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HEALTH

CHAPTER SEVEN HEALTH

The essential objectives of an occupational health and safety program are to take precautions against hazardous events and to reduce the consequences of any accidents that do occur. As in all industrial operations where heavy equipment is handled, accidents occur during offshore drilling, resulting in injuries ranging from the severe, requiring evacuation of the patient to a hospital where specialized medical facilities are available, to the relatively minor which can be treated at the site in the sick bay by the rig's medic. An example of a hazard peculiar to the petroleum industry is loss of well control which can result in the escape from the well of toxic gases or of hydrocarbons in gaseous or liquid form, with the attendant risk of fire and explosion. The hazards associated with exploratory drilling are compounded in the Northwest Atlantic by a particularly hostile marine environment. There is potential for man-overboard incidents that may result in near-drowning or hypothermia, of accidents during the course of diving operations, which may require special hyperbaric facilities and medical expertise and of accidents during the handling of heavy equipment associated with the movement of the rig induced by wind and waves.

The avoidance of potentially hazardous events and of consequent injuries in offshore drilling operations may be achieved by maintaining safe conditions at the workplace, by following proper procedures whether on the drill floor or in the galley, and by preserving a high standard of general housekeeping on the drilling rig as a whole. The objectives of this process, however, require the constant vigilance and commitment to safety of every individual crew member; those responsible for occupational health, from the rig medic to the medical director of the operator, should, from their knowledge and experience, be given the opportunity to contribute.

Records of illness and injury provide important data for assessing the quality of health care offshore and for monitoring the development of any occupation-related illnesses. Individual medical records containing the pre-employment medical examination and the medical history of each worker are necessary also for determining the health status of persons while working on the rig. A well-maintained, confidential medical record system is essential to assessing the nature and origin of health problems that arise during employment. It can also, in time, make an important contribution to a better understanding of the particular health problems of offshore workers and lead to the adoption of preventive measures and thus to the improvement of health care in the offshore drilling industry. The extent to which offshore drilling operations are more hazardous to health than similar industrial activities on land can only be judged in relation to the nature of the activities, to the groups of employees at risk, to the types of injuries encountered and to the nature of the illnesses that arise both during and after employment. Current methods of collecting information on illnesses and on accidents during offshore employment are not sufficiently systematic, either nationally or internationally, to provide reliable data for comparable degrees of risk.[1] Attempts to estimate health hazards in the offshore drilling industry in Norway, the United Kingdom and the United States indicate, without exception, the unsatisfactory nature of the data available.[2] Where health data have already been collected for the population as a whole as in Medicare records, the Canada Health Survey, and on death certificates, the occupation of the individual has not, in many cases, been recorded, so that these data are rendered useless for analysing occupational hazards. Canadian regulatory authorities, in consultation with the industry and with physicians, should institute a system of collating and analysing data and of disseminating the results in a suitable form to all interested agencies.

Variations in the diagnostic criteria used by different rig medics in keeping their daily logs diminish the overall consistency of the data currently recorded on offshore rigs. The standard criterion for rating the severity of an illness or injury is time off work. Some unreliability in data can be ascribed to inaccuracies arising from time lost by a worker due, for example, to difficulty in obtaining transportation back to the rig rather than to the consequences of an illness or injury. The lack of reliability is greatest where there are marked differences among reporting agencies in the accepted standards for severity of illness or injury. This is due in part to inconsistencies in the terms used.[3]

Section 179(1) "Every operator shall, during a drilling program, prepare and submit to the Chief once each week. . .a report in respect of every accident that occurred during the preceding week and that involved an injury to or the death of any person."

Canada Oil and Gas Drilling Regulations. November 1980

The reporting of injuries arising from accidents poses some special problems. Accident reports are an accepted means of monitoring safety procedures and are one measure of the success of safety programs. Safety bonus schemes, pride in a safety record, an individual's embarrassment, reluctance to admit error or to ascribe blame to a colleague can all provide reasons for under-reporting accidents or near-accidents and for individuals not seeking medical attention for what is considered to be a minor injury. There is also a further possibility of inaccurate or incomplete data being provided because the rig medic does not understand the purpose for which the information is required. Nevertheless, even with the errors and inconsistencies that exist, this information would be useful to physicians and planners, if it were available in some processed form. The quality of the statistics would improve rapidly, however, with the adoption of consistent criteria for reporting an agreed range of data on a regular basis.

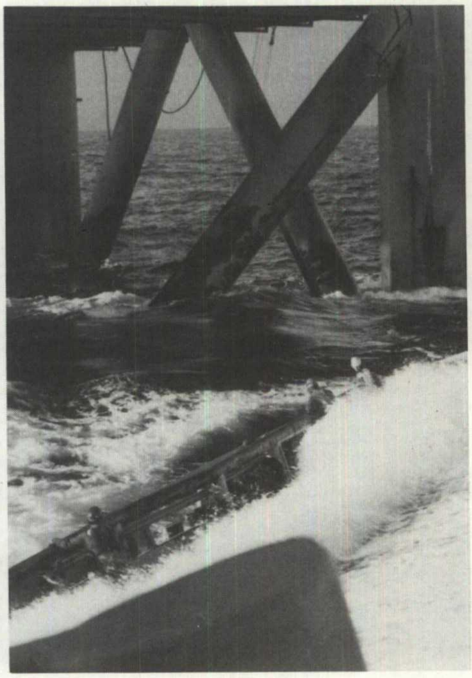
The first stage in the compilation of health data is the pre-employment medical examination. That examination establishes an applicant's health status before hiring. It assesses the individual's fitness, not only to perform a particular job, but also to live and work on the rig under routine conditions; it also assesses that person's ability to cope with an emergency without becoming a liability to himself and to others. The primary purpose of pre-employment medical examinations is to prevent individuals with conditions that present a health risk from entering offshore employment. The exclusion of people whose health makes them unsuitable for working offshore also minimizes the requirements for emergency medical care and potential risks to others on the rig.

It is generally agreed that high standards of medical fitness should be applied to offshore workers because of the nature and location of the work. But in the eastern Canadian offshore industry, pre-employment medical examinations are not

[1]The American Petroleum Institute initiated a recent study of morbidity and mortality involving fifteen thousand employees from nineteen companies. This large-scale study could have produced valuable findings on health hazards in the industry, but it failed to do so because there were too many differences in the ways in which data were collected to permit reliable conclusions to be reached.

[2]The sources now available for the compilation of a health data bank for the eastern Canadian offshore include accident reports to various public agencies and the daily logs kept by rig medics. Regulations require the operators to file reports for accidents which involve serious personal injury. Subsequent guidelines define lost-time accidents as injuries which prevent the worker from completing the present shift and the next regularly scheduled shift. The data collected is not subjected to a formal system of analysis.

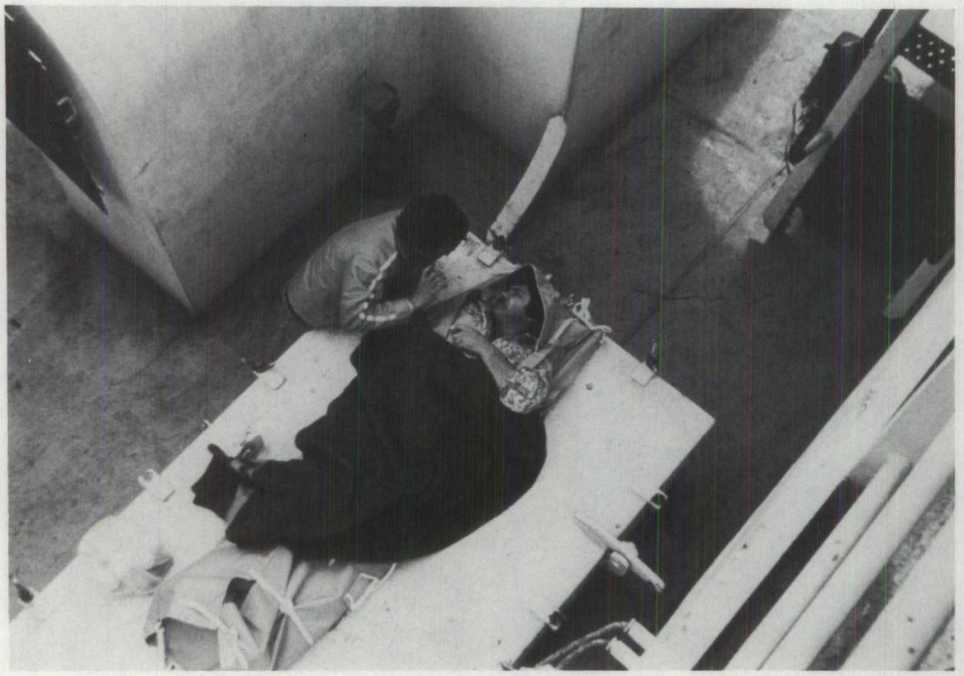
[3]The International Labour Organization has called for a special glossary of terms to meet this need.

7.1 A thorough pre-employment medical examination is needed to establish the health status of applicants and to assess their fitness for offshore work.

standardized. The medical director of each operating company can have examinations conducted, using criteria and procedures that differ from those used by other companies. Drilling contractors and service contractors may also undertake medical screening of their employees in accordance with their own procedures. Basic minimum standards that cover the full range of diseases and disorders have been developed in the United Kingdom and in Norway. These criteria could form the basis for the establishment of minimum standards in pre-employment medical examinations for the eastern Canadian offshore industry, to be applied uniformly to all offshore workers irrespective of their employer. Appropriate standards should be arrived at and adopted following consultation among Canadian regulatory authorities, the industry and physicians involved in the provision of health care offshore. The responsibility for deciding fitness for employment must continue to rest, nevertheless, with the physician designated by the operator who needs to have a knowledge of the working environment and, in the case of diving activities, specialized medical training for which standards should be established. The examining physician can be expected, as in other areas, to exercise clinical judgment. Any departure from the minimum established criteria should be documented in the physician's report.

The effectiveness of any health care facility is generally judged in terms of: its adequacy to deal with the needs of the population that it is intended to serve; the provision of qualified personnel to meet these needs; the physical resources available to house patients and to carry out investigative and treatment procedures; and the extent to which existing services are being properly used and new services developed. The relatively brief experience and sparse data relating to offshore operations make it difficult to evaluate an offshore health facility. It should be evaluated on the basis of its adequacy to deal with everyday problems and to meet the demands of an emergency. The population is relatively homogenous, consisting mainly of young adults already medically screened. Minimum facilities, such as those normally found in a typical family practice clinic ashore, may be deemed sufficient for routine care, but not for emergencies offshore. A rig sick bay may, in adverse conditions, have to treat seriously ill or injured patients until they can be evacuated. The range of response in an emergency must be capable of rapid expansion for brief periods to care for many patients and to deal with major illnesses, such as trauma, burns, hypothermia and



7.2 The initial action of the medic, in the event of a serious injury on board the rig, is to stabilize the patient in preparation for evacuation to shore. If the patient cannot be evacuated immediately, further treatment may be administered under the direction of a shore-based physician.

other difficult medical problems. Adequate basic standards should therefore be established for these facilities.

It is hard to estimate the level of demand for medical service in an emergency. Serious injuries may result from an explosion, a fire, or a helicopter crash on or near the rig. Supplies and equipment should be kept for these emergencies to be used by the rig medic under the direction of the physician on shore. The medic and the physician on shore could then work together on the basis of known resources available on board the rig. The shore-based Medical Emergency Response Team would also know exactly what equipment and supplies they can expect to find on arrival.[4] The medical supplies and equipment that are held on each drilling rig are, at present, matters of individual company or Flag State policy. Minimum levels of medical supplies for the Canadian offshore should be established as standards following consultation between the regulatory authority, the industry, and the physicians.

The Canadian regime for the provision of health care services to offshore drilling operations is more complex than that of Norway, the United Kingdom and the United States because of the division of powers under the Canadian Constitution and the number of agencies involved. Under the Canadian Constitution, responsibility for health and occupational safety within provincial boundaries rests with the provincial ministers of Health and of Labour. Because of the lack of Canadian regulations and the use of rigs of foreign registry, matters relating to occupational health and safety in the eastern Canadian offshore drilling industry are currently governed by the standards of other states. The result is a multiplicity of standards, the acceptance of which on an *ad hoc* basis by Canadian regulatory authorities complicates contingency planning and quality control. This problem would disappear if all drilling operations in eastern Canadian waters were governed by Canadian laws, codes and practices with respect to occupational health and safety. The extension of provincial health jurisdiction to the offshore would also resolve many of the present inconsistencies in the licensing, registration, training, and continuing education of those health professionals who are engaged in the offshore drilling industry.

[4]In St. John's, Newfoundland the Medical Emergency Response Team is made up of specialist physicians, nurses and respiratory technicians from the Health Sciences Centre who may be flown to any location to administer medical care. A similar service has not, so far, been formalized in Nova Scotia.

It is therefore necessary that there be provided a mechanism for effective cooperation and collaboration among the various federal and provincial agencies responsible for health and occupational safety in offshore drilling operations. That mechanism should provide for the views of physicians with experience in offshore health care, professional representatives of the Departments of Health and of Labour from both levels of government, medical and safety professional representatives from the offshore industry, and offshore workers whose welfare is at stake.

Current federal regulations require that the operating company holding a permit from the Canadian regulatory authority be responsible for all health matters in respect of its operations. Adequate standards for the provision of health care offshore have not been established. In practice there is a significant variation in the standards, from excellent on some rigs to inadequate on others. This responsibility for all health matters should be reflected in organizational terms, so that clear lines of authority and communication are established to improve efficiency under normal conditions and to avoid confusion in emergencies. The operator's medical director should be responsible and accountable for all aspects of health care, including pre-employment medical examinations of all personnel, for the professional competence of the rig medic, for the relationship with supporting medical services on shore and for determining clearly the health care arrangements for all personnel on board the drilling rig in normal and emergency conditions.

The rig medic who is responsible for providing medical services and the supervising physician on shore must both have a wide range of skills. Although some physicians have been employed on rigs on a temporary basis, the medical duties at the routine level do not normally require or justify a physician's skills and training unless the rig is located in a very isolated area, as for example, the Labrador Sea. The more appropriate alternative is a registered nurse, preferably with experience and training in outpost and offshore practice. Medics retired from the armed forces, emergency technicians and registered nurses have all been employed as rig medics. Medics trained by the Canadian Armed Forces for independent duties (classified TQ6B), particularly those who have had independent sea-going experience, appear to have an appropriate background for rig medic duties. They, however, have at present no recognized status, legal or professional, in the civilian health care system, with consequent medico-legal implications in determining professional liability. Action should be taken to remove this handicap. The qualifications and experience of emergency technicians are considered unsuitable for the rig medic position. Registered nurses have the minimum requisite skills, the legal and professional status and recognition in the health care system, but additional training in selected areas is necessary.

An advanced first-aid team should be formed and trained to assist the rig medic who may be faced, in an emergency, with caring for an acutely ill patient or for a number of casualties. The training of team members should include components from the Canadian Heart Association's syllabus on cardiopulmonary resuscitation (CPR) and from the petroleum industry's approved course on hydrogen sulphide poisoning.[5] Regular drills and refresher training should be provided by the rig medic for all members of advanced first-aid teams. Since supply vessels do not carry medics, one or two members of their crew should receive advanced first-aid training in addition to the elementary training received by all crew members.

The designated physician on shore who supervises the rig medic should be specially trained. This training should consist of instruction in emergency medicine including basic life support, and the management and treatment of cardiac arrest, near drowning, and hypothermia. A basic knowledge of diving medicine should also

[5]It should also cover such medical procedures used in the treatment of patients as control of hemorrhage or management of intravenous infusion to meet the standards laid down by the Canadian Medical Association for Emergency Medical Attendants.

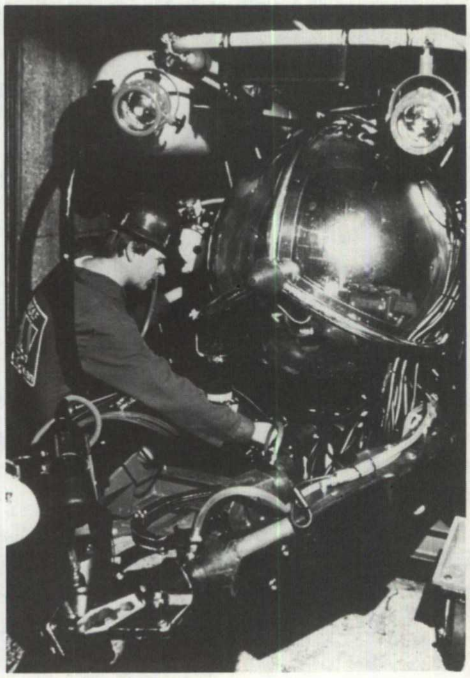
be required. After this initial training, the physician should receive continuing education on methods and techniques in such areas as hyperbaric medicine, the management of trauma and rescue procedures. In addition to the necessary clinical skills, the physician on shore should have knowledge of the administrative procedures within the operator's organization and of action to be taken in an emergency in accordance with the operator's contingency plan.

Diving presents a special challenge to the offshore health care system. There are two methods of performing underwater operations involving divers. The better choice in terms of safety are the one-atmosphere diving systems (ADS). These devices have in general a good safety record although they are vulnerable to entrapment and care must be taken to ensure that life support can be sustained for as long as it takes to rescue divers who are trapped. Although remotely operated vehicles (ROVs) and ADS are used extensively in offshore diving operations, there remain some underwater operations requiring fine hand and eye co-ordination, manual dexterity, versatility or work in confined spaces which must be performed by divers at ambient pressure.

It appears that the health and safety aspects of diving operations carried out in connection with offshore drilling operations in eastern Canadian waters have been generally satisfactory. Regulations do not, however, address surface decompression diving nor deal adequately with the important matter of the training of diver medical technicians. Although diving can be carried out from any type of vessel or platform, contemporary diving support vessels are primarily dynamically positioned. As a number of accidents have occurred during diving operations from dynamically positioned vessels, this mode of diving should be the subject of ongoing scrutiny by Canadian regulatory authorities. A problem area is the evacuation of divers from an offshore location. A diver, while still in saturation, may become ill or be injured and have to be stabilized in the pressure chamber on board the rig before being transferred to shore. A number of divers may have to be transferred to shore while still in saturation, if a general emergency requires the evacuation of the rig while diving operations are in progress. There is need for hyperbaric chambers which can transport divers to a shore-based recompression facility and for compatible hyperbaric facilities on shore in St. John's as in Halifax.

All divers need to be trained to a high standard of first aid, including training for diving emergencies. Providing health care to the sick or injured diver presents special problems because of the isolation of divers in saturation or deep, mixed-gas diving. Since neither the rig medic nor the diving superintendent can attend the diver in the chamber, diving teams should include a diver medical technician trained to render immediate medical care. There are, at present, no courses available in Canada for diver medical technicians and persons functioning in this role have to be trained abroad. For the diver medical technician, additional course modules would be required on near-drowning, hypothermia and on topics and procedures specific to diving medicine. Physicians must not only be specially trained to conduct medical examinations for fitness to dive, but some should be trained as specialists in diving medicine.

The operator is responsible for the health and safety of all personnel engaged in the operation, including divers. The operator's medical director should therefore have access to persons qualified to assess safety in diving and to provide medical backup and services when diving operations are in progress. There is need for further research to be carried out in Canada on the physiological aspects of diving in cold ocean conditions and on the development of diving equipment that is specially adapted to the Canadian offshore environment. In specific terms, improved "bail-out" gas supply systems for deep diving ought to be developed and further research should be undertaken on the physiology and pathophysiology of decompression sickness, thermal protection and oxygen toxicity.



7.3 Diving operations present unique problems for routine and emergency health care offshore. Although manned submersibles operate at atmospheric pressure, many underwater activities still require that divers work at ambient pressure and undergo slow decompression to avoid decompression sickness.

Planning for emergencies must provide for a wide range of support facilities, both offshore and on shore, for several phases of intervention from immediate first aid rendered to the patient by the rig medic through consultation with the physician on shore to the decision to evacuate the patient from the drilling unit or supply vessel. The medical emergency plan should provide for efficient transportation arrangements on shore following evacuation and for reception of patients by appropriate hospital specialist units.

Further research and development are needed to improve methods of communication in the field of health care for offshore operations and to improve the quality of the response in emergencies and for routine consultations. Advances have been made in telemedicine through the transmission of medical data such as x-rays and electrocardiographs, which are beginning to enhance the consultative process between rig medic and onshore physician. With respect to the offshore working environment in general, more biomedical research is required in a number of areas such as hypothermia and seasickness which are routinely experienced during marine emergencies. An intensification of basic research in these areas would provide greater knowledge of the physiological and pathological processes involved. This in turn would give a more rational base for prevention and treatment.

Severe winter storms, blowouts, explosions, collisions or fire may create a disaster. Canadian regulatory authorities require that each operator with drilling operations in eastern Canadian waters prepare and submit for approval a contingency plan which describes in detail the response to an emergency, the responsibilities of key personnel with respect to medical matters and the roles and responsibilities of the rig medic and of the consulting physician. There is need for regional plans to activate and co-ordinate hospital and medical resources in the event of a major disaster. When a disaster has been declared, joint action will be required to mobilize quickly all the resources of industry, government agencies and health care facilities on shore. The response that each will make must then be integrated into a disaster plan for the area or region and be tested periodically in a full-scale exercise. The medical aspects of contingency and disaster plans need to be evaluated on a regular basis.

8

ESCAPE AND SURVIVAL

CHAPTER EIGHT ESCAPE AND SURVIVAL

In 1926 the Northwest Atlantic experienced what meteorologists called the worst winter in 100 years. A 21-day hurricane in October was succeeded in late January by a winter storm of almost unprecedented destructive force. The storm raged relentlessly for more than a week. Seven ships went down, and many lives were lost. Among those rescued were the twenty-five crewmen of the British freighter *Antinoe*. The freighter had been swamped and drifting for sixteen hours with no indication of her bearings when the American luxury liner *S.S. President Roosevelt* picked up her distress signal and managed to locate the stricken vessel. The waves broke portlights in the *Roosevelt's* midships cabins 70 feet above the sea and the liner pitched 30 degrees in the troughs. The winds were measured at 70 knots with gusts to 150 knots. Lifeboats were launched down the 60-foot drop to the sea, only to capsize, spilling the oarsmen into the icy water. Finally, after 100 hours of uninterrupted rescue attempts, the almost lifeless seamen were plucked from the sinking *Antinoe*, and hoisted aboard the *Roosevelt*, "Frost-bitten, thinned in blood, gnarled to the bone / But everyone surviving."[1]

This rescue was not extraordinary; records of similar feats abound in North Atlantic ports. For centuries, society has employed lifeboats to secure the protection of those of its members who, whether for transport, pleasure, profit or duty, have ventured out to sea. During that time, most of the marvels of our modern technological world have come into being, and the contrast between then and now in methods of travel, communication, medicine, and industrial endeavour is truly remarkable. In some areas progress has been slower, reflecting a shift in society's priorities. As man developed faster and safer ways of traversing the ocean, the passenger vessel has come to play a reduced role and little attention has been paid to the development of marine evacuation systems.

But there has been one change in the marine milieu – a dramatic, new addition to the fleet of vehicles used to ply or harvest the seas. Many maritime locations throughout the world, including some of the harshest in terms of climate, are being exploited by ocean-going drilling rigs, designed and instrumented at the "leading edge" of technology. These sea-based marvels of industrial progress house up to a hundred workers who are exposed to all the traditional environmental foes of the mariner in addition to new dangers arising from the rig's industrial mission. And yet, and herein lies the paradox, alongside the sophisticated system of machinery and equipment to drill the well is the anachronistic system of lifeboats and life rafts to protect the workers. Admittedly the traditional wooden lifeboats have been replaced by those of fibreglass-reinforced plastic; they have been enclosed, fitted with motors,

[1]Details from historical accounts of the disaster; quote from E.J. Pratt's "The *Roosevelt* and the *Antinoe*".

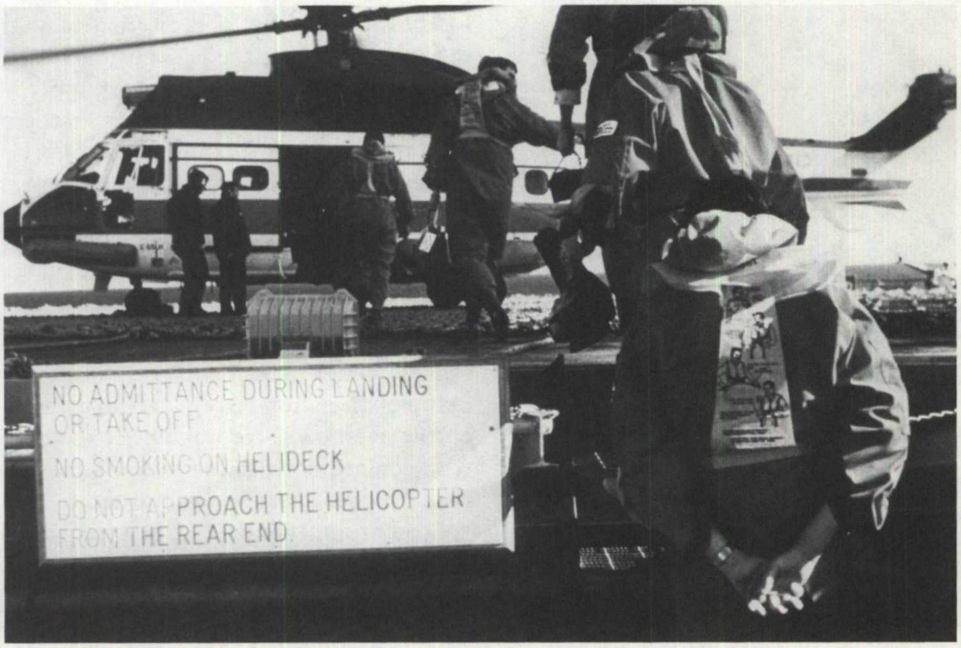
sprinkler systems and communication equipment. But the same hazards presented by lifeboats half a century ago exist today; they still cannot be launched safely into high seas without fear of a malfunction of the launching or release mechanism, or of being blown or washed back against the structure from which they are launched. To state that they fall far short of serving their purpose of protecting the workers is to restate the conclusion reached by virtually every study prepared by research institutes, government or industry on this subject; by experts who have spoken or written on offshore evacuation systems; and by inquiries into the various marine disasters that have claimed the lives of hundreds of people in recent years.

There is, at present, no proven system for the evacuation of offshore drilling rigs that can assure a reasonable chance of survival to those who are obliged to use it during severe storms and other environmental hazards. More specifically, there is no existing evacuation system which is adequate for the environmental conditions frequently encountered in the drilling areas off the eastern coast of Canada.

The astonishing lack of technological progress in evacuation systems for offshore rigs over the years is sometimes rationalized on the grounds that the standard evacuation device for drilling rigs today is the helicopter. Yet those who have studied offshore safety in the North Sea estimate that an installation will have to be evacuated by some means other than helicopter – this normally means by lifeboat – at least once during its operational life of 20 years.[2] Estimates for offshore eastern Canada would probably be higher because helicopter rescue is more uncertain; the rigs are working farther from the land and therefore from the helicopters' base, and at certain times of the year there is a greater likelihood of rime icing or fog to prevent flights. These estimates have in actual fact proved conservative. There have been three emergency evacuations of drilling rigs by lifeboat off Canada's East Coast since 1982. In the first, no lives were saved; in the second, only one life was lost; in the third, all survived. A major factor influencing these outcomes was weather; two occurred in calm seas; one during a winter storm. Yet the circumstances on the night of the *Ocean Ranger* disaster were less adverse than those surrounding many successful vessel evacuations off our shores; the exact location of the rig was known; supply vessels and search and rescue helicopters were on stand-by duty, and the rig itself was equipped with modern evacuation systems. Why an effective rescue was not achieved has provided industry and government with serious food for thought. Improvements must be made in the technology, the equipment and the management of offshore emergency evacuations. Long-term research and development must be started now, but until they come to fruition, short-term interim measures must be taken to upgrade existing evacuation systems.

It is generally agreed that, under normal circumstances, the safest haven offshore is the drilling rig itself. Nevertheless, abnormal circumstances can and do arise. Approaching ice, storm conditions, structural damage, loss of stability, fire, blowout, or the escape of toxic gases from the well – any one of these conditions can make getting off the rig a prerequisite to survival. Evacuation may also be needed from a supply vessel in distress or from a downed helicopter. Those controlling offshore oil exploration recognize the inadequacy of present marine escape and survival technology, particularly during storm conditions. The first line of defence in this potentially perilous situation has been to reduce the need for evacuation by enhancing the safety both of the rig itself and of its support operations. The second has been to determine when evacuation may be required in sufficient time to choose the safest method. When time and weather permit, a rig will be evacuated by helicopter; if that is not possible, the options narrow rapidly through dry transfer to a standby vessel by crane and basket, to the conventional fallbacks of escape by lifeboat and life raft,

[2]Study for the U.K. Department of Energy and the U.K. Offshore Operators Association, 1983. For this study a successful evacuation was defined as one which restored personnel to a level of risk no higher than that which pertained before the emergency occurred.



8.1 The evacuation of a rig by helicopter may be constrained by adverse weather, an inclination of the drilling rig or the presence of toxic or combustible gas. The time required to muster a crew and fly to the site, and the limited capacity of each helicopter impose further limitations.

and finally, directly into the sea. A supply vessel will be evacuated by davit-launched lifeboats and the occupants of a downed helicopter will normally board inflatable life rafts directly from the sea. The effectiveness of each of these methods is seriously restricted by present design and operational limitations; few are completely reliable even under favourable environmental conditions and many pose severe problems in fog, storms or rough seas.

Although helicopters are generally considered to be the safest method of evacuating offshore drilling rigs, there is limited benefit in a safe option if that option is only viable when weather and time permit its use. The extent to which weather impinges upon the operations of helicopters varies with the type of machine, but most of those servicing rigs off Canada's East Coast are affected by poor visibility, and none is capable of start-up in high winds or of flying when icing is a threat. Fog, blowing snow, freezing rain, and high winds are characteristic of that offshore area and these conditions may, either singly or in combination, prohibit helicopter flights as much as one-third of the time. While pilots may well exceed "normal" operational limitations during an emergency, there have been, and there will be, many instances when helicopters simply cannot fly and other means of evacuation must then be sought. If an evacuation occurs because of a blowout, fire, or severe list, helicopters may not be able to land on the rig, and if an emergency arises with little warning, helicopters will not have time to reach the rig before evacuation becomes necessary. If advance warning is given, the helicopter's distance from the site, its carrying capacity, and the proximity of other rigs for offloading passengers and for refuelling all remain critical factors. The net result of these conditions is that there is a relatively small percentage of offshore emergencies in which helicopters will be able to evacuate rigs. Some studies predict that helicopters will be available in only one out of ten events; more optimistic estimates are for one out of four.

Many of the problems that limit the use of helicopters to evacuate rigs are, at present, insoluble for either technological or practical reasons. Helicopters with longer range, anti-icing capability, and better automatic flight control equipment for night and low visibility flying are being developed and should be used as they become available. The time required to reach a rig site and remove a large number of crew members may be shortened somewhat by helicopters with higher speed or greater payload, but unless a helicopter is to be stationed at each rig location and reserved for possible evacuations, a practice that is not deemed to be feasible during the exploration phase, there is no practical way of assuring that helicopter evacuation services will be available on short notice offshore eastern Canada.

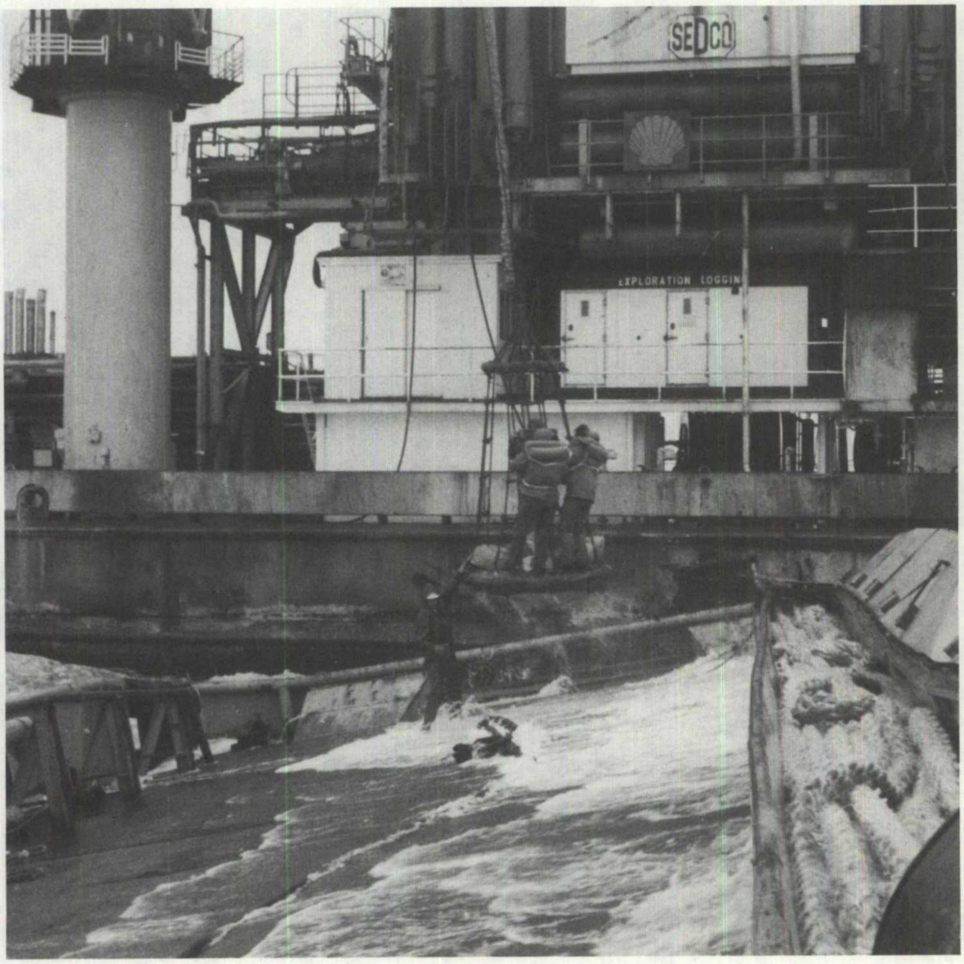
Helicopter flights, whether rescue or routine, are of course subject to inherent risks arising from weather, mechanical problems or pilot error. The risk of a helicopter crash is small, but small, too, are the passengers' chances of survival. Ditching or controlled landing at sea offers a reasonable chance of survival; a Sikorsky S-61, for example, was successfully evacuated after ditching off the coast of Nova Scotia in March, 1985. Incidents in other regions have ended less successfully; the 17 helicopter accidents in the North Sea between 1969 and 1982 involved 157 persons and resulted in 61 fatalities.[3] Escape from a downed helicopter is complicated by the fact that, although most helicopters offer some form of built-in or appended buoyancy, many of these top-heavy craft capsize as they land in rough water. Survivors have, on the average, three minutes to escape from an overturned helicopter and they are then confronted with the task of boarding inflatable life rafts. There are indications that the chances of survival of those involved in a crash or ditching are increased by helicopter underwater escape training (HUET), but improvements in the design of helicopters that operate routinely over water are also needed. Engineering research aimed at increasing the buoyancy and stability of a downed helicopter is to be encouraged. So too are radically new helicopter designs paralleling the dramatic improvements made in other branches of the aviation and aerospace industries.

A second evacuation method is dry transfer – the movement of people from a rig or vessel in distress directly onto another vessel without bringing them into contact with the water. The only method of dry transfer used off the East Coast of Canada is the rig's personnel basket which is lowered by conventional crane to the deck of a standby vessel. Because of the relative motions of the drilling rig and the standby vessel, this mode of transfer involves some risk, particularly in high seas, and is not permitted in the North Sea except in emergencies. If the rig has lost power, electric cranes cannot operate, and dry transfer is no longer an option. This circumstance forced the crew of the *Vinland* to abandon plans for a dry transfer and evacuate the rig by lifeboat after a blowout off the coast of Nova Scotia in February, 1984. Diesel cranes may also present problems if there are combustible gases in the area of operation.

Several systems are under development to improve dry transfer from the rig to the standby vessel. Sliding chutes and telescoping gangways are, at present, subject to weather and sea-state limitations which prevent their use off the East Coast of Canada, but their capabilities may be extended as a result of further research and development. Sophisticated dry transfer systems which propel capsules along wires, cable-car fashion, to dedicated receiving vessels are also being developed, but the expense involved in maintaining a high-technology receiving vessel in a standby position at each rig location may well make their use prohibitive, unless a number of exploration or production facilities are grouped together.

When an emergency occurs and time, weather or circumstances preclude evacuation by helicopter or dry transfer, those on offshore drilling rigs must rely on lifeboats. While size, shape and positioning of lifeboats will vary from rig to rig, they must, by Canadian regulation, have the capacity and potential to provide a means of escape for at least 200 percent of the crew and must be positioned in two different locations on the rig. Generally made of fibreglass-reinforced plastic, these totally enclosed motor propelled survival craft (TEMPSC) are designed to be fire retardant and wave resistant, but recent experience has raised questions about the adequacy of existing standards for the storm-ridden and ice-frequented waters of the Northwest Atlantic.

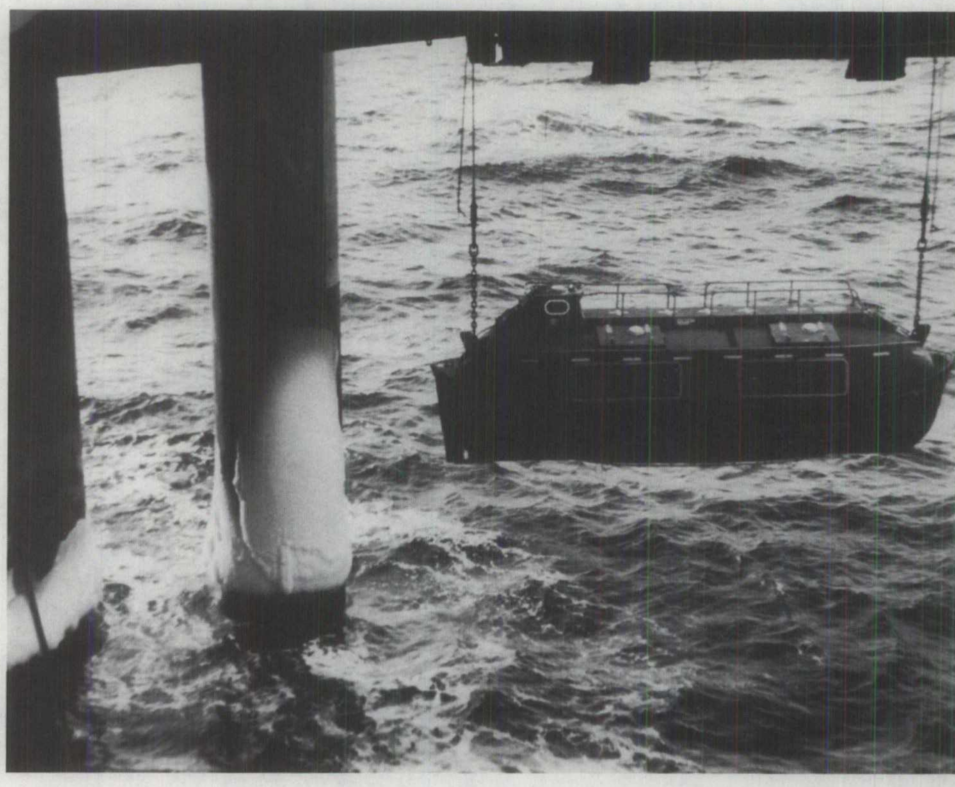
[3]U.K. Civil Aviation Authority Safety Data and Analysis Unit.



8.2 Dry transfer with personnel baskets is often used to move crew members between rigs and supply vessels. This operation becomes increasingly dangerous as sea conditions worsen.

During the public hearings into the loss of the *Ocean Ranger*, evidence was received that the sprayed chopped fibreglass construction often used for lifeboat hulls was contrary to the primary construction specifications of the United States Coast Guard and was permitted only upon demonstration that it would be the equivalent of the required woven roving method. There is little, if any, testing of the actual hulls of lifeboats. The tests are, in fact, carried out on sample pieces of the fibreglass specially fabricated by the lifeboat manufacturer for that purpose. There is not sufficient assurance that the lifeboat hull as a whole will have the same characteristics, a fact which illustrates the need for an effective quality control system. In response to these concerns, existing structural requirements for lifeboats should be re-assessed and more stringent impact standards established.

Another feature of the TEMPSC which has proven inadequate is the arrangement for restraining passengers. The forces to which the occupants may be subjected during lowering and release are dangerously high, and passengers are not adequately protected by the seats and the seatbelts in most current davit-launched models. Tests of current lifeboat designs, conducted at a drop height of 10 feet, showed that peak forces could easily reach 20 times the force of gravity. Figure 8.4 shows the deceleration range that is acceptable for a human passenger, seated in a conforming cushioned seat and restrained by both lap and shoulder harnesses. Without these restraints, serious injury is likely to occur, even at much lower decelerations. These restraints should be required, even though they may reduce the passenger capacity of existing boats by 15 to 20 percent and consequently necessitate the provision of additional ones.



8.3 A conventional, double-fall TEMPSC being lowered into a relatively calm sea. The wire extending from the helmsman's tower at the stern connects to the brake on the davit above, and allows the rate of descent to be controlled from within the lifeboat.

The traditional hazards of launching lifeboats are increased on drilling rigs because of the high freeboards; on the *Ocean Ranger*, for example, the lifeboats were from 70 to 128 feet above the water, according to the rig's draft. Because neither semisubmersibles nor jack-ups are structures that can provide a lee, lifeboats are subjected to the full force of wind and waves during launching. The risk of a lifeboat being blown forcibly against the structure by wind or swept against it by waves is therefore high, and launching problems have proven fatal in several recent rig casualties. In the *Alexander L. Kielland* disaster, only five of the seven lifeboats were launched and none without mishap. A launching mishap took the lives of 36 crew members during an emergency evacuation of the *Anchova* platform off the coast of Brazil in August, 1984. In the *Ocean Ranger* casualty, while the evidence is not clear regarding how many of the three available lifeboats were actually launched, it is clear that none reached the water without serious damage. Current craft are considered unlikely to be launched safely into wave heights over eight metres and wind speeds over 50 knots.[4] The frequency of conditions exceeding these limits off the East Coast of Canada during the months of December to March varies from about 25 percent to 45 percent of the time.

The most hazardous aspect of launching the lifeboat has long been and continues to be the way the craft is released from the falls. The circumstances that lead to the launching of a lifeboat in an emergency are often not conducive to careful, measured action by those involved. People will generally be frightened, sometimes panic-stricken and occasionally injured. It is therefore essential that the release mechanism be as simple as possible, requiring a minimum number of actions and that members of the crew be trained in the launching sequence until they can perform the actions instinctively. It is also essential that there be little or no possibility of misoperation or mechanical malfunction of either manual or automated release systems. A striking

[4]Hollobone, Hibbert and Associates. *Assessment of the Means for Escape and Survival in Offshore Exploration Drilling Operations*. June, 1984.

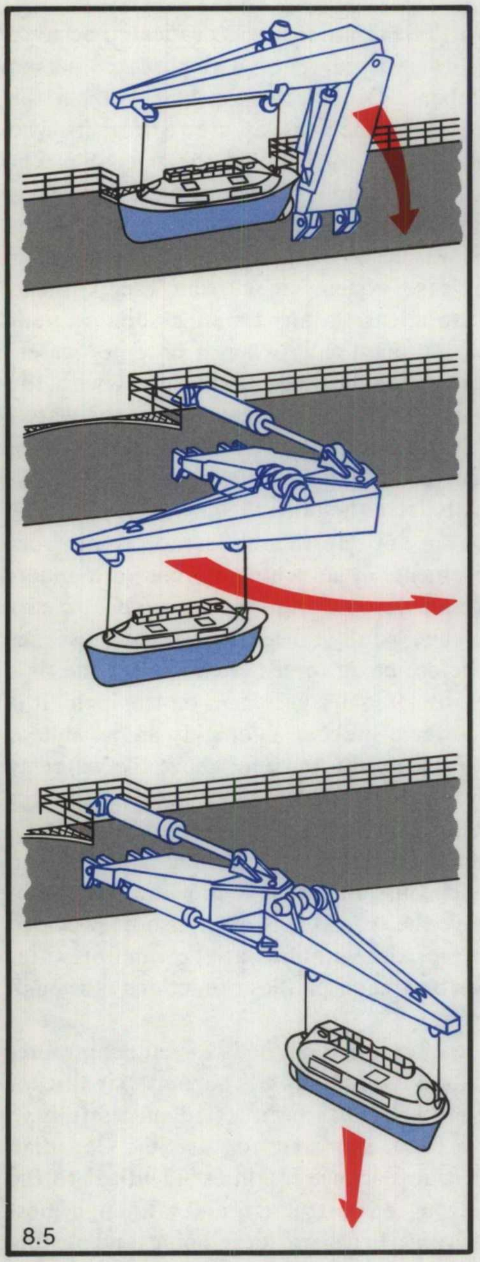
illustration of this point occurred when a North Sea platform was evacuated because of an explosion and fire in 1975. The platform was equipped with three 28-person emergency capsules and a conventional lifeboat. Two of the capsules were in the middle of the fire zone; the third was boarded by the first six crew members who reached it. They attempted to launch immediately, mishandled the release mechanism, and the capsule plunged into the sea, killing three of the occupants and seriously injuring the other three. The remaining 64 people evacuated the rig successfully in the conventional lifeboat even though it was designed to hold only 50 persons.

There are two main categories of release systems in current use. On-load devices permit the occupants of the lifeboat to release at any time including in mid-air; off-load mechanisms release the lifeboat automatically when it becomes waterborne, although there is generally a critical period between first contact with the crest of a wave and the point at which the craft is actually supported by the water. Many launching systems involve double or twin falls. In this case both falls must be released simultaneously; if one fails, as occurred during the *Alexander L. Kielland* evacuation, the boat is left suspended vertically from the other.

Although lifeboats may never provide an entirely reliable escape route from offshore rigs during stormy weather, improvements in launching methods are underway and are long overdue. The basic problems are ensuring that the lifeboat clears the rig's structure during lowering; that it is successfully released; and that it escapes from the vicinity of the rig to the open sea before being forced back against the rig's structure by wind and waves. Although there is some disagreement on the issue, it is now generally considered advantageous to lower a lifeboat as quickly as possible to minimize the chances of impact, and then to release it a few feet above the water by means of an on-load release mechanism. Rapid lowering on winches followed by a short free fall would require several major design changes in the typical TEMPSC. These would include strengthening the basic structure, restraining the passengers to protect them from decelerations which could cause injury, and providing for automatic release at a predetermined height above the sea. Means must also be provided to trigger this automatic release and to reduce decelerations at the time of water impact. Devices have been developed to perform each of these functions, although testing has tended to be under ideal conditions.

Several new developments may provide alternative methods for launching lifeboats which are safer than the traditional davits and falls. The most significant appears to be the Norwegian free-fall lifeboat which has been tested successfully in nine-metre waves and which has recently been approved for use by Canadian authorities. The free-fall lifeboat in outward appearance is almost identical to the conventional TEMPSC. It is, however, of stronger construction and, although most are built of fibreglass-reinforced plastic, several firms are developing and testing steel and aluminum models. The free-fall lifeboat is stored perpendicular to the rig's perimeter and launched by being dropped either vertically, usually from a fixed platform, or along a short skid at about a 35 degree downward angle which propels the craft away from the rig after it enters the sea. Skid-launched boats have been tested successfully from a height of 20 metres and the vertically dropped steel model from 30 metres. The lifeboat is released from inside and falls free by gravity. The occupants are strapped firmly into padded conforming seats so that the deceleration forces on their bodies are evenly distributed when the boat hits the water.

Other improvements in lifeboat launching technology include articulated davits which extend the lifeboat outward from the platform and rotate it to a perpendicular position relative to the rig for lowering (Figure 8.5). Hydraulically controlled launching systems, for example, suspend the lifeboat from the top of a long beam which is hinged at its lower end to the structure of the rig (Figure 8.7). When the beam is activated for a launch, the weight of the lifeboat pulls it outward and away from the rig's structure; the boat is then launched by lowering it from davits but



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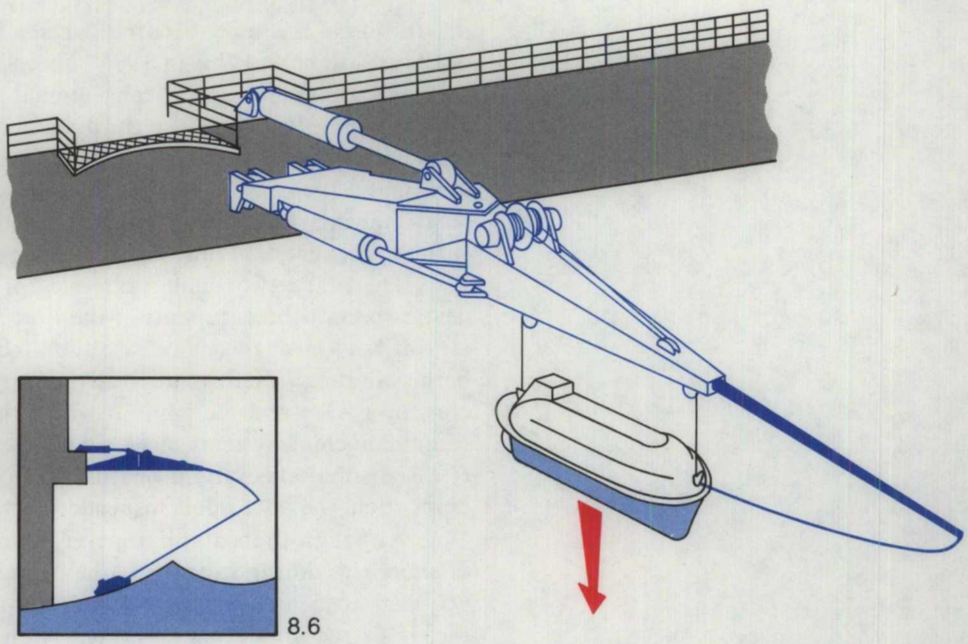

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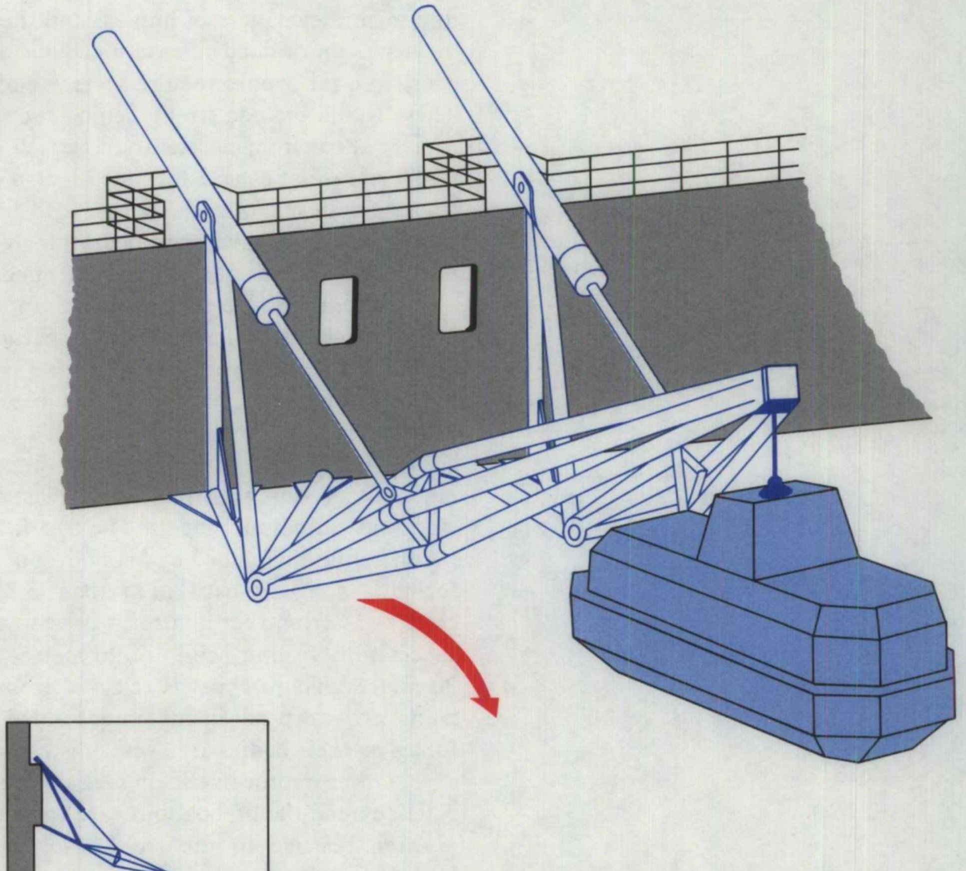

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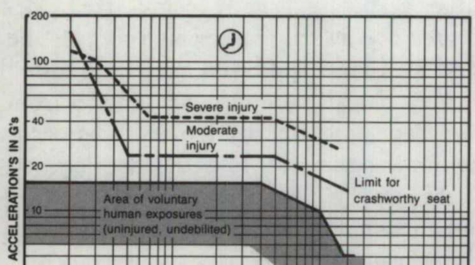

ACCELERATION'S IN G's
200
100
40
20
10
4
2
1
.001
.002
.01
.02
.1
.2
.4
.6
.8
1
DURATION OF UNIFORM ACCELERATION SECONDS
Severe injury
Moderate injury
Limit for crashworthy seat
Area of voluntary human exposures (uninjured, undebilited)

8.4

8.4 The graph (lower left) shows the duration and magnitude of headward acceleration and the consequent effect on the occupants of the lifeboat. The graph was developed from specifications issued by the United States Air Force, and presumes padded, conforming seating and a four-point restraint harness.

8.5 The Debarkosafe articulated davit developed in Norway orients the TEMPSC perpendicular to the rig's perimeter and extends it beyond the structure to lessen the probability of impact.

8.6 The Watercraft PROD system, illustrated in conjunction with the articulated davit, guides the TEMPSC away from the structure after launching. The PROD system may also be used with a conventional davit to pull the TEMPSC into the perpendicular orientation during launching.

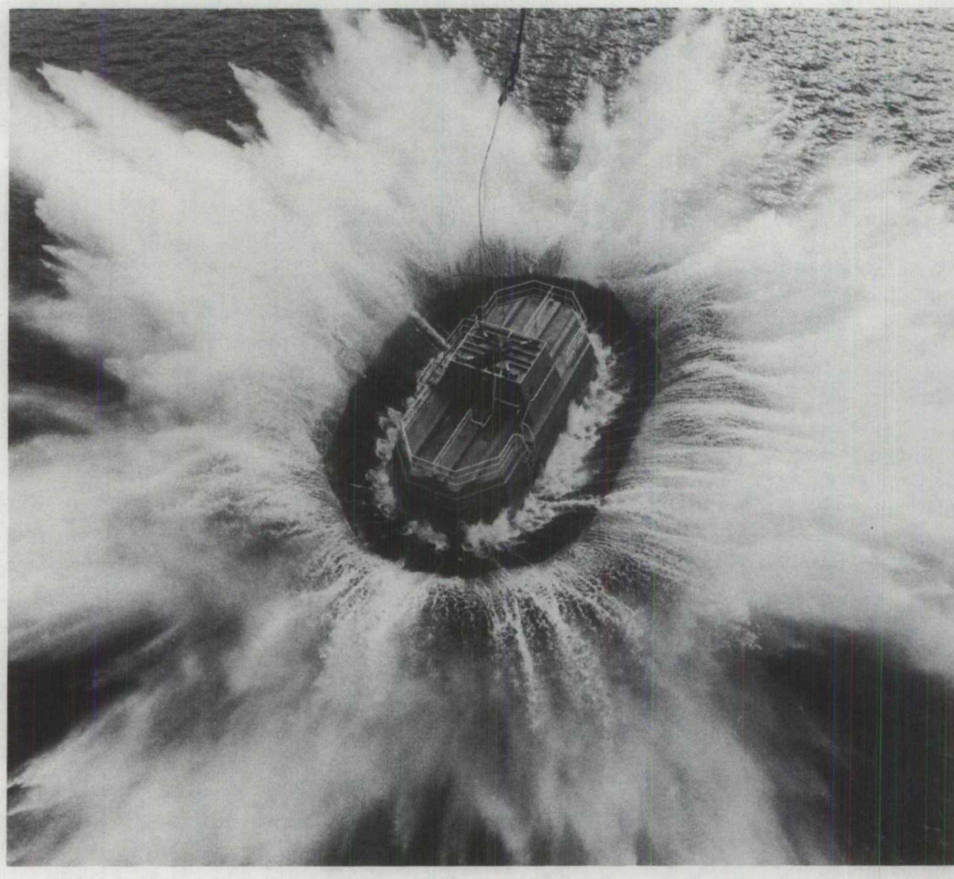
8.7 The launching system developed for the Götaverken Arendal/von Tell Nico Lifescape utilizes a pivoting A-frame beam lowered under hydraulic control. The Lifescape is extended approximately 8 to 12 metres from the rig, and is released to free fall from a height of approximately 8 metres.

from a level well below the rig deck. One recent use of this type of launching mechanism is the Lifescape system developed by Götaverken Arendal AB and von Tell Nicoverken AB. A capsule made of steel and capable of accommodating up to 125 people forms a safe haven on board the rig during an emergency and is released only as a last resort. The capsule is then lowered, extended and dropped a short distance into the sea. While the Lifescape offers considerable promise, it awaits regulatory approval and may not become commercially available for some time. The preferred orientation and displacement (PROD) system designed by Watercraft also rotates the lifeboat to point away from the rig in the course of the lowering process. One end of a tag-line is attached to the bow of the lifeboat and the other to a flexible boom which is fixed to the platform or to an articulated davit. This line keeps the lifeboat perpendicular to the rig's perimeter when it reaches the sea and pulls it away from the rig until the craft overshoots the flexible boom and the line is automatically released.

The practice of installing lifeboats perpendicular to the rig's perimeter has become more prevalent since the loss of the *Ocean Ranger*. This procedure ensures that the lifeboat will not have to turn under power in order to head away from the rig. Lifeboat engines are usually required to achieve at least six knots, the minimum speed needed to make headway in heavy seas. But more important than maintaining a certain speed while underway is the need for an initial acceleration that can take the lifeboat rapidly away from the rig. Existing lifeboat engines should be modified or replaced to meet this requirement.

Few of these innovations for improving lifeboat launching systems for offshore use have been tested in the storm conditions of the North Atlantic. Model tests for free-fall systems have been favourable, as have drops in calm, harbour waters, but these are not an adequate substitute for testing offshore under varying conditions. What is needed is a commitment by all those who will benefit from substantial improvements in escape systems, and a full field-testing program using an operating platform, a recovery vessel, lifeboats and instrumented manikins, all of which may be required for a considerable period of time. This process could well be combined with the existing operations of a drilling rig, so that neither the rig nor the recovery vessel is dedicated exclusively to the testing. But whatever the method, testing must be done, and new systems refined, approved and put into use before we are reminded, yet again, of how vulnerable are the means of escape now provided to those who work offshore on our behalf.

Once a lifeboat is successfully launched, the emphasis turns to its survival and recovery. Access to the TEMPSC is by the several hatchways on each side and one or more at the top, the size of a manhole, for emergency exit. Rescuing survivors from an enclosed lifeboat by helicopter hoist is generally considered too hazardous to attempt in all but exceptional circumstances. Recovery must therefore be by vessel but the transfer of survivors is always problematic. The exterior of the TEMPSC is difficult to walk on, particularly if it is iced, and the differences in size and motions between the lifeboat and the vessel makes the transfer in rough or even moderate seas highly dangerous for healthy survivors and virtually impossible for the injured. There have been several fatal incidents involving loaded lifeboats under tow. It is usually considered safest, therefore, to leave survivors in a TEMPSC under its own power, until the weather abates or a lee can be provided. In many areas off the East Coast of Canada, this delay may extend to many hours or even days. During the evacuation of the *Vinland*, the crew spent about eight hours in the lifeboats, until they reached the lee of Sable Island and could be transferred to supply vessels. The interior design and outfitting of the typical TEMPSC makes prolonged occupancy uncomfortable, debilitating and potentially dangerous. The seats are uncomfortable, heating and ventilation are poor, the interiors are noisy, communications and emergency system controls are often inaccessible and poorly designed for use by persons



8.8 The Lifescape, undergoing full-scale prototype free-fall testing. In order to protect the occupants from the effects of acceleration, the Lifescape incorporates padded, conforming seats and four-point restraint harnesses.

wearing abandonment suits, and there is inadequate provision for the seasick and the injured and none for stretcher cases.

Regulations governing drilling rigs require that life rafts be provided as an alternate means of evacuation to the TEMPSC. The traditional raft which is thrown overboard and inflated serves very little purpose on a high freeboard drilling rig; to expect the crew, particularly when clad in bulky abandonment suits, to climb down scramble nets, swim to the life raft and clamber aboard is not realistic. Recent regulations require that life rafts be davit-launched from rigs. They are inflated and boarded on the deck and launched from a davit or crane by a single wire. Though they are far superior to the throw-overboard type, these rafts are inferior to the TEMPSC as a means of evacuation. During the launching process, the raft is subject to the same forces of wind and wave as the lifeboat, but its lighter weight and construction give it less resistance. Because it has no means of propulsion, the direction of its travel cannot be controlled after release from the rig and there is high risk of wind and waves smashing it against the structure.

Life rafts also lack fire protection and are not as sturdy as TEMPSC. Although the evidence in the case of the life rafts from the *Ocean Ranger* is not conclusive, there are legitimate grounds for concern that a life raft, built to United States Coast Guard standards, is not sufficiently sturdy to survive a severe storm on the Canadian East Coast. Even though life rafts will remain as secondary evacuation systems for rigs, they are the only escape devices for downed helicopters. Improvements are needed both in the construction of life rafts and in the methods used for launching them from offshore structures. Water-filling keel pouches, which are readily available, would provide a major improvement in stability in storm seas; materials and methods of joining the fabric could be improved to strengthen the raft and maintain its structural integrity in storm conditions; and immediate consider-

8.9 Basic training in the use of abandonment suits and life rafts under realistic conditions is an important facet of emergency preparedness. Evacuation directly into the sea, however, is regarded as the least favourable of existing evacuation methods.

ation should be given to the use of fire and heat resistant materials in life raft construction. There should also be improvements in the means of boarding the raft from the sea as the agility of survivors in the water may be considerably constrained by abandonment suits, hypothermia, and exhaustion.

Abandonment suits and personal flotation devices or life jackets, in their present form, are not considered a means of escape from a drilling rig; rather they are used to extend survival time in the water or in a lifeboat or life raft until rescue arrives. The question of how long a person can survive in the waters off the East Coast of Canada is much debated, but the figure is probably several hours with an abandonment suit, varying with the location, many physiological characteristics of the individual, the type of suit involved, and the clothing worn under it. Survival time without a suit is probably several minutes. While abandonment suits do protect survivors from hypothermia for at least a minimal period, they vary considerably in effectiveness. Some float the wearer in a more or less horizontal position, either face up or face down in the water; some have hoods that trap water in front of the wearer's face; many are not watertight because of leaks around neck seals and other areas; most lack handholds for recovering survivors from the sea after they have been located and all are ill-fitting and bulky enough to hamper manoeuvrability and manual dexterity. Despite these inadequacies, abandonment suits are obviously necessary and attempts should be made to improve their utility. Dramatic innovations are needed; heat reflective fabrics, for example, are being developed which will release moisture in one direction yet be impermeable to water penetration in the other. Until such developments are introduced, however, short-term measures for improvement must be adopted and remedies found to the problems listed above so that abandonment suits become more watertight, better fitting, easier to grasp, and less restrictive to movement (Appendix D, Item 2).

On a clear, warm, windless day in a calm sea, any of the existing methods of rig evacuation can be carried out successfully, even direct entry into the sea. Unfortunately, the chances of an emergency occurring during ideal environmental conditions are slight and any realistic appraisal of evacuation capabilities must allow for "worst possible" conditions. Evacuation following a blowout or fire may occur in any weather; evacuation due to storms or ice will probably occur in environmental conditions that are extremely unfavourable. Since the loss of the *Ocean Ranger*, there have been no significant improvements in the quality of escape systems in place on drilling units off eastern Canada. Admittedly there are now lifeboats for 200 percent of the crew, abandonment suits are mandatory, life rafts must be davit-launched and some lifeboats are stored perpendicular to the unit. These improvements, though commendable, do not ensure the safe evacuation of a rig under the conditions that prevailed on February 15, 1982, when the *Ocean Ranger* capsized. Real improvement of survival systems for offshore workers will require short-term equipment modifications of the types reviewed above, and significantly higher long-term priority in the planning and expenditures of both industry and governments.

The basic problem to be solved in designing and regulating evacuation systems for offshore rigs is the conscious determination of an acceptable level of risk. This process would require a realistic assessment of the risks involved in existing systems, a considered plan for diminishing them and a frank admission that there must be some residual level of risk in any escape and survival system operating in these environmental conditions. The acceptable level of risk and the definition of an adequate evacuation system for offshore must, ultimately, be determined by the state. Regulatory authorities and classification societies, over a lengthy period, have developed standards for the design, the construction and the equipment of drilling rigs which have met an acceptable level of safety and which, if operated by a well-trained and competent crew, should function safely in anticipated environmental conditions. This does not mean that drilling rigs will not be involved in accidents, or cannot sink. It means that the risk of their doing so is considered acceptable. But this does not relieve the state of the obligation to its citizens to ensure that action is taken to protect them, if the rig should, in fact, be evacuated or lost.

"Problem areas are widely recognized; it is reasonable to ask what is being done about them. In Norway, the response has been a major government-funded research and development project which has resulted in what is now the Harding free-fall lifeboat. There are some critical comments which can be made regarding this new system. Nevertheless, at this point in time, it is probably the best available solution to the escape and survival problem. Manufacturers of the conventional totally enclosed motor propelled survival craft (TEMPSC) have, on the other hand, tended to work on parts of the problem with the intention of improving existing systems. Nevertheless, no major new system development seems to have been initiated."

C. Shaar, Escape and Survival. Safety Offshore Eastern Canada Conference Proceedings, 1984

The offshore petroleum industry has faced and overcome the problems associated with exploring for and producing oil and gas under major environmental constraints because, without these solutions, exploration and production could not take place. Thus when a rig is being built, such equipment as telescoping risers, drill-string motion compensators, and in some cases dynamic-positioning equipment are deemed essential to the rig's mission and therefore worthy of the latest innovations that technology has to offer. The evacuation system does not meet that same criterion of being essential nor does it elicit the same response. Rig owners and operators contend that they install the best equipment available and ensure that it meets regulatory requirements. Rig designers contend that they design drilling rigs, not evacuation systems. Lifeboats and davit manufacturers lack the incentive and the capital to develop technologically innovative systems and instead make marginal improvements to existing lifeboat designs that will maintain their competitive standing in the marketplace while remaining consistent with regulatory requirements. The current *Canada Oil and Gas Drilling Regulations* for mobile offshore drilling units require that "Every drilling unit carry emergency equipment and lifesaving devices sufficient in number to permit the escape of all persons from the drilling unit under any conditions that may reasonably be anticipated." Conditions have, in fact, occurred in which the lifesaving devices were clearly inadequate; these conditions can be anticipated to occur again; the regulatory criteria, even in their general form, are therefore not being met. Lack of funding, of priorities, of incentives and of regulatory control have all combined to allow a defective system to continue.

The ultimate responsibility for remedying this situation and for providing the type of incentives that have led to dramatic technological advances in other fields rests with the state. Although some government-sponsored research and development in escape and survival systems has been carried out in Canada, the level of funding falls far short of the need. The source of the greatest effort in the development of new evacuation systems has been Norway, the smallest country engaged in offshore drilling. Research and development there has been funded by both government and industry. In the United States, the United Kingdom and Canada, few incentives exist and even when industry or the lifeboat manufacturers do take the initiative to develop new systems or improve existing ones, the testing procedures and regulatory approvals are so lengthy, costly and cumbersome that many good ideas never advance beyond the design or prototype stages. The regulatory system thus operates to impede rather than to encourage development.

Government should set performance standards for lifesaving equipment and require that industry comply with these standards within a given period of time. This step should initiate a concerted program of research and development which may lead to a long-term resolution of the problem within the coming decade. Success will follow if the regulatory requirement is firmly formulated and if the research and development effort is adequately funded. This process should begin now.

Recent developments have essentially been improvements in the lifeboat rather than new ideas. Perhaps what is now needed are breakthroughs, and radically new concepts. The industrial world has marvelled at the ingenuity employed by the offshore oil industry in taming environmental forces and harvesting the seabed for man's productive use. Costs, while a consideration in reaching these goals, did not seem to impede progress. It is possible to achieve the same dramatic improvements in offshore evacuation systems; the technology that put man on the moon can surely meet the challenge of taking him safely off an ocean-based drilling rig. It took the *Titanic* disaster in 1912 to outrage society to the point that improvements were made in safety systems at sea, improvements that included lifeboats for 100 percent of those on board. It took the combined tragedies of the *Ocean Ranger* and the *Alexander L. Kielland* for countries controlling North Atlantic drilling areas to insist on abandonment suits for everyone on board and lifeboats for 200 percent of the crew so that rigs could be evacuated from alternate locations. In view of the technological advances that have been made in medicine, communications, aerospace, and engineering during those 70 years, one cannot help but question the level of commitment and motivation behind the comparative rate of progress in the evolution of marine safety equipment. There is a pressing need for systems that are simple, reliable, and above all, safe, to move people off a rig in distress in Canada's storm- and ice-ridden eastern waters; there is then a need for rescue systems that will find them, succour them and bring them safely home.