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ATTENTION, EMERGENCY RESPONDERS:

NIOSH Interim Guidance on the Use of Chemical, Biological, Radiological and Nuclear (CBRN) Full Facepiece, Air-Purifying Respirators/Gas Masks Certified Under 42 CFR Part 84

CBRN APR User's Guide

DRAFT

DEPARTMENT OF HEALTH AND HUMAN SERVICES
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health
National Personal Protective Technology Laboratory

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FOREWORD

With the escalation of global acts of terrorism, the personal protection equipment needs of emergency responders continue to evolve. As a result, The National Institute for Occupational Safety and Health (NIOSH) is rapidly meeting these challenges by developing new standards for the certification of respirators for protection against chemical, biological, radiological, and nuclear (CBRN) agents.

This interim guidance document provides guidelines for the selection and use of NIOSH-approved full facepiece, tight fitting, non-powered, air-purifying respirators (APR) for protection against quantified CBRN agents. A peer reviewed NIOSH numbered publication will supersede this interim guidance in the near future. Users should periodically check the NIOSH National Personal Protective Technology Laboratory website, below, for additional user guidelines related to NIOSH-approved CBRN respirators.

http://www.cdc.gov/niosh/npptl/default.html

The NIOSH CBRN APR respirator certification standards are the result of collaboration between numerous agencies such as the United States Army's Research, Development and Engineering Command (RDECOM), private civilian standards and certification organizations, and civilian respirator users and user associations. In 1999, the InterAgency Board for Equipment Standardization and InterOperability (IAB) identified the need for the development of standards or guidelines for respiratory protection equipment as a top priority. NIOSH, the National Institute for Standards and Technology (NIST), the National Fire Protection Association (NFPA), and the Occupational Safety and Health Administration (OSHA) entered into a Memorandum of Understanding defining each agency or organization's role in developing, establishing, and enforcing standards for respirators. The collaborative standards development and research efforts resulted numerous new CBRN respirator standards, one being the NIOSH CBRN APR certification standard, dated March 7, 2003.

As emergency responders face new challenges and train to meet the demands of the evolving emergency response environment, this interim CBRN APR guidance document provides vital options for consideration in the development of CBRN respirator protection programs, training standards, purchase specifications and logistical concerns.

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ABBREVIATIONS

AEGL	acute exposure guideline level (National Research Council and Environmental Protection Agency)
AC	hydrogen cyanide
APF	assigned protection factor
APR	air-purifying respirator
CG	phosgene (choking agent)
CK	cyanogen chloride
DP	diphosgene (choking agent)
CBRN	chemical, biological, radiological, and nuclear
CDC	Centers for Disease Control and Prevention
CWA	chemical warfare agent
CRUL	CBRN respirator use life
EPA	Environmental Protection Agency
GA	Tabun (nerve agent)
GB	Sarin (nerve agent)
GD	Soman (nerve agent)
GF	Cyclohexyl Sarin (nerve agent)
H	Sulfur mustard (blister agent)
HD	distilled Sulfur mustard (blister agent)
HN-1, HN-2, HN-3	nitrogen mustards (blister agents)
IDLH	immediately dangerous to life or health
IND	improvised nuclear device

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L, L-1, L-2, L-3	Lewisite (blister agents)
MUC	maximum use concentration
NIOSH	National Institute for Occupational Safety and Health
NPPTL	National Personal Protective Technology Laboratory
OSHA	Occupational Safety and Health Administration
PEL	permissible exposure limit (OSHA)
PS	chloropicrin (choking agent)
RDD	radiological dispersive device
RDECOM	U.S. Army Research, Development, and Engineering Command (formerly SBCCOM)
REL	recommended exposure limit (NIOSH)
SBCCOM	U.S. Army Soldier and Biological Chemical Command (now RDECOM)
SCBA	self-contained breathing apparatus
TIC	toxic industrial chemical
TIM	toxic industrial material
TRA	test representative agent
UI	user's instructions (respirator operations manual)
VX	VX (nerve agent)

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1. Overview

The National Institute for Occupational Safety and Health (NIOSH) is testing and certifying non-powered air-purifying respirators (APR) for use by emergency responders in atmospheres which contain chemical, biological, radiological, and nuclear (CBRN) agents. This document serves as interim guidance on the selection and use of NIOSH-approved CBRN APR until further guidance is published.

The CBRN APR is a full facepiece, tight-fitting respirator, which uses an air-purifying canister filtration media to remove particulates, gases, and vapors from the air. Contaminate quantities must be below acceptable limits for air-purifying respirators and adequate breathable oxygen must be present

This document describes NIOSH recommendations for CBRN APR use and the specific CBRN agent protections provided by the respirator. It also provides guidance for selecting the canister capacity level (also called the "Cap" level) and guidance for establishing a canister change schedule. A unique time-use limitation concept known as the CBRN respirator use life (CRUL), is introduced and designates how long a CBRN respirator system can be used in a chemical warfare agent environment.

A NIOSH-approved CBRN APR can be identified by its olive green NIOSH canister label affixed to the canister and the matching of the part numbers to a part number listing on a NIOSH approval label. Two types of labels are with a CBRN APR- the canister label and the respirator systems label. The user must recognize the usefulness of the NIOSH matrix-style APR canister approval label and matrix-style APR respirator approval label, both of which are required to be provided with the manufacturer's user instructions. The matrix-style labels identify the unique parts and accessories which compose the NIOSH-approved respirator configuration. This is important because inadvertent mixing of similar parts on a respirator could void the NIOSH approval and compromise the effectiveness of the rated protection. A detailed discussion with examples of the canister label and matrix-style approval labels is located on the NIOSH NPPTL website at:

Attention, Emergency Responders: How To Determine If Your Air-Purifying Respirator (APR) Is NIOSH Certified For CBRN Environments
http://www.cdc.gov/niosh/npptl/topics/respirators/cbrnapproved/apr/

2. CBRN Agent Canister Protections

Respiratory CBRN agents are chemical, biological, radiological, and nuclear inhalation hazards which have the potential to be released during acts of terrorism. During the development of the certification standard for the CBRN self-contained breathing apparatus (SCBA), NIOSH collaborated with the U.S. Army Research, Development and

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Engineering Command (RDECOM), formerly Soldier and Biological Chemical Command (SBCCOM), to perform a hazard assessment to identify a list of potential terrorist threats. That same list helped support the hazard assessment for CBRN APR. As part of the CBRN APR certification testing, NIOSH adopted 11 compounds called test representative agents (TRA) to serve as all encompassing test agents of submitted APR canisters. The TRA are 10 gases and 1 particulate oil aerosol for canister filtration testing and they represent different portions of the total 139 CBRN agents recognized by NIOSH as potential terrorist threats. As other CBRN canister protections related to new threats, are identified, NIOSH will inform users accordingly.

NIOSH has categorized the 139 agents into seven test representative agent (TRA) families: organic vapors, acid gases, base gases, hydrides, nitrogen oxides, particulates, and formaldehyde. The agents belonging to each of the seven families are listed in the appendix at the end of this document. The 139 CBRN agents are further sub-divided into 110 chemical agents, 13 biological agents, and 16 radiological/nuclear agents.

2a. Chemical Agents – 110 Agents

The CBRN APR provides protection against 110 chemical gases, vapors, and solid/liquid chemical aerosols identified as potential CBRN agents by the NIOSH/U.S. Army RDECOM threat analysis.

The chemical warfare protections include specific chemical warfare agents GB (Sarin) and HD (sulfur mustard)], and specific toxic industrial chemicals. Among the CBRN APR chemical protections are:

- Choking agents, which include, but are not limited to, phosgene (CG), diphosgene (DP), chlorine, and chloropicrin (PS).

  Additional information on choking agents can be found at the following website:

  CDC Emergency Preparedness and Response, Choking/Lung/Pulmonary Agents
  http://www.bt.cdc.gov/agent/pulmonary/

- Blood agents (cyanogens), which include, but are not limited to, hydrogen cyanide (AC) and cyanogen chloride (CK). Additional information on blood agents can be found at the following website:

  CDC Emergency Preparedness and Response, Blood Agents
  http://www.bt.cdc.gov/agent/agentlistchem-category.asp#blood

- Nerve agents, which include, but are not limited to, GB (Sarin), GA (Tabun), GD (Soman), GF (Cyclohexyl Sarin), and VX. Nerve agents inhibit cholinesterase (ChE) enzymes. Additional information on nerve agents can be found at the following website:

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CDC Emergency Preparedness and Response, Nerve Agents
http://www.bt.cdc.gov/agent/nerve/

- Blister agents (vesicants) which include, but are not limited to, HD (sulfur mustard), nitrogen mustard (HN-1, HN-2, HN-3) and lewisite (L, L-1, L-2, L-3). Additional information on blister agents can be found at the following website:

  CDC Emergency Preparedness and Response, Blister Agents/Vesicants
  http://www.bt.cdc.gov/agent/vesicants/index.asp

2b. Biological Agents - 13 Agents

Biological agents consist of micro-organisms such as pathogens (which include disease causing bacteria, rickettsiae, and viruses) and toxins. The effects of exposure and means of airborne dissemination vary depending on the agent type. Biological agents may be disseminated as aerosols, liquid droplets (toxins only), or dry powders (Zajtchuk 1997).

The CBRN APR canister provides protection from airborne biological agents by using P100 filter media to filter agents from the air. The CBRN APR canister provides protection against the following 13 biological terrorism agents identified in the NIOSH/U.S. Army RDECOM threat analysis: anthrax, brucellosis, glanders, pneumonic plague, tularemia, query (Q) fever, smallpox, Venezuelan equine encephalitis, viral hemorrhagic fevers, T-2 mycotoxins, botulism, ricin, and Staphylococcus enterotoxin B.

Additional information on bioterrorism agents can be found at the following website:

CDC reference page for Bioterrorism Agents/Diseases
http://www.bt.cdc.gov/agent/agentlist.asp

2c. Radiological and Nuclear Agents - 16 Agents

Radiological refers to particulate-borne radiation dispersed by detonation of a radiological dispersive device (RDD) or "dirty bomb". The principal type of RDD combines a conventional explosive, such as dynamite, with radioactive material. When the dynamite or other explosives are detonated, the blast disperses radioactive material into the air. The radioactive materials used in a dirty bomb would probably not create enough radiation exposure to cause immediate serious illness, except to those people who are very close to the blast site. However, the radioactive dust and smoke from the blast site could be dangerous to health if inhaled, see CDC Fact sheet: *Frequently Asked Questions (FAQs) About Dirty Bombs.* http://www.bt.cdc.gov/radiation/dirtybombs.asp.

Nuclear refers to particulate-borne radiation dispersed by detonation of an improvised nuclear device (IND), nuclear weapon or nuclear reactor facility. An IND is intended to

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cause a yield-producing nuclear explosion. An IND could consist of diverted nuclear weapon components, a modified nuclear weapon, or an indigenous-designed device. INDs can be categorized into two types: implosion and gun assembled. Unlike RDDs, which can be made with almost any radioactive material, INDs require fissile material—highly enriched uranium or plutonium—to produce nuclear yield (Central Intelligence Agency. Fact sheet: *Terrorism CBRN: Materials and Effects.* http://www.cia.gov/cia/reports/terrorist_cbrn/terrorist_CBRN.htm)

The CBRN APR canister provides respiratory protection from particulate-borne radiation (liquid and solid aerosols) by capturing particulates in the canister to prevent them from being inhaled into the body and causing internal damage. The CBRN APR canister uses P100 filter media to filter particulates from the air. The protection is defined for filtering particulates, but not for radiological gases or vapors. Airborne particulates have the ability to carry radioactive alpha and beta particles released from the atomic nuclei of an unstable isotope. Additionally, some airborne particulates may be emitters of high energy gamma radiation, which are photons emitted from the atomic nuclei of a substance undergoing radioactive decay.

The CBRN APR canister *does not* shield against or filter out radiation itself (alpha and beta particles or gamma radiation), but rather filters the larger particulates which carry alpha and beta particles or emit gamma radiation. Radiation may still continue to be emitted through the canister by the radioactive particulates once they are collected in the canister.

The CBRN APR canister provides protection against the following 16 radiological and nuclear particulate-borne agents identified in the NIOSH/U.S. Army RDECOM threat analysis: Hydrogen 3, Carbon 14, Phosphorous 32, Cobalt 60, Nickel 63, Strontium 90, Technetium 99m, Iodine 131, Cesium 137, Promethium 147, Thallium 204, Radium 226, Thorium 232, Uranium 235 & 238, Plutonium 239 and Americium 241.

Additional information on radiological and nuclear agents can be found at the following website:

CDC reference page for Radiation Emergencies
http://www.bt.cdc.gov/radiation/index.asp

3. NIOSH Recommended Use of CBRN APR

3a. Use Criteria

NOTE: ----- EMERGENCY RESPONDERS SHOULD NOT USE THE CBRN APR TO ENTER INTO UNKNOWN ATMOSPHERES OR KNOWN/SUSPECTED IDLH CONCENTRATIONS. ----------

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The proper use of a respirator is a complex process. It requires knowledge about respirator selection for a specific contaminant or environment, proper respirator fit, and awareness of the protections and limitations of the respirator.

NOTE: The NIOSH-approved CBRN APR is only recommended for use when *ALL* of the following criteria are met:

- The types of inhalation hazards and their concentrations have been identified.
- The CBRN APR canister is capable of filtering the identified chemical.
- Oxygen concentration is known to be at least 19.5% by volume[1].
- The contaminant concentration is less than the immediately dangerous to life or health (IDLH) limit for the particular hazard[2].
- The contaminant concentration is less than the maximum use concentration (MUC) of the respirator.[3]
- A canister change schedule has been developed if the contaminant is a gas or vapor.
- The user has received a fit test prior to being assigned a respirator.
- The user has received complete training on the operational use, protections, and limitations of their unique CBRN APR system[4].

3b. NIOSH Cautions and Limitations

The NIOSH Cautions and Limitations for the CBRN APR are listed on the CBRN full canister label located on the APR canister housing. They are also located on the matrix-style canister label and matrix-style APR respirator approval labels required to accompany the manufacturer's user instructions.

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[1] NIOSH defines an oxygen-deficient atmosphere as an atmosphere which contains an oxygen partial pressure of less than 148 millimeters of mercury (19.5 percent by volume at sea level) (NIOSH 2005).

[2] The 2004 NIOSH Pocket Guide to Chemical Hazards lists IDLH values established by NIOSH for many chemicals.

[3] The maximum use concentration (MUC) for the CBRN APR is the maximum atmospheric concentration of a hazardous substance for which an employee can be expected to be protected and is determined by the lesser of the following:

1. The assigned protection factor (APF) multiplied by the contaminant's occupational exposure limit. The APF of a CBRN APR equipped with a CBRN canister is equal to 50 when: a) the respirator user adheres to complete program requirements (such as the ones required by OSHA in 29 CFR 1910.134), b) the respirator is assembled in its NIOSH-approved configuration, and c) the user has been individually fit tested to assure a proper fit.
2. The respirator manufacturer's MUC for a hazardous substance (if any).
3. The immediately dangerous to life or health (IDLH) value of the contaminant.

[4] CBRN APR training should include complete respirator training program requirements (such as the ones required by OSHA in 29 CFR 1910.134) including the individual manufacturer's user instructions, and additional training specific to CBRN environments and exposures.

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Cautions and limitations lettered as A, I, J, L, M, O, and S (located in Section 2 of these labels) apply when non-CBRN conditions are present. Cautions and limitations lettered R, T, V, W, X, Y, Z, HH, QQ, and UU (located in Section 3 of these labels) additionally apply when CBRN conditions are present. These limitations are not all inclusive. The respirator manufacturer also may identify further cautions and limitations for their respirators. In addition, regulatory agencies also may place a limit on the use of CBRN APR in their response plans. **In all cases, all NIOSH Cautions and Limitations must be strictly followed or the NIOSH approval is void.**

The following NIOSH Cautions and Limitations appear in Section 2 of the full canister label and respirator matrix-style approval labels:

"**A**" Not for use in atmospheres containing less than 19.5 percent oxygen.

"**I**" Contains electrical parts which have not been evaluated as an ignition source in flammable or explosive atmospheres by MSHA / NIOSH.
Note: Caution and limitation "I" will not be present on units which have met these evaluation requirements by MSHA/NIOSH.

"**J**" Failure to properly use and maintain this product could result in injury or death.

"**L**" Follow the manufacturer's User's Instructions for changing canisters.

"**M**" All approved respirators shall be selected, fitted, used, and maintained in accordance with MSHA, OSHA, and other applicable regulations.

"**O**" Refer to User's Instructions and/or maintenance manuals for information on use and maintenance of these respirators.

"**S**" Special or critical user's instructions and/or specific limitations apply. Refer to User's Instructions before donning.

(**Note:** Caution and limitation "S" will only be on the NIOSH approval label if specified by the manufacturer in the user's instructions. When "S" appears on the NIOSH approval label, the corresponding cautions and limitations that apply under "S", will be explained in a designated section of the manufacturer's user's instructions (UI).

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The following NIOSH Cautions and Limitations appear in Section 3 of the full canister label and canister and respirator matrix-style approval labels and are specific to use in CBRN environments. Note. The previous section 2 limitations and these unique CBRN limitations of section 3 are both in effect for CBRN use.

"R" **Some CBRN agents may not present immediate effects from exposure, but can result in delayed impairment, illness, or death.**

Highly toxic agents and toxicity is not related to volume of contaminating agent. In other words, a very small amount of CBRN agents, particularly CWA, can kill, de-habilitate or render useless in a short amount of time. In comparing a CWA and a TIC, the CWA is more toxic and requires a much lesser amount to achieve its effects. The TIC requires bulk quantities of compound to achieve the same level of toxicity and effect..

"T" **Direct contact with CBRN agents requires proper handling of the respirator after each use and between multiple entries during the same use. Decontamination and disposal procedures must be followed. If contaminated with liquid chemical warfare agents, dispose of the respirator after decontamination.**

CBRN agents are pervasive in that they can be persistent in terms of hazard time. Penetrating and permeating effects of CWA are demonstrated in laboratory conditions and when personal protective equipment is contaminated handling of that PPE must be controlled, contained and quantified during disposal to prevent cross contamination of clean surfaces, recontamination of decontaminated surfaces or exposure. Each time a CBRN APR is used in a contaminated environment does not restart its CRUL clock. The CRUL value starts upon first direct contact with agent and is continuous in that the 8- hours/2-hours are not divided into separate time allocations for convenience of response.

"V" **Not for use in atmospheres immediately dangerous to life and health or where hazards have not been fully characterized.**

CBRN APR are not for entry into uncharacterized environments. The ease of use for a CBRN APR may contribute to its higher receptivity for use in select end user audiences because it is light weight and does not require pressurized air. While this is true, the most important information is not these features but the assigned protection factor for each type of respirator and that fact that a SCBA APF is significantly higher than the APF for an APR. CBRN APR and CBRN SCBA compliment each other in that they are both tested against the same types of agents but at different concentrations for obvious reasons. If an IC wants to accept the risk and enter using CBRN APR, rather than CBRN SCBA, the NIOSH approval is void on the CBRN APR.

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"W" Use replacement parts in the configuration as specified by the applicable regulations and guidance.

NIOSH-approved CBRN APR air pressure boundaries and materials are barriers against the aggressive penetrating and permeating effects of GB and HD. In order to ensure the integrity of the respirator is maintained during and after exposure to these agents, all parts that form a boundary between the air-flow and the ambient conditions are in fact tested by NIOSH. If non-CBRN approved parts are used as replacement parts in CBRN APR the configuration generated voids NIOSH approval.

"X" Consult manufacturer's User's Instructions for information on the use, storage, and maintenance of these respirators at various temperatures.

NIOSH-approved CBRN APR are environmentally stressed under specific temperature extremes and then live agent tested and service life tested. Manufacturers user instructions are the prime resource for end user to determine what the required minimum package storage configuration is and how to maintain the CBRN APR in the configuration.

"Y" This respirator provides respiratory protection against inhalation of radiological and nuclear dust particles. Procedures for monitoring radiation exposure and full radiation protection must be followed.

Radioactive particulate hazards are protected against by the integral P-100 filtration media provided the concentration gradient does not exceed the protective capabilities of the respirator. Proper sealing techniques of use must also be done to ensure that the canister is not bypassed by contaminants as they enter into the breathing zone by compromised seal characteristics of the respirator to face interface region. Monitoring of radiation levels along with full radiation time, distance and shielding must be understood and implemented.

"Z" If during use, an unexpected hazard is encountered, such as a secondary CBRN device, pockets of entrapped hazard or any unforeseen hazard, immediately leave the area for clean air.

CBRN APR canisters are required to provide protection for a minimum service life of 5 minutes when tested at a flow rate of 100 liters per minute, at 50+/-5% humidity and 25 +/- 5 deg C for each gas/vapor identified in the canister test challenge list. This means the canister is rated to provide you an extra level of protection to ally escape from a detonated secondary device respiratory hazard.

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"HH" **When used at defined occupational exposure limits, the rated service time cannot be exceeded. Follow established canister change schedules or observe End-of-Service-Life Indicators to ensure that canisters are replaced before breakthrough occurs.**

Air-purifying respirators require deliberate use decision logic. CBRN CAP 1 is a rated service time for a CBRN canister. The entire CBRN APR, as a system has a 480 minute service life against GB and HD, a 15 minute test time against the TRA and a 5 minute high flow test time against the TRA. Do not exceed the use life of the canister because the canister is the component that has the shortest rated service time and therefore the default for use is to the canister. Establish a canister change schedule and a respirator disposal schedule upon direct contact with CBRN agents, especially CWA. Use detection and monitoring operations to provide end of service life indicators that may contribute to canister replacement before breakthrough occurs.

"QQ" **Use in conjunction with personal protective ensembles that provide appropriate levels of protection against dermal hazard. Failure to do so may result in personal injury even when the respirator is properly fitted, used, and maintained.**

Solitary use of a CBRN APR may occur in crisis response situations. However, if the situation allows always use the respirator in conjunction with compatible dermal protective ensembles that provide a level of protection appropriate to the respirator type being used. If you do not, CBRN agents will cause illness if skin is exposed to known concentrations of CBRN agents, especially liquid HD and GB in aerosol form. If a proper respiratory protection program is not managed and implemented, the fact that a CBRN APR is not properly fit tested, seal checked and maintained will also contribute to illness on the CBRN incident site.

"UU" **The respirator should not be used beyond eight (8) hours after initial exposure to chemical warfare agents to avoid possibility of agent permeation. If liquid exposure is encountered, the respirator should not be used for more than two (2) hours.**

This cautions and limitations statement is the primary basis for the CBRN Respirator Use Life (CRUL) value of 8 hours for vapor and 2-hours for liquid.

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3c. CBRN APR Approval/Use Versus Industrial APR Approval/Use

The same CBRN facepiece that is approved for CBRN protection can be used for industrial workplaces provided the appropriate NIOSH-approved industrial filtration media is attached. However, that same CBRN facepiece will require extensive inspection if it is to transition over into use as a CBRN APR after continual use as an industrial APR.

At a CBRN event, respirators providing the highest level of protection, NIOSH-approved CBRN SCBA, are required to be used until hazard types and concentrations are quantified, removed or determined to be at lower acceptable exposure limits before utilizing any type of CBRN APR (See Section 3a Use Criteria above).

The NIOSH approval requirements for the CBRN APR were developed primarily to address the unique needs of emergency responders in CBRN environments where conditions are appropriate for air-purifying respirator use. However, manufacturers may gain dual approvals for respirator systems which utilize the same facepiece part numbers for both CBRN use and industrial (non-CBRN) use.

An example of such a case could be that the same facepiece part number can be used with a CBRN canister or a canister with only industrial protections (for example, P100 protection). A properly maintained system can be used for both industrial and CBRN use if it is always assembled in the NIOSH-approved configuration specified by the assembly matrixes found in the user's instructions applicable to that NIOSH TC-approval number. All working parts and accessories must be free from damage. CBRN TC-approval numbers have unique numbers just like industrial TC-approval numbers.

NIOSH only approves respirators as systems. The component canisters are approved with either CBRN protection or industrial protections. CBRN canisters are to be used for CBRN response events only, not routine industrial use. They are to remain sealed in their original packaging until needed for CBRN response. For both CBRN canisters and industrial canisters, users should observe canister shelf life restrictions designated by the manufacturer and dispose of any canisters which have expired shelf life dates.

3d. Escape Contingency

The NIOSH certification test criteria for the CBRN canister includes gas testing using ten test representative agent (TRA) chemical gases at high concentrations and high flow rates. This test criterion was implemented to address high contaminant concentrations and elevated user breathing rates that emergency responders may experience while escaping from a secondary event in a CBRN environment. If unknown or high levels of a hazard are generated after entry into the work area due to a secondary hazard source (e.g., a secondary explosive device) or work activities (e.g., a spill), the user should immediately leave the area while continuing to wear the CBRN APR. After using the respirator to

escape, the canister should be replaced before reusing the respirator. There is a potential for the canister's filtration capacity to become depleted during an escape due to a higher than normal breathing rate and possibly a higher contaminant concentration from the escape incident.

3e. Canister Interchangeability

A CBRN APR respirator assembled with an interchanged canister from a different manufacturer is not in a NIOSH-approved configuration; however, the interchangeability of canisters between different manufacturers' facepieces helps to alleviate the complications of matching facepieces to canisters at an emergency response scene involving large numbers of response workers.

The design of the CBRN APR enables the interchangeable exchange of like canisters by standardizing the design requirements for the mechanical connector external threads, canister internal threads and connector gasket of the respirator. Respirators are only in their NIOSH-approved configuration if they are assembled correctly and only with the parts listed in their individual approval matrixes. Gasket retention during canister exchange is one aspect that should be inspected more frequently if canister interchangeability is authorized. Thread depth of canister is also a viable sealing surface that mates up to the connector gasket and provides a working seal. If threads are cut, dented, or fractured discard the canister and obtain a new one. Select connector covers or canister covers may be provided to meet or exceed NIOSH CBRN APR approval requirements. If canister black covers are used to mask the green color of a NIOSH-approved CBRN canister label, the NIOSH label must not be disfigured in the course of applying the cover.

The interchangeability provision for canisters would typically be used under emergency conditions when there is a restrictive supply of CBRN canisters for a manufacturer's facepiece or an abundance of canister types and limited supply of CBRN facepieces. Other CBRN canisters of the same capacity, from a different manufacturer may be used under these emergency conditions specified by the incident commander or lead federal agency. The interchangeability provision only applies to CBRN canisters and not to other subcomponents or assemblies of a CBRN APR.

NOTE: Users should not interchange canisters until they are instructed to do so by the incident commander or other designated command authority.

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3f. Occupational Exposure Limits for CBRN Chemical Agents

Various occupational exposure limits for CBRN chemical agents have been established by different government agencies and private organizations. Comprehensive exposure values may not be available from one particular organization.

Examples of such occupational exposure limits are NIOSH recommended exposure limits (RELs), OSHA permissible exposure limits (PELs), immediately dangerous to life and health (IDLH) values established by different organizations, and acute exposure guideline levels (AEGLs) established by the National Research Council and the Environmental Protection Agency.

OSHA and NIOSH recently collaborated on personal protective equipment (PPE) selection guidelines, including respirators, for CBRN environments. As part of this joint guideline, recommendations are made for selecting the appropriate type of respirator (self-contained breathing apparatus, powered air-purifying respirator, or air-purifying respirator) based on airborne concentrations of select nerve agents and blister agents and maximum user times in agent environments.

The exposure limits presented in the joint OSHA/NIOSH guidance for nerve agents and blister agents are based on acute exposure guideline levels (AEGLs) published by the National Research Council and the Environmental Protection Agency and IDLH values either proposed or accepted by the U.S. Army.

The AEGL limits characterize the risk to the general population during a one-time accident and emergency scenario with time limits not to exceed eight hours. The respirator and protective clothing recommendations made in the OSHA/NIOSH CBRN guideline are based on protecting the responder at the lowest recommended AEGL-1 level for a given exposure duration. At the AEGL-1 level an individual could experience notable discomfort, irritation, or certain asymptomatic, non-sensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure (Federal Register 2001).

Users are referred to the joint OSHA/NIOSH guidance to aid in respirator and protective clothing selection for a CBRN event. The joint OSHA/NIOSH guidance is located on the OSHA website at: OSHA/NIOSH Interim Guidance – August 30, 2004
Chemical - Biological - Radiological - Nuclear (CBRN)
Personal Protective Equipment Selection Matrix for Emergency Responders
http://www.osha.gov/SLTC/emergencypreparedness/cbrnmatrix/index.html

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4. Service Life and Change Schedules

CBRN canisters have a limited time that they can remain in service before they must be changed, that is, disposed of and replaced with a new canister. A *service life* must be determined for canisters used to protect against gases or vapors. Once the service life has been determined, an appropriate *change schedule* can be implemented.

Service life is sometimes referred to as "breakthrough time." It is the length of time required for an air-purifying element to reach a specific effluent/outgoing concentration value. Actual service life of the CBRN canister is determined by the type of substance being removed, the concentration of the substance being removed, the ambient temperature at the time of removal, the specific filtration element being tested (cartridge or canister), the air-flow rate resistance, and the selected breakthrough value requirement (NIOSH 2005). The various methods of estimating service life for developing a change schedule are discussed below in Section 7, Methods for Establishing a Change Schedule.

A *change schedule*[5] is the time interval after which a used canister is replaced with a new one. An appropriate change schedule assures that the canister will be changed before the downstream (inside the respirator) concentration exceeds a predetermined breakthrough concentration. OSHA suggests that employers apply a safety factor to the service life determination to assure that the change schedule is a conservative estimate. The change schedule also must be convenient to implement and enforce.

Relating this to the uncharacterized hazards of a CBRN incident response is challenging. Monitoring and detection methods are required for the establishment of a CBRN APR change schedule. While the change schedule routinely refers to an air filtration media like the canister, for CBRN response, there is also a change schedule for the actual respirator itself. That respirator change schedule is the CRUL value for that particular class of respirator. CBRN SCBA CRUL value is 6 hours. CBRN APR CRUL value is 8 hours for vapor, or 2 hours for pure liquid or combination liquid-vapor contaminants. Exponential analysis of canister performance from NIOSH-approved CBRN canister laboratory test results may support initial development of a change schedule based on the known values of concentration, time, standard temperature and pressure and media. To say that a canister had a test termination time of 17 minutes and this much contaminant was detected in the downstream effluent is grounds for an extrapolation of canister change out but that analysis is not necessarily a linear interpretation.

[5] The OSHA Respiratory Protection Standard [29 CFR1910.134] requires that employers implement change schedules for canisters where end-of-service-life indicators (ESLI) do not exist or are not appropriate for the work environment. Presently, no CBRN APR canisters are approved with ESLIs.

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5. CBRN Canister Capacity (CBRN Cap 1, 2, 3, or 4) Selection Logic

An individual knowledgeable in determining canister service life (see Section 4 above) should determine the appropriate canister capacity (Cap) level to select and when canisters need to be changed. CBRN APR canisters are approved at six different levels of canister capacity (e.g., each level is referred to as a specific Cap). Currently, all CBRN APR respirators have only been approved with CBRN Cap 1 canisters.

The different canister capacity levels relate to relative lengths of service time for the filtration of gases and vapors when exposure conditions are similar (similar contaminant concentration, ambient temperature, relative humidity, and user breathing rate). The higher the CBRN Cap level designation, the longer the service time of the canister; conversely, the lower the CBRN Cap level designation, the shorter the service time when used under similar conditions (see Table 1 below). For example, a CBRN Cap 2 canister will have about twice the service life of a CBRN Cap 1 canister when like gases and vapors are present. If the service life is determined to be too short to be practical, a canister with a higher Cap rating should be selected and a new service life determined, or a CBRN SCBA should be used instead.

NOTE: It is important to note that selecting a higher CBRN Cap designation does not change the respirator maximum use concentration (MUC).

Service life does not vary among cap levels for the filtration of solid and liquid particulates. All CBRN canisters, regardless of CBRN Cap level designation, should be changed immediately if breathing becomes difficult due to clogging/loading by particulates. Canisters should also be changed immediately if they become damaged. All CBRN canisters should be changed in a clean area, free from CBRN contamination.

Table 1. CBRN APR Canister Capacity Relative Gas/Vapor Service Life

CBRN Canister Capacity Designation	Relative Gas/Vapor Service Life compared to a Cap 1 Canister*
Cap 1	---------
Cap 2	2X
Cap 3	3X
Cap 4	4X
Cap 5	6X
Cap 6	8X

*Assumes similar use conditions (similar contaminant concentration, ambient temperature, relative humidity, and user breathing rate).

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6. CBRN Respirator Use Life (CRUL)

CBRN respirator use life (CRUL) for the CBRN APR is a time-use limitation for the entire respirator system (including the facepiece, canister, and all accessories) when the system is used in a chemical warfare agent environment.

NIOSH caution and limitation UU states specific time-use restrictions for CBRN respirator use life for CBRN APR:

"**UU**" The respirator should not be used beyond eight (8) hours after initial exposure to chemical warfare agents to avoid the possibility of agent permeation. If liquid exposure is encountered, the respirator should not be used for more than two (2) hours.

Chemical warfare agents in the context of CRUL are presently nerve agents and blister agents. NIOSH will notify users of additional APR CRUL concepts as they become available.

Confirmed contamination presence using the appropriate quantitative or qualitative methods is the key to determining the 8-hour start point of use. If exposed to a chemical warfare agent *vapor* CRUL is eight hours and 2-hours if exposed to a chemical warfare agent *liquid*). The 8-hour (vapor) and 2-hour (liquid) use life means eight continuous hours or two continuous hours in a single shift, day, or event. The time intervals are continuous and cannot be divided; for example, the 8-hour period **cannot** be broken into four different 2-hour periods over the course of a day.

7. Methods for Determining a Change Schedule

There are several methods available for determining a canister change schedule for gases and vapors. It is important to remember that these methods apply only to gases and vapors, not to particulates. These methods include:

- CBRN Respirator use life (CRUL)
- Software
  - using the specific chemical
  - using a NIOSH Test Representative Agent (TRA) chemical
- Manufacturers' test data (for a specific chemical or NIOSH test representative agent (TRA) chemical)
- "Rules of Thumb"

7a. CBRN Respirator Use Life (CRUL)

The CBRN Respirator use life (CRUL) limitations described in Section 6 of this document apply when a CBRN APR is used in a chemical warfare agent environment.

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The CRUL restrictions apply regardless of the canister Cap level. It is still important to determine canister service life because the change schedule will be more frequent than the CRUL time limitations. In all cases, the entire CBRN APR system (facepiece, canister, and accessories) when contaminated with CWA should not be reused, should be decontaminated and disposed of in a manner that is consistent with the type of contamination present and any government regulations regarding contaminated items.

Chemical warfare agents in the context of CRUL are presently nerve agents and blister agents. The CRUL concept contributes to best practices for before use, during use and after use in a CBRN incident warm zone. The following recommendations are applicable to defining best practice use guidelines relevant to the use of a full face, tight fitting, non-powered air-purifying respirator, also known as a gas mask:

(1) Recommendations for CBRN APR Use *Before* a CBRN Incident Response

a. Inspect the CBRN APR and all accessories prior to use. Replace worn out items and ensure the APR has not permanently creased the faceblank while in storage.

b. Know and train on all NIOSH CBRN APR Cautions and Limitations statements. Determine in advance, resources and decisions that are anticipated as a result of implementing NIOSH Cautions and Limitations. Non-use or only partial use of the cautions and limitations could jeopardize the health and safety of end-users and possibly lead to death.

c. TRAIN with the CBRN APR and other appropriate equipment, under all known or anticipated workplace conditions in advance, if possible.

d. Identify training canisters that stay on the respirator to maintain system integrity and provide a realistic training configuration.

e. Maintain a contingency stockage of unopened canisters, minimum two each per respirator, for real event use. Have systems in place that prevent inadvertent mixing of training and contingency canisters while in storage or in the workplace. Ensure all canister inlet and outlet caps are taken off prior to actual donning and use.

f. Ensure contingency canister and APR stockage is rotated as it expires or found defective.

g. Maintain a parts inventory that can provide worn or malfunctioning part replacement.

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h. Maintain the CBRN APR in storage in the minimum specified configuration identified per the user instructions.

i. Ensure the CBRN Cap Level of canister performance is known and integrated into change out schedules. Keep in mind the Cap level is a test time and not a use time. Actual use is dependent on concentration gradient of exposure, weather conditions, and time of exposure. Radionuclide will collect in the canister and make the canister radioactive. Built up/loading of riot control agent on training canisters or contingency canisters will eventually hinder breathing resistance. With riot control agent, integrated P-100 of CBRN APR will filter CS particulate but supporting carbon filter media will expire and not protect beyond its given carbon capacity to adsorb/absorb toxins or off-gassed compounds from loaded particulate. It is not recommended to just use a particulate N-series, R-series, or P-series industrial particulate filter with a CBRN APR. For a CBRN response, use a CBRN rated canister on the CBRN approved respirator.

j. Ensure canister inlet and outlet caps, if provided, are secure on canisters in the minimum specified package configuration. Ensure vacuum package maintains integrity in accordance with user instructions.

k. Do not mount more than one CBRN APR canister on a single CBRN APR at a time. Dual canister use on a CBRN APR voids the NIOSH approval. When positioning a canister in a desired connector, ensure the opposite or center connectors have tighten caps inserted to prevent leakage. If seal cannot be attained, reconfigure the canister and connector blank and ensure all are hand tightened or tight in accordance with the user instructions. Ensure user instructions are current editions.

l. Ensure all accessories are serviceable and do not impede the use of the CBRN APR.

m. Ensure proper fit testing is done using the identical respirator as intended for field use.

n. Ensure wearers have clean shaved faces and reduced hair lines are maintained to provide optimum sealing properties of the CBRN APR.

o. Know how and when to conduct a positive and negative pressure seal check on the CBRN APR.

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p. Do not mix- match CBRN and non-CBRN parts on a CBRN APR.

q. In a crisis response, a CBRN APR is engineered to accommodate different models of like CBRN canisters while maintaining an acceptable level of CBRN protection. While NIOSH fully endorses the use of all like parts on a like CBRN APR, crisis response logistics may preclude that. When the situation warrants the use of other like but different manufacturer canisters, NIOSH recommends the CBRN Cap ratings match and the NIOSH approval numbers be annotated to support use decision logic. CBRN Cap1 canister from one manufacturer can be replaced with another like CBRN Cap 1 canister from a different manufacturer. If this process cannot be avoided and the IC determines that interchangeable canisters can be used, ensure the CBRN Cap 1 rating is confirmed, ensure threaded connector mates correctly with interchangeable canister and ensure interchangeable canister does not adversely impact on breathing resistance, air flow or vision.

(2.) Recommendations for CBRN APR Use *During* a CBRN Incident Response.

a. Ensure accurate and reproducible calculations are used to show CBRN APR Canister change out schedules expected to be used.

b. Ensure NIOSH CBRN APR Cautions and Limitations are known used and enforced.

c. Ensure all odor threshold smells are known by CBRN responders. If odor threshold concentrations breakthrough while wearing the CBRN APR, escape to clean air and perform unmasking procedures.

d. Don in a clean environment. If donning is done in a dirty environment due to surprise attack effects, don respirator while holding breath and closing eyes. Agent can penetrate through the eyes if agent is trapped inside the respirator while you are donning and prior to a positive pressure seal check is performed. If facepiece slips while being worn and you feel cool air, reseal the facepiece to prevent inadvertent exposure.

e. Use the two-man concept to ensure each responder is properly protected.

f. Use common commands that tell all concerned when to don APR in an attempt to preclude exposure. Use common all clear commands to tell all responders when it is safe to un-mask. Use all communications means available to conduct this warning program. Such examples

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might be verbal "GAS, GAS, GAS" with corresponding hand movements when donned and "All Clear", "All Clear" voice command or other equivalent techniques to tell responders a CBRN incident has been detected or expected.

g. Indicators of terrorist possible use of CBRN are vital to the responder. If the terrorist is barricaded and with hostages and all of a sudden you sight the terrorist or terrorists wearing respirators and donning PPE that is an indicator to you the terrorist may be attempting to move, employ or defuse a CBRN munitions. Immediately don PPE.

h. Sharing CBRN APR between responders is not recommended.

i. Do not remove/doff the CBRN APR while still in a contaminated environment.

j. Do not attempt to unthread or rethread the canister while in a contaminated environment. Once you have a good seal in the clean environment do not deliberately move the canister or adjust the facepiece. If adjustment must be made, withdraw from contamination, process through decontamination and reenter with a new compliant respirator and PPE. Do not re-use the CBRN APR that was initially exposed. CRUL value for an APR starts upon first confirmed exposure to CWA. 8 hours for vapor and 2 hours for liquid contamination. Ensure exposure is prevented by containing contamination on the outside of PPE during the physical removal process of decontamination. Ensure no transfer of liquid or vapor hazards to skin during doffing.

k. Do not use the hydration device in a contaminated environment.

l. With current technology, do not exchange CBRN canisters in a contaminated environment.

m. Adhere to recommended use life concepts for CBRN APR and doff the CBRN APR at the 8 hour limit when only vapor is the concern or at the 2-hour limit when liquid CWA is the concern.

n. CBRN APR failure. If you start to exhibit mild nerve agent poisoning symptoms, clear and reseal your APR and then use available first aid antidote immediately. Keep your CBRN APR on. Ensure all your skin is covered. The tendency to take of the CBRN APR will be tremendous. You must keep it on and go, or be, escorted to decontamination.

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o. Fogging of the APR visor lens usually indicates a seal leak of some kind under normal temperature conditions. Fogging will occur as temperature differentials are passed through but should clear up as temperature stabilizes. Early evening nautical twilight or before morning nautical twilight present the most ideal stable temperature gradients for chemical compounds used in the terrorism incident. If fogging is building up in your APR, move to a clean area, clear and reseal your CBRN APR and ensure you have no impingements on the faceblank sealing surface.

(2) Recommendations for CBRN APR Use *After* a CBRN Incident Response.

a. Unmasking procedures are done in accordance with local procedures.

b. Do not unmask until you have seen quantifiable evidence that the ambient air is all clear of CBRN contaminates.

c. Remain masked while unmasking procedures are done with local detection methodologies or other equivalent or non-equivalent methods.

d. Remain masked during decontamination operations.

e. Always apply decontaminate solution from the top down. Ensure contamination run off is contained, drummed and removed for proper disposal. Maintain your CBRN APR seal during decontamination.

f. If CBRN APR respirators are available, provide respirators to the walking wounded CBRN casualties to prevent additional exposure to CBRN agents during decontamination processing.

g. Use available detection methodologies to confirm effectiveness of decontamination.

h. CBRN APR is the last item of PPE to be removed in the decontamination process. Doffing of APR should never be done in the confined radius lines of the liquid control line or the vapor control line relative to ground zero.

i. Portions of the CBRN APR are expected to have a higher degree of contamination on them than say the head harness protected under a clothing ensemble hood. Those portions of the APR that are exposed to the environment require additional decontamination emphasis than the portion that reportedly was protected.

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j. CBRN APR, once decontaminated to the lowest level possible, should be handled by special procedures. Triple bagging of APR is recommended. Bulk bagging of several APRs is not recommended. Each APR should be individually triple bagged. Bulk bagging may contribute to off-gassing accumulation and possible exposure when opened. Local and state disposal procedures are in effect.

7b. Software

Data software available on the OSHA website and also on select manufacturers' websites can determine change schedules by allowing the user to choose an industrial chemical from a list of chemicals in the database and enter other information, including employee work rate, environmental conditions (environmental temperature and relative humidity), contaminant concentration, and canister specifications.

The respirator manufacturer may have a software program on their website which includes their specific CBRN canister and CWA. Users should contact the manufacturer for questions about using a manufacturer's software program.

The software programs on the OSHA website can only calculate service life for single organic vapors and requires information on the canister (such as the bulk density of the packed bed) which can be obtained from the manufacturer, provided the correct questions are presented and documented. The OSHA software also allows for chemical data (such as molecular weight and vapor pressure) to be entered if the specific chemical is not listed in the software's database.

One such programs, *The Advisor Genius*, was developed in 1998 and is available at: http://www.osha.gov/SLTC/etools/respiratory/advisor_genius_wood/advisor_genius.html

Breakthrough (2003), another downloadable program similar to *The Advisor Genius*, has been updated to include corrections for relative humidity. *Breakthrough* is also limited to only calculating change schedules for single organic vapors. The program is available on the OSHA website at:
http://www.osha.gov/SLTC/etools/respiratory/advisor_genius_wood/breakthrough.html.

Only the NIOSH test representative agent (TRA) chemicals can be used as software surrogate examples for chemicals that are not included in the software programs. The NIOSH CBRN canister protections for chemical gases and vapors are established from the NIOSH certification tests using 10 chemical gases. For example, cyclohexane can be used as the surrogate for acrylonitrile because cyclohexane is used as the TRA for CBRN organic vapor threats, which includes acrylonitrile. The NIOSH TRA chemicals for each family of agents are identified in the appendix of this document. Only the TRA which corresponds to each chemical family can be used. However, a surrogate cannot be used for the acid gas family. This is because there are 5 TRA that represent the acid gas family, and it is not possible to input 5 chemicals at once into the software.

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7c. Manufacturers' Test Data

The manufacturer may be able to provide guidance on canister service life based on their testing of a specific CBRN chemical threat or a NIOSH Test Representative Agent (TRA) chemical gas for that threat. For those agents which are chemical warfare agents, the CBRN respirator use life (CRUL) limitations stated in caution and limitation 'UU' apply and canister service life is limited to the rated CBRN Cap level supporting a CBRN APR system service life of a maximum of 8 continuous hours for a CWA gas or vapor or 2 hours for a CWA liquid.

7d. Rules of Thumb

The *Rules of Thumb* may provide a rough estimation of canister service life, but only for single organic vapors (AIHA 1997). However, they should **NOT** be used as the sole method of determining service life. And entering into the rules of thumb with a chemical warfare agent can produce varying results. These rules state that industrial organic vapor cartridges will last eight hours if the organic vapor has a boiling point of greater than 70°C, the vapor's concentration is less than 200 ppm, and the worker has a breathing rate of 30 liters per minute (moderate work). These rules also indicate that service life is inversely proportional to flow rate. In other words, if the flow rate is reduced by a factor of 2, the service life is increased by a factor of 2. A summary of the "Rules of Thumb" are available on the OSHA website at:

http://www.osha.gov/SLTC/etools/respiratory/rule_of_thumb/rule_of_thumb.html.

7e. Inorganic Chemicals

The software models on the OSHA website only calculate service life for industrial organic vapors. However, some manufacturers' service life software may include certain inorganic chemicals. For service life information on inorganic chemicals (e.g., chlorine or ammonia) users should check the manufacturers' software package or contact the manufacturer for a service-life recommendation. The manufacturer may also have test data on the contaminant in question or its NIOSH test representative agent chemical.

8. Developing NIOSH CBRN Respirator Guidance

NIOSH will continue to develop user guidance for the CBRN APR and other classes of CBRN air-purifying respirators. Future CBRN APR guidance will further explain selection criteria, how to assure proper fit, and maintenance and cleaning guidelines. NIOSH expeditiously published respirator cleaning and sanitization instructions during the response to the World Trade Center attack. Those instructions are still viable as it relates to use of a respirator at a high use rate and under unique contaminant exposure.

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Users should continue to check the NIOSH NPPTL website for updated user guidance documents.

Users are always encouraged to contact the manufacturer of their respirator for specific recommendations on CBRN APR use and establishing CBRN canister change schedules.

Decontamination of CBRN APR exposed to CBRN agents will not eliminate the permeated or penetration effects on material surfaces exposed to chemical warfare agents. Gross water decontamination to physically remove and dilute the chemical warfare agent is showing to be the most effective means of decontamination available to the emergency responder. Contamination run off generated from decontamination should be contained, categorized, pumped into 55 gallon drums and treated as hazardous material for disposal. CBRN APR in direct contact with chemical warfare agents, are not reusable once the CRUL value has been exceeded.

DRAFT

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Glossary

Agent – A force or substance that causes change or effects on an exposed substrate.

Acute Exposure Guideline Level (AEGL) – Published by the National Research Council and Environmental Protection Agency, AEGL limits characterize the risk to the general population during a one-time accident and emergency scenario with time limits not to exceed eight hours. The AEGLs represent threshold exposure limits for the general public and are applicable to emergency exposure periods ranging from ten minutes to eight hours.

Assigned Protection Factor (APF) – The NIOSH minimum anticipated workplace level of protection provided by a properly functioning respirator or class of respirators to a percentage of properly fitted and trained personnel. An APF of 50 is assigned to the CBRN APR.

Biological Agents – Biological agents consist of micro-organisms such as pathogens (which include disease-causing bacteria and viruses) and toxins.

Blister Agents (Vesicants) – Vesicants are highly reactive chemicals that combine with proteins, DNA, and other cellular components to result in cellular changes immediately after exposure. The most commonly encountered clinical effects include dermal (skin erythema and blistering), respiratory (pharyngitis, cough, dyspnea), ocular (conjunctivitis and burns), and gastrointestinal (nausea and vomiting). Blister agents include H (sulfur mustard), HD (distilled sulfur mustard), nitrogen mustards (HN-1, HN-2, HN-3) and Lewisite (L, L-1, L-2, L-3).

CBRN Protection – A NIOSH certification term that signifies that specific respirator systems have been evaluated, reviewed, and approved/certified by NIOSH as providing a defined level of protection against chemical, biological, radiological, and nuclear agents. The approval authority is authorized by the 42 Code of Federal Regulations, Part 84 (42CFR84) and the CBRN statement of standard for a designated respirator class.

CBRN Respirator Use Life (CRUL) – Use limitation applying to the CBRN APR of a continuous 8-hour period (when exposed to a chemical warfare agent vapor) or 2-hour period (when exposed to a chemical warfare agent liquid) beginning at the time of a confirmed exposure, after which the entire CBRN APR must be decontaminated and disposed. The 8-hour (vapor) and 2-hour (liquid) use life practice means eight continuous hours (vapor) or two continuous hours (liquid) in a single shift, day, or event. The time intervals are continuous and cannot be divided; for example, the 8-hour period cannot be broken into four different 2-hour periods over the course of a day. See Section 6 of this document for details.

Chemical Warfare Agents (CWA) – Chemical warfare agents in the context of the CBRN APR cautions and limitations UU pertaining to CBRN respirator use life (CRUL) include nerve agents, blister agents, chemicals that exhibit degrading or destructive

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effects on respirator materials, and other chemicals for which decontamination procedures are unable to decontaminate the respirator to a safe level for reuse. NIOSH will continue to notify users of additional CRUL restrictions as they become available.

Dirty Bomb – A conventional explosive device that has been surrounded by or contaminated with some form of radioactive material.

Exposure – Contact of the respirator wearer or APR components to a chemical, biological, radiological or nuclear agent.

Fit Test – The use of a specific measurement protocol to qualitatively or quantitatively evaluate the fit of a respirator on an individual. See also qualitative fit test (QLFT) or quantitative fit test (QNFT)

Immediately Dangerous to Life or Health (IDLH) – Conditions that pose an immediate threat to life or health or conditions that pose an immediate threat of severe exposure to contaminants, such as radioactive materials, which are likely to have adverse cumulative or delayed effects on health.

Maximum Use Concentration (MUC) – The maximum atmospheric concentration of a hazardous substance from which an employee can be expected to be protected when wearing a respirator. MUC is determined by the assigned protection factor (APF) of the respirator or class of respirators and the exposure limit of the hazardous substance. The maximum use concentration (MUC) of exposure for a respirator is generally determined by multiplying a contaminant's occupational exposure limit (OEL) by the APF assigned to a specific class or type of respirator (MUC=OEL x APF). An OEL can be a NIOSH recommended exposure limit (REL), an OSHA permissible exposure limit (PEL), a short term exposure limit, ceiling limit, peak limit, or any other exposure limit for a hazardous substance.

National Institute for Occupational Safety and Health (NIOSH)/The Institute – NIOSH is the federal agency responsible for conducting research and making recommendations for the prevention of work-related injury and illness. NIOSH is part of the Department of Health and Human Services' Centers for Disease Control and Prevention.

National Personal Protective Technology Laboratory (NPPTL) – Part of NIOSH, the mission of NPPTL is "To prevent work-related injury and illness by ensuring the development, certification, deployment, and use of personal protective equipment and fully-integrated intelligent ensembles."

NIOSH-Approved – Respirator systems that have been reviewed, tested, and approved/certified by NIOSH under 42 Code of Federal Regulation, Part 84 (42CFR84). NIOSH approves respirators as complete systems assembled only with the components designated in the individual NIOSH approval matrix issued with the respirator approval.

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Nerve Agents – Nerve agents consist of a group of very toxic organophosphate chemicals. Nerve agents include GB (Sarin), GA (Tabun), GD (Soman), GF (Cyclohexyl Sarin), and VX. Nerve agents cause effects on the human body by disrupting how nerves communicate and control muscles, glands, and organs.

Oxygen Deficient Atmosphere – An atmosphere which contains an oxygen partial pressure of less than 148 millimeters of mercury (19.5 percent by volume at sea level).

Nuclear Agents – Particulate-borne radiation dispersed by detonation of an improvised nuclear device (IND) or high/low yield nuclear detonation. An IND could consist of diverted nuclear weapon components or a modified nuclear weapon. INDs require fissionable material—highly enriched uranium or plutonium—to produce nuclear yield.

Penetration – The act or process of penetrating, piercing, or entering. As it relates to CBRN approval testing, it is a term that means exposing the respirator to specific quantities of chemical warfare agent with the express intent to determine if the agent is stopped or if it penetrates through air pressure boundaries or material interfaces into the breathing zone of the respirator.

Permeation – The action of passing through the openings or interstices of a substrate at the surface level or the molecular level. As it relates to CBRN approval testing, it is a term that means exposing the respirator to a specific quantity of chemical warfare agent with the express intent to see if the agent is stopped and runs off, or if it beads up and starts to permeate through air pressure boundaries or material surfaces into the breathing zone of the respirator or respirator accessories.

Permissible Exposure Limit (PEL) – An enforceable regulatory limit set by the Occupational Safety and Health Administration (OSHA) on the amount or concentration of a substance in the air. PELs are set to protect workers against the health effects of exposure to hazardous substances and are based on an 8-hour, time weighted average exposure.

Radiological Agents – Particulate-borne radiation dispersed by detonation of a radiological dispersive device (RDD) or "dirty bomb."

Recommended Exposure Limit (REL) – An occupational exposure limit recommended by NIOSH as being protective of worker health and safety over a working lifetime. RELs are time-weighted average concentrations for up to a 10-hour workday during a 40-hour workweek.

Respiratory Protection Program – A written program document which establishes procedures and practices to ensure that respirators are properly selected, used, fit-tested, and maintained. The program is administered by a suitable trained program administrator. The OSHA Respiratory Protection standard (29 CFR 1910.134) defines the requirements of a complete respiratory protection program.

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Test Representative Agent (TRA) – Refers to any of the 11 chemicals (10 gases and 1 particulate aerosol) NIOSH uses for certification testing of the CBRN APR canister. NIOSH uses the 11 TRA chemicals to represent 139 agents which NIOSH recognizes as CBRN threats. See the Appendix of this document for a list of the 139 CBRN threat protections of the CBRN canister and their corresponding TRA chemicals.

Toxic Industrial Chemicals (TICs) - a variety of industrial chemicals used in civilian or military industrial processes which can kill, seriously injure, or incapacitate people if inadvertently released into the environment. Volume of TIC and type of TIC determines downwind hazard evacuation or shelter in place policies. Toxic industrial chemicals are actual chemical compounds used to support industrial business in the manufacturing of a specific industrial product. CL is a TIC. NH3 is a TIC.

Toxic Industrial Materials (TIMs) – a variety of like industrial chemicals usually compatible together and used in civilian or military industrial processes which can kill, seriously injure, or incapacitate people. Toxic industrial materials are comprised of toxic industrial chemicals and are generally more than one select toxic industrial chemical making up an toxic industrial material. An example is the use of an industrial waste storage press that uses several toxic industrial chemicals routed to it for the purpose of generating a solid sludge waste as a toxic industrial material by product for controlled disposal. Industrial Sludge is a TIM. By products in environmental waste roll-offs are TIM.

User's Instructions (UI) – A NIOSH recognized manufacturer publication required to be submitted to NIOSH as part of a certification application requesting NIOSH approval. The UI are included with every new purchase of a NIOSH-approved respirator.

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Appendix A: NIOSH-Approved CBRN APR Canister Protection List

A NIOSH-approved CBRN APR canister provides protection against a minimum of 139 identified CBRN agents, which are classified into the following 7 families: **Organic Vapors** (61), **Acid Gases** (32), **Base Gases** (4), **Hydrides** (4), **Nitrogen Oxides** (5), **Particulates** (32) [composed of 3 chemical, 13 biological, and 16 radiological and nuclear particulate threats], and **Formaldehyde** (1). Actual CBRN incident responses may dictate adjustments to this canister protection listing.

The test representative agents (TRA) NIOSH uses for certification testing to represent each agent family are listed.

Acid Gas Family (32 agents) *5-TRA chemicals are used for NIOSH certification testing to represent the Acid Gas Family.*	*They are Cyanogen Chloride, Hydrogen Cyanide, Hydrogen Sulfide, Phosgene, and Sulfur Dioxide.*
Boron tribromide	Hydrogen chloride
Boron trichloride	Hydrogen cyanide
Boron trifluoride	Hydrogen fluoride
Bromine	Hydrogen iodide
Bromine chloride	Hydrogen sulfide
Bromine trifluoride	Phosgene
Carbonyl fluoride	Phosphorus trichloride
Chlorine	Silicon tetrafluoride
Chlorine pentafluoride	Sulfur dioxide
Chlorine trifluoride	Sulfur trioxide
Chlorosulfonic acid	Sulfuric acid
Cyanogen chloride	Sulfuryl chloride
Dichlorosilane	Titanium tetrachloride
Ethyl phosphonous dichloride	Tungsten hexafluoride
Fluorine	Bromine pentafluoride
Hydrogen bromide	Hydrogen selenide
Nitrogen Oxide Family (5 agents) *1 TRA chemical (nitrogen dioxide) is used for NIOSH certification testing to represent the Nitrogen Oxide Family.*	
Nitric acid	Nitrogen tetraoxide
Nitric acid, fuming	Nitrogen trioxide
Nitrogen dioxide	
Base Gas Family (4 agents) *1 TRA chemical (Ammonia) is used for NIOSH certification testing to represent the Base Gas Family.*	
Allyl amine	Dimethyl hydrazine, 1,2
Ammonia	Methyl hydrazine

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Hydride Family (4 agents) *1 TRA chemical (Phosphine) is used for certification testing to represent the Hydride Family.*	
Arsine	Phosphine
Germane	Stibine

Formaldehyde Family (1 agent) *1 TRA chemical (Formaldehyde) is used for certification testing to represent the Formaldehyde Family.*	
Formaldehyde	
Organic Vapor Family (61 agents) *1 TRA chemical (Cyclohexane) is used for certification testing to represent the Organic Vapor Family.*	NOTE: Chemical warfare agents are in this TRA OV family.
Acetone cyanohydrin	Methanesulfonyl chloride
Acrylonitrile	Methyl orthosilicate
Allyl alcohol	Methyl parathion
Allyl chlorocarbonate	Methyl phosphonic dichloride
Bromoacetone	Mustard, lewisite mixture
Bromobenzylcyanide	Nitrogen mustard HN-1
Chloroacetone	Nitrogen mustard HN-2
Chloroacetonitrile	Nitrogen mustard HN-3
Chloroacetophenone	N-propyl chloroformate
Chloroacetyl chloride	O-chlorobenzylidene malononitrile
Chloropicrin	O-ethyl-s-(2isopropyaminoethyl)methyl phosphonthiolate
Chloropivaloyl chloride	Parathion
Crotonaldehyde	Perchloromethyl mercaptan
Cyclohexyl methyphosphonate	Phenyl mercapatan
Dibenz-(b,f)-1,4-oxazepine	Phenylcarbylamine chloride
Diketene	Phenyldichloroarsine
Dimethyl sulfate	Phosgene oximedichloroforoxime
Diphenylchloroarsine	Phosphorus oxychloride
Diphenylcyanoarsine	Sarin
Diphosgene	Sec-butyl chloroformate
Distilled mustard	Soman
Ethyl chloroformate	Tabun
Ethyl chlorothioformate	Tert-octyl mercapatan
Ethyl phosphonothioicdichloride	Tetraethyl dithiopyrophosphate

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Ethyl phosphorodichloridate	Tetraethyl lead
Ethylene dibromide	Tetramethyl lead
Hexachlorocyclopentadiene	Tetranitromethane
Hexaethyl tetraphosphate	Trimethoxysilane
Iso-butyl chloroformate	Trimethylacetyl chloride
Iso-propyl chloroformate	VX
Lewisite	

Particulate Family Canister Protections (32 agents) *1-TRA chemical (dioctyl phthalate/DOP) is used for certification testing to represent the Particulate Family.*	
Particulate- Chemicals (3)	
Sodium azide	
Adamsite	
Sodium fluoroacetate	
Particulate- Biological (13)	
Anthrax	Venezuelan equine encephalitis
Glanders	Brucellosis
Tularemia	Pneumonic Plague
Smallpox	Query (Q) Fever
T-2 Mycotoxins	Viral hemorrhagic fevers
Ricin	Botulism
Staphylococcus enterotoxin B	
Particulate- Radiological / Nuclear (16)	
Carbon 14	Hydrogen 3*
Cobalt 60	Phosphorous 32
Strontium 90	Nickel 63
Iodine 131	Technetium 99m
Promethium 147	Cesium 137
Radium 226	Thallium 204
Uranium 235 & 238	Thorium 232
Americium 241	Plutonium 239

End of Draft CBRN APR User's Guide, dated 1July2005.

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