

Program Plan Outline for Advanced Certification

Executive Summary

The Consolidated Appropriations Act of 2008 (Public Law 110-161), created the Advanced Certification (AC) subprogram in the Science Campaign. The stated purpose of this new activity is to address issues raised in the summer 2007 JASON review of the Reliable Replacement Warhead (RRW), in the context of any stockpile strategy. In their review, the JASON panel issued recommendations in four generic areas: development of quantitative measures and experiments applicable to certification without testing; improved understanding of materials compatibility and aging; understanding of proposed new manufacturing processes and their effect on certifiability; and increased transparency and consistency in peer review. These are applicable to any stockpile stewardship strategy.

This outline describes how the National Nuclear Security Administration (NNSA) will address each of these recommendations. The NNSA campaigns have ongoing efforts that address some of these recommendations and will continue to do so. In these cases, the recommendations will help provide additional priority to the important work the existing subprograms (Primary Assessment, Secondary Assessment, Enhanced Surveillance, and Enhanced Surety, for example) are already pursuing or have planned.

In areas where there is currently little or no focused effort, Advanced Certification will provide a framework and funding to address the JASON recommendations. This is particularly true in efforts such as adding quantitative rigor to metrics that define the relationship between previously conducted underground tests, the effect of manufacturing variables on performance, and enhancement of the peer review process.

Peer review is the area that the JASON panel placed the most emphasis and is a subject that NNSA has already been addressing through revision of the inter-laboratory peer review process. One recommendation not seriously contemplated prior to the JASON report is the examination of the peer review process by an independent, external group. NNSA is evaluating the utility of establishing an independent panel which will provide scientific transparency to peer review by acting as a scientifically credible independent assessor of the inter-laboratory process. To this end, NNSA conducted a workshop and gathered input from the laboratories, JASON, and Department of Defense (DoD) representatives regarding lessons learned in the RRW review and warhead recent life extension and modification programs.

Introduction

In the Consolidated Appropriations Act of 2008 (Public Law 110-161), Congress created the Advanced Certification (AC) activity in the Science Campaign. The stated purpose of this new subprogram was to address issues raised in the 2007 JASON report on the Reliable Replacement Warhead (RRW). While the report was part of the JASON RRW study, it identified actions broadly applicable to the topics of certification and assessment, whether related to life extension program (LEP) modifications or new designs. The Act also included the following direction from Congress:

“The Administrator of the NNSA is directed to submit...a report to the Committees on Appropriations no later than six months after enactment of this Act on the progress made in implementing the JASON’s recommendations and improving the stockpile certification process.”

Appendix A of this document restates the specific recommendations of the JASON RRW Report. The body of this program plan outline describes how each of the recommendations will be addressed within AC, for stockpile stewardship including legacy systems. Some of the recommendations fall within or overlap the scope of existing NNSA Campaigns. In these cases the existing Campaign which is responsible for the recommended research is identified and the interface with AC defined. Finally, a key issue for JASON was the perceived lack of a sufficiently rigorous and transparent peer review process. As a result there are numerous recommendations regarding peer-review which are applicable not just to RRW but to the entirety of Defense Programs (DP) and the NNSA. For example, the response to the recommendation for additional rigor in peer review will not be limited to selected elements of weapons development activities, but will benefit all of DP.

NNSA Response to Specific JASON Recommendations

On February 27, 2008, NNSA submitted to Congress the first year financial plan for the new AC, (Appendix B). In this document NNSA reported that AC would have a Campaign structure consisting of five major technical efforts (MTEs): Methodology, Near-Neighbor Definition, Manufacturing and Engineering Process Solutions, Advanced Surety Certification, and Failure Modes. These MTEs are supported by work across the current Science, Engineering, Advanced Simulation and Computing (ASC) Campaigns, and Directed Stockpile Work Research and Development (DSW R&D). This outline will describe how the efforts to address each of the above recommendations will be distributed across AC and the existing campaigns.

JASON Recommendation:

1. (a) *Continued investigation and development of quantitative measures that assess the connection of WR1 with the legacy nuclear test data.*

Existing Campaigns: It is already a goal of Defense Programs to develop and apply the Quantification of Margins and Uncertainties (QMU) methodology for stockpile stewardship.

Advanced Certification: The AC will enhance the work of the existing campaigns explicitly making peer review an integral part of the development and application of QMU. AC will develop metrics that define ‘nearness’ of LEP modifications or new designs to existing test data. These efforts will be focused in the “Methodology” and “Nearest Neighbor Definition” MTEs of the AC (see Appendix B for full description).

JASON Recommendation:

1. (b) *Additional hydrodynamic and other (non-nuclear explosive) experiments beyond those indicated in the certification plan presented. Such experiments are intended to extend modeling and simulation capabilities so that future computational tools are predictive not only of device performance, but also of device failure and the limits of validity of the computer simulations. This effort will require the continued availability of hydrodynamic test facilities.*

Existing Campaigns: The existing Campaigns partially address physics and engineering investigations of failure as part of developing predictive capabilities for performance and failures. Where it exists, this work will continue to form the basis of our simulation and modeling efforts. Generic system performance and failure models may require additional hydrodynamic and other experiments informing and validating ASC simulations. Performing experiments for particular LEPs or RRW/WR1 will be associated with qualifying and certifying components and subsystems for those programs that Congress chooses to fund.

Advanced Certification: Generic areas of investigation are specifically identified in the “Failure Modes” MTE in the AC; the overall role of AC is to guide and inform resolution of high impact issues. Experiments to understand failure mechanisms generically relevant to the certification process will also be the responsibility of the AC.

JASON Recommendation:

1. (c) *That an improved understanding of materials aging and interactions over the proposed multi-decade lifetime of RRW systems be developed.*

Existing Campaigns: The understanding of the majority of the materials aging and compatibility work is the purview of the Enhanced Surveillance subprogram of the Engineering Campaign, which will continue to own and fund this responsibility for both

existing and future systems. As of fiscal year 2009 plutonium aging studies have been transferred to the Primary Assessment subprogram of the Science Campaigns.

Advanced Certification: The AC will help guide the requirements for new models and experiments in Enhanced Surveillance and DSW as appropriate.

JASON Recommendation:

2. (a). *The physical understanding of enhanced surety features, which address a top requirement for WRI, is still under development. We recommend that substantial effort be placed into surety science, including modeling, materials properties and experimentation (beyond that proposed in the reviewed certification plan).*
- (b). *Once an improved physical understanding is in hand, a QMU-based assessment of the surety features must be performed.*

Existing Campaigns: Surety science has been and remains the responsibility of the Enhanced Surety subprogram of the Engineering Campaign.

Advanced Certification: The challenges of developing surety technologies in the absence of underground testing require that some additional effort be put into this arena from the AC, from the MTE entitled “Advanced Surety Certification.” Maturing the QMU methodology for both the performance and efficacy of surety features is necessary and will be covered under this MTE. The details of these are classified.

JASON Recommendation:

3. (a). *New fabrication processes are proposed for WRI with the intent of simplifying manufacturing and achieving cost savings. To ensure that new manufacturing processes not have a deleterious effect on WRI performance we recommend that their impact on performance be understood. This will require additional experiments and computer simulations beyond those presented in the certification plan.*
3. (b). *Proven manufacturing processes (should) be maintained as a contingency.*

Existing Campaigns: The new fabrication processes which most concerned JASON related to pit manufacturing. JASON went on to recommend that NNSA maintain existing manufacturing capability (e.g. the processes used at LANL to manufacture the W88 pits). NNSA agrees with this latter recommendation and intends to maintain the existing fabrication capability for the foreseeable future.

Advanced Certification: AC will fund an MTE devoted to Manufacturing & Engineering Process Solutions to address new approaches that have been proposed to reduce the complexity and cost of the manufacturing operations as well as certification. This MTE will conduct manufacturing and engineering process assessments and develop a rigorous connection between performance effects resulting from material, component or manufacturing changes, including reuse of existing components.

Examples of the areas where NNSA intends to explore alternate methodologies that could improve throughput and ease of certifiability in future pit builds are as follow:

Sensitivity to chemistry – Plutonium impurity specifications are currently subject to very tight specifications for trace elements. Production processes to remove these impurities are labor intensive and generate an expensive waste stream. Efforts to better define primary performance sensitivity to the presence of impurities could result in improved ease of certification if higher contaminant levels were allowed.

Inspection requirements – Current inspection techniques for plutonium pit component manufacture have been proven to be labor intensive and difficult. Preliminary studies have indicated that inspections requiring fewer data points and using modern techniques could provide adequate confidence that dimensional tolerances are maintained and increase throughput while realizing no appreciable increase in uncertainty.

Surface specification – The manufacturing process as it exists must meet a very tight surface finish requirement. There is a high rejection rate on parts that do not meet specification. The uncertainty increases due to these conditions is not well defined, making part rejection somewhat arbitrary. Additional efforts to better define these uncertainties are warranted.

This MTE will also help develop options for alternate materials and processes and analyze experimental data provided by the other stockpile stewardship activities to derive performance effects and uncertainties.

JASON Recommendation:

4. (a). The (peer review) process (for RRW systems) must be visible, funded, and administered to assure the nation that all expertise available has been applied to a rigorous evaluation of the new design.

In FY 2008 Congress did not fund work on the chosen RRW design, WR1. Consequently, at present there is no design work to be peer reviewed. NNSA agrees that the peer review of any new or Life Extension Program (LEP) stockpile device development will be funded. LANL and LLNL have drafted an implementation plan for the RRW inter-laboratory peer review. The visibility and transparency of the peer review process is the area that NNSA needs the most improvement. This subject is addressed below.

JASON Recommendation:

4. (b). It is imperative that its effectiveness be examined periodically by an independent organization.

Based on comments in the complete JASON RRW Report as well as discussions with the Chairman and members of JASON, NNSA confirmed that this recommendation does not suggest that JASON be either the reviewing body for the certification process, or the body which determines efficacy of any future peer review process. JASON is not a peer

review organization, but rather a broad ranging technical group serving the national security and intelligence communities.

NNSA is considering options for regular and independent assessment of the planning and effectiveness of peer review. This group will also evaluate the resolution process involving technical disagreements between the design and peer review teams, and provide written opinions to the laboratory directors and NNSA when needed. Such a group should function consistent with other reviews such as the Strategic Applications Group Stockpile Assessment Team (SAGSAT) and Federal technical oversight, preserving the authority of the laboratory directors in the final design decisions.

JASON Recommendation:

- 4. (c). The peer review team should be broadly constituted and have authority to pose formal tests of a computational or experimental nature of the design team.*
- 4. (d). Issues identified through peer review must be documented, tracked and follow a formal process of closure with participation by the peer review team.*
- 4. (e). Responsibility for conducting peer review should be assigned to the weapons design laboratory not leading the design effort.*

NNSA agrees with all of these recommendations. The peer review team will be drawn broadly from across the relevant disciplines at the review laboratory. The peer review responsibility is always the responsibility of the laboratory not chosen to lead the design. This team will have authority, and be funded to perform necessary computational and experimental work for the purpose of their review. The documentation requirements for this process are detailed in the NNSA inter-laboratory peer review process.

Appendix A:
Recommendations from the JASON RRW Review (verbatim)

1. *Certification for WRI will require new experiments, enhanced computational tools, and improved scientific understanding of the connection of the results from such experiments and simulations to the existing nuclear explosive test data. We recommend:*
 - a. *Continued investigation and development of quantitative measures that assess the connection of WRI with the legacy nuclear test data.*
 - b. *Additional hydrodynamic and other (non-nuclear explosive) experiments beyond those indicated in the certification plan presented. Such experiments are intended to extend modeling and simulation capabilities so that future computational tools are predictive not only of device performance, but also of device failure and the limits of validity of the computer simulations. This effort will require the continued availability of hydrodynamic test facilities.*
 - c. *That an improved understanding of materials aging and interactions over the proposed multi-decade lifetime of RRW systems be developed.*
2. *The physical understanding of enhanced surety features, which address a top requirement for WRI, is still under development. We recommend:*
 - a. *That substantial effort be placed into surety science, including modeling, materials properties and experimentation (beyond that proposed in the reviewed certification plan),*
 - b. *Once an improved physical understanding is in hand, a QMU-based assessment of the surety features must be performed.*
3. *New fabrication processes are proposed for WRI with the intent of simplifying manufacturing and achieving cost savings. To ensure that new manufacturing processes not have a deleterious effect on WRI performance we recommend that:*
 - a. *Their impact on performance be understood. This will require additional experiments and computer simulations beyond those presented in the certification plan;*
 - b. *Proven manufacturing processes be maintained as a contingency.*
4. *In the absence of new nuclear-explosive testing, the challenges to certification must be met in a peer review regime that establishes confidence in the WRI design. Peer review is essential to establishing the technical credibility of the new designs. Peer review for RRW certification must play a larger role than provided for by current NNSA guidelines or envisaged in the LLNL plans presented to us. We recommend that NNSA establish a peer review mechanism with the following elements:*
 - a. *The process must be visible, funded, and administered to assure the nation that all expertise available has been applied to a rigorous evaluation of the new design.*
 - b. *It is imperative that its effectiveness be examined periodically by an independent organization.*

- c. The peer review team should be broadly constituted and have authority to pose formal tests of a computational or experimental nature of the design team.*
- d. Issues identified through peer review must be documented, tracked and follow a formal process of closure with participation by the peer review team.*
- e. Responsibility for conducting peer review should be assigned to the weapons design laboratory not leading the design effort.*

Appendix B

60 Day Report - Advanced Certification

Note: The change from the term “campaign” (used below) for Advanced Certification to “subprogram” (used above) has been made to maintain consistency with both the FY 2008 appropriations language and the NNSA FY 2009 budget submission.

Advanced Certification

Campaign Goals

The overall goal of advanced certification may be described as proving the NNSA laboratory assessments and certification statements for untested or modified weapons are at a level of rigor more than sufficient to pass any relevant technical peer-review and assure the entire world that the U.S. nuclear arsenal is reliable without the need to return to testing.

The Advanced Certification Campaign, a subprogram of the Science Campaign will eliminate systemic gaps in the NNSA certification process through the application of stockpile stewardship campaign work products. It will integrate the scientific and technological advances from stockpile stewardship with input from continuing studies, to improve the weapons certification process, refine computational tools and methods, advance of the physical understanding of surety mechanisms, understand failure modes, assess new manufacturing processes, and study system requirements. The focus is on large changes, or aggregations of smaller changes in the future stockpile, as opposed to the individual small changes already capably assessed by the current programs. Advanced Certification will accomplish this by filling gaps not presently covered under the existing stockpile program. Advanced Certification will develop a rigorous connection between performance effects resulting from changes in such areas as pit modification, (including pit re-use), component or manufacturing changes. Examples of specific activities will include: modeling and experiments addressing failure modes, and the development of a rigorous, peer-reviewed linkage of system level requirements to the associated certification needs for the weapons lifecycle under all relevant conditions.

Campaign Structure

As with existing NNSA Defense Programs Campaigns, the Advanced Certification Campaign will be divided into the fundamental major technical elements (MTEs) that systematically address the unique efforts required to achieve the high-level goals identified above. The MTEs of the Advanced Certification Campaign have been identified as:

(1) Methodology

Develop a strategy for certification and assessment of systems and components based on Quantification of Margins and Uncertainties, involving increased peer review and rigorous coupling of science and technology advances to define long term research needs for Advanced Certification.

- In FY 2008 this effort will kick off with a workshop including external participants to develop the definition of a more rigorous certification and assessment process.
- This effort will provide an annual assessment of the state of the enabling tools,
- In the long term this effort will define and refine requirements for life-cycle certifiability.
- Develop a plan to incorporate more probabilistic analysis as the models become more fundamentally physics based and take further advantage of the computational power provided by ASC.

(2) Near-Neighbor Definition

The focus of this effort is to understand the role of archival data from underground tests in the certification process. In particular this effort seeks to define metrics for comparison of tests and ensure that the long term use of Underground Test (UGT) data is rigorously evaluated. As more physics based models are implemented, data from additional historic UGTs will be able to be drawn into the certification process as “near neighbors.”

(3) Manufacturing & Engineering Process Solutions

Conduct manufacturing and engineering process assessments and develop a rigorous connection between performance effects resulting from material, component or manufacturing changes. Certification solutions for variations in pit manufacturing techniques (including reuse). Develop options for alternate materials and processes to minimize the cost or use of expensive or hazardous materials. Analyze experimental data provided by the other stockpile stewardship activities to derive performance effects and uncertainties. Assess, as appropriate, the effect of changes of limited life components to maintain or improve yield margin.

(4) Advanced Surety Certification

This MTE is dedicated to the physical understanding and developing certification methodologies for new surety techniques and mechanisms. This MTE is expected to leverage the results from the related campaigns to validate these techniques and mechanisms.

(5) Failure Modes

Develop a comprehensive catalog of failure modes, thresholds and metrics.

- Model primary and secondary failure modes
- Model engineering failures

- Determine the effects of certification of new or modified components and subsystems under STS conditions such as extremes in temperature or radiation exposure.
- Design experiments to test failure modes.

Campaign Budget

The table below indicates the planned funding splits between the weapons laboratories to conduct Advanced Certification activities in FY08. In order to fully address the expectations of Congress with respect to the campaign goals, a nominal increase in the outyear Advanced Certification campaign budget is expected, but the detailed planning and the sites that are best suited for executing these activities has yet to be determined. Planning for the campaign will evolve through FY08 and the budget splits will be revised and presented in the next revision of this report as activities and plans are solidified.

Funding Table (\$K):

Site	2008	2009	2010	2011	2012	2013
HQ/Unallocated	136	20000	29748	29391	29135	29065
LLNL	8880					
LANL	4900					
SNL	950					