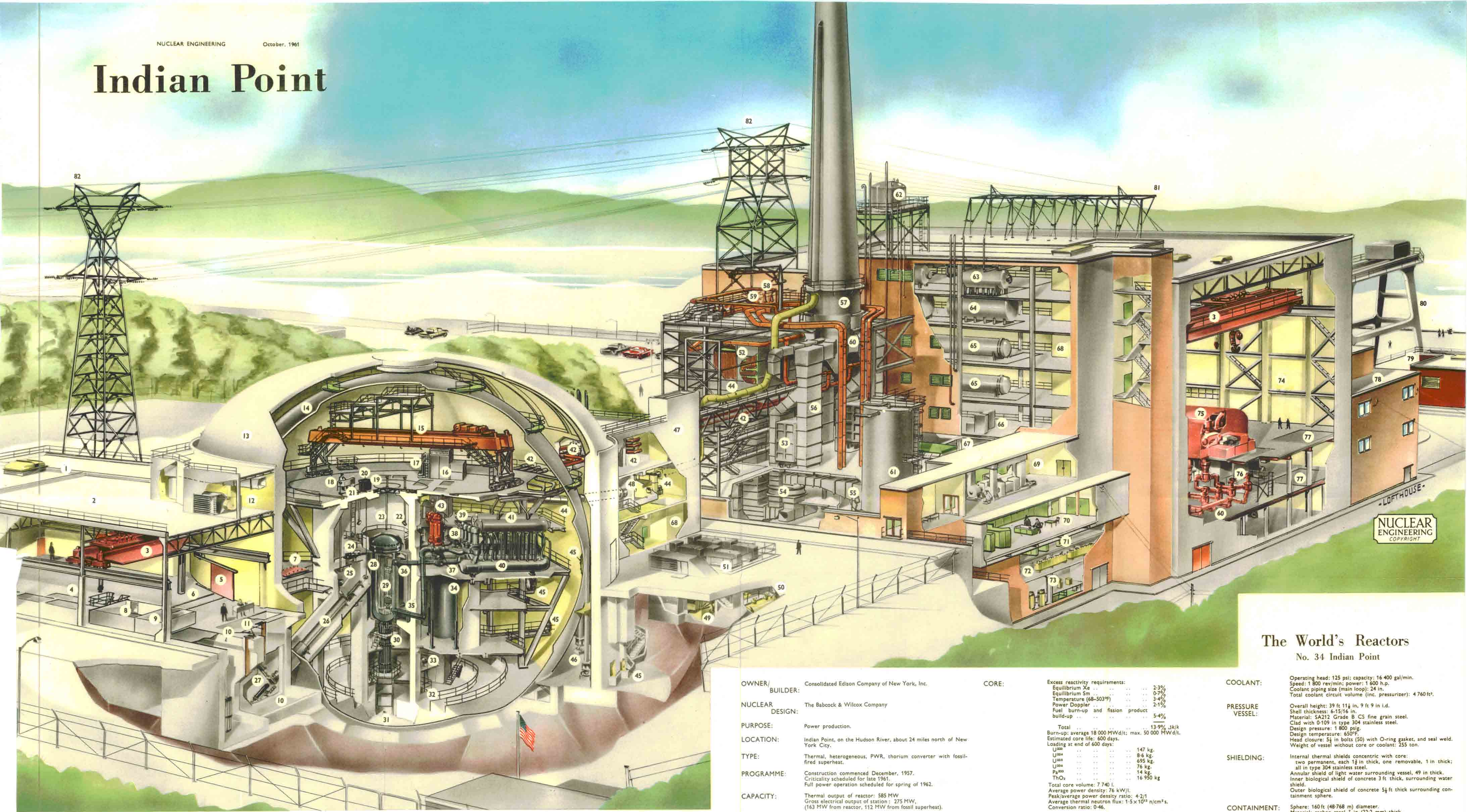


Indian Point



NUCLEAR ENGINEERING
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The World's Reactors No. 34 Indian Point

KEY

- INDIAN POINT**
- Chemical systems building.
 - Fuel handling building.
 - Overhead travelling cranes.
 - Equipment hatches.
 - Equipment removal shield door.
 - Equipment removal rails.
 - Equipment removal trolley.
 - Decontamination wash pit.
 - Decontamination room.
 - Fuel transfer pools.
 - Water gates.
 - Sphere ventilation supply room.
 - External radiation shield.
 - Containment sphere.
 - Polar crane.
 - Elevator.
 - Reactor tool shaft storage.
 - Refuelling console (normally unattended).

- Rotating shield plugs.
- Refuelling shuttle hoist.
- Storage pit hatch cover.
- TV cameras (3).
- Fuel transfer manipulator.
- Transfer tube upper valve.
- Storage pit.
- Transfer tube.
- Transfer tube lower valve and shuttle.
- Reactor vessel.
- Reactor core.
- Control rod drives.
- Reactor pit.
- Sump.
- Sump pump.
- Blowdown tanks (2).
- Reactor inlet.
- Reactor outlet.
- Gate valves.
- Check valves.
- Pumps.

- Steam generators.
- Deaerators.
- Main steam to superheaters.
- Pressurizer.
- Sphere vent to stack.
- Equipment and personnel locks.
- Sphere supports.
- Nuclear service building.
- Sphere vent plenum chamber.
- Service building ventilation room.
- H₂SO₄ storage tanks.
- Transformer yard.
- Oil fired superheaters (2).
- Economizers (2).
- Airheaters (2).
- Blowers (2).
- Flues to stack (2).
- Stack.
- 10-ton jib crane.
- Controlled start piping.
- Superheated steam to turbines.
- Condensate storage tanks (3).

- Service water tank.
- Deaerators.
- Deaerator storage tanks.
- Evaporators.
- Boiler feed pump substations.
- Boiler feed pump room.
- Elevators.
- Ventilation equipment room.
- Central control room.
- Terminal board room.
- Battery room.
- Water treatment rooms.
- Turbine hall.
- Economizers (2).
- Main steam stop valves.
- Loading well covers.
- Administration block.
- Screenwell house.
- Gantry crane.
- Take-off tower.
- Transmission towers.

OWNER/ BUILDER: Consolidated Edison Company of New York, Inc.

NUCLEAR DESIGN: The Babcock & Wilcox Company

PURPOSE: Power production.

LOCATION: Indian Point, on the Hudson River, about 24 miles north of New York City.

TYPE: Thermal, heterogeneous, PWR, thorium converter with fossil-fired superheat.

PROGRAMME: Construction commenced December, 1957. Criticality scheduled for late 1961. Full power operation scheduled for spring of 1962.

CAPACITY: Thermal output of reactor: 585 MW. Gross electrical output of station: 275 MW. (163 MW from reactor, 112 MW from fossil superheat).

FUEL: Enriched uranium oxide (U²³⁵) and U²³⁸ converted from ThO₂. Initial loading: 1100 kg U²³⁵ (1 185 kg U), 17 200 kg ThO₂. Fuel pellets: 0.26 in (6.6 mm) dia. x 0.8 in (20.3 mm) long. Cladding: boron-modified type 304 stainless steel tube. Rod, o.d.: 0.304 in (7.72 mm). Fuel element comprises: 195 rods at 0.374 in (9.3 mm) square pitch forming a square bundle of 14x14 rods, with one corner rod omitted. Bundle encased in 0.155 in (3.94 mm) Zircaloy-2. Element dimensions: 5.711 in (145 mm) square. Active length: 98.5 in (2.5 m). Max. cladding surface temp: 319°C. Max. fuel temp.: 1 927°C. Heat transfer area: 15 600 ft². Mean heat flux: 128 000 Btu/ft²h. Max. heat flux: 533 000 Btu/ft²h.

CORE: Approximate cylinder: 6 ft 6 in (1.981 m) equiv. dia. x 8 ft 3 in (2.515 m) high. No. of fuel elements: 120. Square lattice: pitch 6.32 in (160.5 mm) arranged in three concentric zones of 32, 44, 44 elements. Zone loading: 6.75, 8.79 and 11.3 kg U²³⁵/element respectively. k_{eff}: 1.2. Ref: 1-14.

CONTROL: Cruciform hafnium rods, fixed boron steel shim rods, burnable poison in fuel element cans, and soluble poison in coolant (under cold shut-down conditions). No. of hafnium rods: 21. Dimensions: 10 in square x 0.3 in thick. Total worth (d/k_{eff}) at various temperatures:

68°F	11.2%
450°F	13.6%
503°F	14%

Initial worth of boron (200-225 ppm) in cladding: 2.1% to -2.4%. Soluble poison worth at 68°F: 2.8%. Control rods operated by electro-hydraulic mechanisms from beneath the reactor.

COOLANT: Pressurized light water. Operating pressure: 1 485 psig. Inlet temperature: 486.5°F (252°C). Outlet temperature: 519°F (270.8°C). Total flow through reactor: 52.8 x 10⁶ lb/h. Coolant velocity inside elements: 21.5 ft/s. Number of coolant loops: 4. No. of pumps: 8. Type: vertical centrifugal, canned rotor.

EXCESS REACTIVITY REQUIREMENTS:

Equilibrium Xe	2.3%
Equilibrium Sm	0.7%
Temperature (68-503°F)	3.4%
Power Doppler	2.1%
Fuel burn-up and fission product build-up	5.4%
Total	13.9% (k/k)

Burn-up: average 18 000 MWd/t; max. 50 000 MWd/t. Estimated core life: 600 days. Loading at end of 600 days:

U ²³⁵	147 kg
U ²³⁸	8.6 kg
U ²³⁵	695 kg
U ²³⁸	76 kg
Pa ²³³	14 kg
ThO ₂	16 950 kg

Total core volume: 7 740 l. Average power density: 76 kW/l. Peak/average power density ratio: 4.2/1. Average thermal neutron flux: 1.5 x 10¹⁶ n/cm²s. Conversion ratio: 0.46.

COOLANT: Operating head: 125 psi; capacity: 16 400 gal/min. Speed: 1 800 rev/min; power: 1 600 h.p. Coolant piping size (main loop): 24 in. Total coolant circuit volume (inc. pressurizer): 4 760 ft³.

PRESSURE VESSEL: Overall height: 39 ft 11 1/2 in, 9 ft 9 in i.d. Shell thickness: 6-15/16 in. Material: SA212 Grade B CS fine grain steel. Clad with 0.109 in type 304 stainless steel. Design pressure: 1 800 psig. Design temperature: 650°F. Head closure: 5 1/2 in bolts (50) with O-ring gasket, and seal weld. Weight of vessel without core or coolant: 255 ton.

SHIELDING: Internal thermal shields concentric with core: two permanent, each 1 1/2 in thick, one removable, 1 in thick; all in type 304 stainless steel. Annular shield of light water surrounding vessel, 49 in thick. Inner biological shield of concrete 3 ft thick, surrounding water shield. Outer biological shield of concrete 5 1/2 ft thick surrounding containment sphere.

CONTAINMENT: Sphere: 160 ft (48.768 m) diameter. Material: carbon steel 3/4 in (22.2 mm) thick. Design max. internal pressure: 25 psig. Design max. external/internal differential pressure: 1 psi.

STEAM PLANT: No. of boilers: 4, shell and tube type, with separate steam drum. No. of tubes: 811 1 in o.d. x 0.062 in thick, type 304 s.s. Heat transfer area: 13 773 ft² per boiler. Design pressure: 1 800 psi (primary). Design temperature: 650°F (343.3°C). Design steam flow: 550 000 lb/h. Steam conditions: 405 psi, saturated (449°F) (231.5°C). Feed temperature: 330°F (165.6°C). Superheaters: two, oil-fired type. Steam conditions at t.s.v.: 370 psia, 1 000°F (537.8°C). Turbine: 1 800 rev/min tandem compound, double-flow h.p. cylinder, twin double-flow l.p. cylinders, rated 275 MW at rated steam conditions and 1 inHg condenser pressure. Condenser: 212 000 ft², capable of acting as dump condenser for up to 15% full load, by means of turbine by-pass, reducing valve, and desuperheater.