TURKEY POINT FULL-SCALE TOUCHSCREEN SIMULATOR READY FOR TRAINING

L3Harris MAPPs Inc. | Power Systems and Simulation

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Outline

> Reference Plant and Simulator History
> Plant Training Needs / Glass Panel Simulator (GPS) Project Approach
> Scope, Timeline, Key Participants
> Anticipated Project Issues
> Project Description
> Overcoming Anticipated Project Issues
> Conclusions
Turkey Point Nuclear Station

> Turkey Point Nuclear Plant operated by Florida Power & Light (FPL)

> Located on Biscayne Bay, 24 miles south of Miami, Miami-Dade County, Florida, USA

> Operates two Westinghouse 3-Loop Pressurized Water Reactors, producing ~2,300 MWt each
  – Unit 3 commercial operations: December 1972
  – Unit 4 commercial operations: September 1973

> 2012, Extended Power Uprate modifications completed to increase thermal output (approx. 2,644 MWt)

> December 2019, NRC extended operating licenses by 20 years
  – Unit 3: July 2052
  – Unit 4: April 2053
  – Turkey Point license extension – Unprecedented 80 years of operation
## Simulator History

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1984</td>
<td>FSS for Unit 3 provided by L3Harris [CAE] complete with MCR and back panels</td>
</tr>
<tr>
<td>2002</td>
<td>Simulator Rehost / Instructor Station upgrade</td>
</tr>
<tr>
<td>2004</td>
<td>Classroom Simulator</td>
</tr>
<tr>
<td>2004</td>
<td>DCS Emulation</td>
</tr>
<tr>
<td>2012</td>
<td>Instructor Station upgrade</td>
</tr>
<tr>
<td>2013</td>
<td>Reactor Core / RCS Model replaced by Third-Party</td>
</tr>
<tr>
<td>2014</td>
<td>Simulator Rehost + Touchscreen Simulator (Orchid® Touch Interface)</td>
</tr>
<tr>
<td>2017</td>
<td>I/O System Replacement</td>
</tr>
<tr>
<td>2020</td>
<td>Foxboro I/A updates</td>
</tr>
<tr>
<td>Dec 2021</td>
<td>Unit 3 Glass Panel Simulator (GPS)</td>
</tr>
<tr>
<td>Dec 2021</td>
<td>Unit 3 Full Scope Simulator Software Modernization</td>
</tr>
<tr>
<td>Jul 2022</td>
<td>Unit 4 Full Scope Simulator complete with MCR and back panels</td>
</tr>
</tbody>
</table>
Projects Plan

2022
- Unit 3 GPS
- Unit 3 FSS Modernization

2023
- GPS Update
- Unit 4 FSS

2024
- Plant Updates
Plant Training Needs / GPS Project Approach

> Platform needed for
  – Early design testing and verification to support upcoming digital upgrade in station
  – Reactor Protection System (RPS)
  – Engineered Safety Features and Auxiliary Systems (ESFAS)
  – Nuclear Instrumentation System (NIS)
  – Human Factors studies and verification
  – Assisting with NRC licensing
  – Testing required revisions to plant operations procedures

> Goals
  – Reduce costly design errors prior to installation at station
  – Maximize license operator training well in advance of implementation at station
  – reducing any mis-operation, misunderstandings which may produce undesirable reactor trips

> GPS Simulator project
  – Executed in parallel to Unit 3 Simulator Modernization and Unit 4 Full Scope Simulator
  – Based on Unit 3 original simulator configuration with replacement models for Core/RCS and simulation of Unit 3 stimulated HMs
  – Will be used to support the validation of U3 Simulator Modernization
  – To be updated once Unit 3 Simulator Modernization complete
  – Can be used for future Unit 4 simulation
GPS Scope

> Custom-built GPS
  – Focus: One-to-one Control Room scale to match look-and-“feel” of actual panels
  – Foundation: Orchid® Touch Interface – custom hardware setup (instead of standard touchscreen bays)
    – Customized steel structures with touchscreen monitors (total 83 monitors installed, 9 different models)
    – Incorporated commercial off-the-shelf cabinets for vertical sections

> Virtual Panels → Orchid® Touch Interface/Orchid® Graphic Editor
  – Scaled to 100% (or near 100%)

> Embedded DCS/HMI → Orchid® Control System/Orchid® Graphic Editor
  – Foxboro I/A

> Simulated Paging and Phones → Orchid® Communications Exchange
  – Analog and VoIP phones

> Sounds → Orchid® Sound System

> Lighting control and horns → Compact (Beckhoff) I/O with Orchid® Input Output
### GPS Project Timeline

**> Overall project schedule Start to RFT - 45 weeks**

<table>
<thead>
<tr>
<th>ID</th>
<th>Task</th>
<th>Start</th>
<th>Finish</th>
<th>Project Week</th>
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<tbody>
<tr>
<td>1</td>
<td>Project Start</td>
<td>5-Jan-22</td>
<td>5-Jan-22</td>
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<td>2</td>
<td>Prelim Design</td>
<td>15-Jan-22</td>
<td>3-Feb-22</td>
<td>4</td>
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<tr>
<td>3</td>
<td>Site Survey</td>
<td>11-Feb-22</td>
<td>14-Feb-22</td>
<td>6</td>
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<tr>
<td>4</td>
<td>Detailed Design Hardware</td>
<td>15-Feb-22</td>
<td>3-Mar-22</td>
<td>8</td>
</tr>
<tr>
<td>5</td>
<td>Hardware DRM Complete</td>
<td>---</td>
<td>10-Mar-22</td>
<td>9</td>
</tr>
<tr>
<td>6</td>
<td>Manufacturing Drawings</td>
<td>3-Mar-22</td>
<td>4-Apr-22</td>
<td>13</td>
</tr>
<tr>
<td>7</td>
<td>Detailed Design Software</td>
<td>7-Mar-22</td>
<td>15-Apr-22</td>
<td>14</td>
</tr>
<tr>
<td>8</td>
<td>Software DRM Complete</td>
<td>---</td>
<td>22-Apr-22</td>
<td>15</td>
</tr>
<tr>
<td>9</td>
<td>Software Development</td>
<td>23-Apr-22</td>
<td>1-Sep-22</td>
<td>34</td>
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<tr>
<td>10</td>
<td>Manufacturing &amp; Integration</td>
<td>4-Apr-22</td>
<td>9-Sep-22</td>
<td>35</td>
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<tr>
<td>11</td>
<td>Panel FAT</td>
<td>12-Sep-22</td>
<td>23-Sep-22</td>
<td>37</td>
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<td>12</td>
<td>Shipping</td>
<td>3-Oct-22</td>
<td>14-Oct-22</td>
<td>40</td>
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<tr>
<td>13</td>
<td>Site Installation</td>
<td>14-Oct-22</td>
<td>4-Nov-22</td>
<td>43</td>
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<tr>
<td>14</td>
<td>SAT / RFT</td>
<td>7-Nov-22</td>
<td>18-Nov-22</td>
<td>45</td>
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### Key Participants and Components

<table>
<thead>
<tr>
<th>GPS Design and Manufacturing</th>
<th>Facilities Work</th>
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</thead>
<tbody>
<tr>
<td>&gt; Project Management and Engineering Lead: L3Harris</td>
<td>&gt; Project Management: FPL</td>
</tr>
<tr>
<td>– Models development</td>
<td>– Architectural Engineering</td>
</tr>
<tr>
<td>– Software Integration</td>
<td>– Civil Engineering (Mechanical / Electrical)</td>
</tr>
<tr>
<td>– Phone Paging System</td>
<td>– Building Construction</td>
</tr>
<tr>
<td>&gt; Hardware Design and Manufacturing Partner: Imagine 4D (Montreal)</td>
<td>– Fire Protection</td>
</tr>
<tr>
<td>&gt; Touchscreen Monitor Supplier: Elo</td>
<td>– Fire Alarm System</td>
</tr>
<tr>
<td>&gt; Computers: Dell</td>
<td>– Lighting System</td>
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<tr>
<td></td>
<td>– Dedicated UPS</td>
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<td></td>
<td>– Dedicated HVAC</td>
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Anticipated Project Issues

1. Tight schedule (RFT in 2022)
2. Potential delays due to plant Digital Upgrade (RPS/ESFAS/NIS)
3. Post-COVID supply chain challenges - material and component acquisition (displays, metal, etc.)
4. Quick replacement of Third-party Core/RCS and integration with original Unit 3 training configuration
5. First time implementation of VoIP phones with L3Harris software for control room to outside-control room communications
6. Coordinating 3 concurrent Turkey Point projects with single customer lead
7. Extensive building modifications required prior to installation
8. Physical layout fidelity with actual Unit
9. GPS hardware design to consider future training capability for Unit 4
GPS Rapid Design Evolution

Proposal (Week 0)
> Markup of Unit 3 FSS layout
> Determine location of GPS back panels
> Unit 4 simulation considerations

Initial Monitor Selection (Week 2)
> Mark-up Unit 3 panel photos
> Determine RPS/ESFAS/NIS screen locations / replacing instrumentation

Preliminary Design (Week 4)
> 2D drawing of panel sections
> Superimpose panel photos
> Define monitor size and orientation / placement
GPS Rapid Design Evolution

Site Survey / Data collection (Week 6)
- HMI's / Simulator sounds / paging and phone system data collection
- Laser measurements to locate instrumentation and monitor placement

Preliminary Site Meeting (Week 6)
- Create 3D model of GPS to position monitors and finalize general layout with customer
- Preliminary facility requirements reviewed with FPL Building Services

Detailed Design (Week 8)
- Finalize dimensional drawings
- Create BOM, order long lead items
- Create design docs and site facility report
LiDAR 3D Laser Scanning of Reference Control Room

> During GPS project, scan of reference plant control room performed

> Point cloud data and 3D photosphere plots resulting from scanning activity yields most accurate data source
  – Provides accurate panel dimensioning and precise location of instrumentation

> Strong data baseline for Unit 4 FSS, including for future control room modifications
Phone/Paging System

> Orchid® Communications Exchange deployed previously on naval projects – but never with Voice-Over-IP (VoIP) phones
  – Enhanced Orchid® Communications System to support VoIP phones during GPS project

> Simulated Control Room communication system
  – Analog phones, VoIP phones and paging equipment
  – Allows operators to make voice calls to locations outside the control room
  – Calls automatically forwarded to instructor for role playing

> Features
  – Supports various real-life communication modes: one-to-one calls, conference calls, broadcasting, transfers of calls, hold, etc.
  – Supports public address and broadcast speakers for general notifications
  – Supports instructor-initiated failures such as dropped lines and communication failure
  – Allows Instructor monitoring of all communications
  – Automatically superimposes background noise during a call (e.g. turbine rumble in turbine building)
Mobile Instructor Facility

> GPS does not have traditional Instructor booth overlooking simulator
  – All simulator operations controlled from tablet wirelessly connected to simulation server

> Combination of Orchid® tools utilized for convenient simulator operation and maintenance
  – Orchid® Network Loader: Automated simulator startup and shutdown
  – Orchid® Instructor Station: Simulator controls (e.g. run, freeze, store, restore, select ICs, insert malfunctions, etc.)
  – Simulation Hub (Orchid® Network Loader widget): Easy access to Orchid® tools on GPS

> Enables instructors to control and monitor all aspects of trainee and simulator performance
Hardware Maintenance Considerations

> Monitors
– Utilized latest monitor models and received 5-year availability guarantee from supplier
– Included spare parts for each monitor type
– Facilitated control of power-on / wake up of monitors
  – Orchid® Network Loader interface to Elo Device Management Remote Management

> GPS Steelwork
– Permits replacement monitors with little modification (only front faceplates)
– Easy access to monitors and computers provided via doors in panel sections and walk-in space in vertical cabinets

> Electrical
– Maintenance outlets and lighting provided in all panel sections
– Junction boxes distributed in panel sections by circuit

> Heat Dissipation
– Venting of panels considered
– Consultation with FPL Building Services during design of HVAC
Close Coordination with FPL Building Services

> New dedicated room for GPS required relocation of existing Training Classroom and construction of new briefing room

> FPL needed to make extensive modifications to building
  – Remove/relocate walls
  – Trench floor to include cable raceways
  – New lighting system
  – Independent HVAC system
  – Electrical Mains and UPS

> From site survey through to installation, L3Harris worked closely with FPL’s Building Services to define requirements and establish construction schedule and installation plan
GPS Assembly in Factory
GPS Virtual Panels
Site GPS Room Prep
Site Installation
Ready For Training
## Overcoming Anticipated Project Issues (1)

<table>
<thead>
<tr>
<th>No.</th>
<th>Anticipated Issue</th>
<th>How It Was Addressed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tight schedule (RFT in 2022)</td>
<td>&gt; Fast tracked design phase</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt; Detailed action tracking and early risk mitigation plans → milestones achieved on time</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt; RFT achieved Week 45</td>
</tr>
<tr>
<td>2</td>
<td>Potential delays to plant Digital Upgrade (RPS/ESFAS/NIS)</td>
<td>&gt; It happened</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt; Maintained original control room panel configuration with ability to accommodate RPS/ESFAS/NIS updates</td>
</tr>
<tr>
<td>3</td>
<td>Post-COVID supply chain challenges - material and component acquisition (displays, metal, etc.)</td>
<td>&gt; Advance ordered monitors</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt; Cabinet design and assembly capitalized on readily available standard parts extensively</td>
</tr>
<tr>
<td>4</td>
<td>Quick replacement of Third-party Core/RCS and integration with original Unit 3 training configuration</td>
<td>&gt; Reassigned resources from Unit 3 Simulator Modernization project to accelerate Core/RCS model development</td>
</tr>
</tbody>
</table>
## Overcoming Anticipated Project Issues (2)

<table>
<thead>
<tr>
<th>No.</th>
<th>Anticipated Issue</th>
<th>How It Was Addressed</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>First time implementation of VoIP phones with L3Harris software for control room to outside-control room communications</td>
<td>&gt; Enhanced Orchid® Communications Exchange during project to incorporate VoIP phones</td>
</tr>
</tbody>
</table>
| 6   | Coordinating 3 concurrent Turkey Point projects with single customer lead         | > Good communication between teams  
> Weekly meetings with all parties involved |
| 7   | Extensive building modifications required prior to installation                  | > Early start of engineering at site survey stage  
> Close consultation between L3Harris and FPL Building Services  
> Parallelization of GPS installation and civil work |
| 8   | Physical layout fidelity with actual Unit                                         | > Exact duplication of physical size and placement of steel panel sections  
> Soft panel instrumentation laid out/placed to respect required operator HFE |
| 9   | GPS hardware design to consider future training capability for Unit 4             | > Flexible in early design changes to accommodate Unit 4 specifics  
> Added / removed / changed monitors from proposal to final design |
Conclusions

> GPS is first of three recent projects performed by L3Harris for FPL’s Turkey Point
  – Builds on long-standing relationship between FPL and L3Harris

> GPS, along with ongoing Unit 3 Simulator Modernization and Unit 4 FSS deliveries, key to supporting FPL’s plant license extension

> GPS design leverages original L3Harris simulator software configuration to fast track program, while taking advantage of today’s Orchid® software suite

> Enthusiastic, focused and flexible project team (FPL / L3Harris / Imagine 4D)

> Project performed on-time and on-budget