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INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE MATERIAL SPECIFICATION

SAE AMS 7295A

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Superseding AMS 7295

Submitted for recognition as an American National Standard

RADIOGRAPHIC FILM AND PAPER
Industrial Grade

1. SCOPE:

1.1 Form:

This specification and its supplementary detail specifications cover radiographic film and paper in the form of cut sheet or rolls.

1.2 Application:

These products have been used typically for recording, for permanent record, the radiographic images of parts, but usage is not limited to such applications.

1.3 Classification:

Radiographic film and paper shall be as specified in the applicable detail specification, wherein each product is defined by radiographic characteristics. An example is shown in 8.2. The product covered by each detail specification appears as part of the title.

2. APPLICABLE DOCUMENTS:

The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order.

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

AMS 3608 Plastic Sheet, Methyl Methacrylate, General Purpose
AMS 5044 Steel Sheet and Strip, 0.15 Carbon, maximum, Half Hard Temper
AMS 5045 Steel Sheet and Strip, 0.25 Carbon, maximum, Hard Temper

2.2 ASTM Publications:

Available from ASTM, 1916 Race Street, Philadelphia, PA 19103-1187.

ASTM E 94 Radiographic Testing
ASTM E 142 Controlling Quality of Radiographic Testing
ASTM E 1079 Calibration of Transmission Densitometers
ASTM F 288 Tungsten Wire for Electron Devices and Lamps

2.3 U.S. Government Publications:

Available from Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

MIL-STD-453 Inspection, Radiographic
MIL-STD-2073-1 DOD Materiel, Procedures for Development and Application of Packaging Requirements

2.4 ANSI Publications:

Available from American National Standards Institute, Inc., 11 West 42nd Street, New York, NY 10036.

ANSI PH2.8 Sensitometry of Industrial X-Ray Films for Energies up to 3 Million Electron Volts

3. TECHNICAL REQUIREMENTS:

3.1 Detail Specifications:

The requirements for a specific product shall consist of all requirements specified herein in addition to requirements specified in the applicable detail specification. In case of conflict between requirements of this basic specification and the applicable detail specification, requirements of the detail specification shall govern.

3.2 Material:

3.2.1 Film:

3.2.1.1 Film Base: Shall be polyester or other transparent material known in the industry as "safety film" and shall be clear or slightly color-tinted.

3.2.1.2 Thickness: Shall be as specified in the applicable detail specification.

3.2.1.3 Optical Density: Shall be as specified in the applicable detail specification, determined in accordance with 4.5.1.

3.2.2 Paper:

3.2.2.1 Paper Base: Composition of the paper shall be optional with the manufacturer and shall be essentially white.

3.2.2.2 Thickness: Shall be as specified in the applicable detail specification.

3.2.2.3 Reflection Density: Shall be as specified in the applicable detail specification, determined in accordance with 4.5.1.

3.2.3 Emulsion Coating: Shall be a silver-bearing emulsion of composition optional with the manufacturer and consistent with requirements specified herein and in the applicable detail specification.

3.2.3.1 Thickness: Shall be optional with the manufacturer.

3.2.3.2 Adhesion: There shall be no delamination of the emulsion from the base material at any time up to 12 months storage of unexposed film or paper. The product shall withstand handling, processing, examination, and storage in accordance with manufacturer's recommendations for up to five years from exposure date with no delamination of emulsion from the base material.

3.3 Radiographic Properties:

3.3.1 Gradient: The product shall exhibit gradient or contrast values as specified in the applicable detail specification, determined in accordance with 4.5.2.

3.3.2 (R) Resolution: The product shall exhibit resolution values as specified in the applicable detail specification, determined in accordance with 4.5.3.

3.3.3 Radiographic Quality Level: Shall be such that a product supplied to this specification and the applicable detail specification, exposed, and processed in accordance with manufacturer's recommendations, shall yield radiographs of at least 2-2T sensitivity as defined and determined in accordance with ASTM E 94 and ASTM E 142.

3.3.4 Response to Radiographic Exposure:

3.3.4.1 Film: The manufacturer shall determine for each product the speed of response to radiation exposure at two of the four energy levels specified in ANSI PH2.8, one level being 100 kV X-rays with no lead screen. The speed shall be expressed as the reciprocal of the exposure in roentgens (C/kg) required to produce a density of 2.0 H&D units, +0.1, -0, above the base and fog density (net density of 2.0) under the standard conditions of exposure and processing specified in ANSI PH2.8. The speed of response and the description of the filters used shall be reported in the preproduction test data submitted in accordance with 4.4.1. When requested, film speed at a net density of 2.0 H&D units, determined in accordance with ANSI PH2.8, shall be reported in reciprocal roentgens (reciprocal C/kg) for each lot or emulsion number.

3.3.4.2 Paper: The manufacturer shall determine for each product the speed of response to radiation exposure at two of the four energy levels specified in ANSI PH2.8, one level being 100 kV X-rays using fluorescent screens of a prescribed type, the other using appropriate lead screens. The speed shall be expressed as the reciprocal of the exposure in roentgens (C/kg) required to produce a reflection density of 0.8 H&D units, +0.5, -0, above the fog density (net density of 0.8) under the standard exposure conditions specified in ANSI PH2.8 and processing in accordance with manufacturer's recommendations. The speed of response and the description of the filters and screens used shall be reported in the preproduction test data submitted in accordance with 4.4.1. When requested, paper speed at a net density of 0.8 H&D units, determined in accordance with ANSI PH2.8, shall be reported in reciprocal roentgens (reciprocal C/kg) for each lot or emulsion number.

3.4 Quality:

The product, as received by purchaser, shall be uniform in quality and condition, clean, unexposed, and free from foreign materials and from imperfections detrimental to usage of the product.

3.5 Sizes and Tolerances:

3.5.1 Sheet: Shall be of the size ordered, +0.06, -0.04 inch (+1.5, -1.0 mm).

3.5.2 Rolls: Shall be of the width and length ordered. Width tolerance shall be +0.06, -0.04 inch (+1.5, -1.0 mm). Length tolerance shall be +1.0 inch (+25 mm), -0.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection:
(R)

The vendor of the product shall supply all samples for vendor's tests and shall be responsible for performing all required tests. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the product conforms to the requirements of this specification.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Tests for response to radiographic exposure (3.3.4)
(R) are acceptance tests and shall be performed on each lot.

4.2.2 Periodic Tests: Tests for gradient (3.3.1) and resolution (3.3.2) are
(R) periodic tests and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser.

4.2.3 Preproduction Tests: Tests for all technical requirements are
(R) preproduction tests and shall be performed prior to or on the first-article shipment of a product to a purchaser, when a change in material and/or processing requires reapproval as in 4.4.2, and when purchaser deems confirmatory testing to be required.

4.2.3.1 (R) For direct U.S. Military procurement, substantiating test data and, when requested, preproduction test material shall be submitted to the cognizant agency as directed by the procuring activity, contracting officer, or request for procurement.

4.3 (R) Sampling and Testing:

Shall be as follows:

4.3.1 Acceptance Tests: Sufficient product shall be taken at random from each lot to perform all required tests; a lot shall be all product produced in a single production run from the same batches of raw materials under the same fixed conditions and presented for manufacturer's inspection at one time. A lot is usually identified with an emulsion number.

4.3.2 Periodic and Preproduction Tests: As agreed upon by purchaser and manufacturer.

4.4. Approval:

4.4.1 Sample product shall be approved by purchaser before product for production use is supplied, unless such approval be waived. Results of tests on production product shall be essentially equivalent to those on the approved sample.

4.4.2 Vendor shall use ingredients, manufacturing procedures, processes, and methods of inspection on production product which are essentially the same as those used on the approved sample. If necessary to make any change in ingredients, in type of processing, or in manufacturing procedures, vendor shall submit for reapproval a statement of the proposed changes in ingredients and/or processing and, when requested, sample product. Production product made by the revised procedure shall not be shipped prior to receipt of approval.

4.5 Test Methods:

4.5.1 Optical and Reflection Density:

4.5.1.1 Specimen Preparation: Specimens of suitable size for density determination, but not less than 4 inches (102 mm) square, shall be prepared from film or paper product samples known to be unexposed to X-ray or visible light by subjecting the unexposed product to all steps of the processing procedure. If roller transport processing is used, the sample unexposed product shall be sent through the processor.

4.5.1.2 (R) Optical Density of Film: The density of the developed specimens shall be determined on a densitometer, calibrated in accordance with ASTM E 1079, accurate to ±0.02 H&D units. A densitometer, of the optical comparison type shall not be used for this determination.

4.5.1.3 Reflection Density of Paper: The density of the developed specimens shall be determined on a gray-scale visual comparator or a reflection densitometer, with not less than three determinations for each test.

4.5.2 Gradient Determination:

4.5.2.1 Gradient shall be determined by plotting the net densities resulting from a series of exposures not exceeding $\sqrt{2}$ increments in accordance with ANSI PH2.8 using 100 kV X-ray. The resultant radiograph shall be processed in accordance with ANSI PH2.8. The net density for each exposure shall be the average of five readings, expressed to two decimal places of accuracy, using a densitometer that has been calibrated prior to each series of determinations by the use of a properly approved comparison strip having densities depicted to two decimal places of accuracy (See 8.3.2). A densitometer of the optical comparison type shall not be used for this determination. The average net density for each exposure shall be plotted essentially as shown in Figure 1, except that the abscissa scale would be the exposure in units of Log E($\sqrt{2}$).

4.5.2.2 (R) An alternate procedure would be essentially the same as specified in 4.5.2.1, except that the film or paper sample for each exposure shall be not less than 4 inches (102 mm) square, exposed at 100 kV in a series of at least five exposures, in accordance with the standard testing condition specified in ANSI PH2.8, and consisting of a basic exposure, E, with subsequent doubling and redoubling of this exposure without changing the energy level, such that the series may be described as E, 2E, 4E, 8E, and 16E (See 8.3.3). The five radiographs shall be processed in accordance with ANSI PH2.8 at the same time if manual processing is used, or in direct, uninterrupted sequence if roller transport processing is used. The resultant net density for each radiograph shall be the average of five readings of the same accuracy and controls specified in 4.5.2.1. The average net density for each exposure shall be plotted on square ruled graph paper with each doubling of the exposure value plotted three lines to the right on the abscissa in order to show the resulting difference in density when the log relative exposure is increased by 0.3, and each resulting net density plotted on the ordinate (See Figure 1).

4.5.2.3 Film Exposures: Shall be selected so that the resulting characteristic curve describes the region of net densities from less than 1.5 to more than 3.5 H&D units. The gradient shall then be determined by the slope of the line connecting the points D1 = 1.5 and D2 = 3.5, by dividing the net density range by the exposure units on the abscissa.

4.5.2.3.1 Either the net density for film, D_f, or the Image Quality Indicator (IQI), D_{IQI}, may be used. When the highest density value that can be read on the densitometer is less than 3.5 H&D units, and the next density value exceeds the limitation of the densitometer (over 4.0), use the slope between 2.0 and 3.0 H&D units to determine the gradient and report the method used. Additional exposures at intermediate settings as shown in 8.3.3 may be used to obtain adequate points for gradient determination over the full range.

4.5.2.4 Paper Exposures: Shall be selected so that the resulting characterization curve describes the region of net densities from less than 0.4 to more than 1.2 H&D units. The gradient shall then be determined by the slope of the line connecting the points D1 = 0.4 and D2 = 1.2, by dividing the net density range by the exposure units on the abscissa. As the gradient, resolution, and speed of the papers are greatly influenced by the fluorescent screens with which they are exposed, they may be evaluated under the most favorable conditions and the type of screen used shall be defined in the test data.

4.5.2.5 In case of dispute between purchaser and manufacturer, the "step-wedge" procedure described in 4.5.2.1 shall be the referee.

4.5.3 (R) Resolution Determination: Resolution, defined as pictorial response to show small details in a radiograph when sufficient contrast is present, shall be determined by the use of a 3-wire-size image quality indicator (IQI) essentially as described in Figure 2. Place the IQI in contact with the film or paper cassette during exposure; this exposure may be combined with exposure for gradient determination if desired. Observations shall be made on radiographs exhibiting density over the image quality indicator, D_{IQI}, of 2.0 H&D units or greater, using 3X magnification by a viewer meeting the visual acuity requirements of MIL-STD-453. See 8.4 for an example of such a determination.

4.6 Reports:

When requested by purchaser, the manufacturer of the product shall furnish with each shipment a report showing the results of tests to determine conformance to the acceptance or periodic test requirements, as specified in the request, and stating that the product conforms to the other technical requirements. This report shall include AMS 7295A and the applicable detail specification number and their revision letters, if any, manufacturer's product identification, size or part number, emulsion or lot number, shelf life expiration date, film speed, and quantity.

4.7 (R) Resampling and Retesting:

If any specimen used in the above tests fails to meet the specified requirements, disposition of the product may be based on the results of testing three additional specimens for each original nonconforming specimen. Failure of any retest specimen to meet the specified requirements shall be cause for rejection of the product represented. Results of all tests shall be reported.

5. PREPARATION FOR DELIVERY:

5.1 Identification:

Each sheet or roll shall be identified with the manufacturer's product identification, applied along one edge with characters of such size as to be clearly legible and in a manner that the identification will be visible after processing. Alternatively, the manufacturer may apply a code of punched holes, notched edges, or other symbols within a 0.125-inch (3.18-mm) wide edge area to establish the manufacturer's product identification; such symbols shall not be altered or obliterated in processing the radiograph.

5.2 Packaging:

5.2.1 Sheets of the same size shall be packaged in units of 25, 100, or as ordered, adequately protected from exposure to light or damage from moisture and normal handling. Individual packages shall be identified on the outside wrapper with the manufacturer's product identification, emulsion or lot number, and shelf life expiration data. When specified by purchaser, handling procedures, processing instructions (or reference thereto), and any special notices shall be enclosed with the package.

5.2.2 Rolls shall be individually packaged and shall be protected and identified as in 5.2.1.

5.2.3 (R) Individual packages shall be packed in exterior shipping containers in accordance with commercial practice and in compliance with applicable rules and regulations pertaining to the handling, packaging, and transportation of the product to ensure carrier acceptance and safe delivery.

5.2.4 Each exterior shipping container shall be legibly marked with not less than the following information such that the markings will not smear or be obliterated during normal handling and use:

RADIOGRAPHIC *___, *__ - *__ *enter appropriate code from applicable detail specification
AMS 7295/ *__
MANUFACTURER'S IDENTIFICATION _____
LOT OR EMULSION NUMBER _____
QUANTITY _____
SHELF LIFE EXPIRATION DATE _____
WARNINGS REGARDING STORAGE IN HEAT OR PENETRATING RADIATIONS
SPECIAL MARKINGS _____

5.2.5 (R) For direct U.S. Military procurement, packaging shall be in accordance with MIL-STD-2073-1, Commercial Level, unless Level A is specified in the request for procurement.

6. ACKNOWLEDGMENT:

A vendor shall mention this specification number and the applicable detail specification number and their revision letters, if any, in all quotations and when acknowledging purchase orders.

7. REJECTIONS:

Product not conforming to this specification and the applicable detail specification, or to modifications authorized by purchaser, will be subject to rejection.

8. NOTES:

8.1 Marginal Indicia:

The (R) symbol is used to indicate technical changes from the previous issue of this specification.

8.2 Classification System:

The classification system used to identify each detail specification is shown by the following example of the second line of the title:

Example: 5 - 80

- 80 — Resolution, 80 or more lines per mm (See 3.3.2)
- 5 — Gradient or contrast, 5.0 or more (See 3.1.1)

8.3 Gradient Determination:

8.3.1 In the gradient or contrast determination, 4.5.2, while any convenient source of radiation may be used, the selected energy level (kV) must not be changed from one exposure to the next. There is no evidence to suggest that the shape of the characteristic curve is influenced significantly by the energy level. The use of a moderately low energy level, such as 100 kV, enables the exposure times to be long enough for accurate timing. If a higher level is selected, it may be well to use a longer focal distance to keep the shortest times at reasonable values. In the case of negative film or paper, the resultant slope will always be positive.

8.3.2 A density strip identified as "NIST SRM-1001," available from the National Institute for Standards and Technology (NIST), Office of Reference Materials, Washington, DC 20234, has been successfully used to calibrate a densitometer as required in 4.5.2.

8.3.3 The following exposure parameters have been used in producing satisfactory radiographs:

Energy Level: 100 kV
Source to Film Distance: 2 meters
Exposure: See Table 1

8.3.4 Although the five exposures will establish a curve, the 13 to 18 exposures produced by the step-wedge procedure gives a more accurate curve, and thus a more accurate determination of gradient over the 1.5 to 3.5 H&D unit portion of the curve. Intermediate exposures may be necessary to establish points between 3.5 and 4.0 net density for gradient determination, as extrapolation may result in an inaccurate designation.

8.4 Resolution Determination Example:

8.4.1 To verify that a product meets the resolution requirements, such as 5 - 80, as indicated in the applicable detail specification, the following procedure could be used.

Expose an image quality indicator as described in Figure 2, with the IQI in contact with the film or paper cassette.

Expose at 100 kV at such a distance 3.3 to 6.6 feet (1 to 2 m) that the focal spot size would be of no real consequence, avoiding motion during the exposure. The length of exposure should be sufficient to produce a net density over the IQI of 2.0 H&D units or greater.

Follow ANSI PH2.8 for conditions of exposure and processing, and process in a manner that is conducive to fine grain.

Observe the completed radiograph with 3X magnification by a viewer meeting the visual acuity requirements of MIL-STD-453.

On each axis of the image quality indicator, three wires should be visible. Their diameters are 0.002 inch (0.05 mm) corresponding to 20 lines per mm, 0.001 inch (0.025 mm) corresponding to 40 lines per mm, and 0.0005 inch (0.013 mm) corresponding to 80 lines per mm. Perceptibility of the finest wire establishes the inherent resolving power of the product.

8.4.2 An image quality indicator identified as "IQI No. 3" is in use in industry, which has the same wire sizes and face sheet thickness as in Figure 2, but also contains six lead balls of the following diameters, 0.002, 0.004, 0.006, 0.008, 0.010, and 0.015 inch, ±0.0002 (0.005, 0.10, 0.15, 0.20, 0.25, and 0.38 mm ± 0.005). This IQI may be used interchangeably with IQI No. 1 shown in Figure 2.

8.5 For direct U.S. Military procurement, purchase documents should specify not less than the following:

Title, number, and date of applicable detail specification, including the identification code from the second line of the title
Size of sheet or roll desired
Quantity of product desired
Level A packaging, if required (See 5.2.5).

8.6 Products meeting the requirements of this specification have been classified under Federal Supply Classification (FSC) 6750.

8.7 Key Words:

Silver bearing emulsion

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