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Operation Poorman

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March 18, 1981

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Manuscript date: March 18, 1981

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OPERATION POORMAN

ABSTRACT

The objectives of Operation Poorman were to design and build a portable seismic system and to set up and use this system in a cold-weather environment. The equipment design uses current technology to achieve a low-power, lightweight system that is configured into three modules. The system was deployed in Alaska during wintertime, and the results provide a basis for specifying a mission-ready seismic verification system.

SUMMARY

Operation Poorman was an endeavor to improve U.S. seismic-verification readiness without incurring high cost. The objectives of Operation Poorman were to design a portable, seismic, measurement system and to assess a field team's ability to set up and use the system in a cold-weather environment. These objectives were selected to implement a new approach in the design of a portable, mission-ready, seismic system. We used the U.S.-Soviet Peaceful Nuclear Explosion Treaty as a guide for the type of mission to be carried out. Costs were held down by not trying to address all verification-mission aspects. After completing the design, procurement, and system check-out phases, the final phase of Operation Poorman was a field exercise in wintertime Alaska. Thus, the overall approach was to intertwine our equipment and operational objectives and explore their complex interaction in a field deployment of the system.

The equipment design emphasizes the use of current technology to assemble a low-power, lightweight system packaged into three modules,

each of which can be handled by two people. The system design, a joint LLNL-EG&G effort, was built up from U.S.-sourced equipment units identical to those recently purchased by, and presently used in, the Soviet Union.

Operation Poorman showed that a seismic-measurement system incorporating current technology can be prepared readily for deployment using commercially available equipment units. The Operation also showed that the seismic system is capable of performing at temperatures down to -50°F . However, the cold weather experienced during the Alaskan exercise had a strong negative impact on the capability of the team to carry out field measurements. Because of the cold, and poor light conditions, the team found the time required to perform a given task to be two to three times longer than that required to perform a similar task at the Nevada Test Site. The field team experience with the seismic system provides a basis for specifying a mission-ready seismic verification system.

INTRODUCTION

In the Fall of 1976, a field exercise simulating a Soviet Peaceful Nuclear Explosion (PNE) was carried out at the Nevada Test Site. A detailed

assessment was made of the shortcomings of the exercise and the changes needed to be made prior to undertaking any subsequent readiness exercise. The

results of these evaluations were published in the Evaluator's Report PNE Verification Exercise Red-mud Event, May 1977. Among its recommendations, the report cited the need to examine the impact of working in a cold, dark environment such as might be encountered in a wintertime deployment. In the Spring of 1979, we decided that some of the

recommended test objectives could be accomplished without the cost and complexity associated with a full scale exercise. This led to *Operation Poorman*, a small-scale effort to address, simultaneously, the design of a second-generation seismic-verification system, and the assessment of our capability to deploy such a system in a cold environment.

SEISMIC-SYSTEM DESIGN OBJECTIVES

The design objectives for *Operation Poorman* equipment are presented below. We selected these objectives to be consistent with constraints explicit in the PNE protocol and those anticipated for local seismic monitoring of post-shot events in any context. We had in mind the type of equipment likely to be representative of the second generation equipment that would actually be deployed to the Soviet Union. We envisioned such equipment to be configured into components that could be arranged to meet any anticipated type of verification mission.

LOW POWER

A low-power system has several advantages. Among these are reduction in required battery capacity and quantity of heat to be dissipated. Battery technology is an important aspect in the design of a portable system. We selected as our objective: *design a system with a power level such that its batteries could operate for five days without recharging.*

LOW WEIGHT

A lower weight usually leads to a smaller size. Small size and weight lead to a more easily transportable system. Based on previous experience with the interim seismic system, we recognized that transportation problems could be significant. We took as our objective to design modules of such size and weight that an entire mission-ready seismic system could be transported, without special loading equipment, by a single conventional Boeing 707 type aircraft; and, once off-loaded at the Soviet

port of entry, the system would be transportable to the deployment site by small road vehicles.

MODULAR APPROACH

A problem facing a verification team, while in the field, is the repair, or replacement, of faulty equipment. Because a verification mission would no doubt be allowed a limited number of man-days, the team might not have sufficient manpower to repair malfunctioning equipment in time to gather the necessary verification data; replacement, if it can be done quickly, appears to be a viable alternative to repair. One approach, to reducing the time required to make a replacement, is to build the system from modules that have the following properties:

- Each module type carries out a particular function or functions: for example, data recording or data playback.
- Each module type has a set of quick, easy to perform, diagnostic tests for determining equipment failure.
- Each module type has such size and weight that it is handled readily by two persons.
- Each module type is designed for quick and easy interfacing with other module types.

We adopted as one of our design objectives that we would incorporate as many features of the above modular approach as we could. One assumption, implicit in the modular approach, is that all modules of a particular type do not suffer from the same defect. That is, design and manufacture defects have been detected during bench and field tests, and any defective equipment rejected. The approach, then, is to supply enough extra modules of each type so that, with quick replacement of a

malfunctioning module, any data loss is held to a minimum.

TELEMETRY

A telemetry link was a design objective for the Poorman seismic system. The PNE protocol allows the use of telemetry. We chose to incorporate telemetry in order to assess its effectiveness in reducing the number of man-days required to carry out a verification mission. Further, telemetry increases system flexibility by allowing station and record modules to be separated by distances on the order of 10 km or more.

DESCRIPTION OF SEISMIC SYSTEM

The system is made up of a variety of functional units that first detect seismic signals, then process, telemeter, record, read, and display them. The equipment units make up a system that uses *current, but not state-of-the-art, technology*. The system is configured into three modules, as depicted in Fig. 1. The weight of each module was kept to approximately 100 pounds, or less, for ease of handling by two persons. The modules consist of equipment units, first packed in foam, and then placed in airline shipping containers. The foam retains internal heat, generated by the batteries and electronics, and, thus, provides cold weather protection. The design objectives of low power consumption and light weight were obtained by using CMOS (Complementary Metal Oxide Semiconductor) logic and a low-power, FM/FM, telemetry system. An event-detection recording system was selected to minimize the total recording time.

Module I, the remote-station module, is hardwired to a triaxial seismometer that measures earth motion along three mutually-orthogonal coordinates. The module accepts electrical signals from the seismometer, processes these signals, and relays them to the record module. It has a built-in telemetry-transmitter and two 20-ampere-hour gel-cell batteries.

Module II, the record module, receives and processes signals from the remote-station module. It contains a telemetry receiver, discriminators/filters, an analog and a digital recorder and a 20-ampere-

AVAILABILITY

A design objective was to select equipment units that were readily available from an established commercial supplier.

ENVIRONMENTAL HARDENING

A design objective was to harden each module against transportation damage and against exposure damage while in the field. We took the approach that both objectives could be satisfied simultaneously.

hour gel-cell battery. The analog recorder is capable of recording data continuously for up to 24 hours. The digital recorder selects seismic events out of the continuous stream of incoming data and then records the events in digital format.

Module III, the playback module, will probably be used in an indoor, or sheltered, location. However, it was given the same packaging treatment as the first two modules to insure transport durability, and proper functioning under most cold-weather situations. The playback system contains a digital-playback unit, a strip-chart recorder and a 20 ampere-hour gel-cell battery. Module III, with its playback capability, was included as a demonstration that overall system performance can be monitored in the field. We anticipate this type of capability will be necessary to carry out PNE missions. Typically, earlier systems required transport of tapes back to the home data-reduction center for evaluation. This procedure would have resulted in a significant delay had we needed to send tapes to LLNL for data reduction.

Due to limited funds, and a restricted time schedule, the complete system was purchased from an outside vendor, Sprengnether Corporation of St. Louis, Missouri. Sprengnether was selected on the basis of cost, delivery time, experience, and suitability of hardware units. Using proven commercial off-the-shelf units, the three modules were integrated and delivered, as a "turn-key" system, four months after completion of design, at a cost of

FIG. 1. Schematic of the portable-cold-weather-seismic system delivered by the Sprengnether Company for Operation Poorman. The system was bench checked at EG&G, Las Vegas and then field tested at the Nevada Test Site. Module I was subjected to a cold-chamber test, and, finally, the entire system was deployed in winter-time Alaska.

approximately twenty thousand dollars. In addition to money and time, we were concerned about potential technology transfer problems for the U.S. After selection of Sprengnether equipment units, we discovered that units of these types had been purchased and imported by the Soviet Union. Since then, they have been observed, by American visitors, in use inside the Soviet Union. The implication is that Sprengnether technology, configured into a mission-ready system, would be acceptable to the Soviets, and that any technology transfer problems for the U.S. would be minimized.

The basic Sprengnether units used to build the Operation Poorman system are listed below and described in the following paragraphs.

- S-6000 Seismometer
- PTS-6 Signal Processing Components
- DR-100 Digital Event Recorder with Lid Option
- DP-100 Playback Unit
- MEQ-800-B Smoked Drum Recorder
- Strip Chart Recorder
- Telemetry System: TX-101 and RX-101 Transmitter and Receiver

S-6000 SEISMOMETER

The S-6000 was selected for its ruggedness and portability. The unit is a cube, 18 cm on a side, with a mass of 8.8 kg. The cube is watertight, and houses three transducers oriented orthogonally to each other. The transducers use a moving coil in the stationary field of a permanent magnet; hence, the seismometer is passive, in the sense that it requires no power for its operation. The transducers have a generator constant of 130 volt per metre per second and a natural frequency of 2 Hz. These features make it suitable for post-shot monitoring, and capable of meeting most of the requirements of a PNE mission. Past experience has shown the S-6000 to be so rugged that the care required for its deployment in the field is minimal.

PTS-6 SIGNAL-PROCESSING COMPONENTS

The components usually housed in the Sprengnether PTS-6 unit are: three AS-110 amplifiers, three TC-10 voltage-controlled oscillators, one TC-30 multiplexer, and one TC-205 calibration

component. For the Operation Poorman system, these components were placed in Module 1. They carry out the functions of amplifying the three channels of analog-electrical signals from the three transducers in the S-6000, encrypting these signals into frequency-modulated signals, and multiplexing the three together for transmission by the TX-101 transmitter. The calibration component is designed to operate with moving-coil-type seismometers. The S-6000 transducers are equipped with twenty-turn calibration coils.

DR-100 DIGITAL-EVENT RECORDER WITH LID OPTION

The DR-100 is a 12-bit recorder designed to record signals in the frequency range of 0 to 300 Hz. The unit is capable of recording three signals in parallel, such as those provided by the three transducers in the S-6000 seismometer. Additionally, it is a transient-event recorder that contains an adaptive-trigger system and a circulating solid-state memory to preserve signal onsets. Finally, it has a precision-timing system. The recorder detects events by comparing short- and long-term averages on incoming real-time data. The incoming data are continuously converted from analog-to-digital form. Logic functions are carried out using the digital data. The ratio of short- to long-term averages can be adjusted to select events of interest. At the time of event detection, a circulating memory allows prior data to be recovered, and then recorded, in digital form, on a cassette tape. This technique assures that the onset of the signal and some prior background noise are captured on the cassette recording. The DR-100 has tape-write function only. It is powered by its own battery.

The DR-100-1A lid option provides the interface and signal conditioning necessary to connect various types of seismic transducers to the DR-100. The lid option houses the control, amplifiers, filters, and power supply needed to operate and calibrate one-, two- or three-component seismometers and force-balanced accelerometers.

DP-100 PLAYBACK UNIT

The DP-100 digital-tape-playback unit is designed for complementary operation with the

DR-100 digital-event recorder. It provides both analog and digital output-data formats of one-, two-, or three-channel operation for cassette tapes recorded in the DR-100. The DP-100 has tape-read function only.

Normally, the DP-100 is AC powered, and designed for operation in a laboratory or data processing center. However, for the Operation Poorman system, the DP-100 was adapted to operate with the 12-volt-battery system in Module III. Operation is straightforward, with manual- or remote (computer) -control option. A switch-selectable choice of playback speeds provides flexibility in the output-data rate. Fast-forward/rewind controls facilitate tape search. Start and stop times, and identification information, for each event, are displayed in digital format.

MEQ-800-B SMOKED DRUM RECORDER

The MEQ-800-B is a portable continuous-recording system, with its own precision clock. It is powered by its own battery. The recording medium is smoked paper. Signals are etched on the smoked paper by a ruby-tipped stylus. This recording method was found to work well in extreme-cold environments where ink and dye on paper are known to fail. For Operation Poorman, the drum speed was adjusted to record 24 hours of continuous single-channel data. The smoked-drum recorder was included in Module II to provide quick-look results on system performance. It also allows comparison between its own continuous-recording mode and the "event"-recording mode of the DR-100.

STRIP-CHART RECORDER

The strip-chart recorder records data directly from the DP-100. The recording medium is thermal-sensitive paper. Analog data from the DP-100 are recorded onto the paper by a stylus with an elec-

trically heated tip. Three channels of analog data can be recorded simultaneously.

TELEMETRY SYSTEM

Transmitter. The TX-101 transmitter, located in Module I, is an FM unit capable of output levels up to 500 milliwatts in the VHF and UHF bands. For Operation Poorman, it was set up to operate at 169 MHz with an rf-output power of 100 milliwatts.

Receiver. The RX-101 receiver, in the Record Module, is a dual-conversion receiver. A companion to the TX-101, it provides 0.5 microvolts sensitivity, 10 dB of quieting, and minimal-distortion levels.

Receive and Transmit Antennas. Loaded 5/8-wave whip antennas with 3 dB of gain were used. A six-element-Yagi antenna was considered for use on Operation Poorman, since it was part of the Sprengnether package and would have provided a 9 dB gain; however, it was rejected for use on the Alaskan Exercise, because of difficulties anticipated in installing and aligning it under arctic conditions.

MODULE HARDENING

For Operation Poorman, we selected containers manufactured by the Hardigg Corporation. These containers were made of polypropylene and were certified for use in commercial airline shipments. They were insulated with approximately 6 inches of foam to retain the heat generated from the electronics and batteries (3 watts in Module I). In addition to the thermal insulation, the Hardigg containers provide some shock protection during shipping.

We calculated that a temperature difference of 50°F between the inside of the box and the ambient temperature could be maintained. According to the manufacturer's specifications, the electronics will function, reliably, down to, at least, +10°F. Consequently, the system could be expected to operate at outside temperatures down to -40°F.

SEISMIC-SYSTEM RESULTS

When the three modules were received from the Sprengnether Company, they were thoroughly bench tested. In addition, they were field tested, at

the Nevada Test Site, by operating the system continuously for one month. A few minor defects were discovered and corrected. We then proceeded to

FIG. 2. Graph of temperature histories, inside and outside of Module 1, during cold-chamber test (starting about 1:00 p.m. on December 12, 1979). This test shows that Module 1 can sustain an inside-to-outside-temperature difference of about 40°F.

plan for cold-chamber testing of Module 1 in anticipation of the Alaskan Exercise.

An investigation disclosed that no cold chamber, readily available, was able to hold Module 1 and still provide temperatures down to -50°F. Therefore, a chamber was designed and constructed. The construction costs of the simple plywood chamber were roughly \$270. (See Appendix A., EG&G Cold-Chamber, for construction details.)

This chamber, cooled by dry ice, achieved temperatures of -90°F. Module 1 was cold soaked in the chamber for 36 hours at -40°F, during which time, critical operating parameters, such as battery voltage and transmitter output, were monitored. Figure 2 shows the temperature histories, inside and outside of Module 1, during the cold soak. Module 1 operated satisfactorily at -40°F, giving us confidence that it would perform equally well under actual cold-weather conditions. Since all other system-design objectives had been met, the equipment was now ready for the Alaskan Exercise.

ALASKAN-EXERCISE DESIGN OBJECTIVES

The overall objective of Operation Poorman was to evaluate the man/machine interface, during cold weather operation, between a field team, representative of verification cadre members, and a seismic-data-recording system. This evaluation would enable a realistic assessment of our seismic-data-acquisition and -recording capability during cold-weather operations in the Soviet Union. Specific exercise objectives are given below:

- Attend Arctic Survival School conducted by the Air Force.
- Test operating range of milliwatt-telemetry link under arctic-like conditions.
- Attempt off-road deployment of portable seismic station.
- Survey locations of portable-station site by use of the Omega system in the northern latitudes. (These results will be reported in a separate document.)
- Record local seismic signals using the portable system.
- Test suitability of military and civilian cold-weather clothing.

- Compare team working effectiveness under arctic-like versus Nevada-Test-Site conditions.
- Provide documentary photography of the various phases of the exercise.
- Observe equipment and personnel performance during a cold-weather exercise.

The selection of exercise objectives excluded several elements that would be included in any major-exercise design. Specifically, we chose not to address the issues of the language barrier, the effects of stress that might arise during an actual mission, the experience and personal qualities needed to supply team leadership, the need to carry out in-field data analysis, the navigation required to locate station sites, or the need to survey station locations.

In order to assess our dependency on host-country personnel, for the emplacement of off-road seismic stations, we selected an off-road emplacement as one of our exercise objectives. The PNE protocol states, "the party carrying out an explosion shall assure for designated personnel telecommunications with their authorities, transportation, and other services appropriate to their rights and

functions at the site of the explosion." A careful review of the PNE negotiating record, as compiled in EG&G document LV-19038,* does not provide

any additional information on this statement. As a result, we assumed that the cadre should be configured to be as self-sufficient as possible.

DESCRIPTION OF ALASKAN EXERCISE

EXERCISE LOCATION

Site selection for Operation Poorman used three selection criteria. First, the field team would work at air temperatures of -40°F or lower. No location within the lower 48 states has predictable climate patterns that satisfy this criterion. Secondly, terrain and ground vegetation would simulate our model for a PNE mission, the Kama-Pechora region of the Soviet Union, which is reasonably representative of the northern-Soviet latitudes where a verification mission might occur. Our third criterion was that the field team would deploy on government-controlled property. This would simplify access and minimize environmental-impact control.

During June of 1979, using a light aircraft, we scouted the terrain near Fairbanks, Alaska. A site, on government property near Eielson Air Force Base, Alaska, was selected. Both the Kama-Pechora region and Eielson are about 65 degrees north latitude, have similar interior climates and terrain, and, of course, similar daylight patterns. In addition, the climate for the site gave assurance that our first criterion would be satisfied during mid-January. Figure 3 shows the site location. Figure 4 shows the temperature history experienced by the team during the Alaskan Exercise.

EXERCISE PERSONNEL

Below are listed the individuals making up the five-man field-test team:

(They are representative of the experience levels, ages, and physical conditions of the present verification cadre members who might be called upon to

carry out a cold weather mission in the Soviet Union.)

LLNL	EG&G (Las Vegas)
● R. Geil	● G. Smith
● R. Jones	● J. Tsitouras
● N. Pruvost (team leader)	
● M. Sharp (backup)	

FIG. 3. Map showing site, near Fairbanks, Alaska, used during Alaskan-Exercise phase of Operation Poorman.

FIG. 4. Graph of the temperature profile experienced by the team during the Alaskan Exercise. The profile does not show a small 5 to 10°F daily variation.

*J. Tsitouras and O. Yavorsky (Eds.), *PNE Treaty: Abstracts of Negotiations Communications September 1974 to June 1976*, Las Vegas Operations, EG&G INC., Las Vegas, Nev., LV-19038, 1978.

EXERCISE CLOTHING

Team clothing was purchased in San Francisco from Eddie Bauer (a store). In addition, the team was issued a complete set of U.S. Army cold-weather clothing at Fort Wainwright (see Appendix B., Cold Weather Clothing, for clothing lists). During the exercise, team members used both clothing sets.

EXERCISE LOGISTICS

In order to maintain maximum flexibility, the team rented commercial lodging in Fairbanks. Meals were taken commercially except for lunch which was taken at the PX on Eielson Air Force Base. Transportation consisted of two four-wheel drive trucks (one pickup, one travelall) rented from Hertz in Fairbanks. These vehicles were used in our

commute between Fairbanks and Eielson as well as our deployment to the field site. Figure 5 shows Modules I, II, and III loaded onto the pickup truck. The pickup also contains all of the auxiliary test equipment and support equipment needed to carry out the Alaskan Exercise.

The team arrived in Fairbanks Sunday, January 6, 1980, and departed Tuesday, January 22. All days were work days except January 13, which was set aside for rest and relaxation. Two commercially-rented transceivers were used to maintain voice communication when outside of Fairbanks. While in the deployment area, one transceiver, with a dedicated frequency, was used to maintain communication with Eielson Police as a safety precaution. A copy of the LLNL operational-safety procedure under which the team worked is presented as Appendix C., Operation Poorman Operational Safety Procedure.

ALASKAN-EXERCISE RESULTS

AIR FORCE ARCTIC SURVIVAL SCHOOL

There were two purposes for attending the Arctic Survival School. The first was to enlarge the outdoor-survival capabilities of the team members in order to enhance team safety while on the exercise. The second purpose was to study at the school and become directly familiar with its course of instruction. At present the verification cadre has no training in cold weather skills. Even though the Air Force Survival School curriculum could be used to design a course for the cadre, we believe the most effective training for cadre members would be to attend the school itself. It offers two days of classroom instruction and two days and nights of outdoor practice in an actual arctic environment. The Operation Poorman team attended the two days of classroom instruction but not the outdoor portion. Attending the latter did not seem necessary since we were going to get sufficient outdoor experience on the outdoor exercise; however after attending the classroom portion and then performing the exercise, we believe that receiving the outdoor instruction and practice is advisable for future cadre

members in order for them to gain the self confidence needed to perform outdoor tasks successfully in cold weather. We include, as an appendix, a condensation of the syllabus for the school, Air Force Syllabus S-V87-A.

TELEMETRY RANGE TEST

To determine the telemetry range of our system as configured, we placed Module I in the back of the pickup truck. Module II was kept inside the barracks at Eielson Air Force Base. Its antenna was placed on the roof about 20 metres above ground level. The pickup, carrying Module I, was then driven along roads that radiated out from Module II's location at about 120 degree intervals (see Fig. 6). Voice contact was maintained, by transceivers, between personnel in the pickup and personnel located at Module II. Terrain, between the pickup and Module II, was such that optical line-of-sight was not usually maintained. Nevertheless, the signal transmission, within about a 10 km radius, was good. The ground surface consisted of underbrush covered with snow, and patches of timber with snow-covered branches.

FIG. 5. Modules I, II, and III on the pickup truck in Fairbanks. The pickup also holds all test and support equipment needed for the Alaskan Exercise.

FIG. 6. Schematic of the telemetry-range test. Module I, with transmitter active, was carried, in back of the pickup truck, over the above road pattern. Reception by Module II, at Eielson barracks, failed, at the four positions shown, when Module I was more than, about, 10 km from Module II.

Telemetry interference was experienced while Module I was deployed. Later investigation revealed many communication antennas north-east of the Eielson Air Force Base runways. No further analysis of the radio-frequency interference was attempted. Suffice it to say, that when we deployed Module II at the south end of the base, away from the communication antennas, the interference was of manageable proportions. Note that during these tests and deployment the radiated power of the telemetry transmitter was only 100 milliwatts.

The same telemetry test carried out in Alaska was later duplicated in Yucca Valley at the Nevada Test Site. The results were the same as the Alaskan test, with Module I and Module II maintaining good telemetry up to separations of about 10 km.

Telemetry range can be an important factor on a verification mission. By transmitting data continuously, from a remote station to a telemetry-collection point, several advantages can be realized. For example, with telemetry, the recorders (Module II) can be clustered at a collection point, permitting

the time base of all Module II recorders to be synchronized to a single clock, thereby assuring close time-registration between recorders. Because of temperature variations and long-term drifts, which vary among different DR-100 recorders, time-registration can be lost if data recorders are located at the individual-station sites. In addition, the number of man-days required to collect the data can be greatly reduced if all recorders are clustered at a single location. That is, the time interval needed for collecting data is usually short compared to the time interval needed for servicing an outlying station. Typically, a station requires service every five days or more, whereas data should be collected every few hours, or every day, depending on the mission.

To take advantage of telemetry, the telemetry range must be sufficient to link outlying stations to a convenient telemetry-collection point. The station-to-collection-point distance can vary from mission-to-mission. However, a range of 20 km would appear to be desirable for most cases. To achieve a 20 km range, we estimate that the transmitter power for the Sprengnethel system would have to be increased to 1 watt, from the 100 milliwatts used in Operation Poorman.

OFF-ROAD DEPLOYMENT

The off-road deployment was designed to test the capability of three team members to emplace an off-road remote station. This capability depends on terrain, ground cover, physical strength of team members, and temperature, wind, and light conditions. For our deployment, these factors were not "worst-case," but, rather, considered "typical" of what might be expected on an actual verification mission. The terrain was nearly flat. The off-road course, as plotted before departure, varied in elevation by no more than 25 feet. The terrain was a combination of a frozen lake, lake-side brush, and small timber. Figure 7 shows the type of underbrush typical of the exercise area. The open terrain of the frozen lake was deliberately chosen to assure that a path of minimum difficulty was experienced before the underbrush was encountered.

Before the off-road deployment, Module I had been operated for several days, outside, at air temperatures below -40°F . Measurements, made during this time, confirmed the cold-chamber-test results, discussed earlier, which showed that

Module I was capable of maintaining an inside-to-outside-temperature difference of about 35°F . For the off-road deployment, Module I was loaded onto an eskimo sled, called an akio. The akio we used had a rounded bottom and was about the right size to carry a human being (6 to 7 feet long and about 2-1/2 feet wide). When Module I was lashed to the akio, it hung over the edges by about 6 inches on either side. In addition to Module I, we were able to load a pickaxe, a long-handled shovel, the S-6000 seismometer, and one of the transceivers. Figure 8 shows the akio as loaded for the off-road deployment.

For safety, radio contact was arranged to take place at 15-minute intervals, between the three team members carrying out the off-road deployment and the two members remaining at the road-head. The members at the road-head were also equipped with a transceiver, tuned to the Fielson Police (emergency) frequency, in the event emergency contact became necessary.

While off-road, the akio team worked in air temperatures of -42°F . There was virtually no wind and therefore no wind-chill factor. About 5 to 6 hours of daylight were available on the day of the deployment. Fortunately, there was no heavy overcast and most of the daylight was usable. Figure 9 presents a schematic of the off-road-deployment route. Fig. 10 shows the team just prior to departure. The team started and ended the deployment at the road-head, which was about 200 metres from Transmitter Road. As can be seen from Fig. 9, most of the route was over the level surface of the frozen lake and offered minimal resistance to travel. However, to reach the top of the knoll, the team had to traverse timber and underbrush around the lake edge. (Seen in the background of Fig. 10.) Once off the lake, their rate of progress slowed dramatically. The akio was very difficult to guide through the underbrush. By the time the knoll was reached, the team had decided to abandon the route originally planned and return directly to the station site at the road-head. Although the team was highly motivated, the scheduled route of 2 to 3 km was aborted because of near physical exhaustion, and the need to reserve some energy with which to emplace the remote station. The actual distance travelled was less than 1 km, yet the travel time was an hour and a half. Once the three team members had arrived back at the road-head, all five team members worked on the station emplacement. This effort required an additional hour and a half.

FIG. 7. The photograph shows a portion of the cleared road in contrast with the underbrush and timber, typical of the uncleared terrain in the exercise area. The thick underbrush made off-road deployment very fatiguing.

FIG. 8. The photograph shows Module I on the akio. The snow, seen piled in the akio around Module I, was accumulated because of the overhang of Module I. The overhang scooped up snow as the akio was being pulled; thus, drag and weight were increased, and, consequently, so was fatigue in the off-road-deployment team.

FIG. 9. The schematic shows the route planned for the deployment and the shorter route actually taken by the deployment team. The planned route was abandoned because of fatigue.

As part of the station emplacement, the team was hoping to dig a hole about 20 inches in depth, since the sensitivity of a seismometer placed on the earth's surface can be seriously reduced by the effects of wind noise. To help minimize these effects, it is desirable to bury the seismometer a foot or so below grade. But, using a pick, we were able to chip out a hole only about ten inches deep before fatigue and darkness forced us to give up. We used a propane torch in an attempt to thaw the soil before using the pick, but this approach proved to be ineffective. All team members were surprised at the difficulty of excavating even a small hole in frozen soil. The impact of the pick produced sharp-edged pieces of frozen soil about one inch in size. We believe us-

ing the sharp end of a geologist hammer would have been as effective as the pick. Back-filling around the seismometer was also more difficult than expected because the chipped-out soil behaved about like hard peanut brittle. (Figure 11 shows a team member working on the hole.)

Alternatives to the akio as a means of transporting Module 1 to an off-road-station site were discussed. Snowmobiles, dogsleds, skis in lieu of snowshoes, small tracked vehicles, and helicopters were among the alternative technologies discussed. Only the helicopter was thought to be capable of overcoming the problem of penetrating an environment with underbrush.

FIG. 10. The team about to leave the road-head to carry out the off-road deployment. The knoll reached by the team is visible in the background. The team member on the right is using a movie camera to film the departure.

FIG. 11. The photograph shows a team member, at the road-head, digging a hole in which to emplace the S-6000 seismometer.

SEISMIC-DATA RECORDING

To confirm that the seismic system was operating properly, we collected seismic data for a 24-hour period after Module I was emplaced. Module II was moved from the Eielson Barracks to a site about 1 km from Module I for the telemetry link with Module I. (Unfortunately, this activity took place near the end of the deployment period, during which time the temperature had risen to the neighborhood of 0°F. Hence, the outdoor cold-temperature exposure of Module II was not very severe, so the field survivability of its components was not tested. However, cold-chamber tests of Module II are planned.) Figure 12 presents three channels of seismic data recorded by Module II during a small local earthquake. Records such as this indicate that the seismic system was operating properly.

CLOTHING

There was lack of complete agreement among team members about preferred clothing, however, on comparing notes at the end of the Alaskan exercise, the team members did agree on the following:

- Each team member felt that three to four days of experience was needed to learn how to use cold-weather clothing properly. In addition, classroom instruction could not be used to shorten this learning time. Each individual had to accommodate himself to the clothing in his own way. This required personal experience.
- Application of the layer principle to clothing, as described in cold-weather training, is a valid, if not crucial, requisite to the performance of any outdoor work.
- Experience with cold-weather clothing is a necessary prerequisite to establishing the self-confidence needed to work successfully outdoors.
- Preference between Army issued clothing and Eddie Bauer clothing varied among team members. However, the Army clothing was better designed to implement the layer principle.

WORKING EFFICIENCY

One objective each team member carried out for himself was to note how long a particular job required outdoors. In particular, he noted how long a

job required compared to a similar job under more normal working conditions (e.g., at the Nevada Test Site). Of course, some mental extrapolations were necessary since exactly equivalent jobs were not programmed for comparison. Most of the team members have worked in the field for several years and were able to recollect tasks carried out under variable working conditions. Estimates of efficiency varied somewhat among members and job types. Nevertheless, when team members compared notes near the end of the exercise, one common element surfaced immediately: no one had ever before experienced such a dramatic reduction in working efficiency. In general, there was agreement that efficiency in cold weather was down by a factor of two to three and, in some cases, even more. Although some improvement in efficiency might result from more experience in cold weather, team members believe the improvements would not be significant.

The causes of lower efficiency are difficult to characterize; however, one example is that clothing must be adjusted constantly when body heat is being generated by physical exertion. Exertion rates can vary widely over short periods of time; a person could easily spend as much time removing or putting on clothes as in performing the task. Slowing down his exertion rate so that his body temperature stabilizes (that is, the heat generated is equal to the heat loss, as determined by his clothing) is, of course, an alternative to constant clothing adjustment; however, the impact on efficiency is still negative. For example, if, under cold-weather working conditions, a person must slow his walking rate to one step every six seconds in order to maintain a comfortable body temperature, but can work comfortably at the rate of one step every two seconds under moderate conditions, his efficiency is obviously reduced by a factor of three.

Other factors enter into the efficiency relationship, for example: team members found themselves taking more time deciding how to perform a given task; in addition, the effort required to recover from a poor start seemed to be greater than under ordinary conditions; physical exhaustion set in after less working time than usual, with the associated result that mental work rates also slowed down; and, finally, verbal communication between members was sometimes more difficult than usual. (For example, a person's hearing is reduced with a parka hood over his head; it also reduces his peripheral vision.)

FIG. 12. The figure shows a seismogram of a small local earthquake. It was recorded from the S-6000 seismometer, emplaced at the road-head station during the off-road deployment. The earthquake occurred about 05:27:19 hours, local time, on January 20, 1980. The data were recorded by the DR-100 and show that the recorder was able to capture about one-half second of lead-in-background signal prior to onset of the earthquake signal.

The general low-level of sunlight and the small number of useful daylight hours reduced flexibility in working-schedule changes. For example, field work requiring good visibility was necessarily scheduled for midday when the sun was relatively high. (Even then, it was only a few degrees above the horizon.) Failure to complete the scheduled field work during midday meant postponement until the following day. Working in low-level light, even at midday, sometimes leads to simple mistakes, and, again, a lowering of efficiency.

ALASKAN-EXERCISE PHOTOGRAPHY

Two Nikon Model F 35-millimeter and two Super-8-millimeter Cine Kodak movie cameras were used on this deployment. Little confidence had been placed in the movie cameras before deployment; however, they performed reasonably well in the field, providing they were kept warm until used.

The Nikon Model Fs proved very awkward to focus with mittens or gloves on. A mechanical binding existed between the aperture ring and its remote indicator at the back of the camera. About 30% of the 35-mm film was over- or underexposed. We believe this was caused by a combination of the following factors:

- Film emulsion was too cold.
- Cadmium-sulfide photocell in light meter gave low reading due to nonlinear response to temperature.
- Contrast between white background of snow and dark subjects was not adequately compensated for.
- Shutters in cameras were not degreased (an oversight), and became sluggish when operated at cold temperatures in the field.

Two reels of movie film and about 200 slides were taken during the Alaskan Exercise. The slides were reduced to 100 after culling for redundancy and poor quality.

EQUIPMENT AND PERSONNEL PERFORMANCE

A number of low-temperature effects on the equipment were noted during the exercise. Some examples are:

- Two flat tires occurred without puncture. The cause was diagnosed as the fact that synthetic inner tubes embrittle at temperatures of about -60°F .
- Electrical-cable stiffness increases dramatically in cold temperatures. As an example, the antenna for Module II was placed on the roof of the Eielson barracks and connected to Module II by a type RG-8 cable. To make the connection, the cable was run, vertically, up four stories. When the exercise ended, the cable was detached at the roof line; it toppled stiffly, like a felled tree, into the adjacent field.
- No problems were experienced with cold-starting the vehicles, since they were equipped with 1.5-kW electric-block heaters. (These heaters are installed in the heater line of the vehicle and circulate ethylene glycol within the block of the engine by a thermosyphon effect.) After engine start, a problem does arise—the lubricants in the transmission and differential are both congealed. Gentle rocking of the vehicle in a fore and aft motion must be undertaken before the vehicle can be driven.

CONCLUSIONS

A second-generation seismic system can be made mission-ready using the approach demonstrated by Operation Poorman. A lead time of six months, prior to the team's departure, should be sufficient to acquire and field check such a system.

Telemetry provides a way to increase the team's efficiency in the field. The number of trips required to station sites is greatly reduced. In addition, telemetry allows for more flexibility in module deployment to meet various mission requirements. The use of telemetry could be critical to the success of other types of verification missions as well as a PNE mission.

The team experienced various difficulties during the exercise because of the low temperatures. Fogging of eyeglasses was a constant annoyance, both when going from the warm heated building to the outside, and when breathing heavily with the parka hood in place. (We know of no solution to this problem.) The team did not, for the most part, experience any noticeable amount of wind during the exercise; however, they soon became aware of the importance of the wind-chill factor. One team member was working on the roof of the Eielson Barracks. The air temperature at the time was about -40°F . Even though the wind conditions were mild (10 mph), the apparent temperature, calculated with the wind-chill factor, was -70°F , and he was unable to tolerate exposure for more than about five minutes. (Snowmobiles are conspicuous by their absence when the temperature drops below -30°F ; their forward motion creates a wind-chill factor that is intolerable.) We include, as Fig. 13, the wind-chill chart supplied to us by the Air Force Survival School. Notice that the team worked in the "increasing danger" zone of the chart. (Thin cotton laboratory gloves were found to be useful for fine work in this zone; they prevent fingers from freezing to cold metal and allow a couple of minutes of work before donning warmer mittens or gloves.) We believe that when temperatures and wind factors combine to place a person in the "great danger zone" of the chart, little, if any, useful outdoor work will be performed.

Without a direct field experience simulating the adverse environment of a possible mission, no realistic assessment of readiness or capability is credible.

In general, the team concluded that much of their capability assessment stems from direct first-hand field experience and that much of this experience is not transferable.

We believe that small scale exercises, such as Operation Poorman, are practical and useful, even though they do not incorporate all features of an actual mission. A full scale exercise is needed to address such factors as team management/leadership and the English/Russian language barrier.

Wind Speed		COOLING POWER OF WIND EXPRESSED AS "EQUIVALENT CHILL TEMPERATURE"																				
Knots MPH		TEMPERATURE (°F)																				
Calm	Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45	-50	-55	-60
		EQUIVALENT CHILL TEMPERATURE																				
3-6	5	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45	-50	-55	-65	-70
7-10	10	30	20	15	10	5	0	-10	-15	-20	-25	-35	-40	-45	-50	-60	-65	-70	-75	-80	-90	-95
11-15	15	25	15	10	0	-5	-10	-20	-25	-30	-40	-45	-50	-60	-65	-70	-80	-85	-90	-100	-105	-110
16-19	20	20	10	5	0	-10	-15	-25	-30	-35	-45	-50	-60	-65	-75	-80	-85	-95	-100	-110	-115	-120
20-23	25	15	10	0	-5	-15	-20	-30	-35	-45	-50	-60	-65	-75	-80	-90	-95	-105	-110	-120	-125	-135
24-28	30	10	5	0	-10	-20	-25	-30	-40	-50	-55	-65	-70	-80	-85	-95	-100	-110	-115	-125	-130	-140
29-32	35	10	5	-5	-10	-20	-30	-35	-40	-50	-60	-65	-75	-80	-90	-100	-105	-115	-120	-130	-135	-145
33-36	40	10	0	-5	-15	-20	-30	-35	-45	-55	-60	-70	-75	-85	-95	-100	-110	-115	-125	-130	-140	-150
WINDS ABOVE 40 HAVE LITTLE ADDITIONAL EFFECT		LITTLE DANGER					INCREASING DANGER (Flesh may freeze within 1 minute)							GREAT DANGER (Flesh may freeze within 20 seconds)								
		DANGER OF FREEZING EXPOSED FLESH FOR PROPERLY CLOTHED PERSONS																				

FIG. 13. Wind chill factor chart (issued by Air Force Arctic Survival School). The team worked in the "INCREASING DANGER" portion of the chart.

Cold-temperature effects are likely to slow the rate at which Soviet personnel are able to support our field activities. Such a slowdown would occur even with the best of intentions on the part of the Soviets.

Under cold-weather conditions, and for station emplacements more than 1 km from a road-head, the team will require transportation. We believe that they will be dependent on the Soviets to supply that transportation. Helicopters appear to be the only viable means of transportation, if the mission requires the emplacement of a remote-seismic station.

RECOMMENDATIONS

The incorporation of telemetry into a second-generation seismic system is highly recommended.

Arctic-survival school, including outdoor-living experience, is recommended for each cadre member selected for a mission.

A third recommendation was to have been to improve the Poorman modules by: reducing module size and weight; increasing timing accuracy; and, replacing LED (Light Emitting Diode) displays with LCDs (Liquid Crystal Displays). However, these recommendations were acted upon prior to this publication, as described below.

RECOMMENDATIONS FOLLOW-ON

The most important result of Operation Poorman, relating to equipment, was the insight gained into the many ways Modules I, II, and III could be improved. Upon return from the Alaskan Exercise, we incorporated some of our insights into a redesign of Modules I and II. Two modules, incorporating some of these redesigns, are under development, at this time (Mar., 1981), at EG&G (San Ramon). Although not yet complete, we can list some of the

The Hardigg containers, for the modules, provided a significant benefit to handling efficiency, because repackaging of equipment units was not required after the system left home base at EG&G Las Vegas. That is, the transport, from EG&G to LLNL, to San Francisco Airport, to Fairbanks Airport, to temporary storage at Fort Wainwright, Fairbanks, then further transport to Eielson Air Force Base, and, finally, deployment in the field, was all accomplished with no repackaging. The same was true of the return from field to home.

features incorporated as a result of Operation Poorman. The modules were made smaller and lighter; module volume was reduced to about half, and weight was reduced by greater than 25 percent. In addition, the ratio of lid-insulation to floor-insulation was increased to compensate for the fact that, under extremely cold conditions, the air temperature is lower than the ground temperature. The new modules can accompany team members on commercial airlines as regular passenger baggage. This assures that a team can take full advantage of commercial-airline schedules and that the equipment can travel on the same aircraft with them. With respect to timing, one of the modules is being refitted with a clock, placed in a temperature controlled double oven, while the other is being refitted with a low-power receiver tuned to the timing signal from WWVB. We expect this approach to provide greatly improved timing accuracy, especially when the modules are subjected to temperature extremes in the field. In addition, the LED displays used in the Sprengnether units have been replaced with LCDs. With this change, the display is continuously visible and display-power consumption is reduced by a factor of approximately one thousand.

APPENDIX A. EG&G COLD CHAMBER

Figure 14 depicts a simple cold chamber that was designed and built at the EG&G Atlas facility. Design calculations showed that a chamber, sized to hold the Operation Poorman modules, and insulated with 5 inches of urethane foam, would have a loss of, approximately, 500 Btu per hour, for an inside-to-outside-temperature difference of 110°F. The heat of sublimation for dry ice (CO₂) is 148 Btu per pound. Consequently, the chamber would require approximately 2.7 lb of dry ice per hour. In actual operation, the chamber was found to consume, approximately, 2.5 lb per hour and could maintain steady temperatures between -40°F and -80°F. Temperature control was maintained by use of an adjustable thermostat, which controlled a circulating fan in an on-off mode. Operational experience showed that temperature could be maintained within $\pm 5^{\circ}\text{F}$. Initial cool down was facilitated by the introduction of gaseous CO₂ for approximately 5 minutes.

Note: all dimensions approximate

FIG. 14. Schematic of cold chamber used to test Module I. The chamber was designed and built by EG&G in Las Vegas, Nevada.

APPENDIX B.

COLD-WEATHER CLOTHING

CLOTHING ISSUED TO POORMAN TEAM BY U.S. ARMY

- 1 barrack bag
- 1 pair cold weather boots ("Bunny" or vapor barrier boots)
- 1 insulated cap
- 1 cold weather hood with fur ruff
- 1 cold weather mask (Bacalava)
- 1 cold parka liner
- 1 extra-cold weather parka
- 2 wool man's shirt OG 108
- 1 trousers suspenders
- 1 mitten inserts T F
- 1 trousers man's CIN OG 107
- 1 arctic mitten set
- 1 mitten shell T F

CLOTHING PURCHASED AT EDDIE BAUER IN SAN FRANCISCO

- 1 heavy parka
- 1 stocking mask
- 3 pair heavy underwear
- 1 pair heavy pants
- 1 pair windbreaker pants
- 1 pair suspenders
- 1 pair gauntlet mittens
- 1 pair boots (Sorel)
- 2 pair boot liners
- 1 pair felt inserts
- 4 pair heavy wool socks
- 4 pair light wool socks

CLOTHING ISSUED BY AIR FORCE TO STUDENTS IN FIELD PORTION OF ARCTIC SURVIVAL SCHOOL

(This clothing was not issued to the Operation Poorman team. We include the list for comparison only.)

- 1 parka
- 1 pair boots ("Bunny" Boots)
- 1 insulated trousers
- 1 mountain sleeping bag
- 1 arctic sleeping bag
- 1 sleeping bag cover
- 1 cold weather hood
- 1 pair of gauntlets
- 1 BAG A3
- 1 survival knife
- 1 flashlight with batteries
- 1 saw knife/shovel

APPENDIX C.

OPERATION POORMAN OPERATIONAL SAFETY PROCEDURE

OSP 0-69

PORTABLE SEISMIC SYSTEM FIELD TEST

A. INTRODUCTION

1. General

The purpose of this project is to evaluate the cold weather man-machine interface of a Portable Seismic Station. Results of the deployment are to be used to specify seismic data acquisition and transmission systems for use in OSI-PNE (on-site inspection peaceful nuclear explosives) verification technology programs. The approach includes the fielding of three portable boxes and a team consisting of three persons from Lawrence Livermore Laboratory and two from EG&G.

2. Changes

Any required change in operations that alters the scope or significantly decreases safety controls will not be made until a revision or supplement to this procedure has been signed by the person authorized to implement this operational safety procedure.

3. Review

This OSP shall be reviewed annually or at some shorter interim by the originator and Hazards Control to establish that its contents are appropriate and adequate for current operations.

B. SCOPE

This Operational Safety Procedure is required by the LLL Health and Safety Manual 2.03 and shall authorize the deployment of LLL personnel and equipment to the area near Eielson Air Force Base near Fairbanks, Alaska. It also describes the hazards and their safety and operational controls which shall be followed to conduct this experiment in a safe and efficient manner.

The safety regulations in this OSP supplement the LLL Health and Safety Manual and apply to all participants to the area described.

C. RESPONSIBILITIES

N. L. Pruvost (Alternate: *R. G. Geil*) is responsible for implementing these controls and all applicable Laboratory safety standards and for the safety of this operation.

All participating team members are responsible for performing their work according to the regulations of this OSP. They are expected to take all reasonable precautions to protect themselves and their fellow team members and to perform only those tasks that they believe can be accomplished safely. When participants have any doubt regarding the safety of any phase of their work, they are expected to check with the project supervisor before proceeding.

HAZARDS CONTROL

The Hazards Control Safety Team assists management to institute and to maintain a minimal risk work environment. In addition, Hazards Control may request that management or employees stop an operation when there appears to be an imminent danger to personnel or property (see Health & Safety Manual Section 1.06).

D. HAZARDS ANALYSIS

Following is a list of possible personnel injury or property damage situations that may exist:

1. Driving Conditions

Vehicle travel may be hazardous because of weather and road conditions between the work site and Fairbanks.

2. Climate Conditions

Exposure to extreme cold and wind is a realistic problem in central Alaska in the winter.

3. Equipment Damage

Equipment consisting of portable seismic equipment plus back-up parts and tools, which could be damaged while in transit or when subjected to extreme cold.

4. Working Conditions

Team members will be required to physically transport equipment across rugged, snow-covered terrain.

5. Working Hours

In the winter daylight hours are very limited.

6. Residual Risks

Unknown and hidden hazards may exist or present themselves in the course of this experiment.

E. CONTROLS

Precautions and controls to be taken to reduce the risks associated with the above hazards so that the experiment may be conducted safely are:

1. Team members shall employ safe driving techniques at all times—vehicles must never be driven at speeds in excess of what is safe and prudent (Roads in Alaska in the winter are often covered with ice and snow).
2. All team members shall be clothed in a manner that is designed for use in extreme cold. The clothing is being supplied by the U.S. military, issued at Fort Wainwright, Fairbanks, Alaska. However, some articles of clothing may be substituted for the heavier military garb, at the discretion and with the approval of the project supervisor.
3. The seismic equipment has been pretested for cold exposure by EG&G in a cold chamber. In addition LLL has tested and deployed the equipment at NTS. The instruments are packaged in foam inside rigid fiberglass boxes that are aircraft-certified shipping containers.
4. All team members shall be medically screened by either LLL or REEW (NV) Medical Departments to insure that their health permits their physical exertion in extreme cold conditions.
5. Schedules of work to be performed shall be coordinated so that operations will be conducted during normal working hours.
6. All team members who will participate in this experiment shall attend the Air Force two-day Cold Weather Survival Training course (academic portion) prior to deployment.
7. Team members will be trained in multimedia first aid as certified by LLL Hazards Control. A first-aid kit will be provided.
8. All injuries and accidents will be reported promptly to the project supervisor and Hazards Control.
9. The "working alone" policy outlined in the Health and Safety Manual subsection 1.07 will be followed. Team members shall exercise good judgement when they are required to travel distances from habitation.

10. Teams members shall communicate their plans to the military authorities responsible for the area whenever they are to travel where emergency assistance is difficult to obtain.
11. Team members will become familiar with, and abide by the safety regulations of the host military facility at which the tests are to be conducted.
12. All operations shall cease if weather conditions present a hazardous-to-life situation.

APPENDIX D.
SYLLABUS S-V87-A
(Condensed)

SECTION I
GENERAL
(text omitted)

SECTION II
ADMINISTRATIVE ACTIVITIES
(text omitted)

SECTION III
OPERATIONAL PHASE OF INSTRUCTION
ARCTIC FIELD CRAFT TECHNIQUES

Title and Objectives

SHELTER LOCATION AND CONSTRUCTION

1. Select proper sites for shelter
2. Erect shelters appropriate to conditions
3. Use knots and lashings as required in the construction of arctic shelters

FIRE CRAFT

1. Describe a variety of methods for starting a fire
2. Gather appropriate materials, start, maintain, and use fires
3. Describe the hazards peculiar to use of fires under arctic conditions, and apply appropriate procedures

PROCUREMENT AND USE OF FOOD AND WATER

1. Discuss methods of obtaining water
2. Obtain water by the best means available
3. Construct simple snares
4. Set snares in appropriate locations
5. Prepare food for immediate use

WEAR AND MAINTENANCE OF CLOTHING

1. Use clothing to prevent heat loss

2. Properly maintain clothing by:
 - a. Drying, using fire, and other means
 - b. Repairing as necessary

FIELD MEDICINE

1. Apply the principles of prevention and early detection of injuries and illnesses associated with arctic conditions
2. Discuss signs and symptoms, prevention, and treatment of cold climate environmental injuries and illnesses to include:
 - a. Snow blindness
 - b. Dehydration
 - c. Hypothermia
 - d. Frostbite
 - e. Carbon monoxide poisoning
 - f. Immersion foot

SIGNALLING, COMMUNICATIONS, AND VECTORING

1. Effectively use signals for ground-to-air communications to include:
 - a. Improvised distress symbols
 - b. Ground-to-air signals
 - c. Signal mirrors
 - d. Day/night flares
2. Vector an aircraft overhead using selected survival radio(s)

SECTION IV

ACADEMIC PHASE OF INSTRUCTION

ARCTIC SURVIVAL PRINCIPLES, PROCEDURES AND TECHNIQUES

Title and Objectives

ENVIRONMENTAL CHARACTERISTICS AND SURVIVAL

1. Identify the key climatic and environmental characteristics of arctic and arctic-like regions, emphasizing:
 - a. General geographic location
 - b. Weather and its elements, to include seasonal variations
 - c. Topography and special regional features
 - d. Human habitation
2. Relate key climatic and environmental characteristics of arctic and arctic-like areas to the requirements which they bring about and to the adaptations (survivor responses) required for survival in such areas, with emphasis on:
 - a. Clothing and shelter
 - b. Use of fire
 - c. Food and water
 - d. Travel, communications, and recovery
 - e. Evasion

CLOTHING

1. Describe the basic principles of personal protection as they pertain to arctic clothing
2. Describe the proper fit and intended use of each item of arctic clothing normally issued to aircrews or packed in arctic survival kits, to include:
 - a. Advantages and disadvantages
 - b. Designed characteristics
3. Describe the techniques for proper care of clothing and equipment in cold weather survival

MEDICAL ASPECTS

1. Discuss the basic principles for treatment of injuries common to bailout or crash landing to include:
 - a. Impaired breathing
 - b. Bleeding
 - c. Burns
 - d. Fractures
 - e. Shock
2. Discuss the importance of the prevention and early detection of injuries associated with arctic conditions
3. Describe important specific survival medical treatment for the injuries and illnesses associated with cold weather to include:
 - a. Dehydration
 - b. Hypothermia
 - c. Frostbite
 - d. Snow blindness
 - e. Carbon monoxide poisoning
 - f. Immersion foot

SHELTER

1. Describe how the provision of dry, dead airspace and exploitation of the principles governing heat transfer are involved in construction of arctic shelters
2. Discuss the selection of shelter sites and the construction of a variety of shelters suited for use under arctic conditions

FOOD AND WATER PROCUREMENT AND USE

1. Discuss the importance of proper water intake to the survivor
2. Discuss the location and nature of water sources and methods of water procurement
3. Identify some of the plant and animal life available as food sources
4. Describe common methods of food procurement, preparation, and preservation

RECOVERY AND VECTORING TECHNIQUES

1. Describe the mechanics of a search and rescue mission and relate this knowledge to timing the use of electronic and visual signalling devices
2. Discuss the effective use of ground-to-air signals of various types to include their size, location, and material composition

3. Discuss aircraft vectoring methods to include aircraft position determination by sound; correction of flight path by the clock system; left, right, and forward movements; and the use of radio tone signal for DF
4. Discuss helicopter rescue procedures to include landing for pickup of survivor and hoist rescue procedures

TRAINING EXHIBITS (LABORATORY)

1. View the survival exhibits and displays available in the laboratory
2. Describe the requirements for special knowledge, abilities, equipment, and attitudes necessary for coping with the varying conditions of the arctic

CARE, USE, AND PREPARATION OF EQUIPMENT (LABORATORY)

1. Discuss the effects of extreme cold on survival equipment
2. *Describe the care and use of survival equipment in the arctic*
3. Discuss the uses of the parachute for survival in arctic areas
4. Effectively prepare clothing and equipment for field use
5. Tie and use:
 - a. *Four basic knots and hitches to include:*
 - (1) Square knot
 - (2) Overhand loop
 - (3) Clove hitch
 - (4) *Timber hitch*
 - b. *Two lashings to include:*
 - (1) Square
 - (2) Sheer