Cold Regions Research and Engineering Laboratory

Retrospective
1986–1990

Retrospective 1986–1990

June 1991

Prepared by E.A. Wright

1990 Army Laboratory of Excellence

Commander's Statement

The history of CRREL goes back much further than the 30 years being celebrated by this historical observance. In the 124 years since Alaska was purchased from Russia, the U.S. Army Corps of Engineers has been involved in cold regions research and development. During World War II, organizations were created which, in 1961, were brought together to form the Cold Regions Research and Engineering Laboratory at Hanover, New Hampshire. At no time in that long history have the forces of change been stronger than they are today.

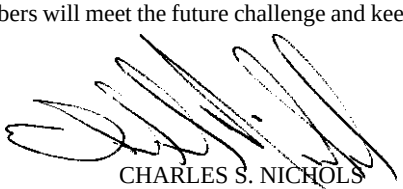
Major changes have occurred on the international scene. The Berlin Wall no longer exists and Germany is again one country. The Warsaw Pact has gone the way of the Wall, and the Cold War has thawed. In early 1991, the United States and a coalition of 33 nations fought one of the most successful military campaigns in the history of warfare in the desert of the Middle East—a war that may reshape military doctrine for years to come.

The United States is committed to reducing the size of the military by 1995. Facilities and installations at home are being closed and consolidated. Bases in Europe will close and our national defense strategy of forward-deployed forces will be replaced by a strategy of "forward presence." The Department of Defense is forcing the services to rely on each other to conduct consolidated or coordinated research through Project Reliance. Secretary Cheney has challenged the Department of Defense to be "the Federal leader in agency environmental compliance and protection," and the environment represents the only portion of the Defense budget that will increase over the next five years. Installation commanders are seeing new construction decrease and existing facilities deteriorate, while the money to properly maintain and renovate them may not be forthcoming.

Change is occurring at an unprecedented rate and may continue indefinitely. The Corps of Engineers is undergoing its first major reorganization since 1942, one designed to shape the Corps of the 21st century. CRREL must and will change to accommodate the new environment and to meet the needs of a changing customer base. We are in a period of chaos, and chaos equates to opportunity for those with the vision to create their own future.

The 30th anniversary celebration is an appropriate time to reflect on our past and to derive lessons from CRREL's response to the challenges of the last 30 years. It is also a time to envision CRREL's future service as a contributing member of the Corps family and its worldwide leadership role in cold regions research. Major challenges remain in the area of environmentally sustainable development of major energy reserves beneath Alaska's North Slope, reducing freeze–thaw damage to military facilities in the northern tier and Alaska, developing more effective year-round construction methods, capitalizing on current and developing remote sensing technologies to meet management and emergency response needs, and helping the nation to restore a rapidly deteriorating infrastructure. And, as always, there is a continuing challenge to improve the fighting capability of the military in the cold environment. CRREL's vision today will determine its success tomorrow.

I am confident that CRREL's junior members will meet the future challenge and keep CRREL a world leader in the 21st century.



CHARLES S. NICHOLS
Colonel, Engineer
Commander and Director

CRREL Retrospective
1986–1990

1986

INITIATIVES

In 1986 CRREL marked its 25th anniversary with a large celebration in the Ice Engineering Facility that was attended by nearly the entire CRREL staff as well as more than a hundred guests and former employees. The principal speaker at the ceremony was the Chief of Engineers, Lt. General E.R. Heiberg III. Other speakers included Agnar Pytte, Provost of Dartmouth College, and Russell Stearns, Professor Emeritus at the Thayer School of Engineering and past President of the American Society of Civil Engineers.

Three significant events also occurred that year. In May, Lewis E. (Ed) Link, Jr., became CRREL's Technical Director. Previously he had been Chief of the Environmental Systems Division, Environmental Laboratory, at the Waterways Experiment Station and had been Assistant Chief of the Coastal Engineering Research Center of the Corps of Engineers. In October the Polar Oceanographic Branch of the Naval Oceanographic Research and Development Activity (now the Naval Oceanographic and Atmospheric Research Laboratory) moved to CRREL from Bay St. Louis, Mississippi. This effectively combined the Navy's and CRREL's experience with, and knowledge of, sea ice. In December, CRREL was designated by the Army as a model laboratory for the Corps of Engineers. This program was met with much enthusiasm, with more

CRREL researchers participated in the winter REFORGER exercise in Germany.

than 80 proposals for improving efficiency and productivity made in 1986 and 1987 alone.

ACCOMPLISHMENTS

CRREL also had several significant technical accomplishments in 1986. At the SNOW IV field experiment in Hollis, Maine, CRREL closed a final gap in a data base relating the effects of the winter environment to the effectiveness of electro-optical devices in weapons and surveillance systems. This entailed obtaining detailed environmental and sensor system performance data under fog and wet snowfall conditions. In Korea, CRREL conducted tests with the Second Engineering Battalion, which showed that the lightweight ribbon bridge could not be effectively deployed in an ice-clogged river, a significant problem that CRREL later addressed. In Germany, CRREL evaluated the off-road mobility and durability of radial truck tires for the 54th Engineer Battalion, and the test results, showing greatly improved performance, were added to the Army Basic Criteria for Tires (ABCT). At the winter REFORGER Exercise in Germany, CRREL demonstrated a prototype soil moisture probe and electronics package that provided input for real-time trafficability estimates under winter battlefield conditions. The output from these probes aided in the preparation of trafficability maps that not only could predict vehicle speed under various conditions but also helped to prevent damage to areas where maneuvers would be destructive to the terrain.

In support of the base expansion at Ft. Drum, CRREL reviewed 118 design submissions and provided design firms with state-of-the-art information on cold regions technology, particularly in the areas of snow loads, roofing system design, and pavement system design. CRREL also established the Army's first space materials data base, SPACEMAT, containing more than 5000 listings of materials suitable for the extremely cold space environment. In addition,

CRREL engineers supported the base expansion at Fort Drum, New York.

A statistical study of Arctic ice ridges was completed.

CRREL also began a program to determine projectile impact data on materials in a simulated space environment of low temperature and pressure.

A statistical study of the height and occurrence of ice ridges in the Arctic and Antarctic oceans was completed, with particular relevance to offshore structures off the north coast of Alaska. Also completed was an ice/ocean model for the Arctic Ocean, providing a framework for predicting the extent of ice cover. Another important accomplishment was the design for an auger that greatly increased penetration into frozen ground, and an improved technique for using an exothermic torch to rapidly bore small-diameter holes in concrete, ice and frozen silt.

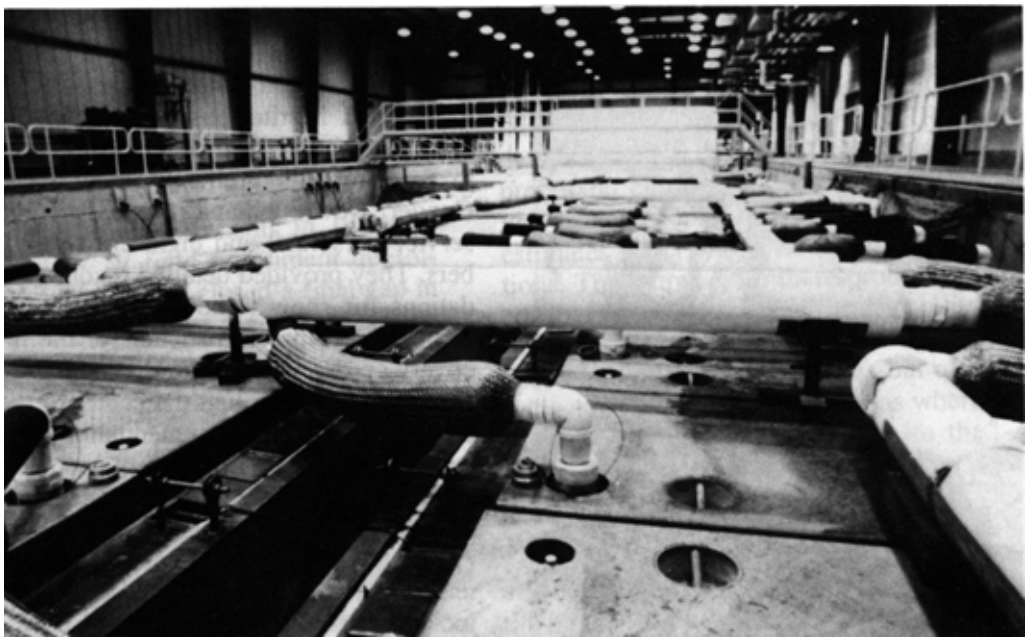
CRREL even provided emergency freezer storage for 700 cubic feet of Dartmouth College books, many irreplaceable, that were damaged by water from a broken main. This assistance prevented deterioration of the books until a contractor could begin restoration services using a freeze-dry process.

Guenther E. Frankenstein received his second Decoration for Meritorious Civilian Service and Col. Morton F. Roth his second Meritorious Service Medal for their support of recovery operations in the aftermath of the DC-8 crash in Gander, Newfoundland, that killed 248 servicemen and eight crew members. They provided detailed recommendations for snow removal, construction techniques to provide shelter for the recovery operations, and for diversion of a stream flowing through the center of the crash site. Each recommendation was accepted and successfully implemented.

John H. Rand and Ben Hanamoto were awarded an Army R&D Achievement Award for developing a complete system for controlling ice at Corps navigation locks that resulted in substantial extension of the navigation season on several northern river systems. The system consisted of air bubblers to raise warmer water at the river bottom to the surface and high velocity air screens to prevent ice buildup or entry of floating ice into the lock.

In September, the New Hampshire Outstanding Civil Engineering Achievement Award was presented to CRREL by the New

A bubbler system developed at CRREL controls ice at a Corps navigation lock.



The Frost Effects Research Facility received the New Hampshire Civil Engineering Achievement Award for design.

Hampshire section of the American Society of Civil Engineers for design and construction of the Frost Effects Research Facility (FERF).

In 1986, CRREL produced 244 technical publications. Patents were issued to M. Mellor for a Triaxial Compression Test Apparatus, and to F. Sayles, W. Black and E. Ellis for a System for Prevention/Relief of Stress/Chill in Pipes.

1987

INITIATIVES

In May of 1987**,** Colonel Charles S. Nichols was selected by the Chief of Engineers to be CRREL's Commander and Director. He was formerly Professor of Military Sciences at the Colorado School of Mines and served with the Army Research Office in London.

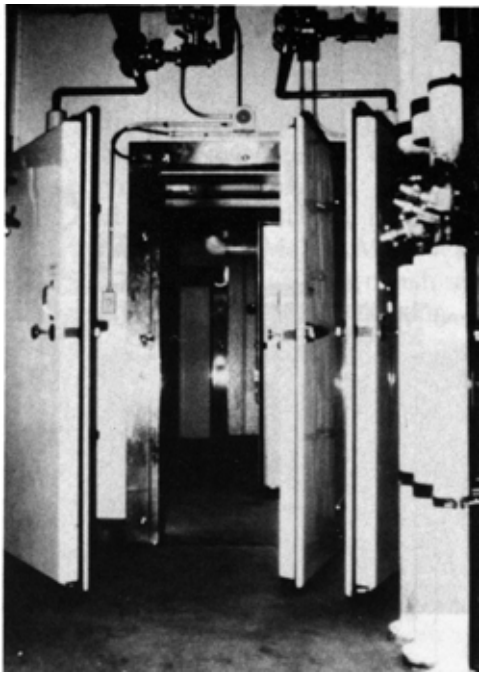
CRREL reorganized several support elements into a new Information Management Division (IMD), creating a centralized focus for technology transfer activities. A.J. Roberto, Jr., was selected to lead this organization. The reorganization combined all computer functions, office automation, telecommunications, audiovisual production, technical publishing, and library services under one management. One of IMD's first accomplishments was to initiate a major study of the future information and technological requirements for CRREL. This Information System Plan became the blueprint

CRREL's Information Management Division centralized all communication and information activities.

for CRREL's information management innovations through 1991. IMD also cut the cost of CRREL's long-distance service in half by using commercial long-distance carrier services and purchasing a state-of-the-art digital switcher for both voice and data traffic. IMD also became the manager of the electronic bulletin board system for the entire Corps of Engineers.

Renovation of the refrigeration system and coldroom complex in the main laboratory building was completed. The project eliminated trichloroethylene as the system refrigerant, replaced the 25-year-old insulation with high R-value, energy-efficient insulation, and upgraded the original 125-ton refrigeration system to an efficient 65-ton system. Throughout CRREL, electricity costs were reduced by 8.5% by installing more energy-efficient lights and ventilation system motors, and heating fuel consumption was cut by 19.8% by installing improved roof insulation and making other improvements.

Further strengthening its ties with the Navy, CRREL was assigned a Navy Liaison Officer, with the responsibility of making Navy organizations aware of appropriate research programs at CRREL that support their objectives.



The coldroom complex was renovated.

ACCOMPLISHMENTS

Finding a solution to the problem identified the previous year, CRREL demonstrated two operational techniques for deploying the ribbon bridge in ice-covered waters on the Imjin River in Korea. In the first technique, bulldozers cleared a storage site on the shore while soldiers cut large sections

CRREL researchers deployed a tactical ribbon bridge across Korea's Imjin River.

CRREL evaluated the Navy's on-shore fleet hospital.

of ice with chain saws and then floated the ice into the storage area. In the second, demolition methods were altered to create large sections of ice that were maneuvered by bridge boats.

In January, CRREL completed construction of a pilot-scale sludge freezing bed facility and immediately began testing it. Results obtained that winter showed the process of freeze dewatering to be highly effective in removing water from sludge.

Another major effort in 1987 was the evaluation of the Navy's on-shore fleet hospital, representative sections of which had been erected at CRREL in late 1986 by Navy Reserve Seabees. Following instrumentation, the hospital was kept fully operational until May 1987. While originally constructed and operated in accordance with the design plans and specifications, many modifications were identified and documented. Several changes were then made, primarily in heating and plumbing systems, to avoid freeze-ups or undesirable variations in room temperature.

CRREL built a physical security research site, called the Geophysical Sensors Cold Regions Research Facility, in South Royalton, Vermont, to study the effects of winter conditions on intrusion detection systems. At this site, the South Royalton Intrusion

CRREL's Geophysical Sensors Cold Regions Research Facility, located at South Royalton, Vermont.

This vehicle tests the mobility of wheeled vehicles in snow.

Detection Systems (SOROIDS) Project began testing the response of intrusion detection sensors to snow covers, icing and frozen ground.

In addition to the extensive site surveys CRREL conducted in 1984 and 1985 for the USAF's North Warning Radar System, assistance was provided to develop the system's final design and site selection criteria. Based on CRREL recommendations, two DEW line sites in Alaska were modified, so that construction of expensive new North Warning sites would be unnecessary.

Important work in mobility was completed, including development of a shallow snow mobility model to predict the ability of wheeled vehicles to move through snow up to 10 inches deep, and assistance in mobility testing of a mobile launcher for the U.S. Air Force's Ballistic Missile Office.

Work was begun on a CRREL-designed $2 million ice control unit to prevent ice jam flooding in Oil City, Pennsylvania. This replaced the temporary dams that had been successful in preventing flooding since their installation in 1983.

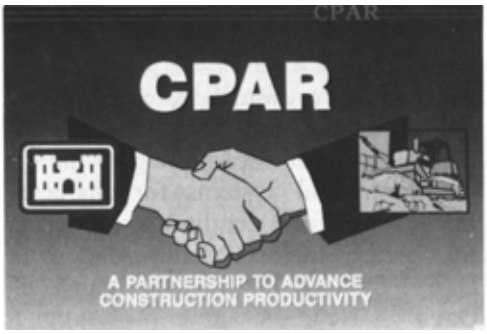
CRREL received eleven Army R&D Achievement Awards, the most ever in one year. The awards were as follows: Paul V. Sellmann, Dr. Steven A. Arcone and Allan J. Delaney for contributions in the use of geophysical systems for characterizing subsurface conditions in permafrost areas; Dr. Malcolm Mellor, Mark Wait, Darryl J. Calkins, Barry A. Coutermarsh and David A. L'Heureux for contributions to techniques for deploying the ribbon bridge in rivers with a significant ice cover; Dr. Thomas F. Jenkins, Jr., and Daniel C. Leggett for contributions to the establishment of a standard analytical method for the determination of residues in ground water; and Michael G. Ferrick for formulating a new theory for understanding river ice breakup.

In 1987 CRREL produced 220 technical publications.

1988

INITIATIVES

During 1988, CRREL played a key role in the development of the Construction Productivity Advancement Research (CPAR) Program, a Civil Works research initiative to improve the productivity of the U.S. construction industry. CRREL was directly involved in the formulation of this unique program, preparing guidance for potential research partners, making presentations to construction industry representatives, and



CPAR is a partnership with industry.

developing informal contacts with potential industry research partners.

In response to the loss of Army funding for the In-House Laboratory Independent Research (ILIR) Program, CRREL established its own ILIR program to continue support for high-risk/high-payoff basic research. This internal program resulted in a new method of measuring shock phenomena in frozen soils; a new procedure for numerical generation of curvilinear coordinates; a patentable method for reversed uniaxial loading of ice (see photo); specifications for a probe to automatically measure icing potential for antennas and aircraft; and an approach to designing fiber optic sensors for use in soil and snow.

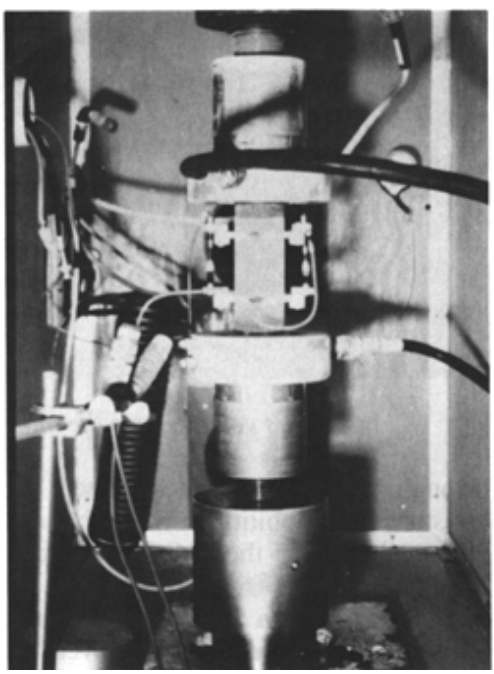
A new Environment Equipment Test Facility was constructed on the west side of the Frost Effects Research Facility (FERF). The new building provided air temperatures down to –25°F. In addition, final design was completed for a child development center and plans were formulated for a new Remote Sensing Assistance Center.

In the information technology area, CRREL's library was the first in the Corps of Engineers to initiate CD-ROM technology to give the research scientists and engineers the ability to conduct literature searches without the expenses associated with telecommunications charges and out-of-date material.

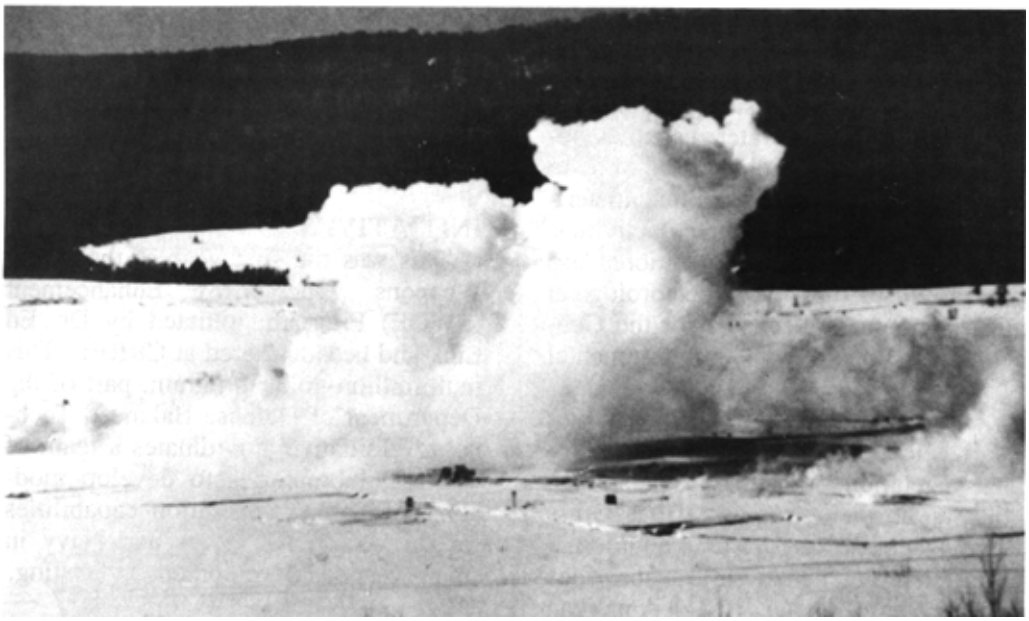
ACCOMPLISHMENTS

A major research development in 1988 was the finalization of a new frost-heave test to determine the frost susceptibility of soils and granular base materials. This new test provided more accurate frost heave prediction, promising major savings in the construction of roads and airfields by allowing safe use of borderline base and subbase materials that currently are rejected by the present standard test.

This was the last year of the River Ice Management (RIM) Program and a number of projects came to fruition. CRREL designed and installed several ice control systems (savings to industry were estimated at $200,000 per year at each lock as a result of reduced lockage time); produced an *Ice Atlas* for the upper Ohio River and portions of the Allegheny and Monongahela Rivers, documenting essential historical information on ice conditions; and published a RIM manual, *Winter Navigation on Inland Water-*



Reversed tension-compression device, for measuring mechanical properties of sea ice, developed as part of the ILIR program.



The effects of tactical smokes are tested under winter conditions.

ways, summarizing all the river ice problems identified and the ice management technologies developed and demonstrated during the five-year program.

In 1988 CRREL actively participated in several field tests and exercises that supported Army operations throughout the world. Principal field measurement and analysis was provided at the Chicken Little Winter Test conducted at Grayling, Michigan, and at the NATO rocket system tests conducted in Germany. At the Defence Research Establishment-Valcartier in Canada the effects of tactical smokes under winter conditions were investigated and models were constructed to describe the scavenging effects of falling snow on obscurant clouds. CRREL also supported the 6th Infantry Division (Light) by documenting the thermal infrared signatures of Army units participating in a winter environment exercise at Fort Richardson, Alaska.

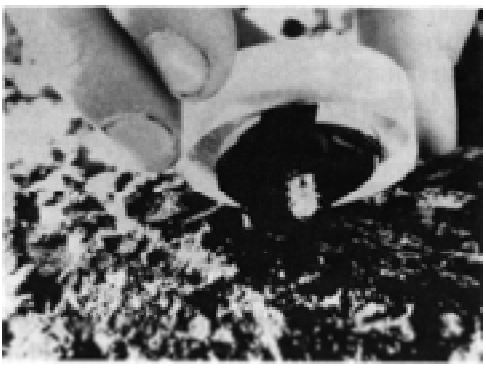
CRREL continued to work with other Army organizations in field water supply research. Two large (600- and 3000-gal./hr) reverse osmosis water purification units (ROWPUs) were tested under controlled environmental conditions in the FERF and recommendations were made to improve their winter performance. A research effort in the area of water source detection was initiated to determine the feasibility of using various airborne radars and microwave systems to locate unfrozen water.

Reverse osmosis water purification units provide a means of supplying water in the field.

In conjunction with the Rock Island District, CRREL conducted a demonstration of remote sensing technologies applicable to

Corps water resources operations. The major objectives were to demonstrate the use of satellite and aerial images in water resources activities; and to demonstrate the operational use of state-of-the-art hydrometeorological and environmental sensors for the Geostationary Operational Environmental Satellite.

Among other accomplishments was the development of techniques to maintain vegetation on ammunition storage bunkers at the Lexington Blue Grass Army Depot in Kentucky. In addition, a CRREL researcher used a subsurface radar system to locate six



This roof blister valve, developed at CRREL, is now produced commercially.

American fighter planes and two bombers that crash-landed on the Greenland ice cap during World War II and were slowly buried under 260 ft of ice.

A patent was awarded to Charles J. Korhonen and Frederick C. Gernhard, for a Blister Pressure Relief Valve. This small roof blister valve, now in commercial production, serves as a one-way pressure relief value, allowing roof blister gases to be vented while preventing intrusion of water into the blister. Use of the blister valve provides a low cost method for repair of roofs before expensive leaks occur, saving approximately $200.00 for each blister repaired.

In 1988 CRREL produced 241 technical publications.

1989

INITIATIVES

This was the first year of the Smart Weapons Operability Enhancement (SWOE) Program, initiated by Dr. Ed Link and headquartered at CRREL. This multimillion-dollar program, part of the Department of Defense Balanced Technology Initiative, coordinates a team of 11 DoD laboratories to develop modeling and scene generation capabilities

for the Army, Air Force and Navy in smart weapons development and testing.

To aid information processing, a local area network was installed to link all computer resources at CRREL. The high-speed data network now allows all employees to access CRREL's minicomputers, workstations, and such peripherals as laser printers and CD-ROM drives. In addition, a major equipment upgrade was completed in the Technical Communications Branch that resulted in a networked minicomputer-based electronic publishing system.

Renovations were completed in the basement of the main laboratory that expanded the mailroom and reproduction room, and created the Materials Engineering Research Laboratory for research on the behavior of materials at low temperatures.

A CRREL engineer (left) works with a student from Vermont Technical College's Summer Technology Camp.

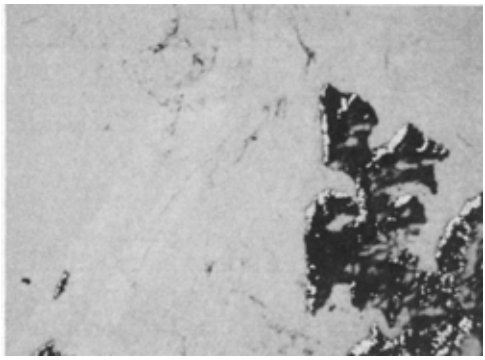
CRREL began a high school apprenticeship program; participated in the Vermont Technical College/Summer Technology Camp; hosted an Engineering Career Day; and established a Science Explorer Post. For CRREL employees, an Intern Program was created to aid in their professional development, and a health promotion council was established to oversee physical fitness, medical screening, health education, smoking cessation, stress management and areas related to their physical and mental well-being.

To encourage technology transfer, CRREL hosted twenty separate conferences and workshops ranging in attendance from 10 to 200. Activities included the DoD Subcommittee on Meteorology's Annual Meeting with its Canadian counterpart, an international pavements workshop, the Navy Arctic Technology Workshop and Arctic Construction Workshop, and a meeting of the Senior Water Control Managers. CRREL initiated and co-sponsored, with the Army Research Office, the Frost Heave Lecture Series, which highlighted state-of-the-art knowledge of the physical processes related to soil freezing and frost heave. CRREL began a major technology transfer effort sponsored by the Office of the Chief of Engineers and the Huntsville Division, focusing on revision of civil engineering and geo-

CRREL employees participating in the new Health Promotion Program.

technical criteria for design, construction and maintenance of roadways and airfields.

As the lead laboratory for the Corps of Engineers Remote Sensing Program, CRREL responded to the Valdez oil spill and the aftermath of Hurricane Hugo. The distribution of the crude oil spilled in Prince William Sound, Alaska, was mapped from satellite imagery, and a real-time system displaying oil concentration was tested. For the Charleston, South Carolina, region, CRREL used SPOT satellite imagery, coordinated with aerial imagery from other agencies, to identify major areas damaged by Hurricane Hugo in September 1989.



The oil spill in Prince William Sound was mapped from satellite imagery.

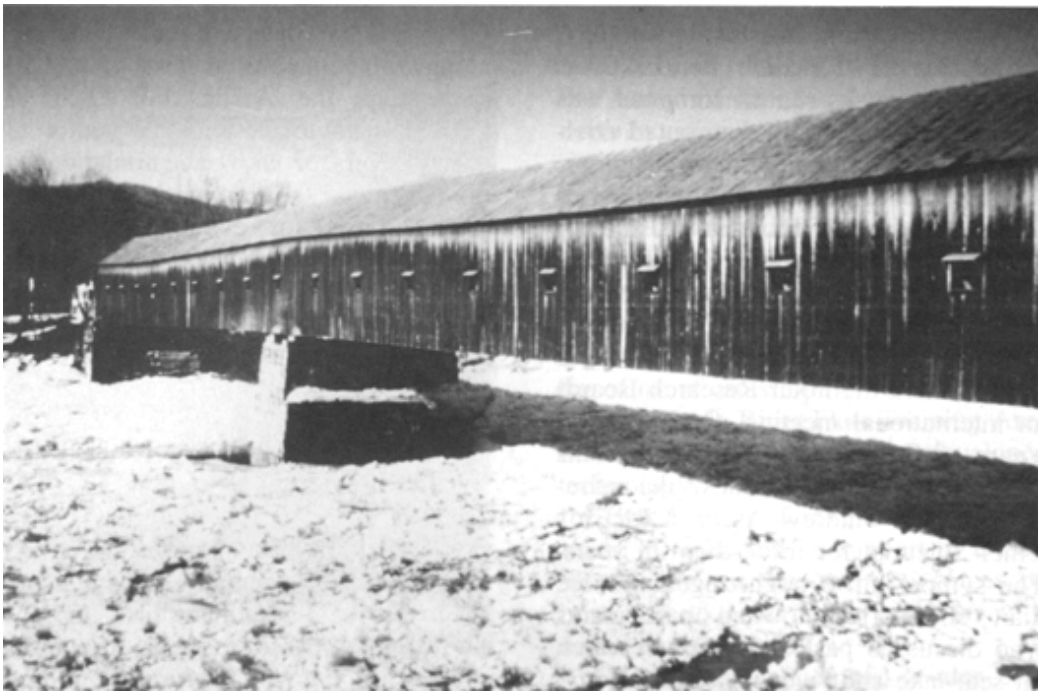
ACCOMPLISHMENTS

CRREL developed two new standards dealing with the measurement of building envelope R-values and insulation performance, and a new standard was published on Roof Design Snow Load Criteria. These methodologies will be National Standards for the construction industry.

A 400-ft section of an airfield runway was installed at CRREL to test an improved system for anchoring the landing mats of the Marine Corps Expeditionary Airfield to frozen soil. CRREL's simple solution involved replacing an unsatisfactory $400 anchor with an effective $2.50 substitute.

A major experiment was conducted on the Connecticut River to determine the validity of a dynamic ice breakup model. A controlled release from the Wilder Dam created a dynamic breakup of the river's solid ice cover and moved the ice approximately 7 miles downstream. The experiment vali-

Airfield landing mats were anchored to frozen soil.



An experiment validated CRREL's dynamic ice breakup model.

dated the model and provided a practical method for the State of New Hampshire to protect the newly rebuilt Cornish-Windsor Covered Bridge, the longest in the U.S., from ice jam flood damage.

Rachel E. Jordan and Dr. Mary R. Albert were awarded Army R&D Achievement Awards for their work in developing an analytical model to predict the surface temperature of a snow cover.

CRREL's staff produced 241 Technical publications, including a new brochure describing CRREL's mission and capabilities. Patents were awarded to William T. Burch, for a Pivoting Cutter for Coring Auger and to James S. Morse and Gary M. Trachier, for an Accurate Electronic Thermometer.

1990

INITIATIVES

In October CRREL opened the first Department of the Army Child Development Center constructed specifically for civilian employees. This center, which opened with 46 children, is operated under the supervision of Cradle and Crayon, a nonprofit corporation of CRREL employees.

Furthering information technology, installation of CRREL's network was completed and its central computer was replaced with a totally distributed environment of interconnected workstations. An Internet gateway was established that allows the CRREL

The Cradle and Crayon Child Development Center was dedicated at a ceremony held in October 1990.

staff to use other computer resources—such as the supercomputer at WES—as if those resources were locally available.

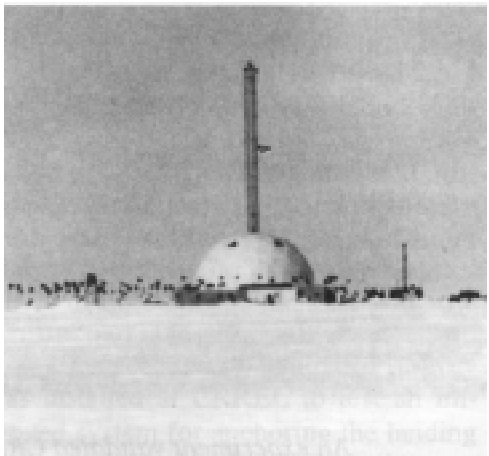
In June, CRREL co-sponsored (with the NSF and the Polar Research Board) an international meeting, *One Hundred Years of Cold Regions Research*. This meeting was held in honor of the retirement of Dr. Andrew Assur, CRREL's Chief Scientist for more than 25 years. The symposium brought together more than 60 world-renowned participants who discussed the past and future of sea, lake and river ice; climatology; snow and ice research; permafrost and frozen ground; and cold regions materials.

A Remote Sensing/Geographic Information System Center was established at CRREL to support the Corps civil works program. The Center uses the combined expertise of all Corps Laboratories, divisions and districts, as well as the private sector.

A Partnership in Education program was formalized with high schools, colleges and Department of Education curriculum supervisors from Vermont and New Hampshire. Additionally, a Partnership in Education was established with Dartmouth College's Women in Science Project and Vermont Technical College's Women in Technology program. CRREL also participated in Dartmouth College's Engineer Placement and Engineer Management Program. CRREL hosted Career Day, attended by more than 220 students from eight area high schools.

ACCOMPLISHMENTS

CRREL supported the U.S. Climate Change Program through the NSF Greenland Ice Sheet Program (GISP) II, along with collaborative research on permafrost in the Arctic. For GISP II CRREL accomplished the delineation of yearly layers of snow accumulation on the Greenland Ice Cap, providing an improved basis for evaluating climatic change over the past 1,000 years.



The ice core drill was used on GISP II.

Laboratory tests and computer modeling were used to develop pavement designs for the $16 million Minnesota Test Road Facility. Studies were also conducted on the use of insulation under pavements to reduce frost effects; the use of scrap rubber from tires in asphalt concrete to reduce ice adhesion; and the drainage of water through pavement structures during freezing and thawing with an innovative application of geotextiles.

In support of the U.S. Antarctic Program, CRREL identified and tested a natural blue ice runway for wheeled aircraft 290 miles from the South Pole and directed the construction of an experimental runway on the Ross Ice Shelf near McMurdo station. The ability to land wheeled instead of ski-equipped aircraft in Antarctica will provide a potential three-fold improvement in logistics capabilities. Also, the vehicle fleet of the U.S. Antarctic program was surveyed and analyzed, and the waste management practices of the U.S. Antarctic Program were evaluated. CRREL also conducted a survey of the structural integrity of the South Pole Station, formulated a plan for repairs, and helped to implement these repair procedures. The design for the newly developed Caterpillar Challenger tractor was modified to make it acceptable for operation in snow-

Blue ice runways are used for wheeled aircraft landings in Antarctica.

covered terrain, improving logistical operations as well as supporting NSF activities in Antarctica.

Among other accomplishments for 1990, CRREL developed the concept for the Army's first effective cold climate decontamination procedure for chemical agents, designed and tested a hybrid thermosyphon system to be used for permafrost stabilization at projects such as the proposed Over-the-Horizon Radar in Alaska, measured for the first time the evolution of lift and drag forces during ice buildup on power lines, discovered the cause of catastrophic waterfowl mortality in Eagle River Flats Training Area near Anchorage, Alaska, developed technology for soil freezing as a barrier for containment of toxic and hazardous waste in soils, and, in support of Desert Storm, advised the coalition forces on how best to cross large pipelines in a desert environment.

CRREL also conducted winter captive flight tests of infrared and millimeter-wave sensors at Camp Grayling, Michigan, completed work for the U.S. Navy on a Laboratory Test for Measurement of Adhesion Strength of Spray Ice to Coated Flat Plates, investigated the LIZ-3 Distant Early Warning (DEW) station water supply for the U.S. Air Force, and completed research on highway snow control technology in Japan, the environmental impact of chemical vapor sensing devices for standoff mine detection, in-situ detection of contaminant plumes in ground water, and use of geotextiles to mitigate frost heave. A new traction algorithm, which decision makers can use when con-

CRREl researchers determined the cause of waterfowl mortality at the Eagle River Flats Training Area near Anchorage, Alaska.

sidering new vehicle options, was validated and added to the Army Mobility Model, and the proposed cold weather add-ons for the Deployable Medical System (DEPMEDS) potable water distribution system were evaluated.

Austin Kovacs and Rexford M. Morey were awarded the Army R&D Achievement Award for the development and use of radar sounding and electromagnetic induction systems for the study of the properties of sea ice and freshwater ice.

In 1990 CRREL produced 293 technical publications, including four monographs synthesizing research in sea ice, construction of snow roads and runways, transport of heavy metals in soils, and heat transfer in water near its maximum density.

CRREL received the 1990 U.S. Army Research and Development Award of Excellence. The letter sent to Col. Nichols from Steven K. Conver, Assistant Secretary of the Army (Research Development and Acquisition), read as follows:

It is a great pleasure for me to present the U.S. Army Cold Regions Research and Engineering Laboratory with the 1990 Army Research and Development Excellence Award. This distinction is based on your Laboratory's collective outstanding achievement with respect to Technical Accomplishments, Management Initiatives and Resources Management for FY89.

You and your Team have made the U.S. Army Cold Regions Research and Engineering Laboratory a facility that is one of our nation's best and one of which we in the Army are very proud. I am confident that you will continue this tradition of excellence in the future.

CRREL looks to the future.

Distinguished CRREL Employees

Andrew Assur

Michael A. Bilello

W. Keith Boyd

Gilbert A. Currier

Francis C. Gagnon

Robert W. Gerdel

Arnold R. Goerke

B. Lyle Hansen

James R. Hicks

Kenneth A. Linell

Edward F. Lobacz

Edward F. Lutz

Thomas L. Marlar

Lillian G. Meier

J. Frank Paul

Stephen L. Pike

Rodney F. Poland, Jr.

Barbara L. Ragan

Eunice V. Salisbury

Herbert T. Ueda

Wilford F. Weeks

Albert F. Wuori

CRREL Chronology

1867 Alaskan territory is purchased from Russia. Corps of Engineers begins stages of exploration and development ... building early trails, establishing port facilities.

1944 Frost Effects Laboratory established in Boston, Massachusetts, within the New England Division, Corps of Engineers, to coordinate research on the effects of frost on the design and construction of roads, airfields and structures in frost-affected areas.

1945 The Permafrost Division of the St. Paul (Minnesota) District, Corps of Engineers, established to determine design methods and construction procedures to be used in construction of airfields on permanently frozen ground.

1946 Construction of Alaska Field Station begins in Fairbanks, Alaska.

1949 The Snow, Ice and Permafrost Research Establishment (SIPRE) established within Corps to conduct basic and applied research in snow, ice and frozen ground.

1951 SIPRE moves to Wilmette, Illinois.

1953 Arctic Construction and Frost Effects Laboratory (ACFEL) established in Boston by combining Frost Effects Laboratory and Permafrost Division of the St. Paul District.

1958 Dr. Andrew Assur receives Distinguished Civilian Service Award.

1959 Camp Century, in Greenland, is first occupied.

1961 The Cold Regions Research and Engineering Laboratory (CRREL) established on 1 February 1961 in Hanover, New Hampshire, by combining SIPRE and ACFEL.

During construction, fire causes extensive damage to main CRREL laboratory building. CRREL transferred from Corps of Engineers to the Army Materiel Command.

1963 CRREL laboratory becomes fully operational. First open house, 22–24 November 1963.

1964 Dr. Andrew Assur receives Exceptional Civilian Service Award.

1966 CRREL drilling team accomplishes first penetration of Greenland ice sheet, retrieving 4550-ft continuous ice core representing more than 120,000 years of climatic history.

1967 Dr. Wilford F. Weeks and B. Lyle Hansen receive Army Research and Development Awards. Mr. Hansen also receives Decoration for Exceptional Civilian Service.

1968 CRREL drilling team makes first penetration of Antarctic ice sheet, drilling through 7100 ft of shifting ice.

CRREL redesignated U.S. Army Terrestrial Sciences Center (TSC).

CRREL Facilities Engineering Building completed.

1969 Terrestrial Sciences Center reassigned to Corps of Engineers.

CRREL designation reassigned.

First voyage of the *Manhattan.*

Guenther E. Frankenstein receives Army Research and Development Award.

1970 Second *Manhattan* voyage.

Photographic Interpretation Research Division transferred to the Army Materiel Command.

Robert B. Northam and Raymond F. May, Jr., receive Army Meritorious Civilian Service Awards.

1971 James R. Hicks receives Army Research and Development Award.

1974 Alaskan Division reorganized as Alaskan Projects Office.

CRREL receives U.S. Army Award for Excellence.

1975 Logistics and Supply Building completed.

1976 Dr. Pieter Hoekstra, Paul V. Sellmann, Dr. Steven A. Arcone, Allan J. Delaney, and Dr. Malcolm Mellor receive Army Research and Development Awards.

1977 Expansion of CRREL's main laboratory building is completed.

Ice Engineering Branch is formed.

Wayne N. Tobiasson receives Army Research and Development Award.

1978 Ice Engineering Facility officially opened.

CRREL receives Army Special Award for Accomplishment.

Frederick E. Crory receives Army Research and Development Award.

Rodney F. Poland, Jr., receives Meritorious Civilian Service Award.

1979 CRREL receives U.S. Army Award for Excellence.

Dr. Wilford F. Weeks is elected to National Academy of Engineering.

Dr. George D. Ashton receives J.C. Stevens Award of the American Society of Civil Engineers.

1980 CRREL Geophysical Sciences Branch formed.

1981 CRREL's 20th birthday celebration on 16 September.

Dr. George D. Ashton receives Army Research and Development Award.

Guenther E. Frankenstein receives Meritorious Civilian Service Award.

Dr. Samuel C. Colbeck, Jr., receives Horton Award of the American Geophysical Union.

Dr. Virgil J. Lunardini, Jr., receives Eugene Jacobson Award of the American Society of Mechanical Engineers.

1983 Nancy M. Perron receives Department of Army Handicapped Employee of the Year Award.

Dr. Yoshisuke Nakano, Dr. Joseph Oliphant, Alan R. Tice and David Deck receive Army Research and Development Awards.

1984 Dr. Edgar L Andreas, Dr. Richard L. Berg, Edwin J. Chamberlain, Jr., David M. Cole, Thaddeus Johnson and Walter B. Tucker III receive Army Research and Development Awards.

1985 CRREL Frost Effects Research Facility is completed and dedicated.

Priscilla B. Newell receives Outstanding Achievement in Equal Employment Opportunity (EEO) Award.

1986 Colonel Morton F. Roth receives Meritorious Service Medal (2nd Award).

Guenther E. Frankenstein receives Meritorious Civilian Service Award.

John H. Rand and Ben Hanamoto receive Army Research and Development Award.

1987 Information Management Division is formed.

Paul V. Sellmann, Dr. Steven A. Arcone, Allan J. Delaney, Dr. Malcolm Mellor, Mark Wait, Darryl J. Calkins, Barry A. Coutermarsh, David A. L'Heureux, Dr. Thomas F. Jenkins, Jr., Daniel C. Leggett, and Michael G. Ferrick receive Army Research and Development Awards.

1988 William T. Bates receives Corps of Engineers Handicapped Employee of the Year Award.

Thaddeus Johnson receives Meritorious Civilian Service Award.

1989 William B. Greeley receives Corps of Engineers Handicapped Employee of the Year Award.

Dr. Mary R. Albert and Rachel E. Jordan receive Army Research and Development Award.

1990 CRREL receives U.S. Army Research and Development Organization Excellence Award.

Cradle & Crayon Child Development Center completed and dedicated.

Sherwood C. Reed receives Meritorious Civilian Service Award.

Frederick E. Crory receives 1990 Harold R. Peyton Award from the American Society of Civil Engineers.

Austin Kovacs and Rexford M. Morey receive Army Research and Development Award.

Dr. Andrew Assur receives Decoration for Exceptional Civilian Service Award.

Symposium held to honor retirement of Chief Scientist Dr. Andrew Assur.

1991 Frederick E. Crory and Guenther E. Frankenstein receive Army Meritorious Civilian Service Award.

Dr. Lewis E. Link, Jr., receives Meritorious Presidential Rank Award.

Command Chronology

1961 Colonel William L. Nungesser is appointed Commanding Officer.

W. Keith Boyd becomes first Technical Director of CRREL.

James A. Bender becomes Chief of the Research Division.

Kenneth A. Linell becomes Chief of the Experimental Engineering Division.

B. Lyle Hansen becomes Chief of the Technical Services Division.

1964 Colonel Philip G. Krueger succeeds Colonel Nungesser.

1966 Colonel Dmitri A. Kellogg succeeds Colonel Krueger.

Dr. Andrew Assur becomes Chief Scientist.

1967 Colonel John E. Wagner succeeds Colonel Kellogg.

Ronald T. Atkins becomes Chief of the Technical Services Division.

Dr. Kay F. Sterrett becomes Chief of the Research Division.

1970 Lieutenant Colonel Joseph F. Castro succeeds Colonel Wagner.

1972 Dr. Dean R. Freitag becomes Technical Director.

1973 Colonel Robert L. Crosby succeeds Colonel Castro.

1974 Albert F. Wuori becomes Chief of the Experimental Engineering Division.

1978 Colonel Alfred B. Devereaux, Jr., succeeds Colonel Crosby

1981 Colonel Wayne A. Hanson succeeds Colonel Devereaux.

1982 Dr. Lloyd R. Breslau becomes Technical Director.

1983 Colonel Morton F. Roth succeeds Colonel Hanson.

1986 Dr. Lewis E. Link, Jr., becomes Technical Director.

Dr. Eugene L. Marvin becomes Chief of the Experimental Engineering Division.

1987 Colonel Charles S. Nichols succeeds Colonel Roth.

A.J. Roberto, Jr., becomes Chief of the Information Management Division.

1990 Dr. George D. Ashton becomes Chief of the Research Division.