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The Safety Circle Approach: A Participatory Framework for Reducing Occupational and Process-Safety Incidents in the Oil Drilling Industry

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Abstract- Oil drilling operations are among the most hazardous industrial activities because they involve high-pressure systems, flammable hydrocarbons, heavy machinery, lifting operations, confined spaces, hazardous chemicals, transportation, and complex interactions between employees and contractors. Although drilling companies use formal safety-management systems, serious incidents may still occur because hazards are not identified early, near misses are underreported, corrective actions are delayed, or communication fails during critical operations. This conceptual paper introduces the Safety Circle Approach, a proactive and participatory framework intended to support incident prevention in oil drilling operations. The approach connects personnel at all organisational levels through a continuous cycle of hazard observation, communication, risk assessment, control implementation, verification, and organisational learning. It places particular emphasis on frontline worker participation, stop-work authority, near-miss reporting, contractor coordination, permit-to-work systems, and verification of safety-critical barriers. The proposed framework is designed for drilling rigs, well-servicing operations, land-based drilling sites, and offshore drilling installations. It integrates safety activities into daily operations, including tripping, drilling, well control, pressure testing, lifting, maintenance, tank cleaning, chemical handling, and simultaneous operations. This paper presents the conceptual foundation, operating stages, implementation model, performance indicators, and proposed evaluation method for the Safety Circle Approach. It argues that a strong safety circle can improve hazard visibility, strengthen safety culture, reduce repeated failures, and support the prevention of major accidents in the oil drilling industry.

Keywords- Oil drilling, process safety, incident prevention, well control, safety culture, near-miss reporting,

I. INTRODUCTION

Oil drilling is a high-risk activity in which people, equipment, pressure, hydrocarbons, chemicals, energy, and environmental conditions interact continuously. Drilling operations may involve rotating equipment, hoisting systems, blowout-prevention equipment, high-pressure lines, drilling fluids,

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electrical systems, welding, confined spaces, working at height, marine operations, and heavy vehicle movement.

A failure in one part of the operation can develop rapidly into a serious event. Examples include:

- Loss of well control.
- Blowout or uncontrolled hydrocarbon release.
- Fire or explosion.
- Dropped objects.
- Caught-in or struck-by incidents.
- Falls from height.
- Crane and lifting accidents.
- Pressure-release injuries.
- Hydrogen sulfide exposure.
- Chemical exposure.
- Vehicle and transportation incidents.
- Fatigue-related errors.
- Environmental releases.

Oil drilling companies commonly use safety-management systems, permit-to-work procedures, job safety analyses, emergency response plans, personal protective equipment, inspections, training, and incident investigations [1]-[3]. These controls are necessary, but they may not be sufficient when safety information is not communicated quickly or when barriers are not verified in actual working conditions.

The Safety Circle Approach is proposed as a practical framework for closing this gap. It treats safety as a continuous cycle involving rig crews, drilling supervisors, toolpushers, company representatives, well-control specialists, maintenance personnel, contractors, managers, and emergency-response teams.

II. PROBLEM STATEMENT

Major incidents in the oil drilling industry frequently involve multiple contributing factors rather than one isolated mistake, consistent with a systems view of accident causation [4]. A technical failure may combine with weak supervision, inadequate communication, production pressure, incomplete procedures, poor maintenance, fatigue, or an ineffective emergency response.

Several safety weaknesses are particularly important in drilling operations:

1. Hazards can change rapidly.
Well conditions, weather, equipment status, pressure, crew composition, and simultaneous operations may change during a single shift.

2. Critical information may not reach the right person.
Poor shift handovers or weak communication between the drilling contractor, operating company, service companies, and subcontractors can create unsafe conditions.

3. Near misses may be underreported.
Workers may fear blame, disciplinary action, loss of employment, or negative performance evaluations.

4. Corrective actions may not address root causes.
Organisations may repair damaged equipment or repeat training without correcting design, planning, supervision, or management weaknesses.

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5. Safety-critical barriers may be assumed to be effective.
Equipment such as blowout preventers, alarms, gas detectors, emergency shutdown systems, barriers, and well-control procedures require regular testing and verification.

6. Production pressure may influence decisions.
Crews may continue work despite changing conditions, equipment defects, fatigue, or incomplete permits.
These challenges demonstrate the need for a safety framework that is continuous, participatory, operationally focused, and capable of identifying weak signals before they develop into major incidents.

III. THE SAFETY CIRCLE APPROACH

The Safety Circle Approach is defined as:
A continuous, participatory safety-management process in which drilling personnel identify hazards, communicate concerns, assess risk, implement controls, verify safety barriers, and apply lessons learned to prevent recurring incidents.

The approach follows six interconnected stages:
Observe -> Communicate -> Assess -> Control -> Verify -> Learn
The process then returns to observation because drilling conditions are constantly changing.

Observe
Personnel identify hazards, abnormal conditions, unsafe behaviours, weak barriers, and changes in the work environment. Observation should include both personal safety and process safety.

Examples include:
- Unexpected pressure changes.
- Gas alarms or unusual readings.
- Damaged hoses or high-pressure lines.
- Defective lifting equipment.
- Inadequate barriers around open areas.
- Poor housekeeping near the rig floor.
- Missing personal protective equipment.
- Unclear permits.
- Simultaneous operations that interfere with one another.
- Excessive crew fatigue.
- Weather conditions affecting lifting or offshore operations.
- Deviations from the well programme.
- Inadequate isolation or lockout/tagout.

Observation should not be limited to visible unsafe acts. It should also examine organisational and operational conditions, including weak signals and degraded barriers [2], [8].

Communicate
Hazard information must reach the people who can control it. Communication channels should include:
- Pre-tour and pre-job meetings.
- Toolbox talks.
- Shift handovers.
- Permit-to-work reviews.
- Radio communication.
- Digital reporting systems.

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- Safety observation cards.
- Near-miss reports.
- Emergency communication systems.
- Daily drilling coordination meetings.

Communication must be clear, timely, and confirmed. Critical information should use closed-loop communication, meaning that the receiver repeats or confirms the message.

Assess

The risk associated with each hazard should be assessed according to:

- Likelihood of occurrence.
- Potential severity.
- Number of people exposed.
- Duration of exposure.
- Effectiveness of existing barriers.
- Possibility of escalation.
- Potential for multiple fatalities or environmental damage.

In drilling, risk assessment should distinguish between ordinary occupational hazards and major accident hazards. A low-consequence event may require one type of response, while a low-frequency but catastrophic event, such as a blowout, requires stronger preventive barriers and emergency controls.

Control

Controls should follow the established hierarchy of controls [3]:

1. Eliminate the hazard.
2. Substitute a safer method or material.
3. Use engineering controls.
4. Apply administrative controls.
5. Use personal protective equipment.

For oil drilling operations, control measures may include:

- Well design and casing programmes.
- Well-control procedures.
- Tested blowout-prevention equipment.
- Pressure-control equipment.
- Gas detection and alarm systems.
- Emergency shutdown systems.
- Mechanical guarding.
- Remote-operated equipment.
- Proper isolation and lockout/tagout.
- Certified lifting equipment.
- Exclusion zones.
- Safe chemical storage.
- Permit-to-work systems.
- Competency assurance.
- Fatigue-management programmes.
- Personal protective equipment.

Personal protective equipment is important but should not be treated as the primary control for hazards that can be eliminated or engineered out.

Verify

Verification is essential because a control is not effective merely because it exists on paper. Process-safety guidance similarly emphasises barrier health and the use of leading and lagging indicators [5].

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Verification should determine whether:

- The equipment is available and functional.
- The procedure is understood by the crew.
- The permit accurately reflects the job.
- Safety barriers are correctly positioned.
- Tests have been completed.
- Corrective actions have been closed.
- Workers are following the agreed method.
- The control remains effective as conditions change.

For safety-critical systems, verification may include testing, inspection, calibration, competency checks, drills, audits, and field observations.

Learn

The organisation should transform observations, near misses, incidents, audits, and emergency exercises into improvements. Learning may result in:

- Revised drilling procedures.
- Improved well-control training.
- Changes to equipment design.
- Better shift-handover processes.
- Updated emergency-response plans.
- Improved contractor requirements.
- Revised risk assessments.
- Additional engineering controls.
- Changes in staffing or work scheduling.
- Communication of lessons to other rigs and locations.

The purpose of learning is not to find someone to blame. It is to understand how the system allowed the unsafe condition to develop, consistent with systems-based approaches to human error [4].

IV. APPLICATION TO OIL DRILLING OPERATIONS

Well-control operations

Well control is a central application of the Safety Circle Approach. The safety circle should ensure that personnel:

- Understand the planned well conditions.
- Monitor relevant indicators continuously.
- Recognise early signs of influx or lost circulation.
- Maintain accurate records.
- Confirm that required barriers are in place.
- Conduct drills and competency assessments.
- Verify blowout-prevention equipment readiness.
- Communicate deviations immediately.
- Exercise stop-work authority when required.

Any unexplained pressure, flow, pit-volume change, gas indication, or equipment abnormality should be treated seriously and communicated promptly.

Drilling and tripping

During drilling and tripping operations, the approach can be applied through:

- Pre-job risk assessments.
- Review of the well programme.
- Confirmation of crew roles.

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- Verification of communication methods.
- Inspection of elevators, slips, tongs, and handling equipment.
- Exclusion zones around rotating or suspended equipment.
- Monitoring of fatigue and workload.
- Continuous review when drilling parameters change.

Pressure testing and high-pressure work

Pressure testing creates significant stored-energy hazards. Safety-circle activities should include:

- Identification of all people who may be exposed.
- Establishment of exclusion zones.
- Confirmation of pressure ratings.
- Inspection of lines, valves, flanges, and connections.
- Verification of gauges and relief devices.
- Controlled pressurisation and depressurisation.
- Clear communication before testing begins.
- Strict prohibition of unauthorised entry into the danger zone.

Lifting and dropped-object prevention

Lifting operations should involve:

- Certified lifting equipment.
- Competent operators and banksmen.
- Approved lifting plans.
- Examination of slings, shackles, hooks, and lifting points.
- Defined exclusion zones.
- Control of suspended loads.
- Consideration of wind and weather.
- Prevention of loose objects falling from derricks and elevated platforms.

Hydrogen sulfide and toxic-gas exposure

Where toxic gases may be present, the safety circle should verify:

- Gas detection and alarm systems.
- Detector calibration.
- Escape routes.
- Breathing apparatus readiness.
- Muster-point arrangements.
- Wind-direction indicators.
- Worker training.
- Emergency drills.
- Contractor awareness.
- Medical-response capability.

Maintenance and energy isolation

Maintenance activities may expose workers to mechanical, hydraulic, electrical, pneumatic, chemical, thermal, or pressure energy. The approach should require:

- Identification of all energy sources.
- Isolation and lockout/tagout.
- Verification of zero energy.
- Clear responsibility for isolation.
- Control of stored energy.
- Permit review.
- Communication between operations and maintenance.

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- Final inspection before equipment is returned to service.

Simultaneous operations

Simultaneous operations can create interaction risks. For example, maintenance, hot work, chemical transfer, lifting, drilling, and well-control activities may occur in nearby areas.

The Safety Circle Approach should require:

- A coordinated simultaneous-operations plan.
- Identification of conflicting activities.
- Defined authority for resolving conflicts.
- Clear communication between departments.
- Permit coordination.
- Review of emergency consequences.
- Suspension of activities when risks cannot be adequately controlled.

V. SAFETY CIRCLES ON A DRILLING RIG

A safety circle should be a multidisciplinary group that meets at planned intervals and also responds to urgent concerns. Participants may include:

- Drillers.
- Assistant drillers.
- Derrickmen.
- Floorhands.
- Toolpushers.
- Drilling supervisors.
- Company representatives.
- Well-control specialists.
- Maintenance personnel.
- HSE personnel.
- Mud engineers.
- Directional drillers.
- Crane operators.
- Catering or support personnel where relevant.
- Contractor representatives.
- Offshore installation management.

The group should not replace the formal chain of command. Instead, it should create a structured opportunity to identify and solve safety problems before they become incidents.

Suggested meeting agenda:

1. Review of recent hazards and near misses.
2. Review of open corrective actions.
3. Changes in the well programme or work scope.
4. Safety-critical equipment status.
5. Contractor and simultaneous-operation issues.
6. Fatigue, staffing, and competency concerns.
7. Emergency preparedness.
8. Worker suggestions.
9. Assignment of actions, owners, and deadlines.

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10. Verification of previously completed actions.

Meetings should produce clear decisions rather than only discussion.

IV. MANAGEMENT RESPONSIBILITIES

The approach requires visible management support. Safety-climate research indicates that management and supervisory priorities materially influence workforce perceptions and safety behaviour [6], [7]. Leaders should:

- Demonstrate that safety takes priority over avoidable production pressure.
- Protect employees who report hazards in good faith.
- Support stop-work authority.
- Provide resources for corrective actions.
- Require verification of safety-critical barriers.
- Include contractors in safety expectations.
- Review safety performance using leading and lagging indicators.
- Avoid using injury rates alone to judge safety performance.
- Recognise effective prevention behaviour.
- Investigate system conditions rather than assigning blame prematurely.

A stop-work policy is only credible when employees know that stopping unsafe work will not result in retaliation.

VII. CONTRACTOR AND INTERFACE MANAGEMENT

Oil drilling commonly involves multiple companies working on the same installation. Interface failures can create significant risk. The Safety Circle Approach should therefore include:

- Common site safety rules.
- Shared induction requirements.
- Clear allocation of responsibilities.
- Competency verification.
- Joint risk assessments.
- Coordinated permit-to-work processes.
- Common emergency procedures.
- Contractor participation in safety meetings.
- Requirements for reporting hazards and near misses.
- Formal communication during shift changes and handovers.

The operating company, drilling contractor, and service companies should agree in advance who has authority to stop work and who is responsible for each safety-critical barrier.

VIII. PROPOSED SAFETY CIRCLE APPLICATION OR REPORTING PLATFORM

A digital Safety Circle platform could strengthen the approach by allowing personnel to report and track hazards in real time. The platform may include:

- Hazard and near-miss reporting.
- Photographs or video evidence.
- Location identification.
- Risk classification.
- Immediate notification of responsible supervisors.
- Corrective-action assignment.
- Deadline reminders.

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- Escalation of overdue actions.
- Anonymous reporting.
- Dashboard summaries.
- Verification records.
- Trend analysis by rig, department, contractor, and hazard type.
- Offline functionality for locations with limited connectivity.

The application should be simple enough to use during field operations. Excessively complicated reporting requirements may reduce participation. Digital tools should support, rather than replace, direct communication and leadership involvement.

IX. PERFORMANCE MEASUREMENT

The effectiveness of the Safety Circle Approach should be assessed using both leading and lagging indicators, consistent with established upstream process-safety KPI practice [5].

Leading indicators

- Number of hazard observations per 10,000 work hours.
- Near-miss reporting frequency.
- Percentage of reports acknowledged within a defined period.
- Percentage of corrective actions closed on time.
- Percentage of corrective actions verified in the field.
- Number of safety-circle meetings completed.
- Worker participation rate.
- Number of stop-work interventions.
- Safety-critical equipment test completion.
- Permit-to-work quality.
- Well-control drill performance.
- Emergency exercise performance.
- Contractor participation.
- Employee confidence in reporting systems.

Lagging indicators

- Recordable injuries.
- Lost-time injuries.
- Serious near misses.
- Dropped-object events.
- Loss-of-containment events.
- Well-control events.
- Fires and explosions.
- Process-safety events.
- Vehicle incidents.
- Environmental releases.
- Repeated incidents.
- Equipment damage.

An increase in hazard or near-miss reporting during the early implementation period may indicate improved trust and reporting culture rather than poorer safety performance; interpretation should therefore consider reporting maturity, exposure hours, and event severity.

X. PROPOSED RESEARCH METHOD

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Research objective

The objective of the proposed future study is to evaluate whether implementation of the Safety Circle Approach improves safety performance and reduces incident potential in oil drilling operations.

Research questions

1. Does the Safety Circle Approach reduce incident frequency in drilling operations?
2. Does it increase near-miss and hazard reporting?
3. Does it improve the timely completion of corrective actions?
4. Does it improve worker perceptions of safety culture?
5. Does it improve verification of safety-critical barriers?
6. Which safety-circle activities have the strongest effect on performance?

Research design

A quasi-experimental design may be used. One drilling rig or operating unit would implement the Safety Circle Approach, while another comparable unit would continue with existing practices. Data should be collected before and after implementation over a period of approximately twelve months.

If a comparison rig is unavailable, a longitudinal before-and-after study may be used. However, the results should be interpreted carefully because external factors may influence safety performance.

Data collection

Data may be obtained from:

- Incident databases.
- Near-miss reports.
- Hazard observation records.
- Permit-to-work audits.
- Well-control drills.
- Corrective-action systems.
- Safety-climate questionnaires.
- Worker interviews.
- Safety-circle attendance records.
- Equipment inspection and testing records.
- Emergency-exercise evaluations.

Proposed hypotheses

- **H1**: The Safety Circle Approach reduces recordable and high-potential incidents.
- **H2:** The approach increases the reporting of hazards and near misses.
- **H3:** The approach improves corrective-action completion and verification.
- **H4**: The approach improves employee perceptions of management commitment to safety.
- **H5:** Higher worker participation is associated with stronger safety performance.
- **H6:** Improved verification of safety-critical barriers is associated with fewer high-potential events.

XI. DISCUSSION

The Safety Circle Approach is especially suitable for oil drilling because drilling operations are dynamic and depend on coordinated action among many specialised personnel. The approach supports both occupational safety and process safety by connecting daily observations with the management of major accident hazards.

Its value is based on five main contributions:

1. It brings frontline knowledge into formal safety decisions.
2. It identifies weak signals before they become major events.

3. It links reporting to visible corrective action.
4. It strengthens coordination among companies and departments.
5. It treats learning as a continuous operational responsibility.

However, implementation may face several challenges. Workers may distrust the reporting process if earlier concerns were ignored. Supervisors may fear that high reporting levels will reflect poorly on their performance. Safety circles may become ineffective if they are used only for announcements. Digital reporting may also create excessive data without sufficient analysis or action.

To overcome these challenges, management should establish clear response times, protect good-faith reporting, verify corrective actions in the field, and measure the quality-not only the quantity-of safety activities. The approach should also be adapted to the realities of each rig, including offshore conditions, crew rotation, language differences, contractor arrangements, and connectivity limitations.

XII. CONCLUSION

The oil drilling industry requires a safety system capable of managing rapidly changing conditions, high-energy hazards, complex equipment, multiple contractors, and potentially catastrophic consequences. The Safety Circle Approach provides a practical framework for achieving this goal.

By connecting observation, communication, risk assessment, control, verification, and learning, the approach can help drilling organisations identify hazards earlier and prevent their recurrence. Its effectiveness depends on worker participation, leadership commitment, reliable reporting, strong contractor coordination, verified safety barriers, and a genuine stop-work culture.

The Safety Circle Approach should not be regarded as an additional administrative programme. It should become part of the way drilling work is planned, performed, reviewed, and improved. When implemented consistently, it can support a stronger safety culture, improve process-safety performance, and reduce the likelihood of injuries, well-control events, fires, explosions, environmental releases, and other serious incidents.

Future field studies should test the approach across land rigs, offshore installations, well-servicing operations, and different contractor structures. Empirical evidence from such studies can refine the framework and establish which components provide the greatest benefit in preventing incidents in the oil drilling industry.

XIII. PRACTICAL IMPLICATIONS

The Safety Circle Approach can be implemented by integrating existing toolbox talks, permit-to-work reviews, shift handovers, hazard observations, near-miss reporting, barrier checks, and corrective-action tracking into one closed feedback loop. A digital platform can improve traceability, but successful implementation depends primarily on timely management response, worker trust, contractor participation, and field verification of actions.

XIV. LIMITATIONS

This paper presents a conceptual framework and proposed evaluation method; it does not report completed field-trial results. Accordingly, causal claims regarding incident reduction require future empirical testing. Effectiveness may vary with rig type, regulatory context, organisational culture, contractor maturity, workforce stability, exposure hours, and the quality of implementation. Reporting-

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based indicators must also be interpreted carefully because increased reporting can reflect improved safety culture rather than increased underlying risk.

Declarations

- **Author contribution:** Dr Ashish Mulraj Ved conceived the Safety Circle Approach and prepared the conceptual framework and manuscript.
- **Funding:** No external funding was received for this conceptual paper.
- **Conflict of interest:** The author declares no known financial or personal conflict of interest relevant to this paper.
- **Ethics statement:** This conceptual paper does not report research involving human participants, animals, or identifiable personal data; ethics approval was therefore not required.
- **Data availability:** No primary dataset was generated or analysed for this conceptual paper.
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