INDUSTRIAL NEUTRON RADIOGRAPHY
IN THE UNITED STATES

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ABSTRACT

This paper covers the neutron radiographic activities in the industrial community as experienced at Aerotest Operations over the last five years. A brief description of the Aerotest facilities, the neutron beam, the physical configuration and special capabilities are discussed. Several unique neutron radiographic applications are described, including a specific weld inspection of the vernier control engines for the space shuttle, the inspection of rubber diaphragms used to pressurize the fuel for operating engines under zero gravity conditions, the inspection of graphite phenolic blocks from which artificial hip joints are machined, and special fixture designs.

AEROTEST FACILITIES

The Aerotest Research and Radiography Reactor (ARRR), one of the two major neutron radiography production facilities in the United States, is shown in Figure 1. The source of neutrons is a 250 kw-thermal reactor located at the bottom of a 10 foot (3 meter) diameter by 23 foot (7 meter) deep, water filled tank. The beam of neutrons is brought to the water surface by a tapered aluminum, helium filled, rectangular cross sectioned duct. Figure 2 illustrates the 22 inch (55cm) by 30 inch (76cm) exposure area at the neutron radiographic location, which allows two neutron radiographic films to be exposed simultaneously.
Standard industrial 14 inch (35cm) by 17 inch (43cm) single sided fine grain film is used in a vacuum cassette. The neutron to electron conversion screen used is a 0.001 inch (0.0025cm) thickness of gadolinium metal that has been vapor deposited onto an aluminum plate.

The unique features of this facility are the long source-to-object distance, 250 inches (635cm); large exposure area; sliding horizontal double-ended shuttle tray and the availability of five switch selectable apertures. These apertures provide L/D ratios from under 100 to 500. The L/D ratio is the length from the source to the object being neutron radiographed, divided by the apparent source size. The apertures have been calibrated according to the ASTM document E 803-81 "Standard Method For Determining The L/D Ratio Of Neutron Radiographic Beams." The long source-to-object distance provides a near parallel beam of neutrons, while the five different apertures provide variable depths of fields to examine areas of interest at various distances from the film or to provide sharp definition for small components. The Aerotest facility also includes a separate, tightly collimated beam of neutrons for neutron gaging. This equipment has been instrumental in providing narrow beam thermal neutron attenuation coefficients for most of the materials that are commonly examined with neutron radiography.

![Figure 1 - Aerotest Reactor Facility](image-url)