Nuclear Facility Life Extension and Rehabilitation; The Canadian Experience

Presented to: WiN Global Conference
Waterloo, Ont.

By: B.A. Shalaby
Chief Engineer, AECL
2006 June 01

Canada

AECL
Atomic Energy of Canada Limited

Outline

1. Plant Life Management (PLiM) ⇒ Plant Life Extension (PLEx).

   1.1 Goals and Drivers

   1.2 Program Implementation; Technical, Institutional

2. Current Rehabilitation Projects

3. Summary

PLiM/PLEx Goals and Drivers

- Short Term
  - Safe, reliable operation for all CANDU NPPs (Canada and offshore).
  - No surprises.
  - PLiM needed for PLEx.
- Plant Life Management (PLiM)
  - Effective PLiM program is essential for safe and reliable plant operation.
  - Most 1st generation CANDUs meet or exceed design targets.
- Plant Life Extension (PLEx)
  - A “must” as a vision for current CANDU stations.
  - Basis for long term energy supply planning.

CANDU Target Lifetime

Effective PLiM Programs

Initial CANDU's

30 years @ 80% C.F. PLiM PLEx for 20 or more years

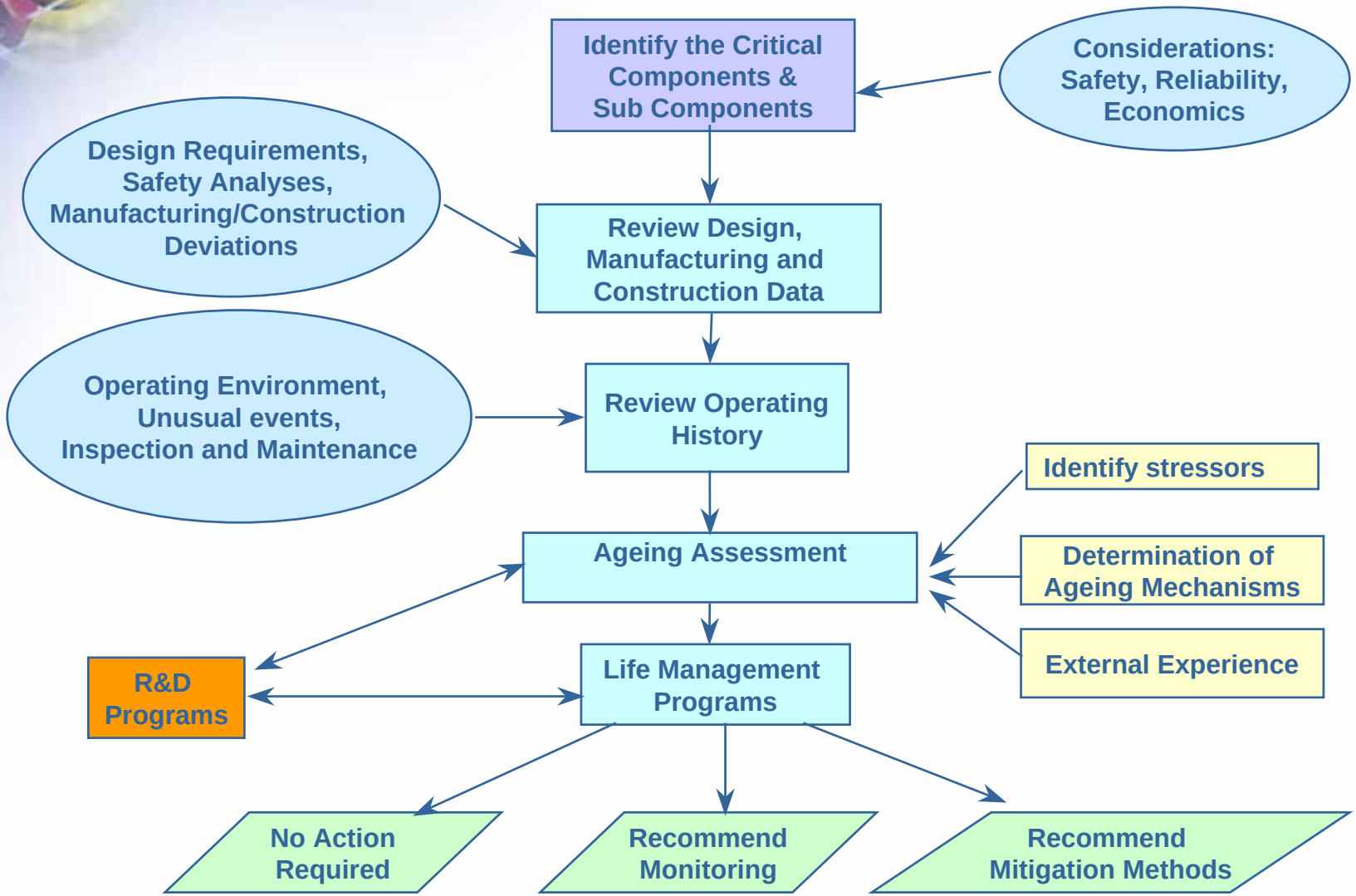
Today's CANDU 6

40 years @ 85% C.F. PLEx for 20 or more years

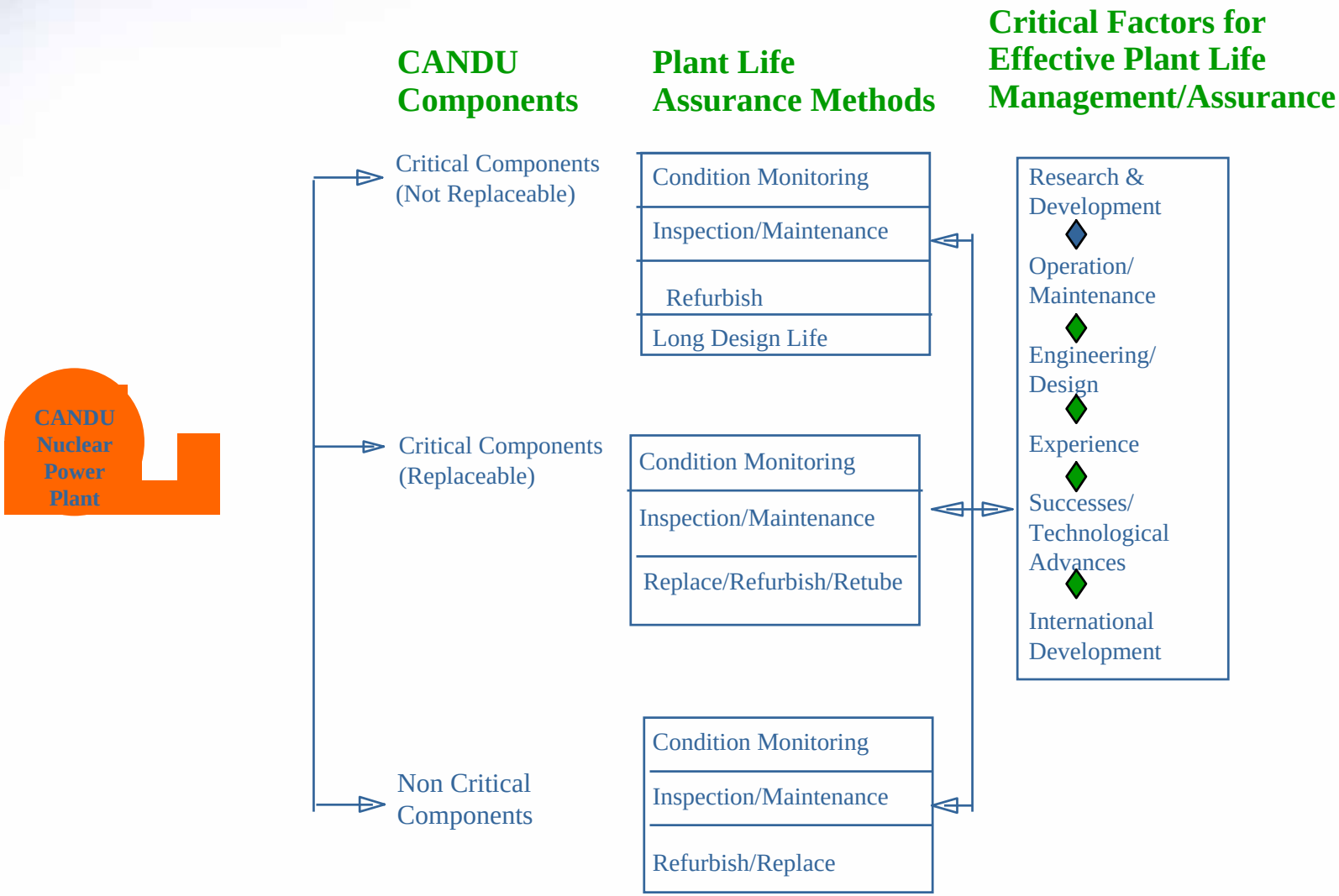
Target for next CANDU's

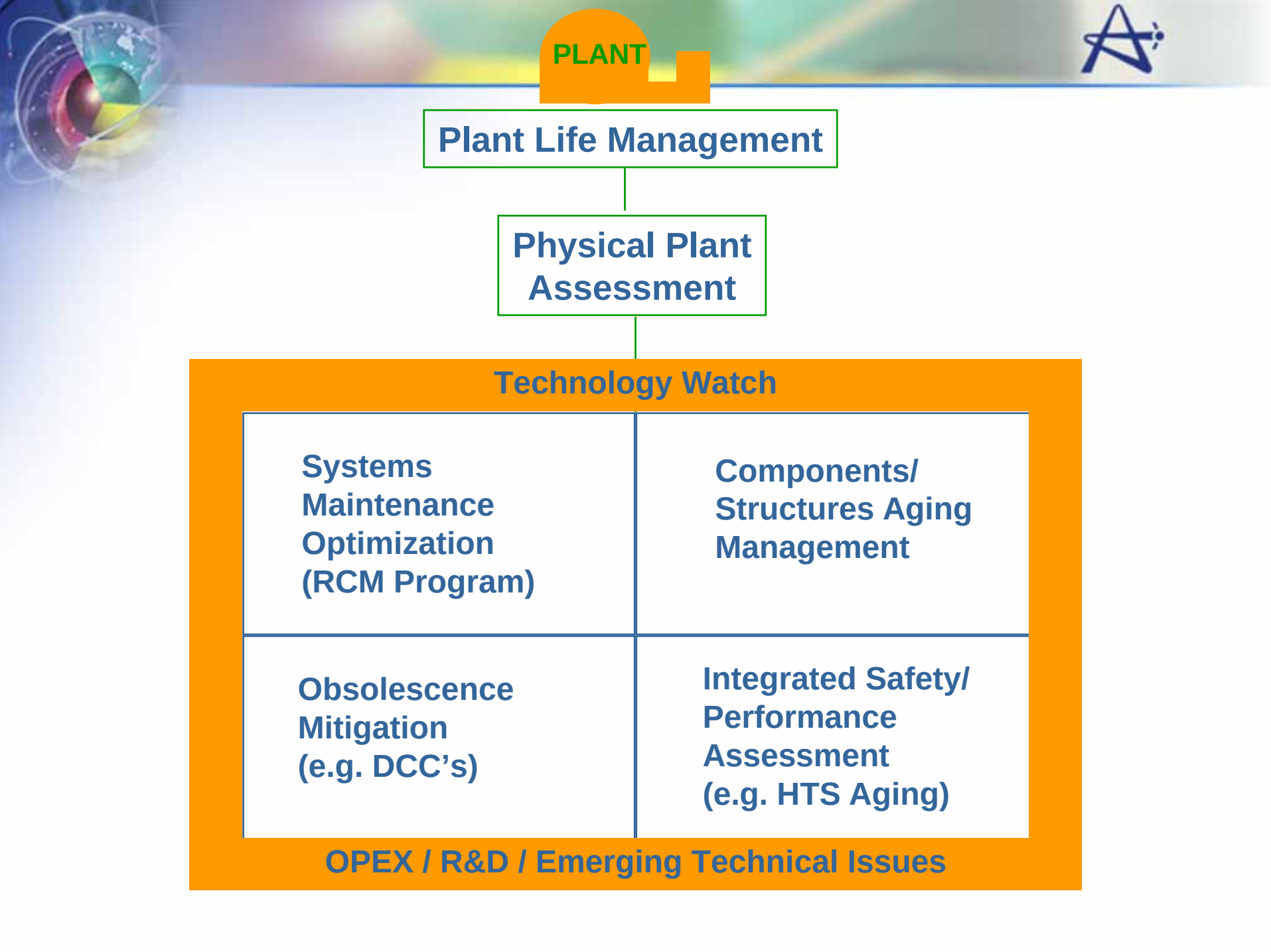
60 years @ 90% C.F.

PLiM CSSC Assessment Methodology



Integrated Approach to Life Assurance




PLANT
Plant Life Management
Physical Plant Assessment
Technology Watch
Systems Maintenance Optimization (RCM Program)
Components/ Structures Aging Management
Obsolescence Mitigation (e.g. DCC's)
Integrated Safety/ Performance Assessment (e.g. HTS Aging)
OPEX / R&D / Emerging Technical Issues

PLANT

Plant Life Management

Institutional Assessment

Management Review

Configuration Control	Organization & Management Process Control
Regulatory, Public & Business Environment Impact	Human Resources & Performance Effectiveness

Self Assessments / Audits / Peer Reviews

Current Rehabilitation/Life Extension Projects

NRU Licensibility Extension (2005-2012)

PLiM Objectives:

- Establish Formal Documented PLiM Program
- Technical Input to Maintenance Program
- Document Material Condition of Facility
- Provide data for health prognosis/planned upgrades/or replacements ⇒ Input to Aging Management Programs

CANDU Refurbishment Plans

1. Point Lepreau Refurbishment (NBP/AECL)

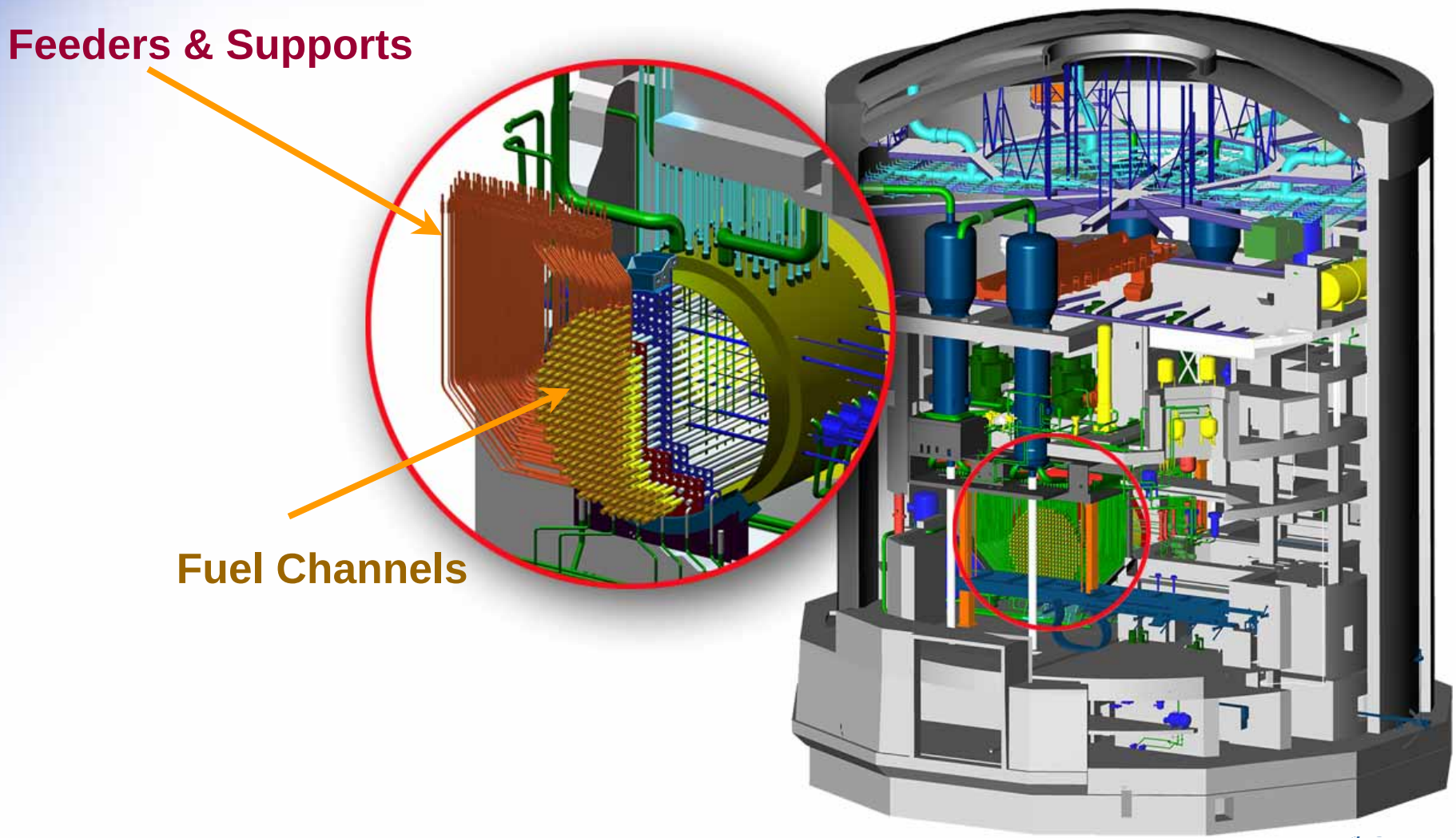
- SCOPE:
  - NBP: Shutdown/Defuel Core
  - AECL: Retube; replace Fuel Channels, Feeders, Refurbishment; DCC replacement, C&I upgrades, Level II PSA, Turbine Upgrades, Main Generator replace or rewind etc.

Refurbishment Plans Cont'd….

2. Bruce 1& 2 Refurbishment (BP/Subcontractors)

- SCOPE:
  - BP: Overall Project Management
  - AECL: Retube; replace Fuel Channels, Feeders
  - Other Subcontractors: other Refurbishment scope

What is being Replaced – Overview (Pt. Lepreau NGS)



Projected Status of Operating CANDU NPPs (Canada)

Name	Capacity Mwe (net)	In-Service date	Estimated Plant Life	Comments
Pickering 1	515	1971	2019	(*) Restarted Nov. 3, 2005
Pickering 2	515	1971	1998	(*) No Refurbishment planned
Pickering 3	515	1972	1998	(*) No Refurbishment planned
Pickering 4	515	1973	2017	(*) Restarted Sept. 2003
Bruce 1	848	1977	2034	(*) Restart in 2009
Bruce 2	848*	1977	2034	(*) Restart in 2009
Bruce 3	848*	1978	2036	(*) Restarted March 2004, Refurbishment 2010/11
Bruce 4	848*	1979	2017	(*) Restarted Dec. 2003, Replace S/G 2007
Point Lepreau	633	1983	2039	Refurb. 2008/09 ~ 18 Months
Gentilly-2	638	1983	2011	Refurb. expected
Pickering 5	516	1983	2011	30 Year original design life (@ 80%)
Pickering 6	516	1984	2014	30 Year original design life (@ 80%)
Pickering 7	516	1984	2014	30 Year original design life (@ 80%)
Pickering 8	516	1986	2016	30 Year original design life (@ 80%)
Bruce 5	860	1985	2015	Refurbish expected
Bruce 6	860	1984	2014	Refurbish expected
Bruce 7	860	1984	2014	Refurbish expected
Bruce 8	860	1987	2017	Refurbish expected
Darlington 1	881	1990	2020	Refurbish expected
Darlington 2	881	1989	2019	Refurbish expected
Darlington 3	881	1991	2021	Refurbish expected
Darlington 4	881	1992	2022	Refurbish expected

(*) Laid up in 1998

Projected Status of Operating CANDU NPPs (Offshore)

Name	Capacity Mwe (net)	In-Service date	Estimated Plant Life	Comments
Cernavoda 1	665	1996	2026	
Embalse	600	1984	2014	Refurbish expected
Wolsong 1	638	1983	2013	Refurbish expected
Wolsong 2	668	1997	2027	
Wolsong 3	668	1998	2028	
Wolsong 4	668	1999	2029	
Qinshan 1	700 x 2	2002	2032	
Qinshan 2	700 x 2	2003	2033	

Summary

- Aging management should begin early when the plant is relatively young. It becomes a bigger challenge in the middle age.
- Develop good understanding of:
  - Fitness-for-service criteria
  - Design margins
  - Degradation mechanisms and how to monitor them
  - Plan of action in case margins are low
- Most CANDU Plants In Service are meeting original design targets and are expected to be refurbished for life extension.
- Predictable safe and economic operation for remainder of original life needed to secure decision for PLEx.
- PLEx essential for future energy supply worldwide.