



# Standard Practice for Solvent Vapor Degreasing Operations<sup>1</sup>

This standard is issued under the fixed designation D 3698; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last approval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This practice recommends work practices for conventional vapor degreasing operations utilizing any solvent or solvent blend that has been categorized as nonflammable.

1.2 This practice is not intended for use in vapor degreasing operations utilizing flammable (low flash point) solvents or in vapor degreasing operations utilizing enclosed (sealed, airtight) equipment. For these non-applicable operations, users should consult the solvent or equipment supplier for additional information.

1.3 The values given in inch-pound units are to be regarded as the standard. The values stated in parentheses are for information only.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

## 2. Referenced Documents

### 2.1 ASTM Standards:

- D 2110 Test Method for pH of Water Extractions of Halogenated Organic Solvents and Their Admixtures<sup>2</sup>
- D 2942 Test Method for Total Acid Acceptance of Halogenated Organic Solvents (Nonreflux Methods)<sup>2</sup>
- D 4276 Practice for Confined Area Entry<sup>2</sup>
- D 4579 Practice for Handling an Acid Degreaser or Still<sup>2</sup>
- D 4757 Practice for Placarding Solvent Vapor Degreasers<sup>2</sup>

### 2.2 Government Documents:<sup>3</sup>

- 40 CFR Part 63.460-469 U.S. EPA, National Emission Standards for Halogenated Solvent Cleaning
- 29 CFR Part 1910.146 U.S. Department of Labor, Occupational Safety and Health Standards, Permit-Required Confined Spaces

### 2.3 Other Documents:

- Threshold Limit Values for Chemical Substances and Physical Agents, ACGIH Industrial Ventilation, ACGIH*<sup>4</sup>
- NFPA 704 Identification System for Fire Hazards of Materials, National Fire Protection Association<sup>5</sup>

## 3. Terminology

### 3.1 Definitions of Terms Specific to This Standard:

3.1.1 *emergency*—any occurrence that may result in an immediate hazard to health including exposures resulting from, but not limited to, equipment failure, rupture of containers, or failure to control equipment.

3.1.2 *hazardous operation*—any procedure or activity where a release of the solvent or the decomposition products of the solvents might be expected to result in a hazard to health.

3.1.3 *nonflammable solvent(s)*—as used herein, is a solvent or solvent mixture having a NFPA flammability hazard rating of 1 or lower (as determined by NFPA 704), intended for use in vapor degreasing operations.

3.1.4 *solvent vapor degreaser*—a solvent and corrosion-resistant tank with a heated solvent reservoir or sump at the bottom, a condensing means near the top, and freeboard above the condensing means, in which sufficient heat is introduced to boil the solvent and generate hot solvent vapor. Because the hot vapor is heavier than air, it displaces the air and fills the tank up to the condensing zone. The hot vapor condenses on the cooled condensing means, thus maintaining a fixed vapor level and creating a thermal balance.

3.1.5 *solvent vapor degreasing operations*—the process by which materials are immersed in vapors of boiling liquids for the purpose of cleaning or altering their surfaces, and are subsequently removed from the vapors, drained and dried in a solvent vapor degreaser.

## 4. Significance and Use

4.1 This practice is intended for use by employers in developing their own specific operation standards for solvent vapor degreasing operations.

<sup>1</sup> This practice is under the jurisdiction of ASTM Committee D-26 on Halogenated Organic Solvents and Fire Extinguishing Agents and is the direct responsibility of Subcommittee D26.02 on Vapor Degreasing.

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<sup>2</sup> *Annual Book of ASTM Standards*, Vol 15.05.

<sup>3</sup> *Code of Federal Regulations*, available from U.S. Government Printing Office, Washington, DC 20402.

<sup>4</sup> Available from American Conference of Governmental Industrial Hygienists, Inc., 1330 Kemper Meadow Dr., Suite 600, Cincinnati, OH 45240.

<sup>5</sup> Available from National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02269-9101.

4.2 Certain vapor degreasing operations are subject to the requirements of the National Emission Standards for Halogenated Solvent Cleaning (Halogenated Solvent Cleaner NES-HAP) as found in 40 CFR Part 63, Subpart T. The determination of the applicability of these, or any additional requirements is the responsibility of the user.

4.3 This practice is not intended to address all of the requirements contained in the Halogenated Solvent Cleaner NES-HAP. Development and implementation of training programs, recordkeeping, and other additional requirements of the NES-HAP are the responsibility of the user.

## 5. Exposure Limit

5.1 No employee may be exposed to any of the solvents utilized in vapor degreasing operations covered by this section in excess of either the OSHA Permissible Exposure Limits (PEL), the ACGIH Threshold Limit Value (TLV®), or any manufacturer's recommended exposure limit.

## 6. System Location and Design

### 6.1 Location:

6.1.1 Degreasers shall be placed in a room having ventilation adequate to maintain operator exposure below the appropriate exposure limit.

6.1.2 A degreaser shall be installed so that it is not affected by drafts from sources such as windows, doors, fans, unit heaters, ventilators, or adjacent spray booths. Normal air circulation (at velocities not exceeding 50 ft (15.24 m)/min) is recommended and should not be confused with direct drafts such as those listed in the preceding sentence. Drafts should be diverted from the top of the degreaser by the use of baffles located on the windward side of the degreaser.

6.1.3 No degreaser shall be installed in areas where solvent vapors may reach open flames or high-temperature surfaces above 350°F (176°C). Solvent degreasing equipment shall not be installed in the proximity of welding and heat treating operations or space heaters unless adequate ventilation of the degreaser or other means are provided to prevent solvent fumes from contacting the high-temperature source.

6.1.4 Gas-heated degreasers (provided with natural draft ventilation of combustion tube) shall not be located in an area where the general mechanical exhaust system produces negative pressure, unless positive exhausting of combustion products by mechanical means is provided.

### 6.2 Design:

6.2.1 The level of vapors below the top edge of the degreaser (freeboard) shall at a minimum be a 1.0 ratio of height to width.

6.2.2 All degreasers shall have durable covers which shall be secured in a closed position when degreasing operations are not occurring. Sliding covers, which allow partial closure during degreasing operations are preferred.

6.2.3 Where gas is used as a fuel for heating, the combustion chamber of the degreaser shall be of tight construction, except for such openings as the exhaust flue, and those that are necessary for supplying air for combustion. Flues shall be of corrosion-resistant construction and shall extend to the outside air. If mechanical exhaust is used on the flue, there shall be provision for outside fresh make-up air. If nonmechanical

exhaust is used on the flue, a back draft diverter shall be used. Gas burners shall be provided with safety protection to provide shut down if the pilot or igniter fails.

6.2.4 Heating elements shall be so designed and maintained that their surface temperature will not cause the solvent or mixture to decompose or break down.

6.2.5 New solvent vapor degreasers or solvent stills of more than 4 ft<sup>2</sup> of vapor area shall be equipped with suitable clean-out or sludge doors located at the bottom of the boiling sump and any other sump having an area of more than 4 ft<sup>2</sup> (0.37 m<sup>2</sup>). These doors shall be designed and gasketed so that there will be no leakage when they are closed.

6.2.6 Floors and platforms around degreasers shall be prevented from becoming slippery both by the original type of construction and by frequent cleaning. They shall be firm, sound, and of the design and construction to minimize the possibility of tripping. Railing requirements for platforms appear in 29 CFR § 1910.23(c).

6.2.7 When an open top degreaser is located in a pit below floor level, the elevation of the top of the degreaser shall be a minimum of 42 in. (1066 mm) above the floor level or the operating level or else a 42-in. (1066-mm) railing must be provided in accordance with 29 CFR § 1910.23(c)(3) and (e)(1). Pit ventilation shall be designed to provide a minimum of two air changes per minute whenever a degreaser is installed in a pit more than 18 in. (457 mm) deep.

6.2.8 Degreasers shall be equipped with means to prevent solvent vapors from overflowing, such as a vapor level control device (vapor safety thermostat) sensitive enough to shut off the heat input if the solvent vapor level rises above the primary condensing coils.

6.2.8.1 The vapor safety thermostat is typically set at a temperature 20 to 30 % below the boiling point of the solvent (based on the boiling point in °F) except for very low boiling solvents (for example, methylene chloride). For these solvents, the vapor safety thermostat should be set at ambient temperature +10°F, but never higher than 100°F (38°C). Recommended temperatures for vapor safety thermostat settings can be determined from Appendix X1, or from the solvent supplier.

6.2.9 Degreasers shall be equipped with safety devices in the boiling sump that can shut off the heat input if the solvent level drops too close to the heating coils (sump level control device) or if the solvent becomes too contaminated (sump safety thermostat).

6.2.9.1 A sump level control device is designed to prevent heat input unless there is adequate solvent in the boiling sump. Such devices may be mechanical (liquid level sensor) or thermostatic (liquid level safety thermostat). The liquid level sensor should interrupt heat input if the liquid level is less than 2 in. above the heating coils. Liquid level safety thermostats, used on electrically heated degreasers, are attached to the upper surface of the heating coil with a maximum recommended setting of 20°F above the boiling point of the solvent.

6.2.9.2 Degreasers should also be equipped with a sump safety thermostat immersed in the boiling liquid. If the degreaser is equipped with an auxiliary still, then the degreaser sump safety thermostat should be set at the temperature corresponding to 25 % oil contamination (see 7.4.2.1). The

sump safety thermostat in the auxiliary still should then be set at the temperature corresponding to 25 % oil concentration if the unit is electrically heated. However, the sump safety thermostat in the auxiliary still can be set at the temperature corresponding to approximately 70 % oil concentration if the unit is indirectly heated by such means as steam. Recommended temperatures for the sump safety thermostat can be determined from Appendix X1, or from the solvent supplier.

6.2.9.3 If reclamation of solvent will be conducted using the degreaser's boiling sump as the still sump, then the safety thermostat in the degreaser may be adjusted to the higher setting during that operation and then readjusted to the temperature corresponding to 25 % oil concentration during normal operation.

6.2.10 Degreasers shall be equipped with a device to prevent heat input unless there is adequate cooling to ensure sufficient condensation of vapor in the degreaser.

6.2.11 Degreasers of the spray type shall be equipped with a method that will prevent spray pump operation unless the solvent vapors have reached normal operating levels.

6.2.12 Steam-heated degreasers shall be equipped with "pop safety valves" down-stream from any pressure control. The pressure relief setting should be consistent with the solvent in use, and may be determined from Appendix X1, or from the solvent supplier.

6.2.13 Conveyorized degreasers shall be equipped with a thermostat that will prevent work from being processed by stopping conveyorized operation unless the solvent vapors have reached the normal operating levels.

## 7. Degreaser Operations Procedures

7.1 *Start-Up*—In starting a vapor degreaser follow the procedures enumerated sequentially where applicable:

7.1.1 Turn on the cooling/condensing system coolant and check to ensure proper operation.

7.1.2 Start air exhaust equipment, if any.

7.1.3 Activate all safety control thermostats.

7.1.4 Adjust solvent levels in all compartments as necessary.

7.1.5 Check that all degreaser covers are in place during heat-up as well as cool-down.

7.1.6 Turn on the heat supply and adjust the settings as necessary. Adjust the heat balance in the degreaser so that the level of the vapor remains constant. A proper balance is achieved if solvent vapors are generated at the same rate they are condensed by work entering the vapor zone and by the condensers.

7.1.7 Once the vapor level reaches the condensing coils, check to ensure the flow of condensed solvent through the water separator and its return to proper degreaser compartments.

7.1.8 Check all gages and thermometers for proper operation.

7.1.9 Begin vapor degreasing of work items.

7.1.10 Check condenser coolant flow and adjust coolant flow or temperature, or both, to maintain temperature to ensure that the vapor line does not rise above the condenser and to minimize condensation of moisture from the room air on the condenser coils. Check that all coolant and heating lines are

free of leaks and the water separator is functioning properly to prevent contamination in the degreaser.

7.2 *Degreasing*—In degreasing follow the procedures enumerated:

7.2.1 Do not allow work loads to exceed designed degreaser capacity. Work should not generally occupy more than 50 % of the open horizontal area of the machine unless the work permits easy passage of vapor through or around it. Secure a highly durable tag to each degreaser indicating the maximum weight and volume of a single load expressed in terms of pounds per load and loads per hour.

7.2.2 Place work loads, where necessary, in free-draining nonporous baskets, trays, racks, and so forth, and position to eliminate solvent drag out.

7.2.3 When working with cup-shaped parts or parts with cavities that may collect liquid, load the parts, and rotate if necessary, in a manner to facilitate complete drainage while in the vapor zone.

7.2.4 Do not allow the vertical rate of entry and withdrawal of work loads to exceed the maximum degreaser design, which should not exceed 11 ft/min (3.4 m/min).

7.2.5 Allow the work loads (and accompanying baskets, trays, racks, and so forth) to remain in the vapor zone until condensation on the work loads (and accompanying baskets, trays, racks, and so forth) has stopped.

7.2.6 Conduct all spraying of work loads within the vapor zone.

7.3 *Shutdown*—In shutting down, follow the procedures enumerated as follows:

7.3.1 Stop the throughput of the work loads.

7.3.2 Turn off the heat supply.

7.3.3 After the level of the vapor has dropped below the condensing coil, turn off the cooling/condensing system.

7.3.4 Turn off the air exhaust equipment, if any.

7.3.5 Put covers in place and maintain the degreaser in a closed condition when the degreaser is not in actual use.

7.4 *Cleanout and Maintenance*:

7.4.1 *Procedures*—Follow the procedures enumerated as follows with respect to cleanout and maintenance of the degreaser:

7.4.1.1 After collecting usable solvent, turn off the heat and allow the degreaser to cool to near room temperature prior to cleaning.

7.4.1.2 Turn off the coolant flow.

7.4.1.3 Pump the dirty solvent or drain to a still, drum, or separate storage vessel for dirty solvent.

7.4.1.4 Remove the heating element and cleanout ports.

7.4.1.5 Remove dirt, sludge, and metal chips from the bottom of each compartment, ordinarily without entering the degreaser. Scrape foreign materials off the heating elements or interior surfaces of the degreaser, or both.

7.4.1.6 A degreaser shall not be entered by an employee except when absolutely necessary. The degreaser may be considered as a permit-required confined space as defined by OSHA (29 CFR 1910.146), and may be subject to the requirements of that standard. When entry is necessary, at a minimum the following precautionary steps shall be taken before entry is made: (1) turn off all power for pumps, conveyors, and heat

sources and lock out; (2) lock closed all solvent supply lines; (3) drain the entire solvent system including water separators; (4) remove all clean-out doors or secure in an open position; (5) expel all solvent vapors; (6) purge the degreaser with forced air; (7) the employee shall wear a harness and lifeline and NIOSH-approved supplied air respirator with a full face piece operated at a pressure-demand mode or continuous flow; (8) a second employee shall hold the free end of the lifeline, shall be similarly equipped for degreaser entry, and shall be able to communicate at all times with the first employee when inside the degreaser; and (9) a third employee must be within audible hailing distance. The second employee shall not enter the degreaser unless absolutely necessary to remove the first, and shall not enter before the third employee has been alerted. The third employee shall not enter the degreaser. Refer to Practice D 4276 for complete entry instructions.

7.4.1.7 Clean the interior of the water separator as necessary.

7.4.1.8 Check and clean the thermostatic controls and indicating thermometers.

7.4.1.9 Reassemble all components and replace clean-out ports and gaskets as necessary.

7.4.1.10 Refill the unit with solvent; the unit is then ready for start-up.

7.4.2 *Frequency*—The frequency of clean out is integrally related to the safety of the operator, the economy of the operation, and the effectiveness of the process. There is no established rule to govern the frequency of clean out. Frequency is determined by the volume of the work processed and the nature and amount of soil to be removed. Frequency should generally be determined by reference to the solvent's (1) boiling point, (2) acid acceptance or pH, or both, or (3) solids accumulation.

7.4.2.1 *Boiling Point*—Degreasers should generally be cleaned when or before the contamination level reaches approximately 25 % by volume. When the contamination is oil, this can be estimated by the boiling point of the solvent-oil mixture. Typical values are listed in Appendix X1.

7.4.2.2 *Acid Acceptance or pH*—For certain applications the acid acceptance or pH of the solvent may provide a useful guide with respect to the need to clean the degreaser. When acid acceptance is used as the guide, clean the degreaser when acid acceptance drops below the recommended levels. See Appendix X1, or consult the solvent supplier. Acid acceptance tests should be made on the distillate from the degreaser water separator and should be conducted in accordance with Test Method D 2942. To determine pH, water extracts of distillate samples should be tested in accordance with Test Method D 2110.

7.4.2.3 *Solids Accumulation*—Degreasers should be cleaned when solids accumulate to a depth such that they reach the bottom of the heating coils (or ¼ in. (6.3 mm) thick on strip-heated electric or steam-jacketed units).

7.5 *Solvent Reclamation*—If solvent is to be recovered from oil residues through the use of a still, pump the solvent or drain directly to the distilling unit or into suitable storage containers. In no case may solvent be drained into or carried in uncovered containers.

7.6 *Acid Degreaser*—An acid degreaser results from the decomposition of solvent or contaminants, or both, to form acids and requires special handling. See Practice D 4579.

## 8. Hazardous Operations and Emergencies

### 8.1 *Hazardous Operations:*

8.1.1 Any operation that generates or involves a high-temperature source, open flame, or ultraviolet light may not be performed in areas where airborne concentrations of the solvents are present or may be present unless such operations are shielded and adequately ventilated. Examples of hazardous operations are those involving open flames, unshielded (unventilated) resistance heating, and arc welding or cutting.

8.1.2 Perform cleaning of, or entry into, degreasers that have contained solvents in accordance with 7.4.1.6 and Practice D 4276.

### 8.2 *Emergencies:*

8.2.1 If, in emergencies such as rescue work, it is necessary to enter a degreaser, follow the procedures in 7.4.1.6 and Practice D 4276.

8.2.2 In emergencies such as major spills where an immediate health hazard is likely, immediately evacuate all personnel likely to be affected. Consult the solvent material safety data sheet for further information. Employees reentering the area to engage in cleanup or other activities shall wear NIOSH-approved respiratory protection and protective equipment commensurate with the magnitude of the potential exposure. Cover spills with absorbent material as recommended by the solvent manufacturer, and collect in closed (but not sealed) containers. Take appropriate measures to avoid overexposure of employees from the collected material.

## 9. Control Methods

### 9.1 *Ventilation:*

9.1.1 Ventilation may be used to reduce employee exposure to below the permissible exposure limits. Appropriate rates of ventilation can be found in *Industrial Ventilation*.

9.1.2 Ventilation systems shall be inspected at least every six months.

### 9.2 *Other Methods:*

9.2.1 A refrigerated freeboard device of sufficient refrigerant capacity to establish an inversion blanket control may be used to reduce employee vapor exposure.

9.2.2 Other methods that reduce emissions may be used if they maintain airborne vapor concentrations below the permissible exposure limit.

## 10. Personal Protection

10.1 Where there is a possibility of splashes, sprays, or spills, or where there may be eye or repeated skin contact with solvent, employees shall be provided with impermeable clothing, gloves, or coverings to protect the area of the body likely to come in contact with the solvent.

10.2 Eye and face protection shall be provided in accordance with 29 CFR § 1910.133(a)(2),(4), (5), and (6).

10.3 The employer shall institute a respiratory protection program in accordance with 29 CFR § 1910.134 meeting all the requirements contained therein.

10.4 First aid facilities specific to the hazards of the operations conducted shall be readily available.

### 11. Housekeeping

11.1 Keep the workplace clean in accordance with 29 CFR § 1910.141(a)(3).

11.2 Spent solvent should be monitored to ensure that no decomposition reactions are occurring.

### 12. Sanitation

12.1 The employer shall provide adequate washing facilities in accordance with 29 CFR § 1910.141(d).

12.2 Shower and eye wash facilities should be available.

### 13. Training, Education, and Information

13.1 The employer shall provide at the time of initial assignment and annually thereafter to each degreaser operator, his direct supervisor, and persons responsible for maintenance of degreasers, a training program in solvent vapor degreasing operations including instruction on the specific hazards and effects of the solvent in use, the necessity of controlling exposures and emissions, emergency procedures, and the procedures for safe operation and maintenance of degreasers.

13.2 The instruction manual for the degreaser, the material safety data sheet (MSDS) for the solvent in use, and a copy of the degreaser operating practices shall be maintained in a legible condition and retained in a solvent-resistant container at the operating site of the degreaser by the operator and adequately identified.

13.3 If the employer shifts from one degreasing solvent to another, a new training, education, and information program shall be implemented, equipment modifications as necessary shall be made, and an appropriate change shall be made in the sign on the degreaser with respect to the chemical solvent in use.

#### 13.4 Signs and Labels:

13.4.1 All degreasers shall have attached to them a legible, highly durable sign or signs bearing the identity of the solvent in use and appropriate hazard warnings.

13.4.1.1 Practice D 4757 contains recommended warnings and operating procedures for posting on vapor degreasers.

### 14. Keywords

14.1 degreasing; halogenated solvent cleaning; halogenated solvents; nonflammable solvents; solvent vapor degreasing; vapor degreasing

## APPENDIX

### (Nonmandatory Information)

#### X1. PROPERTIES OF VAPOR DEGREASING SOLVENTS AND SOLVENT SYSTEMS

X1.1 Table X1.1 includes information on nonflammable solvents intended for use in vapor degreasing. This information is provided for reference only. Inclusion of a particular product on this list is not intended as a recommendation for or against

its use in a particular vapor degreasing application. The selection of a particular product is the responsibility of the user. For information on products not appearing on this table, consult your supplier.

**TABLE X1.1**

Substance	Safety Thermostat Settings °F (°C)				Steam Pressure Relief Valve Setting, psi (MPa)	Minimum Acid Acceptance (Weight % as NaOH)
	Boiling Point, °F (°C)	Sump		Vapor		
		Boiling Temperature with 25 % Mineral Oil	Boiling Temperature with 70 % Mineral Oil <sup>A</sup>			
Methylene chloride	104 (40)	110 (43)	125 (53)	≤100 (38) <sup>B</sup>	5 (0.035)	0.03
Methyl chloroform	165 (74)	175 (79)	200 (94)	130 (54)	15 (0.1)	0.03
Perchloroethylene	250 (121)	260 (127)	295 (146)	190 (88)	60 (0.4)	0.01
Trichloroethylene	188 (87)	195 (91)	221 (105)	155 (68)	15 (0.1)	0.03
Trichlorotrifluoroethane	118 (48)	125 (53)	130 (54)	105 (41)	5 (0.035)	NA
n-Propyl bromide	160 (71)	163 (73)	212 (100)	125 (52)	15 (0.1)	0.04

<sup>A</sup>These settings are to be used with indirect heating only (steam).

<sup>B</sup>The vapor safety thermostat for methylene chloride should be set at ambient temperature +10°F (5.55°C), but should never exceed 100°F (38°C).

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