

CONF-831012--13

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11 FIRST HOT FUEL EXAMINATION FACILITY'S NEUTRON RADIOGRAPHY REACTOR

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25 Argonne National Laboratory-West is located near
26 Idaho Falls, Idaho, and is operated by the University of
27 Chicago for the United States Department of Energy in
28 support of the Liquid Metal Fast Breeder Reactor Program,
29 LMFBR.

31 The Hot Fuel Examination Facility, HFEF, is one of
32 several facilities located at the Argonne Site. HFEF
33 comprises a large hot cell where both non-destructive and
34 destructive examination of highly-irradiated reactor
35 fuels are conducted in support of the LMFBR program. One
36 of the non-destructive examination techniques utilized at
37 HFEF is neutron radiography.

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41 Neutron radiography is provided by the NRAD reactor facility,
42 which is located beneath the HFEF hot cell. The NRAD reactor is
43 a TRIGA reactor and is operated at a steady state power level of
44 250 kw solely for neutron radiography and the development of radi-
45 ography techniques.

47 The reactor core consists of 61 TRIGA-FLIP fuel elements
48 surrounded by graphite reflector assemblies. The reactor core is
49 cooled by natural circulation of the water within the reactor tank.
50 The reactor tank is small compared to most TRIGA facilities, being
51 approximately 2.0 m in diameter and 3.5 m in depth.

MASTER

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The NRAD facility has two neutron beam tubes for radiography. Fig. 1. In order to optimize the epithermal neutron content of the beams, both beams are extracted from the fuel region of the reactor core as opposed to being extracted from outside the graphite reflector. Both beam tubes have removable beam filter packages adjacent to the reactor core, adjustable boron nitride aperture blocks for changing L/D ratios, and a helium atmosphere to provide a better flight path for the neutrons.

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One beam tube extends beneath the hot cell to the East Radiography Station and is utilized for radiographing fuel specimens that are placed within a vertical specimen tube within the hot cell and lowered in the tube to intersect the neutron beam.

AUTHORS' NAMES

The East Radiography Station has the following capabilities:

AUTHORS' AFFILIATION

- L/D ratios of 50:1, 125:1, and 300:1
- Foil plane current of 2×10^6 n/cm²sec
- Specimens: 165 mm diameter

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3 m length
272 kg mass

- Radiography is done in a vertical attitude with vertical positioning accuracy of ± 3.2 mm
- Specimens can be rotated to any angle to within $\pm 0.5^\circ$
- All radiography is done in the hot cell environment

The second beam tube extends 51 feet to a specimen tube designated as the North Radiography Station. Either irradiated or unirradiated specimens may be radiographed in this specimen tube without having to be placed in the hot cell.

The North Radiography Station has the following capabilities:

- L/D ratios of 185:1, 300:1, and 700:1
- Foil plane current of 1×10^6 n/cm²sec
- Specimens: 750 mm diameter
10.6 m length
272 kg mass
- Radiography is done in a vertical attitude with vertical positioning accuracy of ± 3.2 mm
- Specimen can be rotated to any angle to within $\pm 0.5^\circ$
- Radiography is done out of the hot cell environment
- Radiography can be done on either irradiated or non-irradiated specimens

The radiography technique employed at the NRAD facility is the transfer or indirect method in which foils are placed behind the specimen, irradiated, and the latent image later transferred to industrial X-ray film, Fig. 2.

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A technique known as "computed axial tomography" is becoming increasingly important to scientists in reactor fuel development programs. Tomography is the process of obtaining radiographs at many rotational angles, digitizing the information on the radiographs using a scanning microdensitometer, and processing the information with a computer to reconstruct cross-sections of the specimen, Fig. 3. The NRAD facility is the only facility in the United States capable of producing computed axial tomographs of irradiated fuel assemblies.

Development of new radiographing techniques is actively pursued at the NRAD facility, and these techniques are incorporated into use as they are developed. At present the NRAD facility is unique in the United States in that irradiated fuels may be radiographed in a vertical orientation with high throughput.

AN ALIEN'S ATTENTION

REFERENCES

1. W. J. Richards, G. C. McClellan, and D. M. Tow, "Neutron Tomography of Nuclear Fuel Bundles", Materials Evaluation, Vol. 40, No. 12, Nov 1982, pp 1263-1267.
2. W. J. Richards and G. C. McClellan, "Hot Fuel Examination Facility Neutron Radiography Reactor Design", J. P. Barton and P. von der Hardt (eds.), Neutron Radiography, pp 257-262, 1983 ECSG EEC, EAEC, Brussels and Luxembourg.
3. J. P. Barton, C. T. Oien, and K. Bailey, "Feasibility of Neutron Radiography for Large Bundles of Fast Reactor Fuel", June 1977. Argonne National Laboratory (ANL)/RAS 77-20.
4. R. P. Kruger, et al, "Industrial Applications of Computed Tomography at Los Alamos Scientific Laboratory", June 1980. Los Alamos (LA)-1814-MS.
5. W. J. Richards and W. E. Stephens, "Neutron Radiography Facility at the Hot Fuel Examination Facility/North", Proceedings of 25th Conference on Remote Systems Technology, 1977, pp 28+. American Nuclear Society, LaGrange Park, IL.
6. W. J. Richards and G. C. McClellan, "Neutron Radiography at the Hot Fuel Examination Facility", Proceedings of 27th Conference on Remote Systems Technology, 1979, pp 33+. American Nuclear Society, LaGrange Park, IL.
7. W. J. Richards and G. C. McClellan, "Performance of the New Neutron Radiography Facility at the Argonne National Laboratory Hot Fuel Examination Facility", summarized in Paper Summaries

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of ASNT National Fall Conference, Oct. 1978, 1978, pp 74-76.
American Society for Nondestructive Testing, Inc., Columbus, OH.

8. K. T. Smith, D. C. Solomon, and S. L. Wagner, "Practical and
Mathematical Aspects of the Problem of Reconstructing Objects
from Radiographs", Bulletin of American Mathematical Society,
Vol. 23, No. 6, Nov. 1977, pp 1227-1270.

9. J. R. G. Minerbo, "MENT: A Maximum Entropy Algorithm for Reconstructing a Source from Projection Data", Computer Graphics Image Processing, Vol. 10, No. 1, 1979, pp 48-68.

10. D. M. Tow, "Post-Irradiation Examination Using Neutron Tomography", Neutron Radiography, 1983 ECSC, EEC, EAEC, Brussels and Luxembourg.

AUTHORS' AFFILIATION

AND ADDRESS

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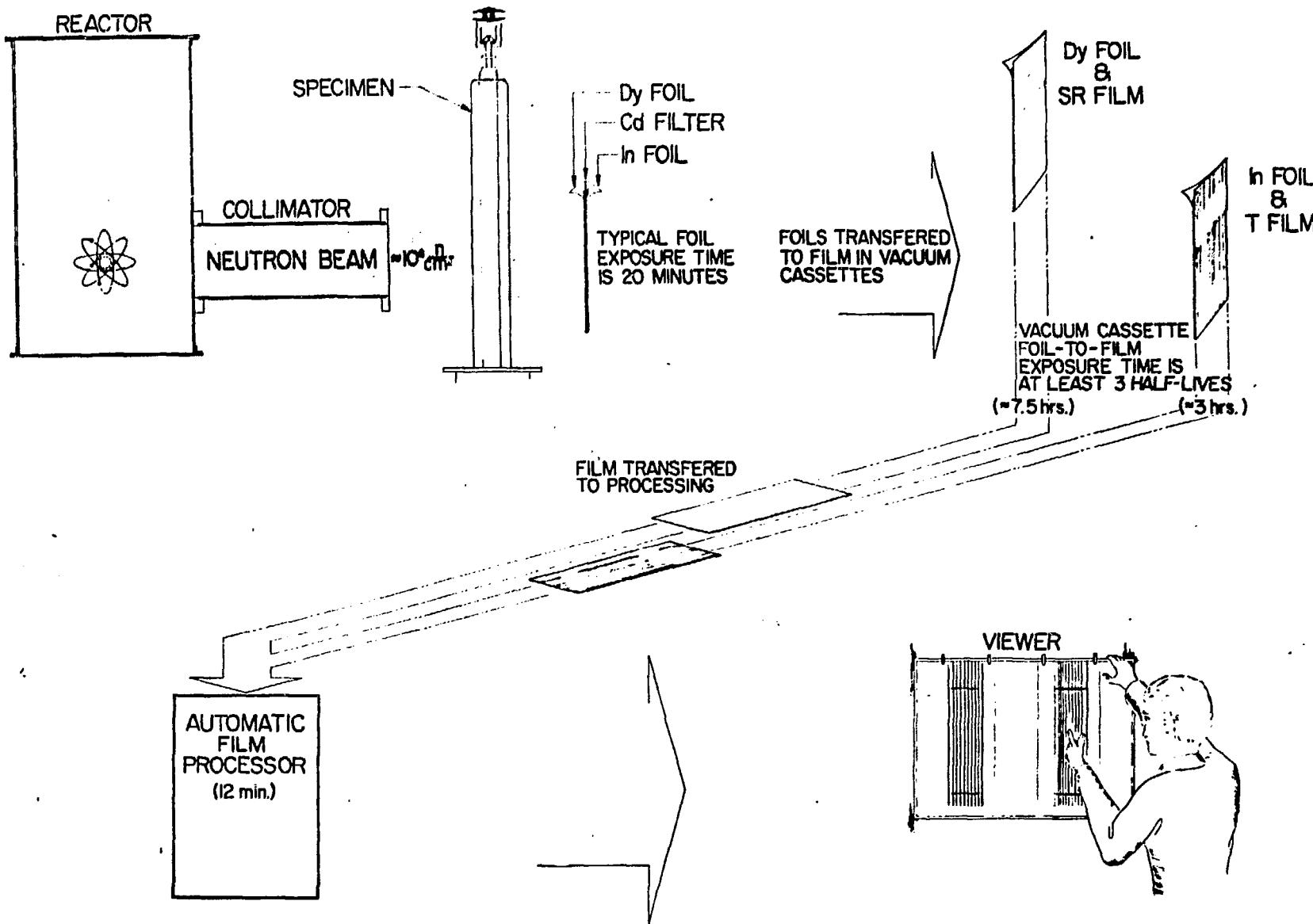
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**NORTH
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REACTOR

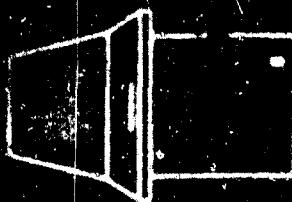
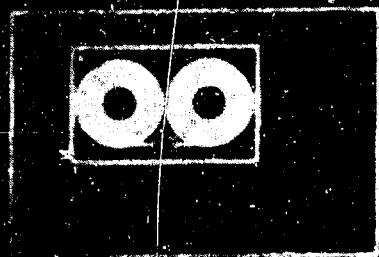
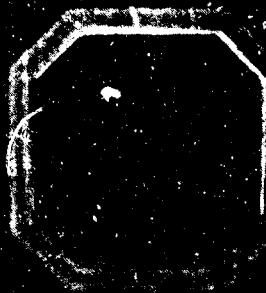
**EAST
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**NEUTRON RADIOGRAPHY FACILITY
(Elevation Section)**



TYPICAL INDIRECT NEUTRON RADIOGRAPHY PROCESS

STEREOPHOTOGRAMM



STEREOPHOTOGRAMM

COMPUTER
PROCESSING