NEAC Nuclear Reactor Technology (NRT) Subcommittee
Advanced Test and/or Demonstration Reactor Planning Study
October 6th, 2015 Meeting Summary and Comments

Given direction from Congress, the Department of Energy's Office of Nuclear Energy (DOE-NE) is conducting a planning study for an advanced test and/or demonstration reactor (AT/DR study) in the United States. The Nuclear Energy Advisory Committee (NEAC) and specifically its Nuclear Reactor Technology (NRT) subcommittee has been asked to provide comments on the AT/DR study as it progresses to its final report in April 2016.

The NRT subcommittee reviewed draft versions of the study's Report Annotated Outline and Gap Analysis for Test Reactor capabilities during August and early September. The consensus comments from this initial review were transmitted to DOE and the Planning team on September 8th and provided in Appendix B of this report. The AT/DR study team will take the NRT comments into account as it finalizes the Report Annotated Outline as well as the supporting Gap Analysis.

The NRT subcommittee held a meeting at DOE Forrestal on October 6th, 2015. The purpose of the meeting was to get an update on recent developments in the AT/DR study, review the criteria, metrics and weighting factors being used in the AT/DR study to evaluate various reactor design concepts and to present the results of a technology assessment for the potential advanced reactor design concepts. Specific advanced reactor point designs were also discussed with the committee. The agenda for the meeting is provided below. Also, individual subcommittee member comments were collected and given in Appendix A.

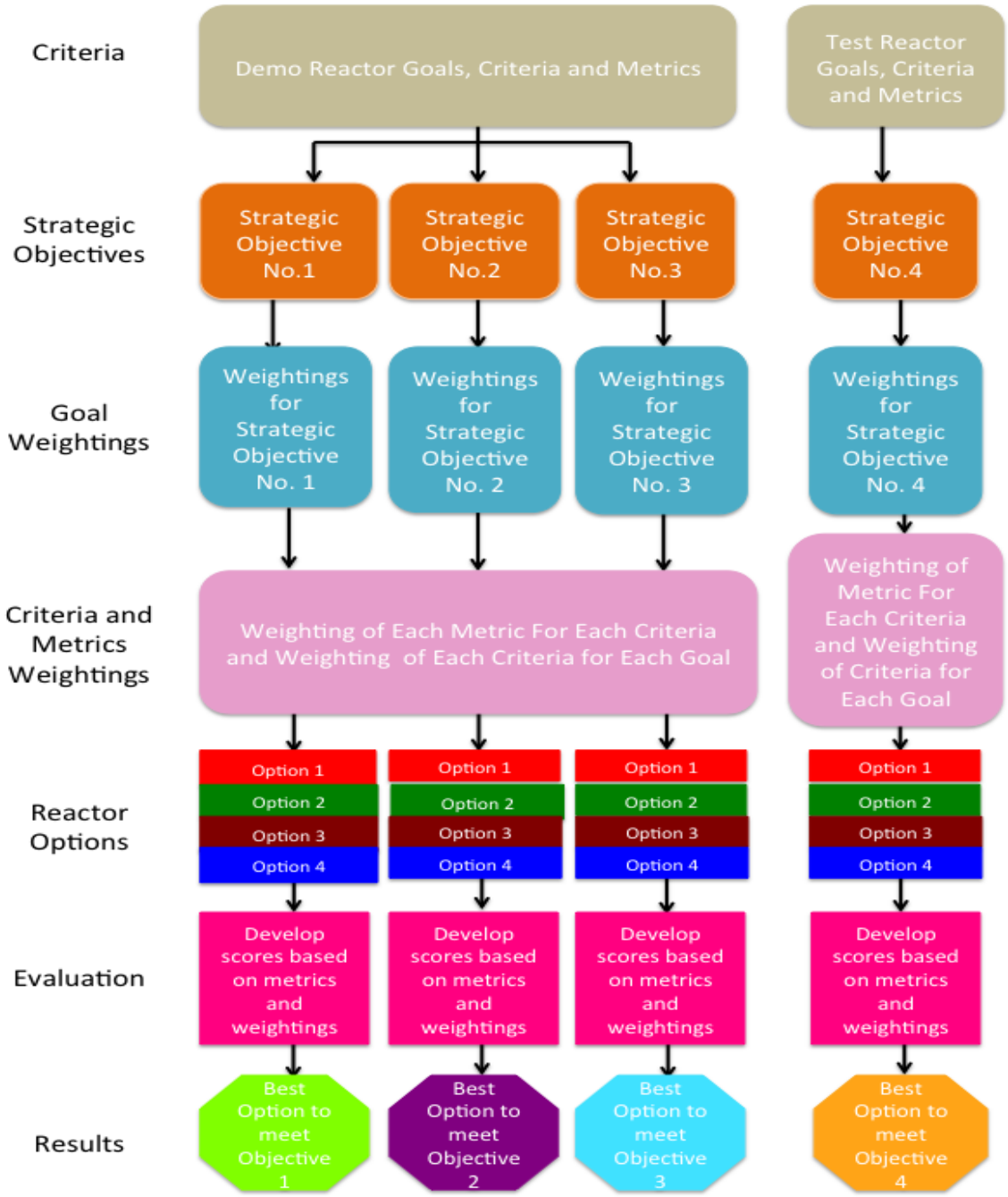
Recent Developments for AT/DR Study

The subcommittee received an update on recent developments and how this planning study fits into broader planning for DOE-NE. The AT/DR study has evolved in its purpose from when it was first conceived over a year ago and was discussed with NEAC NRT in September 2014. It is one element of a broader plan that is being developed by DOE-NE. Our subcommittee had an extended discussion with the DOE about the elements of this broader 'Master Plan' for Advanced Reactor Technology development. We were informed that it is still in the formative stages and that the planning study is a key part of it.

Recommendation: Our subcommittee recommends that this broader 'Master Plan' be presented to the NEAC for its review and comment. This overall plan can put advanced reactor R&D into its proper perspective with other DOE priorities; e.g., LWR R&D activities, infrastructure needs such as a test reactor, modeling and simulation, to name just a few.

Planning Study Evaluation Approach (i.e., Goals, Criteria, Metrics, Weighting)

The AT/DR planning study team presented the overall evaluation process to be employed in the review of specific advanced reactor point designs whether for a test reactor or for a demonstration reactor. The graphic below is a useful way to depict the overall process.



PLANNING STUDY EVALUATION APPROACH

One notes that the evaluation of promising conceptual designs for the test reactor is a separate activity from the evaluation of conceptual designs for the demonstration reactor. There are totally different goals, criteria and metrics for test reactor concept evaluation than for demonstration reactor concept evaluations. The subcommittee concluded this was appropriate and the overall formulation of the goals, criteria and metrics were reasonable.

In order to test the process, our subcommittee suggested, and the planning team agreed, to use the ATR and the EBR-II as real-world examples of a test reactor and demonstration reactor designs to illustrate how the evaluation process would work.

Originally, our subcommittee questioned the need for three different strategic objectives for the demonstration reactor evaluation process; i.e., one each for process heat applications, fuel cycle demonstration, and maturation of new technologies. However, as we discussed the overall evaluation approach, it became apparent that the only difference between the three strategic objectives was the weighting put on the different goals for a demonstration reactor when the evaluation process was done. So assuming that the Planning team does an objective 'third-party' sensitivity analysis of the weighting factors, as suggested at our meeting, then our concerns about the planning study evaluation scoring of demonstration reactor conceptual designs, can be addressed.

While our subcommittee found the general approach to the evaluation method to be reasonable, we offered some specific comments, which could improve the evaluation process and/or the exposition of the process to those making use of the study results.

Need for a Roadmap and Schedule: Whether an advanced test reactor or a demonstration reactor is being considered, there are a number of phases to the projects and those using this planning study need to understand these phases and the schedule that this implies. Even a high-level exposition of this would be useful for the decision-maker.

Identify Constraints: There are many constraints for the deployment of advanced reactor technology including availability of performance data to support licensing, significant time to construction and questions of safety related to siting, and de facto policy issues, e.g., use of high uranium enrichment and plutonium in the fuel cycle. The study should make these constraints clear to both the investor community and the congressional sponsors as a discriminator between technologies. Not only is a roadmap and schedule needed, but also the study should identify constraints and the required technology demonstration to enable technology. Many of the people supporting advanced reactor initiatives are new to the field and have yet to encounter these barriers to development.

Consistency in Explaining the Point Designs being Evaluated: It is quite important that a description of each conceptual point design being evaluated (for either test reactor or demonstration reactor) have a consistent set of information. In the presentations our subcommittee received, that was not the case, although we are early in the evaluation process. Such consistency in the design description and engineering detail is crucial for the reader to get a clear and unbiased view of the various designs being evaluated. For example, it was surprising to see what was proposed for the FHR. The FHR that ORNL was proposing had a closed loop power conversion system rather than an open air Brayton cycle as has been studied and recommended by the MIT/UCB/UW research team. Without a consistent approach to these point designs, the final outcome can become skewed.

Licensing: The test or demo reactor will be licensed by USNRC, given the lack of experience within the DOE. This also supports the long-term mission of commercialization. The

licensing process is not a discriminator in the decision-making process. There was some discussion about the need for revisions in the licensing review process; e.g., regarding the siting of facilities near man-made hazards. These discussion points will need to be examined as the planning process proceeds with more details; e.g., NRC Reg. Guide 1.91.

NEAC NRT Subcommittee

AT/DR Study Update Meeting Agenda

OCTOBER 6, 2015

Date:	October 6, 2015	**Chair:**	Mike Corradini
Time:	8am to 4pm	**Facilitator:**	Tom O'Connor
Location:	Forrestal Conference Room 6A-110	**Note Taker:**	TBD
		Call-in Number:	(202) 287-1301

Time	Topic	Speaker
7:30 am	Check-in at VIP Desk and Logistics	***Evangeline Chase***
8:00 am	Welcome and Introductions (5min)	***Mike Corradini***
8:15 am	Recent Developments for AT/DR Study (30min)	***John Kelly Tom O'Connor***
8:45 am	Updates to: Annotated outline, Criteria and metrics, Gap analysis (90min)	***Planning Team***
10:15 am	***Break***	***All***
10:30 am	Technology assessment results (90min)	***Planning Team***
12:00 pm	***Lunch***	***All***
12:45 pm	Overview of specifics of point design efforts for Test Rx / Demo Rx (90min)	***Planning Team***
2:15 pm	***Break***	***All***
2:30 pm	General discussion on Objectives and Next steps for AT/DR (60min)	***NRT Subcommittee***
3:30 pm	NRT Subcommittee General Discussion	***NRT Subcommittee***
4:00 pm	Adjourn	***All***

Appendix A
Detailed October 6 Meeting Comments from NEAC NRT Subcommittee Members

Mike: This is a brief summary of what I said at the meeting. Regis

1 **Consistent Approach is Needed to Setting the Point Designs** for those designs that will be further evaluated. It was clear that each of the laboratories were working in isolation of the others with their individual point designs. I was particularly surprised to see what was proposed for the FHR and the FHR that the laboratory was proposing had a closed loop power conversion rather than an open air Brayton cycle as is being studied by the MIT/UCB/UW team. Without a consistent approach to the point designs, the final outcome can become skewed depending on what is presented.

2 **More Discussion Up Front is Needed to Set the Stage/Describe the Approach Being Used** in the planning study. We only obtained this understanding by a combination of the presentations and the Q&A. An uninvolved reader will likely not know what is being done by just reading the chapters of the report unless this process discussion is made up front.

3 **As Part of this Planning Study Initiative a Roadmap and Schedule Are Needed**. This might not be possible by the new early March 2016 deadline date, but it could be the next thing done, e.g., during April and May 2016. We were told that funding would be available from the current budget and **I think that this would still be timely** to provide input to Congress and the Administration.

I hope these comments are helpful. If you would like to discuss further, feel free to contact me.

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Mike, Here are some comments for you to consider. Joy

I appreciate the responsiveness of researchers to our comments. I recognize that researchers involved in this effort are under schedule pressures. Please note that my comments are aimed at helping the team identify potential pitfalls with individuals that requested this study (e.g., congress).

Need for a Master Plan: DOE-NE should develop a master plan for technology demonstration efforts that considers various programs (including efforts to fund industry and this AT/DT study). If advanced technologies identified as higher priorities within this study require a US policy decision to enable deployment, the DOE should propose such policy changes to the administration (so that DOE doesn't fund R&D on technologies that cannot be deployed).

The study should consider their audience (e.g., the funding decision-makers that requested it). Results should inform such decision-makers, and DOE should be able to use the results to gain consensus among various organization that influence such decision-makers. The 'master plan' that we are requesting provide decision makers an idea of various timeframes required for various efforts. This master plan should discuss anticipated future steps after the reactor and/or demonstration reactors are built (e.g., how will industry use each new facility, what is its pathway toward commercialization, etc.). It would provide confidence in the results if the study identifies strong 'end-user' support for various facilities proposed in this study. Additional interactions with 'end-users,' such as having them also participate in development of the weighting factors for each technology, would help provide confidence in study results.

Need for Roadmap and Schedule: I agree with Regis' comments that a Roadmap and Schedule should be included in this study. Even if they are only provided at a high level, these items would inform decision-makers about the viability of various options considered in (or eliminated from) the study.

I also agree with Regis that an enhanced description of the ground rules for selecting a reactor technology and the associated point designs, the strategic objectives, the metrics, and the weighting factors needs is needed. During our discussion, several members pointed out the need to consider technologies that could enable easier siting and reduce water usage for heat rejection (e.g., higher thermal efficiency). The need to identify quantitative metrics, such as the reliance on passive safety features, which are used to evaluate safety was also emphasized by our group. Our group also emphasized that need to clarify why any technology falling 'below' the line should be funded by DOE.

Licensing: Some comments related to licensing made by researchers and DOE are puzzling to me:

It is unclear why a 'new' NRC review process (that has been requested by some organizations) is needed for advanced reactor technologies. Prior DOE efforts for gas-cooled and sodium cooled reactors produced Preliminary Safety Information Documents with sufficient detail for NRC evaluations. Furthermore, I'd note that the staff has nearly completed their review of the SHINE Molybdenum-99 production facility construction permit application. This facility significantly differs from other applications recently reviewed by the NRC. The staff will be going before the commission in December 2015 (and it is anticipated that the staff will be able to complete their review within 24 months).

Discussion about licensing a demonstration reactor seem to ignore the impact of collocated hazards on the licensing process. For example, if the strategic objective of a concept is to demonstrate licensing of an advanced nuclear technology that will be used for a process heat application, then both the reactor and the process heat plant should be part of the licensing demonstration. Likewise, if one is to demonstrate the ability to close the nuclear fuel cycle by recycling used fuel in an advanced reactor system, the licensing of the reprocessing system and the advanced reactor system should be considered. Again, the SHINE example comes to mind. The co-located hazard from a 'red oil event' in the radioisotope processing facility must be considered in evaluating the safety of the co-located irradiation units containing fissile material.

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Mike, I agree with the comments from Joy and Regis. I would add the following thoughts, John

Identify Constraints: There are many constraints for the deployment of advanced reactor technology including availability of performance data to support licensing, significant time to construction and questions of safety related to siting. The study should make these constraints clear to both the investor community and the congressional sponsors as a discriminator between technologies. As such, a timeline is important as well as the test and demonstration-reactor support needed for each technology.

I realize that the report does address these issues but I think that the discussion can and should be strengthened. Many of the people supporting advanced reactor initiatives are new to the field and have yet to encounter the barriers to its development.

Appendix B
NEAC Nuclear Reactor Technology (NRT) Subcommittee
Consensus Comments on Planning Study Report Outline and Gap Analysis
September 8, 2015

The NRT committee consensus comments for the Report Outline and Gap Analysis are given below. Each committee member also had detailed comments, which have been provided to the DOE and the Planning Study leadership team.

Report Outline

1] The report (and outline) needs to clearly state the assumptions under which this planning study is being conducted. (Certain assumptions were provided in detailed comments as examples of how AT/DR study fits into the overall DOE-NE plans)

2] The report (and outline) needs to get industry comments and the approach by which this input was obtained. (an example where input will be needed is in the criteria, metrics and associated weighting factors when compared to the technical objectives)

3] The report (and outline) needs to develop the long-term funding picture (capital costs, operational costs, industry cost-share) for the advanced test reactor options and/or the demonstration reactor options.

4] The outline suggests an over emphasis of the Technology Readiness (TR) levels as a basis for decisions. (this will be revisited with details provided in the criteria and metrics)

5] The report (and outline) could indicate that certain reactor concepts of the six GenIV technologies can be ruled out now without going through the detailed exercise of subjecting it to the planning study methodology.

6] The report (and outline) needs to explain how this planning study outcomes fit with other efforts in the US (by industry and DOE) and internationally.

7] There is a parallel effort via the NEI Advanced Reactor Task Force and the report needs to factor in their efforts.

Gap Analysis

The Gap Analysis concludes that there is more than sufficient testing capability for LWR fuels and materials at this time. Therefore, there is a need for an advanced test reactor that goes beyond this capability. Such a test reactor would provide a wider range of capabilities (i.e., fast flux), assure domestic test capabilities, and provide for accelerated fuels and materials testing under a wider range of conditions. While this logic has merit, a number of issues need to be more clearly addressed in the Gap Analysis.

1] The gap analysis concludes that advanced test reactor with a thermal flux would not significantly speed up LWR fuels and materials qualification. While this may be correct more discussion is needed to answer such questions as: Can a larger test volume in a LWR test reactor eliminate the need for lead test assembly in a LWR nuclear plant? Can earlier steps in fuel and materials qualifications be eliminated or accelerated with a larger test volume or multiple test volumes?

2] The NEAC infrastructure subcommittee has noted in its report (REF) that current U.S. experimental test capabilities (including test reactors) suffer from a lack of access and/or coordination both domestically and internationally, lack of reliability, lack of funding for adequate staffing and maintenance, lack of well-instrumented standardized test rigs, as well as a lack of fast flux neutrons to accelerate testing. While the gap analysis recommendation addresses this final issue, the report needs to emphasize the on-going need and NEAC support for DOE-NE funds and organization to address these other issues.

3] The gap analysis indicates that with an advanced test reactor providing a fast neutron flux, it is quite possible to perform accelerated testing of fuels and materials testing in a thermal flux environment. In contrast the reverse is not doable or desirable for a number of reasons (e.g., fluence and materials damage scale distortions). These reasons need further exposition in the report discussion.