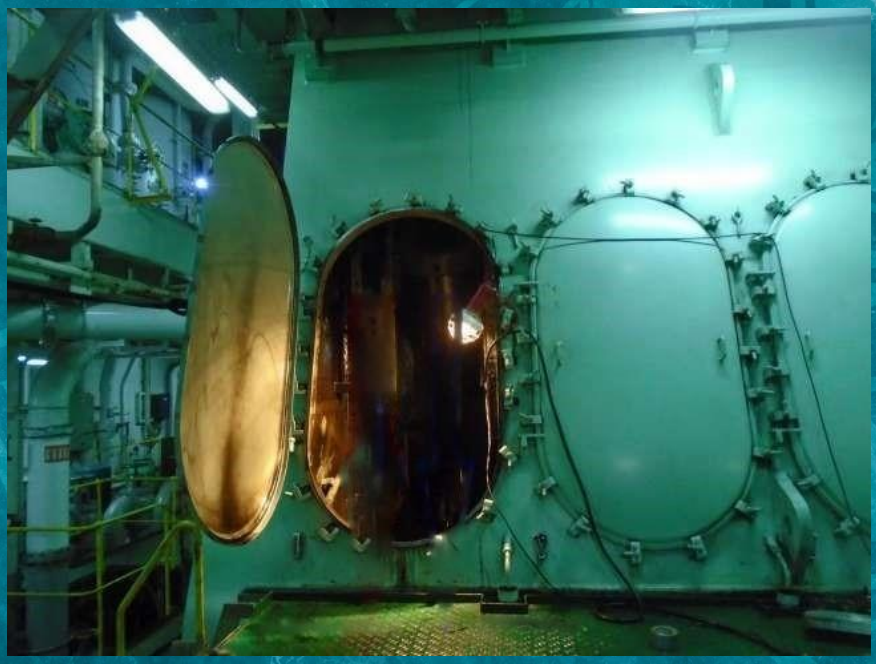
The Bahamas Maritime Authority

Marine Safety Investigation Report

into a crew fatality on Irenes Rose on 08 February 2020



The Bahamas conducts marine safety or other investigations on ships flying the flag of the Commonwealth of the Bahamas in accordance with the obligations set forth in International Conventions to which The Bahamas is a Party. In accordance with the IMO Casualty Investigation Code, mandated by the International Convention for the Safety of Life at Sea (SOLAS) Regulation XI-1/6, investigations have the objective of preventing marine casualties and marine incidents in the future and do not seek to apportion blame or determine liability.

Date of Issue: 19 March 2021
Bahamas Maritime Authority
120 Old Broad Street
LONDON
EC2N 1AR
United Kingdom

Contents

1. Summary

Due to restrictions imposed as a result of the coronavirus pandemic, the BMA investigation team could not travel to the vessel to gather evidence and conduct interviews. Therefore, this investigation was conducted following the hierarchy of controls recognised by IMO Circular Letter No.4204/Add.16 establishing effective safety control measures and reducing the risk to personnel. The evidence, including the witness testimonies and images used for the purpose of this investigation, was provided by Tsakos Conbulk Services (TCB) Ltd.

What happened

Occupational fatality of a crew member while he was working inside the main engine crankcase during a planned engine overhaul. Whilst replacing the main engine piston, the piston lifting tool was released out of sequence, causing the piston to drop inside the crankcase on to the crew member.

Why it happened

Due to ineffective communication, lack of effective supervision and non-compliance with the manufacturer's instructions, the piston lifting tool was released, causing the piston to drop inside the crankcase on to the crew member.

What can we learn

While carrying out any high-risk operation onboard, it is extremely vital to follow the manufacturer's instructions, adequately identify the associated hazards to establish proper safeguards, review all the identified risk and risk control measures in a risk assessment (RA) and effectively establish communication between all the parties involved.

2. Factual Information

Irenes Rose

Vessel Type	Container	**Flag**	Bahamas
Owner	Seany Shiptrade Corporation	**Manager**	Tsakos Conbulk Services (TCB) Ltd.
Classification Society	Nippon Kaiji Kyokai	**Gross/Net Tonnage**	27104/11856
Built	2007	**Propulsion**	Single propeller

IMO No.	Callsign	Length overall	Breadth	Depth
9363417	C6DU4	199.93m	32.20m	16.60m

Last BMA Inspection	Last PSC Inspection
Carried out in Inchon, South Korea, on 30 July 2019. One deficiency identified related to the PSC deficiency was not reported as per BMA bulletin no. 85.	Carried out in Shanghai on 18 November 2019. Five deficiencies were noted. None of the deficiencies were related to this incident.

Crew details

Rank/Role on board	Oiler A (deceased crew member)	Master	Chief Engineer	Second Engineer	Third Engineer
Qualification	Able Seafarer Engine STCW III/5	Master STCW II/2 and GMDSS Radio operator IV/2	Chief Engineer STCW III/2	Second Engineer STCW III/2	Third Engineer STCW III/1
Certification Authority	Philippines	Greece	Greece	Philippines	Philippines
Nationality	Filipino	Greek	Greek	Filipino	Filipino
Age	32	50	58	51	50
Time in rank with the Company	4 years	15 years	15 years	4 years	15 years
Time onboard	2 months and 19 days	3 months and 17 days	2 months and 28 days	6 months and 23 days	7 months and 23 days

Environmental Conditions

Wind Direction	Wind Force	Wave Height	Swell Height	Precipitation / Sky	Visibility Range	Light Conditions
SE	4	0.5	0	Clear	16Nm	Daylight

Voyage Details

The vessel had completed the discharge operation at the port of Saigon, Vietnam, on 02 February 2020 and moved to the anchorage in Vung Tau, Vietnam.

Narrative

All times used in this report are UTC +7 unless otherwise stated.

On 08 February 2020, at 08:00, while the vessel was at anchor in Vung Tau, Vietnam, the engine crew commenced the scheduled planned maintenance of the main engine involving the overhauling of the main engine piston no. 1.

The removal of the piston and stuffing box was carried out by the crew successfully. After completing the overhaul of the removed piston and replacement of the piston rings, at 16:45, the crew commenced the mounting operation for putting back the piston using the piston lifting tool[1].

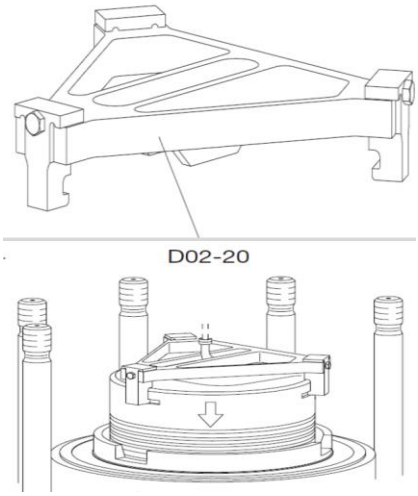


Figure 1: Piston lifting tool

The second engineer was in charge of lowering the piston using the engine room crane. He was stationed at the upper platform near the cylinder head along with the two oilers assisting him with the operation.

The third engineer was in charge of placing the stuffing box into position and was inside the crankcase along with the technician and oiler A (deceased crew member) assisting him to complete the task.

The chief engineer was standing outside the crankcase at the lower platform supervising the whole operation. The second engineer and third engineer each had a personal portable VHF radio used to communicate the piston rod's position while the second engineer was operating the crane.

The third engineer, technician and oiler A took about an hour to stow the stuffing box in its position.

The chief engineer instructed the third engineer to tighten the stuffing box. Oiler A was assisting the third engineer to complete this task.

After tightening the stuffing box, the chief engineer instructed the crew to clear all the tools, clean the surface and exit the crankcase. The third engineer left the crankcase first and went to the engine control room to drink water. The technician came out of the crankcase after removing the tools. Oiler A was still inside the crankcase to clean up the area.

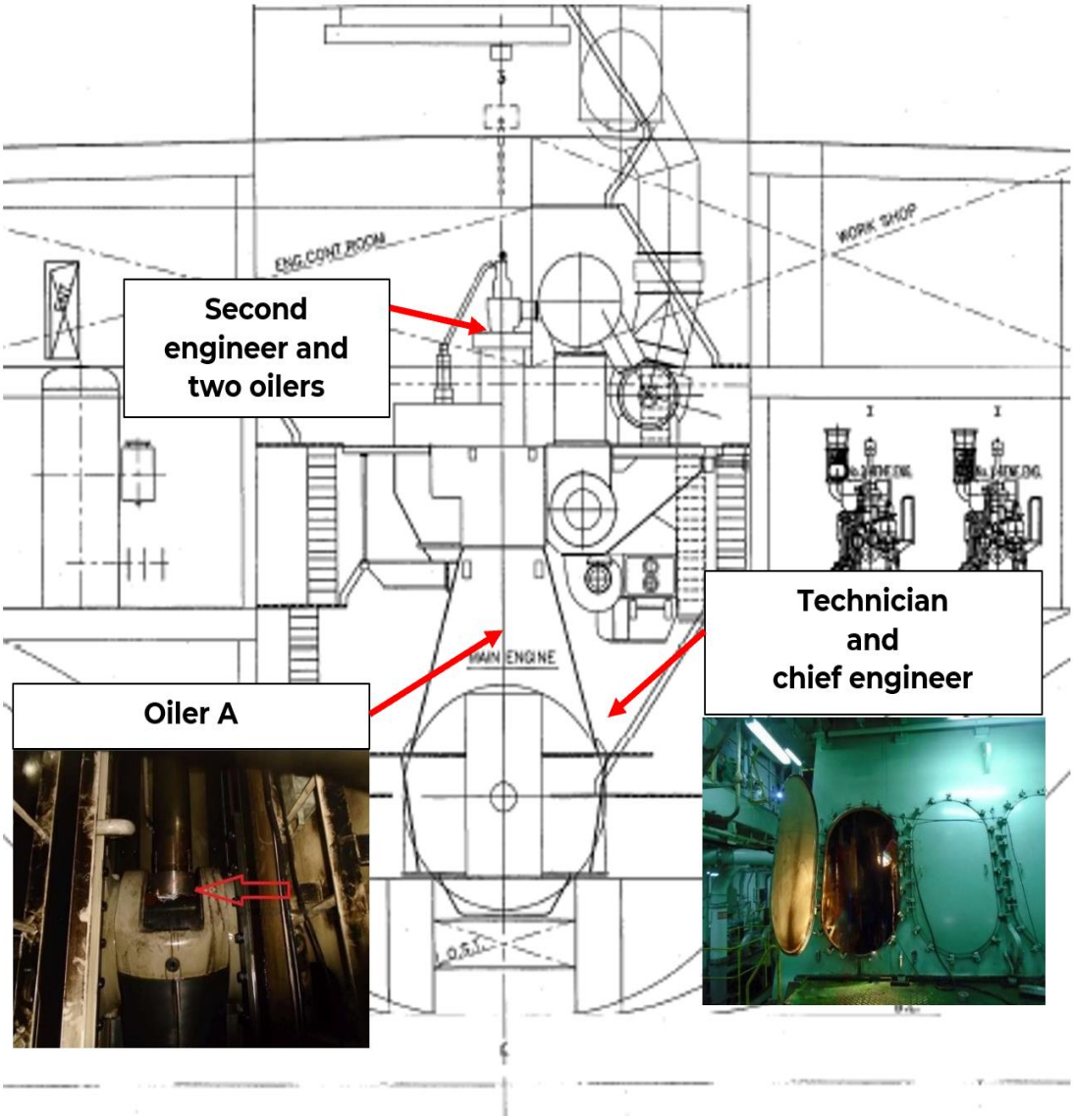


Figure 2: Position of crew members

[1] The lifting tool has three claws: two stationary and one adjustable claw. The claws sit in the piston lifting grooves on the top of the piston.

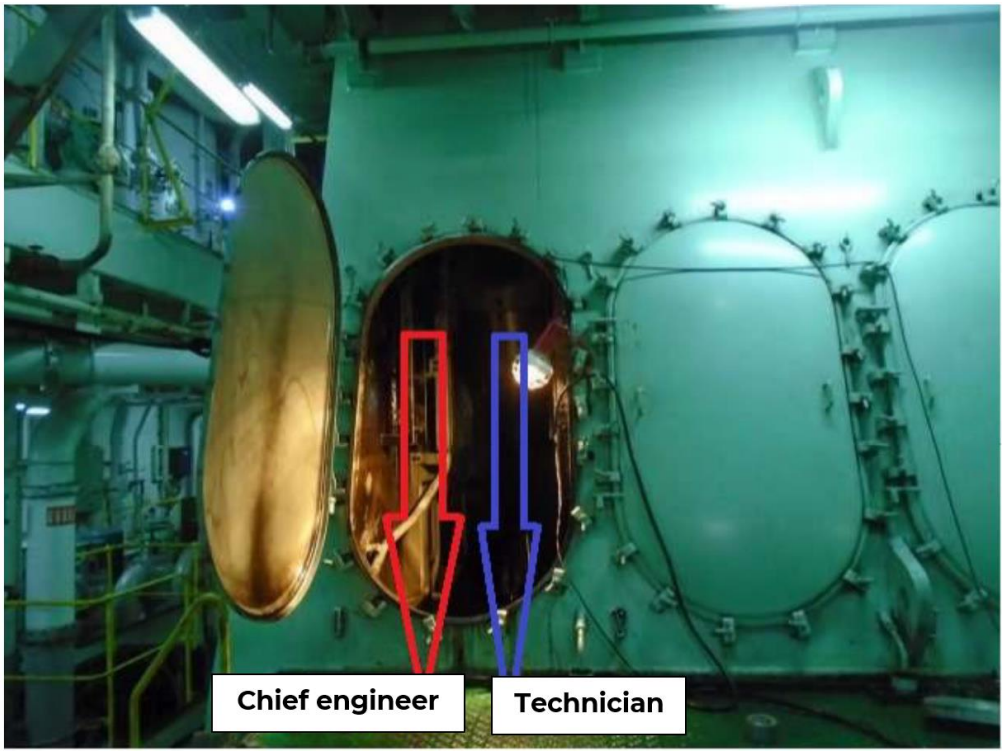


Figure 3: Position of chief engineer and technician

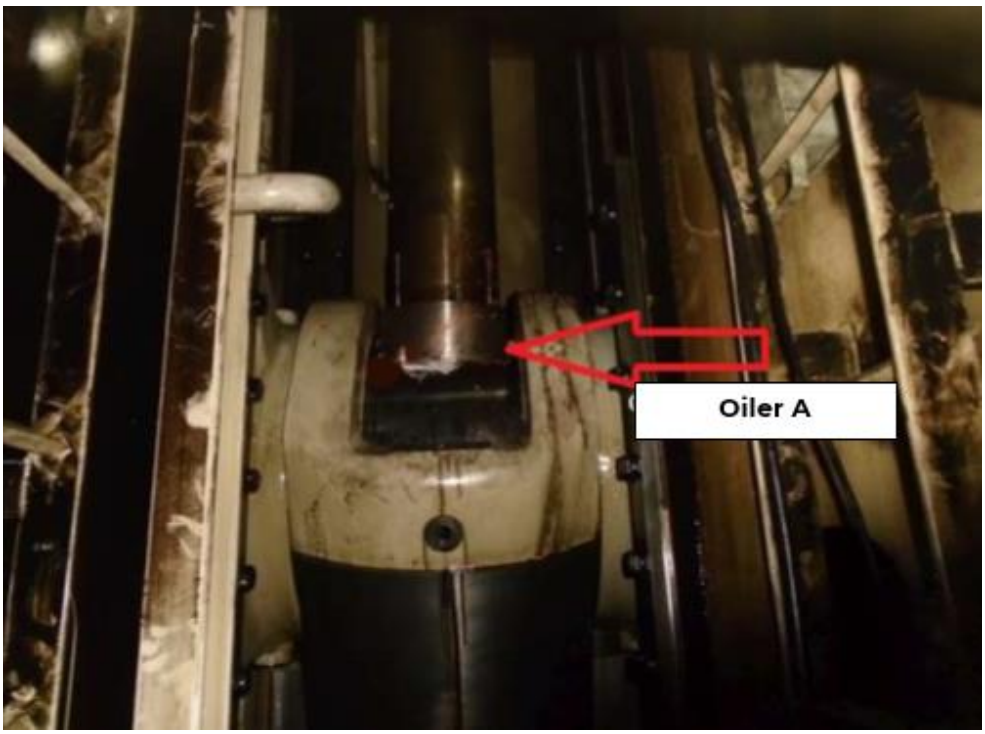


Figure 4: Position of oiler A (deceased crew member)

The third engineer returned to the lower platform and the chief engineer instructed him to turn the engine using the turning gear. At this time, the piston lifting tool was released by the second engineer and the engine crew heard a loud noise of the piston dropping inside the crankcase. Subsequently, oiler A was found, injured and unresponsive, in the sump tank of the main engine.

At 17:45, the chief engineer informed the master about the accident. Five minutes later, the master arrived in the engine room and oiler A was declared deceased.

At 19:30, the deceased oiler was transferred to the vessel's hospital.

3. Analysis

The purpose of the analysis is to determine the contributory causes and circumstances of the casualty as a basis for making recommendations to prevent similar casualties occurring in the future.

Engine manufacturer's instruction manual

The vessel had a 7S70MC-C[2] Man B&W main engine, manufactured by Hitachi Zosen. The engine manufacturer provided a step by step instruction manual that included the chronological steps with diagrams for dismantling, overhauling and mounting of a piston. The manual was not reviewed before starting the work activity and was not discussed at any time during the piston removal, overhauling and mounting process.

The manual identified 16 steps to complete the piston mounting operation (see Appendix 1). The engine crew completed the initial steps of mounting the piston, which corresponded to the first seven steps of the manual. However, step 8 and step 9 were not followed.

Step 8 required the crosshead to be turned nearly to the top dead centre (TDC) while checking that the guide ring of the crosshead enters the centre hole in the piston rod.

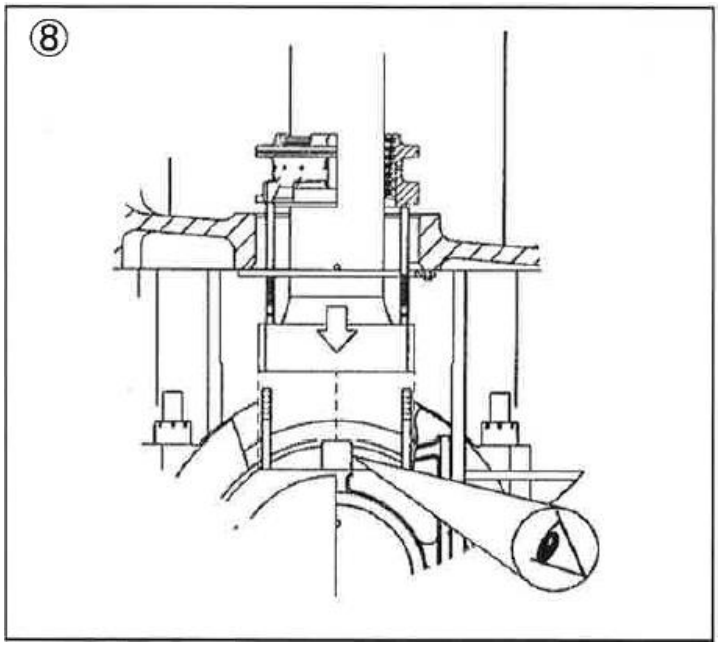


Figure 5: Diagram from the main engine manufacturer's manual for step 8 of piston mounting

[2] Engine type designation for 7S70MC-C engine:
7-Number of cylinders, S-Super long strokes, 70-Diameter of piston in cm, M-Engine performance, C-Camshaft controlled, C-Compact design.

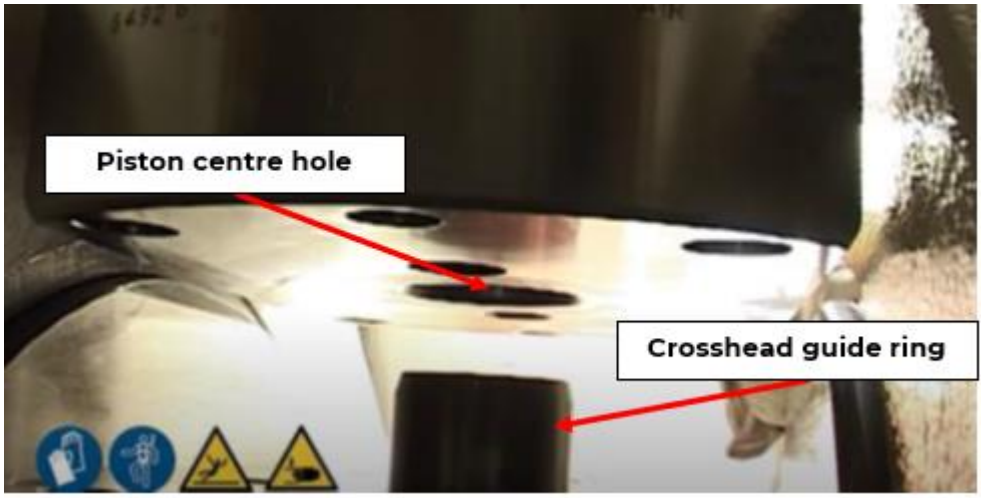


Figure 6: Centre hole of piston and crosshead guide ring

The crosshead was not turned to near the TDC position for the mounting process of the piston.

Step 9 of the manual required the piston to be fully turned to TDC to ensure that the piston rod is in full contact with the crosshead. The adjustable claw of the lifting tool then could be unscrewed and the lifting tool pulled free from the lifting groove in the piston ring.

This step was not followed either and the crosshead was not turned to TDC for the piston rod to be in contact with the crosshead. The second engineer unscrewed the lifting tool's adjustable claw using a spanner and hammer to free the lifting tool from the lifting groove, leading the piston to be unsupported.

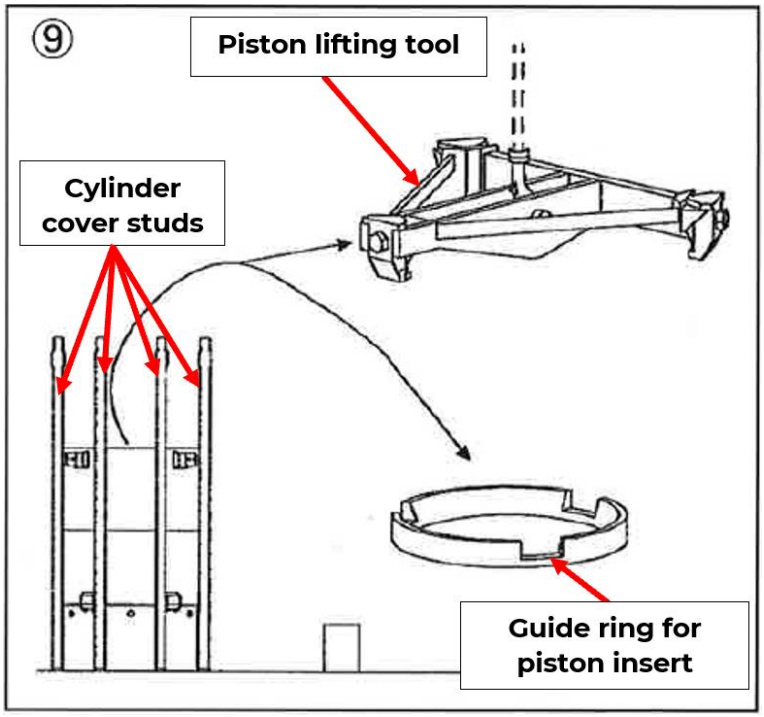


Figure 7: Diagram from the main engine manufacturer's manual for step 9 of piston mounting with parts labelled

The chronological sequence of the instruction manual for further steps was also not followed. As the piston was lowered into the cylinder liner, the chief engineer instructed the third engineer to tighten the stuffing

box and oiler A was assisting him to complete this task. This operation was carried out without turning the engine to TDC or completing instructions outlined under steps 8 and 9 of the manual.

Step number	Engine manufacturers instruction manual steps	Actual steps taken and issues identified
8	Turn the crosshead nearly to TDC while checking that the guide ring of the crosshead enters the centre hole in the piston rod.	Actions corresponding to step 10 and step 11 of the manual were carried out prior to the actions required as per step 8 and step 9.
9	After turning the piston fully to TDC and ensuring that the piston rod has full contact with crosshead, unscrew the adjustable claw of the lifting tool and pull the lifting tool free from the lifting groove in the piston ring. Remove the lifting tool and the guide ring for piston insert.	
10	Turn down and land the stuffing box on the stuffing box flange. Check that the holes in the stuffing box and stuffing box flange are correctly centred. Remove the distance pieces from the piston rod front.	
11	Tighten down the piston rod stuffing box by means of the screws through the inner hole in the stuffing box flange.	

Table 1: Chronological sequence of the instruction manual and issues identified

Inadequate hazard identification and risk assessment

The hazards associated with a crew member being present inside the crankcase during the mounting operation of the piston were not identified in the existing RA before commencing the operation. The International Safety Management Code for the Safe Operation of Ships and for Pollution Prevention (ISM Code) section 1.2.2.2 requires '*Safety management objectives of the Company should, inter alia; assess all identified risks to its ships, personnel and the environment and establish appropriate safeguards.'* The Company's safety management system (SMS) had a risk management procedure for identifying the hazards and implement effective control measures to prevent any harm and reduce risk levels. The procedure stated:

During work planning and prior to start a job/ operation, the RA Library Index should be reviewed, in order to check whether the particular job/ operation is included.

- *If a relevant RA exists, then this RA must be reviewed, in order to confirm that it applies to the case and no additional hazards exist. In such a case records must be maintained in the RA log.*
- *If during the onboard review additional hazards will be identified the RA should be revised with the additional hazards and risk control measures and forwarded to the Company.*
  - *for approval, if the risk involved is High or Medium,*
  - *for notification, if the risk involved is Low.*

The operation for piston overhauling was considered as routine job and risk assessment (RA) 'R2.7 main engine piston overhauling' was available in the RA library for the crew to use. The RA log was also updated, as per the Company's procedures.

Tsakos Columbia Shipmanagement ("TCM") S.A.
Shipboard Safety Operations Manual (SOM)
Form SOM-30: Risk Assessment Log

(1) Date	(2) Description of the Job	(3) RA report Ref. No	(4) Work Safety Meeting participants (Names/rank)	(5) Additional hazards Yes/No	(6) New RA Generated	(7) Date that RA updated or new RA /forwarded to the Company
08/02/20	M/E Piston No1, Overhauling	R 2.7 064-2020	[redacted]	No	No	No

Figure 8: Extract from RA log

The 'additional risk control measures' in the risk assessment required the crew to keep clear during lifting operation and to have close communication between the crane operator and officer guiding the piston removal operation. These control measures were included for lifting operations. However, there were no such hazards identified or risk control measures put in place or included in the risk assessment for the mounting operation.

Risk Treatment						
Ref Hazard No.	Additional Risk Control Measures (input in case of risk above 6,RF>6)	Responsible	Action Timeline	Residual Risk Evaluation (RF= L x S)		
				L	S	RF
4B	All personnel should keep clear from the "dangerous area" below the lifted items, during lifting.	2nd Engineer	During lifting	1	3	3
4C	Close and effective communication must be established between the crane operator and the Officer supervising/guiding the piston removal from the engine and the seating of the piston at the specific support tool.	2nd Engineer	During lifting	1	3	3

Figure 9: Extract from risk assessment for main engine piston overhauling

The risk control measures also included the requirement for developing a plan for undertaking the work by taking the maker's manual into account. However, the maker's manual was not discussed prior to starting or during the operation. It could not be determined through the evidence obtained why one of the specified risk control measures was not incorporated within the safety discussion before or at any point during the task. This requirement as detailed within the existing RA, which was not applied on this occasion, resulted in the task being carried out without adequate risk control measures in place.

8A	A plan for undertaking the work should be developed, discussed and agreed by all who have responsibilities in connection with the work. The work plan should take into account makers manual as well as tools/spares needs.	Ch. Engineer, 2nd Engineer	Prior to the work	1	3	3

Figure 10: Extract from risk assessment for main engine piston overhauling

Ineffective communication

During the overhaul process, the third engineer and second engineer had personal portable VHF radios. While mounting the piston into the cylinder liner, the third engineer was inside the crankcase and was frequently communicating with the second engineer handling the crane to lower the piston.

From the testimonies of the third engineer and second engineer, it was concluded that the communication between both crew members was ineffective and it led the second engineer to believe that the lowering operation of the piston was completed and he could remove the lifting tool from the piston. Subsequently, he started removing the lifting tool using a spanner and hammer. Once the lifting tool was released, the piston fell into the crankcase while oiler A was still inside.

The chief engineer was the supervisor of the whole overhaul operation. He did not have a personal portable VHF radio with him. Although the vessel's working language was English, the communication between the third engineer and second engineer was in Tagalog[3]. The chief engineer, who was a Greek national, did not understand the conversation to verify any action taken by the third engineer or the second engineer.

[3] Language spoken in the Philippines

4. Conclusions

- A crew member died while working inside the main engine crankcase when the piston fell on him. The piston lifting tool was released during the piston mounting operation, leading the piston to drop inside the crankcase.

- As part of the existing RA, taking the engine manufacturer's instruction manual into account while planning the operation was required. However, the manual was not discussed or followed by the crew members at any time during the operation.

- No hazards related to the crew member being inside the crankcase during the mounting operation of the piston were identified in the RA.

- The communication between the third engineer and the second engineer was ineffective and led the second engineer to believe that the lowering operation of the piston was complete and subsequently, he removed the piston lifting tool using a spanner and hammer.

- The chief engineer was the supervisor of the whole operation. However, he did not have any portable radio with him while the task was being carried out. Further, the communication between the second engineer and the third engineer was in Tagalog and chief engineer did not understand the language to verify any action taken by the two engineers.

5. Lessons to be learned

- Before carrying out any high-risk operation, such as overhauling and maintenance of the main engine, the manufacturer's instructions must be discussed and incorporated in the planning of the operation.
- The crew involved in the operation must understand and follow the manufacturer's instructions at all times.
- A thorough review of the risk assessments for any high-risk operation must be carried out to identify the hazards and risks associated with every stage of the operation and to implement appropriate safeguards to eliminate those risks.
- Reviewing all the risk and control measures in a risk assessment are vital for the effectiveness of the risk management process onboard.
- Effective communication should be established while carrying out any operation onboard. The supervisor of the operation and all involved crew members should be equipped with the appropriate communication devices and communicate in the vessel's working language throughout the operation.

6. Actions taken

Actions taken by the Company:

- The Company had issued a fleet-wide alert regarding the accident, highlighting the importance of the main causes of the incident. The same alert had been added to the senior officers' briefing process prior to joining the vessel.

- The Company had enhanced instructions to all personnel involved in similar tasks to reinforce that during planning meetings, all the necessary issues, points of concern and applicable hazards are discussed thoroughly, including manufacturers' special precautions and instructions, fulfilling the obligation contained within recommendation 7.1.

- The Company's risk assessment for the specific overhauling work activity was further amended to incorporate the additional hazards and risk control measures that were revealed during the company's investigation.

- The Company shared the lessons learned/Incident investigation with the manning agencies to enhance further crew awareness for the causes and lessons learned.

- A safety campaign was launched with the aim to further promote and stimulate positive interventions and the significant importance of the Stop Work Authority and hazard identification when performing any task onboard, fulfilling the obligation contained within recommendation 7.2. The name of the campaign was "I AM SAFETY" intended to remind all that safety is everybody's duty and responsibility.

7. Recommendations

Recommendation for the Company:

- Consider updating the Company's procedures to highlight the importance of reviewing and following the manufacturer's instructions for any high-risk operation.
- Provide additional training to the crew members to improve the identification of hazards and conducting job-specific risk assessments.
- Ensure an effective communication plan is established before the commencement of any operation. All the crew members involved shall be equipped with appropriate communication devices and use the vessel's working language to ensure effective and thorough understanding of safety critical matters.

8. Glossary and Definitions

BMA	The Bahamas Maritime Authority
Company	Company means the owner of the ship or any other organization or person such as the manager, or the bareboat charterer, who has assumed the responsibility for operation of the ship from the owner of the ship and who on assuming such responsibility has agreed to take over all the duties and responsibilities imposed by the International Safety Management Code.
m	Meters
nm	Nautical miles
No.	Number
RA	Risk assessment
SMS	Safety Management System
TDC	Top dead centre
VHF	Very High Frequency

Appendices

Appendix 1: Engine manufacture's instruction manual for piston mounting

HZ D&E
S70MC-C

PISTON/ピストン
Mounting/取付け

902-1.4
Edition 0272A
Page 16(20)

1. Check the piston rings and piston crown in accordance with Procedure 902-1.1.

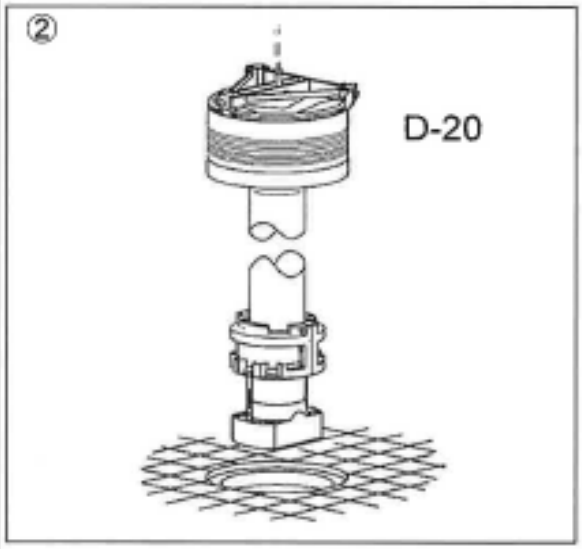
   Coat the piston rings, piston rod and cylinder liner with lubricating oil.

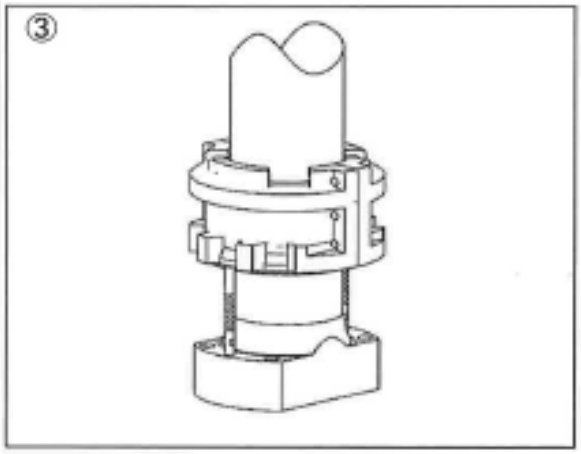
2. Mount the lifting tool on the piston crown.

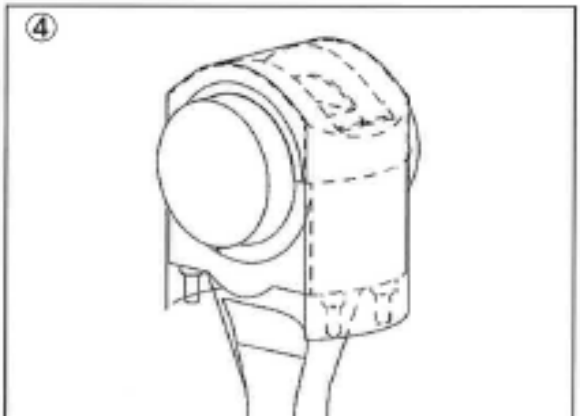
3. Ensure that the stuffing box is correctly positioned over the guide pins in the distance pieces mounted on the piston rod foot.

   Coat the O-rings of the stuffing box with oil.

4. Remove the protective rubber cover from the crosshead.







1. 902-1.1 に従って、ピストンリングとピストンクラウンを点検する。

   ピストンリング、ピストン棒およびシリンダライナに潤滑油を塗布する。

2. ピストンクラウンに吊上要具を取付ける。

3. スタフィングボックスがピストン棒脚部に取付けられたディスタンスピースに正しく位置決めされていることを確かめる。

   スタフィングボックスの O-リングに油を塗る。

4. クロスヘッドから保護カバーを取除く。

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5. Remove the cover from the piston rod stuffing box opening in the bottom of the cylinder unit.

6. Turn the crosshead to a position 45° from TDC.

   Mount the guide ring for piston insert on the cylinder liner.

7. Lower the piston into the cylinder liner - while guiding the piston rod foot through the cut-out in the stuffing box flange. - until the piston rings are inside the liner.

5. シリンダフレーム下部のスタフィングボックス用の穴からカバーを取外す。

6. クロスヘッドをTDCから45°の位置にターニングする。

   シリンダライナ上面にピストン挿入案内要具を置く。

7. ピストン棒の脚部がスタフィングボックスフランジの切欠部を通り、ピストンリングがシリンダライナに入り込むまでピストンを降ろす。

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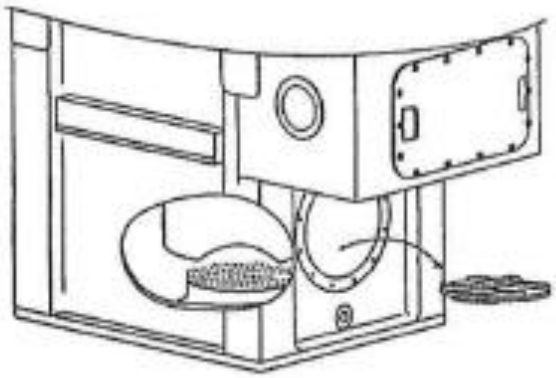

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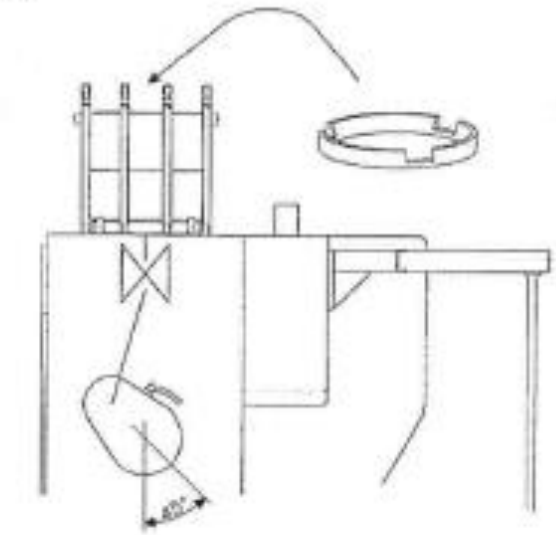

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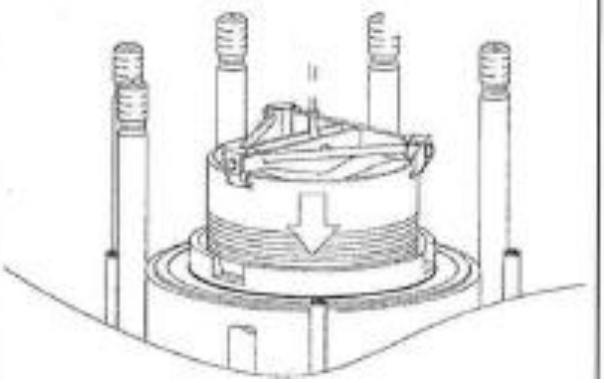

8. Turn the crosshead nearly to TDC while checking that the guide ring of the crosshead enters the centre hole in the piston rod.

9. After turning the piston fully to TDC, and ensuring that the piston rod has full contact with crosshead, unscrew the adjustable claw of the lifting tool and pull the lifting tool free from the lifting groove in the piston.

   Remove the lifting tool and the guide ring for piston insert.

10. Turn down and land the stuffing box on the stuffing box flange. Check that the holes in the stuffing box and stuffing box flange are correctly centred.

    Remove the distance pieces from the piston rod foot.

8. クロスヘッドのガイドリングがピストン棒の中心穴に入ることを確認しながらクロスヘッドを TDC 近くにターニングする。

9. ピストンを完全に TDC にターニングし、ピストン棒がクロスヘッドと完全に接触していることを確認後、吊上要具の爪を取外し、吊上要具を引っ張ってピストンの吊上げ用溝から開放する。

   吊上要具および挿入用ガイドを取外す。

10. 下方にターニングし、スタフィングボックスフランジの上にスタフィングボックスをのせる。スタフィングボックスとスタフィングボックスフランジの穴が正しく合っていることを点検する。

    ピストン棒からディスタンスピースを取外す。

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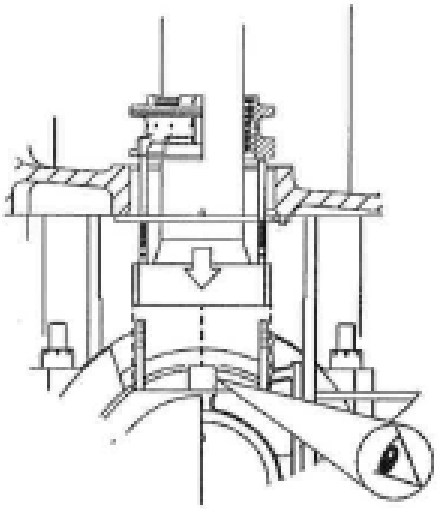

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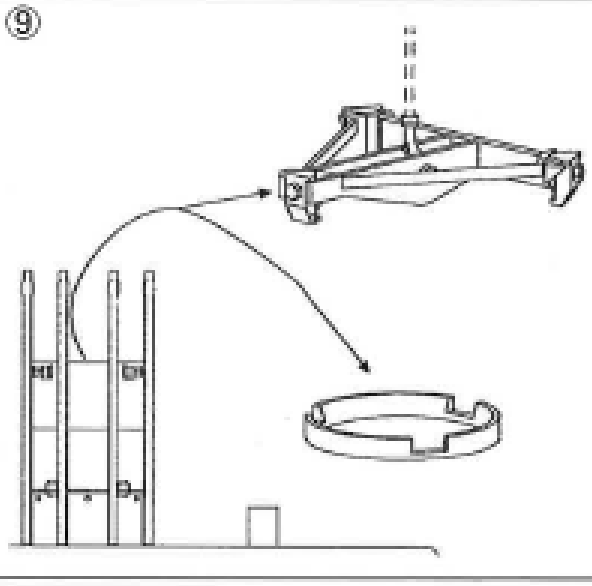

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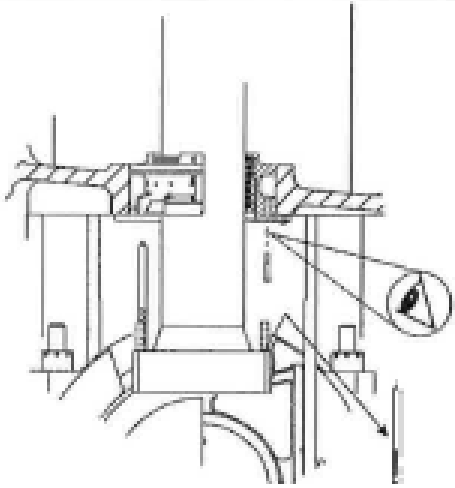

11. Tighten down the piston rod stuffing box by means of the screws through the inner holes in the stuffing box flange.

12. Mount and tighten the piston rod nuts, using the hydraulic jacks.

    For operation of the hydraulic jacks, see Procedure 913-1.

13. Mount the piston cleaning ring (PC ring) according to the scratch mark.

    If the PC ring is damaged (broken or cracked), it must be replaced by new piston cleaning ring. *See also 903-1.1.*

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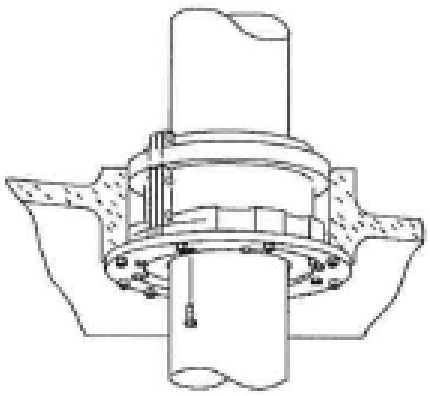

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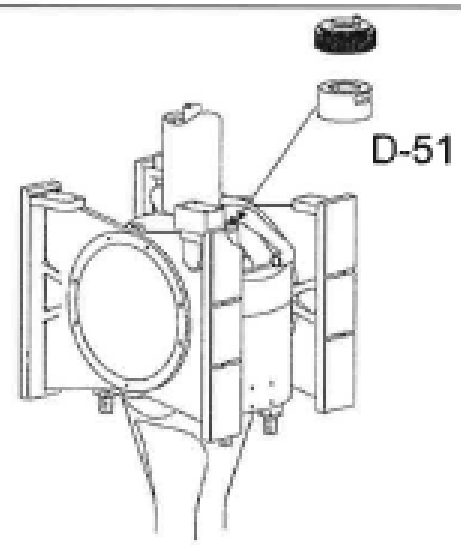

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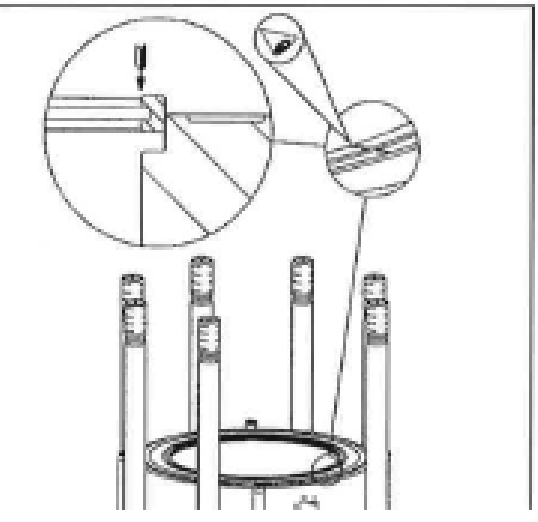


11. スタフィングボックスフランジの内側の穴を通してボルトでスタフィングボックスを締め降ろす。

12. ピストン棒ナットを取付け、油圧ジャッキで締付ける。

    油圧ジャッキの取扱いについて 913-1 参照。

13. 合マークを合わせてピストンクリーニング（PC リング）を取付ける。

    もし、PC リングが損傷（破損あるいはクラック）していたなら、新しいリングと取替える。*903-1.1 も参照。*

14. If the cylinder cover studs have been removed, remount them.

    Carefully clean the surfaces around the base of the studs and check the O-rings on the studs.

    Mount the cylinder cover studs with the stud setter. Screw the stud down to contact and one half revolution back.

15. Land the cylinder cover on the liner and check the distance the stud is protruding from the cylinder cover.

    If necessary, adjust the distance D-50 by turning the stud.

16. Tighten the cylinder cover and mount the necessary pipes.

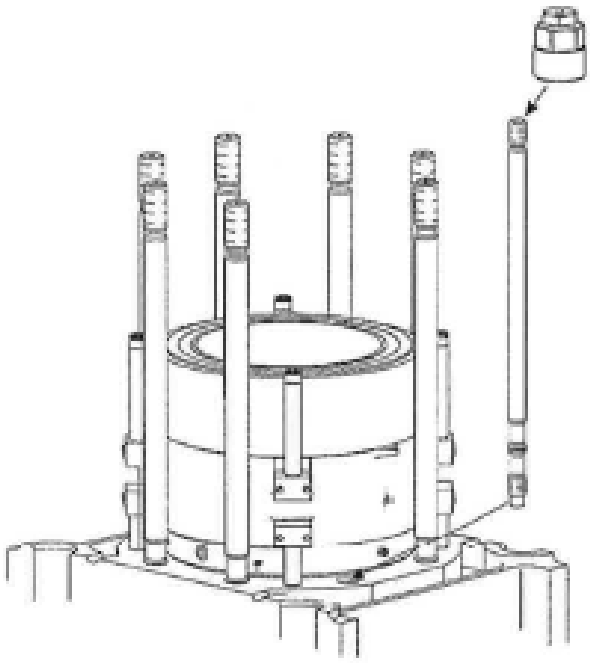
    See Procedure 901-1.4.

    Smear the piston rod with molybdenum disulphide, and turn the crankshaft a couple of revolutions.

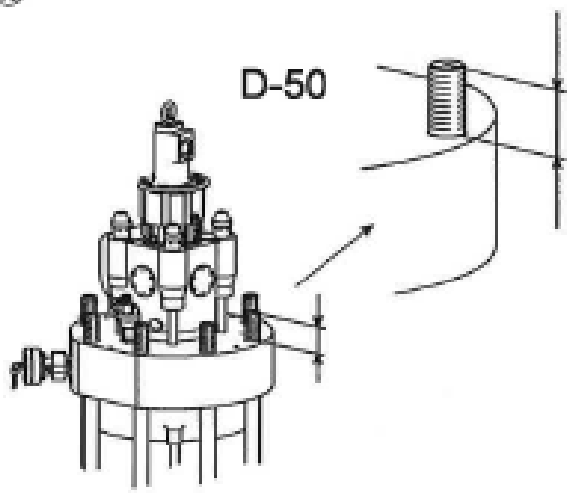
    Start the engine and keep it running for about 15 minutes at a number of revolutions corresponding to very slow.

    Then stop the engine and inspect the piston rod and stuffing box.

⑭



⑮



14. シリンダカバースタッドを取外した場合は、それらを復旧する。

    スタッド座周辺の表面を注意深く清浄にし、スタッドの O-リングを点検する。

    スタッドセッタでシリンダカバースタッドを植え込む。スタッドの底が当るまでねじ込み、1.5 回転戻す。

15. シリンダライナの上にシリンダカバーをのせ、スタッドがシリンダカバーから突き出している寸法を点検する。

    必要ならスタッドを回して、Data D-50 の値に調整する。

16. シリンダカバーを締付け、必要なパイプを取付ける。

    901-1.1 参照。

    ピストン棒に二硫化モリブデンを塗り、2,3 回転クランク軸をターニングする。

    機関を起動し、低速で約 15 分運転する。

    機関を停止し、ピストン棒とスタフィングボックスを点検する。