

MIL-STD-1246A
18 AUGUST 1967
SUPERSEDING
MIL-STD-1246 (MI)
19 DECEMBER 1962

MILITARY STANDARD
PRODUCT CLEANLINESS LEVELS
AND
CONTAMINATION CONTROL PROGRAM



FSC - 3694

MIL-STD-1246A
18 August 1967

SUPERSEDING
MIL-STD-1246(MI)
19 December 1962

DEPARTMENT OF DEFENSE
Washington, D. C. 20301

Product Cleanliness Levels and Contamination Control Program

MIL-STD-1246A

1. This Military Standard is mandatory for use by all Departments and Agencies of the Department of Defense.
2. Recommended corrections, additions, or deletions should be addressed to Commanding General, U. S. Army Missile Command, ATTN: AMSMI-IDD, Redstone Arsenal, Alabama 35809.

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APPENDIX A

CLEANING METHODS AND MATERIALS

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1. SCOPE

1.1 Scope. This standard provides a basis and a uniform method for specifying product cleanliness levels and contamination control program requirements.

1.2 Use. These requirements are unusual and are not required for all products but are intended for use in military procurement and design contracts for only those items that contamination control, by measurement for parts, components, or fluids, is necessary to insure reliability.

1.3 Applicability. When this standard is made a part of a procurement contract, the procuring activity shall be responsible for identifying the applicable requirements contained herein that apply to the particular contract.

2. REFERENCED DOCUMENTS

2.1 Documents. The issues of the following documents in effect on the date of invitation for bids form a part of this standard to the extent specified herein.

GOVERNMENTAL

FED-STD-209 - Clean Room and Work Station Requirements, Controlled Environment

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the Contracting Officer.)

2.2 Other publications. The following documents form a part of this standard to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

NON-GOVERNMENTAL

ASTM-F 24 - Measuring and Counting Particulate Contamination on Surfaces

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- ASTM-F 25 - Sizing and Counting Airborne Particulate Contamination in Clean Rooms and Other Dust-Controlled Areas Designed for Electronic and Similar Applications
- ASTM-D 2390 - Microscopic Sizing and Counting Particles from Aerospace Fluids on Membrane Filters
- ASTM-D 2391 - Processing Aerospace Liquid Samples for Particulate Contamination Analysis Using Membrane Filters
- ASTM-D 2429 - Sampling Aerospace Fluids from Components
- ASTM-D 2544 - Proposed Gas Sampling for Gaseous Analysis

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

- SAE-ARP-598 - Procedure for the Determination of Particulate Contamination of Hydraulic Fluids by the Particle Count Method
- SAE-ARP-743 - Procedure for the Determination of Particulate Contamination of Air in Dust Controlled Spaces by the Particle Count Method

(Application for copies should be addressed to the Society of Automotive Engineers, Inc., 485 Lexington Avenue, New York, N. Y. 10017.)

3. DEFINITIONS

The following definitions apply to terms used in this standard:

- 3.1 Cleanliness level. An established level of maximum allowable contamination based on size, distribution, or quantity in a given area or volume.
- 3.2 Contamination. Any foreign material.
- 3.3 Contamination control. Organized action to control the level of contamination.

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3.4 Micron. A unit of measurement equal to one-millionth of a meter, or thirty-nine millionths of an inch (0.000039 inch), e.g., 25 microns is approximately 0.001 inch.

3.5 Non-Volatile Residue (NVR). Soluble material remaining after evaporation of a volatile liquid or determined by special purpose analytical instruments, usually measured in milligrams per unit volume.

3.6 Particle size. Particle size is expressed as the apparent maximum linear dimension or diameter of the particle.

3.7 Significant surface. Any surface of an item or product which is required to meet established cleanliness level requirements.

4. GENERAL REQUIREMENTS

4.1 Responsibility.

4.1.1 Prescribing product cleanliness. The responsibility for selecting or determining the degree of product cleanliness shall rest with the DOD design activity initially responsible for the product to be produced or processed.

4.1.2 Achieving and maintaining product cleanliness. The responsibility for achieving and maintaining product cleanliness shall rest with the responsible activity whose function is to process or produce the product from the design criteria and related specification requirements.

4.1.3 Assuring the integrity and continuity of the contamination control effort. The responsibility for insuring a continuing contamination control effort shall rest with quality control or similar activity whose function is to insure that the product meets design criteria and specification requirements.

4.1.4 Contamination control plan. A contamination control program plan and its methods for implementation shall be submitted to meet the product requirements for cleanliness as specified. The contamination control plan shall include, but not be limited to consideration of the following factors:

4.1.4.1 Design requirement. The cleanliness level of the product and its sensitivity to contamination shall be determined by the product design activity unless otherwise specified. Contamination limits are to be prescribed by design drawings or specifications consistent with the product requirements. When the product design activity cannot predetermine the cleanliness level,

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a proposed method for determining this level through investigation, experimentation or assessment shall be included.

4.1.4.2 Product design review. A product design review in terms of contamination sensitivity shall be included.

4.1.4.3 Processes and controls. Those processes and controls applicable to the product, at each stage of manufacture or processing, including parts, components, assemblies, and materials, that will affect the cleanliness of the product shall be included.

4.1.4.4 Clean room facilities and work stations. The clean room facilities and work stations shall meet the requirements of FED-STD-209.

4.1.4.5 Sub-tier contractors. A method shall be outlined for imposing contamination control requirements on sub-tier contractors.

4.1.4.6 Calibration procedures. Facility and equipment calibration procedures that are to be followed shall be defined.

4.1.4.7 Quality control. Quality control procedures, sampling plans, etc., shall be detailed to ensure surveillance and compliance.

4.1.4.8 Product protection. Methods for product protection shall be provided to maintain the required product cleanliness level.

4.1.4.9 Personnel. Personnel training, motivation and control methods shall be outlined.

5. DETAILED REQUIREMENTS

5.1 Cleanliness levels. Table Ia and Ib prescribe the cleanliness levels established to provide a uniform set of criteria for specifying product cleanliness, based on contaminant size, distribution, and count. Use of these cleanliness levels provides a basis for specifying and determining conformance to cleanliness requirements.

5.1.1 Application of cleanliness levels. The cleanliness levels of Table Ia and Ib shall apply to surfaces, assemblies, components, or fluids. The following units of measure shall be used:

(a) Surfaces - Particles categorized by size and count per square foot¹ of significant surface area¹. Non-volatile residue in milligrams per

¹NOTE: Areas less than one square foot shall be considered as one square foot. Area may be estimated.

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square foot¹ of significant surface area.

(b) Assemblies and components - Particles categorized by size and count per square foot¹ of significant surface area¹. Non-volatile residue in milligrams per square foot¹ of significant surface area.

(c) Liquid - Particles categorized by size and count per 100 milliliters of fluid. Non-volatile residue measured in milligrams per 100 milliliter of fluid sample.

(d) Gas - Particles categorized by size and count per cubic foot of gas.

5.1.2 Measurement of cleanliness levels. Measurements to determine cleanliness shall be accomplished as follows, or by demonstrated equivalents:

(a) Surfaces - According to ASTM-F 24, ASTM-D 2429 (sampling), ASTM-D 2391 (processing sample), ASTM-D 2390 (sizing and counting), or SAE-ARP-598.

(b) Assemblies and components - Same as surfaces (a).

(c) Liquids - According to ASTM-D 2391 (sampling), ASTM-D 2390 (sizing and counting), and SAE-ARP-598.

(d) Gases - According to SAE-ARP-743, ASTM-F 25, ASTM-D 2544 (sampling). ASTM-D 2390 (sizing and counting). NOTE: For measurement conditions not covered, acceptable methods shall be negotiated between the contracting parties.

5.1.3 Method for specifying product cleanliness levels. Product cleanliness levels shall be specified in the following manner:

MIL-STD-1246 (Level 200), refers to particulates only.

MIL-STD-1246 (Level 200F), refers to particulates and NVR.

MIL-STD-1246 (Level NVR-F), refers to requirement for NVR only.

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CLASSIFICATION OF PRODUCT CLEANLINESS LEVELS

Table 1a

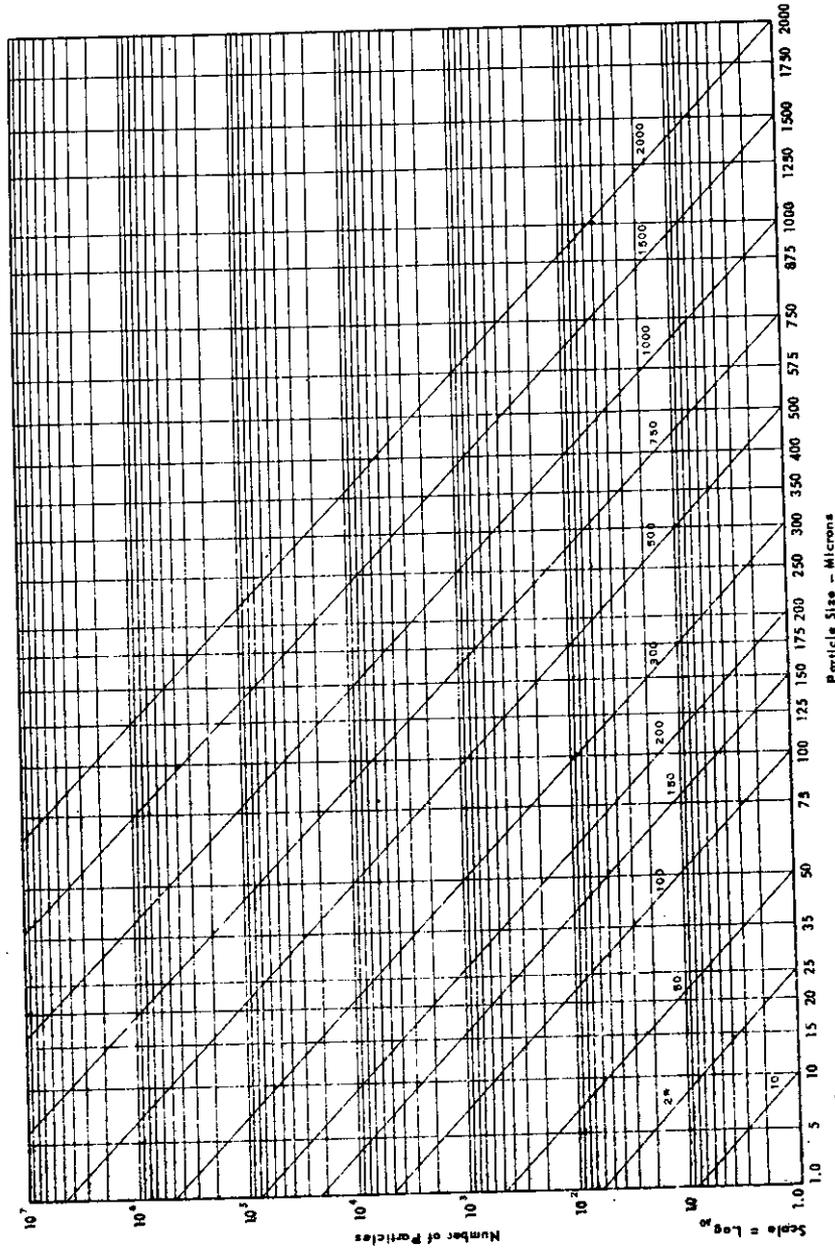
Cleanliness Level	Range Surface and Fluids	Quantity of Particulates
10	5	Less than 3
25	5	21
	15 25	Less than 4 1
50	5	180
	15	25
	25	7
	50	1
100	15	280
	25	75
	50	11
	100	1
200	15	4100
	25	1100
	50	180
	100	16
300	25	7000
	50	1000
	100	90
	250	Less than 3
500	50	11000
	100	950
	250	25
	500	1
750	100	6500
	250	170
	500	7
	750	1
1000	250	1000
	500	45
	750	7
	1000	1

Table 1b
Non Volatile Residue

Level	Quantity NVR
A	Less than 1.0 mg
B	1.0 mg to 2.0 mg
	2.0 mg to 3.0 mg
C	3.0 mg to 4.0 mg
	4.0 mg to 5.0 mg
D	5.0 mg to 7.0 mg
	7.0 mg to 10.0 mg
E	10.0 mg to 15.0 mg
	15.0 mg to 25.0 mg

Derivation of Cleanliness Levels. The cleanliness levels and range within each level of Table 1a were established by plotting the curves in Chart 1. Chart 1 plot point is number of total particles above given size versus particle size.

CHART I
PRODUCT CLEANLINESS LEVELS



Scale = \log_{10}
Scale = \log_{10}
Research shows that naturally occurring particulate contamination follows a log-normal distribution with a geometric mean of near one (1) micron particle. This distribution follows a straight line when plotted on a $\log \times \log$ scale graph. The grid is derived from the log-normal Gaussian distribution function which provides a close fit to real contamination data. The lines on the chart represent the maximum contamination permitted for each level and the plot point is the number of particles above given size versus particle size. The curves can be expressed as $\log n = 0.9260 (\log^2 X_1 - \log^2 X)$, where n is the number of particles, X is the particle size, and X_1 is the cleanliness level.

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Custodians:

Army - MI
Air Force - 71
Navy - AS

Preparing activity:

Army - MI

Project No. MISC-0248

Review activities:

Army - AV
AT
EL
GL
MI
TM
Navy - AS
SA
SH
Air Force - 70
71
84
68

User activities:

Army - ME
MR
MU
SM
WC
Navy - OS
Air Force - 79
80
84

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10.1.1.3 Mild alkaline cleaners and detergents. Used for the removal of organic and inorganic contamination, e.g., oils, fats, shop soil, and grease. Use: inhibited alkaline cleaners (mild alkaline cleaner), soaps, and detergents.

10.1.1.4 Organic solvent cleaners. Used to remove some forms of organic contamination, e.g., oils, grease, and hydrocarbon fuels. Use: halogenated solvents (except carbon tetrachloride), alcohol, benzene, xylene, and toluene.

10.1.1.5 Tap water and deionized water. Used to remove the residual material left by cleaning solutions and as a final flushing or rinsing medium.

10.1.1.6 Neutralizing and passivating solutions. Supplementary treatments to acid, alkaline and mechanical cleaning used to prevent corrosion and acid etching. Use: nitrate, phosphate, alkali with nitrate or phosphate to neutralize; nitric acid or nitric acid and chromate solutions to passivate.

10.1.1.7 Mechanical cleaning. Removes contamination by abrasive action. Used only when physical damage to the item being cleaned will not occur. Includes: wire brushing, shot blasting (wet and dry), grinding, sand blasting (wet or dry), the use of aluminum oxide, abrasive coated papers and cloths, and related methods.

NOTE: Mechanical cleaning often leaves foreign deposits which may require additional cleaning for their removal. Compatibility of dissimilar metals is an important consideration when selecting a mechanical cleaning method.

10.1.1.8 Gross cleaning processes. Table II shows recommended gross cleaning processes and sequences.

10.2 Precision cleaning. This method is performed to achieve a level of product cleanliness to a greater degree than is normally detected by visual means. Articles should be visible clean prior to precision cleaning. Precision cleaning is performed in a controlled environment that will permit the achievement and maintenance of the specified cleanliness level of the product. Precision cleaning should be capable of removing particles, films, biological forms, fibers and other forms of contaminants that are usually not visibly detected and could degrade the specific product or process. The level of precision cleanliness should be demonstrated or verified and evidence of inspection and acceptance provided. Precision cleaned article shall be suitably protected or packaged immediately after verification of cleanliness and prior to leaving the controlled environment.

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APPENDIX

FOREWORD

The purpose of this appendix is to provide nonmandatory supplemental guidance information for the preparation of documents relating to contamination control programs.

10. CLEANING METHODS AND MATERIALS

10.1 Gross cleaning. This method is performed to achieve visible clean articles. Gross cleaning removes contaminants such as weld scale, heat treat scale, corrosion, oxide films, oils, grease, shop soil, fuel and carbon deposits. The cleanliness level achieved by gross cleaning does not normally require verification beyond visual appearance. (Wipe test, waterbreak test, ultraviolet inspection, special lights and mirrors, are considered aids to visual inspection.) Gross cleaning is considered a normal shop process and usually does not require special environmental controls, packaging, handling, or storage beyond accepted good practice that will not degrade the quality of the product.

10.1.1 Gross cleaning types. The following types of cleaners, or their equivalent, may be used for removing gross forms of contamination.

NOTE: Chemical cleaning agents must be compatible to prevent excessive attack or latent degradation.

10.1.1.1 Acid cleaners. Used to remove the contamination, e.g., weld scale, corrosion, and oxide films not removable by other solutions. Use: nitric acid, chromic acid, inhibited hydrochloric acid, inhibited sulfuric acid, inhibited phosphoric acid, mixed acid deoxidizers, and alcoholic-phosphoric acid.

10.1.1.2 Alkaline cleaners. Used for removal of organic and inorganic contamination, e.g., grease, shop soil, scale, and soluble metal oxides. Alkaline cleaners dissolve (etch) certain metals such as aluminum or zinc. Use: alkaline rust strippers, heavy duty alkaline cleaners, molten alkalines, alkali, and alkali with nitrate or phosphate.

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Table II

SELECTION CHART FOR GROSS CLEANING PROCESSES

NOTE Symbols in the block denote a recommended process for the surface condition indicated, and will normally be accomplished in consecutive order from left to right.		Gross Cleaning Processes											
		Mechanical Descale/Clean	Organic Solvent Degrease	Alkaline Clean	Tap Water Rinse	Detergent Clean	Tap Water Rinse	Acid Pickle	Tap Water Rinse	Neutralize and Passivate	Tap Water Rinse	Deionized Water Rinse	Drying
Material	Surface Condition												
Aluminum	Bare or machined, free of heat oxidation		X	X							X	X	X
	Conversion or chemical film coating		X			X						X	X
	Weld scale, corrosion, or heat oxidation	X	X	X	X						X	X	X
Copper, brass, bronze	Bare or machined, free of heat oxidation		X	X							X	X	X
	Conversion or chemical film coating		X			X						X	X
	Weld scale, corrosion, or heat oxidation		X	X	X			X			X	X	X
*Stainless steel	Free of scale		X	X	X			X	X	X	X	X	X
	Weld scale, corrosion, or heat oxidation	X	X	X	X			X	X	X	X	X	X
Carbon steel	Free of scale		X	X	X					X	X	X	X
	Weld scale, corrosion, or heat oxidation	X	X	X	X			X	X	X	X	X	X
Non-metallic parts, clastomers	As received					X					X	X	X
Electroplated parts and dissimilar metals	As received		X	X							X	X	X

* ASTM-A380 describes in detail recommended methods for descaling and cleaning stainless steel.

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10.2.1 Precision cleaning solutions/fluids. Precision cleaning solutions or material shall not react with, combine with, etch, or otherwise cause immediate or latent degradation of the item being cleaned. Precision cleaning fluids should be filtered, controlled, and verified, at a cleanliness level that is demonstrated to be sufficient to achieve the specified product cleanliness. Use of the following fluids is recommended:

- (a) Halogenated solvents
- (b) Ketones
- (c) Alcohols
- (d) Detergent (must be followed by deionized water rinse)
- (e) Deionized water
- (f) Air or inert gas (for drying or removal of volatile fluids)

10.2.2 Precision cleaning methods/processes. Various methods and equipment are available which are suitable for precision cleaning. The process and equipment to use shall be selected on the basis of product configuration, compatibility with cleaning fluids, type and quantity of contaminants, desired cleanliness level, economic factors, and safety considerations. The various precision cleaning fluids are used in a variety of equipment and methods. The following equipment and methods should be considered when selecting the appropriate precision cleaning process for a particular product.

10.2.2.1 Solution cleaning. The item is washed in suitable clean solvent or detergent solution followed by successive rinses. Normally it requires agitation in the solution or use of a soft bristle brush to assure removal of contaminants.

10.2.2.2 Spray cleaning. Spray or stream of a suitable filtered solvent or detergent solution is directed on the item to be cleaned.

10.2.2.3 Ultrasonic cleaning. The item to be cleaned is immersed in a suitable bath of cleaning solution that is energized with an appropriate ultrasonic device. The cleaning solvent or solution and the frequency of the ultrasonic energy must be carefully selected to be compatible and

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effective. This method should not be used on items which may be degraded by sonic energy, unless precautions are taken that are demonstrated to provide effective protection.

10.2.2.4 Vapor cleaning. The item to be cleaned is exposed to heated solvent vapors which condense on the part and wash away contaminants.

10.2.2.5 Flush clean. The item to be cleaned is filled, flooded, or rinsed with a suitable cleaning solution. The item is agitated thoroughly to wash all surfaces and the solution is drained.

10.3 Solution controls should be used.

10.4 A detailed process plan should be developed to specify requirements of the selected precision cleaning process for a particular part, assembly or product. The process plan should include the following elements:

- (a) Product description
- (b) Cleaning equipment to be used
- (c) Operating instructions for the equipment
- (d) Cleaning fluid specifications
- (e) Cleaning/rinse/drying cycle and sequence
- (f) Provisions for control of cleanliness of cleaning and rinse fluids
- (g) Inspection/monitoring requirements
- (h) Interim protection requirements including storage handling and temporary or permanent packaging.
- (i) Layout plan of work area
- (j) Safety and health precautions
- (k) Others as applicable

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10.5 Monitoring precision cleanliness of the product. The results of precision cleaning are not normally visible to the unaided eye. Special detection and measurement techniques are necessary and should be implemented to monitor and verify the achievement of the required level of precision cleanliness.

10.6 Handling during cleaning. Disassembly, cleaning, reassembly, in process handling packaging and other operations involved in accomplishing cleaning should be conducted in a manner to preserve critical tolerances, finishes, calibration, or other sensitive attributes of the product. Adequate tooling, fixtures, handling devices, and product protection should be provided. Written instructions for sensitive or critical activities or procedures should be provided.

20. PROTECTION

20.1 Cleanliness protection. All precision cleaned items should be provided with cleanliness protection prior to leaving the controlled environment.

20.2 Precision clean packaging. The precision clean package shall maintain the cleanliness level specified for the product.

20.3 Storage. Storerooms or inventory control areas should provide adequate protection to the package and the product for the intended storage period.

30. INSPECTION

30.1 Inspection of precision cleaned and packaged products should be performed as required on a regular or cyclic basis to assure continued maintenance of the integrity of the package and the item. The following criteria should constitute rejection of the precision packaged item.

(a) Identification label or decalcomania missing, broken, illegible or incomplete.

(b) Tamper-proof seal missing, broken or incorrectly applied.

(c) Improper seal, open seal or closure, lifted tape, etc.

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(d) Apparently damaged (including pinholes, etc.) or violated package or closure.

(e) Visibly entrapped moisture (or a change in a humidity indicator) or other unwanted material.

(f) Any apparent defect that may interfere with the proper function or use of the item.

30.1.1 If it is necessary to break a closure or open a package for inspection, the item should be opened in a controlled environment and repackaged to the same condition as the original.

30.1.2 Inspection requiring opening of a package or closure should be reduced to a minimum of occurrences consistent with good practice.

30.1.3 To assure traceability of contamination sources, a log book record should be maintained of all incidents of opening or closure of the packages. The record should show the date, responsible person, the reason for opening, and the disposition of the product.

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DEPARTMENT OF THE ARMY

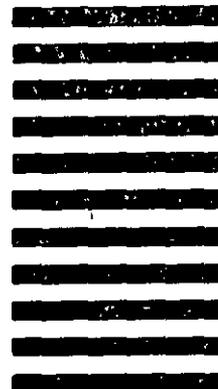


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		<input type="checkbox"/> MANUFACTURER	
		<input type="checkbox"/> OTHER <i>(Specify):</i> _____	
5. PROBLEM AREAS			
a. Paragraph Number and Wording:			
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c. Reason/Rationale for Recommendation:			
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