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| Beam Line Beam Loss Monitors 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.02.03.03  WBS Category Name: Beam Line Beam Loss Monitors  Control 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: B. Drendel, M. Olson, “BLM upgrades for Mu2e Storage Rings and Beam Lines,” Mu2e Documents Database #1179, Februrary 2012. |

Update the existing Beam Line Beam Loss Monitor System to enable beam loss measurement for both g-2 and Mu2e operations in the P1, P2, M1, M2, M3 and Delivery Ring Abort beam lines. Repurpose needed parts from the Tevatron Beam Loss Monitor system. 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.02.03.03.02 | Engineering oversight | FNAD.ENGNRING.PHYST (Engineering Physicist) | 20 | 30% | 26 |
| MuAIP.02.03.03.02 | Engineering oversight | FNAD.ELEC.DESIGN.EN  (Electrical Design Engineer) | 25 | 30% | 33 |

(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.02.03.03.03 | Engineering oversight | FNAD.ENGNRING.PHYST (Engineering Physicist) | 20 | 30% | 26 |
| MuAIP.02.03.03.03 | Engineering oversight | FNAD.ELEC.DESIGN.EN  (Electrical Design Engineer) | 25 | 30% | 33 |

(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.02.03.03.04 | Refurbish Tevatron ion chambers and electronics | FN.M&S.STND | $1K | 50% | $1.5K |
| MuAIP.02.03.03.04 | Engineering oversight | FNAD.ENGNRING.PHYST (Engineering Physicist) | 25 | 30% | 33 |
| MuAIP.02.03.03.04 | Engineering oversight | FNAD.ELEC.DESIGN.EN  (Electrical Design Engineer) | 25 | 30% | 33 |
| MuAIP.02.03.03.04 | Refurbish and installation of components | FNAD.ELEC.TECH  (Electrical Technician) | 68 | 30% | 88 |

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

Beam Loss Monitors (BLMs) will be the primary beam loss system in the P1, P2, M1, M2, M3 and Delivery Ring Abort beam lines. Labor and M&S cost estimates were determined via consultation with Accelerator Division Instrumentation experts and are documented in the BLM costing spreadsheets1, and include both materials as well as contract electricians for cable pulls if necessary.

* Base Plan: Assumes we repurpose eight BLM chassis from the Tevatron, have to assembly 41 integrators cards, refurbish some of the ion chambers, and repurpose 55 ion chambers from the Tevatron. Existing service building to tunnel cable infrastructure will be reused.
* Higher Cost Option: Assumes we purchase parts to build eight new BLM chasses with 86 new integrator cards, and purchase 55 new ion chambers. This costing for this option was determined to be excessive, requiring additional M&S purchases as shown below and detailed in our costing documentation1. Given that unused components from the Tevatron provides a more economical option with similar functionality.

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

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

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| --- | --- | --- |
| Hours | | |
|  | Base Plan | Higher Cost Option |
| Engineering Physicist | 65 | 85 |
| Electrical Engineer | 160 | 160 |
| Electrical Technician | 312 | 684 |
| Radiation Physics | 0 | 40 |

**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 |
| Parts for BLM Chassis (8) | $0K | $32K |
| Parts for BLM Log Integrator Cards | $24.6K  (41 cards) | $51.6K (86 cards) |
| Assemble Log Integrator Cards | $3K | $3K |
| Parts for BLM Ion Chambers (55) | $0K | $23.1K |
| Refurbish BLM Chassis (55) | $1K | $0K |
| Cabling | $4K | $3.3K |
| Cable Pulls (2 Contract Electricians: 160 hours x $250/hr) | $40K | $40K |
| Total | $71.9K | $153K |

References:

1. B. Drendel, M. Olson, “BLM upgrades for Mu2e Storage Rings and Beam Lines,” Mu2e Documents Database #1179, Februrary 2012.