A NUCLEAR PERSPECTIVE ON A FOUNDATION FIELDBUS APPLICATION

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CURRENT NUCLEAR INDUSTRY I&C STATUS

- 25-35 YEAR OLD LEGACY SYSTEMS
- PREDOMINANTLY EARLY ANALOG WITH OLDER PLANTS SIGNIFICANTLY PNEUMATIC
- INCREASING O&M COSTS
- LACK OF SPARE PARTS
- LOSS OF KNOWLEDGABLE MAINTENANCE STAFF
- DETREMENTAL OPERATIONAL IMPACT
- RELIABILITY & AVAILABILITY CONCERNS
- POTENTIAL CHALLENGES TO SAFETY SYSTEMS
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ADDITIONAL SOURCES OF PLANT PERFORMANCE PRESSURES

- NUCLEAR REGULATORY COMMISSION (NRC)
- INSTITUTE of NUCLEAR PLANT OPERATORS (INPO)
- CORPORATE MANAGEMENT
- SYSTEM DISPATCHER
- PLANT MANAGEMENT
- FELLOW PLANT EMPLOYEES
- WALL STREET (HENCE SHAREHOLDERS)
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FROM AMERICAN NUCLEAR SOCIETY’S “NUCLEAR NEW”, DECEMBER 2006

47 PLANTS CURRENTLY RELICENSED

- LICENSED 2029 – 2046

7 PLANTS CURRENTLY UNDER REVIEW

23 ADDITIONAL PLANTS EXPECTED TO RELICENSE OVER NEXT 10 YEARS
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SIGNIFICANT I&C UPGRADES NEEDED TO ENSURE RELIABLE OPERATION

JIG-SAW PUZZLE OF STRATEGIES

- STATUS QUO – REMANUFACTURE or R&R
- UPGRADE to CONVENTIONAL DCS
- SYSTEM STRATEGY with MULTIPLE VENDORS (BEST IN CLASS)
- TOTAL INTEGRATION USING SINGLE VENDOR (THOROUGHLY PLANNED)

LOGISTICAL CONSIDERATIONS

- MOST OBSOLETE FIRST
- MOST IMPORTANT FIRST
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- **DEVELOP A STRATEGY THAT WILL LAST**
  - LONG TERM
  - SCALABLE
  - FLEET APPLICABLE
  - VENDOR INDEPENDENT
- **LEADING EDGE TECHNOLOGIES**
- **COMMODITY SOLUTION**
- **GLOBAL APPLICATIONS**
- **LOW SUPPORT COSTS**
- **IMPROVED HUMAN SYSTEMS INTERFACE**
DEVELOP A STRATEGY THAT WILL LAST

- **LONG TERM APPLICATION**
  - 30 YEARS OF ADDITIONAL LICENSE
  - ELIMINATE HISTORICAL SPARE PARTS CONCERNS
  - ELIMINATE KNOWLEDGE LOSS
  - ELIMINATE PROPRIETARY “SHACKLES”

- **SCALABLE**
  - EASE OF EXPANSION
  - CABLING/POWER CONSUMPTION/HSI VOLUME

- **FLEET APPLICABLE**
  - NON-NUCLEAR APPLICABILITY

- **VENDOR INDEPENDENT**

- **LOSE THE SHACKLES OF THE PAST**
  - I/O LIMITATIONS
  - ADDITIONAL SUPPORT REQUIREMENTS
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LEADING EDGE TECHNOLOGIES

- **FIELDBUS, PC-ETHERNET, CONVENTIONAL DCS, PLC’s OR OTHERS?**
  - DIFFERENT PERSPECTIVES
  - ADVANTAGES TO EACH

- **NON-NUCLEAR SAFETY RELATED (N-NSR) APPLICATIONS**
  - TURBINE & AUXILIARY BUILDING LOCATIONS
  - MILD ENVIRONMENT
    - TEMPERATURES: 30 – 110 DEGREES F
    - RADIATION: < THAN 10E4 TID
    - SEISMIC: NO OBE/SSE (INTEGRITY REQUIRED)

- **APPLIED ASPECTS OF NSR DIGITAL SYSTEMS UPGRADE STRATEGY**
  - USED REQUIREMENTS TRACABILITY MATRIX (RTM)
  - FAILURE MODES & EFFECTS ANALYSIS (FMEA)
  - USE OF VENDOR VERIFICATION & VALIDATION
  - SYSTEM DESIGN DESCRIPTION
    - HARDWARE
    - SOFTWARE
  - APPLICATION OF ADDITIONAL END USER SOFTWARE QUALITY ASSURANCE AND CONFIGURATION MANAGEMENT PROGRAM
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COMMODITY SOLUTION

- NO SINGLE VENDOR DEPENDENCIES FOR NON-NSR COMPONENTS
  - ENTIRE SYSTEMS SHOULD BE COMMODITY PRODUCTS
  - NOT YET COMPLETELY THERE – VERY CLOSE
  - STILL CHASING UNIVERSAL INTEROPERABILITY

- SOME LEGACY ISSUES STILL MAKE FULL COMMODITY BASED FIELDBUS SYSTEMS A GOAL
GLOBAL APPLICATIONS

- BROAD BASED
  - NOT INDUSTRY DEPENDENT
  - INCREASING OPERATING BASE
  - USERS GROUP SHARING OPPORTUNITIES
    - LESSONS LEARNED
    - PROBLEMS
    - APPLICATION INTELLIGENCE AQUISITION

- POTENTIAL FOR OVERHEAD REDUCTIONS
  - SPARE PARTS DEPOTING
  - RESOURCE SHARING
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- LOWER SUPPORT COSTS
  - MAINTENANCE
    - CALIBRATIONS & REPAIRS
  - ENGINEERING
    - SYSTEM SUPPORT
    - MODIFICATIONS
  - OPERATIONS
    - EFFICIENCY GAINS
  - SUPPLY CHAIN
    - REDUCED INVENTORIES
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IMPROVED HUMAN SYSTEMS INTERFACE

- MOVEMENT FROM DISCRETE INTERFACES TO ‘SOFT’ INTERFACE
- BETTER & FASTER INFORMATION AWARENESS
  - NOT JUST DEVICE FUNCTIONAL SPEEDS – HUMAN COGNITIVE SPEED THROUGH BETTER HSI
- EXISTING NUCLEAR PLANTS NOT READY FOR THE “GLASS COCKPIT” JUST YET
  (ALL CRT/PLASMA/LCD CONTROL ROOM – ALSO REGULATORY ISSUES WITH SOFTWARE COMMON MODE FAILURE)
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STRATEGY DETERMINATION

5 POTENTIAL VENDORS
3 FINALISTS
2 VENDORS WITH REAL FIELDbus CAPABILITIES

SMAR SELECTED AS VENDOR DUE TO SUPERIOR FFB CAPABILITIES AND ABILITY TO MEET PLANT SPECIFIC CUSTOMIZING
TECHNOLOGY ADVANTAGES

- FF SELECTED OVER CONVENTIONAL DCS TO ELIMINATE HISTORICAL VENDOR DEPENDENCY AND PHYSICAL REQUIREMENTS
- FOUNDATION FIELDBUS ALLOWS CONTROL STRATEGY TO BE “PUSHED” DOWN TO LOOP LEVEL AT THE ACTUAL FIELD DEVICES
- FF SELECTED OVER TYPICAL “MANUFACTURING” NETWORKS DUE TO MORE “PROCESS” FRIENDLY CAPABILITIES
- FF PROVIDES MORE “DETERMINISTIC” CONTROL CONFIGURATION THAN PC/ETHERNET STRATEGY
- DETERMINISTIC CONTROL A MAJOR CONSIDERATION FOR THE NUCLEAR USER
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OCONEE CONTROL ROOM
PRIOR TO MODIFICATION

1960’S CONFIGURATION
LARGE NUMBER OF DISCRETE INTERFACE DEVICES
OBSOLETE PNEUMATIC & AGING ANALOG
INCREASED MAINTENANCE AND AVAILABILITY ISSUES
OBSOLETE CONTROL ROOM RECORDERS

RECORDERS ORIGINALLY USED FOR OPERATOR INDICATIONS AS WELL AS PROCESS RECORDS

ELIMINATING 95% OF RECORDERS

DATA RETENTION ON PLANT COMPUTER

VIDEO/PAPER RECORDERS REMAIN FOR MINIMUM SET OF PROCESS TRENDING REQUIREMENTS
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TYPICAL PNEUMATIC CONTROL DEVICES

LARGE NUMBERS OF OBSOLETE PNEUMATIC CONTROL DEVICES THROUGHOUT BALANCE OF PLANT

INTEGRATION INTO FF AND CONTROL ROOM HUMAN SYSTEM INTERFACES
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TYPICAL FIELD HAND CONTROLLER

PNEUMATIC HAND CONTROL DEVICES PLACED THROUGHOUT PLANT

LEGACY FROM STAFF INTENSIVE DESIGN STRATEGIES OF THE PAST
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TYPICAL INTERNAL CONTROL BOARD CONDITION

30+ YEARS OF HARDWARE AND WIRING INSTALLATIONS

PNEUMATIC AND ELECTRICAL DEVICES

OVERCROWDED AND DIFFICULT TO WORK IN
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MAINTENANCE TRAINING FACILITY USED AS TEST BED FOR PCS FIELDBUS DEVICES

DEVELOPMENT OF GRAPHICAL USER INTERFACE A JOINT EFFORT BY VENDOR AND OCONEE

ADDITIONAL TESTING PERFORMED ON OTHER VENDOR’S FIELDBUS DEVICES
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STRING MODS INSTRUMENT STRING UPGRADE

**BEFORE**

TRANSMITTERS INDIVIDUALLY COMMUNICATED PROCESS DATA TO CONTROLLER OR INDICATOR IN CONTROL ROOM

<table>
<thead>
<tr>
<th>REMOTE VALVE CONTROLLER</th>
<th>TO RECEIVER GAUGE (LOCAL OR REMOTE)</th>
<th>TO OPERATOR AID COMPUTER</th>
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<tr>
<td>PNEUMATIC</td>
<td>4-20mA OR PNEUMATIC</td>
<td>PNEUMATIC 4-20mA</td>
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<tr>
<td>PRESSURE CONTROL VALVE</td>
<td>PRESSURE TRANSMITTER</td>
<td>TRANSMITTER</td>
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<tr>
<td>WITH CONTROLLER</td>
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**AFTER STRING MODS**

MULTIPLE TRANSMITTERS ON SINGLE FIELDBUS SEGMENT CABLE

- PROCESS CONTROL CABINETS
- FIELDBUS H1 NETWORK
- PID TAKES INPUT DIRECTLY FROM PRESSURE TRANSMITTER
- FIELDBUS PRESSURE TRANSMITTER
- FIELDBUS TEMPERATURE TRANSMITTER
- FIELDBUS LEVEL TRANSMITTER
- OPERATOR HM A
- OPERATOR HM B
- REdundant ETHERNET NETWORK
- OPERATOR AID COMPUTER
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FIELD BUS NETWORK
CABLES USE DISTRIBUTION TERMINATIONS STRATEGICALLY LOCATED IN PLANT

MODIFIED END CONNECTORS TO FIT ARMORED CABLES
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FISHER DVC VALVE POSITIONERS INSTALLED ON 6 VALVES FOR PID CONTROL. 5 NEW CONTROLLER FACE PLATES ON HSI.

MAGNETROL GW RADAR REPLACEMENT FOR OBSOLETE FISHER DISPLACER LEVEL XMTR.
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NEWLY INSTALLED PROCESS CONTROL SYSTEM CABINETS IN CABLE SPREADING ROOM

5 CABINETS
500-640 DROP CAPABLE
SIGNIFICANT EXPANSION CAPABILITY INSTALLED
MILD ENVIRONMENT LOCATION
ENGINEERING WORKSTATION LOCATED HERE

REDUNDANT 120 VAC UPS LOCATED HERE. 208 SINGLE PHASE INPUTS USED

NETWORK INTERFACE TO PLANT COMPUTER
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VERTICAL BOARD AFTER RECORDER REMOVAL AND FLAT PANEL HSI INSTALLATION

FRONT VIEW OF PCS FLAT PANEL HSI
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ORIGINAL PNEUMATIC “PEANUT” GAGES ABANDONED IN PLACE

REPLACED WITH FFB DISPLAYS
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CONVERSION OF CONTROL ROOM DEVICES FROM ANALOG TO FIELDBUS

HUMAN FACTORS CONSIDERATIONS

OPERATIONS CONCENSUS AND BUY-IN REQUIRED TO SMOOTH INSTALLATION

DOCUMENTATION OF CONCENSUS IMPERATIVE

ANALOG TO DIGITAL TRANSITION ISSUES ABOUND

“ARTHRITE VS ACNE”
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SUMMARY

- INCREASE IN I&C UPGRADES AT NUCLEAR PLANTS OVER THE NEXT 10 – 20 YEARS
- OBSOLESCENCE, PLANT IMPACT & CORPORATE FISCAL STRATEGY WILL DICTATE UPGRADE PRIORITY
- AS ALWAYS - NEED FOR WELL PLANNED & INTEGRATED UPGRADE STRATEGY
- VENDOR & PLANT PARTNERING IMPERATIVE FOR SUCCESS
- PLACE FOR NEW NUCLEAR PLANT APPLICATION
  - NUCLEAR IS NOT OFF LIMITS
- FIELD BUS HAS A DEFINITE ROLE IN ALL POWER GENERATION