EFCOG Best Practice #247

Facility: Complex Wide

Best Practice Title: Experience in Executing the Code of Record

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Brief Description of Best Practice: The Code of Record (COR) was first introduced in 2009 by DOE with a revision to DOE O 413.3, "Program and Project Management for the Acquisition of Capital Assets." The purpose of the (COR) was to help identify the set of requirements for a Project to provide a basis for design and change control throughout the project life cycle to CD-4. This Best practice identifies 10 years of project experience captured as best practices in the use of Code of Record on a variety of DOE Projects.

Why the Best Practice was used: The Best Practice is being used to capture the attributes of successful COR implementation across the complex. Different sites have dealt with issues in the implementation and are using the Best Practice approach to share the results. In addition, the concepts of COR that are required for capital line-item projects have advantages of being applied to small projects (e.g., General Plant Projects) and minor modifications.

What are the benefits of the Best Practice: The Best Practices identified in this document will help other sites with similar situations. It also helps to reduce resources on projects by providing acceptable methods for implementation in one document and provide points-of-contact for assistance.

What problems/issues were associated with the Best Practice: A variety of issues have been addressed by the implementation of the COR. Site procedures vary in degrees of requirements and definitions. Interpretations of major modifications and applicability have been difficult to document and defend.

How the success of the Best Practice was measured: The success of the Best Practice is determined by whether it was implemented at the site and accepted by the customer. Secondary criteria evaluate the Best Practice for transportability between sites – and the reasonableness of the approach to implement the requirements.

Description of process experience using the Best Practice: The COR has been implemented by projects for nearly 10 years. Several concepts and approaches have evolved and are provided here for information and use. They represent the current knowledge of the state of implementation at DOE sites and continues to evolve based on changing requirements, evolving needs by the projects and implementation by the line upon completion of the project.

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Background on Code of Record: In 2009, as a result of a Secretarial initiative to improve project management and cost control on its major projects, DOE established a requirement for projects to develop and maintain a COR. The requirement was added to the Project Management Order and was based on a draft policy that contained more detail. The requirement is intended to allow projects to establish a change control process to help control project costs and require technical justification for substantial changes to the record.

The COR and its supporting documents are a single reference source for project design, construction, operating and decommissioning requirements. The COR organizes these documents in a manner that supports accessibility, traceability, and maintainability of facility requirements. Establishing the COR early in the design phase and maintaining it under configuration control for the entire facility lifecycle, will improve project cost performance, schedule and safety.

Subsequent to the establishment of the requirement, the Office of Environmental Management issued an interim policy memorandum directing its new nuclear facilities and major modifications to establish a COR on September 3, 2009. DOE EM sites followed the policy and developed site implementing procedures to implement the new requirement.

Regulatory Background: DOE O 420.1C states, “Together, the invoked standards, the applicable standards, and any other applicable DOE requirement documents, along with any exemptions and equivalencies, make up the ‘Code of Record’ for a given project or design, and reflect DOE’s commitment to standard-based safety management.”

DOE O 420.1C further requires, “For design and construction activities, contractors must identify the applicable industry codes and standards, including the International Building Code (IBC), and the applicable DOE requirements and technical standards. If approved by the responsible DOE Head of the Field Element, state, regional, and local building codes may be used in lieu of the IBC upon contractor submission of documentation providing a basis that demonstrates that implementation of the substituted code for the specific application will meet or exceed the level of protection that would have been provided by the IBC. Additionally, DOE O 413.3B Chg. 5, Program and Project Management for the Acquisition of Capital Assets, requires nuclear projects to establish and maintain a Code of Record (COR) early in project design for identifying applicable industry codes and standards. For leased facilities that are not nuclear hazard category 1, 2, or 3 facilities, the requirements of this paragraph apply to the extent determined by the DOE Head of Field Element.

For fire protection Codes and Standards determined to be applicable, including DOE technical standards, the building code, National Fire Protection Association (NFPA) codes and standards, and other industry codes and standards, must be identified in the fire protection and emergency response programs. The fire protection and emergency response programs may specify provisions for relief (exemptions and equivalencies) from identified, applicable fire protection codes and standards; otherwise, see Attachment 1, Section 2 for relief provisions. (a) Facilities, and major modifications thereto, must be constructed to meet applicable codes and standards that are in effect when design criteria are approved (otherwise known as the Code of Record, or COR). Other facility changes must meet the most recent applicable codes and standards to the extent determined by the Authority Having Jurisdiction (AHJ). Attachment 2 DOE O 420.1C Page II-2 12-4-2012 (b) Provisions of subsequent editions of codes or standards (promulgated after the COR is established) are mandatory only to the extent that they are explicitly stated to be applicable to existing facilities. (c) Conflicts between DOE O 420.1C; NFPA codes and standards; and the applicable building code must be resolved as follows: 1 Requirements of DOE O 420.1C take precedence over all NFPA and building code requirements and are subject to the relief requirements of DOE O 420.1C. 2 Conflicts between NFPA requirements and the applicable building code requirements are resolved by the DOE Head of Field Element, consistent with DOE-STD-1066-2016, and in consultation with designated building code and fire protection subject matter experts.

Nuclear reactors require special attention to design criteria and standards to ensure safe design and operations. The Code of Record for existing DOE nuclear reactors has been established by their designs. When a major modification is made to an existing reactor, the existing Code of Record is the starting point for the design of the major modification, and a design upgrade analysis is required in accordance with DOE-STD-1189-2016 to evaluate the application of nuclear safety design criteria and requirements. This design upgrade analysis may identify updated nuclear reactor safety design criteria and updated codes and standards to be applied to the major modification.

DOE-STD-1189-2016 also addresses Code of Record, by “The Code of Record (COR) and its supporting documents should be organized in a manner that supports accessibility, traceability, and maintainability. The COR is initiated during the conceptual design phase and is placed under configuration management to ensure it is updated to include more detailed design requirements, or changes to requirements, as they are identified during preliminary and final design. The COR is controlled during final design and construction with a process for reviewing and evaluating new and revised requirements to determine their impact on project safety, cost and schedule before a decision is taken to revise the COR. A database tool is often useful in organizing COR information and its specific applicability to project structure, system, or components (SSCs).”

DOE O 413.3B contains specific requirements for the Code of Record at various stages of a project:

1. **Prior to CD-1:** For Hazard Category 1, 2, and 3 nuclear facilities, a Code of Record shall be initiated during the conceptual design.
2. **Prior to CD-2:** For Hazard Category 1, 2, and 3 nuclear facilities, design reviews should include a focus on safety and security systems. Additionally, the Code of Record shall be placed under configuration control during preliminary design. It is controlled during final design and construction with a process for reviewing and evaluating new and revised requirements. New or modified requirements are implemented if technical evaluations determine that there is a substantial increase in the overall protection of the worker, public or environment, and that the direct and indirect costs of implementation are justified in view of this increased protection.
3. **Prior to CD-**4: For nuclear facilities, the Code of Record must be included as part of the turnover documentation from a design and construction phase contractor to the operating phase contractor; from an operating phase contractor to the decommissioning phase contractor; and when a change in contractor occurs during any single life-cycle phase and is maintained under configuration control. (Refer to DOE-STD-1189-2016).

1.0 Development of CORs for DOE Facilities

Design requirements specified in codes and standards should be controlled and implemented by Engineering. For new nuclear or high hazard facilities (Greenfield) or major modifications to existing nuclear/high hazard facilities, these requirements are numerous and are best controlled in a database format, or in a similar software-based system that allows configuration control along with rapid sorting of information and linkage of data.

The Code of Record shall be established and placed under formal change control (configuration management) no later than when the CD-0 package is approved. The Code of Record shall include all requirements that directly affect public, worker, environmental, or nuclear safety; engineering disciplines, including civil, structural, mechanical, electrical, instrumentation and control, piping and fire protection; and management systems including safety, security and quality assurance.

A source for nuclear safety requirements can be found in the DOE Handbook “Design Considerations” (DOE-HDBK-1132) as well as in Attachment 3, Design Criteria for Safety Structures, Systems, and Components, of DOE O 420.1C, Facility Safety. Additional requirements must be applied as mandated by the DOE Orders identified in the facility-specific Contract and per the building codes of the region that the facility is being constructed (example: International Building Code). For new facilities and major modifications, the National Consensus codes listed in 10 CFR 851 must be followed, unless a successor code/standard has been approved by the DOE for the specific project.

The Code of Record shall serve as a management tool and source for the set of requirements used to design, construct, operate and decommission the facility over its lifecycle. The Code of Record shall be included as part of the turnover documentation any time the contract responsibilities shift (example: from Construction to Operations, or from one Operating contractor to a different Operating Contractor).

2.0 Packaging the Code of Record into a Database

To facilitate the design and construction process and later the turnover documentation, the Code of Record should be organized in a manner that supports accessibility, traceability and maintainability. Different sites have developed different procedures, document templates, and tools to accomplish the capture and maintenance of accurate COR information. Often these methods are embedded in the site’s

design process. A Design Criteria Database (DCD) has proven to be an effective method to do this; but word documents are also acceptable.

Regardless of how the COR information is captured, the COR should address requirements that stem from a number of sources including: the contractual design requirements, functional analysis, waste feed compositions and product limits (as applicable), hazards analysis, operability and maintainability analysis, and environmental, health and safety regulations.

The specific requirements that influence the design development are mainly identified in source documents that were developed in the early design stage for the project. These source documents include, but are not limited to:

- DOE and external National codes and standards specifically listed in the facility design/construction contract;
- *Functional Specifications*;
- *Preliminary Hazard Analysis*;
- Preliminary Documented Safety Analysis;
- Operations Requirements Document(s);
- Environmental Plan(s);
- Applicable Federal and State laws and regulations;
- U.S. Department of Energy (DOE) Orders, Standards, and Guidance documents; and
- National consensus codes adopted by the project.

COR source documents should be maintained under configuration control as the design evolves, starting at Critical Decision (CD)-1 for capital line-item projects, as dictated by DOE O 413.3B. It is also advantageous to develop and maintain a similar COR database for smaller projects (e.g., GPPs, etc.)

3.0 Maintaining COR Prior to Turnover to Operations

It is important for the COR to be managed to reflect changes in the DOE Directive system and regulations. As changes are made to the DOE Directive system and regulations, the design and/or construction contractor should have a defined process for evaluating and indicating any changes that may be needed to the COR. Figure 1 provides an example decision matrix on how this decision process may function based on the impacts of the COR change to cost and/or schedule verses the technical benefit of the change. Alternatively, through the contract, this duty may fall on the owner (e.g. Department of Energy) staff to evaluate changes, determine which should be applied and through a contracting officer, direct changes to be implemented to the COR to capture the change in requirement.

Cost and Schedule Impact	Technical Benefit [(a)]	No Technical Benefit [(b)]
No additional cost No additional delay	Use latest codes and standards	Use latest codes and standards
Additional cost No schedule delay	Perform an evaluation to determine if technical benefit outweighs the cost. If yes, use the latest codes and standards. If no, use existing COR.	Use existing COR[(c)]
No additional cost Schedule delay	Perform an evaluation to determine if technical benefit outweighs schedule delay. If yes, use the	Use existing COR[(d)]

Cost and Schedule Impact	Technical Benefit [a]	No Technical Benefit [b]
	latest codes and standards. If no, use existing COR.[d]	
Additional cost Schedule delay	Perform an evaluation to determine if technical benefit outweighs the additional cost and schedule delay. If yes, use the latest codes and standards. If no, use existing COR.[c,d]	Use existing COR[c,d]

Figure 1 – Guide for Evaluation of Technical, Cost, and Schedule Criteria for Latest Codes/Standards versus Existing COR

(a) Technical benefit - the use of the latest codes and standards provides a technical benefit over the use of the existing COR.

(b) No technical benefit - the use of the latest codes and standards does not provide a technical benefit over the use of the existing COR.

(c) Cost penalty - the cost penalty should be significant enough to outweigh the use of latest codes and standards. It is also important to consider life cycle cost as the use of the existing COR may be more expensive over the life of the modification.

(d) Schedule delay penalty -schedule penalty should only be considered if it causes an unacceptable delay to the project.

4.0 Continued Maintenance of Code of Record after New Facility Startup

Once a nuclear/high hazard facility has been started up the COR should be maintained to provide a record of codes in place and used for design and construction. If the facility is modified, the contractor should have a defined process in place to provide a change-controlled record of what changed, by major component/system/area.

5.0 Application of Code of Records for Non-Nuclear, Mission Critical Facilities

Both DOE O 413.3B and DOE O 420.1C provide similar requirements for non-nuclear facilities, as are stipulated for nuclear facilities. Therefore, a non-nuclear, mission critical facility shall establish and place their Code of Record under formal change control early in the design process. A DOE non-nuclear, mission critical facility shall adhere to the same requirements for developing its COR as those specified for DOE Nuclear and Greenfield facilities listed above.

6.0 Code of Record Maintenance for Greenfield or Major Modification

Any DOE facility undergoing a Major Modification as defined by DOE-STD-1189-2016, shall: (1) have a Code of Record developed for the facility as described above including any new information associated with the new modification; and/or (2) modify the existing COR to account for the new modification.

The COR shall serve as a portion of the design input to the following:

- Design and construct the proposed modification,
- Operate, decommission, and close,
- To provide post-closure monitoring and/or Long-Term Stewardship for the nuclear facility over its remaining lifecycle.

If the COR for the existing facility is available as a standalone document, the COR for the modification shall be added to the appendices of the facility's standalone COR.

If a project that was placed on hold before completion, a review of the project's COR and an assessment of impacts due to any changes must be performed before the project restarts.

In addition, the COR should be updated periodically throughout the design and construction as needed, and formally at select points (e.g. CD-2, CD-3 approval). Figure 2 outlines various steps that should be considered when maintaining a COR.

In accordance with facility procedures the DA responsibility is usually delegated to a Project Engineer for major modifications made within operating systems or facilities that require significant time to design or a significant outage for maintenance/installation. This is determined during the development of the activity's Project Execution/Engineering Execution Plan. Exceptions should be handled on a case-by-case basis by the Chief Engineer.

The DA or delegate usually initiates the COR modification during the conceptual design phase (prior to CD-1) for the modification and/or updates the existing COR for procurement of SSCs (prior to CD-4).

The modified COR shall undergo engineering review and peer checking per appropriate procedures to ensure a quality engineering product is generated, legally defensible, technically accurate and upholds all technical rigor requirements. The DA is responsible for ensuring that the appropriate Subject Matter Experts (SMEs) and Engineering Discipline Leads (EDLs) are identified to review and provide input during the COR technical review. The discipline-specific COR sections shall be reviewed by the appropriate EDL/SME. When possible, the review should also include elements of the Design Agent to ensure that the requirements are understood.

In addition, once a nuclear/high hazard facility has been started up, the Code of Record should be maintained to provide a record of codes in place and used for future design and construction efforts. If the facility is modified, the contractor should have a defined process in place to provide a change-controlled record of what changed, by major component/system/area.

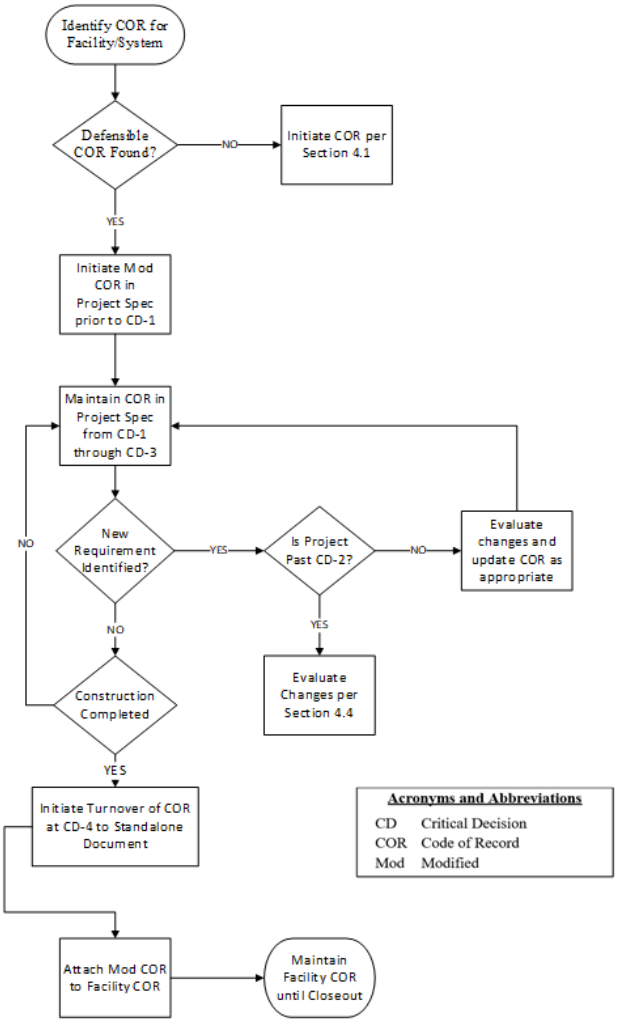

Figure 2- Typical Process Steps in Maintaining a COR

7.0 Code of Record Maintenance for Minor Modifications at DOE Facilities

For minor modifications, the scope of the project or task can be orders of magnitude less complex than for major modifications. For minor modifications, the challenge is often the budgetary and schedule constraints associated with updating the COR, if one formally exists, to reflect the modification or to establish, recovery, or reconstitute the COR where one is not adequately documented. Minor modifications may not have the financial resources or schedule allowances in which to modify or recovery/reconstitute the COR as to the same extent as Greenfield or Major Modifications. For minor modifications, it is usually necessary to utilize a graded approach in regard to the COR depending on the complexity of the modification, whether the modification is to a nuclear facility, whether or not the modification affects a safety related system or component, etc.

For minor modification to existing facilities that have a well-established COR, modifications to the COR can be evaluated as described in Figure 1 above and updated as applicable to reflect the latest Codes to which the modification will be designed, installed, and operated. In other cases, the COR may have previously been established and maintained in a means different than the method described in Section 1 above. In those instances, the Design Authority must evaluated the current COR documentation to

determine how to proceed with revising the COR based on the minor modification and value added to making the COR more closely resemble those requirements stated herein or to revise the COR in its current format. In either of these cases, it is important to clearly identify the scope of the modification and clearly delineate which codes have and have not been affected by the modification in the COR documentation where it exists.

For minor modifications to facilities where no previous COR has been established, see Section 9.0 for recovery/reconstitution of the COR. Again, a graded approach is prudent to follow for the recovery/reconstitution efforts for minor modifications.

Because minor modifications to facilities are usually much more frequent than major modifications to facilities, it is important to establish a means of evaluating existing Codes of Record in regard to changes necessitated by continuous minor modifications.

For nuclear facilities, each new code or new code edition associated with the minor modification must be evaluated for impacts to existing and applicable Authorization Basis documents, Technical Baseline documents, System and Facility Design Descriptions, Fire Hazard Analysis, etc., to determine if the COR for the minor modification is in compliance with these documents. For non-nuclear facilities, the new code or new code edition should be evaluated against the sets of documents that are under configuration control for the affected facility or system to determine if the COR for the minor modification is in compliance with these documents. In some instances, it may not be desirable to make a change in the COR if the impact to these documents is too costly and therefore, the existing COR must be utilized for the minor modification. For either nuclear or non-nuclear facilities, the minor modification to the facility or system must be within the bounds of the existing COR or the pertinent documents revised to reflect COR associated with the scope of the minor modification. Ultimately, this evaluation process will determine the sets of codes (and editions) that make up COR for the minor modification.

In some cases, developing a specific COR for a minor modification make take longer than designing the modification itself. For this reason, some sites have developed and are maintaining a site COR, that allows the design engineer to simply reference the site COR that was in effect on the day the design package was issues. This site COR is time stamped with a date and maintained in a document management system for future retrieval, thus providing a direct tie of the design to the COR in effect.

8.0 Code of Record Maintenance Due to Code/Standard Changes

It is not uncommon for National Consensus Codes and Standards to be revised every two to three years. Therefore, during the lifecycle of a project, system or facility new or amended requirements that pertain to design, construction, and operation (e.g., Federal, state, and local laws and regulations, DOE requirements, national codes and standards) may change. The magnitude of the differences in one edition of a code to the previous edition varies widely depending on the particular code. This is particularly true for codes that are closely tied to rapid changes in technology which result in more drastic changes from one edition to the next. Changes in code editions also present problems where manufacturers supply components that are designed and fabricated to a specific code edition. In each of these instances, it becomes very important for the Engineering Discipline Leads and Project/Facility/System Design Authority (or Cognizant System Engineer) to fully evaluate changes to editions of code where Codes of Record have been previously established for a facility when performing minor modifications to the facility.

Such changes in requirements for DOE nuclear facilities shall be evaluated with respect to impacts on project safety, cost, and schedule, to identify potential needs for a backfit (See Table 1). New or amended requirements in the documents listed in the COR throughout the lifecycle of a project, system or facility,

will be reviewed by the SMEs (which includes EDLs as appropriate) and CSE/DAs for the affected project, system or facility.

For DOE facilities, each new code or new code edition associated with the facility or SSCs, the new code/standard must be evaluated for impacts to existing and applicable Authorization Basis documents, Technical Baseline documents, System and Facility Design Descriptions, Fire Hazard Analysis, etc., to determine if the existing Code of Record remains in compliance with the new changes. Figure 3 and Figure 4 provide examples of a form and a process, respectively on how to conduct a delta gap analysis over the lifecycle of the facility/SSC.

NOTE: As necessary, attached supporting documentation.

Industry Standard or Code:	
Date:	Revision Change:
Synopsis of Change:	
Impact to TOC Facilities? Yes or No	
If yes, Primary Systems/Critical Facilities/Major Projects Impacted?	
Basis of Potential Impact:	
Suggested Future Action:	
Signature: _____	

Figure 3 – Typical Form for Evaluating a Standard/Code Change

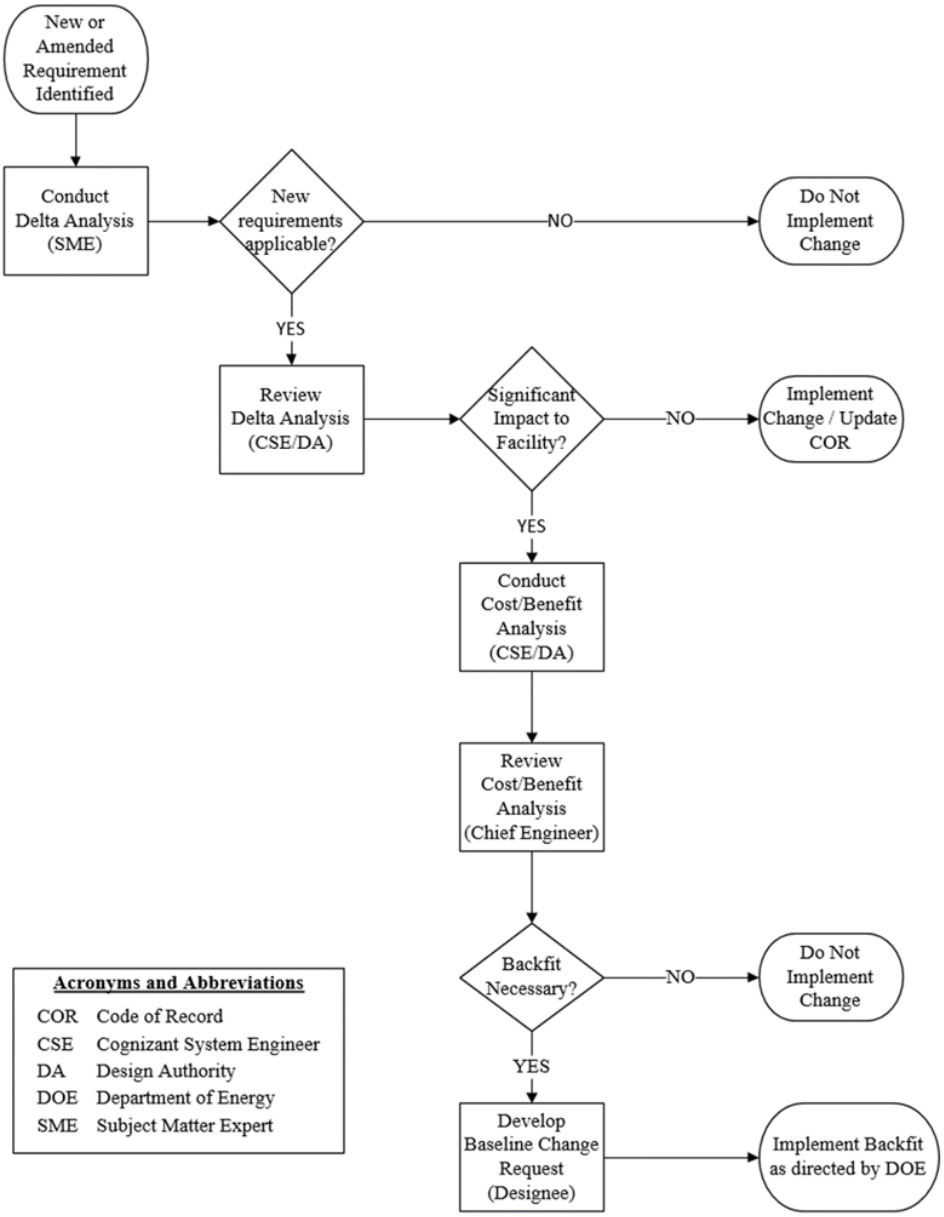

Figure 4: Example Change Analysis for Requirements

A delta gap analysis includes the changes in requirements for DOE nuclear facilities evaluated with respect to impacts on project safety, cost, and schedule, to identify potential needs for a backfit. New or amended requirements in the documents listed in the COR throughout the lifecycle of a project, system or facility, will be reviewed by the subject matter experts (SMEs) (which includes Engineering Discipline Leads [EDLs] as appropriate) and Cognizant System Engineers/Design Authorities (CSE/DAs) for the affected project, system or facility.

Management and DOE will be consulted regarding the potential of backfitting to the specific project, system, or facility as a result of the new or revised requirement in accordance with applicable site procedures.

A cost/benefit analysis of the backfit necessary will be prepared in accordance with Attachment 1. This analysis will be submitted to Management, DOE Management, and Contracts Officers in accordance with site-specific procedures. If directed by Management or DOE approved Contract amendment to implement the most recent document version, the COR will be updated and the project, system or facility will be backfitted accordingly. However, DOE may decide the benefit(s) do not outweigh the cost of the backfit in question. Management will need to obtain a written variance from DOE should a backfitting process not be approved.

9.0 Code of Record Maintenance Due to Lifecycle Phase Shifts

The COR is part of the technical baseline and shall be controlled and maintained current under the configuration control process throughout the lifecycle to design, construct, operate and decommission a nuclear facility. The COR shall serve as a management tool and source for the set of requirements used to design, construct, operate and decommission the facility over its lifecycle. A DOE project lifecycle is illustrated in Table 1.

Table 1: Technical Baseline Evolution through Project Lifecycle Phases

Project Phase	Initiation	Definition	Execution	Operations	Decommissioning	Post Closure
	CD-0	CD-1	CD-2/3	CD-4		
Technical Base Line	Preliminary functions and requirements from pre-conceptual design	Preliminary design requirements baseline	Final design requirements configuration baseline	As-built configuration baseline, operations and maintenance modifications	Deactivation, decontamination, dismantlement, demolition, and closure plans	Post closure, long-term stewardship, or legacy management plans

For projects, the technical baseline documentation (COR) evolves through the various phases of the project's Lifecycle. These phases include the pre-conceptual design phase functions and requirements through project closeout, represented by the as-built configuration. The evolution of the technical baseline through the phases of a project including Operations, Decommissioning, and Post-Closure are depicted in the table, adapted from DOE G 413.3-5A, DOE O 430.1B, and DOE O 436.1.

To facilitate the design and construction process and later the turnover documentation, the Code of Record should be organized in a manner that supports accessibility, traceability and maintainability. A Design Criteria Database (DCD) has proven to be an effective method to do this; but word documents are also acceptable.

When a project is transferred from the operations organization to the decommissioning/closure organization, the COR shall also be transferred, and documented in the Closure Plan. Closure Plans are iterative documents that describe the basis, project plan, implementation plan, and post-closure monitoring plan during the decontamination and decommissioning effort. The Closure Plans may also be amended to contain additional D&D requirements, plans and specifications for the decommissioning process.

When a project is transferred from the decommissioning/closure organization to the post-closure/long-term stewardship organization, the COR shall also be transferred, and documented in the appropriate plan. Each DOE facility has developed different procedures and processes to initiate the COR turn over by transferring the COR from one lifecycle phase to the next.

10.0 Reconstitution of Code of Record (Nuclear and Non-Nuclear)

Recovery of the COR is important when doing a modification (major or minor) to an existing facility or system within a nuclear or non-nuclear facility. This is especially true of safety related systems/components in a nuclear facility. DOE O 413.3B, requires that the COR be maintained throughout the life of a nuclear facility. Requirements for the configuration management of the COR of a non-nuclear facility are not as well defined. The ability to recover the COR of a facility/system will be based on the quality of the configuration management program implemented by the facility owner and whether the facility/system was classified as nuclear or non-nuclear.

The COR of a facility will likely evolve over the life of a facility as new systems are added and as modifications to existing systems/structures are made which use the current codes and standards at the time of modification. As a result, there may be several valid dates (versions) for a particular code/standard (e.g. pipe codes) within a facility based on when a particular system/structure was added or modified. This means that the COR will in all likelihood vary from system to system within an older facility.

To obtain the COR for a nuclear system or facility the Design Authority may have to review some or all of the following documents:

- Authorization Basis (AB)
- Technical baseline documents
- Facility Design Descriptions (FDDs)
- System Design Descriptions (SDDs)
- Fire Hazard Analysis
- Design input documents (e.g. Design Change Package, Modification Traveler)
- Purchase Orders
- Specifications
- Design documents
    - Piping & Instrument Diagrams (P&IDs)
    - Single Line Diagrams (SLDs)
    - Construction installation details
    - Materials of construction
    - Calculations
- Vendor manuals/drawings

After the COR of a system that is to be modified has been determined, it should be assessed against the Authorization Basis (AB) to verify that it is technically compatible with or adequate to meet the latest AB requirements. If the COR is not technically compatible or adequate to meet the requirements in the AB, then current codes and standards should be used.

To obtain the COR for a non-nuclear system or facility the Design Authority may have to review the same documents specified above for nuclear systems.

When the COR can’t be adequately determined for a facility (either nuclear or non-nuclear), then current codes and standards should be applied to the modification.

11.0 Other Considerations for Code of Record

Lessons learned from existing projects have been identified through individual reports, self-assessments and corporate reach-back assessments. Some considerations for effective use of Code of Record include the following:

1. Guidance standards (comprising of handbooks, design guides, and recommended practices) along with source and reference documents, are used to help guide design engineers. Although these standards are used for guidance and are recommended practices, they should be excluded from the code of record.

2. Electronics standards (IEC 61131-3, "Programmable Controllers – Programming Languages," e.g.) change frequently to keep pace with current technology. This standard should not be included in the Code of Record. It and others like it, should be in lower level engineering procedures to enable a project to affect the latest technology and ease impacts on the procurement process.

3. Test Standards (e.g. ASTM) identify tests performed by a vendor, construction, start-up, or commissioning. These standards typically do not impact design unless specific tests equipment or provisions for testing are required. Similar to #2, these standards should be included in lower level procedures.

4. Edition year changes to general standards have significant potential for immediate and long-term impacts on project engineering. Therefore, these revisions must be fully evaluated prior to their incorporation. Edition years should be included into the COR unless the code/standard requires that the latest version be used.

5. Some projects divide the ASME BPVC sections into separate COR entries. In some cases, for example, ASME PPVE Sections II, V, VIII, and IX are identified as separate entities in the COR. According to the ASME BPVC, the work performed under sections V and IX must be in accordance with the latest version of the code. These sections, however, describe processes, and do not typically impact design. Other sections of ASME BPVC must be worked together in order to meet the code and maintain consistent stress allowances, for example. A strategy for addressing ASME BPVC that addresses the various sections appropriately should be considered for development in the COR.

6. Care should be taken to ensure design engineers are aware of the codes and standards that are invoked by DOE contractually approved directives by including them in the COR

7. Sometimes, codes/standards can be withdrawn – the project will need to determine whether to keep the standard in the COR by utilizing a reference to an edition year or eliminate the standard from the COR altogether.

12.0 Definitions Used for Code of Record Best Practice:

Backfit: The modification of or addition to, systems, structures, or components (SSC) of a facility; or to the administrative controls, procedures, analyses, or organization required to design, construct or operate a facility. These changes or additions may result from new or amended requirements in the Code of Record.

Code of Record: Adopted from DOE ORO-EM Procedure No. EM-3.4, Rev. 1: "The set of Federal and State laws and regulations, DOE requirements, codes, standards, and design criteria which govern a DOE EM nuclear facility [or project]. A Code of Record should be established no later than Critical Decision-0 and maintained under configuration control through the Critical Decision process and the remainder of the facilities' life cycle.

Cognizant Systems Engineer (CSE): Required by DOE O 420.1C and assigned by the Chief Engineer to serve as the technical "owner" and Design Authority of assigned system(s). Works in a multi-disciplinary fashion to maintain satisfactory or improve system performance, reliability and safety by using up-to-date information about system configuration, system health, asset condition and performance trends. Specifically, the CSE may act as DA for specific system(s); evaluates and reports on system performance; serves as source of technical expertise on assigned system(s); ensures configuration management including both configuration baseline and Code of Record is documented and up-to-date or leads reconstruction/reconstitution efforts if not up-to-date; and supports maintenance, operations, and any modification to their system(s).

Databases: Information repositories for technical data and information.

Database Output Document: The Portable Document Format (PDF) of the database that is retained in EPCDC at any given time. The PDF includes a cover sheet that specifies the revision number.

Design Authority (DA): The Design Authority, assigned by the Chief Engineer, is responsible for establishing the design basis of facilities and SSCs and ensures that design outputs and the physical plant accurately reflect and satisfy the design intent and design media. The DA is responsible for design inputs and the technical integrity and adequacy of the engineering design output. These responsibilities are applicable whether the design process is conducted fully in-house, partially contracted to outside organizations, or fully contracted to outside organizations. DAs can be assigned to projects, programs, systems (See CSE definition above), and provide authorization basis support.

Design Input: Those criteria, parameters, design bases, regulatory requirements, or other design requirements upon which detailed final design is based.

Design Output: Drawings, specifications, calculations, data sheets and other documents used to define technical requirements of structures, systems, components, and computer programs.

Engineering Discipline Lead (EDL): Assigned by the Chief Engineer to provide as-needed technical and subject matter expertise to the engineering function, as well as operations, maintenance and project delivery. Serve as the site authority for the identification and interpretation of discipline engineering-related requirements (e.g. DOE and consensus codes and standards) and resolution of associated technical issues. Ensure relevant discipline-specific processes, procedures, codes and standards are available and used appropriately.

Final Design: Approved design output documents and approved changes thereto.

Major Modification: Defined per DOE-STD-1189-2016: "Modifications that "substantially change the existing safety basis for the facility." DOE-STD-1189-2016 provides extensive guidance for evaluation of major modifications.

Mission Critical: Mission Critical Equipment/Systems are that which are deemed by Facility Management to provide a vital function for the successful conduct of the DOE Mission activities. Mission Critical Equipment/Systems support other important Operational Equipment and are required in order for DOE to fulfill its mission.

Nuclear Facility: Defined per 10 CFR 830.3: "Nuclear facility means a reactor or nonreactor nuclear facility where an activity is conducted for or on behalf of DOE and includes any related area, structure, facility, or activity to the extent necessary to ensure proper implementation of this Part."

Project: Defined per DOE O 413.3B, Attachment 2: "A unique effort having defined start and end points undertaken to create a product, facility, or system. Built on interdependent activities planned to meet a common objective, a project focuses on attaining or completing a deliverable within a predetermined cost, schedule and technical scope baseline. Projects include planning and execution of construction, assembly, renovation, modification, environmental restoration, decontamination and decommissioning, large capital equipment, and technology development activities. A project is not constrained to any specific element of the budget structure (e.g., operating expense).

Attachment 1: PERFORMING A COST/BENEFIT ANALYSIS:

Based on DOE G 413.3-7A Attachment 6 and the Nuclear Regulatory Commission's CONF-850610--10-Sum, "A Method for Developing Cost Estimates for Generic Regulatory Requirements," the steps for performing a cost/benefit analysis are:

1. Identify the costs and benefits

Conduct a technical evaluation to identify costs that would result from the implementation of the new or revised requirement(s). Implementation costs to be considered include (but are not limited to) the following: Design Engineering, Procurement, Contractor (work package), labor, parts or equipment, installation, testing, training, operating costs, downtime during installation, updating or developing new procedures. Estimating the cost for the requirement may involve several steps including:

Identifying the activities that must be performed to fully implement the requirement
Defining the work packages associated with the major activities
Identifying the individual elements of cost for each work packag
Estimating the magnitude of each cost element
Aggregating individual project, system or facility costs over its lifetime including initial and continuing costs associated with implementation of the change.
Conduct a technical evaluation to identify and quantify benefits that would result from the implementation of the new or revised requirement(s). Implementation benefits to be considered include (but are not limited to) the following:
Decrease in operational complexity

- Lower operating costs
- Reduction in labor
- Reduction in regulatory violations
- Less down time
- Lower equipment cost

– Substantial increase in the overall safety and protection of the worker, public or environment. The direct and indirect costs of implementation should be justified in view of this increase protection.

2. Quantify in units: All costs and benefits should be quantified in units, such as hours, parts, each etc.

3. Calculate units into dollar value

Express anticipated benefits in dollar equivalents.
Convert each of the units into a dollar value to establish a cost and benefit totals.

4. Calculate costs and benefits into time

Express anticipated benefits in dollar equivalents.
Convert each of the units into a dollar value to establish a cost and benefit totals.

5. Project the net benefits and costs

Divide the dollar value of the benefits by the dollar value of the costs to obtain a ratio.
The higher the ratio, the higher the desirability of performing the project.

Nuclear Regulatory Commission's NUREG-1409, "Backfitting Guidelines," provide additional information for this process.