

A photograph of a U.S. Navy nuclear-powered submarine, the USS George Eastman (SSN-764), sailing on the ocean surface. The submarine's conning tower is visible, with the number 764 painted on it. The ship is moving through the water, creating a white wake. The background is a vast, blue ocean under a clear sky.

# U.S. Naval Nuclear Powered Ship Inactivation, Disposal, and Recycling

Eastern Idaho PMI  
February 17, 2010

Kurt D. Hamman, (USN Ret.)

# PRESENTATION OVERVIEW

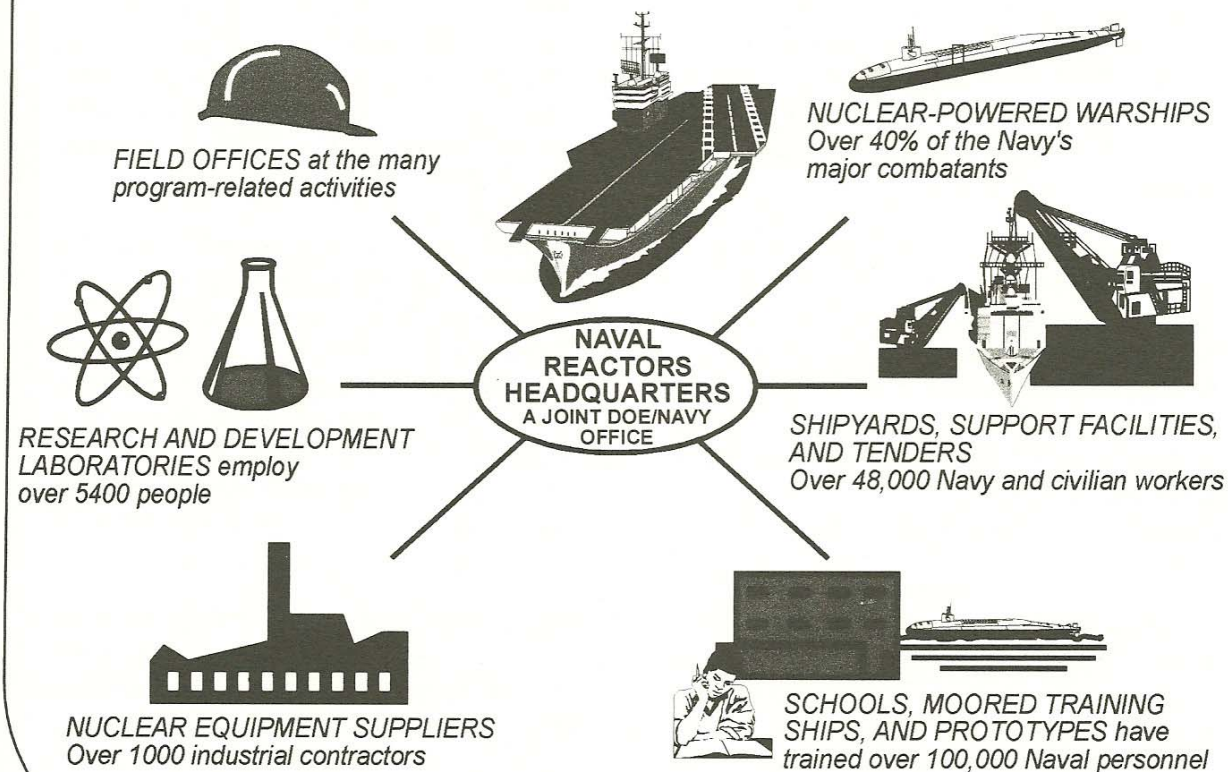
- **NR Organization**
  - **DON/NAVSEA**
  - **DOE/NNSA**
- **History Timeline**
- **Ship Life-Cycle**
  - **Design**
  - **Construction**
  - **Operation**
  - **Inactivation/Disposal/Recycling**
- **References**
- **Questions**



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## NAVAL NUCLEAR PROPULSION PROGRAM

Responsible for the design, development, operation, and disposal  
of Naval nuclear propulsion plants



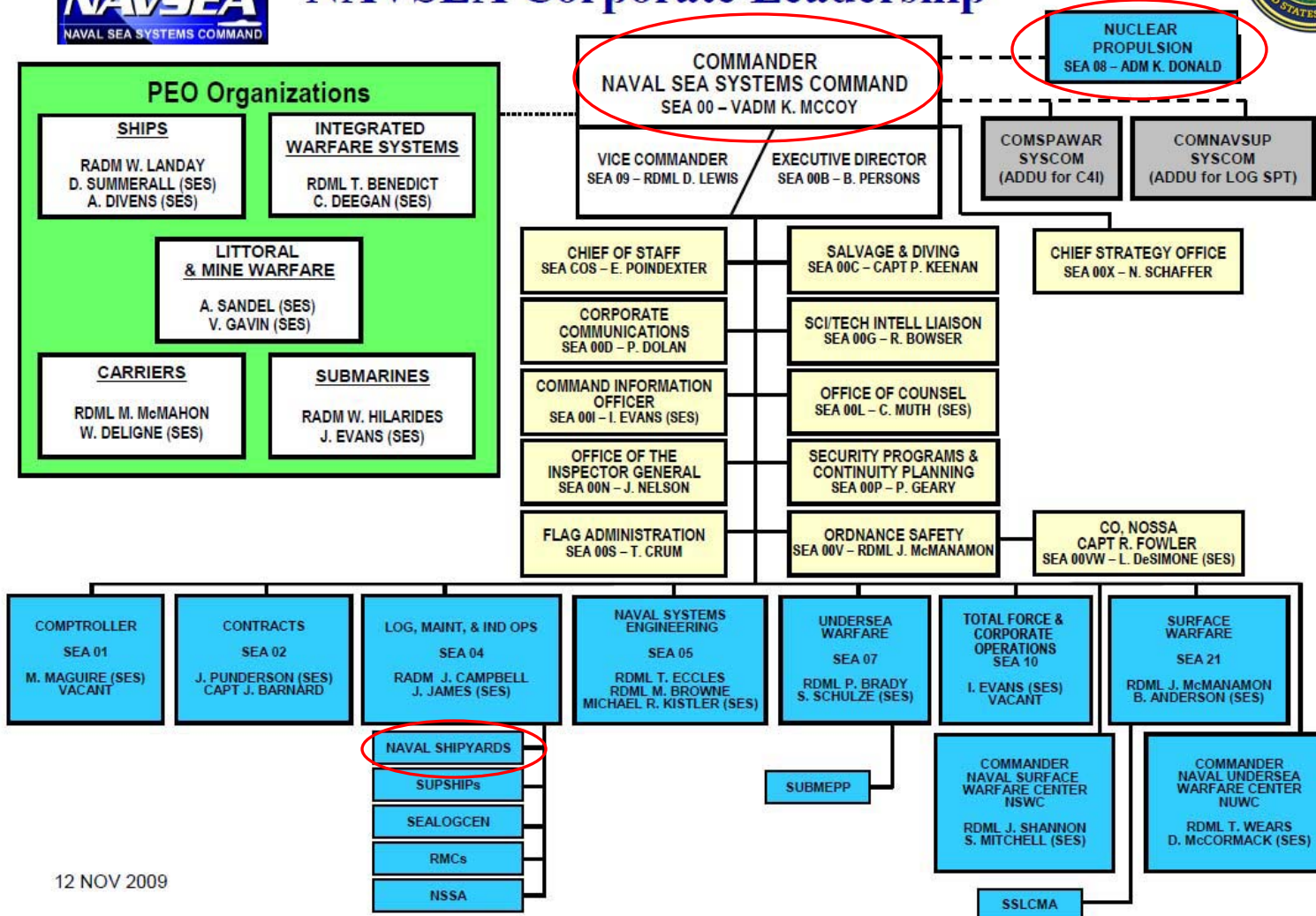
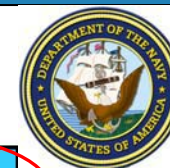
August 2000

*"There was no precedent for a program of such breadth. It was as if Henry Ford had created not only the automobile industry, but also oil refineries, gas stations, highways, motels, roadmaps and the AAA." - Theodore Rockwell, 1992.*





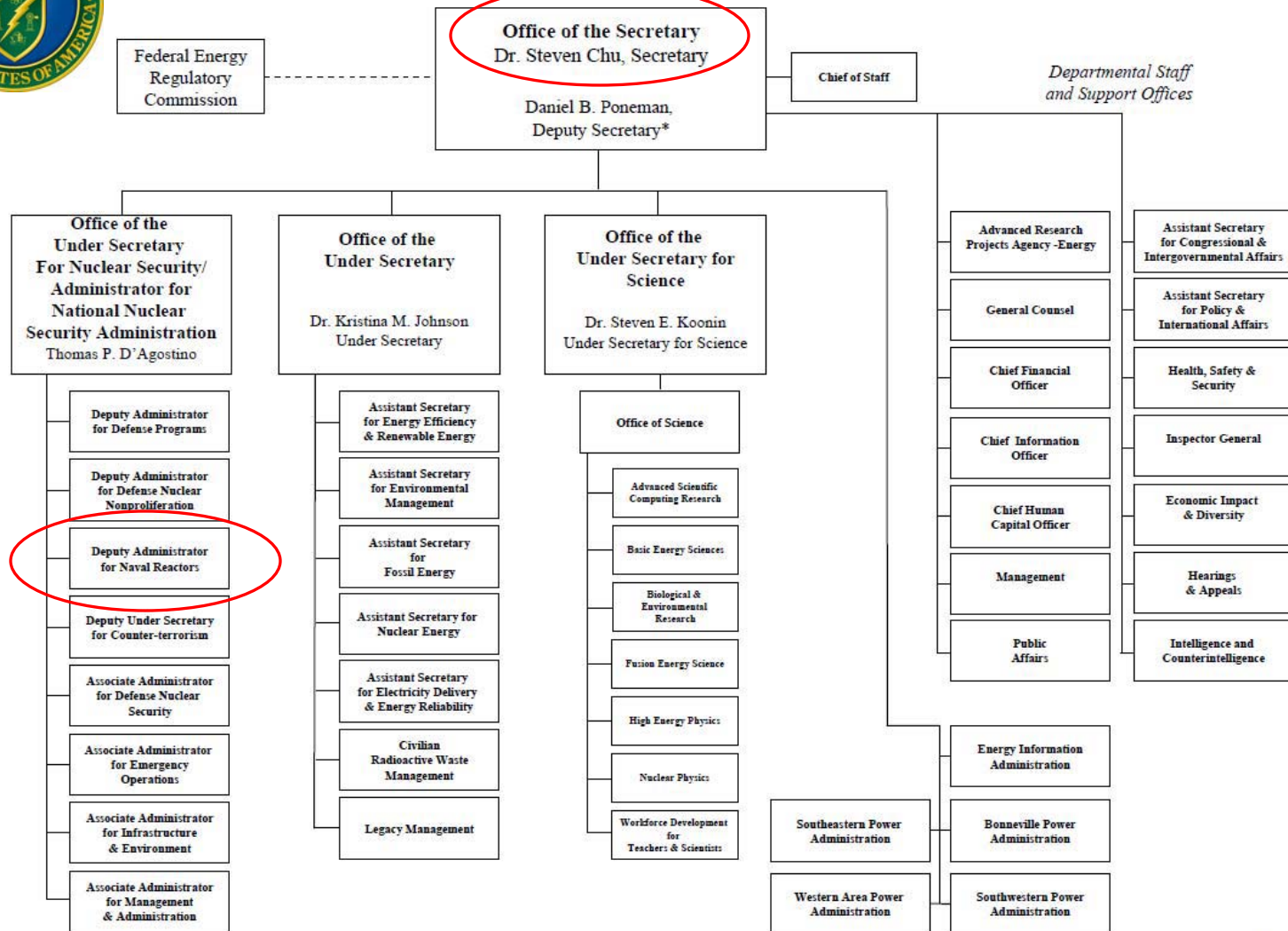
# (Department of the Navy) NAVSEA Corporate Leadership



12 NOV 2009



# DEPARTMENT OF ENERGY



\* The Deputy Secretary also serves as the Chief Operating Officer

26 May 09

# History Timeline

- **1955 – USS Nautilus (SSN-571) went to sea**
- **1970's – Initial planning for inactivation**
- **1980's – SSBNs decommissioning (SALT II)**
- **1984 – EIS (Pre-Los Angeles Class Submarines)**
- **1986 – First RC disposal complete**
- **1990 – Submarine recycling authorized**
- **1991 – First submarine recycling complete**
- **1996 – EIS (Cruiser, Ohio & Los Angeles Class)**
- **1997 – First Los Angeles Class RC disposal complete**
- **1999 – First CGN RC disposal and Recycling complete**
- **2007 – 109 Recycled, 115 defueled RC disposals complete, over 750 container shipments of Naval spent fuel.**

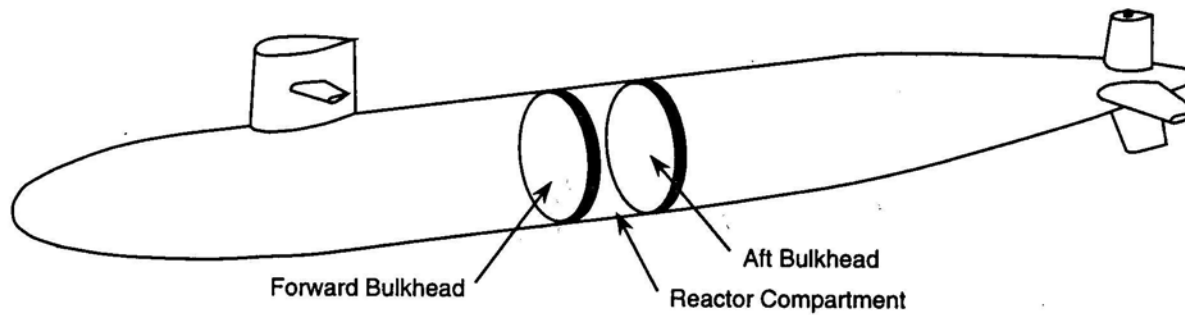
*( As of 2007, Program Operates 103 Reactors )*



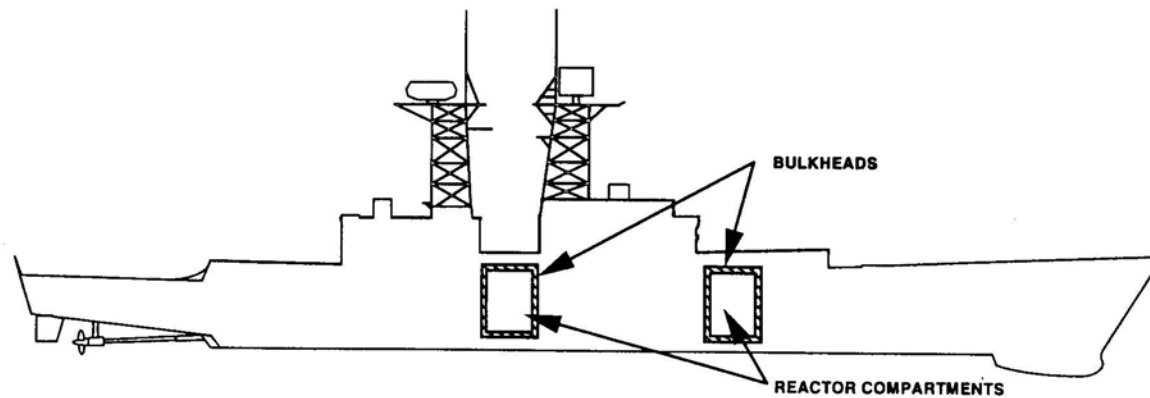
# SHIP LIFE-CYCLE



# DESIGN



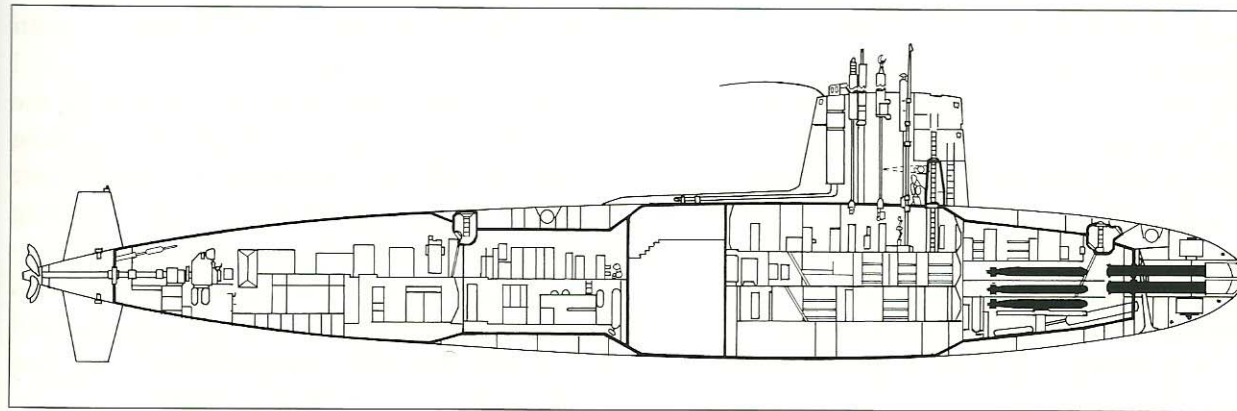
Typical Submarine with Reactor Compartment Location



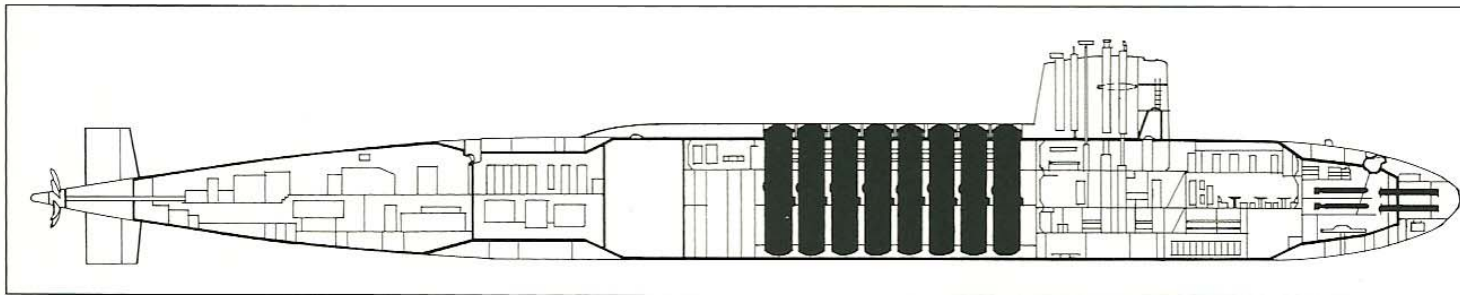
Typical Cruiser with Reactor Compartment Locations



# DESIGN



Skipjack (SSN 585). LOA 252 ft (76.83 m) (©A.D. Baker, III)



George Washington (SSBN 598). LOA 381 ft 8 in (116.36 m) (©A.D. Baker, III)

Source: Norman Polmar & K. J. Moore, "Cold War Submarines," 2004. 9

# DESIGN

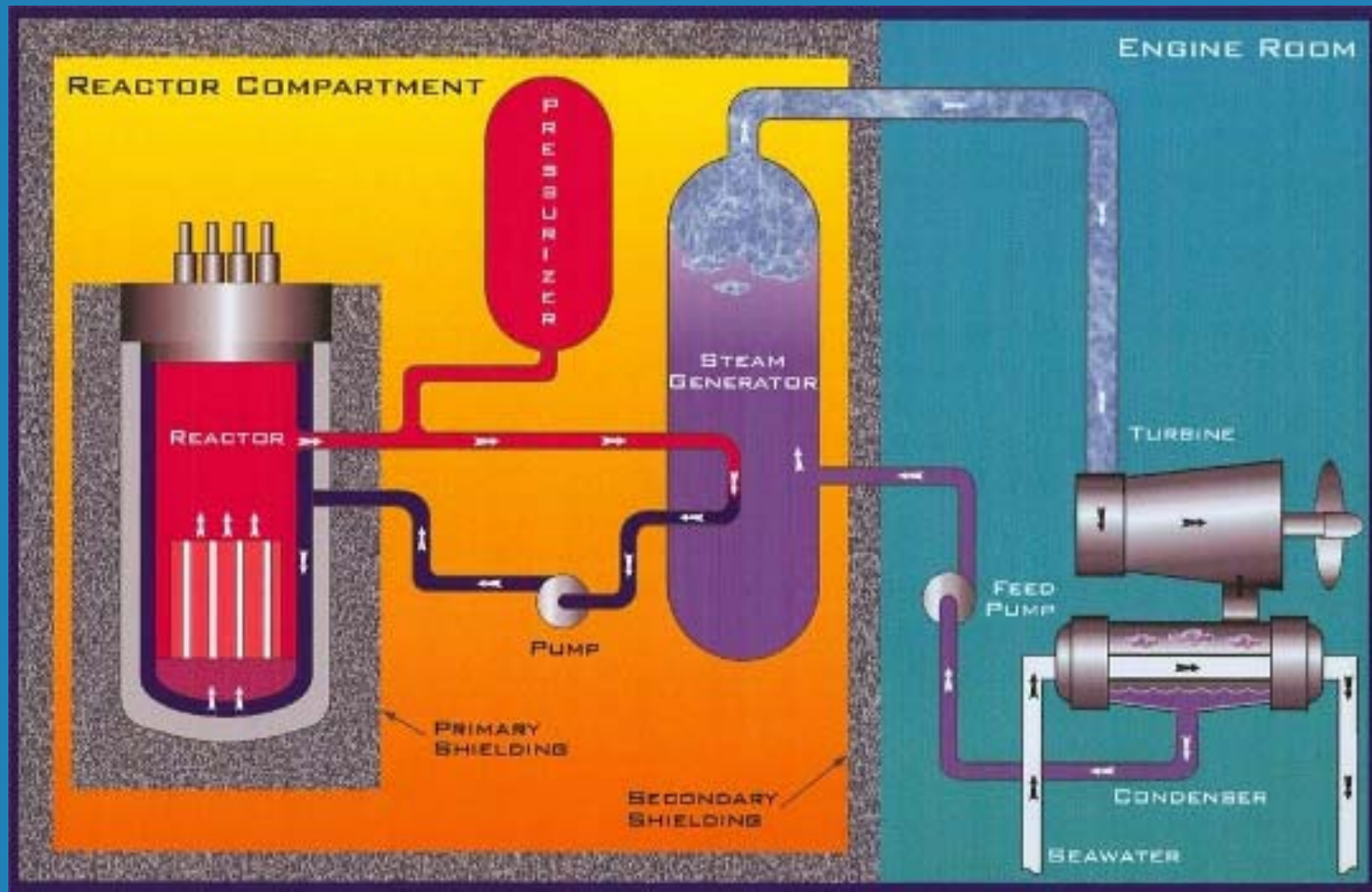


Diagram of a Typical Naval Nuclear Propulsion Plant



# CONSTRUCTION

( Newport News & Electric Boat )



Northrop Grumman Shipbuilding (Newport News) - VA  
General Dynamics Electric Boat - CT

Ingalls Shipbuilding - MS  
Bethlehem Steel (Quincy) – MA  
New York Shipbuilding - NJ

Portsmouth Naval Shipyard - MI  
Mare Island Naval Shipyard - CA



# OPERATION



USS BOISE (SSN 764)



# OPERATION



USS California CGN-36

# Inactivation/Disposal/Recycling Puget Sound Naval Shipyard

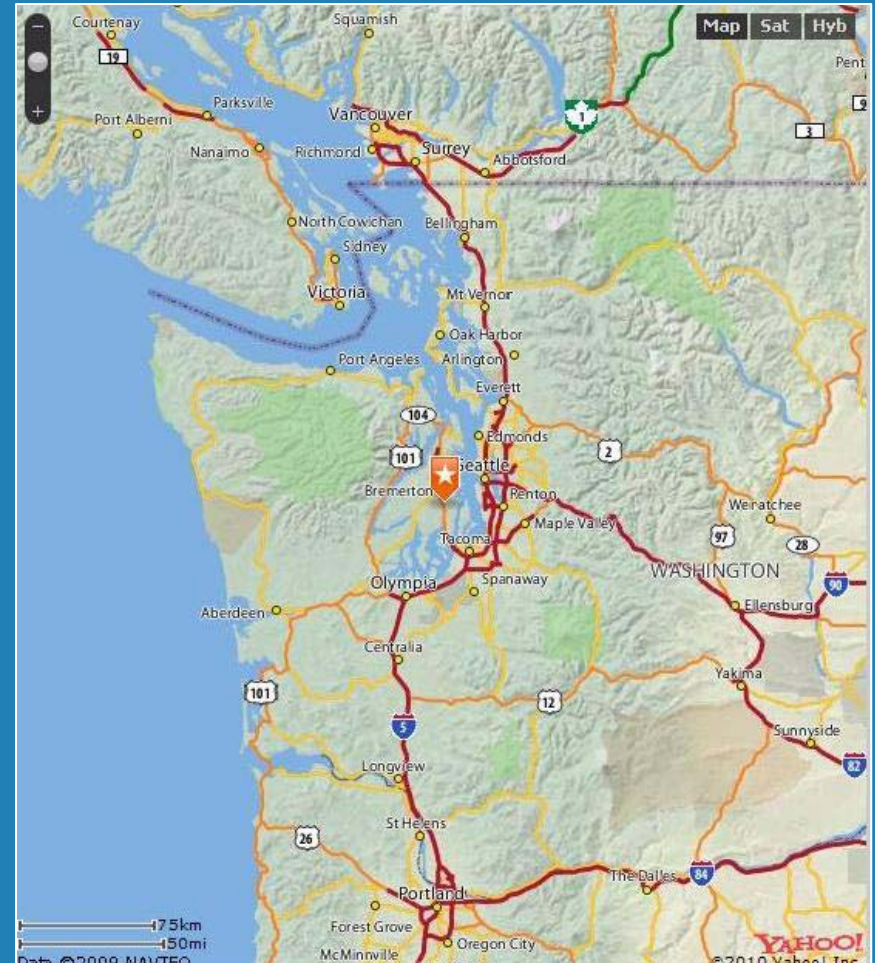




# Inactivation/Disposal/Recycling Puget Sound Naval Shipyard

## History

- **1891**
  - Bremerton, WA
- **WWI**
  - Built 36 ships, 6 submarines
- **WWII**
  - Repair battle-damaged ships
- **1965**
  - Nuclear Repair Facility
- **1980's**
  - RC Disposal
  - ~6% Workload involves inactivation/recycling
- **1987**
  - Homeport USS Nimitz
- **2003**
  - "PSNS & IMF"
  - Largest on the West Coast









# PLANNING FOR DISPOSAL

[ Began in the late 1970's ]

- **Organizations Involved**

- **Federal**

- DOE-RL, EPA, OSHA, USN Region NW, USCG, NCIS, USACE, NUWC

- **State**

- Washington State Department of Ecology, Washington State Department of Health (Division of Radiation Protection), Washington State Department of Fish and Wildlife
    - Oregon State Department of Energy, Oregon State Health Division (Radiation Control Section)

- **Local**

- Port of Benton, Puget Sound Air Pollution Control Agency

- **Native American Indian Tribes and Nations**

- Yakama Indian Nation, Nez Perce Tribe, Confederate Tribes of the Umatilla Indian Reservation

- **Private Industry**

- American Bureau of Shipping, Columbia River Bar Pilots Association, Towing and Landhaul Contractors, Waste Management Federal Services of Hanford, Columbia River Pilots Association

# **AWAITING DISPOSAL**

**( Puget Sound Naval Shipyard March 13, 1996 )**



# REACTOR COMPARTMENT (RC) DISPOSAL PROCESS

- **INACTIVATION**
- **DEFUELING**
- **CONSTRUCTION**
- **TRANSPORTATION**
- **BURIAL**





# INACTIVATION

- **Weapons Offloaded**
  - Prior to arrival in the Shipyard
- **Reactor Shut Down**
- **Ship Drydocked**
  - Expendable materials removed
  - Industrial gases (O<sub>2</sub> & Freon) offloaded
  - Piping systems drained
  - Tanks drained & cleaned
  - Temporary support systems installed



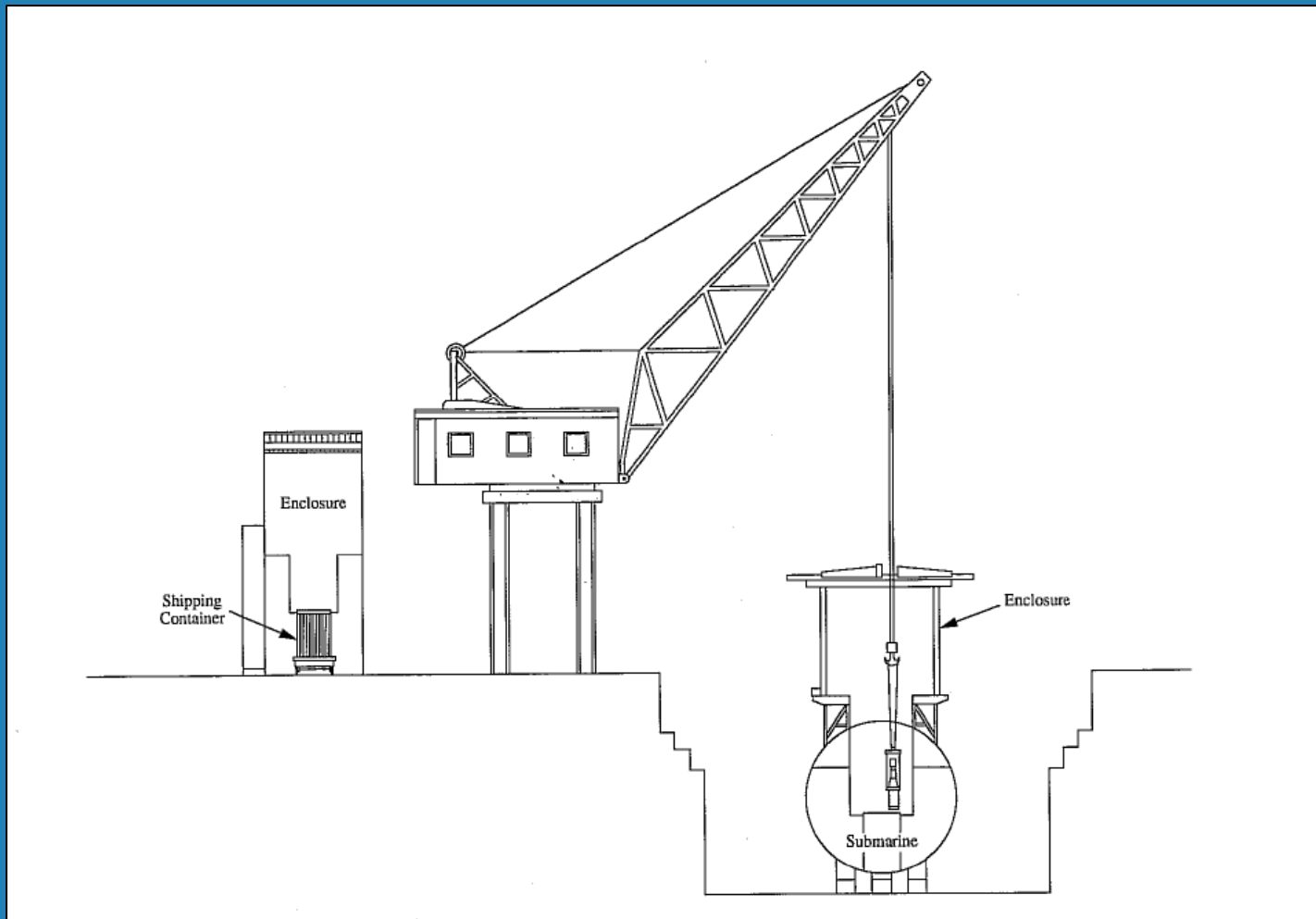
# DRYDOCKING



# DEFUELING

- **Opening Cut in the Hull**
- **Refueling Enclosure Installed**
  - controlled work area
  - filtered ventilation
- **Fuel Removed**
  - shielded transfer container
- **Fuel Moved by Crane to Enclosure**
- **Fuel Placed into Shipping Container**

# DEFUELING



# DEFUELING

## ( Fuel Shipping Container )



M-140 Shipping Container Mounted on Railcar





# **RC PACKAGE CONSTRUCTION**

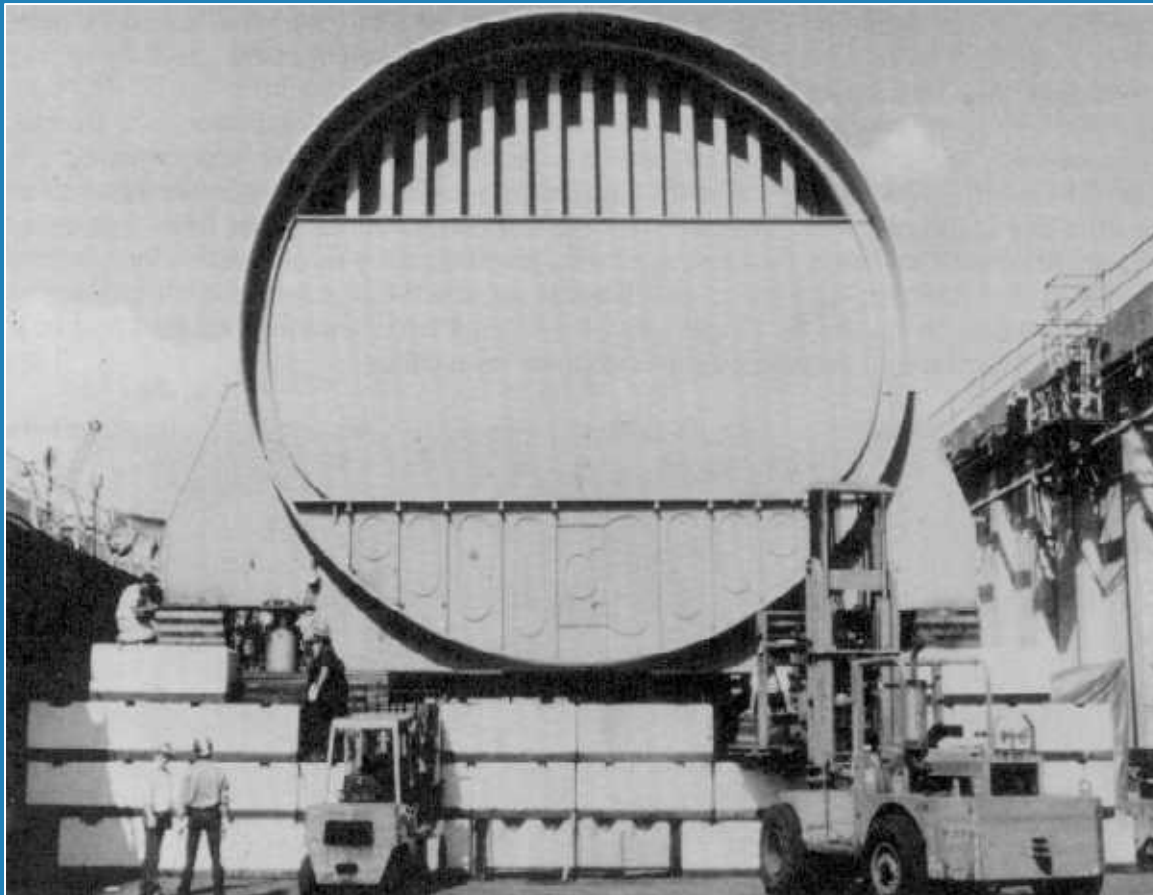
- **RC Removal Preparations**
  - **Reactor Vessel Drained**
  - **Fluid Support Systems Drained**
  - **All Openings into Radioactive Systems Sealed**
- **RC Separated from Ship**
- **End Bulkheads Installed**
  - **Minimum 3/4" steel**

# **RC PACKAGE CONSTRUCTION**

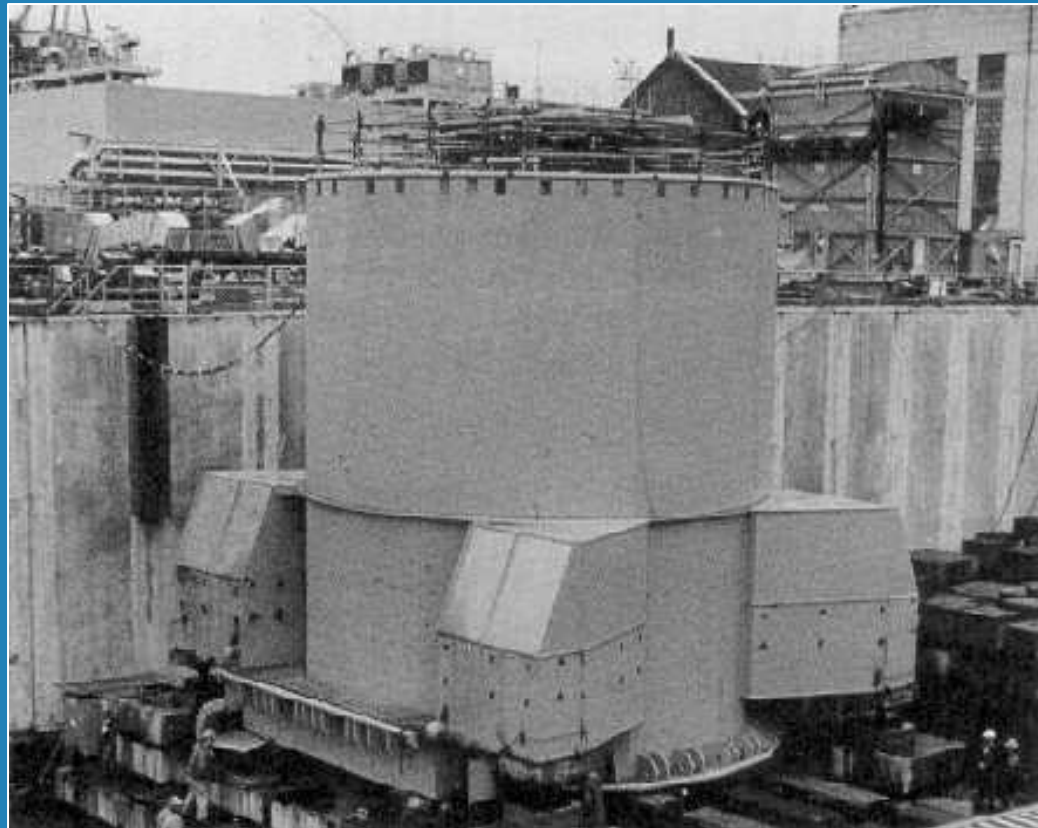
## **[ Separating the RC ]**



# RC PACKAGE ( Submarine )



# RC PACKAGE ( Cruiser )





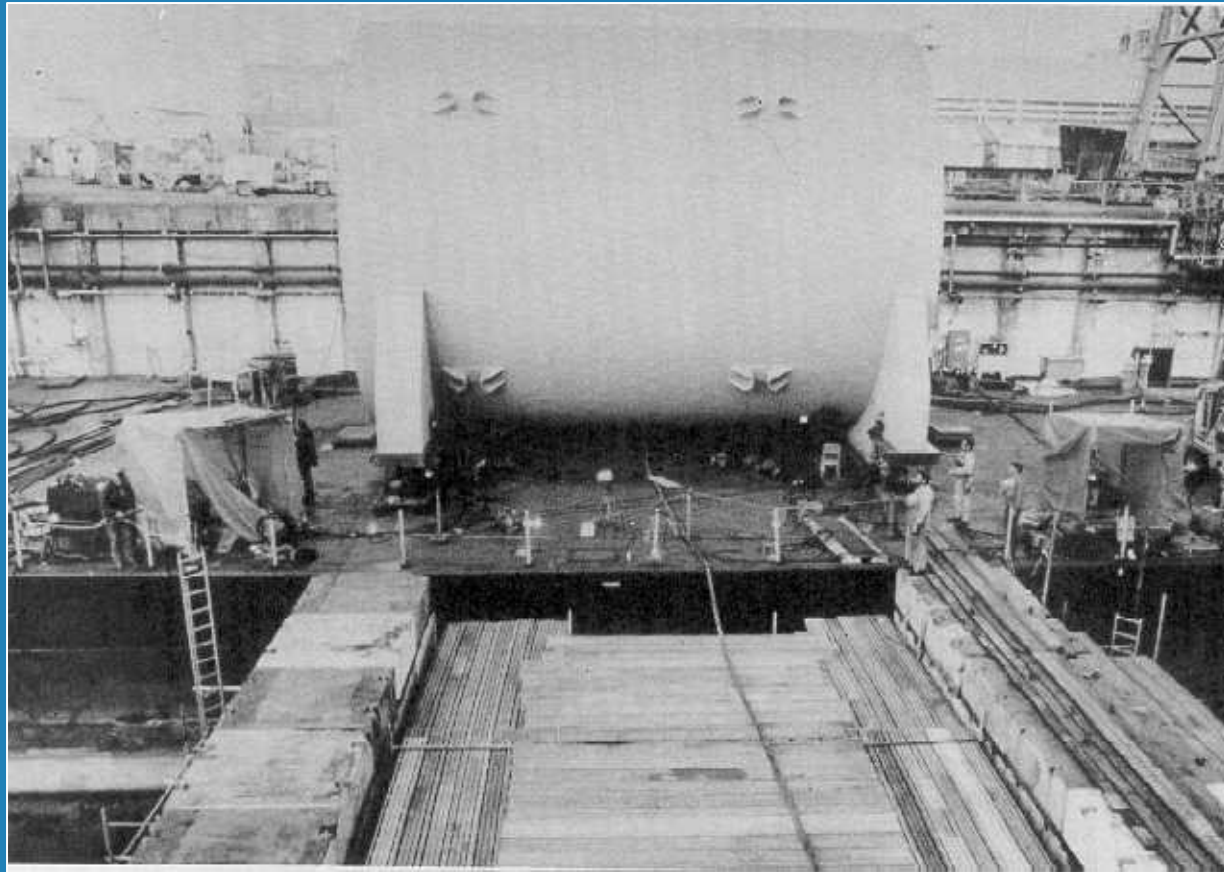


# **TRANSPORTATION**

- **RC Package Loaded on Barge**
- **Barge Towed to Port of Benton**
- **RC Package Loaded onto Trailer**
- **RC Package Transported to Burial Trench**

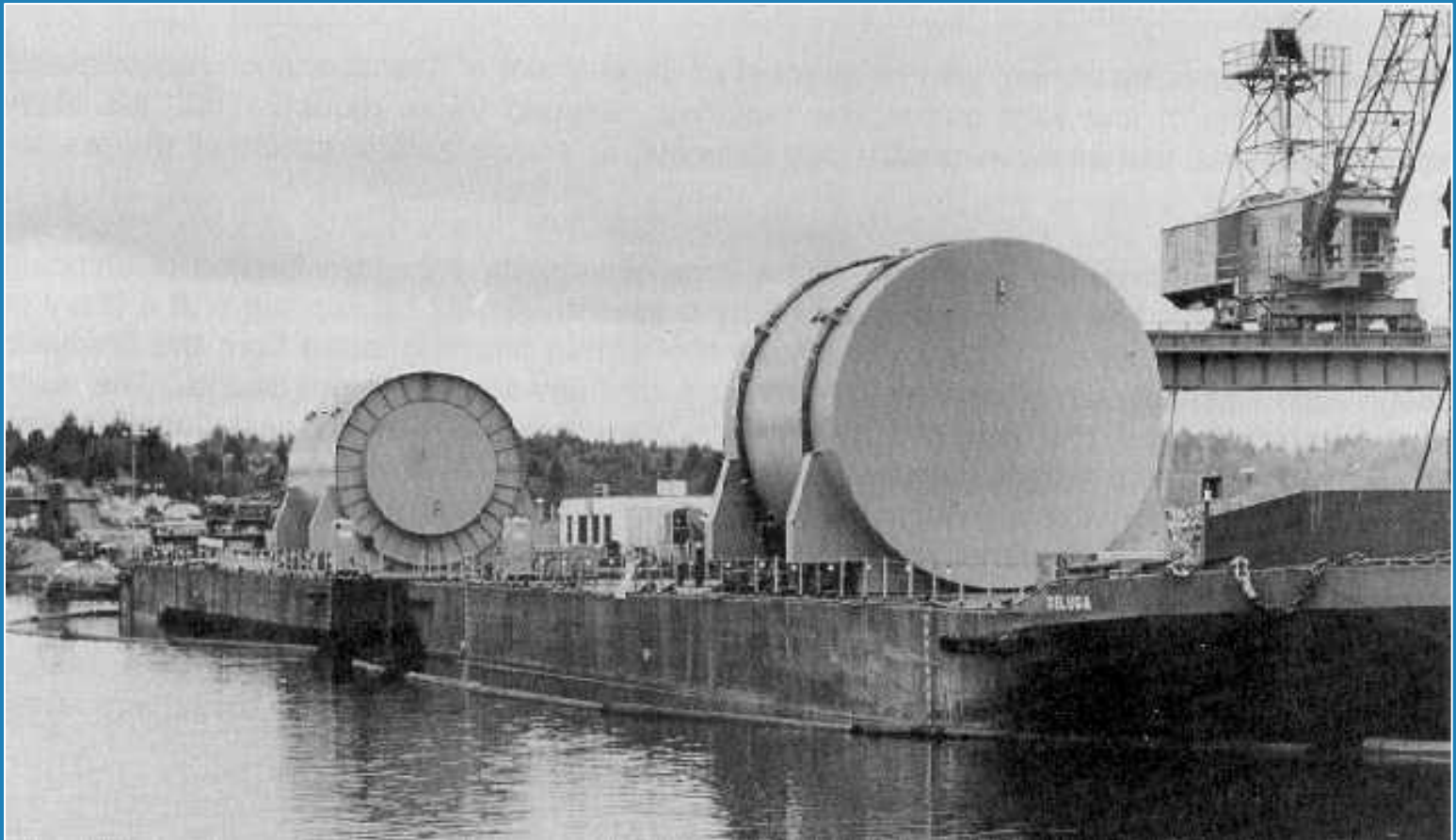
# TRANSPORTATION

## ( Loading Package on Barge )



# TRANSPORTATION

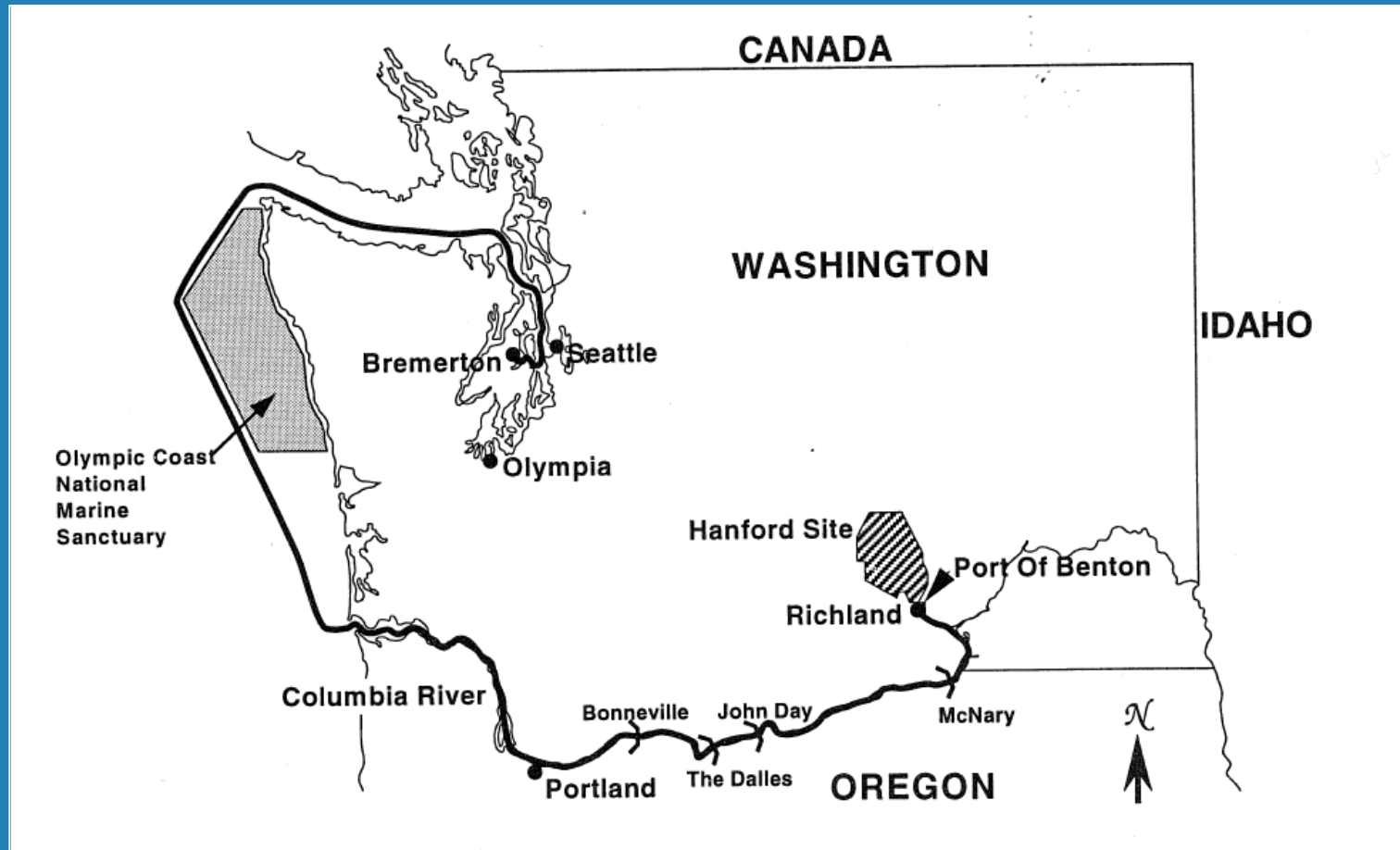
( Ready for Shipment )





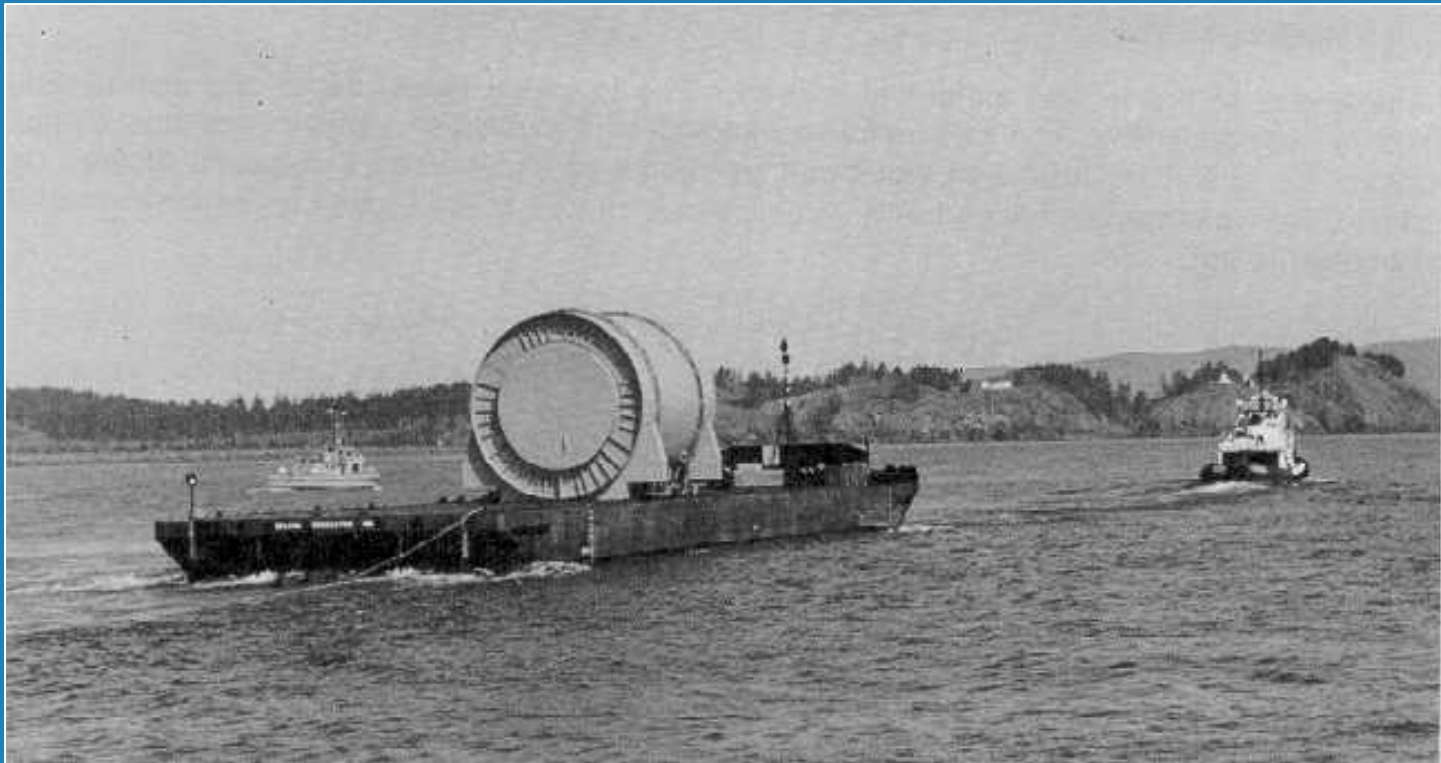
# TRANSPORTATION

## Tow Route



# TRANSPORTATION

## ( Entering Columbia River )



# TRANSPORTATION

## ( Barge on Columbia River )





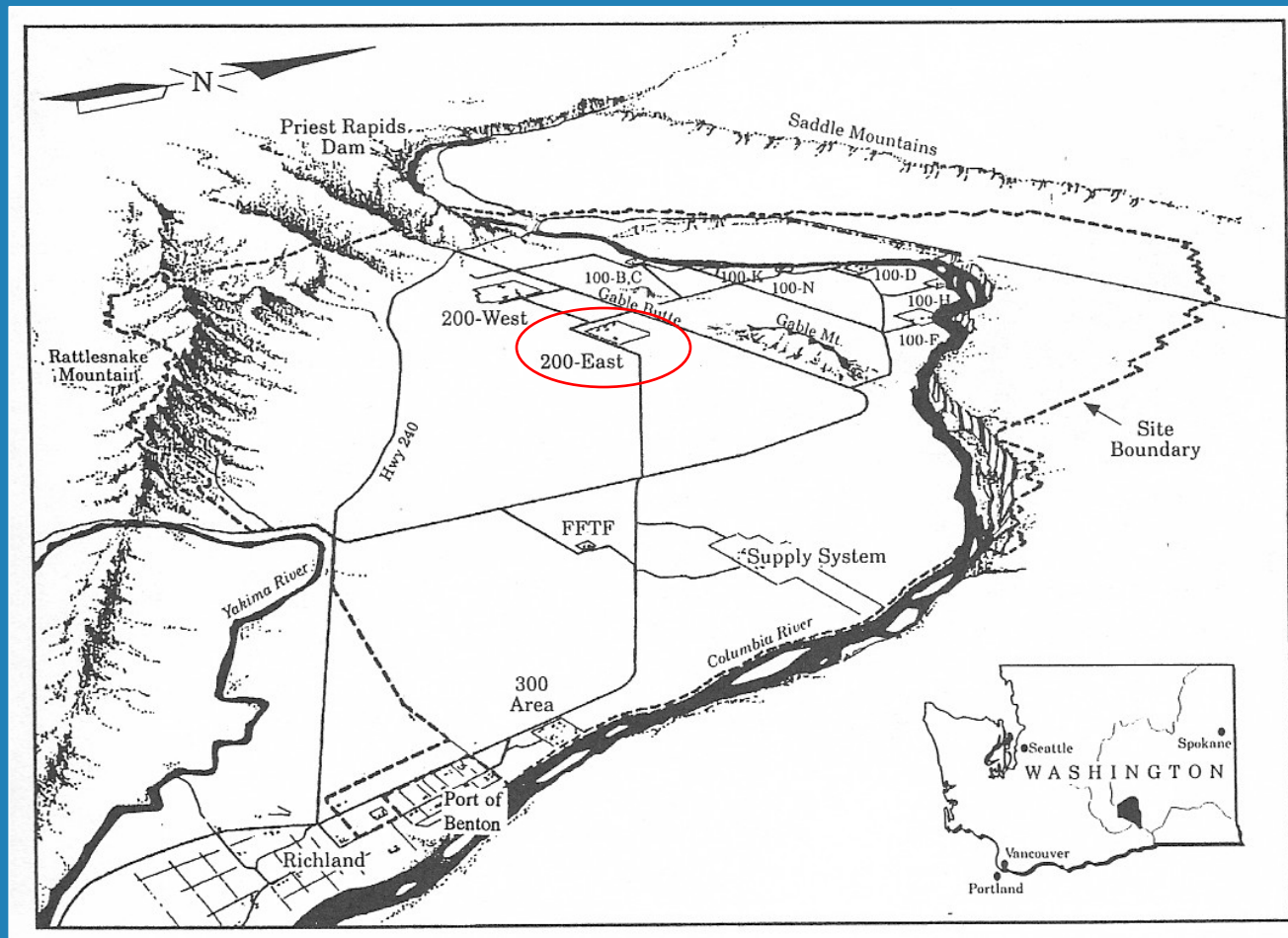
# TRANSPORTATION

## ( Offloading at the Port of Benton )



# TRANSPORTATION

## ( DOE's Hanford Site )



# TRANSPORTATION

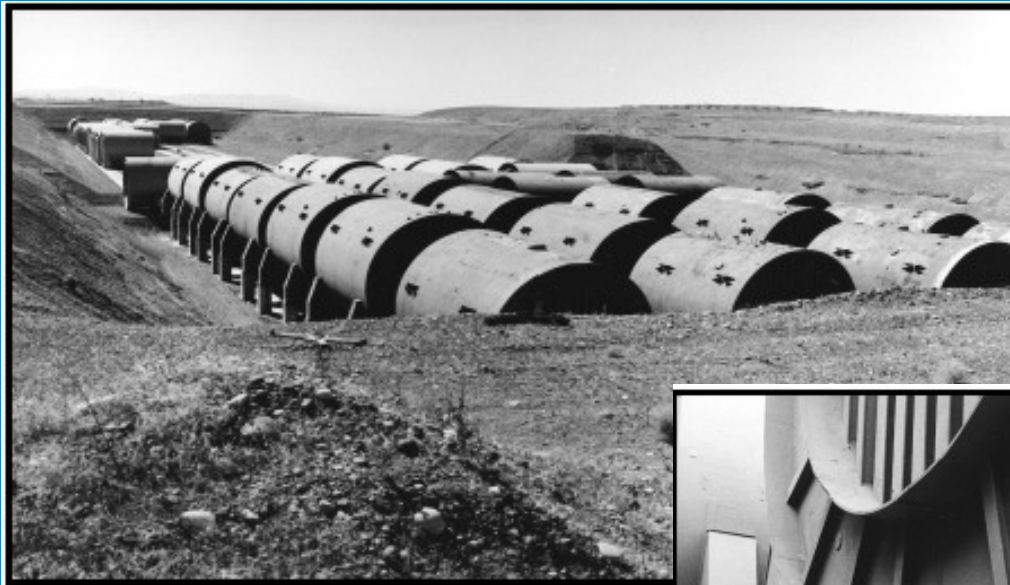
## ( Disposal Trench at Hanford )





# TRANSPORTATION

## ( Disposal Trench at Hanford )

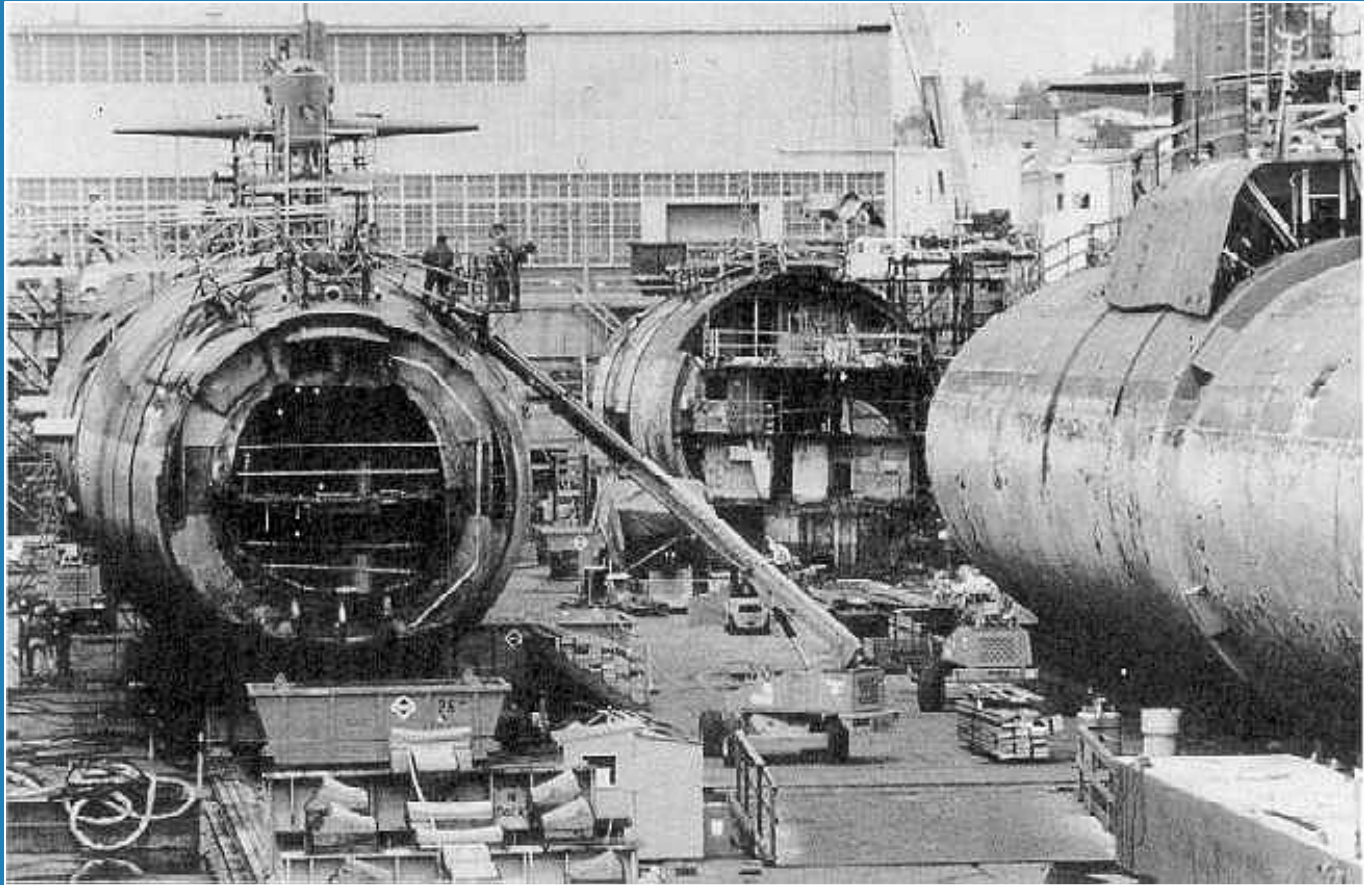


# TRANSPORTATION

( Burial Trench ~2001 )



# RECYCLING PROCESS





# **RECYCLING**

- **Remaining Sections are Recycled**
  - **Hazardous Materials Removed**
    - **PCBs - sound dampening material, transformers**
    - **Asbestos – pipe lagging, deck tiles**
    - **Lead - fixed ballast, batteries**
    - **Mercury – instruments and gauges**
  - **Hull Sections Cut into Pieces**
  - **Segregate and Sell Scrap Metal**



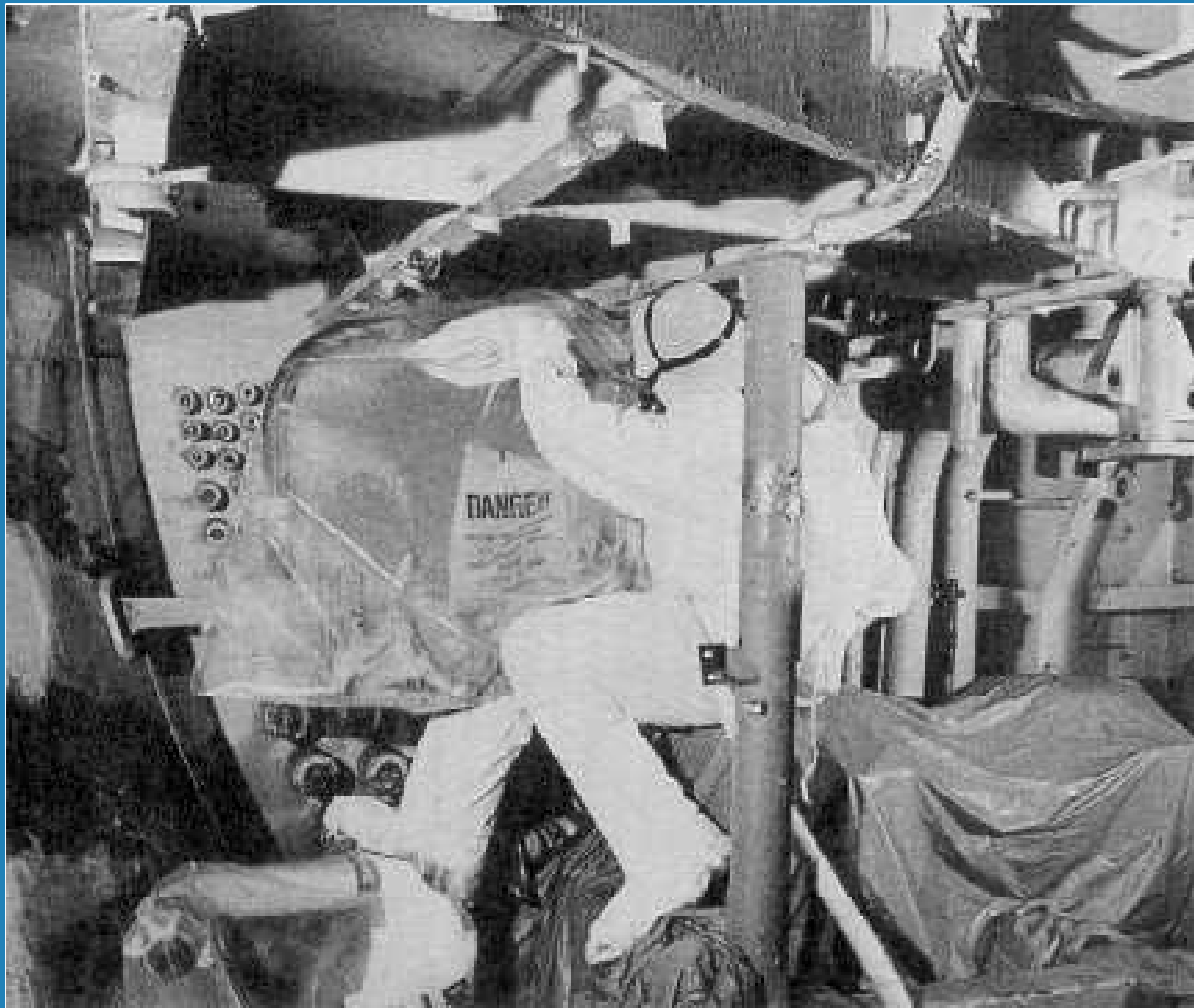
# RECYCLING

( PCB Felt Sound Damping Material Removal )



# RECYCLING

( Asbestos Removal )



# **RECYCLING**

**( Lead Ballast Removal )**



# RECYCLING

## [ Cutting a Missile Tube Section ]





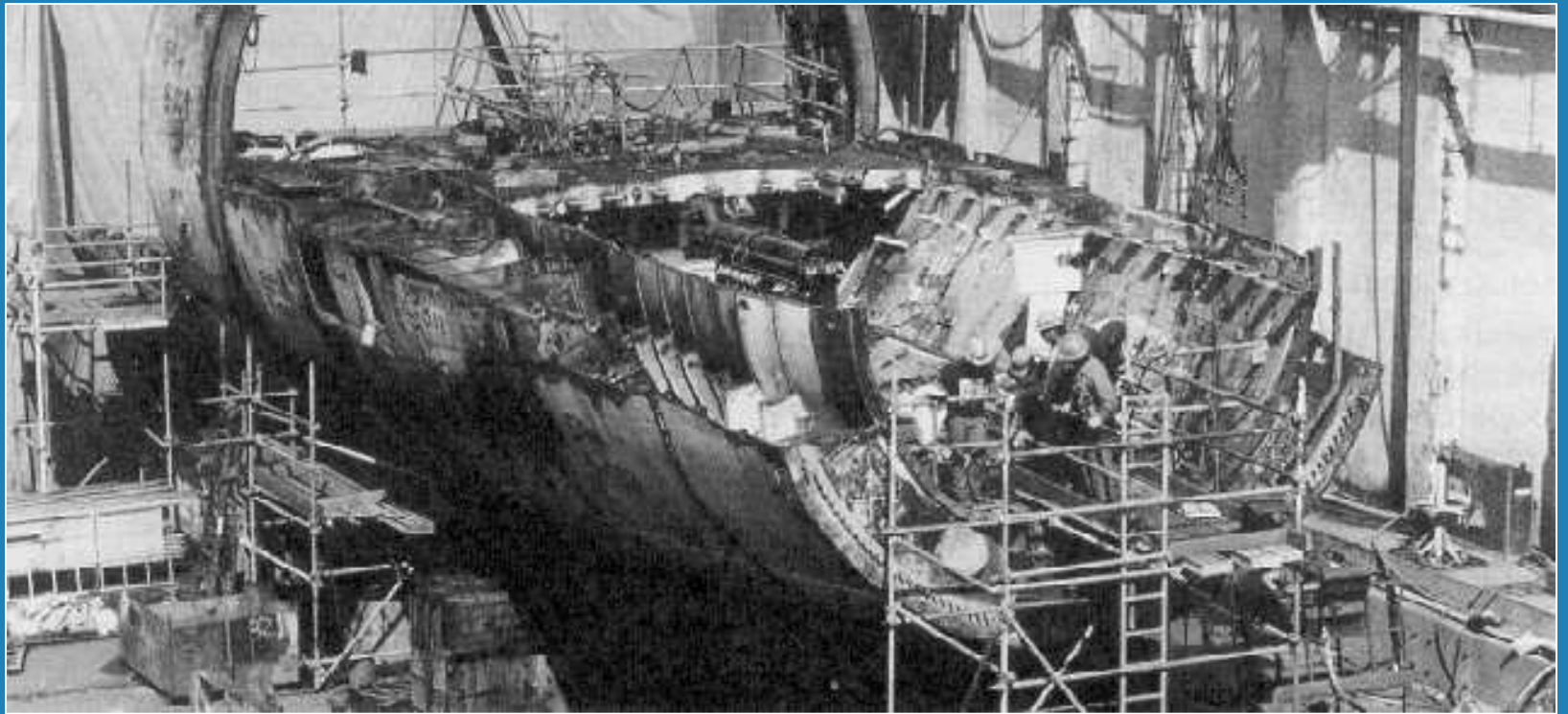
# RECYCLING

( Dockside Dismantlement of Hull Sections )



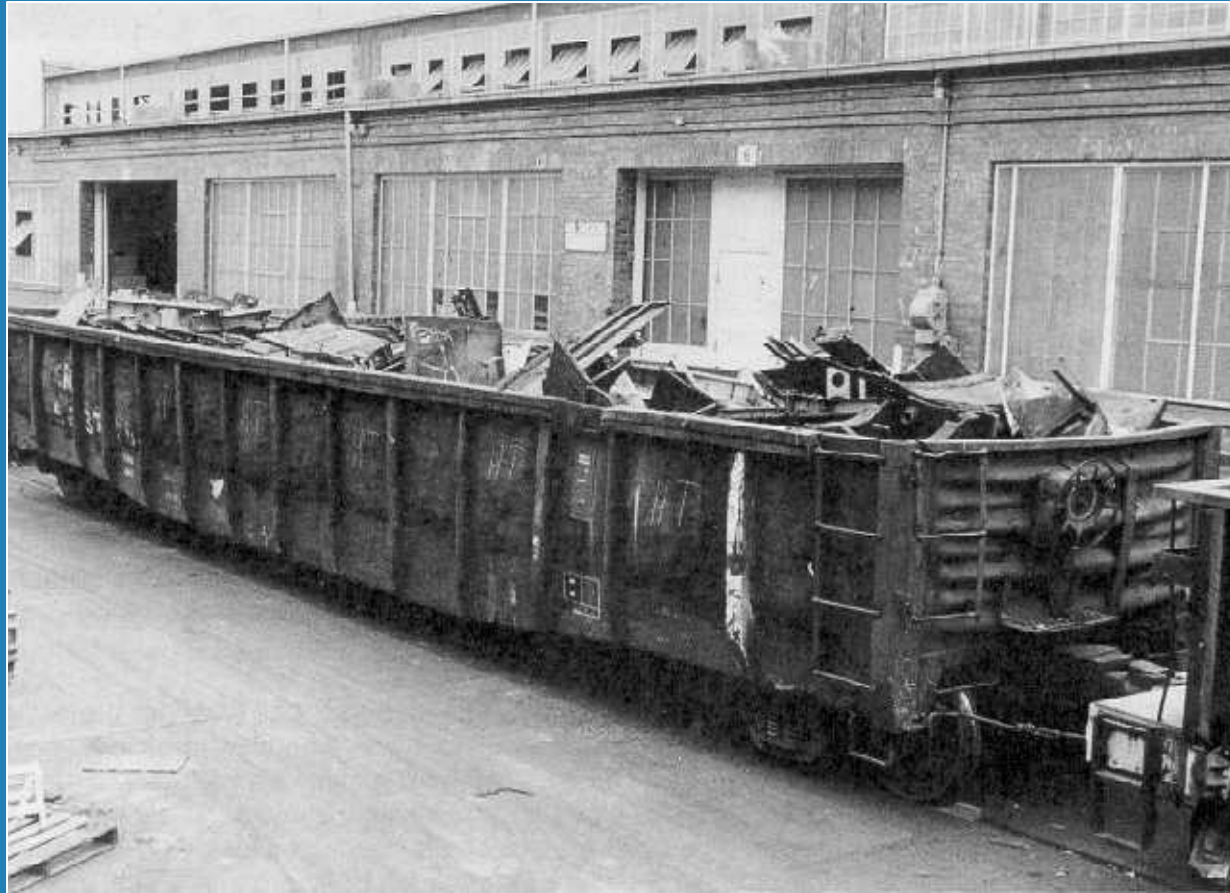
# **RECYCLING**

**( Partially Recycled Submarine )**



# RECYCLING

( Recyclable Material Ready for Shipment )



# Estimated Costs [ 1995 ]

Type	Inactivation Cost	Scrapping Cost
CGN	\$103.9	TBD
SSBN	\$29.6	\$9.2
SSN	\$29.6	\$6.9

(millions of dollars)





# **RECYCLED MATERIAL**

## **Typical Submarine ( pounds)**

- **HY 80 steel => 2,500,000**
- **Lead => 1,800,000**
- **Steel => 600,000**
- **Brass/Bronze => 250,000**
- **Monel => 150,000**
- **Stainless Steel => 110,000**
- **Zinc => 6,500**
- **Sheet Metal => 20,000**
- **Galvanized Steel => 8,000**
- **Copper => 90,000**
- **Aluminum => 85,000**



# **RECYCLED MATERIAL**

## **Typical Cruiser**

- **Hull Steel and Furnishings**
  - 11,000,000 pounds
- **Aluminum Superstructure**
  - 1,000,000 pounds



# **AS OF MARCH 2007 THE NAVY HAS SUCCESSFULLY**

- **Shipped**
  - **115 Defueled RC's to Hanford**
- **Recycled**
  - **109 Nuclear Powered Warships**
- **Container Shipments**
  - **Over 750 Shipments of Naval spent fuel**

# REFERENCES

- **“U.S. NAVAL NUCLEAR POWERED SHIP INACTIVATION, DISPOSAL, AND RECYCLING”**
  - United States Department of the Navy, April 1999
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  - Proceedings of the NATO Advanced Research Workshop on Nuclear Submarine Decommissioning and Related Problems, June 1995
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# QUESTIONS

