

# IJEAST

INTERNATIONAL JOURNAL
OF ENGINEERING APPLIED SCIENCE
AND TECHNOLOGY

VOLUME : 8 ISSUE : 10 Print / Issue Publication Date: 15-April-2024

ISSN : 2455-2143

DOI : 10.33564/IJEAST.2024.v08i10.031

Indexed In

Google SCHOLAR OPEN ACCESS doi Crossref

WWW.IJEAST.COM

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*International Journal of Engineering Applied Sciences and Technology, 2024*
**Vol. 08, Issue 10, ISSN No. 2455-2143, Pages 189-198**
**Published Online February 2024 in IJEAST (http://www.ijeast.com)**

# A FIELD-READY PERMIT-BASED COORDINATION PROTOCOL FOR DYNAMIC SIMOPS HAZARD INTERACTION REVIEW, CRITICAL CONTROL VERIFICATION, AND OPERATIONAL REASSESSMENT

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*Abstract:* **Simultaneous operations (SIMOPS) create safety concerns when individually authorized tasks interact through a shared work area, hazard pathway, operating system, workforce, or emergency route. This paper presents a field-ready coordination protocol that standardizes how an established permit-to-work (PTW) and SIMOPS process can be reviewed, recorded, and reassessed at the workfront. The protocol defines a bounded rule for multi-activity grouping, a minimum critical-control verification record, three coordinated work-decision categories, role ownership, and explicit reassessment triggers. Its contribution is therefore standardization, inspectability, and training support rather than a new safety theory or validated prediction method. A three-activity composite scenario demonstrates the process. Illustrative dashboard and heat-map figures show how permit and verification information may be displayed for human review; all displayed data are synthetic and no software-performance claim is made. The protocol is intended to complement, not replace, site PTW procedures, SIMOPS matrices, competent supervision, or stop-work authority.**

*Keywords:* **simultaneous operations; permit-to-work; construction safety; hazard interaction; critical control verification; work coordination; dynamic risk review.**

## I. INTRODUCTION

A permit-to-work (PTW) system defines the scope, location, timing, precautions, and authority for a particular task. It is necessary for controlling hazardous work, but the safety of one permitted task can be affected by another team working above, below, nearby, on shared equipment, or on a connected process. This is the practical SIMOPS problem: work may be individually authorized while the combined arrangement is unsafe. Permit guidance emphasizes planning, communication, monitoring, and review [10], while SIMOPS guidance calls for minimizing concurrent work, identifying interfaces, assigning competent supervision, and using a coordinated permit authority [11].

The interaction can change during a shift. Work fronts move, lifting routes change, tasks start late, crews enter an area, isolation conditions are updated, or a critical control expires. A planned schedule or permit register may not describe what is physically happening now. Likewise, a check mark showing that a control was required does not establish that it is installed, effective, current, and understood by affected crews. Safety review therefore needs a shared view of the work, a mechanism-based discussion of exposure, and field confirmation of controls before and during concurrent work.

Research available through the end of 2023 had already established useful foundations for this problem. Construction-safety studies examined spatial-temporal exposure and worker trajectories, graph and Bayesian models, and digital-twin or knowledge-graph integration [1]–[9]. These approaches can connect changing locations, tasks, dependencies, and safety information, but they do not by themselves establish whether a required control is physically in place or assign authority for a work decision. Accordingly, the present framework keeps field verification and consequential work decisions with authorized personnel while allowing digital methods to support information organization and candidate screening [8].

The paper's contribution is deliberately practical. Mature operators already use SIMOPS matrices, area authorities, work coordination meetings, permit revalidation, and field checks [10], [11]. This paper does not claim those duties are new. Instead, it packages them as an inspectable process specification: a bounded rule for deciding when several activities must be reviewed as one workfront, a minimum record for control owner/coverage/verification/expiry, a traceable decision category, and trigger-based reassessment. The intended value is consistency between shifts, contractors, and reviewers, and a clearer basis for training and audit. No worksite permit, incident, near-miss, or

control-verification dataset was available; the digital component is therefore illustrative only.

Terminology used throughout the paper is standardized as follows. A workfront is the bounded set of concurrent or operationally linked activities being reviewed together. The SIMOPS coordinator / area authority means the site-designated role responsible for cross-work coordination; local job titles may differ. A critical control means a site-designated control whose failure or absence would materially increase exposure or compromise the basis for continuing the affected work.

## II. BACKGROUND AND RESEARCH POSITION

The assumed context is a high-hazard worksite with an established PTW system, an assigned area or SIMOPS authority, a work look-ahead, and competent persons responsible for verifying controls. Construction, fabrication, and process operations differ in permit categories, isolation rules, regulatory requirements, and emergency arrangements; each site must adapt the pathway list, roles, thresholds, and terminology locally. This paper sets no universal separation distance or authorization rule.

The literature available through 2023 provides complementary analytical building blocks. Spatial-temporal and trajectory methods help represent where and when exposure may occur [2], [3]; graph and Bayesian methods represent dependencies and changing estimates [4], [5], [9]; and digital-twin and knowledge-graph approaches support integration of work, asset, and site information [6]–[8]. These capabilities are useful for organizing evidence and identifying conditions that deserve attention, while operational decisions still require control verification, communication with affected crews, and accountable authorization. The proposed process therefore uses digital support for visibility and screening while retaining human responsibility for field verification and work release.

Literature cutoff: only sources published on or before 31 December 2023 are cited in this manuscript.

Against established industrial practice, the protocol is incremental rather than substitutive. Static SIMOPS matrices remain useful for identifying activity combinations that are prohibited or require additional controls; area-authority and coordination practices remain the governance mechanism for resolving interfaces [10], [11]. The added specification here is the explicit transition from matrix screening to a documented shared-workfront review: define the group boundary, identify the credible pathway or dependency, verify named controls in the field, record the coordinated decision, and reopen the review when a trigger occurs. This makes familiar practice easier to inspect, teach, compare, and audit without presenting the protocol as a replacement for mature operator procedures.

## III. SAFETY FRAMEWORK

### 3.1 Safety principles

The framework is built around five principles. First, the unit of review is the interacting workfront, not only the individual permit. Second, a credible hazard mechanism must connect the activities and an exposed person, asset, or safety function; simple proximity is a screening cue, not proof of danger. Third, controls are considered effective only when their condition, coverage, responsible owner, and verification time are known. Fourth, the assessment is repeated after material change. Fifth, a competent, authorized person retains responsibility for accepting, conditioning, sequencing, or stopping the work.

The framework does not create a new numerical risk matrix. Severity and exposure remain assessed under the site risk process. Where credible severe harm is possible and a critical control is absent, failed, expired, or unconfirmed, work should be held or separated until the authorized site process resolves the condition. A lower software probability must not override a mandatory control, permit condition, or stop-work requirement.

### 3.2 Hazard interaction pathways

SIMOPS screening should consider the physical and organizational routes by which one activity can affect another. The same separation distance can be acceptable for one hazard and inadequate for another: falling objects, airborne contaminants, fire, pressure release, vehicle movement, and electrical or process isolation do not share one universal radius. Vertical separation, direction of travel, barriers, ventilation, wind, shared access, and the location of people can change the pathway. The following categories provide a practical prompt list; they must be adapted to the hazards and approved procedures at each site.

**Table 1. Common SIMOPS Pathways, Field Review Questions, and Typical Critical Controls**

| Pathway | Example concern | Field review questions | Typical critical controls |
|---|---|---|---|
| Line of fire / elevation | Suspended load, dropped object, work above occupied area | Who is exposed? Is the fall/swing zone defined, barricaded and clear? Can lower work be moved or paused? | Exclusion zone; separation; lift plan; dropped-object prevention; controlled access. |
| Ignition / atmosphere | Hot work near coating, vapour, line opening or chemicals | Can vapour, sparks, heat or residue reach the other task? Are required tests, ventilation and fire | Remove incompatible overlap; isolation; ventilation; gas test where required; fire watch; ignition control. |

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| Pathway | Example concern | Field review questions | Typical critical controls |
|---|---|---|---|
| | | precautions current? | |
| Mobile equipment / excavation | Plant movement near pedestrians, excavation or service route | Are routes separated and services/edges identified? Are barriers, spotters and visibility controls effective? | Segregated routes; barriers; banksman/spotter; edge protection; service identification. |
| Shared energy / system | Common isolation, electrical state, pressure boundary or equipment availability | Who owns the isolation? Were affected permits consulted? Is the change verified before restart? | LOTO/isolation verification; single control owner; system status check; coordinated restart. |
| Confined space / rescue | External task changes atmosphere or blocks rescue access | Can adjacent work alter atmosphere/isolation? Are entry, attendant, rescue and communication controls maintained? | Entry isolation; gas testing/monitoring; attendant; rescue readiness; protected access. |
| Access / emergency interface | Scaffold, crane or temporary work obstructs egress/response | Are normal and alternative routes clear? Can emergency services reach the area? Who rechecks after change? | Maintain egress; alternative route; emergency access protection; housekeeping; route monitoring. |

### 3.3 Reviewing groups of activities

Pairwise matrices are useful for first screening but can fragment one shared condition into several separate reviews. The grouping boundary is defined by three filters used together: (1) an operational boundary such as an area, elevation band, shared system, access route, isolation boundary, or emergency function; (2) a relevant time window based on actual or expected execution overlap, including residual hazards that persist after one task stops; and (3) a credible shared pathway or dependency that can affect the same receptor, system, or critical control. No universal distance or radius is prescribed. Each site must use hazard-specific influence zones and its own approved operational boundaries.

Three or more activities are reviewed as one condition when at least one common pathway or dependency links the group and considering the activities together could change the controls, sequence, or work decision. The rule is deliberately non-transitive: if A interacts with B and B interacts with C, A-B-C is not automatically one group. The coordinator confirms whether one shared receptor, system, access/egress route, emergency function, critical control, or hazard mechanism actually spans the group. If not, the pair reviews remain separate. The group ends when the time window closes or the common pathway/dependency no longer exists. The record should state which activities were included, why they were grouped, which adjacent activities were excluded, and who accepted the boundary.

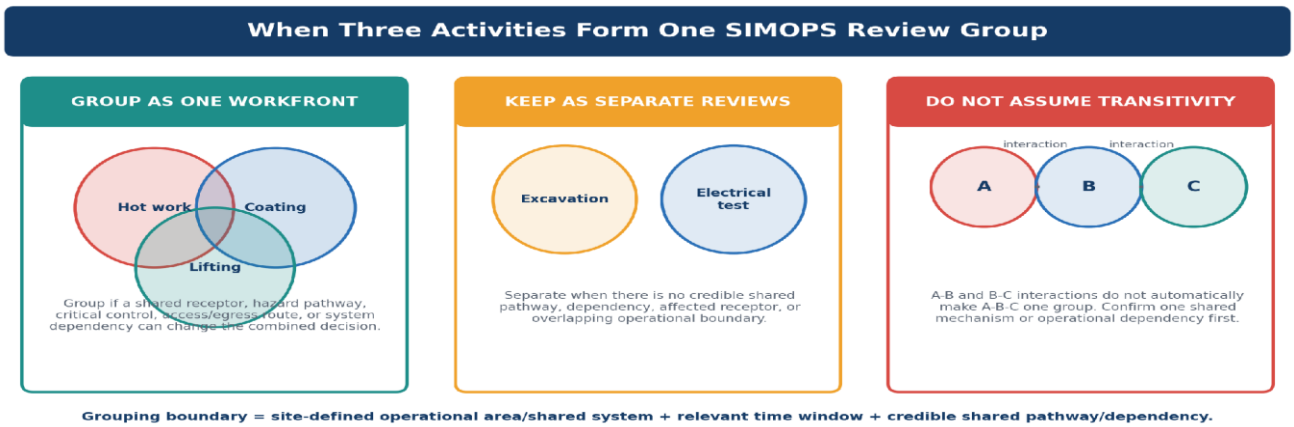



Figure 1A. Practical grouping boundary: when three activities form one shared SIMOPS review group and when pair reviews should remain separate.

For example, hot work, coating application, and lifting may share ignition, vapour, suspended-load, access, and crew-coordination pathways in one workfront. The coordinator resolves incompatible work windows, defines exclusion boundaries, confirms controls, and communicates the start and restart conditions to each affected supervisor.

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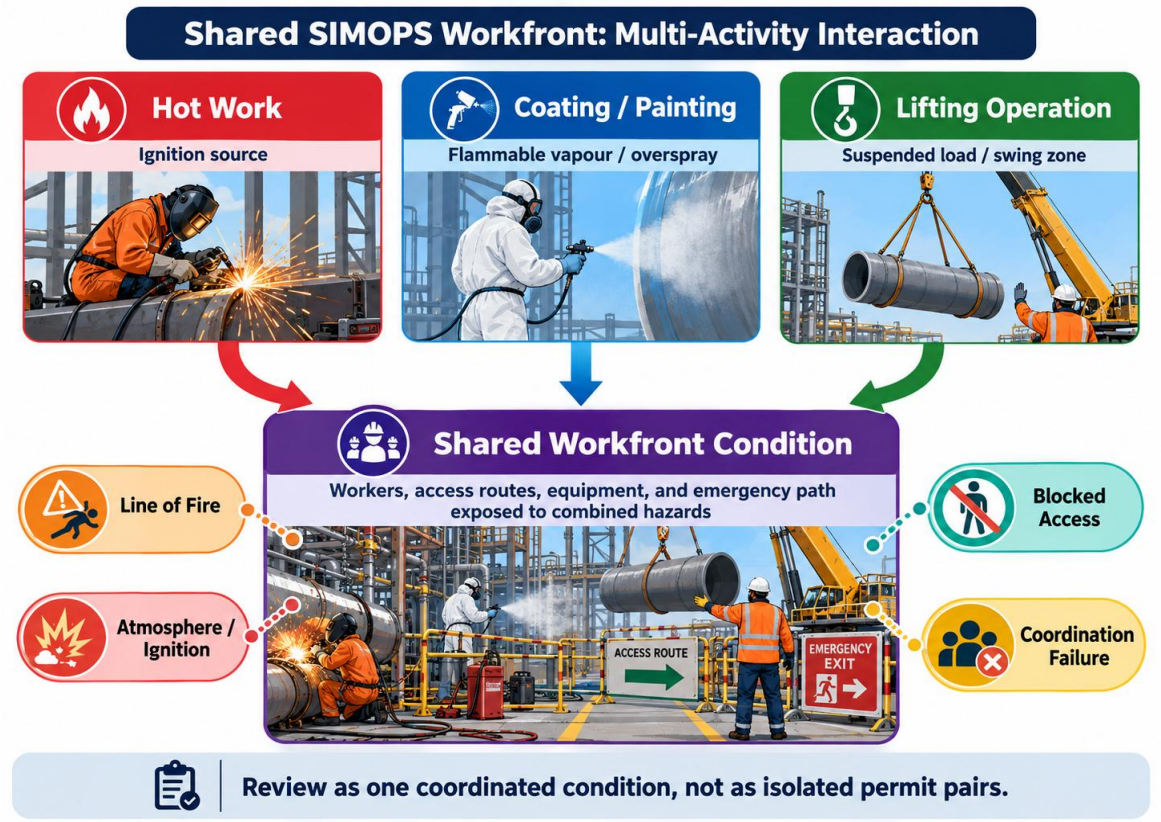



Figure 1. Multi-activity SIMOPS interaction at a shared workfront: hot work, coating/painting, and lifting are reviewed as one coordinated safety condition.

### 3.4 Control assurance and work decisions

For each material interaction, the record should distinguish the control specified in the permit from its state at the workfront. A compact control record includes: what must be controlled; where and for whom it applies; who owns it; how it is verified; when the evidence was obtained; when it expires or must be refreshed; and what condition requires work to pause. "Verified" should not be inferred from a completed form alone when a physical inspection, test, or communication check is required by the site procedure.

Apply the hierarchy of controls explicitly: eliminate the hazardous concurrency where practicable; substitute a less hazardous method, material, or sequence when elimination is not feasible; use engineering controls such as physical separation or isolation; then apply administrative controls such as controlled access, communication, supervision, and permit conditions. Personal protective equipment (PPE) is supplementary and does not replace higher-level controls. A control is not considered available until a responsible person verifies it and affected crews understand the arrangement.

**Table 2. Safety Decision Categories for Coordinated Review**

| Decision | When it is appropriate | Required action before / during work |
|---|---|---|
| Hold, stop, or separate | Credible severe exposure exists; an incompatible task combination is identified; or a critical control is failed, missing, expired, or unknown. | Do not rely on a model score to permit the overlap. Suspend or resequence under site authority; resolve the hazard, verify controls, and reauthorize as required. |
| Proceed only with conditions | The exposure pathway can be controlled, but the overlap requires additional coordination or time-limited verification. | Name each control owner, set boundaries and work windows, brief affected crews, record verification evidence and expiry, and monitor the condition. |
| Proceed with routine coordination | No credible interaction pathway is identified, or the relevant hazards are effectively | Communicate the basis, retain routine permit and field checks, and reassess if the work scope, location, timing, or controls change. |

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| Decision | When it is appropriate | Required action before / during work |
|---|---|---|
| | separated and controls remain current. | |

The framework does not authorize work. The site-designated area authority, PTW authority, SIMOPS coordinator, or other accountable role must make the decision specified by the organization's procedure. Any stop-work authority remains in force. If field conditions differ from the reviewed plan, the affected work should be paused and reassessed through the normal permit and coordination process.

## IV. OPERATIONAL USE AT THE WORKSITE

The proposed review is designed to fit into pre-start planning, daily SIMOPS coordination, permit issue or revalidation, and shift handover. It should use documents already required by the site and add only the information needed to resolve interactions. The review cycle in Figure 2 is deliberately a safety-management cycle; software may help maintain the common work list, but the control checks and work decisions remain operational tasks.

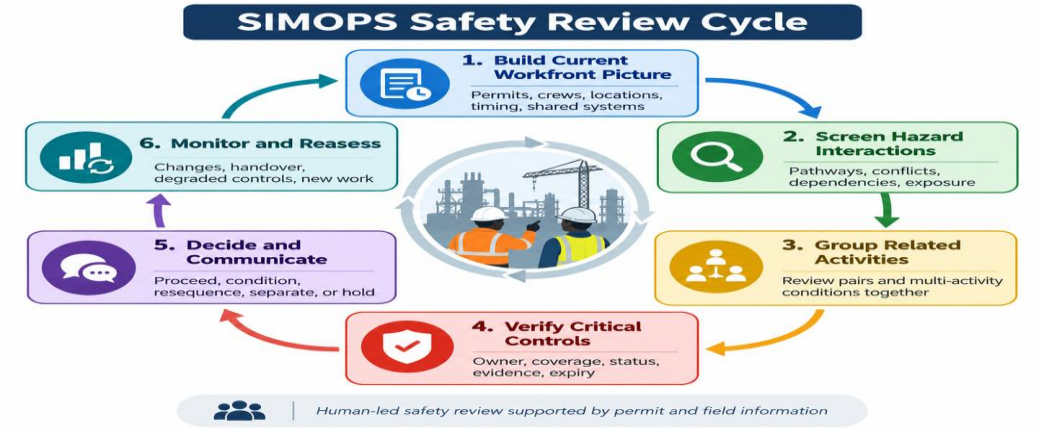



Figure 2. Practical SIMOPS safety review cycle. Step 4—field verification of critical controls—is the non-negotiable gate before reliance on those controls in the coordinated work decision.

### 4.1 Review sequence

1. Establish one current workfront list from approved permits, the look-ahead plan, and field confirmation. Record actual location and execution state separately from planned information.
2. Identify the relevant hazard sources, receptors, equipment, shared systems, work groups, access routes, and emergency functions. Compare vertical and horizontal positions, work periods, and credible pathways.
3. Screen both pairs and larger groups of tasks. Resolve incompatible combinations first through elimination, separation, or sequencing; do not begin by trying to optimize a software score.
4. Confirm critical controls in the field with the responsible owner. Check that the control covers the affected zone, is current, and is communicated to each work group.
5. Record the decision, conditions, actions, named owner, verification time, and restart criteria. Brief affected supervisors and workers before the work overlap begins.
6. Monitor the workfront and repeat the review after a trigger, at shift handover, or when a control is no longer valid.

### 4.2 Roles and accountability

Role names vary between organizations, so the function must be assigned explicitly in the local SIMOPS procedure. The table below separates coordination from control ownership. HSE personnel can facilitate the review and challenge the evidence, but the work authority and technical control owners retain their assigned responsibilities.

**Table 3. Suggested Responsibilities in a SIMOPS Review**

| Role / function | Safety responsibility |
|---|---|
| SIMOPS coordinator | Maintains the combined workfront view; convenes affected parties; resolves timing, location, |

| **Role / function** | **Safety responsibility** |
|---|---|
| / area authority | and shared-system interfaces; records the decision and escalation. |
| Permit issuer / responsible work authority | Confirms work scope and permit conditions; coordinates changes and revalidation; does not rely on another permit's controls without confirmation. |
| Performing authority / supervisor | Confirms the crew, work location, equipment, and actual start state; briefs the task and overlap conditions; stops and reports work when conditions change. |
| Critical-control owner / competent verifier | Verifies the assigned control using the required inspection, test, or confirmation; records evidence, coverage, time, expiry, and any failure. |
| HSE advisor / safety representative | Facilitates hazard-pathway review, checks evidence quality, supports field verification, and records learning; does not replace the designated work authority. |
| Emergency-response / operations representative | Confirms emergency access, response capability, and operational dependencies when the proposed work could affect them. |

**4.3 Reassessment triggers and handover**

Reassessment is required when information used in the review is no longer representative of the workfront. This includes a permit revision or suspension; a changed task, crew, equipment, or work location; a changed start time or sequence; a new work group entering the area; an isolation, gas-test, barrier, fire-watch, lifting, or access control becoming degraded or expiring; a change in weather or operating conditions relevant to the hazard; an incident, near miss, or unexpected release; or a shift handover where conditions or ownership change.

A suspended permit must not be treated as proof that the worksite is physically safe or that residual hazards have ended. Closure and handover should identify unfinished work, remaining energy or material, temporary barriers, open excavations, isolated systems, outstanding tests, and controls that another crew must maintain. The receiving authority should acknowledge ownership before relevant work resumes.

**Table 4. Minimum Reassessment Triggers and Response**

| **Trigger** | **Immediate safety response** |
|---|---|
| Scope, location, sequence, or crew changes | Pause the affected overlap; update the workfront picture and brief impacted supervisors. |
| Critical control fails, expires, or cannot be verified | Hold the affected task or remove the interaction; restore and reverify before restart. |
| New permit, simultaneous task, or shared-system change | Re-screen pairwise and group interactions; consult affected permit and system owners. |
| Atmosphere, weather, equipment, access, or emergency condition changes | Apply the site response procedure, confirm current conditions, and reclassify the SIMOPS decision. |
| Incident, near miss, unexpected condition, or shift handover | Stop and stabilize as needed; communicate residual hazards, actions, owners, and restart conditions. |

## V. ILLUSTRATIVE SAFETY SCENARIO

The following scenario is illustrative and is not drawn from a recorded project or incident. A permit board shows hot work at an elevated workfront, coating application in an adjacent zone, and a crane lift passing near the same area. A lower-level crew is also scheduled to work beneath part of the route. Separate permit reviews may each identify their own precautions, yet the combined arrangement creates a shared SIMOPS condition involving ignition, vapour migration, suspended-load exposure, access, and crew communication.

The coordinator first confirms actual work locations, sequence, wind or ventilation conditions where relevant, the lift path, occupied areas, and any common isolation or access constraints. The affected authorities then remove incompatible concurrency where practicable. For example, the lift may be assigned a dedicated window with the lower area cleared; coating or hot work may be sequenced so incompatible tasks do not overlap; and the work zones and emergency route may be physically protected. Any required atmospheric testing, fire watch, lifting controls, isolation checks, or rescue arrangements must follow the approved site procedure and be verified by the responsible competent person.

Before release, each supervisor is briefed on the permitted sequence, boundaries, hold conditions, and who can authorize restart. The field verifier confirms that required barriers, exclusion zones, tests, and controls are current. If

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the lift route changes, ventilation is lost, a test expires, or a new work group enters the area, the affected work is paused and the SIMOPS review is repeated. The point of the example is the decision process: treat the shared exposure as one coordinated safety condition rather than counting three isolated permits or producing three duplicate alerts.

**Table 5. Illustrative Interaction Review for the Three-Activity Scenario**

| Potential pathway | What could be affected | Coordination and verification response |
|---|---|---|
| Hot work and coating activity | Ignition of flammable atmosphere; exposure to vapour, fumes, or sparks. | Check material and task compatibility, work sequence, separation, ventilation, site-required atmospheric checks and fire precautions; hold incompatible simultaneous tasks. |
| Lifting and occupied workfront | Falling or swinging load, struck-by exposure, blocked route. | Define and barricade the lift exclusion area; clear lower-level work; confirm lift plan, communications, competent supervision, and route before the lift. |
| Combined tasks and shared access | Crews receive conflicting instructions; emergency access or egress is restricted. | One coordination authority communicates the combined plan; assign control owners; confirm access and emergency arrangements; record restart conditions. |

## VI. SUPPORTING SOFTWARE DEMONSTRATION

The digital element is limited to a display and data-structure proof-of-concept. Figure 3 shows how current permits, shared-workfront location, control-verification status, and the human coordination decision can be presented on one screen. Figure 4 shows a separate illustrative heat map and synthetic status summaries. These figures are intended to support discussion and training; they are not a validated risk model and they do not authorize work.

All software inputs, interaction counts, control-status values, and heat surfaces shown in the paper are synthetic. No field prevalence, predictive accuracy, risk-reduction, or software-performance inference is drawn from them. Detailed generator assumptions and exploratory code are retained only in the supplementary technical note and reproducibility package.

The dashboard concept is intentionally subordinate to the safety process: the coordinator still defines the review group, verifies the pathway and controls, records the decision, and reopens the review after a trigger. The software merely organizes information for that human-led review.

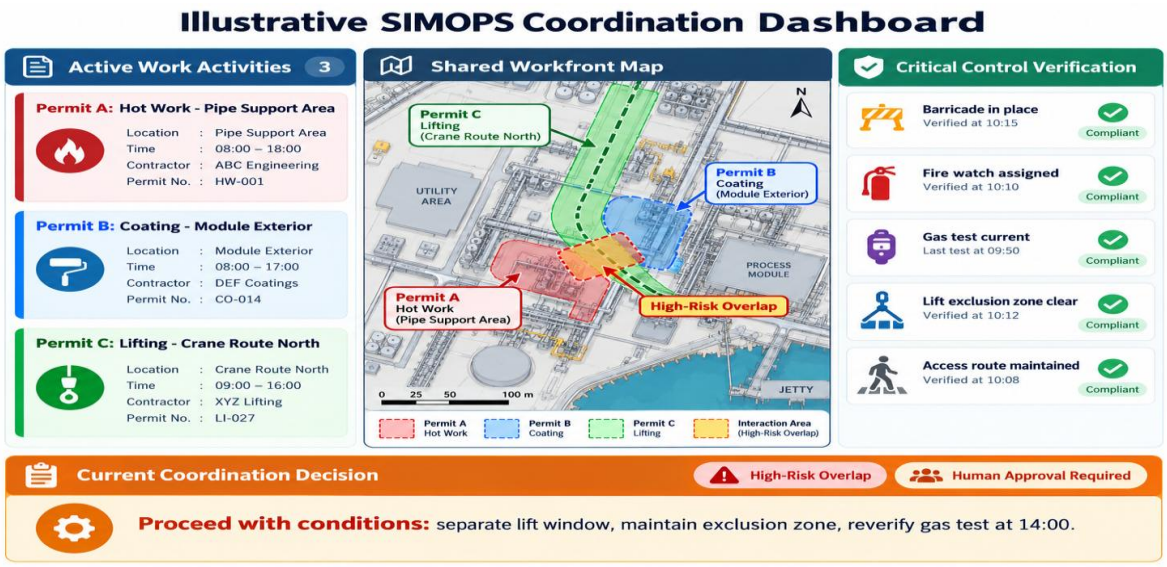



Figure 3. Illustrative SIMOPS coordination dashboard showing three concurrent activities, their shared workfront, critical-control verification, and the human coordination decision. All names, permit numbers, times, and locations are synthetic examples.

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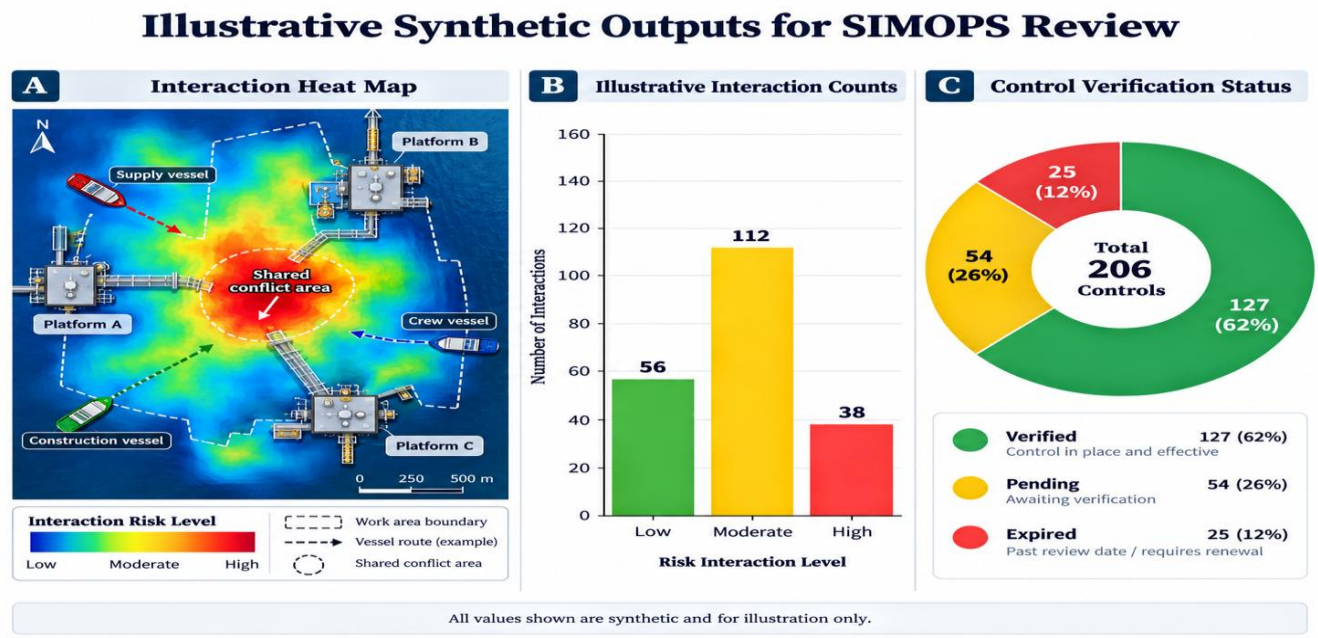



Figure 4. Illustrative synthetic outputs for SIMOPS review: interaction heat map, interaction-count summary, and control-verification status. Values are synthetic and are not measured site risk or exposure data.

Accordingly, the main paper makes no model-performance claim. The prototype demonstrates only that the proposed permit, pathway, group, control, and decision fields can be represented together in a traceable interface.

## VII. DISCUSSION AND PRACTICAL IMPLEMENTATION

### 7.1 Safety contribution

The contribution is best understood as a practical process specification for standardization, inspectability, and training. It turns familiar PTW and SIMOPS duties into a consistent sequence that can be audited: define the workfront, identify the credible pathway, determine whether pair or group review is required, verify critical controls with named ownership and currency, select a work decision, and reopen the review after a trigger. The protocol does not add another approval layer and does not transfer authority to software.

The framework also distinguishes three questions that are often conflated: whether tasks overlap; whether that overlap creates a credible exposure pathway; and whether controls are adequate and verified for the present condition. A spatial intersection can trigger review but does not, by itself, imply an unsafe event. Conversely, a shared isolation, atmosphere, route, or emergency function may create a conflict without a simple geometric intersection. The final work decision depends on the hazard assessment, approved procedures, control evidence, and competent authority.

### 7.2 A staged path to field use

A future site pilot should treat implementation as a safety-management change. Start with a small, high-value scope such as lifting interfaces, ignition-sensitive work, or common access routes. Agree on the site terminology, permit sources, role assignments, trigger conditions, and escalation rules before configuring any software. The initial system should operate in shadow mode: it may identify candidate interactions for review, but must not approve permits, suppress mandatory controls, or automatically direct crews.

A shadow-mode pilot should compare any software-generated candidate flags with independent safety and operations review. At minimum, record: missed high-consequence conflicts identified by independent reviewers; review burden per shift or per 100 permits; critical-control verification completion rate; repeated/duplicate alerts; time from identified conflict to coordinated decision; agreement between independent reviewers on conflict classification; and false-positive burden relative to the independent review. If probabilities are ever introduced, calibration and threshold behavior can be examined separately, but they should not displace the operational measures above. Expansion should depend on evidence that the workflow is usable, does not create alert fatigue, and does not obscure established authority or stop-work processes.

### 7.3 Alert and information management

Where an advisory tool is used, one shared interaction should generate one coordinated case record rather than a separate message for every pair of permits. Alerts should

identify the affected work groups, possible pathway, missing or stale control evidence, decision owner, and response deadline. Repeated alerts can be grouped while the condition is unchanged; a new notification is warranted when exposure changes, a critical control is lost, or the action threshold defined by the site process is reached. Routing should follow the site's assigned responsibilities, and low-priority information should not interrupt emergency or critical communications.

### 7.4 Site adaptation and transferability

The protocol is intentionally generic at framework level but must be configured locally before use. Each site should map its own permit categories, area/elevation boundaries, hazard-specific influence zones, critical-control standards, approval roles, escalation rules, and emergency interfaces. A process plant may place greater emphasis on isolation, line opening, gas testing, and operating-state changes; fabrication and construction sites may place greater emphasis on lifting, work at height, mobile plant, temporary access, and changing work fronts. The framework therefore standardizes the review logic and evidence fields, not the technical thresholds. Local procedures remain controlling.

## VIII. LIMITATIONS AND FUTURE VALIDATION

The principal limitation is empirical grounding. No real permit histories, worksite geometry, near-miss/incident records, independent conflict labels, or practitioner usability dataset were available for this manuscript. The composite scenario is realistic in structure but hypothetical. Therefore, no claim is made that the protocol improves safety performance, reduces review time, or is preferred by practitioners.

The software figures are illustrative representations only. Real influence zones can be directional and conditional on equipment configuration, ventilation, wind, process state, barriers, and human movement. A displayed heat surface should never be interpreted as a measured exposure or as a substitute for site-specific technical criteria.

The minimum next validation step should be either an authorized anonymized field case or a structured practitioner review. For a practitioner review, a small panel of experienced SIMOPS/PTW personnel could independently score the grouping rule, control record, decision categories, trigger table, and checklist for clarity, completeness, usability, and missing conditions; disagreements and requested changes should be reported rather than converted into unsupported performance claims. A later field pilot should use independent event labels, agreement statistics, chronological/site holdout where applicable, and the shadow-mode operational measures specified in Section 7.2. Until such evidence exists, the protocol remains a field-ready proposal rather than a validated intervention.

## IX. CONCLUSION

Dynamic SIMOPS safety depends on more than knowing which permits are open. The workfront must be reviewed for credible interaction pathways, shared systems, people at risk, current field conditions, and verified critical controls. This paper contributes a field-ready coordination protocol that standardizes how those familiar duties are bounded, documented, communicated, and reassessed. Its value is process consistency, inspectability, and training support—not a claim of new safety theory or proven predictive performance.

The dashboard and heat-map figures remain illustrative aids for human review. They provide no evidence of field accuracy, incident reduction, or operational readiness. The next step is practitioner and field evaluation under the site's established PTW, SIMOPS, and stop-work arrangements. Competent site authorities retain responsibility for all work decisions.

### Declarations

### Ethics Approval and Consent

Not applicable. The computational demonstration used synthetic records only and involved no human participants or identifiable personal data.

### Funding

No external funding was received for this work.

### Competing Interests

The author declares no competing interests.

### Data and Software Availability

The illustrative dashboard inputs, synthetic generator notes, code, and exploratory outputs are retained in the accompanying supplementary technical note / reproducibility package. No field or proprietary data were used in this manuscript.

### Generative AI Assistance

Generative AI assistance was used to support code drafting and manuscript editing. The author is responsible for the final manuscript, code, analysis, and references.

### Appendix A. Field SIMOPS Review Checklist

Use this checklist with the site PTW, risk assessment, lifting, isolation, confined-space, emergency, and other applicable procedures. It is a coordination aid and does not replace a required permit or control checklist.

1. Are the permitted tasks, actual locations, active work periods, crews, and supervisors current and visible to all affected parties?
2. Could one activity expose another crew or affect shared equipment, energy, process systems, access, egress, or emergency response?

3. Have vertical separation, line of fire, material or atmosphere movement, vehicle routes, and common dependencies been considered?
4. Have all interacting tasks been reviewed together where a shared exposure or dependency exists?
5. Are required critical controls physically present, verified by the responsible person, in date, and understood by affected crews?
6. Has the authorized person recorded whether tasks will proceed, be conditioned, resequenced, separated, or held?
7. Are control owners, verification times, expiry/recheck conditions, and restart authority clear?
8. Have changes, residual hazards, outstanding actions, and work-area conditions been handed over to the incoming shift?

**Supplementary Material**

Detailed synthetic generator assumptions, feature definitions, exploratory metrics, and dashboard data are provided separately as a supplementary technical note. They are retained for transparency and reproducibility only and are not part of the safety-process contribution or evidence of field performance.

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