

## WM2016 Conference Panel Report

### **PANEL SESSION 123: International Nuclear Power Plants Decommissioning: Time for Awareness and Planning**

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#### **Panelists:**

1. **Scott Moore**, *Acting Director, Office of Nuclear Material Safety and Safeguards, US NRC*
2. **Jeff Hays**, *Vice President, Commercial Decommissioning, AREVA*
3. **Horst Monken-Fernandes**, *Environmental Remediation Specialist, IAEA, (Austria)*
4. **Thomas LaGuardia**, *Managing Member, LaGuardia & Associates LLC*
5. **Tom Palmisano**, *Vice President & Decommissioning Chief Nuclear Officer, San Onofre Nuclear Generation Station*
6. **Terry Pickens**, *Director, Nuclear Regulatory Policy, Xcel Energy*

Session 123 focused on key issues pertaining to the approximately 200 nuclear power plants around the world that are slated to be decommissioned over the next twenty years. In this context, the session discussed global issues and challenges addressing regulatory and operators' perspectives pertaining to: transition and planning for decommissioning, remediation aspects, decommissioning cost estimates, decommissioning waste management, as well as decommissioning lessons learned. The panel consisted of US and international experts as listed above.

#### **Summary of Presentations**

##### **Scott Moore**

Mr. Scott Moore presented the status of NRC decommissioning license terminations since 1998 through 2015. He indicated that in 1997 the NRC regulations for decommissioning were revised. Under these regulations, 7 power reactors have been decommissioned and their licenses terminated; in addition, over 70 "Complex Materials Sites" and 18 Research Reactors have also had their licenses terminated. Subsequently, Mr. Moore described the power reactor decommissioning processes addressing actions needed to be carried out by the licensee and NRC as regulator, as well as public involvement throughout the process. Mr. Moore indicated that the US reactor decommissioning process allows for significant flexibility; with main requirements for initial notification of cease of operation and notification that the reactor has been permanently defueled. When such certification is docketed, the plant is permanently shut-down and can no longer operate. He added, that the licensee must submit a Post Shutdown Decommissioning Activities Report (PSDAR), that provides the decommissioning plans, strategy and schedule, a site specific decommissioning cost estimate, and an affirmation that the decommissioning can be completed within the current environmental review. He discussed in detail the current reactor decommissioning program status indicating that 5 power reactors are currently in active DECON or active dismantling and 14 power reactors are in

## WM2016 Conference Panel Report

SAFSTOR or in deferred dismantling status. He informed that FitzPatrick, Pilgrim, and Oyster Creek NPPs have announced that they will permanently cease operations by 2019. He added, in fact Fitzpatrick will cease operation on January 27, 2017. Mr. Moore gave examples of increased number of power reactors shut-down; he mentioned that after approximately 15 years with no power reactors entering into decommissioning; five reactor units prematurely shutdown in 2013 and 2014, namely: Kewaunee Power Station; San Onofre Nuclear Generating Station, Units 2 and 3; Crystal River, Unit 3; and Vermont Yankee Nuclear Power Station. In this regard, NRC management took a number of immediate actions to facilitate the transitioning from operation to decommissioning. These included the formation of an “Inter-Office Decommissioning Transition Working Group” and a dedicated NRR Branch to manage the licensing actions to facilitate the transitioning. As of February 1, 2016, with the transfer of Vermont Yankee to the “NMSS Reactor Decommissioning Program,” all 5 plants have completed the transitioning.

Mr. Moore discussed NRC’s SRM SECY-14-0118, in which the Commission directed staff to address several decommissioning issues and complete a rulemaking by end of CY 2019. These issues include: Graded approach to emergency preparedness; lessons learned from previous and current decommissioning; option for NRC approval of PSDAR; maintaining three existing decommissioning options/methods and associated timeframes; role of the State and local governments and non-governmental stakeholders; and other issues deemed relevant by staff. The staff has initiated the rulemaking on decommissioning. He noted that the on November 19, 2015, the U.S. Nuclear Regulatory Commission (NRC) issued and requested comments on an advance notice of proposed rulemaking (ANPR) on regulatory improvements for decommissioning power reactors. The due date of comments requested in the original document published on November 19, 2015, (80 FR 72358) was extended to be filed no later than March 18, 2016. The staff will maintain its focus on the current decommissioning transition licensing actions while proceeding on an optimistic schedule to finalize the decommissioning rule in CY 2019. He iterated that the objectives of the “Decommissioning Rule” are to enhance efficiency during transition from operation to decommissioning, reduce the need for exemptions from existing regulations, and to support NRC’s principles of openness, clarity, and reliability.

Mr. Moore summarized key decommissioning issues of high public interest; namely: Decommissioning funding & adequacy; reactor decommissioning strategies (e.g.; *DECON VS. SAFSTOR*; and *Timeliness 60 years to complete*); economic losses to the local community; interim “Spent Fuel Storage Installations (ISFSI);” high-level waste storage and transport; community involvement - advisory group; and future use of the site. Subsequently, Mr. Moore summarized key elements of decommissioning success based on NRC staff experience, with the following concluding remarks:

- NRC power reactors decommissioning is expanding as more shutdowns are anticipated;
- Several regulatory issues related to transitioning from operation to decommissioning are being addressed;
- Early and frequent consultations between NRC, licensees, and stakeholders & the public are good practices throughout the decommissioning process;

## WM2016 Conference Panel Report

- NRC inspections continue until radiological decommissioning is completed and the license is terminated;
- Lessons learned from actual decommissioning cases continue to inform NRC processes; and
- Planning, awareness, transparency, and communication are key elements of a successful decommissioning program.

### **Jeff Hays**

Mr. Jeff Hays presented key statistics regarding international decommissioning activities, indicating that for the next 20 years more than 200 NPPs are expected to be closed, or primed for decommissioning, representing more than half of NPPs currently in operation. He added that the main drivers for decommissioning include: Units have lived out their lifetime or no longer economically justifiable; units that close following an accident or serious incident; and units that are closed prematurely by political decision, or due to regulatory reasons. He summarized anticipated decommissioning status in Europe, showing that there are on track to decommission of approximately 150 reactors in the next 20 years. He estimated the market values of these decommissioning efforts at \$81.5 billion. Subsequently, he summarized market value of NPPs decommissioning in Europe for specific countries for the next 20 years as: France: \$21.5 B; Russia: 13.5 B; UK: 18.7B; and Germany 32.5 B. For the Asia Pacific Region, he estimated decommissioning market value at \$20.3B.

Mr. Hays, presented a viewgraph of the number of units anticipated to end their operating licenses globally for 11 lead nuclear power generating countries from 2012 to 2030 showing that in the year 2024 alone, 10 units are anticipated to terminate their operating licenses. For the US; he presented a forecast for known D&D costs at \$8.5 B, indicating that by 2035, thirty-four reactors will reach the end of their 60-year license. He added that premature plant closings have become a trend in recent years. He concluded that for the US, analysts reaffirm that recent closures are not indicative of a wider trend, but asserted that decisions to shutdown are more hastily done in this uncertain economic environment.

Mr. Hays subsequently discussed the two approaches of decommissioning options “SAFSTOR” vs. “DECON.” He indicated that selection of either one of these options is influenced by: status and confidence in decommissioning funds and cost estimates; local state politics; and public pressure. He added that most early shutdown plants tend to have underfunded decommissioning funds and opt for SAFSTOR because it allows for fund growth. However, he mentioned that assuming that decommissioning cost increase is less than fund growth may not be true across the board, and there are much uncertainties about waste disposal costs, cost of cleanups, and uncertainties in regulatory requirements. He added that once initiated, SAFSTOR decision is not easily changed to DECON. He recommended for a phased approach to DECON, and concluded that the bottom line is *“it is incumbent on our industry (e.g.; utilities and vendors) to responsibly cost effectively, and safely decommission our shutdown fleet.”*

### **Horst Monken-Fernandes**

Mr. Horst Monken-Fernandes presented IAEA background information regarding NPPs decommissioning indicating that considering the global situation, many NPPs were designed and built with little consideration of how to dismantle them.

## WM2016 Conference Panel Report

He mentioned that there are 150 reactors that are over 30 years old and 13 of which are over 40 years old. He added that only 17 of the 129 shutdown NPPs have been fully decommissioned and a final strategy for the decommissioning of the majority of sites has not yet been decided. He showed graphs with statistics of reactors built over the years for key countries and presented a quote of “Nuclear Energy Insider: *“With an estimated €80.4 bn to be spent on nuclear decommissioning globally in the next 25 years and almost 200 reactors due to be shut-down by 2040 the global nuclear decommissioning and waste management industry faces a steep learning curve.”* With recent shutdown announcements in the UK, Germany, and Sweden and other countries, 2016 will be a key year in preparation for nuclear decommissioning in Europe. Mr. Monken-Fernandes summarized the three known approaches to decommissioning and decommissioning challenges including: smarter dismantling; competing for resources and disposal capacity, public acceptability; unpredictability of decommissioning requirements, and uncertainties in costs and financing of decommissioning. Subsequently, he summarized fundamental requirements to decommissioning which include: having a legal and institutional framework; funding scheme, appropriate technologies and trained personnel, waste disposal routes, and safety with decommissioning of damaged facilities. Finally, Mr. Monken-Fernades summarized IAEA activities (e.g.; projects) and initiatives related to decommissioning as given below:

- International Decommissioning Network (IDN)
- Decommissioning and Remediation of Damaged facilities (DAROD)
- Decommissioning Risk Management (DRiMa)
- Data Analysis and Collection for Costing of Research Reactor Decommissioning (DACCORD)
- Definition of “Environmental Remediation End-States (DERES);” and
- The Project on Constraints to Implementing Decommissioning and Environmental remediation programs (CIDER).

Mr. Monken-Fernades concluded that it is important to gain public confidence by working continuously to improve structures and working arrangements to take care of legacy sites, decommissioning of nuclear installations, and avoiding the generation of new legacy sites. He also emphasized the need to have technical expertise in decommissioning globally available and the need to transfer experience and lessons learned to other countries. He also emphasized institutional arrangements for liability and project management to ensure efficient use of scarce national resources. In his final remarks, he announced the IAEA-sponsored International Conference on Advancing the Global Implementation of Decommissioning and Environmental remediation programs which will be held in Madrid/Spain on May 23-27, 2016.

### **Thomas LaGuardia**

Mr. Thomas LaGuardia presented the importance and key purposes of decommissioning cost estimates (DCE) over a facility lifecycle, which include: support early planning for decommissioning; allocation of decommissioning trust funds DTF; support license termination plans; preparing detailed decommissioning implementation plans; and support revisions of decommissioning projects considering available funds and actual costs. Mr. LaGuardia discussed the importance of a comprehensive characterization of decommissioning facilities.

## WM2016 Conference Panel Report

He indicated that comprehensive characterization data and information form the basis for all planning and adequate cost estimates. He added that costs estimate are vital to all phases of DCE and represent the basis of such estimates; it is also vital for establishing contractual scope of work and responsibilities. Examples of characterization data/information envisaged would include: historical site assessment, survey and sampling, as well as approaches and data on risk/dose estimates.

Mr. LaGuardia summarized the status of US cost estimates for decommissioning of NPPs, going back to 1986 when decommissioning costs were not much better than “random numbers.” Then he outlined NRC approach for cost estimates under 10 CFR Part 50 using a standardized format. He indicated that this approach continued to serve the US industry well and has been copied by many cost estimators. Subsequently, Mr. LaGuardia discussed OECD/NEA as well as IAEA and EC approaches to cost estimates. He mentioned that OECD/NEA established the “Working Party for Decommissioning and Dismantling (WPDD),” to address D&D key issues and the formation of a subgroup on “Decommissioning Cost Estimating Group (DCEG) to address decommissioning cost estimates issues. He listed key reports published by DCEG, namely:

- NEA Report on “International Structure for Decommissioning Costing, **ISDC** (2012)”;
- NEA Report on “Cost Control Guide (2012)”;
- NEA Report on “Guide for International Peer Reviews of Decommissioning Cost Studies for Nuclear Facilities, (2014)”;
- NEA Report on “The Practice of Cost Estimation, (2015).”

Mr. LaGuardia pointed out that DCEG joined forces with the IAEA and the EC to address uncertainties in decommissioning cost estimates; as such work is in progress. Subsequently, he presented his suggestions for improving decommissioning cost estimates documentations as give below:

- Follow standardization of DCE formatting;
- Adopt ISDC approach as being implemented in Europe;
- Formatting US cost estimates into ISDC by matrix;
- Simplify “Benchmarking;”
- Use “Benchmark” to verify site-specific DCEs from other countries; and
- Regulators and stakeholders need to see where and how site-specific parameters of DCE compare.

For conducting proper benchmarking, he cautioned that: (a) proprietary contractor data may be unreliable (e.g.; due to possible unreported mistakes, cost overruns, and/or schedule slippage); (b) Cost estimates must be compared in same years’ currency (e.g.; source of inflation and escalation factors may vary); (c) Type of plants (e.g.; PWR/BWR/GCR, etc.) and design can differ considerably; and (d) over-reliance on benchmarks can be misleading. In conclusion; Mr. LaGuardia made the following remarks:

- DCE is not a stagnant practice (e.g.; new methods being applied, computation capability is improving, dealing with unknowns (e.g.; risk); it added a new dimension to understanding uncertainty;
- Planning for decommissioning is a periodic process; and

## WM2016 Conference Panel Report

- Commitments from management to continue to update DCE to match changes in scope, and regulatory/stakeholder's inputs.

### **Tom Palmisano**

Mr. Thomas Palmisano presentation covered topics related to decommissioning of San Onofre nuclear generation station (SONGS). He showed aerial views of SONGS plant and focused on decommissioning principles for safety and stewardship engagement as applied to SONGS decommissioning. In this context, he outlined key activities with co-owners (Southern California Edison) for commitment to safely decommission San Onofre, and safely move the power plant used fuel into dry cask storage, until government approved long-term options are available. Regarding "Stewardship," he emphasized the needs to leave the community better off, spending nuclear trust funds wisely, and return any unused funds to ratepayers. For engagement, he indicated that the decommissioning process is inclusive, forward thinking, and more importantly involving diverse stakeholders.

Mr. Palmisano showed a 20-year bar-chart timeline illustrating Songs key items decommissioning plan. In this regard, the project milestones included: (a) decision to retire units 2 & 3 on June 7, 2013; (b) July- December 2013; transition to decommissioning staffing (e.g.; from 1500 to 500 staff); as well as initial planning, development of decommissioning plan, and community engagement; (c) January – December 2014: awarding ISFSI contract, and major submittals to NRC and to California Public Utility Commission as well as reduction of staff from 500 to 325; and implementation of defueled emergency plan and technical specifications. (d) January –December 2015: Coastal Commission approval of ISFSI Pad Expansion, State Lands Commission application, and California Environmental Quality Act review. He explained three phases of steps undertaken, or to be undertaken, in the used fuel storage starting with SF pools (e.g.; 2668 fuel assemblies) and existing 50 ISFSI canisters with 1187 fuel assemblies; then expanded ISFSI with 75 canisters (e.g.; 2668 fuel assemblies) plus 50 existing canisters; and future state to transfer to DOE a total of 3855 fuel assemblies in 125 canisters.

Mr. Palmisano addressed decommissioning cost estimates with a total cost estimate of \$4.411 Billion (100% share, 2014 \$\$); the cost breakdown includes: \$2.112 Billion for license termination; \$1.276 for SF management; and \$1.023 for Site restoration. He explained how to have appropriate community engagement through: establishing community engagement panel; decommissioning education fairs; SONGS VIP tours; public walking tours, SCE speakers Bureau, SONGScommunity.com website, and using public media. In his closing remarks, Mr. Palmisano summarized lessons learned as given below:

- In dealing with staff transition from operation to decommissioning, actions need to be done quickly with integrity and compassion and anticipation of gaps in management;
- Community engagement need to be transparent and need to use "plain English," as well as use of experts with broader perspectives;
- Need to have timely regulatory submittals;
- Need to communicate with NRC in open and frequent manner including communication with both NRC Regional offices and headquarters.
- For retired systems and equipment need prompt actions to remove hazardous waste off-site and down-powering of energized systems.

## WM2016 Conference Panel Report

- Need to consider possible lack of clear regulatory guidelines such as exemptions as a process vs rulemaking.

### **Terry Pickens**

Mr. Terry Pickens presented utilities perspectives on US NRC “*Advanced Notice of Proposed Rulemaking on Decommissioning, ANPR*” [(80 FR 72358)]. He started by presenting the 2014 decommissioning cost estimates approved by Minnesota Public Utilities Commission (MN PUC) for Prairie Island Unit #1 (\$788 M); Prairie Island Unit #2 (\$917 M); and Monticello (1,307.7 M). He presented a breakdown of estimated costs for license termination, SF management and site restoration. He indicated that transition initially was relatively straightforward and efficient. However; since then the transition process has become uncertain, time consuming, and inefficient. For example, the cost of obtaining licensing actions is >\$1.5M; cost of complying with operating plant requirements while awaiting for licensing actions is >\$1M/month. Licensing action approval times are typically in the range of 12 and 18 months. He emphasized the need for a power reactor decommissioning rulemaking was not driven by any identified safety or security concerns. Rather, the primary objective of the decommissioning rulemaking is to implement appropriate regulatory changes that reduce the number of licensing actions needed during decommissioning. He noted that “Licensing Actions” (e.g.; exemptions and/or license amendments) are required to move from operating plant to decommissioning requirements at the following NPP status points:

- Permanently Defueled: Emergency Preparedness (EP), Security, Work Hours, Staffing/Training, Use of Trust Fund for Spent Fuel Expenses.
- Permanently Defueled – with qualifying SFP analysis: EP, Insurance
- All Fuel in Dry Storage: EP, Security, Staffing/Training, Foreign Ownership
- All Fuel Removed from Site: EP, Security.

### **Questions, Answers & Conclusions**

Several questions were raised by panel members and the audience. The followings are examples of questions and responses:

Q1: Larry Camper asked a question regarding staff plans to conduct a public meeting to summarize ANPR questions and resolution/responses?

A1: Staff is not sure of the exact time or schedule to have such a public meeting; staff needs time to analyze questions due to be received by March 18. Staff will coordinate responses and will announce for such meeting, if necessary, in due course in accordance with NRC protocols and as directed by the Commission.

Q2: Tom LaGuardia asked “Does the proposed rule intend to have flexibility to expend decommissioning funds?”

A2: The ANPR does not deal with limits or specific time table for expending decommissioning funds. However, NRC regulation (e.g.; 10CFR 50.75) and Regulatory Guide (e.g.; 1.184) explain aspects of ability to access the trust funds set for decommissioning. For example, the licensee may use up to 23% of the trust fund amount for decommissioning activities before submitting a site-specific decommissioning cost estimates; included in this 23% is an initial 3% that the licensee can use even before permanent cessation of operation. It should be mentioned that this 20% can be used for actual decommissioning after the licensee has submitted the PSDAR.

## WM2016 Conference Panel Report

Q3: A member of the audience asked a question to Mr. LaGuardia regarding uncertainty in cost estimates due to different decommissioning approaches and how it can be minimized?

A3: Mr. LaGuardia responded: “yes there will be differences in cost estimates for different decommissioning options (e.g.; approaches) and from country to another; however, we are seeking consistency in a structured approach for decommissioning cost estimates. For example, there is no specific guidance to address this issue.

Q4: A question was raised by a member of the audience, if US NRC has a guidance on cost estimates for decommissioning of NPPS.

A4: NRC’s regulations under 10 CFR Part 50 provides a generic formula for NPPSs cost estimates. In addition, NRC’s NURG-1713 “Standard Review Plan for Decommissioning Cost estimates for Nuclear Power Reactors (published December 2004) provides guidance on site-specific cost estimates and Tables for cost adjustment factors.

Q5: Several questions were raised by the audience regarding of how to collect comprehensive reliable data (with breakdown of costs) on actual decommissioning costs from NPPs particularly those completed, or going through, decommissioning.

A5: Panel members responded that currently, there is no appropriate vehicle to collect such data due to propriety information and other reasons as presented by the panel.

Q6: A question was raised by the audience regarding costs of site restoration.

A6: Costs of site restoration are dependent on site-specific conditions and several regulatory requirements including environmental and local State requirements. It is also dependent on stakeholders and public inputs to the end-state.

Q7: A question was raised by the audience regarding DCON vs. SAFSTOR,

A7: The panel and contribution from the audience indicated the safety benefit due to decay of Co-60 and short-lived of radionuclides, and the benefits of reducing radioactive waste generated from decommissioning. Others mentioned the cons due to uncertainties in resources, expertise, knowledge management, and decommissioning costs and funding.

### Comments:

- A comment was made that benchmarking for cost estimates could be misleading as cost estimates is likely to be country dependent;
- Comments were made about waste minimization and use of new technologies to treat and minimize waste volumes,
- Comments were raised regarding decommissioning and legacy waste issues; as well as vendors dominated process for waste disposal.
- A comment was made by the audience of the need to organize and enhance the process of lessons learned from actual decommissioning of NPPs.

In summary, Session 123 covered several aspects of decommissioning planning issues emphasizing planning for decommissioning funding and proper assessment of decommissioning costs of Nuclear Power Plants. The estimated future investment in global decommissioning costs for the next 20 years in Europe could exceed \$80 B. Uncertainties in NPPs decommissioning



## **WM2016 Conference Panel Report**

costs are rather large; the panel emphasized the need to address such uncertainties and provide adequate data on actual decommissioning costs. The panel and members of the public emphasized the need for collecting adequate and reliable characterization data as early as possible to plan for decommissioning planning and to review decommissioning costs throughout the NPPs lifecycle. Communication and interaction between operators and regulators was indicated to be of paramount importance, and transparency and coordination with stakeholders and the public were identified as vital to a successful decommissioning planning.