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HATFIELD
CONSULTANTS LTD
environmental and pollution management

201 - 1571 Bellevue Avenue, WEST VANCOUVER, B.C., CANADA V7V 3R6
Telephone: (604) 926-3261; Telex: 04-352798

AUTHENTICATED
U.S. GOVERNMENT
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# AN OVERVIEW OF ENVIRONMENTAL DESIGN, FIRE AND EXPLOSION HAZARDS AND OIL SPILL CONTINGENCY PLANS OF THE NORTHERN TIER PIPELINE PROJECT IN CLALLAM COUNTY, WASHINGTON

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Prepared for:

The City of Port Angeles
and Clallam County
Washington State

U.S. DEPARTMENT OF COMMERCE NOAA
COASTAL SERVICES CENTER
2234 SOUTH HOBSON AVENUE
CHARLESTON, SC 29405-2413

Prepared by:

HATFIELD CONSULTANTS LIMITED
201-1571 Bellevue Avenue
WEST VANCOUVER B.C.
V7V 3R6

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## ABSTRACT

The Northern Tier Pipeline Company application for site certification, submitted to the State of Washington Energy Facility Site Evaluation Council was reviewed and evaluated. Supplementary documents, including background studies sponsored by the Northern Tier Pipeline Company and expert witness testimony available at the time of review were also examined. The review and evaluation dealt with environmental design, fire and explosion hazards and oil spill contingency plans of the proposed project in the City of Port Angeles and Clallam County.

Major topics for consideration were identified within the general areas of review, and deficiencies and weaknesses were assessed under each major topic. The following inadequacies were determined for the project as proposed: insufficient submarine pipeline studies with respect to local current and sea bottom conditions, and susceptibility to anchor damage; the maneuvering and anchoring of large oil tankers in Port Angeles Harbor; the data base used for fire and explosion hazard conclusions; the implication that inert gas systems are reliable mechanisms to remove explosion risk.

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# I INTRODUCTION

Northern Tier Pipeline Corporation (NTPC) have prepared an application to the State of Washington Energy Facilities Site Evaluation Council (EFSEC) for a port and pipeline system to transport Alaskan and offshore oil from Port Angeles to the U.S. mid-west. Hatfield Consultants Limited (HCL) were contracted by Clallam County and the City of Port Angeles to carry out an environmental assessment of three broad areas of the application: Engineering and Environmental Design; Fire and Explosion Hazards- and Oil Spill Containment and Clean-up. Specific technical subjects to be addressed were agreed upon in a work plan developed with a county/city committee. The geographical area included in the review aspects of the proposed project within Clallam County, and a brief review of submarine pipeline crossings at the eastern end of the Strait of Juan de Fuca and Saratoga Passage.

The results of the assessment are intended for use by the county and city in ensuring their interests are protected at the Energy Facility Site Evaluation Council Hearings, on the application, which are taking place in 1979-1980. This report contains an outline of relevant statements made in the NTPC application, NTPC witness prefiled testimony, backup consultants reports, and HCL's assessment of them. It has been organized by issue under general subject heading in order that the material could be readily used in the hearing process.

The assessment was made within the constraints of a very short (7-week) review period and a very limited budget. Because of this, the reviewers were forced to deal only briefly with some subjects. However, the reviewers believe that the assessment has identified the major information gaps and deficiencies in the application as it has been presented up to the submission date of this report.

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## II REVIEW METHODS

Assessment of the NTPC documentation was carried out during the period April 1 - May 21, 1980.

Project Reviewers Included:

1. Mr. C. Hatfield, Mr. J. Villamere and Mr. M. Winsby - HCL staff;
2. Mr. G. Morgan - Thurber Consultants Ltd.;
3. Mr. J. Bennett - Bennett Environmental Consultants Ltd.;
4. Capt. R. W. Lumsden - Marine Consultant.

Assessment Procedures Included:

1. a one-day site reconnaissance of the port and tank farm site;
2. a two-day reconnaissance of the tanker route from Cape Flattery;
3. review of relevant sections of the NTPC documentation as provided by county personnel;
4. a one week visit to shipping specialists and organizations in London, England. During this visit, the following people were interviewed:

   Capt. M. L. M. Jolivet, Navigation and Safety
   Shell International Marine Limited

   Capt. R. W. Lumsden, Marine Consultant

   Mr. A. E. Fischer, Managing Director
   Marine Pollution Compensation Services Limited

   Ms. F. Holland, Marketing Executive
   H. P. Drewry (Shipping Consultants) Ltd.

   Dr. D. S. Aldwinckle, Senior Ship Surveyor
   Lloyd's Register of Shipping

   Cdr. T. M. Hayes, Inter-Regional Consultant
   Maritime Pollution Technical Cooperation Division, U.N.

   Capt. E. O. Jones
   Shell Tankers (U.K.) Limited

   Mr. R. Brown, Regional Liaison
   Shell International Marine Co. Ltd.

   Mr. J. A. Nichols
   International Tanker Owners Pollution Federation Limited

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Mr. D. Scarfe
International Tanker Owners Pollution Federation Limited

Mr. A. E. Findlater, Maintenance and Machinery Operation
Shell Tankers (U.K.) Limited

Dr. J. Wonham, Marine Pollution Advisor
Inter-Governmental Maritime Consultative Organization, U.N.

5. personal interviews with the following individuals:

Mr. J. Wiechert, Manager
Clean Sound Oil Spill Cooperative, Seattle, Wa.

Capt. W. Stuart, Director
Canadian Coast Guard (retired)
Ottawa, Canada

Mr. T. MacDonald, Fire Chief
Mr. D. Jordan, Deputy Fire Chief
Nanaimo Fire Department
Nanaimo, B.C.

Mr. W. Wolferstan,
Environmental and Land Use Committee
Victoria, B.C.

6. review of relevant reports from HCL and sub-consultants' libraries;

7. judgments of HLC staff and sub-consultants based on experience with the subject areas.

Since documentation for the project was continually changed by new hearing testimony and the filing of supplementary documents up to the due date for this report, some of the issues were dealt with more fully than others. For the same reasons, some aspects of the assessment may only be current as of the original due date (May 21, 1980).

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## III GENERAL COMMENTS

In assessing the NTPC documentation and backup consultants' reports, a consensus developed among HCL reviewers on general impressions of the proposal presentation. There were some subject areas which stand out in the proposal as being major data gaps, deficiencies or simply misinformation. The overall conclusions of the reviewers are presented below. The assessment of specific subject areas should be carried out with these overall conclusions in mind.

1. A critical deficiency in the NTPC application is a lack of good technical information

With some exceptions, backup consultants' reports generally appear to be carried out by competent personnel and are professionally presented. However, the NTPC application itself is one of the poorest documents the reviewers have seen.

The reviewers point out that in applications of this type, the proponent is making commitments to carry out public safety and environmental measures as stated in the application. These commitments can be modified by witnesses appearing at the hearing who clearly have the authority to make commitments on NTPC policy matters or by supplemental filing of application amendments or volumes. It should be emphasized however, that consultants' reports, unless their entire contents are clearly endorsed by NTPC application statements, do not constitute commitments on behalf of NTPC.

A general lack of good specific technical material or even adequate use of that presented in consultants' reports made the application difficult to assess. It is recognized that the project is not at a final engineering design phase nor did the reviewers expect such information at this stage. However, for the subject areas assessed in this report, NTPC did a poor job in presenting enough technical material to make the proposal credible even at this conceptual stage.

2. The application contains incorrect statements and numerous errors

NTPC documentation contains completely wrong statements in some critical subject areas such as safety record of inert gas systems, practical possibility of tankers using low sulfur fuel in port and VLCC anchoring capacities of Port Angeles Harbor, etc. It also has numerous errors in figures and calculations as pointed out in evidence by witnesses at the hearing. This results in misleading impressions of the safety and environmental impacts of the project and ultimately reflects badly on parts which may be adequately done.

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3. <u>During the assessment period a continuous flow of new information was filed, promised documents were filed late, and some reports were filed in draft. This made the task of assessing specific issues of the project more difficult than necessary</u>

Evidence in chief presented by NTPC witnesses and new documents filed at the hearing often contained information differing substantially from original plans in the application. Reviewers of the material, therefore, had to continuously keep up to date on the new ideas and revised plans being presented by NTPC. Crucial documents such as Volume II of the contingency plan were only received a few days before the end of the HCL assessment, even though the document had been promised by NTPC much earlier. It was even then only in draft. Operating in this way may be good hearing strategy from the point of view of NTPC since it makes a thorough review of the application by intervenors extremely difficult. However, it leads the reviewers to believe the project contains substantial areas of "back of an envelope" planning.

4. <u>There is a lack of firm agreements with outside parties concerning critical parameters of the project</u>

The reviewers understand that no firm intent or contractual agreements exist concerning such things as a supply hook-up to existing Puget Sound refineries, membership in the Clean Sound Spill Cooperative and supply of low sulfur bunker fuel. Whether or not such agreements are successfully negotiated has orders of magnitude effects on such things as air quality projections, shipping accident risk analyses and assessment of the adequacy of contingency plans.

5. <u>NTPC has had poor advice and appears to have little in-house expertise on shipping matters</u>

Statements made in the application on tanker inert gas systems, low sulfur fuel burning capabilities in port, anchoring space, etc. are naive. Since such points are of crucial importance to the safety and viability of the project, reviewers found it surprising that NTPC did not make use of the large body of international expertise available on VLCC shipping matters.

6. <u>Accident and safety risk analyses are inadequate for the project</u>

Analyses of accidents occurring and the consequences of such accidents rely heavily on mathematical calculations based on theoretical or local data. They appear to have been made by people unfamiliar with shipping operations, worldwide real incident statistics, case history literature and incident witness information. As such the consultant analyses on such critical factors are inadequate. Conclusions about public safety and probable environmental impact contained in the NTPC application are misleading and bear little relation to real life major oil port problems.

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7. Scenario techniques for analysing effects of accidents and mitigative success were not used extensively enough in the documentation

Projected oil spill movement in U.S. and Canadian waters, the projected success of clean-up operations and projected damage such spills would cause was not done in the application. Fire and explosion scenarios were only touched on superficially. Detailed scenarios on these subjects would permit reviewers and hearing commissioners to have a better real life idea of the possible impacts of the project if there were an accident.

8. The documentation contains little discussion on the projected success of proposed mitigative techniques for dealing with such things as fire and pollution emergencies

Sections in the documentation describe the fire fighting and spill clean-up equipment which will be on hand to deal with emergencies. Plans are presented in different degrees of detail on how this equipment would be used to deal with an emergency situation. The impression is given that if this equipment is available and if it is used it will mitigate the problem. For fire and explosions, this is not necessarily so. For oil spills at sea, this is totally inaccurate, because of a lack of technology to contain and pick up oil at sea even in relatively sheltered waters. This has never been done successfully in any major oil spill.

9. Engineering for the project is generally very preliminary

A review of the references supplied has indicated that the engineering studies that have been carried out to date on the pipeline are generally in a very preliminary stage. In some cases the applicant has recognized considerable uncertainty and has carried out more detailed studies. Examples of this are the R.J. Brown reports dealing with the Port Angeles harbor submarine pipeline crossings. The overall application is thus currently out of balance. It is also out of balance geographically in that relatively little study has been made of that portion of the underwater pipeline route outside of Port Angeles harbor.

10. Where detailed studies have been carried out substantial changes in the study parameters have resulted

Because of the preliminary state of the engineering studies, the apparent lack of precedent in certain areas, and the environmental and economic consequences of an underwater pipeline failure, the reviewers would recommend that, if the project is approved, an independent review board of competent experts be formed for reviewing all engineering aspects of this part of the project as they are developed from design through to construction.

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A. ENGINEERING AND ENVIRONMENTAL DESIGN
1. SUBMARINE PIPELINE AND RIVER CROSSINGS
1.1 SUBMARINE PIPELINE CROSSINGS

A1) The Construction and Operation Designs and Procedures Proposed

EXPLANATION:

The methods used to construct and place submarine pipelines must be appropriate for local conditions, such as water depths, bottom soil and seismic conditions, tidal and wave induced currents and bottom countours.

BACKGROUND - NTPC APPLICATION: SOURCE

Submarine pipelines are proposed for three separate areas: Port Angeles Harbor, Strait of Juan de Fuca (Admiralty Inlet), and Saratoga Passage.

Port Angeles Harbor Crossing:

"The two submarine pipelines will connect the onshore Ediz Hook pipelines to the onshore storage facilities approximately 5.2 miles away at Green Point. These lines, in conjunction with the onshore lines, booster pumper and other elements of the unloading system will be designed to provide a maximum flow rate of 100,000 bph through each line... Preliminary hydraulic and economic studies indicate that the pipelines will be either 48-inches or 52-inches in diameter... Preliminary design studies indicate that the wall thickness for 48-inch and 52-inch pipelines will be approximately 0.75 inches and 0.875 inches, respectively. High density, concrete, weight coating will be applied to the pipe to produce the design submerged weight, which will be determined following route selection, evaluation of bottom currents, investigation of bottom soils, and selection of the construction method." — Vol. II p.6-16

Strait of Juan de Fuca and Saratoga Passage Crossings:

"The pipe will be 42-inch diameter, the same as the land portion of the system in Washington. However, because of possible pipe laying barge capability limitations, it may be necessary to reduce the diameter to 36-inches for about 6 miles through the deeper part of the Strait of Juan de Fuca crossing...the preliminary design studies indicate that the pipe wall thickness will be 0.750 and 0.625 inches for the Strait of Juan de Fuca and Saratoga Passage crossings, respectively"..."the preliminary design studies indicate that the thickness of the concrete weight coating will be approximately 2.6 inches and 3.1 inches respectively for the Strait of Juan de Fuca and Saratoga Passage crossings." — Vol. II p.6-74 to p.6-76

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DISCUSSION:

In reviewing the R.J. Brown and Assoc. Report (1979a, 1979b, 1979c) the following unanswered questions arise:

1. What is the experience with installing large 42-inch diameter pipelines and operating them in waters with significant tidal currents? Are we pressing the limit of our experience?

   Because the required negative bouyancy varies with the square of the design currents from both tides and waves, it is important to reliably determine the magnitude of the currents that are likely to affect the pipeline, both during the operating period and during the installation period. It affects the methods used in installing the pipeline. B.C. Hydro ( 1979) states that the design current velocities over the operating life of a submerged pipeline should be of the order of 100 year maximum conditions. It goes on to state that possibly the 5 year maximum condition could be acceptable for design for installation conditions. Thus in order to reliably determine the currents to be taken into account, one must have surveys of currents continuously carried out over an extensive period. B.C. Hydro ( 1979 ) states that the minimum period should be 6 months to a year. On page 2-19 of R.J. Brown and Associates ( 1979a ) it is implied that 100 year design current velocities are to be taken into account for the operating condition (although here they are referring to wave generated currents only). However, on page 2-17, they imply that they are going to use a 1 year design velocity for designing for the installation condition.

   When one compares Table 2.1 in R.J. Brown and Associates ( 1979a ) with Table 2.1 in R. J. Brown and Associates ( 1979c ) there is a substantial increase in the design tidal currents particularly in the sections of the pipeline off Ediz Hook where velocities up to 3.9 ft/sec were measured. The reason for this increase is that a current measurement survey was undertaken during the period January 29, 1979 and March 1, 1979 in Port Angeles Harbor. This shows the necessity of taking site measurements. However, is this one month long period of measurements long enough in the light of the above comment from B.C. Hydro ( 1979 ).R. J. Brown and Associates ( 1979c ) ,page 2-3, describe an attempt to establish a design current by making a correlation between the measured currents and tidal data. The results were not too encouraging which is to be expected. Most experienced boaters in Juan de Fuca Strait are aware that the relationship between tidal levels and tidal currents at any particular location varies appreciably depending upon the magnitude of tidal level change and prior weather conditions (eg. wind generated seiche). The proponent states that he is taking a "conservative" approach by increasing the maximum measured current taken during the period by 10% and using this value as the design tidal current. Clearly this is no substitute for taking an extended program of readings. We really do not know if 10% is conservative or

not. It is further noted in R.J. Brown and Associates (1979b), page 3-5, that to date, no detailed survey of underwater currents has been conducted on the remainder of the submerged pipeline route outside of Port Angeles harbor. The R.J. Brown design tidal current, a maximum of five feet per second for the Strait of Juan de Fuca, does not appear to be conservative in view of design currents used by earlier studies for NTPC. Mr. Peebles during his testimony did not know whether the R.J. Brown design was feasible above currents of 5 feet per second, which is well below 10.68 feet per second identified by McDermott-Hudson (1977).

2. Why wasn't more on-site investigation conducted at this stage of the study? More on-site investigation should have been conducted which might have prevented the inaccuracies and inconsistencies found in the NTPC reports.

3. What factors of safety are used in selecting submerged weights for a pipeline? Note 2 on Dwg. 1-209 and the equation at the top of page 2-14 indicate that no factor of safety has been used.

   Dwg. 1-209 of R.J. Brown and Associates (1979a) provides the results of wind tunnel tests which indicate that the no ditch case is not the worst case. A small ditch with 1 on 2 side slopes (case No. 1) required higher submerged weights to withstand a given current velocity. Is it possible to make matters worst by trenching?

The following aspects of submarine pipeline installation are considered below: floatation of the pipeline due to liquefaction; the problem of a potential break in the line; shoreline regression at the landfall site; projected cost estimates; and tidal scour.

Floatation of Pipeline due to Liquefaction:

Our major comment here concerns the quality and extent of study which has been given to this topic. Assuming that liquefaction occurs, it should have been a relatively simple matter to determine whether or not the pipeline would float. Yet on page 5-1 of R.J. Brown and Associates (1979c) which is a revision to earlier documents, the conclusion is reached that the pipeline will be negatively bouyant (i.e. will sink) in liquified Type A soil. Only 4 months later in Butler and Associates (1980) it is concluded that floatation rather than sinking of the pipe will be the predominant case. Unlike the anchor penetration problem or the liquefaction problem per se, there is really nothing difficult about this analysis. It is in fact an error that should never have occurred since it reflects upon the credibility of the study. However, it did occur and one is led to the conclusion that some aspects of the project must be in the very preliminary stage of engineering design and that some of the checking leaves much to be desired.

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The Problem of a Potential Break in the Line

A break in the line resulting in an oil spill could be both costly and time consuming to fix. The application does not adequately address how difficult it would be to repair the line if broken. In the Department of Ecology Questions and Answers, response to question H-15, the applicant does acknowledge, however, that repairs would be difficult to accomplish.

Other studies concerning proposed large diameter pipelines that are to be submerged by reservoirs state that location and examination of the failure of a submerged pipe could require several weeks before temporary repair could be initiated. Service could be disrupted for several months in a worst case type of situation. B.C. Hydro (1979), on p.24 states that "Pipeline failure ... would (result in) a long pipeline shutdown during the repair period". With regard to the Northern Tier Pipeline the worst type of situation would be severing of the pipeline due to, say, a large submerged slide which would affect a significant portion of the pipeline. The cost of repairing the worst case would amount to several millions of dollars. However, by comparison the costs of an interruption in the oil supply caused by a breakage would probably be very high.

The applicant has identified two potential causes of a break in the pipeline - liquefaction of sediments on the sea bed (possibly causing slides); and penetration of the pipeline by ships' anchors (eg. in Port Angeles harbor). Anchor damage risk will be discussed in Section A2.

Liquefaction:

In R.J. Brown and Associates (1979c), page 5-2, concern is expressed over the possibility of sea bottom instability on the Ediz Hook Slope in Port Angeles harbor. Here the sea bottom is at an angle of 24 degrees and investigations have shown what appears to be a slide or flow zone. The Applicant proposes to mitigate the effect of further possible slides by installing the pipe in Type B soil below the loose Type A soil and to align the route so that it is perpendicular to the contours. But is is practicable to excavate to Type B soils bearing in mind the expressed difficulty in R.J. Brown and Associates (1979c) of excavating the sand cover (refer to later discussion on floatation of pipeline)?

In the Washington State Department of Ecology Questions and Answers, page 4, it is stated that no borings have been done on the submarine crossings on the Strait of Juan de Fuca or Saratoga Passage, nor are any borings planned at these crossings. On the other hand it is pointed out that Type A deposits probably reach their thickest depths in Saratoga Passage. What then is the possibility of liquefaction induced slides on shallow slopes but of a magnitude that could sever the pipe outside of Port Angeles harbor?

Because of the consequences of a break in the submerged portion of the line and the difficulty in repairing a break, the submerged line should be conservatively located, designed and constructed. The applicant should be required to demonstrate that he had in fact adopted this philosphy. It is difficult to obtain assurance that he has done so from the documents at hand. We feel that the approach towards the design and construction of an underwater pipeline as described in the B.C. Hydro (1979) report portrays a typically conservative approach. Some aspects like the intent not to install block valves along the submerged portion of the line and not to investigate by drilling the sea bed conditions along the portion of the line outside of Port Angeles harbor (M. Veatch, prefiled testimony, p.4) should be further explored. Shannon and Wilson (1979a), page 5, states that 55 samples total were taken along the two studied routes across the Strait of Juan de Fuca and Saratoga Passage to determine bottom soil conditions. Figure 2 shows that the spacing of the location of the samples ranged approximately between 4000 and 8000 ft. This is a very preliminary sampling program. Recommendations are made in Shannon and Wilson (1979a), page 4, for further exploratory work which the Applicant should carry out prior to final design. Conditions could vary from those indicated by Shannon and Wilson (1979a). In particular, we feel that not enough stress has been placed on the possibility of dense soils or rocky material occurring at or close to the ocean bed. The marine charts for this area indicate rocky bottom conditions north of Dallas Bank and south of Partridge Bank. A sharp change from a yielding foundation soil to a non-yielding foundation soil may result in stress problems in the pipe.

It is also not clear how the applicant will monitor the performance of the submerged portion of the pipeline. The response to question 13 in the Washington State Department of Ecology Questions and Answers does not really address this. Does the Applicant intend to use smart pigs to monitor on a regular basis the condition of the pipe? Will these smart pigs be able to detect deformations that have occurred in the pipe as a result of ground movement or floatation?

Shoreline Regression at Landfall Site

It is noticed (Shannon and Wilson, 1979c), that the investigations for the landfall sites were carried out at a reconnaissance level with no drilling or detailed surveys. Some of these landfall sites are undergoing regression by wave erosion. The rate of shoreline regression is not known. On page 7 of (M. Veatch, prefiled testimony), Mr. Veatch is reported stating that the erosion rate for Green Point bluffs is somewhere between 8 to 12 in. per year. The USGS have been reported as stating that the erosion rate for the bluff is 20 to 40 in. per year. Assuming the life of the project to be 20 years (what is the life of the project?) the shoreline regression at Green Point can vary from 20 to 70 feet in the vicinity of the landfall. Do the proposed measures for existing erosion at the landfall sites take into account this magnitude of erosion in adjoining areas?

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Tidal Scour

Tidal scour may well be a problem at Ediz Hook. Currents up to 3.9 ft/sec. have been measured at this location. Shannon and Wilson, 1979b, (fig. 7) shows that at these velocities erosion of fine silty sands can readily occur. Indeed erosion can start to occur at velocities as low as 1 ft/sec. Figure 2 (Shannon and Wilson, 1979b) shows the bottom contours between Ediz Hook and Green Point and it is noted that there is a depression as deep as 20 ft. off the end of Ediz Hook which would be compatible with tidal scour at this location. It would thus be important that the pipe be buried to such a depth as to allow for scour. We can find no indication that these studies have been carried out or are to be initiated.

The reviewers also strongly feel that the approach to design and the construction methods and control for the underwater section be more conservative than is customary in pipeline engineering practice. In particular the applicant should prepare environmental and engineering contingency plans to cover a wide range of project conditions that may arise during the construction and operation of the pipeline.

The applicant should, before construction, obtain as much site data on such things as water, ocean bed and sub-ocean bed conditions as can be economically and environmentally justified, although it is inevitable that much important information will be discovered only during construction. In fact, it is therefore particulary important that the applicant establish a workable liaison between those responsible for construction. The applicant should be required to demonstrate to the review board that all the engineering and environmental implications of the design are being carried through into construction.

## A2) Anchor Damage Potential

EXPLANATION:

All of the submarine pipelines, including the unloading pipelines will be in areas of marine vessel traffic. The Port Angeles Harbor and the Juan de Fuca Strait crossing areas have particularly high numbers of marine traffic transits. Vessels could drop anchors in any of the submarine pipeline crossing areas for anchorage or in emergencies. The vulnerability of pipelines to anchor damage therefore requires thorough examination.

| BACKGROUND - NTPC APPLICATION: | SOURCE |
|---|---|
| "Those factors primarily responsible for leaks and ruptures in submarine pipelines include dropping or dragging anchors damaging lines, internal and external corrosion, structural defects, bottom trawls, hooking lines, and natural causes (USGS 1978)." | Vol. III p.2.11-80 |
| For the unloading submarine pipeline (Port Angeles Harbor) "typical burial depths (coverage over the pipe) of large diameter pipelines vary from 3 feet minimum to approximately 15 feet maximum, depending on the bottom soil characteristics." | Vol. II p.6-17 |
| For the Strait of Juan de Fuca and Saratoga Passage submarine pipelines trench depths are shown to be 7 to 10 feet, respectively. Mechanical backfill of the submarine pipelines will take place in the surf and shallow water zones. Backfilling for the remaining submarine pipeline portions will rely on bottom currents to move sufficient deposition of bottom material over the lines. | Vol. II p.6-173 & p.6-176 (Port Angeles Harbor) Vol. II p.6-154 (Strait of Juan de Fuca) Vol. III p.6-172 (Saratoga Passage) Vol. II p.6-177 |

DISCUSSION:

Anchor Penetration Studies:

Initial analysis (R.J. Brown & Associates, 1979a p. 2-41) indicated that an anchor could penetrate to a maximum depth of 29 feet in Type A material. Subsequent to the issue of this report it was realized that excavation to such depths in loose sands would be difficult to accomplish. A more detailed analysis was carried out and more importantly, the results were calibrated to fit actual experience as reported in some 71 references. As a result, the maximum depth of penetration was reduced to 11 feet (R.J. Brown & Associates, 1979c, p. 6-3). At the same time, it was acknowledged (R. J. Brown & Associates, 1979c p. 1-5) that it is currently beyond the capability of normal marine dredging equipment and pipeline trenching equipment to excavate a depth of 11 feet over the deeper portion of the harbor and that it would be necessary to modify or specially design dredging equipment or mobilize equipment from the Gulf Coast. Presumably because of this it was stated (p. 1-6) that if 11 feet of cover is not achievable then a minimum cover of 4 feet would be accepted for which the risk of anchor contact was estimated to be 1 in 500 years. Our review of the second phase of the studies indicates that the study has made extensive use of available data. However, on p. 6-14, it is stated that "there is not a great deal of data available on the maximum fluke tip penetration of dragging anchors. Also, the data which is available is sometimes conflicting." The report goes on to describe some of this conflicting evidence, yet fails to examine the recent anchor and chain marks on the bottom of Port Angeles Harbor described in the Shannan & Wilson reports. Furthermore, it assumes natural sediment burial of the pipe will be adequate. The National Transportation Safety Board has identified a number of anchor caused pipeline mishaps in the Gulf of Mexico. Recently, a natural gas transmission line in the Gulf of Mexico was ruptured by the grappling hook from an anchor handling boat (National Transportation Safety Board, 1979). During their investigation the Safety Board reviewed U.S. Geological survey records, and found that 42 similar accidents occurred over 12 years in the same area.

There appears to be a theme of rationalization in the reasoning for the extension to the R.J. Brown studies and the results that were obtained. In view of the significance of the findings, it seems very advisable that a commitment be obtained from the applicant to carry out full-scale site-specific tests of anchor penetration in Port Angeles Harbor prior to final design and proceeding with the project. Having established anchor penetration by these field tests, a thorough study should be made of the capabilities of trenching and dredging equipment (modified or otherwise) which is available for use on the project. Again, this study should preferably include field tests. In any case, the applicant should provide greater assurance than he has done of his ability to bury the pipeline to the required depths.

Although the entrance to Port Angeles Harbor could be designated as a non-anchoring location, often ship's anchors are dropped in emergencies and a vessel's master must always consider the ship's safety first. The traffic

in the harbor has been reported as approximately 3500 visits per year (NTPC Application) indicating that the possibility of emergency anchor drops will always exist.

## A3) Potential Environmental Impacts

EXPLANATION:

A submarine pipeline rupture or leak could result in contamination of sensitive areas near Port Angeles Harbour, Dungeness Bay, Sequim Bay and the Skagit delta.

| BACKGROUND - NTPC APPLICATION: | SOURCE |
|---|---|
| **Likelihood of Rupture:** | |
| Table III-6-1 indicates that a submarine pipeline spill (all casualties) frequency would be 1 in 51 years for the Strait of Juan de Fuca and Saratoga Passage. The size of the spill is described as 19 bpy average. Such a spill is expected to cause moderate ecological damage. | Vol. III p.6-17 |
| Table III-6-1 further indicates that a submarine oil spill from the pipeline under Port Angeles Harbour is expected once in 115 years with spill size described as 6.5 bpy. The effect of such a spill is described as negligible. | Vol. III p.6-16 |
| Elsewhere in the application, "the mean spill size in the event of rupture is 5,895 and 1,336 barrels per spill because of the static (drainage) and dynamic losses, respectively." | Vol. III p.2.11-46 |
| **Impact on Water:** | |
| The NTPC Application indicates that, in water systems, a major pipeline rupture could have significant short-term impacts on biological systems and "recovery from a major spill could take two or more years." | Vol. III p.3-4 |
| Released oil could form conglomerates with silt and sediment and remain in bottom areas. The application indicates that "chronic water quality degradation in the embayments could result." | Vol. III p.2.3-30 |
| Submarine pipeline ruptures in Port Angeles Harbour are not directly addressed in relation to water quality. | |
| **Impact on Flora:** | |
| The effects of oil spilled from a submarine pipeline rupture in Port Angeles Harbour again are not directly addressed. However, for ruptures of other submarine pipelines "the salt marsh habitat at the mouth of the Dungeness River, near Dungeness Bay, | Vol. III p.2.4-6 |
| | Vol. III p.2.4-18 |

Skagit delta area, and Stillaquamish delta area, could be damaged extensively by oil introduced by currents and tides."

Significant damage to aquatic plant communities is outlined as "community parameters such as organism abundance, biomass, and species richness, may remain altered for two or more years after exposure to and clean-up from an oil spill... The Dungeness to Sequim and Northern Saratoga Passage to Skagit Bay areas are the most important areas potentially affected by the pipeline."

Vol. III p.3-5

Impact on Fauna:

The application indicates that in terms of the faunal environment that "the lack of detailed site-specific information" allows only general oil impact predictions to be made.

Vol. III p.2.5.2

"Marine mammals are highly mobile and will probably avoid areas of oil spills or areas of high disturbance;" the primary species (harbour seal and northern sea lion) affected "are primarily fish eaters (see 'Fish and Ichthyoplankton' for impacts on fish). In general, losses of food for marine mammals would be too small to be significant; however, these mammals may feed in other areas temporarily until food and other habitat conditions normalize."

Vol. III p.2.5-4
Vol. III p.2.5-3

For birds "the most critical periods are wintering and migration periods... Spring 1978 data indicate that at the peak of migration at least 1,100 diving birds might be exposed to an oil spill in Port Angeles Harbour and at least 350 in the Morse Creek to Green Point critical area" while "a catastrophic spill contaminating Dungeness Bay could involve over 73,000 birds by coating birds and destroying habitat (MSN 1977)."

Vol. III p.2.5-7

For fish in Port Angeles Harbour "impacts on fish from operation of the tanker unloading facilities could result from tanker casualty oil spills, from transfer oil spills, from bunker fuel oil spills, or from miscellaneous contaminants." Also, in Port Angeles Harbour "as with other marine animals, the only major source of impact on zooplanktons during

Vol. III p.2.5-9

Vol. III p.2.5-13

operation of the proposed facilities would be accidental oil spillage."

Macroinvertebrate impacts are not addressed directly because "the possible sources of HC introduction into the marine environment in order of decreasing probability include transfer spills of crude oil or bunker fuel at the tanker berths, crude oil spills associated with tanker accidents and crude oil spillage arising from unloading pipeline accidents." — Vol. III p.2.5-16

"Oil spills will create significant adverse effects if a major tanker or pipeline rupture occurs." Long-term effects are not described directly but "a major pipeline rupture could severely damage fish eggs and larvae, macroinvertebrates, and possibly adult fish in nearby streams, lakes and estuaries." — Vol. III p.3-6

DISCUSSION:

In general, the NTPC Application recognizes the areas and species which would be affected by a major oil spill. In sections of the application discussing net ecological effects, "bpy" units are used to describe spill sizes. The use of such quantities to describe spill sizes is highly misleading when describing spill frequencies of 1 in 115 years (i.e. a 6.5 bpy average spill size for the Port Angeles Harbour pipeline) and 1 in 51 years (i.e. a 19 bpy average spill size for the Strait of Juan de Fuca and Saratoga Passage pipelines). If frequent, minor spills are expected it should be clearly stated because Table III-6-1 in the NTPC Application implies that the described ecological effect is based on minor yearly spill size figures. However, the following statement is underlined in the application: "Therefore, the total probability of an oil spill in the submarine pipeline crossings in Washington (considering both major and minor spills) is 0.0196 per year (once every 51 years), with a predicted spill volume of 196 bpy." (NTPC Application Vol. III, p.2.11-94). Note that both major and minor spills are considered in this determination.

If the spill size figures used in Table III-6-1 of the NTPC Application are meant to describe spills at infrequent intervals, the sizes are then in contradiction with spill size figures used elsewhere in the application. Whereas for the Port Angeles Harbour unloading pipeline, 6.5 bpy x 115 years = 748 barrels; mean spill size losses are described also as 5,895 (static) + 1,336 (dynamic) = 7,231 (NTPC Application Vol. III, p.2.11-46). And whereas for the Strait of Juan de Fuca and Saratoga Passage

pipelines, 196 bpy x 51 years = 969, "the maximum estimated spill is 21,000 barrels for the Strait and 17,000 barrels for Saratoga Passage." (NTPC Application Vol. III, p.2.11-97). The later statement further detracts from a personal communication from ERT to OIW ( 1979a ) where off Port Williams "at this location, a worst case scenario could potentially spill approximately 25,000 bbls (ERT 1979)."

Clearly, as shown above, net ecological impact conclusions are based on the assumption that worst case spills will not occur, rather than on the possibility that they might. Various sections of the application indicate the potentially serious effect oil spills could have on certain biological groups in the Port Angeles Harbour area, Admiralty Inlet, Strait of Juan de Fuca area, and Saratoga Passage area. The potential effects of submarine pipeline spills (as opposed to surface spills) however, are played down by use of the statistics above.

In particular, the environmental severity of submarine pipeline related oil spills in the Port Angeles Harbour area is not addressed directly, or for other submarine pipeline sections, is given cursory treatment because such oil spills are dismissed as being unlikely causes of pollution when compared to other oil spill sources (such as transfer spills of crude oil).

As well, discussion on environmental impact severity resulting from a large rupture generally seems to place great reliance on the leak detection system proposed. A response time of approximately 5 minutes is anticipated for the unloading pipelines and approximately 2 minutes for the other submarine pipelines for ruptures involving leaks at 0.5% of throughput (NTPC Application Vol. III, p.2.11-46 and p.2.11-95). However, "leaks below this limit would continue at a rate of 4,665 bpd (for the ultimate systems throughput) or less until detected visibly on the water's surface... As part of the NTPC oil surveillance program an aerial patrol will traverse the strait following the pipeline route a minimum of once every two weeks to detect visually any small leak that might occur." (NTPC Application Vol. III p.2.11-95). Therefore if a submarine leak below the detection limit occurred between two aerial surveys and remained undetected at the surface for 3 days, then 3 days x 4,665 bpd = 13,995 barrels. Spills of this size could be very significant for the critical species and areas identified for the area (ERT, 1979).

Much of the discussion on the effects of crude oil, relies on comparison of an oil spill in the Santa Barbara Channel with

the effects in the Port Angeles Harbour/Puget/Sound area. Comparisons such as these are subject to qualification. Firstly, a sufficient pre-spill data base was not available to allow detailed pre-and-post spill effects to be made (Straughan, 1971). Secondly, Straughan and Hadley (1978) show that comparisons of oil spills between marine areas should be treated with caution because of differences in effect caused by differences in temperature, crude oil type and species within that area. A further geographical difference should be noted; Port Angeles and Puget Sound shoreline differs from the exposed Santa Barbara coastline. The Port Angeles and Puget Sound area bears more geographic similarity to the biologically and economically sensitive Japanese Seto Sea, where a 50,000 barrel oil spill occurred in December, 1979. Major long-term effects were avoided in the Seto Sea largely as a result of a massive (357,000 workers) and costly (approximately $200 million) clean-up operation (Hiyama, 1979).

Because the oil spill impact from a submarine pipeline is largely ignored for Port Angeles Harbour, the potential short and long-term impact on several biological groups has been insufficiently addressed. Marine bivalves (such as clams) reproductive capability can be affected by crude toxicity (Renzoni, 1975) and both survival and growth can be impaired on oil spill sites (Sow, 1975). This could be critical for the shellfish resources off Ediz Hook and Port Angeles. As well, a fuel oil spill in West Fallmouth, Mass. in 1969 resulted in both severe short-term impact to a saltmarsh habitat (Sanders et al, 1972) and longer term population impact on some species, such as crabs (Krebs and Burns, 1978). Further studies should be conducted in the Ediz Hook to Dungeness Spit area to assess in detail the biological effects of a submarine pipeline rupture.

## 1.2 RIVER CROSSINGS

### A4) Assessment of Construction and Operation Designs Proposed

EXPLANATION:

Stream crossings present special difficulties for overland pipelines. The methods used for construction and operation must take into consideration the size and physical features of the streams crossed.

BACKGROUND - NTPC APPLICATION:

| | SOURCE |
|---|---|
| "As required by DOT regulations, the cover over the pipeline will be a minimum of 48 inches below the 100-year flood level scour depth at waterway crossings unless rock excavation is encountered, where the cover may be reduced to 18 inches. At all major stream crossings, the wall thickness of the pipe will be increased by 20% to provide an additional safety factor at the crossing; additional thickness of corrosion preventive coating will be provided; and either continuous concrete coating or individual concrete weights will be applied to provide the negative buoyancy required to keep the pipeline buried beneath the stream bed." | Vol. II p.6-64 |
| Table II-6.3-4 shows the major and minor stream and river crossings found within Clallam County; Dungeness River, Siebert Creek, McDonald Creek, Matriotti Creek, Cassalery Creek, Gierin Creek, and five irrigation ditches and unnamed creeks. | Vol. II p.6-67 |
| Mainline valves will be installed "on each side of a water crossing that is more than 100 feet wide from high-water mark to high-water mark;" | Vol. II p.6-84 |
| "Stream flow control measures and channelization will be avoided in all areas of pipeline crossings. The current or natural flow character of the streams will be undisturbed by the pipeline." "The method of excavation and construction of the crossing will be dependent on the characteristics of the waterway. Excavation of the underwater trench will be accomplished by the use of backhoes, draglines, or clamshells. In shallow waters, this equipment can work in a normal manner, resting on the bottom. For deep water excavation, the equipment will be mounted on barges, equipped with power winches, and stabilized by anchors to the stream bottom or by cables to the banks. As excavation of the trench progresses, the barge is repositioned by operation of the winches. The excavated material will be placed on the stream bottom adjacent to the ditch to be used as backfill after the pipeline | Vol. II p.6-108 |

is in place. If the crossing permit requires that the excavated material be replaced with select material, then it will be loaded on barges as excavation progresses and carried to shore for disposal.
Streams with sand bottoms and flowing surface water will be wet excavated by means of a dredge or dragline. Sand bottom streams carrying subsurface water will be de-watered with well points and dry excavated with a dragline.
Crossings of drainage ditches and irrigation canals that cannot be open cut will be constructed by boring beneath or spanning overhead as may be required by the agency with jurisdiction.".

DISCUSSION:

Construction and installation of the pipeline over stream crossings in Clallam County does not appear to be an important issue. The major concern of burial depth has been considered, and procedures appear consistent with basic design criteria, subject to final stage details. Stream crossing pipeline engineering is generally a well developed field.

## A5) Potential Environmental Impacts

EXPLANATION:

Oil pipeline crossings of streams can have impacts upon the associated environment during both the construction and operational phases. The degree of impact will depend upon a number of factors.

| BACKGROUND - NTPC APPLICATION: | SOURCE |
|---|---|
| "Streams crossed in the Olympic foothills are in the Dungeness River drainage; these streams are classified as being excellent quality by the State of Washington (1977). Irrigation withdrawals affect stream flows in this drainage, and agricultural, muncipal, and logging activities cause some degradation of water quality, mostly by increasing levels of suspended solids and organic loads. Flows in the Dungeness River average about 470 cfs, with low flows of about 100 cfs and high flows of about 1,300 cfs." | Vol. III p.1.3-18 |
| "Suspended sediment levels are expected to vary widely during excavation, and maximum instantaneous values of several hundred mg/l are expected to occur just downstream from the dredging operation. Assuming that downstream transport of suspended sediment is dependent only on current speed and settling velocity, turbid sediment could be carried about 5 miles downstream before settling to the stream bottom... The crossing of the Dungeness River is about 5 miles from its mouth, and some of the disturbed sediment is expected to reach Dungeness Bay." | Vol. III p.2.3-26 |
| "Any oil spills or leaks from the proposed pipeline into streams in the Puget Sound region of Washington will be of special significance. Most of the streams are classified AA (extraordinary quality), and a portion of any oil released to these streams will probably be transported downstream into embayments in the Strait of Juan de Fuca or Puget Sound... In the Dungeness River, a spill at the river crossing would reach Dungeness Bay in about one to two hours." | Vol. III p.2.3-32 |
| "Leaks that are less than 0.5% of the pipeline capacity could go undetected by the automatic detection system (see Section II-6.3). Based on a maximum volume of 933,000 bpd, leaks of up to | Vol. III p.2.3-31 |

4,665 bpd could go undetected by this system and remain undetected until visually sighted by aerial line patrols, ground patrols, or third party observers."

For the Puget Sound Region, "In all stream types the suspended sediment should not greatly increase the existing sediment loads; thus, effects of sediments and deposition on salmon spawning should not be significant." Vol. III p.2.5-32

DISCUSSION:

The proximity of the proposed pipeline route to the Clallam County coastline, exposes both streams crossed and the associated marine habitat (particularly the Dungeness estuary) to the effects of construction and operational mishaps. These effects include sedimentation, flow rate changes, blasting concussion damage, migration and accidental contamination of fish through construction related activities and operational spills.

Sedimentation can result from clearing, grading, ditching, and back-filling activities on land, in-stream construction activities, and the operation of transportation and construction equipment on disturbed areas. Adult fish are not usually directly affected by suspended sediments unless concentrations are so high that they cause abrasions to gills and clogging of gas exchange mechanisms (Phillips, 1971). When suspended sediment settles out on the stream bed, it can blanket spawning beds and substrates containing invertebrate organisms (Cordone and Kelley, 1961; Dryden and Stein, 1975). As indicated in the application (Vol. III, p.2.3-26), Dungeness Bay could also be affected by sediment loads.

Temporary flow rate changes are likely from the possible extraction of pipeline test water from the Dungeness River. The principal freshwater issues associated with water withdrawal are the biological effects of altered stream flows and aquatic organisms being drawn into intakes. If withdrawal occurs during periods of upstream salmon spawning migrations low flows could result in impeded passage.

If explosives are used to excavate a pipeline trench in stream beds containing bedrock or large boulders, acoustic waves can cause damage to the tissues and organs of fish; the swim bladder is particularly vulnerable to damage (Tyler, 1960). The strength of the shock waves from blasting depends upon distance from the blast, water depth, strength of charge, substrate type and position of charge. The radius of shock waves is much shorter in shallow water than in deep water because of absorption of shock waves striking the bottom (Busbee, 1963). The principle fisheries concern associated with blasting is the possible effect on populations of spawning, rearing, migrating or overwintering fish.

Obstructions to fish passage can occur from vegetation removed from banks during in-stream construction activities and by the accumulation of construction associated solid waste material. Removed vegetation can collect downstream (eg. at culverts) to prevent fish movement. The placement of excavated material on the beds of small shallow streams may cause a weir effect and impair fish passage by increasing stream velocity. Discarded waste material (eg. pieces of construction material) could impede fish movement by collecting downstream.

Construction related spills might involve liquids such as diesel fuel and gasoline as well as propane, lubricants and hydraulic fluid and solvents. Diesel fuel spilled in a stream in California caused fish mortality (Bury, 1972). Gasoline is also toxic to fish and spills of gasoline can cause measurable damage to invertebrate communities for a period of several months (McKee and Wolfe, 1963). Kavanaugh and Townsend (1977) indicate that construction related oil spills were common occurences along the Trans-Alaskan Pipeline, and that reporting and clean-up procedures were often not followed.

Operational oil spills could occur and based on the 933,000 bpd through-put, leaks of 4,665 bpd could go undetected by the described automatic detection system (NTPC Application, Vol. III p2.3-31). Both downstream fish and invertebrate habitat and Dungeness Bay eelgrass beds would be exposed to such a spill. Impingement of oil on the eelgrass beds would have significant repercussions on the surrounding ecosystem (Thayer and Phillips, 1977).

2. TERMINAL FACILITIES
2.1 TANKER DESIGN AND OFFLOADING OPERATIONS

A6) Assessment of Risk and Sources of Oil Spills in Port Angeles Harbor and Strait of Juan de Fuca

EXPLANATION:

Oil spills in harbors frequently occur during transfer operations, and transfer terminals can provide a source of chronic oil pollution. Risk analysis conclusions can be misleading due to the data base being inappropriate.

| BACKGROUND - NTPC APPLICATION: | SOURCE |
|---|---|
| "Four unloading arms will be installed on a steel-framed structure on each service platform to provide a maximum unloading rate of 100,000 gph, with acceptable pressure drop and flow velocity." | Vol. II p.6-11 |
| "All piping, valves, fittings, and connections will be designed to withstand stresses resulting from operating and transient pressures, as well as stresses resulting from the support system, external loads and temperature changes." | Vol. II p.6-11 |
| "The arm ends will be provided with hydraulic actuated couplers designed to withstand safely internal pressures and mechanical loadings." | Vol. II p.6-12 |
| "The terminal dispatcher will open and close the proper tank manifold valves to the onshore storage facilities and when all is ready will give clearance to commence unloading by activating permissive circuits that will allow the dock supervisor to open the marine unloading arm isolating valves. The tanker crew will then be advised to start the ship's pumps." | Vol. II p.6-202 |
| "After cargo has been unloaded and all pumps have stopped, the unloading arm and tank manifold valves will be closed. The unloading arms will then be cleared of oil and disconnected from the ship's manifold." | Vol. II p.6-202 |
| "Oil spill probabilities are estimated for both operational and casualty-related spills based on statistics from the 1971-1972 world tanker fleet data base. To account for possible variations from site-specific factors, environmental conditions (fog, waves, and so forth), operating conditions (navigation controls, traffic levels), and geographic conditions (configuration of the Strait of Juan de Fuca and Port Angeles | Vol. III p.2.11-4 |

harbor) are analyzed. Similarly, the risks are analyzed using different assumptions in the data base. The results of these analyses confirm that use of the 1971-1972 data base provides the most conservative risk analysis, even accounting for site-specific factors."

"During 1971 and 1972, the USCG reported a nationwide total of 624 vessel-related harbor spills of crude oil and refined products, including a nationwide total of 1,000 barrels or less of crude oil." Vol. III p.2.11-5

"A USCG study of oil cargo transfers from tankers and barges (Leaotta and Taylor 1973) found that the quantity of oil transferred has little bearing on the probability of an accidental discharge because it is during hookup and disconnection that most discharges occur. Operational spills are more accurately related to transfer operations or vessel calls than to volume of oil handled on this basis." Vol. III p.2.11-6

For Port Angeles harbor and its approaches:

"Environmental factors most likely to influence accident statistics are incidence and extent of fog, severe storms, and extreme wind and wave conditions. Other influencing factors include hazards from military operations and collisions with fishing vessels or nets. Where appropriate, an attempt is made to identify those mitigating measures or counterposing influences that might lessen the risks." Vol. III p.2.11-21

DISCUSSION:

Loading arms and other equipment associated with tanker-to-pipeline oil transfer should not be a source of large oil spills. The specifications of piping, valves, and connections to be used for the unloading arms and the anticipated stresses on them are not provided and a review of the design of these items cannot be made until they are provided. However, the reviewers assume that NTPC will apply API standards and other safety standards to their engineering designs. A description of the communication pattern to be established between ship and dock (specifically ship's crew operating ship's pumps) is not provided. The proposed communication standards should be addressed by NTPC.

The likelihood of oil escape during vessel unloading operations has been adequately considered in the NTPC Application. NTPC proposes continuous enclosement of the area around the unloading platform with oil containment booms during oil transfer operations.

A major spill in the harbor due to collision, could result in serious environmental and property damage. The capability of cleaning up oil spills by mechanical means is essential, as it is unlikely that permission would be given to use chemical dispersants and natural flushing of the harbor is slow.

There are a few areas in the world where nature takes care of pollution problems in oil ports. One of these is at Milford Haven in Wales. This is a major deep-water port and is often quoted by the oil industry as being a good example of a lack of environmental damage from oil spills along a major enclosed waterway subjected to heavy tanker traffic. The Haven which is the approaching waterway to Milford Haven is very deep water with 25 ft. tides (Dicks, 1975). Due to this flushing action and to the general acceptance of dispersants in the U.K., chemicals are used widely. The dilution effect of the large water body and the tidal movement results in little concentration of oil that could cause environmental damage. However, Port Angeles Harbor is not a comparable situation.

The data base for the NTPC risk analysis is the historic record of oil spills in the Puget Sound (1969-1975, Fig. A6-2) area and world tanker fleet losses in U.S.A. waters for 1971-72. The reviewers conclude that use of the Puget Sound data is not really relevant since few larger tankers entered the area during the time the figures were obtained (Re: Fig. A6-3), and that the latter world figures are out of date. Much more recent tanker casualty figures involving world tanker fleet data on a global scale, indicate an increase in the number of incidents involving large tankers (Lloyds accident Bulletin, 1977-79).

The reviewers recommend that NTPC carry out a much more comprehensive spill risk analysis than has been computed to date. Such a review should use the latest world shipping accident data available and take into account at least the eleven factors listed by a group known as the Oil Companies International Marine Forum. This group is made up of world shipping representatives with wide operational tanker experience. (O.C.I.M.F., 1979)

These factors were concluded by this group as having the main influence on an evaluation of the risk of an incident along

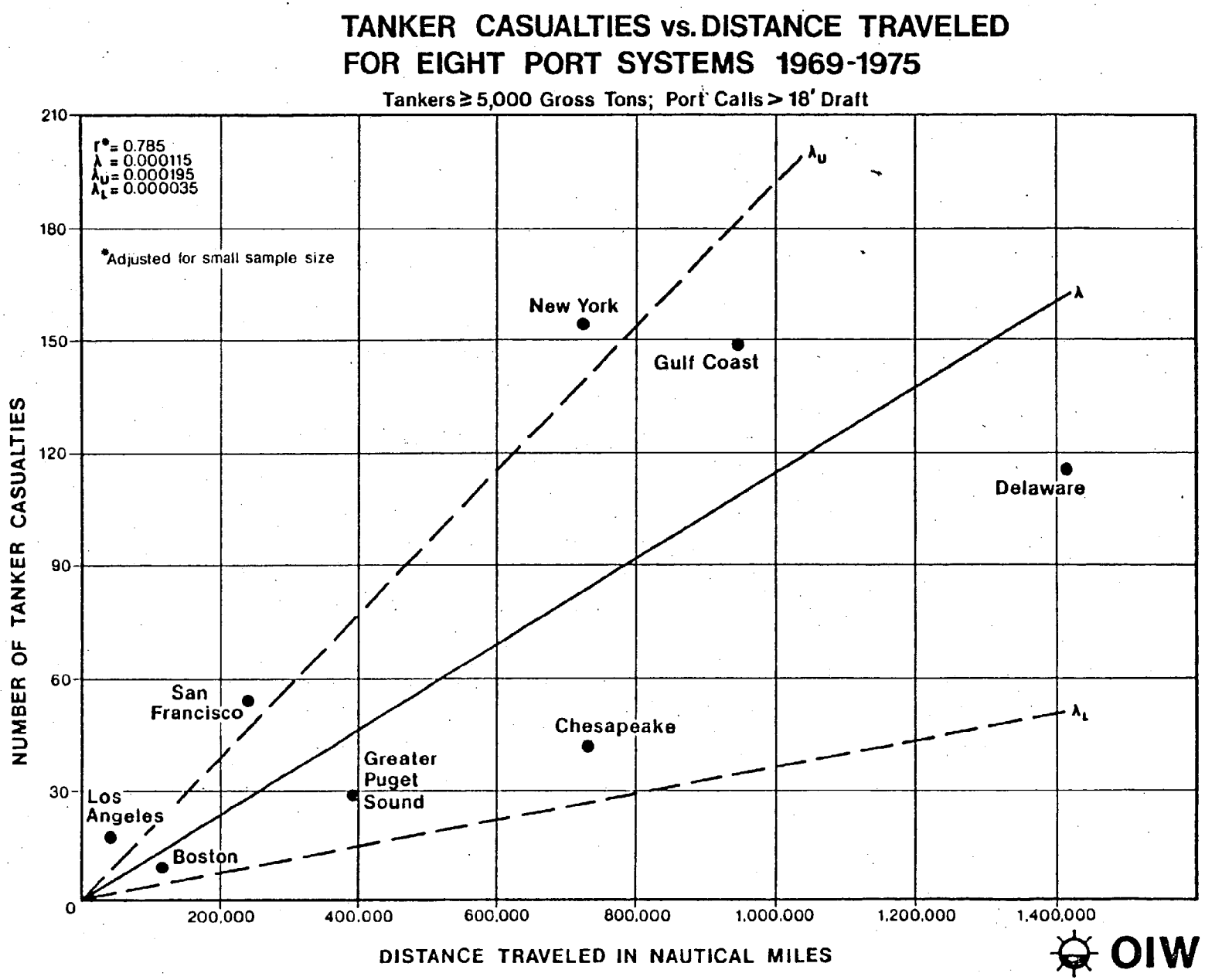
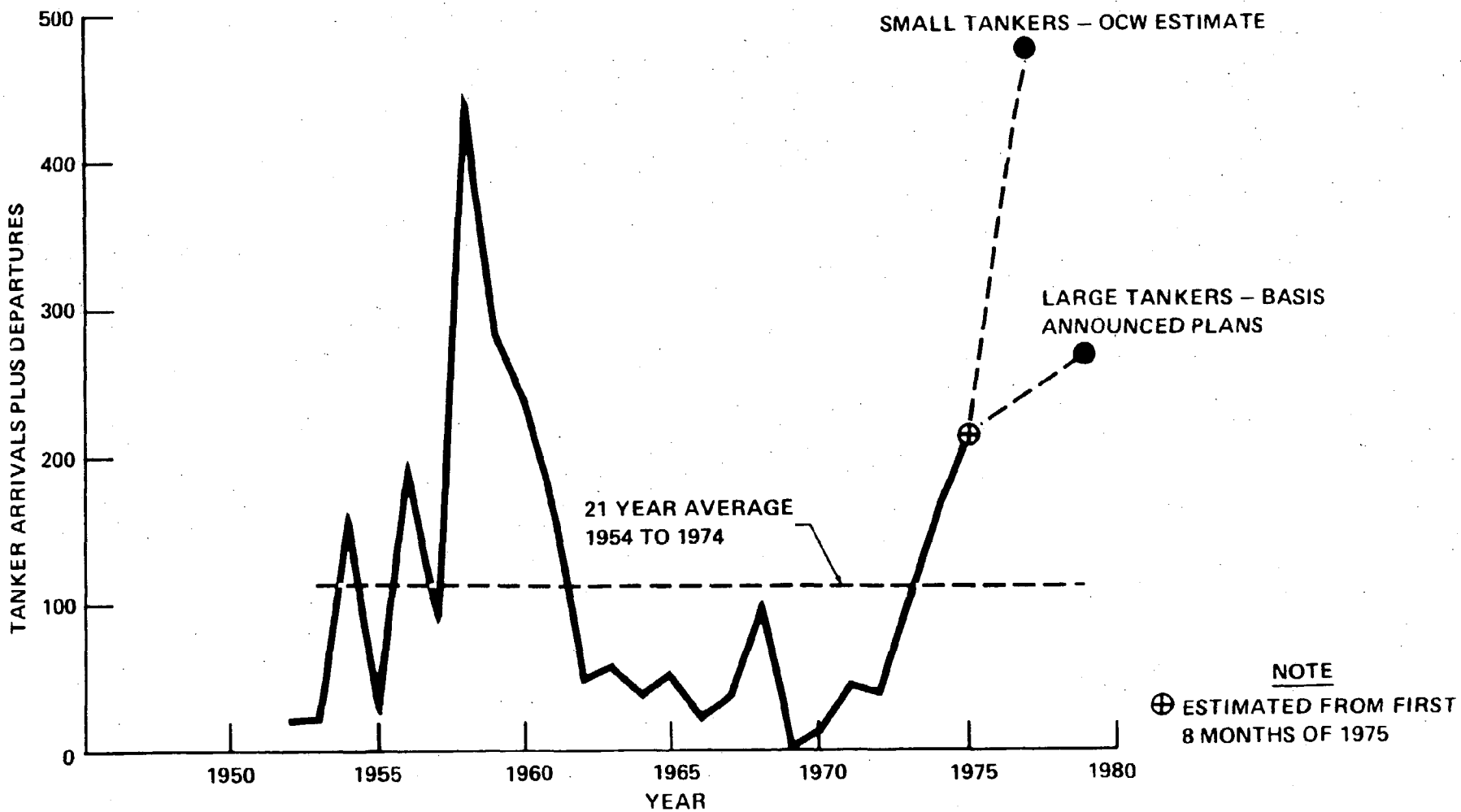

TANKER CASUALTIES vs. DISTANCE TRAVELED
FOR EIGHT PORT SYSTEMS 1969-1975
Tankers ≥ 5,000 Gross Tons; Port Calls > 18' Draft
r* = 0.785
λ = 0.000115
λU = 0.000195
λL = 0.000035
*Adjusted for small sample size
λU
λ
λL
New York
Gulf Coast
Delaware
San Francisco
Chesapeake
Greater Puget Sound
Los Angeles
Boston
NUMBER OF TANKER CASUALTIES
0
30
60
90
120
150
180
210
200,000
400,000
600,000
800,000
1,000,000
1,200,000
1,400,000
DISTANCE TRAVELED IN NAUTICAL MILES
OIW

Fig. A6-2

Fig. A6-3

**CRUDE TANKER ARRIVALS PLUS DEPARTURES THROUGH STRAIT OF JUAN DE FUCA AND SOUTHERN ROSARIO STRAIT**

SOURCE: SEATTLE CHAMBER OF COMMERCE; SHIPPING

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world tanker routes. They are:

1) Traffic density
2) Crossing traffic
3) Width of navigable area
4) Varying visibility and weather
5) Navigational constraints (shoal waters, rocks, islands, etc.)
6) Routing Systems/Traffic Advisory Systems
7) Rounding of headlands
8) Navigational Aids (human)
9) Navigational data
10) Hydrographic data
11) Nature of bottom

Such an assessment should also consider the following factors more site-specific to Port Angeles:

Negative Factors

1) Bad weather conditions relative to visibility, frequent fog along southly in bound traffic lane.
2) No mandatory traffic control at present.
3) No pilot until vessel reaches Port Angeles.
4) Narrow shipping lanes.
5) Rocky shores would damage grounded vessel.
6) No salvage tugs available capable of refloating grounded VLCC.
7) Single screw vessels.
8) High tides and currents.
9) Approximately 50% foreign flag vessels.
10) Oil spill clean-up on water extremely difficult.
11) Earthquake and tidal wave area.
12) Sensitive biological environment.

Positive Factors

1) Relatively low traffic concentration (cf. English Channel, Thames River, Europort (Rotterdam)).
2) Radar surveillance.
3) Deep water.
4) Relatively protected waters from heavy storms.
5) Hydrographic data good.
6) No islands or other obstructions near to shipping lane.

In conclusion, it is of interest to note that that the statistics shown in the publication (O.C.I.M.F., 1979) indicate that tanker accident probabilities in the United States are greater than the world average, and that 92% of all accidents occur in port. The reviewers' concern is not with the small spills from transfer operations or small tankers, but the fact that Port Angeles will be the first port in the U.S.A. to receive VLCCs if the NTPC proposal is accepted. Other sections of this report point out the difficulties in handling such vessels within the port area which compounds the probability of a collision or grounding resulting in a major oil spill.

hcl

A7) Design of the Proposed Surge Relief Tank

EXPLANATION:

The surge relief tank plays an important role in preventing oil spills during vessel unloading operations.

| BACKGROUND - NTPC APPLICATION: | SOURCE |
|---|---|
| "The system will consist of a fast-acting relief valve on each unloading line set to relieve at pressures slightly greater than normal operating pressures and a tank for receiving crude oil diverted through the relief valves. The tank capacity will be designed to contain six minutes of ships' discharge at the rate of 100,000 bph (10,000 barrels) and will be located at distances from adjacent facilities in accordance with applicable code requirements." | Vol. II p.6-15 |

DISCUSSION:

The following statement has been taken from the testimony of Mr. N. Tilden: "The surge (relief) tank may be larger than necessary, but we have not yet done an analysis by computer to determine this." The important design criteria for the surge relief tank are not discussed in the documentation or the testimony reviewed. In fact, it appears that the surge relief tank sizing was based on the space available for it. The experience at other oil ports with surge relief tanks, i.e. sizing, design, frequency of utilization, problems encountered, etc., is not discussed. The surge relief tank design criteria requires better explanation. This is an issue which can be easily resolved by engineering design.

The following points are worthy of consideration:

1. Procedures are not outlined for action to be taken if surge discharge exceeds 6 minutes in length (i.e. where would excess crude oil be directed);

2. The basis for the 6 minute retention design parameter is not clear;

3. The specifications of the "fast-acting relief valve" are not provided nor are the anticipated surge pressures. The capability of the relief valve will depend on the peak pressures to which it will be subjected;

4. If the "applicable code requirements" are known and understood, the distances of the relief tank from the proposed facilities should be defined.

## A8) The "Butler Marine Terminal Simulator"

EXPLANATION:

The operation of a marine terminal requires a coordinated scheme capable of integrating ship and shore activities, without significant operational delays. The scheme should be versatile to contend with unforeseen delays.

BACKGROUND - NTPC APPLICATION:

| | SOURCE |
|---|---|
| "The purpose of the program is to enable the user to make informed design judgments; the program itself makes no such judgments, but merely reports the effects of different design and operating assumptions on terminal performance." | Butler Marine Terminal Simulator (version II) p.1 |
| "At the time of this writing the use is limited to a maximum of: | p.3 |

1) four berths
2) four liquid types
3) ten tanks per liquid type
4) one pipeline

| | |
|---|---|
| "An inbound tanker will advise the terminal by ship to shore radio link of its estimated time of arrival 24 to 36 hours from port." | Vol. II p.6-201 |

DISCUSSION:

It is important to note that the simulator does not indicate consequences to tanker traffic of prolonged or unforeseen delays. The model user must estimate harbor and other delays which might affect terminal operation and presumably must recommend arrival patterns for in-bound traffic. Consequently, the user will have no model by which he can guage the impact on shipping lanes or anchorage sites for the recommended arrival pattern change.

The Marine Terminal Simulator (Version II) paper is extremely general and therefore open to numerous questions of both a specific and general nature. For example, it is not apparent whether the Butler Marine Terminal Simulator has been used at other oil ports and, if so, how effective the program was in predicting important port operating criteria. In the text that follows, statements taken from the Marine Terminal Simulator, Version II are presented; questions with respect to each of these statements are provided:

Statement 1: "The purpose of the program is to enable the user to make informed design judgments; the program itself makes no such judgments but merely reports the effects of different design and operating assumptions on terminal performance."

Comment: The human element involved in design judgment is evident. The qualifications and experience of the person or persons making the judgment is very important and should be questioned.

Statement 2: "Ships arrive according to a pattern specified in advance by the user."

Comment: How does user arrive at the pattern? What types of delays are taken into account in the program?

Statement 3: "When a ship is cleared for berthing and berthing delay is allowed to pass before the ship begins to unload."

Comment: What are the critical factors involved in determining what a berthing delay consists of? How is this berthing delay incorporated into the simulator program? Other potential delays such as terminal equipment failure or emergencies, weather extremes or labor disruption do not appear part of the simulator model at its present stage of development.

Statement 4: Program Output:

Under the "Program Output" heading a list of "Input Items" is presented. Input Items 2 and 4 are noteworthy. Item 2 stipulates initial pipeline start-up delay; Item 4, berthing and deberthing delay times by liquid type. These so-called "input items" are difficult variables to come to grips with. Since these input variables are subject to the judgment of the user, the output from the program is subject to questioning.

Overall Conclusions:

Based on the very limited information presented, it is impossible to determine the value of the Butler Marine Terminal Simulator. It is most important to have Northern Tier address the previous situations during which the Simulator was used, and to relate the situations involved to the proposed development of the Port Angeles harbor. It appears that the Butler Marine Terminal Simulator can best be classified as an indicator of port activities during a period when all activities are occurring as planned; the ability to accomodate unforeseen delays does not appear to have been allowed for in the simulator sketch provided.

## A9) Vessel Crew Unloading Monitoring and Oil Spill Response Capability

EXPLANATION:

During unloading operations, trained crew members should be on duty to help monitor operations and provide on-board support as required. Oil spills resulting from unloading operations can be attended to most quickly by vessel crews. The capabilities and preparedness of tanker crews will vary.

BACKGROUND - NTPC APPLICATION:

| | SOURCE |
|---|---|
| During unloading operations and upon clearance by the terminal dispatcher to commence unloading "the tanker crew will then be advised to start the ships' pumps". | Vol. II p.6-202 |
| "After cargo has been unloaded and all pumps have stopped, the unloading arm and tank manifold valves will be closed. The unloading arms will then be cleared of oil and disconnected from the ships' manifold. Concurrently, the final gauging and checking of ship's tanks will be accomplished". | Vol. II p.6-202 |

DISCUSSION:

The crew of the vessel unloading oil could play a significant role in the early detection of a spill and responding to the spill in an appropriate manner. In the NTPC documentation, no indication is given with respect to the role of the crews in monitoring unloading activities and responding to oil spill situations. This subject should be addressed. In addition, the communication system between the tanker and shore based personnel should be described.

International tankers do not carry oil spill equipment on board and crews are generally not trained with respect to their roles during an oil spill. There is no indication in the documentation that the Port Angeles terminal facilities would have more stringent requirements with respect to the subjects discussed above.

A10) Overview of Proposed Tank Farm.

EXPLANATION:

Tank farm design must conform to standards necessary for adequate public safety and acceptable environmental impact risk.

BACKGROUND - NTPC APPLICATION:

| | SOURCE |
|---|---|
| The onshore storage facilities "will be constructed on a site approximately 6 miles east of Port Angeles near Green Point. The facilities will include the storage tanks and appurtenances, piping systems, oil-water seperators, oil measurement facilities, a control building, environmental controls, support facilities, and services". | Vol. II p.6-32 |
| "storage tanks will be constructed in phases to accommodate the anticipated growth in terminal volumes and to provide gross storage capacity approximately equal to ten days of average daily volume. Tanks and appurtenances will be designed, fabricated and tested in conformance with the requirements of applicable standards and codes." | Vol. II p.6-35 |
| "The proposed storage tanks each will be 285 feet in diameter with a shell height of 56 feet. The tanks will be equipped with floating roofs having primary and secondary seals ..." | Vol. II p.6-35 |
| "The filling lines and manifolds will be designed for the maximum tanker unloading rate of 100,000 bph rate with acceptable pressure draft." | Vol. II p.6-37 |
| "The design, material fabrication, and erection of the storage tanks will be performed by a tank contracting specialist. Material fabrication, forming, and cutting the steel plates will be performed by the tank contractor at a fabrication plant prior to delivery." | Vol. II p.6-143 |
| "Facilities to be constructed or installed by the mechanical and electrical contractors will include oil water separators, fire fighting equipment, utilities, power supply, communications system, controls, and instrumentation." | Vol. II p.6-145 |
| "The marine terminal operations will be controlled and monitored from the main control center located at the onshore facilities near Green Point. Terminal dispatchers will be in charge of the tanker unloading and onshore storage facilities." | Vol. II p.6-197 |

hej

DISCUSSION:

The basic design and construction plans if carried out to API and other applicable standards, represent an acceptable engineering risk. Foundational designs are well within the precedents that have been established. The interglacial soils at the site do not appear to be a problem as foundation material.

Although accidents do happen at tank farms (Section B6) resulting in fires, explosions and/or oil spills, tank farms in general have a good operating record.

## 2.2 TRANSIT AND MANEUVERING OF VESSELS

### A11) Terminal Facility Interaction with Navigational Hazards and Port Angeles Harbor Traffic

EXPLANATION:

Existing navigational hazards and harbor traffic accident risks will be compounded by the placement of an in-harbor terminal facility and by associated terminal tanker traffic.

| BACKGROUND - NTPC APPLICATION: | SOURCE |
|---|---|
| "The harbor is approximately 3 miles long by over 1 mile wide at its entrance. Its deepest water, shown in Figure II-6.1-1 is adjacent Ediz Hook, where depths up to 100 feet occur within 600 to 700 feet off the southern shore of Ediz Hook and extend 2,000 to 3,000 feet across the harbor area." | Vol. II p.6-3 |
| "According to the COE, approximately 3,500 vessels with a maximum draft of 39 feet entered and departed Port Angeles Harbor in 1976." | NTPC Vol. III p.1.14-9 |
| Total traffic recorded by the U.S. Coast Guard VTS in 1977 was 15,216 "which represents about 95% of the estimated traffic in the Strait (Butler Associates Inc., 1978)." This figure represents the number of vessel movements not number of vessels. | Vol. III p.1.14-15<br>Vol. III p.1.14-14<br>EFSEC p.2-132 |
| Vessel types recorded by the VTS include "Freighter", "Tanker", "Tug", "Government" "Ferry", "Misc."; sepcific reference is not made to fishing vessels. However, in reference to the same figures, the EFSEC Draft Environmental Statement states: "In addition, there is an unknown number of transits by private craft and commercial fishing boats which are not recorded as part of VTS." In reference to log carriers, "because of the seasonal nature of log shipments, periods of considerable congestion and ship queuing have occurred when volumes are on the order of 100,000 tons per year." | Vol. III p.1.14-15<br>EFSEC p.2-102<br>Vol. III p.1.14-14 |
| Projected design capacity tanker calls "will generate 433 port calls per year, (395 crude oil and 38 fuel oil tankers)" and "service times for this level of tanker calls will incrase average waiting time to 40% of service times "or approximately 12 hours". | Vol. III p.2.14-18<br>Vol. III p.2.14-18 |

| | |
|---|---|
| "At least one line handling launch will be provided by Northern Tier. Others, when needed, will be available on a contract basis. Tug service will be provided by others; however, before beginning operations Northern Tier will insure that a sufficient number of properly sized tugs are available." | Prefiled Testimony #1 Tilden p.10 |
| "I expect that a fleet of three to four tugs will be required and they would be likely based in Port Angeles Harbor." | Prefiled Testimony Bader p.3 |
| "On a daily basis the Northern Tier project would add about 2 or 3 vessel movements to the existing traffic and thus increase vessel traffic to about 53 or 54 vessels (based on 1978 statistics)." | Prefiled Testimony Bader p.3 |

DISCUSSION:

1. No indication is made of a marker system (buoys, or guidance lights) for the entry of and/or maneuvering and anchorage of VLCCs. The absence of a marker system will leave the placement of tankers in the maneuvering and anchorage areas up to pilot knowledge of the area and depth soundings. However, the placement of buoy marker systems (as opposed to guidance lights) could create hazards for smaller vessels trafficking in the area.

2. The possible influence of tidal currents on anchoring and maneuvering of tankers has not been addressed. The harbor is described as having complex pattern of tidal currents, and westerly winds which "tend to drive floatable materials eastward and southward toward shore." (NOAA, 1978).

3. U.S. chart 18468 shows sand in portions of the proposed anchorage area. Very fine, loose silty sand areas have been identified in the NTPC Application (Vol. II, p.6-133) as occurring off Ediz Hook. Vessels anchored in sand could drift eastward and southward during strong northwesterly wind conditions.

4. Anchorage by VLCCs in the harbor as described in the NTPC proposal is difficult to accomplish without a double anchor system. This problem has not been sufficiently researched by NTPC. A possible double anchoring system is shown in Figure A11-1, note that tide changes would cause vessel rotation around both anchor cables in this diagram.

   A vessel of some 300,000 DWT and having a length of 1,113 feet will require at least a minimum length of cable of 900 feet (equal to 10 shackles or "shots") to lie securely at anchor. The diameter of the swinging circle required would therefore be a minimum of some 2,000 feet.

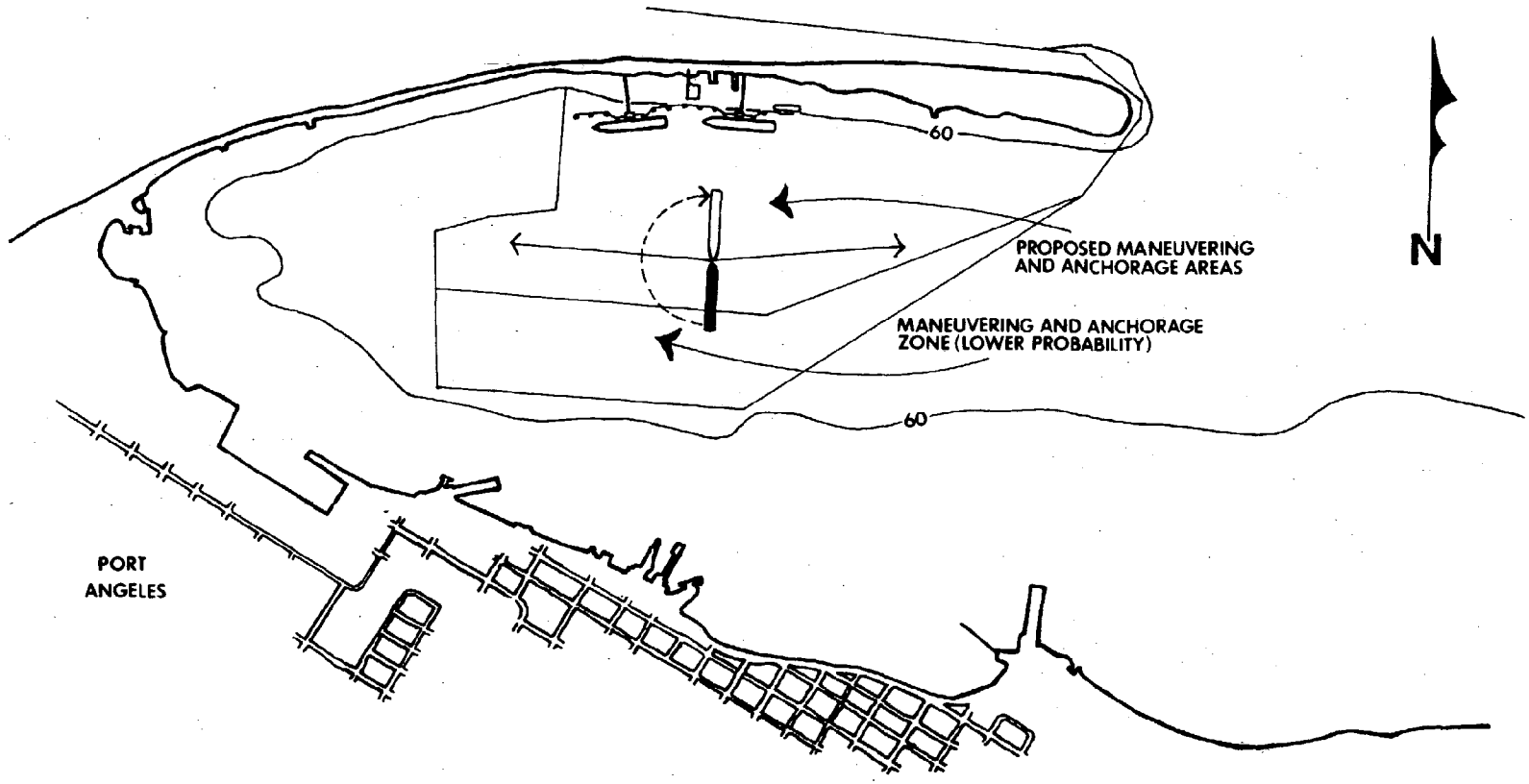



FIGURE A11-1 DOUBLE ANCHORING SYSTEM, PORT ANGELES HARBOUR, WITHIN N.T.P.C. MANEUVERING AND ANCHORAGE AREAS

600 600 1800 3000 4200
0 1200 2400 3600
SCALE IN FEET

hd

Allowance must be made for vessels berthing or unberthing from the oil docks and for vessles lying alongside at the docks (a 300,000 DWT oil tanker has a beam of some 175 feet).

Figure II-6.1-1 "Tanker Unloading Facilities in Port Angeles Harbor" in the NTPC Application shows a berth area of some 1,300 feet width, giving sufficient width for vessels maneuvering into or out of the berths. This plan also shows a "most probable tanker maneuvering and anchorage area" and a "tanker maneuvering and anchorage zone (lower probability)" of a total approximate width of 3,000 feet.

Half of Port Angeles Harbor (U.S. Nautical Chart 18468) is less than 13 fathoms (78 feet). Depths in the lower zone are 11 to 13 fathoms (66 to 78 feet). A 300,000 DWT oil tanker draws 82 feet, therefore the lower zone is unavailable to larger vessels. From these facts, it would appear that a safe swinging circle of 2,000 feet is difficult to obtain unless the vessel anchors well to the north in the anchorage area. A large vessel might then swing dangerously close to the oil berths and any vessels which happen to be alongside them.

Since the space is so limited, this would call for very precise placing of the anchor by the pilot of any large vessel proceeding into the anchorage. This would be very difficult if not impossible for the pilot to accomplish noting that the bridge of a vessel is situated well aft and a long way from the anchor. The vessel is very difficult to maneuver and the vessel direction will be affected by local harbor currents.

Other features of the harbor which might impede docking procedures should be noted. Port Angeles is a busy harbor with considerable ferry and other traffic. Log booms in the vicinity are relatively unmaneuverable and move at very slow speeds when towed.

5. A large vessel anchoring or maneuvering within the narrow confines of the harbor would severely restrict the maneuvering room available to other vessels. Such a problem would be compounded in the event of poor visibility; the Application acknowledges that fog is a frequent occurrence in the Port Angeles area, particularly during summer months. A Devanney et. al., 1979 review of marine collisions has found visibility to be critical and that statistics show low visibility collision occurrences to be 1,000 times greater than high visibility collision occurrences; such collisions are noted to occur even after radar detection has been made.

Oil transfer lines are proposed to the storage facility at Green Point. Restriction on the use of anchors is likely to be imposed in this area. This could inhibit large vessels which have problems of machinery or steering gear failure on entry in the harbor.

6. a) References are made in the NTPC Application to anchorage sites outside of the harbor. G. Bader, in his testimony for Northern Tier states that "although Port Angeles harbor could be used as an anchorage, it appears more likely to me that regulatory agencies would designate an anchorage area outside of Port Angeles harbor for the Northern Tier tankers". However, under cross-examination, Bader indicated that no analysis of alternate anchorage sites has been conducted or is under consideration. The following questions should be addressed by NTPC to clarify this situation:

   i) what areas outside Port Angeles will be used for alternate anchorage sites, if congestion in the harbor requires vessels to move elsewhere?

   ii) if tankers use alternate sites, how will they anchor and what kind of assistance would they require in the event of break-down and/or anchor dragging?

   iii) what penalty system would be imposed if vessels anchoring to the east of Port Angeles harbor inadvertently anchor in or drag over the submarine unloading pipeline?

   iv) where will Puget Sound refinery tankers lighter in the event that they are required to anchor outside Port Angeles harbor?

   b) For tankers anchored in the harbor, the anchoring system used should be described, i.e. how many anchors, deployed in what configuration. The possibility of successive arrivals of log ships, NTPC tankers and Puget Sound refinery tankers has not been addressed nor has an overall traffic management scheme been suggested. As well, the type of communication link between the terminal dispatchers and VTS personnel is not presented.

   Northern Tier should be definitive in its use of Port Angeles harbor as an anchorage site, to prevent confusion by incoming vessels as to whether their occupation of harbor deep water areas will be condoned in emergencies and/or accepted as an habitual occurrence.

7. Given existing traffic patterns identified by NTPC and potential hazards created by VLCC tanker movements in the harbor area, the design and implementation of a master harbor management scheme should be considered. With such a plan, scheduling of harbor use by other concerns could be made in regard to seasonal and daily use by NTPC and NTPC could gauge its harbor activities to the use of Port Angeles harbor waterways by other vessels.

hej

A12) Safe Anchorage Sites

EXPLANATION:

During emergency situations, safe anchorage areas for vessels in distress are critical. For VLCC's which are limited to deep anchorage locations, it is essential that the suitability of nearby safe anchorages be known in advance of emergency situations.

BACKGROUND - NTPC APPLICATION:

| | SOURCE |
|---|---|
| "Alaskan crude will generally be transported in 50,000 DWT to 165,000 DWT tankers. Persian Gulf crude will generally be carried by larger tankers, ranging in size from 200,000 DWT to 300,000 DWT". | Vol. II p.6-6 |
| Based on DWT class characteristics described in the application "the water depth required for a loaded 300,000 DWT class tanker is 90 feet.". | Vol. II p.6-6 |

DISCUSSION:

A discussion of safe anchorage sites is not included in the NTPC application. The testimony of Mr. G. Bader with respect to this subject is relevant and is summarized below. Mr. Bader stated that:

1. no studies have been carried out by NTPC;

2. no studies are being planned by NTPC;

3. information on four sites, Neah Bay, Pillar Point, Clallam Bay and Freshwater Bay, is available (these sites were considered for the oil port and rejected due to proximity to shipping lanes);

4. simulation of the Northern Tier operation may show a need for anchorage.

It is important to emphasize that at some point in time, regardless of how well tanker traffic can be programmed, tankers will be required to drop anchor in or near Port Angeles harbor. The acceptability of a particular anchorage site will depend upon a number of factors including the draft of the tanker, capability of the ocean bottom of holding an anchor, wind conditions, tidal and current conditions etc. It is essential that NTPC develop a plan for the safe anchorage of vessels under a number of operating variables. Potential anchorage sites such as Clallam Bay, Pillar Point and Freshwater Bay may have one or more of the following deficiencies:

1. do not have suitable bottoms at depths at which VLCC's would drop anchor;

2. are exposed to winds from the west, i.e. the prevailing winds;

3. ships at anchor would be in close proximity to the ship traffic lanes.

With respect to item 1, it is possible that permanent anchorages could be constructed. However, to date, NTPC have not addressed this subject.

A13) A Review of Operating Procedures of Tankers in the Strait of Juan de Fuca and Port Angeles Harbor

EXPLANATION:

Safe Operating and docking standards are essential for large vessels such as VLCC's in confined and often unfamiliar coastal areas.

| BACKGROUND - NTPC APPLICATION: | SOURCE |
|---|---|
| "An inbound tanker will advise the terminal by ship-to-shore radio link of its estimated time of arrival 24 to 36 hours from port. Such notice will usually include requests for bunkers, water, ship's stores, and tug assistance and will provide any information regarding the cargo or ship's condition that would affect the berthing and unloading operations." | Vol III p.6-2 |
| "A sufficient number of adequately sized launches will be made available on site. The launches, together with the fireboat and separate oil spill recovery vessel, will be moored at a small dock constructed in the vicinity of the tanker berths". | Vol. II p.6-22 |
| "The number and sizes of tugs required for berthing the tankers at the unloading facilities will be determined following discussions with prospective shippers' marine departments". | Vol. II p.6-22 |
| "I expect a fleet of three to four tugs will be required and they would likely be based in Port Angeles Harbor". | prefiled testimony of Gerald Bader p.3 |
| "The harbor area is felt by the applicants to provide "ample room for maneuvering and turning the largest expected tankers, whether in ballast or fully loaded. Figure II-6.1-1 illustrates the probable harbor space to be used for tanker maneuvering and anchorage.". | Vol. II p.6-3 |

DISCUSSION:

The application provides no details of procedures to be followed for maneuvering and docking tankers. The numbers and sizes of tugboats are left open to future consideration. This could be important if simultaneous berthing and deberthing operations occur, particularly during inclement weather. To dock the larger vessels up to 327,000 DWT would require three 6000 horsepower tugs. These tugs would probably be required only once a day, although they could be required more often as throughput capacity is reached and successive arrivals of crude and bunker tankers surpasses one a day.

It will be possible for large vessels to anchor or wait outside the harbor and to enter when the berth becomes available. A large vessel entering on a draft of 80 feet will be required to pass close to the eastern point of Ediz Hook. To avoid too sharp a turn into the harbor, the vessel would turn well offshore and approach the entrance on a course of approximately 230° True. After rounding the spit buoy, the vessel would turn onto a course of 270° and thence proceed to the berth.

During the maneuvering and while the vessel was picking up her tugs and lining up for the berth, it would be necessary to apply traffic movement limitations. This would avoid the risk of collision. Entry and movement of tankers within the confines of the port should be banned during times of poor visibility.

Problems of Entry

In the event of strong winds creating swell conditions outside the harbor, it might be difficult for tugs to get alongside and secure until the vessel was under the lee of Ediz Hook. In such weather conditions, the vessel may have to keep up a minimum speed of say, three knots, to maintain steerage. The average large tanker has only a proportion of ahead power of roughly 30/40% for astern use. Even with the help tugs, it would be difficult to slow and stop the vessel and line up for the berths in the short distance available after passing the spit buoy. Other vessels in the harbor area would be at risk of collision.

A further point to consider during port entry would be the possibility of sudden machinery or steering gear failure as the vessel was rounding the spit. Provided tugs of adequate power were available, control of the ship should be retained. However, it would be difficult to use vessel astern power, if required, should vessel steering gear fail because the rotation of the propellor would cause the vessel to proceed in an arc.

Problems of Exit

In Section 6.1.6.3 Emission Control, of the NTPC Application, the following is stated: "additional ballast beyond 20% of tanker DWT will be taken into cargo tanks only after the ship is clear of the harbor and Port Angeles vicinity. Tankers without segregated ballast will be limited to a maximum of 20% ballasting while in Port Angeles harbor."

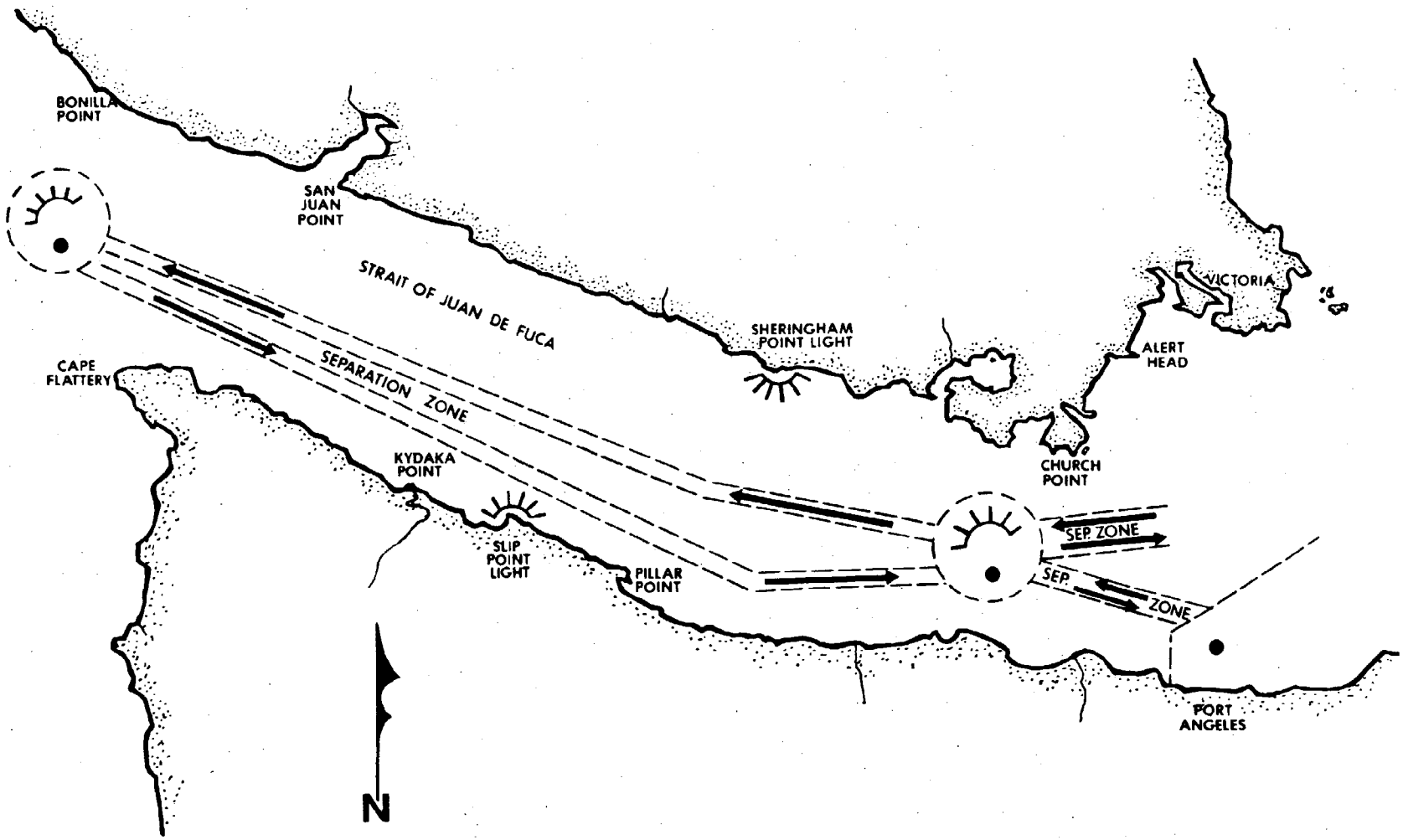
The restriction of 20% seems very small if due allowance has to be made for maneuvering in moderate wind strengths. This gives a 300,000 DWT vessel a ballast weight of only 60,000 tons and a probable mean draft of approximately 30 feet. The ensuing free-board would thus be 75 feet, providing a huge sail area. Such a vessel would be difficult to handle in winds of even moderate strength. This could cause problems for the pilot, particularly if vessels are anchored within the proposed tanker anchorage zone.

Other points for consideration of vessel operating procedures are:

1. It is not indicated whether the tugs decided upon will be capable of dealing with VLCC distress situations during heavy seas in the Strait of Juan de Fuca.

2. It is not indicated whether some tug service will be reserved for exclusive use by Northern Tier Tankers, or if tugs will be in general use (specifically for assisting log carriers). The financial arrangements for tug operation could influence the tug availability.

3. The mandatory imposition of the vessel traffic management scheme for Juan de Fuca Strait would be necessary to increase tanker traffic passage to a safer level. The present traffic separation scheme leading to Port Angeles Harbor is shown in Fig. A13-1. The location of major vessel collision and groundings (1954 to 1973) near Port Angeles Harbor are shown in Fig. A13-2. The critical significance of poor visibility as a factor in marine accidents is discussed in Section A11.




**LEGEND**

- LIGHTS & REPORTING POINTS
- DIRECTION OF TRAFFIC
- PRECAUTIONARY AREA

Fig. A13-1

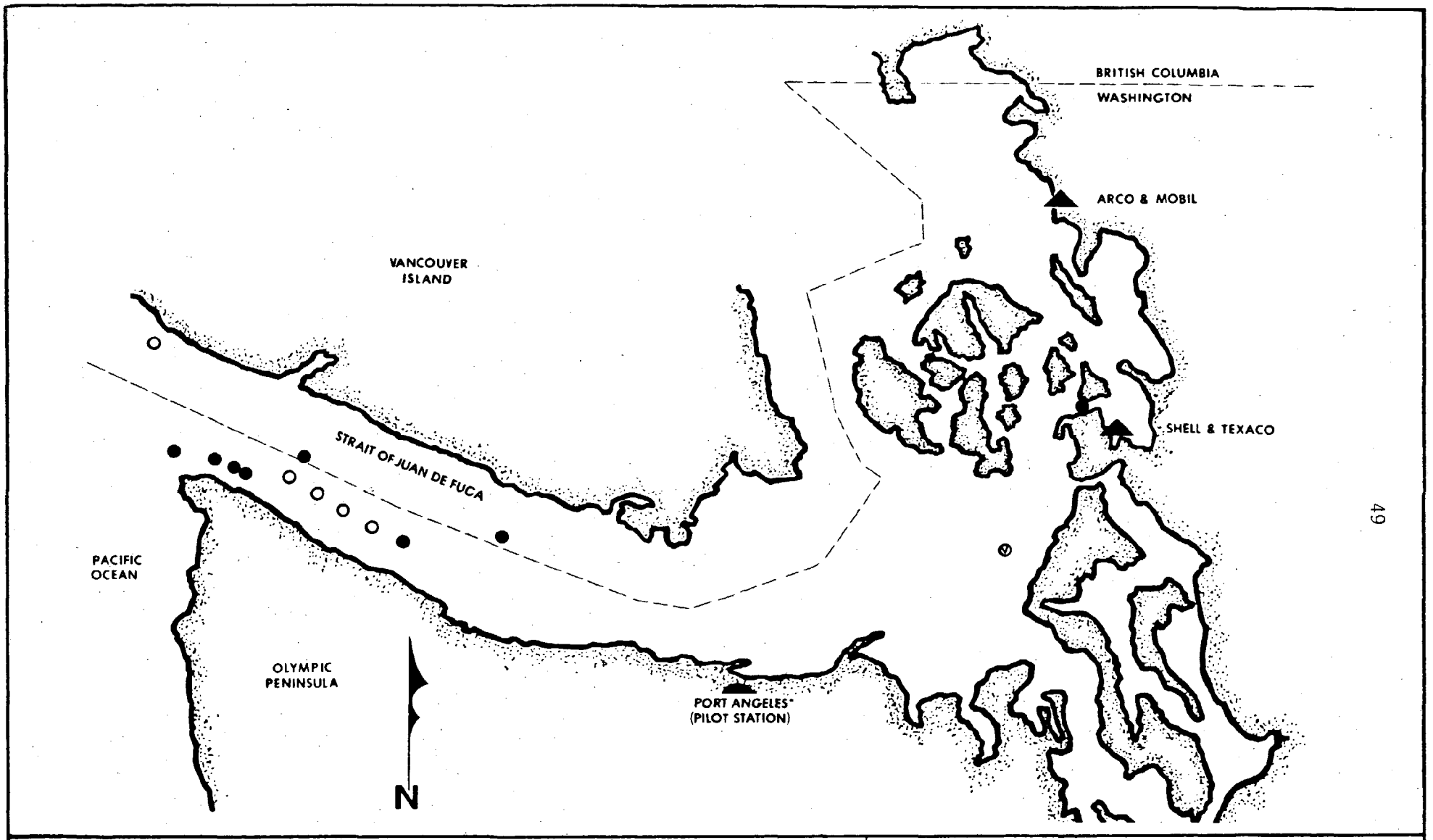
**STRAIT OF JUAN DE FUCA TRAFFIC SEPARATION SCHEME**

Source: Canadian Hydrographic Chart # 3607

**SCALE** 1: 525,000

15 MILES

0 5 10 15




**LEGEND**

- ● VESSEL COLLISIONS
- ○ " " NOT RESEARCHED
- ⊘ VESSEL GROUNDING
- ▲ REFINERIES

Fig. A13-2

**MAJOR COLLISIONS & GROUNDINGS IN NORTHERN PUGET SOUND — JAN/54 TO JUNE/73**

Source: U.S. Coast Guard and Pilots Association

**SCALE** 1 : 841,000

25 MILES

0 5 10 15 20 25

hd

## A14) Non-English Speaking Crew Mishap Relationships

EXPLANATION:

The wide use of multinational crews has created communication difficulties on a number of occasions. In North American waters, English speaking capability is essential for the quick and clear conveyance of important messages.

BACKGROUND - NTPC APPLICATION:

| | SOURCE |
|---|---|
| "The composition of the tanker fleet arriving at the tanker unloading facilities will largely depend on the origin of the crude cargoes." | Vol. II p.6-6 |

DISCUSSION:

There have been accidents involving ships where a foreign language communication problem has contributed to the incident. Records of such problems exist for ports in the Vancouver, B.C. area. However, such incidents are usually related to oil transfer operations between ship and shore. English is the international language of shipping. Officers of all flag ships must pass an English proficiency examination as part of their certification. In the judgement of ship's masters with long sea experience, language communication is not a major problem (Captain R.W. Lumsden, Marine Consultant and Captain M.L.M. Jolivet, Navigation and Safety, Shell International Marine Limited, May 1980, pers. comm.). However, problems do occur. Two recent incidents of communication failure between tanker vessel crews and U.S. Coast Guard personnel have occurred in the Strait of Juan de Fuca. In October, 1976, the White Peony was found using the outbound traffic separation lanes while inbound. Correction of the situation did not occur until hours had passed because of the inability to communicate course instructions. One month later (November, 1976), the Warbah was found in a similar situation, managing to move inward 60 miles along the outbound traffic lane before being boarded by a pilot in Port Angeles.

A15) In-Transit Vessel Assistance Procedures.

EXPLANATION:

The type and degree of assistance provided in-transit vessels is related to the risk of mishap to which the vessels will be exposed. The existence of traffic control systems, radar surveillance, the use of pilots and tugs etc. are relevant to this topic.

BACKGROUND - NTPC APPLICATION:

| | SOURCE |
|---|---|
| "An inbound tanker will advise the terminal by ship-to shore radio link of its estimated time of arrival 24 to 36 hours from port. Such notice will usually include requests for bunkers, water, ship's stores, and tug assistance and will provide any information regarding the cargo or ship's condition that would affect the berthing and unloading operations". | Vol. II p.6-201 |
| "The number and sizes of tugs required for berthing the tankers at the tanker unloading facilities will be determined following discussions with prospective shippers' marine departments. The ordering and payment for tug services will be each ship's responsibility. Private companies presently service the Port Angeles area. Requirements will be discussed with these companies to ensure that adequate tug service will be available when construction of the facilities is completed." | Vol. II p.6-23 |
| "The theoretical average waiting time for initial tanker traffic will be 20% of the average service time; that is, time to berth, unload, and deberth, and ballast, or approximately five to six hours per ship (Swan Wooster Engineering, Inc. 1978). (Average service times, by comparison, will be between 24 and 33 hours per tanker). However, most tankers will occupy much of this theoretical waiting time by slowing down as they approach Port Angeles rather than anchoring in the harbor." | Vol. III p.2.14-15 |
| "According to estimates for the future capacity of the tanker unloading facilities, service times for this level of tanker calls will increase average waiting time to 40% of service times, and some impedance may occur unless additional berthing facilities are provided". | Vol. III p.2.14-18 |

DISCUSSION:

It is the understanding of the reviewers, based on discussions with the Canadian Ministry of Transport, that:

1. The U.S. Coast Guard are currently tracking ships between Cape Flattery and Port Angeles using a radio communication-chart plotting (dead reckoning plot) system;

2. A comprehensive radar system will be in effect in this area within one year or possibly even sooner;

3. At the present time, pilots board vessels heading for Puget Sound ports at Port Angeles, pilots do not board the vessels west of Port Angeles;

4. Marine traffic control lanes are plotted on marine charts of the Cape Flattery to Port Angeles area (see Fig. A13-1) but are absent between the base of Ediz Hook and Dungeness Spit.

The radar system being installed will greatly improve marine traffic control and eliminate a great deal of the risk of ships colliding or grounding, although such installations should not be regarded as failsafe guarantees that accidents will not occur. This system will be installed before the Port Angeles terminal is scheduled for operation.

In the NTPC documentation and expert witness testimony, vessel assistance procedures, especially as they apply to the Cape Flattery to the entrance to Port Angeles harbor, are not dealt with in any degree of detail. The role of pilots and tugs for this portion of the voyage is not addressed. The experience of local pilots and tugboat operators in bringing a VLCC vessel from Cape Flattery to the terminal is also not addressed. It is important to note that a number of recent marine mishaps have been blamed on the pilots. This portion of the documentation requires considerably more input from the proponents (i.e. defining the existing traffic control system and imminent changes and improvements the system will be undergoing) before a thorough assessment can be undertaken. Although detailed information is lacking, it is apparent that the U.S. Coast Guard improvements (i.e. the installation of radar) will certainly improve the marine traffic control situation and serve to reduce the risk of a major marine accident. Figure A13-2 shows the location of major marine accidents occurring between 1954 and 1973.

B. FIRE AND EXPLOSION HAZARDS

1 VESSEL HAZARDS

B1) Causes of Recent Vessel Fires and Explosions

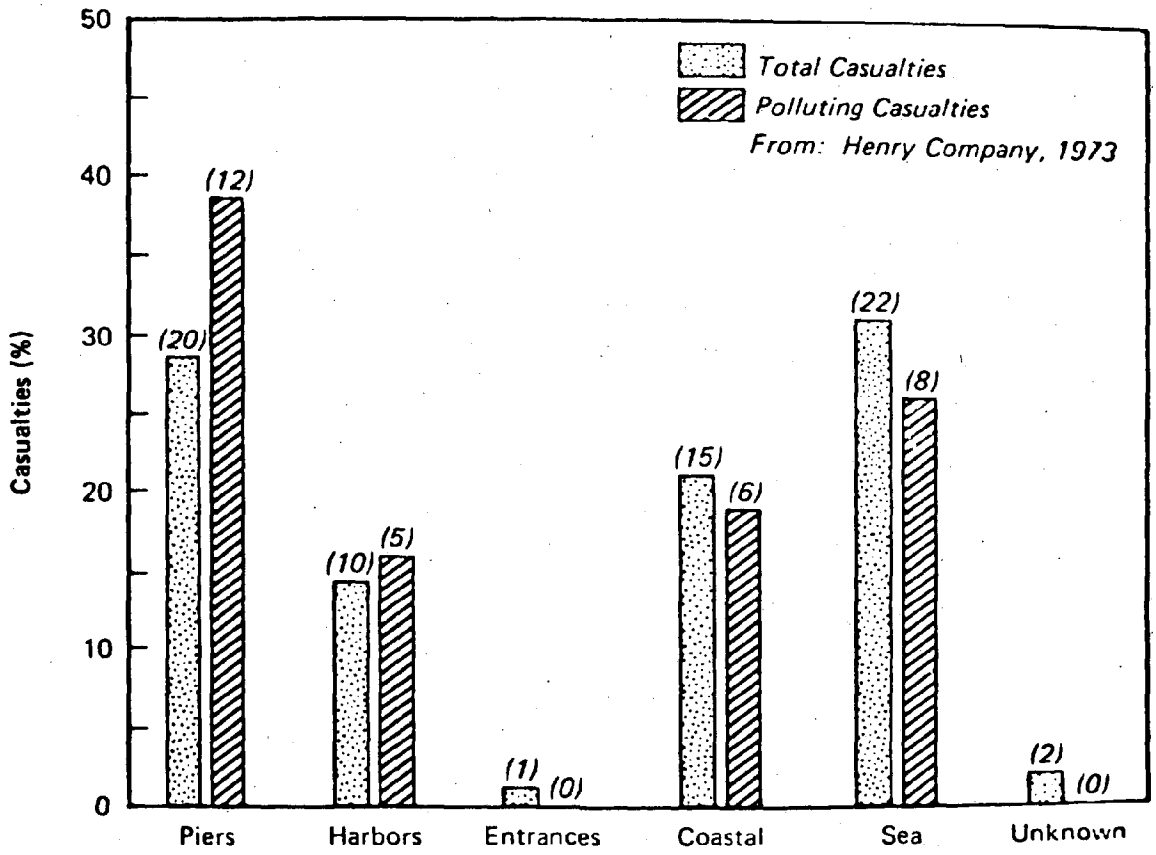
EXPLANATION:

It is relevant to the NTPC Application to have good recent data on this issue.

| BACKGROUND - NTPC APPLICATION: | SOURCE |
|---|---|
| "World tanker fleet data for 1971-1972 tanker explosions and fires are shown in Figures III-2.11-9 and 10, respectively. The graphs indicate that about half of all explosions and fires on tankers occur at piers or in harbours... The probabilities of explosions and/or fires on tankers at piers and in harbours per thousand tanker trips is 0.06 and 0.17, respectively. These data are taken from the USCG information (J. J. Henry Company 1973)." Refer to Figs. B1-1 and B1-2. | Vol. III p.2.11-67 |
| "Figure III-2.11-11 shows the shipboard location of explosions from the 1971-1972 data. Those explosions occurring in locations outside the cargo tanks are often non-catastrophic and usually do not result in oil spills or damage outside the ship." Refer to Fig. B1-3. | Vol. III p.2.11-67 |

DISCUSSION:

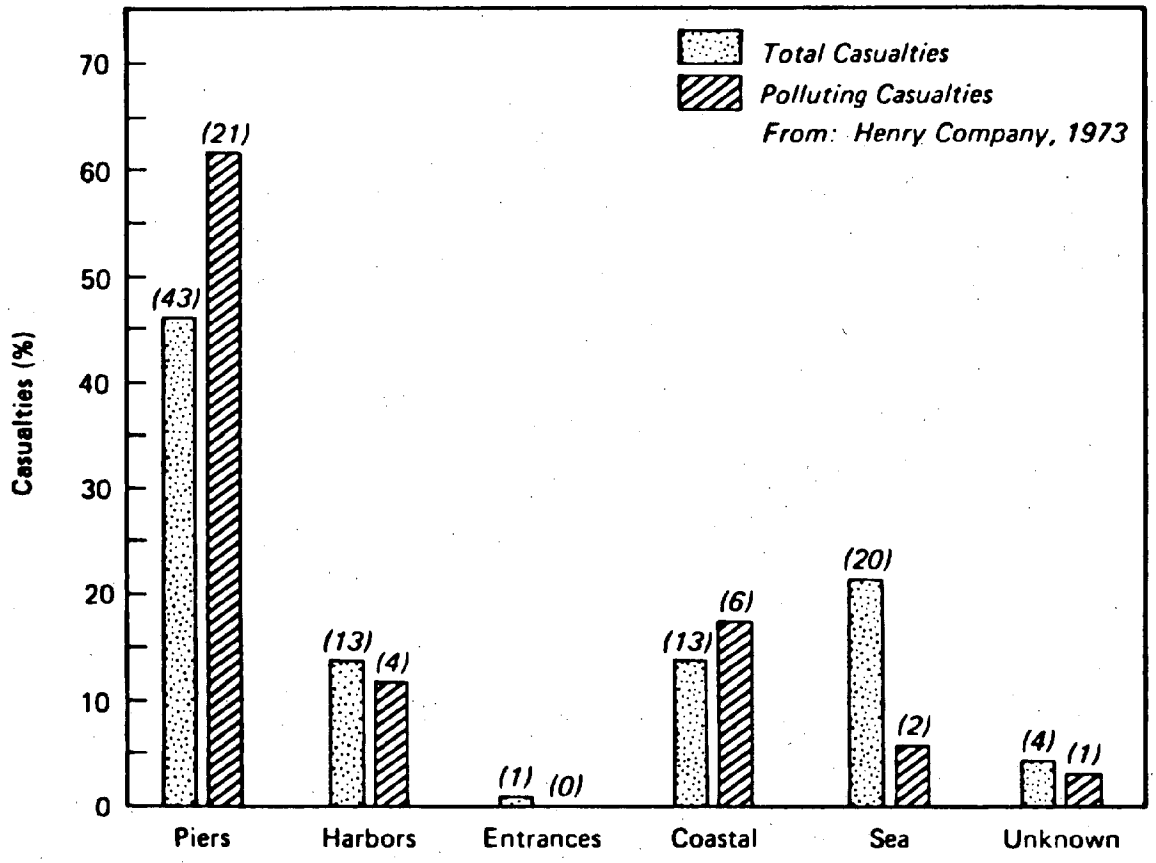
The data presented by NTPC for 1971-1972 is too old to be of maximum relevance to the application. The Lloyd's List of Casualties for tankers over 10,000 DWT, 1977 to 1979 (Fig. B1-4) shows a significant increase in fire and explosion casualties. Note that data for vessels smaller than 10,000DWT are not indicated by this list. There have been 5 recent explosions of tankers to date in 1980. Fig. B1-5 lists total losses of large vessels from January 1, 1979, and again, smaller vessel data is not reflected in this list. The increase in explosion causes has been attributed in part to badly trained crews (Lloyd's News, 5/6/80), particularly in connection with inert gas system maintenance (see Section B-2).




Northern Tier Pipeline Co.

**Figure III-2.11-9** Tanker Casualties from Explosions for 1971-1972

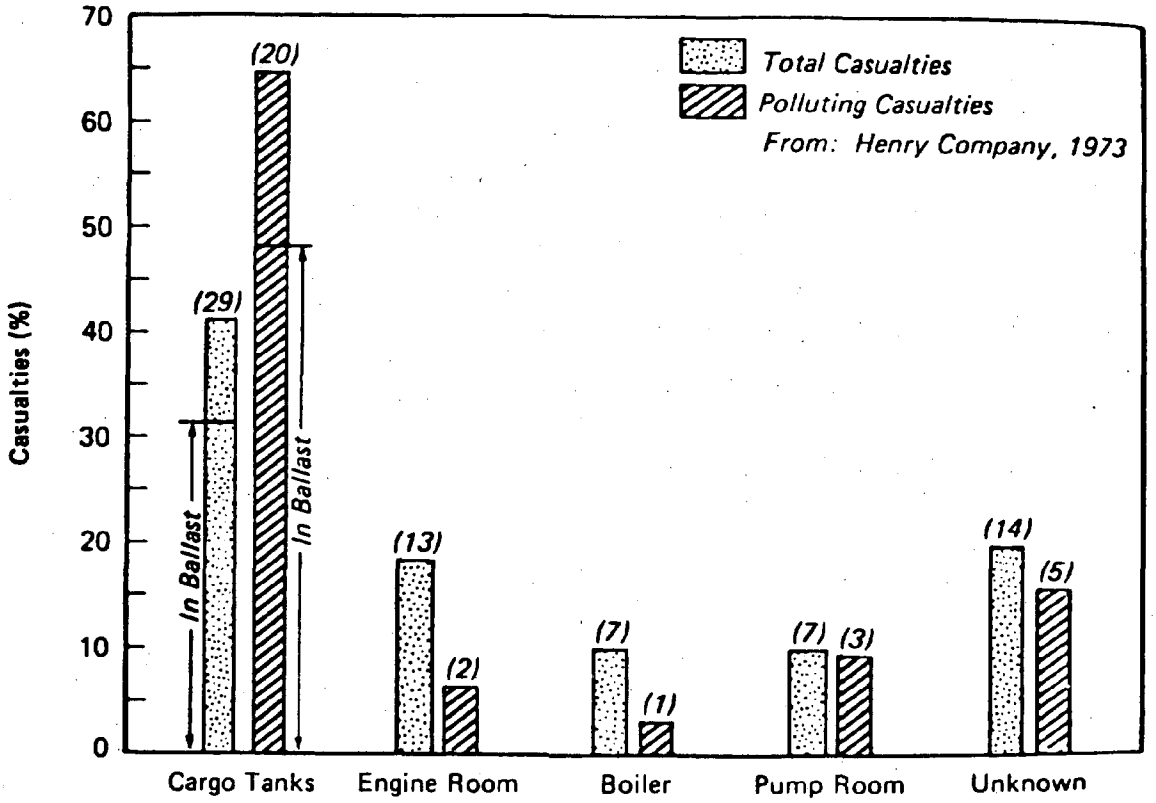
Fig. B1-1




Northern Tier Pipeline Co.

Figure III-2.11-10 Tanker Casualties from Fires for 1971-1972

Fig. B1-2




Northern Tier Pipeline Co.

**Figure III-2.11-11** Shipboard Location of Explosions for 1971-72

Fig. B1-3

Fig. B1-4

SUMMARY OF FIRES AND EXPLOSIONS IN THE CARGO AREA
OF TANKERS OVER 10,000 DWT REPORTED IN LLOYDS LIST
1977-1979
(excluding new construction, under repair, breakers yard & pump room fires)
(Source: Lloyds List, per ICS Casualty Bulletins)

- 1 -

| CASUALTY | | SHIP | | | | CONSEQUENCES | | | INITIATING EVENT | DETAILS | COMMENT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| DATE | PLACE | NAME/MANAGERS | DWT TYPE ICS | BUILT FLAG/MNGT. | CONDITION | HULL DAMAGE | DEAD & MISSING | POLLUTION | | | |
| 1977 | | | | | | | | | | | |
| th Jan. | At Sea (off E. USA) | MARY ANN Global Bulk Carriers | 72,152 O/O | 1969 Lib/USA | Ballast | Extensive | - | - | | Explosion while cleaning "storage tank" | |
| 31st Jan. | At Sea (N. Atlantic) | EXOTIC Nereus Shipping | 152,719 OBO | 1970 Lib/Grk | Ballast | Serious | 8 | - | | Explosion in Nos.7,8,9&10 | |
| 2th Mar. | At Sea (off C. Fear) | CLAUDE CONWAY Cosmopolitan Shipping | 45,946 T | 1957 Pan/USA | Ballast | CTL | 12 | Yes | | Explosion hull split in two | |
| th Apr. | Inland Sea | ASTRO LEO Iono Lines | 88,543 T | 1976 Pan/USA | Loaded Crude | Serious | - | Yes | Collision | Struck i.w.o. Nos.3&4 by 4,349 dwt cargo ship; fire | |
| th June | Sete | GUNNY Algot Johansson | 17,537 T | 1951 Fin/Fin | Ballast | TL | 2 | Yes | | (Under tow); explosion split hull in two | |
| st Aug. | Maracaibo | MANHATTAN DUKE Sanko Steamship | 82,279 T ICS | 1976 Sing/Jap | Ballast | Serious | 1 | - | Jetty Contact | Explosion and fire | Tank believed ine |
| nd Nov. | At Sea S. of Japan | MATSUSHIMA MARUNO Nippon Sujan Kaisha | 77,159 T | 1964 Jap/Jap | Ballast | CTL | 11 | | | Explosion; IP ruptured V/L burnt out; taken in tow after 3 days | |
| th Nov. | At Sea (off Venezuela) | MOSBUKE Mosvold Shipping | 82,644 T | 1967 Nor/Nor | Ballast | Minor | 2 | | Welding | Explosion in tank | |
| th Dec. | At Sea (off S. Africa) | VENOIL Interocean Shipping | 330,954 T ICS | 1973 Lib/USA | Loaded | Serious | 2 | Yes 23,000t | Collision | Fire ford | |
| th Dec. | At Sea (off S. Africa) | VENPET Interocean Shipping | 330,869 T ICS | 1973 Lib/USA | Ballast after Crude | Serious | - | Yes 3,000t | Collision | Struck i.w.o. aft tanks; accommodation gutted | |

| CASUALTY | | SHIP | | | | CONSEQUENCES | | | INITIATING EVENT | DETAILS | COMMENT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| DATE | PLACE | NAME, MANAGERS | DWT TYPE IGS | BUILT FLAG/MNGT. | CONDITION | HULL DAMAGE | DEAD & MISSING | POLLUTION | | | |
| 1978 | | | | | | | | | | | |
| 22nd Feb. | L. Maracaibo | CASSIOPEIA Kathymnis & Kulukundis | 27,871 Oil/Chem | 1973 Grk/Grk | Ballast | TL | 5 | | | Fire in accommodation and on deck; turned back. Explosion blew 2 holes in side; sank | |
| th Feb. | Khorranshahr | CYS INTEGRITY Island Navigation | 29,500 T | 1977 Lib/HK | Discharging Naphtha | Minor | | | | Deck fire | |
| th July | Tg. Priok | PERMINA 1011 Indonesian Govt. | 13,712 T | 1974 Lib/Indo | Loaded products | Minor | | | Fire spread from V/C alongside | At anchor; fire spread from bunker vessel alongside to No1S | |
| th Aug. | At Sea | METHODIC Nereus Shipping | 65,964 OBO | 1966 Grk/Grk | Loaded | Major | | | | Explosion in No.2 upper void space; continued on voyage Mobile - Italy | |
| th Oct. | Manila Bay | FEOSO SUN Feoso Oil | 20,824 T | 1960 Pan/HK | Ballast after crude | TL | 27 | Yes | | At anchor; boat alongside inspecting hull damage, explosions, fire, sank | |
| 31st Dec. | At Sea (B. of Biscay) | ANDROS PATRIA United Shipping & Trading | 218,665 T | 1970 Grk/Grk | Loaded Crude | CTL | 34 | Yes 50,000t | Hull fracture | Heavy weather, full fracture, explosion in ballast tank amidships; lightened S. of Azores | |

| CASULATY | | SHIP | | | | CONSEQUENCES | | | INITIATING EVENT | DETAILS | COMMENT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| DATE | PLACE | NAME/MANAGERS | DWT TYPE IGS | BUILT FLAG/MNGT. | CONDITION | HULL DAMAGE | DEAD & MISSING | POLLUTION | | | |
| 1979 | | | | | | | | | | | |
| [illegible]th Jan. | Bantry Bay | BETELGEUSE Cie Nationale des Petroles | 121,440 T | 1968 Fr/Fr | Ballasting after Crude | TL | 51 | Yes | Hull fracture? | Broke back, deck fire, explosion | |
| [illegible] th Feb. | At Sea E.N. Atlantic | SAINT CHRIS [illegible] | 74,567 OBO | 1967 Lib/ | Ballast | Serious | - | - | | Gas freeing; explosion/fire in Nos. 7-11; accommodation damaged. | |
| [illegible]th Mar. | At Sea Caribbean | WORLD SUET International Operations | 114,144 OBO | 1971 Lib Grk | Ballast | Minor | 2 | - | | Tank cleaning; No.1 hatch covers blown off | |
| [illegible]th Apr. | I. Neches | [illegible] Soc. d'Etudes et des Gestions | 123,692 T IGS | 1974 Lib/Fr | Ballast | CTL | 2 | Yes | Lightning | Explosions and fire; main deck i.w.o. Nos. 2 & 3 blown off, rest distorted; sank | |
| [illegible] th May | Setubal | ATLAS TITAN Interocean Shipping | 212,759 T IGS | 1969 Lib/Grk | Ballast | CTL | 1 | | | Discharging slops using air driven portable pump; deck opened up over Nos. 3,4,& 5 | |
| [illegible] th June | Musi River | BRUCE BINTAN | 15,792 T | 1971 Lib/ | Pt. loaded Crude | Serious | - | | Collision | Struck Mainheron; caught fire; grounded; explosion in No. 1C; gutted | |
| [illegible]th June | Musi River | MAINHERON Chandris Cruises | 19,965 T | 1959 Pan/Grk | Ballast | Serious | - | | Collision | Struck by Bruce Bintan; caught fire; grounded; explosions in Nos. 3P,4P,4C & for'd P.R.; accommodation gutted | |
| [illegible] th June | At Sea Arabian Sea | AVILES | 154,096 T | 1966 Lib/ | Pt. loaded | TL | 12 | Yes | Hull fracture? | Broke in 2, one section caught fire, both ends sank | |
| [illegible]th July | At Sea Off Tobago | AEGEAN CAPTAIN International Operations | 210,257 T IGS | 1968 Lib/Grk | Loaded Crude | Serious | 0 | Yes | Collision | Struck Atlantic Empress in rain storm; fire in for'd compts. and on deck | |
| [illegible]th Aug. | Cabinda | IOANNIS ANGELICOUSSIS Angelic Shipping | [illegible]07,031 T | 1964 Grk/Grk | Loaded Crude | TL | 3 | Yes | | At SBM. Explosion and fire, towed out; sank 4th Sept. after further explosions | |

| CASUALTY | | SHIP | | | | CONSEQUENCES | | | INITIATING EVENT | DETAILS | COMMENT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| DATE | PLACE | NAME/MANAGERS | DWT TYPE IGS | BUILT FLAG/MNGT. | CONDITION | HULL DAMAGE | DEAD & MISSING | POLLUTION | | | |
| 979 Cont'd | | | | | | | | | | | |
| 9th Aug. | At Sea 180' Off Ecquador | OGDEN OTTOWA Ogden Marine | 39,732 T | 1976 Lib/USA | Ballast | Serious | | | | Gas freeing; explosion i.w.o. No.1; 75% of deck i.w.o. No. 1 missing | |
| 0th Aug. | At Sea 17' Off Das I | CHERRY BOKE Norse Management | 29,299 T | 1956 Sing/Sing | Ballast | TL | 6 | | | Explosion and fire; sank | |
| 1st Sept | Mississippi | CHEVRON HAWAII Chevron Shipping | 71,339 T | 1973 USA/USA | Discharg-ing feed-stock | CTL | 3 | Yes 40,000t | Lightning | Struck for'd; explosions and fire; gutted; bow severed; sank, 4 barges caught fire | |
| 0th Oct. | At Sea Off Barbados | TALAVERA Cie Espanola de Petroles | 35,040 T | 1960 Sp./Sp. | Ballast | TL | 1 | | Welding? | Explosions; deck lifted i.w.o. 5P,6P,9,10,11,12 | |
| 7th Oct. | Manaus | GUNVOR MAERSK A.P. Moller | 32,056 T | 1973 Dan/Dan | Pt. Loaded | CTL | | | Struck submerged object | Struck i.w.o. No.2P, explosions in 2 tanks; gutted | |
| 0th Oct. | At Sea Off Senipah | SALLY I Ocean Petrol | 17,749 T | 1972 Lib/HK | Ballast | | | | | Explosion; 1 man blown over-board, later recovered | |
| 1st Nov. | At Sea Off Galveston | BURMA AGATE Kassos Maritime Enterprises | 61,674 T | 1963 Lib/Grk | Loaded Nig. Crude | TL | 31 | Yes | Collision | At anchor; struck by cargo ship i.w.o. No.6; immediate explosion; gutted; aground | |
| 9th Nov. | At Sea S. Atlantic | BERGE VANGA Sig. Bergesen d.y. | 223,965 O/O IGS | 1974 Lib/Nor. | Loaded Iron Ore | TL | 36 | | Welding? | COW retrofit workers on board; no SOS: some debris recovered | |
| th Nov. | Bosphorus | INDEPENDENTA Roumanian Govt. | 150,001 T IGS | 1978 Rum/Rum | Loaded Crude | TL | 54 | Yes | Collision | At anchor; struck by cargo ship; grounded; split in 2 | |
| 2th Dec. | At Sea Off Quoin Is. | ENERGY DETERMINATION Island Navigation | 321,186 T IGS | 1976 Lib/HK | Ballast | TL | 1 | | Accommodation fire | Accommodation fire, spread ER and then cargo tanks; taken in tow, split in 2, aft part sank | |
| 2nd Dec. | Chiba | PRIMAROSA Sarda Gestioni Navali | 254,276 T IGS | 1973 Itl./Itl. | Discharg-ing Crude | Minor | - | No | Back flow of cargo gas in IGS? | Explosion | |

60

Fig. B1-5
Total losses of large vessels from 1 January 1979

| VESSEL | BUILT | SIZE AND TYPE | CLASSIFI-CATION | INERT GAS SYSTEM | HULL VALUE | CARGO VALUE LOST | CASUALTY | OWNER |
|---|---|---|---|---|---|---|---|---|
| Betelgeuse (French) | 1968 | 121,430 dwt large tanker | BV | No | $12.6m | $3.8m | Explosion while discharging. Bantry Bay, Ireland January | Cie Navale des Petroles (Total Oil) |
| Seatiger (Liberian) | 1974 | 123,692 dwt | AB | Yes | $12m | -- | Struck by lightning during storms as finished discharging Nederland, Texas April 19, 1979 | International Navigation Corporation, Monrovia, Liberia |
| Atlas Titan (Liberian) | 1969 | 212,759 dwt VLCC | LR | Yes | $12.8m | -- | Explosion in cargo tanks followed by fire, during tank cleaning, Setubal, Portugal, May 27, 1979 | Centurion Maritime Co., Monrovia, Liberia |
| Aegean Captain (Liberian) | 1968 | 210,257 dwt VLCC | LR | Yes | $ 7m | $55m | Atlantic Empress and Aegean Captain collided off Tobago. July 19, 1979. Aegean Captain sold and broken up; Atlantic Empress, fire and explosion, sank August 2 | Quadrant Shipping Corp. Monrovia, Liberia |
| Atlantic Empress (Greek) | 1974 | 292,666 dwt VLCC | LR | No | $35m | $40m | | Branco Shipping Co., Chios, Greece |
| Stoic (Liberian) | 1971 | 152,790 dwt Combination | AB | No | $12m | $4.5m | Ran aground August 19,1979. Disappeared off Sekibi Shoal, Japan, during typhoon | Southwind Shipping Co., Monrovia, Liberia |
| Berge Vanga (Liberian) | 1973 | 227,912 dwt Combination | NV | Yes | $19m | $5m | Presumed sunk after massive explosion(s) north west of Tristan da Cunna, South Atlantic. Last report October 29, 1979 | Sig. Bergesen D.Y. and Co. Monrovia, Liberia |

Total losses of large vessels from 1 January 1979

| VESSEL | BUILT | SIZE AND TYPE | CLASSIFI-CATION | INERT GAS SYSTEM | HULL VALUE | CARGO VALUE LOST | CASUALTY | OWNER |
|---|---|---|---|---|---|---|---|---|
| Independenta (Romania) | 1978 | 150,000 dwt large tanker | RNR | No | $40.2m | $20m | In collision with general cargo carrier, outside Istanbul Harbour, November 15, 1979 | Navrom, Romania |
| Energy Determination (Liberian) | 1976 | 321,186 dwt ULCC | LR | Yes | $58m | -- | Fire and explosion in Strait of Hormuz, Arab Gulf, December 12, 1979 | United Overseas Petroleum Carriers, Monrovia, Liberia (C.Y. Tung) |
| Salem (Liberian) | 1969 | 213,928 dwt VLCC | LR | No | $24m | $25.5m* net | Sank off the coast of Senegal, cause uncertain. January 17, 1980 | Oxford Shipping Co., Monrovia Liberia |
| Irenes Serenade (Cyprus) | 1965 | 99,688 dwt large tanker | BV | No | $6m | $22m | Exploded, caught fire Navarino Bay, near Pylos, Greece, February 23, 1980 | Maderic Marine Co. Mgr: Tsakos Shipping and Trading, Limassol, Cyprus |
| Maria Alejandra (Spanish) | 1977 | 239,010 dwt VLCC | LR | Yes | $20m | -- | Explosions, sank off the coast of Mauritania March 11, 1980 | Mar Oil, Cadiz, Spain |
| Albahan B (Liberian) | 1971 | 239,410 dwt VLCC | LR | ? | $24m | -- | Exploded, sank off the coast of Tanzania, April 3, 1980 | |

Total losses of large vessels from 1 January 1979

| VESSEL | BUILT | SIZE AND TYPE | CLASSIFI-CATION | INERT GAS SYSTEM | HULL VALUE | CARGO VALUE LOST | CASUALTY | OWNER |
|---|---|---|---|---|---|---|---|---|
| Mycene (Liberian) | 1976 | 238,889 dwt VLCC | LR | Yes | $27.2m | -- | Exploded, sank off the coast of Senegal, April 3, 1980 | Mycene Shipping Co., Monrovia, Liberia |
| Totals | | | | | $309.8m | $175.8m | | |

AB - American Bureau; BV - Bureau Veritas; LR - Lloyd's Register; NV - Norske Veritas; RNR - Registru Naval Roman.

Sources: Lloyd's Register, Lloyd's Intelligence

*Salem cargo was insured for $56 million. A payment of $30.5 million has been made by South Africa to the owners, Shell, leaving £25.5 million outstanding.

## B2) The Effectiveness of Vessel Inert Gas Systems

EXPLANATION:

Vessel inert gas systems are regarded by some as totally effective in eliminating the likelihood of tanker explosions.

| BACKGROUND - NTPC APPLICATIONS: | SOURCE |
|---|---|
| "The number of tankers equipped with inert gas systems and segregated ballast systems is shown in Table III-2.11-21... No ship equipped with an inert gas system has ever had an explosion. The portion of the worldwide tanker fleet with inert gas systems has been increasing and is expected to continue increasing as more of the larger crude carriers are built. This trend should lead to a reduction in the risk of tanker explosions and should make the frequency of explosions and fires used here conservative (high)." Table III-2.1-21 is shown in Fig. B2-1. | Vol. III p.2.11-71 |

DISCUSSION:

Design and Operation Problems

The experience of tanker fleet operators has been that I.G.S.'s are difficult to operate and maintain and, in fact, could cause more problems than they solve, unless they are operated correctly and routinely inspected thoroughly.

1. An I.G.S. has a direct link from boiler exhaust to cargo tanks. Human or mechanical failure can cause explosive fumes to leak back to an ignition source while the I.G.S. is not in use because of:

   a) the water seal not being filled;
   b) the pressure vacuum valve leaking due to a corroded seal;
   c) corrosion in ducting;
   c) The Fan casing leaking fumes into fan room.

   Note that the I.G.S. is related to the cargo tanks only, and therefore will have no effect on fire and explosion sources elsewhere on the vessel.

2. The balance of the inert gas fed to the cargo tank must be correct during offloading. The precent oxygen in the gas could be too high due to varying loads on ship's boiler in port.

Fig. B2-1

TABLE III-2.11-21

PERMANENT BALLAST AND INERT GAS SYSTEM CHARACTERISTICS OF WORLDWIDE TANKER FLEET

| DWT Size Class | Number of Tankers | Number With Permanent Ballast | Percent of Tankers In Size Class With | |
|---|---|---|---|---|
| | | | Permanent Ballast | Inert Gas System |
| **JONES ACT CRUDE TANKERS** | | | | |
| | | | | By 1 June 1981 |
| 50,000 | 6 | 1 | 17 | 100 |
| 62,000 | 3 | 1 | 33 | 100 |
| 70 - 80,000 | 15 | 14 | 93 | 100 |
| 90,000 | 4 | 4 | 100 | 100 |
| 120 - 130,000 | 8 | 8 | 100 | 100 |
| 165,000 | 6 | 6 | 100 | 100 |
| 190,000 | 4 | 4 | 100 | 100 |
| TOTAL | 46 | 38 | | |
| **FOREIGN CRUDE TANKERS** | | | | |
| 100 - 125,000 | 132 | 88 | 67 | 22 |
| 150 - 175,000 | 25 | 18 | 72 | 20 |
| 175 - 200,000 | 22 | 16 | 73 | 14 |
| 200 - 225,000 | 147 | 106 | 72 | 37 |
| 225 - 250,000 | 160 | 118 | 74 | 59 |
| 300 - 327,000 | 21 | 15 | 71 | 71 |
| TOTAL | 507 | 361 | | |

Source: Clarkson & Co. Ltd. 1976.

Recorders of I.G.S. flow and oxygen are not mandatory.

3. Cargo tanks have natural traps for fumes, because of their internal structure, that the I.G.S. might not replace. The vent test would not indicate this. Static electricity generated by cargo tank cleaning jets could ignite these fumes.

4. Retrofit I.G.S. equipment on old tankers often can not keep pace with oil cargo discharge rates.

Explosions on Vessels Equipped with I.G.S.

The NTPC Statement: "No ship equipped with an inert gas system has ever had an explosion" is incorrect.

There are 3,819 crude oil tankers in service in the world; 380 are fitted with I.G.S. In 1979, oil tanker explosions totalled 22. I.G.S. were fitted on 7 of these vessels (See Summary of Fires and Explosions, 1977 - 1979, Fig. B1-4). Large vessel total losses since January 1, 1979, (See Fig. B1-5) total 14. Seven of these were fitted with I.G.S.

These statistics show that an I.G.S. is no guarantee of safety and could in fact be a partial cause of the explosions.

2. HAZARDS SPECIFIC TO PORT ANGELES HARBOR

B3) The Impacts of a Large Tanker Explosion and Fire on the Port Angeles Hospital and Downtown Core.

EXPLANATION:

Noting the proximity of the proposed terminal to a major population area, the potential impacts of a tanker explosion and fire must be addressed.

| BACKGROUND - NTPC APPLICATION: | SOURCE |
|---|---|
| Excerpts quoted below contain corrections found in the ERRATA sheet - Attachment B to the prefiled testimony of Brian Murphy (2/26/80). | |
| "Based on reports of tanker explosions and supported by the analysis provided in Appendix B, an approximate 1500-foot radius appears to be a conservative estimate of the distance over which structural damage could occur because of a tanker explosion. Therefore, the full land width of the end of Ediz Hook near the tanker unloading facilities would be at risk. In addition, the personnel and property of the tanker unloading facilities and the USCG station would be at risk. Port Angeles is over 8,000 feet from the proposed berthing site. According to the analysis in Appendix B, windows are expected to be broken to a distance of 2,880 feet following the explosion of a 130,000 DWT tanker." | Vol. III p.2.11-74 |
| "Impacts might occur in Port Angeles if a tanker exploded or caught fire and remained afloat in the vicinity of the Port Angeles waterfront. If moorings were broken by explosion and if the burning tanker were adrift, wind or currents could force it toward the city. Along the western end of the city, near the forest products industrial facilities, a tanker with a draft of 7 fathoms (42 feet) or less (approximately 70,000 DWT) could come very close to shore before running aground. If the tanker came within 300 to 500 feet of wooden structures on the shore, the tanker fire could produce sufficient radiant heat to ignite those structures. Most of the shoreline along the city, however, is such that a tanker would run aground well out (more than 1,500 feet for a 70,000 DWT tanker) in the harbor and would not endanger the city. Larger tankers could have a larger fire, but would run aground further from shore. Even in those areas where the tanker could get close enough to pose a threat, city firefighting apparatus could wet down exposed buildings sufficiently to reduce significantly the threat of fire. | Vol. III p.2.11-74 |

Any tanker fire will result in large quantities of black smoke, $SO_2$, CO, and $NO_x$ being released into the air. The impact of this large, short-term source of air pollution could range from a nuisance level to a potential health hazard to people with respiratory diseases."

"Downtown Port Angeles is about 9,000 feet from the proposed berthing site. Olympic Memorial Hospital is located about the same distance from the tanker berth. According to our analysis, windows could be shattered following the total explosion of a 327,000 DWT tanker to a distance of 4,040 feet."

Prefiled testimony of Brian Murphy p.8

"Atmospheric factors, including focussing, could be important at low overpressures such as those associated with window breakage, but should not be significant at high overpressures associated with more severe damage"... "A possible example is represented by the 70,000 DWT Liberian tanker Sansinena which exploded in Los Angeles harbor in 1976. Scattered damage to windows occurred in a westerly direction as far as 3-1/16 miles and in a northerly direction as far as 2 miles away. (There were a few reports of broken windows even further out - up to six miles or more) National Transportation Safety Board Report NTSB-MAR-78-6, U.S. Coast Guard Report 16732/71895."

Prefiled testimony of Brian Murphy p.10

"... we considered a spill from one wing tank of an 80,000 DWT tanker having a fire radius of 1,700 feet. Even for a very large wind speed of 34 miles per hour, the smoke plume was calculated to rise 1.32 miles above theOlympic Memorial Hospital roof. For a larger fire resulting from a 327,000 DWT tanker with a fire radius of 5700 feet, the plume rise is even larger - the plume bottom was 2.40 miles above the Olympic Memorial Hospital roof."

ibid. p.11

"The hospital is a reinforced concrete building, and in the worst possible explosion, with the tanker having drifted across the harbor before exploding, it could sustain broken and shattered windows and some structural damage. Any people near the windows facing the harbor could be injured by flying glass from shattered windows."

Prefiled testimony of David L. Moore p.18

"However, there are several factors and circumstances which could possibly result in these impacts occurring at greater distances or which could result in lesser impacts at smaller distances. For example, isolated areas tens of miles from the explosion source can receive focused blast waves due to certain atmospheric effects, particularly low-level temperature inversion.".

ibid. p.15

"The results of the structural damage analysis indicate that in a very unlikely circumstance that an entire 130,000 DWT tanker exploded, the largest area impacted moderately would be 1,220 ft. (or ¼ mile), severely 860 ft. (or 1/6 mile). If only the center tank of a 70,000 DWT tanker exploded, the figures would be approximately 460 ft and 320 ft.". Vol. V p.B-11-68

"As can be seen in Table B-11-32, in the very unlikely event of the explosion of all tanks of a 130,000 DWT tanker, the maximum area with glass shattering would be 2,880 feet (0.55 miles). If only the center tank of a 70,000 DWT tanker exploded, the area impacted would be 1,080 feet (1/5 mile).". Vol. V p.B-11-77

"Shock waves in the atmosphere from sonic booms, for example, can be intensified or focused under some conditions. The conditions necessary for this focusing could exist at the time of a tanker explosion in Port Angeles and the effective glass shattering range somewhat extended.". Vol. V p.B-11-77

DISCUSSION:

Very few VLCC ports are located within 6,500 feet of major population centres such as NTPC are proposing for Port Angeles. Some older terminals, eg. Shell Haven on the River Thames in England, are close to populated areas but new terminals eg. Milford Haven in England and Bantry Bay in Ireland, are normally located at significant distances from populated areas. In fact, tanker movements in the Port Angeles harbor will be such that a fire or explosion could occur at closer distances such as 4,000 to 5,000 feet if a collision were to take place. Northern Tier and its consultants have determined by statistical analysis that the probability of a tanker explosion would be very low and that the use primarily of tankers with inert gas systems will be an additional safeguard (Volume III, Part 2, Environmental Studies, p.2.11-71). NTPC have stated that "No ship equipped with an inert gas system has ever had an explosion." As discussed in Section B-2 of this Report, seven explosions of the fourteen which have occurred in the last year and a half have occurred on tankers with inert gas systems. Inert gas systems cannot be looked upon as a failsafe explosion prevention method and may themselves lead to problems of fire and explosion.

There are three issues with respect to tanker fire and explosion in Port Angeles harbor that should be addressed. They are as follows:

1. range and type of damage due to explosion and fires;

2. air pollution resulting from a tanker fire;

3. smoke impingement.

With respect to item 1 above, studies by ERT and OIW indicate that damages from tanker explosions at the terminal would be limited to shattered and cracked windows in Port Angeles. Damage to the USCG station would be extensive. Noting, Port Angeles is an active harbor, the potential impact of an explosion and fire on other vessels (eg. tugs, fishing boats, the ferry, etc.) using the harbor at the time of the explosion should be addressed. In the documentation, the explosions considered took place at the terminal with certain analyses addressing the issue of fire damage originating from an explosion when the tanker, following the explosion, broke away from its moorings. The issue of a tanker explosion occurring at other locations within the harbor is included in the testimony of Mr. D. Moore. Figure III-7 (Fig. B3-2) from Mr. Moore's testimony is included. Based on this figure, an explosion is said to cause moderate damages to a wood frame house (2600 feet away), a multi-storey brick apartment (2100 feet away), a light steel frame industrial building (1000 feet away), etc. The question arises as to the definition of moderate; the site-specific susceptibility of buildings in the risk area does not appear to have been considered. The question also arises as to the effect on individuals present in the area at the time of the explosion. These subjects are not addressed in the detail warranted.

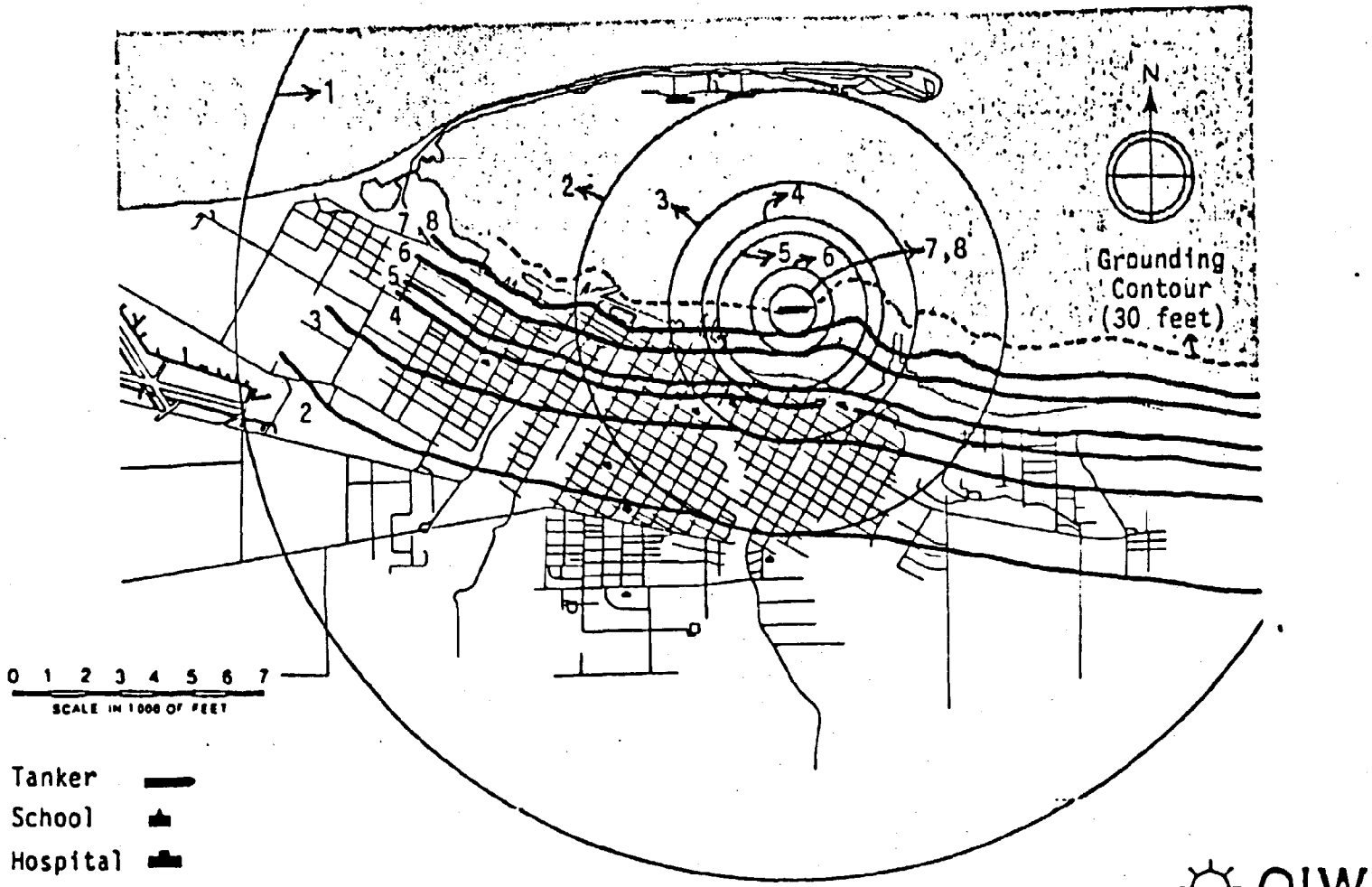
In February, 1980, the tanker Irenes Serenade exploded in Navarino Bay near Pylos, Greece. As a result of the explosion, oil spilled from the ship forming a burning oil slick over a large area of water around it. The explosion and fire took place 1200 meters (approximately 3/4 of a mile) offshore. However, as a result of the fire, the adjacent shoreline was also burned. (Photos B3-1 and B3-2). The fire in the tanker burned for several days. The reviewers believe that a similar situation would be a very difficult emergency for NTPC and Port Angeles control resources to deal with.

There are several important parameters that should be considered with respect to tanker fires in Port Angeles harbor. In the NTPC documentation, it has been noted that a tanker fire occurring near shore may require the wetting down of wood frame buildings by the Port Angeles Fire Department. However, the capabilities of the Fire Department in fulfilling this task when a number of buildings are in jeopardy has not been addressed. In addition, the capability of all available fire fighting units and equipment in putting out the tanker fire itself has not been adequately addressed. Tanker fires such as the Irenes Serenade and the Betelgeuse in Bantry Bay and others have burned for days or sometimes weeks, illustrating that modern fire fighting equipment is not adequate in dealing with tanker fires. It could be desirable to be able to tow a burning tanker from Port Angeles harbor to a safer location. The mechanics of this activity and the proponent's (or others) capability in carrying it out have not been addressed in the documentation. What would happen if other tankers berthed or at anchor in the area also caught fire?

The reviewers believe that the fire and explosion risk posed by a major oil terminal in Port Angeles has not been dealt with in warranted detail in the present NTPC documentation. Serious accidents occur at even the best run terminals. Case histories of recent

Figure III-7

POTENTIAL STRUCTURAL DAMAGE FROM A WORST CASE TANKER EXPLOSION (327,000 DWT) ALONG SHORE




OIW

Types of Damages and Distances

1 - Typical Glass Failure (16,500 feet)
2 - Usual Glass Shattering (6300 feet)
3 - General Light Structural Damage (3600 feet)

Moderate Damage to:

4 - Wood Frame House (2600 feet)
5 - Multistory Brick Apartment (2100 feet)
6 - Light Steel Frame Industrial Bldg. (1000 feet)
7 - Reinforced Concrete Office Bldg. (750 feet)
8 - Steel Frame Office Bldg. (650 feet)

Fig. B3-2

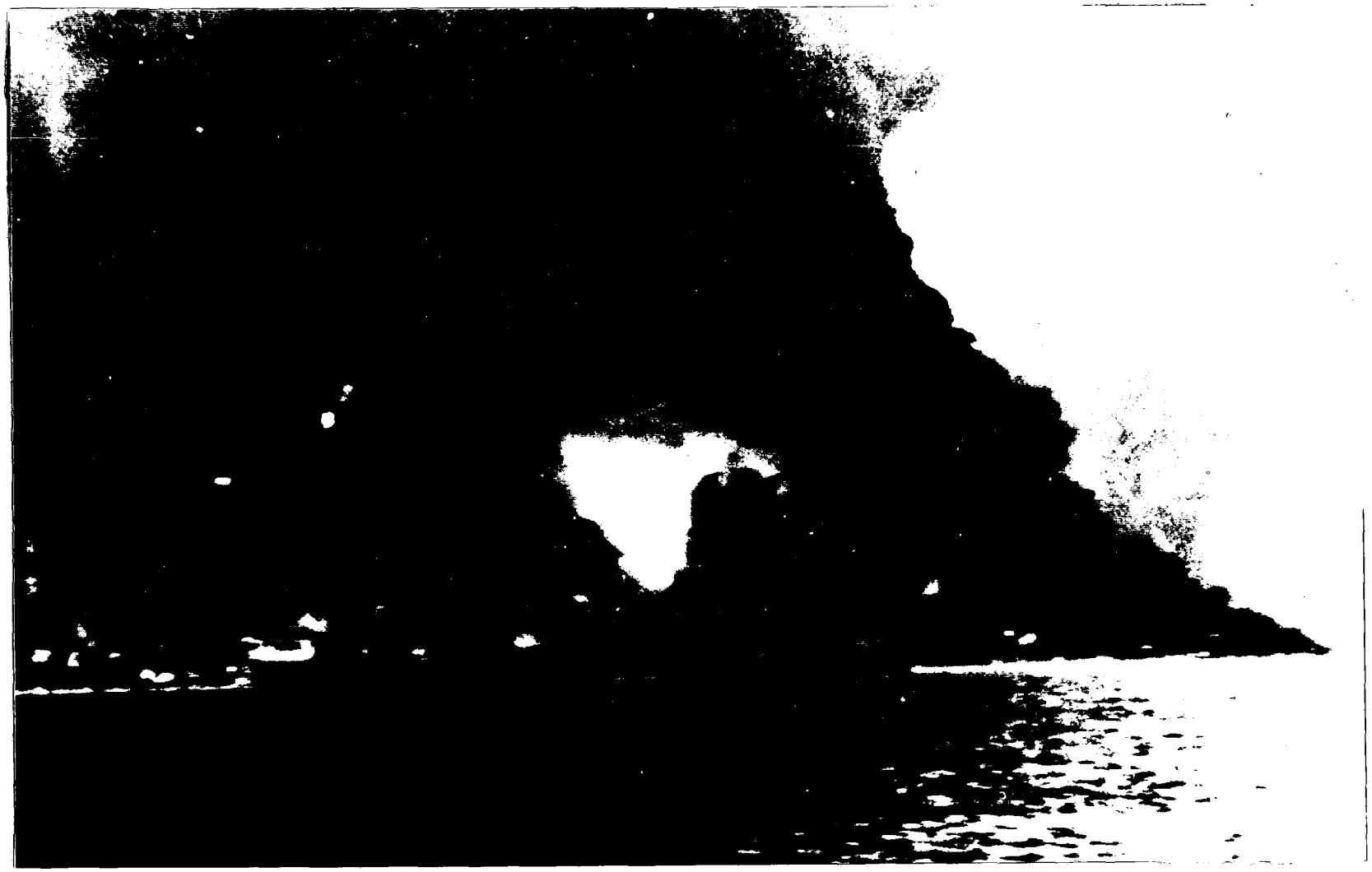


Photo B3-1 Fire following explosion of Irenes Serenade in Navarino Bay, near Pylos, Greece, February, 1980.

Source: Press Photograph

Photo B3-2 Scorched shoulder about 1200 metres (approximately 3/4 mile) from Irenes Serenade

Source: Press Photograph

world tanker fire and explosion incidents indicate the following:

1. that such incidents are increasing with and without inert gas systems installed;

2. that causes of many of the incidents are uncertain and therefore a breakthrough in reducing them in the near future seems unlikely;

3. that such incidents often lead to an uncontrolled situation, the results of which are unpredictable.

Since the present NTPC terminal is to be located in relative proximity to the City of Port Angeles, the reviewers have concluded that considerably more risk analyses, emergency scenario outlines and hard fire fighting capability information is required from NTPC, including the comparison with alternative terminal sites, before the acceptability of the risk can be fully assessed.

With respect to item 2, in the documentation (Vol. III, Part 2) it is stated that "any tanker fire will result in large quantities of black smoke, $SO_2$, CO and $NO_1$ being released into the air. The impact of this large, short-term source of air pollution could range from a nuisance level to a potential health hazard to people with respiratory diseases.". It is important to note that CO and $SO_2$ are extremely hazardous pollutants to man and multiple deaths due to $SO_2$ emissions have been recorded. However, in this report, the amount of these pollutants emitted has not been estimated nor has their effect on ambient air quality been determined. Stating that these pollutants could cause a nuisance or a potential health hazard is quite possibly a major understatement. The definition of "short-term source of air pollution" should also be questioned noting that the Burma-Agate tanker fire, 5 miles off shore from Galveston, Texas burned, or was allowed to burn, for 61 days.

With respect to smoke impingement (item 3), Mr. B. Murphy in his testimony stated that under certain circumstances (a small fire), a smoke plume could reach the Olympic Memorial Hospital. Mr. Murphy's example was: "the burning time for a fire of approximately 75 feet in radius would range from one to five minutes. For a 34 mile per hour wind speed at C stability conditions (but not D stability, for which the plume is narrowed), a fire of this sort could impinge on Olympic Memorial Hospital." In the documentation and the testimony, questions with respect to the probability of this occurring, its effects on hospital patients, the need for hospital evacuation, overall contingency plans, etc. have not been addressed. Presumably, if this fire can result in hospital smoke impingement, there must be a range of fire conditions during which smoke impingement would occur. This range is not discussed.

## B4) Environmental Effects and Health Concerns of a Release of Stored Chemicals

EXPLOSION:

The two major industries in Port Angeles at the present time are pulp mills. Pulp mills store significant quantities of environmentally hazardous liquids such as oils, chemicals and process solutions. Pulp mills also store large volumes of liquid chlorine, a substance that, in the gaseous state, constitutes a major public health concern.

BACKGROUND - NTPC APPLICATION:

The subject of secondary fire and explosion effects is not discussed in the NTPC documentation, nor has it been discussed in the testimony of the NTPC expert witnesses.

DISCUSSION:

The reason that NTPC has not addressed this subject is probably because their risk analyses show the risk of a tanker explosion is small and that in the event of an explosion the on-shore environmental damage will be minimal; however, the possibility of such an explosion cannot be ignored and fires do not necessarily require an explosion for ignition. In the NTPC documentation (discussed in Section B3 of this report) there are circumstances under which shore facilities could be severely damaged. It is important to note that pulp mills (Port Angeles has two) often store in large quantities of process chemcials such as liquid chlorine, sodium chlorate solution, sodium hydroxide, sulfuric acid; milling solutions such as black liquor, green liquor and white liquor and oil products such as bunker oil and lubricating oils. In the event of a major explosion that results in the rupture of the pulp mill storage tankes, significant environmental problems could result. In addition, the rupture of the liquid chlorine storage tank (generally a rail tank car) would result in significant health risk (Chlorine gas is extremely toxic) to workers and possibly even to residents of the area. These potential problems and measures to reduce environmental and health risks require thorough consideration and discussion in the NTPC documentation.

hej

B5) Effectiveness of Port Fire Fighting Systems

EXPLANATION:

A major fire and explosion at the proposed unloading facility will require effective, well maintained equipment and thoroughly trained personnel to deal with it.

| BACKGROUND - NTPC APPLICATION: | SOURCE |
|---|---|
| "Fire fighting design and procedures for the facilities will be developed in cooperation with the Port Angeles Fire Department, the USCG, and the Seattle Fire Department. | Vol. II p.6-20 |

A seawater fire protection system with foam capability will be provided at the tanker unloading facilities. Two diesel engine-driven fire pumps, each one capable of delivering the design volume of seawater, will be installed on a platform, with roadway trestle access from shore. Fire mains will be installed along the roadway and pipeway trestles to form a closed-loop system. Fire hydrants will be located on the berth and booster pump platforms, and at strategic locations on the trestles. A remotely controlled, high-capacity water monitor for fire protection will be provided on the access tower at each tanker berth. Foam monitors will be located on each platform and on the roadway trestles. Portable dry chemical units will be provided on the platforms to control electrical fires.

One fully equipped and manned fireboat will be in service at all times during tanker unloading and bunkering operations as an added safety measure for increased fire protection capability at the tanker unloading facilities.

This 70 to 80 foot vessel will be equipped with fire pumps capable of delivering a total of 6,000 gpm of seawater to remote and manual controlled monitors, onboard fire hose connections, and an articulated water tower. The vessel will also be equipped with a foam chemical system and various portable firefighting and first aid equipment.

Smoke and heat detectors will be located in all buildings, including the booster pump control room and berth operators' shelters. Reporting stations will be

located on the berthing and booster pump platforms and also at the shore ends of the roadway trestles. These stations will sound a general alarm and actuate a warning signal in the main control center at the on-shore storage facilities."

"The proposed fixed fire fighting equipment and spill containment equipment at the berths as proposed provides the ability to utilize large quantities of fire killing foam on any leak or spill which might be ignited, or in the case of an unignited spill, to prevent ignition during the clean-up phase. Similarly foam, plain water or dry chemical extinguishing equipment will be readily available for use on other fires which may occur around the pier facility. Should a tanker be on fire before reaching the berth, the fire boat will be available to supplement the shipboard fire fighting efforts.

Prefiled testimony of G. Kirsop p.3

The design also has automatic early warning fire detection in the control room and other enclosed areas, backed up by portable fire extinguishing equipment. Sea water is currently proposed as the fire protection water source. Many fire protection systems of the type needed for facilities of this kind are currently in operation and have proven satisfactory."

DISCUSSION

Serious in-port tanker explosions and fires which have occurred recently such as the "Betelgeuse" at a Gulf terminal in Bantry Bay, Ireland, the "Independenta" in Istanbul harbor in November, 1979, or the Burmah Agate near Galveston, Texas, have proved beyond the capability of port or larger fire departments to put out. The response in these cases was to let the fire burn its course (the Burmah Agate burned for 61 days) and take one's chances with further explosions. The "Independenta" burned for a number of days causing flaming debris to fall on surrounding harbor facilities and buildings with each further explosion. The 120,000 ton "Betelgeuse" incident was the subject of a thorough inquiry by the Irish governmetn the conclusions of which are not yet public. It took place at a large Gulf oil terminal built in the late 1960s. Some early findings as outlined in a National Oil Week Magazine article of March 14, 1980, were as follows:

1. "On the night, the alarm siren was not working, foam extinguishers were broken, all the jetty staff were casual workers and all but one of the escape ladders to the sea had been removed 'for security reasons'.

2. There was no plan for emergency evacuation. Safety requirements stipulated by architects had been ignored, creating, in one building on the oil jetty, a tinder box condition.

3. A fire-fighting truck and three Land-Rovers commandeered by rescuers failed to start.

4. The last fire-fighting exercise had taken place three years earlier.

A number of conclusions were drawn by the reviewers concerning the topic of port fire fighting capability. They are as follows:

a. Equipment required for fire fighting at oil terminals must be continuously checked and maintained.

b. Terminal personnel who would be involved in fire emergencies require extensive training, and regular hands on fire fighting exercises.

c. Present fire fighting capability is limited to relatively small fires.

d. In large fire situations triggered by or resulting in large explosions, historic incidents to date suggest that fire fighting capability is limited to cooling surrounding structures and quelling smaller fires started by flaming debris.

The application also does not address fire fighting design and procedures to be implemented with respect to the surge relief tank which is to be placed in the unloading facility area.

3. TANK FARM HAZARDS

B6) Recent Tank Farm Fires and Explosions

EXPLANATION:

It is important for reviewers to be aware of the causes of recent tank farm explosions and fires, the methods used to fight these fires and the problems encountered in extinguishing these fires.

BACKGROUND - NTPC APPLICATION: SOURCE

"Oil tank fires generally can be attributed to electrical storms and over-filling of the tanks. Electrical ignition of a floating roof tank is confined to the seal space between the roof seal and the shell where an explosive vapor mixture may occur (1) because of the lack of contact of the seal with the shell or (2) during rapid tank discharge when a flammable mixture may collect the seal. Vol. III p.2.11-76

The frequency of fires in tank farms during 1974 and 1975 was approximately 2.5 fires per 100 tank farms (API 1976). This data leads to an estimate of one fire every 40 years for a given tank farm based on fire statistics from all tank farms."

DISCUSSION:

The causes and circumstances involved in three recent tank farm explosions and fires were investigated by the reviewers. The details are outlined below:

1. Nanaimo, B.C., Canada, September, 1977

   The fire was caused by vandalism. It started in a Shell Oil products tank farm and spread to the adjacent Chevron tank farm (neither facility includes an oil refinery), both of which had fixed roof tanks. The duration of the fire was 15 hours. Use of foam trucked in from Victoria, approximately 75 miles away finally put out the fire.

   Difficulties encountered by Nanaimo Fire Department during the fighting of the fire:

   1) personnel - scheduling of rest periods, refreshment and meal breaks;

   2) water supply - an interruption in flow would have allowed heat to build up again;

3) dykes and pollution - while the fire was still active, too much water in the dyke area would cause burning fuel to overflow the dykes;

4) traffic control - ensuring that observers did not interfere with the arrival of support vehicles and fire fighters;

5) disposal of remaining products - the disposal of the products remaining required caution, was time consuming, and had potential environmental consequences.

Fire protection regulation deficiencies noted in the investigation were a lack of security at the tank farm, the unacceptability of non-lined earthen containment dykes, and the lack of a requirement that enough foam be on hand to deal with a fire emergency.

Damage to tank farms was more than 2.2 million dollars.

The costs to Nanaimo Fire Department, $42,000. There were two fatalities.

2. Clark Oil Co., Taylor, Michigan, December, 1979

At a products tank farm pipeline terminal, a 29,000 barrel, gasoline storage tank with an internal floating roof overflowed. Released vapors ignited.

The fire lasted 32 hours with no fatalities resulting.

Local fire departments were responsible for putting out the fire and, since the fire, level alarms have been placed on all tanks.

3. Mobil Oil Refinery, Torrence, California, October, 1979.

At the oil refinery, the incident involved an 80,000 barrel gasoline storage tank which had an external floating roof.

A blending operation occurred at too high a temperature and vapors escaped from a tank that was only 25% full at the time, and was ignited by a passing motorist.

The fire lasted 3 days and 3 fatalities (2 foremen and a passing motorist) resulted.

During the fire, damage to other tanks in the area occurred and nearby residents were evacuated for 2 days.

It is apparent that the utilization of floating roof tanks does not ensure that tank farm fires will not occur. The human element (sabotage, vandalism, and error) cannot be ignored as important concerns with respect to the occurrence of tank farm fires. The burden placed on the local fire department is also important to note. In two of the examples presented it appears that the facilities of the local fire department were extended to their limit, eliminating their ability to respond to another fire of a residential or commercial nature. The NTPC proposal has not assessed the ability of local fire departments (Port Angeles and Fire District No. 3) to deal with a major tank farm fire; and the response capability of local units cannot be addressed until such information is furnished.

The Norther Tier documentation fails to address in the detail warranted the following issues:

1. details of the fire fighting training program that Northern Tier staff will undertake;

2. the interaction of the Port Angeles and regional fire-fighting staff with NTPC staff in the event of a fire;

3. the effects of a major explosion and fire in the tank farm, i.e. worst possible case effects on workers, local residents, the environment, the continued operation of the facilities;

4. the methods being utilized to prevent sabotage caused by either an employee or a non-employee of NTPC (the Nanaimo tank farm fire in 1977 that resulted in two deaths was the result of vandalism);

5. other issues with respect to potential causes of fires, eg. earthquakes, lightning, plane crashes, etc., are touched upon in the documentation but not dealt with in any degree of detail.

NTPC should be required to address the risks to life and property under the conditions of the worst possible fire and explosion at the tank farm site.

## C. OIL SPILL CONTAINMENT AND CLEAN-UP

### C1) Critical Review of Contingency Plan

EXPLANATION:

An oil spill contingency plan must provide sufficient site-specific detail to initiate immediate mobilization of available resources for the containment and clean-up of an oil spill.

| BACKGROUND - NTPC APPLICATION: | SOURCE |
|---|---|
| "Prior to operation, NTPC will formulate a detailed and comprehensive Oil Spill Contingency Plan in accordance with the requirements of the DOT"... "The Oil Spill Contingency Plan for the marine terminal will be developed in conjunction with the C.S.C. and other appropriate organizations and government agencies to provide rapid response and mobilization of personnel, equipment, and materials to cope effectively with all minor and major spills and other emergency situations and conditions." | Vol. II p.6-211 |
| "Spills are detected by unexplained pressure and flow deviations, and air patrol, employee, or public reports Since minor spills generally cause minimal impacts, this discussion concerns primarily major spills. Typical responses to a spill along the pipeline route on land and water, together with an outline for the proposed Oil Spill Contingency Plan for NTPC, are presented." | Vol. II p.6-213 |

DISCUSSION:

The draft "Oil Spill Contingency Plan" Volume I and II filed by NTPC to date represents a comprehensive compilation of existing literature on the subject. The proponent and their consultant deserve commendation for the effort to date. As such it is a good start in writing a spill problem solving action plan. The reviewers have the following comments on the plan:

General

1. The plan as submitted appears to contain many sections and approaches used in a similar plan done for the Alyeska Pipeline Project in Alaska, and Oil Spill Cooperatives in Southern California with which the reviewers are familiar. Although there is nothing wrong with including information from other plans - in fact many techniques can be used universally - the plans presented for NTPC have not been made site-specific enough to accomplish a spill control and clean-up task in the

difficult marine situations in Juan de Fuca Strait and Puget Sound.

The Plan presented is not an action plan that could be of immediate use to an on-scene commander but rather an outline of the requirements of a plan.

2. The main deficiency in contingency planning as presented in the draft plan documents or in the application is the lack of a full discussion on the probable real life success of spill control plans. The sheer volume of detail in the draft volume documents could give the impression to an inexperienced eye that most spill problems are mitigatable to acceptable levels if the plan is put into operation. For terrestrial spills this is usually the case, providing there is no groundwater contamination problem. However, for river and open water marine spills, case histories show spill control techniques to be very ineffectual and beach clean-up is the rule. The application contingency descriptions and draft plans therefore, do not seriously consider the logistics of such a massive beach clean-up.

3. NTPC spill contingency plans do not contain any detailed description of procedures to be followed when oil crosses into Canadian waters and/or pollutes Canadian beaches. Spill trajectories in three reports predict that this could happen if oil is spilled in Juan de Fuca (Paish, 1972; Stewart, 1978 and O.I.W., 1979b).

4. Discussion of costs for clean-up and damage compensation is not adequate in the application and draft contingency plans.

   Shoreline clean-up is extremely expensive. It demands considerable equipment and manpower, which often have to be provided by municipalities, state governments, armed forces and private contractors. The inland sea spill in Japan cost 200 million dollars to clean up. The AMOCO Cadiz tanker clean-up off Brittany cost in excess of 200 million dollars. Many other examples exist of how counties, municipalities, states and federal governments are left to carry the major cost of clean-up. The whole area of compensation for clean-up and property damage is very vague, and there is no commitment from Northern Tier to cover these costs. The NTPC Application should be specific in their own clean-up cost and damage commitments, and contain a full discussion of TOVOLOP, CHRISTAL, Canadian Maritime Pollution Claims Fund etc.

5. The draft contingency plans are not clearly organized and would be difficult to use in an emergency situation. Background material is interspersed with the operational plan and it appears no consideration has been given to brief field manuals for quick reference in an emergency. The reviewers know of no incidents where the use of a contingency plan presented in the NTPC format has been used successfully to control a significant spill.

6. No firm agreement exists between NTPC and the Clean Sound Co-operative; a firm commitment between the two parties is necessary before NTPC can state they are to use the CSC equipment and know-how.

Specifics

1. Personnel

History has shown that terminal personnel can take care of small spills at the terminal, but are not trained or available to control or take part in major clean-up efforts such as a tanker grounding along the Juan de Fuca Straits. The oil industry in all areas around North America have formed cooperatives such as the Clean Sound organization, and they rely on stand-by contractors to clean up oil spills. These contractors are trained with the equipment and, as they cover a large area such as the Puget Sound, usually have a lot of practice. The plan implies that there is going to be some arrangement with Clean Sound to call for their assistance. This is very vague, and if it is only an agreement to be called in from Seattle at the time of a major accident, then they will arrive too late for any waterborne oil spill clean-up, but will only be useful for organizing clean-up of the beaches. The nearest Clean Sound equipment is located in Bellingham, which is a minimum of 12 hours steaming from Port Angeles. Personnel from Seattle could be flown in, but as they will be bringing a lot of heavy equipment, it is more likely that they will come by road, which will take a minimum of four hours provided that the ferries are operating. The NTPC plan requires clarification on just how this manpower and equipment will be mobilized to a point along Juan de Fuca Strait.

2. Equipment Selection

The NTPC draft contingency plan lists the specific models of equipment that they would locate in Port Angeles, Green Point and Arlington. The Green Point/Arlington equipment would only be useful for spills within the harbour area or, on occasions, in the Straits on a very calm day.

There is no equipment developed to date which has been capable of containing and collecting oil in sea state 2 and 3 conditions. (Tsahalis, 1979; Bright, 1979; Meade and Anderson, 1979; Fricke, 1979; Mathews, 1979; White, Nichols and Garnett, 1979) NTPC state that containment and recovery of oil is possible up to sea state 3 and 1 - 1.5 knots current. This has yet to be demonstrated. However, the author of the equipment list (Woodward, Clyde Consultants

Vol. II) is not aware of current performance data on the types of equipment which are recommended for this purpose, and has recommended equipment which would not be suitable for even sea state 1 to 2 conditions in the Straits.

Examples of this are Marco Type 4 and 7 skimmers. This type of skimmer is not suitable for crude oils or any light fuels, only heavy bunker fuels. (Beak Consultants, Canguard Consulting, Associated Engineering, 1978). "Foam belt skimming units are not suitable for recovery of light fuels or crude oils other than heavy bunkers or heavy crudes." (John Weichert; Manager, Clean Sound Cooperative; pers. comm.)

The VIKOMA Seapack is an air inflated boom of 1600 ft. in length which is heavily reliant upon the operation of air fans, pumps, diesels, etc. Due to their unreliability in performing when needed, the reputation of this equipment is poor. It also has one inherent problem in that it does not have any top or bottom tension member and this results in the loss of oil underneath the boom even in calm seas with a half knot current. The author of the equipment list recognizes the need for top and bottom tension cables in oil booms, as he specifies it in other types. However, the fact that the VIKOMA does not have these tension members is ignored. (Bennett Environmental Consultants, 1980).

3. Beach Clean-Up

This is a major component of the Straits Contingency Plan, and any grounding or accident to the tanker along the Straits will usually result in shoreline pollution.

The present NTPC draft contingency plan does not indicate which beaches could be used as sacrificial beaches in the event that oil containment booms were to arrive on site in sufficient time to at least direct oil to a specific area. There is no plan for clean-up on the Canadian side of the Strait. Although Appendix C of Volume II contains natural resources inventory tables, this information should be mapped to indicate all sensitive areas for fish, shellfish, mammals, birds, tourists, etc. The plan does not address the problems of access to beaches or the logistics of supplying teams of workers in remote locations. Feeding and accommodating the clean-up crews is always a major problem in an extended oil spill clean-up. There are no large town-sites along the Straits which could accommodate a sudden influx of personnel such as was required in the Santa Barbara clean-up which took some nine months and employed an average of 200 workers per day. The traffic congestion, resulting from movements of men and materials to clean-up sites and recovered wastes to dump sites, particularly during the summer vacation period is very disrupting and has some long-term effects on the tourist industry. Santa Barbara is often quoted as being unaffected by the Union Oil oil spill in 1969, and tourism was not down. This is misleading, as during that year all hotels, restaurants, etc., were busy due to the influx of clean-up teams, news media,

salesmen and other interested personnel in the oil spill. Also, the natural scouring and high energy in the intertidal zone in the Santa Barbara Channel resulted in rapid natural clean-up. This high energy and scouring effect by sand does not exist along the Straits.

For NTPC to demonstrate that they are aware of all these problems, they should have included in their Contingency Plan some scenarios, detailing what specific action they would take in some typical spill situations. In scenarios, means of dealing with problems such as the above could be detailed

C2) Detection of Night-Time Spills at Berth or in the Strait of Juan de Fuca

EXPLANATION:

The early detection of oil spills is critical for adequate containment and clean-up.

BACKGROUND - NTPC APPLICATION:

| | SOURCE |
|---|---|
| "The submarine portion of the unloading pipeline route will also be patrolled twice daily by a small launch operated by a competent observer. Relatively small amounts of oil will produce a sheen on the water surface that can be detected visually. The launch will be equipped with an infrared scanning device, designed to detect the presence of oil on water not discernible to the human eye." | Vol. II p.6-30 |
| The Marine Terminal Oil Spill Contingency Plan outlined in the NTPC Application includes the following "Definition of procedures to be followed and lists of personnel, equipment and materials to be mobilized for each type of emergency situation including: | Vol. II p.6-212 |

- minor operational spills at the tanker berths during transfer of crude oil or bunker fuel;
- minor accidental spills in the harbor or in the strait;
- minor and major spills resulting from leaks or ruptures in the unloading pipelines, tanker and bunker berth piping, trestle piping, and booster pumps piping."

DISCUSSION:

This is a problem which has not been adequately addressed by NTPC and is a difficult problem to solve. There are a number of oil spill detectors available on the market. They include designs incorporating hard-wire systems, radio beacons, and infra-red scanners. They all have their inherent problems. The in-water buoy type usually relies on the differing conductivity of oil and water and the direct contact of the spill with the buoy. The problems with this type are that the buoy might not necessarily be in contact with the spill due to current or wind directing the spill away from the buoy, or a very small spill will set off the alarm. As this is a busy port where small quantities of oil will be on the water surface regularly, false alarms would soon result in the misuse of the detector. These detectors require replacement of the element or sensing device each time an alarm is given.

The infrared scanners are more reliable, but still need an experienced eye to identify a spill, and the screen will be confusing to

a casual user of the system. Anything other than water shows on the screen with only a difference in intensity visable. The movement or flow of the object is also an indicator that it is oil. A major problem with this type of device is that significant spills are infrequent and operators become complacent about the use of the equipment.

The best detector of an oil spill at night is a watchman's nose. To be effective, regular inspections of all operations are required during both day and night.

A spill from a tanker underway in the Juan de Fuca Straits at night would be extremely difficult to detect even if each vessel were fitted with its own infrared scanner, as the oil accumulation on the surface astern of the vessel would be too slow to be identified on the scanning system.

C3) Capability of Existing Equipment for use at River Crossings in Clallam County.

EXPLANATION:

For use at river crossings, oil spill containment must be at staging sites for immediate use, and must be capable of operating under a variety of topographical and stream flow conditions.

BACKGROUND - NTPC APPLICATION:

| | SOURCE |
|---|---|
| "Containment would include using earthen dams across ravines and ditches, straw dams and underflow dams across small streams, and floating booms across larger waterways" ... "As much oil as possible would be picked up by tank truck and hauled to an approved disposal site or to the nearest station for reinjection into the pipeline system" ... "Along water courses, work boats would use a water jet from a utility pump and hose to wash down the banks and move the oil to a convenient location for pick-up. Oil slicks on lakes could be contained and moved by two work boats and a boom. The oil-water mixture would be pumped out, skimmed with a floating skimmer, or skimmed in a pit and hauled away. A boom installed at an angle to the bank would serve as a collection trap" ... "After all possible oil had been recovered, a final water clean-up would be made with sorbent pillows and straw.". | Vol. II p.6-214 to p.6-215 |

DISCUSSION:

The equipment stored at Green Point would be the closest equipment to river or stream crossings in Clallam County. Because most streams are crossed at their lower ends, it is unlikely that this equipment could reach a river or stream crossing oil spill in time to be of any effective use. The oil will have reached salt water and probably be in an emulsified form. This emulsion could be trapped in bays or along beaches. Light booms could be used to pool the emulsified oil and the oil mop skimmer has proven to be effective in recovering oil in these conditions. However, for most streams in Clallam County, there would be little that could be done to get equipment to the spill site before the oil had moved downstream and the toxic effects to biological life had taken place.

C4) An Evaluation of the Electronic and Human Surveillance of the Proposed Leak Detection System

EXPLANATION:

The difficulty in containing and cleaning up an oil spill and the degree of environmental impact of the spill will usually be related to the size of the spill. The size of the spill in turn will be related to the sensitivity of the various detection systems.

| BACKGROUND - NTPC APPLICATION: | SOURCE |
|---|---|
| "For the inactive condition, static line pressure will be monitored at the booster pump platform"... | Vol. II p.6-29 to p.6-30 |
| "The quantitative sensitivity of this method will depend on the accuracy of the instrumentation and the temperature compensation computer program associated with the monitoring system and the slope of the pipeline terminations at Green Point. Preliminary studies indicate that leaks as small as 50 to 100 barrels or 0.07% to 0.14%, respectively, of the contents of one line can be detected"... | |
| "For the active or operating condition, a different type of monitoring and leak detection system will be used. For this condition, state-of-the-art sonic flow meters (as discussed in Section II-6.3.7) are planned for installation at the tanker unloading facilities and at the Green Point pipeline terminations. This system will continuously monitor the flow by computer at the booster pump platform and the receiving point at Green Point. This leak detection system will have a comparative measurement accuracy of 0.5% of the pipeline throughput. A second, though less accurate leak detection system for the active condition will consist of the continuous simultaneous monitoring by computer of the quantities indicated by the turbine meters installed on the booster pump platform and the quantities indicated by the automatic tank guages installed on the Green Point storage tanks"... | |
| "The submarine portion of the unloading pipeline route will also be patrolled twice daily by a small launch operated by a competent observer. Relatively small amounts of oil will produce a sheen on the | |

water surface that can be detected visually. The launch will be equipped with an infrared scanning device, designed to detect the presence of oil on water not discernible to the human eye."

"Aerial and on-the-ground pipeline surveillance for possible leaks or other difficulties will be part of the routine operational procedures. Small leaks and other potential pipeline hazards will be detected before they become serious." — Vol. II p.6-111

"As part of the NTPC oil spill surveillance program an aerial patrol will traverse the strait following the pipeline route a minimum of once every two weeks to detect visually any small leak that might occur." — Vol. III p.2.11-95

DISCUSSION:

Ediz Hook to Green Point Pipeline capacity is 100,000 barrels per hour. A maximum undetected leak could be 0.5% of flow or 500 barrels per hour during tanker offloading. NTPC intend surveying the line twice per day. Therefore a leak could go undetected for at least 12 hours. Approximately 6,000 barrels of oil could leak into the harbour undetected during this period.

The maximum throughput for the rest of the pipeline is 933,000 barrels per day. Therefore a maximum undetected leak could be 0.5% of this flow or 4,500 barrels per day which could continue for up to two weeks between aerial surveillance flights in a worst case situation assuming the leak was observed during the next flight.

If an undetected leak occurred from either situation, it is evident that the amounts involved could be significant and as the NTPC Application reviews in Volume III, p.2.3-24 to 2.3-32; 2.4-19 to 2.5-32; 3-4 to 3-6; 4-2; 6-6; 6-8; 6-10 and 6-11, the introduction of oil into the freshwater and marine environments along the route could have serious impact on water quality, flora and fauna over time periods measured in years.

In the experience of the reviewers, it appears that NTPC is using the best state-of-the-art leak detection system that is available. Therefore, the projected environmental impacts from undetected spills would be non-mitigatable residual impacts. For the terrestrial and standard river and stream crossings part of the pipeline, the environmental risks as demonstrated by history of breaks on other existing pipelines is probably acceptable, at least for the projected life of this pipeline. However, the degree

of environmental sensitivity for specific watercrossings (see Section A5) might make the risk locally unacceptable. Environmental risk for the submarine portions of the line may not be acceptable, since as pointed out in other sections of this report the applicant will be utilizing new technology for dealing with site-specific problems at each of the three submarine crossing locations. Therefore, any calculation of undetected leak frequency occurrence for these sections of the pipeline is highly speculative and would be unsubstantiated by historical experience.

C5) Potential Impacts on Groundwater

EXPLANATION:

During the pipeline operations phase in particular, the contamination of groundwater with oil is a significant concern. The clean-up of oil contaminated groundwater is a difficult task.

| BACKGROUND - NTPC APPLICATION: | SOURCE |
|---|---|
| "The impact on groundwater of an operational oil spill at the onshore storage is anticipated to be very small because of the low permeability of the glacial tills to both water and crude oil. Perched groundwater conditions indicate that an oil spill or leak will not reach the regional groundwater table, and only very local contamination of perched water could occur, since the groundwater itself would have to be displaced by the less dense oil to penetrate any perched aquifer zones." | Vol. III p.2.3-14 |
| "Construction activities will not have a potential for contaminating or degrading public water supplies because no municipal water supply sources are located near the onshore storage facilities." | |
| "Oil spilled at Green Point will not affect public water supplies because no public water supply sources are located near the onshore storage facilities." | |
| "Any oil spills or leaks from the proposed pipeline will have varying effects on groundwater. Local contamination will occur if spills or leaks occur in shallow aquifers. Since oil is less dense than water, any spilled oil will remain near the groundwater surface and could expand laterally at a relatively slow rate. Geological characteristics of the area where the spill or leak occurs will influence the magnitude of oil impact to groundwater. If the spill or leak occurs near an aquifer or recharge area where confining rock layers are absent, contamination of groundwater resources will be more severe than if a spill occurs where the aquifer is relatively deep and confining rock beds retard movement of the oil. Leak detection systems and block and check valves will mitigate the amount of oil that could be lost from a pipeline rupture." | Vol. III p.2.3-34 |

With respect to the pipeline during the inactive phase:

"Preliminary studies indicate that leaks as amall as 5o to 100 barrels or 0.07% to 0.14%, respectively of the contents of one line can be detected." Vol. II p.6-29

For the active or operating condition:

"This leak detection system will have a comparative measurement accuracy of 0.5% of the pipeline throughput."

"The potential for groundwater contamination because of pipeline construction is small." Vol. III p.2.3-36

DISCUSSION

It is important to note that oil contamination of groundwater during the construction of the tank farm and pipeline should not be considered a major concern. Although oil contamination is possible, the volumes involved are small and the resultant spill contamination would be both local and small. The amount of contamination during construction will depend on the type of aquifer affected, and the manner in which spills are controlled or responded to. The contamination of groundwater with oil is, however, a major concern during the operational phase of this proposed development. The risks of damage and the magnitude of the potential problem are greatest for the terrestrial portion of the pipeline. The discussion that follows pertains primarily to the terrestrial pipeline.

Minor oil spills could result from leaking valves or gauges and small leaks. Major spills could result from pipeline splits or ruptures caused by defective pipe, imperfect welds, pipe corrosion, landslides, vandalism, sabotage, excavation equipment hitting the pipe, river scour, earthquakes, and operational errors or accidents (Montana Department of Natural Resources and Conservation, 1979). In this context, a minor spill is defined as 5,000 gallons or less and a major spill as more than 5,000 gallons.

In the NTPC documentation, it has been noted during the inactive phase of the operational pipeline that leaks of 50 to loo barrels (presumably per day) can be detected by instrumentation. This could amount to oil losses of 3,500 to 4,500 barrels per day depending upon the pipeline throughput. Losses of this magnitude are a major concern especially noting that this loss will occur at one specific site along the pipeline route.

Oil in the ground will, generally speaking, migrate through the soil and form a pancake-shape layer on the groundwater surface (Concawe, 1977). To a degree, oil and groundwater mixing will take place. Rainwater will percolate through the soil and will dissolve certain oil components, then enter and further contaminate the groundwater system. In that

groundwater flow patterns are very seldom understood, the clean-up of the contaminated groundwater is a costly, difficult and time-consuming process. If the groundwater is being used for water supply purposes, an alternate water supply source will have to be found. Considering the large clean-up time that would be involved, finding an acceptable alternate water supply source may be a difficult and costly problem in some areas traversed by the pipeline.

NTPC should address the following subjects in more detail:

1. improvements that can be made to the pipeline leak detection system;

2. the pipeline leak detection surveillance program;

3. specific procedures in case of a major oil leak and groundwater contamination problem.

C6) Improvements for Oil Spill Prevention, Response, and Clean-Up Capabilities

EXPLANATION:

The NTPC Oil Spill Contingency Plan should outline the best action plan possible to protect the environmental resources of the Juan de Fuca and Clallam County area.

| BACKGROUND - NTPC APPLICATION: | SOURCE |
|---|---|
| "The objective is to design, construct, operate and maintain the proposed facilities in the safest, most economical, and least environmentally damaging manner possible." | p.2-1 |

DISCUSSION:

Collision in the Straits of Juan de Fuca is unlikely, but mandatory traffic control would add a degree of safety. The most likely causes of an accident, and oil spillage, are loss of power, loss of the propellor, or loss of steering. A vessel which suffers any one of these three problems while in transit in the Strait will very quickly run aground. Once aground on the type of shoreline which borders the Strait, it is highly likely that the vessel will break its back. The risk of this type of accident could be reduced if each vessel was piloted by a suitable tug while in transit in the Straits.

The Clean Sound Cooperative has had considerable experience in testing and use of oil spill clean-up equipment and should be fully consulted regarding its selection. Training programs of oil spill response teams should be specified and definitely committed to by NTPC.

The information contained in the draft Volume II Contingency Plan, Appendix C, should be produced in a form easier to read, preferably on maps which would immediately indicate sensitive areas and also predetermined sacrificial beaches. These sacrificial beaches are found to be necessary in every major oil spill clean-up operation. The two main factors in determining specifications for a sacrificial beach are 1) its environmental sensitivity, and 2) its accessibility and ease of clean-up.

The main area of the draft contingency plan that requires considerable improvement is the section dealing with the tanker traffic route Cape Flattery to Port Angeles.

It is well known that the present state-of-the-art oil spill clean-up equipment on open water does not provide the clean-up assurances that are reliable. If large tankers are going to transit the Straits, then a more practical contingency plan is required.

The logistics of cleaning up an oil spill have not been addressed adequately and there is insufficient practical guidance to an on-scene commander in the contingency plan. Pre-determined specific methods should be established for the total shore-line. These methods would include the determination as to the availability of man-power and materials.

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