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PORTABLE LIFE SUPPORT FOR INSTRUMENTATION OF AN OFFSHORE PLATFORM

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INTRODUCTION

Not all portable life support system design takes place in the laboratory. Occasionally a situation arises in an industrial or military operation that requires a unique or unavailable system. The people involved must rely on their own ingenuity to develop a new system or to modify an existing one to meet their needs. This paper discusses just such a situation.

Mechanics Research, Inc. (MRI) received a contract from Continental Oil Company to instrument an offshore drilling platform for measurement of structural response of the platform to severe storms and hurricanes. A typical platform is shown in figure 17.1. Specifically, this instrumentation consisted of the following measurements:

Structural response of a piling driven into the ocean floor
Structural response of the jacket members, including typical welded joints

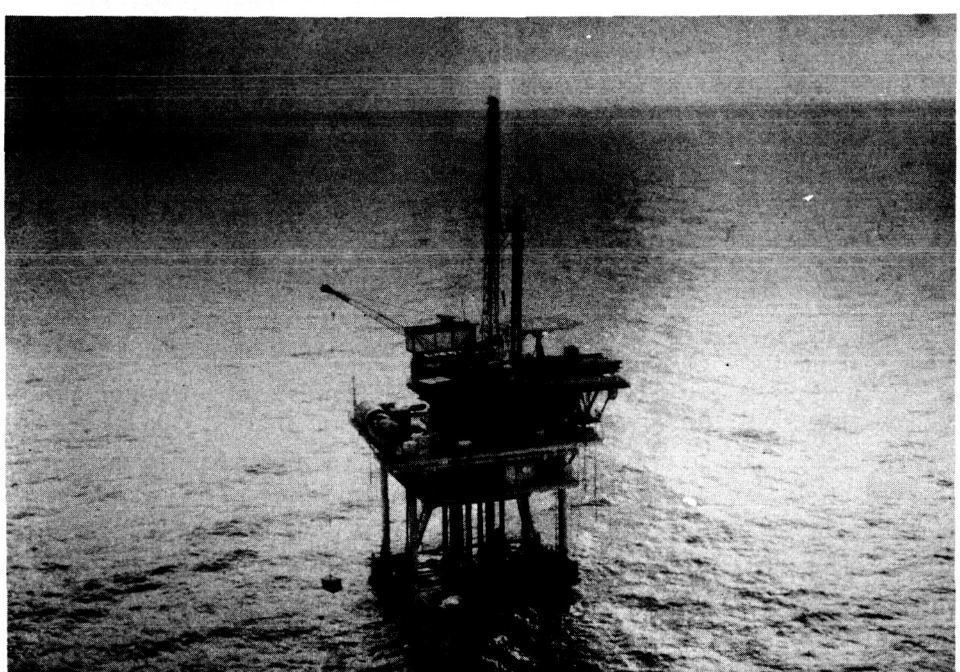

Figure 17.1 *Typical Gulf offshore drilling platform.*

The hydrodynamic parameters of wave height, direction, velocity, and force on a typical structural member

The aerodynamic parameters of wind velocity and direction

This paper discusses the life support considerations for the field engineer installing the instrumentation for the first item listed above. Strain gages were installed in the piling after it had been driven through the leg of the jacket into the ocean floor. The life support requirements are unique in that instrumenting inside a piling below the mud line is a new activity. In this regard, the MRI program constituted a totally new application for portable life support systems.

Life support requirements for this application included the following elements:

Sustaining air supply

Emergency air supply

Provision for monitoring concentrations of CO_2, CO, H_2S and combustible gases such as methane.

For this program, all system requirements were satisfied by commercially available hardware.

PLATFORM DESCRIPTION

As shown in figure 17.2, a typical offshore platform of the type used in the Gulf of Mexico consists of three basic structural components: jacket, deck, and pilings.

The ocean depth at the site involved in this installation was 176 ft, and the resulting jacket was approximately 186 ft high. The pilings are long tubular members that are driven through the legs of the jacket into the ocean floor to anchor the platform. They are then welded to the top of the jacket leg. The deck section legs are then stabbed into the pilings and welded.

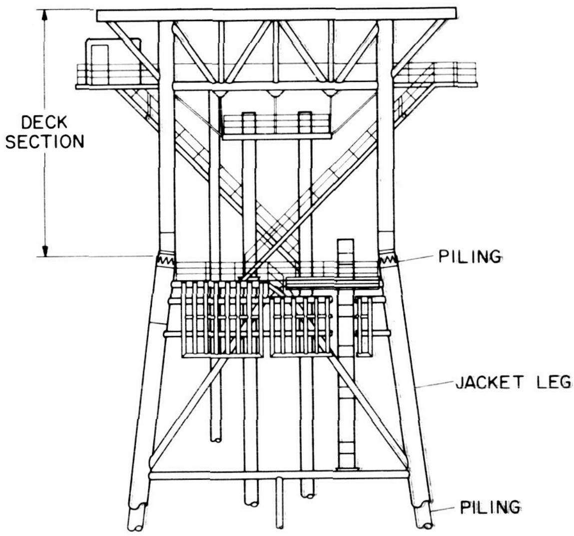

Figure 17.2 *Assembled platform structure.*

ENVIRONMENT

The working area for this program was in one of the cylindrical pilings. The pilings, which are approximately 550 ft long, taper from an inside diameter of 31 in. at the top to 29-1/2 in. at about the mud line. As these pilings are driven into the ocean floor, they fill with mud and water. Prior to installation of the deck structure, the piling to be instrumented is cleaned out to a depth of approximately 70 ft below the mud line. A concrete plug is then poured into the bottom to seal the end. The top of the plug is approximately 60 ft below the mud line.

As shown in figure 17.3, a door cut in the leg at the cellar deck level provided access to the piling work area. Figure 17.4 shows the elevator (powered cage) for transporting the instrumentation engineer and his equipment up and down within the piling. Figure 17.5 shows the elevator equipment compartment with the electrical equipment and welder in place. Figure 17.6 is a top view of the elevator moving within the piling. A view of strain gages in place looking up from the elevator is shown in figure 17.7. There were six vertical strain gage locations starting at the mud line (ocean floor) and terminating 54 ft below the mud line. Work duty cycles within the piling ranged from 3 to 5 hr.

Figure 17.3 *Access door in deck leg.*

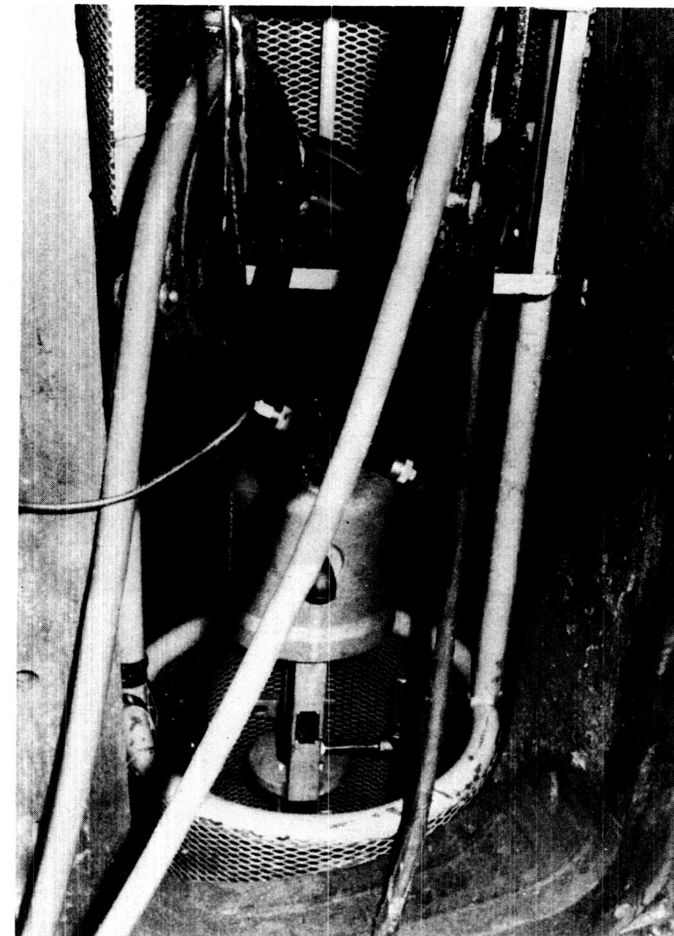

Figure 17.4 *Piling elevator.*

The gaseous environment within the piling was comprised of the following constituents:

Air supplied continuously from the surface
Carbon dioxide from normal respiration
Carbon monoxide from internal combustion engines located at the surface
Acetylene from metal cutting operations
Gases such as methane and sulphur dioxide from the soil into which the piling is imbedded

Air composed the major volume of gas present in the piling during the time that people were working. However, at the outset, it was not known how the concentrations of the other gases would vary during the work period. In this regard, ground gases, such as methane, were of primary concern, because the ground structure had been disturbed by the entrance of the piling.

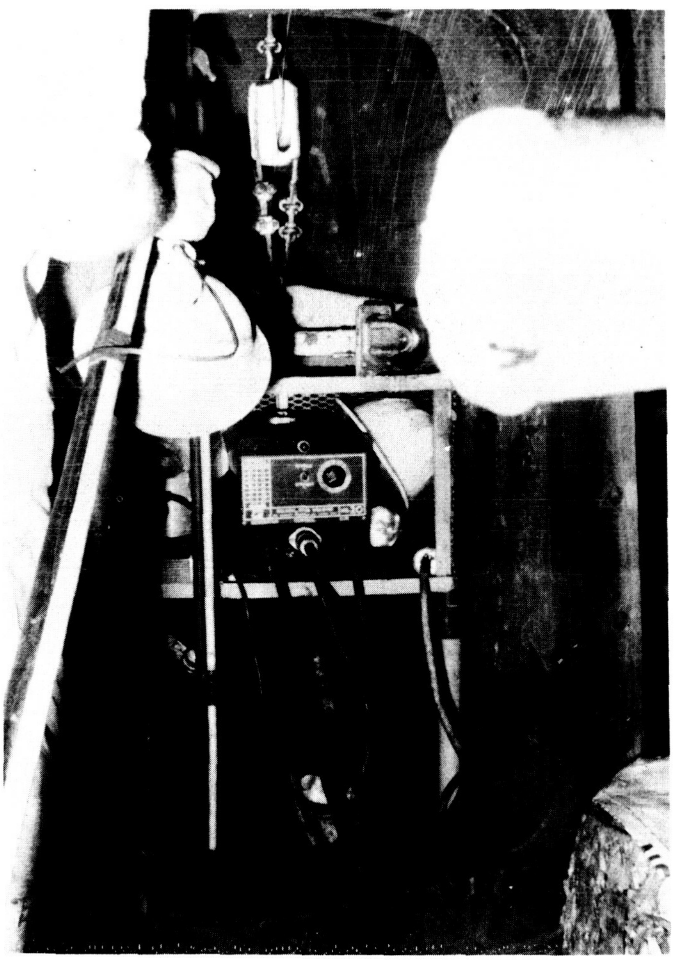

Figure 17.5 *Elevator equipment compartment.*

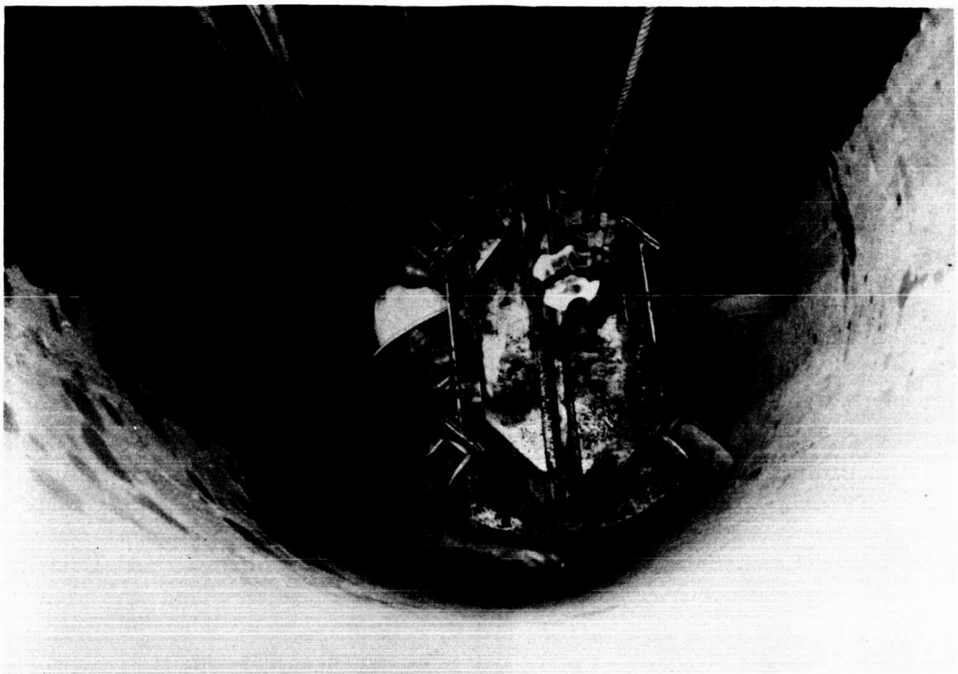

Figure 17.6 *Elevator moving down in the piling.*

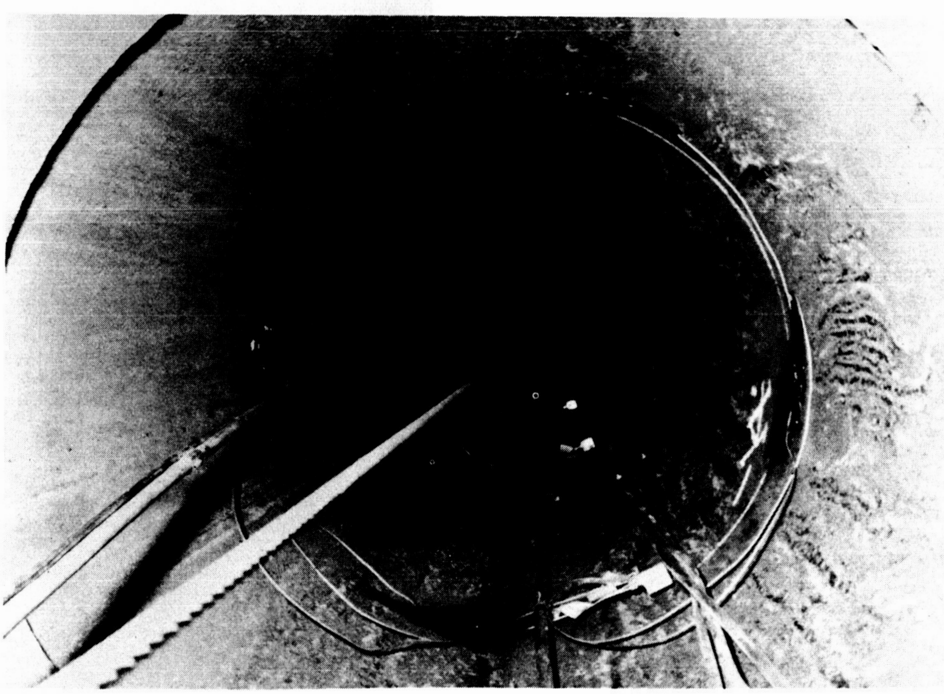

Figure 17.7 *Piling with strain gages in place.*

LIFE SUPPORT SYSTEM

Main Air Supply

The major consideration for life support was supplying clean air to the man working at the bottom of the piling. This clean air was necessary both to satisfy his oxygen needs and to continuously purge the piling of hazardous gases. This was accomplished by a compressor supplying air to the bottom of the piling through a reinforced nylon hose. The compressor used was a two-cylinder two-stage vee-type driven by a three-cylinder air-cooled diesel engine. The compressor was rated at 80 scfm, at a maximum operating pressure of 200 psig. This compressor had a power rating of 35 horsepower.

This type of compressor engine combination (fig. 17.8) is commonly used in the gulf by commercial divers and is considered to be a diving compressor. However, the actual compressor used was a standard commercial unit, not rated as a diving compressor, because of oil lubrication in the cylinder area. Rated diving compressors are either soap lubricated or use nonmetallic carbon or Teflon-coated piston rings to preclude air contamination. Also, the compression cylinders are isolated from the crankcase by a crosshead piston and piston rod seal. However, experience has shown that if the piston rings are in good condition, oil fouling of the air supply is not a serious problem.

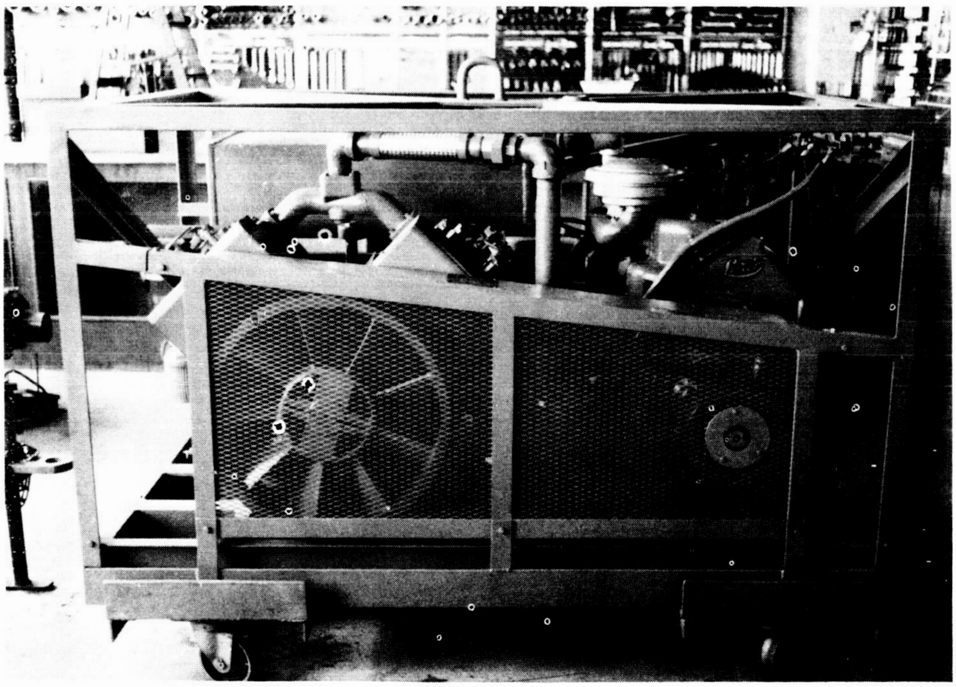

Figure 17.8 *Sustaining air supply compressor-engine combination.*

The air from the compressor was routed to a 50 gallon storage tank where the pressure was regulated between 80 and 120 psig. Discharge air was piped from the reservoir through two centrifugal separators mounted in series to remove water and condensed oil vapors. From the centrifugal separators, the air was routed through an absorption type oil scrubber to remove oil vapor. This system was modified after the first day of operation by the removing the oil scrubber, because the scrubbing material was becoming saturated with water. The water caused the material to pack tightly and thus restrict air flow through the scrubber. The removal of the oil scrubber was not a serious omission because the scrubber was fitted with a visual oil-indicating dye. Results of the first day of operation indicated that no detectable amount of oil was getting into the air.

After leaving the separators, the air was transported 300 ft down the pile where it discharged through a muffler. The air line, shown in figure 17.9 was a lightweight nylon double braid reinforced hose with an inside diameter of 0.5 in., rated for a working pressure of 250 psig. The air line size provided sufficient air flow within the pile to carry debris up the pipe and out the door. This debris resulted from the grinding that had to be done to remove rust prior to strain gage installation. This debris sweeping feature was efficient so when pile grinding was in progress the rust and metal powder was processed out through the top.

Figure 17.9 *Main air hose being fed into piling.*

Air Monitoring

Air quality in the pile was sampled periodically by two devices manufactured by the Mine Safety Appliance Company, a universal tester and an explosion meter.

The universal tester draws a controlled volume of air across a reagent bed contained in a glass indicating tube. A separate glass indicating tube is used for each gas to be detected. The concentration of gas present in the air is indicated by either a color change or the length of stain mark in the reagent bed. If a gas is present in the air sample, the quantity in parts per million or by volume, is determined by comparing the stain color or length to a calibration sheet. The glass indicating tubes used are for the detection of carbon dioxide, carbon monoxide and hydrogen sulfide. This tester required about 5 min for each series tests. On the first round trip to the bottom of the pile, the air was sampled about every 50 ft down to the 300-ft mark.

The explosion meter detects explosive mixtures of gas and air. The explosive mixture can consist of one specific gas and air or many gases in a mixture of air. However, this unit only determines the percent of explosive mixture, and does not identify the constituent gases. The explosion meter operates on the principle of a particular gas or air sample changing the resistance of a heated element, which is part of a Wheatstone bridge. If an air sample contains a combustible gas, the gas will be oxidized by the heated element, and additional heating of the sensitive element will occur, thus changing its resistance even though there is insufficient gas to support combustion. The device is enclosed within a screen to prevent ignition of the test area in the event that enough gas is present to cause an explosion. Readout on the indicator is in percent of an explosive mixture. This device was used to detect the presence of methane and acetylene, and other explosive gases that may have been present in the piling. This device proved to be much simpler and faster to use than the universal tester, and could be used while the elevator was in motion.

Emergency Air Supply

The personnel working in the piling requested that an emergency breathing supply system be used during the initial trips to the bottom, until confidence could be gained in the life support system. Several alternative schemes were investigated and the one selected was a scuba diving unit. This unit consisted of a U.S. Divers single hose two-stage unit attached to a 72 cu ft compressed air tank.

This unit was selected because it is extremely quick donning, simple to use, and can be left on and ready to use without consuming any of the air supply in the standby mode. Storage space was at a premium in the elevator so the compressed air tank was set on the floor of the basket between the workers legs. The mouthpiece was placed in a hanger at waist height, where it would be readily accessible in an emergency.

CONCLUSIONS

The life support system described in this paper proved to be a key item in satisfying the program goals. The commercial elements that made up the system operated satisfactorily during all work modes, and provided a high level of confidence for the men working in the piling.

The assemblage of components that made up this system was tailored to the vertical piling environment. In this regard, the long umbilical (air hose) approach proved satisfactory. On the other hand, it may be worthwhile to consider the development of a compact portable life support system that would have universal application for future offshore platform work activities.