

CU HVDC Converter Upgrades

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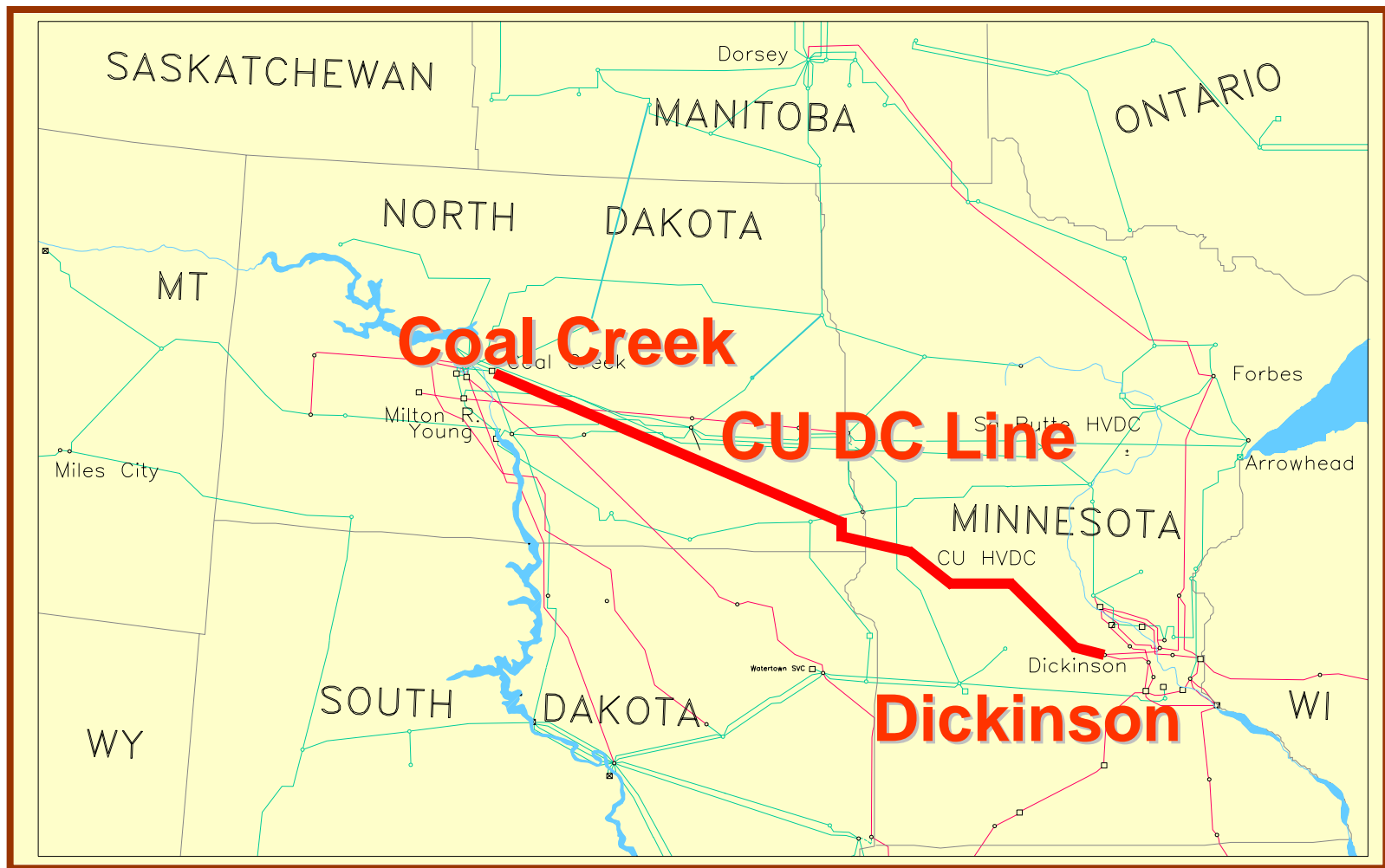
Life Extension of HVDC Systems (Panel Session)
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Overview

- ◆ CU Transmission System
- ◆ Recent Life Extension Projects
- ◆ Control Upgrade Project

CU HVDC System



Need for the CU HVDC Link

- HVDC System and Plant built in 1979
- Coal Creek Station has had major Life Extension investments made
- Backup ac system capability being used up by load growth, wind generation.



CU HVDC System

- ◆ HVDC System Goals
 - Maintain Reliability/Availability
 - ◆ 99+ %
 - Reduce Forced Outage Hours
 - ◆ Upgrade equipment
 - ◆ Reduce troubleshooting time
 - ◆ Increase redundancy
 - Allow Continuous Operation at Overload Rating

CU HVDC Life Extension Projects

- ◆ Valve Control Upgrade
 - Spring, 2001
- ◆ Voltage Upgrade Project
 - Spring, 2002
- ◆ Control System Upgrade
 - Spring, 2004
- ◆ Cooling Tower Replacement
 - Spring, 2008 and Spring, 2010

CU HVDC Future Life Extension Projects

- ◆ Replace All Existing PCB Capacitors
 - 2009-2012
- ◆ Improve Converter Transformer Cooling
 - 2010
- ◆ Replace Oil-filled Wall Bushings
 - 2012
- ◆ Replace Metallic Return Transfer Breaker
 - 2013

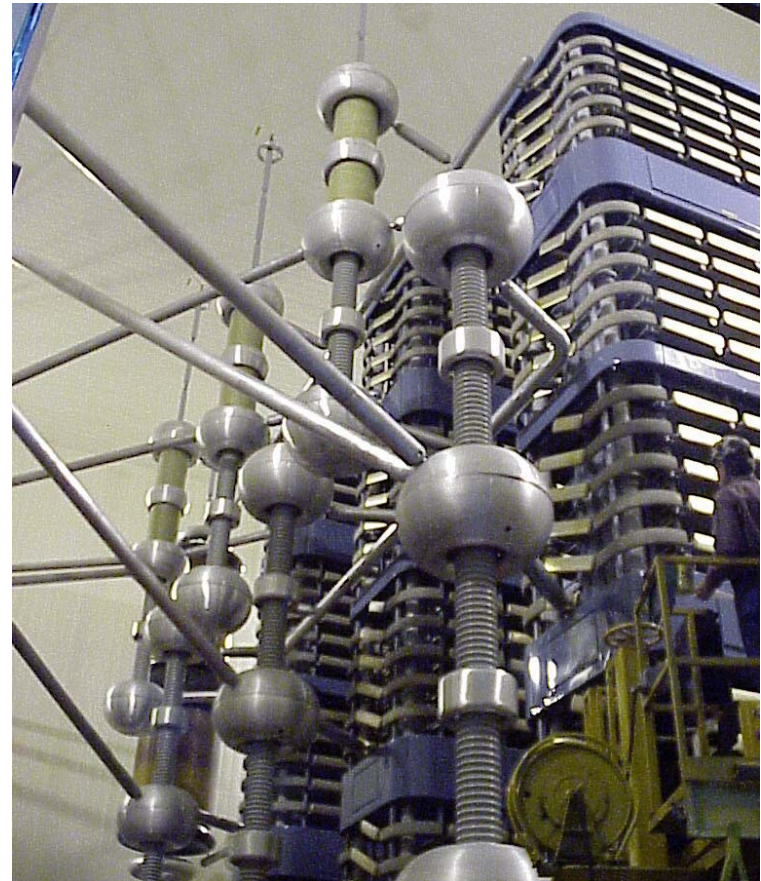
CU Valve Control Upgrade Project Scope

- ◆ Move valve electronics from valvehall to basement
- ◆ Add redundant control electronics
- ◆ Install new valve control cubicles and fiber optic cable trays
- ◆ Install new fiber optic cables (4360/converter) from cubicles in basement to thyristor modules



CU HVDC Voltage Upgrade

- ◆ Increased HVDC Voltage by 2.5 %
- ◆ Project reduced dc line losses by allowing lower dc current at a given power transfer level
- ◆ Project increased summer line rating from 1100 MW to 1128 MW
- ◆ Required replacement of converter valvehall arresters



HVDC Valvehall Cooling Tower Replacement

- ◆ Existing cooling towers are 30 years old, reaching end of life
- ◆ Air-cooled thyristors run hotter than water-cooled, need to improve cooling
- ◆ Extended outage needed to complete replacement
- ◆ Some towers done in 2008, remaining towers to be done during 2010 outage



HVDC Control System Upgrade

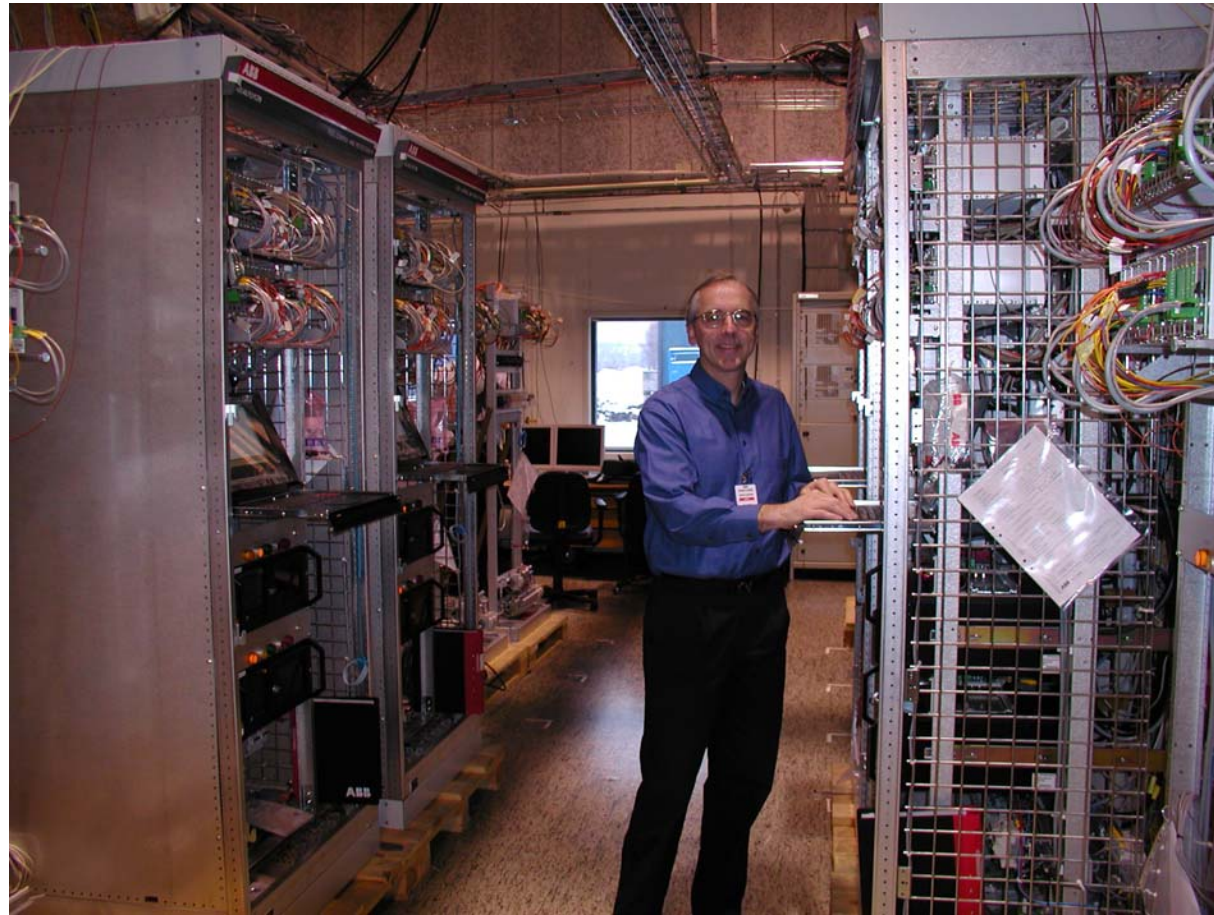
- ◆ Scope is Converter Firing Control, Power Control, Sequences, Converter Protections
- ◆ Necessity to upgrade
 - Obsolescence of current control parts
 - Future deterioration
 - Employee Turnover/Training
- ◆ Benefits
 - Redundancy
 - Supplier Support

HVDC CONTROL SYSTEM UPGRADE

◆ Project Milestones

- Award Contract to ABB in Sept, 2002
- Hardware Delivery for Factory Testing in May, 2003
- Factory System Testing Completed in December, 2003
- Factory Acceptance Tests in Jan., 2004
- Equipment at Sites in mid February, 2004
- Installation Outage -- March 20 through April 16 (4 weeks)

New Control System During Factory Testing



Cubicle Interior with Interface Assembly



Wiring to Existing Terminal Blocks

Interface Assemblies

Fiber Optics to Control Computer

Interface Power Supplies, Supv.

Conclusions

- ◆ Older projects remain useful and important to Owner's bottom line
- ◆ These upgrade projects will provide needed life extension for CU HVDC System
- ◆ Careful planning and project implementation critical to achieving expected benefits at acceptable cost



Questions?