

INCH-POUND

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MILITARY STANDARD
ALDEHYDES AND KETONES, TECHNICAL GRADE



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FSC 6810

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FOREWORD

1. This military standard is approved for use by all Departments and Agencies of the Department of Defense.
2. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commanding Officer, U.S. Army Chemical Research, Development and Engineering Center, ATTN: SMCCR-PET-S, Aberdeen Proving Ground, MD 21010-5423, by using the self-addressed Standardization Document Improvement Proposal (DDI426) appearing at the end of this document or by letter.
3. This is the book format standard generated on esters and metal organics, technical grade. It is intended to provide design data relating to esters and metal organics, including safety, storage and disposal information useful to the Department of Defense. This is not a procurement document. This document is not intended to restrict any service in selecting new items required to support state-of-the-art changes.
4. The Revision C of this standard has added new safety, storage and disposal guidance for all materials, a Section 6 and an index.

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1. SCOPE

1.1 Coverage. This standard is a presentation of nomenclature, formulas, physical and chemical properties, specification requirements, military and typical commercial uses, safety information, storage information and disposal information for aldehydes and ketones, technical grade. This standard does not include all of the items represented by the title or all those items which are commercially available. It does contain items preferred for use in the selection of aldehydes and ketones, technical grade, for application by the Department of Defense.

1.2 Application. Aldehydes, technical grade are mainly used as chemical intermediates for making a variety of other organic chemical products. Ketones, technical grade, are used as solvents and as chemical intermediates.

1.3 Classification. The items in this standard are classified on the basis of chemical composition as aldehydes and ketones.

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2. REFERENCED DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation.

SPECIFICATIONS

FEDERAL

O-A-51	Acetone, Technical
O-D-306	Diacetone Alcohol, Technical (Acetone-Free)

MILITARY

MIL-F-10805	Fuel, Compressed, Trioxane, Ration Heating
MIL-C-51012	o-Chlorobenzaldehyde, Technical Grade

STANDARDS

FEDERAL

FED-STD-313	Material Safety Data Sheets, Preparation and the Submission of
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MILITARY

MIL-STD-12	Abbreviations for Use on Drawings, Specifications, Standards and in Technical Documents
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(Unless otherwise indicated, copies of federal and military specifications, standards and handbooks are available from the Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.1.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this standard to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

PUBLIC LAW (PL)

94-580	Resource Conservation and Recovery Act
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CODE OF FEDERAL REGULATIONS (CFR)

Title 29	Department of Labor, Occupational Safety and Health Administration
Title 40	Protection of the Environment; Environmental Protection Agency

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Title 49 Department of Transportation; Hazardous Materials Regulations

DEPARTMENT OF DEFENSE (DOD)

DODISS Department of Defense Index of Specifications and Standards
 DOD 4145.19-R-1 Storage and Materials Handling
 DOD 4160.21-M Defense Utilization and Disposal Manual
 DOD 6050.5 DOD Hazardous Materials Information System, Hazardous Item Listing
 TB MED 502 Occupational and Environmental Health Respiratory
 (DLAM 1000.2) Protection Program
 TB MED 506 Occupational and Environmental Health Occupational Vision
 TM 38-250 Packaging, Materials Handling - Preparation of Hazardous Materials for Military Air Shipment

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH (NIOSH)

Registry of Toxic Effects of Chemical Substances
 Recommendation for Environmental Exposure Limits

GOVERNMENT PRINTING OFFICE (GPO)

Style Manual

(Application for copies should be addressed to the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.)

2.2 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted shall be those listed in the issue of DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation.

AMERICAN CONFERENCE OF GOVERNMENT INDUSTRIAL HYGIENISTS (ACGIH)

TLVs* Threshold Limit Values for Chemical Substances in the Work Environment Adopted by American Conference of Government Industrial Hygienists (ACGIH) with Intended Changes.

(Application for copies should be addressed to American Conference of Governmental Industrial Hygienists, 6500 Glenway Avenue, Bldg D-7, Cincinnati, OH 45211.)

AMERICAN SOCIETY FOR TESTING AND MATERIAL (ASTM)

D 329 Acetone
 D 740 Methyl Ethyl Ketone
 D 1153 Methyl Isobutyl Ketone
 D 2378 Formaldehyde 50% Grade Uninhibited and 37% Grade Inhibited and Uninhibited
 D 2627 Diacetone Alcohol

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D 2916	Isophorone
D 2917	Methyl Isoamyl Ketone
E 380	Metric Practice

(Application for copies should be addressed to American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

National Fire Codes

(Application for copies should be addressed to National Fire Protection Association, Battery March Park, Quincy, MA 02269.)

(Non-Government standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

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3. DEFINITIONS

3.1 Abbreviations.

Abbreviations conform to the GPO Style Manual and as shown hereinafter.

d Density; specific gravity (d^{20} specific gravity at 20°C referred to water at 4°, d_{20}^{20} specific gravity at 20°C referred to water at 20°)

n Index of refraction (refractive index) (n_0^{20} for 20° and sodium light)

PEL Permissible Exposure Limit

STEL Short Term Exposure Limit - The maximal concentration to which workers can be exposed for a period of up to 15 minutes continuously without suffering from (1) irritation (2) chronic or irreversible tissue change or (3) narcosis of sufficient degree to increase accident proneness.

TLV Threshold Limit Value - Values for airborne toxic materials that are used as guides in control of health hazards and represent time weighted concentrations to which nearly all workers may be exposed 8 hours per day over extended periods without adverse affects.

LD Lethal Dose - LD_{50} a dose which is lethal to 50% of the animals tested.

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4. GENERAL REQUIREMENTS

4.1 Packaging data and labeling. All chemicals included in this standard shall be packaged in accordance with Federal Specification PPP-C-2020 and all applicable documents referenced therein. Shipping containers shall be labeled in accordance with current Department of Transportation (DOT) Hazardous Materials Regulations applicable to each chemical. When shipping by military aircraft the requirements of TM 38-250 shall apply. In addition, each item shall be packaged and labeled as specified in the applicable contract or order. All labels shall also comply with Hazard Communication Standard, 29 CFR 1910.1200(f).

4.2 Hazardous materials information. DOD 6050.5, DOD Hazardous Materials Information System (HMIS) acquires, reviews, stores, and disseminates Material Safety Data Sheet (MSDS) information for all hazardous materials used by DOD. The contractual acquisition of a MSDS is accomplished through use of Federal Acquisition Regulation, paragraph 52.223-3, Hazardous Material Identification and Material Safety Data. The MSDS is prepared in accordance with the instructions of FED-STD-313; and shall comply with requirements of Hazard Communication Standard, 29 CFR 1910.1200(g).

4.3 Safety.

4.3.1 Personal protective measures. The necessary respiratory, eye and skin protection to be used when handling chemicals shall be prescribed by the responsible installation industrial hygiene, medical and safety authorities.

4.3.1.1 Respiratory protection. Respirators, approved by the National Institute for Occupational Safety and Health (NIOSH) or the Mine Safety and Health Administration (MSHA) for the compounds being used, may be employed for intermittent exposure or for supplementing other control measures (refer to TB MED 502 or DLAM 1000.2). Ventilation shall be adequate to remove hazardous concentrations.

4.3.1.2 Skin protection. Personnel using these compounds shall be provided with and required to use impervious gloves, sleeves, aprons, and boots whenever indicated. Protective creams and ointments commonly known as "barrier creams" may be of value in certain cases. However, barrier creams shall not be used to replace protective clothing. In case of contact with the skin, wash affected areas thoroughly with water. Eye lavages and emergency showers shall be located within 50 feet of where there is a potential for direct contact with harmful chemicals. When transferring chemicals, eye lavages and emergency showers shall be within 50 feet of the transfer point. Emergency showers shall be equipped with a valve that will fully open with one pull and deliver 30 gallons of water per minute.

4.3.1.3 Face and eye protection. Personnel using these compounds shall be provided with and required to wear chemical splash-proof safety goggles. In addition, face shields shall be provided and worn over the goggles if splashing could occur. In case of contact with the eyes, immediately irrigate with copious amounts of water for at least 20-30 minutes, and obtain medical attention. (Refer to TB MED 506.)

4.3.1.4 Training. Employers shall provide employees with training and information including MSDS on all chemical items in their work area, in accor-

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dance with 29 CFR 1910.1200(h), to ensure that employees know potential hazards of the chemicals with which they come in contact and the symptoms of exposure as well as how these chemicals affect the body and bodily functions. Employees shall be adequately trained to render first aid.

4.3.1.5 Exercise. Participation in training exercises shall be stressed to demonstrate skills in the use of personal protective equipment and emergency response equipment.

4.3.2 Storage conditions. DOD 4145.19-R-1 describes general storage practices and requirements for hazardous materials in the DOD supply system. Specific requirements provided in the following paragraphs are supplementary in nature and shall be observed in consonance with the DOD storage regulations.

4.3.2.1 Flammable, combustible, pyrophoric and ignitable materials. A flammable material is generally any solid, liquid, vapor or gas that ignites easily and burns rapidly. Combustible materials are generally those that are difficult to ignite and burn slowly. The DOT, in Part 173, Subpart D, Section 173.115 of 49 CFR, defines a flammable liquid as one having a closed cup flash point below 100°F (37.8°C). A combustible liquid is defined, by DOT in the above reference, as one having a closed cup flash point at or above 100°F and below 200°F (93.3°C). A pyrophoric liquid is defined, by DOT in the above reference, as one that ignites spontaneously in dry or moist air at or below 130°F (54.4°C). Materials with flash points of 200°F or higher are not considered to be nonflammable or noncombustible, but are to be considered as burnable. The Environmental Protection Agency (EPA), in Part 261, Subpart C, Section 261.21 of 40 CFR (refers only to materials that have become waste materials), designates the criteria for flammable and combustible materials and oxidizers that exhibit the characteristic of ignitability (I). Liquids with closed cup flash points of less than 140°F (60°C) are defined by EPA as ignitable. The autoignition point (temperature) of a substance is generally defined as the minimum temperature required to initiate or cause self-sustained combustion in the absence of a spark or flame. Materials that ignite easily under normal industrial conditions are considered to be dangerous fire hazards. Such Materials shall be stored in a manner to prevent ignition and combustion. Easily ignitable substances, such as reducing agents, shall be kept away from strong oxidizing agents. All containers shall be tightly sealed. It is important to provide adequate ventilation in storage areas, and to locate the storage areas of these items away from fire hazards. Ample fire control equipment shall be easily accessible. Storage buildings, rooms and cabinets shall comply with provisions of the National Fire Codes. The building shall be electrically grounded and signs posted to prevent the lighting of matches or smoking in the area. Flammable storage areas shall be equipped with smoke or fire detection equipment.

4.3.2.2 Water-sensitive fire and explosive hazardous materials. These are materials that react on contact with water or steam to ignite or evolve heat or explosive gases. Such materials exhibit the characteristic of reactivity (R) as designated by the EPA in Section 261.23 of the above reference. (Refers only to materials that have become waste materials.) These materials shall be stored in well-ventilated, cool, dry areas. All containers shall be tightly sealed. These materials are a fire hazard in contact with water or moisture; therefore, it is essential that no sprinkler be used. Otherwise, the building shall conform to that required for storage of flammable materials. The building shall be water-proof, located on high ground, and separated from other storage areas.

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4.3.2.3 Incompatible materials. Materials that are chemically incompatible shall be segregated in the storage of both serviceable and unserviceable items. The degree of segregation will depend upon DOD 4145.19-R-1 and local supplementary requirements that insure safe storage conditions. Hazardous storage compatibility codes are provided in the HMIS referred to in 4.2.

4.3.3 Chemical hazardous exposure limits. Chemical hazardous exposure limits for airborne concentrations of substances are obtained from the current TLVs* Threshold Limit Values for Chemical Substances in the Work Environment, adopted by the American Conference of Government Industrial Hygienists (ACGIH); current Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PEL), 29 CFR, Section 1910.1000; and NIOSH Recommendation for Environmental Exposure Limits. Such information is also shown in MSDSs and the HMIS referred to in 4.2. Carcinogenic substances are listed by OSHA in Category I for confirmed carcinogens, and in Category II for suspected carcinogens. Category I substances have standard exposure limits set at the lowest possible levels. Category II substances have standard exposure limits set to prevent acute or chronic effects.

4.3.4 Toxicity. Toxicity information for chemical compounds is available from various publications and from MSDSs, which are collected in DOD 6050.5 Hazardous Materials Information System.

4.3.4.1 EPA toxic (T). Some chemical compounds have been designated by the EPA as toxic (T) in accordance with the criteria shown in Part 261, Subpart B, Section 261.119(a)(3) of 40 CFR. (Refers only to materials that have become waste materials.) Some commercial chemical products are listed as toxic under Subpart D, Section 261.33(f).

4.3.4.2 EPA acute hazardous toxicity (H). Some chemical compounds have been designated by the EPA as acute hazardous (H) in toxicity in accordance with the criteria shown in Subpart B, Section 261.11(a)(2) of the above reference, which refers only to materials that have become waste materials. Some commercial chemical products are listed as acute hazardous in toxicity under Subpart D, Section 261.33(e).

4.4 Pollution and disposal.

4.4.1 Pollution potential. All items described in this standard shall be assumed to have a pollution potential. However, to minimize this potential, the proper use, storage and disposal methods shall be strictly followed.

4.4.2 Disposal of excess or unserviceable material. To minimize disposal problems, it is recommended that no more than a one year's supply of each item listed in this standard be stocked. When stocks have been declared excess or unserviceable, they will be disposed of in accordance with the Defense Utilization and Disposal Manual, DOD 4160.21-M, and applicable DOD Policy Memoranda. Guidance can be obtained from your servicing Defense Reutilization and Marketing Office (DRMO) on procedures required for proper reporting and turn-in.

4.4.3 Disposal and storage of hazardous wastes. Items are classified and managed as hazardous wastes as defined by the Resource Conservation and Recovery Act (RCRA) (Public Law 94-580). Items have been identified as meeting the characteristics (i.e., ignitable, corrosive, reactive or EP toxic) or are listed

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(i.e., toxic or acute hazardous) according to Identification and Listing of Hazardous Waste, Part 261; 40 CFR; or have been determined to be hazardous wastes by declaration of the Defense Reutilization and Marketing Service (DRMS) in accordance with procedures set forth in DOD 4160.21-M. Disposal of such items shall be managed in accordance with the Installation Environmental Office, the DRMO, or the Safety and Health Office to insure proper reporting of disposal and treatment actions to the US EPA and State; and shall be managed in accordance with Federal, State and local laws. The three main disposal methods are turn-in to the DRMO, on-post disposal by installation personnel, or disposal by commercial contract. Hazardous wastes that cannot be used, or disposed of as stated in 4.4.3.4.2, shall be stored under environmentally safe conditions until suitable methods of disposal are determined. Short-term storage (less than 90 days) requires proper containment (i.e., packaging and facilities) in accordance with Section 262.34, Part 262 of the above reference. Long-term storage (greater than 90 days) requires permitting by the EPA or by the State under Public Law 94-580 (RCRA), in compliance with the requirements of 40 CFR Parts 264 and 265. Physical custody will be accomplished by the activity with conforming storage or most nearly conforming storage. When physical custody is in question, the Post Commander will make the final decision. In all cases where the wastes are to be collected, stored, transported and disposed of at a State or local permitted disposal facility, the identity and description of the waste shall be maintained and recorded in accordance with Part 262 of the above reference. Transportation of the waste shall be in accordance with Part 263 of the above reference, Standards Applicable to Transporters of Hazardous Waste.

4.4.3.1 Cleanup of liquid spills. To control the migration of spilled or leaking liquids, dike around the item with an inert, dry absorbent (e.g., clay, sawdust or vermiculite) or follow installations spill plans (Spill Prevention Control and Countermeasure Plan and Installations Spill Contingency Plan). Control entry to the spill site and segregate salvageable materials away from the spill area. Initiate waste cleanup operations immediately in accordance with local procedures. The residue shall be safely handled and transported to an approved or permitted disposal or storage facility. Packaging, labeling, transportation and record-keeping requirements for this waste material are determined by the appropriate Federal and State agencies and local procedures. It is recommended that all activities involving disposal preparation and transportation to commercial facilities be properly coordinated with the appropriate Federal and State agencies responsible for health and environmental aspects of hazardous materials. It is imperative that the proper description of waste accompany the packaged item at all times. Final disposal of the waste item shall be accomplished by reutilization, transfer, donation or sales by DRMS in accordance with DOD 4160.21-M or by ultimate disposal as described in 4.4.3.2. Spill residue, including contaminants, to be turned in to the DRMO shall first be properly identified, containerized, and labeled. For large scale spills that grossly contaminate the environment, the Chemical Transportation Emergency Center (CHEM-TREC), can be called for assistance. Applicable procedures of the local spill control plan shall be followed. Necessary respiratory, eye, and skin protection measures are to be used while performing cleanup operations.

4.4.3.2 Ultimate disposal. Ultimate disposal shall be accomplished at a permitted or approved hazardous waste treatment or disposal facility designated by the Installation Environmental Office, DRMO, or Safety and Health Offices.

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4.4.4 DISCLAIMER. RECOMMENDED DISPOSAL INSTRUCTIONS ARE FORMULATED FOR USE BY ELEMENTS OF THE DEPARTMENT OF DEFENSE. THE UNITED STATES OF AMERICA IN NO MANNER WHATSOEVER EITHER EXPLICITLY OR IMPLICITLY WARRANTS, STATES, OR INTENDS SAID INSTRUCTION, TO HAVE ANY APPLICATION, USE OR VIABILITY BY OR TO ANY PERSON OR PERSONS CONTRACTING OUTSIDE THE DEPARTMENT OF DEFENSE OR ANY PERSON OR PERSONS CONTRACTING WITH ANY INSTRUMENTALITY OF THE UNITED STATES OF AMERICA AND DISCLAIMS ALL LIABILITY FOR SUCH USE. ANY PERSON USING THESE INSTRUCTIONS WHO IS NOT A MILITARY OR CIVILIAN EMPLOYEE OF THE UNITED STATES OF AMERICA SHOULD SEEK COMPETENT PROFESSIONAL ADVICE TO VERIFY AND ASSUME RESPONSIBILITY FOR THE SUITABILITY OF THESE INSTRUCTIONS TO THEIR PARTICULAR SITUATION REGARDLESS OF SIMILARITY TO A CORRESPONDING DEPARTMENT OF DEFENSE OR OTHER GOVERNMENT SITUATION.

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5. DETAILED REQUIREMENTS

5.1 Aldehydes. Aldehydes are terminal carbonyl compounds with a hydrogen atom attached to the carbonyl group, whereas there are two organic groups attached to the non-terminal carbonyl group of ketones. As a result, aldehydes are more easily oxidized than ketones. Aldehydes are readily oxidized to carboxylic acids or reduced to primary alcohols. They undergo a variety of addition and condensation reactions to produce various products such as polyols, acetals, dioxolanes, cyanohydrins, amines, imines, oximes and hydrozones. Aldehydes undergo aldol reactions to form higher condensation products. The dialdehydes offer varying degrees of reactivity for crosslinking protein and polyhydroxy materials. Therefore, aldehydes are mainly employed as chemical intermediates for the manufacture of other organic chemical products.

5.1.1 Name. ACETALDEHYDE CH₃CHO FW 44.05
 Acetic aldehyde
 Ethanal (IUPAC)
 Ethylaldehyde

5.1.1.1 Technical description. Acetaldehyde (pure) is a colorless liquid. It is miscible with water, acetone, alcohol, ether, benzene, and other liquid hydrocarbons. Requirements for the physical properties are as shown in Table I. Acetaldehyde, technical grade, is commercially available with a minimum purity of 99.5 percent by weight.

TABLE I. Acetaldehyde - physical properties and characteristics.

Characteristic	Value
Specific gravity, d^{18}	0.7834
Refractive index, n_D^{20}	1.3316
Freezing point, °C	-121
Boiling point (760 mm), °C	20.8
Vapor pressure (20°C), mm Hg	750
Flash point (closed cup), °F (°C)	-38 (-39)
Autoignition temperature, °F (°C)	380 (193)
Explosive limits, % by vol, Lower	4.0
Upper	57
Vapor density (air=1)	1.52

5.1.1.2 Specifications. None.

5.1.1.2.1 Requirements. Refer to 5.1.1.1.

5.1.1.3 Use. Acetaldehyde is intended for military use as a chemical intermediate. Commercial uses include the production of acetic acid and acetic anhydride, other aldehydes, and chloral. Condensation with phenol or urea forms thermosetting resins.

5.1.1.4 Safety precautions.

5.1.1.4.1 Health hazard. Acetaldehyde vapor is an irritant to the eyes and respiratory tract, and in high concentrations can cause narcosis and lung

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injury. The PEL is 200 ppm (360 mg/m³) and the TLV is 100 ppm (180 mg/m³). The liquid is a skin irritant, and can cause eye burns. For personal protective measures, refer to 4.3.1.

5.1.1.4.2 Fire and explosion hazard. Acetaldehyde is a very flammable liquid below 69°F (21°C) that can produce explosive vapor mixtures in air at ambient temperatures.

5.1.1.4.3 Reactivity. Acetaldehyde is reactive with strong oxidizing compounds and reactions can be violent. Contact with air can result in formation of highly-explosive peroxides and corrosive acid. It autopolymerizes readily.

5.1.1.5 Storage. Acetaldehyde shall be stored in containers that have been purged with oxygen-free gas, and kept under nitrogen blanketing at a slight positive pressure. Cool storage is necessary to avoid excessive pressure. Compatible container materials are baked phenolic resin-lined or treated carbon steel, stainless steel and aluminum (copper-free). Contact with galvanized iron, and copper and its alloys must be avoided. Refer to 4.3.2.

5.1.1.6 Disposal. In case of spills, eliminate all sources of ignition. Small spills shall be absorbed with a nonreactive absorbent and placed in sealed containers for disposal. Large spills shall be diluted with water to reduce the vapor hazard, diked to prevent spreading, and transferred to salvage containers. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. Refer to 4.4.4

EPA Hazardous Waste Classification - Ignitable (I); Waste Number U001.

5.1.2	<u>Name.</u> ACROLEIN	CH ₂ =CHCHO	FW 56.07
	Acraldehyde		
	Acrylaldehyde		
	Acrylic aldehyde		
	Propenal or 2-Propenal (IUPAC)		

5.1.2.1 Technical description. Acrolein (pure) is a colorless liquid. It is very soluble in water, and soluble in alcohol, ether and acetone. Requirements for the physical properties and characteristics are as shown in Table II. Acrolein, technical grade, is commercially available with a minimum purity of 99.5 percent by weight, and contains 0.10 to 0.25 percent by weight of hydroquinone as inhibitor.

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TABLE II. Acrolein - physical properties and characteristics.

Characteristic	Value
Specific gravity, d_4^{20}	0.8410
Refractive index, n_D^{20}	1.4017
Freezing point, °C	-86.95
Boiling point (760 mm Hg), °C	52.5 to 53.5
Vapor pressure (20°C), mm Hg	220
Solubility in water (20°C), g/100 ml	20.6
Flash point (closed cup), °F (°C)	-15 (-26)
Autoignition temperature, °F (°C)	532 (278)
Explosive limits, % by vol, Lower	2.8
Upper	31
Vapor density (air=1)	1.9

5.1.2.2 Specifications. None.

5.1.2.2.1 Requirements. Refer to 5.1.2.1.

5.1.2.3 Use. Acrolein is intended for military use as a chemical intermediate, and as a slimicide for water treatment. Commercial uses include the production of glycerol, methionine, polyurethane and polyester resins; the etherification and esterification of food starch; and the preparation of slimicides for the manufacture of paper products that contact food.

5.1.2.4 Safety precautions.

5.1.2.4.1 Health hazard. Acrolein vapor can cause extreme irritation of the eyes and respiratory tract and may produce pulmonary edema. Excessive inhalation may be fatal. The PEL and TLV is 0.1 ppm (0.25 mg/m³). The liquid is a strong irritant and can cause severe eye and skin burns on long contact. For personal protective measures, refer to 4.3.1.

5.1.2.4.2 Fire and explosion hazard. Acrolein is a flammable liquid that can produce explosive vapor mixtures in air.

5.1.2.4.3 Reactivity. Acrolein is reactive with oxidizing compounds and reactions can be violent. Contact with air can result in formation of highly-explosive peroxides. It polymerizes readily upon loss of inhibitor or on contact with alkaline material.

5.1.2.5 Storage. Acrolein shall be stored in containers that have been purged with oxygen-free gas and kept under nitrogen blanketing at a light positive pressure. Cool storage is necessary to avoid excessive pressure. Compatible container materials are plain or baked phenolic resin-lined steel, stainless steel and aluminum. Galvanized iron, copper or its alloys are unsuitable materials. Refer to 4.3.2.

5.1.2.6 Disposal. In case of spills, eliminate all sources of ignition. Small spills shall be absorbed with a nonreactive absorbent and placed in sealed containers for disposal. Large spills shall be diluted with water to reduce the vapor hazard, diked to prevent spreading, and transferred to salvage containers.

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For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. Refer to 4.4.4.

EPA Hazardous Waste Classification - Acute Hazardous Toxic (H), Ignitable (I); Waste Number - P003.

5.1.3 Name. BENZALDEHYDE (IUPAC) C_6H_5CHO FW 106.13
 Benzenecarbonal
 Benzenecarboxaldehyde
 Benzoic aldehyde

5.1.3.1 Technical description. Benzaldehyde (pure) is a colorless liquid. It is very slightly soluble in water, miscible with alcohol and ether, and very soluble in acetone and benzene. Requirements for physical properties and characteristics are as shown in Table III. Benzaldehyde, technical grade, is commercially available with a minimum purity of 98.0 percent by weight.

TABLE III. Benzaldehyde - physical properties and characteristics.

Characteristic	Value
Specific gravity, d^{15}	1.0415
Refractive index, n_D^{20}	1.5463
Freezing point, °C	-26
Boiling point (760 mm Hg), °C	178.1
Vapor pressure (20°C), mm Hg	<1
Solubility in water (20°C), % by wt	0.6
Flash point (closed cup), °F (°C)	148 (64)
Autoignition temperature, °F (°C)	378 (192)
Vapor density (air=1)	3.7

5.1.3.2 Specifications. None.

5.1.3.2.1 Requirements. Refer to 5.1.3.1.

5.1.3.3 Use. Benzaldehyde is intended for military use as a chemical intermediate, and as a solvent for cellulose nitrate and acetate, and resins. Commercial uses include the production of benzoic and cinnamic acids; as a solvent for resins, cellulose ethers, cellulose acetate and nitrate; as a flavoring compound; and in synthetic perfumes and soaps.

5.1.3.4 Safety precautions.

5.1.3.4.1 Health hazard. Benzaldehyde vapor is a narcotic in high concentrations if inhaled. There is no PEL or TLV for benzaldehyde. The liquid acts as a feeble local anesthetic, and may cause contact dermatitis and eye irritation. For personal protective measures, refer to 4.3.1.

5.1.3.4.2 Fire and explosion hazard. Benzaldehyde is a combustible liquid. Soaked materials or carbon filters containing benzaldehyde can ignite spontaneously in air.

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5.1.3.4.3 Reactivity. Benzaldehyde is oxidized to benzoic acid on exposure to air. It is reactive with strong oxidizing agents.

5.1.3.5 Storage. Benzaldehyde shall be stored in containers that have been purged with oxygen-free gas and kept under nitrogen blanketing at a slight positive pressure. Compatible container materials are stainless steel and baked phenolic resin-lined steel. Contact with copper and its alloys shall be avoided. Refer to 4.3.2.

5.1.3.6 Disposal. In case of spills, eliminate all sources of ignition. Small spills shall be absorbed with a nonreactive absorbent and placed in sealed containers for disposal. Large spills shall be diked to prevent spreading and transferred to salvage containers. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. Refer to 4.4.4.

EPA Hazardous Waste Classification - Ignitable (I); Waste Number D001.

5.1.4 Name. BUTYRALDEHYDE $\text{CH}_3\text{CH}_2\text{CH}_2\text{CHO}$ FW 72.12
 Butanal (IUPAC)
 Butyl aldehyde
 n-Butyric aldehyde

5.1.4.1 Technical description. Butyraldehyde (pure) is a colorless liquid. It is slightly soluble in water, miscible with alcohol and ether, and very soluble in acetone and benzene. Requirements for the physical properties and characteristics are as shown in Table IV.

TABLE IV. Butyraldehyde - physical properties and characteristics.

Characteristics	Value
Specific gravity, d^{20}	0.8170
Refractive index, n_D^{20}	1.3843
Freezing point, °C	-99
Boiling point (760 mm Hg), °C	75.7
Vapor pressure (20°C), mm Hg	89
Solubility in water (25°C), % by wt	7.1
Flash point (closed cup), °F (°C)	9 (-13)
Autoignition temperature, °F (°C)	425 (218)
Explosive limits, % by vol, Lower	2.0
Upper	11.8
Vapor density (air=1)	2.5

5.1.4.2 Specifications. None.

5.1.4.2.1 Requirements. Refer to 5.1.4.1.

5.1.4.3 Use. Butyraldehyde is intended for military use as an intermediate in the synthesis of other compounds and resins. Commercial uses include the production of butyric acid and resins.

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5.1.4.4 Safety precautions.

5.1.4.4.1 Health hazard. High vapor concentrations of butyraldehyde vapor can cause irritation of the eyes and respiratory tract, and narcosis or anesthesia. There is no PEL or TLV for butyraldehyde. The liquid can cause skin irritation and eye burns, and can penetrate the skin. For personal protective measures, refer to 4.3.1.

5.1.4.4.2 Fire and explosion hazard. Butyraldehyde is a very flammable liquid, and vapors can cause flash fires.

5.1.4.4.3 Reactivity. Butyraldehyde can form explosive peroxides and butyric acid on exposure to air. It is reactive with strong oxidizing compounds, strong bases and mineral acids.

5.1.4.5 Storage. Butyraldehyde shall be stored in a cool place in containers that have been purged with oxygen-free gas, and kept under nitrogen blanketing at a slight positive pressure. Compatible container materials are stainless steel, baked phenolic resin-lined steel, and aluminum. Contact with galvanized iron, and copper and its alloys shall be avoided. Refer to 4.3.2.

5.1.4.6 Disposal. In case of spills, eliminate all sources of ignition. Small spills shall be absorbed with a nonreactive absorbent and placed in sealed containers for disposal. Large spills shall be diked to prevent spreading and transferred to salvage containers. Water spray can be applied to reduce the fire hazard. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. Refer to 4.4.4.

EPA Hazardous Waste Classification - Ignitable (I); Waste Number P023.

5.1.5 Name. o-CHLOROBENZALDEHYDE C₇H₅ClO FW 140.57
2-Chlorobenzaldehyde
2-Chlorobenzencarbal (IUPAC)

5.1.5.1 Technical description. o-Chlorobenzaldehyde (pure) is a colorless liquid which is available commercially in a purity of not less than 98.5 percent by weight. It is slightly soluble in water, and is soluble in alcohol, acetone, ether, and benzene. Requirements for the physical properties and characteristics are shown in Table V.

TABLE V. o-Chlorobenzaldehyde - physical properties and characteristics.

Characteristics	Value
Specific gravity, d^{20}	1.2483
Refractive index, n_D^{20}	1.5667
Freezing point, °C	12.39
Boiling point (760 mm Hg), °C	211.9
Vapor pressure (50°C), mm Hg	2.3
Flash point (closed cup), °F (°C)	190 (87)
Autoignition temperature, °F (°C)	743 (395)
Vapor density (air=1)	4.84

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5.1.5.2 Specifications. MIL-C-51012, o-Chlorobenzaldehyde, Technical.

5.1.5.2.1 Requirements. The military specification requirements are shown in Table VI.

TABLE VI. o-Chlorobenzaldehyde - military specification requirements.

Characteristics	Requirements	
	Minimum	Maximum
Assay (as o-chlorobenzaldehyde), % by wt	97.0	---
Ash, % by wt	---	0.02
Ethanol insolubles, % by wt	---	0.1
Acidity (as o-chlorobenzoic acid), % by wt	---	1.0
Specific gravity, d_{25}^{25}	1.245	1.250
Freezing point, °C	7.0	---

5.1.5.3 Use. o-Chlorobenzaldehyde is intended for military use as a chemical intermediate in the manufacture of Riot Control Agent, CS. Commercial uses are as a chemical intermediate for the production of dyestuffs and pharmaceuticals.

5.1.5.4 Safety precautions.

5.1.5.4.1 Health hazard. o-Chlorobenzaldehyde vapor is irritating to the eyes and upper respiratory tract. There is no PEL or TLV for o-chlorobenzaldehyde. The solid or liquid is highly irritating to the eyes and skin. For personal protective measures, refer to 4.3.1.

5.1.5.4.2 Fire and explosion hazard. o-Chlorobenzaldehyde is combustible, and the combustion and decomposition products can be irritating, corrosive and toxic.

5.1.5.4.3 Reactivity. o-Chlorobenzaldehyde is corrosive and is reactive with strong oxidizing compounds. Alkalies promote oxidation-reduction reactions. It is sensitive to air and moisture. Hazardous polymerization reactions will not occur.

5.1.5.5 Storage. o-Chlorobenzaldehyde shall be stored in a cool place in plastic-lined steel containers that have been purged with oxygen-free gas, and kept under nitrogen blanketing at a slight positive pressure. Contact with iron, galvanized iron, and copper and its alloys shall be avoided. Refer to 4.3.2.

5.1.5.6 Disposal. In case of spills, eliminate all sources of ignition. Small spills shall be absorbed with a nonreactive absorbent and placed in sealed containers for disposal. Large spills shall be diked to prevent spreading and transferred to salvage containers. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. Refer to 4.4.4.

EPA Hazardous Waste Classification - Ignitable (I); Waste Number P023.

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5.1.6 Name. p-CHLOROBENZALDEHYDE $\text{ClC}_6\text{H}_4\text{CHO}$ FW 140.57
 4-Chlorobenzaldehyde
 4-Chlorobenzenecarbonal (IUPAC)

5.1.6.1 Technical description. p-Chlorobenzaldehyde (pure) is a colorless liquid. It is soluble in water and acetone, and very soluble in alcohol, ether, and benzene. Requirements for the physical properties and characteristics are as shown in Table VII. p-Chlorobenzaldehyde, technical grade, is commercially available with a minimum purity of 98.5 percent by weight.

TABLE VII. p-Chlorobenzaldehyde - physical properties and characteristics.

Characteristics	Value
Specific gravity, d_4^{20}	1.196
Refractive index, n_D^{20}	1.5552
Melting point, °C	47.5
Boiling point (760 mm Hg), °C	213 to 214
Flash point (closed cup), °F (°C)	190 (87)
Vapor density (air=1)	4.84

5.1.6.2 Specifications. None.

5.1.6.2.1 Requirements. Refer to 5.1.6.1.

5.1.6.3 Use. p-Chlorobenzaldehyde is intended for military use as a chemical intermediate. Commercial uses are as a chemical intermediate for the production of dyestuffs and pharmaceuticals.

5.1.6.4 Safety precautions.

5.1.6.4.1 Health hazard. p-Chlorobenzaldehyde vapor is irritating to the eyes and upper respiratory tract. There is no PEL or TLV for p-chlorobenzaldehyde. The solid or liquid is highly irritating to the eyes and skin. For personal protective measures, refer to 4.3.1.

5.1.6.4.2 Fire and explosion hazard. p-Chlorobenzaldehyde is combustible, and the combustion and decomposition products can be irritating, corrosive and toxic.

5.1.6.4.3 Reactivity. p-Chlorobenzaldehyde is corrosive and is reactive with strong oxidizing compounds. Alkalies promote oxidation-reduction reactions. It is sensitive to iron, air and moisture. Hazardous polymerization reactions will not occur.

5.1.6.5 Storage. p-Chlorobenzaldehyde shall be stored in a cool place in plastic-lined steel containers that have been purged with oxygen-free gas, and kept under nitrogen blanketing at a slight positive pressure. Contact with iron, galvanized iron, and copper and its alloys shall be avoided. Refer to 4.3.2.

5.1.6.6 Disposal. In case of solid spills, the material can be scooped up and placed in sealed containers for disposal. Small liquid solution spills

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shall be absorbed with a nonreactive absorbent and placed in sealed containers for disposal. Large liquid solution spills shall be diked to prevent spreading and transferred to salvage containers. For appropriate procedure, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. Refer to 4.4.4.

EPA Hazardous Waste Classification - Ignitable (I); Waste Number P023.

5.1.7 Name. CROTONALDEHYDE $\text{CH}_3\text{CH}:\text{CHCHO}$ FW 70.10
 2-Butenal (trans) (IUPAC)
 Crotonic aldehyde
 B-Methylacrolein

5.1.7.1 Technical description. Crotonaldehyde (pure) is a colorless liquid. It is soluble in water, and very soluble in alcohol, acetone, and ether. It is miscible with benzene. Requirements of the physical properties and characteristics are as shown in Table VIII. Crotonaldehyde, technical grade, is commercially available with a minimum purity of 90.0 percent by weight.

TABLE VIII. Crotonaldehyde - physical properties and characteristics.

Characteristics	Value
Specific gravity, d_4^{25}	0.8495
Refractive index, n_D^{20}	1.4366
Freezing point, °C	-74
Boiling point (760 mm Hg), °C	104 to 105
Vapor pressure (20°C), mm Hg	32
Solubility in water (20°C) % by wt	15
Flash point (closed cup), °F (°C)	45 (7)
Autoignition temperature, °F (°C)	405 (207)
Explosive limits, % by vol, Lower	2.15
Upper	19.5
Vapor density (air=1)	2.41

5.1.7.2 Specifications. None.

5.1.7.2.1 Requirements. Refer to 5.1.7.1.

5.1.7.3 Use. Crotonaldehyde is intended for military use as a chemical intermediate. Commercial uses are as a chemical intermediate in the production of polymers, plastic additives, surface active agents, and pharmaceuticals.

5.1.7.4 Safety precautions.

5.1.7.4.1 Health hazard. Crotonaldehyde vapor is strongly irritating to the eyes and respiratory tract, and can produce pulmonary edema. The PEL and TLV is 2 ppm (6 mg/m³), and the STEL is 6 ppm (18 mg/m³). The liquid is a strong irritant that can cause severe eye injury and skin burns on long contact. Short exposure to liquid can cause skin discoloration. For personal protective measures, refer to 4.3.1.

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5.1.7.4.2 Fire and explosion hazard. Crotonaldehyde is a flammable liquid that can produce explosive vapor mixtures in air. Elevated temperatures can cause violent rupture of containers due to heat of polymerization.

5.1.7.4.3 Reactivity. Crotonaldehyde reacts vigorously with strong oxidizing compounds. Contact with strong alkalis can cause hazardous polymerization reactions. Contact with air can result in formation of explosive peroxides.

5.1.7.5 Storage. Crotonaldehyde shall be stored in a cool place in aluminum or stainless steel containers that have been purged with oxygen-free gas, and kept under nitrogen blanketing at a slight positive pressure. Baked phenolic resin-lined steel or polyethylene-lined steel drums are also suitable. Contact with galvanized iron, and copper and its alloys shall be avoided. Refer to 4.3.2.

5.1.7.6 Disposal. In case of spills, eliminate all sources of ignition. Small spills shall be absorbed with a nonreactive absorbent and placed in sealed containers for disposal. Large spills shall be diked to prevent spreading and transferred to salvage containers. Water spray can be used to reduce the vapor ignition hazard. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. Refer to 4.4.4.

EPA Hazardous Waste Classification - Ignitable (I) and Toxic (T); Waste Number U053.

5.1.8 Name. 2-ETHYLHEXALDEHYDE $\text{CH}_3(\text{CH}_2)_3\text{CH}(\text{C}_2\text{H}_5)\text{CHO}$ FW 128.22
2-Ethylhexanal

5.1.8.1 Technical description. 2-Ethylhexaldehyde (pure) is a colorless liquid. It is very slightly soluble in water, and soluble in alcohol and ether. Requirements of the physical properties and characteristics are as shown in Table IX. 2-Ethylhexaldehyde, technical grade, is commercially available with a minimum purity of 99.0 percent by weight.

TABLE IX. 2-Ethylhexaldehyde - physical properties and characteristics.

Characteristics	Value
Specific gravity, d_{20}^{20}	0.8540
Refractive index, n_D^{20}	1.4142
Freezing point, °C	<-100
Boiling point (760 mm Hg), °C	163
Vapor pressure (20°C), mm Hg	1.8
Solubility in water (24°C) % by wt	0.04
Flash point (closed cup), °F (°C)	112 (44)
Autoignition temperature, °F (°C)	375 (190)
Explosive limits, % by vol, Lower	0.85
Upper	7.2
Vapor density (air=1)	4.42

5.1.8.2 Specifications. None.

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5.1.8.2.1 Requirements. Refer to 5.1.8.1.

5.1.8.3 Use. 2-Ethylhexaldehyde is intended for military use as a chemical intermediate. Commercial uses are as a chemical intermediate in the production of 2-ethylhexanol for ester monomers and ester plasticizers, and in the production of 2-ethylhexanoic acid for metal carboxylates.

5.1.8.4 Safety precautions.

5.1.8.4.1 Health hazard. 2-Ethylhexaldehyde vapor is an irritant to the eyes and respiratory tract. There is no PEL or TLV for 2-ethylhexaldehyde. The liquid is an irritant to the eyes and skin. For personal protective measures, refer to 4.3.1.

5.1.8.4.2 Fire and explosion hazard. 2-Ethylhexaldehyde is a combustible liquid that can produce explosive vapor mixtures in air on heating.

5.1.8.4.3 Reactivity. 2-Ethylhexaldehyde reacts vigorously with oxidizing agents. Contact with strong alkalies or acids can cause hazardous polymerization reactions.

5.1.8.5 Storage. 2-Ethylhexaldehyde shall be stored in a cool place in aluminum or stainless steel containers that have been purged with oxygen-free gas, and kept under nitrogen blanketing at a slight positive pressure. Baked phenolic resin-lined steel containers are also suitable. Contact with galvanized iron, and copper and its alloys shall be avoided. Refer to 4.3.2.

5.1.8.6 Disposal. In case of spills, eliminate all sources of ignition. Small spills shall be absorbed with a nonreactive absorbent and placed in sealed containers for disposal. Large spills shall be diked to prevent spreading and transferred to salvage containers. Water spray can be used to reduce the vapor ignition hazard. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. Refer to 4.4.4.

EPA Hazardous Waste Classification - Ignitable (I); Waste Number D001.

5.1.9 <u>Name</u> . FORMALDEHYDE	HCHO	FW 30.03
Formalin (aqueous solution)		
Formic aldehyde		
Methanal (IUPAC)		
Oxomethane		
Oxymethylene		

5.1.9.1 Technical description. Formaldehyde (pure) is a colorless gas. It is soluble in water and alcohol. It is miscible with acetone, ether, and benzene. The solutions shall be clear and free from suspended matter.

5.1.9.2 Specifications. ASTM D 2378, Formaldehyde 50% Grade Uninhibited and 37% Grade Inhibited and Uninhibited.

5.1.9.2.1 Requirements. Requirements for the physical properties and characteristics are as shown in Table X.

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TABLE X. Formaldehyde - physical properties and characteristics.

Characteristic	Value
Specific gravity, d^{20}	0.815
Freezing point, °C	-92
Boiling point (760 mm Hg), °C	-21
Autoignition temperature, °F (°C)	806 (430)
Explosive limits, % by vol, Lower	7.0
Upper	73
Vapor density (air=1)	1.03

The ASTM specification requirements for the 50% and 37% grades of formaldehyde are shown in Table XI.

TABLE XI. Formaldehyde - chemical and physical requirements.

Characteristics	Requirement			
	50% Grade		37% Grade	
	Minimum	Maximum	Minimum	Maximum
Apparent specific gravity, dependent on formaldehyde and methanol content, d_{25}^{25}	1.1470	1.1520	1.0749	1.1139
Formaldehyde content, % by wt	49.75	50.5	37.0	37.4
Acidity (as formic acid), % by wt	---	0.05	---	0.02
Iron, ppm by wt	---	1.0	---	1.0
Methanol content, % by wt	---	1.5	---	As Required
Color (Pt-Co Scale)	---	10	---	10

The closed cup flash points (TCC) of the different grades of formaldehyde solutions are shown in Table XII.

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TABLE XII. Formaldehyde solutions - closed cup flash points.

Grade	Flash Point	
	°F	°C
37% Uninhibited	185	85
37% Inhibited with 7% methanol	156	69
37% Inhibited with 12 to 15% methanol	141	61
44 to 45 % Uninhibited	165	74
44% Inhibited with 6.5% methanol	150	66
50 to 52% Uninhibited	158	70

5.1.9.3 Use. Formaldehyde is intended for military use as a chemical intermediate. Commercial uses are as a chemical intermediate in the production of resins, dyes and pentaerythritol; and as a reducing agent.

5.1.9.4 Safety precautions.

5.1.9.4.1 Health hazard. Formaldehyde vapor is very irritating to the eyes and respiratory tract, and it is a suspected carcinogen. The TLV is one ppm (1.5 mg/m³). Formaldehyde solutions can cause severe eye burns, and are irritating to the skin. For personal protective measures, refer to 4.3.1.

5.1.9.4.2 Fire and explosion hazard. Formaldehyde solutions are combustible liquids that can produce explosive vapor mixtures in air.

5.1.9.4.3 Reactivity. Formaldehyde solutions are reactive with alkalies, inorganic acids, anhydrides, oxides, and oxidizing compounds. Exposure to air can result in formation of formic acid. Polymerization occurs at low temperatures.

5.1.9.5 Storage. Formaldehyde shall be stored in types 316 or 304 stainless steel containers or resin-lined carbon steel containers. Minimum storage temperatures to prevent polymerization range from 145°F (62.8°C) for a 50% uninhibited solution to 40°F (4.4°C) for a 37% solution containing 15% methanol inhibitor. Higher temperatures than recommended shall be avoided to minimize oxidation to formic acid. Contact with galvanized iron, and copper and its alloys shall be avoided. Refer to 4.3.2.

5.1.9.6 Disposal. In case of solution spills, eliminate all sources of ignition. Small spills shall be absorbed with a nonreactive absorbent and placed in sealed containers for disposal. Large spills shall be diked to prevent spreading and transferred to salvage containers. Water spray can be used to reduce the vapor ignition hazard. For appropriate procedure, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. Refer to 4.4.4.

EPA Hazardous Waste Classification - Toxic (T); Waste Number U122.

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5.1.10 Name. FURFURAL OCH:CHCH:CCHO FW 96.09
 Fural
 α -Furaldehyde
 2-Furaldehyde
 2-Furancarbonsal
 2-Furancarboxaldehyde

5.1.10.1 Technical description. Furfural (pure) is a colorless liquid. It is partly soluble in water, and very soluble in acetone, alcohol, benzene, toluene, and chloroform. It is miscible with saturated aliphatic hydrocarbons. The physical properties and characteristics are as shown in Table XIII.

TABLE XIII. Furfural - physical properties and characteristics.

Characteristics	Value
Specific gravity, d^{20}	1.1594
Refractive index, n_D^{20}	1.5261
Freezing point, °C	-36.5
Boiling point (760 mm Hg), °C	161.7
Vapor pressure (60°C), mm Hg	16
Solubility in water (20°C), % by wt	8.3
Flash point, (closed cup), °F (°C)	143 (61.7)
Autoignition temperature, °F (°C)	600 (316)
Explosive limits, % by vol, Lower	2.1
Upper	---
Vapor density (air=1)	3.3

5.1.10.2 Specifications. None.

5.1.10.2.1 Requirements. Refer to 5.1.10.1.

5.1.10.3 Use. Furfural is intended for military use as a chemical intermediate, and as a solvent for thermoplastic resins such as cellulose esters and ethers, vinyls, and acrylics. Commercial uses are as a chemical intermediate for the manufacture of thermosetting resins by reaction with phenol, and for the manufacture of furan and tetrahydrofuran type derivatives; as a selective solvent for the separation of saturated and unsaturated compounds in refining of petroleum oils; as a solvent for thermoplastic resins; and as a decolorizing agent for wood rosin.

5.1.10.4 Safety precautions.

5.1.10.4.1 Health hazard. Furfural vapor is an irritant to the mucous membranes, eyes and upper respiratory tract, and is a central nervous system poison. The PEL for skin is 5 ppm (20 mg/m³) and the TLV for skin is 2 ppm (8 mg/m³). The liquid is dangerous to the eyes and will penetrate intact skin. For personal protective measures, refer to 4.3.1.

5.1.10.4.2 Fire and explosion hazard. Furfural is a combustible liquid that can produce explosive vapor mixtures in air on heating.

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5.1.10.4.3 Reactivity. Furfural is reactive with strong oxidizing compounds, acids and alkalis. It slowly degrades on exposure to air.

5.1.10.5 Storage. Furfural shall be stored in a cool place in aluminum or steel containers under nitrogen blanketing at a slight positive pressure. Refer to 4.3.2.

5.1.10.6 Disposal. In case of spills, eliminate all sources of ignition. Small spills shall be absorbed with a nonreactive absorbent and placed in sealed containers for disposal. Large spills shall be diked to prevent spreading and transferred to salvage containers. Water spray can be used to reduce the vapor ignition hazard. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. Refer to 4.4.4.

EPA Hazardous Waste Classification - Ignitable (I); Waste Number U125.

5.1.11 Name. GLUTARALDEHYDE $\text{OHC}(\text{CH}_2)_3\text{CHO}$ FW 100.13
 Glutaricaldehyde
 Glutaric dialdehyde
 1,5-Pentanedial (IUPAC)

5.1.11.1 Technical description. Glutaraldehyde (pure) is a colorless liquid with a boiling point of 71 to 72°C at 10 mm Hg, and a boiling point of 187 to 189°C with decomposition at 760 mm Hg. It is miscible with water and alcohol, and soluble in benzene. It is commercially available as two aqueous solutions. The physical properties of these aqueous solutions are shown in Table XIV.

TABLE XIV. Glutaraldehyde aqueous solutions (25% and 50%) - physical properties.

Characteristics	Value
Specific gravity, d_{20}^{20}	
25% solution	1.062
50% solution	1.124
Refractive index, n_D^{20}	
25% solution	1.3772
Freezing point, °C	
25% solution	-7.0
50% solution	-14.0
Vapor pressure (20°C), mm Hg	
25% solution	17
50% solution	17

The solutions have no flash point.

5.1.11.2 Specifications. None.

5.1.11.2.1 Requirements. Refer to 5.1.11.1.

5.1.11.3 Use. Glutaraldehyde solutions are intended for military use as a chemical intermediate. Commercial uses are as a chemical intermediate, for crosslinking protein and polyhydroxy materials, and for tanning of leather.

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5.1.12.2 Specifications. None.

5.1.12.2.1 Requirements. Refer to 5.1.12.1.

5.1.12.3 Use. Glyoxal solution is intended for military use as a chemical intermediate. Commercial uses are as a chemical intermediate for textile resins, and for crosslinking protein and polyhydroxy materials.

5.1.12.4 Safety precautions.

5.1.12.4.1 Health hazard. Glyoxal solution (40%) has no vapor hazard. The solution can cause skin and eye irritation. For personal protective measures, refer to 4.3.1.

5.1.12.4.2 Fire and explosion hazard. Glyoxal solution can explode when heated to 392°F (200°C) in a closed container or system.

5.1.12.4.3 Reactivity. Glyoxal is reactive with strong oxidizing compounds. The solution can undergo oxidative degradation in air during long term storage.

5.1.12.5 Storage. Glyoxal solution shall be stored in stainless steel containers with nitrogen blanketing under a slight positive pressure. Aluminum is unsuitable, and contact with galvanized iron, and copper and its alloys is to be avoided. Refer to 4.3.2.

5.1.12.6 Disposal. Small spills shall be absorbed with a nonreactive absorbent and placed in sealed containers for disposal. Large spills shall be diked to prevent spreading and transferred to salvage containers. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. Refer to 4.4.4.

An EPA Hazardous Waste Classification is not listed in 40 CFR.

5.1.13	<u>Name</u> . p-HYDROXYBENZALDEHYDE	HOC ₆ H ₄ CHO	FW 122.13
	4-Formylphenol		
	4-Hydroxybenzaldehyde		

5.1.13.1 Technical description. p-Hydroxybenzaldehyde (pure) is a white solid. It is slightly soluble in water, very soluble in alcohol and ether, and soluble in benzene. The physical properties and characteristics are as shown in Table XVII. p-Hydroxybenzaldehyde, technical grade, is commercially available with a typical purity of 98 percent and a minimum assay of 95 percent by weight.

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TABLE XVII. p-Hydroxybenzaldehyde - physical properties and characteristics.

Characteristic	Value
Specific gravity, d^{130}	1.129
Refractive index, n_D^{130}	1.5705
Melting point, °C	117
Solubility in water (30.5°C), % by wt	1.36
Flash point (open cup), °F (°C)	350 (174)
Autoignition temperature, °F (°C)	842 (450)

5.1.13.2 Specifications. None.

5.1.13.2.1 Requirements. Refer to 5.1.13.1.

5.1.13.3 Use. p-Hydroxybenzaldehyde is intended for military use as a chemical intermediate. Commercial uses are as a chemical intermediate.

5.1.13.4 Safety precautions.

5.1.13.4.1 Health hazard. p-Hydroxybenzaldehyde has no vapor hazard at ordinary temperatures, and there is no PEL or TLV for the compound. The manufacturer's industrial hygiene guide for the inhalation limit is 10 mg/m³ for dust. The solid causes no skin effects, but can cause slight eye irritation and slight transient corneal injury. For personal protective measures, refer to 4.3.1.

5.1.13.4.2 Fire and explosion hazard. p-Hydroxybenzaldehyde is a burnable solid.

5.1.13.4.3 Reactivity. p-Hydroxybenzaldehyde is reactive with strong oxidizing agents. Hazardous polymerization will not occur.

5.1.13.5 Storage. p-Hydroxybenzaldehyde can be stored in fiber drums as shipped. Contact with galvanized iron, and copper and its alloys shall be avoided. Refer to 4.3.2.

5.1.13.6 Disposal. Solid spills shall be scooped up and collected in salvage containers. Small solution spills shall be absorbed with a nonreactive absorbent and placed in sealed containers for disposal. Large solution spills shall be diked to prevent spreading and transferred to salvage containers. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. Refer to 4.4.4.

An EPA Hazardous Waste Classification is not listed in CFR 40.

5.1.14 Name. ISOBUTYRALDEHYDE (CH₃)₂CHCHO FW 72.12
Isobutylaldehyde
2-Methylpropanal (IUPAC)

5.1.14.1 Technical description. Isobutyraldehyde (pure) is a colorless liquid. It is partly soluble in water. It is miscible with acetone, alcohol, ether, benzene and toluene. The physical properties and characteristics are as

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shown in Table XVIII. Isobutyraldehyde, technical grade, is commercially available with a minimum purity of 98.0 percent by weight.

TABLE XVIII. Isobutyraldehyde - physical properties and characteristics.

Characteristic	Value
Specific gravity, d_{20}^{20}	0.7938
Refractive index, n_D^{20}	1.3729
Freezing point, °C	-65.9
Boiling point (760 mm Hg), °C	64.1
Vapor pressure (20°C), mm Hg	130
Solubility in water (25°C), wt %	6.0
Flash point (closed cup), °F (°C)	0 (-18)
Autoignition temperature, °F (°C)	385 (196)
Explosive limits, % by vol, Lower	2.0
Upper	10.0
Vapor density (air=1)	2.5

5.1.14.2 Specifications. None.

5.1.14.2.1 Requirements. Refer to 5.1.14.1.

5.1.14.3 Use. Isobutyraldehyde is intended for military use as a chemical intermediate. Commercial uses include the production of isobutyl alcohol and isobutyric acid; and also 2,2,4-trimethyl-1,3-pentanediol monoisobutyrate, as an ester-alcohol, for making plasticizers based on its ester derivatives.

5.1.14.4 Safety precautions.

5.1.14.4.1 Health hazard. Isobutyraldehyde vapors are irritating to the eyes and respiratory tract. There is no PEL or TLV established for isobutyraldehyde. The liquid can cause severe eye and skin irritation. For personal protective measures, refer to 4.3.1.

5.1.14.4.2 Fire and explosion hazard. Isobutyraldehyde is an extremely flammable liquid that can produce explosive vapor mixtures with air.

5.1.14.4.3 Reactivity. Isobutyraldehyde is reactive with strong oxidizing compounds, strong acids and bases, and the reactions can be vigorous. Contact with air can result in formation of explosive peroxides and isobutyric acid. Hazardous polymerization may occur.

5.1.14.5 Storage. Isobutyraldehyde shall be stored in aluminum or stainless steel containers that have been purged with oxygen-free gas, and kept under nitrogen blanketing with a slight positive pressure. Cool storage is necessary to avoid excessive pressure. Baked phenolic resin-lined steel containers are also suitable. Contact with galvanized iron, and copper and its alloys shall be avoided. Refer to 4.3.2.

5.1.14.6 Disposal. In case of spills, eliminate all sources of ignition. Small spills shall be absorbed with a nonreactive absorbent and placed in sealed

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containers for disposal. Large spills shall be diked to prevent spreading and transferred to salvage containers. Water spray can be used to reduce vapor ignition hazard. For appropriate procedure, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. Refer to 4.4.4.

EPA Hazardous Waste Classification - Ignitable (I); Waste Number D001.

5.1.15 Name. 2-METHYLPENTALDEHYDE $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}(\text{CH}_3)\text{CHO}$ FW 100.16
2-Methylpentanal (IUPAC)
 α -Methylvaleraldehyde

5.1.15.1 Technical description. 2-Methylpentanaldehyde (pure) is a colorless liquid. It is very slightly soluble in water. It is miscible with acetone, alcohols, ethers, and liquid hydrocarbons. The physical properties and characteristics are as shown in Table XIX. 2-Methylpentanaldehyde, technical grade, is commercially available with a minimum purity of 98 percent by weight.

TABLE XIX. 2-Methylpentanaldehyde - physical properties and characteristics.

Characteristic	Value
Specific gravity, d_{20}^{20}	0.8102
d_{20}^{20}	0.8087
Refractive index, n_D^{20}	1.401
Freezing point, °C	-100 (sets to glass)
Boiling point (737 mm Hg), °C	116
(760 mm Hg), °C	118
Vapor pressure (20°C), mm Hg	14
Solubility in water (20°C), % by wt	0.42
Flash point (closed cup), °F (°C)	54 (12)

5.1.15.2 Specifications. None.

5.1.15.2.1 Requirements. Refer to 5.1.15.1.

5.1.15.3 Use. 2-Methylpentanaldehyde is intended for military use as a chemical intermediate. Commercial uses are as a chemical intermediate.

5.1.15.4 Safety precautions.

5.1.15.4.1 Health hazard. 2-Methylpentanaldehyde vapors are irritating to the eyes and upper respiratory tract. There is no PEL or TLV established for 2-methylpentanaldehyde. The liquid can cause skin irritation and severe eye irritation. For personal protective measures, refer to 4.3.1.

5.1.15.4.2 Fire and explosion hazard. 2-Methylpentanaldehyde is a flammable liquid that can produce explosive vapor in air mixtures.

5.1.15.4.3 Reactivity. 2-Methylpentanaldehyde is reactive with strong oxidizing agents, strong acids and bases, and the reactions can be vigorous.

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Contact with air can result in formation of explosive peroxides. Hazardous polymerization may occur.

5.1.15.5 Storage. 2-Methylpentanaldehyde shall be stored in aluminum or stainless steel containers that have been purged with oxygen-free gas, and kept under nitrogen blanketing at a slight positive pressure. Baked phenolic resin-lined steel or plain steel containers are also suitable. Contact with galvanized iron, and copper and its alloys shall be avoided. Refer to 4.3.2.

5.1.15.6 Disposal. In case of spills, eliminate all sources of ignition. Small spills shall be absorbed with a nonreactive absorbent and placed in sealed containers for disposal. Large spills shall be diked to prevent spreading and transferred to salvage containers. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. Refer to 4.4.4.

EPA Hazardous Waste Classification - Ignitable (I); Waste Number D001.

5.1.16 Name. PARAFORMALDEHYDE $\text{HO}(\text{CH}_2\text{O})_n\text{H}$ FW (30.03)n+18.02
 Paraform where n=8 to 100
 Polyoxymethylene

5.1.16.1 Technical description. Paraformaldehyde (pure) is a white solid. Paraformaldehyde decomposes and releases formaldehyde on heating. It dissolves in water with evolution of formaldehyde. It is insoluble in alcohol and ether. The physical properties and characteristics are as shown in Table XX. Paraformaldehyde, technical grade, is commercially available with purity of flakes between 91.0 and 93.0 percent, and fine powder between 95.0 and 97.0 percent.

TABLE XX. Paraformaldehyde - physical properties and characteristics.

Characteristic	Value
Density, g/cm ³	1.46
Melting range, °C	100 to 150
Sublimation temperature, °C	150
Vapor pressure in dry air, (30°C), mm Hg	1
(60°C), mm Hg	5
Flash point (closed cup), °F (°C)	158 (70)
Autoignition temperature, °F (°C)	572 (300)
Ignition temperature for dust cloud, °F (°C)	770 (410)
Explosive limits (gas), % by vol, Lower	7.0
Upper	73.0

5.1.16.2 Specifications. None.

5.1.16.2.1 Requirements. Refer to 5.1.16.1.

5.1.16.3 Use. Paraformaldehyde is intended for military use as a source of concentrated formaldehyde. Commercial uses are as a source of concentrated formaldehyde for the manufacture of resins, and for other applications of formaldehyde.

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5.1.16.4 Safety precautions.

5.1.16.4.1 Health hazard. Paraformaldehyde dusts and vapors are very irritating to the eyes and respiratory tract. There is no PEL for paraformaldehyde. The TLV for formaldehyde vapor is one ppm (1.5 mg/m^3), and it is a suspected carcinogen. Repeated skin contact with dust can cause a hardening effect and dermatitis. For personal protective measures, refer to 4.3.1.

5.1.16.4.2 Fire and explosion hazard. Paraformaldehyde is a combustible solid that gives off flammable formaldehyde vapor if heated. It is also capable of causing dust explosions.

5.1.16.4.3 Reactivity. Paraformaldehyde is reactive with alkalies, inorganic acids and anhydrides, isocyanates and oxidizing compounds.

5.1.16.5 Storage. Paraformaldehyde shall be stored in aluminum, stainless steel or lined carbon steel containers. Contact with galvanized iron, and copper and its alloys shall be avoided. Storage containers shall be kept in well-ventilated structures away from heat sources. Refer to 4.3.2.

5.1.16.6 Disposal. In case of spills, eliminate all sources of ignition. Spilled solid material shall be collected and transferred to salvage containers. For appropriate procedure, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. Refer to 4.4.4.

An EPA Hazardous Waste Classification is not listed in CFR 40.

5.1.17 Name. PARALDEHYDE $(\text{CH}_3\text{CHO})_3$ FW 132.16
Paracetaldehyde
2,4,6-Trimethyl-1,3,5-trioxane (IUPAC)

5.1.17.1 Technical description. Paraldehyde (pure) is a colorless liquid. It is slightly soluble in water, and miscible with alcohol, ether and chloroform. Paraldehyde decomposes to acetaldehyde by heating with acid. The physical properties and characteristics are as shown in Table XXI. Paraldehyde, technical grade, is commercially available with purity of 99 mol percent.

TABLE XXI. Paraldehyde - physical properties and characteristics.

Characteristic	Value
Specific gravity, d^{20}	0.9943
Refractive index, n_D^{20}	1.4049
Freezing point, °C	12.6
Boiling point (760 mm Hg), °C	128
Vapor pressure (20°C), mm Hg	26
Solubility in water (20°C), % by wt	10.5
Flash point (open cup), °F (°C)	96 (36)
Autoignition temperature, °F (°C)	460 (238)
Explosive limits, % by vol, Lower	1.3
Vapor density (air=1)	4.55

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5.1.17.2 Specifications. None.

5.1.17.2.1 Requirements. Refer to 5.1.17.1.

5.1.17.3 Use. Paraldehyde is intended for military use as a source of acetaldehyde. Commercial uses are as a source of acetaldehyde for the production of other organic compounds.

5.1.17.4 Safety precautions.

5.1.17.4.1 Health hazard. Paraldehyde vapor is an irritant to the eyes and respiratory tract, and in high concentrations can cause narcosis. There is no PEL or TLV for paraldehyde. The liquid is a skin irritant and can cause eye burns. For personal protective measures, refer to 4.3.1.

5.1.17.4.2 Fire and explosion hazard. Paraldehyde is a flammable liquid. Release of acetaldehyde can produce explosive vapor mixtures in air.

5.1.17.4.3 Reactivity. Paraldehyde is reactive with strong oxidizing compounds. It decomposes to acetaldehyde by heating with acids.

5.1.17.5 Storage. Paraldehyde shall be stored in aluminum, stainless steel or baked phenolic resin-lined carbon steel containers. Contact with galvanized iron, and copper and its alloys must be avoided. Storage containers shall be kept in well-ventilated structures away from heat sources. Refer to 4.3.2.

5.1.17.6 Disposal. In case of spills, eliminate all sources of ignition. Small spills shall be absorbed with a nonreactive absorbent and placed in sealed containers for disposal. Large spills shall be diked to prevent spreading and transferred to salvage containers. For appropriate procedure, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. Refer to 4.4.4.

EPA Hazardous Waste Classification - Ignitable (I) and Toxic (T); Waste Number U182.

5.1.18	<u>Name</u> . PROPIONALDEHYDE	CH ₃ CH ₂ CHO	FW 58.08
	Methylacetaldehyde		
	Propanal (IUPAC)		
	Propional		

5.1.18.1 Technical description. Propionaldehyde (pure) is a colorless liquid. It is soluble in water. It is miscible with acetone, alcohol, and ether. The physical properties and characteristics are as shown in Table XXII.

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TABLE XXII. Propionaldehyde - physical properties and characteristics.

Characteristic	Value
Specific gravity, d^{20}	0.8058
Refractive index, n_D^{20}	1.3636
Freezing point, °C	-81
Boiling point (760 mm Hg), °C	48.8
Vapor pressure (20°C), mm Hg	258
Solubility in water (20°C), % by wt	22
Flash point (closed cup), °F (°C)	-16 (-27)
Autoignition temperature, °F (°C)	405 (207)
Explosive limits, % by vol, Lower	2.6
Upper	16.1
Vapor density (air=1)	2.0

5.1.18.2 Specifications. None.

5.1.18.2.1 Requirements. Refer to 5.1.18.1.

5.1.18.3 Use. Propionaldehyde is intended for military use as a chemical intermediate. Commercial uses are as a chemical intermediate in the production of propionic acid and anhydride, propionitrile, acrylonitrile, and resins.

5.1.18.4 Safety precautions.

5.1.18.4.1 Health hazard. Propionaldehyde vapor is an irritant to the eyes and respiratory tract, and in high concentrations can cause narcosis and lung injury. There is no PEL or TLV established for propionaldehyde. The liquid is a severe eye irritant and a skin irritant. For personal protective measures, refer to 4.3.1.

5.1.18.4.2 Fire and explosion hazard. Propionaldehyde is a flammable liquid below 120°F (49°C), and can produce explosive vapor mixtures in air.

5.1.18.4.3 Reactivity. Propionaldehyde is reactive with strong oxidizing compounds, strong alkalies and mineral acids, and reactions can be vigorous. Contact with air can result in formation of explosive peroxides and peracids.

5.1.18.5 Storage. Propionaldehyde shall be stored in aluminum, stainless steel or baked phenolic resin-lined steel containers that have been purged with oxygen-free gas, and kept under nitrogen blanketing at a slight positive pressure. Cool storage is necessary to avoid excessive pressure. Contact with galvanized iron, and copper and its alloys shall be avoided. Refer to 4.3.2.

5.1.18.6 Disposal. In case of spills, eliminate all sources of ignition. Small spills shall be absorbed with a nonreactive absorbent and placed in sealed containers for disposal. Large spills shall be diked to prevent spreading and transferred to salvage containers. Water spray can be used to reduce the vapor hazard. For appropriate procedure, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. Refer to 4.4.4.

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EPA Hazardous Waste Classification - Ignitable (I); Waste Number D001.

5.1.19 Name. SALICYLALDEHYDE $\text{HOC}_6\text{H}_4\text{-CHO}$ FW 122.13
 o-Hydroxybenzaldehyde
 2-Hydroxybenzaldehyde
 Salicylic aldehyde

5.1.19.1 Technical description. Salicylaldehyde (pure) is a colorless liquid. It is slightly soluble in water, and very soluble in acetone and benzene. It is miscible with alcohol and ether. The physical properties and characteristics are as shown in Table XXIII. Salicylaldehyde, technical grade, is commercially available with a minimum purity of 98.5 percent by weight.

TABLE XXIII. Salicylaldehyde - physical properties and characteristics.

Characteristic	Value
Specific gravity, d_4^{20}	1.1674
Refractive index, n_D^{20}	1.5740
Freezing point, °C	-7
Boiling point (760 mm Hg), °C	197
Vapor pressure (33°C), mm Hg	1
Flash point (closed cup), °F (°C)	170 (77)

5.1.19.2 Specifications. None.

5.1.19.2.1 Requirements. Refer to 5.1.19.1.

5.1.19.3 Use. Salicylaldehyde is intended for military use as a chemical intermediate. Commercial uses are as a chemical intermediate, and for the production of coumarin.

5.1.19.4 Safety precautions.

5.1.19.4.1 Health hazard. Salicylaldehyde vapors can cause irritation of the upper respiratory tract. There is no PEL or TLV established for salicylaldehyde, but the manufacturer's industrial hygiene guide for inhalation is 5 mg/m^3 . The liquid can cause marked irritation of the eyes and some corneal injury or burn. The liquid can cause minor to moderate irritation of the skin by short exposure, and prolonged exposure can cause a moderate burn. For personal protective measures, refer to 4.3.1.

5.1.19.4.2 Fire and explosion hazard. Salicylaldehyde is a combustible liquid. The lower and upper explosion limits have not been determined.

5.1.19.4.3 Reactivity. Salicylaldehyde is reactive with strong oxidizing compounds.

5.1.19.5 Storage. Salicylaldehyde shall be stored in aluminum, stainless steel or polyethylene-lined steel containers under nitrogen blanketing at a slight positive pressure. Contact with galvanized iron, and copper and its alloys shall be avoided. Refer to 4.3.2.

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5.1.19.6 Disposal. Small spills shall be absorbed with a nonreactive absorbent and placed in sealed containers for disposal. Large spills shall be diked to prevent spreading and transferred to salvage containers. For appropriate procedure, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. Refer to 4.4.4.

An EPA Hazardous Waste Classification is not listed in CFR 40.

5.1.20 Name. TETRAHYDROBENZALDEHYDE $\text{CH}_2\text{CH}:\text{CHCH}_2\text{CH}_2\text{CHCHO}$ FW 110.16
 3-Cyclohexenecarboxaldehyde |
 3-Cyclohexene-1-carboxaldehyde |
 1,2,3,6-Tetrahydrobenzaldehyde

5.1.20.1 Technical description. Tetrahydrobenzaldehyde (pure) is a colorless liquid. It is very slightly soluble in water. It is soluble in acetone and methyl alcohol. The physical properties and characteristics are as shown in Table XXIV. Tetrahydrobenzaldehyde, technical grade, is commercially available with a minimum purity of 99.5 percent by weight.

TABLE XXIV. Tetrahydrobenzaldehyde - physical properties and characteristics.

Characteristic	Value
Specific gravity, d^{20}	0.9709
Refractive index, n_D^{19}	1.4725
Freezing point, °C	-96.1
Boiling point (760 mm Hg), °C	164
Vapor pressure (20°C), mm Hg	2
Solubility in water (20°C), % by wt	0.5
Flash point (closed cup), °F (°C)	115 (46)
Vapor density (air=1)	3.80

5.1.20.2 Specifications. None.

5.1.20.2.1 Requirements. Refer to 5.1.20.1.

5.1.20.3 Use. Tetrahydrobenzaldehyde is intended for military use as a chemical intermediate and as a solvent for resins. Commercial uses are as a chemical intermediate, as a solvent for resins, and as a water-resistant treatment for textiles.

5.1.20.4 Safety precautions.

5.1.20.4.1 Health hazard. Tetrahydrobenzaldehyde vapor is harmful if inhaled. There is no PEL or TLV established for tetrahydrobenzaldehyde. The liquid can cause burns to the eyes, and can be irritating to the skin. For personal protective measures, refer to 4.3.1.

5.1.20.4.2 Fire and explosion hazard. Tetrahydrobenzaldehyde is a combustible liquid. The lower and upper explosion limits have not been determined.

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5.1.20.4.3 Reactivity. Tetrahydrobenzaldehyde is reactive with strong oxidizing compounds.

5.1.20.5 Storage. Tetrahydrobenzaldehyde shall be stored in stainless steel or baked phenolic resin-lined steel containers under nitrogen blanketing at a slight positive pressure. Contact with galvanized iron, and copper and its alloys must be avoided. Refer to 4.3.2.

5.1.20.6 Disposal. In case of spills, eliminate all sources of ignition. Small spills shall be absorbed with a nonreactive absorbent and placed in sealed containers for disposal. Large spills shall be diked to prevent spreading and transferred to salvage containers. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. Refer to 4.4.4.

EPA Hazardous Waste Classification - Ignitable (I); Waste Number D001.

5.1.21 Name. TRIOXANE $(\text{CH}_2\text{O})_3$ FW 90.08
 Metaformaldehyde
 Sym-Trioxane
 Trioxin
 1,3,5-Trioxane
 α -Trioxymethylene

5.1.21.1 Technical description. Trioxane (pure) is a white solid. It is very soluble in water, and soluble in alcohols, ethers, esters, ketones, aromatic hydrocarbons, and chlorinated hydrocarbons. It decomposes to formaldehyde on heating over an acidic catalyst.

5.1.21.2 Specifications. MIL-F-10805, Fuel, Compressed, Trioxane, Ration Heating.

5.1.21.2.1 Requirements. The physical properties and characteristics are as shown in Tables XXV and XXVI. Trioxane, technical grade, is commercially available with a minimum purity of 99.0 percent by weight.

TABLE XXV. Trioxane - physical properties and characteristics.

Characteristic	Value
Specific gravity, d_{19}^{65}	1.17
Refractive index, n_D	1.43786
Melting point, °C	61.6
Boiling point (760 mm Hg), °C	114.4
Vapor pressure (20°C), mm Hg	10
Flash point (closed cup), °F (°C)	<30 (<-1)
Autoignition temperature, °F (°C)	777 (414)
Explosive limits, % by vol, Lower	3.6
Upper	29.0

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TABLE XXVI. Compressed fuel, trioxane - requirements.

Characteristic	Value
Trioxane, % by wt, min	95.0
Magnesium stearate (calculated as residue after burning) % by wt, max	5.0
Dye (methylene blue)	As required

5.1.21.3 Use. Trioxane is intended for military use in a compressed solid fuel formulation for the heating of food rations. Commercial use is as a source of pure anhydrous formaldehyde.

5.1.21.4 Safety precautions.

5.1.21.4.1 Health hazard. When decomposed into formaldehyde vapor, it is very irritating to the eyes and respiratory tract. The TLV of formaldehyde vapor is one ppm (1.5 mg/m³), and it is a suspected carcinogen. Solid trioxane is irritating to the eyes, and repeated and prolonged skin contact can result in irritation. For personal protective measures, refer to 4.3.1.

5.1.21.4.2 Fire and explosion hazard. Trioxane is a combustible solid that can produce explosive vapor mixtures in air. It can explode if heated in a sealed container.

5.1.21.4.3 Reactivity. Trioxane is reactive with strong oxidizing compounds.

5.1.21.5 Storage. Trioxane shall be stored in aluminum, stainless steel, or plastic-lined fiber shipping drums in a cool, well-ventilated area. Refer to 4.3.2.

5.1.21.6 Disposal. In case of spills, eliminate all sources of ignition. Spilled shall be collected and transferred to salvage containers. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. Refer to 4.4.4.

EPA Hazardous Waste Classification - Ignitable (I); Waste Number D001.

5.1.22 Name. VALERALDEHYDE CH₃(CH₂)₃CHO FW 86.14
 Amyl aldehyde
 Pentanal (IUPAC)
 Valeral

5.1.22.1 Technical description. Valeraldehyde (pure) is a colorless liquid. It is slightly soluble in water, and soluble in alcohol and ether. The physical properties and characteristics are as shown in Table XXVII.

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TABLE XXVII. Valeraldehyde - physical properties and characteristics.

Characteristic	Value
Specific gravity, d^{20}	0.8095
Refractive index, n_b^{20}	1.3944
Purity, % by wt	98.5
Freezing point, °C	-91.5
Boiling point (760 mm Hg), °C	103
Vapor pressure (20°C), mm Hg	26
Solubility in water (20°C), % by wt	1.35
Flash point (closed cup), °F (°C)	41 (5)
Explosive limits, % by vol, Lower	2.1
Upper	7.8
Vapor density (air=1)	3.0

5.1.22.2 Specifications. None.

5.1.22.2.1 Requirements. Refer to 5.1.22.1.

5.1.22.3 Use. Valeraldehyde is intended for military use as a chemical intermediate. Commercial use is as a chemical intermediate.

5.1.22.4 Safety precautions.

5.1.22.4.1 Health hazard. Valeraldehyde vapor is an irritant to the eyes and respiratory tract. The TLV is 50 ppm (175 mg/m³). The liquid can cause eye burns and skin irritation. For personal protective measures, refer to 4.3.1.

5.1.22.4.2 Fire and explosion hazard. Valeraldehyde is a flammable liquid that can produce explosive vapor mixtures in air.

5.1.22.4.3 Reactivity. Valeraldehyde is reactive with strong oxidizing compounds, strong alkalies and mineral acids, and reactions can be vigorous. Contact with air can result in formation of explosive peroxides and peracids. Hazardous polymerization can occur.

5.1.22.5 Storage. Valeraldehyde shall be stored aluminum, stainless steel or baked phenolic resin-lined steel containers that have been purged with oxygen-free gas, and kept under nitrogen blanketing at a slight positive pressure. Contact with galvanized iron, and copper and its alloys must be avoided. Refer to 4.3.2.

5.1.22.6 Disposal. In case of spills, eliminate all sources of ignition. Small spills shall be absorbed with a nonreactive absorbent and placed in sealed containers for disposal. Large spills shall be diked to prevent spreading and transferred to salvage containers. Water spray can be applied to reduce the fire hazard. For appropriate procedure, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. Refer to 4.4.4.

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5.2 Ketones. Ketones are characterized by one or more carbonyl groups within a hydrocarbon structure. The carbonyl carbon atom is bonded to two other carbon atoms. The non-terminal location of the carbonyl group contributes solvent power and stability to these compounds. Solvent characteristics and volatility are determined by the length and structure of the hydrocarbon groups and their substituents attached to the two remaining positions on the carbon atom of the carbonyl group. The carbonyl group is capable of undergoing many addition and oxidation-reduction reactions, and it increases the activity of adjacent groups. In diketones, these reaction properties are enhanced. Diketones can also function as chelating agents. Ketones are employed as solvents for vinyl resins, cellulose esters and ethers, nitrocellulose lacquers, pharmaceuticals, dyestuff stripping, rubber latex coagulation, paint and varnish removers, explosives and propellants, and lubricating oil dewaxing. Ketones are also employed as intermediates for the manufacture of resins, dyes, plasticizers, insecticides, inhibitors, rubber antiozonants, flotation agents, and pharmaceuticals.

5.2.1 Name. ACETONE CH₃COCH₃ FW 58.08
 Dimethylketone
 2-Propanone (IUPAC)

5.2.1.1 Technical description. Acetone (pure) is a colorless liquid. It is miscible with water, alcohols, ethers, esters, ketones, liquid hydrocarbons, and chloroform. The physical properties and characteristics are as shown in Table XXVIII. Acetone, technical grade, is commercially supplied in a purity not less than 99.5 percent by weight (H₃COCH₃).

TABLE XXVIII. Acetone - physical properties and characteristics.

Characteristic	Value
Specific gravity, d_{20}^{20}	0.7899
Refractive index, n_D^{20}	1.3588
Freezing point, °C	-95.35
Boiling point (760 mm Hg), °C	56.2
Vapor pressure (20°C), mm Hg	186
Flash point (closed cup), °F (°C)	0 (-18)
Autoignition temperature, °F (°C)	1000 (538)
Explosive limits, % by vol, Lower	3
Upper	13
Vapor density (air=1)	2.0

5.2.1.2 Specifications. O-A-51, Acetone, Technical; ASTM D 329, Standard Specification for Acetone.

5.2.1.2.1 Requirements. The physical and chemical characteristics of acetone are as shown in Table XXIX. Acetone shall have no residual odor and shall be miscible with water in all proportions.

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TABLE XXIX. Acetone - physical and chemical characteristics.

Characteristic	Requirement			
	O-A-51		ASTM D 329	
	Minimum	Maximum	Minimum	Maximum
Specific gravity d_4^{20}	0.7910	0.7930	0.7905	0.7930
d_4^{25}	---	---	0.7860	0.7885
Color (Pt-Co scale)	---	5	---	5
Distillation range (760 mm Hg), °C	56. ^{1/}		56. ^{1/}	
Permanganate reduction time (25°C in the dark), hrs	0.5	---	0.5	---
Water, % by wt	---	0.50	---	0.5
Alkalinity (as NH ₃), % by wt	---	0.001	---	0.001
Acidity (free acid as acetic acid), % by wt	---	0.002	---	0.002 ^{2/}
Nonvolatile matter, g/100 ml	---	0.005	---	---
Aldehydes (HCHO), % by wt	---	0.002	---	---

^{1/} Within the degree Celsius including the temperature shown.

^{2/} Equivalent to 0.019 mg KOH/g of sample.

5.2.1.3 Use. Acetone is intended for military use as a solvent for various substances and for use in the manufacture of explosives and propellants. Commercial uses are as a solvent and as an intermediate for the production of methacrylate resins. It is also used as an absorbent for acetylene in gas cylinders.

5.2.1.4 Safety precautions.

5.2.1.4.1 Health hazard. Acetone vapor is an irritant to the eyes and respiratory tract, and in high concentrations can cause narcosis and unconsciousness. The PEL is 750 ppm (1000 mg/m³), and the TLV is 750 ppm (1780 mg/m³). The liquid is an eye and skin irritant, and can be absorbed by the skin. For personal protective measures, refer to 4.3.1.

5.2.1.4.2 Fire and explosion hazard. Acetone is a very volatile and flammable liquid that can produce explosive vapor mixtures in air.

5.2.1.4.3 Reactivity. Acetone is reactive with strong oxidizing compounds.

5.2.1.5 Storage. Acetone shall be stored in steel containers in a cool, well-ventilated space away from sources of ignition. A container lined with zinc silicate coating or baked phenolic resin can be used for long term storage to improve product stability. Refer to 4.3.2.

5.2.1.6 Disposal. In case of spills, eliminate all sources of ignition. Small spills shall be absorbed with a nonreactive absorbent and placed in sealed containers for disposal. Large spills shall be diked to prevent spreading and transferred to salvage containers. Water spray can be used to reduce the vapor hazard. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. Refer to 4.4.4.

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5.2.2 Name. ACETOPHENONE (IUPAC) $C_6H_5COCH_3$ FW 120.16
 Acetylbenzene
 Methylphenylketone
 Phenylmethylketone

5.2.2.1 Technical description. Acetophenone (pure) is a colorless liquid or white solid. It is very slightly soluble in water. It is miscible with alcohol, ether, acetone, benzene, and chloroform. The physical properties and characteristics are as shown in Table XXX. Acetophenone, technical grade, is commercially available with a minimum purity of 99.0 percent by weight.

TABLE XXX. Acetophenone - physical properties and characteristics.

Characteristic	Value
Specific gravity, d^{20}	1.0281
Refractive index, n_D^{20}	1.53718
Freezing point, °C	20.5
Boiling point (760 mm Hg), °C	202
Vapor pressure (20°C), mm Hg	0.3
Solubility in water (20°C), % by wt	0.55
Flash point (closed cup), °F (°C)	180 (82)
Autoignition temperature, °F (°C)	1060 (571)
Vapor density (air=1)	4.1

5.2.2.2 Specifications. None.

5.2.2.2.1 Requirements. Refer to 5.2.2.1.

5.2.2.3 Use. Acetophenone is intended for military use in solvent mixtures as a very slow evaporating solvent in the formulation of organic surface coatings. Commercial uses are as a solvent component for cellulose esters and ethers, and vinyl resins in surface coatings. It is also used as a chemical intermediate.

5.2.2.4 Safety precautions.

5.2.2.4.1 Health hazard. Acetophenone vapor is an irritant to the eyes and upper respiratory tract, and in high concentrations can cause narcosis. There is no PEL or TLV for acetophenone. The liquid is an eye and skin irritant. For personal protective measures, refer to 4.3.1.

5.2.2.4.2 Fire and explosion hazard. Acetophenone is a combustible liquid that can produce explosive vapor mixtures in air on heating.

5.2.2.4.3 Reactivity. Acetophenone is reactive with strong oxidizing compounds.

5.2.2.5 Storage. Acetophenone shall be stored in steel containers in a cool, well-ventilated space away from sources of ignition. A container lined

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with zinc silicate coating or baked phenolic resin can be used for long term storage to improve product stability. Storage above 68°F (20°C) is necessary if the product is to be kept in a liquid state. Refer to 4.3.2.

5.2.2.6 Disposal. In case of dry spills, gather up and place in containers. In case of liquid spills, eliminate all sources of ignition. Small spills shall be absorbed with a nonreactive absorbent and placed in sealed containers for disposal. Large spills shall be diked to prevent spreading and transferred to salvage containers. Water spray can be used to reduce the vapor hazard. For appropriate procedure, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. Refer to 4.4.4.

EPA Hazardous Waste Classification - Toxic (T); Waste Number U004.

5.2.3 Name. ACETYLACETONE $\text{CH}_3\text{COCH}_2\text{COCH}_3$ FW 100.13
 Diacetylmethane
 2,4-Pentanedione (IUPAC)

5.2.3.1 Technical description. Acetylacetone (pure) is a colorless liquid. It is soluble in water. It is miscible with acetone, alcohols, ethers, benzene, chloroform, and polar organic solvents. Acetylacetone forms metal chelates with transition-metals. The physical properties and characteristics are as shown in Table XXXI.

TABLE XXXI. Acetylacetone - physical properties and characteristics.

Characteristic	Value
Assay, as 2,4-pentanedione, % by wt, min	95
Specific gravity d_{20}^{20}	0.973
d_{20}^{20}	0.972 - 0.978
Refractive index, n_D^{20}	1.4494
Freezing point, °C	-23
Boiling point (760 mm Hg), °C	140
Vapor pressure (20°C), mm Hg	7
Solubility in water (20°C), % by wt	16.6
Flash point (closed cup), °F (°C)	94 (34)
Vapor density (air=1)	3.5

5.2.3.2 Specifications. None.

5.2.3.2.1 Requirements. Refer to 5.2.3.1.

5.2.3.3 Use. Acetylacetone is intended for military use in solid propellants for rocket motors. Commercial uses are as a solvent for cellulose acetate, as a chelating agent for the preparation of transition-metal acetylacetonates, and as a fuel additive.

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5.2.3.4 Safety precautions.

5.2.3.4.1 Health hazard. Acetylacetone vapor is an irritant to the eyes and upper respiratory tract, and in high concentrations can cause narcosis. There is no PEL or TLV for acetylacetone. The liquid is an eye and skin irritant. For personal protective measures, refer to 4.3.1.

5.2.3.4.2 Fire and explosion hazard. Acetylacetone is a flammable liquid that can produce explosive vapor mixtures in air on heating.

5.2.3.4.3 Reactivity. Acetylacetone is reactive with strong oxidizing compounds.

5.2.3.5 Storage. Acetylacetone shall be stored in stainless steel containers or glass-lined tanks in a cool, well-ventilated space away from sources of ignition. Free iron should be removed from stainless steel surfaces to prevent formation of a soluble, highly colored iron chelate. Refer to 4.3.2.

5.2.3.6 Disposal. In case of spills, eliminate all sources of ignition. Small spills shall be absorbed with a nonreactive absorbent and placed in sealed containers for disposal. Large spills shall be diked to prevent spreading and transferred to salvage containers. Water spray can be used to reduce the vapor hazard. For appropriate procedure, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. Refer to 4.4.4.

EPA Hazardous Waste Classification - Ignitable (I); Waste Number D001.

5.2.4 <u>Name.</u>	CYCLOHEXANONE (IUPAC)	$\text{CO}(\text{CH}_2)_4\text{CH}_2$	FW 98.15
	Cyclohexyl ketone	_____	
	Ketohexamethylene		
	Pimelic ketone		

5.2.4.1 Technical description. Cyclohexanone (pure) is a colorless liquid. It is slightly soluble in water. It is miscible with acetone, alcohol, ether, benzene and chloroform. The physical properties and characteristics are as shown in Table XXXII. Cyclohexanone, technical grade, is commercially available with a minimum purity of 99 mol percent.

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TABLE XXXII. Cyclohexanone - physical properties and characteristics.

Characteristic	Value
Specific gravity, d^{20}	0.9478
Refractive index, n_D^{20}	1.4507
Freezing point, °C	-16.4
Boiling point (760 mm Hg), °C	156
Vapor pressure (20°C), mm Hg	2
Solubility in water (20°C), % by wt	2.5
Flash point (closed cup), °F (°C)	111 (44)
Autoignition temperature, °F (°C)	788 (420)
Explosive limits, % by vol, Lower	1.1
Upper	8.1
Vapor density (air=1)	3.4

5.2.4.2 Specifications. None.

5.2.4.2.1 Requirements. Refer to 5.2.4.1.

5.2.4.3 Use. Cyclohexanone is intended for military use, where a slow evaporating solvent and a high boiling point is desired, in the formulation of organic surface coatings. Commercial uses are as a solvent component for resins such as nitrocellulose, cellulose acetate, vinyls, and for natural resins such as nitrocellulose, cellulose acetate, vinyls, and for natural resins in surface coatings, and for waxes and crude rubber. It is also useful as a solvent in cleaning compounds, and as a dye solvent. It is a chemical intermediate for the production of adipic acid.

5.2.4.4 Safety precautions.

5.2.4.4.1 Health hazard. Cyclohexanone vapor is an irritant to the eyes and upper respiratory tract, and in high concentration can cause mild narcosis. The PEL is 25 ppm (100 mg/m³), and the TLV is 25 ppm (100 mg/m³). The liquid is an eye and skin irritant. For personal protective measures, refer to 4.3.1.

5.2.4.4.2 Fire and explosion hazard. Cyclohexanone is a combustible liquid that can produce explosive vapor mixtures in air on heating.

5.2.4.4.3 Reactivity. Cyclohexanone is reactive with strong oxidizing compounds.

5.2.4.5 Storage. Cyclohexanone shall be stored in steel containers in a cool, well-ventilated space away from sources of ignition. A container lined with zinc silicate coating or baked phenolic resin can be used for long term storage to improve product stability. Refer to 4.3.2.

5.2.4.6 Disposal. In case of spills, eliminate all sources of ignition. Small spills shall be absorbed with a nonreactive absorbent and placed in sealed containers for disposal. Large spills shall be diked to prevent spreading and transferred to salvage containers. Water spray can be used to reduce the vapor

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hazard. For appropriate procedure, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. Refer to 4.4.4.

EPA Hazardous Waste Classification - Ignitable (I); Waste Number U057.

5.2.5 Name. DIACETONE ALCOHOL $\text{CH}_3\text{COCH}_2\text{C}(\text{OH})(\text{CH}_3)_2$ FW 116.16
 4-Hydroxy-2-keto-4-methylpentane
 4-Hydroxy-4-methyl-2-pentanone (IUPAC)
 Methyl 2-hydroxyisobutyl ketone

5.2.5.1 Technical description. Diacetone alcohol (pure) is a colorless liquid. It is miscible with water, alcohol, ether, and most polar organic solvents. The physical properties and characteristics are as shown in Table XXXIII.

TABLE XXXIII. Diacetone alcohol - physical properties and characteristics.

Characteristic	Value
Freezing point, °C	-44
Boiling point (760 mm Hg), °C	169
Vapor pressure (20°C), mm Hg	0.81
Flash point (closed cup), °F (°C)	126 (52)
Autoignition temperature, °F (°C)	1117 (603)
Explosive limits, % by vol, Lower	1.8
Upper	6.9
Vapor density (air=1)	4.0

5.2.5.2 Specifications. O-D-306, Diacetone Alcohol, Technical (Acetone-Free); ASIM D 2627, Diacetone Alcohol.

5.2.5.2.1 Requirements. The requirements for diacetone alcohol are shown in Table XXXIV. Diacetone alcohol shall be miscible with water in all proportions at 20°C.

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TABLE XXXIV. Physical and chemical characteristics of diacetone alcohol.

Characteristic	Requirement			
	D-D-306		ASTM D 2627	
	Minimum	Maximum	Minimum	Maximum
Specific gravity			0.938	0.941
d_{4}^{20}	0.937	0.942	0.935	0.938
d_{4}^{25}	---	---	---	25
Color (Pt-Co scale)	---	25	---	0.01 ^{1/2}
Acidity (free acid as acetic acid), % by wt	---	0.01	---	---
Refractive index, D_{D}^{20}	1.4150	1.4250	---	---
Alkalinity (as NaOH), %	---	0.001	---	---
Distillation range, °C	---	---	145	172
Nonvolatile matter, g/100 ml	---	---	---	0.01
Water, % by wt	---	---	---	0.1
Dryness (as turbidity in gasoline)	---	None	---	---

^{1/2} Equivalent to 0.1 mg KOH/g of sample.

5.2.5.3 Use. Diacetone alcohol is intended for military use in the manufacture of organic protective coatings, as a constituent of hydraulic fluid, and as a special solvent. Commercial uses are as a slow evaporating solvent for natural and synthetic lacquer resins including vinyl types; cellulose ethers and esters; and epoxy resins. It is also used as a special solvent for oils, fats, tars, dyes, waxes and rubbers, and in pentachlorophenol wood preservative solutions.

5.2.5.4 Safety precautions.

5.2.5.4.1 Health hazard. Diacetone alcohol vapor is an irritant to the eyes and upper respiratory tract, and in high concentrations can cause narcosis. Prolonged exposure to high concentrations can cause anemia and damage to kidneys and liver. The PEL and TLV is 50 ppm (240 mg/m³). The liquid is a strong eye and skin irritant. For personal protective measures, refer to 4.3.1.

5.2.5.4.2 Fire and explosion hazard. Diacetone alcohol is a combustible liquid that can produce explosive vapor mixtures in air on heating.

5.2.5.4.3 Reactivity. Diacetone alcohol is reactive with strong oxidizing agents.

5.2.5.5 Storage. Diacetone alcohol shall be stored in steel containers in a cool, well-ventilated space away from sources of ignition. A container lined with zinc silicate coating or baked phenolic resin can be used for long term storage to improve product stability. Refer to 4.3.2.

5.2.5.6 Disposal. In case of spills, eliminate all sources of ignition. Small spills shall be absorbed with a nonreactive absorbent and placed in sealed containers for disposal. Large spills shall be diked to prevent spreading and transferred to salvage containers. Water spray can be used to reduce the vapor hazard. For appropriate procedure, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. Refer to 4.4.4.

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EPA Hazardous Waste Classification - Ignitable (I); Waste Number D001.

5.2.6 Name. DIETHYL KETONE $\text{CH}_3\text{CH}_2\text{COCH}_2\text{CH}_3$ FW 86.14
3-Pentanone (IUPAC)

5.2.6.1 Technical description. Diethyl ketone (pure) is a colorless liquid. It is slightly soluble in water. It is miscible with acetone, alcohols, ethers, and liquid hydrocarbons. The physical properties and characteristics are as shown in Table XXXV. Diethyl ketone, technical grade, is commercially available with a minimum purity of 99 percent by weight.

TABLE XXXV. Diethyl ketone - physical properties and characteristics.

Characteristic	Value
Specific gravity, d^{20}	0.8138
Refractive index, n_D^{20}	1.3924
Freezing point, °C	-39.8
Boiling point (760 mm Hg), °C	101.7
Vapor pressure (20°C), mm Hg	27
Solubility in water (20°C), % by wt	3.4
Flash point (closed cup), °F (°C)	55 (13)
Autoignition temperature, °F (°C)	846 (452)
Vapor density (air=1)	3.0
	4.0

5.2.6.2 Specifications. None.

5.2.6.2.1 Requirements. Refer to 5.2.6.1.

5.2.6.3 Use. Diethyl ketone, technical grade, is intended for military use as a solvent and chemical intermediate. Commercial uses are the same.

5.2.6.4 Safety precautions.

5.2.6.4.1 Health hazard. Diethyl ketone vapor is irritating to the eyes and respiratory tract, and in high concentrations can cause narcosis and lack of coordination. The TLV and PEL are 200 ppm (705 mg/m³). The liquid is an eye and skin irritant and can be absorbed by the skin. For personal protective measures, refer to 4.3.1.

5.2.6.4.2 Fire and explosion hazard. Diethyl ketone is a volatile and flammable liquid that can produce explosive vapor mixtures in air.

5.2.6.4.3 Reactivity. Diethyl ketone is reactive with strong oxidizing compounds.

5.2.6.5 Storage. Diethyl ketone shall be stored in steel containers in a cool, well-ventilated space away from sources of ignition. A container lined with zinc silicate coating or baked phenolic resin can be used for long term storage to improve product stability. Refer to 4.3.2.

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5.2.6.6 Disposal. In case of spills, eliminate all sources of ignition. Small spills shall be absorbed with a nonreactive absorbent and placed in sealed containers for disposal. Large spills shall be diked to prevent spreading and transferred to salvage containers. Water spray can be used to reduce the vapor hazard. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. Refer to 4.4.4.

EPA Hazardous Waste Classification - Ignitable (I); Waste Number D001.

5.2.7 Name. DIISOBUTYL KETONE $(\text{CH}_3)_2\text{CHCH}_2\text{COCH}_2\text{CH}(\text{CH}_3)_2$ FW 142.24
2,6-Dimethyl-4-heptanone (IUPAC)
Isovalerone

5.2.7.1 Technical description. Diisobutyl ketone (pure) is a colorless liquid. It is insoluble in water. It is miscible with acetone, alcohols, ethers, and liquid hydrocarbons. The physical properties and characteristics are as shown in Table XXXVI. Diisobutyl ketone, technical grade, is commercially available without a minimum assay requirement, but with a boiling range of 163° to 173°C at 760 mm Hg.

TABLE XXXVI. Diisobutyl ketone - physical properties and characteristics.

Characteristic	Value
Specific gravity (20°/4°C)	0.8053
Refractive index (21°C)	1.412
Freezing point, °C	-42
Boiling point (760 mm Hg), °C	168
Vapor pressure (20°C), mm Hg	1.7
Solubility in water (20°C), % by wt	0.05
Flash point (closed cup), °F (°C)	118 (48)
Autoignition temperature, °F (°C)	745 (396)
Explosive limits, % by vol, Lower	0.81
Upper	7.1
Vapor density (air=1)	4.9

5.2.7.2 Specifications. None.

5.2.7.2.1 Requirements. Refer to 5.2.7.1.

5.2.7.3 Use. Diisobutyl ketone is intended for military use as a high-boiling ketone with moderate solvent activity for cellulose nitrate and vinyl copolymers. It is useful in cellulose nitrate emulsions, and in polyvinyl chloride organosols. Commercial uses are the same.

5.2.7.4 Safety precautions.

5.2.7.4.1 Health hazard. Diisobutyl ketone vapor is irritating to the eyes and respiratory tract, and in high concentrations can cause narcosis. The PEL and TLV are 25 ppm (150 mg/m³). The liquid is an eye and skin irritant. For personal protective measures, refer to 4.3.1.

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5.2.7.4.2 Fire and explosion hazard. Diisobutyl ketone is a combustible liquid that can produce explosive vapor mixtures in air on heating.

5.2.7.4.3 Reactivity. Diisobutyl ketone is reactive with strong oxidizing compounds.

5.2.7.5 Storage. Diisobutyl ketone shall be stored in steel containers in a cool, well-ventilated space away from sources of ignition. A container lined with zinc silicate coating or baked phenolic resin can be used for long term storage to improve product stability. Refer to 4.3.2.

5.2.7.6 Disposal. In case of spills, eliminate all sources of ignition. Small spills shall be absorbed with a nonreactive absorbent and placed in sealed containers for disposal. Large spills shall be diked to prevent spreading and transferred to salvage containers. Water spray can be used to reduce the vapor hazard. For appropriate procedure, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. Refer to 4.4.4.

EPA Hazardous Waste Classification - Ignitable (I); Waste Number D001.

5.2.8 Name. ETHYL AMYL KETONE $\text{CH}_3\text{CH}_2\text{COCH}_2\text{CH}(\text{CH}_3)\text{CH}_2\text{CH}_3$ FW 128.22
Ethyl-2-methylbutyl ketone
5-Methyl-3-heptanone (IUPAC)

5.2.8.1 Technical description. Ethyl amyl ketone (commercial name) is a colorless liquid. It is very slightly soluble in water. It is miscible with acetone, alcohols, ethers, and liquid hydrocarbons. The physical properties and characteristics are as shown in Table XXXVII. Ethyl amyl ketone, technical grade, is commercially available, without a purity designation, with a distillation range of 156 to 162°C.

TABLE XXXVII. Ethyl amyl ketone - physical properties and characteristics.

Characteristic	Value
Specific gravity, d_4^{20}	0.821
Refractive index, n_D^{20}	1.4149
Freezing point, °C	-57
Boiling point (760 mm Hg), °C	159.2
Vapor pressure (20°C), mm Hg	2.1
Solubility in water (20°C), % by wt	0.26
Flash point (closed cup), °F (°C)	111 (43)
Vapor density (air=1)	4.4

5.2.8.2 Specifications. None.

5.2.8.2.1 Requirements. Refer to 5.2.8.1.

5.2.8.3 Use. Ethyl amyl ketone is intended for military use as a slower evaporating solvent than methyl isobutyl ketone, and where high solvency is desired in the formulation of organic surface coatings. Commercial uses are as a solvent for cellulose esters, vinyl polymer and copolymers, and coating resins for the formulation of surface coatings.

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5.2.8.4 Safety precautions.

5.2.8.4.1 Health hazard. Ethyl amyl ketone vapor is moderately irritating to the eyes and upper respiratory tract, and in high concentrations can cause narcosis. The PEL or TLV is 25 ppm (130 mg/m³). The liquid is an eye and skin irritant. For personal protective measures, refer to 4.3.1.

5.2.8.4.2 Fire and explosion hazard. Ethyl amyl ketone is a combustible liquid that can produce explosive vapor mixtures in air on heating.

5.2.8.4.3 Reactivity. Ethyl amyl ketone is reactive with strong oxidizing compounds.

5.2.8.5 Storage. Ethyl amyl ketone shall be stored in steel containers in a cool, well-ventilated space away from sources of ignition. A container lined with zinc silicate coating or baked phenolic resin can be used for long term storage to improve product stability. Refer to 4.3.2.

5.2.8.6 Disposal. In case of spills, eliminate all sources of ignition. Small spills shall be absorbed with a nonreactive absorbent and placed in sealed containers for disposal. Large spills shall be diked to prevent spreading and transferred to salvage containers. Water spray can be used to reduce the vapor hazard. For appropriate procedure, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. Refer to 4.4.4.

EPA Hazardous Waste Classification - Ignitable (I); Waste Number D001.

5.2.9 Name. ETHYL BUTYL KETONE $\text{CH}_3\text{CH}_2\text{CO}(\text{CH}_2)_3\text{CH}_3$ FW 114.19
Ethyl n-butyl ketone
3-Heptanone (IUPAC)

5.2.9.1 Technical description. Ethyl butyl ketone (pure) is a colorless liquid. It is very slightly soluble in water. It is miscible with acetone, alcohols, ethers and liquid hydrocarbons. The physical properties and characteristics are as shown in Table XXXVIII. Ethyl butyl ketone, technical grade, is commercially available with a minimum purity of 99 percent by weight.

TABLE XXXVIII. Ethyl butyl ketone - physical properties and characteristics.

Characteristic	Value
Specific gravity, d_{20}^{20}	0.8183
Refractive index, n_D^{20}	1.4057
Freezing point, °C	-39
Boiling point (765 mm Hg), °C	147
Vapor pressure (20°C), mm Hg	4
Solubility in water (20°C), % by wt	0.43
Flash point (closed cup), °F (°C)	99 (37)
Vapor density (air=1)	3.9

5.2.9.2 Specifications. None.

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5.2.9.2.1 Requirements. Refer to 5.2.9.1.

5.2.9.3 Use. Ethyl butyl ketone is intended for military use as a solvent where a slower evaporation rate than methyl isobutyl ketone is desired in the formulation of organic surface coatings. Commercial uses are as a solvent for coating resins in air dried and baked finishes.

5.2.9.4 Safety precautions.

5.2.9.4.1 Health hazard. Ethyl butyl ketone vapor is irritating to the eyes and respiratory tract, and in high concentrations can cause narcosis. The PEL or TLV is 50 ppm (230 mg/m³). The liquid is an eye and skin irritant. For personal protective measures, refer to 4.3.1.

5.2.9.4.2 Fire and explosion hazard. Ethyl butyl ketone is a flammable liquid that can produce explosive vapor mixtures in air on heating.

5.2.9.4.3 Reactivity. Ethyl butyl ketone is reactive with strong oxidizing compounds.

5.2.9.5 Storage. Ethyl butyl ketone shall be stored in steel containers in a cool, well-ventilated space away from sources of ignition. A container lined with zinc silicate coating or baked phenolic resin can be used for long term storage to improve product stability. Refer to 4.3.2.

5.2.9.6 Disposal. In case of spills, eliminate all sources of ignition. Small spills shall be absorbed with a nonreactive absorbent and placed in sealed containers for disposal. Large spills shall be diked to prevent spreading and transferred to salvage containers. For appropriate procedure, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. Refer to 4.4.4.

EPA Hazardous Waste Classification - Ignitable (I); Waste Number D001.

5.2.10 Name. ISOBUTYL HEPTYL KETONE FW 184.32
 $(\text{CH}_3)_2\text{CHCH}_2\text{COCH}_2\text{CH}(\text{CH}_3)\text{CH}_2\text{CH}(\text{CH}_3)_2$
 Isobutyl 2-methylisoheptyl ketone
 2,6,8-Trimethyl-4-nonanone (IUPAC)

5.2.10.1 Technical description. Isobutyl heptyl ketone (commercial name) is a colorless liquid. It is insoluble in water. It is miscible with liquid hydrocarbons. The physical properties and characteristics are as shown in Table XXXIX. Isobutyl heptyl ketone, technical grade, is commercially available with a minimum purity of 95 percent by weight.

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TABLE XXXIX. Isobutyl heptyl ketone - physical properties and characteristics.

Characteristic	Value
Specific gravity, d_4^{20}	0.816
Refractive index, n_D^{20}	1.4257
Freezing point, °C	-75
Boiling point (760 mm Hg), °C	218.2
Vapor pressure (20°C), mm Hg	<0.1
Solubility in water (20°C), % by wt	<0.01
Flash point (closed cup), °F (°C)	189 (87.2)
Vapor density (air=1)	6.3

5.2.10.2 Specifications. None.

5.2.10.2.1 Requirements. Refer to 5.2.10.1.

5.2.10.3 Use. Isobutyl heptyl ketone is intended for military use where a very slow evaporating solvent and a very high boiling point is desired in the formulation of organic surface coatings. Commercial uses are the same.

5.2.10.4 Safety precautions.

5.2.10.4.1 Health hazard. Isobutyl heptyl ketone vapor is slightly irritating to the eyes and upper respiratory tract. There is no PEL or TLV for isobutyl heptyl ketone. The liquid is a slight eye and skin irritant. For personal protective measures, refer to 4.3.1.

5.2.10.4.2 Fire and explosion hazard. Isobutyl heptyl ketone is a combustible liquid that can produce explosive vapor mixtures in air on heating.

5.2.10.4.3 Reactivity. Isobutyl heptyl ketone is reactive with strong oxidizing compounds.

5.2.10.5 Storage. Isobutyl heptyl ketone shall be stored in steel containers in a cool, well-ventilated space away from sources of ignition. A container lined with zinc silicate coating or baked phenolic resin can be used for long term storage to improve product stability. Refer to 4.3.2.

5.2.10.6 Disposal. In case of spills, eliminate all sources of ignition. Small spills shall be absorbed with a nonreactive absorbent and placed in sealed containers for disposal. Large spills shall be diked to prevent spreading and transferred to salvage containers. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. Refer to 4.4.4.

An EPA Hazardous Waste Classification is not listed in CFR 40.

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5.2.11 Name. ISOPHORONE $\text{COCH:C(CH}_3\text{)CH}_2\text{C(CH}_3\text{)}_2\text{CH}_2$ FW 138.21
 Isoacetophorone
 3,5,5-Trimethyl-2-cyclohexen-1-one (IUPAC)

5.2.11.1 Technical description. Isophorone (pure) is a colorless liquid. It is slightly soluble in water. It is miscible with acetone, alcohol, ether and benzene. The physical properties and characteristics are as shown in Tables XL. Isophorone, technical grade, is commercially available with a minimum purity of 99.0 percent by weight including trimethylcyclohexanone.

TABLE XL. Isophorone - physical properties and characteristics.

Characteristic	Value
Refractive index, n_D^{20}	1.4759
Freezing point, °C	-8.1
Boiling point (760 mm Hg), °C	215
Vapor pressure (20°C), mm Hg	<1
Solubility in water, % by wt	1.2
Flash point (closed cup), °F (°C)	179 (81.7)
Autoignition temperature, °F (°C)	864 (462)
Explosive limits, % by vol, Lower	0.8
Upper	3.8
Vapor density (air=1)	4.8

5.2.11.2 Specifications. ASTM D 2916, Isophorone.

5.2.11.2.1 Requirements. The ASTM specification requirements for isophorone are shown in Table XLI. The odor of isophorone is characteristic of the material.

TABLE XLI. Isophorone - ASTM specification requirements.

Characteristic	Requirements	
	Min	Max
Apparent specific gravity		
d_{20}^{20}	0.921	0.923
d_{25}^{25}	0.918	0.918
Color (Pt-Co scale)	---	100
Distillation (760 mm Hg), °C		
Initial boiling point	210	---
95 percent point	---	218
Acidity as acetic acid, % by wt	---	0.02
Water, % by wt	---	0.1

5.2.11.3 Use. Isophorone is intended for military use in solvent mixtures as a very slow evaporating solvent in the formulation of organic surface coatings. Commercial uses are as a solvent component for nitrocellulose, cellulose esters and ethers, and vinyl resins in surface coatings.

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5.2.11.4 Safety precautions.

5.2.11.4.1 Health hazard. Isophorone vapor is an irritant to the eyes and upper respiratory tract, and in high concentrations can cause narcosis. The PEL is 4 ppm (20 mg/m³), and the TLV is 5 ppm (25 mg/m³) as a ceiling limit. The liquid is an eye and skin irritant. For personal protective measures, refer to 4.3.1.

5.2.11.4.2 Fire and explosion hazard. Isophorone is a combustible liquid that can produce explosive vapor mixtures in air on heating.

5.2.11.4.3 Reactivity. Isophorone is reactive with strong oxidizing agents.

5.2.11.5 Storage. Isophorone shall be stored in steel containers in a cool, well-ventilated space away from sources of ignition. A container lined with zinc silicate coating or baked phenolic resin can be used for long term storage to improve product stability. Refer to 4.3.2.

5.2.11.6 Disposal. In case of spills, eliminate all sources of ignition. Small spills shall be absorbed with a nonreactive absorbent and placed in sealed containers for disposal. Large spills shall be diked to prevent spreading and transferred to salvage containers. Water spray can be used to reduce the vapor hazard. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. Refer to 4.4.4.

An EPA Hazardous Waste Classification is not listed in CFR 40.

5.2.12	<u>Name.</u> MESITYL OXIDE	CH ₃ COCH:C(CH ₃) ₂	FW 98.15
	Isopropylidene acetone		
	Methylisobutenyl ketone		
	4-Methyl-3-penten-2-one (IUPAC)		

5.2.12.1 Technical description. Mesityl oxide (pure) is a colorless liquid. It is slightly soluble in water. It is miscible with alcohols, ethers, ketones, and most liquid hydrocarbons and chlorinated hydrocarbons. The physical properties and characteristics are as shown in Table XLII. Mesityl oxide, technical grade, is commercially available with a minimum purity of 97.0 percent by weight.

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TABLE XLII. Mesityl oxide - physical properties and characteristics.

Characteristic	Requirements
Specific gravity, d^{20}	0.8653
Refractive index, n_D^{20}	1.4440
Freezing point, °C	-52.85
Boiling point (760 mm Hg), °C	129.76
Vapor pressure (20°C), mm Hg	7.9
Solubility in water (20°C), wt %	3.1
Flash point (closed cup), °F (°C)	77 (25)
Autoignition temperature, °F (°C)	652 (344)
Explosive limits, % by vol, Lower	1.4
Vapor density (air=1)	3.4

5.2.12.2 Specifications. None.

5.2.12.2.1 Requirements. Refer to 5.2.12.1.

5.2.12.3 Use. Mesityl oxide is intended for military use as a solvent with a medium evaporation rate for organic surface coatings, and as a chemical intermediate. Commercial uses are as a solvent for cellulose esters and ethers, synthetic rubbers, polyvinyl chloride, vinyl copolymers, and other resins. As a chemical intermediate, it is used in double bond reactions, and condensation reactions with aldehydes and ketones. It is also useful in paint and varnish remover formulations.

5.2.12.4 Safety precautions.

5.2.12.4.1 Health hazard. Mesityl oxide vapor is an irritant to the eyes and upper respiratory tract, and in high concentrations can cause dizziness and narcosis. Prolonged exposure to high concentrations can cause damage to lungs, liver and kidneys. The STEL is 25 ppm (100 mg/m³), and the TLV is 15 ppm (60 mg/m³). The liquid is a strong eye and skin irritant, and is readily absorbed through intact skin. For personal protective measures, refer to 4.3.1.

5.2.12.4.2 Fire and explosion hazard. Mesityl oxide is a flammable liquid that can produce explosive vapor mixtures in air.

5.2.12.4.3 Reactivity. Mesityl oxide is reactive with strong oxidizing compounds.

5.2.12.5 Storage. Mesityl oxide shall be stored in steel containers in a cool, well-ventilated space away from sources of ignition. A container lined with zinc silicate coating or baked phenolic resin can be used for long term storage to improve product stability. Refer to 4.3.2.

5.2.12.6 Disposal. In case of spills, eliminate all sources of ignition. Small spills shall be absorbed with a nonreactive absorbent and placed in sealed containers for disposal. Large spills shall be diked to prevent spreading and transferred to salvage containers. Water spray can be used to reduce the vapor

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hazard. For appropriate procedure, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. Refer to 4.4.4.

EPA Hazardous Waste Classification - Ignitable (I); Waste Number D001.

5.2.13 Name. METHOXYACETONE $\text{CH}_3\text{OOCH}_2\text{COCH}_3$ FW 88.11
Methoxy-2-propanone
1-Methoxy-2-propanone (IUPAC)

5.2.13.1 Technical description. Methoxyacetone (pure) is a colorless liquid. It is completely miscible with water at 25°C. The physical properties and characteristics are as shown in Table XLIII. Methoxyacetone, technical grade, is commercially available with a minimum purity of 99 percent by weight.

TABLE XLIII. Methoxyacetone - physical properties and characteristics.

Characteristic	Requirements
Specific gravity, d_{20}^{20}	0.953
Refractive index, n_D^{20}	1.3970
Freezing point, °C	<-50
Boiling point (760 mm Hg), °C	112
Vapor pressure (20°C), mm Hg	16.2
Flash point (closed cup), °F (°C)	78 (25.5)
Vapor density (air=1)	3.0

5.2.13.2 Specifications. None.

5.2.13.2.1 Requirements. Refer to 5.2.13.1.

5.2.13.3 Use. Methoxyacetone is intended for military use as a water miscible solvent with a higher boiling point than acetone. Commercial uses are the same.

5.2.13.4 Safety precautions.

5.2.13.4.1 Health hazard. Methoxyacetone vapor is an irritant to the eyes and upper respiratory tract, and in high concentrations can cause mild intoxication. There are no PEL or TLV for methoxyacetone. The liquid is an eye and skin irritant. For personal protective measures, refer to 4.3.1.

5.2.13.4.2 Fire and explosion hazard. Methoxyacetone is a flammable liquid that can produce explosive vapor mixtures in air on heating.

5.2.13.4.3 Reactivity. Methoxyacetone is reactive with strong oxidizing compounds.

5.2.13.5 Storage. Methoxyacetone shall be stored in steel containers in a cool, well-ventilated space away from sources of ignition. A container lined with zinc silicate coating or baked phenolic resin can be used for long term storage to improve product stability. Refer to 4.3.2.

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5.2.13.6 Disposal. In case of spills, eliminate all sources of ignition. Small spills shall be absorbed with a nonreactive absorbent and placed in sealed containers for disposal. Large spills shall be diked to prevent spreading and transferred to salvage containers. Water spray can be used to reduce the vapor hazard. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. Refer to 4.4.4.

EPA Hazardous Waste Classification - Ignitable (I); Waste Number D001.

5.2.14 Name. METHYL AMYL KETONE $\text{CH}_3\text{CO}(\text{CH}_2)_4\text{CH}_3$ FW 114.19
 2-Heptanone (IUPAC)
 Methyl n-amyl ketone
 Methyl n-pentyl ketone

5.2.14.1 Technical description. Methyl amyl ketone (pure) is a colorless liquid. It is very slightly soluble in water. It is miscible with acetone, alcohols, ethers, and liquid hydrocarbons. The physical properties and characteristics are as shown in Table XLIV. Methyl amyl ketone technical grade, is commercially available with a minimum purity of 98 percent by weight.

TABLE XLIV. Methyl amyl ketone - physical properties and characteristics.

Characteristic	Value
Specific gravity, d_{20}^{20}	0.8111
Refractive index, n_D^{20}	1.4088
Freezing point, °C	-35.5
Boiling point (760 mm Hg), °C	151.45
Vapor pressure (20°C), mm Hg	2.14
Solubility in water (20°C), % by wt	0.46
Flash point (closed cup), °F (°C)	102 (39)
Autoignition temperature, °F (°C)	740 (393)
Explosive limits, % by vol, Lower	1.1
Upper	7.9
Vapor density (air=1)	3.9

5.2.14.2 Specifications. None.

5.2.14.2.1 Requirements. Refer to 5.2.14.1.

5.2.14.3 Use. Methyl amyl ketone is intended for military use as a retarder solvent where a slower evaporation rate than methyl isobutyl ketone and high solvency is desired in the formulation of organic surface coatings. Commercial uses are as a solvent for coating resins in the formulation of high-solids lacquers.

5.2.14.4 Safety precautions.

5.2.14.4.1 Health hazard. Methyl amyl ketone vapor is slightly irritating to the eyes and upper respiratory tract, and in high concentrations can result in a narcotic effect. The PEL is 100 ppm (465 mg/m³) and the TLV is 50 ppm (235

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mg/m³). The liquid is an eye and skin irritant. For personal protective measures, refer to 4.3.1.

5.2.14.4.2 Fire and explosion hazard. Methyl amyl ketone is a combustible liquid that can produce explosive vapor mixtures in air on heating.

5.2.14.4.3 Reactivity. Methyl amyl ketone is reactive with strong oxidizing compounds.

5.2.14.5 Storage. Methyl amyl ketone shall be stored in steel containers in a cool, well-ventilated space away from sources of ignition. A container lined with zinc silicate coating or baked phenolic resin can be used for long term storage to improve product stability. Refer to 4.3.2.

5.2.14.6 Disposal. In case of spills, eliminate all sources of ignition. Small spills shall be absorbed with a nonreactive absorbent and placed in sealed containers for disposal. Large spills shall be diked to prevent spreading and transferred to salvage containers. Water spray can be used to reduce the vapor hazard. For appropriate procedure, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. Refer to 4.4.4.

EPA Hazardous Waste Classification - Ignitable (I); Waste Number D001.

5.2.15 Name. METHYL BUTYL KETONE $\text{CH}_3\text{CO}(\text{CH}_2)_3\text{CH}_3$ FW 100.16
Butyl methyl ketone
2-Hexanone (IUPAC)
Methyl n-butyl ketone

5.2.15.1 Technical description. Methyl butyl ketone (pure) is a colorless liquid. It is slightly soluble in water. It is miscible with acetone, alcohols, ethers, benzene, and liquid hydrocarbons. The physical properties and characteristics are as shown in Table XLV. Methyl butyl ketone, technical grade, is commercially available with a minimum purity of 70 percent by weight.

TABLE XLV. Methyl butyl ketone - physical properties and characteristics.

Characteristic	Value
Specific gravity, d_{20}^{20}	0.81127
Refractive index, n_D^{20}	1.4007
Freezing point, °C	-57
Boiling point (760 mm Hg), °C	128
Vapor pressure (38.8°C), mm Hg	10
Flash point (closed cup), °F (°C)	67 (19)
Autoignition temperature, °F (°C)	991 (533)
Explosive limits, % by vol, Lower	1.2
Upper	8
Vapor density (air=1)	3.5

5.2.15.2 Specifications. None.

5.2.15.2.1 Requirements. Refer to 5.2.15.1.

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5.2.15.3 Use. Methyl butyl ketone, technical grade, is intended for military use as a solvent where a higher boiling point than methyl ethyl ketone is desired, and a lower purity than methyl isobutyl ketone can be employed. Commercial uses are the same.

5.2.15.4 Safety precautions.

5.2.15.4.1 Health hazard. Methyl butyl ketone vapor is irritating to the eyes and respiratory tract, and in high concentrations can cause narcosis and lack of coordination. The PEL and TLV are 5 ppm (20 mg/m³). The liquid is an eye and skin irritant and can be absorbed by the skin. The compound can be a neurotoxin resulting from industrial exposure. For personal protective measures, refer to 4.3.1.

5.2.15.4.2 Fire and explosion hazard. Methyl butyl ketone is a flammable liquid that can produce explosive vapor mixtures in air on heating.

5.2.15.4.3 Reactivity. Methyl butyl ketone is reactive with strong oxidizing compounds.

5.2.15.5 Storage. Methyl butyl ketone shall be stored in steel containers in a cool, well-ventilated space away from sources of ignition. A container lined with zinc silicate coating or baked phenolic resin can be used for long term storage to improve product stability. Refer to 4.3.2.

5.2.15.6 Disposal. In case of spills, eliminate all sources of ignition. Small spills shall be absorbed with a nonreactive absorbent and placed in sealed containers for disposal. Large spills shall be diked to prevent spreading and transferred to salvage containers. Water spray can be used to reduce the vapor hazard. For appropriate procedure, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. Refer to 4.4.4.

EPA Hazardous Waste Classification - Ignitable (I); Waste Number D001.

5.2.16	<u>Name</u> . METHYL ETHYL KETONE	CH ₃ COCH ₂ CH ₃	FW 72.11
	2-Butanone (IUPAC)		
	Ethyl methyl ketone		

5.2.16.1 Technical description. Methyl ethyl ketone is a colorless liquid. It is very soluble in water. It is miscible with acetone, alcohols, ethers, and liquid hydrocarbons. The physical properties are as shown in Table XLVI.

5.2.16.2 Specifications. ASTM D 740, Methyl Ethyl Ketone.

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TABLE XLVI. Methyl ethyl ketone - physical properties and characteristics.

Characteristic	Value
Refractive index, n_D^{20}	1.3788
Freezing point, °C	-86.35
Boiling point (760 mm Hg), °C	79.6
Vapor pressure (20°C), mm Hg	70
Solubility in water (20°C), % by wt	26.8
Flash point (closed cup), °F (°C)	20 (-7)
Autoignition temperature, °F (°C)	960 (515)
Explosive limits, % by vol, Lower	1.8
Upper	11.5
Vapor density (air=1)	2.5

5.2.16.2.1 The ASTM specification requirements for methyl ethyl ketone are shown in Table XLVII. Methyl ethyl ketone shall have a nonresidual characteristic odor.

TABLE XLVII. Methyl ethyl ketone - ASTM specification requirements.

Characteristic	Requirements	
	Min	Max
Purity, % by wt	99.5	---
Apparent specific gravity		
d_{20}^{20}	0.805	0.807
d_{25}^{25}	0.801	0.803
Color (Pt-Co scale)	---	10
Distillation range	78.5	81.0
Nonvolatile matter, mg/100 mL	---	5
Water, % by wt	---	0.2
Acidity (free acid as acetic acid)		
% by wt	---	0.005
equivalent to mg KOH/g sample	---	0.047

5.2.16.3 Use. Methyl ethyl ketone is intended for military use as a solvent in surface coatings and in paint and varnish removers. The main intended uses in surface coatings are as a solvent in nitrocellulose and vinyl lacquers, and as a solvent for cellulose nitrate and acetate butyrate in aircraft dopes. Commercial uses are as a solvent for synthetic and natural resins employed in the formulation of printing inks, lacquers and other types of surface coatings; and in solvent dispersed adhesives. It is also used as an extracting agent and chemical intermediate.

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5.2.16.4 Safety precautions.

5.2.16.4.1 Health hazard. Methyl ethyl ketone vapor is irritating to the eyes and respiratory tract, and in high concentration can cause narcosis and lack of coordination. The PEL and TLV is 200 ppm (590 mg/m³). The liquid is an eye and skin irritant, and can be absorbed by the skin. For personal protective measures, refer to 4.3.1.

5.2.16.4.2 Fire and explosion hazard. Methyl ethyl ketone is a very volatile and flammable liquid that can produce explosive vapor mixtures in air.

5.2.16.4.3 Reactivity. Methyl ethyl ketone is reactive with strong oxidizing compounds.

5.2.16.5 Storage. Methyl ethyl ketone shall be stored in steel containers in a cool, well-ventilated space away from sources of ignition. A container lined with zinc silicate coating or baked phenolic resin can be used for long term storage to improve product stability. Refer to 4.3.2.

5.2.16.6 Disposal. In case of spills, eliminate all sources of ignition. Small spills shall be absorbed with a nonreactive absorbent and placed in sealed containers for disposal. Large spills shall be diked to prevent spreading and transferred to salvage containers. Water spray can be used to reduce the vapor hazard. For appropriate procedure, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. Refer to 4.4.4.

EPA Hazardous Waste Classification - Ignitable (I), Toxic (T); Waste Number U159.

5.2.17	<u>Name.</u>	METHYL ISOAMYL KETONE	$\text{CH}_3\text{COCH}_2\text{CH}_2\text{CH}(\text{CH}_3)_2$	FW 114.19
		Methyl isopentyl ketone		
		5-Methyl-2-hexanone (IUPAC)	-	

5.2.17.1 Technical description. Methyl isoamyl ketone (pure) is a colorless liquid. It is very slightly soluble in water. It is miscible with acetone, alcohol, ether, and liquid hydrocarbons. The physical properties are as shown in Table XLVIII.

5.2.17.2 Specifications. ASTM D 2917, Methyl Isoamyl Ketone.

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TABLE XLVIII. Methyl isoamyl ketone - physical properties and characteristics.

Characteristic	Value
Refractive index, n_D^{20}	1.4062
Freezing point, °C	73.9
Boiling point (760 mm Hg), °C	144
Vapor pressure (20°C), mm Hg	4.5
Solubility in water (20°C), % by wt	0.5
Flash point (closed cup), °F (°C)	96 (36)
Autoignition temperature, °F (°C)	795 (425)
Explosive limits, % by vol, Lower	1.0
Upper	8.2
Vapor density (air=1)	3.9

5.2.17.2.1 Requirements. The ASTM specification requirements for methyl isoamyl ketone are shown in Table XLIX.

TABLE XLIX. Methyl isoamyl ketone - specification requirements.

Characteristic	Requirements	
	Min	Max
Purity, % by wt	98	---
Specific gravity		
d_{20}^{20}	0.812	0.815
d_{25}^{25}	0.809	0.812
Distillation range (760 mm Hg), °C	141	148
Water, % by wt	---	0.1
Acidity, as acetic acid, % by wt	---	0.01
Color (Pt-Co scale)	---	15

5.2.17.3 Use. Methyl isoamyl ketone is intended for military use as a retarder solvent where a slower evaporation rate than methyl isobutyl ketone and high solvency is desired in the formulation of organic surface coatings. Commercial uses are as a solvent for coating resins in the formulation of high-solids lacquers.

5.2.17.4 Safety precautions.

5.2.17.4.1 Health hazard. Methyl isoamyl ketone vapor is slightly irritating to the eyes and upper respiratory tract, and in high concentrations can cause a narcotic effect. The PEL and TLV is 50 ppm (240 mg/m³). The liquid is an eye and skin irritant. For personal protective measures, refer to 4.3.1.

5.2.17.4.2 Fire and explosion hazard. Methyl isoamyl ketone is a flammable liquid that can produce explosive vapor mixtures in air on heating.

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5.2.17.4.3 Reactivity. Methyl isoamyl ketone is reactive with strong oxidizing compounds.

5.2.17.5 Storage. Methyl isoamyl ketone shall be stored in steel containers in a cool, well-ventilated space away from sources of ignition. A container lined with zinc silicate coating or baked phenolic resin can be used for long term storage to improve product stability. Refer to 4.3.2.

5.2.17.6 Disposal. In case of spills, eliminate all sources of ignition. Small spills shall be absorbed with a nonreactive absorbent and placed in sealed containers for disposal. Large spills shall be diked to prevent spreading and transferred to salvage containers. Water spray can be used to reduce the vapor hazard. For appropriate procedure, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. Refer to 4.4.4.

EPA Hazardous Waste Classification - Ignitable (I); Waste Number D001.

5.2.18 Name. METHYL ISOBUTYL KETONE $\text{CH}_3\text{COCH}_2\text{CH}(\text{CH}_3)_2$ FW 100.16
Hexone
Isopropyl acetone
4-Methyl-2-pentanone (IUPAC)

5.2.18.1 Technical description. Methyl isobutyl ketone (pure) is a colorless liquid. It is slightly soluble in water. It is miscible with acetone, alcohols, ethers, and liquid hydrocarbons. The physical properties are as shown in Table L.

5.2.18.2 Specifications. ASTM D 1153, Methyl Isobutyl Ketone.

TABLE L. Methyl isobutyl ketone - physical properties and characteristics.

Characteristic	Value
Refractive index, n_D^{20}	1.3962
Freezing point, °C	-84.7
Boiling point (760 mm Hg), °C	116.85
Vapor pressure (20°C), mm Hg	15
Solubility in water (20°C), % by wt	2.0
Flash point (closed cup), °F (°C)	60 (16)
Autoignition temperature, °F (°C)	860 (460)
Explosive limits, % by vol, Lower	1.4
Upper	7.5
Vapor density (air=1)	3.5

5.2.18.2.1 Requirements. The ASTM specification requirements for methyl isobutyl ketone are shown in Table LI.

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TABLE LI. Methyl isobutyl ketone - specification requirements.

Characteristic	Requirements	
	Min	Max
Methyl isobutyl ketone, % by wt	99.0	---
Apparent specific gravity		
d_{20}^{20}	0.800	0.803
d_{25}^{25}	0.796	0.799
Distillation range (760 mm Hg), °C	114.0	117.0
Water, % by wt	---	0.1
Acidity, free acid as acetic, % by wt	---	0.01
equivalent to mg KOH/g sample	---	0.093
Methyl isobutyl carbinol, % by wt	---	0.3
Color (Pt-Co scale)	---	15

5.2.18.3 Use. Methyl isobutyl ketone is intended for military use as a medium boiling solvent in the formulation of paint thinners and organic surface coatings. Commercial uses are as a solvent for coating resins including cellulose esters, vinyl polymers and copolymers, and natural and synthetic resins; and as a solvent in lacquer thinner formulations. It is also used as an extractant in the dewaxing of petroleum products, as a component of synthetic rubber cements, and as an ethyl alcohol denaturant.

5.2.18.4 Safety precautions.

5.2.18.4.1 Health hazard. Methyl isobutyl ketone vapor is irritating to the eyes and respiratory tract, and in high concentrations can cause narcosis and lack of coordination. The PEL is 100 ppm (410 mg/m³) and the TLV is 50 ppm (205 mg/m³) and the STEL is 75 ppm (308 mg/m³). The liquid is an eye and skin irritant, and can cause dermatitis. For personal protective measures, refer to 4.3.1.

5.2.18.4.2 Fire and explosion hazard. Methyl isobutyl ketone is a flammable liquid that can produce explosive vapor mixtures in air on heating.

5.2.18.4.3 Reactivity. Methyl isobutyl ketone is reactive with strong oxidizing compounds.

5.2.18.5 Storage. Methyl isobutyl ketone shall be stored in steel containers in a cool, well-ventilated space away from sources of ignition. A container lined with zinc silicate coating or baked phenolic resin can be used for long term storage to improve product stability. Refer to 4.3.2.

5.2.18.6 Disposal. In case of spills, eliminate all sources of ignition. Small spills shall be absorbed with a nonreactive absorbent and placed in sealed containers for disposal. Large spills shall be diked to prevent spreading and transferred to salvage containers. Water spray can be used to reduce the vapor

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hazard. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. Refer to 4.4.4.

EPA Hazardous Waste Classification - Ignitable (I); Waste Number U161.

5.2.19 Name. METHYL 2-METHOXYISOBUTYL KETONE FW 130.19
 $\text{CH}_3\text{COCH}_2\text{C}(\text{OCH}_3)(\text{CH}_3)_2$
 4-Methoxy-2-keto-4-methylpentane
 4-Methoxy-4-methyl-2-pentanone (IUPAC)

5.2.19.1 Technical description. Methyl 2-methoxyisobutyl ketone (pure) is a colorless liquid. It is soluble in water. It is miscible with esters, ethers, other ketones, and polar organic solvents. The physical properties and characteristics are as shown in Table LII. Methyl 2-methoxyisobutyl ketone is commercially available with a minimum purity of 98.5 percent by weight.

TABLE LII. Methyl 2-methoxyisobutyl ketone - physical properties and characteristics.

Characteristic	Value
Specific gravity, d^{20}	0.908
Refractive index, n_D^{20}	1.4181
Freezing point, °C	-35
Boiling point (760 mm Hg), °C	159
Vapor pressure (20°C), mm Hg	2.6
Solubility in water (20°C), % by wt	28
Flash point (closed cup), °F (°C)	119 (48.3)
Explosive limits, % by vol, Lower	1.1
Upper	6.0
Vapor density (air=1)	4.5

5.2.19.2 Specifications. None.

5.2.19.2.1 Requirements. Refer to 5.2.19.1.

5.2.19.3 Use. Methyl 2-methoxyisobutyl ketone is intended for military use where a slow evaporating solvent and a high boiling point is desired in the formulation of organic surface coatings. Commercial uses are as a solvent component in surface coating systems containing resins such as nitrocellulose, vinyls, acrylics, urethanes and epoxies. It is also useful as a solvent component in cleaning compounds, as a dye solvent, and as an extraction and reaction solvent.

5.2.19.4 Safety precautions.

5.2.19.4.1 Health hazard. Methyl 2-methoxyisobutyl ketone vapor is an irritant to the eyes and upper respiratory tract, and in high concentrations can cause nausea and mild intoxication. There is no PEL or TLV for this compound. The liquid is an eye and skin irritant. For personal protective measures, refer to 4.3.1.

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5.2.19.4.2 Fire and explosion hazard. Methyl 2-methoxyisobutyl ketone is a combustible liquid that can produce explosive vapor mixtures in air on heating.

5.2.19.4.3 Reactivity. Methyl 2-methoxyisobutyl ketone is reactive with strong oxidizing compounds.

5.2.19.5 Storage. Methyl 2-methoxyisobutyl ketone shall be stored in steel containers in a cool, well-ventilated space away from sources of ignition. A container lined with zinc silicate coating or baked phenolic resin can be used for long term storage to improve product stability. Refer to 4.3.2.

5.2.19.6 Disposal. In case of spills, eliminate all sources of ignition. Small spills shall be absorbed with a nonreactive absorbent and placed in sealed containers for disposal. Large spills shall be diked to prevent spreading and transferred to salvage containers. Water spray can be used to reduce the vapor hazard. For appropriate procedure, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. Refer to 4.4.4.

EPA Hazardous Waste Classification - Ignitable (I); Waste Number D001.

5.2.20 Name. METHYL PROPYL KETONE $\text{CH}_3\text{COCH}_2\text{CH}_2\text{CH}_3$ FW 86.14
Methyl n-propyl ketone
2-Pentanone (IUPAC)
Propyl methyl ketone

5.2.20.1 Technical description. Methyl propyl ketone (pure) is a colorless liquid. It is slightly soluble in water. It is miscible with acetone, alcohols, ethers, and liquid hydrocarbons. The physical properties and characteristics are as shown in Table LIII. Methyl propyl ketone, technical grade, is commercially available with a minimum purity of 90.0 percent by weight.

TABLE LIII. Methyl propyl ketone - physical properties and characteristics.

Characteristic	Value
Specific gravity, d^{20}	0.8092
Refractive index, n_D^{20}	1.3895
Freezing point, °C	-77.8
Boiling point (760 mm Hg), °C	102
Vapor pressure (20°C), mm Hg	27.8
Solubility in water (20°C), % by wt	3.1
Flash point (closed cup), °F (°C)	46 (8)
Autoignition temperature, °F (°C)	840 (449)
Explosive limits, % by vol, Lower	1.6
Upper	8.7
Vapor density (air=1)	3.0

5.2.20.2 Specifications. None.

5.2.20.2.1 Requirements. Refer to 5.2.20.1.

5.2.20.3 Use. Methyl propyl ketone is intended for military use as a solvent with a medium-flash evaporation rate for film-formers used in surface

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coatings. Such film-formers include acrylics, cellulose esters, epoxies and vinyls. Commercial uses are the same.

5.2.20.4 Safety precautions.

5.2.20.4.1 Health hazard. Methyl propyl ketone vapor is irritating to the eyes and respiratory tract, and in high concentrations can cause narcosis and lack of coordination. The STEL and TLV are 250 ppm (825 mg/m³). The liquid is an eye and skin irritant and can be absorbed by the skin. For personal protective measures, refer to 4.3.1.

5.2.20.4.2 Fire and explosion hazard. Methyl propyl ketone is a volatile and flammable liquid that can produce explosive vapor mixtures in air.

5.2.20.4.3 Reactivity. Methyl propyl ketone is reactive with strong oxidizing compounds.

5.2.20.5 Storage. Methyl propyl ketone shall be stored in steel containers in a cool, well-ventilated space away from sources of ignition. A container lined with zinc silicate coating or baked phenolic resin can be used for long term storage to improve product stability. Refer to 4.3.2.

5.2.20.6 Disposal. In case of spills, eliminate all sources of ignition. Small spills shall be absorbed with a nonreactive absorbent and placed in sealed containers for disposal. Large spills shall be diked to prevent spreading and transferred to salvage containers. Water spray can be used to reduce the vapor hazard. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. Refer to 4.4.4.

EPA Hazardous Waste Classification - Ignitable (I); Waste Number D001.

5.2.21	<u>Name.</u> PROPIOPHENONE	C ₆ H ₅ COCH ₂ CH ₃	FW 134.18
	Ethyl phenyl ketone		
	Phenyl ethyl ketone		
	1-Phenyl-1-propanone (IUPAC)		
	Propionylbenzene		

5.2.21.1 Technical description. Propiophenone (pure) is a colorless liquid or white solid. It is very slightly soluble in water. It is miscible with methanol, ethanol, ether, benzene and toluene. The physical properties and characteristics are as shown in Table LIV. Propiophenone, technical grade, is commercially available with a minimum purity of 99 percent by weight.

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TABLE LIV. Propiophenone - physical properties and characteristics.

Characteristic	Value
Specific gravity, d_4^{20}	1.0096
Refractive index, n_D^{20}	1.5269
Freezing point, °C	18.6
Boiling point (760 mm Hg), °C	217.5
Vapor pressure (20°C), mm Hg	0.2
Solubility in water (20°C), % by wt	0.2
Flash point (closed cup), °F (°C)	185 (85)
Vapor density (air=1)	4.5

5.2.21.2 Specifications. None.

5.2.21.2.1 Requirements. Refer to 5.2.21.1.

5.2.21.3 Use. Propiophenone is intended for military use in solvent mixtures as a very slow evaporating solvent in the formulation of organic surface coatings. Commercial uses are as a solvent component and as a chemical intermediate.

5.2.21.4 Safety precautions.

5.2.21.4.1 Health hazard. Propiophenone vapor is an irritant to the eyes and upper respiratory tract, and in high concentration can cause narcosis. There is no PEL or TLV for propiophenone. The liquid is an eye and skin irritant. For personal protective measures, refer to 4.3.1.

5.2.21.4.2 Fire and explosion hazard. Propiophenone is a combustible liquid that can produce explosive vapor mixtures in air on heating.

5.2.21.4.3 Reactivity. Propiophenone is reactive with strong oxidizing compounds.

5.2.21.5 Storage. Propiophenone shall be stored in steel containers in a cool, well-ventilated space away from sources of ignition. A container lined with zinc silicate coating or baked phenolic resin can be used for long term storage to improve product stability. Storage above 68°F (20°C) is necessary if the product is to be kept in a liquid state. Refer to 4.3.2.

5.2.21.6 Disposal. In case of dry spills, gather up and place in containers. In case of liquid spills, eliminate all sources of ignition. Small spills shall be absorbed with a nonreactive absorbent and placed in sealed containers for disposal. Large spills shall be diked to prevent spreading and transferred to salvage containers. Water spray can be used to reduce the vapor hazard. For appropriate procedure, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. Refer to 4.4.4.

An EPA Hazardous Waste Classification is not listed in CFR 40.

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6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. This standard is intended to cite nomenclature, formulas, physical and chemical properties, specification requirements, military and typical commercial uses, safety information, storage information, and disposal information for Aldehydes and Ketones preferred for application by the Department of Defense.

6.2 Subject term (key word) listing.

Acetaldehyde
 Acetic aldehyde
 Acetone
 Acetophenone (IUPAC)
 Acetylacetone
 Acetylbenzene
 Acraldehyde
 Acrolein
 Acrylaldehyde
 Acrylic aldehyde
 Amylaldehyde
 Benzaldehyde (IUPAC)
 Benzenecarbonyl
 Benzenecarboxaldehyde
 Benzoic aldehyde
 Biformyl
 Butanal (IUPAC)
 2-Butanone (IUPAC)
 2-Butenal (trans) (IUPAC)
 Butyl aldehyde
 Butyl methyl ketone
 Butyraldehyde
 2-Chlorobenzaldehyde
 4-Chlorobenzaldehyde
 4-Chlorobenzenecarbonyl (IUPAC)
 2-Chlorobenzenecarbonyl (IUPAC)
 Crotonaldehyde
 Crotonic aldehyde
 Cyclohexanone (IUPAC)
 3-Cyclohexene-1-carboxaldehyde
 3-Cyclohexenecarboxaldehyde
 Cyclohexyl ketone
 Diacetone alcohol
 Diacetylmethane
 Diethyl ketone
 Diisobutyl ketone
 2,6-Dimethyl-4-heptanone (IUPAC)
 Dimethylketone
 Ethanal (IUPAC)
 Ethanedial (IUPAC)
 Ethyl-2-methylbutyl ketone

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Ethyl amyl ketone
 Ethyl butyl ketone
 Ethyl methyl ketone
 2-Ethylhexaldehyde
 2-Ethylhexanal
 Ethyl n-butyl ketone
 Ethyl phenyl ketone
 Ethylaldehyde
 Exposure limits, Hazardous chemicals
 Formaldehyde
 4-Formylphenol
 Formalin (aqueous solution)
 Formic aldehyde
 Fural
 2-Furaldehyde
 α -Furaldehyde
 2-Furancarboxal
 2-Furancarboxaldehyde
 Furfural
 Glutaraldehyde
 Glutaric dialdehyde
 Glutaricaldehyde
 Glyoxal
 Hazardous wastes, disposal and storage of
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 3-Heptanone (IUPAC)
 2-Hexanone (IUPAC)
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 4-Hydroxybenzaldehyde
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 Isobutyl heptyl ketone
 Isobutylaldehyde
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 Isopropyl acetone
 Isopropylidene acetone
 Isovalerone
 Ketoexamethylene
 Mesityl oxide
 Metaformaldehyde
 Methanal (IUPAC)
 Methoxyacetone
 4-Methoxy-2-keto-4-methylpentane
 4-Methoxy-4-methyl-2-pentanone (IUPAC)
 Methoxy-2-propanone
 1-Methoxy-2-propanone (IUPAC)
 Methylacetaldehyde
 β -Methylacrolein
 Methyl amyl ketone

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Methyl butyl ketone
 Methyl ethyl ketone
 5-Methyl-3-heptanone (IUPAC)
 5-Methyl-2-hexanone (IUPAC)
 Methyl 2-hydroxyisobutyl ketone
 Methyl isoamyl ketone
 Methylisobutenyl ketone
 Methyl isobutyl ketone
 Methyl isopentyl ketone
 Methyl 2-methoxyisobutyl ketone
 Methyl n-amyl ketone
 Methyl n-butyl ketone
 Methyl n-pentyl ketone
 Methyl n-propyl ketone
 2-Methylpentanaldehyde
 2-Methylpentanal (IUPAC)
 4-Methyl-2-pentanone (IUPAC)
 4-Methyl-3-penten-2-one (IUPAC)
 Methylphenylketone
 2-Methylpropanal (IUPAC)
 Methyl propyl ketone
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 N-Butyric aldehyde
 O-Chlorobenzaldehyde
 O-Hydroxybenzaldehyde
 Oxaldehyde
 Oxomethane
 Oxymethylene
 P-Chlorobenzaldehyde
 p-Hydroxybenzaldehyde
 Paraacetaldehyde
 Paraform
 Paraformaldehyde
 Paraldehyde
 Pentanal (IUPAC)
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 2,4-Pentanedione (IUPAC)
 3-Pentanone (IUPAC)
 2-Pentanone (IUPAC)
 Phenyl ethyl ketone
 Phenylmethylketone
 1-Phenyl-1-propanone (IUPAC)
 Pimelic ketone
 Polyoxymethylene
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 Propionylbenzene
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 Propyl methyl ketone
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Salicylic aldehyde
Sym-Trioxane
Tetrahydrobenzaldehyde
1,2,3,6-Tetrahydrobenzaldehyde
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3,5,5-Trimethyl-2-cyclohexen-1-one (IUPAC)
2,6,8-Trimethyl-4-nonanone (IUPAC)
Trioxane
1,3,5-Trioxane
Trioxin
 α -Trioxymethylene
Valeral
Valeraldehyde

6.3 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes, which include the addition of new safety, storage and disposal guidance for all materials and Section 6 and an Index.

6.4 Abbreviations. The use of abbreviations shall be in accordance with MIL-STD-12 where applicable. Metric system abbreviations and symbols shall be in accordance with ASTM E 380.

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Lead Standardization Activity:

Defense General Supply Center - GS

Preparing Activity:

Army - EA
Project No. 6810-1247

Custodians:

Army - EA
Navy - YD
Air Force - 68

Review Activities:

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Navy - AS
Air Force - None

User Activities:

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Navy - MC
Air Force - None

