17 Management of Fuels and Hazardous Substances

There is a great tendency to underestimate the magnitude of the problems associated with the storage and handling of fuels and hazardous substances that will be used during construction and operation of a natural gas pipeline. From the evidence before me, it appears that the pipeline companies have not given this problem the kind of consideration that it warrants. This causes me some concern, because casual handling of these substances could pose extremely serious risks to the northern environment.

The problem centres on the storage and handling of the various fuels that will be transported in bulk to power the machines necessary to build the pipeline and to support the enormous infrastructure necessary to feed the construction process. But it also involves other substances, such as lubricants, solvents, alcohols, paints and a host of other chemicals in a variety of forms. Moreover, if methanol is the antifreeze in the water mixture used to test the pipeline under pressure when it is completed, large quantities of it will have to be transported north and stored there. The specific problems associated with the use of methanol in testing the pipeline are dealt with in the chapter entitled Pipe Testing.

Hazardous and toxic substances are defined in the Environmental Protection Service's publication *Code of Good Practice for Management of Hazardous and Toxic Wastes at Federal Establishments*, to include any product or substance that is or contains a poisonous, toxic, inflammable, explosive or corrosive product or any substance of a similar nature that, upon release or escape to the environment, may cause or may contribute to a harmful effect on the environment and on human health and safety. Liquid and solid municipal wastes, non-toxic and non-hazardous commercial and industrial solid waste, and construction debris, are not included in this definition. They are dealt with in the chapter entitled Waste Management.

The management of fuels and hazardous substances involves two aspects that must be addressed properly from the outset: first, to avoid spills by careful and comprehensive planning, and, secondly, to minimize environmental damage caused by spills by putting effective contingency plans into action. I wish to emphasize these two issues in this chapter.

Arctic Gas estimated in their application that they would use about 100 million Imperial gallons of fuel and methanol during the construction of the proposed pipeline. Foothills would use quantities of the same order of magnitude. In addition, both companies would use large quantities of other hazardous and toxic substances that could cause substantial damage if they escaped into the environment.

The transportation of fuel and other hazardous substances, whether by rail, air, road, barge or ocean-going ships, and their storage will use both existing and new facilities owned by the Company itself and by non-Company interests. A variety of standards and types of equipment will be used: for example, small volumes of fuel (up to about 1,500 barrels) will be stored in bladder tanks; but steel tanks may be used instead of, or in combination with, bladder tanks for larger quantities (up to about 5,000 barrels). Final selection of tank type will depend on several factors, including volume, length of storage time, and availability of land. Vehicles will transport fuels and other substances from the bulk storage areas to worksites located throughout the project area. During the operation of the pipeline, fuels will be stored at facilities along the right-of-way.

I have heard a great deal of evidence about the threat posed by spills of fuels and other hazardous substances during the construction and operation of a pipeline. Many expert witnesses at the formal hearings testified on environmental aspects of the project, and many people at the community hearings predicted major damage to waterfowl, aquatic mammals, fish and the native people's traditional pursuits, if spills occur. This threat is real, particularly if a spill occurs in the Delta or along the Arctic coast.

The evidence from the hearings, the technical literature and actual world experience show that oil and chemicals, once spilled in water, cannot effectively be cleaned up unless exceptionally calm, temperate conditions prevail at the time of the accident. These conditions are very seldom present in the North. As I emphasized in Volume One, the evidence

demonstrates that we do not have the technical ability to clean up major spills in arctic conditions. Every effort must, therefore, be made to avoid spills.

Fuel spills occurred during the construction of the Alyeska oil pipeline. Gilbert Zemansky, who was engaged in monitoring its construction, informed the Inquiry that there were at least three major oil spills: in 1974, a seam on a bladder tank at the Toolik camp site burst and spilled more than 100,000 gallons; between February 1975 and spring 1976, chronic leakages in buried fuel lines at the Galbraith camp site lost between 100,000 and 600,000 gallons; a similar situation was reported at the Prospect camp site, where over 40,000 gallons leaked into the environment (Zemansky, 1976).

I said in Volume One that the extremely large volume of petrochemicals that must be moved and stored during pipeline construction will make spills inevitable, despite the best planning. This issue was given special consideration in the Pipeline Guidelines, yet the plans the pipeline companies laid before the Inquiry were vague on the subject of what must be done to prevent spills. Some attention has been given to contingency plans, but they are still in the most rudimentary stage of development and they do not answer the problem.

The Limitations of Spill Control

I have heard a good deal of evidence on the need for thorough contingency planning. But such planning is for the purpose of developing an emergency response to an environmental hazard that has already become reality. I have heard very little evidence on spill prevention, despite the fact that is the means – indeed, the only means – to a successful resolution of the risks associated with the use of fuels and hazardous substances on the pipeline project.

It must be clearly understood by everyone who may be concerned with the construction, operation and regulation of a gas pipeline, that petrochemical spills will occur, that the technology for dealing with petrochemical spills is in its infancy, and that, as a consequence, some level of damage to the environment will result.

We know from experience in more temperate regions that, once a spill has occurred, the clean-up operation is very difficult, if not impossible. In the North, the problems of clean-up are far worse. Remoteness and the great distances between centres of activity and supply will seriously affect the efficiency of any clean-up operation. These distances will complicate communications, delivery of clean-up supplies, the feeding and housing of clean-up crews, and the repair and servicing of clean-up equipment, and these problems are only a beginning of the difficulties.

The deployment of men and equipment in low temperatures, through broken and moving ice, in stormy seas, darkness and permafrost conditions may be difficult to the point of impossibility. In winter, fuel and chemicals will run under the ice or, if spilled on the ice, will leak through cracks and between blocks and fissures. An ocean or river current (the Mackenzie River averages approximately three miles per hour) will disperse a spill over a considerable distance in a short period of time. Booms to contain spills are relatively inefficient in currents, waves and ice. Many northern rivers, including the Mackenzie River, are subject to flash floods in summer: after a heavy rain, perhaps far upstream, the river rises quickly with an attendant increase in current velocity. Water levels fall rapidly after a flash flood, and in such circumstances a spill might be widely spread over soft mud on the river's banks. These areas, the tidal flats of the Beaufort Sea, and the low, marshy terrain of the Mackenzie Delta would be difficult or impossible to clean up.

Barges will carry tens of millions of gallons of fuel oil during the short shipping season on the river, the equipment available will be used intensively, and in places there will be transfer operations in fast currents, poor weather conditions and darkness. The barges now used on the Mackenzie River to transport fuel vary in design, age, size, equipment and in the lay-out of their piping and pumping systems. These variations create a further potential for accidents, and the likelihood of spills will be still further increased if inexperienced personnel have charge of equipment to transfer cargo.

There is the very real possibility that the huge cost that would be incurred in the clean-up of a remote area would be used as an argument for leaving the area to recover naturally. This has happened elsewhere. But, in the North, natural recovery is extremely slow and, therefore, the impact of oil pollution on northern species and northern ecosystems is likely to be more devastating than in more temperate climates.

Risks to the Environment

There have been several studies of the effects of oil and chemical spills on the environment. Conclusions differ widely, and many of the mechanisms involved in chemical and oil toxicity are not understood. Petrochemical spills may involve different compounds, and the threat of pollution may come from the slick itself or from the toxic effects of petroleum fractions or chemicals. In an aquatic environment, some hydrocarbons and chemicals will float to the water surface, others will settle to the bottom; some are soluble, and many volatile components of the spill will evaporate.

In Volume One, I outlined the general impacts that might result from the spill of fuels in the North. The most visible effects of a spill on wildlife will be seen on sea-birds and waterfowl. Oil will mat the feathers so they can no longer function for flight, water repellency or insulation, and the birds affected generally die by drowning or from exposure. Birds are also harmed by the toxic effects of oil when they ingest it by preening oil-stained feathers. The enormous flocks of the migratory birds that use the Mackenzie Valley and

Western Arctic are vulnerable to this disaster. The threat is not confined to spills that occur during the summer, when the birds are present in the region. A spill in winter would probably persist and affect the environment used by these birds for many years.

There is conflicting evidence on the effects of oil on marine and aquatic mammals. Contamination of restricted areas, such as whale calving waters, seal haul-out sites, and muskrat and beaver ponds, could have a serious impact on the populations that use these locations. Polar bears could also be affected.

Effects on aquatic organisms are generally more subtle, and might not be visible to the casual observer. Aquatic organisms may be killed directly by coating and asphyxiation, by contact poisoning or by exposure to water-soluble toxic components of the spill. Juvenile forms are generally more sensitive and vulnerable than adults. The higher species in a food chain may be affected by destruction of their food resources lower down the chain. The ingestion of sub-lethal amounts of oil or of oil products into aquatic organisms can result in reduced resistance to infection and other stresses, the destruction of the food value of fishery resources, and the incorporation of carcinogens into the marine food chain and into fish used for food by the local people.

Oil can kill salt-marsh grasses, seaweeds and freshwater vegetation, leading to a loss of food and habitat for wildlife and aquatic organisms and, if extensive enough, to the erosion of sediments normally held in place by the roots of these plants. Once contaminated, vegetation is extremely difficult to clean. It generally takes two, three or more years in temperate regions for heavily oiled vegetation to recover its former productivity.

The threat to the aquatic environment comes not only from fuels, but also from a host of other hazardous and toxic substances that will be used on the pipeline. Substances such as the wide variety of lubricants necessary on the project and chlorine, which is used to treat drinking water and waste-water, could present a threat to the aquatic environment if they are not carefully handled.

In addition to the biological effects of petrochemical pollution, there are many non-biological effects that should also be considered because they could have an economic or aesthetic impact on an area. Boats, wharfs and fishing gear might be fouled. The recreational possibilities and the tourist industry in a spill area might be seriously affected for a long period of time. Water supplies could be contaminated, and specific-status land areas, such as parks, ecological reserves and lands and waters used by native peoples in their traditional pursuits, could be spoiled.

Implications

The problem of oil spills during the construction of a gas pipeline is important because of the very large amounts of fuel and chemicals involved and because the means to control spills in northern waters are inadequate. The prospect of other petroleum-related developments in the region makes the threat of long-term adverse effects on the environment all the more serious.

Granted, government and industry are now spending millions of dollars on research that focuses primarily on clean-up technology for oil spills. It is urgent and vital work, but we must never forget that, in the design, construction and regulation of a pipeline, the emphasis must always be on prevention.

A Management Plan

Commitment to a Plan

The plans for fuel storage and handling and for spill prevention and control that the pipeline companies presented to the Inquiry are, at best, rudimentary. A great deal more work will be required to produce plans that are acceptable.

The drilling program in the Beaufort Sea has given some impetus to improving the state-of-the-art, with particular emphasis on clean-up measures to be taken in arctic marine environments. Since the Inquiry hearings ended in November 1976, an intergovernmental task force has developed contingency plans for a major oil spill in the Beaufort Sea, and the Department of the Environment has drafted contingency planning guidelines for spills from oil and gas pipelines.

These plans, however, are mainly concerned with the organizational aspects of a response to an oil spill: the prevention of spills seems to be receiving less attention. I think my most effective contribution is to specify preventive measures that should be imposed on the pipeline project, because prevention offers the best means of protecting the environment.

Because so few regulations to prevent spills are now in force, and because the work of the pipeline companies on this subject is inadequate, despite the specific requirements of the Pipeline Guidelines, I deem the following recommendations to be essential from the commencement of the project.

Overall Plan

To deal adequately with the handling, storage and clean-up of fuels and hazardous substances that may be spilled, the Company and the Agency must come to terms with a host of complex and interrelated considerations of engineering design, construction and operating measures, environmental disciplines and socio-economic factors. A comprehensive

approach of this nature goes far beyond the pipeline companies' present submissions. The Company and the Agency must agree on an overall plan that will specify precisely the approach to be taken at each stage of the design, construction and operation of the pipeline and its related facilities.

1. Before the final design phase, the Company shall prepare for approval by the Agency an overall plan for the transportation, transferral, storage, use and disposal of fuels and other hazardous substances that will be used during the construction, operation and abandonment of the pipeline and all related facilities used by the Company. The overall plan shall emphasize the need to prevent spills and to control fuels and hazardous substances. It shall demonstrate that facilities and handling equipment will be designed, and personnel will be trained, to minimize the risk of spills. It shall also demonstrate that, during construction and operation of the pipeline, products will be transported, transferred, stored, used and disposed of in ways that will most effectively protect the environment; and that there will be effective contingency plans and trained personnel available to deal with spills that do occur, both at the site of the spill and in other areas that may be affected. The overall plan shall outline training programs for Company personnel who handle hazardous or toxic materials.

Subject to the direction of the Agency, the overall plan shall, as far as possible, be in cartographic form, and shall take into account, by means of overlays or other graphic techniques at the same scale or by notations, the other overall plans requested elsewhere in this report. The Agency may request the Company to resubmit parts of this plan if, for any reason, they do not meet with its approval. The Company shall undertake to keep the overall plan up to date so that it reflects the latest policies and actions of the Company, the Agency and government.

2. The overall plan shall specify the physical and biological aspects of the environment that must be protected to safeguard the living resources along the pipeline corridor from possible spills of fuels or hazardous substances. It should show, for example, waterfowl and sea-bird concentration areas, habitat for rare and endangered species, and fish spawning and overwintering areas along the pipeline corridor and transportation routes. It should also show locations of communities and of hunting and fishing areas and camps; locations and times of use of all domestic, commercial and sports fishing sites; locations and boundaries of all existing and proposed parks, International Biological Programme sites, bird sanctuaries and other ecological reserves; locations of archaeological or historic sites; locations of all harbours for small craft or areas in which they are used, docks and landing sites for marine vessels, and designated landing and take-off areas for floatplanes; and locations of water intakes for temporary and permanent domestic and industrial use, as well as those used for pipeline construction.

In addition, the overall plan shall indicate general locations and periods of use of all transportation routes and storage areas for petrochemical and hazardous and toxic substances, and the volumes of these materials to be moved along various routes and stored at the various locations by season. An outline indicating the inspection and construction requirements for all transportation systems and transfer and storage facilities, whether they are owned by the Company or not, should be provided.

The overall plan shall also list all hazardous and toxic substances to be used, and provide details of the name, properties and use of each substance, the volume, the toxicity data (if available), the proposed method of packing, transporting, transferring and stowing for each substance, and the proposed method of disposing of it.

3. The overall plan shall be approved by the Agency before site-specific applications are submitted for facilities at which fuels or hazardous substances will be handled, used or stored.

Site-specific Information

4. The Company shall file with the Agency, as part of its site-specific applications for construction and operation of project facilities, site-specific information relating to the transportation, use and storage of fuels and other hazardous substances. This information shall include designs for fuel and chemical storage facilities, transfer equipment, and transportation vessels and vehicles owned or used by the Company. Site-specific information for storage facilities shall include a summary of the physical and biological environmental conditions in the area surrounding the installations; a complete set of detailed engineering drawings; a complete set of operating standards, including volume through-puts, number of operating personnel, period of use, expected life of the installation, abandonment criteria, environmental protection criteria and environmental restoration plans. Site-specific information shall also include an operation procedure manual for each spread and for each transfer depot and storage facility.

Site-specific information shall detail specific contingency plans for each spread and for accidents that could occur along transportation routes, as well as specific measures to maximize the chances of cleaning up spills on land rather than on water. To handle spills that do escape into watercourses, plans shall be developed that give first protection to areas important to aquatic birds, fish, marine mammals and human use.

The Agency must approve the location and extent of the areas in which spilled liquids and contaminated materials, such as earth, natural and synthetic absorbants and driftwood, are deposited.

The preparation of the overall plan and of the site-specific information necessary for the submission of site-specific applications will be major undertakings and will require the

detailed specification of designs and procedures and a comprehensive understanding of a wide range of biological and socio-economic factors. The responsibility for preparing the information clearly lies with the Company, but the Agency will also have a major task in assessing the plan.

Spill Prevention

To assist in the preparation of a sound spill prevention program, I have developed a comprehensive set of recommendations based on the final submission of Commission Counsel and the information provided by other participants at the Inquiry.

In making these recommendations, I endorse the use of very specific numerical values. It has been argued that this approach is too restrictive and that, instead, a best judgment based on site-specific features by professionals should be made at each location. I reject that approach because, in view of the scale of the project and the time involved, it is simply not practical. In my opinion, the most practical approach for the pipeline project is the adoption of standards that are easily understood by all concerned: the designer, the executive, the inspector, the biologist and the transportation and pipeline contractors. Cases that require special attention can, of course, be dealt with on an individual basis. If the specified recommendations are unsuitable in a particular case, the Company must document the situation and clearly specify alternative measures, which the Agency can then assess and approve or reject. So far as the Company is concerned, this procedure will involve about the same work that would be required for a best judgment by professionals. The difference is that specific requirements support a general standard, and best judgments, by themselves, may not.

The recommendations read like a safety program, and with good reason. Personnel must be continuously trained and supervised to ensure that they are following sound practice to prevent oil spills. The location, design and construction of facilities must be carried out to minimize environmental damage if a spill does occur. The correct operation of storage facilities is a matter of particular importance, and they must be continuously checked to ensure that they are in good order.

Design Guidelines for Spill Prevention

TANKFARMS

5. *Reinforced concrete or earthen dykes for spill containment shall surround all above-ground tanks. The minimum dyke heights shall be either two feet for concrete dykes, three feet for earthen dykes, or as calculated as follows, whichever is greater: the capacity of the largest tank (in cubic feet) plus 10 percent of the capacity of all other tanks (in cubic feet) divided by the effective tankfarm area (in square feet), plus one foot. The effective tankfarm area equals the entire area that is surrounded by dykes, less the area occupied by all tanks except the largest tank.*

6. *The dyked area of permanent tankfarms shall be rendered virtually leak-proof by ensuring that the maximum percolation rate in the soils is no more than* 5×10^{-6} *cm/sec. This protection may be achieved by locating the tankfarms in areas that have suitable natural soils, or by importing or preparing suitable soils and lining the tankfarm area with them. These soils shall be protected with a minimum cover of 10 inches of gravel to prevent physical damage to the soil below.*

7. *The dyked area of temporary tankfarms shall conform to the soil percolation rate requirement specified for permanent tankfarms. This criterion may be met in the same manner or by the use of oil-resistant membranes manufactured for the purpose, such as those made from polyvinyl chloride (PVC) or urethane. These membranes shall be protected against mechanical damage by a 6-inch layer of sand above and below them. Because PVC membranes become brittle at temperatures below 0°C, they should not be used if in contact with frozen ground. Urethane membranes do not last long and should not be used in installations that will exist for longer than two years.*

8. *Tankfarms shall not be built on permafrost unless the permafrost is insulated from the tanks and other structures to ensure that the contents of the tanks and the structures do not cause melting; and unless soil test results demonstrate that the permafrost will support the loads placed upon it without settlement or movement.*

UNDERGROUND STEEL STORAGE TANKS

9. *Underground tanks shall be constructed according to the specifications given in Underwriters' Laboratories of Canada* Standard S603 *and/or* Standard S603.1.

10. *Underground tanks should not be installed in areas of permafrost.*

11. *Underground tanks shall be surrounded with a minimum of one foot of clean sand, shall be buried a minimum depth of three feet and, in areas where traffic passes over them, they shall be covered with reinforced concrete slabs.*

12. *Permanent underground tanks shall be protected from corrosion by the use of anodes. Points shall be installed for anode testing.*

ABOVE-GROUND STORAGE TANKS

13. *Above-ground shop-fabricated tanks shall be constructed according to the specifications given in Underwriters' Laboratories of Canada* Standard S601. *Above-ground field-fabricated tanks shall be constructed according to the specifications given in American Petroleum Institute* Standard 650.

14. *The Company shall prepare a proposal for approval by the Agency for all steel and welding specifications to be used*

with metal tanks. One area to be considered is protection against the brittle fracture of steel by specifications of a Charpy-Vee Notch impact requirement.

15. *Bladder tanks shall be used for temporary storage only. They shall meet the standards of the Underwriters' Laboratories of Canada or government specifications for their intended use. They shall not be used where atmospheric temperatures may go below the minimum temperature for usage recommended by the manufacturer. The tanks shall be installed on a bed of sand at least one foot thick.*

STORAGE IN FLOATING VESSELS

16. *Storage of fuels and petrochemicals in vessels used for transportation or in any other floating vessel shall be subject to the specific approval of the Agency.*

17. *The use of floating storage shall be prohibited in ice, unless the barges or vessels are fully protected from moving, floating ice and from being held in the ice, either in a river or at sea. However, special consideration may be given in specific instances to ice-strengthened barges or vessels that are designed for the purpose and that have adequate mooring and docks of sufficient strength to support the loads involved.*

18. *The use of barges for storage in waters that have a current shall be avoided. If the current exceeds three knots, the use of floating equipment for storage purposes shall be prohibited, except when waiting a reasonable period (about three days) to be unloaded.*

19. *Barges or vessels may be used for storage in waters provided that the prohibitions on ice and current outlined above are met. The storage barge or vessel shall be surrounded by a floating containment boom, and its mooring arrangements shall be checked and recorded every 12 hours.*

20. *Daily recordings and reconciliations of cargo tank ullages shall be carried out on all barges or vessels used for floating storage.*

21. *All dyking requirements for fixed-tank storage shall apply to floating equipment that is used for storage on land.*

22. *As the bottom structure of most barges is not designed to support the weight of full fuel tanks when they are out of the water, the underside shall be shored up in a manner approved by the Agency for the specific vessel used. Care shall be taken to ensure that the shorings take up the load at the major structural member and not at unsupported panels of plating.*

DRUM STORAGE AREAS

23. *Storage areas for drums (full or empty) shall comprise a concrete slab or some other impermeable ground cover (such as a steel plate) that is graded so that all leakages collect in one area. The storage areas shall drain toward a sump and, in the case of petroleum storage, to an oil separator.*

PIPELINES AND FITTINGS

24. *All pipelines connecting to barges, vessels and petrochemical facilities shall be of steel or a steel alloy that is suitable for the purpose; all joints shall be welded or weld-flanged to the required pressure rating.*

25. *Valves and other pipeline fittings shall be made of forged or cast steel alloys that are suitable for northern temperatures. Valves and fittings used inside vessels or barges may be of cast iron.*

LOCATION OF STORAGE FACILITIES AND ROUTING OF PETROCHEMICAL TRANSPORT

26. *Sites for the bulk storage of petrochemicals shall not be within three-quarters of a mile of areas where waterfowl concentrate or within 1,000 feet of any waterbody, unless otherwise approved by the Agency.*

27. *Because of the environmental sensitivity of the Delta, its low topography and its susceptibility to storm surges and floods, every effort shall be made to avoid the risk of an accidental spill. The Agency shall, therefore, institute special measures for storage facilities located there. These include limiting the size of storage facilities (generally, the maximum tank size should be approximately 125,000 gallons, which is equal to about one-quarter of a barge load); restricting the location of storage tankfarms to stable, high, "Old Delta" ground; and permitting drawdown from only one tank at a time, with all other tanks kept locked.*

28. *Fuel loading and discharge terminals shall be located downstream from loading and discharge berths for general cargo to reduce risks of explosion or fire.*

29. *Bulk storage and handling sites shall have a maximum surface slope of two percent. (The velocity of drainage on such a slope is generally slow enough so that run-off can be controlled.)*

30. *Petrochemical transport shall be along designated and approved routes. Waterborne petrochemical transport should not be routed through large areas of waterfowl concentrations nor through ecological preserves. Routes should avoid areas of waterfowl concentration by at least three-quarters of a mile. Considerable research and field work will be required to establish a complete inventory and evaluation of wildlife resources and the sites of human habitation to be avoided by such transportation routes. Navigation hazards, the practicability of landing, and wharf sites must also be considered.*

31. *Fuel and bulk chemical cargo movements on a river or in the Beaufort Sea should not begin until the ice conditions, water level and current will not hamper activities to contain or clean up an accidental spill (this date may vary from year to year). Fuel and bulk chemical cargo movements on a river should be suspended if there is a rapid change in the water level or current. All fuel and bulk chemical cargo movements should be completed before vessels and barges are in danger of*

being caught by freeze-up (this date may vary from year to year).

32. If, after approval, the Agency finds that any of the procedures for petrochemical transportation, tranfer, storage or waste disposal do not adequately protect the environment, they shall be altered. This may require the re-routing of supplies, the relocation of storage facilities, or the redesigning of transfer and disposal equipment.

MARINE TRANSPORTATION FACILITIES

33. All ships or barges used to carry petrochemical products in bulk for the pipeline project shall be classed by a recognized international marine classification society, such as the American Bureau of Shipping or Lloyd's Register of Shipping, or approved by the Canadian Coast Guard's Ship Safety Branch. New vessels shall be built to the relevant institution's rules and constructed under its supervision.

34. Cargo tanks shall be subdivided according to the requirements of the Canada Shipping Act, "Oil Pollution Prevention Regulations, Amendment," dated September 6, 1973.

35. Operation, construction and outfit of vessels shall be to the requirements of the Canada Shipping Act, "Load Line Regulations."

36. At present it is standard practice for fuel barges to carry deck cargos, but in many instances, fittings and arrangements to prevent spills are incompatible with the carriage of deck cargo. The Company shall submit for approval the modification that will have to be made to existing barges, and the designs that will be required for new equipment.

PETROCHEMICAL TRANSFER: MARINE OPERATIONS

37. To contain spills that occur during transfer operations, a spill-guard shall be fitted around the perimeter of the decks of barges or tankers. A 12-inch-high spill-guard is usually adequate, but the spill-guard shall be higher if the deck is cambered or if the ship usually operates with trim. Spill-guards must have drain openings to prevent the accumulation of rainwater or spray when underway. These openings shall be provided with plugs that must be fitted during transfer operations. A strip of deck outside the spill-guard shall be painted white to allow easy visual identification of a flow of liquids over the side.

38. To contain minor spills within an area smaller than the whole deck, other spill-guards shall be fitted around the "make-break" connections, tank vents and hose stowage racks.

39. As far as practical, loading and discharge manifolds, cargo tank vents, flow meters, level gauges and pump controls shall be grouped together to aid surveillance during transfer operations.

40. At the loading and discharge manifolds, whether on marine vessels or on land, bolted flanges or quick-operating, flange-type connections shall be used. The manifolds shall be fitted with spill-guards of sufficient capacity to contain the amount of liquid that would be spilled from a manifold connection and equal to the flow through it during the time taken to stop the flow in an emergency. The capacity shall be determined by the design shut-down time. In no case shall a manifold be installed that hangs clear over water or land.

41. A positive means of draining the manifold and hose lines shall be provided with a recirculating pump connection that enables the discharge pump to deliver the liquid product back to the ship's tank, instead of to the shore facility, during discharge operations. Test cocks shall also be fitted so that operators can verify that the lines have been purged before disconnecting the hoses.

42. The complete deck area, and all areas where operations may have to be carried out in darkness, shall be adequately lighted. In internal spaces, such as pump rooms, the minimum level of illumination shall be 15 footcandles, at exterior deck at manifolds and pump controls, 10 footcandles, and for the entire exterior deck other than above, five footcandles.

43. To prevent spills and for general safety, the following precautions against fire must be taken. All electrical devices shall be suitable for use in an explosive atmosphere. All cargo tank vents shall have flash screens. A foam firefighting system shall be permanently installed on the deck. It shall be capable of supplying foam to any part of a deck and, to ensure that enough foam is available, it shall have the capacity to produce 0.11 Imperial gallons per square foot of deck per minute for a total of 20 minutes. (Further requirements are contained in the "Fire Detection and Extinguishing Equipment Regulations" of the Canda Shipping Act.) Spaces below deck, in which fires often start, shall be protected by an automatic carbon dioxide or similar flooding system. This system shall automatically shut off all ventilation to the affected space in the event of fire. Adequate dry chemical fire extinguishers shall also be provided, and large "No smoking" signs in languages or in symbols that are understood by everyone on the site shall be displayed at the gangway, the manifold and at any other locations that may be necessary.

44. To soak up any minor spillage caught within the spill-guard, an appropriate quantity of natural or a commercial absorbant material, an empty oil drum, plastic garbage bags, shovels, rakes, brooms, rubber gloves and boots shall be kept on the vessel. They shall be stowed in a convenient watertight and secure locker on the deck.

There are no established transfer procedures defined by regulations, but there can be no substitute for conscientious, well-trained personnel, who will take the necessary precautions. Cutting corners to save time or effort invariably increases the chances and severity of an accident. Continuous training and close supervision of work procedures are always necessary.

The following rules shall be incorporated into work procedures to reduce the possibility of spillage and to mitigate the effects of any spills that may occur.

45. *At all times during the loading or discharge of liquid products, suitably trained and qualified personnel shall stand by at both the receiving and discharge points. For tanks 1,000 feet from the unloading site, the cargo discharge point on the vessel, the receiving point on land, and the receiving point at the tankfarm shall all be manned (three persons). All personnel shall be fluent in the same language and be equipped with two-way radios for good communication and coordination. A supervisor employed by the Company shall be present and responsible for overseeing the entire operation.*

46. *Berth operators and crew at marine facilities shall be trained and competent in all vessel and transfer operations including vessel mooring procedures; transfer connection procedures; shoreside and vessel cargo flow routing, loading phases and system timing details; methods for adapting to the different mooring and cargo transfer situations that may be expected at the mooring berth or elsewhere at the terminal; prescribed operating procedures for a particular berth; and emergency and contingency procedures and plans for the particular berth or terminal.*

47. *During operations that involve the transfer of a liquid product to or from a vessel, all plugs in the spill-guards shall be in place. If there is heavy precipitation, it may be necessary to drain any accumulation of water by removing these plugs; if so, the transfer operation shall be stopped while the plugs are not in place. Transfer of a liquid product shall not be carried out if more than one inch of water is contained within the spill-guards.*

48. *When topping off the receiving facility, the rate of flow of the liquid product shall be reduced. Before disconnecting the hoses, care shall be taken to purge the lines and to verify that they are purged before the connection is broken.*

49. *Fire prevention regulations, such as "No Smoking" rules, shall be strictly enforced, and adequate fire extinguishers shall be available near the transfer location. Personnel shall be trained in the techniques of fighting petrochemical or hazardous substance fires.*

50. *Liquid products shall not be transferred to or from waterborne transport when visibility is restricted.*

51. *In fast-flowing rivers, particular attention shall be paid to the mooring arrangements of barges. Mooring lines shall be of adequate strength for the size of the vessel, and four lines should be employed, two forward and two aft. All lines shall use separate cleats or bollards, both on the ship and on the shore. The mooring arrangements shall be checked regularly (preferably at least once every hour) by a watchman.*

52. *In tidal waters, or in waters such as lakes that do not have appreciable currents, all fuel-transporation equipment shall be surrounded by a floating containment boom during the transfer of a liquid product. This boom could be carried by the vessel, but it should normally be stored at the wharf.*

53. *To keep all transfer systems in good order, a detailed preventive maintenance schedule shall be implemented. Pumps and valves shall be opened for inspection once every 12 months, preferably at the start of each season. Hoses shall be visually inspected for damage before each use and, once every 12 months, preferably at the start of each season, they shall be hydraulically tested to a pressure equal to one and one-half times their maximum working pressure. Rigging shall be visually inspected for damage before each use and, once every 12 months, preferably at the start of each season, it shall be statically tested to one and one-half times its rated capacity. Alarms shall be tested for correct operation before each use of the system. Gauges and meters shall be visually checked for correct operation at each use. Fire-fighting equipment shall be inspected in accordance with "Fire Detection and Extinguishing Equipment Regulations" of the* Canada Shipping Act. *Mooring lines shall be visually inspected for damage before each use, and they shall be replaced every 24 months. Floating containment booms shall be visually inspected for damage before each use.*

PETROCHEMICAL TRANSFER: LAND OPERATIONS

54. *All transfer areas, including — but not limited to — areas for tank truck loading, drum filling and vehicle fuelling, shall have spill collection facilities as outlined in the section "Drum Storage Areas."*

55. *All transfer points shall be controlled by fast-acting valves so that the flow of the liquid product can be terminated immediately if the hoses or any other equipment should fail or if there is a fire.*

56. *Transfer operations shall be constantly monitored by trained personnel who shall be in attendance during the entire transfer period.*

57. *All recommendations made in the section "Petrochemical Transfer: Marine Operations" concerning transfer-point illumination, no-smoking regulations, fire-fighting capabilities, fire extinguishers, and qualified personnel, and relevant points in the preventive maintenance schedule shall apply.*

WASTE PETROCHEMICAL HANDLING

58. *Bottom-drainage lubricating oil change areas shall be supplied with concrete slabs or some equivalent, such as steel plates, that are suitably graded toward a sump and petroleum separator to ensure that any spillage does not contaminate the surrounding area. Top-drainage lubricating oil change areas, where oil is removed from crankcases by mobile or fixed suction pumps, shall not require special protection.*

59. *Used lubricating oil shall either be shipped to a refinery for use as feed stock or for re-refining, or burnt in an incinerator specifically designed for the purpose.*

60. *An application to dispose of a chemical shall be made to the Agency every time a disposal is contemplated, and the Company must have formal approval of its proposal before the disposal is effected. Generally, the disposal shall conform to recommendations in the* Code of Good Practice for Management of Hazardous and Toxic Wastes at Federal Establishments *(Environmental Protection Service, Department of the Environment, 1977).*

CONTAMINATED RUN-OFF CONTROL

61. *It may not be practical or possible to collect all petroleum leakages and spills at each small petrochemical storage facility in living and work areas. Run-off water storage pits shall, therefore, be installed immediately adjacent to these areas to collect all run-off so that it may be monitored for petroleum content.*

62. *Storage pits shall be designed to contain a minimum of 48 hours of run-off from the area drained. The rate shall be based on the maximum 24-hour run-off rate for the 10-year storm-return period.*

63. *In sensitive permafrost areas, pits shall be designed to minimize thermal disturbance and degradation of the surrounding soils.*

64. *Permanent storage pits shall be constructed with soil liners to prevent leakage to the environment. Percolation rates shall be less than* 5×10^{-6} cm/sec.

65. *Temporary storage pits shall conform to the percolation rate requirements specified for permanent storage pits. The criteria may be met in the same manner or by the use of oil resistant polyvinyl chloride (PVC) or urethane membranes specifically manufactured for the purpose, but within the restrictions outlined in the recommendations for tankfarms.*

66. *Water from storage pits shall not be released to the environment until it is ascertained that the oil concentration in it is less than 5 parts per million (ppm).*

67. *Surface run-off water from petroleum storage and handling areas that contain petroleum products in excess of the limits specified shall be collected and transported in closed, leak-proof systems to a separator facility. After treatment in the oil-water separation facility, all run-off water shall be drained into a collection pit. The water in this pit shall be inspected to ensure its purity before it is released to the environment. Oil skim on the water shall be removed by commercially available absorbents and incinerated. The concentration of petroleum in discharge water shall be less than 5 ppm.*

68. *Ice and snow contamination by petroleum products shall be kept in storage pits until it melts. Commercial absorbents shall be used to collect the oil, as described above, which shall then be incinerated.*

Contingency Planning for Spill Control

The measures I have outlined above are aimed at spill prevention. Nevertheless, as I explained in Volume One, spills are bound to occur. We also know that, once they do occur, the technology at present available to clean them up is inadequate. Contingency planning is essential to make spill management as effective as technically possible and such planning must be complete, thoroughly understood and ready for immediate implementation.

The submission by Commission Counsel on spill control dealt with the requirements of contingency planning, personnel training and the selection and deployment of clean-up equipment. This was the only comprehensive outline of these subjects that had been developed to that time. However, since then, the Department of the Environment has developed a draft paper entitled "Contingency Planning Guidelines, Oil and Gas Pipelines" (May 1977). I think it is fair to say that in considerable measure these guidelines are based on Commission Counsel's submission to this Inquiry.

69. *The "Contingency Planning Guidelines, Oil and Gas Pipelines," prepared by the Department of the Environment (draft, May 1977), should be adopted as the basis for specific requirements for industry contingency plans.*

I do not think it is necessary to reprint here either the Department of the Environment's draft or Commission Counsel's recommendations because both of them are only guidelines for the preparation of a contingency plan. Such a plan is urgently required and it does not now exist: it must be comprehensive and it must be compatible with other government plans. In the final analysis, the success of the contingency plan will depend on the scope of the planning, the commitment of money, the training of personnel and the limits of technology.

Government agencies across the nation have prepared contingency plans for spills of various sorts. One example is the draft "Government Contingency Plan for Major Oil Spills in the Beaufort Sea" (Environmental Protection Service, Department of the Environment, November 1976), which aims at the coordination of the responses of various levels and departments of government to an accidental spill in the Beaufort Sea. Exactly this sort of coordinating plan will be necessary for a spill anywhere along the proposed pipeline corridor.

70. *The draft "Government Contingency Plan for Major Oil Spills in the Beaufort Sea" should be completed and tested in the field. Similar plans to cover wider regions of the North should also be prepared.*

The preparation of plans to coordinate the work of government departments and agencies is plainly the job of government itself. However, it is equally clear that industry,

in this case the pipeline company, will have the first responsibility for and the liability to clean up any accidental spill. In fact, the Pipeline Guidelines specifically require industry to prepare a spill contingency plan in the context not only of a gas pipeline and its attendant facilities, but also an oil pipeline along the same corridor:

> ... effective plans [shall] be developed to deal with oil leaks, oil spills, pipeline rupture, fire and other hazards to terrestrial, lake and marine habitats, that such plans be designed to minimize environmental disturbances caused by containment, clean-up or other operations and to bring about adequate restoration of the environment, that they be designed to deal with minor and major incidents, whether they are single-event or occur over a period of time and that they include contingency plans to cope with major hazards or critical situations. [pp. 15-16]

In addition, the Pipeline Guidelines require proposals of specific contingency plans or information regarding:

a) how the possible loss of oil or gas through pipeline leaks would be routinely detected and stopped quickly (the maximum potential undetected loss from the pipeline should be specified and evidence provided. This value is to be as low as is technologically feasible);
b) how oil which has escaped into the terrestrial, lake or marine environment would be detected, how it would be disposed of and how the elements of the environment affected by the oil would be rehabilitated; ... [pp. 22-23]

The pipeline companies must also:

> ... provide documented evidence that they possess not only the necessary knowledge, but also the capability to carry out the specific proposals. [p. 13]

The contingency plans advanced before the Inquiry by the pipeline companies and the producers in the Mackenzie Delta fall far short of the requirements laid down in the Pipeline Guidelines and of the ultimate requirements for the construction and operation of a pipeline. Obviously, I cannot prepare a comprehensive plan: that is the responsibility of the pipeline company. The Pipeline Guidelines are useful, but they are not specific enough in their directions to industry to ensure that their contingency plans will be comprehensive and compatible with those of government.

71. *The Company shall prepare a spill contingency plan that is comparable to and coordinated with those of the relevant government agencies.*

There are four additional points that warrant further consideration and that should ultimately be included in any planning scheme advanced by industry.

72. *There must be some definition of what constitutes a spill and of the appropriate response, given that the size and nature of spills can vary. The contingency plan must describe not only an appropriate level of response, but also an appropriate type of response, taking into account that, in the North, certain clean-up techniques could cause more harm than the spill itself.*

73. *To assist with project planning and spill response, the Company should establish and file with the Agency a catalogue of all the toxic and hazardous materials that will be used during the construction and operation of the pipeline and its ancillary facilities. The catalogue should include details on the quantities shipped, stored and used in various locations and at specified times; the properties of the substance, the probabilities of a spill and the probable success of a clean-up operation with the equipment on hand.*

This procedure might be developed from the methods outlined in the Battelle Memorial Institute's report *Control of Spillage of Hazardous and Polluting Substances* (United States Government Printing Office, 15090 P0Z10/70).

The reporting of spills has been required by law in the United States since the early 1970s, but, except for spills from ships, it is not yet law in Canada. It must be a requirement for the pipeline project and it would be commendable on a nation-wide basis.

74. *Throughout the preconstruction, construction, operation and abandonment phases of the pipeline project there should be a mandatory spill-reporting scheme for the Company and all its contractors and subcontractors.*

Finally, the contingency plan must be proved effective under actual conditions in the field. It does not matter how persuasive the plan is as a written document, as an organization chart or as a computerized response mechanism; if it does not work in the field, it is useless.

75. *Any comprehensive contingency plan must be field-tested regularly with realistic scenarios of all types of spills. Government or Agency inspectors should spot-check contingency planning preparedness by dropping unannounced into camps and facility sites to conduct mock spill exercises.*