# MILITARY SPECIFICATION

# X-RAY SYSTEM

## 1. SCOPE

1.1 This specification covers the quality assurance provisions for the assembling, testing, and preparation for delivery for one type of portable x-ray apparatus, having a 300 kilovolt peak (KVP) rating, and which can be hand carried for general field applications. This apparatus is designated as x-ray system and is operated from a 115-volt, 60-cycle, single-phase power source.

## 2. APPLICABLE DOCUMENTS

2.1 The following documents, of the issue in effect on date of invitation for bids, form a part of this specification to the extent specified herein:

SPECIFICATIONS

FEDERAL

QQ-L-201 - Lead, Sheet.

STANDARDS

FEDERAL

FED-STD-83 - X-ray Tube Focal Spot, Method of Measurement.

MILITARY

MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.

MIL-STD-1169(MU) - Packaging, Packing, and Marking for Shipment of Inert Ammunition Components.

FSC 1195

DRAWINGS

PICATINNY ARSENAL

9221441 - Control Panel Assembly.

9221442 - X-ray Head Assembly.

9221443 - Packing Case Assembly, Control Panel.

9221444 - Packing Case Assembly, X-ray Head.

9221452 - X-ray System.

9221480 - Cable Assembly, Power.

9221481 - Cable Assembly, X-ray.

9221491 - Case, Packing.

9221492 - Case, Packing.

9234892 - Scale.

9234893 - Ring, Centering.

9234895 - Adapter.

9234900 - Centering and Measuring Device.

Copies of specifications, standards, drawings, and publications required by the contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.

3. REQUIREMENTS

3.1 Materials and components. - Materials shall conform to applicable specifications and drawings. Each component shall conform to all dimensions and tests specified on the component drawing. The contractor shall have available verifiable proof (i.e., objective evidence. See 6.2) that materials and components were fabricated, inspected, and tested under controllable conditions as set forth in the contractor's quality control or inspection procedures.

3.2 Assembly. - The x-ray system shall comply with all requirements specified on drawing (dwg.) 9221452, with all requirements specified herein, and with the requirements of applicable specifications to the extent specified on the drawing and herein. For purposes of this specification, the term "x-ray system" shall

mean an assembly consisting of an x-ray head assembly, centering and measuring device, control panel assembly, and connecting cables (see dwg 9221452).

3.3 First article testing. - Requirements for the submission of first article samples by the contractor shall be as specified in the contract (see 4.2.1).

3.4 Voltage output. - The x-ray system's voltage output shall be capable of being varied from 45 to 300 kilovolts (kv), as measured on the control panel kilovoltmeter, when the input voltage to the control panel is set at 105 and 130 volts alternating current (VAC). During this test, the input current shall not exceed 17 amperes with the x-ray system operating at 300 kv. and 3 milliamperes (ma). Testing shall be as specified in 4.4.1.

3.5 Radiation leakage. - With the x-ray system operating at 300 kv. and 3 ma, the indirect radiation from the x-ray head assembly shall be not greater than 0.020 roentgen per hour, except in the direct beam, when measured at a maximum distance of 25 feet from the head assembly. Testing shall be as specified in 4.4.2.

3.6 Sensitivity. - The x-ray system shall be capable of exposing, on an x-ray negative, the 0.060 inch diameter holes in a 0.020 inch thick steel penetrameter when the x-ray system is operating at 300 kv. Testing shall be as specified in 4.4.3.

3.7 Radiation. - The x-ray system shall be capable of exposing an x-ray negative with a gross Hurter and Driffield (H&D) density of 2.0 minimum when the x-ray system is operating at 300 kv. Testing shall be as specified in 4.4.4.

3.8 Focal spot size. - The focal spot size of the x-ray system shall be not greater than 3.0 millimeters square. Testing shall be as specified in 4.4.5.

3.9 Temperature rise. - The maximum temperature rise of the x-ray head assembly shall be not greater than 80°F. when the x-ray system is operated at 300 kv. on a 30 percent duty cycle, of a 10-minute period, for a minimum time of 4 hours. Testing shall be as specified in 4.4.6.

3.10 Dielectric strength. - The x-ray system shall be capable of withstanding a minimum voltage of 1250 volts, 60-cycle, alternating current for a minimum period of 60 seconds. There shall be no evidence of dielectric breakdown or the inability to attain and maintain the test potential. Testing shall be as specified in 4.4.7.

3.11 Remote-control operation.- The x-ray system shall be capable of controlling the operation of the x-ray head assembly when the control panel assembly is connected by a 25-foot length of cable to the power source and the x-ray head assembly is connected by a 120-foot length of cable to the control panel assembly. The x-ray system shall comply with the requirements of 3.4 when tested as specified in 4.4.8.

3.12 High temperature.- The x-ray system shall withstand exposures to high temperatures of 155° ± 5°F., for a minimum period of 4 hours, and 115° ± 5°F. for a minimum period of 1 hour. The relative humidity during the exposure at 115° shall be a minimum of 85 percent. The x-ray system shall comply with the requirements of 3.4 during the 115°F. exposure. Testing shall be as specified in 4.4.9.

3.13 Low temperature.- The x-ray system shall withstand exposures to low temperatures of -65° ± 5°F., for a minimum period of 12 hours, and 0° ± 5°F. for a minimum period of 1 hour. The x-ray system shall comply with the requirements of 3.4 during the 0°F. exposure. Testing shall be as specified in 4.4.10.

3.14 Altitude.- The x-ray system shall withstand a reduced atmospheric pressure corresponding to a minimum altitude of 40,000 feet for a minimum period of 4 hours. After exposure to this reduced pressure, the x-ray system shall comply with the requirements of 3.9. Testing shall be as specified in 4.4.11.

3.15 Workmanship.- All parts and accessories shall be constructed and finished in a thoroughly workmanlike manner. Particular attention shall be given to neatness, marking, cleaning, and freedom of the parts from burrs and sharp edges, which may affect performance or result in injury during handling. All parts shall be free of chips, dirt, grease, rust, and other foreign material. The cleaning method shall not be injurious to any of the parts, nor shall the parts be contaminated by the cleaning agents.

## 4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection.- Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or order, the supplier may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure that supplies and services conform to prescribed requirements.

4.2 First article inspection.

4.2.1 Submission.- When the contract requires first article inspection, the contractor shall submit two consecutively produced x-ray systems for first article testing to the testing facility designated in the invitation for bids or request for proposal.

4.2.2 Inspection and testing to be performed.- The first article inspection samples shall be inspected for the defects specified in 4.3.2.1.00, using inspection methods contained therein, and for all requirements of Section 3 (see Table I) using the test methods specified in 4.4. The x-ray systems shall be tested in the order specified in Table I. If any x-ray system fails to comply with the applicable requirements, the first article samples shall be rejected. Prior to submitting the samples to the testing facility designated (see 4.2.1), the contractor may perform any nondestructive test listed in Table I (tests 1 through 8) but in no event shall any destructive test (test 9 through 11) be performed on the samples to be submitted.

Table I

| Test | Requirement paragraph |
|---|---|
| 1. Voltage output | 3.4 |
| 2. Radiation | 3.7 |
| 3. Sensitivity | 3.6 |
| 4. Focal spot size | 3.8 |
| 5. Radiation leakage | 3.5 |
| 6. Temperature rise | 3.9 |
| 7. Remote-control operation | 3.11 |
| 8. Dielectric strength | 3.10 |
| 9. Altitude | 3.14 |
| 10. High temperature | 3.12 |
| 11. Low temperature | 3.13 |

4.2.3 Inspection equipment.- The inspection and testing specified in 4.2.2 shall be accomplished with the use of the approved gages and test equipment specified in 4.3.4.

4.3 Product acceptance inspection.

4.3.1 Inspection lot.- A lot or batch, and its formation, size, and presentation, are described in MIL-STD-105, Section 5. Accordingly, a lot shall mean an inspection lot and a batch shall mean an inspection batch for the purposes of this specification. The manner in which each inspection lot or batch is to be presented and identified by the contractor, shall be designated or approved by the Government representative.

4.3.2 Product inspection examination.- A sample shall be selected at random from each inspection lot in accordance with the major defect or the minor defect table as applicable (see Table II).

Any defect found in the sample, selected for the major or minor classification, shall reject the lot. Critical defects shall require 100 percent inspection of all items in the inspection lot. If any critical defect is found in an item, the item shall be removed from the lot. The sequence of inspections for the classification of defects need not be followed so long as all the defect inspections are performed.

Table II

| Major Defect Table | | Minor Defect Table | |
|---|---|---|---|
| Lot Size | Sample Size | Lot Size | Sample Size |
| 1 - 25 | 100% Inspection | 1 - 25 | 100% Inspection |
| 26 - 30 | 25 | 26 - 30 | 25 |
| 31 - 35 | 27 | 31 - 35 | 26 |
| 36 - 40 | 30 | 36 - 40 | 27 |
| 41 - 45 | 32 | 41 - 45 | 28 |
| 46 - 50 | 34 | 46 - 50 | 29 |
| 51 - 55 | 35 | 51 - 55 | 30 |
| 56 - 60 | 37 | 56 - 60 | 31 |
| 61 - 65 | 38 | 61 - 65 | 32 |
| 66 - 70 | 39 | 66 - 70 | 33 |
| 71 - 75 | 40 | 71 - 75 | 34 |
| 76 - 85 | 42 | 76 - 85 | 35 |
| 86 - 95 | 43 | 86 - 95 | 36 |
| 96 - 110 | 44 | 96 - 110 | 37 |
| 111 - 130 | 46 | 111 - 130 | 38 |
| 131 - 156 | 48 | 131 - 156 | 39 |

4.3.2.1.00 Classification of defects.

4.3.2.1.01 X-ray Head Assembly (see dwg. 9221442).

| Categories | Defects | Method of Inspection |
|---|---|---|
| Critical: | None defined. | |
| Major: | | |
| | 101. Location of mounting receptacle . . . . . | .Gage |
| | 102. Any component missing, damaged, or loose . . . . | .Visual |
| Minor: | | |
| | 201. Glyptal missing from mounting receptacle screws . . . . . | .Visual |
| | 202. Protective finish missing or improper (including bare spot). . . . . | Visual |
| | 203. Evidence of poor workmanship (see 3.15) . . . . | .Visual |

4.3.2.1.02 Ring, Centering (see dwg. 9234893 covering a detail of dwg. 9234900).

| Categories | Defects | Method of Inspection |
|---|---|---|
| Critical: | None defined. | |
| Major: | | |
| 101. | Pitch diameter of thread, max. . . . . | Gage |
| 102. | Location of bullet catch hole (4 holes) . . . | Gage |
| 103. | Diameter of bullet catch hole, max (4 holes) | Gage |
| 104. | Inside diameter of ring, max. . . . . | Gage |
| Minor: | | |
| 201. | Evidence of poor workmanship (see 3.15) . . . | Visual |

4.3.2.1.03 Adapter (see dwg. 9234895 covering a detail of dwg. 9234900).

| Categories | Defects | Method of Inspection |
|---|---|---|
| Critical: | None defined. | |
| Major: | | |
| 101. | Pitch diameter of metric thread, min. . . . . | Gage |
| 102. | Pitch diameter of internal (longitudinal) thread, max. . . . . | Gage |
| Minor: | | |
| 201. | Protective finish missing or improper . . . . | Visual |
| 202. | Evidence of poor workmanship (see 3.15) . . . | Visual |

4.3.2.1.04 Scale (see dwg. 9234892 covering a detail of dwg. 9234900).

| Categories | Defects | Method of Inspection |
|---|---|---|
| Critical: | None defined. | |
| Major: | | |
| 101. | Scale improperly altered . . . . . | Visual |
| Minor: | | |
| 201. | Evidence of poor workmanship (see 3.15) . . . | Visual |

4.3.2.1.05 Centering and Measuring Device (see dwg. 9234900).

| Categories | Defects | Method of Inspection |
|---|---|---|
| Critical: | None defined. | |
| Major: | | |
| | 101. Any component missing, loose, damaged, or improperly assembled . . . . . | Visual |
| Minor: | | |
| | 201. Evidence of poor workmanship (see 3.15). | Visual |

4.3.2.1.06 Control Panel Assembly (see dwg. 9221441).

| Categories | Defects | Method of Inspection |
|---|---|---|
| Critical: | None defined. | |
| Major: | | |
| | 101. Any component missing, loose, damaged, or improperly assembled . . . . . | Visual |
| | 102. Case damaged (including catches, handle, and missing or improper nameplate . . . | Visual |
| Minor: | | |
| | 201. Evidence of poor workmanship (see 3.15). | Visual |

4.3.2.1.07 Cable Assembly, Power (see dwg. 9221480) and Cable Assembly, X-ray (see dwg. 9221481).

| Categories | Defects | Method of Inspection |
|---|---|---|
| Critical: | None defined. | |
| Major: | | |
| | 101. Connector or plug terminals damaged . . | Visual |
| | 102. Cable insulation cut or damaged . . . . | Visual |
| Minor: | | |
| | 201. Length, min . . . . . | Gage |
| | 202. Evidence of poor workmanship (see 3.15). | Visual |

4.2.3.1.08 Case, Packing (see dwg. 9221491 and 9211492).

| Categories | Defects | Method of Inspection |
|---|---|---|
| Critical: | None defined. | |

Major:

101. Objective evidence missing or unsatisfactory that case conforms to drawing (see 6.2) . . . Visual

Minor:

201. Evidence of poor workmanship (see 3.15) . . . Visual

4.3.2.1.09 Packing Case Assembly, Control Panel (see dwg. 9221443) and Packing Case Assembly, X-Ray Head (see dwg. 9221444).

| Categories | Defects | Method of Inspection |
|---|---|---|

Critical: None defined.

Major:

101. Case damaged (including external hardware) . .Visual

102. Packing improperly positioned and bonded . . .Visual/ Manual

Minor:

201. Evidence of poor workmanship (see 3.15) . . . Visual

4.3.3 Inspection testing. - The contractor shall perform all of the tests specified in this paragraph. The tests shall be performed in the following sequence:

| Test | Test Classification |
|---|---|
| 1. Voltage output | Major |
| 2. Radiation | Major |
| 3. Sensitivity | Major |
| 4. Focal spot size | Major |
| 5. Radiation leakage | Minor |
| 6. Remote-control operation | Minor |
| 7. Dielectric strength | Minor |

None of these tests is considered destructive, and samples so tested shall be returned to the lot.

4.3.3.1 Voltage output (see 3.4), radiation (see 3.7), sensitivity (see 3.6), and focal spot size (see 3.8). - Each x-ray system shall be subjected to these tests (see applicable paragraph in 4.4). If any x-ray system fails to comply with the applicable requirements, it shall be classified defective and be removed from the lot.

4.3.3.2 Radiation leakage (see 3.5) remote-control operation (see 3.11), and dielectric strength (see 3.10). One x-ray system shall be selected from each lot of 10 x-ray systems produced, or portion thereof, and subjected to these tests (see applicable paragraph in 4.4). If the sample fails to comply with the applicable requirements, the lot shall be rejected.

4.3.4 Acceptance inspection equipment. - Inspection and testing shall be performed with the acceptance inspection equipment, operating instructions, and calibration instructions which shall be supplied by the contractor, but shall be approved by the Government representative authorized by the procuring agency prior to use on the contract.

4.4 Test methods and procedures. - The tolerances specified herein are absolute with no allowance for test equipment inaccuracy. The tolerances used by the manufacturer shall be equal to the absolute tolerances less the accuracy tolerances of the test equipment used. Unless otherwise specified, the tests shall be conducted at room temperature ($80^{\circ} \pm 20^{\circ}$F) and at an input voltage of 115 VAC.

4.4.1 Voltage output. - The x-ray system shall be connected to a 60-cycle variable-voltage source. With the input voltage set at 105 volts, vary the kilovoltage selector, on the control panel assembly, to obtain 45 and 300 kv. on the kilovolt meter. With the input voltage set at 130 volts, vary the kilovoltage selector, on the control panel assembly, to obtain 45 and 300 kv. on the kilovolt meter. With the input voltage set at 130 volts and the x-ray head operating at 300 kv. and 3.0 ma, record the input current to the control panel. The x-ray system shall comply with the requirements of 3.4 during this test.

4.4.2 Radiation leakage. - The x-ray system shall be set up for operation at 300 kv. and 3.0 ma. A lead sheet having minimum dimensions of 8x12x$\frac{1}{8}$ inch, and conforming to QQ-L-201, Grade C, shall be placed in the direct beam as close as possible to the radiation source (the 12-inch dimension of the lead sheet shall be bent to conform to the circumference of the x-ray head). Measurements of radiation leakage shall be made by use of a roentgenometer at a maximum distance of 25 feet from the x-ray head assembly. The x-ray system shall comply with the requirements of 3.5 during this test.

4.4.3 Sensitivity. - The x-ray system shall be set up for operation at 300 kv. and 3.0 ma. A medium carbon, cold rolled steel test plate shall be placed directly over the film cassette which is loaded with Eastman Kodak, Type AA film. The test plate shall have minimum dimensions of 10x4x2 inches. The penetrameter, specified in 3.6, shall be placed over the test plate, and the focal distance from the test plate to the x-ray head assembly shall be a minimum of 18 inches. Exposure time shall be as specified

for the film type used. The x-ray system shall comply with the requirements of 3.6 during this test.

4.4.4 Radiation.- The quality and quantity of direct radiation shall be determined by the film measurement method using Eastman Kodak, Type AA film. The film to be used shall be tested for the combined density of the film base and fog, as developed, before exposure, and this density shall not exceed 0.20 H&D. A test plate (as specified in 4.4.3) shall be placed directly over the loaded film cassette, and the focal distance from the test plate to the x-ray head assembly shall be a minimum of 18 inches. The x-ray system shall be operated at 300 kv., and the exposure time shall be as specified for the film type used. The exposed film shall be processed in fresh Kodak developer, as specified in the film instructions, for a maximum period of 5 minutes at 68° ± 2°F. The density of the processed film shall be determined by use of a densiometer and shall be the average of five readings across the portion of the film covered by the test plate. Gross H&D density shall be the total density of the silver image, fog, and film base. The x-ray system shall comply with the requirements of 3.7 during this test.

4.4.5 Focal spot size.- The focal spot size of the x-ray head assembly shall be determined by using the method specified in FED-STD-83. The x-ray head assembly shall comply with the requirement of 3.8 during this test.

4.4.6 Temperature rise.- The x-ray system shall be set up for operation at 300 kv. and operated at the duty cycle specified in 3.9 (3 minutes "ON"; 7 minutes "OFF" for 4 hours). The hottest spot of the x-ray head assembly shall be measured by means of a hand-held pyrometer or by use of a thermocouple fastened to the x-ray head at the hottest-spot area (as determined from previous operations). The x-ray head assembly shall comply with the requirements of 3.9 during this test.

4.4.7 Dielectric strength.- The assembled x-ray system shall be subjected to the dielectric test voltage, as specfied in 3.10, between each of the two power prongs of the power cable (excluding the third, or ground, prong) and the control panel case and the x-ray head assembly case (for a total of 4 tests). During this test, the line switch shall be in the "ON" position and the relative humidity shall not exceed 50 percent. The x-ray system shall comply with the requirements of 3.10 during this test.

4.4.8 Remote-control operation.- The x-ray system shall be assembled with the cables specified in 3.11, and it shall be tested for voltage output (see 4.4.1). The x-ray system shall comply with the requirements of 3.11 during this test.

4.4.9 High temperature.- The x-ray system shall be placed into a test chamber, and the temperature of the chamber shall be raised to 155°F. The x-ray system shall remain at this temperature for

a minimum period of 4 hours (at uncontrolled humidity). At the end of this test period, the temperature of the chamber shall be reduced to 115°F., and the x-ray system shall remain at this temperature for a minimum period of 1 hour. The relative humidity during the 115°F. exposure shall be controlled at 85% minimum. At the completion of the 115°F. exposure period, the x-ray system shall comply with the requirements of 3.12.

4.4.10 Low temperature. - The x-ray system shall be placed into a test chamber, and the temperature of the chamber shall be lowered to -65°F. The x-ray system shall remain at this temperature for a minimum period of 12 hours. At the end of this test period, the temperature of the chamber shall be raised to 0°F., and the x-ray system shall remain at this temperature for a minimum period of 1 hour. At the completion of the 0°F. exposure period, the x-ray system shall comply with the requirements of 3.13.

4.4.11 Altitude. - The x-ray system shall be placed into an altitude chamber, and the internal pressure of the chamber shall be reduced to a pressure equivalent to an altitude of 40,000 feet (5.54 inches of mercury or 2.72 pounds per square inch). After exposure to this pressure for a minimum period of 4 hours, the pressure shall be increased to atomospheric pressure. The x-ray system shall comply with the requirements of 3.14 during this test.

5. PREPARATION FOR DELIVERY

5.1 Preservation, packaging, and packing. - Preservation, packaging, and packing shall be level A.

5.1.1 Level A. - The x-ray system shall be packed and packaged in accordance with dwg. 9221443, 9221444, and MIL-STD-1169(MU).

5.2 Marking. - Marking shall be in accordance with MIL-STD-1169 (MU).

6. NOTES

6.1 Ordering data. - Procurement documents should specify the title, number, and date of this specification.

6.2 Objective evidence. - Records of contractor's quality control and inspections which can be verified.

Custodian:

Army - MU

Preparing Activity:

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Project No: 1195 - A050

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# SPECIFICATION ANALYSIS SHEET

Form Approved
Budget Bureau No. 22-R255

INSTRUCTIONS: This sheet is to be filled out by personnel, either Government or contractor, involved in the use of the specification in procurement of products for ultimate use by the Department of Defense. This sheet is provided for obtaining information on the use of this specification which will insure that suitable products can be procured with a minimum amount of delay and at the least cost. Comments and the return of this form will be appreciated. Fold on lines on reverse side, staple in corner, and send to preparing activity. Comments and suggestions submitted on this form do not constitute or imply authorization to waive any portion of the *referenced document(s)* or serve to amend contractual requirements.

SPECIFICATION

MIL-X-50282(MU), X-ray System

ORGANIZATION

CITY AND STATE

CONTRACT NUMBER

MATERIAL PROCURED UNDER A

☐ DIRECT GOVERNMENT CONTRACT ☐ SUBCONTRACT

1. HAS ANY PART OF THE SPECIFICATION CREATED PROBLEMS OR REQUIRED INTERPRETATION IN PROCUREMENT USE?

A. GIVE PARAGRAPH NUMBER AND WORDING.

B. RECOMMENDATIONS FOR CORRECTING THE DEFICIENCIES

2. COMMENTS ON ANY SPECIFICATION REQUIREMENT CONSIDERED TOO RIGID

3. IS THE SPECIFICATION RESTRICTIVE?

☐ YES ☐ NO *(If "yes", in what way?)*

4. REMARKS *(Attach any pertinent data which may be of use in improving this specification. If there are additional papers, attach to form and place both in an envelope addressed to preparing activity)*

SUBMITTED BY *(Printed or typed name and activity - Optional)*

DATE

DD FORM 1 JAN 65 1426

REPLACES EDITION OF 1 OCT 64 WHICH MAY BE USED.