UTAH OIL AND GAS CONSERVATION COMMISSION

REMARKS: WELL LOG ______ ELECTRIC LOGS ______ FILE X ______ WATER SANDS ______ LOCATION INSPECTED ______ SUB. REPORT/abd. ______

DATE FILED 10-17-74

LAND: FEE & PATENTED ______ STATE LEASE NO. ML 28510 PUBLIC LEASE NO. ______ INDIAN ______

DRILLING APPROVED: 1-6-74

SPUDDED IN:

COMPLETED: PUT TO PRODUCING:

INITIAL PRODUCTION:

GRAVITY A.P.I.

GOR:

PRODUCING ZONES:

TOTAL DEPTH:

WELL ELEVATION:

DATE ABANDONED: 3-24-80 LOCATION ABANDONED- WELL NEVER DRILLED

FIELD: Wildcat 3/86

UNIT:

COUNTY: BOX ELDER

WELL NO. STATE OF UTAH "B" #1 API# 43-003-30001

LOCATION 1320' FT. FROM (N) ~~(S)~~ LINE, 1320' FT. FROM ~~(E)~~ (W) LINE. C NW 1/4 — 1/4 SEC. 5

TWP.	RGE.	SEC.	OPERATOR	TWP.	RGE.	SEC.	OPERATOR
5N	6W	5	AMOCO PRODOCTION				

SPECIAL
OIL SPILLS CONTINGENCY PLAN
FOR THE GREAT SALT LAKE
UTAH

Amoco Production Company
October 1974

INTRODUCTION

Major oil spills in recent years have generated complex technical, legal and public relations problems for the companies involved. Prior planning can help avoid or minimize such difficulties.

It cannot be emphasized too strongly that the best way to handle oil spills is to prevent their occurrence by every possible means, but chiefly through good housekeeping, adequate equipment and proper maintenance and operation of that equipment. GO-730 and API Bulletin D16, Suggested Procedure for Development of Spill Prevention Control and Countermeasure Plans, will serve as the basis for developing Amoco Production Company prevention plans.

However, in spite of the best care, accidental spills will occur and the handling of such spills may require the immediate coordination of efforts of many intra-company departments and, perhaps, contractors and/or outside agencies.

The Oil Spills Contingency Plan described in the following pages is designed to help Amoco Production Company respond quickly and effectively to the problems presented by accidental spills when they occur. Its primary goal is to help the company prevent, as far as practicable, any damage to property, wildlife, or ecology from such a spill.

Within the Oil Spills Contingency Plan Manual, you will find descriptions of the duties that must be discharged in the event of an oil spill. It provides affected personnel with procedures for handling such spills effectively.

Some of the procedures are essential, and they are so identified. Others are merely suggested, and their application will necessarily be varied depending upon the conditions of the spill.

Oil spills will vary in size and importance. A large spill in some instances may be of less importance than a small spill in a critical area. A certain degree of judgment must be exercised at all levels as to the severity of the spill.

The section of technical information pertaining to cleanup methods is subject to modification as technology improves. Additions and revisions will be provided from time to time which should be added to the Manual to keep it up to date.

DEFINITIONS

Definitions of spills used in this plan are based on those contained in the "National Oil and Hazardous Substances Pollution Contingency Plan" as revised August, 1971. A copy of the National Plan plus appropriate Regional Plans will be furnished by the Division Office to an area office for reference when needed.

"Minor Spill" - is a discharge of oil of less than 1,000 gallons (24 bbls) in inland waters, or less than 10,000 gallons (240 bbls) in coastal waters, unless other circumstances require its classification as major. If it endangers critical water areas, generates public concern, or poses a threat to public health or welfare, it should be classified as medium or major depending on its degree of impact. To be classified as a minor spill, it should also be well within the capabilities of being handled by the affected Area without help from other Areas, other subsidiaries, cleanup cooperatives, outside parties, and local, state or federal agencies. These are small spills where control, containment, removal and any necessary cleanup can be handled promptly and effectively by company and appropriate contractor personnel without outside help. If news media become involved, the spill should be moved to a higher classification even if the spilled quantities are in the above limits.

"Medium Spill" - is a discharge of oil of 1,000 gallons (24 bbls) to 10,000 gallons (240 bbls) in inland waters or 10,000 gallons (240 bbls) to 100,000 gallons (2,400 bbls) in coastal waters, unless other circumstances require its classification as major. If it represents a substantial threat to public health or welfare, causes extensive contamination of large water areas, shorelines or beaches, threatens other catastrophic consequences, or generates wide public concern, it should be classified as major even though the quantity conforms to the definition of a medium spill. Medium spills may, however, be of sufficient size or nature such that the affected Area must be given control, containment, and cleanup assistance from other Areas, cooperatives, and outside parties, and news media may become involved.

"Major Spill" - is a discharge of oil of more than 10,000 gallons (240 bbls) in inland waters or more than 100,000 gallons (2,400 bbls) in coastal waters, or one that:

(1) substantially threatens public health or welfare

(2) causes extensive contamination of large water areas, shorelines, or beaches

(3) occurs in or endangers critical water areas

(4) generates wide public concern

(5) becomes the focus of an enforcement action, or

(6) threatens other catastrophic consequences.

Classification of oil films, as contained in the "National Oil and Hazardous Substances Pollution Contingency Plan" is shown below. This terminology should be used in descriptions of oil films.

Standard Term	Gallons of Oil Per Square Mile	Appearance
"barely visible"	25	barely visible under most favorable light conditions
"silvery"	50	visible as a silvery sheen on surface of the water
"slightly colored"	100	first trace of color may be observed
"brightly colored"	200	bright bands of color are visible
"dull"	666	colors begin to turn dull brown
"dark"	1332	much darker brown

(Contd. on Page 5)

OIL SPILLS TASK FORCES

General Office and Division Office task forces have been formed to help coordinate company efforts in those cases where their involvement becomes appropriate:

These task forces have been designated in advance and are so constituted that the members are free to devote their full time to the handling of any spill requiring their involvement. They have prior clearance for the necessary travel and expenses they may occur when their task force is called upon for assistance.

The General Office Task Force will include, as regular members:

	Telephone Numbers Office	Home
Producing Department		
M. S. Kraemer	312-856-2212	312-729-1782
Law Department		
J. M. Gross	312-856-7927	312-357-2892
Public Affairs Department		
George R. Ewing	312-856-4160	312-885-1206
Coordinator of Air & Water Conservation		
E. L. Sampson	312-856-2413	312-644-5074

The Division Office Task Force will include, as members:

	Office	Home
Asst. Division Production Mgr.		
A. M. Roney	303-292-4545	303-789-3829
Coordinator of Air and Water Conservation		
J. E. Lang	303-292-4516	303-985-0198
Division Attorney		
Harry O. Hickman	303-292-4675	303-770-1487
Public Affairs Representative		
William W. Crawley	303-292-4753	303-795-3125
Alternates		
Robert L. Uttley, Kansas City	816-968-4101	913-722-5150
Carl I. Huss, Houston	713-227-4371	713-333-4148

Revised: 9-74

ALERT PROCEDURE

This Contingency Plan becomes effective:

Immediately upon observance of an oil spill from a company installation of any kind which would:

1. Result in discharge of a harmful quantity of oil, as defined by regulations pursuant to the Federal Water Pollution Control Act of 1970. These regulations defined "harmful quantity" of oil as an amount which will:

   a. violate applicable water quality standards, or

   b. Cause a film or sheen upon or discoloration of the surface of the water or adjoining shorelines or cause a sludge or emulsion to be deposited beneath the surface of the water or upon adjoining shorelines.

   As provided by the Act, such harmful discharges are those which occur into or upon the navigable waters of the United States, adjoining shorelines, and into or upon the waters of the contiguous zone.

2. Possibly affect any other waters.

The responsibility for the notification of an oil spill rests with any company employee observing an oil spill.

The Supervisor will confirm the spill, its cause and basic nature; initiate containment and cleanup action, if possible; and notify the Area Superintendent, advising him of the entire situation including all actions being taken.

The Area Superintendent will notify the District Production Superintendent, or the Division Coordinator of Air and Water Conservation (in the absence of the District Production Superintendent) of all spills, and following this discussion notify outside agencies when the spill is the type covered by Federal Water Pollution Control Act of 1970 (as outlined in paragraphs 1 and 2 above).

A list of outside agencies to be notified will be found in Appendix "A".

Provisions of the Federal Water Pollution Control Act of 1970 require that "any person in charge of a vessel or facility immediately notify the appropriate Federal agency of the discharge. Failure to comply with the notification requirement may result, upon conviction, in a fine of up to $10,000 and/or imprisonment of up to one year".

If the person in charge of a facility is unable to contact the Area Superintendent, or Division Office personnel, regarding a spill which is the type covered by the federal law cited above, it would be appropriate for him to report the spill directly to the Environmental Protection Agency Regional Office, and the Coast Guard District Office if navigable waters are involved.

The District Production Superintendent will immediately notify the Division Production Manager of all medium and major spills.

The Division Production Manager, after consultation with the Division Oil Spills Task Force, will initiate action to:

1. Notify the Division Manager.

2. Put in effect a public relations emergency plan (discussed later).

3. Notify by telephone the General Office Task Force through Mr. M. S. Kraemer.

4. Notify by telephone Mr. R. C. Mallatt, Standard's Manager, Environmental Conservation. At that time, the advisability of requesting the assistance of one or more members of the Technical Support Group of Standard's Environmental Conservation Department should be determined. Specialists in the Technical Support Group include a man skilled in the use of oil spill containment and cleanup materials and equipment, a Staff Ecologist, analytical chemists skilled in field sampling methods, an experienced water technologist, and other specialists. Mr. R. G. Will is Technical Support Group Coordinator. The role of the Technical Support Group Coordinator and other Technical Support Group specialists is one of advisor to line management in dealing with the environmental aspects of any mishap. Further, the decision to request their assistance is to be made by the Division Production Manager, or his delegate. The presence of Technical Support Group personnel does not relieve line management from full responsibility, authority, and cost accountability for all countermeasures taken.

	Telephone Numbers Office	Home
R. C. Mallatt Standard's Manager, Environmental Conservation	(312) 856-5485	(219) 663-1451 or (219) 474-5363
R. G. Will Coordinator, Technical Support Group	(219) 659-2700 Extension 611	(219) 838-5247

5. Notify appropriate managerial personnel of sister subsidiaries at their Division or Regional Offices covering the area of operations where the spill occurred. This notification will be for the purpose of (1) informing other subsidiaries so that they can knowledgeably respond to inquiries about the spill which they may receive due to the similar names of Standard's subsidiaries, and (2) to obtain from the other subsidiaries a list of local, state or federal agency management level personnel which they feel should be advised of the spill and kept informed of containment and cleanup efforts. Since some agencies which have regulatory responsibilities with sister subsidiaries may have no involvement with Amoco Production Company, they probably would not be kept properly informed without this coordination. Procedures for ongoing communication with all agencies, including those that have dealings only with other subsidiaries, and for which this is desired by the other subsidiaries, are included under the Public Affairs and Governmental Agency Relations Section.

The information to be transmitted on each oil spill will include, but not be limited to, the following:

Initial Report:

Location of installation where spill occurred.

Time spill observed--or occurred.

Type of oil spilled.

Estimate of amount spilled and quantity recovered, or anticipated recovery, if any.

Environmental conditions -- wind direction and speed, wave action, currents, etc.

Likelihood of public relations consequences. Hazards to company and public property and estimate of area likely to be affected -- river banks, beaches, properties, wildlife, crops, range, etc.

If from barges or vessels -- name of craft, registry, owner, consignee, type of product, grade, DWT, draft, etc.

Cause of spill.

Action being taken.

Persons or agencies already notified.

Subsequent Report:

On "medium" and "major" spills, a subsequent report will be prepared and submitted within a reasonable period of time following cleanup of the spill. This report will follow the format shown in Appendix E. Copies will be forwarded to the Division Office, and the General Office, Attention: Mr. M. S. Kraemer.

In addition to this report, an engineering memorandum may be appropriate on any size spill whenever new or unique cleanup methods or materials are used.

Filing and Amending "Spill Prevention Control And Countermeasure Plans" (SPCC)

Under the provisions of GO-730, certain spill events may make it necessary to file the applicable SPCC plan with the EPA Regional Administrator and affected state agency, and to revise such plan when required by the EPA.

ACTION PROCEDURE

The Contingency Plan is self-starting:

Whenever an oil spill is reported, appropriate control, containment, removal, cleanup, and public and governmental relations operations will begin simultaneously with the Alert Procedure previously described.

The immediate responsibility for abatement, containment, removal and cleanup operations rests initially with the ranking company employee on the scene. However, since the Contingency Plan provides for different degrees or types of response for different types of spills, the responsibility for these operations will automatically move to higher levels of management depending upon the size of the spill, the ability to control it, and the gravity of the situation. See definitions for further explanation of the following responsibility categories.

Minor Spills

The Area Superintendent of the Area involved will be responsible for all spills within the definition of "minor spill" and of a nature or size which may be handled by the affected area without help from other Areas, cooperatives, outside parties or governmental agencies. These would be small spills where control, containment, removal and any necessary cleanup can be handled promptly and effectively by Company or appropriate contractor personnel without outside help. Regardless of the quantity of the spilled material, if news media become involved, the spill should be moved to a higher level of responsibility and reclassified as a medium spill, or even a major spill if wide public concern is anticipated to result.

Medium Spills

Division Production Manager will be responsible for medium spills of which the size or nature indicates that they may escape beyond the bounds or the control capabilities of the local area, requiring control, containment and cleanup assistance from other Areas, cooperatives, governmental agencies, etc. Involvement of news media also moves a spill into the medium category (or "Major" if otherwise of sufficient seriousness). As discussed under "Alert Procedure" above, Division Production Manager should advise the General Office Task Force through notification to Mr. M. S. Kraemer of pertinent information on medium or major spills (by phone or wire) as soon as knowledge becomes available. Contents of press releases being made should be included. These notification instructions are intended simply to keep appropriate General Office personnel informed currently and the responsibility remains as indicated herein. Also, while the "Alert Procedure" provides that the Division Production Manager, or his delegate, may decide to request assistance of the Technical Support Group Coordinator or other Technical Support Group specialists, these specialists are to serve only in an advisory capacity to provide consultation to line management in dealing with the environmental problems associated with any mishap.

Major Spills

Vice President and Division Manager will be responsible for organizing company efforts to deal with major spills where a substantial threat to public health or welfare exists, or where there is extensive contamination of large water areas, shorelines or beaches, or other catastrophic consequences are likely. Spills under this category may require total company effort and possibly outside services. It is anticipated that the General Office Task Force and Standard's Manager, Environmental Conservation or members of his staff, may serve in an advisory capacity to the Vice President and Division Manager of the affected Division in the event of a major oil spill emergency.

Containment and Clean-up Procedures & Equipment for Operations on the Great Salt Lake

Technical information of a general nature regarding oil spill containment is presented in Appendix "D". Utilizing this general information and special studies currently being conducted, prior to commencement of operations Amoco will obtain and have immediately available on a standby basis suitable pollution control equipment which shall include containment booms, skimming apparatus, and such chemical collecting agents or dispersants as may be appropriate after consultation with the Environmental Protection Agency.

ADVANCE PREPARATIONS

Division Production Manager is responsible for:

1. Advance assignment of personnel who might be needed in the event of a spill.

2. Clear definition and distribution of duties of personnel in the event of a spill.

3. Training and orientation of personnel with advance assignments.

4. Arranging for travel clearances in advance of need.

Division Coordinator of Air and Water Conservation will:

1. With information available from Areas, prepare and maintain an inventory of the Division's personnel, materials and equipment, plus availability of personnel, materials and equipment from outside sources, for dealing with spills. These inventories are to be maintained as appropriate Area sections of the Division plan.

2. Provide a periodic review of the Division's readiness for dealing with oil spills, recommending additional equipment and materials as appropriate.

3. Distribute technical data and training materials, obtained both from Coordinator of Air and Water Conservation and from other sources, to personnel who will be responsible in the event of a spill, and provide appropriate technical material for appendix of this material.

4. Consult with members of the Division Task Force on matters concerned with air and water conservation requiring expertise in the various areas of responsibility represented on the Task Force.

Area Superintendents are responsible for:

1. Developing, implementing and maintaining Spill Prevention Control and Countermeasure Plans, in accordance with GO-730 and API Bulletin D16.

2. Amending SPCC Plans when required.

U T A H

OUTSIDE AGENCIES TO BE NOTIFIED OF OIL SPILLS IN GREAT SALT LAKE

Area Superintendent after discussion with District Superintendent should notify following agencies of spills as applicable. Notify air controllers only if spilled material is to be burned. In most states, it is mandatory to notify only one federal agency, such as the Enviromental Protection Agency (or the Coast Guard in Alaska), and one state agency, such as the State Department of Health. Local conditions, however, may require notifying other agencies such as: State Highway Department, local Sheriff's Department, local Fire Department, Indian Agency, surface land owner, United States Geological Survey, or Bureau of Land Management. Area Superintendent may use his judgment as to necessity for reporting to these agencies.

MANDATORY

Environmental Protection Agency Region VIII - Denver, Colorado

Dick Jones - 24 hr. number - (303-837-3880

State Division of Health, Bureau of Environmental Health

Water Quality Section

24 hr. number - (801)-328-6145

Air Quality Section

Dr. Grant S. Winn
Office: (801)-328-6108
Home: (801)-277-3297

State Oil and Gas Conservation Division, Department of Natural Resources

Cleon Feight, Director - (801)-328-5771
Paul Burchell, Pet. Engr. - (801)-328-5771

Division of State Lands

Gale Prince
Office: (801)-328-5381
Home: (801)-582-3917

OIL AND CHEMICAL SPILLS CLEANUP - TECHNICAL INFORMATION

Introduction

In general, the information contained herein pertains to the cleanup of ordinary spills from tankers, barges, piers, loading facilities, refineries, and terminals where oil or chemicals may be accidently discharged into nearby water. It does not include step-by-step procedures on how to deal with specific kinds of spills. Instead, this is a summary of general methods and materials for dealing with spills, leaving the man on the scene the choice as to which of these will work best in his circumstances.

Since spills can occur in many different locations under a variety of conditions, there can be no "routine" method for spill cleanup. The choice methods and materials to be used is dependent upon local conditions including:

1. Type and amount of the spill.
2. Weather--immediate and long range.
3. Location of spill in relation to terrain.
4. Prevailing winds.
5. Water currents.
6. Equipment available--portable or afloat.
7. Labor and supervision available.
8. Local and state laws.
9. Cost factors and economic considerations.
10. Special considerations, such as closeness to drinking water intakes, fishing grounds, wildlife habitats, bathing beaches, or recreational areas.

There are four basic steps in dealing with a spill:

1. Limit the spill.
2. Contain the spill.
3. Remove the spill.
4. Clean up any residual contamination.

Each of these four steps is covered in a separate section. Some preliminary, general facts about oil spills precede these sections.

General Information

An important consideration in dealing with any oil or chemical spill is the potential fire hazard. Refined petroleum products, such as gasoline, benzene, and naphtha are the most flammable. These lighter, low-boiling materials spread quite rapidly on water and, because of their high volatility, evaporate quickly. In open water, where no fire hazard is involved, wind and wave action usually result in fast dispersal. Near a tanker, pier, terminal area, or other location where the fire danger is serious, spills of such products are usually confined and fire-preventive foam spread on the surface of the slick. Subsequent evaporation removes the slick, and the foam returns to a liquid state and dissipates in the water.

Heavier oil products rarely represent as serious a fire hazard since their higher ignition point makes them more difficult to set ablaze. After a short period on the water, crude oil is difficult to ignite and even deliberate attempts to burn off crude oil slicks in the open sea are usually unsuccessful. This is because the volatile fractions of the crude evaporate, leaving a heavy, sticky residue, which is a prime pollution offender.

Oil slicks move and break up under the influence of wind and current. Wind is the dominant factor in open water. Here a slick will move at a speed of 2 to 4 percent of the wind velocity and, in the northern hemisphere, slightly to the right of the direction in which the wind is blowing. In the southern hemisphere, the movement is to the left of the wind direction. In the absence of wind, or in places such as rivers and streams, water currents will be the dominant factor in the movement of a slick.

A rough estimate of the amount of heavy oil on the water surface can be made from the appearance of the slick. A slick which is barely visible under most favorable light conditions indicates 25 gallons per square mile (gpsm). A silvery sheen indicates about 50 gpsm. Faint traces of color indicate 100 gpsm. Bright bands of color indicate 200 gpsm. At concentrations over about 600 gpsm the slick turns a dull brown, while over 1,300 gpsm the color becomes much darker.

Large crude oil slicks sometimes combine with water to form a gelatinous water-in-oil emulsion called "chocolate mousse." The mixture may be as much as 70 percent water. While it is uncertain exactly what conditions will cause this type of emulsion, it is known that it can be formed by agitation of several types of crude oil in salt water.

When "chocolate mousse" is deposited on a beach, it tends, because of its sticky consistency, to stay on the surface of the sand. Oil, on the other hand, depending on its consistency, will penetrate the beach sand. In either case, cleanup usually involves physical removal--although the deeper the oil penetrates the sand, the more difficult the cleanup problem becomes.

As emphasized above, the material presented here outlines the basic considerations for dealing with oil and chemical spills. It is hoped that it will stimulate the reader to study prece-dures, equipment, and materials available, in light of local conditions, and to use this information to develop a spill cleanup contingency program which will suit the needs at his particular location.

Limiting the Spill

Timing is of the utmost importance in limiting the amount of oil or chemical spilled onto a water surface, since the less material that is spilled, the easier it is to clean up. In most cases the means to limit the spill are evident: close a valve that has been accidently left opened, stop pumping through a ruptured line, repair loose or leaking fittings and connections, etc.

Even though the proper corrective action is often obvious, it is unfortunately true that such action is not always taken promptly. Consequently, what should be a relatively minor spill can escalate into a much larger spill with accompanying major headaches.

One of the best ways to limit spills is to anticipate them by thorough training of crews and personnel. Workers should be aware of the potential sources and danger of spills and be prepared to take immediate and effective action to eliminate the source of the spill. Where possible, equipment to control the flow of oil and stop its flow in case of a leak or line rupture should be installed.

Consideration should be given to the delegation of primary responsibility for handling spills to one or several employees. These employees should try to predict where spills are likely to occur on the basis of past experience. Plans for dealing with emergencies should be prepared; necessary equipment and material should be evaluated and made available; crews should be drilled in cleanup procedures. Lines of responsibility and authority should be clear. An oil and chemical spill contingency plan for each company location with a spill potential is included with this technical material. Each plan contains detailed alert and action procedures for dealing with spills.

Sometimes there are ways other than the obvious to lessen the amount of oil spreading onto water. If oil is leaking from a shoreside facility, sandbagging or a temporary dike may prevent it from draining into the water. In the case of a grounded tanker or barge, transfer of the oil to another vessel might be a way to limit the spill.

In addition to anticipation of and preparation for a spill, it is necessary for personnel to be aware of the possible legal and public relations consequences of any oil or chemical spill. It is through this awareness and sense of responsibility that many potentially serious spills may be limited or possibly be entirely eliminated.

Good equipment, through training, and alert, informed and responsible personnel are a good recipe for limiting spills. Add a dash of ingenuity and spills should be held to an absolute minimum. Chances are that the cost of such precautions and preparation will be more than repaid by a reduction in lost oil and by lower cleanup costs. A bonus is the goodwill of a public protected from pollution.

Containing the Spill

Containing an oil or chemical spill means preventing its spread over the surface of the water. There are several advantages to containment. First, it makes it easier to remove the oil from the water. Second, holding the oil near the ship, pier, terminal, or source from which it was spilled, localizes the problem and minimizes pollution.

If a spill is not contained, wind or current may carry it a great distance. When a spill occurs in a lake or tidal harbor, pollution damage can result along the entire path of the spill's movement, thus increasing the area involved and the number of persons affected. If the slick is carried to beaches, recreation areas, or fishing grounds, the cleanup job is more difficult because great care must be taken in selecting materials, such as chemicals, to be used.

To recover or physically remove a spill from the water surface, it is necessary for immediate containment of the spill, prior to its spreading and dispersal. The ability to adequately confine a spill in the area immediately surrounding the source is principally a function of time, availability of equipment and prevailing environmental conditions. An incident that essentially opened an entire vessel on the open sea would involve rapid spreading of the spill, and there would be little chance for the effective use of containment equipment unless it was in the immediate area and ready for use when the incident occurred. In less severe cases where the spill release on the open sea occurs over several days, the ability to confine the spill in the immediate area would depend largely on the prevailing sea conditions. Containment in waters with a sea state greater than three is impractical with presently existing equipment designs; and even with a sea state of three, containment is ineffective if wind conditions are adverse.

For protected harbors and relatively calm waters, mechanical containment of a spill is often practical. Currents in excess of about two knots, however, make containment difficult without the use of extensive skirts and anchoring systems. The use of containment equipment in many rivers and streams is, therefore, often impractical.

There are three general types of containment devices which have been used to control oil spills. These are mechanical floating booms, underwater bubble barriers, and chemical barriers.

Floating Booms. There are numerous floating booms which are available commercially, and some are in common use in harbors and areas where transfers of petroleum products take place. Such booms generally consist of a tubular floating section, either inflatable or filled with a buoyant material. Below the floating section there is usually some form of weighted skirt which prevents oil from passing under the boom. A description of several of the commercially available floating booms is given below.

One of the first commercially available floating boom was the "Warne Inflatable Oil Boom" manufactured by the William Warne Company Ltd. of Essex, England and marketed in this country by Surface Separator Systems, Inc. of Baltimore, Maryland. The boom is available in 25- or 50-foot lengths and has a 22-inch skirt which is weighted with a continuous chain.

Flotation is provided by an air filled float of 8- or 16-inch diameter. Both float and skirt are made of heavy, fabric-reinforced, synthetic rubber. The boom is flexible and follows wave contours relatively well. The inflatable boom may be permanently installed and may be sunk and reinflated to allow passage of vessels. In addition to the flatable model, the Warne Boom is also available as a form or tube filled boom for permanent, floating installation. The Warne Boom is by far the most durable of the commercial booms and is excellent for regular use or permanent installation. It is however, also the most expensive of the floating booms costing up to $40 per linear foot for the inflatable boom and up to $60 per linear foot for the foam filled boom.

Another available floating boom is the "Marsan Oil Barrier" manufactured by the Marsan Corporation of Chicago, Illinois. Originally the Marsan Boom was inflatable, however, it is now available only as a foam filled boom. It is made in 50- or 100-foot lengths and has a chain weighted skirt of 15 to 36 inches. The boom is made of vinyl-covered nylon material which is claimed to remain flexible to -30°F. The original inflatable boom could be deflated and stored in a relatively small space; however, the newer version requires considerable storage space. The Marsan Boom is not as durable as the Warne Boom; however, it is considerably less expensive, costing from $6 to $10 per linear foot. It is not designed for permanent installation and should be used only for containing emergency spills.

Perhaps the most widely used floating boom is the "Slickbar Oil Boom" manufactured by Slickbar, Inc. (formerly Neirad Industries) of Saugatuck, Connecticut. The Slickbar Boom is available in 10-foot increments with skirts from 6 to 24 inches. Flotation is provided by either 4- or 6-inch foamed-plastic float. The skirt is made of plastic and is weighted either with riveted lead ballast or galvanized chain. Cost of the Slickbar Boom varies from about $4 to $14 per linear foot. Experience has shown that the Slick bar Boom lacks durability, and it is not recommended for regular use or permanent installation. Its relatively low cost, however, makes it attractive as an emergency containment device.

A more recent floating boom is the "Spillguard Boom" manufactured by Johns-Manville of New York, New York. The Spillguard Boom is available in 100-foot lengths with heights of 15 and 36 inches with 11- and 24-inch skirts, respectively. Flotation is provided by closed-cell, foamed plastic attached to each side of the vertical skirt. The skirt is made from a semirigid asbestos sheet coated with neoprene and is chain weighted for ballast. The weights of the two sizes of the

Spillguard Boom are 3 and 9 pounds per foot which makes handling somewhat difficult. The semirigid nature of the skirt material makes it difficult for the boom to follow the contour of the water surface. Costs of the two sizes are $7.50 and $20.00 per linear foot, respectively.

The "T-T Oil Boom" was developed in Norway by Trygve Thune and is marketed in this country by Hurum Shipping & Trading Company of Canada. The boom is available in 164-foot (50 meter) lengths and is 3 feet in height, 2 feet of which are submerged when the boom is in the water. Flotation is by plastic foam floats attached to both sides of the skirt. The skirt is made from canvas coated with polyvinyl chloride plastic and is reinforced with vertical aluminum stabilizers. The T-T Oil Boom can be folded and stored in a relatively small area. Cost of the boom varies from $6.80 to $8.10 per linear foot depending on the number of aluminum stabilizers. The boom is not intended for continuous use or permanent installation.

Two recently developed booms which were first used in the Santa Barbara incident are the "Kain Filtration Boom" distributed by Bennett International Services, Inc. of Woodland Hills, California, and the "Conway Retainer Wall" manufactured by Offshore Safety Systems, Inc. of Houston, Texas. Both booms are claimed to have performed well in the Santa Barbara Channel, and the Conway Boom is approved by the U. S. Geological Survey. Additional information is not currently available.

Other floating booms which have only recently been marketed include the "Jaton Floating Oil Retainer" from Centri-Spray Corp., Livonia, Michigan; "Sea Skirt" from Core Laboratories, Inc., Dallas, Texas; "EPS Retainer Seawall" from Environmental Pollution Systems, Inc., Victoris, Texas; "Sea Curtain" from Kepner Plastics, Inc., Torrance, California; "MP Boom" from Metropolitan Petroleum Petrochemicals Co., Inc., Jersey City, New Jersey; "Muletex Oil Boom" from Muehleisen Manufacturing Company, El Cajon, California; "Oscarseal" from the Rath Company, La Jolla, California; and "Sealdboom" from Uniroyal, Inc., Providence, Rhode Island. While each of these booms attempts in some way to be unique, it would appear that none has any more to offer for effectiveness, cost, or availability than any of the others previously described.

A floating boom sets up a simple physical barrier that contains the oil. Boom sections are manufactured in varying lengths, and the sections can be linked together as needed to contain large spills. In use, there must be enough sections to surround the spill or to hold it against another physical barrier, such as the side of a ship, a dock, or a shoreline.

At some terminals, booms are regularly installed around tankers or barges during unloading; but in most instances they are kept ready in case of a spill and are then deployed as needed.

Once the slick has been contained, the perimeter of the boom can be reduced by drawing the boom in from one end. This "piles up," or concentrates, the oil and facilitates its removal from the water by skimming. But in doing so, care must be taken so that the oil does not overflow the boom or escape under it.

At times it is desirable to move oil contained in this way by towing the boom. If this is attempted, tow lines should be secured to a number of points on the boom. When such lines are attached only to the ends of the boom, drag may cause the ends to come together, forcing out the entrapped oil. Care must be taken not to tow a boom at too high a speed. Research indicates that two knots is the maximum speed at which a boom may be towed and still retain the entrapped oil.

In general, the permanent installation of floating booms around docks and terminals is impossible since they interfere with the movement of vessels into and out of the area. In some permanent installations, however, booms, such as the Warne Boom, that can be inflated or deflated while in the water are being used. In position on the surface, the boom protects against spills from a loading or unloading tanker or barge. When the operation is complete, the boom is deflated and sinks to the bottom. The vessel moves off and another takes its place. The boom is then reinflated and rises to the surface in place to protect against spills from the new vessel. Only experience can determine whether the cost of such a setup is justified at a given location.

At docks or terminals where floating or inflatable booms are not permanently installed containment of a spill depends upon swift deployment of portable floating booms. In most instances, this requires the use of a boat plus several men. In some situations, however, configuration of docking facilities or local topography will permit deployment of floating booms without the use of a boat. The Americal Oil Engineering Research Department has developed a method for deployment of floating booms which is applicable to many situations where a boat would otherwise be required. A specially developed air gun is used to propel a light line up to 400 feet across water. This range is generally sufficient to cross most canals and many rivers. After being propelled to an opposite shore, the light line is used to draw across a heavier rope which, in turn, is used to deploy the floating boom.

Many floating booms can be transported on an emergency basis to the site of a remote spill through the use of trucks, trailers, or boats. Inflatable booms take up the least space and are the most easily transportable. Inflatable booms, however, also have the additional requirement of a portable air compressor for inflation. Portable floating booms also require the labor of several men, and normally a boat, for deployment. In some instances, the air gun described above might be of use and would eliminate need for a boat.

In addition to the many commercially available floating booms, makeshift booms are sometimes used. These have been constructed from many materials, including inflated fire hose and railroad ties or telephone poles strung together in a rope-like fashion. One more elaborate improvised boom consisted of oil drums from which a strip of 36-inch conveyor belt, weighted on one side, was suspended. Improvised floating booms suffer the disadvantage of usually being difficult to handle and of not being readily available. After a spill has occurred, the need for rapid containment frequently does not permit the time necessary for construction of an improvised boom.

The success of a floating boom depends on the conditions under which it is used. All booms work best in calm water. The higher the boom rises above the surface of the water and the deeper its skirt descends below the surface, the more oil it will hold and the greater its chance of success in rough water. The use of floating booms in flowing currents presents a somewhat different problem since the moving water tends to sweep the entrapped oil under the boom. The hydraulic force of the moving water pushing against the floating boom also makes control and anchoring of the boom difficult. Experience has shown that a current of two knots is the maximum in which the use of floating booms for spill containment is possible. In some instances, however, it may be possible to use floating booms in somewhat faster currents for the control of spills. By placing a floating boom at an angle to the direction of the current, the water movement would cause the oil to be pushed along the boom instead of being swept under it. Through the use of floating booms and boats, the spill can be effectively funneled towards the bank of a river where the water is more quiescent. Once in quieter water the spill may be contained and then recovered by skimming. While not being applicable to swift flowing streams, this method could extend the usefulness of floating booms to a current of perhaps five knots.

A decision as to what kind of boom will work best in a specific situation plainly is dependent on many factors. The choice of a boom for a given spot should be based on local conditions and knowledge of and experimentation with the different types available.

Though floating booms have been used successfully in many situations, many of the booms commercially available are generally unsatisfactory in open sea or rough water. Here, they are difficult to anchor properly and wave action carries oil over or under the boom. In addition, experience has shown that many of the commercially available booms tend to break apart under the severe stress of wind and wave action.

Bubble Barriers. A bubble barrier consists of submerged, perforated tubing or pipe from which compressed air is released. The result is a rising curtain of bubbles which creates an upswelling of the water surface above the tubing. The upflow of air generates hydraulic flow patterns which produce surface currents directed away from the bubble barrier. The physical height of the upswelling and the surface currents away from the barrier combine to prevent passage of a slick through the bubble barrier. The barrier works successfully as long as the free current of the water and the wind do not overcome the forces set up by the air curtain. The maximum depth of water for installation of bubble barriers is about 30 feet. As depth increases, bubbles released tend to follow a wandering rising path which results in a noncontinuous barrier when they reach the water surface.

Bubble barriers may be either portable or permanently installed. Portable devices suffer the disadvantage of being difficult to transport and deploy, compared to floating booms. A permanently installed bubble barrier, however, may be very effective for protecting restricted areas or around terminal facilities. Some recent applications in this country include installation for protection of beach areas from floating oil and debris and installation in a ship canal at barge terminal facilities. While bubble barriers are comparatively new in this country, they have been used extensively in Europe for protection of terminal and harbor facilities.

At locations where bubble barriers can be permanently installed, they hold the advantage over floating booms since they can be activated at the "flick of a switch." No time or labor is required for deployment as is needed for floating booms. The time saved is particularly advantageous since successful containment of a spill normally depends on quick action. Bubble barriers also allow the unrestricted entry and exit of vessels and, therefore, do not impede navigation. Their main disadvantage is the complete loss of containment in the event of air supply failure. The efficiency of spill containment in calm water and in currents is at least as good as that for floating booms.

The cost of bubble barriers is somewhat greater than that for floating booms; however, in certain applications, its advantages may outweigh the added cost. Bubble barriers are commercially available from Harmstorf, Hamburg, Germany; Ocean Systems of California; American Machine and Foundry Company, Stamford, Connecticut; Submersible Systems, Inc., Riviera Beach, Florida; and Atlas Copco Airpower, Hackensack, New Jersey.

Chemical Barriers. Certain chemicals inhibit the spread of oil on the water surface. Placing these materials around the perimeter of an oil spill will tend to contain the spill. One example of a chemical which can be used as a chemical barrier is Spill-Away manufactured by the Amerace Corporation, Tenafly, New Jersey. This material when applied to the perimeter of an oil slick will cause the spill to form a gell, thus preventing further spread of the spill. Work, with this and other chemicals, is still in the experimental and development phase, and no successful application of the chemical barrier principle to an actual oil spill is known to date. Pending further development, use of chemical barriers is not recommended.

Another containment device which has specific application to the control of under water oil sources has been developed recently. The device was developed by Firestone Coated Fabrics Company for use in the Santa Barbara Channel and is called a "Fabridome". Fabridomes are underwater tents made of nylon coated with polyvinyl chloride which are placed over sources of oil. A hose attached to the top of the tent is used to recover oil which collects in the tent. Fabridomes are now being used to control the oil seepage from the ocean floor in the Santa Barbara Channel but could also be used to contain leaks from underwater pipelines or to cover a sunken barge or vessel which is slowly leaking its cargo.

Removing the Spill

Following successful containment of a spill, the most satisfactory method of cleanup usually involves physical removal of the oil from the water surface. This procedure is called skimming and may be done using specially designed and equipped vessels, pumping devices, or other equipment.

There are several types of skimming vessels for oil recovery which have been designed on a variety of principles. Some have been specially designed and built for the job, others are simply barges or other boats which have been adapted for the work. In general, skimming vessels have equipment to:

1. Remove the oil from the water.

2. Separate the oil from the water.

3. Store the recovered oil.

Perhaps the simplest oil recovery vessel is simply a barge with suction equipment. Through use of floating booms, floating oil can be guided to suction ports where the oil is removed from the water surface and pumped into storage tanks aboard the barge. A variety of suction devices are available. Water recoverd with the oil is separated from the oil in the storage tanks and then discharged overboard. Vessels of this type may be constructed from barges and suction equipment, where available, or may be purchased commercially.

One commercially available suction barge is the Buda-1 "anti-pollution barge" which is marketed by the Marine Pollution Control Corporation, Detroit, Michigan. This vessel is a shallow-draft, 40-foot, self-propelled barge with a displacement of about 12 tons. The barge may be flown, trucked, or towed to the location of a major spill and is designed for use in calm conditions such as rivers, lakes, and harbors. A variety of suction adapters, both screened and unscreened, are available to fit varying wind and water conditions. While no oil recovery rate is claimed for the Buda-1, the storage tanks have a capacity of 5,600 gallons. The barge is equipped to carry 1,000 feet of portable floating boom, can be used as a trash and debris catching vessel, and can be equipped for spraying chemical dispersants. Cost of the Buda-1 barge plus accessories ranges from $28,000-up with delivery times of 4 to 6 weeks.

Oil recovery vessels and devices which operate on the suction principle are well adapted for operation in calm water when removing relatively thick oil slicks. They do not work well, however, in water with waves in excess of about 6 inches or on thin slicks of less than 1/4 inch. In these instances, suction equipment will draw excessive air or will recover an oil-water mixture containing 95+% water which will rapidly fill available tankage.

Another type of oil recovery vessel which is relatively simple utilizes skimming of oil over a weir. As with the suction devices, skimming over a weir will recover excessive amounts of water unless used in calm water on a thick oil slick.

One commercially available oil recovery vessel utilizing skimming over a weir is the T-T Oil Recovery System marketed by Hurum Shipping and Trading Company Ltd., Montreal, Canada, and developed by Trygve Thune of Norway. The system is mounted on a small, 18-foot barge powered by an outboard motor. As the barge moves through the water, floating oil is collected by paravanes on the front of the barge and an oil-water mixture is conveyed by a paddle wheel up an inclined plane over the weir. Having passed over the weir, the oil and water enter a chamber which has a perforated bottom and transverse perforated partitions. The latter eliminate turbulence in the mixture, allowing the oil to rise while the water escapes through the perforations in the bottom. Accumulated oil is then transferred from this chamber to storage tanks. The T-T Oil Recovery System has a maximum oil recovery rate, under ideal conditions, of 60 barrels per hour and a storage capacity of 36 barrels. Cost of the vessel is $33,400, FOB Norway, which includes 1,500 feet of floating oil boom and diesel-hydraulic auxiliary machinery. Because of its small size and recovery limitations in wavy water, use of the T-T Oil Recovery Vessel is limited to protected harbor areas.

A third type of oil recovery vessel utilizes the endless belt principle for oil recovery. The belt, either vertical or slanted, passes through the oil floating on the water surface and then through a roller or scraper system. Oil which preferentially adheres to the belt is removed by the roller or scraper and stored in tanks. A calm water surface is not as critical as for the other skimming devices; and hence, the endless belt principle works better in rough water.

The Oilevator or Petro-Lapper, marketed by Bennett International Services Inc., Woodland Hills, California, is a commercial application of the endless belt principle. The Oilevator utilizes a 3-foot wide conveyor belt made of canvas and terry cloth. After initially being soaked in oil, the belt will reject water and pick up mainly oil. Recovered oil from belts generally contains less than 5 percent water. The claimed oil recovery rate for the device under ideal conditions is 40 barrels per hour and it may be mounted on a variety of barges. Another commercial oil recovery vessel based on the endless belt principle has been developed by Rudolf Harmstorf of Hamburg, Germany; details, however, are not available.

Still another type of oil recovery vessel uses a revolving drum to lift the oil from the water surface. It works because oil tends to adhere to the metal surface of the drum, while water does not. The oil is removed from the drum by a scraper and is then pumped to storage tanks. As with the endless belt devices, recovered oil contains less than 5 percent water. Since the method depends on adherence of the oil to a metal drum, it does not work well with oil-in-water emulsions produced either by the use of detergents or by prolonged agitation by wind and waves.

The Maryland Port Authority currently uses an oil recovery barge named the "Port Service" for spill cleanup in Baltimore Harbor. This vessel uses the revolving drum principle for oil recovery and is marketed by Surface Separator, Inc., Baltimore, Maryland. The barge is 34 feet long and is propelled by a diesel engine. Mounted on the front of the barge are four pickup rollers, each three by four feet equipped with neoprene wipers. The rollers are submerged in the harbor waters at an approximate depth of 9 inches and rotated in an oil spill area. The oil adheres to the cylinders and, at the apex of their revolving cycle, is removed by wipers. The oil then gravitates to an inside well or sump, whereupon it is picked up by an additional roller for deposit into the body of the barge. The storage capacity of the "Port Service" is approximately 70 barrels, and no further separation of the oil and water is necessary. The pickup rollers may be lowered, elevated, and revolved at variable speeds for adjustment to various types of oil. The "Port Service" is designed for oil recovery in wave heights not exceeding one foot and, depending on type of oil, will recover up to 6 barrels per hour. The vessel is equipped for fire fighting and trash collection and may also be used for spraying chemicals. Cost of the "Port Service" plus accessories ranges from $105,000-up with a delivery time of six months.

Perhaps, the most recent development in oil recovery vessels was developed by American Oil Company and involves the use of a revolving drum covered with an absorbent foam. The drum is rotated in the water and absorbs oil and water. As the roller revolves, it is squeezed at a pressure calculated to remove the water. A second squeeze removes the oil, which is pumped to a storage tank.

The foam-covered roller device was initially marketed by Welles Products Corporation, Roscoe, Illinois, under the name "Reclam-Ator". Several of these recovery boats are currently in use at company locations. More recently, an improved version of the device was introduced by Worthington Corporation, Livingston, New Jersey, under the name "Mop-Cat". The Mop-Cat is a 25-foot catamaran with a displacement of about three tons. Propulsion is by water jet with the power obtained from two 20 HP Wankel engines. The Mop-Cat can operate in shallow waters of 2-foot depth, in waves of 2-foot height, and against head winds, river currents, and tides generally found around dock areas. Oil recovery rates for the Mop-Cat vary from 20 to 80 barrels per hour depending on oil viscosity and foam pore size. There is no storage space built into the vessel and recovered oil must be stored in drums on deck or pumped to floating reservoirs, service vessels, or directly to shore. The Mop-Cat is intended to be versatile and can be used for deploying oil booms, collecting floating debris, chemical spraying, and many other uses. Cost of the Mop-Cat ranges from $37,000-up with no specified delivery time.

In additon to the specially designed vessels for oil recovery there are numerous smaller floating surface skimmers which are available commercially. Many of these operate on essentially the same principles as the large vessels and are available through the same manufacturers. These devices are raft-like and have no means of propulsion. They can be permanently moored in places where oil collects and usually pump recovered oil and water to storage facilities located ashore or on a nearby barge. Because of their relatively small size, these floating skimmers are readily portable and can be easily moved to remote locations to recover emergency oil spills. Since these skimmers are not self-propelled, floating oil must be moved to the skimmer through the use of floating booms or by wind or current action.

One of the simplest floating oil skimmers is marketed by Rudolf Harmstorf of Hamburg, Germany, and works by the overflow principle. A receiving chamber with an overflow weir is mounted on gimbals between two floats and is connected by a suction pipe to a pump. Thickness of the oil-water layer overflowing the weir is controlled by regulating the pumping rate from the receiving chamber. The skimming device pumps recovered oil and water to a barge or shore facilities for further separation.

Another floating skimmer working by the overflow principle is manufactured by Acme Products Incorporated, Tulsa, Oklahoma, and is called the "Floating Saucer Water and Sludge Pump". This skimmer is also marketed by Sunshine Chemical Corporation under the name "Sea Broom". The device consists of a floating pump with a fiberglass skimmer attachment which will skim oil or any floating substance from the surface of the water. An adjustable inlet control can be set to allow skimming of one-half to three-inch depths on the surface of the water. Skimmed substances are pumped to tanks, trucks, or pits. The device is available in several sizes and can be powered electrically or by a gasoline or air motor. Variations in model and discharge head allow oil-water recovery rates of 20 to 700 gpm. Cost of the Floating Saucer plus attachments ranges from $750-up. Field experience with the Floating Saucer has revealed that the weight of the discharge hose from the pump causes the device to tilt in the water resulting in its drawing either excessive air or water.

Revolving drum skimmers similar to those used on the "Port Service" in Baltimore are available from Surface Separator Systems, Inc. with oil recovery capacities from 4 to 14 barrels per hour. Models may be either float-mounted or permanently attached to docks or similar facilities. Pumps and drums may be driven by air or electric power or by gasoline or diesel engines. Cost of these devices vary from $3,000 to $38,000 depending on design, with delivery times of one to four months. Roller drum skimmers are not as sensitive as overflow skimmers to surface turbulence and can operate satisfactory in wave heights of up to nine inches. Similar roller drum skimmers are also available from Rex Chainbelt, Inc., Milwaukee, Wisconsin.

Another oil skimming device which was recently introduced by Slickbar, Inc. is the Slickskim Oil-Recovery System. The skimmer consists of a floating skimmer head connected to flexible hose. The skimmer head can be moved through the use of lines from shore. A hose bridge, for crossing containment booms, a shore mounted pump, and a storage box are also included. The skimmer head can be adjusted to vary the skimming depth from 1/4 to 2 inches. Two models (Models 60 and 160) are available with advertised recovery rates of 86 and 254 barrels per hour, respectively. Since large amounts of water are generally recovered with skimming devices of this nature, separation equipment or large storage facilities are necessary. Cost of the Model 60 is $3,750 while the large Model 160 sells for $7,450.

In harbors or near port facilities, vacuum or suction pumps can be used to remove oil spilled close to shore. Such pumps suck up a substantial amount of water along with the oil making necessary the use of oil-water separation equipment. All things considered, vacuum pumping is probably the fastest way to get oil off the water, providing the receiving tanks are sufficiently large to hold all the accompanying water. In emergencies, vacuum trucks and pumping equipment of the type used to clean cesspools can be adapted for this use.

All present skimming equipment is designed to operate in relatively calm water. The efficiency of this equipment decreases as the roughness of the water increases. In some harbors and dock areas, skimming equipment is permanently installed in sheltered locations where oil tends to collect due to wind, water current, or shore configuration.

Skimming vessels and equipment work better when the floating oil is concentrated in a thick layer than when it is spread out over a large area in a very thin film. Thus, successfully confining a spill by use of floating booms or other means greatly facilitates its removal from the water surface.

Final Cleanup

There are many types of oil spills and no one cleanup material or method is the complete answer for all of them. In many situations, however, sorbent materials can be effectively used as an integral part of cleanup operations. For example, following containment of a spill and recovery of most of the oil by skimming techniques, sorbent materials can be used to complete the spill cleanup. In addition, sorbent materials can be used for primary cleanup of small spills where the use of larger recovery equipment is not warranted or for larger spills where cleanup by containment and skimming techniques is not possible.

Sorbent Materials. Effective sorbent materials are generally oil-attracting (oleophilic) and water-repelling (hydrophobic). Their use requires placement of the sorbent on the oil slick, attraction of the oil to the sorbent and retention by it, and subsequent removal and disposal of the resulting oily materials.

Sorbent materials are advantageous in that they do not add materials in solution and thereby contribute to the existing pollution problem. They are generally capable of picking up a high ratio of oil to the amount of sorbent used and can be distributed on an oil spill much more quickly than skimming equipment can be deployed. In addition, they can be used under docks, in marshes, and along shorelines where skimmers can not be operated and can be used on thin oil slicks where skimmers are ineffective. Major difficulties, particularly for large-scale spills, are in obtaining and delivering sufficient sorbent in the proper form at the proper time and place, collecting and transporting the oil-soaked mass to shore, and securing ultimate disposal of the oily material.

A large number of natural and synthetic materials have been used as oil spill sorbent materials. A listing of some of the more widely-used, commercially-available sorbents is given in the attached table. In addition, other materials, such as hay, sawdust, rope, sisal, talc, seaweed, kelp, chrome leather wastes, rock and glass wool, rayon floss, latex, and cotton or textile wastes, have been used depending on availability. These materials may be used in their natural state or in some cases may be specially treated in one or more ways to improve their sorptive properties and handling characteristics.

Straw is the most widely used oil sorbent because of ready availability, cheapness, and accepted effectiveness. Straw has the ability to absorb and retain up to five times its own weight of oil. Long cut wheat straw of the Durham, Marquis, Red Fife, or Kitchener strain is preferable where available. In addition to its sorptive properties, straw also facilitates oil moval through an enmeshing or entrapment phenomenon. This is particularly important on spills of heavy oils such as residual oil and weathered crude. For lighter hydrocarbons recovery by physical enmeshing is not a factor, and straw is somewhat less efficient.

Straw may be distributed over an oil spill manually or mechanically with or without shredding. After dispersal, it has been found that a ripening interval of from three to six hours is required for the maximum sorption to occur prior to harvesting of the oil-soaked straw. After sorption of the oil, the straw is generally harvested by hand either from shore or with the use of boats. Rakes, shovels, and pitchforks are normally used.

Although straw can be effective in the cleanup of many types of spills, it must be adequately worked into the oil; and its retrieval and disposal is a dirty, slow and tedious job requiring equipment and considerable manual labor. In some remote areas oil-soaked straw may be disposed of by burial or where air pollution is not a problem may be burned. In many areas, however, the soaked straw may not be buried because of potential ground water pollution and may not be burned because of existing air pollution codes.

In general, straw is an effective sorbent material which is normally readily available and relatively inexpensive. While straw itself is inexpensive, however, the use of straw for spill cleanup may be very costly because of the huge labor requirement and the problems of ultimate disposal of the oil-soaked straw. In addition, straw and some other natural sorbent materials will decompose during storage, if damp, which makes stockpiling difficult. Because of the storage, recovery, and disposal difficulties, straw is generally not recommended for use on small spills or as a final cleanup agent. It is, however, recommended for large spills where skimming equipment cannot be utilized and where the cost of other sorbents would be prohibitive.

Many other natural and synthetic sorbent materials are available only in bulk form like straw and are distributed and retrieved in a manner similar to that used for straw. Because these sorbents suffer the same disadvantages of straw and are normally considerably more expensive than straw, the use of these sorbent materials in bulk form is not generally recommended.

Several of the sorbent materials included in the following table such as Capilladiamin, Fiberperl, Oil-Blotter, Oil Sop, Petro-Pak, Sea-Serpent, and 3M Brand Sorbent, are available in bag or pillow form which makes distribution and recovery of the sorbent much easier. When used on light oils, such as distillate oil or fresh crude, sorbents in this form are convenient to use and have a high capacity since the light oil can readily penetrate and saturate the sorbent packing. For heavy oils, such as residual oil and weathered crude, however, the bags and pillows do not have a high capacity since the oil does not penetrate the packing to any great depth and much of the sorbent capacity is not utilized. The same is true of the sorbent booms which are available with Conwed, Fiberperl, and 3M Sorbent. Because of their limited capability to absorb heavy oils, the use of sorbents in bags, pillows, and booms is not recommended where these heavy oils may be encountered. In addition, their use is not recommended on large light oil spills since they are many times more expensive than straw.

Two sorbent materials, Conwed and 3M Brand Sorbent, are also available in the form of thin pads or sheets. In this form, the sorbent materials are most convenient to handle and use and are effective for both light and heavy oils. These materials as well as Microfoam and Tyvek are also available in the roll form which can be unrolled and torn for use in any convenient size or shape. The Microfoam and Tyvek are considerably lighter than the Conwed and 3M Sorbent (1-3 oz./yd.^{2} versus 10-12 oz./yd.^{2}) and are therefore more difficult to use under windy conditions. Because of their relatively high costs, these sorbents are not recommended for use on large spills. However, their high sorptive capacity and convenient form make them suitable for use on small spills where other cleanup techniques are not appropriate.

Reuse of sorbent materials is desirable if the recovered oil can be easily removed from the sorbent without seriously decreasing the original sorbent capacity. For most sorbents this is impractical. However, some of the synthetic foams, such as polyurethane, can be regenerated repeatedly and reused with little loss or sorptive capacity. Others, such as the Conwed and 3M Sorbent, are in a form which could be regenerated and reused a limited number of times.

In summary, straw appears to be the only suitable sorbent material for use on large oil spills where other cleanup techniques are not possible and the cost of other sorbent materials is prohibitive. For smaller spills and for final cleanup, sorbents such as Conwed and 3M Sorbent are most appropriate because of their high capacity for all types of oil; their convenient form, and their suitability for stockpiling and storage.

COMMERCIALLY-AVAILABLE OIL SPILL SORBENT MATERIALS

Sorbent	Manufacturer	Material	Form Available	Capacity (lb./lb.)	Type of Oil	Cost ($/lb.)
Absorbent 1012	Colloid Chemical Co.	Expanded Pumice	Bulk	2	All	.33
Agglomoweb	Collins & Aikman Corp.	Polypropylene Fiber Web	Bulk	-	Heavy	.56
ANDE-SIL	American Andesite Corp.	Volcanic Ash	Bulk	3	All	-
Aspen Wood Excelsior	Angeles Paper and Excelsior Products Co.	Excelsior	Bulk	-	Heavy	-
Bark	Many Suppliers	Wood Bark	Bulk	2-3	All	01.02
Bibbipol	Bibby Chemicals, Ltd.	Polyurethane Foam (Shredded)	Bulk	20-50	All	.51
Capillardiamin	U. F. Chemical Corp.	Urea-Formaldehyde Foam (Shredded)	Mesh Bags	30-40	Light	-
Controil	Goodman Laboratories	Expanded Vermiculite	Bulk	2	All	.17
Conwed Sorbent	Conwed Corp.	Treated Cellulose Fibers	Bulk	14-22	All	.07
"	"	"	Rolls	14-22	All	-
"	"	"	Pads	14-22	All	.93
"	"	"	Booms	14-22	Light	1.60
Ekoperl	Grefco, Inc.	Expanded Perlite	Bulk	5	All	.78
Fiberperl	Grefco, Inc.	Expanded Perlite & Cellulose Fibers	Bulk	5-7	Light	.22
"	"	"	Pillows	5-7	Light	-
"	"	"	Booms	5-7	Light	.71

Sorbent	Manufacturer	Material	Form Available	Capacity (lb./lb.)	Type of Oil	Cost ($/lb.)
Gel-Sorb 301	Burns & Russell Co.	Organic Powder	Bulk	2	All	1.50
Microfoam	DuPont	Polypropylene Foam	Rolls	10-40	All	
Oil-Blotter	Rittner Equip. Co.	Carbamide-Urca Foam	Mesh Bags	40-60	Light	4.50
Oil Blotter	(see Slickwik)					
Oil Snare	Parker Systems, Inc.	Polypropylene Yarn	Snares	10-60	Heavy	.80
Oil Sop	Carostan Co.	Foamed Resin	Mesh Bags	30-50	Light	-
Pest	(Many Suppliers)	Peat	Bulk	8-12	All	-
Perlite King SRD-32	Filter-Media Corp.	Expanded Silica-Alumina	Bulk	2	All	.11
Petro-Pak	W. R. Grace & Co.	Treated Vermiculite	Pillows	6-7	Light	.61
Polysorb	Quatek, Inc.	Urea-Formaldehyde Foam (Shredded)	Bulk	10	Light	.75
Sea Serpent	Johns-Manville	Cellulose Fibers	Mesh Bags	7-8	Light	1.37
Slickwik	Anderson Cob Mills, Inc.	Ground Corn Cobs	Bulk	4-5	Light	.10
Sorbent C	Clean Water, Inc.	Expanded Perlite & Cellulose Fibers	Bulk	7	All	.22
Sorbent JW-R-PS	J. W. Winkler Co.	Tires (Shredded)	Bulk	5	All	.86
Sorbent JW-EX-PS	J. W. Winkler Co.	Polystyrene (Shredded)	Bulk	30-200	Heavy	.15
Sorb-Oil	Innova Corp.	Cellulose Fibers	Sheets	7-20	Light	.30
Sosol	Scandanavian Oil Service	Polyurethane Foam	Bulk	20-50	All	3.20
Straw	(Many Suppliers)	Wheat Straw	Bulk	3-5	All	.015

Sorbent	Manufacturer	Material	Form Available	Capacity (lb./lb.)	Type of Oil	Cost ($/lb.)
Strickite Oil Collector	Strickman Industries, Inc.	Polymeric Granuals	Bulk	10-25	All	.51
3M Brand Sorbent	3M Company	Polymeric Fibers	Bulk	10-25	All	1.75
"	"	"	Rolls	10-25	All	1.80
"	"	"	Pads	10-25	All	1.87
"	"	"	Pillows	10-25	Light	2.10
"	"	"	Booms	10-25	Light	2.28
Typar	DuPont	Polypropylene Fabric	Fabric	10	Heavy	1.00
Tyvek	DuPont	Polypropylene Fibers	Bulk	10-50	All	1.05
"	"	"	Rolls	10-30	All	1.35
Vermiculite	Several Suppliers	Expanded Vermiculite	Bulk	5	All	.075
Wonderperl 1640	Perlite Popped Products	Expanded Perlite	Bulk	5	All	.20
Zorb-All	BASF Wyandotte Corp.	Calcinated Clay	Bulk	1-5	All	.025

*Note: Light Oil - Distillate and Fresh Crude
Heavy Oil - Residual Oil and Weathered Crude

Gelling Agents. The use of special gelling or congealing materials applied over the surface or periphery of an oil slick is another approach for containing and cleaning up oil spills. The gelling concept is also in the process of development of stabilizing liquid cargo aboard a stranded or heavily-damaged vessel at sea.

One commercially available gelling agent is Spillaway manufactured by the Amerace Corporation, Tenafly, New Jersey. When applied in spray form it is reported to form a stiff gel with oil on water. When placed around the perimeter of an oil slick, the gel is said to form an effective chemical boom which prevents the oil from further spreading. The oil contained within the inner circle may be removed by mechanical means or the total slick may be gelled to facilitate removal. The developers also claimed that the oils recovered in this manner may be profitably reclaimed. For example, the gelled mass may be mixed with fuel oil and burned as replacement bunker fuel.

Possible toxicity of this class of chemical is unknown but under current evaluation. Data from the manufacturer indicate approximately one part chemical is necessary per part of oil to be gelled, thereby giving an estimated cost of about $1.50 per gallon oil treated. However, these costs very likely reflect laboratory testing and assuredly would be lower for field application.

Dispersants. Dispersants are another group of chemicals which have been used for the final cleanup of oil spills and also as a primary cleanup tool. Scores of products are sold in this country for the purpose of emulsifying oils. Many have been developed for such uses as clearing residual oil from cargo tanks before loading of fresh cargo. Of these, at least 70 have been claimed useful for dispersing oil from the surface of water. These products are known by a variety of names: emulsifiers, detergents, degreasers, dispersants, etc. For consistency, they will be referred to as dispersants since this term describes what they are intended to accomplish--the dispersion of oil from the surface into and throughout the body of water.

A partial list of the many commercially available oil dispersants, along with their manufacturer, cost and recommended application rate where available, is given in the following table.

The primary components in most dispersants are surfactants, solvents, and stabilizers. Surfactants, by their affinity for both oil and water, alter the interaction between oil and water so the oil tends to spread and can be more easily dispersed into small globules--or what is commonly called an emulsion. Soap does the same thing to oil on our hands, allowing it to be emulsified or dispersed and washed away in water.

PARTIAL LIST OF COMMERCIALLY AVAILABLE DISPERSANTS

Dispersant	Manufacturer	Cost ($/Gal.)	Application Rate
Alken OSD	Alken-Murray Company New York, NY	3.00	7-10%
Aquaclene	Metropolitan Petroleum Petrochemicals Co. Jersey City, NJ		8-100%
Aquanex MC*	Montgomery Chemical Co. Jenkintown, PA		
Aquanex 410*	Montgomery Chemical Co. Jenkintown, PA		
BP 1100	British Petroleum Company London, England	1.40	10-25%
Chevron NI-0	Chevron Chemical Company San Francisco, CA		
Corexit 7664*	Enjay Chemical Company Houston, TX	3.75-4.00	1-10%
D-166*	Dunham Chemical Corp., Inc. New York, NY		(15-25%)*

Drew OSE-1*	Drew Chemical New York, NY	2.77-3.25	3-5% (15-25%)*
E-314	DuBois Chemicals Cincinnati, OH		
Gamlen Gamosol*	Gamlen Chemical Company San Francisco, CA		(15-25%)*
Gold Crew	Ara Chem, Inc. San Diego, CA		2-10%
Holl-Chem	Holl-Chem, Inc. Seattle, WA	1.90-2.15	5-20%
Jansolv-60*	Sunshine Chemical Corp. Jacksonville, Fla.	1.90-2.15	
Navee-42*	Amerace Corp. Tenafly, NJ		
Pilot OSE	Pilot Chemical Company Norfolk, VA	2.75	
Polycomplex A-11*	Guardian Chemical Corporation Long Island City, NY	3.00	13-20%
Ridzlik	Ashland Chemicals Company Ashland, KY		
Seasweep	Eureka Chemical Company Olympia, WA		
Slick-Away*	Mankana Chemical Company Baltimore, MD	3.50	10-20%
Slix*	Amerace Corp. Tenafly, NJ		
Spill Remover	Wyandotte Chemiical Company Wyandotte, MQ		

Tretolite MC 150*	Petrolite Corp. St. Louis, MO		
Tretolite W-1439	Petrolite Corp. St. Louis, MO		
Tricon OSE	Magnus Chemical Company Garwood, NJ	2.00-2.58	1-10%
Unisol-4-DT*	Universal Chemical Corp. Central Falls, RI		

*Dispersants evaluated by American Oil's Engineering Research Department

Solvents enable the active agent or surfactant, to mix with and penetrate into the oil slick and thusly form the emulsion. The solvent usually comprises the bulk of the dispersant product and may range from petroleum solvents such as kerosene to water solvents. Petroleum based and chlorinated hydrocarbon solvents represent the most toxic component in the dispersant product but also dissipate rapidly in the water environment. Stabilizers, which are the third major component in most dispersants, fix the emulsion once it is formed.

The use of dispersants in oil pollution incidents is intended to separate the slick into miniscule particles and thus provide a means of accelerating the rate of natural degradation of oil. We know that oil is degraded naturally at sea at a rate depending upon the surface area of the oil available to the microorganism populations. Increasing the surface area of the oil by dispersion accelerates this biological degradation.

Dispersants have been used for a number of years for dispersing small oil slicks in several harbors in this country and abroad. Because of the small quantities involved, the environmental effects were minimal and the complaints limited. Few alternatives exist for handling oil spills and dispersants are easily obtained, transported, and applied. They furthermore, offer visible evidence of "doing something" about pollution incidents.

The first major test of oil dispersants came during the TORREY CANYON incident where 15,000 tons of dispersants were used to treat 75,000 tons of oil. Two-thirds of this amount was used for cleaning oil from contaminated shores and resulted in severe adverse effects on the aquatic life. The areas of the shore where dispersants were not used, but heavily polluted with oil alone, showed very minor damage according to the Plymouth Laboratory of the Marine Biological Association of the United Kingdom, who studied the biological effects of the TORREY CANYON spill. These observations led to the conclusion that dispersants cause much more damage to aquatic life than oil alone.

The dispersants used during the TORREY CANYON incident mostly contained chlorinated hydrocarbons as the solvent base and were highly toxic, killing marine organisms at concentrations around 10 parts per million. The use of these dispersants is not recommended under any circumstances.

The biological damage during the TORREY CANYON spill appeared to be limited to the shore areas. In the open sea where they were also used, there were no detectable effects on marine life. Officials from the United Kingdom took samples by trawling directly beneath slicks treated with emulsifiers and observed no deaths and no tainting of the flavor of commercial species. Procedures for this type of sampling are not notably precise, however.

Current information indicates that oil dispersants vary considerably in toxicity. The early dispersants using chlorinated hydrocarbons, such as those used during the TORREY CANYON incident, were highly toxic as evidenced by the wide-spread adverse effects on aquatic life. Since then, however, other less toxic dispersants have been developed and a considerable amount of research on their toxicity has been conducted. Independent toxicity reports on oil dispersants have been issued by the state of Washington Water Pollution Control Commission and by the Water Resources Commission of the Michigan Department of Natural Resources. Other proprietary studies have been made by the various manufacturers of the oil dispersants. Widely varying toxicity data have been obtained for some dispersants.

For example, the data for Corexit 7664, one of the more widely used dispersants, show toxicity levels of 15.8 mg/l and 3,200 mg/l for the Washington and Michigan studies, respectively. These data show a 200 fold difference in toxicity and compare with a toxicity level, claimed by the manufacturer of over 10,000 mg/l. Wide variations such as this have lead to the development of standard toxicity procedures by the FWPCA.

These procedures are now being used to determine the comparative acute toxicity of dispersants and the FWPCA results when complete will be published in a comprehensive report. In addition to the FWPCA research, Battelle-Northwest is currently assessing toxicity measurement methods in an API sponsored study.

Moreover, the combination of oil and dispersant may conceivably increase the toxicity of either the oil, the dispersant chemical or both. The possibility of this "synergistic" action must be carefully examined before wholesale and widespread use of dispersants is permitted. Dispersing the oil, which by itself is toxic to many forms of marine life, may also compound the damage to the aquatic ecology.

But toxicity is not the only consideration in the use of dispersants. Of equal significance is their effectiveness. Experience at San Juan, Puerto Rico, and field tests conducted by research personnel at Edison, New York, indicate that they are generally ineffective for cleaning oil from beach sand of the type found along our east coast. They actually compound the problem by adding to the amount of pollutants present and by causing the oil to penetrate more deeply into the sand. The "TORREY CANYON Pollution and Marine Life" report also noted that "quicksand" occurred as the result of using these materials, resulting in beach erosion from tidal and wave action.

Evaluation of the effectiveness of dispersants on water is much more difficult in cases of accidental spills. Lack of adequate methods for measuring the amount of oil on water and the rate of natural dispersion make precise evaluation difficult. Their effectiveness during the TORREY CANYON spill is still being debated. Subsequent incidents which are claimed to have demonstrated their effectiveness have been at remote locations and without impartial, qualified observers. Application methods of dispersants and subsequent agitation, which are critical for effective performance, have not always been optimal.

Research work on the effectiveness of oil dispersants, as for the research on toxicity, has shown widely varying results. For example, the Naval Civil Engineering Laboratory in 1968 found Jansolv-60, one of the more widely used dispersants, to be the most effective of the 14 dispersants tested; and it is now on the Navy's list of authorized oil spill cleanup materials. On the other hand, American Oil's Engineering Research Department compared Jansolv-60 with 13 other dispersants and, while generally judging all dispersants as inefficient, rated Jansolv-60 as "poor" on dispersal ability when compared to Drew OSE-1, D-166, and Gamosol.

The procedures and testing methods used by various researchers to evaluate dispersant effectiveness have not been consistent, and this makes comparsion of results difficult. Application procedures and agitation methods have varied widely as have the evaluation criteria. Battelle-Northwest is currently assessing effectiveness of dispersants in an API sponsored study. Being evaluated are permanency, method of application, application rate, extent of agitation required, and reaction time.

While variations in testing procedures may account for the published differences in both toxicity and effectiveness data, it is probable that product quality also has a bearing on the observed differences. Since oil dispersants are generally compounded from low-grade industrial chemicals, it is possible that variations in the quality of these chemicals may have a pronounced effect on either toxicity or effectiveness of the dispersant.

There are two general methods for the application of dispersants to oil spills. The first involves the spraying of neat dispersant on the spill. The dispersant may be sprayed using hand operated pump units, small pressure units, or heavy duty portable pressure units. It may be sprayed from shore, boat, or planes depending on size and location of the spill. After the dispersant has had sufficient time to combine with the oil, usually several minutes, mixing energy is applied to the spill to disperse oil dispersant into the water. This energy may be applied through such means as fire hoses, boat propellers, or helicopter prop wash. In some cases, sufficient mixing energy can be obtained from existing wind and wave action. In general, the equipment necessary for the efficient use of dispersants on large spills, for proper density application, and for agitation of large areas of the sea surface have not been developed.

The second method for dispersant application involves the use of an eductor system to apply the dispersant in a diluted form. Portable pump eductor systems or fixed fire hose eductor systems may be used. When using fire hoses for the application of dispersants, sufficient mixing energy for dispersal is usually obtained from the force of the water flow. Application and dispersal in one step through the use of eductor systems is not as efficient as the two-step method, since the diluted dispersant does not have the intimate contact or reaction time necessary for optimum effectiveness.

The physical properties of the dispersant may have a pronounced effect on its ease of application under various environmental conditions. While most dispersants are relatively easy to apply at room temperature, many become thick and viscous at temperatures approaching 32°F. At these temperatures it is difficult to spray the dispersant or educt it into a fire hose, and it must be diluted with water to increase its fluidity. At temperatures below freezing, many of the dispersants solidify and, since dilution with water is impossible at these low temperatures, become unusable. Of the dispersants evaluated by American Oil's Engineering Research Department only Drew OSE-1, D-166, Aquanex MC, and Gamosol remained fluid at -20°F, a not unreasonable winter temperature at northern refinery or terminal locations. Perhaps conincidently, 3 of these dispersants (Drew OSE-1, D-166, and Gamosol) were also the most effective of the 14 dispersants evaluated. Dispersants which gel or solidify at low temperatures must be kept at room temperature for long periods of time before they can be used. Others upon solidifying separate into rather sharply defined phases and upon warming must be thoroughly mixed before use.

The cost of dispersants generally ranges from $2 to $4 per gallon. Using recommended dosages, this means the cost of dispersant chemical for dispersing a spill of 500 barrels of oil would be approximately $20,000. The cost for treating major spills, including cost of application may be substantial. It is estimated that the cost for chemicals used in the TORREY CANYON incident exceeded $5,000,000.

As with absorbents, different dispersants work best under varying circumstances. It is up to the persons who will be responsible to clean up possible future oil spills at specific locations to be familiar with the dispersants available, their effectiveness, and their applicability for the oil and conditions at each location.

The indiscriminate use of dispersants as a primary oil spill cleanup method is not recommended. Dispersal of an oil spill is not an acceptable substitute for containment and recovery. There are instances, however, where adequate containment and recovery are not possible. On the open sea where wind and wave conditions prevent the use of booms and skimming devices, dispersants may be used to disperse a spill before it reaches beach areas. The toxic effects of dispersants have been shown to be minimal under these conditions. Dispersants may also be used in instances where a substantial safety or fire hazard exists because of a spill of light hydrocarbon. Federal, state, and local officials generally disapprove of the use of oil dispersants since they pose a threat to the marine ecology. In line with this general disapproval, the FWPCA has developed a set of guidelines concerning the use of dispersants to treat oil spills. This policy is reproduced on the following page. The federal policy should be consulted and used as a guideline for the use of dispersants. In some localities ordinances prohibit or limit the use of dispersants, and these ordinances should be followed wherever they exist.

Sinking Agents. Sinking agents are another group of materials which may have limited application for the cleanup of oil spills. Sinking agents are granular solids of high density and generally of fine structure. When applied over the surface of a slick, they adhere to the oil, absorb it, and ultimately sink. Typical oil-sinking agents include sand, brick dust, fly ash, slaked lime, stucco, cement, china dust, omya clay, volcanic ash, chalk, curshed stone, coal dust, and specially-produced materials such as sands and fly ash which have been treated with silicone or wax. A commercial silicone treated fly ash is available from Midland Silicones, Ltd. A refined aluminum silicate clay called AP-10 is marketed by Aqua Pura Inc.

Sinking agents can be efficiently employed on thick heavy or weathered oil slicks. If the oil is widely dispersed on the surface in disassociated masses, quantities of materials required are prohibitive. It is doubtful that sinkants may be profitably used with thin films and light crudes. The absorbent must be evenly mixed with the slick and have proper time for interaction before the ensuing mass eventually sinks. Furthermore, bonding of the agent with the oil must be nearly permanent; or else there will be eventual release of the entrapped and sunken oils back to the water environment.

The largest full-scale application of sinking agents was undertaken by the French during the TORRY CANYON incident. Some 3,000 tons of calcium carbonate with about one percent of sodium stearate added were reportedly used to treat and sink about 20,000 tons of oil found in the Bay of Biscay and originating from the TORREY CANYON. Although good scientific data are generally lacking particularly as to the precise amount of oil actually treated, the oils were reported sunk in 60-70 fathoms and coastal pollution was minimized. The French success was attributed to good spreading and mixing of the chalk into the oil body and the high density of the weathered slick, thereby requiring considerably less absorbent as compared to fresher oils. Subsequent reports state that 14 months after the incident no sign of oil was found over the water surface. On the basis of French experiences above, oil-sinking agents have subsequently become more attractive and promising.

More recently, AP-10 from Aqua Pura Inc. was used as a sinking agent in the Santa Barbara incident. After initial testing of the material indicated that it was not toxic to marine life in the area, "substantial quantities" were purchased by Union Oil Company for use in treating oil slicks in the Santa Barbara Channel.

Opinions on the use of oil sinkants still remain divided as to efficiency, cost, application, and detrimental environmental effects. Advantages of this type of treatment are that it tends to confine the spilled oil and the concomitant damage to a fixed place on the sea and probably minimizes toxicity to free floating plants and animals. Opposition to these agents are ascribed to the potential damage to sea bottom life, the problems associated with transporting and properly applying large amounts of the agents to the oil slicks, plus the possibility of the oil resurfacing following biological degradation of the conglomerate.

Economics of this treatment method varies widely because practically all data have been obtained from laboratory testing rather than from application under field conditions. Early Department of Interior studies suggest three pounds of carbonized sand are required to sink one pound of oil whereas other studies indicate ratios of one or less of sinker weight to oil weight, depending upon density of oil slick and other factors. Large-scale application generally envisions spraying a slurry of sand or other mixture over the slick from a large vessel, hopper dredge, or equivalent. The cost of sinking agents is generally in the range of $20 to $80 per ton, depending upon quantity purchased, and location and type of material required.

The use of sinking agents is most advantageous in deeper ocean waters away from the heavy-fishing zones. If resurfacing of the oils does occur in these locations, it should be gradual and far less objectionable in the event weathered oils were washed ashore at a later time.

The use of sinking agents is not recommended in fresh water lakes and streams and in shallow bays and estuaries where adverse effects on marine life would be expected.

Burning Agents. The concept of setting afire oils which have spilled and spread over the surface of a water body is potentially attractive principally because this appears to offer an inexpensive means of disposing of the problem. Past attempts to burn oils upon the sea have been almost completely unsuccessful, especially in the case of the TORREY CANYON. There, addition of thousands of gallons of aviation fuel, napalm, and sodium chlorate, together with aerial bombing of the vessel, failed to produce sustained burning. Spilled oil may possibly be burned by using catalythic or combustible agents or inducing "wicking" action between the oil and water.

The "wick" theory, assumes that capillary action is induced in the oil slick and a portion of the oil is drawn up to air (oxygen) interface to promote burning. Concurrently, the surface oil is partially insulated from the cooling effect of the sea water underneath. Wood, debris, and flotsam enmeshed with the spilled oil apparently also insulates this layer from the colder water body and sustains burning. Since freshly spilled crude oil contains a relatively high proportion of volatile components, its ignition is more feasible than for weathered crude where the volatiles have already evaporated. Besides potential materials such as felting and asbestos-like agents, three commercial products are known which promote the burning of oils on water.

One of the burning agents is "Pyraxon" and is manufactured by Guardian Chemical Corporation, Long Island City, New York. Pyraxon is specifically designed for the burning of heavy oils, residuals, and high-sulfur asphaltic crudes. It is not recommended for use on light oils which can be treated with dispersants. Pyraxon consists of a liquid and a powder. The liquid is essentially a light hydrocarbon used to dilute the heavy oil and to lower its ignition temperature. Prior to ignition, the powder becomes hot and causes decomposition and cracking of the heavier oil into volatile and partially oxidized hydrocarbons which sustain the combustion process. The manufacturer claims complete combustion of all floating oil, leaving no residue to be cleaned up.

Another commercial burning agent is "Cab-O-Sil ST-2-O" manufactured by the Cabot Corporation, Boston, Massachusetts. Cab-O-Sil is a silicone treated colloidal silica which has a low bulk density, is hydrophobic, and is thermally stable. The silica is applied to the oil slick using a water stream and a conventional venturi feeder system. A localized area is then lighted and the fire spreads to adjacent regions treated with the silica. Oil to sustain combustion is transported through the fumed silica by surface diffusion and capillary action. When combustion is complete, a floating residue, approximately two percent of the original, remains and can be easily removed from the water surface by mechanical means. The manufacturer recommends application of one to four weight percent of the Cab-O-Sil which sells for $2 per pound.

The last burning agent is "SeaBeads" manufactured by Pittsburgh Corning Corp., Pittsburgh, Pennsylvania. SeaBeads are cellulated glass beads approximately one-quarter of an inch in diameter and are naturally buoyant. When applied to a spill, they become covered with oil; and combustion is initiated by an incendiary device, such as a simple blow torch. Oil to sustain combustion is transported through the layer of SeaBeads by a wicking action. The beads have good insulating properties and the heat developed by the fire is not lost to the water below. After combustion is complete the SeaBeads can be collected or merely left to break up from abrasion. They are inert and nontoxic.

None of the burning agents, so far as is known, has been applied in large scale; and therefore factors of logistics, application, and amount of residue are unknown. Controlling the burning oil mass, ensuring air pollution, and disposal of the residue preclude the use of burning agents in all but the most remote locations.

Summary

Wherever possible, oil and chemical spills should be prevented before occurence by proper maintenance of equipment and through proper training of personnel. Each location with a spill potential should establish procedures for dealing with any possible spill which may occur. This could include purchase of oil spill cleanup equipment and chemicals where applicable and perhaps membership in local cleanup cooperatives.

Once a spill has occurred, it is generally preferable to prevent the spread of the spill by means of booms, air curtains, or other physical, chemical, or pneumatic barriers and to remove the oil from the water surface by means of skimming equipment. In some instances, where removal by skimming is not possible, floating absorbent materials, such as straw, and gelling agents may facilitate removal of the spill. In limited instances, dispersants may be used as a primary cleanup device when used judiciously, following the general guidelines established above. Dispersants may also be used as a secondary cleanup device for final cleanup of beaches, dock facilities, booms, and skimming equipment. Sinking and burning agents are not generally recommended for use but may find application under some circumstances.

DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
POLICY ON THE USE OF
CHEMICALS TO TREAT FLOATING OILS

1. Chemicals should not be used to emulsify, disperse, solubilize, or precipitate oil whenever the protection or preservation of (a) fresh water supply sources, (b) major shellfish or fin fish nurseries, harvesting grounds or passage areas, or (c) beaches is a prime concern.

   Such chemicals should only be used in those surface water areas and under those circumstances where preservation and protection of water related natural resources is judged not to be the highest priority or where a choice as to resource preservation may make the use of such materials a necessary alternative.

2. Examples of areas and circumstances where the use of such chemicals might be acceptable are:

   a. where fire or safety hazards are presented by the spill of a petroleum product;

   b. where large numbers of waterfowl may perish because of the priximity of floating oil;

   c. under certain conditions, as a "polishing" or final cleanup of light slicks of oil following mechanical removal of floating oils.

3. Chemicals that emulsify, disperse, solubilize or precipitate oil should be used only under the immediate supervision of the Federal Water Pollution Control Administration except where it is judged that fire or safety hazards require the immediate application of such chemicals.

4. When chemical compounds are used in connection with oil cleanup, only those compounds exhibiting minimum toxicity toward the aquatic flora and fauna should be used. The Federal Water Pollution Control Administration is now developing and will soon issue a standard procedure for determining the toxicity of such chemicals.

5. Materials which aid in the collection of floating oils such as sorbents, gellants and viscosity control additives are considered to be generally acceptable providing that these materials do not in themselves or in comtination with the oil increase the pollution hazard.

6. Research and development to improve chemicals which emulsify, disperse, solubilize or precipitate oil is encouraged. Whenever it is demonstrated to the complete satisfaction of the Federal Water Pollution Control Administration, that such a chemical, by itself and in combination with oil is nontoxic its use may be approved in the areas where the protection or preservation of (a) fresh water supply sources, or (b) major shellfish or fin fish nurseries, harvesting grounds or passage areas is a prime concern.

* * *

4

AMOCO

Amoco Production Company
Post Office Box 17675
Salt Lake City, Utah 84117
801-272-9253

Martin Zimmerman
District Superintendent

March 24, 1980

State of Utah
Division of Oil, Gas, and Mining
1588 West North Temple
Salt Lake City, Utah 84116

File: MZ-141-031.190/WF

Drilling Operations - Great Salt Lake

Please be advised that Amoco Production Company requests cancellation of the following approved "Applications for Permit to Drill":

1) State of Utah "A" #1, NW/4 NW/4
Section 20, T3N-R4W, Davis County

2) State of Utah "B" #1, C - NW/4
Section 5, T5N, R6W, Box Elder County

3) State of Utah "F" #1, NW/4 SW/4
Section 15, T3N, R5W, Tooele County

4) State of Utah "G" #1, SE/4 NW/4
Section 29, T3N, R5W, Tooele County

RECEIVED
MAR 28 1980
DIVISION OF
OIL, GAS & MINING

As a result of revised seismic, geologic and engineering interpretation, new well locations will be selected for subsequent drilling operations.

Martin Zimmerman

Martin Zimmerman
DIstrict Superintendent

SW/crj

Form DOGC-1a

SUBMIT IN TRIPLICATE*
(Other instructions on reverse side)

STATE OF UTAH
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF OIL & GAS

APPLICATION FOR PERMIT TO DRILL, DEEPEN, OR PLUG BACK

1a. Type of Work
DRILL [X] DEEPEN [ ] PLUG BACK [ ]

b. Type of Well
Oil Well [ ] Gas Well [ ] Other Wildcat Single Zone [ ] Multiple Zone [ ]

2. Name of Operator
Amoco Production Company

3. Address of Operator
Security Life Building, Denver, Colorado 80202

4. Location of Well (Report location clearly and in accordance with any State requirements.*)
At surface
1320' FNL & 1320' FWL Section 5, T5N, R6W, S.L.M. C NW
At proposed prod. zone

5. Lease Designation and Serial No.: ML 26510
6. If Indian, Allottee or Tribe Name:
7. Unit Agreement Name:
8. Farm or Lease Name: State of Utah "B"
9. Well No.: 1
10. Field and Pool, or Wildcat: Wildcat
11. Sec., T., R., M., or Blk. and Survey or Area: Section 5-5N-6W

14. Distance in miles and direction from nearest town or post office*
Approxi. 35 miles west of Ogden

12. County or Parrish: Box Elder
13. State: Utah

15. Distance from proposed* location to nearest property or lease line, ft. (Also to nearest drlg. line, if any): 1320
16. No. of acres in lease: 2240
17. No. of acres assigned to this well:

18. Distance from proposed location* to nearest well, drilling, completed, or applied for, on this lease, ft.: none
19. Proposed depth: 10,000'
20. Rotary or cable tools: Rotary

21. Elevations (Show whether DF, RT, GR, etc.): 4199' Ground
22. Approx. date work will start*: August 1975

23. PROPOSED CASING AND CEMENTING PROGRAM

Size of Hole	Size of Casing	Weight per Foot	Setting Depth	Quantity of Cement
	20	94	115	Drive pipe
~~17-1/2~~	~~13-3/8~~	~~48~~	~~300~~	~~300~~
~~12-1/4~~	~~9-5/8~~	~~32.3~~	~~2,000~~	~~800~~
9-3/4	7	26	10,000	400

Well to be drilled in Great Salt Lake. Water depth at this location is 75 feet. Well to be bottomed in Pre-Tertiary to adequately test the Tertiary.

Attached are applicable, pertinent pages from Amoco's oil spill contingency plan.

IN ABOVE SPACE DESCRIBE PROPOSED PROGRAM: If proposal is to deepen or plug back, give data on present productive zone and proposed new productive zone. If proposal is to drill or deepen directionally, give pertinent data on subsurface locations and measured and true vertical depths. Give blowout preventer program, if any.

24.
Signed Clinton L. Pierce Title Sr Staff Engr Date 10-17-74

(This space for Federal or State office use)

Permit No. .... Approval Date ....

Approved by .... Title .... Date ....
Conditions of approval, if any:

*See Instructions On Reverse Side (over)

Instructions

General: This form is designed for submitting proposals to perform certain well operations, as indicated, on all types of lands and leases for appropriate action by either a Federal or a State agency, or both, pursuant to applicable Federal and/or State laws and regulations. Any necessary special instructions concerning the use of this form and the number of copies to be submitted, particularly with regard to local, area, or regional procedures and practices, either are shown below or will be issued by, or may be obtained from, the local Federal and/or State office.

Item 1: If the proposal is to redrill to the same reservoir at a different subsurface location or to a new reservoir, use this form with appropriate notations. Consult applicable State or Federal regulations concerning subsequent work proposals or reports on the well.

Item 4: If there are no applicable State requirements, locations on Federal or Indian land should be described in accordance with Federal requirements. Consult local State or Federal office for *specific instructions.*

Item 14: Needed only when location of well cannot readily be found by road from the land or lease description. A plat, or plats, separate or on this reverse side, showing the roads to, and the surveyed location of, the well, and any other required information, should be furnished when required by Federal or State agency offices.

Items 15 and 18: If well is to be, or has been directionally drilled, give distances for subsurface location of hole in any present or objective production zone.

Item 22: Consult applicable Federal or State regulations, or appropriate officials, concerning approval of the proposal before operations are started.

Parker Drilling Company Heli-Hoist Rig (Rig Number to be furnished later)

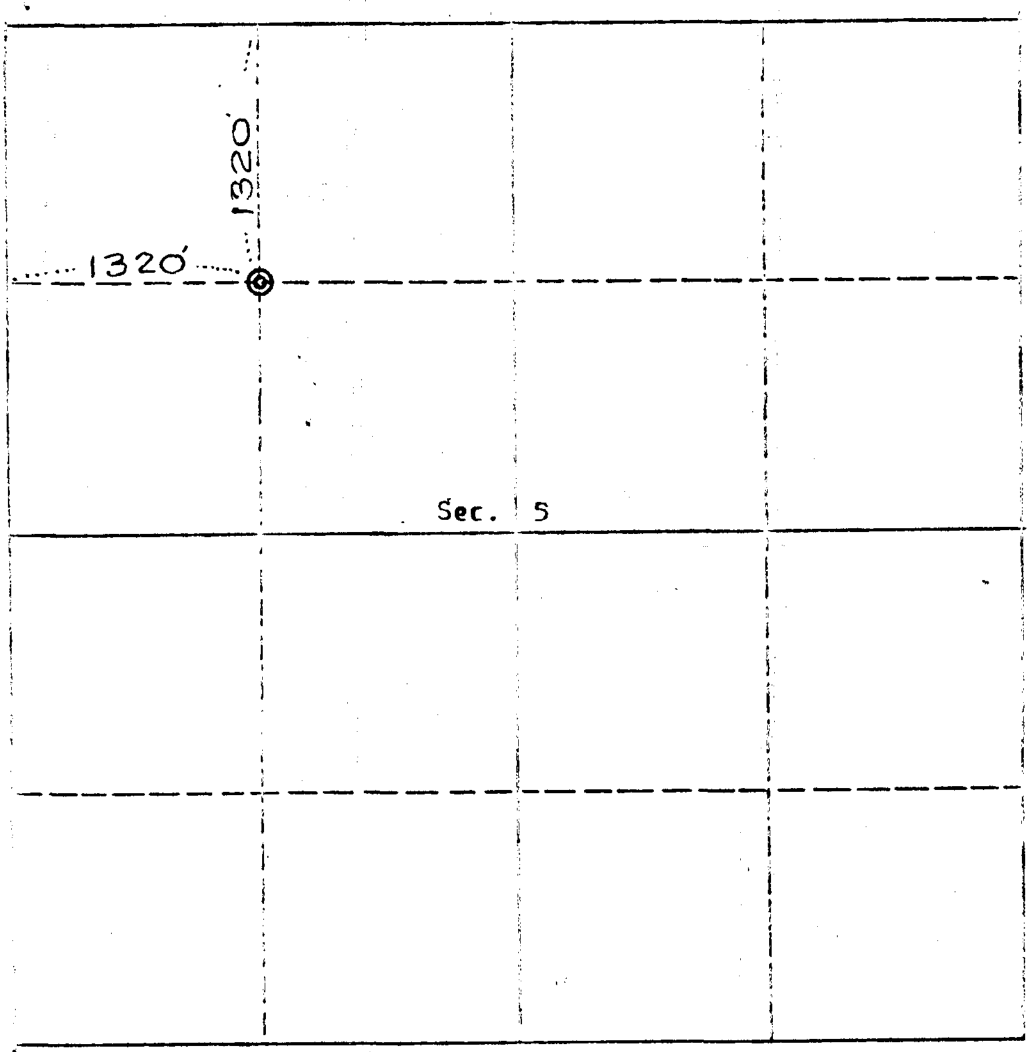
Company Amoco Production Company

Well Name & No.

Location 1320 feet from the North line and 1320 feet from the West line.

Sec. 5 T. 5 N., R. 6 W., S.L.M. County Box Elder Utah

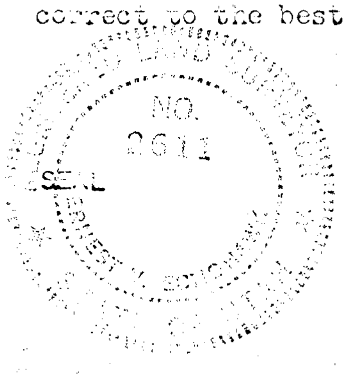
Ground Elevation 4199



Scale 1" = 1000'

Platted May 23 1974

This is to certify that above platted location was prepared from a protraction of official surveys and that the same are true and correct to the best of my knowledge and belief.



E. V. Echohawk

Ernest V. Echohawk
Registered Land Surveyor
Utah Registration No. 2611

January 6, 197~~4~~5

AMOCO Production Company
Security Life Building
Denver, Colorado 80202

Re: Well No's:
State of Utah "A" #1
Sec. 20, T. 3 N, R. 4 W,
Davis County, Utah
State of Utah "B" #1
Sec. 5, T. 5 N, R. 6 W,
Box Elder County, Utah

Gentlemen:

Insofar as this office is concerned, approval to drill the above referred to wells is hereby granted in accordance with the provisions outlined in the Order issued in Cause No. 150-2, dated November 20, 1974; a copy of which is attached.

Should you determine that it will be necessary to plug and abandon these wells, you are hereby requested to immediately notify the following:

CLEON B. FEIGHT - Director
HOME: 466-4455
OFFICE: 328-5771

The API numbers assigned to these wells are:

State of Utah "A" #1	#43-011-30001
State of Utah "B" #1	#43-003-30002

Very truly yours,

DIVISION OF OIL & GAS CONSERVATION

CLEON B. FEIGHT
DIRECTOR