

ACR R&D Program

Presented to CNSC/US NRC

Dr. D.J. Wren

Manager, ACR Research and Development

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Canada 



AECL
Atomic Energy
of Canada Limited

EACL
Énergie atomique
du Canada limitée



Anticipated R&D Program

The planned R&D program is grouped into five areas:

- **Fuel Channel Development**
- **Fuel Development**
- **Safety Verification/Validation**
- **Fuel Handling Development**
- **Component Development**



Fuel Channel Development

- **New ACR fuel channel design to accommodate higher coolant temperature and pressure**
- **Based on proven Zr-2.5%Nb pressure tube**
 - **Extension of performance prediction database**
 - **Deformation**
 - **Corrosion and hydrogen uptake**
 - **Extension of materials properties database**
 - **Fracture toughness**
- **Thicker, stronger calandria tube**



Fuel Development

- **New ACR SEU fuel**
 - Based on qualified CANFLEX design
 - Higher burnup – within current CANDU fuel experience envelope
 - New coolant conditions
- **Qualification Program**
 - Out-reactor: endurance and performance
 - In-reactor: high burnup and power ramp performance
 - Thermalhydraulic performance and correlations



Safety Verification

- **ACR will use the validated CANDU Industry Standard Toolset (IST) for safety analyses.**
- **In selected areas the validation base of the codes will be extended to cover a new range of application for the ACR.**
- **In even fewer areas, limited modifications to the IST codes will be supported to cover new ACR analysis requirements.**



Key Safety Analysis Code R&D

- **Experiments in the ZED-2 critical lattice to validate the WIMS physics codes**
- **Experiments in the RD-14m thermalhydraulics loop to validate the CATHENA code**
- **Experiments in a new, scaled Moderator Test Facility to validate the MODTURC_CLAS code**
- **Experiments to extend the fuel sheath failure database for the ELOCA code**



Key Safety Phenomena R&D

- **Confirmation of the fuel channel heat transfer performance under LOCA and LOCA/LOECI conditions**
- **Extension to the CANDU severe accident progression models to address ACR design parameters**
- **Confirmation of calandria tube performance in the event of spontaneous pressure tube rupture**



Fuel Handling Development

- The ACR on-line refueling systems are based on the proven CANDU concepts.
- The ACR fuel handling components will be designed to improve performance and reliability.
- A comprehensive testing program will confirm the conceptual design of the key fuel handling system components.



Component Development

- **R&D to confirm design decisions, support design specifications or to achieve improved performance**
 - **Steam generators**
 - **Reactor assembly**
 - **Chemistry control and materials specifications**
 - **Plant monitoring capabilities**
 - **Information communication and management technology**
 - **Non-safety systems improvements**

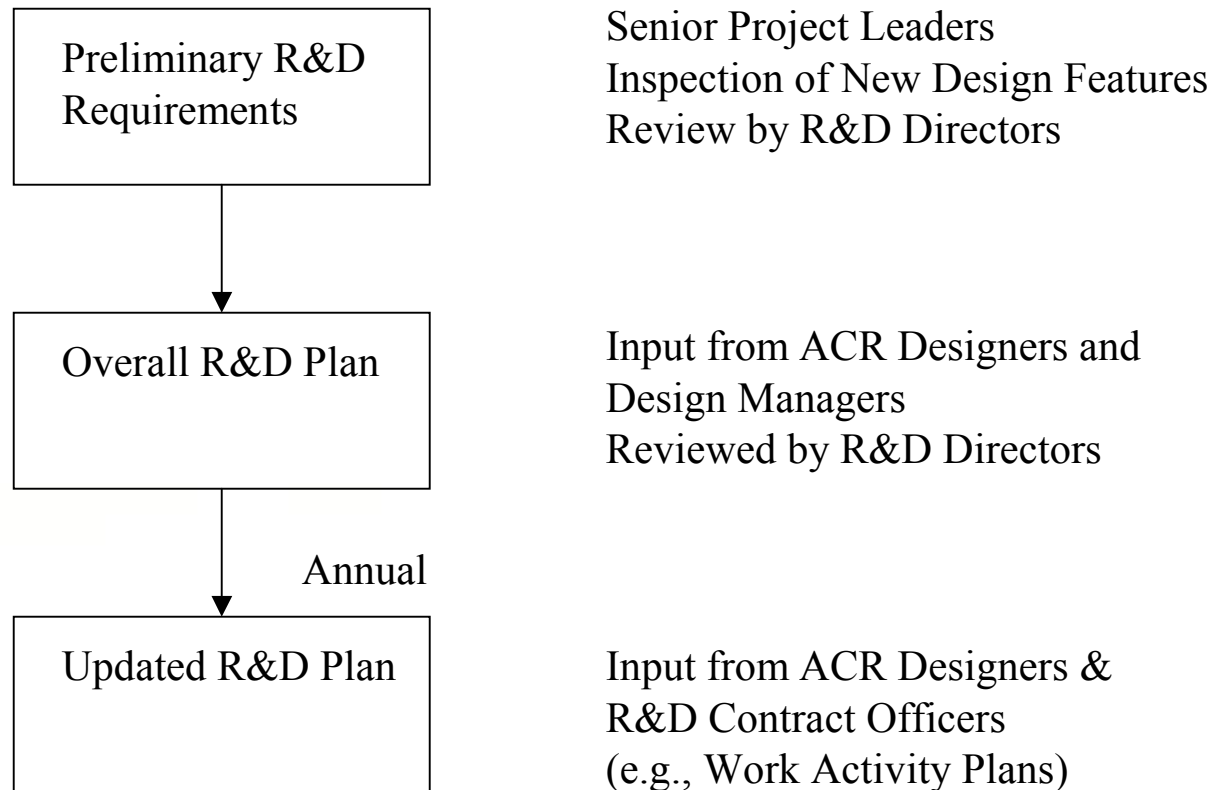


R&D Planning Process

- 1. High-Level Overall R&D Plan**
- 2. Annual R&D Planning**
- 3. Detailed R&D Planning**
- 4. R&D Control**
 - **Level 2/3 Plan (Milestones/Deliverables)**
 - **R&D Contracts**
 - **Tracking of Deliverables**
 - **Change Control – major changes**



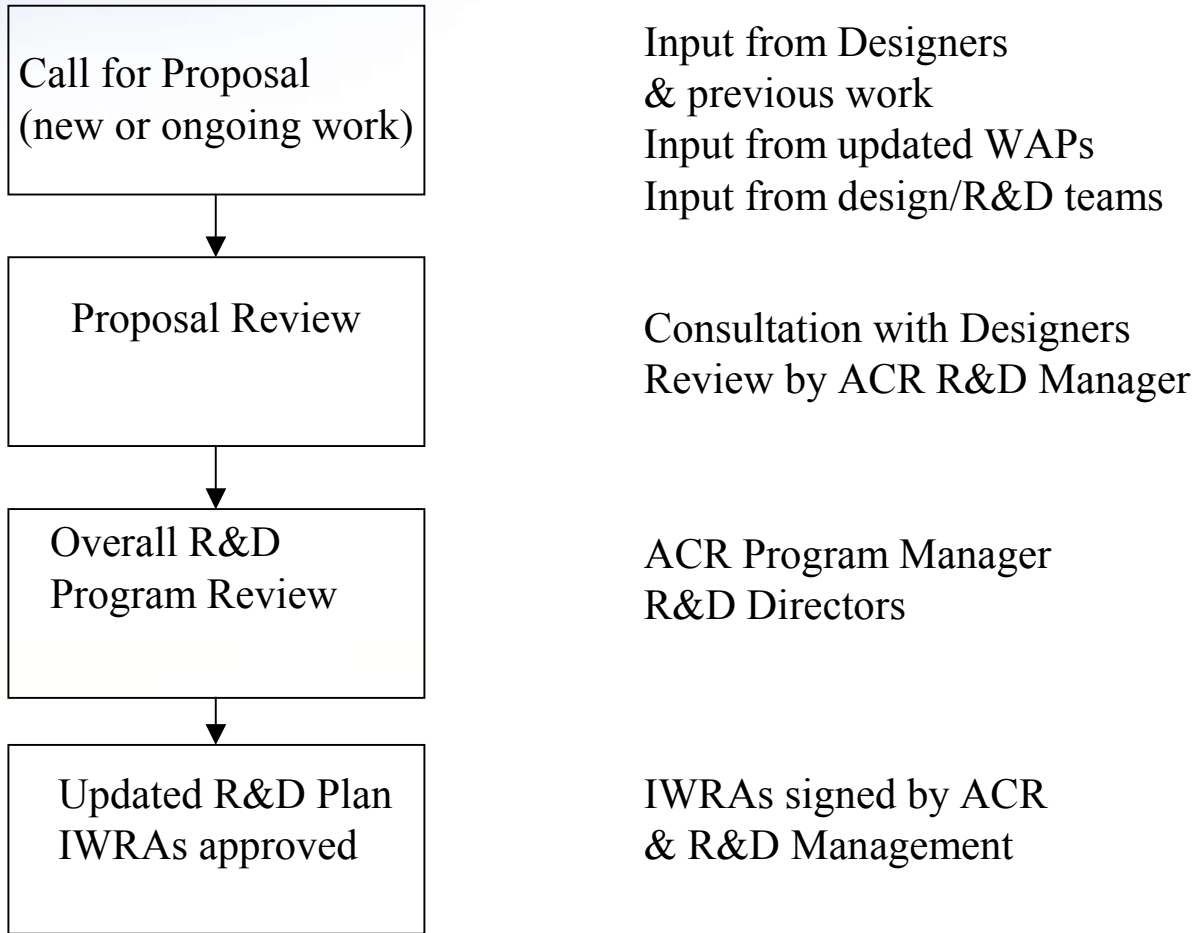
High-Level R&D Plan



R&D Plan maintained and monitored as part of overall ACR Project Plan



Annual R&D Planning



The annual ACR R&D Planning activity is intimately meshed with the other AECL annual R&D Planning processes to ensure that complementary work is identified and planned.

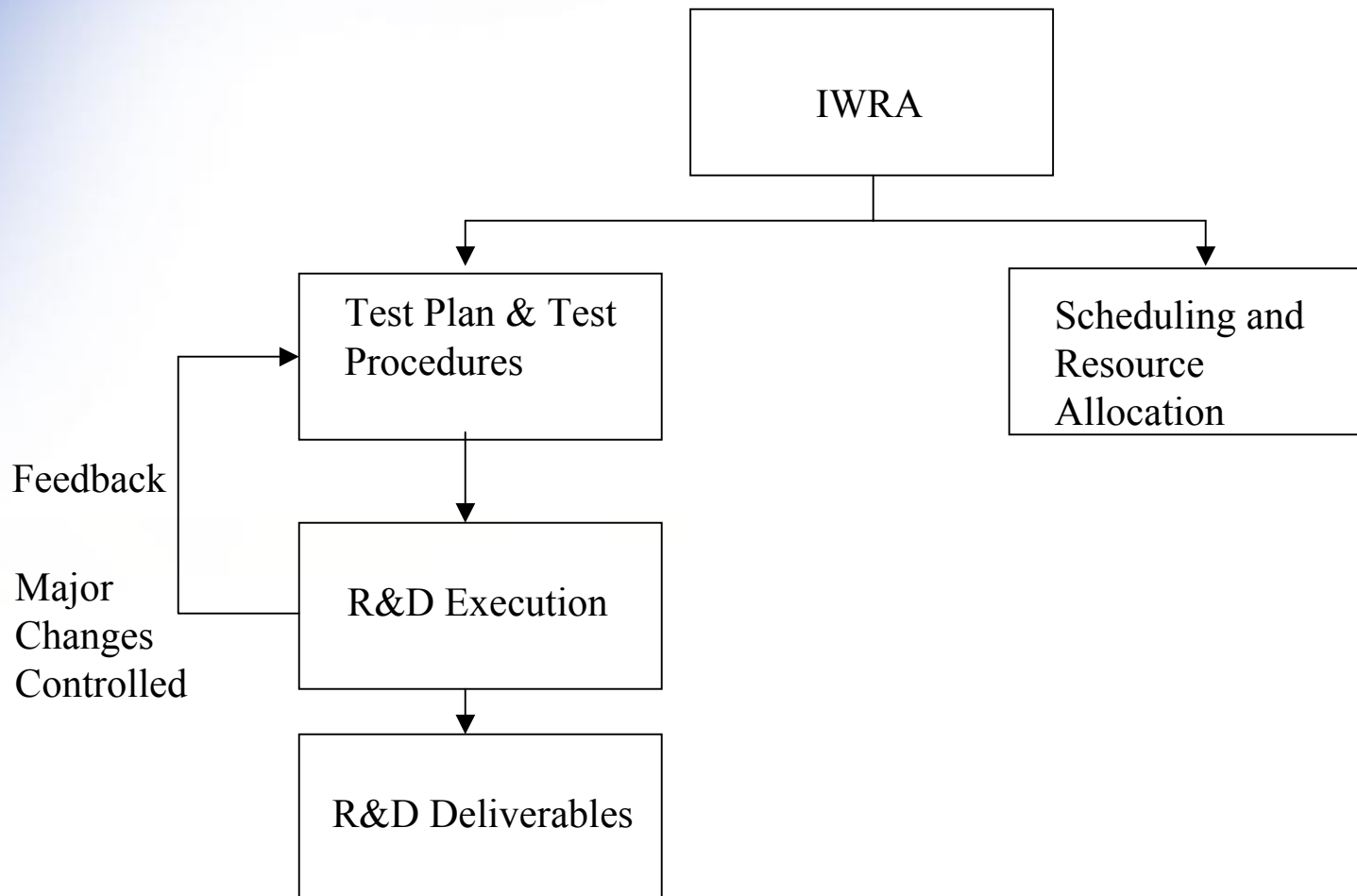


R&D Program Integration

- **Integrated with the ACR Basic Engineering Program**
 - Supports conceptual design decisions
 - Supports safety assessments
- **Integrated with AECL's ongoing Platform R&D program in support of current CANDU plants**
 - Programs directed to provide data of common value
 - Development of generic codes



Detailed R&D Planning





Design Verification

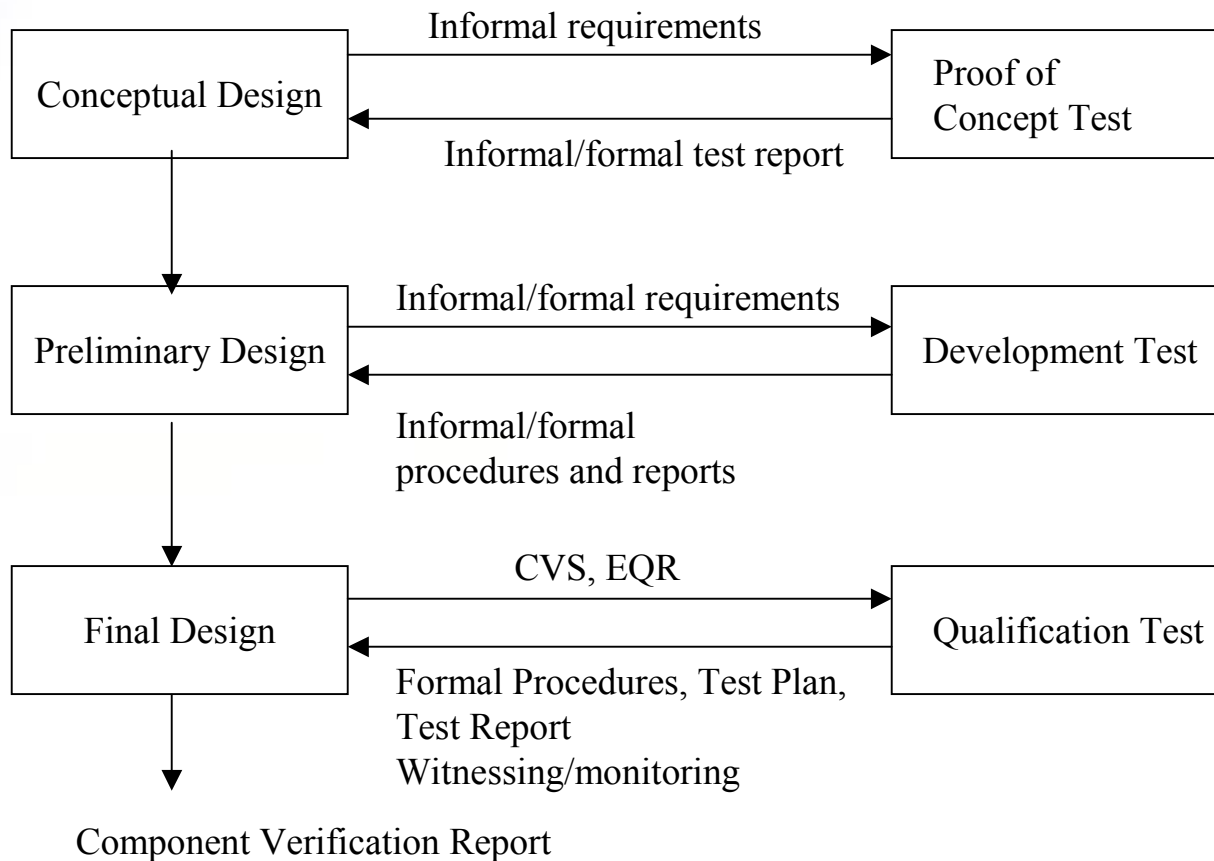
- **Verification is carried out through a combination of analysis and testing.**
- **Designers**
 - Determine the verification requirements and method
 - Establish the testing requirements and success criteria
 - Component Verification Specification
 - Component Verification Report
 - Review R&D activities
- **R&D**
 - Establish detailed test plans and procedures
 - Carry out tests



Component R&D

Design

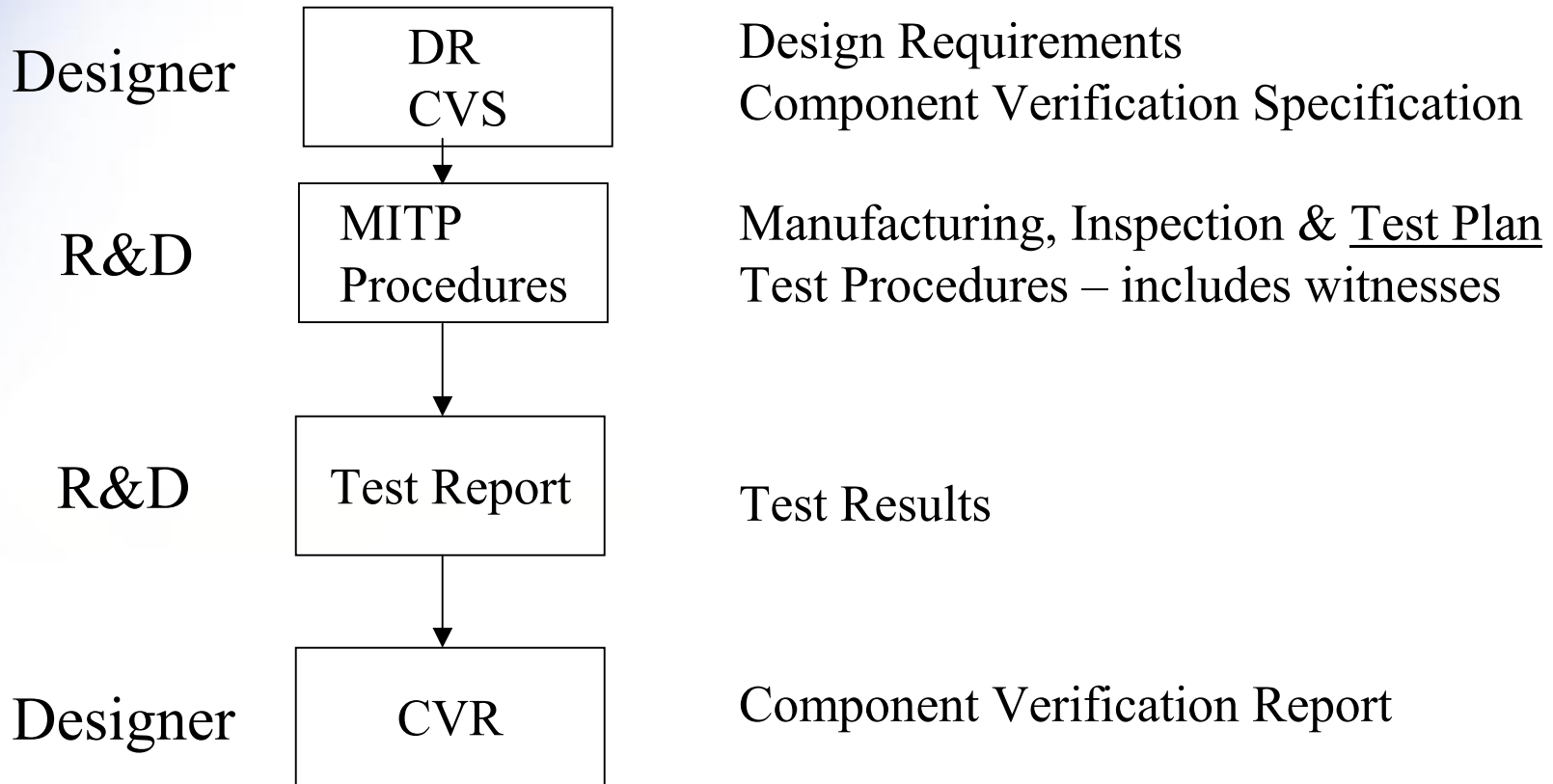
R&D



N286.2 Clause 6



Verification Testing



**Testing at AECL carried out under specific Qualification
Test procedures to meet N286.2 Clause 6 requirements.**



R&D Organizations

- **AECL**
 - Chalk River Laboratories – primarily safety testing and safety code validation, including fuel and physics
 - Whiteshell Laboratories – safety thermalhydraulics code validation
 - CPFS (Sheridan Park) – primarily component/system verification testing
- **Stern Laboratories – thermalhydraulics code validation**
- **Halden Project – fuel irradiation**
- **CEA/OSIRIS – pressure tube material irradiation**



Key Component Verification

- Emergency Core Cooling - Whiteshell (CATHENA validation), CRL
- Shutdown System 1 (SDS 1) - CPFS
- Shutdown System 2 (SDS 2) - CPFS
- Fuel Channel – CPFS, CRL
- Fuel – CPFS, CRL
- Fuel Handling - CPFS



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