REPUBLIC OF THE MARSHALL ISLANDS

Maritime Administrator

FEDERAL INDIANA MARINE SAFETY INVESTIGATION REPORT

Occupational Fatality – Connected Space Entry

Mediterranean Sea | 19 February 2025

Official Number: 10805

IMO Number: 9975387

Published by: Republic of the Marshall Islands Maritime Administrator on 18 August 2026

DISCLAIMER

In accordance with national and international requirements, the Republic of the Marshall Islands Maritime Administrator (the "Administrator") conducts marine safety investigations of marine casualties and incidents to promote the safety of life and property at sea and to promote the prevention of pollution. Marine safety investigations conducted by the Administrator do not seek to apportion blame or determine liability. While every effort has been made to ensure the accuracy of the information contained in this Report, the Administrator and its representatives, agents, employees, or affiliates accept no liability for any findings or determinations contained herein, or for any error or omission, alleged to be contained herein.

Extracts may be published without specific permission providing that the source is duly acknowledged; otherwise, please obtain permission from the Administrator prior to reproduction of the Report.

AUTHORITY

An investigation, under the authority of the Republic of the Marshall Islands laws and regulations, including all international instruments to which the Republic of the Marshall Islands is a Party, was conducted to determine the cause of the casualty.

Maritime Administrator

TABLE OF CONTENTS

LIST OF ABBREVIATIONS AND ACRONYMS 7

DOCUMENTS CITED 7

PART 1: EXECUTIVE SUMMARY 8

PART 2: FACTUAL INFORMATION 10

PART 3: ANALYSIS 18

PART 4: CONCLUSIONS 21

PART 5: PREVENTIVE ACTIONS 21

PART 6: RECOMMENDATIONS 22

LIST OF ABBREVIATIONS AND ACRONYMS

ASD	Able Seafarer Deck
Aug	August
C/O	Chief Officer
CH	Cargo Hold
CO_2	Carbon Dioxide
CPR	Cardiopulmonary Resuscitation
DTS	Deck Trainee Seafarer
EEBD	Emergency Escape Breathing Device
IACS	International Association of Classification Societies
IMO	International Maritime Organization
LSA	Life Saving Appliance
m	Meter
MRCC	Maritime Rescue Co-ordination Centre
MSC	Maritime Safety Committee
NM	Nautical Miles
No.	Number
OOW	Officer of the Watch
OS	Ordinary Seafarer
PMS	Planned Maintenance System
ppm	Parts per Million
PR	Procedural Requirements
Rev.	Revision
SCBA	Self-contained Breathing Apparatus
SMS	Safety Management System
SOPEP	Shipboard Oil Pollution Emergency Plan
UTC	Coordinated Universal Time

DOCUMENTS CITED

IACS PR 37	IACS PR 37 Procedural Requirement for Confined Space Safe Entry, Rev.3 Aug 2023
IMSBC Code	International Maritime Solid Bulk Cargoes Code
IMSBC Code Resolution MSC.268(85)	Adoption of the International Maritime Solid Bulk Cargoes (IMSBC) Code
SOLAS	International Convention for the Safety of Life at Sea
IMO Resolution A.1050(27)	IMO Resolution A.1050(27), Revised Recommendations for Entering Enclosed Spaces Aboard Ships
IMO Resolution MSC.581(110)	IMO Resolution MSC.581(110), Revised Recommendations for Entering Enclosed Spaces Aboard Ships

PART 1: EXECUTIVE SUMMARY

On the morning of 19 February 2025, FEDERAL INDIANA, managed by Anglo-Eastern Ship Management Limited (the "Company"), was underway in the Mediterranean Sea, laden with scrap metal divided over the six cargo holds on board. The Company had assessed scrap metal as an oxygen depleting cargo that could emit toxic gases.

Each cargo hold was accessible by means of two booby hatches located on the main deck: one located at the forward end and one at the aft end. The booby hatches were locked during the voyage. The forward booby hatch for CH No. 1 was located inside a small space under the forecastle deck. The space was naturally ventilated and was accessible through a weathertight door from the cross deck between the forecastle and CH No. 1. Empty pallets and drums with chemicals were stored inside this space. Based on the definitions contained in IMO Resolution A.1050(27), applicable at the time of the incident, the space was assessed as neither an enclosed space nor an adjacent connected space, owing to the previously mentioned presence of natural ventilation.

Around 0815 hours,[1] after the daily planning and Toolbox Talk for the activities on deck, the Bosun and the DTS started to open the four booby hatches of CH Nos. 1 and 2 for inspection of the toggle pins and packings of the booby hatch covers by the C/O. Around 0830, the Bosun and the DTS opened the forward booby hatch cover for CH No. 1 and an additional two of the four booby hatches before the Bosun was called away. Before he left, the Bosun instructed the DTS to open the forward booby hatch of CH No. 2 and then join the ASD1.

When the Bosun later passed by the entrance of the CH No. 1 Access Space, he found the DTS collapsed near the entrance of the space. The Bosun then alerted the other crewmembers who were working on deck and informed the OOW on the Bridge through his handheld radio.

The ASD3 and the Fitter were the first crewmembers who arrived at the CH No. 1 Access Space. The Fitter reported a strange smell and felt uncomfortable breathing, so he went to the ship's side for some fresh air. The ASD3 entered

1 Unless stated otherwise, all times are ship's local time (UTC+1).

CH No. 1 Access Space to help the DTS, but experienced shortness of breath and felt unwell. He managed to get out of the space by his own effort. The ASD1 observed that the ASD3 was unable to get air and realized that compressed air was necessary to safely enter the space. Ultimately, the DTS was rescued out of the space by crewmembers using SCBAs.

The ASD3 recovered after medical oxygen was administered for approximately 20 minutes. The DTS was unconscious, not breathing, and without a pulse. CPR was initiated, shoreside medical advice was consulted, and the Master deviated the ship to the port of Skikda, People's Democratic Republic of Algeria (hereinafter "Algeria") for medical evacuation of the DTS by helicopter.

At 1250, the DTS was declared deceased when he arrived at the hospital.

The Administrator conducted a marine safety investigation and determined that the CH No. 1 Access Space was not identified as a connected space on board FEDERAL INDIANA, consistent with IMO Resolution A.1050(27) applicable at the time of the incident. As this resolution did not define connected spaces in the context of naturally ventilated arrangements, no preventive entry measures were implemented.

The following lessons learned were identified.

- Connected spaces should always be treated as enclosed spaces. Hazardous atmospheres in enclosed spaces can migrate to adjacent and connected spaces[2] when the barrier between both spaces is no longer intact. Natural ventilation of a connected space might be insufficient and should not be relied upon.
- Entering a connected space without following established shipboard enclosed space entry and rescue procedures is extremely hazardous and should not be attempted.
- Enclosed space rescue procedures must be properly practiced and drills conducted as if they were a real emergency.

2 IMO Resolution A.1050(27), as used on board, defines an adjacent connected space. IACS PR37 and IMO Resolution MSC.581(110) defines an adjacent space and a connected space as a different type of space.

SHIP PARTICULARS

Vessel Name
FEDERAL INDIANA

Registered Owner
Federal Trident Ltd.

ISM Ship Management
Anglo-Eastern Ship Management Limited

Flag State
Republic of the Marshall Islands

IMO No.	Official No.	Call Sign
9975387	10805	V7A7453

Year of Build	Gross Tonnage
2024	21,043

Net Tonnage	Deadweight Tonnage
11,607	34,763

Length x Breadth x Depth
196.48 x 23.76 x 14.85 m

Ship Type
Bulk Carrier

Document of Compliance Recognized Organization
DNV

Safety Management Certificate Recognized Organization
DNV

Classification Society
DNV

Persons on Board
22

PART 2: FACTUAL INFORMATION

The following Factual Information is based on the information obtained during the Administrator's marine safety investigation.

Ship particulars at the time of the incident: *see* chart on page 9.

Narrative

On 5 February 2025, the geared, six-hatch bulk carrier FEDERAL INDIANA *(see Figure 1)* departed Newark, United States of America (hereinafter "United States"), laden with a cargo of scrap metal bound for Tsingeli, Hellenic Republic (hereinafter "Greece"), with a scheduled bunker stop en route. On 17 February 2025, the ship completed bunkering at Gibraltar and subsequently continued the voyage.

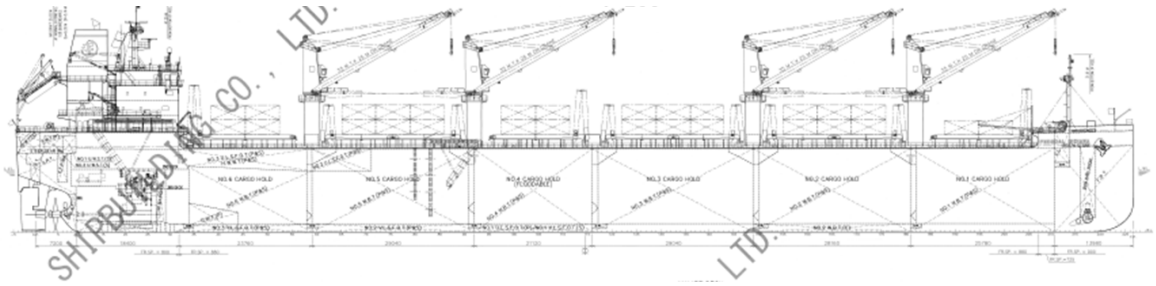

Figure 1: General Arrangement.

On 19 February 2025, FEDERAL INDIANA was underway in the Mediterranean Sea. The DTS commenced his daily routine at 0600 with cleaning duties until 0700, whereafter he had breakfast. At 0700, the Bosun met with the C/O on the Bridge to plan the daily work of the deck crew.[3] At 0800, the entire deck crew with the exception of the ASD4, who had been on duty during the night, assembled on the Bridge Wing for the daily work meeting. The meeting included a Toolbox Talk covering the activities scheduled for that day, the general safety aspects for the activities on deck, and the additional specific hazards associated with each activity, if any.

The following activities were discussed during the meeting.

1. The ASD2 and OS were assigned to grease the exterior of Deck Crane No. 4. For this activity, a permit to work aloft[4] was issued and the risk assessment[5] for working aloft was discussed.

2. The ASD1, together with the DTS, was assigned to lower the SOPEP drums from the No. 1 Mast House and to paint them.

3. The ASD3 was assigned to assist the Fitter with maintenance of the hinge pin of CH No. 3. The working approach was explained together with the general safety aspects.

3 The Bosun, ASD1, ASD2, ASD3, OS, and DTS were assigned deck activities.

4 The Permit to Work-04 in accordance with the ship's SMS was issued.

5 Risk Assessment ID 00274 was discussed on board FEDERAL INDIANA.

4. To prepare the inspection of the toggle pins and the packing of the booby hatch covers by the C/O later that morning, the Bosun and the DTS were assigned to remove the padlocks and to open the booby hatch covers of CH Nos. 1 and 2 for ventilation. During the Toolbox Talk the C/O informed the deck crewmembers that the cargo holds could contain a lack of oxygen and toxic gases emitted by the cargo of scrap metal. The C/O directed that the door of the CH No. 1 Access Space be kept open since the forward booby hatch for CH No. 1 was located inside *(see Figure 2)*.

5. In addition to the scheduled activities, the 3/O, who was on duty as the OOW, requested the Bosun to switch on the power of each deck crane by 0900, to perform a generator performance test.

Figure 2: The CH No. 1 Access Space is indicated in red on the General Arrangement. The bottom left picture shows the location of the weather tight access door with the handwheel identified by the yellow circle. The green arrows in the middle and right pictures point to the booby hatch at the back of the space.

Around 0815, after the meeting, all deck crew went out on deck to start their assigned duties. The Bosun and DTS entered a small space that was accessed through a weathertight door located under the forecastle deck *(see Figure 2)* to open the forward booby hatch cover of CH No. 1. The rubber gasket of the booby hatch cover was stuck to the compression bar of the booby hatch, and it took some time to open it. Next, the Bosun and the DTS went to the cross deck between CH Nos. 1 and 2 and opened the aft booby hatch of CH No. 1 and the forward booby hatch of CH No. 2.

Around 0835, the OS and ASD2 called the Bosun for assistance as they needed a plug for greasing Deck Crane No. 4. The Bosun went to the Engine Room Store to get the correct plug and instructed the DTS to join the ASD1 near the cross deck between CH No. 1 and the forecastle after he opened the aft booby hatch for CH No. 2.

When the Bosun returned from the Engine Room Store, he was reminded by the 3/O to switch on the power of each deck crane. The Bosun first went to the ASD1, who had just removed some pallets from the space in which the open forward booby hatch for CH No. 1 was located. At that moment, the DTS had not yet joined the ASD1. The Bosun requested the ASD1 to switch on the power of Deck Crane No. 1. The Bosun then went to the other cranes to switch on the power while looking for the DTS. When the Bosun passed by the Fitter and the ASD3 near CH No. 3, they confirmed that they had seen the DTS a few minutes earlier.

After switching on the power of each of the deck cranes, the Bosun returned to the cross deck forward of CH No. 1. When he passed by the space in which the forward booby hatch for CH No. 1 was located, he saw the DTS collapsed inside the space. The Bosun was not able to pull the DTS out of the space by himself, so he went aft and called the other deck crew for assistance and informed the OOW on the Bridge through his handheld radio.

The OOW received the call from the Bosun at 0904 and immediately raised the ship's general alarm, whereafter the C/O and the remaining crewmembers also rushed toward the cross deck forward of CH No. 1.

The ASD3 and the Fitter were the first crewmembers to arrive at the entrance of the CH No. 1 Access Space, followed by the ASD1. The Fitter observed a strong smell and stated that it felt like it took his breath away. He left the area and moved to the ship's side to get some fresh air. The ASD3 entered the space and soon thereafter started feeling dizzy, with shortness of breath, and a complete loss of coordination. At that moment, the ship's general alarm was sounded. The ASD1 observed that the ASD3 was unable to get air and realized that the atmosphere inside the space was hazardous and that compressed air was needed to safely enter the space. The ASD1 left the area to get an EEBD. The Engine Room crew, alerted by the message on the handheld radio, arrived near the forecastle, where they met the Fitter who informed them about the condition inside the CH No. 1 Access Space.

A stretcher and SCBAs were brought to the scene. The ASD3 was able to get out of the space without assistance before losing consciousness. He had a pulse and was breathing heavily. He was taken to the ship's Hospital where medical oxygen was administered. He recovered after 20 minutes.

The Bosun and C/E donned SCBAs and rescued the DTS from the CH No. 1 Access Space and laid him on deck. The DTS, who was examined after being removed from the space, did not have a pulse and was not breathing. Crewmembers started to administer CPR and medical oxygen.

At 0917, the Master attempted to contact MRCC Algiers, the Algerian Coast Guard, and Skikda Port Authority, which was approximately 30 NM away, but no contact could be established. At 0925, FEDERAL INDIANA deviated course toward the port of Skikda to enable a medical evacuation of the DTS. Shortly thereafter, the DPA was informed about the incident on board and about the deviation to the port of Skikda.

At 0937, the DTS was still unresponsive and transported to the ship's Hospital, where CPR was continued.

At 0947, contact was established with Skikda Port Authority and an immediate medical evacuation by helicopter was requested.

From 0955 until evacuation, contact was established with 3Cube Medicare medical assistance and crewmembers were advised to continue CPR, as they had been doing continuously.

At 0958, FEDERAL INDIANA established contact with the Algerian Coast Guard regarding the evacuation of the DTS. The helicopter arrived at 1144 and left at 1205 with the DTS and ASD3 on board.

At 1300, the Master was informed that the DTS was deceased when he arrived at the hospital on shore. The ASD3 underwent a medical examination and was declared fit for work.

On 25 February 2025, FEDERAL INDIANA arrived at the anchorage of Amaliapolis, Greece, where a marine chemist boarded to take gas measurements from the gas sampling points of the cargo holds with closed hatch covers. CH Nos. 1, 2, 4, 5, and 6 had high concentrations of carbon monoxide and hydrogen cyanide.[6]

On 26 February 2025, an autopsy of the DTS's body was conducted in Algeria. The autopsy report stated that the cause of the DTS's death was respiratory distress and further indicated signs of violence in the thoracic area of the body, including fracture of the lower third of the sternum, bruises and an erosive thoracic wound, hematomas in the intercostal and paravertebral muscles, bilateral pneumothorax, and pulmonary edema. In addition to the autopsy report, a toxicology report was conducted in Algeria as well.

The results of the autopsy and toxicology report were inconclusive in determining the exact cause of death. The toxicology report was negative for alcohol or drug use but did not confirm or exclude the presence of hydrogen cyanide.

Scrap Metal

When the fatal accident occurred, the cargo holds on board FEDERAL INDIANA were loaded with scrap metal. They were loaded in the ports of Albany and Newark, both located in the United States, between 26 January and 4 February 2025.

A procedure for safe loading was available on board.[7] The procedure stated that scrap metal could cause oxygen depletion in holds, that the cargo could be contaminated by substances emitting toxic gases, and that the cargo can be subject to self-heating. The procedure mentioned that entry into the cargo hold must be controlled by a permit to work, including measurements of the atmosphere inside the cargo hold.[8]

During loading, the temperature of the cargo was monitored and the procedure stated that only dry cargo was allowed to be loaded in dry cargo holds.

The Cargo Information Form[9] received from the shipper and signed on 20 January 2025 stated that the cargo was stowed outside and could be loaded in any kind of precipitation. These conditions were assessed by the Company's Commercial Operations Department and reflect customary industry practice for scrap metal cargo handling.

---

6 The marine chemist used a MultiRAE gas detector for gas measurements. The maximum detectable concentration for carbon monoxide with this equipment is 500 ppm and 50 ppm for hydrogen cyanide. These maximum concentrations were measured, and thus exact concentrations could not be determined.

7 The Company's *Bulk and General Cargo Operations Manual*, Section 5.8 — Scrap Metal.

8 On the date of the accident, the ship was equipped with two portable, three personal, and one tank scope gas detectors.

9 As per *IMSBC Code* and *SOLAS* Regulation XII/10.

The cargo safety precautions provided by the shipper in a separate letter included details on the oxidation of the steel scrap, which can lead to oxygen depletion in the cargo holds. Precautions related to the presence of toxic gases were not included. The safety precautions were signed for receipt by the Master of FEDERAL INDIANA and were posted in the Officer and Crew Mess Rooms.

The IMSBC Code includes requirements for two main categories of scrap metal: scrap metal (Group C) and ferrous materials in the form of iron metal borings, shavings, turnings or cuttings (Group B). FEDERAL INDIANA was loaded with scrap metal (Group C). The IMSBC Code general guidance regarding the hazards of Group C cargoes includes:

1. no special hazards;
2. low fire risk except when cargo contains swarf (fine metal turnings liable to spontaneous combustion); and
3. reference to the entry for FERROUS METAL BORINGS, SHAVINGS, TURNINGS or CUTTINGS UN 2793.

The IMSBC Code also includes the following: "this cargo shall be kept as dry as practicable before loading, during loading and during the voyage. This cargo shall not be loaded during precipitation."

Enclosed Spaces

IMO Definition

According to IMO Resolution A.1050(27),[10] which was applicable at the time of the incident, an enclosed space is characterized by:

1. limited openings for entry and exit;
2. inadequate ventilation; and
3. not being designed for continuous worker occupancy.

The resolution also includes the following non-exhaustive list of types of spaces that comply with this definition:

> *...cargo spaces, double bottoms, fuel tanks, ballast tanks, cargo pump rooms, cargo compressor rooms, cofferdams, chain lockers, void spaces, duct keels, inter-barrier spaces, boilers, engine crankcases, engine scavenge air receivers, sewage tanks, and adjacent connected spaces.*

IMO Resolution A.1050(27) also included a definition of adjacent connected spaces. Adjacent connected spaces are defined as "a normally unventilated space which is not used for cargo, but which may share the same atmospheric characteristics with the enclosed space such as, but not limited to, a cargo space accessway."

The 34th Session of the IMO Assembly endorsed IMO Resolution MSC.581(110) on 3 December 2025 which revoked IMO Resolution A.1050(27).[11] The definition of an enclosed space in IMO Resolution MSC.581(110) is nearly the same as the definition in IMO Resolution A.1050:

10 Adopted by the IMO Assembly on 30 November 2011 and valid on 19 February 2025.

11 IMO Resolution MSC.581(110) was adopted on 27 June 2025 and endorsed on 3 December 2025.

"Enclosed space means a space which may contain a hazardous atmosphere or lack of oxygen and has any of the following characteristics:

1. limited openings for entry and exit;

2. inadequate ventilation; or

3. not designed for continuous human occupancy."

IMO Resolution MSC.581(110) also includes definitions of connected spaces and adjacent spaces. A connected space is defined as: "a space that is connected, by either permanent or temporary means (such as a door), to a source space that may contain a hazardous atmosphere." The recommendations state that a connected space should be treated as containing a hazardous atmosphere until testing proves otherwise. An adjacent space is defined as:

> *...a space that shares a common boundary with a compartment that may contain a hazardous atmosphere. Such a space has no openings, temporary or permanent, into the hazardous compartment whatsoever and is designed to be a contiguous barrier. Such a space may only contain a hazardous atmosphere in the event of failure of that barrier. Precautions should relate to the possibility of such a failure.*

IACS PR 37 Definition

The IACS PR 37[12] definition of a confined space is nearly the same as IMO Resolution A.1050(27) definition.[13] IACS PR 37 also includes definitions of adjacent[14] and connected[15] spaces, which are similar to those contained in IMO Resolution MSC.581(110).

IACS procedures are standards for ensuring uniformity and quality among IACS member classification societies. They are not written to address ship managers or flag States, but they are publicly available.

Company's SMS

The definitions of enclosed spaces and adjacent connected spaces in the Company's SMS were consistent with those in IMO Resolution A.1050(27), the controlling resolution at the time of the casualty.[16]

In addition, the enclosed space entry procedures included a list with examples of spaces that met the definition of an enclosed space. Apart from enclosed spaces, spaces that may have an unsafe atmosphere were listed, such as paint stores. Connected spaces, such as spaces containing direct access to a cargo hold, were not included in any of the lists.

---

12 The most recent revision of IACS PR 37 is Revision 3, which was adopted in August 2023.

13 "Enclosed space means a space which has any of the following characteristics: .1 limited openings for entry and exit; .2 inadequate ventilation; and .3 is not designed for continuous worker occupancy, and includes, but is not limited to, cargo spaces, double bottoms, fuel tanks, ballast tanks, cargo pump-rooms, cargo compressor rooms, cofferdams, chain lockers, void spaces, duct keels, inter-barrier spaces, boilers, engine crankcases, engine scavenge air receivers, sewage tanks, and adjacent connected spaces. This list is not exhaustive, and a list should be produced on a ship-by-ship basis to identify enclosed spaces."

14 "Adjacent space means a space that shares a common boundary with a compartment that contains a hazardous atmosphere. Such a space has no opening or connections into the hazardous compartment whatsoever and is a contiguous barrier. Such a space may only contain a hazardous atmosphere in the event of the failure of that barrier."

15 "Connected space means a space that is connected, by either permanent or intermittent means to a source space that may contain a hazardous atmosphere. A space separated by a door shall be considered 'connected' as it is impossible to tell from outside the space whether it is open or not. A connected space shall be seen as containing a hazardous atmosphere until testing proves otherwise as that atmosphere could be trapped."

16 The Company's *Health and Safety Manual*, 5.2 Enclosed Space Entry Procedures, Revision 11, as part of the ship's SMS.

Annex 3 of the LSA Training Manual[17] on board FEDERAL INDIANA contained a list of all the enclosed spaces on board the ship. The list did not include any adjacent connected spaces. The list was prepared by the Master and approved by the Company's Vessel Manager after the ship was delivered from the shipyard in 2024. Listed spaces included the ship's cargo holds. The space in which the forward booby hatch for CH No. 1 was located was not included in this list.

Access to enclosed spaces on board FEDERAL INDIANA were secured and strict procedures were in place to enter an enclosed space. There was an additional procedure for entry into cargo holds[18] that required the booby hatch covers to be locked when closed. This additional procedure required that when booby hatches needed to be opened, a barrier be placed in the opened booby hatch and secured with a padlock, to prevent unauthorized access *(see Figure 3)*.

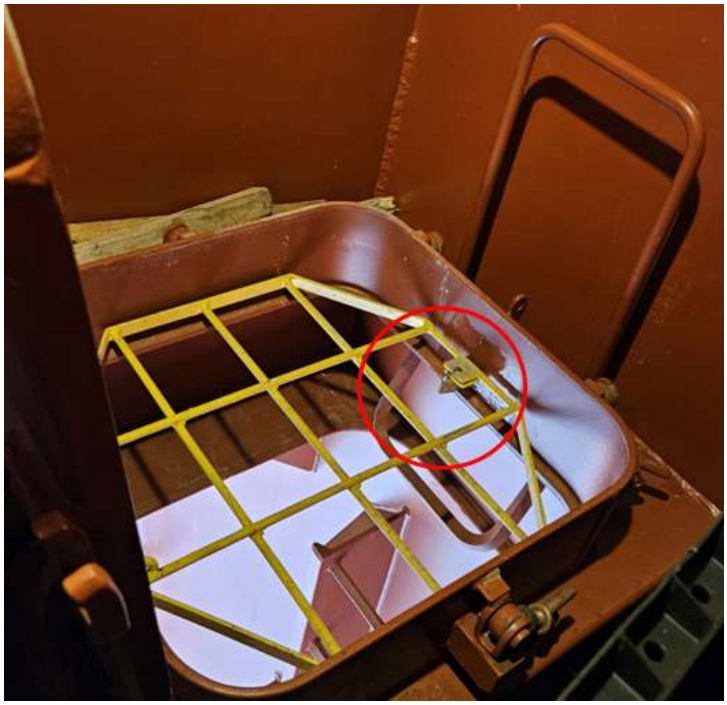

Figure 3: Secured grid (barrier) in the forward booby hatch of CH No. 1.

Onboard Training

Enclosed space entry and rescue drills were carried out on board FEDERAL INDIANA every two months. The most recent drill was executed on 25 January 2025. Shipboard training for the Company's permit to work system was scheduled every six months. The latest training was carried out on 8 February 2025.[19]

Spaces Containing Cargo Hold Access Hatches

CH No. 1 Access Space is a small space of approximately 3.0 x 1.5 m. It is located under the forecastle deck and the space provides access to the forward booby hatch of CH No. 1. The space is designed without any other functionality.

17 As per *SOLAS* Regulation III/35.

18 The Company's *Bulk and General Cargo Operations Manual*, 3.2 Cargo Hold Entry Procedures.

19 The Company's *Policy and Administration Manual*, Annex 1 — Drill Planner and Annex 2 — Shipboard Training Planner.

Access to the space is through a weathertight door *(see Figure 2)*. The space is ventilated by an opening next to the access door *(see Figure 4)*. The booby hatch cover is the only separation between CH No. 1 and CH No. 1 Access Space.

On the day of the accident, empty pallets and barrels with cleaning chemicals[20] were present inside the space. As the space was not defined as an enclosed space, no additional precautions were taken by the ship's crewmembers when they entered this space. The crewmembers on board reported that the last entry before 19 February 2025 was one or two days before, without incident.

Figure 4: Ventilation of the CH No. 1 Access Space.

FEDERAL INDIANA Crew

FEDERAL INDIANA had 22 crewmembers, six more than required by the Minimum Safe Manning Certificate issued by the Administrator.

All involved crewmembers held the appropriate Republic of the Marshall Islands-issued seafarer documentation for their positions on board.

The Administrator did not find any indication that any crewmembers involved with this incident failed to receive the amount of rest mandated by the STCW Code, Section A-VIII/1, paragraphs 2 and 3, and the MLC, 2006, Regulation 2.3.

20 Cement Remover (Hazard phrases H314 and H335) and Alcaclean HD (Hazard phrase H314) — H314: Causes severe skin burns and eye damage. H335: May cause respiratory irritation.

The crewmembers involved had the following experience:

RANK	TIME ON BOARD FEDERAL INDIANA	TIME IN RANK	TIME WITH COMPANY	TOTAL TIME AT SEA
Master	7.1 Months	3 Years	17.7 Years	9.3 Years
C/O	5.4 Months	1.9 Years	14.9 Years	9.9 Years
Bosun	8.5 Months	2.2 Years	21.7 Years	13.8 Years
ASD1	8.5 Months	7.9 Years	16.3 Years	10.9 Years
ASD3	2.8 Months	10.5 Years	5.1 Years	11.2 Years
DTS	4.9 Months	4.9 Months	4.9 Months	4.9 Months

The Safety and Security Familiarisation Checklist and Deck Ratings Changeover Checklist[21] were completed by the ASD1, Bosun, and DTS on 26 September 2024 and by ASD3 on 28 and 29 November 2024. The checklists included information related to the Enclosed Space Entry Permit to Work, LSA Training Manual, and use of personal gas-measuring devices.

PART 3: ANALYSIS

The following Analysis is based on the above Factual Information.

Ship Design

FEDERAL INDIANA was designed with the forward booby hatch for CH No. 1 located under the forecastle deck in a small space with no other function and accessed through a weathertight door. This led to the creation of an additional space under the forecastle deck, the CH No. 1 Access Space. The presence of a closed booby hatch cover in combination with natural ventilation led to an underestimation of the possible hazards inside the space.

Although this space was not designed as a work or storage space, it was regularly accessed by crewmembers and used as storage. The forward location of the CH No. 1 Access Space, in combination with easy access from the cross deck forward of CH No. 1, invited the use of this space to store smaller items.

Assessment of the CH No. 1 Access Space Against Definitions of Enclosed and Connected Spaces

Consistent with IMO Resolution A.1050(27), the CH No. 1 Access Space on board FEDERAL INDIANA, being naturally ventilated, was not classified as an enclosed space. The same principle was applied on board other ships in the Company's managed fleet where access hatches to cargo holds were located inside other structures, such as crane foundations.

IACS PR 37 describes these spaces as connected spaces and requires testing by surveyors entering such spaces, as it cannot be determined visually if the physical barrier, in this case the booby hatch cover, is intact or not.

21 D/32A and D/37 in the ship's SMS is required to be completed upon sign-on to the ship in accordance with *SOLAS III*, Regulation 19.4.1.

As the integrity of the barrier cannot be confirmed visually, a connected space should be treated as an enclosed space where continuous atmospheric measurement is necessary throughout occupancy and prior to entry.

When the forward booby hatch of CH No. 1 was opened, gases inside the cargo hold could have escaped and entered the CH No. 1 Access Space. The amount of gases escaping into this space would have been variable and influenced by the contents of the cargo hold and by environmental conditions.[22]

It can be concluded that the atmosphere inside the connected space, with a broken barrier, should be considered similar to the atmosphere inside the enclosed space.

IMO Resolution MSC.581(110), which was not valid yet at the date of the incident, includes the potential hazards of connected spaces and also handles the risks of a trapped hazardous atmosphere.[23] The text brings the potential hazards of connected spaces to the attention of ship managers.

Cargo, Off Gassing, and Exposure Injuries

Scrap Metal

Generally, the detected hazards associated with cargoes of scrap metal (Group C) include the following:[24]

1. the presence of combustible materials and ignition sources within the cargo and the difficulty to detect it by crewmembers;
2. self-heating of cargoes, leading to temperatures that melted the tank top;[25]
3. production of carbon monoxide and CO_2 in case of self-heating or fire;
4. production of hydrogen by water oxidation of scrap iron and steel, leading to quantities that could cause an explosion if ignited; and
5. reduction of oxygen due to the oxidation of iron and steel, creating asphyxiating atmospheres in cargo holds and in adjacent or connected spaces.

Self-heating occurs because iron and steel oxidize by reacting with oxygen in both air and water. Oxidation reactions produce heat, which tends to be retained due to the insulating effect of surrounding cargo. The oxidation reactions become exponentially faster at higher temperatures, so self-heating can worsen, sometimes to the point of ignition, depending on the circumstances. The IMSBC Code does not give any guidance related to this hazard or to the ventilation of adjacent and connected spaces.

---

22 Environmental conditions such as heat, pressure, airflow, etc. may influence the amount of gas escaping. Depending on the conditions, the movement of gases occurs by processes such as diffusion, forced/unforced convection, etc.

23 A hazardous atmosphere that may be trapped in a connected space in a manner that causes that space's atmosphere to fill and/or empty at a different rate to the source space.

24 Gard. *Scrap metal fires — is the IMSBC Code adequately addressing the risks?* 27 January 2025, www.gard.no; Neil Sanders (Bourgoynes) *Carriage of scrap metal — fire and explosion risks*, 2023 and reviewed in September 2025, www.north-standard.com.

25 As was determined during the investigation into the cause of the fire on board LOWLANDS MIMOSA in the port of Ghent, Kingdom of Belgium on 23 June 2022, https://mobilit.belgium.be/nl/publications/final-report-mv-lowlands-mimosa.

Despite the fact that such hazards exist and might be increased if scrap metal is wet, the shipper and the Company allowed the cargo to be stowed and loaded in any kind of precipitation, consistent with customary industry practice for the loading and carriage of scrap metal. The information on the Cargo Information Form that the cargo could be loaded in any kind of precipitation contradicted the guidance in the IMSBC Code and the Bulk and General Cargo Operations Manual on board.[26] The Administrator's marine safety investigation on board FEDERAL INDIANA did not identify how or why the determination was made by the Company to deviate from the IMSBC Code and the Operations Manual.

The presence of toxic gases related to a cargo of scrap metal and the oxygen reduction inside the cargo holds were taken into account by the Operations Manual and by the crewmembers on board.

Presence of Hydrogen Cyanide

The presence of hydrogen cyanide is unusual in cargoes of scrap metal. High concentrations of hydrogen cyanide were measured in the cargo holds when the ship arrived at the anchorage of Amaliapolis on 25 February 2025. The holds in which high concentrations of hydrogen cyanide were measured also had high concentrations of carbon monoxide. Both carbon monoxide and hydrogen cyanide were measured by a MultiRAE gas detector used by the marine chemist.

The manufacturer issued a technical note that the MultiRAE gas detector is subject to cross-sensitivity. Cross-sensitivity means that a sensor can give a reading in the presence of a gas other than its intended target gas. Based on the RAE Systems sensor cross-sensitivity table for hydrogen cyanide sensors used in a MultiRAE gas detector, 300 ppm of carbon monoxide gives a reading of 15 ppm hydrogen cyanide.[27] As the maximum detectable concentration for carbon monoxide was limited to 500 ppm and the limit for hydrogen cyanide was 50 ppm, the measured value can be attributed to cross-sensitivity, although it cannot be excluded that hydrogen cyanide was present based on the measured values alone.

The results of the autopsy and toxicology report were inconclusive in determining the exact cause of death. The toxicology report was negative for alcohol or drug use but did not confirm or exclude the presence of hydrogen cyanide.

Bodily Injuries

The injuries established during the autopsy can be associated with the administration of prolonged and forceful resuscitation attempts.[28] Based on crewmember testimonies, CPR started shortly after 0904, when the DTS was rescued, until shortly after 1144, when the DTS was evacuated from the ship. The medical advice provided via radio included continuation of CPR.

CPR-related injuries occur frequently in approximately 60% of cases. Factors that contribute to CPR-related injuries include duration of resuscitation, compression depth and force, hand placement, patient-related factors, etc.[29]

As the incident itself did not include any impact to the chest of the DTS, it can be concluded that the observed injuries during the autopsy are likely related to CPR that was administered over a prolonged period.

---

26 The Company's *Bulk and General Cargo Operations Manual*, Section 5.8 — Scrap Metal.

27 *See* manufacturer's Technical Note TN-114 about sensor specifications and cross-sensitivities, https://automation.honeywell.com/content/dam/his-sandbox/products/gas-and-flame-detection/documents/Technical-Note-114_updated_03-26-2018.pdf.

28 Miller AC, Rosati SF, Suffredini AF, Schrump DS. *A systematic review and pooled analysis of CPR-associated cardiovascular and thoracic injuries*. Resuscitation. 2014 June, https://pmc.ncbi.nlm.nih.gov/articles/PMC4031922/#R54.

29 Van Wijck et al. (2024) — *Rib fractures and other injuries after cardiopulmonary resuscitation for non-traumatic cardiac arrest: a systematic review and meta-analysis*.

PART 4: CONCLUSIONS

The following Conclusions are based on the above Factual Information and Analysis and shall in no way create a presumption of blame or apportion liability.

1. Causal factors that contributed to this very serious marine casualty included:
   (a) the presence of toxic gases in the CH No. 1 Access Space;
   (b) the definition of an adjacent connected space in IMO Resolution A.1050(27) which resulted in the space, in which the forward booby hatch was located, as not being identified as an adjacent connected space by the Master and Company; and
   (c) the risk of connected spaces which was not recognized within the Company's SMS or by crewmembers on board.
2. Additional causal factors that may have contributed to this very serious marine casualty included:
   (a) the absence of guidance in the IMSBC Code related to oxidation or to the formation of hazardous gases, such as carbon monoxide for scrap metal (Group C); and
   (b) the overruling of the guidance in the IMSBC Code and in the Company's Bulk and General Cargo Operations Manual by accepting the Cargo Information Form, by the Commercial Operations department, without proper justification.
3. Additional issues that were identified but that did not contribute to this very serious marine casualty included:
   (a) the use of the CH No. 1 Access Space for storage.

PART 5: PREVENTIVE ACTIONS

In response to this very serious marine casualty, the Company has taken the following Preventive Actions:

1. CH No. 1 Access Space has been formally added to the list of connected spaces on board all vessels with a similar structural arrangement.
2. Hydrogen cyanide detection testing tubes have been supplied on board all vessels involved in the loading of scrap cargoes.
3. Owners have mandated strict compliance with IMSBC Code requirements related to loading operations during precipitation.
4. Owners have mandated enhanced inspections of scrap metal cargo prior to and during loading to identify and address any potential hazards or nonconformities.
5. A training video highlighting the hazards associated with adjacent and connected spaces has been developed and issued for mandatory viewing across the fleet.

6. Positive verification of all preventive actions has been incorporated into vessel managers' internal inspection procedures to ensure sustained implementation and effectiveness.

PART 6: RECOMMENDATIONS

The following Recommendations are based on the above Conclusions and in consideration of the Preventive Actions taken.

1. That the Administrator consider submitting a proposal to the IMO to amend the IMSBC Code Resolution MSC.268(85) to require that:
   (a) openings of bulk cargo holds utilized for the carriage of cargoes with a propensity to give off flammable or toxic gases be designed and maintained in a manner which prevents harmful gases from accumulating in work spaces above or below deck; and
   (b) the hazards associated with the carriage of scrap metal be included in the cargo description of scrap metal (Group C).

The Administrator's marine safety investigation is closed. It will be reopened if additional information is received that warrants further review.