# MODERNIZATION TECHNOLOGY ASSESSMENT

| MTA Number | MTA-MA-SEQUENCE |
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**Title**

Reduce maintenance costs and human performance errors with Class 1E Control Board Meter Replacement

**Description**

Failed analog or digital meters in nuclear control rooms require replacement by seismically qualified, safety related equivalents. The cost of replacement equipment rises higher the farther past the obsolescence date of the device. Modern Class 1E LED meters like the PNP (Plug N Play) and NTM (New Technology Meters) allow for better Human System Interfaces (HSI) while providing easier replacement methods. New meters are modular that separate I/O, display, mounting, and signal conditioning. Using a "true white LED" display allows for in situ printed overlays to be installed on front scale plate of the "one movement" display. These can accommodate any color, scale or text with defined color transitions based on the application. Standard mounting adapter plates **(**if necessary**)** fit the present mounting holes and space of the old meter in the control board. A generic hub secures to the back of the display unit. A universal I/O board fits within the hub, which can be configured to accept the field signal and power (if required). As an alternative, the I/O board could be installed in the housing of the meter. The replacement uses standard housing and an I/O board that can be configured for the input signal. The remaining parameters to be selected are the display, face plate and adapter plate **(**if needed**)** Form, fit, and function (FF&F) will be the same as the replaced meter. Developing a general installation specification allows replacement as old devices fail or as dedicated replacement campaign. The additional benefit of these FF&F replacements is that they are available for the following applications: 1) display only, 2) displays powered by the signals they measure (like analogs) with controlling outputs such as relays, 3) solid state relays (SSR) with fail safe contacts,4) 4-20 mA current loop transmission, 5) retransmission and 6) PID options. Replacements with only solid state components like the PNP will avoid lengthy cyber security evaluations, while NTM allows more customization and external serial communications and control.

The signal conversion can be moved to distribution panel/cabinet with a 4-20 mA Current Loop transmitter that uses the identical circuit in the PNP HUB is available in three packages: DIN rail, panel mount and explosion proof. The transmitter includes two displays that monitor the input and output signals simultaneously, accepts same input signals, and power plug in modules than the PNP. The transmitters allow signals to be standardized to 4-20 mA and use loop powered meters. This makes the meters on the control board a simple replacement with correct faceplates. If existing signal wiring from distribution panel/cabinet to individual meters qualifies it can be use to carry the current loop signal/power to existing meters eliminating the need for rewiring. The benefit of using the transmitter would be having on standard display type for meter replacement for all applications.

**Benefits**

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| Benefits Estimate | Level 1 based on a "replace as fail" basis (Savings are less than $1 million per year.)<br>Level 2 based on a large replacement of analog meters. (Savings are between $1 million and $5 million per year).<br>Greater savings are possible with an aggressive reduction of parts in inventory. |
| Benefits Description | Ease of Installation: the NTM and PNP meters are made to be plug compatible with existing analog and digital meters. Little extra training is required for implementation of these meters.<br>Better HSI: replacing analog with digital meters improves accuracy of operators reading of values. Instrument displays a mimic of the original meter,101 segment bar and 4-1/2 digit numeric value. These features eliminate the parallax, uncertainty, dyslexia and the stuck needle syndrome of the analog meters. This avoids re-training for operators.<br>Using a signal powered meter to replace an obsolete signal powered meter allows no change to the fit, wiring signal, and power**.**<br>Using signal or powered meters with controlling outputs (fail safe or standard) require no changes on existing installations. |

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| | Using replaceable meter faceplates allows the number of spare parts to be minimized to one per size/shape. In other words, if a station has 100 meters of same size and shape with different inputs, all it needs is spare meters of every size/shape to cover expected replacements and spare scale plates for each style. Using modular constructions allows the number of spare parts to be minimized. Nuclear Stations may stock required meters, standard IO board, and input configuration boards to match the expected need to replace obsolete instruments. All modules are plugged in, no soldering required.<br>Equipment available from long standing nuclear and military supplier using standards based components to ensure against obsolescence. |
| **Costs and Schedule** | |
| Cost | Level 2 implementation costs of $1 million to $5 million for “replace as fail” strategy, are based on developing a standard replacement specification, stocking spares to be ready. Estimated cost of spares is under $30,000 with optional transmitter and under $50,0000 without.<br>Level 1 implementation costs are expected to be over $5 million but not much over $10 million depending on the number of units replaced, for bulk scale strategy. This cost assumes standard replacement specification, and bulk replacement of meters most likely occurs during an outage.<br>Costs go up for adding communication pathways with the NTMs.<br>Because of the FFF compatibility of the meters, speed of replacement will not be different from the obsolete meters. |
| Schedule | Six months to a year to develop installation specification as part of engineering design change package depending on the complexity of the project, after which<br>• For “replace as fail” strategy, time to plan a replacement maintenance packages, like and kind<br>• For bulk replacement strategy, half a year to plan maintenance packages to replace meters during an outage, expect short replacement window of less than 10 days. |
| Scope Context | Per Unit<br>This MTA focuses on cost savings from selecting a field loop signal or external powered meter to replace obsolete analog and digital control board meters. Keys are form, fit and function replacements for the existing meters. |
| **Risks** | |
| When connecting NTMs to external communication systems, proper segmentation of the systems is required to avoid increased vulnerabilities from cyber security threats as defined by NEI 08-09. Due to the programming on the NTMs, there is a regulatory risk on digital components and handling the licensing concerns of diversity, PNP only connect via the field loop and avoid many vectors of cyber security threats and are constructed of hardware components only, which avoids regulatory and NEI 08-09 concerns.<br><br>Instruments are tested and certified by qualifier to industry standards for electromagnetic compatibility (EMC), seismic, and 1E considerations. Stations should evaluate these tests meet their acceptance criteria.<br><br>Special connections may require custom configuration by vendor, causing higher cost and longer lead time on meters. | |
| **Administrative Items** | |
| Date | TBD |

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| Functional Area Where Benefits Will Be Realized | Maintenance<br>Operations<br>Engineering |
| Reference Implementation Guidance | 3002018392, Human Factors Analysis Methodology for Digital Systems: A Risk-Informed Approach to Human Factors Engineering |
| Industry SME | |
| Previous Implementation | NTMs are installed in a number of US & foreign Nuclear Plants. PNPs are scheduled to be installed as a bulk replacement in a US Nuclear Plant.. |
| Implementation Enablers | N/A |
| SWEEP Score | • Cost - Level 1 for bulk replacement, Level 2 for “replace as fail”<br>• Savings – Level 2 for bulk replacement, Level 1 for “replace as fail”<br>• Payback – Level 2 for both bulk replacement and “replace as fail” strategies<br>• Technical Readiness – Level 3 for NTM (ready for wide operational deployment), Level 2 for PNP (ready for pilot deployment)<br>• Licensing Readiness – Level 3 for all replacement options<br>• Implementation Proficiency – Level 3, technology can be implemented by all sites regardless of digital experience |
| Applicability | All reactor types<br>All geographic regions |
| Keywords | Reduced maintenance; Reduced Human Performance Errors; Instrumentation and Control; |
| Business Case Analysis Cross-Reference | N/A |



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## Acknowledgments

The following organization(s), under contract to the Electric Power Research Institute (EPRI), prepared this report:

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**In addition, EPRI would like to acknowledge the following companies and individuals who contributed to this product:**

**NOTE**

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