Transportation of Radioactive Materials

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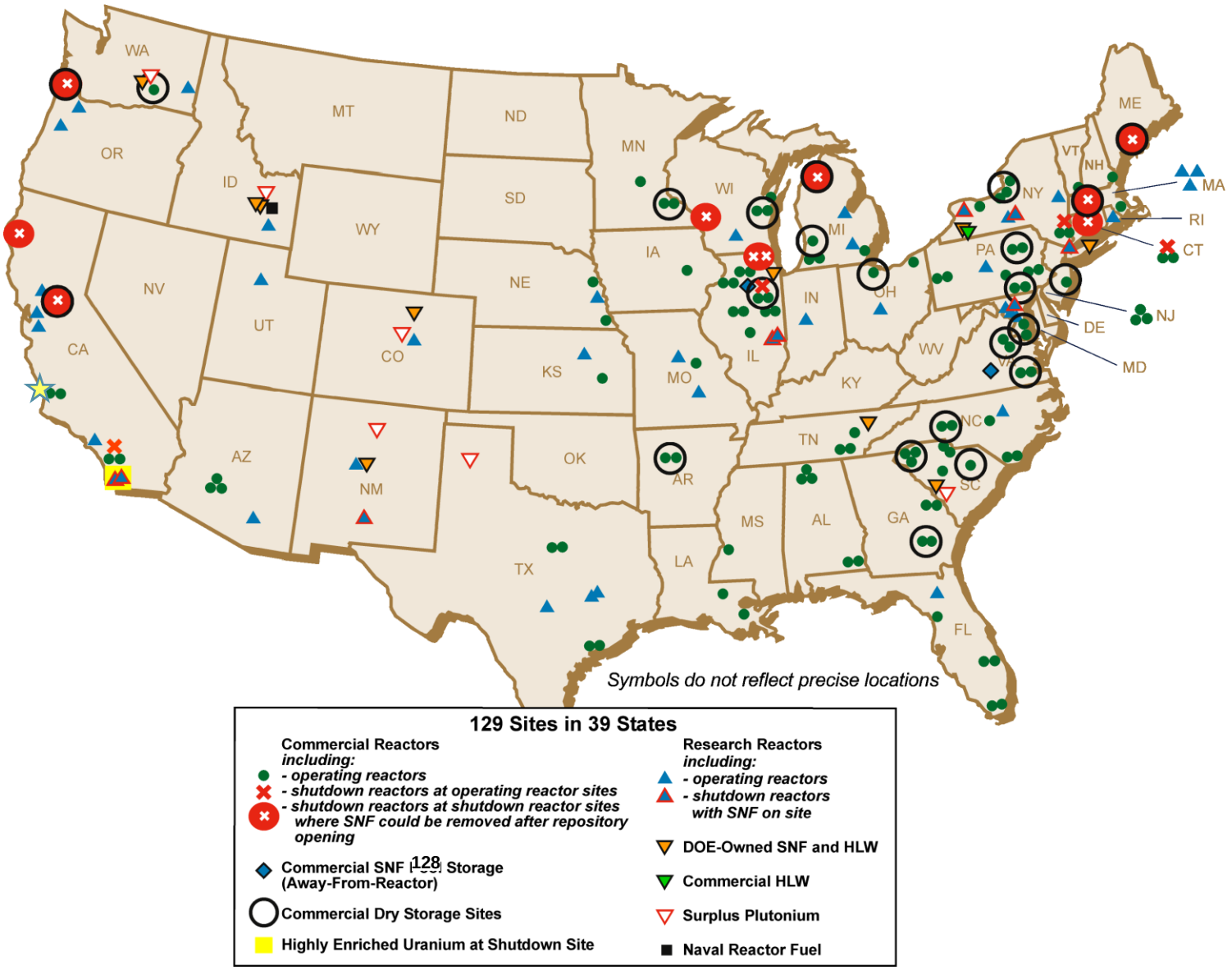
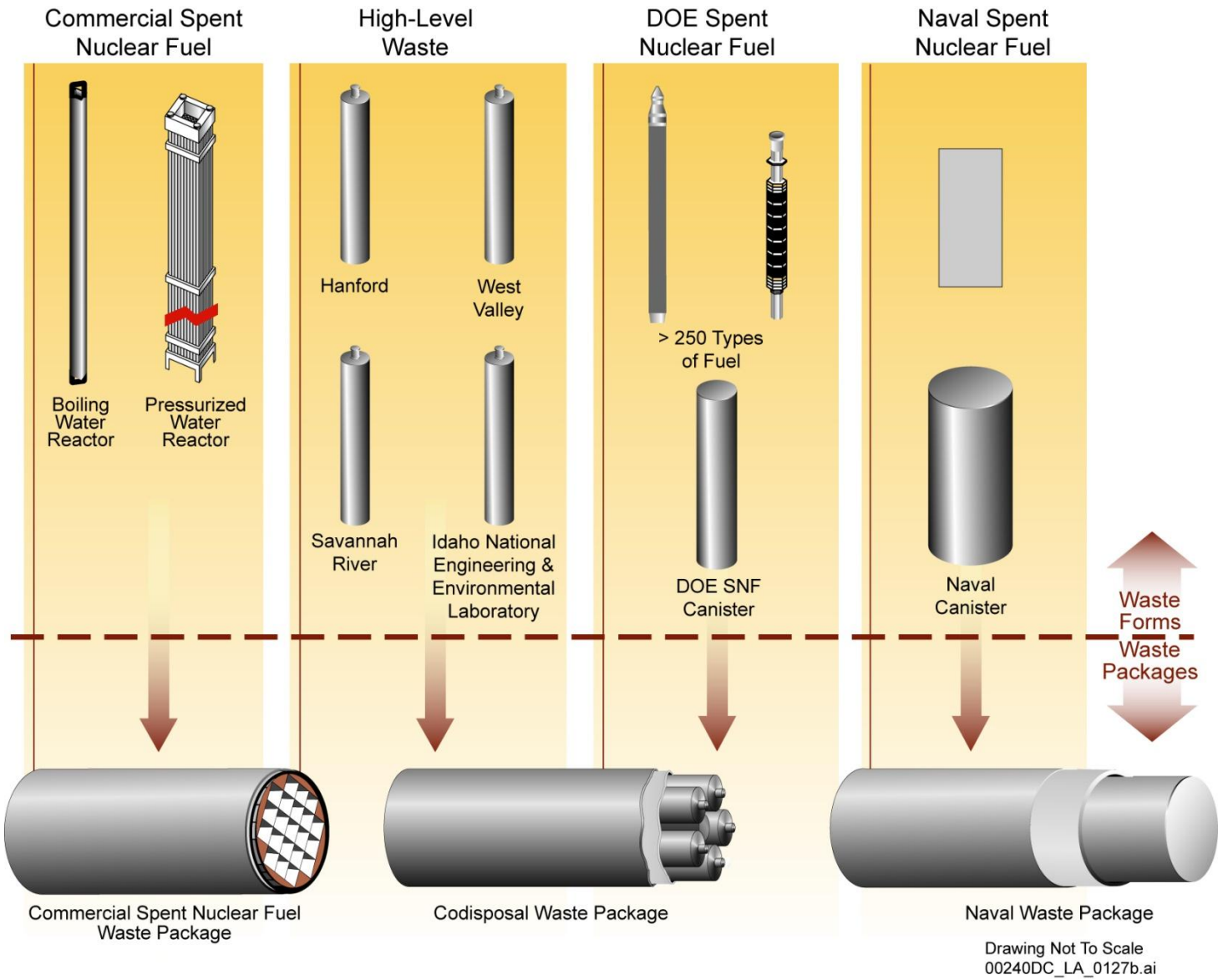
Types of Radioactive Shipments

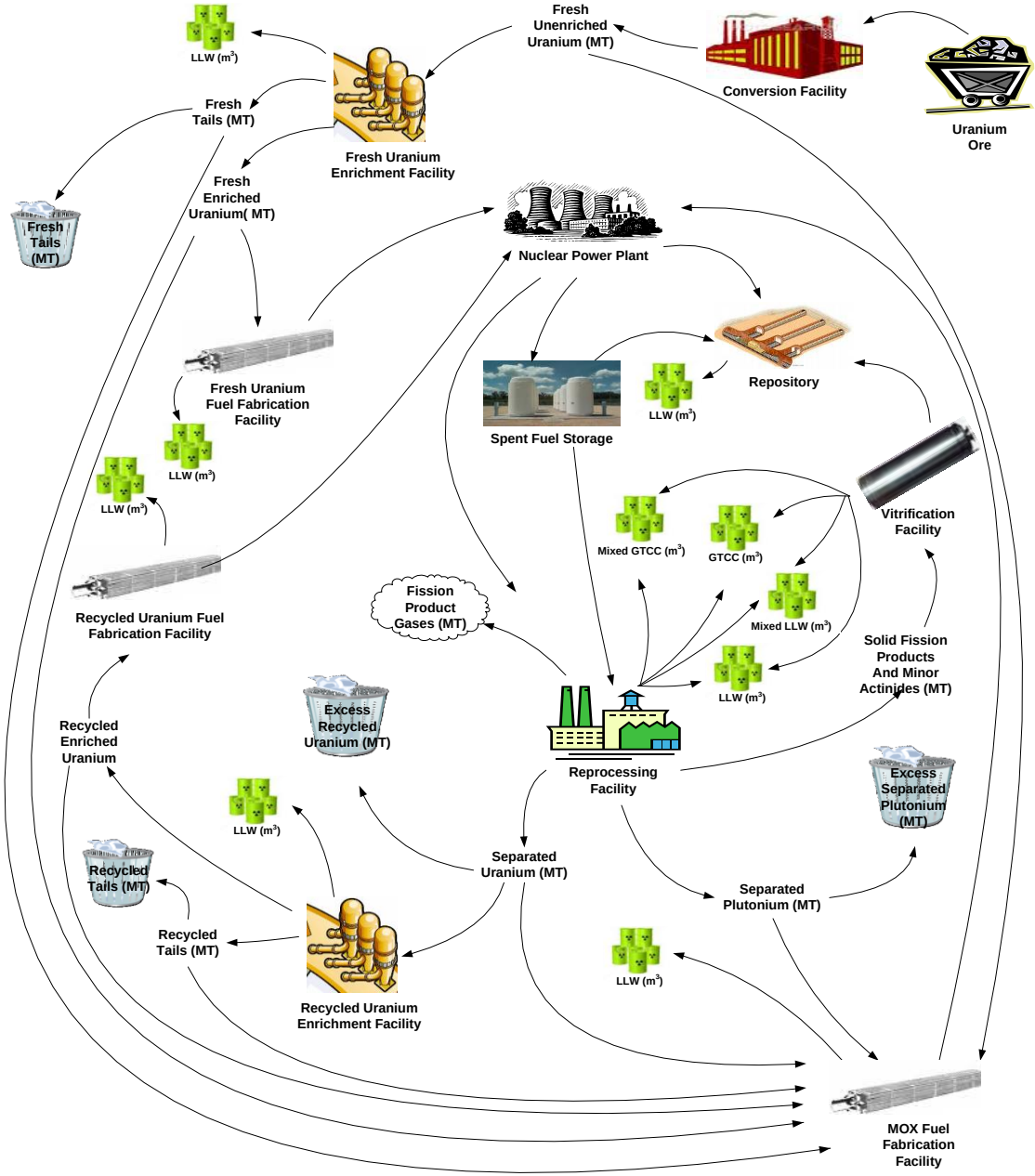
- **Uranium ores**
- **Isotopes**
  - Medical
  - Industrial
  - Research
- **Weapons-related materials**
- **Unused Reactor Fuel (**fresh fuel**)**
- **Radioactive "waste"**
  - Spent fuel (SNF)
  - High level waste (HLW)
  - Transuranic waste (TRU)
  - Low-level waste (LLW)
  - Mixed low-level waste
  - Reactor components
  - Uranium mill tailings



Current Locations of Spent Nuclear Fuel and High-Level Radioactive Waste

Cargo Waste Forms & Package Designs





Nuclear Fuel Cycle Options

Source: Nuclear Waste Technical Review Board

The Transportation Challenge

- **Spatial diversity of shipping origins**
- **Many waste forms**
- **Varying volumes to be shipped**
- **Uncertainties**
  - Where to ship?
  - When to ship?

Topics of Interest

- **Transportation system infrastructure**
- **Radioactive shipment regulators**
- **RAM Package Certification**
- **Responsibilities of shippers & carriers**
- **Mode selection**
- **Routing**
- **Operational issues**
- **Institutional considerations**
- **Experience to date**
- **Risk perception**

Transportation System Infrastructure

- **Transportation networks**
- **Rolling stock**
- **Transportation casks**
- **Loading/unloading facilities**
  - **Wet/dry storage handling**
  - **Crane capacity**
- **Maintenance facilities**

Radioactive Materials Transport Regulators

- **U.S. Department of Transportation**
  - Training
  - Packaging
  - Labeling/placarding
  - Shipping papers
  - Loading/unloading
- **Nuclear Regulatory Commission**
  - Package design & performance
  - Safeguards & security
- **Others** (DOE, USPS, OSHA, EPA, IAEA, IMO, ICAO)

RAM Package Certification

- **In the United States, packages for shipping large amounts of radioactive materials are certified for use by the U.S. NRC and U.S. DOE**
- **Applicable regulations are found in 10 CFR 71 (NRC)**
- **Packages are classified based on amount of radioactive materials carried (Industrial Packages, Type A, Type AF, Type B, Type C)**
- **Required testing for Type AF, B and C packages includes Normal Conditions of Transport (NCT) and Hypothetical Accident Conditions (HAC) tests**

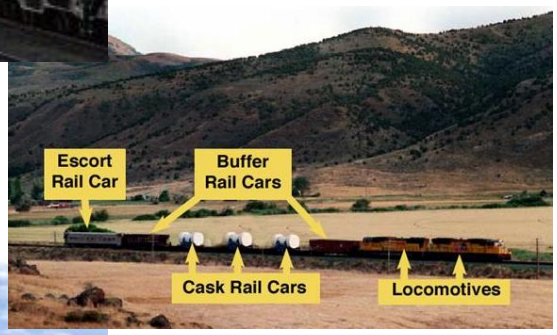
Responsibilities of Shippers & Carriers

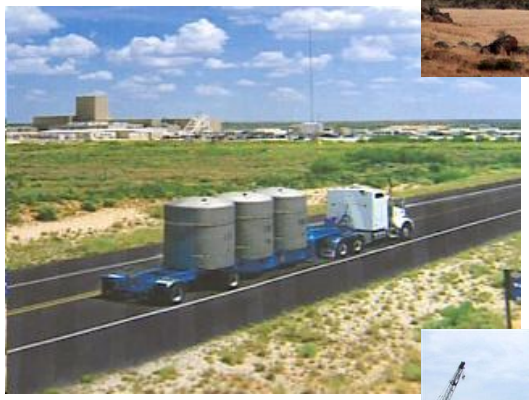
- **Shipper**
  - Classifies & packages radioactive materials
  - Marks & labels packages
  - Completes & signs shipping papers
  - Selects carrier

- **Carrier**
  - Reviews shipping papers
  - Placards vehicle
  - Stows & secures package
  - Complies with driver training and routing requirements
  - Follows vehicle safety requirements
  - Reports incident (if one occurs)

Mode Selection

- **Rail**
  - Regular train
  - Dedicated train
- **Truck**
  - Legal weight
  - Overweight
  - Heavy haul
- **Barge**
- **Intermodal**





Factors Affecting Mode Selection

- **Container size & weight**
- **Characteristics & composition of radioactive contents**
- **Shipping distance**
- **Availability of transportation facilities & infrastructure**

Routing

<u>Highway</u> (DOT HRCQ Routing Regulations)

- **Vehicles operate over preferred routes**
  - TRAGIS
  - Interstate highway system, including bypasses or beltways
  - A state or tribe may designate alternative routes
- **Alternative route selection based on multiple criteria**
  - Travel time
  - Accident rate
  - Population density & special events
  - Temporal considerations (time of day, day of week, season)
  - Continuity of operations

<u>Rail</u>

- **There are no federal rail routing regulations**
- **Standard rail industry practices**
  - TRAGIS
  - Minimize time, distance, number of carriers, interchange points
  - Maximize use of best track

Operational Issues

- **Permits and fees**
- **Advance notification**
- **Inspections**
- **Security**
  - Accessibility
  - Vulnerability
- **Tracking & communications**
- **Safe parking**
- **Contingencies**
- **Emergency response**
  - First response
  - Qualified response
- **Recovery & cleanup**

Institutional Considerations

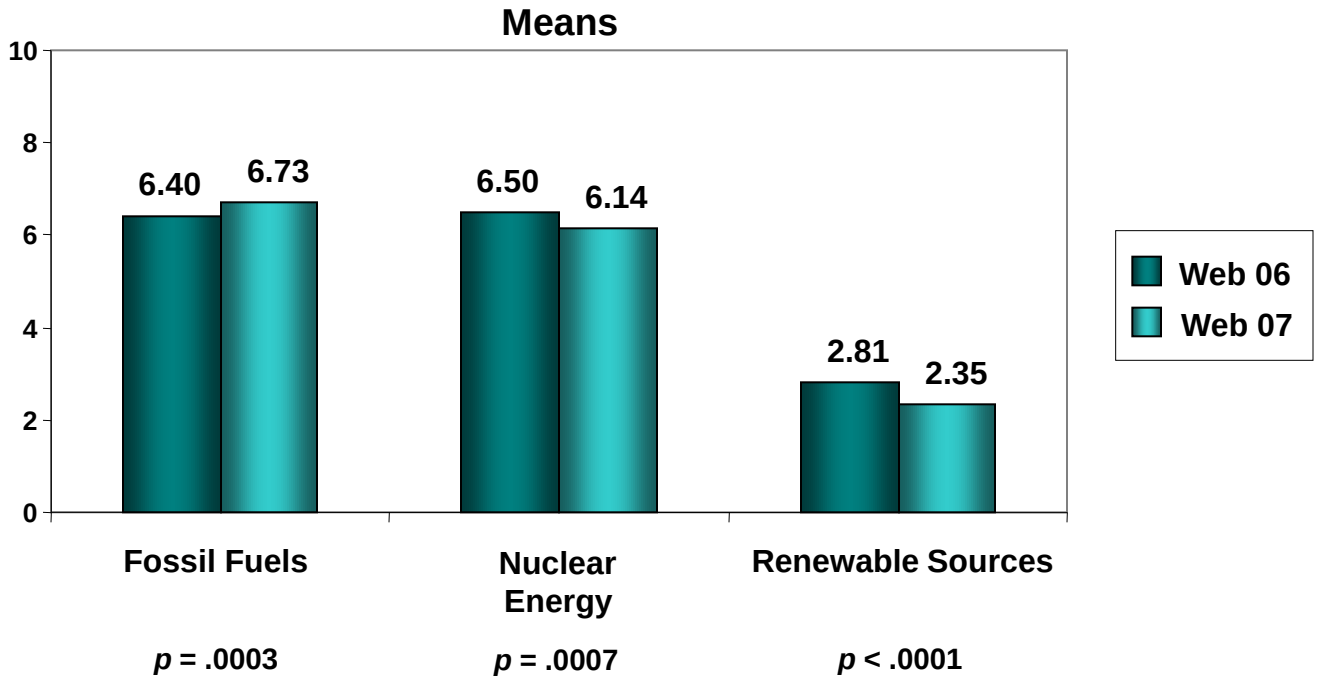
- **Transportation organization and culture**
- **Management processes**
- **Stakeholder identification & interactions**
- **Issue resolution**

Experience to Date

- **Roughly 3,000 shipments of SNF and HLW in the U.S. during the past 30 years**
- **738 Navy container shipments, over 1 million miles since 1957**
- **Average 650 nuclear materials shipments per year in France and Britain**
- **There has never been a release of radioactive material during transport harmful to the public or the environment**

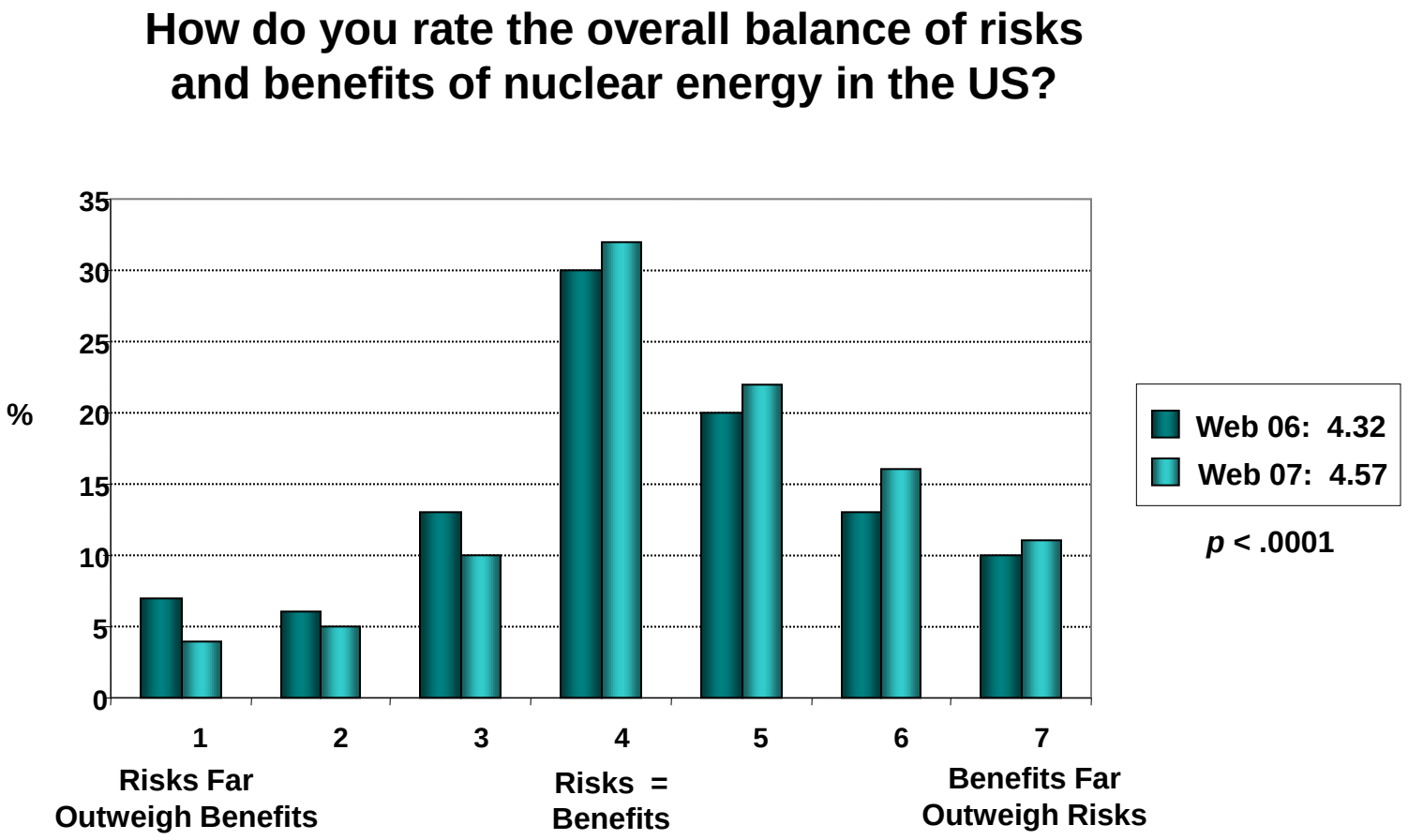
Perceived Relative Risks of Energy Sources

Considering the risks of normal operations and potential accidents, how do you rate the risks to society and the environment from these sources of energy?



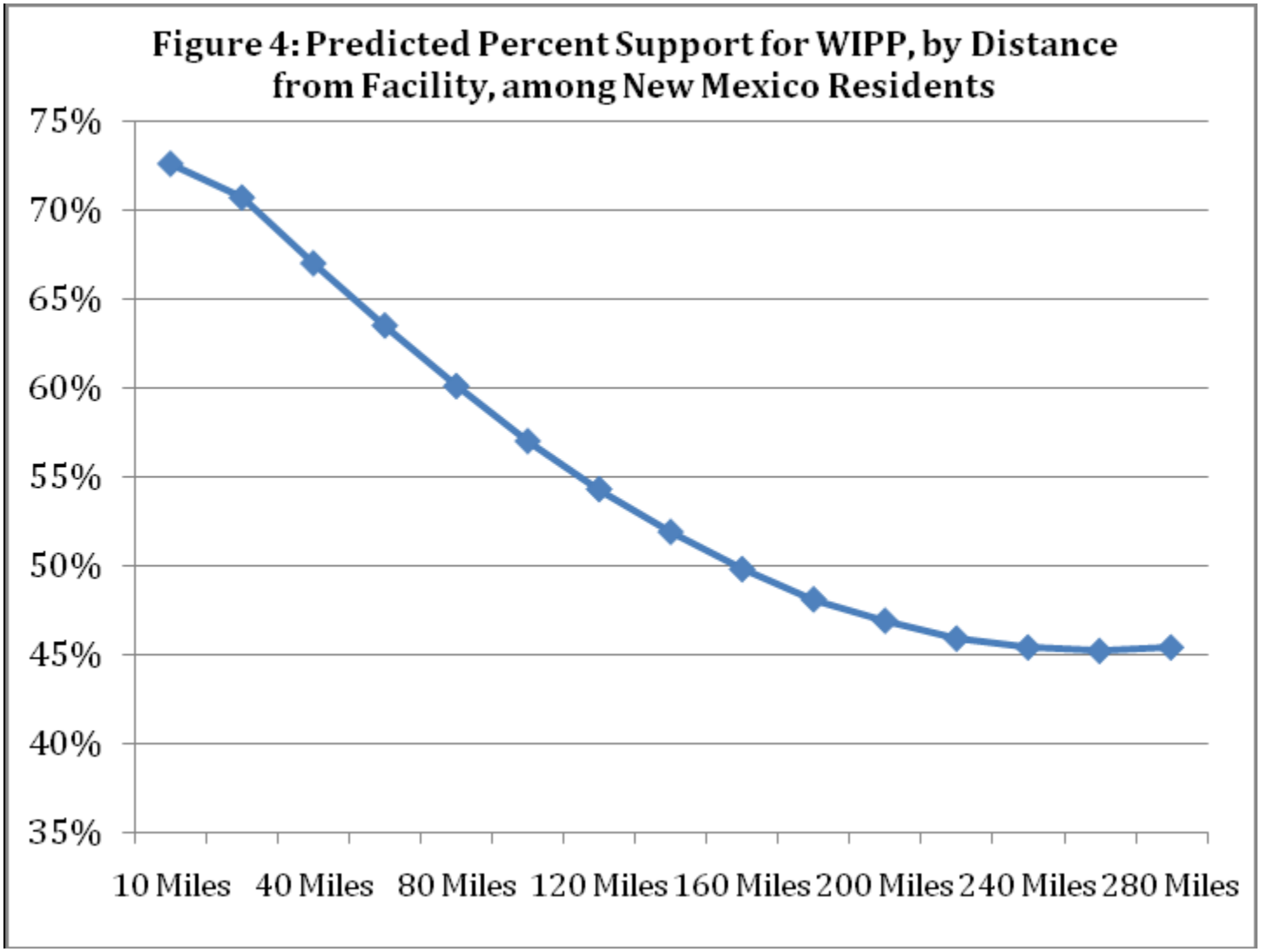
Source: Hank Jenkins-Smith

Perceived Risks vs. Benefits of Nuclear Energy



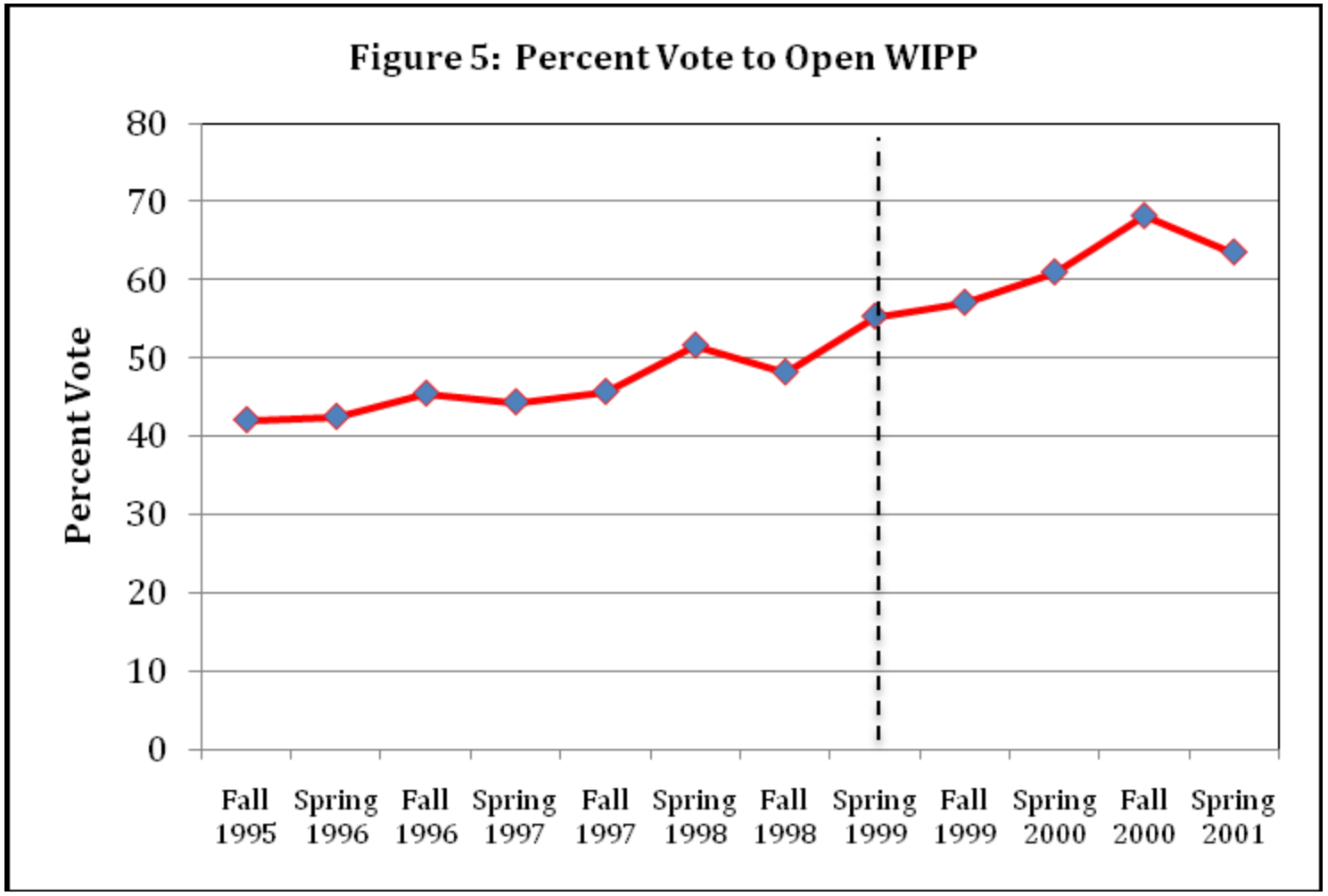
Source: Hank Jenkins-Smith

Support for WIPP by Proximity



Source: Hank Jenkins-Smith

Percent Vote to Open WIPP: State-Wide New Mexico Surveys 1995-2001



Source: Hank Jenkins-Smith

Thank You

Questions?