

Analysis of the Use and Maintenance of Light Fire Extinguishers to Anticipate Emergency Situations on the MV. Tanto Berkat Ship

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Abstract.

Fire safety on board ships depends on the availability of portable fire extinguishers (APAR) as the initial means of extinguishing. This study aims to analyze the suitability of the use and maintenance of APAR and identify factors that influence its implementation on the MV. Tanto Berkat. The study used a qualitative approach with descriptive methods. The study population was all officers responsible for fire safety on board, while the sample was determined purposively, namely the Chief Officer, Second Officer, and Third Officer. The research instruments included semi-structured interview guidelines, observation sheets, and documentation. Data analysis used the interactive model of Miles, Huberman, and Saldaña through data reduction, data presentation, conclusion drawing, and triangulation of sources and techniques. The results of the study indicate that the use and maintenance of APAR have been carried out according to safety procedures through periodic inspections, fire drills, and maintenance records. However, some foam-type APARs were still found to be less easily accessible, periodic testing documentation was not optimal, and cleaning was inconsistent in several periods. In conclusion, the APAR use and maintenance system has met most of the SOLAS requirements, but improvements in documentation, accessibility, and maintenance supervision are still needed to improve preparedness for fire emergencies.

Keywords: Fire Safety, Firefighting Equipment, Maritime Safety, Shipboard Emergency and SOLAS.

I. INTRODUCTION

Shipping safety is a crucial aspect of the maritime industry as it relates to the protection of crew, vessels, cargo, and the marine environment. One major threat is fire on board ships, which can spread rapidly and cause significant losses. Therefore, the International Convention for the Safety of Life at Sea (SOLAS) Chapter II-2 Regulation 10 requires every ship to have a fire protection system, including portable fire extinguishers (APAR), which must be maintained and regularly inspected to ensure they are always ready for use (International Maritime Organization [IMO], 2020; Kim & Jeon, 2023).

Despite the implementation of regulations, numerous ship fire incidents still occur, demonstrating the importance of effective use and maintenance of fire extinguishers. The fires involving the MV Conception, MT New Diamond, and several other merchant vessels demonstrate that delayed response, lack of crew preparedness, and safety equipment failure can magnify the impact of accidents. This situation demonstrates that compliance with safety procedures remains a challenge in ship operations (Maritime and Coastguard Agency, 2023; IMO, 2020).

Previous research has focused more on fire detection systems, automatic extinguishing technology, and analysis of the causes of ship fires. These studies have shown that fire suppression effectiveness is influenced by the readiness of the protection system, crew competence, and the implementation of safety procedures during ship operations (Aboud & Badry, 2023; Arvidson & Mindykowski, 2023).

However, most research still focuses on technological aspects and has not examined the appropriateness of the use and maintenance of fire extinguishers (APAR) as an initial extinguishing tool on ships. Furthermore, factors influencing the inspection, maintenance, and use of APAR on commercial vessels in Indonesia have not been comprehensively studied (Hati *et al.*, 2023; Iskandar *et al.*, 2021).

Based on these conditions, this study aims to analyze the appropriateness of the use and maintenance of fire extinguishers (APAR) on board the MV Tanto Berkat and identify factors influencing its implementation. This research is expected to contribute to strengthening the implementation of SOLAS safety standards and offer practical recommendations to improve crew preparedness in the event of a fire emergency.

II. METHODS

This study used a qualitative approach with descriptive methods to analyze the appropriateness of the use and maintenance of portable fire extinguishers (APAR) on board the MV Tanto Berkat. This approach was chosen because it provides a deep understanding of the implementation of safety procedures based on real-world conditions through observation, interviews, and documentation (Creswell & Poth, 2018; Sugiyono, 2022).

Research informants were selected using a purposive sampling technique, including First, Second, and Third Officers responsible for the use and maintenance of fire extinguishers on board ships. Informants were selected based on their experience and direct involvement in implementing fire safety systems (Creswell & Poth, 2018; Sudaryono, 2021).

The primary research instrument was the researcher (human instrument), supported by semi-structured interview guidelines, observation sheets, and documentation. Data were collected through interviews, direct observation of fire extinguisher conditions, and review of safety documents to obtain comprehensive information and increase the credibility of the research results (Miles *et al.*, 2020; Sugiyono, 2022).

The research began with problem identification and literature review, followed by instrument development and data collection through observation, interviews, and documentation during the sea practice on the MV Tanto Berkat. The data was then verified using triangulation before being analyzed and compiled into research conclusions (Creswell & Creswell, 2023; Emzir, 2020).

Data analysis refers to the interactive model of Miles, Huberman, and Saldaña, which includes data reduction, data presentation, and drawing and verifying conclusions. Analysis was conducted continuously from data collection to research completion to produce valid findings that reflect field conditions (Miles *et al.*, 2020; Sugiyono, 2022).

III. RESULTS AND DISCUSSION

Data Presentation

1. Documentation results

No.	Peralatan	Jumlah	Kondisi	Lokasi
1 FIRE DETECTION & EQUIPMENT				
1	Smoke & Fire Detector Control Panel	1 Set	✓	Bridge Deck
2	Smoke Detector	17 Pcs	✓	Samas Deck
3	Manual Call Point	10 Pcs	✓	Samas Deck
4	General Alarm Push Button	1 Pcs	✓	Samas Deck
5	Fire Alarm Bell	11 Pcs	✓	Samas Deck
2 CO2 FIRE EXTINGUISHER				
1	4.5 Kg Portable CO2	4 Pcs	Agustus 2026	Samas Deck
2	45 Kg Portable CO2	4 Pcs	Agustus 2026	FFA Store
3	45 Kg Fixed CO2 (Inert Room)	1 Pcs	Agustus 2026	Upper Deck
4	45 Kg CO2 Inert Gas System	2 Bottle	Agustus 2026	Upper Deck
5	45 Kg CO2 System	39 Bottle	Agustus 2026	CO, Room
3 FOAM FIRE EXTINGUISHER				
1	9 Liter Portable Foam	21 Pcs	Agustus 2026	Samas Deck
2	45 L Foam Trolley	1 Pcs	Agustus 2026	Area B&E
3	135 L Foam Wheelset	1 Pcs	Agustus 2026	Area Boiler
4	Foam Applicator	1 Pcs	Agustus 2026	Area Boiler
4 DRY POWDER FIRE EXTINGUISHER				
1	12 Kg Dry Powder	2 Pcs	Agustus 2026	-
2	4 Kg Dry Powder	1 Pcs	Agustus 2026	-
3	2 Kg Dry Powder	3 Pcs	Agustus 2026	Lift/Deck
5 EMERGENCY RESCUE BREATHING DEVICE (ERBD)				
1	ERBD 15 Menit	10 Pcs	Agustus 2026	Samas Deck
2	ERBD	Zhangshu TCS	Agustus 2026	FFA Store
3	ERBD 15 Menit	Salvo Etop	Agustus 2026	FFA Store
6 FIREMAN OUTFIT & BA SET				
1	Fireman Outfit & BA Set	2 Set	Agustus 2026	-
2	BA Set + Spare Bottle	1 Set + 3 Botol	Agustus 2026	FFA Store
7 FIRE HOSE BOX & HYDRANT				
1	Fire Hose & Box (Rata-Rata Pemadam)	25 Pcs	-	-
2	Fire Hydrant	25 Pcs	-	-
3	Hydrant	25 Pcs	-	-
4	International Shore Connection	2 Set	-	Pompa Deck K/U/Kanan
5	Fire Hose Control	2 Pcs	-	Pompa Deck
6	Fire Blanket	1 Pcs	-	Daftar

Fig. 1List of Fire Fighting Equipment

Based on the observation results, the number of fire extinguishers on board the MV. Tanto Berkat has met SOLAS requirements, where each main compartment is equipped with at least one fire extinguisher unit, while high-risk areas such as the engine room have more than one unit. The placement of fire extinguishers has also been adjusted to an effective reach so that they are easily accessible in an emergency. In addition, fire extinguisher maintenance is carried out routinely every month based on a checklist that is the responsibility of the Third Officer, so that the condition and suitability of the fire extinguishers are maintained according to safety procedures.

TAHUN : 2025		JENIS : FOAM	
TGL	MONTH	REMRK	SIGNTR
13	JANUARI	Baik	<i>[Signature]</i>
17	FEBRUARI	Baik	<i>[Signature]</i>
19	MARET	Baik	<i>[Signature]</i>
20	APRIL	Baik	<i>[Signature]</i>
	MEI		
	JUNI		
	JULI		
	AGUSTUS		
	SEPTEMBER		
	OKTOBER		
	NOVEMBER		
	DESEMBER		

Fig. 2 APAR Maintenance Checklist

The documentation of the fire extinguisher maintenance checklist on the MV Tanto Berkat vessel shows that the checklist for fire extinguisher maintenance activities carried out on the MV Tanto Berkat vessel is in accordance with the inspection procedures, recording, and implementation in the field. This compliance is an important indicator that the fire safety system on board the vessel has been properly managed and meets the required standards.

2. Observation Results

Table 1 Observation of the MV. Tanto Berkat Fire Extinguisher Maintenance Process

No	Observed Aspects	Criteria	Ye s	No	Informatio n	Observati on Notes
1	APAR position	Installed according to Fire Control Plan	V		Mounted near the panel; easy to reach & visible	–
2	Physical Condition	Not rusty/damaged	V		The tube looks to be in good condition.	–
3	Seal and Pin	Still installed properly	V		The seal and pin are still in good condition.	–
4	APAR Pressure	In normal conditions (green zone)	V		Pressure / status of the cylinder according to	–
5	APAR weight	According to IMO standards	V		It complies with IMO standard weight measurements.	–
6	Instruction Label	Read clearly	V		The label can be read clearly	–
7	Hose/Nozzle	Not clogged/cracked	V		Still looks normal without blockages and cracks	–
8	Cleanliness of Fire Extinguishers	Clean from dust/oil	V		The tube looks clean	–
9	Bracket/Retainer	Firmly attached	V		The retainer is still firmly attached	–

10	Expired date	Still valid	V	Still valid and suitable for use	–
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Based on the results of observations of APAR maintenance on the MV. Tanto Berkat on Voyage 316 A on October 24, 2024, all APARs were in good condition and suitable for use. The position of the APARs was in accordance with the ship's inventory list, easily accessible, and in good physical condition with seals and safety pins still intact. The cylinder pressure was in the green zone, the weight met IMO standards, the usage label was still clearly legible, and the hose, nozzle, and bracket were functioning properly. The APARs were also still valid so they were ready to be used in an emergency. However, some dust was found on some APAR cylinders so regular cleaning was required. Overall, APAR maintenance on the MV. Tanto Berkat was carried out according to procedures and supported the ship's safety preparedness.

Table 2 Observation of the MV. Tanto Berkat Fire Extinguisher Maintenance Process

No	Observed Aspects	Criteria	Yes	No	Information	Observation Notes
1	APAR position	Installed according to Fire Control Plan	V		Mounted near the panel; easy to reach & visible	–
2	Physical Condition	Not rusty/damaged	V		The tube looks to be in good condition.	–
3	Seal and Pin	Still installed properly	V		The seal and pin are still in good condition.	–
4	APAR Pressure	In normal conditions (green zone)	V		Pressure / status of the cylinder according to	–
5	APAR weight	According to IMO standards	V		It complies with IMO standard weight measurements.	–
6	Instruction Label	Read clearly	V		The label can be read clearly	–
7	Hose/Nozzle	Not clogged/cracked	V		Still looks normal without blockages and cracks	–
8	Cleanliness of Fire Extinguishers	Clean from dust/oil	V		The tube looks clean	–
9	Bracket/Retainer	Firmly attached	V		The retainer is still firmly attached	–
10	Expired date	Still valid	V		Still valid and suitable for use	–

Based on the results of observations of the APAR maintenance on Voyage 328 A on April 22, 2025 at Jamuang Anchorage, several APARs were found to be in less than optimal physical condition. The surface of

several cylinders still contained dust, indicating that routine cleaning activities had not been carried out consistently according to procedures that are the responsibility of the Third Officer. In addition, light corrosion was found on the bottom of the cylinder and the connection area. Although it has not yet affected the function of the APAR, this condition needs to be addressed immediately to prevent it from developing into more serious damage. These findings indicate a minor discrepancy in the implementation of maintenance against IMO and SOLAS regulations which require all safety equipment to be kept clean, well-maintained, and ready for use at all times.

Table 3 Observation of the MV. Tanto Berkat Fire Extinguisher Maintenance Process

No	Observed Aspects	Criteria	Yes	No	Information	Observation Notes
1	APAR position	Installed according to Fire Control Plan	V		Mounted near the panel; easy to reach & visible	–
2	Physical Condition	Not rusty/damaged	V		The tube looks to be in good condition.	–
3	Seal and Pin	Still installed properly	V		The seal and pin are still in good condition.	–
4	APAR Pressure	In normal conditions (green zone)	V		Pressure / status of the cylinder according to	–
5	APAR weight	According to IMO standards	V		It complies with IMO standard weight measurements.	–
6	Instruction Label	Read clearly	V		The label can be read clearly	–
7	Hose/Nozzle	Not clogged/cracked	V		Still looks normal without blockages and cracks	–
8	Cleanliness of Fire Extinguishers	Clean from dust/oil	V		The tube looks clean	–
9	Bracket/Retainer	Firmly attached	V		The retainer is still firmly attached	–
10	Expired date	Still valid	V		Still valid and suitable for use	–

Based on the observation results of APAR maintenance on MV. Tanto Berkat on May 3, 2025, all APARs were in good condition and met safety standards. The position of the APAR was in accordance with the inventory list, easily accessible, and the physical condition of the cylinder was free from damage and corrosion. The seal, safety pin, cylinder pressure, APAR weight, instruction label, hose, nozzle, and bracket were also in good condition, while the APAR validity period was still active. The observation results showed

that APAR maintenance had been carried out according to procedures so that all APARs were ready for use in an emergency.

Table 4 Observation of the MV. Tanto Berkat Fire Extinguisher Maintenance Process

No	Observed Aspects	Criteria	Yes No		Information	Observation Notes
			Yes	No		
1	APAR position	Installed according to Fire Control Plan	V		Mounted near the panel; easy to reach & visible	–
2	Physical Condition	Not rusty/damaged	V		The tube looks to be in good condition.	–
3	Seal and Pin	Still installed properly	V		The seal and pin are still in good condition.	–
4	APAR Pressure	In normal conditions (green zone)	V		Pressure / status of the cylinder according to	–
5	APAR weight	According to IMO standards	V		It complies with IMO standard weight measurements.	–
6	Instruction Label	Read clearly	V		The label can be read clearly	–
7	Hose/Nozzle	Not clogged/cracked	V		Still looks normal without blockages and cracks	–
8	Cleanliness of Fire Extinguishers	Clean from dust/oil	V		The tube looks clean	–
9	Bracket/Retainer	Firmly attached	V		The retainer is still firmly attached	–
10	Expired date	Still valid	V		Still valid and suitable for use	–

Based on the results of observations of APAR maintenance on Voyage 331 A on June 10, 2025 in Jamuang, all APARs were in good condition, met safety standards, and were ready to use in an emergency. The position of the APARs was in accordance with the ship's inventory list, was easily accessible, and the physical condition of the cylinder was free from damage, leaks, or corrosion. The seals and safety pins were intact, the cylinder pressure was in the green zone, the APAR weight was in accordance with IMO standards, and the instruction label was still clearly legible. In addition, the hose, nozzle, and bracket were functioning properly, the cylinder was clean, and the APAR's validity period was still active. The observation results showed that APAR maintenance had been carried out according to procedures, thus supporting the crew's preparedness in dealing with fire emergencies.

3. Interview Results

a. The results of the information obtained from the answers of source 1 (Third Officer) as the person responsible for the APAR safety equipment on board the MV. Tanto Berkat ship

Based on the results of an interview with Third Officer Rizal Jafar, the use and maintenance of fire extinguishers on the MV. Tanto Berkat has been carried out according to procedures through monthly visual inspections conducted in conjunction with fire drills. Each fire extinguisher has an inspection label and is supported by maintenance documentation, while fire extinguishers that have been used or experienced a decrease in pressure are immediately refilled or replaced. The placement of fire extinguishers has also been adjusted to the risk level in each area of the ship. However, several foam fire extinguishers on the

deck area are still not easily accessible and require rearrangement. Overall, the condition of the fire extinguishers is considered good and no serious violations were found during inspections by authorities or surveyors.

- b. The results of the information obtained from the answer from source 2 (Chief Officer) as the head of daily work on the MV. Tanto Berkat ship

Based on an interview with Chief Officer Romdoni Saputro, the use and maintenance of fire extinguishers on the MV. Tanto Berkat have been carried out according to procedures through routine inspections, fire drills, and recording in the ship's maintenance book. All crew members have also received training in the use of fire extinguishers, and their placement is adjusted to the level of fire risk in each area of the ship. However, there are still several foam-type fire extinguishers in the deck area that are not easily accessible and therefore need to be rearranged. Overall, the fire extinguisher use and maintenance system has been running well, but the accessibility aspect still needs to be improved.

- c. The results of the information obtained were answers from source 3 (Second Officer) as a deck officer who is also responsible for supervising the safety equipment on board the MV. Tanto Berkat.

Based on an interview with Second Officer Hafidh Alchamd, the use and maintenance of fire extinguishers on the MV. Tanto Berkat has been carried out systematically through periodic inspections, emergency drills, and recording in the ship's maintenance book. Inspections include cylinder pressure, safety seals, and the physical condition of the fire extinguishers to ensure they are always ready for use. In addition, the ship's crew regularly undergoes fire extinguisher use training according to the type of fire. Overall, the fire extinguisher use and maintenance system has been running well, although supervision of fire extinguisher placement and accessibility still needs to be improved.

4. Data analysis

Table 5 Source Triangulation

No	Focus	Informant 1	Informant 2	Informant 3	Informant 4	Interpretation
1	The process of implementing the use and maintenance of APAR	The Third Officer explained that visual inspections of APARs are carried out periodically every month in conjunction with fire drills.	The Chief Officer explained that APAR inspections are carried out routinely through periodic and fire drill activities as part of the ship's safety procedures.	The Second Officer stated that all inspection, maintenance and refilling of the APAR were recorded systematically in the ship's maintenance book.	Based on the observation results, most of the APARs in various areas of the ship are in good condition, the cylinder pressure is normal, they have inspection labels, and their placement is relatively appropriate to the type of fire hazard.	The results of triangulation show that there is agreement between observations and interviews, where the use and maintenance of APAR on ships has been carried out systematically, on schedule, and in accordance with applicable safety procedures.

2	Compliance of APAR conditions with procedures	The Third Officer revealed that there were still several fire extinguishers in the deck area that needed to be rearranged to make them easier to access in an emergency.	The Chief Officer stated that in general the placement of APARs had followed the Fire Control Plan and ship safety standards.	The Second Officer explained that the system of recording and routine checking helps ensure that the APAR remains ready for use at all times.	The observation results show that most of the fire extinguishers have been placed according to standards, but there are several foam type fire extinguishers in the deck area whose positions are less visible and less easy to reach.	There was consistency between observation and interview data, but some minor discrepancies were found regarding the placement of fire extinguishers. This indicates that the system is generally sound, but still requires improvement in certain areas and cleanliness.
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Based on the results of triangulation of interviews and observations, the use and maintenance of fire extinguishers on the MV. Tanto Berkas has been carried out according to procedures through routine inspections, fire drills, and recording in the maintenance book. In general, the fire extinguishers are in good condition, with normal pressure, complete inspection labels, and ready for use. However, several foam fire extinguishers were found in the deck area where they are not easily accessible, so they need to be rearranged to increase their effectiveness in an emergency.

Table 6 Triangulation Techniques

No	Main Theme	Observation and Documentation Results	Interview Results	Conclusion
1	The process of implementing the use and maintenance of APAR	Observation results show that most of the APARs are in good condition, have normal pressure, have inspection labels, and are placed relatively according to the type of fire. There are records of APAR inspections and maintenance in the maintenance book and ship safety checklist, and there are records of APAR inspections and maintenance in the maintenance book and monthly ship	Interviews revealed that the Chief Officer explained that inspections were conducted routinely through periodic inspections and fire drills. The Second Officer stated that all activities were recorded in a	The results of the data conclusions from observations, interviews and documentation show that the use and maintenance of APAR has been carried out systematically and in accordance with ship safety procedures.

		safety checklist.	equipment	maintenance log. The Third Officer added that visual inspections were conducted monthly.	
2	Suitability of conditions and placement of APAR	From the observation results, several foam type APARs were found in the deck area whose positions were less visible and less easy to reach, and not all APAR positions were detailed in the checklist, but referred to the Fire Control Plan on the ship.	the	The results of the interview with the Third Officer stated that the layout of the APAR in the deck area still needs to be improved to make it easier to access in an emergency.	The results of the data conclusions from observations and interviews explain that there is a match between observations and interviews regarding the shortcomings in the placement of fire extinguishers. This shows that although the condition of the fire extinguishers is good, the accessibility aspect still needs to be improved, especially in terms of accessibility in certain areas, and also cleanliness.

Based on the results of technical data triangulation, including observations, interviews, and documentation, it was explained that the use and maintenance of fire extinguishers on board the ship had been carried out systematically and in accordance with applicable safety procedures. This was evident from the good condition of most fire extinguishers, normal cylinder pressure, the presence of inspection labels, and complete records in the maintenance book and safety checklist. Interviews with ship officers also reinforced this finding, where inspections were carried out routinely through periodic inspections, fire drills, and monthly visual checks.

IV. DISCUSSION

1. How is the proper use and maintenance of the light fire extinguisher on board the MV. Tanto Berkat?

Based on the research results, the use of fire extinguishers on the MV Tanto Berkat complies with international regulations regarding placement based on fire class: CO₂ in electrical areas, powder in general areas, foam in flammable liquid areas, and water for non-electrical areas. This demonstrates the ship's proper fire risk identification.

In terms of maintenance, the ship has undergone monthly visual inspections and basic maintenance such as cleaning, seal checks, and cylinder pressure checks. This practice is consistent with the routine inspection recommendations stipulated in SOLAS Chapter II-2 and IMO A.951(23).

Based on the analysis of the conformity between the standards set by the International Maritime Organization through the SOLAS Convention and the practice of using and maintaining APAR on board ships, it can be concluded that the level of implementation shows variations between aspects that have optimally met the standards to aspects that still require significant improvement.

In terms of fire extinguisher placement, the MV. Tanto Berkat has demonstrated a good level of compliance. The placement of extinguishers has been adjusted to the class of fire that could potentially occur

in each area, indicated by the use of appropriate types of fire extinguishers such as CO₂, powder, foam, and water. This reflects an adequate understanding of fire classifications and the application of standard fire prevention principles, thus categorizing it as complying with IMO/SOLAS requirements.

Furthermore, in terms of visual inspections, shipboard practices even exceed established standards. While standards require inspections at least once a year, monthly inspections demonstrate excellent compliance. This higher inspection frequency contributes positively to equipment readiness in emergency situations and minimizes the potential for undetected damage.

However, inconsistencies were still found in the maintenance documentation aspect. Although maintenance activities may have been carried out, inconsistent record keeping indicates weaknesses in the administrative system. However, IMO/SOLAS standards emphasize the importance of complete and structured documentation as part of a safety management system. This lack of consistency can impact audits, inspections, and tracking of fire extinguisher maintenance history.

Furthermore, significant discrepancies were found in the discharge test aspect. Standards require a discharge test on at least one cylinder per type every five years, but on the MV Tanto Berkat, there was no documentation proving this was carried out. This raises doubts about the operational reliability of the fire extinguisher in an emergency, necessitating immediate improvements in both implementation and record-keeping.

Regarding the hydrostatic test, which involves pressure testing the cylinders every ten years, conditions on board the vessel have not been clearly verified. This indicates potential non-compliance, as this test is crucial for ensuring the cylinders' strength and safety against high pressures. Without adequate verification, the risk of equipment failure during use remains high.

Furthermore, in terms of accessibility, it was found that some foam fire extinguishers were slightly obstructed by surrounding objects. This situation indicates that even though the equipment is available, ease of access, a crucial factor in initial fire response, has not been fully met. IMO/SOLAS standards strictly require fire extinguishers to be placed in easily accessible locations without obstruction.

Overall, it can be concluded that the vessel has demonstrated good performance in basic technical aspects such as the placement and frequency of visual inspections. However, several important aspects remain below standard, particularly documentation, periodic testing (discharge and hydrostatic tests), and equipment accessibility. Therefore, improvements are needed, focusing on the administrative system, adherence to testing schedules, and repositioning of fire extinguisher (APAR) to comply with the safety principles established by IMO/SOLAS.

However, several maintenance aspects remain below standard, such as documentation of five-yearly discharge tests, hydrostatic test verification, and provision of spare charges. Furthermore, minor findings related to the accessibility of foam fire extinguishers in the cargo deck area require improvement to ensure their effectiveness in emergencies.

2. What are the factors that influence the use and maintenance of light fire extinguishers on the MV. Tanto Berkat?

Several dominant factors influence the effectiveness of fire extinguisher use and maintenance on ships. These factors directly influence equipment readiness and the crew's response time in the event of a fire.

a. Human Factors (Human Factors)

The high daily workload on board means that ship crews often neglect APAR maintenance activities, such as routine inspections and equipment cleaning.

b. Placement and Accessibility Factors

A fire extinguisher that is obstructed or not positioned according to risk can hamper emergency response. The case of the foam fire extinguisher on the cargo deck shows that the arrangement is very important. determine the effectiveness of the extinguishing.

c. Factors Affecting the Use and Maintenance of Fire Extinguishers.

Table 7 Factors Influencing the Use of Fire Extinguishers

Factor	Impact on Fire Extinguishers	Findings on the MV Tanto Berkat
<i>Human Factors</i>	Determining the ability to use APAR in an emergency	Drills are done, but practical training is not optimal.
Placement & Accessibility	Affects response speed	Some foam fire extinguishers are less visible

V. CONCLUSION

This study shows that the use and maintenance of Light Fire Extinguishers (APAR) on board the MV. Tanto Berkat are generally in accordance with SOLAS provisions and ship safety procedures. The results of observations, interviews, and documentation indicate that the APARs are placed according to fire class, checked periodically through monthly inspections and fire drills, and supported by adequate maintenance records. The physical condition of the APARs, cylinder pressure, seals, labels, and expiration dates are in good condition so they are ready for use in an emergency. However, the study also found several shortcomings, namely the presence of foam APARs that are still not easily accessible in the deck area, suboptimal documentation of periodic tests such as discharge tests and hydrostatic tests, and inconsistent cleaning implementation over several periods. These findings indicate that administrative and accessibility aspects still require improvement to support the effectiveness of the fire safety system on board the ship.

This study was limited to one object of research, namely the MV. Tanto Berkat, so the results cannot be generalized to all merchant vessels with different operational characteristics. In addition, the study used a qualitative approach, so the findings emphasize the description of actual conditions rather than quantitative measurements of compliance levels. Therefore, further research is recommended to involve more vessels, use a mixed methods approach, and examine the effectiveness of crew training, safety management systems, and compliance with periodic inspections. Practically, the results of this study can be used as evaluation material for shipping companies and ship crews to improve the quality of APAR maintenance, improve equipment arrangement for easier access, and strengthen documentation and inspection supervision so that preparedness in dealing with fire emergencies can be continuously improved.

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