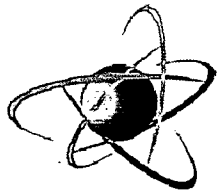

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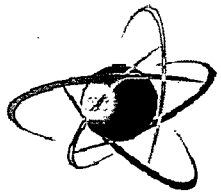
ACRS MEETING WITH THE U.S. NUCLEAR REGULATORY COMMISSION

November 7, 2008



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OVERVIEW

William J. Shack

Accomplishments

- Since our last meeting with the Commission on June 5, 2008, we issued 9 reports:
- Topics included:
  - Security and aircraft impact rulemaking for nuclear power plants
  - Selected chapters of the ESBWR Design Certification Application

- License renewal and stretch power uprate applications
- TRACE thermal-hydraulic system analysis code
- Quality assessment of selected NRC research projects
- PWR sump performance issues

New Plant Activities

- Established design-specific (ABWR, AP1000, EPR, ESBWR, US-APWR) Subcommittees
- Chapter-by-chapter review of the SER for the ESBWR design certification application is progressing
  - Provided four interim letters on 18 Chapters

- **Reviewing topical reports associated with the US-APWR design**
- **EPR Subcommittee participated in the Quadripartite (U.S., France, Japan, and Germany) Working Group meeting on the EPR design**
- **Continue to interact with the NRO staff to establish schedule for review of design certification, early site permit, and COL applications to ensure timely completion of ACRS review**

Ongoing/Future Activities

Advanced reactor research plan

- **Combined license applications**
- **Design certification applications**
- **Digital instrumentation and control systems**
- **Early site permit application (Vogtle)**
- **Extended power uprates**

- Fire protection
- High-burnup fuel and cladding issues
- Human reliability analysis
- License renewal applications
- Next generation nuclear plant (NGNP) project
- PWR sump strainer resolution
- Research quality assessment

- **Revisions to Regulatory Guides and SRPs**
- **Safeguards and security matters**
- **Safety research program report**
- **Seismic issues**
- **State-of-the-Art Reactor Consequence Analyses (SOARCA) Project**
- **Waste management, radiation protection, decommissioning, and materials issues**

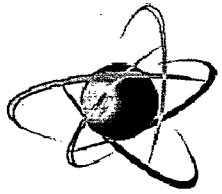
Challenges in CY-2009

- **In CY-2009, ACRS will review several significant matters, including:**
  - **Seven license renewal applications**
  - **AP1000 DCD amendment and ESBWR DC application**
  - **Interim review of EPR and US-APWR DC applications**

  - Interim review of four COL applications
  - Final review of three extended power uprate applications
  - Former ACNW&M activities - significant issues in the areas of Health Physics, Decommissioning, Fuel Cycle, and Low-Level Waste

- At least 50 days of Subcommittee meetings needed for items noted above and other regulatory matters. Any emerging issues would require additional meetings

- **Some meetings may have to be conducted in parallel to meet schedule, which may affect ability of members to fully participate in all reviews of interest to them**
- **Maintain broad expertise, experience, and diversity in Committee membership**



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PWR Sump Performance

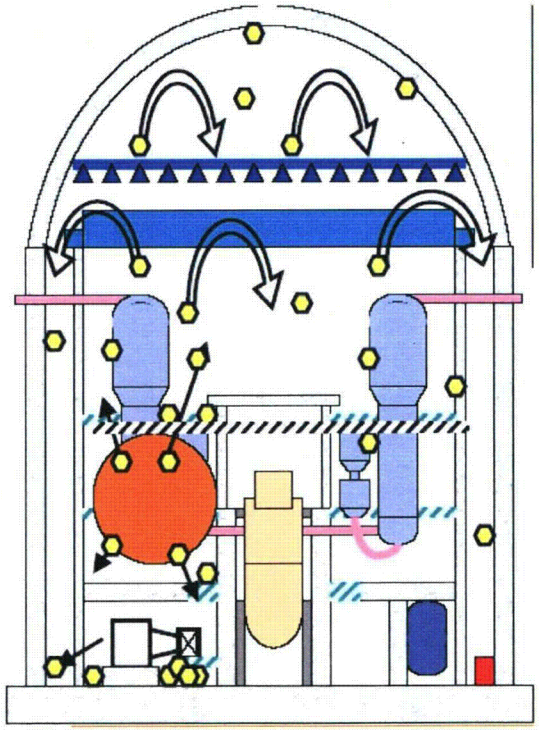
Sanjoy Banerjee

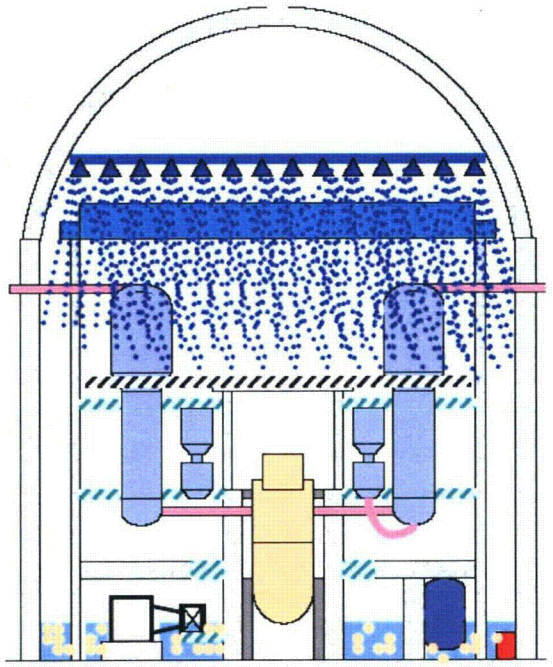
Operating Experience

- Incidents in Barseback-2 (1992), Perry-1 (1993), and Limerick-1 (1995) indicated significant plugging of BWR ECCS Strainers
- Parametric study of screen blockage effects indicated need to evaluate PWRs, leading to Generic Letter 2004-02, which required
  - Evaluation of potential for post-accident debris blockage and prevention of recirculation

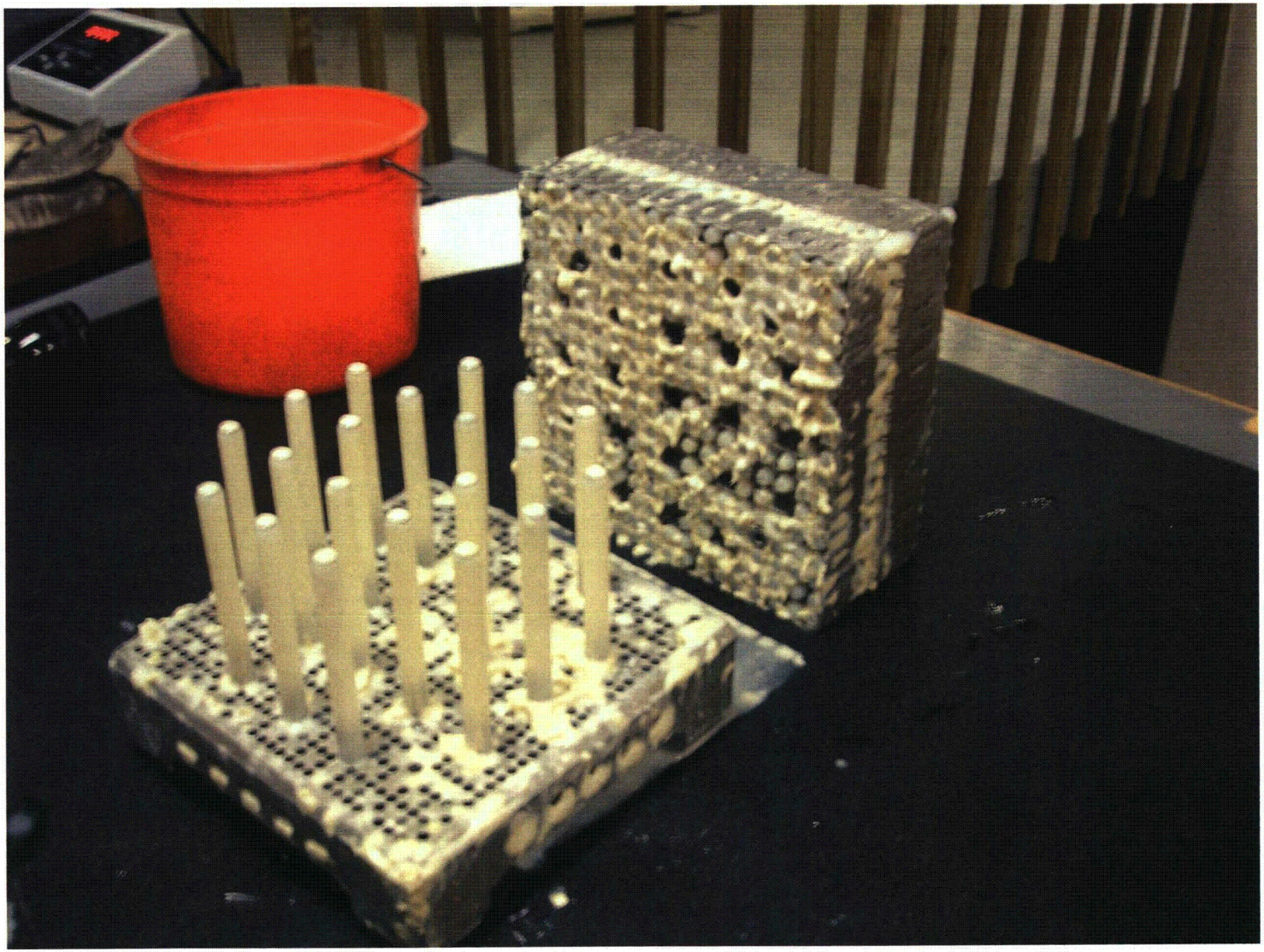
- **Implementation of plant modifications and corrective actions to ensure system functionality**

Schematic of Flow Recirculation Loop and Potential Debris Accumulation Regions (Screens, Core, etc.)





Debris at Core Inlet



GSI-191 Progress

- All licensees have installed significantly larger sump screens
- Some licensees have replaced fibrous insulation, changed chemical buffers, modified water management strategies
- Most licensees have conducted sump screen head loss tests

Status Of Screen Head Loss Tests

- **Plant-specific tests required: plants have different layouts, debris sources, chemical characteristics, screen designs**
- **Guidance for conducting staff reviews and protocols for test procedures have been developed**
- **Staff's review of some tests have been completed, others are in progress**
- **Key issue: do scaled down proof tests extrapolate adequately to plant conditions?**

ACRS Views On Screen Head Loss Tests

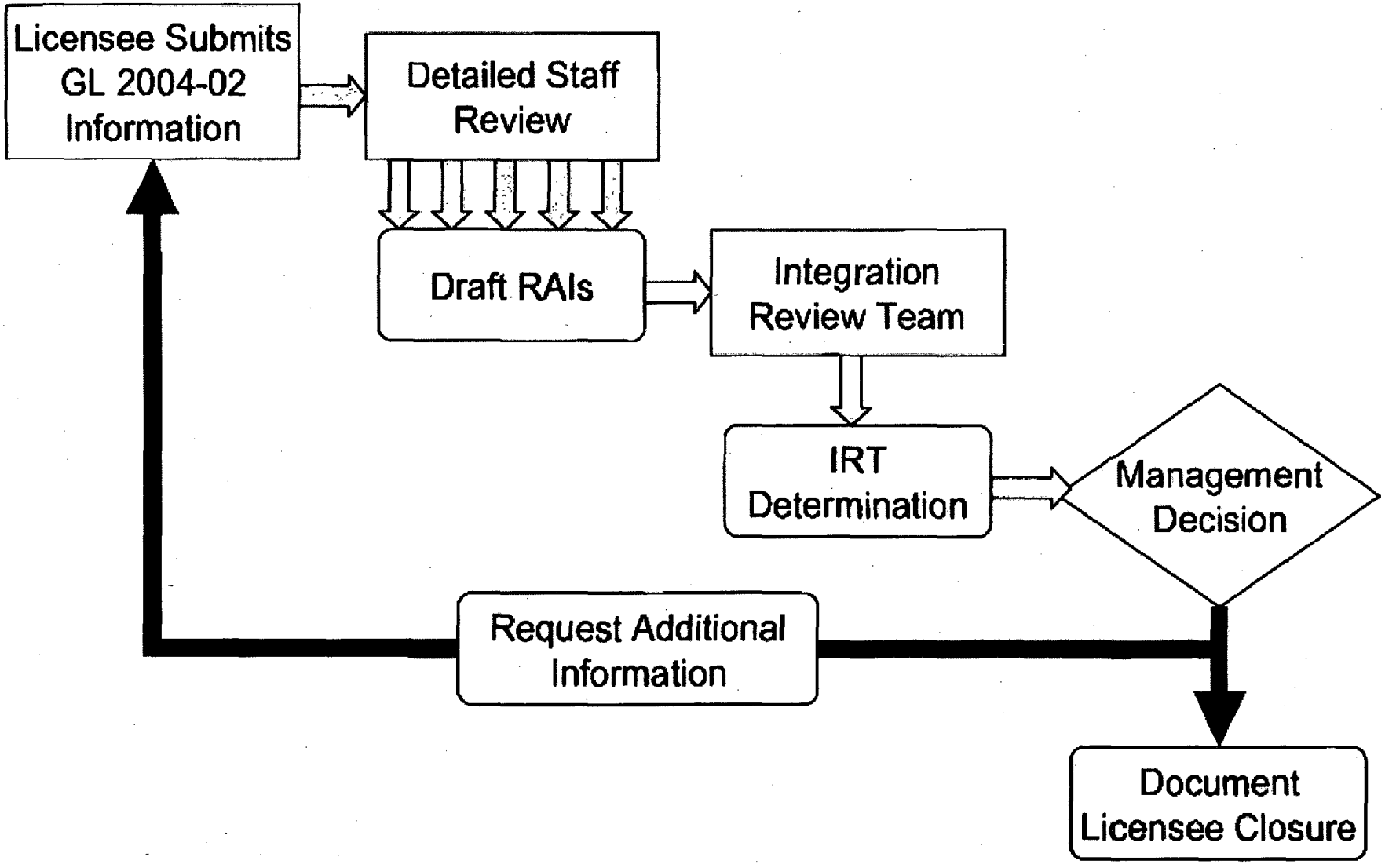
- Tests in which all fine-scale debris is entrained and carried to the screen may be extrapolated to plant scale
- Chemical effects are adequately accounted for
- Further development of test protocols and guidance is required for tests in which a substantial part of debris may settle upstream of the screen

ACRS Views On Downstream Effects

- Core is a second screen (in some sense)
- Ex-vessel effects downstream of the first screen are adequately accounted for
- PWROG investigation of in-vessel effects continuing. PWROG tests must encompass a sufficiently wide range of conditions, including cold-leg breaks

- **Fiber length characteristics and loadings in tests must cover conditions representative of the first few flow passes through core**
- **If debris is uniformly distributed at core inlet, TRACE calculations for cold-leg breaks provide estimates of debris pressure losses that may cause overheating**

STAFF'S CLOSURE PROCESS



- **Staff has proposed a systematic process for closure of GSI-191**
- **Review process complicated by requirements to be plant-specific**
- **Integration Review Team reviews each submission in context of others**
- **ACRS endorses the proposed closure process, and appreciates staff's systematic and deliberate approach to addressing a very complex regulatory issue**

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COMMITTEE VIEWS ON POWER UPRATES FOR BWRs

Mario V. Bonaca

BWR Extended Power Uprates

- **Impact of EPU is highly plant-specific, necessitating focused reviews on:**
  - **Decreases in margins to regulatory limits *(e.g., ATWS peak pressure, peak clad temperature)***
  - **Impacts on equipment and component performance *(e.g., steam dryer performance)***

- **Changes in core and fuel performance *(e.g., fraction of fuel operating near thermal limits)***
- **Impact on systems relied upon to perform safety function *(e.g., containment overpressure credit to ensure adequate NPSH)***

EPU Technical Issues

- Steam Dryer Integrity
- Containment Overpressure Credit

Steam Dryer Integrity

- **Dryer Integrity Resolutions:**
  - **Replacement/Instrumentation**
  - **Use of new and evolving analytical methods to predict loads**
  - **Installation of branch lines to dampen vibrations**
  - **Reliance on power ascension testing**

- **Only Quad Cities Unit 2 and Susquehanna Unit 1 steam dryers were instrumented**

- **Other licensees measure steam line strain data and depend on analytical acoustic-circuit model to infer steam dryer pressure loads**

- **To date, acoustic-circuit model was benchmarked only against Quad Cities Unit 2 measured pressures**
  - **This is limited validation for a model addressing such a complex set of conditions**

- **ACRS accepted Hope Creek EPU application steam dryer evaluations in part because of predicted large margin to the stress limit**

- **Without further validation, we will continue to expect large margin to the stress limit in future applications**

Containment Overpressure Credit

- At EPU conditions, available NPSH for safety systems is reduced
- For some plants, demonstrating adequate NPSH for EPU operation requires:
  - Additional containment overpressure credit
  - Operator action to terminate drywell cooling to increase containment pressure

- **In some cases, pump cavitation is expected even with overpressure credit**

ACRS Position

- COP credit is acceptable:
  - if justified by the approach in RG 1.174, "An Approach for Using PRA in Risk-Informed decisions on Plant-Specific Changes to the Licensing Basis," or
  - if there is no practical alternative and if deterministic analyses show required overpressure is small and duration limited to a few hours

Implications of Staff Position

- **No limit on amount of overpressure and duration is needed, provided available overpressure is supported by conservative calculations**

ACRS and Staff Positions

- Difference of opinion on the duration and magnitude of acceptable overpressure
- Issue was recognized in 1997 and again in 2005
- Proposed Revision 4 to RG 1.82, "Water Sources for Long-Term Recirculation Cooling Following a Loss-of-Coolant Accident," was supposed to address this issue. Proposed Revision was not issued

Browns Ferry Overpressure Credit

- For Browns Ferry Units 1, 2, & 3 EPU (20%) Appendix R scenario, containment overpressure credit of up to 9.3 psi needed for 69 hours
- Drywell cooling is terminated to maximize available overpressure
- Margin between available and required overpressure is as low as 1.6 psi

Browns Ferry Unit 1 Uprate

- In the February 16, 2007 Browns Ferry Unit 1 report on 5% power uprate, ACRS stated that granting of containment overpressure credit during long-term loss-of-coolant accident and 10 CFR Part 50 Appendix R fire scenarios at 120% of the original licensed thermal power will require support by more complete evaluations

Browns Ferry Units 1, 2, & 3 COP Credit

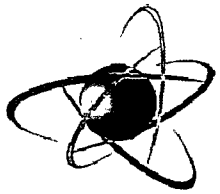
- Viable solutions minimizing need for overpressure credit:
  - Protect a second RHR train for Appendix R scenario
  - Use best-estimate calculation, with uncertainties and biases applied for the LOCA scenario
  - Use more rigorous risk assessment for fire scenario to demonstrate low risk

- **TVA has recently provided additional information to support their request for overpressure credit**
- **We will consider this new information during our formal review of the Browns Ferry EPU Final Safety Evaluation**
- **Difference in staff and ACRS positions needs to be resolved**

Conclusion

- To understand the safety impact of overpressure credit, more information is needed than is available solely from design-basis analyses
- As a minimum, RG 1.82 should be revised to state that when credit for overpressure is requested, additional analyses should be performed to provide more realistic estimates of the actual amount and duration of containment overpressure needed

- **BWROG is developing a more realistic methodology for evaluating COP credit**
- **BWROG methodology is intended to provide more consistent evaluation of COP credit for EPU applications**



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DEVELOPMENT OF THE TRACE THERMAL-HYDRAULIC SYSTEM ANALYSIS CODE

Said Abdel-Khalik

Background

- In the mid-1990s, a decision was made to consolidate the agency thermal-hydraulic analysis capabilities into a single code now called TRACE
- TRACE is intended to serve as the main tool for the confirmatory analyses of a broad range of thermal-hydraulic issues for current and new reactor designs

- **The consolidation proved to be challenging, as anticipated**
- **The models, correlations, and solution methodologies required in-depth review and modification**
- **Extensive validation was performed (data from about 500 experiments in 35 facilities)**

2006 ACRS Report on the NRC Safety Research Program (NUREG-1635, Vol. 7)

- Highest priority should be given to the integration of TRACE code into the regulatory process
- Prioritization of technical improvements might be aided substantially by commissioning a detailed peer review of TRACE

March 22, 2007 ACRS Report

- The schedule for documenting, validating, and peer reviewing TRACE should be accelerated and the work completed expeditiously
- The development of a representative set of TRACE plant models and user testing on applications should also be accelerated to facilitate timely incorporation of TRACE into the regulatory process

September 23, 2008 ACRS Report

- The recently completed peer review identified no major deficiencies that preclude the use of TRACE for confirmatory analyses of postulated LOCAs in current LWRs
- Several improvements have been recommended by the peer reviewers and the staff has proposed a plan to address them. The ACRS agrees with the recommended improvements and the staff's plan

- **Significant progress has been made toward the incorporation of TRACE into the regulatory Process**
- **Further peer review should be conducted to evaluate the applicability of TRACE to new LWR designs, as well as for analysis of coupled reactor physics-thermal hydraulics issues related to EPUs and expanded operating domains**

- **The capability to evaluate uncertainties in its predictions should be incorporated into TRACE**
- **Continued development of TRACE is necessary to keep pace with evolving industry capabilities**

Abbreviations

ABWR	Advanced boiling water reactor
ACNW&M	Advisory Committee on Nuclear Waste and Materials
ACRS	Advisory Committee on Reactor Safeguards
ATWS	Anticipated transient without scram
BWR	Boiling water reactor
BWROG	Boiling Water Reactor Owners Group
CFR	Code of Federal Regulations
COL	Combined license
COP	Containment Overpressure
DC	Design Certification
DCD	Design Control Document
EPR	Evolutionary Power Reactor
EPU	Extended Power Uprate
ESBWR	Economic Simplified Boiling Water Reactor
GSI	Generic Safety Issue
IRT	Integration Review Team
LOCA	Loss-of-coolant accident
LWR	Light water reactor
NGNP	Next Generation Nuclear Plant
NPSH	Net positive suction head
NRC	Nuclear Regulatory Commission
NRO	Office of New Reactors
PCT	Peak clad temperature
PRA	Probabilistic risk assessment
PSI	Pounds per square inch
PWR	Pressurized water reactor
PWROG	Pressurized Water Reactor Owners Group
RG	Regulatory Guide
RHR	Residual heat removal
SER	Safety evaluation report
SRP	Standard Review Plan
SOARCA	State-of-the-Art Reactor Consequence Analyses
TVA	Tennessee Valley Authority
US-APWR	United States – Advanced Pressurized Water Reactor