before, during and after workover operations to ensure well integrity.

Well Barriers: During well workover activities, at least two independent and tested well barriers shall be in place. Two barriers could be the fluid column and BOP.

5.3.1 WELL CONTROL EQUIPMENT AND OPERATIONS

In workover operations, control of well during different phases of operations is of major concern. During operations the possibility of blowout can not be ruled out, because there is likelihood of flow of formation fluids into the wellbore.

Well control fluids & equipment should be available and installed /used as required.
Well should be full of workover fluid of adequate specific gravity to overbalance the bottom hole pressure.

During tripping operation, close watch should be maintained to notice any sign of kick in the well and annulus shall be kept full.

Full opening safety valve (FOSV) with connection for circulation and operating key should be readily available. It should be kept in open position on the derrick floor.

BOP and related equipment like choke and kill manifold, control panel and accumulator should be available, maintained and tested regularly.

BOP equipment should be function tested and pressure tested, when installed and at the appropriate time during operations to determine that BOP functions properly.

Instructions of the BOP operating manual of the manufacturer's should be followed.

All connections, valves, fittings, piping etc. should have a minimum working pressure equal to the rated working pressure of the preventers.

All correct size bolts/nuts and fittings should be used and tightened to the recommended torque. All connections should be pressure tested before resuming operation.

All manually operated valves should be equipped with hand wheels, and always be kept ready for use.

Pit drills should be carried out regularly.

Refer OISD-RP-174 on 'Well Control' for details of BOP system, operation, maintenance, testing etc.

5.4 MODULAR WORKOVER RIG

i) Platform to be checked for strength and adequacy of space before deployment of rig.

ii) It should be ensured that rig loads are directly transferred to the deck legs without affecting the deck trusses.

iii) Dedicated OSV should be available all the time.

iv) Suitable means should be available for the safe transfer of rig components during rig building till the time rig’s crane is commissioned.

v) Adequate fire fighting arrangements should be available.

vi) Gas detection system should be available.

vii) Rig’s evacuation system should be ensured.

viii) Escape ladder and scramble net should be available.

6.0 WELL STIMULATION

It is a general term describing a variety of operations on a well to improve its productivity. It can be designed for remedial purposes or for enhancing production. Two main types of
stimulation operations are matrix acidisation and hydraulic fracturing. Besides these, operations which assist in wellbore cleanup through application of heat, chemical treatment, imposing heavy drawdown etc, like hot oil, coiled tubing operations and nitrogen application also aim to improve the well’s productivity.

6.1 EQUIPMENT USED IN STIMULATION JOBS INCLUDE:

- Fracturing pumps
- Acid pumper
- Acid tanker
- Sand dumper
- Sand blender
- Chemical transporter
- Nitrogen pumper
- Nitrogen bulk carrier
- Coil tubing unit
- Hot oil unit
- Pumper for gravel slurry
- Frac tanks

Checkups and maintenance of both the prime mover and main equipment should be carried out as per manufacturers’ recommendations.

6.2 GENERAL SAFETY PRECAUTIONS

i) Pre-job meeting to be conducted with all the concerned, covering procedures to be followed for job execution, hazards associated and emergencies, alternate plans for job execution and mid way changes to be made if failure of any of the components in the system takes place.

ii) Preplan equipment locations. All trucks and tanks should be located at a minimum distance of 30 mts. upwind from the wellhead, vents, vapor and gas sources and out of the fall line of the mast (if rig is on site).

iii) The operation should be carried out during day time.

iv) All units should be so placed as to allow room to work and space for escape during emergency.

v) All lines connected from pumping unit to wellhead shall have a check valve as close to the wellhead as possible.

vi) Conduct pressure tests on pump(s) and lines and ensure proper valves alignment before pumping.

vii) A pre-treatment pressure test on the pump and discharge lines should be made at a pressure not less than the maximum expected treating pressure, but not to exceed the rated working pressure of the equipment with the lowest rating.

viii) If at any time there is more than one pump in operation there must be way to isolate each pump (isolation and bleed off valve for each pump).

ix) Remain clear of the pressurized lines.

x) All non-essential personnel should stand clear.

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xi) Pump/equipment operator should always be on the control while operation is going on.

xii) Risks involved in handling corrosive substances should be marked on container labels. Do not use the container if the identifying label is missing.

xiii) Use proper lifting techniques and team lifting where appropriate. Use proper hand and body positioning.

xiv) Wear proper PPE including fall protection and respiratory protection, where appropriate.

xv) Follow procedures to release trapped pressure safely.

xvi) During operation when lines are under pressure, no attempt shall be made to tighten the wellhead fittings or the injection line connections. All repairs shall be undertaken only after stopping the pumping units and depressurizing the system. Before breaking out flush all treating lines with water when corrosives, flammable or combustible fluids have been used.

xvii) Brass hammer shall be used whenever there is possibility of an explosive or flammable environment.

xviii) The first aid box and personnel trained in first aid shall be available at the site. Eye wash facility to be provided at the areas where hazardous chemicals are being handled.

xix) Adequate fire fighting facility should be available.

xx) In case of any emergency shut down all units. Evacuate personnel to designated safe place. Once it is determined it is safe to do so, return to the well and close master valve and valves of storage tanks (if could not be closed earlier).

xxi) Smoking shall not be allowed. Use of mobile phone in the well site area should be prohibited. Also, warning signs to be placed around the equipment, having potential hazards which are close to well site area.

xxii) All pumping and discharge lines (pressurized, hot oil, acid, chemicals) shall be secured and shall not be laid under any vehicle.

xxiii) All the exhausts of the engines shall have spark arrestors.

xxiv) While making connections it should be ensured that the threads are clean and lubricated.

xxv) Since all these operations have involvement of many persons at a time proper and good communication should be maintained throughout the job. Also head count to be taken before and after the job.

xxvi) No entry shall be made in any tank, pit, or other confined area until it has been tested for breathable oxygen content.

xxvii) In offshore, since job is undertaken by Stimulation vessel, additionally topics like approach to the rig/platform, weather condition, station keeping, vessel power & redundancy, positioning of vessel in the prevailing weather conditions, emergency plan (including Emergency shut-down procedure & identification of escape route) be discussed.

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- Platform/rig should be clear of all obstructions for the vessel to approach & carry out stimulation Job.

- Good communication should be established between vessel & rig/installation.

- Key personnel from all departments should be readily available during the operation to take immediate action in case of emergency.

- Emergency shut-down procedure shall be agreed upon between the vessel & rig/installation.

Pre-stimulation job checklist is given at Annexure-II.

6.2.1 SAFETY PRECAUTIONS DURING HYDRAULIC FRACTURING

In addition to the general safety precautions, the following points are also to be observed:

i) Wellhead connections should be of such pressure rating as would be suitable for the expected surface fracturing pressure.

ii) Install suitable device (like tree saver) in case frac pressure is expected to exceed wellhead rating.

iii) The suction line should provide positive suction.

iv) Fracturing tanks should be provided with suitable railing on the top for safety of the person who is stationed on the tank during operation.

v) Sand gates should be checked for their opening, before positioning over blender.

vi) Some frac tanks have hatch openings large enough for a person to enter the tank. All rig personnel shall be instructed not to enter any frac tank for any reason. Top of the tank should be covered with chequered plate/ grating.

6.2.2 SAFETY PRECAUTIONS DURING ACIDISATION

Main hazard during acidisation job is due to handling of acids and chemicals. Besides the general safety precautions, the following are the additional points:

i) Acid containers should be stored in a well ventilated space. Chemicals which can react with acids should be kept separately. Storage area and containers should be properly labeled. All used chemical containers should be completely damaged and disposed off to safe location immediately, after completion of the job.

ii) Proper working platform should be provided to stack and handle chemicals & acid.

iii) Acid containers should be lifted preferably with mechanical means.

iv) Personnel handling acids shall be provided with suitable PPE including breathing apparatus.

v) MSDS data of acids shall be available to provide information on acid specific safety precautions.

vi) Adequate quantity of lime/soda should be available to neutralize acid spills.

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vii) Adequate quantity of water should be available for washing continuously the area of the body which has come in contact with acid.

6.2.3 SAFETY PRECAUTIONS DURING HOT OIL OPERATION

In addition to the general safety precautions, the following points are also to be observed:

i) All components of hot oil unit should be inspected before each operation.

ii) At no stage pumping pressure should exceed the burst pressure of the casing and fracturing pressure of the formation.

iii) Choke in the return line should be removed while carrying out hot oil circulation, and installed as soon as well becomes active.

iv) In case return is to an installation, prior intimation shall be given to the installation.

v) In case return is to activation tank, the flow line shall be properly anchored.

vi) Wind direction indicator should be present and visible to the operator.

vii) When pumping hot oil

- All blending equipment shall be electrically grounded.
- All charged suction hoses should be covered with hose covers to deflect fluids in case of rupture.
- All electrical and internal combustion equipment not being used in the job should be shut down.

viii) Fire extinguishers shall be readily available and accessible.

ix) Shut down hot oil operation immediately if leak occurs.

x) No open flame shall be used to initiate ignition of the burner.

xi) Temperature of the fluid being heated should be constantly monitored at the outlet.

xii) All spilled oil should be promptly cleaned up and disposed off suitably.

xiv) Proper PPE such as heavily padded and insulated leather gloves, shall be worn to avoid being burnt by hot oil /line.

6.2.4 SAFETY PRECAUTIONS DURING COILED TUBING OPERATION

In addition to the general safety precautions, the following points are also to be observed:

i) It is important to take extra care and caution during CTU’s movement, because of its configuration. Unit should be driven by an experienced & well versed driver only.

ii) The unit should be positioned in upwind direction as far as possible. It should not be in line with wellhead wing (flow arm) valve. It should be ensured that spark arrestor has been installed on engines exhaust.

iii) Coiled tubing BOP should be checked before use.

iv) In case of acid job with CTU, adequate number of breathing apparatus should be available.

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v) The CTU crane should be maintained in accordance with the manufacturer’s recommendations. Cable must be examined periodically to ensure that there is no excessive wear of the cable to avoid accidents. Proper record of crane cable inspection should be maintained.

Refer OISD-RP-205 on “Crane Maintenance, Operation and Testing”.

vi) While working on live wells, a non-return valve should be used at the pumping line end of the coil tubing.

vii) The injector should be so installed and secured that the wellhead does not support its weight nor does it experience any bending force from the coiling process. Also, the injector should be held with crane.

viii) Working pressure on coiled tubing should not exceed the pressure prescribed by the manufacturer.

ix) No one should be allowed in operator’s cabin except the operator- small distraction can cause serious accidents.

6.2.5 SAFETY PRECAUTIONS DURING NITROGEN APPLICATION

In addition to the general safety precautions, the following points should also be observed:

i) Before commencing any hook-up to a wellhead, ensure that master and wing (flow arm) valves are closed and pressure has been bled off at the tie-end point.

ii) While making connections it should be ensured that the threads are clean and lubricated.

iii) Before opening up discharge / suction lines, ensure that pressure has been released from all sections of lines completely. Ensure all valves in lines are open before hammering on any unions.

iv) Return line from the well shall be properly anchored.

v) To control flow from the well, after nitrogen application, flow control choke should be used instead of throttling the flow arm valve.

vi) Do not place parts of your body in front of bleed off or sample valves.

vii) Avoid exposure to area where nitrogen is being released to prevent suffocation.

viii) Remove personnel to a safe distance from the flow line before well is opened.

ix) Frosted pipes or valves should not be touched with bare skin.

x) Avoid skin contact of liquid Nitrogen to prevent freeze burns.

6.2.6 FLOW-BACK OPERATION ON A STIMULATION VESSEL

i) Installation manager shall be informed before the commencement of flow-back.

ii) The flow back operation shall be carried out only during daylight hours.

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iii) The flow-back of any fluid from a well shall only be flowed-back through the ship’s burner.

iv) Vessel positioning and burner positioning (relative to prevailing wind) to be done in such a way that the discharge from the burner is blown clear from the vessel & adjoining installation.

v) Adequate fire fighting arrangements shall be ensured. Water curtain around the accommodation shall be tried out & started during operation.

vi) Keep proper watch at the burner-boom, choke-manifold & along the flow-back line to detect leaks.

vii) Maintain proper communication between various operation control points on vessel throughout the flow-back operation.

viii) No hot work to be carried out during flow-back.

ix) No unauthorized person shall be allowed around the burner-boom, choke-manifold & flow back line.

x) All vents around the accommodation shall be closed.

xi) A.C. shall be put on total internal re-circulation.

xii) Helicopter operation be suspended during flow-back operation.

7.0 ENVIRONMENT PROTECTION

During workover/stimulation operations, there may be:

i) Discharge of chemicals, hydrocarbons, petroleum products and solid wastes accidentally or otherwise.

ii) Uncontrolled release of high pressure natural gas / nitrogen gas

iii) Noise created by prime movers and other running machinery.

Some effect of operational activities on the environment is inevitable. However concerted efforts shall be made to minimize the impact of these activities on the environment.

In offshore installations one of the primary considerations is prevention of pollution of marine environment. Disposal of any contaminant (liquid hydrocarbons, chemicals, workover fluids, spent fluids, raw sewage and inedible garbage) which may pollute the marine environment shall be prohibited.

For details on recommended practices for ‘Environment Management in E&P Sector’, refer OISD-RP-201.

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ANNEXURE- I

PRE-WORKOVER CHECK LIST (for onland workover rigs)

Rig No.....................Well No.....................Date..........................Project/Asset..............................

We the undersigned as the member of Pre Workover conference checked the readiness of the Workover rig...........for operations.

A) PRODUCTION/DRILLING PART

1. Whether contingency plan for fire and Blowout displayed (including telephone numbers of nearby fire station and health centre)
2. Whether Safety and Environment policy displayed
3. Whether layout plan & prohibitory sign boards displayed
4. Whether hazardous zones demarcated
5. Whether members of rig crew provided with PPE
6. Whether railings around derrick floor/ engine/mud tank walkways provided
7. Availability of well plan
8. Availability of first-aid box & stretcher
9. Availability of fire fighting equipment, as per OISD-STD-189
10. Availability of safety belt & safety harness with life line
11. Availability & condition of Emergency vehicle(arrangement for stretcher)
12. Availability of portable gas detector and its functional status
13. Condition of ladders
14. Condition of casing line
15. Condition of safety lines for tongs & status of fastening clamps
16. Condition of handling tools viz- elevators, slips & power tongs etc.
17. Status of control instruments
18. Functional status of floor-o-matic and crown-o-matic devices
19. Functional status of top-man escape device
20. Functional status of fall prevention device
21. Availability of Trip tank & its functional status
22. Status of BOP control system including remote control system at derrick floor
23. Status of rig building at the time of pre-operation meeting.
24. Any other point

B) MECHANICAL & ELECTRICAL PART

1. Condition of Power-pack Engines
   1) i) 
   2) 
   3) 
2. Condition of Mud pumps
   1) 
   2) 
3. Condition of Compressors
   1) 
   2) 

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4. Condition of Generators
   1) 
   2) 
   3) 
5. Condition of (mech., pneumatic, hydro-matic) brake
6. Whether pressure relief line of mud pumps fitted and secured
7. Status of guards on moving parts
8. Status of auto shut off system at drillers console
9. Status of pressure vessels testing & record thereof
10. Availability of spark arresters in the exhaust manifold of engines
11. Status of communication system
12. Status of earthing system
13. Whether adequate illumination provided at the rig
14. Availability of Emergency light
15. Availability of Aviation light
16. Any other point

C) CIVIL PART

1. Status of hardening and rolling of wellsite area
2. Condition of approach road
3. Capacity of fire water tank
4. Whether toilet provided with water connection
5. Whether septic tank provided
6. Whether proper drainage system with brick work provided
7. Whether fencing around wellsite provided
8. Whether fencing around waste pit provided
9. Whether locking system to chemical store room provided
10. Whether soft cushioning material provided at the landing points of Top-man escape device
11. Any other point

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ANNEXURE II

**CHECKLIST FOR STIMULATION JOBS**

<table>
<thead>
<tr>
<th>Date</th>
<th>____________</th>
<th>Time</th>
<th>_____________</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of job</td>
<td>_______________</td>
<td>Project/Asset.</td>
<td>_______________</td>
</tr>
<tr>
<td>Well no.</td>
<td>_______________</td>
<td>Remarks</td>
<td>Yes/No</td>
</tr>
</tbody>
</table>

1. All concerned present
2. Pre job meeting
3. Job outline
4. Hazards discussed
5. Line of Escape decided
6. Emphasis on saving philosophy (Personnel first, equipment later)
7. Job assignments made
8. Instructions on Pressure Test
9. Pressure limits decided
10. Equipment spotted based on observed wind direction
11. All equipment checked prior to job
12. All pressure lines secured
13. Appropriate personal safety equipment provided
14. Adequate fire fighting system available
15. First aid box and personnel trained in first aid available at the site
16. Eye wash facility available at the site
17. No Smoking Areas /mobile phones prohibited signboards displayed
18. Spark arrestors on the exhausts of all the engines
19. Vehicles properly parked
20. Bystanders cautioned
21. Water available for prime-up, for testing lines and for flushing lines
22. All non-essential engines shut down
23. No open flames on location
24. Hookup reviewed
25. Gelling or chemical mixing procedure reviewed
26. Head count of all personnel on location done(to be checked with head count, after job)
9.0

REFERENCES

API 4G  (Recommended practice for maintenance and use of drilling and well servicing structures)
API 5C1/ISO 10405  (Recommended practice for care and use of casing and tubing)
API 11S3  (Recommended practice for electrical submersible pump installation)
API-54  (Recommended practice for occupational safety for oil and gas well drilling and servicing operations)
API 68  (Recommended practice for oil and gas well servicing and workover operations involving hydrogen sulphide),
Norsok D-010  Well Integrity in Drilling and Well Completion
OMR-1984  Oil and gas well drilling and servicing e-tool (OSHA)
OISD STD/GDN-155, 166, 174,184, 190,192,193, 201, 216, 218,219, 227

ABREVIATIONS

BOP     Blow out Preventer
CTU     Coiled Tubing Unit
FOSV    Full opening shut off valve
GLV     Gas Lift Valve
OSHA    Occupational safety and health administration, USA
PFAS    Personal Fall Arrest System
PPM     Parts per million
SCSSV   Surface controlled subsurface safety valve
SRP     Sucker rod pump

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