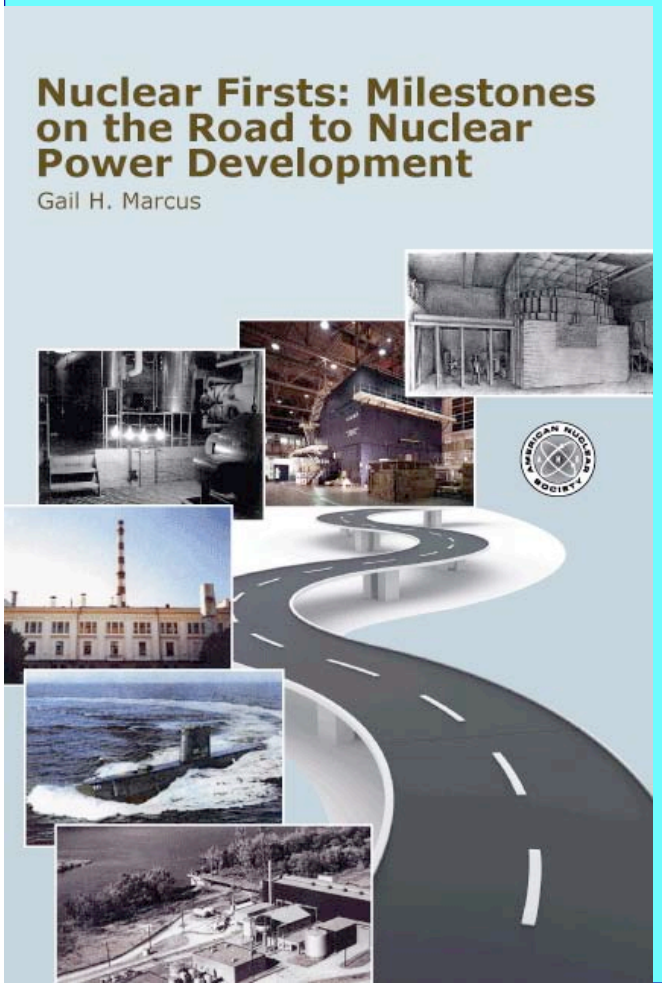
NUCLEAR FIRSTS: MILESTONES ON THE ROAD TO NUCLEAR POWER DEVELOPMENT



Gail H. Marcus, Sc. D.

Past President, ANS (2001-2)

Past Chair, ANS DC Section (1992-3)

American Nuclear Society DC Section

Rockville, MD

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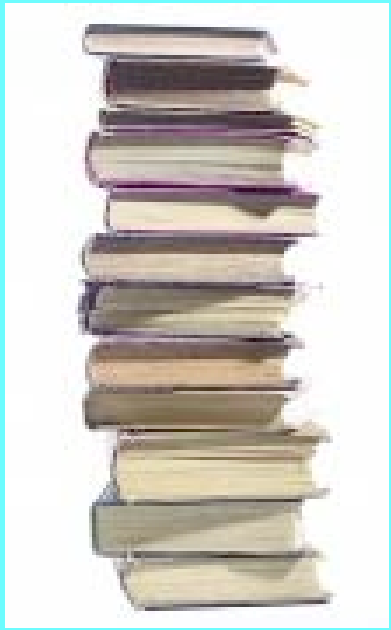
What Inspired this Book

- **Conferences commemorating 50th anniversaries of key events in nuclear history (examples):**
  - **1989, Leningrad, 50th anniversary of nuclear fission (discovery)**
  - **1989, Washington, DC, ANS, 50th anniversary of fission**
  - **1992, Chicago, ANS, 50th anniversary of first controlled fission**
  - **2001, Reno, ANS, 50th anniversary of first nuclear electricity**
  - **2004, Pittsburgh, ANS, 50th anniversary of founding of ANS**
  - **2004, Obninsk, IAEA, 50th anniversary of nuclear power**
- **Numerous articles (NN and elsewhere) commemorating major anniversaries**

Rationale for Book

- **Why another nuclear history book?**
  (there are already many)
- **Why focus on "firsts"?**
  (versus biggest, oldest operating, longest continuous run, etc.)
- **Why me?**
  (there are others who actually made the history)

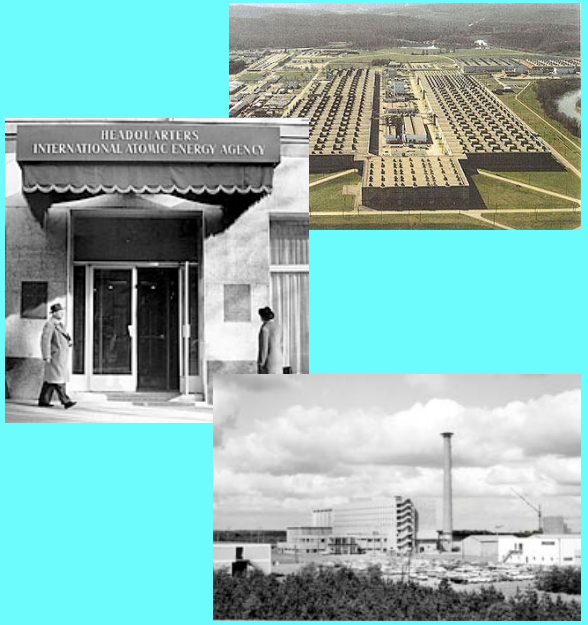


What's a "First"?

- Each *major* design concept (reactors and fuel cycle), fuel type, coolant type, application, institutional infrastructure
- More followed--*or might follow*
- Widely identified as a first

- Associated with fission reactors and fuel cycle *(i.e., not weapons, accelerators, fusion, etc.)*
- Anywhere in world *(including regional firsts)*
- Must actually have operated

My Concept



- Timeline progression--milestones
- Focus on facts--dates, sizes, etc.
- Limited personal recollections

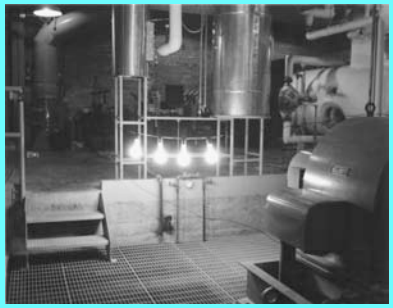
  (would be secondhand; I could not personally verify)
- Short summaries of facts, longer background
- Identification of "firsts" for all parts of fuel cycle
- Include non-power applications, institutions
- Not a history of weapons development
- Not the first of each incremental size, etc.
- Photographs--of what it looked like "then"

Classic Nuclear History Timeline

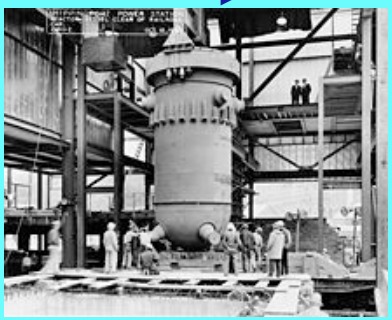
First controlled fission

First electricity on grid

1942 1951 1954/5 1957

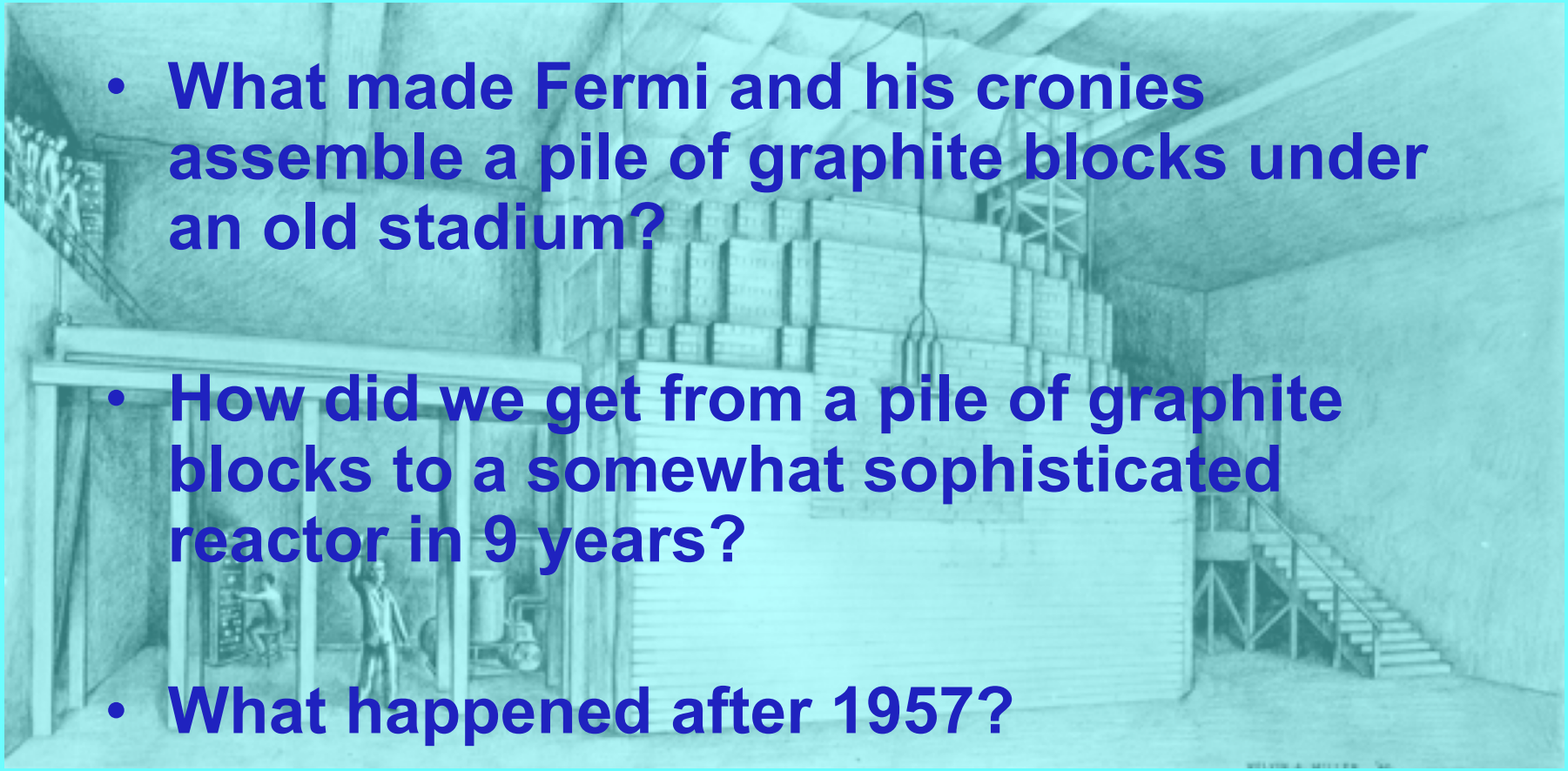


First electricity



First peaceful reactor

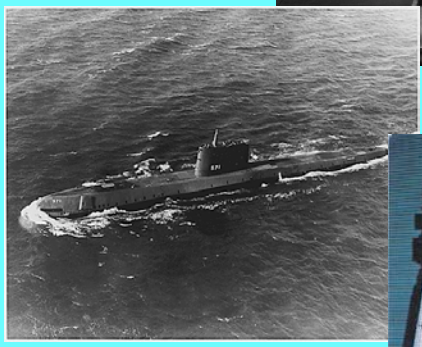
What's Missing from that History?



- What made Fermi and his cronies assemble a pile of graphite blocks under an old stadium?
- How did we get from a pile of graphite blocks to a somewhat sophisticated reactor in 9 years?
- What happened after 1957?

The Rest of the Story

- **Pre-1942**
  - Experiments and theoretical formulations
- **1942-1951**
  - 12 reactor firsts *(not all reactors!)*
  - Reprocessing and enrichment
  - Non-power applications (isotopes, neutron beam)
  - Organizations, educational activities
- **1952-1957**
  - 15 reactor firsts, use of thorium
  - Reprocessing and enrichment (centrifuge)
  - Propulsion (submarine)
  - Organizations (AIF, ANS, IAEA)
- **1957-Present**
  - 20 reactor firsts, use of U233, MOX
  - Rocket and satellite applications, ship propulsion
  - District heating and desalination applications
  - Repositories



Surprises and Puzzles

- First patents registered--1939!
- First electricity--1948!
- Absence of France in earliest reactor development
- First electricity on grid--USSR
- A first in our own DC backyard!
- Several power reactors before Shippingport
- Early entry of universities
- Number of accidents and incidents
- Involvement of Kings, Queens, and Presidents
- Number of countries and states with “firsts”

First Patents--May 1-4, 1939

"A device for energy production"

France
2 patent applications

- **Frederic Joliot-Curie**
- **Hans Holban**
- **Lew Kowarski**
- **Francis Perrin**

First Electricity--September 3, 1948

- **X-10 Graphite Reactor (Oak Ridge)**
- **1/3 Watt!**

Absence of France from Early Reactor Developments

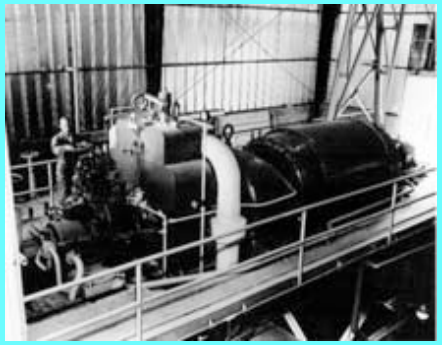
- **France figured heavily in early research:**
  - **Becquerel**
  - **Marie and Pierre Curie**
  - **Irene and Frederic Joliot-Curie**
  - **Halban, Perrin, Kowarski**

- **1940-1944**
  - **France Occupied**
- **France today**
  - **highest percent of electricity from nuclear power**
  - **second highest number of reactors**

First Electricity on Grid

- **AM-I Reactor, Obninsk, USSR**
  - **June 27, 1954**
  - **6 MWe**

- **BORAX-III Reactor, Arco, Idaho**
  - **July 17, 1955**
  - **2 MWe**
  - **First in US**
  - **First for 100% of power (but at midnight!)**



A Reactor in our Backyard--1957

- **Ft. Belvoir, Virginia--April 15, 1957**
- **First offsite electricity**

Power Reactors Before Shippingport

- **Calder Hall in UK (August 1956)**
  - 50 MWe
  - Production reactor
- **Four small reactors in US (~2-5MWe)**
  - EBWR, Argonne (December 1956)
  - SM-1, Ft. Belvoir (April 1957)
  - SRE, Santa Susana, CA (July 1957)
  - VBWR, Pleasanton, CA (October 1957)
    - AEC Operating License #1 (power reactor)

Early Educational Involvement

- Clinton Training School, Oak Ridge (1946)
- Pioneering Universities
  - First courses (1946)
  - First academic program (1950)
  - First degrees (1951, 52, 54)
  - First reactors (1953, 55)
  - First departments (1958)
  - First accreditation (1964)




Accidents and Incidents

- **Environmental contamination**

  Hanford reprocessing (1940s)
  NRX, Canada (December 22, 1952)
  Mayak plutonium production, USSR (1957)
  Windscale, UK (October 10, 1957)
  NRU, Canada (May 24, 1958)
  SRE, Santa Susana, California (July 13, 1959)
  Chernobyl, USSR (April 26, 1986)

- **Fatalities**

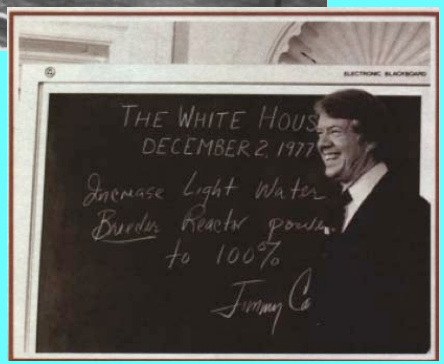
  Los Alamos, New Mexico (August 21, 1945)--criticality accident
  SL-1, Idaho (January 3, 1961)

- **Other**

  Fermi 1, Michigan (October 1966)
  TMI, Pennsylvania (March 28, 1979)

Kings, Queens and Presidents

- President Dwight D. Eisenhower (1954, 55, 58)
- Queen Elizabeth II (1956)
- King Olav V (1959)
- Pope John XXIII (1959)
- King Baudouin (1966)
- President Jimmy Carter (1977)



Countries with “Firsts”

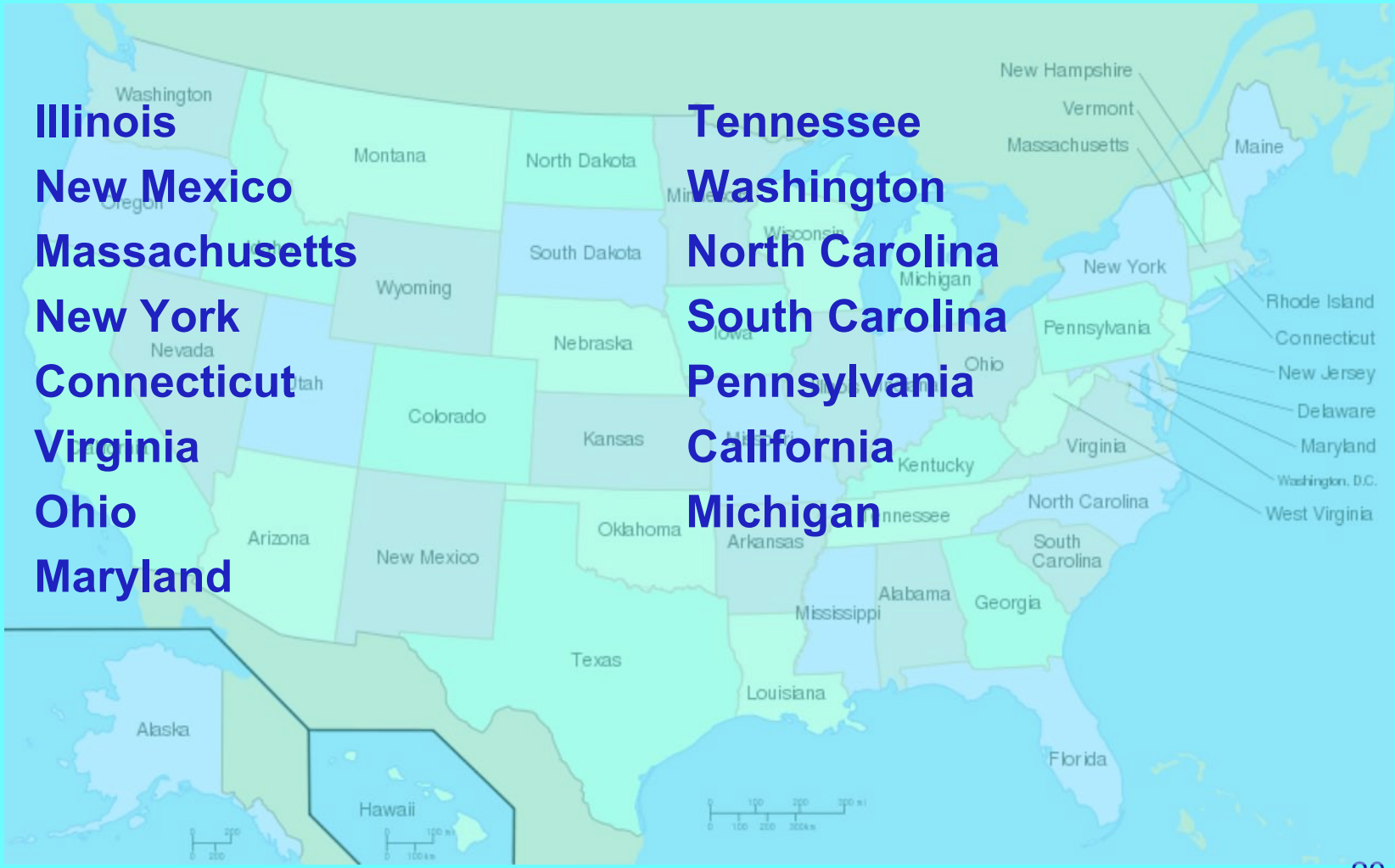
Research
France
Canada
Switzerland
England
Scotland
Italy
Germany
Denmark
Sweden
US

Other Researchers
Poland
New Zealand
Hungary
Serbia

Reactor-Related Development
US
Canada
France
USSR (Russia, Kazakhstan)
UK
Norway
Belgium
Italy
Sweden
Japan /(India)
Germany
Argentina/(Brazil)
South Africa/(Egypt)

Other locations
Panama Canal
Antarctica

US States with Firsts



Other Histories

- **To those interested in history, there are many fascinating stories that tell other parts of the story:**
  - **Early research, researchers**
  - **Manhattan project**
  - **Individual national laboratories**
  - **DOE history**
  - **NRC regulatory history**
  - **Army reactor program**
  - **Submarine program**
  - **Different country histories**
  - **ANS history**
  - **IAEA and NEA histories**
    - http://www.marcus-spectrum.com/NEAHist.pdf

Lessons Learned

- Much history is already lost
- The truth is often nuanced
- The “firsts” were not the only contributors to nuclear power development
- It’s unclear how many more firsts there may be in the future--
  the first candidates are projects currently underway

- “First” is not the only measure of success!
  - France
  - South Korea
  - China