



DL-10547-2018

Evolution of Maritime Safety: Navigating IMO Resolution **MSC.581(110)**

From Procedural Compliance to Enhanced Hazard Awareness and
Atmospheric Intelligence

Dräger

Technology for Life

The Shift in Paradigm

Despite decades of stringent regulation, enclosed space entry remains one of the most persistent causes of fatalities in the maritime industry. Historical data suggests that many tragedies occur not due to a total lack of equipment, but due to a **false sense of security** provided by insufficient monitoring or a misunderstanding of gas behavior.

IMO Resolution MSC.581(110), effective December 3, 2025, marks a definitive end to the “check-box” era of safety. By replacing Resolution A.1050(27), the IMO has signaled that “compliance” now requires **Atmospheric Intelligence** – the ability to continuously monitor, interpret, and document the shifting atmosphere of a space in real-time.

1 The Regulatory Landscape: Decoding the Mandate

MSC.581(110) is not a minor update; it is a structural overhaul of how shipping companies must manage risk.

Broadened Definitions & The “Invisible” Space

The resolution expands the definition of an “enclosed space.” It now encompasses any area with limited access and poor natural ventilation that is **not intended for continuous worker occupancy**. This pulls many “gray area” spaces – such as chain lockers, duct keel, and small void spaces – into the mandatory safety net.

The Enclosed Space Register (ESR)

A centerpiece of the new regulation is the **Ship-Specific Register**. Companies must now maintain a living document that catalogs:

- Every identifiable enclosed space on the vessel.
- The specific hazard profile (e.g., potential for H₂S in bilge areas vs. CO₂ in grain holds).
- Adjacent spaces that may be affected by gas migration or “pocketing.”

2 Risk Assessment: The Science of Stagnation

MSC.581(110) emphasizes that a ship’s structure is a complex labyrinth that defies simple ventilation. Deep tanks, double bottoms, and intricate pipe tunnels create **stagnant pockets**.

The Atmospheric Spectrum:

1. **Oxygen (O₂) Deficiency:** Often caused by “Steel Oxidation” (rust) in ballast tanks or cargo fermentation.
2. **Flammable Gases (LEL):** Hydrocarbon vapors that can ignite with a single spark.
3. **Toxic Gases:** These must be identified individually in the risk assessment for the ship’s cargo. Common examples include H₂S from decaying organic matter and CO from engine exhaust.
4. **Carbon Dioxide (CO₂):** The “Silent Risk” now prioritized by the IMO. Examples of sources include e.g. accidental discharge or slow leaks from fixed CO₂ fire-extinguishing systems.

3 Deep Dive: The Carbon Dioxide (CO₂) Mandate

Historically, maritime safety relied on Oxygen (O₂) levels as a primary indicator of atmospheric safety. MSC.581(110) shifts this paradigm, recognizing that CO₂ is not just an oxygen-displacer, but a potent metabolic toxin.

3.1 The “O₂ Proxy” Fallacy: A Mathematical Danger

A common misconception is that an Oxygen sensor will alert you to high CO₂ levels by showing a drop in Oxygen. However, the chemistry of air displacement proves this is a fatal error.

- **The Science:** Fresh air contains approx. 20.9 Vol% O₂ and 0.04 Vol% (400 ppm) CO₂.
- **The Displacement:** If CO₂ levels rise to 3.0 Vol% (30,000 ppm) – a level that causes severe respiratory distress and heart rate increases – the Oxygen level only drops by about 0.6 Vol%.
- **The Result:** Your O₂ sensor would still read 20.3 Vol%, which is well above the typical 19.5 Vol% low-alarm threshold. The crew member would be in a toxic atmosphere while their device remains silent.

3.2 Physiological Impact & The “Kill Zone”

CO₂ is 1.5 times heavier than air. In a ship’s hold or deep tank, it does not mix evenly; it sinks, creating a “blanket” of gas at the bottom. A crew member descending a ladder may feel fine at the top, only to collapse instantly upon reaching the lower level.

CO ₂ Concentration	Concentration in PPM	Physiological Effect
0.5 Vol% (MSC Limit)	5,000 ppm	Maximum safe entry limit. Occupational Exposure Limit (8hr).
1.0 Vol% - 1.5 Vol%	10,000 - 15,000 ppm	Drowsiness, mild respiratory stimulation, headaches.
3.0 Vol%	30,000 ppm	Severe panting, increased heart rate, impaired judgment.
4.0 Vol% (IDLH)	40,000 ppm	Immediately Dangerous to Life and Health.
8.0 Vol% - 10.0 Vol%	80,000 - 100,000 ppm	Immediate convulsions, unconsciousness, and death within minutes.

Our recommendation for different vessel types:
X-am 5000/5600/8000 equipped as standard with 5 Gas: Ex/O₂/CO/H₂S/CO₂



Tanker



Bulk Carrier

Oil/Gas	Chemicals	Non hazardous cargo	Toxic gas emitting cargo
2x X-am 8000 4x X-am 5000/5600	2x X-am 8000 5 Gas + additional Tox and VOC 4x X-am 5600 5 Gas + additional Tox or organic vapors	2x X-am 5000/5600 with external pump	2x X-am 8000 5 Gas + additional Tox and H ₂ 4x X-am 5600 5 Gas + additional Tox and H ₂



General Cargo



Offshore Support Vessel



Oil Rigs & Jackups

General Cargo	Offshore Support Vessel	Oil Rigs & Jackups
2x X-am 5000/5600 with external pump	2x X-am 8000 4x X-am 5000/5600	2-n x X-am 8000 4-n x X-am 5000/5600



3.3 High-Risk Sources on Modern Vessels

MSC.581(110) requires specific CO₂ monitoring if the risk assessment identifies the following:

- **Cargo Fermentation:** Organic cargoes—such as grain, wood chips, or fish meal—naturally absorb O₂ and emit massive quantities of CO₂ during transit.
- **Carbon Capture Transportation:** As the industry moves toward decarbonization, vessels carrying captured CO₂ (LCO₂) face high-pressure leak risks that can instantly overwhelm a compartment.
- **Onboard Refrigeration Units:** Systems using CO₂ as a refrigerant (R744) or those cooling organic matter can experience leaks.
- **Engine & Vehicle Exhaust:** Exhaust from main engines, generators, or vehicles on Ro-Ro decks can migrate into poorly ventilated enclosed spaces or be drawn in through ventilation intakes.
- **Fire-Fighting Systems:** In enclosed spaces, a faulty or accidentally activated fixed CO₂ fire-extinguishing system releases lethal concentrations of gas. These leaks can also migrate into adjacent machinery spaces or accommodation vents.
- **Inert Gas Systems (IGS):** Many tankers use CO₂-rich flue gas or dedicated CO₂ systems to inert tanks. A leak in a pipe tunnel or an adjacent space can create a stealthy death trap.

4 Vessel-Specific Hazard Profiles

The risks are not uniform. MSC.581(110) requires owners to tailor their monitoring strategy to their specific vessel type.

Vessel Type	Primary CO ₂ /Gas Source	High-Risk Zones
Bulk Carriers	Fermentation of organic cargo (grain/wood) or coal oxidation.	Cargo holds, access trunks, stools.
Tankers	Inert Gas Systems (IGS) using CO ₂ ; cargo vapors.	Pump rooms, double hulls, void spaces.
Container/Cargo	Leaking fire suppression systems (CO ₂ banks) or reefer units.	Hold spaces, CO ₂ rooms, ventilation ducts.
Ro-Ro / Ferries	Exhaust gas accumulation (CO/CO ₂) from vehicle decks.	Lower car decks, ramp machinery spaces.

5 The Dräger Ecosystem: Precision for MSC.581(110)

To bridge the gap between regulation and reality, Dräger provides a hardware-software ecosystem designed for the rigors of the sea.

Hardware: The X-am Family

The Efficient Offering
with XXS CO₂ sensor

D-14519-2009

X-am 5000

- CatEx 125 PR
- **XXS CO₂**
- XXS O₂ PR
- XXS H₂S LC & CO LC

Shipping Approvals:
MED/MER: Yes
DNV type approval: Yes

The Comfort Offering
with IR sensor

D-25637-2009

X-am 5600

- **Dual IR Ex/CO₂ ES**
- XXS O₂ PR
- XXS H₂S LC & CO LC
- + additional toxic

Shipping Approvals:
MED/MER: Yes
DNV type approval: Yes

The Specialist Offering
with IR sensor

D-24014-2020

X-am 8000

- **Dual IR Ex/CO₂ ES**
- **PID for VOCs**
- XXS O₂ PR
- XXS H₂S LC & CO LC
- + additional toxic

Shipping Approvals:
MED/MER: Yes
DNV type approval: Yes

D-23635-2009



Dräger X-am 5600

The world's smallest 6-gas detector. Its Infrared (IR) technology allows for simultaneous measurement of CO₂ and LEL. IR sensors are immune to "poisoning" from silicones or H₂S, ensuring a lifespan of >5 years and one of the lowest TCO in the industry.

ST-1639-2007



Dräger X-am 5000

A versatile Allrounder that combines catalytic bead sensors with electrochemical CO₂ sensors for cost-effective compliance.

D-24010-2020



Dräger X-am 8000

Designed for "Clearance Measurements." It features an integrated high-power pump (sampling up to 45m) and an intuitive "Assistant" that guides the crew through the pre-entry sequence step-by-step.

D-11857-2016



X-am Pump

The Dräger X-am pump, connected to the X-am 5600/8000, allows to reach the bottom of a 45-meter hold before a single foot is placed on a ladder.

The Power of Automation: Dräger X-dock



D-47797-2012

Manual logging of calibration and bump tests is complex and prone to human error - a major liability during Port State Control (PSC) inspections. The **X-dock** system:

1. **Automates Compliance:** Performs bump tests and calibrations in seconds with minimal gas consumption.
2. **Centralizes Data:** Automatically generates certificates and logs every test, fulfilling the documentation requirements of MSC.581(110).
3. **Reduces Cost:** Precision gas dosing pays for the unit via operational savings.

Digital Intelligence (Gas Detection Connect)



D-10492-2025

Dräger Gas Detection Connect (GDC) centralizes fleet-wide safety data:

- **Global Status Transparency:** Monitor the health, calibration status, and sensor life of your entire fleet's inventory from a single shore-based dashboard.
- **Predictive Maintenance & Logistics:** GDC identifies which devices will require sensor exchanges or calibrations before they expire. This allows managers to plan service and spare part deliveries to coincide with specific port calls, avoiding "out-of-service" downtime.
- **Digital Audit Trail:** Automatically stores calibration certificates and entry logs in a secure cloud for instant PSC inspection readiness.

Conclusion: From Compliance to Confidence

MSC 581(110) isn't just a guideline; it's a chance to upgrade to Atmospheric Intelligence. By prioritizing real-time CO₂ monitoring and automated data, shipping companies can move past "checking boxes" and start saving lives.

Notes

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