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HOT FUEL EXAMINATION FACILITY'S NEUTRON RADIOGRAPHY REACTOR

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ABSTRACT

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

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

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

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

DISCLAIMER

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.

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.

The East Radiography Station has the following capabilities:

- L/D ratios of 50:1, 125:1, and 300:1
- Foil plane current of 2×10^6 n/cm^{2}sec
- Specimens: 165 mm diameter
  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 $\pm 0.5°$
- 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/cm^{2}sec
- 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 $\pm 0.5°$
- 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.

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.

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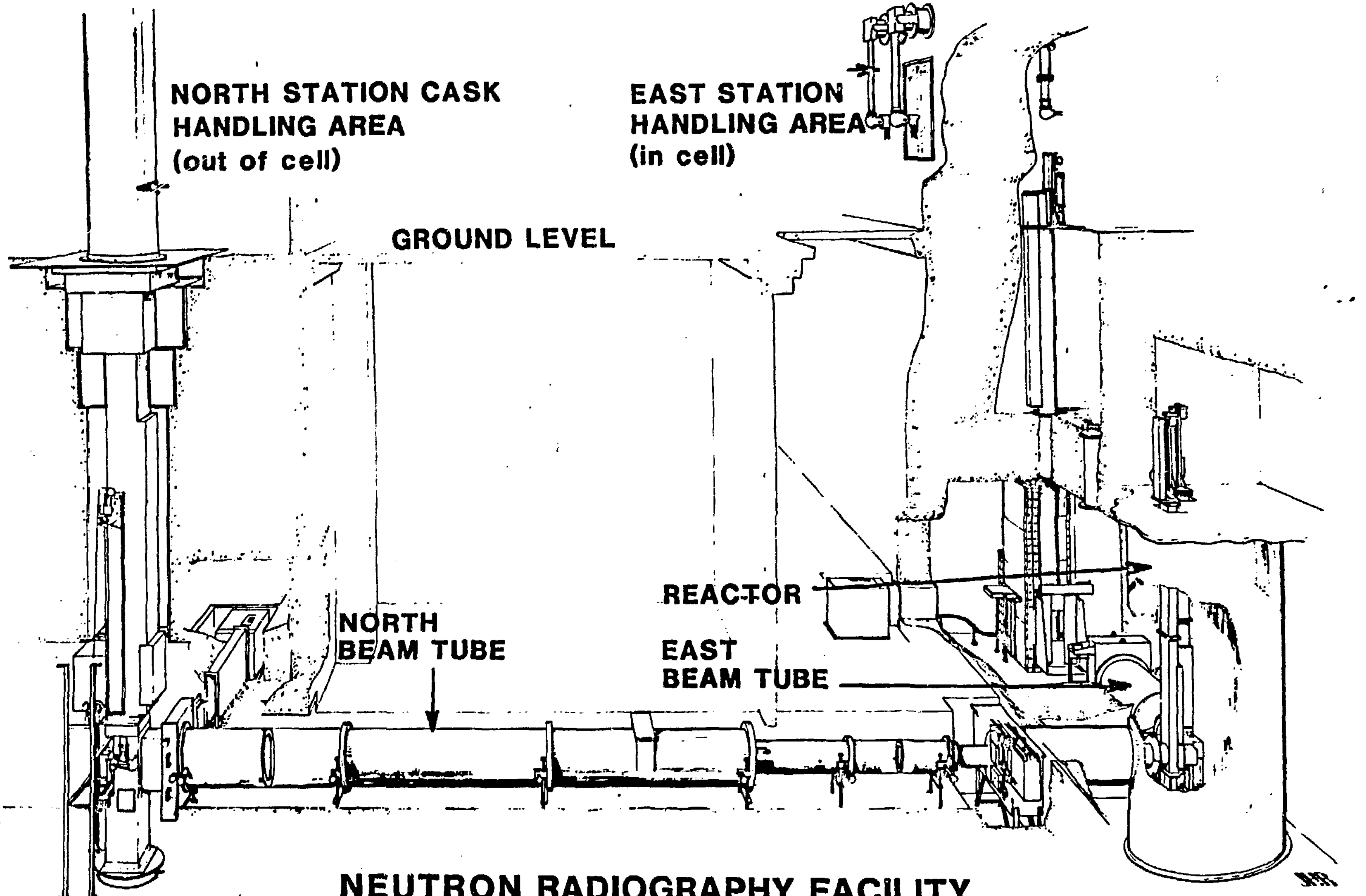
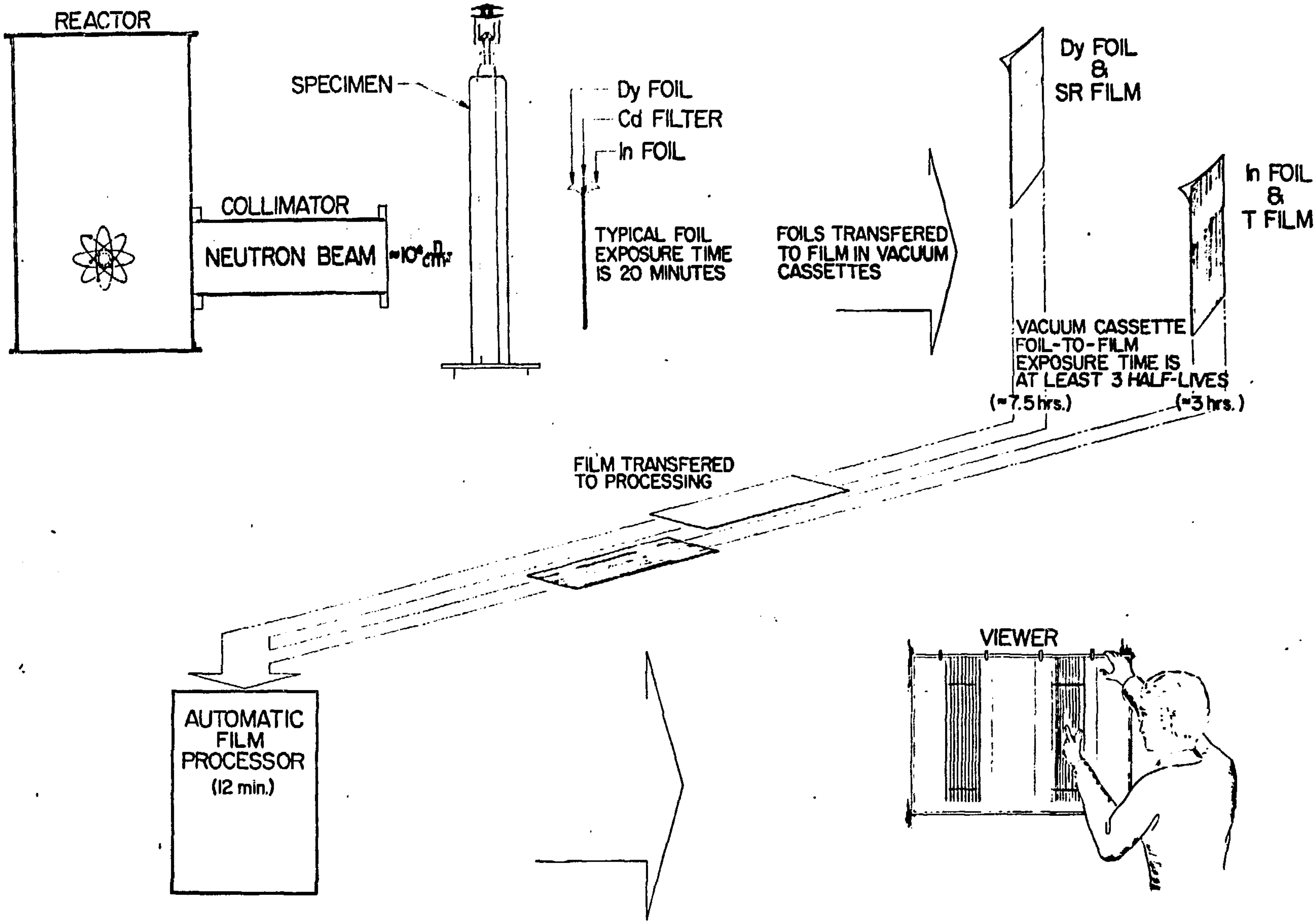


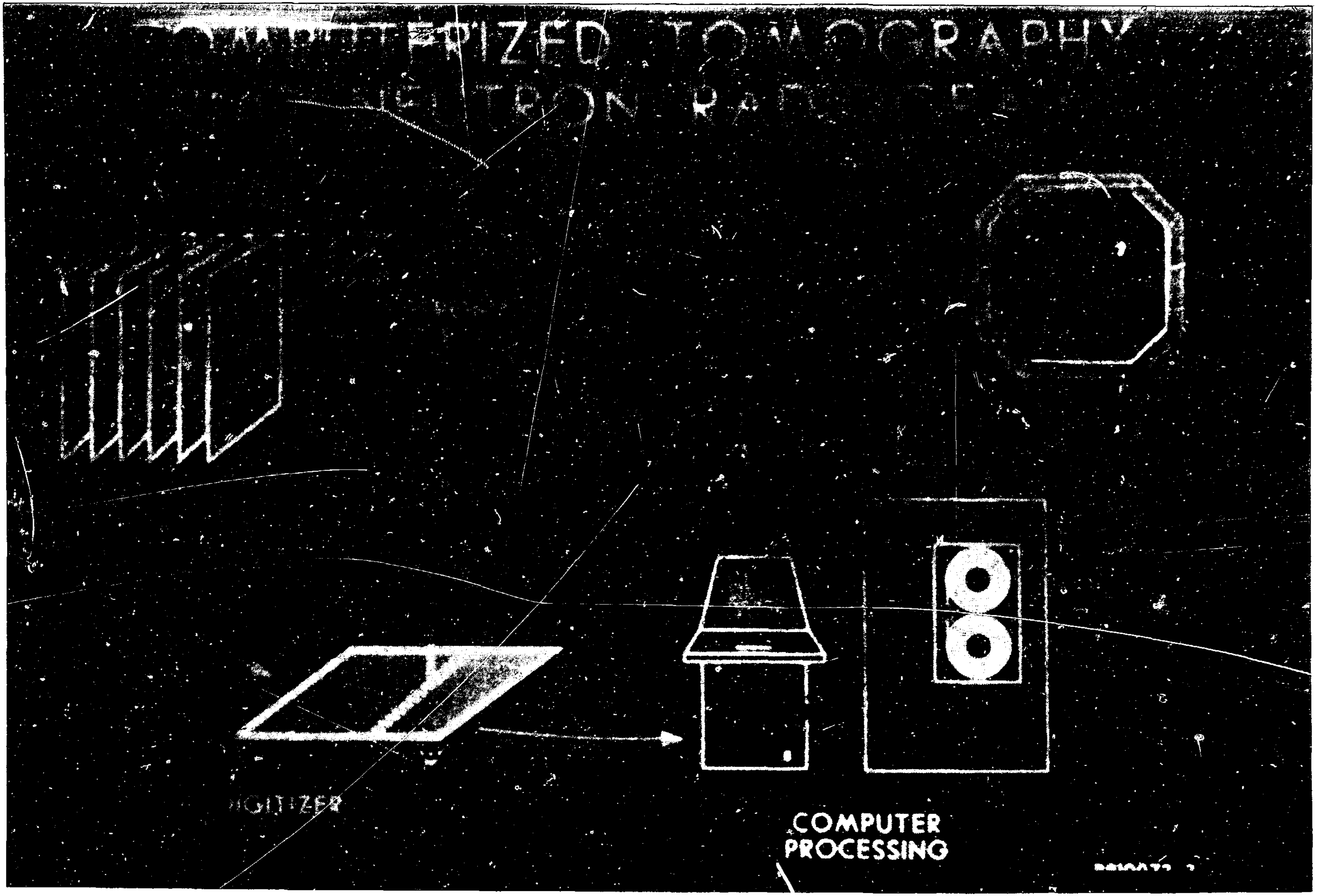
NEUTRON RADIOGRAPHY FACILITY
(Elevation Section)

Fig. 1



TYPICAL INDIRECT NEUTRON RADIOGRAPHY PROCESS

Fig. 2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