



ACR R&D CRL

Presented to CNSC/US NRC

Dr. D.J. Wren

Manager, ACR Research and Development

March 18, 2004

Canada 



AECL
Atomic Energy
of Canada Limited

EACL
Énergie atomique
du Canada limitée



R&D Laboratories

- **ACR R&D primarily conducted within AECL laboratories**
 - **CPFS – primarily component development and verification**
 - **WL – safety thermalhydraulic code validation**
 - **CRL – code validation and safety phenomena research**

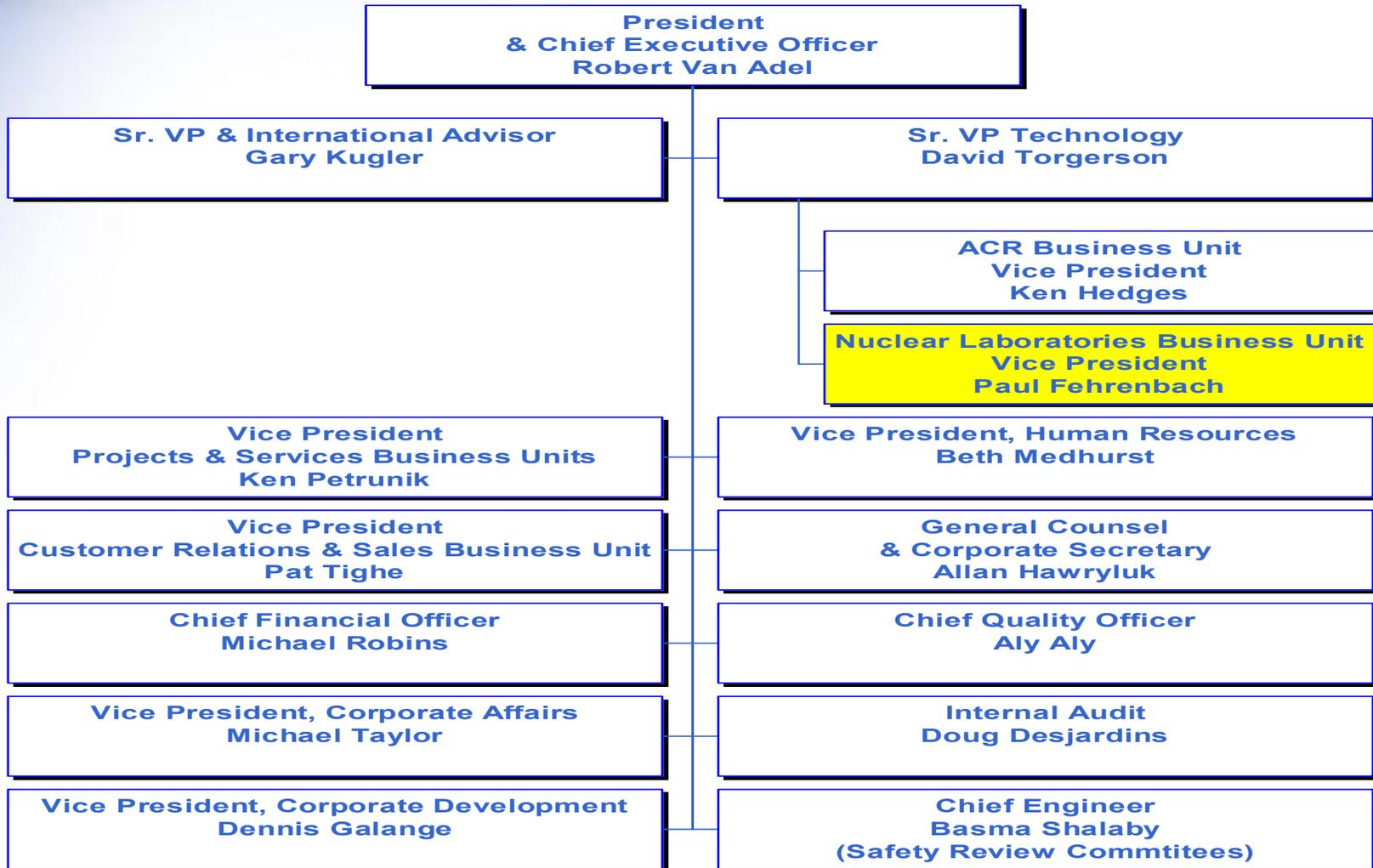


Chalk River Laboratories



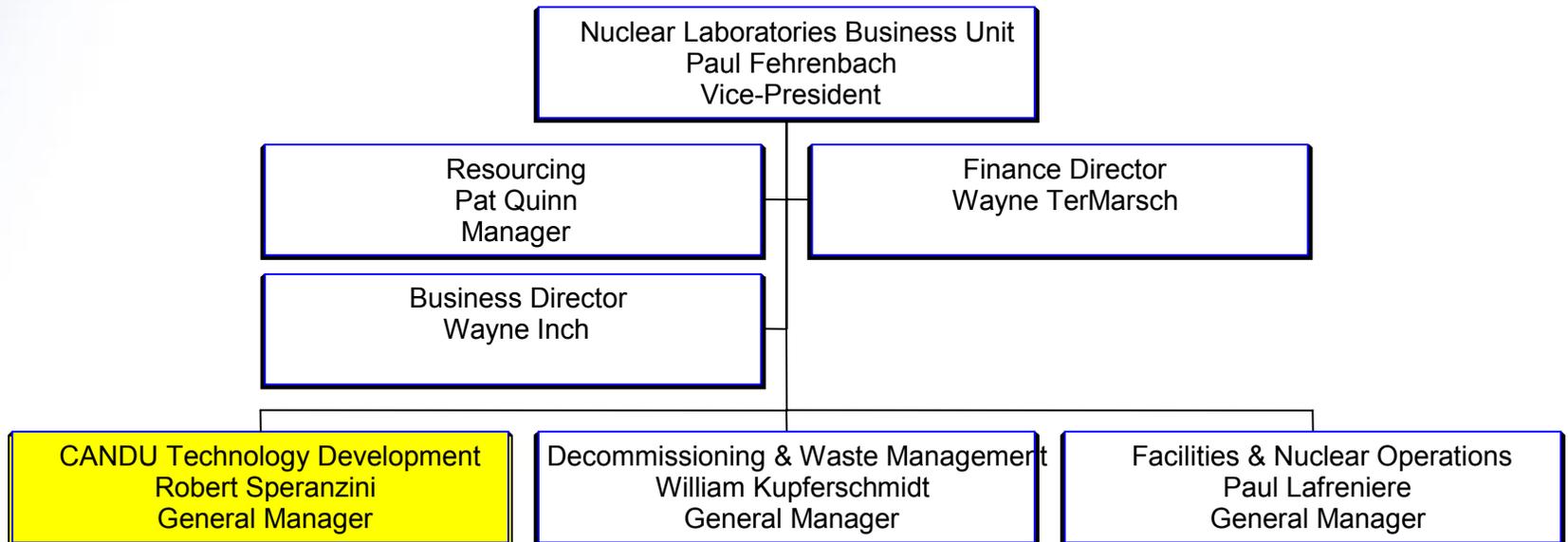


AECL Organization

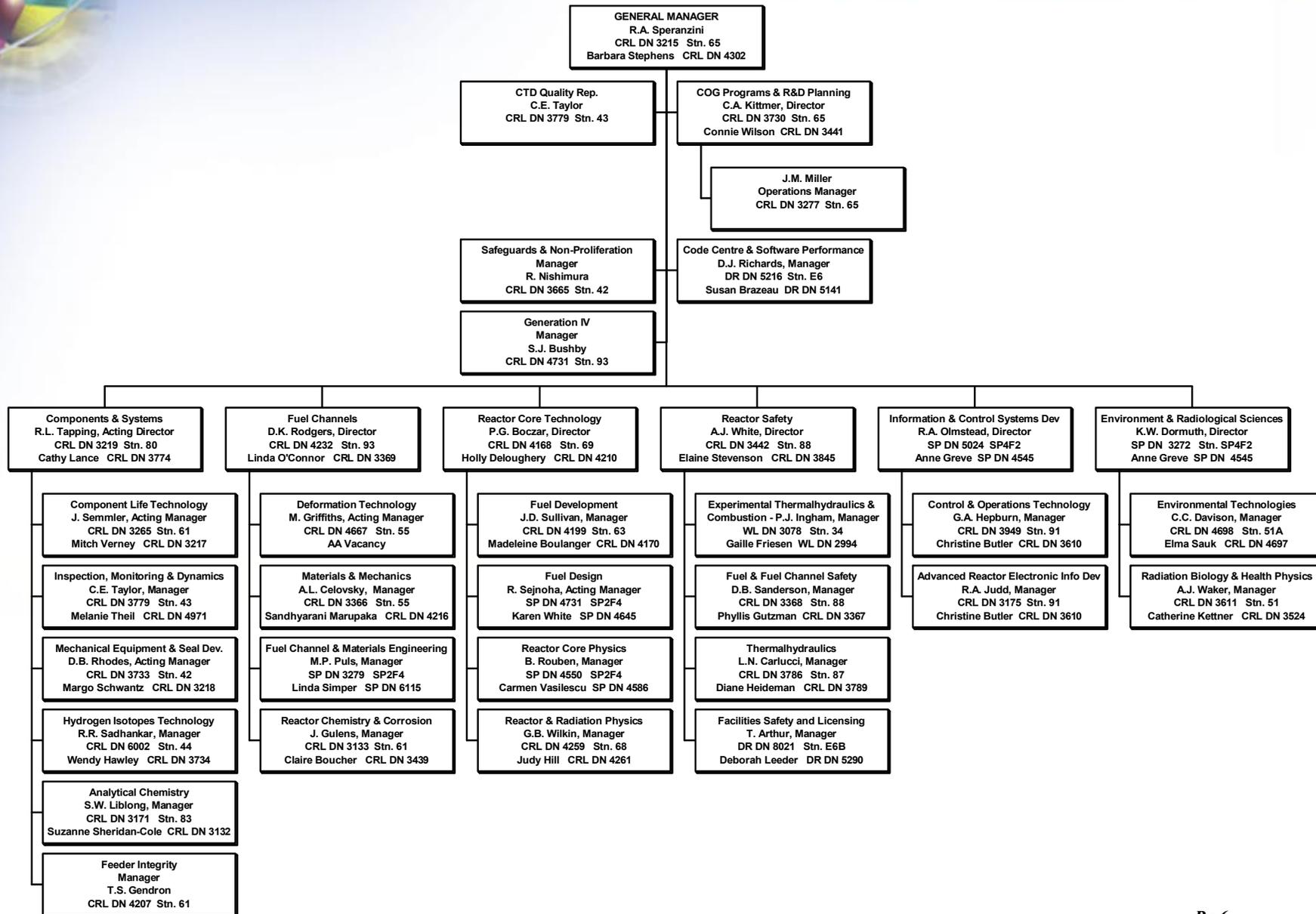




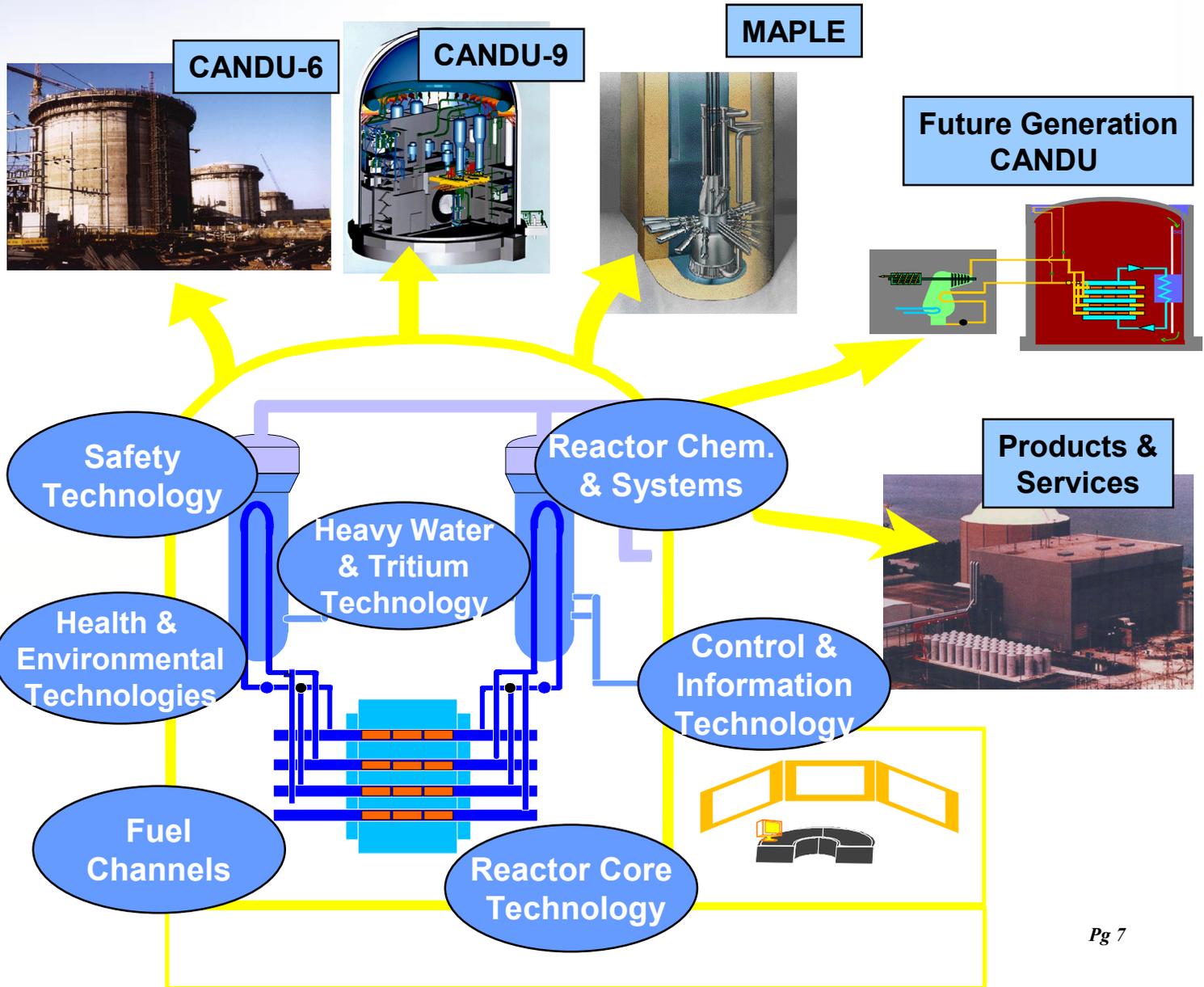
Nuclear Laboratories Business Unit



CANDU TECHNOLOGY DEVELOPMENT



CANDU Technology





Safety Technology Base

- **The ACR design is based on the proven CANDU 6 design in terms of the overall safety system and safety-related system function.**
 - Most key phenomena associated with safety analyses are common with the current CANDUs.**
 - The analysis tools and methodologies used for safety analysis of current plants are generally applicable to the ACR.**



ACR 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 address new ACR analysis requirements.**



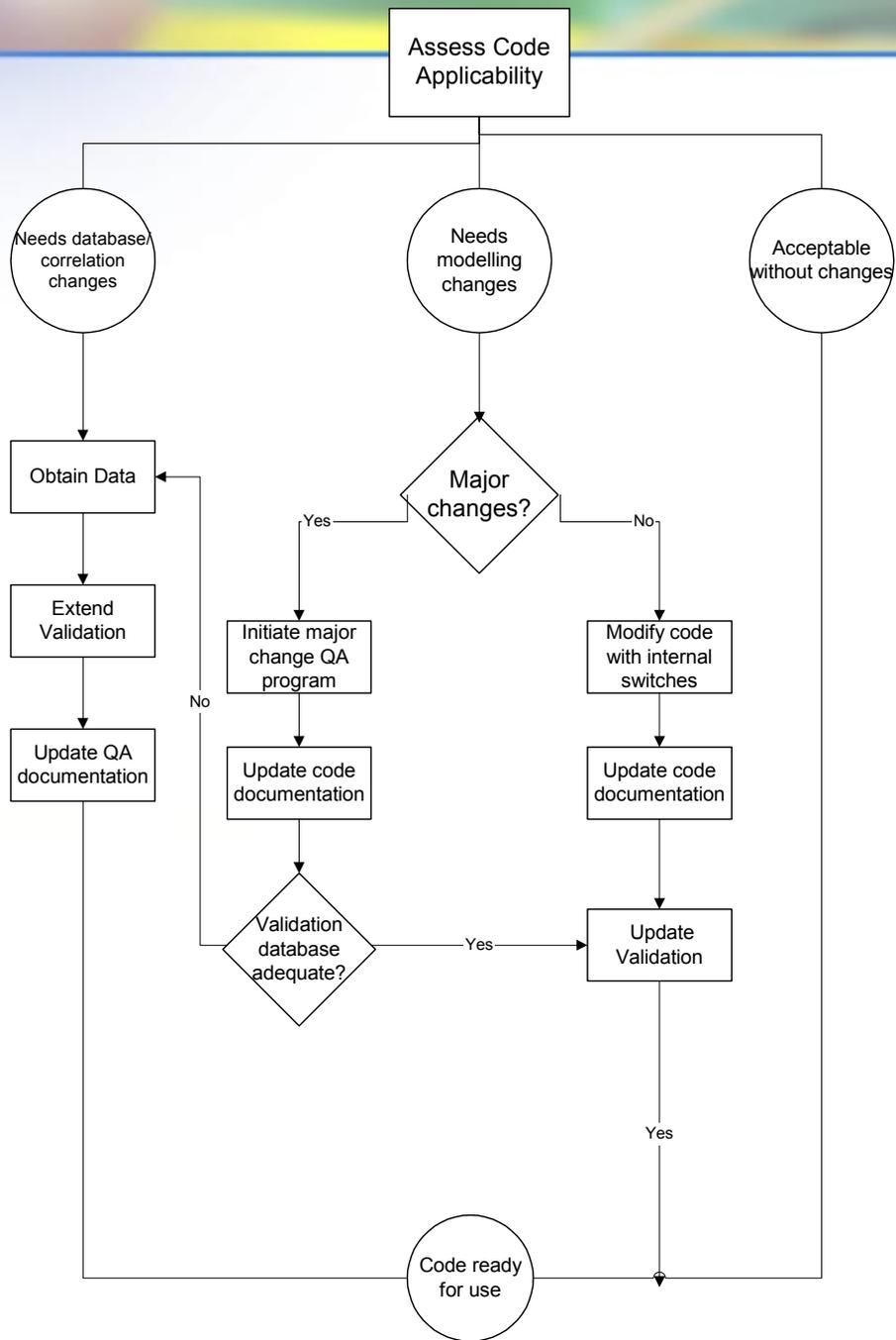
IST Code Validation

- **AECL and the Canadian CANDU utilities have carried out a comprehensive program to fully document and validate the IST codes.**
- **An extensive package of documentation has been submitted to the CNSC for review.**
- **The validation process is ongoing for a limited number of codes.**



Code Validation for ACR Application

- **The computer codes to be used in the safety analysis of the ACR will be qualified following the requirements AECL's Software Quality Assurance Manual and processes.**
- **The qualification process starts with an assessment of code applicability and additional validation requirements (if any).**





ACR Code Validation

- **Technical Basis Document (TBD) for code application**
 - ACR-specific version of TBD.
 - ACR analyses will involve the same broad accident categories and technical disciplines as current CANDUs.
- **Validation Matrices for key phenomena updated for ACR.**
- **Additional validation exercises (as required) for ACR code application.**



Key ACR Code Validation

- **CATHENA – safety thermalhydraulics**
- **NUCIRC – steady-state thermalhydraulics**
- **WIMS/RFSP/DRAGON – reactor physics**
- **ELESTRES – fuel, normal operation**
- **ELOCA – fuel, accident conditions**
- **MODTURC – moderator thermalhydraulics**
- **Fuel Design Codes**



Site Visit

- **NRU ACR Fuel Tests**
- **Moderator Test Facility**
- **Thermalhydraulics Loops**
- **ZED-2 – Physics Tests**
- **High-Temperature Heat Transfer Laboratory**

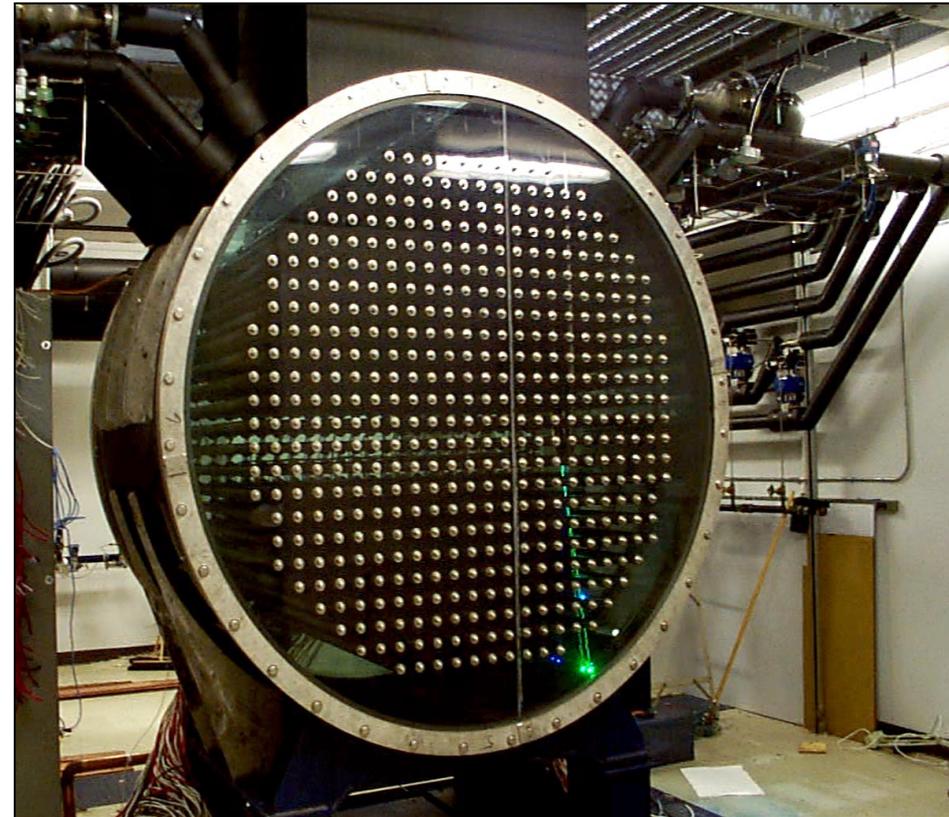


In-Reactor Fuel Tests

- **Irradiation of bundles in NRU to full burnup.**
 - **High power channel envelope**
- **Irradiation of individual elements in CANFLEX demountable bundle in NRU.**
 - **high-power envelope,**
 - **power ramp transients(fuel handling),**
 - **dysprosium fuel performance**
- **Halden fuel element irradiation (ACR coolant temperature)**
 - **Cladding performance data.**

Moderator Test Facility

- Large-scale facility to measure three-dimensional velocity and temperature distributions in moderator geometry.
- 1/4 scale calandria used to validate CANDU 9 design.
- 1/3 scale calandria will be used to validate ACR design.





Full-Scale Thermalhydraulic Tests

- **Water Tests – Stern Laboratories**
 - Full-scale ACR bundle string fabricated with representative axial flux distribution (AFD) and radial (RFD)
 - CHF and PDO tests using three flow-tube creep profiles (0, ~2%, and ~5%).
 - Conditions up to 12.5 MPa and 29 kg/s.
- **Freon Tests - CRL**
 - Full-scale ACR bundle string with representative AFD and RFD (RFD can be varied over a range) will be constructed.
 - CHF (mainly RFD effect) and PDO tests to confirm earlier results obtained from the uniform AFD bundle tests.



Physics

- **Physics analyses performed using IST codes**
 - WIMS, RFSP, DRAGON
- **Physics code validation using ZED-2 facility**
 - Zero-power critical lattice



High Temperature Heat Transfer

- **Heat transfer for overheated fuel channels**
 - LOCA + LOCEI
- **Pressure tube/calandria tube failure**
- **TUBRUPT validation tests**



AECL