



Frontera Space Emergency Procedure: Toxic Gas Alarms

Revision: 01

Frontera Space Document: 000017

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1 PURPOSE

The purpose of Document 000017 is to define required response actions for any toxic-gas detection event occurring within or around the PTSD (Portable Test Stand by Dan). This procedure establishes:

- Toxic-gas alarm thresholds tied to OSHA PEL limits
- Required PPE postures (A, B, C) based on operational state and hazard level
- Tiered response actions from early detection through hazardous release
- Stand safing, personnel fallback, and evacuation requirements
- Stabilization, troubleshooting, and return-to-operations criteria

These actions ensure personnel safety, prevent hazardous inhalation exposure, and support safe identification and correction of leaks or system failures.

2 SCOPE

This document applies to:

- All personnel working in or around the PTSD stand
- All operations involving hypergolics, pressurants, purges, cleaning agents, and decomposition products
- All toxic-gas detectors, alarm systems, and remote-sensing equipment
- All testing, conditioning, troubleshooting, and recovery activities

Compliance with this procedure and associated training is mandatory for all personnel.

3 TOXIC GAS ALARM LEVELS, PPE POSTURES, AND REQUIRED ACTIONS

The PTSD stand uses a defined PPE posture system (A–C) that governs personnel access and permitted activities. Toxic-gas alarm tiers are tied directly to OSHA PEL percentages and dictate required escalation steps. Under normal operations, no detectable hypergolic concentration is expected and any reading while personnel are on the stand is treated as abnormal. During evacuated testing, breaking into wetted lines, or test-article changeout, limited detectable quantities may occur, and these activities must follow the appropriate PPE posture and alarm-response requirements.

3.1 PPE Postures for Stand Operations

PPE Posture A – Safe State

- Stand is fully safed and depressurized.
- Minimal PPE.
- Allowed for administrative tasks, inspection, configuration, and pre-test setup.
- Any toxic-gas detection requires elevation to Posture B or evacuation consistent with alarm tier.

PPE Posture B – Active Operations

- Required for any personnel inside the PTSD fence once interaction, testing, or pressurization begins.
- Personnel may operate safely below 100% OSHA PEL, provided concentrations are stable or decreasing.
- Any upward trend requires increased caution and may trigger escalation.

PPE Posture C – SCAPE Emergency Operations (Supplied-Air, Fully Encapsulating)

- Required for any entry into areas where toxic-gas concentrations exceed 100% OSHA PEL.
- Only Posture C is authorized for emergency shutdown, leak isolation, or rescue when hazardous levels are present.
- No other PPE posture is permitted above PEL.

3.2 Toxic Gas Alarm Tiers Based on OSHA PEL Thresholds

Toxic-gas alarms escalate according to detector readings as a percentage of OSHA PEL limits. Each tier defines allowed PPE postures and mandatory operational actions.

Substance (CAS)	Regulatory limits (representative)	Tier 1 Limit	Tier 2 Limit	Tier 3 Limit
Monomethylhydrazine (CH ₃ NHNH ₂) (CAS 60-34-4)	OSHA PEL: C 0.2 ppm	0.05 ppm	0.10ppm	0.2 ppm
MON-3 (N ₂ O ₄ /NO + reported as NO ₂ equivalents) (NO ₂ CAS 10102-44-0)	OSHA PEL: C 5 ppm	1.25 ppm	2.5ppm	5 ppm

Tier 1 – 25% OSHA PEL (Cautionary Alarm)

Conditions:

- Detector reaches ≥ 25% OSHA PEL
- Early indication of a potential leak
- Below the work-stop threshold

Required Actions:

- Work may continue per standard procedures.
- Personnel remain in PPE Posture B inside the fenced area.

- Operators begin trend monitoring for stability or growth.
- Remote camera inspection is used to check for frost, vapor, or discoloration.

If levels rise or trend upward, escalate to Tier 2.

Tier 2 – 50% OSHA PEL (Work-Stop Level)

Conditions:

- Detector reaches $\geq 50\%$ OSHA PEL
- Confirms active leak requiring investigation

Required Actions:

- Stop all work on the stand.
- Personnel inside the fenced area stay in PPE Posture B.
- Shift focus to identifying likely leak sources using remote sensors and camera review.
- Avoid hardware manipulation unless required by troubleshooting steps.

If readings climb further or instability is observed, escalate to Tier 3.

Tier 3 – $>50\%$ but $<100\%$ OSHA PEL (Elevated Hazard – Fall Back)

Conditions:

- Detector reads above 50% PEL but remains below 100% PEL
- Significant release or continuing leak, but not yet hazardous to Posture B

Required Actions:

- Personnel at the stand fall back to the fence line to reduce exposure.
- Posture B remains acceptable at the fence line, and planned intervention via documented emergency intervention.
- Troubleshooting continues remotely (camera, instrumentation, sensor analysis).
- Stand remains fully safed—no testing or pressurization permitted.
- If readings approach 100% PEL, escalate immediately to Tier 4.

Tier 4 – $\geq 100\%$ OSHA PEL (Hazard-Level Release)

Conditions:

- Detector reaches or exceeds OSHA PEL
- OSHA hazardous exposure threshold exceeded
- Potential IDLH environment

Required Actions:

- Immediate evacuation of all personnel from the fenced area.
- PPE Posture B is no longer authorized anywhere inside the fence.
- Only PPE Posture C (SCAPE) may re-enter for emergency intervention.

- Troubleshooting and monitoring are done remotely until conditions subside.

4 EXCLUSION ZONES & STAND SAFING

4.1 Scene Safety Assessment

Before any personnel re-enter the area:

- Verify stand safing and valve isolation via remote instrumentation.
- Confirm toxic-gas readings, stability, and trend direction.
- Review camera feeds for active vapor release or abnormal hardware conditions.
- Establish routes of safe movement if debris or obscurants are present.
- Personnel in PPE Posture C may enter above OSHA PEL; Posture B is allowed only below PEL.

4.2 Exclusion Zone Requirements

- The PTSD fence line defines the exclusion zone.
- All non-essential personnel must remain outside the fence line for Tier 2–4 events.
- Re-entry restrictions:
 - **Posture A** only after full clearance
 - **Posture B** allowed only below 100% OSHA PEL
 - **Posture C** required for concentrations \geq 100% OSHA PEL

The exclusion zone remains in effect until concentrations stabilize and the Safety Officer grants clearance.

4.3 Stabilization Procedure

After alarm stabilization:

- Allow concentrations to naturally disperse or be drawn down via vent/flare systems (as applicable).
- No manual adjustments may be made until readings decrease.
- Confirm concentration decay and temperature stabilization remotely.
- Once stable:
 - Inspect regulators, valves, seals, and lines

- Identify any failed components
- Tag-out and remove compromised hardware

Document all findings

5 COORDINATION WITH EXTERNAL RESOURCES

5.1 EMS Integration

EMS shall be activated for:

- Any personnel exhibiting symptoms of inhalation or chemical exposure
- Loss of consciousness, respiratory distress, or suspected IDLH exposure
- Any medical condition beyond on-site treatment capability

An escort will meet EMS at the access point and guide responders.

5.2 Hazard Communication

Provide EMS or external responders with:

- Detector logs and concentration time history
- SDSs for chemicals involved
- System summary and pressurization state
- Identification of stored-energy or ignition hazards

6 DOCUMENTATION & INCIDENT REPORTING

Comprehensive documentation and reporting are required for all toxic-gas alarm events, including MMH/hydrazine-class vapors and $\text{NO}_2/\text{N}_2\text{O}_4$ oxidizer vapors. All reporting must comply with the requirements established in the Frontera Prevention Program & Hazard Management Plan (Document 000011) and applicable federal and state regulations.

6.1 Immediate Documentation

After stabilization of any Tier 1–4 toxic-gas alarm:

- Record alarm data, including:
 - detector concentration values,
 - alarm tier,
 - timestamped trend logs.

- Capture video from PTZ and fixed cameras showing vapor, frost, discoloration, or leak evidence.
- Document stand configuration at the time of the event:
- valve positions,
- system pressures,
- purge status,
- pressurant conditions.
- Preserve information on PPE posture used by personnel in the fenced area.
- Document weather conditions (wind direction, wind speed), consistent with the Prevention Program wind-sector restrictions.
- Identify all personnel potentially exposed or present in the hazard zone.

All collected data becomes part of the facility's permanent incident record.

6.2 Formal Incident Report

A formal written incident report must be submitted within 24 hours. The report shall include:

- Narrative timeline of the event.
- Type of chemical detected (MMH/hydrazine-class vapor or $\text{NO}_2/\text{N}_2\text{O}_4$).
- Estimated quantity released or vaporized.
- Duration and peak concentration of the detected levels.
- PPE posture in use at time of detection and during response.
- Actions taken to safe the stand and prevent escalation.
- Personnel exposure assessment, including medical evaluation if required.
- Hardware or system components suspected or confirmed as the source.
- Photographs, detector logs, camera evidence, and system telemetry.
- Any EMS or external agency involvement.

This report fulfills the incident documentation requirements established in the Prevention Program (Section 11).

6.3 Root-Cause Analysis & Corrective Actions

Root-cause analysis shall begin once the stand is stabilized and hazard levels are below re-entry thresholds.

Actions include:

- Mechanical inspection of wetted lines, flanges, valves, purge circuits, and regulators.
- Retrieval, tagging, and preservation of failed components for engineering analysis.
- Evaluation of purge and vent sequencing for abnormalities.
- Identification of procedural, hardware, or environmental contributors.
- Development and documentation of corrective actions.

- Updating SOPs, training requirements, and hazard reviews as required by the Prevention Program.
- Tracking corrective actions to closure via QA processes.
- The final RCA is retained in compliance with Prevention Program QA requirements.

6.4 External Notifications (Regulatory Reporting Requirements)

External reporting requirements for hydrazine (MMH) and $\text{NO}_2/\text{N}_2\text{O}_4$ releases are defined under EPCRA, CERCLA, and state emergency-response rules, and are fully integrated into the Prevention Program (Document 000011).

6.4.1 Triggers for External Notifications

External reporting is required when:

- A release meets or exceeds CERCLA Reportable Quantities (RQ):
 - **MMH: 10 lb**
 - **NO_2 (from N_2O_4): 10 lb**
- Vapors migrate beyond the PTSD fence-line or toward off-site receptors.
- Any personnel exposure requires EMS or medical evaluation.
- Liquid oxidizer or fuel releases vaporize sufficiently to exceed RQ estimates.
- Fire or EMS are activated as part of the response.
- LEPC expectations require notification under EPCRA Section 302 planning terms.

6.4.2 Required External Notifications

If any of the above conditions are met, the Safety Officer must contact:

- **National Response Center (NRC)** — immediate notification for ≥ 10 lb releases.
- **Texas Commission on Environmental Quality (TCEQ)** — state-level reporting.
- **Local Emergency Planning Committee (LEPC)** — per EPCRA planning requirements.
- **Local Fire Department / EMS** — if not already engaged.

These notifications support federal and state regulatory obligations for MMH and $\text{NO}_2/\text{N}_2\text{O}_4$ as outlined in the Prevention Program (Section 10).

6.4.3 Regulatory Documentation Requirements

All regulatory communications shall be documented in the incident package and include:

- Report time and agency contact information
- Name of chemical released and estimated quantity
- Concentration, duration, and affected area
- Weather conditions and wind direction
- Actions taken to isolate and stabilize
- Any field measurements, air-monitoring data, or plume tracking
- Confirmation of follow-up written reports (if required)

6.5 Record Retention (Aligned With Prevention Program QA Requirements)

All toxic-gas alarm records, incident reports, RCA findings, corrective-action documentation, and regulatory filings must be retained in accordance with the Prevention Program's documentation and QA requirements, including:

- Detector logs and calibration records
- SOPs and revisions triggered by the incident
- Training and qualification records
- Waste-handling and decontamination records
- Regulatory notifications and external reports

These records ensure compliance with EPA RMP, EPCRA Tier II, CERCLA, and internal Frontera safety standards.

7 RETURN-TO-OPERATIONS AUTHORIZATION

Operations may resume only when:

- All toxic-gas hazards are eliminated
- Detector readings remain below Tier 1 for a continuous stabilization interval
- Hardware inspection is complete and all failed components are replaced
- Safety Officer grants clearance for PPE Posture A
- Test Director issues formal return-to-operations authorization

8 PROGRAM MAINTENANCE

Document 000017 shall be:

- Reviewed annually
- Updated after any toxic-gas event or system redesign
- Revised when detection equipment, chemicals, or safety requirements change