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United States Nuclear Regulatory Commission

Protecting People and the Environment

ACRS MEETING WITH THE U.S. NUCLEAR REGULATORY COMMISSION

November 5, 2010

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Overview

Said Abdel-Khalik

Accomplishments

- ***Since our last meeting with the Commission on June 9, 2010, we issued 15 Reports:***
- ***Topics:***
  - ***Closure of DAC for New Reactors***
  - ***Draft Final Rule for Risk-Informed Changes to LOCA Technical Requirements (10 CFR 50.46a)***
  - ***Mixed Oxide Fuel Fabrication Facility***
  - ***Application to Amend the Certified ABWR Design to Incorporate the AIA Rule***
  - ***Long-term Core Cooling for the ESBWR***

- ***Topics (cont.):***
  - ***Closure Options for GSI-191***
  - ***Final SER Associated with the ESBWR Design Certification Application***
  - ***SER Related to the South Texas Project COLA Referencing the Certified ABWR Design***
  - ***Risk-informed Regulatory Guidance for New Reactors***
  - ***Digital I&C Interim Staff Guidance on Licensing Process (ISG-6)***

- ***Topics (Cont.):***
  - ***Final SERs Associated with the License Renewal Applications for:***
    - ***Cooper Nuclear Station***
    - ***Duane Arnold Energy Center***
  - ***Regulatory Guides***
    - ***RG1.216, Containment Structural Integrity Evaluation for Internal Pressure Loadings Above Design-Basis Pressure***
    - ***RG 3.74, Guidance for Fuel Cycle Facility Change Processes***
  - ***Standard Review Plan, NUREG 1520, Fuel Cycle Facility License Applications***

New Plant Activities

- ***Reviewing:***
  - ***Amendments to the AP1000***
  - ***DC applications and SERs associated with the US EPR and US APWR designs***
  - ***Adequacy of Long-term Core Cooling Approach for the ABWR and AP1000***
  - ***Reference COLAs for AP1000, ABWR, ESBWR, US APWR and US EPR***
- ***Continuing to complete reviews of available material promptly***

License Renewal

- Completed review of Cooper and Duane Arnold
- Completed interim reviews and will perform final review of Kewaunee, Palo Verde, and Hope Creek
- Will perform interim and final reviews of Crystal River, Salem, Diablo Canyon and Columbia in CY 2011
- Will review updates to the GALL Report and associated SRP

Power Uprates

- ***Will review the Nine Mile Point and Point Beach Extended Power Uprate Applications***
- ***Will review associated topical reports such as:***
  - ***RAMONA5-FA, "A Computer Program for BWR Transient Analysis in the Time Domain"***
  - ***Supplements to NEDC-33173P-A, "Applicability of GE Methods to Extended Operating Domains"***

Other Ongoing/Future Activities

- ***Staff's paper on CAP***
- ***SOARCA***
- ***Safety Culture***
- ***Fire Protection***
- ***Digital I&C***
- ***10 CFR 50.46(b)***
- ***Comparison of ISA and PRA for Fuel Cycle Facilities***
- ***Small Modular Reactors***
- ***Proposed rules and regulatory guidance***
- ***Emerging technical issues***

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ABWR Aircraft Impact Assessment

Said Abdel-Khalik

Aircraft Impact Assessment

- ***New nuclear power plant applicants must perform an aircraft impact assessment (AIA - 10 CFR 50.150)***
- ***AIA does not need to be submitted to NRC, but will be subject to inspection by the NRC***

- ***Realistic analyses to identify and incorporate design features and functional capabilities needed to show that, with reduced use of operator action:***
  - ***Reactor core remains cooled or containment remains intact***
  - ***Spent fuel cooling or spent fuel pool integrity is maintained***

ABWR Amendment

- ***STP Application to amend ABWR design to address AIA submitted on June 30, 2009***
- ***Future COL applicants can address the requirements of 10 CFR 50.150 by referencing amended ABWR standard design***

- ***ACRS Reviewed:***
  - ***AIA made available by the applicant***
  - ***Associated safety evaluation and inspection report***

- ***Review process to be followed for other design centers***

September 20, 2010 ACRS Report

- ***Staff inspection of the applicant's AIA was thorough - maintaining same personnel with high-level skill in reviewing the application and performing the inspection significantly enhanced quality***
- ***The application and SER are acceptable subject to satisfactory closure of the issues identified in the Notice of Violation & our Recommendation***

September 20, 2010 ACRS Report

- ***The staff should ensure that the applicant demonstrates that the temperature within the fire-protected area where the AFI system instrument rack is to be located will not exceed the instruments' environmental qualification conditions***
- ***The staff should ensure that the assumptions and initial conditions credited in the applicant's AIA are properly incorporated into the amended DCD***

September 20, 2010 ACRS Report

- ***The staff should ensure that COL applicants referencing this amendment have an appropriate process to assure the reliability of the AFI system***
- ***The staff should complete the lessons-learned review to identify any deficiencies in the AIA Inspection Procedure and the industry AIA methodology***

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Risk-Informed Changes to Loss-of-Coolant Accident Technical Requirements (§ 50.46a)

William J. Shack

Background

- *In March 2003, the Commission approved the staff's recommendations related to possible changes to LOCA requirements and directed the staff to prepare a proposed rule (§ 50.46a) that would provide a risk-informed alternative maximum break size*
- *ACRS Nov. 16, 2006, letter recommended that the 2006 version of the proposed rule not be issued*
- *The staff further met with ACRS in May 2009 and September/October 2010*

Overview of the § 50.46a Rule

- ***ECCS Analysis Requirements***
- ***Breaks < Transition break size (TBS)***
  - ***No change from current §50.46***
- ***Breaks > TBS***
  - ***No single failure assumption***
  - ***Credit for offsite power***
  - ***Credit for non-safety equipment***
  - ***Alternative metrics for "coolable geometry" may be used, if justified***

Overview of the § 50.46a – Cont.

Risk-Informed Acceptance Criteria

- ***For changes submitted for NRC review***
  - ***"very small" cumulative risk increase***
- ***For self-approved changes***
  - ***"minimal" risk increase***
  - ***§50.59 is satisfied***
- ***For all changes***
  - ***defense-in-depth***
  - ***safety margins***
  - ***monitoring program***

ACRS Letter November 16, 2006, on Needed Revisions to Proposed Rule

- ***Needed to strengthen the assurance of defense in depth for breaks beyond the transition break size (TBS)***
- ***Magnitude of the increases in risk that could occur due to changes that did not require prior NRC approval inconsistent with usual RG 1.174 guidance***

ACRS Letter November 16, 2006, on Needed Revisions to Proposed Rule

- ***Needed to address revised 50.46(b) guidance for cladding failure***
- ***Needed to perform plant-specific analyses to assure applicability of NUREG-1829 and NUREG-1903 results on transition break size***

Resolution of ACRS Comments in Draft Final Rule

- ***Requires licensees submit the codes used for the analyses of breaks beyond the TBS to the NRC for review and approval***
- ***Process for changes that can be made without prior NRC approval has been revised and is now acceptable***

Resolution of ACRS Comments in Draft Final Rule (cont')

- ***Rule still reflects current 50.46(b) cladding failure criteria. However, additional research has increased our understanding and a Notice of Advanced Rulemaking has been published and staff acknowledges rule will have to be revised if 50.46(b) is updated. We now find it acceptable to proceed***

Resolution of ACRS Comments in Draft Final Rule

- ***Requires plant specific demonstration that results of NUREG-1829 and NUREG-1903 for transition break size are applicable***
  - ***August 23, 2010, version required only demonstration that results on direct break sizes are applicable***
  - ***In response to ACRS comments the September 27, 2010, version was revised to also require a demonstration that results on indirect break sizes are applicable***

Resolution of ACRS Comments in Draft Final Rule (cont)

- ***With these changes we find Draft Final Rule 50.46a an acceptable risk-informed alternative to the current 10 CFR 50.46(a) for operating reactors***

Application of Risk-Informed 50.46a to New Reactors

- ***Current version of Draft Proposed Rule is applicable to new reactors***
  - ***TBS determined on a plant-specific basis***
- ***ACRS agrees that improved material selection, water chemistry, and design practices will further reduce the likelihood of large LOCAs***
- ***Premature to extend the proposed 10 CFR 50.46a to new reactors at this time***
  - ***Risk profiles are significantly different from current reactors***
  - ***Appropriate risk metrics and risk acceptance criteria are still being developed***

Application of Risk-Informed 50.46a to New Reactors (Cont)

- ***Risk informed changes should not result in a significant decrease in the level of safety otherwise provided by the certified design***
  - ***Language is consistent with Option 2 of recent SECY, but even if approved by Commission specific guidance would need to be developed***
  - ***Rule should be based on specific guidance rather than a concept not yet clearly defined***

Application of Risk-Informed 50.46a to New Reactors (Cont)

- ***If new reactors are included in the scope of the rule, then the requirement that the adoption of the rule should not result in a significant decrease in the level of safety should apply to all risk-informed elements including determination of allowable time without capability to mitigate a beyond-transition break size LOCA***

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MOX Fuel Fabrication Facility

Dana Powers

Background

- ***Mixed oxide (MOX) facility being built for the U.S. DOE by MOX Services, LLC at Savannah River Site***
- ***Will convert weapons-grade PuO_2 to MOX fuel for use in commercial nuclear power plants***

Background (Cont)

- ***Strategy for processing plutonium and fabricating fuel is patterned after system used in France***
- ***Builds upon substantial U.S. experience with use of PUREX process***
- ***MOX process is simpler, no large inventory of fission and neutron capture products***

Background (Cont)

- ***NRC review process involves two stages:***
  - ***Construction Authorization Request***
  - ***License to possess and use special nuclear materials***

ACRS Report, February 24, 2005

- ***ACRS previously reported on Safety Evaluation of Construction Authorization Request***
  - ***highlighted the need for the license application to address criticality, hydroxylamine nitrate, the "red oil" phenomena, and glove box fires***

ACRS Report, September 27, 2010

- ***Recent review of safety strategies revealed no deficiencies***
  - ***Adequate shielding and filtration to protect the public***
  - ***Uses practices that have been proved effective***
  - ***Had gone beyond Defense Nuclear Facilities Safety Board recommendations***

ACRS Report, September 27, 2010 (Cont)

- ***The Staff has prepared an adequate Safety Evaluation Report for the Mixed Oxide Fuel Fabrication Facility and the report should be issued***
- ***The proposed facility can be constructed, operated, and maintained with no undue risk to the public health and safety***

Path Forward

- ***Construction of the facility will be verified by inspection prior to granting a license to possess and use special nuclear material***
- ***The ACRS will revisit the safety evaluation of the MOX facility as construction approaches completion***

ESBWR Long-Term Core Cooling

Michael L. Corradini

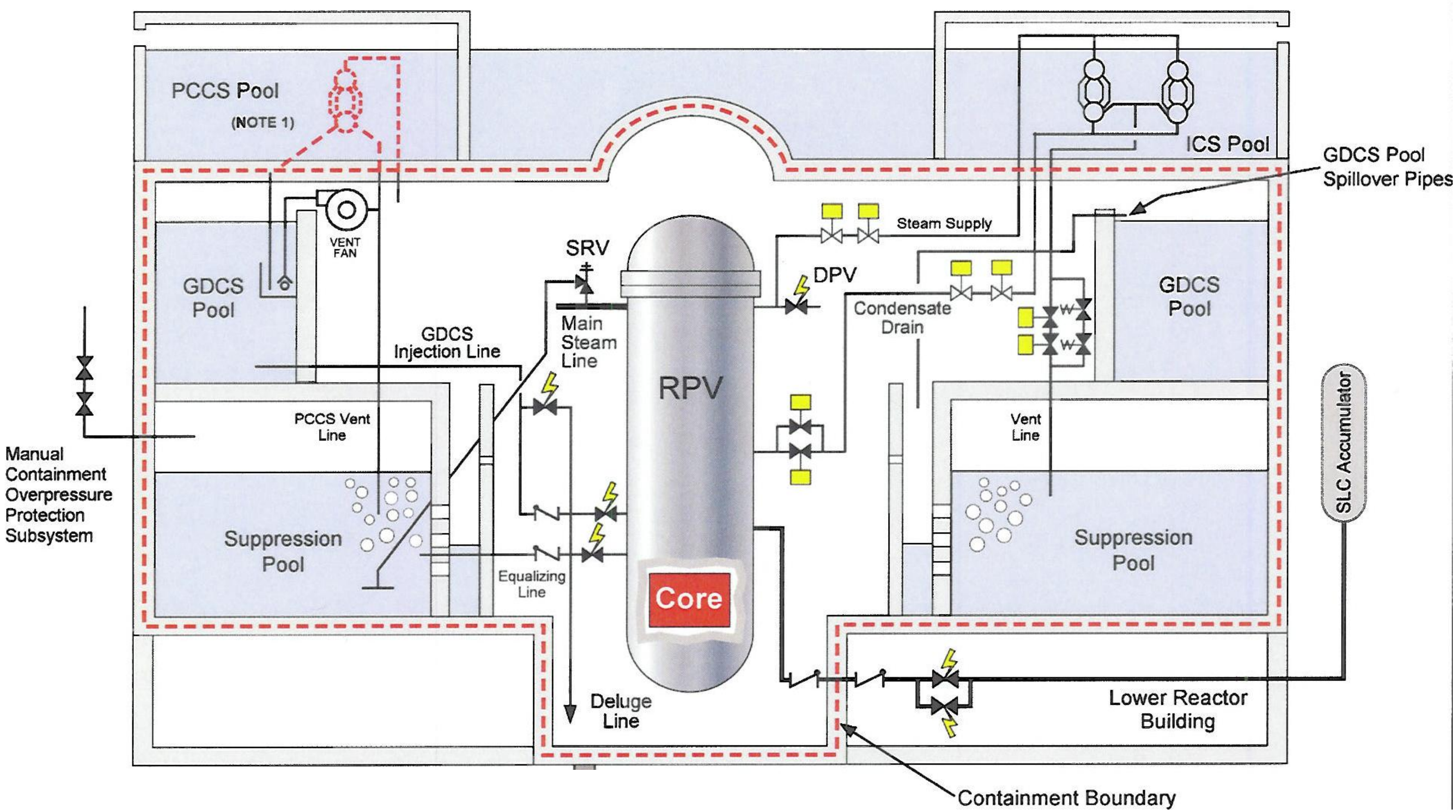
- ***On May 8, 2008, the Commission requested the ACRS to advise the staff and Commission on the adequacy of the design basis long-term core cooling approach for each new reactor design based, on either its review of the design certification or the first license application referencing that reactor design***

- ***The ESBWR is an advanced light water reactor design that uses a direct-cycle power conversion system driven by natural circulation in the reactor vessel***

- ***A passive ECCS is designed to perform its intended function without the need of emergency AC power systems for core cooling during the first 3 days following a reactor transient or accident. The design employs Isolation Condensers and a Passive Containment Cooling System (PCCS) to transport heat to the ultimate heat sink for all accident scenarios.***

- ***The ESBWR design has a long-term core cooling mode that is qualitatively different from current reactors, since its passive safety systems can respond to a design basis accident without recirculation through the suppression pool.***

Schematic of ESBWR Containment



- ***The generic issues that have normally raised concerns for long-term core cooling in a recirculation mode for the ECCS are not present in this design because of the following:***

– ***No fibrous insulation is used in the plant design, all containment surface coatings are qualified, and no complex water chemistry is present.***

- ***The debris which reaches the suppression pool is not transported to the PCCS. The recirculation cooling path for long-term core cooling is wet steam into the PCCS, condensate from there to the Gravity-Driven Cooling System, and then back to the reactor vessel.***

Conclusion

- ***ACRS concurs with the staff's assessment that the regulatory requirements for long-term core cooling for design basis conditions have been adequately met and this issue can be closed for ESBWR***

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Closure of Design Acceptance Criteria for New Reactors

Dennis C. Bley

ACRS Report, August 9, 2010

1. ***DAC closure requires expertise, judgment, and interpretation. It should be performed by NRC staff experts with an independent assessment by the ACRS***
2. ***It is preferable that all DAC be resolved no later than the COL stage. However, whether resolved as part of the COL process or post-COL, proper closure of DAC requires a consistent scope and depth of evaluation in accord with our first recommendation***

Background

- ***Statements of Consideration (SOC) for 10 CFR Part 52 state that Early Site Permit, Design Certification, and COL processes do not eliminate any material safety issue from consideration, they just move their resolutions to earlier review stages***
- ***In essence, NRC cannot allow operation of a nuclear power reactor unless all material safety issues are resolved***

Statements of Consideration

"The Commission does not believe that it is prudent to decide now, before the Commission has even once gone through the process of judging whether a plant built under a combined license is ready to operate, that every finding the Commission will have to make at that point will be cut-and-dried-proceeding according to highly detailed "objective criteria" entailing little judgment and discretion in their application, and not involving questions of 'credibility, conflicts, and sufficiency' "

Background

- ***Part 52: conformance with certified design verified through ITAAC***
- ***Practicalities led staff to develop concept of special kind of ITAAC called DAC***
- ***DAC, as presently constituted, are clearly among those issues for which judgment will be required in order to reach a finding that the acceptance criteria have been satisfied***

History of DAC

- **SRM on SECY-90-377 "Requirements for Design Certification under 10 CFR Part 52"**
  - **Applications for design certification reflect a design that is complete except to accommodate as-procured hardware characteristics**
- **1990 ACRS Report on SECY-90-377**
  - **Agreed with process and recommended that the staff focus the scope on that needed for safety**

History of DAC

- ***The concept of DAC was introduced in SECY-92-053, "Use of DAC During 10 CFR Part 52 Design Certification Reviews," dated February 19, 1992, and written in response to the Commission's SRM on SECY-90-377, dated November 7, 1991***
  - ***identified need***
  - ***identified potential pitfalls***

History of DAC - SECY-92-053

- ***Defined DAC as a set of prescribed limits, parameters, procedures, and attributes in a limited number of technical areas***
- ***DAC were to be objective (measurable, testable, or subject to analysis using pre-approved methods) and were to be sufficiently detailed to provide an adequate basis for the staff to make a final safety determination regarding the design***

History of DAC - SECY-92-053

- ***Recognized that "…although there is nothing in Part 52 which would necessarily limit the use of DAC, the staff believes that the use of DAC should be limited"***
- ***"restrictions should be based upon a consideration of those design areas affected by rapidly changing technologies"***

ACRS Feb 14, 1992, Report

- ***Supported limited DAC approach***
- ***Carefully defined limits relating to scope and extent of design coverage should be placed on the use of DAC***
- ***Use of DAC should be limited to that portion of each given design feature where either the technology is still evolving or the required information is unavailable for good reason***

ACRS Feb 14, 1992, Report

- ***In any case, DAC should be used only when it is possible to specify practical and technically unambiguous criteria***
- ***DAC can hide unforeseen systems interactions that might be uncovered if an actual design were available***

ACRS Feb 14, 1992, Report

"If DAC are employed extensively in lieu of design detail, this would place an additional design burden on the COL holder and create a possible discontinuity in the design and review process that may be adverse to safety"

History of DAC

- ***Later in the same year ACRS formed an Ad Hoc Subcommittee on DAC in response to a Commission SRM issued on April 1, 1992. Staff and the ACRS appear to have come to quick agreement on Radiation Protection, Piping Design, and Control Room Design (now part of Human Factors Engineering) for ABWR DAC. I&C DAC were more troublesome and never appear to have been completely resolved***

ACRS Oct 16, 1992, Report

"Finally, we are concerned about the significant number of post-design certification activities associated with these two DACs – control room design, and I&C. The COL applicant or holder will be responsible for carrying out these activities. This will involve extensive future negotiations with the staff. It will also have the effect of diminishing the value of certified designs and seems to us to be contrary to the spirit of 10 CFR Part 52"

ACRS Oct 16, 1992, Report

"We believe that the argument that these DACs represent areas of rapidly changing technology is being overplayed by both the staff and GE in justifying the extent to which the DAC process is being used"

ACRS Expectations

- ***DAC would be limited to the extent possible and generally closed by the time of the COL issuance***
- ***For DAC to be closed after COL and before fuel load, Staff evaluation of ITAAC used to close DAC would be thorough***
- ***ACRS would be involved in Staff evaluation of DAC closure, at least for the first applications***

Observations for DI&C DAC

- ***DI&C systems for new designs are highly integrated and pervasive, affecting nearly all plant equipment***
- ***Unanticipated failure modes could create very confusing situations that could place the plant or lead operators to place the plant in unexpected or unanalyzed configurations***

Observations for DI&C DAC

- **Five keys to reliability of DI&C**
  - Essential objective design principles: redundancy, independence, determinant data processing & communication, defense-in-depth & diversity
  - Subjective attribute, simplicity
- **DI&C design can be functionally specified and shown to meet the essential criteria regardless of the parts technology**

Observations for DI&C DAC

- ***Some essential design principles (e.g., redundancy & defense-in-depth) can be specified in functional block diagrams in DCD and verified by objective ITAAC***
- ***Some (e.g., determinant data processing) must be confirmed as implemented in the final design of the DI&C systems***

Observations for DI&C DAC

- ***Despite ability to eliminate many DI&C DAC from design certifications or COL applications, most are not planned to be resolved until after COL issuance***
- ***More DAC than necessary***

Observations for DI&C DAC

- ***Many current DI&C DAC are not technically unambiguous***
- ***Many DI&C DAC are process oriented, but only an evaluation of the complete design can reveal the intricacies of possible interactions and failures, especially common cause and other dependent failure mechanisms***

ACRS Report, August 9, 2010

1. ***DAC closure requires expertise, judgment, and interpretation. It should be performed by NRC staff experts with an independent assessment by the ACRS***
2. ***It is preferable that all DAC be resolved no later than the Combined License (COL) stage. However, whether resolved as part of the COL process or post-COL, proper closure of DAC requires a consistent scope and depth of evaluation in accord with our first recommendation***

ACRS Report, October 20, 2010

- ***If applicant provides additional descriptive information--integrated system logic diagrams and detailed functional descriptions--reviews would be simpler and safety judgments more robust***
- ***Lack of sufficient ESBWR DI&C design information led to commitment to revise DCD with sufficient expanded functional descriptions and DAC/ITAAC to support safety finding***

Path Forward

- ***Several subcommittees are struggling with DI&C DAC***
- ***We are following the work of staff's Task Working Group on DAC Closure***
- ***Subcommittee meeting October 21, 2010, staff presented examples and discussed state of plans for DAC closure***

Abbreviations

ABWR	Advanced Boiling Water Reactor
AC	Alternating Current
ACRS	Advisory Committee on Reactor Safeguards
AFI	Alternate Feedwater Injection
AIA	Aircraft Impact Assessment
APWR	Advanced Pressurized-water Reactor
AP1000	Advanced Passive 1000
BWR	Boiling Water Reactor
CAP	Containment Accident Pressure
CFR	Code of Federal Regulations
COL	Combined License
COLA	Combined License Application
CY	Calendar Year
DAC	Design Acceptance Criteria
DC	Design Certification
DCD	Design Control Document
DI&C	Digital Instrumentation & Control
DOE	Department of Energy
ECCS	Emergency Core Cooling System
EPR	Evolutionary Power Reactor
ESBWR	Economic Simplified Boiling Water Reactor
GALL	Generic Aging Lessons Learned
GE	General Electric
GSI	Generic Safety Issue
ISA	Integrated Safety Analysis
I&C	Instrumentation & Control
ISG	Interim Staff Guidance
ITAAC	Inspection, Test, Analysis, And Acceptance Criteria
LOCA	Loss of Coolant Accident
LTR	Licensing Topical Report
MOX	Mixed Oxide
NRC	Nuclear Regulatory Commission
PCCS	Passive Containment Cooling System
PRA	Probabilistic Risk Assessment
P_UO2	Plutonium Dioxide
PUREX	Plutonium – Uranium Extraction
RG	Regulatory Guide
SECY	Secretary of Commission
SER	Safety Evaluation Report
SOARCA	State-of-the-Art Reactor Consequence Analyses
SOC	Statements of Consideration
SRM	Staff Requirements Memorandum/Memoranda
SRP	Standard Review Plan
STP	South Texas Project
TBS	Transition Break Size