INCH-POUND

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PERFORMANCE SPECIFICATION

FLUORESCENT PENETRANT INSPECTION (FPI) UNITS, SEPARATE MODULAR STATION TYPES

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1 SCOPE

1.1 Scope.

This specification covers fluorescent penetrant inspection (FPI) units for nondestructive inspection/testing using the liquid penetrant method.

1.2 Classification.

The FPI units are of the following types, sizes, classes and forms as specified (see 6.2).

1.2.1 Types.

The types of FPI units are as follow:

Type I - Water washable (self emulsified) with dry developer.

Type II - Post-emulsified with aqueous developer.

Type III - Post-emulsified with dry developer.

Type IV - Solvent-removable (inspection station only).

NOTE: Type designations of FPI units do not match ASTM E1417/E1417M type designations for FPI processes.

Comments, suggestions, or questions on this document should be addressed to AFLCMC/ENRS, Bldg 28, 2145 Monahan Way, Wright-Patterson AFB OH 45433-7017 or emailed to AFLCMC/EN_EZ Engineering Standards@us.af.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at https://assist.dla.mil.

AMSC N/A FSC 6635

1.2.2 Sizes.

The sizes of the FPI units are as shown in table I. Size 1 is no longer used, but retained for other sizes to match prior acquisition documents. The designation refers to Penetrant Testing (PT) followed by the frame size in inches. Length dimensions are left-to-right and width dimensions are front-to-back.

TABLE I. FPI unit sizes.

Size	Designation	Frame Size	Minimum Useable Tank Size
1	Not used	N/A	N/A
2	PT-24	24" long x 34" wide x 36" height	19" long x 29" wide x 26" deep
3	PT-36	36" long x 34" wide x 36" height	31" long x 29" wide x 26" deep
4	PT-48S (short)	48" long x 34" wide x 36" height	43" long x 29" wide x 26" deep
5	PT-48	48" long x 34" wide x 36" height	43" long x 29" wide x 26" deep
6	PT-72	72" long x 50" wide x 36" height	67" long x 44" wide x 26" deep

1.2.3 Classes.

FPI units are in the following classes:

Class A - unpowered tanks.
Class B - pneumatically-powered tank lifts.

NOTE: Class A units are often used with an overhead hoist/conveyor.

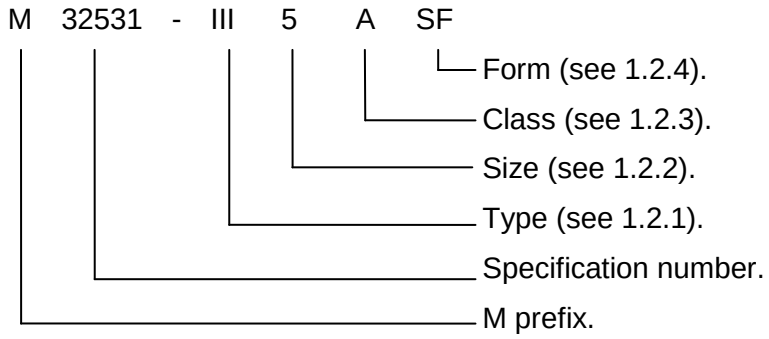
1.2.4 Forms.

The FPI units will be in two forms:

Standard Form – Left-to-right processing, beginning with the penetrant tank.
Reverse Form – Right-to-left processing, beginning with the penetrant tank.

1.3 Part or Identifying Number (PIN).

PINS to be used for FPI units acquired to this specification are created as follows:



2. APPLICABLE DOCUMENTS

2.1 General.

The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3 and 4 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks.

The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-PRF-20696	Cloth, Waterproof, Weather Resistant

(Copies of this document are available online at http://quicksearch.dla.mil.)

2.2.2 Other Government documents, drawings, and publications.

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

AIR FORCE TECHNICAL ORDER (AFTO)

TO 00-25-252	Intermediate and Depot Level Maintenance Instructions Aeronautical Equipment Welding (Joint NAVAIR 01-1A-34/TO 00-25-252/T.C. 9-238 publication)

(Copies of this document are available online at http://www.robins.af.mil/library/technicalorders.asp or http://www.robins.af.mil/shared/media/document/AFD-091005-064.pdf.)

2.3 Non-Government publications.

The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

ASTM INTERNATIONAL

ASTM A123/A123M	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products (DoD Adopted)
ASTM A240/A240M	Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications (DoD Adopted)

ASTM E1210	Standard Practice for Fluorescent Liquid Penetrant Testing Using the Hydrophilic Post-Emulsification Process
ASTM E1417/E1417M	Standard Practice for Liquid Penetrant Testing (DoD Adopted)

(Copies of these documents are available from www.astm.org.)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	National Electrical Code, Article 500, Hazardous (Classified) Locations, Classes I, II, and III, Divisions 1 and 2 (DoD Adopted)

(Copies of this document are available from www.nfpa.org.)

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC-Paint 20	Paint Specification No. 20 Zinc-Rich Coating Type I – Inorganic and Type II – Organic (DoD Adopted)

(Copies of this document are available from at www.sspc.org.)

2.4 Order of precedence.

Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 First article.

When specified (see 6.2), a sample shall be subjected to first article inspection in accordance with 4.3.

3.2 Design and construction.

The FPI units shall be designed and constructed to perform complete and efficient penetrant inspections of parts and assemblies in accordance with ASTM E1210 and ASTM E1417/E1417M. They shall be constructed to hold aerospace components or similar parts and inspection materials without deformation of the components. The units shall be designed and constructed so that during the normal inspection process there will be no leakage of penetrant, remover, developer, and/or water within the area bounded by the outermost extremities of the inspection unit; nor shall they leak from station to station, except for the penetrant drain station back to the penetrant station. All welds shall be aerospace quality in accordance with TO 00-25-252. All tanks shall be inside fillet welded. All welds shall be continuous across their respective sections. All carbon-steel components shall be hot-dip galvanized per ASTM A123/A123M or inorganic zinc-rich coating per SSPC-Paint 20, type I as a primer. The paint finish system used shall resist degradation or attack from the chemical systems used in the fluorescent penetrant inspection process. The exterior paint color shall be the same on all stations; however the interior of the inspection station shall be painted flat black in color. Roller grilles shall have a capacity of 250 pounds supported by only two rollers.

3.3 Tolerances.

All tolerances for dimensional specifications for tank and frame sizes listed in this specification are ±0.5 inch unless otherwise noted.

3.4 Stations.

All stations shall be a modular design to enable customization of installation with end-user procured accessories, such as 90 degree roller stations. All stations shall bolt together to maintain integrity of entire system and height adjustment feature on frames shall be required to bolt sections together. Penetrant drain, developer drain, and rest stations shall not have left-to-right frame supports across the front of the stations to allow storage of equipment and supplies under these stations. No station shall exceed 108 inches in height, except the class B Dryer and Dry Developer stations on size 6 shall not exceed 132 inches in height due to pneumatically-operated doors.

3.4.1 Type I stations.

The inspection units shall consist of the following stations: penetrant tank, penetrant drain, wash, rest, dryer, rest, dry developer, rest, and inspection station.

3.4.2 Type II stations.

The inspection units shall consist of the following stations: penetrant tank, penetrant drain, pre-rinse, remover tank, wash (remover-rinse), aqueous developer tank, developer drain, dryer, rest, and inspection station.

3.4.3 Type III stations.

The inspection units shall consist of the following stations: penetrant tank, penetrant drain, pre-rinse, remover tank, wash (remover-rinse), rest, dryer, rest, dry developer, rest, and inspection station.

3.4.4 Type IV stations.

The inspection units shall consist of only the inspection station. For class B units of this type only, the dust pan and roller grille requirements in 3.4.16 are eliminated, replaced by a stainless steel sheet-metal surface over a wood-supporting structure.

NOTE: To add an additional inspection station to an existing FPI unit, procure type IV, class A. For a stand-alone inspection station, procure type IV, class B. The inspection stations for sizes 2-4 are identical.

3.4.5 Station dimensions.

The usable area inside the tank shall conform to the useable tank sizes listed in table I. The “basic” frame shall have overall outside dimensions listed in table I; height will exclude tank cover and cover handle. However, the pre-rinse, wash, dryer, dry developer, and inspection station will exceed the heights given in table I. All tanks and covers shall be made of 16 gauge stainless steel. Type 304 stainless steel in accordance with ASTM A240/A240M shall be used unless otherwise specified. Covers shall have mechanisms to reduce the lifting force to no more than 15 pounds.

3.4.6 Penetrant tank station.

This station shall consist of a frame, tank, and cover. The tank bottom shall be sloped toward the tank drain opening at the rear of the tank and supported by frame members no more than 24 inches apart. The station drain shall be equipped with a stainless steel or copper-based alloy (e.g., brass or bronze)(abbreviated as SS/Cu) metal cut-off valve, pump, SS/Cu-metal drain gate valve to empty the tank contents with hose a minimum of 0.5 inch diameter and 12 feet long, and SS/Cu-metal valve(s) and SS/Cu-metal plumbing to filter the tank contents through a 25 micron “spin-on” disposable filter located behind the tank in a vertical orientation and return fluid to the tank. There shall be a shelf with a 0.5 inch lip under the filter to contain any minor leaks during filter change. The pump shall have a minimum capacity of one gallon per minute, with the on/off switch at the front of the tank. For class A units, the tank shall contain a slatted grille made from open (i.e., I, C, or hat section) aluminum extrusions with a nominal size of one (1) to two (2) inches. The slatted grille shall not be made from closed (i.e., square or rectangular section) aluminum extrusions. The slatted grille shall have holes or slots for lateral movement of penetrant oil.

3.4.7 Penetrant drain station.

The penetrant drain stations shall consist of a frame, drain pan, and a full roller top grille. The drain station shall be structurally supported from below. Design shall be such to insure that the penetrant is completely directed back into the penetrant tank. The drain pan shall prevent fluids from running off parts to be inspected and dripping on the floor. The total length and width of the roller top grille shall conform to the length and width of the station and conform to the height of adjacent stations. However, the roller top grille shall be made in sections of 12 to 24 inches in length to facilitate removal for cleaning of the drip pan. The length of the size 4 drain stations shall be 24 inches to reduce total system length.

3.4.8 Pre-rinse station.

The pre-rinse station shall consist of a frame, tank, backsplash, side-splashes, and a hand hose with a lever-operated nozzle. A drain connection with SS/Cu-metal cut-off valve shall be provided at the bottom of the tanks using standard National Pipe Thread (NPT) sizes, a minimum of 0.75 inch for size 2, increasing to 1.25 inches for size 6. The tank bottoms shall be sloped toward the tank drain opening at the rear of the tank and be supported by frame members no more than 24 inches apart. The station shall be plumbed to provide both hot and cold water to the rinse hose. Separate controls for water temperature, pressure regulation, and flow regulation shall be provided and shall be located on the front of the station. Gauges displaying Fahrenheit and PSI shall be provided to monitor temperature and pressure of rinse water. Protrusions from controls and gauges from the front of the stations shall be minimized, and shall avoid any finger-pinch conditions (such as by tilting valves out approximately 10 degrees from vertical). For class A units, the tank shall contain a slatted grille made from open (i.e., I, C, or hat section) aluminum extrusions with a nominal size of one (1) to two (2) inches. The slatted grille shall not be made from closed (i.e., square or rectangular section) aluminum extrusions. The slatted grille shall have holes or slots for lateral movement of inspection liquids.

3.4.8.1 Backsplash.

The backsplash shall be provided to prevent overspray from the rinse stations from reaching the rear of the unit. The backsplash itself shall be fabricated from corrosion resistant stainless steel, while the supporting backsplash frame may be carbon steel. The height of the backsplash shall rise to a minimum overall height of six feet from the floor.

3.4.8.2 Side-splash.

The side-splashes shall be hinged against the backsplash on both sides. When deployed, they shall extend to the front of the pre-rinse tank to prevent overspray to the adjacent stations. There shall be mechanisms to hold the side-splashes in both the normal (against the backsplash) and deployed (against the sides of the tank) conditions. The side-splashes shall be fabricated from corrosion resistant stainless steel. The side-splashes shall extend into the pre-rinse tank a minimum of two inches on class A units and 0.5 inches on class B units, and shall extend within two inches from the top of the backsplash. The side-splashes may be hinged in the center if required.

3.4.8.3 Rinse hose.

The rinse hose shall be attached to a spring-loaded arm projecting from the center-top of the backsplash. The hose shall have a lever-operated nozzle. The hose and arm shall have a rest position above the top edge of the tank and centered above the tank, and have enough movement to reach all portions of the tank. The station shall have a mechanism to hold the hose against the backsplash to reduce interference with overhead hoist or powered tank lifts.

3.4.9 Remover station.

The remover station shall consist of a frame, tank, cover, and air agitation system. The tank bottom shall be sloped toward the tank drain opening at the rear of the tank and supported by frame members no more than 24 inches apart. The station drain shall be equipped with a SS/Cu-metal cut-off valve, pump, SS/Cu-metal drain gate valve to empty the tank contents with hose a minimum of 0.5 inch diameter and 12 feet long, and SS/Cu-metal valve(s) and SS/Cu-metal plumbing to filter the tank contents through a 25 micron “spin-on” disposable filter located behind the tank in a vertical orientation and return fluid to the tank. There shall be a shelf with a 0.5 inch lip under the filter to contain any minor leaks during filter change. The pump shall have a minimum capacity of one gallon per minute, with the on/off switch at the front of the tank. The agitation system shall include an air distribution manifold, manifold shutoff valve, air pressure regulator, and an air pressure gauge displaying PSI. All controls and gauges (i.e., manifold shutoff valve, air pressure regulator and pressure gauge) shall be readable from the front of the remover station. Protrusions from controls and gauges from the front of the stations shall be minimized, and shall avoid any finger-pinch conditions (such as by tilting valves out approximately 10 degrees from vertical). The agitation shall allow thorough agitation of the remover solution throughout the tank, and shall not cause the remover solution to foam. For class A units, the tank shall contain a slatted grille made from open (i.e., I, C, or hat section) aluminum extrusions with a nominal size of one (1) to two (2) inches. The slatted grille shall not be made from closed (i.e., square or rectangular section) aluminum extrusions. The slatted grille shall have holes or slots for lateral movement of penetrant remover. A pneumatic hose, 8 feet in length, with universal quick coupler plugs shall be provided on the rear of the station. A data plate showing minimum pressure and volume requirements for shop air will be affixed to the rear of the station.

3.4.10 Wash station.

The wash station (also called remover-rinse station) shall consist of frame, tank, backsplash, roof, one inspection blacklight, two overhead fluorescent-tube blacklights for area illumination, curtains, and a rinse hose with nozzle. A drain connection with SS/Cu-metal cut-off valve shall be provided at the bottom of the tanks using standard NPT sizes, a minimum of 0.75 inch for size 2, increasing to 1.25 inches for size 6. The tanks bottoms shall be sloped toward the tank drain opening at the rear of the tank and be supported by frame members no more than 24

inches apart. The station shall be plumbed to provide both hot and cold water to the rinse hose. Separate controls for water temperature, pressure regulation, and flow regulation shall be provided and shall be located on the front of the station. Gauges displaying Fahrenheit and PSI shall be provided to monitor temperature and pressure of rinse water. Protrusions from controls and gauges from the front of the stations shall be minimized, and shall avoid any finger-pinch conditions (such as by tilting valves out approximately 10 degrees from vertical). A holder shall be provided for the blacklight at both the front and back of the station. The roof frame shall be constructed such that personnel can hand carry small parts unobstructed from the previous station to the wash station, and from the wash station to the next station; that is, there shall be no roof support post(s) in front of the station. The length of station shall be 48 inches for sizes 2 - 5, and 72 inches for size 6. The station shall be equipped with an hour/minutes/seconds clock display which is visible in the blacklight-illuminated environment. For class A units, the tank shall contain a slatted grille made from open (i.e., I, C, or hat section) aluminum extrusions with a nominal size of one (1) to two (2) inches. The slatted grille shall not be made from closed (i.e., square or rectangular section) aluminum extrusions. The slatted grille shall have holes or slots for lateral movement of inspection liquids.

3.4.10.1 Backsplash.

The backsplash shall be provided to prevent overspray from the wash stations from reaching the rear of the unit. The backsplash itself shall be fabricated from corrosion resistant stainless steel, while the supporting backsplash frame may be carbon steel. The height of the backsplash shall rise to bottom of the station roof.

3.4.10.2 Side-splash.

The side-splashes shall be hinged against the backsplash on both sides. When deployed, they shall extend to the front of the pre-rinse tank to prevent overspray to the adjacent stations. There shall be mechanisms to hold the side-splashes in both the normal (against the backsplash) and deployed (against the sides of the tank) conditions. The side-splashes shall be fabricated from corrosion resistant stainless steel. The side-splashes shall extend into the pre-rinse tank a minimum of two inches on Class A units and 0.5 inches on Class B units, and shall extend within two inches from the top of the backsplash. The side-splashes may be hinged in the center if required.

3.4.10.3 Rinse hose.

The rinse hose shall be attached to a spring-loaded arm projecting from the center-top of the backsplash. The hose shall have a squeeze-to-operate nozzle. The hose and arm shall have a rest position above the top edge of the tank and centered above the tank, and have enough movement to reach all portions of the tank. The station shall have a mechanism to hold the hose against the backsplash to reduce interference with overhead hoist or powered tank lifts.

3.4.10.4 Roof.

The class A unit shall utilize two (split) roof segments which are hinged at the top-rear of the remover-rinse station, which rotate horizontally to the side when needed to use the overhead hoist/conveyor. The split roof segments shall not interfere with operation of adjacent stations. The class A unit roof segments shall have ropes or chains to assist in opening and closing the roof. The class B unit roof shall be a fixed cantilever construction from the back of the unit. The roof shall contain two overhead fluorescent-tube blacklights for area illumination; one per segment on class A units. The inside height of the roof with lights shall be a minimum of seven feet from the floor.

3.4.10.5 Curtains.

The wash station shall have curtains on three sides of the roof, with splits to allow ingress and egress through the station. The curtain material shall be weather resistant, waterproof cloth meeting the intent of MIL-PRF-20696, type II, class 2. The curtain material shall be attached to the roof with snaps, or hook and pile fasteners, for removal and replacement. The roof with curtains shall not allow more than 20 lux of light from the outside. The curtains shall extend from the roof to the tank on the sides, and within two feet of the floor around the front of the station.

3.4.11 Aqueous developer station.

The developer station shall consist of a frame, tank, and air agitation system. The tank bottom shall be sloped toward the tank drain opening at the rear of the tank and supported by frame members no more than 24 inches apart. The station drain shall be equipped with a SS/Cu-metal cut-off valve, pump, SS/Cu-metal drain gate valve to empty the tank contents with hose a minimum of 0.5 inch diameter and 12 feet long, and SS/Cu-metal valve(s) and SS/Cu-metal plumbing to filter the tank contents through a 25 micron “spin-on” disposable filter located behind the tank in a vertical orientation and return fluid to the tank. There shall be a shelf with a 0.5 inch lip under the filter to contain any minor leaks during filter change. The pump shall have a minimum capacity of one gallon per minute, with the on/off switch at the front of the tank. The agitation system shall include an air distribution manifold, manifold shutoff valve, air pressure regulator, and an air pressure gauge displaying PSI. All controls and gauges (i.e., manifold shutoff valve, air pressure regulator and pressure gauge) shall be readable from the front of the aqueous developer station. Protrusions from controls and gauges from the front of the stations shall be minimized, and shall avoid any finger-pinch conditions (such as by tilting valves out approximately 10 degrees from vertical). The agitation shall allow thorough agitation of the developer solution throughout the tank, and shall not cause the developer solution to foam. For class A units, the tank shall contain a slatted grille made from open (i.e., I, C, or hat section) aluminum extrusions with a nominal size of one (1) to two (2) inches. The slatted grille shall not be made from closed (i.e., square or rectangular section) aluminum extrusions. The slatted grille shall have holes or slots for lateral movement of aqueous developer. A pneumatic hose, 8 feet in length, with universal quick coupler plugs shall be provided on the rear of the station. A data plate showing minimum pressure and volume requirements for shop air will be affixed to the rear of the station.

NOTE: The filter will not be used with aqueous suspendable developers.

3.4.12 Aqueous developer drain stations.

The developer drain stations shall consist of a frame, fixed drain pan, removable drain pan(s) and a full roller top grille. The developer drain station shall be structurally supported from below. Design shall be such to insure that excess developer is captured by the removable drain pan(s), which shall have a minimum depth of two (2) inches and handles for lifting. The fixed drain pan shall prevent fluids from running off parts to be inspected and dripping on the floor. The total length and width of the roller top grille shall conform to the length and width of the station and conform to the height of adjacent stations. However, the removable drain pans and roller top grille shall be made in sections of 12 to 24 inches to facilitate removal for cleaning. The length of the type II, size 4 drain stations shall be 24 inches to reduce total system length.

3.4.13 Dryer stations.

The dryer station shall incorporate a full roller grille to facilitate the movement of parts from/to the adjacent stations. The dryer shall allow access for dryer element replacement with minimal disassembly. Insulation of the dryer shall meet industry practice. The noise level from the dryer shall not exceed 82 dB at a distance of three feet. The heaters and fans shall not extend from the back of the dryer. The interior and exterior dimensions and heater capacity shall be as specified in table II. Drip pans shall be provided to allow for catching penetrant/developer residue. If the heaters or fans are below the dryer “box”, then the drips pans shall be staggered on two levels for air flow. The drip pans shall have handles and be removable for cleaning after roller grille segments have been removed. For class A dryer stations, the dryer cabinet shall be designed with a split roof to allow access from an overhead hoist/conveyor with both ends opened.

TABLE II. Dryer station dimensions.

Size	Maximum Exterior Dimensions	Minimum Usable Interior Dimensions	Minimum Wattage
1	N/A	N/A	N/A
2	24" long x 42" wide	20" long x 29"wide x 26" height	3,000
3	36" long x 42" wide	32" long x 29"wide x 26" height	5,000
4	48" long x 42" wide	44" long x 29"wide x 26" height	8,000
5	72" long x 42" wide	68" long x 29"wide x 26" height	12,000
6	96" long x 62" wide	92" long x 44"wide x 44" height	16,000

3.4.13.1 Controls.

The thermometer - thermostat shall be scaled from 100 to 200 °F, with maximum increments of 5 °F. The thermostat shall control the dryer temperature to ±5 °F of this setting. The thermostat shall be protected against accidental adjustment. The thermocouple inside the heater shall be protected from damage due to parts passing through the heater. The dryer station shall maintain 155 to 165 °F average temperature during normal operation, as tested in 4.4.10.4 and 4.4.10.5.

3.4.13.2 Curtains.

For class A units, split curtains shall be provided for each end. The curtain material shall be attached to the dryer ends with snaps, or hook and pile fasteners, for removal and replacement. The curtain material shall be weather resistant, waterproof cloth meeting the intent of MIL-PRF-20696, type II, class 2. However, an insulating layer and/or reflective coating on the inside of the curtains and/or magnets to assist with closure to conserve energy are highly desirable. For class A units, an insulating curtain shall be provided for the split roof when the overhead conveyer is not used and be attached to the dryer roof with sewn-in magnets. If the dryer adjacent to the magnets is not painted/galvanized steel, then galvanized steel patches of sufficient size for the magnets shall be attached.

3.4.13.3 Doors.

For class B units, individually-controlled pneumatically-operated lifting doors shall be provided at each end. The doors shall be fitted with safety stops to prevent falling in case of pneumatic or cable failures. The rate at which the doors close shall be adjustable. A pneumatic hose, eight (8) feet in length, with universal quick coupler plugs shall be provided on the rear of the station. A data plate showing minimum pressure and volume requirements for shop air will be affixed to the rear of the station.

3.4.14 Dry developer station.

The dry developer station shall incorporate a powered “vortex/dust storm” to deliver dry developer media to the component being inspected. The interior and exterior dimensions shall be as specified in table III. The station shall have pneumatically-operated lifting doors at the entrance and exit of the station. The doors shall be fitted with safety stops to prevent falling in case of pneumatic or cable failures. The rate at which the doors close shall be adjustable. The station shall have full roller grille to facilitate the movement of parts from/to the adjacent stations. The station shall have a vacuum system to prevent free-floating dry developer from leaving the station. The station shall have controls to start the developer injection cycle, followed by an adjustable well (15-minute DoD standard cycle), and followed by vacuum extraction cycle. An indicator light shall identify when the station is operating. Both classes use the same dry developer station, as there is no split-roof requirement for the dry developer station. The noise level from the dry developer station shall not exceed 82 dB at a distance of three feet. A pneumatic hose, 8 feet in length, with universal quick coupler plugs shall be provided on the rear of the station. A data plate showing minimum pressure and volume requirements for shop air will be affixed to the rear of the station.

TABLE III. Dry developer station dimensions.

Size	Maximum Exterior Dimensions	Minimum Usable Interior Dimensions
1	N/A	N/A
2	24" long x 36" wide x 80" height	18" long x 29" wide x 26" height
3	36" long x 36" wide x 80" height	30" long x 29" wide x 26" height
4	48" long x 36" wide x 80" height	42" long x 29" wide x 26" height
5	72" long x 36" wide x 80" height	66" long x 29" wide x 26" height
6	96" long x 50" wide x 96" height	90" long x 44" wide x 44" height

3.4.15 Rest station.

The rest stations shall consist of a frame, fixed drain pan, removable drain pan(s), and a full roller top grille. The rest station shall be structurally supported from below. Design shall be such to insure that any inspection residue is captured by the removable drain pan(s), which shall have a minimum two-inch depth and handles for lifting. The fixed drain pan shall prevent fluids from dripping on the floor. The total length and width of the roller top grille shall conform to the length and width of the station and conform to the height of adjacent stations. The roller

top grille shall be made in sections of 12 to 24 inches to facilitate removal for cleaning of the drip pan. The length of the size 4 rest stations shall be 24 inches to reduce total system length.

3.4.16 Inspection station.

The inspection station shall be provided with full roller grille, dust pans, roof, curtains, an exhaust fan, two inspection blacklights with holders, two overhead fluorescent-tube blacklights for area illumination, an overhead white light, four 120 VAC power outlets, and a storage shelf near the base of the station. The inside height of the roof with lights shall be a minimum of seven feet from the floor. The dust pans shall be located directly under the roller grille for the exclusion of light. The roller top grille and dust pans shall be made in sections of 12 to 24 inches to facilitate removal for cleaning. The inspection station shall have a material stop that can be positioned in the roller grille at either end of the inspection station. The inspection station shall have curtains on three sides of the roof, with splits to allow ingress and egress through the station. The back of the station shall be solid galvanized and painted sheet metal surface. The curtain material shall be weather resistant, waterproof cloth meeting the intent of MIL-PRF-20696, type II, class 2. The curtain material shall be attached to the roof with snaps, or hook and pile fasteners, for removal and replacement. The curtains shall extend from the roof to the roller grille on the sides, and within two feet of the floor around the front of the station. For class A units, the roof shall allow access of an overhead hoist/conveyor; and a curtain shall be provided for the opening when the overhead hoist/conveyer is not used and be attached to the inspection station roof with sewn-in magnets. If the inspection station adjacent to the magnets is not painted galvanized steel, then galvanized steel patches of sufficient size for the magnets shall be attached. Ambient light levels inside the inspection station shall not exceed than 20 lux of light from the outside.

The dimension of the inspection station shall be as specified in table IV. Height of the roller top grille work surface shall be 36 inches and match the height of adjacent stations.

TABLE IV. Inspection station dimensions.

Size	Maximum Exterior Dimensions	Minimum Roller Grille Dimensions
1	N/A	N/A
2	48" long x 48" wide x 96" height	48" long x 29" wide
3	48" long x 48" wide x 96" height	48" long x 29" wide
4	48" long x 48" wide x 96" height	48" long x 29" wide
5	72" long x 60" wide x 96" height	72" long x 29" wide
6	96" long x 72" wide x 96" height	96" long x 44" wide

3.5 Powered tank lifts.

For class B units, each tank (penetrant, pre-rinse, remover, wash, and aqueous developer tank) shall have a pneumatically-powered tank lift with rollers to lower and raise the part into each tank. The lift shall lower and raise parts weighing up to 500 pounds. Appropriate protection shall be provided to operators to prevent personal injury. Lift controls shall be located on the front of each tank and designed to prevent inadvertent operation. Lift controls shall include adjustment for time to lower and raise the lift. A pneumatic hose, 8 feet in length, with universal

quick coupler plugs shall be provided on the rear of the station. A data plate showing minimum pressure and volume requirements for shop air will be affixed to the rear of the station.

3.6 Voltage.

All wiring, insulation, and electrical components shall be in compliance with the NFPA 70. Dryer heater element(s) in sizes 2 through 5 shall be capable of operating from both 208 and 240 VAC, 50 and 60 Hertz. The size 6 dryer heater element(s) shall be capable of operating from 208, 240 and 480 VAC, 50 and 60 Hertz. The heater elements shall be the only components to operate directly from line voltage above 120 VAC. The initial line operating voltage shall be 240 VAC unless otherwise specified by the procuring activity. The rest of the equipment shall operate from 110-120V, 50 or 60 Hertz, single phase AC source and shall be Ground Fault Circuit Interrupter (GFCI) and circuit breaker protected. The unit shall require a single connection to each source (only one 120V and only one 208V, 240V, or 480V source). An Electrical Identification Plate shall be affixed to the back of the unit near the higher voltage connection. Each motor shall have an electrical identification plate showing manufacturer, model, serial number, horsepower, voltage, amperage, and frequency.

3.7 Electrical controls.

Each blacklight, white light, exhaust fan, dryer heater circuit, dry developer station, and pump shall operate independently of any other unit and shall have a separate control or switch.

3.8 Nozzles.

The nozzles at the pre-rinse and remover-rinse stations shall have a spring-operated, lever-type hand swivel valve and be of the fan/conical-shaped coarse spray type. Nozzles that have adjustable spray patters shall not be used. The delivery rate of the nozzles shall be not less than three (3) gallons per minute, and not more than six (6) gallons per minute at 40 psi pressure.

3.9 Blacklights.

The blacklights which are employed to fluoresce the inspection medium shall have an initial intensity of 2000 microwatts per square centimeter at 15 inches. The blacklight wavelength shall be in the range of 320 to 380 nanometers (nm), with a peak intensity of 365 nm. A ten minute warm-up is allowed before blacklight measurements. The lights shall be supported by adjustable brackets and directed toward the part to be inspected. The lights shall be readily dismountable from the adjustable brackets without removing or loosening any fasteners for fixtures, and have an insulated handle for inspector use. Except the blacklight lens itself, no part of the blacklight may exceed 120 °F in operation to prevent injury to personnel. If the blacklight lens itself exceeds 150 °F, “standoffs” are required to keep the lens from touching other materials when the blacklight is placed face down in the inspection station. Mercury-vapor blacklights are to be used unless otherwise specified.

3.10 Baskets.

Six wire baskets, with handles, made of corrosion resistant stainless steel shall be provided with the unit. They shall have hooks on one side to suspend the basket from the inside-front-top of the tank while allowing the tank covers to close. Unless otherwise specified, the baskets shall have dimension of 12 inches long x 8 inches wide x 6 inches deep and a maximum mesh opening of 1/2 inch square.

3.11 Trays

Welded aluminum processing trays shall be provided with the unit. Quantity and sizes shall be per table V. The rectangular tray frame shall be made from aluminum angle stock with a leg of 1.5 inches and a thickness of 3/16 inches. Welded inside the frame shall be 14 gauge (0.063 inch) perforated aluminum sheet. Perforated hole diameter shall be 0.25 to 0.5 inch.

TABLE V. Tray quantity and dimensions.

Size	Quantity	Width	Length
1	N/A	N/A	N/A
2	3	28” wide	18” long
3	3	28” wide	30” long
4	3 1	28” wide 28” wide	22” long 42” long
5	3 1	28” wide 28” wide	30” long 42” long
6	3	43 “ wide	43” long

4. VERIFICATION

4.1 Classification of inspections.

The inspection requirements specified herein are classified as follows:

a. First article inspection (see 4.2).

b. Conformance inspection (see 4.3).

4.2 First article inspection.

First article inspection shall be performed on one complete FPI unit when a first article sample is required (see 3.1). This inspection shall include the examination of 4.4.

4.3 Conformance inspection.

Conformance inspection shall include the visual examination of 4.4.1 through 4.4.3, 4.4.8, 4.4.13, and 4.4.15.

4.4 Examination.

4.4.1 Examination of components.

Visual inspection of all components to verify all components of proper type, size, class, and form have been delivered as specified at contract award.

4.4.2 Visual inspection.

Verify all welds are aerospace quality. Verify all tanks are fillet welded. Verify all welds are continuous across their respective sections. Verify tank covers are included for penetrant, remover, and aqueous developer stations, as applicable. Verify drain connections and valves are constructed using NPT standard pipe sizes, and all tanks slope toward drains. Verify tank bottom has frame supports no more than 24 inches apart. For class A units, verify tanks have bottom grille construction made from one to two inch open aluminum extrusions. Verify full roller grilles on drain, rest, dryer, dry developer, and inspection stations, as applicable. More than one mis-drilled hole per station, or more than three per complete system, is cause for quality failure.

4.4.3 Dimensional inspection.

Using steel tape measure, confirm individual tank and frame sizes are within 0.5 inch tolerances of dimensions stated in table I. Using thickness gauge, verify tank walls are 16 gauge material. Verify stainless steel tank alloy documentation or test using X-ray fluorescence analyzer. Verify the length of roller sections are between 12 and 24 inches and are removable for cleaning.

4.4.4 Penetrant tank station test.

Verify presence of SS/Cu-metal valves and plumbing. Verify pump documentation indicates minimum capacity of one gallon per minute. Operationally check pump to verify filtering function with no leaks. Verify filter is of 25 micron size. Verify presence of shelf under filter. Verify drain hose is a minimum of 12 feet long.

4.4.5 Penetrant drain station test.

Verify drain station is supported from below and excess penetrant is directed back to the penetrant station. Verify no horizontal supports across the front of the station.

4.4.6 Pre-rinse station test.

Verify presence of SS/Cu-metal cut-off valve and NPT pipe size between 0.75 and 1.25 inches. Verify both hot and cold water are provided to the rinse hose. Verify separate controls and gauges for temperature and pressure are at the front of station and no finger pinch condition exists. Verify backsplash is constructed of corrosion resistant stainless steel and extends to a minimum height of six feet from floor. Verify side-splashes are constructed of corrosion resistant stainless steel and have mechanisms to secure them in both normal and deployed locations. Verify side-splashes extend required distance into the tank and within two inches of the top of the backsplash. Verify the rinse hose is on a spring-loaded arm above the tank and spray can reach all areas of the tank.

4.4.7 Remover station test.

Verify presence of SS/Cu-metal valves and plumbing. Verify pump documentation indicates minimum capacity of one gallon per minute. Operationally and visually check pump to verify filtering function with no leaks. Verify filter is of 25 micron size. Verify presence of shelf under filter. Verify drain hose is a minimum of 12 feet long. Visually inspect for proper agitation system controls. Visually inspect operation of air agitation system to verify thorough agitation of remover and no foaming of solution. Verify no finger pinch conditions exist. Verify pneumatic hose and coupler at rear of station.

4.4.8 Wash station test.

Verify presence of SS/Cu-metal cut-off valve and NPT pipe size between 0.75 and 1.25 inches. Verify both hot and cold water are provided to the rinse hose. Verify separate controls and gauges for temperature and pressure are at the front of station and no finger pinch condition exists. Verify backsplash is constructed of corrosion resistant stainless steel and extends to bottom of station roof. Verify bottom of roof is at least seven feet from floor. Verify the rinse hose is on a spring-loaded arm above the tank and spray can reach all areas of the tank. Verify class A roof swings horizontally to allow hoist access and include ropes/chains to assist in opening/closing. Verify hour/minute/seconds displaying clock is visible in the blacklight illuminated environment. Verify curtains are constructed of appropriate material and extend to proper length. Using a calibrated digital radiometer/photometer, verify white light level at the top-center of tank is no more than 20 lux.

4.4.9 Aqueous developer station test.

Verify presence of SS/Cu-metal valves and plumbing. Verify pump documentation indicates minimum capacity of one gallon per minute. Operationally and visually check pump to verify filtering function with no leaks. Verify filter is of 25 micron size. Verify presence of shelf under filter. Verify drain hose is a minimum of 12 feet long. Visually inspect for proper agitation system controls. Visually inspect operation of air agitation system to verify thorough agitation of developer and no foaming of solution. Verify no finger pinch conditions exist. Verify pneumatic hose and coupler at rear of station.

4.4.10 Dryer stations test.

Verify the dryer dimensions meet table II requirements within 0.5 inches. Verify dryer elements meet minimum wattage in table II. Verify dryer allows replacement of dryer elements with minimal disassembly. Verify the dryer has full roller grille and are removable. Verify noise level is below 82 dB at three feet away. Verify temperature control is variable within 100 - 200 °F and controllable within 5 °F. Verify thermostat is protected against accidental adjustment. Verify thermocouple is protected against damage due to parts passing through dryer.

4.4.10.1 Class A dryer stations.

Verify dryer has split roof feature to allow overhead hoist. Verify drip pans are removable for cleaning. Verify split curtains are provided for each end and are removable without tools. Verify a curtain for the split roof is provided.

4.4.10.2 Class B dryer stations.

Verify drip pans are removable for cleaning. Verify operation of pneumatic doors. Verify pneumatic hose and coupler at rear of station.

4.4.10.3 Temperature rise, normal conditions.

Install thermocouples at four corners and center of dryer, suspended midway from top to bottom, and attach to data logger outside of dryer. Verify ambient temperature is between 65 - 75 °F. Set dryer thermostat to 160 °F and energize heating elements. Determine average temperature after 30 minutes; temperature less than 155 °F, or greater than 165 °F, is cause for failure.

4.4.10.4 Temperature recovery.

While dryer is still stabilized at 160 °F, open cabinet curtains or doors for one minute, then close. Determine average temperature after eight minutes, less than 155 °F, or greater than 165 °F, is cause for failure.

4.4.11 Dry developer station test.

Verify the station dimensions meet table III requirements within 0.5 inches. Verify the station has a powered “vortex/dust storm” delivery system for the developer powder. Verify the doors are pneumatically operated and have safety stop mechanisms. Verify the station has a vacuum system. Verify the station has controls with an adjustable timer and includes operating indicators. Verify noise level is below 82 dB at three feet away. Verify pneumatic hose and coupler at rear of station.

4.4.12 Rest stations test.

Visually inspect rest stations to verify structural support from below. Verify rest stations have removable roller grille and drain/dust pans. Verify no horizontal supports across the front of the station.

4.4.13 Inspection station test.

Visually inspect for proper grille, blacklights, white lights, exhaust fan, dustpans, and curtains. Visually inspect for overhead hoist/conveyor access on Class A units. Visually inspect to verify the curtains are of proper material, extend to proper length, and are replaceable without tools. Using steel tape measure, confirm inspection station size is within 0.5 inch tolerances of dimensions stated in table IV. Using a calibrated digital radiometer/photometer, verify white light level at the center of inspection area is no more than 20 lux.

4.4.14 Powered tank lifts test.

Verify class B units have tank lifts for penetrant, pre-rinse, remover, wash, and aqueous developer tanks as applicable to type and size. Verify tank lifts have full roller grilles. Using ten each, 50-pound test weights, verify pneumatic-powered mechanism will completely lower and raise a minimum of twenty times (20x). Verify appropriate personnel protection is provided. Verify pneumatic hose and coupler at rear of station.

4.4.15 Voltage inspection.

Visually inspect Electrical Identification Plate to verify the unit was wired for the correct voltage specified. Verify only one electrical connection for 120 VAC and one for higher voltage (208, 240, 480 VAC as applicable). Manually test the GFCI(s) to determine if all hand held blacklights are protected.

4.4.16 Electrical controls inspection.

Visually inspect for separate electrical controls, including usage indicators, for lights, exhaust fan, motor, heater, and dry developer as applicable.

4.4.17 Nozzles inspection.

Visually inspect pre-rinse and wash station nozzles for lever-operated, fan-shaped coarse spray pattern. Using a five gallon container, visually determine if the time to fill is between 50 and 100 seconds.

4.4.18 Inspection of blacklights.

Using a non-destructive inspection/non-destructive testing (NDI/NDT) calibrated digital radiometer/photometer verify that all blacklights have an initial intensity of 2000 microwatts per square centimeter at 15 inches after ten minute warm-up. Visually inspect to determine if they are attached by adjustable brackets and are dismountable.

4.4.19 Baskets inspection.

Visually inspect to determine if six wire baskets have been included with the unit, they have correct nominal dimensions, have hooks to attach them to the tanks, and the tank covers close with the baskets hanging on the inside of the tanks.

4.4.20 Tray inspection.

Visually inspect to determine if the correct quantity and size processing trays have been included with the unit.

4.4.21 Documentation.

Verify FPI unit includes documentation specified in the Contract Data Requirements List (DD Form 1423).

4.4.22 Leakage test.

Apply penetrant to tank welds in accordance with ASTM E1417/E1417M. Dwell for 30 minutes, apply developer to exterior, and inspect under blacklight for evidence of leaks.

4.4.23 Penetrant drain inspection.

Plug drain, fill with fluid, and unplug. Visually inspect for incomplete drainage and no fluids drip on floor.

4.4.24 Roller top grilles, load test.

Place a five sided, open top box, 24 inches long x 7 inches wide x 12 inches high, constructed from welded ¼" steel plate, on the roller grille supported by only two rollers, load box with 250 pounds of lead. Manually move the box over the rollers to verify free movement and no damage to the grille assembly.

4.4.25 Roller top grille, roll test.

Raise one end of a grille assembly to create an angle of between 6 and 7 degrees. Using the steel box and 25 pounds of lead, place the box across only two rollers at the elevated end of the grille assembly. Using only enough external force to start movement, verify the box freely and smoothly moves to the opposite end of the grille assembly.

5. PACKAGING

5.1 Packaging.

For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When packaging of materiel is to be performed by DoD personnel or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activities within the Military Service or Defense Agency, or within the

military service's system commands. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

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

6.1 Intended use.

These FPI units are intended for field and depot use to perform fluorescent penetrant inspections of metallic aerospace and non-aerospace equipment. NOTE: Size 5 is equivalent to cancelled MIL-I-25105, Type MA-2. Size 6 is equivalent to cancelled MIL-I-25106, Type MA-3. Size 4 was developed to maintain full field capability at the expense of throughput, while reducing total unit length.

6.2 Acquisition requirements.

a. Title, number, and date of this specification.

b. Type, size, class, and form (see 1.2).

c. When first article is required (see 3.1).

d. Packaging requirements (see 5.1).

Note to Government Buyer: Equipment should be packaged to withstand 30 days outside storage without damage. Drain valves should be left open to prevent accumulation of water and not be capped or plugged. Plastic sheeting should be used inside of crates (i.e., "draped" over components and open at the bottom) to provide temporary protection from water intrusion.

6.3 Technical manuals.

The requirement for technical manuals should be considered when this specification is applied on a contract. If technical manuals are required, specifications and standards that have been authorized and assigned an Acquisition Management Systems Control (AMSC) number must be listed on a separate Contract Data Requirements List (DD Form 1423), which is included as an exhibit to the contract. The technical manuals must be acquired under separate contract line item in the contract.

Note to Government Buyer: Each FPI unit should include a paper and electronic (CD-ROM) copy of the installation (including minimum utility requirements and procedures to change input voltage), operation, and maintenance instructions, and an Illustrated Parts Breakdown. The documentation should list part numbers and sources for replaceable items, such as lamp bulbs, filters, curtains. A listing of available user-procured accessory items should be included in the documentation. An electronic copy should be provided to the cognizant engineering office to pre-plan installations.

6.4 National Stock Number (NSN).

NSN	PART NUMBER	CAGE CODE
6635-01-483-0552RN	M32531-II2ASF	81348
6635-01-483-0548RN	M32531-II3ASF	81348
6635-01-483-0559RN	M32531-II4ASF	81348
6635-00-110-9463RN	M32531-II5ASF	81348
6635-00-249-5341RN	M32531-II6ASF	81348

6.5 Subject term (key word) listing.

Aqueous developer
Backsplash
NDI/NDT
Post-emulsified
Water-wash

CONCLUDING MATERIAL

Custodians:
Army – GL
Navy - AS
Air Force – 11

Preparing activity:
Air Force – 11

Review activities:
Army – AV
Navy – CG
Air Force – 70, 71, 84
DLA – GS

(Project No. 6635-2015-002)

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at https://assist.dla.mil.