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10 CFR 830 Major Modification Determination for Advanced Test Reactor LEU Fuel Conversion

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Idaho National Laboratory
Idaho Falls, Idaho 83415

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Advanced Test Reactor

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for
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Developed by:

N. R. Duckwitz, NSA Safety Analyst — 5/24/2012 Date

M. A. Lehto, BEA Project Lead Safety Analyst — 5/25/2012 Date

Approved by:

R. A. Jordan, Manger ATR Facility Safety Engineering — 5/25/12 Date

S. R. Morrell, Project Manager ATR LEU Fuel Conversion Project — 5/24/12 Date

E. J. Schuebert, Manager ATR Operations — 5/24/12 Date

J. A. Jacobi, Chair, Safety Operation Review Committee — 5/24/2012 Date

(SEAN MORRELL) FOR M. LOVE PER TELECON
M. D. Love, Director ATR Complex Program — 5/25/2012 Date

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DEFINITIONS

Major modification - A modification to a DOE nuclear facility that is completed on or after May 9, 2001, that substantially changes the existing safety basis for the facility. (10 CFR 830)

Nuclear facility - A reactor or a 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 the requirements established by 10 CFR 830. (10 CFR 830)

Safety basis - The documented safety analysis and hazard controls that provide reasonable assurance that a DOE nuclear facility can be operated safely in a manner that adequately protects workers, the public, and the environment. (10 CFR 830)

Simple modification - A modification to a DOE nuclear facility not requiring a new or revised hazard analysis and accident analysis and new safety controls. (DOE-STD-1189)

ACRONYMS and ABBREVIATIONS

ATR	Advanced Test Reactor
ATRC	Advanced Test Reactor Critical Facility
BFD	Base Fuel Demonstration
CFR	Code of Federal Regulation
CSDR	conceptual safety design report
DOE	U.S. Department of Energy
EFPD	effective full power days
GFE	government furnished equipment
GTRI	Global Threat Reduction Initiative
HC	hazard category
HEU	high enriched uranium
HPRR	high performance research reactor
INL	Idaho National Laboratory
LEU	low enriched uranium
MAR	material-at-risk
NMIS	Nuclear Materials Inspection and Storage Facility
NPH	natural phenomena hazard
PDSA	preliminary documented safety analysis
PSDR	preliminary safety design report
RERTR	Reduced Enrichment for Research and Test Reactors
RERTR-FE	RERTR (full-size) fuel element
SAR	safety analysis report
SC	safety class
SDS	safety design strategy
SS	safety significant
SSC	structure, system, or component
STD	standard
TSR	technical safety requirement

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1. INTRODUCTION

The Advanced Test Reactor (ATR), located in the ATR Complex of the Idaho National Laboratory (INL), was constructed in the 1960s for the purpose of irradiating reactor fuels and materials. Other irradiation services, such as radioisotope production, are also performed at ATR. The ATR is fueled with high-enriched uranium (HEU) matrix (UAl_x) in an aluminum sandwich plate cladding.

The National Nuclear Security Administration Global Threat Reduction Initiative (GTRI) strategic mission[1] includes efforts to reduce and protect vulnerable nuclear and radiological material at civilian sites around the world. Converting research reactors from using HEU to low-enriched uranium (LEU) was originally started in 1978 as the Reduced Enrichment for Research and Test Reactors (RERTR) Program under the U.S. Department of Energy (DOE) Office of Science. Within this strategic mission, GTRI has three goals that provide a comprehensive approach to achieving this mission: The first goal, the driver for the modification that is the subject of this determination, is to convert research reactors from using HEU to LEU. Thus the mission of the ATR LEU Fuel Conversion Project is to convert the ATR and Advanced Test Reactor Critical facility (ATRC) (two of the six U.S. High-Performance Research Reactors [HPRR]) to LEU fuel by 2017.

2. PROJECT DESCRIPTION

This project description is based on the drafted Preliminary Project Execution Plan for the ATR LEU Fuel Conversion Project.[2]

The ATR LEU Fuel Conversion Project includes all support activities necessary to convert ATR and ATRC from HEU fuels to LEU fuels. The ATR/ATRC conversion project supports the GTRI mission and the HPRR Conversion Program objectives.

In general, the programmatic work elements of reactor conversion include the following:

1. Prepare a feasibility analysis to ensure the reactor can be converted to using LEU fuel without adversely affecting the scope and scale of operations
2. Conduct additional scoping studies to ensure reactor performance and missions continue to be achievable with LEU fuel
3. Conduct safety analyses and prepare a safety analysis report (SAR), if required
4. Prepare a conversion project execution plan for the conversion
5. Submit reports and plans and obtain regulatory approval
6. Procure LEU fuel
7. Execute the conversion plan and re-start the reactor, after which GTRI can take credit for having completed the Joule Metric
8. Project management and project administration.

In 2009, the initial feasibility study was performed to determine whether transition to LEU fuel was technically feasible, could be done without crucially impacting necessary performance parameters, and if the transition from HEU to LEU fuel would satisfy key safety requirements.

The initial feasibility study indicated that reactivity to maintain operating lifetime has been demonstrated to be achievable without changing the ATR fuel element geometry or dimensions. Given the unchanged physical attributes for the ATR LEU fuel element design, the hydrodynamic stability is expected to be very similar if not exactly the same as the current ATR HEU fuel element. Studies for the ATR conversion have used both variable fuel meat thickness and burnable absorbers in the four inner and four outer most plates to hold down the initial excess reactivity and maintain the radial heat flux profile across the 19 fuel plates of the ATR LEU fuel element. The initial feasibility study indicates that conversion with the monolithic uranium-molybdenum (U-Mo) fuel will likely be technically feasible once the fuel is qualified and the full safety analyses are completed to evaluate all major accident scenarios to support licensing of LEU fuel use in the reactors. However, the initial feasibility study did emphasize "technical feasibility" rather than broader project feasibility due to concerns about the economic impact of LEU fuel use, which is still under development. Additional scoping studies must be performed to ensure that reactor performance and current missions continue to be achievable.

Follow on analyses are planned to evaluate the ability of the ATR monolithic U-Mo fuel to do the following:

1. Maintain safety margins during normal operation and key accident scenarios

2. Allow operating cycle lengths to be maintained for efficient and effective use of the facility

3. Preserve an acceptable level and spectrum of key neutron fluxes to meet the scientific mission of the facility, including the following:

    a. Naval reactors thermal/fast flux requirements

    b. National Scientific User Facility thermal/fast flux requirements

    c. DOE fuel development requirements

4. Maintain flexibility for core power splits.

Full safety analyses will be performed and regulatory approvals must be received before ATR can convert. In addition to regulatory approval, conversion of ATR and ATRC will be dependent on the fuel development programs providing qualified fuel that meets the requirements of the ATR/ATRC reactor program and fuel that can be commercially fabricated. Specifying the burnable absorber to be used and optimizing the amount of the burnable absorber of the inner and outer plates will require additional analysis and irradiation testing. To preserve fuel performance of the developed LEU monolithic fuel, U10Mo, a study is needed to integrate cladding burnable absorbers that physically separate the burnable absorber from the fuel meat. Input from the fuel development program will be solicited to help identify acceptable fuel design candidates for analysis and testing. Development of the ATR LEU fuel is completed through a fuel qualification plan and includes irradiation testing and post irradiation examination.

3. HAZARDS DISCUSSION

3.1 Material-at-Risk

The ATR material-at-risk (MAR) consists of the reactor core, the radioactive materials (irradiated fuel elements and other hardware) stored in the canal, isotope production targets, and experiments containing fuel and non-fueled components. The ATR is a Category A reactor with an operating power level up to 250 MW_t and, as such, has a radioactive material inventory with the potential for significant off-site consequences.

The proposed project will have some impact on MAR. A perspective of the impact has been gained from studies to-date with the RERTR element. In ECAR-1388, "Evaluation of Source Terms and Radiological Consequences for ATR Safety Analysis Report Addendum,"[3] the activities and dose consequences for radiation shielding and accident scenarios were calculated relative to an ATR core with one RERTR (full-size) fuel element (RERTR-FE) plus 39 HEU 7F fuel elements relative to an ATR core with 40 HEU 7F fuel elements at the ATR Upgraded Final Safety Analysis Report (SAR-153)[4] bounding power of 250 MW, 60 EFPD, in addition to the nominal operating power of 115 MW, 150 EFPD. The safety basis for the LEU fuel uranium mass must be premised upon a value that envelopes all possible designs. For example, the safety mass for the all-LEU-fuel-element-core could be premised upon the assumption of each LEU fuel element consisting of 19 LEU fueled plates with a plate thickness of 0.013 in. (the same safety basis defined for the Base Fuel Demonstration [BFD] fuel element, per TEV-1501, "BFD Project Mass Bounding Calculation"[5]). Based upon the above assumptions, it is possible to then scale the activities and dose consequences calculated for ECAR-1388 for the RERTR-FE to a value for the all-LEU-fuel-element-core that should be sufficiently bounding. From this scaling, it is possible to arrive at the radiological 'hazard' differential. From this scoping estimate, the anticipated outcome is that the dose consequence differential will not be significant. However, there will be a mass increase of the actinides (even if the activity and dose contribution compared to the fission products are relatively negligible).

3.2 Fires and/or Explosions

The HEU to LEU fuel conversion does not introduce any new fire/explosion hazards.

3.3 Natural Phenomena Hazards

Natural phenomena hazards (NPHs), including earthquakes (seismic events), extreme wind, tornado, flood, volcanic, and lightning, are potential hazards to the facility for causing building damage and/or failure of safety-related operational equipment. These NPH hazards were evaluated in SAR-153 for existing facilities in support of current operations. Based on the SAR-153 analysis, the fuel elements and core support tank assembly (no equipment number assigned to fuel elements; core support tank assembly equipment Nos. 670-M-161-71) are classified as safety-related. The fuel elements and core support tank assembly are qualified as a passive Seismic Category I components (i.e., equipment is not required to perform active functions in an accident environment). Analysis of the final LEU fuel element design must meet the same seismic qualification. In addition, the seismic qualification of the core support tank assembly and other qualified internal components supporting the fuel may require requalification if the mass for the converted LEU fueled core is greater than the core mass considered in the current seismic qualification for the core support tank assembly and reactor internals that support the core.

4. MAJOR MODIFICATION EVALUATION CRITERIA

DOE-STD-1189-2008, "Integration of Safety into the Design Process,"[6] was developed to provide consistent DOE complex-wide criteria to be used in determining if a change constitutes a major modification. The standard includes Table 8-1, "Major Modification Evaluation Criteria." The table

provides a methodology for evaluating a project against the 10 CFR830, "Nuclear Safety Management,"[7] major modification evaluation criteria and was used as a basis for this major modification determination. The table is reproduced herein as Table 1, "Major Modification Evaluation Criteria." The purpose of Table 1 is to focus on the nature of the modification and the associated impact on the existing facility safety basis for the ATR facility.

Major modifications are defined as those changes that "substantially change the existing safety basis for the facility." The guidance for applying the table states that in applying the criteria, the intent is not to automatically trigger the need for a preliminary documented safety analysis (PDSA) if one or more of the criteria are met. Rather, it is intended that each criterion be assessed individually and then an integrated evaluation be performed based on the collective set of individual results. In performing this evaluation, the focus should be on the nature of the modification and its associated impact on the existing facility safety basis. Even a project that results in changes that ripple through the safety basis documents does not "substantially change the existing safety basis for the facility" solely because many parts or pages of the safety basis documentation need to be revised.

A major modification requires the development of a PDSA per 10 CFR 830.206, following the facility modification process as depicted in Figure 1. Since DOE-STD-3009, "Preparation Guide for U. S. Department of Energy Nonreactor Nuclear Facility Documented Safety Analyses,"[8] is not the safe harbor format for SAR-153, the safety design strategy (SDS) must establish the expectations and the format for integrating the subject major modifications to the update of SAR-153.

Table 1. Major modification evaluation criteria.

Major Modification Evaluation Criteria (DOE-STD-1189, Table 8-1)
Project Information The proposed project will convert ATR and ATRC from HEU fuel to LEU fuel. This major modification evaluation will specifically evaluate the criteria against the safety basis for the ATR reactor safety basis, being the more significant of the two reactors and the reactor most likely to be impacted by the project. If, on this basis, the modification is determined to be a major modification, then the integration of safety into design provisions of DOE-STD-1189 are applicable to the project, which will include consideration of impacts to the other safety basis that uses or stores the new LEU fuel (i.e., ATRC as well as the Nuclear Materials Inspection and Storage Facility [NMIS]). The scope of this task is to convert the ATR HEU fuel to LEU fuel while retaining all key functional and safety characteristics of the reactor. To demonstrate that the LEU core fuel cycle performance can meet the SAR-153 safety requirements, a series of comprehensive studies must be orchestrated, addressing all safety issues, functional requirements, and auxiliary effects of conversion.

Evaluation Criterion No.	Evaluation Criteria	DOE-STD-1189 Discussion	Conversion of the ATR Reactor from HEU to LEU Fuel
1	Add a new building or facility with a material inventory ≥ Hazard Category 3 (HC 3) limits or increase the HC of an existing facility?	A new building may be a structure within an existing facility segment. That structure may or may not have direct process ties to the remainder of the segment/process. The requirements of DOE-STD-1027-92, Change Notice 1, September 1997, are used in evaluating Hazard Categorization impacts.	No. The ATR is a DOE Category A reactor. As such, it is classified as a DOE Hazard Category (HC) 1 nuclear facility. The proposed modification to convert the reactor from HEU to LEU fuel does not change the HC of the existing facility or add any new buildings.
Evaluation Criterion No.	**Evaluation Criteria**	**DOE-STD-1189 Discussion**	**Conversion of the ATR Reactor from HEU to LEU Fuel**
2	Change the footprint of an existing HC 1, 2 or 3 facility with the potential to adversely affect any safety class (SC) or safety significant (SS) safety function or associated structure, system and component (SSC)?	A change in the footprint of an existing facility requires the identification and evaluation of any potential adverse impacts on SC or SS safety functions or associated SSC (e.g., structural qualification, evacuation egress path, fire suppression spray pattern) or safety analysis assumptions. Changes that may involve adverse impacts require careful attention to maintaining adherence to applicable engineering standards and nuclear safety design criteria.	No. An initial HEU to LEU fuel conversion feasibility study indicated that reactivity to maintain operating lifetime has been demonstrated to be achievable without changing the ATR fuel element geometry or dimensions. Therefore, no ATR facility footprint changes will be required. It is expected that the mass of the LEU fuel elements will be greater than the current HEU elements.[2] The fuel elements are supported by the flux trap baffles and other core internals. The ATR core support tank assembly, flux trap baffles and other core internal structural components are classified as safety-related and qualified as passive Seismic Category I components and structural elements. While analysis must confirm that the structural qualification is maintained, change in footprint is not expected.

Evaluation Criterion No.	Evaluation Criteria	DOE-STD-1189 Discussion	Conversion of the ATR Reactor from HEU to LEU Fuel
3	Change an existing process or add a new process resulting in the need for a safety basis change requiring DOE approval?	A change to an existing process may negatively affect the efficacy of an approved set of hazard controls for a given event or accident. Likewise, potential safety concerns associated with a new process may not be adequately addressed by the existing approved control sets. In this case, it is assumed that the existing analyses addressed the hazards associated with the new or revised process, but the specified control set(s) may no longer be valid. The evaluation of any new hazards introduced by the revised or new process should be addressed via Criterion 6	Yes. The proposed change of fuel from HEU to LEU is a change to an existing process resulting in a need for a safety basis change requiring DOE approval. The conversion to LEU fuel affects the safety basis. The fuel element power limit (TSR-186, "Technical Safety Requirements for the Advanced Test Reactor,"[9] 3.6.1) and reactivity control operability requirement (TSR 3.7.1) may be affected negatively. It is conservatively assumed that the reactor core safety parameters associated with these technical safety requirements (TSRs) may require revision. Implementation of these TSRs relies on the ATR core safety analysis package (CSAP) preparation process. It is planned through the technical management plan for the LEU fuel conversion (which will drive the development, review, and approval of new or revised safety analysis and controls) to proceed with the phased incorporation of a newer physics analysis methodology into the CSAP preparation process. To demonstrate that the LEU core fuel cycle performance can meet the ATR safety basis requirements, a series of comprehensive studies must be orchestrated. The impact assessment being performed under the technical management plan will be used to evaluate the viability of the current technical and functional requirements of the ATR against the parameters affected by conversion. Once identified, any technical and functional requirements that are impacted will be evaluated against safety requirements, resulting in a modified (as required) technical and functional requirements document as well as safety basis changes requiring DOE approval.

Evaluation Criterion No.	Evaluation Criteria	DOE-STD-1189 Discussion	Conversion of the ATR Reactor from HEU to LEU Fuel
4	Utilize new technology or government furnished equipment (GFE) not currently in use or not previously formally reviewed / approved by DOE for the affected facility?	This assessment should include consideration of the impact that the use of new technology (including technology scale-up issues) or GFE may have on the ability to specify the applicable nuclear safety design criteria with a high degree of certainty in the early stages of the project. Additionally, refer to GFE discussion in Section 8.3. GFE may have a technical baseline that is not directly and fully supportive of the project functional and performance requirements. An example would be employing a new technology for removal of certain nuclides from a waste stream.	Yes. LEU fuel utilizes new technology not currently in use and has not been previously formally reviewed and approved by DOE for the ATR. The RERTR LEU fuel development program is based on a high uranium density uranium molybdenum (U-Mo) alloy fuel. Extensive irradiation testing has been conducted in the ATR on mini-size and full-size LEU fuel plates over the last decade to establish an understanding of fuel performance parameters and fabrication techniques. Testing of prototypic full size fuel elements is required to demonstrate integrated fuel performance behavior and scale up of fabrication technique. More recently, an addendum to SAR-153 for the ATR safety analysis report (SAR-153-ADD-4, “SAR-153 Addendum for the Use of RERTR-FE Test Fuel Elements in the ATR”[10]) has been under development to provide the design and safety analyses to support irradiation of the full-size RERTR-FE in a single ATR driver fuel element position. The irradiation of the RERTR-FE is not intended to be a ‘bounding test case’ where the fuel is pushed to the upper limits of the allowable operating envelope for the fuel. SAR-153-ADD-4 has been reviewed but not yet approved by DOE.

Evaluation Criterion No.	Evaluation Criteria	DOE-STD-1189 Discussion	Conversion of the ATR Reactor from HEU to LEU Fuel
5	Create the need for new or revised safety SSCs?	Consideration should be given to the relative complexity of the controls and the ease with which the controls can be implemented. The use of a complicated multi-channel Safety Class seismically qualified instrumented system to provide multiple interlock and alarm functions would typically pose a higher risk to the project than the use of a safety significant passive design feature. The degree of design and regulatory uncertainty should be addressed for this criterion for the development, review, and approval of new or revised safety analysis and attendant controls (e.g., presence of multiple regulatory/technical agencies on a single project).	Yes. Specifically, the technical and functional requirements for the fuel may require revision along with the TSR operating limits and surveillance requirements for the fuel elements. The current degree of design and regulatory uncertainty is being addressed through the technical management plan, which will also drive the development, review, and approval of new or revised safety analysis and attendant controls. To demonstrate that the LEU core fuel cycle performance can meet the SAR-153 safety requirements, a series of comprehensive studies must be orchestrated, addressing all safety issues, functional requirements, and auxiliary effects of the conversion. The impact assessment being performed under the technical management plan will be used to evaluate the viability of the current technical and functional requirements of ATR against the parameters affected by the conversion. Once identified, any technical and functional requirements that are impacted will be evaluated against safety requirements, resulting in a modified (as required) technical and functional requirements document. Execution of the latter half of Phase One of the technical management plan will include a comprehensive study of safety parameters and requirements to be used for the update of the ATR safety basis. A formal plan will be developed to complete all of the identified analyses required for the final safety analysis.

Evaluation Criterion No.	Evaluation Criteria	DOE-STD-1189 Discussion	Conversion of the ATR Reactor from HEU to LEU Fuel
6	Involve a hazard not previously evaluated in the Documented Safety Analysis?	Hazards can include the introduction of an accident or failure mode of a different type from that previously analyzed in addition to radiological or toxicological hazards. The need to address a new hazard early in the design process may lead to some degree of uncertainty related to the proper specification of applicable nuclear safety design criteria. In such cases, this uncertainty should be addressed within this evaluation.	No. No new accidents and failure modes are expected. However, maintaining current safety margins is a function of the new fuel design and must be verified. The proposed project will have some impact on MAR radionuclide distribution. A perspective of the impact has been gained from studies to-date with the RERTR-FE. In ECAR-1388, the activities and dose consequences for radiation shielding and accident scenarios were calculated relative to an ATR core with one RERTR-FE plus 39 HEU 7F fuel elements relative to an ATR core with 40 HEU 7F fuel elements at the SAR-153 bounding power of 115 MW, 150 EFPD. The safety basis for the LEU mass must be premised upon a value that envelopes all possible designs. For example, the mass for the all-LEU-fuel-element-core could be premised upon the assumption of each LEU fuel element consisting of 19 LEU fueled plates with a plate thickness of 0.013 in. (the same safety basis defined for the BFD fuel element, per TEV-1501). Based upon the above assumptions, it is possible to then scale the activities and dose consequences calculated for ECAR-1388 for the RERTR-FE to a value for the all-LEU-fuel-element core that should be sufficiently bounding. From this scaling, it is possible to arrive at the radiological ‘hazard’ differential. From this scoping estimate, the anticipated outcome is that the dose consequence differential will not be significant. However, there will be a mass increase of the actinides (even if the activity and dose contribution relative to the fission products are relatively negligible).

Summary and Recommendation: Three of the six criteria (Criterion 3, 4, and 5) resulted in positive responses in this major modification evaluation. As discussed above, the project does not introduce any new hazards. However, to demonstrate that the LEU core fuel cycle performance can meet the ATR safety basis requirements, a series of comprehensive studies must be orchestrated. Essentially, an entire core analysis (from a modeling and analysis perspective) is required to completely address all safety issues, functional requirements, and auxiliary effects of conversion. The ATR LEU fueled core will be born entirely under the new computational reactor physics modeling by coordinating efforts with the ATR Core Modeling Update Project. The first phase of the technical plan for fuel conversion is a conversion impact assessment. Two of the primary goals in the first phase include a full understanding of LEU fuel capabilities versus customer needs (i.e., power, cycle length, and spectral shift) and a limiting postulated accident scenario that will supply information necessary to evaluate several systems associated with the ATR safety analysis to determine conversion impact. The impact assessment will be used to evaluate the viability of the current technical and functional requirements of the ATR against the parameters affected by conversion. Once identified, any technical and functional requirements that are impacted will be evaluated against individual customer needs and safety requirements, resulting in a modified (as required) technical and functional requirements document. The latter half of Phase One will include a comprehensive study of safety parameters and requirements to be used for the updated final SAR in Phase Two. A formal plan will be developed to complete all of the analyses required for the final safety analysis once identified. The analysis effort and impact assessment require careful attention to ensure all applicable and credited engineering and nuclear safety design criteria are identified along with potential adverse impacts to their designated safety functions. Based on these considerations, it is concluded that this project constitutes a major modification and will, therefore, require the development, review, and approval of a PDSA. It is recommended that the project proceed accordingly. Also, since DOE-STD-3009 is not the safe harbor format for SAR-153, the SDS must establish the expectations and the format for the PSDR (if needed) and PDSA to integrate the subject major modifications into SAR-153. It should also be noted that as described in the referenced Project Execution Plan, the project also impacts the ATRC safety basis. In addition, the ATR Complex NMIS, where the LEU fuel elements will be stored prior to installation in the ATR, may be impacted by the project. The SDS should include consideration of these potential impacts.

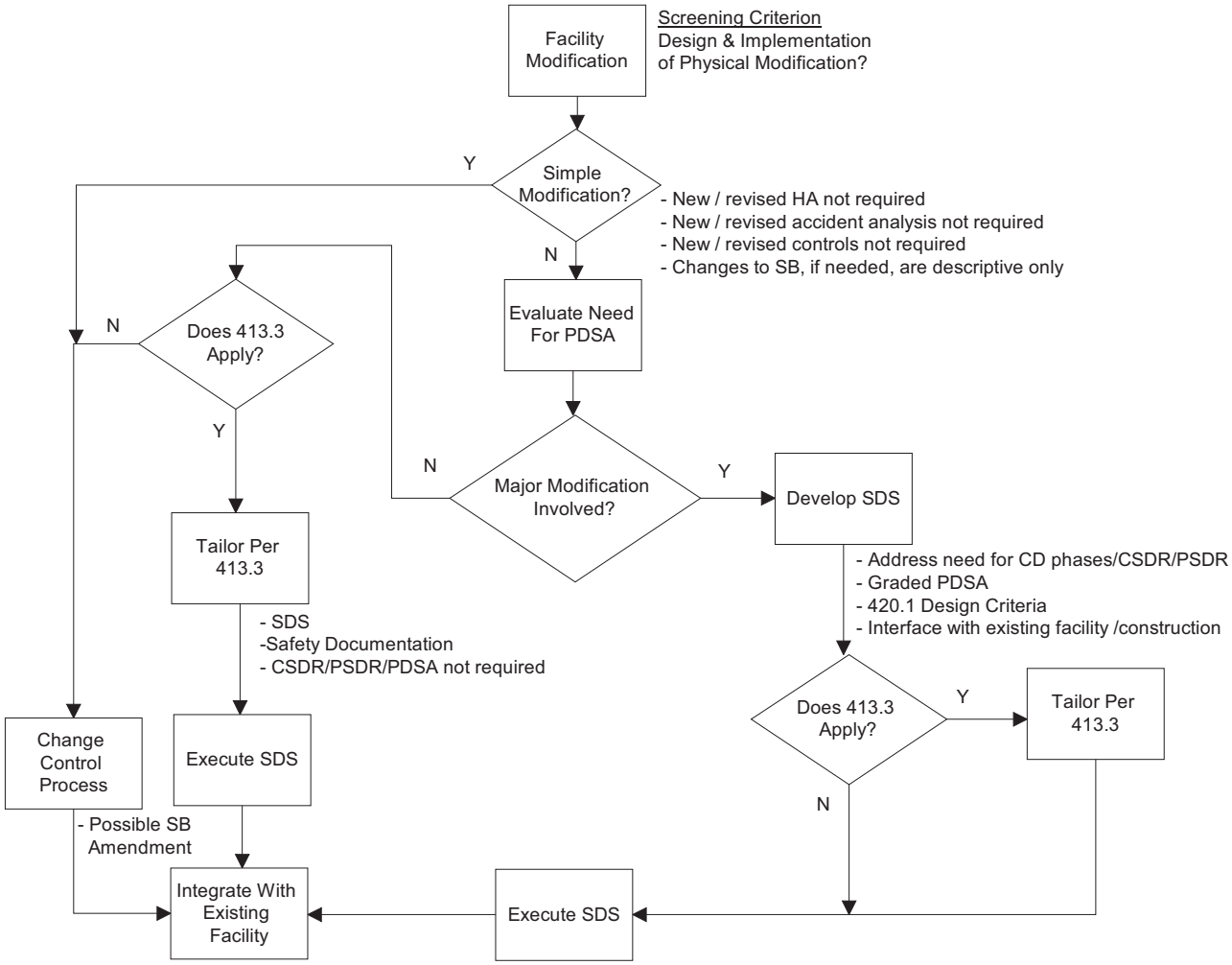

Figure 1. Facility modification process (taken from DOE-STD-1189, Figure 8-1).

5. CONCLUSION

The major modification criteria evaluation of the project pre-conceptual design identified several issues that lead to the conclusion that the project is a major modification:

1. Evaluation Criteria #3 (Change of existing process). The proposed strategy for analyzing the core with LEU fuel utilizing a newer physics analysis methodology into the CSAP preparation process will possibly result in changes (as required) to the technical and functional requirements document as well as changes to the safety basis requiring DOE approval.
2. Evaluation Criteria #4 (Use of new technology). LEU fuel utilizes new technology/fuel design not currently in use and has not been previously formally reviewed and approved by DOE for the ATR.
3. Evaluation Criteria #5 (Create the need for new or revised safety SSCs). The LEU fuel conversion requires modification to the fuel design. The technical and functional requirements for the fuel may require revision along with the TSR operating limits and surveillance requirements for the fuel elements.

The positive major modification determination is driven by the fact that substantial analysis is required to completely address all safety issues, functional requirements, and auxiliary effects of the LEU fuel conversion. This analysis and modeling is the underpinning of the safety strategy as presented in the safety basis documentation. The safety analysis supporting this major modification will need to be tailored appropriately as discussed in the following text from DOE-STD-1189, Chapter 8:

> "Where a major modification is found to exist, an SDS must be developed that addresses (1) the need for a CSDR or PSDR (as well as the required PDSA) to support project phases, (2) the graded content of the PDSA necessary to support the design and modification, (3) the application of nuclear safety design criteria, and (4) the interface with the existing facility, its operations, and construction activities."

6. REFERENCES

1 . GTRI Strategic Plan, January 2009.

2. PLN-3863, "Preliminary Project Execution Plan for the Advanced Test Reactor Conversion Project," Rev. 0 (Draft 1), March 2012.

3. ECAR-1388, "Evaluation of Source Terms and Radiological Consequences for ATR Safety Analysis Report Addendum," Rev. 0, August 2011.

4. SAR-153, "Upgraded Final Safety Analysis Report for the Advanced Test Reactor," Rev. 30, February 2011.

5. TEV-1501, "Low Enriched Uranium Base Fuel Demonstration Bounding Element Parameters," Rev. 0, April 2012.

6. DOE-STD-1189-2008, "Integration of Safety into the Design Process," Department of Energy, March 2008.

7. 10 CFR 830, Subpart B, "Nuclear Safety Management," *Code of Federal Regulations*, Office of the Federal Register.

8. DOE-STD-3009-94, Change 3, “Preparation Guide for U. S. Department of Energy Nonreactor Nuclear Facility Documented Safety Analyses,” Department of Energy, March 2006.

9. TSR-186, “Technical Safety Requirements for the Advanced Test Reactor,” Rev. 27, April 2012.

10. SAR-153-ADD-4, “SAR-153 Addendum for the Use of RERTR-FE Test Fuel Elements in the ATR,” Draft.