Minutes
Nuclear Energy Advisory Committee Meeting (NEAC)
July 9, 2018
Crowne Plaza Hotel, Arlington, Virginia

Committee Members Participating:

Eric Anderson
John Bear
David Blee
Matthew Bunn
Dana Christensen
Caroline Cochran
Ralph DiSibio
Jay Faison
John Hopkins
Susan Ion (via telephone)
Karen Kirkland
Maria Korsnick
Regis Matzie
Richard Meserve, Chair
Carl Paperiello
Joy Rempe, Co-Chair
Ray Rothrock
Alfred Sattelberger
Kim Seungjin
Brien Sheahan

Committee Members Absent:

Lisa Marie Cheney, Stephen Kuczynski, Pete Lyons, Sean McGarvey, Burt Richter

Other Participants:

Tracey Bishop, Deputy Assistant Secretary for Nuclear Infrastructure Programs, Office of Nuclear Energy, USDOE
Alice Caponiti, Director for Advanced Reactor Technologies, Nuclear Technology Research and Development, Office of Nuclear Energy, USDOE
Brian Plesser, Office of the General Counsel, USDOE
John Herczeg, Deputy Assistant Secretary for Nuclear Technology Research and Development, Office of Nuclear Energy, USDOE
Suzanne Jaworowski, Senior Advisor, Office of Nuclear Energy, USDOE
Shane Johnson, Associate Deputy Assistant Secretary for Nuclear Technology Demonstration and Deployment, Office of Nuclear Energy, USDOE
Wendy Jue, NEAC Support Staff, Allegheny Science and Technology
Steven Katradis, Recording Secretary, Allegheny Science & Technology
Sarah Lennon, Acting Deputy Assistant Secretary for International Nuclear Energy Policy and Cooperation, Office of Nuclear Energy, USDOE
Bill McCaughey, Director for Advanced Fuels Technologies, Nuclear Technology Research and Development, Office of Nuclear Energy, USDOE
Edward McGinnis, Acting Assistant Secretary and Principal Deputy Assistant Secretary, Office of Nuclear Energy, USDOE
Patricia Paviet, Director for Materials and Chemical Technologies, Nuclear Technology Research and Development, Office of Nuclear Energy, USDOE
Robert Rova, NEAC Designated Federal Officer, Office of Nuclear Energy, USDOE
Jennifer Wachter, NEAC Support Staff, Allegheny Science and Technology
Michael Worley, Associate Deputy Assistant Secretary for Nuclear Technology Demonstration and Deployment, Office of Nuclear Energy, USDOE

About 35 others were in attendance in the course of the meeting.

Morning Session

Before the meeting, **Brian Plesser** of the USDOE's Office of the General Counsel conducted the Committee's annual ethics briefing.

At 9:00 a.m., **Edward McGinnis** welcomed everyone and provided opening remarks on the purpose of NEAC, stating that this is the very first NEAC Meeting that is chartered and where everyone has been personally invited by DOE Secretary Rick Perry. McGinnis said that this is now indeed not only a new chartered and invited committee, but, a committee that has now undergone an expansion with regards to the breath of the expertise of the leadership of the sectors represented by the members in this committee. In the past, there has been more of a narrow focus on research and development (R&D) and on research, development and demonstration (RD&D). What is different in this committee is that our responsibility is no longer only including R&D and RD&D, but, is also extending into nuclear energy more broadly. Our responsibility is to support the health and the vitality of the U.S. nuclear energy sector. Together, what the DOE brings to the table is unsurpassed world class national laboratory capability, technical expertise and many other things. We have are taking a private public approach, not a public private approach; certainly in the nuclear sector we are looking for industry-led innovative solutions and responsiveness to the needs of the customer base. Before he provided the committee a sense of the policy priorities of the Office of Nuclear Energy (NE) and what its most pressing challenges are, he had the Committee members introduce themselves.

McGinnis thanked all of the Committee members for taking the time to be a part of this committee and for their service to the DOE and to the country. He stated that the representation of the members was very intentional and aimed to invite leaders and experts from a broad spectra and not only focus leading technologists, but, also Nobel Prize winning physicists, highly esteemed laboratory leaders, state leaders in commerce committees, regulatory leaders, transmission leaders, venture capitalists, investors, bankers, philanthropists, interest groups, industry associations and builders. So with such talent and expertise in this committee, we have a great opportunity to succeed.

McGinnis then discussed the objectives of this meeting and the perspectives from the new administration. He expanded on what the opportunity that currently exists, means to all of us and what the situation at hand is, from the perspective of NE. In the U.S.A., clearly nuclear energy represents 20% of our electricity. The nuclear sector has been performing a noble task with a fleet that hasn't had a new build in over 30 years. This is an exemplary record of efficiency and performance and the nuclear industry has managed to successfully maintain and operate that 20% for a number of decades without any additions to its current fleet of nuclear power plants in over 30 years. That is a remarkable service. We also see the role of nuclear energy as not just as electrons on a grid and providing reliable electric energy. We also consider nuclear energy in our country as an energy security matter, as a national security asset. This is incredibly important. This is our approach. We also recognize that nuclear energy plays an important role when it comes to the environment. After all, the nuclear sector provides well over 50% and close to 60% of our clean energy in the energy portfolio of this country. That is a significant valuation we place on nuclear energy.

Thus, at this moment, we are in a historic moment in our country with nuclear energy. We are truly witnessing an inflection point. We are determined, this Administration and the DOE are determined to ensure that this inflection point ends up with a growth in nuclear energy and revitalization of the nuclear energy sector. When President Trump came to the DOE it was clear that the new Administration has embraced nuclear energy and the President said that we shall begin now, taking the right steps to revitalize and expand the U.S. nuclear energy sector. We have received a clear message and unequivocal direction to move forward and do everything we can to support the revitalization and expansion of our nuclear energy sector. Secretary Perry strongly believes in the role of nuclear energy. Perry passionately supports the importance of the current fleet, but, he also believes we should have a market that values nuclear energy for its multiple roles, including resiliency, but, also the need to open up the pipeline of reactors with SMRs. The historic moment we have before us, where our back is frankly against the wall, is that we have an unexpected number of reactors that are closing because of market issues, regulatory

issues, policy issues; many in the nuclear community over the years had assumed that we had the 2020s to work on the development and proving out and validating the next generation of reactor technologies and that the 2030s was the decade where we needed to bring in the next wave. I would submit that this is no longer the case. We are at least looking a decade forward where suddenly, the time that we thought we had to prove out and support the next generation, is no longer time we actually have. We are looking at forecasts now where our percentage, our national contribution of electricity, if we do not figure out how to open up the pipeline with new reactors, will start to precipitously decline, very possibly a drop in our contribution of electricity in the U.S. in the middle to late 2020s. So we have a pressing moment for us. But, the good news in the United States is, when you look back at times of major inflection points in other industries, that is when the best comes out in us, in innovation and leapfrogging, transformational disruptive actions begin to happen. I truly believe we are at that moment in the nuclear energy sector. I would suggest that what we are witnessing with the advent of entirely new types of the nuclear technologies as well as applying current technologies in new innovative ways – such as advanced light water small modular reactors, micro reactors, additive manufacturing, and 3D printing. We need to jump ahead very quickly and transform our approaches to be able to get on a stable and growth footing and also on a competitive footing globally. We are going to have to realize transformational improvements. We are going to need to look to disrupting and leapfrogging, I humbly do not believe we are going to able to get back to be able to fully compete and competitively prevail globally by finding incrementally-paced ways.. We need to transform the way the products come to market. We are looking to invest in transformative disruptive technological approaches and that's why you are all here. We need to bring everything to the table if we are going to step up and succeed in the future by being able to respond to the challenges that we have today.

In conclusion, McGinnis said that the way NE is approaching this very broad challenge, in order to be able to succeed, is to take an intuitive and almost simplified approach to the articulation of NE's mission priorities and focus. To accomplish this, (1) our Number 1 Priority is the Nuclear Fleet, maintaining the sustainability and viability of the existing nuclear fleet, (2) establishing the Pipeline of new advanced reactors -- that is a top priority, (3) developing and establishing the Fuel Cycles and Infrastructure, and everything that comes along with it, that includes, test platforms, advanced test reactors, advanced fuel supply (such as HA-LEU supply), of which we are lacking for many of the advanced reactors, and other fuel cycle infrastructure aspects, to include as well, human capital development to support the necessary traits and other aspects associated with fuel cycle infrastructure, and (4) finally, achieving Global Competiveness in Exports; we are at a stage where many if not most of the U.S. companies in order to be successful, must go overseas to compete in exports; if companies are going to be profitable, first they are going to have to be able to secure markets overseas; thus, we must put priority on the global export and competiveness of our U.S. nuclear sector. These are our four objectives and what we are asking you to do is to not just review or critique what we are doing, but, think innovatively and disruptively, as much as possible, at what we are doing and ask yourselves, what is it that we are missing, is there something that we can do better, what else could we be doing to support the pipeline of new reactors and to support re-establishing our fuel capabilities. NE also will establish a strategic plan and roadmap for the future. We will be looking for you to provide us your valuable input. Lastly, McGinnis mentioned that he already discussed (with Suzie, Richard and Joy), having the four subcommittees be calibrated moreso with these four objectives/priorities (previously mentioned). We want to see an alignment of these subcommittees with these four priorities and we will expect to have therefore a subcommittee for the Nuclear Fleet, a Subcommittee for the Pipeline of New Reactors, a Subcommittee for the Fuel Cycle and a Subcommittee for Global Competiveness.

McGinnis then turned the meeting over to Chair Richard Meserve and Joy Rempe.

At 9:38 a.m., Committee Chair **Richard Meserve** thanked Ed McGinnis for his helpful insights and opened the public portion of the meeting.

Meserve reinforced the four areas that define the mission for NE that McGinnis spoke about. He also emphasized what McGinnis said earlier, that in each of these four areas, we are truly confronting challenges many of which are quite new and all of which that need to be addressed. For example, if you

look at the challenge with the existing fleet of 99 operating reactors in the U.S., there is a threat that maybe 10 - 20 of them could be on the bubble of their competiveness and may not survive. If we lose them, it will be a great tragedy in terms of maintaining infrastructure that's important for the nation. And it's a combination of things that brought about that situation. Part of it is the very low price for natural gas, part of it is that electricity demand has not been growing, another part is the favoritism for renewables which works to the disadvantage of nuclear energy. So you have a combination of factors that are resulting in plants that have been running today better than they ever had and have been running safer and yet somehow we are able to keep them going. So we have a serious challenge in trying to keep the fleet going.

On the second topic of advanced reactors, we are at a remarkable time since there are 40 or more companies, with private money behind them, that are pursuing various ideas; some of them are Light Water Reactors (LWRs) like NuScale, but, there are others have different coolants like liquid metals, gas, molten salts and so forth, in companies that believe that they offer improved economics, greater efficiency, higher temperature operation offering more thermodynamic efficiency and the possibility of producing process heat, improve waste burnup and reductions in the mass of generated waste. There is a variety of possibilities that some of these technologies provide, that enable even a step increase possibly beyond what we have today. Somehow we need to find a way to actually push some of these technologies forward or create an environment in which the good ideas can survive and thrive and grow.

On the fuel cycle and infrastructure, the third area of emphasis, and that's one, where these advanced reactors with different types of fuels, there are challenges that need to be met in terms of the performance of the safety systems of those reactors development of fuel forms, understanding, for example, molten salt, where it is critical to understand corrosion characteristics and so forth. The previous version of this committee had advocated a test reactor with an opportunity of various loops that would allow the expiration of some of these technologies. The continuation of this work will be important, we will hear more on this later today. Also the importance of human capital is paramount, we need to create the stream people necessary to allow both the existing fleet and some of these advanced ideas to go forward.

On the final topic of global competiveness, which is not only the economic benefits of our being able to export our technology abroad, but, also, we need to understand that if we are not in the international market with our technology, we are going to be losing out particularly, to Russia and China, as being the major exporters and our capacity to define basically the rules of the road, safety, security and non-proliferation is going to be constrained. If we are not a major player, we are going to be diminished. Most of the construction around the world today is Russian. They use the sale of reactors as a means to project their foreign policy interests and they subsidize it. So they are very aggressive in their pursuit of sales abroad and that is a threat to us not only from an economic point of view, but, also in our capacity to influence policy in some very important areas.

So we have a situation in which there are not only existing countries that have nuclear power plants that are talking about growth of their activities, but, the interesting thing is the twenty or so countries that don't have nuclear power plants, that are interested in acquiring them. Our capacity to be involved in those countries in a very economical way is related to this issue of global competiveness and this is an issue that needs to be addressed across the entire federal government and not just the DOE.

We have a range of important issues, in every one of the four priority areas that has been mentioned. Some of the issues are new or intensified, so there is a lot of important work ahead of us that we have to provide in these areas, and it is imperative that we all work together to bring new ideas and approaches to the table and gain momentum.

Meserve then turned the meeting over to Co-Chair Joy Rempe.

At 9:44 a.m., Committee Co-Chair **Joy Rempe** thanked everyone for coming to this meeting.

Rempe provided a historical perspective of NEAC and reiterated some objectives as provided to us for this meeting. Obviously our purpose is to provide advice to the DOE, helping them assure that the U.S. has a healthy nuclear program and the facilities required to accomplish their mission and support our nuclear program. Typically NEAC conducts its work through subcommittee meetings, where the subcommittees will have more-in-depth reviews of ongoing activities and we want to use the expertise of

the members to identify areas that we may be missing in these ongoing activities. We historically have issued some thoroughly significant reports and one of the most recent ones issued has been the one regarding the Versatile Test Reactor (VTR), which right now is a major program within the DOE. We typically have our meetings twice per year and during such meetings, we typically review the reports issued by the subcommittees, along with having some presentations by the DOE program managers. This time the agenda is slightly different, it is focused on a lot of discussion, for everyone to not only hear and learn about ongoing activities, but, also to provide an opportunity for each member to comment. As you are listening to the discussions today, be thinking ahead of time on which of the subcommittees you will like to serve. Rempe thanked everyone again for agreeing to serve on this committee and stated that in the afternoon session, it will be discussed how each member can convey their input on which subcommittees they would like to serve.

Rempe then turned the meeting over to Suzanne Jaworowski.

At 9:47 a.m., **Suzanne Jaworowski** thanked Richard Meserve and Joy Rempe and briefly described the objectives of the meeting and the current Administrations' perspectives, stating that she will yield most of her time instead of telling everyone what she does, since she will do so as the day progresses.

Jaworowski mentioned that Secretary Perry has talked a lot about making nuclear energy "cool" again and said that what he essentially has done is identify that one of our real tangible obstacles in the industry and an obstacle to our goal of "Revitalize and Expand", is perception and lack of information; lack of accurate content in making up your mind about how you feel about nuclear energy. He has charged Jaworowski with an Education and Outreach Program, which she said she will tell everyone about, on a one-on-one basis, throughout the day.

Jaworowski said she will like to set the stage for a very productive working group meeting. She said everyone will hear briefings from the deputy assistant secretaries, from different areas of the office, who will provide very top-line information about the areas that they manage and the programs that they are working on. We hope that you can think about how you can be productive in outcome and results from this day. Think how you can contribute to the framework for establishing a strategic plan for nuclear energy and achieving the goal and focusing on those objectives, the goals of "Revitalizing and Expand" with the objectives of focusing on the existing fleet, the development of a pipeline for nuclear reactors, the infrastructure including the fuel cycle, that includes the full breadth of the fuel cycle, including what to do with spent fuel, as well as the international market opportunities, recognizing that international opportunities will have a major effect on our infrastructure and supply chain, here, domestically. Those are the four areas of focus that we would like you to be thinking about and how you may be able to contribute on a committee in those areas. So, again, think how you might contribute to our strategic plan.

Jaworowski mentioned that after the DASs give their briefings, in the afternoon session, there will be a Strengths, Weaknesses, Opportunities and Threats (S.W.O.T.) Analysis, brainstorming session, where we will all roll up our sleeves up and think about the what the SWOTs are to the industry and what the major priorities and ideas are in helping us to address those SWOTs.

Jaworowski then turned the meeting over to Chair Richard Meserve.

At 9:50 a.m., Committee Chair **Richard Meserve** took over the meeting.

Rothrock expressed thanks for a terrific introduction and said it is great to have so many new members join the committee, particularly on the business side (which does not happen very often). He asked where did finance, where did the money part of the nuclear business, factored into the picture. He said that from his role in the GAIN advisory business and his investments in the advanced reactors, that raising money is very hard and that although this is not the primary mission of the DOE, it greatly affects the results of the DOEs current mission.

McGinnis responded that the finance part is a huge factor. We are trying to find ways to better communicate to not only the investment community, whether it is debt-financing, equity investment and others. We have representatives here now from the pipeline living and breathing the issue of investors. Communication and perception is important. Perception greatly impacts the appetite for investment or debt-financing. For example, if there is a perception that the Federal Government is not committed long-term, that could have a huge impact. If there is a perception that we have a regulatory body that is not

fully committed to supporting the guidelines for new advanced technologies, in an efficient way that could have an impact. So the pipeline finance is huge. This is one reason why we invited the broader breadth. Internationally, there is no doubt, China's uses the biggest wedge of all; which is their ability to put equity down. And Russia too. Financing in not only their great equalizer, but, also their ace in the hole to try and win deals over superior technologies, products and services from the U.S. If we don't have investors, we are not going to have the industry that we need.

Jaworowski responded that the issue of finance is a major obstacle to our objectives and we will see that more and more as we proceed throughout the day, especially when we get into the SWOT exercises. Finance is a challenge. The regulatory aspects impacts finance and the markets. All are tied together. She clarified that if during this meeting, there is one area that you as NEAC, find is such a major obstacle to our objectives, by all means you as a group can spend more time to address this issue rather than many other issues that may not be as big obstacles. So it will be up to you to decide.

McGinnis added that he and Jaworowski are planning to go to NYC in a month or so, to meet with investment bankers and that Bloomberg and others were facilitating this effort. This will be an informal information sharing session with investment houses and investment bankers, to let them know what we are doing, how serious we are and that we are working towards these objectives and next we are thinking of going to Silicon Valley. This is our current thought process.

Jaworowski added that if there are others that anyone felt we should also be targeting and that we should be sharing this information with, to let her know, so they can be added to the list being built at this time.

Bunn said that the markets are very challenging right now with the low cost of natural gas, but, government policy affects the structure of those markets and so it seems that the DOE should have (within NE or between NE and various financing offices) a deeper think about all of the different tools that the government has available to affect risk, which affects financing costs and so on. In the past, we have had the loan guarantees, think there are opportunities such as NuScale which has been pursuing to deploy its technology on government sites, having long-term purchase agreements that would reduce risk. Need to have an overall game plan, putting all of these things together in an integrated fashion. Otherwise, without a game plan, the markets by themselves will choose natural gas.

Bunn also suggested that we should not be in too much of a hurry. He expressed disagreement with two things McGinnis said earlier, that he felt were contradictory; that is we can't afford to wait even until the late 2020s, but, on the other hand, we need to be transformational. He said if we are going to be transformational, we need to be willing to take the time for the new technologies to get to the plants that can get licensed and demonstrated and convince markets that it is reasonable to buy them and so on. Many may be interested in technologies that are not going to be ready until the 2030s, even technologies that would be ready in the 2050s may still be worthy of serious attention. So by being too much in a rush, we could be leaving things off the table, that may not be considered and which may be of great value or benefit. Thus, we should not be limiting ourselves because we are in a rush.

Meserve asked whether there were any other questions about the general charge (because there will be many opportunities to explore many of these other issues), before progressing into the morning's presentations. There were no further questions.

At 9:58 a.m., **Shane Johnson** was asked to present the Reactor Technology Program Overview.

Johnson welcomed the new committee members and welcomed the opportunity to speak with all of the committee members in detail and get help in what we are doing in any of these areas and do it better as we go forward. We actively engage the three big sectors; industry and private sector in the U.S.A., the DOE National Laboratory Complex and then we have the extensive University Community. We engage in those three areas to help us mature technologies and pursue new innovative areas. As previously mentioned by McGinnis and others, the mission priorities of NE are really focused on the areas of the existing fleet, helping to develop the advanced reactor pipeline and develop the fuel cycle infrastructure in support of the fleet and the new pipeline. If you look at what we are doing in NE, if you look at our budget requests, if you look at the appropriations, the funding and sources that we have is in these three

areas. Johnson stated that he will address the first two areas (the existing fleet and the advanced reactor pipeline) and John Herczeg will address the third area (fuel cycle infrastructure).

With respect to the Existing Fleet, we have in place now for a number of years the Light Water Reactor Sustainability Program whose aim is to solve significant highest priority cost and technical problems threatening existing plants. Through this program we have been addressing principally long-term operability and reliability of the existing fleet. A lot of the work was initiated in looking at the initial round of license extension from the initial 40-year operation to 60 years. A lot of work has also been done looking on how do we go beyond 60 years. A large part of the work has been done on material aging, component aging and reliability. Recently, we have asked ourselves, given the condition of the existing fleet, should the primary focus be in going from 60 to 80 years. So we have tried to continue with some of the more critical, longer-term R&D work, but, also open it up to try to see what is it that industry could use some assistance from the DOE on, to help more near-term issues. Right now there are a couple of pilot programs with industry, in big data analytics, looking at historical plant operation data and analyzing it to basically forecast developing issues within the plant. An example on that would be in Boiling Water Reactors and moisture carryover from the core into the moisture separators. We have actually gone through some tens of millions of data points from instrumentation over the course of operation and it has been very rewarding since we have actually been able to see where a few key pieces of instrumentation within the plant that actually, by monitoring just those few instruments we can see where the onset of moisture separation laden fuel cycle within the plant starts to occur. So using data analytics, there is a lot that the DOE can do to assist the industry and keeping the plants operating safer and more reliably.

Johnson said that Herczeg will talk more about the Accident Tolerant Fuel (ATF) Program in more detail but again this is another area where NE is engaging in some critical R&D in support of the existing fleet and how we can continue to help the fleet to continue operating into the future.

And lastly, we have been conducting Cyber Security research to develop intrusion-resistant systems and practices in support of US nuclear plants. Have been working with EPRI and the NRC to determine some critical areas in cyber space for where we could make small investments and get some big returns.

Moving on to the Advanced Reactor Pipeline, via the Gateway for Accelerated Innovation in Nuclear (GAIN) initiative, NE is providing U.S. nuclear technology developers access to the DOE National Laboratory complex through: the Technical staff, Advanced computational methods and machines, Specialized R&D infrastructure, and Nuclear Technology R&D data from historic DOE demonstration programs; NE is executing First of a Kind (FOAK) Advanced Small Modular Reactor (SMR) competitive private-public partnerships to ensure SMRs commence powering the grid by 2026-2028; NE is executing competitively-awarded private-public Advanced Reactor Technology development projects for High Temperature Gas and Molten-Salt Reactors; and NE is supporting Industry-identified R&D originating from the NEI/GAIN Technology Working Groups on High Temperature Gas, Molten-Salt, and Fast Reactors. With these three Technology Working Groups is to focus the research activities that we are sponsoring, on the areas that the industry has identified that is of common value to the companies on the various working groups. So what we are really trying to do is move our research program to support specifically the areas that the industry has identified as critical areas of investigation that can help them take their commercial products further down the technical maturation process.

One of the big things this fiscal year in helping us, again, get our research, focused on industry's needs has been what we refer to as our Industry-Focused Funding Opportunity Announcement. This is something that we started working on about a year ago and rolled out at the end of last calendar year. What this does is it's a contract mechanism by which we put out a solicitation seeking industry's input, having industry identify to the DOE what are the areas, where can we be of assistance. It is a cost share program depending on the funding level it can range from 50-50 co-share to 70-30 or 80-20. For FY 2018 we identified about $110M of funding available that we can make available to the private sector through our various appropriated accounts. So far this year we received 39 proposals during what we call our first-two Cycles (2018-1 and 2018-2) of the Inaugural Year. We have announced results from the first cycle a couple months ago and actually later this week we will be announcing the results of the awards from Cycle 2018-2. So in total there are 40 projects that have been proposed to the DOE, totaling about

$318M: in Tier 1, FOAK Nuclear Demonstration projects, 10 proposals, $215 million; in Tier 2, Advanced Reactor Development projects, 23 proposals, $101 million and in Tier 3, Regulatory Assistance grants, 6 proposals, $2 million. From this you can see that the funding that is available, which I think is substantial, is clearly not sufficient to meet the needs of the industry and identify the work to be done. We have taken this funding and structure it in such a way so as to try to meet the needs of companies, large and small. This is not just for the advanced reactor community, but, it is also for the existing fleet. So while we are here talking there are companies out there that are working to wrap up the proposals for the third cycle. The 3rd Cycle (2018-3) application window closes on July 31st.

Johnson then presented a chart with the FY 2017, FY 2018 and FY 2019 (requested) funding levels, for the various areas/projects that are on the table, across the Office of NE R&D activities. He mentioned that in August there will be a workshop/lessons-learned session with the private sector to gage how we are doing. The dates are finalized and invitations will be sent out to industry.

Johnson asked if there were any questions.

Anderson asked two questions on Slide #5 (Industry-Focused Funding Opportunity Announcement) in terms of the funding opportunities for the private sector. He asked if Johnson: (1) could comment towards the general time frame relevant to some of the funding that is being provided, in terms of when the demonstration would occur and what would the time frame be for commercialization, for some of the technologies the funding was being provided for, and if Johnson (2) could comment on the criteria used to select entities that the funding would be provided to.

Johnson responded that with respect to the timing on terms of the demonstration of the technologies we are looking to demonstrate our finished product by a particular date. We are being asked to provide assistance in the development of small parts of the overall project and how they feed in. All of the companies are on different timelines, some have more specific timelines than others and some are very vague. Also, none of the proposals to date have been something that would constitute a complete reactor system demonstration.

McGinnis asked Shane to explain how time is valued; in other words, if you are looking at different technologies, would an advanced reactor with plans to get into the market sooner than another one be valued higher.

Johnson provided a response to Anderson's second question that the biggest criteria (used in the selection process for a company to receive funding), is the time frame that the company forecasts moving their technology into commercial space. We would put a higher value on such a company and it would end up getting a higher competitive ranking than another that may need a longer time frame to bring its technology to market. The level of technical maturity of the proposed work, cost share the company is willing to put into it and the cost share coming from the private sector, are other key factors that come into the evaluation criteria and positively contribute to a higher ranking.

Matzie commented that as we all know nuclear is an expensive endeavor in terms of development and given the large number of proposals and the limited funding and asked if there has been much discussion within DOE of fewer awards at higher levels so that the ideas don't die of a thousand cuts.

Johnson responded yes and stated that this is part the reason NE wants to have the workshop with industry is to get their views on that. Some will comment that we should go with a smaller number of awards with a smaller dollar value versus the way we are doing it now. We have been very careful not to become de facto decision makers on technology development. There's at least two schools of thought on that; those who advocate that we should down select just a few critical technologies and there is another view that says that supports putting a lot of seed out and then see what the industry does. We have been letting the private sector set NEs priorities. Define where NE should be making funding investments in terms of RD&D. NE is mindful of the different views on having fewer projects, higher dollar value or smaller dollar value and more projects. We can't satisfy everyone. But, we definitely want to ensure that the serious companies out there that have secured private funding, get all the help they need to be successful.

Kirkland said that Anderson's question got her thinking about the timing and the funding. She said she could see that one of the challenges being faced, would be giving fiscal year funding (not knowing

how much will be available in the future), generally funding research on a 1, 2 or 3 year level while some of the research could take 10 or 20 years to come to fruition. She asked if that was one of the main challenges, in other words, trying to balance the number of years of funding that can be awarded.

Johnson said it is and that during the first two cycles NE has tried to fully fund the proposals. Almost all proposals are multi-year efforts so they have been allowing projects up to 3 years in duration. But we are trying to fund them all up front so that we are not carrying some type of liability. What we don't want to do is make a lot more awards than Congress would appropriate funding for. The last thing that we would want to happen is to get the company too far down the road and then not have the funding for Year 2 or 3. We are trying to be very deliberate. That leads to fewer awards, but it also ensures that the DOE is a reliable partner in the activity. And we do not want to repeat the shortfalls of the past with many universities where we could not get the funding and lots of research had to be stranded. By all means we are trying to avoid this from happening with the private sector.

Christensen said that the existing fleet is our bedrock right now and without having the existing fleet the future technologies are not going to make it to the marketplace. I have always been concerned that the extension on any reactors has always been a one-off activity by the operators as opposed to a system activity that's been conducted by some larger group, the government or someone else. And you have the vendors out there, you've got the operators, you have the regulators, you've got proprietary information that often becomes a barrier, there are a lot of complicated constituencies out there and I have always thought that the only way to succeed from a systems point of view in securing our existing fleet, is by bringing all of these constituencies together. Is there any effort to bring all of the constituencies together as a group to talk about how do we overcome or what type of barriers are in there.

Johnson responded no and said that under the Light Water Reactor Sustainability Program, NE has worked with EPRI, expecting EPRI to have been the integrating organization across the Owners, at least, bringing in vendors as necessary. As we are moving forward (and taking your point in consideration) we probably should re-evaluate how we are engaged in that larger group of stakeholders. Historically, we have relied on EPRI to bring forward the issues that are most common across their membership with respect to the existing fleet and license extension.

McGinnis clarified that the budget slide in Johnsons' presentation represents a subset of the overall budget for NE. The slide in John Herczegs' presentation represents the total budget which we are operating off right now and is $1.2B, based on 2018 appropriations from Congress.

Johnson made one additional comment that this budget represents the work we are doing in R&D.

Matzie commented that the VTR budget seems to be going in the wrong direction taking into consideration how important it could be and being a relatively high priority item. He said that one would expect the VTR budget to be more than what it was in FY18 for FY19 and not half the FY18 level, if you were trying to accomplish anything.

McGinnis asked Herczeg if he had a viewpoint on Matzie's comment.

Herczeg commented that the Administration has to live with a budget constraint and with all budget constraints something has to give. At this particular time these were the funding levels that were acceptable to the overall Administration ($30M for FY18 and $15M for FY19).

McGinnis offered additional comments by stating that the budget NE received from the current Administration has been almost double from what was requested and based on what it used to be and that personally he had not seen such an increase since the 1990s. NE requested $704M in 2018 and received $1.2B. It was very similar for 2019, where NE requested $754M in 2018 and received $1.48B, which does not include Yucca Mountain, disposition & storage. So, this is quite remarkable and it shows a remarkable bipartisan bicameral support for the importance of nuclear energy which is a really unique opportunity for us, unequivocal Administration direction that nuclear energy is vital and unequivocal support by Congress.

Meserve then turned the meeting over to John Herczeg, after first suggesting a short break.

A break was declared at 10:35 a.m.

The meeting was called back into session at 10:50 a.m.

At 10:51 a.m., **John Herczeg** was asked to present the Nuclear Fuels Technology Program Overview.

Herczeg welcomed the new members of the Committee. The current mantra is “expand, revitalize”, he said he hears it every day and added that he can personally attest that the Secretary Perry is 100% behind us, as we go forward. Herczeg presented an overview of the Fuel Cycle part of his office, starting with an overall NE organizational chart, explaining where his office, NE-4, the Office of Nuclear Technology Research and Development (NTRD) fits in. The NE-4, NTRD scope of work all falls under three branches: NE-41, Office of Advanced Reactor Technologies, NE-42, Office of Advanced Fuel Technologies and NE-43, Office of Materials and Chemical Technologies. Herczeg introduced the directors of NE-41 (Alice Caponiti), NE-42 (Bill McCaughey) and NE-43 (Patricia Paviet - absent). He mentioned the functions of NE-3 (Tracey Bishop) and NE-8 (Melissa Bates) and stressed that NE-4 is integrally coupled with NE-3 and NE-5 and that there are no boundaries between NE-5 and NE-4 or NE-5 and NE-3. Mentioned that NE-8 has a very large fraction of the Fuel Cycle budget. The specific nuclear energy work areas that NTRD is engaged in at this particular point in time, was further illustrated in another large-picture diagram (in yellow), which indicated all of the nuclear energy work areas the DOE in involved in.

Herczeg described the Accident Tolerant Fuel Development Plan (ATF) since ATFs is a major focus area within NE. The FY18 budget is $125M (typically $60M to 70M). In 2008 and 2009, NE was very concerned with the amount of waste that was generated with LWRs, and ATFs evolved from that time period. Program started in 2012 and that’s when Congress mandated a 10-year program to have either test rods or a test assembly in an LWR by 2022. We are beating this deadline by 2 years. We have seen major changes in the way the NRC is working with the DOE in regards to ATFs. In the beginning the transition was not smooth between the ATF vendors, utilities and the NRC on how to license this fuel, but, that changed later when the NRC begun to listen. So the licensing of advanced fuels for use, especially ATFs, is on a new pathway within the NRC. Commercialization of ATFs is expected by the 2022 – 2023 time frame with expected full core loads in late 2020’s to early 2030’s. The DOE is funding three major vendors who are developing their ATF concepts. Each vendor has their own type of proprietary approach to ATFs: Framatome has been using chrome-coated zirconium cladding and doped uranium dioxide fuel; General Electric has been using iron-chrome-aluminum cladding and conventional uranium dioxide fuel, although they are now questioning it, because if steel cladding is used, as opposed to zirconium cladding, the neutron economy gets slightly worse off, requiring an increase in the fuel enrichment; and Westinghouse, has been looking at two types of cladding, using uranium silicide fuel with a silicon carbide cladding (which is delayed and will not make the 2022 time frame) and a chrome zirconium cladding (which they are currently looking at). What’s important is that thanks to Congress and advisory committees, we are beginning to get all of these issues in line, and solve them one by one, as we march through.

McGinnis commented that there is a tension here between time, customer need and development once you get into this issue in more depth. From the utilities perspective, they have a challenge in their hands if we do not prove these new advanced fuels worthy and make them available for use by 2024, 2025 or 2026, etc., they would have to default to executing long-term orders to continue to use conventional fuels that do not offer the heat tolerances and the economic benefits of advanced fuels. This is an example of a challenge, thus, time is absolutely a critical factor and innovation in technologies like this is an example that translates into the ability to get into market with new products and services.

Herczeg, responded that economics is one of the drivers in using ATFs because they would offer significant cost margins. Many utilities are convinced that the use of ATFs, would result in cost reductions. The cost reductions would be realized because of the safety margins associated with ATFs. These safety margins would allow the maintenance of the lower level safety systems in current nuclear power plants to not be required to be maintained at current levels, thus, resulting in better economics. So here exists an economic driver for the utilities.

Herczeg’s presentation also included a discussion on the Versatile Test Reactor (VTR) project, which is conducting a 3-year R&D effort on core design; focusing on a high flux of 4×10^{15} n/cm^2-s with a prototypical spectrum; as large a load factor as possible (maximizing to > 30 dpa/year); a pathway toward driver-fuel disposal; flexibility for novel experimental techniques; a capability of concurrently running

loops representative of typical fast reactors; a user-defined range of effective testing heights of ≤ 1 m, an ability to perform a large number of experiments simultaneously; and a metallic driver fuel such as HA-LEU or LEU+Pu. This project is both supported by the House and Senate. If we are going to build an advanced reactor today it needs to use advanced fuels. Currently we do not have this capability and to be able to license that fuel. We can build advanced reactors and use the old fuel technologies, but with the old technologies we cannot reach the goal of having fuels that can be used for 30 years without having to refuel the advanced reactors. So we need this test reactor if we are going to have truly advanced reactors that are economical. Fuel claddings need to be developed to perform in these advanced reactors for 30 years. Many including China are interested in such reactors and ATFs because they don't have much uranium and not having to refuel every 18 months results in significant cost improvements. Herczeg said NE has received funding of $35M in 2018 ($15M was requested) and that going forward would not be a problem with the current funding. He said this reactor will be a Chevy, but it will not be a Cadillac nor a Mercedes. At some point in the future we hope to be able to license this reactor by the NRC. Our goal is to have a reactor that can run on advanced fuels for long periods of time without generating the waste that conventional reactors generate.

Herczeg said the mission of the Office of Materials and Chemical Technologies (which is a smaller office, but, a very important one), is to develop advanced material recovery as well as advanced waste form development technologies that improve current fuel cycle performance and enable a sustainable fuel cycle, with minimal processing, waste generation, and potential for material diversion.

Currently the ongoing work is divided into four main areas: (1) Electrochemical Processing of Used Nuclear Fuel (develop and demonstrate deployable and sustainable technology for fast reactor fuel recycling and demonstrate flowsheets with irradiated used nuclear fuel under Joint Fuel Cycle Study with Republic of Korea); (2) Off-Gas Capture and Immobilization (management of process off-gasses [I-129, H-3, Kr-85, and C-14] to meet U.S. regulatory constraints); (3) Waste Management (demonstrate technologies at laboratory scale for advanced ceramic and glass ceramic waste forms and understand long-term performance of waste forms); and (4) Aqueous Processing of Used Nuclear Fuel – CoDCon Project and Advanced Recycling (demonstrate recovery of useful materials, Uranium, Plutonium and Minor Actinides from used nuclear fuel thereby enabling recycle options for the sustainability of the nuclear fuel cycle).

Herczeg provided the FY18 Omnibus budget for the NTRD Programs: Supercritical CO_2 ($5M), Reactor Concepts RD&D ($237M) and Fuel Cycle R&D ($260M). The Fuel Cycle R&D budget of $260M, also includes a budget of about $87M for Used Fuel Disposition R&D and Integrated Waste Management. The fuel cycle program has run for about 14 years, with a budget ranging from $180M to $220M. He said these budget levels are sufficient for R&D work, but if we were going to engage in more advanced activities and try to produce or build materials, a higher budget would be required.

Herczeg concluded his presentation by stating that the fuel cycle office is an integrated office and its R&D infrastructures is really the key. He emphasized that the test reactor is really the key to assuring a sustainable fast-reactor industry in the long-run. He praised the TREAT Reactor program that has already restarted and was completed under budget by $20M. Lastly, he stressed that this is the example he plans to use on the VTR program which is aimed for completion within a budget of $2.5B to $3B and not $10B that some estimate it would cost. The VTR is targeted for availability by 2026. He then opened the floor for questions.

Korsnick asked if Herczeg had confidence that the funding levels for the VTR will continue as has been the case in the past.

Herczeg said that the VTR program is a two-part, 3-year R&D program under DOE O413. It is an R&D research design effort that focused on the reactor. We would need about $300M - $350M, over three years, to complete this work. We started at $35M in December 2017. We see that going to $65M. The team is small, but it will start to grow. If we can prove to Congress and industry that we can do this in a timely fashion, it is believed that Congress will fund the project at $150M per year, starting in the second and third year. $65M is a good start and we are there, the next funding level will require $100M - $150M. This is needed to fully integrate in the industry at an early stage. There is a request for proposal

out to industry to bid on the design of the reactor. The first $7M of the $35M is needed to fund work on the design of the reactor core vessel and the auxiliary systems. He believes that Congress will fund the project at $150M per year, starting in the second and third year. Once an architect-engineer is engaged to do the design work, heavier funding (the first $150M budget) would be required. He said he is optimistic because industry is involved. The advanced reactor community needs it. He believes that $100M to $150M would be approved in 2020.

Korsnick said this needs to stay on top of the list of the committees' agenda, because it is so significant.

Bunn said he is skeptical that a fast reactor will be the most economical type. At some point loops were going to be included to allow thermal testing to be conducted. He asked if this was still the case.

Herczeg said that this was initially the plan, but they discovered that to include thermal testing a much larger reactor would be required and that made the reactor more expensive, so because of cost, the thermal testing has been removed from the plans. Also, in answer to your technical question, we are not saying that this type of reactor will be the winner, what we are saying is that this is the tool to get you all the other technologies. It will serve as an accelerator for science.

McGinnis commented that so far you have all seen piecemeal, parts of the budget, but this slide shows the overall budget (presented a new slide). He said, the yellow, to the far left, is what the final appropriation was in 2018. The subtotal shows our current operating budget, which is just slightly above $1.2B. You can also see the 2019 budget and then you can see now what is happening in Congress. On the House side you have $1.346B, which does not include the Yucca Mountain and Interim Storage (which is $220M), with an $85M peel out, but ultimately, you are looking at $1.56B, after you peel out the $85M. As for the Senate, they are holding us at or their proposal is to hold it at the 2018 appropriations. This provides an overall sense of the total budget picture for NE.

McGinnis pointed out one other highlight, that Johnson and Herczeg are also working under, which is guidance from him and senior leadership on an issue about the need for appropriate products. We are not just trying to push reactors of the past, large and larger, because they may not have the necessary attributes that are necessary. There are basically four attributes that we have been aiming for: scalability, versatility, application and finance ability which are key to our goals and finally safety. We are seeing in many of these reactor designs, built-in passive design features with safe shutdown (on loss of power or loss of coolant) of the core being achieved automatically and without human interaction. This would all help us to gain a high level of confidence with the public.

He turned the meeting over to Alfred Sattelberger.

McGinnis took a brief moment to announce that there was going to be a swap of the S.W.O.T Analysis session with the Challenges and Opportunities session, such that the former would take place in the afternoon session.

At 11:29 a.m., **Alfred Sattelberger** was asked to present the Nuclear Technologies R&D Subcommittee report.

Sattelberger first provided a list of the subcommittee members. He said that Margaret Chu had resigned and that there was now a vacancy, if anyone was interested. He praised the subcommittee members stating that there is a tremendous level of expertise represented in this list of folks.

Sattelberger briefly went over the highlights of the Nuclear Technologies R&D Subcommittee one-day meetings of December 11, 2017 and May 7, 2017. Presentations at these meetings covered a much wider list of topics, however, for the purposes of this meeting he said he decided to only talk about the following topics: Budget Updates; Versatile Test Reactor (VTR); Accident Tolerant Fuels (ATFs); Advanced Manufacturing, including 3-D Printing; Material Protection, Accounting and Control Technologies (MPACT) and Co-decontamination (CoDCon) Project; Portable Micro Reactors for Remote Applications; TREAT Restart and NE-4 Education Activities.

Sattelberger provided budget highlights: The Interim Storage and Transportation planning scope moved under new Yucca Mountain (YM) and Interim Storage Programs, which plan to restart licensing activities for the YM nuclear waste repository and to initiate a robust interim storage program; there were Significant plus-up in Advanced Fuels; there were Significant plus-up in Advanced Reactor

Technologies; the FY18 VTR funding is now at $35M (request was $10M); and $60M was allocated for U.S industry awards in support of advanced nuclear technology development.

Sattelberger provided some brief highlights about the VTR. He said that the VTR will support the accelerated development of advanced fuels and materials for US advanced reactor vendors, as well as provide the capability for testing those fuels and materials to support licensing by the NRC. It is a high neutron flux reactor that will revitalize our research infrastructure and remove the critical impediments for US developers of advanced nuclear energy technologies. It is to be constructed and operated under DOE authority in close collaboration with the NRC. The $35M budget approved for 2018 will help NE achieve Goal CD-0, which is Critical Decision Zero and that is a Statement of Mission Need, which will be issued by January 2019. That's an important first step in a major acquisition project.

Sattelberger then identified critical path items for the VTR, as the project moves forward and matures, that are recommended by the subcommittee, that: the Project develop a best cost estimate and a schedule with an identifiable critical path; the Project review the critical path for potential areas of delay and develop contingency plans in the event such delays should occur; the Project develop an integration function to coordinate the two tracks with the objective of identifying and managing potential delays in advance; the Project execute regulatory engagement throughout the project; and the Project develop and then execute an experimenter engagement plan to identify industrial customers, to develop an understanding of their experimental needs, and to prioritize test vehicles and instrumentation design and deployment.

Sattelberger provided general comments and observations about the ATF Program: the ATF Program has been tasked by Congress to pursue the development and qualification of ATFs that would enhance the safety of present and future generation LWRs; vendors are pursuing a strategy that relies on the ability of ATFs to significantly extend the time before initiation of the exothermic oxidation reaction of the zircaloy cladding used in current LWR fuel; the TRLs differ as does the associated qualification approach proposed by each vendor. Ultimately, all 3 vendors (GE, Framatome and Westinghouse) will need to qualify their fuels for high burnup (> 62 GWD/MtU); DOE has developed infrastructure to support LOCA testing of irradiated fuel at ORNL, and irradiated fuel material characterization and thermal property testing at INL; and in 2017, DOE signed a MOU with the NRC whereby NRC could access information from DOE necessary to prepare for licensing ATF concepts and to help ensure that DOE's R&D.

Sattelberger then provided the subcommittee's recommendations about the ATF Program: Re-evaluate the current strategy for ATF deployment. The revised strategy should include input from the regulator to ascertain exactly what data are required for rendering regulatory decisions; if it is determined that the required data should be obtained from U.S. facilities, then the revised strategy should describe upgrades required at the facilities or their instrumented experimental capabilities. The Subcommittee believes it is unlikely that ATFs can be commercialized w/o implementing this revised strategy; and efforts to develop a business case should be expedited to provide confidence that ATF efforts will yield a product that can be commercialized.

On Advanced Manufacturing, incl. 3-D Printing, the subcommittee had the following general comments and observations: over the past 6 years, the program has funded $15M of work (plus 10 NSUF projects totaling $10M); the program is (appropriately) examining a broad range of advanced manufacturing approaches. Methods under evaluation include high-speed welding techniques, high strength concrete and rebar, advances in manufacturing processes (incl. hot isostatic pressing, additive manufacturing, and surface modification methods), as well as improved construction, inspection and testing methods; and most projects appeared to focus on development of the manufacturing process. Less mention was made on the qualification of materials for their intended purpose. The subcommittee's recommendation was to review the scope of the program and set strategic directions. Is the purpose to 'seed' innovative techniques or to demonstrate more quantifiable advantages to adoption of one or more methods in particular applications?

Sattelberger discussed the MPACT Project, stating that its objectives are to: develop and demonstrate advanced material control and accounting technologies, addressing important gaps; develop, demonstrate

and apply analysis tools to assess effectiveness and efficiency, guide R&D, and support advanced integration tools; perform technical assessments in support of advanced fuel cycle concepts and approaches, and develop guidelines for safeguards and security and apply to new facility concepts. The current goal is to complete a lab-scale demonstration of an advanced safeguards and security system by 2020.

The CoDCon Project is a study of the use of on-line process instrumentation to prepare a 70:30 U:Pu MOx material using a co-decontamination flowsheet applied to used commercial nuclear fuel.

The subcommittee's recommendations on the MPACT and CoDCon Projects were that the subcommittee is pleased with progress to date on the CoDCon demo and that more lab-scale research is needed before moving to engineering-scale.

Sattelberger described the Advanced Reactor Technologies Focus Areas as being: Advanced Light Water Reactors; Fast Reactor Technologies (demonstrate feasibility of advanced systems and component technologies; methods and code validation to support design and licensing; and advanced alloy materials qualification for metal-cooled systems); Gas Reactor Technologies (advanced alloy and graphite materials qualification for high temperature gas-cooled systems; and scaled integral experiments to support design and licensing TRISO-coated particle fuel development and qualification); Molten Salt Reactor Technologies (investigate fundamental salt properties; and materials, models, fuels and technologies for salt-cooled and salt-fueled reactors); and Cross-Cutting Technologies (advanced energy conversion Supercritical Carbon Dioxide (sCO2) Brayton Cycle Micro reactors for remote defense and commercial applications).

On the Portable Micro Reactors for Remote Applications, the subcommittee had the following general comments and observations: Portable Micro Reactors are deployable nuclear power sources that can be integrated into very small electrical grids, including those in remote locations. A joint Los Alamos-INL design effort was described for a heat pipe cooled, UO2fueled reactor weighing less than 50 tons; and requirements include: amenability to rapid deployment, e.g., air transportability; low, scalable power in the range of 2-10 MWe; operational within 3 days of arrival; removal within 7 days of shutdown; inherent safety and security; and ease of operation and cost effectiveness. The subcommittee's recommendation was that in addition to preparing for anticipated regulatory action, the design team should also complete a quantitative Proliferation Resistance and Physical Protection (PRPP) analysis, perhaps in conjunction with NNSA, on the eventual baseline design to facilitate even broader public acceptance of deployed nuclear energy technology.

The highlights on the TREAT Reactor Restart Program were as follows: achieved criticality on November 14, 2017; calibration and start-up testing continues; test vehicles are being developed for transient testing of multiple fuel types in the next few years; over 20 GW Peak Transient Power (120 kW steady-state power); core: height (4 feet); diameter (about 6 feet); surrounded by 2 feet graphite reflector; and fuel: 19 x 19 array (approximately 360 fuel elements) of 4" x 4" fuel and reflector assemblies.

On the TREAT Reactor Restart Program, the subcommittee had the following general comments and observations: Congratulations to the Resumption Team for achieving the initial criticality of the refurbished reactor one year ahead of schedule and approximately $20M under budget; ATFs will require transient testing to establish their safety basis –and to quantify the advantage they represent in safety relative to current fuel designs; a number of advanced reactor technologies under development may require transient testing of fuel and components to establish failure modes, failure thresholds, and radionuclide source terms; and enhanced utilization of the existing LWR reactor fleet may be enabled via improved transient effect quantification, particularly to support advanced analytical tools. The subcommittee's recommendation was to develop a set of "standardized test vehicles" able to perform testing on a significant variety of fuel samples. The instrumentation supported by each "standardized test vehicle" should be developed with the targeted user-community (vendors and regulators).

Sattelberger then presented the NE-4 Education Activities the subcommittee had the following general comments and observations: the Gen-IV International Forum (GIF) Education and Training Task Force (ETTF) was established in 2015 to share resources and collaborate in the development of curricula. Patricia Paviet is the current Chair; ETTF has emphasized identifying and curating web-based training

materials accessible in an open forum, and has initiated a set of monthly webinars –one hour on-line lectures by top-level international experts. Webinars can be viewed live and are archived; and as of May 7, webinars have been viewed a total of 3387 times. The subcommittee recommends continued support, and exploring the value of this material to educational pipelines through engagement with additional stakeholders; and the subcommittee supports the idea of the elevation of the ETTF to a GIF working group, in order to explore bigger projects such as development of online courses (MOOC), books, and coordination of students and postdocs working on GIF-related topics.

Meserve asked if there were any questions for Sattelberger.

Matzie asked why a joint INEL design was used for the micro reactor while there are a number of startups that are working on this and was any information collected from these startups and why are we funding laboratories to do this work.

Sattelberger responded that we are funding laboratories for this work.

Matzie responded that it is obvious that there is a redundancy on that type of work and since the national laboratories efforts would never go commercial, that it would have been prudent to gather information from these commercial startup entities.

Sattelberger commented to Matzie that he had an excellent suggestion and that NE will pursue it.

Cochran said Matzie brings up a good point that the committee has been thinking about a lot lately not just at Oklo but the entire advanced reactor community. Several past DOE and lab programs have projects that hopefully will enable the industry, however, once the industry is enabled, hopefully the labs won't be competing with industry. For instance, for the VTR and also for the transformational reactor where does the fuel supply come from, does that compete with the industry's ability to get fuel supplies (it's a very limited supply of course off course), not just from a materials consideration perspective, but also from a design point of view. Are we making a case where we are funding labs to create designs that then are not supposed to necessarily become commercialized, but, are sort of trying to compete in an odd way with designs coming from industries. This had been of great concern.

McGinnis commented that the labs are not to compete with industry, they are there to support industry, because industry does it a lot better and that's the DOE's mandate, anyhow.

Meserve asked whether there were any other questions. There were none. He then made a motion to approve both subcommittee reports. Meserve's motion was seconded. The vote was unanimous to accept both reports.

Blee asked Meserve if these approved reports could be obtained from the website

A break for lunch was declared at 12:02 p.m.

Afternoon Session

The meeting was called back into session by **Suzanne Jaworowski** at 1:09 p.m.

Jaworowski opened the Strengths, Weaknesses, Opportunities and Threats (S.W.O.T.) Analysis part of the meeting, welcoming everyone back and summarized this morning's activities. Then she turn the meeting over to the Members of the Committee, stating that from here on the meeting will be self-guided, from a point of view of giving the members an opportunity to do an analysis of the industry, for both the domestic and international nuclear power industry. Jaworowski again emphasized that this analysis should be focused on the goals in two areas; keeping in mind the overall goal assigned by the President, which is "Revive, Revitalize and Expand" the nuclear industry, as well as the four objectives that Ed laid out in the morning session; that is the objective of helping the Existing Fleet, the objective of developing the New Pipeline for the Future, the objective of the Fuel Cycle and its Infrastructure and then finally the objective of succeeding in the International Markets. Jaworowski said that those are our four objective areas and there are Strengths, Weaknesses, Opportunities and Threats, that affect all of those areas, and that NE would like to not only hear from each member what the thoughts and opinions are in regards to the strengths and weaknesses of the industry, but, also hear about any opportunities for improvement and about any threats that currently plague the industry. And she said that if the members would rather view the strengths and weaknesses of the industry as obstacles and opportunities, that, this would also be fine.

She turned the meeting over to the members. The members collectively discussed those attributes they perceived need to be considered in order to "Revive, Revitalize and Expand" the nuclear industry and each one of those attributes brought forward was then grouped into one of the four SWOT categories, based on whether they were considered to be Strengths, Weaknesses, Opportunities and/or Threats. The groupings that were discussed, were as follows:

Strengths
Innovation
Emission-Free, Carbon-Free Life Cycle
Competent Regulator – Admiration for NRC
Universities – Offer Excellent Nuclear Education
Reputation for Excellent Safety
Reputation for Excellent Security
More Capital to be potentially spent
National Laboratories System is an Asset
Strong Chairmen at National Laboratories
Technical Expertise at Nuclear Power Plants
Human Capital
Change Culture on Nuclear Energy
Nuclear Navy – Has Excellent Track Record

Weaknesses
Lack of Permanent Waste Disposal
Market Recognition
Regulatory Streamlining to Reduce Cost
Loss of Industrial Infrastructure
Construction Cost Overruns
Lack of Public Support
Package as U.S. Projects
Fuel Recycling and Reprocessing
Need Broad Political Support
Government Approach, Overall
Wholesale Markets Do Not Support Exist. Fleet
Amplified Positive Attributes
Global Competiveness

Opportunities
Legacy Data
Potential to Recycle Fuel (closed fuel cycle)
Potential to Reprocess Fuel
Capital Markets
Must Re-Educate Public about Nuclear Energy
Education - Benefits, Radiation, Environment
Human Capital
Need More Student Interest

Threats
Legacy Data, Improper Storage, Potential Loss
Human Capital (Talent Pipeline)
Global Competiveness
Knowledge Transfer – Export Controls
810 Regulations and 123 Agreements
Long-Term Training Outside U.S.
Natural Gas, Renewables
Capital Markets (U.S. Work More Long-Term)
Other Countries (Competition w/Russia/China)

At 1:32 pm, Jaworowski paused the meeting to state that the SWOT Analysis part of the meeting will be wrapped up soon, because NE also wanted to hear from the members next, about what each one felt was the most pressing one or two areas that we have to attack first as an industry. Would that be the Markets, the International Competition, which one of those weaknesses would it be that we need to go after. What would the most pressing priorities be that we need, to pursue to achieve our goals. Finally, we will take the four objectives that Ed laid out and see if anybody has any suggestions or ideas for how to achieve those objectives. Specifically, these objectives are the Existing Fleet, the New Pipeline, the Fuel Cycle and Infrastructure and the International Markets. Then we will wrap it up towards the framework for a strategic plan.

At 1:39 pm, Jaworowski began the second part of the afternoon session, going around the table and seeking discussion on the most pressing priorities in the most urgent areas that need to be addressed, as soon as possible, that would achieve NEs goals and objectives. The members came up with the following comments or suggestions, as follows:

Rothrock made three points; first, for market adoption in the US to occur, you need great economics, you need certainty and you need credit for the full value. The second, is state-on enterprises which is crucial, because a state has an infinite balance sheet, companies don't. These things take time, they take strategy. States also have a strategy that lasts longer than 2 or 5 years. Market adoption in the US, you want to build them and learn them locally and state-on enterprises because both of those need political air cover, which would be tremendous. All of this other stuff, fuel cycle, innovation, etc., if it's broken its

fixable. But, what's hard to fix is the political air cover to create the market with economics and then with state-on enterprises, because that is so hard to compete.

Korsnick agreed with Rothrock and would summarize it by saying that for the US to maintain its leadership in nuclear, we have to build reactors domestically & internationally. But we have to get to a place where it makes sense to build.

Bear said that we need to figure out how to create demand for our product. Everyone wants low-carbon assets and renewables, but, they don't associate nuclear with that and they don't value all of the attributes that come with that. So how do we create demand for our product?

Kirkland is in favor of keeping the existing fleet going because if the fleet goes down it will be hard to bring it back. We don't want to lose what we have right now. And we have to bring new reactors on line, but, we also have to keep up what we have going now in a healthy state.

Sheahan wanted to underscore what Korsnick and Bear said. Markets need to value the carbon-free attributes that nuclear offers, and it doesn't seem likely that this is going to happen. Need to think about the set of tools that states have available to keep these plants on line. At the end of the day we must have rate payers that can pay and are willing to pay and this is a most important consideration.

Joworowski asked Sheahan to elaborate on what tools are needed by states (coming from Illinois) to keep these plants on line.

Sheahan stated that the State of Illinois passed a law that unbundled the carbon-free attributes of generation and created a market around that so it can be valued aside from the actual electricity that's generated at the plant. The FERC has indicated that they are likely to mitigate that in the markets. So I think the alternative will be that States must begin to identify their own capacity resources and not depend on the markets. Eventually you are going to see a market that's like PJM capacity markets collapse. The states will need some kind of alternative. Also I don't think that gas and renewables should be in the threat category, that's not a constructive way to think about them. In many ways, we are in the same boat as renewables at least in terms of the federal markets like PJM.

Hopkins said that after hearing years ago about the Eisenhower philosophy, let's go do it, he wasn't encumbered by OMB. He made a plan at the very senior levels of government to say this is a national security imperative, for all of the reasons the Chairman talked about this morning; that we are seeing all of these countries with state-owned enterprises as market penetrators and once they build these reactors, they are there for 100 years. Somebody at a very senior level (perhaps Secretary Perry) is going to have to mandate that we are going to do this, because if we constantly have to go through a mid-level OMB when they have their own initiatives, we are going to get stuck.

Kim agrees with Korsnick that we need to build new nuclear plants that will simply fix a lot of the problems we are talking about, as well as support reactor development. If we build new power plants, we don't have to worry about many of the things we are talking about. To do so though there should be state and federal level support towards the vendors. In my view, this would be a major priority that needs to happen.

Meserve commented that if he was to list two things that would be of high priority, one would be to keep the existing fleet running. That has to be the foundation for the whole nuclear industry that is to maintain the supply chain. We also need the carbon-free energy, so it's going to be critically important for us to have nuclear energy in the future, and we accomplish this by keeping the fleet going. The second thing, let me say was reinforced by my experience last week, when I was in Jordan, which is a resource-poor country, highly dependent on natural gas from Egypt to keep them healthy. Egypt has been a very unreliable supplier (because the pipeline, occasionally gets blown up) and simply because Egypt just diverts gas for itself. So they are developing an energy strategy where they are going to rely on renewables to the extent they can, that is solar, since they have the benefit of the sun (and they should do that), but, its intermittent, and they would like to have a backup of nuclear power. So they are very interested in a nuclear reactor. Their highest priority is to find a reactor that is available from a cost and size perspective. They have a small grid and a 1000 MW reactor is too big for them, so they are interested in an SMR. They are interested in NuScale, they are interested in the Chinese gas reactor, which has the lead because it will be available soon. It's going to be built soon. They don't want to be the country that

buys the first of any unit. They want to have something that has been built someplace else with some confidence that it is real. So if I had a second priority that we want to pursue SMRs, we need to build it. We are not going to sell it abroad, unless we have experience. So I would say my second priority is let's get on with it and build something.

Rempe commented that she echoes what Meserve is saying, but, can I put it on a higher level and say we must have a strategy. I suggest if you can find a way to take it out of the annual appropriations process so we don't change our course, we need to stay the course because we tend to go back and forth.

Faison commented that we should build it, but, make sure that the folks that are in the red zone (which are kind of sitting in this room), get over the goal line. We need a story. Right now we are selling Vogtle and Summer. If we try to sell this idea of nuclear to somebody, it will be a hard sell. We need a new story, I don't think consumer marketing (which is also a big problem) is the way to go, that would be a waste of time, we don't have the budgets, it will take years and tens of millions of dollars to build brand awareness, but, a story is the way to go. Take a story out of the master story book of new technologies and sell it. But, you will need a plan that is cemented into the ground that will be implemented regardless to changes in administrations and changes in personnel. We have language in the omni that mandates DOE to put together a plan by September 30th. So let's follow through on that even if we are worried about OMB stuffing the plan, let's find some help, let's follow through on the mandate that we already have, ask for a plan and once we have a plan written into the record, it's going to be hard to change it, as the winds of politics change.

Cochran commented that she agrees with others that we need to build new reactors. What keeps me up at night is the worry that we can't build things if we don't have fuel for them. We can't have reactors sitting there that are licensed and can't run because they don't have fuel. I don't think you can get through the licensing process without a viable source of fuel. That's the point where we are at right now for advanced reactors, for NuScale reactors they have a path for it. The majority of advanced reactors need this HA-LEU advanced fuel and there is none commercially available in the USA. There is maybe four reactors we can get it from. This is one major point. The second point is that we need fuel data to get through the regulatory process here in the USA. So if we don't get this data before these people are gone (within 1 year or 2) we are going to have issues. The third point is separate from the two main points and is public education. Thinks we can see a real change by using social media and the internet. In today's world, education can reach many people very quickly if the material is made available. Focusing on young people is also great. Cochran praised Jaworowski for her work in this area.

Blee said he agrees with a lot of what has already been said, but, he thought of most importance was the window of opportunity for innovation for a new generation of reactors that would appear to younger generations of Americans. Off course you have to build them as Korsnick said earlier. We are leaders in passive safety technology in our Gen III+ designs which is the leading technology in the world. We need to continue regulatory streamlining across the board and also certainly, our orientation to 123 agreements and what they are about, non-proliferation or are they about commercial trade or maybe both. And also streamline our export controls philosophy.

DiSibio said to continue on the same path there are several seeds planted including things like national security. What's the difference between the Nuclear Navy and the Commercial Nuclear? We just make it happen in the Navy. We just dictate it. It just happens because there is a seven hundred billion dollar budget next year for building nuclear ships. Nobody questions that. There are thousands of empty facilities owned by the government (including all of the bases and so forth), throughout the USA. Why don't we dictate that the SMRs are put there to supply the power because it is important to our national security. And make that case. But there has to be bold action on the part of the Secretary to make these kind of pronouncements that that's his goal and objective. He does not have to have the strategy in place. But the announcement would be important. It's like when Kennedy spoke about going to the moon in ten years. The announcement is important. It makes the commitment.

Anderson said we have talked about the impact of gas and relatively cheap gas plants and cheap renewables. We did not touch on energy efficiency, the impact of distributed generation, storage, and the advantages nuclear has over storage issues with renewables, and when you package this together it begins

to displace demand for new nuclear. So for nuclear to again hold its percentage of the overall stack, I think innovation is critical and the ability to leverage technology more effectively meet some of the needs of generation today is what will ultimately drive things forward.

Bunn commented that a lot of people said that we need to keep the existing fleet and we need to build new ones. How? In both cases, the key is money and we need to find ways to support not only low-carbon, but also low-fine particulates, which is the part of pollution that actually kills people. We need to find a way to do that that does not appear to be special-pleading for nuclear itself. There is a perception out there that the nuclear industry has been subsidized for decades, they can't make it on their own, thus, at this point, it's too bad, so let's forget about it. That would help the existing fleet and also help making the case for new investment. Internationally, we need to find a way to provide some kind of enhanced financing for our offerings, because if you are asking a country for everything itself at high interest rates, and the competition offers better terms, you can't beat that. So we need to do something about the financing. Bunn thinks this is the biggest issue for the foreign sells.

Christensen thinks our first step has to be to establish an integrating policy around our nation's energy supply. We have done this type of thing in the past, as an example, to electrify the south. This stimulated economic growth in those areas of the country. We need to build a strong case. We have to stop thinking about the cost of the next kW-hr. It has to be an investment that the country makes in order to be able to support the growth of the economy and the long term health of the country. A bold statement needs to be made by the Secretary or by the Administration. Energy is the life blood of our nation and we need to have an integrated policy and strategy around our long-term energy supply for the country.

Matzie said he thinks the most important priority is to maintain the existing fleet. It has to be done by legislative activity and incentives, federal and state. Part of the sell has been the carbon emissions, energy security and one that's not mentioned a lot is the reliability of nuclear power. Even in bad weather, nuclear provides electricity to the grid. So reliability has to be part of the sell.

We need to break the position internationally that certain competitive countries have against us. US does it really have nuclear vendors any more. Think our hope overseas is SMRs. We have the innovation that has been demonstrated in their design. We have two hurdles: speed the market, because we seem to have a slow mindset that we have to design everything before we can get it to the regulator (that's requires a 10-year minimum time frame) and build one here in the USA first, if we are going to sell them abroad. So if we can get over these two hurdles, we can have SMRs that a lot of the world wants, they would be very valuable in the US as a way of getting nuclear energy, because you won't be betting the company's entire assets on it and if you build it in the US, we will have lots of opportunities to build it overseas.

Paperiello said he would strongly endorse a lot of things he heard. Our first priority is to build something. If the NRC certifies an SMR design, there are existing prequalified sites around the US where you can put this plant at. It will probably require some kind of subsidy because someone will have to build a factory to build the first reactor, and since this would be a FOAK, it would be expensive. A subsidy for something that is important to our national security, is not out of the question and you do have to build one first. He cited several examples in US history where the government subsidized large expensive projects before, such as the interstate highway system, the building of the transcontinental railroad or the Tennessee Valley Authority. The second priority would be to deal with waste disposal. We have to close the fuel cycle. That is a burden that would be carried on forever. DOE was supposed to accept this waste long time ago. There are sites in the US with decommissioned reactors that store spent fuel in canisters, which has to be eventually taken care of.

Sattelberger agreed with many others that we have to build reactors, but, he said we have to put an envelope around what the cost of building a nuclear reactor is. The cost must be pinned down to 1x, not 3x (x being an unknown), which has been the case in the southwest for many years. So this is equally applicable to the people building the SMRs. Can we ever get to figure this out so that a buyer of a new reactor will know the total cost? If we manage to do that, then we have a chance.

Also storage of the used spent fuel is a top priority. Utilities have been paying into the nuclear waste fund for years. Where is the payback? Where is the collection point? We are wrapped around this Yucca

Mountain again. Is it going to open, is it not going to open. We have spent over $14B to investigate that site. It's a perfect site for storing waste. I can't and so can't anybody else in this room answer what will happen in a million years, but, it can be done. Again, this has to do with what has been said before; that we need the will to do it and that it needs to come from the White House. When the White House says we are going to do something, magically it happens. So we need that type of pressure from the top to make it go.

Summary of our most pressing priorities/Most Urgent Areas to Address ASAP
Keep the Existing Fleet while Developing New Advanced Reactors – Supply Chain
State Federal Level Vendor Support
Energy Security – Nuclear Energy/SMRs
Build SMRs and Get Over Goal Line
Keep In Annual Appropriations
Cement Plan
US Fuel Supply – SMRs
Solid Stories – Public Education
Packaged Renewables Perception
Particulates Messaging
National Security/Economic Development Imperative – Stimulus
Long-Term Energy Supply Strategy (Nuclear Energy Baseload)
Our Hope – SMRs (Time Scale, Build Them in the US) – Sell Overseas
SMRs – Existing US Sites (Are Not Available) – National Security

Jaworowski said that she would like to finish up this session by putting all of these ideas up with each objective:

Support the Existing Fleet
Reduce Regulations and Use Risk-Informed Regulation
Market Support
Upgrading Technology through Policy Support (Nimble Process State and Federal)

Pipeline for New Reactors
Clear Licensing Pathway
Versatile Test Reactor (HA-LEU)
Tax Credits
Clean Energy Standards
Value for Small Modular Reactors to Fill, Need/Gaps
Loan Guarantees
Federal Government not just Fund, but, also be the Customer

Infrastructure Fuel Cycle
Versatile Test Reactor
Open Yucca Mountain
Advanced Manufacturing
Talent Pipeline (Human Capital)
Infrastructure Financing
Metallic Fuel such as HA-LEU

International Markets
Approach to Government Financing
International Nuclear Safety and Security Initiative

Jaworowski thanked everyone for their ideas and suggestions and stated she hoped that it can all be organized in a way that would lead to a salient strategic plan. She turned the meeting over to Chair Richard Meserve and Co-Chair Joy Rempe.

Meserve thanked Jaworowski stating that this discussion has been very helpful. He reiterated what McGinnis said this morning that one of the objectives he hopes to obtain out of this group is to provide input into a strategic plan. He said that he thinks what we have done, by brainstorming through these four areas is a sketch of an outline that would then develop further, presumably within some sub groups that would then actually prepare materials that would be useful to dig deeper into all of these issues. There's clearly a lot of insight around the room on this. He said that Joy will be talking more about the organizational structure to achieve it, which I think is simple because we have sort of settled on these four mission areas, as being sort of the core of it. But, I think what I would like to do at this moment, where we could have a future assignment discussion, I think there's one assignment already which is going to provide input to the strategic plan. Meserve then said he would like to open the floor again for comment on two different questions, asking members to speak about: (1) anything that we are missing and (2) what should we be doing that we are not or are not thinking about, that is unrelated to or may fall outside of the four mission areas, that has been the focus of discussion all day long. He said he would like to cast that as a thought out for the group to ponder over for a moment and then make some suggestions. He begun the discussions by offering his suggestion first as a strawman as a way to provoke thought.

Meserve said that so far, most of our discussion has been where to go from here on forward. Another way to think about this, would be to propose the end state that we would like to have for our energy system and then think about how to get there. He presented his personal vision to the group for an appropriate end state, which he said is something that had not quiet been articulated. Where do we think we are going to end up in terms of our energy strategy in terms of supply? He said that given the enormous significance of climate change and the need to control carbons, the need for environmental concerns more broadly with regard to energy resources, we should be looking for energy sources that can supply our needs that are carbon free, at least in their generation. That means the end state should be nuclear and renewables. Getting deeper into this, we must then assess what the balance should be. The challenge of renewables is the challenge of its intermittency. Some would argue that you can fill in the intermittency factor with storage. The generation capacity of renewables is about 20 – 25%, so you would need lots of storage capacity. When the sun is shining you have an overcapacity of energy and would need to store the extra energy. So it turns out that you would have to invest in a huge amount of storage capacity which tends to be very expensive and will likely tend to be so for a long time. So to get a large supply of your energy from renewables, would be prohibitively very expensive. That means you need something else and in Meserve's view, that's nuclear, as the other alternative. Nuclear is on 24-7 and you would turn it off when your renewables supply is providing the energy supply you need. So we are to be thinking about what the coproducts could be.

Rothrock said has been a venture capitalist for 30 years and has seen 10,000 pitches and the best pitch is a story. We don't have a narrative, a story. It's hard to come up with it, but it's doable. When it's a great story from an investor's point of view, the confidence goes up, risk does not go down, but they feel better and they overcome the risk. We don't have a story on what role nuclear plays. In the Silicon Valley there's a lot of things going on every day where many billionaires get together and discuss nuclear energy. Are we in that dinner club? Is Washington in that dinner club? No. These people have lots of means and are smart and there are a lot of people that are doing things for them. But it takes a narrative to attract them. We have an opportunity if we can come up with our story. I only bring up Silicon Valley because 75% of the private capital in this country is based within 30 miles of San Fransisco. Washington struggles to partner with the Valley, and the Valley struggles to partner with Washington. But, here is a good opportunity to take a real leadership position to talk to those investors that have an interest, describe the opportunity, tell the story how we can all work together to meet our goals. Washington is often

thought off as an adversary, but it does not have to be. Right now there is an opportunity because nuclear is very low, carbon-free energy discussions is high on the agenda and there is an awful lot of capital and capital can influence decisions that are made by other people. I would advocate a great story, put it together, have dinners and make it happen. This is not trivial. We should start a drumbeat and work on it. The first pitch is very important. So my contribution is to get our story out to these folks.

McGinnis asked Rothrock how could we do that, how could we go about approaching this.

Rothrock responded that we would need to first define our objective. Understand our objective and then we would have to weave a story around that. You have to sincerely present the risks and put them on the table in a friendly way. Two things motivate people; fear & greed, but greed is a much more powerful motivator. And to talk about it that way is an opportunity, both to make money, but there is a national mission here. We should present this to people who know us, start in a small way. It's a process and the effort involved would be a multi-year effort. And we must have a long-term view that answers the question on what we are trying to achieve. An investment pitch would involve at least a 10-year plan.

Lennon presented information on her involvement and experience with the Nuclear Innovation Clean Energy Future, which is a new initiative and was the brainchild of Secretary Perry under the clean energy ministerial. Have partners in Canada and Japan and it was recently formally launched. We are partnering with like-minded countries looking to broaden the dialogue on nuclear energy beyond just those directly involved. The idea behind this is to get the folks that are behind green and clean energy to look at nuclear energy in a different way. One other partner is ClearPath and many others. Our aim is to start broadening the dialogue through webinars to let everyone all over the world know about this new initiative. New international partners who have signed up are Argentina, Poland, Romania, Russia, the UAE and the UK and there are other countries who are interested and the idea is to look at how nuclear can be better valued, which is similar to what we have been talking about here, today; things like not only the current fleet, but also new innovative ideas for the future, looking at high grid or integrated energy systems, to partner nuclear, perhaps an SMR in the future with a wind plant or solar. India and Argentina are interested in this. We have also been discussing that we need a story, so I think this initiative is a real good story that we have started to communicate more broadly. At the last webinar there were 80 different participants from 40 different countries. There are more webinars next month.

Faison commented that he agrees with Rothrock and that he spent a lot of time on the Hill to tell these stories, that he tried a lot of different things, even making similar efforts with environmental groups. He said his add to Rothrock's and Lennon's would be to pay attention to segmentation of the audience. We must have a different story for a different audience. For example, a Republican Member of Congress in a Lab District is going to think differently about nuclear than an environmental organization, and thus, needs to hear a different story than the environmental organization. We would need to focus on the latter more, because that has been causing us a lot of heartburn all over the place. Some environmental organizations are still stuck in the Jane Fonda age which is a real problem for nuclear energy. Many environmental leaders pay a lot of attention to the Bloomberg New Energy Finance report on energy (which was recently released) and they misread the report and use it to state that nuclear energy is not needed, hanging their hat on the goal that we will have 50-60% renewables by 2050. What they miss to understand in this report is that natural gas is the supplement, the peaking energy source that fulfills our energy needs and fills the gap when batteries can't cover the need or are empty from renewable sources. The environmental groups must understand that you can cover this gap with natural gas that emits or you can fill this need with advanced nuclear. The other point that they must understand is that although the world will de-carbonize in the future and that oil and coal will be losing ground and renewables will be gaining ground, that by 2050, we will still be filling a 30-40% gap of our energy needs with natural gas which is not emission-free. Also environmentalists don't believe in achieving carbon capture not even by 2050. So our primary audience to be targeted should be environmental fault leaders. Resiliency will be a tougher sell than selling carbon-free energy and that will be more so as we go down the road. And we simply cannot lock into a natural gas future if we truly want to be de-carbonized.

Cochran added one new comment that Diablo Canyon is partnering with providing power for a desalinization plant and keeping this plant running and this is a different approach that could become more widespread elsewhere.

Bunn said that with nuclear, first, we must keep in mind our ability to respond to disasters. We all lived through Fukushima in 2011 and we offered some great help to Japan, but it was all unexpected to all of us and we were not well prepared. We did not really have a focused government emergency response capability and as an industry we really didn't have a reasonable sort of political response capability. And that could happen again. Fukushima had a huge impact on the industry in this country and globally, on beliefs and expectations on whether this is a reasonable way to go. We need to think hard about how we respond to disasters. Secondly, we talked a lot today about the competition from other countries, we also need to be thinking in a balanced way about competition and cooperation. The reality is that the Europeans, the Russians, the Chinese, even the Indians, are probably putting more money into advanced nuclear than we are. They have facilities that in some cases we may like to be able to use, at least until we get our own facilities. In the case of the Chinese, actually doing big projects, it helps a lot to be a dictatorship with $2 Trillion in the bank. So we need to think about how much intellectual property do we sell and share and how to manage it all, how we deal with situations where it is getting stolen, because the reality is that we are living in an industry where we must learn how to cope with these issues.

Matzie said that given our struggles in the US on financing large projects, manufacturing high-value large components and constructing plants we are to be pursuing (at a governmental level) collaboration with big countries on big projects both domestically and internationally and those could be as an example, the VTR, it could be building plants internationally and domestically, whether they are SMRs or large plants. I was envisioning that our best partners will be countries like Japan and Korea. They are both very capable in the things mentioned and both have domestic struggles in nuclear. Both of these countries would be very receptive to a very high level of collaboration. We seem not to want to collaborate at high levels to do big projects. So if there is something that others seem to know how to do, I would propose that if it is something we are missing, we are to throw it on the table and try to use it in such a way of maybe pulling the nuclear industry out of its hole, in the future.

Sattelberger followed up on Rothrock's comment (on who has deep pockets, referring the Dept. of Defense), suggesting that a lunch take place between Secretary Perry and James Mattis to talk about this face-to-face and put something on the table.

Meserve commented that he was going to suggest taking a break, but he learned that McGinnis has an important telephone call scheduled in 30 minutes, so he turned the meeting over to Joy Rempe.

Rempe stated that we have a path forward with four areas to focus on. The meeting notes will be provided to us. In the interim, think about which organization you would like to participate in (where you will be a best fit at), that is on which subcommittee to serve on and send a note to Rob Rova to that effect. Not everyone can be on the same committee, so prioritize your preferences (use #s 1-4) ad we will look at the list and try to balance the group and get back to you.

Meserve added that it was previously discussed that the subcommittees should have Co-Chairs, to be selected from the list of previous NEAC Members and a Co-Chair who is one of the new entrants, this way we bring new blood into the process. So, anyone interested to serve in this capacity, as a Co-Chair, should let him or Rempe know.

Blee asked Rempe who were the current subcommittee Chairs outside of Alfred Sattelberger and Regis Matzie.

Rempe commented that Mike Corradini, who was not a NEAC Member, was serving on what was the current fleet subcommittee. The organizational structure of NE changed so he was also doing advanced reactors, however, this position is open right now.

Blee asked Rempe to illuminate how many subcommittee members were actually NEAC members.

Rempe asked Sattelberger who were currently the NEAC Subcommittee Members in his subcommittee.

Sattelberger responded that only he and Rempe were currently NEAC Members. Rempe then asked McGinnis if that was his intent to still have non-NEAC Members on the subcommittees.

McGinnis asked Rova what the rules were and what authorities did NE have in this regard. He said that obviously either NE has the authority to do so, but, do the subcommittee chairs also have the authority to invite non-members.

Rova responded that only NE could make this decision.

McGinnis asked Rova for more clarification on this and cited an example where the Chairs for the New Pipeline Subcommittee wanted to invite non-members.

Rova responded they can do so with your (McGinnis') approval.

McGinnis clarified that this will be a request that can be approved and that he would certainly be open to that. McGinnis said that he wants to support everyone as much as possible and that he did not want to speak for the subcommittees, because if it was highly beneficial and they wanted to bring someone in that was not a member that he did not want to preclude the subcommittees from asking those non-members. He said he won't do away with consideration, if there is a compelling need, but that he would leave it up to the group to decide.

Rempe said it would be important to give each NEAC member the opportunity to serve on a subcommittee.

McGinnis said that by the same token he didn't think it would be x to have a subcommittee that is majority-populated by non-members, certainly now that the subcommittee numbers have been increased.

Korsnick asked for clarification on the current vision; whether the existing subcommittees will remain and four new ones will be re-invented on these four categories that were discussed today, or the existing subcommittees will be replaced with the four new ones.

McGinnis said the latter will take place and he listed the four existing subcommittees for everyone's benefit. He reiterated them as: (1) the International Subcommittee, (2) the Fuel Cycle Subcommittee, (3) the Technology R&D Subcommittee, and (4) the Infrastructure Subcommittee. He said his suggestion/preference is to keep four subcommittees that also track the priorities of NE that we have been discussing all day, today. He said it is obvious that the Infrastructure Subcommittee does not track well with the four categories we discussed today and asked everyone to think about all of this and not try to nail this down today. So don't worry about the previous four subcommittees, since they will be renamed/restructured as needed. He added that we are still asking the Chairs of the previous four subcommittees to continue to lead. He asked the members to think about where they would most effectively spend their time and contribute and let the Subcommittee Chairs know by next week.

Rempe asked if September 30th is the day that the subcommittees will be striving to provide input for the strategic plan.

McGinnis responded that the input to the strategic plan is important, but what is more important is to determine what these four subcommittees are going to do and focus on, in addition to providing input for the strategic plan. He said that Bob Rova can help with this matter. He recommended that new members get up to speed and also seek debriefings from Shane Johnson's and Tracey Bishop's Offices. Ultimately, I see two outputs; recommendations to the DOE on how to go after these four priorities and (2) recommendations and input into a strategic plan. Those are the two things. The bottom line is to recommend to the DOE what could be done better, what is missing.

McGinnis expressed appreciation to the intellectual power that is on this table. He said there is a lot to do and the majority of people realize that time is not in our hands. We have windows that aren't going to close. He said that once he convenes today, he will need to send a "draft" charge letter to the committee and he will work with the two Chairs to accomplish this. This letter will be drafted in a way that it empowers everyone.

Jaworowski said that Faison brings up a very important point that I would like to submit to each of the subcommittees that as you are developing your strategic plan ideas and suggestions, keep in mind what is happening on the Hill what kind of legislation is pending or perhaps coming up and we can help by sending to the group what is happening on the Hill and giving you a list and then keep those in mind as you are developing your strategic plan suggestions.

Rempe said that's a great idea because I heard that there are some ATF qualification requirements that are coming up. She asked if there were any other questions.

Matzie asked if meeting notes will be sent to the committee members.

Jaworowski stated yes.

Sattelberger asked what happens to NE-8.

McGinnis responded that NE-8 remains until such time that the DOE changes it in the Fuel Cycle Infrastructure category, it falls within the back end of nuclear fuel disposition and integrated waste management.

Bunn asked McGinnis whether there should be a 5th subcommittee given the importance of nuclear waste management and spent fuel storage and disposal.

Meserve commented that the infrastructure committee on fuel cycle will do that.

Rempe asked if there were any additional questions. There was none. Then she opened the floor to public comment.

Meserve clarified that there were no signups for public comments.

McGinnis provided closing remarks stating that it is incredible to have this talent around the table all day. It is remarkable to see so many leaders last night at dinner and today and to hear the history and life from each one around the table and how deep and broad and varied the leadership and experience is and to have all of you come together here for this is humbling. He said he and Jaworowski will reinforce their satisfaction to Secretary Perry and Brian McCormack and others on how robustly attended this meeting was how extremely represented we are in this committee. He said he has a duty to do absolutely as much as possible to do justice to your input. This is a historic moment and most of us will be looking back at life as we retire and will have ownership of where nuclear goes one way or another. McGinnis said he did not want to be part of the generation that watched the demise of nuclear energy. So, he said we have an amazing opportunity, and that this committee has his 100% commitment to do his very best to do justice to your advice. He then asked Jaworowski if she wanted to say a few words.

Jaworowski said that she echoes what McGinnis has said and that she is very much impressed with the team and is very much appreciative for everyone's time and efforts and that she thought that this is the beginning of a very aggressive move forward in trying to "revive, revitalize and expand" nuclear energy in this country. Further, she stressed that she thought that we have some of the best of the best and the brightest of the brightest in the country, in all different areas, that are the right people, at the right time and with the right solutions and thanked everyone for a very productive meeting.

McGinnis also thanked Chair Richard Meserve and Co-Chair Joy Rempe for their great stewardship.

Rempe thanked everyone. [Round of applause.]

Meserve replied that we are good to close the meeting.

There being no further business, the meeting was adjourned at 3:32 p.m.

Respectfully submitted,
Steven Katradis
Recording Secretary
July 21, 2018