INL/EXT-18-50114
Revision 0

Completion of the ATR LEU Conversion Conceptual Design

Thomas Maddock, Joe Palmer

March 2018

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Revision 0

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March 2018

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Completion of the ATR LEU Conversion Conceptual Design

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Revision 0

March 2018

Approved by:

See eCR 657514	
Eric Woolstenhulme ATR LEU Conversion Project Manager	Date
See eCR 657514	
Thomas Maddock ATR LEU Conversion Technical Lead	Date
See eCR 657514	
Joe Palmer Design Review Chairman	Date
See eCR 657514	
Anne McCartin ATR Nuclear Safety	Date

SUMMARY

The Advanced Test Reactor (ATR) Low Enriched Uranium (LEU) Conversion Project at the Idaho National Laboratory (INL) has been developing a new fuel element design capable of converting the ATR from Highly Enriched Uranium (HEU) to LEU fuel. A single concept was selected and analyzed in a series of reports. On October 26, 2017 a Conceptual Design Review kickoff meeting was held. Reviewers took the next two weeks to document their comments on the design and analysis. Those comments have been resolved to the satisfaction of the reviewers. Not all of the known issues and short comings of the design have been resolved. Some may never be resolved but mitigation strategies are being developed that should reduce the impact to acceptable levels. It is recommended that the current design be approved by the U.S. High Performance Research Reactor (HPRR) Program for fabrication and used for the ET-1 base fuel qualification test. It is also recommended that analysis for the conversion of ATR and ATR Critical reactors and the necessary Safety Analysis Report (SAR) addendums for the testing of the ATR LEU elements proceed using the current design. Where there are remaining ambiguities in the design specifications or drawings, it is recommended that they be clarified with revisions or superseding documentation.

CONTENTS

TABLES

Completion of the ATR LEU Conversion Conceptual Design

1. Design Review

In accordance with PLN-5391, "Conceptual Design Plan for the ATR LEU Conversion Element," a conceptual design was developed for a new element to convert the ATR to LEU fuel. During development work, the fuel element was designated Mark 1A Enhanced LEU Fuel (Mark 1A ELF). PLN-5391 outlined a series of four hypothetical ATR cycles that would be analyzed to determine if "the fuel design has a high probability of meeting the ATR operational and safety objectives." The analysis of those cycles is complete, and the conceptual design review has been held.

The review period was initiated with a kick-off meeting held October 26, 2017. The design review package (Table 1) was presented and reviewer responsibilities and expectations discussed. Presentations by the project team included a project overview and summaries of the neutronic, thermal, and structural analyses. The participants were instructed to review the design in accordance with their knowledge area and submit written comments, questions, or deficiencies (CQDs). The CQDs were received from reviewers on Form 412.13. Their comments were resolved and acceptance signatures were received. The 412.13 forms are attached in Appendix B.

2. Documentation

The documents shown in Table 1 were provided to the reviewers. All documents were released or in a final draft form having been technically checked previous to the review. All of the ATR LEU Conversion Project's conceptual design work was done at quality level 3. Independent peer reviews are not required at the INL for quality level 3 work, but were performed regardless because of the importance of the conceptual design. When the final design phase begins, all documents used to support the development of a SAR addendum or a SAR revision will be performed as Safety Structure System or Component (SSC) applicable. Recent changes to INL procedures created the Safety SSC applicable designation for Engineering Calculation and Analysis Reports (ECARs), which is similar to quality level 1 in the old procedures. Regardless of the terminology, work done to support a nuclear facility's safety basis will be performed with the highest level of rigor, whereas conceptual work was done to a lower level of rigor.

An additional conceptual document is being created to supersede TEV-1972, "Conceptual Design Parameters for ATR LEU U-MO Conversion Demonstration Experimental Irradiations." The new document was not subject to the design review and is also quality level 3. It has been created at the request of the U.S. HPRR Program Fuel Qualification pillar to provide expected ATR fuel plate power, flux, and burnup information, as opposed to conservative or bounding values presented in other conceptual design documents. This document supports the design of future irradiation tests and will be provided to the Reactor Conversion pillar lead to share with the other pillars upon completion.

Table 1. Conceptual Design Documents Subject to Review.

Document Identifier	Document Title
ECAR-3908	Serpent Model Used in ELF Mk 1A Conceptual Design Neutronic Analysis
ECAR-3909	Results of ELF Mk 1A Conceptual Design Neutronic Analysis
ECAR-3162 Rev 0	ELF Concept Structural Evaluation for ATR Vessel Loadings
DWG-604400 Rev 0	ATR Mark 1A ELF Fuel Element Drawing
SPC-1694 Rev 0	ATR Mark 1A ELF Fuel Specification

1129-0076-CALC-002	ATR LEU Cycle R1 Analysis
1129-0076-CALC-003	Mark 1A ELF Thermal Hydraulic Inputs
1129-0076-CALC-006	ATR LEU Cycle R2 Analysis

3. Reviewers and Attendees

Three mandatory reviewers were selected by the ATR Conversion project to review work in their fields of expertise. Hikaru Hiruta reviewed the neutronic ECARs. Nolan Anderson reviewed the thermal/hydraulic Calculation Reports (CALCs), and Nate Oldham reviewed the fuel element drawings and structural ECARs. All others who attended the conceptual design review kickoff meeting were invited to review the documents and provide comments if they desired.

Table 2 is a list of attendees at the design review kickoff meeting. It also shows who submitted a written comment sheet. The attendance sheet is attached as Appendix A. All of the comment sheets are included in Appendix B.

Table 2. Attendees at the Conceptual Design Review.

Name	Organization	Review Status
Gable Roth	INL	
Charles Maggart	DOE-NE	
Andrew Keene	MPR	
Brian Hallee	MPR	
Mary Rose Holtz	INL	
Boyd Christensen	INL	Comments Received
Zain Karriem	INL	
Jeff Brower	INL	Comments Received
Nolan Anderson	INL	Mandatory Reviewer – Thermal/Hydraulic
Hikaru Hiruta	INL	Mandatory Reviewer - Neutronic
Adam Robinson	INL	
Vern M Peterson	DOE-ID	
Ryan Little	INL	
Aleksey Rezvoi	INL	
Vic Pearson	DOE	
Evan Nef	INL	
Eric Woolstenhulme	INL	
Thad Heltemes	ANL	
Nick Woolstenhulme	INL	
Barry Rabin	INL	
Erik Wilson	ANL	
Tom Maddock	INL	
Jody Henley	INL	
Anne McCartin	INL	Comments Received

Nate Oldham	INL	Mandatory Reviewer - Mechanical
Demetrius Siachames	MPR	
John Stillman	ANL	Did not attend kickoff meeting but compiled and submitted all ANL comments
Jeff Sherman	INL	Comments Received
Joe Palmer	INL	Design Review Chairman

4. Recommendations

1. The ATR LEU Conversion Project has spent many years performing scoping studies and conceptual work. The final set of conceptual design documents subject to this review has shown the design is mature enough to move beyond the conceptual phase. The project recognizes that there are still outstanding questions and issues that need to be resolved. The conceptual analysis provides a high level of confidence that the remaining issues can be overcome using the current conceptual design as the basis. The details of those solutions will need to be determined in the final design and will require element testing.
2. It is recommended that the final design process for the ATR conversion begin immediately. The most notable change in the transition from conceptual to final design will be the types of documents created and their quality level. Final design documents will be performed as safety SSC applicable to support element testing in the ATR which will require safety basis changes. Those changes will come in the form of SAR addendums and revisions.
3. The element drawing and fuel specification were acceptable for a conceptual design, but lacked some of the detail required for final design and fabrication. The element drawings should be redrawn using 3D parametric design software. A revised drawing and fuel specification should be released and sent to the U. S. HPRR Fuel Fabrication pillar to confirm that minor changes or clarifications do not affect the ability to fabricate the fuel elements. The 3D model should be used to estimate the element mass for future structural calculations. Drawing changes should also be disseminated to the thermal, hydraulic, nuclear, and structural analysts to confirm their models, calculations, reports, and references are correct.
4. It is recommended that with the creation of new fuel element drawings, a new name be given to the ATR LEU fuel element to distinguish the final design work from the conceptual or scoping work done under the titles Mark 1A and ELF. The recommended name is the LOWE element, simply standing for low enriched. The name or acronym used for the fuel element has implications in the SAR. LOWE was selected to avoid confusion with other acronyms and descriptions already in use. If future variations of the new element with different plate loadings are required for ATRC or to minimize Beryllium cracking, a “type” designator could be added i.e. LOWE Type 1 and LOWE Type 2.
5. Although the drawings for the fuel elements require some refinement, it is recommended that the current element design be approved for fabrication. Very small changes to plate positions and channel gaps are expected as well as clarification on the fuel foil location. There are no expected changes to fuel foil and cladding thickness. The fabrication of fuel plates can begin with no increased risk while the remaining details are worked out.

Appendix A
Attendance Sheet

ATR LEU Fuel Element Conceptual Design Review Meeting October 26, 2017		
Name	Company/Lab	Email
Gable Roth	BEA	gable.roth@inl.gov
Charles Maggart	DOE NE	maggarcl@id.doe.gov
Andrew Koene	MPR	akeene@mpr.com
Brian Hallee	MPR	bhallee@mpr.com
Mary Rose Holtz	BEA	rose.holtz@inl.gov
Byrd Christensen	BEA	byrd.christensen@inl.gov
Zain Karriem	BEA	zain.karriem@inl.gov
JEFF BROWER	BEA	jeffrey.brower@inl.gov
Nolan Anderson	BEA	nolan.anderson@inl.gov
Hikaru Hiruta	BEA	hikaru.hiruta@inl.gov
ADAM ROBINSON	BEA	ADAM.ROBINSON@INL.GOV
VERN M PETERSON	DOE-ID	petersvm@id.doe.gov
RYAN LITTLE	BEA - ATR	Ryan.Little@inl.gov
Aleksey Rezvoi	BEA - ATR	aleksey.rezvoi@inl.gov
Vic Pearson	DOE-ID	pearsove@id.doe.gov
Evan Nef	BEA	Evan.Nef@INL.GOV
Eric Woolstenhulme	INL	ecw@inl.gov
Thad Heltemes	ANL	heltemes@anl.gov
Nick Woolstenhulme	INL	woolne@inl.gov
Barry Rabin	INL	barry.rabin@inl.gov
ERIK WILSON	ANL	WILSONE@anl.gov
Tom Maddock	INL	thomas.maddock@inl.gov
Judy Henley	INL	judy.henley@inl.gov
Anne McCartin	INL	anne.mccartin@inl.gov
Nate Oldham	INL	nate.oldham@inl.gov
Demetrios Siachames	MPR	dsiachames@mpr.com

ATR LEU Fuel Element Conceptual Design Review Meeting October 26, 2017		
Name	Company/Lab	Email
Jeff Sherman	BEA / INL	Jeffrey.Sherman@inl.gov
Joe Palmer	BEA/INL	joe.palmer@inl.gov

Appendix B

Comment Review Sheets

412.13
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DOCUMENT MANAGEMENT
REVIEW COMMENTS AND RESOLUTIONS

Tracking No.: _____ (Optional)

Technical Point of Contact:	Phone No.:	Return Comments To:	MS:	E-Mail:	Comments Due By:	Reviewer's Name/Discipline:	Phone No.:
MPR						Anne K. McCartin	208-533-4461

Comments resolved by:	Date:	Signature of reviewer accepting comment resolutions:	Date:
Collin Clark	12/4/2017	Anne K McCartin	1/9/2018

Comments, submitted within the scope of the review, should be resolved between reviewer and document owner, or their agent. If an acceptable resolution cannot be negotiated, the reviewer may escalate the issue to management for resolution.

Document ID: 1129-0076-CALC-006			Document Title: ATR LEU Cycle R1 Analysis	Revision ID Revision 1	eCR No.:
Item No.	Page No	Section or Zone	Review Comment	Comment Resolution	
1		3.1	3.1 and throughout – we should eliminate use of PALM. The use of PALM for a high power cycle is slang and can be misleading. PALM is only indicative of the hardware that cycles a test in and out of the core, and the hardware is also frequently used during lower power cycles. The R2 analysis is not evaluating any cycled experiments, so we should not be referring to it as a PALM.	Changed the naming convention from "PALM Operation" case to "Steady Operation" case throughout the document.	

Page 1

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Tracking No.: _____ (Optional)

Document ID: 1129-0076-CALC-006			Document Title: ATR LEU Cycle R1 Analysis	Revision ID Revision 1	eCR No.:
Item No.	Page No	Section or Zone	Review Comment	Comment Resolution	
2		3.3	This section (and elsewhere) states that the SBLOCA case represents a 3-in. break in a demineralizer line. The SAR SBLOCA is a DEOS of the 6-in line leading from the 36-in reactor vessel inlet line to the bypass demineralizer downstream of a 2.5 in. orifice (which is assumed to have a diameter of 3 in.). Please clarify the break location.	The SBLOCA is modeled with a 3 in. equivalent break size using component 594 in the RELAP5 deck. This component represents a 3 in break in the 6 in. bypass demineralizer line (component 593), just as is modeled in Section 15.6.4 of the SAR. MPR has adjusted the wording in the calculations to clarify the location of the break. The sentence discussing the SBLOCA in Section 3.3 has been changed to, "The SBLOCA case represents a break in the 6 inch bypass demineralizer line downstream of a 2.5 inch orifice that is modeled as a 3 inch orifice for this analysis. This case challenges the Emergency Coolant Pump (ECP) and Emergency Firewater Injection System (EFIS) to protect the fuel." In Section 9.2 the first sentence has been replaced with, "The SBLOCA is initiated by opening a 3 inch break in the 6 inch bypass demineralizer line."
3		4.0	Similar to my comment on the R1 analysis. Position 18 is known to be limiting based on it having the peak point-to-average power density for a 70/20 split. Table 4-1 indicates that the limiting element x-x-18 was a fresh element for this cycle. Since some material properties are influenced by fission density, how does this analysis provide reasonable assurance that acceptable margins will be demonstrated for recycled fuel elements in that position?	The purpose of the Cycle R1 and R2 calculations is to provide reasonable confidence in the safety of using ELF Mk 1A fuel in the ATR core as a driver fuel. It is acknowledged that the Cycle R1 and Cycle R2 calculations are limited in scope and still in the conceptual design phase. Future calculations will be needed to further refine the safe power-to-burnup envelope for specific positions throughout the core.	

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Tracking No.: _____ (Optional)

Document ID: 1129-0076-CALC-006			Document Title: ATR LEU Cycle R1 Analysis	Revision ID Revision 1	eCR No.:
Item No.	Page No	Section or Zone	Review Comment	Comment Resolution	
4		5.5	This discussion needs clarification that these are not the SAR-153 acceptance criteria but proposed acceptance criteria for LEU fuel. Note – SAR wording for Condition 2 has changed and is not consistent with what is presented herein.	Added the following sentence to the end of the first paragraph in Section 5.5. "Due to differences in the LEU fuel design and analysis methodology, the acceptance criteria proposed in Table 5-1 are different than the ATR SAR; however, the acceptance criteria in Table 5-1 are consistent with the safety basis and intent of the ATR SAR." The last sentence of the paragraph describing a Condition 2 event has been changed to reflect the wording found in SAR-153-15-0, Revision 25. This sentence now reads, "No rupture of the fuel plate cladding is allowable unless the accident is a fuel failure which occurs independent of a reactor, PCS, or canal accident."	

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Tracking No.: _____ (Optional)

Document ID: 1129-0076-CALC-006			Document Title: ATR LEU Cycle R1 Analysis	Revision ID Revision 1	eCR No.:
Item No.	Page No	Section or Zone	Review Comment	Comment Resolution	
5		7.1.2	This section should provide some clarification for the reader that these transient cases are not representative of the Chapter 15 bounding accident analyses. Specifically, the steady state conditions for initiation of the transients are specific to this cycle and not representative of the steady state conditions assumed in Ch 15 (they are actually higher than assumed in Ch 15).	Based on the multiple comments about the ATR SAR, the purpose statement (Section 1.0) of this calculation is adjusted to provide clarity that this is not a calculation of record for the ATR SAR. The following sentence is added to the end of the first paragraph of Section 7.1.2. "The transient cases in this calculation are not intended to represent the bounding accident transients of the ATR SAR." Added the following sentence to the end of the paragraph under Initial Conditions. "The initial conditions in this calculation are not intended to represent the initial conditions used for the accident analyses in the ATR SAR."	
6		7.1.5	Bullet following Figure 7-14. The analysis cites a SIPT experimental loop power adjustment to 694 kW per Roth. Question – the Roth analysis assumes 250 WM for the loop MOD3 model and 179.5 MW for the core MOD2.5 model. I am not clear on the interaction between the two models, but if your core model power is 230 MW, is the 694 kW max experiment loop power calculated in Roth still representative of the max experiment loop power or could the max be higher?	The 694 kW total experiment loop power is appropriate since it produces an experimental fission power of 200 kW, which is the operational limit given for the SIPT in EDF-4520. This assumes that the SIPT model power distribution is appropriate for an LEU core and for all power tilts, which are both reasonable assumptions. An Assumption will be added to the Calculations that states, "The power distribution of the SIPT is assumed to be unchanged due to LEU fuel or due to the modeled core power tilt. These are reasonable assumptions since the SIPT power distribution is primarily an axial distribution, which is very similar for LEU and HEU fuel, and for different core power tilts."	

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Document ID: 1129-0076-CALC-006			Document Title: ATR LEU Cycle R1 Analysis	Revision ID Revision 1	eCR No.:
Item No.	Page No	Section or Zone	Review Comment	Comment Resolution	
7		8.0	The paragraph discussing use of ATR-SINDA on bechler should include acknowledgement that use on bechler has not been qualified under the INL QA program at the time of this calculation's signing (similar to what was identified for SASQUATCH).	Added the following sentence to the end of the paragraph discussing ATR-SINDA. "This program is undergoing qualification under INL's QA program for use on bechler at the time of this calculation's signing."	
8		9.2.1	Editorial. First sentence should read "sequence of events..." Same comment for 9.3.1 and 9.4.1.	Fixed.	
9		10.0	Reference 14. Editorial. National is spelled wrong. Also, the GDE is not issued in EDMS. It either needs issued or should be cited as draft.	Fixed.	

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Technical Point of Contact:	Phone No.:	Return Comments To:	MS:	E-Mail:	Comments Due By:	Reviewer's Name/Discipline:	Phone No.:
MPR						Anne K. McCartin	208-533-4461

Comments resolved by:	Date:	Signature of reviewer accepting comment resolutions:	Date:
Raheem Rashid	12/5/2017	Anne McCartin	1/9/2018

Comments, submitted within the scope of the review, should be resolved between reviewer and document owner, or their agent. If an acceptable resolution cannot be negotiated, the reviewer may escalate the issue to management for resolution.

Document ID: 1129-0076-CALC-003 R1	Document Title: Mark1A ELF Thermal Hydraulic Inputs	Revision ID Revision 1	eCR No.:

Item No.	Page No	Section or Zone	Review Comment	Comment Resolution
1			List of References. References 8 and 22 are out of date and should reflect the current versions at time of issue.	Agreed. Reference 8 has been changed to spc-1635 which contains the fuel plate specifications referenced. SAR-153 is replaced with the SINDA-SAMPLE manual in the reference list to avoid referencing the SAR. SINDA-SAMPLE Heat Transfer Correlation Uncertainties citation has also been corrected.

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MPR						Anne K. McCartin	208-533-4461

Comments resolved by:	Date:	Signature of reviewer accepting comment resolutions:	Date:
Collin Clark	12/4/2017	Anne K McCartin	1/9/2018

Comments, submitted within the scope of the review, should be resolved between reviewer and document owner, or their agent. If an acceptable resolution cannot be negotiated, the reviewer may escalate the issue to management for resolution.

Document ID: 1129-0076-CALC-002			Document Title: ATR LEU Cycle R1 Analysis	Revision ID Revision 1	eCR No.:
Item No.	Page No	Section or Zone	Review Comment	Comment Resolution	
1		3.2	Item 4 should be reworded to eliminate use of PALM. The use of PALM for a high power cycle is slang and can be misleading. PALM is only indicative of the hardware that cycles a test in and out of the core, and the hardware is also frequently used during lower power cycles. The R2 analysis is not evaluating any cycled experiments, so we should not be referring to it as a PALM.	The mention of PALM is removed from the description of Cycle R2. The "normal operation" case is now referred to as the "steady operation" case to be consistent with the new terminology in the Cycle R2 calculation.	

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Document ID: 1129-0076-CALC-002			Document Title: ATR LEU Cycle R1 Analysis	Revision ID Revision 1	eCR No.:
Item No.	Page No	Section or Zone	Review Comment	Comment Resolution	
2		3.3	This section (and elsewhere) states that the SBLOCA case represents a 3-in. break in a demineralizer line. The SAR SBLOCA is a DEOS of the 6-in line leading from the 36-in reactor vessel inlet line to the bypass demineralizer downstream of a 2.5 in. orifice (which is assumed to have a diameter of 3 in.). Please clarify the break location.	The SBLOCA is modeled with a 3 in. equivalent break size using component 594 in the RELAP5 deck. This component represents a 3 in break in the 6 in. bypass demineralizer line (component 593), just as is modeled in Section 15.6.4 of the SAR. MPR has adjusted the wording in the calculations to clarify the location of the break. The sentence discussing the SBLOCA in Section 3.3 has been changed to, "The SBLOCA case represents a break in the 6 inch bypass demineralizer line downstream of a 2.5 inch orifice that is modeled as a 3 inch orifice for this analysis. This case challenges the Emergency Coolant Pump (ECP) and Emergency Firewater Injection System (EFIS) to protect the fuel." In Section 9.2 the first sentence has been replaced with, "The SBLOCA is initiated by opening a 3 inch break in the 6 inch bypass demineralizer line."	

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Item No.	Page No	Section or Zone	Review Comment	Comment Resolution	
3		3.6	Editorial. Second paragraph. Second sentence is missing an "of". "...because the combination of its power and fission density..."	Corrected during Nolan's review.	
4		4.0	Position 23 is known to be limiting based on it having the peak point-to-average power density for a 60/40 split. Table 4-1 indicates that the limiting element x-x-23 was a fresh element for this cycle. Since some material properties are influenced by fission density, how does this analysis provide reasonable assurance that acceptable margins will be demonstrated for recycled fuel elements in that position? Figure 3-1 indicates many once used (and twice) used elements with much higher fission densities.	The purpose of the Cycle R1 and R2 calculations is to provide reasonable confidence in the safety of using ELF Mk 1A fuel in the ATR core as a driver fuel. It is acknowledged that the Cycle R1 and Cycle R2 calculations are limited in scope and still in the conceptual design phase. Future calculations will be needed to further refine the safe power-to-burnup envelope for specific positions throughout the core.	
5		5.5	This discussion needs clarification that these are not the SAR-153 acceptance criteria but proposed acceptance criteria for LEU fuel. Note – SAR wording for Condition 2 has changed and is not consistent with what is presented herein.	Added the following sentence to the end of the first paragraph in Section 5.5. "Due to differences in the LEU fuel design and analysis methodology, the acceptance criteria proposed in Table 5-1 are different than the ATR SAR; however, the acceptance criteria in Table 5-1 are consistent with the safety basis and intent of the ATR SAR." The last sentence of the paragraph describing a Condition 2 event has been changed to reflect the wording found in SAR-153-15-0, Revision 25. This sentence now reads, "No rupture of the fuel plate cladding is allowable unless the accident is a fuel failure which occurs independent of a reactor, PCS, or canal accident."	

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Document ID: 1129-0076-CALC-002			Document Title: ATR LEU Cycle R1 Analysis	Revision ID Revision 1	eCR No.:
Item No.	Page No	Section or Zone	Review Comment	Comment Resolution	
6		7.1.2	This section should provide some clarification for the reader that these transient cases are not representative of the Chapter 15 bounding accident analyses. Specifically, the steady state conditions for initiation of the transients are specific to this cycle and not representative of the steady state conditions assumed in Ch 15, and the scaling of the loop power for the LOCP is also cycle-specific.	Based on the multiple comments about the ATR SAR, the purpose statement (Section 1.0) of this calculation is adjusted to provide clarity that this is not a calculation of record for the ATR SAR. Added the following sentence to the end of the first paragraph of Section 7.1.2. "The transient cases in this calculation are not intended to represent the bounding accident transients of the ATR SAR." Added the following sentence to the end of the paragraph under Initial Conditions. "The initial conditions in this calculation are not intended to represent the initial conditions used for the accident analyses in the ATR SAR." No change is made for the scaling of the loop power. The second bullet in Initial Conditions in Section 7.1.5 states that the scaled loop power is cycle specific.	
7	22		Editorial. First paragraph under Pump Parameters is missing a period.	Fixed.	
8		8.0	The paragraph discussing use of ATR-SINDA on bechler should include acknowledgement that use on bechler has not been qualified under the INL QA program at the time of this calculation's signing (similar to what was identified for SASQUATCH).	Added the following sentence to the end of the paragraph discussing ATR-SINDA. "This program is undergoing qualification under INL's QA program for use on bechler at the time of this calculation's signing."	
9		9.1.1	Table 9-1. Note 2. Editorial. Delete extraneous "is a" – "… and vessel inlet pressure are ~~is a~~ constant RELAP5 inputs."	Corrected during Nolan's review.	
10		9.2.1	Editorial. First sentence should read "sequence of events…" Same comment for 9.3.1 and 9.4.1.	Fixed.	

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Item No.	Page No	Section or Zone	Review Comment	Comment Resolution	
11		10.0	Reference 14. Editorial. National is spelled wrong. Also, the GDE is not issued in EDMS. It either needs issued or should be cited as draft.	Fixed.	

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Tracking No.: _____ (Optional)

Technical Point of Contact:	Phone No.:	Return Comments To:	MS:	E-Mail:	Comments Due By:	Reviewer's Name/Discipline:	Phone No.:
Boyd Christensen							

Comments resolved by:	Date:	Signature of reviewer accepting comment resolutions:	Date:
Thomas Maddock	Unknown		1-9-18

Comments, submitted within the scope of the review, should be resolved between reviewer and document owner, or their agent. If an acceptable resolution cannot be negotiated, the reviewer may escalate the issue to management for resolution.

Document ID: SPC-1694, Cacl-002, Calc-003			Document Title:	Revision ID:	eCR No.:
Item No.	Page No	Section or Zone	Review Comment	Comment Resolution	
1	9 of 39	1.1	SPC-1694, Editorial: In line 13 of the first para "This document is intended to be used..." Need to add the word "as"	Accepted, the change will be made.	
2	11 of 39	1.3	Calc-003, Editorial: In the first two para after Figure 1, be consistent in the use of "nineteen" curved plates and "19"	Do not agree. The word 'nineteen' is not used in the calculation.	
3		10.0	Calc-002, Spell checkReferences: 3 (Laboratories to Laboratory), 14 (Natioanl Laboratories to National Laboratory), 19 (Laboratoies to Laboratory)	Fixed.	
4		7.0	Calc-003, Spell check Ref 13 (Laboratory, not Laboratories)	This reference is deleted from the proposed rev. 2 version of this calculation to resolve another review comment for this calculation.	

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						Earl Feldman/Thermal-Hydraulics & John [redacted]	630-252-4277

Comments resolved by:	Date:	Signature of reviewer accepting comment resolutions:	Date:
Tom Eglet	3/19/2018	(John Stillman)	12/19/17

Comments, submitted within the scope of the review, should be resolved between reviewer and document owner, or their agent. If an acceptable resolution cannot be negotiated, the reviewer may escalate the issue to management for resolution.

Document ID: 1129-0076-CALC-003, Revision 1	Document Title: Mark 1A ELF Thermal Hydraulic Inputs	Revision ID: 1	eCR No.:

Item No.	Page No	Section or Zone	Review Comment	Comment Resolution
1	31	Fueled Width	When the equation for fueled width is evaluated using the fuel plate radii derived from Section E-E, Sheet 3, of DWG-604400, it does not match the values of the fuel width reported in Table 4-1 (page 9).	There is a typographical error in the equation. The widths of the side plate water channels 2 x 0.032" are also subtracted from the fuel element envelope. This is accounted for in the fueled widths reported in Table 4-1, so the values are correct. The equation will be updated to reflect the contribution of the side plate water channels. RESPONSE FROM ANL: This issue was previously identified and addressed as documented in ANL/RTR/TM-17/5, Section 4.3.4, where MPR noted that the element spacing should not be included in the calculation of the fuel arc width. The radiii in Section E-E, Sheet 3, DWG-604400 are relatative to a centroid formed by two lines that run along the outside edge of the side plates, and thus exclude the spacing between elements when they are loaded in the ATR core. However, while the fuel meat arc widths reported in Table 4-1 of the subject report are calculated with a formula that uses the element spacing, the analysis appears to be conservative. We accept the resolution.

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Document ID: 1129-0076-CALC-003, Revision 1			Document Title: Mark 1A ELF Thermal Hydraulic Inputs	Revision ID: 1	eCR No.:
Item No.	Page No	Section or Zone	Review Comment	Comment Resolution	
3	21	Fuel Blistering Temp. Correlation	This may be a typographical error. It appears that "Reference 13" was inadvertently substituted for "Reterence 9".	This error has been addressed and corrected in another review comment and resolution form. RESPONSE FROM ANL: It is uncertain what the resolution of this comment is. Nonetheless, as this is a typographical error, we acknowledge that the error has been corrected.	
4	20	Plate Swelling Correlation	This may be typographical error. The term "t0" in the denominator should be in the numerator. As written, the equation evalutes to an incorrect value for the plate thickness increase due to swelling.	This error has been addressed and corrected in another review comment and resolution form. RESPONSE FROM ANL: It is uncertain what the resolution of this comment is. Nonetheless, as this is a typographical error, we acknowledge that the error has been corrected.	

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						John Stillman/Neutronics & Lara	630-252-4277

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Thomas Maddock	Unknown	(John Stillman)	12/19/17

Comments, submitted within the scope of the review, should be resolved between reviewer and document owner, or their agent. If an acceptable resolution cannot be negotiated, the reviewer may escalate the issue to management for resolution.

Document ID: DWG-604400	Document Title: ATR Enhanced LEU Fuel (ELF) Element Assembly	Revision ID:	eCR No.:

Item No.	Page No	Section or Zone	Review Comment	Comment Resolution
1	3		The fuel core boundary is drawn with a minimum core boundary that is 0.570 inches from the ends of the fuel plate and a maximum core boundary that is 0.370 inches from the ends of the fuel plate. The nominal fuel plate length is 49.5 inches. For the fuel core to fit within the minimum and maximum core boundaries, the fuel core length must be between 48.36 and 48.76 inches, but the nominal fuel core length for ATR fuel is 48.0 inches.	The fuel core boundary and the associated dimensions and tolerances will be redrawn in a way that inculdes the nominal value of 48 inches and maintains the same acceptable range of .4 inches on the length. ANL RESPONSE: We accept the resolution.

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						Earl Feldman/Thermal-Hydraulics & John [illegible]	630-252-4277

Comments resolved by:	Date:	Signature of reviewer accepting comment resolutions:	Date:
Thomas Maddock	Unknown	(John Stillman)	12/19/17

Comments, submitted within the scope of the review, should be resolved between reviewer and document owner, or their agent. If an acceptable resolution cannot be negotiated, the reviewer may escalate the issue to management for resolution.

Document ID: ECAR-3162	Document Title: ELF Concept Structrual Evaluation for ATR Vessel Loadings	Revision ID:	eCR No.:

Item No.	Page No	Section or Zone	Review Comment	Comment Resolution
1	I5	Condition 4 RIA	This is a typographical error. The second bullet states that the "Greater than 3-inch RIA temperatures..." This should be "Greater than 0.5-inch temperatures..."	The typo will be corrected to say 0.5 instead of 3 inch. ANL RESPONSE: We accept the resolution.

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						John Stillman/Neutronics & Lara [illegible]	630-252-4277

Comments resolved by:	Date:	Signature of reviewer accepting comment resolutions:	Date:
Matt Johnson	Unknown	(John Stillman)	12/19/17

Comments, submitted within the scope of the review, should be resolved between reviewer and document owner, or their agent. If an acceptable resolution cannot be negotiated, the reviewer may escalate the issue to management for resolution.

Document ID: ECAR-3908	Document Title: Serpent Model Used in ELF Mk 1A Conceptual Design Neutronics Analysis	Revision ID:	eCR No.:

Item No.	Page No	Section or Zone	Review Comment	Comment Resolution
1	11	8.2.1	Typographical error. It is stated that all coolant channels in the model are 0.0307 cm wide. All coolant channels are modeled as the same width (more commonly, the term thickness is applied to this dimension). Channels 1-10 in the ATR element are 0.078 inches "thick," which converts to 0.1981 cm. Suspect that a units conversion error was made in reporting the value in the text.	Sentence changed to "All coolant channels are 0.1981 cm thick" ANL RESPONSE: We accept the resolution.

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Document ID: ECAR-3908			Document Title: Serpent Model Used in ELF Mk 1A Conceptual Design Neutronics Analysis	Revision ID:	eCR No.:
Item No.	Page No	Section or Zone	Review Comment	Comment Resolution	
2	11	Table 2	Serpent model may use a fueled width that is narrower than the nominal fuel dimensions. This is conservative in some respects. For cycle length may be non-conservative. The as-modeled dimensions for the fuel meat of each plate is given. Using the arc length and avg. radius values specified in Table 2, assuming a side plate width of 0.187 inches, and the equation for the fueled width provided on page 31 of MPR report 1129-0076-CALC-003, the correpsonding unfueled width from the edge of the fuel meat to the side plate can be calculated. This calculation yields an unfueled width of 0.127 inches. This value is within the range of 0.045 to 0.145 inches for the unfueled width specified in Section E-E of Sheet 3 of DWG-604400. However, it is wider than the nominal unfueled width of 0.095 inches.	The mean fuel meat arc lengths provided in Table 4-1 of 1129-0076-CALC-003 match the Serpent model. The fuel meat arc length formula given in the MPR report contained a typo that has been fixed. To summarize, if 45 degrees is used for θ and 187 mils is used as the sideplate thickness, the water gap between elements must also be included in the formula like so: W_f = 2π*R_f*θ/360 - 2*W_sp- 2W_(sp-f)-W_wg where W_wg is the water gap width of 0.064 mils. This formula is consistent with the centers of the fuel plate radii being coincident with the center of the flux trap. The nominal unfueled widths can be back-calculated correctly using this formula along with arc lengths and radii from ECAR-3908. Additionally, I have verified that the unfueled width in the Serpent model is correct by examining the surface definitions in the input and manually calculating the distance between the planes that define the inside of the sideplate and the fuel meat edge. RESPONSE FROM ANL: This issue was previously identified and addressed as documented in ANL/RTR/TM-17/5, Section 4.3.4, where MPR noted that the element spacing should not be included in the calculation of the fuel arc width. The radiii in Section E-E, Sheet 3, DWG-604400 are relatative to a centroid formed by two lines that run along the outside edge of the side plates, and thus exclude the spacing between elements when they are loaded in the ATR core. However, while the fuel meat arc widths reported in Table 2 of the subject report are calculated with a formula that uses the element spacing, the analysis appears to be	

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						John Stillman/Neutronics & Lara [illegible]	630-252-4277

Comments resolved by:	Date:	Signature of reviewer accepting comment resolutions:	Date:
Matt Johnson	Unknown	John Stillman	12/19/17

Comments, submitted within the scope of the review, should be resolved between reviewer and document owner, or their agent. If an acceptable resolution cannot be negotiated, the reviewer may escalate the issue to management for resolution.

Document ID: ECAR-3909			Document Title: Results of ELF Mk 1A Conceptual Design Neutronics Analysis	Revision ID:	eCR No.:
Item No.	Page No	Section or Zone	Review Comment	Comment Resolution	
1	9	8.1	Typographical error near the bottom of the page. It is stated that "element 5 has a history of "34-30", meaning it occupied position 34 during P1 and position 30 during P1." The last occurrence of "P1" in this sentence should be "P2".	Sentence corrected to read "... and position 30 during P2" ANL RESPONSE: We accept this resolution.	
2	10	Table 3, 4	Typographical error. The EOC exposure is given in unites of MW. This should be MWd.	Units changed to MWd ANL RESPONSE: We accept this resolution.	

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						John Stillman/Neutronics & Lara	630-252-4277

Comments resolved by:	Date:	Signature of reviewer accepting comment resolutions:	Date:
Thomas Maddock	Unknown	(John Stillman)	12/19/17

Comments, submitted within the scope of the review, should be resolved between reviewer and document owner, or their agent. If an acceptable resolution cannot be negotiated, the reviewer may escalate the issue to management for resolution.

Document ID: SPC-1694			Document Title: Specification for Advanced Test Reactor Low Enriched Uranium (LEU) Fuel Elements	Revision ID:	eCR No.:
Item No.	Page No	Section or Zone	Review Comment	Comment Resolution	
1	19	3.3.1.1	It is stated that fuel bearing plates "shall be in compliance with Section 3.1 of this specification." Section 3.1 of SPC-1694 specifies requirements for the fuel foil. Should Section 3.2, which specifies requirements for the fuel plates, also be included in this statement?	Changed to read "shall be in compliance with Section 3.1 and 3.2 of this specification." ANL RESPONSE: We accept the resolution.	
2	33-36	8	Recommend using the definitions in SPC-1635 (Rev. 8, dated 10/31/17). This would be especially helfpful for the definitions of Diffusion Barrier Layer, Foil, Fuel Core, Fuel Plate, and Fuel System. The term "Fuel Meat" is used in SPC-1694, but this is not the typical term for monolithic fuels.	The term "Fuel Meat" will be removed from the definition list and other definitions will be revised to be consistant with the latest version of SPC-1635 ANL RESPONSE: We accept the resolution.	

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						Nate Oldham Mechanical Engineering	6-6336

Comments resolved by:	Date:	Signature of reviewer accepting comment resolutions:	Date:
Thomas Maddock	Unknown	Nate Oldham	2018 Jan 25

Comments, submitted within the scope of the review, should be resolved between reviewer and document owner, or their agent. If an acceptable resolution cannot be negotiated, the reviewer may escalate the issue to management for resolution.

Document ID: ECAR-3182			Document Title: ELF Concept Structural Evaluation	Revision ID: -	eCR No.: -
Item No.	Page No	Section or Zone	Review Comment	Comment Resolution	
1.	B25	Weight	Dry weight is calculated at 41.3 lbf and drawing says 37.3 lbf.	A suggested change was added to the document in EDMS to correct this error when the document is revised next. A revision is planned for 2018.	
2.	B41-B42	Item 32	Actual weld area is machined down to remove slots from side plates. I believe that the model incorrectly has too much cross-sectional area in the weld region.	A suggested change was added to the document in EDMS to correct this error when the document is revised next. A revision is planned for 2018.	
				Changes to be made at revision 1	
				01/23/18. Suggestion ID	
				23159, 23160 and 23161	

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						Nate Oldham Mechanical Engineering	6-6336

Comments resolved by:	Date:	Signature of reviewer accepting comment resolutions:	Date:
Thomas Maddock	Unknown	Nate Oldham	2018 Jan 25

Comments, submitted within the scope of the review, should be resolved between reviewer and document owner, or their agent. If an acceptable resolution cannot be negotiated, the reviewer may escalate the issue to management for resolution.

Document ID: 604400			Document Title: ATR ELF Element Assembly	Revision ID: -	eCR No.: -
Item No.	Page No	Section or Zone	Review Comment	Comment Resolution	
1.	1	Weld call-out	Thsis drawing shows a one-sided weld. It seems more likely that this is a double sided weld.	Confirmed welds are actually one sided. No change being made.	
2.	1	Item 32	Add UNS R60001 to item material description.	Change has been made	
3.	All	All	The Mark VII fuel element has been updated to Autodesk Inventor software. Suggest converting this drawing from Autocad to Inventor to be consistent.	This is going to be done in the near future. Current drawing set is being revised one more time.	
4.	2	Zone C2	The 4X on the tack weld and the 2X on the view along with the double-sided weld symbol makes it seem like there is 16 welds. Suggest just removing the 4X because the tail description describes it best.	Change has been made	
5.	3	Table 1	This table along with the plate detail describe inspection dimensions. I suggest adding a table of nominal dimensions – i.e. radius, arc lengths, and fuel thickness – so that it can be modeled correctly.	No change is currently being made. This is being considered for a planned drawing revision in the near future.	
6.	3	Zone D7	Identify the tooling point.	Change has been made	
7.	3	Zone B3	Add section arrows to show where the view M section is applicable.	Change has been made	
8.	3	Zone B1	Suggest mentioning that fuel plate items are bonded per SPC-1694.	Bonding lines were update to accurately show how LEU fuel is made.	
9.	3	Zone C1	View M shows the Zr interlayer on the ends of the fuel meat. This is inconsistent with SPC-1694.	Zr was removed from the end of detail view.	
10.	All	All	Misc. editorial comments provided per a redline markup of the drawing.	Other editorial comments were accepted.	

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						Nolan Anderson/Thermalhydraulics	208 526-9323

Comments resolved by:	Date:	Signature of reviewer accepting comment resolutions:	Date:
Collin Clark	11/17/2017	Nolan Anderson	12-14-17

Comments, submitted within the scope of the review, should be resolved between reviewer and document owner, or their agent. If an acceptable resolution cannot be negotiated, the reviewer may escalate the issue to management for resolution.

Document ID: 1129-0076-CALC-006			Document Title: ATR LEU Cycle R2 Analysis	Revision ID: 0 (preliminary)	eCR No.:
Item No.	Page No	Section or Zone	Review Comment	Comment Resolution	
1	18	7.1.3	Figure 7-6 gives the trips which shut down two of the pumps. Is the shutdown of the third pump automatic, or does an additional trip need to be added for the third pump?	Trips 455 and 456 are time delay trips for PCPs and are implemented for LOCA transients. Trip 455 completes the trip for pump 145 (PCP M-6) and Trip 456 completes the trip for pump 155 (PCP M-7) and 165 (PCP M-8). Therefore, these two trips alone accomplish the trip function for all three PCPs during a LOCA. In order to add clarity, an additional sentence is added.	
2	22,66	7.1.5,9.4	In speaking of the LOCP case the write up talks about 2 PCPs being active, but cycle R2 has three active PCPs. It appears that the input is correct, but the write up should be modified to indicate that 3 PCPs are active	The write-up is modified to indicate that 3 PCPs are active.	
3	22	7.1.5	Trip 452 displayed in Figure 7-17 is set to 2.0 in the input deck but is labelled as 0.0 here. I believe the Trip in the write up is incorrect, but correct in the input deck.	The write up is modified to indicated that trip 452 occurs at 2.0 seconds.	

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						Nolan Anderson/Thermalhydraulics	208 526-9323

Comments resolved by:	Date:	Signature of reviewer accepting comment resolutions:	Date:
Collin Clark	11/17/2017	Nolan Anderson	12-14-17

Comments, submitted within the scope of the review, should be resolved between reviewer and document owner, or their agent. If an acceptable resolution cannot be negotiated, the reviewer may escalate the issue to management for resolution.

Document ID: 1129-0076-CALC-002			Document Title: ATR LEU Cycle R1 Analysis	Revision ID: 0 (preliminary)	eCR No.:
Item No.	Page No	Section or Zone	Review Comment	Comment Resolution	
			No comment	No edits made due to comments.	

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						Nolan Anderson/Thermalhydraulics	208 526-9323

Comments resolved by:	Date:	Signature of reviewer accepting comment resolutions:	Date:
Raheem Rashid	November 20, 2017	Nolan Anderson	12-14-17

Comments, submitted within the scope of the review, should be resolved between reviewer and document owner, or their agent. If an acceptable resolution cannot be negotiated, the reviewer may escalate the issue to management for resolution.

Document ID: 1129-0076-CALC-003			Document Title: Mark 1A ELF Thermal Hydraulic Inputs	Revision ID: 1	eCR No.:
Item No.	Page No	Section or Zone	Review Comment	Comment Resolution	
1	10	4.1	The thermal conductivity properties listed in Table 4-2 are generated with a correlation given later in the document. This correlation is dependent on variable Fd (fission density). The properties in the table were calculated with a fission density of 0.0. Is this appropriate being that some of the fuel has already been irradiated? In any case, a comment should be added indicating that the thermal conductivity properties were calculated with Fd = 0.	A fission density of 0 is assumed for input to the RELAP model. This is reasonable because RELAP is used to model the bulk ATR system response while ATR-SINDA is used to model the detailed coolant channel and plate behavior. Thus material property degradation and fuel swelling are considered in the ATR-SINDA model, but not in RELAP5. Assumption 5 was added to the calculation to clarify this modeling assumption.	
2	10	4.1	The values that I calculated for the volumetric heat capacity using the provided correlations do not match the values in Table 4-2. The differences are not huge, but I calculated them for Fd = 0 with the exact same correlations and I got different results. This was not the case for the thermal conductivity.	The values in Table 4-2 are calculated using a constant U-10Mo density at room temperature. This is done to maintain the mass of fuel modeled in RELAP, which does not account for changes in volume as a function in temperature. A note will be added to the table to clarify this.	
3	20	5.6	Should add a note that the units that the correlations are converted to are necessary for input to SINDA.	Agreed; note added.	
4	20	5.6	Fd is listed as being fissions/cm^3, but it is actually 10^21 fissions/cm^3 to make the units work.	Agreed; units for fission density are corrected.	
5	20	5.6	Equation for tswell, t0 should be in the numerator.	Agreed; correlation is corrected.	
6	20	5.6	U10-Mo thermal conductivity equation converts T from F to K by (T+459.67)/1.8, but materials.dat file uses 273.15 + (T-32)/1.8 which is equivalent, but may cause confusion.	Agreed; temperature conversion is made consistent between materials.dat and calculation.	
7	21	5.6	The units for Fd for the fuel blistering temperature correlation are different than used otherwise. Here a value of > 1.5*10^21 fissions/cm^3 is required. Should make units of Fd consistent.	A new variable fd has been introduced with units of fissions/cm3 to avoid confusion with the varibale Fd with units of x1021 fissions/cm3.	

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Document ID: 1129-0076-CALC-003			Document Title: Mark 1A ELF Thermal Hydraulic Inputs	Revision ID: 1	eCR No.:
Item No.	Page No	Section or Zone	Review Comment	Comment Resolution	
8	21	5.6	Did not find the equation for Fuel Blistering Temperature when Fd > 1.5 *10^21 fissions/cm^3 in the Reference cited.	The reference cited has been updated.	

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				hikaru.hiruta	11/09/2017	Hikaru Hiruta	

Comments resolved by:	Date:	Signature of reviewer accepting comment resolutions:	Date:
Matt Johnson	Unknown		12.14.17

Comments, submitted within the scope of the review, should be resolved between reviewer and document owner, or their agent. If an acceptable resolution cannot be negotiated, the reviewer may escalate the issue to management for resolution.

Document ID: ECAR-3908			Document Title: Serpent Model Used in ELF Mk 1A Conceptual Design Neutronic Analysis	Revision ID:	eCR No.:
Item No.	Page No	Section or Zone	Review Comment	Comment Resolution	
1	7	4	What does "ELF" stand for? "ELF" appears in the first time in the statement "The dimension of the ELF Mk 1A element are taken ...". State a full name as "E___ L___ F___ (ELF)".	Wording changed as recommended.	
2	13		The title of Table 4 would be better to change to "Burnable region volumes in each axial level."	Title changed as recommended	
3	34	8.6.1	The first statement, "Serpent calculates reaction rates... ... by tallying a fine-group spectrum in each material.". Recommend to change to "Serpent calculates reaction rates ... by a unified energy grid for all materials." and cite Serpent manual as a reference.	Changed the statement to: "Serpent calculates the one-group cross sections needed for the depletion calculation by tallying a fine-group spectrum in each material and using this spectrum to collapse the continuous energy cross sections. The flux spectrum is calculated using the problem's unionized energy grid which contains about 200,000 points (see Section 8.6.2 for additional discussion of the unionized energy grid). "	
4	35		In Table 17, values in last 4 rows are not REs, so it should be mentioned in the footnote by putting marks (*, 1), or etc) in these numbers.	I split the table to show which quantities are REs and which quantities are +/-	
5	39		Is Figure 9 really showing the distribution of "peak" fission density? This sensitivity study was performed without azimuthal levels, right? Then, it should be just fission density instead of peak fission density?	You are correct. Plot axis label and plot title changed to reflect that it is the fission density.	
6	39		This is related to Item No. 5. Is table 19 comparing the difference of peak fission densities of 5- and 20-level cases which occur in the axial center of each plate or the maximum difference of the axial distribution of the fission density?	The table is comparing the peak which occurs at the axial midplane. Added wording to section 8.6.3.1" "Results are shown in Table 21. The results are presented as the percent difference in the peak fission density (i.e. the fission density at the core mid-plane) between the 5 level discretization and the 20 level discretization."	

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Document ID: ECAR-3908			Document Title: Serpent Model Used in ELF Mk 1A Conceptual Design Neutronic Analysis	Revision ID:	eCR No.:
Item No.	Page No	Section or Zone	Review Comment	Comment Resolution	
7	40		Similarly, Is Table 20 showing the percent difference of the peak fission densities, which occur in the azimuthal edge of plates? Please clarify.	Adjusted and added the following: "The effect on plate peak fission density at day 112 is shown Table 22. The peak fission density always occurs on either the left-most or right-most region of the plate."	
8	40		One more thing about this azimuthal discretization study. Do both 5 and 20 azimuthal-region cases have the same burnup zones (5 as stated in Section 8.2.1)? This should also be stated clearly.	Yes they do use the same burnup zones. I have written, "Two cases are considered, the first case has an azimuthal discretization identical to production runs. The second case has every plate divided into 20 equally sized azimuthal regions. Both discretizations use the plate material grouping as described in Table 3."	

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Technical Point of Contact:	Phone No.:	Return Comments To:	MS:	E-Mail: hikaru.hiruta	Comments Due By: 11/09/2017	Reviewer's Name/Discipline: Hikaru Hiruta	Phone No.:
Comments resolved by: Matt Johnson		Date: Unknown		Signature of reviewer accepting comment resolutions:		Date: 12/4/17	

Comments, submitted within the scope of the review, should be resolved between reviewer and document owner, or their agent. If an acceptable resolution cannot be negotiated, the reviewer may escalate the issue to management for resolution.

Document ID: ECAR-3909			Document Title: Results of ELF Mk 1A Conceptual Design Neutronic Analysis	Revision ID:	eCR No.:
Item No.	Page No	Section or Zone	Review Comment	Comment Resolution	
1	8	8.1	In the statement of the first paragraph of Sectipn 8.1, "The first two cycles, called Cycle P1 (P1) and Cycle P2 (P2), are used to generate a library of spent fuel elements." "Spent fuel" sounded like the one that has removed from the reactor and never come back. It might be better to change to "... to generate a library of once and twice burned fuel elements, respectively."	Changed as recommended	
2	8	8.1	Similarly in the next statement, "... a mixture of fresh and spent fuel shuffled in a realistic manner." Change "spent fuel" to "burned fuel".	Changed as recommended	
3	9	8.1	In the sentense of the last paragraph, "... "34-30", meaning it occupied position 34 during P1 and position 30 during P1". The second P1 should be P2.	Changed	
4		8.1	Will it be possible to add core map to show where positions 1-40 are?	Added a core map as Figure 1	
5	32	8.2.5	In Section 8.2.5, what are the conditions (fuel temp., mod. temp., and mod. density) for the "reference" state for the evaluation of reactivities. They should be stated in the paragraph.	Added the sentence, "Nominal fuel temperature, moderator temperature, and moderator pressure is given in Section 8.2.2 of ECAR-3908."	
6	50-58		In Figures 9-17, titles of these figures should also indicate what they are. For instance, instead of "Figure 9: Plate 19 of element zero at P1 day 0 (left) and P1 day 3 right", it is better to be "Figure 9: Distributions of power and fission densities over Plate 19 of element zero at ...."	Changed as recommended	

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Document ID: ECAR-3909			Document Title: Results of ELF Mk 1A Conceptual Design Neutronic Analysis	Revision ID:	eCR No.:
Item No.	Page No	Section or Zone	Review Comment	Comment Resolution	
7			This is just question. In reality, will HEU->LEU transition occur by completely removing all HEU plates and loading all fresh LEU to startup like Cycle P1 in the report, or gradually replacing HEU fuel elements with fresh LEU fuel (if possible)? In case of Cycle P1, were there any indications of higher peak-to-average power ratio compared to Cycles R1 or R2? If so, are there any safety issues because of higher peak-to-average ratio?	The intent of this design is to never operate at full power with an all fresh core. A fully fresh core would require burnable poison and this would affect the power profiles and peaking in some manner, although the magnitude of the effects would depend on the solution used. The P1 cycle used fixed Hf rods in the small B, A, and H positions. ECAR-2547 used Gd poisons in the large B positions to suppress reactivity. ECAR-2546 did not report the effects on fuel power peaking. Gd is a much blacker poison, but the large B positions are further away from the fuel than the small B and A positions. I'm not sure off the top of my head whether Gd poisons in the large B would be worse (w.r.t. power peaking) than the Hf shims in multitudinous locations. For a simple comparison of peaking consider the following: The highest power density seen in the reactor during P1 was 59.9 [kW/cm^3] and the highest heat flux was 660 [W/cm^2]. The highest power density seen during R2 was 57.8 [kW/cm^3] and the highest heat flux was 717 [W/cm^2]. The peak power density (which occurs in plate 19) is higher in the all-fresh poisoned core, but the peak heat flux (which occurs in plate 15 usually) is lower. How much of this difference is due to the poisons and how much is due to differences in OSCC rotation is not known at this time. A more rigorous analysis is needed to prove anything definitively, but it appears that peaking in an all-fresh core isn't significantly worse than peaking in an all-fresh lobe. We will operate with an all-fresh core during post-CIC physics testing once we have fully converted and probably once before we start the HEU->LEU transition process, but this is only for low power operation.	

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Matthew P. Johnson	208-526-2786					Anne K. McCartin	208-533-4461

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Matt Johnson	Unknown	Anne K McCartin	12/14/17

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Document ID: ECAR-3909			Document Title: Results of ELF Mk 1A Conceptual Design Neutronic Analysis	Revision ID: CDR Draft	eCR No.:
Item No.	Page No	Section or Zone	Review Comment	Comment Resolution	
Template 7			Quality levels no longer apply to analyses. There is a new template.	Changed front page to match latest template	
7			Section 7 states that the results of the report should not be used as inputs to downstream QL-1 analyses. Could a similar statement be included on page 1 in the conclusions section (minus the QL designation – perhaps in analyses that support the safety basis?)	Changed section 7 to read: "Serpent is used in accordance with its code validation plan for ATR LEU conversion. Serpent is not validated for Nuclear Use." Added the following sentence to the conclusions section of the introduction, "It should be noted that outputs from this analysis may not be applied to anything designated Nuclear Use."	
8.1	9		First paragraph after Table 1 and throughout. Please eliminate the reference to "PALM" to describe the high-power cycles. The use of PALM to describe high-power cycles is really slang, since PALM is actually just the experiment positioning hardware and has not power requirements with it, and it is also used during lower-power cycles. Since we are not modelling positioning of an experiment throughout the cycle, we should not be calling it a PALM cycle.	Removed the word PALM from the document. Now I call P1 and R2 "high-power cycles".	
8.2.7			First sentence. Should we also be referencing the original NR requirements letter?	Reference added.	

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Matt Johnson	Unknown	Anne K McCartin	12/14/17

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Document ID: ECAR-3908			Document Title: Serpent Model Used in ELF Mk 1A Conceptual Design Neutronic Analysis	Revision ID: CDR Draft	eCR No.:
Item No.	Page No	Section or Zone	Review Comment	Comment Resolution	
Template 7			Quality levels no longer apply to analyses. There is a new template.	Changed the front page to match the new template	
9	1		Section 7 states that the results of the report should not be used as inputs to downstream QL-1 analyses. Could a similar statement be included on page 1 in the conclusions section (minus the QL designation – perhaps in analyses that support the safety basis?)	Changed section 7 to read: "Serpent is validated for work related to ATR LEU conversion.[Error! Reference source not found.] Serpent is not validated for Nuclear Use." Added the following sentence to the conclusions section of the introduction, "It should be noted that outputs from this analysis may not be applied to anything designated Nuclear Use."	
8.2.1	12		Editorial. A few lines above Table 3. Sentence reads "and 15-19 are treated as uniquely..." Change uniquely to unique.	Tweaked the wording in that section. That sentence now reads "and 15-19 are treated individually..."	

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Joe Palmer					11/9/2017	Jeff Sherman/Nuclear Safety	6-7324

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T. Maddock, M. Johnson, MPR,	Misc	Jeffrey B. Sherman	12/12/2017

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Document ID:			Document Title: ATR LEU Conversion Fuel Element - Conceptual Design	Revision ID:	eCR No.:
Item No.	Page No	Section or Zone	Review Comment	Comment Resolution	
1	7	sect. 5	ECAR-3908, editorial, fix "the that"	removed "the"	
2		Table 1	ECAR-3908, fuel regions row, clarify "universe 1000" meaning	Removed reference to universe 1000 since it didn't really fit in the table well. Changed the description to read, "input file that pieces the 40 fuel elements into a serpentine configuration". Also added a footnote to Table 8 explaining that universes 1-40 contain fuel elements 1-40. There is only one other reference to a universe found Section 8.4.8, but this one is explaining an example line of Serpent input so I think it is self-contained enough that it doesn't require additional clarification	
3		Table 3	ECAR-3909, EOC Exposure column header should be MWD (also in Table 4)	Column header changed as recommended	
4		sect. 8.2.1	ECAR-3909, Cycle R1 is 56 day length; why not 60 to more closely match ATR capability?	56 days comes from the NR functional requirements for cycle length, specifically 56 days at 120 MW.	
5		sect. 8.2.2	ECAR-3909, correct "that the an" in 1st paragraph	Changed to "that an"	
6		sect. 8.2.3	ECAR-3909, "were' should be "where" in 1st paragraph	Changed	
7	4		ECAR-3162, Recommendation is to test a full size element to validate assumption about Zr bond heat transfer as part of the fuel development effort. Is there a plan to do this test prior to putting ET-1 in ATR?	This recommendation will be considered during the final design. Currently there are no plans to conduct the test.	

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						J. O. Brower	6-4457

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T. Maddock, M. Johnson, MPR,	Misc	J O Brower	1/22/18

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Document ID: multiple			Document Title: ATR LEU Conversion Fuel Element	Revision ID:	eCR No.:
Item No.	Page No	Section or Zone	Review Comment	Comment Resolution	
PLN-5391	5 of 10	1	First paragraph, fourth line, typo, missing "and" between "conditions" and "select".	PLN-5391 is not being reviewed as part of the conceptual design review. If a revision is made to this document the typo will be fixed.	
PLN-5391	10 of 10	7	Table at bottom of page, why aren't the document numbers included in the table?	PLN-5391 is not being reviewed as part of the conceptual design review. The plan was created before the documents were produced. The document numbers weren't included because they weren't available at the time.	
FOR-317	8 of 8	References	[11] Why is INL Drawing 035658, "ATR Fuel Element Mark VI Assembly" included as a reference? Mark VI ATR fuel elements weren't fabricated after the mid-1970's. The current ATR Mark VII Fuel Element drawing is 405400, Rev. 20.	FOR-317 is not being reviewed as part of the conceptual design review and was not written by the ATR conversion team.	

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Document ID:			Document Title: ATR LEU Converion Fuel Element	Revision ID:	eCR No.:
Item No.	Page No	Section or Zone	Review Comment	Comment Resolution	
SPC-1694	All	All	The following is a brief summary of the most recent changes in SPC-1635 Rev. 8, which should also be incorporated into SPC-1694: • The definition of "fuel meat" was eliminated, as this is a term appropriate for dispersion fuel, not monolithic fuel. The term "fuel meat" was replaced with either "fuel foil" or "fuel core," as appropriate. • The definition of "fuel core" was revised. "Fuel Core. The uranium bearing region of each fuel plate." • The definition of "foil" was revised. "Foil. A thin product of metal alloy containing fissionable material with or without the diffusion barrier layers." • SPC-1635, 1.05 Definitions, U-Mo Alloy, "coupons" will never be used to fabricate U-Mo fuel cores in the future. The definition of "coupon" and the usage of the word "Coupon" in the definition of U-Mo Alloy can be deleted from SPC-1635. The use of "coupon" remains unchanged in TEV-2009. • The definition of "cladding" was revised to specify that it is an aluminum alloy rather than aluminum. The term "clad" was changed to "cladding," particularly in SPC-1635. • SPC-1635, Section 4.05.A, will be revised as follows: "A. The as received cladding shall be aluminum (see def.) alloy 6061 (per ASTM B209)." The Aluminum Association prefix of "AA" will be used in front of the 6061 aluminum alloy designation. No heat treatment suffix will be specified, since the 6061 aluminum alloy will change form during the HIP process. Other uses of UNS A96061 or AA6061 used throughout SPC-1635, FOR-158, and TEV-2009 are not required to be changed.	Definitions have been updated. Material specifications will be resolved when drawings and SPC-1694 are revised during the final design.	
SPC-1694	11 of 39	Figure 1	Figure 1, Schematic diagram showing the cross section of a fuel plate will be corrected to show "AA6061 Cladding" and "U-Mo (Fuel Core)". Barry Rabin revised the image component labels.	Materaial specifcations will be resolved during the final design process.	
SPC-1694	All	All	References to LEU Fuel Plate Specification SPC-1635. SPC-1635	No change	
SPC-1694	19 & 20 of 39	3.3.1	Materials are listed on the drawings in the material list.	This paragraph was rewritten to explain materials are shown on the drawing.	
SPC-1694	30 of 39	5.8.1	DO NOT DELETE "BLISTER TEST."	No action required	
Dwg 604400	1 of 3	C-8	INSPECTION ENVELOPE, Change "2X 1.303" to "2X 1.330". Older versions of this detail on drawing 035658 included a Note 10. "Final assembly shall fit within inspection envelope without interference at any point (the top 3 inches and side plate pads excepted.)" The pads should fit within the inspection envelope.	The dimension was changed and the note was revised to include the pads in the inspection process.	
Dwg 604400	1 of 3	New Note 22	Note 22. As cast, radius dimensions on upper and lower adapters, that are not machined during fabrication, are reference dimensions established by the casting. These are not critical dimensions and shall not be measured.	This note will be included in a future revision planned for the element drawing.	

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Item No.	Page No	Section or Zone	Review Comment	Comment Resolution	
1129-0076-CALC	All	All	Historically, ATR HEU fuel elements have been fabricated with AA6061 aluminum alloy, which is special ordered to contain 10 ppm Boron or less. Standard AA6061 aluminum alloy may contain up to 30 ppm Boron. Most of the other USHPRRs can use standard aa6061 aluminum alloy with up to 30 ppm Boron. Have the ATR LEU neutronics analyses included the higher Boron limit of 30 ppm or less?	Boron has not been part of the analysis but will be considered during the final design. If analysis shows the Boron requirement can be eliminated it will be.	