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| SUBJECT: | FERMI RESEARCH ALLIANCE PROCEDURES PROJECT MANAGEMENT | NUMBER: | 12.PM-004 |
| RESPONSIBILITY: | Office of Project Support Services | REVISION: | 5.1 |
| APPROVED BY: | Head, Office of Project Support Services | EFFECTIVE: | 7/5/2016 |
| TITLE | Project Scheduling | | |

1.0 PURPOSE

This document describes the formal process for implementing the planning and scheduling requirements defined in the FRA *Earned Value Management System Description* document.

2.0 SCOPE

This procedure defines the scheduling approach and identifies the requirements and responsibilities for the development of plans and schedules for FRA projects where DOE Order 413.3B, "Program and Project Management for the Acquisition of Capital Assets," is required, or for projects where an Earned Value Management System (EVMS) is deemed appropriate. The terms activity, task, and work package are synonymous.

3.0 RESPONSIBILITIES

3.1 Project Manager (PM) is responsible for

- establishing project technical requirements and criteria to meet customer needs
- developing the project work scope by using appropriate design and engineering services to create a technical description
- defining the WBS, WBS Dictionary, OBS, and RAM for their project for internal control and for external reporting
- working with the customer and Laboratory management to establish programmatic milestones
- working with the Control Account Managers (CAMs) to establish intermediate milestones
- working with the CAMs and Fermilab functional line management to identify the resources for the project
- maintaining the WBS, WBS Dictionary, OBS, and RAM as controlled documents
- ensuring the preparation of drawings, specifications, procurement documents, installation and test instructions, and other documents to establish and record the project configuration, including as-built documentation
- implementing the project controls systems
- establishing and mediating interfaces between control accounts

3.2 Control Account Manager (CAM) is responsible for

- developing the required list of activities and intermediate milestones associated with each of their control accounts

| PROCEDURES: PROJECT SCHEDULING | | | |
|--------------------------------|--------------|-------------------|--------------|
| NUMBER 12.PM-004 | REVISION 5.1 | EFFECTIVE: 7/5/16 | PAGE 2 OF 14 |

- specifying the nominal duration for each activity
- specifying the detailed labor, material, and subcontract resource assignments for each activity
- specifying risks, uncertainties, and to the extent possible, mitigation strategies
- specifying the desired predecessor–successor relationships between activities and milestones
- specifying target dates or other constraints for each activity and/or milestone, if needed
- providing supplementary notes for control accounts, as needed

3.3 Project Controls is responsible for

- setting up the framework for the resource-loaded project schedule utilizing the scheduling software designated for the project
- entering schedule-related information provided by each CAM into the scheduling program/database
- entering additional activity information required for integration with the earned value reporting software into the scheduling program/database
- performing time analysis and budget/cost calculations using the scheduling and cost processor software
- working with the CAM and other senior project managers to analyze and develop the schedule and budget to match resource and funding availabilities and arrive at a credible Performance Measurement Baseline (PMB)
- updating the PMB schedule through the change control process throughout the project lifecycle
- identifying and emphasizing to the CAMs the timing for converting planning packages into work packages
- updating the forecast schedule and any associated revisions to the Estimate To Complete (ETC) to develop the new Estimate At Completion (EAC).
- collecting and entering schedule progress information into the scheduling program throughout the project lifecycle
- providing schedule reports to CAMs and senior project management
- advising CAMs and PM of FRA EVMS requirements to ensure the project is compliant

3.4 Functional Managers are responsible for

- Reviewing activities involving their organizations, including identifying and establishing durations and relationships

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|---------------------------------------|---------------------|--------------------------|----------------------------|
| PROCEDURES: PROJECT SCHEDULING | | | |
| NUMBER 12.PM-004 | REVISION 5.1 | EFFECTIVE: 7/5/16 | PAGE 3 OF 14 |

4.0 PROCEDURE

4.1 General

A formal, documented, consistent, and tailored approach is used for scheduling project work. Using a tailored approach allows the level of planning and scheduling control to be balanced against the project work.

During project scheduling, the PM and CAMs will identify internal and external project conditions that could impact the project, including critical resource availabilities, funding, and collaborative support. Once the schedule preparation activities are completed, the final product is an approved PMB schedule that is used to compare against actual performance. This baseline is maintained throughout the project lifecycle, and any PMB schedule changes are incorporated using a formal change control process (see *Change Control*, EVMS Procedure 12.PM-007). The baseline schedule includes an appropriately detailed, hierarchical, integrated, and resource-loaded set of activities with defined milestones at appropriate points in time. High-level milestones indicate the start or completion of major phases of the project. Lower-level milestones that will facilitate more frequent tracking of the project's progress should also be identified and included. The schedule will allow the determination of the critical path and the anticipation of time-phased resource requirements.

The baseline schedule must also identify and incorporate all the activities necessary to accomplish the project scope. Project activities should be organized based on the project's WBS. Nominal durations for each lowest-level activity are included, with consideration of the work required, the availability of required resources and the risk(s) associated with each activity.

A high-level project summary schedule sometimes called a master schedule, is created, based on the detailed schedule. This schedule details the overall project timeframe and depicts major activities by summary WBS elements. See Appendix C for an example of a master schedule.

Project schedules should be prepared using standard scheduling best practices to ensure integrity and quality. Example characteristics of high-quality schedules include maintainability, transparency, vertical and horizontal traceability, a valid critical path, documented justifications for constraints and lags, and reasonable values for floats.

4.2 Project Schedule

The development of the Project Schedule is the responsibility of the entire project team and may involve multiple iterations in order to reach a workable plan for accomplishing the work scope. The CAMs are responsible for the content and accuracy of their respective schedules. The project schedule is structured and numbered consistently with the project WBS.

The project schedule is used to plan and control the interdependencies of all the activities and resources needed to execute the project. Schedules address both how and when the work is to be performed by identifying all activities necessary to accomplish the project scope and time phasing these activities using durations and schedule logic. Each activity's duration is determined by understanding the effort involved in performing the activity as well as the resources needed to accomplish it. These resources can be both labor and material.

The time-phased labor resource needs of all tasks are compared to availabilities for each required resource category to arrive at durations and time phasing of the work that is supported by current and projected staffing levels. In addition, a fiscal year funding profile, provided by the customer, establishes the availability of funds for the project. The time phasing of the schedule activities, combined with applying labor and material (M&S) resource requirements

| PROCEDURES: PROJECT SCHEDULING | | | |
|--------------------------------|--------------|-------------------|--------------|
| NUMBER 12.PM-004 | REVISION 5.1 | EFFECTIVE: 7/5/16 | PAGE 4 OF 14 |

to each task produce a profile of budget needs for the life cycle of the project. Contingency needs are then added to this time-phased budget to produce a fiscal year profile for the budget needs of the project. This profile must fall within the funding projection from the customer.

The time phasing mentioned above involves applying schedule logic to each task which identifies the key relationships between the activities that determine their proper sequencing. Not all work can be completed simultaneously, and not all work is accomplished serially. With input from CAMs and their subordinates, the proper logic ties are created.

In addition to the budgeted activities, the project schedule may also contain summary level activities which represent successively higher levels in the WBS for reporting purposes. No resources will be applied to these summary activities. They represent the accumulated information from the detail activities up through the lower level summary tasks. Finally, milestones will be included at various levels in the schedule to reflect the start or completion of significant events. They are linked to their associated tasks with logic ties such that when the scope of that activity is accomplished, the milestone will reflect that accomplishment. These milestones will be coded to reflect their level of significance. Significant milestones, as determined by the Federal Project Director and PM, will be listed in the Project Execution Plan (PEP).

4.3 Detailed Schedule Preparation

This section provides step-by-step instructions on schedule preparation. A scheduling process flowchart is shown in Appendix D. Project controls personnel, working with the PM and the CAMs, carry out these steps using the indicated instructions.

Step 1. Develop Work Breakdown Structure

A WBS provides structure to the schedule and should extend to at least the control account level where work can be assigned to one responsible organizational element. The WBS used in the schedule is same as the WBS used in the cost estimate.

Step 2. Identify high-level milestones and work scope

The PM negotiates with the customer and Laboratory management to create programmatic milestones and assign target dates for those milestones. In addition, the PM will work with the CAM to establish intermediate milestones and assign target dates for those milestones.

Step 3. Develop detailed activities

Project Controls meets with CAMs to understand the WBS and OBS and to identify all necessary work scope to an appropriate level of detail. This step normally involves a series of meetings to ensure that all work scope has been identified at the necessary level of detail. Detailed activities are developed as work packages, while less detailed activities may be developed as planning packages. See *Control Accounts, Work Packages, Planning Packages*, EVMS Procedure 12.PM-002 for further understanding of Work Packages and Planning Packages.

Step 4. Organize work scope and technical milestones based on WBS

Work packages and planning packages are organized within a WBS. Each activity and milestone are assigned to a WBS element, which is used to map activities to Control Accounts. Because in-kind or contributed effort work scope has no BCWS, associated schedule milestones or activities are used to determine progress.

| PROCEDURES: PROJECT SCHEDULING | | | |
|--------------------------------|--------------|-------------------|--------------|
| NUMBER 12.PM-004 | REVISION 5.1 | EFFECTIVE: 7/5/16 | PAGE 5 OF 14 |

Step 5. Determine nominal durations for each activity

Determine the most probable duration for each activity, factoring in the planned level of resources and level of risk. Activities should have relatively short durations and are consistent with information provided in the activity's Basis of Estimate (see *Cost Estimating*, EVMS Procedure 12.PM-005). For activities that do not lend themselves to a short duration, it may be necessary to document the activity's scope and specifying "peg points," steps, or another qualitative measure for earned value analysis.

Step 6. Establish logical predecessor-successor relationships

Identify predecessor-successor relationships between pairs of activities and any associated programmatic and technical milestones utilizing four types of scheduling relationships (Finish-to-Start, Start-to-Start, Finish-to-Finish, Start-to-Finish), along with required lead or lag times. Identify and logically link chains of activities that could affect, or be affected by, changes to programmatic milestone dates.

Step 7. Define resources

A list of the resources required to complete the scope of work is organized into a Resource Breakdown Structure (RBS). Resources are broadly categorized as labor and M&S. M&S is any cost other than labor and includes materials, procurements, contracted labor, subcontracts, etc. The lowest-level resource in the RBS will have an associated unit cost or cost-per-use.

Step 8. Assign labor, material, and subcontract resources to each activity

Using the RBS, types and quantities of resources are assigned to each activity. The resource loading of activities results in a spread or quantity of units per time over the duration of the activity. Care should be taken in creating the PMB, to ensure the RBS spread reflects the expected accrual or actual costs for the activities. An obligation baseline can also be created based on resource spreads or obligation activities. The obligation baseline is only used to match time-phased funding at the time the PMB is established and is not used for earned-value analysis. Control Accounts (CA) are then associated with resource loaded work packages, activities, or planning packages for reporting and control.

Step 9. Perform schedule calculations

Schedule calculations are performed using the scheduling software. Early and late dates, critical path, and activity float are determined. Calculations can be performed at various times during the preparation of the schedule to allow for preliminary reviews and resource leveling.

Step 10. Assign risk-based schedule contingency

Part of the scheduling process includes project management determining the risk-based schedule contingency or allowance that is derived from the uncertainty and unknowns associated with a set of tasks and/or the overall project. Schedule contingency is used (like budget contingency) to accommodate approved scope changes and resultant schedule impacts without impacting overall project schedule objectives. Schedule contingency will be applied only to programmatic milestones and not to schedule detail.

Step 11. Prepare schedule reports

Project Controls will prepare reports and graphics that provide a summary schedule and detailed schedule for the entire scope of work. In addition, the resource usage over time sorted

| PROCEDURES: PROJECT SCHEDULING | | | |
|--------------------------------|--------------|-------------------|--------------|
| NUMBER 12.PM-004 | REVISION 5.1 | EFFECTIVE: 7/5/16 | PAGE 6 OF 14 |

by resource category, and a critical path and near critical paths will be provided to the PM and CAMs.

Step 12. Assemble and review schedule package

A complete schedule package will be made available to the project team and stakeholders for review. This package will contain the WBS, schedule graphics, resource reports, cost estimates, pertinent documentation, assumptions used in preparing the schedule, and the location of supporting files and reference information.

Step 13. Obtain schedule approval

Once the schedule package is reviewed by the CAMs and project controls staff and approved by the PM, the baseline summary schedule is included in the PEP. After customer review and approval, the fully detailed PMB schedule is considered a controlled document. No changes are allowed to the PMB unless approved through the project change control process described in *Change Control*, EVMS Procedure 12.PM-007.

4.4 Schedule Maintenance

The baseline schedule or PMB maintains the original agreed-upon work package and milestone dates, resources, CA, and PMT unless altered in accordance with the project's formal change control procedures. Current status of the project is compared to the PMB for progress measurement and analysis. At regular intervals, but not less than monthly, the CAMs review planned and completed activities to determine progress. As required by project management, Project Controls may provide on a regular basis critical path analyses, resource usage reports, forecast schedules, and other analysis reports.

4.4.1 Baseline Schedule or PMB

When the project schedule described in 4.3 has gone through the necessary number of iterations and is deemed complete and accurate by the CAMs and the PM, it is ready to be baselined and can be used to establish the PMB. When establishing the PMB, it is important that write-access to the project schedule be restricted to the project controls staff. The approval for establishing the PMB is obtained from the customer as part of the CD-2 process, consistent with DOE Order 413.3B. During the approval process, the schedule will be reviewed by the customer, or their representatives, for completeness with respect to technical scope, adequate labor resources, and material dollars for material purchases and contracts. It will also be reviewed for conformance with the customer funding profile. Once approved and baselined, the dates, resource hours, material dollars, and Performance Measurement Technique (PMT) can only be changed as part of a documented and approved change control process. This process is documented in the PMP and is driven by change control thresholds also in the PMP as described in *Change Control*, EVMS Procedure 12.PM-007.

The baseline or PMB schedule represents the approved plan against which the project's actual work performance or Earned Value (EV) is measured. This baseline information will be integrated with performance reporting software to obtain planned value or Budgeted Cost of Work Scheduled (BCWS) and when associated with EV, or Budgeted Cost of Work Performed (BCWP), will be the basis for a formal schedule performance reporting system. This performance will be reported to the customer, senior management, and project management as described in *Monthly Status Reporting*, EVMS Procedure 12.PM-006.

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|---------------------------------------|---------------------|--------------------------|----------------------------|
| PROCEDURES: PROJECT SCHEDULING | | | |
| NUMBER 12.PM-004 | REVISION 5.1 | EFFECTIVE: 7/5/16 | PAGE 7 OF 14 |

4.4.2 Working or Forecast Schedule

Once the baseline schedule has been established as described in section 4.3 and 4.4.1, it will be necessary to update actual progress on a per-period and cumulative basis and compare it to the baseline plan. For FRA, the update period is monthly, with the cutoff date being the last day of each month.

Progress and status are maintained on the current forecast (also called working) schedule, which reflects the project's work progress or forecasts including activity start and finish dates, and durations.

- The forecast schedule represents the remaining work and will be archived periodically.
- The forecast schedule is used for internal project management and DOE reporting purposes. A comparison of the forecast and baseline schedules indicates the extent to which the project is ahead of or behind schedule. This comparison also identifies the specific activities and events that are the source of current schedule variances or impending problems.
- Every month, each CAM will determine the status of each open or scheduled activity in the forecast schedule for which they are responsible, and the schedule will be updated accordingly. Various methods are used to assess the status for different kinds of activities to ensure that progress is being determined objectively.
- Subcontracts subject to earned value provisions require subcontractors to submit an earned value report at least monthly. Such subcontractors are required to provide quantitative data that can be used to assess the status of their work activities.
- Subcontracts not subject to earned value provisions may have contractual requirements for the subcontractor to develop a schedule that supports the details in the project schedule. The CAMs are responsible for ensuring that the methods used to status these schedules result in an objective measurement of progress.

The process of providing statuses for schedules may vary by project depending on the project size and CAM accessibility. The objective of the status process is to ensure accurate BCWP and forecast data is appropriately reflected in working schedule. The schedule is updated to reflect the current status in accordance with the processes developed and documented by each project. The status process may be referenced or detailed in the PMP.

The status for working schedules is developed to provide the following information:

- Progress reporting to DOE and project management, focusing on those areas of greatest impact on, or potential risk to, key milestones and project completion.
- Progress as compared to the baseline schedule.
- The basis for forecasts of future events, milestones, activities, and project completion.

Status information, which is collected at the detail schedule level, includes the following information:

- Actual start dates for activities begun during the status period.
- Actual finish dates for activities completed during the status period.
- Actual occurrence dates for milestones accomplished during the status period.

PROCEDURES: PROJECT SCHEDULING

NUMBER 12.PM-004

REVISION 5.1

EFFECTIVE: 7/5/16

PAGE 8 OF 14

- Percentage complete and/or remaining duration of activities started but not complete.
- Forecast completion dates for activities previously started but not yet completed.
- Forecast duration, start and finish dates for activities – and occurrence dates for milestones – that are currently scheduled in the future and for which a change is foreseen.

The following is a general outline of schedule status steps:

- Project controls personnel issuing “turnaround” reports to the CAMs near the end of each reporting period.
- CAMs return progress information in the form of actual dates and/or new schedule forecast information for each activity in the report. The reports typically address all activities within a time window that look ahead three to six months beyond the current reporting period.
- CAMs provide data for each in-progress activity that allows updating its physical percent complete.
- Project controls personnel vet the information supplied by the CAMs and then incorporate it into the working schedule to obtain an updated forecast schedule. It is important to note that progress information is not used to modify dates in the PMB schedule. The PMB dates, duration, resources, etc. are only changed utilizing the baseline change control process.

Since the schedule activities are logically tied together, applying actual and updated forecast information to activities within a near-term window can have a “ripple” effect throughout the schedule, causing the forecast dates for other downstream activities to be delayed or advanced. These delays/advances may also affect future milestones that may be part of the monthly reporting cycle. The updated forecasts, when compared with the baseline dates, provide management with an indication of the schedule performance for the overall project. In addition, the information obtained from the status effort will be integrated with other performance reporting software to obtain earned-value information for formal performance reports.

| PROCEDURES: PROJECT SCHEDULING | | | |
|---------------------------------------|---------------------|--------------------------|----------------------------|
| NUMBER 12.PM-004 | REVISION 5.1 | EFFECTIVE: 7/5/16 | PAGE 9 OF 14 |

5.0 REFERENCES

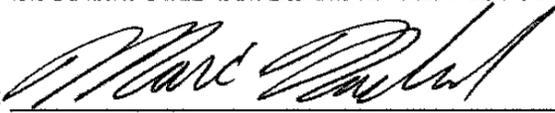
DOE Order 413.3B *Program and Project Management for the Acquisition of Capital Assets Fermi Research Alliance, LLC (FRA) Earned Value Management System Description*
EVMS Procedure 12.PM-005 *Cost Estimating*
EVMS Procedure 12.PM-006 *Monthly Status Reporting*
EVMS Procedure 12.PM-007 *Change Control*

6.0 APPENDICES

12.PM-004A: Appendix A: Signature Page and Revision History
12.PM-004B: Appendix B: Acronyms and Glossary
12.PM-004C: Appendix C: Master Schedule Example
12.PM-005D: Appendix D: Project Scheduling Flowchart

Appendix A
SIGNATURE PAGE AND REVISION HISTORY

This procedure approved by:



7/5/2016
DATE

Marc Kaducak

Head, Office of Project Support Services
Fermi National Accelerator Laboratory

TABLE OF REVISIONS

| Author(s) | Description | Revision | Date |
|--------------|--|----------|----------|
| | Initial Version | 0 | 10/17/08 |
| E. McCluskey | In Appendix B changed the definition of Control Account and added a definition for Control Account Manager. | 1 | 12/02/08 |
| E. McCluskey | Minor wording clarifications | 2 | 03/27/09 |
| E. McCluskey | In Step 8, included work package assignment to CAs. | 3 | 09/17/09 |
| M. Kaducak | Changed references to DOE 413.3A to 413.3B. Changed references to OPMO to OPSS. Added paragraph on schedule integrity to Section 4.1. | 4 | 8/18/13 |
| R. Marcum | Referenced other procedures rather than duplicate guidance to avoid redundancy and possible guidance disconnects. Added some clarification to responsibilities. Updated schedule preparation requirements. | 5 | 12/18/15 |
| R. Marcum | Incorporated detail removed from FRA EVMS Description into this procedure | 5.1 | 6/5/2016 |

Appendix B ACRONYMS AND GLOSSARY

| | | |
|----------------|---|--|
| BCWP | – | Budgeted Cost of Work Performed |
| BCWS | – | Budgeted Cost of Work Scheduled |
| CA | – | Control Account |
| CAM | – | Control Account Manager |
| CD-0 | – | DOE critical decision milestone – Mission Need Determined |
| CD-1 | – | DOE critical decision milestone – Baseline Range Established |
| CD-2 | – | DOE critical decision milestone – Baseline Approved |
| CD-3A | – | DOE critical decision milestone – Long-Lead Procurements Can Begin |
| CD-3B | – | DOE critical decision milestone – Start of Construction Approved |
| CD-4 | – | DOE critical decision milestone – Project Complete |
| DOE | – | U.S. Department of Energy |
| EV | – | Earned Value |
| EVMS | – | Earned Value Management System |
| M&S | – | Materials and Services |
| OBS | – | Organizational Breakdown Structure |
| PEP | – | Project Execution Plan |
| PM | – | Project Manager |
| PMB | – | Performance Measurement Baseline |
| PMT | – | Performance Measurement Technique |
| RAM | – | Responsibility Assignment Matrix |
| RBS | – | Resource Breakdown Structure |
| WBS | – | Work Breakdown Structure |
| WP | – | Work Package |

Control Account (CA) - A key management control point located at the natural intersection point of the WBS and the OBS, where functional responsibility for work is assigned. It represents the point at which budgets (resource plans) and actual costs are accumulated and compared to earned value for management control purposes.

Control Account Manager (CAM) – The member of the project team responsible for the performance defined in a Control Account and for managing the resources authorized to accomplish the tasks.

Critical Decision (CD) – On DOE projects, a formal determination made by the Acquisition Executive and/or designated official at a specific point in a project life cycle that allows the project to proceed. Critical Decisions occur in the course of a project: at the determination of Mission Need (CD-0), at the completion of conceptual design (CD-1), at project baselining (CD-2), at the commencement of execution (CD-3), and at turnover (CD-4).

Functional Manager – Line manager whose responsibility includes assigning staff for matrix to projects

Project Controls – Project support staff for planning, baseline development, management system plan preparation, as well as for monitoring, assessing, controlling, and reporting progress against the project baseline.

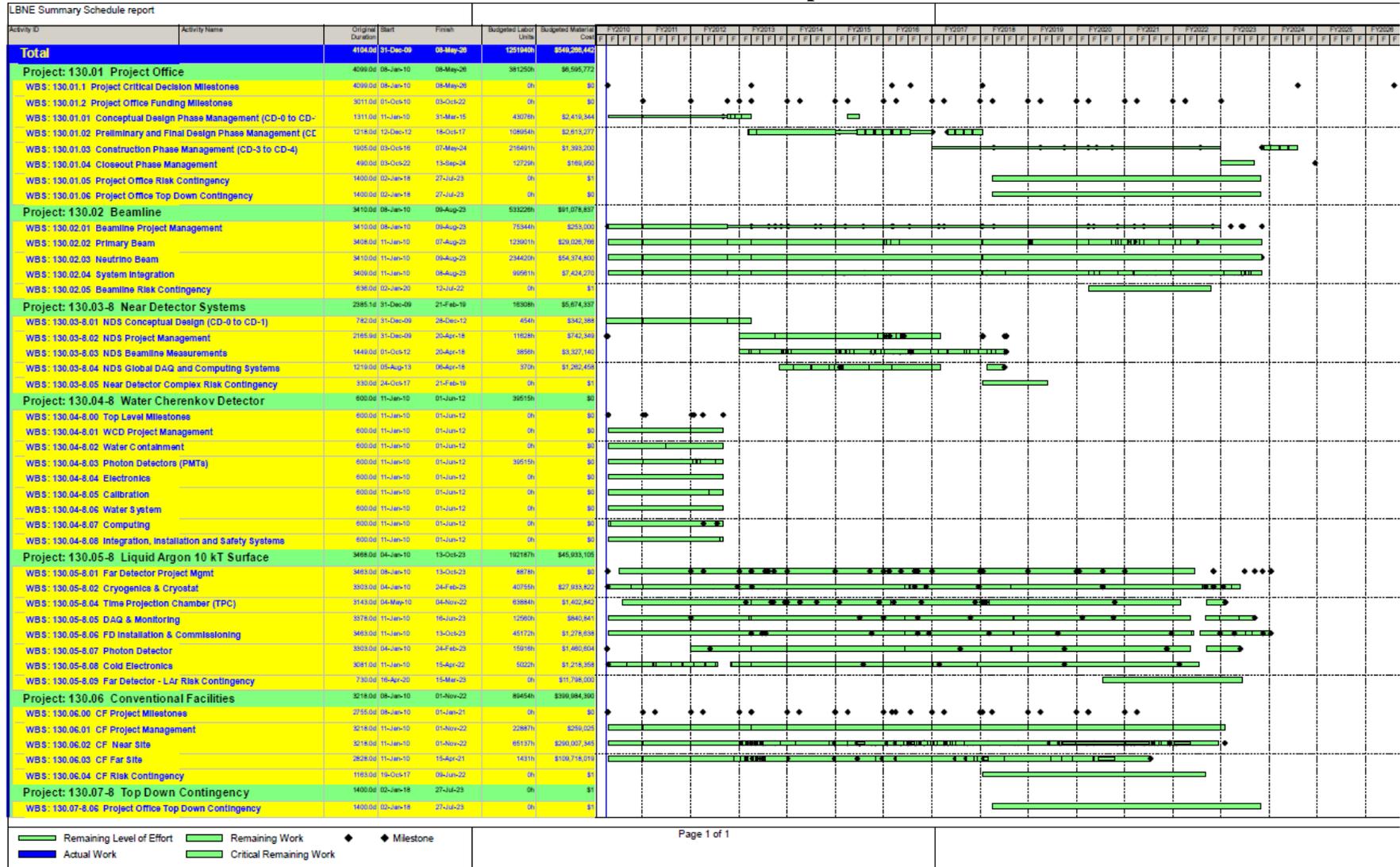
Responsibility Assignment Matrix (RAM) - A structure that relates the project organization structure to the work breakdown structure to help ensure that each element of the project's scope of work is assigned to a responsible individual.

Resource Breakdown Structure (RBS) – A hierarchical grouping of resource elements that organizes and defines the resources available for use by a project. These include labor, material, and subcontracts.

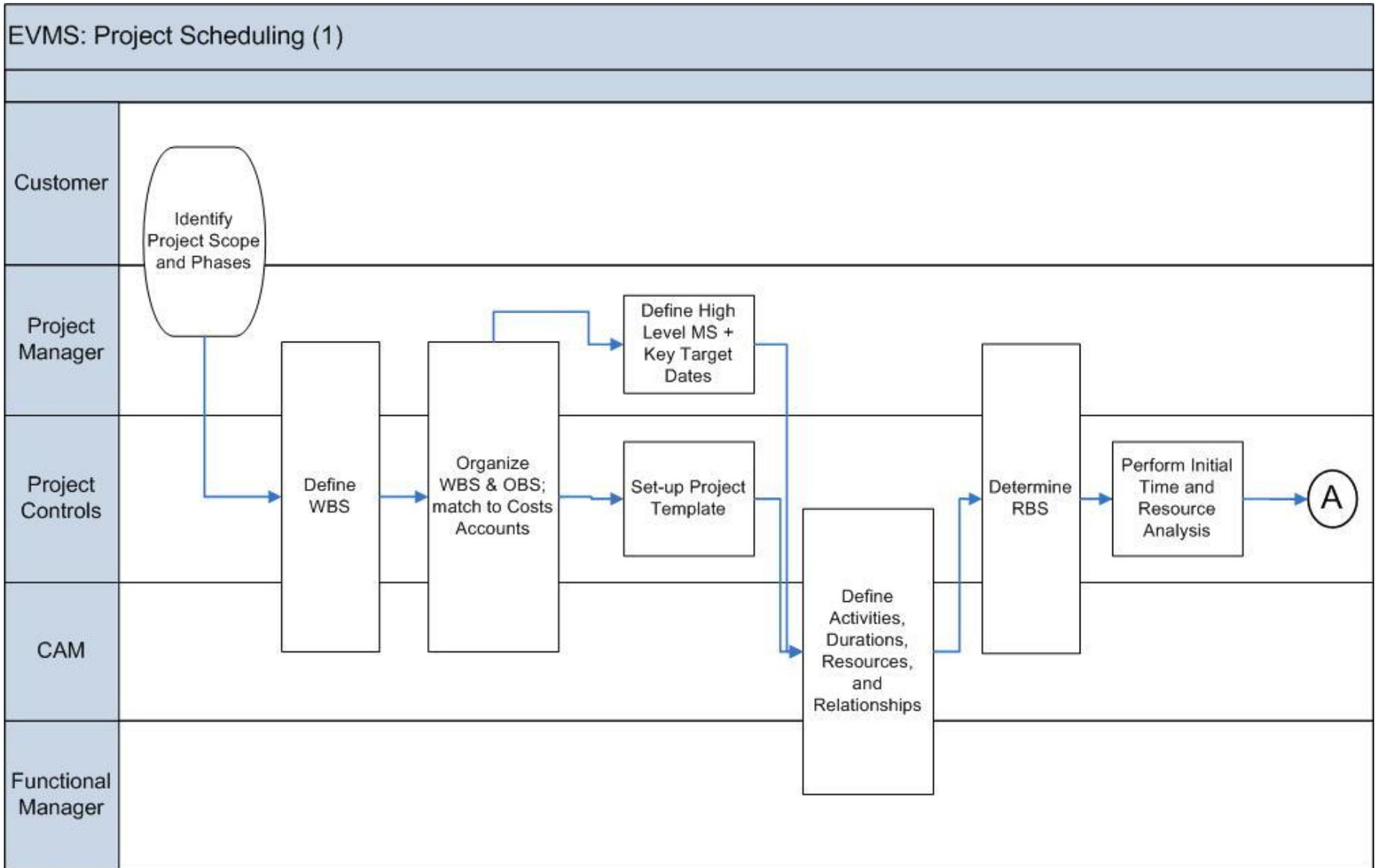
Work Breakdown Structure (WBS) - A product-oriented grouping of project elements that organizes and defines the total scope of the project. The WBS is a multilevel framework that organizes and graphically displays elements representing work to be accomplished in logical relationships. Each descending level represents an increasingly detailed definition of a project component. Project components may be products or services. It is the structure and code that integrates and relates all project work (technical, schedule, and cost) and is used throughout the life cycle of a project to identify and track specific work scopes.

Work Package (WP) – A task or set of tasks performed within a control account. The work package is the lowest level activity to which resources are assigned.

Appendix C Master Schedule - Example



APPENDIX D Project Scheduling Flowchart



APPENDIX D Project Scheduling Flowchart (continued)

