PLANNING AND HAZARDS OF SPILL RESPONSE IN ANTARCTICA

Erich R. Gundlach
E-Tech International, Inc.
P.O. Box 2976
Acton, Massachusetts 01720

John J. Gallagher
Gallagher Marine Systems, Inc.
635 Slaters Lane, Suite 210
Alexandria, Virginia 22314-1177

John Hatcher and Tom Vinson
Raytheon Polar Services Company
61 Inverness Drive East, Suite 300
Englewood, Colorado 80112-5121

ABSTRACT: *Antarctica is unique in many ways that greatly add to the complexity of spill response. McMurdo Station is the largest of all Antarctic facilities (>1,300 people in summer, <200 people in winter) and has a storage capacity of over 11 million gallons. A single tanker arriving in February each year supplies fuel, which is augmented by a minor amount supplied by U.S. Coast Guard icebreaker. Waterborne spill response equipment is operationally hazardous to use because of broken ice conditions, limited open water, and difficulty of putting equipment into the water. Operating from shore is preferred as the station has extensive pumping, hose, and storage capability. During major spills, alternative response techniques, particularly burning, would be favorably considered. Additional support from outside Antarctica would not be expected to arrive for several days at best.*

Outside of McMurdo Station, seasonal field camps are supplied by airlift, and oil is stored in metal drums placed within a containment area. Transport to South Pole Station is by ski-equipped C-130 aircraft, and storage is in a new, multitank facility with containment. Oil spills on the ice sheet are unique in that the oil penetrates deep into the snow, making its capture and recovery very difficult. Additionally, because of subzero temperatures, response is very weather dependent, and protection is needed to fully avoid contact with the spilled material.

Background

Established in 1959, the U.S. Antarctic Program (USAP), financed by the U.S. National Science Foundation (NSF), supports an array of scientific investigations in Antarctica, including those in geology, geophysics, glaciology, meteorology, upper atmosphere physics, mapping, biology, and ocean sciences. Under contract to NSF, Raytheon Polar Services Company (RPSC) provides support for USAP operations at the three primary research stations: McMurdo, Amundsen-Scott (South Pole), and Palmer. RPSC also provides support functions for field camps as well as two research vessels, the *R/V L.M. Gould* and *R/V N. B. Palmer*. Figure 1 shows the location of past and present permanent USAP installations in Antarctica. Figure 2 provides details in the McMurdo Station area. In addition to the sites shown, temporary camps are set up each year to conduct research at various locations across the continent.

Because of the relative isolation of the individual elements of the USAP and the extreme weather conditions (including unusually wide excursions of both temperature and wind), each element must to a large degree constitute a stand-alone entity. Most must be capable of sustaining operations for periods of time without continuing support from or physical contact with the outside. Added to these conditions, Antarctic Treaty requirements mandate that the entire project must be conducted in such a manner that no residual solid or liquid pollutants remain in the Antarctic environment. Pollution prevention and waste recovery, treatment, and/or "export" (retrograde) therefore constitutes an unusually high percentage of the program support effort. For these reasons, the singular character of the operations supporting and constituting the USAP present some unique problems faced nowhere else that, in turn, oftentimes demand unique solutions.

Governing agreements. No one owns Antarctica. The Antarctic Treaty, signed by 27 ratifying countries and 16 nonconsultative countries, sets aside territorial claims in Antarctica and reserves the continent for cooperative scientific study. There are a series of operating agreements under which all Antarctic facilities operate. Particularly related to spill response is the Antarctic Treaty-Protocol on Environmental Protection, which provides guidelines for spill contingency planning. U.S. activities in Antarctica are not only governed by these treaty provisions, but also by direct U.S. regulations as set forth in the Antarctic Conservation Act. These regulations, which require permitting for all activities conducted in Antarctica, also require specific environmental protection practices including spill response and cleanup. Additionally, the USAP voluntarily has adopted pertinent sections of several other U.S.-based regulatory standards as both a practical and "best management practice" approach. These include the National Environmental Policy Act (NEPA), the Resource Conservation and Recovery Act (RCRA), Occupational Safety and Health Agency (OSHA) regulations, and others. Pertinent U.S. environmental legislation specific to oil spills include both U.S. Environmental Protection Agency (EPA) and U.S. Coast Guard (USCG) requirements promulgated in response to the Oil Pollution Act of 1990 (OPA 90). This has particular importance as it relates to response capabilities even though only one tanker supplies the majority of U.S. facilities each year.

Contingency planning. The Contingency Plan for U.S. facilities in Antarctica is based on the "One Plan" designed for

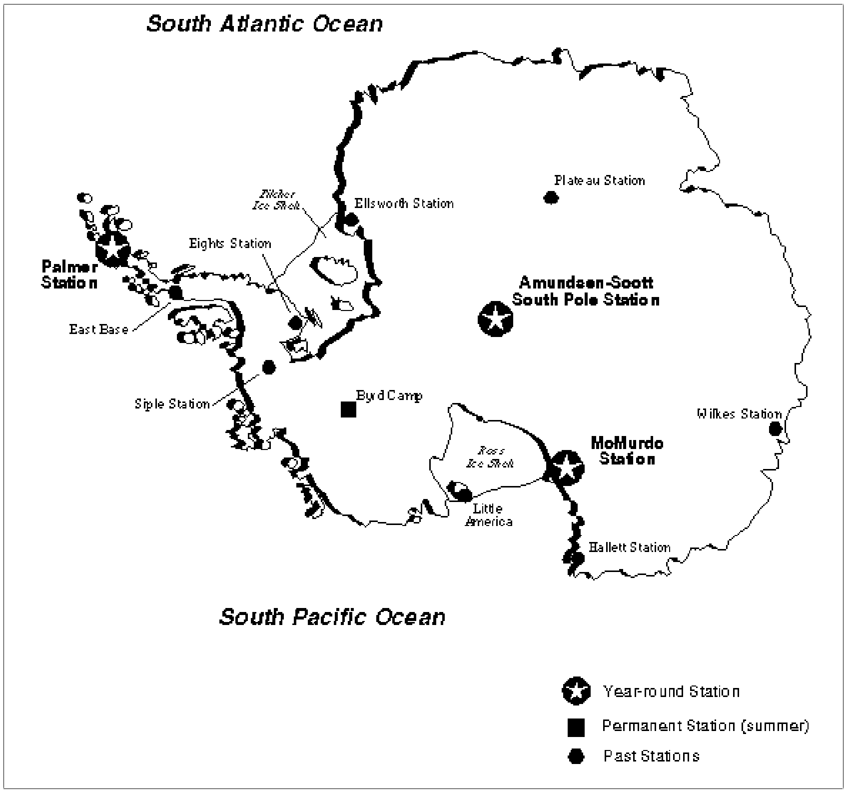

Figure 1. Location of U.S. Antarctic facilities, past and present.

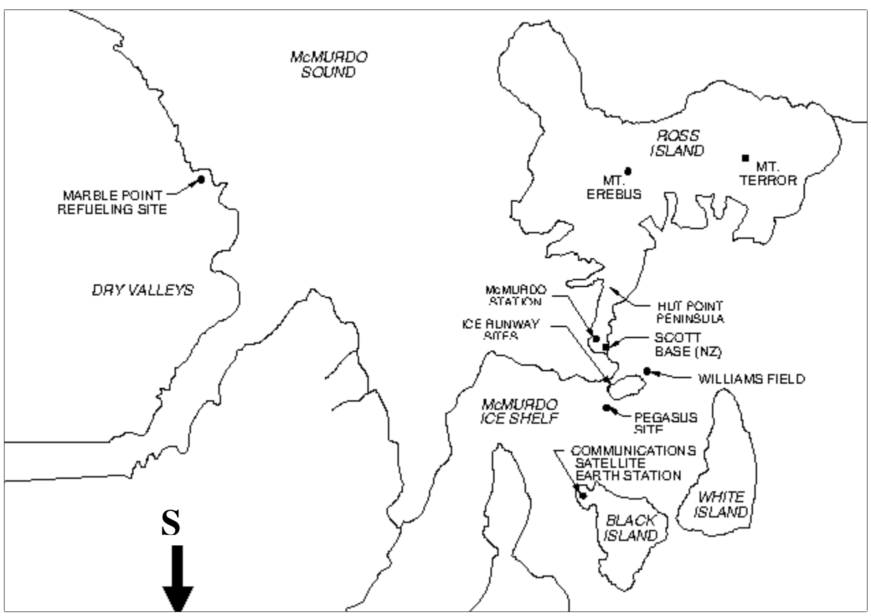

Figure 2. Details of McMurdo Station and surroundings.

operations that fall under differing U.S. federal jurisdictions, such as McMurdo Station, which has both a marine terminal (USCG authority) and land-based storage capacity (EPA authority). The guidance document for the One Plan is "The National Response Team's Integrated Contingency Plan Guidance[1]." The Contingency Plan for U.S. Antarctic facilities also contains additional material to conform to the "Guidelines for Oil Spill Contingency Planning, 1992" developed by the Council of Managers of National Antarctic Programs (COMNAP) in response to the Protocol on Environmental Protection. The plan includes response methods for oil as well as hazardous materials and was developed by the authors.

The One Plan is designed for the unique situation presented by Antarctica, particularly the seasonal nature of activities, the limited amount of vessel traffic (commonly only three vessels making port call annually), the limited amount of vesselborne oil cargo (two vessels per year), and the role of a contractor in managing these facilities for the NSF. While the core One Plan document provides all the material necessary to implement and maintain a spill response effort, a pocket-sized "Spill Response Guide" was developed for first responders and to initiate a response. The pocket-sized guide is given to all potential spill responders, field camp supervisors, and all others involved with the handling of fuel and hazardous materials.

Description of facilities and fuel handling

McMurdo Station. Figure 3 is the primary U.S. facility in Antarctica. Located at 77º51'S, 166º40'E, it is a coastal station on the low ash and lava volcanic hills at the southern tip of Ross Island situated about 3,864 km (2,415 mi) south of Christchurch, New Zealand and 1,360 km (850 mi) from the South Pole. The original station was constructed in 1955–1956. After many additions and modernizations over the years, the present station serves as the primary logistics base for airborne re-supply of inland stations and field science projects. The station is also the waste management center for much of the USAP.

Figure 3. McMurdo Station, Antarctica. The old tank farm in the upper right is being replaced with new bermed tanks in the lower right. The sole tanker calling each year at McMurdo is offloading, left center of the photograph.

Approximately 90% of USAP participants reside at or pass through McMurdo Station. The annual winter population ranges from 150 to 170 people, while the summer population may exceed 1,300. The mean annual temperature is –18°C (0°F). Temperatures may reach as much as 8°C (46°F) in summer and –50°C (–58°F) in winter. The average wind speed is 12 knots but has exceeded 100 knots. The station normally is isolated from late February until early October, except for a brief period in August when several closely spaced flights (known as WINFLY) deliver personnel, supplies, and early science parties in preparation for the forthcoming austral summer operations.

Facilities associated with McMurdo include three airfields: Williams Field, and the Sea Ice and Pegasus (Blue Ice) Runways. These airfields are used at different times and for different purposes during the operational season. Other facilities served by McMurdo Station are Amundsen-Scott South Pole Station located at the geographic South Pole and a variety of temporary field camps supporting science projects across the Antarctic continent.

McMurdo Station constitutes the largest oil facility on the continent with more than 11 million gallons of bulk fuel storage. Varying amounts of AN-8 aviation turbine fuel (JP-8 with an icing inhibitor to depress the freezing point to –72°F), JP-5, and gasoline are delivered annually by ice-reinforced tanker for storage and distribution to end-users. McMurdo fuel is distributed in various ways via pipeline and tank trucks to other storage tanks, directly to vehicles, and via pipeline to Williams Field and the Ice Runway. McMurdo Station has numerous service tanks having an aggregate capacity of over 70,000 gallons that are refilled/topped off once or twice per week.

Product is delivered to McMurdo Station by tanker once per year, normally in mid to late January. Annual deliveries average 5 to 6.5 million gallons of AN-8 or JP-5 and 160,000 to 180,000 gallons of MoGas.

Williams Field. Williams Field is a skiway on the Ross Ice Shelf, 16 km (10 mi) from the station and is adapted to accommodate only ski-equipped airplanes. Ski-equipped LC-130s routinely operate between Christchurch, New Zealand and McMurdo Station and between the station and inland program stations and field projects. The aviation fuel system consists of up to 12 storage tanks, interconnecting 10-cm (4-in) fuel hose, and the filters, pumps, fueling hoses, and other fittings required to receive, store, and dispense fuel. Fuel is transported from McMurdo Station via a 10 km (6 mi), 15 cm (6 in) flexible feed hose line.

Williams Field is a portable air facility. The 20,000-gallon aviation fuel storage tanks, 2,500-gallon MoGas storage tank, and all buildings at the field are mounted on skids or sled runners. Some of the buildings, with their attendant service tanks, are relocated to support operations at the Sea Ice or the Pegasus Field Blue Ice Runways during their periods of operation.

Marble Point Helicopter Refueling Station. This station is located on the opposite (eastern) shore of McMurdo Sound from McMurdo Station (Figure 2). The station provides an austral summer refueling base for helicopter transportation from McMurdo Station in support of the summer field camps situated in the Dry Valleys to the east of Marble Point. The station consists of operating facilities, fuel storage and dispensing facilities for refueling helicopters, and living quarters for the small staff residing at the facility during the summer operational period.

Primary fuel storage at Marble Point consists of six 25,000-gallon horizontal cylindrical fuel tanks surrounded by a lined earthen-berm secondary containment. Aviation turbine fuel is transported once a year to the vicinity of Marble Point by a USCG icebreaker assigned to USAP for the season and delivered to the facility via 2 km (1.5 mi) of 15 cm (6 in) hoseline (Figure 4). Because USCG regulations do not permit the carriage or use of fuels with flash points lower than 140°F in Coast Guard vessels, the fuel delivered to Marble Point is JP-5 rather than AN-8.

Figure 4. The USCG icebreaker *Polar Seas* offloading fuel to Marble Point. The offloading hose is visible to the left of the vessel.

Black Island Satellite Station. The Black Island Satellite Station supports a satellite antenna remotely located with respect to McMurdo Station to isolate it from interference by the satellite station communications antennas. Signals through the Black Island Station are transmitted to and from McMurdo via microwave linkup. The station normally is unmanned and is designed to operate automatically using a power control system that switches preferentially between wind-driven generators, solar cell banks, and battery banks, with closed-cycle fuel engine driven generators as a backup power source. Fuel is stored in four 25,000-gallon horizontal cylinder tanks surrounded by a rectangular earthen berm and is supplied by McMurdo Station once a year.

Pegasus Field. This field, named for a wrecked Lockheed "Pegasus" (Constellation) remaining in the ice nearby, utilizes a blue ice runway on the permanent ice of the Ross Ice Shelf. This runway is capable of supporting wheeled aircraft operations but is some distance farther from McMurdo than Williams Field. Its capability of accommodating larger-capacity, wheeled aircraft makes its utilization preferred during the high-logistics throughput periods during WINFLY and station reductions at the end of the summer season.

The aviation fuel system at Pegasus Field consists of two to four 20,000-gallon storage tanks, interconnecting 10-cm (4-in) fuel hose, and the filters, pumps, fueling hoses, and other fittings required to receive, store, and dispense fuel. Like Williams Field, Pegasus Field is a portable facility in that the fuel storage tanks and all buildings at the field are mounted on skids or sled runners. Because the Pegasus runway surface is glacial ice rather than compacted snow or sea ice, Pegasus Field has the potential to support flight operations through the austral winter.

Sea Ice Runway. The Sea Ice Runway, immediately adjacent the McMurdo Station, is a harder, smoother facility on the sea (seasonal) ice that accommodates wheeled aircraft. It is, however, only suitable for use from September until December while the sea ice is hard enough to sustain operations. The throughput capacity of this facility is augmented not only by its ability to support wheeled LC-130 operations, but also by its ability to sustain operations of larger aircraft up to and including C-141s and C-5As. Its aviation fuel system consists of four 20,000-gallon storage tanks, relocated from the Williams Field aviation fuel system to provide the necessary storage capacity.

Amundsen-Scott South Pole Station. The South Pole Stations is located at 90º00'S and is the second largest USAP facility in Antarctica. The Station comprises a number of structures clustered near the pole with the principal operational buildings housed under an aluminum geodesic dome in the Dome Complex (Figure 5). During the austral summer operational period, overflow personnel and visitors are housed in Summer Camp adjacent the Dome Complex. Fuel, personnel, and all material, are brought in by ski-equipped LC-130 aircraft utilizing a snow runway immediately adjacent the station (Figure 6).

The Amundsen-Scott Station fuel facility is comprised of three fuel systems: bulk storage, emergency reserve, and service tanks. In addition, small quantities of MoGas are transported to the Station by LC-130 and stored in 55-gallon drums. Bulk storage, the primary station fuel system, has a total nominal capacity of 450,000 gallons. It is comprised of an array of 45, well-contained 10,000-gallon tanks located in the Fuel Arch with, as seen in Figures 7 and 8, the tanks arranged in nine pods of five tanks each.

Field research camps. Camps are supported from McMurdo Station. The Dry Valley camps (77º37'S, 162º54'E) are approximately 25 km (15 mi) northwest of McMurdo Station, while Deep Field Camps (such as Siple Dome) may be several hundred kilometers away. Fuel is stored at these camps for heating, cooking and vehicles, and possibly to refuel aircraft (Figure 7).

Spill response and risk management

Prevention is the first line of attack against oil spillage. As discussed below, there are a number of redundant and backup safety features to prevent the accidental loss of oil and to restrict losses when spilled. However, as will be illustrated, there are additional measures yet to be implemented.

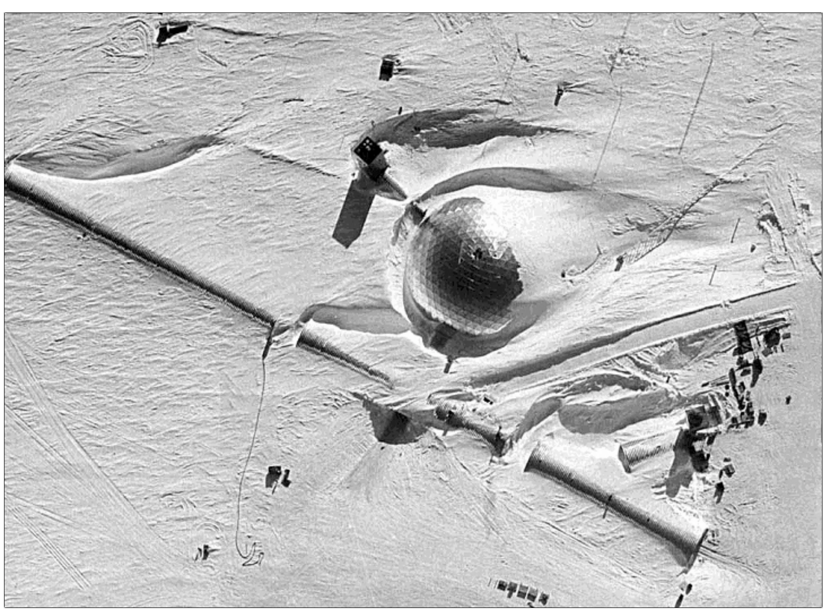

Figure 5. South Pole Station. Refueling line is visible in center left of photograph.

Figure 6. Offloading fuel from ski-equipped LC-130 at South Pole Station.

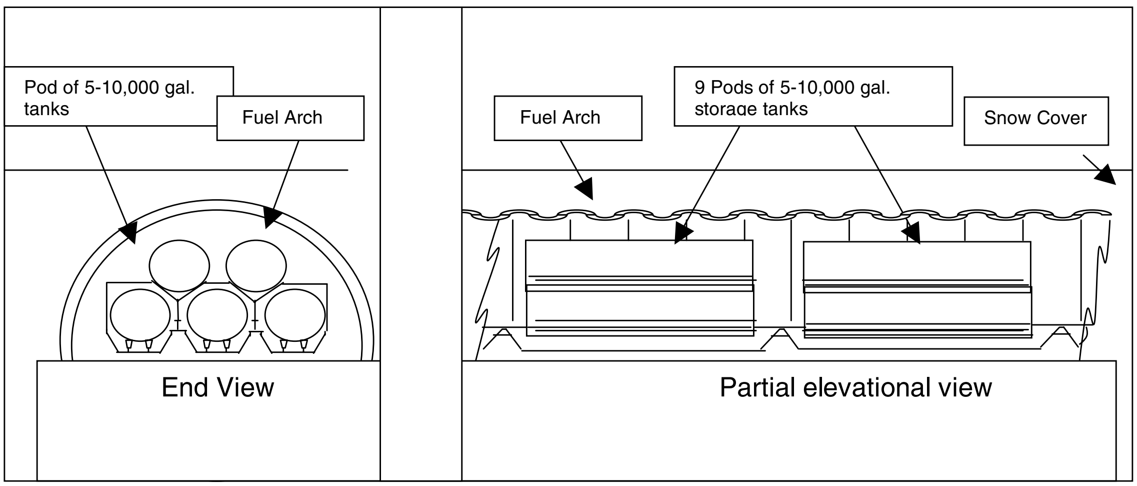

Figure 7. Fully contained fuel storage pods at South Pole Station.

Figure 8. Photograph of the end view of the fuel storage pods during construction.

Spill risk and prevention. There are two potential causes of a major spill incident in the Antarctic marine environment: (1) an accident occurring to resupply tank ship, and (2) a rupture of an unbermed storage tank at McMurdo Station. The next tier of risk is associated with the potential loss of fuel on-board the intermittent tourist ship and the single USCG vessel operating in Antarctica. The lowest tier, having limited environmental impact but higher probability (e.g., they comprise the vast majority of spills in Antarctica), is associated with transfer operations: tank-to-vehicle, tank-to-tank, and via pipelines.

Table 1 presents a summary of all reported spills (including glycol) at all U.S. Antarctic facilities from 1990–2000. Most spills have been small. During the last 3 years with a concerted effort of all fuel handlers, less than 1,000 gallons has been spilled during all operations. The reason for the spill primarily is related to equipment failure (which is not surprising considering the harshness of the environment and age of the facility), followed by operator error. Vessel-related spills are notably very low (0 for the last 3 years). One of the largest spills, on the order of 10,000 gal, occurred in the 1989–1991 timeframe before spill statistics were kept. It occurred on the ice and provides an idea of the difficulty of dealing with fuel spills in ice conditions. The lost fuel rapidly burrowed 20 m into the ice and out of sight as it dissolved into the ice. Nothing was recovered at the time.

To prevent spills related to tank ship operations, there are several measures put in place to detect and control any leakage while the vessel is offloading at the McMurdo Ice Pier (Figure 9). The operation is continually monitored on 24-hour basis. Inspectors walk the length of temporary 15-cm (6-in) lightweight fabric reinforced polyurethane hose connecting from the ship to

Table 1. Spill statistics 1991–October 2000 for U.S. installations in Antarctica.

		Operator		Equipment failure		Unknown		Gallons spilled				
	Total spills	#	%	#	%	#	%	Fuel	Oil	Glycol	Other	Total
McMurdo spill statistics												
2000	27	9	33	17	63	1	4	134	46	55	0	235
1999	29	9	31	17	59	3	10	86	27	86	21	220
1998	34	9	26	23	68	2	6	777	100	25	3	905
1997	31	13	42	17	55	1	3	3,203	84	7	45	3,339
1996	41	18	44	20	49	3	7	690	0	77	128	895
1995	49	16	33	31	63	2	4	1,299	24	47	24	1,394
1994	84	33	39	51	61	0	0	2,256	561	235	11	3,063
1993	53	23	43	26	49	4	8	8,090	74	79	19	8,262
1992	54	30	56	22	41	2	4	1,658	83	142	190	2,073
1991	10	7	70	3	30	0	0	23	5	12	16	56
Totals	385	158	41	210	55	17	4	18,082	958	710	457	20,207
Spole spill statistics												
2000	5	4	80	1	20	0	0	4	0	21	0	25
1999	10	5	50	5	50	0	0	170	81	90	1	342
1998	10	3	30	6	60	1	10	40	7	1	6	54
1997	10	1	10	9	90	0	0	10	10	4	1	25
1996	4	1	25	3	75	0	0	160	158	0	0	318
1995	3	1	33	2	67	0	0	130	0	0	0	130
1994	3	0	0	3	100	0	0	1,475	0	10	0	1,485
1993	No data	0	0	0	0	0	0	0	0	0	0	0
1992	No data	0	0	0	0	0	0	0	0	0	0	0
1991	No data	0	0	0	0	0	0	0	0	0	0	0
Totals	40	11	28	28	70	1	3	1,985	256	105	8	2,354
Palmer spill statistics												
2000	0	0	0	0	0	0	0	0	0	0	0	0
1999	2	1	50	1	50	0	0	1	1	0	0	2
1998	2	1	50	1	50	0	0	1	0	0	1	2
1997	4	0	0	4	100	0	0	11	60	0	1	72
1996	3	1	33	2	67	0	0	5	5	0	1	11
1995	4	3	75	1	25	0	0	1	1	3	0	5
1994	4	2	50	2	50	0	0	58	0	0	1	59
1993	5	2	40	3	60	0	0	127	31	0	0	158
1992	2	1	50	1	50	0	0	900	1	0	0	901
1991	4	1	25	3	75	0	0	271	0	0	0	271
1990	1	1	100	0	0	0	0	100	0	0	0	100
Totals	23	11	48	12	52	0	0	1,462	38	3	2	1,505
Vessel spill statistics												
2000	0	0	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0	0	0
1998	0	0	0	0	0	0	0	0	0	0	0	0
1997	3	0	0	3	100	0	0	0	4	0	2	6
1996	1	0	0	1	100	0	0	0	5	0	0	5
1995	2	1	50	1	50	0	0	1	0	0	4	5
1994	1	1	100	0	0	0	0	0	0	0	1	1
Totals	4	2	50	2	50	0	0	1	5	0	5	11
Program-wide spill												
2000	32	13	41	18	56	1	3	138	46	76	0	260
1999	41	15	37	23	56	3	7	257	109	176	22	564
1998	46	13	28	30	65	3	7	818	107	26	10	961
1997	48	14	29	33	69	1	2	3,224	158	11	49	3,442
1996	49	20	41	26	53	3	6	855	168	77	129	1,229
1995	58	21	36	35	60	2	3	1,431	25	50	28	1,534
1994	92	36	39	56	61	0	0	3,789	561	245	13	4,608
1993	58	25	43	29	50	4	7	8,217	105	79	19	8,420
1992	56	31	55	23	41	2	4	2,558	84	142	190	2,974
1991	14	8	57	6	43	0	0	294	5	12	16	327
1990	1	1	100	0	0	0	0	100	0	0	0	100
Totals	422	142	34	175	41	11	3	17,244	948	605	395	19,192

Note: Spills include fuel, oil, glycol and other (chemicals).

Figure 9. Boom deployment around USCG icebreaker and offloading tanker at McMurdo Station.

the hard piping system of the facility's tank farms. The hose can be quickly shut down via clamp valves along the hose. A metal pipeline recently has replaced most of the hose eliminate the risk of spills from the fabric hose. When able, a boom is placed around the ship as illustrated in Figure 9. Outside of the dock area, the ship is essentially on its own but closely monitored by the USCG icebreaker, which commonly needs to open up a free channel from the open waters to McMurdo Station. During the transfer of fuel from the USCG icebreaker to the tanks at Marble Point, the temporary fabric hose is similarly monitored. During offloading in 2000, a small leak was detected which resulted in only a minor loss because of the methods in place.

The spill risk associated with the unbermed tanks at McMurdo Station, visible in Figure 3, is due to potential rupture and downhill flow into Winter's Quarters Bay. To reduce the risk of oil reaching the water, the response effort would rapidly seal off the single drainage culvert at the base of the tank farm. Fortunately this risk will be eliminated as the old tanks are replaced by the new bermed tankage. All unbermed tanks will be removed from storage duties by the end of 2001.

To reduce the most common source of spills, those associated with transfer operations, including leaking valves, lines, and tank/vehicle overflow, several control procedures have been implemented by the Fuels Department. Quality-management procedures are in place to follow up on each incident as needed, with an evaluation of the spill cause and new measures needed to prevent a similar occurrence. As part of the spill control measures implemented throughout all field camps, even though handling only small amounts of product, all fuel tanks and refueling areas are contained in bermed, sealed rubber matting. If leakage occurs, contaminated snow/sediment are stored and sent back first to McMurdo Station and then to the United States for proper disposal.

Spill control and cleanup. In those cases where spillage could not be prevented, the response strategy at U.S. Antarctic is, like elsewhere, to control and clean up the spill and prevent it from reaching sensitive areas. Sensitive resource sites include specially protected areas such as penguin rookeries, sites of special scientific interest, and historic monuments. These are defined under the Antarctic Conservation Act of 1978 and have been mapped by NSF in 1995. At McMurdo Station in particular, there is a special emphasis on preventing oil from reaching marine waters.

For the vast majority of spills in Antarctica, control has involved valve or line closure and then a simple cleanup and storage of the contaminated snow or sediment. In cases where oil spillage can't be immediately controlled, berms have effectively been created to prevent the further spread of oil. All contaminated material is retrograded back to the United States for proper disposal.

The current on-site response capability to control and clean up oil on water and in broken ice in Antarctica is limited, although NSF is considering requests for additional equipment. On-water capability is limited to a few small vessels and boom, which would only be operational under optimal conditions (e.g., open water with little or no broken ice, and nonhazardous weather conditions). Although weak in on-water response capability, there is a substantial shore-side response capability primarily consisting of hoses, pumps, and storage capacity. Several small skimmers would be used to assist in collecting oil and limiting the amount of water taken in. The equipment requested for future use includes additional skimming and on-water storage capacity. Small work barges in particular would provide oil storage as well as a work platform.

The current response capability generally is restricted to the immediate vicinity of McMurdo Station. Even working 20 km from the station to respond to a vessel spill would severely stretch local capabilities, particularly considering the potential hazards to personnel when cleaning up oil in broken ice in near zero temperatures. Outside of the limited capability of the USCG icebreaker, there are no major work platforms (e.g., ships or barges) for deploying equipment and personnel or for collecting and storing oil. For this reason, *in situ* burning is being considered, but not yet approved, by NSF as a response tool under appropriate circumstances. The situation, however, is less than simple because of certain restrictions within the Antarctic Treaty. As yet, there is no stockpiling of incendiary devices or gel, nor is there equipment for aerial deployment. Similarly, no fire boom is available.

In cases of a major event in the Antarctic, NSF would call for the assistance of other U.S. federal agencies, particularly the U.S. Navy Supervisor of Salvage (SUPSALV) and USCG for equipment and expertise, and National Oceanic and Atmospheric Administration (NOAA) for scientific support, and other agencies as needed. There are currently no interagency agreements delineating this support, nor have there been drills or practices in which resources have potentially been called out. In addition, it is likely that, at best, it would take on the order of 3 to 5 days for equipment to start arriving due to the involved distances and weather conditions. For this reason, it is likely that resources in New Zealand and Australia would be requested. These agreements are also not in place, and as they are international in character, the State Department would be also involved in these negotiations.

Response organization. The remote nature of the Antarctic causes an inherent self-sufficiency to be developed at all levels. At the first level, the Fuels Department is the first line of defense to prevent spillage and then to respond as needed. In the vast majority of cases, these are very small spills and are rapidly cleaned up and stored for retrograde back to the United States.

For the next scale of event, which would need additional personnel, equipment or expertise, the central McMurdo switchboard (Fire Dispatch manned 24-hours) is notified to call out the designated Spill Response Team Leader. At McMurdo Station, the Team Leader has the ability to call out up to 20 responders during the summer months and 4 responders during the winter. Spill response is specifically part of job requirements of these potential responders, and they receive stateside training before being stationed in Antarctica for the season. Because of lesser risks and fewer personnel at the South Pole Station, their response team consists of two teams of three persons during summer months and one on-duty person in the winter.

In cases needing still more manpower or equipment (e.g. bulldozers, backhoes, etc), the Spill Response Team Leader requests support from the other on-site Departments. At locations outside of McMurdo and South Pole Stations, on-site managers provide the first responders, augmented by support from McMurdo as needed.

A modified Incident Command System (ICS) structure is used as the organizational structure. In large spill incidents where additional personnel are brought in from the outside, they will be integrated into the local command structure, and may take over certain roles and responsibilities.

[1] Listed in pages 28642–28664 of Volume 61, No. 109 of the *Federal Register* dated June 5, 1996.