Applicability of EPRI Decommissioning Pre-Planning Manual to International Decommissioning Projects

Leo LESSARD[a*], Jim KAY[a], Donald LEFRANCOIS[a], Richard FURR[a], Matthieu LUCAS[a], Konrad SCHAUER[b]

[a]*AREVA Inc., 7207 IBM Drive, Charlotte NC 28262, USA*

[b]*AREVA GmbH, Paul-Gossen-Str. 100, 91052 Erlangen, Germany*

**corresponding author: Leo.Lessard@AREVA.com*

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ABSTRACT

Industry models for planning the efficient decommissioning of a nuclear power plant continue to evolve. Effective planning is a key to cost control, a critical aspect of decommissioning. In 2001, the Electric Power Research Institute (EPRI) published the "Decommissioning Pre-Planning Manual", referred to as the "Manual". The goal of the Manual was to develop a framework for use in pre-planning the decommissioning of a nuclear power plant. The original research was based on information collected during the active decommissioning of power reactors in New England, and the ongoing decommissioning planning of another reactor still in operation. The research team identified thirty-two (32) major Decommissioning Tasks that support the strategic and tactical planning that can be conducted in advance of plant shutdown. The Decommissioning Tasks were organized in a logical sequence of execution, and sorted in common discipline groupings. Owners of U.S. nuclear plants that have shut down prematurely during the past 5 years have found the EPRI Decommissioning Pre-Planning Manual useful in developing their transition plans from an operating to shutdown facility.

Concurrently, during the past 15 years, the IAEA has published numerous technical and safety reports on nuclear reactor decommissioning planning and execution. IAEA's goal is to provide its global members with useful and timely guidance for the planning and execution of nuclear decommissioning projects. This information has been used extensively by international nuclear plant operators.

One of the key objectives will be to develop a roadmap linking the 32 EPRI Decommissioning Tasks with the comparable (or equivalent) topics covered in the IAEA library of decommissioning knowledge. The logical and convenient structure of the Manual will be cross-referenced to the IAEA topics to aid in organizing the development of decommissioning plans. The roadmap will serve to provide a basis for improved communication and collaboration between U.S. and international decommissioning planners.

The paper will also provide a summary of changes that have occurred since the Manual was published in 2001. Major differences and gaps between the Manual and the IAEA will be identified, with recommendations for future development provided.

Background

Industry models for planning the efficient decommissioning of a nuclear power plant continue to evolve. Effective planning is a key to cost control, a critical aspect of decommissioning. In 2001, the Electric Power Research Institute (EPRI) published the "Decommissioning Pre-Planning Manual" [29], referred to as the "Manual". The Manual was developed by AREVA under contract with EPRI. The goal of the Manual was to develop a framework for use in pre-planning the decommissioning of a nuclear power plant. The original research for the Manual was based on information collected during the active decommissioning of power reactors in New England, and the ongoing decommissioning planning of another reactor still in operation. The research team identified thirty-two (32) major Decommissioning Tasks that support the strategic and tactical planning that can be conducted in advance of plant shutdown. The Decommissioning Tasks were organized in a logical sequence of execution, and sorted in common discipline groupings. Owners of U.S. nuclear plants that have shut down prematurely during the past 5 years have found the Manual useful in developing their transition plans from an operating to shutdown facility.

Concurrently, during the past 20 years, the International Atomic Energy Agency (IAEA) has published numerous technical and safety reports on nuclear reactor decommissioning planning and execution. IAEA's goal has been to provide its global members with useful and timely guidance for the planning and execution of nuclear decommissioning projects. This information has been used extensively by international nuclear plant operators.

Objectives of this Paper

The major objectives of this paper are:

1. To present a summary of the Manual as originally drafted in the 2001 report. This review will provide a basis for understanding the contents of decommissioning planning activities that have been conducted in the United States.
2. To provide an update of changes to the Manual that should be considered based on decommissioning industry developments since 2001.
3. To present a sample matrix that cross-references the Manual topics to IAEA reports containing decommissioning content. Cross-reference matrices provide decommissioning planners from different countries an efficient and useful tool for identifying the tasks required to achieve excellence in reactor decommissioning planning.
4. To present a sample matrix that cross-references the typical contents of a Decommissioning Plan, as presented in IAEA Safety Reports Series No. 45 [3] entitled "Standard Format and Content for Safety Related Decommissioning Documents," to the Manual . This will serve to demonstrate the applicability of U.S.-based decommissioning planning processes to those implemented in other countries, regardless of maturity.

Description of 2001 EPRI Decommissioning Pre-Planning Manual

Since publication in 2001, the Manual has been widely adopted by U.S. reactor owners as a useful reference for conducting the decommissioning planning of commercial power reactors. The knowledge gained from decommissioning numerous reactors during the 1990s (i.e., Yankee Rowe, Maine Yankee, etc.) formed the basis for the Manual. During the past 15 years, many reactor decommissioning projects have been concluded, leaving behind a restored site along with an Independent Spent Fuel Storage Installation (ISFSI) awaiting Department of Energy action. Most recently, San Onofre, Kewaunee, and Vermont Yankee have been prematurely shut down. With the advent of persistently

low natural gas prices in the U.S., merchant nuclear plants (in particular) will continue to see increasing economic pressure resulting in eventual permanent shutdown of these plants.

Whereas the Manual is intended for use at any stage of a nuclear plant's life cycle, it is ideally suited for operating plants with sufficient lead time before the final operating cycle. Transition from a power operation to a decommissioning mentality is not something easily accomplished with an organization accustomed to generating electricity.

The Manual is decommissioning-strategy neutral, therefore it can be applied to either U.S. NRC DECON (immediate dismantlement) or SAFSTOR (safe storage for a defined time period, then dismantlement) decommissioning strategies.

The Manual presents sixty-five (65) Decommissioning Activities (DA) organized into thirty-two (32) Decommissioning Task Outlines (DTO). The DTOs can best be described as major topics comprising distinct and separate scopes of work worthy of independent classification. The DAs correspond to sub-topics within the frame of the major DTO topics. The DTOs and DAs are very useful as starting points for decommissioning work breakdown structures (WBS), project schedules, and decommissioning cost estimates (DCE). The DTOs can also correspond to a WBS Level 2, with DAs corresponding to WBS Level 3.

Each DA is presented in detail in the Manual and includes a description of the following:

- Objective of the DA
- Value to the planner
- Prerequisites
- Task description
- Resources required to develop
- Description of deliverable
- Useful references

Exhibit 1 presents the DTOs and the DAs with their respective professional disciplines (also refer to Tables 3-1 and 3-2 in the Manual). The DAs are arranged in groupings according to the professional disciplines that will lead each DA. The four professional groupings include:

1. Management, Finance and Human Resources
2. Licensing, Operations, Training and Quality Assurance
3. Engineering
4. Environmental Management and Occupational Health and Safety

A unique and useful feature included in the Manual is the Decommissioning Pre-Planning Precedence Diagram presented in Exhibit 2 (also refer to Figure 3-1 in the Manual). Whereas the precedence diagram provides a conceptual diagram of the sequence in which the DTOs should be developed, it is based on the actual experience gained during the decommissioning of U.S. nuclear plants during the 1990s. It is worth noting that DTOs will develop both sequentially and as parallel undertakings. This sequencing diagram has proven to be useful for developing early decommissioning pre-planning critical path schedules. A similar approach may be applied to the IAEA decommissioning planning processes that can be adapted to country-specific regulatory processes.

Update of Changes to the Manual since 2001

Reactor decommissioning has continued to evolve since publication of the Manual in 2001. The authors of this paper have performed a review of the Manual in conjunction with industry lessons learned with the goal of updating it to reflect meaningful changes that have occurred that are worthy of note in this discussion.

The following specific topical areas are recommended for consideration as either new DTOs or as an addition to an existing DTO:

1. Dismantling Strategy (early developments of potential options)
2. Final Status Survey
3. Site Closure Plan
4. Records Management
5. Risk Assessment
6. Need for Mitigating Strategies
7. Review Regulatory Environment/Changes

Each of these topic areas are described below as candidates for further DTO development.

Dismantling Strategy (early developments of potential options)
Critical to decommissioning is having a clear understanding of what can and can't be done based on the status of the nuclear decommissioning trust fund (NDT) and projected timing of the plant shutdown. With the recent premature shutdowns due to changing energy market conditions and utility economics, decommissioning trust funds are not fully funded leading to conditions where a plant must wait to begin active decommissioning. This DTO would focus on those steps necessary to identify options and develop plans for dismantlement activities based on the availability of those funds.

Final Status Survey
When the Manual was published in 2001, there was little experience on the actual conduct of license termination activities (DTO 21), specifically with respect to adopting and implementing site release criteria and development and conduct of final status surveys. The design, development and execution of the final status surveys in conjunction with the MARSSIM guidance is used to demonstrate compliance with the established site release criteria. This DTO would describe the process for development of the final status surveys to support license termination and release of the property.

Site Closure Plan
Decommissioning should begin with a clear vision, i.e. "begin with the end in mind." This DTO would focus on development of a description of what the expected end state is for ultimate release of the property and license termination. The objective of this document would be to (1) delineate the process which would be used to complete the decommissioning, environmental investigation, environmental remediation, site closure and post-closure property transfers, and (2) to identify all of the significant regulatory approvals and permits necessary to carry out the decommissioning, environmental remediation and site closure activities. The key to this document is gaining alignment of all pertinent stakeholders with this plan to achieve those objectives in a timely and efficient manner by:

- Engage regulators early in the process
- Gain alignment on "End State" and approach with all regulators as soon as possible
- There are multiple regulators involved and the criteria for performance and end-state achievement are not always clear or consistent

- RCRA closure (Chemical Remediation) is as challenging as License Termination (Radioactive Remediation)
- Clarity and reliability in the regulatory process is crucial to project success
- Regulatory alignment with plan and approach is fundamental to stakeholder confidence

Records Management

Many of the plant records are important to the safety and cost efficient planning for decommissioning. The early development of a systematic approach to records management to support decommissioning is therefore important. Numerous lessons learned have been developed that indicate the necessity of an effective records management system. The following questions could be asked in developing an approach to records management (and potential request for exemption from records retention requirements to eliminate records no longer needed):

- Is the record needed to support only continued safe operation?
- Is the record needed as a license requirement?
- Is the record needed to quantify/characterize waste?
- Is the record needed for future decommissioning tasks?
- Is the record needed for long-term care/maintenance (i.e., spent fuel management)?
- Is the record needed to preserve exposure information?
- Is the record new data since last records review?
- Is the record needed in potential litigation?
- Is the record one that should be retained although not directly related to operations or decommissioning?
- Is the record considered to be non-permanent?

Risk Assessment

This DTO would focus on identifying and understanding the risks associated with decommissioning and the choices made to accomplish those tasks, given that risks change immediately and throughout the project. Due to nature of the work, "unknowns" are often encountered and contingency planning (schedule and cost) is crucial to success.

The art and science of project risk management has evolved to a point where robust methods can be employed to systematically identify risks and anticipate responses to risks should they occur. Fundamentally, a sound risk management approach would involve deployment of a tool containing the following basic steps:

- Risk identification
- Risk analysis
- Prioritization of risks
- Development of risk responses
- Implementation of risk strategies and tactics
- Evaluation of risk strategy results
- Documentation of risk strategy results

The most successful project risk management techniques involve those where project stakeholders actively maintain a "living risk register" database that is continually updated.

Need for Mitigating Strategies

Mitigation strategies were required for operating reactors and most of these strategies can be eliminated once the plant is permanently shut down. Some strategies, however, may be required for

maintenance of spent fuel pool makeup capability and preservation of water inventory over the spent fuel while it is stored in the fuel pool. This issue would need to be addressed in an update to DTO 7, Certifications, Exemptions Requests and Fee Relief, with submittal of those exemptions and license amendment necessary for Emergency Plan changes.

Review Regulatory Environment/Changes

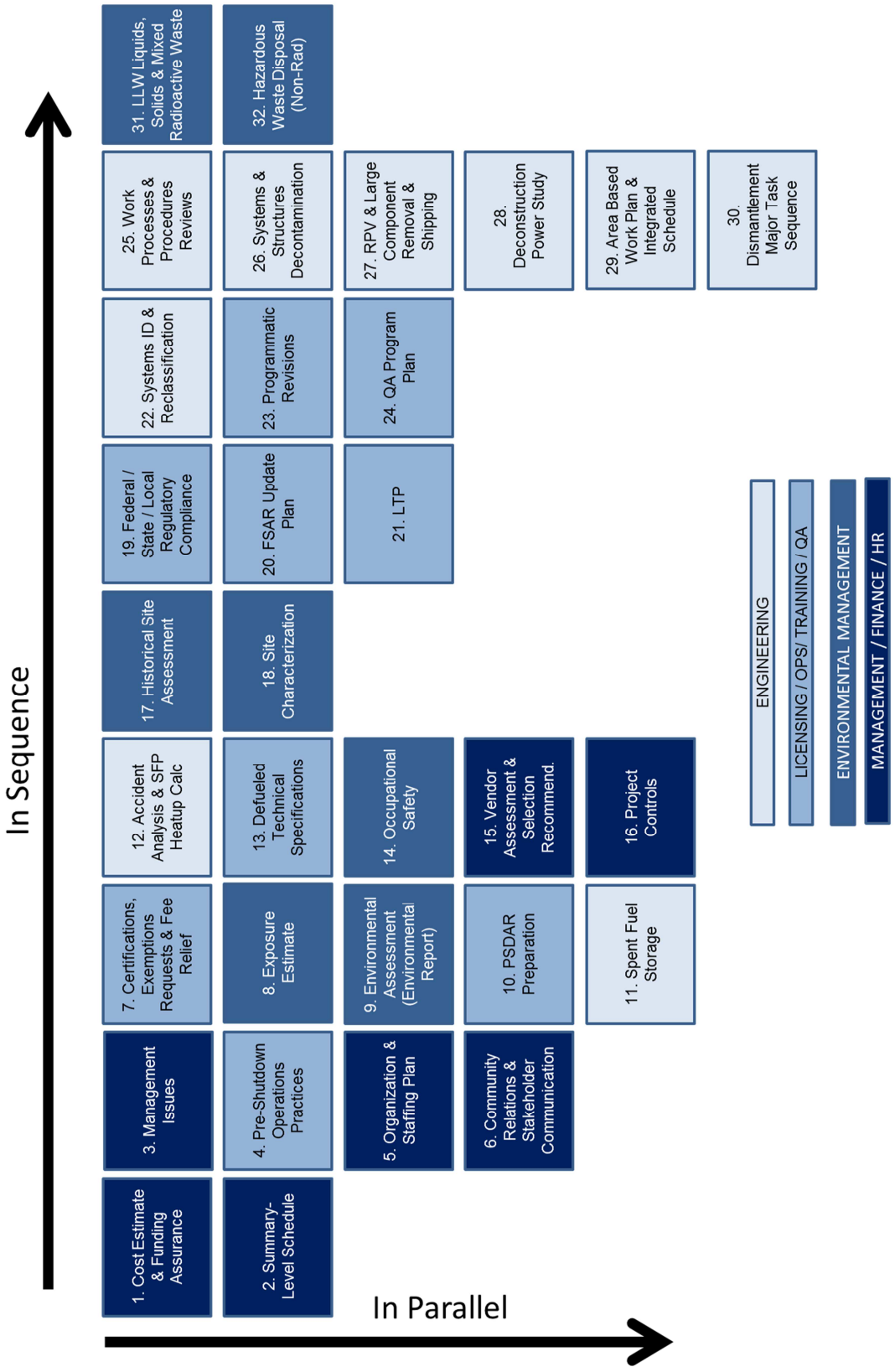
A clear understanding of the regulatory environment is crucial to successful decommissioning. Understanding what changes can be made with and without prior regulatory approval is critical. Having an updated licensing basis based on the permanently shut down condition is important to timely execution of changes necessary to get to conditions where decommissioning can begin efficiently and safely (i.e., cold & dark and SFP island implementation). Understanding what additional regulatory processes (i.e., State and/or local related) are necessary to undertake, and potentially approve, decommissioning activities is critical to planning and scheduling activities. An update to DTO-19, Federal/State/Local Regulatory Compliance, would be considered to address these regulatory issues.

DTO No.	EPRI DTO Name	Activity No.	EPRI Activity Name	Professional Groupings
-	N/A	1	Strategic Planning	Management/Finance/HR
		2	Tactical Planning	Management/Finance/HR
		5	DOC/Decom Bid Specifications Development	Management/Finance/HR
		9	Contingencies	Management/Finance/HR
		16	Special Issues for Decommissioning	Management/Finance/HR
1	Cost Estimate & Funding Assurance	6	Decommissioning Cost Estimate	Management/Finance/HR
		8	Funding Assurance	Management/Finance/HR
		24	Tax Status Modification	Licensing/Ops/Training/QA
2	Summary-Level Schedule	4	Schedule	Management/Finance/HR
3	Management Issues	3	Management Structure	Management/Finance/HR
		7	Decommissioning Oversight	Management/Finance/HR
		13	Cultural Transition	Management/Finance/HR
		17	Decommissioning Performance Indicators	Management/Finance/HR
4	Pre-Shutdown Recommended Practices	40	Pre-Shutdown Operations/Maintenance Activities	Licensing/Ops/Training/QA
5	Organization & Staffing Plan	14	Decommissioning Organization & Staffing	Management/Finance/HR
		15	Employee Retention/Release Policies	Management/Finance/HR
6	Community Relations & Stakeholder Communications	12	Community Relations & Stakeholder Communications	Management/Finance/HR
7	Certifications, Exemptions Requests & Fee Relief	18	Certification of Cessation of Operations	Licensing/Ops/Training/QA
		22	Exemptions Requests	Licensing/Ops/Training/QA
		27	Relief from Operational Fees	Licensing/Ops/Training/QA
8	Radiation Exposure Estimate	59	Radiation Exposure Estimate	Environ. Mgmt. and OH&S
9	Environmental Assessment (Environmental Report)	64	Environmental Assessment (Environmental Report) Plan	Environ. Mgmt. and OH&S
10	Post Shutdown Decomm Activities Report (PSDAR)	26	PSDAR Preparation	Licensing/Ops/Training/QA
11	Spent Fuel Storage	43	Spent Fuel Storage Strategy	Engineering
		44	Spent Fuel Pool Island Studies	Engineering
12	Accident Analysis & Spent Fuel Pool Heatup Calculation	45	Accident Analysis & Spent Fuel Pool Heatup Calculation	Engineering
13	Defueled technical Specifications	19	Defueled Technical Specifications	Licensing/Ops/Training/QA
14	Occupational Safety	65	Occupational Safety Program	Environ. Mgmt. and OH&S
15	Vendor Assessment & Selection Recommendations	10	Decommissioning Vendor Selection & Assessment Recommendation	Management/Finance/HR
16	Project Controls	11	Financial Administration	Management/Finance/HR
17	Historical Site Assessment	57	Radiological Historical Site Characterization Plan	Environ. Mgmt. and OH&S
		58	Non-Radiological Historical Site Characterization Plan	Environ. Mgmt. and OH&S
18	Site Characterization	57	Radiological Site Characterization Plan	Environ. Mgmt. and OH&S
		58	Non-Radiological Site Characterization Plan	Environ. Mgmt. and OH&S

Exhibit 1: Decommissioning Task Outlines with Decommissioning Activities and Professional Groupings

DTO No.	EPRI DTO Name	Activity No.	EPRI Activity Name	Professional Groupings
19	Federal/State/Local Regulatory Compliance	20	Federal and Local Permits	Licensing/Ops/Training/QA
		21	State Compliance	Licensing/Ops/Training/QA
20	Final Safety Analysis Report (FSAR) Update Plan	25	FSAR Update Plan	Licensing/Ops/Training/QA
21	License Termination Plan (LTP)	31	License Termination Plan (LTP)	Licensing/Ops/Training/QA
22	Systems Identification & Redassification	42	Procedure Revisions Related to Declassification	Engineering
		49	Identification of Support Systems	Engineering
		51	Systems Reclassification	Engineering
23	Programmatic Revisions	23	License Basis/Design Basis Review	Licensing/Ops/Training/QA
		28	Revisions to License Commitments	Licensing/Ops/Training/QA
		29	Withdrawal: Licensing Submittals Supporting Operations	Licensing/Ops/Training/QA
		30	Operations (Certified Fuel Handler) Training Program	Licensing/Ops/Training/QA
		32	Emergency Plan Program	Licensing/Ops/Training/QA
		33	Fire Protection	Licensing/Ops/Training/QA
		34	Security Program	Licensing/Ops/Training/QA
		35	Station Blackout	Licensing/Ops/Training/QA
		36	Maintenance Rule Program	Licensing/Ops/Training/QA
		37	Fitness for Duty Program	Licensing/Ops/Training/QA
		38	Safety Reviews (50.59)	Licensing/Ops/Training/QA
		41	Engineering Support Personnel (ESP) Training Program	Licensing/Ops/Training/QA
24	Quality Assurance (QA) Program	39	QA Program	Licensing/Ops/Training/QA
25	Work Processes & Procedures Reviews	52	Procedure Review Plan	Engineering
		53	Work Process Simplification	Engineering
26	Systems & Structures Decontamination	48	Systems Decontamination Studies	Engineering
27	Reactor Vessel & Large Component Removal & Shipping	46	Reactor Pressure Vessel and Large Component Removal	Engineering
		47	Reactor Pressure Vessel and Large Component Shipping	Engineering
28	Deconstruction Power Supply	50	Deconstruction Power Supply	Engineering
29	Area-Based Work Plan & Integrated Schedule	54	Integrated Schedule	Engineering
		55	Area-Based Work Plan	Engineering
30	Dismantling Major Task Sequence	56	Dismantling Major Task Sequence	Engineering
31	LLW Liquids, Solids & Mixed Radioactive Waste	60	Low-Level Liquid Waste Disposal	Environ. Mgmt. and OH&S
		61	Low-Level Solid Waste Disposal	Environ. Mgmt. and OH&S
		63	Mixed Waste Disposal	Environ. Mgmt. and OH&S
32	Hazardous Waste Disposal (Non-Rad)	62	Hazardous Waste Disposal (Non-Rad)	Environ. Mgmt. and OH&S

Exhibit 1(cont'd): Decommissioning Task Outlines with Decommissioning Activities and Professional Groupings



<u>Exhibit 2:</u> Decommissioning Pre-Planning Precedence Diagram

EPRI Decommissioning Pre-Planning Manual/IAEA Cross-Reference Matrix

IAEA, EPRI and others have published reports covering a wide range of decommissioning topics from planning guidelines and technical requirements to actual project lessons learned and experience summaries. To date, no one has provided a consolidated cross-reference between the IAEA decommissioning documents and where they apply in the decommissioning process.

Therefore, AREVA decommissioning engineers recently developed a Decommissioning Planning Matrix that cross-references the 65 DAs categorized in the 32 DTOs within the Manual with the contents of numerous IAEA reports and technical documents. The matrix does not include all of the currently available IAEA reports on decommissioning, but represents a critical mass of information considered suitable for decommissioning planning. The matrix provides an additional benefit of cross-referencing individual IAEA report contents with those of other IAEA reports. The matrix is not intended to be all inclusive, but serves as a living reference database that can be revised and expanded as new information becomes available.

Exhibit 3 & 5 present cross-reference matrices that were created as quick reference guides.

By looking at the matrices one can see "X" for each IAEA document that contains information for a specific DA. As example in Exhibit 3, using the matrix for a search on the topic of "Radiation Exposure Estimates" (EPRI DA Number 59) will identify 10 IAEA documents having information that may be helpful in further understanding this topic. Use of this tool makes it easy to gain knowledge on decommissioning topics by being able to see which documents contain information and then going directly to the source. Before the creation of this matrix, a search through a number of documents was required to find the needed information. In addition, the matrix can be used to place IAEA documents into the Manual recommended order of activities.

DTO No.	DTO Name	Activity No.	Activity Name	IAEA REFERENCE																									
				[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]	[20]	[21]	[22]	[23]	[24]	[25]	[26]	[27]	[28]
1	Cost Estimate & Funding Assurance	6	Decommissioning Cost Estimate	X	X	X	X	X	X		X					X											X			X
		8	Funding Assurance	X	X	X	X	X	X	X	X					X												X			X
		24	Tax Status Modification																									X			
2	Summary-Level Schedule	4	Schedule	X	X	X	X	X	X		X				X	X			X									X			X
3	Management Issues	3	Management Structure	X	X	X			X		X	X	X			X	X	X								X					X
		7	Decommissioning Oversight	X	X	X			X				X			X	X	X													X
		13	Cultural Transition			X			X		X	X	X			X	X	X								X					X
		17	Decommissioning Performance Indicators			X										X	X											X			X
4	Pre-Shutdown Recommended Practices	40	Pre-Shutdown Operations/Maintenance Activities	X	X	X					X				X		X		X												X
5	Organization & Staffing Plan	14	Decommissioning Organization & Staffing	X	X	X	X	X	X		X	X				X	X	X								X					X
		15	Employee Retention/Release Policies	X	X						X	X				X	X	X								X					X
6	Community Relations & Stakeholder Communications	12	Community Relations & Stakeholder Communications	X	X	X	X	X	X		X		X			X	X	X		X			X		X	X					X
7	Certifications, Exemptions Requests & Fee Relief	18	Certification of Cessation of Operations																												X
		22	Exemptions Requests																												X
		27	Relief from Operational Fees																												
8	Radiation Exposure Estimate	59	Radiation Exposure Estimate	X	X	X			X				X	X	X	X			X												X
9	Environmental Assessment (Environmental Report)	64	Environmental Assessment (Environmental Report) Plan	X	X	X	X	X	X			X	X	X	X	X				X						X	X	X			X
10	Post Shutdown Decomm Activities Report (PSDAR)	26	PSDAR Preparation	X	X	X	X	X	X	X		X	X	X	X	X	X		X							X	X				X
11	Spent Fuel Storage	43	Spent Fuel Storage Strategy		X		X	X			X	X	X	X	X	X			X	X											X
		44	Spent Fuel Pool Island Studies					X	X		X			X	X	X	X														X
12	Accident Analysis & Spent Fuel Pool Heatup Calculation	45	Accident Analysis & Spent Fuel Pool Heatup Calculation	X										X	X	X															X
13	Defueled Technical Specifications	19	Defueled Technical Specifications		X									X	X	X															X
14	Occupational Safety	65	Occupational Safety Program	X	X	X	X	X	X			X	X	X	X	X					X	X	X	X	X						X
15	Vendor Assessment & Selection Recommendations	10	Decommissioning Vendor Selection & Assessment Recommendation			X										X	X														X
16	Project Controls	11	Financial Administration	X												X	X														X
17	Historical Site Assessment	57	Radiological Historical Site Characterization Plan	X	X	X					X		X	X	X	X				X	X	X	X	X					X	X	
		58	Non-Radiological Historical Site Characterization Plan	X	X	X					X		X	X	X	X					X	X	X	X							X
18	Site Characterization	57	Radiological Site Characterization Plan	X	X	X					X		X	X	X	X				X	X	X	X	X					X	X	
		58	Non-Radiological Site Characterization Plan	X	X	X					X		X	X	X	X					X	X	X	X							X

Exhibit 3: EPRI Decommissioning Pre-Planning Manual / IAEA Cross-Reference Matrix

DTO No.	DTO Name	Activity No.	Activity Name	IAEA REFERENCE																								
				[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]	[20]	[21]	[22]	[23]	[24]	[25]	[26]	[27]	[28]
19	Federal/State/Local Regulatory Compliance	20	Federal and Local Permits			x	x	x	x		x	x	x	x	x	x			x						x				x
		21	State Compliance			x	x	x	x		x	x	x	x	x	x			x						x				x
20	Final Safety Analysis Report (FSAR) Update Plan	25	FSAR Update Plan			x								x	x	x													x
21	License Termination Plan (LTP)	31	License Termination Plan (LTP)	x		x	x	x	x					x	x	x				x			x		x				x
22	Systems Identification & Reclassification	42	Procedure Revisions Related to Declassification	x			x					x		x	x	x													x
		49	Identification of Support Systems	x		x					x		x	x	x	x													x
		51	Systems Reclassification	x		x					x		x	x	x	x													x
23	Programmatic Revisions	23	License Basis/Design Basis Review	x	x	x					x	x	x	x	x	x													x
		28	Revisions to License Commitments	x	x	x					x	x	x	x	x	x													x
		29	Withdrawal: Licensing Submittals Supporting Operations	x	x	x								x	x	x													x
		30	Operations (Certified Fuel Handler) Training Program	x	x											x													x
		32	Emergency Plan Program	x	x	x									x	x	x												x
		33	Fire Protection											x	x	x													x
		34	Security Program		x	x								x	x	x													x
		35	Station Blackout											x	x	x													x
		36	Maintenance Rule Program	x	x										x	x													x
		37	Fitness for Duty Program												x	x													x
		38	Safety Reviews (50.59)	x	x	x					x	x	x	x	x	x													x
		41	Engineering Support Personnel (ESP) Training Program	x		x					x	x	x	x	x	x	x												x
24	Quality Assurance (QA) Program	39	QA Program	x	x	x			x		x	x	x	x	x	x	x		x										x
25	Work Processes & Procedures Reviews	52	Procedure Review Plan	x	x	x			x		x	x	x	x	x	x													x
		53	Work Process Simplification	x		x			x		x	x	x	x	x	x													x
26	Systems & Structures Decontamination	48	Systems Decontamination Studies		x	x					x		x	x	x	x			x		x	x	x	x					x
27	Reactor Vessel & Large Component Removal & Shipping	46	Reactor Pressure Vessel and Large Component Removal											x	x	x			x					x					x
		47	Reactor Pressure Vessel and Large Component Shipping											x	x	x			x										x
28	Deconstruction Power Supply	50	Deconstruction Power Supply											x	x	x			x										x
29	Area-Based Work Plan & Integrated Schedule	54	Integrated Schedule			x									x	x	x		x										x
		55	Area-Based Work Plan			x									x	x	x		x										x
30	Dismantling Major Task Sequence	56	Dismantling Major Task Sequence	x	x				x					x	x	x			x			x							x
31	LLW Liquids, Solids & Mixed Radioactive Waste	60	Low-Level Liquid Waste Disposal	x	x	x	x	x		x	x	x	x	x	x	x			x	x	x	x	x	x					x
		61	Low-Level Solid Waste Disposal	x	x	x	x	x		x	x	x	x	x	x	x			x	x	x	x	x	x					x
		63	Mixed Waste Disposal	x	x	x	x	x		x	x	x	x	x	x	x			x	x	x	x	x	x					x
32	Hazardous Waste Disposal (Non-Rad)	62	Hazardous Waste Disposal (Non-Rad)	x	x	x	x	x		x	x	x	x	x	x	x			x		x	x	x	x					x

Exhibit 3 cont'd: EPRI Decommissioning Pre-Planning Manual / IAEA Cross-Reference Matrix

Alignment Matrix between IAEA Decommissioning Plan Outline and EPRI Manual DTOs

Of the many key documents required to conduct decommissioning at nuclear power plants, the decommissioning plan stands out as the most comprehensive. IAEA refers to the decommissioning plan as "the cornerstone of a successful decommissioning project." This has been validated with international clients who seek to learn about the process of developing a decommissioning plan in an efficient and orderly manner. With that in mind, the authors reviewed IAEA Safety Report No. 45 [3] with the goal of cross-referencing those contents with the Manual.

The resulting matrix, presented in Exhibit 4, demonstrates that there is significant consistency between IAEA and the Manual. Most of the topics of concern are covered in both documents, albeit using a different structure. The Exhibit 5 was prepared by combining the matrix presented in Exhibit 3 with the Cross-Reference of Exhibit 4.

The matrix thus becomes a useful communication tool for U.S. and international decommissioning planners to find common ground when working together to develop decommissioning solutions for nuclear facilities throughout the world.

During the preparation of the alignment matrix, some DTOs did not actually find matches in the typical decommissioning plan outline, thus creating only a one-way cross-reference relationship. These discrepancies were very limited and all the critical activities matched with a DTO & DA. The alignment highlights the coherence between the U.S. approach to prepare multiple documents during the Decommissioning Planning phase and the IAEA approach to prepare one master document called the Decommissioning Plan which incorporates most of the U.S. separate documents.

IAEA Decommissioning Plan		EPRI Manual		EPRI Manual	
No.	Activity Title	No.	Activity Name	No.	DTO Name
2.0	Facility Description				
2.1	Site location and description	26	PSDAR Preparation	10	Post Shutdown Decomm Activities Report (PSDAR)
		25	FSAR Update Plan	20	Final Safety Analysis Report (FSAR) Update Plan
2.2	Building and system description	26	PSDAR Preparation	10	Post Shutdown Decomm Activities Report (PSDAR)
		25	FSAR Update Plan	20	Final Safety Analysis Report (FSAR) Update Plan
2.3	Radiological status	57, 58	Radiological & Non-Radiological Site Characterization Plan	17, 18	Historical Site Assessment & Site Characterization
2.4	Facility operating history	57, 58	Radiological & Non-Radiological Site Characterization Plan	17, 18	Historical Site Assessment & Site Characterization
3.0	Decommissioning Strategy				
3.1	Alternatives considered	1	Strategic Planning	-	N/A
		2	Tactical Planning	-	N/A
3.2	Rationale for chosen strategy	1	Strategic Planning	-	N/A
		2	Tactical Planning	-	N/A
4.0	Project Management				
4.1	Legal and regulatory requirements	20	Federal and Local Permits	19	Federal/State/Local Regulatory Compliance
4.2	Project management approach	3	Management Structure	3	Management Issues
4.3	Project management organization and responsibilities	14	Decommissioning Organization & Staffing	5	Organization & Staffing Plan
4.4	Task management organization and responsibilities	7	Decommissioning Oversight	3	Management Issues
4.5	Safety culture	65	Occupational Safety Program	14	Occupational Safety
4.6	Training	41	Engineering Support Personnel (ESP) Training Program	23	Programmatic Revisions
4.7	Contractor support	5	DOC/Decom Bid Specifications Development	-	N/A
4.8	Schedules	4	Schedule	2	Summary-Level Schedule
5.0	Decommissioning Activities				
5.1	Contaminated structures	57, 58	Radiological & Non-Radiological Site Characterization Plan	17, 18	Historical Site Assessment & Site Characterization
5.2	Contaminated systems and equipment	46	Reactor Pressure Vessel and Large Component Removal	27	Reactor Vessel & Large Component Removal & Shipping
		48	Systems Decontamination Studies	26	Systems & Structures Decontamination
5.3	Soil	64	Environmental Assessment (Environmental Report) Plan	9	Environmental Assessment (Environmental Report)
5.4	Surface and groundwater	64	Environmental Assessment (Environmental Report) Plan	9	Environmental Assessment (Environmental Report)
5.5	Decommissioning schedules	54	Integrated Schedule	29	Area-Based Work Plan & Integrated Schedule
		56	Dismantling Major Task Sequence	30	Dismantling Major Task Sequence
6.0	Surveillance and Maintenance				
6.1	Equipment and systems requiring surveillance and maintenance	36	Maintenance Rule Program	23	Programmatic Revisions
		40	Pre-Shutdown Operations/Maintenance Activities	4	Pre-Shutdown Recommended Practices
6.2	Schedule for surveillance and maintenance	54	Integrated Schedule	29	Area-Based Work Plan & Integrated Schedule
7.0	Waste Management				
7.1	Identification of waste streams	57, 58	Radiological & Non-Radiological Site Characterization Plan	17, 18	Historical Site Assessment & Site Characterization
7.2	Solid radioactive waste	61	Low-Level Solid Waste Disposal	31	LLW Liquids, Solids & Mixed Radioactive Waste
7.3	Liquid radioactive waste	60	Low-Level Liquid Waste Disposal	31	LLW Liquids, Solids & Mixed Radioactive Waste
7.4	Waste containing both radionuclides and other hazardous material	63	Mixed Waste Disposal	31	LLW Liquids, Solids & Mixed Radioactive Waste
8.0	Cost Estimate and Funding Mechanisms				
8.1	Cost estimate	6	Decommissioning Cost Estimate	1	Cost Estimate & Funding Assurance
8.2	Funding mechanisms	8	Funding Assurance	1	Cost Estimate & Funding Assurance
9.0	Safety Assessment				
9.1	Identification of relevant safety criteria	25	FSAR Update Plan	20	Final Safety Analysis Report (FSAR) Update Plan
		23	License Basis/Design Basis Review	23	Programmatic Revisions
9.2	Operational limits and conditions	40	Pre-Shutdown Operations/Maintenance Activities	4	Pre-Shutdown Recommended Practices
9.3	Hazard analysis of normal decommissioning activities	64	Environmental Assessment (Environmental Report) Plan	9	Environmental Assessment (Environmental Report)
		45	Accident Analysis & Spent Fuel Pool Heatup Calculation	12	Accident Analysis & Spent Fuel Pool Heatup Calculation
9.4	Hazard analysis of abnormal events and incidents	45	Accident Analysis & Spent Fuel Pool Heatup Calculation	12	Accident Analysis & Spent Fuel Pool Heatup Calculation
		64	Environmental Assessment (Environmental Report) Plan	9	Environmental Assessment (Environmental Report)
9.5	Assessment of potential consequences	45	Accident Analysis & Spent Fuel Pool Heatup Calculation	12	Accident Analysis & Spent Fuel Pool Heatup Calculation
		64	Environmental Assessment (Environmental Report) Plan	9	Environmental Assessment (Environmental Report)
9.6	Preventive and mitigating measures	45	Accident Analysis & Spent Fuel Pool Heatup Calculation	12	Accident Analysis & Spent Fuel Pool Heatup Calculation
		64	Environmental Assessment (Environmental Report) Plan	9	Environmental Assessment (Environmental Report)
9.7	Risk assessment	1	Strategic Planning	-	N/A
		2	Tactical Planning	-	N/A
9.8	Comparison of analysis results with relevant safety criteria	59	Radiation Exposure Estimate	8	Radiation Exposure Estimate
		64	Environmental Assessment (Environmental Report) Plan	9	Environmental Assessment (Environmental Report)
9.9	Conclusions	59	Radiation Exposure Estimate	8	Radiation Exposure Estimate
		64	Environmental Assessment (Environmental Report) Plan	9	Environmental Assessment (Environmental Report)
10.0	Environmental Assessment				
10.1	Background data	64	Environmental Assessment (Environmental Report) Plan	9	Environmental Assessment (Environmental Report)
10.2	Description of project	64	Environmental Assessment (Environmental Report) Plan	9	Environmental Assessment (Environmental Report)
10.3	Environmental protection programme	64	Environmental Assessment (Environmental Report) Plan	9	Environmental Assessment (Environmental Report)
10.4	Effluent monitoring programme	60	Low-Level Liquid Waste Disposal	31	LLW Liquids, Solids & Mixed Radioactive Waste
10.5	Effluent control programme	60	Low-Level Liquid Waste Disposal	31	LLW Liquids, Solids & Mixed Radioactive Waste
11.0	Health and Safety				
11.1	Radiation protection plan	59	Radiation Exposure Estimate	8	Radiation Exposure Estimate
		52	Procedure Review Plan	25	Work Processes & Procedures Reviews
11.2	Nuclear criticality safety	45	Accident Analysis & Spent Fuel Pool Heatup Calculation	12	Accident Analysis & Spent Fuel Pool Heatup Calculation
11.3	Industrial health and safety plan	65	Occupational Safety Program	14	Occupational Safety
11.4	Audits and inspections	39	QA Program	24	Quality Assurance (QA) Program
11.5	Record keeping programme	39	QA Program	24	Quality Assurance (QA) Program
11.6	Optimization analyses and programme	53	Work Process Simplification	25	Work Processes & Procedures Reviews
11.7	Dose estimation and optimization for major tasks	59	Radiation Exposure Estimate	8	Radiation Exposure Estimate
11.8	Clearance criteria	31	License Termination Plan (LTP)	21	License Termination Plan (LTP)
		57, 58	Radiological & Non-Radiological Site Characterization Plan	17, 18	Historical Site Assessment & Site Characterization
11.9	Final release criteria	31	License Termination Plan (LTP)	21	License Termination Plan (LTP)
		57, 58	Radiological & Non-Radiological Site Characterization Plan	17, 18	Historical Site Assessment & Site Characterization
12.0	Quality Assurance				
12.1	Organization	39	QA Program	24	Quality Assurance (QA) Program
12.2	Quality assurance programme	39	QA Program	24	Quality Assurance (QA) Program
12.3	Document control	39	QA Program	24	Quality Assurance (QA) Program
12.4	Control of measuring and test equipment	39	QA Program	24	Quality Assurance (QA) Program
12.5	Corrective actions	39	QA Program	24	Quality Assurance (QA) Program
12.6	Quality assurance records	39	QA Program	24	Quality Assurance (QA) Program
12.7	Audits and surveillance	39	QA Program	24	Quality Assurance (QA) Program
12.8	Lessons learned programme	39	QA Program	24	Quality Assurance (QA) Program
13.0	Emergency Planning				
13.1	Organization and responsibilities	32	Emergency Plan Program	23	Programmatic Revisions
13.2	Emergency situations	32	Emergency Plan Program	23	Programmatic Revisions
13.3	Records	32	Emergency Plan Program	23	Programmatic Revisions
14.0	Physical Security and Safeguards				
14.1	Organization and responsibilities	34	Security Program	23	Programmatic Revisions
14.2	Physical security programme and measures	34	Security Program	23	Programmatic Revisions
14.3	Safeguards programme and measures	34	Security Program	23	Programmatic Revisions
15.0	Final Radiation Survey				
15.1	Final Radiation Survey	31	License Termination Plan (LTP)	21	License Termination Plan (LTP)

Exhibit 4: Matrix between IAEA TSR 45Activities and EPRI D&D Pre-Planning Manual DTOs & DAs

DTO Number	EPRI DTO Name	IAEA Number	IAEA Activity Title	IAEA REFERENCE [1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]	[20]	[21]	[22]	[23]	[24]	[25]	[26]	[27]	[28]
1	Cost Estimate & Funding Assurance	8.1	Cost estimate	X	X	X	X	X	X	-	X	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	X	-	-	X
		8.2	Funding mechanisms	X	X	X	X	X	X	-	X	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	X	-	-	X
2	Summary-Level Schedule	4.8	Schedules	X	X	X	X	X	X	-	X	-	-	-	X	X	-	-	X	-	-	-	-	-	-	-	X	X	-	-	X
3	Management Issues	4.2	Project management approach	X	X	X	-	-	X	-	X	X	X	-	-	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	X
		4.4	Task management organization and responsibilities	X	X	X	-	-	X	-	-	-	-	-	-	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	X
4	Pre-Shutdown Recommended Practices	6.1	Equipment and systems requiring surveillance and maintenance	X	X	X	-	-	-	-	X	-	-	-	X	X	X	-	X	-	-	-	-	-	-	-	-	-	-	-	X
		9.2	Operational limits and conditions	X	X	X	-	-	-	-	X	-	-	-	X	X	X	-	X	-	-	-	-	-	-	-	-	-	-	-	X
5	Organization & Staffing Plan	4.3	Project management organization and responsibilities	X	X	X	X	X	X	-	X	X	-	-	-	X	X	X	-	-	-	-	-	-	-	-	X	-	-	-	X
6	Community Relations & Stakeholder Communications	N/A																													
7	Certifications, Exemptions Requests & Fee Relief	N/A																													
8	Radiation Exposure Estimate	9.8	Comparison of analysis results with relevant safety criteria	X	X	X	-	X	-	-	-	X	X	X	X	-	X	-	-	X	-	-	-	-	-	-	-	-	-	-	X
		9.9	Conclusions	X	X	X	-	X	-	-	-	X	X	X	X	-	X	-	-	X	-	-	-	-	-	-	-	-	-	-	X
		11.1	Radiation protection plan	X	X	X	-	X	-	-	-	X	X	X	X	-	X	-	-	X	-	-	-	-	-	-	-	-	-	-	X
		11.7	Dose estimation and optimizaton for major tasks	X	X	X	-	X	-	-	-	X	X	X	X	-	X	-	-	X	-	-	-	-	-	-	-	-	-	-	X
9	Environmental Assessment (Environmental Report)	5.3	Soil	X	X	X	X	X	X	-	-	X	X	X	X	-	-	-	-	X	-	-	-	-	-	X	X	X	-	-	X
		5.4	Surface and groundwater	X	X	X	X	X	X	-	-	X	X	X	X	-	-	-	-	X	-	-	-	-	-	X	X	X	-	-	X
		9.3	Hazard analysis of normal decommissioning activities	X	X	X	X	X	X	-	-	X	X	X	X	-	-	-	-	X	-	-	-	-	-	X	X	X	-	-	X
		9.4	Hazard analysis of abnormal events and incidents	X	X	X	X	X	X	-	-	X	X	X	X	-	-	-	-	X	-	-	-	-	-	X	X	X	-	-	X
		9.5	Assessment of potential consequences	X	X	X	X	X	X	-	-	X	X	X	X	-	-	-	-	X	-	-	-	-	-	X	X	X	-	-	X
		9.6	Preventive and mitigating measures	X	X	X	X	X	X	-	-	X	X	X	X	-	-	-	-	X	-	-	-	-	-	X	X	X	-	-	X
		9.8	Comparison of analysis results with relevant safety criteria	X	X	X	X	X	X	-	-	X	X	X	X	-	-	-	-	X	-	-	-	-	-	X	X	X	-	-	X
		9.9	Conclusions	X	X	X	X	X	X	-	-	X	X	X	X	-	-	-	-	X	-	-	-	-	-	X	X	X	-	-	X
		10.1	Background data	X	X	X	X	X	X	-	-	X	X	X	X	-	-	-	-	X	-	-	-	-	-	X	X	X	-	-	X
		10.2	Description of project	X	X	X	X	X	X	-	-	X	X	X	X	-	-	-	-	X	-	-	-	-	-	X	X	X	-	-	X
		10.3	Environmental protection programme	X	X	X	X	X	X	-	-	X	X	X	X	-	-	-	-	X	-	-	-	-	-	X	X	X	-	-	X
10	Post Shutdown Decomm Activities Report (PSDAR)	2.1	Site location and description	X	X	X	X	X	X	X	-	X	X	X	X	X	X	-	X	-	-	-	-	-	-	-	X	X	-	-	X
		2.2	Building and system description	X	X	X	X	X	X	X	-	X	X	X	X	X	X	-	X	-	-	-	-	-	-	-	X	X	-	-	X
11	Spent Fuel Storage	N/A																													
12	Accident Analysis & Spent Fuel Pool Heatup Calculation	9.3	Hazard analysis of normal decommissioning activities	X	-	-	-	-	-	-	-	-	-	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X
		9.4	Hazard analysis of abnormal events and incidents	X	-	-	-	-	-	-	-	-	-	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X
		9.5	Assessment of potential consequences	X	-	-	-	-	-	-	-	-	-	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X
		9.6	Preventive and mitigating measures	X	-	-	-	-	-	-	-	-	-	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X
		11.2	Nuclear criticality safety	X	-	-	-	-	-	-	-	-	-	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X
13	Defueled technical Specifications	N/A																													
14	Occupational Safety	4.5	Safety culture	X	X	X	X	X	X	-	-	X	X	X	X	X	X	-	-	-	X	X	X	X	X	-	-	-	-	-	X
		11.3	Industrial health and safety plan	X	X	X	X	X	X	-	-	X	X	X	X	X	X	-	-	-	X	X	X	X	X	-	-	-	-	-	X
15	Vendor Assessment & Selection Recommendations	N/A																													
16	Project Controls	N/A																													
17	Historical Site Assessment &	2.3	Radiological status	X	X	X	-	-	-	-	X	-	X	X	X	X	X	-	-	X	X	X	X	X	X	-	-	-	X	X	X
		2.4	Facility operating history	X	X	X	-	-	-	-	X	-	X	X	X	X	X	-	-	X	X	X	X	X	X	-	-	-	X	X	X
		5.1	Contaminated structures	X	X	X	-	-	-	-	X	-	X	X	X	X	X	-	-	X	X	X	X	X	X	-	-	-	X	X	X
18	Site Characterization	7.1	Identification of waste streams	X	X	X	-	-	-	-	X	-	X	X	X	X	X	-	-	X	X	X	X	X	X	-	-	-	X	X	X
		11.8	Clearance criteria	X	X	X	-	-	-	-	X	-	X	X	X	X	X	-	-	X	X	X	X	X	X	-	-	-	X	X	X
		11.9	Final release criteria	X	X	X	-	-	-	-	X	-	X	X	X	X	X	-	-	X	X	X	X	X	X	-	-	-	X	X	X

Exhibit 5: IAEA TSR45 Activities grouped according to EPRI DTOs with IAEA References

DTO Number	EPRI DTO Name	IAEA Number	IAEA Activity Title	IAEA REFERENCE [1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]	[20]	[21]	[22]	[23]	[24]	[25]	[26]	[27]	[28]
19	Federal/State/Local Regulatory Compliance	4.1	Legal and regulatory requirements	-	-	X	X	X	X	-	X	X	X	X	X	X	-	-	-	X	-	-	-	-	-	X	-	-	-	-	X
20	Final Safety Analysis Report (FSAR) Update plan	2.1	Site location and description	-	-	X	-	-	-	-	-	-	-	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X
		2.2	Building and system description	-	-	X	-	-	-	-	-	-	-	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X
		9.1	Identification of relevant safety criteria	-	-	X	-	-	-	-	-	-	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X
21	License Termination Plan (LTP)	11.8	Clearance criteria	X	-	X	X	X	X	-	-	-	X	X	X	X	-	-	-	X	-	-	X	-	-	X	-	-	-	-	X
		11.9	Final release criteria	X	-	X	X	X	X	-	-	-	X	X	X	X	-	-	-	X	-	-	X	-	-	X	-	-	-	-	X
		15.1	Final Radiation Survey	X	-	X	X	X	X	-	-	-	X	X	X	X	-	-	-	X	-	-	X	-	-	X	-	-	-	-	X
22	Systems Identification & Reclassification	N/A																													
23	Programmatic Revisions	4.6	Training	X	-	X	-	-	-	-	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	X
		6.1	Equipment and systems requiring surveillance and maintenance	X	X	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	X
		9.1	Identification of relevant safety criteria	X	X	X	-	-	-	-	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	X
		13.1	Organization and responsibilities	X	X	X	-	-	-	-	-	-	-	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	X
		13.2	Emergency situations	X	X	X	-	-	-	-	-	-	-	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	X
		13.3	Records	X	X	X	-	-	-	-	-	-	-	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X
		14.1	Organization and responsibilities	-	X	X	-	-	-	-	-	-	-	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X
		14.2	Physical security programme and measures	-	X	X	-	-	-	-	-	-	-	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X
		14.3	Safeguards programme and measures	-	X	X	-	-	-	-	-	-	-	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X
24	Quality Assurance (QA) Program	11.4	Audits and inspections	X	X	X	-	-	X	-	X	X	X	X	X	X	X	-	-	X	-	-	-	-	-	-	-	-	-	-	X
		11.5	Record keeping programme	X	X	X	-	-	X	-	X	X	X	X	X	X	X	-	-	X	-	-	-	-	-	-	-	-	-	-	X
		12.1	Organization	X	X	X	-	-	X	-	X	X	X	X	X	X	X	-	-	X	-	-	-	-	-	-	-	-	-	-	X
		12.2	Quality assurance programme	X	X	X	-	-	X	-	X	X	X	X	X	X	X	-	-	X	-	-	-	-	-	-	-	-	-	-	X
		12.3	Document control	X	X	X	-	-	X	-	X	X	X	X	X	X	X	-	-	X	-	-	-	-	-	-	-	-	-	-	X
		12.4	Control of measuring and test equipment	X	X	X	-	-	X	-	X	X	X	X	X	X	X	-	-	X	-	-	-	-	-	-	-	-	-	-	X
		12.5	Corrective actions	X	X	X	-	-	X	-	X	X	X	X	X	X	X	-	-	X	-	-	-	-	-	-	-	-	-	-	X
		12.6	Quality assurance records	X	X	X	-	-	X	-	X	X	X	X	X	X	X	-	-	X	-	-	-	-	-	-	-	-	-	-	X
		12.7	Audits and surveillance	X	X	X	-	-	X	-	X	X	X	X	X	X	X	-	-	X	-	-	-	-	-	-	-	-	-	-	X
		12.8	Lessons learned programme	X	X	X	-	-	X	-	X	X	X	X	X	X	X	-	-	X	-	-	-	-	-	-	-	-	-	-	X
25	Work Processes & Procedures Reviews	11.1	Radiation protection plan	X	X	X	-	-	X	-	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	X
		11.6	Optimization analyses and programme	X	-	X	-	-	X	-	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	X
26	Systems & Structures Decontamination	5.2	Contaminated systems and equipment	-	X	X	-	-	-	-	X	-	X	X	X	X	X	-	-	X	-	X	X	X	X	-	-	-	-	-	X
27	RPV & Large Component Removal & Shipping	5.2	Contaminated systems and equipment	-	-	-	-	-	-	-	-	-	-	X	X	X	X	-	-	X	-	-	-	-	X	-	-	-	-	-	X
29	Area-Based Work Plan & Integrated Schedule	5.5	Decommissioning schedules	-	X	-	-	-	-	-	-	-	-	X	X	X	X	-	-	X	-	-	-	-	-	-	-	-	-	-	X
		6.2	Schedule for surveillance and maintenance	-	-	X	-	-	-	-	-	-	-	-	X	X	X	-	-	X	-	-	-	-	-	-	-	-	-	-	X
30	Dismantling Major Task Sequence	5.5	Decommissioning schedules	-	X	X	-	-	X	-	-	-	-	-	X	X	X	-	-	X	-	X	-	-	-	-	-	-	-	-	X
31	LLW Liquids, Solids & Mixed Radioactive Waste	7.2	Solid radioactive waste	-	X	X	X	X	-	-	X	X	X	X	X	X	X	-	-	X	X	X	X	X	X	-	-	-	-	-	X
		7.3	Liquid radioactive waste	-	X	X	X	X	-	-	X	X	X	X	X	X	X	-	-	X	X	X	X	X	X	-	-	-	-	-	X
		7.4	Waste containing both radionuclides and other hazardous material	-	X	X	X	X	-	-	X	X	X	X	X	X	X	-	-	X	X	X	X	X	X	-	-	-	-	-	X
		10.4	Effluent monitoring programme	-	X	X	X	X	-	-	X	X	X	X	X	X	X	-	-	X	X	X	X	X	X	-	-	-	-	-	X
		10.5	Effluent control programme	-	X	X	X	X	-	-	X	X	X	X	X	X	X	-	-	X	X	X	X	X	X	-	-	-	-	-	X
32	Hazardous Waste Disposal (Non-Rad)	N/A																													

Exhibit 5 (cont'd): IAEA TSR45 Activities grouped according to EPRI DTOs with IAEA References

Summary

There are over 400 nuclear plants in the world, many of them approaching end of life. Decommissioning planning will be required to ensure that nuclear plants will decontaminated and dismantled in an orderly and safe manner, with the ultimate goal of restoring the sites for reuse. The Manual, used in conjunction with the IAEA reports on decommissioning, provides nuclear decommissioning planners with an abundance of useful information.

This paper concludes that:

1. The Manual published in 2001 continues to be a meaningful reference for reactor decommissioning planning, both in the U.S. and internationally.
2. There have only been a few new U.S. industry developments that would result in slight modification to the Manual. These include:
    - Dismantling Strategy (early developments of potential options)
    - Final Status Survey
    - Site Closure Plan
    - Records Management
    - Risk Assessment
    - Need for Mitigating Strategies
    - Review Regulatory Environment/Changes
3. The EPRI-IAEA matrices presented herein are very useful planning tools that should enhance the effectiveness of the decommissioning planning process.
4. The subject matrices are excellent communication and training tools that should be maintained as living documents for the duration of decommissioning life cycles.

References

[1] *IAEA Safety Standards - Decommissioning of Facilities*, General Safety Requirements Part 6 (No. GSR Part 6), 2014.

[2] *IAEA Safety Standards - Decommissioning of Nuclear Power Reactors and Research Reactors*, Safety Guide No. WS-G-2.1, 1999.

[3] *Standard Format and Content for Safety Related Decommissioning Documents*, Safety Reports Series No. 45, 2005.

[4] *Selection of Decommissioning Strategies: Issues and Factors*, IAEA-TECDOC-1478, 2005.

[5] *Policies and Strategies for the Decommissioning of Nuclear and Radiological Facilities*, IAEA Nuclear Energy Series No. NW-G-2.1, 2011.

[6] *Integrated Approach to Planning the Remediation of Sites Undergoing Decommissioning*, IAEA Nuclear Energy Series No. NW-T-3.3, 2009.

[7] *Decommissioning Strategies for Facilities Using Radioactive Material*, Safety Reports Series No. 50, 2007.

[8] *Transition from Operation to Decommissioning of Nuclear Installations*, Technical Reports Series No. 420, 2004.

[9] *Managing the Early Termination of Operation of Nuclear Power Plants*, Safety Reports Series No. 31, 2003.

[10] *Safety Considerations in the Transition from Operation to Decommissioning of Nuclear Facilities*, Safety Reports Series No. 36, 2004.

[11] *IAEA Safety Standards - Safety Assessment for the Decommissioning of Facilities Using Radioactive Material*, Safety Guide No. WS-G-5.2, 2008.

[12] *Safety Assessment for Decommissioning*, Safety Reports Series No. 77, 2013.

[13] *Planning, Management and Organizational Aspects of the Decommissioning of Nuclear Facilities*, IAEA-TECDOC-1702, 2013.

[14] *Organization and Management for Decommissioning of Large Nuclear Facilities*, Technical Reports Series No. 399, 2000.

[15] *Decommissioning of Nuclear Facilities: Training and Human Resource Considerations*, IAEA Nuclear Energy Series No. NG-T-2.3, 2008.

[16] *Design Lessons Drawn from the Decommissioning of Nuclear Facilities*, IAEA-TECDOC-1657, 2011.

[17] *Managing Low Radioactivity Material form the Decommissioning of Nuclear Facilities*, Technical Reports Series No. 462, 2008.

[18] *Disposal Aspects of Low and Intermediate Level Decommissioning Waste*, IAEA-TECDOC-1572, 2007.

[19] *Management of Problematic Waste and Material Generated During the Decommissioning of Nuclear Facilities*, Technical Reports Series No. 441, 2006.

[20] *Innovative and Adaptive Technologies in the Decommissioning of Nuclear Facilities*, IAEA-TECDOC-1602, 2008.

[21] *State of the Art Technology for Decontamination and Dismantling of Nuclear Facilities*, Technical Reports Series No. 395, 1999.

[22] *Radiological Characterization of Shut Down Nuclear reactors for Decommissioning Purposes*, Technical Reports Series No. 389, 1998.

[23] *An Overview of Stakeholder Involvement in Decommissioning*, IAEA Nuclear Energy Series No. NW-T-2.5, 2009.

[24] *Managing the Socioeconomic Impact of the Decommissioning of Nuclear Facilities*, Technical Reports Series No. 464, 2008.

[25] *Financial Aspects of Decommissioning*, IAEA-TECDOC-1476, 2005.

[26] *Selection and Use of Performance Indicators in Decommissioning*, IAEA Nuclear Energy Series No. NW-T-2.1, 2011.

[27] *Long term Preservation of Information for Decommissioning Projects*, Technical Reports Series No. 467, 2008.

[28] *Planning, Managing and Organizing the Decommissioning of Nuclear Facilities: Lessons Learned*, IAEA-TECDOC-1394, 2004.

[29] *Decommissioning Pre-Planning Manual*, EPRI, Palo Alto, CA: 2001. 1003025.