Department of the Navy Technical Guidance on Occupational Sensitizers for Industrial Hygienists

Navy and Marine Corps Force Health Protection Command

June 2025

Summary of Revisions

Version	Date	Change Description	Updated By

Disclaimer: The purpose of this document is to provide technical internal working guidance for the practice of industrial hygiene (IH) to Bureau of Medicine and Surgery (BUMED) IH field personnel. It is not meant to dictate official policy unless referring specifically to federal or other regulatory agency, Department of Defense (DoD), Navy, or Marine Corps policy documents. Nothing in this document is intended to contradict or circumvent official policy or legal requirements.

620 John Paul Jones Circle, Suite 1100
Portsmouth, VA 23708-2103
(June 2025)

Executive Summary

A unified, systematic approach to identifying and controlling occupational sensitizers supports the continued enhancement of force health protection efforts across the Department of Defense (DoD). This document provides technical guidance and recommendations to help ensure that chemical sensitizers are effectively addressed within existing Industrial Hygiene (IH) practices and medical surveillance programs. Incorporating this guidance into current procedures will further strengthen the protection of Navy, Marine Corps, and Defense Health Agency personnel, foster a safer working environment, and support long-term mission readiness.

Background

The National Institute for Occupational Safety and Health (NIOSH) has identified chemical dermal and respiratory sensitizers, DSEN and RSEN respectively, as significant health risks to workers in various industries, including the military [1]. This guidance seeks to address and mitigate the exposure to such sensitizers among Navy, Marine Corps, and Defense Health Agency personnel, whose health and mission readiness can be compromised by repeated exposure to these substances. Despite the known risks, chemical sensitizers—whether affecting the skin or respiratory system—are often under-recognized in workplace assessments. Hypersensitivity reactions resulting from repeated exposures can lead to chronic conditions, impairing both individual health and operational effectiveness.

Selection Methodology

Hazard identification for occupational sensitizers incorporates data from a variety of sources, including epidemiological studies, in vitro and animal research, and the physicochemical properties of substances [2, 3]. To develop a comprehensive list of occupational sensitizers, initial selection criteria were applied based on extensive research, a thorough modified literature review, and input from senior Department of the Navy (DON) Occupational Environmental Health (OEH) staff (e.g., industrial hygiene, toxicology, occupational environmental medicine, etc.). Key references for this process include documents from international and federal regulatory agencies, as well as authoritative organizations such as NIOSH, American Conference of Governmental Industrial Hygienists (ACGIH), European Union (EU), *et al* [4 ,5, 6, 7, 8, 9]. These sources were selected for their systematic approach and reliability, ensuring high confidence in the inclusion of chemicals on the sensitizer list. This guidance, however, does not extend to pharmaceutical or consumer product sensitizers, which are outside of the intended scope. For more information on these types of sensitizers, readers are directed to sources such as Matheson and the U.S. Consumer Safety Commission [10, 11]. The lists of Navy-recognized occupational dermal and respiratory sensitizers are included in TABLES 1 and 2 and will be continuously reviewed and updated as new data emerges.

620 John Paul Jones Circle, Suite 1100
Portsmouth, VA 23708-2103

As part of an ongoing process, candidate chemicals for sensitizer lists will be thoroughly documented with source validation, a weight of evidence review, and included upon agreement from designated OEH staff. Similarly, any sensitizer removed from these tables will undergo the same rigorous documentation process. While TABLES 1 and 2 represent a current understanding of Navy-recognized sensitizers, they may not encompass all possible sensitizers. Evaluation of additional chemicals for sensitivity is critical to IH practice. Requests to review potential sensitizers from DON staff are encouraged and can be facilitated by contacting the NMCFHPC IH Department at usn.hampton-roads.navmcpubhlthcenpors.list.nmcphc-ask-ih@health.mil.

Lists of Dermal and Respiratory Sensitizers: TABLES 1 and 2

TABLES 1 and 2 contain comprehensive lists of dermal and respiratory sensitizers, as identified through the selection methodology outlined above. These chemicals are considered significant hazards in the workplace and are to be annotated as such in the Defense Occupational Environmental Health Readiness System – Industrial Hygiene (DOEHRS-IH). Enabled Standardized Industrial Hygiene Survey Report when designated as stressors for specific shop processes. Additionally, a breakdown of frequently notated sensitizers and their corresponding common processes is provided in APPENDIX A.

TABLE 1: List of Dermal Sensitizers

STRESSOR	CAS #	DSEN SOURCE(S)
1,3-Dichloropropene	542-75-6	NIOSH
2,3-Pentanedione	600-14-6	NIOSH
2-Hydroxypropyl Acrylate	999-61-1	ACGIH
2-Mercaptobenzothiazole	149-30-4	NIOSH
3-Carene	13466-78-9	ACGIH
Acrylamide	79-06-1	ACGIH
Alachlor	15972-60-8	ACGIH
Allyl propyl disulfide	2179-59-1	ACGIH
Aniline	62-53-3	NIOSH
a-Pinene	7785-70-8	ACGIH
Azinphos-Methyl	86-50-0	ACGIH
Benomyl	17804-35-2	ACGIH
Beryllium Compounds (as Be)	7440-41-7	ACGIH
Bisphenol A	80–05–7	NIOSH
b-Pinene	127-91-3	ACGIH
Captafol	2425-06-1	ACGIH
Captan	113-06-2	ACGIH

620 John Paul Jones Circle, Suite 1100
Portsmouth, VA 23708-2103

STRESSOR	CAS #	DSEN SOURCE(S)
Catechol	120-80-9	NIOSH
Chromyl chloride [as Cr (VI)]	14977-61-8	ACGIH
Citral	5392-40-5	ACGIH
Cobalt	7440-48-4	ACGIH
Cyanoacrylate, ethyl	7085-85-0	ACGIH
Cyanoacrylate, methyl	137-05-3	ACGIH
Demeton-S-Methyl	919-86-8	ACGIH
Diacetyl	431-03-08	ACGIH/NIOSH
Dichlorvos	62-73-7	ACGIH
Diethylenetriamine	111-40-0	NIOSH
Dimethenamid-P	163515-14-8	ACGIH
Dimethyl phenol, all isomers	95-65-8; 95-97-4; 105-67-9; 108-68-9; 526-75-0; 576-26-1; 1300-71-6	ACGIH
Dimethylamine	124-40-3	ACGIH
Divinylbenzene-ethyl styrene mixtures	69011-19-4;7525-62-4; 108-57-6; 105-06-6	ACGIH
Dodecyl mercaptan	112-55-0	ACGIH
Epichlorohydrin	106-89-8	ACGIH/NIOSH
Ethyl Acrylate	140-88-5	NIOSH
Ethyl Isocyanate	109-90-0	ACGIH
Folpet	133-07-3	ACGIH
Formaldehyde	50-00-0	ACGIH/NIOSH
Glutaraldehyde	111–30–8	ACGIH/NIOSH
Glycidyl Methacrylate	106-91-2	ACGIH
Glyoxal	107-22-2	ACGIH
Hexamethylene Diisocyanate (HDI)	822-06-0	NMCFHPC
Hexamethylenetetramine	100-97-0	ACGIH
Hexavalent Chromium Compounds, Water Soluble [as Cr (VI)]	18540-29-9	ACGIH
Hydrazine	302-01-2	NIOSH
Indium tin oxide (as In)	50926-11-9	ACGIH
Isophorone Diisocyanate (IPDI)	4098-71-9	NMCFHPC
Lead chromate	7758-97-6	ACGIH
Maleic anhydride	108-31-6	ACGIH
Methyl Acrylate	96-33-3	ACGIH

620 John Paul Jones Circle, Suite 1100
Portsmouth, VA 23708-2103

STRESSOR	CAS #	DSEN SOURCE(S)
MDI, Methylene Bisphenyl Diisocyanate	101-68-8	NMCFHPC
Methyl Isocyanate	624-83-9	ACGIH/NIOSH
Methyl methacrylate	80-62-6	ACGIH
Methyltetrahydrophthalic anhydride isomers	3425-89-6; 5333-84-6; 11070-44-3; 19438-63-2; 19438-64-3; 26590-20-5; 42498-58-8	ACGIH
Naled (Dimethyl-Dibromo-Dichloroethyl-P)	300-76-5	ACGIH
Natural Rubber Latex	9006-04-6	ACGIH
n-Butyl acrylate	141-32-2	ACGIH
n-Butyl Glycidyl Ether (BGE)	2426-08-6	ACGIH
Nicotine	54-11-5	NIOSH
Nitroglycerin (NG)	55-63-0	NIOSH
o-Phthalaldehyde	643-79-8	ACGIH
Phenothiazine	92-84-2	ACGIH
Phenyl Glycidyl Ether (PGE)	122-60-1	ACGIH
Phenyl Isocyanate	103-71-9	ACGIH
Phenylhydrazine	100-63-0	NIOSH
Phthalic Anhydride	85-44-9	ACGIH
Piperazine and salts as piperazine	110-85-0	ACGIH
p-Phenylenediamine	106–50–3	NIOSH
Propylene dichloride	78-87-5	ACGIH
Propylene oxide	75-56-9	ACGIH
Resin acids, as Total Resin acids	8050-09-7	ACGIH
Sodium 2-Mercaptobenzothiazole	2492-26-4	NIOSH
Styrene oxide	96-09-3	ACGIH
Tetrachlorvinphos	22248-79-9; 22350-76-1; 961-11-5	ACGIH
Tetrakis (hydroxymethyl) phosphonium chloride	124-64-1	ACGIH
Tetrakis (hydroxymethyl) phosphonium sulfate	55566-30-8	ACGIH
Thiodicarb	59669-26-0	ACGIH
Thioglycolic Acid	68-11-1	ACGIH
Thiram	137-26-8	ACGIH

620 John Paul Jones Circle, Suite 1100
Portsmouth, VA 23708-2103

STRESSOR	CAS #	DSEN SOURCE(S)
Toluene Diisocyanate (TDI)	584-84-9, [4]	ACGIH/NIOSH
Toluene-2,4-Diisocyanate (TDI)	584-84-9	ACGIH/NIOSH
Toluene-2,6-Diisocyanate (TDI)	91-08-7	ACGIH/NIOSH
Trichlorfon	52-68-6	ACGIH
Trimellitic Anhydride	552-30-7	ACGIH
Turpentine	8006-64-2	ACGIH
Wood dusts, Western Red Cedar		ACGIH
Zinc 2-Mercaptobenzothiazole	155-04-4	NIOSH

- Chromium (III) (water soluble compounds) may elicit cross-reactivity with Chromium VI; there is limited evidence of toxicological significance that Chromium III induces sensitization alone and will accordingly not be categorized as a sensitizer at this time.

TABLE 2: List of Respiratory Sensitizers

STRESSOR	CAS #	RSEN SOURCE(S)
Beryllium Compounds (As Be)	7440-41-7	ACGIH
Captafol	2425-06-1	ACGIH
Chromyl chloride [as Cr (VI)]	14977-61-8	ACGIH
Cobalt	7440-48-4	ACGIH
Cyanoacrylate, ethyl	7085-85-0	ACGIH
Cyanoacrylate, methyl	137-05-3	ACGIH
Flour Dust		ACGIH
Formaldehyde	50-00-0	ACGIH
Glutaraldehyde	111–30–8	ACGIH
Hexamethylene Diisocyanate (HDI)	822-06-0	NMCFHPC
Hexavalent Chromium Compounds, Water Soluble [as Cr (VI)]	18540-29-9	ACGIH
Isophorone Diisocyanate (IDPI)	4098-71-9	NMCFHPC
Lead chromate	7758-97-6	ACGIH
Maleic anhydride	108-31-6	ACGIH
Methylene Bisphenyl Diisocyanate (MDI)	101-68-8	NMCFHPC
Methyltetrahydrophthalic anhydride isomers	3425-89-6; 5333-84-6; 11070-44-3; 19438-63-2; 19438-64-3; 26590-20-5; 42498-58-8	ACGIH

620 John Paul Jones Circle, Suite 1100
Portsmouth, VA 23708-2103

STRESSOR	CAS #	RSEN SOURCE(S)
Natural Rubber Latex	9006-04-6	ACGIH
o-Phthalaldehyde	643-79-8	ACGIH
Phenyl Isocyanate	103-71-9	ACGIH
Phthalic Anhydride	85-44-9	ACGIH
Piperazine and salts as piperazine	110-85-0	ACGIH
Resin acids, as Total Resin acids	8050-09-7	ACGIH
Toluene Diisocyanate (TDI)	584-84-9, [4]	ACGIH/NIOSH
Toluene-2,4-Diisocyanate (TDI)	584-84-9	ACGIH/NIOSH
Toluene-2,6-Diisocyanate (TDI)	91-08-7	ACGIH/NIOSH
Trimellitic Anhydride	552-30-7	ACGIH
Wood dusts, Western Red Cedar		ACGIH

- Chromium (III) (water soluble compounds) may elicit cross-reactivity with Chromium VI; there is limited evidence of toxicological significance that Chromium III induces sensitization alone and will accordingly not be categorized as a sensitizer at this time.

IH Assessment

Federal risk assessment incorporates hazard identification and exposure assessment as crucial components in the overall process [2,3], both of which are integral to IH practice. Per reference [12], workplace chemical hazards that are designated as respiratory and/or dermal sensitizers must be regarded as significant. These hazards are to be specifically identified, annotated, and assessed in periodic industrial hygiene surveys to minimize exposure risks. TABLES 1 and 2 provide the necessary details for identification and annotation.

Documentation

Occupational Exposure Limits (OELs)

Establishing occupational exposure limits (OELs) for chemical sensitizers has proven historically challenging as hypersensitivity responses can occur at very low exposure levels and are not always reflected in traditional toxicity endpoints. In contrast to toxicants which cause health effects in a normal distribution of exposures, reactions to sensitizers are often idiosyncratic, with significant reactions in individuals to exposures several orders of magnitude lower than what is tolerated by the general population. For dermal sensitizers, innovative approaches such as the murine Local Lymph Node Assay (LLNA) have shown promise by deriving EC3% values that correlate with human sensitization outcomes. These values can help inform surface wipe limits and allow chemicals to be grouped into Occupational Exposure Bands (OEBs), thereby offering a potential basis for developing dermal OELs [13]. However, many methods, as well as modeling applications, are still in the research phase and not yet fully integrated into regulator practice.

Respiratory sensitizers present an even greater challenge; even minimal airborne concentrations can trigger severe immune responses. Recent regulatory advancements in

620 John Paul Jones Circle, Suite 1100
Portsmouth, VA 23708-2103

Europe have led to the establishment of more stringent OELs for diisocyanates, where limits are based on measurements of isocyanate (-NCO) functional groups that reflect immune-mediated endpoints [14]. In the United States, ACGIH has developed threshold limit values (TLVs) for certain chemicals that incorporate immune-mediated endpoints. For example, some diisocyanates have TLVs based on observed sensitization doses, providing a valuable reference point for controlling exposures. Nonetheless, many current OELs continue to be derived primarily from toxicity endpoints, such as irritation or carcinogenicity, rather than immune-mediated responses.

This limitation is evident when considering chemicals like beryllium, hexavalent chromium, or formaldehyde. The Occupational Safety and Health Administration (OSHA)'s permissible exposure limit (PEL) for beryllium is 0.2 µg/m³ [8-hour time-weighted average (TWA)], a value established primarily on endpoints of respiratory irritation and carcinogenicity. Similarly, the OSHA PEL for hexavalent chromium is 5 µg/m³ (8-hour TWA), and for formaldehyde, the PEL is 0.75 ppm (8-hour TWA), with a short-term exposure limit of 2 ppm. In contrast, ACGIHTLVs for these substances are often set at lower levels incorporating immune-mediated endpoints and assigned a "DSEN" and/or "RSEN" notation; for instance, the ACGIH TLV-TWA for formaldehyde is 0.1 ppm (as compared to the OSHA PEL of 0.75 ppm). These discrepancies underscore that while existing PELs provide a baseline for controlling exposures based on toxicity, they may not fully protect against the subtle, immune-mediated effects that can lead to sensitization. As research continues to evolve, integrating immune-based endpoints into OEL derivation—both for dermal and respiratory sensitizers—remains an essential goal to enhance worker protection and refine current risk management frameworks.

IH Surveys

It is crucial that all DON IH surveys identify and annotate the sensitizers listed in TABLES 1 and 2. The NMCFHPC will provide periodic updates to these tables, and it is recommended that Navy IH personnel regularly check for the most current version. While these tables represent Navy-recognized sensitizers, they may not include all potential substances, and Navy IH staff must conduct thorough evaluations of Safety Data Sheets (SDSs), product labels, and other relevant technical information per reference [12]. Sensitizers are to be designated by shop or Similar Exposure Group (SEG) and work operation/process. Navy IH is to advise and assist commands in avoiding the use of sensitizing chemicals, if possible.

Hazardous Material Authorized Use List

Navy IH identifies all hazardous materials used in work operations/processes that are not on the command's Hazardous Material (HM) Authorized use List (AUL), which informs commands of required updates for the HM AUL [12]. During periodic surveys, Navy IH should review changes in the HM AUL and document all sensitizers in TABLES 1 and 2 not previously recognized. Navy IH personnel must ensure that all hazardous materials used in work operations/processes not listed on the command's HM AUL are properly identified. The HM AUL provides a critical framework for tracking and controlling the use of hazardous materials. Navy IH personnel should regularly review and update the periodic IH survey to ensure that sensitizers not previously recognized are documented and addressed.

Quantitative Exposure Assessment

Dermal and Respiratory Quantitative Assessments

In accordance with OSHA standards, dermal exposure can be assessed through both direct and indirect methods. Direct monitoring techniques involve the use of dermal dosimeters, such as patches or whole-body suits, as well as skin washes, wipes, and fluorescent tracers, to directly quantify the amount of substance on the skin. Indirect monitoring, on the other hand, estimates dermal dose by measuring biological indicators, such as cholinesterase activity in blood. It is important to acknowledge that, while these methods are available, there are currently no universally applicable methodologies for accurately calculating personnel skin exposure to dermal sensitizers. Therefore, a precautionary approach, focused on robust engineering and administrative controls, as well as the consistent use of appropriate personal protective equipment (PPE), is critical. Further detailed guidance on conducting direct reading and wipe sampling of skin can be found within the OSHA Technical Manual (OTM) Section II: Chapter 2 [15], which should be consulted for specific procedural details. This policy mandates the thorough documentation of all monitoring activities, including methods used, results obtained, personnel exposed, and any corrective actions taken, to ensure effective management of dermal exposure risks.

In the absence of established sensitization exposure limits and universally applicable quantitative methods for assessing DSEN and RSEN, a risk-based approach is paramount. This approach necessitates the utilization of available resources, including those referenced in APPENDIX B and exposure monitoring data, to comprehensively assess the potential for both dermal and respiratory exposure and subsequent sensitization. When conducting such assessments, the identification of a sensitizer coupled with a high potential for dermal and/or respiratory contact mandates implementation of the most conservative control measures. These measures should prioritize the elimination or minimization of dermal and respiratory sensitizer exposures through a hierarchy of controls, beginning with engineering solutions, followed by administrative procedures, and culminating in the diligent use of appropriate PPE. For detailed guidance on recommended workplace controls, please refer to the Workplace Controls Section of this document, which provides specific strategies and implementation protocols.

Qualitative Exposure Assessment

Given the lack of established OELs based on immune-mediated endpoints for many known chemical sensitizers, qualitative exposure assessment strategies remain critical for evaluating potential DSEN and RSEN exposures. Navy IH will first identify all DSEN/RSEN exposures recognized in TABLES 1 and 2 during the walkthrough survey, interviews with shop personnel, and record reviews (e.g., previous IH surveys, command HM AUL, pertinent SDSs, etc.). In addition to gathering the basic information necessary to characterize any chemical exposure (e.g. frequency and duration of use, quantities present, concentrations, handling/application methods, etc.), Navy IH should collect the following information for processes involving DSEN/RSEN - physical and chemical properties, available potency data, existing protective measures, and workplace and hygiene practices. Documentation of the above information can

be recorded by using the Chemical Sensitizer Assessment Questionnaire, APPENDIX C or a similar checklist/questionnaire, as approved by the directing Industrial Hygiene Program Office (IHPO).

Dermal and Respiratory Qualitative Assessments

Navy IH personnel should use the Chemical Sensitizer Assessment Questionnaire, Appendix C, as a structured tool to gather comprehensive data on each DSEN and RSEN. For assessing dermal exposures, DSEN collected data can then be used to populate the Dermal Sensitizer (DSEN) Risk Rating Tool, APPENDICES D1 and D2, a matrix that synthesizes the qualitative information into an overall risk rating for each chemical. Where moderate or high-risk exposures are identified—particularly for chemicals with known strong sensitizing potency—more targeted quantitative data collection (e.g., air sampling and dermal wipe samples, etc.) may be conducted to refine the assessment.

Physical and Chemical Properties

Documenting each DSEN and RSEN's intrinsic characteristics, such as volatility, dustiness, molecular weight, and solubility, is essential in accurately assessing overall exposure risk as these properties describe each chemical's potential to become airborne or penetrate the skin.

Existing Protective Measures

Documenting current PPE and control measures provides insight into how DSEN/RSEN exposures are currently managed. This information will help determine if existing engineering, administrative and PPE controls are adequate or if improvements are needed to safeguard personnel.

Workplace and Hygiene Practices

Recording methods used for cleaning, decontamination, and overall workplace hygiene offers a view of the operational practices that affect DSEN/RSEN exposure. These practices are critical for minimizing accidental exposures and ensuring that proper procedures, per the respective SDS, are followed consistently.

Available Toxicity Data

Toxicity data collected from dermal testing methodologies, such as those described by the Organization for Economic Cooperation and Development (OECD) [16] provides a scientific basis for estimating the sensitizing potential for chemicals, specifically DSEN. These data support the classification of sensitizers into risk categories and help guide decisions on appropriate exposure controls. Given the ability to elicit severe outcomes at low concentrations, respiratory sensitizer exposure characterization poses additional, unique challenges [17]. Compounded by individual susceptibility, the absence of reliable dose-response metrics underscores the value of early screening techniques and health surveillance. Furthermore, many low molecular weight (LMW) agents linked to occupational asthma are also capable of dermal sensitization, creating a dual route of concern [17]. Accordingly, if DSEN/RSEN associated tasks produce aerosols, fumes, or dusts—such as mixing powders, spray painting, epoxy spraying, or cleaning ventilation systems—a review should merit scrutiny by

620 John Paul Jones Circle, Suite 1100
Portsmouth, VA 23708-2103

Navy IH. Where symptoms such as skin rashes, pruritus, wheezing, shortness of breath, or other respiratory distress are indicated firsthand by personnel or via health records reviews, immediate follow-up via exposure monitoring, medical consultation (e.g., occupational health, primary care, dermatology, allergy & immunology, etc.), and potential engineering or administrative interventions are recommended.

NOTE: For documenting physicochemical properties, toxicology data, and control measures for DSEN and RSEN, refer to broad chemicals databases such as OECD, ECHA CHEM, WHO-INCHEM, PubChem, and specialized occupational health resources including the current ACGIH Guide to Occupational Exposure Values, NIOSH Pocket Guide, and Vendor SDS, etc.

Qualitative Assessment Tools

Dermal Sensitizer (DSEN) Risk Rating Tool

Adapted from American Industrial Hygiene Association's (AIHA) Dermal Risk Assessment Model (DRAM) [18], the Dermal Sensitizer (DSEN) Risk Rating Tool provided in APPENDICES D1 and D2 can assist Navy IHs in assigning an overall risk rating to each DSEN identified. This matrix uses qualitative categories to derive hazard and exposure ratings akin to NMCFHPC's Health Risk Rating (HRR) derivation methodology [12]. Most ratings are qualitative, thus requiring expert judgment when scoring exposure categories such as concentration, contact frequency, and retention time in the context of actual workplace conditions [18, 19].

A Note on Modeling

While modeling tools (e.g., Stoffenmanager®, ECETOC-TRA, UISS) exist to estimate sensitizer exposures, they are not widely employed in Navy IH practice due to data requirements, uncertainties, cost, and specialized assumptions that may not align with Navy and Marine Corps operations. Where used as screening or research aids, they should be interpreted with caution and supplemented by professional judgment and field observations.

Workplace Control Measures

Control measures should be used to prevent or minimize exposure to sensitizers. A combination of interventions based on the hierarchy of controls [elimination, engineering, administrative, work practice controls, and PPE] can be appropriately used.

Control Recommendations

Engineering Controls

When elimination or substitution of dermal and respiratory sensitizers is infeasible, engineering controls (e.g., adequate local and general exhaust ventilation, enclosures, isolation, etc.) are crucial for mitigating occupational exposures. Per OSHA, the employer must use engineering controls to reduce and maintain employee airborne exposure below the respective permissible exposure and 15-minute short-term exposure limits, unless the employer can demonstrate that such controls are not feasible. Whenever possible, work to reduce exposures to dermal and respiratory sensitizers to the alternate occupational exposure limits mentioned in OPNAV M-5100.23 CH-3 [20] and by recommending implementation of engineering controls as stated in

620 John Paul Jones Circle, Suite 1100
Portsmouth, VA 23708-2103

the Standardized Navy Industrial Hygiene Survey Guidance Document [21]. For specific engineering controls examples, please refer to TABLE 3.

Be aware that substitution and replacement for military-specific equipment is often not feasible; however, these methods of control should be a consideration in workplaces where sensitizers may be present or where nonmilitary-specific operations occur [15]. Continuous monitoring and evaluation of these controls are essential for maintaining a safe working environment.

620 John Paul Jones Circle, Suite 1100
Portsmouth, VA 23708-2103

TABLE 3: List of Engineering Controls for Common Sensitizers

Common Hazards/CAS	Typical Engineering Controls	Reference (s)
Beryllium/7440-41-7	Machining: Material or process substitution, isolation (partial or full enclosures), wet methods and automation Abrasive blasting: Substitution of blast media containing beryllium, walk-in abrasive blast room or blast cabinet Dentistry: Laboratory hood	29 CFR 1910.1024, 1915.1024, 1926.1124, ACGIH Industrial Ventilation Manual [22, 25]
Chromium (VI)/18540-29-9 [Use Chromium (VI) as stressor of record for: Chromic acid/133-82-0 Barium chromate/10294-40-3 Chromyl chloride/14977-61-8 Lead chromate/7758-97-6 Magnesium chromate/23371-94-0 Strontium chromate/7789-06-2 Zinc chromate/13530-65-9]	Coatings: Paint booth or bay (full aircraft) Sanding: Walk-in sanding booth, low volume-high velocity HEPA-filtered pneumatic tools Welding: Moveable hood, slot hood welding bench Blasting: Walk-in abrasive blast room or blast cabinet Primer application: Paint booth or bay (full aircraft)	29 CFR 1910.1026, 1915.1026, 1926.1126, and ACGIH Industrial Ventilation Manual [23, 25]
Formaldehyde/50-00-0	Embalming: Slot hood Autopsy: Downdraft table Laboratory: Chemical fume hood, moveable hood, downdraft table	29 CFR 1910.1048, 1915.1048, 1926.1148, and ACGIH Industrial Ventilation Manual [24, 25]
Ethyl isocyanate/109-90-0 Hexamethylene diisocyanate (HDI)/822-06-0 Isophorone diisocyanate (IPDI)/4098-71-9 Methylene bisphenyl diisocyanate (MDI)/ 101-68-8 Methyl isocyanate/624-83-9 Phenyl isocyanate/103071-9 Toluene diisocyanate (TDI)/584-84-9 Toluene 2,4-diisocyanate (TDI)/584-84-9 Toluene 2-6-diisocyanate (TDI)/1-08-7	Polyurethane application: Paint booth or bay (full aircraft) Foam application: Laboratory fume hood, closed system	ACGIH Industrial Ventilation Manual [25]

620 John Paul Jones Circle, Suite 1100
Portsmouth, VA 23708-2103

Administrative Controls: Training and Communication

Administrative controls may include training workers on hazards [22, 23, 24, 26], eliminating unnecessary tasks that involve sensitizer exposure, and allowing only necessary personnel to be in the vicinity of processes involving the use of sensitizers. Other administrative controls to consider when evaluating sensitizer exposures include defining work areas and operations (i.e., signage and labeling), relocating workers from the source, or applying shift rotation, if applicable, especially in instances where workers may be exposed to sensitizers at high frequencies and prolonged durations. NMCFHPC OEH staff can provide resources and effective communication strategies for training and education purposes.

Personal Protective Equipment (PPE)

Recommendation of proper PPE is imperative. Protective clothing and equipment prevent skin sensitization and are required by the respective OSHA Standards when there is potential for skin or eye contact. To reduce dermal exposures, recommend the use of chemical-protective gloves, arm sleeves, aprons, and other appropriate clothing. Dependent upon exposure assessments and SDS requirements, respirators may be recommended to reduce inhalation exposures. Always consult the SDS for proper PPE selection [15]. Whenever possible, work to reduce exposures to dermal and respiratory sensitizers as stated per reference [21]. For specific PPE examples, please refer to TABLE 4. Additional information on chemical protective clothing and glove selection can be found in Chapter 10 of reference [12]. For further information or consultation please contact the NMCFHPC IH Department at usn.hampton-roads.navmcpubhlthcenpors.list.nmcphc-ask-ih@health.mil.

620 John Paul Jones Circle, Suite 1100
Portsmouth, VA 23708-2103

TABLE 4: List of Personal Protective Equipment for Common Sensitizers

Common Hazards/CAS	Personal Protective Equipment	Reference(s)
Beryllium/7440-41-7	**Minimum Respiratory Protection:** Exposures **< 10** times the OSHA PEL: • Air-Purifying Respirator (APR) with P100 filters • Qualitatively Fit Tested (QLFT) Exposures **≥ 10** times the OSHA PEL: • Full-face APR with P100 filters • Quantitatively Fit-Tested (QNFT) Blasting Operations: • Type CE supplied-air respirator (hood or helmet) **Dermal Protection:** • Nitrile, PVC, butyl rubber, or neoprene gloves • Skin protective barrier cream (machinists) • Disposable coveralls may be needed to protect, arms, torso, and legs	29 CFR 1910.1024, 29 CFR 1915.1024, 29 CFR 1926.1124 29 CFR 1910.134, Quick Selection Guide to Chemical Protective Clothing [22, 27, 28
Chromium (VI) 18540-29-9 [Use Chromium (VI) as the stressor of record for: Chromic acid/133-82-0 Barium chromate/10294-40-3 Chromyl chloride/14977-61-8 Lead chromate/7758-97-6 Magnesium chromate/23371-94-0 Strontium chromate/7789-06-2 Zinc chromate/13530-65-9]	**Minimum Respiratory Protection**: Exposures **< 10** times the OSHA PEL: • APR with P100 filters • QLFT Exposures **≥ 10** times the OSHA PEL: • Full-face APR with P100 filters • QNFT Blasting Operations: • Type CE supplied-air respirator (hood or helmet) Primer Application: • Combination organic vapor (OV) cartridges/P100 filters Welding operations: • Low-profile APR with P100 filters or powered-air-purifying respirator (PAPR) with HEPA filters **Dermal Protection:** • Nitrile rubber gloves • Disposable coveralls may be needed to protect arms, torso, and legs • For chromic acid in dip tanks: Butyl or Viton™ gloves and aprons	29 CFR 1910.1026, 1915.1026, 1926.1126, 29 CFR 1910.134, and Quick Selection Guide to Chemical Protective Clothing [23, 27, 28]

620 John Paul Jones Circle, Suite 1100
Portsmouth, VA 23708-2103

Common Hazards/CAS	Personal Protective Equipment	Reference(s)
Formaldehyde/50-00-0	**Minimum Respiratory Protection:** Exposures **< 10** times the OSHA PEL: • Full-face APR with formaldehyde cartridges • QLFT Exposures **≥ 10** times the OSHA PEL: • Full-face APR with formaldehyde cartridges • QNFT **Dermal Protection:** • Nitrile, neoprene, butyl or Viton™ gloves • Disposable coveralls may be needed to protect arms, torso, and legs **Eye Protection:** • Chemical splash goggles for products containing 1% or greater of formaldehyde	29 CFR 1910.1048, 1915.1048, 1926.1148 and 29 CFR 1910.134 [24, 27]
Ethyl isocyanate/109-90-0 Hexamethylene diisocyanate (HDI)/ 822-06-0 Isophorone diisocyanate (IPDI)/ 4098-71-9 MDI, methylene bisphenyl diisocyanate/101-68-8 Methyl isocyanate/624-83-9 Phenyl isocyanate/103071-9 Toluene diisocyanate (TDI)/ 584-84-9 Toluene 2,4-diisocyanate (TDI)/ 584-84-9 Toluene 2-6-diisocyanate (TDI)/ 91-08-7	**Minimum Respiratory Protection**: Exposures **< 10** times the OSHA PEL or ACGIH TLV: • Full-face APR with OV/N95 (or OV/P100) • QLFT Exposures **≥ 10** times the OSHA PEL or ACGIH TLV: • Full-face APR with OV/N95 (or OV/P100) • QNFT **Dermal Protection:** • Vitron™ or butyl rubber gloves • PE/EVAL or PE gloves for methyl isocyanate • Tyvek® or comparable coveralls with hood, and shoe covers	29 CFR 1910.134, 3M Respirator Selection Guide and Quick Selection Guide to Chemical Protective Clothing [27, 28, 29]
Bisphenol A/11140-0	**Dermal Protection:** Adhesives • Nitrile or butyl rubber gloves for brush or stick application where skin contact is minimal • Other protective gloves may be considered if changed immediately upon skin contact	Quick Selection Guide to Chemical Protective Clothing [28]
Diethylenetriamine/111-40-0	**Dermal Protection:** Adhesives • Butyl rubber, Neoprene Viton™ gloves	Quick Selection Guide to Chemical Protective Clothing [28]
Epichlorohydrin/106-89-8	**Dermal Protection:** Adhesives • Butyl rubber gloves Brush on stick application where skin contact is minimal • Other protective gloves may be considered if changed immediately upon skin contact	Quick Selection Guide to Chemical Protective Clothing [28]

620 John Paul Jones Circle, Suite 1100
Portsmouth, VA 23708-2103

Further Control Recommendations

The recommendation to enroll an individual into a medical surveillance program is based on OSHA regulatory requirements and/or the qualitative/quantitative exposure assessments of the various occupational chemical, biological, and/or physical hazards. Although enrollment in an exposure-based medical surveillance program can occur based on qualitative assessment results, it usually occurs once a quantitative exposure assessment has been performed where results indicate exposures above the action level or OEL, or if OSHA has identified specific requirements in their substance specific standards [12]. Exposure limits for many chemicals were set without specifically considering sensitization, and sensitizer exposures may create adverse health effects at levels below existing OELs. Since sensitizer concentrations eliciting adverse effects may be less than current OELs and responses are varied per individual using ½ the OEL for an action level has been carefully considered. Enrollment in medical surveillance occurs after evaluation of IH survey results and collaborative determination of the likelihood of exposure to actual and potential hazards by staff representing Safety, IH, and Occupational Medicine [30]. When using qualitative and quantitative data please apply the following considerations when recommending controls, including Medical Surveillance enrollment [21]:

- If the sampling data or professional judgment indicates exposure levels (8-hr-TWA/95th percentile) are greater than Limit of Detection (LOD) and less than 10% of the OEL, then document the exposure assessment as acceptable. Dermal PPE and respiratory protection are recommended to minimize sensitization risk. Medical surveillance for sensitizers is not required.
- If the sampling data or professional judgment indicates exposure levels (8 hour-TWA/95th percentile) are greater than 10% but less than 50% of the OEL, then document the exposure assessment as acceptable. Dermal PPE required and respiratory protection is highly recommended to minimize sensitization risk. Medical surveillance for sensitizers is not required.
- If sampling data or professional judgment indicates exposure levels (8 hour-TWA/95th percentile) are greater than or equal to 50% of the OEL for 30 days or more per year, then document the exposure assessment as unacceptable. Respiratory protection, PPE, and medical surveillance are required based on the potential for sensitization.

NOTE: Given that many chemical sensitizers are not explicitly addressed within substance-specific OSHA standards, **the establishment of a comprehensive medical surveillance program for potential sensitizers should be developed utilizing the Navy's Medical Matrix** [20, 31, 32]. For sensitizers not already covered in the Navy's medical matrix, collaboration for determining development of new programs should encompass OEH, and additional professionals as appropriate. For further information or consultation please contact the NMCFHPC IH Department at usn.hampton-roads.navmcpubhlthcenpors.list.nmcphc-ask-ih@health.mil.

620 John Paul Jones Circle, Suite 1100
Portsmouth, VA 23708-2103

References

1. The National Institute for Occupational Safety and Health (NIOSH). (2022). *Workplace Safety and Health Topics: Skin Exposure and Effects*.
2. National Research Council (US) Committee on the Institutional Means for Assessment of Risks to Public Health. (1983). *Risk Assessment in the Federal Government: Managing the Process*. Washington (DC): National Academies Press (US). PMID: 25032414.
3. Occupational Safety and Health Administration (OSHA). (2024). *Code of Federal Regulations, 1910.1200 APPENDIX A. Health Hazard Criteria (Mandatory)*.
4. The National Institute for Occupational Safety and Health (NIOSH). (2022). *Skin Notation Profiles*.
5. American Conference of Governmental Industrial Hygienists. (2024). *TLVs and BELs. Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices*. Cincinnati, OH.
6. European Agency for Safety and Health at Work. (2003a). *Factsheet 39 - Respiratory Sensitisers*.
7. European Agency for Safety and Health at Work. (2003b). *Factsheet 40 – Skin Sensitisers*.
8. Safe Work Australia. (2024). *Workplace Exposure Standards for Airborne Contaminants*.
9. Deutsche Forschungsgemeinschaft. (2024). *List of MAK and BAT Values 2024 Permanent Senate Commission for the Investigation of Health Hazards of Chemical Compounds in the Work Area Report 60*.
10. Matheson, J. (2014). *Strong Sensitizer Supplemental Definition* [PowerPoint slides]. United States Consumer Product Safety Commission, Department of Health Sciences, Toxicologist.
11. United States Consumer Product Safety Commission. (2017). Accessed November 25, 2024.
12. Navy and Marine Corps Force Health Protection Command. *Industrial Hygiene Field Operations Manual, NMCPHC–TM6290.91–2*. Latest version.
13. Naumann, B. D., & Arnold, S. F. (2019). Setting surface wipe limits for skin sensitizers. *Toxicol Ind Health*, *35*(9), 614–625.
14. European Union. (2024). *Directive (EU) 2024/869 of the European Parliament and of the Council of 13 March 2024 amending Directives 2004/37/EC and 98/24/EC as regards the limit values for lead and its inorganic compounds and for diisocyanates.*

620 John Paul Jones Circle, Suite 1100
Portsmouth, VA 23708-2103

15. Occupational Safety and Health Administration (OSHA). (2022). *Technical Manual (OTM)* (OSHA Instruction TED 01-00-015OSHA/OTM).

16. Organisation for Economic Co-operation and Development (OECD). *Testing of chemicals*. (n.d.).

17. Connell, S., & Araya, S. (2020, June). Respiratory Sensitizers: Strategies to Address Occupational Asthma Caused by Respirable Allergens. *The Synergist*.

18. American Industrial Hygiene Association (AIHA). (2015). *A Strategy for Assessing and Managing Occupational Exposures* (4th ed.). Chapter 13, Dermal Exposure Assessments. Fairfax (VA): AIHA Press.

19. American Chemistry Council (ACC). (2024, July). *Dermal Monitoring Decision Framework*. Washington, DC: ACC.

20. M-OPNAVINST 5100.23 (2023, September). *Navy Safety and Occupational Health Program*.

21. Navy and Marine Corps Force Health Protection Command. *Standardized Navy Industrial Hygiene Survey Guidance Document*. Latest version.

22. Occupational Safety and Health Administration (OSHA). *Title 29 Code of Federal Regulations, Beryllium*.

23. Occupational Safety and Health Administration (OSHA). *Title 29 Code of Federal Regulations, Chromium (VI)*.

24. Occupational Safety and Health Administration (OSHA). *Title 29 Code of Federal Regulations, Formaldehyde*.

25. American Conference of Government Industrial Hygienists (ACGIH). (202). Industrial Ventilation A Manual of Recommended Practice for Design 31st Edition. Cincinnatti, OH.

26. Occupational Safety and Health Administration (OSHA). *Title 29 Code of Federal Regulations 1910.1200 Hazard Communication*.

27. Occupational Safety and Health Administration (OSHA). *Title 29 Code of Federal Regulations 1910.134, Respiratory Protection*.

28. Forsberg, K., Van Den Borre, A., Henry III, N., & Zeigler, J. P. (2020). *Quick Selection Guide to Chemical Protective Clothing* (7th ed.). Wiley.

29. 3M. (2024). Respirator Selection Guide.

30. Bureau of Medicine and Surgery. Navy and Marine Corps Public Health Center. *Medical Surveillance Procedures Manual and Medical Matrix (Latest edition)* (Navy and Marine Corps Public Health Center Technical Manual NMCPHC-TM OM 6260).

620 John Paul Jones Circle, Suite 1100
Portsmouth, VA 23708-2103

31. Bureau of Medicine and Surgery (22 January 2025). *BUMEDINST 5100.13G: Navy Medicine Safety and Occupational Health Program*.

32. Department of Defense (5 April 2024). *DOD Manual 6055.05: Occupational Medical Examinations: Medical Surveillance and Medical Qualification*.

33. OECD (2010), *Skin Sensitisation: Local Lymph Node Assay. OECD Guideline for the Testing of Chemicals* No 429, Paris.

34. 33rd Annual Joint Safety and Environmental Professional Development Symposium (22 April 2025). *An Overview of Occupational Sensitizers Presentation*.

35. OpenAI. (2025). ChatGPT (May 22 version) [Large language model].

620 John Paul Jones Circle, Suite 1100
Portsmouth, VA 23708-2103

APPENDIX A: Navy DOEHRS-IH Breakdown of Frequently Notated Sensitizers and Corresponding Common Processes

The tables below present frequently notated sensitizers (stressors) and the most associated processes throughout the Navy utilizing data from DOEHRS-IH. The following tables represent data pulled from DOEHRS-IH via Business Intelligence Common Services (BCS) in October 2024. Only Navy data with active shops and work processes were pulled. No stop-dated data was included.

TABLE 1A. This table breaks down the most frequent stressors assigned to a hazard in DOEHRS-IH. This table does not take common process into consideration.

Stressor
Hexavalent Chromium Compounds
Isocyanates [HDI, Hexamethylene Diisocyanate, Isophorone Diisocyanate (IPDI), MDI, Methylene Bisphenyl Diisocyanate, Phenyl Isocyanate, Toluene-2,4-Diisocyanate (TDI), Toluene-2,6-Diisocyanate (TDI), TDI, Toluene Diisocyanate]
Formaldehyde
Epichlorohydrin
Cobalt
Beryllium Compounds (As Be)
Methyl methacrylate
Resin acids, as Total Resin acids/8050-09-7
Cyanoacrylate, ethyl
Iodine and Iodides

TABLE 2A. This table lists the 20 most frequent common process assigned in DOEHRS for any Sensitizer.

Top 20 Common Processes	
Coating/Painting Operations	Composite Work
Adhering/Bonding/Sealing	Weapons & Ordnance
Brazing/Soldering/Welding/Cutting	HM/HW Handling & Cleanup
Coating/Paint Removal	Professional/Technical
Medical	Dental
Equipment Repair/Prev. Maintenance	Laboratory Operations
Aircraft Maintenance	Plastics/Rubber Processing
Metal Machining	Cleaning- Other
Cleaning- Mechanical	Aircraft/Flightline Operations
Electrical/Electronics	Miscellaneous Operations

620 John Paul Jones Circle, Suite 1100
Portsmouth, VA 23708-2103

TABLE 3A. The table below breaks down the top potential skin sensitizers and notes their most frequent common processes. This list of common processes is not exhaustive.

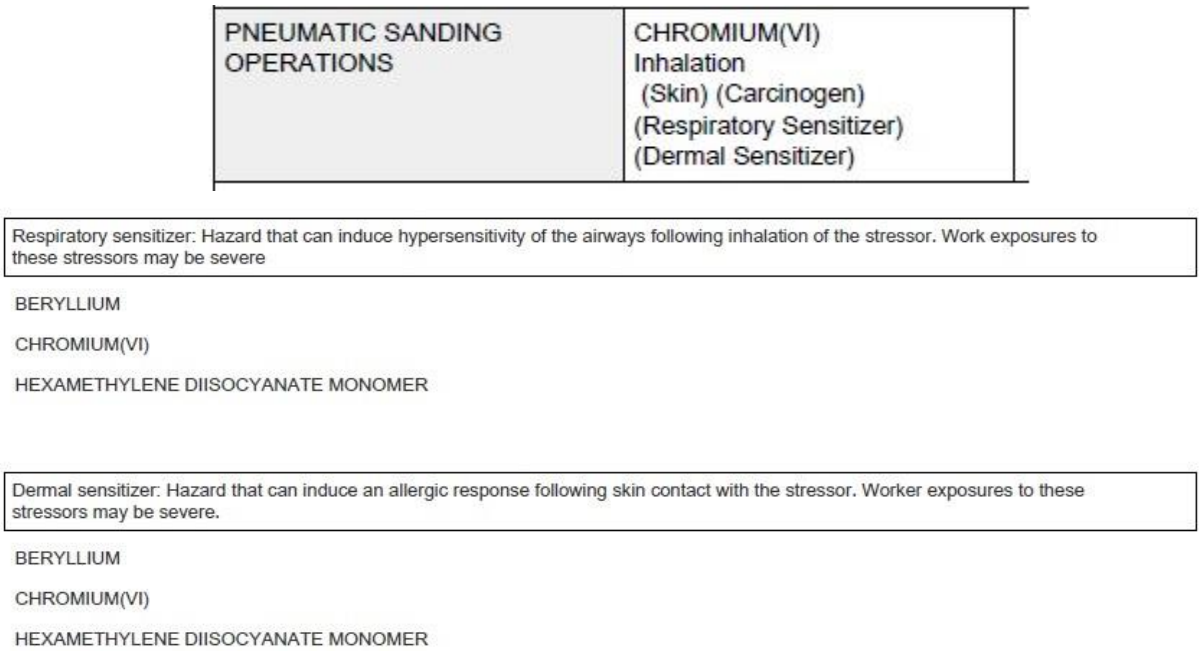
Stressor	Top Common Processes
Hexavalent Chromium	Coating/Painting Operations
	Brazing/Soldering/Welding/Cutting
	Coating/Paint Removal
	Cleaning- Mechanical
	Adhering/Bonding/Sealing
	Aircraft Maintenance
Formaldehyde	Medical
	Adhering/Bonding/Sealing
	Coating/Painting Operations
	Brazing/Soldering/Welding/Cutting
	Aircraft Maintenance
Isocyanates [HDI, Hexamethylene Diisocyanate, Isophorone Diisocyanate (IPDI), MDI, Methylene Bisphenyl Diisocyanate, Phenyl Isocyanate, Toluene-2,4-Diisocyanate (TDI), Toluene-2,6-Diisocyanate (TDI), TDI, Toluene Diisocyanate]	Coating/Painting Operations
	Adhering/Bonding/Sealing
	Plastics/Rubber Processing
	Aircraft Maintenance
	Equipment Repair/Preventive Maintenance
Epichlorohydrin	Adhering/Bonding/Sealing
	Coating/Painting Operations
	Equipment/Repair/Preventive Maintenance
	Aircraft Maintenance
	Composite Work
Cobalt	Brazing/Soldering/Welding/Cutting
	Coating/Paint Removal
	Metal Machining
	Cleaning- Mechanical
	Equipment Repair/Prev. Maintenance
Beryllium Compounds	Coating/Paint Removal
	Electrical/Electronics
	Brazing/Soldering/Welding/Cutting
	Metal Machining
	Equipment Repair/Prev. Maintenance

620 John Paul Jones Circle, Suite 1100
Portsmouth, VA 23708-2103

Stressor	Top Common Processes
Methyl methacrylate	Adhering/Bonding/Sealing
	Dental
	Brazing/Soldering/Welding/Cutting
	Equipment/Repair/Prev. Maintenance
	Electrical/Electronics

Sensitizers Special Notation on DOEHRS-IH Surveys

Both respiratory and dermal sensitizers will appear at the end of (DOEHRS-IH) Enabled Standardized Industrial Hygiene Survey Report with a special notation. The picture below is an example of how the notations will appear. Additional guidance for sensitizers will be updated in the Navy Industrial Hygiene Standardized Report Guidance [21].



PNEUMATIC SANDING OPERATIONS	CHROMIUM(VI) Inhalation (Skin) (Carcinogen) (Respiratory Sensitizer) (Dermal Sensitizer)

Respiratory sensitizer: Hazard that can induce hypersensitivity of the airways following inhalation of the stressor. Work exposures to these stressors may be severe

BERYLLIUM

CHROMIUM(VI)

HEXAMETHYLENE DIISOCYANATE MONOMER

Dermal sensitizer: Hazard that can induce an allergic response following skin contact with the stressor. Worker exposures to these stressors may be severe.

BERYLLIUM

CHROMIUM(VI)

HEXAMETHYLENE DIISOCYANATE MONOMER

620 John Paul Jones Circle, Suite 1100
Portsmouth, VA 23708-2103

APPENDIX B: Supporting Documentation from the European Union [14]*

Occupational exposures to chemical sensitizers or any stressor can be quantified through exposure monitoring. Quantifiable methods to determine consensus exposure limits that would protect workers from adverse effects from a particular sensitizer are limited. Since everyone is unique, personal exposure thresholds will vary, and adverse effects can range from no adverse effect over an individual's lifetime to a severe reaction within seconds.

The European Union (EU) recently published more stringent exposure limits for diisocyanates (measured as the NCO functional groups). These limits may be used as an alternative to TLV-TWAs when conducting assessments if it is determined that the current TLV-TWAs are not effective in determining proper controls to prevent exposure. It is important to document the reasoning for these limits to be selected over TLV-TWAs as they are not within the hierarchy of exposure limit selection.

**Provided for informational purposes only; follow Navy and Marine Corps Force Health Protection Guidance.*

620 John Paul Jones Circle, Suite 1100
Portsmouth, VA 23708-2103

APPENDIX C: Chemical Sensitizer Assessment Questionnaire

Command:	
Shop:	
Bldg. / Location:	
Shop POC Information: (Name, Email, Phone #)	
Industrial Hygienist:	
Survey Date:	
Process / Task:	
Job Titles:	

1. Identification of Sensitizers

   a. Are DSEN and RSEN as identified in TABLES 1 and 2 of *Department of the Navy Technical Guidance on Occupational Sensitizers for Industrial Hygienists* present and/or used by personnel to perform this task/process?

      Yes / No

   b. List of Identified DSEN/RSEN:

      _____
      _____
      _____
      _____
      _____
      _____
      _____
      _____
      _____

   c. For each listed DSEN/RSEN, list exposure time information below

Sensitizer (DSEN/RSEN)	Frequency	Duration

   - Frequency: 1) daily; 2) 2 – 3x/day; 3) weekly 3) 2 – 3x/week; 4) monthly; 5) 2-3x/month; 6) yearly; 7) 2 – 3x/year; 8) quarterly; 9) special
   - Duration: 1) 0 – 15 min; 2) 15 min – 30 min; 3) 30 – 60 min; 4) 1 – 2 hours; 5) 2 – 4 hours; 6) 4 – 6 hours; 7) 6 – 8 hours; 8) > 8 – 10 hours; 9) >10 hours

620 John Paul Jones Circle, Suite 1100
Portsmouth, VA 23708-2103

2. Physical and Chemical Properties

For each identified chemical sensitizer identified, record the following properties using the table below:

Sensitizer (DSEN/RSEN)	Volatility (Low, Medium, or High)	VP (mm Hg)	BP (°C)	VHR	Dustiness / Particle Size Distribution	Molecular Weight (Da)	Octanol-Water Partition Coefficient (K_{ow})

Instructions:

- *Sensitizer (DSEN/RSEN):* List each chemical sensitizer identified.
- *Volatility*: Provide a qualitative rating based on the chemical's VP and BP using chart below.

Volatility Rating			
	Low	**Medium**	**High**
BP Range (°C)	> 400	240 – 400	< 0 – 240
VP Range (mm Hg)	< 0.75	0.75 – 3.75	> 3.75

- *Vapor Pressure (VP):* Enter the vapor pressure in mm Hg.
- *Boiling Point (BP):* Enter the boiling point in °C.
- *Vapor Hazard Ratio (VHR):* Record the VHR as determined from available data or calculate using the following formula: VHR = VP × 10^6/(OEL × 760 mm Hg)
- *Dustiness/Particle Size Distribution*: Note relevant particle size characteristics (e.g., fine, coarse, specific particle size range) or gaseous state
- *Molecular Weight*: Record the molecular weight in Daltons (Da)
- *Octanol-Water Partition Coefficient (K_{ow}):* Provide the K_{ow} value

3. Available Potency Data

For each identified sensitizer, note available potency data such as murine Local Lymph Node Assay (LLNA) EC3% values from the literature (e.g., OECD, ECHA CHEM, WHO-INCHEM, PubChem) to help estimate sensitizer potency.

DSEN/RSEN	LLNA EC3% Value	Potency	Source/Reference

620 John Paul Jones Circle, Suite 1100
Portsmouth, VA 23708-2103

Instructions:

- *Sensitizer (DSEN/RSEN)*: List each chemical sensitizer identified.
- *LLNA EC3%* [The EC3% is the estimated concentration of a substance required to produce a stimulation index (SI) of 3 in the LLNA test, which assesses a substance's potential to cause skin sensitization in mice (33).]: Locate Potency Data by searching reputable sources such as OECD guidelines, ECHA CHEM, WHO-INCHEM, or PubChem for available (LLNA) EC3% values.
- *Potency*: Classify potency by using the EC3% value to categorize potency:
    - Strong: EC3% < 2%
    - Moderate: EC3% = 2%–100%
    - Weak: EC3% > 100%
- *Source*: Document the data source used classify each sensitizer

4. Existing Protective Measures

Record information on current protective measures and equipment:

a. *Protective Clothing/Gloves/Eyewear*:

List types, materials, and coverage areas (e.g., hands, forearms, face, neck):

_____
_____
_____
_____

b. *Respiratory Protection*:

Is respiratory protection in use?

Yes / No

If yes, record details [e.g., assigned protection factors (APFs), facepiece type, filter/cartridge type, change-out schedule]:

_____
_____
_____
_____

5. Workplace and Hygiene Practices

Document procedures and available hygiene measures:

a. *Equipment/Tool Cleaning/Decontamination Methods*:

_____
_____
_____
_____

b. *Hygiene Facilities and Practices*:

(*e.g., availability of handwashing stations, use of barrier creams*)

_____
_____
_____
_____

620 John Paul Jones Circle, Suite 1100
Portsmouth, VA 23708-2103

6. Recommended Actions

Based on the collected data, summarize any recommendations for additional control measures. This may include enhanced PPE, improved work practices, further quantitative monitoring, or engineering controls.

Recommendations:

_____
_____
_____
_____

620 John Paul Jones Circle, Suite 1100
Portsmouth, VA 23708-2103

APPENDIX D1: Dermal Sensitizer (DSEN) Risk Rating Tool[1]

		Low (Score 1)	Medium (Score 2)	High (Score 3)	Very High (Score 4)
Step 1: DSEN Hazard Rating	**DSEN Hazard Score**	Reversible or very low skin or systemic sensitization	Moderate but reversible skin sensitization	Irreversible/chronic skin or systemic sensitization	Life threatening sensitization
	Navy IH Sensitizer Guidance TABLE 1 Sensitizer	YES	YES	YES	YES
	LLNA EC3% Range[2]	≥ 10 to 100%	≥ 1 to < 10%	≥ 0.1 to < 1%	< 0.1 %
	Sensitizer Classification[1]	Weak sensitizer	Moderate sensitizer	Strong	Extreme
Step 2: Dermal Exposure Rating	**Dermal Contact Area (CA)**	Unexpected/unlikely	Very small area of skin contact	Contact possible to moderate area of skin	Contact possible to significant area of skin
	Parameters Impacting Contact Area	1. Reliable controls are in place 2. Small volumes (mL or mg) handled infrequently with good handling technique 3. Up to part of fingertips rarely exposed	1. Contact possible with small volumes (mL or mg) 2. Fingertips only or small amounts on other body parts	Contact possible to parts of hands, hands, and parts of forearms	1. Contact possible to significant area of skin (more than hands and forearms) 2. May have significant contamination of clothing (inside gloves, aprons, coveralls, or other garments)
	Dermal Concentration or Loading (C)	Negligible concentration of chemical likely to contact or load onto skin	Low concentration of chemical likely to contact or load onto skin	Moderate concentration of chemical likely to contact or load onto skin	High concentration of chemical likely to contact or load onto skin
	Parameters Impacting Concentration or Loading	1. Less than 1 µg/cm^2 adherent loading 2. Not likely to permeate from vehicle or substance matrix	1. Low viscosity carrier unlikely to remain as a film on skin 2. In the range of 1µg/cm2 adherent loading 3. Total daily concentration giving cause for concern: dust 500 mg, liquid 10 mg	Total daily concentration giving cause for concern: dust 50 mg, liquid 1 mg	Any amount of dust or liquid is cause for concern

620 John Paul Jones Circle, Suite 1100
Portsmouth, VA 23708-2103

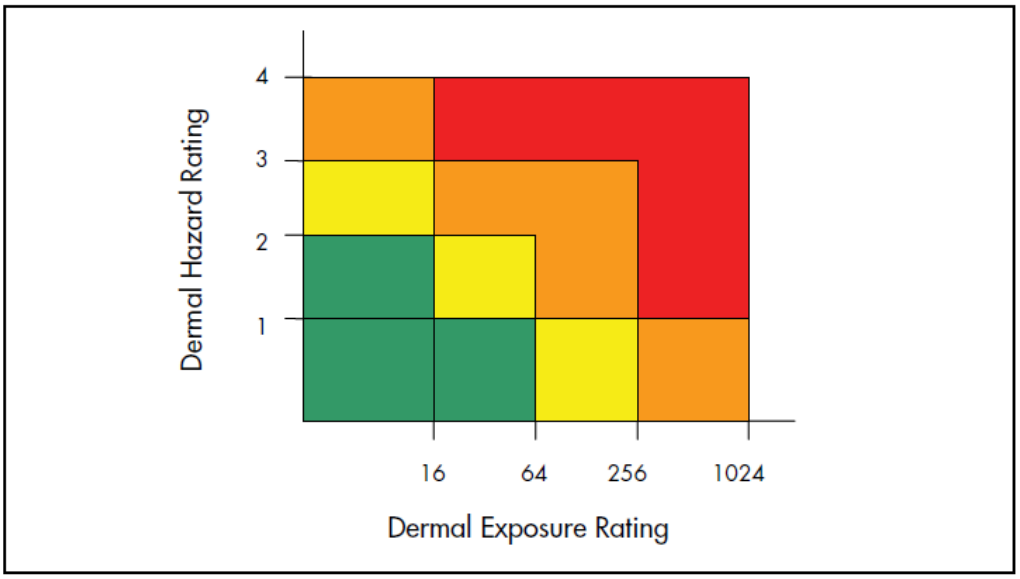
		Low (Score 1)	Medium (Score 2)	High (Score 3)	Very High (Score 4)
Step 2: Dermal Exposure Rating	**Dermal Contact Frequency (CF)**	Minimal contact with skin; one or two incidental contacts; contact during less than 5% of task	Up to 10 incidental contacts with skin; contact during less than 10% of task	Up to 50 incidental contacts with skin; contact during less than 50% of task	Routine incidental contact with skin throughout shift; contact during 50-100% of task
	Dermal Retention Time (RT)	Amount transferred unlikely to remain on skin for any period of time	Amount transferred may remain on skin for some time	Amount transferred is likely to remain on skin for a significant period of time	Amount transferred very likely to remain on skin
	Parameters Impacting Retention Time	1. High volatility chemical (vapor pressure >3.75 mm Hg, Kow –3 to 3) (unless occlusion is expected) 2. Dry and powdery compound	1. Some volatility (semi-volatile, vapor pressure 0.075-3.75 mm Hg, Kow 3 to 6) 2. Damp powder or moist skin	1. Low volatility (KOW 6 to 9) 2. High MW 3. Sticky or consolidated on skin	1. Non-volatile chemical (vapor pressure <0.075 mm Hg, Kow >9) 2. MW>100 3. Substance likely to stick to skin
	Dermal Penetration Potential (PP)	Not likely	Low potential	Possible or slow	Probably or likely
	Parameters Impacting Penetration Potential	1. Physical-chemical properties not compatible with skin permeation 2. MW > 500 Daltons 3. log K_{ow} outside of range: 1-4	1. Small insoluble particles < 1 micron 2. Poor lipid solubility 3. Poor water solubility	1. Very small insoluble particles < 1 micron 2. Some lipid solubility 3. Some water solubility 4. Marginal skin health	1. Good lipid solubility 2. Good water solubility 3. Poor skin health 4. Solvents or other mixture components that may enhance absorption or present as dermal hazards themselves

[1] Adapted from AIHA's Dermal Risk Assessment Model (DRAM).

[2]Adapted from Naumann, B. D., & Arnold, S. F. (2019). Setting surface wipe limits for skin sensitizers. *Toxicol Ind Health*, *35*(9), 614–625.

620 John Paul Jones Circle, Suite 1100
Portsmouth, VA 23708-2103

APPENDIX D2: Dermal Risk Rating Matrix



*Exposure Rating = CA * C * CF * RT * PP =*

Adapted from AIHA's Dermal Risk Assessment Model (DRAM).

620 John Paul Jones Circle, Suite 1100
Portsmouth, VA 23708-2103

APPENDIX E: Acknowledgements

The development of this Navy sensitizer technical guidance document would not have been possible without the valuable contributions, expertise, and collaboration of a dedicated team of professionals. We gratefully acknowledge the efforts of the following individuals who provided subject matter knowledge, technical writing, critical review, insightful suggestions, and overall support throughout the development process.

Sensitizer Working Group Members

We extend our sincere appreciation to the core members of the Sensitizer Working Group for their significant contributions, commitment to excellence, and collaborative spirit:

- Catherine Jennings, CIH – NMRTC San Diego – IH Department Head
- Revonna Sanders, CIH, CSP – NMCFHPC – Industrial Hygienist
- Amy Delong, PhD, CIH, DABT – NMCFHPC – Occupational Toxicologist
- Brian Niland – NMRTC Portsmouth, NH – New England IH Department Head
- Chelsea Siepka – NMCFHPC – Industrial Hygienist
- Joanna Houston – NMCFHPC – Industrial Hygienist
- Dr. John Muller – NMCFHPC – Occupational Medicine Physician
- CDR Paul Hendrickson, MD, MPH – NMCFHPC – Occupational Medicine Department Head & Medical Matrix Committee Chair
- Robert Garnet, CIH – NMCFHPC – Industrial Hygienist

Additional Contributors

We are also grateful to the following professionals outside of the core working group who provided their expertise, reviews, and thoughtful recommendations that strengthened the quality and clarity of this document:

- Todd Young, CIH – Portsmouth New Hampshire Naval Shipyard, Code 106 – Industrial Hygienist
- LCDR Kathleen Kramer, MD – Naval Medical Center San Diego – Dermatology Chief Resident
- CDR Hyun Jun (Robert) Park, MD, PhD, FACAAI, FACP – USU – Associate Professor, Medicine
- Jill Kauker, CIH – NMRTC Charleston – Industrial Hygienist
- LCDR Stephan Nwandu-Vincent – NMCFHPC – EH Department Head
- David Koch, CIH – NMCFHPC – IH Program Support Division Head

Each of your contributions has been instrumental in shaping a comprehensive and practical guidance document. We thank you for your dedication to improving occupational health and safety within the Department of the Navy and the broader Department of Defense community.

620 John Paul Jones Circle, Suite 1100
Portsmouth, VA 23708-2103