Designing a new science facility for McMurdo Station

Ground was broken for McMurdo Station's new science laboratory on 9 January 1988. Dr. Peter Wilkniss, Director of the National Science Foundation's Division of Polar Programs, hosted the ceremony, which was attended by many of the station's residents. Distinguished guests of the U.S. Antarctic Program—U.S. Congressmen Alan B. Mollohan (D., Virginia) and Tim Valentine (D., North Carolina) and National Science Board members Dr. Craig Black and Dr. Frank Rhodes—honored the gathering by participating in the ceremony.

For many years the National Science Foundation (NSF), manager of the U.S. program in Antarctica, has recognized that a replacement for the existing laboratory facilities at McMurdo Station was needed. Since the first temporary laboratory was opened in April 1959, the science program has expanded and changed. Scientists no longer come to Antarctica merely to survey the continent and the surrounding oceans. Instead they come to Antarctica to study problems that have global significance.

To keep pace with a rapidly changing science program, the early laboratories were enlarged and modified—and remodified. Today these buildings are inadequate and outdated and, in some cases, fall short of recognized safety standards. The new facility, designed to alleviate such problems, will provide scientists with not only adequate work space but also modern equipment. The building is designed for maximum flexibility so that as the science program changes in the future, it will be possible to alter the building to meet new demands.

The development of a design plan

In the fall of 1984, the National Science Foundation (NSF) contracted with the Pacific Division of Naval Facilities Engineering Command in Honolulu, Hawaii (PACDIV) for design of the new antarctic science laboratory. As NSF's agent PACDIV selected the CJS Group Architects, Ltd., from Honolulu, to survey the existing science facilities at McMurdo Station. Two members of the CJS design staff, S. Lee Davis and Joseph Ferraro* visited McMurdo Station from 22 December 1984 to 18 January 1985, when many science projects were underway. They visited and surveyed all of the science facilities at the station, interviewing about 50 researchers, NSF staff members at McMurdo, and support staff from NSF's contractor ITT/Antarctic Services, Inc. Interviews were conducted individually and by support or science discipline

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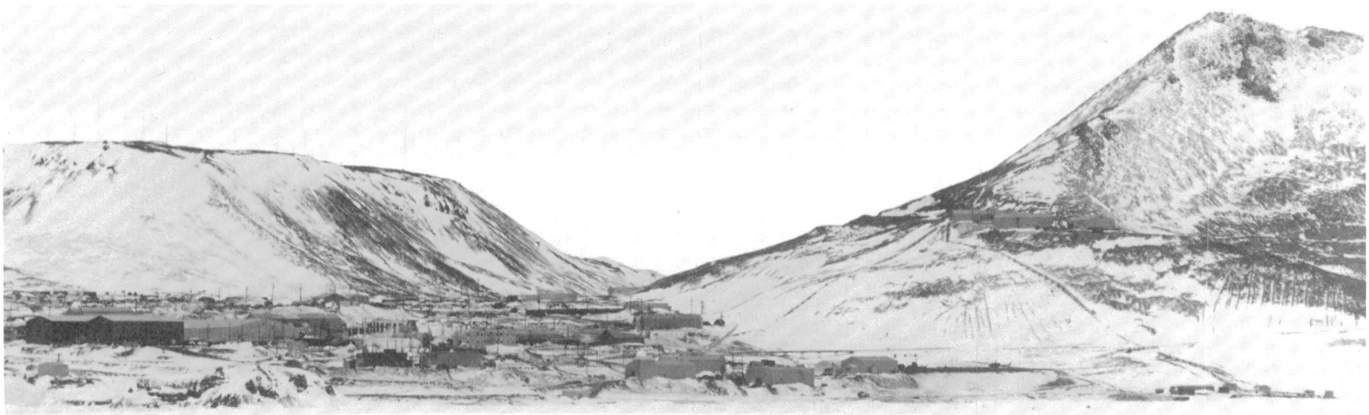
To improve support to scientists working in Antarctica as part of the U.S. Antarctic Program, the National Science Foundation began in 1984 planning the construction of a new multi-disciplinary science facility for McMurdo Station. Employees of ITT/Antarctic Services Inc., the NSF support contractor prepared the area for the new laboratory drawing the 1987-1988 austral summer and began laying the foundations at the beginning of the 1988-1989 season.

NASA photo by Larry Sammons.



group. Each person or group was interviewed several times, yielding a compendium of data that, after analysis, was used to form a design plan.

Environmental considerations. The climate and terrain of Ross Island presented some unique design problems for the architects. McMurdo Station (77°51'S 166°40'W) is built on the bare volcanic rock of Hut Point Peninsula on Ross Island, approximately 2,100 statute miles south of New Zealand. Recorded temperature extremes range from −57°F (−50°C) to +47°F (+8°C). The annual mean temperature is 0°F (−18°C). Monthly mean temperatures range from +27°F (−3°C) in January (austral summer) to −18°F (−28°C) in August (austral winter). Drifting snow can accumulate about 5 feet (1.5 meters) per year, although during the austral summer the station is relatively snow-free. Average wind speed is about 10 knots (12 miles per hour or 5 meters per second), though gusts can exceed 100 knots (116 miles per hour or 52 meters per second). Local features include Mount Erebus (an active volcano), McMurdo Sound, the Ross Ice Shelf, and the ice-free dry valleys of southern Victoria Land.

CJS conducted a site analysis, studying several sites in and near McMurdo Station, then recommended a specific building site. As CJS developed its plan for the new laboratory, they integrated the needs of the users carefully with the demands of the severe environment.

Science support considerations. The resulting plan included a list and analysis of current facilities, a determination of how space would be used (e.g., labs, storage, offices, etc.) and how much space was required presently and in the future, and an assessment of the relationships between the various scientific disciplines. Because the science program evolves in response to the science community, CJS recommended a "pod" concept to allow for changes in program emphasis and for growth.

CJS presented the initial plan to NSF and members of the polar science community at two general meetings on 6 and 7 March 1985. After discussions that led to some adjustments in the plan, NSF adopted the CJS' document as the design plan for the replacement science laboratory, and CJS proceeded with more detailed planning. In June 1986 conferences were held in San Diego and Washington, D.C., with members of the science community. CJS presented the full design concept to the scientists participating at the meetings, as well as to PACDIV and NSF. PACDIV and NSF continued to monitor the development of the design and construction specifications at 35 percent, 65 percent, and 95 percent completion stages. Because the NSF support contractor will construct the building, the present contractor, ITT/Antarctic Services, Inc., (ANS), also participated in all design review meetings. This close coordination among users, owner, design agent, designers, and construction contractor has contributed to the success of the project thus far.

The final design of the facility includes a core pod or wing containing administrative and other functions common to all science disciplines. Each discipline group will have a pod or wing connected to the rest of the facility by a circulation spine. In the future, the laboratory could be expanded by building outward from each wing or by adding pods to the spine.

The 45,650-square-foot (4,240-square-meter) facility will consist of five pods all linked by a circulation spine:

- *Core.* The core pod (12,500 square feet or 1,160 square meters) houses general offices, library, conference rooms, a photography laboratory, a small computer room, glassware washing and storage rooms, and shipping/receiving plus various storage rooms. Special rooms for vibration-sensitive equipment would be in the core pod.
- *Biology.* The biology pod (15,500 square feet or 1,440 square meters) includes microbiology, general biology, and physiological biology laboratories, offices for the researchers, clean rooms, preparation rooms, and environmental chambers. Chemical and flammable storage rooms and a field-party staging area are also part of the design.
- *Aquarium.* The aquarium (4,200 square feet or 390 square meters) includes a holding tank area with piped ambient temperature salt water (about −1.8°C or +28°F) and a laboratory.
- *Earth sciences (including glaciology and ocean sciences).* The earth sciences pod (6,300 square feet or 585 square meters) features a rough-cut and sectioning room, environmental rooms, instrument rooms, and a laboratory. It also has offices for the researchers, a loading dock, and a shipping and receiving area.
- *Atmospheric sciences.* The atmospheric sciences pod (5,500 square feet or 510 square meters) includes an electronics receiving and recording area and workshop, an environmental laboratory, a shipping and receiving area, and offices.

The flexible design allows for variations in the function of spaces, for the present as well as the future, as research emphasis changes. Removable partitions at office groupings provide flexibility and are compatible with the selected furnishing modules. Operable partitions are used in the library and conference areas.

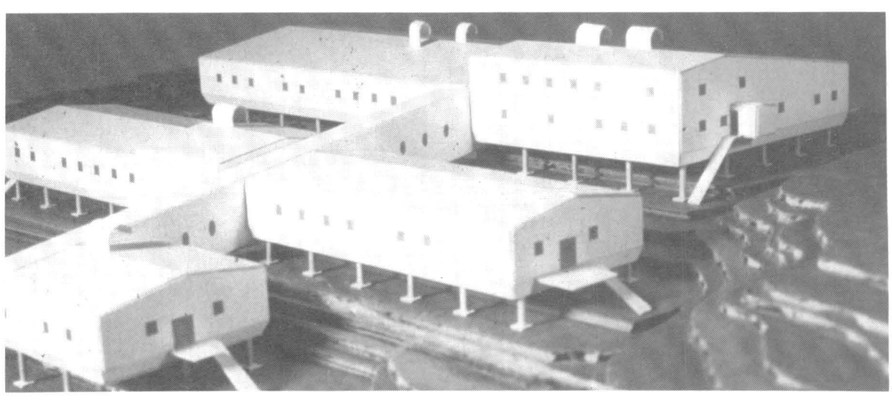
Design specifications for construction

Designed to withstand the extreme variations of weather conditions, the new facility has an expected life of at least 20 years and is considered to be a "permanent" structure. Its exterior design will make it a prominent feature at McMurdo Station, and its interior environment will enhance the research efforts. The facility is capable of being fully functional year-round, although portions of the building can be deactivated during the winter when science activities are minimal.

Classified "industrial" and designated ordinary hazard group 3 for most areas, the building will have a sprinkler system throughout with service from a hydropneumatic storage tank that has a 15-minute supply.

The mechanical systems will ensure a healthy, constant interior climate and include back-up equipment in the event of failure. Laboratory environmental health and safety considerations are part of the design and were reviewed by E. Robinson Hoyle of Arthur D. Little, Inc., Cambridge, Massachusetts. The mechanical systems will provide 10 cubic feet per minute (0.28 cubic meters per minute) per person of fresh air in the laboratories and 5 cubic feet per minute (0.14 cubic meters per minute) per person in other areas. In the occupied mode, the building occupancy is planned for 24 hours per day, 7 days per week. Ventilation in occupied laboratories is specified at 10 air changes per hour. The operating capacity is based on the actual installed fume-hood flow-rate requirements and a hood face velocity of 100 feet per minute

An artist's model of the new science laboratory, which is currently under construction at McMurdo Station.



(1,830 meters per second) with the hood sash in any open position. Six air changes per hour are specified for offices, open work areas, and working utility spaces.

The primary heating system will consist of two low-pressure steam boilers with diesel fuel (arctic grade) as the primary fuel source. Low-pressure steam will heat outside air and offset the building skin load, provide humidification, and heat domestic hot water. A steam/water heat exchanger will generate hot water for the terminal heating coils that control the individual zone temperatures. Each boiler will serve the entire facility independently. The specified interior temperature is 70°F ±3°F (21°C ±1.7°C) at 30 percent relative humidity with both boilers operational. If one of the steam-generation systems did not function, the temperature could drop to 50°F ±3F (10°C ±1.7°C) at 20 percent relative humidity under the worse weather conditions. With both systems down, the back-up electrical heating system would maintain the interior at 45°F +3°F/−5°F (7.2°C +1.7°C/−2.8°C). Electric space heaters located in the perimeter spaces and in the crawl space below the first floor will serve as back-up heating to maintain space temperature if both of the independent primary systems should fail.

Acoustic and vibration considerations were a major program concern. The planned use of very sensitive electron microscopes and other similar equipment required special design attention. Alan T. Rosen and Anthony P. Nash (PE) of Charles M. Salter and Associates, San Francisco, conducted a vibration analysis and participated in the design of the facility.

The environment dictated special considerations. The elevated structure chosen by the designers will maintain the frozen-grade conditions. The building alignment with respect to prevailing winds will minimize snow drifting. Model testing helped designers select the optimum orientation and height above grade. To encourage the natural flow of the cooling winds and create a venturi effect, the lower portion of the sides of the structure will slope inward at 45 degrees, to create a funneling effect. A snowdrift control study, involving model analysis, was conducted by Rowen Williams Davies and Irwin, Inc., Consulting Engineers and Microclimate Specialists, Guelph, Ontario.

The structures will have a hybrid framing system incorporating structural steel, cold-formed steel, wood, and precast concrete. The elevated buildings will be completely enclosed within an insulated skin. The building panels will be factory fabricated from galvanized G90 steel, 26-gauge minimum thickness, steel-faced insulated panels with polyurethane foam insulation. The finish will be a factory-applied polyester coating system, "pewter metallic" in color. Individual panels will provide a maximum U-factor of 0.04. When erected, the complete panel system will provide a homogeneous envelope of insulation enclosing the building and its structure with a maximum U-factor of 0.05. This includes suitable allowances for losses through joints and panel fasteners but does not consider windows, doors, and other major penetrations that are not part of the panel system. Air infiltration through the panel system will be less than 0.025 cubic feet per minute per square foot (0.0076 cubic meters per minute per square meter) of fixed area of panel system. Precast concrete foundation blocks and columns will be the only structural elements penetrating the skin. Wood-bearing plates and wood blocking will provide a thermal break between the inside and outside of the building.

The laboratory is being built on about 2-1/2 acres (1 hectare) of mildly sloping terrain, which will provide a view from each pod. Cut and fill of the site provide a level area for each building pod. Water and sewer connections, made to existing utilities that cross the project site, will be above ground on steel supports in preinsulated, fiberglass heat-traced pipe. Potable water, salt water, sewage, and electric utilities will be on the same supports.

Construction costs and timetable

Construction at McMurdo is possible for only about 5 months each year during the austral summer, which lasts from October through February. All construction materials are imported on the U.S. program's single supply vessel, which arrives at McMurdo in late January or early February. Because of this, planning, procurement, and shipping must be completed a full year before a project begins. Additionally, there is no indigenous labor force. These three factors affect the planning, construction methods, timetable, and costs of all buildings in Antarctica but particularly a building of this size and complexity.

Construction costs for the science facility are anticipated to be $19.6 million (approximately $429 per square foot or $4,620 per square meter), including all furniture and built-in equipment. The median 1987 U.S. cost of research laboratories (as estimated in *Building Construction Cost Data*, 1987, 45th annual edition, R.S. Means Company) is $88.65 per square foot excluding furniture and built-in equipment. Typically estimates for construction projects in Antarctica are based on the cost of materials delivered to the pier at Port Hueneme, California, with labor at three times Washington, D.C., rates. Shipping costs from Port Hueneme to McMurdo are considered separately. Productivity losses and extraordinary recruiting costs account for the triple rate.

Site preparation for the facility started in October 1987 and was virtually complete by February 1988, the end of the 1987–1988 season. Vertical construction will start in October 1988. NSF is planning for partial occupancy during the 1991–1992 season, with completion and full occupancy no later than the 1993–1994 austral summer.

—Robert J. Haehnle (PE), Engineering Manager, U.S. Antarctic Program, Division of Polar Programs, National Science Foundation, Washington, D.C. 20550.

U.S. Antarctic Safety Panel submits final report and recommendations

In July 1988 The U.S. Antarctic Safety Review Panel presented to the Division of Polar Programs (DPP) the results of their year-long study of environmental, health, and safety practices in the U.S. Antarctic Program. The panel was established in July 1987 after an internal National Science Foundation committee recommended to DPP that such a review be performed. Responding to this recommendation, the Director of the Division of Polar Programs Peter Wilkniss appointed former astronaut Rusty Schweikart to chair the 6-person group.

The panel was directed to

- perform a comprehensive review of all aspects of safety related to U.S. operations in Antarctica
- review not only air, ship, facility, and other operations practices and procedures but also institutional and management concerns
- review, evaluate, and advise on activities, procedures, systems, and policies that affect safety in the U.S. Antarctic Program
- recommend ways to improve safety in USAP operations with priority to those activities that may be life-threatening
- prepare a report discussing conclusions and recommendations.

During their review the panel found that the U.S. program had shifted in character from expeditionary to operational. This change requires that NSF must place greater emphasis on its role as manager and accept the responsibility for safety throughout the program. Included in the 13 recommendations that focus on improving NSF's management capabilities is establishing a new position in the Division of Polar Programs. The person in this position would be responsible for managing and overseeing safety, environmental, and health considerations for the program.

The panel divided its findings and recommendations into nine categories—health and medical care; accident pre-