



Industry Perspective: Nuclear Energy and a Need to Include Codes & Standards in Engineering Education

Kenneth R. Balkey

**Vice President, ASME Nuclear Codes and Standards
Consulting Engineer, Westinghouse Electric Company**

*“International Mechanical Engineering Education Conference”
“Programs in Nuclear Engineering Workshop”*

Galveston, Texas

April 6, 2008



1



Industry Perspective: Nuclear Energy and a Need to Include Codes & Standards in Engineering Education

The author acknowledges with appreciation the contributions to this presentation by –

- Mr. John Goossen, Director, Science & Technology Department
 - Dr. Regis Matzie, Chief Technology Officer and Senior Vice President, Westinghouse Electric Company
 - Mr. Kevin Ennis, ASME, Director, Nuclear Codes and Standards
 - Ms. Jackie Oppenheim, ASME, Director, Continuing Education Institute
 - Mr. Jim Rameriz, ASME, Program Manager, Standards Technology, LLC
-



2



International Energy Agency World Energy Outlook

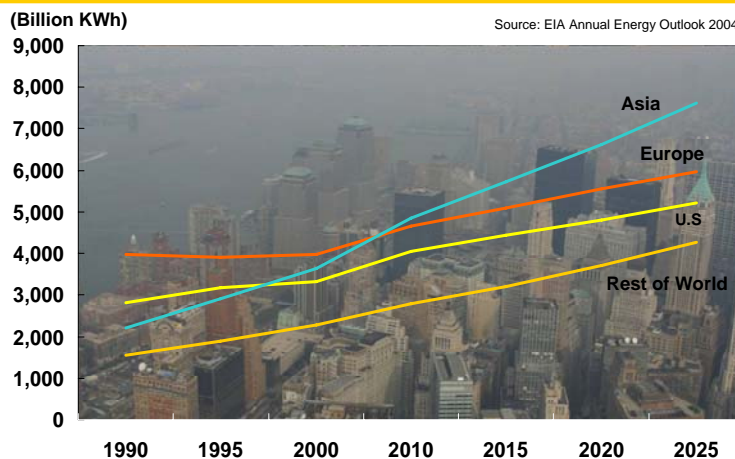
- “Some 1.6 billion people – one quarter of the world’s population – have no access to electricity. In the absence of vigorous new policies, 1.4 billion people will still lack electricity in 2030.”
- “Lack of electricity and heavy reliance on traditional biomass are hallmarks of poverty ... lack of electricity exacerbates poverty and contributes to its perpetuation as it precludes most industrial activities and the jobs they create.”



3



Forecast Electricity Demand by Region



An extensive expansion of installed generating capacity will be required. 63% increase needed in next 20 years!



4

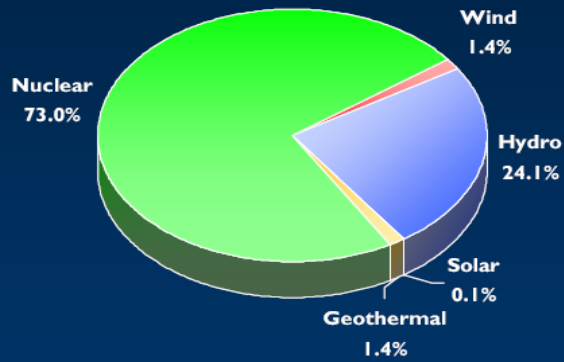
Benefits of Nuclear Energy

Nuclear Power Has Many Benefits

- Safety a Top Priority
- Environment
- Economics
- Excellent performance and reliability
- Contributes to energy security



U.S. Sources of Emission Free Electricity 2005*



* Preliminary
Source: Global Energy Decisions / Energy Information Administration
Updated: 4/06



U.S. Capacity Factors by Fuel Type 2005

Fuel Type	Average Capacity Factors (%)*
Nuclear	89.6
Coal (Steam Turbine)	72.6
Gas (Combined Cycle)	37.7
Gas (Steam Turbine)	15.6
Oil (Steam Turbine)	29.8
Hydro	29.3
Wind	26.8
Solar	18.8

* Preliminary
Source: Global Energy Decisions / Energy Information Administration
Updated: 4/06



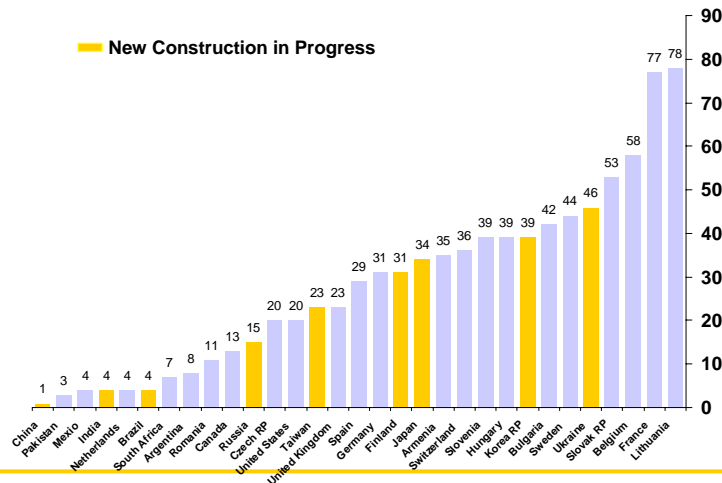
How Does Nuclear Power Fit Into the World's Energy Mix?

Nuclear Power Plays A Major role in Global Electricity Generation

Over 440 Operating Commercial Nuclear Power Plants Worldwide

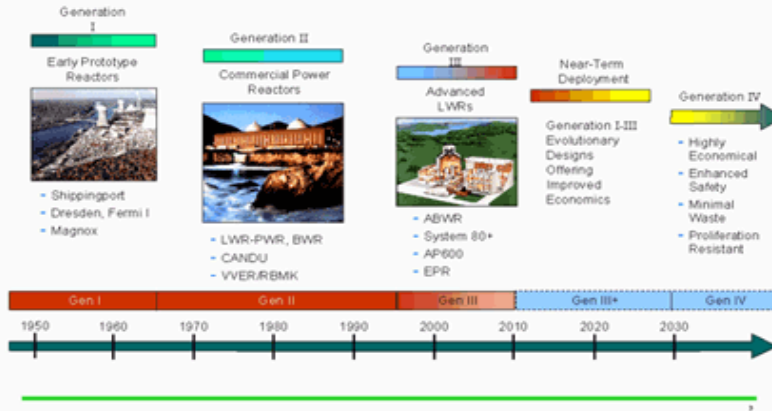
Percentage

■ New Construction in Progress

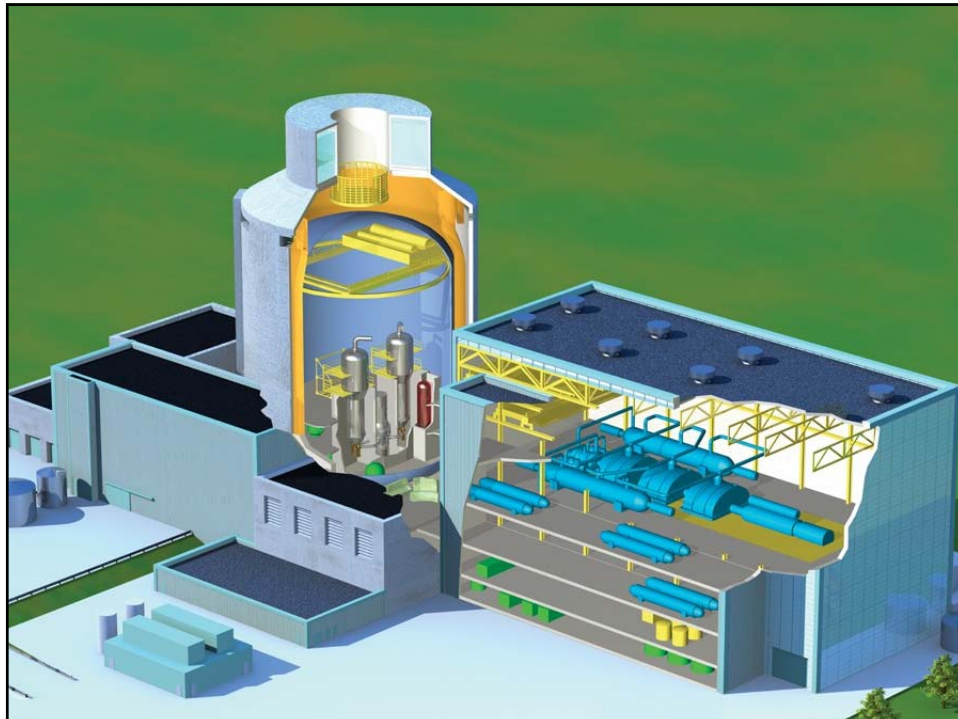


Source: International Atomic Energy Agency & World Nuclear Association Database

The Evolution of Nuclear Power

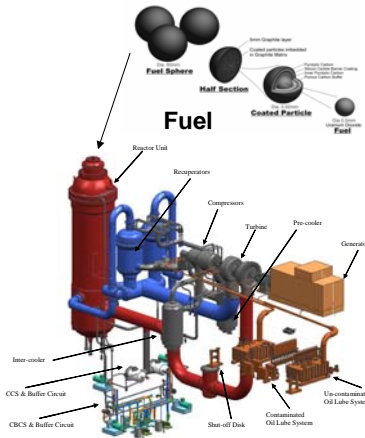


Source: "www.nuclear.gov" generation IV initiative



What is a Generation IV High Temperature Gas-cooled Reactor (HTGR) Today?

- Small thermal reactor
400 - 600 MWth
- Gas cooled – helium
- High temperature
850-950°C coolant outlet temperature
- Graphite moderated
- Particle fuel core – pebble or prismatic design
- Passive safety with inherent characteristics



Pebble Bed Module Reactor Example

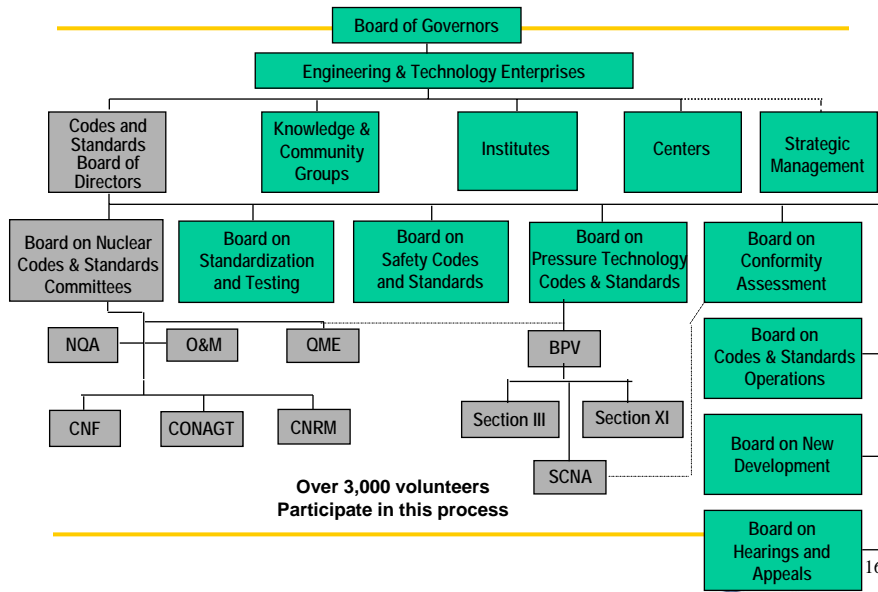
The Promise of HTGRs

- High Thermal Efficiency
- Enhanced Safety Allowing Close-in Siting
- Better fuel Utilization
- Improved Waste Disposal
- Enhanced Proliferation Resistance
- Competitive Economics
- Process Heat Applications – Particularly For Hydrogen Generation



ASME Board on Nuclear Codes & Standards (BNCS) Efforts in Engineering Education

ASME Organization





ASME Board on Nuclear Codes & Standards

Standards Committees

- Operation & Maintenance
- Qualification of Mechanical Equipment
- Nuclear Air & Gas Treatment
- Nuclear Quality Assurance
- Nuclear Risk Management
- Nuclear Cranes

Subcommittees of ASME Boiler & Pressure Vessel Standards Committee

- III – Nuclear Power
 - Division 1 Components
 - Division 2 Concrete and Metal Containment
 - Division 3 Waste Storage & Transport
- XI – Inservice Inspection
- Nuclear Accreditation



Nations Turning to Nuclear Energy



Source: World Nuclear Association (as of Dec. 8, 2006) in *Nuclear Energy Insight*, January 2007

U.S. Nuclear Industry Workforce

- 30% of the nuclear industry workforce will be eligible to retire in the next 5 years & nearly 50% in 10 years
- 90,000 entry level workers will be needed over the next 10 years
- Nuclear engineers are the third-best compensated engineering discipline
 - median income in 2000 was \$102,970
 - BS degreed graduates received an average base salary of \$50-\$55K in 2000
 - Advance Degreed is an additional \$10 to \$20K
- Nuclear steam supply system vendors, architect engineering firms, nuclear utility owners, and U.S. Nuclear Regulatory Commission are all hiring

Source: Nuclear Energy Institute

Challenges in Attracting and Keeping Students in Engineering Programs

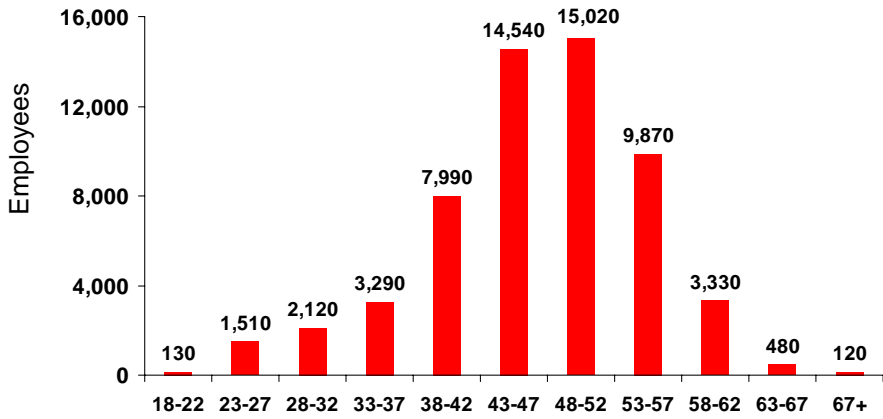
- Universities can be challenged in keeping students in engineering programs
- Fewer engineering students pursue advanced degrees or stay in engineering field after graduation
- Many international students who obtain advanced degrees go back to country of origin – many U.S. base companies have locations overseas
- Need to reach out to students earlier (middle or high school)
- Lack of engineers in the workforce across all disciplines in many industries

[Ref: Lecture by Dr. Daria Kotys-Schwartz to ASME Board on Nuclear Codes & Standards at University of Colorado at Boulder, Sept. 18, 2007]



Demographics of Today's Workforce

58,400 direct nuclear plant employees



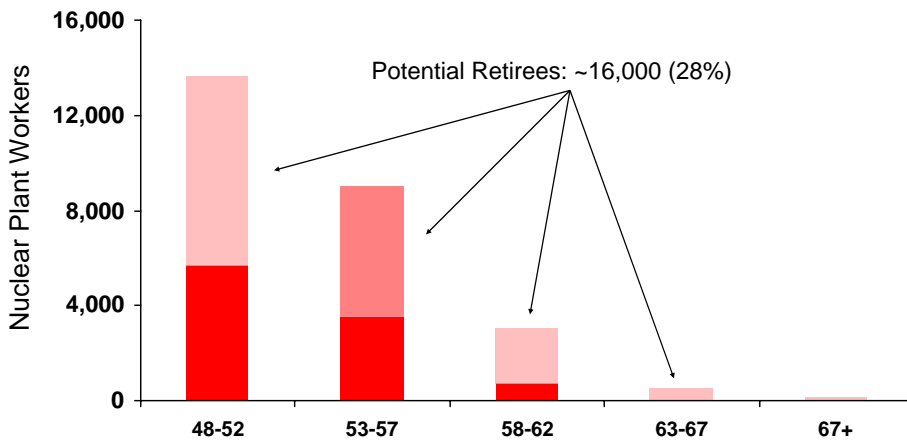
Source: 2003 NEI Nuclear Staffing Survey
Last Updated 12/04/03



21



2003 Survey Findings



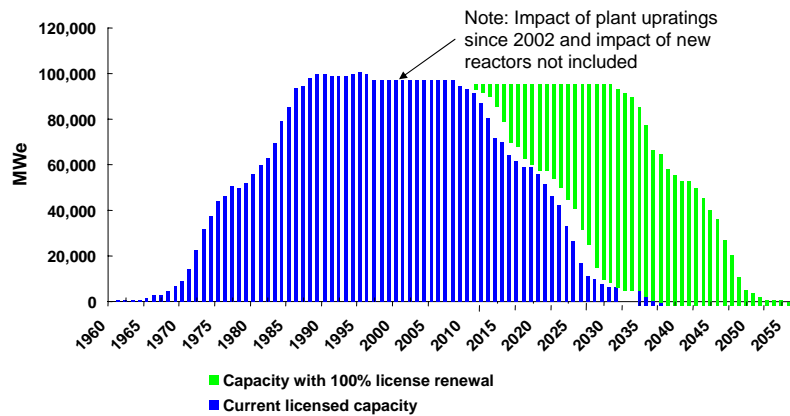
Potential Retirees are defined as employees that will be older than 53 with 25+ years of service, or older than 63 with 20 years of service, or older than 67 within the next five years.

Source: NEI Nuclear Staffing Survey
Last Updated 12/4/03



22

U.S. Nuclear Generating Capacity With and Without License Renewal



Source: NRC Info Digest 2001 Edition - Updated: July 2002

ASME Nuclear Codes and Standards Volunteers

- Approximately 900 volunteers
 - 10% from outside U.S. and rapidly growing
 - <5% women but increasing
 - ~1% under age 30 but increasing
 - <5% under age 40 and increasing
 - Vast majority over age 50 with many in their 60s and several in their 70s and beyond
- Presents enormous challenge for recruiting, retention, and knowledge transfer as the nuclear industry is rapidly expanding worldwide



ASME BNCS Meetings at Universities

- University of Pittsburgh – School of Engineering – October 17-19, 2006
- University of Colorado at Boulder – September 18-19, 2007
- Would like to meet with SUNRISE organization in Atlanta – September 2008



ASME Participation with Universities in Key Initiatives

- **University of Dayton Research Institute** – Lead Investigator – Task 1 - Alloy 800H and Grade 91 Allowables for ASME Gen IV New Reactor Materials Project sponsored by DOE
- Cooperative research projects under DOE Nuclear Energy Research Initiative (NERI)
 - **University of Pittsburgh** (Lead)
 - **University of Michigan** (Lead) – Selected
- **University of Pittsburgh** Proposal to U.S. Department of Labor – Engineering Workforce Challenge in Southwestern Pennsylvania Energy Industry



Potential Research Areas in ASME

Nuclear Codes and Standards – New Reactors

- General
 - DOE Gen IV New Reactor Materials Program
 - New risk-informed, performance-based process for licensing new reactors
 - Process heat applications, particularly for hydrogen generation infrastructure
- New Materials
 - Graphite Core Supports - material properties, risk-informed design
 - Ceramics
 - Use of plastics in pressure boundary applications in light water reactors



Potential Research Areas in ASME

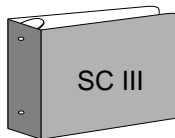
Nuclear Codes and Standards – New Reactors

- Section III
 - Seismic design rules
 - Treatment of environmental fatigue
 - Probabilistic design requirements for new high temperature gas-cooled reactors (HTGRs)
- Section XI
 - Risk-informed in-service inspection requirements for HTGRs
- Committee on Nuclear Risk Management
 - Development of Level 1, 2 and 3 PRA Standards for new reactors for all modes of operation
- Qualification of Mechanical Equipment
 - Risk-informed qualification guidelines of active mechanical equipment

Opportunities in Nuclear

- Take advantage: U.S. NRC and DOE are helping to fund University Nuclear engineering programs
 - NRC Nuclear Education program: Faculty Development \$15 million, Trade school scholarships \$15 million
 - DOE setting aside ~15% of budget for University Nuclear programs
 - ASME Standards Technology, LLC research opportunities through RFP's: \$200K in 2007
 - ASME Standards Technology can be a vehicle for grants or partnerships
-

ASME Nuclear Codes and Standards – Technical Training Material

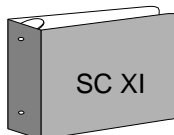


Boiler and Pressure Vessel Code, Section III
Rules for Nuclear Components

Division 1 – 8 Subsections

Division 2 – Concrete Containments

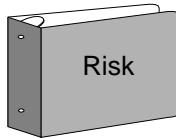
Division 3 – Transport Packaging



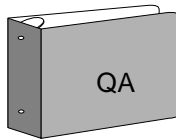
Boiler and Pressure Vessel Code, Section XI
Inservice Inspection



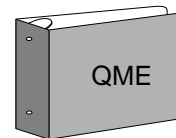
ASME Nuclear Codes and Standards – Technical Training Material



Probabilistic Risk Assessment – RA-S
ASME / ANS Combined PRA Standard



Nuclear Quality Assurance – NQA -1



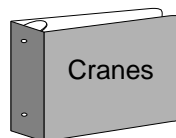
Qualification of Mechanical Equipment – QME-1



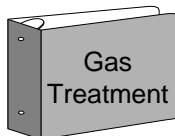
31



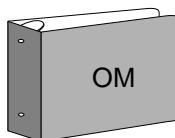
ASME Nuclear Codes and Standards – Technical Training Material



Overhead and Gantry Cranes – NOG-1
Underhung and Monorail – NUM-1



Air and Gas Treatment – AG-1



Operation and Maintenance – OM
Standards and Guides – SG



32



Getting Nuclear Codes & Standards Technology into Engineering Curricula

- ASME Continuing Education Institute (CEI) has courses ready or under development
 - Section III and XI, NQA, PRA and Sections VIII and IX
 - Model exists between ASME CEI, Boeing and Kansas State University
 - ASME on-line classes audited by Kansas State and reviewed for Undergraduate credits
 - Boeing employees take classes and entitled to get either Undergraduate credits or Continuing Education Units
 - Similar approach could be used for Codes & Standards for participation by one or many universities
 - Could also have branded portal (or url page) for each university
-



Summary

- Growing global energy needs are resulting in many nations looking to significantly expand the use of nuclear power
 - Significant U.S. nuclear industry and ASME Nuclear Codes and Standards workforce challenges exist to meet emerging demands
 - The ASME Board on Nuclear Codes & Standards have key initiatives underway to address the global nuclear industry and education needs
 - ASME Nuclear Codes & Standards, ASME Standards Technology, and ASME Continuing Education Institute have approaches to assist with university research and education programs to support global nuclear industry
-

Information Sources on Nuclear Energy

- “www.nuclear.gov” (A DOE web-site)
- “www.nei.org”
- “www.asme.org”
- “www.ans.org”

Questions

