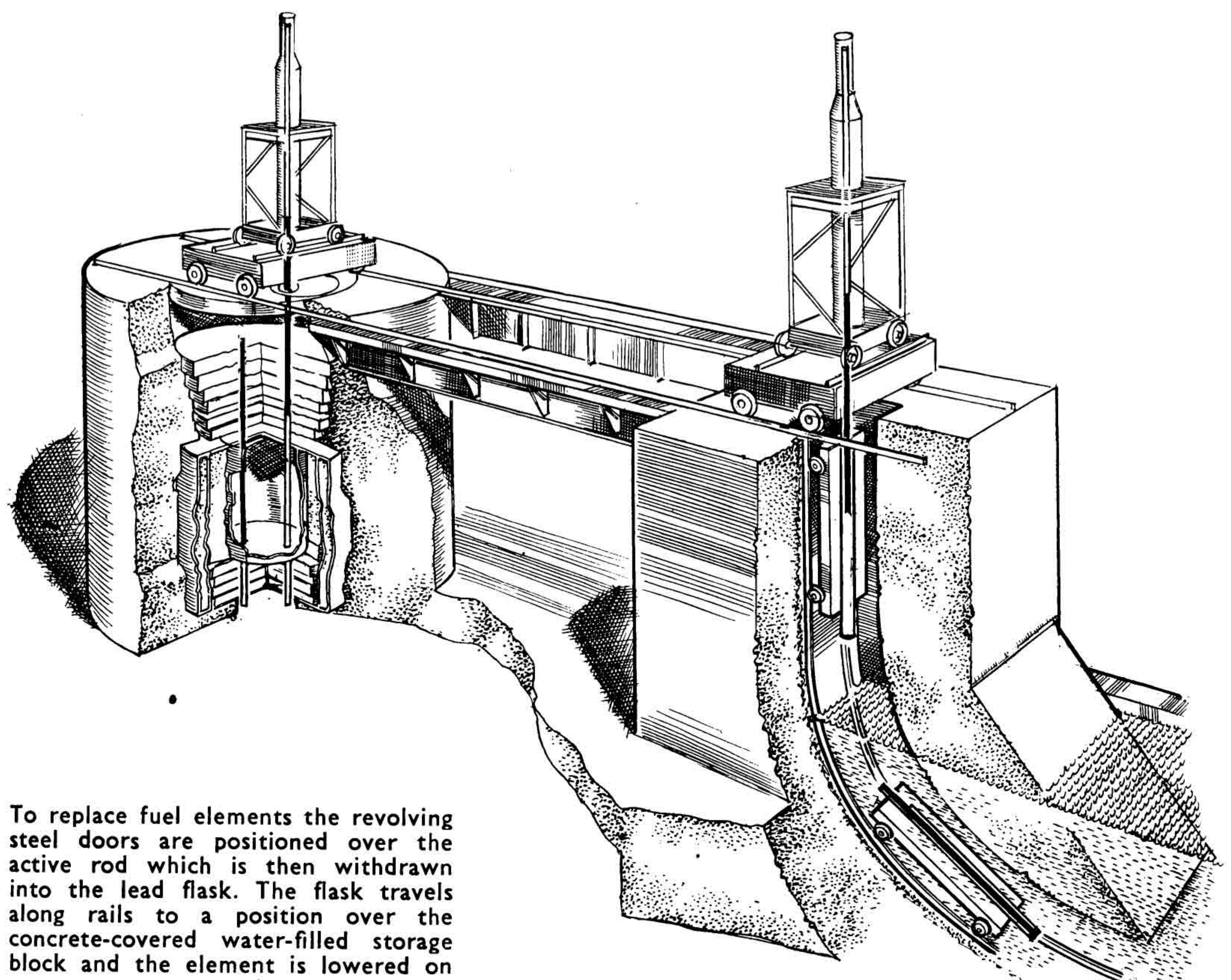
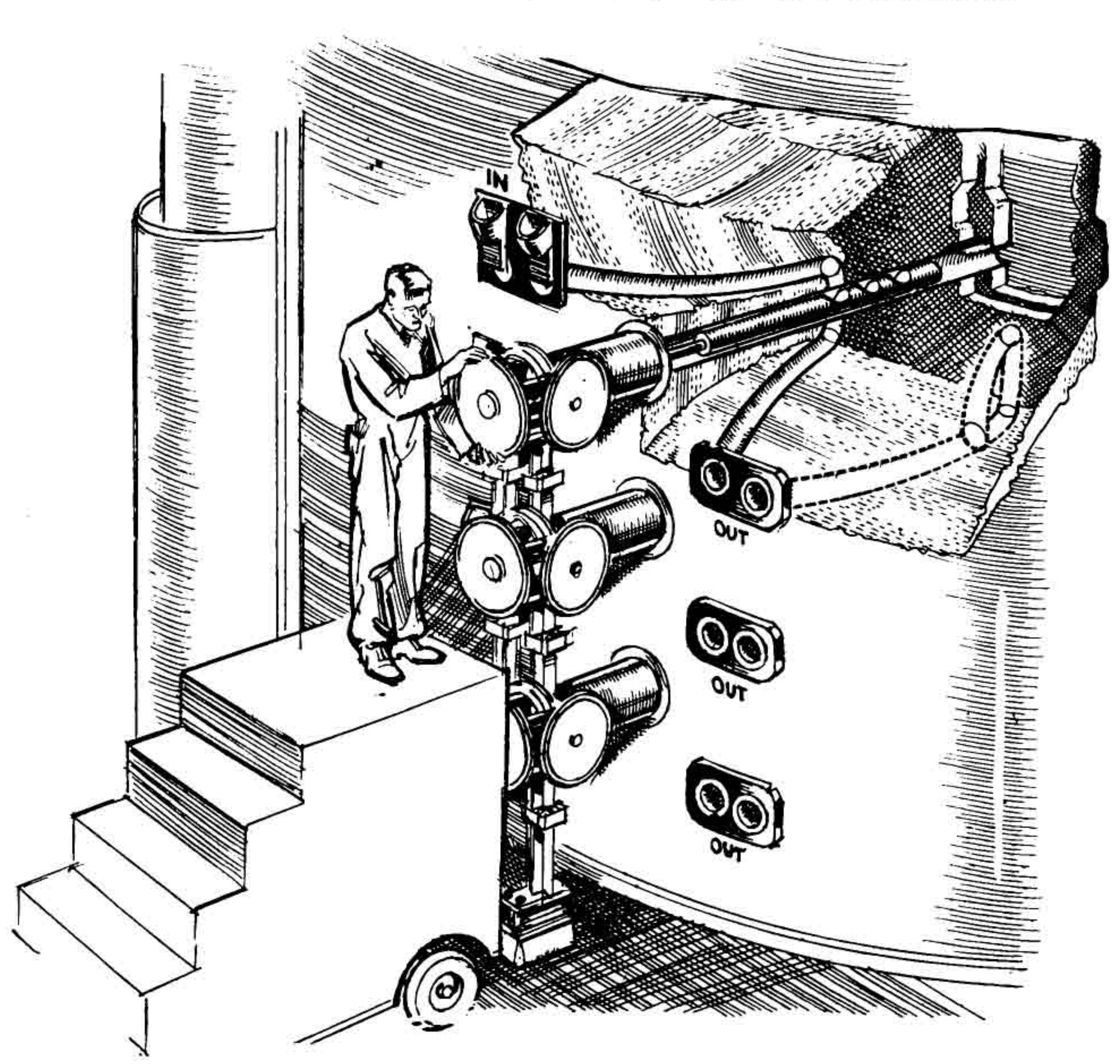
The World's Reactors

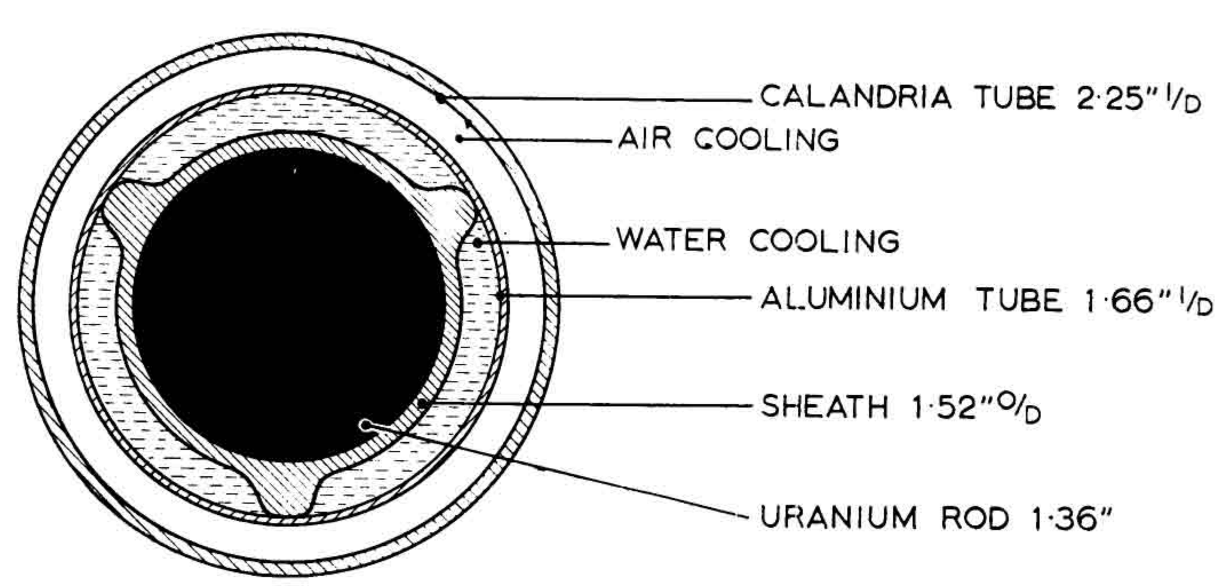
No. 3 — N R X



To replace fuel elements the revolving steel doors are positioned over the active rod which is then withdrawn into the lead flask. The flask travels along rails to a position over the concrete-covered water-filled storage block and the element is lowered on to a carriage.

Samples for irradiation are placed in an aluminium ball which runs down the continuously dropping and curving channel into the graphite plug which can then be moved into the pile. On withdrawal the rod is turned to allow the ball to roll out and down a similar channel into a shielded container.





Cross section of NRX fuel rod assembly. Immediately surrounding the sheathed uranium is an annular space through which river water flows. The fuel rod sits symmetrically in the calandria tube and air is forced through the annular gap.

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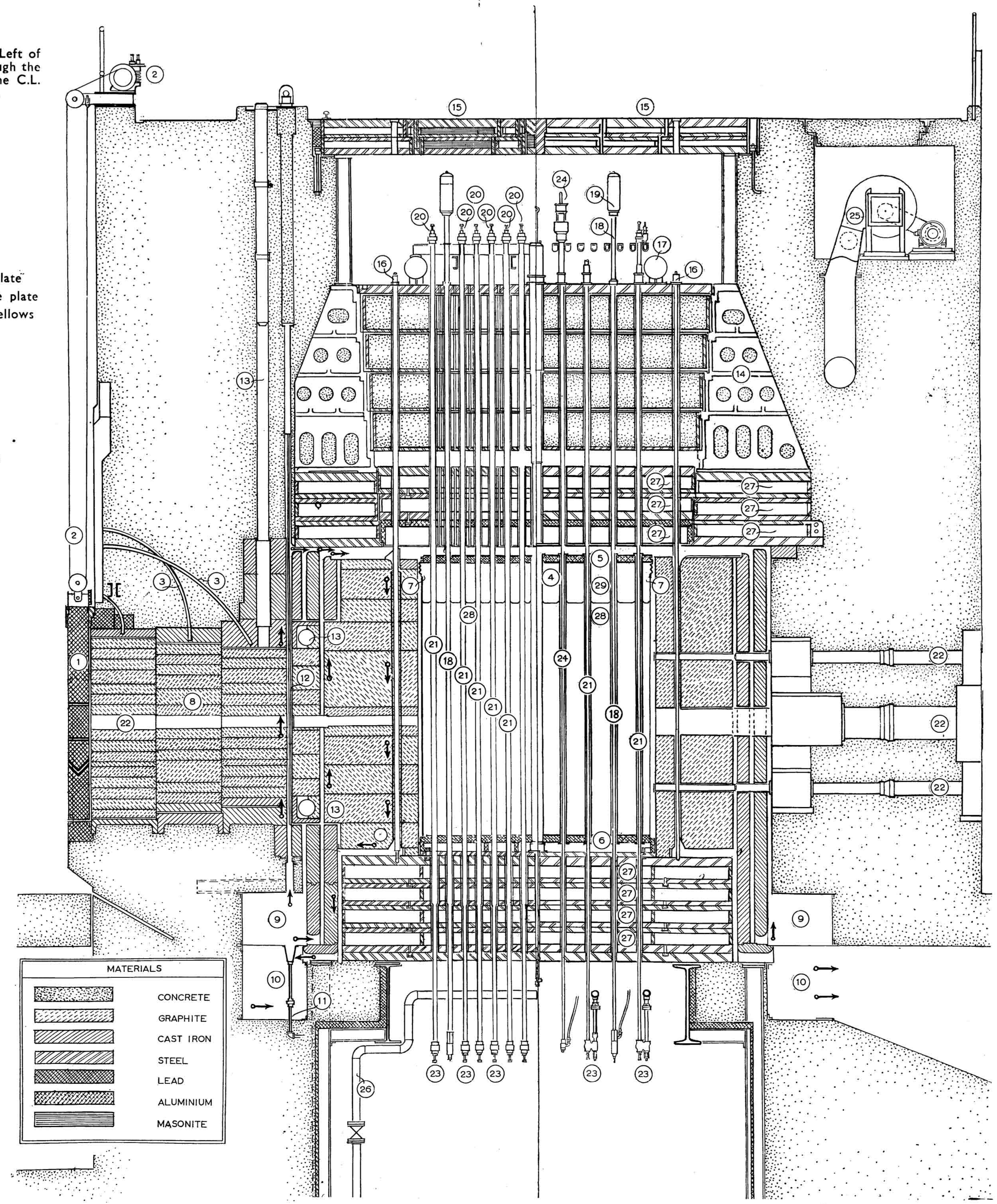
(Right) Cross section of NRX. Left of C.L. is in the direction N-S through the thermal column and right of the C.L. is in the E-W direction.

KEY

1. Lead door
2. Lead door hoist
3. Thermo-couple holes
4. Calandria
5. Top calandria tube plate
6. Bottom calandria tube plate
7. Calandria extension bellows
8. Thermal column
9. Air inlet
10. Air exhaust
11. Drain to sump
12. Cadmium shutter
13. Ion chamber cavity
14. Gusset plate
15. Revolving steel doors
16. Conversion rods
17. Ring cooling header
18. Shut off rod
19. Pneumatic gun
20. Coolant inlet valves
21. Fuel rod
22. Experimental hole
23. Coolant outlet valves
24. Control rod
25. Air circulating fan
26. Outlet header
27. Water filled shields
28. Heavy water level
29. Helium filled



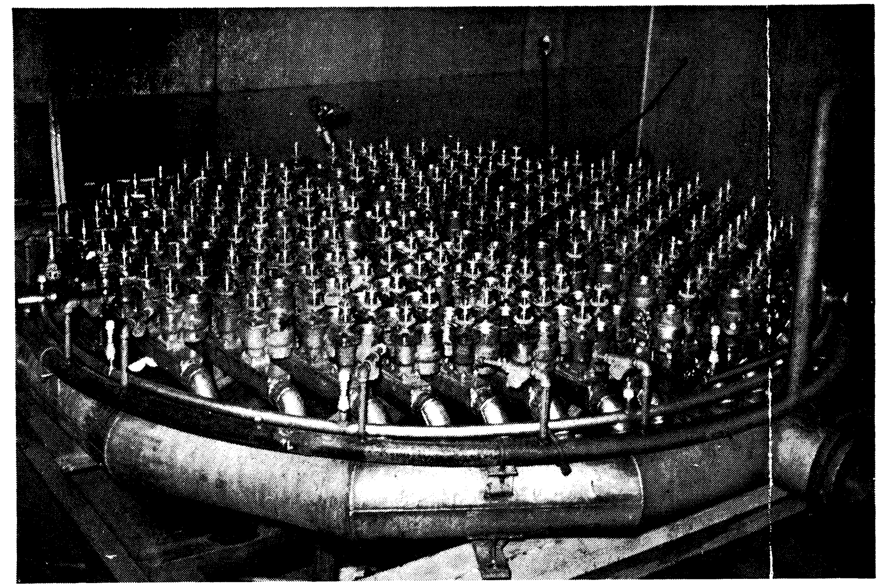
Acknowledgment is due to Atomic Energy of Canada Ltd. for supplying the drawings upon which these illustrations, drawn by a staff artist of *Nuclear Engineering*, are based.

The World's Reactors No. 3

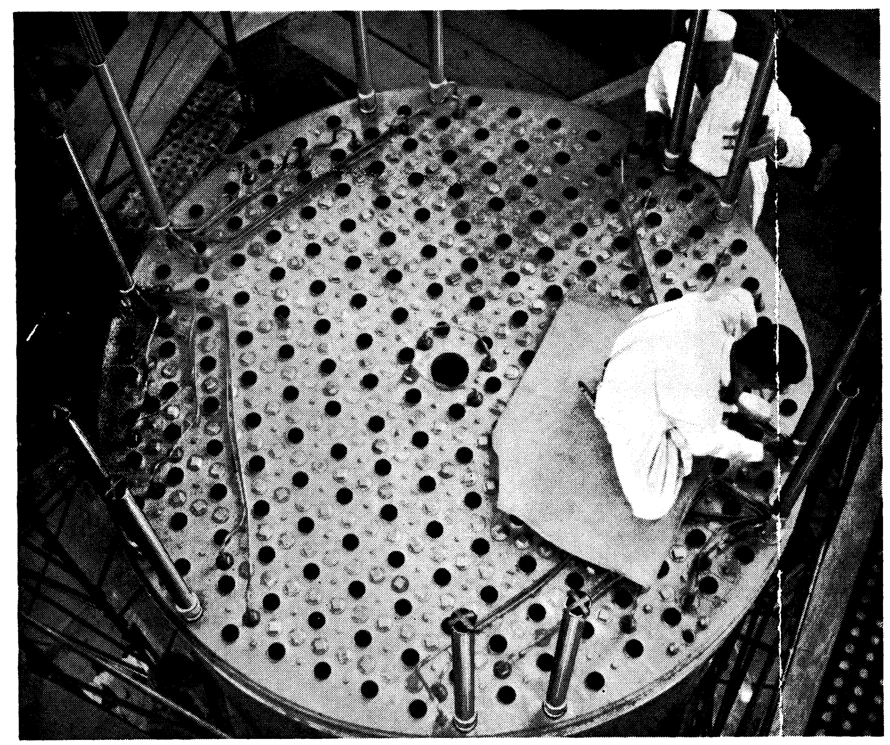
NRX — NATIONAL RESEARCH EXPERIMENTAL

TYPE:	Thermal heterogeneous.
PURPOSE:	General research using pile radiations. Production of radio-isotopes. Production of U_{233} from thorium; production of Pu. Special test loops.
LOCATION:	Chalk River, Canada, 130 miles from Ottawa.
OPERATION:	Commenced operation July 22, 1947.
FUEL:	Natural uranium. Rolled metal bars, 1.36 in. dia. x 10.25 ft. long. Charge for operation: 10.5 tons. Maximum fuel temperature:
FUEL CANS:	Pure aluminium (U.S. spec. 1S). Wall thickness: 0.080 inch. Can temperature:
FERTILE:	Thorium (as oxycarbonate). Form: Rods, $2\frac{1}{2}$ in. diameter, made of pellets. Number of rods: 90 at 4-in. separation.
MODERATOR:	Heavy water. Weight of D_2O: 18 tons approx. Max. temperature: 50°C.
CORE:	Reacting core: cylinder of heavy water 8.75 ft. dia. x 10.5 ft. high. Height of D_2O for criticality about 7.2 ft. Lattice: Regular equilateral triangular lattice $6\frac{13}{16}$ in. pitch. Number of fuel channels: 175 (199 channels in 22 hexagonal rings available).
REFLECTOR:	Graphite. Inner: 9-in. layer of graphite next to calandria. Outer: 24-in. layer of graphite. Air gap: $2\frac{1}{2}$-in. air-gap between inner and outer reflectors to accommodate uranium rods and air cooling.
LATTICE CONSTANTS:	Thermal utilization factor—(f). Fast fission factor—(ϵ). Neutrons born per neutron absorbed in fuel—(η)=2.112 (U_{235}). Resonance escapes probability—(p)= (Slowing-down length)^2—(L_s^2)=114 cm^2. (Diffusion length—(L_d^2)=156 cm^2. Critical buckling—$B^2=4.07 \times 10^{-4}$ cm^{-2}.
COOLANT:	Fuel cooling: light water from Ottawa River. Flow rate: 3,500 gallons per minute. Temperature rise: 40°C. Outlet water: returned to river after 2 hours hold-up. Shielding and thorium blanket cooling: Air, 70,000 lb./hr. Moderator cooling: River water in external heat exchanger, 250 gallons per minute. Air in calandria fuel channels.
PUMPING POWER:	Normal operating power: 40 MW approx.
FLUX:	Maximum thermal neutron flux: 6.8×10^{13} n/cm^2-sec.
CONVERSION:	U_{238} to Pu_{239}. Conversion factor: approx. 0.80.
BURN-UP:	Up to 3,000 MW-days per tonne have been reported.
CONTROL:	Shut-off rods: 6 in number. Construction: boron-carbide powder in steel tubes. Coarse control: height of D_2O controlled by weir. Fine control rod: 1 in number. Construction: cadmium slugs in steel tube.
SHIELDING:	Top shields: Inner: Aluminium water cooled. Intermediate: Steel, water-cooled, two 5 tons each. Outer: Concrete, four in number, 17 to 19 tons each. Bottom shields: Inner: Steel and water sandwich, water cooled. Outer: Steel, four in number, water cooled. Side shields: Inner: Cast iron, 6 in. thick, two layers, air cooling between, total weight 155 tons. Outer: Concrete, 7 ft.
OVERALL SIZE:	Diameter: 34 ft. Height: 34 ft.

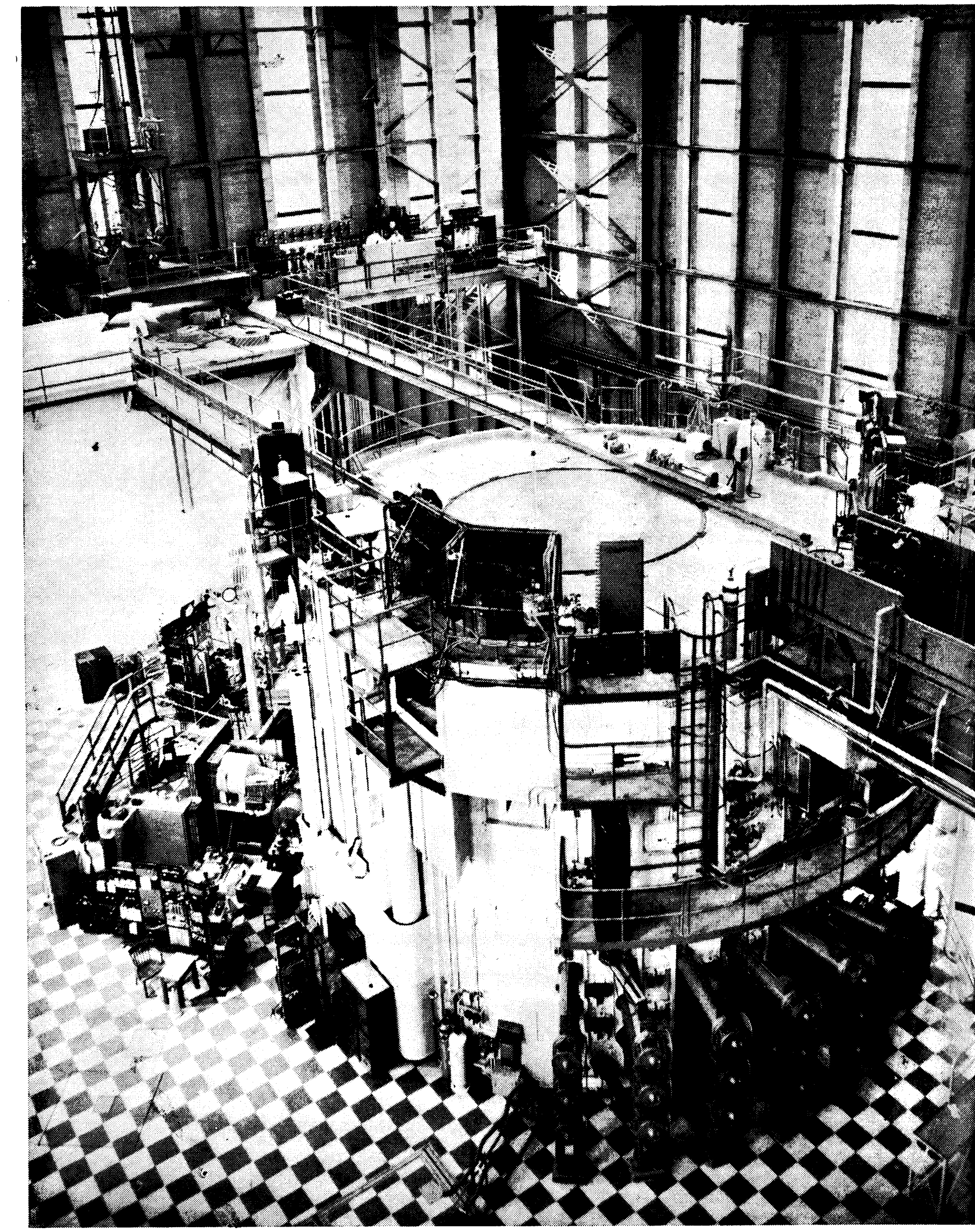
Figures absent from specification will be published when available.



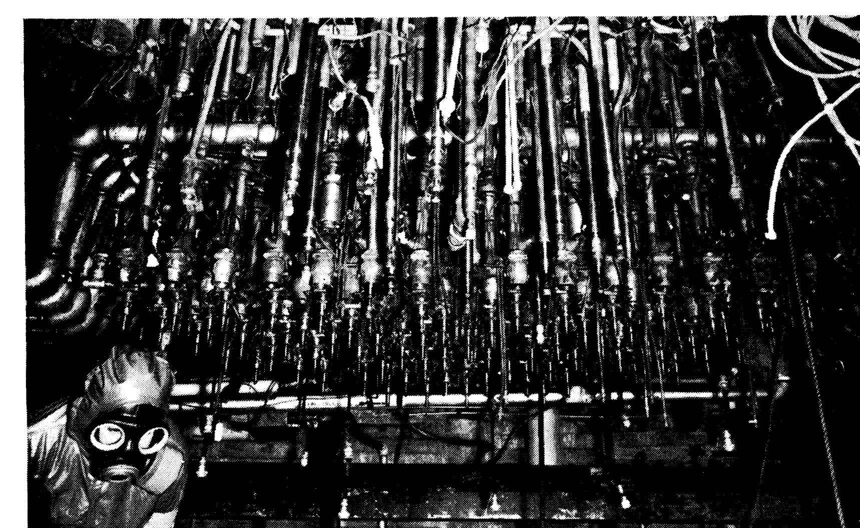
View of the top of the reactor immediately below the rotating shield, showing cooling connections to the fuel rods—cooling water ring header in foreground.



Above—Looking down on the top cover plate of the calandria showing the hexagonal lattice of fuel element tubes and the central experimental hole. Shut-off and control rods occupy vacant fuel channels. Details of cooling and scavenging are not yet available.



General view of NRX. The rod emerging from the top shield is an extension of the single control rod. In the right foreground can be seen a bank of self-serve mechanisms for sample irradiation and top left the lead flask in position over the storage block.



Right—Lower ends of fuel rod assemblies and shut off rods. This photograph was taken during the reconstructional operations following the power surge on December 12, 1952—hence mask and protective clothing.