Developing and Implementing a Health and Safety Plan for Hazardous Field Work in Remote Areas

Michael Gochfeld
Conrad Volz
Stephen Jewett
Joanna Burger
Charles Powers
Barry Friedlander

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ABSTRACT
Developing standard operating procedures is an essential feature of most workplaces. They range from words of caution and a checklist for new employees in a retail store to extensive tomes and material data safety sheets in a manufacturing facility. Formal health and safety plans (HASPs) are a requirement for hazardous waste work, and embody the training, equipping, and evaluation of workers. There are relatively few manuals that provide practical guidance in what a HASP should cover or how to create and implement one. This paper details development of a HASP to cover field researchers and the ship's personnel in a remote area of the world (western Aleutian Islands in the North Pacific Ocean), hundreds of kilometers from the nearest emergency room. It illustrates the meshing of a general HASP with a ship safety plan, a dive safety plan, an on-Island remote camping and trekking plan and covers components including firearms and vehicle safety and communication strategy. An expedition of this sort requires extensive planning and experienced safety personnel, and cannot rely on luck to assure the safe return of participants.

INTRODUCTION

Health and Safety Plans are an organized and detailed means of dealing with potential environmental, health, and safety conditions, particularly in uncontrolled environments (Sawyer and Martin, 2000). A HASP is "a dynamic document that must be continually updated if and when new information is discovered (Sawyer and Martin, 2000).

In the summer of 2004 the Consortium for Risk Evaluation with Stakeholder Participation (CRESP) conducted research expeditions in remote areas of the western Aleutian Islands to study possible radiological contamination of the marine environment from the underground nuclear tests conducted decades earlier (1965-1971). The authors developed the health and safety plan to assure that the senior scientists, university technicians, U.S. Naval personnel, Aleut fishermen and crew of the *Ocean Explorer* who participated on the expeditions would return safely. Although the authors had extensive past experience with health and safety plans in a variety of non-typical research venues, the remoteness of the expeditions and the diversity of activities on lands and sea, imposed some unusual challenges.

The traditional HASP required by the Occupational Safety and Health Administration Hazardous Waste standard 1910.120, was designed for a fixed hazardous waste site, on which three zones could be clearly delineated. Guidance provided by chapters in *Protecting Personnel at Hazardous Waste Sites* (Martin and Gochfeld 2000) offered a useful starting point, but much new ground was covered in planning for Amchitka. "Protecting workers on hazardous waste sites requires recognizing the full range of activities that may be performed including some that are not traditionally recognized as hazardous waste work." (Burger and Gochfeld 2000).

This paper indicates how we developed the HASP, documents the challenges of remote areas, raises questions for future remote investigations, and provides an outline (Table 1) of the HASP itself. It draws on a review of hazards facing ecologic workers (Burger and Gochfeld 2000) including divers. It provides useful lessons learned on designing for safe investigation of remote areas and harsh environments.

Background on Amchitka

Amchitka Island is a member of the Rat Island group of the western Aleutians, located about 1200 km west of Anchorage. In 1965, at the height of the Cold War, the United States set off an underground nuclear test, *Long Shot*, on Amchitka Island in the western Aleutians (Table 2). This is the most seismically and volcanically active region of the world (Wood and Kienle, 1990), and most of the Richter 7 Earthquakes each year occur in the area from the central Aleutians to Japan. Moreover, in 2003, two of the 15 Richter 7 earthquakes were centered in the Rat Island (National Earthquake Information Center 2004a). Five of the ten greatest quakes of the 20th century (Richter 8.5 or greater) occurred in the region, including a including a 1965 Richter 8.7 Rat Islands quake, only months before the *Long Shot* test (National Earthquake Information Center 2004b). The avowed purposed of *Long Shot* was to determine whether an underground nuclear test could be disguised as a natural earthquake on the basis of its seismic signal. The size of *Long Shot* was about 80 kilotons (compare with 12 ??17 kilotons over Hiroshima and 22 kt over Nagasaki).

In 1969, as part of its development of a nuclear warhead for the Spartan Missile, the Atomic Energy Commission conducted the *Milrow* test (about 1 megaton) on Amchitka. In 1971, over strenuous objections from native communities, the state of Alaska, the American public, and international voices, the *Cannikin* test (about 5 megatons) was conducted on Amchitka. *Cannikin* was the largest American underground nuclear test. Although some of the dire predictions of a major tsunami, for example, did not materialize, *Cannikin* had a major impact on the local geology of the island and caused widespread mortality among fish, birds, and marine mammals.

Amchitka was left with three underground cavities about 800m (*Long Shot*), 1300 m (*Milrow*) and 2500 m (*Cannikin*) below the ground surface. Optimists assumed that all the radioactive debris produced by the blasts had been trapped in the molten rock and were safely vitrified (a popular remedy for immobilizing long-lived radioisotopes). Skeptics suggested that some of the radionuclides were in soluble or semisoluble form and could be eluted from the cavity and transported by ground water movement through porous rock or through fissures, eventually reaching the seafloor and entering the marine food chain. Since the AEC and its successor Department of Energy (DOE) have maintained that the contents of the cavities (radioisotopes produced and relative amounts) are classified (ostensibly to prevent reverse engineering), there was little likelihood that public concern could be assuaged by DOE reassurance.

Amchitka had been a U.S. Navy base during World War II and the infrastructure was expanded in the 1960s to support the AEC activities. Thus buildings, vehicles, running water, and electric power were well-developed on the island at the time that pre- and post- *Cannikin* scientific studies were conducted (Merritt and Fuller 1977). And the infrastructure was maintained through 2001, at which point an island-wide surface cleanup of hazardous waste and military debris was completed. As the final step of the cleanup vehicles and buildings were removed, and even the airport landing lights were eliminated, although a 3 km paved airstrip remains on Amchitka, affording the possibility of air evacuation, at least in fair weather.

After the cleanup of the island, the Department of Energy (successor to the AEC) planned to terminate its responsibility for the island, which reverted to the jurisdiction of the U.S. Fish and Wildlife Service (USFWS) as part of the Maritime National Wildlife Refuge. However, both the USFWS and the State of Alaska Department of Environmental Conservation (ADEC), objected on the grounds that the DOE had not demonstrated that the island, the surrounding marine environment, and the organisms and ecosystem, were free of contamination from the activities and nuclear tests. The native communities, represented by the Aleutian/Pribilof Island Association, felt strongly about this issue of possible current or future contamination, because in the future people might want to exploit the Amchitka marine environment for subsistence hunting and fishing. These stakeholders imposed on DOE the burden of demonstrating that the underground cavities posed no hazard.

The DOE responded by pointing to the lack of major contamination detected immediately after the testing (1970s), and by commissioning a ground water model (DOE 2002a) and screening risk assessment (DOE 2002b) which convinced DOE that the former tests posed negligible risk to the marine ecosystem or to human consumers of foods from the Amchitka environment. However, the ground water model did predict that there might be breakthrough of radionuclides from the test cavities sometime between 10 and 1000 years, and the risk assessment, although sophisticated, relied on unlikely or at least uncertain assumptions such as instantaneous dilution of any leakage to the seabed.

To resolve the issue, in 2001, the stakeholders prevailed on the DOE to commission an independent scientific assessment of the Amchitka marine environment. For the previous decade the Consortium for Risk Evaluation with Stakeholder Participation (CRESP), a multi-university scientific consortium, had been working with the DOE on projects related to stakeholder concerns about its hazardous waste remediation and on health and ecological risk issues. CRESP had achieved a good reputation with stakeholders and with the department for its scientific objectivity, its risk communication expertise, and its ability to respond to issues that arose throughout the farflung DOE complex. CRESP was therefore uniquely positioned to design and implement the independent scientific assessment. Researchers from the University of Alaska-Fairbanks joined the CRESP team, and the process began with a stakeholder meeting in Fairbanks in February 2002 (CRESP 2002). Over the next 15 months CRESP developed an elaborate multi-pronged scientific plan to investigate the biological and physical environment and to interact with various stakeholder communities (CRESP 2003). The Amchitka plan was approved in summer 2003 by four signatories (DOE, AHEC, USFWS, and APIA) and planning began for the field expeditions to be launched in 2004.

The CRESP scientific plan was developed under the guidance of its principal investigator, Charles Powers. Powers established three guiding principles for the Amchitka expeditions: redundancy, contingency, and cost-effectiveness.
CRESP researchers visited the Aleutians in 2003 to meet with local communities, explain the proposed investigation, and elicit suggestions regarding the study. CRESP also consulted with many other individuals in Alaska who had participated in earlier investigation and remediation activities. It immediately became clear that weather imposed a severe burden on planning the expedition. We were warned to plan on a minimum of 33% down-time imposed by fog, high winds and rain. Previous studies on Amchitka had documented rain 40% of the time. Accordingly, we planned on extensive foul-weather gear to maximize the opportunities for field work even under poor weather conditions. We also had to plan on equipment for preventing and managing exposure and hypothermia.

Field Operations

Phase I of the CRESP expedition (June 6 to June 23) was dedicated to both land and sea physical measurements. Phase II of the expedition (June 28 to July 20) focused on collecting biota (kelp, invertebrates, fish, and sea birds) for subsequent radiologic analysis. Phase III involved stationing a technician on a commercial trawler operated by the National Oceanographic and Atmospheric Administration (NOAA). Components of the expeditions included work on ship, on land both on foot and by all terrain vehicles, and under the sea by a four-person dive team.

The ship used was the *Ocean Explorer*, a 50 meter long fishing trawler operated by B&N Fisheries in Seattle with a36' beam, 16' draft and a 1764 hp main engine. Most field supplies were shipped to Seattle and loaded on the ship in April. The ship transported the equipment to Dutch Harbor in the Aleutians, where the supplies were off-loaded and stored in a warehouse, while the ship operated other charters in May. In June the ship returned to Dutch Harbor, retrieved the CRESP supplies and equipment, and steamed to Adak, where the first group of CRESP researchers embarked on the expedition. This is mentioned, because the off-loading and retrieval process left the CRESP planners with a degree of uncertainty over whether all equipment would actually be on the ship when the expedition began. Although we need not have worried, it imposed the need for a substantial redundancy in planning and essential supplies.

Phase I included practicing magnetotelluric and island movement measurements (Precise Geographic Positioning System Measurements [GPS]) on Adak Island and performing the actual physical measurements on Amchitka Island. Oceanographic work included bathymetric mapping of marine transects closest to the Long Shot and Cannikin sites, by using Multibeam (SM200) sonar and sub-bottom profiling using a Klein 3000 Side Scan Sonar and DataSonics SIS 1000 Side Scan Sonar/Sub Bottom Profiler. Determination of saltwater-freshwater anomalies was performed using Conductivity-Temperature-Density (CTD) probe drops. CTD probe units were raised and lowered using ship mounted winches. Additionally, water samples and sediment samples were taken from the ship at depths ranging from 30 to 103 meters using a Niskin sampler and Van Veen Grab respectively. These samplers were raised and lowered using a crab pot winch.

Shipboard activities always carried the possibility of ”Man Overboard”, especially during the handling of expensive and sensitive sonar equipment at the aft of the research vessel (see picture 1 –Michael-I think that this picture captures quite a bit of the essence of Phase I). Additionally these operations carried the possibility of entrapment in winch pinch points and excess line. Standard procedures and responsibilities were discussed during the Health and Safety talk every day, these discussions and assignments became part of the HASP by incorporation for all on deck operations.

Phase I operations on Amchitka Island itself began on June 13, 2004 at approximately 4 pm local time. All materials for an on-land stay of 10 days by a land party of up to 7 people required unloading including tents, cook stoves, fuel and food, sleeping bags and aircell mattresses, 4 off-road vehicles, entrenching tools, metal detectors, Magnetotelluric rods and electrodes as well as electrical equipment, generators and car batteries, tarps, and personal equipment in backpacks and dry bags. The unloading of such a volume of equipment on a remote dock was not without incident (discussed in incident section).

Exposure to icy winds, sporadic gales and late spring snow storms were a constant hypothermia concern during Phase I of the expedition. An immediate concern for the land portion of the expedition upon arrival was to find a camp location that would provide adequate protection from a building northeast wind and approaching cold mist and to set-up camp before nightfall at approximately 11 pm local time. Written into the HASP was a requirement that tents and sleeping bags as well as emergency food and water and communication devices be carried on any trip from basecamp. During the Magnetotelluric field operations these requirements were expanded to require teams to take 1 to 2 hour breaks inside tents during a workday. Specific individuals were assigned to heat water for hot beverages and to mix with dehydrated food so that those coming out of the field could be provided with a warm meal while they remained unexposed to the elements (Possible picture #2,showing mandatory safety and meal stop during each day).

Magnetotulleric(MT) measurements required the use of much heavy and awkward equipment including car batteries, flux rods, coils of electrical wire, electrodes, shovels, post hole diggers and field central processing units in addition to personal clothing, first aid kits, communications and GPS units and emergency food and water. While this equipment could be carried in the bed of the Polaris Ranger on established roads, our Island Permit issued by the U.S. Fish and Wildlife Service (USFWS) did not permit off road motorized equipment (at this time of year, early June, off road use of vehicles was impossible because of snow melt and torrential rains. Even some established roads had to be scouted thoroughly before vehicle use was permitted). Magnetotelluric measurements were to be made on island transects which roughly crossed the island from north to south and were parallel to each other. Magnetotelluric measurement thus required the carrying of heavy awkward loads over tundra for distances of approaching 3 km each way. MT equipment was apportioned to members of each team (generally a team consisted of 3 people). Loads were based on the strength and agility of each group member; batteries were loaded in the bottom of a crew members backpack so that the center of gravity of the load was located at the base of the spine. Heavy top loads increased the susceptibility of trips and falls, especially while walking over uneven tundra and hillocks and up or down-climbing steep slopes.

Even though the loads were adjusted, the tundra still presented dangers to those walking across it. Great care had to be taken to determine each foot placement. As a result of trial and error, it was determined that there should be specified rest times in route to each Magnetotelluric station. Approximately every 250 meters the group of three or four stopped for a period of three to four minutes in order to rest and regroup and insure that all carried items were secured properly. Even with these precautions they're occasionally were falls and trips necessitating a rest time and reevaluation of load sharing.

For Phase II of the expedition the trawler converted its fish factory hold into a laboratory, where specimens were processed and frozen for eventual shipment back to CRESP. The laboratory facilities included five stainless steel wet-tables for dissections, equipment storage, and six freezer chests. The ship also carried four inflatable skiffs with outboard motors, and these were off- and on- loaded by a crane, which imposed additional safety concerns. Indeed, shipboard accidents, slips and falls, were a major consideration in the HASP.

Many of the tasks that ecological workers encounter at hazardous waste sites include habitat characterization, sampling, capturing, preparing, and transporting organisms, and collecting soil, sediment, and water samples (Burger and Gochfeld, 2000). This involves deployment of a variety of equipment which needs to be packed either on vehicles or skiffs. Unlike most hazardous waste sites, accessing the coastline of Amchitka for biological sampling of the shore and intertidal, proved challenging. Not all collecting areas were accessible by land, some involving long walks over undulating, boggy tundra and climbs down steep cliffs. Access from the sea was complicated by floating kelp, partially exposed rock tables, and crashing waves. Climbing in and out of skiffs was a relatively dangerous activity, requiring appropriate equipment, timing and care.

Climbing over wet rocks, made slick by growing algae, was particularly hazardous. The HASP required the use of non-skid footgear, walking sticks for support, and hard hats.

HEALTH AND SAFETY PLAN

Process

The Process for developing the HASP (see Figure 1) began with the Science Plan (CRESP 2003) and its objectives, including scientific study of the marine environment, the terrestrial environment, and the biota. We identified a number of relevant documents. Next it was necessary to identify the health and safety expertise which would guide the development of the HASP. Volz was designated the Expedition Manager with responsibility for logistics issues and for radiation safety. Gochfeld was designated the Expedition Health and Safety Director. Jewett, the University of Alaska-Fairbanks (UAF), Dive Safety Officer, assumed responsibility for the dive safety program and the selection and training of the diver team. Burger as the expedition leader was responsible for balancing the collecting requirements against weather and safety concerns. Powers, in New Jersey, assumed overall responsibility for possible dangers and damage, and negotiated appropriate insurance coverage. It was agreed that the ship Captain would have the final say over safety issues involving the mother ship or the deployment of any skiffs.

Identifying these lines of authority led to a matrix of day-to-day decision making which enhanced the productivity of the expedition, while maintaining vigilance over health and safety matters.

In spring 2004, project leaders began to assemble their field teams. The project leaders were all senior investigators with many years of experience leading field expeditions, often in remote areas.

The team leaders identified the relevant components and documents to include in the HASP, either by text or by reference. The main components were the OSHA HAZWOPR Standard (CFR 1910.120), the UAF Dive Safety Plan, and the ship safety plan used by the parent company, B&N Fisheries. With these documents as background, the authors revisited the expedition objectives, identified the likely personnel, the equipment they would need, and the activities on land and sea.

The Health and Safety Plan draft was completed about one month prior to the start of the expedition. It was reviewed by the team leaders, revised, and sent electronically to all expedition participants, requesting verification of receipt.

Medical Clearance

Work in remote areas, on difficult terrain or under the water, for long hours, often involving intense physical exertion, imposes physical demands. Team leaders were required to clarify this to all team members, and each participant (except the U.S. Navy employees) completed a health certification form which was reviewed by the physician

HASP from OSHA 1910.120

Relevant requirements for field operations derive from the Occupational Safety and Health Administration (OSHA's) Hazardous Waste Worker Operations?? (HAZWOPER) Standard (CFR 1910.120). The HASP summarizes hazards, either specifically when known, or generally. The Amchitka HASP included sections on all of the components of the scientific assessment. A base camp was established for the first expedition, and issues of sanitation and food protection were addressed.

Policies, Personnel and Procedures

We invoke the three "P's" as the first step in HASP development. What policies will guide the expedition, what personnel will be involved, and what procedures will they be conducting. As mentioned above, redundancy, contingency, and cost-effectiveness were guiding principles, and all agreed that the safety of field personnel was a highest priority. It was recognized that safety considerations might make it very difficult for the expeditions to achieve all objectives, particularly if weather were unfavorable, as indeed it often was.

Since the details of the expedition projects and participants were not finalized until a few weeks before the field work commenced, it was challenging to plan on the personnel and procedures. Although the numbers of participants were limited by the 14 person capacity of the *Ocean Explorer*, we did not know how many land-based versus ship-based activities, nor how many senior scientists vs junior technicians would be involved. The HASP therefore had to be as broad as possible.

Authority

An important feature of any HASP is to have clearly designated authority, even if these have to be a mosaic. Of particular importance was the Stop Work authority. It was essential on both expeditions and at hazardous waste clean-up sites that ultimate on-site and final decision making authority to stop all operations for logistical as well as health, safety and environmental considerations reside with one person (Setnicka 1980) (Section 2.1.4 Rocky Mountain Arsenal CERCLA Management Systems, *www.pmrma.army.mil/contract/qap2.html*). This requirement was echoed by the Director, Department of Risk Management and Insurance of Rutgers University as essential for finding supplemental insurance markets for the project[1].

From the ground up, each individual was responsible for their own health and safety and that of their immediate co-workers. This included serious attention to training and written guidance as well as daily briefings. Field work was divided into teams, each headed by a senior researcher who was responsible for the health and safety of their own

[1] We do not here address the relatively complicated process through which IRM and CRESP Principal Investigator Charles Powers went to assure that all participants in all phases of the expedition were fully covered, not only with health but other forms of liability insurance protection. Since the participants were drawn from diverse universities and included, for example, representative of the Aleutian/Pribilof Island Association, assuring such coverage involved utilization of the special insurance that has always covered CRESP activities, coordination of policies and even special spot purchase of insurance in several instances.

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team. Gochfeld and Volz were responsible for health and safety and radiation safety; Burger was responsible for balancing needs vs risks. All reported to Powers, the Principle Investigator. Ultimately, however, the ship's captain was responsible for onboard safety, for deployment of small vessels, and for weather related decisions.

Once in the field, daily operational decisions always included safety concerns, and were made on a daily (or more often) basis by the team leaders, Volz, and the captain. All personnel were reminded periodically that if they had safety concerns, there was the explicit right to refuse hazardous assignments.

Interactions

The Plan also had to mesh with the *Ocean Explorer's* own safety plan as well as with the University of Alaska's Dive Safety Plan. In the former we were fortunate in that the six man crew of the ship included trained and certified emergency medical technicians and in the latter we were fortunate that lead scientist, Stephen Jewett, was also the University of Alaska's Dive Safety Officer.

Training

All personnel were required to attend a Basic Life Support course and to submit both the BLS Certificate and a medical clearance form for review by the CRESP Health and Safety Officer (Gochfeld). In addition, divers were required to be trained in cardiopulmonary resuscitation (CPR) as well as Oxygen First Aid for Scuba Diving Injuries. The Health and Safety officers held Advanced Life Support certificates. Prior to boarding the *Ocean Explorer*, all personnel participated in a briefing that reviewed the HASP, the individual and team responsibilities, emergency procedures, safety involving boats, vehicles, and fire arms. All program participants were required to sign an acknowledgement that they had read the HASP, agree to abide by outlined procedures and that they had an opportunity to discuss questions with Gochfeld/Volz.

Radiation Training, Dosimetry and Monitoring

Amchitka was, after all, a nuclear test site, and the rationale for the Amchitka expeditions stemmed from concern over possible radiation leakage to the marine environment. Despite continued reassurance by DOE's National Nuclear Safety Administration (Nevada) which had jurisdiction over Amchitka, and despite the interpretation of the ground water and risk assessment models, it was prudent to plan for the eventuality that the expeditions might encounter radioactivity. We benefited from recent terrestrial investigations on Amchitka. In 1996 a Green Peace investigation had identified surface radioactivity, rekindling public attention on Amchitka. However, subsequent studies by Dasher et al. (2002) did not verify these findings, and the evidence indicated that if there was surface radioactivity that might be encountered by CRESP field teams, it was local and limited.

Leakage into the marine environment was another matter. There had been no investigations since the 1970's, and the ground water model (DOE 2002a) predicted that breakthrough might already have occurred. Although the risk assessment model (DOE 2002b) which assumed immediate dilution to negligible levels could have been adduced as a basis for complacency, the CRESP investigators considered it prudent to assume that there might be unacceptably high (“hot”) radiation levels at some points on the sea floor or that “hot” biota might be handled.

Health physicists at Rutgers University (Rutgers Environmental Health Services) were consulted. The conclusion was that any potential exposure would be below the threshold at which REHS would require badging (thermoluminiescent dosimetry badges TLD) or radiation worker training. Although only four of the participants were from Rutgers University, this advice was considered appropriate for personnel from the other universities (University of Alaska-Fairbanks, University of Pittsburgh, University of Alberta).

Although we did not require rad-worker training for CRESP participants, we did incorporate a level of radiation familiarity in our training program. Moreover, we agreed that since this was a research expedition, all participants would wear TLD badges for the duration of their participation on the expedition. And as a control, each person would wear a second TLD badge for an equivalent period of time after the expedition. We achieved total cooperation for the first part and 86 % cooperation for the control badges.

Since radiation was both an expedition endpoint and a health concern all sediment, water and biota samples taken during both phases of the expedition were screened using handheld survey meters equipped with gamma scintillation and G-M Pancake probes. Additionally wipe samples were taken during dissection of specimens and after cleaning at the end of each day to assure that specimen preparation did not release radionuclides and to prevent sample cross-contamination. A more detailed account of the radiation health planning, implementation, instrumentation and results, is provided separately (Volz et al).

A second issue had to be considered in HASP development. If one or more specimens were “hot”, would this contaminate the ship, causing costly cleanup. It was assumed that if marine organisms were alive it was not likely that they included a sufficient body burden of radiation to harm persons who might handle the organism for a few minute, much less contaminate the ship. Nonetheless it was considered both a safety and liability issue, as well as a matter of scientific interest, to screen all organisms for radioactivity, before they were brought on board the ship, or at least before they were processed in the hold of the ship.

(Have included in Radiation Training, Dosimetry and Monitoring.- I think that what I wrote and changed in the rad section is enough-if you disagree let me know and I will put in a section

Emergency Planning and Evacuation

All personnel had at least Basic Life Support training, divers and health and safety officers had Advance level training, and crew members were certified emergency technicians. The ship carried an automatic external defibrillator (AED), and CRESP acquired a second AED which would be used for land-based activities. AED training was included in the required BLS course.

Amchitka had an all weather airstrip, but no navigation lights or controls. It was subject to frequent fog conditions, which would have made landing problematic. The nearest airport was at Adak, a distance of 282km. However, no aircraft were regularly berthed at Adak, so in effect, the nearest source of air evacuation would likely have been at Anchorage, about three hours away by jet, six hours by piston prop. Kiska, which occupied a week's activity, was an additional 140 km to the west.

A major concern for the Principal Investigator (Powers) was maintaining a contingency fund in case any personnel required emergency evacuation.

Ship Safety

The *Ocean Explorer* had an elaborate safety plan including evacuation in case of sinking, fire or collision. All participants were required to learn these procedures and to don and emergency evacuation suit. This was documented by a digital photograph. However, there are numerous hazardous areas on a ship, such as cranes, overhead obstructions, stairwells, raised ledges, hatch covers, made more dangerous by pitching actions in high wave conditions. Daily safety briefings included identifying any near-miss activities and advising all personnel. The Safety and Health officers regularly toured the public areas of the ship to identify no obstructions resulting from field activities or maintenance.

Alcohol Safety

Alcoholic beverages and alcohol-related behavior are frequent causes of accidents. No alcoholic beverages were allowed on board the ship. No one mentioned missing these.

Vehicle Safety

The land vehicles consisted of four off-road vehicles capable of operating at 80 kph. Many of the roads on Amchitka still had excellent pavement or were all-weather gravel. The roads on the island were graded and in remarkably good condition considering that they had not been maintained for three years. Since research sites were as much as 20 km from the harbor, extensive driving was required. Drivers were instructed to maintain a speed limit of 50 kph, and to maintain distance between vehicles to avoid flying gravel. Two vehicles were fitted with plexiglass windscreens to protect against flying objects. Off-road operations across the tundra were strongly discouraged by the U.S. Fish and Wildlife Service, and were kept to a minimum. Users of off road vehicles were required to wear eye protection and helmets at all times.

Land Safety

During Phase I a Base Camp was constructed for the expedition. A total of 7 people staying at this base camp, which consisted of 7, three person three season tents, a tarped cooking and eating area, an area for storage of gasoline for cooking and ATV usage, an area for stationing of generators and land vehicles, a storage area for foodstuufs and one for research supplies and two latrine trenches. The area chosen for the base camp was in a ravine sheltered from direct winds coming off both the Bering Sea and the North Pacicic Ocean. Specific areas for gasoline storage and generator usage were established to meet the requirements of CRESPS Island Permit with the United States Fish and Wildlife

Service (US FWS) and to isolate flammable substances. The cooking area was also isolated from the other areas for the same purpose. Substantial efforts were made to keep generators and charging car batteries from exposure to water to prevent electrical hazards.

The sleeping area was located on tundra that has been swept for unexploded ordinance (UXO), the entire campsite and all storage areas and walkways located at coordinates North 51.39624 and East 179.24472 were swept with a metal detector before placement of any material or tent. Additionally, latrines for both men and women were set up approximately 100 yards from camp. The path from the camp to each latrine was swept with a metal detector to determine the presence of UXO and the pathway was posted with flags. All personnel were instructed to walk within 2 feet of the flags to the latrine. .

Tents were pitched so that the main opening was opposite the prevailing northwest winds. All tents were anchored using dead-man/ buried snow pegs to maintain the integrity of the campsite during inclement weather. Even with these precautions a gale on the night of 6/18/04 resulted in 3 tents being blown various distances from the campsite with resulting water saturation of sleeping bags and personal clothing. Team members spent an uncomfortable night but were not in serious danger of development of hypothermaia because all land based expedition members were issued Therm-A-Rest ground pads (reducing thermal heat loss to the ground) as well as sleeping bags, which are rated to +20 degrees Fahrenheit. Sleeping bags are filled with a synthetic fiber, which retains over 70% of its insulating capacity even when wet. This tent/ground pad and sleeping bag arrangement reduced the chances for hypothermia. Four extra sleeping bags were stationed at base camp for use in an emergency or for evacuations. Additionally personnel were required to have polypropylene underwear and layers of pile pants and coats: these materials also retain their insulating capacity when wet.

Phase 1 communications system -- on board the ocean Explorer a communication system was worked out with the magnetotelluric steam. Each group of the M. T. team has a VHF phone edition only Martyn Unsworth had a satellite phone. The VHF phone will initially be used for communication at 812 and four clock between the magnetotelluric teams and the ocean Explorer. Additionally rhino radio transmitter phones were used to communicate between groups on shore doing magnetotelluric work.

Rommel spikes and were spotted in various locations in the vicinity of the campsite. An impromptu meeting of all magnetotulleric personnel was held, personnel were instructed not to venture within 50 yards of Rommel stake rows and not to climb ridges which were topped by Rommel spikes, often times visible Rommel spikes stakes are surrounded by smaller Rommel stakes which cannot be seen and are five to 6 inches above ground.

A communication system was designed each day so that each group could be in communication with the Captain of the Ocean Explorer, the Project Manager, Health and Safety Officer, Team Leaders and with each other. Each group was issued as a minimum a VHF phone set. Team leaders were issued satellite phones. Additionally rhino radio transmitter phones were issued to personnel to communicate within land groups. Land crews were expected to check in with the Captain at 8 am, 12 noon, at 4pm and 8pm.

This was not a hard and fast rule resulting in a search and rescue party if communications were not made. The VHF sets sometimes failed to reach the Ocean Explorer, groups were given leeway of a few hours for check in. If groups with VHF phones were not able to raise the ship they could climb up a hill and try once again. If this failed, groups with VHF's were trained to relay communications to team leaders with satellite phones.

At morning Health and Safety and planning briefings the location, including map coordinates, of all collection points were discussed and logged. As check-ins were made by each group over the course of the day, the coordinates of each group were noted. At this point each group's subsequent plans were discussed by as much of the project management as possible so that travel routes and destinations were authorized and well established.

Climbing safety

Capturing Bald Eagle chicks involved accessing nests on high and hazardous slopes and on top of pinnacles, which were often surrounded by the sea at high tide. All climbing activities followed principals taught at the Pacific Crest Outward Bound School (http://outwardboundwest.com/courses/activities/mountain/SN_mtn7.html) where, climb coordinator (CV) was a 2001 graduate. CV also received additional training in Mountaineering Search and Rescue Techniques from the Bay Area Branch of the Sierra Club.

All pinnacle climbing and down climbing of cliffs was based on the standard buddy system of climbing etiquette. No one was permitted to up or down climb until they announced "On Belay" and the belay chief replied "Belay is On". Overall set up of belay systems and route selection was developed by CV and all climbing was accomplished by Sean Burke (SB), A routine 3 point protection equalization system was placed to hold repel rope in place for down climbing cliffs, additionally all the repels were belayed. The belayer was tied to rock formations in a position to arrest the climber if the climber or down climber were to fall. This was critical in one situation were the cliff was extremely high and required a third team member Chris Jeitner (CJ) to belay CV who was in turn belaying SB. All belayers were supplied with climbing harnesses, which were clipped via 2 inch slings to rock formations. Climbing equipment included Sterling Evolution Nitro, 9.8mm * 70 meter Dry Core Ropes, 20 Locking Carabineers,, 10 assorted chalks and cramming devices, 4 Black Diamond belay/repel devices, 2 Petzol Elios Class Helmets with visors (visors were necessary to protect against adult eagles attacking the head of the belayers and climber as well as for rock slides) and assorted slings and climbing cord. All Personal Protective Equipment (PPE) was used according to Health and Safety directions and manufacturer's recommendations.

No incidents resulted from climbing and down climbing to capture birds, although the down climbing process to retrieve a sick eagle chick on Kiska Island took over three hours to accomplish safely.

http://outwardboundwest.com/courses/activities/mountain/SN_mtn7.html

Unexploded Ordnance and Rommel Stakes

Unexploded ordnance poses a problem at hazardous waste sites on military reservations (Pastorick 2000). Although the Department of Defense and Department of Energy had tried to remove contamination, debris and ordnance from Amchitka, there remained the possibility of unexploded ordnance. This was even more of a hazard on Kiska. Rommel stakes, sharp-pointed steel rods that had once supported fences of concertina wire, were widespread on Amchitka. Although most stood nearly a meter tall, there were numerous small pointed spikes hidden in the tundra vegetation. All team members were instructed on the pattern of Rommel stake placement and the potential hazards, and were told to strictly avoid working in the line of stakes where the hidden points were likely to occur. Magnetotelluric team members, who spent all of their time hiking across the Island wore boots with metal shanks. Nonetheless one boot penetration (fortunately without injury) did occur, while personnel were walking on the beach

On Amchitka Magnetotelluric operations required digging 1ft wide by 6 ft.long by 1.5 ft deep trenches for the *X* and *Y* coordinate rods and a 4 foot deep posthole for the *Z* coordinate rod. These holes were carefully dug in conjunction with the use of metal detectors scanning for unexploded ordinance.

Weapons safety

Since the shooting of birds and mammals both by scientists and Aleut participants, was an important part of the CRESP plan, several shotguns and rifles were brought on board. . A locked firearms cabinet controlled by the ship's captain was provided for safe transport of firearmsIt was necessary to coordinate shooting activities, particularly when there were two gunners in a skiff. A lead gunner was assigned in each collecting situation.

Dive Safety The University of Alaska is an organizational member of the American Academy of Underwater Sciences, and, as such, must adhere to strict research dive safety guidelines. Although diving activity itself was controlled under the UA Dive Safety Manual, diving was still the most regularly potentially hazardous activity on the biological expedition. Weather conditions producing dangerous underwater surges as well as above water hazards (getting in and out of skiffs, and off and on the ship). Entanglement with underwater kelp, or perhaps with rope, netting or wire debris from former island operations, was also a potential hazard. Many dive opportunities were cancelled or curtailed due to changing wind conditions.

A major concern was to locate a recompression chamber in case of a diving emergency. Jewett canvassed various sources, discovering that the chambers on Adak and Attu had been decommissioned and were no longer available. The nearest public chamber was at Anchorage, and the minimum access time would have been approximately 12 hours. A private chamber was located at Unalaska Island (Dutch Harbor) with a minimum 6 hour access time. .Accordingly, the original diving plan was modified to adhere to "no decompression" diving. Most work was done in the 5-18 m (15 to 60 foot) range. Decompression illness is still a problem for shallow water operations, and the team was particularly cautious to remain well within the dive-time guidelines for these depths. The Dive Plan contained all pertinent emergency contacts for the divers, US Coast Guard, public and private recompression chambers, and public health/safety facilities at Adak, Dutch Harbor, Kodiak, and Anchorage.

Navy Team

On the first expedition there were five U.S. Navy personnel assigned to the CRESP multibeam and side-scan sonar project, operating equipment leased from the Navy. It was assumed that the Navy medical clearance would be sufficient for CRESP clearance. However, Navy personnel were included in the safety briefing(s) and were required to adhere to provisions of the HASP and sign the acknowledgements sheet that they had read and understand the HASP. Additionally, the Navy team reported directly to Chief Oceanographic Scientist, Mark Johnson for installation, safe operation and decommissioning of provided equipment.

Implementation of HASP

About a week prior to departure, an electronic copy of the HASP was sent to all participants by email with an admonition to familiarize themselves with all aspects of the plan. The first training of all field staff was conducted on Adak, in the day prior to embarkation. All participants were required to attend, and all aspects of the HASP were reviewed. This involved a clear delineation of lines of authority. One aspect of the plan was "right to refuse hazardous assignments". All participants were told that they had the right to exercise personal judgment if a planned activity appeared unacceptably hazardous. Moreover, all team leaders were reminded that the ship captain had the final authority over whether or not it was safe to launch field teams from the ship. A second training was conducted by the captain on the ship, which included learning to don emergency survival suits. A reporting system was developed for all incidents on the ship and off the ship.

EVALUATION, FEEDBACK AND ITERATION

An important feature of the HASP design and implementation was the role for evaluation, feedback and modification. This occurred on a daily basis. Some items were found to work better than others, and some of the changes were simpler than others. For example, the Plexiglas windscreens on the off-road vehicles, installed for safety from flying objects, became hazardous after several weeks of road use led to abrasion and decreased visibility. The decision to remove them late in the expedition was accompanied by the vow that future expeditions would carry backups. The role for feedback is shown clearly in the double-headed, dotted arrows in figure 1.

INCIDENTS

Although there were no major safety breaches, there were many minor injuries. Particularly dangerous were the narrow stairs on the ship which were frequently obstructed by gear. Crane operation required personnel on deck, particularly when boats, cargo and vehicles were being lowered. The use of portable crane controls, allowed the operator to change positions to constantly monitor personnel, and avert injuries. Positioning cargo as it was raised and lowered through the hatch, brought staff into close proximity with heavy swinging objects, and the potential for crush injuries. Although hard hats were specified and used, the HASP did not adequately foresee and address this hazardous activity.

Even using the portable controls as well as having prior plans and meetings concerning cargo loading and unloading expedition personnel were not fully prepared for the actual conditions faced on an expedition of this type. Both scientists and crew were extremely excited upon arrival at Amchitka Island and quite eager to unload the tons of equipment and supplies for the Magnetotelluric portion of the expedition, especially given imminent bad weather. In this excitement and zeal the first casualty was safety because people hurried to unload equipment so that a base camp could be scouted and established. Within 10 minutes of arrival both the captain and the health and safety officer needed to remind people to wear their hardhats at all times, while unloading the ship, using the overhead crane.

Additionally, expedition personnel were not paying attention to the location of the overhead crane, both loaded and unloaded. In an unloaded position the crane cable carried a hook weighing approximately 15 pounds; it had to be dropped through a storage hatch into the hold where palletized material was stored. It presented a hazard to both personnel on the deck as it was swung over the starboard railing and down to the hatch and below deck where hands were awaiting the crane hook to move previously palletized material and where loose material was being palletized and shrink wrapped for offloading.

Palletized material in the hold was attached to the crane hook using 4 inch wide slings attached to steel rods, which were ran through the interstitial space of the pallet and extended beyond the pallet ends by approximately 6 inches. These rods could easily catch a loader under the chin or become entangled in clothing, while that person was turning, stabilizing and watching the load rise or swinging the load on to shore. Although Ocean Explorer crew knew to stay clear of these rods during crane operations, scientific personnel involved in on and off-loading operations needed constant reminders to stay clear of these rods while the crane was hoisting loads and insure that body parts and clothing were clear of both rods and pallets before giving the order to hoist loads.

A load shifting incident did occur during Phase I unloading in Constantine Harbor on Amchitka Island. Expedition materials had to be carefully loaded onto pallets inside the ocean Explorer hold. Heavy Magnetotelluric equipment required loading onto pallets positioned on the deck of the hold and maneuvering the loaded pallets over a bulkhead before they could be raised through the hatch. Care was taken to equalize equipment weight over the surface of the pallet. The contents of each pallet were then shrink wrapped to minimize load shifting and provide an additional safeguard against falling objects. Lighter equipment and implements were loaded onto pallets positioned directly on top of a bulkhead. These items included backpacks, tents, cook stoves, digging implements, metal detectors, food supplies, cooking equipment, generators, and personal equipment. Although Expedition materials had to be carefully loaded onto pallets inside the ocean Explorer hold. Heavy Magnetotelluric equipment required loading onto pallets positioned on the deck of the hold and maneuvering the loaded pallets over a bulkhead before they could be raised through the hatch. Care was taken to equalize equipment weight over the surface of the pallet. The contents of each pallet were then shrink wrapped to minimize load shifting and provide an additional safeguard against falling objects. Lighter equipment and implements were loaded onto pallets positioned directly on top of a bulkhead. These items included backpacks, tents, cook stoves, digging implements, metal detectors, food supplies, cooking equipment, generators, and personal equipment. Although much lighter than the magnetotelluric equipment, these loads could become awkward and unbalanced when raised. They therefore required more time to load, more precise placement and more intricate tie down and shrink wrapping. During the raising of all loads personnel in the hold where required to be completely undercover of the deck plate. All heavy Magnetotelluric and transportation equipment was unloaded without incident. However there was an incident involving unloading of boxes of lighter equipment. This accident occurred when a shore side hand grabbed hold of the pallet, as it was being lowered but still 4 feet above the level of the dock and pulled the pallet toward shore. This action tilted the load and one plastic container with wire strippers, volt meters and electrical tape was dropped into the sea. Luckily, due to the redundant nature of expedition planning these items were duplicated in another container which was part of a different hoist. Immediate action was taken to prevent a reoccurrence of this accident. These measures included:

- The immediate cessation of all unloading operations both above and below deck.
- An investigation to determine the cause of the accident. It was concluded that the incident resulted from a combination of two factors. First, there was not adequate shrink wrapping around and over the top of the equipment at the top of the pallet. Second, the shore hand should not have pulled the pallet toward shore but should have indicated to the crane operator to extend the crane boom further so that the pallet could have been positioned further from the edge of the dock.
- Calling an impromptu meeting of all crew involved in unloading operations.
- Detailing to all crew members the accident and the causes of the accident.
- Informing offloading crew to slow down, decrease the height of loads, insure that all loads are shrink wrapped to their full height including over the top of the load and when on shore to signal to the crane operator to indicate the desired placement of the pallet.

Loading and unloading personnel from the ship to the small boats (skiffs), was often challenging, whether climbing up and down a vertical rope ladder, or scrambling up the 45 degree sloping ramp at the rear of the ship. Wave action made this hazardous and was a frequent cause of curtailed field activities. The captain often had to terminate planned activities when entering or leaving the skiffs was too dangerous.

Operations on land were difficult due to the very irregular and spongy terrain. Carrying heavy loads and negotiating steep slopes through the tall grass over hidden rocks, resulted in falls and sprains. Although the authors of the HASP had not previously set foot on Amchitka, there was ample warning from other expedition participants and other scientists about the difficulty of working on the island and surrounding waters. The HASP anticipated some of these difficulties, but only in generalities. In retrospect, it would have been useful to have an additional team member to divide some of the heavy loads.

Fatigue is well established as a contributing factor to occupational injury. With 20 hours of daylight on Amchitka, it was enticing to work long hours on land, and then spend additional hours on the ship processing specimens long into the night. The HASP did not anticipate that circadian rhythm would be affected in this manner, and many team members got less than the optimum amount of sleep.

DISCUSSION

In the western Aleutians we encountered a complicated mix of physical and biologic hazards, with difficult terrain and stormy seas. We were far from any support base with a long latency before anyone could reach a hospital or decompression chamber.

It is gratifying to report that despite fielding more than 20 personnel for 10 to 23 days on a ship, often in stormy conditions, and on land and under the water, there were no significant injuries or illnesses. It would be good to report that all personnel adhered to all safety guidelines at all times, but university researchers are notorious for individuality. Nonetheless, transgressions were generally minor and consequences minor as well.

A HASP is not supposed to rely on luck. Rather, it is a blueprint for eliminating, insofar as possible, luck as a factor. We relied on careful planning rather than good luck, to minimize the likelihood of adverse events, and we relied on careful planning to minimize the impact of adverse events or bad luck. Indeed our occupational safety and health profession operates on the principle that good planning minimizes the likelihood of bad luck intervening and reduces consequences when it happens.

Moreover, bad luck is most likely to impose itself when good judgment is suspended; when the desire to maximize productivity sends people into harms way. When gambles are taken, even though the likelihood of harm may be low on any particular outing, the cumulative effect of multiple outings, may assure that an adverse event occurs. The authors of the CRESP HASP were aware of this principle, and with the strong support of the PI, it was clear that safety would never be jeopardized, if there were a question about the ability of a field team to depart and/or return to the ship safely. The captain assumed primary responsibility for determining whether sea conditions allowed safe loading and unloading of skiffs. High winds made it difficult to lift the inflatable skiffs from the deck to the sea, while waves made entering and leaving the skiffs dangerous. The ship crew performed admirably, considering that their experience as trawl fishermen did not generally include skiff operations.

Since weather was the primary safety factor to be considered on any day, we watched weather closely, relying on the local experience of the captain, on the limited weather communications available, and we relied extensively on the experience and wisdom of our Aleut team whose lives and livelihood depend on reading weather sign. We benefited repeatedly from their wisdom, for they mixed an enthusiasm for field work with careful observation of wind and waves. Although we had not written this into our field plan, we came to rely on their judgment.

Processing the complex information, allowed us to make good decisions about moving the ship from a bad weather location to a better weather location, and even though we had foul weather or fog, almost every day, good decisions allowed us to capitalize on intervals of fair weather, so overall we only lost about 20% of days completely.

LESSONS LEARNED: WHY A HASP

Development of a formal HASP, although not specifically required under any applicable occupational standard, forced us to identify a wide variety of potential hazards and to address every one (Table 1). Although developing the document entailed a substantial professional effort in advance, it saved time in the field, and increased the confidence of all leaders, that all participants were versed in the hazards and responsibilities.

Clear delineation of the different health and safety responsibilities, lines of authority, participation in decisions, and stop-work authority, were valuable to have established in advance.

And, since personnel were required to read and say that the had read the document, this acknowledgement further highlighted the importance of safety. One aspect consistently emphasized was "right to refuse hazardous assignment" which, it was felt, personalized that fact that personnel safety was always the highest consideration. Delineating the clear lines of authority, and identifying the ship-board personnel who would be involved in the day-to-day or even hour-to-hour planning, led to smooth cooperation in the field, mutual respect, and maximization of productivity.

The HASP was prepared with the input of all researchers, taking advantage of their field experience and knowledge of conditions in the Aleutian Islands. Preparing the HASP also made us better quartermasters, identifying the kinds of equipment needed for safety, particularly from the elements. This was routine for the Dive Safety and Climbing Safety plans, but would not have been routine for those planning work in the littoral zone (inter-tidal) or on land. By paying attention to slips and falls in writing the HASP, we were able to purchase appropriate equipment to minimize such events.

In conclusion we endorse and recommend development of a formal HASP as a heuristic, training, and legal mechanism for enhancing personnel safety in remote locations and harsh environments.

Acknowledgements

Preparing the HASP and this description of it have required the diligence and cooperation of many people, including many secondary sources not named below:
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Finally MG and JB thank their hosts Andy Sonneborn and David Sonneborn MD, staff of and all of the scientists and technicians who made the Amchitka expeditions a success, and by adhering insofar as possible to the HASP, contributed to an impressive and safe scientific venture: Sean Burke, Christopher Jeitner, Dan Snigaroff, Ron Snigaroff, Tim Stamm, Max, Hoberg, Heloise Chenelot, William Shulbe, Vulcan Truncer, Anna Forestrom, Martyn Unsworth, Crystal Rae, Wolfgand Soyer, Mark Johnson and Sokmi Moon and James Weston,

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Table 1. Outline for the CRESP-Amchitka Health and Safety Plan.

1.0 General Project Information
- 1.1 Purpose of the Safety and Health Plan
- 1.2 Project Scope and Activities
  - 1.2.1 Group Assembly and Disassembly on Adak Island
  - 1.2.2 General Maritime Operations and Authority of the Ocean Explorer Captain
  - 1.2.3 Bathymetric Profile/ CTD Scanning and Water and Sediment Sampling
  - 1.2.4 Magnetotullerics and on Island Hydrogeological Work
  - 1.2.5 Base Camp Construction
  - 1.2.6 Biological Sampling/ Intertidal
  - 1.2.7 Biological Sampling/Subtidal-Dive Operations
  - 1.2.8 Biological Sampling/Fishing
  - 1.2.9 Biological Sampling/Marine Mammal Take and Salvage
  - 1.2.10 Rifle and Shotgun Safety
  - 1.2.11 Biological Sampling/ Bird Take
  - 1.2.12 Climb Safety
  - 1.2.13 Biological Sampling Rat Take
  - 1.2.14 Biological Preparation, Sample Dissection and Compositing
  - 1.2.15 Biological Sample Storage
  - 1.2.16 Offloading and Shipment of Samples
  - 1.2.17 NOAA Trawl Boat Activity
  - 1.2.18 Base Camp Sanitation and Housekeeping
  - 1.2.19 Base Camp Refuse Disposal
  - 1.2.20 Fueling Operations
  - 1.2.21 Operation of Mobile Equipment
  - 1.2.22 Medical Services
- 1.3 Management Structure, Key Project Personnel and Responsibilities and Stop Work Authority
- 1.4 Applicable Regulations
- 1.5 Disclaimer
- 1.6 Daily Coordination and Safety Meetings
- 1.7 Personal Medical Data
- 1.8 Emergency First Aid/CPR/AED Training

2.0 Hazard Analysis
- 2.1 Physical Hazards
  - 2.1.1 Man Overboard
  - 2.2.2 Ship Evacuation/ Fire and/or Collision
  - 2.1.3Ship Hazards, Slips/Falls/Overhead Cranes/Pinch Points/Head Trauma/Eye Injury
  - 2.1.4 Excursion/Small Boat Water Hazards-Sinking, Flipping and Grounding; Fog and Lack of Visibility, Lost and Lost Communication with the Ocean Explorer
  - 2.1.5 On Island, Slips, Trips and Falls
  - 2.1.6 Rommel Stakes and Concertina Wire
  - 2.1.7 Adverse Weather
  - 2.1.8 Hypothermia
  - 2.1.9 Unexploded Ordinance
  - 2.1.10 Operation of All Terrain Vehicles (ATV'S) and Polaris Vehicles
  - 2.1.11 Compressed Gases (Dive Tank Refill and Compressor Usage, Emergency Oxygen Tanks
  - 2.1.12 Extreme Slopes and Pitches (Bird and Bald Eagle Take)
  - 2.1.13 Rifle and Shotgun Storage, Ammunition Storage and Usage
  - 2.1.14 Lost on Land and/or Out of Communication
  - 2.1.15 Explosion and Fire Hazards
  - 2.1.16 Falls during Collection in the Intertidal
  - 2.1.17 Dive Team Hazards
  - 2.1.18 Fishing Team Hazards
  - 2.1.19 Specimen Preparation Hazards

2.2 Radiological Hazards
2.2.1 Biological Sample Collection and Preparation
2.2.2 Sediment and Water Sampling
2.2.3 CTD Scanning
2.2.4 Land Based Radiological Hazards
2.3 Biological Hazards
2.3.1 Rattus Norvegicus
2.3.2 Wild Animals
2.3.3 Waterborne Bacteria and Parasites
3.0 Activity Safety Controls, Personal Protective Equipment and Training
4.0 Radiological Monitoring and Action Levels
4.0.1 Personnel Monitoring
4.0.2 Area Monitoring (Alpha and Beta)
4.0.3 Countertop Monitoring
5.0 Decontamination Procedures
5.0.1 Deck Area
5.0.2 Laboratory Benches
5.0.3 Cross Contamination Issues
5.0.4 Procedures for Specimens with High Activity
6.0 Dive Safety Procedures
7.0 Emergency Procedures
7.0.1 Emergency Signals
7.0.2 Evacuation Procedures
7.0.3 Emergency Response Organizations
7.0.4 Emergency Notification and Order of Notification

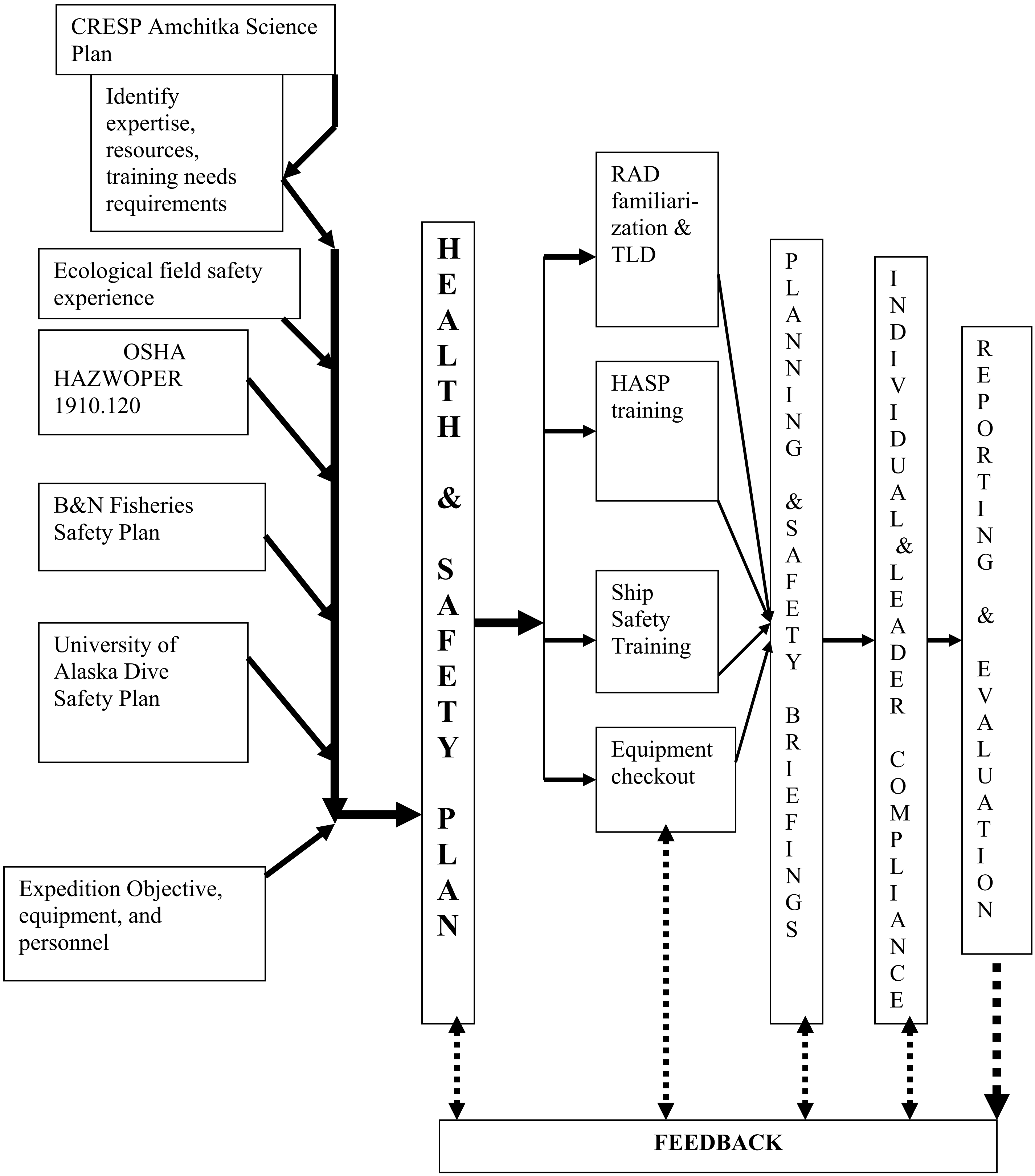
Table 2?? Should we have a similar outline of the Dive Safety plan or should we have a web site to refer.
Table 3. should we have a similar outline of the Ship safety plan. I think that Xio has this only in hard copy.

Figure 2. The process of developing the HASP began with the Science plan and the research elements that it defined. The second step was to identify the expertise available for planning and implementation, the resources that were required, any training needs and compliance requirements. It incorporated (not necessarily sequentially) requirements of the OSHA standard, the University of Alaska's Dive Safety Plan, as well as the host ship's only safety plan. We reviewed a variety of existing health and safety plans as models, borrowing certain elements and rejecting others.

Once the HASP first draft was complete it was reviewed by the Principal Investigator, the CRESP Management board, and the team leaders. Additions and revisions were incorporated and the working draft----recognized as mutable----was circulated to all participants.

Several levels of training were incorporated to assure that all participants were familiar with the plan, and were cognizant of their rights and responsibilities. Daily briefings to review safety, weather, and changing sea conditions were part of the plan. Finally the opportunity for reporting and evaluation was an important step. Many observations on the first expedition, improved working conditionsa for the secoind expedition.

Finally, the two-headed dotted arrows show the importance of feedback and iteration at all phases of plan implementation.


CRESP Amchitka Science Plan
Identify expertise, resources, training needs requirements
Ecological field safety experience
OSHA HAZWOPER 1910.120
B&N Fisheries Safety Plan
University of Alaska Dive Safety Plan
Expedition Objective, equipment, and personnel
HEALTH & SAFETY PLAN
RAD familiari-zation & TLD
HASP training
Ship Safety Training
Equipment checkout
PLANNING & SAFETY BRIEFINGS
INDIVIDUAL & LEADER COMPLIANCE
REPORTING & EVALUATION
FEEDBACK