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| Beam Line Secondary Emission Monitor AIP **BASIS of ESTIMATE FORM (BoE)** | **Document Number:** Mu2e-doc-1577**Date of Estimate:** 5/4/12**Prepared by:**  Brian Drendel |

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| WBS Category Number: MuAIP.02.03.04WBS Category Name: Beam Line Secondary Emission MonitorControl Account (number and name):  |
| Costing Method:\_\_\_ Existing P.O. \_\_\_ Prior Experience (source: )\_\_\_ Catalog Listing / Vendor Quote \_\_\_ Expert Opinion\_\_\_ Budgetary Estimate \_\_\_ Pre-conceptual Design\_X\_ Engineering Experience \_\_\_ Other (description: ) |
| External Supporting Documents: 1. B. Drendel, G. Tassotto, “Beam Line and Storage Ring SEM and Multiwires for Mu2e,” Mu2e Documents Database #1608, February 2012. |

Update the existing Beam Line Secondary Emission Monitors to enable beam profile measurements for both g-2 and Mu2e operations in the P1, P2, M1, M2, M3 and Delivery Ring Abort lines. Modify existing electronics, hardware and cabling to meet updated performance requirements.

**Preliminary Design:**

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| WBS Category Name: Preliminary Design of infrastructure improvements to the beam lines |
| Costing Method:\_\_\_ Existing P.O. \_\_\_ Prior Experience (source: )\_\_\_ Catalog Listing / Vendor Quote \_\_\_ Expert Opinion\_\_\_ Budgetary Estimate \_\_\_ Pre-conceptual Design\_X\_ Engineering Experience \_\_\_ Other (description: ) |

The preliminary design will continue to develop requirements and specifications for improvements and upgrades to components/hardware and provide data for completing the design effort. The information will also establish data for use by project management to determine a high confidence level in the specifications. Effort will focus on providing documentation to determine if the proposed design meets project requirements.

**Preliminary Design Labor:**  Costing was determined via consultation Accelerator Division Instrumentation Engineers and is detailed in the supporting documentation1. Contingencies follow labor contingency rule #3.

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| **Activity ID** | **Description** | **Resource ID****(mu2e-doc-1305)** | **Base Est.****(hours)** | **Cont.** **(%)** | **Base Est. + Cont.****(hours)** |
| MuAIP.02.03.04.02 | Engineering design and oversight | FNAD.ENGNRING.PHYST(Engineering Physicist) | 20 | 30% | 26 |
| MuAIP.02.03.04.02 | Engineering design and oversight | FNAD.MECH.DESIGN.EN(Mechanical Engineer) | 6 | 30% | 8 |
| MuAIP.02.03.04.02 | Engineering design and oversight | FNAD.ELTN.DESIGN.EN (Instrumentation Engineer) | 66 | 30% | 86 |

 (labor estimates assume 85% efficiency)

**Final Design Labor:**

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| WBS Category Name: Final Design of infrastructure improvements to the beam lines |
| Costing Method:\_\_\_ Existing P.O. \_\_\_ Prior Experience (source: )\_\_\_ Catalog Listing / Vendor Quote \_\_\_ Expert Opinion\_\_\_ Budgetary Estimate \_\_\_ Pre-conceptual Design\_X\_ Engineering Experience \_\_\_ Other (description: ) |

The final design will provide the documents necessary to repurpose and upgrade required components/hardware. Effort will focus on finalization of documentation.

**Final Design Labor:** Costing was determined via consultation Accelerator Division Instrumentation Engineers and is detailed in the supporting documentation1. Contingencies follow labor contingency rule #3.

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| **Activity ID** | **Description** | **Resource ID****(mu2e-doc-1305)** | **Base Est.****(hours)** | **Cont.** **(%)** | **Base Est. + Cont.****(hours)** |
| MuAIP.02.03.04.03 | Engineering design and oversight | FNAD.ENGNRING.PHYST(Engineering Physicist) | 20 | 30% | 26 |
| MuAIP.02.03.04.03 | Engineering design and oversight | FNAD.MECH.DESIGN.EN(Mechanical Engineer) | 6 | 30% | 8 |
| MuAIP.02.03.04.03 | Engineering design and oversight | FNAD.ELTN.DESIGN.EN (Instrumentation Engineer) | 66 | 30% | 86 |

 (labor estimates assume 85% efficiency)

**Implementation:**

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| WBS Category Name: Implementation of infrastructure improvements to the beam lines |
| Costing Method:\_\_\_ Existing P.O. \_\_\_ Prior Experience (source: )\_\_\_ Catalog Listing / Vendor Quote \_\_\_ Expert Opinion\_\_\_ Budgetary Estimate \_\_\_ Pre-conceptual Design\_X\_ Engineering Experience \_\_\_ Other (description: ) |

Implementation will include the installation of components and hardware necessary to support a fully functioning system. Effort will involve repurpose and refurbishing of components to meet project requirements. Included will be the installation and testing of items to ensure functionality.

**Implementation M&S and Labor:** Costing was determined via consultation Accelerator Division Instrumentation Engineers and is detailed in the supporting documentation1. Contingencies follow labor contingency rule #3. M&S contingencies were determined by M&S contingency rule #5.

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| **Activity ID** | **Description** | **Resource ID****(mu2e-doc-1305)** | **Base Est.****(hours)** | **Cont.** **(%)** | **Base Est. + Cont.****(hours)** |
| MuAIP.02.03.04.04 | Refurbish motor assembly feed can and electronics | FN.M&S.STND | $25K | 40% | $35K |
| MuAIP.02.03.04.04 | Engineering design and oversight | FNAD.ENGNRING.PHYST(Engineering Physicist) | 25 | 30% |  33 |
| MuAIP.02.03.04.04 | Engineering oversight | FNAD.ELTN.DESIGN.EN (Instrumentation Engineer) | 66 | 30% |  86 |
| MuAIP.02.03.04.04 | Refurbish and installation of components | FNAD.ELTN.TECH (Instrumentation Technician) | 192 | 30% | 250 |
| MuAIP.02.03.04.04 | Mechanical Oversight | FNAD.MECH.DESIGN.EN(Mechanical Engineer) | 6 | 30% | 8 |
| MuAIP.02.03.04.04 | Mechanical Maintenance | FNAD.MECH.SYSTM.TECH(Mechanical Technician) | 216 | 30% | 281 |
| MuAIP.02.03.04.04 | Survey and align SEMs | FNPD.METROLOGIST (Alignment) | 120 | 30% | 156 |

 (labor estimates assume 85% efficiency)**Additional Background Information**

Secondary Emission Monitors (SEMs) will provide beam profile, position and intensity information during studies periods in the P1, P2, M1, M2, M3 and Delivery Ring abort lines. These are destructive diagnostics that create losses when placed in the beam, so they will not be left in the beam during normal operations. Instead, SEMs will only occasionally be put into the beam for troubleshooting, diagnostic reasons and beam studies.

Labor and M&S cost estimates were generated via consultation with Accelerator Division Instrumentation Engineers and are documented in the Multiwire/SEM costing spreadsheet1. Estimates include both materials as well as contract electricians for cable pulls.

* Base Plan: Assumes tunnel components are not changed, and electronics will not be upgraded. Assumes no SEM will be moved but some cabling between the service building and tunnel will need to be replaced.
* Higher Cost Option: Assumes the motor assemblies will be replaced new, all vacuum cans replaced, new cables pulled and all new electronics will be implemented. The higher cost option would result in additional labor and M&S. The differences are outlined in the below two tables.

A comparison of the total labor and M&S costing for the two options mentioned above are given below1:

**Labor:** Total labor for preliminary design, final design and implementation stages of the project.

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| Total Labor Hours |
|  | Base Plan | Higher Cost Option |
| Controls Engineer | 0 | 61 |
| Controls Technician | 0 | 324 |
| Mechanical Engineer | 18 | 1016 |
| Mechanical Technician | 216 | 1088 |
| Instrumentation Engineer | 198 | 264 |
| Instrumentation Technician | 192 | 780 |
| Alignment | 120 | 720 |
| Engineering Physicist | 65 | 152 |

**M&S:** Total M&S for preliminary design, final design and implementation stages of the project.

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| M&S |
|  | Base Plan | Higher Cost Option |
| Motor Assembly | $10K | $270K |
| Vacuum Can | $10K | $285K |
| Electronics | $0K | $85K |
| Electricians ($1600/week/2 person team) | $5.5tronics will not be changed.K | $5K |
| Total | $25K | $645K |

References:

1. B. Drendel, G. Tassotto, “Beam Line and Storage Ring SEM and Multiwires for Mu2e,” Mu2e Documents Database #1608, February 2012.