DoD 6055.05-M

OCCUPATIONAL MEDICAL EXAMINATIONS and SURVEILLANCE MANUAL

Incorporating Change 3, August 31, 2018

May 2, 2007

Under Secretary of Defense for Acquisition and Sustainment

OFFICE OF THE UNDER SECRETARY OF DEFENSE
3000 DEFENSE PENTAGON
WASHINGTON, DC 20301-3000

ACQUISITION,
TECHNOLOGY
AND LOGISTICS

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FOREWORD

This Manual is issued in accordance with the authority of DoD Instruction (DoDI) 6055.05 (Reference (a)). It provides health professionals with information and references appropriate for developing and conducting occupational medical examinations and surveillance prescribed in Reference (a) by identifying the known health risks associated with specific jobs, processes, and exposures.

DoD 6055.5-M, "Occupational Medical Surveillance Manual," May 4, 1998, (Reference (b)) is hereby canceled.

This Manual applies to the Office of the Secretary of Defense, the Military Departments, the Chairman of the Joint Chiefs of Staff, the Combatant Commands, the Office of the Inspector General of the Department of Defense, the Defense Agencies, the DoD Field Activities, and all other organizational entities in the Department of Defense (hereafter referred to collectively as the "DoD Components").

This Manual is effective immediately and is mandatory for use by all the DoD Components in developing, performing, interpreting the results of, and conducting population-based surveillance with the results of occupational medical examinations. Data collected through environmental sampling and individual surveillance should be entered into appropriate electronic data systems, as available.

Send recommended changes to this Manual to the following address:

Office of the Deputy Under Secretary of Defense
(Installations and Environment)
Environmental Readiness and Safety
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Washington, DC 20301-3400

The DoD Components, other Federal Agencies, and the public may download this Manual from the Washington Headquarters Services Web site at http://www.dtic.mil/whs/directives/.

SUMMARY OF CHANGE 3. This change reassigns the office of primary responsibility for this manual to the Under Secretary of Defense for Acquisition and Sustainment in accordance with the July 13, 2018 Deputy Secretary of Defense Memorandum (Reference (c)).

Philip W. Grone
Deputy Under Secretary of Defense for
Installations and Environment

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REFERENCES

(a) DoD Instruction 6055.05, "Occupational and Environmental Health (OEH)," November 11, 2008
(b) DoD 6055.5-M, "Occupational Medical Surveillance Manual," May 4, 1998 (hereby canceled)
(c) Deputy Secretary of Defense Memorandum, "Establishment of the Office of the Under Secretary of Defense for Research and Engineering and the Office of the Under Secretary of Defense for Acquisition and Sustainment," July 13, 2018
(d) DoD Directive 6490.02E, "Comprehensive Health Surveillance," February 8, 2012, as amended
(e) DoD Instruction 6490.03, "Deployment Health," August 11, 2006
(f) Under Secretary of Defense for Personnel and Readiness Policy 04-004, "Department of Defense Deployment Biomonitoring Policy and Approved Bioassays for Depleted Uranium and Lead," February 6, 20041
(g) Title 29, Code of Federal Regulations
(h) Parts 339 and 339.205 of title 5, Code of Federal Regulations
(i) Department of Health and Human Services, National Institute for Occupational Safety and Health, Publication No. 79-116, "A Guide to the Work-Relatedness of Disease," January 1979[2]
(j) DoD Instruction 6055.12, "DoD Hearing Conservation Program (HCP)," December 3, 2010
(k) Department of Health and Human Services, National Institute for Occupational Safety and Health, Publication No. 85-115, "Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities," October 1985
(l) Sections 12101 and 2000e of title 42, United States Code
(m) Part 391.41-9 of title 49, Code of Federal Regulations
(n) Journeay, S., and Goldman, R. 2014. "Occupational Handling of Nickel Nanoparticles: A Case Report." American Journal of Industrial Medicine 57(9):1073-1076
(o) Song, Y., Li, X., and Du, X. 2009. "Exposure to Nanoparticles is Related to Pleural Effusion, Pulmonary Fibrosis, and Granuloma." European Respiratory Journal 34:559-567
(p) National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication 2013-145, "Current Intelligence Bulletin 65: Occupational Exposure to Carbon Nanotubes and Nanofibers," April 2013[3]
(q) National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication 2011-160, "Current Intelligence Bulletin 63: Occupational Exposure to Titanium Dioxide," April 2011
(r) National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication 2009-116, "Current Intelligence Bulletin 60: Interim Guidance for Medical Screening and Hazard Surveillance for Workers Potentially Exposed to Engineered Nanoparticles," February 2009
(s) DoD Instruction 6055.01, "DoD Safety and Occupational Health (SOH) Program," October 14, 2014

[1] Available at http://www.health.mil/~/media/MHS/Policy%20Files/Import/04-004.ashx
[2] Available at http://www.cdc.gov/niosh/docs/1970/79-116.html
[3] Available at http://www.cdc.gov/niosh/docs/2013-145/

(t) Association of Occupational and Environmental Clinics, "Medical Management Guidelines for Lead-Exposed Adults Revised 04/24/2007, CSTE Medical Management Guidelines Added October 2013"[4]

[4] Available at http://www.aoec.org/documents/positions/mmg_revision_with_cste_2013.pdf

ABBREVIATIONS AND ACRONYMS

AL	action level
ALT	alanine aminotransferase
AP	alkaline phosphatase
AR	Army Regulation
AST	aspartate transferases
β_2-M	beta-2-microglobulin
BLL	blood lead level
BUN	blood urea nitrogen
CAS	Chemical Abstract Service
CBC	complete blood count
CdB	blood cadmium
CdU	urine cadmium
CFR	Code of Federal Regulations
CO	carbon monoxide
COHb	carboxyhemoglobin
Cr	creatinine
DA PAM	Department of the Army Pamphlet
dB	decibel
DoDI	DoD Instruction
DOT	Department of Transportation
DSN	Defense Switched Network
EP	erythrocyte protoporphyrin
FEV-1	forced expiratory volume in the first second
FVC	forced vital capacity
GGT	glutathione transferases
H&H	hemoglobin and hematocrit
HAZWOPER	Hazardous Waste Operations and Emergency Response
HCP	Hearing Conservation Program
HIV	human immunodeficiency virus
Hz	hertz
LFT	liver function test
LLN	lower limit of normal
MC	methylene chloride
MDA	methylenedianiline
µg/dL	microgram per deciliter

µg/g	microgram per gram
µg/m^3	micrograms per cubic meter
MI	myocardial infarction
ml	milliliter
MW	molecular weight
NEHC	Naval Environmental Health Center
NFPA	National Fire Protection Association
NIH	National Institutes of Health
NIOSH	National Institute for Occupational Safety and Health
NMCPHC	Navy and Marine Corps Public Health Center
OSHA	Occupational Safety and Health Administration
PA	posteroanterior
PEL	permissible exposure limit
PFT	pulmonary function testing
pH	potential of hydrogen
PPE	personal protective equipment
ppm	parts per million
RBC	red blood cell
RPP	Respiratory Protection Program
SCBA	self-contained breathing apparatus
STEL	short-term exposure limit
STS	significant threshold shift
TLV	threshold limit value
TM	technical manual
TWA	time-weighted average
UA	urinalysis
USAPHC	U.S. Army Public Health Center (Provisional)
ZPP	zinc protoporphyrin

C1. CHAPTER 1

GENERAL INFORMATION

C1.1. PURPOSE

C1.1.1. This Manual summarizes medical surveillance and employer requirements of the Occupational Safety and Health Administration (OSHA), issues additional DoD policy for surveillance and management, and provides health professionals with additional information and references appropriate for developing and conducting consistent occupational medical examinations and surveillance.

C1.1.2. Developing and administering occupational medical examinations based on this Manual will satisfy the basic medical surveillance requirements prescribed in DoDI 6055.05 (Reference (a)).

C1.1.3. Occupational medicine specialists are available for consultation at the following centers of occupational health:

C1.1.3.1. U.S. Army. Commander, U.S. Army Public Health Center (Provisional) (USAPHC), 5158 Blackhawk Road, Aberdeen Proving Ground, MD 21010-5403. Telephone: (800) 222-9698; (410) 436-4375; Defense Switched Network (DSN) 584-4375. Internet address: http://chppm-www.apgea.army.mil/

C1.1.3.2. U.S. Navy. Commanding Officer, Navy and Marine Corps Public Health Center (NMCPHC), 620 John Paul Jones Circle, Suite 1100, Portsmouth, VA 23708-2103. Telephone: (757) 953-0700, DSN 377-0700, after hours (757) 621-1967. Internet address: http://www.med.navy.mil/sites/nmcphc/Pages/Home.aspx

C1.1.3.3. U.S. Air Force. Commander, U.S. Air Force School of Aerospace Medicine, 2510 5th Street, Building 840, Wright-Patterson Air Force Base, OH 45433-7913. Telephone: Environment, Safety and Occupational Health Service Center, (937) 938-3764; DSN 798-3764; or toll free 1-888-232-3764;. Internet addresses: http://www.wpafb.af.mil/afrl/711hpw/usafsam.asp and https://hpws.afrl.af.mil/dhp/OE/ESOHSC

C1.1.4. Health professionals who identify potentially hazardous agents not covered in this Manual shall provide prompt notification to the respective occupational health center.

C1.1.5. Service-specific requirements for military deployment-related medical screening and surveillance may include elements not in this Manual. Additional information on joint medical surveillance for deployment may be found in DoD Directive 6490.02E, DoDI 6490.03, and Under Secretary of Defense for Personnel and Readiness Policy 04-004 (References (d), (e), and (f)).

C1.2. REQUIREMENTS

C1.2.1. Workplace Exposures. Industrial hygiene surveys of workplaces identify potential exposures and other worker safety and health risks, and establish workplace exposure profiles.

Industrial hygiene program managers must ensure exposure information is readily available to the health professional. (See Reference (a) for additional guidance on industrial hygiene surveillance.) Certain OSHA standards include specific screening and surveillance requirements. If there is no specific requirement of OSHA to initiate occupational medical surveillance, surveillance is usually initiated for workplace exposures greater than one half the permissible exposure limit (PEL) (OSHA Table Z substances) or greater than one half the threshold limit value (subpart Z of part 1910 and part 1910.1000 of title 29, Code of Federal Regulations (CFR) (Reference (g))). Medical surveillance activity should consider all relevant occupational exposure limits pursuant to Reference (a).

C1.2.2. Work-Related Health Effects. The health of workers must be monitored to determine if work-related exposures have resulted in adverse health effects. The occupational safety and health program meets the legal and regulatory requirements to assess the effects of work-related exposures on workers' health status.

C1.3. OCCUPATIONAL MEDICAL EXAMINATIONS

C1.3.1. Background Information

C1.3.1.1. When performing an occupational medical examination or constructing an examination protocol, the health professional should understand the reasons for obtaining each historical item, performing each physical examination procedure, and ordering each laboratory test. This understanding is important to the practitioner in properly performing the examination, investigating abnormalities, interpreting results, and formulating appropriate medical recommendations. No examination, in and of itself, is purely surveillance or screening. All tests may have more than one purpose.

C1.3.1.2. This Manual does not cancel or supersede other DoD Component instructions that pertain to the physical examination of military or civilian personnel, such as induction, retirement, periodic, or reenlistment physical examinations that are conducted for purposes other than the recognition and evaluation of health risks associated with exposure to chemical, physical, and biological hazards in DoD workplaces.

C1.3.1.3. Workers who are not qualified for positions and wish to apply for reinstatement under an exception to policy are responsible to provide medical evidence of their fitness.

C1.3.2. Primary Reasons for Conducting Occupational Medical Examinations. Occupational medical examinations are conducted to determine:

C1.3.2.1. If workers are medically and physically able to perform the assigned duties without substantial risk of harm to themselves, others, or the mission (fitness for duty examinations).

C1.3.2.2. Whether the workplace is causing workers injury or illness due to an occupational exposure (medical surveillance examinations).

C1.3.3. Types of Occupational Medical Examinations

C1.3.3.1. Preplacement/Initial/New Hire Examinations. These examinations are performed before placement in a specific job to medically assess if the worker will be able to perform the job safely. They may be combined with occupational medical surveillance to record a baseline of values for future comparison. Ideally, these medical examinations should be done before the worker commences work. However, if the individual has already started work, these examinations shall be completed within 60 days of assignment, unless more stringent requirements exist.

C1.3.3.2. Personnel Policy Enforcement Examinations. Personnel policy enforcement examinations medically assess workers to determine if they meet established standards and conditions of employment. Examples of these types of examinations are drug use screening and fitness for duty examinations (part 339 of title 5, CFR (Reference (h))). Other types of personnel policy examinations may include work related injury/illness evaluations, return to work examinations, and impairment evaluations.

C1.3.3.3. Medical Certification Examinations. Medical certification examinations determine if an individual meets specific medical fitness standards, such as those promulgated by the Federal Aviation Administration and Department of Transportation (DOT) for aviators and commercial drivers. In addition, the examination should determine if the individual can perform the essential duties of the position without endangering self or others. (See paragraph C1.4.7. for a discussion of medical determinations and recommendations.) The individual is either within all standards and thus medically qualified, or fails to meet one or more standards and thus is not medically qualified.

C1.3.3.3.1. If an individual does not meet one or more established medical fitness standards, he or she is considered not medically qualified. The individual may, if he or she can perform the essential job functions, originate a request for waiver with the agency granting the certification such as the Federal Aviation Administration or DOT.

C1.3.3.3.2. Temporary medical conditions such as elevated systolic blood pressure are ordinarily only temporarily disqualifying. The individual would not need to request a waiver from the agency granting the certification unless the condition persists.

C1.3.3.4. Medical Surveillance Examinations. Medical surveillance examinations, often referred to as occupational health examinations, provide baseline and periodic assessments or measurements to detect abnormalities in workers exposed to work-related health hazards. If detected early enough, these examinations can prevent or limit disease progression by exposure modification or medical intervention. Many medical surveillance examinations have a regulatory component (OSHA-required). Medical surveillance examinations are effective for the individual if useful screening techniques (history questionnaires, medical exams, or lab tests) are available to identify abnormalities in the target organ system at a stage when modifying exposure or providing medical treatment can arrest progression or prevent recurrence. Medical surveillance can be valuable for the population even if it does not directly benefit an individual worker.

C1.3.3.4.1. Baseline Surveillance Examinations. Baseline examinations are performed before placement in a specific job to obtain baseline measurements for future comparison. As with preplacement examinations, these medical examinations should be done

before the worker commences work, or within 60 days of assignment, unless more stringent requirements exist. Baseline surveillance examinations can often be accomplished at the same time as preplacement examinations, but the content of each of these examinations might not be the same.

C1.3.3.4.2. Periodic Surveillance Examinations. Periodic monitoring examinations are conducted at scheduled intervals. Periodic examinations may include an interval history, a physical examination, and/or clinical and laboratory screening tests.

C1.3.3.5. Termination. The two kinds of termination examinations are:

C1.3.3.5.1. Termination of Employment Examinations. These examinations are designed to assess pertinent aspects of a worker's health when the worker leaves employment. Documentation of examination results may be beneficial in assessing the relationship of any future medical problems to an exposure in the workplace. These exams are particularly applicable to conditions that are chronic or that may have long latency periods, such as the sequelae of chronic exposure to asbestos. Federal regulations, such as part 1910.1001 of Reference (f) for asbestos, require termination of employment examinations.

C1.3.3.5.2. Termination of Exposure Examinations. These examinations are performed when exposure to a specific hazard has ceased. Exposure may cease when a worker is reassigned, a process is changed, or the worker leaves employment. Termination of exposure examinations are most beneficial when the health effect being screened for is likely to be present at the time exposure ceases. Federal regulations, such as part 1910.120 of Reference (f) for Hazardous Waste Operations and Emergency Response (HAZWOPER), require termination of exposure examinations.

C1.3.3.6. Employee Health Promotion Examinations. Employee health promotion examinations are nonoccupational medical examinations given to workers as a benefit and are not addressed in this Manual.

C1.4. OCCUPATIONAL MEDICAL EXAMINATION PROCESS

C1.4.1. Identifying Workers Who Need Occupational Medical Examinations

C1.4.1.1. The three ways to identify workers at risk of work-related health problems are: by job title, by workplace, and by individual exposure.

C1.4.1.1.1. Job Title. Identification by job title and description characterizes the basic tasks, hazardous exposures, and health outcomes likely to be experienced by the majority of workers in a specific occupational group. This type of grouping assumes all workers will have similar job demands, experience similar stresses, have the same exposures to hazardous agents, and experience the same health effects.

C1.4.1.1.2. Workplace

C1.4.1.1.2.1. Identification by workplace characterizes the hazardous agents present in the workplace and assumes all workers assigned to that workplace are potentially exposed to the levels of hazards found at the time the workplace was evaluated.

C1.4.1.1.2.2. Identification by similar exposure group is a subset of workplace exposure and also assumes all workers assigned to that workplace are potentially exposed to the levels of hazards found at the time the workplace was evaluated.

C1.4.1.1.3. Individual Exposure. Identification by individual exposure quantifies job demands, stresses, and hazardous exposures for each individual.

C1.4.1.2. Each of the three methods of identifying workers at risk has limitations. Likewise, the utility of any standardized examination protocol developed using a single method to identify the workers at risk will be limited. To minimize these limitations, a combination of these methods is recommended.

C1.4.2. Determining Evaluation Content and Developing Protocols

C1.4.2.1. Installation occupational health and safety personnel are jointly responsible for identifying work areas where workers need medical examinations because of specific hazardous exposures.

C1.4.2.2. The Army and the Air Force often generate examination protocols locally, although some are developed centrally. In lieu of developing individual examination protocols, NMCPHC Technical Manual (TM) NMCPHC-TM OM 6260, "Medical Surveillance Procedures Manual and Medical Matrix,"[5] (hereafter referred to as the "Navy's Medical Matrix") provides a useful tool.

C1.4.2.3. Examination protocols may include employee health promotion and personnel programs. Local medical personnel must be aware of collective bargaining agreements and support agreements that entitle specific employee groups to health benefit programs or other medical benefits.

C1.4.2.4. Useful factors to consider when determining examination content and developing examination protocols include:

C1.4.2.4.1. Specific job tasks and/or requirements.

C1.4.2.4.2. Workplace risk factors including exposure to physical, chemical, biological, radiological, and other agents (e.g., ergonomic stressors).

C1.4.2.4.3. Personal risk factors (personal health).

C1.4.2.4.4. Target organ systems.

C1.4.2.4.5. Public health and safety impact.

[5] Available at http://www.public.navy.mil/surfor/Documents/6260_NMCPHC_TM.pdf

C1.4.2.4.6. Legal and regulatory requirements.
C1.4.2.4.7. Employee health promotion and personnel programs.

C1.4.2.4.8. Previous job tasks and/or requirements or work history.

C1.4.2.4.9. Environmental risk factors (e.g., household and hobbies exposures).

C1.4.2.4.10. Use of personal protective equipment (PPE).

C1.4.2.4.11. Allergies.

C1.4.2.4.12. Tobacco, alcohol, and/or illicit drug use.

C1.4.2.4.13. Diet.

C1.4.2.4.14. Use of medications, vitamins, herbals, and supplements.

C1.4.2.4.15. Other factors set forth in National Institute for Occupational Safety and Health (NIOSH) Publication No. 79-116 (Reference (i)).

C1.4.3. Performing the Evaluation

C1.4.3.1. The health professional takes a focused medical history based on complaints and risk factors, elicits a pertinent review of systems, and then performs a targeted physical examination and orders specific laboratory tests to characterize the status of specific organ systems.

C1.4.3.2. If an illness or condition is found, it may or may not be work-related. Appendix 2 of this Manual, "Sentinel Events," contains a list of medical conditions historically associated with workplace overexposures that should prompt the practitioner to investigate the worker and the workplace for systemic problems. Consultation with the industrial hygiene staff is strongly recommended. The importance of collaborating with industrial hygiene personnel cannot be overemphasized. Such cross collaboration can add valuable and crucial information to the evaluation of exposure, ultimately leading to a more accurate diagnosis and better care of the worker.

C1.4.4. Record Keeping (Documenting Examination Results). Occupational medical surveillance examinations shall be recorded and maintained according to Reference (a) and DoD Component implementing directives. All results must be recorded in employees' medical records whether paper or electronic. Standardized forms, such as those produced using the Navy's Medical Matrix, have been developed to aid in collecting and recording occupational medical information.

C1.4.5. Informing the Worker of Examination Results

C1.4.5.1. The health professional shall inform all workers of the results of their occupational medical examinations as soon as possible following completion of the exam. It is

not necessary to discuss every laboratory value with every worker, but all workers should be provided an explanation of:

C1.4.5.1.1. Whether they are qualified.

C1.4.5.1.2. Whether a medical condition was discovered that would place them at an increased risk of material impairment of their health from continued exposure to work-related chemical or physical agents.

C1.4.5.1.3. Whether limitations are recommended for their exposures or for use of PPE.

C1.4.5.1.4. What, if any, work restrictions or corrective devices, such as corrective lenses, must be worn to be qualified to perform the job.

C1.4.5.2. The health professional shall document patient notification in the medical record. All personnel with significant abnormalities must be further evaluated or referred to their private physician for evaluation, as appropriate. In cases where the abnormal lab/exam is likely work-related but not proven, further evaluation is warranted by the agency physician. Abnormalities that are likely not work-related should be further evaluated by the worker's private physician. In cases where the abnormality is thought to be work-related, the worker may be eligible for compensation. In such cases, the worker should be advised to file a Department of Labor Form CA-2, "Notice of Occupational Disease and Claim for Compensation," and select a provider for further evaluation, as needed.

C1.4.6. Counseling and Education Concerning Identified Health Risks. The health professional shall inform the worker receiving the occupational medical examination of significant health risks present in the work environment. The extent of the information provided to the worker will vary depending on the nature of the hazards and health status of the worker, and need not be formal or in writing.

C1.4.7. Medical Determinations and Recommendations Regarding Fitness for Duty and Placement

C1.4.7.1. The examining physician makes a medical recommendation to management on the individual's ability to perform the essential job functions. The fitness for duty decision rests solely with the appointing official or the Service member's commander. Employment-related decisions are fundamentally managerial, not medical.

C1.4.7.1.1. Medical standards exist and are justified because the positions in question are arduous, hazardous, or require a specific level of fitness to protect personal and public safety or to insure security is not compromised. The Office of Personnel Management normally promulgates or approves medical standards. Examples include vision requirements for aviators and limb requirements for drivers. Waivers for medical standards are discussed in subpart B of part 339 of Reference (h). Relatively few job titles have medical standards. If a candidate does not meet a promulgated medical standard, the examining physician should annotate in the record that the worker is "not medically qualified."

C1.4.7.1.2. Physical standards are established by agency or activity management at the local level, usually in conjunction with a personnel staffing specialist. Examples of physical standards include lifting requirements, communication skills, and ability to tolerate certain working environments. Physical standards information is usually indicated in a position description or circled on the front of Optional Form 178, "Certificate of Medical Examination." Candidates are not disqualified on the basis of not meeting a physical standard; instead the medical officer should annotate what deficiencies the worker has (e.g., "maximum lifting: 21 pounds," where the standard is 50 pounds). Waiver of physical standards resides at the local management level; it is not a medical responsibility.

C1.4.7.2. Normally, management has the obligation to consider issues that are not strictly medical (e.g., reasonable accommodation or assessment of undue hardship on the agency's operations).

C1.4.7.3. The role of the health professional in assisting management in making employment and/or placement decisions is limited to determining whether the individual meets the physical requirements of the position and can, from a medical standpoint, perform the job capably and safely.

C1.4.7.3.1. If the individual is medically capable of performing the required tasks only with some accommodation or restriction, without risk to his or her health or to that of others, the health professional must provide a list of restrictions, expected duration, and therapeutic or risk-avoiding benefits. If the individual has a large number of restrictions or limitations but is otherwise qualified, the health professional should complete a case summary outlining the findings and the medical logic that led to the conclusions, recommendations, and restrictions. (See subparagraph C1.4.7.1.2.)

C1.4.7.3.2. If the individual is medically incapable of performing essential tasks, will be unsafe, or fails to meet medical requirements for the job, the physician should communicate the finding to management for a decision. (See subparagraph C1.4.7.1.1.)

C1.4.8. Documenting Medical Determinations

C1.4.8.1. Unsuitability. For a worker determined to be medically unsuited for the job, the health professional should prepare a summary statement and file it in the worker's medical record. The health professional must inform the appointing official of the disqualifying recommendation; however, the summary, as confidential medical information, should be provided to management only when necessary and authorized. The following information concerning the disqualifying condition(s) should be included in all summary statements.

C1.4.8.1.1. Diagnosis. Justified according to established diagnostic criteria.

C1.4.8.1.2. History. Including references to findings from previous examinations, treatment, and responses to treatment.

C1.4.8.1.3. Clinical Findings. Including results of any laboratory tests, X-rays, or special evaluations performed.

C1.4.8.2. Qualified with Restrictions. If a worker has a large number of restrictions but is otherwise qualified, the physician should complete a similar case summary outlining the findings and the medical logic that led to the conclusions, recommendations, and restrictions.

C1.4.9. Special Cases with Bargaining Units. Certain occupational medical surveillance examination procedures (e.g., firefighter examinations) may be part of an installation or area-wide collective bargaining agreement between the Government and employee unions or organizations. Whenever changes are proposed in collective bargaining-agreed upon procedures, the responsible parties must be notified and allowed to accept or decline the changes. The local or area-wide Civilian Personnel/Human Resources Office can provide information on collective bargaining-required occupational medical surveillance, and is the occupational medicine professional's point of contact for proposing any changes in examination procedures.

C1.5. HEALTH RISK COMMUNICATION

Sometimes making a medical diagnosis and/or recommendation will cause the worker concern. Disqualifying a worker or providing seriously adverse test results can be difficult to communicate. Furthermore, some occupational exposure issues may be due to risk communication factors only (e.g., perceived exposures with no supporting medical or occupational data), and can only be addressed effectively using a combined risk communication/medical approach.

C1.5.1. Medical personnel must be prepared to deal with situations in which patients, management, labor unions, or other stakeholders do not agree with the medical recommendation and/or assessment.

C1.5.2. Medical personnel should be trained in effective health risk communication skills to effectively manage these situations. The medical assets listed in paragraph C1.1.3. can provide appropriate agency risk communication support.

C2. CHAPTER 2

MEDICAL SURVEILLANCE FOR OSHA-REGULATED HAZARDS

C2.1. INTRODUCTION

With the establishment of OSHA in 1970, the Federal Government began to mandate the basic elements of medical surveillance, including occupational medical surveillance examinations, for a number of chemical and physical stressors in the workplace. OSHA standards apply to military and civilian workplaces except as otherwise exempted.

C2.2. MEDICAL SURVEILLANCE

C2.2.1. Facilities with employees exposed to stressors at or above the action level (AL) are required to perform appropriate medical surveillance examinations if a suitable examination exists. The scope of these medical screening examinations shall be determined at the Service, command, or activity level based on the nature and extent of personnel exposed at or above the AL. Medical screening exams should be targeted and based on sound rationale. This Manual includes useful recommendations for the Department of Defense. The Navy's Medical Matrix is required for Navy surveillance. Consultation with Service points of contact listed in paragraph C1.1.3. is encouraged to optimize the use of laboratory testing to assess specific organ function.

C2.2.2. The medical surveillance requirements for the OSHA-regulated programs that may be expected to be found in a military environment are listed in Tables C2.T1. to C2.T17. Most of these programs require a written medical opinion for the employer regarding the worker's suitability for exposure to a specific stressor, as reflected in the tables. The requirements outlined in these tables should be considered the minimum for medical surveillance. DoD's blood lead requirements are more restrictive than OSHA's. The OSHA standard allows for higher blood lead levels in workers who are occupationally exposed to lead. See Table C2.T11 for a summary of all OSHA lead requirements and Table C4.T2 for DoD's health-based requirements and guidelines associated with blood lead laboratory results. The Navy's Medical Matrix is required for Navy occupational medical surveillance.

C2.2.3. Part 339.205 of Reference (h) allows an agency to require a medical evaluation (surveillance exam) or a medical standard exam (fitness for duty exam). If the worker refuses medical examination, the provider should notify the supervisor, civilian personnel representative, and Judge Advocate General (labor specialist) as applicable.

Table C2.T1. Acrylonitrile, Chemical Abstract Service (CAS) # 107-13-1 (Part 1910.1045(n) of Reference (g))

Target Organs	Medical Surveillance Criteria	Required Exam	Required Medical History	Physical Exam Elements	Required Special Procedures	Other Required Elements
Central nervous system Gastrointestinal Liver Peripheral nervous system Respiratory Skin	Employees who are or may be exposed at or above AL without regard to respirator use Examinations conducted by or under the supervision of a licensed physician	Initial (baseline) Annual (at a minimum) Emergency exposure Termination of employment (within 6 months of termination)	Work history (employer must provide) Medical history with special attention to: - Skin - Respiratory - Gastrointestinal - Central nervous system - Peripheral nervous system - History of smoking	Complete physical exam with particular attention to: - Central nervous system - Gastrointestinal - Peripheral nervous system - Respiratory - Skin - Thyroid	Chest X-ray (14”x17” posteroanterior (PA) view only) Fecal occult blood testing if age >40 Other tests deemed appropriate by the physician Respirator medical exam if required	Physician’s written opinion to employer: - Results of medical examination and testing - Opinion whether exposure places worker at increased risk for health impairment - Recommended work limitations - Statement that employee has been informed of exam results and conditions that may require further evaluation Employer shall provide copy of written opinion to affected employee

Table C2.T2. Arsenic-Inorganic, CAS # 7440-38-2 (Part 1910.1018(n) of Reference (g))

Target Organs	Medical Surveillance Criteria	Required Exam	Required Medical History	Physical Exam Elements	Required Special Procedures	Other Required Elements
Bladder Lung Mucus membranes Skin	Employees who are or may be exposed at or above AL for more than 30 days per year without regard to respirator use Examinations conducted by or under the supervision of a licensed physician	Initial (baseline) Annual (at a minimum) Emergency exposure Termination of employment (within 6 months of termination)	Work history (employer must provide) Medical history including: - Smoking history - Respiratory symptoms	Nasal Respiratory Skin	Chest X-ray (PA view only) Other tests deemed appropriate by the physician Respirator medical exam if required	Physician's written opinion to employer: - Results of medical examination and testing - Opinion whether exposure places worker at increased risk for health impairment - Recommended work limitations - Statement that employee has been informed of exam results and conditions that may require further evaluation Employer shall provide copy of written opinion to affected employee

Table C2.T3. Asbestos, CAS # 1332-21-4 (Parts 1910.1001(l), 1926.1101(m), and 1915.1001(m) of Reference (g))

Target Organs	Medical Surveillance Criteria	Required Exam	Required Medical History	Physical Exam Elements	Required Special Tests	Other Required Elements
Cardiovascular system Digestive system Lungs and pleura	General industry: Employees who are or will be exposed to airborne concentrations of asbestos fibers at or above the time-weighted average (TWA) and/or excursion limit Construction: See part 1926.1101 of Reference (g) for details Maritime: See part 1915.1001(m) of Reference (g) for details Examinations conducted by or under the supervision of a licensed physician	Preplacement Annual Termination of employment	Preplacement: Medical and work history using DD Form 2493-1, "Asbestos Exposure Part I – Initial Medical Questionnaire" Annual: Medical and work history using DD Form 2493-2, "Asbestos Exposure Part II – Periodic Medical Questionnaire" Termination: Same as annual	Complete physical exam of all systems with particular attention to: - Respiratory system - Digestive tract	Pulmonary function testing (PFT): Persons other than licensed physicians who administer the PFT shall complete a training course in spirometry sponsored by an appropriate academic or professional institution Chest X-ray: See appendix E of part 1910.1001 of Reference (g) for chest X-ray schedule and B-reader requirements	Counsel smokers regarding increased risk of lung cancer with asbestos exposure Physician's written opinion to include: - Whether employee has medical conditions that would place employee at risk from exposure to asbestos - Whether employee has limitations regarding PPE - A statement that the employee has been informed of exam results - A statement that employee has been informed by physician of increased risk of lung cancer if employee is a smoker Employer shall provide copy of written opinion to employee within 30 days

Table C2.T4. Benzene, CAS # 71-43-2 (Part 1910.1028(i) of Reference (g))

Target Organs	Medical Surveillance Criteria	Required Exam	Required Medical History	Physical Exam Elements	Required Special Procedures	Other Required Elements
Blood/bone marrow Central nervous system Eyes Respiratory Skin	Employees who are or may be exposed: - At or above AL 30 days per year - At or above PEL 10 days per year - At or above 10 parts per million (ppm) 30 days per year prior to 1987 - To >0.1% benzene solvent as tire building machine operators Examinations conducted by or under the supervision of a licensed physician Nonphysician PFT personnel must have completed a government, academic, or professional training course	Initial (baseline) Annual Emergency exposure	Detailed work exposure history (provided by employer) Medical history including: - Past exposure to benzene or other blood/bone marrow toxins - Renal disease - Liver disease - Medication history - Exposure to ionizing radiation - Exposure to bone marrow toxins outside the work environment - Personal or family history of blood dyscrasias including blood/bone marrow neoplasms, genetic hemoglobin abnormalities, bleeding disorders, or abnormal function of formed blood elements	Initial complete physical exam Annual: Brief history regarding any new exposures, changes in drug use, appearance of physical signs relating to blood disorders Respirator medical exam if required	Complete blood count (CBC) (results reviewed by examining physician) Other tests deemed appropriate by the physician PFT (every 3 years if required to use a respirator >30 days a year) Emergency exposure: Annual exam requirements plus end-of-shift urinary phenol test (See Chapter 4 of this Manual) Refer to full standard for guidance on further evaluation/ordering of laboratory tests	Physician's written opinion to employer: - Results of medical examination and testing - Opinion whether exposure places worker at increased risk for health impairment - Recommended work limitations - Statement that employee has been informed of exam results and conditions that may require further evaluation Employer shall provide copy of written opinion to affected employee

Table C2.T5. 1,3-Butadiene, CAS # 106-99-0 (Part 1910.1051(k) of Reference (g))

Target Organs	Medical Surveillance Criteria	Required Exam	Required Medical History	Physical Exam Elements	Required Special Procedures	Other Required Elements
Blood Central nervous system Eyes Liver Lymphatic Respiratory Spleen	Employees who are or may be exposed: - At or above AL 30 or more days per year - At or above PEL 10 or more days per year - At or above PEL 30 or more days per year for 10 or more years - At or above AL for 60 or more days per year for 10 or more years - Above 10 ppm on 30 or more days in past year - Emergency exposure Examinations conducted or administered by a licensed physician or other licensed health care professional	Initial (baseline) Every 3 years At the discretion of the physician or other health professional reviewing the annual health questionnaire and CBC Emergency exposure (within 48 hours) Termination of exposure Termination of employment	Baseline health questionnaire including comprehensive personal and occupational health history with annual update See Appendix C of part 1910.1051 of Reference (g) for sample questionnaire content	Complete physical exam with particular attention to: - Liver - Lymph nodes - Skin - Spleen Respirator medical exam if required For emergency exposure: Physical exam to evaluate symptoms and CBC	CBC Other tests deemed appropriate by the physician	Referral to specialist for evaluation of abnormalities Physician's written opinion to employer: - Results of medical examination and testing - Opinion whether exposure places worker at increased risk for health impairment - Recommended work limitations - Statement that employee has been informed of exam results and conditions that may require further evaluation Employer shall provide copy of written opinion to affected employee Information learned from medical surveillance must be disseminated to covered employees in a manner that ensures confidentiality of individual medical information

Table C2.T6. Cadmium, CAS # 7440-43-9 (Part 1910.1027(l) and Part 1926.1127(l) of Reference (g))

Target Organs	Medical Surveillance Criteria	Required Exam	Required Medical History	Physical Exam Elements	Required Special Procedures	Other Required Elements

Blood
 	
Kidneys
 	
Prostate
 	
Respiratory
	Employees who are or may be exposed:
	- At or above AL 30 or more days a year
	- Previous exposure above AL total of 60 months
		Initial (baseline)
		
		After 1 year and then at least every 2 years (determined by laboratory surveillance)
		
		Emergency exposure
		
		Termination of employment (within 6 months of termination)
			Detailed work and medical history with emphasis on:
			- Cadmium exposure
			- Smoking history/ status
			- Reproductive status
			- Medications (nephrotoxins)
			- The following systems:
			  - Cardiovascular
			  - Respiratory
			  - Renal
			  - Hematopoetic
			  - Musculoskeletal
				Complete physical exam with particular attention to:
				- Blood pressure
				- Prostate exam or equivalent diagnostic test in males >40 yrs
				- Respiratory system
				- Urinary system
				
				Respirator medical surveillance if required, including:
				- Detailed medical and occupational history
				- Smoking history and current smoking status
				- History of kidney, cardiovascular, respiratory, blood or musculoskeletal dysfunction
				- Blood pressure test
				- Laboratory tests unless done in previous 12 months (Urine cadmium (CdU), Blood cadmium (CdB), Beta-2 microglobulin in urine (β_2-M))
					CdU
					
					CdB
					
					β_2-M
					
					For exam and laboratory test schedule requirements, see part 1910.1027 of Reference (f) and section C4.3. of this Manual
					
					PFT
					
					Chest X-ray (PA view only)
					
					CBC
					
					Blood urea nitrogen (BUN)/Creatinine (Cr)
					
					Other tests deemed appropriate by the physician
						Medical removal assessment
						
						Physician's written opinion to employer:
						- Results of medical examination and testing
						- Opinion whether exposure places worker at increased risk for health impairment
						- Recommended work limitations
						- Statement that employee has been informed of exam results and conditions that may require further evaluation
						
						Employer shall provide copy of written opinion to affected employee

Table C2.T7. Chromium (VI) (Part 1910.1026(k) of Reference (g))

Target Organs	Medical Surveillance Criteria	Required Exam	Required Medical History	Physical Exam Elements	Required Special Procedures	Other Required Elements
Eyes Mucus membranes Skin	Employees who are: - Or may be occupationally exposed to chromium (VI) at or above AL for 30 or more days a year - Experiencing signs or symptoms of the adverse health effects associated with chromium (VI) exposure - Exposed in an emergency Examinations conducted by or under the supervision of a licensed physician	Baseline Annual Suspected exposure Termination of exposure	Past, present, and anticipated future exposure to chromium (VI) History of respiratory system dysfunction Any history of asthma, dermatitis, skin ulceration, or nasal septum perforation Smoking status and history	Skin and respiratory tract (nostrils and other parts of body to detect ulceration)	Medical evaluation if respirator required	Occupational history Description of any PPE used Physician's written opinion: - Whether employee has a medical condition placing the employee at increased risk from chromium (VI) exposure - Any recommended protective measures or limitations for employee - Statement that employee has been informed of exam results and need for further evaluation/ treatment Employer shall provide copy of written opinion to employee within 15 days

Table C2.T8. Ethyleneimine, CAS # 151-56-4 (Part 1910.1012 of Reference (g)): Medical Surveillance Guidance (Part 1910.1003(g) of Reference (g))

Target Organs	Medical Surveillance Criteria	Required Exam	Required Medical History	Physical Exam Elements	Required Special Procedures	Other Required Elements
Blood Cardiovascular Central nervous system Immune system Kidneys Liver Lungs Reproductive Skin	Prior to assignment to enter a regulated area	Initial (baseline) Annual	Personal medical history including information about: - Genetic or family illnesses - Reduced immunologic competence - Reproductive status - Environmental carcinogenic exposures - Smoking - Treatment with steroids or cytotoxic drugs	As directed by medical history; content not specified in OSHA standard	Respirator medical evaluation if required	Physician's written opinion regarding employee's suitability for employment in the exposure environment

Table C2.T9. Ethylene Oxide, CAS # 75-21-8 (Part 1910.1047(i) of Reference (g))

Target Organs	Medical Surveillance Criteria	Required Exam	Required Medical History	Physical Exam Elements	Required Special Procedures	Other Required Elements
Blood Central nervous system Eyes Reproductive Respiratory Skin	Employees who are or may be exposed at or above AL >30 days per year without regard to use of respirators Examinations and procedures conducted by or under the supervision of a licensed physician	Initial (baseline) Annual Emergency exposure Termination of exposure Termination of employment Other frequency as determined by the physician	Personal and work history (employer to provide exposure information) with emphasis on: - Eyes - Hematologic system - Neurologic system - Pulmonary system - Reproductive system - Skin	Eyes Hematologic system Neurologic system Pulmonary system Reproductive system Skin	CBC Pregnancy/fertility testing if requested by employee and deemed appropriate by physician Respirator medical exam if required Other testing deemed appropriate by the physician	Smoking history Physician's written opinion: - Whether the employee has medical conditions that would place employee at increased risk of health impairment from exposure to ethylene oxide - Limitations on employee use of PPE - Statement that employee has been informed of exam results and need for further treatment Employer shall provide copy of written opinion to employee within 15 days

Table C2.T10. Formaldehyde, CAS # 50-00-0 (Part 1910.1048(l) of Reference (g))

Target Organs	Medical Surveillance Criteria	Required Exam	Required Medical History	Physical Exam Elements	Required Special Procedures	Other Required Elements
Eyes Respiratory system Skin	Employees who are or may be exposed at or above AL or exceeding the short-term exposure limit (STEL) Based on the evaluation of the medical disease questionnaire, the physician shall determine whether a medical examination is necessary for employees who are not required to wear a respirator	Initial (baseline) Annual Emergency exposure	Administration of medical disease questionnaire including information on: - Work history (work and exposure information provided by employer) - Smoking history - Eye/nose/throat irritation - Respiratory problems including chronic airway or hyperactive airway disease - Allergic skin conditions or dermatitis See Appendix D of part 1910.1048 of Reference (g) for sample questionnaire content	Complete physical exam with particular attention to evidence of: - Eye irritation - Irritation/sensitization of skin or respiratory system - Shortness of breath Respirator medical examination if required	Baseline and annual PFT every year (if required to wear a respirator) Other testing deemed appropriate by the physician	Counseling of employees having medical conditions that would be aggravated by exposure to formaldehyde Physician's written opinion: - Whether employee is at risk for health impairment from exposure to formaldehyde - Recommended limitations on employee's exposure or PPE - Statement that employee has been informed of results of exam and need for further treatment Employer shall provide copy of written report to employee within 15 days

Table C2.T11. Lead, CAS # 7439-92-1, General Industry (Part 1910.1025(j) of Reference (g)), Construction (Part 1926.62(j) of Reference (g))

Target Organs	Medical Surveillance Criteria	Required Exam	Required Medical History	Physical Exam Elements	Required Special Tests	Other Required Elements

Blood/bone marrow
 	
Central and peripheral nervous systems
 	
Gastrointestinal system
 	
Gums
 	
Kidneys
 	
Reproductive system
 	
Cardiovascular system
	Employees who are or may be exposed above the AL for 30 days per year
	
	Examinations conducted by or under the supervision of a licensed physician
	
	A multiple-physician review may be required (See part 1910.1025(j)(3)(iii)) or part 1926.62(j)(3)(iv)) of Reference (g) for details)
	
	See Paragraph C4.8. of this Manual for DoD's blood lead requirements that are more restrictive than OSHA's.
		Preplacement (baseline)
		
		Annual (at least annually for any employee with a blood lead level (BLL) at or above 40 µg/100g in preceding 12 months)
		
		Emergency exposure
		
		When medically appropriate for each employee either removed from or otherwise limited with regard to lead exposure
		
		Upon request of employee for medical advice regarding lead exposure and reproductive health
		
		As required for respirator clearance
			Detailed medical and work history with emphasis on:
			- Past lead exposure
			  - Occupational
			  - Nonoccupational
			- Personal habits
			  - Smoking
			  - Hygiene
			- Past problems
			  - Gastrointestinal
			  - Renal
			  - Reproductive
			  - Neurological
			  - Hematologic
				Complete physical exam with particular attention to:
				- Teeth
				- Gums
				- Hematologic system
				- Gastrointestinal tract
				- Kidneys
				- Heart
				- Blood vessels
				- Blood pressure
				- Neurologic system
				- Lungs (if respirator will be required)
					Blood lead (at least every 6 months)
					
					CBC with indices and peripheral smear morphology
					
					Zinc protoporphyrin (ZPP) (required each time a BLL is measured)
					
					BUN
					
					Cr
					
					Urinalysis (UA) with microscopic
					
					Medical evaluation if respirator required
					
					For biological monitoring details, see part 1910.1025(j)(2) or part 1926.62(j)(2) of Reference (g)
					
					See Paragraph C4.8. of this Manual for DoD's blood lead requirements that are more restrictive than OSHA's.
						Employee may request additional physician evaluation (up to three physicians total)
						
						Other tests deemed appropriate by examining physician
						
						Physician's written opinion that includes:
						- Whether employee has a medical condition placing the employee at increased risk from lead exposure
						- Any recommended protective measures or limitations for employee
						- Any recommendation regarding limited use of respirators
						- Results of blood lead determinations
						- Statement that employee has been informed of exam results

Table C2.T12. Methylene Chloride (MC), CAS # 75-09-2 (Part 1910.1052(j) of Reference (g))

Target Organs	Medical Surveillance Criteria	Required Exam	Required Medical History	Physical Exam Elements	Required Special Procedures	Other Required Elements
Cardiovascular system Central nervous system Eyes Skin Liver Blood	Employees who are or may be exposed at or above AL on 30 or more days per year, or above the 8-hour TWA PEL or the STEL on 10 or more days per year Employees who are or may be exposed above the 8-hour TWA PEL or STEL with other risk factors (See part 1910.1052(j)(1)(ii) of Reference (g) for details)	Initial (baseline) Annual medical and work history update Annual physical exam for employees 45 or older Exam every 3 years for employees <45 Emergency exposure Termination of exposure Termination of employment	Comprehensive work history (exposure information provided by employer) and medical history: - Neurological symptoms - Skin conditions - Heart disease symptoms and risk factors - Liver disease - Blood disease See Appendix B of part 1910.1052 of Reference (g) for sample questionnaire content	Extent of exam shall be determined by the physician or other licensed health care professional and shall include: - Cardiovascular system (including blood pressure and pulse) - Liver - Lungs - Nervous system - Skin	Based on medical and work history and observed health status See Chapter 4 for laboratory notes See appendix B of part 1910.1052 of Reference (g) for further information	Other physician consultation as deemed appropriate by examining physician Written medical opinion regarding whether exposure to MC may aggravate employee's existing health, regarding duty limitations and required PPE, and stating that employee has been informed of the results of the exam

Table C2.T13. Methylenedianiline (MDA), CAS # 101-77-9 (Part 1910.1050(m) of Reference (g))

Target Organs	Medical Surveillance Criteria	Required Exam	Required Medical History	Physical Exam Elements	Required Special Procedures	Other Required Elements
Liver Skin	Employees who are or may be exposed: - At or above AL for 30 or more days per year - To dermal exposure for 15 or more days per year - Exposed in an emergency situation - Showing signs or symptoms of exposure	Initial (baseline) Annual Emergency exposure	Initial: Detailed work and personal history to include: - Past work exposure to MDA or any other toxic substances - Medications - Drug/alcohol use - Tobacco use - History of dermatitis or chemical skin sensitization - History of liver disease Annual: Brief history regarding any new potential liver toxin exposure; changes in drug, tobacco, or alcohol intake; and symptoms relative to liver or skin Emergency: History of exposure, liver function tests (LFTs), skin examination	Complete physical exam with particular attention to: - Signs of liver disease - Skin	LFTs: See part 1910.1050(m)(4-6) of Reference (g) for details regarding evaluation of abnormal LFTs UA Additional testing as deemed appropriate by the physician	Consultation as needed: See part 1910.1050(m)(4-6) of Reference (g) for description of the multiple-physician review mechanism Medical written opinion containing: - Occupationally pertinent results of medical exam and testing - Indication of whether employee's health is at risk from exposure to MDA - Recommended limitations to MDA exposure and use of PPE - Statement that employee has been informed of exam results and need for further evaluation/ treatment Employer shall provide employee with copy of written opinion within 15 days

Table C2.T14. Bloodborne Pathogens (Part 1910.1030(f)(1) of Reference (g))

Target Organs	Medical Surveillance Criteria	Required Exam	Required Medical History	Physical Exam Elements	Required Special Procedures	Other Required Elements
Organs susceptible to diseases due to pathogenic micro-organisms present in human blood such as: - Hepatitis B and C - Human immuno-deficiency virus (HIV)	All employees reasonably anticipated to be at risk for exposure to contaminated blood/body fluids via: - Eyes - Skin - Mucus membranes - Parenteral routes	Baseline: Bloodborne pathogen education and administration of hepatitis B vaccination series to employees with occupational exposure who are not immune Emergency exposure: Post-exposure evaluation and follow-up	Emergency exposure: Detailed history of exposure event to determine health risk Health risk appraisal of source individual History of prior hepatitis B vaccine	Examination of exposure site with site care as appropriate Content not otherwise specified in part 1910.1030 of Reference (g)	Initial: Verification of hepatitis B immunity (antibody testing or documentation of vaccination) Emergency exposure: - Immediate cleansing specific to the type of exposure (i.e., intact or nonintact skin, percutaneous, mucus membrane) - Testing of employee's blood for hepatitis B and C serological status; testing of source's blood for HIV and hepatitis B and C infectivity	Hepatitis B vaccination as indicated Declination of hepatitis B vaccine Written medical opinion: - Whether hepatitis B vaccination is indicated and was received - Employee informed of results of evaluation - Employee counseled regarding the risk associated with the specific exposure experienced and potential consequences of exposure - Employee counseled regarding post-exposure prophylaxis efficacy, indications for initiation, timing of initiation, and regimen selection as soon as possible.

Table C2.T14. Bloodborne Pathogens (Part 1910.1030(f)(1) of Reference (g)), Continued

Target Organs	Medical Surveillance Criteria	Required Exam	Required Medical History	Physical Exam Elements	Required Special Procedures	Other Required Elements
						The goal is to start HIV post-exposure prophylaxis within 1 to 2 hours after exposure

Table C2.T15. Noise (Part 1910.95(g) of Reference (g)) and DoDI 6055.12 (Reference (j))

Target Organs	Medical Surveillance Criteria	Required Exam	Required Medical History	Physical Exam Elements	Required Special Procedures	Other Required Elements
Cochlea	Employees who are or may be exposed equal to or greater than 85 A-weighted decibelsTWA and/or impulse noise equal to or greater than 140 peak decibel	Baseline audiogram within 1 month of first exposure at or above AL Baseline audiogram to be preceded by 14 hours without exposure to workplace noise Annual audiogram Termination of exposure	Content not specified in OSHA Standard See Service implementing document for guidance	Content not specified in OSHA standard	Comparison of annual and baseline audiograms with evaluation of problem audiograms by audiologist, otolaryngologist, or physician	None

Table C2.T16. HAZWOPER (Part 1910.120(f) of Reference (g))
(Also see NIOSH Publication No. 85-115 (Reference (k))

Target Organs	Medical Surveillance Criteria	Required Exam	Required Medical History	Physical Exam Elements	Required Special Tests	Other Required Elements
Virtually any organ system susceptible to disease	Employees who: - Are or may be exposed to hazardous substances or health hazards above PEL for 30 or more days per year - Wear a respirator for 30 days or more per year as required by part 1910.134 of Reference (g) - Become ill or injured due to possible hazardous materials overexposure - Are hazardous material team members	Preplacement Annual Emergency exposure Termination of employment More frequent intervals as determined by a physician Examination by or under supervision of licensed physician	Medical and work history with emphasis on: - Known health hazards - Fitness for using or wearing PPE Use resources such as: - Industrial hygiene data - Site assessment data	Content not specified in OSHA Standard; content to be determined by examining physician Physician should consult the Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities	Respirator medical evaluation if required	Physician's written opinion that includes: - Recommended limitations on work - Results of examination and tests - Statement that employee has been informed of exam results, medical conditions and follow-up

Table C2.T17. Respiratory Protection (Part 1910.134(e) of Reference (g))

Target Organs	Medical Surveillance Criteria	Required Exam	Required Medical History	Physical Exam Elements	Required Special Tests	Other Required Elements
Cardiovascular system Mental status (claustrophobia) Respiratory system	All employees wearing respirators Examinations conducted by a licensed physician or other licensed health care professional	Before the employee is fit tested or required to use the respirator Follow-up exams: - For any employee giving positive response to any question in Figure C4.F1. or who demonstrates need for follow-up exam - If anyone feels employee needs re-evaluation - If change occurs in workplace conditions that may require increased physiological burden on employee	See mandatory medical questionnaire at Appendix C of part 1910.134 of Reference (g) Guidance for workers who are wearing respirators though not required under the standard can be found in Appendix D of part 1910.134 of Reference (g)	Content not specified in OSHA Standard Follow-up medical exam shall include any medical tests, consultations, or diagnostic procedures that the licensed health professional deems necessary	None	Written opinion including: - Limitations on respirator use related to the medical condition of the employee or conditions under which respirator will be used - The need for any follow-up medical evaluations - A statement whether a positive pressure respirator may be used if a negative pressure respirator poses a health risk - A statement that the health care provider has provided the employee with a copy of the written recommendation

C3. CHAPTER 3

EXAMS FOR SPECIFIC GROUPS

C3.1. INTRODUCTION

C3.1.1. Medical surveillance procedures for most substances not otherwise regulated by OSHA, as well as most job categories, may be found in the Navy's Medical Matrix. The Medical Matrix is used by the Navy, and may be used by other Services when no other DoD or Service guidance is provided.

C3.1.2. Several occupational groups require special consideration because of their unique exposures, specific health risk considerations, or otherwise regulated medical surveillance requirements. This Chapter includes guidance regarding the medical surveillance of surety (chemical/biological/nuclear) workers, firefighters, police officers and security guards, workers in their reproductive years, pregnant workers, breastfeeding workers, and workers who require DOT examinations.

C3.1.3. The DoD examination specifically focuses on whether a worker's medical condition qualifies the worker for his or her job duties. The requirements of the DoD examination and those of normal routine preventive medical services often overlap. In these situations, such as in an examination of the cardiovascular system, the DoD examiner is not expected to perform, nor to order performed, specialized testing above that specifically required by this Manual. Routine preventive medical examinations and testing are the responsibility of the worker's private physician.

C3.2. SURETY (CHEMICAL/BIOLOGICAL/NUCLEAR) WORKERS

C3.2.1. Workers with access to chemical, biological, and nuclear materials require special consideration. Medical programs for these workers place added emphasis on safety, security, and personnel reliability, collectively known as "surety." Certain medical evaluation and reporting requirements arise out of personnel reliability programs, while others come from the occupational health program. Guidance on personnel reliability program requirements and occupational medicine evaluation and surveillance of workers with access to biological select agents is currently under development. It can be obtained by contacting the Surety Medicine Consultant at the Office of The Army Surgeon General.

C3.2.2. Details regarding medical evaluation and support for other surety workers are found in:

C3.2.2.1. Department of the Army Pamphlet (DA PAM) 385-61, "Toxic Chemial Agent Safety Standards," November 13, 2012.[6]

C3.2.2.2. DA PAM 40-173, "Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Mustard Agents H, HD, and HT," June 3, 2003.[7]

[6] Available at http://www.apd.army.mil/Search/ePubsSearch/ePubsSearchForm.aspx
[7] Available at http://www.apd.army.mil/Search/ePubsSearch/ePubsSearchForm.aspx

C3.2.2.3. DA PAM 50-6, "Chemical Accident or Incident Response and Assistance (CAIRA) Operations," March 26, 2003.

C3.2.2.4. DA PAM 50-5, "Nuclear Accident or Incident Response and Assistance (NAIRA) Operations," March 20, 2002.

C3.2.2.5. Army Regulation (AR) 50-6, "Chemical Surety," June 26, 2001.

C3.2.2.6. AR 50-5, "Nuclear Surety," August 1, 2000.

C3.2.2.7. AR 50-7, "Army Reactor Program," August 16, 1996.

C3.3. FIREFIGHTERS

C3.3.1. Components of the Firefighter Examination

C3.3.1.1. The components of the firefighter examination are evidence-based and derived from a thorough review of the medical literature. The purpose of the firefighter examination is to determine the reasonable likelihood of a firefighter's ability to execute the essential functions of fire suppression and rescue. As a result of the examination, the physician issues the appropriate documents that certify a firefighter's qualifications or limitations. (See Table C3.T1. for the firefighter examination schedule.)

C3.3.1.2. The firefighter examination does not directly assess the capacity to execute the essential functions of firefighting. For example, the examination does not directly measure the firefighter's ability to climb a ladder and carry a weight while wearing standard firefighting apparel. Rather, the examination evaluates historical and medical parameters that may be reasonably correlated with the safe and effective conduct of fire suppression and rescue.

C3.3.1.3. The most critical and valuable element of the examination is the medical history. The physical examination and required ancillary testing augment the medical history and logic required to render an opinion regarding qualification for firefighting duties.

C3.3.1.4. The primary purpose of the firefighter occupational medical examination is to determine fitness for duty. The secondary purpose is exposure-related medical surveillance.

C3.3.1.4.1. National Fire Protection Association (NFPA) guidelines recommend highly detailed physical examination items, such as physical ability testing, and certain preventive services to include mammography and colonoscopy. Some of these items fall under the category of preventive services, primary care, or health promotion, and are outside the scope of the firefighter occupational medical examination. For example, although NFPA Standard 1582, "Comprehensive Occupational Medical Program for Fire Departments,"[8] recommends colon cancer screening for firefighters, a review of 21 medical studies of colon cancer in firefighters did not support an increased risk. The DoD examiner is expected to use the examination guidelines that are supported by the medical literature for medical surveillance and

[8] Available at http://www.nfpa.org/aboutthecodes/AboutTheCodes.asp?DocNum=1582

for certifying that the firefighter is reasonably able to perform the essential job functions in a safe manner. A summary of these is included in Table C3.T1.

C3.3.1.4.2. The U.S. Preventive Services Task Force, in its "Guide to Clinical Preventive Services,"[9] recommends preventive screening for all persons regardless of occupation. The preventive screening should be performed by the worker's personal physician.

C3.3.2. Special Considerations for Coronary Artery Disease

C3.3.2.1. Coronary artery disease is progressive and is the number one risk of death for firefighters while performing fire suppression and rescue. Cardiac risk factor evaluation is particularly important for firefighters. Counseling firefighters about coronary artery disease risk factors (diabetes, hypertension, lipid profile, smoking) and the importance of modifying them is vital. C-Reactive Protein may be another worthwhile screening tool in high-risk populations (those with a 10-20 percent risk of having a coronary event within 10 years), but currently is not validated for routine use. C-Reactive Protein may be considered to further delineate risk in borderline cases. Stress tests may or may not predict the likelihood of future coronary events.

C3.3.2.2. The Framingham 10-year risk calculation is probably the most useful single tool to characterize a firefighter's risk of a cardiac event. The National Cholesterol Education Program offers an online tool for calculating this risk.[10] Those with a high 10-year risk may be considered for further evaluation, such as stress testing, stress thallium scintigraphy, stress echocardiography, or other methods.

C3.3.2.3. Metabolic syndrome is defined as three or more of the following: waist greater than 40 inches for males, greater than 35 inches for females; triglyceride greater than 150; blood pressure greater than 130 over 85; high density lipoprotein less than 40; fasting blood glucose greater than or equal to 110. Individuals with metabolic syndrome are at increased risk of coronary artery disease. They should be referred to their primary care provider for aggressive risk factor control, generally using a multimodal approach including pharmacologic therapy, weight reduction, diet counseling, exercise, and control of other risk factors.

C3.3.2.4. Diabetes and impaired glucose tolerance in firefighters deserve added comments. Firefighters with diabetes (either Type I or II) are at markedly increased risk for myocardial infarction (MI). Between 20 and 50 percent of diabetics have undiagnosed coronary heart disease. The risk of MI for diabetics (without previous MI) is the same as for workers with previous MI, about 5 times the background incidence. Diabetics with a history of MI have 10 times the risk of MI within 7 years than nondiabetics with no infarction history.

C3.3.2.5. Optimization of all risk factors is critical to reducing the likelihood of MI in diabetic firefighters. In diabetic firefighters, urinary microalbumin and hemoglobin A1c are useful adjuncts to obtain concomitantly with other urine or blood values. Routine urinalyses do not detect microquantities of albumin; testing for this must be requested separately.

C3.3.2.6. Physicians need to spend extra time counseling firefighters on the factors that put them at increased risk and the importance of modifying them. Physicians should also

[9] Available at http://www.ahrq.gov/clinic/uspstfix.htm
[10] Available at http://hin.nhlbi.nih.gov/atpiii/calculator.asp?usertype=prof and http://hin.nhlbi.nih.gov/atpiii/riskcalc.htm

counsel firefighters to maintain good follow-up with their personal health care providers for these factors.

Table C3.T1. Physical Examination Schedule for Firefighters

Examination	Frequency		
Audiogram	Baseline	Annually	Termination
Health history	Baseline	Annually	Termination
Height, weight, body mass index, vital signs	Baseline	Annually	Termination
Spirometry	Baseline	Annually	Termination
Visual acuity and confrontational fields	Baseline	Annually	
Workplace exposure summary	Baseline	Annually	Termination
Physical examination	Baseline	Every 5 yrs until 40, then annually	Termination
Alanine aminotransferase (ALT)	Baseline	Every 5 yrs until 40, then annually	Termination
CBC	Baseline	Every 5 yrs until 40, then annually	Termination
Dipstick urine for glucose	Baseline	Every 5 yrs until 40, then annually	Termination
Lipid profile	Baseline	Every 5 yrs until 40, then annually	
Urinary microalbumin and hemoglobin A1c (diabetics)		Every 5 yrs until 40, then annually	
Electrocardiogram	Baseline	Ages 35 and 40, then annually	Termination
Tetanus and diphtheria vaccines	Check status at baseline	Booster Q 10 yr	
Hepatitis B vaccine/titers	Baseline		
Hepatitis A vaccine/titers (for search and rescue post national disaster)	Baseline		
HIV	Baseline	If indicated	
Respirator questionnaire/exam	Baseline	If indicated	
Full UA	Baseline		
Chest X-ray	Baseline		

C3.4. POLICE OFFICERS AND SECURITY GUARDS

C3.4.1. General Considerations. Pursuant to section 12101 of title 42, United States Code (Reference (l)), commonly known as the Americans with Disabilities Act of 1990), individuals must be evaluated for a job based on their ability to safely perform the essential job functions with or without reasonable accommodation, not on the basis of the mere presence of a disease or disability. The evaluation must be made on a case-by-case basis. The California Commission on Peace Officer Standards and Training publication, "Medical Screening Manual for California Law Enforcement,"[11] is a useful source for identifying the significance of medical or physical deficiencies. Health professionals should realize that some law enforcement functions may require significantly higher medical standards. Individuals who meet the minimum guidance outlined below are not necessarily qualified for all law enforcement occupations or functions.

C3.4.2. Special Considerations

[11] Available at https://www.post.ca.gov/medical-screening-manual.aspx

C3.4.2.1. Coronary Artery Disease

C3.4.2.1.1. Police and security personnel are required to respond to emergency situations that may impose significant physical and psychological stress. Such stress may trigger sudden death or MI in the presence of underlying heart disease. For this reason, cardiac risk evaluation may be appropriate for them.

C3.4.2.1.2. The Framingham 10-year risk calculator is probably the most useful single tool to characterize the risk to a police officer or security guard of a cardiac event. The Framingham Risk score uses independent risk factors (age, gender, total cholesterol, high density lipoprotein cholesterol, systolic blood pressure, treatment for hypertension, and cigarette smoking) to assess an individual's absolute risk for developing a cardiac event, such as MI or new onset angina, within 10 years. However, workers can only be medically disqualified by actual medical conditions, not simply risk factors.

C3.4.2.1.3. Generally, those individuals with a high 10-year risk, and those with coronary artery disease or coronary artery disease equivalent (peripheral arterial disease, abdominal aortic aneurysm, symptomatic carotid artery disease, diabetes) are candidates for additional testing (usually a treadmill stress test, stress thallium, or stress echo). The occupational medicine physician should consider temporarily disqualifying these individuals from strenuous duties and/or duties that require wearing a respirator (except a mask for escape purposes only), pending the results of evaluation by the workers' private physicians.

C3.4.2.1.4. Police and security personnel with intermediate or high 10-year risk should be referred to their primary care provider for risk factor reduction. Risk control should occur prior to undertaking strenuous duties.

C3.4.2.1.5. If an individual undergoes a therapeutic procedure (catheterization or coronary artery bypass graft), the DOT "Cardiovascular Advisory Panel Guidelines for the Medical Examination of Commercial Motor Vehicle Drivers"[12] may be useful in determining return-to-work criteria. At a minimum, an individual should have a normal, graded, exercise stress test to 8 metabolic equivalents and receive cardiologist approval to work as a security force member before returning to duty.

C3.4.2.2. Arrhythmias. Arrhythmias that predispose to or have a risk of cerebral hypoperfusion and impaired consciousness, and/or that require anticoagulation, are generally not compatible with safe performance of the duties of police and security personnel. Security force personnel with pacemakers may be qualified if the underlying disease does not pose a significant risk; they should be evaluated on a case-by-case basis. Implanted defibrillators are generally not compatible with safe performance of the duties of police and security personnel.

C3.4.2.3. Hypertension. Patients with hypertension should have a treatment plan for controlling it documented by a physician. The following guidelines for members with hypertension are adapted from DOT guidelines.

[12] Available at https://www.fmcsa.dot.gov/sites/fmcsa.dot.gov/files/docs/cardio.pdf

C3.4.2.3.1. Stage 3 (greater than or equal to 180/110). Restricted until less than 140/90, with semiannual recertification.

C3.4.2.3.2. Stage 2 (160-179/100-109). May be qualified for 3 months if under treatment. Must be temporarily restricted from strenuous duties and/or duties that require participation in a respiratory protection program (RPP) (except a mask for escape purposes only). Must be less than 140/90 within 3 months.

C3.4.2.3.3. Stage 1 (140-159/90-99). May be qualified for 1 year if under treatment. Must be less than 140/90 at reevaluation. If still Stage 1 at 1 year, may be given one 3-month certification to gain control into normal range.

C3.4.2.4. Diabetes. Because diabetes mellitus can interfere with safe performance of the essential job functions, such a diagnosis should be closely scrutinized. In general, blood glucose should be under excellent control for an extended period of time and glycosylated hemoglobin should be less than 8.0. In addition, the examinee should have no evidence of end organ damage (nephropathy, neuropathy, proliferative retinopathy), no uncontrolled hypertension, and no history of ketoacidosis or severe hypoglycemia in the previous year.

C3.4.2.5. Hearing. Police and security personnel exposed to hazardous noise should be enrolled in a hearing conservation program, with audiometry conducted annually. In general, pure-tone, unaided, air conduction hearing threshold levels should not exceed 30 decibel (dB) hearing loss on average for each ear at 500, 1000, and 2000 hertz (Hz), with no single level greater than 35 dB hearing loss at these frequencies. Thresholds should not exceed 55 dB at 4000 Hz in each ear. If the hearing loss exceeds these levels, a full audiologic evaluation should be considered. This evaluation may require a speech-in-noise test with and without hearing aids (if the individual wears them). Individuals with significant asymmetry should undergo evaluation by an audiologist. The requirement for hearing aids to satisfy the medical requirements of this position is not disqualifying.

C3.4.2.6. Vision. Vision screening may be adequate for preplacement, periodic, and termination examinations. Optometry referral is not required unless indicated by poor vision or an inability to properly assess the vision. When an examinee's vision is worse than indicated below, the individual will most likely not be able to safely perform the essential job functions. The examining physician should consider this in his or her assessment.

C3.4.2.6.1. Individuals must be binocular without exception.

C3.4.2.6.2. Using the individual's best optical correction, distance vision should be at least 20/30 in one eye and 20/100 in the other, or 20/40 in one eye and 20/70 in the other, and near vision should be correctable to 20/40 binocularly (both eyes open). Uncorrected binocular visual acuity should be at least 20/100, but may be 20/200 in situations where soft contact lenses may be worn and the individual has been a successful soft contact lens wearer. Exceptions to this guidance should be rare; decreasing visual acuity is directly related to increased risk for errors (such as decisions to shoot or not to shoot), especially in decreased light environments.

C3.4.2.6.3. Individuals should be able to discriminate vivid red/green color. Some higher-skill law enforcement functions will require a higher standard, such as passing the Farnsworth D-15 or pseudoisochromatic plates.

C3.4.2.6.4. Individuals should have normal muscle balance, defined as the lack of strabismus (greater than 15 diopters), nystagmus, and diplopia. Some higher-skill law enforcement functions will require a higher standard, such as depth perception to at least 40 seconds of arc (point #6 on a Titmus eye testing machine).

C3.4.2.6.5. Individuals should have a minimum total horizontal visual field of 120 degrees and a minimum total vertical visual field of 40 degrees (20 above the horizontal meridian and 20 below the horizontal meridian) in each eye. Some higher-skill law enforcement functions will require a higher standard, such as a total of 100 degrees of total vertical visual field.

C3.4.2.6.6. Individuals should not have a history of abnormal night vision.

C3.4.2.6.7. The U.S. Navy Medical Matrix provides the baseline Navy-required examination.

C3.4.2.7. Psychiatric Disorders. Psychiatric disorders, which could affect safe and efficient job performance, require additional evaluation to determine whether the individual is able to safely and successfully perform the essential job functions. The presence of any psychiatric disorders, or a history of such, warrants referral for further evaluation by a psychologist or psychiatrist.

C3.4.2.8. Neurological Problems. Chronic headaches, a history of head trauma, cranial defects, and epilepsy are among the neurological disorders that can interfere with performance of police officer and security guard functions. Epilepsy can be particularly dangerous and the likelihood of an on-the-job seizure must be assessed. The best method of evaluating this risk is described in pages IX-3 through IX-12 of the "Medical Screening Manual for California Law Enforcement." The physician must also assess nonseizure-related impairments, such as interictal electroencephalogram discharges (which can cause transient cognitive impairment) or anti-epileptic drug side effects (which cause about 30 percent of patients using them to experience moderate to severe side effects, which can include cognitive impairment, visual effects, and ataxia).

C3.5. WORKERS IN THEIR REPRODUCTIVE YEARS

C3.5.1. It is DoD policy (Reference (a)) to provide a safe and healthy work environment for all military and civilian workers. This includes the protection of workers' reproductive capabilities from potentially harmful workplace exposures. Reproductive hazards are those stressors that have the potential to adversely affect the reproductive process. Generally, the engineering controls, administrative policies, and PPE that protect the overall health of workers from harmful chemical, biological, or physical stressors will also protect their reproductive

health. Occupational medicine professionals, working with industrial hygienists and safety personnel, should be familiar with potential reproductive hazards in the environment over which they have cognizance, enabling them to advise the command regarding hazard management and to provide appropriate examination of and counseling for concerned workers.

C3.5.2. Service-specific policies and technical guidance are available to assist the occupational medicine professional in providing optimum care for men and women in their reproductive years. These references include:

C3.5.2.1. AR 40-501, "Standards of Medical Fitness," January 18, 2007.

C3.5.2.2. Chief of Naval Operations Instruction 5100.23G, Chapter 29, "Navy Safety and Occupational Health (SOH) Program Manual," December 30, 2005.[13]

C3.5.2.3. Chief of Naval Operations Instruction 6000.1C, Navy Guidelines Concerning Pregnancy and Parenthood," June 14, 2007.

C3.5.2.4. Naval Environmental Health Center (NEHC)-TM OEM 6260.01A, "Reproductive and Developmental Hazards: A Guide for Occupational Health Professionals," April 2010.

C3.5.2.5. Air Force Instruction 44-102, "Medical Care Management," March 17, 2015.[14]

C3.6. PREGNANT WORKERS

While uncomplicated pregnancy does not necessarily require significant alteration of the work environment, modification of job tasks may be required to create the safest and healthiest environment for the pregnant worker and her unborn child. Concern for safety and health should not, however, lead to inappropriate actions that may constitute discrimination against pregnant women in the workplace. Section 2000e of Reference (l) (commonly known as the Pregnancy Discrimination Act) and part 1604.10 of Reference (g) provide helpful guidance regarding the rights of pregnant workers.

C3.7. BREASTFEEDING WORKERS

The military mission may supersede the woman's desire to breastfeed. However, as breast milk is widely recognized as a superior food for infants, breastfeeding may be a common practice in some work environments. If workplace breastfeeding is permitted, command consideration should be given to providing a clean and private environment for breastfeeding and/or pumping of breast milk during working hours, scheduling breaks to allow pumping, and dedicating

[13] Available at https://doni.daps.dla.mil/Directives/05000%20General%20Management%20Security%20and%20Safety%20Services/05-100%20Safety%20and%20Occupational%20Health%20Services/5100.23G%20w%20CH-1.pdf
[14] Available at http://static.e-publishing.af.mil/production/1/af_sg/publication/afi44-102/afi44-102.pdf

refrigerated storage to preserve breast milk until the end of the workday. Control of environmental exposures and promotion of workplace hygiene can limit the transfer of industrial chemicals into the breast milk. Due to the varying nature of the military mission, breastfeeding should be managed on a case-by-case basis.

C3.8. COMMERCIAL DRIVERS

All drivers holding a Commercial Driver's License must possess and carry on their person a DOT Medical Examiner's Certificate stating that they are physically qualified to drive a commercial motor vehicle (part 391.41-9 of title 49 CFR (Reference (m))). The driver and medical examiner must complete the DOT "Medical Examination Report for Commercial Driver Fitness Determination." The medical examiner must be knowledgeable regarding Federal Motor Carrier Safety Regulations to perform the examination correctly. The report provides detailed guidance for completion. Guidance is also available from the Navy's Medical Matrix.

C3.9. NANOMATERIALS WORKERS

C3.9.1. Nanotechnology is being explored and applied in many different industries, including electronics, energetics, batteries, material coatings/protectants, and food additives. DoD use includes aluminum nanoparticles as diesel fuel additives, alloys, and explosives. There are many knowledge gaps within this dynamic emerging field; research and development efforts may be particularly problematic where toxicity and chemical interactions are yet unknown.

C3.9.2. The term "nanomaterial" only describes the physical property of the material (having a particle size <100 nanometers in at least one dimension), not its chemical makeup or toxicity. The toxicity of nanomaterials may be affected by the physical properties of a substance (e.g., influencing absorption), as well as the chemical form of the particles and the route and dose of exposure. Many nanomaterials in use are deliberately produced engineered nanomaterials. Nanomaterials may also be produced naturally or as a consequence of other processes (e.g., combustion). Ambient air ultrafine particles are a complex mixture of particles derived from a variety of sources.

C3.9.3. Nanomaterials can be added to fuels, paints, adhesives, etc., which can potentially expose workers throughout the products' life cycle. The exposure profile of nanomaterials may depend on their formulation. A nanomaterial additive that becomes agglomerated or fixed in a solid will likely not have the same exposure profile as a pure, powdered form.

C3.9.3.1. The sonication, shaking, stirring, pouring, or spraying of powdered nanomaterials can result in inhalation exposure. Nanoparticles that are fixed within a matrix are less hazardous until and unless there is mechanical disruption, such as grinding, cutting, or burning. In addition to inhalation, nanomaterials may be absorbed through the skin or ingested.

C3.9.3.2. Products containing nanomaterials may be procured from outside vendors without awareness that the product contains nanomaterials. Nanomaterials are ubiquitous in

commercial products and there are no requirements to specifically identify their presence on labels or safety data sheets, and chemical content information may be of limited value when determining the potential hazards from nanomaterials. However, awareness of the nanomaterial's presence is necessary to limit exposure and establish appropriate medical surveillance programs.

C3.9.4. While there are no federal occupational exposure limits or OSHA PELs for nanomaterials, NIOSH does have recommended exposure limits for titanium dioxide, carbon nanotubes, and carbon nanofibers.

C3.9.5. To date, there have been very few case reports of human illness attributed to exposure to engineered nanomaterials (Journeay and Goldman (Reference (n)) and Song, Li, and Du (Reference (o))). Rodent species exposed to carbon nanofibers and carbon nanotubes have developed pulmonary fibrogenic inflammation, granulomas, and pulmonary fibrosis. Precautionary guidance warrants conservative, risk-based measures in protection of workers, as traditional control measures may be ineffective. Workers exposed to engineered nanomaterials should have appropriate exposure controls and medical surveillance programs tailored to their exposure.

C3.9.6. With limited knowledge on the health effects of nanomaterials, their effects will likely depend on the nanomaterials' chemical and physical composition.. Therefore, no single medical surveillance program for all nanomaterials workers is warranted or recommended.

C3.9.6.1. Base medical surveillance programs on the specifics of the exposure, in consultation with knowledgeable workplace supervisors and specialists in industrial hygiene, occupational and environmental medicine, and safety. Occupational health providers should follow the same process as with other potential workplace hazards whereby supervisors, industrial hygienists, and safety personnel identify potentially hazardous products and processes, and industrial hygienists and safety personnel perform appropriate hazard risk assessments.

C3.9.6.2. NIOSH and other national and international governmental agencies have established guidelines and regulations (see NIOSH Publications 2013-145, 2011-160, and 2009-116 (References (p), (q), and (r)). These may assist in developing appropriate medical surveillance programs for occupational exposure to nanomaterials. Occupational health providers should use the most recent guidance.

C4. CHAPTER 4

ANCILLARY TESTS

C4.1. INTRODUCTION

C4.1.1. Ancillary testing, as an element of biological monitoring, serves the following three main functions.

C4.1.1.1. Detects the biological effect of potentially serious individual exposures before the occurrence of clinical illness or at a point where intervention and/or treatment can benefit outcome (decrease severity or extent of disease or limit disability and rehabilitation).

C4.1.1.2. Provides indirect monitoring of the workplace exposure of the employee group as a whole to detect relatively small changes in the group's mean value of ancillary testing levels that may indicate the existence of some repeated, common, and correctable exposure.

C4.1.1.3. Detects sentinel health events (such as mesothelioma).

C4.1.2. Sections C4.2. through C4.16. present guidelines to assist in the appropriate use and/or interpretation of ancillary tests.

C4.2. HEARING CONSERVATION PROGRAM (HCP)

C4.2.1. The risk of hearing injury from hazardous noise is perhaps the most prevalent occupational risk faced by both military and civilian workers. Personnel exposed to steady-state noise levels greater than or equal to 85 A-weighted decibels (8 hour TWA) or impulse noise levels greater than or equal to 140 peak decibels for any duration are at risk for noise-induced hearing injury. To reduce the risk, implement the DoD HCP, with input by an occupationally trained audiologist.

C4.2.2. The DoD HCP includes leadership policies, strategies, and processes to prevent noise-induced hearing loss among military and civilian personnel. The basic components of an HCP are noise hazard identification, engineering controls, hearing protectors, monitoring audiometry, health education, enforcement, and program evaluation. Command emphasis and information regarding hearing conservation is critical in preventing noise-induced hearing injury.

C4.2.3. The Defense Occupational Environmental Health Readiness System-Hearing Conservation is the database application used to monitor audiometry and manage the HCP within the Department of Defense.

C4.2.4. Detailed DoD information can be found in Reference (j). Service-unique information can be found in the following.

C4.2.4.1. DA PAM 40-501, "Hearing Conservation Program," December 10, 1998.

C4.2.4.2. Air Force Instruction 48127, "Occupational Noise and Hearing Conservation Program," February 26, 2016.

C4.2.4.3. NEHC-TM OEM 6260.51.99.2, "Navy Medical Department Hearing Conservation Program Procedures," September 15, 2008.

C4.2.5. Workers enrolled in the DoD HCP should undergo initial and annual audiometric evaluation. These tests should be conducted using audiometers (manual or microprocessor) calibrated to American National Standards Institute S3.6 according to Reference (j). Pure-tone, unaided, air conduction hearing threshold levels should be determined.

C4.2.6. In communication-sensitive jobs, hearing thresholds should generally not exceed 30 dB hearing loss on average for each ear at 500, 1000, and 2000 Hz, with no level above 35 dB hearing loss at these frequencies. Thresholds should not exceed 55 dB at 4000 Hz in each ear. If the hearing thresholds exceed these standards, the worker may require hearing aid(s) and should be considered for a full audiologic evaluation.

C4.2.6.1. If the hearing thresholds continue to exceed the levels described above, the audiologist should also perform a speech-in-noise test without hearing aids, and with hearing aid(s) if the individual wears them (e.g., the Hearing in Noise Test, Quick Speech in Noise Test, or Speech Recognition in Noise Test, depending upon the audiologist's preference).

C4.2.6.2. A Speech Recognition in Noise Test CD-ROM can be obtained from the USAPHC, Army Hearing Division, (410) 436-3797.

C4.2.6.3. Workers who previously required a complete audiologic evaluation do not require a repeat evaluation unless they have a significant threshold shift (STS) on their annual audiometry. The STS is defined by OSHA using the individual's baseline audiogram for comparison, and is automatically calculated by Defense Occupational and Environmental Health Readiness System-Hearing Conservation.

C4.2.7. Field "use" tests are neither as reliable nor valid as the speech-in-noise test used by the audiologist. Speech-based use tests invoke a large number of variables such as the content of the message, context, accent, background noise, etc. The speech-in-noise test controls for these factors. The "whispered voice test" has many of the same problems as field use tests.

C4.3. CADMIUM

C4.3.1. Medical Surveillance and Biomonitoring. Workers exposed at or above the AL (2.5 micrograms per cubic meter ($\mu g/m^3$) of air) on 30 or more days of the year must be enrolled in cadmium medical surveillance. The objectives for medical surveillance of cadmium workers are:

C4.3.1.1. Identifying workers at risk of exposure.

C4.3.1.2. Preventing cadmium-induced disease.

C4.3.1.3. Detecting and minimizing cadmium-induced disease.

C4.3.2. Examination. The initial medical examination is conducted within 30 days of initial assignment to a cadmium-covered position. The examination should include:

C4.3.2.1. Medical and work history (cadmium exposure history, review of systems, smoking history).

C4.3.2.2. Biological monitoring (CdU, CdB, and β_2-M).

C4.3.2.2.1. CdU is reported as micrograms of cadmium per gram Cr. CdB is reported as micrograms of cadmium per liter of whole blood. β_2-M is reported as micrograms of β_2-M per gram of Cr.

C4.3.2.2.2. Table C4.T1. shows cadmium biomonitoring results determining three exposure categories, with the highest result determining the category except as noted. Each exposure category requires a unique medical surveillance schedule.

Table C4.T1. Cadmium Biomonitoring Results

	Category A Medical examinations every other year. Laboratory examinations (CdU, CdB, β_2-M) every year.	Category B Medical examinations at 90 days, at 1 year, and then every year. Laboratory examinations at 90 days, 6 months, and then every 6 months.	Category C Medical examinations at 90 days, 6 months, and then every 6 months. Laboratory examinations at 90 days, 3 months, and then every 3 months.
CdU	≤3	>3 & ≤7	>7
CdB	≤5	>5 & ≤10	>10
β_2-M	≤300	>300 & ≤750	>750*

*For medical removal, must also have CdU greater than 3 or CdB greater than 5.

C4.3.3. Laboratory Notes

C4.3.3.1. A UA must be performed, including urine potential of hydrogen (pH), specific gravity, BUN, and Cr.

C4.3.3.2. The most frequent manifestation of chronic cadmium exposure is proteinuria. Initially, renal tubule cell damage is manifested by an increase in urinary low molecular weight (MW) proteins such as β_2-M.

C4.3.3.3. Those engaged in performing cadmium medical exams should ensure the lab is familiar with CdU collection and analysis procedures.

C4.3.3.3.1. After collection, the sample should be checked for specific gravity to ensure it is not too diluted, which would render the result (corrected per gram Cr) falsely high. To avoid this, a specimen should have a specific gravity greater than 1.008 to be submitted for lab analysis.

C4.3.3.3.2. The specimen should also be screened for pH. A sample too acidic (pH below 5.5) will falsely lower β_2-M results. If the pH is below or equal to 5.5, sodium hydroxide must be added to raise the pH to approximately 7. Alternatively, the collection container can be rinsed with a dilute sodium hydroxide solution before collection and the residual will normally raise the pH into an acceptable range.

C4.3.3.3.3. Finally, β_2-M degrades quickly. To collect it properly, the worker must void (This sample can be used for the UA and the CdU.), then void a second sample (for the β_2-M) within 1 hour of the original voiding.

C4.4. CARBOXYHEMOGLOBIN

C4.4.1. In addition to inhalation of carbon monoxide (CO) from incomplete combustion, MC metabolism is a source of CO in the human body. MC is a chlorinated solvent used in the Department of Defense primarily as a paint remover. OSHA regulates this substance in part 1910.1052 of Reference (g). Appendix B of part 1910.1052 of Reference (g) gives the medical surveillance information. CO is a metabolite of MC. The measurement of end-of-shift carboxyhemoglobin (COHb) is recommended, but not required, by part 1910.1052 of Reference (g). Normals are usually less than 3 percent for nonsmokers. Smokers usually have elevated levels in the 9 to 12 percent range (OSHA suggests using 10 as a cutoff.), but the upper normal for smokers should be established with the help and guidance of the lab officer.

C4.4.2. Elevated COHb is confirmed by co-oximeter blood gas analysis. Routine blood gas assay (not done by co-oximetry) provides a calculated oxygen saturation rather than a measured one; this calculated level will be falsely preserved in CO-exposed patients. Likewise, pulse oximetry is not reliable when COHb levels are significant.

C4.4.2.1. Cigarette smoking increases COHb, usually 2 to 10 percent in current smokers. COHb levels over 30 percent often result in moderate to severe symptoms; levels over 60 percent are usually lethal.

C4.4.2.1.1. Individual variation in clinical manifestations of a particular COHb level is great. Some patients may be comatose at a COHb of 38 percent, while others may have an apparently clear sensorium as high as 55 percent. Many factors can aggravate clinical effects, such as heavy labor, high ambient temperature, and altitudes over 2000 feet. Pregnant women are particularly susceptible, and fetal COHb levels may be significantly higher than maternal levels.

C4.4.2.1.2. Above 25-percent COHb, the electrocardiogram may show evidence of ST-segment depression. MI can occur in severe CO intoxication, and typical chest pain symptoms may be absent.

C4.4.2.1.3. Breath analysis for CO can be used to estimate blood COHb level.

C4.4.2.2. Estimated peak CO exposure levels can be extrapolated using COHb levels drawn hours after exposure ceases. This calculation uses time since last exposure, duration of oxygen therapy prior to blood draw, the difference in COHb between the measured value and background COHb level, and the 5 to 6 hour half life of COHb. For example, a COHb level of 16 percent at 5 to 6 hours after last exposure in a person breathing room air since exposure yields an estimated peak COHb of 32 percent. This corresponds with an inhaled CO of approximately 300 ppm for 5 or more hours. (The PEL for CO is 50 ppm TWA.) As a greater number of hours elapses after exposure, the accuracy of this calculation decreases significantly.

C4.4.2.3. Blood should be drawn for COHb measurement as soon as possible after exposure, and within a few hours following suspected exposure. Once drawn, blood for COHb assay can be stored for days to weeks without loss of testing accuracy.

C4.5. CHEST X-RAYS

C4.5.1. Detailed information can be found in parts 1910.1001 and 1926.1101 of Reference (g), and in NEHC-TM OEM 6260.51.99.2.

C4.5.2. B-readings are required for Navy asbestos medical surveillance as indicated in pages 37-42 (examinations 113, 114, 115, and 116) of the Navy's Medical Matrix.

C4.5.3. For the Army and the Air Force, asbestos chest films shall have International Labor Organization classifications done. This can be performed by radiologists, B-readers, or those trained in reading and classifying pneumoconioses.

C4.5.4. Other than as directed by OSHA or the Navy's Medical Matrix, routine use of chest X-rays is not indicated for medical surveillance. History and physical exam are superior tools for identifying occupational lung problems and may support the directed use of other tests when there are positive clinical findings. These other tests may include chest X-ray, high-resolution computerized axial tomography, and spirometry. Sputum cytology has limited application in occupational medical surveillance.

C4.6. CHOLINESTERASE

C4.6.1. Biomonitoring. Cholinesterase testing is the single most important tool in the medical supervision of pesticide workers. For nerve agent workers, refer to paragraph C3.2.1. and Service-specific guidance for field exposures to nerve agents.

C4.6.2. Laboratory Notes

C4.6.2.1. Establishing an individual's baseline (preexposure) value for both plasma and red blood cell (RBC) cholinesterase activity is essential for medical monitoring and supervision.

C4.6.2.2. All subsequent monitoring results must be interpreted as a percentage of the individual's baseline value.

C4.6.2.3. To ensure reliability of test results for a given individual, serial cholinesterase monitoring should be performed in the same laboratory using the same analytical method whenever possible.

C4.6.2.4. Depression of an employee's cholinesterase, either plasma or RBC, is an indication for action.

C4.6.2.4.1. For less than 80 percent of the plasma or RBC cholinesterase baseline values:

C4.6.2.4.1.1. Investigate the work practices of the employee, including employee sanitation, pesticide-handling procedures, and equipment usage, and conduct a review of safety equipment and its condition.

C4.6.2.4.1.2. Maintain a written record of the findings, changes in equipment or procedures, and any recommendations made to the employee. Depression to this level indicates prompt retesting.

C4.6.2.4.2. For less than 70 percent of RBC cholinesterase baseline value or less than 60 percent of plasma cholinesterase:

C4.6.2.4.2.1. Remove from exposure to cholinesterase-inhibiting pesticides. The employee shall not be allowed to return to work with these pesticides until his or her RBC cholinesterase and plasma cholinesterase activity levels both return to 80 percent or more of baseline.

C4.6.2.4.2.2. Maintain written records of the date of removal and the date when the employee is returned to exposure.

C4.6.2.5. A worker removed from a job because of depressed cholinesterase levels may be employed at other types of work.

C4.6.2.6. Recommended testing intervals:

C4.6.2.6.1. Before starting pesticide work/spraying (baseline).

C4.6.2.6.2. First in-season test at 45-60 days.

C4.6.2.6.3. Quarterly thereafter if spraying continues.

C4.6.2.7. Certain organophosphates may selectively inhibit either plasma pseudocholinesterase (chlorpyrifos and mevinphos) or RBC acetylcholinesterase (phosmet and dimethoate). The enzyme activity level, especially the plasma pseudocholinesterase (plasma,

serum, or butyryl cholinesterase) level, may be decreased by dosages considerably less than are required to cause a symptomatic poisoning.

C4.6.2.8. Plasma and RBC cholinesterase can be depressed in the absence of chemical inhibition. About 3 percent of the population has a naturally low level of plasma pseudocholinesterase that is genetically determined. Individuals with hepatitis, cirrhosis, malnutrition, chronic alcoholism, and dermatomyositis exhibit low plasma cholinesterase activities. Cocaine, carbon disulfide, benzalkonium salts, organic mercury compounds, ciguatoxins, solanines, pregnancy, birth control pills, and metoclopramide may also depress the plasma cholinesterase level. The RBC cholinesterase may be reduced in conditions that damage the RBC membrane (hemolytic anemia); however, it is less likely than the plasma enzyme to be affected by factors other than organophosphate compounds.

C4.6.3. References. The State of California Environmental Protection Agency publication, **"**Guidelines for Physicians Who Supervise Workers Exposed to Cholinesterase-Inhibiting Pesticides,"[15] presents the current rationale for using both plasma cholinesterase and RBC cholinesterase determinations.

C4.6.3.1. Plasma cholinesterase, or "pseudo-cholinesterase," is more labile than RBC cholinesterase and is thus less reliable in reflecting actual enzyme depression at neuro-effector sites. It is generally more rapidly inactivated by exposure to organophosphates. Since plasma cholinesterase is produced in the liver, it can be regenerated relatively quickly compared to RBC cholinesterase. After mild exposure, there is sometimes a rebound phenomenon resulting in elevated levels.

C4.6.3.2. RBC cholinesterase, or "true cholinesterase," is biochemically the same enzyme as the acetylcholinesterase located at the neuro-effector cell synapses. It is often depressed more slowly than plasma cholinesterase by exposure to organophosphates. Regeneration of RBC cholinesterase is slow and occurs only as new RBCs are regenerated (a rate of approximately 1 percent per day).

C4.6.3.3. Two cholinesterase testing methods are in use, the Ellman technique and the Michel method (include Delta pH). A conversion equation has been developed for comparing the TestMate (Ellman) and Michel methods. The health professional should contact the USAPHC Cholinesterase Reference Lab at (410) 436-8259, (410) 436-3983, or DSN 584-8259 for details. Results should be reported in international units per milliliter (ml) on the converted (Ellman) scale. To be acceptable, the results between the alternative and the reference methods should have at least a 0.9 correlation coefficient squared (r^2). "Kit" methods, which test whole blood and do not provide separate measures for plasma and RBC cholinesterase determinations, are not satisfactory.

[15] Available at http://oehha.ca.gov/media/docguide2015-1.pdf

C4.7. COMPLETE BLOOD COUNT AND OTHER HEMATOLOGIC TESTS

C4.7.1. Introduction. Benzene, lead, and methemoglobin formers represent the majority of occupational hematotoxins. The CBC should not be a routine test unless it is directly related to a hazard or required by law, regulation, or other Service requirement. A CBC has many (approximately 20) components. Any given sample taken in an asymptomatic, unexposed individual is likely to have at least one result outside the normal range. This makes it a suboptimal occupational medical surveillance test. Methemoglobin formers are better tracked with methemoglobin levels and with a hemoglobin and hematocrit (H&H) than a CBC since the H&H and methemoglobin relate directly to the underlying toxicology. Although the CBC is required for medical surveillance under the benzene standard, it is not an efficient tool to detect early acute leukemias.

C4.7.1.1. A trend of decreasing or increasing values over time is far more significant than any single abnormal value.

C4.7.1.2. A trend across multiple cell lines is far more significant than any single abnormal value.

C4.7.2. Benzene

C4.7.2.1. CBC is required medical surveillance under the benzene standard. Evidence of toxicity can be virtually any change in the CBC. Using this criteria, however, may create many false positives.

C4.7.2.2. The most important elements in monitoring CBC in benzene workers are:

C4.7.2.2.1. Red cell indices (macrocytosis, i.e., increased mean corpuscular volume).

C4.7.2.2.2. White cell counts (especially lymphocytopenia, or leukopenia of less than 4000 per cubic millimeter).

C4.7.2.2.3. Red cell counts (decreased red cell mass, i.e., anemia).

C4.7.2.2.4. Platelet counts (a 20-percent change, even if the total is within the normal range).

C4.7.2.2.5. Differential (especially an upward trend of basophils, ringed sideroblasts, or immature forms).

C4.7.2.3. For most cases, repeating the CBC and reviewing the work practices are appropriate actions. If the abnormalities persist, prompt referral to a hematologist or internist is necessary.

C4.7.2.4. The determination of total urinary phenols can be used as a Biological Exposure Index to back-calculate benzene exposures. However, this should only be used in

emergency and/or unexpected overexposure situations and not in routine surveillance. Values less than 75 milligrams of phenol per liter of urine are normal.

C4.7.2.5. Smoking should be avoided within 2 hours of drawing the CBC; smoking is well known to elevate white blood counts.

C4.7.3. Lead. Lead effects on the hematologic profile initially include normochromic anemia followed later with basophilic stippling of RBCs. In severe cases, microcytic hypochromic anemia can form due to hemolysis. The OSHA lead standard (part 1926.62 of Reference (g)) requires an H&H instead of a CBC.

C4.7.4. Methemoglobin. Methemoglobin formers include nitro compounds, aromatic amines, naphthalenes, paradichlorobenzenes, phenols, hydroquinones, chlorates, arsine, chloroquine, primaquine, and other substances. These can cause oxidative stress to RBCs, forming methemoglobin. If the oxidative stress is high enough, hemolysis will result. The H&H is a more appropriate test than the CBC.

C4.8. LEAD

C4.8.1. Biomonitoring

C4.8.1.1. Laboratory tests currently used to clinically evaluate lead exposure include the BLL and erythrocyte protoporphyrin (EP), also known as the ZPP assays. Several other tests may be helpful in certain situations, but are not generally useful for screening. OSHA requires both the BLL and ZPP for medical surveillance. BLL and ZPP do not measure total body burden but are more reflective of recent, past, or ongoing exposures.

C4.8.1.2. Most retained lead in the human body is ultimately deposited in bones. The bones and teeth of adults contain about 94 percent of their total lead body burden; in children the figure is approximately 73 percent. Bone-to-blood lead mobilization increases during pregnancy, lactation, menopause, physiologic stress, chronic disease, hyperthyroidism, kidney disease, broken bones, and advanced age, and is exacerbated by calcium deficiency. Consequently, the normally inert pool poses a special risk because it is a potential endogenous source of lead that can maintain BLLs long after exposure has ended. Significant drops in a person's BLL may take several months, or sometimes years, even after complete removal from the exposure sources.

C4.8.1.3. Hair and fingernails are subject to external environmental contamination; therefore, assaying their lead content is an uncertain estimate of body burden and is not recommended.

C4.8.2. Laboratory Notes

C4.8.2.1. BLL

C4.8.2.1.1. Venous BLL testing is the most useful screening and diagnostic test for recent or ongoing lead exposure. Given the greater risk of sample contamination from the skin when using the finger-stick method, an elevated BLL obtained through finger-sticking should always be confirmed through venipuncture. BLLs respond relatively rapidly to abrupt or intermittent changes in lead intake (e.g., ingestion of lead paint chips by children) and, for relatively short exposure periods, bear a linear relationship to those intake levels. For individuals with high or chronic past exposure, however, BLLs often underrepresent the total body burden because most lead is stored in the bone and may be found at "normal" levels in the blood. (One exception is patients with a high body burden under stressful circumstances, whose BLLs may be elevated from the release of lead stored in bones.)

C4.8.2.1.2. The U.S. national BLL geometric mean among adults was 1.2 micrograms per deciliter (µg/dL) during 2009-2010. The National Research Council has concluded that there is overwhelming evidence that the OSHA standard provides inadequate protection for DoD firing-range personnel and any other worker populations covered by the OSHA general industry standard.

C4.8.2.1.2.1. Currently for adults in the workplace, OSHA considers an average of three BLLs of 50 µg/dL or any one BLL at or above 60 µg/dL as cause for removal from the job OSHA requires employee notification of results within 5 working days after the receipt of biological monitoring results. OSHA requires written notification of results for employees whose BLL is at or above 40 µg/dL. The DoD requires written notification for employees whose BLL is at or above 20 µg/dl.

C4.8.2.1.2.2. Table C4.T2. provides DoD requirements and guidelines for medical surveillance and management based on occupational blood lead monitoring. The DoD requirements are more stringent than OSHA requirements. OSHA's medical removal BLL is based on one blood test at or greater than 60 µg/dl or 3 consecutive BLL tests at or greater than 50 µg/dl . OSHA allows employees to return-to-work when their BLL is at or below 40 µg/dl. DoD's medical removal is based on BLLs at or greater than 20 µg/dl, and employee return to work when BLL is at or below 15 µg/dl. The remaining sections of the OSHA lead standard (e.g., medical surveillance AL, required examination frequency, examination content, collection of detailed work and medical histories), as depicted in Table C2.T11 still apply.

C4.8.2.1.2.3. Where military necessity requires deviation from these guidelines, leadership at the appropriate level of authority will follow Enclosure 3 of DoDI 6055.01 (Reference (s)) to assess, accept, document, and periodically re-evaluate the risk.

C4.8.2.2. EP/ZPP Levels

C4.8.2.2.1. EP/ZPP assays complement BLL testing and are required for OSHA medical surveillance. EP/ZPP is not specific for lead other than to meet OSHA requirements, it is not a test of choice.

C4.8.2.2.2. The EP/ZPP assays indicate elevated levels of protoporphyrin in the blood due to substitution of zinc for iron in the porphyrin moiety. The assays are indirect

measures of intermediate (longer term than for BLL) exposure to lead. Normal values of EP/ZPP are usually below 35 µg/dL. The EP/ZPP is also elevated in jaundice, iron deficiency anemia, and sickle cell and other hemolytic anemias. The most common cause of elevated EP/ZPP in the United States is iron deficiency anemia.

C4.8.2.3. Blood Lead Laboratory Results and Health-Based Management Guidelines

C4.8.2.3.1. Introduction. Blood lead laboratory results and health-based management requirements and guidelines are shown in Table C4.T2.

Table C4.T2. Blood Lead Laboratory Results and Health-Based Management Requirements and Guidelines

BLL µg/dL	Short-term Risks (Lead exposure < 1 yr)	Long-term Risks (Lead exposure ≥ 1 yr)	Actions*
<5	Studies have demonstrated adverse effects from lead exposure across populations, including on neurologic, reproductive, and renal functions and blood pressure, that occur at extremely low levels of exposure and appear not to have a threshold as reported by the Association of Occupational and Environmental Clinics, "Medical Management Guidelines for Lead-Exposed Adults" (Reference (t)).		Supervisor/Personnel Management • Ensure personnel are informed of potential health risks. • Consider reduction or avoidance of lead exposure for all workers. • Ensure personnel exposed to lead above the 30 µg/m^3 AL are enrolled in medical surveillance. Medical Management • As part of health education and risk communication, recommend reduction or avoidance of lead exposure. • Educate on potential health risks. Surveillance • Coordinate with industrial hygiene, safety, and employee management. • Use current OSHA selection criteria (i.e., AL of 30 µg/m^3 for 30 days per year). • Repeat BLL testing at least annually for individuals selected for BLL surveillance, and more frequently at the discretion of a medical provider.
5-9	• Possible spontaneous abortion • Possible postnatal developmental delay	Short-term risks plus: • Possible hypertension • Possible kidney dysfunction	Supervisor/Personnel Management • Ensure personnel are informed of potential health risks. • Consider reduction or avoidance of lead exposure for all workers. • Ensure personnel exposed to lead above the AL are enrolled in medical surveillance. Medical Management • As part of health education and risk communication, recommend reduction or avoidance of lead exposure . • Educate on potential health risks. Surveillance • Coordinate with industrial hygiene, safety, and employee management. • Use current OSHA selection criteria (i.e., AL of 30 µg/m^3 for 30 days per year). • Repeat BLL testing at least annually for individuals selected for BLL surveillance, and more frequently at the discretion of a medical provider.

Table C4.T2. Blood Lead Laboratory Results and Health-Based Management Requirements and Guidelines, Continued

BLL µg/dL	Short-term Risks (Lead exposure < 1 yr)	Long-term Risks (Lead exposure ≥ 1 yr)	Actions*
10-19	• Possible spontaneous abortion • Possible postnatal developmental delay • Reduced birth weight • >15 µg/dL adverse effects on sperm or semen	Short-term risks plus: • Hypertension and cardiovascular disease • Possible kidney dysfunction • Possible subclinical neurocognitive deficits	Supervisor/Personnel Management • Ensure personnel are informed of potential health risks. • Consider reduction or avoidance of lead exposure for all workers. • Ensure personnel exposed to lead above the AL are enrolled in medical surveillance. Medical Management • As part of health education and risk communication, recommend reduction or avoidance of lead exposure . • Educate on potential health risks. Surveillance • Coordinate with industrial hygiene, safety, and employee management. • Use current OSHA selection criteria (i.e., AL of 30 µg/m^3 for 30 days per year.) • Repeat BLL testing every 3 months or more frequently at the discretion of a medical provider.
20-29	• Spontaneous abortion • Possible postnatal developmental delay • Reduced birth weight • Adverse effects on sperm or semen	Short-term risks plus: • Hypertension and cardiovascular disease • Possible kidney dysfunction • Possible clinical neuro-cognitive deficits	Supervisor/Personnel Management • Ensure personnel are informed of potential health risks. • Remove from lead exposure if repeat BLL testing is at or above 20 µg/dl. • Collaborate with occupational medicine to ensure employee is notified in writing within 5 working days of receiving results for any BLL of 20 µg/dL or above. • Return to lead work after 2 BLLs < 15 µg/dL 1 month apart. Medical Management • Notify supervisor/personnel management to remove from lead exposure if repeat BLL testing is at or above 20 µg/dL in 4 weeks. • Notify employee in writing within 5 working days of receiving results for any BLL of 20 µg/dL or above. • Educate on potential health risks.

Table C4.T2. Blood Lead Laboratory Results and Health-Based Management Requirements and Guidelines, Continued

BLL µg/dL	Short-term Risks (Lead exposure < 1 yr)	Long-term Risks (Lead exposure ≥ 1 yr)	Actions*
			Surveillance • Perform monthly BLL testing. • Recommend to supervisor/personnel management return to lead work after 2 BLLs < 15 µg/dL 1 month apart. • When BLL has maintained at 15 µg/dL or below for 1 month and the worker is returned to lead work, repeat BLL testing every 3 months; more frequently at the discretion of a medical provider. • Surveillance frequency and management for each new BLL result will correspond to the directions in this table.
30-39	• Spontaneous abortion • Possible postnatal developmental delay • Reduced birth weight • Adverse effects on sperm or semen	Short-term risks plus: • Hypertension and cardiovascular disease • Possible kidney dysfunction • Possible clinical neuro-cognitive deficits • Possible nonspecific symptoms**	Supervisor/Personnel Management • Ensure personnel are informed of potential health risks. • Remove from lead exposure if single test result is ≥ 30 µg/dl. • Collaborate with occupational medicine to ensure employee is notified in writing within 5 working days of receiving results for any BLL of 20 µg/dL or above. • Return to lead work after 2 BLLs < 15 µg/dL 1 month apart. Medical Management • Notify supervisor/personnel management to remove from lead exposure. • Notify employee in writing within 5 working days of receiving results. • Educate on potential health risks. Surveillance • Perform monthly BLL testing. • Recommend return to lead work after 2 BLLs < 15 µg/dL 1 month apart. • When BLL has maintained at 15 µg/dL or below for 1 month and the worker is returned to lead work, repeat BLL testing every 3 months; more frequently at the discretion of a medical provider. • Surveillance frequency and management for each new BLL result will correspond to the directions in this table.

Table C4.T2. Blood Lead Laboratory Results and Health-Based Management Requirements and Guidelines, Continued

BLL µg/dL	Short-term Risks (Lead exposure < 1 yr)	Long-term Risks (Lead exposure ≥ 1 yr)	Actions*
40-79	• Spontaneous abortion • Possible postnatal developmental delay • Reduced birth weight • Neurocognitive deficits • Sperm abnormalities • Adverse effects on sperm or semen	Short-term risks plus: • Hypertension and cardiovascular disease • Kidney dysfunction/ neuropathy • Neurocognitive deficits • Subclinical peripheral neuropathy • Anemia • Colic • Possible gout • Nonspecific symptoms**	Supervisor/Personnel Management • Ensure personnel are informed of potential health risks. • Remove from lead exposure if single test result is ≥ 30 µg/dl. • Collaborate with occupational medicine to ensure employee is notified in writing within 5 working days of receiving results for any BLL of 20 µg/dL or above. • Return to lead work after 2 BLLs < 15 µg/dL 1 month apart. Medical Management • Notify supervisor/personnel management to remove from lead exposure. • Consider chelation therapy for BLL > 50 µg/dL with significant symptoms or signs of lead toxicity. Notify employee in writing within 5 working days. • Educate on potential health risks. Surveillance • Perform monthly BLL testing. • Recommend return to lead work after 2 BLLs < 15 µg /dL 1 month apart. • When BLL has maintained at 15 µg/dL or below for 1 month and the worker is returned to lead work, repeat BLL testing every 3 months; more frequently at the discretion of a medical provider. • Surveillance frequency and management for each new BLL result will correspond to the directions in this table.
≥80	All of the short-term risks for BLLs between 5 and 79 µg/dL plus: • Encephalopathy • Anemia • Colic	All of the short- and long-term risks for BLLs between 5 and 79 µg/dL	Supervisor/Personnel Management • Ensure personnel are informed of potential health risks. • Remove from lead exposure if single test result is ≥ 30 µg/dl. • Collaborate with occupational medicine to ensure employee is notified in writing within 5 working days of receiving results for any BLL of 20 µg/dL or above. • Return to lead work after 2 BLLs < 15 µg/dL 1 month apart. Medical

			Management • Notify supervisor/personnel management to remove from lead exposure.

Table C4.T2. Blood Lead Laboratory Results and Health-Based Management Requirements and Guidelines, Continued

BLL µg/dL	Short-term Risks (Lead exposure < 1 yr)	Long-term Risks (Lead exposure ≥ 1 yr)	Actions*
			• Refer for immediate/urgent medical evaluation. • Educate on potential health risks. • Notify employee in writing within 5 working days of receiving results for any BLL of 20 µg/dL or above. • Probable chelation therapy. Surveillance • Perform monthly or more frequent BLL testing. • Consider return to lead work after 2 BLLs < 15 µg/dL 1 month apart. • When BLL has maintained at 15 µg/dL or below for 1 month and the worker is returned to lead work, repeat BLL testing every 3 months; more frequently at the discretion of a medical provider. • Surveillance frequency and management for each new BLL result will correspond to the directions in this table.

* Consider more conservative management in the context of combined exposures to lead and other hazards (e.g., exposure to heavy metals increases the risk of noise induced hearing loss). Medical conditions that may be at increased risk from continued exposure include pregnancy, chronic renal dysfunction (serum creatinine > 1.5 milligrams per deciliter for men and >1.3 milligrams per deciliter for women, or proteinuria), hypertension, neurologic disorders, and cognitive dysfunction.
** Nonspecific symptoms may include headache, fatigue, sleep disturbance, anorexia, constipation, arthralgia, myalgia, and decreased libido.

C4.8.2.3.2. Expert Consensus on Chelation Therapy

C4.8.2.3.2.1. Greater than or equal to 100 BLL in µg/dL: Chelation therapy recommended.

C4.8.2.3.2.2. 80 to 99 BLL in µg/dL: Strongly consider chelation therapy.

C4.8.2.3.2.3. 50 to 79 BLL in µg/dL: Possibly consider chelation therapy if symptoms of lead toxicity are present.

C4.8.2.3.2.4. A number of chelating agents are currently in use in the United States. These chelators differ in their efficacy, and side effects vary with the specific chelating agent. Chelating agents, however, are not specific and may bind nontarget substances as well.

C4.8.2.3.2.5. Chelating therapy is not without inherent risks of its own, including redistribution of lead into the central nervous system, severe drug reactions, and excretion of other "desirable elements." Many of these elements (e.g., iron, copper, magnesium, manganese, cobalt, zinc, and calcium) are essential nutrients necessary for normal metabolic activity. Calcium, when excreted in excess, may cause hypocalcemia, leading to cardiac arrhythmias and tetany. This strongly suggests that chelation therapy be conducted in a hospital with cardiac monitoring capabilities.

C4.8.2.3.2.6. Data documenting efficacy of chelation in terms of clinical outcome is sparse; i.e., excretion does not necessarily equal efficacy. Hence, when considering chelation therapy, the practitioner should carefully weigh the benefit versus the harm.

C4.9. LIPID PANEL TESTS

Treating physicians (generally the primary care physicians) should use appropriate clinical practice guidelines, to include the latest version of the National Institutes of Health (NIH) National Cholesterol Education Program report of the Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults,[16] or the NIH National High Blood Pressure Education Program report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure.[17] General counseling regarding abnormal lipid results is within the practice of occupational medicine physicians.

C4.10. LIVER FUNCTION TESTS

C4.10.1. The clinical laboratory contains a number of tests related to the liver, its function and dysfunction. These tests are not only some of the most frequently ordered, they often present challenges for the occupational medicine physician.

C4.10.2. Some key issues worth considering are:

C4.10.2.1. These tests are commonly referred to as LFTs, but often do not reflect liver function. In reality, the most commonly ordered tests, the transferases--ALT (also known as SGPT, serum glutamic-pyruvic transaminase), aspartate (AST, also known as SGOT, serum glutamic-oxaloacetic transaminase) and glutathione (GGT)--measure liver injury rather than liver function.

C4.10.2.2. Transferases (especially GGT) have significant false positive rates.

C4.10.2.3. Transferases have a high degree of correlation.

C4.10.2.4. Most industrial chemicals do not cause cholestasis.

[16] Available at https://www.nhlbi.nih.gov/files/docs/guidelines/atp3xsum.pdf
[17] Available at http://www.nhlbi.nih.gov/files/docs/guidelines/jnc7full.pdf

C4.10.2.5. In addition to the liver, other organs produce these substances and enzymes. For example, bones produce alkaline phosphatase (AP), and the lungs, heart, and muscles produce lactic acid dehydrogenase, AST, and ALT.

C4.10.2.6. Bilirubin has a high false positive rate (Gilbert's disease) and low sensitivity.

C4.10.2.7. Albumin has very low sensitivity for mild to moderate disease.

C4.10.2.8. Prothrombin time is not sensitive for mild to moderate disease or injury.

C4.10.2.9. The tests often have an excellent inverse relationship between sensitivity and specificity.

C4.10.2.10. None of the commonly available tests are particularly sensitive for chemical injury; GGT is the best at about 45 percent, followed by AP at 27 percent, and ALT at 20 percent.

C4.10.2.11. AP has nearly 100 percent specificity for positive biopsies in chemical workers' livers. Specificity of the ALT is in the high 80-percent range, and of the GGT, in the low 80-percent range.

C4.10.2.12. AST/ALT ratios of 2 or more are strongly correlated to alcoholic liver disease.

C4.10.2.13. ALT is positively correlated with Basal Metabolic Index; AST is not.

C4.10.2.14. A total of 23 percent of males age 30-39 have ALT values above the laboratory upper limit of normal. The best explanation for this is that most "normal ranges" are made using a small sample (20-30 values) and assumptions that the distribution of values will be normal. Much research points to the fact that normal ranges (especially for ALT) should be made nonparametrically, using a large sample (150 plus).

C4.10.2.15. ALT (using the above described methodology) is the most accurate single test because it minimizes the total number of false test results. This does not necessarily mean it is the best surveillance test.

C4.10.2.16. ALT and AST are not as good for detecting low-level, chronic chemical exposures as AP and GGT.

C4.10.2.17. Most of the time, the purpose of monitoring the liver is to detect unexpected, chronic exposures to a hepatotoxin. Occasionally, workers are monitored after a known or likely acute exposure. High, acute (i.e., emergent) exposures have a higher prevalence of injury; therefore, the physician can have more confidence in an abnormal test result. In low-level, chronic exposures (e.g., routine industrial operations), the prevalence of disease is less, so interpreting abnormal test results is more difficult. This information provides some useful considerations in liver monitoring. The physician should:

C4.10.2.17.1. If possible, use large-sample, nonparametric methods to determine normals for the laboratory. This is most important for ALT and AP. Discussion with the lab officer may be necessary.

C4.10.2.17.2. Use a Bonferroni adjustment when multiple liver tests are drawn. For example, if five liver tests are drawn, the physician should use the ninety-ninth percentile as the upper limit of normal. By doing this, the false positive rate is 5 percent, the common standard. Not correcting for the five tests causes the false positive rate to jump to 23 percent. If two tests are used, the 97.5 percentile should be used as the upper limit of normal.

C4.10.2.17.3. Consider sequential testing, using AP as a screening test; if the results are abnormal, confirm with a GGT.

C4.10.2.17.4. Consider the occupational history, exposure information, and PPE use with abnormal tests. Removal from an industrial exposure for 30 days will often indicate if the causal entity is occupationally related.

C4.11. MERCURY

C4.11.1. Biomonitoring

C4.11.1.1. Mercury can be measured in urine, blood, hair, and finger and toe nails. Urine and blood concentrations reflect more recent exposure; hair and nails can provide evidence of exposure occurring over a longer period of time.

C4.11.1.2. A 24-hour urine collection is the best indicator of exposure to elemental or inorganic mercury; however, spot urine collection is also adequate when adjusted for Cr content. Blood is the best test for exposure to organic mercury (methylmercury) but is also indicated for severe, acute exposures to elemental or inorganic mercury. Hair and nail samples must be guarded from external contamination and must be carefully processed by experienced laboratories; these tests have limited usefulness. (In the case of mercury exposure, hair sampling is only useful for methyl mercury.) Unconventional (alternative medicine) laboratory panel evaluations should be avoided.

C4.11.1.3. Urine Testing

C4.11.1.3.1. In nonoccupational exposures, levels will usually be 1 to 5 µg/g Cr.

C4.11.1.3.2. Concern should be triggered by values of greater than 35 µg/g Cr.

C4.11.1.3.3. Subclinical effects can be seen when urine values are 20 to 100 µg/g Cr.

C4.11.1.3.4. Clinical effects can be seen when urine values exceed 100 µg/g Cr.

C4.11.1.3.5. Exposed individuals with levels above 50 µg/g Cr should be placed in a non-exposed job until their exposure has been further evaluated and corrected and their urine levels have fallen below 50 µg/g Cr.

C4.11.1.3.6. Adults excreting less than 50 µg/g Cr are unlikely to have renal dysfunction.

C4.11.1.4. Blood Testing

C4.11.1.4.1. Blood testing is the best test for organic mercury.

C4.11.1.4.2. Blood mercury is influenced by dietary (fish eating) habits.

C4.11.1.4.3. Elevated blood mercury and absent urine mercury are indicative of organic exposure.

C4.11.1.4.4. Levels per 100 ml of whole blood by fish consumption are:

C4.11.1.4.4.1. No fish: 0.2 µg.

C4.11.1.4.4.2. Less than two fish meals per week: 0.48 µg.

C4.11.1.4.4.3. Two to four fish meals per week: 0.84 µg.

C4.11.1.4.4.4. Greater than four fish meals per week: 4.44 µg.

C4.11.1.4.5. Sequential determinations are useful to document the effectiveness of dietary manipulation.

C4.11.2. Laboratory Notes

C4.11.2.1. Urine

C4.11.2.1.1. Ideally, the urine sample should be collected for 24 hours; however, spot urine mercury sampling can be done. If spot urine mercury sampling is performed on chronically exposed workers, care should be taken to collect the specimen at the same time of day and at the end of the workweek.

C4.11.2.1.2. Samples must be collected in containers provided by the testing laboratory as a preservative is required. A minimum of 25 mls of urine must be collected for each sample. Care must be taken to prevent mercury contamination of the sample by the workplace environment, clothing, or skin.

C4.11.2.2. Blood Mercury

C4.11.2.2.1. Blood mercury reflects exposure to organic mercury as well as to metallic and inorganic mercury. Mercury remains in the bloodstream only a few days after exposure, so testing must occur soon after exposure.

C4.11.2.2.2. Samples should be taken at the same time of day at the end of the workweek. The blood should be collected in mercury-free heparinized tubes after careful skin cleansing.

C4.11.2.2.3. In persons not exposed to mercury, the amount of mercury in the blood is usually less than 2 µg/100 ml. Early effects of mercury toxicity have been found when the blood concentration exceeds 3 µg/100 ml. Levels above 2.8 µg/ml require that workers be removed from mercury exposure until dietary and occupational exposures have been evaluated and blood levels have returned to baseline.

C4.12. RENAL FUNCTION TESTS

C4.12.1. The kidney is one of the two main organs that bioactivate and deactivate toxic substances.

C4.12.2. For most industrial toxins, the site of injury is the proximal tubule. Proximal tubule dysfunction is usually manifested by the failure to reabsorb small proteins and amino acids. Aminoaciduria is usually only seen on acute insults (not chronic injury) so its usefulness as a marker is diminished. β_2-M has been used to detect proximal tubule injury; however, it is rapidly hydrolyzed in acid urine (anything less than pH 5.5). To use it as a marker, the dwell time of the urine in the bladder must be 1 hour or less and the pH must be raised to above 6 at the time of collection. These problems make β_2-M less than an ideal test. Retinol binding protein can also detect tubule injury and does not require special collection or handling. A later sign of tubule dysfunction could be the failure to reabsorb glucose.

C4.12.3. Glomerular injury is possible from occupational toxins, but is relatively unlikely. Laboratory evidence of glomerular injury includes the presence of large substances such as albumin or RBCs. Considering the MW of the protein excreted provides good information regarding the site of the injury: large MW protein suggests glomerulus and small MW protein suggests renal tubule. BUN and Cr are measures of glomerular function, and this feature makes them a less than useful measure of kidney injury from most toxins. Also, BUN and Cr do not change much until massive quantities of glomerular function are lost.

C4.13. RESPIRATOR CLEARANCE

C4.13.1. Introduction. A respirator clearance is a common examination since it must be performed prior to the use of a respirator according to part 1910.134 of Reference (g), except as noted in subparagraph C4.13.2.2. The respirator is PPE that reduces the exposure of toxins into the respiratory tract. The physician needs to know what hazard(s) exist (toxin and concentration), what kind of respirator will be used by the worker, how frequently the respirator will be used, and in what situations. A second key piece of information to determine the likelihood of successful respirator use is the answer to the question, "Do you have any problems when you wear your respirator?" If the answer is no, detailed testing is unlikely to be helpful. If the worker is not currently wearing a respirator or there are positive responses to the OSHA respirator questionnaire, more evaluation is necessary.

C4.13.1.1. The two systems most likely to limit the use of a respirator are the respiratory system and the cardiovascular system. Lung function is usually the most important factor; many respirators can result in increased airway resistance and increased dead space. The increased resistance and dead space can make breathing with the respirator more difficult.

C4.13.1.2. The following list ranks common respirators from highest to lowest in terms of work required for breathing.

C4.13.1.2.1. Nonpowered, air-purifying respirators (e.g., gas masks), which require the most work.

C4.13.1.2.2. Powered, air-purifying respirators, which reduce the work required.

C4.13.1.2.3. Demand-type supplied air respirators, in which air does not flow until inhalation begins, can cause some increased work. Pressure-demand supplied air respirators, in which there is always some positive pressure (flow) into the mask, reduce the work significantly, as do continuous-flow supplied air respirators.

C4.13.1.3. Any factor that increases work is likely to worsen respiratory muscle fatigue and can limit use of the respirator. Workers tolerate pressure-demand and continuous-flow airline respirators better than air purifying ones. Some workers can breathe more comfortably with a pressure-demand airline respirator as it provides a positive pressure effect (helps keep emphysematous airways open). Wearers of air-purifying respirators can also experience increased resistance as the filter becomes clogged; this is more likely to be a problem in workers with underlying pulmonary or cardiovascular disease.

C4.13.1.4. Self-contained breathing apparatus (SCBA) respirators may present particular challenges. They are heavy and add to the musculoskeletal and cardiovascular demands of a worker; for an average worker, maximal exertion is reduced by about 20 percent. Impermeable clothing, which is often worn with SCBA or other high levels of respiratory protection, creates additional heat burden that can likewise increase cardiovascular demands.

C4.13.1.5. The PFT cannot be used to absolutely determine a worker's ability to use a respirator. There are no endpoints for vital capacity or expiratory volume that disqualify respirator use. Thus, the PFT is not a requirement for the RPP.

C4.13.1.6. Other factors to consider are allergies related to mask materials, skin problems, face shape, facial hair, and psychological issues related to tolerating the mask (e.g., claustrophobia). All of these may influence the ability to wear a given respirator.

C4.13.1.7. Workers who have never used a respirator but are enrolled in the RPP for emergency egress or similar contingency uses present unique challenges. Where their ability to tolerate respirator use is questionable, a trial use is recommended. The provisions of such a trial include an understanding by the worker that removing the respirator during the trial constitutes disqualification for the RPP. The trial should follow normal fit testing for the type of respirator worn. Depending on the degree of concern over the worker's medical condition, a medical provider may or may not need to be present during the trial test. The trial should consist of the worker wearing the mask while performing activities simulating the actions required while using the respirator on the job.

C4.13.2. Steps/Algorithm

C4.13.2.1. OSHA requires administration of a questionnaire before initial qualification for respirator use. (See appendix C of part 134 of Reference (g).) Except for the use of SCBAs,

only the first nine questions of Part A, Section 2 of the OSHA Respirator Questionnaire are critical. If any of the responses are yes, the physician needs to see the worker.

C4.13.2.2. Figure C4.F1. shows the nine questions that every employee selected to use any type of respirator must answer. This sample questionnaire includes comments added to make the questions easier to understand and answer. However, equivalent questionnaires or a combination of questionnaires and/or medical examinations are permissible. The Respirator User Certification Exam (Program #716 of the Navy's Medical Matrix) is more stringent than OSHA requirements and shall be used by Navy personnel.

Figure C4.F1. OSHA Respirator Questionnaire, Part A, Section 2

Questions	Yes	No
1. Do you CURRENTLY smoke tobacco, or have you smoked tobacco in the last month?		
2. Have you EVER HAD any of the following conditions? a. Seizures (fits)? (Sudden incapacitation can be a problem in highly dangerous environments as the rescues become more difficult.) b. Diabetes (sugar disease)? (A sudden incapacitation, not often seen with Type II diabetics, can also be a problem in highly dangerous environments.) c. Allergic reactions that interfere with your breathing? (Sudden onset of asthma could put the person at undue risk, especially if in a highly dangerous environment.) d. Claustrophobia (fear of closed-in places)? (Inability to where the mask at all or a sudden episode of claustrophobia could put the person at undue risk, especially if in a highly dangerous environment.) e. Trouble smelling odors? (This symptom relates to certain types of fit testing not usually used by the Department of Defense.)		
3. Have you EVER HAD any of the following pulmonary or lung problems? a. Asbestosis? (If the worker has restrictive lung disease, it could greatly interfere with using many respirators. Spirometry and a more detailed exam would be useful here. Some respirators actually reduce the work of breathing, so each case must be evaluated individually. Consulting an occupational medicine physician is recommended.) b. Asthma? (See allergic reactions in 2.c. above.) c. Chronic bronchitis? (RARELY DISQUALIFYING.) d. Emphysema? (If the worker has obstructive lung disease, it could greatly interfere with using many respirators. Spirometry and a more detailed exam would be useful here.) e. Pneumonia? (Unlikely to affect a qualification decision unless frequent, severe or with sequelae.) f. Tuberculosis? (Active cases would be a contraindication; recovered cases probably should have a chest film and spirometry.) g. Silicosis? (If the worker has restrictive lung disease, it could greatly interfere with using many respirators. Spirometry and a more detailed exam would be useful here) h. Pneumothorax (collapsed lung)? (If recurrent or some kind of underlying systemic defect, such as cystic fibrosis, the worker could be at risk in a highly dangerous environment.) i. Lung cancer? j. Broken ribs? k. Any chest injuries or surgeries? l. Any other lung problem that you've been told about?		
(Items j. through l. relate primarily to the ability to breathe in deeply. If in doubt, spirometry should answer the question.)		
4. Do you CURRENTLY have any of the following symptoms of pulmonary or lung illness? (For the most part, these questions relate to general fitness. Spirometry is probably the easiest measure of cardiopulmonary fitness; however, abnormal tests are not necessarily disqualifying and most workers can be given a controlled (clinician-observed) trial with the given respirator. For the questions relating to asthma and chronic obstructive pulmonary disease (COPD), see questions in Sections 2 and 3.) a. Shortness of breath? b. Shortness of breath when walking fast on level ground or walking up a slight hill or incline? c. Shortness of breath when walking with other people at an ordinary pace on level ground? d. Have to stop for breath when walking at your own pace on level ground? e. Shortness of breath when washing or dressing yourself? f. Shortness of breath that interferes with your job? h. Coughing that produces phlegm (thick sputum)? i. Coughing that wakes you early in the morning?		

Questions	Yes	No
j. Coughing that occurs mostly when you are lying down? k. Coughing up blood in the last month? l. Wheezing? m. Wheezing that interferes with your job? o. Chest pain when you breathe deeply? p. Any other symptoms that you think may be related to lung problems?		

Figure C4.F1. OSHA Respirator Questionnaire, Part A, Section 2, Continued

Questions	Yes	No
5. Have you EVER HAD any of the following cardiovascular or heart problems? (Most of these questions (and those in Section 6) are self-explanatory. Poorly controlled high blood pressure can limit the effective time in wearing a respirator. The question about swelling in the legs is to identify workers with congestive heart failure. A history of most of these needs a consultation with the appropriate specialist and/or residency-trained occupational medicine physician before a clearance is issued.) a. Heart attack? b. Stroke? c. Angina? d. Heart failure? e. Swelling in your legs or feet (not caused by walking)? f. Heart arrhythmia (heart beating irregularly)? h. High blood pressure? i. Any other heart problem that you've been told about?		
6. Have you EVER HAD any of the following cardiovascular or heart symptoms? a. Frequent pain or tightness in your chest? b. Pain or tightness in your chest during physical activity? c. Pain or tightness in your chest that interferes with your job? d. Your heart skipping or missing a beat in the past two years? e. Heartburn or indigestion that is not related to eating? f. Any other symptoms that you think may be related to heart or circulation problems?		
7. Do you CURRENTLY take medication for any of the following problems? (This section is also designed to identify heart or lung disease or a seizure disorder.) a. Breathing or lung problems? b. Heart trouble? c. Blood pressure? d. Seizures (fits)?		
8. If you've used a respirator, have you EVER HAD any of the following problems? (If you've never used a respirator, check the following space and go to question 9.) a. Eye irritation? b. Skin allergies or rashes? (Relates to a possible allergy to mask materials.) c. Anxiety? (Relates to possible claustrophobia.) d. General weakness or fatigue? (Relates to general poor cardiopulmonary fitness.) e. Any other problem that interferes with your use of a respirator?		
9. Would you like to talk to the health care professional who will review this questionnaire about your answers to this questionnaire?		

C4.14. SPIROMETRY/PULMONARY FUNCTION TEST

C4.14.1. Introduction

C4.14.1.1. Spirometry includes but is not limited to the measurement of forced vital capacity (FVC), the forced expiratory volume in the first second (FEV-1), and other forced expiratory flow measurements such as the forced expiratory flow 25-75 percent. In addition, it sometimes includes the measurement of maximum voluntary ventilation. A graphic representation (spirogram) of the maneuver should be a part of the results. Spirometry testing should be done by technicians, nurses, or physicians who have had formal training in administering the tests, preferably a NIOSH-certified course. Although the test is not difficult, it is easy to do incorrectly, and incorrectly performed tests are of no value. Spirometry is an effort-dependent test that requires careful instruction and the cooperation of the test subject. Inability to perform acceptable maneuvers may be due to poor subject motivation or failure to understand instructions. Physicians should receive formal training in interpreting spirogram results. Some of the basic tenets of spirometry follow.

C4.14.1.2. The objective of spirometry is to assess ventilatory function.

C4.14.1.3. Spirometry may be indicated as part of an assessment of lung function or to meet regulatory, surveillance, or other requirements.

C4.14.2. Relative Contraindications to Performing Spirometry

C4.14.2.1. Hemoptysis of unknown origin (forced expiratory maneuver may aggravate the underlying condition).

C4.14.2.2. Pneumothorax (collapsed lung).

C4.14.2.3. Unstable cardiovascular status (forced expiratory maneuver may worsen angina or cause changes in blood pressure).

C4.14.2.4. Recent MI (heart attack).

C4.14.2.5. Pulmonary embolus (blood clot).

C4.14.2.6. Thoracic, abdominal, or cerebral aneurysms (danger of rupture due to increased thoracic pressure).

C4.14.2.7. Recent eye surgery.

C4.14.2.8. Presence of an acute disease process that might interfere with test performance (e.g., nausea, vomiting).

C4.14.2.9. Recent surgery of thorax or abdomen.

C4.14.3. Criteria for Results. The results of spirometry should meet the following criteria for number of trials, acceptability, and reproducibility.

C4.14.3.1. Number of Trials. At least three acceptable tracings.

C4.14.3.2. Acceptability. The three most important criteria are:

C4.14.3.2.1. No coughing in the first second.

C4.14.3.2.2. Complete inability to exhale any more air, or demonstration of a good plateau on the volume time spirogram (less than 25 ml change in volume per second after at least 6 seconds of expiration).

C4.14.3.2.3. Starting the test without hesitation.

C4.14.3.3. Reproducibility. The two highest FVCs should not vary more than 150 ml. The two highest FEV-1s should not vary more than 150 ml.

C4.14.4. Reporting Results. The largest FVC and FEV-1 should be reported even if they do not come from the same curve.

C4.14.5. Interpreting Results

C4.14.5.1. Physicians should attend a training course to learn how to interpret spirometric values correctly. This guidance is provided as an adjunct and is not a substitute for an instructional program.

C4.14.5.2. The lower limit of normal (LLN) is given as the lowest 5 percent of a given population (i.e., 95 percent of workers with the same age and height have a larger test value). FVCs, FEV-1s, and FEV-1/FVC ratios below the LLN identify workers with abnormal patterns.

C4.14.5.3. Workers with an FVC less than the LLN have a restricted pattern (consistent with fibrotic lung disease such as asbestosis or silicosis).

C4.14.5.4. Workers with an FEV-1/FVC ratio less than the LLN are considered to have an obstructive pattern (with the exception of tall workers with large FEV-1s). Obstructive patterns are seen with asthma, chronic obstructive pulmonary disease, and emphysema. If both the FVC and the FEV-1 are low, the worker is considered to have a mixed obstructive and restrictive pattern. (See tables C4.T3. and C4.T4.)

Table C4.T3. Severity of Obstruction by FEV-1 Criteria

Pattern	FEV-1
Mild obstruction	< LLN but ≥ 70% of predicted
Moderate obstruction	< 70% and ≥ 60% of predicted
Moderately severe obstruction	< 60% and ≥ 50%
Severe obstruction	< 50% and ≥ 34% of predicted

Table C4.T4. Severity of Restriction by FVC Criteria

Pattern	FVC
Mild restriction	< LLN but ≥ 70% of predicted
Moderate restriction	< 70% and ≥ 60% of predicted
Moderately severe restriction	< 60% and ≥ 50% of predicted
Severe restriction	< 50% and ≥ 34% of predicted

C4.14.5.5. Serial testing over time is important in distinguishing meaningful from nonmeaningful changes in ventilatory performance since there is day-to-day and week-to-week variability in the test. A change over 1 year in FEV-1 or FVC that exceeds 15 percent should be considered meaningful and should prompt further evaluation.

C4.15. URINE

As a general rule, the routine dipstick (and microscopic) UA is of limited value in medical surveillance. This test does not usually detect a renal system injury until that injury is fairly severe. Other tests and uses are:

C4.15.1. Urine pH. Rarely useful except for determining if a base needs to be added for a β_2-M test.

C4.15.2. Urine Specific Gravity. Useful for identifying dehydration, adulterated (diluted) specimens in drug testing, or a loss of concentrating ability, but usually not for medical surveillance.

C4.15.3. Urine Bilirubin. A very weak test for liver injury.

C4.15.4. Urine Hemoglobin or RBCs. Could be useful for surveillance with exposure to aromatic amines (e.g., 4,4'-Methylenebis (2-Chloroaniline)); however, most authorities would recommend urine cytology for workers with known exposure to potent bladder carcinogens.

C4.15.5. Urine Glucose. A late finding in tubule injury. Surveillance tests should find evidence of hazard control failures and overexposures at an early state, not a late one.

C4.15.6. Urine Ketones. Has no occupational surveillance use.

C4.15.7. Urine Leukocyte Esterase. Has no occupational surveillance use.

C4.15.8. Urine Nitrites. Has no occupational surveillance use.

C4.15.9. Urinary Urobilinogen. Has poor specificity and is unlikely to be useful, although occasionally it will show an elevation with mild lead exposure.

C4.15.10. Urine Protein. Sensitive for albumin (signifying glomerular dysfunction which is uncommon for industrial toxins), but not for the light chain proteins like retinol-binding protein and β_2-M which are seen in tubule injury, the more common problem with industrial chemicals.

C4.16. LASER WORKERS

Medical surveillance is required for personnel working with Class 3b and Class 4 lasers and laser systems. It is not a requirement for personnel working with Class 1, Class 2, or Class 3a lasers or laser systems. DA Pam 40-506 provides detailed information on classes of lasers. All laser accidents should be reported through the local safety office according to DoD Component procedures.

C4.16.1. Classification of Laser Workers

C4.16.1.1. Laser Workers. Laser workers are those individuals who routinely work in a laser environment and, therefore, have a higher risk of accidental exposure. Those working with Class 3b or 4 lasers are at greatest risk of injury due to such exposures. Laser workers include those who regularly perform laser research, development, testing, and evaluation; individuals who work with or near medical lasers found in operating rooms; and workers who perform routine laser maintenance. Laser workers have a moderate to high risk potential for laser injury.

C4.16.1.2. Incidental Laser Workers. Incidental laser workers are those individuals whose work makes it possible, but unlikely, that they will be exposed to laser energy that could damage the eye. Incidental workers include operators of fielded laser equipment, individuals who oversee laser use on approved laser ranges, and soldiers who participate in force-on-force laser training exercises. Incidental laser workers are considered to have a low risk potential for laser injury.

C4.16.2. Laser Medical Surveillance and Assessment

C4.16.2.1. Laser Workers (Laser Personnel). Laser workers shall have an ocular and visual history, visual acuity, color vision test, and a central visual fields test (via Amsler Grid or similar macular integrity test) at preplacement and termination. Visual acuity, color vision, and central field tests shall be performed on each eye separately. No further examination is required if the worker's distance corrected visual acuity is 20/20 in each eye, the color vision test is normal, central visual fields are normal via Amsler grid test or similar macular integrity test, and the medical history is normal for the eyes. Any deviation from the acceptable normals shall be evaluated to determine the reason. This may be done by ocular funduscopic examination or other tests as deemed appropriate by the eye care professional. Baseline funduscopic photography may be useful for documenting the retinal status.

C4.16.2.2. Incidental Laser Personnel (Incidental Health Care Personnel). Incidental laser workers shall have each eye screened for visual acuity. This screening is part of the preemployment physical.

AP1. APPENDIX 1

DEFINITIONS

AP1.1. AL. That level of worker exposure determined by workplace sampling at or above which occupational medical surveillance examinations shall be performed. With substances with a PEL (defined below), the AL is defined and may be one-half of the PEL. For other exposures not regulated by OSHA, other consensus standards may be used for an AL. One such consensus standard is use of one-half of the threshold limit value (TLV) (defined below) as an AL.

AP1.2. Emergency Exposure. Any occurrence, such as, but not limited to, equipment failure, rupture of containers, or failure of control equipment, that may or does result in an unexpected release of and exposure to a hazardous substance or condition.

AP1.3. Engineered Nanomaterials. Discrete materials having structures with at least one dimension between 1 and 100 nanometers that are intentionally created, as opposed to those that are naturally or incidentally formed. They do not include larger materials that may have nanoscale features (e.g., etched silicon wafers), biomolecules (proteins, nucleic acids, and carbohydrates), and materials with occupational exposure limits that address nanoparticles for that substance.

AP1.4. Occupational Exposure Limits. A generic term used to apply to all exposure limits, to include DoD standards from Reference (s), OSHA PELs, DoD Component standards, military exposure guidelines, American Conference of Government Industrial Hygienists TLVs, NIOSH recommended exposure limits, and other exposure limits reviewed for potential use.

AP1.5. Occupational Medical Examinations. Medical examinations performed to prevent work-related health problems by assessing the health status of individuals in relation to their work and making medical recommendations regarding worker placement, accommodation, and exposure controls. An occupational medical examination may include:

AP1.5.1. Occupational Medical and Environmental History. Information regarding an individual's medical background including work history, specific occupational exposures, work practices, and work-related health problems. The occupational medical history augments the basic medical history in assisting the practitioner in determining if the worker has (or is at risk of developing) work-caused or aggravated health problems.

AP1.5.2. Physical Examination. The actions of a health professional using their senses to inspect or test a body, its parts, or components to detect the presence or absence of disease.

AP1.5.3. Clinical Laboratory Tests. Clinical tests and measurements used to characterize the status of specific organ systems and physiologic functions.

AP1.5.4. Biologic Exposure Monitoring. Analysis of chemical or other markers in biological media (usually urine and/or blood) as an aid to the assessment of exposure to hazardous substances.

AP1.6. PEL. The worker's statutorily permitted exposure to any material listed in tables Z-1, Z-2, or Z-3 of OSHA regulation part 1910.1000 of Reference (g).

AP1.7. Similar Exposure Group. A group of workers with the same general exposure profile because of the similarity and frequency of the tests they perform, the materials and processes with which they work, and the similarity of the way they perform the tasks.

AP1.8. STS. Shall include a change in hearing threshold relative to the current baseline audiogram of an average of 10 dB or more at 2000, 3000, and 4000 Hz, either ear. Age corrections shall not be applied. The former 15 dB criteria at 1000, 2000, 3000, or 4000 are retained as an early warning flag only with no requirements for follow-up testing or referrals.

AP1.9. TLV. Airborne concentrations of substances that represent conditions under which it is believed that nearly all workers may be repeatedly exposed day after day without adverse health effects. TLVs are recommendations of the American Conference of Government Industrial Hygienists.

AP1.10. TWA. Concentrations of stressors or hazards that have been weighted for the time duration of the sample. Most commonly expressed as an average concentration for a normal 8-hour workday or 40-hour workweek.

AP1.11. Workplace. A physical location where the agency's work or operations are performed. Workplaces may be administrative, operational, or industrial, and may be staffed by civilian or military personnel. The DoD Components shall apply OSHA and other non-DoD regulatory safety and health standards to military-unique equipment, systems, operations, or workplaces, in whole or in part, insofar as practicable.

AP2. APPENDIX 2

SENTINEL EVENTS

Table AP2.T1. Medical Conditions Associated with Workplace Overexposure
(R.J. Mullan and L.I. Murthy. Occupational sentinel health events:
An updated list for physician recognition and public health surveillance.
American Journal of Industrial Medicine, Volume 19, pages 775-779)

Condition	Industry/Process/Occupation	Agent
Acute bronchitis, pneumonitis, and pulmonary edema due to fumes and vapors	Refrigeration, fertilizer, oil refining industries	Ammonia
	Alkali and bleach industries	Chlorine
	Arc welders, nitric acid industries	Nitrogen oxides
	Refrigeration industries	Sulfur dioxide
	Demilitarization workers	Cadmium
	Plastics industry	Trimellitic anhydride
	Boiler maintenance operators	Vanadium pentoxide
Acute or chronic renal failure	Battery makers, plumbers, solderers	Inorganic lead
	Electrolytic processes, arsenical ore smelting	Arsine
	Battery makers, jewelers, dentists	Inorganic mercury
	Fluorocarbon formulators, fire extinguisher makers	Carbon tetrachloride
	Antifreeze use	Ethylene glycol
Agranulocytosis or neutropenia	Occupations with exposure to benzene	Benzene
	Explosive and pesticide industries	Phosphorus
	Pesticides, pigments, and pharmaceuticals	Inorganic arsenic
Aplastic anemia	Explosive manufacture	Trinitrotoluene
	Occupations with exposure to benzene	Benzene
	Radiologists, radium chemists	Ionizing radiation
Asbestosis	Asbestos industry and utilizers	Asbestos
Cancer of larynx	Asbestos industry and utilizers	Asbestos
Cancer of nasal cavities	Woodworkers, cabinet and furniture workers	Hardwood dusts
	Chromium producers, processors, users	Chromates
	Nickel workers	Nickel
Cancer of nasopharynx	Carpenters, cabinetmakers, sawmill workers, lumberjacks, electricians, fitters	Chlorophenols
Cancer of trachea, bronchus, and lung	Asbestos industry and utilizers	Asbestos
	Chromium producers, processors, users	Chromates
	Nickel users	Nickel
	Mustard gas formulators	Mustard gas
	Plant, protection workers/agronomists	Pesticides, herbicides, fungicides, insecticides
	Welders	Unknown inorganic arsenic, sulfur dioxide, copper, lead, sulfuric acid, arsenic trioxide
Cancer of trachea, bronchus, and lung	Welders, gas cutters	Asbestos, hexavalent chromium
	Foundry-floor molders and casters	Polyaromatic hydrocarbons
	Chromate painters	Lead chromate, zinc chromate
	Pigment production	Zinc chromate dust
	Automatic lathe operators, metal workers	Mineral/cutting oils
	Tool setters, fitters, cotton spinners, chimney sweeps, machine operators	Mineral oil/pitch, tar
	Radiologists	Ionizing radiation
	Occupations with exposure to benzene	Benzene
	Plastics industry	Trimellitic anhydride
Cerebellar ataxia	Chemical industry using toluene	Toluene
Chronic beryllium disease of the lung	Aircraft maintainers, beryllium alloy workers, nuclear reactor workers	Beryllium

Condition	Industry/Process/Occupation	Agent
Contact and allergic dermatitis	Leather workers, raw fish handling, adhesives and sealants industry, boat building and repair	Irritants (e.g. cutting oils, phenol, solvents, acids, alkalis, detergents); allergens (e.g., nickel, chromates, formaldehyde, dyes, rubber products)
Extrinsic asthma	Alloy workers	Platinum
	Polyurethane, adhesive, paint workers	Isocyanates
	Alloy, catalyst, refinery workers	Chromium, cobalt
	Solderers	Aluminum soldering flux
	Plastic, dye, insecticide makers	Phthalic anhydride
	Foam workers, latex makers, biologists	Formaldehyde
	Nickel platers	Nickel sulfate
	Bakers	Flour
	Plastics industry, organic chemicals manufacture	Trimellitic anhydride
	Woodworkers, furniture makers	Red cedar (plicatic acid) and other wood dusts
	Hospital and geriatric department nurses	Psyllium dust
	Latex manufacture and packing	Latex particles
Mesothelioma	Asbestos industry and utilizers	Asbestos
Methemoglobinemia	Explosive and dye industries	Aromatic amino and nitro compounds (e.g. aniline, trinitrotoluene, nitroglycerine)
	Rubber workers	Aniline, o-toluidine, nitrobenzene
Mononeuritis of upper limb and mononeuritis multiplex	Dental technicians	Methyl methacrylate monomer
Noise effects on inner ear	Occupations with exposure to excessive noise	Excessive noise
Parkinson's disease (secondary)	Manganese processing, battery makers, welders	Manganese
	Internal combustion engine industries	Carbon monoxide
Raynaud's phenomenon (secondary)	Chain sawyers, grinders, chippers, rock drillers, stone cutters, jackhammer operators, riveters, lawn equipment operators	Whole body or segmental vibration
Silicosis	Quarrymen, sandblasters, silica processors; mining, metal, and ceramic industries	Silica
Toxic encephalitis	Battery, smelter, and foundry workers	Lead
Toxic hepatitis	Solvent users, dry cleaners, plastics industry	Carbon tetrachloride, chloroform, tetrachloroethane, trichloroethylene, tetrachloroethylene
	Explosives and dye industries	Phosphorus, trinitrotoluene
	Fumigators, gasoline and fire extinguisher formulators	Methyl bromide, ethylene dibromide
	Disinfectant, fumigant, and synthetic resin formulators	Cresol
Toxic neuropathy	Pesticide industry, pigments and pharmaceuticals formulators	Arsenic/arsenic compounds
	Furniture refinishers, degreasing operations	Hexane
	Plastic-coated fabric workers	Methyl n-butyl ketone
	Explosives industry	Trinitroluene
	Chloralkali plants, fungicide makers, battery makers	Organic mercury
	Ethylene oxide sterilizer operators, microbiologists, supervisors, inspectors	Ethylene oxide

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