Overall Licensing Approach for ACR

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CANDU Plants are Safe

- ACR builds on foundation of decades of successful CANDU design and operation
- Technology is mature and well-supported
  - Familiarization sessions with USNRC
- CANDU has been a single design concept with AECL responsible for design as well as both project and technology R&D
  - Close ties to Canadian and foreign CANDU operating utilities, IAEA
- Experienced, knowledgeable Canadian regulator with long track record on CANDU reactor licensing
- Successfully licensed in four other countries using Canadian experience as a basis

Licensing Objectives are Similar

- Canadian and US objectives similar at a high level
  - Consistent with IAEA and Western reactor approach to defense-in-depth
  - Water reactor technology largely common
- Implementation differs
  - Canadian approach is non-prescriptive, emphasizes safety goals
    - Innovation encouraged in meeting goals
    - Reliability targets in design and operation
    - Acceptance criteria more restrictive for more frequent events
    - Burden of proof on applicant, CNSC closely examines the proof
  - Canadian regulatory requirements largely specific to CANDU design
  - US licensing is more prescriptive for traditional LWRs

Design and Licensing are Tied

- Approach to safety in CANDU inextricably linked to the design, and both are linked to licensing
- CNSC develop & maintain licensing technology of CANDU
- Important to start from a safety / licensing approach that has been proven
- NUREG-1226 is supportive of licensee proposing new acceptance criteria that better suit new reactor designs (e.g. like the Canadian approach)

USNRC LWR Requirements & ACR

- 10CFR50 covers 'light water reactors'
- ACR is a light-water cooled reactor but not a pressure-vessel reactor
- Those USNRC requirements which are specifically linked to light-water coolant are relevant to ACR (e.g. technology basis)
- Some USNRC requirements *explicitly* pertain to reactor vessels (e.g. 50.61) and are not applicable to ACR
- Many USNRC 'LWR' requirements based *implicitly* on pressure vessel aspect, not light-water aspect, and are not applicable to ACR

Pressure Vessels vs. Pressure Tubes

- USNRC limit of 2200ºF in LOCA relevant to proximity of fuel assemblies to other fuel assemblies, and control rods. In ACR, each fuel pin is no further than 3 inches away from a backup heat sink; and control & shutdown rods are in the separate cool moderator.
- Avoidance of fuel damage in LWRs relevant to uniformity of core behaviour. In ACR, some accidents which damage fuel *inherently* limited to one channel, which dilutes the risk.
- Need for large, fast inherent negative reactivity feedback in LWRs relevant to rod ejection. In ACR, the reactivity coefficients are negative and small, and the control rods have low worth, so that there is no way to add *large* amounts of positive reactivity quickly.

Pressure Tubes vs. Pressure Vessels

- Core pressure boundary failure limited in size to one 5” channel
  - Moderator is an energy absorber
  - Prevent: failure propagation, impairment of SDS1
- Accidents in one channel can lead to high fuel temperatures in that channel, but amount of fuel at risk is small & rest of core remains cooled
- Severe core damage accident progression is slow, and channel failures are spread out over a long period of time (hours)
  - 5 times as much water surrounding the core as in the RCS, connected to 25 times as much water in the elevated Reserve Water Tank

North American Deployment

- US and Canadian regulatory bodies each retain legal authority in its country & must fulfill its statutory duties
- GOAL is one set of requirements that appropriately address the characteristics of the design
  - Avoid simple sum of both the US and Canadian regulations
- Canadian requirements are a vital part of this goal
- Include relevant parts of US experience with new designs
- Creates management challenge to both CNSC and USNRC to communicate this goal and implement it in their organizations

AECL's Overall Licensing Approach

- Generic ACR designed according to Canadian requirements where considered applicable by AECL
  - Proposals from AECL to CNSC on application of some regulatory documents
- Show equivalence to the US requirements (i.e., 10CFR, SRP, Reg. Guides, NUREGS etc.) for the aspects of the design that are similar to pressure-vessel LWRs
- Use Canadian requirements directly for CANDU-unique aspects
- Use the less prescriptive Canadian approach where it has been shown to be beneficial and/or there is an absence of applicable NRC criteria
  - Consistent with NUREG-1226 except CANDU has a licensing track record
  - Opportunity for improved safety & flexibility in regulatory approach
- Use lessons learned from US experience
- Promotes innovative enhancement of safety in advanced designs

AECL's Activities Leading up to SDC

- Familiarization of USNRC
  - Familiarization meetings – broad technology base complete
  - Some key codes transferred
  - Move into phase of identifying issues, R&D, costs, schedule
- Detailed review of US GDC, SRP, Reg. Guides, etc.
  - Joint with Bechtel as US-knowledgeable consultant
  - Classify each item as:
    - Equivalent or identical to Canadian requirement, or CANDU practice meets intent of US requirement
    - Not relevant to pressure-tube concept
    - Fundamental difference in approach which could require design / analysis change or application of a new regulatory approach

AECL's Activities Leading up to SDC – cont'd

- Incorporation of results of pre-application review
- Production of generic safety analysis report (SAR) & Probabilistic Risk Assessment (PRA)
- Adaptation of SAR (& PRA) to US format & content
- Production of all other submissions required for SDC

Schedule

- Schedule of deliverables to CNSC and NRC allows for co-operative reviews of the same topics & therefore joint conclusions, or at least common technical findings
- Details in next presentation

Summary

- Good safety record in design and operation
- Experienced, knowledgeable Canadian regulator
- Licensed in other countries
- US & Canada have similar safety & licensing goals but differing implementation
- Linkage of design – safety – licensing
- Single North American product
- One set of requirements that appropriately address the nature of the design
- Schedule will permit co-operative review & common technical positions


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