CHAPTER 3
SAMPLING PROCEDURES

1. **DEFINITIONS.**

a. 8-hour Time-Weighted Average (TWA)/8-hour TWA-OEL. The TWA concentration for a normal 8-hour workday and a 40-hour workweek, which cannot be exceeded. It is accepted to be a concentration to which nearly all workers may be repeatedly exposed, day after day, without adverse effects. The average level of a stressor over a specified time period, weighted for the length of time at each measured level. The measurement is usually a concentration of a chemical contaminant or a level of a physical agent (e.g., noise). The duration of the TWA must be specified. The most common industrial hygiene TWA duration is 8 hours, which is the length of the most common workday. A TWA may be determined by a single sample (i.e., the averaging is done by the sampling device throughout the sampled period) or by mathematical combination of one or more consecutive samples.

b. Action Level (AL). One-half the 8-hour TWA value designated as the OEL unless a specific AL is established in an Occupational Safety and Health Administration (OSHA) Permissible Exposure Limit (PEL) adopted by the Navy (e.g., 60% of the OSHA standard for inorganic lead). The AL may initiate the implementation of specific actions, such as periodic monitoring, training or medical surveillance if specified by a Navy safety and occupational health (SOH) or OSHA standard.

The necessity for an employee exposure AL is based on variations in the occupational environment (i.e., variations in the employee's daily exposures). As such, the employer should attempt to prove with 95% certainty that no employee's true daily average exposure (i.e., 8-hour TWA) exceeds the standard. (References 3-1 and 3-2).

c. Ceiling (C)-OEL. A contaminant concentration that should not be exceeded during any part of the working exposure. If instantaneous monitoring is not feasible, samples are collected and assessed as a 15-minute TWA exposure, except for those substances that may cause immediate irritation when exposures are short. (Reference 3-3).

d. Excursion Limit (EL)-OEL. Only one stressor, asbestos, currently has an EL. The EL for asbestos was set as a TWA over a 30-minute period, distinguishing it from a Short-Term Exposure Limit (STEL), which has a shorter averaging period. For substances that have an 8-hour TWA-OEL but no short term exposure limits, excursions in worker exposure levels may exceed 3 times the 8-hour TWA-OEL for no more than a total of 30 minutes during a work day, and under no circumstances should exceed 5 times the 8-hour TWA-OEL, provided the 8-hour TWA does not exceed the 8-hour TWA-OEL. (Reference 3-3).

e. Occupational Exposure Limit (OEL). Limits established to protect workers from workplace exposure to certain chemical substances or physical agents. An exposure assessment cannot be made without an OEL. Navy OELs for chemical contaminants include:

(1) Current OSHA PELs, i.e. regulatory standards contained in 29 CFR 1910.1000 Z Tables.

(2) Non-Governmental Chemical and Particulate Exposure Standards. It is recognized that OSHA PELs may be less protective than exposure standards that reflect more recent medical evidence and promulgated by reputable organizations devoted to occupational health. Industrial hygienists are ethically bound to evaluate all recognized occupational health risks and provide professional recommendations to minimize or eliminate those risks cost effectively. As part of the Navy's overall desire to manage risk, industrial hygienists may recommend more stringent exposures standards than OSHA PELs contained in 29 CFR 1910.1000, Z Tables. The primary sources for these exposure standards are:

(a) Current edition of the American Conference of Governmental Industrial Hygienists Threshold Limit Values® and Biologic Exposure Indices®

(b) Exposure standards developed by the American Industrial Hygiene Association

(3) Other standards as approved by the Navy Bureau of Medicine and Surgery and published in the Navy Industrial Hygiene Field Operations Manual.

For further guidance on the appropriate applications of OEL, IHPO should contact their respective regional command or Navy and Marine Corps Public Health Center for assistance.

f. Permissible Exposure Limit (PEL). A legally enforceable (in the U.S.) occupational exposure standard established by federal OSHA or by a state-run program accepted by OSHA. Most PELs are time-weighted average concentrations for a normal 8-hour workday and a 40-hour work week, which shall not be exceeded. However, PELs may also be "Ceiling" values or "Excursion Limits." PELs are accepted to be a concentration to which nearly all workers may be repeatedly exposed, day after day, over a working lifetime without adverse effects.

g. Short-Term Exposure Limit (STEL)-OEL. A 15-minute TWA exposure that should not be exceeded at any time during the workday. The STEL is often associated with an 8-hour TWA-OEL in cases where there are recognized acute effects from a substance whose toxic effects are primarily chronic. The STEL may also be a separate independent OEL. Exposures above the 8-hour TWA-OEL up to the STEL should not be longer than 15 minutes and should not occur more than four times per day. In addition, there should be at least 60 minutes between successive exposures in this range. (Reference 3-3).

2. **PURPOSE OF SAMPLING.** Sampling is conducted to quantify occupational exposures to workplace stressors. In most cases, when a qualitative positive determination is made, sampling is necessary to determine the extent of the exposure, adequacy of control methods in use, or additional controls required to eliminate or minimize the hazard. The exposure monitoring plan should be developed and implemented for those operations/processes needing further evaluation and those stressors for which periodic sampling is required by regulation or directive.

3. **TYPES OF AIR SAMPLES.** The following are the two major types of air samples used to determine the airborne concentration of contaminants:

a. Personal Samples. For stressors having OELs, for which a decision to sample has been made, personal exposure is determined by collecting breathing zone (BZ) samples. In rare instances, breathing zone sampling may not be feasible due to the lack of a personal

sampling method or other considerations of the workplace environment. To obtain the sample, air is collected from within the breathing zone of the employee, a hemisphere forward of the shoulders and centered at the nose, with a radius of approximately 6 to 9 inches. Breathing zone samples may be collected in the following two ways:

(1) The sampling device is attached to the employee and worn continuously during the work shift or operation. This is the preferred method.

(2) The sampling device is held by a second individual within the breathing zone of the employee. For example, the industrial hygienist may use a detector tube hand pump or direct reading instrument to collect one or a series of samples from within the breathing zone of the employee.

NOTE: For stressors where there is no acceptable level of exposure, such as those regulated under 29 CFR 1910.1003, 1910.1004 and 1910.1006 through 1910.1016, personal sampling may not be necessary to document personnel exposures. These standards rely on work practice requirements and appropriate feasible control technology to eliminate exposures.

b. General Area (GA) Samples. The sampling equipment is placed in a fixed location in the work area. General area samples are not be used to evaluate employee exposure. They may be used to determine whether re-entry is warranted into a contaminated area, if there is potential contamination of adjacent work areas, or to verify the integrity of a negative pressure enclosure during asbestos ripout operations. They may not be used for OEL compliance determinations except in the rare instances where no feasible personal sampling method exists.

4. **SAMPLE DURATION.** Sample duration may vary from a few seconds to 8 hours or more. The time period for sample collection depends on a variety of factors including: the sampling and analytical method, the expected concentration of the contaminant being measured, the type of OEL to which the sample will be compared, the number of consecutive samples to be collected on a single employee during a single work shift, and whether the work shift is longer than 8 hours. Consider the following factors in determining the appropriate sample duration.

a. Sampling Method. The sampling method is one factor in determining the duration of each sample. A single grab sample collected with short-term detector tubes is collected over a period of seconds to minutes. Low flow and high flow sampling pumps, combined with filter, impingers, and/or solid sorbent media, are used to collect longer duration samples generally 15 minutes to 8 hours. Direct reading instruments provide almost instantaneous or real-time results.

b. Contaminant Concentration and Analytical Method. The concentration of a contaminant in the sampled air has a large effect on the sample duration. All other things being equal, the higher the concentration the shorter the duration of a single sample and vice versa. Minimum sampling times aim to collect enough mass of contaminant to be above the analytical method's reliable limit of quantification (LOQ). Maximum sampling times aim not to collect too much mass of contaminant to avoid sorbent breakthrough or filter overloading. For example, charcoal tubes may need to be changed frequently to prevent breakthrough. The breakthrough time of a charcoal tube is a function of the air

concentration of the contaminant being sampled, the sample flow rate, and the humidity of the environment being sampled. Breakthrough time is also a function of the type, amount, size and packing configuration of the charcoal in the tube and competition for sorbent sites by other contaminants present in the air. Similar limits on sampling time apply to filters and impingers to prevent overloading. Judgment should be exercised in changing sampling media of any type often enough to sample a sufficient volume of air to quantify the sample without the occurrence of breakthrough.

c. Type of OEL to which the Sampling Results will be Compared. Samples collected for as close as possible to 100% of the time period for which the OEL is defined provide the best estimate of the time-weighted average employee exposure. Each type of OEL imposes different sample duration requirements as follows:

(1) Ceiling (C). Samples collected to determine compliance with ceiling limits are usually taken as a series of 15-minute samples during periods of maximum expected exposures. An exception would be if a real-time instrument (e.g., a data logging dosimeter) were available to provide instantaneous and continuous measurements. According to Reference 3-2, samples taken for comparison with ceiling limit OELs are best taken in a non-random fashion, during periods of maximum expected concentrations. A minimum of three measurements should be taken during each work shift sampled. The highest of all the measurement results is the best estimate of the employee's upper exposure for that shift.

(2) Short-Term Exposure Limit (STEL). STEL samples should be taken over a 15 minute period. STEL samples should also be taken in a non-random fashion during periods of maximum expected concentration.

(3) 8-hour Time Weighted Average (TWA). Evaluate the potential for employee overexposure through observation and, if appropriate, collection of screening samples before any partial- or full-shift air sampling is conducted.

(a) Full-shift samples should be taken to evaluate TWA exposures whenever possible. However, due to the realities of field sampling (e.g., time lost due to placing and removing multiple sampling devices at the beginning and end of the work shift and lunch breaks), it is unusual that a sample or series of consecutive samples spans the entire work shift. In practical terms, a full-shift sample should omit no more than one hour of the full work shift (e.g., sample at least 7 hours of an 8-hour work shift or 11 hours of a 12-hour work shift).

(b) If full-shift sampling is not possible, it is essential to sample the entire duration of the task producing the exposure of interest. Every attempt should be made to sample the period of greatest exposure during the operation. Such exposure may occur during routine set-up, take-down, and end-of-shift clean-up operations. If an operation lasts less than a full shift, then sampling is to be conducted for the entire operation, or as long as personnel are potentially exposed to the contaminant (e.g., personnel may remain in a potentially contaminated work area after the operation ceases), whichever is longer.

(c) If the employee is leaving the general area of the work (e.g., going off-base or to an on-base fast food vendor) for lunch the sampler and media should be removed

during the lunch period. If the employee will be eating lunch in a lunch room at the work site it is permissible to leave the sampler and media on the employee but any sampling pump should be turned off and the sample inlet should be capped. Be sure that the lunch break "on" and "off" times are recorded on the sampling data sheet and cap/seal and identify all cassettes/tubes if they are removed from the employee. One exception to removing and capping sampling devices during lunch are certain passive monitors, which would require removal of the diffusion membrane to be capped. In such cases the monitor may be left in place during the lunch break with documentation to that effect or the monitor may be removed and placed in a sealed container at a clean air location. Shut-down and removal of the sampling train during lunch is preferred.

(d) If technology has not been developed to allow full-shift sampling for an 8-hour TWA, a series of "grab" or "spot" samples taken randomly throughout the work shift is acceptable. A sound statistical approach should be used to design the sampling strategy. See Reference 3-1 for a complete discussion.

d. Number of Consecutive Samples to be Collected per Employee. The number of consecutive samples that should be taken during a work shift depends on the desired error of measurement as discussed in References 3-2, 3-4, and 3-5 and in Chapter 4 of this manual. Two 4-hour consecutive samples provide more statistical power than one 8-hour sample when documenting the exposure for an 8-hour work shift. Up to a point, a larger number of shorter duration consecutive samples provide more statistical power. However, the need to collect sufficient mass of contaminant for accurate analysis limits how many consecutive samples may be used to cover a specific work shift.

e. Work Shifts Longer than 8 Hours. In general, a single sample or multiple samples are to be taken to determine the initial 8 hours of exposure for comparison with the standard. This allows direct comparison to the 8-hour OEL. A separate sample is used to determine any additional exposure beyond the initial 8 hours.

5. CALCULATING THE TIME-WEIGHTED AVERAGE FROM THE SAMPLE RESULTS.

a. Unsampled Work Periods. To properly calculate an employee's TWA exposure, professional judgment is necessary to decide what assumption should be made regarding the exposure during unsampled work periods. For example, if the work shift is 8 hours and sampling was conducted for 7 hours and 15 minutes, the industrial hygienist can either assume a zero exposure for the unsampled period or assume that exposure is equal to the TWA over the sampled period. If a zero exposure is assumed for all unsampled periods, the resulting TWA is calculated per Equation 3-1a below and the industrial hygienist should document on the sampling data sheet reasons/circumstances that explain the employee's time of non-exposure (e.g., lunch break, operation completed, etc.). Where equal exposure is assumed, the resulting TWA is calculated per Equation 3-1b below and the industrial hygienist also should document the rationale on the sampling data sheet.

$$TWA\ (8\text{ - hour}) = \frac{C_1T_1 + C_2T_2 + \ldots + C_nT_n}{480\text{ minutes}}$$

Equation 3-1a

NOTE: Equation 3-1a, above, assumes that the average contaminant concentration during any unsampled portion(s) of the work shift is zero (0) and that the length of the work shift is 8 hours (i.e., 480 minutes). Field observations by the person conducting the sampling should determine if the zero exposure assumption is supportable. The denominator in Equation 3-1a must be the changed to the total minutes in the actual work shift if the work shift is other than 8 hours.

$$TWA = \frac{C_1T_1 + C_2T_2 + \ldots + C_nT_n}{T_1 + T_2 + \ldots + T_n}$$

Equation 3-1b

NOTE: Equation 3-1b, above, assumes that the contaminant concentration during any unsampled portion(s) of the work shift is equal to the average exposure for all sampled portions of the work shift. This is a conservative estimate of exposure, which is biased in favor of the worker. Field observations by the person conducting the sampling should determine if this assumption is supportable.

Where:

TWA = Time-weighted average contaminant concentration

C_i = the contaminant concentration in Sample i

T_i = the duration (minutes) of Sample i

b. Non-traditional Work Schedules. Standards based on 8-hour exposures may not provide appropriate protection when non-traditional work schedules are used, e.g., four 10-hour days per week. Comparison of the full-shift exposure measured during a non-traditional work schedule requires that the 8-hour OEL be adjusted to account for differences in the number of exposure (i.e., work) hours and recovery (i.e., non-work) hours. The following adjustments are not applicable to STEL, Ceiling, or Excursion Limit OELs.

(1) Recommended adjustments based on the Reference 3-6 model of Brief and Scala.

(a) Limitations of the model. The adjustments in Equations 3-2 and 3-3 below are based on the Brief and Scala model for unusual work shifts, which is discussed in Reference 3-7. This is a conservative model that accounts for both increased work shift exposures and decreased recovery time (i.e., non-occupational exposure periods). Following are some general application guidelines for the Brief and Scala model.

1. The model does not account for biological half-lives of the stressor, as do the pharmacokinetic models. However, there is a general rule of thumb that PEL adjustments are not applied if the stressor half-life is less than 3 hours or greater than 400 hours. Toxicant studies show that only moderate half-life chemicals (i.e., 6-200 hours) are likely to have day-to-day accumulation during the week, even at exposures at or near the PEL.

2. The model assumes average body burden for the stressor rather than peak burden.

3. The model can be used if the PEL is based on systemic effects, regardless of whether the effects are acute or chronic.

4. Adjustments can be applied only for extended work shifts/weeks, defined as >7 hours/day or >35 hours/week. Do not use these equations for shortened work schedule adjustments (i.e., the OEL shall NEVER be adjusted upward for shortened work days or weeks). In addition, neither adjustment equation is appropriate for 24-hour (i.e., continuous) exposure.

5. Do not make PEL adjustments when the stressor is a primary irritant (i.e., PEL based on sensory irritation effects). In such cases, the stressor's action is based on "compartmental" vice whole body effects. Further, the irritation threshold is probably independent of the number of hours worked (i.e., exposed).

(b) Work weeks of less than 7 days. Equation 3-2 is used to adjust the OEL, if the work week is less than seven days.

$$\text{Adjusted OEL} = \text{OEL} \times \left(\frac{8}{h} \times \frac{24 - h}{16} \right)$$

Equation 3-2

Where:

h = number of hours worked per day

8 = number of hours per traditional workday

24 = number of hours per day

16 = number of recovery hours per traditional workday

This adjusted OEL is then used for comparison with the employee's TWA exposure, and its upper or lower confidence limits as appropriate, calculated using the applicable form of Equation 3-1. Confidence limits are discussed in Chapter 4. Note that when the full shift is not sampled, you must make assumptions about the concentration during the unsampled portion of the work shift. The traditional assumptions are that the average exposure during the unsampled period is either equal to zero or equal to the average exposure during the sampled period. Any

other assumptions are difficult to support and should be used rarely and with adequate documentation.

(c) 7-day work weeks. If the non-traditional work schedule involves work on all 7 days of the week, adjust the OEL as shown in Equation 3-3:

$$\text{Adjusted 7-day work week OEL} = \text{OEL} \times \left(\frac{40}{h} \times \frac{168 - h}{128} \right)$$

Equation 3-3

Where:
h = number of work (exposure) hours per 7-day work week

40 = number of work hours per traditional work week

168 = number of hours per 7-day work week (7 days x 24 hours)

128 = number of recovery (exposure-free) hours per traditional work week

(2) Adjustments mandated by OSHA in some standards (e.g., lead). Another model often used is the OSHA model, which accounts for increased work shifts only (i.e., no adjustment for decreased recovery time). The adjustments, shown in Equations 3-4 and 3-5 are based on whether the stressor acts as an acute or cumulative (chronic) hazard (OSHA has a chemical categorization table where you can look up the hazard category). The OSHA model can be used to adjust for work shifts from 15 minutes to 24 hours per day. The acute hazard equation is intended to modify the PEL to a dose no greater than that of an 8-hour exposure at the PEL. The cumulative hazard adjustment is meant to prevent excessive accumulation following many days (years) of exposure such that workers exposed more than 40 hours per week will not develop body burdens greater than those of workers in a normal 8 hour/day, 40 hour/week schedule. If a chemical is considered both an acute and a chronic hazard, calculate both adjustments and apply the more conservative PEL.

$$\text{Adjusted PEL (Acute Hazard)} = \text{PEL} \times \frac{8 \text{ hours}}{\text{Hours of Exposure per Day}}$$

Equation 3-4

$$\text{Adjusted PEL (Cumulative Hazard)} = \text{PEL} \times \frac{40 \text{ hours}}{\text{Hours of Exposure per Week}}$$

Equation 3-5

(3) Adjustments based on other models. There are several other models, each with its own limitations and advantages. Consult Reference 3-7 for a complete discussion. Keep in mind that establishing limits for unusual work shifts is complicated by many factors, including individual susceptibilities, stressor biological half-lives, metabolic pathways, and exposure schedules (e.g., recovery time allowances, means of elimination, consistency of exposure during extended work shift, etc.).

c. Mixtures.

(1) Additive effects. Mixtures of stressors with ADDITIVE effects may be compared to a normalized OEL for the mixture of one (1) by calculating the concentration of each individual component of the mixture as a fraction of the OEL for that component (i.e., normalized to the OEL) and then summing these values as in Equation 3-6 below:

$$\text{Mixture summed, normalized OEL} = \frac{C_1}{OEL_1} + \frac{C_2}{OEL_2} + \ldots + \frac{C_n}{OEL_n}$$

Equation 3-6

If the "mixture summed, normalized OEL" is greater than one (1) the measured mixture level is considered to exceed the OEL for the mixture.

(2) Independent effects. If the chemical substances in the mixture have different biological actions (i.e., independent effects), the data must not be combined into a single exposure value. Instead the concentration of each chemical substance must be separately compared to its OEL.

(3) Synergistic effects. If the chemical substances in the mixture have synergistic effects, interpretation of the data should be done on a case by case basis and with great caution.

6. **SAMPLE COLLECTION AND ANALYTICAL METHODS.** All industrial hygiene samples should be collected and analyzed using methods described in Reference 3-8, the *Industrial Hygiene Sampling Guide for Comprehensive Industrial Hygiene Laboratories* (CIHLs), Navy and Marine Corps Public Health Center (NMCPHC), January 2014.

7. **MINIMUM SAMPLE VOLUME.** The limit of quantitation of the analytical procedure establishes the minimum required volume of air for a sample. The minimum sample volume and the required sample time are computed using Equations 3-7 and 3-8:

$$\text{Minimum Sample Volume (liters)} = \frac{\text{Analytical Limit of Quantitation } (\mu\text{g})}{\text{OEL } (\text{mg}/\text{m}^3) \times \text{Desired Fraction of OEL}}$$

Equation 3-7

$$\text{Required Sample Time (minutes)} = \frac{\text{Minimum Sample Volume (liters)}}{\text{Sample Flowrate (liters / minute)}}$$

Equation 3-8

NOTE: Be careful when using laboratory results that are less than the limit of quantification. This is especially important when ordering an ICP (inductively coupled plasma) scan for metals, which gives results for a standard set of 14 metals. If "metal Z" was not present in the process being sampled, you should not use the “less than” result to make ANY evaluation of exposure to "metal Z."

8. **PRE-PLANNING.** When a positive determination is made that there is potential for an employee to be exposed to a chemical, physical or biological agent at or above the AL, sampling is usually conducted to determine the extent of the exposure. Since many decisions will be based on the sampling results, it is necessary to develop a standardized sampling protocol to ensure the highest level of confidence in reported exposure levels. Careful preparation is essential to facilitate and assure the collection of valid samples. The following checks are to be made prior to field sampling:

   a. All sampling equipment is to be factory and/or field calibrated in accordance with manufacturer's instructions and/or in accordance with Chapter 8 of this manual.

   b. Ensure that pumps are fully charged (voltage check) and are pre-calibrated to the proper flow rates.

   c. Forms for documenting air samples, bulk samples, wipe samples and heat stress surveys, along with the associated form definitions and explanations, are provided in Appendix 3-A. Appendix 3-A also includes information on the changeover from using Navy Industrial Hygiene Operation Codes (OPCODEs) to the Defense Occupational Environmental Health Readiness System (DOEHRS-IH) Process Category/Common Process/Process Method pick lists.

   d. Use the correct collection media as specified in Reference 3-8, the *Industrial Hygiene Sampling Guide for Comprehensive Industrial Hygiene Laboratories (CIHLs),* NMCPHC, January 2014. You may need to consult with the laboratory before collecting samples, particularly for unusual analytes. The laboratory may require a bulk sample or extra tubes for desorption efficiency studies.

9. **GENERAL SAMPLE COLLECTION PROCEDURES USING SAMPLING PUMPS.**

   a. Select the employee to be sampled and discuss the purpose of the sampling strategy. Advise the employee not to remove or tamper with the sampling equipment. Inform the employee when and where the equipment will be removed.

   b. Instruct the employee to notify the industrial hygienist or the supervisor should the sampling equipment require temporary removal.

   c. Place the sampling equipment on the employee so that it does not interfere with work performance.

   d. Attach the collection device (e.g., filter cassette, charcoal tube, etc.) to the shirt collar (i.e., within the employee's breathing zone). The inlet orifice should generally be in a downward vertical position to avoid contamination. Ensure the collection device inlet

will not be covered by loose items of clothing. Position the excess tubing so as not to interfere with the work of the employee.

NOTE: For welding fume samples, place the cassette inside the welder's helmet.

e. Turn on the pump and record the time.

f. In order to determine if the desired flow rate is being maintained during sampling, the following methods should be used:

(1) A precision rotameter should be plugged into the cassette and the flowrate should be checked based on the center of the ball reading. Adjust the pump flow-rate to the desired flow rate as indicated by the precision rotameter reading if the flowrate is greater than 5% difference from the original flowrate. Record the time and flowrate prior to adjustment on the sampling form. Also record the new adjusted flow rate and time. In this case two volumes for the sample will be calculated based on the lowest flowrate for each time period. See paragraph 10 for more details. The two volumes would then be added together for the total volume. Note that if the flowrate has changed greater than 5%, consideration should be given to change out the pump with a different calibrated pump. The pump that did not maintain the flowrate should be put out of service until repairs are made, such as changing out the battery. The pump should be retested prior to use following the procedures outlined in Chapter 8 of this manual.

NOTE: Per the OSHA Technical Manual, Section II: Chapter 1, Personal Sampling for Air Contaminants, Appendix F, Calibration, (updated 2/11/2014), [reference 3-4] OSHA no longer uses precision rotameters for calibration due to the potential measurement error that may occur due to pump pulsation. OSHA uses electronic flow calibrators instead. A precision rotameter can be used as a secondary standard as long as it is calibrated in accordance with Chapter 8 of this manual. Only use calibration points where the rotameter ball is stable. For example, at lower flow rates the ball may not be stable and therefore should not be used.

(2) Built-in rotameters on pumps can be used for visual verification of flow rate stability during sampling. Do not use built-in rotameters for calibration purposes.

(3) As a minimum, the flow on all pumps should be checked after the first half-hour, hour, and every 2 hours thereafter. During pump checks, check for filter loading. Particulate accumulation on the filter may affect the flow rate, especially on pumps that are not constant flow. If this occurs, replace the filter with a new one. Ensure that the collection device is still assembled properly and that the hose has not become pinched or detached from the cassette or the pump.

g. **Do not leave sampling equipment unattended**. Monitor the operation and employees throughout the work shift to ensure that sample integrity is maintained, and cyclical activities and work practices are identified. Record the time course of events, taking detailed notes concerning airborne contaminants and other conditions to assist in determining appropriate engineering controls.

h. Prepare field blank(s) during the sample period. Blanks are prepared in the same manner as the actual cassettes or tubes used for sampling, except air is not drawn through them. Blanks should also be from the same lot number as the samples. Remove both the inlet

and outlet plugs from the cassette at the sampling site and immediately replace them. If using tubes, break off both ends of the blank tube at the sampling site and immediately cap.

i. For each type of sample collected, submit at least one field blank per 20 samples for OSHA sampling methods. For NIOSH sampling methods, a minimum of 2 field blanks are required for each set of samples of a specific type. If a set contains more than 20 samples, the number of field blanks required by NIOSH is 10% of the total number of samples with all fractions rounded up. NIOSH states than in no case are more than 10 field blanks required regardless of the number of samples in the set.

j. Before removing the pump at the end of the sample period, check the flow rate to ensure that the rotameter ball is still at the calibrated mark. Record the pump or precision rotameter reading.

k. Turn off the pump and record the ending time.

l. Remove the collection device from the pump. Cap tubes. If using impingers (rarely, if ever used) the fluid is usually transferred to a glass bottle and the bottle is capped and tape is wrapped around the bottle and cap in a clockwise fashion. For cassettes, insert cassette plugs. For open face sampling, insert the inlet cap (top) into the retaining ring (spacer). A shrink band should be placed around the cassette covering the inlet cap, retaining ring and outlet cap (bottom) to ensure the integrity of the sample. Note shrink bands should already be used on the cassettes prior to sampling. For open face sampling, ensure the shrink band does not cover the inlet cap since this cap is removed during sampling.

m. Prepare the samples for submission to the analytical laboratory.

n. Pumps should be post-calibrated after each day of sampling (before charging). Record the post-calibration results.

o. Activities are encouraged to develop provisions for sealing sampling media to prevent tampering and for using sample logs and chain of custody forms where such documentation is appropriate.

10. **SAMPLING PUMP CALIBRATION AND SAMPLING AND ANALYTICAL METHOD PRECISION.**

a. If the initial (pre-) and final (post-) calibration flow rate differential is within 5%, a volume calculated using the lower flow rate should be reported to the laboratory. If the difference between the pre- and post-calibration flow rates is not within 5%, the pump may not be functioning properly. Check the battery first. If the problem is still not corrected, have the pump repaired.

NOTE: If the pump flow rate differential is greater than 5%, the sample results may still be used for exposure evaluations. The total coefficient of variation (CV_T), or overall precision (S_{rT}), of a sampling and analytical method incorporates a ±5% pump error. Depending on the CV_T or S_{rT} of the method, sampling conducted with a pump error greater than 5% may still be usable by factoring in an additional error in the CV_T or S_{rT}

provided. However, the CV_T or S_{rT} should be within the required accuracy of ± 25% at the exposure limit criterion, with a confidence level of 95%.

Example: You are sampling for dichlorodifluoromethane by NIOSH method 1018. Your pump differential (i.e., pre and post calibration) is 7%. This is greater than the recommended 5%. You check the method, and find the overall precision (S_{rT}), which in the past was referred to as the total coefficient of variation (CV_T), to be 0.063. Combined with an estimate of bias (B) for the method, the accuracy of the method is calculated to be approximately ± 12.3% (NIOSH lists the accuracy as 12.8% from the concentration range studied). Your increase of 2% pump error can be included in an adjusted S_{rT} by calculating the cumulative error as shown below:

$$\text{Adjusted } S_{rT} = \sqrt{E_1^{\,2} + E_2^{\,2}}$$

$$\text{Adjusted } S_{rT} = \sqrt{(0.063)^2 + \left(\frac{7-5}{100}\right)^2}$$

$$\text{Adjusted } S_{rT} = \sqrt{(0.063)^2 + (0.02)^2}$$

$$\text{Adjusted } S_{rT} = 0.066$$

Where: E_1 = overall method precision (S_{rT})

$$E_2 = \frac{(\text{Actual pump error in \%}) - (\text{Method's pump differential in \%})}{100}$$

The adjusted S_{rT} of 0.066 equates to about ± 13% overall accuracy for the sampling and analytical method. An explanation of how S_{rT} is used along with the method bias (B) to calculate the method accuracy is available on pages 39-43 of Reference 3-9. Since this is within the allowable ± 25%, the sample can be used to "screen" the sampled operation exposure to determine if further sampling is needed. Remember that overall precision is based on concentrations <u>at 0.1 to 2 times the exposure limit</u> (for NIOSH 1018, 495 to 9,900 mg/m^3) and the S_{rT} listed in the method may not be applicable at lower concentrations.

b. <u>Estimating overall precision of a NIOSH sampling and analytical method when S_{rT} is not provided.</u> If you want to determine the confidence interval limit on an exposure measurement (e.g., calculating the lower confidence limit [LCL] for determining non-

compliance at 95% confidence, or calculating the upper confidence limit [UCL] to determine with 95% confidence that the exposure was compliant) and only the method precision (S_r) is provided, you must also consider sampling (pump) error in the calculation of the UCL/LCL. The overall precision (S_{rT}) can be estimated as follows:

$$\text{Estimated } S_{rT} = \sqrt{S_r^{\,2} + E^{\,2}}$$

Where: S_r = Method precision for the analyte

$$E = \frac{(\text{Assumed or actual pump error in \%})}{100}$$

The following apply to NIOSH methods:

* Overall precision (S_{rT}) includes sampling errors (e.g., pump error).

* Method precision (S_r) relates to analysis only.

* For analytical methods used for multiple analytes (i.e., metal scans and many organics), the method precision (S_r) of the individual analytes is tabulated and included in the documentation.

* When providing an overall precision (S_{rT}) for a method, NIOSH includes pump errors, other sampling errors, and bias.

c. Calibration should be conducted at the same temperature and pressure as sampling.

NOTE: Per the OSHA Technical Manual, Section II: Chapter 1, Personal Sampling for Air Contaminants, Appendix F, Calibration, (updated 2/11/2014), [reference 3-4] OSHA recommends calibrating an open-face cassette by using the cover section (inlet cap) which comes with the cassette and attaching the tubing directly from the calibrator to the inlet port on the cassette cover. Be certain there are no leaks and do not use a Luer adapter. Calibrate as if it were a closed face cassette.

11. **SAMPLING METHODS FOR RESPIRABLE, THORACIC, AND INHALABLE, OR "TOTAL" AEROSOLS.** Aerosol samples may represent the respirable, thoracic, or inhalable fractions of the aerosol or the nominal "total" aerosol. Each aerosol fraction requires a different sampling device. Care should be taken to determine which aerosol fraction an OEL refers to and to ensure that the correct sampling device is used.

a. Respirable Aerosol Sampling. Respirable dust is collected using a clean cyclone at a flow rate recommended by the cyclone manufacturer to achieve the collection efficiencies cited below. The respirable fraction of an aerosol is defined as the fraction of particles collected according to a table of collection efficiencies agreed upon by the International Organization for Standardization (ISO), the European Standardization Committee (CEN),

and the American Conference of Governmental Industrial Hygienists (ACGIH). The table of collection efficiencies is published in Reference 3-3. The most often cited characteristic is the median (i.e., 50%) collection efficiency, which is for particles with an aerodynamic diameter of 4 micrometer (μm). Sampling is usually done with a cyclone upstream of the filter to preselect the fraction of particles of each size that pass through (i.e., penetrate) the cyclone and are collected on the filter. Several types of cyclones are available commercially the most common being the 10 mm nylon (i.e., Dorr-Oliver) cyclone and the Higgins and Dewell cyclone which evolved into the SIMPEDS cyclone. The flow rate through the cyclone is critical to obtaining the correct aerosol distribution. At present a flow rate of 1.7 L/min is used with the 10 mm nylon cyclone and a flow rate of 2.5 L/min is used with the SKC cyclone. As more cyclone performance test data becomes available flow rate recommendations change; therefore, the manufacturer should be consulted for the currently recommended flow rate to conform to the ISO/CEN/ACGIH respirable aerosol size distribution.

NOTE: When sampling for respirable dust for comparison to the ACGIH TLVs® per the International Standards Organization/ European Standardization Committee (ISO/CEN) protocol, no change is recommended for the measurement of respirable particulates using a 10 mm nylon cyclone at a flow rate of 1.7 L/min (Reference 3-1).

b. Thoracic Aerosol Sampling. Currently, the ACGIH TLV® for sulfuric acid is the only OEL, generally used by Navy industrial hygienists, that requires thoracic aerosol sampling. However, with international agreement on what this fraction is with respect to the size distribution (Reference 3-3), more such OELs may soon follow. NMCPHC is aware of only one personal sampler of this type, which is the GK2.69, offered by BGI Incorporated. At present, the manufacturer's recommended flow rate for this cyclone is 1.6 L/min to collect a thoracic aerosol size distribution. When such devices are used, the manufacturer should be consulted to determine the correct flow rate to collect a thoracic aerosol size distribution.

c. Inhalable Aerosol Sampling. There are some ACGIH TLVs® that are set for inhalable aerosols. Three inhalable aerosol samplers are widely available in the U.S. (i.e., the Institute of Occupational Medicine [IOM] sampler, the Button sampler (both distributed by SKC, Inc.) and the Conical Inhalable Sampler [CIS] distributed by BGI, Incorporated). The IOM sampler operates at 2 L/min, the button sampler at 4 L/min and the CIS sampler at 3.5 L/min. Other samplers are known to exist. As more OELs are set for inhalable aerosols, other samplers will probably be introduced. When such devices are used, the manufacturer should be consulted to determine the correct flow rate to collect an inhalable aerosol size distribution.

d. "Total" Aerosol Sampling. All OSHA PELs for "total" aerosols are sampled with a closed face 37 mm filter cassette. Studies have shown that this sampling method collects less aerosol than an inhalable sampler.

e. Relationship of the Results Obtained with the 37 mm Filter cassette to the IOM Sampler. Studies indicate the 37 mm filter under samples significantly for aerosols of larger particle sizes. One researcher (Reference 3-10) has proposed a range of conversion factors for estimating inhalable aerosol concentration based on measured "total" aerosol concentrations using a closed face 37 mm filter cassette. Table 3-1 presents suggested

working conversion factors where the field evaluator deems it desirable to adjust exposure data for change in the assessment rationale between total and inhalable (IOM) aerosol results (from Reference 3-10). Measured inhalable aerosol concentrations tend to exceed corresponding total aerosol concentrations except in welding environments due to the small particle sizes of fumes. For operations that may generate particle sizes other than smoke or fume, the field evaluator should sample using the IOM sampler or other inhalable sampler meeting the International Standards Organization (ISO) inhalation curve presented in reference 3-3 when comparing exposures to an OEL based on the inhalable mass.

NOTE: With identical exposure limits, work environments with exposures only slightly below the total aerosol OEL could have inhalable aerosol concentrations above an inhalable ACGIH TLV®.

Table 3-1

Aerosol Classification/Process Category	Suggested Conversion Factor
Dust – Mining Ore and Rock Handling Handling/transportation of bulk aggregate Textiles Flour and grain handling, etc.	2.5
Mist – Oil mist and other machining fluids* Paint sprays Electroplating, etc.	2.0
Hot processes – Metal smelting and refining Foundries	1.5
Welding – All types	1.0
Smoke and fumes – All types	1.0

***** NIOSH has a thoracic recommended exposure limit for metal working fluids assessed by using “total” aerosol sampling based on a specific applied conversion factor.

f. Use of Total Aerosol Results to Which Inhalable Correction Factors Have Been Applied. When Total Aerosol sample results are corrected to estimate Inhalable exposures that corrected result should only be used to determine if exposures would merit sampling with a true inhalable sampler. If an industrial hygienist wishes to compare exposures to an Inhalable OEL those exposures should be documented with true inhalable sampling not by correction of total aerosol sampling.

12. **GRAVIMETRIC ANALYSIS.** Particulates/aerosols can be collected on polyvinyl chloride (PVC) filters or matched weight mixed cellulose ester filters (MCEF) using a flow rate generally in the range between 1.5 and 2.5 liters per minute (L/min). Preparation and gravimetric analysis of filter samples is performed as follows:

a. Filter Properties and Preparation.

(1) PVC filters. Desiccate all PVC filters for at least 24 hours before pre-sample and post-sample weighing. Be sure to remove the plugs from the cassette while filters are being desiccated. PVC filters should be weighed prior to (tare weight), and after collecting the sample to arrive at the sample weight.

(2) Matched weight filters. Matched weight filters are pairs of MCEFs with weights that are matched within 100 micrograms (μg). They are mounted one on top of the other in the same cassette. The top filter is used to collect the sample while the bottom filter acts as a reference filter which was exposed to the same environmental conditions (e.g., humidity) but has no weight gain due to capture of particulates. The difference in their weights after sampling is the sample weight. However, if the weight difference is less than 100 μg, it cannot be assumed to be due to the sampling.

b. Weighing Procedure (Pre-sample or Post-sample Weighing). The step-by-step procedure for weighing depends on the make and model of the balance. Read the manufacturer's instruction manual for specific directions. Also, follow any procedures specified by the particular analytical method being used.

(1) The balance should be in a vibration-free room.

(2) Calibrate and zero the balance prior to use, after every 10 samples, and after any period it is left unattended.

(3) Using blunt-tipped forceps (i.e., do not use your fingers) remove the filter from the cassette.

(4) Immediately prior to placement on the balance, pass filter over or through an ionization unit to remove static charges. (Be sure that these ionization units are registered and handled in accordance with any radiological control program that may be applicable.)

(5) Weigh all filters at least twice.

(a) If there is more than 0.005 milligram (mg) difference in the two weighings, re-zero and recalibrate the balance.

(b) If there is less than 0.005 mg difference between the two weighings, average the weights for the final weight.

(6) Record and maintain all the weighing information in a filter weighing log.

(7) Include all loose material from an overloaded filter and cassette in the weighing of the filter.

NOTE: Do NOT exert downward pressure on the weighing pans. Such action can break the stirrup or damage the weighing mechanism.

NOTE: Weighing inhalable aerosol samplers may require special considerations and procedures. Please note that for weighing IOM sampling inserts, a balance with at least 1 µg resolution and 20 gram (g) capacity is recommended. (Please contact NMCPHC for a list of balances known to meet those requirements.) Also, always consult the requirements and instructions for the particular sampler used.

13. **SAMPLING METHOD USING SORBENT TUBES.**

a. Organic vapors and gases are collected on activated charcoal, silica gel, or other adsorption tubes. Immediately before sampling, break off the ends of the adsorption tube to provide an opening approximately one-half the internal diameter of the tube. Do not use the charging inlet or the exhaust outlet of the pump to break the ends off the sorbent tubes.

b. Position the adsorption tube with the arrow in the direction of air flow, i.e., toward the sampling pump. To prevent injury to the worker, tubes should be placed in tube holders.

NOTE: If there is no arrow on the adsorption tube, insert the tube so the backup (smaller of two segments in tube) portion is closest to the pump.

c. The air to be sampled should be drawn directly into the inlet of the adsorption tube and not be passed through any hose or tubing before entering the tube. When air sampling methods require tubes in a series, as in nitrogen dioxide/nitric oxide air sampling, they can be joined via the shortest practicable piece of tubing. Ensure the tubing will not absorb the analyte. Chemical inert tubing is available.

d. When sampling with tubes connected in a series, label each tube and any pre-filter(s) with a single sample number (i.e., your field sample number), followed by successive letters (A, B, C, etc.). For example, three tubes in series on field sample number 96-578 will be submitted to the laboratory as samples 96-578A, 96-578B and 96-578C. Since all of these tubes represent a SINGLE sample, they should be entered on a SINGLE column on the air sample form (NMCPHC 5100/13). Further, each tube's position in the sampling train should be noted on the sample sheet (i.e., primary (farthest from the pump) or secondary (closest to the pump).

e. Cap tubes with the supplied plastic caps immediately after sampling.

14. **SAMPLING METHOD USING MIDGET IMPINGERS/BUBBLERS.**

a. Add the specified amount of the appropriate reagent to the impinger flask either in the office or at the sampling location. If flasks containing the reagent are transported either to or from the sampling site, both the impinger stem and side arm should be sealed with caps or parafilm.

b. Collect impinger samples using a maximum flow rate of 1.0 L/min.

c. The impinger should be attached to the employee's clothing using an impinger holster. It is very important that the impinger does not tilt, causing the reagent to flow down the

side arm to the hose and into the pump or to spill onto the worker's skin and clothing. Place a trap in line after the impinger to protect the pump from the absorbing solution.

d. In some instances, it will be necessary to add reagent during the sampling period to prevent the amount of reagent from dropping below one half of the original amount. Always remove the impinger from the employee before adding reagent.

e. After sampling, remove the glass stopper and stem from the impinger flask.

f. Rinse the absorbing solution adhering to the outside and inside of the stem directly into the impinger flask with a small amount (1 or 2 milliliters (ml)) of the sampling reagent. Stopper the flask tightly with the plastic cap provided or pour the contents of the flask into a 20 ml glass bottle. Rinse the flask with a small amount (1 or 2 ml) of the reagent and pour the rinse solution into the bottle. Use a Teflon® liner in the cap of the glass bottle. The cap should be taped securely in the same direction as the cap closes (clockwise).

NOTE: Sampling with impingers is rarely, if ever used, for new analytical procedures.

15. **SAMPLING METHODS USING DIRECT READING INSTRUMENTS.**

a. Detector Tube. Detector tubes should be used primarily as a screening tool. Samples are to be taken in the breathing zone of the employee.

(1) Detector tubes may be used to determine what areas should receive full shift samples. They may also be used concurrently with full shift samples to trace sources of exposure and track variations in exposure levels throughout the work shift.

(2) Detector tubes can be used only with the pump supplied by the manufacturer, as there may be differences in flow rate between different manufacturer's pumps. Flow rate determines the adsorption rate for the chemical reactions that produce the color change or length of stain. Calibrate pumps using the method described in Chapter 8.

(3) Consult the manufacturer's instructions for information on interferences and relative standard deviations for the specific tube, as well as the number of strokes, time between strokes, time for allowing color development, and temperature, humidity and atmospheric pressure effects. Reliable readings may not be possible when interferences are present.

(a) Where there is a gradation of color change, the end point should be taken as that point where the color change can first be detected.

(b) If the indication occurs at an angle, take the reading of the longest and shortest discoloration and use the average as the end point.

(4) When interpreting the results of detector tube sampling, the largest relative standard deviation reported by the manufacturer (for the exposure range) should be applied. Where screening results may exceed the AL (after the standard deviation has been applied) then full shift sampling should be accomplished.

(5) Useful life can be adversely affected by improper care. Avoid exposing tubes to prolonged high temperatures (e.g., automobile trunks in the summertime). Refrigerated storage is recommended. Detector tubes that have exceeded their expiration date shall not be used.

(6) Consider the effects of temperature on chemical reaction speed. Tubes can be warmed in the winter by placing loose tubes in an inside pocket for approximately 15 minutes before use.

b. Direct Reading Gas Monitors. Direct reading gas monitors, including monitors for carbon monoxide, hydrogen sulfide, combustible gases, organic vapors, and oxygen should be operated in accordance with the manufacturer's instructions. Readings should be taken as frequently as necessary to adequately characterize the exposure.

(1) Combustible gas meter.

(a) When measuring explosive levels in atmospheres where the identity of the explosive contaminant is known, calibrate the meter using the manufacturer's recommended calibration gas and use the manufacturer's response curves/conversion charts for that explosive contaminant.

(b) When measuring explosive levels in atmospheres where the identity of the explosive contaminant is not known or no manufacturer's response curve is available for the explosive contaminant, many manufacturers consider it best to calibrate the meter with either propane or pentane (consult the manufacture of the particular meter), since they fall in the middle of the relative sensitivity/response chart, and most gases and vapors will respond within a reasonable safety margin. This calibration, combined with an alarm set point of 10% of the lower explosive limit, minimizes the differences in meter readings that are due to the relative response of the combustible sensor. The subject of relative sensitivity/response is illustrated in Table 3-2 below. (Reference 3-11). Table 3-2 is an example of the expected response of a sensor that has been calibrated to pentane, propane or methane to a variety of combustible gases. The closer the relative response is to 1.0, the more accurate the reading. As shown by Table 3-2, when in an atmosphere where the identity of the explosive contaminant is not known, readings taken on a meter calibrated with methane usually underestimates the lower explosive limit.

Table 3-2 Example of Relative Sensitivity/Response Ratios

Combustible Gas/Vapor	Relative response when sensor is calibrated on…		
	Pentane	Propane	Methane
Hydrogen	2.2	1.7	1.1
Methane	2.0	1.5	1.0
Propane	1.3	1.0	0.65
n-Butane	1.2	0.9	0.6
n-Pentane	1.0	0.75	0.5
n-Hexane	0.9	0.7	0.45
n-Octane	0.8	0.6	0.4
Methanol	2.3	1.75	1.15
Ethanol	1.6	1.2	0.8
Isopropanol	1.4	1.05	0.7
Acetone	1.4	1.05	0.7
Ammonia	2.6	2.0	1.3
Toluene	0.7	0.5	0.35
Gasoline (Unleaded)	1.2	0.9	0.6

(Reference 3-11)

NOTE: Table 3-2 is only an example. The actual relative sensitivity/response of a sensor would vary by manufacturer.

(Due to the effect of some substances (e.g., silicones, halogenated hydrocarbons) to reduce the sensitivity or poison the combustible sensors or filaments of the meter, it is recommended that methane also be used to check the meter for loss of sensitivity to methane. This check is not a recalibration but is to be done in addition to the propane or pentane calibration.)

(c) This type of meter is not used to determine personal exposures to organic vapors.

(d) Each meter approved for potentially explosive atmospheres will be labeled with the approved classes, groups and approving organization. Only use the meter for the classes and groups for which it is approved. Do not use a meter without an approval label.

(e) Meters are not allowed in locations where fire or explosion hazards <u>may</u> exist unless the meter is certified intrinsically safe for the type (Group) of atmosphere present. When replacing batteries, use only those specified on the safety approval label.

(f) Consult and comply with manufacturer's instructions and directions regarding the operation, capabilities and limitations of the meter. Meters shall be used only for

their designed purpose and within the limitations specified by the manufacturer. (Reference 3-12).

1. Many meters will not give reliable results in oxygen-deficient atmospheres. For this reason and other obvious safety considerations, always measure the oxygen content of the location first.

2. Certain contaminants, including (but not necessarily limited to) silicones, silicates, lead containing compounds, halogenated hydrocarbons, acrylonitrile, carbon disulfide, formaldehyde, styrene, high concentrations of hydrogen sulfide or high concentrations of other combustible gases, may reduce the sensitivity or poison the sensors or filaments of the meter and produce false readings or failure. At times, sensitivity can tend to first be lost with respect to methane. Therefore, the meter may calibrate with and respond appropriately to other gases but have reduced sensitivity or not respond to methane. It is recommended that methane also be used to check the meter for this initial loss of sensitivity to methane. This check is not a recalibration but is to be done in addition to the usual calibration. (Reference 3-12)

3. EMI resulting from the use of portable radios in close proximity to some meters can cause erratic or lower than normal readings of the meters.

4. Temperatures outside of the manufacturer’s recommended range for the meter can cause erratic readings of the meter.

(2) Oxygen meter.

(a) Following manufacturer's guidelines, calibrate the meter in air known to contain 20.9% oxygen and outside of the space to be tested.

(b) Consult and comply with manufacturer’s instructions and directions regarding the operation, capabilities and limitations of the meter. Meters shall be used only for their designed purpose and within the limitations specified by the manufacturer. (Reference 3-12).

1. Changes of altitude or atmospheric pressure can affect the performance of some meters, requiring that the meters be calibrated for existing conditions.

2. EMI resulting from the use of portable radios in close proximity to some meters can cause erratic or lower than normal readings of the meters.

3. (Temperatures outside of the manufacturer’s recommended range for the meter can cause erratic readings of the meter.

c. Direct Reading Dust Monitor.

(1) (l) Follow the manufacturer's instructions for the operation and calibration of the monitor.

(2) Use the monitor as a screening device to estimate total or respirable dust levels.

(3) The monitor is non-specific; it measures the airborne mass concentration of dust and not specific toxic substances. Some instruments are calibrated to a specific type of

dust (e.g., Arizona road dust) and may not give accurate results for dusts with different size distributions.

(4) The monitor may give erroneous readings due to differences in collection efficiency for large particle sizes when measuring total dust.

d. Others. Other technical equipment may be used for field evaluation, such as toxic gas monitors, photoionization detectors, infrared analyzers, radiation monitors/meters, etc. All should be calibrated, maintained and operated according to the manufacturer's instructions and directions and within the limitations specified by the manufacturer.

16. **SAMPLING METHODS USING PASSIVE MONITORS.**

a. Instructions and limitations of the monitors are defined in the manufacturer's user's manual and should be carefully followed.

b. As with any sampling method, an accuracy of ± 25% at the 95% confidence level within 0.5 to 2 times the PEL should be demonstrated. If this information is not available through the manufacturer, duplicate sampling can be useful in supporting the accuracy of the sampling method.

c. In high humidity environments some organic vapor monitors may experience problems due to competition of water vapor for adsorption sites on the charcoal leading to underestimation of actual concentrations.

d. Most monitors require a minimum air flow rate over the diffusion membrane to prevent creating an artificially low stressor concentration at the membrane. Therefore, many monitors may not be suitable for area sampling. Consult the manufacturer for minimum required air flow rates and suitability for use as an area monitor.

e. Care should be taken to ensure that the diffusion membranes are not torn during sampling, which invalidates the sample. Since monitors are small and light-weight, they are easily turned over so that the sampling face is not exposed or may be covered by loose clothing. The industrial hygienist or technician should ensure that neither of these events occurs, otherwise the sample will be invalid.

NOTE: Passive monitors are usually designed for full-shift sampling of gases and vapors. Particulates, such as paint mist, may coat the monitor's diffusion membrane and invalidate the results.

f. Always record the manufacturer, model, series and serial number (if available) of the passive monitor on the sampling form. This information is needed to look up the appropriate sampling rates/uptake rates used during concentration calculations for the particular chemicals being analyzed. (e.g., for a SKC Formaldehyde dosimeter, the actual serial number of the passive monitor is needed in addition to the manufacturer, model and series to look up the sampling rate/uptake rates.) Sometimes the sampling rates/uptake rates are available on the passive monitor box or paperwork. If so, also recording the sampling rates/uptake rates for the particular chemicals being requested for analysis would be helpful. This passive monitor information can be recorded on the sampling form in the Media, Lot/Tube#, Time Course of Events/Comments or Calculations fields.

17. **SAMPLING FOR SURFACE CONTAMINATION.**

a. General Information.

(1) The terms "wipe sampling," "swipe sampling" and "smear sampling" are used synonymously to describe the techniques used for assessing surface contamination. The term "wipe sampling" will be used in this chapter.

(2) There are a variety of reasons why surface contamination, and especially removable surface contamination, may need to be assessed. Several reasons are listed below:

(a) Many toxic materials may gain entry into the body via ingestion and, in some instances, via penetration (absorption) through intact skin.

(b) Surfaces which may contact food or other materials which are ingested or placed in the mouth (e.g., chewing tobacco, gum, cigarettes) may be wipe sampled (including hands and fingers) to show contamination.

(c) Skin irritants may be evaluated for potential contact by wiping surfaces, including exposed skin (e.g., fingers, hands).

(d) Effectiveness of decontamination of surfaces and protective gear (e.g., respirators) may sometimes be evaluated by wipe sampling.

(3) There is a very strong possibility that wipe samples will give a false negative; that is, that some or all of the existing surface contamination will not be removed by a wipe sample.

(4) Available toxicological information concerning chronic skin absorption, dermatitis, etc. should be used to determine if the resulting exposure presents a potential employee hazard.

b. General Technique for Wipe Sampling.

(1) Generally, there are three types of media recommended for taking wipe samples:

(a) Glass fiber filters (37 mm) are usually used for materials that are analyzed by high pressure liquid chromatography (HPLC), and often for substances analyzed by gas chromatography.

(b) Paper filters are generally used for metals, and may be used for anything not analyzed by HPLC.

(c) Pre-moistened wipes meeting ASTM E1792 requirements may be used for metals.

(2) Pre-loading a group of vials with appropriate filters is a convenient method. The Whatman smear tabs should be inserted with the tab end out. Always wear clean disposable gloves when handling filters.

(3) The following procedures apply to the collection of wipe samples:

(a) At the worksite, prepare a rough sketch of the area(s) or room(s) and identify surfaces to be wipe sampled on the Industrial Hygiene Bulk/Wipe Sample Survey Form under the Comments section..

(b) If sampling an employee's skin or personal protective equipment, prepare/position the employee or equipment so that further contact is not needed prior to wiping.

Skin wipes should not be done for materials with high skin absorption. Under no conditions should any solvent other than distilled water be used on skin or personal protective gear that directly contacts the skin.

(c) Put on a pair of clean impervious disposable gloves. A clean set of gloves should be used with each individual sample. This avoids contamination of the filter and the hand and the subsequent possibility of false positives.

(d) If needed for sampling, moisten Smear Tabs or Whatman filters with deionized water prior to use.

NOTE: For some chemicals, wipe media may require specific solvents or derivation solutions for sampling and/or field treating. Consult laboratory for specific information.

(e) Withdraw the filter from the vial. If a damp wipe sample is desired, moisten the filter with the appropriate solution.

(f) Wipe approximately 100 square centimeters (cm^2) of the surface to be sampled.

NOTE: If a template is used to outline a 100 cm^2 (for example 10 cm X 10 cm) area, a new template should be used for each location where a sample is taken. This prevents contamination of other sample sites. Often a heavy piece of paper will suffice as a template.

(g) Start at the outside edge and progress toward the center of the surface area by wiping in concentric squares of decreasing size. Firm pressure should be applied when wiping.

(h) Without allowing the filter to contact any other surface, fold the filter with the exposed side in, and then fold it over again. Place the filter in a sample vial, cap the vial, number it, and place a corresponding number at the sample location on the sketch. Include notes with the sketch giving any further description of the sample. Also fill out the rest of the sample form.

(i) OSHA wipe method presented in ID-125G for metals: If using a pre-moistened wipe, remove it from its package and unfold it. Next fold the wipe in half. Wipe a 10-cm × 10-cm area by starting at the outside edge of the surface, applying firm pressure, wipe the surface and progress towards the center by making concentric squares of decreasing size. Fold wipe in half, with contaminant side in, and wipe the surface again by making concentric squares of decreasing size. Fold the wipe in half, contaminant side in, and wipe surface a third time. If using a Smear Tab or Whatman filter, wipe a 10-cm × 10-cm area by starting at the outside edge of the surface, applying firm pressure, wipe the surface and progress towards the center by making concentric squares of decreasing size. If possible wipe the area at least 3 times. Fold the wipe sample with exposed side in. Transfer the wipe sample into a 20 mL scintillation vial and seal with vinyl or electrical tape.

(j) At least one blank wipe or filter treated in the same fashion but without wiping, should be placed in a separate vial and submitted for each sampled area.

c. Special Techniques for Wipe Sampling.

(1) Acids and bases. When examining surfaces for contamination with strong acids or bases, use pH (litmus) paper moistened with neutral distilled water (i.e., pH 7.0).

(2) Asbestos. When examining surfaces for asbestos contamination, a technique called micro-vacuuming may be used. Micro-vacuuming only identifies presence of fibers and quantifies levels of contamination in terms of number or mass concentration. The microvacuum method has been standardized in ASTM D5755-95 and ASTM D5756-95 (References 3-13 and 3-14), which should be followed when conducting such testing. There are no regulatory standards for interpretation of microvacuum results.

(3) Metals. Wipe sampling for metal-contaminated dusts should be conducted per paragraph 17 b above. Guidance on Sampling and Interpreting the Concentrations of Metal Particulates Deposited on Surfaces in Non-Industrial Areas is provided in Appendix 3-B. For sampling and interpretation of metal contaminated dusts not listed in Appendix 3-B, please contact the NMCPHC Industrial Hygiene Department.

(4) Polychlorinated biphenyls (PCB). PCB wipe samples should be collected following the guidance in References 3-15 and 3-16. Special preparation is required for the collection media. Contact the laboratory where the sample will be analyzed for specific requirements.

18. **REFERENCES.**

3-1 Leidel, N. A. and Busch, K. A.: *Statistical Design and Data Analysis Requirements*. In: Patty's Industrial Hygiene and Toxicology, 3rd ed., Vol. III, Part A, edited by R. L. Harris, L. J. Cralley and L. V. Cralley. New York: John Wiley & Sons, Inc. 1994. pp. 453-582.

3-2 Leidel, N. A., Busch, K. A. and Lynch, J. R.: *Occupational Exposure Sampling Strategy Manual*. DEW/NIOSH Pub. No. 77-173. Washington, D.C.: Government Printing Office. 1977.

3-3 ACGIH. *TLVs® and BEIs, Threshold Limit Values for Chemical Substances and Physical Agents*. Cincinnati, OH: American Industrial Hygiene Association. Latest edition.

3-4 OSHA. *Occupational Safety and Health Administration Technical Manual*, Section II, Chapter 1, Personal Sampling for Air Contaminants. OSHA Instruction TED 1-0.15A. Washington, D.C.: U.S. Department of Labor. 2014.

3-5 American Industrial Hygiene Association (AIHA). *A Strategy for Occupational Exposure Assessment*, edited by N. C. Hawkins, S. K. Norwood and J. C. Rock. Akron: American Industrial Hygiene Association, 1991.

3-6 Brief, R. S. and Scala, R. A.: *Occupational Exposure Limits For Novel Work Schedules*. Am. Ind. Hyg. Assoc. J. 36(6):467-471

3-7 Paustenbach, D. J.: *Occupational Exposure Limits, Pharmacokinetics, and Unusual Work Schedules*. In: Patty's Industrial Hygiene and Toxicology, 3rd ed., Vol. III, Part A, edited by R. L. Harris, L. J. Cralley and L. V. Cralley. New York: John Wile & Sons, Inc. 1994. pp. 191-348.

3-8 NMCPHC. *Industrial Hygiene Sampling Guide for Comprehensive Industrial Hygiene Laboratories (CIHLs)*. 2014.

3-9 NIOSH. *NIOSH Manual of Analytical Methods*, 4th Edition. DHHS (NIOSH) Publication No. 94-113. Cincinnati, OH: Government Printing Office. 1994

3-10 Werner, M. A., Spear, T. M. and Vincent, J. H.: *Investigation into the impact of introducing workplace aerosol standards based on inhalable fraction*, The Analyst, 121, pp. 1207-1214 (1996).

3-11 Biosystems A Bacou-Dalloz Company. *Use of "Equivalent" Calibration Gas Mixtures.* Biosystems Application Note Number AN 20010808. 2001.

3-12 NAVSEASYSCOM. *Naval Ships' Technical Manual.* NSTM017. 2000.

3-13 ASTM. *Standard Test Method for Microvacuum Sampling and Indirect Analysis of Dust by Transmission Electron Microscopy for Asbestos Structure Number Concentrations*. ASTM D5755-95. West Conshohocken, PA: American Society for Testing and Materials. 1995.

3-14 ASTM. *Standard Test Method for Microvacuum Sampling and Indirect Analysis of Dust by Transmission Electron Microscopy for Asbestos Mass Concentration*. ASTM D5756-95. West Conshohocken, PA: American Society for Testing and Materials. 1995.

3-15 Environmental Protection Agency (EPA). Sampling Requirements. Code of Federal Regulations, Title 40, Part 761, Section 130.

3-16 EPA. *Field Manual for Grid Sampling of PCB Spill Sites to Verify Cleanup*. EPA-560/5-86. U.S. EPA. May 1986.

Appendix 3-A

INDUSTRIAL HYGIENE AIR SAMPLE, BULK SAMPLE, WIPE SAMPLE AND HEAT STRESS SURVEY FORMS, DEFINITIONS, EXPLANATIONS AND CODES

1. **FORMS**. The standard forms to be used when collecting air, bulk or wipe samples or when conducting a heat stress survey are listed below. These forms are in Microsoft Word format and require Microsoft Word to be installed on your computer in order to open them. To open each form, click on the hyperlink.

   a. Industrial Hygiene Air Sample Survey Form (One Worker, Many Stressors) - NMCPHC Form 5100/13

   b. Industrial Hygiene Single Stressor Air Sample Survey Form (Many Workers, One Stressor) - NMCPHC Form 5100/14

   c. Industrial Hygiene Direct Reading Single Stressor Sample Survey Form - NMCPHC Form 5100/15.1

   d. Industrial Hygiene Direct Reading Sample Survey Form (One Worker, Many Stressors) - NMCPHC Form 5100/15.2

   e. Industrial Hygiene Bulk/Wipe Sample Survey Form - NMCPHC Form 5100/16

   f. Industrial Hygiene Heat Stress Ashore Survey Form - NMCPHC Form 5100/19

   g. Industrial Hygiene Heat Stress Afloat Survey Form - NMCPHC Form 5100/20

2. **ASSOCIATED FORMS DEFINITIONS AND EXPLANATIONS**. Definitions and explanations about proper use are provided for the NMCPHC Forms listed above. These documents are in Adobe Acrobat Reader PDF format and require Adobe Acrobat Reader to be installed on your computer in order to open it. To open the document, click on the hyperlink.

   a. Industrial Hygiene Air Sample Survey Form (One Worker, Many Stressors) - Definitions and Explanations for NMCPHC Form 5100/13

   b. Industrial Hygiene Single Stressor Air Sample Survey Form (Many Workers, One Stressor) - Definitions and Explanations for NMCPHC Form 5100/14

   c. Industrial Hygiene Direct Reading Single Stressor Sample Survey Form (Many Workers, One Stressor) - Definitions and Explanations for NMCPHC Form 5100/15.1

   d. Industrial Hygiene Direct Reading Sample Survey Form (One Worker, Many Stressors) - Definitions and Explanations for NMCPHC Form 5100/15.2

   e. Industrial Hygiene Bulk/Wipe Sample Survey Form - Definitions and Explanations for NMCPHC Form 5100/16

   f. Industrial Hygiene Heat Stress Ashore Survey Form - Definitions and Explanations for NMCPHC Form 5100/19

   g. Industrial Hygiene Heat Stress Afloat Survey Form - Definitions and Explanations for NMCPHC Form 5100/20

3. **OPERATION CODES.** For years, Navy Industrial Hygiene OPCODEs have been used to denote work operations and have been documented on industrial hygiene sampling forms. These OPCODEs were provided in tabular format as the Navy Industrial Hygiene Operation Codes Dictionary. With the advent and use of the new DOEHRS-IH, processes now need to be defined in two basic ways: a user defined Process Name and the DOEHRS-IH Process Category/Common Process/Process Method pick lists. DOEHRS-IH requires the choice of a Process Name for each work operation. The Process Name is user defined and is what the user typically sees. Since Process Name is user defined, care must be taken to use a business practice that ensures accurate and consistent Process Names are created. The DOEHRS-IH Process Category/Common Process/Process Method pick lists are in the form of a three tiered process pull down pick list. The DOEHRS-IH Process Methods from the pick list are the equivalent of the old OPCODEs. It is very important that proper selections are made from these DOEHRS-IH pick lists and that they are accurate and consistent for the process under consideration in order to facilitate future data mining. A spreadsheet of the entire DOEHRS-IH Process pick list is available on the NMCPHC DOEHRS-IH webpage: http://www.med.navy.mil/sites/nmcphc/industrial-hygiene/defense-occupational-environmental-and-health-readiness-system/Pages/default.aspx.

   To aid in finding the appropriate pick list selections, a listing showing suggested mappings between the previously used OPCODEs and the new DOEHRS-IH Process Category/Common Process/Process Method pick lists is provided below. For ease of use, OPCODEs can, currently, continue to be used on the industrial hygiene sampling forms, if desired. However, the DOEHRS-IH Process Name and Process Category/Common Process/Process Method pick list choices for the samples now also need to be documented on the sampling forms (once selected).

NAVY OPERATION CODES (OPCODES) TO DOEHRS-IH PROCESS PICKLISTS MAPPINGS

NAVY OPCODE	Navy OPCODE Description	DOEHRS-IH Process Category	DOEHRS-IH Common Process	DOEHRS-IH Method
CLE-000-00	Administrative/Clerical	Administrative	Administrative	Clerical And Office Automation
CLE-001-00	Clerical, Computer Use, Multiple Operations	Administrative	Administrative	Computer Use, Multiple Operations
CLE-001-01	Clerical, Computer Use, Keyboard And VDT	Administrative	Administrative	Computer Use/Keyboard And VDT
CLE-001-99	Clerical, Computer Use, NEC	Administrative	Administrative	Computer Use, NOC
CLE-999-99	Administrative/Clerical, NEC	Administrative	Administrative	Administrative, NOC
CON-000-00	Construction	Industrial	Structure Fabrication/Renovation	General Construction
CON-001-00	Structure Fabrication/Repair, Multiple Operations	Industrial	Structure Fabrication/Renovation	Structure Fabrication/Renovation, Multiple Operations
CON-001-01	Structure Fabrication, Wharf Building	Industrial	Structure Fabrication/Renovation	Structure Fabrication/Renovation, Wharf Building
CON-001-02	Structure Fabrication/Repair, Ceiling Installation/Repair	Industrial	Structure Fabrication/Renovation	Structure Fabrication/Renovation, Ceiling Installation
CON-001-03	Structure Fabrication/Repair, Roofing Installation/Repair	Industrial	Structure Fabrication/Renovation	Structure Fabrication/Renovation, Roofing Repair
CON-001-04	Structure Repair, Paint Removal, Scraping	Industrial	Coating/Paint Removal	Coating/Paint Removal, Hand Sanding/Scraping
CON-001-05	Structure Repair, Paint Removal, Sanding	Industrial	Coating/Paint Removal	Coating/Paint Removal, Machine Sanding/Scraping
CON-001-06	Structure Repair, Paint Removal, Chemical	Industrial	Coating/Paint Removal	Coating/Paint Removal, Chemical Stripping, Spraying
CON-001-07	Structure Repair, Paint Removal, Thermal	Industrial	Coating/Paint Removal	Coating/Paint Removal, Heat Gun
CON-001-08	Structure, Lock/Door, Repair/Install/Maintain	Industrial	Structure Fabrication/Renovation	Structure Fabrication/Renovation, Structure Lock/Door
CON-001-09	Structure Fabrication/Repair, Floor Installation/Repair	Industrial	Structure Fabrication/Renovation	Structure Fabrication/Renovation, Floor
CON-001-10	Structure Fabrication/Repair, Powder Actuated Tool	Industrial	Structure Fabrication/Renovation	Structure Fabrication/Renovation, Powder Actuated Tool
CON-001-99	Structure Fabrication/Repair, NEC	Industrial	Structure Fabrication/Renovation	Structure Fabrication/Renovation, NOC

NAVY OPERATION CODES (OPCODES) TO DOEHRS-IH PROCESS PICKLISTS MAPPINGS

NAVY OPCODE	Navy OPCODE Description	DOEHRS-IH Process Category	DOEHRS-IH Common Process	DOEHRS-IH Method
CON-002-00	Electrical Installation/Repair, Multiple Operations	Industrial	Electrical/Electronics	Electrical, Multiple Operations
CON-002-99	Electrical Installation/Repair, NEC	Industrial	Electrical/Electronics	Electrical, Installation/Repair
CON-003-00	Plastering And Related Tasks, Multiple Operations	Industrial	Drywall/Plastering	Plastering, Multiple Operations
CON-003-01	Drywall Installation	Industrial	Drywall/Plastering	Drywall Installation
CON-003-02	Plastering And Related Tasks, Mix And Apply	Industrial	Drywall/Plastering	Plastering
CON-003-99	Plastering And Related Tasks, NEC	Industrial	Drywall/Plastering	Drywall/Plastering, NOC
CON-004-00	Plumbing Installation/Repair, Multiple Operations	Industrial	Plumbing	Plumbing Installation/Repair
CON-004-01	Plumbing Installation/Repair, Transite Water Pipe	Industrial	Plumbing	Plumbing, Transite Water Pipe
CON-004-99	Plumbing Installation/Repair, NEC	Industrial	Plumbing	Plumbing, NOC
CON-005-00	Structure Demolition, Multiple Operations	Industrial	Structure Demolition	Structure Demolition, Multiple Operations
CON-005-01	Structure Demolition, Roof Removal	Industrial	Structure Demolition	Structure Demolition, Roof Removal
CON-005-02	Structure Demolition, Floor Tile Removal	Industrial	Structure Demolition	Structure Demolition, Floor Tile Removal
CON-005-03	Structure Demolition, Siding Removal	Industrial	Structure Demolition	Structure Demolition, Siding Removal
CON-005-04	Structure Demolition, Ceiling Tile Removal	Industrial	Structure Demolition	Structure Demolition, Ceiling Tile Removal
CON-005-05	Structure Demolition, Transite Panel Removal	Industrial	Structure Fabrication/Renovation	Structure Fabrication/Renovation, Transite Panel Removal
CON-005-06	Structure Demolition, Mastic Removal	Industrial	Structure Demolition	Structure Demolition, Mastic Removal
CON-005-99	Structure Demolition, NEC	Industrial	Structure Demolition	Structure Demolition, NOC
CON-006-00	Concrete And Masonry Work, Multiple Operations	Industrial	Cementing And Related Tasks	Cementing And Related Tasks, Multiple Operations
CON-006-01	Concrete And Masonry Work, Brick Cutting	Industrial	Cementing And Related Tasks	Brick Cutting
CON-006-02	Concrete And Masonry Work, Jack Hammering	Industrial	Roads & Grounds Maintenance	Jackhammering

NAVY OPERATION CODES (OPCODES) TO DOEHRS-IH PROCESS PICKLISTS MAPPINGS

NAVY OPCODE	Navy OPCODE Description	DOEHRS-IH Process Category	DOEHRS-IH Common Process	DOEHRS-IH Method
CON-006-03	Concrete And Masonry Work, Cement/Mortar Mixing	Industrial	Cementing And Related Tasks	Cement/Mortar Mixing
CON-006-99	Concrete And Masonry Work, NEC	Industrial	Cementing And Related Tasks	Cementing And Related Tasks, NOC
CON-007-00	Excavating/Grading, Multiple Operations	Industrial	Roads & Grounds Maintenance	Excavating/Grading
CON-007-99	Excavating/Grading, NEC	Industrial	Roads & Grounds Maintenance	Digging/Excavating, Machine
CON-008-00	Paving, Multiple Operations	Industrial	Roads & Grounds Maintenance	Paving
CON-008-99	Paving, NEC	Industrial	Roads & Grounds Maintenance	Paving
CON-009-00	Well Drilling, Multiple Operations	Industrial	Miscellaneous Operations	Well Drilling
CON-009-99	Well Drilling, NEC	Industrial	Miscellaneous Operations	Well Drilling
CON-999-99	Construction, NEC	Industrial	Structure Fabrication/Renovation	Structure Fabrication/Renovation, NOC
IND-000-00	Industrial	Industrial	Miscellaneous Operations	Industrial, NOC
IND-000-01	Noise Hazardous Equipment Use/Working In A Noise Hazardous Area	Industrial	Miscellaneous Operations	Noise Hazardous Equipment Use
IND-001-00	Metal Cleaning Mechanical, Multiple Operations	Industrial	Cleaning- Mechanical	Metal Cleaning, Multiple Operations
IND-001-01	Abrasive Blast, Hydro	Industrial	Coating/Paint Removal	Abrasive Blast, Hydro
IND-001-02	Abrasive Blast, Glass Bead	Industrial	Coating/Paint Removal	Abrasive Blast, Glass Bead
IND-001-03	Abrasive Blast, Mineral Grit	Industrial	Coating/Paint Removal	Abrasive Blast, Mineral Grit
IND-001-04	Abrasive Blast, Sand	Industrial	Coating/Paint Removal	Abrasive Blast, Sand
IND-001-05	Abrasive Blast, Shot	Industrial	Coating/Paint Removal	Abrasive Blast, Shot
IND-001-06	Abrasive Blast, Organics	Industrial	Coating/Paint Removal	Abrasive Blast, Organics
IND-001-07	Barrel Finishing	Industrial	Cleaning- Mechanical	Barrel Finishing
IND-001-08	Metal Cleaning Mechanical, Grinding	Industrial	Cleaning- Mechanical	Metal Cleaning, Grinding
IND-001-09	Metal Cleaning Mechanical, Polishing And Buffing	Industrial	Cleaning- Mechanical	Metal Cleaning, Polishing And Buffing
IND-001-10	Metal Cleaning Mechanical, Wirebrushing	Industrial	Cleaning- Mechanical	Metal Cleaning, Wirebrushing
IND-001-11	Metal Cleaning Mechanical, Sanding	Industrial	Cleaning- Mechanical	Metal Cleaning, Sanding
IND-001-12	Metal Cleaning Mechanical, Needlegunning	Industrial	Coating/Paint Removal	Coating/Paint Removal, Needlegunning
IND-001-13	Abrasive Blast, Cleanup, General	Industrial	Coating/Paint Removal	Abrasive Blast, Cleanup

NAVY OPERATION CODES (OPCODES) TO DOEHRS-IH PROCESS PICKLISTS MAPPINGS

NAVY OPCODE	Navy OPCODE Description	DOEHRS-IH Process Category	DOEHRS-IH Common Process	DOEHRS-IH Method
IND-001-14	Abrasive Blast, Glove Box	Industrial	Coating/Paint Removal	Abrasive Blast, Glove Box, NOC
IND-001-15	Abrasive Blast, Hopper Tending/Helper	Industrial	Coating/Paint Removal	Abrasive Blast, Hopper Tending/Helper
IND-001-16	Abrasive Blast, Aluminum Oxide	Industrial	Coating/Paint Removal	Abrasive Blast, Aluminum Oxide
IND-001-17	Metal Cleaning Mechanical, Chipping	Industrial	Cleaning- Mechanical	Metal Cleaning, Chipping
IND-001-18	Metal Cleaning Mechanical, Deck Crawler	Industrial	Cleaning- Mechanical	Metal Cleaning, Deck Crawler
IND-001-19	Abrasive Blast, Cleanup, Cabinets	Industrial	Coating/Paint Removal	Abrasive Blast, Cleanup, Cabinets
IND-001-20	Abrasive Blast, Cleanup, Waterfront	Industrial	Coating/Paint Removal	Abrasive Blast, Cleanup, Waterfront
IND-001-21	Abrasive Blast, Cleanup, Walk-In Booths	Industrial	Coating/Paint Removal	Abrasive Blast, Cleanup
IND-001-22	Abrasive Blast, Soda	Industrial	Coating/Paint Removal	Abrasive Blasting, Soda
IND-001-23	Abrasive Blast, Vacuum	Industrial	Coating/Paint Removal	Abrasive Blasting, Vacuum
IND-001-99	Metal Cleaning Mechanical, NEC	Industrial	Cleaning- Mechanical	Cleaning- Mechanical, NOC
IND-002-00	Cleaning, Chemical, Multiple Operations	Industrial	Cleaning- Chemical, & Degreasing	Cleaning, Chemical, Multiple Operations
IND-002-01	Acid Cleaning, Bright Dip	Industrial	Cleaning- Chemical, & Degreasing	Acid Cleaning, Bright Dip
IND-002-02	Acid Cleaning, Pickling	Industrial	Cleaning- Chemical, & Degreasing	Acid Cleaning, Pickling
IND-002-03	Acid Cleaning, Descaling	Industrial	Cleaning- Chemical, & Degreasing	Acid Cleaning, Descaling
IND-002-04	Alkali Cleaning, Descaling	Industrial	Cleaning- Chemical, & Degreasing	Cleaning, Chemical
IND-002-05	Alkali Cleaning, Etching	Industrial	Cleaning- Chemical, & Degreasing	Alkali Cleaning, Etching
IND-002-06	Degreasing, Wipe Cleaning	Industrial	Cleaning- Chemical, & Degreasing	Degreasing, Wipe Cleaning
IND-002-07	Degreasing, Dipping	Industrial	Cleaning- Chemical, & Degreasing	Degreasing, Dip Tank, Cold
IND-002-08	Degreasing, Spray	Industrial	Cleaning- Chemical, & Degreasing	Degreasing, Spray
IND-002-09	Degreasing, Vapor	Industrial	Cleaning- Chemical, & Degreasing	Degreasing, Vapor
IND-002-10	Degreasing, Emulsion	Industrial	Cleaning- Chemical, & Degreasing	Degreasing, Emulsion
IND-002-11	Acid Cleaning, Wipe	Industrial	Cleaning- Chemical, & Degreasing	Acid Cleaning, Wipe
IND-002-12	Acid Cleaning, Spray	Industrial	Cleaning- Chemical, & Degreasing	Acid Cleaning, Spray
IND-002-13	Steam Cleaning	Industrial	Cleaning- Other	Cleaning, Other- Steam
IND-002-14	Chemical Paint Stripping	Industrial	Cleaning- Chemical, & Degreasing	Chemical Stripping
IND-002-15	Gauge Cleaning/Flushing	Industrial	Cleaning- Chemical, & Degreasing	Cleaning/Washing, Flush Cleaning
IND-002-16	Detergent Cleaning, Washing	Industrial	Cleaning- Chemical, & Degreasing	Cleaning/Washing, Detergent
IND-002-17	Acid Cleaning, Etching	Industrial	Cleaning- Chemical, & Degreasing	Acid Cleaning, Etching

NAVY OPERATION CODES (OPCODES) TO DOEHRS-IH PROCESS PICKLISTS MAPPINGS

NAVY OPCODE	Navy OPCODE Description	DOEHRS-IH Process Category	DOEHRS-IH Common Process	DOEHRS-IH Method
IND-002-18	Acid Cleaning, Flushing	Industrial	Cleaning- Chemical, & Degreasing	Cleaning/Washing, Flush Cleaning
IND-002-19	Power Washing	Industrial	Cleaning- Other	Cleaning, Other- Powered
IND-002-20	Water Jetting/Lancing	Industrial	Cleaning- Other	Cleaning, Other- Powered
IND-002-99	Cleaning, Chemical, NEC	Industrial	Cleaning- Chemical, & Degreasing	Cleaning, Chemical
IND-003-00	Cleaning, Other, Multiple Operations	Industrial	Cleaning- Other	Cleaning, Other- Multiple Operations
IND-003-01	Cleaning, Other, Ultrasonic	Industrial	Cleaning- Other	Cleaning, Other- Ultrasonic Cleaning
IND-003-02	Cleaning, Other, Hand Sanding	Industrial	Cleaning- Other	Cleaning, Other- Hand Sanding
IND-003-03	Cleaning, Other, Manual Wirebrushing	Industrial	Cleaning- Other	Cleaning, Other- Manual Wirebrushing
IND-003-04	Cleaning, Other, Scraping	Industrial	Cleaning- Other	Cleaning, Other- Scraping
IND-003-99	Cleaning, Other, NEC	Industrial	Cleaning- Other	Cleaning, Other- NOC
IND-004-00	Electroplating, Multiple Operations	Industrial	Electroplating	Electroplating, NOC
IND-004-01	Electroplating, Selective/Brush Plating	Industrial	Electroplating	Selective Plating
IND-004-02	Electroplating, Open Tank	Industrial	Electroplating	Electroplating, Dip Tank
IND-004-03	Electroplating, Vaporization	Industrial	Electroplating	Electroplating, Vaporization
IND-004-04	Mixing Electroplating Solutions	Industrial	Electroplating	Electroplating, Mixing/Pouring Solutions
IND-004-99	Electroplating, NEC	Industrial	Electroplating	Electroplating, NOC
IND-005-00	Painting, Multiple Operations	Industrial	Coating/Painting Operations	Coating/Painting, Multiple Operations
IND-005-01	Spray Painting, Compressed Air	Industrial	Coating/Painting Operations	Coating/Painting, Spray - Standard Gun
IND-005-02	Spray Painting, Airless	Industrial	Coating/Painting Operations	Coating/Painting, Airless Spraying
IND-005-03	Spray Painting, Electrostatic	Industrial	Coating/Painting Operations	Coating/Painting, Spray - Electrostatic Automatic
IND-005-04	Powder Coating	Industrial	Coating/Painting Operations	Coating, Powder
IND-005-05	Brush/Roller Painting	Industrial	Coating/Painting Operations	Coating/Painting, Brush/Roller
IND-005-06	Dip Painting	Industrial	Coating/Painting Operations	Coating/Painting, Dip
IND-005-07	Spray Painting, Aerosol Can	Industrial	Coating/Painting Operations	Coating/Painting, Spray/Aerosol
IND-005-08	Paint Mixing/Pouring	Industrial	Coating/Painting Operations	Coating/Paint Mixing/Pouring
IND-005-09	Spray Painting, High Volume Low Pressure (HVLP)	Industrial	Coating/Painting Operations	Coating/Painting, Spray - HVLP Gun
IND-005-10	Spray Painting, Air Brush	Industrial	Coating/Painting Operations	Coating/Painting, Airbrushing

NAVY OPERATION CODES (OPCODES) TO DOEHRS-IH PROCESS PICKLISTS MAPPINGS

NAVY OPCODE	Navy OPCODE Description	DOEHRS-IH Process Category	DOEHRS-IH Common Process	DOEHRS-IH Method
IND-005-11	Paint Pen Touch Up Painting	Industrial	Coating/Painting Operations	Painting, Pen Touchup
IND-005-12	Cleaning Painting Equipment	Industrial	Coating/Painting Operations	Coating/Painting, Cleaning Equipment
IND-005-99	Painting, NEC	Industrial	Coating/Painting Operations	Coating/Painting Operations, NOC
IND-006-00	Coating Operations, Multiple Operations	Industrial	Coating/Painting Operations	Coating/Painting, Multiple Operations
IND-006-01	Coating Operations, Dip	Industrial	Coating/Painting Operations	Coating/Painting, Dip
IND-006-02	Coating Operations, Wipe	Industrial	Coating/Painting Operations	Coating, Wipe
IND-006-03	Coating Operations, Brush/Roller	Industrial	Coating/Painting Operations	Coating/Painting, Brush/Roller
IND-006-04	Coating Operations, Spray	Industrial	Coating/Painting Operations	Coating/Painting, Spray/Aerosol
IND-006-05	Coating Operations, Tinning	Industrial	Brazing/Soldering/Welding/Cutting	Tinning
IND-006-99	Coating Operations, NEC	Industrial	Coating/Painting Operations	Coating/Painting Operations, NOC
IND-007-00	Metal Forming, Multiple Operations	Industrial	Metal Forming	Metal Forming, Multiple Operations
IND-007-01	Metal Forming, Forging	Industrial	Metal Foundry Operations	Forging
IND-007-02	Metal Forming, Extrusion	Industrial	Metal Forming	Metal Forming, Extrusion
IND-007-03	Metal Forming, Bending/Forming	Industrial	Metal Forming	Metal Forming, Bending
IND-007-04	Metal Forming, Squeezing	Industrial	Metal Forming	Metal Forming, Squeezing
IND-007-05	Metal Forming, Drawing	Industrial	Metal Forming	Metal Forming, Drawing
IND-007-99	Metal Forming, NEC	Industrial	Metal Forming	Metal Forming, NOC
IND-008-00	Heat Treating/Hardening, Multiple Operations	Industrial	Metals Treatment	Heat Treating/Hardening, Multiple Operations
IND-008-01	Heat Treating/Hardening, Carburizing	Industrial	Metals Treatment	Heat Treating/Hardening, Carburizing
IND-008-02	Heat Treating/Hardening, Cyaniding	Industrial	Metals Treatment	Heat Treating/Hardening, Cyaniding
IND-008-03	Heat Treating/Hardening, Gas Nitriding	Industrial	Metals Treatment	Heat Treating/Hardening, Gas Nitriding
IND-008-04	Heat Treating/Hardening, Annealing	Industrial	Metals Treatment	Heat Treating/Hardening, Annealing
IND-008-05	Heat Treating/Hardening, Quenching	Industrial	Metals Treatment	Heat Treating/Hardening, Quenching
IND-008-99	Heat Treating/Hardening, NEC	Industrial	Metals Treatment	Heat Treating/Hardening, NOC
IND-009-00	Foundry Operations, Multiple Operations	Industrial	Metal Foundry Operations	Foundry Operations, Multiple Operations
IND-009-01	Molding, Green Sand	Industrial	Metal Foundry Operations	Molding, Green Sand
IND-009-02	Molding, Shell	Industrial	Metal Foundry Operations	Molding, Shell
IND-009-03	Molding, Investment Casting	Industrial	Metal Foundry Operations	Molding, Investment Casting

NAVY OPERATION CODES (OPCODES) TO DOEHRS-IH PROCESS PICKLISTS MAPPINGS

NAVY OPCODE	Navy OPCODE Description	DOEHRS-IH Process Category	DOEHRS-IH Common Process	DOEHRS-IH Method
IND-009-04	Molding, Full Mold	Industrial	Metal Foundry Operations	Molding, Full Mold
IND-009-05	Coremaking, Sodium Silicate	Industrial	Metal Foundry Operations	Coremaking, Sodium Silicate
IND-009-06	Coremaking, Hot Box System	Industrial	Metal Foundry Operations	Coremaking, Hot Box System
IND-009-07	Coremaking, No Bake	Industrial	Metal Foundry Operations	Coremaking, No Bake
IND-009-08	Coremaking, Shell	Industrial	Metal Foundry Operations	Coremaking, Shell
IND-009-09	Casting, Furnace Melting	Industrial	Metal Foundry Operations	Casting, Furnace Melting
IND-009-10	Casting, Open Hearth	Industrial	Metal Foundry Operations	Casting, Open Hearth
IND-009-11	Casting, Arc Furnace	Industrial	Metal Foundry Operations	Casting, Arc Furnace
IND-009-12	Casting, Induction Furnace	Industrial	Metal Foundry Operations	Casting, Induction Furnace
IND-009-13	Casting, Crucible Furnace	Industrial	Metal Foundry Operations	Casting, Crucible Furnace
IND-009-14	Casting, Cupola	Industrial	Metal Foundry Operations	Casting, Cupola
IND-009-15	Transfer, Pouring, Cooling	Industrial	Metal Foundry Operations	Transfer/Pouring/Cooling
IND-009-16	Shakeout	Industrial	Metal Foundry Operations	Metal Mold Shakeout
IND-009-17	Cleaning And Finishing	Industrial	Metal Foundry Operations	Cleaning And Finishing
IND-009-18	Babbitting	Industrial	Metal Foundry Operations	Foundry Operations, Babbitting
IND-009-19	Small Melt/Pour Operations	Industrial	Metal Foundry Operations	Small Melt/Pour Operations
IND-009-99	Foundry Operations, NEC	Industrial	Metal Foundry Operations	Foundry Operations, NOC
IND-010-00	Metal Machining, Multiple Operations	Industrial	Metal Machining	Metal Machining, Multiple Operations
IND-010-01	Metal Machining, Cutting	Industrial	Metal Machining	Cutting, Abrasive Blast Method
IND-010-02	Metal Machining, Piercing/Punching	Industrial	Metal Machining	Piercing Or Punching
IND-010-03	Metal Machining, Sawing	Industrial	Metal Machining	Sawing
IND-010-04	Metal Machining, Abrasive Grinding	Industrial	Metal Machining	Grinding
IND-010-05	Metal Machining, Drilling/Boring	Industrial	Metal Machining	Drilling And Boring
IND-010-06	Metal Machining, Milling	Industrial	Metal Machining	Milling
IND-010-07	Metal Machining, Turning	Industrial	Metal Machining	Turning
IND-010-08	Metal Machining, Shaping/Slotting	Industrial	Metal Machining	Shaping
IND-010-09	Metal Riveting	Industrial	Metal Machining	Riveting
IND-010-10	Metal Machining, Engraving	Industrial	Metal Machining	Metals/Plastic Engraving
IND-010-11	Metal Machining, Pipe Threading	Industrial	Metal Machining	Pipe Threading

NAVY OPERATION CODES (OPCODES) TO DOEHRS-IH PROCESS PICKLISTS MAPPINGS

NAVY OPCODE	Navy OPCODE Description	DOEHRS-IH Process Category	DOEHRS-IH Common Process	DOEHRS-IH Method
IND-010-99	Metal Machining, NEC	Industrial	Metal Machining	Metal Machining, NOC
IND-011-00	Welding, Multiple Operations	Industrial	Brazing/Soldering/Welding/Cutting	Welding, Multiple Operations
IND-011-01	Welding, Resistance	Industrial	Brazing/Soldering/Welding/Cutting	Welding, Resistance Spot
IND-011-03	Welding, Oxyfuel	Industrial	Brazing/Soldering/Welding/Cutting	Welding, Oxyfuel Gas
IND-011-04	Welding, Solid State	Industrial	Brazing/Soldering/Welding/Cutting	Welding, Solid State
IND-011-05	Welding, Brazing	Industrial	Brazing/Soldering/Welding/Cutting	Brazing
IND-011-06	Welding, Laser	Industrial	Brazing/Soldering/Welding/Cutting	Welding, Laser
IND-011-07	Welding, Electron Beam	Industrial	Brazing/Soldering/Welding/Cutting	Welding, Electron Beam
IND-011-08	Welding, Shielded Metal Arc (SMAW/Stick)	Industrial	Brazing/Soldering/Welding/Cutting	Welding, Shielded Metal Arc Welding (SMAW/Stick)
IND-011-09	Welding, Gas Metal Arc (GMAW/MIG)	Industrial	Brazing/Soldering/Welding/Cutting	Welding, Gas Metal Arc (MIG)
IND-011-10	Welding, Gas Tungsten Arc (GTAW/TIG)	Industrial	Brazing/Soldering/Welding/Cutting	Welding, Gas Tungsten Arc Welding (TIG)
IND-011-11	Welding, Plasma Arc	Industrial	Brazing/Soldering/Welding/Cutting	Welding, Plasma Arc
IND-011-12	Welding, Air Carbon Arc	Industrial	Brazing/Soldering/Welding/Cutting	Welding, Air Carbon Arc
IND-011-13	Soldering, Electrical (Electrical Soldering Iron)	Industrial	Brazing/Soldering/Welding/Cutting	Soldering, Electrical
IND-011-14	Soldering, Torch	Industrial	Brazing/Soldering/Welding/Cutting	Soldering, Torch
IND-011-15	Welding, Flux Core Processes	Industrial	Brazing/Soldering/Welding/Cutting	Welding, Flux Core Processes
IND-011-16	Hot Work Helper/Firewatch Historical	Industrial	Brazing/Soldering/Welding/Cutting	Hotwork Helper/Firewatch
IND-011-17	Welding, Stud	Industrial	Brazing/Soldering/Welding/Cutting	Welding, Stud
IND-011-18	Welding, Spot	Industrial	Brazing/Soldering/Welding/Cutting	Welding, Spot
IND-011-19	Soldering, Heated Iron	Industrial	Brazing/Soldering/Welding/Cutting	Soldering, Heated Iron
IND-011-20	Welding, Plasma Transferred Arc	Industrial	Brazing/Soldering/Welding/Cutting	Welding, Plasma Arc
IND-011-21	Welding, Helper/Assistant	Industrial	Brazing/Soldering/Welding/Cutting	Hotwork Helper/Firewatch
IND-011-22	Welding, Firewatch	Industrial	Brazing/Soldering/Welding/Cutting	Hotwork Helper/Firewatch
IND-011-99	Welding, NEC	Industrial	Brazing/Soldering/Welding/Cutting	Welding, NOC
IND-012-00	Thermal Spraying, Multiple Operations	Industrial	Thermal Spraying	Thermal Spraying, Mulitple Operations
IND-012-01	Electric Arc Spraying	Industrial	Thermal Spraying	Electric Arc Spraying
IND-012-02	Flame Spraying	Industrial	Thermal Spraying	Flame Spraying

NAVY OPERATION CODES (OPCODES) TO DOEHRS-IH PROCESS PICKLISTS MAPPINGS

NAVY OPCODE	Navy OPCODE Description	DOEHRS-IH Process Category	DOEHRS-IH Common Process	DOEHRS-IH Method
IND-012-03	Plasma Spraying	Industrial	Thermal Spraying	Plasma Spraying
IND-012-04	High Velocity Oxyfuel (HVOF) Spraying	Industrial	Thermal Spraying	High Velocity Oxyfuel (HVOF) Spraying
IND-012-05	Thermal Spraying, Helper/Assistant	Industrial	Thermal Spraying	Hotwork Helper/Firewatch
IND-012-99	Thermal Spraying, NEC	Industrial	Thermal Spraying	Thermal Spraying, NOC
IND-013-00	Cutting, Multiple Operations	Industrial	Brazing/Soldering/Welding/Cutting	Cutting, Multiple Operations
IND-013-01	Thermal Cutting	Industrial	Brazing/Soldering/Welding/Cutting	Cutting, Thermal
IND-013-02	Oxygen Cutting	Industrial	Brazing/Soldering/Welding/Cutting	Cutting, Oxygen/Oxyacetylene
IND-013-03	Arc Cutting	Industrial	Brazing/Soldering/Welding/Cutting	Cutting, Arc
IND-013-04	Electron Beam Cutting	Industrial	Brazing/Soldering/Welding/Cutting	Cutting, Electron Beam
IND-013-05	Laser Cutting	Industrial	Brazing/Soldering/Welding/Cutting	Cutting, Laser
IND-013-06	Air Carbon Arc Cutting	Industrial	Brazing/Soldering/Welding/Cutting	Cutting, Air Carbon Arc
IND-013-07	Plasma Cutting	Industrial	Brazing/Soldering/Welding/Cutting	Cutting, Plasma
IND-013-08	Cutting, Helper/Assistant	Industrial	Brazing/Soldering/Welding/Cutting	Hotwork Helper/Firewatch
IND-013-09	Cutting, Firewatch	Industrial	Brazing/Soldering/Welding/Cutting	Hotwork Helper/Firewatch
IND-013-99	Cutting, NEC	Industrial	Brazing/Soldering/Welding/Cutting	Cutting, NOC
IND-014-00	Non-Destructive Test, Multiple Operations	Industrial	Non-Destructive Inspection/Testing	Multiple Operations
IND-014-01	Non-Destructive Test, Visual	Industrial	Non-Destructive Inspection/Testing	Visual Inspection
IND-014-02	Non-Destructive Test, Magnetic Particle Test	Industrial	Non-Destructive Inspection/Testing	Magnetic Particle Test
IND-014-03	Non-Destructive Test, Liquid Penetrant Test	Industrial	Non-Destructive Inspection/Testing	Liquid Penetrant Test
IND-014-04	Non-Destructive Test, Ultrasonic Test	Industrial	Non-Destructive Inspection/Testing	Ultrasonic Test
IND-014-05	Non-Destructive Test, Acoustical Emission Test	Industrial	Non-Destructive Inspection/Testing	Acoustical Emission Test
IND-014-06	Non-Destructive Test, Radiographic Test	Industrial	Non-Destructive Inspection/Testing	Radiography
IND-014-07	Non-Destructive Test, Laser Inspection	Industrial	Non-Destructive Inspection/Testing	Laser Inspection/Test
IND-014-08	Non-Destructive Test, Weight Test	Industrial	Non-Destructive Inspection/Testing	Weight Test
IND-014-09	Non-Destructive Test, Acid Spot Test	Industrial	Non-Destructive Inspection/Testing	Acid Spot Testing
IND-014-10	Non-Destructive Test, Patch Test	Industrial	Non-Destructive Inspection/Testing	Patch Test

NAVY OPERATION CODES (OPCODES) TO DOEHRS-IH PROCESS PICKLISTS MAPPINGS

NAVY OPCODE	Navy OPCODE Description	DOEHRS-IH Process Category	DOEHRS-IH Common Process	DOEHRS-IH Method
IND-014-99	Non-Destructive Test, NEC	Industrial	Non-Destructive Inspection/Testing	Non-Destructive Inspection/Testing, NOC
IND-015-00	Plastics/Rubber Processing, Multiple Operations	Industrial	Plastics/Rubber Processing	Processing, Multiple Operations
IND-015-01	Plastics/Rubber Potting	Industrial	Plastics/Rubber Processing	Potting
IND-015-02	Plastics/Rubber Depotting	Industrial	Plastics/Rubber Processing	Depotting
IND-015-03	Plastics/Rubber Molding	Industrial	Plastics/Rubber Processing	Molding, Pour
IND-015-04	Plastics/Rubber Foaming	Industrial	Plastics/Rubber Processing	Foaming
IND-015-05	Plastics/Rubber Grinding	Industrial	Plastics/Rubber Processing	Grinding
IND-015-06	Plastics/Rubber Cutting	Industrial	Plastics/Rubber Processing	Cutting
IND-015-07	Plastics/Rubber Drilling	Industrial	Plastics/Rubber Processing	Drilling
IND-015-08	Plastics/Rubber Gluing	Industrial	Plastics/Rubber Processing	Gluing
IND-015-09	Plastics/Rubber Mixing	Industrial	Plastics/Rubber Processing	Mixing, Machine-Assisted
IND-015-10	Helmet Pour	Industrial	Plastics/Rubber Processing	Helmet Pour
IND-015-11	Plaque Pour	Industrial	Plastics/Rubber Processing	Plaque Pour
IND-015-12	Plastics/Rubber Sanding	Industrial	Plastics/Rubber Processing	Sanding
IND-015-13	Plastics/Rubber Polishing And Buffing	Industrial	Plastics/Rubber Processing	Polishing And Buffing
IND-015-14	Plastics/Rubber Heat Sealing	Industrial	Plastics/Rubber Processing	Heat Sealing
IND-015-15	Plastics/Rubber Milling/Machining/Engraving	Industrial	Plastics/Rubber Processing	Milling/Machining/Engraving
IND-015-99	Plastics/Rubber Processing, NEC	Industrial	Plastics/Rubber Processing	Plastics/Rubber Processing, NOC
IND-016-00	Fiber Reinforced Composite, Multiple Operations	Industrial	Composite Work	Composite Work, Multiple Operations
IND-016-01	Fiber Reinforced Composite, Layup, Hand	Industrial	Composite Work	Composite Work, Layup- Hand
IND-016-02	Fiber Reinforced Composite, Layup, Spray	Industrial	Composite Work	Composite Work, Layup- Spray
IND-016-03	Fiber Reinforced Composite, Grind/Sand, Mechanical	Industrial	Composite Work	Composite Work, Grinding/Sanding
IND-016-04	Fiber Reinforced Composite, Cutting	Industrial	Composite Work	Composite Work, Cutting
IND-016-05	Fiber Reinforced Composite, Drilling	Industrial	Composite Work	Composite Work, Drilling

NAVY OPERATION CODES (OPCODES) TO DOEHRS-IH PROCESS PICKLISTS MAPPINGS

NAVY OPCODE	Navy OPCODE Description	DOEHRS-IH Process Category	DOEHRS-IH Common Process	DOEHRS-IH Method
IND-016-06	Fiber Reinforced Composite, Remove Coatings, Sand	Industrial	Composite Work	Composite Work, Remove Paint/Sand
IND-016-07	Fiber Reinforced Composite, Remove Coatings, Needlegun	Industrial	Composite Work	Composite Work, Remove Paint- Needlegun
IND-016-08	Fiber Reinforced Composite, Remove Coatings, Grind	Industrial	Composite Work	Composite Work, Remove Paint- Grind
IND-016-09	Fiber Reinforced Composite, Remove Coatings, Blast	Industrial	Composite Work	Composite Work, Remove Paint- Blast
IND-016-10	Fiber Reinforced Composite, Mixing	Industrial	Composite Work	Composite Work, Mixing
IND-016-11	Fiber Reinforced Composite, Hand Sanding	Industrial	Composite Work	Composite Work, NOC
IND-016-12	Fiber Reinforced Composite, Remove Coatings, Deck Crawler	Industrial	Composite Work	Composite Work, Deck Crawler
IND-016-99	Fiber Reinforced Composite, NEC	Industrial	Composite Work	Composite Work, NOC
IND-017-00	Insulation, Asbestos, Multiple Operations	Industrial	Asbestos Work	Asbestos Insulation, Multiple Operations
IND-017-01	Asbestos, Installation	Industrial	Asbestos Work	Asbestos, Installation
IND-017-02	Asbestos, Class I, NPE Removal	Industrial	Asbestos Work	Class I OSHA Asbestos Work, Negative Pressure Enclosure
IND-017-03	Asbestos, Fabrication	Industrial	Asbestos Work	Asbestos Work, Fabrication
IND-017-04	Asbestos, Non-Containment Removal	Industrial	Asbestos Work	Non-Containment Removal
IND-017-05	Asbestos, Class I, Multiple Glove Bag Removal	Industrial	Asbestos Work	Class I OSHA Asbestos Work, Multiple Glove Bag
IND-017-06	Asbestos, Gasket Work	Industrial	Asbestos Work	Asbestos Gasket Work
IND-017-07	Asbestos, Ambient Sampling	Industrial	Asbestos Work	Asbestos Air Sampling, Background
IND-017-08	Asbestos, Encapsulation	Industrial	Asbestos Work	Asbestos Abatement, Chemical Encapsulation
IND-017-09	Asbestos, Class I, Mini-Enclosure Removal	Industrial	Asbestos Work	Class I OSHA Asbestos Work, Mini-Enclosure
IND-017-10	Asbestos, Class III, Mini-Enclosure Removal	Industrial	Asbestos Work	Class III OSHA Asbestos Work, Mini-Enclosure
IND-017-11	Asbestos, Class III, Single Glove Bag Removal	Industrial	Asbestos Work	Class III OSHA Asbestos Work, Glove Bag

NAVY OPERATION CODES (OPCODES) TO DOEHRS-IH PROCESS PICKLISTS MAPPINGS

NAVY OPCODE	Navy OPCODE Description	DOEHRS-IH Process Category	DOEHRS-IH Common Process	DOEHRS-IH Method
IND-017-12	Asbestos, Mechanical Loader Bagging	Industrial	Asbestos Work	Handling, Mechanical Loader Bagging
IND-017-13	Asbestos, HEPA Vacuum Maintenance	Industrial	Asbestos Work	Asbestos, HEPA Vacuum Maintenance
IND-017-14	Asbestos, Class I, Glovebox Removal	Industrial	Asbestos Work	Class I OSHA Asbestos Work, Glovebox
IND-017-15	Asbestos, Class I, Waterspray Removal	Industrial	Asbestos Work	Class I OSHA Asbestos Work, Waterspray Process
IND-017-16	Asbestos, Class I, Single Glove Bag Removal	Industrial	Asbestos Work	Class I OSHA Asbestos Work, Single Glove Bag
IND-017-17	Asbestos, Floor Care/Maintenance	Industrial	Asbestos Work	Vinyl Asbestos Tile, Floor Care/Maintenance
IND-017-18	Asbestos, Packing Material Work	Industrial	Asbestos Work	Packing Material
IND-017-99	Insulation, Asbestos, NEC	Industrial	Asbestos Work	Asbestos Work, NOC
IND-018-00	Insulation, Man Made Fibers, Multiple Operations	Industrial	Insulation	Man Made Fibers, Multiple Operations
IND-018-01	Insulation, Man Made Fibers, Installation	Industrial	Insulation	Man-Made Fibers, Installation
IND-018-02	Insulation, Man Made Fibers, Removal	Industrial	Insulation	Man-Made Fibers, Removal
IND-018-03	Insulation, Man Made Fibers, Fabrication	Industrial	Insulation	Man-Made Fibers, Fabrication
IND-018-04	Insulation, Man Made Fibers, Patching	Industrial	Insulation	Man Made Fibers, Patching
IND-018-99	Insulation, Man Made Fibers, NEC	Industrial	Insulation	Man-Made Fibers, NOC
IND-019-00	Insulation, Other, Multiple Operations	Industrial	Insulation	Insulation, Multiple Operations
IND-019-01	Insulation, Other, Installation	Industrial	Insulation	Insulation, Installation
IND-019-02	Insulation, Other, Removal	Industrial	Insulation	Insulation, Removal
IND-019-03	Insulation, Other, Fabrication	Industrial	Insulation	Insulation, Fabrication
IND-019-04	Insulation, Other, Mixing	Industrial	Insulation	Insulation, NOC
IND-019-99	Insulation, Other, NEC	Industrial	Insulation	Insulation, NOC
IND-020-00	Woodworking, Multiple Operations	Industrial	Woodworking	Woodworking, Multiple Operations
IND-020-01	Woodworking, Cutting	Industrial	Woodworking	Sawing
IND-020-02	Woodworking, Jointing	Industrial	Woodworking	Jointing
IND-020-03	Woodworking, Drilling	Industrial	Woodworking	Drilling
IND-020-04	Woodworking, Mortising/Routing	Industrial	Woodworking	Mortising/Routing
IND-020-05	Woodworking, Turning Lathes	Industrial	Woodworking	Lathes

NAVY OPERATION CODES (OPCODES) TO DOEHRS-IH PROCESS PICKLISTS MAPPINGS

NAVY OPCODE	Navy OPCODE Description	DOEHRS-IH Process Category	DOEHRS-IH Common Process	DOEHRS-IH Method
IND-020-06	Woodworking, Sanding, Drum	Industrial	Woodworking	Sanding, Drum
IND-020-07	Woodworking, Sanding, Disk	Industrial	Woodworking	Sanding, Disk
IND-020-08	Woodworking, Sanding, Belt	Industrial	Woodworking	Sanding, Belt
IND-020-09	Woodworking, Sanding, Hand	Industrial	Woodworking	Sanding, Hand
IND-020-10	Woodworking, Preservative Application	Industrial	Woodworking	Preservative Application
IND-020-11	Woodworking, Gluing	Industrial	Woodworking	Gluing
IND-020-12	Woodworking, Staining	Industrial	Woodworking	Staining
IND-020-13	Woodworking, Transparent Finishes	Industrial	Woodworking	Sealing
IND-020-14	Woodworking, Dust Collector Cleaning	Industrial	Woodworking	Dust Collector Cleaning
IND-020-15	Woodworking, Planing	Industrial	Woodworking	Woodworking, Planing
IND-020-16	Woodworking, Milling	Industrial	Woodworking	Woodworking, Milling
IND-020-99	Woodworking, NEC	Industrial	Woodworking	Woodworking, NOC
IND-021-00	Stone, Mineral Handling, Multiple Operations	Industrial	Stone/Mineral Handling	Stone, Mineral Handling, Multiple Operations
IND-021-01	Stone, Mineral Handling, Installation	Industrial	Stone/Mineral Handling	Stone, Mineral Handling, Installation
IND-021-02	Stone, Mineral Handling, Removal	Industrial	Stone/Mineral Handling	Stone, Mineral Handling, Removal
IND-021-03	Stone, Mineral Handling, Cutting	Industrial	Stone/Mineral Handling	Stone, Mineral Handling, Drilling
IND-021-04	Stone, Mineral Handling, Drilling	Industrial	Stone/Mineral Handling	Stone, Mineral Handling, Cutting
IND-021-99	Stone, Mineral Handling, NEC	Industrial	Stone/Mineral Handling	Stone, Mineral Handling, NOC
IND-022-00	Electronics Repair/Maint, Multiple Operations	Industrial	Electrical/Electronics	Electronics Repair, Multiple Operations
IND-022-01	Electronics Repair/Maint, Installation/Repair	Industrial	Electrical/Electronics	Electronics Repair, Installation Repair
IND-022-02	Electronics Repair/Maint, Calibration, Manometric	Industrial	Electrical/Electronics	Electronics Repair, Calibration, Manometric
IND-022-03	Electronics Repair/Maint, Calibration, RFR Equipment	Industrial	Electrical/Electronics	Electronics Repair, Calibration, RFR Equipment
IND-022-04	Electronics Repair/Maint, Operate Equipment	Industrial	Electrical/Electronics	Electronics Repair, Operate Equipment

NAVY OPERATION CODES (OPCODES) TO DOEHRS-IH PROCESS PICKLISTS MAPPINGS

NAVY OPCODE	Navy OPCODE Description	DOEHRS-IH Process Category	DOEHRS-IH Common Process	DOEHRS-IH Method
IND-022-05	Electronics Repair/Maint, Pressurizing Waveguide	Industrial	Electrical/Electronics	Electronics Repair, Pressurizing Waveguide
IND-022-06	Electronics Repair/Maint, Calibration, Other	Industrial	Electrical/Electronics	Electronics Repair, Calibration, Other
IND-022-99	Electronics Repair/Maint, NEC	Industrial	Electrical/Electronics	Electronics Repair, NOC
IND-023-00	Equipment Repair/Maint/Test, Multiple Operations	Industrial	Equipment Repair/Prev. Maintenance	NOC, Multiple Operations
IND-023-01	Equipment Repair/Maint/Test, Hydraulics	Industrial	Equipment Repair/Prev. Maintenance	NOC, Hydraulics
IND-023-02	Equipment Repair/Maint/Test, Generator	Industrial	Equipment Repair/Prev. Maintenance	NOC, Generators
IND-023-03	Equipment Repair/Maint/Test, Aircraft Engine Testing	Industrial	Engine Testing	Jet Engine Testing, All Modes
IND-023-04	Equipment Repair/Maint/Test, Mechanical Assembly/Repair	Industrial	Equipment Repair/Prev. Maintenance	Equipment Assembly/Disassembly
IND-023-05	Equipment Repair/Maint/Test, Engine Accessory Testing	Industrial	Equipment Repair/Prev. Maintenance	Engine Accessory Testing
IND-023-06	Equipment Repair/Maint/Test, Brake/Gearbox/Clutch Repair	Industrial	Equipment Repair/Prev. Maintenance	NOC, Brake/Gearbox/Clutch Work
IND-023-07	Equipment Repair/Maint/Test, Fuel Accessory Testing	Industrial	Equipment Repair/Prev. Maintenance	Fuel Accessory Testing
IND-023-08	Equipment Repair/Maint/Test, Electrical/Battery	Industrial	Equipment Repair/Prev. Maintenance	NOC, Electrical/Battery
IND-023-09	Equipment Repair/Maint/Test, Engine Test	Industrial	Engine Testing	Engine Testing, NOC
IND-023-10	Equipment Repair/Maint/Test, Engine Preservation	Industrial	Equipment Repair/Prev. Maintenance	Engine Preservation
IND-023-11	Equipment Repair/Maint/Test, Ordnance Testing	Industrial	Weapons & Ordnance	Ordnance Testing
IND-023-12	Equipment Repair/Maint/Test, Fuel Cell	Industrial	Fuels	Fuel Cell Repair, NOC
IND-023-13	Equipment Repair/Maint/Test, Sealant/Adhesive Work	Industrial	Adhering/Bonding/Sealing	Adhering/Bonding/Sealing - All Usages
IND-023-14	Equipment Repair/Maint/Test, Body Work	Industrial	Equipment Repair/Prev. Maintenance	NOC, Body Work

NAVY OPERATION CODES (OPCODES) TO DOEHRS-IH PROCESS PICKLISTS MAPPINGS

NAVY OPCODE	Navy OPCODE Description	DOEHRS-IH Process Category	DOEHRS-IH Common Process	DOEHRS-IH Method
IND-023-15	Equipment Repair/Maint/Test, Non-Asbestos Gasket Work	Industrial	Equipment Repair/Prev. Maintenance	NOC, Non-Asbestos Gaskets
IND-023-16	Equipment Repair/Maint/Test, PMS	Industrial	Equipment Repair/Prev. Maintenance	Preventive Maintenance
IND-023-17	Equipment Repair/Maint/Test, Gauge Calibration	Industrial	Equipment Repair/Prev. Maintenance	Gauge Calibration
IND-023-18	Equipment Installation, Pull/Install Cable	Industrial	Equipment Repair/Prev. Maintenance	Equipment Installation, Cable Pulling
IND-023-19	Equipment Installation/Removal	Industrial	Equipment Repair/Prev. Maintenance	Equipment Installation/Removal
IND-023-20	Equipment Repair/Maint/Test, Tire And Wheel	Industrial	Equipment Repair/Prev. Maintenance	NOC, Tire & Wheel
IND-023-21	Equipment Repair/Maint/Test, Elevator/Hoist	Industrial	Equipment Repair/Prev. Maintenance	NOC, Elevator/Hoist
IND-023-22	Equipment Repair/Maint/Test, Pump	Industrial	Equipment Repair/Prev. Maintenance	Equipment Repair/Prev. Maint., NOC
IND-023-23	Equipment Repair/Maint/Test, A/C & R	Industrial	Equipment Repair/Prev. Maintenance	Charging/Recharging, NOC
IND-023-24	Equipment Repair/Maint/Test, Liquefied Gas Operations	Industrial	Equipment Repair/Prev. Maintenance	Liquefied Gas Operations
IND-023-99	Equipment Repair/Maint/Test, NEC	Industrial	Equipment Repair/Prev. Maintenance	Equipment Repair/Prev. Maint., NOC
IND-024-00	Chemical Processing, Multiple Operations	Industrial	Miscellaneous Operations	Chemical Processing, NOC
IND-024-01	Chemical Processing, Add/Mix X-Ray Developer	Industrial	X-Ray Processing	X-Ray Developer Chemicals, Add/Mix
IND-024-02	Chemical Processing, X-Ray Developing	Industrial	X-Ray Processing	X-Ray Developing
IND-024-03	Chemical Processing, Change Processing Chemicals	Industrial	X-Ray Processing	X-Ray Developer Chemicals, Change-Out
IND-024-99	Chemical Processing, NEC	Industrial	Miscellaneous Operations	Chemical Processing, NOC
IND-025-00	HM/HW Handling/Cleanup, Multiple Operations	Industrial	HM/HW Handling & Cleanup	Handling/Cleanup, Multiple Operations
IND-025-01	HM/HW Handling/Cleanup, Ballast Installation	Industrial	HM/HW Handling & Cleanup	Handling/Cleanup, Ballast Installation
IND-025-02	HM/HW Handling/Cleanup, Ballast Removal	Industrial	HM/HW Handling & Cleanup	Handling/Cleanup, Ballast Removal
IND-025-03	HM/HW Handling/Cleanup, Asbestos	Industrial	Asbestos Work	Handling/Cleanup, Asbestos
IND-025-04	HM/HW Handling/Cleanup, PCBs	Industrial	HM/HW Handling & Cleanup	Handling/Cleanup, PCBs

NAVY OPERATION CODES (OPCODES) TO DOEHRS-IH PROCESS PICKLISTS MAPPINGS

NAVY OPCODE	Navy OPCODE Description	DOEHRS-IH Process Category	DOEHRS-IH Common Process	DOEHRS-IH Method
IND-025-05	HM/HW Handling Cleanup, Filter Maintenance	Industrial	HM/HW Handling & Cleanup	Handling/Cleanup, Filter Maintenance
IND-025-06	HM/HW Handling Cleanup, Lead Shielding	Industrial	HM/HW Handling & Cleanup	Handling/Cleanup, Lead Shielding
IND-025-07	HM/HW Handling Cleanup, Solvent/Metal Reclamation	Industrial	HM/HW Handling & Cleanup	Handling/Cleanup, Solvent/Metal Reclamation
IND-025-08	HM/HW Handling Cleanup, Container Crush/Puncture	Industrial	HM/HW Handling & Cleanup	Container Crushing/Puncturing
IND-025-09	HM/HW Handling Cleanup, Fluorescent Tube Crushing	Industrial	HM/HW Handling & Cleanup	Light Bulb Crushing
IND-025-10	HM/HW Handling Cleanup, Container Sample/Open	Industrial	HM/HW Handling & Cleanup	Container Opening/Sampling
IND-025-11	HM/HW Handling Cleanup, Pouring	Industrial	HM/HW Handling & Cleanup	Pouring
IND-025-12	HM/HW Handling Cleanup, Issue/Receive	Industrial	HM/HW Handling & Cleanup	Handling/Cleanup, Issue/Receive
IND-025-13	HM/HW Handling Cleanup, Spill Response	Industrial	HM/HW Handling & Cleanup	Handling/Cleanup, Spill Response
IND-025-14	HM/HW Handling Cleanup, Mixed Waste Operations	Industrial	HM/HW Handling & Cleanup	Handling/Cleanup, Mixed Waste Operations
IND-025-15	HM/HW Handling Cleanup, Tank Cleaning/Flushing	Industrial	HM/HW Handling & Cleanup	Handling/Cleanup, Tank Cleaning/Flushing
IND-025-16	HM/HW Handling Cleanup, Aerosol Can Crush/Puncture	Industrial	HM/HW Handling & Cleanup	Handling/Cleanup, Aerosol Can Crush/Puncture
IND-025-17	Plastic Waste Shredder/Processor Operation	Industrial	HM/HW Handling & Cleanup	Plastic Waste Shredder/Processor Operation
IND-025-18	Zinc Anode Work	Industrial	Miscellaneous Operations	Cathodic/Anodic Protection, Zinc Anode Work
IND-025-19	HM/HW Handling Cleanup, HEPA Vacuuming	Industrial	HM/HW Handling & Cleanup	Handling/Cleanup, HEPA Vacuuming
IND-025-99	HM/HW Handling/Cleanup, NEC	Industrial	HM/HW Handling & Cleanup	HM/HW Handling & Cleanup, NOC
IND-026-00	Explosive Production, Multiple Operations	Industrial	Weapons & Ordnance	Explosive Production, Multiple Operations
IND-026-01	Explosive Production, Premix Operations	Industrial	Weapons & Ordnance	Explosive Production, Premix Operations
IND-026-02	Explosive Production, Mixing And Pouring	Industrial	Weapons & Ordnance	Explosive Production, Mixing And Pouring

NAVY OPERATION CODES (OPCODES) TO DOEHRS-IH PROCESS PICKLISTS MAPPINGS

NAVY OPCODE	Navy OPCODE Description	DOEHRS-IH Process Category	DOEHRS-IH Common Process	DOEHRS-IH Method
IND-026-03	Explosive Production, Cleaning Mixing Equipment	Industrial	Weapons & Ordnance	Explosive Production, Cleaning Mixing Equipment
IND-026-04	Explosive Production, Testing	Industrial	Weapons & Ordnance	Explosive Production, Testing
IND-026-05	Explosive Production, Detonation	Industrial	Weapons & Ordnance	Explosive Production, Detonation
IND-026-99	Explosive Production, NEC	Industrial	Weapons & Ordnance	Explosive Production, NOC
IND-027-00	Laboratory, Multiple Operations	Industrial	Laboratory Operations	Multiple Operations
IND-027-01	Laboratory, Fuel Testing	Industrial	Fuels	Fuels Lab
IND-027-99	Laboratory, NEC	Industrial	Laboratory Operations	Laboratory Operations, NOC
IND-028-00	Hyperbaric Atmospheres, Multiple Operations	Industrial	Hyperbaric Atmospheres	Multiple Operations
IND-028-01	Hyperbaric Atmospheres, Sonar Dome Work	Industrial	Hyperbaric Atmospheres	Sonar Dome Work
IND-028-99	Hyperbaric Atmospheres, NEC	Industrial	Hyperbaric Atmospheres	Hyperbaric Atmospheres, NOC
IND-029-00	Electrical, Multiple Operations	Industrial	Electrical/Electronics	Electrical, Multiple Operations
IND-029-01	Electrical, Battery, Charging	Industrial	Electrical/Electronics	Electrical, Battery Charging
IND-029-02	Electrical, Motor Rewind	Industrial	Electrical/Electronics	Electrical, Motor Rewind
IND-029-05	Electrical, Battery, Maintenance	Industrial	Electrical/Electronics	Electrical, Battery Maintenance
IND-029-99	Electrical, NEC	Industrial	Electrical/Electronics	Electrical, NOC
IND-030-00	Boiler Overhaul, Multiple Operations	Industrial	Boiler Overhaul	Multiple Operations
IND-030-01	Boiler Overhaul, Insulating Brick/Block, Cut	Industrial	Boiler Overhaul	Insulating Brick/Block, Cut
IND-030-02	Boiler Overhaul, Insulating Brick/Block, Install	Industrial	Boiler Overhaul	Insulating Brick/Block, Install
IND-030-03	Boiler Overhaul, Insulating Brick/Block, Remove	Industrial	Boiler Overhaul	Insulating Brick/Block, Remove
IND-030-04	Boiler Overhaul, Castable/Mortar Cement, Mixing	Industrial	Boiler Overhaul	Castable/Mortar Cement, Mixing
IND-030-05	Boiler Overhaul, Castable/Mortar Cement, Install	Industrial	Boiler Overhaul	Castable/Mortar Cement, Install
IND-030-06	Boiler Overhaul, Castable/Mortar Cement, Remove	Industrial	Boiler Overhaul	Castable/Mortar Cement, Remove

NAVY OPERATION CODES (OPCODES) TO DOEHRS-IH PROCESS PICKLISTS MAPPINGS

NAVY OPCODE	Navy OPCODE Description	DOEHRS-IH Process Category	DOEHRS-IH Common Process	DOEHRS-IH Method
IND-030-07	Boiler Overhaul, Fiberfrax, Install	Industrial	Boiler Overhaul	Fiberfrax, Install
IND-030-08	Boiler Overhaul, Fiberfrax, Remove	Industrial	Boiler Overhaul	Fiberfrax, Remove
IND-030-09	Boiler Overhaul, Cutting Tubes	Industrial	Boiler Overhaul	Cutting Tubes
IND-030-10	Boiler Overhaul, Cleaning Tubes, Water Jetting	Industrial	Boiler Overhaul	Cleaning Tubes, Water Jetting
IND-030-11	Boiler Overhaul, Boiler Cleaning, Mechanical	Industrial	Boiler Overhaul	Boiler Cleaning, Mechanical
IND-030-12	Boiler Overhaul, Boiler Cleaning, Chemical	Industrial	Boiler Overhaul	Boiler Cleaning, Chemical
IND-030-13	Boiler Overhaul, Boiler Cleanup, General	Industrial	Boiler Overhaul	Boiler Cleanup, General
IND-030-14	Boiler Overhaul, Boiler Inspection	Industrial	Boiler Overhaul	Boiler Inspection
IND-030-99	Boiler Overhaul, NEC	Industrial	Boiler Overhaul	NEC
IND-031-00	Cryogenics, Multiple Operations	Industrial	Miscellaneous Operations	Cryogenics, Multiple Operations
IND-031-01	Cryogenics, Production	Industrial	Miscellaneous Operations	Cryogenics Production
IND-031-02	Cryogenics, Storage	Industrial	Miscellaneous Operations	Cryogenics Storage
IND-031-03	Cryogenics, Handling/Transport	Industrial	Miscellaneous Operations	Cryogenics Handling/Transport
IND-031-04	Cryogenics, Filling Dewar Flasks Or Other Containers	Industrial	Miscellaneous Operations	Cryogenics, Filling Dewar Flasks
IND-031-05	Cryogenics, Freezing Seals/Components	Industrial	Miscellaneous Operations	Cryogenics, Freezing Seals/Components
IND-031-99	Cryogenics, NEC	Industrial	Miscellaneous Operations	Cryogenics, NOC
IND-032-00	Quarrying, Multiple Operations	Industrial	Miscellaneous Operations	Quarrying, Multiple Operations
IND-032-01	Quarrying, Heavy Equipment Operation	Industrial	Miscellaneous Operations	Quarrying, Heavy Equipment Operation
IND-032-02	Quarrying, Drilling	Industrial	Miscellaneous Operations	Quarrying, Drilling
IND-032-03	Quarrying, Blasting/Explosives	Industrial	Miscellaneous Operations	Quarrying, Blasting/Explosives
IND-032-99	Quarrying, NEC	Industrial	Stone/Mineral Handling	Quarry Work
IND-999-99	Industrial, NEC	Industrial	Miscellaneous Operations	Industrial, NOC
MED-001-00	Medical, Multiple Operations	Industrial	Medical	Medical, Multiple Operations
MED-001-01	Medical, EtO Sterilization	Industrial	Medical	Sterilization, EtO
MED-001-02	Medical, Anesthetic Administration	Industrial	Medical	Anesthesia

NAVY OPERATION CODES (OPCODES) TO DOEHRS-IH PROCESS PICKLISTS MAPPINGS

NAVY OPCODE	Navy OPCODE Description	DOEHRS-IH Process Category	DOEHRS-IH Common Process	DOEHRS-IH Method
MED-001-03	Medical, Anatomical Specimen Preservation	Industrial	Medical	Anatomical Specimen Preservation
MED-001-04	Medical, Tissue/Organ Grossing	Industrial	Medical	Tissue/Organ Grossing
MED-001-05	Medical, Cast Cutting	Industrial	Medical	Cast Cutting
MED-001-06	Medical, Corrective Lens Edging	Industrial	Medical	Corrective Lens Edging
MED-001-07	Medical, Corrective Lens Generating	Industrial	Medical	Corrective Lens Manufacturing
MED-001-08	Medical, Cryotherapy	Industrial	Medical	Cryotherapy
MED-001-09	Medical, Sterilization/Disinfection, Other	Industrial	Medical	Sterilization, NOC
MED-001-10	Medical, Tissue Disposal	Industrial	Medical	Tissue Disposal
MED-001-11	Medical, Tissue Conference	Industrial	Medical	Tissue Conference
MED-001-12	Medical, General OR Operations	Industrial	Medical	Medical, General Or Operations
MED-001-13	Medical, Manufacture Of Orthotic Devices	Industrial	Medical	Manufacture Of Orthotic Devices
MED-001-14	Medical, Surgery	Industrial	Medical	Surgical Procedures
MED-001-15	Medical, Handling Medical Waste	Industrial	Medical	Handling Medical Waste
MED-001-16	Medical, Phlebotomy (Blood Collection)	Industrial	Medical	Phlebotomy
MED-001-17	Medical, Collection Of Body Fluid/Waste Samples	Industrial	Medical	Collection Of Body Fluid/Waste Samples
MED-001-18	Medical, Laboratory Analysis Of Biological Specimens	Industrial	Medical	Lab Analysis
MED-001-19	Medical, Radiology	Industrial	Medical	Medical, Radiology Procedures, NOC
MED-001-20	Medical, Embalming	Industrial	Medical	Embalming
MED-001-21	Medical, Administering Pharmaceuticals	Industrial	Medical	Administering Pharmaceuticals
MED-001-22	Medical, Formulating Pharmaceuticals	Industrial	Medical	Pharmaceutical Mixing/Dispensing
MED-001-23	Medical, Autopsy/Cadaver Work	Industrial	Medical	Autopsy/Cadaver Work
MED-001-99	Medical, NEC	Industrial	Medical	Medical, NOC
MED-002-00	Dental, Multiple Operations	Industrial	Dental	Dental, Multiple Operations
MED-002-01	Dental, Filling/Drilling	Industrial	Dental	Dental, Filling/Drilling
MED-002-02	Dental, Prosthetics, Grinding	Industrial	Dental	Dental, Prosthetics Grinding
MED-002-03	Dental, EtO Sterilization	Industrial	Dental	Sterilization, Using EtO

NAVY OPERATION CODES (OPCODES) TO DOEHRS-IH PROCESS PICKLISTS MAPPINGS

NAVY OPCODE	Navy OPCODE Description	DOEHRS-IH Process Category	DOEHRS-IH Common Process	DOEHRS-IH Method
MED-002-04	Dental, Anesthetic Administration	Industrial	Dental	Dental, Anesthesia
MED-002-05	Dental, Prosthetics, Casting	Industrial	Dental	Dental, Prosthetics Casting
MED-002-06	Dental, Prosthetics, Acrylics	Industrial	Dental	Dental, Prosthetics/Acrylics
MED-002-07	Dental, Oral Surgery	Industrial	Dental	Oral Surgery
MED-002-08	Dental, Sterilization/Disinfection, Other	Industrial	Dental	Sterilization
MED-002-09	Dental, Prophylaxis	Industrial	Dental	Dental, Prophylaxis
MED-002-10	Dental, Tooth Extraction	Industrial	Dental	Dental, Tooth Extraction
MED-002-11	Dental, Media (e.g. Cement) Application	Industrial	Dental	Dental, Cement Application
MED-002-12	Dental, Acid Etching Teeth	Industrial	Dental	Dental, Acid Etching Teeth
MED-002-13	Dental, Endodontics	Industrial	Dental	Endodontics
MED-002-14	Dental, Radiology	Industrial	Dental	Dental, X-Rays
MED-002-99	Dental, NEC	Industrial	Dental	Dental, NOC
MIL-000-00	Military Specific Operations	Industrial	Weapons & Ordnance	Military Specific Operations
MIL-001-00	Weapons Handling, Multiple Operations	Industrial	Weapons & Ordnance	Weapons/Small Arms Handling, Multiple Operations
MIL-001-01	Range Cleaning	Industrial	Weapons & Ordnance	Weapons/Small Arms, Range Cleaning
MIL-001-02	Weapons Firing	Industrial	Weapons & Ordnance	Weapons/Small Arms Firing, NOC
MIL-001-03	Range Supervision	Industrial	Weapons & Ordnance	Weapons/Small Arms, Range Supervision
MIL-001-04	Pit Cleanup	Industrial	Weapons & Ordnance	Weapons/Small Arms, Backstop/Pit Cleanup
MIL-001-05	Torpedo Fueling/Defueling	Industrial	Weapons & Ordnance	Torpedo Fueling/Defueling
MIL-001-06	Torpedo Disassembly	Industrial	Weapons & Ordnance	Torpedo Disassembly
MIL-001-07	Weapons Cleaning/PMS	Industrial	Weapons & Ordnance	Weapons Cleaning/Preventive Maintenance
MIL-001-08	Torpedo Priming	Industrial	Weapons & Ordnance	Torpedo Priming
MIL-001-09	VLS Canister Offload	Industrial	Weapons & Ordnance	VLS Canister Offload
MIL-001-10	VLS Plenum Cleaning	Industrial	Weapons & Ordnance	VLS Plenum Cleaning
MIL-001-11	VLS Technician Work	Industrial	Weapons & Ordnance	VLS Technician Work
MIL-001-99	Weapons Handling, NEC	Industrial	Weapons & Ordnance	Weapons Handling, NOC
MIL-002-00	Flight Line Operations, Multiple Operations	Industrial	Aircraft/Flightline Operations	Flight Line Operations, Multiple Operations

NAVY OPERATION CODES (OPCODES) TO DOEHRS-IH PROCESS PICKLISTS MAPPINGS

NAVY OPCODE	Navy OPCODE Description	DOEHRS-IH Process Category	DOEHRS-IH Common Process	DOEHRS-IH Method
MIL-002-01	Flight Line Operations, Line Trouble Shooting	Industrial	Aircraft/Flightline Operations	Flight Line Operations, Troubleshooting
MIL-002-02	Flight Line Operations, Aircraft Loading	Industrial	Aircraft/Flightline Operations	Aircraft Loading
MIL-002-03	Flight Line Operations, Launch And Recovery	Industrial	Aircraft/Flightline Operations	Launch And Recovery
MIL-002-04	Flight Line Operations, Fueling/Defueling Aircraft	Industrial	Fuels	Fuel/Defuel Aircraft
MIL-002-05	Flight Line Operations, Liquid Oxygen Handling	Industrial	Aircraft/Flightline Operations	Cryogenics (Liquid Oxygen Handling)
MIL-002-06	Flight Line Operations, Deicing	Industrial	Aircraft/Flightline Operations	Deicing, Chemical
MIL-002-07	Flight Line Operations, Operate Support Equipment	Industrial	Aircraft/Flightline Operations	Operate Support Equipment
MIL-002-08	Flight Line Operations, MK 105 Sled Operation	Industrial	Aircraft/Flightline Operations	MK105 Sled Operation
MIL-002-09	Flight Line Operations, Military Aircraft/Helo Operation	Industrial	Aircraft/Flightline Operations	Aircraft/Flight Line Operations, NOC
MIL-002-99	Flight Line Operations, NEC	Industrial	Aircraft/Flightline Operations	Aircraft/Flight Line Operations, NOC
MIL-003-00	Shipboard Processes, Multiple Operations	Navy	Shipboard Duties	Shipboard Processes, Multiple Operations
MIL-003-01	Shipboard Processes, Watchstanding, Bridge	Navy	Shipboard Duties	Shipboard/Submarine Watchstanding, Bridge
MIL-003-02	Shipboard Processes, Watchstanding, Flight Deck	Navy	Shipboard Duties	Shipboard Watchstanding, Flight Deck
MIL-003-03	Shipboard Processes, Watchstanding, Engineering	Navy	Shipboard Duties	Shipboard/Submarine Drills
MIL-003-04	Shipboard Processes, Watchstanding, Other	Navy	Shipboard Duties	Shipboard/Submarine Watchstanding, Other
MIL-003-05	Shipboard Processes, Drills, BECCE	Navy	Shipboard Duties	Drills, BECCE
MIL-003-06	Shipboard Processes, Drills, General Quarters	Navy	Shipboard Duties	Drills, General Quarters
MIL-003-07	Shipboard Processes, Atmosphere Equipment Maintenance	Navy	Shipboard Duties	Atmosphere Equipment Maintenance

NAVY OPERATION CODES (OPCODES) TO DOEHRS-IH PROCESS PICKLISTS MAPPINGS

NAVY OPCODE	Navy OPCODE Description	DOEHRS-IH Process Category	DOEHRS-IH Common Process	DOEHRS-IH Method
MIL-003-08	Shipboard Processes, Fueling/Defueling	Navy	Shipboard Duties	Fueling/Defueling
MIL-003-09	Shipboard Processes, Line Handling	Navy	Shipboard Duties	Line Handling
MIL-003-10	Shipboard Processes, Well Deck Operations	Navy	Shipboard Duties	Well Deck Operations
MIL-003-11	Shipboard Processes, Anchoring	Navy	Shipboard Duties	Anchoring
MIL-003-12	Shipboard Processes, Working Aloft	Navy	Shipboard Duties	Working Aloft
MIL-003-13	Shipboard Processes, Landing Craft Operations	Navy	Shipboard Duties	Landing Craft Operations
MIL-003-14	Shipboard Processes, Underway (Connected) Replenishment	Navy	Shipboard Duties	Underway Replenishment
MIL-003-15	Shipboard Processes, Watchstanding, Low Visibility	Navy	Shipboard Duties	Shipboard/Submarine Watchstanding, Other
MIL-003-99	Shipboard Processes, NEC	Navy	Shipboard Duties	Shipboard Duties, NOC
MIL-004-00	Military Training, Multiple Operations	Industrial	Miscellaneous Operations	Military Training, Multiple Operations
MIL-004-01	Military Training, Breeching	Industrial	Weapons & Ordnance	Breeching
MIL-004-02	Military Training, Tear Gas Exercises	Industrial	Protective Services-Security	Tear Gas Exercises
MIL-004-03	Military Training, Water Survival	Industrial	Miscellaneous Operations	Military Training, Water Survival
MIL-004-04	Military Training, Indoor Simulated Marksmanship Trainer	Industrial	Weapons & Ordnance	Indoor Simulated Marksmanship Trainer
MIL-004-99	Military Training, NEC	Industrial	Miscellaneous Operations	Military Training, NEC
MIL-999-99	Military Specific Operations, NEC	Industrial	Weapons & Ordnance	Military Specific Operations
MIS-000-00	Miscellaneous, Multiple Operations	Industrial	Miscellaneous Operations	Miscellaneous, Multiple Operations
MIS-000-01	Equipment Monitoring	Industrial	Miscellaneous Operations	Equipment Monitoring
MIS-000-02	Machine Sewing	Industrial	Fabric Work	Machine Sewing
MIS-000-99	Miscellaneous, NEC	Industrial	Miscellaneous Operations	Industrial, NOC
NOC-000-00	Non-Occupational			
NOC-001-00	Residential, Multiple Operations	Industrial	Miscellaneous Operations	Residential, Multiple Operations
NOC-001-01	Residential, Indoor Air Quality	Industrial	Miscellaneous Operations	Residential, Indoor Air Quality
NOC-001-99	Residential, NEC	Industrial	Miscellaneous Operations	Residential, Multiple Operations

NAVY OPERATION CODES (OPCODES) TO DOEHRS-IH PROCESS PICKLISTS MAPPINGS

NAVY OPCODE	Navy OPCODE Description	DOEHRS-IH Process Category	DOEHRS-IH Common Process	DOEHRS-IH Method
NOC-999-99	Non-Occupational, NEC			
PRO-000-00	Professional/Technical And Management	Industrial	Professional/Technical	Professional, Tech And Mgmt
PRO-001-00	Professional/Technical, Multiple Operations	Industrial	Professional/Technical	Professional And Technical, Multiple Operations
PRO-001-01	Laboratory Chemical Analysis/Sampling	Industrial	Professional/Technical	Laboratory, Chemical Analysis/Sampling
PRO-001-02	Musical Performance	Industrial	Professional/Technical	Musical Performance
PRO-001-03	Computer Operations	Industrial	Professional/Technical	Computer Operations
PRO-001-04	Asbestos Inspection And Bulk Sampling	Industrial	Asbestos Work	Asbestos Inspection And Bulk Sampling
PRO-001-05	Asbestos Inspection	Industrial	Asbestos Work	Asbestos Inspection
PRO-001-06	Fiber Counting/Identification	Industrial	Asbestos Work	Asbestos Fiber Counting/Identification
PRO-001-07	Workplace Sampling/Measurements	Industrial	Professional/Technical	Workplace Monitoring/Measurements
PRO-001-08	Worksite/Equipment Inspections	Industrial	Professional/Technical	Safety/Industrial Hygiene Surveys
PRO-001-09	Instruction/Demonstration	Industrial	Professional/Technical	Teaching/Training
PRO-001-99	Professional/Technical, NEC	Industrial	Professional/Technical	Professional/Technical, NOC
PRO-002-00	Management, Multiple Operations	Industrial	Professional/Technical	Management, Multiple Operations
PRO-002-01	Supervision	Industrial	Professional/Technical	Supervision
PRO-002-99	Management, NEC	Industrial	Professional/Technical	Management, NOC
PRO-999-99	Professional/Technical And Management, NEC	Industrial	Professional/Technical	Professional/Technical, NOC
RND-000-00	Research And Development, Multiple Operations	Industrial	Laboratory Operations	Research And Development
RND-000-99	Research And Development, NEC	Industrial	Laboratory Operations	Research And Development, NOC
RND-001-00	Destructive Testing, Multiple Operations	Industrial	Laboratory Operations	Destructive Testing
RND-001-01	Destructive Testing, Abusive Battery	Industrial	Laboratory Operations	Destructive Testing
RND-001-02	Destructive Testing, Strain Gauging	Industrial	Laboratory Operations	Destructive Testing
RND-001-03	Destructive Testing, Pressure/Force	Industrial	Laboratory Operations	Destructive Testing
RND-001-04	Destructive Testing, Explosive	Industrial	Laboratory Operations	Destructive Testing
RND-001-05	Destructive Testing, Burn	Industrial	Laboratory Operations	Destructive Testing
RND-001-06	Destructive Testing, Fatigue	Industrial	Laboratory Operations	Destructive Testing

NAVY OPERATION CODES (OPCODES) TO DOEHRS-IH PROCESS PICKLISTS MAPPINGS

NAVY OPCODE	Navy OPCODE Description	DOEHRS-IH Process Category	DOEHRS-IH Common Process	DOEHRS-IH Method
RND-001-07	Destructive Testing, Impact	Industrial	Laboratory Operations	Destructive Testing
RND-001-08	Destructive Testing, Etching	Industrial	Laboratory Operations	Destructive Testing
RND-001-99	Destructive Testing, NEC	Industrial	Laboratory Operations	Destructive Testing
SER-000-00	Service	Industrial	Miscellaneous Operations	Service, NOC
SER-001-00	Transportation, Multiple Operations	Industrial	Transportation	Transportation, Multiple Operations
SER-001-01	Transportation, Truck Operation	Industrial	Transportation	Driving, Truck
SER-001-02	Transportation, Train Operation	Industrial	Transportation	Train Operation
SER-001-03	Transportation, Tractor Trailer Operation	Industrial	Transportation	Driving, Tractor Trailer
SER-001-04	Transportation, Small Watercraft Operation	Industrial	Transportation	Small Watercraft Operation
SER-001-05	Transportation, Railroad Track Maintenance	Industrial	Transportation	Railroad Track Maintenance
SER-001-06	Transportation, Fueling/Defueling	Industrial	Fuels	Fueling/Defueling, Non-Aircraft
SER-001-07	Transportation, Taxi/Bus Operation	Industrial	Transportation	Driving, Taxi/Bus
SER-001-08	Transportation, Aircraft Operation	Industrial	Aircraft/Flightline Operations	Aircraft/Flight Line Operations, NOC
SER-001-99	Transportation, NEC	Industrial	Transportation	Driving, Unpaved Roads
SER-002-00	Motor Vehicle Maintenance, Multiple Operations	Industrial	Vehicle Maintenance	Vehicle Repair, Multiple Operations
SER-002-01	Motor Vehicle Maintenance, Testing	Industrial	Vehicle Maintenance	Vehicle Testing/Tuning
SER-002-02	Motor Vehicle Repair/Overhaul	Industrial	Vehicle Maintenance	Vehicle Repair, Multiple Operations
SER-002-03	Motor Vehicle Maintenance, Brake Work	Industrial	Vehicle Maintenance	Vehicle Repair, Brake Work
SER-002-04	Motor Vehicle Maintenance, Clutch Work	Industrial	Vehicle Maintenance	Vehicle Repair, Clutch Work
SER-002-05	Motor Vehicle Maintenance, Body Work	Industrial	Vehicle Maintenance	Vehicle Body Repair, NOC
SER-002-99	Motor Vehicle Maintenance, NEC	Industrial	Vehicle Maintenance	Vehicle Maintenance, NOC
SER-003-00	Pest Control, Multiple Operations	Industrial	Pest Control	Pest Control, Multiple Operations
SER-003-01	Pest Control, Mixing	Industrial	Pest Control	Pesticide Mixing
SER-003-02	Pest Control, Pump Spray	Industrial	Pest Control	Pest Control, Sprayer, Powered
SER-003-03	Pest Control, Fogging	Industrial	Pest Control	Pest Control, Fogging
SER-003-04	Pest Control, Fumigation	Industrial	Pest Control	Pest Control, Fumigation

NAVY OPERATION CODES (OPCODES) TO DOEHRS-IH PROCESS PICKLISTS MAPPINGS

NAVY OPCODE	Navy OPCODE Description	DOEHRS-IH Process Category	DOEHRS-IH Common Process	DOEHRS-IH Method
SER-003-05	Pest Control, Aerosol Can Spray	Industrial	Pest Control	Pest Control, Aerosol Can Spray
SER-003-06	Pest Control, Powder Application	Industrial	Pest Control	Pest Control, Powder Application
SER-003-07	Pest Control, Power Spray	Industrial	Pest Control	Pest Control, Power Spraying From Vehicle
SER-003-99	Pest Control, NEC	Industrial	Pest Control	Pest Control, NOC
SER-004-00	Facility Maintenance, Multiple Operations	Industrial	Housekeeping/Janitorial/Maintenance	Facility Maintenance, Multiple Operations
SER-004-01	Facility Maintenance, Sweeping	Industrial	Housekeeping/Janitorial/Maintenance	Sweeping
SER-004-02	Facility Maintenance, AC/R Charging	Industrial	HVAC	Air Conditioning/Refrigeration Charging
SER-004-03	Facility Maintenance, Crawl Space/Attic	Industrial	Housekeeping/Janitorial/Maintenance	Facility Maintenance, Crawl Space/Attic
SER-004-04	Facility Maintenance, Class IV Asbestos	Industrial	Asbestos Work	Class IV OSHA Asbestos Work, Building Maintenance
SER-004-05	Facility Maintenance, Clean Ventilation Systems	Industrial	HVAC	Clean Ventilation System
SER-004-06	Facility Maintenance, Compressed Gas Service	Industrial	Storage Of Materials	Compressed Gas Service
SER-004-07	Facility Maintenance, Plumbing	Industrial	Plumbing	Plumbing, Minor Facility Maintenance
SER-004-08	Facility Maintenance, Electrical	Industrial	Electrical/Electronics	Electrical, Facility Maintenance
SER-004-99	Facility Maintenance, NEC	Industrial	Housekeeping/Janitorial/Maintenance	Facility Maintenance, NOC
SER-005-00	Grounds Maintenance, Multiple Operations	Industrial	Roads & Grounds Maintenance	Grounds Maintenance, Multiple Operations
SER-005-01	Grounds Maintenance, Street Sweeping	Industrial	Roads & Grounds Maintenance	Street Sweeping
SER-005-02	Grounds Maintenance, Lawn Maintenance	Industrial	Roads & Grounds Maintenance	Lawn Maintenance
SER-005-03	Grounds Maintenance, Trash Compacting	Industrial	Miscellaneous Operations	Trash Compacting
SER-005-99	Grounds Maintenance, NEC	Industrial	Roads & Grounds Maintenance	Grounds Maintenance, NOC
SER-006-00	Protective Services, Fire, Multiple Operations	Industrial	Protective Services-Fire	Firefighting
SER-006-01	Protective Services, Fire, Training	Industrial	Protective Services-Fire	Firefighting Training
SER-006-99	Protective Services, Fire, NEC	Industrial	Protective Services-Fire	Protective Services, Fire, NOC
SER-007-00	Protective Services, Security, Multiple Operations	Industrial	Protective Services-Security	Security, Multiple Operations

NAVY OPERATION CODES (OPCODES) TO DOEHRS-IH PROCESS PICKLISTS MAPPINGS

NAVY OPCODE	Navy OPCODE Description	DOEHRS-IH Process Category	DOEHRS-IH Common Process	DOEHRS-IH Method
SER-007-01	Protective Services, Firing Range Cleaning	Industrial	Protective Services-Security	Firing Range Cleaning
SER-007-02	Protective Services, Weapons Firing	Industrial	Protective Services-Security	Small Arms Firing
SER-007-03	Protective Services, Firing Range Supervision	Industrial	Protective Services-Security	Firing Range Supervision
SER-007-04	Protective Services, Firing Range Pit Cleaning	Industrial	Protective Services-Security	Firing Range Pit Cleaning
SER-007-05	Protective Services, Weapons Cleaning	Industrial	Protective Services-Security	Small Arms Cleaning
SER-007-06	Protective Services, Document Shredding	Industrial	Protective Services-Security	Document Shredding
SER-007-07	Protective Services, Guard Operations	Industrial	Protective Services-Security	Guard Operations
SER-007-99	Protective Services, Security, NEC	Industrial	Protective Services-Security	Protective Services- Security, NOC
SER-008-00	Graphic Arts, Multiple Operations	Industrial	Crafts	Crafts, Multiple Operations
SER-008-01	Graphic Arts, Silk Screening	Industrial	Photography/Graphic Arts	Silk Screening
SER-008-02	Graphic Arts, Photography Developing	Industrial	Photography/Graphic Arts	Film Developing, Automatic
SER-008-03	Graphic Arts, Photography Chemical Mixing	Industrial	Photography/Graphic Arts	Film Processor Chemical Mixing
SER-008-04	Graphic Arts, Photography Equipment Cleaning	Industrial	Photography/Graphic Arts	Photography Equipment Cleaning
SER-008-99	Graphic Arts, NEC	Industrial	Crafts	Crafts, NOC
SER-009-00	Recreation, Multiple Operations	Industrial	Recreation/Services	Recreation
SER-009-99	Recreation, NEC	Industrial	Recreation/Services	Recreation/Services, NOC
SER-010-00	Production/Dist. Of Utilities, Multiple Operations	Industrial	Utility Production/Distribution	Production/Dist. Of Utilities, Multiple Operations
SER-010-01	Compressed Breathing Air	Industrial	Utility Production/Distribution	Compressed Air/Breathing Air Distribution
SER-010-02	Boiler Cleaning Historical	Industrial	Utility Production/Distribution	Boiler Cleaning
SER-010-03	Boiler Repair Historical	Industrial	Utility Production/Distribution	Boiler Repair
SER-010-04	Equipment Monitoring	Industrial	Utility Production/Distribution	Equipment Monitoring
SER-010-05	Transformer Repair/Maintenance	Industrial	Utility Production/Distribution	Transformer Repair/Maintenance
SER-010-06	Ship/Shore Connection	Industrial	Utility Production/Distribution	Boiler Water Treatment
SER-010-07	ESP Maintenance/Cleaning	Industrial	Utility Production/Distribution	ESP Maintenance/Cleaning

NAVY OPERATION CODES (OPCODES) TO DOEHRS-IH PROCESS PICKLISTS MAPPINGS

NAVY OPCODE	Navy OPCODE Description	DOEHRS-IH Process Category	DOEHRS-IH Common Process	DOEHRS-IH Method
SER-010-08	Steam Pit Maintenance	Industrial	Utility Production/Distribution	Steam Pit Maintenance
SER-010-99	Production/Dist. Of Utilities, NEC	Industrial	Utility Production/Distribution	Production/Distribution Of Utilities, NOC
SER-011-00	Supply/Materials Handling, Multiple Operations	Industrial	Supplies/Materials Handling	Supply And Materials Handling, Multiple Operations
SER-011-01	Supply/Materials Handling, Foam In Place Packaging	Industrial	Supplies/Materials Handling	Foam-In-Place Packaging
SER-011-02	Supply/Materials Handling, Material Handling Equipment/Forklift Operation	Industrial	Supplies/Materials Handling	Forklift Operation
SER-011-03	Supply/Materials Handling, Tool/Parts Issue	Industrial	Supplies/Materials Handling	Tool And Parts Issue
SER-011-04	Supply/Materials Handling, Crane Operation	Industrial	Supplies/Materials Handling	Crane Operation
SER-011-05	Supply/Materials Handling, Packaging	Industrial	Supplies/Materials Handling	Packaging
SER-011-06	Supply/Materials Handling, Rigging	Industrial	Supplies/Materials Handling	Rigging
SER-011-07	Supply/Materials Handling, Bulk Fuels	Industrial	Fuels	Fuels Distribution
SER-011-99	Supply/Materials Handling, NEC	Industrial	Supplies/Materials Handling	Supply And Materials Handling, NOC
SER-012-00	Printing/Reproduction, Multiple Operations	Industrial	Printing/Reproduction	Printing, Multiple Operations
SER-012-01	Printing/Reproduction, Diazo Printing	Industrial	Printing/Reproduction	Blueprint Developing, Diazo/Blueline Machine
SER-012-02	Printing/Reproduction, Document Preparation	Industrial	Printing/Reproduction	Document Preparation
SER-012-03	Printing/Reproduction, Equipment Cleaning	Industrial	Printing/Reproduction	Equipment Cleaning
SER-012-04	Printing/Reproduction, Offset Printing	Industrial	Printing/Reproduction	Offset Printing
SER-012-05	Printing/Reproduction, Engraving	Industrial	Photography/Graphic Arts	Engraving
SER-012-06	Printing/Reproduction, Operate Equipment	Industrial	Printing/Reproduction	Operate Equipment
SER-012-99	Printing/Reproduction, NEC	Industrial	Printing/Reproduction	Printing/Reproduction, NOC
SER-013-00	Communications, Multiple Operations	Industrial	Communications	Communications, Multiple Operations
SER-013-01	Communications, Teletype Operation	Industrial	Communications	Communications, Teletype Operation
SER-013-02	Communications, Equipment Operation	Industrial	Communications	Communications, Equipment Operation

NAVY OPERATION CODES (OPCODES) TO DOEHRS-IH PROCESS PICKLISTS MAPPINGS

NAVY OPCODE	Navy OPCODE Description	DOEHRS-IH Process Category	DOEHRS-IH Common Process	DOEHRS-IH Method
SER-013-99	Communications, NEC	Industrial	Communications	Communications, NOC
SER-014-00	Food Service, Multiple Operations	Industrial	Food Preparation/Handling	Multiple Operations
SER-014-01	Food Service, Scullery Work	Industrial	Food Preparation/Handling	Scullery Work/Dishwashing
SER-014-02	Food Service, Oven Cleaning	Industrial	Food Preparation/Handling	Oven Cleaning
SER-014-99	Food Service, NEC	Industrial	Food Preparation/Handling	Food Preparation/Handling, NOC
SER-015-00	HW/Sewer Treatment, Multiple Operations	Industrial	Water/Wastewater Plant Operations	Wastewater Treatment, Multiple Operations
SER-015-01	HW/Sewer Treatment, Lift Station Operation/Maintenance	Industrial	Water/Wastewater Plant Operations	Wastewater/Sanitary Sewer Operation And Maintenance
SER-015-02	HW/Sewer Treatment, Lift Station Cleaning	Industrial	Water/Wastewater Plant Operations	Wastewater/Sanitary Sewer Operation And Maintenance
SER-015-03	HW/Sewer Treatment, Wastewater Treatment	Industrial	Water/Wastewater Plant Operations	Wastewater Treatment, Multiple Operations
SER-015-04	HW/Sewer Treatment, Equipment Repair	Industrial	Water/Wastewater Plant Operations	Wastewater/Sanitary Sewer, Equipment Repair
SER-015-99	HW/Sewer Treatment, NEC	Industrial	Water/Wastewater Plant Operations	Wastewater Treatment, NOC
SER-016-00	Water Treatment, Multiple Operations	Industrial	Water/Wastewater Plant Operations	Water Treatment, Multiple Operations
SER-016-01	Water Treatment, Chlorination/Bromination/Other	Industrial	Water/Wastewater Plant Operations	Water Treatment, Chlorination/Bromination/Other
SER-016-99	Water Treatment, NEC	Industrial	Water/Wastewater Plant Operations	Water Treatment, NOC
SER-017-00	Laundry Services, Multiple Operations	Industrial	Laundry Services	Laundry Services, Multiple Operations
SER-017-01	Laundry Services, Dry Cleaning	Industrial	Laundry Services	Dry Cleaning
SER-017-02	Laundry Services, Dry Cleaner Maintenance	Industrial	Laundry Services	Dry Cleaner Maintenance
SER-017-03	Laundry Services, Washer/Dryer/Press Operation	Industrial	Laundry Services	Washer/Dryer/Pressing Operation
SER-017-99	Laundry Services, NEC	Industrial	Laundry Services	Laundry Services, NOC
SER-018-00	Barbering/Cosmetology, Multiple Operations	Industrial	Miscellaneous Operations	Haircutting/Cosmetology, Multiple Operations
SER-018-01	Barbering/Cosmetology, Cutting Hair	Industrial	Miscellaneous Operations	Haircutting/Cosmetology, Cutting Hair
SER-018-02	Barbering/Cosmetology, Nail Salon Work	Industrial	Miscellaneous Operations	Nail Salon Processes

NAVY OPERATION CODES (OPCODES) TO DOEHRS-IH PROCESS PICKLISTS MAPPINGS

NAVY OPCODE	Navy OPCODE Description	DOEHRS-IH Process Category	DOEHRS-IH Common Process	DOEHRS-IH Method
SER-018-99	Barbering/Cosmetology, NEC	Industrial	Miscellaneous Operations	Haircutting/Cosmetology, NOC
SER-019-00	Cleaning, Janitorial, Custodial, Multiple Operations	Industrial	Housekeeping/Janitorial/Maintenance	Janitorial/Custodial, Multiple Operations
SER-019-01	Cleaning, Wet/Dry Vacuum Operation	Industrial	Housekeeping/Janitorial/Maintenance	Wet/Dry Vacuum Operation
SER-019-02	Cleaning, General Housekeeping	Industrial	Housekeeping/Janitorial/Maintenance	General Housekeeping
SER-019-03	Cleaning, Pressure Wash	Industrial	Housekeeping/Janitorial/Maintenance	Pressure Wash
SER-019-99	Cleaning, Janitorial, Custodial, NEC	Industrial	Housekeeping/Janitorial/Maintenance	Housekeeping/Janitorial, NOC
SER-020-00	Recycling, Multiple Operations	Industrial	HM/HW Handling & Cleanup	Recycling Multiple Operations
SER-020-99	Recycling, NEC	Industrial	HM/HW Handling & Cleanup	Recycling, NOC
SER-021-00	General Animal Care, Multiple Operations	Industrial	Veterinary Services/Animal Care	Animal Care, Multiple Operations
SER-021-99	General Animal Care, NEC	Industrial	Veterinary Services/Animal Care	Animal Care, NOC
SER-999-99	Service, NEC	Industrial	Miscellaneous Operations	Service, NOC

APPENDIX 3-B

GUIDANCE ON SAMPLING AND INTERPRETING THE CONCENTRATIONS OF METAL PARTICULATES DEPOSITED ON SURFACES IN NON-INDUSTRIAL AREAS

1. **BACKGROUND.**

   a. Issue. The presence of metal particulates deposited on surfaces in non-industrial areas, such as lunch or break rooms and administrative areas, adjacent to industrial work areas has been recently cited as housekeeping violations by Federal OSHA at a U. S. Navy facility. The source of the metal particulates is multiple processes conducted in the industrial areas that generate metal particulates, such as sanding, grinding, abrasive blasting, spray painting and cleaning performed by dry sweeping or with non-HEPA-filtered vacuum cleaners.

   b. Control.

      (1) Best practice. The key to minimizing the amount of metal particulates deposited on non-industrial surfaces is primarily control of the contaminants at the source of generation. That means properly designed and operated engineering controls, e.g., industrial ventilation, good work practices and effective housekeeping. Preventing the dispersion and widespread deposition of metal dusts at the source is the most cost effective and efficient means of control. Locating lunch and break rooms in a building detached from any industrial area or without any entrances into an industrial area also has benefit.

      (2) Controlling secondary spread of contamination. Controlling metal particulate brought into food and break rooms by the patrons is also essential. If personnel enter the lunch or break room with metal particulates adhering to their clothes and shoes and without having washed their faces and hands, much of the benefit of controlling direct migration of metal particulates from the industrial area to break areas will be lost.

      (3) Controlling contamination that escapes source of generation control. Relying primarily on removing metal particulates once dispersed throughout the facility and deposited on surfaces is inefficient, costly, difficult and often not completely possible. However, some contamination may occur despite source of generation controls and work practices. The purpose of a housekeeping program is to minimize contamination that occurs despite the implementation of “best practice” control measures.

   c. Proper Response to Evidence of Poor Control. The presence of visible dust in lunch or break rooms is cause for improved source control and housekeeping, not wipe sampling. One should expect all non-industrial areas to be free of visible dust to minimize the transfer and ingestion of potentially toxic materials.

   d. Summary of the Response Process. Figure 1 flowcharts the process for responding to concerns about metal particulates deposited on surfaces in non-industrial and non-regulated areas. Note that an initial briefing to the requesting command by the Industrial Hygienist is vital to ensuring the customer fully understands the process and the resolution options.

2. **WHEN IS WIPE SAMPLING APPROPRIATE?**

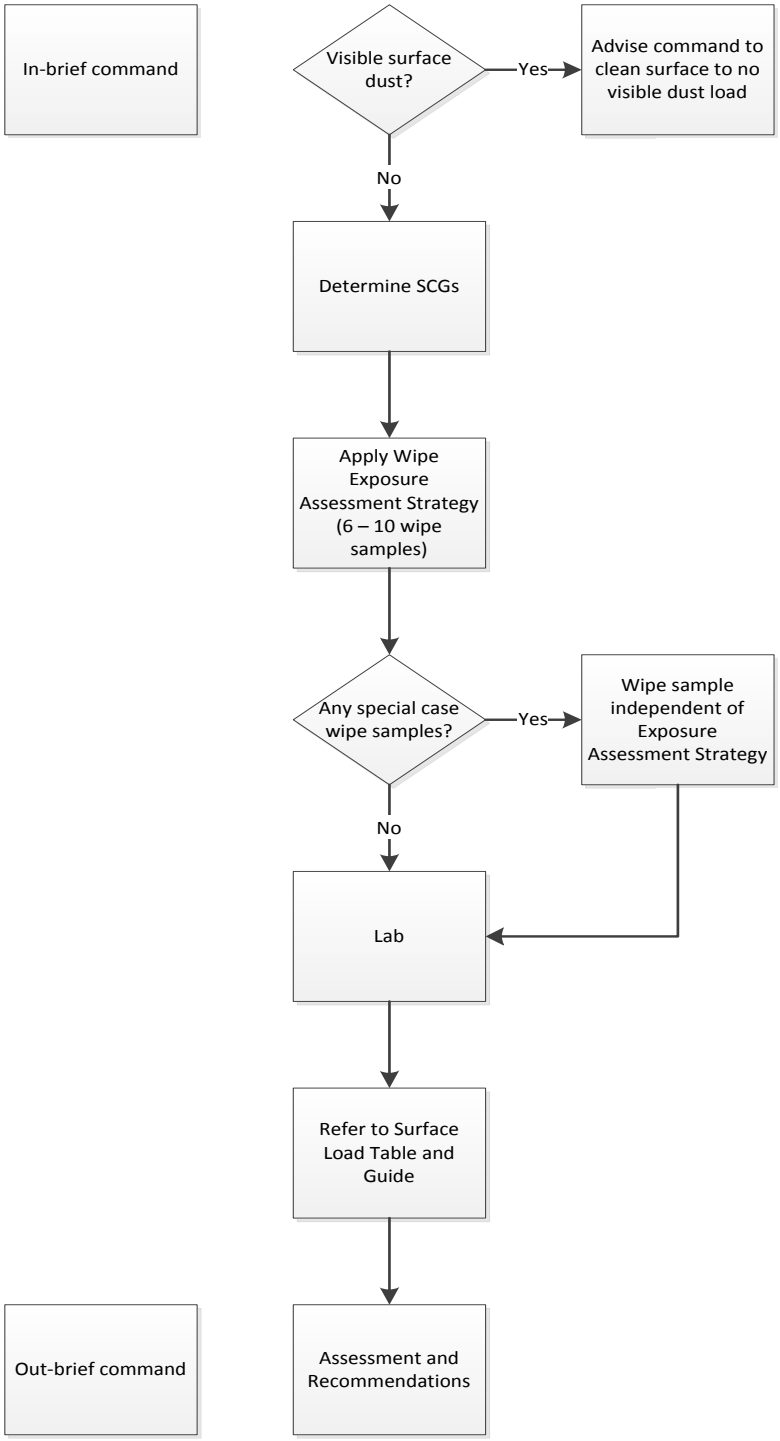
   a. Verifying the Effectiveness of New Cleaning Methods before Facility-Wide Implementation. When a new cleaning method has been selected for possible implementation, a narrowly focused study to demonstrate the effectiveness of removing metal particulates can be accomplished with wipe sampling. Such a study should be restricted to a small area, e.g., a single lunch room, until proven effective. Randomly selected representative surfaces are wipe sampled before the new cleaning method is applied, and then the same surfaces are wipe sampled after the new cleaning method has been performed.

   b. Verifying the Continuing Effectiveness of Source Controls and Housekeeping. Random sampling of representative surfaces can be used on a periodic basis, e.g., semi-annually, to verify that control of metal particulates at the point of generation and the housekeeping methods in place are maintaining metal particulate surface loading at a constant acceptable concentration. Such sampling should be random and representative rather than 100% sampling of all surfaces in all areas.

3. **DEFINING THE MECHANISM OF METAL PARTICULATE SURFACE CONTAMINATION DEPOSITION**. There are two primary mechanisms of metal particulate deposition that create surface contamination - settling and direct transfer. The amount of contamination is referred to as "surface loading." The first mechanism is settling where metal particulates suspended in the room air are deposited on a surface as a result of their downward motion due to gravity. While particles can also be deposited by impaction, interception, diffusion and electrostatic attraction, settling is the main process. The second mechanism is direct transfer that occurs when a person deposits metal particulates on a surface by touching it with contaminated hands, brushing against it with contaminated clothing, sitting on it while wearing contaminated clothing or walking across it with contaminated clothing and footwear. The concentrations found on surfaces are dependent on the total contribution from each mechanism as modified by removal processes.

4. **DEFINING THE MECHANISM OF METAL PARTICULATE SURFACE CONTAMINATION REMOVAL.** The concentration of metals on surfaces is also affected by contamination removal methods. The primary removal mechanism is cleaning performed during housekeeping activities. Some removal occurs, especially on chair seats and backs, when personnel sit in the chairs. If their clothes are clean, they remove contamination by transfer to their clothing. Dirty clothing is less likely to remove contaminants. Similarly, touching surfaces, such as a microwave oven keypad, with clean hands removes some contamination.

Figure 1
Process Flowchart for
Responding to Concerns about Metal Particulates Deposited on Surfaces in Non-Industrial and Non-Regulated Areas



5. **EFFECT OF HOUSEKEEPING ON METAL PARTICULATE SURFACE LOADING.** The same types of surfaces will have different surface loading in areas where a routine housekeeping program is ongoing vice an area where housekeeping is either not performed or sporadically performed. The response to such situations is to educate the customer about the benefits of routine housekeeping. In the interim, wipe sampling results can support that discussion.

6. **EFFECT OF BUILDING OPERATION AND MAINTENANCE ACTIVITIES ON METAL PARTICULATE SURFACE LOADING.** Cleaning of return air grilles, changing air filters, changing bulbs in light fixtures and replacing drop ceiling tiles can disturb, disperse and transfer metal particulates. Those particulates may settle on horizontal surfaces and increase surface loading. Those particulates may also adhere to the clothing, footwear, skin and hair of maintenance personnel and be redeposited throughout the workplace. Increased surface loading from these activities is episodic, and the magnitude of contribution varies with each activity and the contamination present on the items disturbed. Work practices for each of these activities should be established to anticipate and control the spread of contamination during the work. Consideration should also be given to performing housekeeping following such activities.

7. **DEFINING SIMILAR CONTAMINATION GROUPS (SCGS).** Just as Similar Exposure Groups (SEGs) can be defined based on a common process that creates a reasonably uniform airborne exposure, a Similar Contamination Group (SCG) can be defined based on common metal particle deposition mechanisms that create a reasonably uniform surface loading. One can group the various surfaces in the workplace into those expected to have similar contamination levels due to similar deposition and removal mechanisms. The same sampling strategy defined by the AIHA Occupational Exposure Sampling Strategy in reference 3-B-1 can then be applied to minimize the number of samples required to provide objective data to refine the assignment of surfaces to SCGs and estimate the highest surface loadings expected in each SCG. Rules to define a SCG follow:

   a. Geographical Extent of a SCG. SCGs that extend beyond a single building will probably not prove to be a SCG when statistical analysis of the wipe sampling data is done. However, it is acceptable to establish a geographically large SCG as long as the SCG is refined based on the results of the wipe sample analyses. Be aware this may result in additional sampling if the initial SCG proves to be too large. The combination of all types of work performed and materials worked on in a building determines the composition of the metal particle aerosol that moves throughout the building. The aerosol composition is unlikely to be the same in any other building because it depends on the operational tempo of each process performed, the effectiveness and abundance of industrial process engineering controls, the adherence to established work practices, operation of general ventilation (mechanical or natural) and many other factors.

   b. Horizontal Surface SCGs. Horizontal surfaces that are open to the general room air, i.e., the top of a refrigerator or table, are greatly affected by settling of airborne metal particulates, but can be divided into two general subsets based on accessibility and human contact. It may be necessary to further divide horizontal SCGs to account for other variables after reviewing initial sampling results. For example, one must consider whether particulate loading on a surface inside a room with a door that is normally closed and must be opened to enter and exit is expected to be different from the particulate

loading on a surface that is either inside a room with no door or not in a separate room at all.

(1) Non-contact horizontal surface SCGs. The tops of some room furnishings are relatively undisturbed and because the primary mechanism for metal contamination on these surfaces is settling, they can be sampled as a single SCG. Examples are the tops of refrigerators, microwave ovens and vending machines. There may be some disturbance or contamination from placing items on these tops, but since settling occurs continually and items are placed sporadically, direct transfer should be a subordinate mechanism. The removal mechanism is primarily cleaning.

(2) Contact horizontal surface SCGs.

(a) Non-floor contact horizontal surface SCGs. Furnishing surfaces such as the tops of tables, tops of counters and seats of chairs should have a different surface loading. In addition to settling of metal particulates, they experience transfer - both addition and removal - due to contact with potentially contaminated clothing, hands and forearms and dispersal/resettling because of human activity in the space. Surface loading is also affected by frequency and quality of housekeeping activities. Initially, all such surfaces may be sampled as a single SCG, and the results used to separate them into different SCGs as warranted. For example, it is likely that chair seats have a different surface loading than table and counter tops.

(b) Floor contact horizontal surface SCGs. Floor surface loading is largely due to settling of metal particulates, but there may be a significant contribution from metals transferred from personnel footwear. This contribution is probably significantly different than what is deposited from work clothes onto chair seats, table tops and counter tops. Since floors are cleaned differently than other contact horizontal surfaces, the overall surface loading is expected to be different. Therefore, floors should be sampled as separate SCGs.

c. Vertical Surface SCGs. Because the surface loading on vertical surfaces is not controlled by settling of airborne metal particulates, vertical surfaces should have a lower surface loading unless contamination is added by direct contact. Microwave oven keypads/handles, refrigerator handles and vending keypads are examples of vertical surfaces with a high potential for contaminant transfer when personnel do not wash their hands before touching such surfaces in non-industrial spaces. Keypads and handles may be sampled as a single SCG. Due to the variety and irregularity of shapes, handles present unique challenges in wiping a standard area when sampling.

d. Other Surface SCGs. Other surfaces may be included in a sampling strategy if the Industrial Hygienist so chooses. However, if the surfaces previously discussed are proven to have an acceptably low surface loading by wipe sampling results, it is reasonable to assume that other surfaces in that area are also acceptably clean if subject to the same type and frequency of housekeeping activities. Examples of such surfaces include, but are not limited to, the delivery opening of vending machines, tops of coffee makers, inside surfaces of refrigerators and freezers, paper towel holders and cabinets. At the discretion of the Industrial Hygienist when a health risk is perceived, a random wipe sampling of these or similar surfaces may be used as an infrequent quality assurance check.

e. What Not to Sample. Do not sample surfaces that cannot be reached when standing on the floor, e.g., roof trusses and suspended ceiling grids. Such surfaces are only indirectly relevant to transfer of metal particulates via the ingestion route of entry since food and drink are not placed on or consumed from them. However, such surfaces can accumulate significant metal particulate surface loadings that may be resuspended in the room air by air currents and building structure-borne vibration. Therefore, the building owner should control metal particulate surface loading on these surfaces.

8. **HOW MANY SAMPLES SHOULD BE TAKEN FROM EACH SCG?** Just as in the AIHA occupational exposure assessment strategy that Navy Industrial Hygienists use to characterize airborne exposures, 6 to 10 wipe samples is adequate to define a metal surface loading profile of each established SCG. It is also sufficient to identify situations when the SCG has been defined too broadly. There is little benefit in collecting more than 10 samples per SCG and doing so reduces the efficient use of Industrial Hygiene resources.

9. **WHAT LEVEL OF METAL SURFACE LOADING IS ACCEPTABLE?** The metal surface loading concentrations in Table I are recommended guidelines for non-industrial and non-regulated area surfaces that are visibly free of metal dust contamination and thus assumed not to present a health risk to adult workers. They were developed by the NMCPHC using the EPA's approach in reference 3-B-2 for a lifetime exposure assessment. The values also include assumptions about contamination efficiency transfer and interpretations of the available data for oral intake based on hand contact to contaminated surfaces and hand contact to the mouth. The surface loading criteria do not consider pulmonary or systemic effects that can only be assessed by air sampling.

Table I
Surface Loading Guidelines for Selected Metals in Non Industrial, Non-Regulated Work Areas

Metal	**Surface Loading Criteria ($\mu g/100\ cm^2$)**
Antimony	57
Arsenic (inorganic)	4
Beryllium and Compounds	280
Cadmium	140
Cobalt	4,300
Chromium (III)	210,000
Chromium (VI)	420
Copper	230
Iron	2,100
Manganese	20,000
Molybdenum	700
Nickel	700
Lead	21.5
Vanadium	1,300
Zinc and Compounds	4,300

NOTE: Acceptable Surface Loading Criteria are surface-only levels that are not anticipated to cause increased health risk for a healthy adult worker population. They do not account for the effects of exposure via inhalation.

10. **HOW SHOULD THE INDUSTRIAL HYGIENIST USE THE SURFACE LOADING GUIDELINES?** The results of samples collected in the occupational environment approximate a log-normal distribution and may be interpreted by using the descriptive and inferential statistical parameters of the log-normal distribution. It is desirable that the majority of wipe sample results for metal particulates generated by similar processes be less than the guidelines in Table I. As in exposure to airborne metal particulates, the generally accepted criteria is that 95 percent be below the guideline. In other words, the ninety fifth percentile (95th %ile) surface loading concentration that is estimated from 6 to 10 wipe samples collected and analyzed for each SCG for each metal of interest should be less than the guideline's surface loading criteria. The Industrial Hygienist should follow the same data analysis process in reference 3-B-3 that is used by the Navy for interpreting air sampling data. The major points of that process are:

    a. Ensure that the 6-10 samples for each SCG pass the criteria that defines a SCG. Typically, this requires a geometric standard deviation (GSD) of 2.5 or less and data that approximates a log-normal distribution as judged from a log-probability plot and the relevant statistical tests for goodness of fit. Refine the SCGs if they do not meet these criteria. Some professional judgment is warranted in deciding whether a GSD of 2.5 is too stringent.

b. The Industrial Hygienist should calculate the 95th %ile point estimate and its 95% upper confidence limit (UCL), also known as the 95% upper tolerance limit ($UTL_{95\%,95\%}$). Compare these values to the Table I guidelines to make the following decisions:

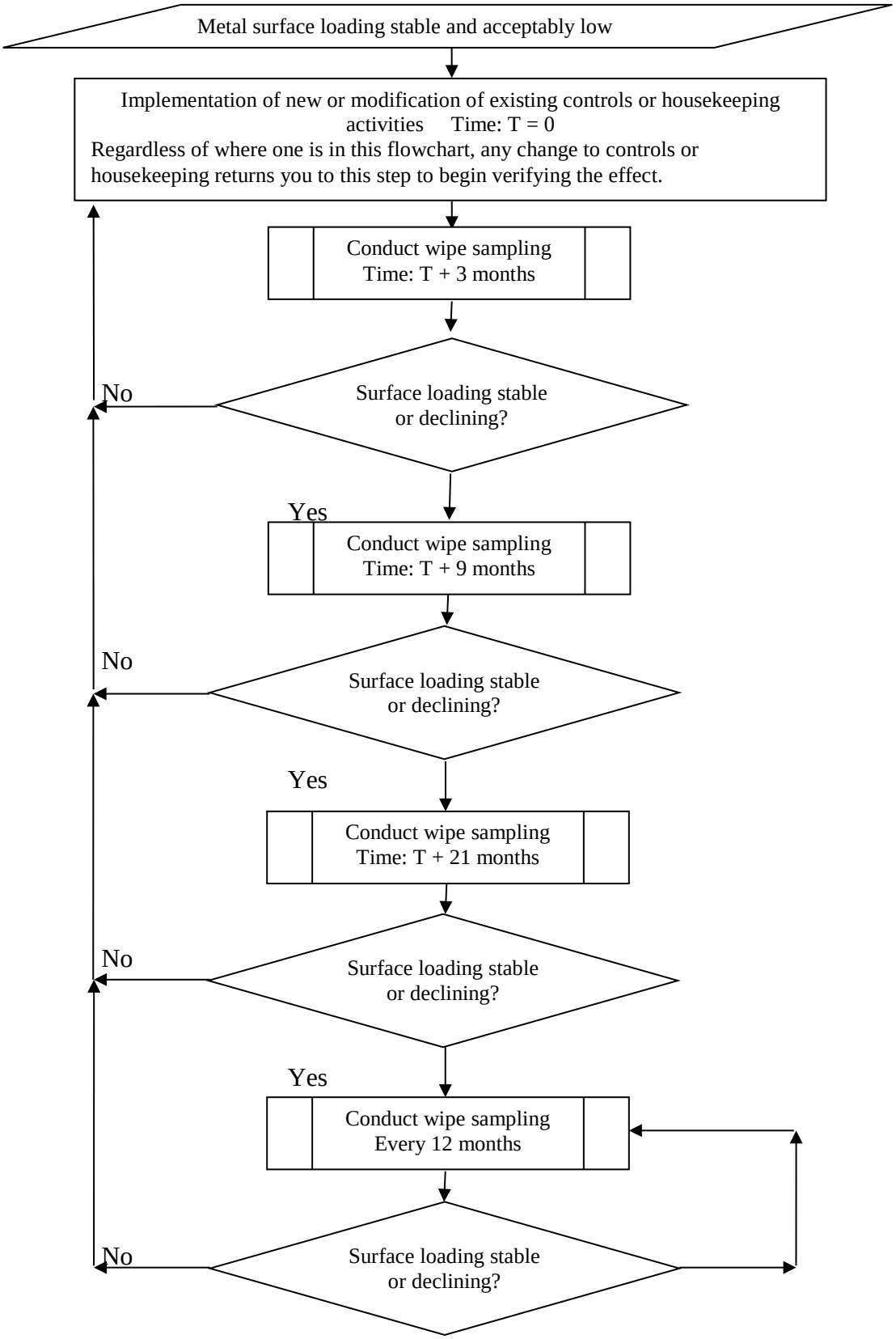
(1) If the 95th %ile is greater than the Table I guideline, further control of metal particulate surface loading is needed.

(2) If the 95th %ile is less than the Table I guideline but the $UTL_{95\%,95\%}$ is greater than the guideline, the metal particulate surface loading is acceptable. The amount that the $UTL_{95\%,95\%}$ exceeds the 95th %ile indicates the level of uncertainty inherent in the 95th %ile point estimate. Considering the uncertainty, the Industrial Hygienist may make recommendations to collect more samples to reduce the uncertainty, increase the frequency of periodic monitoring or improve the control measures in use.

(3) If the 95th %ile and the $UTL_{95\%,95\%}$ are both less than the Table I guideline, controls are apparently adequate and only periodic monitoring is needed to ensure the situation does not change.

11. **HOW OFTEN SHOULD PERIODIC MONITORING BE CONDUCTED?** A recommended periodic monitoring process is described below and outlined in the flowchart in Figure 2. This process is applicable to situations where surface loading appears to be in good control and the level of uncertainty is moderate or low. Additional sampling of SCGs over time adds to the available data and allows the Industrial Hygienist to determine whether surface loading is increasing over time and, if so, to recommend corrective action. After source of generation controls and housekeeping programs are implemented and metal surface loading is proven to be acceptable, it is prudent to resample after three months. Three months allows any changes in surface loading to become large enough to be detected by wipe sampling. If surface loading is found to be stable or declining, the next re-sampling should be 6 months later, i.e., 9 months after initial implementation. If surface loading continues to be stable or declining, the next re-sampling should be 12 months later, i.e., 21 months after initial implementation. If surface loading continues to be stable or declining, then continue monitoring on an annual frequency. Significant changes in industrial processes, source of generation engineering controls, work practices and housekeeping practices require beginning the periodic monitoring process anew at the top of the flowchart and executing each step as prescribed.

Figure 2 - Periodic Metal Wipe Sampling Surveillance Monitoring Flowchart



12. **REFERENCES.**

3-B-1 *A Strategy for Assessing and Managing Occupational Exposures*, Third Edition, AIHA, 2006

3-B-2 "Risk Assessment Guidance for Superfund Volume 1, Human Health Evaluation Manual (Part A)", EPA/540/1-89/002, Dec 1989, U.S. EPA

3-B-3 Industrial Hygiene Field Operations Manual, NMCPHC Technical Manual TM-6290.01-2 Rev B with continuous maintenance updates