United States Nuclear Regulatory Commission

Protecting People and the Environment

Overview of NRC/DOE February 19-21, 2008 Workshop on U.S. Nuclear Power Plant Life Extension Research and Development ("Life Beyond 60")

R.L. Tregoning
Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission

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Workshop's Goals

- Identify technical issues that may require resolution to support safe long-term operations of light-water reactors (LWRs)
- Identify prioritized research areas
- Identify appropriate responsibilities and roles for industry, DOE, and NRC in potential collaborative research program to ensure continued safe LWR operation
- Presentations and other materials can be found on Workshop's website: http://www.energetics.com/nrcdoefeb08/

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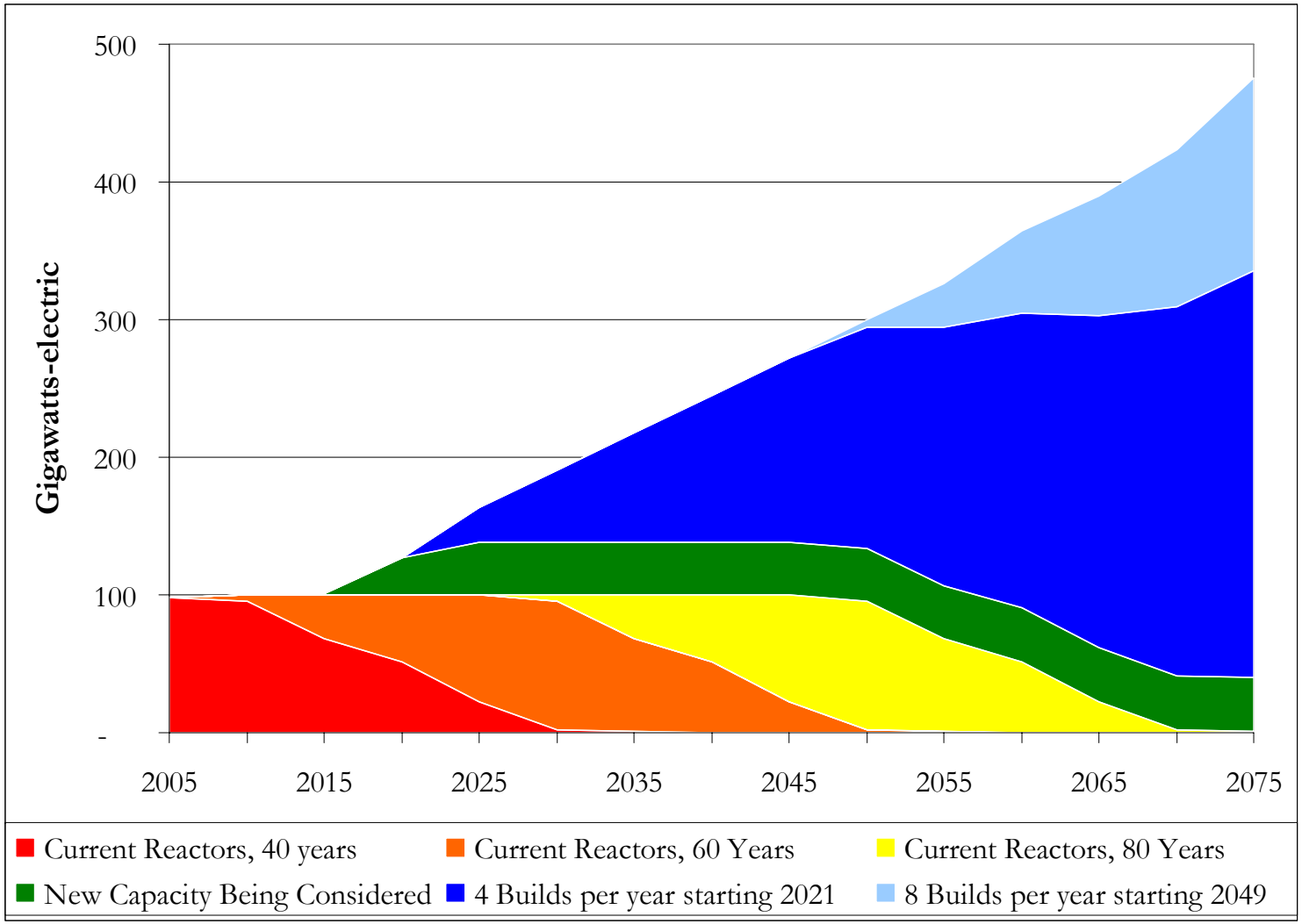
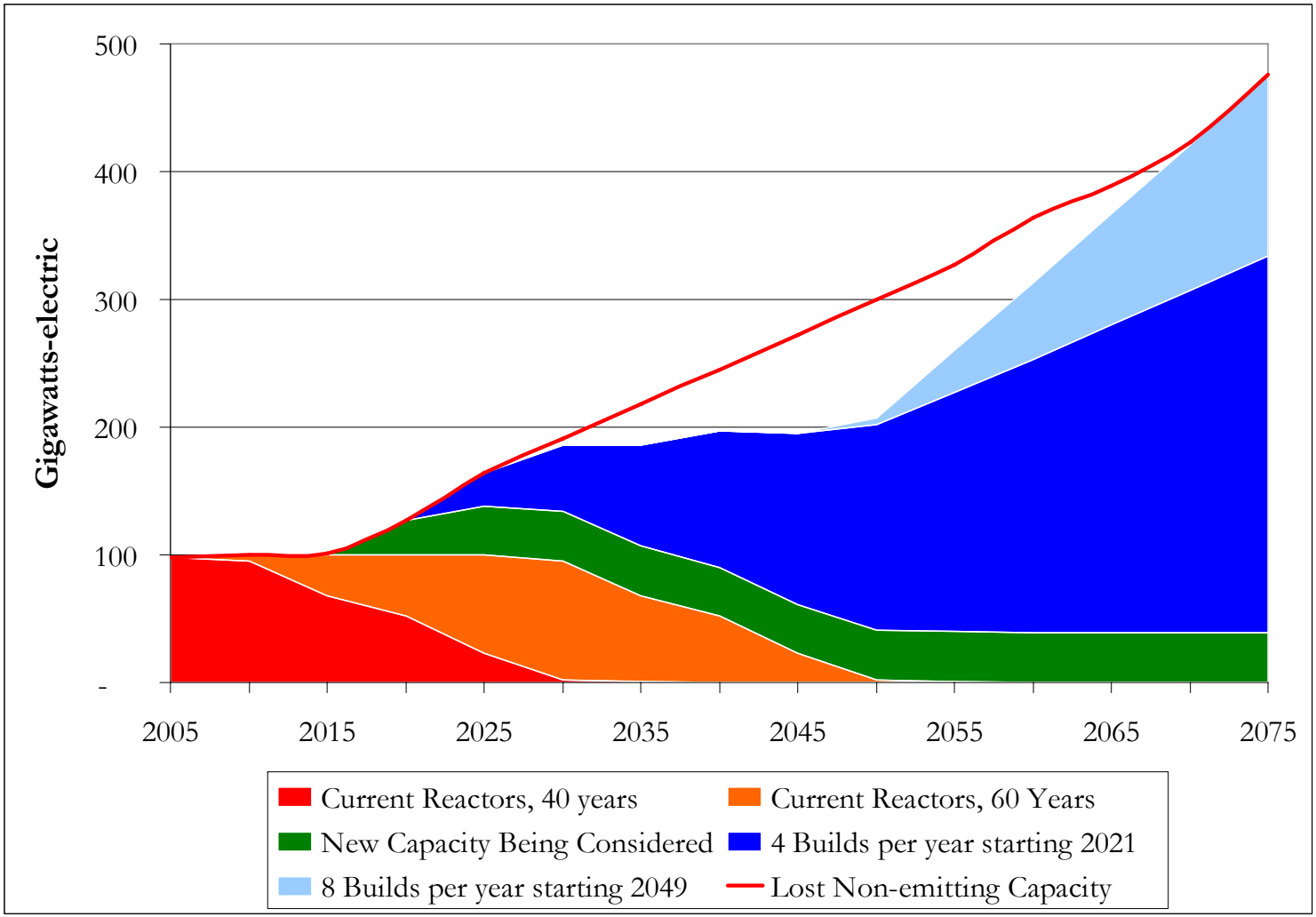
Motivation:
Role in CO_2 Abatement



DOE stated that, to significantly reduce carbon emissions, the United States will need 300 Gigawatts of nuclear power by 2050.

Motivation:
Without 80 year Extensions

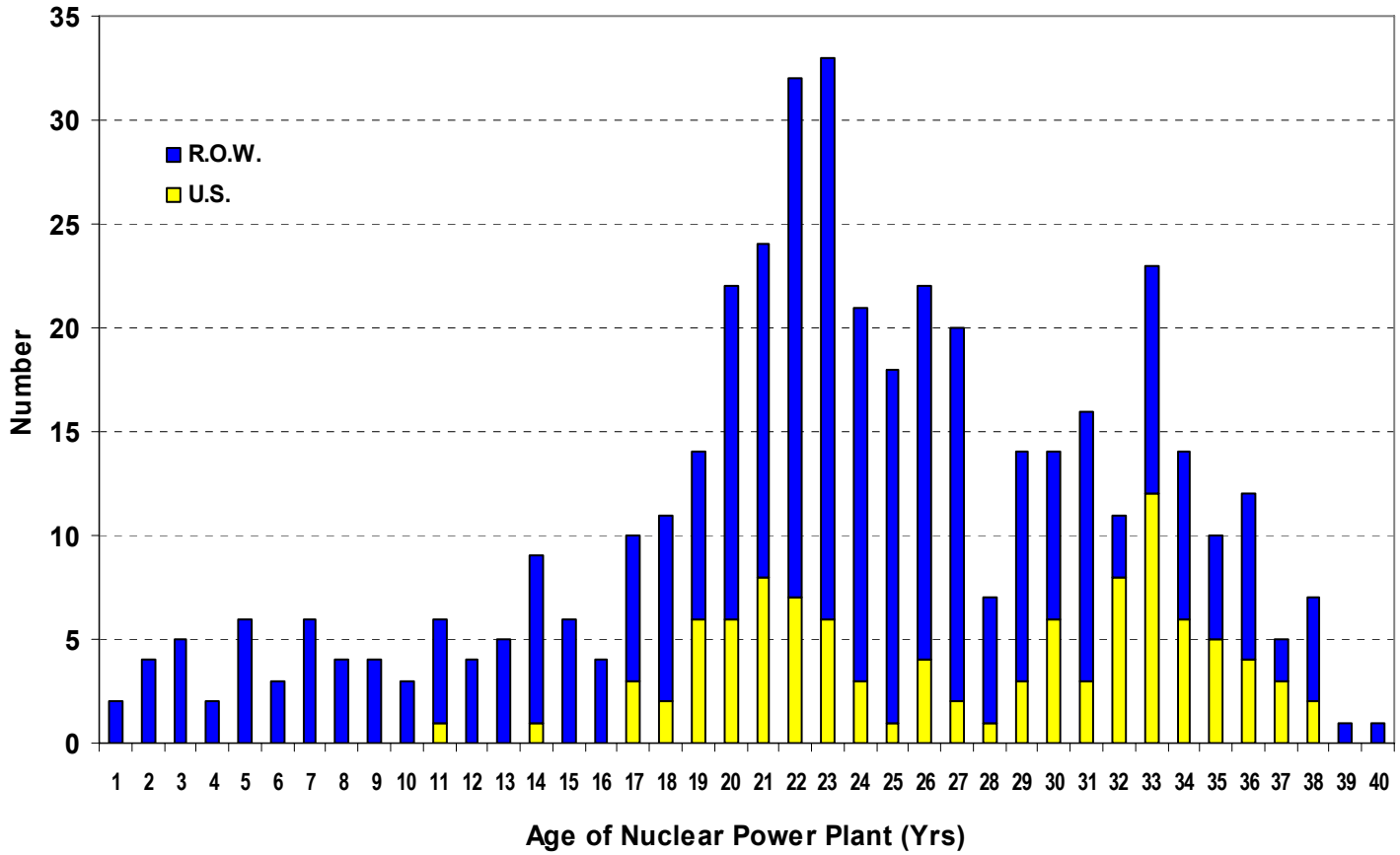


DOE stated that, in total, 15 Trillion Kilowatt Hours and 12 Billion Metric tons of avoided CO_2 emissions would be lost without license extensions.

That total electricity output could provide power to over 70 million households for 20 years

General Observation

Global Status – 435 Commercial Reactors



Workshop Sessions

- Session 1
  - Industry Discussion on Historical License Renewal Efforts
  - Industry Perspective on Future Industry Needs for Continued Operation Beyond 60 Years
- Session 2
  - Long-Term Reliability of Systems, Structures, and Components
- Session 3
  - Management of Age-Related Materials Degradation Issues
- Session 4
  - Determination of New Technologies, Tools, and Applications for Diagnostics and Monitoring

Session 1 Observations

- Interest in subsequent license renewal expressed by all stakeholders
- Existing nuclear plants need to remain a significant part of the nation's energy portfolio to affect climate change and energy security
- No compelling policy, regulatory, or industry issues preclude renewal beyond 60 years
- NRC mandate remains to ensure nuclear plant safety
- International interest is evident in R&D for plant life extension

Session 1 Observations

- 10 CFR 54 (license renewal regulations) has been successfully implemented and does not need to be changed
- Industry suggests that license renewal implementation guidance can be simplified
- Research is necessary to support plant life extension beyond 60 years
- Ultimately, plant life extension is a utility business decision

Session 2 Observations

- No absolute barriers to continued plant operation were identified
- Potential challenges to optimum Long Term Operation (LTO)
  - Need to ensure operating experience is sufficiently captured for passive components (current and replacements)
  - Inspection capabilities, predictive diagnostics
  - Better understanding of analysis limitations in determining service life of equipment, especially for fatigue and environmental qualification
- Systematic component replacement and LTAM (Long Term Asset Management) are important to maintaining long-term reliability
  - Design for inspection, diagnostics (sensors)
  - Better environmental protection (cable, buried piping)
  - Optimize replacement designs (corrosion resistant materials, size for power uprates / improved plant operability)
  - Need LTAM planning for LTO

Session 2:
Additional Research Suggestions

- Create industry-wide passive-System, Structures, and Components (SSC) operating experience database
- Improve inspection, prediction methods (including limited accessibility)
- Expand utilization of retired SSCs
- Develop “sentinel samples” for key knowledge needs
- Develop proactive repair methods
  - Cables, buried pipe
- Integrate technical areas which contribute to degradation (i.e., thermal-hydraulic, materials, loading, risk
- Use risk-informed approach to address aging for LTO

Session 3 Observations

- Tools such as the Materials Degradation Matrix could help target research
  - Environmental effects on fracture resistance/fatigue
  - Stress corrosion cracking (SCC) of nickel-based alloys and stainless steels
  - Effect of fluence on SCC and crack growth
- Coatings important to protect structural materials and piping
- Suggested prioritized research pathways
  - Research to establish effective age management programs
  - Improved models/experiments/probes to understand degradation mechanisms and radiation response

Session 3:
Additional Research Suggestions

- Evaluate combined effects in material aging
- Understand complex aging mechanisms
  - Late blooming phases
  - How microstructure effects bulk properties
- Ensure mitigation procedures are effective over extended life
- Develop concrete damage models and mitigation technology
- Improve inspection technologies for cast-austenitic stainless steels (CASS) and concrete
- Develop alternates to existing coating technologies
- Improve welding processes and weld repairs
- Develop damage tolerant approach to fatigue

Session 4 Observations

- Establish basis for new technologies
  - Goal is simplest and most effective verification of component reliability whether through online diagnostics, current inspection techniques, or other mitigation
- Prognostic tools useful in predicting component failures
  - Established track record in other industries
- Identify proper diagnostic metrics
  - Managing uncertainty in monitoring and prediction is biggest challenge
- Demonstrate that new methods are reliable and cost effective
  - Challenging to adapt laboratory techniques for field use
- On-Line monitoring/diagnostics
  - Use measured plant process parameters and other data in physical or empirical models
  - Examine multiple factors with probabilistic techniques to give early indication of potential aging issues to ensure continued safe operation
  - May allow reduction of some maintenance activities

Session 4:
Additional Research Suggestions

- Develop an NDE/measurements matrix *analog* to material degradation matrix (MDM)
- NDE research (use "measurements matrix" to guide)
  - Concrete: NDE methods and targets
  - Cables: Infared and nanocoatings
  - Cast stainless steel: Ultrasonic capability poor
  - Groundwater protection: buried pipe/tanks, spent fuel pool liner (welds)
  - Global vs local tests: e.g. guided waves, acoustic emission
- Critical issues:
  - Accessibility, design for inspection, validation, applicability/safety
- NDE Needs:
  - Enhanced techniques, mgmt/analysis of large data, personnel
- Online monitoring:
  - Establish failure signature database

Primary Roles/Responsibilities

- Industry: Identify technical issues, initiate needed research, develop solutions, and develop management strategies
- NRC's: Ensure safety through focus on important, independent, confirmatory research
- DOE: Facilitate research and development and coordinate national laboratory efforts
- Research community: Industry, national laboratories, academia, and international organizations should collaborate on necessary research and development