CNS CONFERENCE
Qinshan Project - June 2003

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Canada

AECL
Atomic Energy
of Canada Limited

CANDU CONSTRUCTION IN CHINA
Ahead of Schedule – Under Budget

Contents

Site - Detailed Location in China

Reference Data

- Qinshan III CANDU NPP
  - 2 x 728 MWe by AECL and TQNPC
  - Zhejiang Province, China
- Contract effective – 1997 Feb 12
- Start construction – 1998 Jun 8
- Scheduled in-service:
  - Unit 1: 2003 Feb 12 – Actual 2002 Dec 31
  - Unit 2: 2003 Nov 12- Predicted 2003 July


October 1997

Major Participants

- AECL overall project manager, designs & supplies NSP, manages NSP construction
- Third Qinshan Nuclear Power Company (TQNPC) owner, manages BOP construction & executes commissioning
- Chinese Construction Contractors CNI-23, HXCC, CNI-22, ZTPC
- Consortium of Hitachi/Bechtel for BOP design and supply

Contract Structure

	NSP		BOP
Project Management	**AECL**		
Engineering Design	**<u>NSSS Design</u>** **AECL**	**<u>BNSP Design</u>** **CANATOM NPM** BNSP Subcontract	**BOP Consortium** Design & Supply Subcontract
Supply	**CANATOM NPM** NSP Supply Subcontract		**BOP Consortium** Design & Supply Subcontract
	Hitachi NSP Supply Subcontract		
	HANJUNG NSP Supply Subcontract		
Site Construction Management	**CANATOM NPM** Project Management Subcontract		**TQNPC**
Commissioning	**TQNPC under guidance and direction by AECL**		
Construction	**NSP Construction Contractors** (under AECL direction)		**BOP Construction Contractors** (under TQNPC direction)
Training	**Hydro Quebec** NSP Training Subcontract		**BOP Consortium** Design & Supply Subcontract

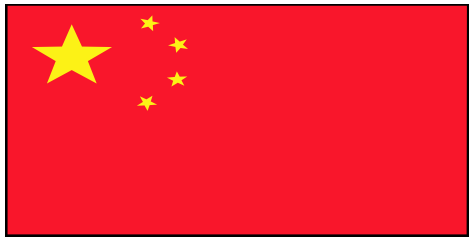
Heavy Water and Fuel	**AECL**

CHALLENGES

- Many participants-not worked together before on a project
- Unfamiliarity with China
- Shortest schedule of any NPP committed in China
- First CANDU in China
- Regionalized construction not able to benefit from prior PWR experience
- Smallest site in China with water on three sides
- Internal focus on jobs in government companies, not on best for task - structural steel had large schedule impact

- Chinese planning milestone based
- Different country and company cultures – AECL – Chinese – Bechtel - Hitachi
- Young inexperienced Chinese commissioning staff
- Complex execution model; owner manages BOP construction, AECL directs NSP contractors - owner pays
- CONTRACT- LUMP SUM with LDs
- AECL first time use of CADDs, Open Top and all electronic document systems---”on the run”
- Needed to take site construction quality from a paper to effective program.

HOW WE DID IT



TEAMWORK

Meeting the Schedule – Qinshan Phase III

- Good people and teamwork among participants
- Project management leadership and culture with good support from head office and freedom to do job within context of total Contract – focal point accountability
- Good client (TQNPC) and local construction contractors
- State of the Art Project Management Tools
- Early planning, integrated schedules and parallel activities
- Improved construction methods-open top

- Large part of design ready at CED for NSP
- Team in place at CED to produce all project procedures at Rev 0 before work started.
- Design by area not system to match actual construction program
- Effective training and support from Hydro Quebec Gentilly 2 CANDU 6 station
- Excellent commissioning by integrated Chinese and Canadian Teams

NOTE: PROJECT decisions on CADDS, open top, electronic tools made after Contract signing based on dealing with RISKS and CHALLENGES

Quality a Priority

- Promoted NCR culture
- Used NCRs to control and stop work on a localized area
- Used stop work orders to set policy and direction
- Electronic document system supported quality records and processes
- “All” expat site staff were quality surveyors
- Quality was a LINE responsibility
- Client and contractors evolved to accepting International Quality Program-cultural shift
- Independent Chinese QS body on NSP program

State of the Art Project Management Tools

- **CADDs – LESS errors and better understanding of overall design and equipment to support easier installation – MANY interferences eliminated**
- **CANDU Material Management System (CMMS)**
  - **tracks equipment and materials from RFQ to issue for construction**
  - **system supports ongoing plant operation & maintenance**
  - **items bar coded for inventory control and reduced costs**

State of the Art Project Management Tools (contd.)

- Asset Information Management (AIM) - all "formal" project records in electronic format
  - on-line and common access to official drawings and documents by all parties
  - reduces errors
  - real time access by all parties
    - dramatically improves quality & efficiency
    - reduces costs
- IntEC – Integrated database for wiring/cabling and Instrument calibration with real time access.

Construction Methods
- Modularization & VHL (Open Top)

- Shortens installation time
- Work access from top and bottom
- Reduces construction labor and interferences between contractors
- Gives schedule flexibility
- Done on site for Qinshan after Contract signed
- Improves quality
- REDUCES COSTS
- Compensated for other project delays

Integrated Schedules

- 76 event contract milestone schedule
- 8500 event level 2 schedule shows
  - design deliverables
  - equipment deliveries
  - construction & commissioning activities
- Integrated level 3 schedule by construction contractors
- Parallel activities between civil and installation
  – New for Chinese but shortened schedule


1998 SEPTEMBER


OCTOBER 1998


OCTOBER 1998


NOVEMBER 1998
Coffer Dam


DECEMBER 1998


January 1999


JANUARY 1999


March 1999


MARCH 1999


March 1999


June 1999
Unloading
Calandria
ALSTOM
FORE

Major Lifts (tons) - (70 lifts done)

- Steam generator - 220
- Temporary roof - 150
- Pressurizer - 103
- Reactivity deck - 43
- Feeder frames - 40 each,
- Condenser shells - 270 each,
- T/G stator - 280

- Evolution of Reference Plant design by Chinese contractors and AECL for modularization of:
  - dousing steel and piping
  - lower dome formwork
  - spent fuel transfer
- AECL staffing featured hands on field staff to provide training for contractors. Unit 2 durations about 3/4 of Unit 1


July 1999
Condenser Heavy Lift Unit 1


December 1999


November 2000
Dousing Module Lift
中核华兴


April 2001


January 2003

Commissioning TEAM

- TQNPC - 1000 staff
- AECL, Bechtel and Hitachi - 46 expat advisors
- 232 TQNPC staff trained at Gentilly 2 NPP in Canada
- Full scope CANDU 6 simulator on-site
- Control room operators licensed by NNSA
- Integrated team very successful


October 2001

World Records by Chinese Nuclear Contractors CNI 23 and HXCC

• Slipforming Unit 1	18 days
• Slipforming Unit 2	14 days
• FC installation Unit 1	69 days
• FC installation Unit 2	64 days
• Steam generator installation	8 hours
• Pressurizer installation	8 hours

New Record for Chinese NPP Construction

	First Concrete to Criticality (Months)	Criticality (Year)	First Concrete to 100% Power
Qinshan I	77	1991	87
Qinshan II (U 1)	66	2001	70
Daya Bay U1	71.5	1993	75.5
Daya Bay U2	69.5	1994	71.5
Ling'ao U1	56.5	2002	60.5
Ling'ao U2	55.5	2002	57.5
Qinshan III (U 1)	51.5	2002	54

Qinshan Early Completion

Plant		Q3 earlier by months from CED
Daya Bay 1	FRAMATOM	17
Daya Bay 2	FRAMATOM	13
Qinshan II-1	CNNC	16
Qinshan II-2*	CNNC	>20
Ling'ao 1	Guangdong	6
Ling'ao 2	Guangdong	6
Qinshan III-1	AECL	0
Qinshan III-2*	AECL	0
Tianwan 1*	MINATOM	13
Tianwan 2*	MINATOM	18

*predicted

June 2003

- **Owner's staff: 900**
- **Contractors direct site labour force: 500 (down from 8000 peak)**
- **AECL & offshore subcontractors: 60 expatriates on site (peak of 180)**
- **Unit 2 Criticality April 29, 2003**
- **On Track to Full Power in summer 2003 – months ahead of schedule**

Summary and Conclusions

- AECL CANDU 6 built to shortest construction schedule of any NPP in China even though it was first CANDU
- Experience and achievements of Chinese contractors and owners commissioning group show that with earlier design and procurement, and some added modularization, construction of the CANDU 6 which is an existing design and proven technology, can be shortened to give a 66 month project schedule from CED. NOTE: Much better possible for NEW design (ACR) which integrates design and construction and commissioning during design phase.

HOW WE DID IT

PROJECT MANAGEMENT AND TEAMWORK

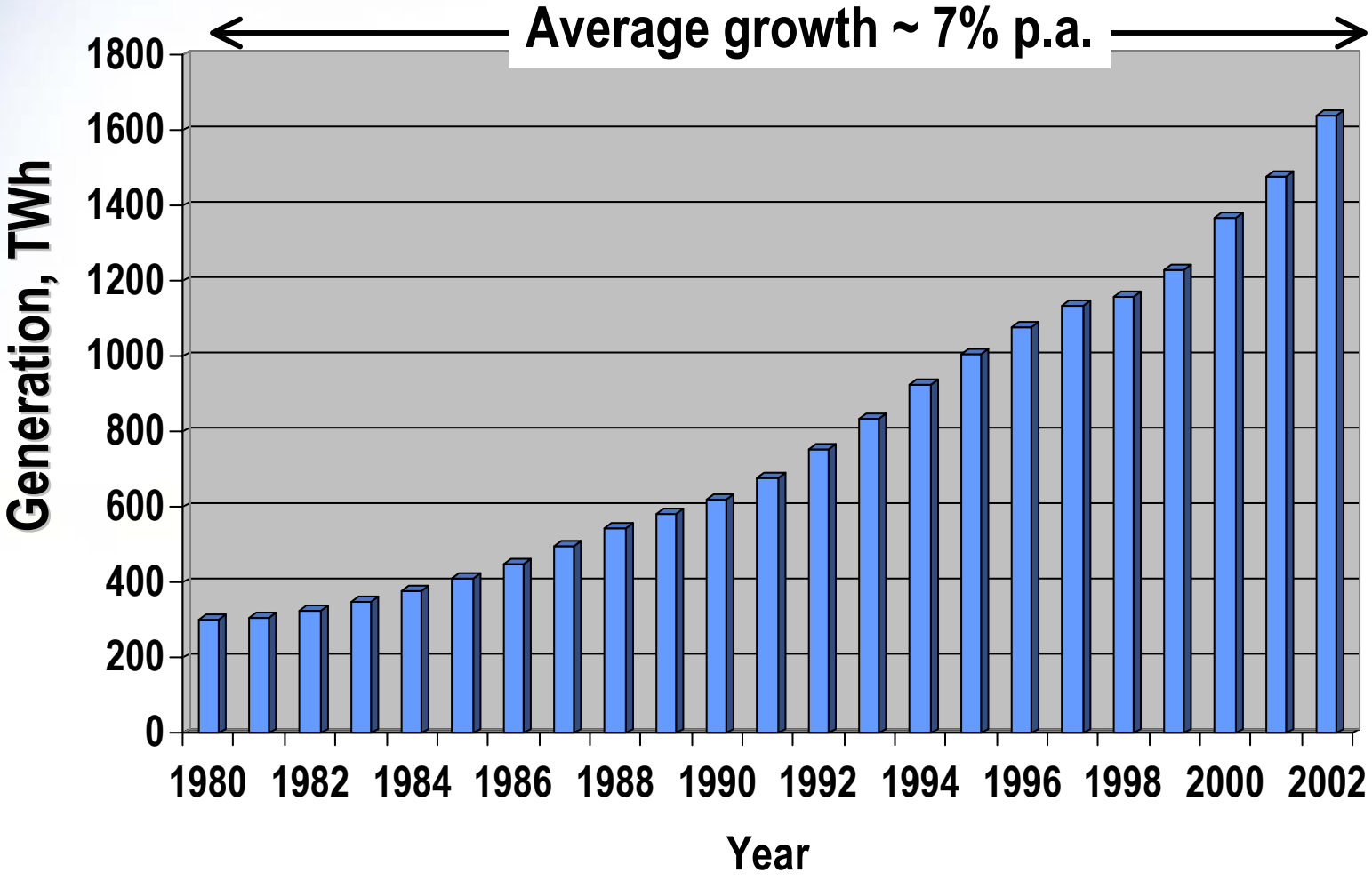
CANDU Q3R

- Replicate Qinshan III
- Same design except pump house
- China as project manager
- Same Chinese contractors
- AECL with Hitachi and Bechtel provide equipment and technical support
- Increased localization
- China does commissioning

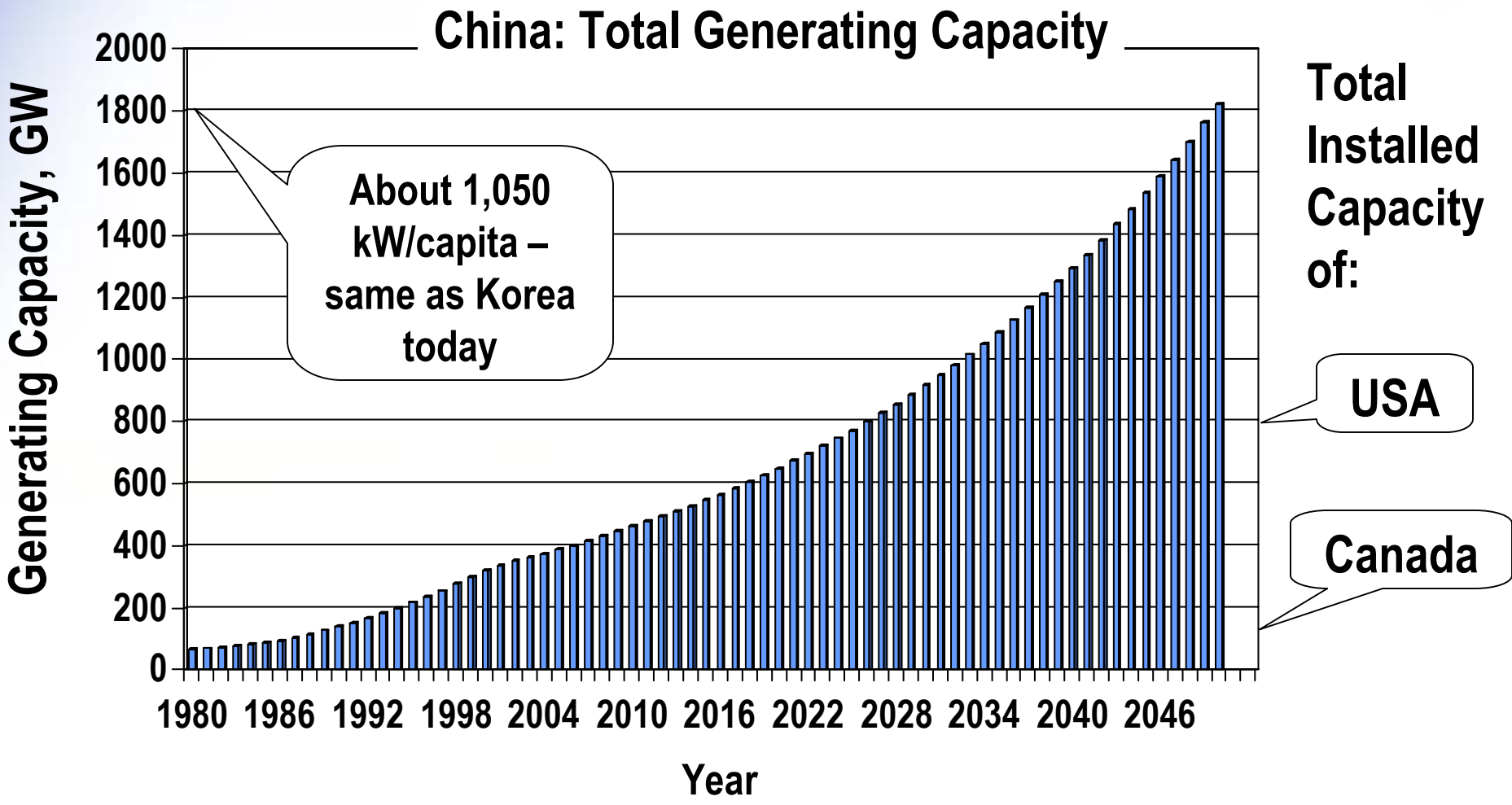
CANDU Q3R (CONTD.)

- Cost about ¼ less than Q III (1500$ kw)
- Schedule 66 months vs. 72 months for QIII
- Shortest schedule in China supports faster connection to grid.

The last 20 years: 7% p.a. growth
China's Electricity Generation



The next 50 years – 3.5% p.a. growth



Nuclear Potential in China

Generating Capacity Additions

	Short Term 2003-2015	Long Term 2003-2050
Total capacity added, MW/yr	30,000	36,000
Nuclear market share	6%	16%
Nuclear capacity added, MW/yr	1,800	6,000

CANDU Opportunities in China

- CANDU advantage is short schedule, economic, fuel cycle flexibility
- Ongoing good performance of Qinshan supporting new projects
- Good Chinese Canadian partnership


TQNPC


AECL