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DOE G 413.3-5B

Approved: XX-XX-XXXX

PERFORMANCE BASELINE GUIDE

[This Guide describes suggested non-mandatory approaches for meeting requirements. Guides are not requirements documents and are not to be construed as requirements in any audit or appraisal for compliance with the parent Policy, Order, Notice, or Manual.]

U.S. Department of Energy
Washington, D.C. 20585

AVAILABLE ONLINE AT:
www.directives.doe.gov

INITIATED BY:
Office of Project Management
Oversight and Assessment

FOREWORD

This Department of Energy (DOE) Guide is for use by all Departmental elements and suggests approaches for implementing Performance Baseline (PB) development requirements of DOE Order (O) 413.3B, *Program and Project Management for the Acquisition of Capital Assets*.

DOE Guides, which are part of the DOE Directives System, provide non-mandatory information for fulfilling requirements contained in rules, regulatory standards, and DOE directives. Guides are not requirements documents and are not to be construed as requirements in any audit or appraisal for compliance with the parent Policy, Order, Notice, or Manual.

PURPOSE

This guide identifies key PB elements, development processes, and practices; describes the context in which DOE PB development occurs; and suggests ways of addressing the critical elements in PB development.

SCOPE

The scope of this Guide includes the overall process for the development of PBs; describing key elements of PBs in context of the DOE project management system; defining key deliverables associated with PBs; and providing useful guidance for achieving the desired outcomes for the approved PB. The original PB is established at Critical Decision (CD)-2.

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1.0 BASELINES IN DOE PROJECT MANAGEMENT SYSTEMS

Establishing a PB is a central feature of the DOE project management system.

The Department’s ultimate objective is to deliver every project at the original PB on schedule, within budget, and fully capable of meeting mission performance, scope, design, key performance parameters (KPPs), safeguards and security, quality assurance, sustainability, and environmental, safety, and health requirements. Consistent with this objective, it is DOE’s goal that a project will be completed at CD-4 within the original approved PB.

DOE O 413.3B promotes well-defined and managed project scope and risk-informed PBs as well as stable funding profiles that support the original PB as one of its key project management principles.

The original PB, in general, is established at CD-2. Revised PBs after CD-2 approval via Baseline Change Proposals (BCPs) should be the exception. Refer to DOE O 413.3B, page A-19, *Performance Baseline Changes*. Performance baseline changes should comply with change control procedures. Refer to DOE G 413.3-20¸ *Change Control Management Guide*.

The term PB applies to defining project scope, cost and schedule; formalizing corporate DOE commitments via CD-2 approval; establishing a project’s readiness for obtaining commitment and funding from the Office of Management and Budget (OMB) and Congress.

1.1. Characteristics of a Performance Baseline

Regardless of type or sources of funding, a PB needs to be developed for each individual project. The project PB documents the high-level summary statement of the project’s key technical, schedule, cost, and performance parameters. It formalizes these elements and places them under formal change management procedures.

The Federal Project Director (FPD), along with the Integrated Project Team (IPT), which include contract, engineering, design, safety, and management professionals develop the PB using an extensive and diverse collection of project planning processes and tools. The PB includes the entire Total Project Cost (TPC), including fee and contingency. It is important to distinguish that Performance Measurement Baseline (PMB) differs from the PB and is the baseline cost that encompasses all contractor project work. PMB does not include Management Reserve, Contingency, fees and other direct costs. Figure 1.1 below depicts PB components for Capital Asset Projects.

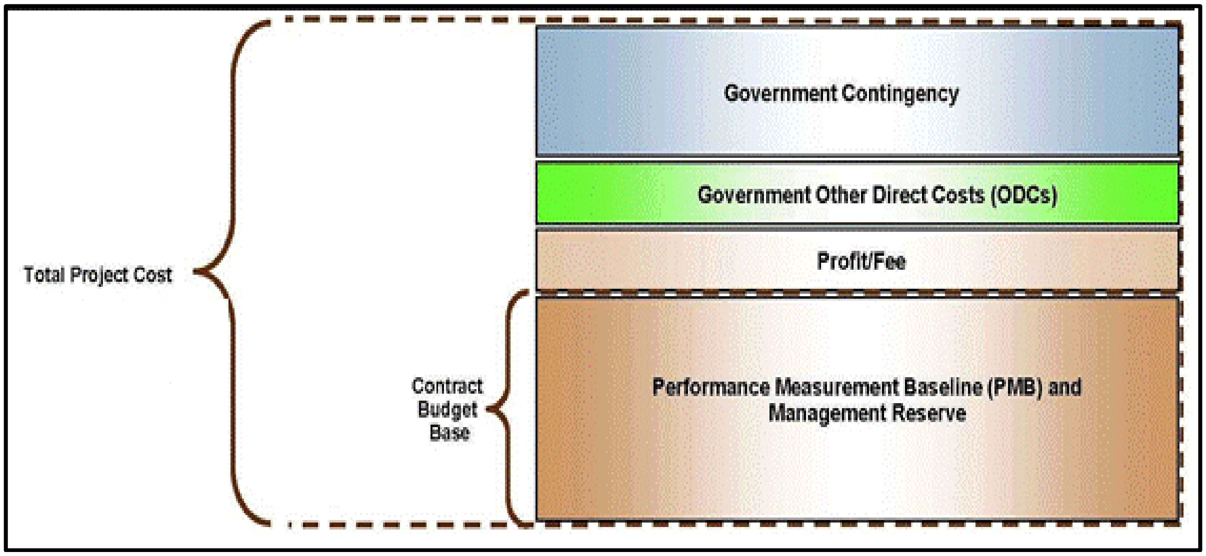

Figure 1-1. Performance Baseline Components for Capital Asset Projects

The objective is to provide the Project Management Executive (PME), for approval, a complete and accurate baseline that can reasonably and confidently be achieved. The document signed by the Chief Executive (CE) or PME approving CD-2 must clearly specify the project's approved PB, which includes the TPC, CD-4 date (month and year), scope and minimum KPPs that must be achieved at CD-4.

The remaining sections of this Guide describe the significance of PBs as a DOE corporate commitment and place development activities in context of the overall project phases. Table 1.1 outlines the processes and products that can be used to develop the technical, cost, and schedule information needed to achieve the desired outcomes at CD-2.

Table 1.1. Scope, Schedule, Cost of a Performance Baseline

PB Element	Characteristics
Scope	Work breakdown structure (WBS) encompasses all project scope and/or contractual scope requirements/work authorization defined to levels sufficient to support detailed cost and schedule estimates under formal change management procedures and configuration management.
• *Design*	Is mature when a point estimate can be developed, can establish a high-quality, reliable cost and schedule estimate for a PB, and is ready for an independent review. Refer to DOE O 413.3B, Figure 3, page C-6, *Facility Design Maturity General Guidelines for CD-2*.
• *KPPs*	Primary KPPs defined, understood, and agreed to by the PME, Program sponsor, and FPD, and forms the requirements of the prime contract. Represents threshold KPPs to achieve CD-4
Cost	TPC established with 70-90% confidence level. Higher confidence level should be considered for changes to the PB. Refer to DOE O 413.3B, page C-21.
Schedule (CD-4)	Project completion date established with 70-90% confidence level. Higher confidence level should be considered for changes to the PB. Refer to DOE O 413.3B, page C-21.

All baseline documentations should be complete, approved by an appropriate authority, and effectively organized to enable traceability of supporting plans, assumptions, and analyses from the lowest to the highest level, and summary statement of the PB should be contained in the Project Execution Plan (PEP) or in the program requirements document (PRD) for National Nuclear Security Administration (NNSA) projects.

2.0 PERFORMANCE BASELINES ESTABLISH DOE CORPORATE COMMITMENTS

PB approval establishes the organization’s corporate commitments (based on the funding profile established at baseline) and defines cost, schedule, performance, and scope commitments for successfully delivering projects.

Table 2.1 identifies key DOE project stakeholders for whom the PB serves as a corporate commitment.

Table 2.1. Key DOE Project Stakeholders

Key Stakeholders	Nature of PB Commitment
Congress	The PB is a commitment to deliver on time and within budget and a justified investment of taxpayer dollars.
OMB	The PB is a result of realistic priorities; well-coordinated plans and budgets; and provides measureable benefits.
PME	Project performance, scope, schedule, and cost are well defined, reasonable, and achievable.
Owner	Submits budget request to support the project.
DOE Program	Mission need will be satisfied.
User Community	End-state achieved will be reflective of the needs, inputs, and commitments.
Regulators	Regulatory requirements will be met.

Baselining processes incorporate elements that are fundamental to project planning and execution in any organizational setting.

These commitments are published in highly visible project documents and systems such as the PEP, OMB Business Case for Non-Information Technology (IT) Capital Acquisition (Exhibit 300s), Congressional Budget Requests, Project Data Sheets (PDS), and the Project Assessment and Reporting System (PARS). Refer to DOE G 413.3-15, *Department of Energy Guide for Project Execution Plans*, Departmental budget guidance, and PARS II guidance.

The PB represents the Department’s commitment to Congress to deliver the project’s defined scope/KPPs by a particular date and at a specific cost. Estimates of PB elements in advance of CD-2 in particular, at CD-0 and CD-1, do not represent such commitments.

Developing PBs allow:

- Effective coordination and integration of top-down and bottom-up planning, decision making, and documentation among diverse DOE organizations represented in IPTs (Headquarters, site offices, and contractors).

- Routine monitoring and reporting on all aspects of project performance by a large number of external oversight organizations (i.e., OMB, Government Accountability Office (GAO), Inspector General, Defense Nuclear Facilities Safety Board, Congress, etc.).

- Improved project definition to ensure that requirements are progressively and rigorously refined to validate and approve PBs at CD-2.

- Appropriate KPPs are established for the unique portfolio of DOE projects (nuclear weapons stockpile stewardship; radiologic and hazardous waste cleanup; and large-scale, basic, and applied energy and scientific research facilities).

- A greater degree of certainty on a large number of first-of-a-kind projects that typically have high cost, significant impact on stakeholders, and high visibility.

3.0 DEVELOPMENT & MANAGEMENT AS KEY ACTIVITY IN PROJECT PHASES

While the PB is formally approved by the PME at CD-2, the PB development should begin at the earliest stages of a project. The planning process matures as more data and analyses provide greater definition and detail, relying on a continuous and iterative process throughout the project.

The DOE acquisition management system for capital asset projects consists of four major phases; initiation, definition, execution, and transition/closeout. Refer to DOE O 413.3B, Figures 1 and 2 and alignment with CD approvals. Within DOE, projects typically progress through five CDs, which serve as major milestones approved by the CE or PME. Each CD marks an authorization to increase the commitment of resources by DOE and requires successful completion of the preceding phase or CD. The PB development is a key process leading up to CD-2, the original PB. The PB management (configuration control and change management) becomes a critical effort through the remainder of the project.

Table 3.1 illustrates the relationship of the PB components as the project progresses. The PB components should be clearly documented in the PEP and in the PRD, for NNSA projects, along with high-level assumptions and limitations. The original PB components and, if applicable, the latest approved PB component must be archived because they are the basis to determine if CD-4 is achieved. Further, the PB cost elements that are identified in the DOE Earned Value Management System (EVMS) Gold Card should be clearly documented. Refer to DOE G 413.3-10A, *Earned Value Management System,* Appendix B.

Table 3.1. DOE Project Phases

PB COMPONENT	PROJECT PHASES CD-0 Initiation	CD-1 Definition	CD-2/3 Execution	CD-4 Closeout
Scope of Work	Preliminary functions and requirements from pre-conceptual design	Preliminary design requirements baseline	Final design requirements configuration baseline	As-built configuration baseline
• *KPPs*	Preliminary KPPs derived from the mission need	Preliminary KPPs	Final KPPs	Demonstration of KPPs
Schedule Baseline	Order of magnitude project duration and forecast need date	Preliminary schedule and milestones	Complete schedule hierarchy	Actual completion date
Cost Baseline	Order of magnitude cost estimate and cost range	Preliminary cost estimates and cost range	Final TPC estimate	Actual project costs

3.1. Initiation (CD-0; Approve Mission Need)

In the initiation phase the project's need is identified and justified, high-level objectives and functional requirements to meet those objectives are outlined, rough order-of-magnitude cost estimate ranges and a few key milestones are established, and project team formation begins. In this phase preliminary KPPs are used to describe and communicate the mission need to project stakeholders.

After CD-0 is approved, the project may request funding as part of the budget process (e.g., using a PDS and Exhibit 300).

3.2. Definition (CD-1; Approve Alternative Selection and Cost Range)

In the definition phase additional information is gathered or developed to enhance conceptual development; alternative courses for achieving project objectives are identified; design criteria are developed; more accurate estimates of technical scope, schedule and cost are developed for the identified alternatives; and value management/trade off study processes are typically employed to refine project systems and functions. Accordingly, there should be more discrete KPPs based on the selected alternative. At this point the project team should begin to articulate and document preliminary KPPs, preliminary schedule, and initial cost estimate and cost range. The definition phase culminates with the PME approving CD-1.

3.3. Execution (CD-2/3; Approve Performance Baseline/Approve Start of Construction/Execution)

The PB is established at CD-2. Preliminary project design is finalized, scope of work, and KPPs are created, and final cost and schedule baselines are established. Completion of full project definition indicates that the project has been adequately defined to commit resources. Once these elements are complete, the final PB is documented. Prior to CD-2 approval, for projects with a TPC of $100M or more, an External Independent Review (EIR) of the project PB, lead by the Office of Project Management Oversight and Assessments (PM) is required, and PM will develop an Independent Cost Estimate (ICE) to support validation of the PB. For projects with a TPC between $50M and $100M, an Independent Project Review (IPR) by the project management support office is required. Upon approval of CD-2, the PB sets the final course for the project and is subject to formal change management procedures. Accordingly, the PB may be updated if a baseline change occurs.

3.4. Closeout (CD-4; Approve Start of Operations or Project Completion)

When the project nears completion and has progressed into formal transition and commissioning, which generally includes final testing, inspection, and documentation, the project is ready for operation, long-term care, or closeout. The PB, and especially KPPs, serves as a basis for assessing, verifying, and documenting completion of the project and whether the objectives of the project have been realized.

4.0 THE PERFORMANCE BASELINE DEVELOPMENT PROCESS

The PB development process should be a continuous and iterative process.

For any PB development effort to be successful it should be developed by qualified people, follow well-defined processes, be subject to rigorous quality assurance requirements and processes, and be supported by the careful consideration and application of appropriate project definition tools.

PB development requires the constant engagement and expert technical direction by the owner and Program Organization; strong leadership by the PME, the FPD, and dedicated support by the IPT. Accordingly, qualified staff (including contractors) must be available in sufficient numbers to accomplish all contract and project management functions. Project staffing requirements should be based on a variety of factors. Refer to DOE G 413.3-19, *Staffing Guide for Project Management*, for additional guidance.

4.1. People and Partnerships

Personnel involved in the PB development process have a major effect on the accuracy, completeness, and overall quality of the final deliverables. At each step, we need to assemble the right number of people with the right mix of experience and skill set. Roles and responsibilities must be clearly defined, understood, and accepted. Individuals with the appropriate capabilities and experience must be engaged in all phases of the PB development and the IPT must have a proactive communication plan. If the internal resource is lacking, then contract support staff should be pursued to augment the effort.

Many project management studies have identified the need to align all parties to the project goals and objectives as a prerequisite for project success. Many studies have gone further by suggesting that project roles are most effectively executed when relationships among participants are viewed as partnerships. Formal partnering may be appropriate for our largest projects, as early as possible, to ensure we get the technical and project requirements and functional layout right at the start.

4.2. Baselining Processes

Figure 4.1 below highlights the baselining process, packaged into workflows, and which also supports the GAO-09-3SP 12 steps of the cost estimating process.

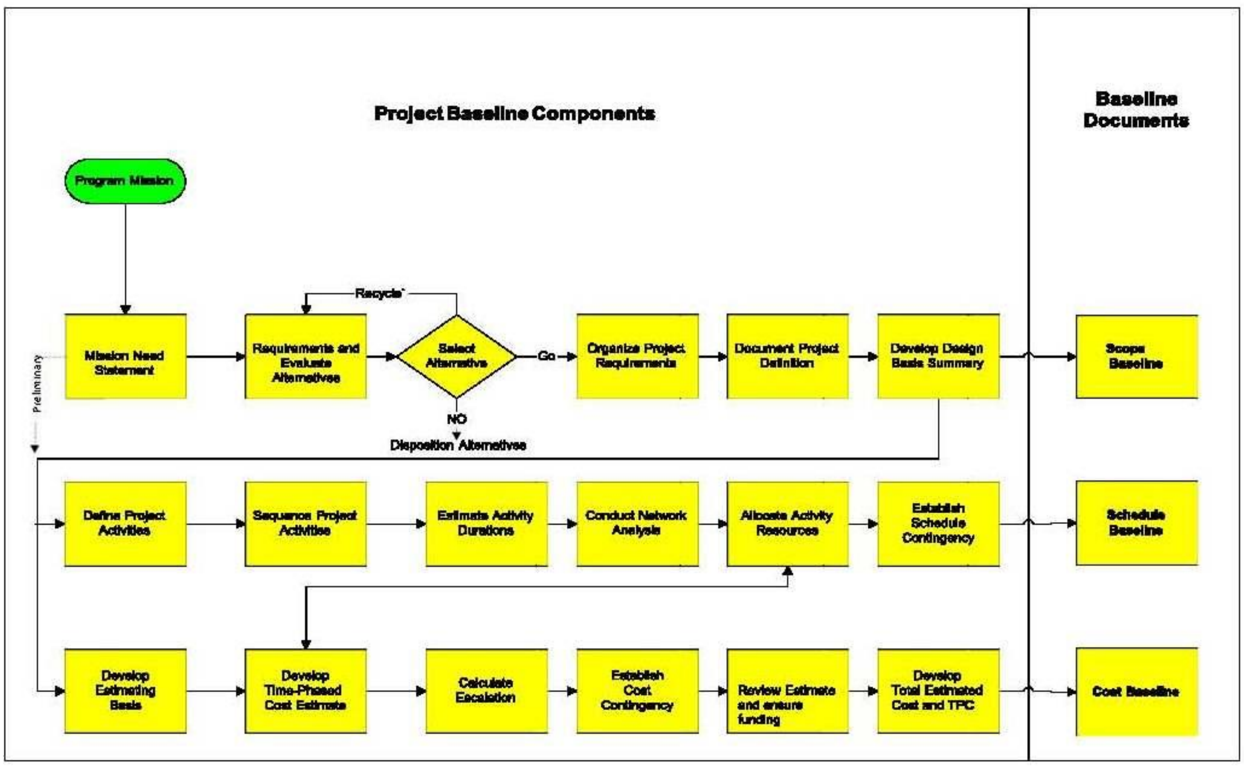

Figure 4.1. Overall Performance Baseline Development Process

4.3. Tools and Methods

The tools and methods used by project teams are extensively reported in the literature and are included here, grouped into categories, only to highlight those most common and to provide a starting point for further research:

- Front-end planning (project/scope definition ratings; gap analysis; benchmarking, checklists). Two specific tools are provided below:
    - The Project Definition Rating Index (PDRI) to assess the project definition. Refer to DOE G 413.3-12, *Project Definition Rating Index Guide*.

- o The Technology Readiness Assessment (TRA) to assess the maturity level of a new proposed technology. Refer to DOE G 413.3-4, *U.S. Department of Energy Technology Readiness Assessment Guide*.

- Systems engineering (functional analysis; requirements definition; configuration management). Refer to DOE G 413.3-1, *Managing Design and Construction Using Systems Engineering.*

- Alternatives analyses (life-cycle cost analysis; cost-benefit analysis; trade studies). Refer to GAO best practices, GAO-15-37, DOE and NNSA Project Management: *Analysis of Alternatives Could Be Improved by Incorporating Best Practices (Dec 2014).* In addition, refer to updated 22 best practices that GAO identified for analyses of alternatives, GAO-16-22, *Amphibious Combat Vehicle: Some Acquisition Activities Demonstrate Best Practices; Attainment of Amphibious Capabilities to be Determined (Oct 2015).*

Refer to DOE G 413.3-7A, *Risk Management Guide*, and DOE G 413.3-21, *Cost Estimating Guide*, for additional information.

5.0 ESTABLISHING KEY PERFORMANCE PARAMETERS (KPPs)

The KPPs establish a measurable benchmark for completing project scope. Further, a KPP is a discrete quantitative objective that can be tracked during project execution. Collectively, KPPs provide a checklist for project completion and a metric for success. They should define the measurable criteria that meet the mission need.

Traditionally, in DOE, a project “baseline” is comprised of three components - scope, cost, and schedule - each of which is related to the others. The requirement to establish KPPs is a prominent feature of DOE project management and KPPs for a project must be clearly defined at CD-2. The KPPs drive scope. Scope drives schedule and cost.

The KPPs, in DOE O 413.3B, are defined as a vital characteristic, function, requirement or design basis that if changed, would have a major impact on the facility or system performance, scope, schedule, cost and/or risk, or the ability of an interfacing project to meet its mission requirements. A parameter may be a performance, design, or interface requirement. Appropriate parameters are those that express performance in terms of accuracy, capacity, throughput, quantity, processing rate, purity, reliability, sustainability, or others that define how well a system, facility, or other project will perform. In aggregate, KPPs drives the scope of the project.

KPPs are defined in terms of what is desired and what is required. Each KPP succinctly and in quantitative terms, if possible, states the desired objective value and the associated minimum threshold value. The *objective value* is the desired performance, scope, cost, or schedule that the completed asset should achieve, whereas the *threshold value* is more conservative representing the minimum acceptable performance, scope, cost, or schedule that an asset must achieve. The threshold value is what is expected at CD-4.

Preliminary KPPs should be identified during the concept development phase, as part of the CD-

1 approval. They are a result of the analysis which leads the IPT to the conclusion that a particular concept is the appropriate solution that will meet the required mission need. They are finalized at CD-2.

The total number of KPPs should be the minimum number needed to characterize the major drivers of project scope and performance. The number and specificity of performance parameters may change over time. Early in PB development, the KPPs should reflect broadly defined, operational-level measures of effectiveness or measures of performance to describe needed capabilities. As a project matures, system-level requirements may provide a better basis for establishing project KPPs.

It is important for the owner and Program sponsor (typically possessing technical understanding and expertise) to provide strong leadership in the development and agreement on KPPs. The more technically complex the project is, the more the owner needs to be involved.

DOE PM *Statement of Work and Key Performance Parameters Handbook* dated September 30, 2014 provides additional information and guidance in establishing KPPs for capital asset projects.

6.0 SCOPE BASELINE DEVELOPMENT

The scope baseline defines technical goals, objectives, and scope of work, and provides the basis for estimating project cost and schedule. The scope baseline is driven by project KPPs.

Development should encompass IPT actions necessary to identify, define, integrate, and document the project mission, functional objectives, design requirements, and detailed specifications in order to define, execute, and control the technical requirements necessary to accomplish the project's scope of work.

A well-defined and documented scope baseline is a key factor for ensuring project success. It should be established in such a way that technical requirements can be understood, broadly communicated, and effectively controlled throughout the life of the project.

The scope baseline should include design requirements, criteria, and characteristics that provide the basis for project definition.

The DOE O 413.3B process is based on industry methods of conducting iterations of requirements during each project phase. As technologies are matured (if applicable) and requirements defined, design and/or studies are conducted to gain more project knowledge, and refinement of requirements is made based on the designs and/or studies. An iteration of these steps, providing more detail, occurs for each phase throughout the project until final and mature systems architecture is achieved.

This iterative project planning process should start by defining the project's mission need. Once internal and external stakeholders understand and commit to the mission need, the project team identifies KPPs, functional requirements, evaluates alternatives for satisfying requirements, conducts appropriate analyses, and recommends a preferred alternative.

Evolving KPPs and technical requirements and supporting assumptions should be captured initially in informal but complete scoping documents and then after conceptual designs have been approved, they should be incorporated into a formalized scope baseline.

The IPT should ensure that as the scope and technical requirements become better defined, they trace back to the mission need, KPPs and functional requirements developed earlier in the project definition effort.

The IPT should use a graded approach for determining the level of detail required for scope baselines. Additionally, information in all scope baselines should be traceable to clearly identifiable assumptions, a methodology that is consistent with industry standards, and well-documented supporting information.

The benefit of the iterative process is that internal and external stakeholders can agree on high-level requirements before spending significant time and effort defining any particular alternative. Project requirement identification and definition are two of the most critical elements of PB development. Not achieving agreement on the path forward early in the project definition process can cause significant cost increases or schedule delays later in the process. The scope baseline development process is described in Figure 6.1.

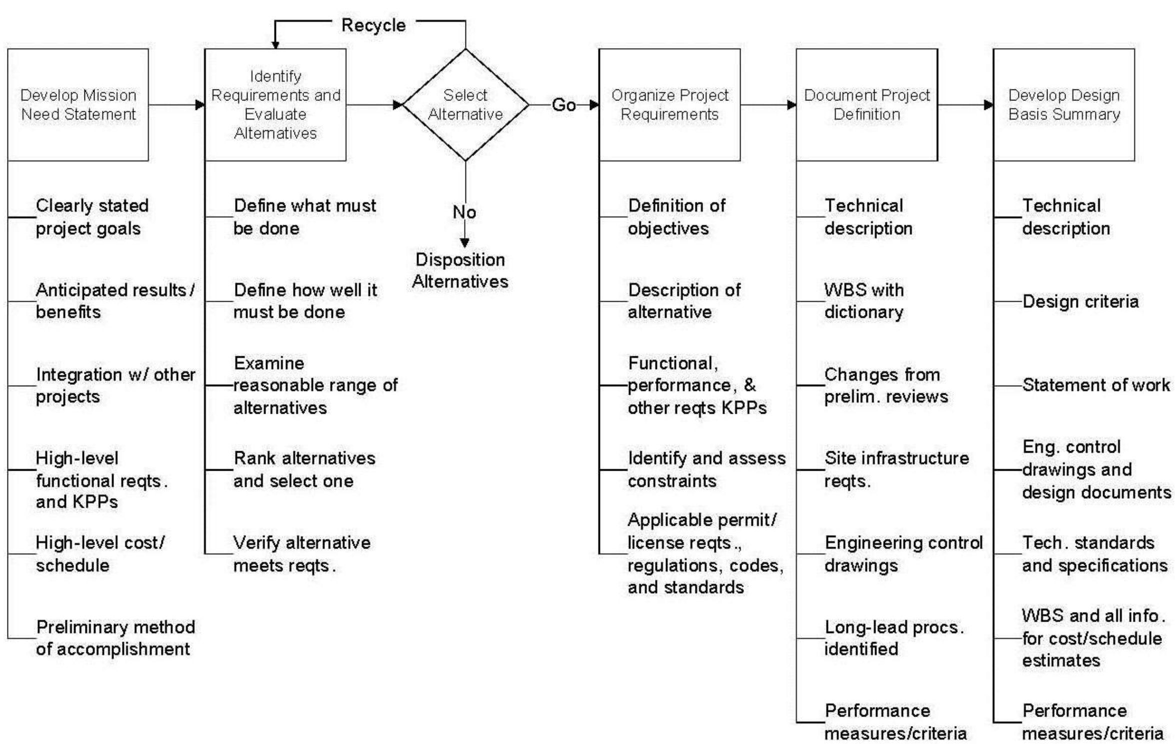

Figure 6.1 Scope Baseline Development Process

6.1 Mission Need

The mission need defines the project's high-level technical goals and requirements and should:

- provide direction for future planning, engineering, and decision making;
- initiate more detailed technical definition (project requirements, project definition, and design basis) that guide cost and scheduling estimating; and
- help build commitment and buy-in from project stakeholders.

Refer to DOE G 413.3-17, *Mission Need Statement*, for additional information.

6.2 Identify Requirements and Evaluate Alternatives

At this stage, it is a good practice to identify and evaluate alternatives to increase the likelihood of satisfying project objectives and KPPs. An analysis of alternatives (AoA) should identify a single approach that fulfills the mission need in the most effective manner (cost, time, and operationally). In some cases, the alternatives may be competing concepts or simply variations on a common approach. A high-level definition of each alternative should be developed sufficiently to permit an informed selection.

The responsible program office is required to conduct an AoA that is independent of the contractor organization responsible for managing the construction or constructing the capital asset project. The AoA will be consistent with published GAO best practices. Refer to GAO-15-37, DOE and NNSA Project Management: *Analysis of Alternatives Could Be Improved by Incorporating Best Practices (Dec 2014).* In addition, refer to updated 22 best practices that GAO identified for analyses of alternatives, GAO-16-22, *Amphibious Combat Vehicle: Some Acquisition Activities Demonstrate Best Practices; Attainment of Amphibious Capabilities to be Determined (Oct 2015).*

At the conclusion of the identification and evaluation activities, the best alternative that safely fulfills the mission in the most effective manner should be selected. In some cases, it might be necessary to carry forward a limited number of short-listed alternatives to address major uncertainties that require further design development to resolve.

Project objectives are drafted and revised throughout the alternative evaluation and selection phase. These objectives ultimately become the basis for developing project requirements.

6.3 Organize Project Requirements

Clearly defining project requirements at the earliest time in project execution is essential to ensure that objectives and design criteria are complete and consistent by translating mission need and KPPs into a technical plan. The requirements clearly articulate a set of technical expectations that guide overall project definition.

The project objectives should be stated as measurable goals, performance parameters, or end states. Multiple objectives may be prioritized into primary and secondary objectives. Primary objectives are the ones without which the project would not be undertaken. Secondary objectives are additional benefits, but are not sufficient to justify the project. By categorizing objectives in this way and then ranking them, the IPT establishes design priorities and provides greater flexibility in acquisition planning.

Design criteria relate project objectives to technical design requirements to ensure that all design efforts will be developed in an orderly fashion. The primary purpose of the design criteria is to focus the design effort. Development of design criteria is generally the first effort to formalize the technical approach and performance requirements for the project.

6.4 Document Project Definition

Project definition should focus on defining the selected alternative to the level of detail necessary to ensure that the functional requirements, design criteria, major physical attributes, and performance parameters (including KPPs) are clearly established. Engineering drawings and specifications should be developed to control engineering and field construction. When project definition activities are complete and a design basis document issued, the project should be adequately defined to commit resources to the final detailed design, execution, completion, closure, and/or operational activities.

Assessing the project definition utilizing the PRDI and the maturity level of a new proposed technology are critical prior to the execution phase and CD-2.

Refer to DOE G 413.3-12, *Project Definition Rating Index Guide for Traditional, Nuclear and Non-Nuclear Construction Projects*, for additional information.

6.5 Develop Design Basis

The design basis is a comprehensive technical project description including reviewed and approved engineering design drawings. This package provides the appropriate level of definition necessary to approve an Architectural and Engineering contractor to begin detailed engineering designs, represents completion of project definition, and marks the beginning of the execution phase.

Technical requirements are finalized during the development of the design basis summary; should provide sufficient detail to ensure that defined objectives are achieved and an accurate work scope is furnished to direct execution phase efforts; and should be developed thoroughly enough to ensure a high probability of project execution success and minimize the probability of scope changes.

7.0 SCHEDULE BASELINE DEVELOPMENT

The integrated master schedule (IMS) establishes the overall project duration and completion date. It should clearly identify all project activities, to include critical path, near critical path activities and key project milestones.

A tailored approach should be used to determine how much detail to include in the schedule. The number of activities should not be so few as to prevent suitable progress tracking and not so numerous that the number of activities overwhelms the system and its users—rendering the schedule logic incomprehensible and too burdensome to status. The schedule should reflect planning by appropriate technical experts as to how the activities will be accomplished.

All known project and contract requirements, major procurements, milestones, and constraints should be identified during the planning and scheduling process. Activities external to the project that could reasonably be expected to impact the project should also be considered.

The overall schedule baseline development process is described in Figure 7.1.

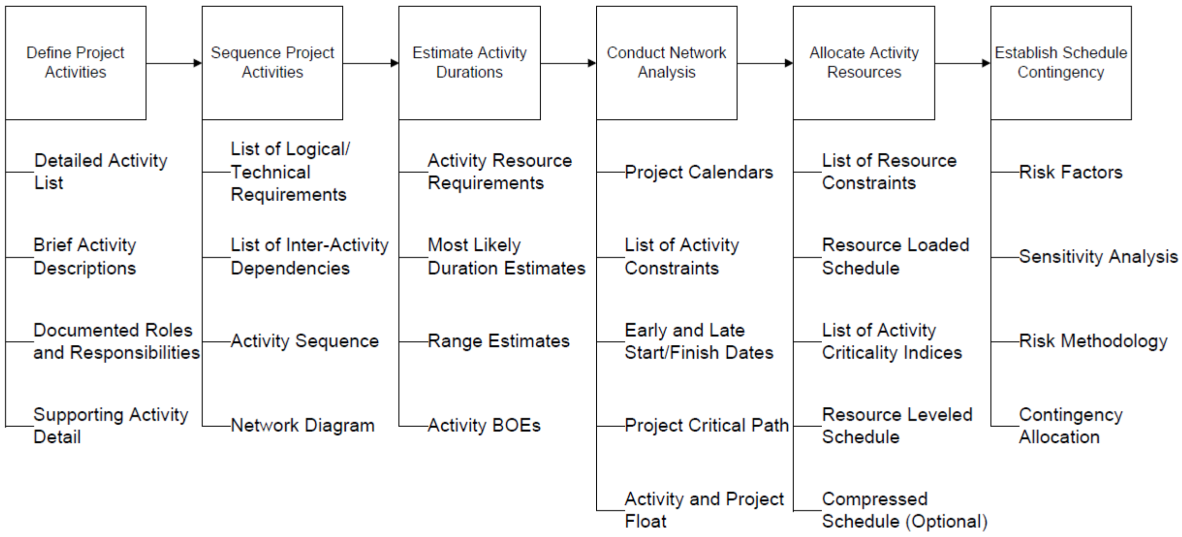

Figure 7.1. Schedule Baseline Development Process

7.1. Define Project Activities

An activity is a basic element of work that consumes time and resources and has a definable beginning and end. Activities are performed in order to produce the results and deliverables identified in the project WBS. The activities necessary to accomplish a defined scope of work are often based on historical information from similar projects that have been modified to meet the constraints and assumptions of the current effort.

The definitions of these activities should flow from the project planning and scope definition processes, and the level of definition will depend on the project phase.

7.2. Sequence Project Activities

Sequencing involves the development of chronological relationships among project activities based on the technological, organizational, and contractual requirements governing their completion. A sequence of activities is best displayed graphically in the form of a network diagram. Three common methods of network diagramming include arrow, node, and precedence diagrams.

Activities should be sequenced logically to establish the foundation for an achievable project work plan. A sequence of activities in the form of a network diagram is necessary for performing critical path, total float, and resource leveling analyses. The results of these analyses are implicitly tied to the mandatory, discretionary, and external dependencies identified by the project team and included in the network schedule.

The project team should discuss and establish a realistic sequence of events for the completion of activities based on inter-activity dependencies.

7.3. Estimate Activity Durations

Estimates of the time required to perform each project activity are based on assumed labor, equipment, efficiency and productivity, and material requirements and availability. These durations may take the form of a single point estimate describing the mean or most likely number of work periods needed to complete an activity (e.g., based on historical data), or may be defined by a range estimate that captures a continuum of durations spanning from the most optimistic to the most pessimistic as conceived by one or more subject matter experts on the project team.

Similar to the sequencing of activities, estimating activity durations is essential for developing a sound project schedule. Because of the inter-activity dependencies inherent in network scheduling, the effects of poorly defined duration estimates can be compounded through precedence relationships and milestone constraints. Successful critical path and resource leveling analyses are therefore directly dependent upon the accuracy of the duration estimating process.

Activity durations should be estimated by the project team member most familiar with the nature of a specific activity and who is responsible for ensuring its completion. The duration of most activities will be significantly influenced by both the amount of resources applied to a task (e.g., part-time versus full-time, single versus multiple crews) and the capabilities of those specific resources (e.g., novice versus experienced laborers). These trade-offs should be considered and documented during the estimating process; however, they may be adjusted later during a resource allocation exercise. Whenever possible, duration estimates should be based on expert judgment that is supported by historical information contained in project files or commercial estimating databases.

7.4. Conduct Network Analysis

The critical path is the longest path through a network schedule that consequently defines the shortest possible duration for completing a project. This path and its duration are determined by performing forward and backward passes through the network diagram based on the defined activity sequence and estimated activity durations.

The basic scheduling computations performed on a network diagram provide the earliest and latest allowable start and finish times for each activity and as a by-product, indicate the amount of slack or float time associated with each noncritical path. This information forms the basis of the project management plan and subsequently is used for performance measurement and earned value reporting, baseline change control, milestone tracking, and schedule contingency management.

7.5. Allocate Activity Resources

The feasibility of a network schedule should be validated with respect to labor, equipment, and material requirements not explicitly considered in the initial critical path analysis. The process of allocation is used to distribute resources across multiple project activities within known limits and expected constraints. Some activities may be re-sequenced to compress the schedule and/or to obtain a more level distribution of resources.

Resource allocation often entails several iterations of the basic scheduling computations and should include modification of some project activities to achieve an acceptable plan (i.e., one that meets all milestone dates and externally imposed constraints without exceeding the available labor, material, and equipment levels).

7.6. Establish Schedule Contingency

Schedule contingency is the amount of time identified within the project schedule to compensate for the potential for schedule risk factors such as technical data gaps, infrastructure constraints, labor productivity levels, labor availability, project complexity, stakeholder involvement, excessive scope changes, regulatory delays, and constructability issues.

The amount of contingency to be included in the baseline schedule depends on the status of the project design, procurement, and construction and the complexity and uncertainty of various baseline elements. It should be based on expert judgement based on past experience and other factors.

Schedule contingency should explicitly address the risks identified by the project team during the schedule development and risk management efforts, especially those factors that are likely to have the greatest impact on project execution as determined by a sensitivity analysis.

Additional information regarding development of the IMS and the ten best practices associated with a high-quality and reliable schedule and their concepts are outlined in the *GAO Schedule Assessment Guide dated May 2012 (GAO-12-12OG)*. Also, refer to National Defense Industrial Association (NDIA) Planning and Scheduling Excellence Guide (PASEG), Jun 2012.

8.0 COST BASELINE DEVELOPMENT

The cost baseline supports the development of the TPC and is established to ensure that costs and budgets for labor, services, and materials are defined and time-phased.

While the scope baseline ensures that technical requirements are focused on achieving the project mission, the cost baseline supports planning, programming, budgeting, execution, and reporting processes. For instance, estimates provide the basis for formulating annual budget requests, establishing the project and activity resources, hours and quantities that are used to develop the schedule and quantitative units to be measured, evaluating contract bids and proposals, providing a sense of scale that often aids in understanding the overall scope of a project, and evaluating the impact of change to the PB.

Fundamental estimating skills and knowledge should be reinforced as a basis for estimating and controlling costs. Well documented Basis of Estimate (BOE) and the consistent application of rigorous estimating methods are significant defenses against concerns for estimate accuracy and credibility.

A general cost baseline development process is shown in Figure 8.1. Per the Secretarial policy memorandum dated June 8, 2015, *Project Management Policies and Principles*, cost estimates are to be developed, maintained and documented in a manner consistent with the methods and best practices identified in GAO-09-3SP *Cost Estimating and Assessment Guide*.

Prior to CD-2 approval, for projects with a TPC of $100M or more, PM will conduct an ICE and EIR to support validation of the PB.

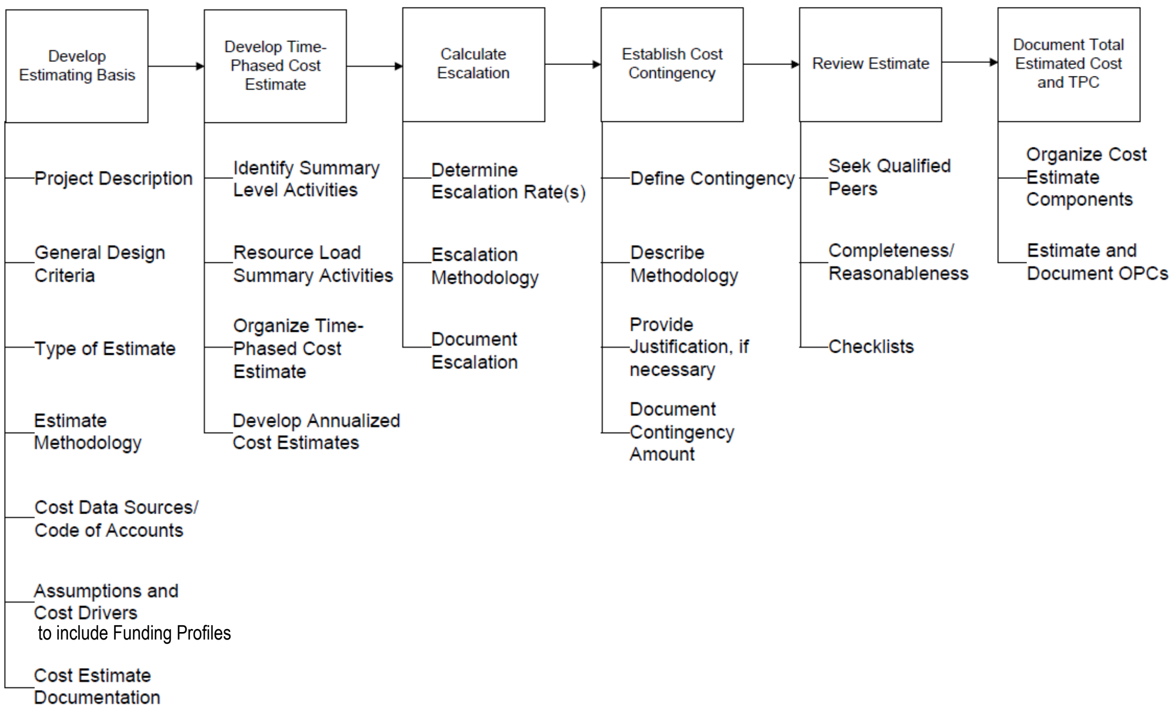

Figure 8.1. Cost Baseline Development Process

8.1. Develop Basis of Estimate

The BOE documents known project information, assumptions, and methodologies and identifies links to supporting documentation when the estimate is developed and updated. Specifically, the BOE should provide a description of the project, general design criteria, project phase and type of estimate, date of the estimate, cost estimating methodology/tools, cost estimate data sources, WBS, significant features or components, proposed method of accomplishment, proposed schedule/milestones, regulatory drivers, resource requirements/availability (including proposed funding profile) and associated costs, assumptions, and other facts that may impact costs. The level of detail in the cost estimate should be consistent with the project phase or degree of project definition. This approach offers the greatest level of detail in the near-term to support current year work plan development and annual budget formulation. Top-down or parametric cost estimating can be used to support out-year life-cycle planning if necessary.

Estimators should work closely with the IPT to understand the influences that the technical (e.g., scope definition) and schedule (e.g., activity definition/duration) baselines have on the cost estimate. As the project matures and designs are finalized, the initial cost estimate parameters can be compared to current conditions. Changes to scope, schedule, and cost planning should be identified as part of the estimate and especially at estimate reviews. If necessary, a revised cost estimate should be prepared.

Investment in developing a well-defined BOE pays dividends by improving communication among project team members and with key stakeholders; highlighting items that significantly influence the estimate; and avoiding confusion over what is and is not included in the estimate.

8.2. Develop Time-Phased Cost Estimate

Each project activity has a duration (planned start and expected finish dates) and a cost for resources (labor, materials, equipment) associated with it. When duration and cost are linked together, a profile that defines the project cost over time is produced.

The time-phased cost profile (e.g., resource-loaded schedule) can be used to develop a funding profile for those project activities with a schedule duration of greater than a year. Often, a proposed funding profile helps shape a time-phased cost baseline. This is important for multi-year projects where annual budget requirements are developed, reviewed, justified, and appropriated through an annual budget formulation process.

In some projects, a constrained funding profile may be provided. If this is the case, the funding profile should be based on and commensurate with the work to be performed and the cost baseline.

Once project activities have been resource-loaded the process of resource leveling or rescheduling activities based on resource limitations is extremely valuable in balancing labor and equipment requirements with schedule production requirements. It can also be used to ensure that project planning is consistent with the realistic out-year funding expectations while maintaining regulatory compliance in the project baseline.

8.3. Escalation

Escalation is the provision in a cost estimate for increases in the cost of equipment, material, labor, etc., due to continuing price level changes over time. Escalation is used to estimate the future costs of a project (predictive or forecast) or to state historical costs in current year dollars. Since the duration of larger projects can extend over several years, a method of forecasting or predicting the funds should be developed to allow for the comparison of project costs from different time frames.

Escalation should be applied to each activity of an estimate and shown as a separate line item. Most cost estimating is done in current dollars and then escalated to the time when the project will be accomplished. The cost estimate should clearly identify the escalation rate used, the source, relationship to the WBS and schedule, assumptions made, and the rationale for their use.

Two basic methods for calculating and applying escalation include:

- Midpoint of Activity - Escalation may be applied from the date an estimate was prepared to the midpoint of the performance schedules for the major work elements.

- Separate Escalation by Year - Activities escalated yearly/annually.

Cost of escalation for capital construction projects are calculated by establishing a midpoint for the project, and applying the yearly escalation to the midpoint of the project. In this case the impact of escalation is “averaged” over the life of the project.

8.4. Establish Cost Contingency

As an integral part of a cost estimate, contingency should be included and clearly identified in the TPC. The amount of contingency is a reflection of management judgment on how best to address the risks and uncertainties associated with the project.

DOE cost estimating directives recognize that project estimates should always contain contingency. DOE guidance advises that contingency analysis be performed to ensure that appropriate allowances are included in the baseline cost estimates. The contingency analysis should indicate the rationale or process used to reach the conclusion.

Approaches to contingency estimates range from formal risk-based analysis to project definition rating or scoring. A graded approach can be used in selecting a method depending on the complexity, cost, and phase of the project. It should also be noted that the cost value of schedule contingency will result in additional cost contingency and needs to factor into the cost baseline. Contingency should decrease over time as the project matures and project scope is more clearly defined.

Contingency management includes establishing a process for reviewing, approving, and tracking the distribution of contingency. Change control thresholds can be established to identify the approving authority for requested changes to contingency. Tracking tools such as contingency registers can be used to monitor the status of contingency.

Additional information regarding contingency development is outlined in *DOE Risk Management Guide, DOE G 413.3-7A, dated January 2011*.

8.5. Review Estimates

Well-executed estimate reviews will increase credibility and accuracy of the estimate, and will also help the project management team better understand the level of scope definition and the basis for the estimate. The review of estimates is important because it helps estimators understand the contents and level of accuracy of the estimate.

The number of reviews will vary depending on the size of the project, type of estimate, length of time allowed for preparing the estimate, and other factors. For any estimate there should be both an internal review during development of the estimate and a final review at or near completion of the estimate.

In some situations it may be desirable to use outside reviewers such as an experienced peer group to validate assumptions, key estimate accounts, construction sequence, and potential omissions. In other situations a third party may be engaged to perform an independent review. The reviews will provide a check to compare the estimate with past similar estimates from the perspective of a different team. This review should provide an unbiased check of the assumptions, productivity factors, and cost data used to develop the estimate. An independent cost review is a vital step in providing consistent, professionally prepared cost estimates.

Additional information regarding cost estimate development is outlined in *DOE Cost Estimating Guide*, *DOE G 413.3-12, dated May 2011*.

APPENDIX A.
GLOSSARY

1. Cost Baseline. A budget that has been developed from the cost estimate that is time-phased, supports the technical baseline, and is traceable to the WBS. The cost baseline is a subset of the *performance measurement baseline or performance baseline* and use should be clarified to ensure what is being referenced.

2. Contract Budget Base (CBB). When the contract is awarded, the CBB is the total estimated contract cost. In project terms the contract budget base is performance measurement baseline plus contractor management reserve.

3. Key Performance Parameter (KPP). A vital characteristic, function, requirement or design basis that if changed, would have a major impact on the facility or system performance, scope, schedule, cost and/or risk, or the ability of an interfacing project to meet its mission requirements. A parameter may be a performance, design, or interface requirement. Appropriate parameters are those that express performance in terms of accuracy, capacity, throughput, quantity, processing rate, purity, reliability, sustainability, or others that define how well a system, facility or other project will perform. In aggregate, KPPs comprise the scope of the project. For a typical project, the expectation is for about 3-5 succinct and, measurable KPPs to be identified. Refer to DOE O 413.3B, page C-13.

4. Management Reserve (MR). Management Reserve is an amount of the total contract budget withheld for management control purposes by the contractor for unexpected growth within the currently authorized work scope, rate changes, risk and opportunity handling, and other project unknowns. It is held outside the Performance Measurement Baseline but within the Contract Budget Base.

5. Performance Baseline (PB). The collective key performance, scope, cost, and schedule parameters, which are defined for all projects at CD-2. The PB includes the entire project budget (TPC including fee and contingency) and represents DOE's commitment to Congress. Refer to DOE O 413.3B, pages C-14 and Attachment 2, page 9.

6. Performance Measurement Baseline (PMB). The total time-phased budget plan against which project performance is measured. It is the schedule for expenditure of the resources allocated to accomplish project scope and schedule objectives, and is formed by the budgets assigned to control accounts and applicable indirect budgets. The PMB also includes budget for future effort assigned to higher level accounts, also referred to as summary level planning packages, plus any undistributed budget. Management Reserve is not included in the baseline, as it is not yet designated for specific work scope. Refer to DOE O 413.3B, Attachment 2, page 10.

7. Schedule Baseline. Identified as the Integrated Master Schedule, it is the time-phased plan based on a logical sequence of interdependent activities, milestones, and events necessary to complete the project.

8. Scope Baseline. Part of the Performance Baseline, the Scope Baseline is the approved version of the detailed scope statement, work breakdown structure (WBS) and its associated WBS dictionary.

9. Work Breakdown Structure (WBS). Used by the project management team to organize and define a project into manageable objectives and create a blueprint by which the steps leading to the completion of a project are obtained. It is a product-oriented family tree composed of hardware, software, services, data and facilities and other project-unique tasks which serves as an outline of the project that becomes more detailed under the subheadings or work packages. Refer to DOE O 413.3B, Attachment 2, page 14.

Refer to *DOE Acquisition and Project Management Glossary of Terms Handbook*, September 2014 for additional information.

APPENDIX B. REFERENCES

1. DOE O 413.3B, *Program and Project Management for the Acquisition of Capital Assets*, 11-29-2010.

2. DOE G 413.3-4, *Technology Readiness Assessment Guide*, 9-15-2011.

3. DOE G 413.3-7A, *Risk Management Guide*, 01-12-2011.

4. DOE G 413.3-10, *Earned Value Management System (EVMS)*, 03-13-2012.

5. DOE G 413.3-15, *Project Execution Plans*, 11-1-2008.

6. DOE G 413.3-12, *Project Definition Rating Index Guide for Traditional Nuclear and Non-Nuclear Construction Projects*, 07-22-2010.

7. DOE G 413.3-19, *Staffing Guide for Project Management*, Change 110-12-2011.

8. DOE G 413.3-21, *Cost Estimating Guide*, 05-09-2011.

9. PARS II guidance, http://management.energy.gov/online_resources/pars2.htm.

10. GAO-09-3SP, *GAO Cost Estimating and Assessment Guide – Best Practices for Developing and Managing Capital Program Costs*, dated 03-2009.

11. GAO-12-120G, *GAO Schedule Assessment Guide: Best Practices for Project Schedules – Exposure Draft*, dated 05-30-2012.

12. GAO-15-37, *DOE and NNSA Project Management: Analysis of Alternatives Could be Improved by Incorporating Best Practices*, dated 12-11-2014; GAO-16-22, updated analyses of alternatives best practices, Amphibious Combat Vehicles: *Some Acquisition Activities Demonstrate Best Practices; Attainment of Amphibious Capabilities to be Determined*, dated 10-2015.

13. *Statement of Work and Key Performance Parameters Handbook*, 9-30-2014.

14. DOE G 413.3-17 *Mission Need Statement Guide*, 6-20-2008.

15. DOE Project Management Policy and Guidance documents can be found at http://energy.gov/projectmanagement/project-management-policy-guidance-documents

16. The Secretary of Energy Policy Memorandum, subject: *Project Management Policies and Principles*, 6-8-2015.

APPENDIX C.
ACRONYMS

AoA	Analysis of Alternatives
BCP	Baseline Change Proposal
BOE	Basis of Estimate
CBB	Contract Budget Base
CE	Chief Executive
CD	Critical Decision
DOE	Department of Energy
EIR	External Independent Review
EVMS	Earned Value Management System
FPD	Federal Project Director
GAO	Government Accountability Office
ICE	Independent Cost Estimate
IPR	Independent Project Review
IPT	Integrated Project Team
IT	Information Technology
KPP	Key Performance Parameter
MR	Management Reserve
O	Order
OMB	Office of Management and Budget
NDIA	National Defense Industrial Association
NNSA	National Nuclear Security Administration
PARS	Project Assessment and Reporting System

PASEG	Planning and Scheduling Excellence Guide
PB	Performance Baseline
PEP	Project Execution Plan
PDS	Project Data Sheet
PDRI	Project Definition Rating Index
PMB	Performance Measurement Baseline
PME	Project Management Executive
PM	Project Management Oversight and Assessments
PRD	Program Requirements Document
TPC	Total Project Cost
TRA	Technology Readiness Assessment
WBS	Work Breakdown Structure