

Washington, DC, 20460; telephone (202) 566-1288.

#### SUPPLEMENTARY INFORMATION:

##### A. Background on McMurdo Station Ice Pier

The NSF was established as an independent agency of the Executive Branch of the government in 1950. Following the International Geophysical Year in 1957-1958, President Eisenhower decided that the NSF should have full responsibility for the formulation, coordination, and management of the United States Antarctic Program (USAP). The NSF currently operates three major bases in Antarctica: McMurdo Station on Ross Island, adjacent to McMurdo Sound; Palmer Station, near the western terminus of the Antarctic Peninsula; and Amundsen-Scott South Pole Station, at the geographic South Pole.

McMurdo Station, which is located on the southern tip of Hut Point Peninsula on Ross Island, is the largest of the three stations. This station is the logistics hub of the USAP, with a harbor, landing strips on both sea ice and shelf ice, and a helicopter pad. The majority of personnel and supplies destined for bases and field camps on Antarctica pass through McMurdo Station.

The approximately 85 buildings at the Station range in size from a small radio shack to large three-story structures. This year-round facility has a peak summer population of approximately 1150 persons, and a winter population of 150 to 200. McMurdo Station is the most southerly port in the world that is accessible by ship.

For most of the year, McMurdo Station is closed in by sea ice. However, in early January, a U.S. Coast Guard icebreaker opens a channel to the harbor at McMurdo Station, allowing a fuel tanker and a supply vessel to replenish the station. The tanker normally arrives in mid-January to unload AN-8 fuel (JP-8 fuel with an icing inhibitor added), and unleaded gasoline. The AN-8 fuel is the primary fuel for power generation, heating sources, and aircraft; the gasoline is used for small portable equipment. In early February, the resupply vessel arrives and off-loads the annual provision of supplies for McMurdo Station and other U.S. Antarctic bases. After unloading its cargo, the supply vessel is backloaded with the previous year's accumulation of wastes, which are returned to the United States for disposal and recycling.

To permit the various vessels to dock and unload at McMurdo Station, construction of an ice pier is necessary. This ice pier, which is approximately 800 feet long, 300 feet wide, and 22 feet

thick, is constructed during the winter season in the following manner.

Construction begins when the frozen ice pack in McMurdo Sound reaches approximately 0.6 m (2 ft) in thickness. Snow is bermed to a depth of about 0.6 m (2 ft) on the ice pack, at the perimeter of what will be the ice pier. Heavy-duty pumps are then used to flood the ice pack inside the bermed snow with about 10 cm (4 in) of seawater. This water freezes solid in about 24 hours, when the process is repeated with another 10 cm of seawater. This process is repeated until the ice thickness of the pier reaches approximately 1.5 m (5 ft). When that thickness of the pier is achieved, several holes are drilled in the ice near the periphery of the ice pier, and lengths of 2" steel pipe are inserted vertically into the holes. The space surrounding the pipe-ice interface is flooded with water and allowed to freeze, fixing the pipes in the ice pier. Approximately 2,100 m (6,900 ft) of 1" steel cable is then woven around the steel pipes frozen in the ice, providing a horizontal reinforcement mat for the first layer of the ice pier.

The entire process is repeated three more times, until the ice pier is approximately 6.7 m (22 ft) thick. However, the horizontal mat of steel cables is not employed in the last repetition of the process; thus, there are three layers of cable reinforcement in the completed ice pier. When the final layer is created and the pier is approximately 6.7 m (22 ft) thick, three or four wooden utility poles are vertically embedded approximately four feet deep in the ice pier to provide support for electrical cables for lighting, power for equipment, and telephone service to structures on the pier. These poles consist of natural, chemically-untreated wood. In addition, just before the pier is completed, several shorter utility poles are frozen into the proximal edge of the pier, to serve as bollards, to attach the pier to the mainland at McMurdo. When the construction of the ice portion of the pier is completed, a 15-20 cm (6-8 in) thick layer of 2 cm (¾ in) or smaller gravel is applied to cover the surface of the pier, to provide a non-slip working surface.

In summary, the following types and approximate quantities of materials would normally be used in the construction of an ice pier at McMurdo Sound Station:

- 1" steel cable: 6,300 m (21,000 ft).
- 2" steel pipe: 200 m (650 ft).
- Wooden utility poles: 3 or 4, plus several bollards.
- 2 cm or smaller gravel: 4,200 m<sup>3</sup> (5,000 yd<sup>3</sup>).

At the end of each austral summer season, the pier is inspected, and as much of the gravel non-slip surface as possible is removed and stored for use the following season. If the pier is to be reused the next year, it is flooded with seawater during the winter to create a new surface for the following summer season. The pier has a normal viable life of three to five years; after that period, factors such as stress cracking and erosion no longer allow the pier to be used. The erosion of the seaward face of the ice pier is caused by such factors as wave action, contact of vessels with the pier face, and the discharge of coolant water from ships docked at the pier.

When the pier has deteriorated to the point that it is not capable of being used the following season, the wooden poles are cut off just above the surface of the ice, the gravel is scraped off for use in the following season, all transportable equipment, materials, and debris are removed, and the pier is physically separated from its attachment to McMurdo Base at the end of the austral summer. It is then towed by a U.S. Coast Guard cutter into McMurdo Sound past the distal end of the open channel in the ice, as near to the Ross Sea currents as possible. The pier is set free in a direction that will allow it to flow with the Ross Sea currents, away from the open channel in the ice. The pier then floats free amidst the ice pack, where it mixes with the annual sea ice, and eventually disintegrates.

Complete information is not available on the time required for melting and disintegration of an ice pier, or on the path an ice pier takes after its release. NSF scientists have estimated, however, that melting and disintegration will take place over several years, and that ice piers will drift from their release point in McMurdo Sound, into the Antarctic Sea, and eventually into the Southern Ocean, where they will presumably float with the currents of the Southern Ocean. These estimates are supported by tracking data collected on an ice pier disposed by NSF in February 1999 under an emergency permit. One condition of that permit was that the pier be tracked by the use of emplaced pingers for a period of one year. Tracking records indicated that the pier traveled approximately 600 miles in a generally northerly direction into the Southern Ocean during the first six months, when it then became locked in ice. No further movement of the ice pier was detected in the second six months of the year-long tracking period. These tracking results confirm what NSF staff believed would happen to any released ice piers.