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| Delivery Ring Abort Dump AIP  **BASIS of ESTIMATE FORM (BoE)** | **Document Number:** Mu2e-doc-1494  **Date of Estimate:** 5/16/12  **Prepared by:** Brian Drendel |

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| --- |
| WBS Category Number: MuAIP.03.04.02  WBS Category Name: Abort Dump  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:   1. B. Drendel, et.el. “Using the Existing AP2 Shielding Stack for the Mu2e Abort,” Mu2e Document Database #1971, January 2012. 2. B. Drendel, R. Schultz “BoE Costing for Debuncher and Accumulator Beam Abort” Mu2e Document Database #1494, May 2011. 3. D. Augustine, “Mu2e Storage Rings Mechanical Schedule,” Mu2e Document Database #1571 4. J. Morgan, “MP0x Cost Estimate,” Mu2e Document Database #1628, May 2012. 5. J. Morgan, “Septum Magnet Cost,” Mu2e Document Database #1628, May 2012. |

Construct a beam dump for the Delivery Ring in the AP2 line that will satisfy the beam removal requirements for g-2 and Mu2e operations. Existing steel shielding material in the AP2 line will be moved and additional steel and concrete shielding will be added to meet E&S 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:**  A further breakdown of these Resource IDs by task is covered in the R&D plan outlined later in the document.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Activity ID** | **Description** | **Resource ID**  **(mu2e-doc-1305)** | **Base Est.**  **(hours)** | **Cont.**  **(%)** | **Base Est. + Cont.**  **(hours)** |
| MuAIP.?? | Engineering Oversight | FNAD.ENGNRING.PHYST (Engineering Physicist) | 20 | 30% | 26 |
| MuAIP.?? | Engineering Oversight | FNAD.  (Engineer) | 10 | 30% | 13 |
| MuAIP.?? | Drawings | FNAD.  (Drafter) | 15 | 30% | 19.5 |
| MuAIP.?? |  | FNAD.  (Technician) | 10 | 30% | 13 |
| MuAIP.?? | Simulations | FNAD.  (Physicist) | 15 | 30% | 19.5 |

(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 drawings and documents necessary to build or purchase components/hardware. Effort will focus on finalization of drawings and other documentation for building or purchasing components/hardware.

**Final Design Labor:**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Activity ID** | **Description** | **Resource ID**  **(mu2e-doc-1305)** | **Base Est.**  **(hours)** | **Cont.**  **(%)** | **Base Est. + Cont.**  **(hours)** |
| MuAIP.?? | Engineering Oversight | FNAD.ENGNRING.PHYST (Engineering Physicist) | 20 | 30% | 26 |
| MuAIP.?? | Engineering Oversight | FNAD.  (Engineer) | 10 | 30% | 13 |
| MuAIP.?? | Drawings | FNAD.  (Drafter) | 15 | 30% | 19.5 |
| MuAIP.?? |  | FNAD.  (Technician) | 10 | 30% | 13 |
| MuAIP.?? | Simulations | FNAD.  (Physicist) | 15 | 30% | 19.5 |

(labor estimates assume 85% efficiency)

**Implementation:**

|  |
| --- |
| 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 purchase/or build of components and hardware necessary to support a fully functioning system. Effort will involve the purchase of vendor items or build/modification of components to meet project requirements. Included will be the installation and testing of items to ensure functionality.

**Implementation M&S and Labor:**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Activity ID** | **Description** | **Resource ID**  **(mu2e-doc-1305)** | **Base Est.**  **(hours)** | **Cont.**  **(%)** | **Base Est. + Cont.**  **(hours)** |
| MuAIP.?? | M&S Total | FN.M&S.STND | $120K | 40% | 168 |
| MuAIP.?? | Engineering Oversight | FNAD.ENGNRING.PHYST (Engineering Physicist) | 40 | 30% | 52 |
| MuAIP.?? | Engineering Oversight | FNAD.  (Engineer) | 20 | 30% | 26 |
| MuAIP.?? |  | FNAD.  (Mechanical Technician) | 124 | 30% | 161 |
| MuAIP.?? |  | FNAD.  (Electrical Technician) | 32 | 30% | 42 |
| MuAIP.?? |  | FNAD.  (Survey) | 42 | 30% | 55 |
| MuAIP.?? |  | FNAD.  (Welder) | 4 | 30% | 5 |

(labor estimates assume 85% efficiency)

**Additional Background Information**

Line items are as follows:

1. Abort Installation: All efforts involved with installation of the abort dump stack.
2. Abort Technical Design: Includes all physics efforts including Mars and ANSYS monte carlo simulations and analysis.

Below is a breakdown of the most likely manpower needed for each category.

**Conceptual Design Labor**:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Labor Hours | | | | | | |
|  | Engineering Physicist (hours) | | | Engineer (hours) | | |
| Abort installation |  | 20 |  |  | 15 |  |
| Abort Technical Design |  | 6 |  |  | 10 |  |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Conceptual Design | | | | | | |
|  | Physicist (hours) | | |  | | |
| Abort Technical Design |  | 20 |  |  |  |  |

**Preliminary and Final Design Labor:**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Preliminary and Final Design | | | | | | |
|  | Engineering Physicist (hours) | | | Engineeer (hours) | | |
| Abort installation |  | 20 |  |  | 10 |  |
| Abort Technical Design |  | 20 |  |  | 10 |  |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 475.02.04.05.02.013010 Post CD-1 Preliminary and Final Design | | | | | | |
|  | Drafter (hours) | | | Technician (hours) | | |
| Abort installation |  | 10 |  |  | 10 |  |
| Abort Technical Design |  | 20 |  |  | 10 |  |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 475.02.04.05.02.013010 Post CD-1 Preliminary Design | | | | | | |
|  | Physicist (hours) | | |  | | |
| Abort Technical Design |  | 30 |  |  |  |  |

**Implementation and Closeout Labor:**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 475.02.04.05.03.014010 Post CD-3 Implementation & Close-out | | | | | | |
|  | Engineering Physicist (hours) | | | Engineeer (hours) | | |
| Abort installation |  | 20 |  |  | 10 |  |
| Abort Technical Design |  | 20 |  |  | 10 |  |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 475.02.04.05.03.014010 Post CD-3 Implementation & Close-out | | | | | | |
|  | Technician (hours) | | | Survey (hours) | | |
| Abort installation |  | 40 |  |  | \* |  |
| Abort Technical Design |  | 0 |  |  | 0 |  |

\*Covered in another category below.

M&S numbers for the implementation stage will involve the cost of materials used to construct the abort line and dump as well as the cost of contracting out iron workers. From our project schedule2, here is the labor and M&S cost associated with installation of the beam line elements for the Debuncher abort located in the existing AP2 line. This includes surveying the beam line, installing a new vertical dipole magnet, installing trims and instrumentation, moving the beam line, and connecting water, vacuum and electrical.

From our project schedule2,and engineering costing estimate1, here are the labor and M&S costs of installing the Debuncher Dump. The engineering costing estimate had larger cost numbers for iron workers. This is set as the maximum estimate. The project schedule has a smaller cost estimate for the iron workers. This is set as the minimum and most likely estimates.

**Debuncher Beam Dump Installation M&S:**

|  |  |  |  |
| --- | --- | --- | --- |
|  | M&S Cost | | |
| Iron Workers (contract) |  | $74.4K |  |
| Rigging TM |  | $13.02K |  |
| Totals |  | $87.42K |  |

From our costing spreadsheet1, here are the expected cost of materials used to construct the beam dump. The Minimum estimate has us re-purpose steel and concrete that already exists at the lab. It is estimated that at best we could re-purpose 60-80% of the steel and 60-80% of the concrete. Re-purposed steel would also have additional cost of machining the steel to the desired dimensions which eliminates much of the cost saving. The most likely and maximum estimates assume that new materials are purchased to construct the dump.

**Debuncher Beam Dump Parts M&S:**

|  |  |  |  |
| --- | --- | --- | --- |
| M&S 475.02.04.05.03.014010 Post CD-3 Implementation & Closeout | | | |
|  | Minimum/Likely/Maximum | | |
| Steel Core (6”x6”x144” at $1.90/lb) |  | $2.8K |  |
| Graphite (6”x6”x30”) |  | $0K |  |
| Concrete–sides (18”x36”x144”) x2 |  | $6.2K |  |
| Concrete – bottom (36”x36”x144”) |  | $3.1K |  |
| Concrete – top (72”x36”x144”) |  | $6.2K |  |
| Totals |  | $18.3K |  |

For the abort costing, I am assuming that we use the 36”x36”12’ AP2 steel shielding. Fill the 6”x6”x12’ hole with steel. Put abort on 36” concrete base. Have 18” of concrete on each side, 36” on top and 36” on the back side. Iron rigging will need to be recalculated.

References:

1. B. Drendel, et.el B. Drendel, et.el. “Using the Existing AP2 Shielding Stack for the Mu2e Abort,” Mu2e Document Database #1971, January 2012.
2. B. Drendel, R. Schultz “BoE Costing for Debuncher and Accumulator Beam Abort” Mu2e Document Database #1494, May 2011.
3. D. Augustine, “Mu2e Storage Rings Mechanical Schedule,” Mu2e Document Database #1571
4. J. Morgan, “MP0x Cost Estimate,” Mu2e Document Database #1628, May 2012.
5. J. Morgan, “Septum Magnet Cost,” Mu2e Document Database #1628, May 2012.. “Using the Existing AP2 Shielding Stack for the Mu2e Abort,” Mu2e Document Database #1971, January 2012.