AECL CANDU 9 PLANT CONTROL

- Migration from DCC to DCS Architecture
- Overview of DCC Features
- Functionality Replacement by DCS
- Controls & Display Integration Strategy
- Control Centre Improved Operability
- Simulation Use in the Design Process
- Simulation use for Plant Dynamic Models
- Plant Dynamic Models Analysis
- Status of the DCS design initiative

MIGRATION from DCC to DCS

- Reference Design - Annunciation, Displays and Computer Controls in a central dual minicomputer set
- CANDU 9 allocates these functions to dedicated separate computers for control (DCS), display (PDS), annunciation and calculation/service routines
  - At least minimum DCC functionality retained
  - Now no practical memory constraints for these applications
  - Now no execution limitations for these applications
  - More structured S/W design and management can be applied

OVERVIEW of DCC Control FEATURES

- Good operational reliability achieved (99.5%)
- Field signals wired to dual computer I/O subsystems
- All major control programs executing in each DCC
- Single control programs can fail-over to the standby DCC
- Master computer failure requires all programs to transfer
- Defined Failure status for program or computer failure
- Tuneable parameters can be adjusted during commissioning

FUNCTIONALITY REPLACEMENT by DCS

- Design DCS reliability target raised to 99.9%
- DCS architecture based on partitions derived from an independence assessment of control requirements
- Channelized device level stations for I/O
- Redundant group control can access all data (A,B,C or X&Y)
- Group 1 control programs executing in separate DCS partitions on redundant processors
- Master processor failure causes an automatic transfer to the associated standby processor
- Previous Dual Computer stall has now been reduced to the equivalent impact of a DCC dual program stall for that partition
- Defined Failure status for program or computer failure same as DCC but can now be enhanced
- Tuneable parameters can be adjusted during commissioning

Controls & Display INTEGRATION STRATEGY

- Systematic Design process - requirements, function analysis, function allocation, task analysis
- Application of a consistent hard/soft philosophy
- Extensive verification and validation sequences
- Utilization of simulation and mock-ups for testing/evaluations
- Ensure that necessary information is presented in an appropriate manner within the needed time context for successful performance

Control Centre IMPROVED OPERABILITY

- Improved operator workstation interfacing
  - ⇦ central consoles with access to safety systems, testing,annunciation, plant control displays, critical safety parameters, critical production indicators
- Standardization
  - ⇦ Standard panels for NSP, BOP and FHC
  - ⇦ Standard display and data presentation philosophy
  - ⇦ General appearance, meaning and operability methods
  - ⇦ Panel position, colours, light indicators, HSs, VDU displays, etc
  - ⇦ Minimize assimilation time & reduce perception errors
  - ⇦ Hard/Soft function allocations

Control Centre IMPROVED OPERABILITY

- Improved Operator Awareness
  - Computerized annunciation with filtering & prioritizing
  - Overview Display to present high level unit status
  - Flexible, user friendly display navigation system
  - Computer Systems 'System Health Displays'
- Enhanced Data Presentations
  - Plant-wide common database
  - allows monitoring, checking, display & annunciation
  - decrease operator work load for cross checking
  - signature value comparison checks
  - powerful calculation capabilities - rate and margin values
  - provision of additional lead time for event responses
  - predictive maintenance capabilities

SIMULATION USE in the DESIGN PROCESS

- **Pentium based PC simulation**
- **Interfaced to DCS, PDS and the Mock-up panels**
- **Used as a tool in the design & testing evaluation**
- **Disable control emulations to evaluate DCS control codes**
- **Integrated control, display & annunciation can be evaluated**
- **Operating procedures can be assessed**

SIMULATION USE for Plant Dynamic Models

- **Consistent with EPRI 3.1.3.5 Analysis Requirements, suitable for:**
- **Overall plant control automatic responses**
- **Individual control system reponses**
- **Evaluating operator actions and interventions**
- **Analyzing plant steady state & transient behaviour**
- **Confirming the automatic/operator control allocation**
- **Confirming completeness & correctness of control schemes**
- **Operating procedures can be developed & assessed**

SIMULATION USE for Plant Dynamic Models

- **Consistent with EPRI 3.1.3.5 Analysis Requirements, key features:**
- **Assessed against applicable commissioning test data for DNGS-A and BNGS-B stations**
- **Developed at the start of the design integration phase**
- **Simulation runs on a general purpose PC**
- **Simulation model is well documented**

Plant Dynamic Models Analysis

- **Consistent with EPRI 3.1.3.5 Analysis Requirements, key features:**
- **Evaluate control strategies under normal, abnormal, upset & emergency conditions**
- **Confirm the adequacy of conceptual and detailed control designs**
- **Confirmation of the control strategy functional adequacy**
- **Confirmation of proposed tuning parameters - numbers & ranges**
- **Ensures adequate test suites are compiled**
- **Allows modifications to be incorporated within the test suite**
- **Simplifies documentation of test results**