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Appendix C
Site-Specific
Health and Safety Plan

for

Installation Restoration (IR) Site 5
Indian Head Division
Naval Surface Warfare Center

Indian Head, Maryland

Northern Division
Naval Facilities Engineering Command
Contract Number N62472-90-D-1298
Contract Task Order 0157

August 1994

R-06-94-3

APPENDIX C
SITE-SPECIFIC
HEALTH AND SAFETY PLAN
FOR
INSTALLATION RESTORATION (IR) SITE 5
INDIAN HEAD DIVISION, NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
EPA - Chesapeake
Naval Facilities Engineering Command
Building 212, Code 181
Washington Navy Yard
Washington, D.C. 20374-2121

Submitted by:
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993 Old Eagle School Road, Suite 415
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CONTRACT NUMBER N62472-90-D-1298
CONTRACT TASK ORDER 0157

AUGUST 1994

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1.0 SITE INFORMATION AND PERSONNEL ASSIGNMENTS

Site Name: Indian Head Division Naval Surface Warfare Center

Client Contact: Tom Symalla Phone Number: (301) 743-6745

Address: Indian Head, Maryland

Effective Date: January 1, 1994

Purpose of Site Visit: Construction surveillance and post-removal action verification sampling.

Proposed Dates of Work: TBD

Project Team:

Halliburton NUS Personnel:	Discipline/Tasks Assigned:
Kevin F. Donnelly, P.E.	Project Manager
Robert F. Simcik	Field Operations Leader (FOL)/Project Engineer
Thomas M. Dickson	Health and Safety Officer (HSO)
TBD	Geologist/Sampler

Non-Halliburton NUS Personnel:

Shawn Phillips	EFACHES, Remedial Project Manager
Allen Wilson	EFACHES, Engineer in Charge
Jim Behrend	ROICC - Indian Head NSWC

Plan Preparation:

Prepared by: Thomas M. Dickson

Reviewed and Approved by:

HALLIBURTON NUS
Navy CLEAN
Health and Safety Manager: Matthew M. Soltis, C.S.P

Reviewed:

HALLIBURTON NUS

Project Manager: Kevin Donnelly, P.E.

Follow Up Report:

Responsible Person: Robert F. Simcik (Must fill out Follow-Up Report)

1.1 INTRODUCTION

This Health and Safety Plan (HASP) has been developed to provide the minimum safety procedures for Halliburton NUS personnel engaged in construction surveillance and verification sampling activities at the Indian Head Division, Naval Surface Warfare Center (NSWC). This plan was developed using available information regarding known/suspected chemical contaminants and physical hazards that may be encountered during the planned activities. If additional information becomes available, prior to, or throughout the course of field activities, this document will be modified accordingly. It is the responsibility of the Halliburton NUS Health and Safety Officer (HSO) to determine the need for modification. It is the responsibility of the Project Manager (PM) to communicate the new information and any modifications to this HASP to the appropriate personnel. This HASP is intended to be in compliance with 29 CFR 1910.120, "Hazardous Waste Operations and Emergency Response," applicable OSHA General Industries (29 CFR 1910), and Construction Industry Standards (29 CFR 126), as applicable.

1.2 KEY PROJECT PERSONNEL AND ORGANIZATION

This section establishes responsibility for site safety and health for Halliburton NUS personnel. The Halliburton NUS Project Manager (PM) is responsible for the overall direction and implementation of this project HASP.

The Halliburton NUS Project Engineer is responsible for: implementation of this HASP with the assistance of an appointed Health and Safety Officer (HSO); management of field activities; execution of the work plan; and enforcement of safety procedures as they apply to the work plan.

The HSO supports site activities by advising the Project Engineer on all aspects of health and safety on site. These duties and activities may include, but not limited to, coordinating safety and health activities with the Project Engineer, selection, application, inspection, and maintenance of Personal Protective Equipment (PPE); establishment or modification of work zones and control points; implementation of the monitoring program for onsite activities; confirms team members training and medical status with regards to site activities; implements supporting elements of the health and safety program such as Hazard Communications and Respiratory Protection; and coordinates emergency services.

These requirements and activities set forth in this HASP are monitored by the Navy CLEAN Health and Safety Manager (HSM) for compliance with federal standards and the CLEAN Health and Safety

Management Plan. This monitoring and evaluation forms the preliminary basis by which the effectiveness of this document and its implementation may be assessed.

2.0 DESCRIPTION AND BACKGROUND

IR Site 5, the site study area consists of Building 731 which is an x-ray photographic lab, and associated effluent drainage channels to be investigated, located on the Naval Surface Warfare Center, Indian Head Division. The building and the effluent drainage channels in question have been impacted by past photographic waste management practices. These practices have included expelling x-ray tube cooling and x-ray photographic film wash water, with silver, sodium thiosulfate, and hydroquinone as constituents into a drainage ditch with no treatment for a period of over twelve years.

Previous sampling efforts have exhibited silver concentrations above background, however, no other constituents which were thought to be associated with the discharge product were detected. Soil sampling during February 1994 by Halliburton NUS delineated total silver concentrations as high as 1,180 ppm in the soils around Building 731/1135 and through the swale. Halliburton NUS prepared engineering plans and specifications for the excavation of the contaminated material in excess of 10 ppm total silver.

More detailed information on the location and additional background information may be found in Section 1.0 and 2.0 of the Field Sampling Plan, a copy of which will be maintained onsite (with this HASP) throughout the performance of field activities.

3.0 PROJECT SCOPE OF WORK

The Halliburton NUS Project Engineer will be on-site during the removal action to provide construction surveillance support for the Navy. The removal action will be conducted by the LANTDIV Remedial Action Contractor (RAC).

The Halliburton NUS Project Engineer has no responsibility or authority to direct the activities of the RAC. The Halliburton NUS Project Engineer will collect soil samples for laboratory analysis. The samples will be collected from the surface (0-6 inches) of the excavation. The analysis will be used to verify that removal action objectives have been met.

A total of 30 soil samples with 3 QA/QC samples will be collected. The soil samples will be collected from the surface with disposable spatulas, and mixing bowls. More detailed information concerning this activity and the sampling procedures may be found in Section 3.0, of the Field Sampling Plan. All sample locations will be accessible by foot.

4.0 HAZARD ASSESSMENT

4.1 CHEMICAL HAZARDS

The primary chemical contaminant hazard associated with this investigation is silver. Potential for exposure to this compound, and subsequent health effects may be accomplished through inhalation, ingestion, and dermal contact. Table 4-1 presents a compilation of information on silver, and can be used as a reference. Additional information concerning the health effects extracted from "Patty's Industrial Hygiene and Toxicology" 3rd Revised Edition may be found in Appendix C-II of this document. This information will provide exposures concentrations and occupational relevance as associated with those exposures.

As the contaminant of concern (silver), if/where present, is considered to be encountered in a solid form, it may present a potential hazard in an airborne, particulate form. Therefore, visual observation will be used as a primary means to identify potential emissions and therefore potential exposures to this contaminant. The use of personal protective equipment (PPE), and observance of proper decontamination, site control, and standard work practices, Sections 6.0, 7.0, 12.0, and 10.0 of this plan, respectively, will be used to help reduce or eliminate potential exposures and therefore reduce the potential for adverse health effects.

4.2 PHYSICAL HAZARDS ON SITE

During the execution of the proposed scope of work (see Section 3.0) certain physical hazards may be encountered by field personnel while engaged in on site activities. Based on the hazard analysis, it is anticipated the physical hazards could involve, but are not limited to the following items:

- Work in the X-Ray Photographic Laboratory Area
- Uneven or unstable terrain (slip, trip hazards)
- Strain or muscle pulls
- Cold stress control
- Inclement weather

Control efforts for these potential hazards shall employ a variety of safety measures to mitigate these hazards. These measures shall be discussed individually with each area of concern mentioned above.

TABLE 4-1

PRIMARY CHEMICAL CONTAMINANT

Names and Synonyms	Chemical Abstract Service Number (CAS No.)	Safe Exposure Limit, OSHA; ACGIH; NIOSH	Physical Description	Routes of Exposure	Signs and Symptoms Exposure	Physical Properties
Silver (metal dust and soluble compounds as Ag) Synonyms: • Silver metal • Synonyms of soluble compounds vary depending upon the specific compound.	7440-22-4	0.01 mg/m^3 IDLH: N.E.	Metal: White, lustrous solid	• Inhalation • Ingestion • Contact Recommended Gloves: This is in the particulate form. Therefore, any glove suitable to prevent skin contact. (Nitrile has been the one most widely used for the other substances.)	Symptoms: • Blue-gray eyes, nasal septum, throat, and skin • Irritated skin, ulceration • GI disturbance First Aid: • Eye: irrigate • Skin: water flush • Breath: resp. support • Swallow: med. attention Target Organs: • Nasal septum • Skin • Eyes	Boiling Point: 3632°F Melting Point: 1761°F Freezing Point: NA Solubility: Insoluble Specific Gravity: 10.49 Vapor Pressure: 0 mm Flash Point: NA LEL: NA UEL: NA MW: 107.9 Incompatibles: • Acetylene • Ammonia • Hydrogen peroxide • Bromoazide • Chlorine trifluoride • Ethyleneimine • Oxalic acid • Tartaric acid

N.E. = Not established

NA = Not applicable

4.2.1 Work in the X-Ray Photographic Laboratory Area

Building 731 of NSWC employs the x-ray services in supporting its ordnance activities. The Halliburton NUS field crew will observe all required Navy and Removal Action Contractor procedures and rules associated with work in the area. These include, but are not limited to, the following:

- Halliburton NUS personnel will vacate IR Site 5 during any "cast" operations in Building 731.
- Access to the restricted area around Building 731 will require a Navy Escort. Access will be prohibited during periods of active x-ray operations. Access beyond the fenced area around Building 731 is allowed during normal x-ray operations.
- No sparking equipment
- No Two-Way Radios
- No fires and/or Smoking

4.2.2 Uneven or Unstable Terrain

During the soil and sediment sampling there is potential for slip, trip, and falls associated with wet, steep or unstable banks and surfaces along the ditches and excavations, and other areas associated with the sampling task. Hazards of this sort may result in injuries including falls, strained or pulled muscles, cuts or abrasions. To minimize the hazards of this nature, the FOL and/or the HSO shall preview the intended work areas to evaluate the degree of these hazards and where they may exist. This information will be passed to the personnel required to work in and along these areas.

4.2.3 Strain, Sprains, and/or Muscle Pulls

During execution of this scope of work there is potential for strains, sprains and/or muscle pulls due to the physical demands and nature of this task. To avoid injury, during lifting tasks personnel are to lift with the force of the load carried by their legs and not their backs. When lifting or handling heavy material or equipment, use an appropriate number of personnel. Due to the type of environment/topography and possible conditions associated with activities at this time of the year, locomotion and operation may be difficult thereby creating an opportunity for hazards of this nature. These conditions increase hazard

potential and make even small jobs more difficult. Therefore extreme caution and best professional judgment should be exercised to mitigate these hazards as they are encountered.

4.2.4 Cold Stress

Persons working outdoors in temperatures at or below freezing may experience symptoms associated with cold stress. Extreme cold for a short time may cause serve injury. Areas of the body most vulnerable to the effects of cold stress include the fingers, toes, and ears.

Detailed procedures on detection, monitoring, prevention, and control of cold stress is provided in Appendix C-III of this document.

4.2.5 Inclement Weather

As all work will be conducted outdoors, inclement weather may be encountered. As conditions may vary, it will be at the discretion of the FOL and/or the HSO to temporarily suspend work until conditions improve. All activities shall be terminated in the event of electrical storms.

5.0 AIR MONITORING AND ACTION LEVELS

The primary contaminant associated with this task is silver and silver contaminated soils. Currently, there is no suitable real time monitoring instrument available for the detection, identification, and quantification of this contaminant.

It is assessed, based on the tasks to be completed, and the manner these tasks are to be completed, little opportunity exists to create the potential suitable for exposure. In addition, current weather conditions creating a wet environment decrease the potential even more for significant airborne concentrations, and thereby presenting a threat of exposure.

Because of these factors visual observations will serve as the primary means for detection, and no monitoring instruments will be used.

6.0 PERSONAL PROTECTIVE EQUIPMENT (PPE)

Personal Protective Equipment (PPE) will be employed to protect personnel from the site contaminant where applicable. The following equipment has been selected based on the hazards anticipated and the tasks to be completed.

6.1 PPE SELECTION CRITERIA/LIMITATIONS:

- Standard field dress (i.e., long sleeve shirts, long pants, etc.), cold weather equipment, steel toe/shank hard sole work boots were selected as minimum requirements to protect personnel from hazards which may exist on site. Nitrile outer gloves and cotton work inner gloves were selected as a precaution against direct skin contact with site contaminants and potential cold stress. Tyvek coveralls were selected for tasks that involve a potential for contamination only by dust, and dirt. Rainsuits were selected for all other tasks including those to be conducted which could result in the saturation of work clothes due to wet or muddy conditions. Rubber boots or chemical-resistant boot covers were selected to prevent contamination and saturation of work boots.

- TLD badges are required for all Halliburton NUS personnel.

- Safety glasses and hardhats will be employed when overhead or eye hazards exist, or as directed by the FOL or HSO.

Personal Protective Equipment (PPE) anticipated for use has been summarized in Table 6-1.

TABLE 6-1

PPE ANTICIPATED FOR EACH SITE TASK/OPERATION
INDIAN HEAD, MARYLAND

Task/Operation	PPE Anticipated
Soil Sampling	Safety glasses, steel-toe shank, hard sole work boots, Tyvek* coveralls, nitrile outer gloves, cotton work inner gloves, rubber boots or chemical protective boot covers
Decontamination Activities	Rainsuits as applicable to protect against the saturation of work clothes, nitrile outer gloves, cotton work inner gloves, rubber boots or cover, splash shield and safety glasses.

* If the potential exists for the Tyvek and work clothes to become saturated, rainsuits will be worn in place of Tyvek.

7.0 DECONTAMINATION

7.1 PERSONNEL DECONTAMINATION REQUIREMENTS

The decontamination of personnel and their protective clothing shall be performed in three stages. Stage 1 includes removing contamination from reusable protective clothing with a detergent/water solution and soft-bristle scrub brushes. Stage 2 shall include removal of protective clothing (disposable items shall be discarded into a container conspicuously marked "Potentially Contaminated Clothing"). Stage 3 shall consist of workers washing hands and face with potable water and soap whenever they remove PPE and leave the exclusion zone. All Halliburton NUS contamination procedures will be coordinated with the RAC HSO. The procedure for decontamination will proceed in the following manner:

- Personnel will proceed to the wash station at which point the outer gloves, boots, and rainsuits, as applicable, will be washed free of visible dirt and/or mud.

- The next step will consist of personnel moving to the following rinse station and rinsing outer gloves, boots/boot covers, and rainsuits, as applicable.

- This final station will consist of removal and disposal of outer gloves, and the removal of the rainsuits and boots/boot covers. These items will be dried to the extent possible, bagged, and stored for reuse.

All decontamination waste fluids and potentially contaminated PPE shall be containerized, labeled, and disposed of in accordance with the requirements stipulated by the project manager and client contact.

7.2 DECONTAMINATION OF SAMPLING TOOLS

All sampling equipment that will be leaving the site will require a thorough decontamination. This can be accomplished either by steam cleaning or by a detergent wash and potable water rinse until tools are visibly clean. Decontamination of sampling tools to prevent cross contamination of samples shall be performed in accordance with client specifications. All equipment, prior to leaving the site, will be inspected by the Project Engineer to verify it has been properly decontaminated.

7.3 PPE REQUIREMENTS FOR DECONTAMINATION OPERATIONS

All decontamination efforts will require the use of chemical-protective clothing as described below:

- Rainsuits
- Nitrile, outer gloves
- Cotton work inner gloves
- Rubber boots (or rubber boot covers)
- Splash shield (if respirator not worn)

8.0 TRAINING REQUIREMENTS

This section describes the minimum requirements for initial, refresher, supervisory, and site-specific training.

8.1 INTRODUCTORY AND REFRESHER TRAINING

8.1.1 Requirements for all Halliburton NUS Personnel

All Halliburton NUS personnel must complete 40 hours of introductory hazardous waste site training, prior to performing work at Indian Head. Additionally, Halliburton NUS personnel who have had introductory training more than 12 months, prior to site work, must have completed 8 hours of refresher training within the past 12 months, before being cleared for site work.

8.1.2 Supervisory Training

All personnel operating in the capacity of management or supervisory will be required to produce documentation as to the additional training received concerning the elements of 29 CFR 1910.120(e)(4).

Documentation of Halliburton NUS introductory and refresher training will be maintained at the project. Copies of certificates, or other official documentation, will be used to fulfill this requirement.

8.2 SITE-SPECIFIC TRAINING

Halliburton NUS will provide site-specific training to all Halliburton NUS employees who will perform work at this project. Site-specific training will include:

- Names of personnel and alternates responsible for site safety and health
- Safety, health and other hazards present on site
- Use of personal protective equipment
- Work practices to minimize risks from hazards
- Safe use of engineering controls and equipment
- Medical surveillance requirements
- Signs and symptoms of overexposure
- The contents of the health and safety plan and addendum

- Emergency response procedures (evacuation and assembly points)
- Review the contents of relevant Material Safety Data Sheets

8.2.1 Site-Specific Training Documentation

Halliburton NUS personnel will sign a statement indicating receipt of site-specific training and understanding of site hazards and control measures. Figure 8-1 is used to document site-specific training.

FIGURE 8-1

SITE-SPECIFIC TRAINING DOCUMENTATION

My signature below indicates that I am aware of the potential hazardous nature of performing investigation activities at NSWC Indian Head and that I have received site-specific training which included the elements presented below:

- Names of personnel and alternates responsible for site safety and health
- Safety, health and other hazards present on site
- Use of personal protective equipment
- Work practices to minimize risks from hazards
- Safe use of engineering controls and equipment
- Medical surveillance requirements
- Signs and symptoms of overexposure
- The contents of the health and safety plan
- Emergency response procedures (evacuation and assembly points)
- Review contents of relevant Material Safety Data Sheets

I further state that I have been given the opportunity to ask questions and that all of my questions have been answered to my satisfaction.

NAME	SIGNATURE	DATE

9.0 MEDICAL SURVEILLANCE

9.1 REQUIREMENTS FOR HALLIBURTON NUS PERSONNEL

All Halliburton NUS personnel participating in project field activities have a physical examination meeting the requirements of Halliburton NUS' medical surveillance program and 29 CFR 1910.120(f) and are medically qualified to perform hazardous waste site work using respiratory protection.

Documentation indicating medical clearances will be maintained onsite and made available as necessary.

9.2 REQUIREMENTS FOR ALL FIELD PERSONNEL

Each field team member is required to complete and submit a copy of Attachment C (Medical Data Sheet). This is provided to the HSO, prior to participating in site activities, and presented to the RAC HSO on site.

10.0 STANDARD WORK PRACTICES

The following Standard Work Practices are to be applied in addition to the Health and Safety Standard Operating procedures:

- Eating, drinking, chewing gum or tobacco, taking medication, and smoking are prohibited in the exclusion or decontamination zones, or any location where there is a possibility for contact with site contaminants exists.

- Upon leaving the exclusion zone, hands and face must be thoroughly washed with soap and potable water. Any protective outer clothing is to be decontaminated and removed as specified in this HASP, and left at a designated area prior to entering the clean area.

- Contact with potentially-contaminated substances must be avoided. Contact with the ground or with contaminated equipment must also be avoided.

- No facial hair, which interferes with a satisfactory fit of the mask-to-face seal, is permitted on personnel required to wear respiratory protective equipment.

- All personnel must satisfy all training requirements (40-hr, 8-hr refresher, site-specific training, supervisory, emergency response training, etc.) prior to commencing site activities.

- All personnel must have a working knowledge of this HASP. Including being aware of the action levels for upgrading/downgrading levels of protective equipment, and emergency procedures.

- All personnel must satisfy medical monitoring procedures.

- All personnel must complete a medical data sheet, to be maintained on site (see Attachment C).

- All personnel working in sight restriction areas of heavy vegetation or where the topography does not permit line of sight contact must utilize the buddy system.

- When lifting or moving equipment or material, use proper lifting techniques.

- All work areas must be kept free of ground clutter.

- No flames or open fires will be permitted on site.

- Site personnel must immediately notify Halliburton NUS Health Sciences of all incidents for OSHA recordkeeping purposes.

- If personnel note any warning properties of chemicals (irritation, odors, symptoms, etc.) or even remotely suspect the occurrence of exposure, they must immediately notify the HSO for further direction.

- Site personnel are not to undertake any activity which would be considered a confined-space entry without first being trained in the proper procedures by the HSO, and obtaining a Confined Space/Limited Egress Permit.

- A full-sized copy of the OSHA poster included as Attachment B of this HASP shall be conspicuously posted on site.

11.0 SPILL CONTROL

11.1 SPILL CONTROL

Bulk liquids will not be handled during this work and major spills of hazardous materials are, therefore, not anticipated and a spill discharge and control plan is not necessary.

12.0 SITE CONTROL MEASURES

12.1 EXISTING PERIMETER AND/OR ZONE CONTROLS

Perimeter, zone, and site control will be accomplished through implementation of the following control factors:

- Base Security
- Perimeter/Zone Identification (Map)
- Traffic Control/Number of Personnel
- Sampling Area Security

12.1.1 Base Security

Restriction of general traffic is accomplished through Base security. Restriction of unauthorized base personnel is coordinated through the Base contact and Safety and Environmental Management Section.

12.1.2 Perimeter/Zone Identification

Perimeter/Zone identification is accomplished in a dual-step approach. The first step is the overall identification of the sampling areas utilizing maps in Section 1.0, and the maps available illustrating the proposed sampling points. This is used to educate field personnel of potential areas of contamination and therefore areas of restriction. It is impossible to secure the entire area to be sampled, so a three-zone delineation is utilized in Step 2 of the dual stage approach. Security of the work zones are established in and about the sampling points to restrict unauthorized personnel during intrusive activities (sampling) when potential for incidental exposure is the greatest.

12.1.3 Three Zone Delineation of the Sampling Points

A three-zone approach is used to secure sampling points, control potential migration of site contaminants, and to protect the health and welfare of the site workers, base personnel, and general public. This approach will designate the sampling point and a 10-foot circumference as the Exclusion Zone, the area of known contamination. A 10-foot circumference outside the exclusion zone shall act as the Contamination Reduction Zone, where all decontamination activities will take place, as necessary. All operations conducted within these two zones shall employ extra measures of protection stipulated in this plan to be utilized in the

presence of contamination. The third, and final zone is the support zone. This is a designated clean zone where no contamination is present. All materials and support for these operations will be routed from this zone. Movement between the zones will be done through control points. All movement from the exclusion zone outward toward the support zone will require complete decontamination and approval from the field team leader or the on site health and safety representative for all equipment and personnel. These zones will not be physically delineated, however, controlled by site personnel.

12.2 COORDINATION WITH THE RAC

While engaged in on-site activities, the Project Engineer will coordinate all his activities with the RAC Site Safety Officer to insure compliance with all sections of Hazardous Waste Operations and Emergency Response Standard OSHA 1910.120. Line of site personnel accountability will be maintained between RAC Personnel and the Halliburton NUS Field Team.

12.3 COMMUNICATIONS

Personnel will work in close proximity to one another during field activities, therefore, no supported means of communications are necessary. There is an active construction trailer located just west of Building 731. The communications system in this building will serve as the primary link with the emergency services should the need arise.

12.4 MATERIAL SAFETY DATA SHEETS (MSDS) REQUIREMENTS

Halliburton NUS personnel will provide MSDSs for all chemicals brought on site by Halliburton NUS or its subcontractors. The MSDSs are maintained in a central location (i.e., temporary office, or vehicle) and are available for anyone to review upon request.

13.0 EMERGENCY RESPONSE PLAN

In the event of any onsite emergencies (i.e., fires, significant spills or releases, etc.), site personnel shall be immediately evacuated to a safe place of refuge and notify appropriate offsite response agencies (Figure 13-1), the Halliburton NUS Project Manager (Kevin Donnelly, P.E.), and the CLEAN Health and Safety Manager (Matthew M. Soltis, C.S.P.). In view of this approach, this section of the Health and Safety Plan is provided to be in compliance with OSHA Standard 29 CFR 1910.38(a) [as permitted by OSHA 29 CFR 1910.120(l)(1)(ii)].

13.1 EMERGENCY ESCAPE

If site evacuation becomes necessary, personnel shall immediately take the most direct route to the main gate where they will await further instruction from the Halliburton NUS Project Engineer.

13.2 MAINTENANCE OF CRITICAL OPERATIONS

It is not anticipated that any personnel will need to remain at their worksite to maintain any critical operations. If this condition should change, the site Health and Safety Officer shall identify the personnel and their responsibilities in this regard and amend this Plan accordingly. Any such modifications must be communicated to the Health and Safety Manager for concurrence.

13.3 PERSONNEL ACCOUNTING

In the event of an emergency evacuation, personnel shall immediately report to the designated refuge location, and remain there. The HSO, assisted by the Project Engineer, shall conduct a roll call (using the site log book) to account for all personnel to ensure that a total worksite evacuation has taken place. If the roll call identifies that any personnel are not accounted for, this information shall be immediately communicated to the offsite emergency response agency upon their arrival. This information is to be supplemented with any additional information available which could be of assistance in conducting rescue operations (i.e., last known location of the missing personnel, etc.). Site personnel are not authorized to participate in emergency response/rescue operations.

13.4 RESCUE AND MEDICAL DUTIES

Site personnel are not authorized to participate rescue in activities. However, any personnel present who are trained to perform emergency first aid activities may perform these functions, if needed, after rescue or evacuation operations have been completed.

13.5 EMERGENCY REPORTING

Emergency reporting functions are the responsibility of the Project Engineer. Figure 13-1 identifies the agencies to be contacted. The Project Engineer will become thoroughly familiar with this Plan prior to the initiation of any site work activities. Figure 13-1 will be communicated with a copy for the RAC HSO.

In the event that an emergency incident occurs and offsite response assistance is necessary, the Project Engineer shall contact the appropriate agency (or agencies) and communicate the following information:

- Nature of the incident (fire, spill, chemical exposure, physical injury, etc.)
- Number of injuries and type(s) of injury (injuries)
- Possible contaminants which may be encountered in response efforts

13.6 SITE EMERGENCY ALARM SYSTEM

All workers will be in close proximity to each other, therefore, an emergency alarm system is not needed.

FIGURE 13-1

EMERGENCY NOTIFICATION AND DIRECTIONS TO HOSPITAL

EMERGENCY PHONE NUMBERS

Tom Symalla	(301) 743-6745
Fire Department (NSWC)	(301) 743-4333
Police Department (NSWC)	(301) 743-4111
Rescue/Ambulance (NSWC)	(301) 743-4333
Primary Hospital (Physicians Memorial)	(301) 645-0100
Alternate Hospital (Southern Maryland)	(301) 868-8000
Offsite Emergency Service (Sheriff)	(301) 870-3232
Poison Control Center	(800) 962-1253
National Response Center	(800) 424-8802
Project Manager, Kevin F. Donnelly	(412) 921-8195
CLEAN HSM, Matthew Soltis, CSP	(412) 921-8912

DIRECTIONS TO HOSPITAL:

Physicians Memorial Hospital, La Plata, Maryland (PRIMARY)

Take Indian Head Highway (MD. Route 210) North to MD. Route 225. Turn right on 225 and follow until junction with MD. Route 301. Turn right on 301. Turn left at first traffic light. The hospital is on the right, about a 1/2 block past the railroad tracks.

Southern Maryland Hospital, Clinton, Maryland (ALTERNATE)

Take Indian Head Highway (MD. Route 210) North to MD. Route 373. Follow until intersection with Branch Ave. (MD. Route 5). Turn left on Branch Ave., right on Surratts Road. The hospital is just past the Colony South Hotel.

14.0 PERMIT-REQUIRED CONFINED SPACE

No permit-required confined space activities are anticipated as per this Scope-of-Work. Therefore, this section is not applicable.

15.0 MATERIALS AND DOCUMENTS

The Halliburton NUS Field Operations Leader shall ensure the following materials/documents are taken to the project site and utilized as required.

- Incident Reports (blank)
- Medical Data Sheets (blank)
- Follow-Up Reports (to be completed by the Field Operations Leader - see Attachment A)
- OSHA Job Safety and Health Poster (Posted in site trailer - see Attachment B)
- Training Documentation Form (Blank)

APPENDIX C-I

SILVER

1290. O. A. Levander and V. C. Morris, *J. Nutr.*, 101, 1013 (1971).
1291. I. Bach et al., *Adv. Thyroid Res., Trans. Int. 4th Goitre Conf. 1960, Proc.*, 1961, p. 501.

29 Silver, Ag

29.1 Source and Production (1, 2)

Silver is a relatively rare element, being sixty-third in order of abundance. Although it occurs free in nature, for the most part Ag is found in ores such as argentite, Ag_2S, the most abundant, and in several other minerals in which Ag_2S is combined with the sulfides of other metals such as Sb and Cu, stephanite, $5Ag_2S \cdot Sb_2S_3$; polybasite, $9(Cu_2S,Ag_2S) \cdot (Sb_2S_3)(As_2S_3)$; proustite, $3Ag_2S \cdot As_2S_3$; and pyrargyrite, $3Ag_2S \cdot Sb_2S_3$. Cerargyrite, AgCl, or horn Ag, containing no sulfides is also mined commercially. Because soil contains small amounts, Ag occurs in traces in most foods, for example, from 0.3 ppm in wheat flour to 0.9 ppm in bran, and mushrooms are said to contain up to several hundred ppm, presumably because of their growth in humus that is high in Ag (up to 5 ppm).

Of the more than 300 U.S. Ag producers in 1974, most were concentrated west of the Mississippi River in Idaho, producing 37 percent; Arizona, 19 percent; Montana and Utah, 10 percent each; Colorado 8 percent; Missouri, 7 percent; and all other states, 6 percent. Three of the leading producers mined Ag ores predominantly, and the remaining Cu, Pb, and Zn ores. Domestic mine production in 1974 was 33.76 million troy oz, providing 19 percent of the Ag consumed by industry and the arts. The main sources of imports, of which refined bullion was 67 percent of the total, were Mexico, 29 percent; Canada, 27 percent; United Kingdom, 14 percent; Peru, 13 percent; and Japan, 4 percent; with other countries supplying the remaining 13 percent. World production in 1974 was 296 million oz, or about eight times that of the United States.

The metallurgical extraction of Ag is essentially a by-product of base-metal ores of Cu, Pb, and Zn, and accounts for at least three-quarters of world production. In the extractive process, Ag follows these metals through the concentrating and smelting stages. There are two main production methods, slime smelting from the electrolytic refining of Cu, and the Parkes process for obtaining Ag from Pb and Zn ores.

In extracting Ag from Cu, the electrolytic process is used, because Ag is lost in refining Cu by fire processes. The Ag-rich raw slimes from the electrolytic refining are treated with a sulfuric acid and air leach to remove Cu, which also combines the Ag with Se and Te present. The treated slimes are smelted with fluxes such as $CaCO_3$, SiO_2, CaF_2, and $Na_2B_4O_7$ in a small reverberatory doré furnace ("doré" denotes an alloy of Au and Ag). In this process, most of the base metals are removed as silicates in the slags. Because they contain significant amounts of Ag (and Au), they are returned to the Cu anode furnace. The resulting matte of Ag, Au, Se, and Te and residual base metals is treated first with Na_2CO_3 to remove any residual S, and then with KNO_3 and air to rid the matte of Se and Te through the formation of water-soluble compounds.

The impure Ag bullion is repeatedly treated with KNO_3 to remove residual base metals, and the resulting doré is cast into anodes for electrolytic refining. Doré anodes are electrolyzed in a nitrate solution from which Ag of better than 99.9 percent purity is deposited in needlelike crystals at the cathode. It is then washed, melted, and cast into commercial bars of about 1100 troy oz.

In the extraction of Ag from Pb ores, Ag may leave the Pb main stream at any one of several points: 1) after the Pb blast furnace to go to the Cu matte smelter, 2) after Pb drossing, 3) after desilvering to Zn crusts and dezincification through cupellation, and 4) to doré Ag anode to electrolysis, where Ag (and Au) are recovered as doré and Pb as litharge (PbO).

Silver produced by amalgamation with Hg and by cyanidation, as in the recovery of Au, represented a very small fraction of that produced by smelting in 1974; 0.01 percent by amalgamation and 0.99 percent by cyanidation.

Silver recovery from secondary sources is of increasing importance because of limited world supply and rising cost. Recovery from spent photography solutions was reported to be at a rate of 90 to 95 percent in 1974 (1). Figures for Ag recovery from other sources, such as silverware and scrap, do not seem to have been gathered.

29.2 Uses and Industrial Exposures

Six end-use categories consumed 86 percent of the total Ag in 1974: photography, 28 percent, of which X-ray film consumed about 50 percent; electrical contacts and conductors, 18 percent; coins, commemorative objects and medallions, 13 percent; sterling ware, 12 percent; brazing alloys, 8 percent; and electroplated ware, 7 percent. The use of Ag in catalysts and jewelry ranked next, being about one-half that of electroplated ware, and that for batteries and mirrors was one-half that for catalysts. Silver for dental and medical supplies accounted for only a minor amount, one-hundredth of the total annual consumption of the United States for 1974.

Industrial exposures associated with the melting and working of Ag in Cu–Ag or Pb–Ag ores are outlined in the respective sections on Cu and Pb, Sections 11.2 and 18.2. Industrial exposures to Ag in metallic vapor, chemical, or colloidal form can result in a condition perculiar to Ag, argyria, a permanent pigmentation of the skin and eyes, slate gray, blue gray, or sometimes purplish, that is cosmetically disturbing. No other physiological effects are associated with this condition.

Silversmiths, or those that work with metallic Ag, can acquire small, focal, pigmented lesions by a process equivalent to tattooing from injuries by sharp tools used in filing, drilling, turning, engraving, and forging.

29.3 Physical and Chemical Properties (Table 29.29.1)

Pure Ag, 999 fine, is a moderately soft metal, only slightly harder than Au, and second to it in malleability and ductility. Masses of Ag, like those of other precious metals, are measured on the troy scale which counts 12 oz to 1 lb. Silver is available commercially

Table 29.29.1. Physical and Chemical Properties of Industrial Silver and Its Compounds

Form of Ag	At. or Mol. Wt.	Sp. Gr.	M.P. (°C)	B.P. (°C)	Solubility
Silver (*agentum*) (Ag)	107.868	10.5 (20°C)	961.93	2212	Insol. cold, hot H_2O; sol. HNO_3, hot H_2SO_4, KCN; insol. alkalis
Silver oxide (Ag_2O)	231.74	7.143 (16.6°C)	Dec. 300	—	0.013 g/liter (20°C), 0.053 g/liter (80°C); sol. acid, KCN, NH_4OH, alcohol
Silver acetate ($AgC_2H_3O_2$)	166.92	3.259 (15°C)	Dec.	—	10.2 g/liter (20°C), 25.2 g/liter (80°C); sol. dil. HNO_3
Silver bromide (AgBr)	187.78	6.473 (25°C)	432	Dec. >1300	84×10^{-6} g/liter cold H_2O, 0.0037 g/liter (100°C); sol. KCN, $Na_2S_2O_3$; sl. sol. NH_4OH
Silver chloride (native cerargyrite) (AgCl)	143.32	5.56	455	1550	0.00089 g/liter (10°C), 0.021 g/liter (100°C); sol. NH_4OH, $Na_2S_2O_3$, KCN
Silver cyanide (AgCN)	133.84	3.95	Dec. 320	—	0.00023 g/liter (10°C); sol. HNO_3, NH_4OH, KCN, $Na_2S_2O_3$
Silver iodate ($AgIO_3$)	282.77	5.525 (16.5°C)	>200	Dec.	0.03 g/liter (10°C); 0.19 g/liter (60°C); sol. HNO_3, NH_4OH, KI
Silver iodide (native iodyrite) (AgI)	234.77	5.683 (30°C)	Tr. 146 to β	—	28×10^{-7} g/liter (25°C); 25×10^{-6} g/liter (60°C); sol. KCN, NH_4OH, KI, $Na_2S_2O_3$
Silver nitrate ($AgNO_3$)	169.87	4.352 (19°C)	212	Dec. 444	1.222 kg/liter (0°C);9.52 kg/liter (100°C); sol. ether, glycerol; v. sl. sol. abs. alcohol
Silver sulfate (Ag_2SO_4)	311.80	5.45 (29.2°C)	652	Dec. 1085	5.7 g/liter (0°C), 14.1 g/liter (100°C); sol. acid, NH_4OH; insol. alcohol

as sterling (2.5 percent Cu) and in ingots, plate, moss, sheets, wire, castings, tubes, powder, and colloid.

Chemically, Ag is the most reactive of the noble metals, but it does not oxidize readily; rather it "tarnishes" by combining at ordinary temperatures with S or H_2S. Oxidizing acids, nitric or sulfuric, will oxidize Ag to the unipositive ion, in which it exists in most of its compounds, except the oxide, fluoride, and sulfide, in which it is divalent. As oxide or peroxide, it is a strong oxidizing agent, finding considerable use as an oxidizing catalyst in organic reactions and as an oxide or peroxide anode with a Zn cathode in an alkaline electrolyte.

Silver in photography, its greatest present-day use, starts with the nitrate in a gelatin emulsion, which is converted to Ag halide crystals (chloride, bromide, or iodide depending on the desired sensitivity) finely dispersed in the emulsion.

Silver in batteries, one of its smaller uses, is constructed of an Ag oxide or peroxide anode with a Zn cathode in an alkaline electrolyte. Its advantage is large output per unit weight; its disadvantages are limited number of recharges and low shelf life.

29.3.1 Ag Alloys

Silver alloys are numerous. Silver, being soft and ductile, requires hardening for industrial uses. Copper is the common hardener, and is the component in sterling Ag alloy and in Ag coinage. An Ag–Cu eutectic mixture (28 percent Cu) and modifications with other elements, Cd, Li, P, Sn, and Zn, are widely used for brazing where strong joints with relatively good corrosion resistance is needed. When higher strengths at elevated temperatures are required, Ag–Cu–Pd alloys are used.

Silver has proved to be a useful component for heavy-duty bearings in aircraft engines, where it may be overlaid with a thin coating of Pb and In.

Silver, a component of many of the colored Au alloys, is rendered suitable for rubbing electric contacts by the addition of Pt or Pd which augments strength and hardenability.

Because Ag does not oxidize on heating, it is used in applying electrically conductive coatings to ceramics for making connections to ceramic capacitors. Similar coatings are used for decorating glassware; and to prevent tarnishing, Rh is electrodeposited.

Because of its resistance to acetic acid and other acidic organic materials as well as alkalis, Ag-lined equipment finds considerable use in industry, in autoclaves, piping, and similar chemical equipment.

Dental amalgam is an alloy of Ag with Sn plus small amounts of Cu and Zn as a fine powder mixed with equal amounts (50 percent) of Hg.

29.3.2 Ag Compounds

The *Chemical Buyer's Directory for 1977–78* (723) lists 23 compounds that are commercially available in addition to Ag metal in various forms, as powder, flake, and colloid, out of 72 inorganic and 19 organometallic complexes of Au in the *Handbook of Chemistry and Physics* (583).

In addition to the large use of Ag halides in photography, AgI has had some use in cloud seeding for artificial rainmaking, although other substances will probably replace the Ag salt because of cost. The oxide is also finding special use in purifying drinking water, but concern is expressed by health authorities for its long-term adverse cosmetic effects. The oxide has long found application in polishing and coloring glass (yellow), as a catalyst, and as noted previously, in Ag battery plates. The main use of Ag cyanide is in Ag plating. Silver nitrate has the widest use of all Ag compounds; besides its use in photography as previously noted, and as a starting agent for other Ag salts, the nitrate is used in Ag plating, for silvering mirrors, a relatively large use, and as a germicide and antiseptic (for newborns).

Silver complexes, such as Ag sulfadiazine and Ag–Zn allantoate, have been used in the treatment of burns to prevent infection, because of their effectiveness against a wide variety of bacterial species.

Monovalent silver forms a large number of stable coordination compounds. These are often two-coordinate, having two ionic or molecular groups attached to a central Ag^+ ion, as in $[Ag(NH_3)_2]^+$ or $[Ag(CN)_2]^-$. Three-coordinate complexes, such as $[AgCl_3]^{2-}$, are also known, and four-coordinate complexes like $[AgCl_4]^{3-}$ and $[Ag(Cn_4]^{3-}$ probably occur in solution. Silver cyanide, AgCN, is a long-chain coordination compound made up of alternating silver and cyanide ions. Divalent silver can be stabilized against decomposition by complexing the Ag^{2+} ion with the organic compounds *o*-phenanthroline, pyridine, and α,α'-dipyridyl. The trivalent Ag^{3+} ion can be stabilized through complexing with ethylenedibiguanide. Complex Ag forms are not generally available on a commercial scale.

29.4 Analytic Determination

The Midwest Research Institute report on Ag (1292) lists some 30 methods culled mostly from texts on the subject between the years 1949 and 1973. The methods have ranged from gravimetric and titrimetric for the determination of Ag in alloys and industrial products, to potentiometric for the determination of Ag in photographic paper and film and waste products in the photographic industry, to neutron activation analysis (NAA) for determining low levels of Ag in aqueous media (1293) or for biologic samples, to emission spectrochemical and atomic absorption spectrometry (AAS) for analysis of biologic samples. Sunderman (1294) has successfully used AAS for the determination of Ag in clinical pathology.

The AAS methods, flame or thermal atomization, have the conventional sensitivity of 0.030 μg/ml, and the carbon rod atomizer, 1.2 pg. Detection limits of emission spectroscopy are from 0.1 to 50 μg/liter. The NAA method (1293), in which 110m Ag is separated from other radionuclides, has a coefficient of variation of ± 10 percent at an Ag level of 40 ng/liter.

A thermal NAA method for the determination of Ag in artificially produced rain uses the $^{109}Ag(\eta,\gamma)$–^{110}Ag reaction determined by X-ray spectrometry, using the 24-sec half-

life of ^{110}Ag. The method has a sensitivity down to 10^{-11} M gained by sample enrichment prior to activation (1294).

AAS is the method used by Eastman Kodak Company for aqueous solutions of Ag ≥ 30 ppb; for amounts ≤30 ppb, an inductively coupled plasma, optical, emission spectrograph is used, provided there are no interferences. Air samples are usually collected on filters and solubilized prior to analysis (1296a).

29.5 Physiologic Response

Silver and its compounds do not present serious industrial health problems provided careful attention is given to maintaining airborne Ag below 0.10 mg Ag/m^3 (to prevent generalized and localized argyria of respiratory tract) (1297), and provided solutions of complex Ag salts are kept from penetrating the intact skin by way of the sweat gland pores to prevent localized argyria at that site (1298). The 239 cases of argyria recorded up to 1939 by Hill and Pillsbury (1299) show what can happen when such controls are not maintained. Moreover, it should not go unnoticed that the Ag ion and its complexes with organic moieties are highly toxic to microorganisms generally, hence its use as an antiseptic agent, and more recently for purification of drinking water supplies, which is giving concern to health authorities regarding its long-term effects.

29.5.1 Acute Toxicity

The acute toxic effects from Ag in man have resulted from accidental or suicidal overdoses of medical forms of Ag, Collargol or Ag sticks (75 percent $AgNO_3$, 25 percent $KMnO_4$). From these lethal outcomes, it has been estimated (994) that the oral lethal dose for man is 10 g, form unspecified, but individuals have survived 30 g. Much of the acute toxic effects results from the causticity of Ag nitrate, which in large doses produces a burning sensation in the throat, violent abdominal pain, vomiting, collapse, and death. Silver as a colloid, a form commercially available (723), is reported (171) to be highly toxic by vein to man, 700 μg/kg, or about 0.05 g being the lowest lethal dose (LD_{LO}).

The acute experimental animal toxicity data are limited to five Ag compounds in rodents—mouse, rat, and guinea pig—by oral, subcutaneous, or intraperitoneal routes (171). In general, the acute toxicity is high by all routes tested, except for the relatively insoluble oxide, Ag_2O, which has an oral LD_{LO} for the rat of 2820 mg/kg. By comparison, Ag nitrate, the most toxic in animals of those tested, had an oral LD_{50} for the mouse of 50 mg/kg, or almost 60 times more toxic than the oxide by this route. By the intraperitoneal route, the nitrate was even more toxic, the mouse LD_{50} being 0.129 mg/kg. Interestingly, the simple cyanide, AgCN, appeared to be less toxic than the nitrate, again probably because of its low solubility, having an oral rat LD_{50} of 123 mg/kg, but the complex cyanide, $AgK(CN)_2$, was more toxic than the nitrate by a factor of about 2 (oral rat LD_{50}, 21 mg/kg). The fluoride appears to be about six times less toxic than the nitrate, having an oral LD_{LO} for the guinea pig of 300 mg/kg. Oddly, the fluoride was considerably less toxic by the subcutaneous route with an LD_{LO} of 800 mg/kg, although

the determinations were made by different investigators and at different times. Taking the data all together, there may be reason to question their validity in some instances, whether because of testing differences or failure to characterize the test substance sufficiently, a factor particularly important in the case of Ag colloid where large differences in surface area could affect toxicity markedly. A case in point is that 500 mg was found to be lethal to a 10-kg dog administered intravenously by Shouse and Whipple (1300), whereas 0.05 mg for a 70-kg man similarly administered was the LD_{LO}, as previously noted. Neither does the 216 mg/kg LD_{LO} for $AgNO_3$ intraperitoneally in the guinea pig (395) appear to be in line with 0.129 mg/kg for the nitrate LD_{50} in the mouse (171).

Silver nitrate solutions have long been recognized to be highly irritating to the skin, mucous membranes, and the eyes, even at relatively low concentrations, and ocular damage from application of solutions greater than 2 percent have been the occasion of several reports in the literature. One of the latest (1301) reports corneal opacification and bleeding conjunctiva within an hour after application of two drops from an $AgNO_3$ stick into the eyes of a newborn. Opacification may be so severe as to cause blindness. Necrotizing, ulcerative gingivitis has been reported to result from application of $AgNO_3$ to the gingiva (1302).

Acute irritation of the respiratory tract can also occur from inhalation of $AgNO_3$ dust, but only at concentrations considerably higher than those which will produce rather rapid staining of the eyes, mucous membranes of the nose and throat, and eventually generalized argyria (1303).

29.5.2 Chronic Toxicity

Argyria or argyrosis, both localized and generalized, is the sole chronic effect resulting from occupational exposures. Localized argyria may occur on the skin from either handling metalic Ag from particles becoming embedded in the skin, or from absorption through pores in the sweat glands of complex Ag salts (1298). The respiratory tract may also be a site of local argyria (1297). Here the only symptom is mild chronic bronchitis, but the nasal mucosa shows a bilateral, symmetric impregnation of Ag of the walls of the middle and upper regions. There is, however, no discoloration of the skin, eyes, and mouth. In more severe cases, isolated plaques of pigmentation appear at the tracheobronchial junction and uniform zones of grayish yellow coloration around the orifices of the smaller bronchi. The nasal mucous membrane shows deposition of Ag in the subepithelial region as does the basal membrane of the seromucous glands. The author regarded this condition as a form of pneumoconiosis, but differing from other varieties in that it carries no risk of fibrosis and represents a pigmentation comparable to that of anthracosis or siderosis.

When argyria is localized in the eyes, the conjunctiva is most frequently affected with Ag deposition on the elastic fibers (993).

Generalized argyria is recognized by widespread pigmentation of the skin, eyes, and nails which show a uniformly dark, slate-gray color. The pigmentation appears early on the face, spreading gradually to the ears and neck with fairly early involvement of the

hands (1304). In severest cases the skin becomes almost black and has a metallic luster. The eyes usually show discoloration, first apparent in the conjunctiva, with some localization in the inner canthus which may precede pigmentation of the face. The cornea also becomes involved, as was first reported by Larsen (1305) among $AgNO_3$ workers, and since then by others. According to these later workers, long exposure can result in turbidity of the anterior capsule of the lens and involvement of the posterior elastic lamina of the cornea (Descemet's membrane). These changes are not accompanied by failure of vision, by may cause some disturbance in dark adaptation.

Experimental argyria has resulted in glomerular lesions in mice (1306) following the demonstration of Ag deposition in the glomerular basement membrane (1307).

There is no evidence that Ag or its compounds are carcinogenic for man. Silver foil elicited a 32 percent incidence of fibrosarcomas in rats by the subcutaneous embedding technique of the Oppenheimers (1956). Other investigators have elicited sarcomas in rats from implanted disks (1292).

29.5.3 Metabolism

Silver has no known physiological function in man, and hence is suspected of being a natural contaminant (1308), despite the estimated daily intake of Ag, mainly from food sources, and possibly from tableware, to be up to 0.088 mg for the human adult, and despite measurable amounts of Ag throughout most tissues of their body.

As has been previously intimated, Ag is one of the most physically cumulative and also the most physiologically cumulative of the elements, leading to a disturbing, permanent cosmetic effect when the body burden has accumulated Ag in excess of 1 g (1299). Because of this, considerable attention has been given to determining the Ag content of foods and human tissues and fluids.

Normal Values. The Ag content of foods ranges from 0.3 ppm in wheat flour to 0.9 ppm ($\mu g/g$) in bran, according to Kent and McCance (1309) for crops grown in English soil. Mushrooms had a particularly high content of several hundred ppm, presumably from their growth in plant humus which in itself is high in Ag (5 ppm) according to Ramage and Sheldon (1310), again for a crop from English soil. Kehoe et al (1311), analyzing diets in the United States at about the same time (late 1930s), found the daily intake of Ag to be between 0.06 and 0.08 mg. Concern that milk might be a significant contributor of Ag to dietary intake, especially early in life, Murthy and Rhea (1312) analyzed samples on a quarterly basis from various cities in the United States and found that the average Ag content from the different cities varied between 0.027 and 0.054 ppm (mg/liter) with little variation from one city to another, indicating that milk could be a significant contributor to the daily intake of Ag in the United States.

Tipton and Cook (755) determined the Ag content of adult human tissues of U.S. residents by emission spectrographic procedures and found that 13 of the 30 tissues analyzed (43 percent) had Ag values ranging from >0.1 to 2.5 $\mu g/g$ ash. Skin content was highest, with a medium value of 1.3 $\mu g/g$, and 21 of 22 samples showed values of

0.8 to 2.5 μg/g. Liver content followed with 0.7 to 1.0 μg/g; adrenals, <0.1 to 2.0; brain, 0.5 to 0.8; thyroid, <0.1 to 2.0; cecum, <0.1 to 0.8; ovary, <0.1 to 0.5, and trachea, <0.1 to 0.4. The remainder of the 22 tissues had Ag levels from <0.1 μg/g, the limit of detection of their method, to 0.3 μg/g. Oddly, the major organs, heart, lung, and kidney, which showed 23, 39, and 47 percent positive for Ag of 138 to 148 samples analyzed, had Ag contents either below the limit of detection or just above it. The finding by Kehoe et al. (1309), a quarter of a century earlier, that only 10 percent of adult human tissues analyzed by the same procedure had detectable amounts of Ag, can probably be explained by the gain in sensitivity made by Tipton and Cook in analyzing tissue ash rather than wet tissue.

The Ag concentration in whole human hearts has been determined in Sweden and compared with that in calves and cows by neutron activation analysis following chemical separation by ion exchange and measurement by γ-spectroscopy (1312a). As expected from the values obtained by Tipton and Cook in the United States, the values were extremely low: human heart muscle, 0.0025 μg/g wet weight, range 0.0006 to 0.025; calves, 0.00076 to 0.0013; and cows, 0.0007 to 0.005 μg/g. Contamination from the separating solution, sucrose, prevented determination of Ag in subcellular fractions.

The mean Ag content of whole blood of 47 residents of southern California was found by Butt et al. (1313) in the early 1960s using emission spectroscopy to be 0.024 μg/g, S.E. 0.003. The Ag content of serum from 122 blood donors was 0.004 μg/g; from 93 hospital patients, 0.03 μg/g, (almost tenfold greater?); and from 48 "normals" (hospital employees), 0.013 to 0.014, with seven of the 48 having Ag values below the limit of detection. There was no significant difference in Ag serum values between males and females, but the higher values for whole blood would indicate that Ag, like most trace elements, is attached to the red cells. Mertz et al. (1314), using the same method at about the same time, found the mean Ag content of serum of West German residents to be 0.0029 μg/g, a value in fair agreement with that of California blood donors.

Absorption, Distribution, Excretion. Silver, as Ag nitrate, is absorbed from the respiratory and gastrointestinal tracts, and complex Ag salts are absorbed into the bloodstream through the unbroken skin; absorption of Ag nitrate through the intact skin is of no physiological significance (1303), however, some absorption through the mucous membranes of the nose and throat probably occurs. The absorbed Ag is tenaciously retained after its deposition in elastic tissues throughout the body. When Ag is from dietary sources, it is deposited throughout the body tissues in the relative proportions found by Tipton and Cook (755) (see Section 29.5.3); when it is from other routes of intake or dosages, distribution may differ as shown in Table 29.29.2.

A comparison of tissue distribution in the rat after intramuscular administration of carrier-free and added Ag (1315) with that found by Tipton and Cook after an adult lifetime is shown in Table 29.29.2. It is seen that tissues in which Ag is first deposited differ considerably from those after a steady state has been attained (although corresponding tissues unfortunately were not analyzed in some cases). A still different order of depostion was found (1315) when 1 mg Ag was added to the carrier-free Ag (Table

Table 29.29.2. Comparison of Order of Tissue Deposition of Silver in Man After a Lifetime of Dietary Intake with that of the Rat Four Days After Intramuscular Injection

Man: Dietary Intake	Rat: Carrier-free Ag	Rat: Carrier-free + 1 mg Ag
Skin	Muscle	Liver
Liver	Large intestine	GI tract
Adrenal	Liver	Skin
Brain	Blood	Blood
Thyroid	Bone	Spleen
Cecum	Skin	Muscle
Ovary	Small intestine	Bone
Trachea	Kidneys	Kidneys
Lungs	Lungs	Heart and lungs

29.29.2). In this case 46.5 percent Ag was unabsorbed and only 39.5 percent of that absorbed was excreted, with as much as a hundredfold increase in Ag concentration in the liver, kidneys, spleen, skin, bone, and muscle. Thus it can be concluded that tissue distribution of Ag is greatly influenced by dosage, at least over the short term.

Phalen and Morrow (1316) found that the fraction deposited in the respiratory tract of dogs intubated with agglomerated radioactive Ag particles (median aerodynamic diameter ca. 0.5 μm) was 0.17 + 0.05 when the absolute deposition averaged about 1 mg/kg. The lung was found to have a biologic clearance half-life of 1.7, 8.4, and 40 days corresponding to the clearance of 59, 39, and 2 percent, respectively, of the total amount deposited. Corresponding values for the liver were 9 (97 percent) and 40 days (3 percent). Excretion was predominantly fecal, the major portion of which was considered to have been secreted into the bile, as had been shown previously by Scott and Hamilton (1315). The liver was the major site for depostion when the Ag was inhaled, followed by lung, brain, and muscle.

To complicate the Ag distribution picture further, Furchner et al. (1317) found wide differences among animal species. Using oral doses of from 0.25 to 0.6 μCi of ^{110m}Ag, the effective retention was negligible after 15 days in monkeys, whereas after 150 days, 0.2 percent of the dose was still retained by the dogs. Retention, however, was similar between the two species following intravenous administration, although dogs still retained greater amounts than the monkeys at 140 days (0.9 percent vs. 0.4 percent). In rats receiving the Ag parenterally, all tissues analyzed resembled the pattern of whole-body retention, except brain and spleen. These organs retained more than 13 times that of the whole-body concentration at 24 days, once again a different tissue site distribution from that found by Tipton and Cook for man with dietary Ag sources. On the route of excretion, however, Furchner et al. found, as did other investigators, that 90 to 99

percent of oral doses were not absorbed, irrespective of species or route of administration, although as would be expected, less absorption occurred when the route was oral. Excretion was found to fit a three-component system in most cases, as was found for elimination from the respiratory tract by Phalen and Morrow.

A biologic half-life of 52 days was found for ^{110m}Ag inhaled accidently by a worker. Deposition was confined mainly to the liver, and excretion was solely by the gastrointestinal tract (1318).

Some attention has been given to subcellular distribution of Ag. Ham and Tange (1319) found that Ag, given as the nitrate in the drinking water to rats, had particular affinity for the glomerular basement membrane. Silver deposition aggregated along the endothelial side of the membrane. After Ag administration stopped, Some Ag deposits increased in size, and heavy deposits persisted in the axial basement membrane with a progressive accretion of Ag in the cells, whereas in the peripheral basement membrane, Ag deposits decreased and eventually disappeared.

Silver was also found to accumulate in the lysosomes of the Kupfer cells of the liver, at the basal membrane of capillaries, and in connective tissue of the pancreas, in rats given 1 percent colloidal Ag intravenously, or given 0.5 percent $AgNO_3$ in the drinking water for 9 months (1320). In parenchymatous cells, Ag was found only in traces as a lipoid–Ag complex, or in lipofuchsinlike lysosomes. In epithelial secretory cells, little accumulation occurred, as in the pancreatic acinar cells. From this experimental work, the author concluded that it confirmed his findings in a biopsy from a clinical case.

Adrenal tissue was also shown to take up the highest percentage per gram of tissue of rats given radio-labeled Ag intravenously (1321). In the metabolic pathway in man, Ag appeared first, mostly associated with the red blood cells and in the globulin fraction of the plasma. The radio-labled Ag was rapidly removed from the blood and at postmortem was found mainly in the liver and skin. Excretion again was principally via the bile into the gastrointestinal tract, with a very small amount in the urine, probably as a function of the plasma concentration.

29.5.4 Mechanism

From application of chemical and electron microprobe techniques to the skin of a patient with localized argyria, the manner in which Ag from its complex salts is locally deposited in the skin leading to argyria has been postulated by Buckley et al. (1322). Following entrance of the complex Ag salts into the sweat gland pores, they pass down the epidermal portion of the sweat duct, and because their rate of transit is slowed at the lower level, they pass laterally through the duct. They then cross the adjacent epidermal cells comprising the sweat duct structure and enter the papillary bodies. Within the papillary body, they move across it multidirectionally, being slowed in their movement by connective tissue matrix, cellular elements, and the papillary capillaries. Movement essentially ceases when met by the opposing epidermal interface. As a result, Ag sulfide precipitates under the influence of competitive ions and changes in pH, for instance, arranging itself in oval structures.

Silver precipitation in oval structures had also been noted by Prose (1323) in an electron microscopic study of a case of *generalized* argyria. Here, the "Ag" was located in circumferential, bandlike stucture around the glandular, secretory parts of the basal eccrine sweat gland coils within the amorphous widened basement membranes. Dempsey and Wislocki (1324) found Ag granules within the vesicle structure of the proximal convoluted tubules of the kidney and in the hepatic and pancreatic cells, in structures showing internal folds and double membranes whose dimensions were the same as those of mitochondria. This prompted the speculation that the oval structures containing the Ag_2S of Fassett and associates were mitochondria. The chemical evidence produced by these investigators (1322) leaves no doubt that the high density images produced by the electron microscope in the oval structures were Ag_2S.

Up until the early 1970s essentially no experimental investigations had been made on particular biochemical constituents of the body with which Ag reacts. Among the more recent reports showing reactions with nuclear DNA and RNA is that of Kharchenko et al. (1325). Using concentrations of 0.5, 2, and 20 mg/liter of "electrolytic" (colloidal?) Ag in the drinking water of young adult rats, the 2 mg level reduced the nucleic acid in the brain and liver after 1 year. The 20-mg level, however, increased the DNA and RNA content of the brain after 6 months, and after 12 months, caused dystrophic changes in the brain which were associated with a decrease in nucleic acid level. The sensitivity of the liver to Ag was less than that of the brain.

Because biochemical mechanisms involved in the chronic toxicity of Ag are poorly understood, Wagner et al. (1326) showed that Ag, as Ag acetate, at 76 and 751 ppm in the drinking water of rats fed 0.5 ppm Se, as Na selenite, reduced the activity of their liver glutathione peroxidase (GSH-Px) a selenoenzyme, to 30 and 4 percent of that of rats not given Ag (controls). Silver concentration in the liver and kidney was increased threefold, however, when supplemental Se (0.5 ppm) was fed to rats on a diet lacking in vitamin E, although growth depression and mortality caused by Ag administration (751 ppm) was prevented. The biochemical mechanisms involved would appear to be best explained by diversion of Se by Ag to biologic inactivity, producing an increased tissue concentration of Ag and concomitant modification of Ag toxicity. Whether Ag decreases activity of GSH-Px, a probable protective agent against Ag toxicity, or decreases biosynthesis of GSH-Px due to interference with Se metabolism is unresolved.

Tolerance to the acute toxicity of Ag has been reported (1327); mice pretreated with one-tenth the lethal dose had a lower mortality than untreated mice when given a 70 to 80 percent lethal dose of the respective metal ion. A cross-tolerance between the pretreatment metal and the lethal dose metals As, Cd, In, Pb, Mn, Hg, and Sn also was found. No explanation of the mechanism was given.

29.5.5 Industrial Experience

In the course of medical examinations in the years before 1940 of workers manufacturing $AgNO_3$, using it in compounding photographic emulsions and recovering Ag from scrap film and paper in the photographic industry, cases of generalized argyria were

seen. Atmospheric levels were of the order of 1 mg Ag/m^3, although environmental sampling was inadequate at the time to allow reliable estimates of average weighted exposures, photographic operations providing an intermittent type of exposure. Levels estimated to be of the order of 0.1 mg/m^3 were observed to result in some staining of the mucous membranes of the nose and throat and some eye discoloration, characteristic pigmentary changes appearing before generalized argyria (1303). Since the cases of argyria in the 1930s, repeated examination of workers has not revealed a single case of argyria, and no other adverse effects in periodically monitored personnel have appeared. In the high exposure areas, Ag concentrations averaged about 40 to 60 μg/m^3, with values as high as about 150 μg/m^3 (1296a).

29.6 Industrial Standards of Exposure

The TLV Committee of the American Conference of Governmental Industrial Hygienists adopted a TLV of 0.01 mg Ag/m^3 for Ag and its compounds in 1966. It was developed from an estimation of the amount of accumulation acquired during an 8-hr workday to attain 1 g Ag body burden in a period of exposure of 20 years (844). When the TLV was proposed to the medical department of Eastman Kodak Company in 1960, the limit seemed sufficiently low "not to produce any generalized argyria after long (many years) continued exposure, although pigmentation of the nose and throat may occur" (1303). Preliminary evaluation of data from an epidemiologic study covering a period of the last 25 years, now find the TLV much too low; a TLV of 0.1 mg Ag/m^3 and a STEL of 0.150 mg/m^3 is now recommended.

West Germany and Italy have the same Ag standard as that adopted by the TLV Committee in 1966, evidently taking the value directly from the TLV list of that year. The OSHA (1978) standard is 0.01 mg/m^3.

REFERENCES

1292. B. L. Carson and I. C. Smith, "Silver, an Appraisal of Environmental Exposure," Midwest Res. Inst. Rept. No. 3, July 16, 1975.

1293. K. Kawabuchi and J. P. Riley, *Anal. Chim. Acta*, **65**, 271 (1973).

1294. F. W. Sunderman, Jr., *Human Pathol.*, **4**, 549 (1973).

1295. J. A. Warburton and L. G. Young, *Anal. Chem.*, **44**, 2043 (1972).

1296. (a) Communication from Dr. C. J. Terhaar, Eastman Kodak Co., Rochester, N.Y., September 14, 1978; (b) Dr. R. L. Raleigh, Eastman Kodak Co., November 10, 1978.

1297. A. Montaudon, *Arch. Mal. Prof.*, **20**, 419 (1959).

1298. W. R. Buckley, *Arch. Dermatol.*, **88**, 531 (1963).

1299. W. R. Hill and D. M. Pillsbury, *Argyria, The Pharmacology of Silver*, Williams and Wilkins, Baltimore, 1939.

1300. S. S. Shouse and G. H. Whipple, *J. Exp. Med.*, **53**, 413 (1931).

1301. A. Hornblass, *J. Am. Med. Assoc.*, **231**, 245 (1975).

1302. P. D. Fletcher et al., *N.Y. J. Dent.*, **46**, 122 (1976).

APPENDIX C-II

STANDARD OPERATING PROCEDURES FOR COLD STRESS CONTROL

NUS CORPORATION ENVIRONMENTAL MANAGEMENT GROUP	STANDARD OPERATING PROCEDURES	Number HS-10	Page 1 of 10
		Effective Date 05/04/90	Revision 2
		Applicability EMG	
		Prepared Health and Safety	
Subject COLD STRESS CONTROL		Approved D. Senovich	

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1.0 PURPOSE

To establish procedures for the implementation, operation, and monitoring of a cold stress prevention, evaluation, and response program.

To describe signs and symptoms which characterize excessive exposure of field personnel to cold environments. Recognition of these signs and symptoms necessitates prompt corrective action to prevent injury or death.

2.0 SCOPE

Applies to all NUS/EMG activities, where personnel may be exposed to environments with an ambient temperature of 30°F or less.

3.0 GLOSSARY

Frostbite - Local tissue damage caused by exposure to low temperature environmental conditions. Severe occurrence may lead to deep tissue damage, gangrene, and loss of the affected parts.

Hypothermia - Lowering of the body core temperature due to exposure to cold. Severe hypothermia may result in the death of the victim.

Equivalent Chill Temperature (ECT) - An index describing the effect of the cooling power of moving air on exposed flesh. The effect of wind velocity at a certain temperature is expressed as the equivalent cooling effect of a lower temperature with still air.

ACGIH TLV 1985/6 - Cold Stress Threshold Limit Values (TLVs) are intended to protect workers from the severest effects of cold stress (hypothermia) and cold injury as well as to describe exposures to cold working conditions, under which it is believed that nearly all workers can be repeatedly exposed without adverse health effects. The TLV objective is to prevent the deep body core temperature from falling below 36°C (96.8°F) and to prevent cold injury to body extremities. Deep body temperature is the core temperature of the body as determined by rectal temperature measurements. For a single, occasional exposure to a cold environment, a drop in core temperature of no lower than 35°C (95°) should be permitted. In addition to provisions for total body protection, the TLV objective is to protect all parts of the body (with an emphasis on hands, feet, and head) from cold injury. Cold stress TLVs are currently tentative and portions are quoted with permission of the ACGIH.

4.0 RESPONSIBILITIES

All Site Personnel - All site personnel must be alert to signs of development of excessive cold stress in those working with them and shall be aware of emergency action described in first-aid texts.

Health and Safety Officer (HSO) - The HSO is responsible for implementing a cold stress monitoring according to this guideline. He/she is charged with enforcing the work/warm up regimen to control cold stress.

5.0 PROCEDURES

5.1 EFFECTS OF COLD STRESS

Persons working outdoors in temperatures at or below freezing may experience frostbite. Extreme cold for a short time may cause severe injury to the surface of the body. Areas of the body that have a high surface area to volume ratio, such as fingers, toes, and ears, are the most susceptible.

Two factors influence the development of a cold injury: ambient temperature and the velocity of the wind. Wind chill (Table 1, Attachment A) is used to describe the chilling effect of moving air in combination with low temperature. For instance, 10°F with a wind of 15 mph is equivalent in chilling effect to still air at -18°F.

As a general rule, the greatest incremental increase in wind chill occurs when a wind of 5 mph increases to 10 mph. Additionally, water conducts heat 240 times faster than air. Thus, the body cools suddenly when chemical-protective equipment is removed, if the clothing underneath is soaked with perspiration.

5.2 FROSTBITE

Local injury resulting from cold is included in the generic term frostbite. There are several degrees of damage. Frostbite of the extremities can be categorized into:

1. Frost nip or incident frostbite - the conditions are characterized by sudden blanching or whitening of skin.

2. Superficial frostbite - skin has a waxy or white appearance and is firm to the touch, but tissue beneath is resilient.

3. Deep frostbite - tissues are cold, pale, and solid; extremely serious injury.

5.3 HYPOTHERMIA

Authorities agree that there are degrees of hypothermia which are characterized as "moderate" and "severe". A victim of moderate hypothermia, who may exhibit the first seven signs listed in 5.3.1, is still conscious but often confused. Severe hypothermia is determined by extreme skin coldness; loss of consciousness; faint pulse; and shallow, infrequent, or apparently absent respiration. Death is the ultimate result. (See Attachment B.)

Practically, the onset of severe shivering signals danger to personnel. Exposure to cold shall be immediately terminated for any severely shivering worker.

5.3.1 Signs of Hypothermia

1. Severe shivering
2. Abnormal behavior
3. Slowing
4. Stumbling
5. Weakness
6. Repeated falling
7. Inability to walk
8. Collapse
9. Stupor
10. Unconsciousness

5.4 EMERGENCY ACTION

1. Remove the victim from the hypothermia-/frostbite-producing environment.

2. Seek expert medical help immediately.

3. Reduce handling to a minimum. Do not rub or massage the victim.

4. Prevent further body heat loss by covering the victim lightly with blankets. Plastic may be used for further insulation. Do not cover the victim's face.

5. If the victim is still conscious, administer hot drinks. Encourage activity, such as walking while wrapped in a blanket. Do not administer any form of sedative, tranquilizer, or analgesic (pain reliever), because these may facilitate further heat loss and convert moderate hypothermia into a severe case.

5.5 WORK-PLACE MONITORING

Work-place monitoring is required as follows:

1. A thermometer accurate to 1°F shall be assigned at any workplace where the environmental temperature is known or expected to be below 60°F, to enable overall compliance with the requirements of this procedure.

2. Whenever the air temperature at a work place falls to 30°F or below, the dry-bulb temperature and wind speed shall be measured and recorded at least every 4 work-hours.

3. The equivalent chill temperature shall be obtained from Table 1 (in all cases where air movement measurements are required) and shall be recorded with the other data in the site log, together with a record of the length of time spent working and resting.

5.6 WORK-WARMING REGIMEN

If work is performed continuously in the cold at an ECT of 20°F or below, heated warming shelters shall be made available for use by employees during warmup breaks. A work-warming regimen will be established using Table 2 (Attachment C). This table assumes that all workers are properly clothed for periods of work temperatures below freezing.

When entering the heated shelter, the outer layer of clothing shall be removed and the remainder of the clothing loosened to permit sweat evaporation or a change of dry work clothing provided. A change of dry work clothing shall be provided, as necessary, to prevent workers from returning to their work with wet clothing. Dehydration, or the loss of body fluids, occurs insidiously in the cold environment and may increase the susceptibility of the worker to cold injury due to a significant change in blood flow to the extremities. Warm sweet drinks and soups should be provided at the work site to provide caloric intake and fluid volume. The intake of coffee shall not be permitted because of a diuretic and circulatory effect.

For work practices at or below 10°F ECT the following shall apply:

1. The worker shall be under constant protective observation (buddy system or other direct supervision).

2. The work rate should not be high enough to cause sweating that results in wet clothing. If heavy work must be done, all rest periods must be taken in heated shelters and the opportunity for changing into dry clothing shall be provided.

3. Provision shall be made to make sure employees shall become accustomed to the working conditions and required protective clothing.

4. The weight and bulkiness of clothing as well as the required work performance and weights to be lifted by the worker shall be included in estimating.

5. The work shall be arranged in such a way that sitting still or standing still for long periods is minimized. Unprotected metal chair seats shall not be used. The worker should be protected from drafts to the greatest extent possible.

6. The workers shall be instructed in cold weather procedures. The training program shall include, as a minimum, instruction in:

   a. Proper rewarming procedures and appropriate first-aid treatment.
   b. Proper clothing practices.
   c. Proper eating and drinking habits.
   d. Recognition of impending frostbite.
   e. Recognition of signs and symptoms of impending hypothermia or excessive cooling of the body, even when shivering does not occur.
   f. Safe work practices.

5.7 SPECIAL MEDICAL CONSIDERATIONS

Employees shall be excluded from work in the cold at 30°F or below if they are suffering from diseases or taking medication, which interferes with normal body temperature regulation or reduces tolerance to work in cold environments. The HSO shall document this situation for each worker during site training. Workers who are routinely exposed to temperatures below -10°F (with wind speeds less than 5 miles per hour) or air temperature below 0°F (with wind speeds less than 5 miles per hour) should be medically-certified as suitable for such exposures.

Trauma sustained in freezing or subzero conditions requires special attention, because an injured worker is predisposed to secondary cold injury. Special provisions must be made to prevent hypothermia and secondary freezing of damaged tissues, in addition to providing for first-aid treatment.

For exposed skin, continuous exposure will not be permitted when an ECT of -25°F is anticipated.

At air temperatures of 36°F or less, any worker who becomes immersed in water or whose clothing becomes wet will be immediately be provided with a change of clothing and be treated for hypothermia.

5.8 PERSONAL PROTECTIVE EQUIPMENT REQUIREMENTS

Since prolonged exposure to cold air or to immersion in cold water (at temperatures well above freezing) can lead to dangerous hypothermia, whole body protection must be provided as follows:

- Adequate insulating clothing, to maintain core temperatures above 97°F, must be provided to workers if wo is performed in air temperatures below 40°F. Wind chill or the cooling power of the air .s a critical factor. As wind speed increases and work area temperature decreases, the insulation values of the workers' protective clothing must increase. An equivalent chill temperature chart, relating the actual dry bulb air temperature and the wind velocity, is presented in Attachment A. The equivalent chill temperature must be used when estimating the combined cooling effects of wind and low air temperatures on exposed skin or when determining clothing insulation requirements to maintain the deep body core temperature.

- Older workers or workers with circulatory problems require special precautionary protection against cold injury. The use of extra insulating clothing and/or a reduction in the duration of the exposure period are among the special precautions which shall be considered. The precautionary actions to be taken will depend upon the physical condition of the work and shall be determined with the advice of a physician who knows cold stress factors and the medical condition of the worker.

- Special protection of the hands is required to maintain manual dexterity as follows:

  - If fine work is to be performed with bare hands for more than 10-20 minutes in an environment below 60°F, special provisions shall be established for keeping the worker's hands warm. For this purpose, warm air jets, radiant heaters (fuel burner or electric radiator), or contact warm plates may be utilized. Metal handles of tools and control bars shall be covered by thermal insulating material at temperatures below 30°F.

  - If the air temperature falls below 60°F for sedentary, 40°F for light, or 20°F for moderate work (and fine manual dexterity is not required), then gloves shall be used by the workers.

- To prevent contact frostbite, the workers must wear anticontact gloves and follow the provisions shown below:

  - When cold surfaces below 20°F are within reach, a warning should be given to each worker by his supervisor to prevent inadvertent contact by bare skin.

  - If the air temperature is 0°F or less, the hands should be protected by mittens. Machine controls and tools for use in cold conditions should be designed so that they can be handled without removing the mittens.

- Provisions for additional total body protection is required if work is performed in an environment at or below 40°F. The workers shall wear cold protective clothing that is appropriate for the level of cold and physical activity:

  - If the air velocity at the job site is increased by wind, draft, or artificial ventilating equipment, the cooling effect of the wind shall be reduced by shielding the work area or by wearing an easily removable outer windbreak garment.

  - If only light work is involved and if the clothing on the worker may become wet on the job site, the outer layer of the clothing in use shall be impermeable to water. The outer garments must include provisions for easy ventilation in order to prevent wetting of inner layers by sweat. If work is done at normal temperatures or in a hot environment before entering the cold area, the employee shall make sure that his/her clothing is not wet from sweating. If his/her clothing is wet, the employee shall change into dry clothes before entering the cold area. The workers shall change socks and any removable felt insoles at regular daily intervals or use vapor barrier boots. The optimal frequency of change shall be determined empirically and will vary individually, depending on the type of shoe worn and how much the individual's feet sweat.

  - If workers' extremities, ears, toes, and noses, cannot be protected sufficiently by handwear, footwear, and face masks to prevent sensation of excessive cold or frostbite, the protective items shall be supplied in auxiliary heated versions.

  - If the available clothing does not give adequate protection to prevent hypothermia or frostbite, work shall be modified or suspended until adequate clothing is made available or until weather conditions improve.

  - Workers handling evaporative liquid (gasoline, alcohol, or cleaning fluids) at air temperatures below 40°F shall take special precautions to avoid soaking of clothing or gloves with the liquids. This is because of the added danger of cold injury due to evaporative cooling. Special note should be taken of the particularly acute effects of splashes of "cryogenic fluids" or those liquids with a boiling point just above ambient temperatures.

6.0 REFERENCES

ACGIH TLV Booklet, 1985-1986.

7.0 ATTACHMENTS

Attachment A - Cooling Power of Wind on Exposed Flesh Expressed as an Equivalent Temperature
Attachment B - Signs of Hypothermia
Attachment C - Work/Warm-up Schedule for 4-Hour Shift

ATTACHMENT A
TABLE 1

COOLING POWER OF WIND ON EXPOSED FLESH EXPRESSED AS AN EQUIVALENT TEMPERATURE (UNDER CALM CONDITIONS)*

Estimated Wind Speed (in mph)	Actual Temperature Reading (°F)											
	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
	Equivalent Chill Temperature (°F)											
calm	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
5	48	37	27	16	6	-5	-15	-26	-36	-47	-57	-68
10	40	28	16	4	-9	-24	-33	-46	-58	-70	-83	-95
15	36	22	9	-5	-18	-32	-45	-58	-72	-85	-99	-112
20	32	18	4	-10	-25	-39	-53	-67	-82	-96	-110	-121
25	30	16	0	-15	-29	-44	-59	-74	-88	-104	-118	-133
30	28	13	-2	-18	-33	-48	-63	-79	-94	-109	-125	-140
35	27	11	-4	-20	-35	-51	-67	-82	-98	-113	-129	-145
40	26	10	-6	-21	-37	-53	-69	-85	-100	-116	-132	-148
(Wind speeds greater than 40 mph have little additional effect.)	**LITTLE DANGER** In < hr with dry skin. Maximum danger of false sense of security.				**INCREASING DANGER** Danger from freezing of exposed flesh within one minute.				**GREAT DANGER** Flesh may freeze within 30 seconds.			
Trenchfoot and immersion foot may occur at any point on this chart.												

*Developed by U. S. Army Research Institute of Environmental Medicine, Natick, MA.

ATTACHMENT B
SIGNS OF HYPOTHERMIA

Core Temperature		Clinical Signs
°C	°F	
37.6	99.6	"Normal" rectal temperature.
37	98.6	"Normal" oral temperature.
36	96.8	Metabolic rate increases in an attempt to compensate for heat loss.
35	95.0	Maximum shivering.
34	93.2	Victim conscious and responsive, with normal blood pressure.
33	91.4	Severe hypothermia below this temperature.
32 31	89.4 87.8	Consciousness clouded, blood pressure becomes difficult to obtain but reacts to light; shivering ceases.
30 29	86.0 84.2	Progressive loss of consciousness; muscular rigidity increases; pulse and blood pressure difficult to obtain; respiratory rate decreases.
28	82.4	Ventricular fibrillation possible with myocardial irritability.
27	80.6	Voluntary motion ceases; pupils nonreactive to light; deep tendon and superficial reflexes absent.
26	78.8	Victim seldom conscious.
25	77.0	Ventricular fibrillation may occur spontaneously.
24	75.2	Pulmonary edema.
22 21	71.6 69.8	Maximum risk of ventricular fibrillation.
20	68.0	Cardiac standstill.
18	64.4	Lowest accidental hypothermia victim to recover.
17	62.6	Isoelectric electroencephalogram.
9	48.2	Lowest artificially cooled hypothermia patient to recover.

ATTACHMENT C
TABLE 2
WORK/WARM-UP SCHEDULE FOR 4-HOUR SHIFT*

Air Temp. Sunny Sky °F	No Noticeable Wind		5 mph Wind		10 mph Wind		15 mph Wind		20 mph Wind	
	Max. No. of Period	Work Breaks	Max. No. of Period	Work Breaks	Max. No. of Period	Work Breaks	Max. No. of Period	Work Breaks	Max. No. of Period	Work Breaks
1. -15° to -19°	(Norm Breaks)	1	(Norm. Bre		min.	2	55 min.	3	40 min.	4
2. -20° to -24°	(Norm Breaks)	1	75 min.	2	55 min.	3	40 min.	4	30 min.	5
3. -25° to -29°	75 min.	2	55 min.	3	40 min.	4	30 min.	5	Nonemergency work should cease.	
4. -30° to -34°	55 min.	3	40 min.	4	30 min.	5	Nonemergency work should cease.			
5. -35° to -39°	40 min.	4	30 min.	5	Nonemergency work should cease.					
6. -40° to -44°	30 min.	5	Nonemergency work should cease							
7. -45° & below	Nonemergency work should cease.									

Notes:

1. Schedule applies to moderate to heavy work activity with warm up breaks of 10 minutes in a warm location. For light-to-moderate work (limited physical movement): apply the schedule one step lower. For example, at -30°F with no noticeable wind (Step 4), a worker at a job with little physical movement should have a maximum work period of 40 minutes with four breaks in a 4 hour period (Step 5)

2. The following is suggested as a guide for estimating wind velocity If accurate information is not available -- 5 mph: light flag moves; 10 mph: light flag fully extended; 15 mph: raises newspaper sheet; 20 mph: blowing and drifting snow.

*From Occupational Health & Safety Division, Saskatchewan Department of Labor

ATTACHMENT A

SITE HEALTH AND SAFETY FOLLOW-UP REPORT

SITE HEALTH AND SAFETY FOLLOW-UP REPORT

Appendix A must be filled out and returned to the Site Health and Safety Officer after the conclusion of each site visit.

Person responsible for follow-up report: _____

Actual date(s) of work: _____

1. **Actual Project Team:**

Halliburton NUS Personnel:	Discipline/Tasks:

Non-Halliburton NUS Personnel/Affiliation:	Discipline/Tasks:

2. **Personal Protective Equipment Used:**

• Level of Respiratory Protection Used	Activity

• Field Dress	Activity

3. General Safety

Were any health or safety problems encountered while on site?

Explain: _____

4. Incident Report Information

Did any team member report:	Yes	No
• Chemical exposure	_____	_____
• Illness, discomfort, or unusual symptoms	_____	_____
• Environmental problems (heat, cold, etc.)	_____	_____
• Injury	_____	_____

Explain: _____

_____

_____

_____

_____

_____

_____

_____

_____

Was an Employee Incident Report Completed? _____ Yes _____ No

5. Evaluation of Site Health and Safety Plan

Was the Health and Safety Plan adequate? _____ Yes _____ No

What changes would you recommend?

_____

_____

_____

_____

_____

FIRST AID SUPPLIES USAGE FORM

Project Number	Date	Item(s) Used	Kit Number

Please submit this information as soon as possible to the Halliburton NUS/Equipment Manager for first-aid supply replenishment. Telephone number: (412) 921-7281.

SCBA LOG

Site: _____

Location: _____

Dates of Investigation: _____

User	Date of Use	SCBA Number	Satisfactory Check-Out (Yes/No - Initials)	Date Cleaned

SCBA Performance Comments:

_____ Site Manager

_____ Date

Return to HSO at Completion of Activity

AIR-PURIFYING RESPIRATOR LOG

Type of Respirator: _____

Site: _____

Location: _____

Dates of Investigation: _____

User	Date of Use	Cleaned and Inspected Prior to Use (Initials)	Cartridges Changed Prior to Use (Yes/No)	Total Hours on Cartridge

_____ _____

Site Manager Date

Return to HSO at Completion of Activity

INCIDENT REPORT

Report No. _____

Site: _____ Project No. _____

Location: _____

Date of Report: _____ Preparer's Name: _____

Name and Address of Injured: _____ SSN: _____ Age: _____

_____ Sex: _____

Years of Service: _____ Time of Present Job: _____ Title/Classification: _____

Division/Department: _____ Date of Incident: _____ Time: _____

Incident Category: _____ Motor Vehicle _____ Property Damage _____ Fire

_____ Chemical Exposure _____ Near-Miss _____ Other

Severity of Injury or Illness: _____ Nondisabling _____ Disabling

_____ Medical Treatment _____ Fatality

Amount of Damage: $ _____ Property Damage: _____

Estimated Number of Days Away from Job: _____

Nature of Injury or Illness: _____

1. **Classification of Injury**

_____ Fractures
_____ Dislocations
_____ Sprains
_____ Abrasions
_____ Lacerations
_____ Punctures
_____ Bites
_____ Respiratory Allergy

_____ Heat Burns
_____ Chemical Burns
_____ Radiation Burns
_____ Bruises
_____ Blisters
_____ Respiratory Exposure
_____ Ingestion
_____ Dermal Allergy

_____ Cold Exposure
_____ Frostbite
_____ Heat Stroke
_____ Heat Exhaustion
_____ Concussion
_____ Faint/Dizziness

Part of Body Affected: _____

Degree of Disability: _____

Date Medical Care Was Received: _____

Where Medical Care Was Received: _____

Address (if off site): _____

2. Incident Location

Causative agent most directly related to accident (object, substance, material, machinery, equipment, conditions): _____

_____

_____

_____

Was weather a factor? _____

Unsafe mechanical/physical/environmental condition at time of accident (Be specific):

_____

_____

_____

Unsafe act by injured and/or others contributing to the accident (Be specific, must be answered):

_____

_____

_____

Personal factors (improper attitude, lack of knowledge or skill, slow reaction, fatigue):

_____

_____

_____

Level of personal protection equipment required in Site Safety Plan:

_____

_____

_____

Modifications: _____

_____

_____

Was injured using required equipment? _____

_____

_____

If not, how did actual equipment use differ from plan? _____

_____

_____

What can be done to prevent a recurrence of this type of accident (modification of machine; mechanical guards; correct environment; training)?

_____

_____

_____

Detailed narrative description (how did accident occur, why; objects, equipment tools used, circumstances, assigned duties). Be specific:

_____

_____

_____

(Use back of sheet, as required)

Witnesses to accident: _____

_____

_____

Signature of Preparer _____

Signature of Site Manager _____

3. **Department Appraisal and Recommendation**

In your opinion, what actions or equipment contributed to this accident?

_____

_____

_____

Your recommendation:

_____

_____

_____

Date: _____ Signature of Department Manager _____

4. Costs of the Incident (to be Completed by Health Sciences Department)

Temporary total _____

Death or permanent total _____

Started losing time _____

Returned to work _____

Time charge _____

Permanent partial _____

Part of body _____

Percent loss or loss of use _____

Time charge _____

Compensation $ _____

Other $ _____

Medical $ _____

Total $ _____

Name and Address of Hospital _____

_____

Name and Address of Physician _____

_____

cc: Office Health and Safety Supervisor
Office Manager
Manager of Health Sciences
Medical Consultant

INCIDENT FOLLOW-UP REPORT

(To be Completed by Health Sciences Department)

Date of Incident: _____

Name: _____ Employee No. _____

Site: _____

Brief description of incident: _____

_____

_____

_____

_____

_____

_____

Outcome of incident: _____

_____

_____

_____

_____

_____

_____

Physician's recommendations: _____

_____

_____

_____

_____

_____

Date returned to work: _____

ATTACH ANY ADDITIONAL INFORMATION TO THIS FORM

cc: Office Health and Safety Supervisor
Office Manager
Manager of Health Sciences
Medical Consultant

ATTACHMENT B

OSHA POSTER

JOB SAFETY & HEALTH PROTECTION

The Occupational Safety and Health Act of 1970 provides job safety and health protection for workers by promoting safe and healthful working conditions throughout the Nation. Requirements of the Act include the following:

Employers

All employers must furnish to employees employment and a place of employment free from recognized hazards that are causing or are likely to cause death or serious harm to employees. Employers must comply with occupational safety and health standards issued under the Act.

Employees

Employees must comply with all occupational safety and health standards, rules, regulations and orders issued under the Act that apply to their own actions and conduct on the job.

The Occupational Safety and Health Administration (OSHA) of the U.S. Department of Labor has the primary responsibility for administering the Act. OSHA issues occupational safety and health standards, and its Compliance Safety and Health Officers conduct jobsite inspections to help ensure compliance with the Act.

Inspection

The Act requires that a representative of the employer and a representative authorized by the employees be given an opportunity to accompany the OSHA inspector for the purpose of aiding the inspection.

Where there is no authorized employee representative, the OSHA Compliance Officer must consult with a reasonable number of employees concerning safety and health conditions in the workplace.

Complaint

Employees or their representatives have the right to file a complaint with the nearest OSHA office requesting an inspection if they believe unsafe or unhealthful conditions exist in their workplace. OSHA will withhold, on request, names of employees complaining.

The Act provides that employees may not be discharged or discriminated against in any way for filing safety and health complaints or for otherwise exercising their rights under the Act.

Employees who believe they have been discriminated against may file a complaint with their nearest OSHA office within 30 days of the alleged discrimination.

Citation

If upon inspection OSHA believes an employer has violated the Act, a citation alleging such violations will be issued to the employer. Each citation will specify a time period within which the alleged violation must be corrected.

The OSHA citation must be prominently displayed at or near the place of alleged violation for three days, or until it is corrected, whichever is later, to warn employees of dangers that may exist there.

Proposed Penalty

The Act provides for mandatory penalties against employers of up to $1,000 for each serious violation and for optional penalties of up to $1,000 for each nonserious violation. Penalties of up to $1,000 per day may be proposed for failure to correct violations within the proposed time period. Also, any employer who willfully or repeatedly violates the Act may be assessed penalties of up to $10,000 for each such violation.

Criminal penalties are also provided for in the Act. Any willful violation resulting in death of an employee, upon conviction, is punishable by a fine of not more than $10,000, or by imprisonment for not more than six months, or by both. Conviction of an employer after a first conviction doubles these maximum penalties.

Voluntary Activity

While providing penalties for violations, the Act also encourages efforts by labor and management, before an OSHA inspection, to reduce workplace hazards voluntarily and to develop and improve safety and health programs in all workplaces and industries. OSHA's Voluntary Protection Programs recognize outstanding efforts of this nature.

Such voluntary action should initially focus on the identification and elimination of hazards that could cause death, injury, or illness to employees and supervisors. There are many public and private organizations that can provide information and assistance in this effort, if requested. Also, your local OSHA office can provide considerable help and advice on solving safety and health problems or can refer you to other sources for help such as training.

Consultation

Free consultative assistance, without citation or penalty, is available to employers, on request, through OSHA supported programs in most State departments of labor or health.

More Information

Additional information and copies of the Act, specific OSHA safety and health standards, and other applicable regulations may be obtained from your employer or from the nearest OSHA Regional Office in the following locations:

Atlanta, Georgia
Boston, Massachusetts
Chicago, Illinois
Dallas, Texas
Denver, Colorado
Kansas City, Missouri
New York, New York
Philadelphia, Pennsylvania
San Francisco, California
Seattle, Washington

Telephone numbers for these offices, and additional area office locations, are listed in the telephone directory under the United States Department of Labor in the United States Government listing.

Washington, D.C.
1988 (Revised)
OSHA 2203

Ann McLaughlin, Secretary of Labor

U.S. Department of Labor

Occupational Safety and Health Administration

Under provisions of Title 29, Code of Federal Regulations, Part 1903.2(a)(1) employers must post this notice (or a facsimile) in a conspicuous place where notices to employees are customarily posted.

GPO : 1988 O - 219-447

ATTACHMENT C

MEDICAL DATA SHEET

MEDICAL DATA SHEET AND FIELD TEAM REVIEW

This brief Medical Data Sheet will be completed by all onsite personnel and will be kept in the command post during the conduct of site operations. This data sheet will accompany any personnel when medical assistance is needed or if transport to hospital facilities is required.

Project _____

Name _____ Home Telephone _____

Address _____

Age _____ Height _____ Weight _____

Name of Next of Kin _____

Drug or other Allergies _____

Particular Sensitivities _____

Do You Wear Contacts? _____

Provide a Checklist of Previous Illnesses or Exposure to Hazardous Chemicals. _____

_____

_____

_____

What medications are you presently using? _____

_____

_____

Do you have any medical restrictions? _____

_____

_____

Name, Address, and Phone Number of Personal Physician: _____

_____

_____

_____

_____

I am the individual described above. I have read and understand this HASP.

_____ _____

Signature Date

APPENDIX C

SITE-SPECIFIC HEALTH AND SAFETY PLAN (HASP)