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OCT 13 1981

ANCHORAGE, ALASKA

Shell Oil Company
EXPLORATION PLAN
SEAL PROSPECT

BEAUFORT SEA, ALASKA

APPENDIX I
PROPRIETARY DATA

SHELL OIL COMPANY
PACIFIC DIVISION
OCTOBER 1981
DISCUSSION

The "Seal" Prospect is a faulted gentle anticline displaying simple closure (Enclosure 1). Principal objectives include the Jurassic Sag River Sandstone and the Permo-Triassic Sadlerochit Formation. Deltaic and shallow-marine sandstones of the Sag River and Sadlerochit Formations are thought to possess a common oil-water contact, and are sealed by the overlying Kingak Shale (Enclosure 2).

Secondary objectives include the Cretaceous Kuparuk River Sandstone, Carboniferous limestones of the Lisburne Formation, and Mississippian Sandstones of the Kekiktuk Formation. Shallow marine Kuparuk River Sandstones are erosionally truncated by the Lower Cretaceous unconformity, and are top-sealed by the overlying Cretaceous Shales. The Paleozoic units are erosionally truncated by a Permian unconformity and have been subsequently block-faulted (Enclosure 2).

The seismo-stratigraphic relationship of these objectives is depicted on Enclosure 3.
LEASE OPERATIONS PLAN AND
EXPLORATION PLAN
BEAUFORT SEA AREA
SEAL PROSPECT
ALASKA

SHELL OIL COMPANY
OPERATOR FOR SHELL, AMERADA HESS, AMOCO, TEXAS EASTERN AND MURPHY

OCTOBER 1981
# TABLE OF CONTENTS

**LEASE OPERATIONS PLAN AND EXPLORATION PLAN**  

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>Island Location</td>
<td>1</td>
</tr>
<tr>
<td>Proprietary Data</td>
<td>1</td>
</tr>
<tr>
<td>Description and Schedule of Proposed Activity</td>
<td>2</td>
</tr>
<tr>
<td>Exploration Depth</td>
<td>4</td>
</tr>
<tr>
<td>Island Description</td>
<td>4</td>
</tr>
<tr>
<td>Storm &amp; Tide Surge</td>
<td>5</td>
</tr>
<tr>
<td>Transportation</td>
<td>5</td>
</tr>
<tr>
<td>Supplies</td>
<td>5</td>
</tr>
<tr>
<td>Personnel</td>
<td>5</td>
</tr>
<tr>
<td>Rig Description, Critical Operations Curtailment Plan &amp; Drilling Prognosis (Public Information)</td>
<td>6</td>
</tr>
<tr>
<td>Development/Production Discussion</td>
<td>6</td>
</tr>
<tr>
<td>Oil Spill and Hydrogen Sulfide Contingency Plans</td>
<td>6</td>
</tr>
<tr>
<td>Hazardous Materials</td>
<td>7</td>
</tr>
<tr>
<td>Disposal of Waste &amp; Test Oil &amp; Natural Gas</td>
<td>7</td>
</tr>
<tr>
<td>Solid and Liquid Waste Disposal</td>
<td>7</td>
</tr>
<tr>
<td>Air Emissions</td>
<td>8</td>
</tr>
<tr>
<td>Consistency Certification</td>
<td>8</td>
</tr>
<tr>
<td>Drilling Mud Components</td>
<td>9</td>
</tr>
<tr>
<td>Water Supply</td>
<td>9</td>
</tr>
<tr>
<td>Mud Logging Unit</td>
<td>9</td>
</tr>
<tr>
<td>Geophysical Hazards</td>
<td>10</td>
</tr>
<tr>
<td>Environmental Training Program</td>
<td>11</td>
</tr>
<tr>
<td>Island Disposition</td>
<td>12</td>
</tr>
<tr>
<td>Special Restriction</td>
<td>12</td>
</tr>
<tr>
<td>Relief Well Discussion</td>
<td>13</td>
</tr>
</tbody>
</table>
ENCLOSURES

Enclosure 1  Location Map
Enclosure 2  Proposed Exploration Unit
Enclosure 3  Typical Island Plan
Enclosure 4  Typical Island Section
Enclosure 5  Typical Rig Layout

TABLES

Table A  Quantities of Waste Materials
Table B  Projected Air Emissions
Table C  Mud Components and Toxicity Tests

LIST OF APPENDICES

Appendix 1  P&C Geologic Data (3 Enclosures)
Appendix 2  P&C Island Design Documentation
Appendix 3  Rig Description Critical Operation and Drilling Prognosis
Appendix 4  Oil Spill Contingency Plan and Hydrogen Sulfide Contingency Plan
Appendix 5  References for Table C
Appendix 6  Mud Logging Unit Description

ACCOMPANYING MATERIAL

Environmental Report
Introduction

Shell Oil Company, as operator of a proposed unit located in the Beaufort Sea, to be formed for the purpose of exploring for hydrocarbon accumulations (Enclosure 2), hereby submits for approval our Lease Operations Plan and Exploration Plan to 1) build a gravel island drill site, Seal "A", on Lease ADL 312799 (BF-47), and 2) drill up to five exploratory wells from the island to explore and delineate the prospect. The environmental report as required by 30 CFR 250.34-3 is submitted with this exploration plan.

Gravel Island Location

3,300' FSL and 13,500' FWL of ADL 312799 (BF-47)

Alaska State Zone 4 Coordinates $x = 1,800,311.7'$ (548,736.1m)
$y = 6,031,148.7'$ (1,838,297.8m)

Lat = 70°29'29.9023"N
Long = 148°41'33.8465"W

UTM Zone 6 Coordinates

$x = 1,433,445.3'$, (436,915m)
$y = 25,660,729.5'$, (7,821,406m)

Proprietary Data

Appendix 1, "Private and Confidential, Shell Oil Company, To Accompany Seal Exploration Plan Submitted To The Division of Minerals and Energy Management
(DMEM) and the United States Geological Survey (USGS) For Their Exclusive Use" is enclosed as private and confidential data for use only by DMEM and the USGS. Contents include the proposed unit, a structure map showing the prospect area and appropriate seismic data. A copy of our complete tentative graphic prognosis is also included in this assemblage of proprietary data. This information is for the sole use of the DMEM and the USGS.

Appendix 2 entitled "Private and Confidential, Shell Oil Company, Seal "A" Island Design Documentation, Submitted To DMEM and USGS For Their Exclusive Use" is also Shell's proprietary information.

Description and Schedule of Proposed Activity

We propose to build a gravel island with a surface working diameter of approximately 400 ±25 feet, in about 11.9 meters (39.0 feet) water depth. It is our plan to obtain gravel at a proposed active gravel extraction site onshore for which an application has been made. Upon approval of our application to build a gravel island and to obtain gravel, which is anticipated by early 1982, we plan to build an onshore ice road to a suitable shore site and then on to Long Island and the Seal "A" Island site over the ice. Gravel will be transported by trucks over ice roads to the island site during the 1981-82 ice season, (Enclosure 1). In the event ice conditions preclude completion of the island during the 1981-82 winter, it is our plan to transport gravel for the island construction to Long Island where it will be stockpiled as also shown on Enclosure 1 for transport by barge to the island site during the summer of 1982. We will plan to transport a small excess amount of gravel to the stockpile area to assure no net gravel removal from Long Island. The gravel required for the sandbag protection of the island and the berm will be stockpiled on the gravel island. Sandbagging of the
island will take place either during the ice season or as early as possible during the summer. We anticipate completion of the island by the end of the ice season, May 15, 1982. The proposed North Slope Borough Ordinance requires that the first island in this area be exposed to ice forces for two winter seasons prior to commencement of drilling operations. The presale notice indicates a similar requirement for islands in water depths exceeding 13 meters, 1.1 meters deeper than the Seal "A" location. The construction schedule noted above will allow the island to be exposed to late winter ice forces during the winter of 1981-82 and to ice forces during the entirety of the 1982-83 season. We believe that this exposure period along with observations of island performance should satisfy the proposed ordinance. The current NSB ordinance places the Seal "A" Island location in the Deferred Development (DD) Subdistrict where petroleum related activities are prohibited until October 1, 1984, a condition to be reviewed annually. In event the NSB ordinance is unchanged, we will request an early annual review of the requirement. Thus it is our plan to construct the island, to expose the island to the winter seasons of 1981-82 and 1982-83, and to commence year-round drilling operation about June 1, 1983.

Either during the winter of 1982-83 or at the earliest following open-water time possible, we plan to transport the BSI Rig 84 or its equivalent to the island and prepare to commence drilling operations about June 1, 1983, assuming proper permits are obtained. State and Federal Lease Stipulation Nos. 9 and 8, respectively, limits downhole activities to the period November 1 to March 31. This lease stipulation is to remain in effect for two years following lease issuance. The two-year stipulation will expire during February and August, 1982 for the leases involved. Since we are requesting a permit to commence drilling
about June 1, 1983, we are also requesting a permit that provides for year-round, continuous drilling until the proposed project has been completed or information has been obtained that warrants discontinuing the program.

**Exploration Depth**

Estimated total depth is 12,300 feet subsea for the first test. We request approval of a maximum depth of 13,500 feet subsea for all wells in our Exploration Plan.

**Island Description**

As indicated, we contemplate construction of a gravel island using proven techniques in a water depth of 11.9 meters (39.0 feet) with a surface diameter of approximately 122 ±7.6 meters (400 ±25 feet), (Enclosure 3). Planned freeboard is 7.6 ±1.5 meters (25 ±5 feet), (Enclosure 4). A 2.1 meter (7-foot) sandbag berm will be placed on the surface perimeter of the island. Sandbags will be placed on the 1:3 island slope to the ocean bottom for protection of the island. Filter fabric will be placed between the gravel and the sandbags to afford additional protection of the structure. The island diameter at sea level will be about 167.6 ±16.8 meters (550 ±55 feet). The island base on the sea floor will be about 239.0 ±16.8 meters (784 ±55 feet) in diameter. We estimate construction of the gravel island structure will require about 573,400 m$^3$ (750,000 yds$^3$) of gravel. A typical rig layout on the gravel island is included (Enclosure 5).

We plan to observe overall island performance and those environmental parameters which significantly affect performance during the proposed exposure period. Plans for these activities will be finalized after consultation with the appropriate agencies.
Storm & Tide Surge

Data indicate that a total storm and tide surge of about 1 meter (3.4 feet) can reasonably be expected with a return frequency of about 10 years. A conservative estimate of the 100-year storm and tide surge is about 2.6 meters (8.7 feet). This is well below our planned island freeboard of 7.6 ±1.5 meters (25 ±5 feet) and the 2.1 meter (7-foot) perimeter sandbag berm. The protection of the outer surface of the island by armoring with sandbags will be adequate to withstand these forces.

Transportation

Access to the drill site will be from facilities at Deadhorse and Prudhoe Bay to the gravel island by helicopter and/or hovercraft year-round, by ice roads during the winter and by water during the open-water season.

Supplies

We expect to supply equipment and materials for the proposed drilling operations from the existing dock and supply areas at Deadhorse and Prudhoe Bay.

Personnel

Staff and rig employees are expected to work 7- or 14-day shifts with some 20 drilling contractor employees including supervisory personnel on location at any given time. We expect to have two or three Shell supervisory personnel on location at all times. The number of service company and other contract personnel on the island will vary depending upon activity and is expected to range from 5 to 50 persons. Living quarters will be a portable camp located on the gravel island. During the island construction phase, a temporary camp will be located on Long Island for emergency housing of personnel employed at the island site.
Rig Description, Critical Operations Curtailment Plan & Drilling Prognosis

We plan to utilize Brinkerhoff Drilling Company's Rig 84, or equivalent, which has been active on the North Slope. The rig was used to drill the Shell-Texaco-Murphy-West Mikkelsen Unit No. 3 on the North Slope. Thus it has been operational under the adverse winter conditions encountered in the area. A rig description is included herewith in Appendix 3. This appendix also includes our Critical Operations Curtailment Plan and a public information copy of our drilling prognosis.

Development/Production Discussion

We estimate that, as a maximum, a successful exploration program could result in a development/production program requiring two or three production islands with up to 100 wells and a production peak on the order of 170,000 barrels of oil per day. While the foregoing represents the maximum case anticipated, a discovery of this magnitude is statistically improbable.

State Stipulation No. 7 and Federal Stipulation No. 5 require the use of pipelines to transport the production to shore, if feasible, subject to specifically designated qualifications. The presale notice prohibits continuous fill causeways.

Oil Spill and Hydrogen Sulfide Contingency Plan

Our Oil Spill Contingency Plan is attached as Appendix 4. As indicated, we provide our own facilities for containment and cleanup of smaller spills. However, Shell Oil Company is a member of the Alaska Beaufort Sea Oilspill Response Body (ABSORB) with full access, as warranted, to ABSORB facilities and management personnel. By reference, the ABSORB Oilspill Contingency Plan is made
a part of our contingency plan. Further, for identification of protection and clean up priorities of the coastal area, the Alaskan Beaufort Sea Coastal Sensitivity Analysis, to be finalized before the end of 1981 is also made, by reference, a part of our plan. In addition and if warranted, other operators in the area would make facilities available for our use in emergency situations. Our Hydrogen Sulfide Contingency Plan is also attached as part of Appendix 4. Continuous monitoring equipment capable of detecting concentrations of five parts per million will be utilized. If concentrations exceed 10 ppm, protection and/or corrective measures will be undertaken.

**Hazardous Materials**

All hazardous material spills will be reported and cleaned up.

**Disposal of Waste and Test Oil and Natural Gas**

Waste and test oil will be disposed of in an approved manner--by burning through a burner or incinerator, containerized and transported to an onshore site or pumped down the 13 3/8 to 9 5/8-inch casing annulus or other method as specified. Any gas produced during testing will be burned by means of a flare.

**Solid and Liquid Waste Disposal**

Drill cuttings, drilling muds and wastewater will be discharged as approved in the required NPDES ocean discharge permit. State and Federal Lease Stipulation No. 6, Paragraph 2. provides that the discharge of mud and cuttings into marine waters is prohibited except that the Commissioner of the Department of Environmental Conservation or the Supervisor may approve discharges (a) in tracts greater than 10 meters of water on a case-by-case basis. Permission is also requested for permission to pump oil contaminated mud and waste water, lube
oil and other liquids down the 13 3/8 to 9 5/8-inch casing annulus and/or down
the last casing string below the 13 3/8-inch casing as warranted. Table A lists
our estimate of the quantities and planned disposition of the waste materials
resulting from the proposed exploration. All putrescible wastes and sewage
sludge will be incinerated in an approved unit. Wood, paper, and cardboard will
be open-burned in a manner that will not emit black smoke. Tin cans will be
incinerated before disposal and incinerator residue backhauled to an approved
site. Nonburnable items (steel drums, rubber, metals, batteries, etc.) will
also be backhauled to an approved site.

Air Emissions

Our estimates of air emissions from the island drilling operations,
onshore support and transportation equipment are detailed on Table B. As pre-
scribed for drilling on an OCS Lease we have calculated the exemption levels "E"
for each air pollutant based on a distance of 5.5 statute miles to the nearest
onshore area. While the nearest land area is Long Island, 3.1 miles, this
island is uninhabited. Thus we have based our exemption level on the distance,
5.5 miles, to the nearest mainland. Based on these formulas, the exemption level
"E" for CO is 10,594 TPY, while the exemption levels for TSP, SOx, NOx, and
VOC are 183.2 TPY. From Table B, it can be calculated that total emissions of
the pollutants CO, SOx, NOx, TSP and VOC would be 40.9, 36.9, 107.3, 23.4 and
7.3 tons per year and the facility is exempt from further air quality review.

Consistency Certification

The activities proposed in this Exploration Plan are consistent with
Alaska's Coastal Management Program and will be conducted in a manner consistent
<table>
<thead>
<tr>
<th>WASTE</th>
<th>QUANTITIES</th>
<th>Per Day</th>
<th>Per Well</th>
<th>Disposal</th>
</tr>
</thead>
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<tr>
<td>Drilling Mud</td>
<td></td>
<td>15 Bbl. (1)</td>
<td>3550 Bbl. (2)(3)</td>
<td>Discharge into Beaufort Sea in accord with NPDES Permit to be obtained. If oil contaminated inject into subsurface disposal zone or transport to approved onshore disposal site.</td>
</tr>
<tr>
<td>Cuttings</td>
<td></td>
<td>25 Bbl. (1)</td>
<td>4250 Bbl. (3)</td>
<td>Discharge into Beaufort Sea in accord with NPDES Permit to be obtained. Remove any oil contamination prior to discharge or transport to an approved onshore disposal site.</td>
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<tr>
<td>Sewage and Gray water</td>
<td></td>
<td>4,000 Ga. (4)</td>
<td>680,000 Gal. (1)</td>
<td>Use in drilling mud and for rig wash down. Discharge excess into Beaufort Sea in accord with NPDES Permit to be obtained.</td>
</tr>
<tr>
<td>Trash</td>
<td></td>
<td>1,000 lb. (5)</td>
<td>170,000 lb. (1)</td>
<td>Incinerate at site.</td>
</tr>
<tr>
<td>- Combustible materials</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- wood, paper, kitchen</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- wastes, etc.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junk</td>
<td></td>
<td>500-1,000 lb.</td>
<td>85,000-170,000(1)</td>
<td>Transport to an approved onshore disposal site.</td>
</tr>
<tr>
<td>- Noncombustible items</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- such as oil drums,</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- junk, tires, batteries</td>
<td></td>
<td></td>
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</tbody>
</table>

(1) Based on 170 day drilling operation.

(2) Includes approximately 1000 Bbl. of mud to be discharged or injected if oil contaminated upon completion of the last of up to 5 exploratory wells projected from Seal "A" Island.

(3) Estimated maximum well depth 13500 feet subsea.

(4) Approximately 30 gal/day sewage and 30 gal/day gray water for average 60-70 persons.

(5) AP-42-Solid Waste Disposal-10 lb/trash/day/person plus drilling rig operation wastes.
<table>
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<th>SOURCE</th>
<th>SOX 1b/D</th>
<th>T/W</th>
<th>TSP 1b/D</th>
<th>T/W</th>
<th>NOX 1b/D</th>
<th>T/W</th>
<th>VOC 1b/D</th>
<th>T/W</th>
<th>CO 1b/D</th>
<th>T/W</th>
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<tr>
<td>1. Camp at Location</td>
<td>19.7(2)</td>
<td>1.7(2)</td>
<td>21.2(2)</td>
<td>1.8(2)</td>
<td>99.5(1)</td>
<td>8.5(1)</td>
<td>5.3(1)</td>
<td>0.5(1)</td>
<td>31.7(1)</td>
<td>2.7(1)</td>
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<tr>
<td>1 Model 3408 Cat Eng.</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>400 Continuous HP 550 gpd</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>2. Drilling Rig</td>
<td>88.7(2)</td>
<td>7.5(2)</td>
<td>95.2(2)</td>
<td>8.1(2)</td>
<td>381.0(1)</td>
<td>32.4(1)</td>
<td>23.8(1)</td>
<td>2.0(1)</td>
<td>142.9(1)</td>
<td>12.1(1)</td>
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<td>Power Generation</td>
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<td>3 Model 398 Cat Eng.</td>
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<td>600 Continuous HP ea. 2250 gpd</td>
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<td>Steam Boilers (3)</td>
<td>56.8</td>
<td>4.8</td>
<td>4.0</td>
<td>0.3</td>
<td>44.0</td>
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<td>0.2</td>
<td>10.0</td>
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<td>2-150 hp McWilliams Davis 2000 gpd</td>
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<td>Hot Air Heaters (3)</td>
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<td>2.0</td>
<td>0.2</td>
<td>22.0</td>
<td>1.9</td>
<td>1.0</td>
<td>0.1</td>
<td>5.0</td>
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<td>2-Tioga Heaters 4.2 MMBTU-1000gpd</td>
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<tr>
<td>Incinerators (3)</td>
<td>5.7</td>
<td>0.5</td>
<td>0.4</td>
<td>0.03</td>
<td>4.4</td>
<td>0.4</td>
<td>0.2</td>
<td>0.02</td>
<td>0.5</td>
<td>0.04</td>
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<tr>
<td>1-8'X 15' 1 SDU Type Neptune Micro Floc PC Chemical Waste Plt 200 gpd</td>
<td></td>
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<tr>
<td>1. Model 966 Cat Loader (2)</td>
<td>2.0</td>
<td>0.2</td>
<td>2.2</td>
<td>0.2</td>
<td>31.2</td>
<td>2.7</td>
<td>2.5</td>
<td>0.2</td>
<td>6.8</td>
<td>0.6</td>
</tr>
<tr>
<td>1 400 amp Welder</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>2 4X4 Crew Cab Truck) (4)</td>
<td>0.1</td>
<td>0.01</td>
<td>0.2</td>
<td>0.02</td>
<td>5.7</td>
<td>0.5</td>
<td>4.4</td>
<td>0.4</td>
<td>27.0</td>
<td>2.3</td>
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<tr>
<td>TOTAL</td>
<td>201.4</td>
<td>17.1</td>
<td>125.2</td>
<td>10.7</td>
<td>587.8</td>
<td>50.1</td>
<td>39.2</td>
<td>3.4</td>
<td>223.9</td>
<td>19.0</td>
</tr>
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</table>

06/29/81
(Continued)
TABLE B
(1) Based on emission factors provided by Caterpillar Engine Company for these particular diesel engines.

(2) Based on emission factors from EPA AP-42 Table 3.3 3.1 Diesel Powered Industrial Engines.

(3) Based on emission factors from EPA AP-42 Table 1.3-1 Industrial & Commercial Boilers (0.2% S by wt)

(4) Based on emission factors from EPA AP-42 Table 3.1 1-1 Average Emission Factors for Highway Vehicles corrected.
with the Program. Consistency will again be certified in our application for a Corps of Engineers permit and in our application for an NPDES Permit.

Drilling Mud Components

As required by OCS Order No. 7 for a drilling permit, Table C is a list of the common names of the drilling mud components that we plan to use and also includes results of toxicity testing on similar types of muds. Specifically we plan to utilize a seawater nondispersed mud using bentonite for gel and barium sulfate as weighting material. References for Table C are contained in Appendix 5. Given current velocities of two to five cm/sec together with experience elsewhere which indicates dispersion to background values at about 200 meters from discharge, background values should be attained in about 1.1 to 2.8 hours. During times of ice cover with low phytoplankton production, the impacts of this mud discharge are expected to be negligible. Because Beaufort Sea currents are essentially wind-driven during open-water season, dispersion should occur during a shorter time span again resulting in a negligible adverse impact on the environment.

Water Supply

Potable water will be obtained from approved land sources in Deadhorse, deep fresh water lakes in the area or possible desalinization (which will require an NPDES Permit for discharged salt water) and/or snow melters and treated to meet Alaska Drinking Water Standards.

Mud Logging Unit

A mud logging unit will be used on all exploratory wells drilled in the proposed exploration plan. In addition to regular monitoring of the drilling
<table>
<thead>
<tr>
<th>MATERIAL</th>
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<tbody>
<tr>
<td>Bentonite (Gel)</td>
</tr>
<tr>
<td>Barite (Barium sulfate)</td>
</tr>
<tr>
<td>Caustic Soda</td>
</tr>
<tr>
<td>Drispac-Polanionic</td>
</tr>
<tr>
<td>Cellulose Polymer</td>
</tr>
<tr>
<td>XC Polymer</td>
</tr>
<tr>
<td>Separan-Polymer</td>
</tr>
<tr>
<td>Lubrikleen-Organic detergent, lubricant, with amines</td>
</tr>
<tr>
<td>Lost circulation material as required</td>
</tr>
<tr>
<td>Seawater</td>
</tr>
</tbody>
</table>
TABLE C (CONTINUED)

SUMMARY OF LABORATORY STUDIES ON BIOLOGICAL EFFECTS OF DRILLING FLUIDS ON MARINE ORGANISMS

This table summarizes the results of bioassays reported in the literature that are most relevant to assessment of drilling fluid impacts in north temperate and sub-Arctic regions. Results of acute tests (Table C-1) are generally grouped by study in approximate decreasing order of relevance.

The bioassays reported in the literature were performed with five different fractions of used drilling fluid (or some component of drilling fluid) and seawater mixtures. These are designated in the table as:

Layered Solid Phase (LSP). A known volume of drilling fluid is layered over the bottom or added to seawater. Although little or no mixing of the slurry is done, the water column contains very fine particulate fractions which do not settle out of solution.

Suspended Solids Phase (SSP). Known volumes of drilling fluids are added to seawater, and the mixture is kept in suspension by aeration or other mechanical means.

Suspended Particulate Phase (SSP). One part by volume of drilling fluid is added to nine parts artificial seawater. The drilling fluid-seawater slurry is well mixed, and the suspension is allowed to settle for 4 hr before the supernatant (100 percent SPP) is siphoned off for immediate use in bioassays.

Mud Aqueuous Fraction (MAF). One part by volume of drilling fluid is added to nine parts seawater. The mixture is stirred thoroughly and then allowed to settle for 20 hr. The resulting supernatant (100 percent MAF) is siphoned and is used immediately in the bioassays. The MAF is similar to the SPP except that longer settling times of MAF allow for a lower concentration of particulates.
Filtered Mud Aqueous Fraction (FMAF). The mud aqueous fraction (MAF) or whole drilling fluid is centrifuged and/or passed through a 0.45-u filter eliminating all particulates greater than this size.

SW is used in these tables as an abbreviation for seawater, and chrome lignosulfonate is abbreviated CLS.
<table>
<thead>
<tr>
<th>Test Material</th>
<th>Test Organisms</th>
<th>Test Conditions</th>
<th>Results (LC\textsubscript{50})(b)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Used Cook Inlet lignosulfonate drilling fluid</td>
<td>Stage I larvae of: Paralithodes camtschatica, (king crab) Cancer magister (Dungeness crab) Chionoecetes bairdi (tanner crab)</td>
<td>SW, 28.4-30.9 ppt, 4.5-7.5°C Static LSP, PMAF(d)</td>
<td>(144 hr) 0.20-0.94% LSP (144 hr EC50)(c) 0.28% LSP (king crab larvae only) (144 hr) LC50=1.41-3.34% PMAF (144 hr) EC50=0.56-2.58% PMAF</td>
<td>Carls and Rice 1981</td>
</tr>
<tr>
<td>Used Cook Inlet lignosulfonate drilling fluid</td>
<td>Stage I larvae of: Eusulsius suckleyi (kelp shrimp) Pandalus hypsinotus (coonstripe shrimp) Pandalus danae (dock shrimp)</td>
<td>SW, 28.4-30.9 ppt, 4.5-7.5°C Static LSP, PMAF</td>
<td>(144 hr) 0.05-0.44% LSP (144 hr EC50) 0.05-0.50% LSP (144 hr) 0.30-0.90% PMAF (144 hr) 0.32-0.56% PMAF</td>
<td>Carls and Rice 1981</td>
</tr>
<tr>
<td>New Prudhoe Bay lignosulfonate drilling fluid</td>
<td>Stage I larvae of: Pandalus hypsinotus (coonstripe shrimp)</td>
<td>SW, 28.4-30.9 ppt, 4.5-7.5°C Static LSP, PMAF</td>
<td>(144 hr) 15.31% PMAF (144 hr) 9.07% PMAF</td>
<td>Carls and Rice 1981</td>
</tr>
<tr>
<td>New Prudhoe Bay drilling fluid without lignosulfonate</td>
<td>Stage I larvae of: Paralithodes camtschatica (king crab)</td>
<td>SW, 28.4-30.9 ppt, 4.5-7.5°C Static LSP, PMAF</td>
<td>(144 hr) 2.33-2.3% PMAF (144 hr EC50) 2.42% PMAF (Pandalus only) (144 hr EC50) &lt;1% LSP</td>
<td>Carls and Rice 1981</td>
</tr>
<tr>
<td>Used Homer spad mud</td>
<td>Stage I larvae of: Paralithodes camtschatica (king crab)</td>
<td>SW, 28.4-30.9 ppt, 4.5-7.5°C Static LSP, PMAF</td>
<td>(144 hr) 9.45% PMAF (144 hr EC50) 6.69% PMAF</td>
<td>Carls and Rice 1981</td>
</tr>
<tr>
<td>New Homer drilling fluid</td>
<td>Stage I larvae of: Paralithodes camtschatica (king crab) Pandalus hypsinotus (coonstripe shrimp)</td>
<td>SW, 28.4-30.9 ppt, 4.5-7.5°C Static LSP, PMAF</td>
<td>(144 hr) ≤5 to 7.17% PMAF (144 hr EC50) ≤5 to 6.18% PMAF (144 hr EC50) &lt;1% LSP (king crab)</td>
<td>Carls and Rice 1981</td>
</tr>
<tr>
<td>Used Homer drilling fluid</td>
<td>Stage I larvae of: Paralithodes camtschatica (king crab) Pandalus hypsinotus (coonstripe shrimp)</td>
<td>SW, 28.4-30.9 ppt, 4.5-7.5°C Static LSP, PMAF</td>
<td>(144 hr) 30.08-37.62% PMAF (144 hr EC50) 10.05-26.79% PMAF (144 hr EC50) 1.53-2.98% LSP</td>
<td>Carls and Rice 1981</td>
</tr>
</tbody>
</table>

(a) PMAF used by Carls and Rice began with 50 percent whole mud in seawater rather than 10 percent used by most other authors.

(b) 96-hr LC\textsubscript{50} given unless otherwise stated.

(c) EC\textsubscript{50}=concentration at which 50% of organisms ceased swimming.
### SUMMARY OF RESULTS OF ACUTE DRILLING FLUID BIOASSAYS ON MARINE ORGANISMS

<table>
<thead>
<tr>
<th>Test Material</th>
<th>Test Organism</th>
<th>Test Conditions</th>
<th>Results (LC₅₀(b))</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Used Cook Inlet</td>
<td>Stage I larvae of:</td>
<td>SW, 28.4-30.9 ppt, 4.5-7.5°C</td>
<td>(144 hr) 1.47-3.91% FMAF at 7 days</td>
<td>Carls and Rice</td>
</tr>
<tr>
<td>lignosulfonate</td>
<td>Paralithodes</td>
<td>Static LSP, FMAF(a)</td>
<td>(144 hr) EC50 (c) 0.92-2.41% FMAF at 7 days</td>
<td>1981</td>
</tr>
<tr>
<td>drilling fluid</td>
<td>centachaticia (king crab)</td>
<td>Test for toxicity of aged drilling fluid (144 hr) 4.08-6.03% FMAF at 14 days</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pandalus hypsinotus</td>
<td>SW, 29 ppt, 12°C</td>
<td>(144 hr) EC50 2.49-3.63% FMAF at 14 days</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(coonstripe shrimp)</td>
<td>Static LSP</td>
<td>(144 hr) 5.63-5.83% FMAF at 21 days</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(144 hr) EC50 2.87% FMAF at 21 days</td>
<td></td>
</tr>
<tr>
<td>Used high density</td>
<td>Pandalus hypsinotus</td>
<td>SW, 27 ppt, 13°C</td>
<td>(144 hr) 4.19% FMAF at 28 days</td>
<td></td>
</tr>
<tr>
<td>lignosulfonate</td>
<td>(coonstripe shrimp)</td>
<td>Static SSP</td>
<td>(144 hr EC50) 3.82% FMAF at 28 days</td>
<td></td>
</tr>
<tr>
<td>drilling fluid</td>
<td></td>
<td></td>
<td>(5 experiments)</td>
<td>Houghton et al.</td>
</tr>
<tr>
<td>Used high density</td>
<td>Oncorhynchus gorbuscha (pink</td>
<td>SW, 29 ppt, 13.5°C</td>
<td>4.4%</td>
<td>1980b</td>
</tr>
<tr>
<td>lignosulfonate</td>
<td>salmon fry)</td>
<td>Static LSP</td>
<td>5.0% &lt;48 hr LC50 &lt;10.0%</td>
<td></td>
</tr>
<tr>
<td>drilling fluid</td>
<td></td>
<td></td>
<td>(2 experiments)</td>
<td></td>
</tr>
<tr>
<td>Used high density</td>
<td>Oncorhynchus gorbuscha (pink</td>
<td>SW, 29 ppt, 12°C</td>
<td>2.9%</td>
<td></td>
</tr>
<tr>
<td>lignosulfonate</td>
<td>salmon fry)</td>
<td>Static SSP</td>
<td>0.3-1.9%</td>
<td></td>
</tr>
<tr>
<td>drilling fluid</td>
<td></td>
<td></td>
<td>(2 experiments)</td>
<td>Houghton et al.</td>
</tr>
<tr>
<td>Used high density</td>
<td>Eogammarus</td>
<td>SW, 29 ppt, 11.4°C</td>
<td>&gt;20%</td>
<td></td>
</tr>
<tr>
<td>lignosulfonate</td>
<td>conferviciculus (amphipods)</td>
<td>Static LSP</td>
<td>1% &lt;48 hr LC50 &lt;5%</td>
<td></td>
</tr>
<tr>
<td>drilling fluid</td>
<td></td>
<td></td>
<td>&gt;7%</td>
<td>Houghton et al.</td>
</tr>
<tr>
<td>Used high density</td>
<td>Eogammarus</td>
<td>SW, 29 ppt, 10°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>lignosulfonate</td>
<td>conferviciculus (amphipods)</td>
<td>Static SSP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>drilling fluid</td>
<td></td>
<td></td>
<td></td>
<td>Houghton et al.</td>
</tr>
<tr>
<td>Used high density</td>
<td>Necomyis integer</td>
<td>SW, 26 ppt, 13°C</td>
<td>(48 hr LC50) 7.4%</td>
<td></td>
</tr>
<tr>
<td>lignosulfonate</td>
<td>(mysids)</td>
<td>Static LSP</td>
<td>10% &lt;48hr LC50 &lt;15%</td>
<td></td>
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<tr>
<td>drilling fluid</td>
<td></td>
<td></td>
<td>10% &lt;96 hr LC50 &lt;12.5%</td>
<td></td>
</tr>
<tr>
<td>Used high density</td>
<td>Necomyis integer</td>
<td>SW, 26 ppt, 13°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>lignosulfonate</td>
<td>(mysids)</td>
<td>Static SSP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>drilling fluid</td>
<td></td>
<td></td>
<td></td>
<td>Houghton et al.</td>
</tr>
<tr>
<td>Used high density</td>
<td>Necomyis integer</td>
<td>SW, 26 ppt, 13°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>lignosulfonate</td>
<td>(mysids)</td>
<td>Static SSP</td>
<td></td>
<td>Houghton et al.</td>
</tr>
<tr>
<td>drilling fluid</td>
<td></td>
<td></td>
<td></td>
<td>1980b</td>
</tr>
<tr>
<td>Used high density</td>
<td>Gnathosomatus</td>
<td>SW, 29 ppt, 10°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>lignosulfonate</td>
<td>oregonensis (isopods)</td>
<td>Static SSP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>drilling fluid</td>
<td></td>
<td></td>
<td></td>
<td>Houghton et al.</td>
</tr>
</tbody>
</table>

(a) FMAF used by Carls and Rice began with 50 percent whole mud in seawater rather than 10 percent used by most other authors.
(b) 96-hr LC₅₀ given unless otherwise noted.
(c) EC₅₀—concentration at which 50% of organisms ceased swimming.
<table>
<thead>
<tr>
<th>Test Material</th>
<th>Test Organism</th>
<th>Test Conditions</th>
<th>Results (LC$_{50}$)$^{(b)}$</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Used high density lignosulphonate drilling fluid</td>
<td>Leptocottus armatus (staghorn sculpin juveniles)</td>
<td>SW, 12.4°C Static SSP</td>
<td>10% ≤ 48 hr LC$_{50}$ ≤ 20%</td>
<td>Houghton et al. 1980b</td>
</tr>
<tr>
<td>Used high density lignosulphonate drilling fluid</td>
<td>Modiolus modiolus (mussels)</td>
<td>SW, Static LSP</td>
<td>(13.6 day LC$_{50}$) &gt; 9%</td>
<td>Houghton et al. 1980b</td>
</tr>
<tr>
<td>Used CMC/ResineX/ Tannatin/Gel drilling fluid</td>
<td>Melaneis loveni (polychaetes)</td>
<td>SW, ≤ 20 ppt, ≥ 0°C Static, LSP</td>
<td>&gt; 60%</td>
<td>Tornberg et al. 1980</td>
</tr>
<tr>
<td>Used CMC/ResineX/ Tannatin/Gel drilling fluid</td>
<td>Saduria entomon (isopods)</td>
<td>SW, 15 ppt, ≤ 3°C Static, LSP</td>
<td>&gt; 53% to &gt; 60% (2 experiments)</td>
<td>Tornberg et al. 1980</td>
</tr>
<tr>
<td>Used CMC/ResineX/ Tannatin/Gel drilling fluid</td>
<td>Melaneis loveni (polychaetes)</td>
<td>SW, ≤ 20 ppt, ≥ 1°C Static, LSP</td>
<td>&gt; 70%</td>
<td>Tornberg et al. 1980</td>
</tr>
<tr>
<td>Used CMC/ResineX/ ResineX drilling fluid</td>
<td>Hysia sp. (mysidae)</td>
<td>SW, 30 ppt, 11.8°C Static LSP</td>
<td>≤ 6% to 7.3% (2 experiments)</td>
<td>Tornberg et al. 1980</td>
</tr>
<tr>
<td>Used CMC/ResineX/ ResineX drilling fluid</td>
<td>Hyochoephalus quadricornis (fourhorn sculpin juveniles)</td>
<td>SW, 5 ppt, 19°C Static LSP</td>
<td>7% to 7% (2 experiments)</td>
<td>Tornberg et al. 1980</td>
</tr>
<tr>
<td>Used CMC/ResineX/ ResineX drilling fluid</td>
<td>Hysia sp. (mysidae)</td>
<td>SW, 11 ppt, 7.8°C Static LSP</td>
<td>21.5%</td>
<td>Tornberg et al. 1980</td>
</tr>
<tr>
<td>Used CMC/ResineX/ ResineX drilling fluid</td>
<td>Hyochoephalus quadricornis (fourhorn sculpin juveniles)</td>
<td>SW, 11 ppt, 7.7°C Static LSP</td>
<td>12%</td>
<td>Tornberg et al. 1980</td>
</tr>
<tr>
<td>Used CMC/ResineX/ ResineX drilling fluid</td>
<td>Eligius navaga (saffron cod)</td>
<td>SW, 15 ppt, 7.8°C Static LSP</td>
<td>17% to 30%</td>
<td>Tornberg et al. 1980</td>
</tr>
<tr>
<td>Used CMC/ResineX/ ResineX drilling fluid</td>
<td>Coregonus nasus (broad whitefish juveniles)</td>
<td>SW, 9.8 ppt, 10.1°C Static LSP</td>
<td>&gt; 20%</td>
<td>Tornberg et al. 1980</td>
</tr>
</tbody>
</table>

$^{(b)}$ 96-hr LC$_{50}$ given unless otherwise stated.
<table>
<thead>
<tr>
<th>Test Material</th>
<th>Test Organism</th>
<th>Test Conditions</th>
<th>Results (<em>LC₅₀</em>) (b)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Used XC-polymer/Unical drilling fluid</td>
<td>Saduria antomon</td>
<td>SW, 20 ppt, 0°C Static LSP</td>
<td>31.4% &lt; 96 hr LC₅₀ &lt; 50%</td>
<td>Tornberg et al. 1980</td>
</tr>
<tr>
<td>Used XC-polymer/Unical drilling fluid</td>
<td>Onisimus sp.</td>
<td>SW, 22 ppt, 1°C Static LSP</td>
<td>22.1% to 38.1% (6 experiments)</td>
<td>Tornberg et al. 1980</td>
</tr>
<tr>
<td></td>
<td>Boeckosimus sp. (amphipods)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Used XC-polymer drilling fluid</td>
<td>Mysis sp. (mysis)</td>
<td>SW, 15 ppt, 10°C Static LSP</td>
<td>5% &lt; 96 hr LC₅₀ &lt; 17% (3 experiments)</td>
<td>Tornberg et al. 1980</td>
</tr>
<tr>
<td>Used XC-polymer drilling fluid</td>
<td>Hyochocephalus quadricornis (fourhorn sculpin juveniles)</td>
<td>SW, 16 ppt, 10°C Static LSP</td>
<td>5% to 21.5% (5 experiments)</td>
<td>Tornberg et al. 1980</td>
</tr>
<tr>
<td>Used XC-polymer drilling fluid</td>
<td>Hyochocephalus quadricornis (fourhorn sculpin juveniles)</td>
<td>SW, 6.5 ppt, 11°C Static SPP Maximum test concentration 25% drilling fluid to seawater (V/V)</td>
<td>25%</td>
<td>Tornberg et al. 1980</td>
</tr>
<tr>
<td>Used XC-polymer drilling fluid</td>
<td>Coregonus nasus (broad whitefish juveniles)</td>
<td>SW, 10 ppt, 7.5°C Static LSP</td>
<td>6.4% to 37% (4 experiments)</td>
<td>Tornberg et al. 1980</td>
</tr>
<tr>
<td>Used XC-polymer drilling fluid</td>
<td>Coregonus nasus (broad whitefish juveniles)</td>
<td>SW, 8 ppt, 9°C Static SPP Maximum test concentration 25% drilling fluid to seawater (V/V)</td>
<td>10% &lt; 96 hr LC₅₀ &lt; 17%</td>
<td>Tornberg et al. 1980</td>
</tr>
<tr>
<td>Used XC-polymer drilling fluid</td>
<td>Boreogadus saida</td>
<td>SW, 17 ppt, 10.8°C Static LSP</td>
<td>25%</td>
<td>Tornberg et al. 1980</td>
</tr>
<tr>
<td>Used lignosulfonate drilling fluid</td>
<td>Hyochocephalus quadricornis (fourhorn sculpins)</td>
<td>SW, 15 ppt, 9°C Static LSP</td>
<td>35%</td>
<td>Tornberg et al. 1980</td>
</tr>
<tr>
<td>Used lignosulfonate drilling fluid</td>
<td>Coregonus nasus (broad whitefish)</td>
<td>SW, 20 ppt, 9.9°C Static LSP</td>
<td>&lt; 10%</td>
<td>Tornberg et al. 1980</td>
</tr>
<tr>
<td>Used lignosulfonate drilling fluid</td>
<td>Boreogadus saida (Arctic cod)</td>
<td>SW, 18 ppt, 7.6°C Static LSP</td>
<td>20% &lt; 96 hr LC₅₀ &lt; 25%</td>
<td>Tornberg et al. 1980</td>
</tr>
<tr>
<td>Used lignosulfonate drilling fluid</td>
<td>Coregonus autunnalis (Arctic cisco)</td>
<td>SW, 20.8 ppt, 7.1°C Static LSP</td>
<td>40%</td>
<td>Tornberg et al. 1980</td>
</tr>
</tbody>
</table>

(b) 96-hr LC₅₀ given unless otherwise stated.
### TABLE C-1 (Continued)

<table>
<thead>
<tr>
<th>Test Material</th>
<th>Test Organism</th>
<th>Test Conditions</th>
<th>Results (LC₅₀) (º)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Used KCl-polymer drilling fluid</td>
<td><em>Salmo gairdneri</em> (saltwater acclimated juvenile rainbow trout)</td>
<td>SW, 26 ppt 12°C</td>
<td>2.4º</td>
<td>Division of Applied Biology B.C. Research 1976</td>
</tr>
<tr>
<td></td>
<td><em>Oncorhynchus kisutch</em> (juvenile coho salmon)</td>
<td>Static SSP</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Oncorhynchus keta</em> (juvenile chum salmon)</td>
<td>SW, 26 ppt 12°C</td>
<td>2.4º</td>
<td>Division of Applied Biology B.C. Research 1976</td>
</tr>
<tr>
<td></td>
<td><em>Oncorhynchus quibuscha</em> (juvenile pink salmon)</td>
<td>SW, 26 ppt 12°C</td>
<td>4.1º</td>
<td>Division of Applied Biology B.C. Research 1976</td>
</tr>
<tr>
<td>Used KCl-polymer drilling fluid</td>
<td><em>Nereis vexillosa</em> (mussel worm)</td>
<td>SW, 26 ppt 12°C</td>
<td>3.7º</td>
<td>Division of Applied Biology B.C. Research 1976</td>
</tr>
<tr>
<td></td>
<td><em>Mya arenaria</em> (soft-shelled clam)</td>
<td>SW, 26 ppt 12°C</td>
<td>4.2º</td>
<td>Division of Applied Biology B.C. Research 1976</td>
</tr>
<tr>
<td>Used KCl-polymer drilling fluid</td>
<td><em>Hemigrapsus nudus</em> (purple beach crab)</td>
<td>SW, 26 ppt 12°C</td>
<td>5.3º</td>
<td>Division of Applied Biology B.C. Research 1976</td>
</tr>
<tr>
<td>Used SW/polymer drilling fluid</td>
<td><em>Oncorhynchus kisutch</em> (juvenile coho salmon)</td>
<td>SW, 26.5 ppt, 12ºC</td>
<td>13º</td>
<td>Division of Applied Biology B.C. Research 1976</td>
</tr>
<tr>
<td></td>
<td><em>Nereis vexillosa</em> (mussel worm)</td>
<td>SW, 26.5 ppt, 12ºC</td>
<td>22.0º</td>
<td>Division of Applied Biology B.C. Research 1976</td>
</tr>
<tr>
<td></td>
<td><em>Mya arenaria</em> (soft-shelled clam)</td>
<td>SW, 26.5 ppt, 12ºC</td>
<td>32.0º</td>
<td>Division of Applied Biology B.C. Research 1976</td>
</tr>
<tr>
<td>Used SW/polymer drilling fluid</td>
<td><em>Hemigrapsus nudus</em> (purple beach crab)</td>
<td>SW, 26.5 ppt, 12ºC</td>
<td>53.0º</td>
<td>Division of Applied Biology B.C. Research 1976</td>
</tr>
<tr>
<td></td>
<td><em>Orchestia traskiana</em> (sand flea)</td>
<td>SW, 26.5 ppt, 12ºC</td>
<td>23.0º</td>
<td>Division of Applied Biology B.C. Research 1976</td>
</tr>
</tbody>
</table>

(b) 96-hr LC₅₀ given unless otherwise stated.
<table>
<thead>
<tr>
<th>Test Material</th>
<th>Test Organism</th>
<th>Test Conditions</th>
<th>Results (LC₅₀) (b)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Used KCl-XC polymer drilling fluid</td>
<td>Oncorhynchus kisutch (juvenile coho salmon)</td>
<td>SW, 27 ppt, 12°C</td>
<td>2.3%</td>
<td>Division of Applied Biology B.C. Research 1976</td>
</tr>
<tr>
<td></td>
<td>Hereis vexillosa (mussel worm)</td>
<td>SW, 27 ppt, 12°C</td>
<td>4.1%</td>
<td>Division of Applied Biology B.C. Research 1976</td>
</tr>
<tr>
<td></td>
<td>Mysa arenaria (soft-shelled clam)</td>
<td>SW, 27 ppt, 12°C</td>
<td>5.6%</td>
<td>Division of Applied Biology B.C. Research 1976</td>
</tr>
<tr>
<td></td>
<td>Hemigrapsus nudus (purple beach crab)</td>
<td>SW, 27 ppt, 12°C</td>
<td>7.8%</td>
<td>Division of Applied Biology B.C. Research 1976</td>
</tr>
<tr>
<td></td>
<td>Orchestia traskiana (sand flea)</td>
<td>SW, 27 ppt, 12°C</td>
<td>1.4%</td>
<td>Division of Applied Biology B.C. Research 1976</td>
</tr>
<tr>
<td>Used weighted polymer drilling fluid</td>
<td>Oncorhynchus kisutch (juvenile coho salmon)</td>
<td>SW, 26.8 ppt, 12°C</td>
<td>1.5%</td>
<td>Division of Applied Biology B.C. Research 1976</td>
</tr>
<tr>
<td></td>
<td>Hereis vexillosa (mussel worm)</td>
<td>SW, 26.8 ppt, 12°C</td>
<td>2.3%</td>
<td>Division of Applied Biology B.C. Research 1976</td>
</tr>
<tr>
<td></td>
<td>Mysa arenaria (soft-shelled clam)</td>
<td>SW, 26.8 ppt, 12°C</td>
<td>1.0%</td>
<td>Division of Applied Biology B.C. Research 1976</td>
</tr>
<tr>
<td></td>
<td>Hemigrapsus nudus (purple beach crab)</td>
<td>SW, 26.8 ppt, 12°C</td>
<td>6.2%</td>
<td>Division of Applied Biology B.C. Research 1976</td>
</tr>
<tr>
<td></td>
<td>Orchestia traskiana (sand flea)</td>
<td>SW, 26.8 ppt, 12°C</td>
<td>3.4%</td>
<td>Division of Applied Biology B.C. Research 1976</td>
</tr>
<tr>
<td></td>
<td>Oncorhynchus kisutch (juvenile coho salmon)</td>
<td>SW, 24.6 ppt, 12°C</td>
<td>19.0%</td>
<td>Division of Applied Biology B.C. Research 1976</td>
</tr>
<tr>
<td></td>
<td>Hereis vexillosa (mussel worm)</td>
<td>SW, 24.6 ppt, 12°C</td>
<td>12.0%</td>
<td>Division of Applied Biology B.C. Research 1976</td>
</tr>
</tbody>
</table>

(b) 96-hr LC₅₀ given unless otherwise stated.
<table>
<thead>
<tr>
<th>Test Material</th>
<th>Test Organism</th>
<th>Test Conditions</th>
<th>Results (LC&lt;sub&gt;50&lt;/sub&gt;)&lt;sup&gt;(b)&lt;/sup&gt;</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Used weighted Gel/XC polymer drilling fluid</td>
<td><em>M. arenaria</em> (soft-shelled clam)</td>
<td>SW, 24.6 ppt., 12°C Static SSP</td>
<td>56.0%</td>
<td>Division of Applied Biology B.C. Research 1976</td>
</tr>
<tr>
<td></td>
<td><em>H. nudus</em> (purple beach crab)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Used weighted Gel/XC polymer drilling fluid</td>
<td><em>O. traskiana</em> (sand flea)</td>
<td>SW, 24.6 ppt., 12°C Static SSP</td>
<td>42.0%</td>
<td>Division of Applied Biology B.C. Research 1976</td>
</tr>
<tr>
<td>Used Gel Chemical XC drilling fluid</td>
<td><em>O. kisutch</em> (juvenile coho salmon)</td>
<td>SW, 28 ppt., 12°C Static SSP</td>
<td>3.9%</td>
<td>Division of Applied Biology B.C. Research 1976</td>
</tr>
<tr>
<td>Used Gel Chemical XC drilling fluid</td>
<td><em>M. vexillosa</em> (mussel worm)</td>
<td>SW, 28 ppt., 12°C Static SSP</td>
<td>&gt;56%</td>
<td>Division of Applied Biology B.C. Research 1976</td>
</tr>
<tr>
<td></td>
<td><em>M. arenaria</em> (soft-shelled clam)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>H. nudus</em> (purple beach crab)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Used Gel Chemical XC drilling fluid</td>
<td><em>O. traskiana</em> (sand flea)</td>
<td>SW, 28 ppt., 12°C Static SSP</td>
<td>8.0%</td>
<td>Division of Applied Biology B.C. Research 1976</td>
</tr>
<tr>
<td>Used Gel XC-polymer drilling fluid</td>
<td><em>O. kisutch</em> (juvenile coho salmon)</td>
<td>SW, 28 ppt., 12°C Static SSP</td>
<td>3%</td>
<td>Division of Applied Biology B.C. Research 1976</td>
</tr>
<tr>
<td>Used Gel XC-polymer drilling fluid</td>
<td><em>M. vexillosa</em> (mussel worm)</td>
<td>SW, 28 ppt., 12°C Static SSP</td>
<td>2%</td>
<td>Division of Applied Biology B.C. Research 1976</td>
</tr>
<tr>
<td>Used Gel XC-polymer drilling fluid</td>
<td><em>M. arenaria</em> (soft-shelled clam)</td>
<td>SW, 28 ppt., 12°C Static SSP</td>
<td>&gt;56%</td>
<td>Division of Applied Biology B.C. Research 1976</td>
</tr>
<tr>
<td></td>
<td><em>H. nudus</em> (purple beach crab)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>O. traskiana</em> (sand flea)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(b) 96-hr LC<sub>50</sub> given unless otherwise stated.
<table>
<thead>
<tr>
<th>Test Material</th>
<th>Test Organism</th>
<th>Test Conditions</th>
<th>Results (LC&lt;sub&gt;50&lt;/sub&gt;)&lt;sup&gt;(b)&lt;/sup&gt;</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Used drilling fluid containing freshwater sodium montmorillonite, BaSO&lt;sub&gt;4&lt;/sub&gt;, NaOH, XC-polymer, potassium chrome alum, polyamionic cellulosic polymer, vinyl acetate-maleic acid copolymer; CLS may or may not be present</td>
<td>Onchorhynchus gorbuscha, (pink salmon fry, 48-mm T.L.)</td>
<td>SW, 12.5°C, static, media stirred once each hour to resuspend mixture, media was not changed after beginning of experiment, 96-hr exposure</td>
<td>Observed mortality less than 10% for concentrations of drilling fluid to SW of 1.0 to 10.0% (V/V) except at 5.6% concentration where 2 organisms died (17% mortality)</td>
<td>Johnson and LeGore 1976</td>
</tr>
<tr>
<td>Same drilling fluid as above plus paraformaldehyde at a concentration of 0.25 lb per barrel of mud</td>
<td>Onchorhynchus gorbuscha, (pink salmon fry, 48-mm T.L.)</td>
<td>SW, 12.5°C, static, media stirred once each hour to resuspend mixture, media was not changed after beginning of experiment, 96-hr exposure</td>
<td>Observed mortality less than 10% for all test concentrations (1.0 - 10.0% by volume)</td>
<td>Johnson and LeGore 1976</td>
</tr>
<tr>
<td>Drilling fluid as above with and without paraformaldehyde</td>
<td>Pandalus borealis (pink shrimp), P. danar (coonstripe shrimp)</td>
<td>SW, 12.5°C static, SPP media was not changed after beginning of experiment, 96-hr exposure</td>
<td>3 mortalities in all test concentrations including the control tank. No apparent toxic effect to 10% drilling fluid</td>
<td>Johnson and LeGore 1976</td>
</tr>
<tr>
<td>Drilling fluid as above without paraformaldehyde</td>
<td>Spirontocaris sp.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drilling fluid as above without paraformaldehyde (1.0 lb/barrel)</td>
<td>Copepods and mysids</td>
<td>SW, 6.0-8.1°C static, SPP media was not changed after the beginning of experiment, 48-hr exposure, test concentrations 1.0-10.0% drilling fluid to seawater by volume</td>
<td>40-60% copepod mortality in test concentrations greater than 1.8%, control mortality of 30%. No significant mysid mortalities at concentrations less than 4.5%. Concentrations 35.6% had 40% mortality</td>
<td>Johnson and LeGore 1976</td>
</tr>
<tr>
<td>Drilling fluid as above without paraformaldehyde (1.0 lb/barrel)</td>
<td>Copepods and mysids</td>
<td>SW, 6.0-8.1°C static, SPP media was not changed after the beginning of experiment, 48-hr exposure, test concentrations 1.0-10.0% drilling fluid to seawater by volume</td>
<td>Mortality of 80-100% after 48-hr exposure of SPP media concentrations of 1.0-10.0% for both copepods and mysids</td>
<td>Johnson and LeGore 1976</td>
</tr>
<tr>
<td>Drilling fluid as above with Lubrikleen (1.0 lb/barrel)</td>
<td>Mysids</td>
<td>SW, 10.0-12.0°C static, SPP media was not changed after the beginning of experiment, 48-hr exposure, 1.0-10.0% concentrations</td>
<td>No significant mortalities excluding an apparent experimental artifact at 1.0% concentration (80% mortality)</td>
<td>Johnson and LeGore 1976</td>
</tr>
<tr>
<td>Drilling fluid as above with paraformaldehyde (0.25 lb/barrel) plus Lubrikleen (1.0 lb/barrel)</td>
<td>Mysids</td>
<td>SW, 10.0-12.0°C static, SPP media was not changed after the beginning of experiment, 48-hr exposure, 1.0-10.0% concentrations</td>
<td>No significant mortalities</td>
<td>Johnson and LeGore 1976</td>
</tr>
</tbody>
</table>

<sup>(b)</sup> 96-hr LC<sub>50</sub> given unless otherwise stated.
<table>
<thead>
<tr>
<th>Test Material</th>
<th>Test Organism</th>
<th>Test Conditions</th>
<th>Results (LC$_{50}$)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Used SW CSL drilling fluid composed primarily of SW, bentonite, CLS, lime, caustic soda, lime, and barite</td>
<td><em>Clibanarius vittatus</em></td>
<td>Static MAF changed daily</td>
<td>28.7% MAF</td>
<td>Neff et al. 1980</td>
</tr>
<tr>
<td></td>
<td><em>Peneaus aztecus</em> adults</td>
<td>Static MAF changed daily</td>
<td>41.5% MAF</td>
<td>Neff et al. 1980</td>
</tr>
<tr>
<td></td>
<td><em>Peneaus duorarum</em> postlarvae</td>
<td>SW, 28 ppt, 22°C, Static MAF</td>
<td>868% MAF</td>
<td>Neff et al. 1981</td>
</tr>
<tr>
<td></td>
<td><em>Pleomeles pugio</em> 1st Zoeae postlarvae</td>
<td>SW, 16 ppt, 22°C, Static MAF changed daily</td>
<td>27.5% MAF</td>
<td>Neff et al. 1980</td>
</tr>
<tr>
<td></td>
<td>4-day Zoeae adults</td>
<td>Static MAF changed daily</td>
<td>34% MAF</td>
<td>Neff et al. 1981</td>
</tr>
<tr>
<td></td>
<td><em>Donax variabilis</em> (coquina clam) adults</td>
<td>SW, 35 ppt, 22°C, n=20-25 Static SPP changed daily</td>
<td>(72 hr) 92.4% SPP</td>
<td>Neff et al. 1980</td>
</tr>
<tr>
<td></td>
<td>juveniles</td>
<td>Static SPP changed daily</td>
<td>53.7% SPP</td>
<td>Neff et al. 1980</td>
</tr>
<tr>
<td></td>
<td>adults</td>
<td>Static MAF</td>
<td>&gt;100% MAF</td>
<td>Neff et al. 1981</td>
</tr>
<tr>
<td></td>
<td><em>Neanthes arenaceodentata</em> (marine annelid worm) Juveniles</td>
<td>Static MAF</td>
<td>85% MAF</td>
<td>Neff et al. 1981</td>
</tr>
<tr>
<td></td>
<td>Adults</td>
<td>Static MAF</td>
<td>95% MAF</td>
<td>Neff et al. 1981</td>
</tr>
<tr>
<td></td>
<td><em>Ophryotrocha lahornica</em> (marine annelid worm) adults</td>
<td>SW, 34 ppt, 25°C Static MAF</td>
<td>&gt;100% MAF</td>
<td>Neff et al. 1981</td>
</tr>
<tr>
<td></td>
<td><em>Dinophilus sp.</em> (marine annelid worm) adults</td>
<td>SW, 33 ppt, 25°C Static MAF</td>
<td>76% MAF</td>
<td>Neff et al. 1981</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Static SFP</td>
<td>45% MAF</td>
<td>Neff et al. 1981</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Static MAF</td>
<td>(480 hr) 13% MAF</td>
<td>Neff et al. 1981</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Static SFP</td>
<td>(480 hr) 15% SFP</td>
<td>Neff et al. 1981</td>
</tr>
</tbody>
</table>

(b) 96-hr LC$_{50}$ given unless otherwise stated.
<table>
<thead>
<tr>
<th>Test Material</th>
<th>Test Organism</th>
<th>Test Conditions</th>
<th>Results ($LC_{50}$)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Same CLS mud as above</td>
<td><em>Mysidopsis almyra</em></td>
<td>SW, 20 ppt, 25°C</td>
<td>(48 hr) 32.0% MAF</td>
<td>Neff et al. 1980</td>
</tr>
<tr>
<td>1-day old postlarvae of (opposeum shrimp)</td>
<td>Static MAF changed daily</td>
<td>72 hr) 29.0% MAF</td>
<td>Neff et al. 1980</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Static MAF changed daily</td>
<td>27% MAF</td>
<td>Neff et al. 1981</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Static MAF changed daily</td>
<td>40% MAF</td>
<td>Neff et al. 1980</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Static MAF</td>
<td>79% MAF</td>
<td>Neff et al. 1981</td>
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<tr>
<td>3-day old</td>
<td>Static MAF</td>
<td>73% MAF</td>
<td>Neff et al. 1981</td>
<td></td>
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<tr>
<td>7-day old</td>
<td>Static MAF</td>
<td>81% MAF</td>
<td>Neff et al. 1980</td>
<td></td>
</tr>
<tr>
<td>14-day old</td>
<td>Static MAF</td>
<td>96% MAF</td>
<td>Neff et al. 1981</td>
<td></td>
</tr>
<tr>
<td><em>Mercenaria compaechiensia</em></td>
<td>SW, 20 ppt, 22°C, Static MAF</td>
<td>&gt;100% MAF</td>
<td>Neff et al. 1981</td>
<td></td>
</tr>
<tr>
<td>Adult (hard shell clam)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Penaeus duorarum</em> postlarvae (pink shrimp)</td>
<td>SW, 20 ppt, static SPP changed daily 160-hr exposure to 10 ml drilling fluid/1 SW (10,000 ppm or 1.0% by volume)</td>
<td>71% survival</td>
<td>Neff et al. 1981</td>
<td></td>
</tr>
<tr>
<td><em>Penaeus aztecs</em> juveniles (brown shrimp)</td>
<td>SW, 20 ppt, static SPP changed daily 160-hr exposure to 10 ml drilling fluid/1 SW (10,000 ppm or 1.0% by volume)</td>
<td>40% survival</td>
<td>Neff et al. 1981</td>
<td></td>
</tr>
<tr>
<td><em>Portunus spinicarpus</em> adult (crab)</td>
<td>SW, 35 ppt, static SPP changed daily, 160-hr exposure to 20 ml drilling fluid/1 SW (20,000 ppm or 2.0% by volume)</td>
<td>100% survival</td>
<td>Neff et al. 1981</td>
<td></td>
</tr>
<tr>
<td><em>Mercenaria compaechiensia</em> adult (hard shell clam)</td>
<td>SW, 20 ppt, static SPP changed daily, 160-hr exposure to 20 ml drilling fluid/1 SW (20,000 ppm or 2.0% by volume)</td>
<td>100% survival</td>
<td>Neff et al. 1981</td>
<td></td>
</tr>
<tr>
<td><em>Rangia cuneata</em> adult (mollusc)</td>
<td>SW, 20 ppt, static SPP changed daily, 160-hr exposure to 20 ml drilling fluid/1 SW (20,000 ppm or 2.0% by volume)</td>
<td>100% survival</td>
<td>Neff et al. 1981</td>
<td></td>
</tr>
<tr>
<td><em>Donax variabilis</em> tesselana juvenile and adult (coquina clam)</td>
<td>SW, 35 ppt, 22°C, static LSP changed daily, 96-hr exposure to 100 ml drilling fluid/SW (100,000 ppm or 10% by volume)</td>
<td>32% survival of juveniles (&lt;1 cm) and 0% survival of adults</td>
<td>Neff et al. 1981</td>
<td></td>
</tr>
</tbody>
</table>

(b) 96-hr $LC_{50}$ given unless otherwise stated.
<table>
<thead>
<tr>
<th>Test Material</th>
<th>Test Organism</th>
<th>Test Conditions</th>
<th>Results (LC50)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Same CLS as above</td>
<td><em>Aequipecten amplusicanthus</em> adult (estuarine scallop)</td>
<td>SW, 20 ppt, 22°C, Static LSP changed daily, 96-hr exposure to 20 ml drilling fluid/1 SW (20,000 ppm or 2% by volume)</td>
<td>40% survival</td>
<td>Neff et al. 1981</td>
</tr>
<tr>
<td></td>
<td>Meanthea arenacordata juvenile and adult (marine worm)</td>
<td>SW, 32 ppt, 22°C, Static LSP changed daily, 96-hr exposure to 40 ml drilling fluid/1 SW (40,000 ppm or 4% by volume)</td>
<td>77.5% survival of juveniles and 25% survival of adults</td>
<td>Neff et al. 1981</td>
</tr>
<tr>
<td></td>
<td>Ophryotrocha labronica adult (marine worm)</td>
<td>SW, 34 ppt, 22°C, Static LSP changed daily, 96-hr exposure to 50 ml drilling fluid/1 SW (50,000 ppm or 5% by volume)</td>
<td>95% survival</td>
<td>Neff et al. 1981</td>
</tr>
<tr>
<td></td>
<td>Myisidopsis alyra 1-day old (opposum shrimp)</td>
<td>SW, 20 ppt, 22°C, Static LSP changed daily, 168-hr exposure to 25 ml drilling fluid/1 SW (25,000 ppm or 2.5% by volume)</td>
<td>55% survival</td>
<td>Neff et al. 1981</td>
</tr>
<tr>
<td></td>
<td>Crangon septemspinosa (sand shrimp)</td>
<td>SW, 31-33 ppt, 7-12°C, static MAF</td>
<td>&gt;100% MAF</td>
<td>Gerber et al. 1980</td>
</tr>
<tr>
<td></td>
<td>Mytilus edulis (blue mussel)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mercis virens (sand worm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fundulus heteroclitus (killifish)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Used low density lignosulfonate drilling fluid</td>
<td>Crangon septemspinosa (sand shrimp)</td>
<td>SW, 31-33 ppt, 8-22°C Static MAF, SSP; flow-through LSP</td>
<td>&gt;100% MAF at 8°C 98% MAF at 18°C 77% LSP at 18°C &gt;15,000 ppm SSP at 18°C</td>
<td>Gerber et al. 1980</td>
</tr>
<tr>
<td></td>
<td>Carcinus maenas (green crab)</td>
<td>SW, 31-33 ppt, 8-22°C Static MAF, SSP flow through LSP</td>
<td>&gt;100% MAF at 8°C 89% LSP at 8°C &gt;15,000 ppm SSP at 8°C</td>
<td>Gerber et al. 1980</td>
</tr>
<tr>
<td></td>
<td>Homarus americanus (American lobster)</td>
<td>SW, 31-33 ppt, 8-22°C Static MAF, SSP flow through LSP</td>
<td>5% MAF at 18°C 19-25% MAF</td>
<td></td>
</tr>
</tbody>
</table>

(b) 96-hr LC50 given unless otherwise stated.
# TABLE C-1 (Continued)

## SUMMARY OF RESULTS OF ACUTE DRILLING FLUID BIOASSAYS ON MARINE ORGANISMS

<table>
<thead>
<tr>
<th>Test Material</th>
<th>Test Organism</th>
<th>Test Conditions</th>
<th>Results (<a href="b">LC50</a>)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Used low density</td>
<td>Macoma balthica (clam)</td>
<td>SW, 31-33 ppt, 8-22°C</td>
<td>&gt;100% MAF at 8°C</td>
<td>Gerber et al. 1980</td>
</tr>
<tr>
<td>lignosulfonate drilling fluid</td>
<td>Placopecten magellanicus (ocean scallop)</td>
<td>Static MAF, SSP flow through LSP</td>
<td>4% to 100% LSP</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Littorina littorea (periwinkle)</td>
<td></td>
<td>&gt;15,000 ppm SSP for <em>Macoma</em> and <em>Thais</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Thais lapillus (dog whelk)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nerita virens (sand worm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Strongylocentrotus droebachiensis (green sea urchin)</td>
<td>Static exposure</td>
<td>100% mortality in 2 days of 25,000 ppm drilling fluid</td>
<td>Carr et al. 1980</td>
</tr>
<tr>
<td></td>
<td><em>Myisidopsis alyma</em> (opposum shrimp)</td>
<td>SW, 20 ppt, 25°C</td>
<td>96% mortality in 4 days of 50% SSP</td>
<td></td>
</tr>
<tr>
<td>Used medium density</td>
<td></td>
<td>1st day juveniles, LSP</td>
<td>12% mortality in 7 days of 50% MAF</td>
<td></td>
</tr>
<tr>
<td>lignosulfonate mud</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>composed primarily of SW, bentonite, clay, CLS, lignite, NaOH, barite,</td>
<td></td>
<td>1st day juveniles, static SFP</td>
<td>32% SFP</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1-14 day old, static MAF</td>
<td>41-112.8% MAF</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1st day juveniles, MAF changed daily</td>
<td>26.8% MAF</td>
<td></td>
</tr>
</tbody>
</table>

**Note:** Drilling mud exposure reduced biomass production and net growth efficiency of *mysis* at sublethal concentrations in the range of 15 to 30% MAF.

<table>
<thead>
<tr>
<th><em>Clibenarius vitatus</em> adults</th>
<th>SW</th>
<th>Static MAF with daily replacement</th>
<th>34.5% MAF</th>
<th><em>Hoff et al. 1980</em></th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Penaeus aztecs</em> adults</td>
<td>SW</td>
<td>Static MAF with daily replacement</td>
<td>16% MAF</td>
<td><em>Hoff et al. 1980</em></td>
</tr>
<tr>
<td><em>Penaeus aztecs</em> juveniles</td>
<td>SW</td>
<td>Static MAF with daily replacement</td>
<td>35.0% MAF</td>
<td><em>Hoff et al. 1980</em></td>
</tr>
<tr>
<td><em>Palaeonetes pugio</em> adults</td>
<td>SW</td>
<td>Static MAF with daily replacement</td>
<td>91.0% MAF</td>
<td><em>Hoff et al. 1980</em></td>
</tr>
<tr>
<td><em>Ophryotrocha</em> adults</td>
<td>SW</td>
<td>Static MAF with daily replacement</td>
<td>60.0% MAF</td>
<td><em>Hoff et al. 1980</em></td>
</tr>
<tr>
<td><em>Myisidopsis alyma</em> 1-day old, postlarvae (opposum shrimp)</td>
<td>SW</td>
<td>Static MAF with daily replacement</td>
<td>(24-hr LC50) 47.9% MAF</td>
<td><em>Hoff et al. 1980</em></td>
</tr>
<tr>
<td></td>
<td>SW</td>
<td>Static MAF with daily replacement</td>
<td>(40-hr LC50) 28.5% MAF</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SW</td>
<td>Static MAF with daily replacement</td>
<td>(72-hr LC50) 14.5% MAF</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SW</td>
<td>Static MAF with daily replacement</td>
<td>(96-hr LC50) 12.8% MAF</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SW</td>
<td>Static MAF with daily replacement</td>
<td>(24-hr LC50) 22.0% MAF</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SW</td>
<td>Static MAF with daily replacement</td>
<td>(48-hr LC50) 18.0% MAF</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SW</td>
<td>Static MAF with daily replacement</td>
<td>(72-hr LC50) 14.5% MAF</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SW</td>
<td>Static MAF with daily replacement</td>
<td>(96-hr LC50) 13.0% MAF</td>
<td></td>
</tr>
</tbody>
</table>

(b) 96-hr LC50 given unless otherwise stated.
### Table C-1 (continued)

**SUMMARY OF RESULTS OF ACUTE DRILLING FLUID BIOASSAYS ON MARINE ORGANISMS**

<table>
<thead>
<tr>
<th>Test Material</th>
<th>Test Organism</th>
<th>Test Conditions</th>
<th>Results (LC₅₀)(b)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Used medium density</td>
<td>Donax variabilis (coquina clam)</td>
<td>Static SPP changed daily</td>
<td>(48-hr LC₅₀) 49% SPP (72-hr LC₅₀) 38% SPP (96-hr LC₅₀) 29% SPP (192-hr LC₅₀) 20% SPP</td>
<td>Neff et al. 1980</td>
</tr>
<tr>
<td>mud composed primarily of freshwater, bentonite, CLS, lignite, NaOH, lime and barite</td>
<td>Cremnochrea gigea (oyster spat)</td>
<td>Static SPP</td>
<td>(48-hr LC₅₀) 83% SPP (72-hr LC₅₀) 65% SPP (96-hr LC₅₀) 53% SPP</td>
<td>Neff et al. 1980</td>
</tr>
<tr>
<td></td>
<td>Cragon septemspinosa (sand shrimp)</td>
<td>SW, 31-33 ppt, 6-12°C Static MAF, SSS Flow through, LSP</td>
<td>&gt;100% MAF &gt;15,000 ppm SSS (Cragon and Carcinus only) 96-hr LC₅₀ = 29-90% LSP</td>
<td>Gerber et al. 1980</td>
</tr>
<tr>
<td></td>
<td>Carcinus maenas (green crab)</td>
<td>SW, 31-33 ppt, 10-12°C Static MAF, SSS Flow through LSP</td>
<td>&gt;100% MAF &gt;15,000 ppm SSS (Mytilus only) &gt;100% LSP</td>
<td>Gerber et al. 1980</td>
</tr>
<tr>
<td></td>
<td>Homarus americanus (American lobster)</td>
<td>SW, 31-33 ppt, 5°C Static MAF, FMAF</td>
<td>17% MAF 19% FMAF</td>
<td>Gerber et al. 1980</td>
</tr>
<tr>
<td></td>
<td>Mytilus edulis (blue mussel)</td>
<td>SW, 31-33 ppt, 10-12°C Static MAF, SSS Flow through LSP</td>
<td>&gt;100% MAF</td>
<td>Gerber et al. 1980</td>
</tr>
<tr>
<td></td>
<td>Littorina littorea (periwinkle)</td>
<td>SW, 31-33 ppt, 5°C Static MAF, SSS Flow through LSP</td>
<td>&gt;100% MAF &gt;15,000 ppm SSS (Mytilus only)</td>
<td>Gerber et al. 1980</td>
</tr>
<tr>
<td></td>
<td>Nerita virens</td>
<td>SW, 31-33 ppt, 5°C Static MAF, SSS Flow through LSP</td>
<td>&gt;100% MAF</td>
<td>Gerber et al. 1980</td>
</tr>
<tr>
<td></td>
<td>Pandanus borealis (northern shrimp larvae)</td>
<td>SW, 31-33 ppt, 5°C Static MAF, FMAF</td>
<td>17% MAF 19% FMAF</td>
<td>Gerber et al. 1980</td>
</tr>
<tr>
<td></td>
<td>Placopecten magellanicus (ocean scallop)</td>
<td>SW, 31-33 ppt, 13°C Flow through LSP</td>
<td>3.200 ppm (0.32%) LSP</td>
<td>Gerber et al. 1980</td>
</tr>
<tr>
<td></td>
<td>Pundulus heteroclitus</td>
<td>SW, 31-33 ppt, 14°C Static MAF, SSS</td>
<td>&gt;100% MAF &gt;15,000 ppm SSS</td>
<td>Gerber et al. 1980</td>
</tr>
</tbody>
</table>

(b) 96-hr LC₅₀ given unless otherwise stated.
<table>
<thead>
<tr>
<th>Test Material</th>
<th>Test Organism</th>
<th>Test Conditions</th>
<th>Results (LC&lt;sub&gt;50&lt;/sub&gt;)&lt;sup&gt;(b)&lt;/sup&gt;</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Used high-weight lignosulfonate drilling fluid. Composed primarily of fresh water, bentonite, CLS, lignite, NaOH, soda ash, NaHCO&lt;sub&gt;3&lt;/sub&gt;, polyatomic cellulose derivative, berite</td>
<td>Clathanarius vittatus adults</td>
<td>Static MAF changed daily</td>
<td>65.6% MAF</td>
<td>Neff et al. 1980</td>
</tr>
<tr>
<td></td>
<td>Palaeomonetes pugio 1st zoae grass shrimp adult grass shrimp</td>
<td>Static MAF changed daily</td>
<td>&lt;10.0% MAF 93.3% survival in 96 hr</td>
<td>Neff et al. 1980</td>
</tr>
<tr>
<td></td>
<td>Ophryotrocha labronica adult marine worm</td>
<td>Static MAF changed daily</td>
<td>87.5% survival in 96 hr</td>
<td>Neff et al. 1980</td>
</tr>
<tr>
<td></td>
<td>Myxidopsis almyra (opossum shrimp) 1-day old postlarvae</td>
<td>Static MAF changed daily</td>
<td>(24-hr LC50) 93.0% MAF (48-hr LC50) 20.0% MAF (72-hr LC50) 16.0% MAF (96-hr LC50) 16% MAF</td>
<td>Neff et al. 1980</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(48-hr LC50) 90.0% MAF (72-hr LC50) 30.0% MAF (96-hr LC50) 32.5% MAF</td>
<td>Neff et al. 1980</td>
</tr>
<tr>
<td></td>
<td>DONAX variabilis (coquina clam)</td>
<td>Static SPP changed daily</td>
<td>(48-hr LC50) 95% SPP (72-hr LC50) 77% SPP (96-hr LC50) 56% SPP (192-hr LC50) 41% SPP</td>
<td>Neff et al. 1980</td>
</tr>
<tr>
<td></td>
<td>Crassostrea gigas oyster spat 3-10 mm</td>
<td>Static SPP changed daily</td>
<td>(48-hr LC50) 97% SPP (72-hr LC50) 84% SPP (96-hr LC50) 74% SPP</td>
<td>Neff et al. 1980</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(72-hr LC50) 84% SPP (96-hr LC50) 73% SPP</td>
<td>Neff et al. 1980</td>
</tr>
<tr>
<td></td>
<td>Palaeomonetes pugio (grass shrimp) 1-day (21)</td>
<td>Static SPP changed daily</td>
<td>(48-hr LC50) 10.0% SPP (72-hr LC50) 13.2% SPP (96-hr LC50) 11.8% SPP</td>
<td>Neff et al. 1980</td>
</tr>
<tr>
<td></td>
<td>5-day (23)</td>
<td>Static SPP changed daily</td>
<td>(24-hr LC50) 23.2% SPP (48-hr LC50) 20.6% SPP (72-hr LC50) 15.8% SPP (96-hr LC50) 13.2% SPP</td>
<td>Neff et al. 1980</td>
</tr>
<tr>
<td></td>
<td>10-day (24-25)</td>
<td>Static SPP changed daily</td>
<td>(24-hr LC50) 60.0% SPP (48-hr LC50) 17.6% SPP (72-hr LC50) 15.5% SPP (96-hr LC50) 11.7% SPP</td>
<td>Neff et al. 1980</td>
</tr>
</tbody>
</table>

<sup>(b)</sup> 96-hr LC<sub>50</sub> given unless otherwise stated.
<table>
<thead>
<tr>
<th>Test Material</th>
<th>Test Organism</th>
<th>Test Conditions</th>
<th>Results (LC₅₀)¹(b)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Used high density</td>
<td>Crangon septemspinosa</td>
<td>SW, 31-33 ppt,</td>
<td>&gt;100% MAF</td>
<td>Gerber et al.</td>
</tr>
<tr>
<td>lignocellulose</td>
<td>(sand shrimp)</td>
<td>6-14°C</td>
<td>&gt;15,000 ppm SSP</td>
<td>1980</td>
</tr>
<tr>
<td>drilling fluid</td>
<td>Camarus locusta</td>
<td>Static MAF, SSP</td>
<td>28 to &gt;100% LSP</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(amphipod)</td>
<td>Flow through SSP</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Carcinus maenas</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(green crab)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mytilus edulis</td>
<td>SW, 31-33 ppt,</td>
<td>&gt;100% MAF</td>
<td>Gerber et al.</td>
</tr>
<tr>
<td></td>
<td>(blue mussel)</td>
<td>7-12°C</td>
<td>&gt;15,000 ppm SSP for (Mytilus only)</td>
<td>1980</td>
</tr>
<tr>
<td></td>
<td>Macoma balthica</td>
<td>Static MAF, SSP</td>
<td>&gt;100% LSP</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(clam)</td>
<td>Flow through LSP</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Littorina littorea</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(periwinkle)</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Neris lima menemus</td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>(sand worm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pandalus borealis</td>
<td>SW, 31-33 ppt,</td>
<td>96-hr LC₅₀ = 65% MAF</td>
<td>Gerber et al.</td>
</tr>
<tr>
<td></td>
<td>Stage I</td>
<td>2°C</td>
<td>96-hr LC₅₀ = 55% FMAT</td>
<td>1980</td>
</tr>
<tr>
<td></td>
<td>(northern shrimp larvae)</td>
<td>Static MAF, FM</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fundulus heteroclitus</td>
<td>SW, 31-33 ppt,</td>
<td>96-hr LC₅₀ &gt;100% MAF</td>
<td>Gerber et al.</td>
</tr>
<tr>
<td></td>
<td>(killifish)</td>
<td>14°C</td>
<td>96-hr LC₅₀ &gt;15,000 ppm SSP</td>
<td>1980</td>
</tr>
<tr>
<td></td>
<td>Static MAF, SSP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Used spud mud</td>
<td>Paleomonetes pugio</td>
<td>Static, MAF or</td>
<td>LC₅₀ for all bioassays &gt;100% MAF or SPP</td>
<td>Neff et al. 1980</td>
</tr>
<tr>
<td></td>
<td>tet male and adults</td>
<td>SPP changed daily</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ophryotrocha labronica</td>
<td>Static, MAF</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>adults</td>
<td>changed daily</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Myxidopsis alyra</td>
<td>Static, MAF</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1- and 7-day old</td>
<td>changed daily</td>
<td>100% survival after 96-hr exposure</td>
<td>Neff et al. 1980</td>
</tr>
<tr>
<td></td>
<td>pteropod larvae</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Donax variabilis</td>
<td>Static SPP</td>
<td>100% survival after 192-hr exposure</td>
<td>Neff et al. 1980</td>
</tr>
<tr>
<td></td>
<td>adults</td>
<td>changed daily</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Crassostrea gigas</td>
<td>Static SPP</td>
<td>100% survival of oyster spat after 96-hr exposure</td>
<td>Neff et al. 1980</td>
</tr>
<tr>
<td></td>
<td>spat (Pacific oyster)</td>
<td>changed daily</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

¹ 96-hr LC₅₀ given unless otherwise stated.
<table>
<thead>
<tr>
<th>Test Material</th>
<th>Test Organism</th>
<th>Test Conditions</th>
<th>Results (LC&lt;sub&gt;50&lt;/sub&gt;)&lt;sup&gt;(b)&lt;/sup&gt;</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Used spud mod</td>
<td><strong>Cragon septemspinosus</strong>&lt;br&gt;(sand shrimp)</td>
<td>SW, 31-33 ppt, 7-12°C</td>
<td>&gt;100% MAF</td>
<td>Gerber et al. 1980</td>
</tr>
<tr>
<td></td>
<td><strong>Gammarus locusta</strong>&lt;br&gt;(amphipod)</td>
<td>Static MAF</td>
<td>&gt;100% LSP (Gammarus only)</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Mytilus edulis</strong>&lt;br&gt;(blue mussel)</td>
<td>Flow through LSP</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Nereis virens</strong>&lt;br&gt;(sand worm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Fundulus heteroclitus</strong>&lt;br&gt;(killifish)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18 used drilling fluids from an exploratory platform in Mobile Bay.</td>
<td><strong>Falesomimus pugio</strong>&lt;br&gt;intermolt (Stage C)&lt;br&gt;(grass shrimp)</td>
<td>SW, 10 ppt, 20°C</td>
<td>30% mortality or greater in 96-hr exposure at 1,000 ppm for 7 of 18 drilling fluids assayed. Mortality was 100% in 96 hr for drilling fluid XVIII</td>
<td>Conklin et al. 1980</td>
</tr>
<tr>
<td>5 used drilling fluids (most toxic in initial collection of 18 samples)</td>
<td><strong>Falesomimus pugio</strong></td>
<td>SW, 10 ppt, 20°C</td>
<td>36.3 to 739 ppm</td>
<td>Conklin et al. 1980</td>
</tr>
<tr>
<td>Most toxic drilling fluid sample (XVIII) from collection above</td>
<td><strong>Myxodopsis bahia</strong>&lt;br&gt;1 day through 42 days old (entire life cycle) (mysid or opossum shrimp)</td>
<td>SW, 10 ppt, 20°C continuous flow</td>
<td>4-day LC&lt;sub&gt;50&lt;/sub&gt; = 161 ppm&lt;br&gt;7-day LC&lt;sub&gt;50&lt;/sub&gt; = 116 ppm&lt;br&gt;14-day LC&lt;sub&gt;50&lt;/sub&gt; = 85 ppm&lt;br&gt;21-day LC&lt;sub&gt;50&lt;/sub&gt; = 77 ppm&lt;br&gt;28-day LC&lt;sub&gt;50&lt;/sub&gt; = 59 ppm&lt;br&gt;35-day LC&lt;sub&gt;50&lt;/sub&gt; = 57 ppm&lt;br&gt;42-day LC&lt;sub&gt;50&lt;/sub&gt; = 50 ppm</td>
<td>Conklin et al.</td>
</tr>
<tr>
<td>Diesel-based drilling fluid plus cuttings. Components by percent weight: barite (6.5%) bentonite (22.0%) diesel (64.7%)</td>
<td><strong>Crasostrea virginica</strong>&lt;br&gt;(oysters) 70-120 mm</td>
<td>SW, 4.4-16.5%, 27-29°C&lt;br&gt;Solutions changed 3 times per day</td>
<td>50% mortality after 6 days exposure&lt;br&gt;50% mortality after 7 days exposure&lt;br&gt;50% mortality in both controls and treatment organisms after 14 days exposure</td>
<td>Cabrera 1968</td>
</tr>
</tbody>
</table>

<sup>(b)</sup> 96-hr LC<sub>50</sub> given unless otherwise stated.
mud, drilling parameters and drill cuttings, the unit incorporates hydrocarbon and \( \text{H}_2\text{S} \) detection equipment and alarm systems for which the sensitivity can be preselected. A description of the mud logging unit is included as Appendix 6.

**Geophysical Hazards**

The Harding-Lawson Associates Marine Geophysical Survey, Tract 42, Beaufort Sea, Alaska, describes the results of a survey of BF-47. In general, as recorded by the Harding-Lawson Associates survey, the seabed in the vicinity of the proposed island location is fairly regular and slopes upward becoming shallower to the southeast, toward Long Island. The Holocene sedimentary unit is indicated to be between 4 and 6 feet of sandy silt directly overlying Pleistocene alluvium. Only one small area of sand waves, indicative of bottom currents, was observed in the area. Numerous ice gouges were observed in the area which is in the floating fast ice zone. The depth of incision of all gouges observed was less than one meter. Relict bonded permafrost is indicated to be 30 to 59 meters (98 to 194 feet) in this area in HLA/USGS Borings 4 and 5.

High resolution seismic reflection records in Tract BF-47 indicate only one small area of signal attenuation indicative of acoustically turbid sediments having a high compressibility due to the presence of interstitial gas bubbles. This area is located over one mile to the southeast of the island location. No signal attenuation indicative of hydrocarbon presence was observed at the island location.

Soil borings at the island site encountered about 6 to 8 feet of silts, silty clays and silty sands. These materials are fairly hard as indicated by
resistance to the push Shelby sampler. Underlying these sediments is continuous sandy, silty gravel grading to cleaner sand and gravel at 20 to 25 feet below the seabed. Permafrost was not encountered in any of the soil borings at the island site, the deepest of which penetrated 62-1/2 feet below the seabed.

Seismicity of the area is very low.

**Environmental Training Program**

State and Federal Lease Stipulation No. 2 requires that any exploration plan shall include a proposed environmental training program for all personnel involved in exploration activities (including personnel of the lessees' contractors and subcontractors) for review and approval by the Director, Division of Minerals and Energy Management and the Supervisor. Shell Oil Company has participated in the cost of the videotape presentation prepared by Mobil, Sohio, and Exxon which has been reviewed and found satisfactory by the Joint Federal/State Biological Task Force. The program will be given to all personnel involved in the exploration activities. These tapes have been edited for industry-wide application under guidance from the Alaska Oil and Gas Association. The tapes are narrated by qualified instructors to insure that personnel understand and use techniques necessary to preserve archaeological, geological and biological resources. The program is designed to increase the sensitivity and understanding of personnel to community values, customs and lifestyles in areas in which such personnel will be operating. The required continuing technical environmental briefing program for supervisory and managerial personnel involved including those of Shell, its agents, contractors and subcontractors has also been videotaped for industry-wide use.
Island Disposition

Based on present knowledge, we have located the Seal "A" gravel island at a position that will permit use of the island for both an exploratory and a development/production plan. If the planned exploration effort fails to establish the presence of commercial hydrocarbons, we believe that the retention of the island will be environmentally desirable to provide predator-free resting and nesting sites for birds as well as a favorable marine habitat. We see no adverse environmental impacts as a result of leaving the island in place. However, State Lease Stipulation No. 3 requires removal of all exploratory structures and restoration of the site to its original condition unless the structure is to be used for production or additional exploratory drilling or unless it is not in the best interest of the public or the environment to require removal or restoration. Authorization to leave the structure in place must be obtained from the Director, DMEM after consultation with the Department of Fish and Game and the Department of Environmental Conservation.

Special Restriction

The proposed island site is located inside the 13-meter water depth line in a Borough subdistrict with special restrictions. At the site, the water depth of 11.9 meters (39 feet) places the island site in the NSB Deferred Development Subdistrict where all petroleum related activities are prohibited until October 1, 1984, subject to annual review. In event the current NSB ordinance is extended, we ask for an early review of the October 1, 1984 date.

A proposed NSB ordinance requires that the gravel island withstand two winter seasons before petroleum activities are initiated. The proposed construction schedule will allow the island to be exposed to late winter ice forces in
1981-82 and to ice forces during the entirety of 1982-83. Satisfactory performance of the island during this exposure period should, in our opinion, satisfy the two-year requirement regarding island integrity.

**Relief Well Discussion**

Arctic OCS Orders require provisions to deal with an emergency situation involving a means of drilling a relief well should a blowout occur. We consider this to be an extremely remote possibility because of extensive precautions taken to prevent such an occurrence. Fundamental to these precautions is the training of all personnel involved in the exploratory operations and the rig safety equipment. All crew and supervisory personnel will be trained in accordance with OCS Order No. 2 (GSS-OCS-T1). A list of personnel and training will be available on the rig on request.

In the unlikely event of a blowout, the equipment for building a relief well drilling island will be mobilized from Deadhorse and Prudhoe to the location. Contractors are listed in the ABSORB manual. The equipment to be used and method of transport will depend upon the time of year and weather conditions. For such an emergency it is customary for all operators in the area to cooperate in making a suitable drilling rig immediately available. If required, a rig adapted to transport by a Hercules (C-130) cargo carrier could be used. Depending upon the time of year, the rig could be transported by helicopter or an air-cushioned vehicle.

Immediately, supplies such as tubulars and wellhead equipment would be stockpiled at Deadhorse for use at the relief well. Normal supplies such as mud, cement, bits, fuel and other items utilized in drilling the relief well and for killing the uncontrolled well are available at Deadhorse and would be
transported to the relief well site when the site is completed or near completion. Gravel for the relief well drilling pad will be available at the gravel site for the Seal "A" Island or from supplies at Prudhoe, depending upon the season.

Transportation during the ice season would be over ice roads already built and by boat and/or barge during the open-water season. During freeze up and breakup, transportation will be by helicopter or possibly by an air-cushioned vehicle.

During the ice season, a gravel island of design similar to that proposed herein would be constructed using proven techniques. Because of the temporary nature of the relief well drilling, an island somewhat smaller than the presently proposed island would be constructed. The drilling rig would be moved onto the site at the earliest time considered safe. Island construction could proceed until the island size was adequate for the relief well drilling and supply storage. During the open-water season, island construction would be by barge and tugs. Relief well island construction will not be attempted during freeze up and breakup until conditions are deemed safe for personnel and equipment. During any such delays, all possible preparations will be done for transporting and stockpiling materials and equipment to expedite island construction and drilling of a relief well.

The relief well drill site will be determined by consideration of forecasts of meteorological data, directional survey data from the blowout well and the indicated required depth of intersection of the relief well bore with the blowout well bore. Water depth would be shallower or similar to that at the blowout well site. The relief well would always be located away from the blowout at a distance adequate for the protection of personnel and equipment.
EXHIBIT "A"

PROPOSED SEAL EXPLORATION UNIT
BEAUFORT SEA OFFSHORE
NORTH ALASKA
STRUCTURE TOP SAG RIVER
CONTOUR INTERVAL: 200'

SHELL OIL COMPANY
WESTERN E&P OPERATIONS PACIFIC DIVISION EXPLORATION DEPARTMENT

PROPOSED SEAL EXPLORATION UNIT
BEAUFORT SEA OFFSHORE
NORTH ALASKA
STRUCTURE TOP SAG RIVER
CONTOUR INTERVAL: 200'

Report:
Province/Field: State: ALASKA
County: End.: 1
Author: Date: 11/80 File: 1200302-00
BUILD EXPLOSION AREA 3,300' FSL & 13,500' FWL, ADL 312799

LOCATION: X = 436,915 (METERS)  
UTM (ZONE 6) Y = 7,821,406 (METERS)

OBJECTIVE: X = 434,842 (METERS)  
Y = 7,823,539 (METERS)

WELL: BF-047-#1, ADL 312799

ELEVATION: SEA LEVEL  
LAT = 70°29'29.9023"N  
LONG = 148°41'33.8564"W  
T.D. X = 434,507 (METERS)  
Y = 7,823,905 (METERS)

DEVIATION

TRAIGHT HOLE

BASE OF PERMAFROST  900
KOP  1000 1000

47.5° ∴  2405 2585

COLVILLE  7000 9378

SEABEE  8525 11635

PEBBLE  8625 11783
KUPARUK  8675 11857

10600 14705

SAG RIVER  10875 15112
*SADLEROCHIT 11025 15335

IVISHAK  11350 15815
LISBURNÉ  11450 15965
KEKIKTUK  12150 17000

T.D.  12300 17221

H. VIS  47.5°

BUILD TO 47.5° IN A N43°W DIR AT 3°/100'

PREHEATED GEL/SEAWATER

HOLD 47.5° TO T.D.

MUD LOGGER AND DRILLING DATA UNIT

925' OF CORES

200' LAP

12-1/4"  8-1/2"

17-1/2"  13-3/8"

9-5/8"

Cemented from shoe to 10,000 (M.D.)

Cemented full length of liner (200' LAP)

Cement and conductor surfe to T.D.
PRIVATE & CONFIDENTIAL

EXPLORATION PLAN
SEAL PROSPECT

BEAUFORT SEA, ALASKA

APPENDIX I
PROPRIETARY DATA

SHELL OIL COMPANY
PACIFIC DIVISION
OCTOBER 1981
APPENDIX 2

PRIVATE & CONFIDENTIAL

Released to public file
Name: [Signature] Date: MAR 23 2012

SHELL OIL COMPANY

SEAL "A" ISLAND DESIGN DOCUMENTATION
APPENDIX 2

The Seal "A" Island Design Documentation
will be submitted approximately
November 10, 1981.
The drilling rig used for this proposed exploration operations will be BSI Rig 84 owned by Brinkerhoff Signal Incorporated or an equivalent. The following is a list and description of equipment for BSI Rig 84.

**MAJOR DRILLING EQUIPMENT**

**Drawworks**
1 - NATIONAL 110 UE drawworks, 1500 hp, double drum for 1-3/8" line, 5/8" sand line and TOTCO instrumentation console.

**Brake**
1 - PARMAC hydromatic brake.

**Engines and Generators**
3 - BEMAC III generators, 1000 KVA, each driven by a Caterpillar D-390, 912 hp diesel engine.
1 - ROSS HILL SCR power distribution system.
1 - BYRON JACKSON 3 1/2" X 130" elevator bails.
1 - BYRON JACKSON hook, 500 ton capacity.
1 - CONTINENTAL EMSCO MA 50-5 taveling blocks, 500 ton capacity.

**Drill Pipe and Collars**
11,000' - 5" 19.5# Grade E drill pipe.
4,000 - 5" 25.6# Grade E drill pipe.
12 - 8" X 2-13/16" drill collars.
18 - 6 1/4" X 2-13/16 drill collars.

**1000 Barrel Mud System**
1 - BRANDT dual shale shaker.
1 - DRILCO degasser.
1 - PICENCO 15 cone desilter with MISSION MAGNUM 5" X 6" pump driven by GENERAL ELECTRIC motor, 50 hp.

**Mast**
1 - IDECO full view 145' mast, 1,090,000# gross nominal capacity with 7 sheave crown block.
Substructure
1 - 29' H pin type substructure.

Pumps
2 - CONTINENTAL EMXCO F-1300 triplex mud pump, 7 1/4" X 12", 1300 hp.
   Each pump equipped with 2-752 CONTINENTAL EMSCO traction motors.

Rotary Table
1 - NATIONAL C-275 rotary table, 27 1/2" opening, independently driven.

Traveling Equipment
1 - GRAY Type B-44M Swivel, 500 ton capacity.
1 - PICENCO mud cleaner with MISSION MAGNUM 5" X 6" pump driven by
   GENERAL ELECTRIC motor, 50 hp.
5 - BRANDT mud mixers, 7 1/2 hp.

DRILLING SAFETY SYSTEMS

 Blowout Preventers and Controls
1 - HYDRIL MSP 21 1/4" 2000 psi.
1 - HYDRIL GK 12-5/8" 5000 psi.
1 - HYDRIL double gate V 13-5/8" 5000 psi.
1 - HYDRIL single gate V 13-5/8" 5000 psi.
1 - 13 5/8" 5000 psi drilling spool with 2-4" flanged outlets.
1 - HYDRIL VALCON accumulator closing unit, 180 gallons, 3000 psi.
1 - CHoke manifold 5000 psi.

Mud System Monitoring Equipment
- Mud pit level indicator with visual and audio warning devices.
- Mud return indicator with visual and audio warning devices.
1 - 90 barrel trip tank.
- Gas detecting equipment.

Fire Fighting Equipment
17 - ANSULS hand-held extinguisher
CRITICAL OPERATIONS CURTAILMENT PLAN

Certain operations performed in drilling are more critical than others with respect to well control and for the prevention of fire, explosion, oil spills and other discharges or emissions. These operations will be limited or curtailed when particular meteorological, oceanographic or ice conditions exist or are predicted. The following are the more critical operations which will be limited or curtailed.

(1) Well production testing.

(2) Drilling into formations anticipated to be abnormally pressured.

These operations will be limited or curtailed if meteorological, oceanographic or ice conditions are or are predicted to be severe enough to shutdown logistical support of the drilling operation.
TENTATIVE
GRAPHICAL PROGNOSIS

FIELD: SEAL EXPLORATION AREA

LOCATION: X = 436,915 (METERS)
(Y = 7,821,406 (METERS))

WELL: BF-047-#1, ADL 312799

ELEVATION: SEA LEVEL
LAT 70°29'29.9023"N
LONG 148°41'33.8564"W
T.D.

OBJECTIVE:

INJECTION
CONTROL

LOGS

GEOLoGIC
TOPS

TV/MD
WELL
DEPTH

HOLE
SIZE

CASING
AND
Cement

MUD

HOLE
DEViATION

TRAIGHT
HOLE

BASE OF
PERMAFROST
KOP

BUILD
RATE AT

HDT/SWS

FDC/CNL/PML

DIL/SP/GC & ISS/BHGS

MUD LOGGER AND DRILLING DATA UNIT

CORES

MNTAIN

T.D.

PREHYDRATED GEL/SEAWATER

SURFACE & CONDUCTOR
STRINGS CONT TO SURF.

H. V.I.

BUILD TO
IN A
AT

DIR.

RATE
OIL SPILL

CONTINGENCY PLAN

FOR

SEAL "A"

GRAVEL ISLAND

EXPLORATORY WELLS

ADL 312799 (BF-47), ADL 312798 (BF-46), ADL 312808 (BF-56), ADL 312809 (BF-57)

ISSUED: OCTOBER 1981
TABLE OF CONTENTS

1. INTRODUCTION .......................................................... 1 - 1
   1.1 NAME OF FACILITY .................................................. 1 - 2
   1.2 TYPE OF FACILITY .................................................. 1 - 2
   1.3 LOCATION OF FACILITY ............................................. 1 - 2
   1.4 OPERATOR ............................................................ 1 - 2
   1.5 PERSON ACCOUNTABLE FOR OIL SPILL PREVENTION ................. 1 - 2
   1.6 OBJECTIVE .......................................................... 1 - 2
   1.7 SPILL PREVENTION ................................................... 1 - 2
   1.8 INSPECTION AND RECORDS .......................................... 1 - 3
   1.9 GRAVEL ISLAND SITE ................................................. 1 - 3
   1.10 GENERAL SITE DETAILS ............................................ 1 - 3
   1.11 ON-SITE SPILL RESPONSE TEAM .................................. 1 - 4
   1.12 SHELL OIL SPILL RESPONSE TEAM ................................ 1 - 4
   1.13 LARGE SPILLS ...................................................... 1 - 4
   1.14 AVAILABLE EQUIPMENT AND MATERIALS ......................... 1 - 5
   1.15 CONTAINMENT AND RECOVERY EQUIPMENT CAPABILITY .......... 1 - 6
   1.16 CONTINGENCY EQUIPMENT RESOURCES ............................ 1 - 6
   1.17 SUPPORT VESSEL/VEHICLES ...................................... 1 - 6
   1.18 DISPERSENS ........................................................ 1 - 6
   1.19 SUPPORT PERSONNEL .............................................. 1 - 7
   1.20 ABSORB EQUIPMENT ACQUISITION LIST .......................... 1 - 7
   1.21 DRILLS ............................................................. 1 - 7
   1.22 TRAINING ........................................................... 1 - 7
   1.23 OIL SPILL TRAINING PROGRAMS .................................. 1 - 8
   1.24 SITE SURVEILLANCE ............................................... 1 - 8
   1.25 NOTIFICATION REQUIREMENTS ................................... 1 - 9
   1.26 OIL CONTAINMENT PLAN .......................................... 1 - 9
   1.27 SPILL CLEANUP PROCEDURES .................................... 1 - 12
   1.28 FUEL TRANSFER PROCEDURES .................................... 1 - 12
   1.29 ABSORB COASTLINE SENSITIVITY ATLAS ........................ 1 - 12
   1.30 OIL SPILL HANDBOOK ............................................. 1 - 13
   1.31 UNCONTROLLED BLOWOUT (RELIEF WELL) PLAN .................. 1 - 13
   1.32 CONTINGENCY PLAN UPDATING PROCEDURES ..................... 1 - 15
   1.33 DISPOSITION OF OILY EFFLUENT ............................... 1 - 16

2. ORGANIZATION AND NOTIFICATION PROCEDURES ..................... 2 - 1
   2.1 GENERAL ORGANIZATION .......................................... 2 - 1
   2.2 RESPONSE TEAM JOB DESCRIPTIONS ............................... 2 - 7
   2.3 DOCUMENTATION PROCEDURES ...................................... 2 - 19
      2.3.1 Initial Reporting ........................................... 2 - 19
      2.3.2 Spill Logs ................................................... 2 - 19
      2.3.3 Written Reports .............................................. 2 - 23
      2.3.4 Cost Accounting & Equipment Use Documentation ........ 2 - 23
      2.3.5 Photography ................................................. 2 - 28
   2.4 PUBLIC RELATIONS ................................................ 2 - 31
      2.4.1 Public Relations Guidelines .............................. 2 - 32
<table>
<thead>
<tr>
<th>FIGURE NO.</th>
<th>TITLE</th>
<th>PAGE NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 1</td>
<td>Rig Layout</td>
<td>2b</td>
</tr>
<tr>
<td>1 - 2</td>
<td>Containment Dike Area</td>
<td>4a</td>
</tr>
<tr>
<td>1 - 3</td>
<td>Oil Boom Containment</td>
<td>10a</td>
</tr>
<tr>
<td>2 - 1</td>
<td>Shell Organization</td>
<td>2</td>
</tr>
<tr>
<td>2 - 2</td>
<td>Shell Response Team Members</td>
<td>2 - 7</td>
</tr>
<tr>
<td>2 - 3</td>
<td>Shell Initial Report Form</td>
<td>20</td>
</tr>
<tr>
<td>2 - 4</td>
<td>USGS Pollution Report Form</td>
<td>26</td>
</tr>
<tr>
<td>2 - 5</td>
<td>Shell Equipment Use Log</td>
<td>27</td>
</tr>
<tr>
<td>2 - 6</td>
<td>Shell Material Requisition</td>
<td>29</td>
</tr>
<tr>
<td>2 - 8</td>
<td>Shell Media Inquiry Form</td>
<td>34</td>
</tr>
<tr>
<td>3 - 1</td>
<td>Key to Contingency Plan</td>
<td>2</td>
</tr>
<tr>
<td>3 - 2</td>
<td>Initial Action</td>
<td>4</td>
</tr>
<tr>
<td>3 - 3</td>
<td>Notification</td>
<td>5</td>
</tr>
<tr>
<td>3 - 4</td>
<td>Spill Evaluation</td>
<td>6</td>
</tr>
<tr>
<td>3 - 5</td>
<td>Response Planning</td>
<td>7</td>
</tr>
<tr>
<td>3 - 6</td>
<td>Response</td>
<td>8</td>
</tr>
<tr>
<td>3 - 6b</td>
<td>Phone List for Equipment and Supplies</td>
<td>9b</td>
</tr>
<tr>
<td>3 - 7</td>
<td>Shell Initial Report Form</td>
<td>10</td>
</tr>
<tr>
<td>3 - 8</td>
<td>Government Notification Requirements for Spills in the Lease Sale Area</td>
<td>12</td>
</tr>
<tr>
<td>3 - 9</td>
<td>Response Activation Levels (Assuming Onsite Personnel/Equipment Cannot Handle Spill)</td>
<td>14</td>
</tr>
<tr>
<td>3 - 10</td>
<td>Applicability of Major Cleanup Techniques</td>
<td>15</td>
</tr>
<tr>
<td>FIGURE NO.</td>
<td>TITLE</td>
<td>PAGE NO.</td>
</tr>
<tr>
<td>-----------</td>
<td>----------------------------------------------------------------------</td>
<td>----------</td>
</tr>
<tr>
<td>3 - 11</td>
<td>Shoreline Protection</td>
<td>3 - 16</td>
</tr>
<tr>
<td>3 - 12</td>
<td>Extreme Environmental Factors</td>
<td>3 - 18</td>
</tr>
<tr>
<td>3 - 13</td>
<td>Logistics Summary</td>
<td>3 - 19</td>
</tr>
<tr>
<td>3 - 14</td>
<td>Daylight and Sea Ice Conditions - Beaufort Sea</td>
<td>3 - 20</td>
</tr>
<tr>
<td>3 - 15</td>
<td>Volumetric Characteristics of a Variety of Oil Spills After</td>
<td>3 - 21</td>
</tr>
<tr>
<td></td>
<td>Achieving a Relatively Stable Condition</td>
<td></td>
</tr>
<tr>
<td>3 - 16</td>
<td>Spread of Crude Oil on Sea Water</td>
<td>3 - 22</td>
</tr>
<tr>
<td>3 - 17</td>
<td>Evaporation Rates for Diesel and Crude Oil Spilled on</td>
<td>3 - 23</td>
</tr>
<tr>
<td></td>
<td>Water and Land</td>
<td></td>
</tr>
<tr>
<td>3 - 18</td>
<td>Viscosity of Prudhoe Bay Crude Oil Versus Temperature</td>
<td>3 - 24</td>
</tr>
<tr>
<td>3 - 19</td>
<td>Oil Content in Snow (Percent Volume after Sample Melts)</td>
<td>3 - 25</td>
</tr>
<tr>
<td>3 - 20</td>
<td>Spread of Oil on a Frozen Surface</td>
<td>3 - 26</td>
</tr>
</tbody>
</table>
SECTION I
INTRODUCTION

The purpose of this plan is to direct Shell Oil Company personnel in their response to an oil spill emergency and help them in their prevention and cleanup efforts by compiling sources of assistance and materials in such a way that they can be easily located and obtained.

Each recipient of this plan should read it thoroughly and familiarize himself with the response procedures. Personnel with job assignments under this plan should pay particular attention to their job descriptions, and the resources available to help them deal quickly and efficiently with any spill emergency.

Each recipient of this plan should record any pertinent changes or additions that come to his attention on his copy of the plan, and also notify the Division Safety and Environmental Conservation Manager. The Division SEC Manager will be responsible for notifying other recipients of any changes that come to his attention.
1.1 NAME OF FACILITY: Seal A

1.2 TYPE OF FACILITY: Exploratory Well(s) on a Gravel Island

1.3 LOCATION OF FACILITY:

   ±3,300' FSL and 13,500' FWL of Lease ADL 312799 (BF-47)

   Alaska State Zone 4 Coordinates
   \[ x = 1,800,311.7' (548,736.1m) \]
   \[ y = 6,031,148.7' (1,838,297.8m) \]
   \[ \text{Lat} = 70° 29'29.9023"N \]
   \[ \text{Long} = 148° 41'33.8465"W \]

   UTM Zone 6 Coordinates
   \[ x = 1,433,445.3' (436,915m) \]
   \[ y = 25,660,729.5' (7,821,406m) \]

   Water depth at this location is

1.4 OPERATOR: Shell Oil Company
   P. O. Box 527
   Houston, TX 77001
   (713) 870-2440
   (713) 870-2441

1.5 PERSON ACCOUNTABLE FOR OIL SPILL PREVENTION:

   W. M. Marshall
   Division Production Manager
   Pacific Division
   P. O. Box 527
   Houston, TX 77001
   (713) 870-2440
   (713) 870-2441

1.6 OBJECTIVE

   Up to five wells will be drilled to a subsea depth of approximately 13,500 feet. The wells will be drilled to evaluate possible hydrocarbon accumulations. Maximum expected well rates are 50MM CFD for gas and 5000 BOD for oil.
1.7 SPILL PREVENTION - CASING & BLOWOUT PREVENTION EQUIPMENT

(1) The Well Casing Programs are designed by Shell and must be approved by Alaska State and/or U.S. Government Oil and Gas Regulatory Agencies.

The Casing Programs are designed to provide the capability of controlling any wellhead pressure that is expected to be encountered by each individual component.

(2) The Blowout Prevention Equipment listed in the following Drilling Co. Rig Inventory, meets the known requirements for well control on the North Slope of Alaska and those of the Alaska Division of Oil and Gas Commission.

(3) Each well program is designed, utilizing the most current data available regarding subsurface conditions, to meet the requirements of sub-paragraphs 1 and 2, above. Casing and BOPE of greater containment capacity will be utilized at any time the need develops.

(4) Further, the BOP is periodically tested (and repaired as required) to insure continued performance of this equipment as specified by the manufacturer.

1.7.1 EMERGENCY SHUTDOWN SYSTEM

Manual controls are provided on the drill floor and at a remote location from the rig to allow activation of the BOP equipment.

1.7.2 FACILITY DESCRIPTION

The layout of the rig as assembled in an operating status, is shown on Figure 1-1.

The drilling rig used for this proposed exploration operations will be BSI Rig 84 owned by Brinkerhoff Signal Incorporated or an equivalent. The following is a list and description of equipment for BSI Rig 84.
MAJOR DRILLING EQUIPMENT

Drawworks
1 - NATIONAL 110 UE drawworks, 1500 hp, double drum for 1-3/8" line, 5/8" sand line and TOTCO instrumentation console.

Brake
1 - PARMAC hydromatic brake.

Engines and Generators
3 - BEMAC III generators, 1000 KVA, each driven by a Caterpillar D-398, 912 hp diesel engine.
1 - ROSS HILL SCR power distribution system.
1 - BYRON JACKSON 3 1/2" X 130" elevator bails.
1 - BYRON JACKSON hook, 500 ton capacity.
1 - CONTINENTAL EMSCO MA 50-5 traveling blocks, 500 ton capacity.

Drill Pipe and Collars
11,000' - 5" 19.5# Grade E drill pipe.
4,000 - 5" 25.6# Grade E drill pipe.
12 - 8" X 2-13/16" drill collars.
18 - 6 1/4" X 2-13/16 drill collars.

1000 Barrel Mud System
1 - BRANDT dual shale shaker.
1 - DRILCO degasser.
1 - PICENCO 15 cone desilter with MISSION MAGNUM 5" X 6" pump driven by GENERAL ELECTRIC motor, 50 hp.

Mast
1 - IDECO full view 145' mast, 1,090,000# gross nominal capacity with 7 sheave crown block.
Substructure
1 - 29' H pin type substructure.

Pumps
2 - CONTINENTAL EMXCO F-1300 triplex mud pump, 7 1/4" X 12", 1300 hp.
Each pump equipped with 2-752 CONTINENTAL EMSCO traction motors.

Rotary Table
1 - NATIONAL C-275 rotary table, 27 1/2" opening, independently driven.

Trailing Equipment
1 - GRAY Type B-44M Swivel, 500 ton capacity.
1 - PICENCO mud cleaner with MISSION MAGNUM 5" X 6" pump driven by
GENERAL ELECTRIC motor, 50 hp.
5 - BRANDT mud mixers, 7 1/2 hp.

DRILLING SAFETY SYSTEMS

Blowout Preventers and Controls
1 - HYDRIL MSP 21 1/4" 2000 psi.
1 - HYDRIL GK 12-5/8" 5000 psi.
1 - HYDRIL double gate V 13-5/8" 5000 psi.
1 - HYDRIL single gate V 13-5/8" 5000 psi.
1 - 13 5/8" 5000 psi drilling spool with 2-4" flanged outlets.
1 - HYDRIL VALCON accumulator closing unit, 180 gallons, 3000 psi.
1 - CHOKE manifold 5000 psi.

Mud System Monitoring Equipment
- Mud pit level indicator with visual and audio warning devices.
- Mud return indicator with visual and audio warning devices.

1 - 90 barrel trip tank.
- Gas detecting equipment.

Fire Fighting Equipment
17 - ANSULS hand-held extinguisher
1.7.3 PRIMARY CONTAINMENT EQUIPMENT

The following specifications apply to the fuel storage and transfer equipment.

(1) All fuel storage tanks are of steel construction. All fuel storage tanks are atmospheric vessels, with permanently installed vents.

(2) The fuel discharge connection on each tank is equipped with manually operating valves.

(3) The fuel tanks have no automatic fluid level control devices. These tanks are installed, unprotected from the weather. Arctic conditions frequently cause failure of automatic control equipment. The tank fuel levels are observed and controlled manually.

(4) Fuel is transferred to and from the storage tanks through steel lines, and/or flexible arctic grade fuel handling hoses. Expansion, contraction and vibration is not transferred through these flexible sections. All lines have threaded connections, including quick-connect couplings and/or unions. All threaded connections are accessible for inspection and repair, if required.

(5) All liquid mud storage tanks are of steel construction. The mud tanks are atmospheric tanks with open tops. The fluid level is controlled manually in each tank.

(6) All liquid mud is transferred through steel and/or high pressure steel braided hoses, specifically designed for this application.

(7) Drip pans are located under rig floor machinery to catch and collect lubricating oil leakage and spillage.

(8) Lubricating products are shipped to the drillsite in drums which have tested leakproof. Drum handling procedures are utilized to minimize damage at the drillsite. These drums are stored at central point(s) to isolate the effects of any leakage or spillage. No other means of transporting these products to the drillsite is currently available.

The cellar constructed around the well under the drilling rig is excavated and lined with an impervious structural material. Any fluids spilled into the cellar will be pumped to the reserve pit.
1.8 INSPECTIONS AND RECORDS

Shell Oil Company has written instructions incorporated as part of the well plan for each well as to procedures, test, inspections and reporting. This plan is very explicit about tripping, hole filling practices, and blowout preventer hook ups and use. The Contingency Plan will be on file along with the Well Plan at the Drill Site. Shell Oil Company's on-site supervisor will be responsible for seeing that procedures are carried out and that proper records are kept.

1.9 GRAVEL ISLAND SITE

The gravel island location will be designed and built to accommodate the drilling rig, camp, and necessary supplies for a year round drilling operation. The location will have a freeboard of 15 feet which is designed to resist ice override and lateral movement and is above the maximum indicated tide and storm surge based on observations along the surrounding coast.

If it is desired to later use this island for production purposes, it can be enlarged to meet this need. Note that in addition to the 15-foot freeboard, a 7-foot berm is planned for the perimeter of the island. Slope protection is also planned to control slope erosion. The rig and associated equipment and supplies will either be trucked over ice roads to the location or will be barged during the summer open water period.

1.10 GENERAL SITE DETAILS

The rig location and operating plan will be designed to provide containment of all drilling operation effluents that could be considered as pollutants. An impermeable sheet will be placed under the drilling rig to collect and divert any liquid waste for proper disposal. In addition to this, drip pans and other containment measures will be provided under the engines and rig machinery. Good housekeeping will be stressed on all parts of the location, with emphasis on minimizing contamination of the peripheral drainage from the island. Fuel will be stored in double-walled steel tanks located on an impervious area inside a gravel berm. An impervious reserve pit will provide space for emergency discharge of fluids, if required, and will normally be kept dry to maximize storage capacity.

Additional precautions will be taken to prevent drainage of hydrocarbons to the sea. After freezeup, the surface of the island will be sprayed with water to form an impervious ice seal. This will enhance cleanup of liquids spilled. Also, any spills will be cleaned up as soon as possible. Snow contaminated by toxic substances will be incinerated on site or hauled to a disposal site on shore. The island surface will be thoroughly cleaned after clearing the island of all drilling equipment.
Mechanical devices including spill booms and skimming equipment outlined in the Oil Spill Containment and Cleanup Plan will be used to contain an open water spill. After freezeup, the natural snow surrounding the location will be used to stop the spread of any potential pollutants.

1.11 ON-SITE SPILL RESPONSE TEAM

Selected members of the drilling and roustabout crew, under direction of the Shell Drilling Supervisor, will be designated as the On-Site Spill Response Team. This team, along with on-site Shell and contract drilling supervisors, will be given periodic instruction in all phases of pollution control including the following:

A. Pollution prevention and good rig and location housekeeping practices.
B. Pollution detection methods under different climatic conditions.
C. Control and containment methods for toxic spills under different climatic conditions including drills in using the various items of containment and cleanup equipment listed below.
D. Cleanup and proper disposal procedures.

The ABSORB Manual will serve as a training manual for this instruction.

The On-Site Team will be responsible for investigating and handling all minor spills, both on location and between Deadhorse and the location. This team will be able to handle most minor operational spills of oil, which will be collected with sorbent material and disposed of by incineration. At the discretion of the Shell Drilling Supervisor, additional labor crews and material can be mobilized from Deadhorse to assist the Spill Team in cleanup.

1.12 SHELL OIL SPILL RESPONSE TEAM

For spills beyond the capability of the On-Site Team to contain or to clean up, the Shell Oil Spill Response Team, as outlined in Section 2.0 will be activated to the degree required by the severity of the spill up through complete loss of control and blowout of a well.

1.13 LARGE SPILLS

In the event of an uncontrolled blowout, a berm pre-built on the island perimeter will provide containment. Figure 1-2 outlines the containment berm. The berm will be constructed of sandbags and will be approximately 400 feet in diameter. The berm, which is seven feet in height, will contain over 100,000 BBLS of oil.
Assuming a 5,000 BBL per day blowout, the berm could contain up to 20 days of production. This is considered a maximum probable discharge.

This delay will provide adequate time to (a) activate the Oil Spill Response Team, (b) evaluate the alternatives available and the environmental risks posed and to form sound operational judgments including the possibility of ignition and/or (c) begin relief well activities.

If oil threatens to escape the island berm during winter, a snow and ice berm can be constructed around the island. During the open water season, containment booms and skimmers will be available.

Shell Oil Company is a member of the Alaska Beaufort Sea Oilspill Response Body (ABSORB) with full access to ABSORB facilities and management personnel. In addition, equipment and materials are available through a number of organization and service companies, such as Crowley Environmental, Arctic Oilfield Environmental Services, Inc., Gulf of Alaska Cleanup Organization (GOAC), Cook Inlet Response Organization (CIRO), Alyeska, Sohio, Arco and Exxon.

A complete detailed discussion of Gravel Island oil spill scenarios, communications, logistics, equipment, cleanup techniques and environmental data is provided in the "ABSORB Oil Spill Contingency Plan". The ABSORB manual is to be considered as an integral part of Shell's Oil Spill Contingency Plan. Shell and ABSORB radios will be distributed as shown in Figure 2-1.

## AVAILABLE EQUIPMENT AND MATERIALS

To allow for deployment of pollution control equipment and construction of dikes, berms and other structures, the following equipment will be maintained on location and at Deadhorse:

<table>
<thead>
<tr>
<th>On-Site</th>
<th>At Deadhorse**</th>
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<tbody>
<tr>
<td>1 Caterpillar 966 Front Leader</td>
<td>Front End Loaders</td>
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<tr>
<td>1 Caterpillar D-7 Bulldozer</td>
<td>Rollingons</td>
</tr>
<tr>
<td>1 Spill Containment Boom</td>
<td>Belly Dumps</td>
</tr>
<tr>
<td>(1,500 feet long)</td>
<td>Boats, Barges and Tugs</td>
</tr>
<tr>
<td>1 Oil Skimmer</td>
<td>Labor Crews</td>
</tr>
<tr>
<td>Dispersant &amp; Sprayers</td>
<td>Graders, Bulldozers, Trucks</td>
</tr>
<tr>
<td>Tankage (1,000 BBL)</td>
<td>Ditching Machines</td>
</tr>
</tbody>
</table>

** Equipment available at Deadhorse is expected to require 6 to 12 hours to mobilize to the location, dependent upon weather conditions.
In addition to the equipment shown above, the following construction and absorbent materials will be maintained on location to combat oil spills:

Polyethylene Sheeting and Plastic Bags
10 Rolls - 5/8" x 3' x 150' Absorbent Sheeting
Barite
Bentonite
Lost Circulation Materials (Walnut hulls, cellulose, etc.)
Centrifugal Pumps and Hoses
Hand Tools

Additional spill cleanup equipment including oil mops and sorbent materials can be mobilized from Anchorage to Deadhorse within 6 to 48 hours. Also, additional personnel and equipment can be rapidly mobilized from the Alaskan Beaufort Sea Oil Spill Response Body (ABSORB) Organization, of which Shell is a member.

1.15 CONTAINMENT AND RECOVERY EQUIPMENT CAPABILITY

The above equipment is considered "state of the art" technology for the environmental conditions in which the equipment will be used. Contingency equipment and techniques will be effective for oilspills under, or on, solid ice cover.

1.16 CONTINGENCY EQUIPMENT RESOURCES

Initial response contingency equipment and techniques will be capable of recovering and storing or disposing of a minimum of 1,000 barrels of oil per day. Additional contingency equipment will be available in the event of larger oilspills.

1.17 SUPPORT VESSEL/VEHICLES

Vessel/vehicles needed for year-round deploying and operation of contingency equipment will be available in six hours for initial response and 48 hours for support response. The crews or operators of vessels/vehicles used in contingency operations will be trained and familiar with the equipment deployed and operated by or on the vessel/vehicle.

1.18 DISPERSANTS (PRIOR APPROVAL REQUIRED)

Equipment for applying chemical dispersant will be available for use within a six hour response time. Enough chemical dispersant will be maintained on the island to continue application of dispersants until additional dispersants are available from secondary sources. The decision to use dispersants will be made using the criteria and procedures set forth in the Annex X of the National Contingency Plan. NOTE: Prior approval required.
1.19 SUPPORT PERSONNEL

Dedicated pollution response personnel shall be provided and available at the ABSORB warehouse at Deadhorse to insure that the equipment availability, capability, and response times can be met.

A professional cleanup manager will be available from ABSORB to direct pollution response efforts when the spill is beyond the capability of the on-site crew.

1.20 ABSORB EQUIPMENT ACQUISITION LIST

A detailed list of existing ABSORB equipment is shown in Section 4.

1.21 DRILLS

Shell or a contractor serving Shell will hold drills for familiarization with pollution control equipment and operational procedures. This will be done upon placement of the drilling rig on location prior to drilling operations and every six months thereafter, or upon continuation of the drilling operation into a new seasonal environmental condition (i.e., from ice cover to open water), whichever is first.

The personnel identified as the onsite oil spill response operating team in the Contingency Plan shall participate in these drills. The drills shall be realistic and shall include deployment of equipment. A time schedule with a list of equipment to be deployed will be submitted to the USGS-DCM, Offshore Field Operations, and to the Director, Alaska Department of Minerals and Energy Management for approval. The drill schedule will provide sufficient advance notice to allow U.S. Geological Survey personnel to witness any of the drills. Drills will be recorded, and the records will be made available to U.S. Geological Survey personnel.

1.22 TRAINING

Shell will ensure that training classes for familiarization with pollution-control equipment and operational procedures are provided for the oil spill response operating team.

The supervisory personnel responsible for directing the oil spill response operations will receive oil spill control instruction suitable for all seasons. Shell will retain course completion certificates or attendance records issued by the organization where the instruction was provided. These records will be available to any authorized representative of the U.S. Geological Survey upon request.
1.23 OIL SPILL TRAINING PROGRAMS

ABSORB has begun a series of oil spill training schools geared specifically to the kinds of hardware/techniques used in the Beaufort Sea. These schools provide both classroom instruction and hands-on experience at the warehouse and in the field. A detailed description of planned schools is presented in Section 5. Selected Shell personnel and contractor representatives will attend these schools.

1.24 SITE SURVEILLANCE

Under normal drilling operations the Shell Drilling Supervisor will be responsible for conducting frequent reviews of the drill site to ensure that equipment maintenance is kept up to standards and that proper on-site procedures are followed. The items to be checked during site surveillance include, but are not limited to:

1. Mechanical condition of tankage, lines and pumps. (Daily)
2. Correct positioning of flowline valves. (Installation)
3. Operation of relief valves. (Weekly)
4. Fluid levels in drip pans, containment pits, etc. (Daily)
5. Condition of drains (ensure clean and unfrozen). (Daily)
6. General condition and cleanliness of rig. (Daily)
7. Condition of spill removal equipment and material. (Daily)
8. Proper operation of sewage treatment facilities. (Continuous)
9. Snow removal status. (Daily)
10. Check outer edges of location to be sure no seepage from pad. (Daily)

In addition, the following procedure will be followed while operating on these locations:

1. The Shell Drilling Supervisor will designate "Briefing Areas" where all personnel will meet in case of emergency and where emergency equipment will be kept.
2. The site will be equipped with a Shell operated radio system.
3. A list of current emergency telephone numbers and a map of the local area will be maintained by the Drilling Supervisor.
1.25 NOTIFICATION REQUIREMENTS (See Pages 3-10 thru 3-13)

In the event of an oil spill, the Shell Drilling Supervisor shall immediately contact the Anchorage Office and issue a report including the following information:

A. Date and time spill occurred or was first observed.
B. Where spill occurred and present location.
C. Estimate of amount and type of material spilled.
D. Environmental conditions (temperature, wind, etc.).
E. Description of area likely to be affected.
F. Cause of spill.
G. Action taken to combat spill.

The Shell Drilling Supervisor will be responsible for making contact with Division Drilling, Legal, and all required governmental agencies. General procedures for the Supervisor to follow in this regard are:

A. Contact U.S. Coast Guard by telephone and notify that spill has occurred and is being investigated, only if the spill threatens to enter any navigable waters (lakes, streams, ocean and/or ice).
B. Notify Alaska Department of Environmental Conservation by telephone for spills within three-mile limit.
C. Notify Headquarters Drilling of the spill providing available details.
D. Contact USGS by telephone immediately if spill is greater than 6.3 BBLS and with 12 hours if less than 6.3 BBLS.

1.26 OIL CONTAINMENT PLAN

A. Before Freezeup (Summer Operations)

In the event that an oil spill occurring before freezeup at the location cannot be contained on the drill site or in the contingency pit and pollutants reach open water, the following steps will be taken to contain the oil spill:

1. Stop the spill at its source unless it is the result of an uncontrolled blowout, in which case see Uncontrolled Blowout Plan.
2. Mobilize all equipment required to contain the spill fluid.

3. Ascertain the direction of current (general direction in which the spill is moving).

4. Using boats, deploy the spill containment boom to surround the spilled fluids, block the fluid flow, and collect the spilled fluids. As the 1,500 feet of boom will not surround the entire perimeter of the island, it will be necessary to place the boom to block the expected path of spill migration. A typical deployment diagram is shown in the attached Figure 1-3.

5. Once the spill containment boom is in place, deploy the oil skimmer directing it into the location of the highest oil concentration.

6. Make a sweep periodically of the outside perimeter of the containment boom to assess whether any oil has escaped to open water.

7. Mop up any residual fluids with absorbent materials and recover all contaminated ice, snow, and gravel, placing contaminated materials in containers for disposal.

B. During Freezeup

During freezeup limited operations may be possible to contain and mop up spilled fluid depending upon the extent of the ice cover and ice conditions.

If sufficient ice leads exist to allow navigation of small boats in and through open ice, the following procedures may be initiated:

a. Deployment of the spill containment boom may be feasible if open water exists around the drill site area.

b. The oil skimmer may be deployed in large ice leads to mop up isolated spills.

c. Sorbent materials should be used where applicable to clean up oil spilled in small ice leads.

d. An oil mop can be used in conjunction with a small boat to recover floating oil slicks in ice leads.

If sufficient ice leads do not exist and/or only a thin continuous ice layer exists, the general perimeter of the spill should be staked and movement of the spill area
FIGURE 1-3
TYPICAL DEPLOYMENT OF THE
SPILL CONTAINMENT BOOM
(SUMMER OPERATIONS ONLY)
closely monitored. In this case, the procedure will be to allow the ice pack to freeze sufficiently so that equipment and personnel can be mobilized for cleanup procedures identified in the after freezeup section.

NOTE: SAFETY OF PERSONNEL IS A MAJOR CONSIDERATION WHILE CONDUCTING CLEANUP OPERATIONS DURING THE PERIOD OF FREEZEUP. PERSONNEL SHOULD NOT OPERATE ON ICE PACKS HAVING QUESTIONABLE INTEGRITY OR ON FREE-FLOATING ICE.

Oil entering the water during freezeup will eventually become entrained in the sheet ice. Later into the winter, this oil could be mechanically recovered or burned in place as conditions warrant.

C. After Freezeup (Consolidated ice pack existing.)

After freezeup the primary defense outside the island perimeter will be the naturally occurring snow on top of the ice. Recent information indicates this is preferable to building a snow berm around the location for limiting the spread of a spill.

Cleanup operations after freezeup should be aided by the increased viscosity of fluids at low temperatures. Recovered fluids and contaminated cleanup materials (snow, ice, absorbents, etc.) should be placed in steel containers for disposal.

D. Breakup

As spring breakup approaches, any oil that has been frozen into ice will tend to rise to the surface through brine drainage channels in the sea ice. This oil could be mechanically recovered or burned in place as conditions warrant.

Access to a spill site during breakup will be provided by helicopter or hovercraft, amphibious vehicles or specialized boats.

As more and more ice melts with the coming of summer, small boats and specially-designed skimmer vessels could be employed to remove any oil that may have been trapped by or on the ice.

Recovered oil could be burned offshore on a barge, or transported to the onshore gravel extraction pit (previously used for island construction) where it could be incinerated, injected back underground through a Prudhoe Bay disposal well, or salvaged and processed for flow through the trans-Alaska pipeline with other oil produced from the Prudhoe Bay field.
1.27 SPILL CLEANUP PROCEDURES

The spill cleanup efforts at the locations will be directed toward returning the affected area to as near natural state as possible. Minor spillage of fluid will be cleaned by use of absorbent materials and recovery of contaminated materials such as gravel, etc. These soaked materials will be placed in containers for future disposal. Major oil spillage will be handled by use of conventional skimming equipment. Snow, absorbent materials, and other contaminated materials will be recovered and processed by incineration.

1.28 FUEL TRANSFER PROCEDURES

Operations involving fuel transfer are critical in that mistakes occurring at this time will likely lead to an oil spill. It is the Drilling Supervisor's responsibility to ensure that proper procedures are implemented during each fuel transfer. General guidelines for these operations are:

A. Ensure by testing or inspection that all equipment and lines are in proper working order before each transfer begins. Lines are to be pressure tested to 1.5 times the maximum anticipated transfer pressures.

B. Review procedures with all personnel involved to ensure that everyone knows his job.

C. Double check that all valves are positioned correctly before transfer begins.

D. Make a visual inspection of equipment once transfer begins. Keep track of volumes and pressures during pumping. Shut down operations immediately at the first sign of pressure loss or leakage.

1.29 ABSORB COASTLINE SENSITIVITY ATLAS

If a major oil spill occurs in the nearshore Alaska Beaufort Sea, it is possible that not all spilled oil will be contained and cleaned up offshore. Oil escaping containment will likely move east southeast down wind toward sections of the Beaufort Sea coast.

Since it is not possible to protect an entire coastline, methods have been developed to evaluate the relative sensitivity of each stretch of coast so that the most sensitive areas threatened by a spill can be protected first. Oil spill countermeasures can then be directed at minimizing the impact of the oil on other threatened areas.
ABSORB is now developing a Coastline Sensitivity Atlas showing locations and rankings of sensitive areas, along with specific methods to protect each area from an oil spill.

The draft atlas is currently (July 1981) being reviewed by interested government agencies. The final study should be complete and available for utilization by Shell and ABSORB by the end of 1981 before drilling commences on the island.

For each segment of Beaufort Sea coast, the Coastline Sensitivity Atlas will identify response priorities based on the variety of factors that can influence the behavior of an oil spill, i.e., currents, wind, ice and the biological, social and economic values to be protected. The completed atlas will describe countermeasures recommended to minimize the impact of the spill on particular environments. The countermeasures and priorities for protection given in the atlas will be subject to periodic review and revision as information becomes available.

1.30 OIL SPILL HANDBOOK

An oil spill handbook is currently being compiled by ABSORB and will be available by November 1, 1981 before drilling commences on the island.

1.31 UNCONTROLLED BLOWOUT (RELIEF WELL) PLAN

A. Scope

This section of the Contingency Plan covers action to be taken to initiate relief well operations in the event of an uncontrolled blowout in the area of operations. The possibility of this occurring is considered extremely low because of the extensive precaution to be taken to prevent loss of well control. This section does not deal with control of pollution resulting from the blowout. This is dealt with in the ABSORB Manual.

B. Well Ignition

The blowout well will be ignited at the discretion of the on-site Shell Senior Supervisor if there is immediate danger to personnel. Otherwise, the well will be ignited for safety and to limit the potential for adverse environmental impact only after evaluation of the alternatives available and after discussion with Shell management and the proper governmental agencies.

C. Equipment and Supply Mobilization

In the event of a blowout, all equipment necessary for constructing the relief well pad would be immediately mobilized from Prudhoe to the location. The equipment used and transpor-
tation method will depend upon the time of the year and availability. The ABSORB Manual contains comprehensive lists of construction companies located at Prudhoe. A drilling rig will also be located at this time and planned for mobilization as soon as the pad is available.

The relief well drilling rig could be any industry rig in current arctic service. If all adequate rigs are under contract and in use at the time of the spill, current oil industry practice dictates that one or two will be released from their commitments to enable their use for relief well service.

If necessary, as a last resort, a Herc transportable rig could be flown into Deadhorse from another area.

Depending on the time of year the blowout occurred, it may be necessary to obtain a helicopter transportable rig. Supplies and equipment required for drilling the relief well would be obtained and located at a staging area at Deadhorse to permit rapid transportation to the location as soon as the relief well pad was completed. Gravel for the relief well pad would probably be obtained from the same gravel source as the original island or from Prudhoe sources during the open water season. It is anticipated that most rig and supply movement will take place over existing ice roads or by tug and barge during the summer season. During the periods of breakup and freezeup, all transportation will be by airplane, helicopter, or possibly air cushion vehicles.

D. Relief Well Location

The optimum location for a relief well pad is dependent upon several factors existing at the time of the blowout, including blowout well depth and both current and projected wind and current conditions at the location. In this nearshore area, currents are strongly influenced by wind direction. Wind patterns have been recorded on a monthly basis at the Prudhoe airport. An attempt would be made to place the location in minimum water depth at a distance from the blowout well to provide optimum directional drilling parameters for the relief well. In case the blowout well was directional, an attempt would be made to locate the relief well pad such that the relief well could be drilled as nearly as possible as a straight hole to intercept the blowout wellbore. In all cases, the relief well pad will be placed a sufficient distance from the blowout well to ensure personnel and equipment safety for the duration of the anticipated drilling program. It is anticipated that in most cases the relief well pads would be located in water depth similar to the original pad.
E. Pad Construction

After freezeup a gravel location large enough to accommodate the drilling rig and kill equipment would be constructed using construction techniques similar to those used for the original pad. All available equipment that could be used efficiently would be utilized. As soon as pad size is large enough to support the drilling rig and associated drilling support equipment, the rig and equipment may be mobilized to the pad over ice roads, ice conditions permitting. Pad size could then be expanded as necessary to accommodate the kill equipment and fluids which will not be required until the relief well is drilled to TD. Another possibility, depending on timing, is that the kill equipment could be brought to the location on barges after breakup.

During open water periods, a relief well gravel location would be constructed by the proven technique of using barges and tugs to transport the gravel from the Prudhoe Bay West Dock to the location.

During periods of breakup and freezeup, pad construction would not be attempted until such time as conditions were safe for personnel and equipment to operate. In this case, all supplies, equipment, and material necessary for construction would be assembled at the nearest staging point such that construction could begin immediately when safe to do so.

1.32 CONTINGENCY PLAN UPDATING PROCEDURES

Each recipient of this plan should record any pertinent changes or additions that come to his attention on his copy of the plan, and also notify the Division Safety and Environmental Conservation Manager. The Division SEC Manager will be responsible for notifying other recipients of any changes that come to his attention.

Annually, a notice will be distributed to all plan recipients advising that this plan is being updated. Each recipient should reply by including any recommended changes at that time. In this manner, the plan can be kept current.
1.3.3 DISPOSITION OF OILY EFFLUENT FROM SECONDARY CONTAINMENT

The inventory of equipment for the drilling rig includes an incinerator. Disposition of oily waste materials will be in accordance with the following procedures.

(1) All used engine oil, machinery lubricants of any kind, and small volumes of spilled and recovered fuel oils will be burned in an incinerator.

(2) All absorbent materials used for oil spill clean-up which are combustible will be incinerated.

(3) All burning operations will be conducted under the direction of Shell's On-Site Representative and the terms and conditions of our burning permits.

(4) The Rig Superintendent, with the approval of Shell's Drilling Supervisor, will supervise the execution of burning operations for the disposal of all oil waste materials remaining in the reserve pit upon completion of drilling operations, and at any other time justified. This procedure will be followed for disposing of any oily waste residue on any portion of the drillsite and/or campsite.
2. ORGANIZATION AND NOTIFICATION PROCEDURES:

2.1 General Organization

The purpose of this section is to describe Shell's administrative organization
and the assignment of duties for an oil spill cleanup operation. The procedures
for documenting spills are also discussed, along with guidelines for coordination
with the government, the media, and the public.

Figure 2-1 shows the organization which would be required for a full-scale
response to a major spill. For a small spill, only the Operations Manager
and several members of his staff may be needed, depending on the particular
expertise required. In some cases each supervisor may elect to assume the
responsibilities of all or several of his coordinators.

The Operations Manager will obtain as much labor support as necessary at the
time of an actual spill emergency. This help will come from contractors or
from internal Shell sources as deemed feasible.
Revised 9/29/81

Production Manager

Operations Manager (1)

Drilling Supervisor (6)
- Coordinators:
  - Operations
  - Engineering

Cleanup Supervisor (5)
- Coordinators:
  - Containment (9)
  - Recovery (10)
  - Storage/Transfer (11)
  - Disposal (12)
  - Dispersal (13)

Support Services Supervisor (4)
- Coordinators:
  - Documentation
  - Government Liaison
  - Security
  - Accounting
  - Legal/Insurance
  - Public Affairs

Technical Supervisor (3)
- Coordinators:
  - Environmental
  - Safety
  - Engineering

Logistics Supervisor (2)
- Coordinators:
  - Communications (7)
  - Manpower
  - Equipment/Material (8)
  - Transportation
  - Food/Housing

Figures in brackets refer to radio numbers.

2 - 2
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<th>Job Title</th>
<th>Assigned To</th>
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<tr>
<td>Production Manager</td>
<td>W. M. Marshall</td>
<td>Production Manager Pacific Division Houston, TX</td>
<td>(713) 870-2440 (Office)</td>
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<tr>
<td></td>
<td></td>
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<tr>
<td></td>
<td>J. E. Dozier, Jr., Alt.</td>
<td>SEC Manager Pacific Division Houston, TX</td>
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<tr>
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<tr>
<td>Operations Manager</td>
<td>L. P. Ramirez</td>
<td>Operations Manager Pacific Operations Ventura, CA</td>
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<td>(805) 644-6785 (Home)</td>
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<td></td>
<td>G. T. Karnes, Alt.</td>
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<td>Manpower Coordinator</td>
<td>P. M. Molnar, Alt.</td>
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<td>E. W. Quayle</td>
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<td>M. W. Dimock</td>
<td>Senior Materials Control Analyst</td>
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<td>Food/Housing Coordinator</td>
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|                           | G. B. Evans, Alt.     | Safety Representative, SEC  
Pacific Operations  
Ventura, CA            | (805) 643-1197 (Office)  
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<td>Storage/Transfer Coordinator</td>
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<td>Drilling Supervisor</td>
<td>M. L. Woodson</td>
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<td>E. C. Johnson, Alt.</td>
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<td>D. E. Smith</td>
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<td>L. A. Primm, Alt.</td>
<td>Senior Drilling Engineer Pacific Division Ventura, CA</td>
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Proper record-keeping is essential to an efficiently run cleanup operation and is the responsibility of all members of the response team. All coordinators will report daily to the Documentation Coordinator or at a minimum, provide documentation of key transactions and decisions to ensure that a complete spill history is being maintained. The subject of record-keeping is addressed in more detail in Section 2.3.

The following subsections contain detailed descriptions of the duties of each member of the Operations Manager's staff.

2.2 Response Team Job Descriptions

OPERATIONS MANAGER

- In compliance with company policy and in coordination with senior management, has complete responsibility and total authority for directing field operations and for making or revoking decisions regarding procedural matters.

- Reports directly to spiller company management and represents their interests throughout the cleanup operation.

- Is the only member of the Response Team with authority to contract for services and equipment from ABSORB or other sources. He may delegate this authority to the Logistics Supervisor.
Establishes the field command post.

- Directs all line supervisors.

- Establishes priorities on use of radios and telephones.

- With the daily input of his supervisors, monitors the spill and its cleanup to determine if more manpower and/or equipment are required.

- Oversees and approves the deployment of men and equipment.

- Approves the movement and activities of all visitors (press, public, etc.) on-scene. Provides liaison with these groups as necessary through the Support Services and Logistics Supervisors.

- Clears all press releases after they are checked by the Legal/Insurance Coordinator and sends them on to spiller company upper management for approval.

- Meets routinely with government on-scene observers and as necessary with Regional Response Team (RRT) personnel to discuss cleanup plans and priorities and the adequacy of results.

- Directs preparation of daily reports and a final written report on the cleanup operation, with assistance from the Documentation Coordinator.
LOGISTICS SUPERVISOR

- Supports the field operation by acquiring and sending to the spill site the manpower and equipment requested by the Operations Manager.

- Is responsible for directing the efforts of the Communications Coordinator, Manpower Coordinator, Equipment/Materials Coordinator, Transportation Coordinator, and the Food/Housing Coordinator.

- Depending on the size of the spill cleanup operation, may elect to assume the responsibilities of one or several of these coordinators.

Communications Coordinator

- Sets up and maintains the field communications system.

- Sees that a detailed log of all communications (other than routine operational transmittals) is kept by command post personnel manning telephones and radios. Provides this log to the Documentation Coordinator.

- Checks out portable radios to authorized personnel according to the provisions of this contingency plan.

- Assigns a dispatcher as necessary to take and relay messages.
Manpower Coordinator

- Arranges for manpower needs as requested by the cleanup coordinators.
- Keeps time records of all workers.
- Keeps current list of all personnel involved in the cleanup operation.
- Provides necessary personnel information to the Accounting Coordinator for maintenance of payroll records.

Equipment/Materials Coordinator

- Serves as the clearinghouse for requests for equipment and supplies.
- Maintains careful records of company, contractor, and other equipment being used. Records should cover such items as location of use, hours of use, supplies used, spare parts and replacements needed, etc.
- Sets up and runs a maintenance shop for equipment being used for the cleanup operation.
- Manages mechanics and laborers assigned to maintenance.
- Provides spare parts and gas, oil, and other supplies as needed for cleanup equipment.
- Spot checks contractor maintenance procedures on critical equipment.
- Handles inventory and distribution from staging areas.

Transportation Coordinator

- Arranges for transportation of all personnel and material to the spill site.
Coordinates with airlines, service companies, etc. to fill requests for transportation.

Combines small shipments into larger ones to reduce equipment use.

Keeps careful records of requests and expenditures.

Establishes and manages a staging area for shipment of men and materials to the spill site.

**Food/Housing Coordinator**

- At the request of the Operations Manager, arranges for the mobilization of required portable camp facilities.
- Coordinates meals and lodging at available facilities at Prudhoe Bay.
- Supervises efforts of workers assigned to food preparation and housekeeping at the portable camps.
- Arranges for acquisition and delivery of food supplies.

**TECHNICAL SUPERVISOR**

- Is responsible for providing the Operations Manager and the other supervisors with the technical information they need on equipment and the environment and for ensuring the safety of the operation.
- Directs the Environmental Coordinator, the Safety Coordinator, and the Engineering Coordinator, but will assume their roles for a smaller operation.

**Environmental Assessment Coordinator**

- Maintains liaison in the field with environmental/scientific representatives of governmental agencies. Coordinates with the Government Liaison Coordinator.
- Provides the Operations Manager with damage assessments.
Surveys the spill area and advises the Operations Manager of environmentally sensitive areas to protect.

- Responds to requests for technical information concerning environmentally sensitive areas.
- Coordinates wildlife rehabilitation activities.
- Provides liaison between the spiller company and environmental groups.
- Monitors the spill cleanup to ensure proper cleanup and restoration procedures are followed.
- Establishes sampling programs to determine the environmental effects of the spill.
- Maintains an awareness of the coastal ecology in the response area.
- Maintains up-to-date files of environmental information on the response area.
- Works with the Engineering Coordinator to determine best disposal techniques.
- Works closely with the Dispersal Coordinator and Government Liaison Coordinator on questions of use of dispersants.
- Advises the Operations Manager on adequacy of cleanup.
- Establishes liaison as required with environmental specialists from other companies or consultants. Obtains from the National Weather Service and other sources weather and ice forecasts, satellite photos, and information on tides and currents.

**Safety Coordinator**

- Determines precautions to be taken to minimize the hazards of explosion, fire, vapor inhalation, or any other possible accident.
- Regularly inspects the scene of the cleanup operation to identify and eliminate safety hazards.
- Checks safety features of equipment being sent to the spill site and advises on safe operation of all equipment.
Dispenses first-aid, safety, and survival equipment and maintains the inventory of these items.

Coordinates the staging of fire control equipment.

Arranges for procurement and distribution of safety equipment and survival gear as requested by the Logistics Supervisor.

Contacts first-aid centers at the North Slope and hospitals in Anchorage and Fairbanks to prepare them for possible injured Response Team members.

**Engineering Coordinator**

- Determines the magnitude of the spill and associated flowrates.
- Monitors spill movement and behavior.
- Advises the Operations Manager on technical aspects of containment and cleanup, i.e., adequacy of techniques and equipment, effects of ice and reduced temperatures, etc.
- Advises on physical/chemical aspects of ice loading, oil combustion, strength of materials, etc.
- Works with the Environmental Coordinator to determine best disposal techniques.
- Provides needed technical information from company files and establishes liaison as necessary with engineers from other companies and with consultants.

**SUPPORT SERVICES SUPERVISOR**

- Handles the public affairs, legal, governmental, and financial aspects of the cleanup operation.
- Is responsible for providing clerical help and security for the cleanup operation.
- Supervises the Documentation Coordinator, Government Liaison Coordinator, Security Coordinator, Accounting Coordinator, Legal/Insurance Coordinator, and Public Affairs Coordinator and may assume their functions for a small operation.
- The Support Services Supervisor and his staff maintain close liaison with any counterparts in Anchorage.
**Documentation Coordinator**

- Keeps a detailed daily log of the following:
  - Events and their timing
  - Communications by radio or telephone (other than routine operational transmittals)
  - Minutes of meetings
- Uses the log to write brief narratives of each day's events for distribution to management and for use in the spill history.
- Coordinates the record-keeping of all other staff members to ensure that the proper data is being recorded.
- Arranges for a photographer to record important events of the spill cleanup.
- Maintains a complete file of all correspondence, reports, data sheets, etc. on the cleanup operation.
- Arranges for the collection of newspaper clippings and other information on media coverage of the spill cleanup operation. Includes monitoring radio and television broadcasts.
- Assists in the preparation of a comprehensive final report and in submitting required reports to government agencies (this task is to be coordinated with the Government Liaison Coordinator).

**Government Liaison Coordinator**

- Reports the spill to appropriate local, state and federal agencies as requested by spiller company upper management.
- At the request of the Operations Manager, obtains necessary government approvals and permits for actions subject to regulation such as use of dispersants, access to lands, location and use of disposal sites, use of government-owned equipment, etc. Coordinates with the Environmental Coordinator on these matters.
Establishes and maintains contact with representatives of government agencies and conveys information and requests to the Operations Manager.

With approval of the Operations Manager, arranges for observation visits to the spill site by representatives of government agencies and serves as a guide during these visits.

Works closely with the Environmental Coordinator, sharing the responsibility of conducting site visits with government on-scene observers.

Serves as spiller company representative to the Regional Response Team or any other committee formed by government to assist in the cleanup.

Keeps accurate notes for use in the spill history.

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Security Coordinator

- Insures that only authorized personnel enter the field office and spill cleanup zone.
- Assigns security officers to area as required.
- With approval of Operations Manager, issues passes to members of the press, government agencies, and other visitors.
- Provides badges as necessary for Response Team and support (contract) cleanup personnel.

Accounting Coordinator

- Documents labor, materials, and services used for the cleanup operation. Keeps records of:
  - Labor breakdown by hours and rates
  - Equipment rentals
  - Materials and supplies purchased or rented
  - Time and contracts cost
  - Freight charters
  - Food and lodging
- Prepares bills, pays invoices, and audits contractors as necessary.
Advises the Operations Manager of costs and prepares daily cost forecasts.

Assists in preparation of a detailed financial report at end of project.

**Legal/Insurance Coordinator**

- Provides legal advice to the Operations Manager to point out potential legal actions and areas of liability.
- Is thoroughly familiar with all applicable local, state, and federal laws and regulations affecting the member company's cleanup efforts.
- Advises the Documentation Coordinator at the start of an operation of which records are necessary to properly document the spill and cleanup operation in anticipation of potential lawsuits and insurance claims.
- Reviews press releases.
- Provides qualified claims adjusters to investigate claims of damage.
- Obtains rights-of-way and permits as necessary for a cleanup operation.
- Handles inquiries from insurance companies and accompanies claims adjusters on tours of site.

**Public Affairs Coordinator**

- Deals with the news media as stipulated in Section 2.4, Public Relations.
- Coordinates with public relations representatives assigned to the spill site.
- Prepares regular press releases and statements for release after approval by spiller company management, the Operations Manager, and the Legal/Insurance Coordinator.
- Arranges for and chaperones tours by members of the news media.
Maintains a close working relationship with the news media, government agencies, conservation groups, and public organizations during the cleanup operation.

Keeps accurate notes for use in the spill history.

CLEANUP SUPERVISOR

Is responsible for directing the cleanup crews.

Directs the Containment Coordinator, Recovery Coordinator, Storage/Transfer Coordinator, Disposal Coordinator, and Dispersal Coordinator, but will assume their roles for a small cleanup operation.

Containment Coordinator

Directs all containment operations.

Determines action required and assigns work crews and equipment.

Arranges for men and equipment through the Logistics Supervisor.

Monitors performance of field foremen and work crews, directs crew shifts, settles disputes, insures that safety procedures are followed, and signs daily worksheets.

Recovery Coordinator

Directs operation of oil recovery equipment.

Determines action required and assigns work crews and equipment.

Arranges for men and equipment through the Logistics Supervisor.

Monitors performance of field foremen and work crews, directs crew shifts, settles disputes, insures that safety procedures are followed, and signs daily worksheets.
Storage/Transfer Coordinator

- Directs the movement of oil from recovery devices to transfer vessels to storage or disposal locations.
- Determines action required and assigns work crews and equipment.
- Arranges for men and equipment through the Logistics Supervisor.
- Coordinates with the Recovery and Disposal Coordinators.
- Monitors performance of field foremen and work crews, directs crew shifts, settles disputes, insures that safety procedures are followed, and signs daily work-sheets.

Disposal Coordinator

- Arranges for disposal of oil and oily waste as directed by the Cleanup Supervisor.
- Checks with the Government Liaison Coordinator to ensure that government approval has been obtained for in-situ burning, incineration, and any other disposal techniques requiring government approval.
- Arranges for men and equipment through the Logistics Supervisor.
- Monitors performance of field foremen and work crews, directs crew shifts, settles disputes, insures that safety procedures are followed, and signs daily work-sheets.

Dispersal Coordinator

- Directs any dispersal operations at the request of the Cleanup Supervisor and only after requisite government approvals have been obtained through the Government Liaison Coordinator.
- Arranges for men and equipment through the Logistics Supervisor.
- Coordinates with the Environmental Coordinator.
- Monitors performance of field foremen and work crews, directs crew shifts, settles disputes, insures that safety procedures are followed, and signs daily work-sheets.
DRILLING SUPERVISOR

- Responsible for ongoing drilling operations in the event that additional rigs are brought in to assist in emergency situations, i.e., to drill relief wells, etc.

Drilling Coordinator

- Advises Drilling Supervisor on operational aspects of techniques and equipment required for relief well or other activities.

Engineering Coordinator

- Advises Drilling Supervisor on technical aspects of techniques and equipment required for relief well.
- Provides needed technical information from Company files and establishes liaison as necessary with engineers from other companies and with consultants.
2.3 DOCUMENTATION PROCEDURES

Because of potential legal and public relations problems, the maintenance of thorough records of all events which transpire during an oil spill cleanup operation is extremely important. The early hours of a spill response are extremely hectic, with the potential for numerous conflicting requests. A complete log of events and communications makes the task of reconstructing the spill much easier. The following paragraphs present instructions for maintaining the necessary spill history information.

2.3.1 Initial Reporting

Figure 2-3 is a copy of the Initial Report Form to be filled out.

Several government agencies require verbal reports of a spill, and it is the responsibility of the spiller company to see that these reports are made. Either a telex or letter should be sent immediately to provide documentation of the verbal report. A verbal reporting checklist is presented in Figure 3-8 in Section 3.

2.3.2 Spill Logs

The principal spill log will be maintained by the Operations Manager, with assistance from the Documentation
INITIAL REPORT FORM

I. SPILL DATA

TIME OF CALL ____________________ DATE ____________________

PERSON REPORTING SPILL _______________________________________

AFFILIATION ______________________________________

(Specify) Company ______________________________________

Government Agency ______________________________________

SPILL LOCATION ___________ TYPE OF OIL ___________ EST. GRAVITY__

SPILL SOURCE (Blowout, Tank rupture, etc.) ________________________

VOLUME/FLOWRATE _______________ FLOW STOPPED? □ Yes □ No


________________________________________________________________

ACTIONS TAKEN (Briefly): ________________________________________

________________________________________________________________

EQUIPMENT DEPLOYED (Major Pieces): _______________________________

________________________________________________________________

AGENCIES NOTIFIED ___________________________________________

II. ENVIRONMENTAL CONDITIONS AT SITE

WIND (Speed & Direction) _______________________

TEMPERATURE ___________ VISIBILITY ___________

ICE CONDITIONS ___________

SEA STATE ___________

ENVIRONMENTAL DAMAGE (Real or Potential) __________________________
III. IN VolvEMEN T

EQUIPMENT REQUESTED (Specify quantity of each)

Facilities

Office Equipment
Warehouse Equipment
Miscellaneous Tools & Equip.
Field Command Post
Field Camp

Transportation

Workboat
Jon Boat

Detection

Gas Detector
Current Meter
Ice Amper

Containment

Heavy-Duty Containment Boom
Compactable Containment Boom
Boom Accessories

Recovery

Rope Mop Skimmer
Vessel Skimmer
Portable Weir-Type Skimmer
Sorbents

Storage

Portable Containment Device
Towable Bladder
Bladder Tank

Transfer

Arctic Hose & Fittings
Pump (Viscous)
Pump (Diaphragm)
Pump (Centrifugal)
Trans-Vac System

Disposal

Igniters
Burner
Incinerator
Dispersant
Dispersant Boat Equip.

Logistical Support

Radios
Communications Trailer
Bird Rehab. Equip.
Bird Scarer & Float
Generator
Auxiliary Lighting System
Air Compressor
Heater
First-Aid Equipment
Chain Saw
Flotation Suit/Life Vest
Arctic Clothing & Equip.
Field Response Kits w/ hand tools
Welder's Tent

RESPONSE TEAM (Specify Members Requested)

* OPERATIONS MANAGER
* LOGISTICS SUPERVISOR
* Communications Coordinator
* Manpower Coordinator
* Equipment/Materials Coord.
* Transportation Coordinator
* TECHNICAL SUPERVISOR
* Environmental Coordinator
* Safety Coordinator
* Engineering Coordinator

* SUPPORT SERVICES SUPERVISOR
* Documentation Coordinator
* Government Liaison Coord.
* Security Coordinator
* Accounting Coordinator
* Legal/Insurance Coordinator
* Public Affairs Coordinator
* CLEANUP SUPERVISOR
* Containment Coordinator
* Recovery Coordinator
* Storage/Transfer Coord.
* Disposal Coordinator
* Dispersal Coordinator

* Most likely to be mobilized
Coordinator. Any log book should be sturdily bound (not loose leaf) with consecutively numbered pages, and all entries are to be made in handwriting in ink, dated, and signed by the person making the entry. Each page should be used completely; any unused space should be crossed out. All corrections must be initialled and dated. As much information as possible will be recorded, including but not limited to:

- Records of decisions
- Important communications
- Summary of the day's work, including measurement of area cleaned and amount of oil recovered.
- Meeting minutes
- Directives from government representatives
- Arrival and departure times for visitors and inspectors.
- Number of people involved on a daily basis.

It is especially important to record carefully all directives from government representatives. The person recording the order should sign the page and have the government representative countersign. In this way, later disagreement can be avoided.

For a large-scale operation, the Operations Manager will delegate the task of maintaining the principal log to the Documentation Coordinator, and other logs may be kept by the various supervisors.
2.3.3 Written Reports

A checklist of government-required written reports is presented in Table 2-1. Figure 2-4 contains a sample of the U.S. Geological Survey report form (9-1880). Other agencies do not have special forms for written reports. The Operations Manager is responsible for completing all written reports, with assistance from the Documentation Coordinator. In addition, daily written reports will be prepared by the Documentation Coordinator, and the Operations Manager will prepare a detailed final report upon completion of the cleanup.

2.3.4 Cost Accounting and Equipment Use Documentation

The Accounting Coordinator is responsible for maintaining a complete cost history of the cleanup operation. He will submit a detailed financial report to the Operations Manager following completion of the spill cleanup operation.

Equipment Use Log (Figure 2-5). A log of equipment used in cleanup operations is to be maintained. This log will show:

1) Description of equipment (with number)
2) Party using equipment
U.S. Geological Survey - (Form 9-1880)

- All verbal spill reports must be confirmed in writing, and give cause, location, volume of spill and action taken. (For spills >5 cubic meters (31.5 bbl), include sea state, meteorological conditions, and size and appearance of slick)

U.S. Environmental Protection Agency (40 CFR 112.4(a))

- For facilities requiring SPCC plans, a written report must be filed when the facility has either: one spill >1,000 gal or 2 spills in a 12-month period which cause a sheen. This report must include:

  (1) Name of the facility;
  (2) Name(s) of the owner or operator of the facility;
  (3) Location of the facility;
  (4) Date and year of initial facility operation;
  (5) Maximum storage or handling capacity of the facility and normal daily throughput;
  (6) Description of the facility, including maps; flow diagrams, and topographical maps;
  (7) A complete copy of the SPCC Plan with any amendments;
  (8) The cause(s) of such spill, including a failure analysis of system or sub-system in which the failure occurred;
  (9) The corrective actions and/or countermeasures taken, including an adequate description of equipment repairs and/or replacements;
  (10) Additional preventive measures taken or contemplated to minimize the possibility of recurrence;
  (11) Such other information as the Regional Administrator may reasonably require pertinent to the Plan or spill event.

TABLE 2-1  GOVERNMENT-REQUIRED WRITTEN REPORTS
Within 15 days after end of cleanup, a report must be submitted containing:

(1) Date and time of discharge
(2) Location of the discharge
(3) Person or persons causing or responsible for the discharge
(4) Type(s) and amount(s) of hazardous substance(s) discharged
(5) Cause(s) of the discharge
(6) Environmental damage caused by the discharge
(7) Cleanup actions undertaken
(8) Location and method of disposal of the hazardous substance and contaminated cleanup materials, including date of disposal
(9) Actions being taken to prevent recurrence of the discharge
(10) Other information ADEC requires in order to fully assess the cause and impact of the discharge
| EQUIP. NO. | DESCRIPTION | DATE/TIME IN | DATE/TIME OUT | AUTHORIZED USER | SIGNATURE | FUEL | OIL | GAS | REPAIRS | REQUIRED REPAIRS | D-Diesel | G-Gas | | | |
|-----------|-------------|--------------|---------------|----------------|------------|------|-----|-----|---------|-------------------|---------|-------| | | | | | |
3) Signature of person checking out equipment
4) Time and date checked out
5) Time and date returned
6) Condition of equipment
7) Fuel used
8) Required repairs when returned

2.3.5 Photography

As soon as possible after the initiation of the spill cleanup operation, arrangements will be made by the Documen-
tation Coordinator for a photographer to record the operation. As a minimum, 35 mm slides and prints (color and black and white) will be taken; however, the Operations Manager may also request TV tape and/or movies if he deems them necessary. Photographic documentation should include and not be limited to wide-angle pictures; aerial shots; land, beach, and ice closeups; and pictures of equipment, people, and operations. For each picture taken, the following information should be recorded:

- Location and reference to landmarks
- Date and time
- Names of photographer and any witnesses
- Description of photograph
- Shutter speed, lens opening, and film type
- Weather conditions and angle of sun

2.4 PUBLIC RELATIONS

Oil spills, particularly moderate and major ones, generate public interest and its attendant media coverage. This simple fact can present a great deal of difficulty for a spiller if he does not have a consistent public relations policy with strong procedures and a single spokesman to put the policy and procedures into action. The purpose of this section is to provide guidelines for use in dealing with public relations problems during a spill.
2.4.2 Public Relations Guidelines

Spokesman

The only persons authorized to speak with the news media regarding the spill cleanup operation are the Operations Manager and the Public Affairs Coordinator or his designated representatives. Any statement will be made only after approval of spiller company management. As soon as the operational organization is functioning, a statement will be issued advising all media representatives to contact the Public Affairs Coordinator. All members of the Response Team are to refer any inquiries from the news media or
public to the Public Affairs Coordinator and call him informing him of the inquiry. In addition, the team member receiving the inquiry will submit to the Public Affairs Coordinator a report on the Media Inquiry Form (Figure 2-8). The Public Affairs Coordinator fills in the "Action" section of the Media Inquiry Form. Depending on the situation, the Operations Manager may authorize supervisory personnel onsite or offsite to answer inquiries.

Press Releases

All press releases will be issued through the Public Affairs Coordinator and will be approved by the Operations Manager, the Legal/Insurance Coordinator, and spiller company management prior to release. It is very important that press releases accurately and succinctly explain to the public what has happened and what is being done about it. Press releases will not include speculations on the cause of the spill, responsibility, damage, or any other fact not properly determined by technically competent representatives of the spiller company management.

Appropriate information initially released to the media might include:

- Brief description of the events surrounding the spill.
- Amount of oil spilled (if accurately known)
MEDIA INQUIRY
FORM

DATE ____________________________
TIME ____________________________
CALLER __________________________
AFFILIATION _______________________
QUESTION/REQUEST ____________________________

ACTION ____________________________

Representative:

FIGURE 2-8 MEDIA INQUIRY FORM
• Agencies notified
• General types of countermeasures taken (men and equipment deployed)
• Special efforts to protect property or wildlife

Subsequent releases might explain the progress being made in terms of:
• Amount of oil recovered to date
• Specific techniques being employed
• Cooperation with government authorities
• Extent of contracted assistance
• Continued efforts to protect property or wildlife

It may be advisable to set up a recorded telephone message containing the above information and update it once or twice a day. Such a service could reduce the demand representatives of the media tend to make on the Public Affairs Coordinator's time.

Press Conferences and Briefings

At the outset of a spill cleanup operation, the Public Affairs Coordinator will generally hold a news conference as soon as possible. The first press release will normally be issued at this time, and reporters will be briefed on the procedures to be followed.

If the response of the media warrants it, the Public Affairs Coordinator will arrange for transportation and lodging for a group of newsmen to visit the site, but only

2-35
after approval by the Operations Manager and company management. Either the Public Affairs Coordinator or his designated assistant will accompany the group and chaperone them throughout their visit. From time to time, subsequent press briefings will be held to issue further press releases and to ensure that the media receives its information from one spokesman. At all times, media representatives are to be reminded that they should contact only the Public Affairs Coordinator and his designated assistants. Unless explicit permission is given by the Operations Manager, no members of the press are to interview other members of the cleanup operation either onsite or offsite.

**Coordination With Government Spokesmen**

As soon as possible at the start of the operation, the Public Affairs Coordinator and the Government Liaison Coordinator will contact the spokesmen for the state and federal on-scene representatives. Together, they will establish procedures for handling information dissemination to avoid the issuance of conflicting statements.
3. RESPONSE ACTION OUTLINE

3.1 INTRODUCTION

This section is designed to provide the user of this contingency plan with a reference guide to the decision-making necessary to conduct a spill response. The flowchart shown in Figure 3-1 on the next page gives a key to Section 3. Five flowcharts presented in Figures 3-2 through 3-6 in Section 3.2 represent the heart of the Response Action Outline:

<table>
<thead>
<tr>
<th>Figure No.</th>
<th>Flowchart</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-2</td>
<td>Initial Actions</td>
</tr>
<tr>
<td>3-3</td>
<td>Notification</td>
</tr>
<tr>
<td>3-4</td>
<td>Spill Evaluation</td>
</tr>
<tr>
<td>3-5</td>
<td>Response Planning</td>
</tr>
<tr>
<td>3-6</td>
<td>Response</td>
</tr>
</tbody>
</table>

Each flowchart details the decisions involved in that particular aspect of a spill response. These five flowcharts are supported by a series of figures which are referenced in the flowcharts and which are presented in order in Section 3.3, Supporting Figures.
3.2 DECISION FLOWCHARTS

The flowcharts shown on the following pages provide a step-by-step guide to the decisions and actions involved in mounting a successful oil spill cleanup operation. Where appropriate, these flowcharts reference the supporting figures in Section 3.3.

Below is the key to the flowcharting system used in the Response Action Outline.

- Action or Direction
- Other considerations
- Information/Data Source
- Decision
FIGURE 3-2  INITIAL ACTION
FIGURE 3-3  NOTIFICATION
Figure 3-4  Spill Evaluation

1. Initial Actions (Figure 3-2)
2. Notification (Figure 3-3)

- Assess Initial Actions
- Confirm Notification of Appropriate Government Agencies

3. Is Spill Stopped?
   - Yes
   - No

4. Can Onsite Personnel/Equipment Control Spill?
   - Yes
   - No (Minor Spill)

5. Activate Response Team

   - Use Fig. 3-9 to Conduct Preliminary Evaluation Based on Nature and Location of Spill
   - Expand Evaluation Process to Include Details on Oil Spill:
     * Movement and Dispersion
     * Evaporation/Degradation
     * Persistence
     * Impact

6. National Weather Service

7. Environmental Data
8. Fate & Effects
9. Trajectory Analysis
10. Coastline Sensitivity Analysis

Response Planning (Figure 3-5)
**FIGURE 3-6 RESPONSE**

**RESPONSE**

**PLANNING (FIGURE 3-5)**

**INITIATE RESPONSE ACTIVITIES**
- AERIAL/SURFACE SURVEILLANCE
- CONTAINMENT & RECOVERY
- SHORELINE PROTECTION
- STORAGE & DISPOSAL
- CHEMICAL DISPERSAL

**CONTINUE RESPONSE**

**MONITOR CLEANUP**

**IS MORE RESPONSE NECESSARY?**

**YES**

**NO**

**CONDUCT RESTORATION**

**CRITIQUE**

**DOCUMENT**

**CONDUCT BRIEFING WITH ONSITE & OFFSITE MANAGERS & SUPERVISORS**

**CONDUCT BRIEFING WITH COORDINATORS**

**BRIEF GOV'T REPRESENTATIVES AND PRESS AS NECESSARY; ARRANGE SITE VISITS AS SOON AS PRACTICAL**
3.3 SUPPORTING FIGURES

The illustrations presented in this section are designed to complement the five flowcharts in Section 3.2. They provide more detailed information that may be needed in making decisions indicated on the flowcharts.
The following equipment and supplies, located in the Deadhorse Area, may be used in an emergency:

A. High Pressure Pumps, Cement and Bulk Handling Equipment.
   1) Dowell                              Telephone 659-2434
   2) Halliburton                          Telephone 659-2492

B. Mud and Weight Materials
   1) IMCO Service                        Telephone 659-2492

C. Oilfield Trucks, Floats, Tank Trucks, Vacuum Trucks, etc.
   1) Mukluk Freight Lines               Telephone 659-2686
   2) Kodiak Oilfield Haulers "          Telephone 659-2648

D. Construction Equipment - Dozers, Fork Lifts, Scrapers, Dump Trucks, Front End Loaders, Water Trucks, Belly Dumps, etc.
   1) Frontier Rock and Sand/Telephone   659-2565
   2) Kodiak Oilfield Haulers "          659-2648
   3) Alaska General Const. Co "         659-2445
   4) S. & G Construction
      (Equipment on remote North Slope Welsite) Telephone 272-4512

E. Helicopter and Air Transportation
   1) ERA Avionics                        Telephone 659-2465
   2) Sea Airmotive                      Telephone 659-2646

F. General - BP Alaska and ARCO have large stockpiles of materials and equipment that they will make available for emergencies.
   1) BP Alaska                          Telephone 659-2662
   2) ARCO                              Telephone 659-3106

NOTE: These are Deadhorse telephone exchange telephone numbers with the 659 prefix.
INITIAL REPORT FORM

I. SPILL DATA

TIME OF CALL __________________________ DATE __________________________
PERSON REPORTING SPILL ____________________________________________
AFFILIATION ________________________________________________________
(Specify) Company ____________________________________________________
Government Agency _________________________________________________
SPILL LOCATION ________ TYPE OF OIL ________ EST. GRAVITY ________
SPILL SOURCE (Blowout, Tank rupture, etc.) ____________________________
VOLUME/FLOWRATE ______________ FLOW STOPPED? □ Yes □ No
___________________________________________________________________

ACTIONS TAKEN (Briefly):
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

EQUIPMENT DEPLOYED (Major Pieces):
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

AGENCIES NOTIFIED

II. ENVIRONMENTAL CONDITIONS AT SITE

WIND (Speed & Direction) __________________________
TEMPERATURE ____________ VISIBILITY ____________
ICE CONDITIONS ____________
SEA STATE __________________
ENVIRONMENTAL DAMAGE (Real or Potential) __________________________

3-10
### INITIAL REPORT FORM

**III. INVOLVEMENT**

**EQUIPMENT REQUESTED** (Specify quantity of each)

<table>
<thead>
<tr>
<th>Facilities</th>
<th>Transfer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office Equipment</td>
<td>Arctic Hose &amp; Fittings</td>
</tr>
<tr>
<td>Warehouse Equipment</td>
<td>Pump (Viscous)</td>
</tr>
<tr>
<td>Miscellaneous Tools &amp; Equip.</td>
<td>Pump (Diaphragm)</td>
</tr>
<tr>
<td>Field Command Post</td>
<td>Pump (Centrifugal)</td>
</tr>
<tr>
<td>Field Camp</td>
<td>Trans-Vac System</td>
</tr>
</tbody>
</table>

**Transportation**

<table>
<thead>
<tr>
<th>Workboat</th>
<th>Disposal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jon Boat</td>
<td>Igniters</td>
</tr>
<tr>
<td></td>
<td>Burner</td>
</tr>
<tr>
<td></td>
<td>Incinerator</td>
</tr>
<tr>
<td></td>
<td>Dispersant</td>
</tr>
<tr>
<td></td>
<td>Dispersant Boat Equip.</td>
</tr>
</tbody>
</table>

**Detection**

<table>
<thead>
<tr>
<th>Gas Detector</th>
<th>Logistical Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Meter</td>
<td>Radios</td>
</tr>
<tr>
<td>Ice Auger</td>
<td>Communications Trailer</td>
</tr>
<tr>
<td></td>
<td>Bird Rehab. Equip.</td>
</tr>
<tr>
<td></td>
<td>Bird Scarer &amp; Float</td>
</tr>
<tr>
<td></td>
<td>Generator</td>
</tr>
<tr>
<td></td>
<td>Auxillary Lighting System</td>
</tr>
<tr>
<td></td>
<td>Air Compressor</td>
</tr>
<tr>
<td></td>
<td>Heater</td>
</tr>
<tr>
<td></td>
<td>First-Aid Equipment</td>
</tr>
<tr>
<td></td>
<td>Chain Saw</td>
</tr>
<tr>
<td></td>
<td>Flotation Suit/Life Vest</td>
</tr>
<tr>
<td></td>
<td>Arctic Clothing &amp; Equip.</td>
</tr>
<tr>
<td></td>
<td>Field Response Kits w/ hand tools</td>
</tr>
<tr>
<td></td>
<td>Welder's Tent</td>
</tr>
</tbody>
</table>

**Containment**

| Heavy-Duty Containment Boom                    |                                              |
| Compactible Containment Boom                   |                                              |
| Boom Accessories                               |                                              |

**Recovery**

| Rope Mop Skimmer                               |                                              |
| Vessel Skimmer                                 |                                              |
| Portable Weir-Type Skimmer                    |                                              |
| Sorbents                                       |                                              |

**Storage**

| Portable Containment Device                    |                                              |
| Towable Bladder                                |                                              |
| Bladder Tank                                   |                                              |

**RESPONSE TEAM** (Specify Members Requested)

- OPERATIONS MANAGER
- LOGISTICS SUPERVISOR
- Communications Coordinator
- Manpower Coordinator
- Equipment/Materials Coord.
- Transportation Coordinator
- Food/Housing Coordinator
- TECHNICAL SUPERVISOR
- Environmental Coordinator
- Safety Coordinator
- Engineering Coordinator

- SUPPORT SERVICES SUPERVISOR
- Documentation Coordinator
- Government Liaison Coord.
- Security Coordinator
- Accounting Coordinator
- Legal/Insurance Coordinator
- Public Affairs Coordinator
- CLEANUP SUPERVISOR
- Containment Coordinator
- Recovery Coordinator
- Storage/Transfer Coord.
- Disposal Coordinator
- Dispersal Coordinator

* Most likely to be mobilized
<table>
<thead>
<tr>
<th>SPILL LOCATION</th>
<th>U.S. COAST GUARD</th>
<th>U.S. ENVIRONMENTAL PROTECTION AGENCY</th>
<th>U.S. GEOLOGICAL SURVEY</th>
<th>AK DEPT. OF ENVIRONMENTAL CONSERVATION</th>
<th>AK OIL &amp; GAS CONSERVATION COMMISSION</th>
</tr>
</thead>
<tbody>
<tr>
<td>ON LAND ONLY</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ON LAND BUT THREATENING OR INLAND SURFACE WATER</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ON WATER (Within 3-nautical-mile limit)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ON WATER (Between 3- and 200-nautical-mile limit)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- ✓ = NOTIFICATION REQUIRED

1/If oil is from a well on a federal oil lease
2/If oil is from a well on a state oil lease
<table>
<thead>
<tr>
<th>AGENCY</th>
<th>SPILL SIZE</th>
<th>VERBAL REPORT</th>
<th>PHONE NUMBER</th>
<th>WRITTEN REPORT</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S. COAST GUARD</td>
<td>All Spills</td>
<td>Immediately</td>
<td>(211) ZENITH 9355 or 271-5137</td>
<td>Recommended but not required</td>
</tr>
<tr>
<td>U.S. ENVIRONMENTAL PROTECTION AGENCY</td>
<td>All Spills</td>
<td>Immediately</td>
<td>(211) ZENITH 5555 or 271-5083 (Days) 344-9327 (Nights)</td>
<td>For facility requiring SPCC Plan if spill is &gt; 1000 gallons or if spill is second spill in 12 months</td>
</tr>
<tr>
<td>U.S. GEOLOGICAL SURVEY</td>
<td>&gt; 1 cu. meter (6.3bbl)</td>
<td>Immediately</td>
<td>271-6348 (Days)</td>
<td>All spills (Form 9-1880)</td>
</tr>
<tr>
<td></td>
<td>&lt; 1 cu. meter (6.3bbl)</td>
<td>Within 12 hours</td>
<td>271-6303 (Nights)</td>
<td></td>
</tr>
<tr>
<td>AK DEPT. OF ENVIRONMENTAL CONSERVATION</td>
<td>Water</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt; 55 gal or 1000 sq. ft. sheen</td>
<td>Immediately</td>
<td>(211) ZENITH 9300 or 452-1714 (Fairbanks)</td>
<td>Within 15 days of end of cleanup operation</td>
</tr>
<tr>
<td></td>
<td>Hazardous material other than oil</td>
<td>Immediately</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&lt; .5 pt or &lt; 100 sq. ft.</td>
<td>7 days</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>All other water spills</td>
<td>24 hours</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Land</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt; 55 gal</td>
<td>5 hours</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>10 to 55 gal</td>
<td>24 hours</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&lt; 10 gal</td>
<td>7 days</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Any other hazardous material</td>
<td>Immediately</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OIL &amp; GAS CONSERVATION COMM.</td>
<td>All Spills</td>
<td>Immediately</td>
<td>279-1433</td>
<td>Within 5 days of spill report</td>
</tr>
</tbody>
</table>

*See Section 2.3.3 for details of report requirements.

FIGURE 3-8 (Cont'd) GOVERNMENT NOTIFICATION REQUIREMENTS FOR SPILLS IN THE BEAUFORT LEASE SALE AREA
<table>
<thead>
<tr>
<th>PRELIMINARY RESPONSE ACTIVITY</th>
<th>BLOCKOUT</th>
<th>TRANSPORTATION SPILL (Barges &amp; Tank Trucks)</th>
<th>STORAGE SPILL</th>
<th>MINOR OPERATIONAL SPILL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OFFSHORE</td>
<td>ONSHORE</td>
<td>OFFSHORE</td>
<td>ONSHORE</td>
</tr>
<tr>
<td>Surface Well Control</td>
<td>★</td>
<td>★</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relief Well</td>
<td>★</td>
<td>★</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface Reconnaissance</td>
<td>★</td>
<td>★</td>
<td>★</td>
<td>★</td>
</tr>
<tr>
<td>Aerial Reconnaissance</td>
<td>★</td>
<td>★</td>
<td>★</td>
<td>★</td>
</tr>
<tr>
<td>ABORES Manager Support</td>
<td>★</td>
<td>★</td>
<td>★</td>
<td>★</td>
</tr>
<tr>
<td>Spiller Company Personnel</td>
<td>★</td>
<td>★</td>
<td>★</td>
<td>★</td>
</tr>
<tr>
<td>Other ABORES Member Support</td>
<td></td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contractor Support</td>
<td></td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Customs Support</td>
<td></td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spiller Company Equipment</td>
<td>★</td>
<td>★</td>
<td>★</td>
<td>★</td>
</tr>
<tr>
<td>ABORES Equipment</td>
<td>★</td>
<td>★</td>
<td>★</td>
<td>★</td>
</tr>
<tr>
<td>Other ABORES Member Equipment</td>
<td></td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contractor Equipment</td>
<td></td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Military Personnel &amp; Equipment</td>
<td></td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canadian Personnel &amp; Equipment</td>
<td></td>
<td>-</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**KEY**

<table>
<thead>
<tr>
<th>ACTIVATION LEVELS</th>
<th>★ - HIGHEST</th>
<th>★ - HIGH</th>
<th>★ - MODERATE</th>
<th>★ - LOW</th>
<th>★ - LOWEST</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personnel</td>
<td>Activate as soon as possible</td>
<td>Key personnel and field supervisors report immediately for briefings; backup crews on alert</td>
<td>Key personnel on alert</td>
<td></td>
<td>Not applicable or delay response</td>
</tr>
<tr>
<td>Equipment</td>
<td>Mobilize support equipment as soon as possible</td>
<td>Major and minor response equipment and all logistical support readily for immediate mobilization</td>
<td>Minor response equipment and light logistical support readily for mobilization</td>
<td>Equipment/material availability confirmed; storage and staging areas identified and prepared</td>
<td>Not applicable or delay response</td>
</tr>
</tbody>
</table>

**FIGURE 3-9** RESPONSE ACTIVATION LEVELS (ASSUMING ONSITE PERSONNEL/EQUIPMENT CANNOT HANDLE SPILL)
<table>
<thead>
<tr>
<th>Operating Environment</th>
<th>Water</th>
<th>Beach</th>
<th>Dry Land</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BROKEN ICE (% Coverage)</td>
<td>SOLID ICE Oil Located:</td>
<td>ICE FREE</td>
</tr>
<tr>
<td></td>
<td>ICE FREE</td>
<td>&lt;25</td>
<td>25 - 50</td>
</tr>
<tr>
<td>Spill Control Technique</td>
<td>Conventional Booming</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ice Deflect/Filter Booming</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ice Subsurface Barriers</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bottom-Anchored Barriers</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ice/Snow Surface Barriers</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bubble Barriers</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chemical Collectants</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Surface Spraying</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Land Surface Modifications</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Containment</td>
<td>Vessel-Mounted Skimmers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recovery</td>
<td>Portable Skimmers</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Direct Pumping</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mechanical Removal</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sorbents</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>In-Situ Burning</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Onsite Incineration</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Offsite Incineration</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Onshore Disposal Pits</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disposal</td>
<td>Chemical Dispersants</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**FIGURE 3-10** APPLICABILITY OF MAJOR CLEANUP TECHNIQUES

- ☑ Applicability - Good
- ☑ Applicability - Fair/Limited
- ☑ Applicability - Has Potential
<table>
<thead>
<tr>
<th>Method</th>
<th>Rock</th>
<th>Man-Made</th>
<th>Mud</th>
<th>Sand</th>
<th>Pebble</th>
<th>Cobble</th>
<th>Boulder</th>
<th>Mixed Sediment</th>
<th>Marsh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beach-Cleaning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Burning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manual Digging</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manual Removal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sump/Pump</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clamshell/Dragline</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bulldozer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Front-End Loader</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grader/Scraper</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mixing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low-Pressure Hoses</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sand Blasting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Steam Cleaning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High-Pressure Hoses</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chemical Dispersants</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Owens, 1977

FIGURE 3-11

SHORELINE PROTECTION CONSIDERATIONS
Method/Equipment for Cleanup of Sand and Gravel Beaches

<table>
<thead>
<tr>
<th>SIZE OF AREA</th>
<th>TYPE OF OIL</th>
<th>DEPTH OF PENETRATION</th>
<th>TYPES OF BEACHES</th>
</tr>
</thead>
<tbody>
<tr>
<td>LARGE</td>
<td>HEAVY</td>
<td>SHALLOW, 1cm to 2.5cm</td>
<td>GRADER and ES or FFL</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MODERATE, 2.5cm to 25cm</td>
<td>GRADER and ES or FFL</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DEEP, 25cm+</td>
<td>WFEL*</td>
</tr>
<tr>
<td></td>
<td>LIGHT</td>
<td>--</td>
<td>BEACH CLEANING MACHINES</td>
</tr>
<tr>
<td>SMALL</td>
<td>HEAVY</td>
<td>--</td>
<td>MANUAL REMOVAL OR WFEL*</td>
</tr>
<tr>
<td></td>
<td>LIGHT</td>
<td>--</td>
<td>MANUAL REMOVAL, RAKE</td>
</tr>
</tbody>
</table>

ES - Elevating Scraper
WFEL* - Wheeled Front-end Loader, firm gr. only
FFL - Forced Feed Loader
Tracked front-loader for low bearing cap. soils

Source: Sartor and Foget, 1970
<table>
<thead>
<tr>
<th>EVENT</th>
<th>Probability of Occurrence</th>
<th>Low</th>
<th>Moderate</th>
<th>High</th>
<th>NATURE OF INFLUENCE ON CLEANUP OPERATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extreme Low Temperatures</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Reduced personnel exposure times and working efficiency; difficulty starting equipment; materials subject to fatigue and failure; viscosity of oil increases; rapid ice buildup.</td>
</tr>
<tr>
<td>Strong Winds</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Reduced visibility from blowing snow and dust; ACVs and helicopters severely restricted; increased chill factor and chances for frostbite and hypothermia; ice buildup with spray; movement of oil slicks.</td>
</tr>
<tr>
<td>Low Visibility</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Nearly all transportation and field cleanup activities halted.</td>
</tr>
<tr>
<td>Ice Over-Ride</td>
<td>Land Fast</td>
<td></td>
<td></td>
<td></td>
<td>Drilling and field response activities temporarily halted; beach cleanup limited, if not stopped; access to contaminated shorelines prevented.</td>
</tr>
<tr>
<td>Storm Surge</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Strong wind and ice over-ride influences produced (above); high water and low water extremes occur, increasing oil contact zones; beach and offshore cleanup temporarily halted; moderate waves produced.</td>
</tr>
<tr>
<td>Ice Deformation</td>
<td>Pack Ice</td>
<td></td>
<td></td>
<td></td>
<td>Vehicle traffic over ice restricted; ACV movements possibly limited; relocation of offshore support camps and cleanup activity necessitated; airstrips and ice barriers destroyed; oil movement altered.</td>
</tr>
<tr>
<td>Ice Separation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ice traffic seriously curtailed; transport limited to helicopters; relocation and eventual termination of offshore support camps and cleanup activity necessitated; most barriers destroyed; under-ice oil exposed.</td>
</tr>
<tr>
<td>Ice Surface Flooding</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Traffic seriously impeded off major river deltas because of inches to feet of water over ice; ice breakup processes accelerated; oil lifted from on and under ice and free to move.</td>
</tr>
<tr>
<td>Heavy Broken Ice Field</td>
<td></td>
<td></td>
<td>Remote Poss.</td>
<td></td>
<td>All offshore surface traffic halted except for large vessels with ice-strengthened hulls; air traffic by helicopter only; no oil recovery until ice concentrations well below 50% coverage.</td>
</tr>
<tr>
<td>Earthquake</td>
<td></td>
<td></td>
<td>Remote Poss.</td>
<td></td>
<td>No recorded earthquakes to date.</td>
</tr>
</tbody>
</table>

**FIGURE 3-12** EXTREME ENVIRONMENTAL FACTORS
**Source:** Crowley Environmental Services Corp., 1978

**FIGURE 3-15** VOLUMETRIC CHARACTERISTICS OF A VARIETY OF OIL SPILLS AFTER ACHIEVING A RELATIVELY STABLE CONDITION
Source: Sohio-Alaska Petroleum Co., 1980

FIGURE 3-17: EVAPORATION AFTER 4 TO 8 HOURS FOR DIESEL AND CRUDE SPILLED ON WATER AND LAND
Figure 3-18: Viscosity of Prudhoe Bay Crude Oil versus Temperature

Source: Deslauriers et al., 1979
FIGURE 3-19  OIL CONTENT IN SNOW (PERCENT VOLUME AFTER SAMPLE MELTS)

Source: Allen, 1979
REFERENCES

SECTION 3


August 3, 1981

TO: ABSORB Member Company Representatives
    Technical Subcommittee Members
    Chairman - Legal Subcommittee
    Chairman - Accounting Subcommittee
    Chairman - Communications Subcommittee

FROM: Al Allen, ABSORB Manager

SUBJECT: Update on ABSORB State of Readiness

The following information is provided to assist you in developing site-specific spill contingency plans for the Beaufort Sea and in dealing with questions and/or concerns from government agencies regarding ABSORB's operational readiness.

CONTINGENCY PLAN

ABSORB's Oil Spill Contingency Plan has undergone an extensive review since its release in July, 1980. This review has resulted in a set of three revision packages. The first package, covering a few changes in wording and phone numbers, etc., was mailed to all plan holders on July 10, 1981. The second revision package, covering equipment specifications, site restoration, communications network, government agencies, personnel job descriptions and minor wording changes will be mailed within a few days of the completion of our annual meeting (August 18/19, 1981). This second mailing will include the names and phone numbers of the officers of ABSORB's Executive Committee for the remainder of 1981 and for the new fiscal year, 1982.

A third package of revisions is being planned for a November/December, 1981 mailout providing substantially new information on our training programs, sensitivity atlas and equipment/services resource inventory and retrieval system.

FIELD MANUAL (or HANDBOOK)

ABSORB is currently developing an Oil Spill Contingency Field Manual (or Handbook) with assistance from Crowley Environmental
August 3, 1981
Page 2

Services, Anchorage. The field manual will be a condensed version of several chapters out of the larger ABSORB Oil Spill Contingency Plan. It will be a loose-leaf notebook approximately (6 1/2" by 9") prepared for use by operational personnel in the field.

This field manual will be prepared in a style and format to facilitate a simple conversion of the manual to a site-specific document for use by any of ABSORB's member companies. While serving as a useful field-oriented, mini-contingency plan for the ABSORB Response Team (ART), the manual will be easily converted, as necessary, for site-specific offshore drilling operations. The planning and preparation of the manual has been coordinated with Federal and State agencies to insure its adequacy in meeting all regulatory concerns.

FACILITIES

Anchorage - The ABSORB headquarters will relocate on or about September 1, 1981 from 6700 Arctic Spur Road to 201 Danner Avenue, Suite 170. The Cook Inlet Response Organization (CIRO) and Gulf of Alaska Cleanup Organization (GOACO) headquarters will also move to the same location. All existing telephone numbers should remain in effect.

The ABSORB warehouse in Anchorage (4,600 sq.ft.) is located at 525 Potter, Bay #1, and is currently used in receiving and preparing equipment for shipment to the North Slope warehouse, and for storing certain backup resources such as sorbents, containment boom and a complete bird rehabilitation center. These materials can be moved quickly to the slope or any other area of need upon demand.

North Slope - The ABSORB warehouse at Prudhoe Bay (10,800 sq.ft.) was completed in April 1981. The warehouse is located on Spine Road, next to the VECO camp and construction facilities, mid-way between the Deadhorse Airport and the ARCO airstrip. The warehouse contains wood and metal workshops, storage bins and racks, dispatch office, and a large room for training or for onshore support functions during an actual spill. The building together with approximately two acres of gravel pad, is capable of holding the entire inventory of ABSORB's oil spill response equipment, materials and support vehicles/vessels.
ABSORB's 20-man Herc-able camp, capable of supporting 20 to 40 personnel at a remote location if desired, is presently being set up next to the North Slope warehouse. The camp will be used for lodging warehouse personnel and instructors, and for a potential R & D program out on the ice this winter. The camp is connected by detachable walkways to our warehouse and to two equally mobile modules comprising our Command and Communications Center and a Government Liaison/Debriefing Room.

**EQUIPMENT**

As of August 1, 1981, approximately 95% of ABSORB's oil spill equipment inventory was in place at the North Slope warehouse, or enroute to arrive at Prudhoe Bay within a few days. The remaining portion of ABSORB's planned fiscal year 1981 equipment acquisitions will be in place by November, 1981. Additional equipment and materials have since been identified, and pending approval of the new budget for the rest of 1981 (September - December) and all of 1982, these items will be acquired and on board by June 1, 1982.

A list of our response equipment and materials, along with dates to be in place, has been attached for your review and use as desired.

**TRAINING SCHEDULE**

On July 27, 1981, I sent a complete breakdown of our planned training schedule to each of the recipients of this memo. As indicated, approximately ten separate training activities are planned between now and mid-November.
## ABSORB
### SPILL CLEANUP EQUIPMENT
*(in place or enroute to Slope)*

<table>
<thead>
<tr>
<th>QUANTITY</th>
<th>DESCRIPTION</th>
<th>AUG 1</th>
<th>NOV 1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FACILITIES</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>--</td>
<td>Major warehouse equipment</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>--</td>
<td>20-man camp</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>--</td>
<td>Anchorage warehouse <em>(leased)</em></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>--</td>
<td>Prudhoe Bay warehouse <em>(leased)</em></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td><strong>VESSELS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 ea</td>
<td>32' workboat</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>1 ea</td>
<td>16' jon boat w/25hp motor and trailer</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td><strong>VEHICLES</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 ea</td>
<td>18' 6-ton van truck <em>(4 wheel drive)</em></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>2 ea</td>
<td>Snow machines &amp; sleds</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td><strong>DETECTION</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 ea</td>
<td>Current meter <em>(handheld)</em></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>1 ea</td>
<td>Current meter <em>(self-recording)</em></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>7 ea</td>
<td>Ice augers</td>
<td>X (2)</td>
<td>X (5)</td>
</tr>
<tr>
<td>3 ea</td>
<td>Vapor analyzers</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td><strong>CONTAINMENT EQUIPMENT</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2035'</td>
<td>Goodyear Sea Sentry boom</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>1000'</td>
<td>Kepner Reel Pak boom <em>(on two separate 500' reels)</em></td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>
CONTAINMENT EQUIPMENT (cont'd)

<table>
<thead>
<tr>
<th>QUANTITY</th>
<th>DESCRIPTION</th>
<th>AUG</th>
<th>NOV</th>
</tr>
</thead>
<tbody>
<tr>
<td>2700'</td>
<td>Ocean Dike containment boom</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>900'</td>
<td>Mini boom</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>1000'</td>
<td>American Marine Simplex oil boom</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

An additional 10,000 to 15,000 feet of boom will be purchased following open water test and evaluation activities this summer. The additional boom should be on board by June, 1982.

OIL RECOVERY EQUIPMENT

<table>
<thead>
<tr>
<th>QUANTITY</th>
<th>DESCRIPTION</th>
<th>AUG</th>
<th>NOV</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 ea</td>
<td>SLURP portable weir skimmers</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Under-Review) Rope Mop skimmers (small)</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>10,000'</td>
<td>3M type 280 sorbent boom</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>457 rolls</td>
<td>3M type 100 sorbent rolls</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>197 bales</td>
<td>3M type 157 sorbent</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>100 bales</td>
<td>3M type 151 sorbent</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

Rop Mop and disc-type skimmers of various types and configurations are currently under review, and planned for purchase this summer. These additional recovery capabilities will be ready for use prior to breakup, 1982.
<table>
<thead>
<tr>
<th>QUANTITY</th>
<th>DESCRIPTION</th>
<th>AUG 1</th>
<th>NOV 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>STORAGE EQUIPMENT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 ea</td>
<td>1000 gallon air berm storage containers</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>2 ea</td>
<td>2000 gallon air berm storage containers</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>2 ea</td>
<td>3000 gallon air berm storage containers</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>20 ea</td>
<td>Firestone Fabritank 2250 gallon bladders</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>4 ea</td>
<td>Firestone Fabritank 4400 gallon bladders</td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

Dracone barges (500 bbl class) are currently under review and will likely be purchased within the next 6 months.

TRANSFER EQUIPMENT

<table>
<thead>
<tr>
<th>LENGTH</th>
<th>DESCRIPTION</th>
<th>AUG 1</th>
<th>NOV 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1620'</td>
<td>2&quot; B. F. Goodrich suction hose w/fittings</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>4020'</td>
<td>3&quot; B.F. Goodrich suction hose w/fittings</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>10 ea</td>
<td>2&quot; Multiquip QP20T self-priming trash pumps</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>10 ea</td>
<td>3&quot; Multiquip QPD302 diaphragm pump</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>2 ea</td>
<td>Slickbar Trans-Vac, skid-mounted vacuum units w/skimmer heads</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>QUANTITY</td>
<td>DESCRIPTION</td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------</td>
<td>-------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Communication system with value of $255,000, including:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 ea</td>
<td>G. E. Porta Mobil II UHF &amp; VHF X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 ea</td>
<td>G. E. Master II Mobil UHF &amp; VHF X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20 ea</td>
<td>Motorola MX 360 UHF X(5) X(15)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 ea</td>
<td>Motorola MX 360 VHF X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 ea</td>
<td>G. E. Deskon II base controller X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 ea</td>
<td>G. E. Mastr II UH &amp; VHF repeaters X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 ea</td>
<td>Comco 731 air to ground X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 ea</td>
<td>Motorola Micom-Consolette single sideband H. F. tranceiver X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 ea</td>
<td>Motorola VHF marine X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 ea</td>
<td>G. E. Mastr II VHF X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 ea</td>
<td>40 kw diesel generator and housing X</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bird rehabilitation center X(partial) X(complete)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16 ea</td>
<td>Bird scare-away cannons &amp; floats X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 ea</td>
<td>1.5 kw Homelite generator/(gas) X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 ea</td>
<td>Pincor 3.0 kw generators/(gas) X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 ea</td>
<td>Pincor 5.0 kw generators/(gas) X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 ea</td>
<td>Pincor 8.5 kw generators/(gas) X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 ea</td>
<td>Pincor 13.0 kw generator/(diesel) X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 ea</td>
<td>TPA500-4 tripod lights w/4 Tungsten halogen flood lights X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 ea</td>
<td>100,000 btu direct-fired space heater X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>QUANTITY</td>
<td>DESCRIPTION</td>
<td>AUG '81</td>
<td>NOV '81</td>
</tr>
<tr>
<td>----------</td>
<td>-----------------------------------------------------------------------------</td>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td><strong>LOGISTICAL SUPPORT (cont'd)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 ea</td>
<td>150,000 btu direct-fired space heaters</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>2 ea</td>
<td>320,000 btu direct-fired space heaters</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>3 ea</td>
<td>Chain saws, 2 w/36&quot; bars; 1 w/7&quot; bar</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>10 ea</td>
<td>Response boxes</td>
<td>X(partial)</td>
<td>X(complete)</td>
</tr>
<tr>
<td></td>
<td>Small hand tools</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Personnel protection gear</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Miscellaneous supplies-beach cleanup</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 ea</td>
<td>Weatherport shelters 12'x20' insulated</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>60 ea</td>
<td>Life vests (Gentex Comfort King)</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>60 ea</td>
<td>Mustang U-VIC jackets</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>4 sets</td>
<td>Arctic clothing and survival equipment</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td><strong>OIL DISPOSAL EQUIPMENT</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 drums</td>
<td>Dispersant (Corexit 9527)</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>10 drums</td>
<td>Dispersant (ARCO-chem)</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>(Under-</td>
<td>Ignitors (for in-situ burning of oil)</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Review)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
A majority of the above resources are now owned or will soon be purchased by ABSORB. A small portion of ABSORB's equipment resources, however, has been, and will continue to be, leased. The following resources will likely remain in a lease-as-needed mode:

- Additional crew cabs and pickup trucks
- Special airborne oil detection sensors
- Aircraft, all-terrain vehicles, tribikes, etc.
- Additional workboats, tugs, barges, etc.
- Special ice harvesters & melters
- Aerial dispersant equipment/aircraft

Additional items may be placed into ABSORB's inventory under long-term lease agreements or other immediate-access arrangements. Such items include:

- Large storage barges
- Onshore emergency pipeline systems for waste oil transport
- Onshore storage tanks
- Flaring systems and waste oil incinerators
July 27, 1981

TO:  
ABSORB Member Company Representatives  
ABSORB Technical Subcommittee  
Chairman, Legal Subcommittee  
Chairman, Accounting Subcommittee  
Chairman, Communications Subcommittee  
Loren Gordon, Manager, Cook Inlet Response Organization  
Budd Bernhardt, Manager, Gulf of Alaska Cleanup Organization

FROM:  Al Allen, ABSORB Manager

SUBJECT:  Training Program - Summer/Fall, 1981

This year two 3-day Oil Spill Control Schools and a 1-day Dispersants Seminar have already been completed. These activities were classroom oriented and rather general in terms of the topics covered. In addition we held several R & D/training sessions on the ice as we concluded our in-house Oil & Ice research off West Dock. Representatives from the Technical Subcommittee, local contractors, the University of Alaska, Federal and State agencies, and the North Slope Borough took part in these exercises.

As you know, ABSORB's North Slope Warehouse has now been completed; our 20-man camp is presently being positioned next to the camp; and most of our spill response equipment is in place. We are now prepared to begin a series of oil spill training schools geared specifically to the kinds of hardware/techniques we will be dealing with in the Beaufort Sea. Some of these schools will still require a substantial amount of classroom instruction; however, every effort will be made to provide hands-on experience at the warehouse and in the field.
July 27, 1981
Page 2

The training schools envisioned for the remainder of 1981 will fall into two basic categories:

1. **ABSORB Sponsored** — Those provided as a portion of ABSORB's normal on-going training program (Appendix C, ABSORB Oil Spill Contingency Plan).

2. **Operator Sponsored** — Those requested, attended and funded by specific operating companies within ABSORB to meet their in-house training requirements. This latter category will involve reimbursement to ABSORB for all costs incurred in preparing training materials and in conducting any field exercises.

The first category, open to participants from any member company, will involve training schools which are modular in nature, providing detailed, in-depth experience in the following areas:

1. Open Water Response (surveillance, containment, recovery, transfer, storage and disposal).

2. Shoreline Response (surveillance, containment, recovery, transfer, storage and disposal).

3. Solid and Broken Ice Response (surveillance, containment, recovery, transfer, storage and disposal).

4. Dispersant Application (basic chemistry, regulations, fate & behavior, biological effects, application techniques).

5. Burning Techniques (safety, physics/chemistry of oil and combustion processes, materials/equipment handling, ignition systems).

6. Operations Management (government liaison, regulations, P. R., Logistics, technical support services, environmental and spill cleanup techniques).

7. Support Services (documentation, accounting, security, legal, insurance, public affairs).
July 27, 1981

Page 3

8. Logistics (communications, manpower, equipment, material, transportation, food/housing, safety, engineering).


The second category, the need for which was requested by Exxon and approved by the Executive Committee, will typically involve 2-day schools at the ABSORB warehouse. It was agreed that only participants approved by the sponsoring operator company would be permitted to attend, and the school would be geared heavily toward the kinds of spills that could conceivably occur at the operator's specific drillsite. Typically, one day would be spent in the classroom while the second day would be devoted to hands-on work in the warehouse and/or the field.

It should be recognized that while only Exxon has requested training of its drillsite personnel in such operator-oriented schools, the Alaska Department of Environmental Conservation has specified that all offshore operators will be expected to provide such training for its drillsite supervisors. Should ABSORB be requested to coordinate individual operator-sponsored schools for each potential operating company this year, there would likely be an insufficient number of days to conduct all of the training schools needed. For this reason I am suggesting that 2 or 3 operating companies may wish to sponsor joint training sessions and share the costs. In any event, instruction during this latter school would include such topics as:

1. Organization, Authority, and Responsibilities of the Spill Response Team.

2. Fate and Behavior of Oil.

3. Equipment Sources and Availability.

4. Equipment Use, Advantages and Limitations.

5. Equipment Operation, Maintenance and Support.

6. Familiarization (hands-on experience) with the ABSORB-Owned Equipment.
July 27, 1981
Page 4

It is very difficult to plan specific dates for the many training activities anticipated over the next few months because of uncertainties involving vessel availability, contractor/instructor availability, weather, etc. In addition, we will undoubtedly be requested to consider special operator-oriented schools for other member companies. Many participants have also expressed conflict periods, some of which overlap, thereby creating definite scheduling problems. I have therefore attempted to create a schedule that minimizes conflicts while permitting an efficient blend of school types and open-water experience prior to freeze-up (schedule attached). Some of the operator-sponsored training sessions (unrequested at this date) will undoubtedly have to shift into the late fall or be conducted jointly as suggested above.

After reviewing the attached Training Schedule, please determine the number of individuals your company will likely send to each of the training sessions. We would like to have the number of participants called in to the ABSORB office by August 15, 1981. If possible we would also appreciate the name, title and home office location of each participant. Participants for the Shoreline Response Workshop (No.5) must be identified by name by August 15th as we will want to fill every available space in the helicopters.

In all cases, participants should arrange for their own transportation to/from the slope, food & lodging, hip boots and all foul weather clothing. All participants should arrive at the slope no later than the night preceding the school, be at the ABSORB warehouse (next to VECO) by 8:00 a.m., and plan to be available each day of each exercise until 6:00 p.m.. Bag lunches should be brought each day -- extra lunches can be arranged through VECO. Please do not hesitate to call any of the ABSORB personnel if you have any questions about these training exercises.

ABSORB Office (Anchorage) (907) 349-6491
ABSORB Warehouse (Anchorage) (907) 279-9033
ABSORB Warehouse (Slope) (907) 659-2405
## ABSORB
### TRAINING SCHEDULE
(Summer/Fall 1981)

<table>
<thead>
<tr>
<th>Date</th>
<th>Activity</th>
<th>Participants *</th>
</tr>
</thead>
<tbody>
<tr>
<td>July 27</td>
<td><strong>Kepner Boom-Field Test &amp; Evaluation</strong></td>
<td>Staff &amp; Contractors</td>
</tr>
<tr>
<td></td>
<td>Deployment and recovery of Kepner Reel-Pack system at East Dock. Towing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>of boom in U-configuration with tensiometers.</td>
<td></td>
</tr>
<tr>
<td>Aug. 3</td>
<td><strong>Instructors Workshop</strong></td>
<td>Staff, Contractors &amp; Member Company Personnel</td>
</tr>
<tr>
<td></td>
<td>Instruction techniques, materials preparation, audience control,</td>
<td>(Most candidate instructors have been notified already)</td>
</tr>
<tr>
<td></td>
<td>preparation of visuals, etc., Begin at 8 a.m. in Exxon Conference Room,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Calais II Bldg. Adjourn by 4:00 p.m..</td>
<td></td>
</tr>
<tr>
<td>Aug 4-14</td>
<td><strong>Equipment Test &amp; Evaluation</strong> (General Shakedown)</td>
<td>Staff &amp; Contractors (To be scheduled around other activity on the slope -- member personnel may request last-minute notification if desired).</td>
</tr>
<tr>
<td></td>
<td>Deployment and recovery of boom systems (Kepner, Goodyear, Ocean dikes,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>American Marine); Field testing of support equipment (North Star vessel,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>small boats, portable skimmers, pumps, generators, etc.); verification</td>
<td></td>
</tr>
<tr>
<td></td>
<td>of logistics support requirements using over-land, vessel and airlift</td>
<td></td>
</tr>
<tr>
<td></td>
<td>transport systems.</td>
<td></td>
</tr>
<tr>
<td>Date</td>
<td>Activity</td>
<td>Participants</td>
</tr>
<tr>
<td>------------</td>
<td>------------------------------------------------------------</td>
<td>---------------------------------------</td>
</tr>
<tr>
<td>Aug 24 &amp; 25 (4)</td>
<td>Open Water Response Training School</td>
<td>Staff, Contractors &amp; Member Company Personnel</td>
</tr>
<tr>
<td></td>
<td>Field and classroom instruction focusing on the deployment, operation and recovery of equipment on open water off Prudhoe Bay. Classroom instruction will emphasize response equipment limitations and techniques, case examples, fate and effects of spills, and operations strategies. Field instruction will involve hands-on experience with a broad range of containment and recovery equipment and associated logistics support systems.</td>
<td></td>
</tr>
<tr>
<td>Sept 2-4 (5)</td>
<td>Shoreline Response Workshop</td>
<td>ABSORB staff and Member Company Personnel (Supervisor or Coordinator level, 1 person/company)</td>
</tr>
<tr>
<td></td>
<td>Classroom and field instruction including helicopter transport to a number of shoreline types near Prudhoe Bay. Dr. Ed Owens of Woodward-Clyde, Victoria, will discuss and identify in the field those geologic and oceanographic factors that affect the distribution, impact and persistence of stranded oil. He will also describe onshore protection and cleanup methods as they apply to different shoreline types.</td>
<td></td>
</tr>
<tr>
<td>Sept 9 &amp; 10 (6)</td>
<td>Spill Control School - Operator Sponsored</td>
<td>Exxon Company Personnel</td>
</tr>
<tr>
<td></td>
<td>Classroom instruction and hands-on experience will be provided at Prudhoe Bay involving response team organization, oil fate and behavior, and equipment availability limitations, operation and maintenance.</td>
<td></td>
</tr>
<tr>
<td>Date</td>
<td>Activity</td>
<td>Participants *</td>
</tr>
<tr>
<td>------------------</td>
<td>--------------------------------------------------------------------------</td>
<td>-----------------------------------------------------</td>
</tr>
<tr>
<td>Sept 24 &amp; 25 (7)</td>
<td>Shoreline Response Training School</td>
<td>Staff, Contractors &amp; Member Company Personnel</td>
</tr>
<tr>
<td></td>
<td>Classroom and field instruction at Prudhoe Bay covering shoreline</td>
<td></td>
</tr>
<tr>
<td></td>
<td>protection and cleanup techniques, equipment transport and deployment,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>oil fate and behavior and case studies.</td>
<td></td>
</tr>
<tr>
<td>Oct 21 &amp; 22 (8)</td>
<td>Spill Control School -Operator Sponsored</td>
<td>Exxon Company Personnel</td>
</tr>
<tr>
<td></td>
<td>Same as 6 above.</td>
<td></td>
</tr>
<tr>
<td>Nov 4 &amp; 5 (9)</td>
<td>Spill Control School-Operator Sponsored</td>
<td>Exxon Company Personnel</td>
</tr>
<tr>
<td></td>
<td>Same as 6 above.</td>
<td></td>
</tr>
<tr>
<td>Nov 18 &amp; 19 (10)</td>
<td>Environmental Coordination/Impact Assessment Training School</td>
<td>Staff, Contractors &amp; Member Company Personnel</td>
</tr>
<tr>
<td></td>
<td>Workshop oriented school designed for Environmental Supervisor/</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Coordinator level personnel. Topics covered will include effects of</td>
<td></td>
</tr>
<tr>
<td></td>
<td>oil on biological and physical resources, sampling techniques, government</td>
<td></td>
</tr>
<tr>
<td></td>
<td>liaison, response planning and impact assessment. School likely to be</td>
<td></td>
</tr>
<tr>
<td></td>
<td>held in Anchorage or Seattle.</td>
<td></td>
</tr>
</tbody>
</table>

* In all cases, contractor support personnel will be used as necessary to complement the ABSORB staff and member company instructors. CIRO and GOACO Managers are also encouraged to participate in all training exercises as time and space permit.
## SECTION 6

### TRAINING SCHOOL ATTENDANCE

<table>
<thead>
<tr>
<th>Date</th>
<th>School</th>
<th>Name, Title and Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>September 24-25</td>
<td>Shoreline Response Training School</td>
<td>J.H. Douglas, Production Foreman No. Star Route 1, P.O. Box 485 Kenai, AK 99611</td>
</tr>
<tr>
<td></td>
<td></td>
<td>W.P.L. Smith, Operations Foreman No. Star Route 1, P.O. Box 485 Platform C, Kenai, AK 99611</td>
</tr>
<tr>
<td>October 12-13</td>
<td>Spill Control School Operator Sponsored</td>
<td>L P. Ramirez, Division Operations Manager, P.O. Box 92047 Worldway Center, Los Angeles, CA 90009</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M.L. Woodson, Division Production Superintendent, 601 W. 5th Ave., Suite 810, Anchorage, AK 99501</td>
</tr>
<tr>
<td></td>
<td></td>
<td>J.H. Douglas, Production Foreman No. Star Route 1, P.O. Box 485 Kenai, AK 99611</td>
</tr>
<tr>
<td></td>
<td></td>
<td>W.P.L. Smith, Operations Foreman No. Star Route 1, P.O. Box 485 Platform C, Kenai, AK 99611</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M.R. Cornell, Alaska Development Project Manger, P.O. Box 527 Houston, TX 77001</td>
</tr>
<tr>
<td></td>
<td></td>
<td>D.E. Glass, Manager Coastal Environmental Activities, 601 W. 5th Ave., Suite 810, Anchorage, AK 99501</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M.G. Dunckley, Mechanic, No. Star Route 1, P.O. Box 485, Platform C, Kenai, AK 99611</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B.J. Thomas, Production Operator No. Star Route 1, P.O. Box 485 Platform A, Kenai, AK 99611</td>
</tr>
</tbody>
</table>
Date          School                                           Name, Title and Address

October 12-13

Environmental Coordination Impact Assessment Training School

November 18-19

W.F. Gusey, Sr. Stf. Wildlife Specialist, P.O. Box 2463, Houston, TX 77001

T.L. Steinman, Production Operator, No. Star Route 1, P.O. Box 485, Platform A, Kenai, AK 99611

L.F. Strehlow, Lease Operator, No. Star Route 1, P.O. Box 483 Onshore Facility, Kenai, AK 99611

A.J. Cline, Utilityman, No. Star Route 1, P.O. Box 485, Platform C, Kenai, AK 99611

J.W. Henderson, Sr. Storekeeper, 601 W. 5th Ave., Suite 810, Anchorage, AK 99501

A.D. Goode, Mechanic, No. Star Route 1, P.O. Box 485, Platform A, Kenai, AK 99611

T.L. Pritchard, Sr. Operations Technician, No. Star Route 1, P.O. Box 485, Platform C, Kenai, AK 99611

G.F. Daniels, Utilityman, No. Star Route 1, P.O. Box 485, Platform C, Kenai, AK 99611

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3 Brinkerhoff Drilling Company Drillers

(Names and addresses will be supplied as soon as available.)

Revised 9/29/81
APPENDIX 4
HYDROGEN SULFIDE CONTINGENCY PLAN
TERN PROSPECT

I. **Scope**

This contingency plan is prepared on the basis that hydrogen sulfide is highly unlikely to be encountered in quantities dangerous to personnel or equipment. However, since there is no absolute assurance that hydrogen sulfide will not be encountered, the contingency plan provides for early detection and suspension of drilling operations before hydrogen sulfide would be dangerous to personnel or equipment. Further, the plan provides for orderly evacuation of personnel and protective equipment for those who may be required to shut in the well. Should hydrogen sulfide be encountered in unsafe levels and should it be decided to continue drilling with hydrogen sulfide present, a modified, more detailed plan will be prepared before drilling is again started.

II. **Physical Properties — H₂S**

Hydrogen sulfide is a colorless, transparent gas with a characteristic rotten-egg odor. The disagreeable odor of hydrogen sulfide occurs only at relatively low concentrations. Those who have been rendered unconscious from high concentrations and survived, report that they did not notice the so-called rotten-egg odor but rather that it had a sickening sweet odor. Others reported that the odor was sweet and not unpleasant. Just exactly at what concentration it becomes sweet-smelling is not known, but some believe it is around 500 to 1000 ppm. It should always be borne in mind that some people cannot detect the odor of H₂S.

H₂S is flammable in the range of 4.3 to 45.5 percent in air. A mixture of two volumes H₂S and 3 volumes oxygen will explode violently when ignited.

H₂S has a specific gravity of 1.192 (compared to 1.00 for dry air) or a molecular weight of 34.08 as compared to 29 for air. Hence, H₂S may be considered heavier than air and in concentrated form may collect in low places. However, at a concentration of 2,000 ppm, which may produce unconsciousness almost immediately, the specific gravity or density of the mixture of air and H₂S is only 1.003 so that the mixture for all practical purposes has the same density as air.
H₂S is readily soluble in petroleum hydrocarbons and is soluble in water at room temperatures at the rate of three volumes H₂S for one volume of water. Such things as heating and agitation of the water will reduce the concentration. This solubility and the effect of heat can account, for example, for open drainage ditches evolving dangerous amounts of H₂S during the heat of the day in cases where there was no significant amount found during the cool morning hours.

Information as to the concentrations of H₂S that are detectable by smell vary considerably. It is readily detected at about 5 ppm; however, it is generally accepted that concentrations as low as 0.025 ppm are detectable, 0.3 is distinct, 3 to 5 is strong and 20 to 30 ppm is strong but not intolerable. Above 30 ppm the odor does not become more intense as the concentration increases, and above 200 ppm the disagreeable odor appears less intense. These figures are based on initial perceptions. With continuous inhalation, the odors will appear less, due to olfactory fatigue. It must also be recognized that some other odors will mask even an odor as disagreeable as H₂S. For example, the odor of creosols effectively masks the odor of H₂S.

III. Physiological Effects - Hydrogen Sulfide

There are three principal effects from exposure to H₂S: 1) the irritant action of high concentrations on mucous membranes, 2) the effects on the eyes which may result from repeated exposures to low concentrations as well as short exposures to high concentrations, and 3) the most significant effect - paralysis of the respiratory nerve endings from exposure to relatively high concentrations of 500 to 700 ppm or more.

Aside from the irritant effects on the eyes, the principal mode of entry into the body is through the lungs. Skin contact even to high concentrations is not considered significant. It has been reported that a perforated ear drum can be a route of significant exposure. There is less resistance to outside atmosphere via the perforation than via the breathing apparatus, and therefore, it is reported, H₂S can be inhaled through the ear under such circumstances. Ear wax and Ear plugs offer little protection.

Persons seriously exposed to H₂S but who recover may suffer some lung irritation which can lead to pulmonary edema or bronchial pneumonia.

The systemic effects from absorption of H₂S into the blood stream via the lungs is by far the most significant effect. Under normal circumstances, when absorbed into the blood stream, H₂S at low concentrations is oxidized rapidly to pharmacologically inert compounds such as thiosulfate or sulfate. When the amount absorbed into the blood stream exceeds that which is readily oxidized, systemic poisoning results in a general action on the nervous system; labored respiration occurs shortly, and respiratory paralysis may follow immediately. Death then occurs from asphyxiation unless the exposed person is removed immediately to fresh air and breathing is stimulated by artificial respiration before heart action has ceased.
In high concentrations of gas, the mechanics of this respiratory paralysis, formerly thought to involve a chemical reaction with the respiratory enzymes or with the hemoglobin or both, are now believed to be reflexes resulting from irritation of the carotid sinus. Moderately high concentrations on the other hand cause an arrest of breathing, but not respiratory paralysis, after overstimulation of the respiratory center. In such cases, resumption of breathing would probably occur, after removal from exposure, even without artificial respiration. Recovery from acute exposure to H₂S is usually considered complete, although sometimes prolonged for as much as several weeks, unless there has been damage to the brain due to prolonged oxygen deficiency. Transient and sometimes permanent psychic or nervous changes may be encountered if there has been damage to the brain. It is believed that the presence of alcohol in the blood potentiates the effects of H₂S in acute poisoning cases. Those recovering from acute poisoning and who have had alcohol during the past 24 hours reportedly become quite violent.

In cases of chronic, or perhaps more properly named sub-acute exposures, symptoms that occur include headache, dizziness, excitement, nausea or gastrointestinal disturbances, dryness and sensation of pain of the nose, throat and chest, and coughing.

The following indicates responses to various concentrations of H₂S in the atmosphere:

PHYSIOLOGICAL RESPONSE TO VARIOUS CONCENTRATIONS OF HYDROGEN SULFIDE

<table>
<thead>
<tr>
<th>Response</th>
<th>Concentration PPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum acceptable concentration for prolonged exposure. <em>(TLV)</em></td>
<td>10</td>
</tr>
<tr>
<td>Minimum concentration causing eye irritation</td>
<td>10</td>
</tr>
<tr>
<td>Minimum concentration causing lung irritation</td>
<td>Moderately above 20</td>
</tr>
<tr>
<td>Slight symptoms after several hours</td>
<td>70-150</td>
</tr>
<tr>
<td>Maximum concentration for 1 hour without serious consequences</td>
<td>170-300</td>
</tr>
<tr>
<td>Dangerous after ½ hour to 1 hour exposure</td>
<td>400-700</td>
</tr>
<tr>
<td>Pulmonary edema or bronchial pneumonia from prolonged exposure</td>
<td>250-600</td>
</tr>
<tr>
<td>Rapidly produces unconsciousness, cessation of respiration and death</td>
<td>700-900</td>
</tr>
<tr>
<td>Unconsciousness at once, with early cessation of respiration and death in a few minutes</td>
<td>1000-2000</td>
</tr>
</tbody>
</table>

*TLV - Threshold Limit Value
Eyes can be affected by H$_2$S exposure. It is believed that the effect on the eyes is due to the caustic action of sodium sulfide formed by interaction of the H$_2$S and the alkali of the cells in the presence of moisture in the eyes. Symptoms and effects of exposure to the eyes that have been reported include blurred vision, as though viewing objects through a silk screen; appearance of colored rings around street or other lamps, car lights which appear to be dumbbell-shaped, blurred and surrounded by colored halos; red and inflamed, eyes, somewhat resembling the "pink eye", and there may be a gritty feeling. There may be intense aching of the eyes, and the eyelids may go into spasms and be difficult to open. These symptoms may disappear overnight or may persist into the next day. Hydrogen sulfide may have a slight anesthetic effect on the eyes, as often the symptoms do not occur until the 2nd to 4th day of exposure. Estimates of minimum concentrations of H$_2$S required to cause eye effects are reported as ranging from 4 to 25 ppm.

IV. Physical Properties - Sulfur Dioxide

Sulfur dioxide is colorless gas or liquid. It has a pungent odor and is not flammable. It is formed when hydrogen sulfide is burned. The specific gravity of the vapor is 2.264 (compared to 1.00 for dry air). Anhydrous sulfur dioxide is non-corrosive to steel or other commonly used metals. In moist environments, it combines with water to form sulfuric acid, but it only very slowly oxidizes to sulfuric acid. In the presence of water, sulfur dioxide is corrosive to steel and other metals.

Concentrations of 6 to 12 ppm cause immediate irritation of the nose and throat. A level of 0.3 to 1 ppm can be detected by the average individual possibly by taste rather than by the sense of smell.

V. Physiological Effects - Sulfur Dioxide

Sulfur dioxide is intensely irritating to the eyes, throat and upper respiratory system. Its irritant properties are due to the rapidity with which it forms sulfuric acid on contact with moist membranes. An estimated 90 percent of all SO$_2$ inhaled is absorbed in the upper respiratory passages with only slight penetration in the lower respiratory tract.

Sulfur dioxide exerts its toxic influence on humans through acute and possible chronic effects. Acute symptoms of exposure are eye, mucosal and upper respiratory irritation. Potential chronic effects include nasopharyngitis, reduction of pulmonary function and increased resistance to air flow.
Chronic effects of sulfur dioxide exposure may result from repeated bronchoconstriction. While bronchoconstriction is not itself a chronic effect, it is believed that continual exposure can lead to substantial permanent pulmonary impairment in excess of the normal gradual decrease in pulmonary function due to the aging process.

There are only limited epidemiological studies and a few animal studies which attempt to uncover any chronic effects due to sulfur dioxide exposure. Generally, the results indicate the possibility of permanent effects from continuous or long-term exposure but are inconclusive.

This material is so irritating that it provides its own warning of toxic concentrations. The TLV is 5 ppm. Fifty to 100 ppm is considered to be the maximum permissible concentration for exposures of 30 to 60 minutes. Four hundred to 500 ppm is immediately dangerous to life.

VI. \( \text{H}_2\text{S} \) Detection and Monitoring Equipment

A. Although hydrogen sulfide is not expected, monitoring is needed to alert personnel immediately to the presence of hydrogen sulfide in event it is encountered. To provide the necessary warning, International Sensor Technology \( \text{H}_2\text{S} \) Detectors or equivalent which are capable of detecting 5 ppm \( \text{H}_2\text{S} \) in the air will be installed to automatically monitor the shale shaker. In addition, the mud logging unit will be equipped with \( \text{H}_2\text{S} \) measuring equipment.

B. Two portable Draeger gas detectors and one portable International Sensor Technology \( \text{H}_2\text{S} \) detector or equivalent units will be available for spot-checking of \( \text{H}_2\text{S} \).

VII. Personnel Protective Breathing Apparatus

Self-contained pressure demand air breathing apparatus will be available for each member of drilling crew on duty. Although normally a drilling crew consists of five men, ten self-contained units will be provided. Two spare air bottles will be available for each unit and a cascade air refill system with a nine-bottle refill capacity will also be provided. All units shall be stored on the rig floor. Personnel with perforated eardrums shall not be permitted to use this equipment in an \( \text{H}_2\text{S} \) environment.

Equipment:

Ten - Survivair 30-minute pressure demand units or equivalent.

One Cascade air refill system complete with regulator and three 300 cubic foot air cylinders.
VIII. Other Equipment

1. Six chalk boards and six note pads will be provided on the rig floor.

2. Two bull horns shall be provided.

3. Vapor tester (explosimeter).

4. Resuscitator with spare oxygen bottles.

5. Rope and harness sets for going into \( \text{H}_2\text{S} \) areas.

6. Stokes litter or equivalent.

7. Wind Indicators

Windstocks, streamers, or other devices will be positioned around the location such that they can be seen from the rig floor and from any position around the location.

8. Mud Treatment and Checks

In the event the mud becomes contaminated with sulfides, a supply of "Milgard" (100% zinc carbonate) or an equivalent scavenger will be available in Deadhorse in sufficient quantity to treat the entire mud system with 2 lbs per barrel.

Below protective casing, daily mud checks will be made to determine the presence of sulfides in the mud using a Garrett Gas Train or equivalent.

9. Well Site Communication

Portable two-way radios will be provided on location in order to permit rapid communication between supervisory personnel in case of an emergency.

10. "Danger - Hydrogen Sulfide - \( \text{H}_2\text{S} \)" signs will be displayed whenever hydrogen sulfide level is above 10 ppm outside of the rig floor, mud pit or shale shaker areas. Each sign shall have a minimum width of eight feet and a minimum height of four feet and shall be painted a high-visibility yellow color with black lettering of a minimum of 12 inches in height.

All signs shall be illuminated under conditions of poor visibility and at night when in use.
IX. Briefing Areas

Two briefing areas will be designated at each location. The Shell Drilling Superintendent on location will designate which briefing area is to be used depending on wind direction.

X. Training

A. Self-Contained Breathing Apparatus

Personnel who may be required to use self-contained breathing apparatus in the event hydrogen sulfide is encountered shall be trained in the use and proper maintenance of breathing apparatus. All personnel shall be trained in use and proper maintenance of Robertshaw air capsules or equivalent. Personnel will also be required at least weekly to don this equipment to assure understanding in how to use it properly. A written record of this training will be kept.

B. Hydrogen Sulfide Detection Equipment

Personnel required to operate permanent or portable monitoring equipment will be trained in the proper use and maintenance of units.

C. Evacuation Procedures

All personnel will be advised of evacuation procedures, alarms, reporting areas and steps to take in event of a hydrogen sulfide emergency. Training will be provided permanent personnel to assure effective operation of evacuation equipment and understanding of evacuation procedures.

D. First-Aid Course

All personnel in the drilling crews shall be trained in basic first aid.

E. Safety Meetings

Safety meetings will be held at least monthly. These meetings will include review of hydrogen sulfide hazards, warning systems, location of safe briefing areas and training sessions on equipment. Records of attendance will be maintained on the drilling facility.

F. No Smoking

Areas where smoking is permitted will be established and identified. Should an alert be called, smoking shall not be permitted during the alert. All personnel shall be informed of no smoking areas and regulations pertaining to smoking.
XI. \( \text{H}_2\text{S} \) Emergency Procedures

A. If at any time as much as 10 ppm of \( \text{H}_2\text{S} \) is detected, the following steps will be taken:

1. The person detecting the \( \text{H}_2\text{S} \) must immediately notify the Driller. He must then notify the Shell Drilling Supervisor and contract Toolpusher.

   The Shell Drilling Supervisor and contract Toolpusher will bring portable gas detectors to the rig floor in order to find the source of \( \text{H}_2\text{S} \).

2. Upon notification of the emergency, the Driller will shut down mud pumps and continue to rotate the drill pipe.

3. The rig floor and supervisory personnel will immediately put on gas masks. All other personnel will immediately leave the area and go to the upwind briefing or other safe area.

4. The contract Toolpusher will alert all personnel that an \( \text{H}_2\text{S} \) emergency exists. He should be prepared to shut off the Forced Air Circulation System in the living quarters.

5. The Mud Engineer will run a sulfide determination on the flowline mud.

6. A maximum effort must be made by supervising personnel to resolve the cause of the \( \text{H}_2\text{S} \) and to suppress the \( \text{H}_2\text{S} \) as quickly as possible. Drilling must not proceed until the cause of the \( \text{H}_2\text{S} \) is determined and the well is circulated. Rig floor and mud pit personnel will keep breathing equipment on while monitoring this circulation.

7. The contract Toolpusher will make sure all nonessential personnel are out of the potential danger area, i.e., mud pit area, mudlogger unit, mud storage room, etc. All persons who remain in the potential danger areas must utilize the "buddy system."

8. The Shell Drilling Supervisor in charge will notify the Shell Operations Superintendent of current conditions and actions taken.

9. The on-duty Shell Drilling Supervisor will see that all monitoring devices are functioning properly and reading accurately and will increase gas monitoring activities with portable Drager units.

10. The Shell Drilling Supervisor in charge will notify all approaching vehicles and helicopters to stay upwind and to be prepared to evacuate nonessential personnel.
11. The Shell Drilling Supervisor in charge will alert the Deadhorse dispatcher to assure continuous radio watch. The U.S. Geological Survey and U.S. Coast Guard must also be notified.

B. If the H₂S concentration exceeds 20 ppm (from an increase in gas cut mud) and the well is not attempting to flow, the following steps will be taken:

1. The person detecting the H₂S must immediately notify the Driller. He must then notify the Shell Drilling Supervisor and contract Toolpusher.

2. Driller will shut down mud pumps and continue to rotate drill pipe.

3. The rig floor and supervisory personnel will immediately put on air breathing units. Any other personnel in the high concentration area should hold their breath and evacuate to a safe area.

4. Once air breathing equipment is on, the Driller should:
   a. Stop rotary.
   b. Pick up kelly above rotary table.
   c. Be ready to hang off and close the BOP's if necessary.
   d. If well control problems develop, shut in the well.

5. The contract Toolpusher will alert all personnel that an H₂S emergency exists. He must shut off the forced Air Circulation System in the living quarters.

6. All personnel not listed above must report to the upwind safe briefing area for further instructions from the off-duty Toolpusher or Supervisor. If you are located on the downwind side of the rig when the alarm is sounded, hold your breath and proceed to the upwind safe briefing area.

7. Always put on a portable air breathing mask before proceeding to assist one affected by the gas and utilize the "buddy system." If the affected person is stricken in a high concentrated area, put on a safety belt with 50 feet of tail line and obtain standby assistance before entering the area. Always use the "buddy system" when entering possible contaminated areas.
8. The Shell Drilling Supervisor in charge will notify all approaching vehicles and helicopters to stay upwind and to be prepared to evacuate nonessential personnel.

9. Notify dispatcher to alert heliport and establish 24-hour watch. Notify appropriate state agencies in addition to USGS and USCG.

10. **DO NOT PANIC**

C. The Shell Drilling Supervisor and contract Toolpusher will assess the situation and assign duties to each person to bring the situation under control. When the severity of the situation has been determined, all persons will be advised. The Shell Drilling Supervisor and contract Toolpusher will:

1. Direct corrective action.

2. Notify the Shell Operations Superintendent in Anchorage on action being taken.
APPENDIX 5

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GEMDAS XI - SYSTEMS DESCRIPTION

A. GENERAL

A fully winterized skid mounted logging unit to accommodate the equipment to perform GEMDAS service. Working space is provided for client's representative, in addition to Consultant's personnel.

Unit Specifications: Dimensions - 8' x 26' x 8½'
Shipping Wt.- 20,000 lbs.
Power System - 440 VAC, 3 phase, 30 KVA

B. EQUIPMENT CONFIGURATION

1. Operating Systems

1.1 Internal Pressurization System. To prevent hazardous gas buildup within unit.

1.2 Internal Hydrocarbon Safety Monitor. To monitor unit atmosphere for hazardous gases.

1.3 Shunt Diode Safety Barrier Box. To prevent hazardous voltages exiting unit to sensors.

1.4 Flame Ionization total Gas and Chromatograph for more sensitive detection of hydrocarbons.

1.5 Hydrogen Sulfide (H2S) continuous monitor - Monitoring ditch gas plus four remote stations located around the rig. Each station individually alarmed for low and high concentrations of H2S. Calibrations performed every 2-3 days or on demand.

1.6 Depth Recording System.

1.7 Analog Chart Recorders for Data Output.

1.8 Patch Panel for routing of data to chart recorders.

1.9 Drill Monitoring Panel (DMP) to display and record normal drilling parameters. These parameters are computed to aid pore pressure prediction.

1.10 Mud Monitoring System (flow, density, temperature, resistivity). All systems measure mud in and mud out automatically with data being displayed around rig.

1.11 Pit Volume Totalizer (PVT), Microprocessor System. Capable of monitoring up to 12 pits with ± 2 bbl. accuracy.
5. **Formation Evaluation Systems**
5.1 Binocular Microscope
5.2 Ultra Violet Viewing Box
5.3 Sample Drying Oven
5.4 Typewriter with geological symbols
5.5 Field copying machine.
5.6 Equipment to aid in ditch cuttings analysis
5.7 Equipment to aid in drilling mud analysis
5.8 Single Solution Shale Density System
5.9 Light Table

6. **Data Monitoring And Acquisition System**
6.1 Two computers with 64K memory are interfaced with the drilling data sensors via a multiplexer unit.
6.2 Computers provide time sharing capability.
6.3 Two display terminals interfaced with computers allows data entry combined with a display facility.
6.4 Six Tape Drives are used for program and data storage.
6.5 Two Printer-Plotters are linked with the computational hardware.
6.6 Five CRT information Systems provide real-time drilling data throughout the unit with capacity for remote stations on the rig.
6.7 An uninterruptible power supply provides a minimum of 20 minutes of AC power in the event of a rig power failure.
6.8 Three remote CRT's supplying critical drilling data around rig (e.g. on rig floor, and drilling superintendents quarters).

7. **Software Support Systems**
7.1 With computation and processing equipment described, drilling performance functions can be calculated automatically on a continuous basis using field proven programs developed by Exploration Logging. Exploration Logging provides a library of programs to aid data acquisition and interpretation at the wellsite. Programs available include:

7.1.1 Real Time Monitors
Drill, Trip and Kill Monitors with output of critical data to data tape, printer and CRT display.

7.1.2 Offline and Data Processing Programs -
Offline Prints
Offline Plots
Data Editing
Lag Data Storage and Formatting
Data Re-evaluation and Analysis
Data Tape Copying

7.1.3 Engineering Assistance Programs -
Complete Mud Hydraulics Analysis
Swab and Surge Calculation
Bit Hydraulics Optimization
D-exponent Analysis
Advanced D-exponent Analysis
Normalized Exponent Analysis
Formation Abrasiveness and Tooth Wear
Bit Cost/Foot Breakeven Analysis
Fast Kick Analysis
Complete Kick Analysis
Fracture Gradient Analysis
Overburden Gradient Computation
Directional Survey Computation and Graphical Presentation
Cementation Volume Calculation
Pressure Build-up Analysis
Electric Log Analysis Including:
  Resistivity Crossplots
    FDC, CNL Plot -
    M&N Plot
    SW, SXO, Porosity Calculation
  Shaly Sand Calc
  RT, RXO Crossplot
  RWA, SP Crossplot
  SW By Ratio Method
  RW Determination Form SP
GEMDAS: STANDARD FORMATION EVALUATION

The integration of Exlog's geological formation evaluation services with the engineering data base yields a most comprehensive picture of drilling-in-progress. Formation evaluation remains an important and complementary part of GEMDAS.

Geological services include:
- Show evaluation
- Total gas curve plotting
- Drilled cuttings gas analysis
- Chromatographic gas analysis
- Lithological analysis

Computerized drilling data analysis benefits the wellsite geologist in several important areas:
- Formation tops may often be more accurately predicted by evaluation of changes in drilling parameters.
- Torque and drilling exponent plots may help interpret lithology and assist in detecting fractures and faults.
- Geological data entered into the computer can be plotted alongside data from offset wells as a powerful aid to correlation.
- Correlation of formation tops in deviated wells is simplified by the automatic computation of true vertical depth.
- Tooth wear estimates may aid in evaluating drilling breaks.
- Formation porosity and pore pressure estimates may aid in evaluating hydrocarbon shows.
- Temperature regression analysis yields the estimated bottom hole temperature, aiding in determining temperature gradient.

Standard Equipment
- Full GEMDAS instrumentation and analysis equipment
- H₂S Detector (continuous recording type)
- Continuous resistivity "in" and "out"
- Shale density
- Binocular microscope (10x30)
- Ultra Violet viewing box (fluoroscope)
- Oil show evaluation chemicals
- Blender and cuttings gas detector
- Chemical testing equipment
- Sample drying oven
- Copy machine

Specialized Equipment:
- CO₂ analyzer (continuous recording type)
- H₂S tube indicator
- O₂ detector
- Continuous conductivity "in" and "out"
- Portable resistivity meter
- Nitrate ion tracer testing kit
- Shale factor
- Autocaliometer (quantitative carbonate analysis)
- Rock stain kit (carbonate, evaporite)
- External alarm system (audio and/or optical)
- Intercom System
- Wellsite mud check and special mud test equipment
- Additional video monitors
- Wellsite core analysis (porosity, permeability, SG and oil/water saturation)
- Core slabber
- Plastic heat sealer
- Geothermal and air/foam equipment service

Two principle wellsite tools provide geologists and engineers with the basic data needed to make recommendations for further exploration, deepening, stepsout, or abandonment. Exploration Logging's Masterlog, illustrated below, is one of these tools. It provides a unique "first-look" prior to extensive invasion or formation damage and can reveal features easily lost with other post-drilling investigative methods. Often the only chronological record of the well encompassing both geological and engineering features, the Masterlog delineates potentially productive zones and provides detailed evaluation of shows.

FIGURE 3
GEMDAS: QUALITY SENSORS ON THE JOB

Any automated data acquisition system must be based on safe, reliable, conveniently-placed sensors. Exlog sensors pass the test. In cases where suitable sensors have not been commercially available, we have developed our own.

Some of the benefits of Exlog sensors include:

- Safety — Sensors are installed in explosion-proof housings and are connected to the GEMDAS unit through a safety barrier system. This shunts sensor power and prevents shorting should a sensor cable be inadvertently cut. Exlog sensor systems are designed and installed to satisfy the most stringent installation requirements of national regulatory authorities and international agencies.

- Reliability — Sensor housings are constructed of materials such as stainless steel that can best withstand the corrosive wellsite environment.

- Ease of Replacement — In the advent of a failure, the majority of our sensors may be replaced in a matter of minutes. In some cases, a spare sensor is mounted within the housing.

- Convenience — Designed to be connected to existing rig equipment without causing undue interference with the drilling operation.

Sensor Systems

Listed below are calculated parameters and the sensor system from which each is derived. Figures 4 and 5 illustrate sensor system flow and sensor locations, respectively.

1) Kelly Height — Hydraulic pressure from kelly sensor converted to electronic signal at rig floor level by a pressure transducer, motion compensated for offshore drilling operation.

2) Total Depth — Incremented in 1/10 ft. intervals from kelly position transducer. Software drill logic control.

3) Rate of Penetration — Electronically derived from kelly position transducer, motion compensated for offshore drilling operations.

4) Pump Pressure — Independent standpipe pressure transducer (over-range rating 20,000 psi; accuracy 0.5% on 1-10,000 psi range).

5) Casing Pressure — Independent choke line pressure transducer.
6) Hookload/WOB — Strain gauge transducer (attached to rig dead-
line gauge system).
7) Rotary Speed — Magnetic proximity switch.
8) Total Bit Revolutions — Accu-
cumulative digital electronic coun
t device using impulses received from Rotary Speed sensor.
9) Rotary Torque — Electrical or mechanical (may be independent or slaved to rig sensor).
10) Pump Stroke — Microswitch
counter.
11) Mud Weight In and Out — Strain
gauge transducer.
12) Mud Flow In — Pump stroke
sensor.
13) Mud Flow Out — Strain gauge
transducer.
14) Mud Temperature In and Out —
Platinum thermistor.
15) Mud Resistivity In and Out — In-
duction closed loop.
16) Rig Heave — Magnetic/reed switch type (attached to Rucker
tensioner).
17) Pit Volume — Magnetic/reed switch type.
18) Gas Detectors — Catalytic and flame ionization methods.
19) GEMDAS Unit.
20) Remote Video Displays
21) Pressurization Line Intake.

FIGURE 5

Courtesy of Aker Group A/S Akers Mek. Verksted.