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TECHNICAL MANUAL

PREPARATION AND HANDLING OF INDUSTRIAL PLANT EQUIPMENT FOR STORAGE OR SHIPMENT

DEPARTMENT OF THE ARMY

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DEPARTMENT OF THE ARMY

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PREPARATION AND HANDLING OF INDUSTRIAL PLANT EQUIPMENT FOR STORAGE OR SHIPMENT

REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

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CHAPTER 1

INTRODUCTION

Section I. PURPOSE AND SCOPE

1-1. Purpose

The purpose of this publication is to provide information on the fundamental principles and approved methods and techniques used in the preparation of Industrial Plant Equipment (IPE) and Other Plant Equipment (OPE) for storage or shipment. It is published as an official document for use in operations and in the training of military and civilian personnel from all segments of the Army, especially interested industrial personnel. It contains information based on specifications, standards, and other pertinent documents, which are current as of the date of preparation and coordination of the publication.

1-2. Scope

a. General. This manual emphasizes the importance of preparation and packaging of Department of the Army plant equipment, including IPE and OPE, prior to storage or shipment. It contains detailed information concerning the requirements for preservation, packing, marking, inspection, and maintenance during storage. The dimensions and weight measurements in this manual are in the United States (U.S.) Customary Systems of Units (US) with the International Systems of Units (SI) or metric equivalent in parenthesis. It prescribes methods, standards, and materials to be used in accomplishing the following operations:

(1) Cleaning, preservation, packing, storage, maintenance in storage, and shipping of IPE and OPE including tooling, attachments, and accessories.

(2) Selection of storage conditions under which inactive IPE and OPE may be maintained.

(3) Methods relative to receiving plant equipment at a storage facility, including the inspection procedures necessary to assure that such equipment will be maintained in storage free of deterioration.

(4) Methods and procedures and the necessary tools and instruments required to perform inspections and tests, using technical maintenance standards and analytical test patterns to determine equipment condition and operating capabilities.

(5) Methods of preservation, packing, skidding, internal blocking and bracing, external blocking and bracing on carrier equipment, and shock mitigating carrier equipment for shipment to storage or use facilities.

NOTE

THE COVERAGE OF INTERNAL AND EXTERNAL BLOCKING, BRACING, AND SKIDDING IN THIS MANUAL IS COMPLEMENTARY TO THAT IN MIIL-HDBK-701, WHICH COVERS THE BASIC PRINCIPLES.

b. Conflict between documents. This manual is consistent with the requirements of MIL-P-116, MIL-STD-107, and MIL-HDBK-701.

(1) In the event of a conflict between this technical manual (TM) and the governing content specification or Military Standard (MIL-STD), the governing content specification or MIL-STD will take precedence.

(2) When conflict exists between a contract and this TM, the contract shall take precedence.

c. Detailed preservation, packaging, and packing requirements. Detailed information on preservation, packaging, and packing materials, processes, methods procedures, boxes, and crates is found in TM 38-230-1 and TM 38-230-2.

Section II. FORMAT, OBJECTIVES, AND CONTENTS

1-3. Format

This manual is published in loose leaf format and punched with three holes to fit standard three-ring binders. The loose leaf arrangement will permit the use or replacement of a single chapter or section without the need for the entire volume at one time. It will also facilitate upkeep of the manual.

1-4. Objectives

This manual outlines the objectives for achieving uniform preservation, packing, skidding, shipping, handling, and storage of IPE. These objectives are:

a. Assure maximum life, utilization, and performance of IPE and OPE through prevention of deterioration.

b. Provide efficient and economical protection to plant equipment from physical and mechanical damage during shipment, handling, and storage.

c. Facilitate efficient receipt, storage, inventory, transfer, and issue of plant equipment.

d. Provide identification markings, bar code markings, electronic markings, hazard markings, condition tags, and preservative tags when specified.

e. Assure the greatest practicable uniformity in packaging processes for like items of plant equipment.

f. Effect economics by assuring the use of minimum weight and cube consistent with the anticipated storage and shipping hazards.

1-5. Definition of Terms

Definitions of terms peculiar to this publication are listed below.

a. Cleaning. A process accomplished by a variety of methods to remove all sludge, chips, abrasives, dirt, lust, and other harmful foreign matter.

b. Cube. The volume of space occupied by the unit under consideration, computed by multiplying overall exterior length, width, and height. For shipping purposes, cube is expressed to the nearest tenth of a cubic foot.

c. Department of Defense (DOD) component. A military DOD agency and its subordinate activities. For the purpose of this manual it includes the cognizant contract administration component and assigned contractors who take required action pursuant to individual contract terms and approved procedures as appropriate.

d. DOD Component Mobilization Reserve. IPE held in reserve in Assistant Secretary of Defense (Acquisition and Logistics) (ASD (A&L)) approved Plant Equipment Packages by DOD components in support of approved mobilization requirements.

e. Defense General Supply Center (DGSC). A primary level field activity of the Defense Logistics Agency (DLA) responsible for providing services to DOD components.

f. Defense Industrial Reserve (DIR). IPE which is being held to support projected DOD operational and mobilization requirements. This reserve is composed of two major segments:

(1) DOD General Reserve.

(2) DOD Component Mobilization Reserve.

g. Disassembly. The removal of major components and assemblies, and other operations further dividing plant equipment to facilitate inspection, cleaning, preservation and/or shipment.

h. Documentation. Consists of packing lists, inspection and test reports, operation and installation instructions, historical records, diagrams of electrical and hydraulic systems, and utility connections. When specified, the documentation shall include photographs, manufacturing procedures, and other required technical data.

i. Electrostatic discharge (ESD). A transfer of electrostatic charge between bodies at different electrostatic potentials caused by direct contact or induced by an electrostatic field.

j. Elephant tools. Items of IPE with an acquisition cost of $250,000 or more, exclusive of numerical control attachments. They are usually long procurement and installation lead time tools (18 months), requiring building alterations to install, and remove.

k. Excess IPE. Items of IPE which are not required by the owning DOD component, and which are not required by DGSC to support current and future requirements of the DOD in accordance with the policies and procedures contained in DOD Instruction 4215.18, Management of Defense-Owned Industrial Plant Equipment and DLAM 4215.1/AR 700-43.

l. Exercising or cycling. Operation of machine at no load to distribute lubricants and rotate bearings.

m. Historical record. A record or group of records on each item of IPE which accompanies the equipment on transfer.

n. IPE accessory. A device identified to the basic unit of IPE which facilitates or enhances the operation but which is not essential for its operation, such as remote control devices.

o. IPE auxiliary. Devices identified to the basic unit of IPE without which the basic unit cannot operate.

p. IPE material release order/shipping instructions. Shipping instructions issued by DGSC to direct shipment of idle IPE will be by Military Standard Requisitioning and Issue Procedures (MNILSTRIP) documentation (DD Form 1348M; DD Form 1348-1; or MILSTRIP teletype format).

q. Industrial Plant Equipment (IPE). That part of plant equipment with an acquisition cost of $15,000 or more used for the purpose of cutting, abrading, grinding, shaping, forming, joining, testing, measuring, heating, treating, or otherwise altering the physical, electrical, or chemical properties of materials, components, or end items entailed in manufacturing/maintenance, supply, processing, assembly, or research and development operations.

r. Laid-away IPE. DOD-owned equipment (in contractors' plants, or in a military installation or activity) which meets all the criteria for IPE, and is part of an approved Plant Equipment Package (PEP), and has been properly preserved and processed for storage.

s. Mechanical damage. The damage resulting from any direct or indirect forces which may impair the mechanical or operating function of IPE items. Some of the causes of physical and mechanical damage are improper handling, improper storage, improper shipment, and vibration.

t. Metalworking machinery. A category of IPE consisting of power-driven, stationary machines in Federal Supply Classes 3405, 3408, 3410 through 3419, 3422, and 3441 through 3449.

machines in Federal Supply Classes 3405, 3408, 3410 through 3419, 3422, and 3441 through 3449.

u. National stock number (NSN). A national stock number is a 13-digit number. The first four digits of the NSN comprise the Federal Supply Classification (FSC), the 5th and 6th digits denote the North Atlanta Treaty Organization (NATO) code number and the last seven digits comprise the national item identification number (NIIN).

v. Nonseverable equipment. Nonseverable plant equipment which, due to size or design, cannot be economically removed from its installed position for storage or shipment.

w. Other Plant Equipment (OPE). That part of plant equipment regardless of dollar value which is used in conjunction with the manufacture of components or end items relative to maintenance, supply, processing, assembly, or research and development operations, but excluding items categorized as IPE.

x. Packaging. The processes and procedures used to protect material from deterioration, damage, or both. It includes cleaning, drying, preserving, marking, and unitization.

y. Packing. Assembling of items into a unit, intermediate, or exterior pack with necessary blocking, bracing, cushioning, weatherproofing, and reinforcement.

z. Physical damage. Damage from internal or external forces which result in breakage, denting, marring, displacement, and/or abrasion to IPE or OPE.

aa. Plant Equipment Package (PEP). A PEP consists of active and/or inactive equipment which is required for replenishment/reconstitution production when requirements cannot be readily made available from industry.

ab. Plant Equipment Code (PEC). A 12 digit, subclassification system within the framework of the Federal Supply Classification (FSC) to encode the primary characteristics of items of IPE.

ac. Preservation. Application or use of adequate protective measures to prevent deterioration resulting from exposure to atmospheric conditions, handling, shipment, and storage, such as fungus, excessive drying, high humidity, fumes, and gases.

ad. Rebuild. To restore an item to a standard as near as possible to original, or new condition in appearance, performance, and life expectancy.

ae. Repair. The specified maintenance necessary to correct material damage or failure, as required, to restore the end item, assembly, or subassembly to the normal operating condition.

af. Serviceable item. Item in new or used condition suitable for issue and use.

ag. Skidding. The placement of aluminum or wood skid runners, with connecting structure, under IPE and OPE for protection and to facilitate handling.

ah. Special test equipment. Single or multipurpose integrated test units engineered, designed, fabricated, or modified to accomplish special purpose testing in performing a contract. It consists of items or assemblies of equipment including standard or general purpose items or components that are interconnected and interdependent so as to become a new functional entity for special testing purposes. It does not include material, special tooling, facilities (except foundations and similar improvements necessary for installing special test equipment), and plant equipment items used for general plant testing purposes.

ai. Special tooling. All jigs, dies, fixtures, molds, patterns, taps, gages, other equipment, and manufacturing aids, and replacements thereof, which are of such a specialized nature that, without substantial modification or alteration, their use is limited to development or production of particular supplies or parts thereof, or the performance of particular services. It does not include material, special test equipment, facilities (except foundations similar improvements necessary for the installation of special tooling), general or special machine tools, or similar capital items.

aj. Storage, adjacent. Storage of equipment in the vicinity of the premises of the contractor/user.

ak. Storage on site. Equipment stored on the premises of the user.

1-6. Policy

It is the policy of the DOD to retain only that IPE and OPE needed to support the readiness of U.S. Military Forces, their phased expansion, and the production rates that will satisfy their replenishment/reconstitution consumption requirements.

a. IPE and OPE retained for a specific application must be in such an operable condition as to satisfactorily perform the required operation for which it is retained.

b. IPE and OPE retained for general assignment to maintain combat readiness must be in such operating condition as to satisfactorily perform the type and class of work normally assigned to that make and model of equipment.

c. To assure that the preparation of IPE and OPE for storage or shipment complies with DOD policy, it must be processed to the appropriate level of protection.

1-7. Levels of Protection

The degree of protection is defined in terms of the amount of processing required to protect the equipment under known conditions. There is no direct relationship between

protection and their application are determined by the condition that the equipment may be expected to encounter during shipment, handling, and storage. Methods of preservation and packing are determined by physical characteristics of specific items of IPE and OPE to be protected. The contract or order should specify the degree of protection required. If it does not, the appropriate level of protection shall be selected according to AR 700-15, specifically:

a. Adequate, but not excessive, protection shall be provided to prevent damage or deterioration.

b. Items shall be processed for shipment in accordance with the level/method specified in the shipping document.

c. Items previously prepared to a higher level shall not be reworked to conform to any lower level(s) specified in the shipping document with the possible exception of packing of items for air shipment. Items previously prepared at a lower level shall be reprocessed to conform to any higher level(s) specified in the shipping document.

d. The following levels of protection apply equally to preservation and packing:

(1) Level A. This level is designed to provide the degree of protection required against the most severe conditions known or anticipated during shipment, handling, and storage. Level A protection is provided to selected items of plant equipment that are designated Military Support Items (MSI). Normally, level A protection is provided for IPE and OPE destined for noncontrolled storage or for overseas shipment.

(2) Level B. This level is designed to provide the degree of packing protection against conditions known to be less severe than those requiring level A, but more severe than those for which level C is adequate. Items packed to this level are intended to be shipped and handled under cover and expected to be stored in warehouses or other structures having equivalent protection from weather. This level of protection is adequate for standby-in-place, standby-on-site, and central storage of plant equipment.

(3) Level C. This level provides the degree of protection required against known favorable conditions during shipment, handling, and storage. It should be used on items of plant equipment to be placed in controlled humidity storage and for domestic shipment from user to user, user to DOD Industrial Reserve, user to Defense Reutilization and Marketing Office (DRMO) for disposal, or manufacturer to user for immediate use. It involves provision of the minimum protective measures required to ensure delivery to the first receiving activity without deterioration or damage during shipment and handling.

(4) Industrial packaging will be acceptable for any level of protection when the technical design of the package meets all conditions of the level of protection specified. It must provide the same level of protection against physical and environmental damage as the military package.

1-8. Type of Load and Critical Items Consideration

a. Type of loads. The term “type of load” refers to the physical characteristics of the item, including the nature of the item as it contributes to the support of, or possible damage to, the container. The design of the shipping container to be used is influenced by the type of load. There are three types of loads, type 1, type 2, and type 3.

(1) Type 1, easy load. This type of load is composed of a single item or single interior package which provides complete and uniform support to all faces of the shipping container. The container contents are of moderate density, are relatively sturdy, and require no blocking or bracing.

(2) Type 2, average load. This type of load is composed of more than one item or possesses an interior container which gives some support to all faces of the shipping container. The contents are of moderate density and are relatively sturdy. Blocking and bracing is sometimes needed.

(3) Type 3, difficult load. This type of load gives little or no support to the shipping container. The contents vary from extremely heavy to very fragile and are very irregular in shape. Blocking and bracing is used to convert type 3 loads into type 1 and type 2 loads.

b. Weatherproofing. Weatherproofing, when necessary, is to provide a waterproof barrier in the form of a case liner, crate liner, shroud, or wrap fabricated of barrier materials, conforming to PPP-B-1055 or MIL-B-121. Such waterproof barriers are primarily intended to prevent deterioration of the items and of the preservation materials used to protect the articles by excluding entry of free water or by diverting water from materials which are subject to water damage. In addition, waterproof barriers will afford protection from dust, dirt, and other foreign matter. Waterproof barriers will not be used when the interior packs are already waterproofed or when asphalt (in some of barrier materials or sealants) would be injurious to the enclosed articles.

1-9. Sources of National Stock Numbers

a. National stock numbers are listed in Federal Supply Catalogs (FSCs) published by the Defense Logistics Agency (DLA).

b. Catalogs published by General Services Administration contain numbers and descriptions of items handled by the agency.

1-10. Application

a. This manual is primarily intended as a basis for indoctrination of industry and Government personnel, both military and civilian, in the art of preparing IPE and OPE for storage or shipment.

b. It may be used as a guide by Government personnel having responsibility for the

preparation of the “scope of work” contained in contractual documents, which are relative to the preparation of IPE and OPE for storage or shipment. In contractual documents this document will not be referred to as a whole, but excerpts may be included.

c. This manual cannot be interpreted as superseding any requirements in specifications or other documents referenced in contracts, but it should be used as a guide to the detailed requirements concerning the preparation of IPE and OPE for storage or shipment.

1-11. Health and Safety Hazards

Cleaning processes specified herein can create health and safety hazards. Cleaning processes shall comply with the requirements of the Occupational, Safety and Health Administration (OHSA) Code of Federal Regulations (CFR) 29 CFR 1910. Vapor degreasing demands special care, because the toxic vapor from the degreaser can cause injury to the lungs and skin. Some solvent cleaning materials are flammable, and will cause skin irritations or nausea if the vapor concentration is excessive. Special equipment and sufficient ventilation are required for solvents. Water base cleaners, when heated, can cause burns and rashes.

1-12. Changes and Revisions

a. Changes or revisions to this manual, due to major changes in preservation packaging concepts and policies or due to revisions of specifications in other official publications, will be made on a continuing basis, as required.

b. Users of this manual are encouraged to submit recommended changes or comments to improve the manual. The changes or comments should be keyed to the specific page, paragraph, and line of the text in question. Reasons should be provided to ensure understanding and complete evaluation. Changes or comments should be addressed to Director, U.S. Army Industrial Engineering Activity, ATTN: AMXIB-I, Rock Island, IL 61299-7260.

CHAPTER 2

CLEANING, DRYING, AND PRESERVATIVES

Section I. CLEANING MATERIALS AND PROCESSES

2-1. Decontamination of Equipment

a. Whenever IPE is contaminated with polychlorinated biphenyls (PCBs), explosives, acids, or other corrosive material and/or toxic substances, it must be decontaminated prior to being prepared for storage or shipment.

b. Detailed decontamination procedures for IPE may be obtained by contacting the Defense General Supply Center, ATTN: DGSC-SSM, 8000 Jefferson Davis Highway, Richmond, VA 23297-5501.

2-2. Cleaning

a. Importance of cleaning. The successful preservation of IPE or OPE depends upon the use of approved processes.

(1) A preservative film will not protect an item if the surfaces are dirty or covered with corrosion producing particles. Inadequate cleaning makes all succeeding operations ineffective.

(2) When surfaces are covered with foreign material which is not part of the item, they are contaminated. Every item is subjected to many kinds of contamination from the time it is manufactured until it is removed from service. Examples of contaminants are drawing, milling, or cooling compounds, metal shavings, chips, abrasives, and shop dirt.

b. Basic cleaning requirement. Basic cleaning requirements apply to all items of IPE and OPE. Cleaning should be performed in accordance with this manual. Processing operations shall be accomplished within rain-proof facilities which will substantially prevent infiltration of wind blown dust. Equipment brought into processing facilities shall be allowed to reach ambient temperature before processing.

CAUTION

IN ORDER TO PREVENT DAMAGE TO **IPE**, IT MAY BE NECESSARY TO BLOCK OR BRACE INTERNAL AND EXTERNAL PORTIONS OF THE ITEM PRIOR TO MOVEMENT INTO TILE PROCESSING AREA.

(1) The processing area shall be heated and/or cooled, as required, and shall contain adequate processing equipment.

(2) A thorough cleaning shall be accomplished in accordance with process C-1.

(3) Critical operating surfaces and other machine surfaces shall be treated for removal of fingerprint and perspiration residue.

(4) Cleaning, drying, inspections, fingerprint removal, and the application of preservatives shall comprise an uninterrupted series of operations. The time required to accomplish these operations shall be held to the absolute minimum.

(5) Equipment shall be disassembled only to the extent necessary to permit required inspections, cleaning, and preservation.

(a) All disassembly and reassembly shall be accomplished by technically qualified personnel, who are knowledgeable of the machines involved.

(b) Care shall be exercised in the handling of parts to avoid damage and conditions which promote the formation of corrosion.

(c) Parts and assemblies removed during disassembly shall be properly identified to show correct reassembly.

(d) Disassembly of high speed spindle heads shall not be attempted by personnel not fully qualified for this work. This type of work shall be performed in accordance with the repair instructions of the manufacturer.

(6) Prior to cleaning with solvents, exposed precision bearings, motors, control panels, electrical systems, and items containing organic materials shall be covered with barrier material conforming to MIL-B-121, to prevent their damage or contamination. Barrier material conforming to MIL-B-81705 should be used to protect electrostatic sensitive devices from damage.

(7) Wiring, piping, and tubing should never be cut. All disconnects should be made at proper disconnect points, such as junction boxes, terminals, fittings. Disconnected wires, pipes, and tubing shall be identified to indicate proper reassembly.

(8) Cleaning material used in the cleaning processes must be selected to comply with the requirements of the 29 CFR 1910, and regulations in force in the geographic areas where cleaning is performed.

c. Cleaning processes, materials, procedures. The cleaning processes described throughout this manual are generally applicable to metalworking machinery and related to IPE and OPE. The processes selected should adequately prepare items being cleaned for the application of a preservative. There is no single process which will properly condition any and all surfaces. The proper cleaning processes must be utilized to prevent damage.

(1) Requirements. In the absence of a specification or direct instructions, the selection of a cleaning process becomes optional with operating personnel. Care must be taken so that the cleaning process selected will not damage the mechanism, structure, or function of the equipment. The choice of a cleaning process will depend on the following:

(a) Material composition.
(b) Nature of the equipment's surface.
(c) Complexity of construction.
(d) Nature of contaminants to be removed.
(e) The portion or area of the equipment requiring cleaning.
(f) The degree of contamination.
(g) Availability of cleaning materials and equipment, and hazards involved.

WARNING

APPROPRIATE SAFETY PRECAUTIONS MUST BE TAKEN TO PROTECT PERSONNEL FROM CLEANING MATERIALS THAT MAY PRESENT FIRE HAZARDS, CAUSE SKIN IRRITATION, OR HAVE TOXIC EFFECTS WHEN INHALED. USE CLEANING MATERIALS IN A WELL VENTILATED AREA. THE USE OF GASOLINE AND CARBON TETRACHLORIDE IS PROHIBITED.

(2) Type of contaminants. Contaminants generally associated with IPE vary according to their composition, and the degree of difficulty they present in their removal. The contaminants may be classified as follows (see fig 2-1).

(a) Oily contaminants such as oils, grease, cooling compounds, and oily or greasy factory residue.

(b) Water soluble contaminants, such as perspiration, factory markings, and any contaminants which will dissolve in water.

(c) Solid contaminants such as dust, rust, scale, and metal chips further classified into loosely adhering and tightly adhering. Examples of loosely adhering solid contaminants are metal chips and shop dust. Examples of tightly adhering solid contaminants are the rust and scale that develop on metals.

(d) Other contaminants that must be considered are chemical contaminants such as plating solutions, acids, alkali residue, salts, and other chemical agents used in heat treating operations and other manufacturing processes.

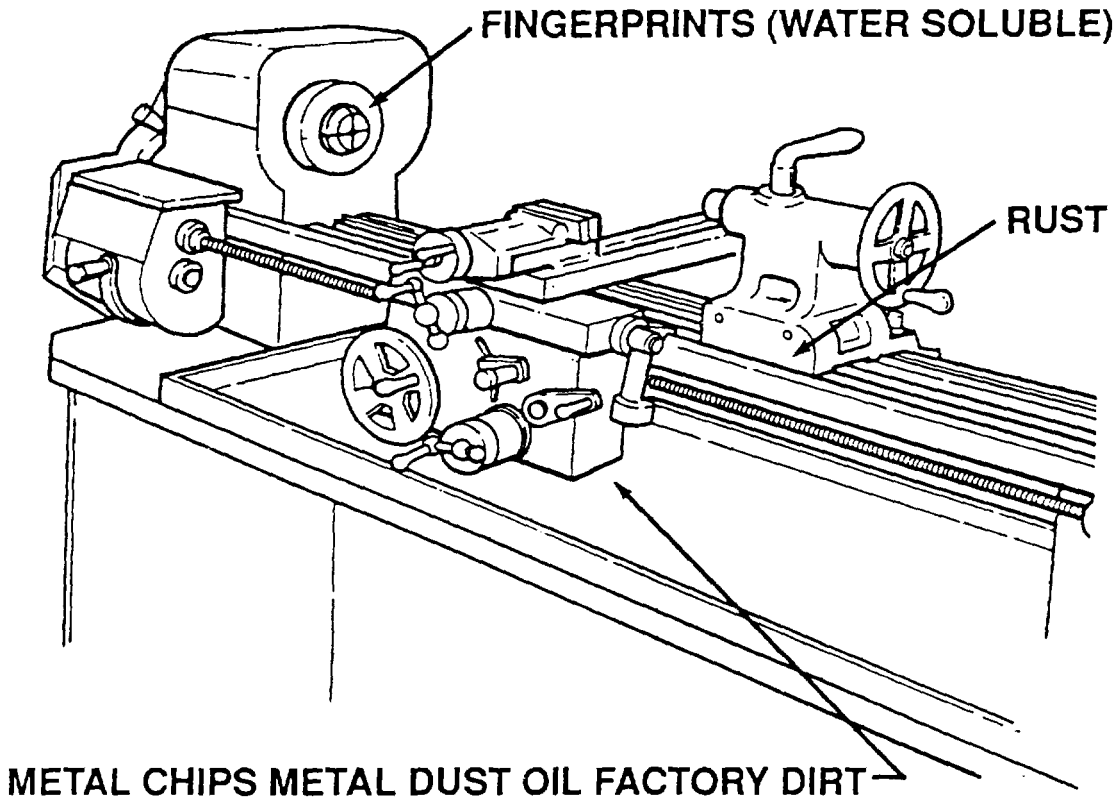


Figure 2-1. Types of Contamination

WARNING

POLYCHLORINATED BIPHENYL (PCB) IS A CANCER CAUSING SUBSTANCE. IT IS A POISONOUS ENVIRONMENTAL POLLUTANT AND MUST BE REMOVED AND DISPOSED OF IN ACCORDANCE WITH ALL APPLICABLE FEDERAL, STATE, AND LOCAL ENVIRONMENTAL REGULATIONS, WHEN THE SYSTEM CONTAINING THE **PCB** IS AT A LEVEL ABOVE 50 PARTS PER MILLION (PPM). SYSTEMS WHICH HAVE BEEN FOUND TO CONTAIN PCBs INCLUDE HYDRAULIC SYSTEMS, TRANSFORMERS, AND CAPACITORS. THEY SHALL, BE INSPECTED AND TESTED WITH PROCEDURES FOUND IN 40 **CFR** PART 761.30(E)(1). PCB CONTAMINANTS MAY BE PRESENT IN TANKS OR OTHER CONTAINERS WHICH ARE CONSIDERED **OPE**, OR THEY MAY HAVE CONTAMINATED OTHER ITEMS OF EQUIPMENT WHICH ARE IN USE IN THE IMMEDIATE VICINITY OF THE CHEMICAL. NEUTRALIZATION AND REMOVAL OF PCB CHEMICALS MUST BE ACCOMPLISHED THOROUGHLY. A NEUTRALIZING AGENT MAY BE IDENTIFIED BY EITHER THE USER OR MANUFACTURER OF THE CHEMICAL.

d. Process C-1, any applicable process. Process C-1 is any cleaning process or combination of processes (mechanical or chemical) that will accomplish a thorough cleaning of an item of IPE without damage to the item or any component thereof. The prime considerations here are the removal of all contaminants and protection of the performance capability of the machine. The methods and materials used for cleaning may include but are not limited to those listed in MIL-P-116 and this manual. Process C-1 can be used either when required by a specification, contract, or when MIL-P-116 is cited as the cleaning guide without reference to any specific process.

(1) Mechanical processes are used to remove tightly adhering contaminants. These processes use abrasive materials, pressure and power tools and often subject the item to severe treatment. Some of the processes are wire brushing, impact tool cleaning, ultrasonic cleaning, and buffing cleaning.

(a) Wire brushing (power/manual). Wire brushing may be used to remove loose paint, scale, rust, and other deposits from noncritical surfaces. This method is commonly used on cast surfaces of such items as machine frames, furnace shells, and structural iron components. Wire brushes should be made of the same material as the metal being cleaned. Oily or greasy contaminants must be removed before wire brushing. Wire brushing will not remove tightly adhered mill scale, oxides, or imbedded corrosion.

CAUTION

WIRE BRUSHES MAY DAMAGE PRECISION SURFACES.

(b) Impact tool cleaning. Impact tool cleaning may be used on noncritical surfaces to remove mill scale, heavy rust, and old dry coatings. It consists of loosening up the contaminants by means of tapping on the item with hand, pneumatic, or electric hammers, chisels, scaling tools, chippers, scrapers, and rotary wheels, or by subjecting the item to intense and repeated vibration (see fig 2-2).

(c) Vacuum cleaning. Vacuum cleaning can be used on IPE and OPE to remove contaminants such as dust and lint particles. It should be used on items, such as electrical control cabinets, which cannot be cleaned by other mechanical or chemical processes.

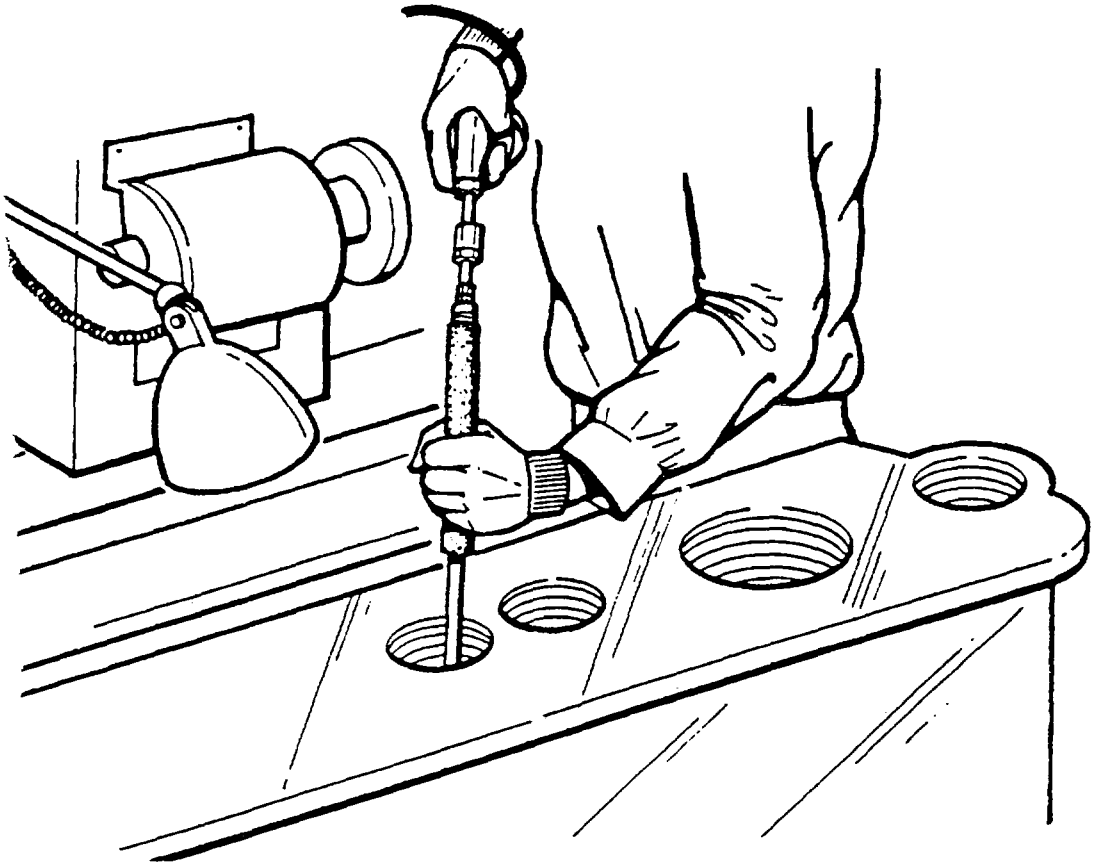


Figure 2-2. Impact Tool Cleaning

(d).Ultrasonic cleaning. Ultrasonic cleaning is well suited to the cleaning of precision parts and/or assemblies. Ultrasonic cleaning will effectively remove light rust, oily contaminants, and other loosely adhering contaminants, from blind holes, crevices, indentations, and recesses. Ultrasonic cleaning may be used to clean assembled components, thereby eliminating disassembly.

(e) Buffing. Buffing may be used to remove light surface rust, stains, and discoloration firm critical surfaces and close tolerance areas. Crocus cloth or other mild abrasive should be used to ensure the base metal is not removed and the surface finish is not marred or scratched.

(f) Chemical process. The chemical processes are acid, alkaline, and detergent cleaning. Prior to the application of the rust remover, all greases, oils, old preservatives, and loose scale must be removed. Phosphoric acid may be applied directly to the rusted areas. Do not allow acid to run into cracks, crevices, oil holes, or gear boxes since it will corrode metal when trapped for prolonged periods of time. Allow the acid to remain long enough to loosen rust. Rinse surface areas covered with acid with hot water to remove all traces of acid. Allow to dry thoroughly prior to application of a preservative.

WARNING

WHEN USING PHOSPHORIC ACID, PROTECT HANDS, FACE, AND EYES. WEAR RUBBER GLOVES, APRON, AND GOGGLES. IF SPLASHED ON SKIN, FLUSH WITH WATER, FOLLOWED BY A WATER RINSE CONTAINING 1 PERCENT BICARBONATE OF SODA AND THEN OBTAIN PROPER MEDICAL ADVICE. AVOID PROLONGED BREATHING OF VAPORS AS THEY MAY BE HARMFUL

(g) Other chemical processes. Another chemical process is the use of commercial neutralizing agents. This involves the removal of acid or alkaline solutions with a neutralizing agent e.g., an alkaline rinse to remove acid residues.

e. Process C-3, solvent cleaning. Cleaning process C-3, is used to remove oils, light grease, grinding grit, metal chips, and dirt by its washing and dissolving action. The solvents, degreasers, and paint thinners used in this process shall be Environmental Protection Agency (EPA) approved and free of all ozone depleting chemicals (ODC). This cleaning process is most adaptable to, and most commonly used in cleaning IPE classified as metalworking machinery.

CAUTION

KEEP SOLVENT AWAY FROM OPEN FLAME OR SOURCE OF SPARKS. DO NOT BREATHE VAPORS. PROVIDE ADEQUATE VENTILATION, WEAR RUBBER GLOVES, WORK APRONS, AND SAFETY GOGGLES. WHEN NOT IN USE, COVERS SHOULD BE CLOSED ON SOLVENT TANKS. A CARBON DIOXIDE FIRE EXTINGUISHER, PERSONNEL TRAINED ON THEIR USE, AND FIRE BLANKETS SHOULD BE AVAILABLE IN THE VICINITY OF THE SOLVENT CLEANING.

The three general ways of accomplishing solvent cleaning are as follows:

(1) Solvent cleaning immersion. This process is applicable to components, accessories, and tooling which are small enough to be immersed in tanks of petroleum solvent. The items are initially cleaned by complete immersion in a tank of solvent. To aid in the cleaning process, agitate, brush, or scrub parts whenever possible. The initial cleaning shall be followed by immersing the items in a second tank of clean solvent (agitate if possible). The second tank is used as a rinse to remove contaminated film remaining after immersion in the first tank.

(2) Cleaning by brushing or wiping. This process is applicable to larger items and basic machines of such size that immersion would not be practicable. The solvent shall be applied to bare metal areas of equipment by brush or saturated cloth. The cleaning should be a combination of soaking and scrubbing or wiping as necessary. Repeat the application of clean solvent until all contaminants are removed. Rinse with a clean cloth soaked in clean solvent. Exercise care to clean only the areas which will not be damaged by solvent. Drain or wipe off excess solvent with a clean cloth.

(3) Solvent spray cleaning. This process may be used for the removal of oil, grease, sludge, chips, dust, or light preservation compounds on items of simple construction, free of cavities and indentations. The force of the spray mechanically removes insoluble contaminants. Spray cleaning is most effective on metal parts or simple assemblies that can be reached by the sprayed solvents. Solvent spray cleaning should not be used on assemblies with surfaces that will be damaged by, or trap solvent. The spray pumping system should have sufficient pressure and should have the spray nozzles placed so that all surfaces of the parts to be cleaned are reached by a high-pressure stream of solvent. Drain or wipe off excess solvent with a clean cloth.

f. Process C-8, perspiration and fingerprint removal. After cleaning and drying, and before application of preservatives, all critical functions or close tolerance surfaces shall be treated for the removal of fingerprints and perspiration residue using process C-8. The solvent used for this process should conform to MIL-C-15074. In addition to removing fingerprints and perspiration residue, this solvent is also effective for removing some acids and other inorganic contaminants. Perspiration and fingerprint removal will always follow, never precede, other cleaning processes. Clean gloves should be worn at all times when handling parts being cleaned by this process. The following procedures are recommended for cleaning perspiration and fingerprints from IPE.

(1) Any item which has been contaminated during interim storage following any of the cleaning processes described in this section, must be recleaned by using the solvent cleaning

process, prior to the use of the fingerprint removal solvent. It is necessary that the fingerprint removal material be applied only to a clean surface.

(2) Small items must be immersed and agitated in a tank containing the fingerprint solvent for a period of not less than 2 minutes. Scrub or brush the items as necessary to assist in the cleaning action.

(3) Large items not suitable for immersion should be cleaned with a clean cloth saturated with the fingerprint remover.

(4) After completion of (1) or (2) above, thoroughly rinse off fingerprint remover material as rapidly as possible in clean solvent which is EPA approved and free of ODCs.

2-3 Drying Requirements

a. General drying requirements. All items of IPE must be thoroughly dried immediately following any cleaning process which may leave moisture on the equipment.

(1) The drying of IPE should be accomplished in accordance with drying procedures as shown below.

(2) The drying procedure selected shall not damage the item of IPE.

(3) Clean gloves should be worn by personnel during the drying procedures to prevent contamination of the items being dried.

(4) A preservative should be applied immediately after drying bare metal surfaces.

b. Procedures. One or more of the following drying procedures may be used to accomplish the drying of equipment.

(1) Process D-1, prepared compressed air. Drying by use of prepared compressed air is accomplished by subjecting the item(s) to a blast of cleaned compressed air.

WARNING

GOGGLES SHOULD BE WORN WHEN USING COMPRESSED AIR.

(a) This procedure is excellent for drying large items of IPE.

(b) The pressure of the compressed air should not exceed 30 pounds per square inch (psi).

(c) Each outlet or group of air outlets should be provided with an oil and dirt filter.

(d) Whenever air flow is restricted or contains oil and foreign material, the filters should be cleaned or replaced.

(e) Moisture traps should be provided for each outlet or group of outlets. The traps should be located in the air line as close as possible to the outlet.

(f) The presence of moisture in compressed air may be readily detected by observing a polished metal part for condensation when the air is blown on the part.

(g) Whenever the presence of moisture is found in a moisture trap, it should be drained and oven-dried or replaced.

CAUTION

CARE MUST BE EXERCISED IN THE USE OF COMPRESSED AIR FOR DRYING, SO THAT NO DAMAGE RESULTS FRONT ITS USE. FOR EXAMPLE, TAPED WINDINGS OF ELECTRIC MOTORS ARE SUSCEPTIBLE TO DAMAGE IF AIR IS DIRECTED IN A MANNER THAT WILL LIFT OR DISLODGE THE TAPE OR INSULATION FROM THE ENDINGS.

(2) Process D-2, oven. Oven drying shall be accomplished by exposing item(s) to heated air within a properly ventilated and temperature controlled oven.

(a) All pockets of trapped cleaning solutions must be drained from parts before they are placed in ovens.

(b) In most situations, the oven temperature should be maintained between 270 and 350° F (132 and 176° C). Lower temperatures should be used to dry parts which may be damaged by heat. Lower oven temperatures may also be used when drying is used merely to speed the evaporation of solvents.

(c) A fan, air jet, or other suitable ventilation system must be provided to prevent the air in the oven from becoming saturated with water or solvent vapors. The ventilation system should be provided with an approved type of fire protection system.

(d) Drying times may vary according to the amount of residual water or solvent, the mass of the part, and the oven temperature.

(e) After oven drying, it may be necessary to cool the parts before further processing.

(f) To ensure complete removal of all possible moisture, oven drying may be used to further dry parts on which compressed air has been used.

(g) Oven drying is suitable for drying items such as tooling, certain types of gages, and accessories.

(3) Process D-3, infrared lamp. Infrared lamp drying consists of exposing the item(s) to direct heat rays, from infrared lamps.

(a) All pockets of trapped cleaning solvents must be drained from parts before they are exposed to the direct heat rays of the infrared lamps.

(b) A temperature of 160° F (71° C) must be maintained to effectively dry the parts.

(c) Temperatures attained by individual parts will depend upon the speed of the conveyor, the number and spacing of the lamps, the distance between the lamps, the mass and composition of the parts, and the distance from the lamps to the parts.

(d) It is necessary to remove flammable vapors from the drying area to avoid further danger from fire.

(e) This drying procedure is applicable to machine tooling and accessories.

(4) Process D-4, wiping. Drying by wiping is accomplished by wiping the surfaces of the item(s) with clean, dry, lint free cloths, or lint free wiping papers.

(a) Drying by wiping shall be accomplished in two steps; Step 1 The first wiping should remove all cleaning solvent and leave an apparently dry surface. Step 2 A final wipe should be performed using a clean, dry, lint free cloth or paper to assure a thoroughly dried surface.

(b) When disposing of solvent-saturated cloths or paper, care must be exercised to see that they are placed in approved metal containers with closed tops. The containers must be emptied at regular intervals.

WARNING

SINCE MOST SOLVENT CLEANING OPERATIONS INHERENTLY INVOLVE FIRE HAZARDS, AN ADEQUATE SUPPLY OF FIRE EXTINGUISHERS SHOULD BE LOCATED IN THE VICINITY OF THE CLEANING OPERATIONS. FOAMITE TYPE FIRE EXTINGUISHERS ARE RECOMMENDED FOR PETROLEUM FIRES IN GENERAL, AND DRY CHEMICAL ALL PURPOSE A, B, AND C TYPE EXTINGUISHERS ARE RECOMMENDED FOR GENERAL USE.

(5) Process D-5, draining. When the final step in the cleaning operation involves the use of a petroleum solvent, a thorough draining of the solvent shall be permitted as a drying procedure.

(a) This procedure may be used only when cold-application solvent cutback compounds, such as P-2, P-3, P- 19, and P-21, of table 2-1, are to be used as preservatives on the items. Preservatives P-3, P-19, and P-21, of table 2-1, are basically petroleum preservatives.

Residue from cleaning will not affect these solvent-cutback preservatives but might harm other types.

(b) This method is not intended for use when contact preservatives are not required. Prior approval of this draining procedure shall be obtained by the owning command for conditions other than these specified in (a) above.

Section II. PRESERVATIVE MATERIALS AND THEIR APPLICATION

2-4. Deterioration Data

a. Complexity of IPE. Corrosion and deterioration are always threats to the useful life of IPE. This type of equipment usually contains a complex assortment of many different kinds of material. Rubber, textiles, paper, plastic, metals, and other organic materials are used extensively. Typical of the metals and alloys that can be found in a single unit of IPE are steel, iron, magnesium, chromium, bronze, brass, copper, nickel, and silver. When such a variety of metals is consolidated in a single unit, the deterioration problem is intensified.

b. Basic reason for deterioration. The reason why most equipment and materials are in a constant battle against deterioration by their environments is that they are not in their natural form. For example, pure metals are seldom found in nature. They exist in nature in the combined state, that is in combination with other substances.

c. Metallic corrosion. Metallic corrosion is chemical destruction of metal by its environment. The oxidation process is chemical, in that some substances are converted into new substances such as iron into rust. It is electrochemical in that the chemical action either causes or is caused by electric current. Corrosion is distinguished from erosion which is mechanical wearing away of a metal. Corrosion usually occurs at the surface of a metal since that is the place where the metal comes into contact with the corrosives in the environment. The agents of corrosion, which are various solids, liquids, and gases in the environment, react or combine with the metal to form the corrosion product such as rust and verdigris.

d. Other forms of deterioration. The absorption of water, by wire and cable insulations and by other component parts, can produce swelling, warping, or cracking. In addition, the presence of moisture engenders the growth of fungi which contributes to corrosion, in that it tends to hold moisture against exposed surfaces.

2-5. Selecting the Proper Preservatives

a. Control of environment. If the agents of deterioration which occur in the equipment's environment are not controlled, they will eventually render equipment unusable. This can be prevented by the application of proper preservatives to the most exposed surface areas of IPE. When selecting the type of preservation to be used, consideration must be given to the environment in which the equipment will be stored. Instructions for selecting the correct type of preservative for the type of storage condition to be used is outlined in more detail in chapters 3

and 4. The exact nature of corrosion and how to prevent all of it is not known. Most efforts must, at present, be content merely with slowing down the process. However, several forms of corrosion have been identified and numerous corrosion preventive processes have been developed.

b. Preservative selection criteria. To choose the type of preservative to be applied to a specific item of IPE, a number of factors must be considered: 1) The physical characteristics of the item to be preserved. The composition, surface, finish, complexity of construction, size, and shape must all be evaluated before a preservative is selected. 2) The characteristics of the preservative which must be evaluated. Some preservatives become hard when they dry and are difficult to remove. Some are thin and drain off too rapidly under high temperatures. 3) The degree of protection desired. If the item is to be used within a relatively short period of time, only a light temporary preservative is necessary, but if the item is to be shipped overseas, or must remain in storage for several years, then a more persistent coating is demanded. 4) The requirements of the user must be considered. If it is necessary to spend excessive hours attempting to remove hard-drying and hard-setting preservative without adequate cleaning equipment, the cost could be prohibitive.

c. P-type preservatives. Preservative materials that are most commonly used on IPE, and their recommended use are listed in table 2-1.

Table 2-1. P-Type Metal Preservatives.

P-No	Specification no	Grade type or class	Description	Physical Properties: Flashpoint (min)	Physical Properties: Melt or flow point (min)	Uses	Application	Removal
P-2	MIL-C-16173	Grade 2, soft film	An amber colored compound diluted with solvent that remains soft upon evaporation of the solvent. Mixes readily with oil. Must be applied cold because of low flash point	100 °F (37.8 °C)		Extended under cover protection to Interior or exterior surfaces of machinery, Instruments, bearings, or material with or without the use of supplementary barrier materials, for outdoor protection of material for limited periods where metal temperatures do not leach levels which produce a prohibitive flow of corrosion preventive film	Dipping, spray-Ing, or brushing at room tempera-ture.	Petroleum solvents or vapor degreasing.
P-3	MIL-C-16173	Grade 3, Water dlis-placing Soft film	A solvent dispersed compound which deposits a thin non-drying film upon evaporation of solvent. It contains ingredients having a greater attraction to metal surfaces than water, thus giving water displacing characteristics	100 °F (37.8 °C)	Used where fresh or salt water must be displaced from corrodible surfaces and the corrosion prevented or stopped, for protecting interior surfaces of machinery, instruments, or material under cover for limited periods and for protecting critical bale steel or phosphated surfaces for extended periods when satisfactorily packaged.		Dipping brushing, spraying, of exterior, flushing; filling or flushing of Interiors at room temperature	Vapor de-greasing petroleum solvent

Table 2-1. P-Type Metal Preservatives. Continued

P-No	Specification no	Grade type or class	Description	Physical Properties: Flashpoint (min)	Physical Properties: Melt or flow point (min)	Uses	Application	Removal
P-9	VV-L-800	One grade only	A highly refined, light, low viscosity oil containing rust inhibiting additives. Its viscosity is similar to SAE 5 oil	275 °F min (135 °C) NOTE: This oil loses its neutonian properties at very low tempera-tures; it should be tested for use on specific machine designs at temp below -40 °F before adoption.	-70 °F (pour point max) (-56.6 °C)	For use in lubrication and protection against corrosion of certain small arms, automatic weapons, fuse mechanisms, components of internal combustion engines, exterior surfaces of machinery for short time periods such as use to use redistribution and wherever a general purpose low temperature lubricating oil is required.	Any method at room temperature Available In gas pressurized containers for use in areas difficult to preserve	Petroleum solvents vapor degreasing.
P-10	MIL-L-21260	Type I, Grade 10	A petroleum product compounded with additive material. Light viscosity equal to SAE No. 10	360 °F (182.2°C)	-20 °F (-28.8 °C) pour point max	For preservation and break-in use in reciprocating spark ignition and compression ignition engines, in all types of ground equipment at temperatures above -10 °F.	Any method at room temperature	Petroleum solvents. Removal before use not generally required

Table 2-1. P-Type Metal Preservatives. Continued

P-No	Specification no	Grade type or class	Description	Physical Properties: Flashpoint (min)	Physical Properties: Melt or flow point (min)	Uses	Application	Removal
P-10 Cont	MIL-L-21260	Type I, Grade 30	Medium viscosity equal to SAE Grade 30	390 °F (198.8 °C)	0 °F (-17.7 °C) pour point max	levels up to 150 p.s.i. (1 048 kpa), (BMEP). Also to protect engine parts from deterioration during shipment and storage. Should be used as factory-fill and bread-in oils for all new and rebuilt engines Oils are also operational and need not be drained until the first scheduled oil change. Same as above except Type II oils are Intended for use In super charged compression- ignition engines operating at output levels of approximately 150 p.s i (1048kPa) BMEP, and above.		
	MIL-L-21260	Type I, Grade 50	Heavy viscosity equal to SAE Grade 50	400 °F (204.4 °C)	15 °F pour point max-			
	MILL-21260	Type II, Grade 10		360 °F (182.2 °C)	20 °F (-28.8 °C)			
	MIL-L-21260	Type II, Grade 30		390 °F (198.8 °C)	0 °F (-17.7 °C)			
P-11	MIL-L-10924	One grade only	A smooth homogenous mixture of mineral or synthetic oil or combination there-of with a gelling agent stabilized to give low and high temperature performance between -65 and 225 °F (-53.9 107.2 °C)			For lubrication of automotive and artillery equipment operating over an ambient temperature range of minus 65 F to plus 225 F(-53.9 °C to 107.2 °C) for protection of lubricated bearings Particularly suitable for equipment operating at both very low and very high	Brush, grease gun, or swab-bing at room temperature	Toluene, benzene or hot SAE oil followed by solvent. Removal not generally required

Table 2-1. P-Type Metal Preservatives. Continued

P-No	Specification no	Grade type or class	Description	Physical Properties: Flashpoint (min)	Physical Properties: Melt or flow point (min)	Uses	Application	Removal
P-19	MIL-C-16173	Grade 4, Transparent, nontacky film	Transparent during protective life of film Solvent- dispersed, amber colored nontacky film	100 °F (-37.8 °C)		General purpose indoor and limited outdoor preservation of corrodible metals, with or without an overwrap, and where handling, stacking, free coat Where a transparent coating is required in addition to protective qualities, where there Is no requirement for miscibility with lubricating oil, and where ease of removal with petroleum solvent is Important.	Dipping and brushing at room temperature	Petroleum solvents or vapor degreasing
P-21	MIL-C-16173	Grade 5, Thin film cold application low pressure steam removable	A solvent-dispersed corrosion preventive compound which deposits a thin, easily removable film after evaporation of the solvents	100 °F (37.8 °C)		Used where fresh or salt water must be displaced from corrodible surfaces; for protecting Interior surfaces of material under cover for limited periods; and for protection of critical bare steel or phosphated surfaces for extended periods when packaged with satisfactory barrier materials. Used in lieu of grade 3, MIL-C-1 f6173, where chemical "boil-out" cannot be used for removal	Dipping, brushing, spraying or exterior surfaces and flushing, filling, or slushing of interior surfaces at room temperature (40 °F(4.4 °C) or higher).	Vapor degreasing, solvents or low pressure steam.

NOTE

COMPOUNDS MIXED WITH SOLVENTS SUCH AS THOSE SPECIFIED AS P-2, P-3, P19, AND P-21 OF TABLE 2-1, MUST BE THOROUGHLY MIXED PRIOR TO USE.

2-6. Preservative Application

a. General. Most P-type preservatives are oily or greasy in nature, and vary greatly in chemical composition and consistency. For this reason they cannot be indiscriminately used on all kinds of materials. They may destroy the usefulness of an item due to the difficulty of their removal. A preservative may penetrate into unwanted areas and cause swelling or decomposition of some of the materials.

b. Application requirements. Petroleum or P-type preservatives, are applied to those metal surfaces on which corrosion in any form, such as oxides, sulfides, and verdigris could occur. The type of preservative to be used on a particular item is usually specified in procurement documents or processing specifications. In the absence of specific instructions, the choice of preservatives is made from those listed in table 2-1. Care must be taken that the preservative selected will not damage the mechanism, structure, or function of the item either when applied, in use, or during removal.

c. Exceptions to the application requirements. P-type preservatives are not applied to surfaces which are protected with solid film lubricants such vitreous plastic, primer, or paint. They are not normally used on noncritical metal surfaces that are inherently resistant to corrosion, such as items made from copper, nickel, chromium, brass, bronze, or other corrosion resistant metals and alloys. P-type preservatives are not applied to noncritical items that have been coated with materials such as chromium, silver, nickel, cadmium, zinc, or tin. Oily type preservatives are not applied to items that are vulnerable to damage by the petroleum ingredients such as those fabricated from textiles, cordage, plastics, mica, rubber, paper, felt, leather, and leather products, or pre-lubricated bushings. These preservatives are not applied to certain types of electrical and electronic components or equipment such as condensers, electrical connectors, distributor rotors, circuit breakers, fuses, switches, resistors, and rectifiers. P-type preservatives are not applied to any item which would suffer damage to the mechanism or structure, or where malfunction or unsafe operational conditions would result from the application or removal of the preservative.

d. Application of preservatives. After the proper preservative is selected, it must be applied to the item(s), assuring that a uniform continuous coating of the preservative adheres to the item(s). Preservatives shall be applied to previously cleaned interior and exterior unpainted surfaces by one or more of the methods of application listed in (1) through (8) below.

(1) Dipping. Dipping is applicable to the preserving of parts that can be dipped in the preservative material at room temperature. Dipping is well suited to applying preservative oils and solvent cut back preservative compounds.

(a) When dipping parts of equipment, hold the parts by metal tongs, by hand (rubber gloves must be worn), or by a wire basket. Wire baskets are used to dip small parts in large quantities. Parts should be placed in the basket in such a manner as to permit the formation of a continuous unbroken preservative film around each part.

(b) Parts shall be dipped in the temperature range set forth in the preservative material specification. Parts should be introduced into the tank so that air bubbles are not caught on any surfaces of the parts. All items dipped should be completely immersed.

(c) When parts are removed from the tank, excess preservative should be drained from all surfaces, to prevent entrapment of the preservative in holes, cuts, or recesses.

(d) Do not disturb the finished coating until the preservative dries and sets. Bare spots left by hooks or baskets should be touched up with a brush.

(e) Parts, dipped separately, should be hung individually on hooks, rings, rods, or racks until dry. items dipped by basket should be left in the basket until the preservative film sets. Under certain conditions, preservative P-19 of table 2-1 will not dry fast enough to permit continuous operation. Normally the coating should feel dry to the touch within 4 hours. Where a more rapid setting is desired, infrared drying lamps or ovens may be utilized.

(2) Flow coating. Before flow coating the surfaces, the surfaces to be protected must be clean and not touched with bare hands or dirty gloves.

(a) Use sufficient preservatives to completely cover the desired areas and then allow the excess to drain off by gravity.

(b) Position items before coating, and drain after coating in such a manner as to prevent collecting of the preservative in blind holes or cavities.

(c) Ensure that all surfaces requiring preservatives are sufficiently coated.

(d) Ample time must be allowed for draining and setting of the preservative before further processing.

(3) Slushing. Slushing is accomplished by pouring the preservative into the part to be preserved, and then rotating, agitating, or positioning the part to ensure complete coverage of all internal surfaces.

(a) Never mix two different preservatives for slushing, as this may create an ineffective chemical solution.

(b) Slushing is most often used to coat the inside surfaces of chambers, tubing, oil coolers, metal tanks, and other cavities not accessible by other means. For this reason, oils and soft thin film preservatives should be used. If properly selected, the preservatives do not normally require removal from the item before using. If removal should be required, the preservatives are easily flushed out.

(c) Pour a sufficient quantity of the preservative into the interior of the item to cover all surfaces when the item is rotated. If available, a small pump with a flexible outlet hose may be used to pump the preservative into the item.

(d) To prevent the collection of preservative in blind holes and crevices, rotate the item, while draining off excess preservative. Take care to prevent spilling the preservative to avoid safety or fire hazards. Equipment and methods of operation should ensure economy through the reuse of preservative.

(e) After draining, close all openings of the item to keep out dirt and other foreign material. Plastic plugs are most satisfactory for sealing openings. Male and female types are available for various kinds of openings. Never use wooden plugs as closures, since splinters from the wood are difficult to remove, and may clog fuel or oil lines and cause serious damage.

(4) Brushing. Brushing is accomplished by coating the item, or limited surfaces of the item, with a preservative using a brush. This procedure is used when no other procedure is available or suitable. Brushing is used extensively where only one part of an assembly requires the coating, such as adjoining hinge fittings, inside surfaces of bushings, or bare metal surfaces next to fabric or rubber materials that must not be coated with preservative compounds.

(a) Make sure the item is clean and dry before brushing. Use only clean brushes for applying the coating. Apply an even and continuous coating. Do not handle items with bare hands or dirty gloves.

(b) Inspect the item to be sure that areas not readily visible are coated. It may be necessary for more than one brush application to provide an unbroken, continuous coating.

(5) Filling or flushing. Filling or flushing is accomplished by completely filling the item(s) with preservative until all interior surfaces are satisfactorily coated and then by draining the item(s).

(a) Ensure coverage of all interior surfaces by completely filling item with preservative. Care should be taken so that entrapped air will not prevent complete coverage of the interior surfaces.

(b) Drain the preservative and close all openings. If the preservative is not to be drained, leave enough space for thermal expansion. Close all openings and make sure they are sealed to prevent any leakage. Wipe up any spilled oil, to avoid possible fire hazards.

(6) Fogging. Fogging is accomplished by coating interior surfaces of items, such as tanks and chambers, with preservatives injected as a cloud or mist from an air atomizing gun, until the enclosed atmosphere is saturated.

(a) Fill the fogging gun tanks with a light preservative oil, such as P-10, grade 30 or P-9, of table 2-1, and adjust the preservative and air valves on the fogging gun to obtain the desired mixture for fogging purposes.

(b) Insert the nozzle of the fogging gun into the opening of the item and fog the interior until an atomized mist begins to form around the nozzle and the opening. If more than one opening is available on the item, repeat the process at each opening to ensure complete fogging of the interior. For extra large tanks or chambers, extensions are available to attach to the nozzle to reach into otherwise inaccessible corners and pockets.

(7) Spraying. Spraying is accomplished by coating surfaces (exterior or interior, as applicable) of the item(s) with preservative applied as spray. Spraying is useful for preservation of large and heavy items that cannot be dipped, or assemblies requiring a preservative only on certain portions of their surfaces. Thin film or oil-type preservatives usually are used in spraying.

(a) Mask all surfaces that are not to be coated, including electrical wiring, receptacles, and rubber and fabric components. Suitable materials for masking are Kraft paper and pressure-sensitive tape. Thin film preservatives and oils will not damage paints or primers on metal surfaces; therefore, such surfaces are not usually masked.

(b) Spraying must be done in a well ventilated area. Wear protective clothing, such as masks and gloves. Fill the spray gun with the selected oil or thin film preservative. Adjust the spray gun and apply an even, continuous, and unbroken film around each item surface. Use normal spray painting techniques for applying the coating. Allow preservative coating to thoroughly dry or set before handling.

(8) Circulating under power. Internal mechanisms and systems are preserved with an oil type preservative with the machine operating under power.

NOTE

NEVER USE PRESERVATIVES P-11 OR P-21 OF TABLE 2-1 IN INTERNAL MECHANISMS HAVING SMALL INTEGRAL OIL LINES. THE PRESERVATIVE WILL HARDEN AND REMOVAL IS VERY DIFFICULT.

(a) Operate the machine at its lowest speed, to ensure circulation of preservative throughout the system.

(b) After thorough circulation drain the oil and close all openings.

CHAPTER 3

MAINTENANCE AND USE-TO-USE REDISTRIBUTION

Section I. GENERAL SHUTDOWN MAINTENANCE PROCEDURES

3-1. General

a. Purpose. The purpose of the procedures listed herein is to provide guidance in establishing a more uniform policy relative to contractual shut down maintenance of industrial plant equipment (IPE).

b. Federal Acquisition Regulation. Federal Acquisition Regulation (FAR) 52.245-7(h) sets forth binding contractual requirements relative to preventive maintenance of Government property in the possession or control of contractors and industrial vendors. Under this clause are provisions for packaging IPE that will not be used for over 18 months. IPE includes accessories and special tools furnished with the item of IPE but not regularly used with the machine. Contractors and vendors also have the responsibility to repair, clean, dry, preserve, pack, and ship IPE for reuse. All shutdown cleaning, drying, preservation and packing shall be the responsibility of the contractor or vendor as identified in the contract.

c. Interim storage. When metal working machinery and related plant equipment is designated for storage following the end of production, the time element between shutdown and processing for long term storage is referred to as interim storage.

(1) During the interim storage period, grit, grease, fingerprints, and other acid and alkali residue may cause considerable damage to critical functions or to close tolerance surfaces. These residues form a coating or crystallized sediment.

(2) Once this coating or sediment has formed, considerable disassembly may be required to accomplish its removal and the removal of resultant corrosion. Therefore, it is paramount that established shutdown procedures be followed.

d. Rebuild. When IPE is being shipped to a rebuild facility for rebuild, the shipping activity or owning activity will process the equipment only to the extent necessary to ensure that the item reaches it's destination without deterioration or damage. In addition, the processing used to protect the item will do so for a minimum of 60 days. The receiving activity shall certify that the preliminary rebuild activities of cleaning will be initiated within 60 days or that equipment will be stored in a dehumidified environment. If the time to initiate the rebuild process exceeds 60 days, the item shall be processed by the rebuild facility in accordance with the interim preservation procedures specified in this manual.

3-2. Guide for Shutdown Maintenance

a. Production phase down. As production is phasing down, the using activity, contractor, or Government activity shall evaluate the production capability of each item of IPE.

(1) The operating capability (condition code) of the item shall be based on general purpose utilization. Both static and dynamic (analytical) testing shall be performed. Each item to be placed in storage shall also be mechanically capable of performing the required operation for which it will be retained. In addition to condition coding, unusual circumstances such as, missing parts, defective components, and/or, erratic operation and malfunctioning that would affect the manufacturer's design operability shall be noted. This data will provide backup for permanent records such as the DD Form 1342 (DOD Property Record) maintained by using activity, contractor, or Government activity.

NOTE

Under no circumstances shall the condition code be established solely on the performance of a specific repetitive operation.

(2) Shutdown maintenance procedures shall begin as soon as the equipment becomes idle and continues down the production line until the last item is turned off. Every effort shall be directed toward initiating these progressive maintenance actions within 48 hours of first machine shutoff. These procedures represent the minimum cleaning and preservation operations to be performed on plant equipment. They do not, however, release any responsibility for disassembly when such action is required to meet the minimum requirements of cleaning and preservation for long term storage. Manufacturing residues are carried by the coolants to cracks and voids throughout the machine. To ensure adequate removal of these residues, varying degrees of disassembly will be mandatory. Under normal atmospheric conditions, it is estimated these procedures will provide interim protection for a 30/60 day period, at which time additional cleaning and preservation are mandatory.

b. Procedures. The following procedures shall be followed when performing shutdown maintenance on each item of IPE, OPE, special tooling, and special test equipment.

WARNING

Remove all electrical power prior to performing any type of maintenance or cleaning.

(1) Remove all production materials and parts (i.e. in-process parts, raw materials, and bulk process materials such as quench oils, chemicals, acids, etc.)

(2) Remove such items as covers, inspection plates, and guards, as necessary, to facilitate removal of manufacturing residue. Standard accessories and attachments, such as chucks, face plates, steady rests, tool holders, grinding wheels, consumables, dies, jigs, arbors, and fixtures, shall be detached prior to external cleaning.

(3) Each unit containing hydraulic systems shall be tested for polychlorinated biphenyl (PCB) before draining. Further processing or decontamination of these systems shall be accomplished prior to shipment or preparation for long term storage.

(4) Drain the coolant system of all soluble and cutting type fluids. Remove residual sediment, sludge, and manufacturing residue from accessible reservoirs, drip pans, and machine voids.

(5) Clean all exterior machine surfaces (precision, painted, and unpainted), removing manufacturing residue, such as shop dirt, metal chips, and contaminants, with EPA approved cleaning solvents. Precession and bare metal surfaces cleaned with cleaning solvent shall be thoroughly dried and a protective coat of preservative oil P-10, grade 30 of table 2-1, shall be applied.

CAUTION

Care shall be exercised during the cleaning operation to prevent damage or contamination to the electrical systems, motors, electronic components, and precision bearings from the cleaning solvent.

(6) Install a sufficient quantity of solution A in any coolant reservoir(s) to permit free circulation of the solution through the pump and piping system when the equipment is cycled.

Solution A: One part lubricating oil P-10, type I, grade 30, of table 2-1, and nine parts dry cleaning solvent.

NOTE

If the coolant system is of such a size that it would not be economical to flush with the cleaning fluid solutions, the coolant pump may be disconnected to prevent operation during cycling.

(7) If the coolant system is of such size that it would be uneconomical to flush (over 50 gallons (189 liters)), it may be possible to open the lines and bleed sufficient flushing solution A through the system lines to ensure freedom from contamination such as sludge and grit. However, if an auxiliary pump is used, the machine pump must be removed or disconnected during the cycling operation and disassembled to insure complete cleaning and subsequent preservation. Be sure the coolant and sludge remaining in pockets between the baffles are removed using a suction pump or a hand method if necessary.

(8) Reinstall covers, inspection plates and guards which were removed to facilitate external cleaning to the extent necessary to ensure safe machine operation. Check all lube systems, gear boxes, oil cups, and grease fittings to ensure each is filled to operating levels. Cycle the machine for approximately 15 minutes or as required to bring operating oils and fluids up to normal operating temperature. During the cycling operation, permit solution A to flow freely over the machines precision surfaces normally subject to cutting fluid, and back through the reservoir to accomplish as much washing action as possible. During the cycling operation, assemblies such as carriages, tables, and slides (power or manual), shall be manipulated to assist in the washing action.

(9) Immediately following cycling, drain solution A from the coolant and/or cutting fluid system(s). It may be necessary to use a suction pump to ensure complete removal of fluids. Visual inspection of internal and external surfaces and mechanisms will verify completeness of cleaning and provide a basis for determination if disassembly will be required for additional cleaning.

(10) All systems drained and/or cleaned above shall be coated with preservative oil P-10, grade 30, of table 2-1. This may be accomplished by flushing the systems with the above preservative oil. External precision and unpainted surfaces shall be coated with preservative oil, P-10, grade 50 of table 2-1. Precision mating surfaces should be manipulated manually to ensure coating with preservative. An exception will be systems normally lubricated with high pressure, light viscosity oil, such as high-speed, close-tolerance spindle assemblies. These assemblies should be preserved with preservative oil, P-9, of table 2-1.

(11) Pressure-type grease fittings shall be charged with preservative grease, P-11, of table 2-1. Oil cups shall be filled with the manufacturer's recommended lubricant.

(12) Special tooling, accessories, and attachments previously removed will be cleaned and preserved at the same time as the parent machine using the same cleaning materials, processes, and preservatives. They will then be wrapped in barrier material conforming to MIlL-B-121, grade A, type I or II, class 2 or MIL-B-22191 type I or II. They will then be placed in a container conforming to MIL-STD-2073- 1, table VII and secured with tape conforming to PPP-T-60.

(13) Items of IPE and OPE that have been cleaned and preserved shall be covered with a protective dust cover to prevent recontamination. Electrical or electronic systems will be vacuum cleaned, bagged desiccant installed and the cabinet closed.

c. Records. All records for each item of IPE, shall be updated to reflect all findings and any actions taken during shutdown maintenance. Records, including historical records installation and foundation drawings, and manufacturers parts and operation manuals shall be packaged in accordance with C-1 of MIL-P-116. The package shall be marked "TECHNICAL DATA" in bold black lettering. The package shall be protected against puncture and abrasion. The package shall then be placed in a storage compartment of the machine, a box containing accessories or disassembled components of the machine, or taped to the side of the machine with tape conforming to PPP-60, type IV.

Section II. Use-to-Use Redistribution

3-3. General Procedures

a. Policy. The procedures listed herein may be used as guidance in establishing a more uniform policy relative to contractual use-to-use movements of Government-owned IPE. The guidelines set forth represent a sample of work which can be adopted to specific situations with or without modification.

b. Guidance for use-to-use movement. The following information is presented as a guide in preparing IPE for use-to-use redistribution.

(1) Removal from production. All items scheduled for relocation and immediate placement in a production line should be inspected by the prospective receiving activity to determine that the items are capable of performing the assigned work. If the equipment being inspected is not suitable, it should be rejected. No requirement exists for analytical testing to ascertain the condition code for general purpose capability.

(2) Procedures. The preparation of IPE for use-to-use movement shall be accomplished in accordance with paragraphs 3-2b(1) through (13) along with the additional general instructions listed below.

c. General instructions. Disassembly of complete items of IPE for cleaning shall be limited to the degree necessary to assure that critical surfaces are free of contamination. If disassembly for cleaning is required and the degree of disassembly is such that reassembly could result in mismatch or misalignment, the machine shall not be operated under power until assembly and inspection have been accomplished. After inspection the machine shall be operated under power.

NOTE

The machine shall be recleaned and represerved after being test run.

(1) All gear cases, lubricating systems and hydraulic systems shall be tested for PCB contamination. All contaminated systems shall be drained and decontaminated by cycling and flushing with new fluids (hydraulic fluid conforming to MIL-H-5606 or MIL-H-6083) until it meets requirements of Title 40 CFR Part 761. After decontamination, systems shall be drained and all openings closed.

(2) When preparing items for shipment, drain any gear case, lubricating system or hydraulic system subject to leakage/spilling or drain affected systems if it is necessary to disconnect liquid lines. Clean non contaminated fluids shall be drained into clean containers for reuse. Disconnected lines shall be match-marked, tagged or otherwise identified to facilitate reassembly. Open ends shall be plugged or capped to prevent leakage and/or prevent entrance of foreign matter and to prevent damage in transit.

(3) Main external electrical feed lines shall be disconnected at respective terminal blocks or junction boxes. Disconnected wiring shall be tagged or otherwise identified to aid in reassembly. Under no circumstances shall wiring be cut behind terminal or junction connections. Machine control wiring shall not be disconnected unless required for shipment. If continuity is disturbed, proper match marking identification shall be made.

(4) Tension shall be relieved on drive belts unless it involves major disassembly or there is no provision for adjustment. In the event the drive motor must be removed for safe shipment, the drive belt will be attached to the basic machine.

(5) Fixtures attached to tables and other machined surfaces not removed for cleaning shall be removed and mating surfaces cleaned with cleaning solvent conforming to P-D-680, type II and preserved with preservative oil P-10, grade 50 table 2-1. Removed items may be returned to the assigned position on the basic machine for shipment. Previously unremoved shank and socket type tooling shall be removed to permit cleaning and preservation of mating surfaces.

(6) Equipment disassembly for shipment shall be limited to that to facilitate handling/movement and/or weight/size requirements for shipment. Motors and other items subject to damage may either be removed or blocked and braced in place to prevent damage. Machine counter weights shall also be blocked/braced in place. Machine heads and tables shall be placed in their lowest position and centered for shipment.

(7) External precision and unpainted surfaces shall be cleaned and dried in accordance with chapter 2 and preserved with preservative compound P-2, P-3 or P-21 of table 2-1. When exterior painted surfaces are chipped or otherwise, surfaces shall be processed in accordance with paragraph 4-7t.

(8) Standard accessories such as spare parts and, consumable items (to be shipped with the basic machine), shall be cleaned with EPA approved cleaning solvents, and coated with preservative oil P-10, grade 50, of table 2-1. Items shall be wrapped with barrier material conforming to MIL-B-121, grade A, cushioned and packed in accordance with MIL-P-116 and attached to the basic machine. Boxes used as shipping containers for these items shall conform to PPP-B-601 and/or PPP-B-621. A packing list shall be placed inside a water-resistant envelope and securely attached to the outside of the container in the most protected location. DD Form 1342 may be used as a packing list. All markings for IPE, special tooling, and special test equipment shall conform to MIL-STD-129.

NOTE

Additional information on packing lists and markings may be found in MIL-STD-129.

(9) Instruments such as metallic gages and measuring devices shall be cleaned with particular attention given to the removal of fingerprints and rust. Clean and dry these items in accordance with chapter 2. All cleaned items shall be preserved with preservative P-10, grade 30, of table 2-1 immediately after drying. All preserved items shall be wrapped in barrier material conforming to MIL-B-121, grade A. Wrapped items shall be cushioned and packed in accordance with MIL-P-116. Packing lists and markings for packed/boxed items shall conform to MIL-STD-129, as per paragraph 3-3c(5).

(10) Items of special test equipment are usually unique items and each must be considered for cleaning, preservation, and preparation for shipment on an individual basis.

(11) Delicate electrical and electronic equipment such as control panels, X-ray machines, electrolimit gages, comparators, numerical control (NC) units, computer numerical control and memory units are placed in a separate category with respect to cleaning, preservation, and packing. The complexity of their design and circuitry, necessitates their being processed as assembled units, using only cleaning processes that will not destroy delicate systems materials. Solvent flushing shall not be used in cleaning of electrical circuits. Low pressure moisture-free compressed air, vacuum cleaner or a lint-free cloth may be used for cleaning. No further cleaning is required.

(a) It is important that cushioning, blocking, and bracing be accomplished in preparing delicate electrical and electronic equipment for shipment. Vibration, which can cause extensive damage to internal and external components, shall be held to a minimum. Cushioning, blocking, and bracing shall be in accordance with MIL-STD-1186 and MIL-E-17555. Cushioning materials listed in MIL-E-17555 shall be used to immobilize all fragile and delicate parts. Heavy components shall be adequately blocked and braced or removed. Many heavy components do not have adequate internal support to ensure safe delivery. Therefore, consideration shall be given to possible removal of heavy items, such as transformers and motors, which might break loose and cause damage. When components are removed from the equipment, disconnections shall be marked and identified to assure correct reinstallation. All screws and bolts used to secure such items as circuits boards, panels, and shelves, shall be tightened to prevent movement of the components during transportation and handling.

(b) Packing and marking of parts which have been removed shall be in accordance with MIL-E-17555 and MIL-STD-129. Electrical and Electronic equipment need not be skidded unless the weight and size are such that skidding is essential for handling. Cabinet doors shall be locked and secured with banding conforming to ATSM D3953 or CID A-A-880. Adequate cushioning shall be used to prevent the banding from scratching or otherwise damaging the cabinet. Keys for the cabinet door shall be packed using submethod C-1 and taped to the equipment adjacent to the lock.

(c) Due to the high susceptibility of delicate electrical and electronic items to damage from vibration and shock, these items shall be shipped on specialized equipment available from the carrier for the movement of fragile items. Regardless of the mode of transportation, the equipment shall be processed, loaded, and shipped in a manner that will protect the equipment to the maximum extent possible. Transportation mode shall comply with the 49 CFR 100 through 199.

(12) Items such as special tooling, jigs, and fixtures, suitable only for single purpose utilization shall not be shipped with the basic machine unless required for production by the consignee. Disposition of extraneous and special purpose tooling will be the responsibility of the consignor. If the tooling is part of a plant equipment package (PEP), the tooling shall be retained in storage with the PEP.

(13) Exotic and very complex items should be prepared and shipped in accordance with the manufacturer's specifications. In many instances, it is advisable to solicit the services of a company technical representative. Utilization of air ride vans/trucks is recommended for items with delicate components. On all rail shipments, the consignor may request services of the rail carrier to provide load, block, and brace guidance and inspection clearance.

(14) Records, including technical and historical records, shall include all available data pertinent to each item of plant equipment. Technical data including photographs, installation and foundation drawings, manufacturer's parts and operations manuals, and other manufacturer's data related to maintenance and lubrication shall be assembled and packed in accordance with submethod, IC- 1 of MIL-P- 116. The package shall be marked "TECHNICAL DATA" in bold black letters. The package shall be protected against puncture and abrasion. The data shall be either attached to the machine with tape conforming to PPP-T-60, type IV, placed in a storage compartment of the machine, or placed in a consolidated box containing accessories or disassembled components.

(15) Preparation for shipment shall be in accordance with b through c above, as applicable, with additional instructions in MIL-STD-107 and MIL-HDBK-701. Skidding should be held to the minimum required to ensure safe transit. Optimum usage of DOD aluminum skids shall be exercised. Equipment shall be provided with a protective cover or shroud from consignor plant to consignee plant.

(16) Each machine shall have a caution tag attached stating: **"Machine has been preserved for shipment and/or storage. Before putting the machine into operation, fill all reservoirs and lubrication systems completely."** The tag will conform to UU-T-81 and a listing of preservatives used.

NOTE

Machinery using counterweights inside the frame or column to facilitate movement of heavy machine components must have the counterweight removed or blocked and tension on connecting cable or chain relieved to prevent damage in shipment. Machinery equipped with ball or roller antifriction devices under ways or guide surfaces of tables or heads shall be blocked so the antifriction balls or rollers do not carry the weight of the applicable component during shipment.

d. Hydraulic systems. When preparing a large hydraulic system (over 50 gallons (189 liter)) for shipment, it may be necessary to lay the machine on its back or side on the transporting vehicle to obtain the necessary clearance under bridges and through tunnels.

(1) Due to Environmental Protection Agency regulations, it is recommended that hydraulic fluid not be shipped to the consignors facility. Tag the system indicating the requirement that hydraulic chambers be filled before placing the equipment into operation. The tag should also indicate the type of hydraulic fluid required. Clean and preserve all exterior machine surfaces in accordance with paragraph 3-2b(5).

(2) If hydraulic systems are of such a configuration that draining of the system is not required, they shall be shipped without draining the operating fluid with the following exceptions.

(a) Draining prior to shipment has been specifically directed.
(b) Such shipment of fluids is determined to be uneconomical for the Government.
(c) Any reservoir subject to spillage during shipment shall be drained.

(3) If hydraulic systems are shipped without draining, clean and preserve all exterior machine surfaces in accordance with paragraph 3-2b(5).

CHAPTER 4

CLEANING AND PRESERVATION PROCEDURES FOR LONG TERM STORAGE

Section I. INTRODUCTION

4-1. GENERAL

a. This chapter provides basic instructions for cleaning and preserving some common types of OPE and IPE by various classification. It is divided into nine sections. The continuity of these sections is in the order that processing generally will be performed. Paragraphs 4-34 through 4-37 cover sample scopes of work for two categories of storage, stand-by-in-place and controlled humidity storage.

b. There will be times when either exotic or very complex items of plant equipment with numerical control (NC) units will require cycling (exercising) during their tenure in storage. Whenever this occurs, separate scopes of work shall be prepared to cover specific or unique situations for in-place storage.

c. When possible, processing for storage should be accomplished while the equipment is still connected to power. This will, in most instances, reduce processing time and eliminate the necessity of running an auxiliary power line to other processing areas.

d. Cleaning and preservation should be accomplished in one continuous operation. Any delay between the two processes subjects the cleaned items to new contaminants, lest, and corrosion.

4-2. CLEANING

a. A thorough cleaning is the first essential process in any effective preservation method. Improper cleaning makes all subsequent preservation operations ineffective.

b. The conditions under which the equipment will be stored should not influence the degree of cleaning that must be accomplished.

c. The type of equipment being processed determines the degree of cleaning required. For example, equipment such as conveyors, furnaces, rough-type foundry equipment, and spray booths will not require the same degree of cleaning that is necessary for precision-type plant equipment, such as metalworking machinery.

4-3. PRESERVATIVES

a. The preservative materials are listed by "'P" numbers in the preservative compound chart in chapter 2, table 2-1.

b. Other preservatives not classified as P-types are referenced in various sections.

NOTE

PERSONNEL PERFORMING THE CLEANING AND PRESERATION OPERATIONS MUST BEAR IS MIND THAT P-TYPE PRESERVATIVES CANNOT BE USED INDISCRIMINATELY ON ALL KINDS OF MATERIALS. PRESERVATIVES CAN PENETRATE TO UNWANTED AREAS AND/OR CAUSE SWELLING OR DECOMPOSITION OF CERTAIN MATERIALS.

Section II. METALWORKING MACHINERY

4-4. GENERAL

There are many different usage requirements for metalworking machinery. To meet these requirements, the machine tool manufacturers have developed a wide variety of designs and sizes. In view of the many designs, no attempt has been made in this manual to furnish complete details for processing each type. There are, however, areas and assemblies that are common to many types. Instructions contained in the subsequent paragraphs will serve as a guide for processing these areas and assemblies.

4-5. DEFINITIONS

a. Coolant pumps. Coolant pumps are used to supply coolant to the cutting tools when the machine tool is in operation.

b. Critical surfaces and items. Surfaces and items which are subject to chemical or physical deterioration.

(1) Critical item, chemical. Items which are of such a nature that any degree of deterioration (in the form of corrosion, stain, scale, mold, fungi, bacteria) caused by oxygen, moisture, sunlight, living organisms, temperature, time, and other contaminants will result in premature failure or malfunction of the item or equipment.

(2) Critical item, physical. Items which are of such a nature that a slight degree of physical action on the item, or any integral surface thereof, renders it unfit for use. This includes items having a surface finish of 32 microinches (0.80 mm) or less, surfaces requiring a high degree of cleanliness and freedom from contamination as well as those requiring special protection against shock, vibration, abrasion, and distortion.

c. External areas. Areas on which the external assemblies travel and are usually unpainted or finished precision external surfaces.

d. External assemblies. Assemblies which include, but are not limited to carriages, work tables, cross-feed mechanisms, chucks, tool slides, turrets, and tail stocks.

e. Gear housings. Housings that contain gear assemblies and spindles associated with most drive mechanisms of plant equipment. Some of these housings may require an Extreme Pressure (EP) lubricant or a lubricant similar in appearance to grease used for automobile differentials.

f. Grease fittings. Fittings which provide access to individual bearing assemblies for the purpose of applying lubricants. A grease gun is normally required for charging these fittings.

g. Self-contained lubricators. These are lubricators with a built-in reservoir for which there are attached small lubricating lines feeding various bearings and other assemblies and areas.

h. High-speed spindle housings. Housings that contain high-speed spindles are usually associated with grinders. These spindles require a very light oil for lubrication. Some high-speed spindles are self-contained in sealed units and therefore do not require cleaning or preservation.

i. Hydraulic systems. These systems are referred to as either open or closed type. The reservoirs for open types are incorporated into the base of the machine. The reservoir for the closed type may be incorporated into the base of the machine or attached to or mounted on the floor adjacent to the basic machine. The capacity of closed type reservoirs may vary from a few gallons to several hundred gallons, and are referred to as "small closed type" and "large closed type." The following is an analysis of each type:

(1) Open type. This type is subject to contamination by leakage of coolant and cutting oils into the system. Grinding grit, shavings, and other contaminants may also infiltrate the open-type reservoirs.

(2) Small closed type, not more than 100 gallon (378.5 liter) capacity. These systems are used for operating machine tools and small hydraulic presses. Those that are used on machine tools are subject to contamination more than those used for hydraulic presses. Soluble-type coolant may work its way into these systems through packing glands or on piston rods. Gum and sludge deposits are caused by breakdown and oxidation of the hydraulic oil in small systems.

(3) Large closed type, 100 gallon (378.5 liter) or greater capacity). These systems are usually found on large hydraulic presses. The degree of exposure to contamination is much less than that of the small type, and in most instances, will require external cleaning only.

(4) Systems serving tracer mechanisms. These systems may also provide power for other hydraulically-operated assemblies.

4-6. PROCEDURES FOR CLEANING AND PRESERVATION OF MACHINE TOOLS THAT CANNOT BE ECONOMICALLY CONNECTED TO POWER

a. Follow procedures in paragraphs 3-3a through d.

b. Thoroughly clean the coolant reservoir, and when applicable, the areas located under the beds of such items as lathes and milling machines. Be sure the coolant and sludge remaining in pockets between baffles are removed, using a suction pump or hand method.

c. Disconnect and remove the coolant pump from the machine.

d. Clean external areas with solution A as described in paragraph 3-2.

e. Clean all internal assemblies and areas, with the exception of hydraulic systems, by washing with solution A. This may be performed by manual methods by utilizing a portable pump connected to a tank of solution A. One effective method is to have one pressure spray pump and one suction pump operating simultaneously with a hose from each extended into the areas which require cleaning. This will permit free circulation of the cleaning solution through the system.

CAUTION

UNDER NO CIRCUMSTANCES SHALL SOLUTION A BE USED TO CLEAN HYDRAULIC SYSTEMS.

f. Hydraulic systems. All hydraulic systems shall be inspected to determine the condition of the hydraulic fluid. If the hydraulic fluid is clean, uncontaminated, and meets the requirements of the 40 CFR 761, no further processing is required.

(1) If the hydraulic fluid is found to be contaminated with polychlorinated biphenyls (PCBs), the hydraulic system shall be processed in accordance with 40 CFR 761. After decontamination, the system shall be filled with hydraulic fluid specified in the operators manual or conforming to MIL-H-6083.

(2) If the hydraulic fluid is found to be dirty or contaminated (excluding PCBs), the system shall be drained and refilled with hydraulic fluid specified in the operators manual or conforming to MIL-H-6083.

g. Disassemble, as required, and accomplish additional cleaning and preservation as required by following the procedures for shutdown maintenance in chapter 3.

h. When preserving internal assemblies where cleaning solvent may be trapped, fill them to a sufficient level with the proper preservative to ensure displacement of the solvent.

i. Where timing and alignment have not been accomplished, a tag will be attached to the machine stating that this operation has not been performed.

4-7. PROCEDURES FOR CLEANING AND PRESERVATION OF MACHINE TOOLS THAT ARE CONNECTED TO POWER

a. Follow the cleaning procedures in paragraphs 3-3a through d.

NOTE

IF THE COOLANT SYSTEM IS OF SUCH A SIZE THAT IT WOULD NOT BE ECONOMICAL TO FLUSH WITH THE CLEANING FLUID SOLUTION THE COOLANT PUMP MAY BE DISCONNECTED TO PREVENT OPERATION DURING THE CYCLING PERIODS.

b. Hydraulic system. The hydraulic system shall be processed in accordance with paragraph 4-6f of this technical manual.

c. Cycle the machine for approximately 15 minutes. The purpose of this operation is to bring the operating oils to operating temperature and at the same time, cause contaminants to be held in suspension when these systems are drained.

d. Immediately following this cycling period, drain all fluids from assemblies except the following:

(1) Operating oil for large, closed-type hydraulic systems.

(2) The flushing solution from cutting fluid systems.

e. Fill lubricators with preservative oil P- 10, grade 30, of table 2-1. Fill all assemblies that have been drained (except lubricators) to operating level with solution A.

f. Cycle the machine to clean the internal assemblies filled with the flushing solution and at the same time test the hydraulic systems for operating condition. This cycling period will continue as long as cleaning action is being achieved by the cleaning solution. Leave the coolant outlet nozzle open to ensure free circulation of the solution through the coolant system. During the cycling period, thoroughly test all hydraulic systems to determine if they function properly.

g. Drain the solution from all assemblies, with the exception of gear and spindle housings, immediately following the cycling period and after determination has been made that additional cleaning is not required.

h. Attach a tag to the machine with the following statement, as appropriate.

(1) "The hydraulic system has been tested and functions properly, therefore, disassembly for the purpose of cleaning is not necessary."

(2) "The hydraulic system has been tested and failed to function properly. Disassembly is required for repair and adjustment."

i. Thoroughly clean the hydraulic reservoirs associated with the hydraulic systems that have been drained in accordance with the above instructions. The hydraulic systems, which have been drained shall be refilled with hydraulic fluid specified in the operators manual or hydraulic fluid conforming to MIL-H-6083.

j. Cycle the machine for approximately 5 minutes. The purpose of this cycling period is to cause as much contamination as possible to be in suspension and, at the same time, cause the preservation oil that has been added to the hydraulic system to be thoroughly circulated. Immediately following the cycling, drain all cleaning solutions remaining in the machine.

NOTE

DO NOT DRAIN THE HYDRAULIC FLUID THAT HAS BEEN ADDED TO THE HYDRAULIC SYSTEMS OR THE OPERATING FLUID FROM LARGE CLOSED TYPE HYDRAULIC SYSTEMS.

k. At this time an inspection should be made of all assemblies and areas that have been cleaned with solution A to determine whether additional cleaning is necessary. Internal assemblies requiring additional cleaning should be cleaned of all corrosion or other contaminants by using a wire brush or any other method which will not cause damage. If practical, internal assemblies should be cleaned without disassembly.

(1) General. Metalworking machinery should be disassembled only to the extent that a thorough cleaning can be accomplished. Some assemblies, such as gear trains and clutches are so complicated that reassembly may be accomplished only with the aid of special drawings or the services of factory trained personnel.

(2) Mandatory disassembly. It is mandatory that grinders and other metal-working machinery that have been using soluble type coolant be disassembled to the extent that the)y may be inspected and thoroughly cleaned and preserved. Performance of shutdown maintenance does not eliminate the necessity for disassembly of this type of equipment.

(3) Liquid lines. All liquid lines such as hydraulic, lubricating, and coolant ,hall be disconnected at fittings or connection points. Such lines shall be properly tagged, latch marked, or otherwise identified to facilitate reassembly. The open ends of piping and fittings shall be properly sealed or plugged to prevent entrance of foreign matter.

NOTE

CUTTING OF LIQUID LINES BY ANY METHOD IS PROHITED.

1. Electrical wiring. All control wiring shall be disconnected at its respective terminal block or junction box. To aid in reassembly, disconnected control wiring shall be tagged or otherwise identified to show terminal block junction box connection points. Specific attention is called to lead connections in conduit boxes of motors. Under no circumstances will the lead connections and/or other control wiring be cut behind the connection terminals.

m. Fingerprint removal. Immediately after cleaning and prior to reassembly, precision or close tolerance surfaces shall be cleaned in accordance with MIL-P- 116, method C-8, as specified in chapter 2. Use clean gloves to handle parts.

NOTE

IMMEDIATELY AFTER CLEANING PARTS WITH CLEANING PROCESS C-8, APPLY A THIN CAOT OF PRESERVAITVE OIL P-9, AS SPECIFIED IN TABLE 2-1 OF THIS TECHNICAL MANUAL

n. Air cylinders. Leave air cylinders installed if possible. Clean and dry internal surfaces of the cylinders and their operating system. Fog the interior of the cylinders completely with preservative oil P-10, grade *30,* of table 2-1. Remove and replace any organic packing.

o. High-speed spindle housing. High-speed spindle housings shall be cleaned as required and filled to operating level with preservation oil P-9 of table 2-1, prior to reassembly.

p. Gear Housings. Gear housings and their assemblies should have been thoroughly cleaned and preserved prior to this time.

(1) If additional cleaning is required and disassembly is mandatory, they should be accomplished only by qualified machine tool repairperson.

(2) If disassembly is necessary, all parts and surfaces shall be cleaned in accordance with MIL-P-116 process C-5 and immediately preserve with preservative oil P- 10, grade 30, of table 2-1, prior to reassembly.

(3) If cleaning and preservation of external surfaces are required, process according to g above.

q. Hydraulic systems. Hydraulic systems shall be processed as follows:

(1) Open-type and small closed type. Piston rod packing shall not be removed unless it is necessary for replacement purposes. If the hydraulic assemblies or other internal mechanisms fail to function properly, they should be disassembled to the extent necessary to ensure proper cleaning and adjustment. The reservoir for open type hydraulic systems should be painted, or

preserved with hydraulic fluid, conforming to that which is specified in the operators manual. In cases where the fluid specified in the operators manual is unavailable, use fluid corresponding to MIL-H-5606 or MIL-H-6083. If a deficiency is found to exist, it should be identified and recorded on DD Form 1342 or other applicable inspection documents.

(2) Large closed type. In the event disassembly is necessary, the valve connecting the reservoir to the assembly should be closed to retain the operating oil within the reservoir. Cleaning and preserving shall be accomplished in accordance with (1) above. Operating hydraulic oils with a petroleum base will have basically the same preservative qualities as preservative oil P-10 conforming to MIL-L-21260. Whenever possible, all hydraulic systems shall be cleaned and preserved with hydraulic fluid conforming to that which is specified in the operator's manual. In cases where the fluid specified in the operators manual is unavailable, use fluid corresponding to MIL-H-5606 or MIL-M-6083. Hydraulic oil shall be tested for contamination by a qualified testing laboratory. The following procedure shall be followed:

(a) Cycle the machine for approximately 20 minutes and immediately take a one gallon (3.785 liter) oil sample.

(b) Identify the test sample to the system from which it was obtained (ID and TAG NO.) and test to determine if an excessive amount of foreign material or contaminants is present and if the level of preservation is adequate.

(c) If the hydraulic oil is contaminated and considered unsatisfactory, it may be centrifuged to remove foreign particles or replaced as necessary.

(d) Oils failing to meet the corrosion protection specified in MIL-H-5606 or MIL-H-6083 shall be replaced.

NOTE

MIXING OF ADDITIVES OR RUST INHIBITORS IS NOT RECOMMENDED DUE TO INCOMPATABILITY WHICH MAY CAUSE JELLING.

(e) If the fluid has been tested and determined to be free of contamination and the preservative qualities are adequate, the fluid may be returned to the reservoir. The system shall be filled to the operating level with fluid of the same brand and glade that was previously in the system.

(f) All filters shall be cleaned and filter elements replaced or cleaned as appropriate.

NOTE

ANY QUESTIONS ON HYDRAULIC SYSTEMS WITH PECULIAR FEATURES SHOULD BE DIRECTED TO THE MACHINE MANUFACTURER FOR SOLUTION. HYDRAULIC SYSTEMS UTILIZING WATER-BASED HYDRAULIC FLUIDS SHALL BE HANDLED ON AN INDIVIDUAL BASIS AND THE MANUFACTURER OF THE FLUID SHOULD BE CONSULTED FOR INFORMATION ON THE PRESERVATIVE QUALITIES OF THE FLUID.

(3) Hydraulic systems for tracer mechanisms. These systems are not to be cleaned unless the pump and mechanisms fail to function properly. Packing for these systems is not subject to contamination and need not be replaced.

r. Self-contained lubricators. Self-contained lubricators shall not be cleaned unless contamination is present.

s. Coolant pumps. Coolant pumps should be disassembled to the extent that thorough cleaning may be accomplished. Remove all solvents trapped in the system.

(1) If the pump is direct motor driven, do not disturb the seal that prevents moisture from entering the electric motor.

(2) Preserve the pump by thoroughly coating all interior and exterior unpainted surfaces with preservative oil P-10, grade 50, of table 2-1. This may be accomplished by dipping, spraying, or brushing.

NOTE

THE COOLANT SHOULD NOT BE OPERATED AGAIN UNTIL THE MACHINE TOOL HAS BEEN PLACED BACK INTO PRODUCTION. THE PUMP MAY BE PACKAGED SEPARATELY OR MOUNTED ON THE MACHINE, BUT SHOULD NOT BE CONNECTED DURING THE TIMING AND ALIGNMENT OF THE MACHINE TOOL.

t. Painted surfaces. Surfaces where paint is chipped or abraded shall be touched-up or repainted. The basic purpose for painting equipment is preservation, but appearance is also of importance. The color and workmanship of paint application shall be such that appearance is enhanced as much as practical. The choice between touch-up and complete painting shall be made primarily on the basis of economy, but if either the number of spots or the total area requiring touch-up is excessive, the item shall be completely painted. Care should be taken to paint those areas previously painted. Precision surfaces should be protected during painting.

(1) Surface preparation. All loose paint shall be removed. All edges of old paint shall be feather-edged. To ensure firm adhesion of the new coat, the old paint shall be abraded. This shall normally be accomplished by sanding. Missing or loose filler material shall be replaced with new filler material, conforming to TT-F-322. After abrading the old paint, all surfaces to be painted shall be thoroughly clean.

(2) Application paint. Paint should be applied by spraying, but may be applied by brushing. The paint coating shall be uniform and complete, without sags, runs, blisters, or holidays. Holidays are spots accidentally left uncovered on coated or painted surfaces.

(3) Painting requirements. One coat of Lacquer resisting, lust-inhibiting, synthetic, coating Primer conforming to TT-P-664, shall be applied to all areas not already prime coated. After the primer is dry, two coats of gloss alkyd enamel, conforming to TT-E-489 shall be applied. The first coat should be thoroughly dry, prior to application of the second coat. For touch-up purposes, the enamel shall match the existing color of the item. When complete repainting is required the color shade shall be medium gray, number 16187, in accordance with FED-STD-595.

u. Drive belts. All drive belts shall be either removed from the equipment or have the tension released.

(1) All removed belts shall be cleaned by wiping with clean dry cloth. If a glazed surface has formed on the pulley side of the belt, it may be removed with a cloth lightly dampened with a 50-50 percent solution of alcohol and glycerin or with cleaning solvent.

(2) All removed belts shall be packed in accordance with MIL-P-116, method III and secured to the equipment. All drive belts shall be identified with the drive units to which they belong.

(3) Clean the faces or grooves of all ferrous metal pulleys with cleaning solvent, and dry in accordance with paragraph 2-3 process D-1 or D-4. The faces or grooves of the metal pulleys shall be coated with primer conforming to TT-P-664, after cleaning.

v. Packings and wipers. Various types of packing and wipers used in connection with hydraulic, lubricating, and pneumatic systems have a destructive effect on metal surfaces when maintained in stationary contact for extended periods. Because of the presence of residual tanning and finishing chemicals, leather packing may cause pitting. Other types, due to their moisture-absorbing qualities, cause corrosion at the point of contact with metal surfaces. To alleviate these conditions all packing and wipers shall be thoroughly saturated with preservative oil P-10, grade 30, of table 2-1.

(1) Organic type packing in coolant, lubricating, hydraulic, and other liquid carrying systems shall not be removed unless it is necessary for replacement purposes.

(2) All way wipers shall be removed and replaced with new ones. New way wipers shall be thoroughly saturated with preservative oil P-10, grade 10, of table 21.

4-8. PREPARTION/PRESERVATION FOR TIMING AND ALIGNMENT

a. All metalworking machinery except for large, complex equipment (para .4-11) shall be preserved for timing and alignment in accordance with the following procedures:

(1) External assemblies and areas. Preserve all surfaces subject to friction with preservative oil P-10, grade 30, of table 2-1.

(2) High-speed spindle bearings. Fill to operating level with preservative oil P-9 of table 2-1.

(3) Spindle housing. Fill to operating level with preservative oil P-10, grade 30, of table 2-1.

(4) Gear boxes and housings. Fill to operating level with preservative oil P-10, grade 30, of table 2-1.

(5) Hydraulic systems. Hydraulic systems shall be preserved as follows:

(a) Open-type, Fill to operating level with the hydraulic fluid specified in the operators manual or preservative oil P-15 conforming to MIL-H-5606, MIL-H-81322, MIL-H-6083.

(b) Small closed type. Fill to operating level with preservative P-15 conforming to MIL-H-5606, MIL-H-6083, or the hydraulic fluid in the operators manual.

(c) Large closed type. In lieu of preservative oil, the operating oil may remain in these systems provided the oil is treated in accordance with paragraph 4-7q(2)(a) through 4-7q(2)(e). If the operating oil has been drained and discarded, fill the hydraulic system to its normal operating level with preservative oil P-15 conforming to MIL-H-5606, MIL-H-6083, MIL-H-81322 or the hydraulic fluid specified in the operator's manual.

(d) Hydraulic systems for tracer mechanisms. Fill the reservoir with preservative oil P-15, conforming to MIL-H-5606 or MIL-H-6083, or that which is specified in the operators manual.

(6) Self-contained lubricators. Fill the reservoir with preservative P-15 conforming to MIL-H-5606, MIL-H-6083, or that which is specified in the operators manual.

(7) Grease fittings. Charge all grease fittings with preservative grease P11, of table 2-1.

4-9. TIMING, ALIGNMENT, AND FINAL PRESERVATION OF METALWORKNG MACHINERY

a. Metalworking machinery that has been disassembled and reassembled while being processed for storage should be operated at all speeds and feeds to ensure that tinting is correct and that all parts are in alignment and function properly.

b. Metalworking machinery will be preserved in such a manner that the preservative will afford the best possible protection while the equipment is in storage. The type of preservatives used may vary according to the storage category in which the equipment will be maintained.

c. Table 2-1 lists metal preservatives and paragraphs 2-4 through 2-5 list considerations to be used in the selection of preservatives.

4-10. ELECTRICAL AND ELECTRONIC EQUIPMENT

a. The procedure for processing electrical and electronic equipment of metalworking machinery are contained in paragraphs 4-20 through 4-23 and 4-24 through 4-27.

b. Process this equipment only after the parent machine has been processed, timed, and aligned.

4-11. CLEANING AND PRESERVATION OF LARGE COMPLEX EQUIPMENT THAT WILL NOT BE STORED "STANDBY" AND IS OF SUCH SIZE AND/OR DESIGN THAT DISASSEMBLY IS NECESSARY PRIOR TO MOVING

a. This type of equipment shall not be reassembled for the purpose of timing and alignment. It is necessary that cleaning and preservation be accomplished without any delay between the two operations.

b. The following procedures may be used as a guide for preservation of large, complex equipment:

(1) Matching surfaces. Assemblies removed from the basic machine shall be cleaned in accordance with MIL-P-116 process C-3 as described in paragraph 2-2. All cleaned areas shall be dried by either drying procedure D-1 or D-4 which is detailed in paragraph 2-3. Immediately after drying, all cleaned surfaces shall be preserved with preservative P-2, grade 2, of table 2-1.

(2) High-speed spindle bearings. It is unlikely that this type of assembly would be found on large complex equipment. If high-speed spindle bearings are part of this equipment, they shall be preserved/filled with preservative oil P-9, of table 2-1 and plugged to prevent spillage during handling.

(3) Gear housings. Thoroughly coat the mechanisms and all areas of the reservoir with preservative oil P-10, grade 30, of table 2-1. This may be accomplished by spraying or any other suitable method.

(4) Hydraulic systems. Apply a thorough coating of hydraulic oil specified in the operators manual, on all operating mechanisms in the hydraulic system. This may be accomplished by any suitable method of preservative application. If this fluid is not available, use preservative oil P-15 conforming to MIL-H-5606 or MIL-H-6083.

(5) Self-contained lubricators. Fill all self-contained lubricators to operating level with preservative oil P-10, grade 30, of table 2-1.

(6) Grease fittings. Charge all grease fittings with preservative grease P-l 1 of table 2-1.

Section III. EQUIPMENT PIPES AND VALVES

4-12. GENERAL

This section addresses cleaning and preservation of pipes associated with IPE and OPE. The information contained here is general and should not be used as a substitute for common sense when attempting to establish cleaning and preservation requirements for pipe used on exotic equipment with exotic chemicals. Always consider the chemical compatibility of cleaning materials with the material previously contained in the pipe. Whenever possible, manufacturer specifications for the equipment and associated pipe should be obtained for layaway.

4-13. EQUIPMENT STEAM LINES AND AIR LINES

All water shall be completely drained from the system and dried with moisture-free compressed air. No preservative shall be applied to these systems. Close off all openings with pipe fittings or plastic cap plugs conforming to MIL-C-5501.

4-14. CUTTING FLUID SYSTEMS

Drain all cutting fluid, chips, sludge, and other foreign matter. Flush the system with a solution of one part P-10, grade 30 preservative oil conforming to MIL-L-21260 and nine parts cleaning solvent. Circulate and thoroughly drain the solution. The system shall then be preserved by flushing with P-3 preservative conforming to MIL-C-16173 and drained. All open ends of pipe fittings shall be plugged with pipe fittings or plastic cap plugs conforming to MIL-C-5501.

NOTE

APPLICATION OF CLEANING FLUIDS OR PRESERVATIVES ARE PROHIBITED IF THEY WILL DAMAGE THE SYSTEM, BE EXCESSIVELY DIFFICULT TO REMOVE, OR IF THE PRESENCE OF ANY RESIDUAL PRESERVATIVE WOULD BE INCOMPATIBLE WITH OPERATIONAL FLUIDS, OILS, OR GREASES AND WOULD POTENTIALLY CAUSE MALFUNCTION DURING OPERATION.

4-15. INDUSTRIAL PLANT EQUIPMENT AND OTHER PLANT EQUIPMENT PIPE

a. Remove any insulation on the outside of the pipe that will retain moisture such as asbestos. To clean the pipe, flush the system with solution A or with fresh water, whichever is more practical. The exterior of the pipe shall then be cleaned with process C-1 as specified in this manual in paragraph 2-2.

b. To preserve the interior of the pipe, flush with P-10 or an 80 percent glycol and 20 percent fresh water mixture. If the application of a preservative is prohibited, simply blow the interior of the pipe dry with compressed air.

4-16. VALVES

Critical valves shall be either disassembled, cleaned with process C- 11, greased with preservative P-11, and loosely reassembled without gaskets; or disassembled, cleaned with process C-1, greased with preservative P-11, and matchmarked, wrapped with greaseproof barrier material, sealed with pressure sensitive tape, tagged, and placed in humidity controlled storage where possible. Used gaskets shall be discarded.

Section IV. PRECISION INSTRUMENTS, TOOLS, DIES, JIGS, FIXTURES AND SPARE AND REPLACEMENT PARTS

4-17. PRECISION INSTRUMENTS

a. Precision measuring and recording instruments, such as air gauges, optical gauging machines, dial indicators, and like equipment will not require preserving in most instances. Metalworking assemblies of precision instruments shall be coated with preservative oil P-9, of table 2-1.

b. Pens and recording-type instruments shall be removed and cleaned with a commercial cleaner or one recommended by the manufacturer.

c. Small items that do not have precision working assemblies shall be preserved by coating with preservative compound P-2, grade 2, or P-3, grade 3, of table 2- 1.

4-18. TOOLS, DIES, JIGS, AND FIXTURES

a. Tools and tool accessories shall be cleaned, dried, preserved, and packed in accordance with PPP-P-40.

b. Special tooling, dies, jigs, and fixtures shall be removed from the basic unit prior to shipping to Government storage as part of a package. Each item shall be properly identified to the machine tool, press, or other item of plant equipment to which it was attached when in use.

4-19. SPARE AND REPLACEMENT PARTS

a. Spare and replacement parts include motors, coolant pumps, anti-friction bearings, and similar items for the repair and maintenance of Government-owned plant equipment.

b. Items that have been used or contaminated due to prolonged storage shall be cleaned, dried, and preserved, as applicable.

c. When individual units of plant equipment are shipped to storage as Defense Industrial Reserve (DIR) equipment, the spare and replacement parts purchased especially for each unit shall be packed and shipped with the unit. When an individual unit of plant equipment is transferred to another U. S. agency, those spare and replacement parts purchased for maintenance of that particular unit shall be preserved/packed to level A, C, or to commercial practice, unless otherwise directed, and shipped with the unit.

d. Spare and replacement parts represent a large investment of Government funds and shall be packed separately and stored with a package line. In those instances where a production line has been declared excess to the needs of the Government, disposition of the spare and replacement parts will be at the discretion of the owning agency.

Section V. ELECTRICAL EQUIPMENT

4-20. GENERAL

a. Most items of plant equipment arc dependent upon electrical energy as their main source of power. This energy is applied by electrical assemblies such as motors, relays, and automatic controls.

b. Copper and aluminum, because of their low resistance to the flow of electrical current, are two of the most satisfactory elements for use as electrical conductors. For this reason they are found in most electrical assemblies. Other nonferrous metals such as gold and silver, are also used as conductors. Despite the fact that silver has a lower resistance than either copper or aluminum, its extreme cost generally limits its use to coatings of copper and aluminum parts. Care must be taken when cleaning these coated surfaces, as they can be easily damaged or removed by abrasives used for cleaning purposes.

c. An electrical circuit must be a complete and continuous path between the power supply and the load. For this reason the circuit must be insulated from any external conductors along its path. As a result, many types of insulating or nonconducting materials such as rubber, plastic, fabric, and other coatings will be found in electrical assemblies. Since different cleaning materials may attack these insulating materials, care must be taken to assure that the cleaner and the insulating materials are compatible.

d. Ferrous metals are used extensively in electric motors. Shafts, housings, laminations, and a number of the smaller components of electric motors are usually constructed from steel or cast iron. The ferrous parts inside the motor are generally coated with varnish, which serves to protect them from rust and corrosion.

e. There are too many items of electrical equipment to list them individually in this manual. The preservation and packing requirements for various items of electrical equipment are contained in military specification MIL-E-17555. If a particular component is not listed in this specification, the process listed for a similar item should be used.

4-21. PROCESSING ELECTRICAL EQUIPMENT

WARNING

MAKE SURE THE SOURCE OF ELECTRICAL POWER IS DISCONNECTED BEFORE ANY WORK IS PERFORMED ON THE ELECTRICAL SYSTEM. .

a. Process electrical equipment only after the parent machine has been processed, timed and aligned.

b. When the removal of electrical assemblies is necessary in the processing of the parent machine, avoid unnecessary disassembly that may have to be repeated until after timing and alignment of the machine.

c. Disconnect control wires at the terminals, they should never be cut. Tag or otherwise identify the disconnected terminal ends to show the terminal block or junction box numbers.

d. Disconnect bus bars at terminal ends only.

e. Employ only experienced electricians or electrical maintenance personnel for the processing of electrical assemblies.

f. To eliminate expensive delays in research at the time of reactivation, wiring diagrams and operator's manuals of assemblies which are to be separated from the parent machine for shipping or storage purposes shall be placed in an envelope, identified with the basic machine, and enclosed within the control panel or with the packing slip and allied papers.

g. Due to the differences in design and fabrication of the various items of electrical equipment such as recorders, motors, and instruments, they have been broken down into separate categories with respect to cleaning and preservation and are covered in subsequent paragraphs.

4-22. ELECTRIC MOTORS AND GENERATORS

a. General. The extent of and procedures to be employed in the cleaning of motors and generators depend upon the degree of contamination. For the purpose of this section, the word "motor" will refer to both motors and generators unless specifically stated otherwise. Manufacturer instructions, if available, should be followed. Totally enclosed motors will rarely require internal cleaning. An open or semi-open motor which, upon inspection, is found to have the interior of the motor contaminated with oily motor lint, sludge, or other deposits shall be disassembled to the degree necessary to accomplish a thorough cleaning. When it is necessary to disassemble a motor, care should be exercised so as not to drag the rotor across the windings. Heavy rotors should be handled with a sling. When removing the armature from a direct current motor, the armature should always be supported or lifted by its shaft. If this is impossible, a wide lifting belt may be used around the armature. Care must be taken not to allow the weight of the armature shaft to rest on the commutator or coils. After removal, the armature shaft should be supported in a frame or between V-blocks in such a manner that the armature will not touch the

floor or table. Under no condition should the armature ever be rolled upon the floor or work bench.

b. Cleaning procedures. The procedures to be used in cleaning electric motors are as follows:

(1) When the motor is small and all surfaces are accessible, remove all contaminants with a clean dry cloth. Cloth waste should not be used for this purpose.

(2) Blow out dirt with a jet of compressed air. This is particularly effective when the dirt has collected in places which cannot be reached with the cloth. Cleaning may be done more quickly with compressed air than with a cloth, especially on large motors. When using compressed air, do not blow the air against insulation until it is certain that the air is dry and does not carry water which may have condensed and accumulated in the air line. Do not use air pressure greater than 30 PSI, (206(KPA)) as high pressures may damage insulation. Do not direct the stream of compressed air in such a way that dirt will be difficult to remove and where it might close ventilating ducts.

WARNING

PERSONNEL USING COMPRESSED AIR FOR CLEANING SHALL WEAR APPROPRIATE EYE. PROTECTION.

(3) Loose dirt and dust may be removed by the use of a vacuum cleaner.

(4) Oil or grease shall be removed by cleaning with dry cleaning solvent.

CAUTION

USE WITH ADEQUATE VENTILATION. AVOID PROLONGED OR REPEATED BREATHING OF VAPOR OR CONTACT WITH SKIN. DO NOT TAKE INTERNALLY.

NOTE

SOLVENTS SHALL NOT BE USED FOR CLEANING SILICONE TREATED WINDINGS AS THE SOLVENT WILL DISSOLVE THE VARNISH COATINGS.

(5) Verdigris and other corrosion deposits on metal surfaces may be removed with crocus cloth, wood scraper, or other suitable methods not injurious to the part affected. Do not use abrasives for cleaning plated surfaces.

c. Preservation. Component parts and surfaces of electric motors shall be preserved as follows:

(1) Bearings. Sealed (anti-friction) bearings require no preservation, but will need to be replaced if defective. Open type (exposed) bearings shall be preserved with either preservative grease conforming to MIL-G-23827 P-11 or preservative oil conforming to MIL-L-21260 P- 10, grade 30, as applicable.

(2) Armatures, rotors, stators, and windings. The rotors and stators of AC motors and the armatures and field windings of DC motors are coated with varnish. This varnish serves to protect these parts from rust and corrosion. If inspection shows that the varnish coating has deteriorated, it shall be replaced by recoating the affected parts. Only a high grade insulating varnish approved for motor maintenance is to be used. Prior to the application of the varnish, the parts to be protected should first have a resistance test performed. If the test shows the presence of any moisture, affected parts must be thoroughly dried before coating with the varnish. Testing and coating with varnish should be performed by experienced electrical maintenance personnel.

(3) Commutators and brushes. When commutators are accessible, lift brushes and completely wrap the commutator with barrier material conforming to MIL-B-121 grade A. Release the brushes and allow them to rest on barrier material. An alternate method is to disengage the brushes from brush holders and secure them in such a manner that they will not come in contact with the commutator.

(4) Motor shaft. Preserve all bare metal surfaces of motor shafts with preservative compound P-2, grade 2, of table 2-1.

NOTE

WHEN PRESERVING MOTOR SHAFTS, PLACE A PROTECTIVE COVER OVER THE MOTOR WINDINGS TO PROTECT THEM FROM THE PRESERVATIVE.

(5) Geared head motors. Fill the lubrication reservoir with preservative oil P-10, grade 30, of table 2-1. All parts shall be completely covered by the preservative.

(6) Generator sets. Drain all fuel and engine coolant. Drain crankcase and fill with engine preservative oil. Tag generator to drain and refill before placing in operation. Pour preservative oil in spark plug holes and replace spark plugs. Seal the intake of the exhaust. Leave the coolant system empty and loosen the fan belt.

d. External surfaces. Repaint or touch up external painted surfaces, where needed. Preserve external bare metal surfaces such as shafts, and couplings with preservative compound P-2, grade 2, of table 2-1.

e. Silicone-treated windings. Silicone-treated varnish is found principally in motors with a class "H" insulation. These motors are expensive, and as a result are used only in those applications requiring extreme moisture resistance or high temperature requirements. In general, any motor in which the name plate lists the rise in temperature of not less than 167° F (75° C) higher or than 194° F (90° C), can be assumed to have class "H" insulation and silicone varnish on its windings. These motors shall be treated in accordance with (1) below. Usually the varnish will be colored, however, it may be found with a clear coating.

NOTE

CLEANING SILICONE-TREATED WINDINGS IS A SPECIAL CASE. STANDARD ORGANIC SOLVENTS INCLUDING PETROLEUM DISTILLATES GENERALLY USED FOR CLEANING ELECTRIC MOTORS MAY ATTACK THE VARNISH AND SHALL NOT BE USED. SILICONE-TREATED VARNISH WILL DISSOLVE IN THESE SOLVENTS.

The recommended procedure for' cleaning silicone-treated windings is to use water containing a detergent. The work should be done as rapidly as possible. Excess moisture shall be wiped off with a clean dry cloth and the apparatus dried immediately.

4-23. SWITCH BOXES, CONTROL, PANELS, AND DRY CELL, BATTERIES

a. Switch boxes and control panels shall be cleaned in accordance with MIL-P-116 process C-1 or C-3 as described in paragraph 2-2.

NOTE

WHEN SOLVENT CLEANING IS USED ON THE ABOVE, IT WILL NOT COME IN CONTACT WITH WINDINGS, INSULATION, AND OTHER WIRING. ELECTRICAL CIRCUITS SHALL BE PROTECTED FROM WATER MOISTURE AND MILDEW WITH IGNITION VARNISH CONFORMING TO MIL-V-13811.

b. All dry cell batteries shall be removed from the equipment and disposed of tags bearing descriptive information shall be placed in the location occupied by the batteries. The tag shall state: "DRY CELL HAS BEEN REMOVED. DRY CELL IDENTIFICATION NO. , DESCRIPTION, GOVT TAG NO. OF BASIC UNIT. " (see Fig 4-1).

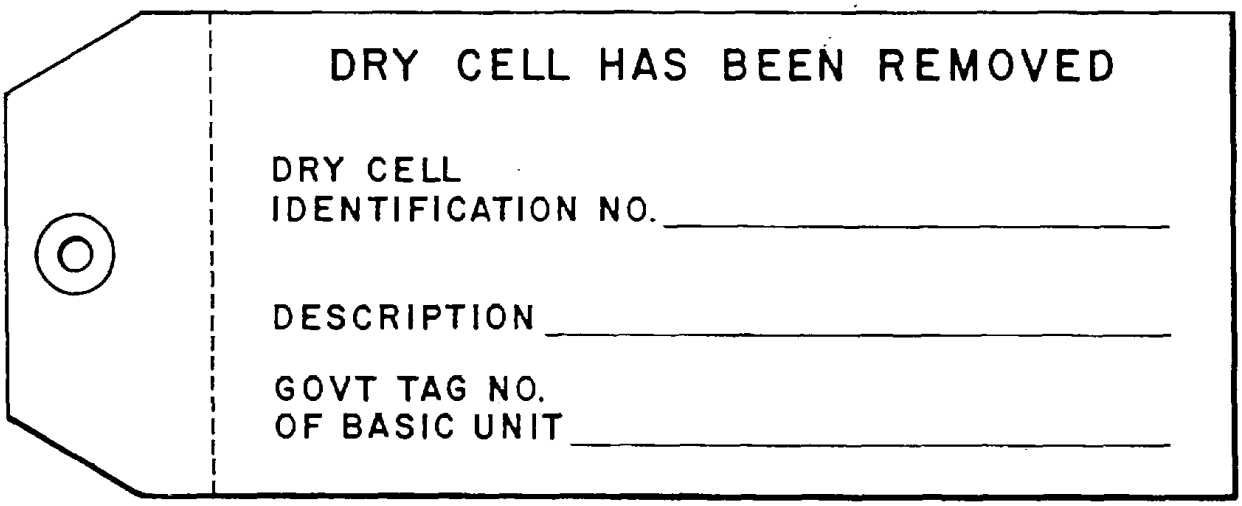


Figure 4-1. Dry Cell Identification Tag.

c. Preservatives which could interfere with the operation of the equipment shall not be applied. Machined ferrous metal surfaces that are not plated shall be preserved with preservative oil P-10, grade 30, of table 2-1. Avoid excessive application that would cause dripping of the preservative materials.

d. Electrical control panels, switch boxes, and such items disconnected from electric power shall have openings, resulting from the removal of conduit, sealed with waterproof adhesive tape conforming to PPP-T-60, type III, class 1. Contact points and copper components such as knife switches and fuse clips shall not be preserved. All switches shall be left in the open/off position.

e. Cleaning. Cleaning shall be accomplished only by personnel experienced in servicing this type of equipment. When using compressed air, be sure the air is dry and the pressure- does not exceed 25 PSI (206 kPa). Avoid excessive use of solvent. Most intricate assemblies can be cleaned with a soft-bristle brush or a clean, lint-free cloth, or paper. Pens or recording-type instruments shall be removed and cleaned in aqueous ammonia, rinsed in alcohol, and replaced.

NOTE

DISASSEMBLY SHALL BE AVOIDED UNLESS IT IS PERFORMED BY AN INSTRUMENT SPECIALIST.

f. Fingerprint removal. Finished ferrous surfaces of large items, such as bench-type micrometers, shall be treated to remove fingerprints by cleaning process C-8, as described in paragraph 2-2.

g. Preserving. Precision measuring instruments are generally manufactured from nonferrous metals that do not require a preservative. There are, however, a few large items in the category of measuring instruments, such as bench-type micrometers and carriages of comparators that will require preservation. Be sure the preservative used will not cause damage. If items are to be shrouded or packaged to prevent contamination from dust, the item shall be coated with preservative compound P-2 or a light preservative oil such as P-9 or P-10, grade 10, of table 2-1.

Section VI. ELECTRONIC EQUIPMENT

4-24. ENVIRONNMENTAL CONDITIONS AND THEIR EFFECTS

a. General. Most electronic equipment is designed to withstand conditions beyond those of normal operating criteria of heat, cold, or humidity. It is, however, another matter when it becomes necessary to store equipment for indefinite periods of time.

(1) As an example, normal operating conditions generate enough heat to eliminate excessive amounts of humidity, thereby preventing corrosion and fungus growth.

(2) There are times when moisture will affect certain electronic components if the moisture is not controlled or eliminated. Variable and adjustable resistors may be affected because of exposed metal surfaces; various kinds of capacitors may be damaged by moisture, dust, and leaking electrolyte; inductors may absorb moisture in their windings; transformers have a tendency to rust; alternate heat and cold will cause insulation deterioration; connector sockets will rust and corrode from moisture; relays, timers, solenoids, and switches suffer from corrosion on contact points and fungus growth on coils; and wires and cables are damaged due to chemical attack on the insulation from contact with organic solvents. There are many other electronic components, too numerous to list in this manual, that require protection from environmental conditions.

b. Environmental hazards. All electronic assemblies or components shall be stored with adequate protection from physical damage, dust, insects, rodents, and aerial contaminants, as well as the more obvious influences of extreme heat, cold, or high humidity.

c. Electrostatic discharge. All electronic assemblies and components subject to electrostatic discharge shall be stored with adequate protection from electrostatic discharge (ESD) and electromagnetic induction (EMI). A metal cabinet containing electronic components is probably sufficient to provide static protection for enclosed components because of the equal potential between the cabinet and components. The electronic assemblies and components should not be handled directly without a wrist grounding strap or other static protection device as defined by DOD-STD-1686. The manufacturer should provide a warning label to this effect. If there is not a warning label, a tag should be taped or wired in an obvious location on the outside of the cabinet with the following warning: DO NOT OPEN CABINET WITHOUT USING AN APPROVED STATIC CONTROL DEVICE.

4-25. NUMERICAL CONTROL UNITS

a. Numerical controls. Numerically controlled machine tools, while having their own unique features, can be processed in the same manner as prescribed for conventional machine tools. Numerically controlled machine tool controls are generally referred to as Machine Control Units (MCUs).

b. Components. Components of MCUs are relatively light weight, as compared to the more massive and bulky components of the machines themselves, and, except for earlier models, are almost exclusively solid state devices.

(1) Insulation from vibratory loadings is of paramount importance to the entire MCU (which may be of considerable cubage and weight).

(2) It is imperative that the mechanical security of a MCU be assessed initially for internal requirements (component cards, power supplies, loaded shelving, and tape readers, when applicable) and then for the application of boxing or crating, skidding, environmental barriers, vibration dampening materials placement, and other physical security measures.

(3) In addition to the preservation, packaging, and packing requirements contained in MIL-E-17555, the following detailed requirements are applicable when preparing numerically controlled machine tools for shipment.

(a) The assembled units shall be processed using only those cleaning processes that will not damage delicate systems and materials.

(b) Solvent cleaning shall not be used in the cleaning of electrical or electronic circuitry.

(c) Low pressure, dry, prepared compressed air, vacuum cleaning, or wiping with a clean lint-free cloth may be used for cleaning.

(d) No further cleaning or preservation is required.

(4) Electron tubes shall be processed in accordance with k. below.

c. Cushioning, blocking, and bracing. Cushioning, blocking, and bracing of MCU shall be in accordance with MIL-STD- 1186 and military specification MIL-E- 17555.

(1) Foam-in-place packing procedures. IPE, accessories, and component parts may be blocked, braced, and cushioned in accordance with the foam-in-place packing procedures of MIL-STD-1191.

(2) Heavy items, such as transformers, power supplies, and amplifier assemblies especially if shelf mounted, shall be blocked and braced to prevent dislodgment or failure of the supporting structure(s) throughout the transit/handling period.

(a) When this degree of protection cannot be assured, the heavy items shall be removed and processed separately.

(b) In-place immobilization is preferable, when practical, to minimize electrical disconnections.

d. Packing. Packing shall be level A, level B, level C, or industrial as specified by the owning activity. Packing shall be designed to comply with minimum weight and cubage requirements of AR 70-44.

e. Skidding of MCUs. MCUs need not be skidded unless the weight and size are such that skidding is essential for safe handling, transportation, and storage.

(1) Units provided with rods or other means for securing circuit boards in place shall have these devices installed.

(2) Units not provided with the above listed devices shall be fitted with corrugated fiberboard, cut to fit behind the circuit boards, and secured in place with pressure-sensitive adhesive tape.

(3) All cabinet doors shall be locked and secured with nylon strapping conforming to PPP-S-76. Cushioning shall be placed between the cabinet and strapping to prevent scratching or damaging the cabinet.

(4) Cabinet door keys shall be packaged in accordance with MIL-P-116, submethod C-1, identified to the specific machine, and attached to the unit door(s) with pressure-sensitive adhesive tape.

f. MCU packing covers. All MCUs shall be protected from contaminants such as water and dirt by covering the units with plastic material that conforms to L-P-378 or waterproof material conforming to PPP-B-1055, grade, type, and class as applicable.

(1) All covers shall be of sufficient strength to provide adequate protection throughout the transit period.

(2) All sharp corners and projections of the unit shall be cushioned or padded to prevent the rupture of the cover.

(3) The cover shall be secured in place with pressure-sensitive adhesive tape.

(4) All units shall be protected in this manner regardless of the type of transportation or packing specified.

g. Combined machine tool/MCU shipment. When practical, the machine tool and the MCU may be shipped together on a single skid assembly. The MCU should remain connected to the machine tool with power and control line conduits disassembled only as necessary to permit positioning for minimum cubage pack.

h. Separate shipment machine tool and MCU. When the MCU is disconnected for separate shipment, the machine model number, identification number, nomenclature, and manufacturer's name shall be recorded on a tag conforming to UU-T-81 and taped to the inside of the control cabinet door.

(1) The above data shall also be stenciled on the shipping cover or container to assure connect identification/matching of machine tool and MCU at destination.

(2) If it is necessary to disconnect the MCU from the machine tool, disconnections shall be made at the proper disconnect points, such as junction boxes, terminals, or fittings. All disconnected wires shall be matchmarked to permit proper assembly.

i. Identification and handling markings. All identification and handling markings shall be in accordance with MIL-STD-129.

j. Transporting vehicles. MCUs shall be shipped by air ride vans/trailers, whether singular or in concert with the skid mounted machine tool. When MCUs are shipped separately with level C packing, packing requirements may be relaxed at the discretion of the Defense Contract Administration Services (DCAS) Transportation and Packaging office or by sending a request to the Defense General Supply Center, ATTN: DGSC-SSM, 8000 Jefferson Davis Highway, Richmond, VA 23297-5501.

k. Detail requirements. All electronic equipment shall be cleaned, preserved, and packaged in accordance with military specification MIL-E-17555.

(1) In addition to the requirements contained in military specifications MIL-E-17555, the detailed requirements listed in paragraph 3-3c(8) apply when preparing delicate electronic equipment for shipment.

(2) Electron tubes subject to damage if left in place during transportation shall be removed. Removed tubes and their sockets shall be matchmarked to indicate correct tube
installation at time of reassembly.

4-26. STORAGE OF ELECTRONICS EQUIPMENT

a. Storage processing. The following information prescribes the requirements for processing electronic equipment for storage. These requirements should be followed in the order in which they appear in the text.

CAUTION

AT NO TIME SHALL EQUIPMENT BE DISCONNECTED BY CUTTING OR OTHERWISE DAMAGING WIRES AND CABLES.

(1) All switches and circuit breakers of the electronic equipment will be opened, or set to the "OFF" position, and the equipment will be completely disconnected from the power source.

CAUTION

ALWAYS CONSIDER ELECTRONIC EQUIPMENT DELICATE AND HANDLE IT CAREFULLY.

(2) Opening the equipment. Prior to opening the cabinet, measures should be taken to prevent damage to the internal electronic components of the equipment by complying with the requirements listed in paragraph 4-24. c. The electronic equipment should be opened so that the wiring and component parts may be reached for processing. The ways of opening different electronic equipment varies almost as much as the locations of the component parts of the equipment. There are various combinations of doors, panels, chassis covers, and sliding units. These must be unfastened and opened or removed from the equipment. Detailed instructions for opening should be found in the instruction manual accompanying the equipment.

(3) Capacitors and cathode ray tubes (CRTs)

(a) Discharge capacitors. After the electronic equipment is completely disconnected from power, all high-voltage capacitors and CRTs should be discharged by qualified personnel. Equipment manufacturers sometimes place warning signs on equipment near the terminals of high voltage capacitors. The terminals of many high-voltage capacitors are automatically short-circuited when the equipment is turned off. Automatic shorting devices are intended only to safeguard the incautious and should never be relied upon.

(b) Electrolytic capacitors. This type of capacitor tends to deform after extended periods of time (approximately 2 to 10 years, depending on the electrolyte). The capacitors act as a short in the circuit when they deform and risk damaging the electronic components of the equipment. The capacitors could be reformed by running the equipment, but this risks shorting the equipment. A tag, conforming to UU-T-81 identified in MIL-STD-129, should be attached to the power supply capacitor after discharging stating the following: "DO NOT POWER UP EQUIPMENT UNTIL TESTING THIS CAPACITANCE WHEN EQUIPMENT HAS BEEN INACTIVE FOR MORE THAN 2 YEARS. "

(4) Grounding rod. A grounding rod is one method which may be used to discharge capacitors. The grounding rod should be used as follows:

(a) Solidly fasten the ground clamp to a reliable ground on the equipment such as a clean, unpainted metal part of the chassis or frame.

(b) Grasp the handle with one hand, but avoid touching any metal part of the grounding rod.

(c) Place the other hand in your pocket.

(d) Hold the metal probe against each terminal of each capacitor for several seconds to ensure complete discharge of the capacitor.

(5) Removal of dry cells. Due to dry cells corroding in storage, they shall be removed from electronic equipment and discarded. To assist in replacing them properly during reactivation, a tag bearing the following information shall be attached to the equipment in the place of every dry cell: The identification number and the description of the dry cell, and the Government tag number of the basic unit from which the dry cell was taken (fig 4-1). A rubber stamp may be used for preparing the tag.

(6) Cleaning. Electronic equipment should be given a thorough external and internal cleaning. This equipment, being constructed mostly of nonferrous materials, will not, in most instances, be contaminated by rust and corrosion. However, due to the proximity of electronic equipment to production areas, contaminants such as dirt, dust, oil, and, grease can find their way into this equipment.

(a) Extreme care must be exercised in the selection of a cleaning material to prevent damage to parts. Solvents (and their vapors) may cause dimensional or chemical changes to insulation, wiring, or other susceptible organic parts of critical electronic equipment.

(b) The cleaning materials and processes listed in chapter 2 shall be used to clean electronic equipment and components. Solvents should only be used to clean parts contaminated with oils and greases. In most instances it will only be necessary to use a soft-bristled brush, wiping cloths, and low pressure dry compressed air to accomplish the cleaning.

CAUTION

EXERCISE EXTREME CARE WHEN CLEANING PLATED SURFACES. SOME COMPONENTS MAY APPEAR TO BE SOLID COPPER OR SILVER, BUT ACTUALLY THEY ARE ONLY COATED WITH THESE MATERIALS. NEVER, UNDER ANY CONDITION, USE ABRASIVE MATERIALS FOR CLEANING ELECTRONIC COMPONENTS.

(7) Avoiding recontamination. Cleaning should be so planned that when contaminants are being removed from one part of the electronic equipment they are prevented from falling on parts that have already been cleaned. This can be done by cleaning from top to bottom of the equipment and by cleaning inside surfaces of cabinets and cases before cleaning the parts they enclose. Contaminants may be kept from falling on parts by temporarily spreading cloth or paper over them.

(8) Special handling. The following electronic component parts require special cleaning or handling.

(a) Air filters. Spun glass air filters shall be removed, discarded, and replaced by new spun glass filters. Metal air filters shall be removed and cleaned by immersion and agitation in soapy water or in petroleum solvent, conforming to P-D-680, type II. Cleaning in soapy water shall be followed by a rinse of clean water. Immersion in solvent shall be followed by a final immersion in clean petroleum solvent. After being dried, the metal filters shall be replaced without being reoiled. Attach a tag to each metal filter with the following instruction: "Reoil Filter Upon Reactivation of Equipment. "

(b) Vacuum tubes. Vacuum tubes (except water-cooled) should not be removed from their sockets for cleaning unless the condition of the rest of the equipment indicates that contamination probably exists between the tubes and sockets. Contamination on tube pins may be removed with petroleum solvent and clean, lint free cloth, but shall not be removed with crocus cloth or sandpaper.

(c) Drying. Immediately after being cleaned, the electronic equipment shall be thoroughly dried by one of the drying procedures listed in paragraph 2-3.

(9) Repainting. Surfaces from which paint is removed may be smoothed with fine sandpaper or crocus cloth, cleaned, and repainted in a matching color. The exterior surfaces of doors, panels, and cabinets are the ones most likely to require repainting.

(10) Preservation. A common method for preserving and packaging electronic equipment utilizes water-vaporproof barrier materials in conjunction with absorbent agents such as a desiccant. In controlled humidity enclosures, this preservation procedure need not be used. There are, however, other requirements that are necessary to adequately protect electronic equipment. These include application of moisture-fungus proofing compounds, silicone compounds to connectors, insect and rodent control, and specific physical protection procedures.

(11) Corrosion of electronics is influenced by three major factors, namely; humidity, temperature, and environmental contamination. Relative humidity above 50 percent drastically increases the rate of corrosion, however, it is not the sole factor causing corrosion. The environmental contamination by pollutants such as reactive sulfides and chlorides is a significant factor in the corrosion process. Corrosion can occur at extremely low levels of contamination and low levels of relative humidity. Temperature is also significant since expansion and contraction of metals causes movement of components which in turn causes certain types of corrosion. Humidity controlled warehouses or hutments as discussed in chapter 5, along with temperature regulation, is recommended whenever possible to control the elements of corrosion.

(12) Rodent and insect control. Positive control of rodents and insects is required where electronic gear is stored in the clear, not individually boxed or crated. The destructive effects of rodents and insects can be significant wherever electronic equipment is stored. The application of any or a combination of fumigants, poisons, traps, and physical protection required for effective control must be employed to prevent damage to electronic equipment. Historically, rodents have caused severe damage to wiring and electronic components in laid away equipment by nesting among the circuitry and gnawing on the plastic coated wires. Investment in controlling this problem is a requirement.

(13) Closing the equipment. All panels, chassis covers, and sliding units of electronic equipment shall be reattached and all doors closed. All handles, locks, screws, and other fasteners on these items shall be secured.

b. Preservation packing, and skidding. Electronic equipment shall be cushioned, blocked, braced, preserved/packed, and skidded in accordance with paragraphs 3-3c(11)(a) and (b). Be sure to include manufacturer's instructions, and/or descriptive literature with each item.

4-27. TRANSPORTATION OF ELECTRONICS EQUIPMENT

a. Transportation mode for numerically controlled equipment. All numerically controlled equipment including machine units, accessories, components, and assemblies shall be shipped in air ride vans only. To realize the maximum protection in the usage of air ride vans, the equipment should be located over rear wheels of the van. The transportation mode shall comply with Title 49 Code of Federal Regulation, transportation parts 100 to 199.

b. Waiver of transportation mode. When it is determined to be more economical or otherwise in the best interests of the Government to relax the transportation mode or when air ride vans cannot be utilized due to size, weight, or configuration of an item of IPE, a written request for waiver shall be addressed to: Defense General Supply Center, ATTN: DGSC-SSM, 8000 Jefferson Davis Highway, Richmond, VA 23297-5501.

c. Specialized equipment. Whenever specialized equipment is required for shipment of delicate electronic equipment, a commercial carrier should be contracted for the appropriate transporting vehicle. Contractors requiring this specialized equipment shall contact the cognizant DCAS Transportation Office for guidance on its availability and use. In unusual circumstances that require specific instructions for transporting highly sensitive and delicate electronic equipment associated with IPE, instructions should be requested from DGSC. Requests should be directed to Commander, Defense General Supply Center, ATTN: DGSC-SSM, 8000 Jefferson Davis Highway, Richmond, VA 23297-5501.

Section VII. FORGE SHOP EQUIPMENT, INCLUDING FORGE AND HEAT-TREAT FURNACES, COOLING OVENS, BONDERIZERS, SPRAY BOOTHS, CONVEYORS, AND FOUNDRY EQUIPMENT.

4-28. GENERAL

a. This type of equipment generally does not contain precision surfaces and functions associated with metalworking machinery, except for bearings.

b. Instructions for processing component parts and assemblies such as hydraulic systems, gear boxes, belt drives, and packing are covered in paragraph 4-8. Other assemblies common to plant equipment such as electrical and electronic equipment are covered in paragraphs 4-20 through 4-27. Precision measuring and recording instruments are covered in paragraph 4-17 in subparagraphs a through c.

4-29. FURNACES-HEAT TREATING, AND FORGING

a. Removal of any large furnace from its installed position shall be considered only after determination by qualified Government personnel that it can be reused elsewhere.

(1) Subassemblies, attachments, and accessories shall be removed to avoid damage or reduce cubage.

(2) Ceramic muffle boards and radiant tubes shall be removed and separately packaged and packed with adequate cushioning.

(3) Installation and operating instructions shall be placed in a greaseproof, waterproof envelope made from barrier material conforming to MIL-B-121 grade A, class I. This envelope shall be marked, "Installation Operating Instructions," and shall be securely attached to the furnace.

b. Remove and discard all firebrick and insulation in electrode type salt bath furnaces with ceramic pots.

c. Firebricking and refractory lining shall be removed entirely from any other type of furnace which has been in uninterrupted service for 5 years or more, or if burned, cracked, or otherwise deteriorated sections are found.

d. A furnace which has been in service for less than 5 years, or has had interrupted service and been under constant low heat while idle, shall be considered for transportation with its firebrick and refractory lining in place if it is substantially free from any type of deterioration.

e. Lining shipped separately from the furnace will be packed in a domestic shipping container conforming to MIL-STD-2073-1, table VII. Each piece of lining shall be separated from the other and from the inside face of the container with cushioning material conforming to CID A-A-1898. Container specifications with regard to weight must be followed.

f. Blocking and bracing of brick and lining shall be in accordance with MIL-HDBK-701.

g. Records shall show whether firebricking or refractory lining has been removed.

h. Scale from exterior and interior surfaces may be removed by sandblasting or wire brushing. It is not necessary to remove iron oxide (rust), except scale, by manual methods. These surfaces may be adequately prepared for the application of preservatives by cleaning with cleaning process C-1 from paragraph 2-2. This includes the conveyor and holding fixtures for projectiles on heat-treat furnaces. Scaly surfaces of conveyor chains that have been operating through quenching oil need not be disturbed.

i. Disconnect supply lines from water cooled bearings and disassemble to the extent necessary to remove rust and sludge. Disconnect piping serving other water-cooled components such as doors, door frames, and cooling chambers. Drain the system and remove moisture from

the lines and components by drying, in accordance with procedure D-l from paragraph 2-3, by subjecting the item to a blast of prepared dry, clean, compressed air. Wherever possible, refractors should be left intact.

j. Charge grease fitting with preservative grease conforming to MIL-G-23827, P- 11. Coat unpainted bright metal surfaces, conveyor chains, and sprockets with preservative P-2, grade 2, of table 2- 1. Compound wall surfaces, both internal and external, that are not covered with insulation or refractory, shall be painted.

k. Furnaces remaining in their operating position should have their doors blocked in an open position.

4-30. SAND SLINGER, SHAKE OUTS, CONVEYORS, ELEVATORS, MULLERS, DUST COLLECTORS

a. Cleaning. Remove sand, dust, and other foreign materials from jig arms, chambers, cooling ducts, conveyor buckets, hoppers, conveyor frames and chains, dust collector tubes, and tube compartments. Painted surfaces shall be cleaned with cleaning solvent conforming to P-D- 680, type II. The inside of wet-type dust collectors shall be hosed down with water. Water may be used on any type of equipment where danger of contaminating electrical equipment and precision parts does not exist. Rusted surfaces of metal conveyors (except bearings), hopper walls, elevator buckets, and dust collectors shall be cleaned as follows.

(1) Remove heavy scale by cleaning process C-l.

(2) After removal of heavy scale, clean contaminated surfaces by using cleaning process C- I in paragraph 2-2 of this TM.

(3) Drain water. Drain and blow out water lines, core oil piping systems, and other areas where water may be trapped.

b. Preservation. Paint all surfaces of the equipment where the paint would not be detrimental to the normal functions of the equipment when it is in use. Preserve all other unpainted ferrous metal surfaces with preservative compound P-2, P- 19, or P-21, of table 2-1.

Section VIII. SAMPLE SCOPE OF WORK FOR PROCESSING INDUSTRIAL PLANT EQUIPMENT FROM USE TO STAND-BY-IN-PLACE (NO CYCLING)

4-31. PRODUCTION PHASE DOWN

a. As production is phasing down, the using facility Contractor-owned, contractor-operated (COCO); Government-owned, contractor-operated (GOCO); Government-owned, Government- operated (GOGO) shall evaluate the production capabilities of each line item of Government owned IPE used in the manufacturing process.

b. Operational data shall be weighed against design characteristics and capabilities to establish a current, accurate condition code, in addition to noting missing or defective parts or components, erratic operation and malfunctioning that would effect the manufacturers design operability.

NOTE

UNDER NO CIRCUMSTANCES SHALL THE CONDITION CODE BE ESTABLISHED SOLELY ON TIIE PERFORMANCE OF A SPECIFIC REPETITIVE PRODUCTION OPERATION.

c. The subject evaluation data shall be recorded on the appropriate DOD or DLA forms in accordance with AR 700-43 and validated by the contractor and Government representative.

4-32. GENERAL INSTRUCTIONS

a. The following shutdown maintenance and long term preservation procedures shall be accomplished as the first machine tools are taken out of productive service. Shut down maintenance preservation shall continue down the production line behind the sequence of operation so that by the time the last machining operation is performed, the plant equipment utilized on preceding jobs will have been cleaned and preserved.

b. The idle period between the termination of production and shutdown cleaning shall not exceed 48 hours. Cleaning and preservation shall be accomplished with the machine connected to power so that machine power can be used to assist in the cleaning operation, the circulation of cleaning solutions and, preservative oils, and to allow power operations to assure correct reassembly after cleaning and preservation.

c. Disassembly shall be held to the minimum necessary to ensure a thorough cleaning. If disassembly is necessary and the degree of disassembly is such that reassembly could result in mismatch or misalignment, the machine shall be operated under power to ensure proper reassembly.

d. If it is necessary to-relocate IPE in-house, liquid lines shall be disconnected and matchmarked, tagged, or otherwise identified to facilitate reassembly. Open ends and threaded elements shall be plugged, taped, or otherwise protected to prevent entrance of foreign matter and/or damage in movement.

e. If IPE is removed from its operating position in-house, the main external electrical feedlines shall be disconnected at respective terminal blocks or junction boxes. Disconnected wiring shall be tagged or otherwise identified to aid reassembly. Under no circumstances will wiring be cut behind terminal or junction connections. Machine control wiring shall not be disconnected unless required for relocation. If continuity is disturbed proper identification shall be made.

f. Tension shall be relieved on drive belts or the belts shall be removed and attached to the machine. In the event the drive motor must be removed for safe relocation, all removed drive belts shall be processed in accordance with paragraph 4-7u.

g. Fixtures attached to tables and other machined surfaces shall be removed. Mating surfaces should then be cleaned with cleaning solvent conforming to P-D-680, type II, dried, and preserved with preservative oil P-10, grade 30, of table 2-1 and reinstalled. If the removed items are not returned to the machine, they shall be cleaned and dried as above, and preserved with preservative compound P-2, P-3, or P-19, or P-21, of table 2-1. All preserved items shall be wrapped with barrier material conforming to MIL-B-121, grade A. The items shall then be boxed and stored with the basic machine. Previously unremoved shank and socket type tooling shall be removed to permit similar type cleaning and preservation of mating surfaces.

h. Standard accessories, spare parts, and consumable items to be retained with the basic machine shall be cleaned with cleaning solvent conforming to P-D-680, type II, dried, and preserved with preservative compound P-2, P-3, P-19, or P-21, of table 2-1. Items not returned to the machine shall be wrapped with barrier material, conforming to MIL-B-121, grade A, then boxed, stored with the basic machine. Packing lists shall be prepared for all boxed items and all markings shall conform to MIL-STD-129.

i. Items such as metallic gages and measuring devices shall be cleaned for removal of rust and fingerprints and dried in accordance with chapter 2. All items shall be preserved with preservative oil P-9 of table 2-1 and then wrapped with barrier material conforming to MIL-B-121, grade A, and packaged in accordance with MIL-P- 116, submethod IA-15 or C-1. Packaged items shall be boxed and stored with the basic machine. Packing lists shall be prepared for the boxed items with all markings conforming to MIL-STD-129.

j. Electric and electronic equipment incorporating delicate and intricate components shall be processed in accordance with paragraphs 4-20 through 4-27.

k. All records, including technical manuals, pamphlets, handbooks, and other documentation shall be packaged in accordance with MIL-P-116, submethod C-1, and shall be attached to the basic machine.

l. On machines stored standby-in-place, except for those which are to be exercised, all overhanging assemblies, such as heads, knees, saddles, tables, and arms, shall be moved to their lowest position and, whenever possible, nearest to the mating column, and blocked as required for proper support. Tables on milling machines shall be centered on saddles. Extremely heavy fixtures mounted at the end of tables shall be removed. All tables and moving arms shall be secured in position by means independent of the machine's locking devices. All adjustment wheels and levers shall be locked in place.

m. Unless required for relocation in-house, skidding will not be required. Care shall be exercised to assure relocated IPE is maintained on a level plane.

n. Complex items should be prepared and stored in accordance with the manufacturer's specifications. In many instances, it is advisable to solicit the services of the manufacturer's technical representative.

4-33. SEQUENTIAL CLEANING AND PRESERVATION PROCEDURES

Follow sequential cleaning and preservation procedures listed in paragraphs 3-3a through d.

Section IX. SAMPLE SCOPE OF WORK FOR PROCESSING INDUSTRIAL PLANT EQUIPMENT FROM USE TO CONTROLLED HUMIDITY STORAGE

4-34. PRODUCTION PHASE DOWN

Follow production phase down guidance in paragraphs 4-31 a through c.

4-35. GENERAL INSTRUCTIONS

Follow the general instructions as specified in paragraphs 4-32a through c.

4-36. SEQUENTIAL CLEANING AND PRESERVATION PROCEDURES

a. Follow sequential cleaning and preservation procedures in the order in which they are listed in paragraphs 3-3a through d.

(I) Hydraulic systems. Wash down reservoirs, filtering devices and any other accessible hydraulic fluid chambers with hydraulic fluid and drain. All hydraulic fluid in voids, pump, sumps, and lines should be removed with a suction pump. If the filter is a throwaway type, discard and replace. (Refer to paragraph 4-7q for processing of hydraulic systems.)

(2) All hydraulic systems drained and/or cleaned shall be preserved with preservative oil P-10, type I, grade 10, of table 2-1. This may be accomplished by spraying, fogging, or flushing. External precision and unpainted surfaces shall be cleaned and dried in accordance with chapter 2 and preserved with preservative compound P-2, P-3, P-19, or P-21 of table 2-1. Damaged exterior painted surfaces shall be processed in accordance with paragraph 4-7t.

(3) Pressure type grease fittings shall be purged of the present lubricant and charged with preservative grease P- 11 of table 2-1.

(4) Wipers used on slides and carriages shall be removed and replaced with new ones. They shall be placed on the original location on the machine. All protective type seals on components such as spindles and shafts shall be removed, thoroughly cleaned or replaced, saturated with preservative P- 10, type I, grade 30, of table 2-1 and returned to their original location on the machine.

(5) Main external electric motor feedlines shall be disconnected at respective terminal blocks or junction boxes. Disconnected wiring shall be tagged or otherwise identified to aid reassembly. Under no circumstances will motor wiring be cut behind terminal or junction connections. Machine control wiring shall not be disconnected unless required for shipment. If continuity is disturbed, proper identification shall be made.

(6) Tension shall be relieved on drive belts or the belts can be removed and attached to the machine. In the event the drive motor must be removed for safe shipment, all removed drive belts shall be processed in accordance with paragraph 4-7u.

(7) Electric motor brushes shall be removed, thoroughly cleaned, and packed in accordance with MIL-P-116, submethod C-1. Attach a tag to the motor indicating that the brushes have been removed. Badly worn or chipped brushes shall be replaced. The packaged brushes may be attached to the motor or boxed with other component parts of the machine. All items shall be identified and marked in accordance with MIL-STD-129.

(8) Fixtures attached to tables and other machined surfaces shall be removed and mating surfaces cleaned with cleaning solvent conforming to P-D-680, type II, dried and preserved with preservative compound, P-2, P-3, P-19, or- P-21, table 2-1. If removed items are not returned to the machine, wrap with barrier material conforming to MIL-B-121, grade A. Items shall be cushioned, boxed and stored with the basic machine. Packing lists shall be prepared for boxed items and shall be marked and identified in accordance with MIL-STD-129. Previously unremoved shank and socket type tooling shall be removed to permit similar type cleaning and preservation of mating surfaces.

(9) Items such as standard accessories and spare parts to be retained with the basic machine shall be cleaned with cleaning solvent conforming to P-D-680, type II, dried, and preserved with preservative compound P-2, P-19, or P-21 of table 2-1. Items not returned to the machine shall be wrapped with barrier material conforming to MIL-B- 121, grade A, boxed, and shipped with the basic machine. Packing lists shall be prepared for all boxed items. All markings shall be in accordance with MIL-STD-129.

(10) Precision dial measuring instruments shall be cleaned with cleaning solvent conforming to P-D-680, type II, taking care to avoid contamination of internal surfaces. Removal of fingerprints and drying shall be in accordance with chapter 2. All items shall be preserved with preservative oil P-9 of table 2-1, wrapped with barrier- material conforming to MIL-B- 121, grade A, and packed in accordance with MIL-P- 116, submethod IA- 15 or C-1. Packaged items shall be cushioned, boxed, and shipped with the basic machine. Micrometers, height gages, verniers, scales, plugs, ring, and snap gages shall be preserved with preservative oil P-9 of table 2-1 and wrapped in barrier material conforming to MIL-B-121. In lieu of preservative oil and barrier materials, certain gages and plugs can be packed in accordance with MIL-P-116, submethod IB- I or IB-2. Care shall be exercised to prevent cleaning or preservative materials from entering the internal parts of the items. Packing lists shall be prepared for all boxed items and markings shall be in accordance with MIL-STD-129.

(11) Electric equipment incorporating delicate and intricate components shall be processed in accordance with paragraphs 4-20 through 4-23. Electronic equipment shall be processed in accordance with paragraphs 4-24 through 4-27 as applicable.

(12) All records, including technical manuals, pamphlets, handbooks, and other documentation shall be packed in accordance with MIL-P-116, submethod C-1 and shall be attached to the basic machine.

(13) Containers used for liquid such as cleaning solution and flushing oils shall be plainly marked. Cleaning solution from coolant systems shall not be used for gear boxes or any system except coolant systems.

4-37. PREPARATION FOR SHIPMENT/MOVE.

When preparing IPE for shipment, it must be ascertained that all cleaning, preservation, and packing requirements have been accomplished prior to the operations listed below.

NOTE

MACHINERY USING COUNTERWEIGHTS INSIDE THE FRAME OR COLUMN OF HEAVY MACHINE COMPONENTS SHALL HAVE THE COUNTERWEIGHTS BLOCKED AND TENSION ON THE CONNECTING CABLE OR CHAIN RELIEVED TO PREVENT DAMAGE IN SHIPMNENT. MACHINERY EQUIPPED WITH BALL OR ROLLER ANTIFRICTION DEVICES UNDERWAYS OR GUIDE SURFACES, TABLES, OR HEADS SHALL BE CUSHIONED TOP AND BOTTOM OR REMOVED SO THAT THE ANTIFRICTION BALLS OR ROLLERS DO NOT CARRY THE WEIGHT OR MAKE CONTACT WITH THE APPLICABLE COMPONENTS DURING SHIPMENT.

a. Records. Prior to loading, the shipment shall be inspected to ensure that all required records are packed in accordance with MIL-P- 116, submethod C-1, and attached to the basic units.

b. Inspection requirements. Prior to shipment, the equipment shall be inspected to verify that it has been prepared for shipment in accordance with this manual and MIL-STD-107.

c. Blocking and bracing. Machine heads shall be locked in position. Moving parts shall be either removed or carefully locked in position and braced to prevent movement in transit or handling. All plant equipment shall be completely assembled when being prepared for shipment whenever weight and size permit, provided all necessary blocking can be accomplished to provide adequate protection to all components, attachments, and accessories. When it is feasible to ship a machine assembled, accessories, attachments, and components shall be packed according to weight in accordance with chapter 8. Projecting parts, such as brackets, arms, tables, motors, and pumps which are difficult to support or protect, or which will require considerable additional blocking if left on the machine, shall be removed, boxed, and if possible, placed on the same skid as the basic unit. Tables which move on ball bearings shall be removed

or blocked in a manner that will prevent brinelling or other damage to the ways. Slides, counterbalances, motors, hydraulic tables, and any movable mountings shall be securely braced to the machine itself. Relieve the tension from all components such as cables and springs. Equipment shall never be blocked to the walls or floor of the car or truck in which equipment is being shipped. Detailed requirements for blocking and bracing of plant equipment are contained in MIL-HDBK-701.

d. Counterweights. Counterweights shall be securely blocked in place against movement in any direction, or shall be removed and securely mounted outside the equipment.

e. Skidding. Skidding instructions are contained in MIL-HDBK-701. In preparing plant equipment for domestic shipment, skidding rather than crating or boxing is considered to be economically advantageous. Used skids shall be replaced if necessary for safe shipment.

f. Shipping cover. After the equipment has been loaded and secured to the conveyance, a visual examination shall be made to detect any disturbance of preservatives on machined sulfates. The integrity of the preservatives shall be verified and, if touch-up procedures are required, the same type of preservative shall be applied to bare areas. When open type transportation is utilized, all equipment shall be covered with flexible, waterproof material conforming to PPP-B- 1055, class E, or heavier, or plastic sheet and strip, thin gauge polyolefin conforming to L-P-378, class 1, type II. All covers shall be of sufficient strength and shall be secured in a manner to provide adequate protection throughout the transit period. Covers constructed from waterproof paper shall not be used. All sharp corners and projections shall be padded or cushioned before covering. Covers shall be draped in a manner to completely cover the item and shall be arranged to avoid the formation of water pockets. Tarp seams shall be sealed with water resistant adhesive conforming to MMM-A-260.

g. Caution tag. When applicable, a waterproof tag conforming to UU-T-81 shall be attached to each machine. The tag shall state: **"Machine has been preserved for shipment/storage. Service all reservoirs and lubricate completely before putting in operation. "**

CHAPTER 5

STORAGE CONTROL

Section I. INTRODUCTION

5-1. General

a. This chapter sets forth technical requirements and guidance relative to storage of IPE and OPE. The requirements set forth herein are to be complied with by maintenance and storage personnel and organizations involved in the storage of IPE.

b. There are three basic causes of corrosion and deterioration of IPE in storage. They are:

(1) Contaminants not removed from equipment prior to being placed in storage.

(2) Humidity in the atmosphere surrounding the equipment in storage.

(3) Temperature causing thermal expansion and relative movement of component contacts.

c. Other chapters in this manual explain in detail how to clean IPE and also list preservative materials that are applied to surface areas of the equipment. The preservatives form a barrier between these areas and the corrosives in the atmosphere, thereby affording some protection against the corrosive elements.

d. Preservative materials are effective for a limited time only. The useful life of these materials may be greatly extended by controlling the corrosive elements in the storage atmosphere. This chapter deals primarily with those elements and lists the various means of controlling or slowing down their damaging influences to IPE.

e. Before proceeding with the various methods of controlling the atmosphere in the storage environment, it is necessary to understand certain definitions and what the corrosive elements are and their effect on IPE.

5-2. Definitions

a. Controlled humidity storage. Space which has been especially prepared and equipped to control relative humidity.

b. Cocoon. A protective covering wrapped, placed, or sprayed over equipment in storage.

c. Heated storage. Area in which the temperature can be controlled within specified limits by the application of heat.

d. Interim preservation procedures. Procedures identified as interim preservation of IPE are those set forth in chapter 3 of this manual. They have been established for use in maintaining IPE for a period not to exceed 1 year with reprocessing required if the period must be extended. These procedures are an absolute minimum.

e. Long-term (maximum) preservation. This type of preservation is used when IPE is to be stored for indefinite periods without the benefit of controlled humidity storage. Procedures are contained in chapter 4 of this manual.

f. Noncontrolled humidity storage. All storage buildings/facilities that are not equipped with proper equipment to maintain controlled relative humidity level.

g. Open storage. Improved or unimproved outside (outdoor) storage areas.

h. Preservation. Application of protective measures including cleaning, drying, preservation materials, barrier materials, cushioning, and containers when necessary.

5-3. Corrosive Environments

a. General. The condition of IPE in storage depends on the prevailing physical and chemical forces of deterioration. These forces are influenced by heat, moisture, dusts, gases and fungi. The dust particles, oxygen, and moisture are natural products of the atmosphere, however, sulphur, chlorine, and other chemicals are by-products of industrial facilities located in the vicinity of the storage site. Moisture is probably the most critical agent since it affects the corrosiveness of all the others, but, like the others, it is not destructive by itself. Corrosion can occur at extremely low levels of relative humidity. Therefore, the construction of humidity controlled hutments along with temperature regulation are recommended wherever possible.

b. Dew point and relative humidity. The amount of moisture the air can hold depends upon temperature. Warm air is capable of holding more moisture than cold air. When the temperature of a given volume of air which contains a given amount of moisture drops to a certain point (the dew point), the moisture will condense and appear in liquid form. This liquid water on metallic surfaces of IPE may cause corrosion to occur. Relative humidity is the ratio between the actual amount of moisture in the air and the amount that the air can hold at that temperature. Relative humidity of 50 percent means that the air contains one-half the moisture it could hold at the existing temperature.

c. Corrosion in the presence of moisture. Corrosion can occur in the presence of extremely small amounts of moisture on a metallic surface. The temperature of the atmosphere does not have to be falling through the dew point for exposed metal surfaces to become moist and begin to corrode. Most types of dust and dirt are hygroscopic, that is, they are able to absorb or attract moisture from the air at relative humidities less than 100 percent. Moisture may be picked up while the particles are still in the air or after they are deposited on exposed surfaces. Dirt and

dust will retain moisture even after nearby clean surfaces have dried by evaporation. Rust and other corrosive products also are hygroscopic, which partially accounts for the fact that rust spots spread rapidly. Because of such absorption, the corrosion rate for a given metal increases rapidly above a certain relative humidity, called the critical humidity. The critical humidities of metals vary. Some are quite high, that of copper being nearly 100 percent, while most ferrous metals will corrode in a relative humidity of approximately 50 percent when they are bare.

5-4. Record of Storage Atmosphere

a. Hygrothermographs. A continuous record of temperature and relative humidity shall be kept for inspection for 1 year for all controlled humidity storage enclosures (buildings and hutments). In some instances, where humidity is controlled by the application of heat, the controls are equipped with instruments for recording both temperature and humidity. Where this type of recorder is present, no further recording instruments are needed. For all other storage enclosures, a 30 day, vertical-drum hygrothermograph is recommended.

b. Sensing elements. The sensing elements on hygrothermographs should be maintained in accordance with the manufacturer's recommended procedures.

c. Psychrometry. The properties of the storage atmosphere and the accuracy of the humidistat and hygrothermographs may be determined by using a sling psychrometer and a psychometric chart or by using a battery-powered, motor-driven relative humidity indicator. The manufacturer's recommendations for using either of these instruments must be followed.

5-5. Types of Storage Environment

a. Controlled humidity storage. Types of controlled humidity storage areas are listed below.

(1) Controlled humidity storage. Controlled humidity (CH) storage is a type of storage in which the relative humidity within an enclosed building or hutment is maintained at 50 percent or less by use of dynamic dehumidification equipment, and controlled by automatic or semiautomatic regulators.

(2) Heated storage. Heated storage is a type of storage in which relative humidity within an enclosed building or hutment is maintained at 50 percent or less through the use of temperature-regulated controls.

b. Noncontrolled storage. Noncontrolled storage denotes those storage areas that have no means for controlling the relative humidity. Examples are: enclosed buildings, outdoor, under cover (shed and lean-to), and outdoor (no covered structure). Outdoor storage is satisfactory for rough type items such as tanks, furnace shells, conveyors, anvils, heavy castings, and forgings. Storage under open sheds should be restricted to semi-rough type items. The term "noncontrolled storage" referenced in this paragraph is used in its generic form "noncontrolled humidity storage" in paragraph 5-1 la.

(1) IPE should be placed in the type of storage affording the highest degree of protection that can be economically provided.

(2) Paragraphs 5-6 through 5-13 provide the instructions for placing the above storage conditions into effect.

Section II. CONTROLLED HUMIDITY STORAGE

5-6. General

a. Controlled humidity storage is that type of storage where the atmosphere in the storage area is maintained at a relative humidity of 50 percent or less. This type of storage will protect properly cleaned and preserved IPE for an indefinite period.

b. Controlled humidity storage is achieved by removing water vapor from the storage area until the desired relative humidity has been reached.

c. When water vapor is removed from a storage space, a vapor pressure differential is established between the dehumidified space and the variable vapor pressure in the outside air. The pressure differential, or force, attempts to equalize itself by diffusing water vapor through all porous hygroscopic wall materials and also through window and door openings, open ventilators, and cracks in walls. This diffusion effect is called water vapor transmission. As the wind blows against the building, air moves into the enclosed space. This is called infiltration, and it carries wet air in and dry air out. A good vapor barrier must be provided to exclude this air and vapor transfer. This requirement is generally achieved by the erection of a vapor barrier, which makes the storage area relatively air-tight and moisture-proof.

d. A vapor barrier may be provided by the following methods:

(1) By sealing the storage building against water seepage, water vapor transmission, and air leakage (controlled humidity buildings).

(2) By the erection of a polyethylene hutment (indoor plastic film controlled humidity structure).

(3) By the erection of a hutment designed specifically to prevent infiltration of water vapor and outside air (indoor metal hutment or commercially available humidity controlled structure).

e. Dehumidification equipment.

(1) There is not a set formula which can accurately predict the size of the dehumidification unit required for an individual storage site. Dehumidification unit size is based on the number of cubic feet to be dehumidified; however, the transmission rate of outside air and moisture from the floor, etc. , directly affect the amount of water a dehumidification unit must remove to keep the relative humidity below 50 percent. The sizes of dehumidification units

range from 150 cubic feet to 60,000 cubic feet. The requirements will depend upon the amount and nature of the material stored in the area to be dehumidified and also the moisture vapor transmission through the storage structure.

(2) The dehumidification of any enclosed structure has two distinct phases:

(a) The initial pull-down period where water is gradually removed from the structure and the skidding of the equipment.

(b) The subsequent period during which the humidity is maintained at the desired operating level. The time to reduce the relative humidity in a storage enclosure can take up to 120 days.

(3) Dynamic dehumidification machines are manufactured by several different companies in the United States and may be purchased by the using agency or by the contractor concerned. Dry, desiccant type dehumidification machines for dynamic dehumidification will conform to military specification MIL-D-28594.

(4) Wiring. Care should be taken to ensure that the dehumidification unit, in combination with other items drawing from the same power source, does not exceed the maximum load for that power source. For maintenance, repair, and emergency shutdown, a remote fused disconnect switch should be installed.

(5) Location and ducts. A plan of the site should be prepared showing the arrangement of the dehumidification units and, if applicable, the hutments, support panels, duct work, equipment entrance of the hutment, humidistat, electrical line connections and the source of power for the dehumidification units. The dehumidification unit must be installed in a flat, level surface with sufficient room to perform service and repair. The length of the duct work should be kept to a minimum. For dehumidification of a building, machines should be installed on the inside of the dehumidified building, preferably adjacent to an outer wall of the building with the machine and sensing element of the controller in the region of the building which is normally the coolest. This will eliminate the effects of temperature variations due to uneven heating by the sun and help ensure the operation of the dehumidification machine to correct localized relative humidity conditions and reduce the amount of duct work for the reactivation air outlet and inlet. For dehumidification of hutments, the preference is to install the dehumidification machine on the outside of the indoor hutments, although they can also be installed on the inside. Here too, it is recommended that the dehumidifier be placed near the hutment in the coolest region practical, if temperature variations exist. In addition, ducts shall be located so as not to short circuit dehumidified air with return air or so as not to interfere with moving equipment inside the hutment. Duct connections from the dehumidification unit to the hutment shall be of the size recommended by the manufacturer.

(6) Control equipment. The humidistat shall be installed in the vicinity of the absorption air return to the dehumidifier. Care should be taken not to locate it in the general area of the dried air outlet.

(7) Alarm system. It is recommended that there be an audible alarm wired to the dehumidification system to warn of equipment failure. Care should be taken not to locate it in the general area of the dried air outlet.

(8) Dehumidification equipment replacement parts. It is critical that humidity is not allowed to exceed 50 percent; therefore, any down time of the dehumidification unit should be kept to an absolute minimum. To ensure that this is so, the procuring activity should consider purchasing essential replacement parts as recommended by the manufacturer of the dehumidification unit.

(9) Dehumidification equipment maintenance. Units should be inspected weekly to ensure smooth operation. The manufacturer's maintenance schedule should be followed for lubrication, belts, filters, etc. The humidistat must be calibrated according to the manufacturer specifications.

5-7. Controlled Humidity Buildings

a. Controlled humidity buildings. These are permanent buildings sealed against water seepage, water vapor transmission, and air leakage. Only sound buildings with a limited number of openings and with a limited ratio of wall area to floor area or volume can be economically sealed and dehumidified. A sound, built-up roof is required. All doors, windows, ventilation, and other openings not required for operational purposes shall be secured and sealed against water vapor transmission and air leakage (fig *5-1).*

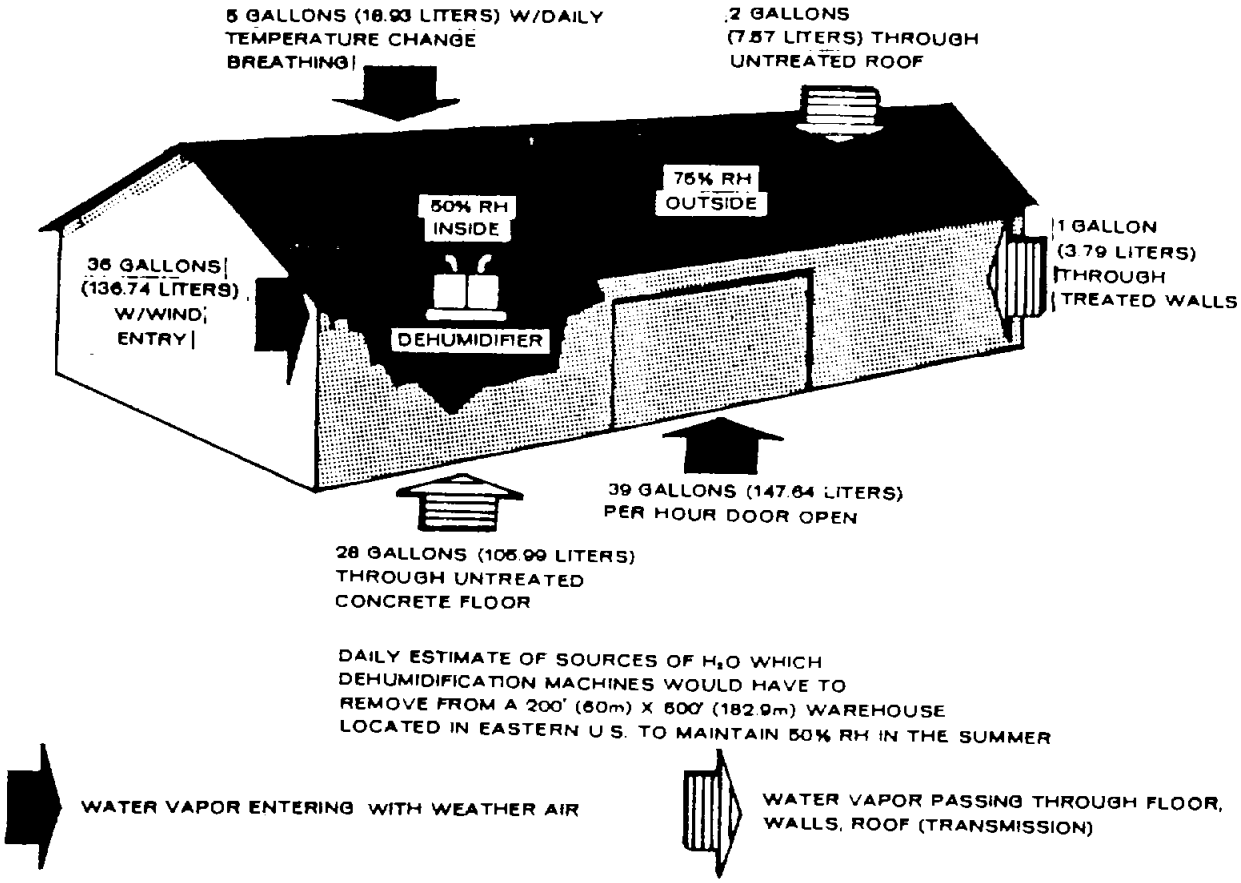


Figure 5-1. Example of Daily Water Vapor Load in a Controlled Humidity Warehouse

b. Dehumidification load. The rate at which water vapor must be removed from the building to maintain the desired level of relative humidity is known as the dehumidification load. Once the moisture in excess of the residual has been removed, the daily dehumidification load in a warehouse is based upon maintaining an inside relative humidity of 50 percent. Since the outside relative humidity varies greatly, ranging from 10 to 100 percent, depending upon weather factors, the quantity of moisture gained from the outside air never remains fixed. Estimates based upon weather data from previous years may be used. Sources of humidity are:

(1) Open doors. During the period that an external cargo door is open, outside air has free access to the warehouse, the rate being dependent upon the wind velocity and direction at the time. Actual observations of air flow through an open cargo door have shown that a 5 mile per hour wind will produce a mean velocity through a doorway of approximately 70 cubic feet per minute resulting in the potential for a drastic increase in relative humidity.

(2) Infiltration. Infiltration of air into the warehouse is due to wind forcing outside air through cracks and other apertures on the windward side of the warehouse, while a like quantity of dehumidified air leaves through similar openings of the-lee side. The quantity of infiltrated air is a function of wind velocity and the number, size, and character of openings through which it can enter.

(3) Floors. The vapor permeability of concrete has a wide range and may be a critical factor in the transmission of moisture through a floor slab. The resistance of concrete to the penetration of moisture depends to a considerable degree on the curing time and the amount of water used in the mix. While there can be considerable transmission of moisture through the floor, the cost of treating floors to reduce this transmission may be greater than potential savings. However, where unusually damp conditions prevail, savings can be made.

(4) Breathing. The moisture gained from breathing is caused by the daily temperature changes in the building and the changes in barometric pressure. An increase in temperature in the building causes the air to expand and forces some dehumidified air out of the building. Shrinking of the air in the structure as the inside temperature falls causes a like quantity of humid air to be drawn into it. The difference in quantity of water in the indrawn air and that in the dry air which it replaced constitutes the dehumidification load due to breathing.

(5) Transmission. Calculated transmission loads through the roof, walls, and floor are all based upon empirical data obtained in laboratories and filed tests. Some leakage through the concrete floor is undoubtedly due to capillary transmission. Where the underlying rock strata and the hydraulic conditions in the area combined to deliver water under pressure to the lower side of the concrete floor, excessive quantities of water may be forced through the concrete to add to the dehumidification load.

(6) Receipts of equipment. Moisture in excess of the residual moisture brought in with equipment adds to the dehumidification load. The equipment may have been shipped from any portion of the country, and may have been exposed to snow or rain en route. Wooden skids will retain moisture, temporarily adding to the dehumidification loads.

(7) Example load. The following tabulation is an example of the elements of the estimated dehumidification load for a 182 by 1,447 foot warehouse of average height on an average July day in the Eastern United States. The majority of the load in the following example is carried into the warehouse through the entry of outside air, and all but 5.0 percent of this subject to control. The infiltration load can be lowered by improving the sealing of the building, and the open-door time might be reduced. Emphasis must be placed on adequate surveillance of building sealing and the establishment and enforcement of local regulations that will keep open door time to humidity controlled areas at a minimum (see fig 5-1).

CHART 5-1

LOAD	POUNDS PER DAY MOISTURE	GALLONS PER DAY MOISTURE	PERCENT LOAD
Breathing	**150**	**18**	**5. 0**
Door opening (1 door for 1 hr/day	**1,000**	**120**	**33. 3**
Infiltration	**940**	**113**	**31. 3**
(Inventory turn-over) New Equipment	**150**	**18**	**5. 0**
Concrete floor (untreated)	**630**	**75**	**21. 0**
Transmission			
Walls (treated)	**60**	**7**	**2. 0**
Roof (untreated)	**70**	**8**	**2. 4**
TOTAL	**3,000**	**359**	**100. 0**

NOTE: ONE GALLON OF WATER WEIGHS 8. 35 POUNDS

c. In most instances, the average manufacturing building cannot be adequately sealed for the purpose of controlling relative humidity. It is impossible to stop the breathing of a warehouse, because of the nature of the structure and because it would not resist the pressure generated by temperature and barometric changes. When equipment stored in such buildings must be maintained under relative humidity controlled conditions, it may be necessary to erect a controlled humidity structure or apply heat to the manufacturing area.

5-8. Hutments

The term "hutment" generally refers to a structure which has been specially erected for the storage of equipment under dehumidified conditions. Hutments must be designed to have as little free air space as practicable to minimize the introduction of water-vapor by breathing, diffusion, and infiltration. Sealing the structure is critical if the hutment is to be an efficient vapor barrier. Essentially, there are two types of hutments: Indoor plastic film dehumidified structures (fig 5-2) and indoor metal hutments (fig 5-3).

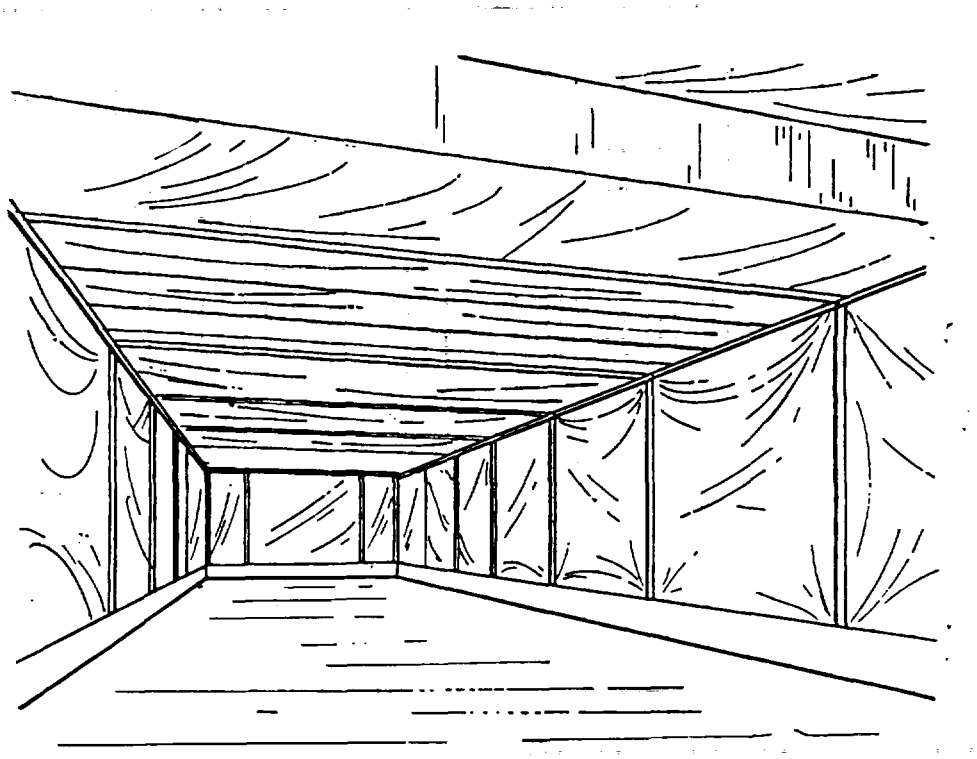


Figure 5-2. Dehumidified Plastic Film Structure

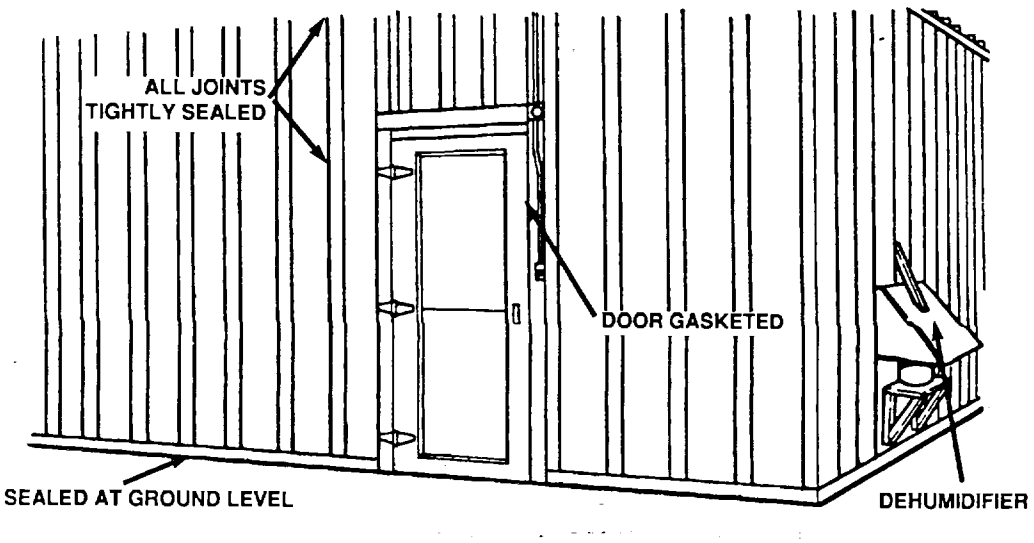


Figure 5-3. Indoor Metal Hutment

a. Indoor plastic film dehumidified structures.

(1) A dehumidified plastic film structure is a semi-permanent type indoor hutment that can be purchased commercially or built with a polyethylene cover over a pipe framework. Polyethylene is prone to tearing at lower thickness (at or below 0. 006 (6 mil)), but seams will not seal well at higher thickness (above 0. 006 (6 mil)). Commercially available cocoons or humidity control structures are potentially more durable but may be substantially more expensive. These factors should be taken into consideration when making the decision to erect a humidity controlled structure. Either type of hutment provides a satisfactory water vapor barrier to the surrounding atmosphere, controlling the relative humidity by dynamic dehumidification. This type of structure is adaptable for erection inside of existing buildings over consolidated or in-place equipment. Overhead obstructions, interfering conveyor systems, piping, and electrical connections may have to be removed to allow for the installation of a humidity controlled structure.

(2) If the decision is made to build a hutment as opposed to buying one commercially, the following steps can be used as a guideline in the construction of the structure. These guidelines are for a pipe supported style hutment, but some of the general information can be used to build other types of structures.

(a) Overhead cold water pipes shall be removed or insulated to prevent condensation in hot weather and the resulting accumulation of the condensate on the hutment roof. Roofing requiring major repair or replacement within approximately 2 years shall be repaired before hutment installation. Sources of excessive drafts shall be repaired or modified to prevent tearing of plastic film.

(b) Seams. Wherever feasible, procure a sheet of polyethylene large enough to cover the entire hutment. If this is not possible and the material must be joined together to provide a cover of sufficient size to cover equipment and provide for trim allowance, the seams shall be heat sealed and have strength characteristics equal to 80 percent of the parent material. The seams shall be continuous on the inside of the cover and free of holes, skips in welds, or burned through spots. The seams shall be continuous on the inside of the cover, so that after erection, resealing of the seams will be possible.

(c) Personnel and equipment entrance. Each hutment shall be provided with one combination personnel and equipment entrance. This entrance shall consist of 2 zippers, installed vertically in the side wall of the plastic cover with the open end flush with the edge of the blanket. A pull tab will be located on the outside of the plastic wall. The length and location of the zippers shall be specified by the procuring agency. The base plate and screws between the two zippers shall be removable for hutments with a wood base. Sandbag sealed bases can be opened up anywhere along the sandbag sealed hutment walls; therefore, it is not necessary to install a personnel and equipment entrance (see paragraphs f and g below).

(d) Ordering information. The procuring agency shall supply the dimensional data for the hutment to include the trim allowance around the hutment as well as the location of the equipment entrance zippers. (See fig 5-4.) The polyethylene blanket shall be fabricated of 0. 006 inches (6 mil) thick clear polyethylene of the widest widths practical for the hutment size.

(e) Preconditioning of flooring. The floor area to be occupied by the hutment shall be preconditioned wherever practical to overcome openings and cracks in the area within the hutment. Irregular levels around the perimeter must be corrected. All cracks in the floor within the hutment shall be wire brushed and sealed with hot asphalt. A sealer coat can be used to prevent moisture coming through the concrete where concrete is prone to moisture permeation. Equipment pit openings, floor drains, and other openings shall be effectively closed and sealed when the equipment is not to be laid-away in place. Areas under the machines located in place will not be seal coated. The procuring agency shall specify the extent of seal coating.

(f) Installation of the base plate. The floor area around the perimeter of the base plate location shall be cleaned and wire brushed. The joint for the base plate shall be made by troweling a heavy coat of asphalt compound for the full width of the base plate around the entire perimeter of the space to be occupied by the hutment. The base plate shall be secured to the floor

by means of lag bolts, power driven studs, or other acceptable devices except for the personnel entrance as mentioned above. The base plate must be drawn down tightly to the floor so that the sealing compound exudes from beneath the base plate to form an air tight joint. Base plates should be 2 by 4 inches, seasoned, finished, lumber. To locate and secure the vertical support pipes, wood blocks, 2 by 4 by 12 inches with a 1-3/8 inch diameter hole, drilled in the center of each block, shall be nailed to the top of the base place as shown in fig 5-4. Reinforced sealing tape one-eighth by three-fourths of an inch should be applied to the outside of the base plate by stapling on 12 inches centers as shown in figure 5-5.

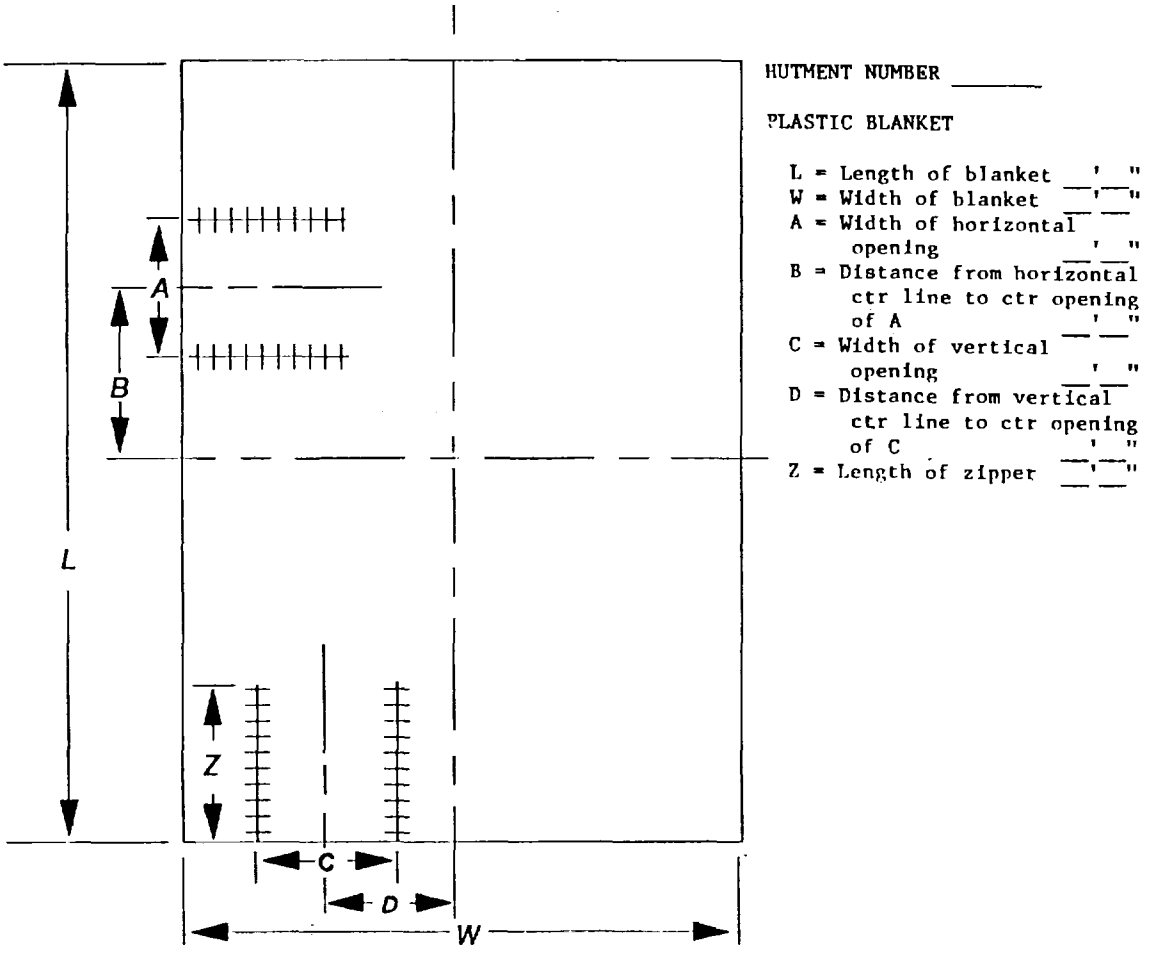
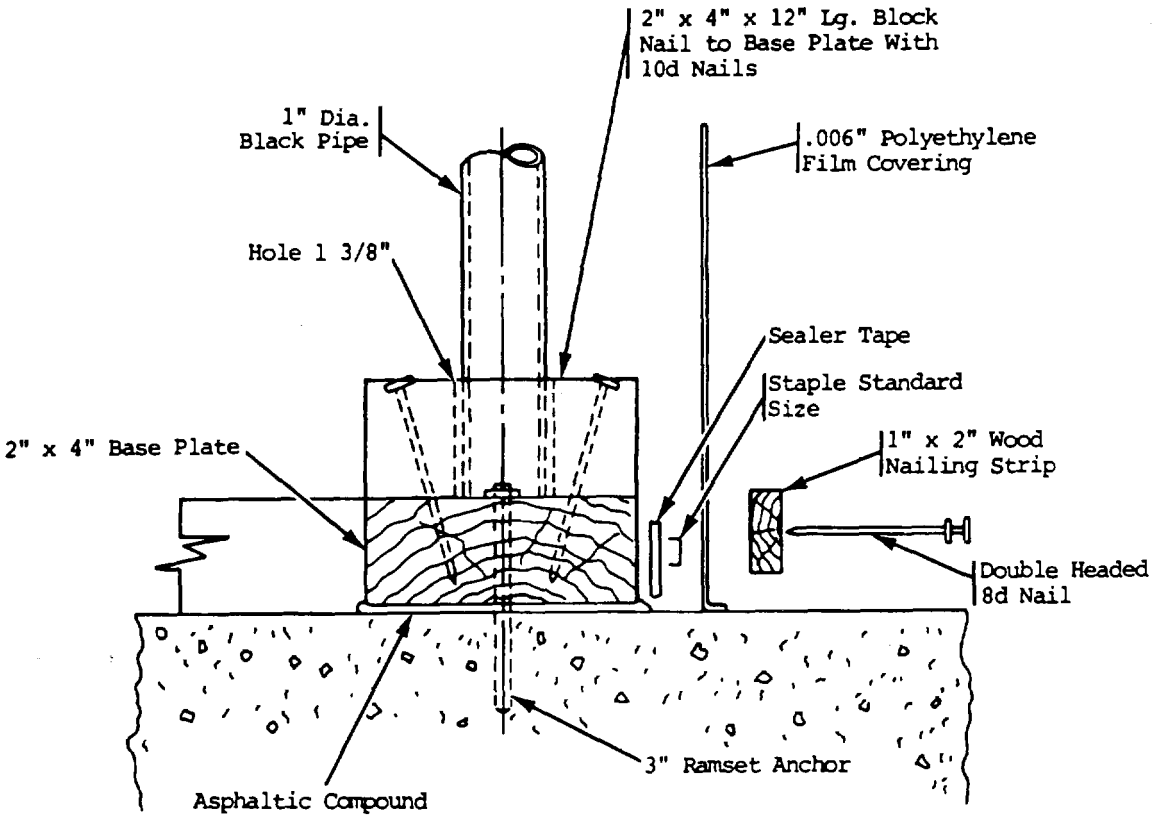


Figure 5-4. Hutment Plastic Blanket Layout



INSTALLATION INSTRUCTIONS

1. Clean floor where base plate is to be installed.
2. Apply asphalt mastic sealer to floor.
3. Set base plate and secure to floor with power driven studs (or equal method).
4. Apply sealing tape, secure to base plate with staples.
5. Place polyethylene cover over supporting structure, secure cover to base plate.
6. Secure polyethylene cover to base plate with nailing strip.

Figure 5-5. Base Plate Construction

(g) Alternate method of sealing the cover to the floor. Sand tubes may be substituted for the base plate when it is necessary to have access to the equipment from all sides. Medium weight canvas tubes filled with sand shall be laid on the polyethylene cover, around the perimeter of the hutment. The tubes shall be 3-1/2 inches in diameter by 12 feet long, either sewn or seamless, and tied at the ends. The tubes shall overlap 6 to 12 inches at each end. Each vertical support pipe shall be placed over a single power driven stud to retain its position on the floor. Access to the hutment can be gained by removing the sand tubes from the corner of the hutment at the point of access. The excess material in the corner fold will allow the side wall film to be raised to allow entrance for machinery removal.

(h) Pipe framework. The supporting pipe framework shall be fabricated of 1 inch diameter unthreaded, standard weight, black iron pipe. The framework shall be connected together with slip on type rail fittings. Vertical and horizontal pipe members shall be spaced depending on the final hutment size with a maximum spacing as shown in figure 5-6. If additional support of the polyethylene blanket is necessary, use number 16 gauge wire spaced on 30 inch centers. Tighten the wire with turnbuckles to obtain the desired tension. Tape the ends of the wire to avoid puncturing the blanket and secure the wire by twisting it around the horizontal pipe members.

(i) Dehumidifier duct support panel. It may be necessary to construct and install a support panel for the air duct piping to and from the dehumidification equipment as specified by the procuring agency. The panel should be constructed of three-fourths inch plywood and secured flush with the outside of the base plate in a location specified by the procuring agency. The holes in the duct support panel shall not be over one-eighth inch larger than the air duct piping.

(j) Installation of polyethylene cover. The plastic cover shall be removed from its shipping container and laid across the framework in such a location so that the cover can be unfolded into its final position. The cover shall be centered on the framework so that the entrances will be in the correct position. Extreme care should be taken not to rupture the plastic cover. The cover shall be fitted over the framework and along the base plate with excess material extending out on the floor. The zipper for the equipment opening must coincide with the ends of the removable section of the base plate. The material at the corners shall be folded back inside in a position where it will not interfere with the zipper openings. The cover shall be secured and sealed to the outer edge of the base plate with 1 by 2 inches wood nailing strips fastened with 8 penny double headed nails on 12-inch centers as shown in figure 5-5. The nailing strip at the removable base section of the equipment entrance shall be secured with single headed nails so that one half of each zipper is attached to the permanent section of the base plate and the other half to the removable section.

(k) Repairs. The contractor erecting the hutment shall be responsible for the repair of all ruptures, punctures, or tears which result from applying the polyethylene cover over the pipe framework. Repairs shall be made by heat sealing.

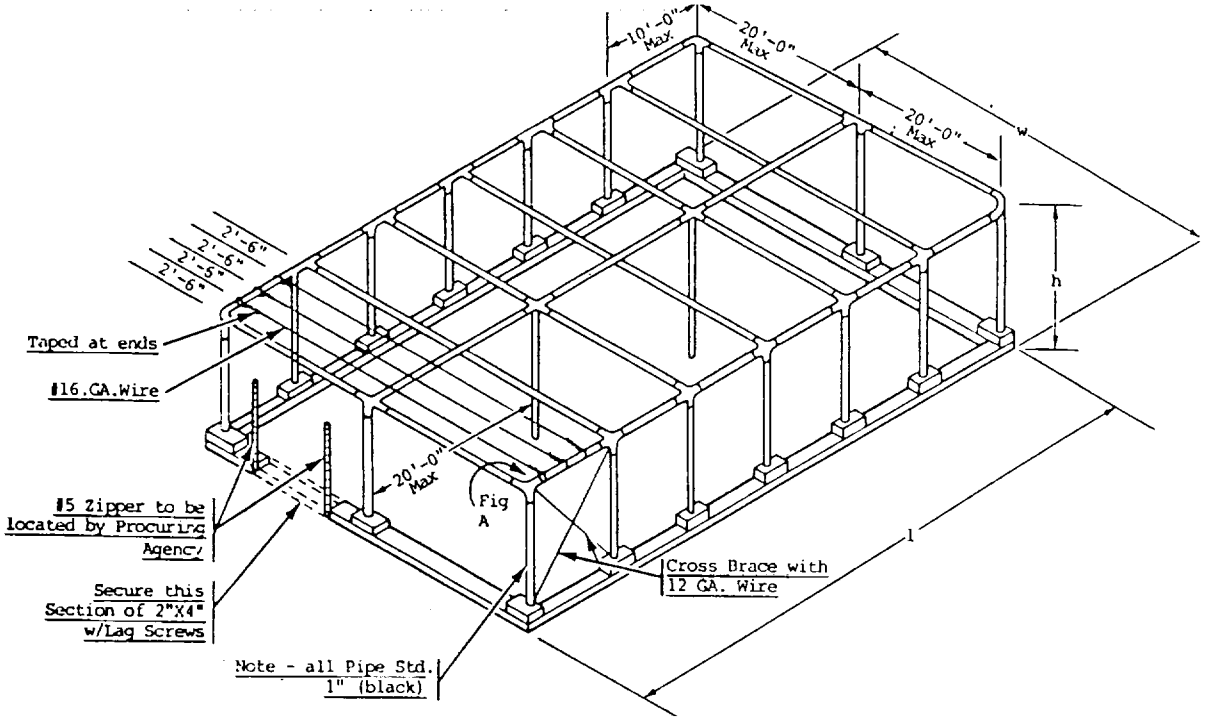


Figure 5-6. Hutment Framework (Width over 20 Feet)

(l) Dehumidification system. The dehumidification system shall include the proper size dehumidification unit, humidistat control, hygrothermograph, duct work, and line connections. It shall conform to MIL-D-28594.

(m) Duct work. After the dehumidification equipment has been installed, the contractor shall furnish and install all necessary galvanized sheet metal ducts. Ducts shall also be located so as not to short circuit dehumidified air with return air or interfere with moving equipment inside the hutment. The duct work shall be appropriately sealed so that all joints where leakage may occur is eliminated.

b. Indoor metal hutments.

(1) This type of structure serves the same purpose as indoor plastic film dehumidified structures. However, they are more expensive and are subject to more air changes per day (fig 5-3).

(2) These structures are made from lightweight galvanized sheets fabricated to structural members. However, some are corrugated quonset-type and are self-supporting. There are a number of private companies including some of the steel manufacturing companies that sell indoor-type metal hutments. Each manufacturer has his/her own particular design.

(3) Indoor metal hutments will last indefinitely because they are not exposed to outside weather conditions. Some of their advantages over plastic film hutments are:

(a) Walk-in type door.

(b) Removable roof sections for egress and ingress of heavy equipment with the use of overhead cranes.

(c) Impervious to tearing.

(d) Potential for reutilization.

Section III. HEATED STORAGE

5-9. General

a. Heated Storage. This method of control is adaptable to most manufacturing buildings and warehouses where an adequate heating system is already installed. A 20° F (11.1° C) rise in temperature doubles the capacity of the storage air to hold water vapor. For example, if the temperature in a storage enclosure is 60° F (11.1° C) and the relative humidity is 90 percent, by heating the storage atmosphere to 80° F (26.7° C), the relative humidity would be lowered to 45 percent. This type of control is used to maintain a maximum of 50 percent relative humidity in the storage area to prevent moisture vapor from condensing on the surfaces of production equipment. This may be accomplished by automatically controlling the heating system with a humidistat connected in parallel with an adjustable room thermostat. The humidistat and the thermostat should be installed approximately 5 feet above the floor level to avoid temperature variations. The humidistat will be set to activate the heating system at a temperature 2° F below maximum dew point temperature, which can be obtained at the local library or weather service. As long as the humidity is 50 percent or more, the heating system will be activated by the humidistat, but when the humidity is below 50 percent and the temperature drops to 2° F below the maximum dew point temperature, the thermostat will close and activate the heating system.

b. The use of heat for control of relative humidity may not be economically feasible for those facilities for which the cost of comfort heating is excessive. Buildings need not be vapor sealed for effective heat control; however, reasonable efforts should be made to prevent unnecessary heat loss.

5-10. Geographical Locations

a. There are some geographic areas in the United States where IPE is unlikely to corrode either from high humidity or condensation during certain months of the year. for example, in Phoenix, Arizona, heat would be required January and February only.

b. For those installations where heat has been discontinued during the temperate seasons, ventilation may be accomplished as follows:

(1) On bright, sunny days when the barometric pressure is holding steady, doors and windows may be opened.

(2) When the barometric pressure is falling rapidly, or evidence of a weather front (cloudy or stormy weather conditions) is moving in, the storage buildings should be closed tightly.

(3) Under all conditions, the buildings should be closed 3 hours before sundown and never opened for ventilation before 0900.

c. There are some geographic areas in the United States where condensation is unlikely to occur during certain months of the year. During this time, the humidistat for controlling the environment may be shut off. The fuel required to protect equipment from condensation can be saved that month. For example, in Birmingham, Alabama, the environmental system would be controlled by the humidistat only during the months of July, August, and September, while in Hartford, Connecticut, the humidistat would have to be left on throughout the year.

NOTE

WHEN MOVING IPE FROM ONE CLIMATE TO ANOTHER, THE UNITED STATES WEATHER BUREAU SHOULD BE CONSULTED FOR THE HUMIDITY AND CONDENSATION INDEXES FOR THAT PARTICULAR AREA.

Section IV. STORAGE OF INDUSTRIAL PLANT EQUIPMENT IN NONCONTROLLED HUMIDITY STORAGE ENVIRONMENTS

5-11. General

a. Noncontrolled humidity storage includes all storage building/facility areas that are not equipped to maintain a controlled relative humidity level. Those areas having the most adverse effects on unprotected equipment are unheated buildings, sheds, shelters, and open (outdoor) storage areas. The term "noncontrolled storage" referenced in paragraph 5-5b is used in its generic form in this paragraph.

b. Noncontrolled humidity storage. Noncontrolled humidity storage areas include warehouses and open areas which have been paved to permit effective material handling equipment operation and open areas which have not been improved but can be used for storage purposes. Equipment not stored in enclosed buildings shall be protected by tarps, cocoons, or other appropriate means.

c. Storage areas. IPE may be stored in adjacent storage areas, in-place areas on-site, or at storage-maintenance facilities.

d. Adjacent storage. When equipment is to be placed in adjacent storage, preparation should be in accordance with the level specified.

e. Storage-in-place. When IPE is to be stored-in-place, preparations shall be made immediately following or during shutdown. Equipment shall remain in the original operating position connected to power. Preparation shall be in accordance with the level specified. Exercising of equipment may be specified by the cognizant activity to maintain a high level of readiness.

5-12. Protection From Environmental Hazards

a. IPE stored under these environmental conditions can only be protected to the extent that a barrier between the atmosphere and the surface of the equipment can be applied.

b. The barrier shall completely encompass the equipment in such a manner that the equipment is fully protected from water, dirt, and other harmful foreign matter. This may be accomplished by shrouding the equipment with flexible waterproof barrier material conforming to PPP-B- 1055, class E or heavier, or plastic strip, thin gauge polyolefin, conforming to L-P-378, class i, type II.

(1) All covers shall be of sufficient strength to provide adequate protection throughout the storage period and shall be secured in a manner to ensure that such protection is achieved.

(2) Covers made from waterproof paper shall not be used.

(3) All sharp corners and projections shall be padded or cushioned before shrouding.

(4) Shrouds shall be draped in such a manner as to completely cover the item. They shall be arranged to avoid possible formation of water pockets. It is important that shrouds be secured to prevent damage or loosening during storms. Shrouds should extend to approximately 6 inches (152 mm) from the base of the equipment to permit free circulation of air over and around the equipment to prevent any sweating of the equipment.

c. When it is necessary to store IPE in open storage, it must be accepted that the effects of the atmosphere will deteriorate those components of equipment which, because of their nature, cannot be provided with a barrier.

d. Rubber, electrical, and electronic systems and their components are examples of items which are particularly vulnerable to the effects of noncontrolled atmosphere.

5-13. Preservation Requirements

a. When it is necessary to store IPE in noncontrolled storage, the preservation requirements specified in chapter 4 shall apply.

b. The preservation specified in chapter 4 cannot be considered as an equal alternative to controlled humidity storage when a choice between the two is possible. Equipment stored in noncontrolled storage with long-term preservation also requires represervation, rehabilitation, repair, and replacement of components as the term of storage extends.

CHAPTER 6

SHIPPING AND STORAGE OF INDUSTRIAL PLANT EQUIPMENT

Section I. SHIPPING, RECEIVING, AND LOCATING INDUSTRIAL PLANT EQUIPMENT

6-1. General

a. TM 38-230-I/DSAM 4145. 2, Preservation, Packaging, and Packing of Military Supplies and Equipment, contains uniform DOD instructions/guidance pertaining to receipt, storage, issue, and stock location control of items and equipment. These methods and procedures are mandatory for military CONUS and OCONUS supply installations, depots, and storage activities.

b. Activities engaged in the movement and storage of IPE at major military supply installations will refer to TM 38-230-1 (as necessary) in addition to the guidance listed below.

6-2. Shipping

a. General. Shipping is a vital link in the chain of warehousing operations and must be efficient if the Government agency or private industrial facility is to receive supplies on time, in the quantities requested, and in good condition. Effectiveness of this function depends upon proper receiving, proper storage, handling, packing, and packaging.

b. Planning. The sound application of the principles of traffic management and good shipping practices can alleviate unnecessary problems during periods of national emergencies. At the same time, more efficient and economical transportation will be provided for the DOD. Planning a shipping operation at the storage site begins long before receipt of a shipping document. The receipt, location, and storage of supplies should be planned to expedite and simplify shipping. However, the planning for a specific movement begins upon receipt of the proper documents authorizing shipment of designated items to a specific location. Planning will include, but will not be limited to, the following considerations:

(1) Quantity of items to be shipped.

(2) Total weight and volume to be shipped.

(3) Special preparations required for shipment.

(4) Availability of personnel and equipment.

(5) Method of transportation.

(6) Date required at destination.

(7) Assembly for shipment.

c. Movement to carrier. Items designated for shipment should be moved along the quickest route from the storage area to the packing and assembly area. Usually the packing and assembly area is the location for pickup by the carrier.

d. Loading the carrier's equipment. After IPE and OPE have been carefully prepared for shipment, properly marked, documented, assembled for loading, and the carrier has arrived, loading should be accomplished as expeditiously as possible. Care must be exercised to assure that the item is properly blocked and braced in accordance with the requirements of MIL-HDBK-701. Prior to loading on the carrier's equipment, an inspection shall be made to determine that all hold-down bolts of skidded items which may have been loosened for storage have been tightened. The equipment shall be shrouded for protection in transit.

e. Transportation costs. When computing costs for layaway or plant clearance of machine tools, transportation costs must be included in the total estimated cost. The skidded weight or gross weight should be used in estimating transportation costs.

(1) Transportation costs must be added to the Packing, Crating, and Handling (PCH) costs to arrive at the total cost of preparing IPE for shipment or storage. See the cost estimating guide provided in appendix B.

(2) The rates for the anticipated mode of transportation should be verified through the Defense Military Traffic Management Command office serving the region or area in which shipment will originate.

(3) In some instances, the transportation rates for trucks are quoted on a per mile basis regardless of load. The relation of weight to skid area of IPE makes it difficult to reach the maximum load capacity of the vehicle.

(4) Due to the high susceptibility of damage from rail shipment, such as humping, side wise motion, up and down motion, lengthwise forces, start and stop motion, forward thrust, backward thrust, and other impact forces which may damage IPE, rail transportation is not recommended, and should not be used as a mode of transportation unless a waiver is granted by DGSC-SSM.

6-3. Receiving

a. Unloading. Each unloading operation requires planning and on-the-spot supervision. The physical unloading of IPE should be properly coordinated with storage personnel. The shipment should be inspected for damage that may have occurred during the transportation cycle. In general, the mechanics of unloading vary according to the type of carrier, type and weight of shipment, type of unloading facility, and materials handling equipment available.

b. Moving to storage. The movement of IPE and OPE to storage is a continuation of the unloading operation. The movement should be made by the most expeditious and economical

means available. Sound principles of warehousing shall be practiced in the storage of equipment to minimize storage costs and assure protection of the equipment.

(1) IPE and OPE prepared for layaway (long-term storage) shall be cleaned and preserved in accordance with chapter 4.

(2) IPE and OPE assigned to storage shall be stored in a condition that will facilitate shipment or reactivation in the event of replenishment/reconstitution.

(3) In order to prevent distortion of skidded equipment, all skids shall be in contact with the floor and the weight shall be evenly distributed.

(a) Hold-down bolts on wooden skids shall be loosened a minimum of one-half inch from the machine base. This step shall be eliminated by using aluminum skids, since they will not warp as wooden skids can.

(b) The threads of the bolts on both types of skids (wooden and aluminum) shall be preserved with preservative P-7 of table 2-1.

CAUTION

ALL LOOSE HOLD-DOWN BOLTS SHALL BE TIGHTENED BEFORE THE EQUIPMENT IS MOVED.

(4) Skidded, crated, or boxed equipment shall not be stored in its received condition unless the containers and skids are determined to be in satisfactory condition. Repair to skids or boxes and preservative touch-up shall be performed prior to locating IPE and OPE in the storage facility. IPE and OPE which do not meet all the preservation requirements of chapter 4 after repair or touch-up shall not be reprocessed when:

(a) The present packing will assure protection against deterioration and corrosion.

(b) Safe handling and storage are assured with the existing skid, crate, or box.

(c) The existing preservation/packing will meet the carrier's requirements when reshipment is authorized.

(5) Lifting devices, when available, shall be used to facilitate handling of IPE and OPE.

(6) All IPE and OPE having ways or other precision-aligned elements over 6 feet long (1.829 meters), horizontally, shall be maintained in a level position, by shimmying supporting members to prevent distortion of the precision elements.

(a) Leveling of IPE and OPE on wood skids shall be accomplished by placing shims either between the machine base and the skid platform or between skid runners and the floor.

(b) Leveling of IPE and OPE on aluminum skids shall be accomplished by placing shims between the skid runners and the floor.

(c) Leveling of IPE and OPE stored without skids may be accomplished by using shims between the machine base and the dunnage or between the dunnage floor. The leveling screws on the machine base (legs) may also be used.

(d) If it becomes necessary to move IPE and OPE which requires leveling, the equipment shall be releveled upon completion of the move.

(e) The degree of leveling required in storage is less precise than that required for machine operation. The degree of leveling required in storage would be comparable to that required in building or construction operations. Normally, the elimination of distortion in the skid platform will protect the skidded items. However, when wood skids are used, warp or twist in the wood members may create a requirement for shims between the skid and machine base.

(7) The warehousing of IPE and OPE requires the normal housekeeping, safety, fire protection, and locator systems. However, protection of the equipment and normal storage site operations, within economic bounds will require consideration of the following requirements common to IPE storage.

(a) Equipment shall be placed in the storage area with sufficient space between adjacent items to permit surveillance inspection and to facilitate the removal of individual items.

(b) The width and location of access aisles should be governed by the size of the equipment to be stored and the facilities available for handling.

(c) Equipment identified to a specific end item should be grouped in the storage area.

(d) Skidded components of an item of equipment should be stored adjacent to each other and to the basic item.

(e) Boxed or crated accessories, attachments, or tooling may be block-stacked separately but the locator records must indicate the -relation to the basic item of equipment and a warning tag should be attached to the basic item of equipment directing attention to the stacked items.

c. Dunnage. IPE and OPE received at storage facilities without benefit of skidding shall be elevated above the floor level by the use of dunnage or other specially built platforms. The type of storage *area* will determine to a great extent the type of platform required to provide adequate ventilation beneath the stored equipment. On well drained paved storage areas the platform shall provide a minimum clearance of 4 inches (102 mm) between the equipment and pavement. On well drained gravel or similarly surfaced areas, the platform shall be increased to provide a minimum clearance of 8 inches (203 mm).

d. Shrouding. Where protection is required to prevent dust from settling on the preserved

surfaces of stored items, the items shall be shrouded. Shrouds may be fabricated from flexible, waterproof barrier material conforming to PPP-B-1055, class E or heavier, or plastic sheet and strip, thin gauge polyethylene conforming to L-P-378, class I, type II, as outlined in chapter 4. The shroud should be constructed in such a fashion that it extends to a level 6 inches (102 mm to 152 mm) from the top of the skid or dunnage. This will allow free circulation of air over and around the stored equipment. To prevent an excessive build up of condensation within shrouds, it is recommended that vertical surfaces of the shrouds, have 3 inch (76 mm) diameter (tip to tip) half moon slits to allow breathing. The spacing of the splits should be one slit to each 3 foot (914 mm) width of the vertical surface of shroud. They should be located on the vertical surface in a horizontal plane, one-third of the distance (top to bottom) from the top of the shroud. All slits shall have the tips pointing up to prevent excessive moisture from entering the shroud.

e. Identification. Identification markings such as bar codes, labels, tags, and marking boards shall be affixed to the exterior of the shrouded item in the most conspicuous location. The identification markings shall contain all the necessary information to identify the stored equipment without disrupting the shroud.

6-4. Locating

a. General. The accelerated selection of IPE for shipment, efficient handling of receipts, and maximum utilization of storage space are contingent upon the effective use of an adequate locator system. The locator system should contain only as much information as is necessary to locate the stored item with a minimum of time and effort.

b. System. A good locator system will contain the current location for each stored item of equipment.

(1) The record card should contain, as a minimum, the identification number (ID), plant equipment code (PEC), nomenclature, plant equipment package (PEP) number, if applicable and location of the stored item, plus any additional information deemed necessary for administration by the storage activities.

(2) All changes in the location of individual equipment shall be recorded immediately upon completion of the move.

(3) A locator system shall be maintained by the Storage/Maintenance activities.

Section II. MAINTENANCE AND INSPECTION

6-5. Maintenance

a. General. The surveillance and maintenance of IPE and OPE in storage apply not only to stored equipment but also to the equipment used to maintain the specified storage conditions. Maintenance of equipment used to control the humidity in a storage installation is important in the proper performance of such equipment and materially affects the stored items. Theoretically, the material in dehumidified or other controlled storage requires little or no maintenance as long

as the dehumidification equipment is operating satisfactorily and the specified humidity level is being maintained. The maintenance requirements for IPE and OPE in noncontrolled storage are increased over those for controlled storage and are largely dependent on the type of equipment and the storage conditions. The purpose of the instructions contained herein is to provide technical and economic information for a better understanding of these requirements, and a basis for increasing the effectiveness and efficiency of surveillance on maintenance activities.

b. Surveillance. Surveillance of inactive IPE and OPE shall be accomplished in order to ascertain that the equipment is being maintained at the level of preservation which will prevent corrosion and/or other deterioration. Surveillance inspections shall direct the extent of maintenance activities. Frequency of surveillance inspections and maintenance will vary with climatic conditions, type of preservatives used, and type of storage provided for the equipment. When corrosion, deterioration, preservative breakdown, or drainage is found during surveillance inspections, corrective action shall immediately be accomplished. Future surveillance and maintenance activities will be increased as deemed necessary for the protection of the equipment.

c. Maintenance. Maintenance is the action required to sustain stored accessories in a state of replenishment/reconstitution readiness. Maintenance may consist of, but is not limited to:

(1) Surveillance.

(2) Removal of rust or corrosion.

(3) Correction of deficiencies and/or deterioration other than (2) above.

(4) Repair and adjustment of dehumidification equipment including replacement and/or addition of desiccant.

(5) Calibration of control equipment, such as hygrothermographs, humidistats, thermostats, and other control equipment.

(6) Repair or replacement of damaged shrouds.

(7) Represervation, where materials have been disturbed or removed to accomplish operations cited in (2) and (3) above.

(8) Inspection of wooden skids for any evidence of warping.

6-6. Inspection

a. General. Storage of IPE and OPE requires some type of inspection so that proper protection is maintained and deficiencies are corrected. Periodic inspections shall be performed often enough to recognize early signs of trouble before extensive or irreparable damage has been done. Complete inspection at frequent intervals would prevent serious deterioration, but it would also entail unnecessary costs. A practical plan for inspecting equipment in storage is presented in

this section. The plan was developed within the limitations of available historical data for current types of storage. It is applicable to both DOD and contractor activities and is intended only for major items of precision equipment.

b. Structure of the inspection plan. A system of inspection must take into account the complexity of different types of storage. When devising a comprehensive sampling and inspection procedure, the major factors that must be considered include:

(1) The general, climatic, and atmospheric conditions of the storage location.

(2) The degree of protection afforded by different storage techniques and their combinations such as preservative oils and/or exercising, 50 percent or less relative humidity, heated storage, and nonhumidity controlled storage.

(3) The minimum limits of protection.

(4) The number of machine tools in the installation.

(5) The frequency and inclusiveness of inspection procedures.

(6) The type of corrosion deterioration involved such as atmospheric, galvanic, or chemical.

(7) The susceptibility of different types of machine tools to corrosion or deterioration.

(8) The relative value and importance of various types of machine tools.

(9) The thoroughness of cleaning and preservation activities.

(10) The length of time between intermittent preservative treatments.

c. Historical data. Because historical data on these factors is lacking, a simplified approach to the problem of inspection has been developed. While it first appears over-simplified, the approach seems justified by existing circumstances. First of all, only two conditions which judge the quality of preservation shall be recognized, namely corroded and unaffected. A machine tool shall be called corroded when there is any evidence of rust, exclusive of discoloration on a machined or precision surface. Although contingent conditions such as moisture, condensation, tom shrouds, should be noted, recorded, and corrected, they should not be construed as evidence of Corrosion. The corrosion of nonprecision surfaces shall also be noted and the cause determined and corrected, even though such a condition shall not be used as a basis for rejecting a storage facility. The plan applies only to major items of IPE and OPE. Minor items such as tooling, are less subject to corrosion; therefore, their condition is not an acceptable criteria for judging the characteristics of a storage environment. Since available inspection reports do not usually differentiate between the types of machine tools, there is no factual basis for assuming a difference in susceptibility to corrosion between items in storage. It has been assumed that it is

equally important that each machine tool, regardless of type or size, be kept free of deterioration. While this assumption is justified on the basis that any defective unit can disrupt performance of a production line, particularly in an emergency situation, it does not account for the possibility that a small, low-cost machine tool is more readily replaced than a large complex item. It has been assumed that the number of machine tools in a storage installation will vary from a single unit to several thousand items.

d. Inspection in storage. Inspection of IPE and OPE in storage is required and the inspection phases and frequency shall be determined by the storage environment, such as CH, heated, or nonhumidity controlled storage.

e. Inspection phases. The inspection phases include visual, periodic, and detailed inspections for each storage environment. Visual inspection does involve actions on specific equipment. Periodic and detailed inspections involve actions on equipment which must be selected. The number of items requiring these inspections are based on a percentage of the total number of items in storage at the site. A similar procedure is used for individual hutments or buildings. The various storage-inspection combinations are as follows:

(1) Controlled Humidity (CH) visual inspection. Visual inspection shall be performed on all items of IPE and OPE in storage on a 100 percent per year basis. A suggested procedure is the inspection of several items of IPE and OPE each week when the hygrothermographs are inspected for proper operation. All inspections require the viewing of external preserved surfaces. This requires lifting of opaque shrouds or dust covers and the removal of tops or covers not secured to individual boxes or containers. No deviation from a 100 percent per year visual inspection is required unless:

(a) Control of humidity is lost for a period in excess of 72 hours and the hygrothermograph indicates a relative humidity above 50 percent, or

(b) Control of humidity is lost and the temperature falls through the dew point giving rise to condensation on the equipment.

(c) If either condition should occur, 100 percent visual inspection shall be conducted upon the return of CH within the affected areas.

(d) Corrective actions shall be taken immediately when unsatisfactory conditions are found.

(2) CH-periodic inspection. Periodic inspection includes the inspection of external preserved and painted surfaces and internal mechanisms such as gear boxes, bearings, and sumps. Periodic inspections are not required on items of IPE that have been in storage 3 years or less. If a visual inspection indicates the formation of incipient deterioration or discoloration of the preservative in excess of 10 percent of all items, periodic inspection shall be performed on all affected items.

(a) The number of items of IPE and OPE to be inspected per year shall be such size to include a total inventory over a 5 year period (assume static condition for each year's sample).

(b) Items of IPE and OPE shall be scheduled for periodic inspections every 5 years. The inspection shall include all types of items not previously inspected within the last 5 years.

(c) Preservatives shall be removed to the extent necessary to determine if rust or corrosion is present on the items or parts thereof. This includes boxes or containerized items.

(d) If inspection reveals the condition of the item and its accessories/parts are satisfactory, preservatives of the same type removed shall be applied to the bare metal areas immediately after the inspection has been completed.

(e) In the event the periodic inspection indicates the condition of the item of IPE, OPE, attachments, or accessories is unsatisfactory, a detailed inspection of that item shall be performed immediately.

(f) If there is evidence of continuing deterioration, a special study shall be made to determine the corrective action to be taken to eliminate unsatisfactory conditions. The special study will include determining corrective action in regard to conditions causing the discrepancy, determining the extent of damage and the corrective action required, and initiating the corrective action.

(3) CH-detailed inspection. There is no requirement for detailed inspection of items of IPE and OPE in storage during the first 10 years unless conditions outlined in (2) above exist.

(a) After 10 years of CH storage, detailed inspections shall be performed annually to include 5 percent of the total inventory among all types of items. If results ,u-c unsatisfactory, a special study shall be made to correct unsatisfactory conditions.

(b) Detailed inspection includes the removal of all preservative materials, oils, and greases from each selected item to definitely determine if there is any evidence of rust or corrosion. All kinds of contamination shall be removed.

(c) Immediately after the inspection has been completed, all items of IPE and their components, attachments, and accessories shall be preserved for storage with the same level of protection that was applied prior to the inspection.

(d) If sufficient reason exists to change the level of protection, all records shall be adjusted accordingly.

(4) Heated storage-visual inspection. Visual inspection shall be performed on all items of IPE and OPE in storage on a 100 percent per quarter basis. A suggested procedure is the inspection of several items of IPE each week when the heating system is inspected for proper operation.

(a) All inspections require the viewing of external preserved surfaces. This requires lifting of opaque shrouds or dust covers and the removal of tops or covers not secured to individual boxes or containers.

(b) No deviation from a 100 percent per quarter visual inspection is required unless control of heat is lost for a period in excess of 72 hours, or control of heat is lost and the temperature falls through the dew point giving rise to condensation on the equipment.

(c) If this condition should occur, 100 percent visual inspection shall be conducted upon the return of heat within the affected areas.

(d) Corrective actions shall be taken immediately when unsatisfactory conditions are found.

(5) Heated storage-periodic inspection. Periodic inspections are not required on items of IPE that have been in storage I year or less. Periodic inspections shall be scheduled following the first year of storage. If a visual inspection indicates the formation of incipient deterioration of the preservative in excess of 10 percent of all items, a periodic inspection shall be performed on all affected items.

(a) The number of items to be inspected per year shall be of such size to include a total inventory over a 5 year period (assume static condition for each year's sample).

(b) Items of IPE and OPE shall be scheduled for periodic inspection every 5 years. The inspection shall include all types of items not previously inspected within the last 5 years.

(c) The inspection procedures to be followed for heated storage-periodic inspection are the same as those outlined in 6-6e(2)(c) through (t) above.

(6) Heated storage-detailed inspection, There is no requirement for detailed inspection of items of WPE and OPE in storage during the first 5 years.

(a) If it is found during visual inspection, that there is a formation of incipient deterioration of the IPE or OPE, or discoloration of the preservative in excess of 10 percent of all items, a detailed inspection shall be performed on all affected items. If less than 10 percent of the items are affected, corrective actions shall be taken immediately to eliminate the unsatisfactory conditions.

(b) The inspection procedures to be followed for heated storage-detailed inspection are the same as those outlined in 6-6e(3)(b) through (d).

(7) Noncontrolled humidity storage-visual inspection. Visual inspection shall be performed on all items of IPE and OPE in storage on a 100 percent per month basis.

(a) A suggested procedure is to inspect a group of items each week and by the end of the month all items will have been inspected.

(b) All inspections require the viewing of external preserved surfaces. This requires lifting of opaque shrouds or dust covers and the removal of tops or covers not secured to individual boxes or containers.

(c) Deviation from a 100 percent per month visual inspection is not permitted.

(d) If visual inspection indicates the formation of deterioration of the preservative in excess of 10 percent of all items, a periodic inspection shall be performed on all affected items. Corrective actions shall be taken immediately when unsatisfactory conditions are found.

(8) Noncontrolled humidity storage-periodic inspection. No periodic inspections are required on items of IPE that have been in storage 6 months or less. Periodic inspections of IPE shall be scheduled for the seventh month of storage.

(a) The number of items of IPE and OPE to be inspected per year shall be of such size to include a total inventory over a 3 year period (assume static condition for each year's sample).

(b) Items of IPE and OPE shall be scheduled for periodic inspections every 3 years. The inspection shall include all types of items not previously inspected within the last 3 years.

(c) The inspection procedures to be followed for noncontrolled humidity storage-periodic inspection are the same as those outlined in 6-6e(2)(c) through (f) above.

(9) Noncontrolled humidity storage-detailed inspection. There is no requirement for detailed inspection of items of IPE and OPE in storage during the first 3 years unless there is evidence of deterioration of the preservative and/or equipment.

(a) After 3 years of noncontrolled humidity storage, detailed inspections shall be performed annually to include 10 percent of the total inventory among all types of items. If results are unsatisfactory, a special study shall be made to correct unsatisfactory conditions.

(b) The inspection procedures to be followed for nonhumidity storage-detailed inspection are the same as those outlined in 6-6e(3)(b) through (d).

6-7. Recording of Inspection Results

a. The results of each inspection are important since they can be used to determine the influence of such factors as geographical location, type of storage, machine design, size of installation, type of housing, or the quality of preservation. This type of information is needed to effect future economies in storage techniques and to formulate a concise and specific sampling plan.

b. A record of the results is also important for charting the progress of sampling and inspection activities. It is essential that inspection results are carefully recorded and that the data and terminology are standardized as much as possible.

c. Types of data which should be recorded are shown in figures 6-1 and 6-2. Figure 6-1 illustrates the type of data needed to judge the quality of preservation and assess the effect of the various factors mentioned above. One copy of this data shall be retained at the storage installation or the contractor's office. The results which are recorded shall be summarized similar to the example in figure 6-2. The summarized data provide a quick reference for reviewing the progress. Inspection activities provide a means of detecting any gradual deterioration in the corrosion prevention characteristics of the storage environment.

DATE OF INSPECTION:_____
NAME OF FACILITY:_____
LOCATION: CITY_____ STATE_____
TOTAL NUMBER OF MAJOR ITEMS:_____
COMPLETION DATE OF LAYAWAY:_____
SUMMARY OF PREVIOUS INSPECTION: DATE_____
NUMBER OF ITEMS INSPECTED _____ ACCEPTED _____REJECTED_____
HOUSEKEEPING IN STORAGE AREA: GOOD _____ FAIR_____ POOR_____

TYPE OF STORAGE:
DEHUMIDIFIED: _____
OF HRS RH WAS ABOVE 40% DURING PREVIOUS WEEK (FROM HYGROTHERMOGRAPH)
_____HEATED:_____
OF HRS RH WAS ABOVE 50% DURING PREVIOUS WEEK (FROM HYGROTHERMOGRAPH)
_____
NONCONTROLLED ___ EXERCISING ____FREQUENCY_____TYPE DUST SHIELD_____
NONE _____ OTHER_____ SPECIFY TYPE _____

SAMPLE:
LOT SIZE 1-10_____ 11-100_____ 10-50_____ 501-1,000 _____ 1,001-2,000 _____
SEVERITY SCHEDULE: MAXIMUM_____ MEDIUM_____ MINIMUM_____
NUMBER OF ITEMS INSPECTED:_____
PROPERTY OR SERIAL NUMBER OF ITEMS INSPECTED:_____

DEFECTIVE ITEMS:

PROPERTY NUMBER	OCATION DEFECT	DESCRIPTION OF DEFECT

EVIDENCE OF SWEATING ON MACHINES: YES _____ NO _____
EVIDENCE OF WATER ON FLOOR: YES _____ NO _____
ORIGIN OF WATER: ROOF _____ OTHER_____

CONCLUSIONS:
FACILITY ACCEPTED_____ FACILITY REJECTED _____
IF REJECTED COMPLETE THE FOLLOWING:
TOTAL NUMBER OF DEFECTIVE ITEMS IN FACILITY_____
PROPERTY NUMBER OF DEFECTIVE ITEMS_____
GENERAL DESCRIPTION OF EXTENT AND DISTRIBUTION OF DETERIORATION:
_____
_____
COMPLETE DATE OF REHABILITATION:_____
REMARKS:

SIGNED _____
INSPECTOR'S NAME

Figure 6-1. Sample format for inspection.

Name of facility:_____
City:_____State_____
Total number of major items:_____
Date the layaway was completed:_____
Type of storage:_____

Date of last inspection	Hrs RH% was above maximum previous week	Lot size for inspection	Severity schedule	Cumulative sample size	Number corroded items	Accepted or rejected	Inspector

Figure 6-2. Sample Format for Summary of Inspection

CHAPTER 7

INSPECTION AND TESTING OF INDUSTRIAL PLANT EQUIPMENT

SECTION I. GENERAL REQUIREMENTS

7-1. Purpose

a. General. This chapter sets forth the basic methods and procedures to be used in the inspection and testing of IPE to determine serviceability.

b. Policy. The requirements for inspection and testing of IPE are set forth in DLAM 4215. 2, Operations Manual for Storage/Maintenance of Defense Industrial Plant Equipment.

(1) The instructions contained in the above document establish the categories of equipment which shall or shall not be analytically tested.

(2) Inspection and operational testing of IPE shall be accomplished in accordance with the applicable Maintenance Instruction (MI) or Technical Maintenance Standard (TMS). When TMSs are not available for the equipment being inspected or tested, the appropriate technical order, technical manual, manufacturer's manual, maintenance instructions, specification, or technical engineering and quality standards shall be used.

(3) The results of the inspection and testing shall be recorded on the DGSC Form 900-1 000 series, Test Pattern for Analytical Inspection of Metalworking Machinery, or other documents that are specified on the applicable TMS.

NOTE

DGSC FORM 900-1000 SERIESSERIES IS AVAILABI,E FROM DGSC, UPON REQUEST.

(4) In situations where equipment for which DGSC Form 900-1000 Series has been published, but due to design or construction of the equipment, it could not have originally met the corresponding tolerances of the test pattern, it shall be tested using the manufacturer's original tolerances, after authorization is given by DGSC.

(5) Inspection and testing shall be accomplished with measuring and test equipment, which have been calibrated by standards and accuracy which are traceable to the National Bureau of Standards.

c. Definitions. The following terms, as defined are used throughout this chapter.

(1) Analytical inspection. The analysis by examination and testing to determine the operation and tolerance characteristics of a metal working machine tool as measured or compared to a specific level of performance.

(2) Inspection. The examination and testing of equipment to determine whether or not it conforms to the technical requirements set forth for the equipment.

(3) Maintenance Instruction (MI). Applicable technical document (procurement specifications, manufacturer's specifications, military services technical publications, or other published documents) with instructions that will be utilized to perform required maintenance of plant equipment.

(4) Operational/functional testing. The complete power and manual operation of all systems to determine correct functioning of all mechanical and/or electrical controls and devices.

(5) Technical Maintenance Standard (TMS). A standard which applies to a format used to specify the definite requirements of technical data that will be utilized in the performance of required maintenance of plant equipment.

(6) Testing. An element of inspection which denotes the determination, by technical means, of the properties or elements of plant equipment, or components thereof, and involves the application of established scientific principles and procedures.

(7) Visual inspection. Visual inspection is accomplished while observing the operation of the equipment performing its normal operations.

SECTION II. INSPECTION AND TESTING

7-2. Inspection Testing Procedures

a. Minimum requirements for inspection and testing. Inspection and testing of machine tools shall be accomplished in two ways by visual and analytical inspection.

(1) Visual inspection. In the performance of visual inspection, past performance, visual and audible evidence of wear, as well as the degree of maintenance employed shall be the factors used in determining the condition code of the machine. The ability of the machine to repeat or consistently produce items of uniform size to established tolerances (roundness, concentricity, parallelism, or flatness) may be observed. The results of the visual inspection shall be recorded and verified on documents conforming to the requirements specified on the applicable TMS.

(a) Inspection shall be performed before production stops.

(b) The machine condition should be discussed with the operator and maintenance personnel to determine any machine peculiarities.

(c) Minimum cleaning and disassembly, including the removal of inspection covers to provide access to the various mechanisms, wiring, and components, shall be accomplished.

(d) A thorough visual inspection shall be conducted of all accessible interior and exterior components to detect missing, excessively worn, cracked, broken, or improperly installed components or extremely rusty conditions.

(2) Operational/functional testing. Operational/functional testing shall be accomplished after completion of visual inspection and shall include, but is not limited to, the following operations:

(a) Determination of special equipment, environmental conditions, and procedures required to conduct operational/functional testing.

(b) Lubrication and servicing of components and systems, as required to assure freedom of movement and proper functioning.

(c) Manual operation of all applicable components to detect any discrepancies that could affect power operation.

(d) Assembly and minor adjustment of all necessary associated components, attachments, accessories, and auxiliary equipment.

(e) Powered operation for a sufficient time to assure that equipment reaches the normal operating temperature.

(f) Complete power and manual operation of all systems to determine correct functioning of all mechanical and/or electric controls and devices.

(g) All observed defects and malfunctions shall be recorded and verified on documents conforming to the requirements specified on the applicable TMS.

(3) Analytical inspection. Analytical inspection shall only be accomplished after completion of visual and functional testing. Analytical inspection tolerances shall conform to those specified on the appropriate DGSC Form Test Pattern for analytical inspection of metalworking machinery. Analytical inspection shall be performed with the inspection aids which have been identified, inspected, and calibrated in accordance with requirements of MIL-STD-120 and as specified on the applicable test pattern. Analytical inspection shall also include, but is not limited to, the following:

(a) Cleaning of machine ways, tables, and other working surfaces to provide for accurate measurements.

(b) Assembly and adjustment of all necessary associated components, attachments, accessories, and auxiliary equipment as necessary.

(c) Checking of all flat bearing surfaces for less than 0. 0015 inch (0. 04mm) feeler gage entry.

(d) Applicable locking clamps or gibs shall be secured during test.

(c) Internal spindle tapers, when applicable, shall be checked and repaired as necessary to attain an approximate 85 percent bearing contact, evenly distributed along the taper.

b. One copy of the document used to record the results of the analytical inspection shall be retained by the maintenance activity in the job order folder and one copy shall be placed in the equipment's historical record folder.

7-3. Analytical Test Patterns and Technical Maintenance Standards

a. Analytical test patterns (DGSC Form 900-1000 Series). Analytical test patterns differ from the TMSs.

(1) Analytical test patterns are used to determine the allowable tolerances, operational capability, and/or the extent of maintenance required for machine serviceability. Examples of a test pattern for analytical inspection of metalworking machinery are shown in figures 7-1 and 7-2.

TEST PATTERN FOR ANALYTICAL INSPECTION OF METAL WORKING MACHINERY

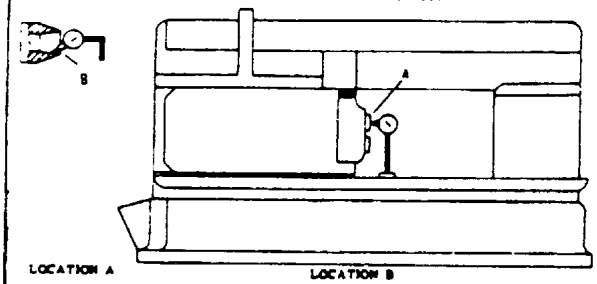
SCREW MACHINE, BAR, HORIZONTAL, MULTI-SPINDLE

ALIGNMENT TESTS

BASIC REQUIREMENT ON MAJORITY OF SCREW MACHINES WHILE CONDUCTING ALIGNMENT TESTS

1. MACHINES MUST BE LEVELED.
2. ALL LOCKING CLAMPS OR GIBS MUST BE SECURED DURING TESTS.
3. CONTACTING FLAT BEARING SURFACES MUST NOT ALLOW .0015 FEELER GAGE ENTRY.

FIG. 1 - SPINDLE END PLAY AND RUN-OUT



LOCATION A

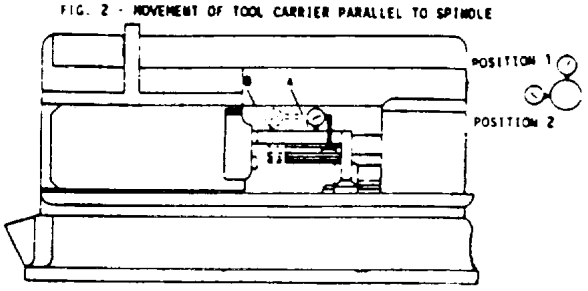
1. MOUNT INDICATOR ON TABLE WITH CONTACT POINT ON FACE OF SPINDLE, THRUST SPINDLE INTO SPINDLE HEAD, AND SET DIAL TO ZERO
2. THRUST SPINDLE OUTWARD FROM SPINDLE HEAD AND RECORD INDICATOR READING.

LOCATION B

1. REMOVE COLLET FROM SPINDLE NOSE AND REMOVE ALL NICKS, BURRS, AND FOREIGN MATERIAL FROM INTERNAL SURFACE OF SPINDLE.
2. PLACE INDICATOR CONTACT POINT ON I.D. OF SPINDLE AND SET DIAL TO ZERO.
3. ROTATE SPINDLE 360 DEGREES AND RECORD MAXIMUM DEVIATION.

NOTE: REPEAT ALL ABOVE TESTS FOR REMAINING SPINDLES

FIG. 2 - MOVEMENT OF TOOL CARRIER PARALLEL TO SPINDLE



1. MOVE TOOL CARRIER TO EXTREME OUTWARD END OF ITS TRAVEL, MOUNT TEST ARBOR ON SPINDLE NOSE, AND ADJUST TO ZERO RUN-OUT AT FREE END AND APPROXIMATELY 1" FROM SPINDLE NOSE.
2. MOUNT INDICATOR ON TOOL CARRIER WITH CONTACT POINT AGAINST VERTICAL CENTER-LINE OF TEST ARBOR NEAR ITS FREE END (LOCATION A), AND SET DIAL TO ZERO.
3. MOVE TOOL CARRIER INWARD UNTIL INDICATOR IS APPROXIMATELY 1" FROM SPINDLE NOSE AND RECORD INDICATOR READING.
4. REPEAT OPERATIONS 1, 2, AND 3 WITH INDICATOR CONTACT POINT ON HORIZONTAL CENTERLINE OF TEST ARBOR.

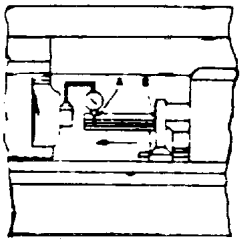
RECORD OF TEST POSITION

A	A	A	A	MAX DEV B	MAX DEV B	MAX DEV B	MAX DEV B
A	A	A	A	MAX DEV B	MAX DEV B	MAX DEV B	MAX DEV B

RECORD OF TEST POSITION (TRAVERSE DISTANCE MUST BE NOTED)

POSITION 1	POSITION 2

FIG. 3 - TOOL CARRIER CLAMPING SURFACE PARALLEL TO SPINDLE

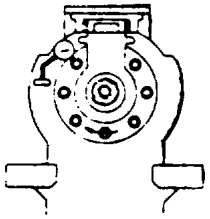


1. REMOVE ALL NICKS, BURRS, AND FOREIGN MATERIAL FROM TOOL CLAMPING SURFACES OF TOOL CARRIER AND MOVE CARRIER TO EXTREME OUTWARD POSITION.
2. MOUNT INDICATOR ON STATIONARY PART OF MACHINE WITH CONTACT POINT ON TOOL CARRIER CLAMPING SURFACE LOCATION A, AND SET DIAL TO ZERO.
3. ADVANCE TOOL CARRIER TO ITS EXTREME INWARD POSITION (LOCATION B) AND RECORD MAXIMUM DEVIATION.
4. REPEAT OPERATIONS 1, 2, AND 3 FOR THE OTHER TOOL CLAMPING SURFACES OF TOOL CARRIER.

RECORD OF TEST POSITION (TRAVERSE DISTANCE MUST BE NOTED)

MAX DEV	MAX DEV	MAX DEV	MAX DEV
MAX DEV	MAX DEV	MAX DEV	MAX DEV

FIG. 4 - ROTARY PATH OF CARRIERS CONCENTRIC WITH SPINDLE CARRIER

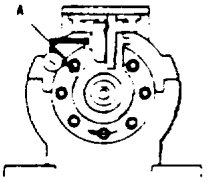


1. MOUNT INDICATOR ON STATIONARY PART OF MACHINE SO THAT CONTACT POINT IS AGAINST O.D. OF SPINDLE NOSE ON CENTERLINE WHICH PASSES THROUGH CENTER OF SPINDLE CARRIER (LOCATION A), AND SET DIAL TO ZERO.
2. ROTATE SPINDLE CARRIER 360 DEGREES SO THAT INDICATOR CONTACT POINT TOUCHES EACH REMAINING SPINDLE O.D. AND RECORD MAXIMUM DEVIATION.

RECORD OF TEST POSITION

MAX DEV			
MAX DEV			

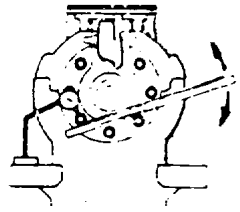
FIG. 5 - RELATIVE ALIGNMENT OF SPINDLES IN INDEXED POSITIONS



1. WITH TEST BARS IN SPINDLES MOUNT INDICATOR ON VERTICAL TOOL SLIDE AND PLACE CONTACT POINT AGAINST HORIZONTAL CENTERING OF TEST BAR IN UPPER SPINDLE (LOCATION A), AND SET DIAL TO ZERO.
2. RETRACT TOOL SLIDE UNTIL INDICATOR CLEARS TEST BAR AND INDEX SPINDLE CARRIER ONE POSITION.
3. ADVANCE TOOL SLIDE UNTIL INDICATOR CONTACT POINT IS ON HORIZONTAL CENTERLINE OF TEST BAR AND RECORD INDICATOR READING
4. REPEAT OPERATIONS 1, 2, AND 3 FOR REMAINING SPINDLES.

RECORD OF TEST POSITION

FIG. 6 - SPINDLE CARRIER FREE FROM LOST MOTION IN ITS BEARINGS AND INDEX PIN.



1. WITH TEST BARS IN SPINDLES MOUNT INDICATOR ON FRONT TOOL SLIDE WITH CONTACT POINT ON TOP CENTERLINE OF TEST BAR NEAREST TOOL SLIDE
2. PLACE PRY BAR BETWEEN TWO SPINDLES. EXERT A CLOCKWISE FORCE ON SPINDLE CARRIER AND SET DIAL TO ZERO.
3. EXERT A COUNTERCLOCKWISE FORCE ON SPINDLE CARRIER AND RECORD INDICATOR READING.
4. REPEAT OPERATIONS 1, 2, AND 3 FOR REMAINING SPINDLES.

RECORD OF TEST POSITION

DIPEC FORM 972 (19 MAR 73) Replaces DD Form 972 (Mar 72)

Figure 7-1. Test Pattern for Analytical Inspection of Metalworking Machinery (Front of Pattern)

ANALYTICAL INSPECTION TOLERANCES					
INSPECTION ACTIVITY		MAKE OF MACHINE	MODEL	JOB NO.	
		SERIAL	I.D.	MAINT. CODE	
FIG NO.	INSPECTION REQUIREMENTS	MAXIMUM STANDARDS		INSPECTION TOLERANCES	
		SERVICEABLE	OVERHAUL	INITIAL	FINAL
2.	Table Flatness				
	TIR	0.001	0,0005		
	Plus for each additional 12 inches	0,0005	0,0005		
6.	Table Runout				
	Position (1)	0.003	0.001		
	Position (2)	0.003	0.0015		
12.	Side Head Vertical Travel Square with Table				
	Position (1) - AB	0.0015	0.0005		
	Position (2) - AB	0.0015	0.0005		
13.	Head Transverse Travel parallel with Table				
	AB	0.002	0.001		
	Plus for each additional 12 inches	0,0005	0,0005		
14.	Cross Rail Travel Square with Table				
	(1) and (2) - AB	0.0015	0.0005		
	Plus for each additional 12 inches	0,0005	0,0005		
15.	Ram Travel Square with Table				
	(1) and (2) - AB	0.0015	0.0005		
	Plus for each additional 12 inches	0,0005	0,0005		
16.	Side Head Horizontal Travel Parallel with Parallel				
	AB	0.002	0.001		
	Plus for each additional 12 inches	0,0005	0,0005		
17.	Turret Radial Stop Rigidity				
	Each Station	0.0015	0.001		
19.	Turret Index Positioning Accuracy				
	Position (1)	0.002	0.001		
	Position (2)	0.002	0.002		

REMARKS

Figure 7-2. Analytical Inspection Records of Metalworking Machinery

(2) The test patterns outline in detail the step-by-step procedures and methods to be followed in performing the analytical inspection test.

(3) It should be noted that the analytical test patterns do not duplicate all tests conducted by manufacturers of new machine tools. The primary purpose of the analytical test is the establishment of the tolerances to which the machine will operate and hold. The tests indicated on the test patterns are considered to be sufficient and adequate to make such a determination. However, under certain circumstances, additional tests may be required. When this is done, a description of the test and results shall be recorded in the space available on the test pattern form.

(4) The test, measurements, and tolerances for those machines which differ from designs given in the analytical inspection forms are to be transferred to test records of similar types or an additional sketch made. For example, the test pattern to be used on a four-spindle drill would be the test pattern for a single spindle drill of comparable design. The alignment and run-out of each spindle will be identified and recorded by the number of spindles from left to right.

b. TMSs. TMSs are used in part to determine the operability/serviceability of IPE and the repair necessary to return it to a specified level of performance.

(1) Any maintenance required on machine tools, as a result of analytical inspection shall be performed in accordance with the applicable TMS.

(2) TMSs and analytical test patterns are used in conjunction with each other. For example, when an analytical test pattern is required from DGSC, it will be attached to the appropriate TMS and forwarded to the requestor.

(3) DGSC develops all TMSs to cover all items of IPE in the DGSC inventory which may require maintenance. The TMS may also be used to determine the serviceability of machine tools.

(4) TMSs arc available from DGSC, ATTN: DGSC-SSM, 8000 Jefferson Davis Highway Richmond, VA, 23297-5501, for any of the machine tools that are DGSC controlled.

7-4. Personnel Qualifications

a. In performing tests and inspections on any machine tool, the importance of obtaining correct figures and data cannot be overemphasized. Nothing less than accurate results will be acceptable.

b. Only personnel trained and experienced in performing precision work can be relied upon o obtain accurate results. The degree of skill and experience required to perform tests and inspections is not acquired by any one individual in any short period of time or course of instruction. It is experience gained over a considerable length of time in the operation, maintenance, testing, and inspection of machine tools. Reliable data can only be obtained by conducting tests using skilled and experienced personnel.

7-5. Leveling for Analytical Tests

a. The importance of leveling machine tools for analytical tests cannot be over-emphasized. This is particularly true of items such as lathes, grinders, and planers, having long beds which may develop a twist as a result of improper leveling. This cannot be remedied by merely raising portions of the bed to conform with the required inspection standards. Irreparable damage may occur from sudden changes to correct misalignment which has been caused by gradual settling. Machines must be properly leveled. It must be done gradually and the machines allowed to settle or normalize during the process. Where deformation is present due to the machine's being used when not level, correction should be made gradually in increments of 0.010 inch (.025mm) to 0.015 inch (0.038mm) with a reasonable length of time allowed for normalizing. Where conditions permit, slight adjustments may be made daily until the time when precision leveling to the desired degree is accomplished.

b. Machines which are in noncontrolled humidity storage or which have been in transit should be allowed to reach room temperature before any leveling is attempted. This may require as much as several days for a large machine. The average machine tool in the small and medium size groups will present little difficulty in leveling within the required tolerances. Machines leveled to the proper degree of accuracy on a firm foundation will permit indicator readings of a conclusive nature. Certain machines with very long beds may require leveling by means other than the spirit level. State-of-the-art technology for leveling equipment may include the use of a laser which can be accurate to millionths of an inch. This may be necessary for equipment which must be capable of producing extremely close tolerances. Equipment should be leveled with sufficient accuracy to meet the tolerances of the machine. In many instances, a precision level At will provide sufficient accuracy.

c. The statements in a and b above are for the purpose of stressing the importance of leveling. While this is a primary consideration, it is not necessarily the first step in performing the analytical test. Chronological sequence may be as follows:

(1) Clean.

(2) Level.

(3) Check end play.

(4) Check rotary path.

(5) Check parallelism.

(6) Check perpendicularity.

(7) Check angular relationship.

(8) Check concentricity.

(9) Check indexing.

(10) Summarize results of test.

7-6. Equipment Used for Inspection and Test

a. Most manufacturing plants or installations have available all the equipment necessary for properly testing of the alignment and accuracy of machine tools. Generally, this equipment consists of items such as precision levels, straight edges, parallel squares, test arbors, and indicators.

b. Testing equipment shall be of unquestionable quality both from an engineering and accuracy standpoint. Makeshift testing equipment crudely made from improper designs or materials cannot be depended upon for accurate results. Test results can be no more accurate than the accuracy of the instruments used. Information pertinent to the quality and use of these tools and instruments is listed in (1) through (4) below.

(1) Dial indicators. Dial indicators are commonly used to determine parallel and square alignments of machine units and to check run-out of spindles. The dials should be sufficiently large so that the graduations are clearly visible. For checking square and parallel alignment of machine tools, dial indicators with 0.001 (0.01 mm) inch graduations are normally satisfactory. However, indicators used in checking run-out of spindles, spindle tapers, and spindle sleeve nose should have 0.001 inch (0.01m) or 0.0005 inch (0.002mm) graduations. In all cases, dial indicators shall be securely clamped to substantial holders or posts to avoid vibration and deflection. When testing with dial indicators, the initial pressure applied shall not cause a reading of less than 0.005 (0.01mm) inch.

(2) Precision levels. Only precision type levels should be used. These levels should have a sensitivity of 0.0005 of an inch or 0.0127 of a millimeter for each division. Levels should be placed only on clean scraped, ground, or finished, planed surfaces. To check the traverse levels of surfaces with two or more ways, place the level on top of parallels which span the way surface.

(3) Angle plates, master squares, straight edges, and parallels. This type of instrument must be free of nicks and burrs which can cause inaccurate readings. Surfaces should be machined and scraped flat and parallel to within 0.00025 of an inch or 0.00635mm.

(4) Test arbors. Test arbors shall be made of hardened steel with the cylindrical portion and the taper shank accurately ground. The concentricity diameters shall not vary more than 0.0002 inch (0.005mm) in diameter for the entire length. Countersink centers shall be provided in both ends so that arbors may be used between centers for true running. Test arbors shall be clean and free from burrs and defects.

7-7. Analytical Test Procedures

a. The methods, procedures, and equipment to be used in connection with the performance of analytical tests are contained on the test patterns for analytical inspection of metalworking machinery DGSC Forms 900 to 1000 Series.

b. The instructions outlined in (1) through (10) below apply to machine tools in general and not to any specific machine.

(1) Cleaning. The machine ways, table, and other working surfaces must be clean and free of burrs to allow for accurate analytical inspection.

(2) Leveling. The machines must be level to accomplish an accurate alignment test. On small solid base machines (4 by 4 ft) (1.22m x 1.22m), leveling is not so important; however on long machines, such as engine lathes, it is very important, and only skilled personnel should attempt the procedure. Only precision levels shall be used. The machine shall be level within its own structure, and legs or base of the machine, shall be leveled as close as possible. The precision level bubble should settle between the two main cross lines when placed on the table work surface in any position. On the majority of machines, such as milling machines, drills, and lathes plus or minus one division is acceptable depending on the accuracy desired. In all cases, the machine shall be placed on a solid foundation to keep it from creeping or rocking when in operation.

(3) Flat bearing surfaces. All flat bearing surfaces shall be checked for less than 0.0015 (0.04mm) inch feeler gage entry. This shall be adjusted tight enough to allow free manual movement without binding or looseness between contacting bearing surfaces.

(4) Internal spindle tapers. After determining the correct spindle taper, thoroughly clean internal taper. If possible, feel inside the spindle taper to check for the presence of nicks. If nicks are present, a fine round abrasive stone may be used for their removal under power. Reclean inside the spindle taper to inspect the bearing pattern. Apply a light coat of red lead paint or prussian blue ink to the correct test arbor shank and insert into the taper. Remove and check the arbor for the bearing pattern. Eighty-five percent bearing contact, evenly distributed along the taper is desired.

(5) Spindle end play. Before inspecting for spindle end play in the bearings, it is recommended that the spindle be rotated under high speed to bring the bearings to normal operating temperature. Mount the indicator on the face of the spindle, thrust the spindle into the spindle head, and set the indicator dial on zero. Thrust the spindle outward and record the reading. When the indicator stand is placed on the table and the thrust is applied, check to make sure that the table is locked tight to avoid false readings. The movement of the spindle end play, not the movement of the table is being checked.

(6) Spindle run-out. Clean thoroughly and insert the test arbor firmly into the internal taper. If possible, a draw-in rod should be used to pull the test arbor into the spindle head. When the machine is of the type where draw-in rods are not used, be sure the test arbor is inserted in

place snug enough to keep it from falling out of the spindle. Place the indicator approximately one inch from the spindle nose and rotate it under power to obtain readings. Use a slow speed as high speeds will whip the test arbor and false readings will be obtained. Move the indicator set up to the free end and repeat the procedure. Total indicator reading is recorded for each position. If the readings are out of tolerance, recheck the internal taper for dirt or nicks. Check several times before reaching a decision when the readings obtained are out of tolerance.

(7) Spindle parallel with table travel. To obtain accurate readings on this check, it is important that the previous inspections in (6) above, check within tolerance. When rotating the arbor and indicating the free end, mark the test arbor at the high or plus indicator reading. When inspecting position turn the high spot 90 degrees. Place the indicator either at the top or bottom of the test arbor. The readings should be identical. Move the table to the extreme inboard position. Using approximately 0.005 inch (0.01m) pressure on the indicator, set the dial on zero with the contact point on the vertical center line. Move the table to the extreme out position to obtain the readings. For position 2, repeat the above procedure making sure that the high position is 90 degrees away from the indicator travel. Connect the indicator on the horizontal center line. Upon completion of the test, remove the high spot mark.

(8) Checking T-slot is used quite often for the locating of fixtures. The slot should be inspected in relation to wearing of the ways. It is recommended that the T-slot should not be indicated directly, as T-bolt clamping during production may have burred the slot. Use hardened keys and small toolmaker knees. Make sure that the knees are tight against the keys by the use of the Jacob chuck, attach the indicator and contact the knee. Move the table so that the indicator moves from one knee to the other. This check is similar for various types of machines, and the indicator should be kept as close to the table as possible. Tramming checks for T-slots are used quite often on horizontal machines utilizing approximately the same setup. Move the sweep or tramming rod out as far as possible. Be sure that the indicator is mounted rigidly. Use approximately 0.005 inch (0.01m) pressure and set the indicator at zero. Manually rotate the spindle to contact the other knee and obtain the reading.

(9) Vertical alignment of head and tail centers. For this check, use a straight test arbor.
Master centers that are concentric on all diameters shall be used to accomplish an accurate inspection. Clean the centers thoroughly and insert the test arbor between the centers. The arbor shall be tightened between the centers to eliminate end play, but at the same time must be loose enough to be rotated by hand. Using a magnetic base holder with an indicator attached, contact the test arbor on each end and check for concentricity. When concentricity is established, contact the vertical center line of the arbor by moving transversely, and apply approximately 0.005 (0.Ol mm) inch pressure. Then move the carriage from one end to the other. Check the transverse on each end to make sure of the contact on the crown of the arbor.

(10) Spindle travel square with table surface. Inspections of this type are usually accomplished on vertical machines.

(a) Move the working table to the center of travel.

(b) Use a fine abrasive stone to remove all nicks and burrs from the table.

(c) Wipe the table with a clean cloth to remove any grit or dust that may have accumulated on the table.

(d) Double check the table for any nicks or burrs that were not removed in (b) above.

(e) Place a precision square (precision knees or angle plates are acceptable) on the table and place a sheet of tissue paper under each end of the square's base.

(1) Pull on the tissue papers to make sure they are tight beneath the base of the square.

(g) Ascertain that the square is perpendicular or parallel to the T-slots, depending on the check being made.

(h) Mount the indicator rigidly using a drill chuck.

(i) Move the table to contact the indicator point with approximately 0.001 inch (0.Ol mm) pressure.

(j) Set the dial on zero and move the spindle down to obtain the reading.

(k) Always make the inspection in the direction normally used in operating the machine.

(I) Observe the direction of the arrows on the test patterns and ascertain that they are followed.

CHAPTER 8

PACKING

SECTION I. GENERAL REQUIREMENTS

8-1. Purpose

a. General. Packing as used in this chapter, includes assembling items of industrial plant equipment (IPE), other plant equipment (OPE), and special tooling (ST)/special test equipment (STE) into a unit, intermediate, or exterior pack with necessary blocking, bracing, skidding, cushioning, weatherproofing, reinforcement, and marking. The objectives of packing IPE and OPE are to extend the life span of the item.

(1) Since the requirements for each of the above are dependent upon the type of storage and the nature of the equipment, separate methods and procedures are required for each condition.

(2) Detailed information on packing procedures, operations, and container construction is covered in TM 38-230-2.

b. Determination of packing requirements. As preservation alone cannot provide all the protection that IPE and OPE and accessories or attachments require, the selection and application of packing procedures are extremely important.

(1) Packing consists of more than the selection and use of an appropriate shipping container.

(2) It is not possible for the exterior shipping container alone to provide full protection.

(3) It is usually necessary to provide additional protection to IPE through the use of blocking, bracing, and cushioning.

(4) All IPE and OPE to be packed shall be studied carefully, considering the shape, size, weight, strength, and degree of fragility, in order to determine the packing requirements.

(5) Additional consideration shall be given to the availability of mounting points, the degree of disassembly required, special use requirements, and the handling and storage capacities at the destination.

(6) Each step of the packing procedure must be carefully performed to enable the contents to withstand the damaging forces encountered in transportation, handling, and storage.

Section II. SHIPPING CONTAINERS

8-2. Requirements

a. General. Most machine tools, disassembled parts, accessories, attachments, or components require some kind of boxing or crating, depending upon the level of protection specified.

(1) Boxing and crating are more common, however; for smaller tools and projecting parts which, due to the difficulty involved in their protection, must be removed from the basic unit of IPE.

(2) Examples of these removed parts would be tables, motors, starters, electrical controls, brackets, disconnect switches, and similar items.

(3) Packing requirements. There are occasions when military concepts of packing require adjustment due to the specialized requirements of IPE. These should be minimal; military concepts can be applied whenever possible to promote standardization with resultant economy and efficiency.

(4) Packing. Packing shall be level A, level B, level C, or industrial as specified by the organization directing the shipping. Packing shall be designed to comply with minimum weight and cubage requirements of Joint Regulation AR 70-44/OPNAVINST 4600.22B/AFR 80-18/MCO 4610.14C/DLAR 4500.25.

b. Level A packing. Level A packing shall be used for overseas shipment of IPE which is to be retained in noncontrolled storage. All items preserved to level A shall be consolidated in overseas type containers conforming to table VII of MIL-STD-2073-1.

(1) Equipment weighing 1,000 pounds (454kg) or less. Each complete item weighing 1,000 pounds (454kg) or less shall be packed in an overseas container conforming to table VII of MIL-STD-2073-1. Each container with contents weighing more than 200 pounds (91kg) shall be modified by the installation of skid runners in accordance with the container specification. The contents of each container shall be secured in waterproof case liners or wrap conforming to MIL-I-24768/9 or PPP-B- 1055 class E or heavier. Cushioning, blocking, bracing, and anchoring shall be in accordance with MIL-STD- 1186. Container closure and strapping shall be in accordance with the container specification and shall be zinc coated.

(2) Equipment weighing between 1,001 and 30,000 pounds (454 and 1,814kg). Each complete item weighing between 1,001 and 4,000 pounds (454kg 1,814kg) shall be packed in an overseas container conforming to table VII of MIL-STD-2073- 1. The contents of each container shall be secured in waterproof case liners or wrap conforming to MIL-I-24768/9 or PPP-B- 1055, class E or heavier. Cushioning, blocking, bracing, and anchoring shall be in accordance with MIL-STD- 1186. Closure and strapping shall be in accordance with the container specification and shall be zinc coated.

(3) Equipment weighing over 30,000 pounds (13,605kg). Each complete item weighing over 30,000 (13,605kg) or dimensionally in excess of the limitations specified in MIL-C-104 shall be packed in accordance with directions issued by the organization directing the shipment. Blocking, bracing, anchoring, cushioning, and water proofing shall be in accordance with MIL-STD-1186. The contents of each container shall be secured in waterproof wrap or shroud conforming to PPP-B- *1055,* class E or heavier or MIL-I-24768/9. Strapping shall be in accordance with the box specification except the strapping shall be zinc coated.

c. Level B packing. Level B packing shall be used for domestic or overseas shipment of IPE under favorable environmental conditions. Level B packing is identical to level A packing except the container strapping need not be zinc coated. All items preserved and packaged to level B shall be consolidated in domestic type shipping containers conforming to table VII of MIL-STD-2073- 1.

d. Level C packing. Level C packing shall be used for domestic shipment of IPE. Each complete item shall be packed in a manner that will prevent deterioration and damage during shipment, handling, and storage. Containers and packing shall comply with the National Motor Freight Classification Rules as applicable.

e. Commercial packing. When commercial packing is specified, the basic item of IPE, its attachments, accessories, components, repairs parts, and tools shall be packed in accordance with the American Society for Testing Materials (ASTM) D 3951, Standard Practice for Commercial Packaging. Industrial packing requires that the items packaged be given the degree of protection normally employed by industrial suppliers. It shall provide protection against corrosion, shock, vibration, physical, and environmental damage during shipment, handling, and storage. This level of protection is normally utilized for shipment of newly procured IPE from the prime manufacturer to the user.

f. Foam-in-place packing procedures. IPE, accessories, and component parts may be blocked, braced, and cushioned in accordance with the foam-in-place packing procedures of MIL-STD-1191.

g. Packing list. Packing lists shall be applied to all shipments in accordance with MIL-STD-129.

h. Requirements of MIL-STD-1186. Due to the rather extensive reference to MIL-STD-1186 in this manual, the following excerpts concerning cushioning, blocking and bracing, anchoring, and waterproofing are provided.

(1) Cushioning. Where applicable, cushioning shall be used in one or more of the following ways to provide the necessary physical protection. Cushioning materials shall be separated from surfaces (which might be corroded) at points of contact by either transparent flexible barrier material conforming to specification MIL-B-22191 or grease proof barrier material conforming to MIL-B-121, grade A. Cushioning or wrapping materials containing asphalt shall not be permitted to come in direct contact with highly finished, varnished, or lacquered surfaces.

(2) Blocking and bracing. Items which do not completely fill the shipping container shall be blocked, braced, anchored, or otherwise immobilized within the container. Items or movable parts of items mounted on springs or other flexible supports shall be braced securely to prevent movement, except where such mounting is part of the package cushioning or is designed to protect against shock and vibration during shipment. The materials selected for all blocking and bracing shall be compatible with the load to be supported and the size, shape, and strength of bearing areas of the item.

(3) Anchoring. Anchoring of heavy items shall be accomplished by securing the item to a base by tension devices, either by bolts through mount bolt holes on the item (bolting down), or by metal strapping, cables, tie rods, chains, wire, or other tension devices attached to or applied over the item (tie down or hold down), or by both. The same washer requirements as specified for bolts shall apply to tie rods in that the inside washer diameter shall be equal to the diameter of the bolt or tie rod.

(4) Waterproofing. Waterproof liners, wraps, shrouds, or other suitable means shall be provided in shipping containers as necessary to protect contents against entry of free water. Such protection, however, is not necessary when items, dunnage, exterior cushioning, and interior packages are water-resistant or otherwise waterproofed. Waterproof liners, wraps, shrouds, and other similar protection shall also be required when necessary to prevent the entry of dust, dirt, and other foreign matter. All seams shall be completely and continuously sealed to provide water resistance equivalent to that provided by the barrier material itself.

8-3. Shipping Containers Authorized for IPE

a. Boxes, wood, cleated plywood, conforming to PPP-B-601. Cleated plywood boxes are available in 11 styles, depending on the cleat arrangement. Styles A, B, I, and J are designated as domestic type boxes.

(1) The overseas type cleated plywood box is designated for level A packing requirements of IPE accessories and attachments.

(2) The domestic or overseas type cleated plywood box is designated for level B packing requirements of IPE accessories and attachments.

b. Boxes, wood, nailed lock-corner, conforming to PPP-B-621. Nailed wood boxes are classified as class 1 for domestic shipments and class 2 for overseas shipments.

(1) Class I (domestic type boxes).

(a) Class I nailed wood boxes are furnished in nine different styles, 1 through 7 and includes styles 2-1/2 and 4-1/2.

(b) The class 1 nailed wood box, style optional, is designated for level B packing requirement of IPE accessories and attachments.

(2) Class 2 (overseas type boxes).

(a) Class 2 nailed wood boxes are furnished in seven different styles, 2 through 7 excluding style 6.

(b) The class 2 nailed wood box, style 2, 2-1/2, or 3, as applicable, is designated for level A packing requirements of IPE accessories and attachments.

c. Boxes, wood-cleated, skidded load-bearing base conforming to MIL-B-26195.

(1) Type I-Domestic shipment; class I plywood base.

(2) Type II-overseas shipment; class II-lumber base.

d. Crates, general.

(1) Definition of a crate. A crate is a rigid container constructed of a structural member (wood or metal) fastened together to protect the contents. It may be sheathed or unsheathed (open), demountable (reusable), or nondemountable (one trip).

(2) Use of crates. Crates are generally selected in preference to boxes for shipment of supplies and equipment when an item exceeds 10 feet in any direction or the net weight of the contents exceeds 1,000 pounds (454kg).

(3) Classification of crates. Since there are so many different crate specifications, it is difficult to give one classification for each crate specification. Some crates are designed for general use and others for specific use. Crates may be designed for domestic or overseas shipment. For practical purposes, a classification may include one or a combination of several of the above.

(a) Open crates. An open crate is a container formed of framing members (wood or metal) without exterior sheathing, wood, plywood, fiber board, or paper-overlaid veneer attached to the framing members.

1. Open crates derive their strength from the truss like framework formed by the diagonal vertical, and longitudinal members.

2. These crates may be covered with a lightweight material for watershed protection but are not to be construed as sheathed crates.

(b) Sheathed crates. Sheathed crates are similar in construction to open crates except that the frame members are completely covered with sheathing material, such as plywood, wood, paper-overlaid veneer, or fiber board. Sheathed crates not only provide mechanical protection to the contents, but also protect the contents from the elements during outdoor storage.

(4) Crates used for packing IPE for shipment to storage.

(a) MIL-C-52950 Crates, Wood, Open and Covered, Maximum Load 4,000 Pounds (1,814kg).

(b) MIL-C-3774, Crates, Wood, Open, 12,000 and 16,000 Pound Capacity (5,443kg to 7,257kg).

(c) MIL-C-104, Crates, Wood, Lumber and Plywood Sheathed, Nailed and Bolted (Maximum Load 30,000 Pounds) (13,608kg).

Section III. INTERIOR BLOCKING, BRACING, AND CUSHIONING OF INDUSTRIAL PLANT EQUIPMENT AND ACCESSORIES

8-4. Interior Blocking, Bracing, and Cushioning Requirements

a. General. There are essentially two causes of potential damage to IPE. They are:

(1) Damage from climatic hazards.

(2) Damage from physical hazards.

b. Factors to be considered in blocking, bracing, and cushioning. To block, brace, or cushion IPE, the natural and physical limitations of the equipment must be thoroughly considered.

(1) Shock resistance. The resistance of a piece of equipment or component to shock means its ability to withstand impact without damage. It is the primary factor in determining whether equipment is to be regarded as rugged, semifragile, or fragile.

(a) Equipment and components are considered rugged if they can withstand severe impact without damage. Rugged items can be blocked and braced rigidly. In general, cushioning is used on rugged items only to prevent surface abrasion.

(b) Equipment and components are classed as semifragile if they can withstand a limited amount of impact without damage. any semifragile items can be fastened to one face of a container to prevent damage. At least 2 inches (51 mm) clearance should be allowed between the items and all other faces of the container. Cushioning shall be used in the packing of semifragile articles to prevent surface abrasion and to absorb part of the impact.

(c) Equipment or components are classified as fragile if they can withstand very little impact without damage. If an item is fragile, the interior pack must provide sufficient cushioning to absorb the shock to which the pack may be subjected. Fragile items shall not be fastened to or

come in contact with any face of a shipping container. They may be blocked and braced to one or more faces of an interior container which in turn is floated by cushioning in an exterior container.

(2) Size. A large item does not necessarily require more extensive or stronger blocking or larger amounts of cushioning than a smaller item by virtue of its size alone. The larger item may require more extensive and stronger blocking to bridge or support the wider span between the points which support the blocking.

(3) Shape.

(a) Curved surfaces call for carefully fitted blocking and bracing to prevent damage to equipment.

(b) Long, slender items, especially if heavy, develop considerable thrust when subjected to impact and must be blocked to prevent endwise movement.

(4) Weight. The weight of the equipment or component is a very important factor in blocking, bracing, and cushioning.

(a) When weights are concentrated over small areas, it is often necessary to distribute the weight over larger areas or to transfer part of weight from one container face to the edge of the corners of the container by the use of end blocks.

(b) The heavier and more concentrated the weight of the item, the greater the requirement for blocking and bracing.

(5) Degree of disassembly. The complexity of IPE design often dictates the removal of overhanging components or assemblies to prevent damage or loss.

(a) The decision to remove or block and brace should be based upon the economics involved in providing adequate protection.

(b) Disassembly may simplify blocking and bracing requirements or simplify preservation of the various parts.

(6) Type of loads. Types of loads are determined by the degree of structural strength supplied to the shipping container by the contents. Loads are classified as type I, easy loads; type II, average loads; and type III, difficult loads. The definition of each type is as follows:

(a) Type 1, easy load, provides support to the six faces of the container without the requirement for blocking or bracing.

(b) Type 2, average load, provides partial support to the six faces of the container and blocking and bracing is sometimes required.

(c) Type 3, difficult load, provides no support to the six faces of the container and blocking and bracing is used to convert the type 3 load into either a type I or a type 2 load. Blocking and bracing is sometimes used in connection with type 2 loads. In the case of type 3 loads, it is almost an unavoidable operation due to the irregular shape, fragility, heaviness, or high density of accessories or tooling which make up such loads. Cushioning is applied to the three types of loads. In the case of type 1, it is used primarily to prevent surface abrasion. In the case of type 2, to prevent surface abrasion and to absorb part of the impact shock. In the case of type 3 loads, it is used to prevent contact of the items with each other and/or with the faces of the container, and to absorb shocks, jolts, and vibrations.

(7) Lack of/or availability of mounting provisions. It is often possible to secure an accessory or tooling, to the basic item, to a skid platform, or within a container using integral mounting devices. Many items of IPE, accessories, or tooling may not have adequate mounting devices. Appropriate alternate methods, such as tie-rods, yoke assemblies, and J-bolts, which will protect the equipment must be selected.

8-5. Blocking and Bracing of IPE

a. General. Internal blocking and bracing are used to rigidly secure and support movable and over hanging components to substantial elements of the equipment by means of wood blocks and other mechanical devices.

(1) The purpose of internal blocking and bracing is to prevent distortion or breakage of components while in transit. Internal blocking and bracing must make contact only with solid or substantial parts of the equipment. Do not block or brace a machine component to the skid platform.

(2) Skidding, including the attachment of the machine to the skid, and external blocking and bracing, or the attachment of the skidded machine to the transporting vehicle are covered in paragraphs 8-8 through 8-12.

(3) Failure to block and brace movable parts and fixed components with fragile mountings results in greater damage to shipments of IPE than any other factor.

(4) Many metalworking machines and grinders, may have tables, grinding heads, and/or other heavy components that are supported or moved on ball or roller type bearings.

(a) Special attention should be paid in these cases to preparation for shipment.

(b) Blocking to prevent movement shall be properly designed and installed.

(c) Action must be taken to relieve the weight carried by the balls or rollers since transportation shock may generate flat spots on the bearings or dents in the load bearing member. Damage of this nature is costly and time consuming to repair.

(5) MIL-HDBK-701 provides detailed methods for internal blocking and bracing of various machine tools. These detailed procedures for specific machine tools furnish general guidance applicable to most types of equipment.

(6) A representative example of the internal blocking and bracing required for an engine lathe is as follows (see fig 8-1):

(a) Manufacturer: Boye and Emmes Machine Co. Model "E".

(b) Approximately-weight. Machine 12,500 pounds (5,670kg), primary skid 310 pounds (141kg), and accessory skid 111 pounds (50kg).

(c) Skid sizes. Primary skid 5 (1.52m) by 13 feet; accessory skid 4 (1.22m) by 5 (1.52m) feet. Item 1 is a 2 (51mm) by 4 inch (102mm) wood block, cut to fit, and is placed on each way between the spindle housing base and the cross slide. Item 2 is a 2 (51mm) by 4 inch (102mm) wood block, cut to fit, and is placed on each way between the cross slide and tail stock. Item 3 is a 2 (51mm) by 4 inch (102mm) wood block, cut to fit, and is used to hold down the wood blocks of items 1 and 2. It is placed across the top of the two blocks under the way casting with a one-half inch steel rod. Item 4 is a 4 (102mm) by 4 inch (102mm) wood block, cut to fit, and is placed under the way casting. Item 5 is a 4 (102mm) by 4 inch (102mm) wood block, cut to fit, and is placed at the tailstock base. Wood blocks called out in items 4 and 5 have a 2 inch (51 mm) bevel on one side and are bolted together with two one-half inch steel rods using 1/4 by 3 inch (76mm) steel plates and lock washers.

(d) Buttress blocking. Figure 8-1 shows the lathe buttress blocked for motor shipment. Item 6 consists of two 4 (102mm) by 6 inch (152mm) wood blocks, cut to fit, and are placed between the machine base casting and the header at one end of the skid assembly. Item 7 is a 4 (102mm) by 6 inch (152mm) wood block, cut to length, and is placed between the base casting and the header on the tail base end of the assembly.

(e) Parts and accessories. Item 8 is an accessory skid assembly on which the spindle drive motor and face plate are secured to the accessory beams with four L-brackets.

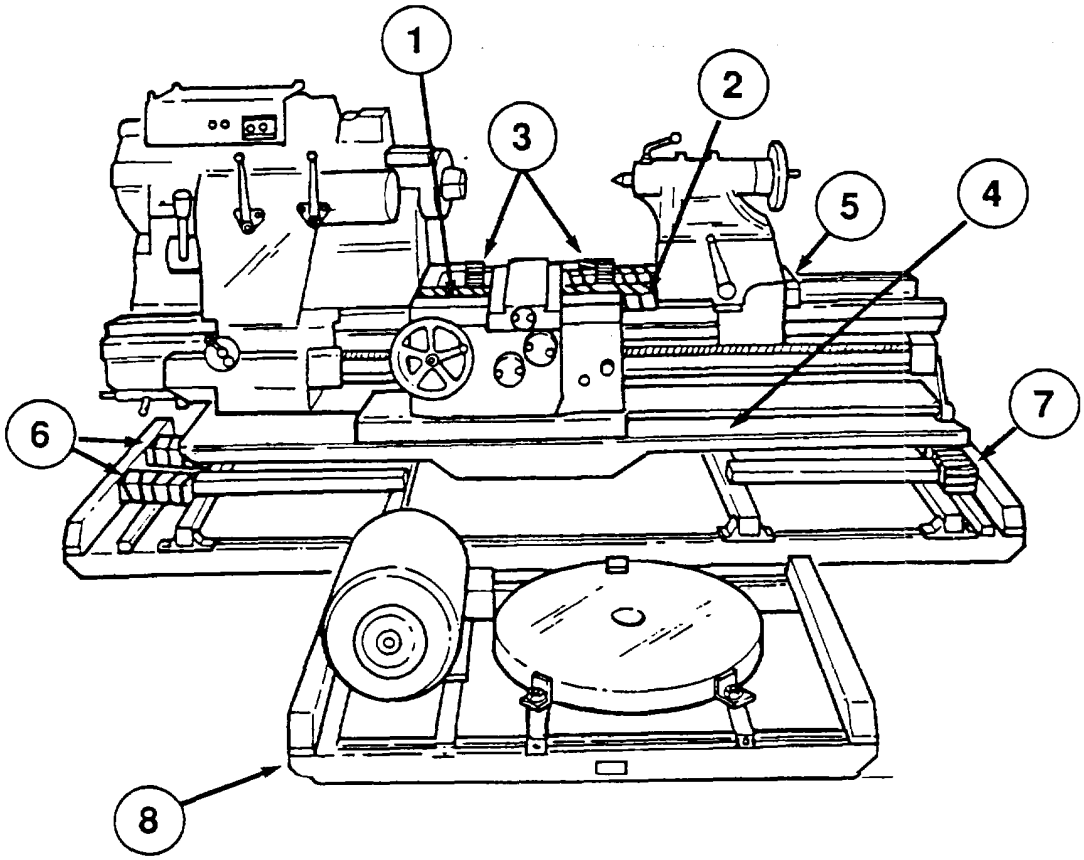


Figure 8-1. Internal Blocking and Bracing of a Lathe

b. Materials. Blocking of movable parts and unsupported components with fragile mounting is accomplished with wood blocks, tie rods, yoke assemblies, steel rods, steel strapping, and wire rope.

c. Unsupported components. Due to oscillating movement during transportation the heavy suspended weights of tables, motors, control panels, and bracketed fixtures will cause damaging stresses at mounting points.

(1) Overhanging and suspended components not easily removed, such as tables, electric motors, starters, and pumps shall be reinforced by blocking and bracing.

(2) It may be costly and impractical to remove and separately package complex wiring systems such as electrical control panels, disconnect switches, starters, and like items. These items frequently have fragile mounting areas and particular care shall be exercised to assure safe movement. In addition, doors shall be secured by steel strapping.

d. Moveable parts. Operating heads, sliding tables, rams, counterbalances, and other movable parts shall be secured by mechanical locking devices incorporated in the machine tools. These devices alone do not provide adequate security to prevent movement in handling and transportation and, therefore, must be augmented by devices prescribed in b above.

(1) Assemblies having vertical movement shall be blocked and braced in a lowered position. Those capable of moving transversely shall be centered for blocking and bracing.

(2) When heads, motors, tables, rams, and similar movable components are activated by hydraulic systems, positioning must be accomplished prior to disconnecting from the power source.

(3) Machine tools with movable heads and hollow spindles shall be secured by placing wood blocking between movable and fixed heads or base castings with a single tie rod assembly through the hollow spindles (fig 8-2).

(4) Items having solid spindles shall be secured by double yoke tie rod assemblies (fig 8-2). In blocking of spindle assemblies, blocking will be to the spindle housing, not to the spindle itself.

(5) Wood blocking between movable and fixed assemblies or bases shall be secured in position to avoid dislodging due to material shrinkage.

(6) Tables or heads which have roller bearings in contact with the ways shall be blocked so as to remove the weight from the bearings to prevent brinelling of the ways. Indicate on a tag that tables or heads have been blocked to remove the weight from the bearings and that the blocking must be removed before operating the machine. Attach a tag to the machine in close proximity of tables or heads that are blocked. An alternate method is to remove the bearings and insert filler pieces of soft material such as brass, bronze, plastic, or soft steel.

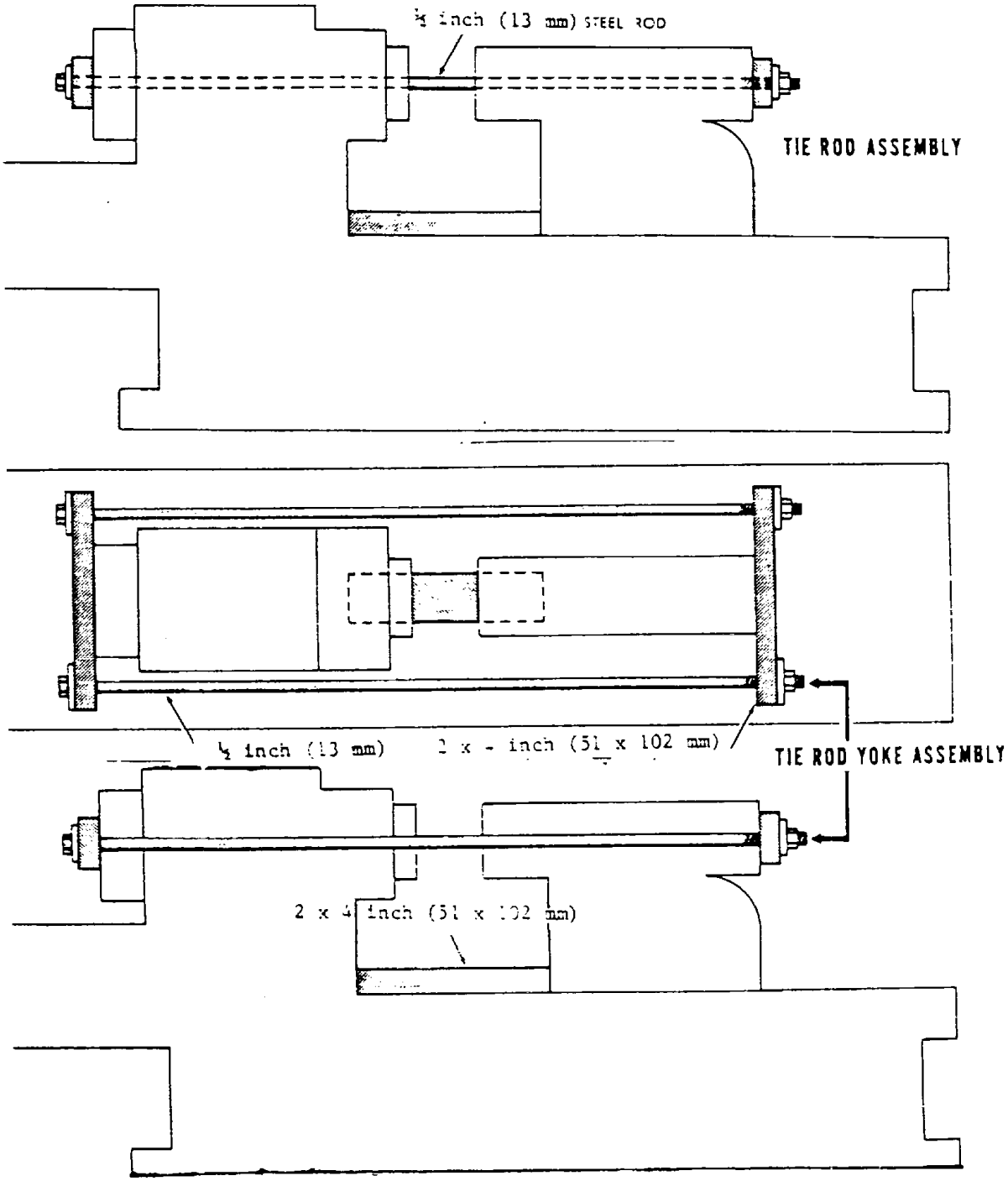


Figure 8-2. Blocking Spindle Assemblies.

(7) Counterweights shall be locked and blocked in a manner which will release all tension from supporting cables, chains, and springs. Concealed counterweights suspended in closed columns shall be removed or securely blocked to prevent vertical and horizontal movement.

(a) If the counterweight is in a closed column and the machine cannot be skidded and shipped in its normal upright position, the counterweight shall be removed.

(b) Many machines with the counterweights in a closed column have holes provided in the column for a support bar.

(c) When a machine can be shipped in the normal upright position, the counterweight should be supported on the bar or pipe in the holes provided and wedged against the inside of the column to prevent movement in handling.

(8) Doors shall be secured with steel strapping, tie-rods, or other devices, in addition to mechanical locks or catches incorporated in the machine tool.

(9) Hand wheels, cranks, levers, and similar controls shall be secured in position by common annealed wire, steel, or nylon strapping.

8-6. Blocking and Bracing of Components, Attachments, and Accessories

a. General. Whenever size and weight permit, all IPE shall be completely assembled when being prepared for shipment.

(1) Attachments and components shall be removed and packed separately when it is not feasible to ship a machine fully assembled.

(2) Projecting parts, such as brackets, arms, motors, and pumps, which are difficult to support or which cannot be adequately protected by bracing and blocking if left on the machine shall be removed for shipment.

(3) These components shall then be blocked and braced within a wood box, which in turn shall be placed on the same skid as the basic unit.

(a) IPE shall be prepared for shipment as a single package whenever possible. Size, weight, and difficulty in blocking and bracing may dictate disassembly or removal of components and assemblies. Whenever possible, all elements making up an item of IPE should be on a single skid.

(b) Components, accessories, and attachments which are considered part of the item shall be preserved, packaged, packed, and attached to the skid for the basic item.

b. Functions of blocking and bracing. Blocking and bracing is used to secure items or components so that they will not shift within a container. Blocking and bracing is also used to

make irregular-shaped items fit a regular-shaped container and to distribute the weight of irregular items over the maximum surface area of the container.

(1) Blocking and bracing may be used to modify the original shape of an item so that it is protected adequately and so that it fits the container.

(2) Materials used for blocking and bracing differ from cushioning in that they are not intended to absorb shocks. Items having legs or other projecting parts which may become loose or broken or which might puncture the container must be supported by adequate blocking and bracing.

(3) Blocks and braces shall be applied against portions of the container that are strong enough to resist forces tending to distort them. Likewise, the bracing should be arranged to distribute forces to several reinforced sections of the surface of the item.

c. Blocking and bracing materials and their applications. Materials used for blocking and bracing shall be strong and rigid. The greater the need for support, the stronger and more rigid the materials must be.

(1) Use of lumber. Lumber used in blocking and bracing shall be free from cross grain and should not have knots located near the center of a piece that is being used as a beam or column. If knots cannot be avoided, the following should be carefully considered:

(a) Edge knots shall be placed so that the knots will always be in compression.

(b) Center knots shall not have a diameter greater than one-fourth the width of the piece of lumber.

(c) Knots shall be tight.

(d) Thin pieces of wood split more easily than thick ones; therefore, thin pieces should not be used in blocking unless precautions are taken against splitting. If thin boards are used, do not nail too close to the edge of the board, use the correct size of nail, predrill holes for nails, and reinforce the board with a facing of plywood.

(e) All braces should, if possible, have their edges against the article in order to utilize their maximum strength. If it becomes necessary to have the flat face of the brace against the article, the size of the brace must be increased.

(f) When bases of ordinary lumber are used, they shall be constructed with sufficient cleats at right angles to the grain of the base boards and securely fastened with clinched nails to prevent the boards from splitting at the bolt holes.

(g) Wood braces that are positioned between two faces of a container shall be held in place by cleats fastened to the faces of the container with a sufficient number of clinched nails. When the pressure is from more than one direction, wood braces shall be held in place by the use of a pocket cleat arrangement. Such braces shall never be held in place by the use of end-grain nailing or the use of notches cut into the container's face boards.

(2) Use of metal brackets or frames. Many articles have attachment points which provide facilities for bolting, but the points are not located on a regular base which can be fastened directly to the container. In such instances, specially constructed brackets or frames made of metal, structural iron, wood or a combination of these can be used.

(3) Use of metal strapping. The use of metal strapping to tie down an article to the base or other face of the container is often the only procedure that can be used. Metal strapping may be flat strapping or round wire. General precautions on the use of both flat strap and round wire are as follows:

(a) Use annealed wire or strap only for lighter articles since it stretches readily.

(b) Non-metallic strapping conforming to ASTM D3953 and ASTM D4675, may be used for securing hand wheels and other light items.

(c) Straps shall be placed only on those strong portions of the article which can withstand the impact load and weight of the article.

(d) Place material such as felt or solid fiberboard between the straps and the article to prevent damaging finished surfaces.

(e) Use one piece strapping whenever possible.

(f) When strapping over a sharp edge of the item, use corner protectors to prevent the strapping from fracturing.

(g) When it is impossible to encircle the item and its support, anchor the two ends of the strap to the container for flat strapping with anchor plates or, if the strap is annealed, by direct nailing. For round wire, anchor the two ends of the wire to the container with drive screws and staples. Loop the wire around the shank of the drive screw and further fasten by the staples.

(4) Use of nails. Nails are the most common fastenings for blocking and bracing, especially standard sinkers or cooler nails. Clout nails, which are similar to roofing nails, are recommended where plywood of one-half inch (13mm) thickness or less is used, because of their larger heads.

8-7. Cushioning Materials and Their Use

a. General. In order to use cushioning materials effectively in the cushioning of IPE and OPE components and accessories, a general knowledge of the cushioning materials and their characteristics is required. Different cushioning materials behave differently under similar conditions based upon the characteristics of material. The chemical and physical characteristics of cushioning will have a bearing on the type of cushioning required for a given time.

(1) Items which require cushioning include dial type indicators, precision instruments, inspection equipment, delicate electronic and electrical equipment, control panels, and similar fragile components.

(2) The following statements summarize the functions of cushioning materials:

(a) To protect delicate and fragile items against the effects of shock and vibration hazards encountered in handling and transportation.

(b) To protect delicate and highly polished surfaces against abrasion.

(c) To prevent rupture or severe abrasion to grease proof or waterproof barriers at the point of contact with solid wood blocks or bracing materials.

(d) To protect small projections on items.

(e) To absorb liquids.

(f) To protect moisture-vaporproof barriers at points of contact from sharp edges of the item itself, packing materials, or container surfaces.

(g) To protect at points of contact with wood blocking or bracing, and protect strippable compound coating applied to large or heavy tooling related to IPE.

b. Cushioning materials used for IPE and OPE. There are many materials available that possess excellent cushioning qualities but are too numerous to list in this manual. Therefore, the cushioning materials most generally used for IPE are listed below by title and specification number:

(1) A-A-1898: Cushioning Material, Cellulose.

(2) PPP-C-850: Cushioning Material, Resilient Expanded Polystyrene.

(3) PPP-C-1752: Cushioning Material, Packaging, Unicellular Polyethylene, Flexible Foam.

(4) PPP-C-1797: Cushioning Material, Low Density Polypropylene Foam.

c. Use of cushioning material to prevent abrasion. There are many kinds of IPE that have polished and painted surfaces which require protection from abrasion during handling and shipment. They could range from small light weight equipment to large complex equipment. The kind of cushioning material used will depend upon the kind of equipment involved (chap 4).

Section IV. SKIDDING OF INDUSTRIAL PLANT EQUIPMENT

8-8. Purpose

a. General. Skidding is one of the more important phases of the preparation of IPE for storage or shipment.

(1) The skidding of IPE and OPE serves two purposes.

(a) It provides physical protection to IPE during handling, shipment, and storage.

(b) It provides a means of handling the equipment through the use of mechanical lifting devices.

(2) The information on skidding of IPE and OPE contained in this section is minimal so that it does not duplicate the information contained in MIL-HDBK-701, Blocking, Bracing, and Skidding of Industrial Plant Equipment for shipment and storage. Refer to MIL-HDBK-701 for detailed information.

b. Definitions. The following definitions are provided for the purpose of interpreting the terminology used in this section.

(1) Buttress blocking. Buttress blocking is a type of external blocking placed on a skid between the equipment base and the skid headers. The purpose of buttress blocking is to reinforce equipment hold-down bolts and prevent their distortion or failure while in transit.

(2) External blocking and bracing. External blocking and bracing are used to prevent shifting or overturning of equipment while in transit by means of wood blocks and other mechanical devices. The concepts of external blocking and bracing are contained in paragraphs 8-16 through 8-28.

(3) Internal blocking and bracing. Internal blocking and bracing are used to rigidly secure and support movable and overhanging components to substantial elements of the equipment by means of wood blocks and other mechanical devices. The purpose of internal blocking and bracing is to prevent components from distoiting or breaking while in transit. Internal blocking and bracing make contact only with parts of the equipment. Internal blocking and bracing is covered in paragraph 8-5.

(4) Skidding. Skidding is the placement of aluminum or wood skid runners, with connecting structure, under IPE to facilitate handling with mechanical lifting devices. Skidding provides additional protection to IPE and OPE during handling and shipment by providing a rigid platform to prevent distortion under extreme lifting and handling conditions. Aluminum skids do not warp as wood skids are prone to do. This eliminates the need to loosen hold down bolts when placing equipment in storage and tighten them when removing equipment from storage. Information on skids can be obtained from DGSC as indicated in paragraph 8-12.

c. Wood materials. Groups II, III, and IV woods conforming to MIL-STD-73 I, shall be used for skid construction, blocking, hold downs, cleats, buttress blocks, and related purposes.

d. Clearances. The length and width of the skid assembly is determined by the length and width of the machine tool after disassembly (fig 8-3).

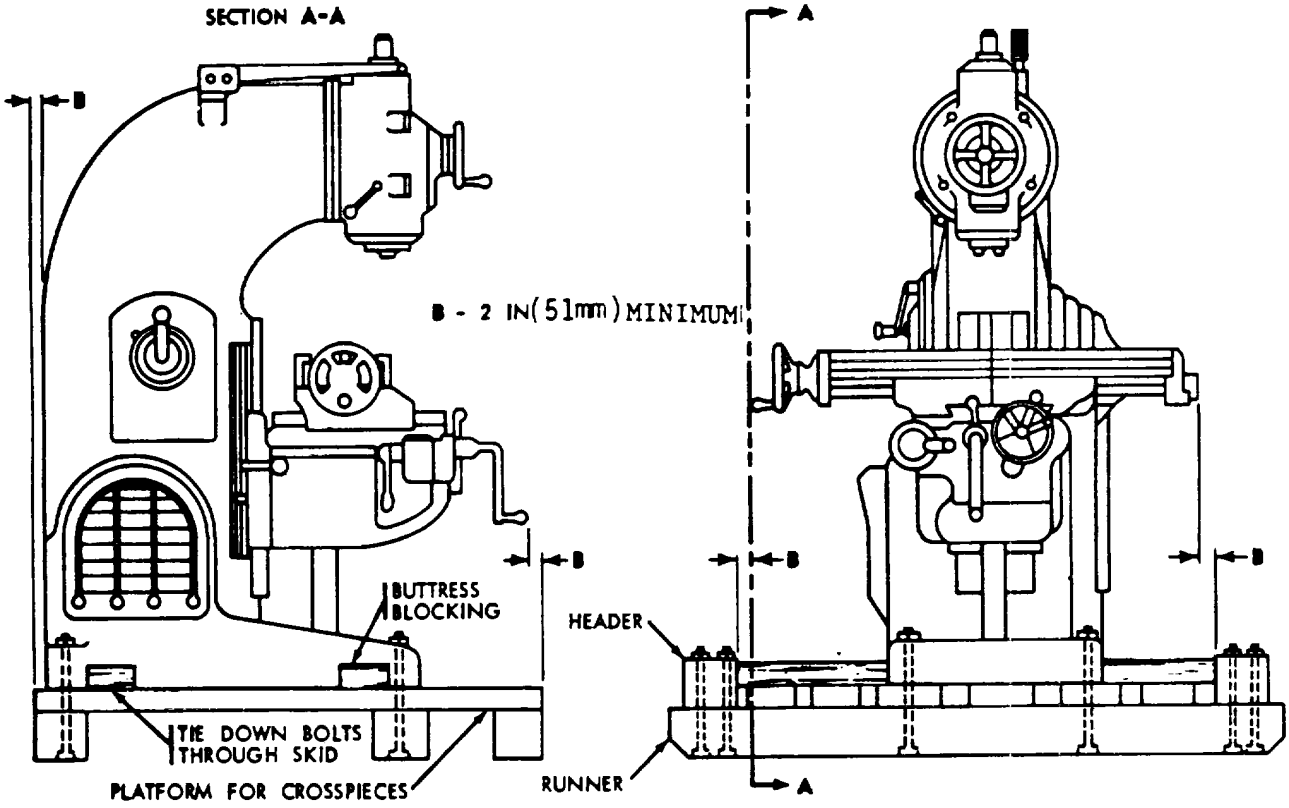


Figure 8-3. Skidding Clearance.

(1) The width of the skid assembly shall extend a minimum of 2 inches (51mm) beyond the farthest projection on each side of the machine.

(2) The length of the skid assembly shall provide a minimum of 2 inches (51mm) clearance between the farthest projection of the equipment and the inside edge of the skid header.

e. Top-heavy machine tools.

(1) The transporting vehicle and route will vary with top-heavy machine tools and items with height exceeding normal shipping dimensions. Blocking and bracing shall be located at points of the machine with sufficient rigidity to carry the machine weight.

(2) Skid assemblies for top-heavy items requiring upright skidding due to such factors as design and structural weakness shall be sized to provide stability in handling and transit. The length and width of the skid platform should extend beyond the machine a distance equivalent to the height of the center' of gravity of the machine above its base.

f. Multiple skidding. Multiple skidding of machine tools on wood skids is permitted only for stability of top-heavy items and then only when items are to be stored for the same planned producer.

g. Skid assembly. The skid assembly consists of runners, headers, floor crosspieces, and mounting plates for crossbeams. The assembly selves as a base to provide safe movement, protection of equipment during transit, and means of leveling equipment in storage.

h. Equipment not required to be skidded. Many kinds of IPE, OPE, and ST/STE due to construction or configuration, may be shipped safely, conveniently, and more economically without skidding.

(1) This kind of equipment includes many heavy, durable, or solid base items, such as press frames, drop hammers, bases, and anvils.

(2) Small, sensitive, delicate, or comparatively fragile equipment 200 pounds (91kg) or less need not be skidded, but shall be packed in containers conforming to table VII of MIL-STD-2073-1.

(3) Equipment similar to that outlined above, but weighing more than 200 pounds (91 kg) (not to exceed the box weight limitations), shall be packed in the same kind of box. Boxes exceeding 200 pounds (91 kg) gross weight shall be modified by applying a minimum of two exterior cross skids on the bottom to facilitate handling.

i. Placement of IPE on skids. The correct placement of IPE on skids is necessary so that the desired protection and handling can be achieved. The following requirements are applicable to equipment which is mounted on either wood or aluminum skids as per MIL-HDBK-701.

(1) The longer dimension of the base of the equipment shall be positioned parallel to the skid runners, with bolt holes centered over the runners, maintaining the required clearances

(2) The required clearances for the skidding of IPE are those set forth in paragraph 8-8d.

8-9. Wood skids

a. General. Platform flooring, number, and dimension of runners, nailing, bolting, and arrangement are dictated by the weight, dimensions, hold-down devices, and type of equipment to be skidded. Due to the variance in contour and location of hold down points on IPE, a greater number of runners with lesser dimensions may provide the most economical skid assembly.

b. Securing equipment to wood skids with bolts. Machines shall be secured to the skid by not less than four bolts. When sufficient bolting points are not available, J-clamps, tie rod assemblies, tie rod yoke assemblies, or other devices should be used to provide a minimum of four holding points.

(1) Bolts and other holding devices must pass completely through wood skid runners and flooring.

(2) Lag screws, nails, steel or nylon strapping, and spikes are not used to secure machines to skids.

(3) Carriage or step bolts must be of sufficient length to pass through the runner, flooring, machine mounting holes, or holding devices and permit the affixing of nuts.

(4) In the absence of other adequate hold down devices, leveling screw bolt holes may be used. The threads in the machine base shall be protected by a lead sleeve after removal of the leveling screw. When hollow leveling screws are a part of the machine and they provide a more adequate hold down than the bolt hole of the machine base, the bolts should be backed off flush with the underside of the base and the lock nut on the upper side set. A lead protective sleeve is required inside the hollowed leveling screw.

(5) Bolt heads shall be countersunk in wood runners so that no portion projects below the base of the skid runner. Cut washers shall be placed under nuts and bolt heads. Nuts shall be tightened to the extent possible with a hand wrench, then backed off one-fourth to one-half turn to relieve tension in the machine adjacent to the bolt hole. Power wrenches shall not be used.

(6) Table 8-1 provides the minimum diameter of bolts in relation to the weight of the equipment when four mounting points are available. When the size of the bolt holes incorporated in the machine design is greater than the bolt diameters indicated in table 8--1, sleeves or larger bolts shall be used to assure a snug fitting mounting without upsetting bolt threads or damaging machine mounting holes.

(7) If the mounting holes of the machine base do not permit bolts of the size specified in table 8- 1, the number of hold down bolts or other devices shall be increased to compensate.

c. Unsupported columns. Unsupported columns shall be reinforced by securing snug fitting filler blocks between the skid floor and the recessed portion of the base casting. Filler blocks [l not place stress on the recessed areas on base castings or hold down points.

d. Leg type machines. Leg type machines with slotted bolt holes for mounting shall be secured by nailing or bolting a wood block to a runner, bearing against each leg opposite the slot opening (fig 8-4).

TABLE 8-1. BOLTING REQUIREMENTS.

Machine Weight	Diameter of bolts
Under 7,500 pounds (3,402kg)	5/8 In (15.875mm)
7,500 to 25,000 pounds (3,402 to 11,340kg)	3/4 in (19.050mm)
25,000 to 50,000 pounds (11,340 to 22,680kg)	1 In (25.400mm)

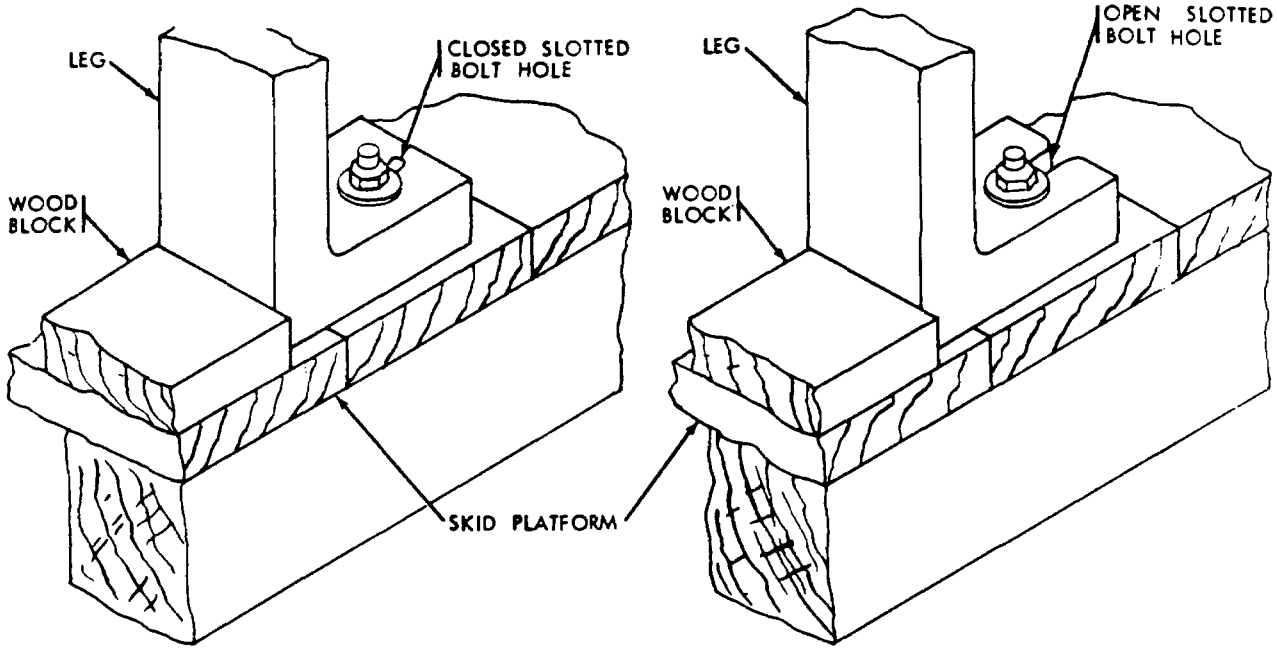


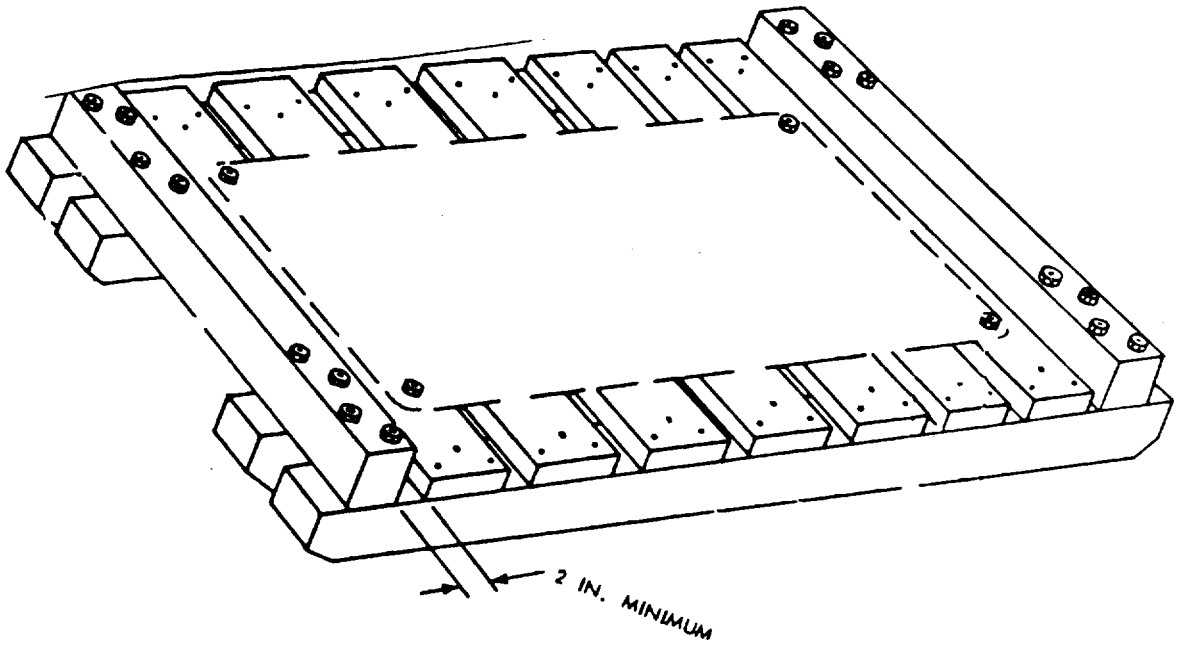
Figure 8-4. Back up Cleats for Slotted Bolt Holes.

e. Leg and end frame machines. Leg and end frame type machines that require reinforced diagonals or cradle blocking to prevent end thrust on the bed and straining of the super structure, legs, frame, or mounting points, shall be blocked and braced with wood blocks and tie rod assemblies. Refer to MIL-HDBK-701 for materials and their application.

f. Runners and skid assembly. Skids should be assembled to conform to the general characteristics of the skids shown in figures 8-5, 8-6, and 8-7. Runners shall be of one piece whenever possible and all runners shall be equal in length and cross sectional dimensions. Runners should be beveled on each end from the bottom edge one-third the height at a 45 degree angle to the bottom. When lumber of necessary size and length is not available, splices or laminated runners may be substituted provided the requirements of MIL-IIDBK-701 are met.
Explanation of spliced and laminated runners are as follows:

(1) Spliced runners. Spliced runners shall be constructed with one splice per runner. The splice should be located at the one-third point measured from either end of the skid. Adjacent runners shall be spliced at alternate ends. The surfaces holding bolt heads shall be positioned so that the load is transmitted to the floor.

(2) Laminated runners. Lumber used in the lamination of runners shall be not less than a 2 inch nominal thickness. Lamination shall be on a vertical plane only, and the overall width shall be not less than that required for solid runners.



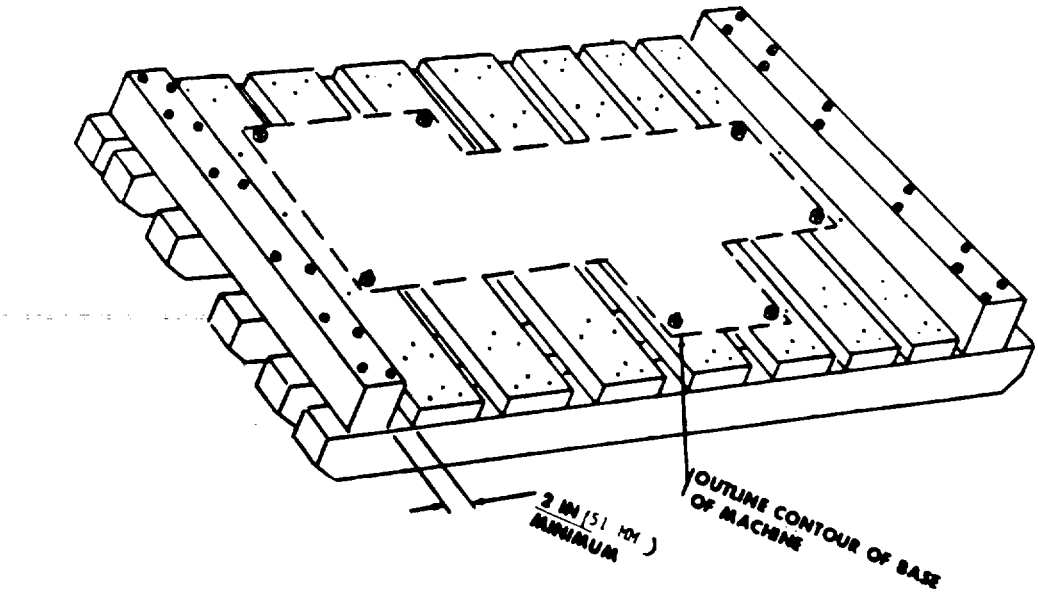


Figure 8-6. Skid Arrangement, Irregular Base Machines

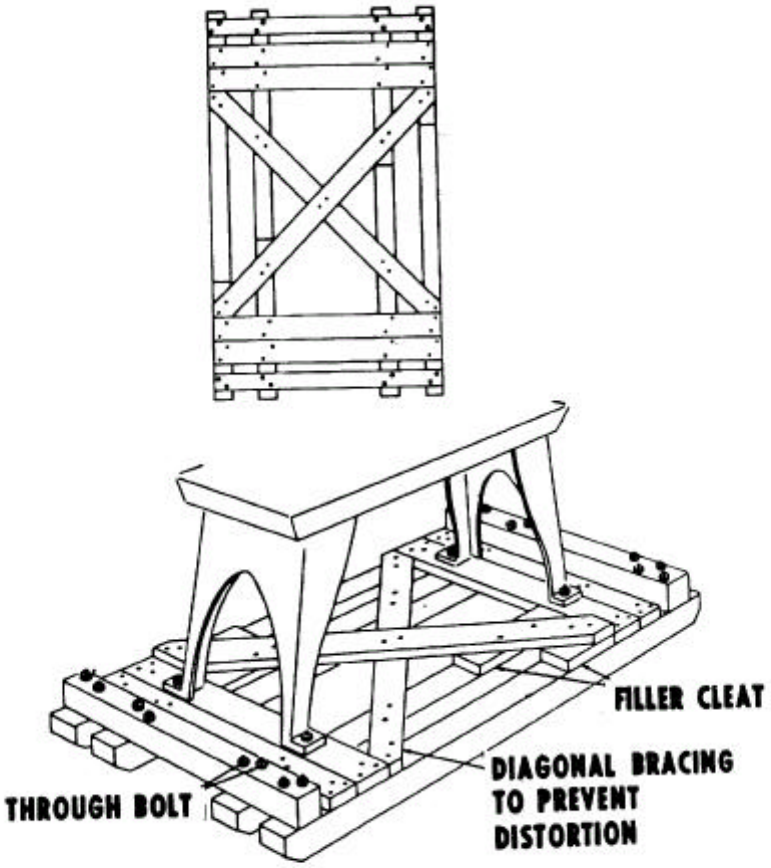


Figure 8-7. Skid Arrangement, Leg Type Machines

g. Headers. Both headers shall be of the same length, of one piece (no lamination), and of the same cross sectional dimensions as the runners. They shall be secured to the runners at right angles by two carriage bolts at each point of intersection with the runner.

(1) For safety in handling and storage, headers shall not project beyond the outside edge of the outermost runners.

(2) Requirements for bolt spacing, bolt size, and header spacing are indicated in MIL-HDBK-701. Countersinking of bolt heads on the floor-bearing side of the runners shall be to such a depth that bolt heads will not contact the floor.

h. Flooring. Skid platforms shall be floored with boards of identical thickness, and not less than 6 inches in width. See figure 8-8 regarding diagonal flooring to prevent distortion.

(1) Variations in thickness of flooring lumber shall be avoided because they can result in rupture of base castings due to stress points and unequal distribution of weight. The surface between headers on skids, except for leg end frame type machines requiring diagonal bracing, shall be not less than 60 percent floored, parallel to the header.

NOTE

SPACE BETWEEN FLOOR BOARDS SHOULD NOT EXCEED THE WIDTH OF FLOORING BEING USED. A MINIMUM OF 2 INCHES (51MM) MUST BE PROVIDED BETWEEN THE HEADER AND THE FIRST FLOOR MEMBER TO FACILITATE HANDLING BY SLING, CABLE, OR CHAIN.

(2) Flooring shall be positioned so that each machine hold down bolt or device will be centered on a floor member.

(3) Flooring lumber- for machines weighing up to 1,000 pounds (454kg) shall not be less than 1 inch (25mm) nominal thickness and, for items weighing over 1,000 pounds (454kg) the minimum nominal thickness shall be 2 or 3 inches (51 to 76mm) as required for adequate support.

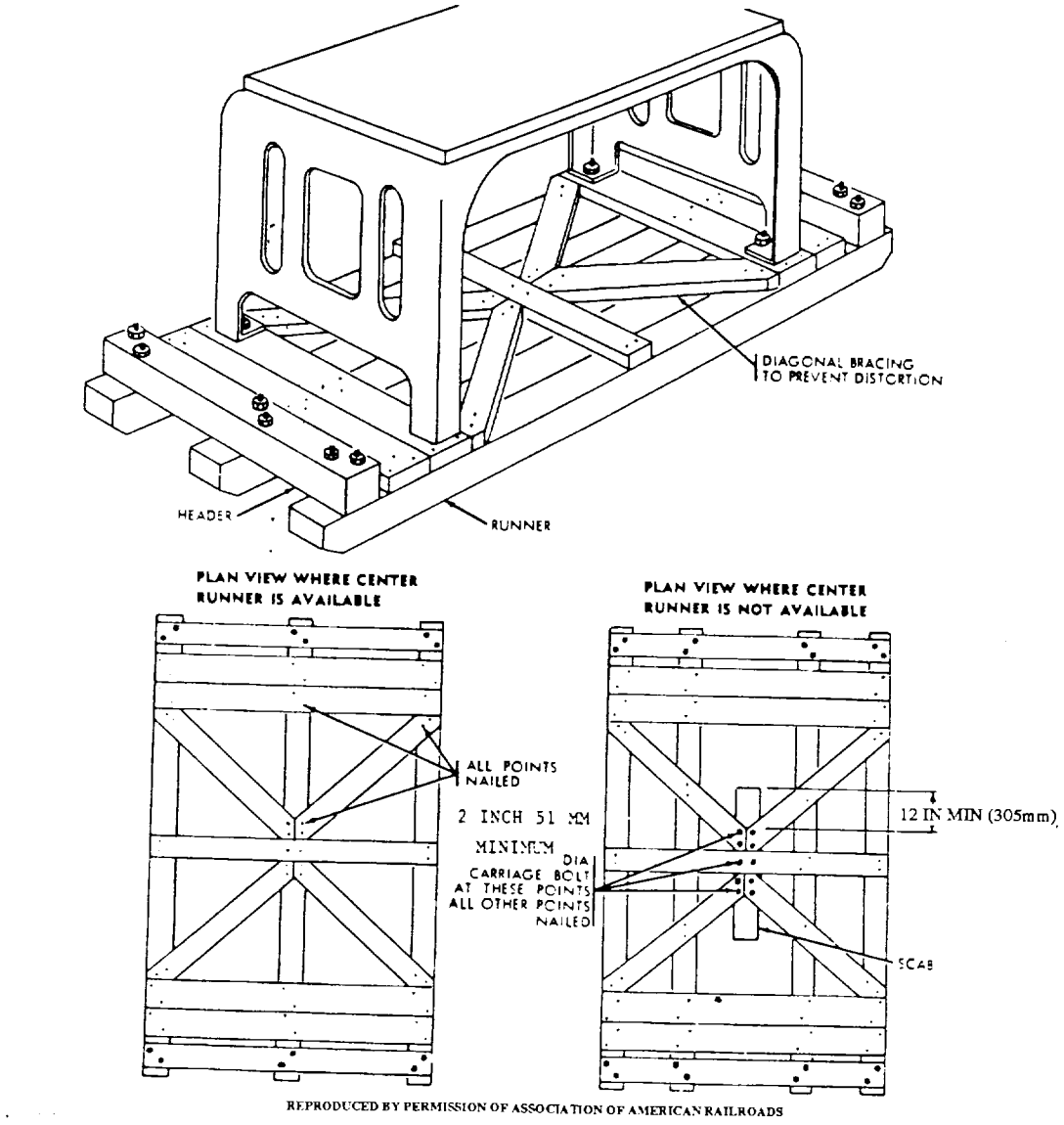


Figure 8-8. Diagonal Flooring for Skid Platform

(5) Flooring shall be secured at each intersection with a runner member, using cement coated nails. There shall be no knots at fastening points.

8-10. Aluminum Skids

a. General. Aluminum skids are so designed that a combination of various components may be adopted for use, which will provide adequate support to IPE of many sizes, shapes, and weights. Advantages from using aluminum skids may include lower costs in terms of time and materials for shuttling shipments of equipment to storage or using them with removal and reuse for other shipments.

(1) Clearance. The clearances for aluminum skids are the same as those specified for wood skids. End and side clearances, however, may be greater than 2 inches (51 mm) if necessary to permit use of standard member lengths.

(2) Runners. Runner beams shall all be of equal length and sufficiently long to maintain clearance, as well as to permit the application of buttress blocking, and to provide stability for top heavy items. Equipment shall be skidded with the long dimension parallel to the runner beams. Runner beams are secured to the header beams at each point of juncture by one of four bolts as the skid design requires. The ends of outside runner beams shall be secured to the extremities of the header members.

(3) Headers. Both header beams shall be of the same length and long enough to provide the necessary clearances. Header beams will be perpendicular to runners, and shall not extend beyond the outside runners.

(4) Assembly. The following general information pertains to the assembly of aluminum skids.

(a) Wood components are not to be substituted for aluminum components.

(b) The manufacturer's design of the skid and its components should not be altered except as authorized in a coordinated military document.

(c) Splicing of runners, headers, or crossbeams is not permitted.

(d) All bolts including those used for machine hold down, shall have flat washers and lock washers under the nuts. All bolts shall be drawn tight.

(e) Hold down bolts shall be the largest size that can be used. When skid design prohibits use of a hold down bolt of a size that fits the hold down bolt holes of the machine, bushings shall be inserted in the oversize holes.

(5) DOD skid types. The inventory of DOD aluminum skids consists of two types. The primary skid now in use conforms to MIL-S-9968 and will be referred to as a type I. The type II skids are no longer manufactured, and when the supply on hand is exhausted, the type II

designation will be eliminated. The construction of the two types of skids are entirely different, therefore, the components are not interchangeable. Either type of skid can be arranged for safe skidding of most types of IPE weighing up to 42,000 pounds (19,050kg).

(6) DOD-owned aluminum skids. The Defense General Supply Center (DGSC), Richmond, VA, manages and controls the inventory of DOD-owned aluminum skids that are specifically designed for the shipment and handling of IPE. When shipping or handling IPE, DOD activities are encouraged to requisition, use, and return these skids to the designated DGSC Storage Facility. DOD policy and procedures for management and reutilization of DGSC skids are covered in AR 700-43/DLAM 4215.1. Appendix A of MIL-HDBK-701 establishes the requirements and approved methods of identifying DOD aluminum skid components.

(7) Skid sizes. Due to the large variety of IPE characteristics such as weights, shape, sizes, configuration, and location of hold down points, it has not been practical to establish standard skid sizes within the DOD skid inventory. The following paragraphs provide detailed information for selecting the appropriate skid type, component arrangement, number and length of the components required.

b. Type I skid. The type I skid is designed for the skidding of machine dimensions ranging up to 9 feet (2.75m) wide 34 feet (10.36m) long with weights up to 42,000 pounds (19,050kg). The type I skid is designed to support the load by means of parallel runner members which are held together at each end by header members. The load is secured to the runner members by means of mounting plates and auxiliary tie bars. The skid has been made universally adaptable by a system of nine-sixteenths inch (14.3mm) square hoses spaced on 2.33 inch (58.4mm) centers, which allows the components to be fastened together by standard hardware to provide a larger number of skid component arrangements.

(1) Inner runners. The two inner runners are considered load bearing members.

(2) Outrigger runners. Outrigger runners are those which are not directly under the equipment base. They are usually necessary only to provide required skid width for protection of overhanging components and therefore do not increase the safe load limit of the assembly.

(3) Runner beams. The number of runner beams required is determined by the weight of the equipment, center of gravity, contour of the machine base, location of hold-down points incorporated in the machine, devices necessary to provide sufficient hold downs, and the requirements for protection of overhanging parts.

(a) Each load bearing runner beam has a safe load limit of 12,000 pounds (5,443kg). The basic skid as shown in figure 8-9 is designed for a safe load weight of 24,000 pounds (10,886kg) supported on the two inner runners with an outrigger runner on each side.

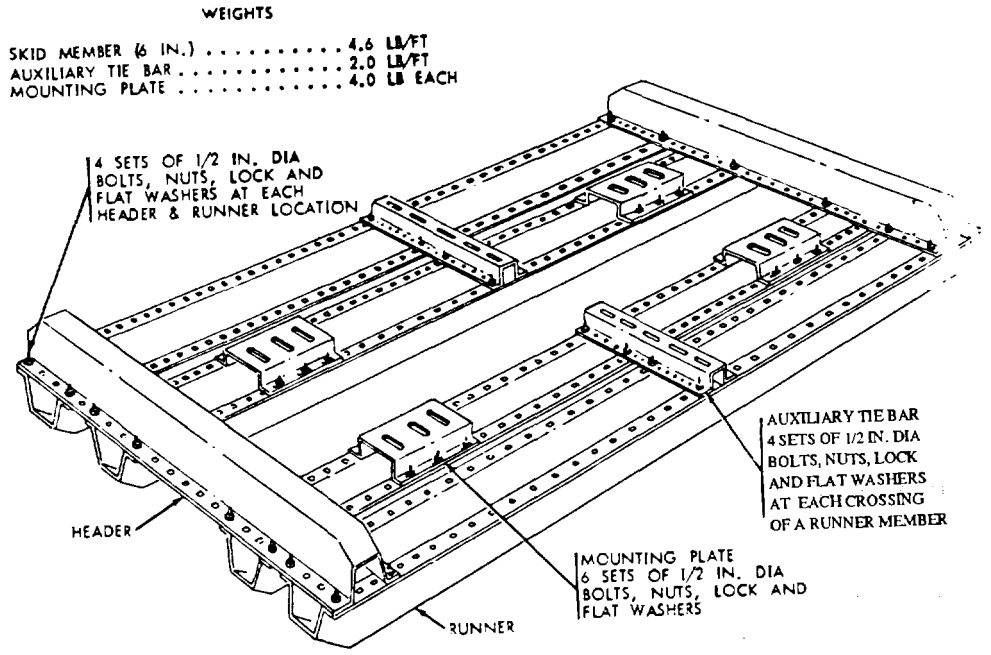


Figure 8-9. Type I Aluminum Skid Assembly.

(b) The skid would have the same safe carrying capacity without the two outrigger runners.

(c) Outrigger runner beams need not be used when protruding components have been removed or when the clearance requirements can otherwise be met without outrigger runners.

(d) For equipment weighing over 24,000 pounds (10,886kg) additional runner beams and hold down points are required.

(e) Additional runners may also be required to increase the rigidity of the skid for specific items of IPE, or to provide the necessary hold down points for machines with irregular-shaped bases.

(4) Header beams. Each header beam shall be attached to the runner beams at right angles with four carriage bolts at each point of intersection.

(5) Mounting plates. Each mounting plate is designed to carry a maximum of 6,000 pounds (2,722kg). One mounting plate is required for each hold down bolt, clamp, or device used to secure the equipment to the skid. The minimum number of mounting plates for machines of various weight is indicated in MIL-HDBK-701. Mounting plates are also used as supports under heavy columns.

(a) Mounting plates shall be placed parallel with runner beams except where hold down

points are offset. Mounting plates should be positioned in a manner that will prevent extension beyond the outside extremities of the outrigger runner beams.

(b) Mounting plates must be uniformly distributed around the base of the machine at tie down points.

(6) Auxiliary tic bars. Auxiliary tie bars are required on skids over 6 feet in length to add rigidity between the outrigger and load bearing runner beams. Tie bars shall be uniformly spaced, not more than 6 feet (1.8m) apart, between header beams. Auxiliary tie bars are also used to provide mounting points for accessory items such as motors, base plates, or boxed accessories.

(7) Hardware. Standard hardware is used in the assembly of the type I skid and for the mounting of IPE on the skid.

(8) Hold down bolts. Standard steel step bolts are used for securing equipment to the mounting plates.

c. Type 1I runner beam skid. The basic type II runner beam skid consists of four runners and two header beams, accessory beams, and special hardware (fig 8-10).

(1) Inner beams. The two inner beams are considered load bearing members. The outrigger beams are for protection of overhanging components of the equipment and do not increase the safe load limit of the assembly.

(2) Hardware. The hardware used for assembly of type II aluminum :skids for mounting equipment thereon is special and no sources are currently known except the manufacturer. MIL-HDBK-701 provides a list of the hardware and the manufacturers part numbers.

(3) Runner beams. Runner beams for the type II skid are used in the same manner as for the type I skid. Requirements and load capacity are as indicated in MIL-HDBK-701.

(4) Header beams. Header beams are bolted to each runner beam. Header beams are secured to the outside runner beams using header beam hardware.

(5) Accessory beams. Accessory beams may be used for mounting points for attaching items such as motors, coolant pumps, guards, or boxed items which are part o(f the basic equipment. They are also used for support of buttress blocking. Accessory beams are attached to the outside runner members with hardware.

(6) Mounting Points. Equipment shall be mounted directly on runner members if the number- of machine hold down bolt holes does not meet requirements for tic down points, clamps, J-bolts, yokes, or other tie down devices which provide equivalent strength.

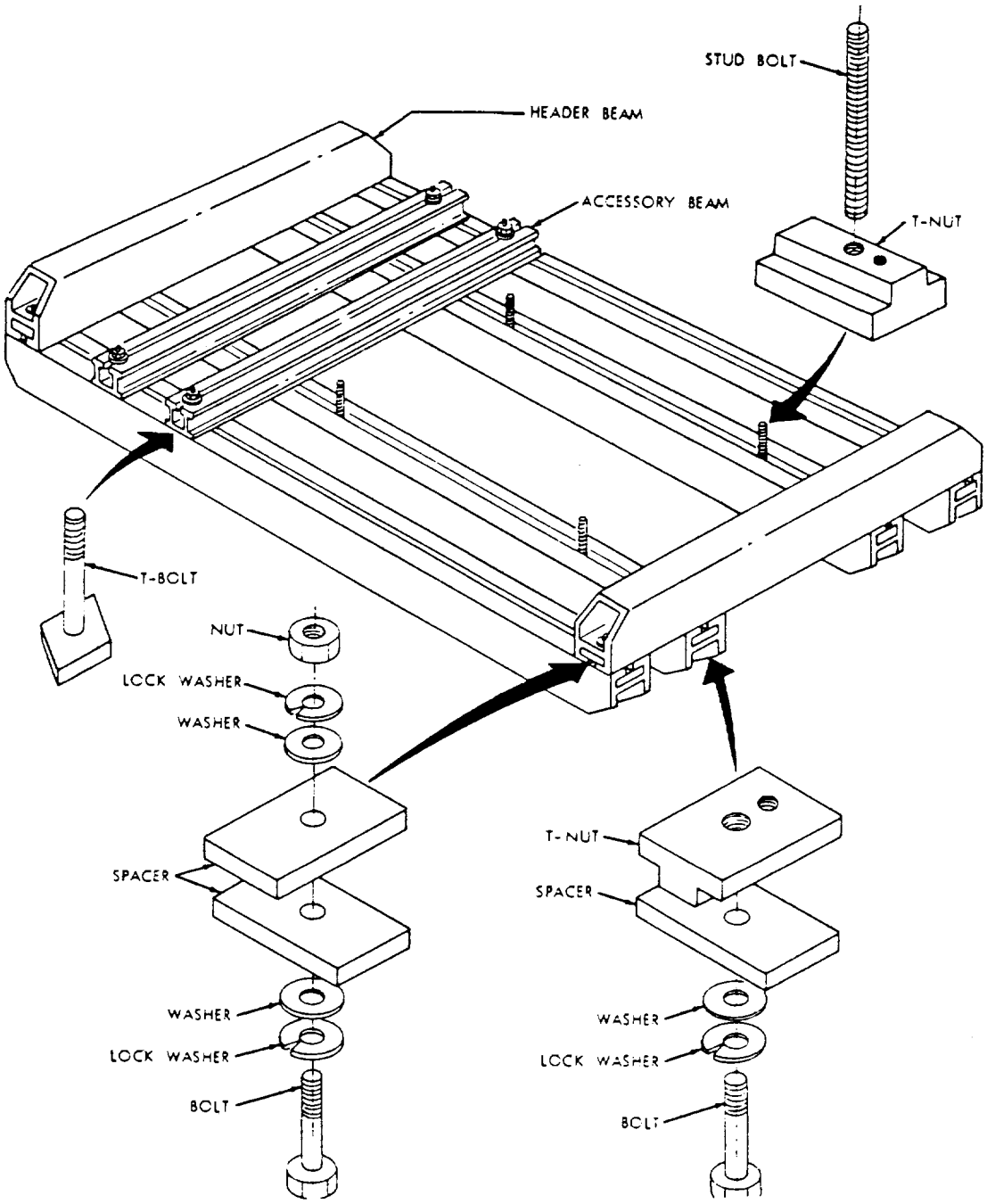


Figure 8-10. Type II Aluminum Skid Assembly

8-11. Buttress Blocking

a. General. Buttress blocking of equipment mounted on skids is required to eliminate end and side movement and to reinforce hold down points (fig 8-11).

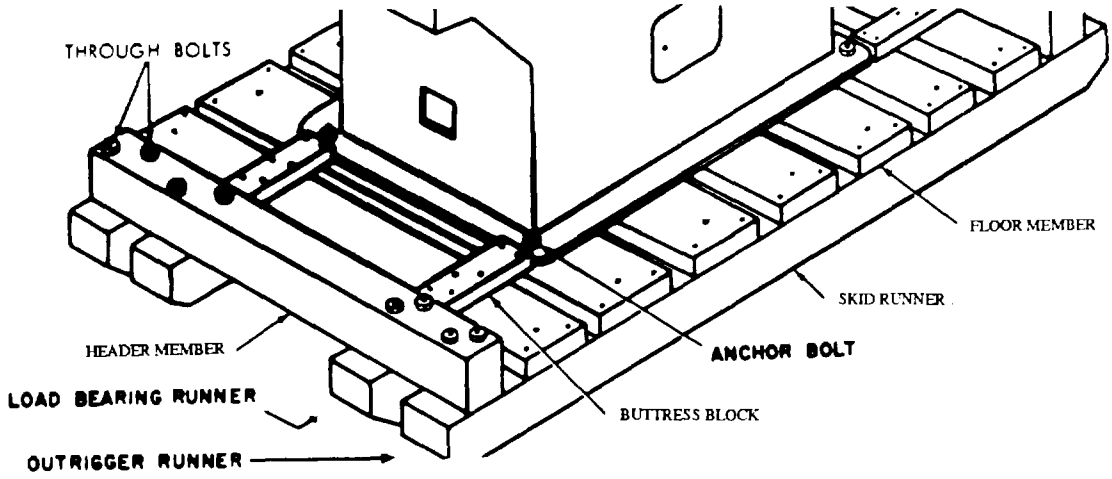


Figure 8-11. Buttress Blocking

(1) All items of IPE moving by rail transportation shall have end buttress blocking.

(2) Equipment moving by other modes of transportation shall be end buttress blocked, as described in MIL-HDBK-701.

(3) Wood used in buttress blocking shall be in accordance with MIL-STD-731.

(4) The size of buttress blocking is dependent upon the weight of the equipment. Refer to MIL-HDBK-701 for buttress block dimensions.

b. End buttress blocking. End buttress blocking shall be placed between the equipment base and the skid header- member on each end of the skid to reinforce hold down bolts or devices and minimize shearing action on the bolts.

(1) Blocking shall be positioned parallel to the runner beams and in line with the equipment hold down bolts.

(2) Buttress blocking is secured by bolts and other hardware, as described in MIL-HDBK-701.

c. Side buttress blocking. Side buttress blocking is required for all items of IPE weighing in excess of 20,000 pounds (9,000kg) or when tie down points do not come in direct contact with the skid member. Side buttress blocks shall be of the same cross section as end buttress blocks and are secured to skid members using not less than 2 1/2 inch (13mm) bolts per block.

8-12. Obtaining Aluminum Skids

Type I and II aluminum skids and aluminum skid components can be obtained from DGSC by annotating the remarks block of DD Form 1348 (MILSTRIP Requisition) or DD Form 1149 (Requisition and Invoice Shipping Document). If approved forms are not available, or when the urgency of the situation warrants, a request may be submitted in writing or by whatever means is deemed expedient. The remarks of the DD Form 1348 or DD Form 1149 shall state that aluminum skids are required for shipment of the item. A complete aluminum skid package with all necessary components for skidding the item will be furnished. If a complete skid package is not required, individual skid components can be obtained from DGSC by listing the components required, and their military part number on the DD Form 1348, DD Form 1149, or other means. The military part numbers for all type I skid components available from DGSC are listed in MIL-HDBK-701, Military Standardization Handbook, Blocking, Bracing, and Skidding of Industrial Plant Equipment for Shipment and Storage. The DGSC point of contact for aluminum skids is DGSC-SSM, 8000 Jefferson Davis Highway, Richmond, VA 23297-5501.

Section V. IDENTIFICATION AND MARKING OF INDUSTRIAL PLANT EQUIPMENT

8-13. Marking Requirements

a. General. All shipments of IPE shall be packed, marked, and labeled in a manner suitable for the mode of shipment to be used.

(1) All unauthorized markings on shipping containers shall be obliterated.

(2) Each shipping container and unpacked machine shall be marked with the address of the intended recipient activity.

(3) Labels shall be used for address markings in preference to tags except when it is impracticable to affix labels.

(4) All markings shall conform to the requirement of MIL-STD-129, unless otherwise required by documentation.

b. Marking materials and methods. All marking shall be accomplished by the use of labels, stamping, stenciling, or printing.

(1) Stenciling shall be accomplished by brushing, rolling, or spraying.

(2) Hand lettering or writing shall not be used unless specifically authorized, except for piece number, total pieces, weight, and cube information.

(3) The location of strapping on containers shall be considered when applying markings. Markings shall never be covered by strapping.

(4) All surfaces to be marked shall be free of oil, grease, and all markings not applicable to the shipment.

(a) Unacceptable markings shall be removed by covering with paint conforming to T-E-515.

(b) A quick drying opaque paint conforming to MIL-P-52108, approximately the color of the container, may be used when approved by the cognizant activity for covering of markings

(5) All markings shall be clear, legible, nonfading, and durable. Markings shall be black except when applied to surfaces on which black is not legible. The color used shall provide a definite contrast. For example, yellow or white lettering shall be applied on lusterless olive drab coloring.

c. Use of labels and tags. Labels (DD Form 1387 (Military Shipment Label)) shall be used for domestic and overseas address marking.

(1) Plain white labels are permitted ft-or contract data and shall be used when required by regulation or statute.

(2) Labels are permitted for markings on shipping containers when the type or size of the shipping container does not permit stenciling.

d. Securing of labels. Labels used on level A, B, and C marking boards shall be securely affixed to containers or marking boards with water-resistant adhesives which shall not smear or blur the markings. Water resistant adhesives conforming to MMM-A-105 or MMM-A-179 may be used.

(1) Labels for level A packs shall be protected by using an overcoating of spar varnish conforming to TT-V- 121 or clear acrylic coating compound conforming to MIL-C- 17504.

(2) Labels for level B and level C packs do not require a protective coating.

e. Size of markings. Lettering for all markings shall be capital letters of equal height and proportional to the available space on the container or marking board. -

(1) Lettering for markings other than the address shall not be less than three-eighths of an inch (9.5m) and not larger than 1 inch (25.4mm) in height.

(2) Lettering for identification, special, and address markings on plastic or cloth tags and paper labels shall be not less than three-thirty seconds of an inch (2.4mm). Markings on metal tags shall not be less than three-sixteenths of an inch (4.7mm).

f. Standard marking, exterior containers. Standard exterior container markings for level A, B, and C packs shall consist of the following (fig 8-12):

(1) Identification markings. The following identification markings shall be placed on each exterior container:

(a) National stock number (NSN) or plant equipment code (PEC) and identification number (ID).

(b) Nomenclature.

(c) Quantity, unit, level, and date of preservation/packing.

(d) Gross weight and cube.

(e) Outside dimensions, whenever a single dimension exceeds 72 inches (1,829mm).

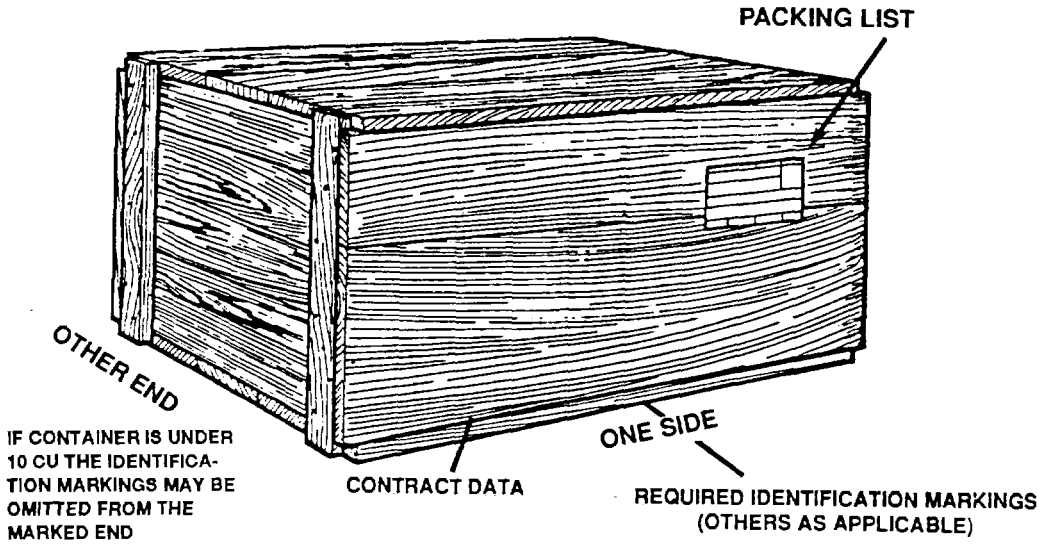


Figure 8-12. Standard Exterior Markings

(2) Outside dimensions.

(a) Outside dimensions shall be shown on all shipping containers, bundles, or secured lifts having any single dimension of 72 inches (1829mm) or over.

(b) Outside dimensions shall be shown in the order of length, width, and height, and shall appear in addition to the cube.

(c) Dimensions shall be shown in inches to the nearest inch and shall be located below the identification data.

(3) Contract data markings.

(a) Contract data markings are standard and are applicable to all shipments originating with a contractor.

(b) These markings shall consist of the contract number, purchase or delivery order number, or modification for change order number, when required, and the name and address of the prime contractor, including ZIP Code.

(c) Whenever supplies and equipment are shipped from a subcontractor, only the name and address of the prime contractor shall be used.

(4) Address markings.

(a) Domestic shipment address. The domestic address marking for transportation priority (TP) I and 2 shipments shall be marked on a red or blue bordered DD Form 1387 (label). Red bordered labels or tags with red numerals shall be used to identify TP I shipments. Blue bordered labels or tags with blue numerals shall be used to identify TP 2 shipments. When the DD Form 1387 is not available at the vendor's plant and the time required to obtain it would preclude meeting the required delivery date (RDD) on a TP I or TP 2 shipment, any available label or tag of the same size may be used provided; 1) the data content is the same as DD Form 1387; 2) red or blue border as appropriate, is applied; 3) approval is obtained from the contracting officer. Shipments to be moved under TP 3 shall be marked on the plain DD Form 1387 . As an alternate for TP 3 shipments, military shipping activities may use the computer generated label or a plain tag, whereas contractors may use any type of label or tag readily available at time of shipment. Labels shall be securely affixed in place with water-resistant adhesive. Labels for level A shipments shall be waterproofed by the appropriate waterproofing compound. The domestic address shall be composed of the transportation control number (TCN), prefixed by TCN ———, (Example TCN A25TBB 3130 0010 XXX), required Delivery Date (RDD) or expedited handling code, project code (when applicable), and transportation priority number-, prefixed as appropriate by RDD ——, PROJ ——, TP——, the name and address of the consignor (bar coded and in the clear), the name and address of the consignee (bar coded and in the clear), and the piece number, total pieces, weight, and cube.

NOTE

ADDRESS MARKINGS SHOWN IN 8-13F4(A) ABOVE, DO NOT APPLY TO SHIPMENTS MOVING IN SUPPORT OF GOVERNMENT CONTRACTORS WHERE THE SHIPMENT IS ACCOMPLISHED BY COMMERCIAL OR GOVERNMENT BILL OF LADING (GBL) FROM, TO, OR BETWEEN CONTRACTORS' PLANTS OR SHIPMENTS FROM THE CONTRACTORS' PLANT WHICH DO NOT ENTER THE DEFENSE TRANSPORTATION SYSTEM (DTS) SUCH AS FIRST DESTINATION SHIPMENTS FROM CONTRACTORS' PLANTS TO MILITARY DEPOTS FOR STOCK OR STORAGE. THE BAR CODED DATA IN 8-13F4(A) ABOVE, IS NOT REQUIRED ON CONTRACTOR SHIPMENTS.

(b) Overseas shipment address. The requirements for the overseas address are the same as those set forth in 8-13f.4(a) and the TCN, RDD or expedited handling code, project code when specified, TP, consignor (bar coded and in the clear). (For contract shipments, the activity address code of the contract administrator followed by the actual shipper shown in the clear). Port of embarkation (POE)/Aerial port of embarkation (APOE) (bar coded and in the clear). Port of debarkation (POD)/Aerial port of debarkation (APOD) (bau coded and in the clear). Consignee (bar coded and in the clear), piece number, total pieces, weight (each piece), and cube (each piece).

g. Special markings. Special markings are those that would identify components, accessories, and attachments being shipped with the basic machine.

(1) Set or assembly markings (fig 8-13).

(a) When a set, assembly, or1 disassembled machine is placed in two or' more containers, the component parts are shipped together'. The basic item shall be numbered as the number one container, and shall carry the records and documentation.

(b) Each container shall have its own number within the set, total number of containers, and the number of the set within each shipment.

(c) A 2-inch (51mm) black circle shall be placed above these numbers on each container as shown in figure 8-13.

(d) All component parts of disassembled items having a serial number shall have the serial number on each container of the set. Example: The black circle, followed below by SET 1 then PK 1 of 5 and under the package number, SERIAL 18063.

(e) If the item has no serial number, then the black circle, set number and package number as indicated in (1)(d) above shall be followed by a date and a capital letter to identify a set. Examples are:

SET 1	SET 2	SET 3
PK 1 of 3	PK I of 3	PK 1 of 3
12-1-76A	12-1-76B	12-1-76C

(f) Set or assembly markings shall be placed on the surfaces containing the identification marking and located in the lower light hand comer.

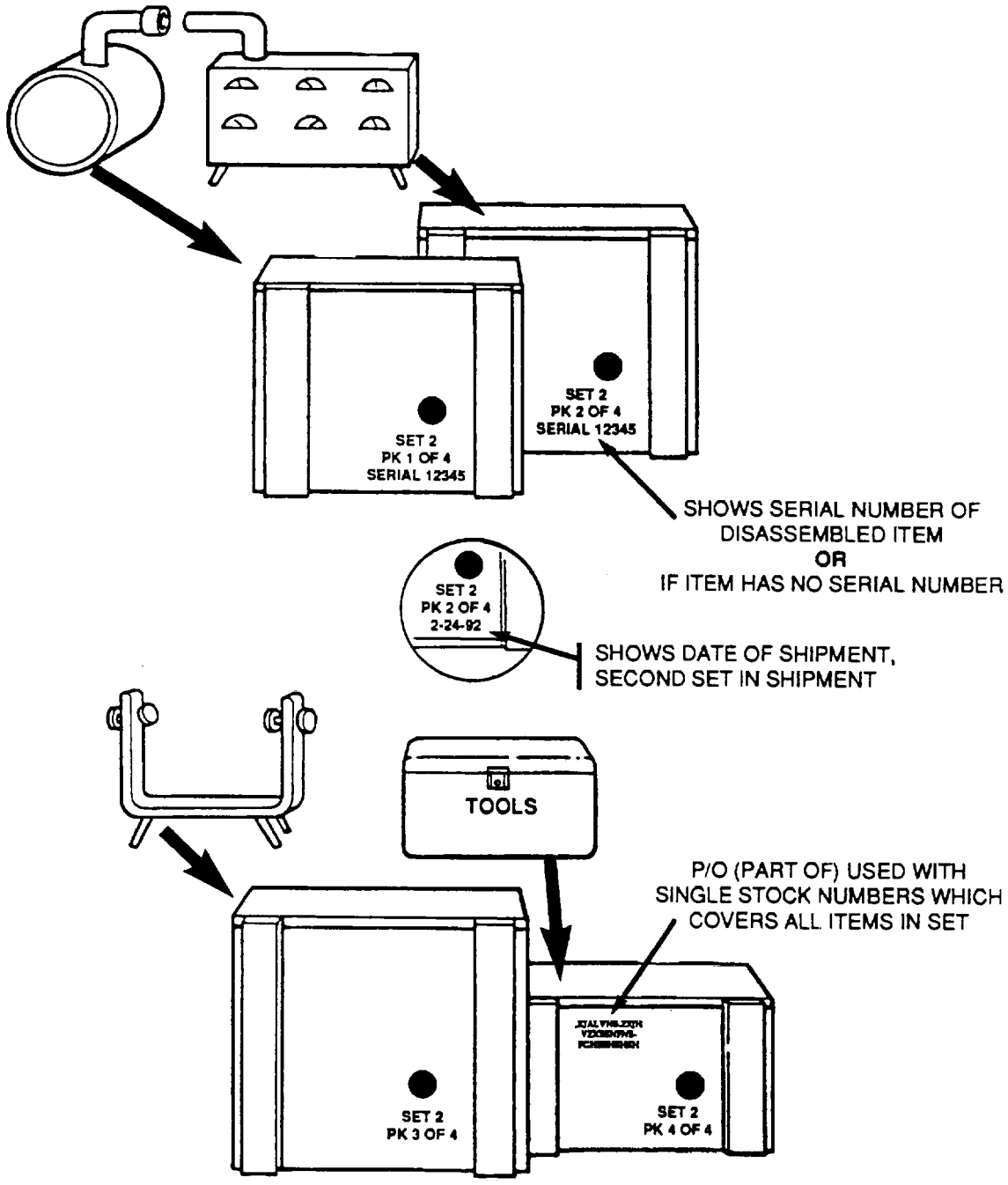


Figure 8-13. Set or Assembly Markings

(2) Arrows. Arrows are used to ensure proper handling of containers when the contents of the container need to be handled with the top surface up.

(a) When placed on containers, the word UP shall be stenciled on two sides of the container with an arrow towards the top of the container.

(b) These markings are affixed when the potential for damaging the contents is caused by tipping the container.

(3) Fragile markings. Fragile markings shall be shown on two surfaces of rectangular containers, which are packed with fragile equipment.

(a) Fragile markings shall be used on containers where the contents are delicate or of a fragile nature.

(b) Fragile labels, stencils, or imprints may be used on containers.

(c) The labels and stencils shall be placed so as to be conspicuous but not interfere with other markings.

8-14. Marking of Unboxed Industrial Plant Equipment

a. Marking of unboxed (skidded) IPE shall be accomplished through the use of a marking panel (fig 8-14).

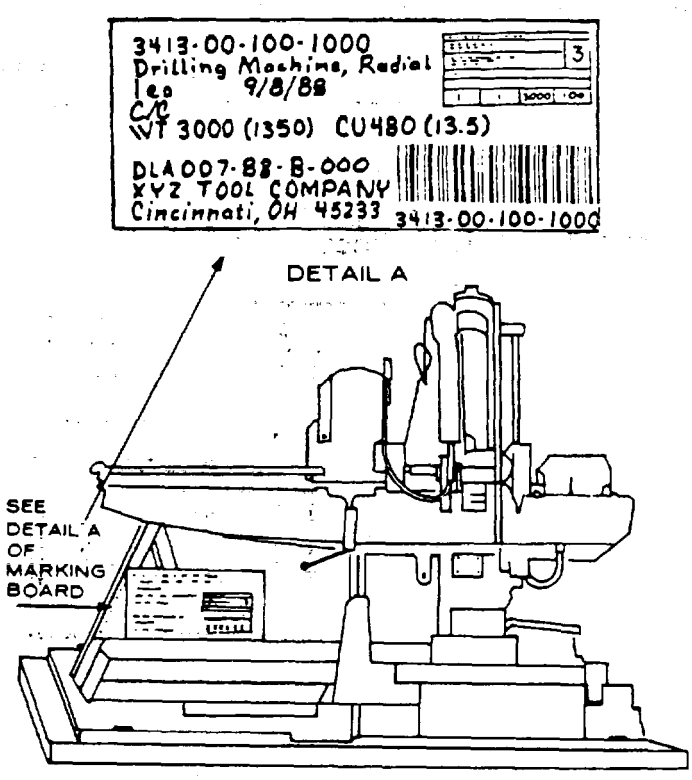


Figure 8-14. Marking of Unboxed (Skidded) Equipment

b. The markings shall consist of the following:

(1) Shipping address (use DD Form 1387 label).

(2) Identification data (may be stencilled or affixed to a plain white label).

(3) Contract data (may be stenciled or affixed to a plain white label).

c. Secure the marking panel in a convenient, but unobstructed location on the skidded equipment.

d. Bar code marking shall be accomplished in accordance with MIL-STD-129 and MIL-STD-1 189.

8-15. Packing Lists

a. A separate packing list shall be prepared on a DD Form 250 for each shipping container and/or shipping unit, regardless of whether it is boxed, crated, loose bundled, skidded, or unskidded. When more than one container is used for a machine, in addition to the packing list for each container, a master packing list shall be prepared.

b. When the items are assigned to, or part of, a specific unit of plant equipment, the packing list shall indicate the PEC and log number of the basic unit and the nomenclature of the parts or component. If Government tag numbers or other identifiers are assigned to these parts or components, they shall be used with the nomenclature.

c. The packing list shall be placed in a water-resistant envelope and securely attached to the outside of the container in the most protected location.

d. No exterior packing list is required for:

(1) Containers having like items.

(2) Kits, providing the contents are listed on a label, lithographed, or listed in a manual within the kit container.

e. As an alternate to the DD Form 250 activities with facilities to program computer output packing lists from Basic Issue Item (BII) cards furnished by commodity managers may use these listings as a packing list for single stock numbered sets, kits, or assemblies.

(1) The contents of the listing shall be so organized as to be readily understood and shall not include information that has no bearing on the items or to the receiving activity.

(2) A DD Form 1149, DD Form 1342, or DD Form 1348-1, may be used as a packing list for IPE shipments, provided the forms are marked to the effect that they constitute a packing list.

Section VI. LOADING OF INDUSTRIAL PLANT EQUIPMENT

8-16. Purpose

a. General. Considerable damage to IPE continues to occur due to improper blocking, bracing, or tie down of the equipment on the transporting vehicle.

(1) Personnel engaged in securing IPE to the transporting vehicle should recognize the various forces that develop when the transporting conveyance is placed in motion or is braked to slow or stop it.

(2) Personnel engaged in the loading of IPE should adhere to published instructions, employ correct equipment, and follow loading diagrams. Failure to do this generally results in hazardous conditions developing during the movement of IPE aboard transporting vehicles.

b. Planning. The loading, blocking, and bracing of IPE for shipment requires extensive planning of the complete complement of equipment rather than each item or each load.

(1) Movement of IPE seldom consists of a number of items with similar weights, dimensions, or handling characteristics.

(2) The individual weights and dimensions, handling facilities at origin and destination, skid dimension, and the modes of transportation must be evaluated.

(3) By careful planning of the loading, IPE can be manipulated into an accumulation on the transportation unit that will provide:

(a) Space for application of blocking and bracing.

(b) Proper weight distribution over the floor of the transportation unit.

(c) Adequate weights to meet the carrier's published rate minimums.

(d) An arrangement requiring a minimum of blocking and bracing materials.

8-17. Inspection of IPE Before Shipment

Prior to shipment, IPE shall be inspected to determine that it has been prepared for shipment in accordance with this manual, MIL-STD-107, and MIL-HDBK-701.

8-18. Publications

a. Loading, blocking, and bracing requirements vary with the different modes of transportation and the type of equipment furnished by the carriers. Basic requirements of each type of transportation are published by the various carriers covering tariffs, classifications, loading rules, or other publications.

b. The most complete collection of rules and regulations pertaining to the loading, blocking, bracing, and handling of machinery is published by The Association of American Railroads (AAR). These publications provide detailed guidance in connection with the loading procedures for rail movement. The techniques described therein also have application to loading for other modes of transportation.

8-19. Selection of Carrier Equipment

a. Equipment furnished by the carriers should be inspected by the shipper to detect the presence of corrosive elements from the previous loading. Evidence of salt, sulfur, or carbide would be cause for rejection of carrier equipment.

b. Carrier equipment accepted for loading must have sound and reasonably smooth floors and be equipped with substantial intermediate floor supports. Floors must be of a condition to prevent the seepage of water, dust, or other elements.

c. With the exception of barges, only carrier equipment with wooden floors should be loaded. Metal floors do not provide the natural fiction afforded by the wood-to-wood contact, or metal-to-wood contact in the case of aluminum skids, nor do they provide the flexibility in blocking and bracing.

8-20. Wood Materials

a. All wood materials used in the blocking and bracing of IPE on carrier conveyances shall be as specified in MIL-STD-73 1.

b. Any of the wood species used shall be as specified in the Rules and Regulations published by the AAR.

8-21. Shipment by Open Conveyance

a. The final step in preparing an item of IPE for transportation is to protect the item from contamination by water-, dirt, or other elements.

(1) All shipments of machine tools made on an open conveyance must be protected by watershed tarpaulins, plastic sheet, or strip thin gauge polyolefin conforming to L-P-378, class I, type I, or waterproof barrier material conforming to PPP-B-1055 class E, or heavier. The scams shall be sealed with water-resistant adhesive conforming to MMM-A-260.

(2) This shrouding shall not be accomplished until the carrier's representative has had opportunity to inspect the loading, blocking, and bracing.

b. All sharp corners and projections of equipment shall be padded and cushioned to prevent rupture of the shroud material.

c. Shrouds will be draped in a manner to fully cover the item of IPE and skid assembly, and then secure the shroud to the floor of the conveyance with nailed wood battens.

d. The shroud is draped in a manner to eliminate water pockets from forming then roped tightly so that it assumes the contour of the machine to minimize air pockets.

8-22. Transportation Mode

a. Transportation mode. Except for shipment of delicate equipment, such as MCUs and other fragile items, all IPE may be shipped by motor carrier, ship, or air transportation as specified by the shipping activity. Due to the high susceptibility of delicate electronic and electrical items to damage from vibration and shock, these items shall be shipped on specialized equipment available from the carrier for movement of fragile items. Regardless of the mode of transportation, the equipment shall be processed, loaded, and shipped in a manner that will protect the equipment to the maximum extent possible. The transportation mode shall comply with the 49 CFR 100 through 199.

b. Transportation mode for numerically controlled equipment. All numerically controlled equipment, including machine control units, accessories, components, and assemblies, shall be shipped in air ride vans only. To realize the maximum protection in the usage of air ride vans, the equipment should be located over the rear wheels of the van. The transportation mode shall comply with 49 CFR 100 through 199.

c. Waiver of transportation mode. When it is determined to be more economical or otherwise in the best interests of the Government to relax the transportation mode or when air ride vans cannot be utilized due to size, weight, or configuration of the item, a written request for waiver shall be addressed to: Defense General Supply Center (DGSC), ATTN: DGSC-SSM, 8000 Jefferson Davis Highway, Richmond, VA 23297-5501.

d. Shipping covers for MCUs. All machine control units shall be protected by enclosing them in material conforming to L-P-378 or PPP-B-1055, class E or heavier. The seams shall be sealed with water resistant adhesive conforming to MMM-A-260.

8-23. Equipment on Wood Skids, Rigid Method

a. For equipment weighing less than 20,000 pounds (9,072kg) a cross block, the full width of the car floor with its width and height equal to the skid runner, is placed tightly against each end of the skid assembly and secured to the car floor with bolts. The bolts are evenly distributed

the length of the cross car block using metal plates at least 4 (102mm) by (102mm) by five-sixteenths inch (8mm) on the cross car block and 4 (102mm) by 4 inch (102mm) by one-half inch (13mm) under the car floor.

b. The cross bar blocks are reinforced by backup blocks located lengthwise to the car in line with each skid runner.

(1) Backup blocks consist of 2 (51mm) by 4 inch (102mm) material, not less than 18 inches (457mm) in length, laminated to be equal in height to the cross car block.

(2) The lower piece of the lamination is secured to the car floor with six or more 30d nails staggered over the length, with each lamination nailed in a like manner.

(3) When possible, the blocks shall be abutted to stakes inserted in the pockets at the end of the car or to the end walls when loading box cars.

c. To prevent side movement of the skid assembly, a cleat equal in length to the skid runner is placed against each side of the skid assembly.

(1) For skid assemblies with 4 (102mm) by 4 inch (102mm) runner beams, the cleat is of 2 (51mm) by 4 inch (102mm) material, secured to the car floor with 30d nails staggered not more than 12 inches (305mm) apart.

(2) For skid assemblies with runners of greater than 4 (102mm) by 4 inch (102mm) material, the lengthwise cleat is of 4 inch (102mm) material, secured to the car floor with spikes or bolts.

d. Backup blocks of equivalent height and not less than 12 inches (305mm) in length shall be nailed to the car floor perpendicular to the cleat.

(1) When clearances do not permit a 12 inch (305mm) backup block, the car walls, or stakes shall be used.

(2) At least two backup blocks shall be used at each side, and additional blocks shall be installed to provide not more than 30 inch (762mm) spacing.

e. When stakes are used, they shall be 4 (102mm) by 5 inches, (127mm), cut and tapered to fit all stake pockets opposite the skid assembly. The stakes shall extend at least 4 inches (102mm) below the stake pocket and be held in place with a 40d nail driven into the stake directly below with the head even with the outside of the stake pocket.

f. Type II runner beam skids over 10 feet (3m) long shall be blocked with 4 inch (102mm) wood blocks nailed in place between the outrigger and load bearing runner beams not more than 30 inches (762mm) apart.

g. For equipment weighing more than 20,000 (8,072kg), the cross car block shall be increased to 6 (152mm) by 8 inches (203mm) and the lamination backup blocks shall be increased to 2 (51mm) by 6 (152mm) by 36 inch (914mm) pieces. The two larger dimensions shall be parallel to the floor.

h. Machines with a high center of gravity (top-heavy) are secured to prevent tipping in any direction with rods or cables. Steel banding is not recommended for this use.

(1) Cables must have double turns at points of attachment and must have thimbles secure with a 2-bolt cable clamp to prevent sharp turns.

(2) Rods or cables must be secured only to substantial portions of the machine castings, and any contact with precision surfaces shall be avoided.

8-24. Snubbing Methods

Blocking and bracing by the snubbing method when required, shall be in accordance with MIL-HDBK-701.

8-25. Motor Carrier Shipments

a. The rules, regulations, and methods pertaining to loading, blocking, and bracing motor carrier shipment of IPE are limited to those published in freight classifications and tariffs.

(1) In general, these publications contain information pertinent to methods of packaging, such as loose, skidded, boxed, or crated items.

(2) Specific guidance, such as that furnished by the AAR, governing the loading of equipment on open and closed cars, is not provided by the Motor Carrier Industry.

(3) The application of the principles and recommended methods of the AAR publications to the loading of motor carrier equipment will result in carrier acceptance, and under the normal hazards of truck transportation, will provide damage-free movement.

b. Due to the variance in load limits, clearance, and restrictions established by regulatory bodies, loading shall be accomplished taking cognizance of all limitations to be encountered on the entire route. The best source of information concerning restrictions that may be involved is the appropriate Military Traffic Management Command (MTMC) area office or the carrier designated by that agency in the routing.

c. When IPE is loaded on motor carrier transportation units, the following requirements shall be adhered to:

(1) IPE shall be prepared for shipment in accordance with DGSC's shipping instructions, as necessary, to meet applicable carrier requirements.

(2) Loading of IPE on carrier equipment shall be in accordance with the applicable tariff and/or regulatory directive. If this is not available, loading shall be in accordance with instructions of the carrier's representative.

(3) Securing of loads shall be by means of approved tie-down devices giving due consideration to the item(s) as prepared for shipment, the carrier equipment being used, and instructions of the carrier's representative. If no blocking and bracing is accomplished, this fact should be indicated on the GBL or other shipping documents.

(4) IPE with a high center of gravity shall be given particular attention in securing it to carrier equipment to eliminate or reduce the hazards that are inherent in transporting this type of equipment.

(5) The responsible transportation element for the shipping activity shall provide accurate weight information on shipping documents, bills of lading, and related papers. When exact weights are unknown, the estimated weight shall be used in accordance with AR 55-355.

d. In the selection of motor carrier equipment, the dimensions, weights, handling facilities, and type of equipment to be loaded shall be considered.

(1) The "high-cube" type trailers are similar in length to flat-bed, open-top, or standard closed trailers.

(a) The front of the trailer can only be utilized for items approximately 6 feet (1.829m) long since the additional foot is required for blocking.

(b) The rear portion of the trailer that is 31 feet (9.449m) is reduced to 29 feet (8.839m) of loading area due to loss for blocking material.

(c) Except when skid assemblies are of a size adaptable to loading, the "high-cube" type trailers are not recommended for use.

(2) The heavy or specialized carriers make use of "flat-bed" and "low-boy" type trailers which are particularly advantageous since the trailer equipment is designed for movement of TPE and heavy material.

(a) The low-boy trailer is adaptable for loading and handling equipment with a high center of gravity.

(b) The use of these types of trailers will also require protection from the elements; therefore, the final step in preparing IPE would be covering it with waterproof tarpaulins, vinyl coated fabric covers, or nylon reinforced laminated plastic sheets.

8-26. Blocking Motor Carrier Shipments

a. Open-top and closed trailers. The positioning of skid assemblies on open-top and closed trailers shall be in a manner which will provide equal weight distribution, as related to the right and left sides of the transportation unit.

(1) With this requirement, skids shall be loaded in a manner that will make use of the greatest amount of floor space possible and at the same time reduce the amount of blocking and bracing materials required under normal motor carrier movement.

(2) Lengthwise impacts are of a lesser degree than encountered in rail movement.

(3) Side movement, although not as prevalent in motor transportation, is more hazardous since corners, curves, and pitch of the roadbed place a greater thrust on the upper extremities of the load.

b. Flat bed and low-boy trailer. IPE shall be positioned on flat bed and low-boy type trailers as specified by the carrier representative's instructions. This shall include the necessary instructions for the securing of top heavy machines.

8-27. Barge, Inland Waterways

a. The use of the inland waterways and barges provides a low cost method of movement for IPE and a capacity for transporting tremendous volumes with little or no damage during transit. Although considered slow moving, a complement of machines may be transported with less overall transit time than when other modes are utilized.

b. The versatility of barge movement is limited to the navigable waterways as related to the location of IPE. When employing a transportation service in addition to the water movement, the plant equipment shall be protected for all modes of transportation involved in the movement.

c. About 300 tons (270 metric tons) of IPE of average size and density may be loaded in a 35 (32m) by 196 foot (179m) barge. When handling facilities are available at the origin and destination, barge transportation provides an ideal method of movement.

d. Barge loading shall be accomplished in such a manner as to ensure an even draft.

(1) When required, the carrier may require realignment of the load to connect the draft. When retention time for correction exceeds the "free time," based upon tons loaded, a demurrage, or shipping charge for detention will be assessed against the shipper.

(2) Blocking and bracing shall provide the protection necessary for safe movement on inland waterways.

(3) Skidded equipment shall be positioned in the hold as closely together as possible, leaving space only for removal and application of lifting devices.

(4) To facilitate unloading operations, the skidded equipment shall be placed on dunnage, spaced to provide a balanced distribution of weight.

e. When items of IPE are of a height exceeding the headroom in the barge, the telescope cover is left open, adjacent covers are secured, and the open area protected with tarpaulin or other waterproof material after cushioning the projecting portion of the machine.

SECTION VII. PACKING, CRATING, HANDLING AND TRANSPORTATION COSTS (PCH&T)

8-28. Purpose

a. General. Whenever IPE is prepared for storage or shipped from a contractor's plant the Packing, Crating, Handling and Transportation (PCH&T) costs are normally funded through the issuance of an amendment to the existing production or facilities contract.

(1) This contract change is issued to the contractor by the Administrative Contracting Officer (ACO), who also provided the PCH&T instructions along with the shipping instructions and funding information. PCH&T instructions are prepared by the ACO's contract administration packaging specialist.

(2) PCH&T costs funded by DGSC do not include funds for any work other than PCH.

b. Other cost factors. Since the DGSC funding for PCH&T does not include funds for other work, it is essential that there is a clear distinction between strictly PCH&T work and other work.

(1) Other work includes shutdown cleaning, interim preservation, disassembly, disconnection, building alterations and restoration, displacement of other equipment to facilitate the movement of IPE, interruption of contractor production, and other similar activities.

(2) These other costs must be considered to be either a part of the contractor's maintenance procedures (shutdown preservation) or fundable directly under the production of a facilities contract.

8-29. Costs to be Charged to Packaging, Crating, and Handling

a. The costs most commonly assigned to packaging, crating, and handling are listed below:

(1) The cost of material, including cleaning and drying materials, preservatives, wraps, barrier materials, cushioning materials, containers, labels, tags, tapes, strapping materials, equipment, lumber, and skids.

(a) In addition to the cost of the materials, additional costs are incurred which include the cost of procuring, storing, controlling, moving, protecting, and assuring the quality of these

(b) The cost of financing the inventory and disposing of scrap and surplus materials must also be considered.

(2) The cost of labor, tools, amortized capital equipment, maintenance storage space, utilities, production controls, and industrial engineering must be taken into consideration.

(3) The cost of documentation is another factor to be considered. This includes such items as GBL, Commercial Bills of Lading (CBL), and various Department of Defense forms used in declarations and inventory movement reports.

(4) The cost of damage and/or the repair or replacement factors cannot be ignored. Extensive damage to IPE could render the equipment unrepairable and consequently a total loss.

(5) The cost of administrative services must be included. These costs consist of training, research operations, specification and contract review and negotiation, and maintaining a technical library.

8-30. Estimating Costs

a. A few years ago, packaging specialists had very few sources of information to use when estimating PCH&T costs. Many relied on their own experience to estimate these costs.

b. Today, the packaging specialist has several sources of information that will assist in estimating PCH&T costs. One of these is the cost matrix of Appendix B.

8-31. PCH&T Cost Matrix

Whenever IPE is prepared for storage or shipment an analysis shall be made to determine the actual costs involved. The PCH&T cost matrix is helpful in estimating PCH&T contracts. The cost matrix is for illustrative purposes only and does not necessarily reflect current material prices. Also see Appendix B for accompanying examples and instructions.

8-32. Changes from Previous Issues

Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extensive number of changes.

APPENDIX A

REFERENCES

A-1. Applicable documents

The following is a list of all commercial item descriptions, specifications, and standards referred to in this publication.

MILITARY SPECIFICATIONS	TITLE
A-A-880	Strapping, Steel Flat and Seals
A-A-1898	Cushioning Material, Cellulosic, Packaging
L-P-378	Plastic Sheet and Strip, Polyolefin
TT-P- 102 VOC)	Paint, Oil (Alkyd Modified, Exterior, Low
TT-F-322	Filler, Two-Component Type for Dents, Cracks, Small Holes, and Blow Holes
TT-V-121	Varnish, Spar, Water-Resisting
TT-T-291	Thinner, Paint, Mineral Spirits, Regular and Odorless
TT-E-489	Enamel, Alkyd Gloss (Low VOC Content)
TT-E-515	Enamel, Alkyd, Lusterless, Quick Drying
TT-C-598	Caulking Compound, Oil and Resin Base Type (For Masonry and Other Structures)
TT-P-664	Primer Coating, Alkyd, Corrosion-Inhibiting, Lead and Chromate Free, VOC-Complant
UU-T-81	Tags, Shipping and Stock
VV-L-800	Lubricating Oil, General Purpose Preservative (Water Displacing, Low Temperature)
MMM-A-105	Adhesive and Sealing Compounds, Cellulose, Nitrate Base, Solvent Type

MMM-A-179	Adhesive: Paper Label
MMM-A-260	Adhesive, Water-Resistant (For Sealing Waterproofed Paper)
PPP-P-40	Preservation and Packing of Hand Tools; Tools and Tool Accessories for Power Driven, Metal and Wood-working Machinery
PPP-T-60	Tape, Packaging Waterproof
PPP-T-76	Tape, Packaging, Paper (For Carton Sealing)
PPP-B-601	Box, Wood, Cleated-Plywood
PPP-B-621	Boxes Wood, Nailed and Lock Comer
PPP-D-729	Drums, Shipping and Storage, Steel, 55 Gallon (208 liters)
PPP-C-850	Cushioning Material, Polystyrene
PPP-B- 1055	Barrier Material, Waterproof, Flexible
PPP-C-1752	Cushioning Material, Packaging, Polyethylene Foam
PPP-C-1797	Cushioning Material Resilient, Low Density, Unicellular, Polypropylene Foam
MIL-C-104	Crate, Wood, Lumber and Plywood Sheathed, Nailed and Bolted
MIL-P- 116	Preservation, Methods of
MIL-B-121	Barrier Material, Greaseproofed, Waterproofed, Flexible
MIL-V- 173	Varnish, Moisture and Fungus Resistant (for Treatment of Communications, Electronics and Associated Equipment)
MIL-C-3774	Crate, Wood: Open 12,000- and 16,000-Pound Capacity

MIL-C-5501	Caps and Plugs, Protective, Dust and Moisture Seal
MIL-H-5606	Hydraulic Fluid, Petroleum Base, Aircraft, Missile and Ordnance
MIL-H-6083	Hydraulic Fluid, Petroleum Base, for Preservation and Operation
MIL-S-9968	Skid Components, DOD Reusable
MIL-C- 10578	Corrosion Removing and Metal Conditioning Conditioning Compound (Phosphoric Acid Based)
MIL-G-10924	Grease, Automotive and Artillery
MIL-V-13811	Varnish, Waterproofing, Electrical, Ignition
MIL-C-15074	Corrosion Preventative Fingerprint Removal
MIL-C-16173	Corrosion Preventive Compound, Solvent Cutback, Cold Application
MIL-C-17504	Coating Compound, Acrylic, Clear
MIL-E-17555	Electronic and Electrical Equipment, Accessories, and Provisioned Items (Repair Parts) Packaging and Packing of
MIL-L-21260	Lubricating Oil, Internal Combustion Engine
MIL-B-22191	Barrier Materials, Transparent, Flexible, Heat Sealable
MIL-G-23827	Grease, Aircraft and Instrument, Gear and Actuator Screw
MIL-I-24768/9	Insulation, Plastic, Laminated, Thermosetting, Nylon-Fabric-Base, Phenolic-Resin (NPG)
MIL-B-26195	Boxes, Wood-Cleated, Skidded, Load-Bearing Base
MIL-D-28594	Dehumidifier, Rotary, Dry-Desiccant Type, Automatic, Continuous Duty

MIL-P-52108	Paint, Water Emulsion Type (for Stenciling and Obliterating)
MIL-C-52950	Crate, Wood, Open and Covered
MIL-H-81322	Grease Aircraft, General Purpose, Wide Temperature Range
MIL-B-81705	Barrier Materials, Flexible, Electrostatic-Protectable, Heat Sealable

MILITARY STANDARDS

MIL-STD-107	Preparation and Handling of Industrial Plant Equipment for Shipment and Storage
MIL-STD-120	Gage, Inspection
MIL-STD-129	Marking for Shipment and Storage
MIL-STD-731	Quality of Wood Members for Containers and Pallets
MIL-STD-1186	Cushioning, Anchoring, Bracing, Blocking and Waterproofing with Appropriate Test Method
MIL-STD-1189	Standard Department of Defense Bar Code Symbology
MIL-STD-1191	Foam-in-place Packaging, Procedures for
MIL-STD-2073- 1	DOD Material Procedures for Development and Application of Packaging Requirements
MIL-STD-2073-2	Packaging Requirement Codes

TECHNICAL MANUALS

TM 38-230-1	Packaging of Materiel and Preservation (Volume I)
TM 38-230-2	Packaging of Materiel and Preservation (Volume II)

ARMY REGULATIONS	
AR 55-355	Military Traffic Management Regulation
AR 70-44/OPNAVINST 4600.22B/AFR 80-18/MCO 4610.14C/DLAR 4500.25	DOD Engineering for Transportability
AR 700-15/DLAR4145.7/NAVSUPINST 4030.28C/AFR 71-16/MCO 4030.33C	Packaging of Materials
FORMS	
DD Form 250	Materiel Inspection and Receiving Report
DD Form 1149	Requisition and Invoice/Shipping Document
DD Form 1348M Document (Manual)	DOD Single Line Item Requisition System
DD Form 1348-1	DOD Single Line Item Release/Receipt Document
DD Form 1384	Transportation and Control Movement Document
DD Form 1387	Military Shipping Label
DGSC Form 900-1000 Series	Test Patterns
MISCELLENOUS	
ASTM D 3950	Strapping, Plastic (and Seals)
ASTM D 3951	Standard Practice for Commercial Packaging
ASTM D 3953	Strapping Steel, Flat and Seals
ASTM D 4675	Flat Strapping Materials, Selection and Use of
DOD-STD-1686	Electrostatic Discharge Control Program For Protection of Electrical and Electronic Parts, Assemblies and Equipment Excluding Explosive Devices

FED-STD-595	Colors Used in Government Procurement
MIL-HDBK-701	Blocking, Bracing, and Skidding of Industrial Plant Equipment for Shipment and Storage

APPENDIX B

COST ESTIMATING GUIDE

INSTRUCTIONS:

1. Divide machine tools into the following weight classifications:

    a. Up to 3,999 lbs.

    b. 4,000- 8,000 lbs. (3 ton class).

    c. 8,001-16,000 lbs. (6 ton class).

    d. 16,001-32,000 lbs. (12 ton class).

    e. over 32,000 lbs.

2. To calculate the cost of layaway for machines under 4,000 lbs., you must first add all the weights together for the items that fall in this weight class. This total weight should be divided by 4,000 lbs. If the result includes a decimal of .5 or above it should be rounded up to the nearest whole number. If the decimal is below .5, it should be rounded down to the nearest whole number. Add this whole number to the number of machines in the 3 ton weight class.

e.g	machine 1	+	machine 2	+	machine 3	+	machine 4	=	total weight
	1200	+	3599	+	1380	+	3999	=	10,178 lbs.

total wt./4,000 lbs = number of machines in the 3 ton class.
10,178/4,000 = 2.54 - round to 3 and add to the 3 ton class.

3. To calculate the cost of layaway for machines over 32,000 lbs., you must add the weights together for all items that fall over 32,000 lbs. This total weight should be divided by 24,000 lbs., the median weight for the 12 ton weight class. The whole number portion of the quotient equals the number of equivalent 12 ton weight class items. Add this whole number to the quantity of machines in 1d. Any remainder should be weight classed as applicable; if under 4,000 lbs., add one 3 ton machine to the quantity established in section 1b.

4. Total up the items for each weight class.

5. Select the series of layaway actions applicable to each weight class, i.e., flush, disconnect, load and brace, etc., page B-3.

6. For layaway actions in each weight class, multiply the work hours time the local commercial labor rate.

7. Estimates for processing, packaging, packing, and loading of tooling are calculated by determining the replacement value of the tooling and manufacturing aids not standard to the basic machine and multiplying this quantity by 6 percent or .06.

8. The average cost for transporting machine tools by truck is $1.02 per mile regardless of weight, with a maximum truckload of 45,000 pounds. Rates are averages and vary greatly by shipping origin and destination. Multiply $1.02 by the number of miles the truck must travel to deposit the equipment in storage to obtain the truck transportation estimate.

9. Total all costs for material, labor, tooling, and transportation. Two examples are provided in this appendix.

COST ESTIMATING GUIDE FOR LAYAWAY OF IPE

	3 Ton (4,000-8,000 lbs)		6 Ton (8,001-16,000 lbs)		12 Ton (16,001-32,000 lbs)	
LAYAWAY ACTION	**MAN HOURS**	**MATERIAL**	**MAN HOURS**	**MATERIAL**	**MAN HOURS**	**MATERIAL**
1. FLUSH	6	65.00	8	75.00	15	162.00
2. DISCONNECT	4	6.00	4	12.00	6	21.00
3. CLEAN EXTERIOR	4	18.00	5	28.00	8	47.00
4. DISASSEMBLY -CLEAN-REASSEMBLY	42	38.00	66	60.00	78	81.00
5. PRESERVE LEVEL “A”	8	65.00	14	159.00	20	224.00
6. PRESERVE LEVEL “C”	5	38.00	6	60.00	8	81.00
7. MOVE TO SKID & BOX AREA	2	31.00	6	53.00	10	79.00
8. SKID & BOX (ALUM SKID)	12	38.00	14	49.00	22	60.00
9. SKID & BOX (WOOD SKID)	20	405.00	20	1235.00	32	1500.00
10. MOVE TO LOADING DOCK	2	24.00	4	34.00	6	49.00
11. LOAD & BRACE (TRUCK)	3	43.00	5	53.00	6	63.00
12. LOAD & BRACE (RAIL)	8	65.00	14	117.00	20	172.00
13. SHROUD (POLYETHYLENE)	3	21.00	6	37.00	12	63.00
14. MOVE TO STORAGE AREAS-LEVEL	3	27.00	6	47.00	8	71.00
15. RECORDS & OFFICE	4	18.00	4	18.00	4	18.00
16. INCIDENTALS/MISC	4	13.00	4	13.00	4	13.00

NOTE: This cost estimating guide does not provide estimating factors for the following:

1. Receiving & placement charges.
2. Shipment by barge.
3. Analytical Inspection.
4. Presses.
5. Elephant tools.
6. Furnaces.
7. Tanks, above or below ground.
8. Conveyors.
9. Cranes.
10. Rolling stock.
11. Electronic & communications equipment.
12. Plant rehabilitation.
13. Electric power components.
14. Numerically controlled equipment.
15. Dust Collecting & abrasive or blast systems.
16. Glass forming & delicate items.
17. Special test equipment.
18. Non-severables.

SAMPLE PCH&T ESTIMATES

EXAMPLE 1: LAYAWAY OFF SITE FOR A 12,000 lb. MILLING MACHINE. ASSUMING A LABOR RATE OF 38.16/HOUR, 3500.00 TOOLING REPL COST, AND 500 MILES TO TRANSPORT.

LAYAWAY ACTIONS		6 TON (800-16,000 lbs) MAN HRS	MATERIAL
.1.	FLUSH	8	75.00
.2.	DISCONNECT	4	12.00
.3.	CLEAN EXTERIOR	5	28.00
.4.	DISASSEM-CLEAN-REASSEMB	66	60.00
.5.	PRESERVE LEVEL'A'	14	159.00
.6.	PRESERVE LEVEL'C'*	6	60.00
.7.	MOVE TO SKID & BOX AREA	6	53.00
.8.	SKID & BOX (ALUM SKID)	14	49.00
.9.	SKID & BOX (WOOD SKID) *	20	1235.00
10.	MOVE TO LOADING DOCK	4	34.00
11.	LOAD & BRACE (TRUCK)	5	53.00
12.	LOAD & BRACE (RAIL) *	14	117.00
13.	SHROUD (POLYETHYLENE)	6	37.00
14.	MOVE TO STORAGE AREAS-LEVEL	6	47.00
15.	RECORDS & OFFICE	4	18.00
16.	INCIDENTALS/MISC	4	13.00
		186 M/H	2050.00

Manhours 186 X 38.16/HR commercial labor rate	= 7097.76
Material cost	= 2050.00
Tooling cost .06 X 3500.00 estimated tool repl	= 210.00
Transportation) 1.02 X 500 miles	= 510.00
Estimated PCH&T Cost for (1) 12,000 lb. Mill	9867.76

*This chart is intended to show all actions to be considered. Some layaway actions may not be required depending on the disposition of the IPE. Labor rates and material costs will vary based on geographic location. Labor rates used are for example only. Results of this calculation are estimates.

EXAMPLE 2 LAYAWAY IN PLACE TO LEVEL "A" FOR (3) 3000 lb. DRILLS. ASSUMING A LABOR RATE OF 20.00/HR, 2000.00 TOTAL TOOLING REPL COST FOR 3 DRILLS, AND 1000 MILES TO TRANSPORT.

3000 + 3000 + 3000 = 9000 lbs. total wt. (3) drills; 9000/4,000 = 2.25 round down 2 machines. Conversion to 3 ton class.

LAYAWAY ACTIONS	MAN HRS	3 TON (4000-8,000 lbs) MATERIAL
1. FLUSH	6	65.00
3. CLEAN EXTERIOR	4	18.00
4. DISASSEM-CLEAN-REASSM	42	38.00
5. PRESERVE LEVEL'A'	8	65.00
13. SHROUD	3	21.00
15. RECORDS & OFFICE	4	18.00
16. INCIDENTALS/MISC	4	13.00
	71	238.00

71 M/H X 20.00/HR Labor = 1420.00
Material cost = 238.00 TRSPN 1.02 X 1000 Mi = 1020.00
Tooling .06 X 2000 = 120.00

= 1658.00 X 2 (4 Ton Equiv. Mach) = 3316.00

ESTIMATED PCH&T FOR (3) 3000 lb. DRILLS = 4456.00

APPENDIX C

PRODUCTION EQUIPMENT REPLACEMENT FACTORS

AS OF SEPTEMBER 1990

YEAR OF ACQUISITION	METALWORKING MACTIHNERY EQUIPMENT*	METAL CUTTING & METAL, FORMING MACHINE TOOLS**	SPECIAL TOOLING ***	SPECIAL TEST EQUIPMENT****
1993	1.00	1.00	1.00	1.00
1992	1.01	1.01	1.02	1.02
1991	1.04	1.03	1.04	1.05
1990	1.08	1.07	1.08	1.09
1989	1.12	1.15	1.11	1.24
1988	1.16	1.20	1.14	1.28
1987	1.20	1.24	1.16	1.30
1986	1.22	1.27	1.17	1.32
1985	1.24	1.29	1.19	1.34
1984	1.27	1.33	1.21	1.37
82/83	1.31	1.37	1.26	1.46
80/81	1.47	1.55	1.41	1.67
78/79	1.85	2.03	1.77	1.94
76/77	2.23	2.55	2.13	2.17
74/75	2.67	3.15	2.55	2.54
72/73	3.45	4.23	3.31	2.97
70/71	3.66	4.57	3.51	3.10
68/69	4.00	5.08	3.84	3.32
66/67	4.34	5.49	4.15	3.52
64/65	4.69	6.17	4.49	N/A
60/63	4.91	6.70	4.71	N/A
57/59	5.25	7.08	5.02	N/A
55/56	5.96	8.12	5.70	N/A
52/54	6.68	9.19	6.40	N/A
49/51	7.56	11.10	7.24	N/A
46/48	8.93	13.74	8.56	N/A
41/45	10.67	N/A	N/A	N/A
39/40	11.21	N/A	N/A	N/A
38-PRIOR	13.09	N/A	N/A	N/A

* The Metalworking Machinery and Equipment column represents machine tools, power driven hand tools, welding machines and equipment, industrial process furnaces and ovens, cutting tools and accessories, and abrasive products.

** Metal Cutting and Metal Forming Machine Tools are subgroups of the Metalworking Machinery and equipment group. They include conventionally and numerically controlled machine tools and parts for same.

*** Special Tooling as used in this column means jigs, dies, fixtures, molds, patterns, taps, gauges, and other equipment which are of such a specialized nature that without substantial modification or alteration their use is limited to the development or production of particular supplies or performance of particular services (FAR 45.101)

**** The Special Test Equipment column applies to single or multi-function test equipment, measuring and controlling devices, physical properties testing and optical and analytical instruments engineered, designed, fabricated or modified to accomplish special purpose testing. Special Test Equipment consists of items or assemblies of equipment including standard or general purpose item or components that are interconnected and interdependent so as to become a new functional entity for special testing purposes (FAR 45.101).

NOTES:

a. Acquisition cost times replacement factor equals replacement value.

b. Because of the continuous technological improvement in machine tools and the increasing number of “custom built” machines, reliable wholesale price indexes (which are intended to measure price changes not influenced by changes in quality, product mix, etc.) are difficult to develop. Recognizing this fact, the data should be used with caution. If available, new replacement prices should be used.

c. Changes in calculating the Finished Goods Price Index were published by the U.S. Department of Labor, Bureau of Labor Statistics in January 1988 which affected the calculations for developing the replacement factors. IEA developed new replacement factors based upon the indexes provided and previous available data. Replacement factors are based on an average price index through January 1993.

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