Reg M-311 SP-20

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: MAR 28 1986

In reply refer to: M-86-22 through -24

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On January 15, 1985, the U.S. semi-submersible mobile offshore drilling unit (MODU) GLOMAR ARCTIC II was conducting well testing operations 130 nautical miles east-southeast of Aberdeen, Scotland, in the North Sea. About 2030, an explosion occurred in the port pontoon pumproom. The chief engineer and the third assistant engineer were killed in the blast. Damage to the drilling vessel was estimated to be $2.3 million. 1/

At 1950 on January 15, 1985, a member of the Otis Pressure Control Company (Otis) well testing crew opened the adjustable choke valve and allowed crude oil from the well to flow through well testing and sampling equipment to the Otis crude oil burner on the port burner boom. Hydrocarbons from the well contaminated the rig compressed air system through a fracture in the No. 3 burner tip on the port side crude oil burner. The rig compressed air system then furnished contaminated compressed air to the purge air system. The automatic methane gas alarm, which was installed in the exhaust vent duct in the overhead of the drillers house, sensed methane gas in a mixture of explosive hydrocarbon gas that was expelled from equipment enclosures pressurized by the contaminated purge air. At 2010, the automatic methane gas alarm sounded at the drillers house. The Safety Board believes that sometime between 1950, when the adjustable choke valve was opened, and 2010, when the automatic methane gas alarm sounded, the No. 3 burner tip fractured.

The point of interconnection of the industrial crude oil piping system and the marine rig compressed air system was at the crude oil burner. To prevent the possible hydrocarbon contamination of a MODU's rig compressed air system, atomizing compressed air supplied to the crude oil burners should be furnished from a dedicated, separate, compressed air source. Furthermore, steps should be taken to prohibit the backflow of high pressure hydrocarbons that may enter the dedicated, separate, atomizing compressed air piping system. This could be accomplished by installing a device, such as a nonreturn (check) valve, in the atomizing compressed air piping.

1/ For more detailed information, read Marine Accident Report—"Explosion and Fire Onboard the U.S. Mobile Offshore Drilling Unit GLOMAR ARCTIC II in the North Sea, 130 Nautical Miles East-Southeast of Aberdeen, Scotland, January 15, 1985" (NTSB/MAR-86/03).

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The flow test conducted by the Robert Gordon Institute of Technology (R.G.I.T.) verified the path created by the fracture between the normally isolated crude oil supply piping and the atomizing air piping of the nozzle assembly. Due to the lightly tightened No. 3 burner tip, the most probable flow path of the crude oil was between the fuel body and the underside of the fuel disc flange and through the fracture. The underside of the fuel disc flange had a clearance created when crude oil supply pressure against the fuel disc exterior moved the fuel disc forward against the underside of the lightly tightened burner tip which opened a flow path from the crude oil supply pipe to the fracture. Once through the fracture, the crude oil entered the atomizing air side of the nozzle assembly where wax and other solids in the crude oil obstructed 9 of the 20 atomizing air outlets in the burner nozzle. The crude oil pressure of 385 psig was over three times higher than the 120 psig atomizing air pressure. With nearly half of the atomizing air outlets blocked, the route of the crude oil inside the air piping was back through the atomizing air piping and into the rig compressed air piping system leading to various areas, including the purge compressed air system and the valve remote control compressed air (tank) receiver in the port pontoon pumproom. The excessive crude oil pressure within the valve remote control compressed air receiver caused the pressure relief valve on the air receiver to open and release the crude oil vapor into the atmosphere of the pumproom. The crude oil vapors created an explosive hydrocarbon atmosphere in the port pumproom. This explosive atmosphere probably could have been ignited by any number of possible ignition sources because, under the design standards used, the pumproom and the propulsion room were considered as nonhazardous unclassified locations and, therefore, did not require explosion-proof enclosures on electrical equipment.

At the time of the accident, the required United States inspections, examinations, and operational tests of the GLOMAR ARCTIC II addressed the vessel's shipboard and industrial permanent equipment and systems. Crude oil burners are not a part of the MODU's permanent equipment. They are portable, temporary pieces of equipment brought onboard the MODU and installed by a well testing company. In this case, Otis, operating under the provisions of a contract to Phillips Petroleum U.K., Limited, installed two Otis CB-12A crude oil burners on the GLOMAR ARCTIC II. One burner was installed on the port side burner boom, and the other was installed on the starboard burner boom. At installation, the crude oil burners were connected to the vessel's permanent shipboard and industrial piping systems of compressed atomizing air, water, and crude oil/gas.

According to the drilling supervisor, there were no user manuals onboard the GLOMAR ARCTIC II concerning the burners or nozzle assemblies. The Otis maintenance procedures for the crude oil burners and nozzle assemblies were inadequate and permitted the reinstallation of a compression gasket that essentially loses its sealing effectiveness after the initial installation and compression. Onboard Otis inspection procedures for the crude oil burners and nozzle assemblies were nonexistent. Furthermore, at the time of the accident, there were no existing United States or United Kingdom regulatory requirements, and there were no classification society rules concerning the inspection, certification, or approval of portable, temporary industrial equipment, such as crude oil burners and their component parts. The inspection, maintenance, and proper assembly of the Otis crude oil burner and its component parts were left to the discretion and were the sole responsibility of the owner and operator of the equipment, Otis and its employees. In addition, during the manufacturing Otis failed to establish or require quality control procedures to ensure strict adherence to specifications for the manufacture of the burner tips.

The dimensions of the inner fillet radius of the three burner tips from the GLOMAR ARCTIC II's portside crude oil burner were measured. The inner fillet radius of burner tip No. 1 was found to be 0.60 inch as specified on the Otis engineering drawings. However, the inner fillet radii of the Nos. 2 and 3 burner tips were found to be 0.014 inch which is smaller, much sharper, and well below the 0.060 inch radius specified. A smaller radius is a much higher stress raiser (area of stress concentration) than a large radius. Corrosion pits, which also are stress raisers, were observed on the inner radius of the No. 3 burner tip. The observed corrosion pits in the nitrided case of the sharp inner radius would make section 'YY' susceptible to breakage on impact loading due to the increased stress raisers created by the corrosion pits and the sharp radius. Impulse pressure conditions arising from liquid/gas and wax slugs or solids impacting on the upstream (exterior) side of the fuel disc imparted additional stresses to section 'YY' of the burner tip. Except for an increased fatigue resistance, there appears to be no reason for having a high surface hardness, such as that obtained by a nitrided case. The fracture of the No. 3 burner tip was characterized as being typical of a single load overstress separation in material which is case hardened and has a tempered core, such as nitrolloy 135M. The Safety Board believes that the initiation of the fracture occurred at the point of the highest concentration of stress, that being at or near the location of one or more of the corrosion pits in the sharp inner radius at section 'YY' of the No. 3 burner tip.

Otis Company drawings of a properly assembled burner nozzle unit clearly show that the faces of the burner nozzle and burner tip are flush and level with each other when assembled properly. The dimensional checks to the nozzle assembly and its components showed that over 1/4 inch of clearance existed between the No. 3 burner nozzle face and the improperly recessed burner tip face, which should have been an immediate visual indication to the well test crew that the compression gasket was not seated properly within the assembly and that the nozzle assembly was misassembled. Although neither the burner tip material nor the sharp inner shoulder radius separately or together probably would have resulted in the failure of the No. 3 burner tip, they each contributed to the high levels of stress experienced by the No. 3 burner tip. Therefore, Otis should establish quality control procedures to ensure that manufacturing defects are identified and that improperly manufactured components are not distributed. The Safety Board believes that the No. 3 burner nozzle and burner tip were improperly assembled which resulted in increased bending loads and ultimately resulted in the fracture of the No. 3 burner tip.

Therefore, as a result of its investigation, the National Transportation Safety Board recommends that the Otis Pressure Control Company of the Otis Engineering Corporation:

> Develop and implement comprehensive inspection, maintenance, and assembly procedures for the crude oil burner and its component parts for the use of personnel involved in well testing operations. (Class II, Priority Action) (M-86-22)
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> Develop and implement quality control standards and procedures so that component parts of the crude oil burner are manufactured as specified. (Class II, Priority Action) (M-86-23)

Revise the operating procedures to require that compressed air supplied to crude oil burners be furnished by a dedicated, separate, compressed air source and that the compressed air supply piping to crude oil burners be fitted with a device to prohibit the backflow of well hydrocarbons that may enter the compressed air piping. (Class II, Priority Action) (M-86-24)

The National Transportation Safety Board is an independent Federal agency with the statutory responsibility "... to promote transportation safety by conducting independent accident investigations and by formulating safety improvement recommendations" (Public Law 93-633). The Safety Board is vitally interested in any actions taken as a result of its safety recommendations and would appreciate a response from you regarding action taken or contemplated with respect to the recommendations in this letter. Please refer to Safety Recommendations M-86-22 through -24 in your reply.

BURNETT, Chairman, GOLDMAN, Vice Chairman, and LAUBER, Member, concurred in these recommendations.

By: Jim Burnett
Chairman