PHASE 2

STUDY DESIGN/PROTOCOL

Based on an understanding of the project objectives, KTA/SET Environmental (KTA/SET) has developed a study protocol for the Phase 2 "field" portion of the project. The protocol is based on the stated research objectives, the pilot industrial hygiene study conducted by NIOSH and KTA/SET during February 1996, the Phase 1 "laboratory" study, and KTA/SET experience in conducting abrasive blast cleaning studies.

The project requires stringent controls over many variables. Exhaustive quality assurance/control measures will be maintained throughout this phase in order to obtain valid meaningful data. Because of these requirements, the study will be under the direct supervision of Daniel P. Adley, a Certified Industrial Hygienist (CIH). The principal investigator will be Kenneth A. Trimber.

Protection of human operators will be a top priority. Operators will be provided with proper training and personal protective equipment to ensure their safety and health. Implementation of project specific training on the hazards associated with the various abrasive blast cleaning media, use of properly maintained ventilation systems during the field phase, observation of work practices including personal hygiene, and adequate respiratory protection (Bullard Series 88 Type CE supplied air respirator with an assigned protection factor of 1,000) will help ensure the safety of human operators. This protection will be complimented by a medical surveillance program designed to assess worker health status prior to and following Phase 2 of the project.

PHASE 2 (FIELD STUDY) PROTOCOL

1. Blast Cleaning Facilities

1.1. KTA/SET will use a customized containment and ventilation system to conduct Phase 2 of the study. The containment will be appropriately sized to recreate (as feasible) the KTA 12' x 8' x 8' walk-in blast room used for the Phase 1 work. Once the field site is selected, a KTA/SET containment/ventilation design engineer will conduct a site visit and subsequently design a containment and ventilation system. The containment system will be constructed by KTA/SET personnel, based on drawings submitted to and approved by NIOSH.

1.2. The blast cleaning equipment will include a production Clemco six cubic foot gravity feed abrasive hopper equipped with an abrasive metering valve and a 15 foot length of reinforced air/abrasive hose. A new section of hose will be assembled prior to the initiation of Phase 2. The hose will be flushed, washed, and dried inside and out prior to use with each new abrasive. A Boride brand No. 7 (7/16" orifice) nozzle will be used for the field study. The nozzle orifice size will be monitored throughout Phase 2 using a Clemco nozzle orifice gage. The nozzle will be replaced if the orifice diameter increases

by one size (to 8/16" or when uneven wear is observed). The metering valve setting will vary, depending upon each abrasive media. The metering valve setting will be established by the operator prior to each abrasive trial. This procedure will be conducted on the day prior to the actual blast trial using a small quantity of abrasive. All IH monitoring samples and post blast abrasive media samples will be obtained prior to establishing the metering valve setting for the following day's trial.

1.3. The volume of air supply (cubic feet per minute) will be maintained throughout the project by employing a 375 CFM air compressor. The air supply will be examined for oil and water contamination in accordance with ASTM D4285 (blotter test) prior to each abrasive study.

1.4. The blast operator will be equipped with a Bullard Series 88 Type CE supplied air respirator (blast helmet), which has an assigned protection factor (APF) of 1,000. The breathing air will be filtered through an Industrial Scientific Model PL-100 3 stage breathing air purification unit, which also monitors for carbon monoxide.

1.5. Blast cleaning air pressure will be maintained at 90-100 psi at the blast nozzle and will be held constant for each abrasive. Actual blast cleaning air pressure will be measured using a hypodermic needle pressure gage and the results documented for each abrasive.

1.6. Phase 2 of the blast cleaning study will be performed on the side of a barge which is in temporary dry dock. The surface will be homogeneous, so that the results of the study for each abrasive are comparable. The actual surfaces to be prepared are subject to approval by NIOSH prior to project initiation. An area of approximately 70 square feet will be demarcated for each abrasive material. Upon completion of blast cleaning, the containment will be thoroughly cleaned, then moved to a new section of the barge side wall and prepared for the next abrasive material.

1.7. The nozzle-to-work piece distance will be held at a consistent distance (18 inches) throughout the study. A ¼" diameter rod will be mounted on the blast nozzle and so configured to touch the surface without affecting the abrasive/air pathway. The operator will use this rod to maintain the nozzle-to-substrate distance. The operator will be instructed to keep the nozzle perpendicular to the substrate, producing the greatest amount of abrasive ricochet, simulating a worst-case airborne dust condition.

1.8. The containment will be ventilated throughout the study. Cross draft ventilation will be used. Target air flow will be 50 to 75 feet per minute (fpm) for each abrasive trial. Actual cross-sectional air flow will be measured and recorded prior to each abrasive trial using a rotating vane anemometer.

1.9. Environmental conditions within the containment will be recorded prior to each abrasive trial. Environmental conditions will be assessed using a 24-hour recording hygrometer (probe stationed inside the containment), and a digital thermocouple-equipped surface temperature thermometer. Barometric pressure will also be recorded.

1.10. A Lunardini abrasive media vacuuming system will be used to collect the abrasive debris and to vacuum all containment surfaces after each abrasive trial.

2. Abrasive Media

2.1 The generic types of abrasives and number of each to be studied are as follows:

Abrasive Type	No. of Abrasives
01 Silica Sand	1
02 Silica Sand w/Dust Suppressant	1
03 Coal Slag	1
04 Copper Slag	1
05 Nickel Slag	1
06 Garnet	1
07 Staurolite	1
08 Steel Grit	1

3. Substrate Material

3.1 The substrate material for Phase 2 will be comprised of the side of a barge in temporary dry dock. The surfaces for blast cleaning will be steel, with corrosion products present. Attempts will be made to locate eight (8) areas which are similar in appearance and condition. The existing substrate conditions will be documented and photographed. SSPC Visual Standard No. 1 (VIS 1-89) will be employed as appropriate.

4. Health Screenings and Training of Human Subjects (Blast Operators)

4.1 Prior to initiating the blast cleaning portion of the Phase 2 study, human subjects will receive the following health screening. Items 4.1.2, 4.1.3 and 4.1.5 will be reassessed after the Phase 2 work is completed.

4.1.1 Pulmonary Function Test (if not current)

4.1.2 Blood Test for Lead, Zinc Protoporphryn (ZPP), and cadmium

4.1.3 Urinalysis for Cadmium

4.1.4 Qualitative Respirator Fit Testing (if not current)

4.1.5 Blood chemistry profiles and complete blood count with differential.

4.2 Prior to initiating the field study, human subjects will receive training in the following areas:

4.2.1 Health Hazards of Lead, Chromium, Cadmium, Arsenic, Beryllium, Iron Oxide, and Silica

4.2.2 Proper Use of Respirators

4.2.3 Hygiene Practices

4.2.4 Review of Project Testing Protocol – Roles/Responsibilities

5. Protocol for Abrasive Trials

5.1. Assessment of Containment Conditions

5.1.1. Environmental conditions within the containment will be assessed prior to each abrasive evaluation. The conditions that will be monitored include air temperature, relative humidity, dew point, surface temperature, and barometric pressure. Data will be acquired using a thermocouple equipped digital surface temperature thermometer, a barometer, and a 24-hour recording hygrometer (remote probe stationed inside the containment).

5.1.2. The containment will be ventilated throughout the study. Cross draft ventilation will be used. A cross-sectional assessment of air flow will be conducted and documented prior to abrasive evaluations using an Alnor Rotating Vane Anemometer. Target ventilation will be 50 to 75 feet per minute.

5.2. Testing Protocol for Each Abrasive Media

5.2.1. Upon receipt of each abrasive shipment, the manufacturer, supplier, trade name, size and grade will be recorded in a log book. Each abrasive media will be assigned a unique number representing the KTA/SET project number, phase number, and abrasive number (e.g., J97119-P2-01).

5.2.2. An area approximately 14 feet long by 5 feet high (~70 square feet) will be demarcated for each abrasive.

5.2.3. A one hundred pound sample of abrasive, as received, will be riffled to ensure homogeneity, then a one-pound sample will be collected from the homogenous mix for submittal to NIOSH for analysis.

5.2.4. A second 100 gram sample will be collected from the riffled quantity and a sieve analysis conducted in accordance with ASTM C 136 “Standard Test method for Sieve or Screen Analysis of Fine and Coarse Aggregates”.

5.2.4.1 The grit will be tamped and shaken through a series of sieves (screen numbers 10, 12, 16, 20, 30, 40, 50, 60, 70, 100, 140, 200, 270 and a pan at the bottom) for seven minutes using an automated shaker. The abrasive collected on each screen will be emptied into numbered and tared sample cups. The underside of each screen will be cleaned with a brass brush to loosen trapped particles, which will also be collected into the appropriate sample cups. The contents of each sample cup will be weighed and documented.

5.2.5. The abrasive media will be loaded into a 6 cubic foot Clemco abrasive hopper equipped with a specialized metering valve. A sufficient quantity of media will be loaded to attain a continuous 30 - 45 minute blast sequence or to clean the available square footage, whichever occurs first.

5.2.6. The air pressure utilization (in psi) at the nozzle will be maintained at 90-100 psi and will be measured and recorded using a hypodermic needle pressure gage prior to each abrasive trial.

5.2.7. Prior to initiating blast cleaning operations, operator and area sampling pumps will be calibrated and the filter media loaded onto the sample holders, or onto the operator (as required). See Industrial Hygiene Protocol (Section 6.0).

5.2.8. The operator will continuously blast clean the designated area , until the abrasive supply is exhausted.

5.2.9. Upon completion of the sampling durations described in Section 6.0, the operator and area sampling pumps will be turned off and the time of day recorded. The sampling media will be removed from the operator and containment when the blast cleaning is completed, and immediately sealed to prevent contamination.

5.2.10. The quantity of time required to blast clean the designated area will be recorded. The actual square footage cleaned will be measured and recorded, along with the total elapsed time.

5.2.11. The area cleaned will be photographed.

5.3. Collection of Blast Cleaning Data

5.3.1. Surfaces will be inspected to verify the required SSPC SP10/NACE No. 2 "Near-White Metal" blast condition has been achieved. SSPC VIS1-89 pictorial standards for assessing surface cleanliness will be used.

5.3.2. Surface profile will be measured in accordance with ASTM D 4417-93 "Standard Test Methods for Field Measurement of Surface Profile of Blast , Method C. X-Coarse Testex replica tape and a spring micrometer will be used. Fourteen (14) measurements will be obtained and documented from the unpitted areas of the structure.

5.3.3. Abrasive embedment will be assessed in 35 random locations using a 10x illuminated magnifier and a 1/2" x 1/2" grid containing 100 squares. The number of squares containing embedded material will be quantified in each of the areas, and a total percentage of embedment calculated and documented.

5.3.4. The abrasive remaining in the blast hose and abrasive hopper (if appropriate) will be collected and weighed to calculate the total consumption rate of the abrasive media (by comparison with original weight used to fill the hopper).

5.3.5. A representative 100 pound sample of the spent abrasive and debris will be collected from the containment floor and riffled (to ensure homogeneity), then a one-pound sample will be collected from the homogenous mix for submittal to NIOSH for analysis.

5.3.6 A 100 gram sample of the riffled spent abrasive and debris will be used for sieve analysis in accordance with ASTM C 136 "Standard Test method for Sieve or Screen Analysis of Fine and Coarse Aggregates". The sample will be tamped and shaken through a series of sieves (screen numbers 10, 12, 16, 20, 30, 40, 50, 60, 70, 100, 140, 200, 270 and a pan at the bottom) for seven minutes using an automated shaker. The material collected on each screen will be emptied into tared, numbered sample cups. The underside of each screen will be cleaned with a brass brush to loosen trapped particles, which will also be collected into the appropriate sample cups. The contents of each sample cup will be weighed and documented.

5.4. Cleaning Procedure Between Abrasive Trials

5.4.1. The abrasive hopper, blast hose and nozzle will be cleaned by exhausting clean, dry compressed air through the system for approximately one minute with the ventilation system in operation. The blast hose will be rinsed with fresh water and dried with compressed air. Two blast hoses will be used and alternated to allow thorough drying prior to use.

5.4.2. The walls, floor, and ceiling of the containment will be thoroughly vacuumed between abrasive media trials. The worker will also decontaminate the blast helmet, coveralls, gloves and boots after each abrasive trial using a vacuum and damp wiping as required. Blasting capes will be alternated and cleaned daily.

5.4.3. An industrial hygiene technician, under the direction of a Certified Industrial Hygienist (CIH), will witness all cleaning procedures and inspect the containment after each cleaning to ensure prevention of sample cross contamination. Additional cleaning with damp cloths will be used, as necessary. The IH Technician will visually verify the cleanliness of all equipment.

5.5. Photographic/Videographic Documentation

5.5.1. 35mm slide photography and 8mm videography will be employed throughout the testing protocol to record typical operations.

6. Industrial Hygiene Monitoring Protocol

5.6. Industrial Hygiene monitoring will be conducted prior to project initiation (background), and during each abrasive trial. Monitoring will entail collection of airborne samples for :

5.6.1. Respirable Crystalline Silica

5.6.2. Respirable Radiochemical Activity

5.6.3. Total Airborne Radiochemical Activity

5.6.4. Total Airborne Elements

5.7. Prior to each abrasive trial, sampling pumps will be calibrated using a Gilian Gilibrator-2 primary calibration precision flow bubble meter equipped with a standard flow cell

(20cc-6 lpm). Calibration will be conducted through the representative filter media. The actual flow rates for each pump will be documented on the pump calibration report (attached).

5.8. Verification of flow rates will be conducted upon completion of each abrasive trial. Post trial pump flow rates will be measured and documented on the pump flow verification form (attached).

5.9. Filter media will be positioned in sample holders in four locations within the containment, and include :

5.9.1. Make-up Air Side of Containment (fixed location)

5.9.2. Operator Area (fixed location)

5.9.3. Exhaust (ventilation) Area of Containment (fixed location)

5.9.4. On the operator, within the breathing zone

5.10. Sample bank holders will be mounted 12" from the containment side walls (make-up, operator area and exhaust), at breathing zone height (5-6'). Samples will have a 6" clearance from each other.

5.11. Filter media positioned in the operator's breathing zone will be mounted in a hemisphere 6-9" from the nose/mouth, forward of the shoulders in a downward direction, outside of respiratory protection.

5.12. Sampling for Respirable Dust and Respirable Crystalline Silica

5.12.1. Respirable crystalline silica samples will be collected in each of the three areas in the containment and within the breathing zone of the operator using MSA 10mm nylon cyclones equipped with 37mm, 0.5 micron pore pre-weighed PVC filter media, at a flow rate of 1.7 liters per minute. Sampling for crystalline silica will commence after three minutes of blast time has elapsed, to facilitate equilibrium within the containment. Twenty four (24) minute samples will be obtained.

5.12.2. Samples will be analyzed for respirable dust and silica. Analysis for respirable crystalline silica will be conducted in accordance with NIOSH method 7500 (x-ray diffraction); analysis for respirable dust will be conducted by NIOSH laboratories in accordance with NIOSH Method 0600.

5.13. Sampling for Respirable Radiochemical Activity

5.13.1. Respirable radiochemical activity samples will be collected in each of three areas in the containment using MSA 10mm nylon cyclones equipped with 37mm, 0.5 micron pore pre-weighed PVC filter media, at a flow rate of 1.7 liters per minute.

5.13.2. Sampling for respirable radiochemical activity will commence after three minutes of blast time has elapsed, to facilitate equilibrium within the containment. Twenty four (24) minute samples will be obtained.

5.13.3. Analysis for respirable radiochemical activity will be conducted by NIOSH laboratories.

5.14. Sampling for Total Radiochemical Activity

5.14.1. Total radiochemical activity samples will be collected in each of three areas in the containment using pre-weighed 37mm, 0.5 micron pore PVC filter media at a flow rate of 4.0 liters per minute.

5.14.2. Sampling for total radiochemical activity will commence after 3 minutes of blast time has elapsed, to facilitate equilibrium within the containment. Twenty-four (24) minute samples will be obtained.

5.14.3. Analysis for total radiochemical activity will be conducted by NIOSH laboratories.

5.15. Sampling for Elements

5.15.1. Elemental samples will be collected in each of the three areas in the blast room and within the breathing zone of the operator using sampling pumps equipped with 37mm, 0.8 micron pore mixed cellulose ester membrane filter media. Sampling will be conducted at a flow rate of 2.0 liters per minute.

5.15.2. Sampling for elements will commence after three minutes of blast time has elapsed, to facilitate equilibrium within the containment. Twenty-four (24) minute samples will be collected.

5.15.3. Analysis for elements will be conducted by NIOSH laboratories in accordance with NIOSH Method 7300.

5.16. Background Monitoring

5.16.1. Prior to initiating Phase 2, background monitoring will be conducted for seven (7) hours. Airborne samples for respirable dust, respirable crystalline silica, respirable radiochemical activity, total radio-chemical activity and elements will be collected in each of three areas within the containment, with the ventilation system in operation. The air flow (in fpm) will be measured and documented for the background study. Flow rates will be similar to those targeted during actual blast cleaning operations.

7. Report Format

7.1 Upon completion of all testing procedures and receipt of analytical data from the NIOSH laboratory, a written report will be prepared. The report will be formatted as follows:

7.1.1 Introduction

7.1.2 Executive Summary

7.1.3 Description of Abrasive Media Test Procedures

7.1.4 Description of Industrial Hygiene Monitoring Procedures

7.1.5 Results of Abrasive Media Testing

7.1.6 Results of Industrial Hygiene Analysis

7.1.7 Calculation of Operating Costs based on Economical Factors

7.1.8 Statistical Analysis of Operator and Area Exposure Monitoring Data

7.1.9 Quality Assurance/Quality Control Procedures Implemented to Ensure Validity of Testing

7.1.10 Testing Errors, Deficiencies or Deviations Encountered

7.1.11 Conclusions and Recommendations

7.1.12 Photographic Documentation