NRC FORM 658
(9-1999)

U.S. NUCLEAR REGULATORY COMMISSION

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DATE OF MEETING
07/24/2002

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Docket Number(s)	**None**
Plant/Facility Name	**Atomic Energy of Canada Limited ACR-700**
TAC Number(s) (if available)	**None**
Reference Meeting Notice	**ML022030462**
Purpose of Meeting (copy from meeting notice)	**AECL presentation on the ACR-700 design and proposed scope of the pre-application review**

NAME OF PERSON WHO ISSUED MEETING NOTICE	TITLE
BRETT A. RINI	**ACR-700 Project Manager**

OFFICE
NRR

DIVISION
NRLPO

BRANCH

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Introducing the ACR-700™

AECL
TECHNOLOGIES INC.

Introduction to AECL and AECL Technologies

By Ken Hedges, GM, Development Projects

Presented to US Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
July 24, 2002

AECL TECHNOLOGIES INC.

Agenda and Purpose

- Introduction of ACR team
  - Dave Torgerson – Sr. VP, Technology
  - Ken Hedges – GM, Development Projects
  - Victor Snell – Director, Safety & Licensing, ACR
  - Vince Langman – Manager, Safety & Licensing, ACR
  - Ian Hastings – GM, ACR US Initiatives
  - Stephen Yu – Director, ACR Development
  - Bob Speranzini – GM, CANDU Technology Development
  - Mike Soulard – Manager, Technology
  - Roger Gale – GF Energy LLC
  - Glenn George – GF Energy LLC
  - Sophie Ras – GF Energy LLC

Agenda & Purpose (cont'd)

- Purpose of meeting: Launch ACR pre-application review
  - Officially requested in letter from AECL President/CEO Robert Van Adel to Sam Collins, Director of the Office of Nuclear Reactor Regulation, June 19, 2002
  - AECL letter suggests an 18-month review period – current AECL planning is based on 24 months
- Agenda:
  - Introduction to AECL and AECL Technologies
  - CANDU Safety Basis
  - The Evolution of the ACR Design
  - Overview of the Proposed Pre-Application Licensing Plan
  - Discussion
- Anticipated outcome: Agreement with NRC on next steps e.g., September workshop

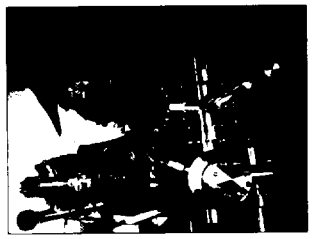
Introduction to AECL and AECL Technologies

- AECL and AECL Technologies
- ACR-700
- Recent Project Experience
- CANDU Performance
- Commitment to ACR
- Commitment to the US Market
- Summary

AECL TECHNOLOGIES INC.

AECL (Atomic Energy of Canada Limited)

- Global nuclear technology company established in 1952
- ~4,000 employees
- ~$400M commercial revenues
- Involved in all aspects of nuclear power and have major facilities at CRL
- Also, will partner on ACR with others who bring complementary skills and resources



AECL (cont'd)

- Designs, builds and services reactors around the world
- Full lifecycle service packages
- Bundled services (O&M support, plant life management programs, waste management)
- Turnkey solutions and project risk-/benefit-sharing

AECL TECHNOLOGIES INC.

AECL (cont'd)

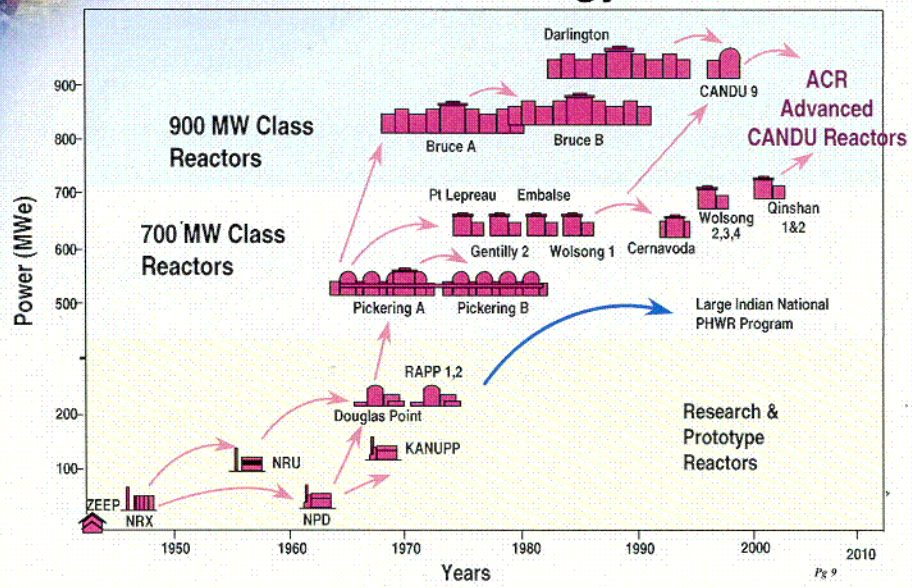
- Since 1990, completed construction of 4 CANDU units; 3 currently under construction (2 in China; 1 in Romania)
- Plus 2 AECL-designed dry used fuel storage units (MACSTOR)
- 2 medical isotope-producing MAPLE reactors under construction in Canada, which add to AECL's world-leading position in medical isotopes

AECL Technologies Inc.

- Wholly-owned subsidiary of AECL
- Established in 1988 in Gaithersburg, Maryland
- Head Office in Washington, DC
- Manages US business

AECL TECHNOLOGIES INC.

CANDU Genealogy



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Chalk River Laboratories

Comprehensive R&D infrastructure, including hot cells and research reactors; nuclear platform infrastructure

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C01

Sheridan Park

Canadian Head Office, near Toronto: product design & development; nuclear services; business development

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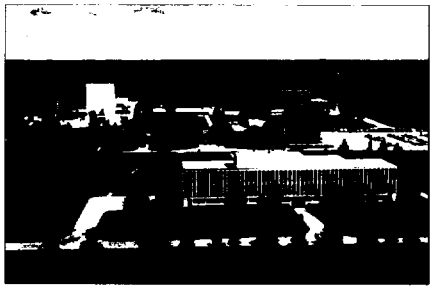
Whiteshell Laboratory

Underground Research Laboratory and other Laboratories



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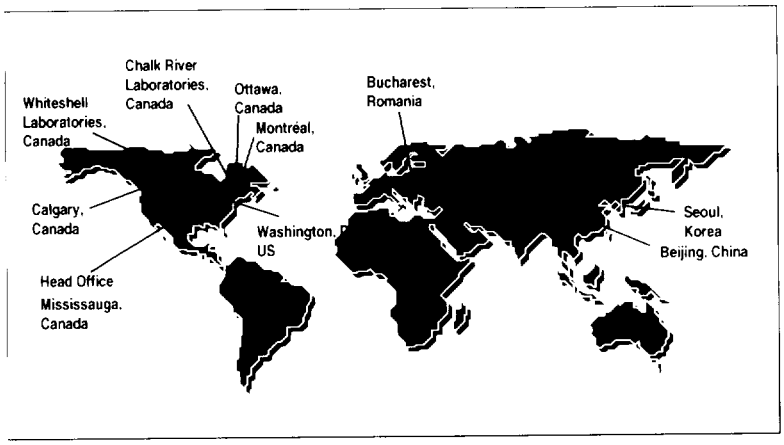
Offices



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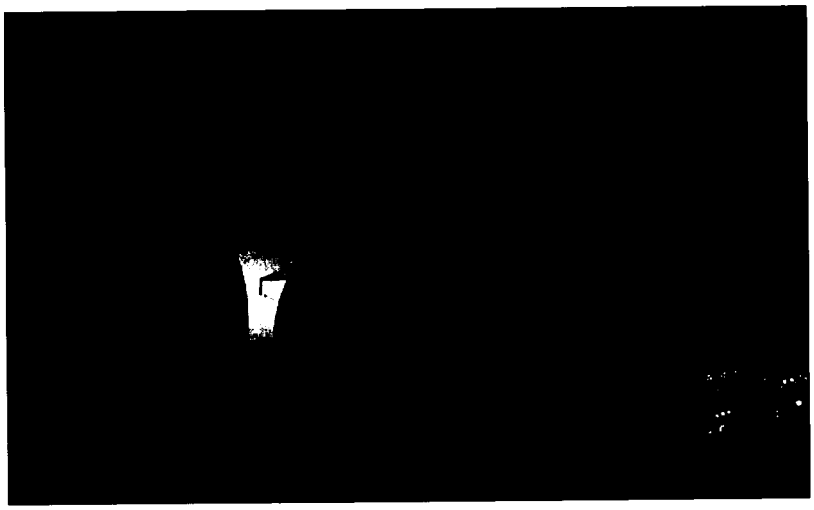
ACR-700™
(Advanced CANDU Reactor™)



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ACR-700

- The ACR is an evolutionary extension of the proven CANDU 6 lineage—with eight units in operation on four continents, and three units currently under construction
  - This provides a sound basis for projecting highly reliable performance, low project risk, assured costs, licensability.

ACR-700 (cont'd)

- Most of the ACR construction project improvements have been successfully demonstrated in recent CANDU projects.
- 75% of internal components same as PWR technology
  - Main difference: ACR has pressure tubes and reactor assembly; PWR has pressure vessel.

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Design Targets for ACR-700

Specific overnight capital cost:	$1,000/kWe
Project schedule:	60/48 months
LUEC:	$30/MWh
Capacity factor:	>90%
Plant Operating Life:	60 years

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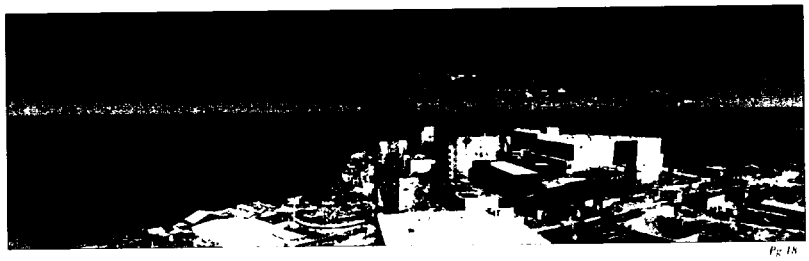
Recent Build Projects

- Qinshan Phase III, China
  - 2 x 728 MWe CANDU 6 units scheduled for in-service in 2003
  - Considered the best-run project by the Chinese
  - Uses open-top construction, prefabricated components, project integrating techniques
  - To date: on schedule; fuel loading started
  - Essentially a turnkey Project



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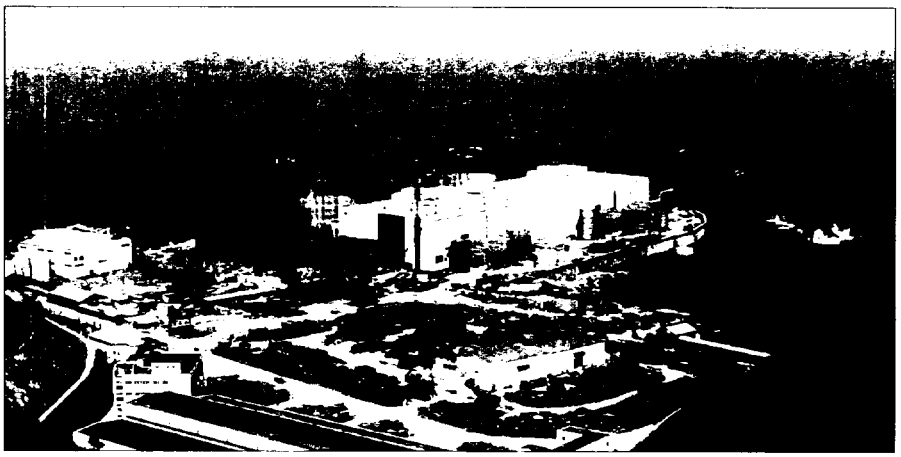
Recent Build Projects (cont'd.)



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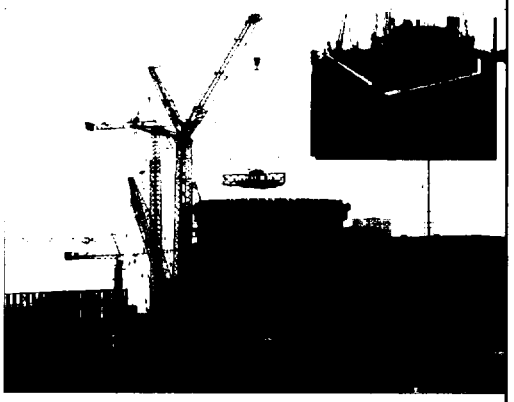
Recent Build Projects (cont'd.)

Qinshan: Modularization and Open-top Construction

- Open-top construction allows easy access and flexible construction sequences.
- Very-heavy-lift cranes used to lift major components



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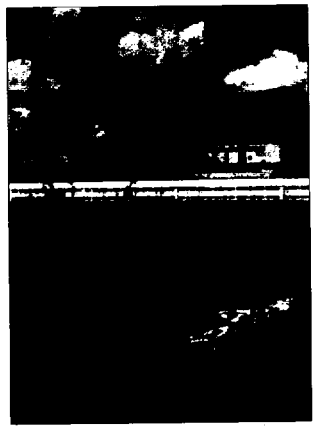
Recent Build Projects (cont'd)

Cernavoda Unit 2, Romania

- Construction proceeding, with in-service in 2005

Cernavoda Unit 3, Romania

- In 2002, the Romanian government plans re-launch of work.



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Recent Build Projects (cont'd)

Wolsong Units 2, 3, 4, Republic of Korea

- Units 2, 3 and 4 completed in 1997, 1998 and 1999 respectively
- Used many of the innovative techniques being used at the Qinshan Phase III project
- Local content rose from 15% on Unit 1 to 75% on Unit 4
- Completed on-schedule; variance less than 0.1%

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CANDU Performance

- Operating experience of all CANDU 6 plants has been world class.
- Year ending December 2000 - Wolsong Unit 3 achieved capacity factor of 103.1%.
- Top 3 CANDU 6 units for year ending December 2001 had a capacity factor of 96.6%.

CANDU Performance (cont'd)

- In Ontario, after many years of exceptional performance, OPG experienced significant management difficulties with operation of their units.
- In late 1990s, OPG laid-up 8 of their 20 units.
- Reason for lay-up: To focus resources on improving operations of the remaining units
- OPG has always acknowledged the robustness of CANDU technology; safety of units was not an issue.
- Six of the laid-up units are being refurbished for return to service.

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ACR Size Consideration

- ACR-700 concept complete
- ACR-700 is reference design
- Also looking at ACR-1000
- Potential markets for both sizes

AECL's Commitment to ACR

- Three-year product development funding approved
- ACR-700 concept complete
- Non-site specific engineering completed 2005
- Hitachi investing in BoP optimization and plant-wide modularization
- Construction strategy and schedule defined
- Working with Canadian, US and UK utilities to bring ACR to commercialization
- Licensing the product in 3 countries

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Previous NRC Interaction

- 1980s – potential developing market for small (~450 MWe), low-capital-cost competitive reactors
- AECL developed CANDU 3U for US market
- 1989 – NRC started pre-application review
- 1994 – AECL submitted application for Standard Design Certification – docketed
- 1995 – obvious lack of any near-term market in US; CANDU 3U development discontinued and AECL focused on other markets
- US utility initiatives and government support convince AECL of a near-term opportunity—hence our return to the US market

AECL's Commitment to the US

- Pre-application review
- Providing data to support utility ESP submissions
- Actively participating in industry initiatives related to new reactor builds

AECL TECHNOLOGIES INC.

Summary

- Global nuclear technology and engineering company; established in 1952
- Wholly-owned US subsidiary
- Successful, recent CANDU construction projects
- Full lifecycle services packages
- Turnkey solutions and project risk-/benefit-sharing
- Serious financial commitment to ACR
- Major commitment to US Market
- Very positive utility response
- Look forward to working with NRC on the pre-licensing application

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Pg 30

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Safety Foundations of CANDU®

By Victor Snell, Director, Safety & Licensing, ACR

Presented to US Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
July 24, 2002

AECL TECHNOLOGIES INC.

Pg 1

Agenda

- Purpose of Presentation
- Origins
- CANDU Safety
- Technical Basis
- Regulation
- Summary

Pg 2

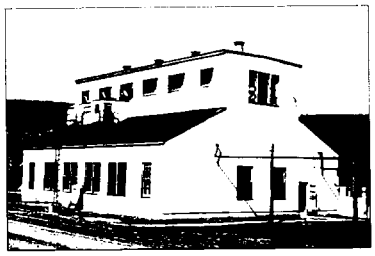
Purpose of Presentation

- To summarize the technology basis of the ACR-700™
  - An evolutionary development of existing CANDU reactors
  - Uses the research, development, and operating experience underlying the CANDU design
- To describe some safety aspects particular to ACR-700; details will be presented in later meetings.

Origins

ZEEP

World's First Reactor Outside the US
Joint cooperation at Montreal Laboratories – US/UK/Canada



ZEEP building at Chalk River Laboratories near Chalk River, Ontario, as it appeared around the time of its first startup in 1945.

ZEEP photograph taken during the 1950s. Experiments were conducted on fuel for early CANDU designs, including NPD and Douglas Point.

Conversion to Civilian Power Program

Determinants:

- To ensure reliability of fuel supply
  - Natural uranium
- To ensure self-sufficiency in manufacture
  - Pressure tube as coolant pressure boundary in core
- To ensure neutron economy
  - Heavy water moderator

Operating CANDUs all use heavy water coolant.

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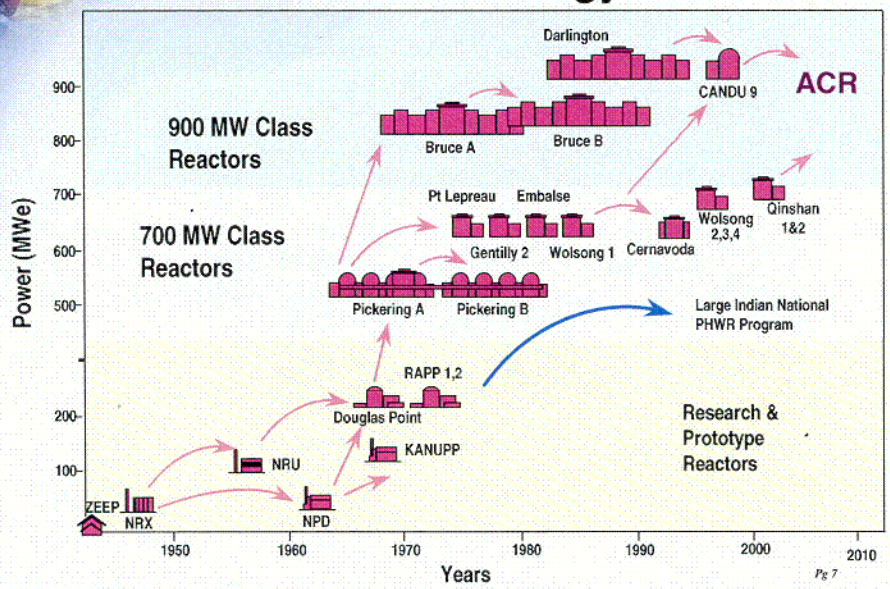
CANDU Genealogy



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CANDU has a long history of successful development and deployment

Pg 8

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C02

CANDU Safety

Early Lessons

- Accident in the NRX research reactor in 1952 was pivotal in developing subsequent safety approach to CANDU design:
  - Separation of control and safety systems
  - Reliability targets demonstrated by testing during operation
  - Redundancy and diversity of shutdown
- NRX reactor vessel was replaced and provided good R&D results until it closed in 1992.

Four Safety Functions

1. Control power and, if needed, shut down reactor
2. Remove heat after shutdown
3. Contain radioactivity
4. Monitor the state of the plant

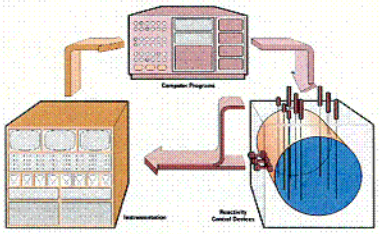
These will be summarized here and covered in detail in the September 25/26 Workshop.

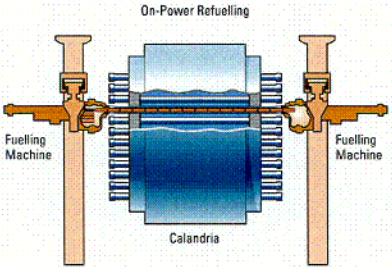
Reactivity Control

- Long prompt neutron lifetime
  - Rate of rise in power is relatively slow.
- Reactivity control mechanisms penetrate the low-pressure moderator, not the coolant pressure boundary; do not interact with the fuel
- Void coefficient is the only source of fast reactivity change:
  - Positive in operating CANDUs
  - *Small* and *negative* in ACR-700
  - Smaller absolute value (whatever the sign) reduces requirements on shutdown speed.
- Little reactivity hold-up in the reactor control system
  - Long-term reactivity control via on-power fueling
  - Small control device reactivity worth (< 30¢ per rod)
  - No need for boron in the coolant to hold down reactivity.

Reactor Power Control

- Reactor control through redundant digital computers
  - Fail-safe & reliable (99% each)
  - Distributed digital control for ACR-700

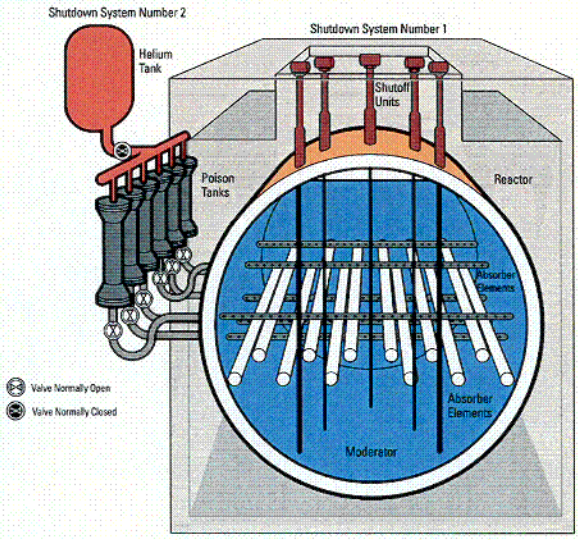




- On-power refueling
  - Detect & remove failed fuel at power

Shutdown Systems

- Redundant
- Diverse
- Separated
- Reliable
- Testable



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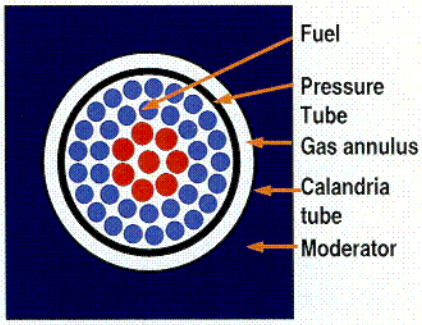
C03

Heat Removal - Pressure Tubes as Core Pressure Boundary

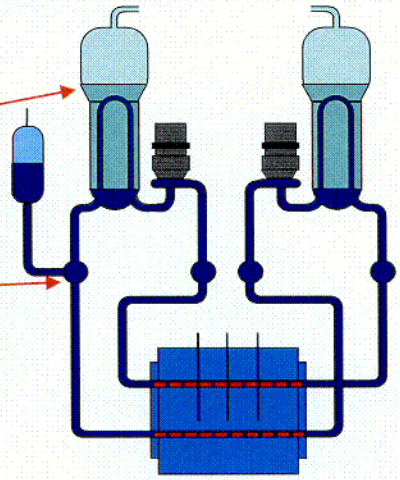
- Simple geometry; inspected in-service
- Individually replaceable
- All can be replaced to extend plant life.
- "Leak before break" demonstrated
- ACR-700 – calandria tube will contain pressure-tube failure.
- Channel failure will not propagate
- No large high-pressure pipes directly connected to the reactor structure
  - no overturning forces
- All fuel < 2½ inches from moderator



Reactor Coolant System

Above the reactor – similar to PWRs

- Steam generators above the reactor
  - promotes thermosyphoning at decay power
- Each channel individually connected to collectors (headers) above the core
- No large RCS piping at or below core level



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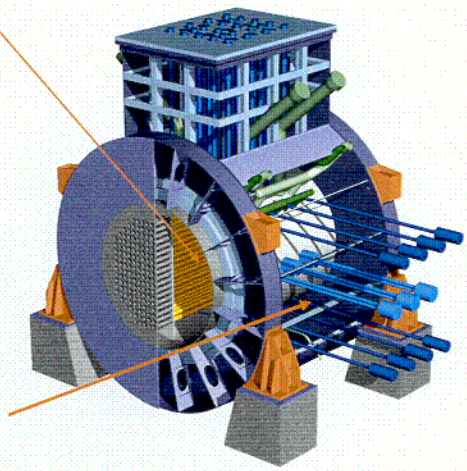
C04

Emergency Core Cooling System (ECCS)

- Conventional accumulator-driven high-pressure stage + pumped injection into reactor coolant system headers
- Major simplifications on ACR-700 because of light water coolant

Moderator

- Cool, low-pressure heavy-water moderator
- Removes ~ 5% of the fuel heat in normal operation, similar to decay heat shortly after shutdown
- Absorbs energy from a postulated channel failure
- Long-term emergency heat sink for LOCA with loss of ECCS
  - no melting of the UO_2 fuel; preserves channel integrity
- Backed up by light water shield tank – slow and graceful progression of severe core damage



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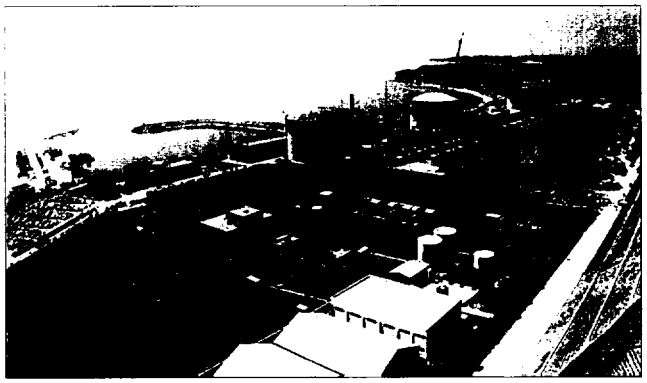
C05

Containment

- Single-unit CANDU – complete containment – leak-tight, lined, pre-stressed thick-walled concrete building envelope similar to LWR
- Enhancements for external event protection on ACR-700



Monitoring

- Main control room and separated secondary control area, from either of which the operator can:
  - Shut down the plant
  - Remove heat after shutdown
  - Maintain barriers to release of radioactivity
  - Determine the plant state

CANDU Safety Record

- Design assumes accidents and human errors are possible; design prevents, stops, controls and mitigates them.
- No-one has ever been killed or injured as a result of a nuclear accident in CANDU.
- There has been no significant damage to the fuel in a CANDU due to an accident.
- There have been a number of minor incidents, notably heavy water spills, with insignificant consequences to public health.
- On the few occasions when the safety systems have been needed, they have responded as designed.
- AECL uses operating experience to improve the design of current and future products.

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CANDU Safety Record (cont'd)

- CANDU design has forgiving safety characteristics
- Operating safety record has been excellent

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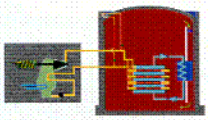
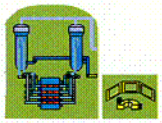
Technical Basis

Safety R&D

- Overall direction of R&D program
  - Support operating CANDUs
  - Validate and improve safety analysis codes
  - Improve system response to design basis events
  - Contain severe core damage consequences
  - Develop advanced concepts
- ACR-700
  - Built on existing CANDU R&D
  - Anticipatory R&D covered in September workshop
  - No requirement for full-size prototype
- Significant commonality with PWR safety research areas and issues

Linkage of Safety Research to Plant Licensing





SAFETY R&D

ADVANCED DESIGNS

CURRENT PROJECTS

KNOWLEDGE

MODELS

CODES

SAFETY REPORT

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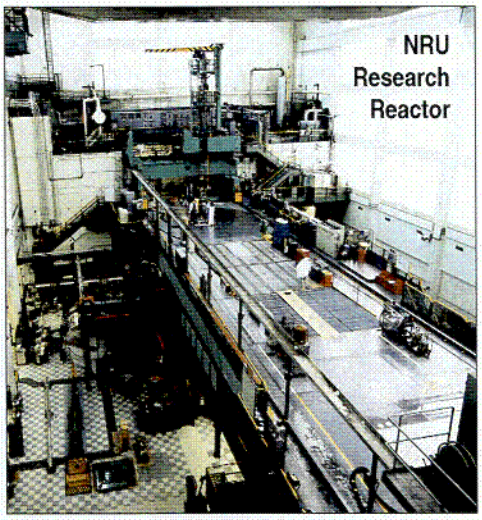
Safety Research

- Large (orig. 200 MW(th)) heavy-water moderated research reactor (NRU)
- Severe accident in-reactor loop (Blowdown Test Facility) in NRU
  - work completed
- Zero-energy reactor (ZED-2)
- Hot cells
- Advanced fuel fabrication and testing
- Critical heat flux
- Moderator circulation



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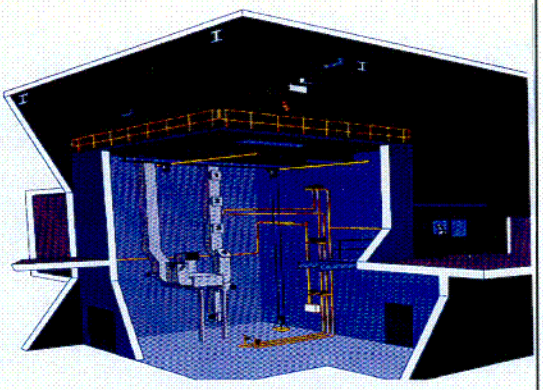
C06

Safety Research (cont'd)

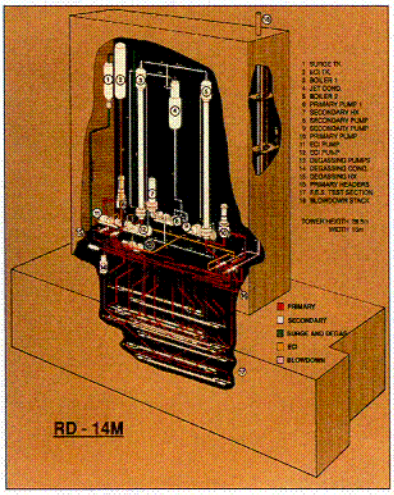
- Large-scale vented combustion facility
- Radioiodine test facility
- RD-14M thermal hydraulics test loop
- Large-scale gas mixing facility
- Pressure-tube ballooning and moderator subcooling



Large-scale gas mixing facility

Thermal Hydraulics of Heat Transport System

- Full elevation simulation of reactor coolant system
- 10 full-length channels
- Mass flux, transit times, pressure and enthalpy distribution similar to CANDU
- Large and small LOCA
- ECCS injection and refill
- Natural circulation at full and partial inventory
- Loss of shutdown cooling



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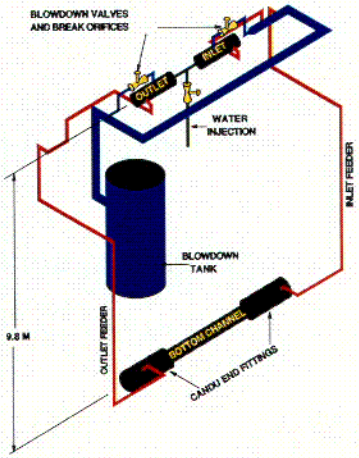
C07

Cold Water Injection Facility

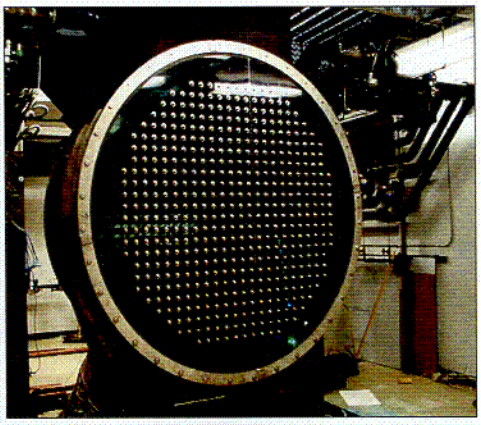
- Full-scale heated fuel channel & fuel string
- Representative feeders and end-fittings
- Blowdown and refill performance



CWIT Test Facility

Moderator Circulation

- Measure three-dimensional velocity and temperature distributions in moderator geometry
- ¼ linear scale



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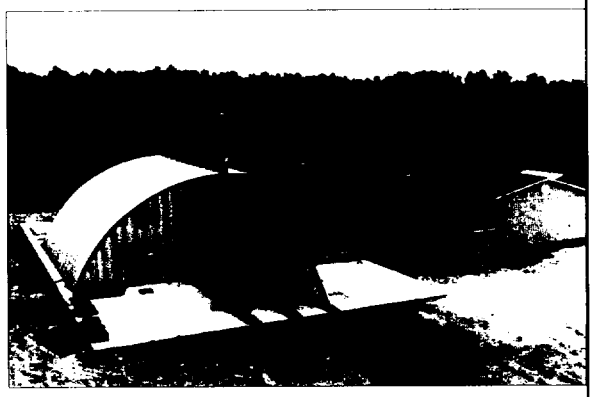
C08

Hydrogen Mixing and Combustion

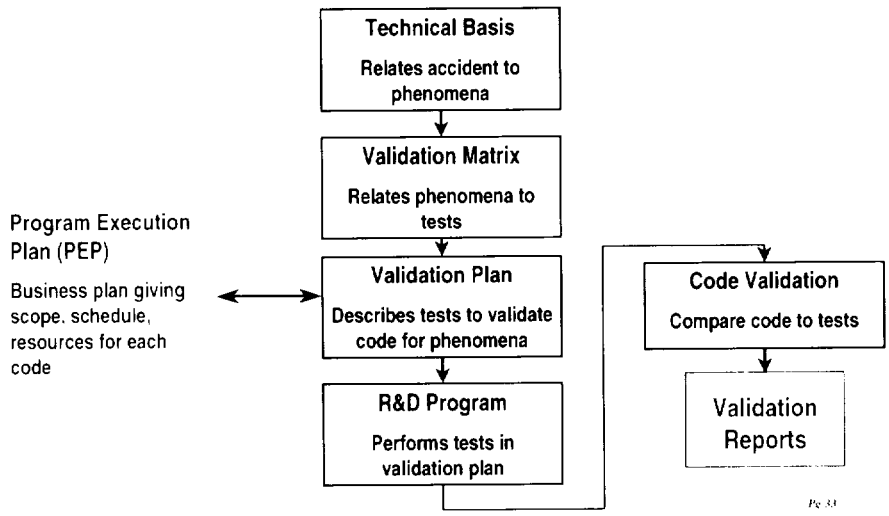
- Large-scale vented combustion facility
- Hydrogen combustion and detonation boundaries in various steam-air-hydrogen mixtures
- Interior geometry can be configured.



Other Areas

- Fission product release and transport
  - hot-cell and in-reactor tests
- Severe core damage
  - demonstrate basic phenomena of core collapse for CANDU in small-scale facility
- Containment thermal hydraulics

Code Validation Uses Standard Methodology



Pg 33

Extensive safety R&D provides solid technology base for confidence in safety analysis tools.

Pg 34

Regulation

Experience

- CANDUs successfully licensed in:
  - Canada
  - Argentina
  - Romania
  - Korea
  - China
- Licensing approach has facilitated development of regulatory bodies in other countries who are knowledgeable and competent in CANDU.

Embalse, Argentina

Regulatory Philosophy in US

- US and Canadian high-level goals are similar: CANDU meets applicable General Design Criteria.
- Lower level safety and regulatory objectives similar for US and Canada but achieved in different ways.
- ACR-700 will meet US regulations as stated, or meet the safety intent behind the regulation.

Summary

- CANDU has a long history of successful development and deployment.
- CANDU design has forgiving safety characteristics.
- Operating safety record has been excellent.
- Extensive safety R&D provides solid technology base for confidence in safety analysis tools.
- Regulatory objectives similar to those for PWRs
- Licensable and licensed in many jurisdictions
- As an evolutionary design, ACR-700 benefits from the CANDU track record.

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The Evolution of the ACR Design

By Stephen Yu, Director, ACR Development Project

Presented to US Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
July 24, 2002

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ACR-700 Design

- The evolutionary approach has great advantages
  - Can deliver safety enhancement and economic savings with practical innovation, building on strong CANDU knowledge base
  - Priority on ensuring robust safety case
- Key elements:
  - Application of enabling technologies
  - Balance of experience and innovation in design

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Status of ACR-700 Design

- Design definition and optimization
  - Conceptual design studies for ACR-700 completed in March 2001
  - Defined optimized reference ACR-700 design in March 2002
  - Design meets safety, cost and schedule targets
  - Other size option: ACR-1000

Engineering Program

- January 2002 to September 2005
- 45-month program to perform generic engineering to have market-ready product and to support pre-project licensing
- Program infrastructure is in place.
- Program is mobilized with a total of 160 staff currently working on basic engineering and specific anticipatory R&D support.
- Major contributions from partners and staff in support of business development are in addition to the above.
- Program staff will continue to increase to 2003.

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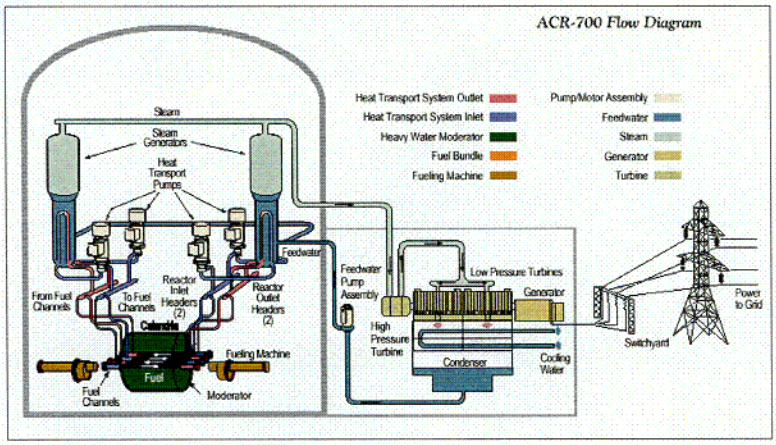
Basis of ACR-700 Design

- Evolutionary approach adopted by building on CANDU 6 design, project and operational experience
- Retained traditional CANDU features:
  - Modular horizontal fuel channels
  - Simple, economical fuel bundle design
  - Heavy water moderator
  - On-power fueling
  - High neutron efficiency
- Feedback from CANDU plants
  - Operating CANDU plants
  - Construction/commissioning feedback from Qinshan III CANDU 6 project

Pg 5

Overall ACR-700 Plant Flow Diagram



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Safety and Cost Reduction Innovations

- Remove constraints associated with using natural uranium fuel
- Improve core characteristics and reduce D_2O inventory
  - H_2O coolant in D_2O moderated lattice
  - Smaller lattice pitch - 11.25" to 8.7" (22 cm)
  - Slightly enriched uranium (SEU) fuel
- Reduce fuel element rating and increase maximum channel and bundle powers
  - Use CANFLEX fuel bundle design
- Increase operating margin and turbine cycle efficiency
  - Thicker pressure tube
  - Higher reactor coolant and secondary steam temperature and pressure
- Reduce size of reactor core and reactor building

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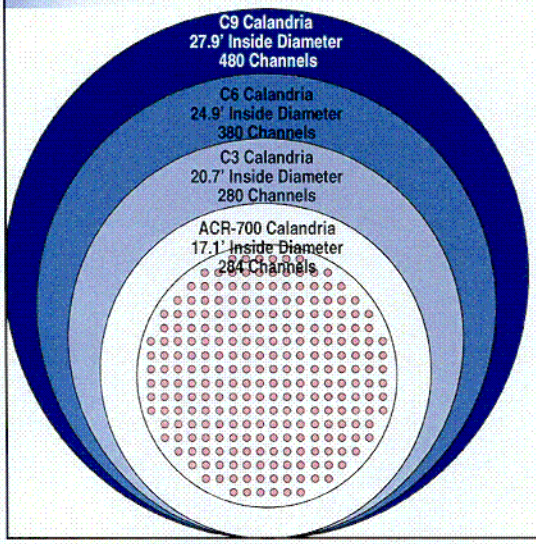
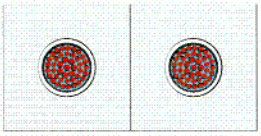
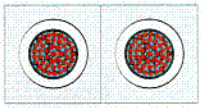
ACR-700 Reactor Size vs Other CANDU Reactors





CANDU 6
Lattice Pitch = 11.25"
PT O.R. = 2.2"
CT O.R. = 2.6"
VM / VF = 16.4



ACR-700
Lattice Pitch = 8.7"
PT O.R. = 2.2"
CT O.R. = 3.1"
VM / VF = 7.1

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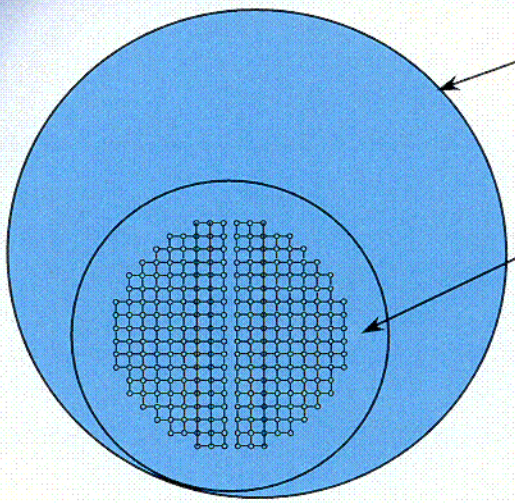
C10

Core Size Reduction



CANDU 6
728 MWe
380 channels
Diameter = 24.9'

ACR-700
731 MWe
284 channels
Diameter = 17.1'

- Calandria volume reduced by 60% from C6
- By using H_2O coolant, less than 25% of D_2O used in C6 is required

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Characteristics of the ACR-700 Core

Parameter		CANDU 6	ACR-700
Number of Fuel Channels		380	284
Number of Bundles per Channel		12	12
Thermal Output to Steam Generators	MWt	2064	1982
Gross Electrical Power Output	MWe	728	731
Lattice pitch (square)	in	11.25	8.7
Reactor Diameter	ft	24.9	17.1
Coolant (average)		D_2O @554°F	H_2O @577°F
Moderator (outlet)		D_2O @154°F	D_2O @176°F
Radial Form Factor		0.83	0.93
Fuel Type		37 Element CANDU	43 Element CANFLEX
Fuel Enrichment	wt% ^{235}U	0.71	2
Core-Average Fuel Burn-up	MWd/MT	7,500	20,500
Maximum Fuel Element Burn-up	MWd/MT	17,000	26,000
Fuel Bundles Required per Full Power Day		16	5.8
Channel Visits per Full Power Day		2	2.9
Fueling Scheme		8-bundle-shift	2-bundle-shift
Maximum Time-Average Channel Power	MWt	6.7	7.5
Maximum Time-Average Bundle Power	kWt	800	880
Maximum Instantaneous Channel Power	MWt	7	7.8
Maximum Instantaneous Bundle Power	kWt	900	900
Max. Instantaneous Linear Element Rating	kW/ft	17.4	15.5

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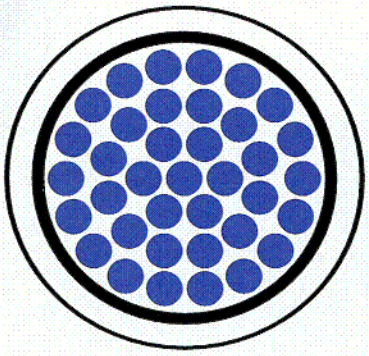
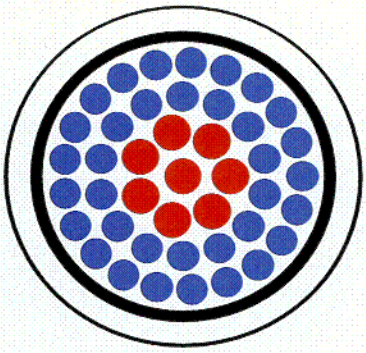
C11

CANDU Fuel Bundle Designs



37-Element Bundle



CANFLEX Bundle

Pg 11

CANFLEX Fuel Bundle

Pg 12

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C12

ACR-700 CANFLEX Fuel

- CANFLEX NU fuel bundles have been tested in operating CANDU 6 reactor
- Substantial experience in slightly enriched uranium fuel in test reactors
- Main features of the ACR CANFLEX fuel bundle:
  - Central element contains NU pellets with ~4% dysprosium
  - All other fuel elements contain 2.0 wt% ^{235}U SEU pellets
  - Fuel burn-up 20,500 MWd/MT (U), and further increase with operating experience
  - Thicker cladding
  - Shorter pellets with larger chamfers
  - Longer and taller bearing pads
- Further confirmatory testing of the SEU fuel:
  - Physics validation tests in ZED-2 to start 2002
  - Irradiation tests in NRU to start 2003

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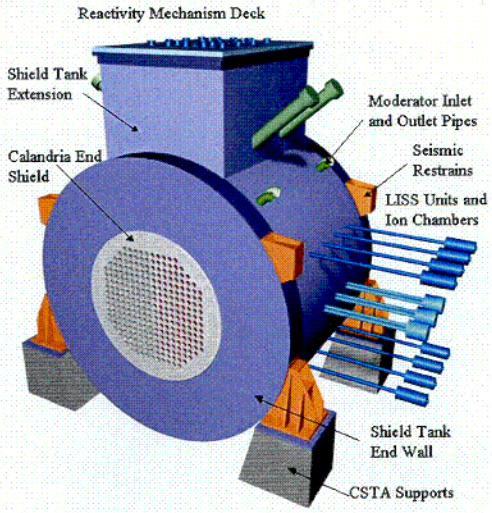
ACR-700 Reactor Assembly



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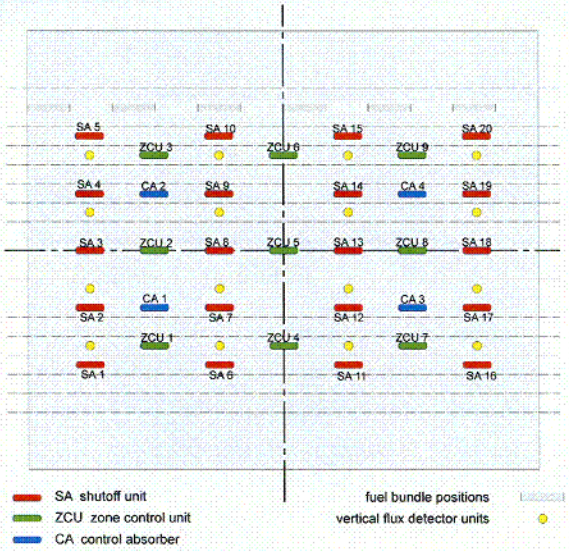
C13

ACR-700 Reactivity Mechanisms Plan View



Pg 15

Reactor Coolant System

- The Reactor Coolant System (Heat Transport System) circulates light water (H_2O) coolant through the reactor fuel channels
- The ACR-700 arrangement is similar to a single loop of the two loops of the CANDU 6 design
- Major components are:
  - 2 steam generators
  - 4 heat transport (HT) pumps
  - 2 reactor inlet headers
  - 2 reactor outlet headers
  - Interconnecting piping

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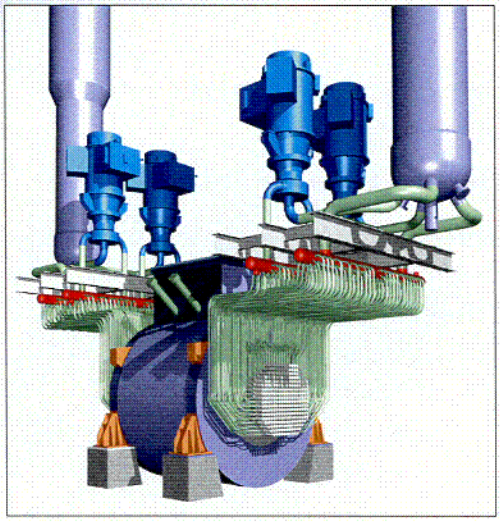
C14

Reactor Coolant System Layout



Conventional system piping layout

All large reactor coolant piping above headers

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Comparison of CANDU 6 / ACR-700

		CANDU 6	ACR-700
Thermal Output to steam generator	MWt	2064	1982
Gross / Net Electrical Output	MWe	728/668	731/681
Number of Fuel Channels		380	284
Number of Elements in Fuel Bundle		37	43
Number of Loops		2	1
Maximum Channel Flow	lb/s	52.9	57.3
Reactor Outlet Header Pressure	psig	1437	1727
Reactor Outlet Header Temperature	°F	590	617
Reactor Outlet Header Quality	%	4	2
Number of Heat Transport Pumps		4	4
Heat Transport Pump Motor Rating	MWe	6.7	6.9
Number of Steam Generators		4	2
Heat Transfer Area per Steam Generator	ft^2	34445	95368
Steam Pressure at SG Outlet	psig	668	929
Containment Inside Diameter	ft	136	125
Containment Height	ft	168	194

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C15

Reactor Coolant System

- Increased coolant pressure enables core outlet temperatures typical of PWRs, and similar steam generator and turbine conditions
- Steam generators (2) are similar to PWR SGs.
- HT pumps (4) are similar to the CANDU 6 design
- Lower feeder material is made of stainless steel, while rest of HT circuit is made of carbon steel.
- Feeder header assemblies are pre-assembled and modularized for faster installation.
- Discussions are underway with suppliers of the SGs, HT pumps and other major nuclear equipment.

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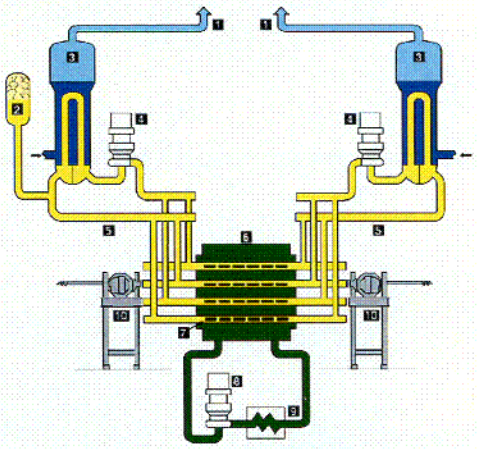
Nuclear Steam Systems

Major nuclear systems

- STEAM
- FEEDWATER
- LIGHT WATER COOLANT
- HEAVY WATER MODERATOR

1 MAIN STEAM PIPES
2 PRESSURIZER
3 STEAM GENERATORS
4 HEAT TRANSPORT PUMPS
5 HEADERS
6 CALANDRIA
7 FUEL
8 MODERATOR PUMP
9 MODERATOR HEAT EXCHANGER
10 FUELING MACHINES



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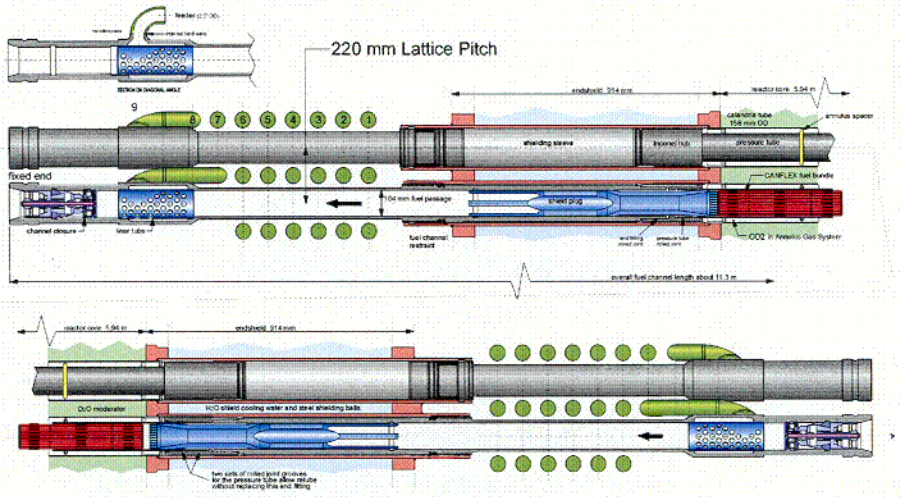
C16

ACR-700 Fuel Channel



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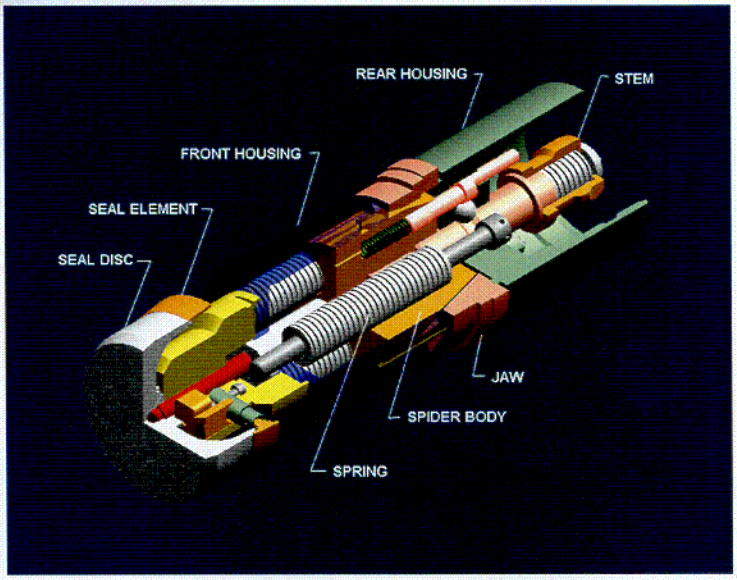
Bore Seal Closure



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Fuel Handling System

- On-power refueling retained in ACR-700
- System is designed to:
  - Perform two-bundle shift during refueling
  - Simplify manufacture, installation and commissioning
  - Reduce O&M costs
- Major improvements in the design include:
  - Fueling machine head and carriage
  - Electric drives replacing oil hydraulic drives
  - Elimination of D_2O resulting in simpler fueling system
  - New and spent fuel transfer mechanism
- Space required for fuel transfer and storage is reduced

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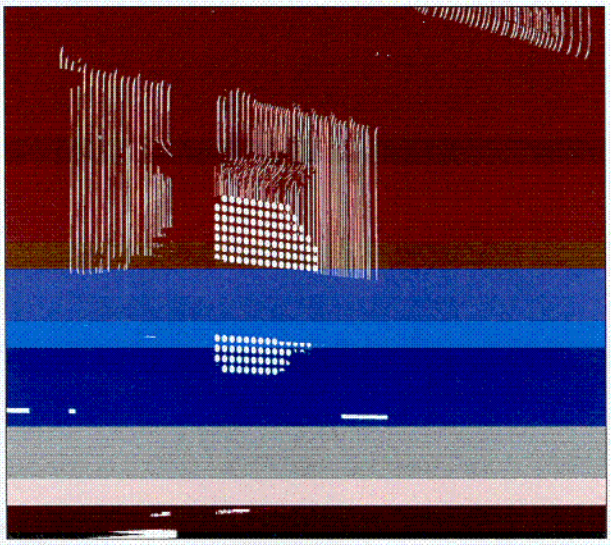
Fueling Machine and Carriage



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C18

Safety Systems

- Safety Systems based on existing, proven CANDU designs
- Safety Shutdown System 1 (SDS1)
  - 20 SOR units (based on CANDU 6 design)
- Safety Shutdown System 2 (SDS2)
  - 6 LISS nozzles (based on CANDU 6 design)
- Emergency Core Cooling System (ECCS)
  - High-pressure accumulator injection
  - Low-pressure pump injection and long-term heat removal
  - Simplified ECCS design due to light water coolant
- Containment
  - Pre-stressed concrete containment structures with steel liner (based on CANDU 9 and PWR designs)

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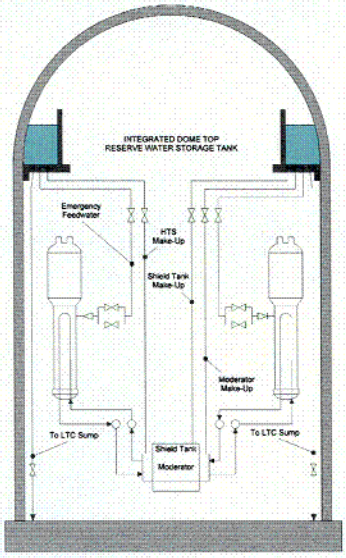
Passive Heat Sinks



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C19

Summary

- Improved safety characteristics and margins combined with established CANDU safety features
- Energy systems technology is similar to PWR: light water coolant, slightly enriched fuel, balance of plant
- Robust CANDU project experience
  - Currently building CANDUs in China and Romania
- Slightly Enriched Uranium fuel with D_2O moderator and reflector gives well-optimized core design, improving efficiency and reducing cost
- ACR-700 uses advanced features, such as advanced alarm system, which are being incorporated into current CANDUs
- ACR delivers low-cost option, incorporating best features of LWR and CANDU
  - Combination of proven evolutionary approach and advanced technology base

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Overview of the Proposed Pre-Application Licensing Plan

By Vince Langman, Manager, Safety & Licensing, ACR

Presented to US Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
July 24, 2002

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Presentation Outline

- Pre-Application Licensing Plan Objectives
- Basis of the Pre-Application Review
- Guidance from NUREG-1226
- Scope of the Pre-Application Review
- Review Schedule
- Proposed Next Steps

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Pre-Application Licensing Plan Objectives

- To develop a clear understanding with the NRC staff of:
  - Scope of NRC review work
  - Amount and cost of labor to perform NRC review work
  - Schedule of NRC review work
- To obtain a Standard Design Certification for an ACR-700

Pre-Application Licensing Plan Objectives (cont'd)

- Enable early identification of ACR-700 technical issues requiring further study by the NRC:
  - Obtain estimates of the NRC's review scope, completion schedules and associated costs to address these identified technical issues

Pre-Application Licensing Plan Objectives (cont'd)

- To obtain an NRC Safety Evaluation Report on the ACR-700 that:
  - Identifies key issues
  - Provides guidance on applicable licensing criteria
  - Assesses the adequacy of the ACR-700 technology base
  - Identifies issues, if any, associated with licensing the ACR-700 in the US
  - Provides estimates of the scope, cost and schedule for the NRC's review efforts for ACR-700 design certification

Basis of the Pre-Application Review

- It is AECL Technologies' understanding that the scope of the ACR-700 Pre-Application Review will be guided by:
  - NUREG-1226, "Development and Utilization of the NRC Policy Statement on the Regulation of Advanced Nuclear Power Plants"
  - Applicable LWR regulations and guidance

Basis of the Pre-Application Review (cont'd)

- The ACR-700 design will be assessed against existing regulations for LWRs:
  - Where differences in design approach arise, show equivalence from a safety goals perspective
  - A limited number of additional safety and design criteria may be required to address some of the unique design features of the ACR-700.

Guidance from NUREG-1226

- The ACR-700 design will address:
  - Defense-in-depth
  - Standardization
  - The Commission's safety goal and severe accident policies
  - Applicable US industry codes and standards

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Guidance from NUREG-1226 (cont'd)

- The extensive technology base for the ACR-700 will be described:
  - Existing technology base
    - Decades of analysis, development, qualification, testing and operation of CANDU materials, components, fuel, systems and reactors worldwide
  - Anticipatory R&D
    - ACR-700-specific R&D that is currently underway/planned

Guidance from NUREG-1226 (cont'd)

- The Design and Safety Criteria for the ACR-700 will be clearly addressed.
- New criteria will be explained from a safety goal perspective against the closest equivalent LWR criteria:
  - Address how any new criteria would ensure safety
  - Describe the benefits of any new criteria compared to the traditional NRC process of regulation

Scope of the Pre-Application Review

Two phases of NRC pre-application review

- Phase 1 (June 2002 to June 2003)
  - Familiarize the NRC with the ACR-700 design and technology base
    - Design
      - Plant layout
      - Accident analysis methodology
      - Safety analysis results in support of design
    - Technology base
    - Fuel cycle
    - CANDU operability
    - Security and safeguards

Scope of the Pre-Application Review (cont'd)

- Phase 1 (cont'd)
  - Identify information requirements for both phases of the NRC pre-application review
  - Identify technical issues that may require further study
  - Assess and document the NRC resource, schedule and cost requirements for completion of Phase 2 of the pre-application review

Scope of the Pre-Application Review (cont'd)

- Phase 2 (July 2003 to June 2004)
  - Further assessment of the design and technology base for the ACR-700
  - Finalize resolution strategies for identified issues
  - Assess and document the NRC resource, schedule and cost requirements for completion of a design certification for the ACR-700 (i.e., including resolution of identified issues)

Review Schedule

- Pre-Application Review (June 2002 to June 2004)
  - Phase 1 (June 2002 to June 2003)
  - Phase 2 (July 2003 to June 2004)
- Complete documentation to support ACR-700 design certification (July 2004 to end of 2004)
- Apply for ACR-700 Design Certification (early 2005)

Proposed Next Steps

- Licensing
  - Provide the proposed ACR-700 Pre-Application Licensing Plan to the NRC (early September 2002)
  - Meeting with NRC to discuss the proposed Pre-Application Licensing Plan (mid-October 2002)

- Initial ACR-700 Familiarization Meetings with the NRC
  - ACR-700 Overview (2-day workshop, September 25/26 2002)
  - The ACR-700 Core (1-day meeting in mid-November 2002)
  - ACR-700 Thermal hydraulics (1-day meeting in mid-January 2003)