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A BRIEF HISTORY OF NUCLEAR AT ARGONNE NATIONAL LABORATORY

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U.S. DEPARTMENT OF ENERGY
Argonne National Laboratory is a U.S. Department of Energy laboratory managed by UChicago Argonne, LLC.

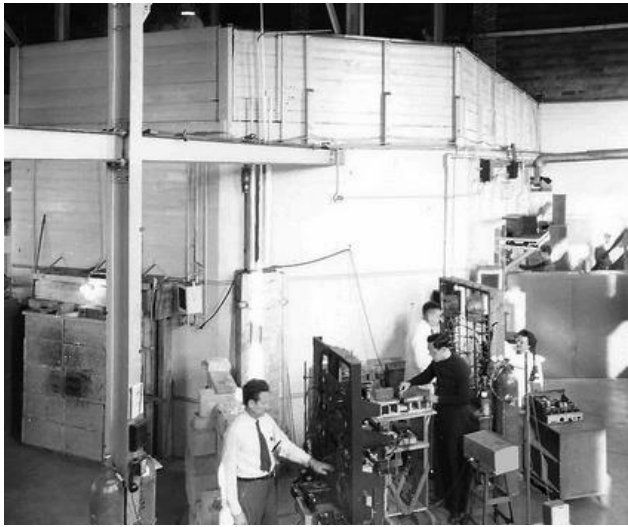
Argonne NATIONAL LABORATORY

BIRTHPLACE OF NUCLEAR ENERGY

- Argonne's heritage dates back to Enrico Fermi and the first controlled chain reaction (CP-1)
- Needed to prove that neutrons could sustain a chain reaction to assist in plutonium production for weapons
- CP-1 went critical on December 2, 1942 under Stagg Field at UChicago
- CP-1 led to other reactors in the Manhattan Project

SITE A: 1943 - 1946

- February 1943: CP-1 dismantled and moved to a forest preserve location (Argonne Woods) near Palos Park, about 5 miles from Argonne's present location.
- Called Argonne Laboratory, Fermi was first director.
  - Originally intended as the location to build CP-1.
- CP-1 expanded and renamed CP-2.
- Built CP-3: First (heavy) water-cooled reactor – eventually led to the CANDU design



CHANGES IN 1945 WITH POST-WAR TRANSITION

Attitudes and priorities

ATTITUDES

General Leslie Groves: Win the war; post-war considerations are not in the Army's purview.

Arthur Holly Compton: The nation's long-range welfare depends on establishing scientific leadership in nuclear energy, by doing the maximum amount of basic research as soon as possible.

PRIORITIES

- During the war, time is of the essence, money is no object.
- After the war, money is important, time can wait (at least a little). Cut inefficient production processes and excess production
- What to do with the Manhattan Project facilities, properties, material and staff – and yet leave enough program for national security.

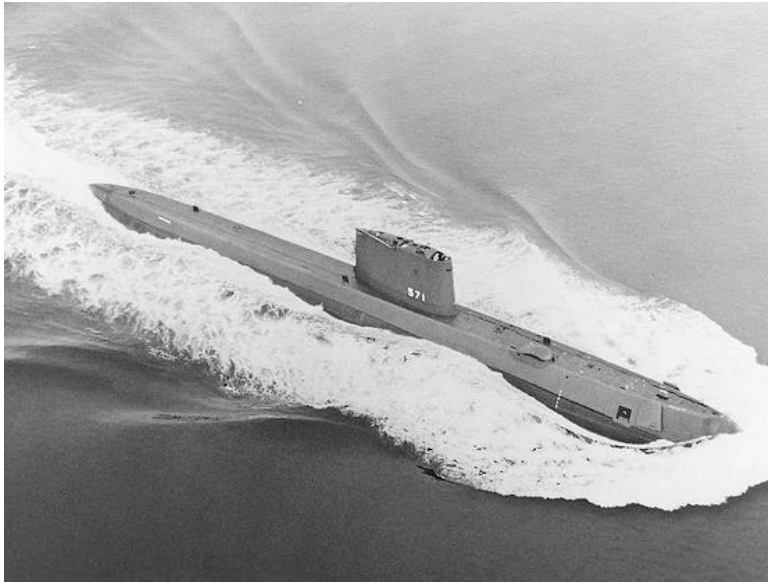
ESTABLISHING A NATIONAL LAB

- ***April 1946:*** Argonne National Laboratory is established for the "cooperative research in nucleonics", but has no director or location
- ***June 1946:*** Walter Zinn is named director of Argonne National Laboratory. It subsumes the Met Lab. Some work is at Site A, some is at UChicago, some administrative offices at MSI
- ***February 1947:*** Press release sent out about potential DuPage County site (Site D), Argonne's current site. Army acquisition of land begins.
- ***September 1948:*** First Argonne staff move to Site D.
- ***August 1949:*** Argonne-West is established at the National Reactor Testing Station
- ***1955:*** All work is now at the modern site (Site D) or in Idaho

PRESSURIZED WATER REACTORS

Working with Westinghouse for the US Navy

- Started developing PWR systems in 1948
- USS Nautilus: First nuclear-powered submarine, commissioned in 1954
- Shippingport (commercial reactor) went critical December 2, 1957

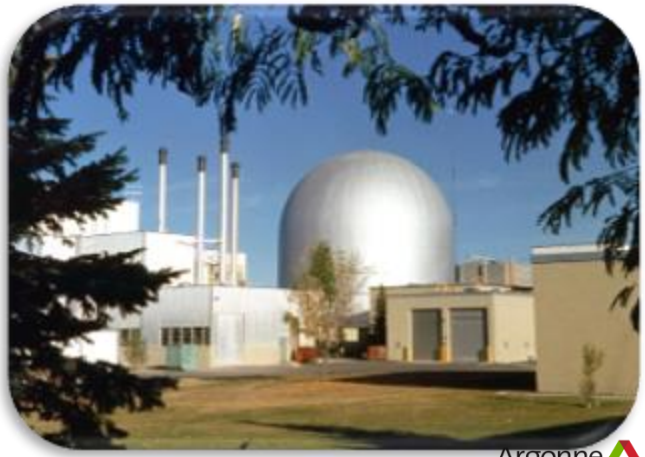


BOILING WATER REACTORS

- 1952: Suggestion to let the water boil the core
- 1953: BORAX reactor experiments begin in Idaho (5 reactors in total)
  - 1955: BORAX-3 powered the town of Arco, ID (2 MW), first nuclear-powered city in the world
- 1957: EBWR prototype at Argonne
- 1960: Dresden-1 (commercial reactor) goes critical

FAST REACTORS

- EBR-1 (CP-4, ZIP): Arco, Idaho 1951-
  - — Sodium-potassium-cooled fast-spectrum reactor, ~1.5 MWth
  - — Lit 4 light bulbs – first useable electricity from a nuclear reactor
- EBR-2: Idaho, 1964-1994
  - — Sodium-cooled fast-spectrum reactor, ~20 MWe
  - — Demonstrated a closed fuel cycle – led to development of pyroprocessing
  - — 1984-86, Performed passive safety tests, finished in April 1986
- Developed ARC codes for fast reactor analysis



INTEGRAL FAST REACTOR

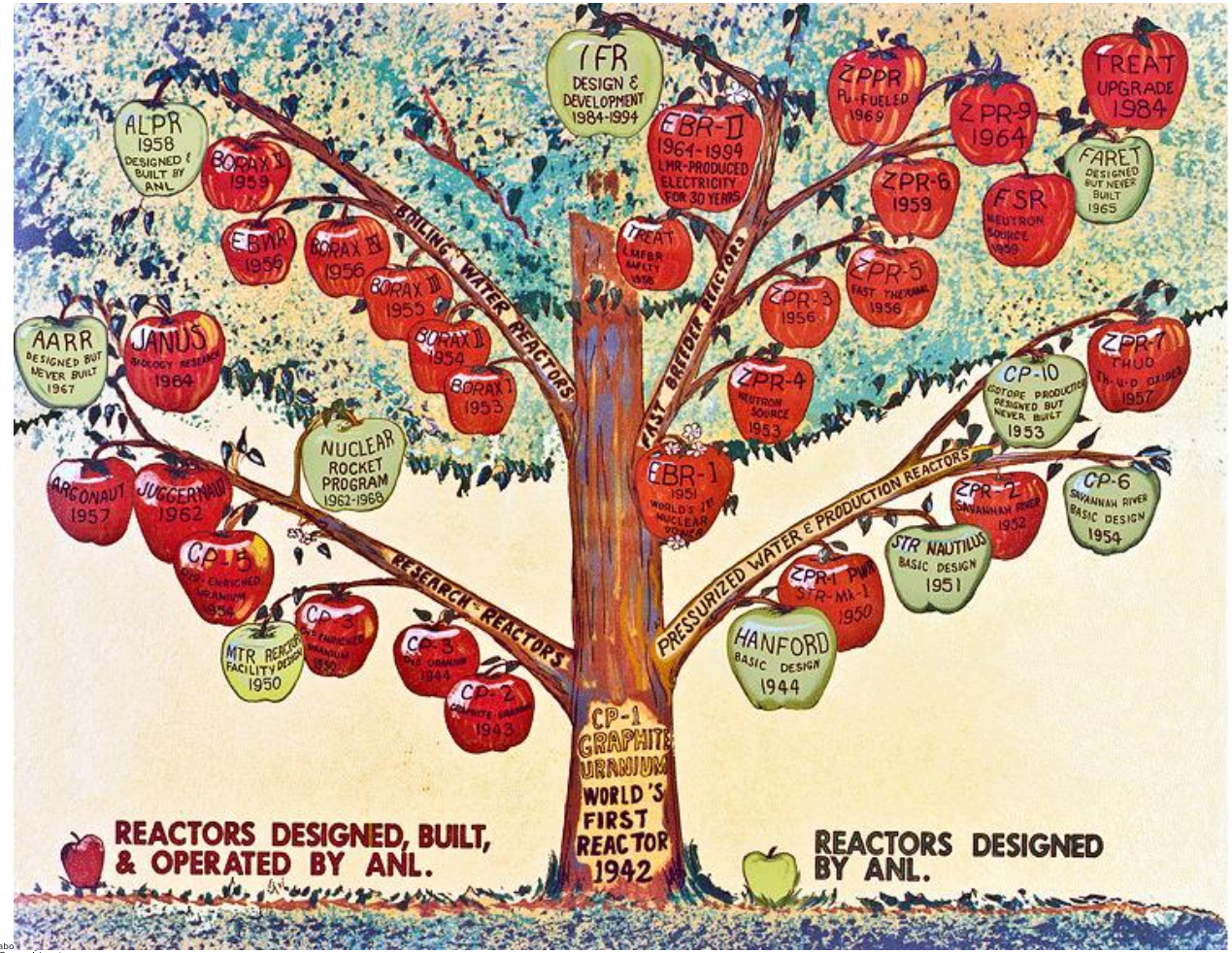
- EBR-2 is the primary prototype for the IFR: Inherently passively safe, pool-type, metallic-fueled SFR
  - — Modified the EBR-2 facility in 1984
- Have a self-sustaining fuel cycle – irradiate fuel in a reactor (i.e., EBR-2), reprocess the fuel, fabricate actinides into fresh fuel, refuel the reactor
- Used EBR-2 to develop high-burnup metallic fuel
- Read more: Plentiful Energy by Charles Till and Yoon Chang

EDUCATION AND TRAINING

- CP-5 (operational in 1954): Started with materials research, transitioned to training operators for Dresden-1
- International School of Nuclear Science and Engineering (Argonne-East)
  - Established in 1955 to help fulfill Eisenhower's Atoms for Peace Vision (1953)
- 1957-1972: Argonaut reactor – a training reactor used to teach students from around the Midwest and around the world
  - Updated to the Juggernaut reactor in 1962 after the 1958 Geneva Peaceful Uses of Atomic Energy Conference

BIOLOGICAL RESEARCH

- 1957: A fuel imaging system Argonne was developing accidentally turned into the first ultrasound for imaging the human body
- JANUS (1964): First reactor commissioned for biological research
  - Could irradiate biological specimens to study biological and genetic effects of acute and chronic neutron exposure.


IFR
DESIGN & DEVELOPMENT 1984-1994
ALPR 1958 DESIGNED & BUILT BY ANL
BORAX V 1959
EBWR 1956
BORAX IV 1956
BORAX III 1955
BORAX II 1954
BORAX I 1953
BOILING WATER REACTORS
AARR DESIGNED BUT NEVER BUILT 1967
JANUS BIOLOGY RESEARCH 1964
NUCLEAR ROCKET PROGRAM 1962-1968
ARGONAUT 1957
JUGGERNAUT 1962
CP-5 1954
MTR REACTOR FACILITY DESIGN 1950
CP-3 1944
CP-5 1944
CP-2 1943
RESEARCH REACTORS
EBR-II 1964-1994 LMR-PRODUCED ELECTRICITY FOR 30 YEARS
TREAT (LMFBR SAFETY) 1958
ZPR-3 1956
ZPR-4 NEUTRON SOURCE 1953
EBR-1 1951 WORLD'S 1ST NUCLEAR POWER
FAST BREEDER REACTORS
ZPPR Pu-FUELED 1969
ZPR-9 1964
TREAT UPGRADE 1984
FARET DESIGNED BUT NEVER BUILT 1965
ZPR-6 1959
FSR NEUTRON SOURCE 1959
ZPR-5 FAST THERMAL 1956
CP-10 ISOTOPE PRODUCTION DESIGNED BUT NEVER BUILT 1953
ZPR-7 THOR Th-U-D OXIDE 1957
PRESSURIZED WATER & PRODUCTION REACTORS
ZPR-2 SAVANNAH RIVER 1952
CP-6 SAVANNAH RIVER BASIC DESIGN 1954
STR NAUTILUS BASIC DESIGN 1951
ZPR-1 PWR STR-MK-1 1950
HANFORD BASIC DESIGN 1944
CP-1 GRAPHITE URANIUM WORLD'S FIRST REACTOR 1942
REACTORS DESIGNED, BUILT, & OPERATED BY ANL.
REACTORS DESIGNED BY ANL.

MODERN DAY WORK

Continuing with our expertise of reactor designs

- Applying fast reactor experience to current commercialization and research efforts
  - Natrium (TerraPower)
  - Aurora (Oklo)
  - SFR metal fuel design (JAEA)
- Reactor conversions – reduce proliferation risk of HEU-fueled research reactors
- Fuel cycle technology
  - Better sensors and proliferation resistance for pyroprocessing
  - Helping companies explore how they can commercialize the technology
- Component and thermal hydraulics testing for advanced reactor designs – METL and NSTF
- Maintaining software for fast reactor analysis – ARC/PyARC
- Materials research with APS, IVEM, ATLAS, etc.

TIMELINE SUMMARY

- 1932: Chadwick discovers the neutron
- 1942: CP-1 goes critical
- 1946: Argonne National Laboratory established
- 1951: EBR 1 powers 4 light bulbs
- 1954: Atoms for Peace Speech, Atomic Energy Act
- 1964: EBR 2 becomes operational
- 1975: AEC splits into the DOE and NRC
- 1984-1986: EBR-2 passive safety tests
- 1994: EBR 2 is decommissioned
- 1995: First light at APS
- 2005: ANL-West merges with INEEL to form Idaho National Laboratory
- 2024: Aurora is commissioned