



SURFACE VEHICLE INFORMATION REPORT

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Penetrating Radiation Inspection

RATIONALE

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1. Scope—The purpose of this SAE Information Report is to provide basic information on penetrating radiation, as applied in the field of nondestructive testing, and to supply the user with sufficient information so that he may decide whether penetrating radiation methods apply to his particular inspection need. Detailed information references are listed in Section 2.

2. References

2.1 Applicable Publications—The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply.

2.1.1 ASTM PUBLICATIONS—Available from ASTM, 1916 Race Street, Philadelphia, PA 19103

ASTM E 94—Recommended Practice for Radiographic Testing

ASTM E 545—Standard Method for Determining Image Quality in Thermal Neutron Radiographic Testing

2.2 Related Publications—The following publications are provided for information purposes only and are not a required part of this document.

2.2.1 ASM PUBLICATION—ATTN: MSC/Book Order, ASM International, PO Box 473, Novelty, OH 44072-9901.

Metals Handbook, Vol. 17, 1989, pp. 295–357.

2.2.2 ASME PUBLICATION—Available from ASME, 345 East 47 Street, New York, NY 10017-2330.

"ASME Boiler and Pressure Vessel Code."

2.2.3 ASTM PUBLICATIONS—Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959

ASTM E 142, "Controlling Quality of Radiographic Testing."

ASTM E 545 "Standard Method for Determining Image Quality in Thermal Neutron Radiographic Testing."

ASTM E 748 "Standard Practice for Thermal Neutron Radiography of Materials."

H. Berger, ed., "Practical Applications of Neutron Radiography and Gaging," ASTM STP 586.

2.2.4 OTHER PUBLICATIONS

- Nondestructive Testing Handbook, Vol. 3, Radiography and Radiographic Testing, 1985, American Society for Nondestructive Testing, Columbus, OH 43228
- Tool and Manufacturing Engineers Handbook, Vol. 4, Quality Control Assembly, 1987, Society of Manufacturing Engineers, Dearborn, MI 48121
- "Radiography in Modern Industry." Eastman Kodak Co., Rochester, NY, 1969.
- John R. Bradford, ed., "Radioisotopes in Industry." 1953.
- R. C. McMaster, ed., Nondestructive Testing Handbook, Vol. I, Section 13–27, 1959. American Society of Nondestructive Testing, Columbus, OH 43321.
- H. Berger, Neutron Radiography. New York: American Elsevier Publishing Co., 1965.
- W. J. McGonnagle, Nondestructive Testing. New York: McGraw-Hill Book Co., 1961.
- R. Halmshaw, ed., Industrial Radiology Techniques. New York: American Elsevier Publishing Co., 1971.
- E. T. Clarke, "Gamma Radiography of Light Metals." Nondestructive Testing, Vol. 16, May-June 1958, p. 265.
- "Qualification and Certification of Personnel." Recommended Practice No. SNT-TC-1A, Supplement A (Radiography), American Society for Nondestructive Testing, Columbus, OH 43328.
- Justin G. Schneeman, Industrial X-Ray Interpretation. Evanston, IL: Intex Publishing Co., 1968.
- "Radiographic Testing." Programmed Instruction Handbook PI-4–6, Convair Div., General Dynamics Corp., 1967.
- AMS 2635 C "Radiographic Inspection." July 15, 1981.
- "Military Standard Inspection—Radiographic." MIL-STD-453, U.S. Department of Defense.
- M. R. Hawkesworth, ed., "Radiography with Neutrons," British Nuclear Energy Society, London, 1975."
- Neutron Radiography Issue, Atomic Energy Review, Vol. 15, No. 2, International Atomic Energy Agency, Vienna, 1977.

3. **General**—Penetrating radiation is a versatile nondestructive test method used in modern industry. The use of penetrating x-rays, gamma rays, thermal neutrons, and other forms of radiation which do not affect the material being inspected, provide the basic information by which soundness can be determined. Radiography provides a permanent record on film of internal conditions. Fluoroscopy differs from radiography in that the radiation image is projected on a fluorescent screen or other readout monitor and is often observed visually in real time rather than recorded on a film. Systems are available that produce digitally reconstructed, photographic, or magnetically recorded displays. Penetrating radiation enables industry to monitor a variety of products for a number of types of imperfections. Objects inspected range in size from microminiature electronic parts to very large components in a wide range of manufactured forms (for example, castings, weldments, assemblies).
4. **Principles**—X-rays, gamma rays, and neutrons possess the capability of penetrating materials, even those that are opaque to light. In passing through matter, some of these rays are absorbed or scattered. Materials absorb x-rays and gamma rays in proportion to their mass. Neutron absorption, on the other hand, is not related proportionally to atomic number or mass; neighboring elements can differ in neutron absorption by factors of 100 or more. Differential absorption of the radiant energy passing through the object due to the presence of voids, discontinuities, or density variations caused by inhomogeneity or internal construction is recorded on radiographic film or observed directly by fluoroscopic methods. With acceptable conditions of technology and equipment, it is generally agreed that discontinuities can be detected which present to the axis of radiation a minimum dimension of 1 to 2% of the thickness of the object undergoing radiographic examination, or 2 to 6% for fluoroscopic examination. Two-dimensional imperfections, such as cracks and cold shuts, are not detectable unless they present an effective thickness difference of the above magnitude, or greater, and are in appropriate alignment with the beam of radiation.