

3. Case Studies of Serious Accidents (3 Cases)

From among the published accident investigation reports, let us introduce a few examples of serious fatal and injury accidents related to on-board works, which occurred in Japan.

Serious Accident : Case 1

During discharge of copper sulfide concentrate, oxygen-deficient air was inhaled, leading to anoxia

Outline: While the cargo ship was berthed at the wharf of Port of Saganoseki for discharging a cargo load of copper sulfide concentrate at about 08:30, June 13, 2009, one of the workers fell while descending a ladder inside No. 3 cargo hold on his way to undertaking the job of stevedoring. Two of the three other workers who went to rescue him also collapsed in the cargo hold. All of the three workers were rescued from No. 3 cargo hold, but later they were confirmed dead.

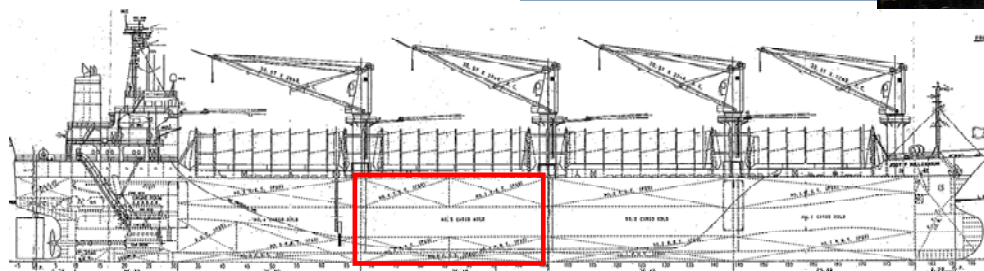
【Operation Team Members】 (7 workers as below)

- ① Foreman (*1)(victim, cargo work supervisor)
- ② Heavy vehicle driver in cargo hold No. 3 (victim, “Driver B”)
- ③ On-shore crane senior operator (victim, “Operator C”)
- ④ Ship crane operator (“Operator D”)
- ⑤ Heavy vehicle driver in cargo hold No. 1 (“Driver E”)
- ⑥ Operator of on-shore crane (“Operator F”)
- ⑦ Heavy vehicle’s slinging worker, etc.

*1 : “The Foreman” is a person who discusses the time of arrival/departure and operation schedule with the shipping company, agent and shipper, and cargo work procedure, safety operations, etc. with chief officer, as well as supervising cargo work.

The Ship (Cargo Ship)

Gross ton: 15,071 tons
 L × B × D: 159.94m × 26.00m
 × 13.50m
 Port of registry: Hong Kong



cargo hold No. 3
 Above: general arrangement”(excerpt)
 Left: approach to cargo hold
 Right: rescue operation



Events Leading to the Accident

The ship carrying copper concentrate at Port Moresby Harbour (Independent State of Papua New Guinea) sailed to port of Saganoseki.

While the ship was berthed at the wharf of port of Saganoseki, and Driver B entered cargo hold No. 3 and was descending toward the bottom, he inhaled oxygen-deficient air (*4), developed anoxia and died.

The Foreman, Operator C and Operator F entered cargo hold No. 3 in order to rescue Driver B. The foreman inhaled oxygen-deficient air, developed anoxia and died.

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Causal Factors of the Accident

During the voyage, the copper concentrate loaded in cargo hold No.3 oxidized, and the oxygen in the airtight hold was consumed. The atmosphere (*2) in cargo hold No. 3 became oxygen-deficient, and at the same time, odorous hazardous gases, which were heavier than air, were generated by the floatation reagents (*3) adhering to the copper concentrate and accumulated in the cargo hold.

For details, refer to “Causal Factors of the Accident Occurred” (The primary accident) (next page)

For details, refer to “Causal Factors of the Accident Occurred” (The secondary accident) (next page)

*2: “Atmosphere” is defined as the conditions of a particular gas or mixed gas.

*3: “Floatation” is one ore dressing method that processes copper ore with a low percentage content to obtain copper concentrates. Specifically, powdered crude ore is suspended in water, an oil or floatation reagent stirred in and the copper concentrates float and attach to surface where they are collected. Oils and reagents used in this process are called “Floatation reagents.”

*4: “Oxygen deficiency” is the reduction of O₂ concentration in air, and can cause anoxia if inhaled. Anoxia causes dizziness, loss of consciousness and even death.

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Upon entering cargo hold No.3 after the Foreman and Operator C, Operator F felt choked. Operator F returned to the upper deck with Operator C as Operator C signaled him to go back.

At that time, although Operator F thought of deterring the Foreman and Operator C, he thought he also had to join the rescue, felt impatient and responsible and lost his sense of composure.

“Standard for Measuring O₂ Concentration (on-board works)” by the stevedoring company

- ✓ The operations chief of oxygen deficient danger measures the O₂ concentration, after the mooring of a vessel and opening the hatches and before the workers board.
- ✓ The operations chief of stevedoring should not allow workers into the cargo hold unless O₂ concentration is 18% or more, after the chief received the report.

As Operators C and F entered cargo hold No. 3 once again in order to rescue the Driver B and the Foreman, Operator C inhaled oxygen-deficient air, developed anoxia and died. When Operator F came back to near the entrance hatch, he was pulled up to the upper deck by the crew of the ship and was rescued.

For details, refer to “Causal Factors of the Accident Occurred” (The tertiary accident) (this page)

Causal Factors of the Accident Occurred (The primary accident: Driver B)

The following factors are considered to have contributed to the occurrence of the accident.

- ▶ Driver B entered cargo hold No. 3, which was oxygen-deficient, inhaled oxygen-deficient air and developed anoxia.
- ▶ Causal factors leading to Driver B entering oxygen-deficient cargo hold No.3
 - the access permit notice board was posted at the entrance hatch of cargo hold No.3
 - another operator had started driving a heavy vehicle in cargo hold No.1
- ▶ Casual factors leading to oxygen-deficiency in cargo hold No.3
 - the copper concentrate loaded in cargo hold No. 3 had oxidized during transportation from Port Moresby Harbour to port of Saganoseki, and the oxygen in airtight cargo hold No.3 had been consumed, creating an oxygen-deficient environment
- ▶ Other factors
 - the Foreman was not aware of the oxygen-deficient atmosphere in cargo hold No.3
 - it became customary to measure O₂ concentrations without following the prescribed method
 - the smelter (Company A) and the stevedoring company (Company B), unaware that the cargo operation supervisors including the Foreman had not practiced the O₂ concentration measurement method as regulated, did not instruct them to follow the regulated measurement method



access permit notice



gas mask and canister

Causal Factors of the Accident Occurred (The secondary accident: the Foreman)

The following factors are considered to have contributed to the occurrence of the accident.

- ▶ The Foreman, informed that Driver B had collapsed, was unaware of the oxygen-deficient atmosphere in cargo hold No.3 and entered the hold to rescue Driver B together with Operator C and Operator F, and as a result, the Foreman inhaled oxygen-deficient air and developed anoxia.
- ▶ It is likely that the Foreman was not aware of oxygen-deficient atmosphere in cargo hold No. 3 as he felt impatient and responsible to rescue Driver B, and lost his sense of composure.
- ▶ There were workers who had a misunderstanding that oxygen-deficient conditions in cargo holds were removed by natural ventilation as time passed after opening the hatch covers. (Odorous gases, heavier than air, generated by the floatation reagents accumulated at the lower layer of the hold, and were not replaced by air).
- ▶ Since the fatal accident from anoxia in a hold four years ago, measurements for detecting oxygen-deficient atmosphere had not been done by the time when this case occurred, and there had been no accidents causing injury or death.
- ▶ No appropriate instruction or training had been given to the workers by the stevedoring company in dealing with cases of a fatal accident in a cargo hold loaded with copper concentrate.

Causal Factors of the Accident Occurred (The tertiary accident: Operator C)

The following factors are considered to have contributed to the occurrence of the accident.

- ▶ Operator C entered cargo hold No.3 wearing a gas mask, together with Operator F, to rescue the Foreman and Driver B, and as a result, he inhaled oxygen-deficient air and developed anoxia.
- ▶ He thought he could cope with the condition of oxygen-deficient atmosphere with a gas mask only.
- ▶ He felt impatient and responsible, and lost his sense of composure.
- ▶ As he had already developed anoxia when he went to rescue at the time of the primary accident, he could not make appropriate decisions.
- ▶ Appropriate education and training on coping behavior in case of fatal accidents in a cargo hold loaded with copper concentrate had not been provided to the personnel by the stevedoring company.

Proposals (Recommendations · Safety Recommendations · Opinions)

In view of the results of this accident investigation, the Japan Transport Safety Board recommended Companies A and B to implement the following measures, pursuant to paragraph (1) of Article 27 of the Act for Establishment of the Japan Transport Safety Board.

Recommendations to Company A

- (1) To train all employees who have the possibility of being engaged in cargo operation to understand the properties and risks of copper sulfide concentrate.
- (2) To train all employees, who have the possibility of being engaged in cargo operation, with the handling of O₂ meters in order to measure O₂ concentrations safely and surely as necessary.
- (3) To request the MSDS (*5) of floatation reagents from shippers.
- (4) To inform all employees who have the possibility of being engaged in cargo operation that depending on the floatation reagent adhering to copper sulfide concentrate, it may generate toxic gas, and since the generated toxic gas is heavier than air, it stagnates in cargo hold, hence, there is a danger of not being replaced by air.
- (5) To make the risks of oxygen-deficient conditions and anoxia known to all personnel who have the possibility of being engaged in cargo operation and to familiarize them with appropriate coping behavior in case of fatal accidents occurring in cargo holds loading copper sulfide concentrate.

Recommendations to Company B

- (1) To train all employees who have the possibility of being engaged in cargo operation to understand the properties and risks of copper sulfide concentrate.
- (2) To train all employees, who have the possibility of being engaged in cargo operation, with the handling of O₂ meters in order to measure O₂ concentrations as necessary.
- (3) To make the risks of oxygen-deficient conditions and anoxia known to all employees who have the possibility of being engaged in cargo operation and to familiarize them with appropriate coping behavior in case of fatal accidents occurring in cargo holds loading copper sulfide concentrate.

In view of the results of this accident investigation, the Board recommended Company C, shipper of copper sulfide concentrate, to implement the following measures (safety recommendations).

Safety Recommendations to Company C

In case of the possibility of the existence of floatation reagents adhering to copper sulfide concentrate, it is recommended to Company C as the shipper to submit information (MSDS, etc.) on floatation reagents in addition to information of copper sulfide concentrate (MSDS, etc.) to ships and consignees in order to make the properties and the risks of copper sulfide concentrate and floatation reagents known to ships and consignees.

In view of the results of this accident investigation, the Board expressed its opinions as follows to the Minister of Land, Infrastructure, Transport and Tourism, pursuant to Article 28 of the Act for Establishment of the Japan Transport Safety Board in order to prevent the recurrence of similar casualties.

Opinions to the Minister of Land, Infrastructure, Transport and Tourism

The Board requests the Minister to widely disseminate through the International Maritime Organization (IMO) such information regarding the risks of the use of floatation reagents as that depending upon the properties of the floatation reagent adhering to copper sulfide concentrate, it may generate toxic gas, and that since the generated toxic gas is heavier than air, it stagnates in cargo hold, hence, there is a danger of not being replaced by air.

*5: "MSDS" (Material Safety Data Sheet) is a document that contains information necessary for the safe handling of chemical substances or raw materials containing chemical substances

In order to Prevent Recurrence

In order to contribute to the prevention of recurrence of similar accidents, personnel who are engaged in the transport and the cargo operation of copper concentrate are requested to pay further attention to the followings:

- (1) In order to know the atmosphere of enclosed space, it is necessary that the O₂ concentration and gases should be measured properly.
- (2) It is necessary that personnel should understand the atmosphere of enclosed space. No personnel should enter enclosed space until the atmosphere becomes safe by forced draft, etc.
- (3) It is necessary that personnel should keep in mind that it is not easy to enter the cargo hold and rescue quickly the injured, and that once anoxia developed, it is difficult to return from the cargo hold alive.

Also, the Board has requested the industry and organizations involved in the transport and the cargo operation of copper concentrate to familiarize the parties concerned with this report, and to remind them further of the risk which may arise in handling copper concentrate.

The investigation report of this case is published on the Board's website (issued on April 27, 2012)

http://www.mlit.go.jp/jtsb/eng-mar_report/singaporegrace.pdf

(This report is a translation of the Japanese original investigation report. The text in Japanese shall prevail in the interpretation of the report.)