

Analysis of Alternatives

DOE G 413.3-22

H2C Compliance Focus

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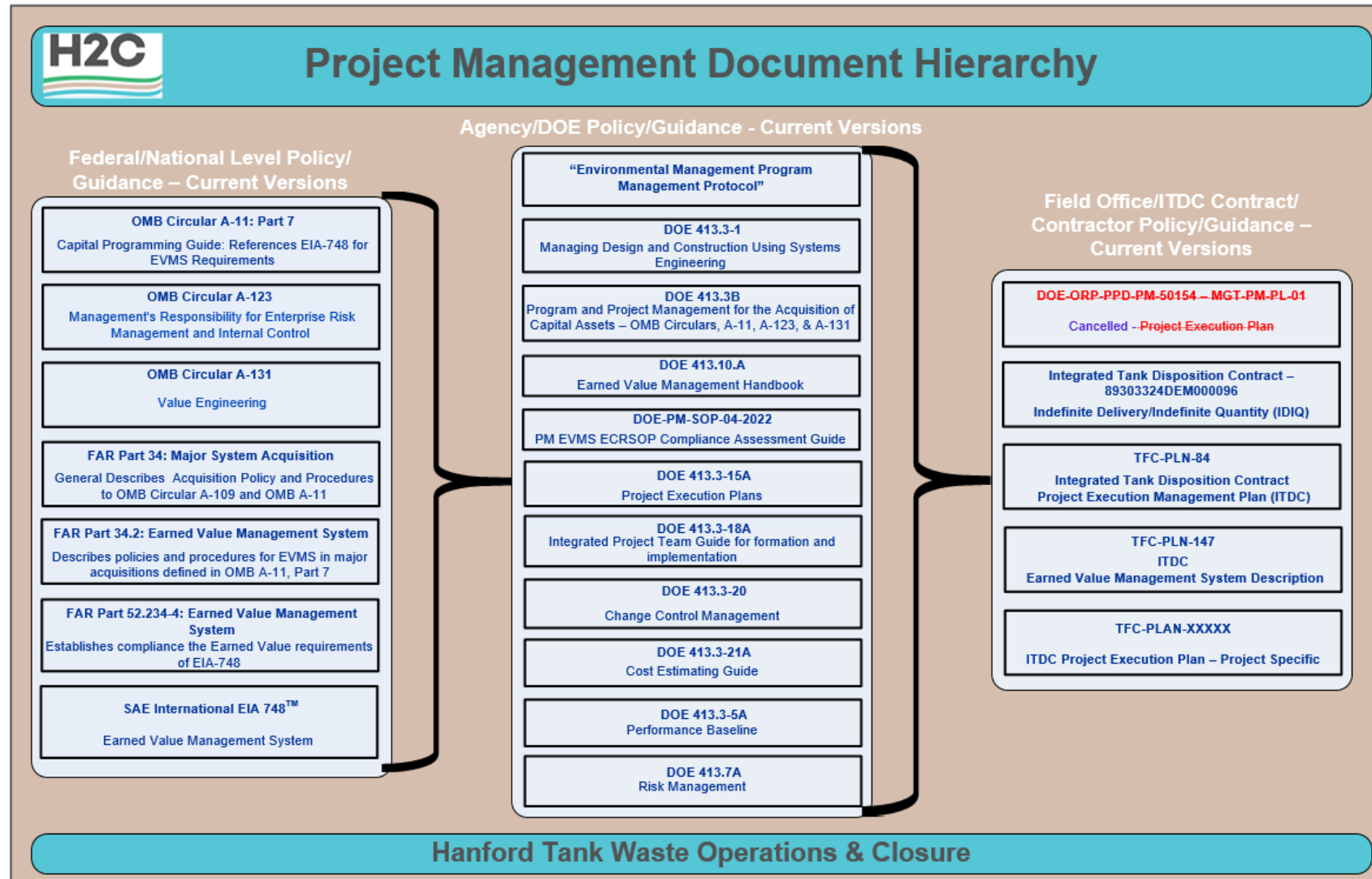
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Foreword

This Department of Energy (DOE) Guide is for use by all DOE elements. This Guide assists individuals and teams in conducting Analysis of Alternatives (AoA) for capital asset projects and programs consistent with published Government Accountability Office (GAO) best practices (see GAO report GAO-16-22, Amphibious Combat Vehicle, Some Acquisition Activities Demonstrate Best Practices; Attainment of Amphibious Capability to be Determined, Appendix 1, dated October 2015). The suggested DOE tailored process uses a systems engineering methodology that integrates requirements analysis based on mission need, identification and analysis of alternatives, risk identification and analysis, and concept exploration in order to evolve a cost effective, preferred alternative to meet a mission need.

DOE Guides are part of the DOE Directives Program and are issued to provide supplemental information and additional guidance regarding the Department's expectations of its requirements as contained in rules, Orders, Notices, and regulatory standards. Guides may also provide acceptable methods for implementing these requirements, but are not prescriptive by nature. Guides are neither substitutes for requirements, nor do they replace technical standards that are used to describe established practices and procedures for implementing requirements. Send citations of errors, omissions, ambiguities, and contradictions found in this guide to PMpolicy@hq.doe.gov.

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Introduction

Purpose

An Analysis of Alternatives (AoA) is an important element of the Department of Energy's (DOE) requirements and acquisition process. The overall goal is to improve project management by ensuring the identification and analysis of feasible solutions to mission needs, or capability gaps, prior to making costly investment decisions. As such, DOE O 413.3B requires that an independent AoA be conducted prior to Critical Decision (CD)-1 and recommends that it be consistent with best practices identified by the GAO, which is outlined in their latest report GAO-16-22.3 This guide describes how GAO's recommended AoA best practices are implemented into DOE O 413.3B. It should be noted that GAO recognizes that "these practices can provide a framework to help ensure that entities consistently and reliably select the best alternative that best meets mission needs." The guidance below is meant as an overview of the key principles that lead to a successful AoA process and not as a "how to" guide with detailed instructions for each best practice identified.

The AoA is an analytical comparison of the operational effectiveness, suitability, risk, and life cycle cost (or total ownership cost, if applicable) of alternatives that satisfy validated capability needs. AoAs are not decisional documents, but are inputs that may be used by Program Secretarial Offices to recommend a preferred alternative. AoAs also help Federal Project Directors (FPDs) and Project Management Executives (PMEs) determine the most effective approach for achieving the technical and functional requirements associated with a specific mission need within the constraints provided. The AoA process is a critical step in the project planning and approval process and is not a substitute for an Acquisition Plan as required by the Federal Acquisition Regulation once an alternative has been selected.

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AoAs are conducted as part of the DOE systems engineering methodology that integrates requirement analysis, alternative analysis, risk identification and analysis (including application-specific technical maturity, safety, security, health, and environmental considerations), acquisition strategies, and concept exploration in order to determine a preferred solution to meet a mission need.

DOE O 413.3B requires that the responsible program office shall 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 conducted for projects with an estimated Total Project Cost (TPC) greater than \$50M prior to approval of CD-1, Approve Alternative Selection and Cost Range, and may also be conducted when a performance baseline deviation occurs or if new technologies or solutions become available. This determination will be made by the PME. The AoA should be consistent with published GAO best practices, as delineated in GAO-16-22.

There are many similarities between AoAs and the Feasibility Studies or other reviews that are conducted as appropriate, in accordance with **Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)**, **Resource Conservation and Recovery Act (RCRA)**, and **National Environmental Policy Act (NEPA)** before a decision is made (e.g., selection of a remedial action). The AoA best practices outlined in this guide are relevant and should be incorporated into the CERCLA, RCRA, and NEPA processes as applicable. AoAs performed in order to meet the requirements of CERCLA and RCRA will be accepted as satisfying the requirements for an independent AoA.

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DOE programs may use this guide directly or to assist in the development of their own AoA Process Guides, Manuals, or Handbooks tailored to their particular technologies and processes. A program-specific AoA Guide, Manual, or Handbook should take precedence over this Guide when conducting a review of an AoA for projects under that specific program. While Programs developing their own guides, manuals and handbooks is a reasonable practice, the ultimate authority for the conduct of an AoA should be the PME or the Program Secretarial Officer (PSO) approved in the Preliminary Project Execution Plan (PPEP).

Applicability

This guide is for use by all DOE elements. This guide should assist individuals and teams involved in conducting AoAs. **For DOE capital asset projects subject to DOE O 413.3B, this guide is especially useful to DOE program and project managers.**

AoA and the DOE Acquisition Management Process

An AoA is part of the DOE Acquisition Management Process for capital asset projects. See figure below for an illustration of how the AoA plays an important role in the DOE critical decision process, specifically for implementing the requirement for the responsible program office to conduct an AoA that is independent of the contractor organization responsible for managing the construction or constructing the capital asset project prior to CD-1; and as applicable, when a performance baseline deviation occurs, or when new technologies or solutions become available as determined by the PME.

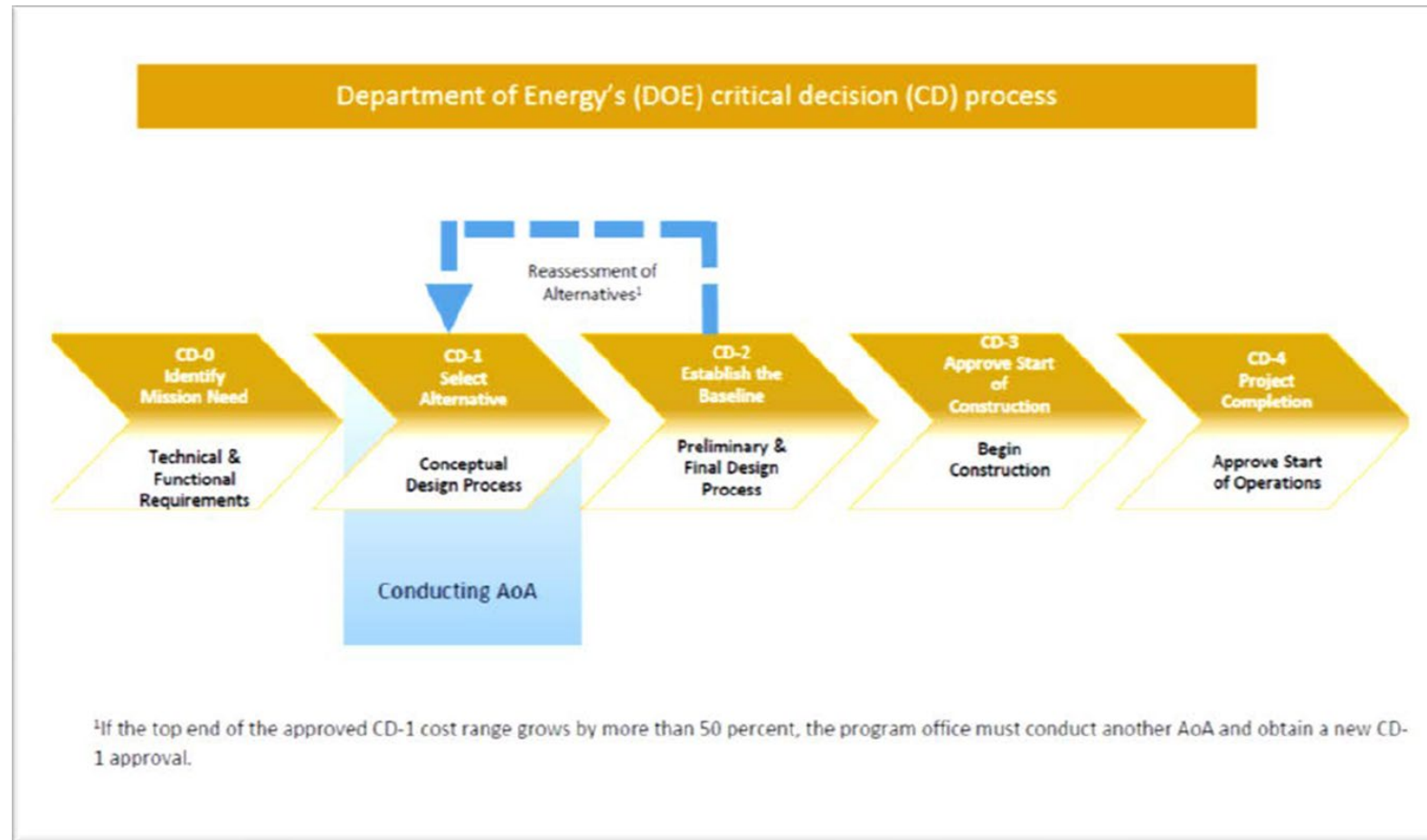
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This guide advocates a uniform and documented process consistent with the 22 criteria of best practices identified in the GAO-16-22 report. Emphasis is made on frequent and open communication in the AoA process both to understand what the senior decision makers need and to convey what the analysis uncovers. This guide advocates a sound analytical process rather than specific tools. Detailed analytical tools are often necessary for key parts of the AoA, but it is often more practical to adhere to simpler approaches such as parametric analysis and requirements gathering. The complexity of the AoA depends on the project cost, risks, geographical location, and technological complexity (nuclear vs. non-nuclear, or hazardous vs. non-hazardous). The key is to lay down early the key requirements and assumptions for selection of the best alternative and following a process that avoids the pitfalls of biased analysis.

The recommended DOE AoA process, which is based on and adapted from the GAO best practices, is discussed in detail in Section 2.0 of this guide. However, it should be emphasized that the AoA process does not stand alone **but is an important step of the overall DOE Systems Engineering Process that integrates requirement analysis based on problem definition/mission need (which also should be verified and validated), function and requirements analysis, alternative analysis, risk identification and analysis** (including application-specific technical maturity, safety, security, health and environmental considerations), **acquisition strategies, and concept exploration in order to evolve a cost effective, preferred solution to meet a mission need.**

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Conducting AoA as Part of the DOE's Acquisition Management Process for Capital Asset Projects



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Systems Engineering

The DOE Systems Engineering Process is a comprehensive, iterative problem solving process that is used to:

- Transform validated customer needs and requirements into a life-cycle balanced solution set of system product and process designs;
- generate information for decision-makers; and
- provide information for the next acquisition phase.

The problem (the gap in the mission need) and success criteria are defined through requirement analysis, functional analysis/allocation, and system analysis and control.

Alternative solutions, evaluation of those alternatives, selection of the best life-cycle balanced solution, and the description of the solution, through the design package are accomplished through synthesis and system analysis and control.

This guide emphasizes the AoA process, within the framework of DOE O 413.3B, as adapted from the GAO-16-22 best practices to support CD-1 as shown in the figure above.

DOE programs should conduct early systems engineering analysis when selecting alternatives prior to CD-1 to provide an assessment of whether the proposed candidate materiel solution approaches are technically feasible and have the potential to effectively address capability gaps, desired operational attributes, and associated external dependencies.

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OVERVIEW OF THE DOE AOA PROCESS

This section presents a sequential process consistent with the GAO-16-22 best practices for identifying alternatives, analyzing alternative and selecting the preferred alternative. The GAO best practices add consistency and reliability to the overall process.

GAO Characteristics of High-Quality AoA

The GAO has identified four characteristics that help identify high-quality, reliable AoA. The AoA should be **well-documented**, **comprehensive**, **unbiased**, and **credible**.

By **well-documented** it is meant that the AoA process is thoroughly described in the relevant documents (e.g., the AoA Study Plan and Final AoA Report), which collectively should include as applicable: the data sources used, reliability of the data, stated assumptions, clearly detailed methodologies, sufficiently detailed calculations and results, as well as explanations for evaluation criteria.

An AoA is **comprehensive** if the AoA process is predicated on a mission need statement that is well defined (i.e., CD-0 requirements in DOE 413.3B), but independent of any particular solution such that a robust set of alternatives can be considered, with no viable alternatives omitted and that each alternative is examined thoroughly for the project's entire expected life-cycle.

An **unbiased** AoA process ensures that the AoA is not conducted with a predisposition toward one alternative over others; it is performed independent of the contractor responsible for executing the project, and based on traceable and verified information.

As for **credibility**, this requires that the AoA process thoroughly discusses the limitations of the analysis resulting from the uncertainty that surrounds both the data and the assumptions for each alternative. This is often supported through uncertainty analyses on assumptions, criteria weighting, etc., that are included as part of the AoA documentation.

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Adaptation of the GAO-16-22 Best Practices for DOE AoAs

The GAO-16-22 best practices can be applied to a broad range of capability areas, projects, and programs in which an alternative should be selected from a set of possible options. These best practices can provide a framework to help entities select the project alternatives that best meet mission needs. However, the structure, terminology, and use of those best practices will be dependent on the project management framework in which they are applied. For the acquisition of capital assets in the DOE, this is provided in DOE O 413.3B and its related guides. The following describes how the 22 AoA best practices defined by GAO are implemented by the Department.

The best practices, as adapted by DOE, are grouped into six sequential phases, the first of which occurs prior to initiation of the formal AoA process (refer to Appendix C for comparison to the overall five-phase process as described by GAO):

- 1. Pre-AoA process – CD-0, Approve Mission Need:** includes best practices that are applied before starting the AoA process of identifying, analyzing, and selecting alternatives. This includes determining the mission need and functional requirements, which are part of the DOE O 413.3B CD-0 requirements for capital asset projects. **For DOE capital asset projects, AoA should not begin until after CD-0 approval.**
- 2. Initialize the Formal AoA process:** includes best practices that develop the study time frame, create a study plan, and determine who conducts the analysis. Deliverables in this phase should be an **AoA Charter**, which may include a **Study Guidance Document**, initializing the planning process, **selection of the AoA team** who will conduct the AoA, and the **AoA Study Plan with resources and schedule.**

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3. **Identify alternatives:** includes best practices that help ensure the alternatives to be analyzed are sufficient, diverse, and viable.
4. **Analyze alternatives:** includes best practices that compare the alternatives to be analyzed. The best practices in this category help ensure that the team conducting the analysis use standard quantitative and, when appropriate, qualitative processes to assess the alternatives.
5. **Document and review the AoA process:** includes best practices that would be applied throughout the AoA process, such as documenting all steps taken to initialize, identify, and analyze alternatives and to select a preferred alternative in a single document. This phase includes an independent review of the AoA process by a team or organization independent of the proponent program office and the project's chain of command to validate the analytical quality and process of the AoA. This process verifies that the AoA adequately reflects the program's mission needs and provides a reasonable assessment of the cost and benefits associated with the alternatives. The main deliverable in this phase should be the AoA Final Report validated by the independent review team.
6. **Select a preferred alternative:** includes a best practice that is applied by the decision maker to compare alternatives and to select a preferred alternative. The decision maker (the Project Management Executive) reviews the alternatives presented in the validated AoA Final Report and chooses the preferred alternative.

Being consistent with the 22 best practices for an AoA listed in GAO-16-22 helps entities select the project alternatives that best meet mission needs. The following Table 1 lists the 22 best practices within each of the six sequential phases, as defined for DOE applications:

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GAO Best Practices for the AoA Process

Best Practices for the AoA Process	
Phase I. Pre-AoA - CD-0 Mission Need	
1. Define mission need	
2. Define functional requirements	
Phase II. Initialize the Formal AoA Process	
3. Develop AoA timeframe	
4. Establish AoA team (the AoA team should be independent of the contractor organization responsible for managing the construction or constructing the capital asset project)	
5. Define selection criteria	
6. Weight selection criteria	
7. Develop AoA process plan	
Phase III. Identify alternatives	
8. Develop list of alternatives	
9. Describe alternatives	
10. Include baseline alternative	
11. Assess alternatives' viability (initial screening of alternatives)	
Phase IV. Analyze alternatives	
12. Identify significant risks and mitigation strategies	
13. Determine and quantify benefits/effectiveness	
14. Tie/benefits/effectiveness to mission need	
15. Develop life-cycle cost estimates (LCCs)	
16. Include a confidence interval or range for LCCs	
17. Perform sensitivity analysis	
Phase V. Document and review the AoA process	
18. Document the AoA process in a manner to best convey the information (e.g., single document or multiple volumes, as appropriate).	
19. Document assumptions and constraints	
20. Ensure AoA process is impartial	
21. Perform independent review	
Phase VI. Select a preferred alternative	
22. Compare alternatives	

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Appendix C presents a brief description for each of the best practices in the AoA process. **Adherence to these definitions/descriptions in the execution of the AoA process should assist in meeting the four characteristics that identify a high-quality, reliable AoA.**

Appendix G provides a crosswalk of the AoA four characteristics and the relevant AoA best practices useful for an entity, independent of the AoA process and outside the project's chain of command, conducting an independent review of the AoA process (GAO best practice #21).

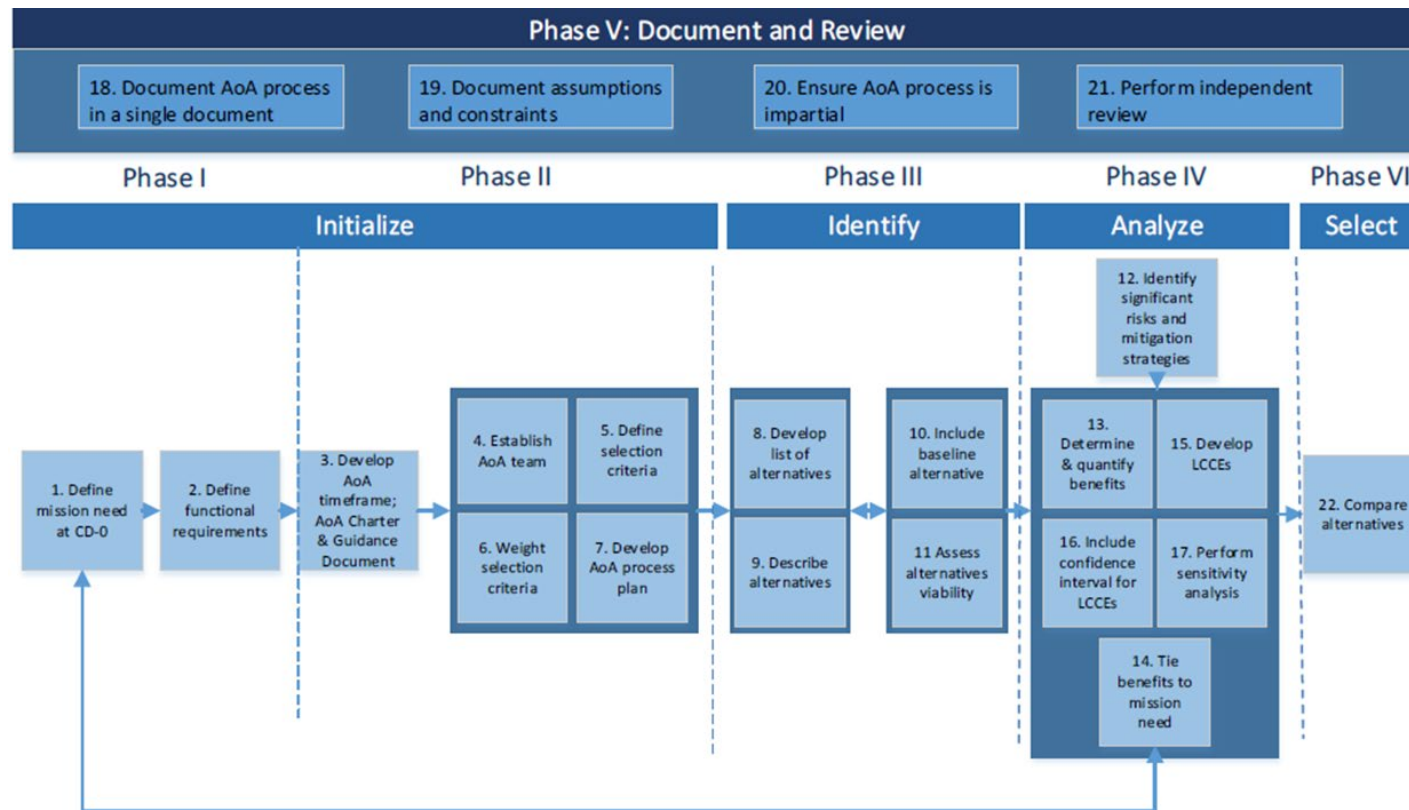
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AoA Process Flowchart

The figure below illustrates the recommended AoA process flow as it progresses systematically through the DOE six phases of development, which is an adaptation of the GAO five phases for DOE applications (DOE Phases I and II are combined under the GAO Initialize Phase, which implements the recommended 22 best practices within each phase (see Appendix C). Notice that Phase V, Document and Review, should be implemented from the start of the process through the selection of the best alternative (for quality assurance and control of the process). **In DOE, the formal AoA process starts after CD-0, Approve Mission Need, and definition of functional requirements, and ends at the selection of the best alternative by the PME at CD-1, Approve Alternative Selection and Cost Range.** Some of the best practices included in a phase can take place concurrently and do not have to follow the order presented in the table above. The phases should occur in sequence (with the exception of Phase V; documentation and review should be executed across the AoA process as a quality assurance best practice) to prevent bias from entering the analysis and adding risk that the AoA team will analyze alternatives that have not been defined. For example, best practice #5 (define selection criteria) can be done at the same time as best practice # 6 (weight selection criteria). On the other hand, best practice #20 (ensure AoA process is impartial) can be done at the end of every step or every phase to ensure the impartiality of the AoA as it progresses. The best practices represent an overall process that results in an AoA that can be easily and clearly traced, replicated, and updated.

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AoA Process Flowchart



AoA Analysis of Alternatives
LCCE Life-Cycle Cost Estimate
Numbers are the GAO Best Practices

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AoA Process DOE Key Entities

There should be four key entities that are involved in the AoA process: the customer [the Project Owner], the decision maker [the Project Management Executive (PME)], the AoA team conducting the AoA analysis, and the Independent Review team reviewing the study plan and reviewing/assessing the AoA final report.

The Project Owner normally refers to the program secretarial office, service, or agency that identifies a mission need (e.g., a credible gap between current capabilities and those required to meet the goals articulated in the strategic plan) and coordinates the budget. The decision maker (PME) is the person or entity that signs off on the final decision and analysis documented by the AoA report.

The AoA team is the group of subject matter experts who are involved in the day-to-day work of the AoA process and work to develop the analysis that is the foundation of the AoA process. The AoA team must be independent of the contractor organization responsible for managing the construction or executing the capital asset project, but as appropriate may receive support from the contractor organization in providing subject matter expertise in operational and/or site information.

The Independent Review team (GAO best practice #21) determines the extent to which the best practices were followed. The review team consists of individuals or entity independent of the AoA process and outside of the project's chain of command selected by the PME.

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Example of DOE Key Entities Roles in the AoA Process and Deliverables

DOE Stage	AoA Initiation	AoA Kick off	AoA Planning	AoA Analysis	AoA Preliminary Results Review	AoA Finalization	AoA Documentation and Review	Alternative Selection
Description	After CD-0, the <u>PME</u> tasks the <u>Project Owner</u> to conduct the AoA. The <u>PME</u> chooses an <u>AoA Team</u> and selects a Federal AoA Lead as the team lead.	The <u>Project Owner</u> conducts a kick-off meeting with the AoA Team relevant stakeholders, and other SME's as required.	The <u>AoA Team</u> describes the structure and methodology of the AoA, to include selection criteria and weighting, in a Study Plan.	The <u>AoA Team</u> conducts the AoA analysis based on the project functional and technical requirements, initial screening and evaluating alternatives, conducting a cost analysis, risk and opportunity identification, and a sensitivity analysis, and documenting the results.	The Project Owner and AoA Team present initial results to the <u>PME</u> who may provide additional guidance as necessary. An <u>Independent Review Team</u> may also conduct a review of the <u>AoA Team's</u> initial results, providing additional guidance as necessary.	The <u>AoA Team</u> compiles the results of the AoA analysis into one document with all supporting information and previous deliverables. The <u>Independent Review Team</u> reviews the Final Report and prepares the Sufficiency Memo.	The <u>Project Owner</u> reviews the validated Final Report and Sufficiency Memo and forward to the Program <u>PME</u> .	The <u>PME</u> selects an alternative based on the results of the AoA
Deliverable	AoA Charter and Study Guidance Document		AoA Study Plan			AoA Study Final Report	Sufficiency Memo	Alternative Selection Document; CD-1 Authorization

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OVERVIEW OF THE AOA KEY DOCUMENTATION DELIVERABLES

The table above lists the key deliverables at each stage of the of the DOE AoA process.

Key documentation deliverables at the initiation/planning stage are:

- **Study Guidance.** Usually called the Charter Memo or the Tasking Memo. The attachment to the Charter Memo is the Study Guidance which describe the mission need and gaps approved at CD-0, the purpose and scope of the analysis; the management expectations from the analysis; assumptions, constraints and limitations; resources available to the AoA team and the target schedule; expected deliverables, and the AoA membership composition. A Federal lead for the AoA team should also be selected. GAO best practices criteria # 1-6.
- **Study Plan.** The Study Plan establishes the roadmap for how the AoA analysis should proceed; details who is responsible for what; structure and methodology to be followed; assumptions, constraints and limitations; including an initial list of alternatives to be evaluated along with screening criteria as well as selection and evaluation criteria with respective weighting for viable alternatives; and resources required. GAO best practice criteria # 7

The next key deliverable is at the AoA finalization stage:

- **Study Final Report.** The Study Final Report should be a standalone document (or documents, depending on the complexity of the project and the AoA) that integrates the results of the analysis, justifications, supporting documentation, and all previous project deliverables including the AoA Study Plan. GAO best practice criteria # 18.

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Another suggested document deliverable presented in the table above is the Sufficiency Memo which is essentially a transmittal from the Independent Review Team to the PME of the Study Final Report with their endorsement and certification that it has been deemed sufficient by the Independent Review team.

Study Guidance Document

Responsible Party: Project Management Executive

A Charter Memo or Study Guidance is drafted for the PME to authorize the conduct of an AoA and clarifies the expectations of the AoA process (see Appendix D: “Suggested Template for the AoA Charter Memo and Study Guidance Document”). As a minimum, this memorandum and the Study Guidance attachment should describe the mission need and gaps approved at CD0, the purpose and scope of the analysis; the management expectations from the analysis; assumptions, constraints and limitations; resources available to the AoA team and the target schedule; expected deliverables; and the AoA membership composition. A Federal lead for the AoA team should also be selected.

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Additional information that may be included in the guidance for the study.

Guidance for the AoA Study that may be included in the Charter or as an attachment document:

- The guidance should set time limits on the analysis timeline. If the AoA analysis is expected to take longer than a specified time, the scope of work should be reconsidered to ensure the analysis planned is truly necessary to inform the key milestone decision maker (CD-1).
- The guidance should establish an early milestone/date for the AoA team to present their detailed methodology and data approaches, tools, scenarios, metrics, and data in-depth to the Program Office, other stakeholders, and the independent review team of the AoA process.
- The guidance should instruct the AoA team to spell out the selection and evaluation criteria to be used in the study plan. Although not required, weighting factors applied to these metrics should be defined and the rationale for applying each weighting factor explained. Metrics should include comparisons between the (weighted) metrics to facilitate cost, performance and schedule tradeoff discussions.
- The guidance should instruct the AoA team that in addition to the project risks, full treatment to non-operational risks, with particular focus on integration risks, should be provided.
- Guidance regarding the use of critical new technologies and their maturity level to be considered during risk identification and mitigation in the AoA analysis.
- Guidance regarding affordability and projected budget available for the project.

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Study Plan Document

Responsible Party: The AoA Team

The Study Plan Document is prepared by the AoA Team and is reviewed and endorsed by the Project Owner. Approval should be granted by the PME prior to proceeding with the study. For large complex projects or programs the Study Plan may have another volume called the Analysis Plan for a more in depth discussion of the analytical approach, down-selection strategy for the alternatives and the cost estimating methodology. See Appendix E for a generic suggested template for the Study Plan Document.

Study Plan. The study plan is a key project deliverable that describes how the AoA will be conducted. It includes the ground rules and assumptions for the planned AoA process; describes the composition, roles, and responsibilities of the AoA team, working groups, and stakeholders; and describes the oversight and review process for the AoA. The Study Plan should include an initial list of preliminary alternatives to be evaluated along with proposed screening and evaluation criteria. The study plan should also identify the data (programmatic, technical, test and cost) and other resources the AoA team will need to complete the study and/or describe the governance and program/project management processes through which data will be requested and provided. Other important considerations that should be covered in the Study Plan, if applicable, are a description of how to incorporate applicable requirements of the National Environmental Protection Act (NEPA) in accordance with the DOE regulations and guidance; other health, security, and nuclear safety considerations; and, sufficiently detailed description of the methodology the AoA team intends to use for each phase of the analysis.

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Since an AoA typically embarks in a path of discovery, it may be expected for the team to identify additional alternatives as the plan is implemented and as the team becomes more knowledgeable on the problem at hand. It may be possible, that through this learning process, not only the number of alternatives may increase, but also the data and resource requirements. At this point, the team should revisit the schedule and resources required to complete the analysis and negotiate these new requirements with the decision makers and the stakeholders. Similarly, during the actual evaluation of alternatives, weaknesses and/or missing elements may be identified related to the criteria and related measure and weights. The AoA process should be flexible to incorporate these types of modifications to the extent that they are justified and well documented. The Study Plan serves as the skeleton for the final AoA report.

Note: The purpose of the Study Plan is not to provide a discussion on how to perform an analysis of alternatives, or recommend specific tools and models for constructing decision support methodologies. The selection of such tools and methodology is dependent on the program/project being evaluated.

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Some Considerations in Planning the AoA

- The independence of the AoA team is vital to the defensibility of the AoA results.
- The AoA results inform the decision-making process but may not identify one definitive solution.
- Who should conduct the AoA (i.e., the study team lead and composition of the study team)?
- How will the study team be organized (i.e., use of the core team members versus engaging outside Subject Matter Experts for input and advice)?
- Roles and responsibilities of the team members

Maintain continuity of the core team membership from organization and initiation of the AoA (and beyond). Having enduring team membership will help provide continuity, greatly facilitate AoA planning, and ensure the stakeholder communities are properly represented.

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Capture other information about the solution space (alternatives) in addition to that found in the mission need document. Some examples of other information to help define the solution space include:

- Overarching assumptions (these are the assumptions that are specific to the problem and apply to all potential solutions)
- Overarching operational concept/deployment concept
- Overarching operational considerations (this is problem specific and applies to all potential solutions equally)
- Overall implications that apply regardless of solution

The structure of the AoA study team depends upon the scope of the AoA and the level of effort required. Depending on the scope of the AoA, the team is usually organized along functional lines to conduct the effectiveness, risk, and cost analyses.

Recognize that risk identification is the responsibility of every member of the AoA team, and should occur throughout the conduct of the study.

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Some Considerations in Scoping the AoA

An iterative development process with explicit reconsideration of study scope at critical junctures should be adopted.
The study phases and key considerations or constraints are listed below:

- **AoA context:** program deadlines, contractual arrangements for the various participants, and government oversight expectations.
- **Analytic starting point:** AoA governance, especially the AoA study team in relation to other program activities; key reference and background documents, anticipated scope, and scale of the alternatives.
- **Analytic study plan and execution:** identification of alternatives; degree and depth of analysis; specification of analytic methodology, especially determination.

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The following are typically used to establish the scope of the AoA:

- Capability gaps and any identified prioritization.
- Mission areas and tasks.
- Operational concepts and environment.
- Project/Program risks
- Measures and standards.
- Approaches and alternative concepts, including the baseline
- Maturity of the new technologies
- Operational risk.
- Timeframes.
- Ground rules, constraints, and assumptions.
- Science and Technology (S&T) activities.
- Resource availability
- CERCLA, RCRA and NEPA requirements

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Study Final Report Document

Note: This is the final key deliverable for the AoA process. Before the preparation of this document, the conduct of the AoA analysis should be made (GAO best practices Phases II and III, Identify Alternatives; and Analyze Alternatives) as described in Section 4.0. Upon its conclusion the results feed into the preparation of the AoA Study Final Report (GAO best practices Criteria # 18). However, since Section 3.0 describes the key documentation deliverables for the AoA process, the AoA Study Final Report is discussed herein.

Responsible Party for the Study Final Report: The AoA Team.

The AoA Team should document and present the results of the AoA to the Independent Review Team for review and validation (GAO best practices Criterion # 18). **The Independent Review Team consists of members or an entity independent of the AoA process and outside of the project chain of command selected by the DOE Program or the PME.** The Project Owner reviews the final report, endorses it, and submits the final report to the PME for selection of the best alternative (Note: the various DOE Programs may have different procedures for the review, validation and approval chain). The AoA Study Final Report should be a standalone document that integrates the results of the analysis, justifications, supporting documentation, and all previous project deliverables including the AoA Study Plan. A recommended template for this final report is provided in Appendix E.

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The Final Report should include the following:

- Names of all AoA Team members with corresponding affiliations and roles;
- Description of the mission need, program requirements, gap analysis, and assumptions and constraints that are driving the AoA, as set out by the Charter Memo and the Study Guidance Document, as applicable (see Section 3.1);
- Descriptions of all alternatives considered;
- The justifications driving the initial screening (down-select) process and the results;
- All evaluation criteria and relation to the program requirements;
- Complete life-cycle assessment costs of each alternative (after the initial down-select) including calculations and rationale;
- Summary of risks for each alternative;
- Sensitivity analysis;
- The final results of the evaluation, and;
- All previous final deliverables (e.g., Study Plan).

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SUGGESTED DOE AOA ANALYSIS STEPS

The subsequent sections of this guide will focus on the formal suggested best practices process of identification and analysis of alternatives prior to compiling the final results for the PME to make the final determination for the best value alternative. See Appendix I, Suggested DOE AoA Analysis Steps, for the recommended sequence of activities to follow after approval of the Mission Need at CD-0. This recommended sequence of steps is compatible with the GAO AoA Process Flowchart above.

Develop Screening and Evaluation Criteria

The AoA team reviews the mission need and functional requirements to define the screening criteria, which should be used to pre-screen the alternatives (see Appendix I for the sequence of activities – GAO best practices # 5-7). The screening criteria are based on the mission need and program requirements independent of a particular asset or technological solution.

The AoA team develops evaluation criteria based on the unique characteristics and program requirements of the assessed project and assigns weights to each criterion based on its relative importance to the mission need. At a minimum, these criteria should account for performance, risks (to include application-specific technical maturity, security, environment, safety and health considerations early in the alternatives evaluation process), costs, and schedule while directly reflecting mission need and program requirements. **The selection and evaluation criteria should be documented in the AoA Study Plan.**

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This guide advocates a sound practical analytical process not specific tools. Detailed analytical tools are often necessary for key parts in the AoA, but it is often more practical to adhere to simpler approaches such as parametric analysis and requirements gathering. The key is early identification of the key requirements and assumptions for selection of the best alternatives and following a process that avoids the pitfalls of biased analysis.

Develop Preliminary Alternatives and Screen Preliminary Alternatives

The AoA team develops a diverse range of plausible and preliminary alternatives that could potentially meet the mission need. **One alternative should represent the status quo (no alterations to current efforts) in order to provide a basis of comparisons for the other alternatives (GAO best practices # 8-11).** All alternatives and their descriptions should be documented.

The AoA team screens the list of preliminary alternatives against the set of screening criteria developed under Section 4.1. Alternatives are screened against the selection criteria, which should be based on mission need and requirements. The status quo should not be screened out in order to continue to provide a basis for comparison. The justification for the results of the screening process should also be documented. The primary purpose of the initial screening process is to contribute to identifying which alternatives should be carried forward for further analysis.

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Some Key Considerations in Identifying Alternatives

- The status quo (baseline) should always be included as one of the alternatives to be evaluated and a description of the baseline system should be included.
- Viability of alternatives -identify objective criteria for inclusion of alternatives.
- Feasibility of comparison:
 - Develop consistent concepts for system alternatives.
 - Identify prospective measures for prospective alternatives.
- Reasonable study scope:
 - Establish or define system scope.
 - Define the “scale” of alternatives – Alternatives should be defined with the same level of specificity. The development stage of the alternative will impact the level of specificity i.e., a conceptual system will have fewer detailed characteristics than one that is in service elsewhere. A short deployment timeline may require more specific alternative definition, thus a conceptual system may not have the specific data necessary to put it on equal analytic footing. As a result, this definition of scale often leads to a decision about whether to characterize alternatives as specific, vendor-available systems or models or as more general classes. When considering classes, the study team should still describe how the representative systems are defined (i.e., performance specifications and costs). To properly portray the wider class of systems the team may have to relax specificity. In some cases a summary level Technology Readiness Assessment may be required to provide a basis for relative technical maturity of the alternatives.

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- Beware of subdivision into subsystems – minimize the possible combination of subsystems.
- Process for eliminating alternatives: -Identify Predetermined qualitative technical and operational factors to determine viability of alternatives
 - All alternatives are examined against the predetermined factors
 - Alternatives found viable are examined fully in the AoA process
 - All assumptions and factors regarding nonviable status of alternatives are fully documented

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Evaluate and Rank Alternatives

The AoA team quantitatively, to the extent practicable, analyses and ranks the screened alternatives using the set of evaluation criteria developed under Section 4.1 and documented in the AoA Study Plan (GAO best practices #12-16). This analysis should be informed by a summary of quantified benefits, life-cycle cost estimates generated for each alternative, and a list of associated risks with mitigation strategies for each alternative. The team should use methods and techniques from industry standards and best practices as well as any applicable DOE policies, procedures and processes.

- If applicable, the AoA team determines each alternative's benefits using a standardized process and documenting the rationale behind the assessment. **Benefits should be quantifiable and determined over the alternative's full life cycle.** Benefits should relate and support the mission need.
- The life-cycle cost estimates for each alternative should include all costs from inception of the project through design, development, deployment, operation, maintenance, and disposition. Life-cycle cost estimates should be shown in present value terms over the entire life-cycle. Cost estimates should be expressed as a range or with confidence interval, not solely as a point estimate (consistent with requirements under DOE O 413.3B; cost estimates to support AoA at CD-1 should be expressed as a range). The AoA team should document the basis, assumptions, and calculation used.
- The AoA team identifies a list of significant risks (programmatic, technical, and operational) and mitigation strategies for each alternative.

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Conduct Sensitivity Analysis

The AoA team conducts a sensitivity analysis that tests the sensitivity of the cost and benefit estimates and the evaluation criteria to changes in the key assumptions.

Alternatives whose effectiveness is stable over a range of conditions provide greater utility and less risk than those lacking such stability. Alternatives are typically defined with certain assumptions made about their performance parameters. These alternatives may then be assessed against defined scenarios under a set of defined assumptions. This analysis results in specific cost and performance estimates, but does not assess the stability of an alternative's performance to changes in system parameters, scenarios, employment, and other assumptions. **A sensitivity analysis is not just important for stability but is critical to ensuring that the AoA process was not unduly biased (example: by weighting certain evaluation criteria too heavily).**

Stability can be investigated through sensitivity analyses in which the most likely critical parameters are varied; for instance: reduced waste disposal rate or increased waste storage, greater or less accuracy, or when overarching assumptions are changed. This form of parametric analysis can often reveal strengths and weaknesses in alternative performance that are valuable in making decisions to keep or eliminate alternatives from further consideration.

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Compile Preliminary Final Results and Submit the Validated Final AoA Report

The AoA team documents all steps taken to identify, analyze, and select alternatives in a single preliminary final report (GAO best practices #18-21). The Independent Review Team reviews the initial results and provides additional guidance as necessary to assure the AoA is well documented, comprehensive, unbiased and credible following the GAO 22 criteria of best practices.

Also, the early initial involvement by the Independent Review Team to weigh in on the process is important to reduce time and energy if the AoA team has to re-do something. The AoA team presents the results of the analysis with accompanying justifications, calculations and supporting documentations in the AoA final report for validation by the Independent Review Team.

The Independent Review Team reviews the Final Report, reconciles final adjustments to the report with the AoA Team, and presents its findings through a Sufficiency Memo to the PME. The Project Owner reviews the AoA Final Report and prepares a transmittal Memo concurring with the completeness, quality, and technical soundness of the AoA process.

The Sufficiency Memo is presented to the PME in conjunction with the AoA Final Report to select a preferred alternative as part of the CD-1 approval package (GAO best practices # 21 and #22).

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Summary Key Considerations for Selecting the Preferred Alternative

The final presentation of AoA results should provide decision makers with a detailed view of the alternatives considered. This enables decision makers to identify and potentially eliminate alternatives that do not meet one or more of the basic performance requirements.

After making this initial cut (if any), decision makers should conduct a more nuanced down-selection process that involves balancing not only the remaining alternatives' costs and operational effectiveness results, but also their risks, schedule, flexibility, and any other factors of concern to the decision maker.

This may (and often does) require the decision maker to consider other sources of information in addition to the AoA results. In this way, the AoA significantly informs the government's final selection, but does not by itself necessarily result in the preferred solution being chosen.

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AOA REVIEWS

According to the GAO-16-22 best practices it is important that the AoA process and its results (see key documentation deliverables in Section 3.0 of this guide) are validated by an organization independent of the AoA team and the program office to ensure that a high-quality AoA is developed, presented, and defended to management.

This independent review of the AoA process and deliverables verifies that the AoA adequately reflects the program's mission needs and provides a reasonable assessment of the costs and benefits associated with the alternatives.

This guide provides a generic example of the key entities in the AoA process, to include the role of the Independent Review team. DOE Programs may define the role of the key entities, or other intermediate organizations and additional entities, in the AoA process by a tasking memo or any other formal means.

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In-Process Reviews

At the discretion of the DOE Program Office or the PME, usually based on the size and complexity of the project, other reviews besides the AoA Preliminary and Final Report independent reviews may be conducted such as at the following points:

- **Development of the AoA Study Plan** – evaluation of the scope, structure and methodology proposed for the study.
- **Development of the criteria and their weighting** – evaluation of proposed methodology.
- **Preliminary Results (prior to independent review)** – evaluation of the execution of the study, preliminary results, completeness, credibility, and alignment with the characteristics of a well-executed AoA.

The reviews may use the review checklists suggested at the Appendices to this guide to assist in evaluating AoA.

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AOA REVIEW TEMPLATE TOOLS

The following suggested template tools were developed to assist in the review process which can be found in the Appendices Sections to this guide:

Appendix C – GAO Best Practices Used to Inform the DOE AoA Process.

Appendix D – Suggested Template for the AoA Charter Memo and Study Guidance Document.

Appendix E – Suggested Template for the AoA Study Plan and Final Report.

Appendix F – Suggested DOE AoA Analysis Steps.

Appendix G – Crosswalk of GAO Characteristics of High-Quality AoA and the Relevant AoA Best Practices.

Questions and Comments

