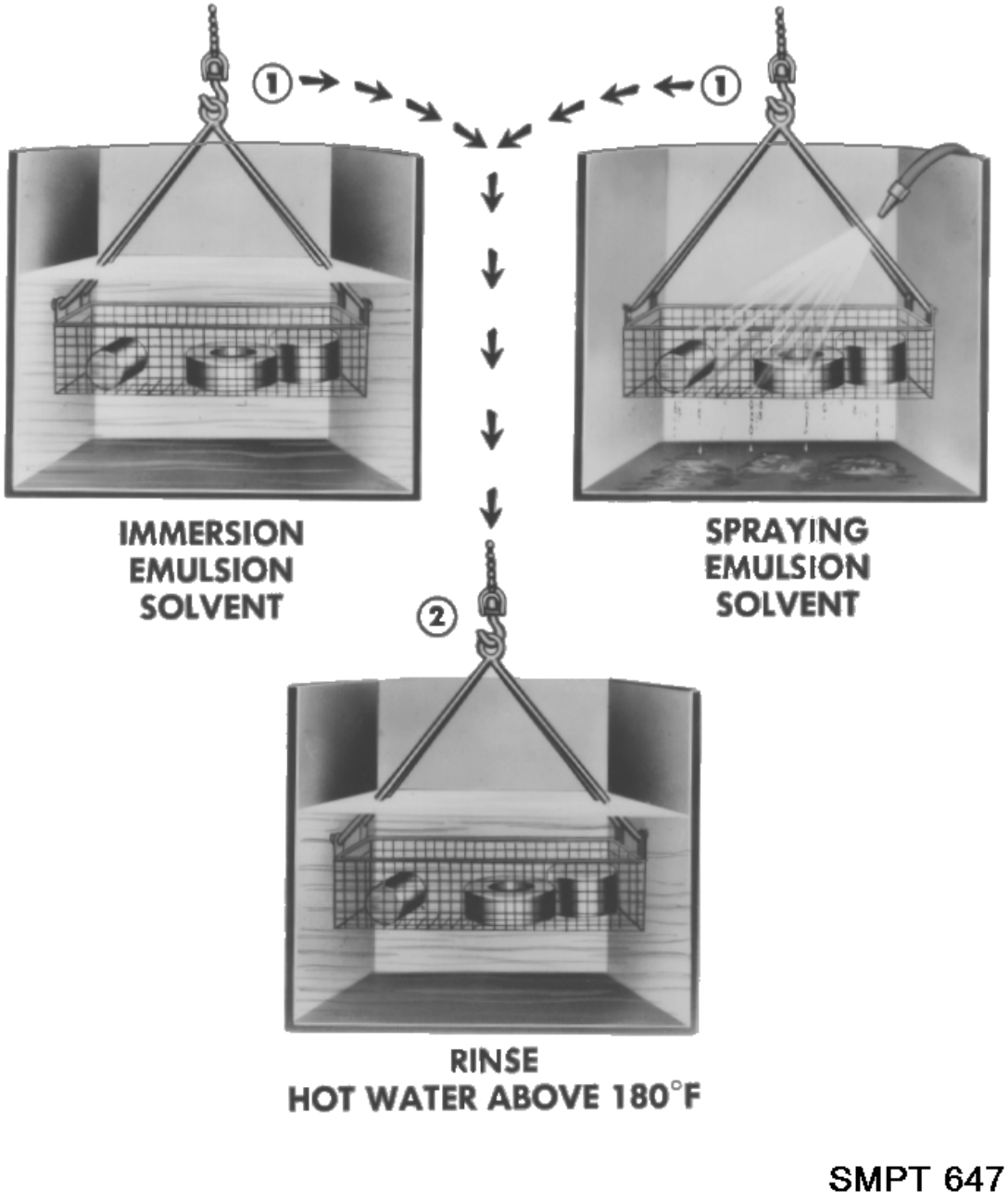

Figure 2-27. Emulsion cleaning.

Applicability

Emulsion cleaners are effective for removing stubborn pigmented, drawing, buffing, and polishing compounds and slushing oils. Since traces of a soapy film are left on an item's surface after emulsion cleaning, this type of cleaning is used only when the permitted degree of cleanliness is somewhat less than that obtained by the petroleum solvent or alkaline cleaning processes. Emulsion cleaning should not be used on any assemblies containing fabrics, rubber, and other organic materials, unless it has been reliably determined that no harmful effects will result. Also, it should not be used on any item or assembly which will tend to trap and hold rinse water that would eventually cause corrosion.

Material

An approved emulsion cleaning material is grease emulsifying, solvent cleaning compound (P-C-444). It is a liquid concentrate capable of mixing readily with kerosene or other solvents.

Equipment (figure 2-28)

The equipment required for emulsion cleaning is essentially the same as described for petroleum solvent cleaning. Representative types of spray equipment are shown in figure 2-28.

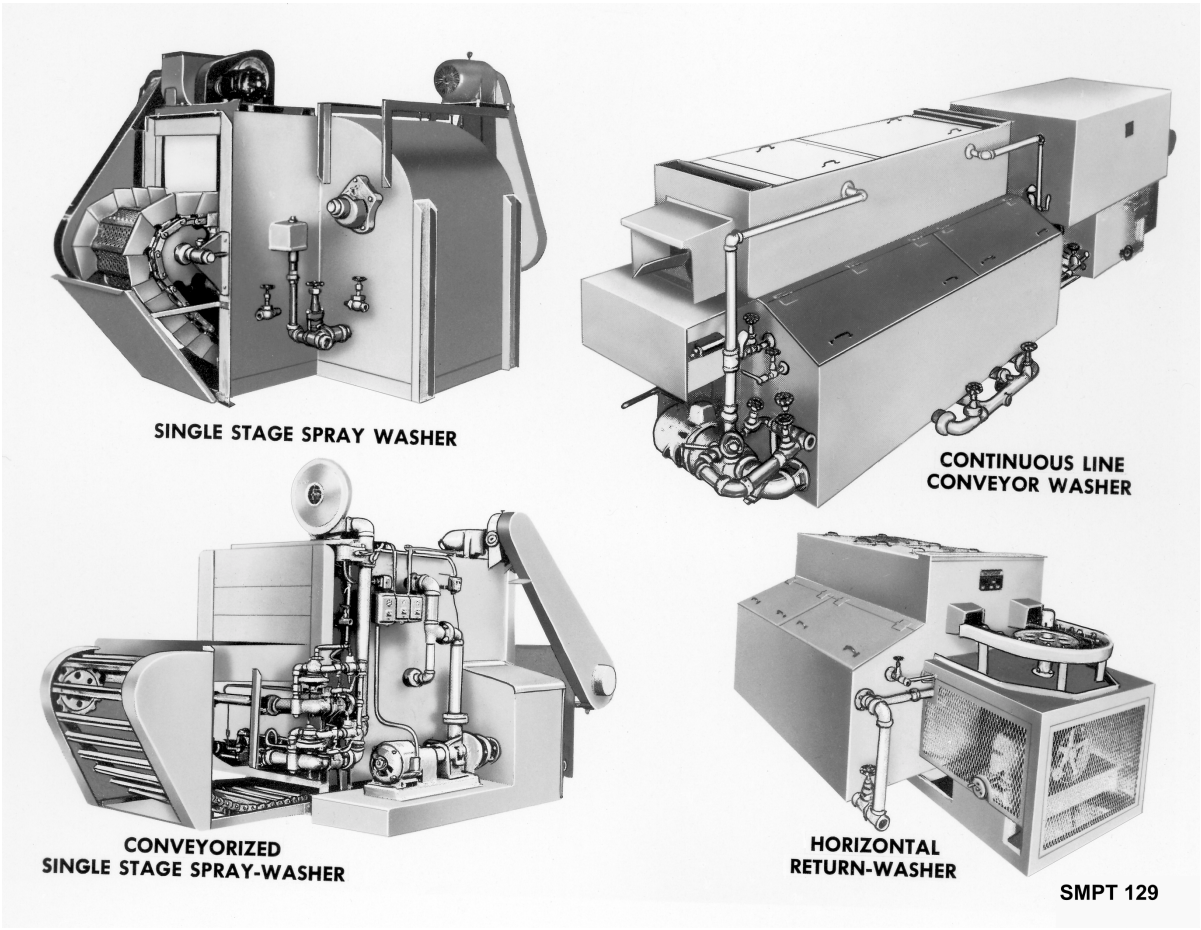

Figure 2-28. Emulsion spray washers.

Pressure Spray Technique

This process subjects items to a pressure spray of emulsion cleaner. It should be limited to cleaning unit metal items or very simple assemblies, on which all surfaces can be reached by the spray, and on which no surface will tend to trap the solution. The steps for this cleaning are -

- X Wear protective goggles, rubber gloves, and apron.
- X Adjust all spray nozzles for proper spraying.
- X Check filter screens in the circulating system to permit a free flow of cleaner through the unit.
- X Adjust temperature controls to keep heaters operating within the range recommended by the manufacturer of the equipment.
- X Load items so that sprayed emulsion will reach all surfaces to be cleaned.
- X Adjust nozzle spray pressure so all surfaces will be reached with enough impact to remove the soil.
- X Pass items through or suspend them in the emulsion spray zone.
- X Check results of cleaning and readjust spray nozzles as necessary to insure effective cleaning.
- X Follow the pressure spraying by thorough immersion rinsing in clean hot water (180ºF).
- X If machine is equipped with a drier, allow items to remain in the drying zone until dry.
- X If equipment does not have an automatic blowoff, dry items with clean compressed air or other approved drying procedure.
- X Inspect for cleanliness and test as necessary.

Immersion Technique

This process consists of soaking items in a tank of emulsion cleaner at room temperature, followed by an immersion rinse in clean water above 180ºF. The emulsion solvent cleaner must not be heated above room temperatures because of the fire hazard. The hot rinse helps remove emulsion cleaner residues and aids in the drying procedure. Accomplish the cleaning as follows:

- X Take necessary safety precautions and wear safety equipment.
- X Place items into baskets, on hooks, or on racks to provide for complete drainage from pockets and crevices.
- X Lower items to be cleaned into emulsion tank and allow them to soak for 1 to 10 minutes, as determined by amount of dirt to be removed.
- X If the tank is not equipped with agitation devices, agitate and scrub items to speed up the operation.
- X Take items from solvent tank after they have soaked enough to be clean.
- X Examine for cleanliness while items are draining.
- X Transfer, if clean, to a hot (above 180ºF) water rinse for 30 to 60 seconds.
- X Remove, drain, and dry.
- X Test for cleanliness as appropriate.

Steam Cleaning (figure 2-29)

General

Steam cleaning subjects items to a stream of steam alone or to a stream of steam with an added cleaning compound followed by steam alone. Steam cleaning is a common cleaning process because of the relatively low cost of material, the simplicity of steam generating units, and the adaptability to various items to be cleaned. Steam cleaning combines three powerful

cleaning actions: the chemical action of the detergent, in penetrating, wetting, and emulsifying surface deposits; the physical action of the high pressure steam and solution working their way through successive layers of dirt and grease; and the dissolving action of the heat on oils, greases, and other deposits.

Applicability of Steam Cleaning

Steam cleaning has wide applications. It is used on vehicles and other field equipment too large to be soaked in tanks or conveyed through spraying machines. By using steam with detergent, all types of contaminants except solid rust and scale are readily removed.

Materials

Materials required for steam cleaning are water for steam and steam cleaning compound.

Water for Steam

Water should be as free from scale forming contaminant as possible. Hard water will cause rapid formation of coil-clogging scale and increase the corrosion of the steam material. Use of water softening equipment is essential in hard water areas. Periodic descaling of steam coils is also an important preventive maintenance operation.

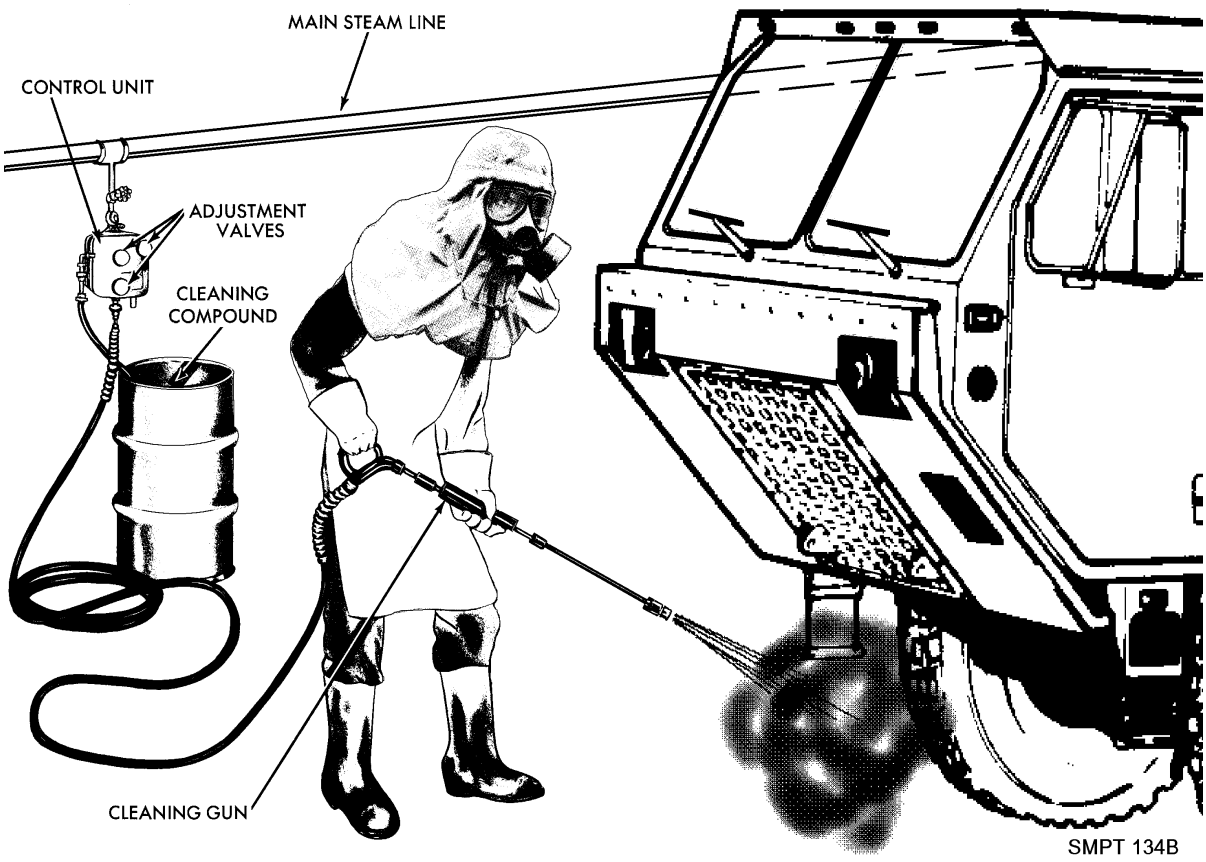

Figure 2-29. Steam cleaning.

Steam Cleaning Compound (A-A-59133)

This is a uniformly granular mixture of alkaline compounds and soaps developed for use in high pressure steam cleaning machines. It is a noncaking, nonclogging blend of powders which should not cause skin burn or sneezing to users.

Equipment

The equipment required for steam cleaning may be either stationary or portable.

Cleaner, Steam, Pressure Jet, Skid-Mounted (MIL-C-9911 (USAF))

This specification covers one type of electrically operated, skid-mounted, kerosene or diesel fuel-fired, pressure jet, steam cleaner. The cleaner covered by this specification is intended for use in the washing and cleaning of aircraft engines and components, vehicles, and miscellaneous ground equipment by the application of vapor pressure and cleaning compound solution.

Cleaner, Steam, Pressure Jet, Trailer Mounted (MIL-C-23023 (MC))

This specification covers one type of trailer mounted, gasoline engine driven, steam cleaner designed to remove surface deposits of foreign material by means of a forced stream of steam and water or steam, water, and detergent. This cleaner is intended for use in the cleaning of vehicles, vehicle parts, aircraft engines, machinery, and other surfaces. The unit may also be used for sterilizing, disinfecting, and paint removal. This cleaner may be connected to a cold water supply tank, pressure tap, a well, lake, stream, river, or any other available outside source of water.

Cleaner, Steam, Pressure Jet, Wheel-Mounted (MIL-C-22894).

This specification covers two sizes of electric-motor-driven, wheel-mounted, oil-fired, pressure jet, steam cleaners with a minimum discharge capacity of 100 gallons per hour (gph) or 180 gph. The cleaner is intended for the washing and cleaning of vehicles and miscellaneous ground equipment by the application of steam, pressure, and cleaning compound solution.

Safety Precautions

Boots, rubber aprons, gloves, and goggles must be worn to protect against the hot steam and avoid burns from handling the hose and nozzle. When steam cleaning compound is used, avoid excessive contact of the material with the eyes and skin. The closing off and shutting down of a portable steam cleaner requires careful safety procedures. The supplier's manual should be consulted at all times.

WARNING

Remember that steam causes very serious burns! Be careful at all times!

CAUTION

Steam cleaning may damage electrical wiring insulation, upholstery materials, antifriction bearings, etc.

Steam Cleaning Operations

The detailed operations of steam cleaning will vary with the type of equipment. It is advisable to follow the operator's manual that is provided for each type of unit. The steps for operating one type of portable, electrically driven steam cleaner are -

- X Wear appropriate protective clothing.
- X Prepare the cleaner for operation by checking assembly, water supply, electrical source, fuel supply, proper lubrication, and position of all valves, open or closed, as required.
- X Follow the instruction manual for starting the jet cleaner. When water is circulating through the system at the proper rate, start the burner.
- X Prepare soap concentrate, following instructions on cleaner container.
- X Start soap pump assembly by turning on the soap control valve.
- X Exhaust excess air from soap pump assembly. By loosening the tube coupling nut on top of the soap pump, check valve housing assembly. Observe the appearance of vapor emitting from the cleaning gun assembly. It will change appreciably when the soap concentrate is blended with the hot vapor.
- X Direct discharge from cleaning gun assembly at the item requiring cleaning. Spray steam over the item requiring cleaning. Spray steam over the item allowing steam and compound to effectively carry out its cleansing action.
- X Shut off the flow of soap concentrate and turn gun control handle from VAPOR to RINSE. Open soap control valve 1/8 turn from closed position to allow a small amount of soap solution to flow and thus prevent heating coil restriction.
- X Rinse item with clean high pressure steam until all residues have been removed.
- X Shut off steam unit, following instruction manual details with great care.

ABRASIVE CLEANING

Abrasive cleaning comprises three processes and several materials. Abrasive cleaning breaks down solid, tightly adhering contaminants on an item's surfaces by blasting them at a high velocity and impact with hard or soft granulated particles. The effect of this abrasive action may be modified by controlling the hardness and type of grain; choice of particle size; velocity of abrasive steam projecting on the item; and the method of application used in directing abrasive steam. The high velocity particles are directed against the item's surfaces with centrifugal wheels, high velocity air, or pressurized water. The choice of abrasive materials is so wide and varied that almost any type of surface finish desired may be obtained by the proper selection of abrasive type, mixture, size, and stream velocity. The selection of the right abrasive will depend on the cleaning process, the desired finish on the item, the hardness of the item, and the type of scale or soil being removed.

Applicability of Abrasive Cleaning

With three processes of abrasive cleaning available, it is possible to clean a wide range of items contaminated with varying types and amounts of foreign materials. The processes can effectively produce a surface that is both chemically and mechanically clean. When surfaces are coated with heavy greases, this grease must be removed by a degreasing process before abrasive cleaning.

Abrasive Blasting Process

This process consists of directing a high velocity stream of abrasive against an item, driven by either compressed air or thrown mechanically from a centrifugal wheel. This process is best suited for cleaning rough castings or other surfaces where the removal of some base metal will not impair the item's function.

There are materials consisting of cast iron or hardened cast steel grit and shot for blast cleaning of castings, forgings, ship hulls and decks, or other parts prior to use for the removal of sand, rust, and marine incrustation. There are also cast iron or hardened cast steel shot or cut steel wire shot for cleaning the surface of metals.

Cleaning process

The procedure for abrasive blast cleaning will depend on the type of equipment employed. In general, the following steps are performed:

- X Protect yourself with approved protective equipment.
- X Mask off any portions of work that must not be blasted.
- X Adjust pressures of compressed air to the type of surface being cleaned 60 to 100 psi for hard materials or 30 to 50 psi for the softer materials.
- X Direct the stream of abrasive at a 90º angle to the work surface and move nozzle only as fast as the surface is cleaned.
- X Blow off with compressed air or rinse in an inhibited cleaning solution if surfaces are dusty and have metal chips clinging to them after blasting.
- X Demagnetize items prior to blast cleaning if iron dust and metallic particles continue to adhere to metal surfaces after rinsing.

Abrasive Blast Honing Process

This process subjects the item to a steam of atomized water containing a selected abrasive and suitable corrosion inhibitors. Vapor blasting is applicable for the removal of light coats of rust or scale from item surfaces where a slight amount of polishing will not hinder the function of the item.

Materials

There are several inorganic abrasives available in a wide range of grain sizes for use in the honing process. They are as follows:

Novaculite is a decomposed lava-type crushed rock that is available in mesh sizes from 100-mesh to 5000-mesh. The 5000-mesh material is about three times as fine as face powder. This material is used for close tolerance and precision work. When used with a corrosion inhibitor, it produces a finish that has extensive corrosion resistance.

Silica sand is available in sizes from 50-mesh to 400-mesh. It is used for general cleaning, either wet or dry, and as a carrier medium for other selected abrasives.

Quartz sand is the familiar cleaned and sifted beach sand. It is relatively cheap but does not possess the abrasive cutting qualities of some of the artificial abrasives.

Garnet abrasives have long life and are very aggressive. The comparable mesh size of garnet will produce a much rougher surface than silica sand.

Aluminum oxide is a hard, synthetic abrasive produced in an electric furnace.

Several grain sizes are available. It is used extensively in vapor blast operation.

Glass beads are used for cleaning selected surfaces of steel, aluminum, and magnesium.

Cleaning Process

In using a vapor blast cabinet, follow these steps:

- X Wear rubber gloves while loading items into cabinet.
- X Place items on table, in tumbler, or in baskets depending on their size and ease of handling, pass through side door into the cleaning chamber and close door.
- X Thrust arms through rubber sleeve openings. See that sleeves fit tightly around the wrists and form a watertight seal.
- X Hold items in one hand while blasting. Direct the blasting stream with the other. Leave items on turntable and rotate slowly if they are too large to handle easily.
- X Adjust the pressure needed by moving the knee control lever.
- X Continue the vapor blasting operation until all contamination is removed.
- X Keep this rinse tank heated above 140ºF or more to speed up the drying.
- X Dry the items as soon as possible after rinsing.

Soft Grit Blasting Process

This process uses relatively soft abrasives with or without a corrosion inhibitor. The abrasive is carried by a high velocity stream of water directed at the contaminated surfaces of the item. This process is applicable to the removal of relatively soft contaminants and to cleaning items with surfaces that can tolerate only a minimum amount of metal removal during the cleaning process.

Material

Soft abrasive grains conforming to A-A-1722 (formerly MIL-G-5634) must be used for this cleaning process. The material is used for the removal of carbon from metal surfaces and cleaning of operating jet engines. Abrasive grains of the following types are authorized:

- X Apricot pit shell or black walnut shell (for use on aircraft jet engines or general purpose use).
- X Pecan shell, corn cob, or rice hull (for general purpose use only).
- X English walnut shell, apricot pit shell or mixture of the two (for use on aircraft jet engines only).

Cleaning Process

This process is accomplished in the same cabinet as for vapor blast cleaning. The soft grains are used alone or with a suitable corrosion inhibitor. The steps to clean the items are essentially the same as the honing process.

Equipment for Abrasive Cleaning

Abrasive cleaning equipment may consist of specially designed blast cleaning cabinets, blasting rooms, or blast cleaning machines.

Blast cleaning cabinets are inclosures equipped with necessary devices through which abrasive materials are ejected by air pressure against the surfaces to be cleaned. There are two types of cabinets described by this specification:

Liquid abrasive cabinets, as shown in figure 2-30, have a window in the front or top and two or more arm openings fitted with rubber sleeves. They are provided with a slurry hopper tank for mixing, storing, and recollecting the abrasive slurry. The slurry is delivered to the blasting gun by compressed air or circulating pumps.

Dry abrasive cabinets shown in figure 2-31, are similar in design to liquid abrasive cabinets except a dust collector is used to return the exhausted dust from the cabinet, and an abrasive reclaimer unit replaces the slurry hopper tank. The abrasive is delivered to the blasting gun either by direct pressure or by suction.

Dry, knockdown, blasting room is shown in figure 2-32. This is a sectional blasting room that is large enough to accommodate the items, the sand blast hoses, nozzles, and the operators. The abrasives that are used are sandblast sand, refractory slag, metal cleaning abrasive grain, steel shot, and steel grit. The room consists of the sectional blasting room including floor-type screw conveyor, bucket elevator, abrasive separator, abrasive storage system, blast tank, dust collector, ventilating system, hoses, nozzles, and other equipment.

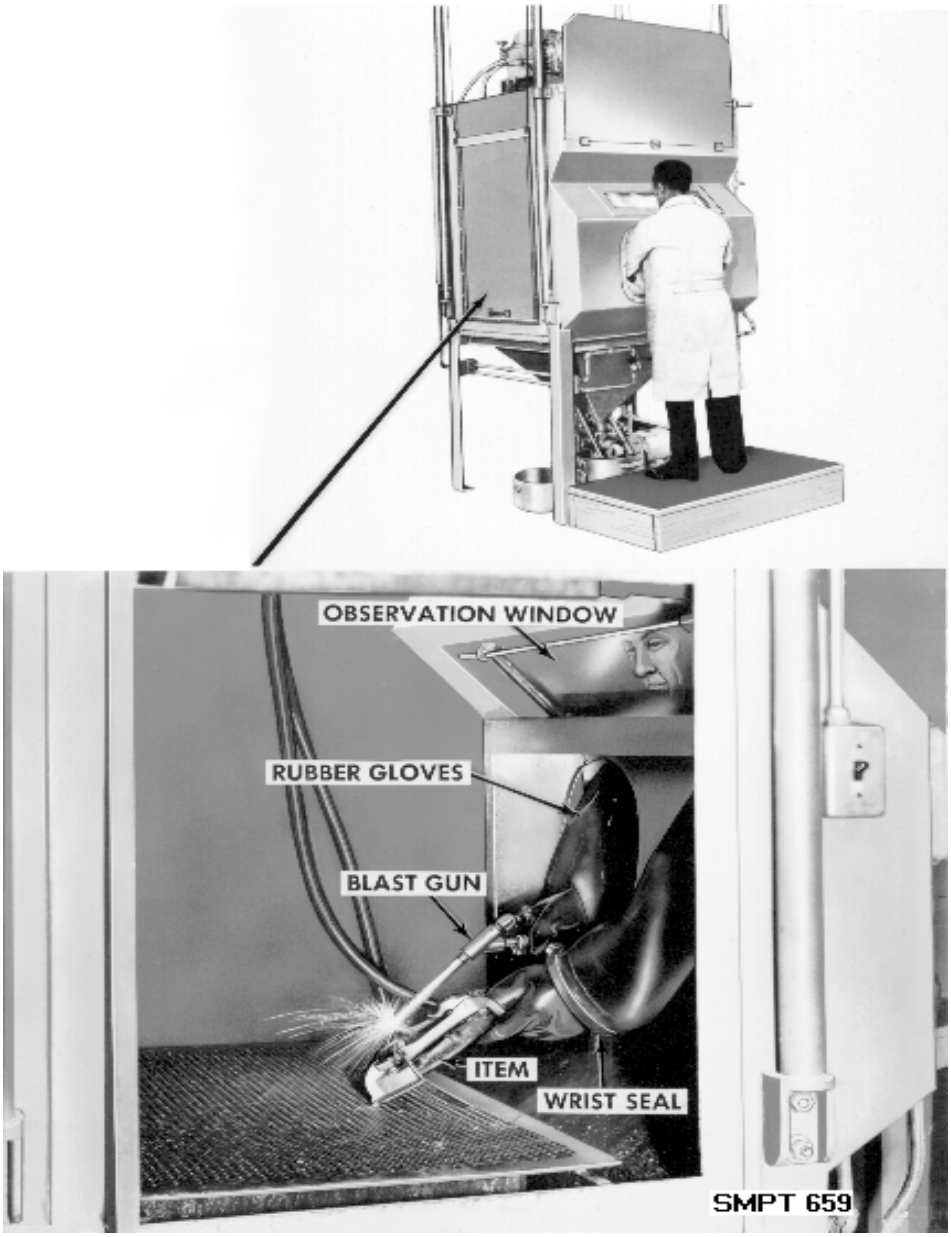

Figure 2-30. Liquid abrasive cabinet.

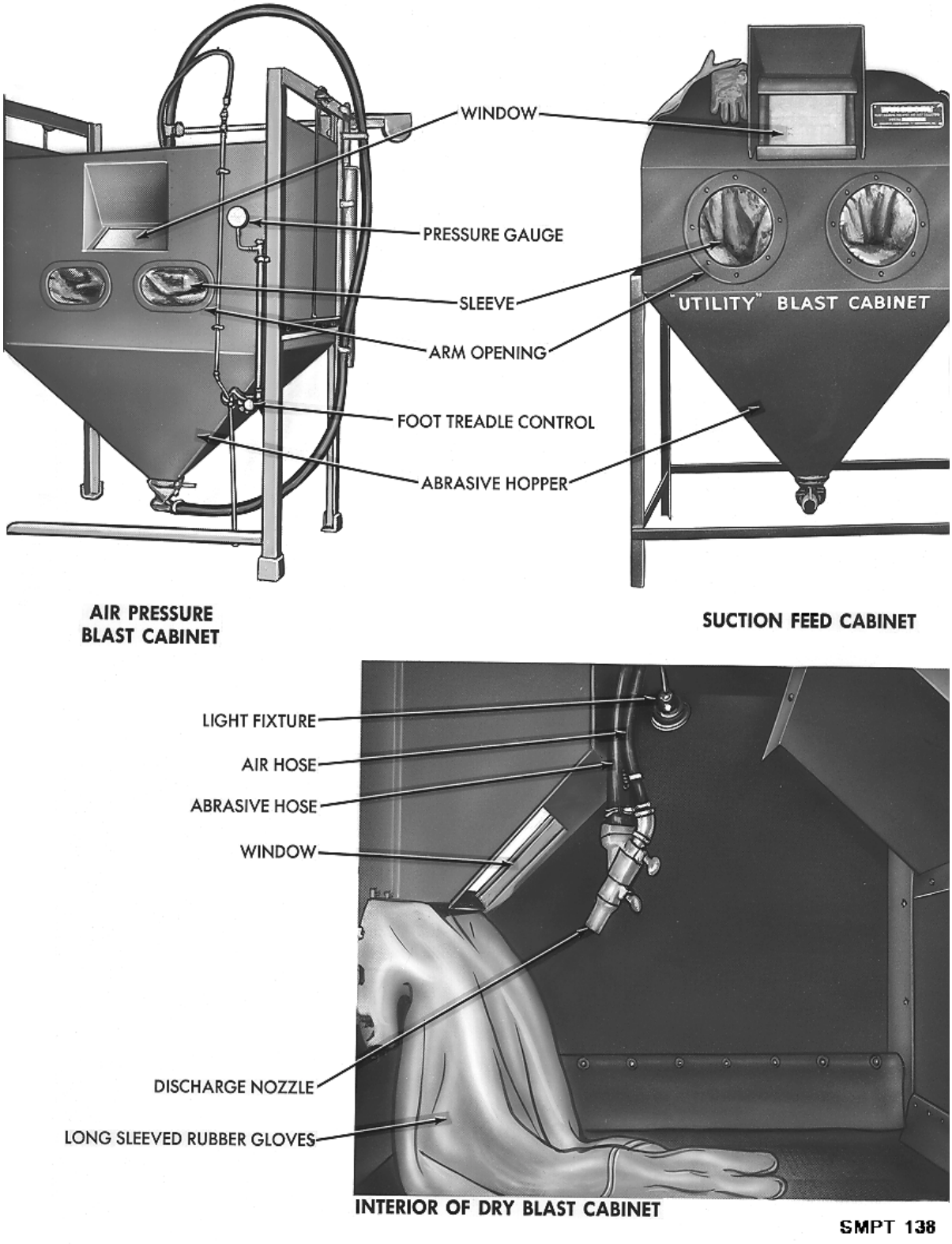

Figure 2-31. Dry abrasive cabinet.

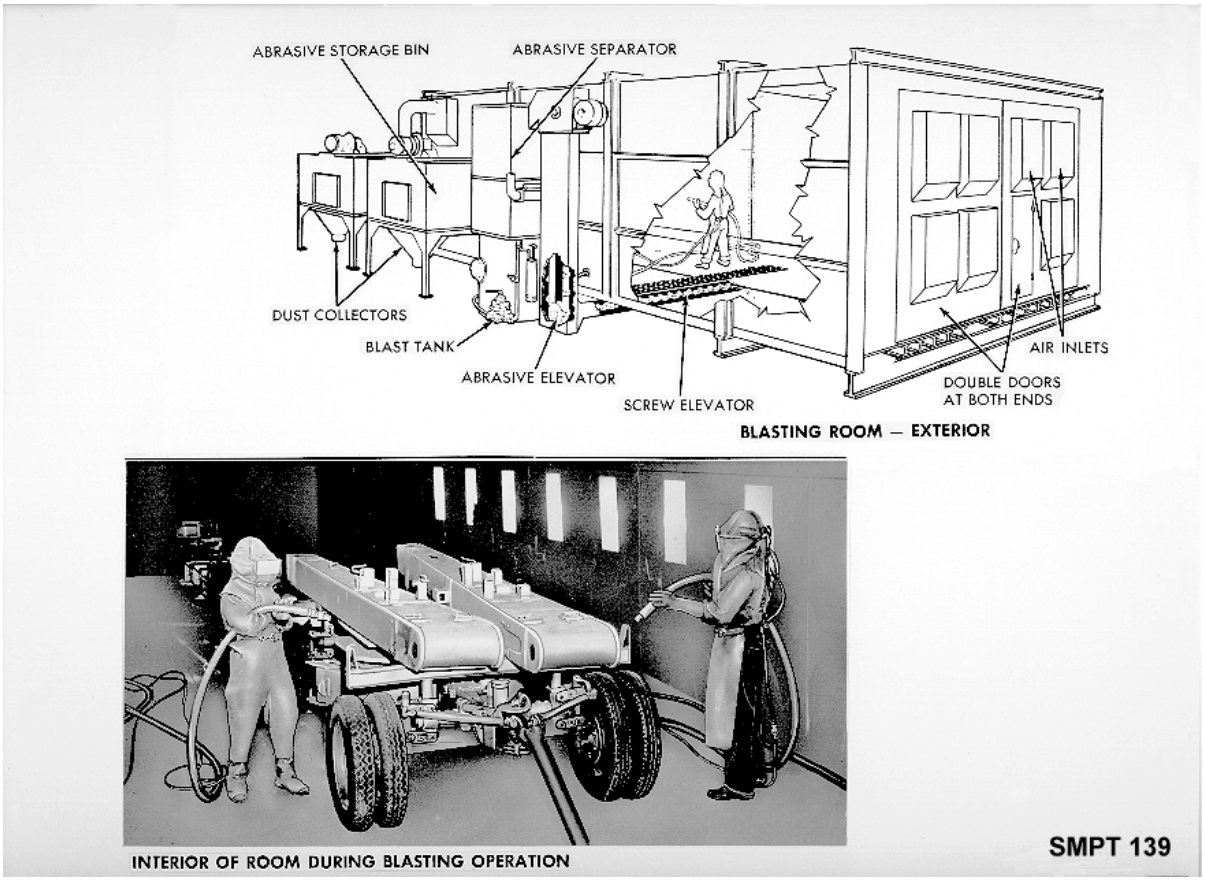

Figure 2-32. Blasting room with operations.

A tumbler-type abrasive blasting and cleaning machine with a dust collector is shown in figure 2-33. This is an airless tumbler machine with a load capacity of not less than 5 cubic feet. The cabinet houses an endless belt conveyor upon which items are loaded, agitated, and unloaded. When the cabinet door is closed, the unit is dust and abrasive tight. The blast action is provided by controlled centrifugal force acting upon the abrasive. An abrasive recovery and handling system is an integral part of the unit. The dust collector is a separate cabinet equipped with its own motor. The items are tumbled on the endless belt which moves vertically so the items are tumbled against the vertical portion of the belt. The cleaned items are discharged from the blast chamber by opening the cabinet door and reversing the direction of the belt. When using the tumbler-type equipment, follow these procedures:

- X Place items in the cabinet on the belt and close door.
- X Start the machine.
- X Stop the machine after about 5 minutes and inspect for cleanliness. If items are not clean, close door and run machine a few more minutes. Use rubber gloves when handling items for inspection.
- X Reverse machine, open cabinet door and deposit cleaned items in a receiving basket or tray.
- X Blow loose dust particles from items with compressed air or rinse in inhibited liquid rinse.

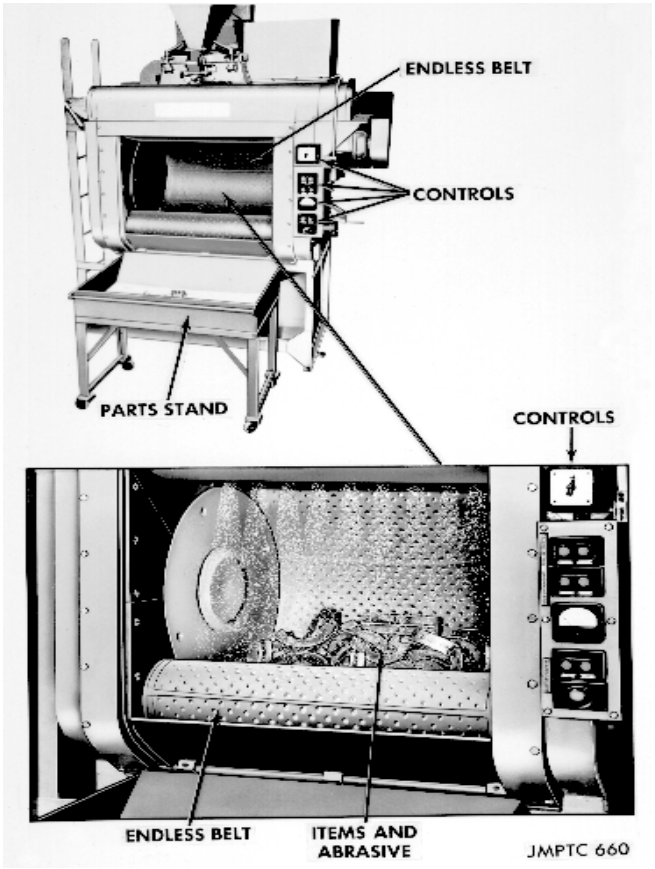

Figure 2-33. Tumbler-type abrasive blasting and cleaning machine.

A table-type abrasive blasting machine is shown in figure 2-34. These machines have a turntable on which the items are placed. The table rotates, carrying the items into the blasting zone where they are abraded and cleaned by the abrasive thrown against them by a centrifugal wheel. The blasting zone is a steel housing which covers 3/4 of the circular turntable. The entrance and exit are closed by split rubber curtains which retain the abrasive and dust. The turntable is perforated so that the spent abrasive and abraded particles can fall through to the collecting hopper. The usable abrasive is reclaimed and returned by elevator to the abrasive throwing device. When using table-type equipment, follow these procedures:

- X Wear protective clothing.
- X Place items to be cleaned on turntable. Items must be free of oil and grease. Do not overload the table. Place items so they do not shield each other from the blasting.
- X Start the machine and, as the table rotates, place additional items on the table. The rate of rotation of the turntable should be adjusted to the degree of contamination present.
- X Examine items as they come through the exit curtains and reposition any poorly cleaned items and pass them through the blasting zone again.
- X Remove items from the turntable. Use gloves to prevent further contamination.
- X Remove dust with compressed air or dip in an inhibited liquid rinse.
- X Clean dust collector periodically.

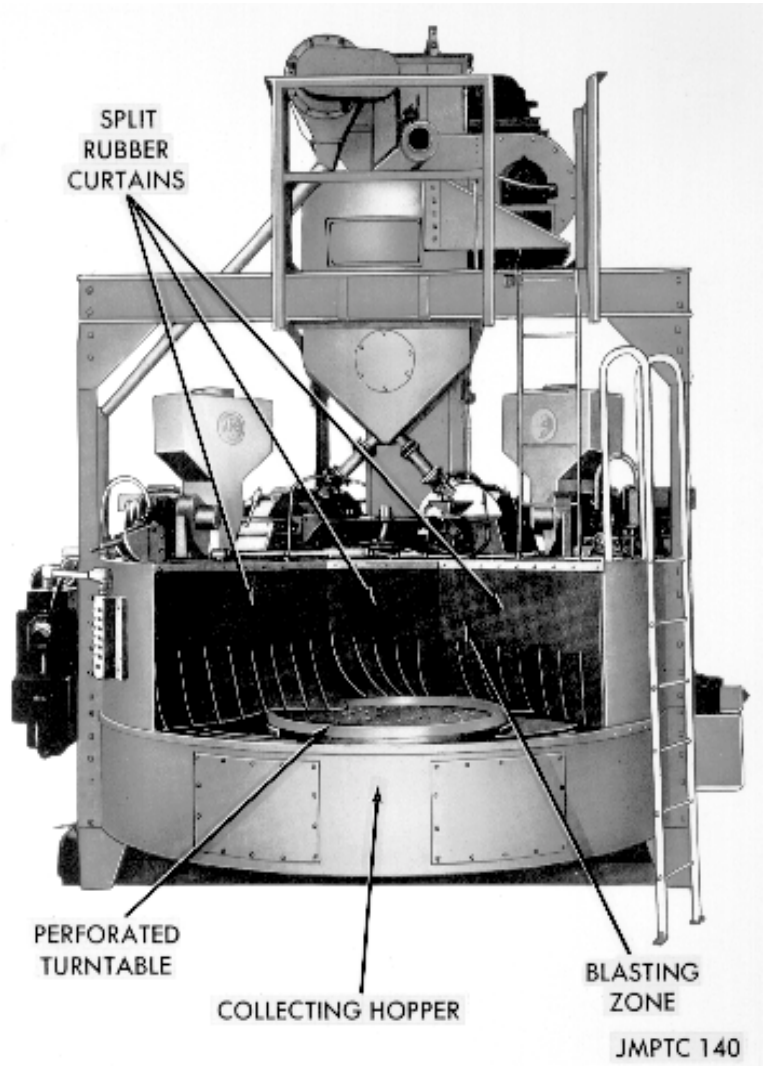

Figure 2-34. Table-type abrasive blasting machine.

Safety Precautions

Abrasive blast cleaning is hazardous to the extent that the high velocity of the abrasive particles a potential danger to the eyes and skin. Breathing of the dust created by the breakdown of the nonmetallic inorganic types of abrasive can lead to an occupational lung disease (silicosis). Proper protection is necessary.

Protective Clothing and Equipment (figure 2-35)

For blasting within an abrasive blast cleaning room, approved respiratory equipment should be provided. This should include rubber covered helmets with air fittings, hygienic helmet air supply units, replaceable plastic windows and protective screens. Armored leather gloves, leg and foot protectors, and protective aprons are also worn by operators within blasting rooms. Complete information concerning approved types of protective clothing and equipment for any types of blast cleaning may be obtained from the National Safety Council, 425 North Michigan Avenue, Chicago, IL 60611.

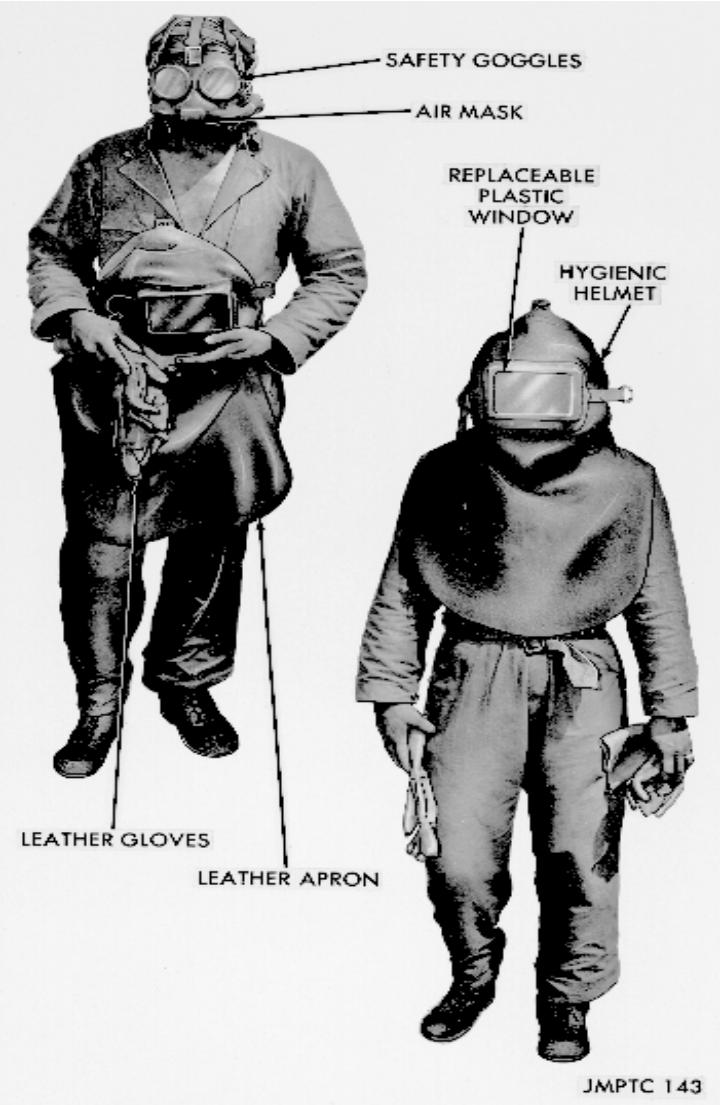

Figure 2-35. Protective clothing for abrasive blast cleaning.

ULTRASONIC CLEANING (FIGURE 2-36)

This process converts electrical energy into high frequency sound waves. These sound waves help remove all foreign particles from the surface by focusing high frequency sound energy, above the human audible range of 20,000 cycles per second, upon the surfaces of the item while it is suspended in the bath. The ultrasonic waves do not replace the cleaning agent. They merely make the cleaning agent more effective by producing "cavitation" or "cold boiling" in the fluid. As a result, tiny bubbles form and collapse against the item being cleaned. The "bubble collapsing" provides the main suction or scrubbing action. Ultrasonic cleaning is applied to non-absorbent materials such as glassware, metals, electronic equipment, and molded products. Hand wiping or brushing operations are eliminated by this process. Contamination in cavities, hollow indentations, small holes, and on precision finished surfaces is removed, thus giving a degree of cleanliness not achieved by any other process. The cleaning operations are carried out in a tank or chamber connected to an electronic generator, which supplies high frequency power. A transducer unit converts the electrical energy into ultrasonic waves in the stainless steel cleaning chamber.

A recirculating filter reservoir removes the dirt from the cleaning solution and maintains the solution at a predetermined level and temperature. A rinsing area and a drier complete the equipment. Special water-detergent solutions are frequently employed but in some instances organic, chlorinated, or petroleum solvents may be used to advantage. Many cleaning agents commonly used for other cleaning processes are also excellent for use in ultrasonic cleaning. Some of these agents are water-emulsion cleaning compound (MIL-C-43616) and cold carbon remover (MIL-C-19853). Experience has shown that, when some special solvents are used, the sealing compound between the transducer disk and the solvent reservoir may be affected by the solvent. This is remedied by placing the special solvent in a pyrex beaker submerged in water in the solvent chamber and supported on rubber stoppers.

SPECIAL SYSTEMS CLEANING

Cleaning in such areas as complex hydraulic, pneumatic, and propellant systems of missiles and rockets; intricate primary coolant systems of nuclear weapons; high speed bearing systems of turbines in vessels and aircraft; and specialized electronics equipment of tracking and guidance systems of space vehicles, demands special standards of cleanliness.

Importance of Special Systems Cleaning

A single particle of steel can immobilize a critical bearing. Contaminants in the cooling system of a nuclear reactor could interfere with the movement of a valve, speed up corrosion, upset the water chemistry, or affect the heat transfer or radiation. O-rings, seals, and gaskets may leak if a particle becomes wedged between a smooth surface and the seal. Particle buildup in an orifice of a burning chamber may deflect the fuel stream creating a local "hot spot". Particles entrapped and accumulating in a noncritical area may break loose and result in the misfire or malfunction of a critical component or system. Organic particles, lint, oil, grease, etc., coupled with a sudden pressure change in a liquid oxygen system, could result in an explosion. It is necessary to obtain clean equipment delivered from the manufacturer and maintain this cleanliness. The accumulation of contaminants in a system must be controlled to avoid the possibility of system foulup or explosive conditions from developing.

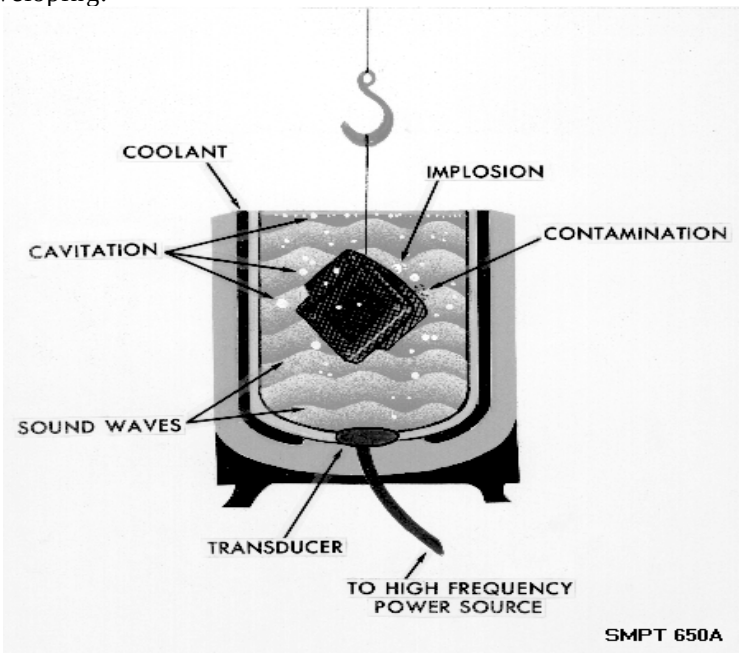

Figure 2-36. Ultrasonic cleaning.

Degrees of Cleanliness

The degree of cleanliness must be adequate for the design and utility of the system component. For example, different cleaning requirements are established for fluorine and hydrogen peroxide systems than for liquid oxygen or hydrazine fuel systems. The size of the particles that are tolerated in a cleaning solution must be no larger than the smallest openings or orifices in the system. Particle size is determined through examination with a microscope of the filter taken from samples of the cleaning or flushing solutions. Particles are measured in terms of microns (0.00003937 inch or 0.000001 meter). Particle size limits have been established for the various degrees of cleanliness (figure 2-37).

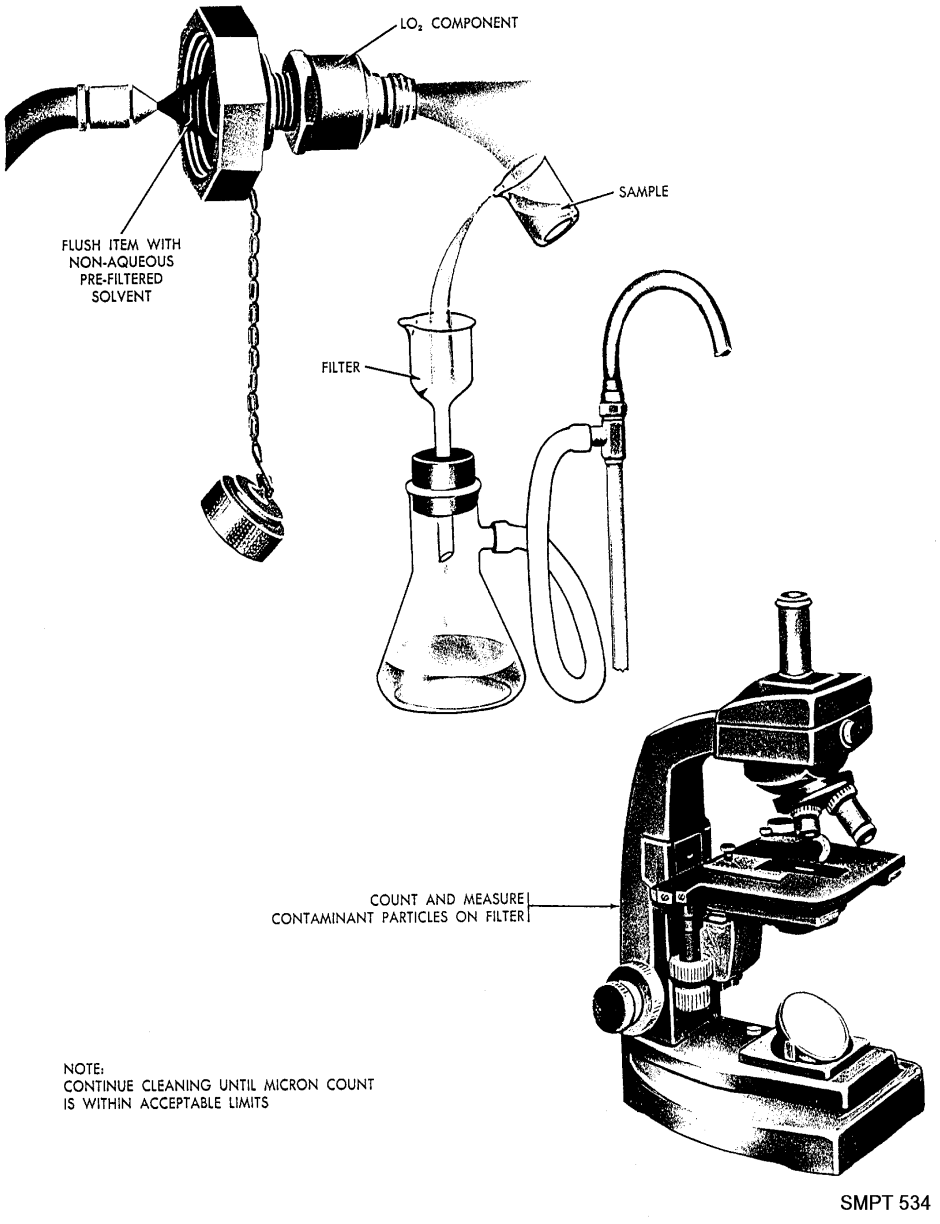

Figure 2-37. Determining particle size.

Preservation Personnel's Responsibility

Since the details of special systems cleaning are beyond the scope of this manual, it is imperative for preservation personnel to know and appreciate the fact that these systems have components that require extreme degrees of cleanliness. Items requiring this extra cleanliness will be processed in a specially designated clean room where the required degree of cleanliness may be accomplished. When such cleaning has been completed, items are protected by a contamination barrier, such as a bag, wrap, plug, cap, blind flange or other device which will prevent contamination of the cleaned surfaces during all succeeding operations. The cleaned items in the contamination barriers should be marked with an appropriate color code to designate the system for which they have been cleaned. Preservation personnel, receiving items that have been processed in this fashion, must realize that the contamination barrier is considered a critical part of the item being packaged and any damage, such as punctures, tears, abrasions, separation of seals, and leakage of flanges discovered upon inspection, necessitates a complete reprocessing through all previous steps. It is, therefore, incumbent upon all preservation personnel to recognize these processed items and handle them with the care their importance deserves.

Cleaning Inspection

Cleaning inspection insures proper cleaning before the item is processed further. It also conserves cleaning materials through their timely recovery for reuse. Cleaning inspection prevents inadequate cleaning losses in time, labor, and materials. In MIL-STD-2073-1C, Table G.I. “Preservation Inspection Provisions” outlines the criteria for cleaning and preservation inspections.

Determination of cleanliness

Items will be examined or tested for cleanliness in accordance with the following techniques of Method 4004 of Federal Test Method Standard No. 101 as applicable.

Visual Test for Cleanliness (figure 2-38)

This test visually determines freedom from or the presence of foreign materials or corrosion.

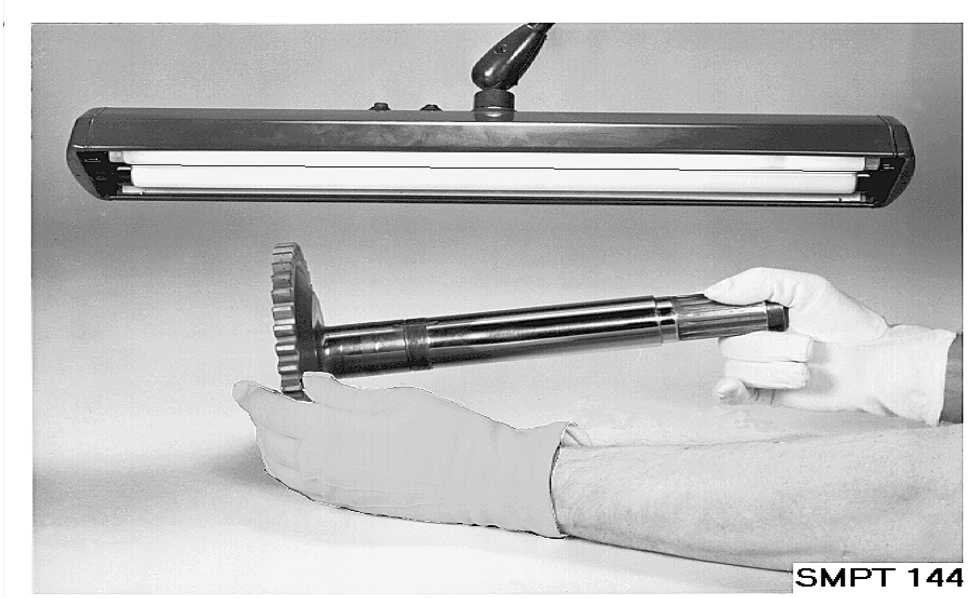

Figure 2-38. Visual test for cleanliness.

Equipment Required

X Lamp to insure adequate lighting.
X Gloves, barrier material, or other means of holding item to prevent contamination.

Procedure for Test

X Hold item to strong light.
X Examine all surfaces for the presence of foreign materials and corrosion.

Interpretation of Test Results

X Presence of dirt, oil, grease, or other foreign materials on the item will be cause for rejection.
X Presence of corrosion on the item also will be cause for rejection.

Wipe Test for Cleanliness (figure 2-39)

This test determines freedom from foreign material and corrosion that was not discovered in the visual test.

Equipment Required

X Adequate light source.
X One piece each of clean, lint free, white and dark cloth.

Procedure for Test

X Wipe a portion of the item being tested with the white cloth.
X Wipe another portion of the item with the dark cloth.
X Examine both cloths for evidence of the presence of foreign materials.

Interpretation of Test Results

The presence of a dark smudge on the white cloth (or white deposit on the dark cloth) is cause for rejection.

Figure 2-39. Wipe test for cleanliness.

Freedom From Alkalies and Acids Test (figure 2-40)

This test determines if alkalies or acids remain on the item in quantities that would endanger the preservation of the item.

Equipment Required

X Indicator papers methyl red and red litmus, or a universal indicating paper conforming to O-P-94.

X Distilled or deionized water and medicine dropper (use if item is not still wet from final rinse).

Procedure for Test

X Wet a small area of item with distilled water, if not still wet from final rinse.

X Touch both the methyl red and the red litmus paper to the wet surface.

X Examine the wet surfaces of the papers for color change.

X Compare color change of universal indicating paper with color chart.

Interpretation of Test Results

X A red tint on the methyl red paper indicates to much acidity.

X A blue tint on the red litmus paper indicates to much acidity.

X If the color change reading of universal indicating paper indicates a reading below pH 6.4 or above pH 8.3 when compared with the chart on the dispenser, this is cause for rejection of the items.

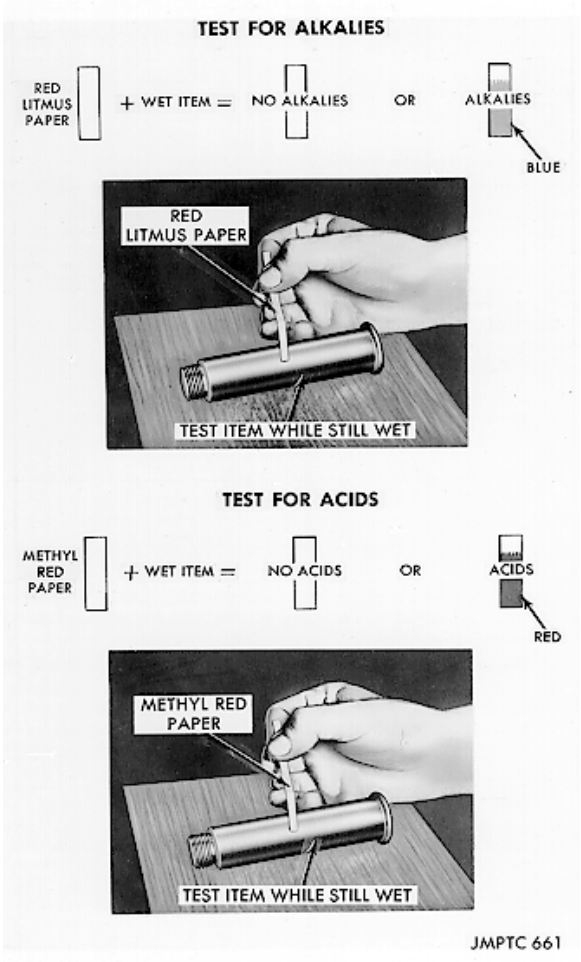

Figure 2-40. Freedom from alkalies and acids test.

Materials Tests

Test to be performed on cleaning materials during cleaning operations are the determination of sludge concentrations in petroleum and chlorinated solvents and the determination of acidity in chlorinated solvents.

Sludge Content of Petroleum Solvents (figure 2-41)

Solvents require frequent determinations of the sludge content. When the concentration of the sludge exceeds 30 percent, the solvent should be replaced. The requirements for this test is published by ASTM, the American Society for Testing and Materials. The sludge content is measured by taking a 100-cubic-centimeter sample of the cleaning solution. This sample is distilled in a laboratory distilling flask. The amount of solvent collected after distillation at the boiling point of the solvent is measured in cubic centimeters. The difference in amount collected from the original sample of 100 cubic centimeters represents the residue of sludge remaining in the distilling flask and is the percent of sludge in the solution.

Sludge Content of Chlorinated Solvents.

As items are cleaned, there is a gradual buildup of sludge with an increasing rise in the boiling temperature of the resulting mixture. When the sludge concentration reaches thirty percent, it is not economical to continue to use the material. The percent of sludge in the solvent may be determined by the use of a thermometer or hydrometer.

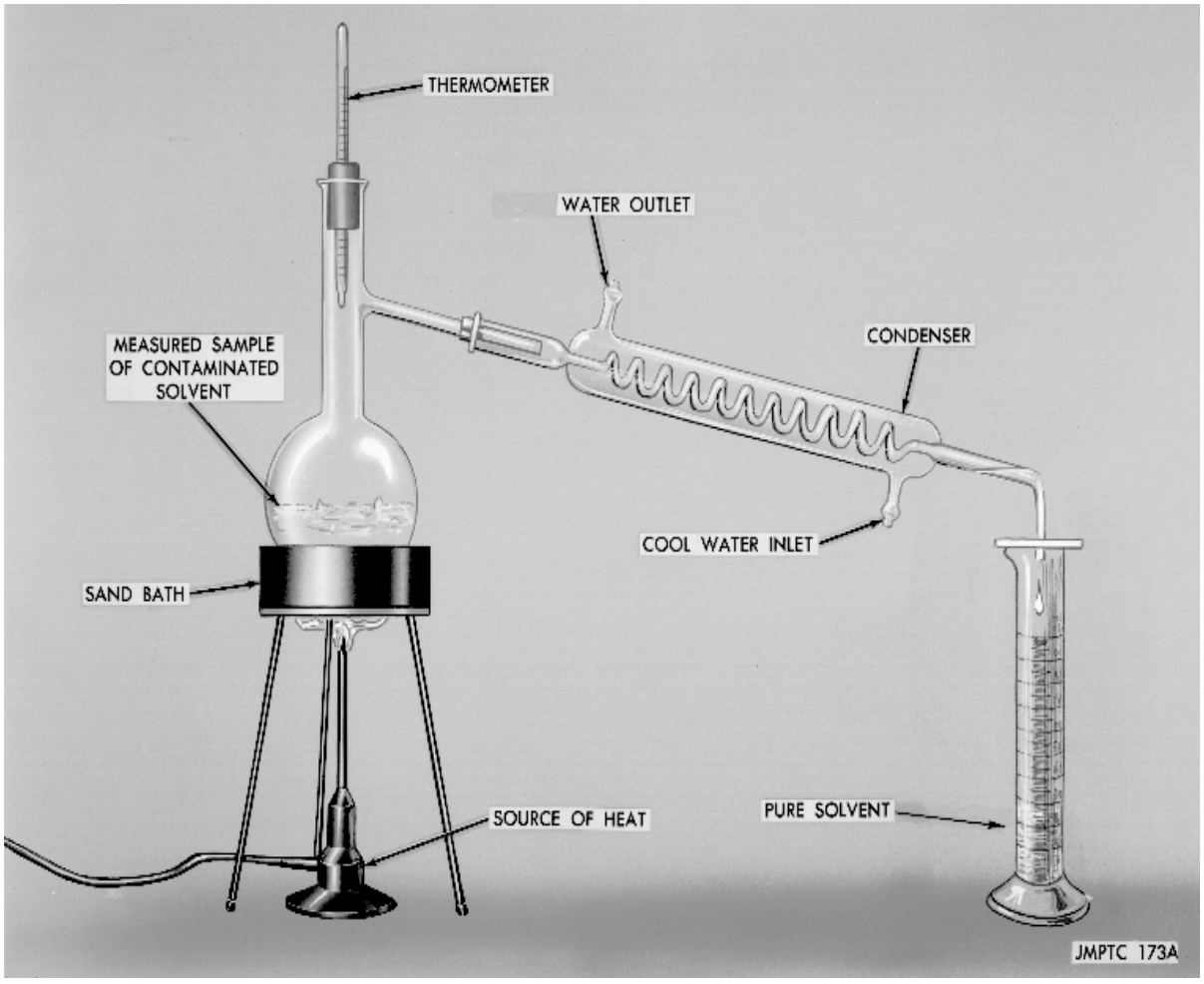

Figure 2-41. Determining sludge content of petroleum solvents.

Sludge Content by Temperature Method (table 2-1 & figure 2-42)

Figure 2-42 shows boiling points and the corresponding sludge content for ASTM D 4081 and ASTM D 4376. When the boiling point of tetrachloroethylene reaches 260ºF, replace the solvent. The boiling points at 10, 20, and 30% are based on oil and grease contaminants.

The Specific Gravity Method is shown in table 2-1. A hydrometer may be used to determine the specific gravity of the dirty solvent. A reading is made at room temperature, using a sample in a hydrometer jar. Read the specific gravity and compare with the values shown in table 2-1.

Table 2-1. Determining Solvent Contamination.

Sludge Content	Reading (ºF)	Hydrometer Reading
None	250	1.61
10%	252	1.47
20%	255	1.33
30%	260	1.22
	Tetrachloroethylene ASTM D 4081/ ASTM D 4376	

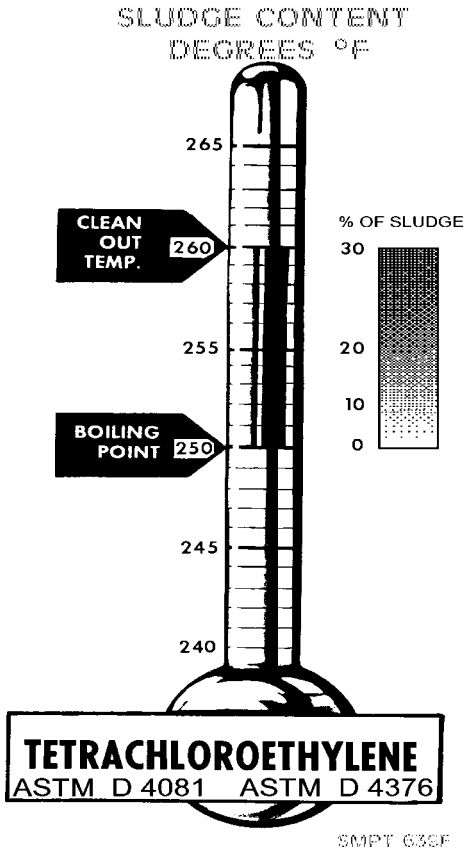

Figure 2-42. Determining sludge content by temperature method.

Acid Condition of Chlorinated Solvents

Continuous operation during humid weather produces a gradual breakdown of the vapor by hydrolysis which result in the formation of hydrochloric acid. This requires frequent checking of the solvent acidity. A rough test is made by lowering a clean dry dipper into the vapor zone and collecting some condensate. Dip a strip of blue litmus paper moistened with distilled or deionized water into the condensed solvent. If the paper changes from blue to pink, acid is present in the vapor. This indicates that the solvent needs replacing. An accurate confirming check is made by sending solvent samples to a qualified laboratory where the acidity is determined by using a pH meter or a universal pH indicator test paper.

DRYING PROCEDURES

Immediately after cleaning, items must be thoroughly dried to remove cleaning solutions or residual moisture. The drying may be accomplished by one or more of five different procedures, provided the item is not injured by the procedure.

DRYING WITH PREPARED COMPRESSED AIR (FIGURE 2-43)

Drying is accomplished by subjecting the item to a blast of prepared dry and clean compressed air. The steps are -

- X Check the air supply to see that it is free from oil and dirt. Water in the air supply is detected by blowing the air on a polished metal surface or mirror at room temperature and checking for condensation.
- X Adjust the air pressure to 30 pounds per square inch (maximum to be used).
- X Apply the compressed air to the surfaces of the item until all traces of solvent have evaporated.

DRYING WITH OVENS (FIGURE 2-43)

This procedure consists of exposing the items to heated air in a well ventilated and temperature controlled oven. The drying steps are -

- X Set the temperature of the oven to operate between 270ºF and 350ºF. Lower the temperature range if the items are liable to damage by the higher temperatures.
- X Place items in the oven in baskets or on racks.
- X Circulate and replace the air in the oven by a fan or air jet to hasten drying and remove excess solvent vapors.
- X Remove items from oven when dry.

DRYING WITH INFRARED LAMPS (FIGURE 2-43)

This is a commonly used procedure for drying. It is adapted to conveyor systems of cleaning and preservation. To increase the effectiveness and hasten drying, items are often blown with compressed air prior to being placed in the infrared cabinet. The steps for infrared drying are -

- X Place items on conveyor or monorail and pass into infrared cabinet.
- X Adjust the speed of the conveyor so that items are thoroughly dried, but not overheated.
- X Set the thermostat so that the temperature of the item is maintained at 160ºF. The temperature items will reach will depend upon the length of exposure under the lamps, the number and placement of the lamps, their distance from lamps, and the mass of the item.

DRYING BY WIPING (FIGURE 2-43)

This procedure is accomplished only when it is impractical to use any other drying procedure. It is performed as follows:

- X Drying is accomplished by wiping the surfaces of the item with clean, dry, lint free cloths or specially prepared paper wiping towels (linen combed cotton and General Services Administration (GSA) Stores Stock Catalog listed lint free nonwoven fabric cleaning cloths may be used).
- X Change to fresh, clean, dry, lint free cloths and polish until assured of a thoroughly dried surface.
- X Discard wiping cloths when they become saturated or soiled by placing them in an all metal container with a closed lid. Empty container at regular intervals as required by safety regulations.

DRYING BY DRAINING (FIGURE 2-43)

When the final step in cleaning involves a petroleum solvent, thorough draining of the solvent is permitted as a drying procedure. Unless otherwise specified, this drying procedure is used only when followed by the application of a cold application solvent cutback preservative. It is not intended for use under methods of preservation when a preservative is not applied. Precautions must be taken to insure that residual films of petroleum solvent will not reduce the effectiveness of the applied preservative compounds. Draining is completed as follows:

- X Remove the items from cleaning tank and place on rack to drain.
- X Check item surfaces to assure no residual solvent remains to dilute or interfere with preservative application.

JET SPRAY WASHING

Jet spray washing is an advanced cleaning method designed to operate with very low buildup, emission, or generation of environmentally hazardous contaminants.

ENVIRONMENTALLY SAFER CLEANING METHODS

Traditional cleaning procedures, previously mentioned, such as vapor degreasing, cold solvent cleaning, electrochemical cleaning, etc., which require the use of chloroflourocarbons and/or solid water contaminants that do not meet EPA's standards for clean air emissions and/or effluent standards for waste streams are becoming obsolete.

Jet spray washing provides an environmentally safer cleaning alternative that is attribute to the following:

- X use of a cleaning compound MIL-C-29602 which meets EPA's standards for waste materials.
- X the new equipment developed for using the above cleaning compound.

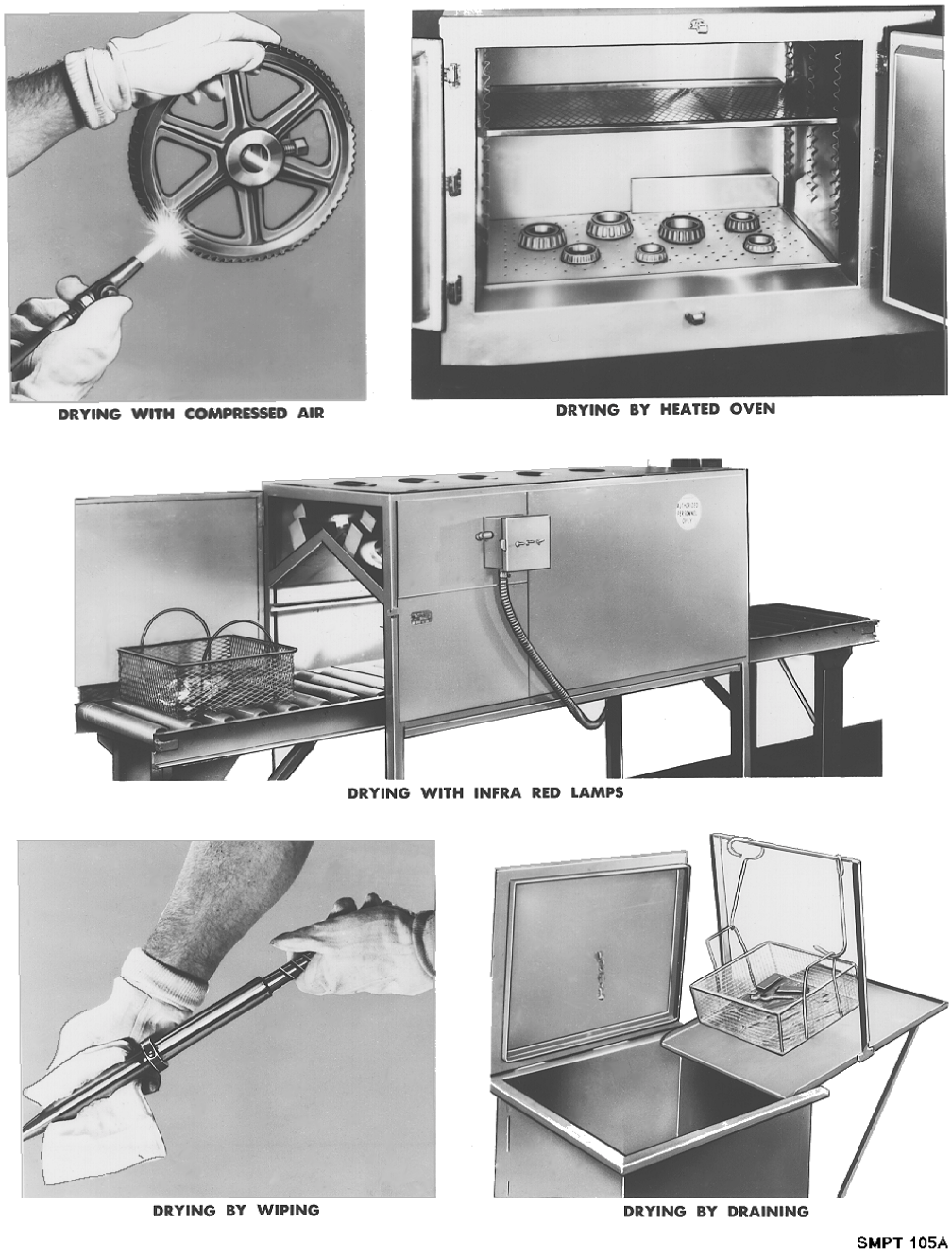

Figure 2-43. Drying procedures.

DOD has authorized the purchase and use of cleaning materials cited in the publication TB 43-0135, Environmentally Safe Substances for Use With Communications-Electronics Equipment.

Cleaning materials cited in TB 43-0135 are used for many types of items and item managers may find many useful substitutes listed in TB 43-0135 for their present solvent cleaning materials which may be hazardous. The proponent for this document is

U.S. Army Communications-Electronics Command
ATTN: ANSEL-LC-LM-LT
Fort Monmouth, NJ 07703-5007

Alternate solvents and solvent substitutes are listed in the paragraph "Environmentally Safe Solvents" at the end of this chapter.

JET SPRAY WASHING EQUIPMENT

DOD has also authorized the purchase and use of equipment for using the cleaning materials. Examples of some of the units are shown in figures 2-44, 2-45 and 2-46, but not all units of this type are shown. The various sizes of equipment which may be used are depicted, depending upon the size, contour, or nature of the item to be cleaned.

JET SPRAY CLEANING PROCESS

In brief, the units work in the following way:

- X items with heavy or light greases or oils are placed into the units which are preheated to temperatures of about 95ºF.
- X hot water and detergent (MIL-C-29602) are forcefully or "jet" sprayed onto the items until they are clean.
- X it is also possible to use a hand spray attachment for detail work which may be desired.
- X as the items are being cleaned, the contaminants (oils, greases, sludge, etc.) are scraped or skimmed from the surface of the cleaning solvent and are then compressed into very small units for subsequent disposal.
- X the liquid portion of the cleaning compound is a safe effluent for systems.
- X items receive thorough cleaning and are very hot at the end of the cleaning cycle. No special drying procedure is necessary.

Regardless of the high cleaning temperatures, jet-spray washing will not remove fingerprints, perspiration, etc., from critical surfaces of metal items. The fingerprint removal compound process will still be necessary.

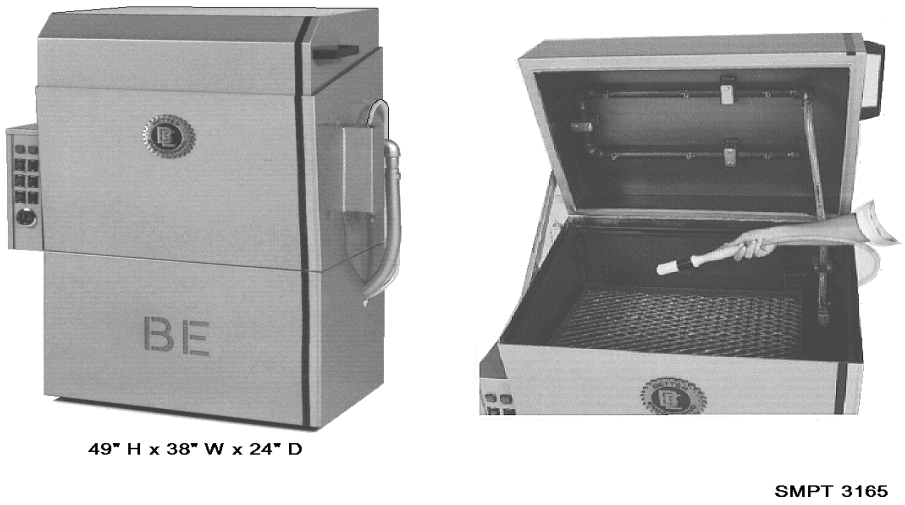

Figure 2-44. Automated cleaning unit with rinsing and drying capability.

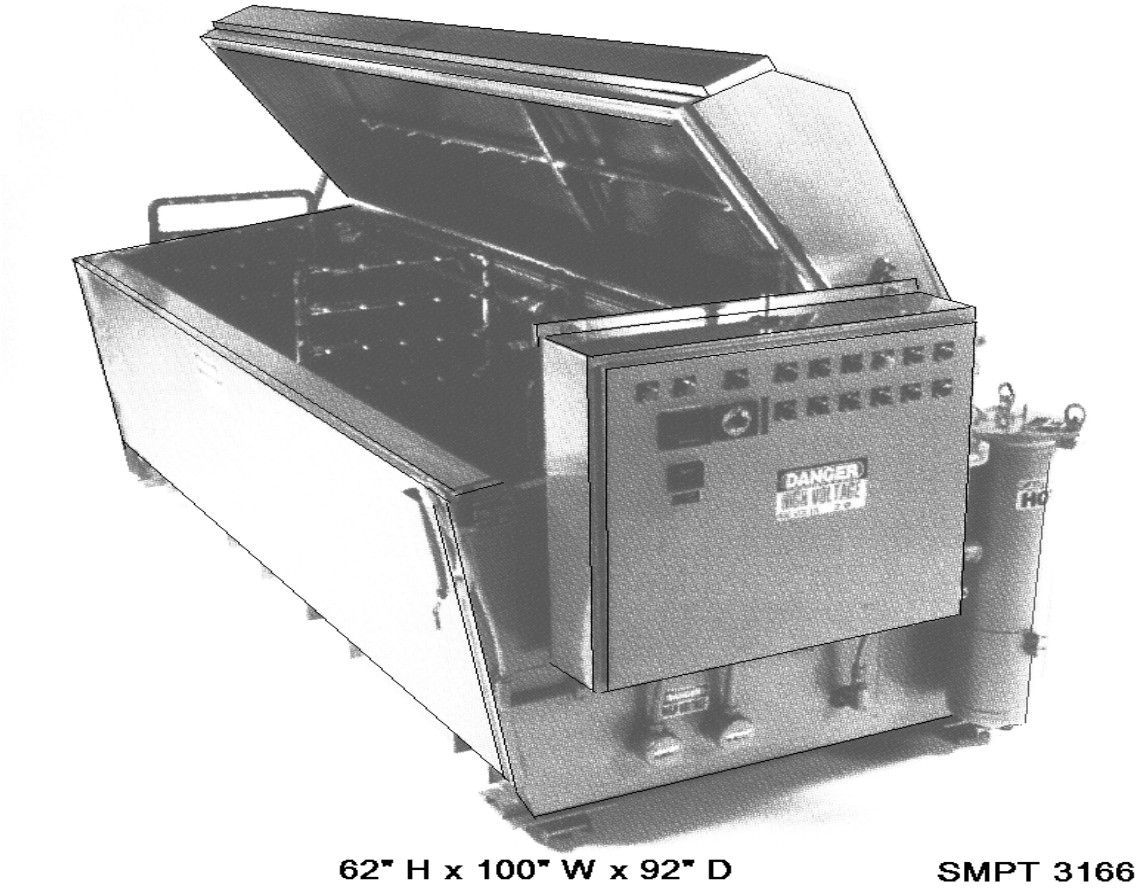

Figure 2-45. Automated cleaning unit (Larger) with rinsing and drying capability.

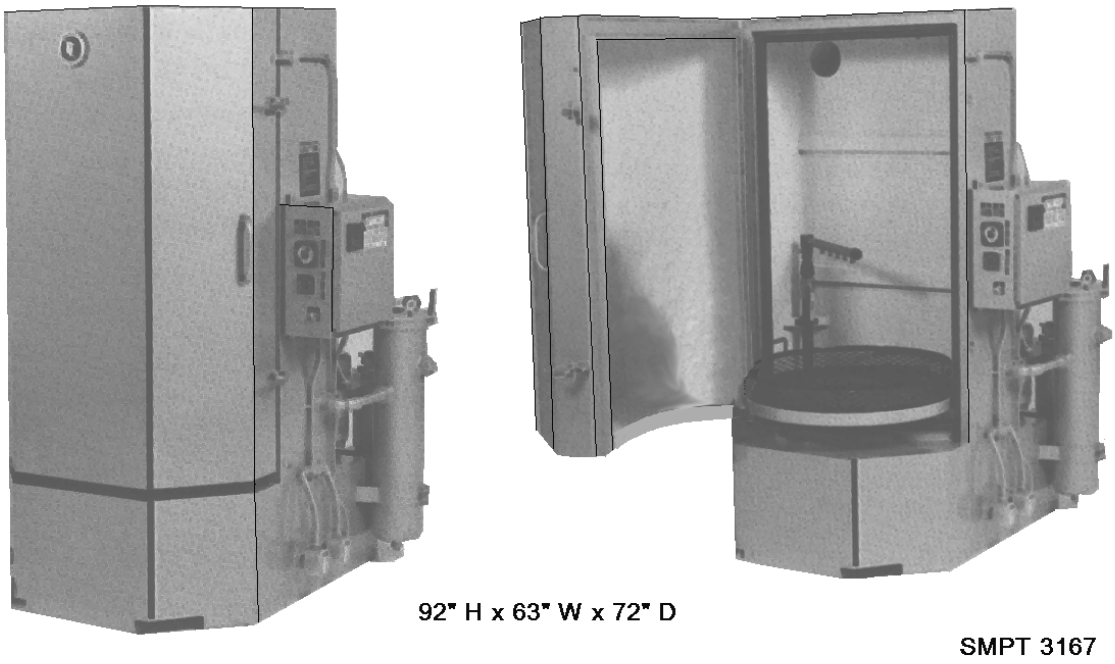

Figure 2-46. Automated cleaning unit with hand-detailing capability.

Use of the new cleaning units was proven to be cost-effective at several installations. At Langely AFB, a net savings of over $100,000.00 was reported after the first year of operations, and the savings continued to increase. A Naval Base also reported savings for the first year of over $1,000,000.

Studies and tests reveal that the jet-spray washing technique results in the following:

- X less hazardous waste production.
- X savings due to elimination of certain labor costs.

NAVY'S HAZARDOUS MATERIALS REDUCTION PROGRAMS

The Navy via the Naval Supply Systems Command, has taken a major role in reducing or helping to eliminate DOD's environmentally harmful waste products through their Plastics Removal in Marine Environment (PRIME) and Hazardous Substance Management System (HSMS) programs. In addition, the Navy is complying with the International Convention for the Prevention of Pollution from Ships (MARPOL 73-78). Also, there are other United Nation's requirements for international shipments of hazardous materials by water for which Navy has direct responsibility. For additional information on pollution control, contact the following department:

Naval Inventory Control, Mechanicsburg
P.O. Box 2020
5450 Carlisle Pike
Mechanicsburg PA 17055
(717)790-5623

ENVIRONMENTALLY SAFE SOLVENTS

P-D-680 dry-cleaning solvent has been used for many years but is being eliminated because it is flammable, toxic, and becomes a hazardous waste. Therefore, Types I and II of P-D-680 are curtailed for use but Type III, with NSN 6850-01-221-3349 (5 gal) or NSN 6850-01-244-3207 (55 gal drum), is still approved for use but will eventually be "phased-out".

An approved substitute for P-D-680 is **134 HI-SOLV**, NSN 6850-01-277-0595 (5 gal) and NSN 6850-01-244-3207 (55 gal drum).

Other approved solvents are listed below:

Product	NSN (5 Gal)	NSN (55 gal)
Breakthrough	6850-01-376-0679	6850-01-378-0666
Eelctron 296	6850-01-375-5553	6850-01-375-5555
Skysol 100	6850-01-381-4423	6850-01-381-4401
Skysol	3850-07-381-4420	6850-01-381-4404
PF	7930-01-328-4061	7930-01-328-4058

For details concerning the properties, action, and replacement of P-D-680, we recommend the reading of TARDEC Technical Reports Nos. 13630 (Oct 1996) and 13643 (Sept 1995) by In-sek Rhee, Carlos Velez, and Karen Von Bernewitz at the USA Tank Automotive RDE Center, TACOM Research, Development, and Engineering Center, Warren Michigan 48397-5000.