Advanced Work Package Application for Nuclear Construction Project : Review on the Work Breakdown Structure

Dongwoo Choo, Wooyong Jung*
Department of Nuclear Power Plant Engineering, KEPCO International Nuclear Graduate School,
658-91 Haemaji-ro, Seosaeng-myeon, Ulju-gun, Ulsan 45014
**Corresponding author: trustjung@gmail.com*

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1. Introduction

Advanced Work Packaging (AWP) is a structured project execution methodology that enhances schedule predictability, cost efficiency, and quality control in complex industrial projects. By integrating Engineering, Procurement, and Construction (EPC) through predefined work packages, AWP improves coordination and reduces inefficiencies [1,2].

Despite its proven success in oil & gas and infrastructure sectors, AWP adoption in nuclear power plant (NPP) construction has not been applied yet. However, a few nuclear power plant construction clients are requiring bidders to review the application of AWP.

Despite that South Korea has developed an optimized NPP project management system over multiple NPP projects it is crucial to evaluate the feasibility of implementing an AWP-based NPP project.

This paper reviews the differences between the Work Breakdown Structure (WBS) of traditional NPP projects and AWP, emphasizing the importance of WBS definition as a fundamental task in the planning phase. It examines the necessary modifications required for AWP integration and proposes a tailored WBS model for future nuclear projects.

2. Structure of the WBS

2.1. Traditional NPP project WBS

The Traditional WBS in NPP projects are typically phase (EPC)-based breakdowns structured as in Figure 1 [3]. This structure is primarily designed to support project progress and cost, rather than optimizing field execution efficiency. That is one of the reason schedules have different hierarchies.

It is difficult to define a single standard WBS tree, as its structure varies depending on the specific purpose and application within a project but typically the characteristics of the WBS is:

- EPC-Driven Segmentation: The WBS is initially broken down by EPC, with each phase operating under its own breakdown structure. This separation makes cross-discipline integration challenging, often requiring manual intervention to resolve misalignments.
- Discipline (and high level FBS) based engineering breakdown: Engineering work is structured based on disciplines, rather than being directly aligned with construction execution needs.
- Procurement Structured by Purchase Orders (POs): Procurement work packages are organized based on POs, grouping materials and equipment by type or category. To prevent delays, material deliveries must be aligned with construction schedules.
- Lack of Construction-Driven Work Planning: Engineering and procurement activities are not fully integrated with field execution, leading to potential delays and inefficiencies in work sequencing.

This traditional WBS structure, while effective for progress and cost control, lacks the flexibility and execution alignment required for optimized construction planning. Meaning it requires well-defined attribute information for deliverables such as the Physical Breakdown Structure (PBS), Organizational Breakdown Structure (OBS), Functional Breakdown Structure (FBS), etc.

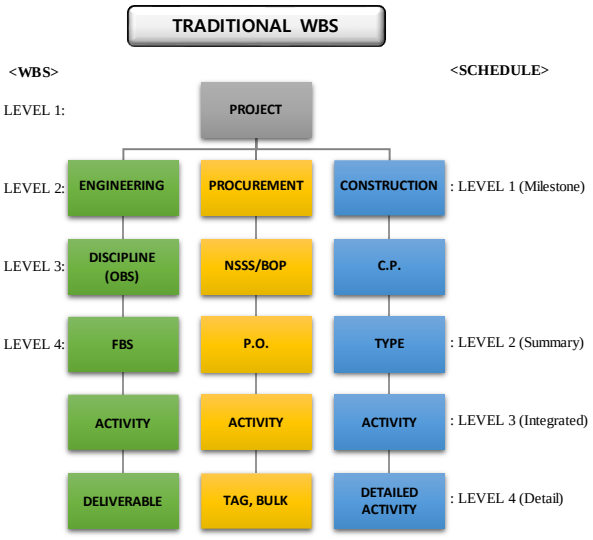

Figure 1 Example structure of the traditional NPP project WBS & schedule levels

2.2. AWP-WBS

AWP organizes work into structured packages that enhance efficiency and execution. The core elements of AWP include [1,2]:

- Path of Construction (POC): The optimal sequencing of execution of construction activities (within Construction Work Areas and Construction Work Packages) to achieve desired project performance. The engineering deliverables schedule must be aligned with the Path of Construction.
- Construction Work Area (CWA): A critical organizational unit in AWP that integrates engineering, procurement, and construction into logical execution zones. Unlike traditional phase-based breakdowns, by inserting a level of the CWA, it ensures work is structured for field execution.
- Engineering Work Package (EWP): Defines engineering deliverables required for construction.
- Procurement Work Package (PWP): Aligns procurement with construction needs to ensure timely material delivery.
- Construction Work Package (CWP): Organizes construction activities into executable scopes.
- Installation Work Package (IWP): Provides detailed, constraint-free work plans for site execution.

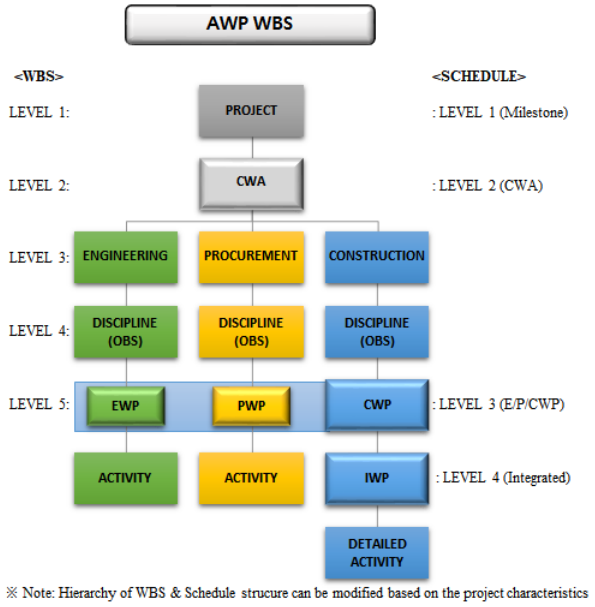

Figure 2 Example structure of the AWP-WBS

3. Comparison of traditional NPP Project WBS and AWP WBS

Table 1 Comparison of Traditional NPP project WBS and AWP-WBS

Aspect	Traditional NPP WBS	AWP-Based WBS	Key Considerations
Overall Break-down Structure	Phase-based. Different WBSs exist for each purpose (e.g. cost, schedule).	Organized by CWA for better execution zone alignment	To adopt CWA concept, physical definitions (e.g. PBS, area etc.) may require modifications
Engineering	System & physical based design hierarchy	EWP aligns directly with the CWA & CWP	Contents of engineering drawings and specifications may be redefined based on the CWA and CWP
Procurement	Purchase order (PO) based hierarchy	PWP aligns directly with the CWA & CWP	Scope of POs may be redefined based on the CWA and CWP (Repackage)
Construction	Construction package-based hierarchy	CWP organizes work into logical execution units	Construction Packages (C.P.) need to be redefined based on the CWA and CWP (Repackage)
Work Assignment	Tasks created based on the level 3 schedule activity	IWP provides specific task-level execution plans based on the CWP	Activity scope must be redefined (split/merged based on CWP & IWP)

4. AWP-Based WBS model for NPP Projects

To integrate AWP into NPP construction, the WBS must be modified to align with CWA, CWP, EWP and IWP principles. Figure 3 is an AWP adopted WBS model that could be referred when defining the project WBS.

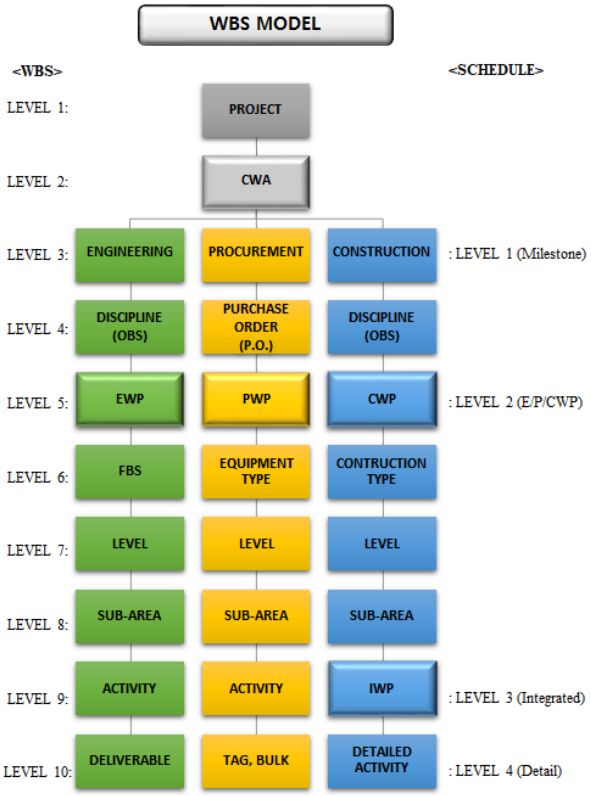

Figure 3 WBS example of AWP-based NPP project WBS

The WBS model introduces a flexible 10 leveled structure, by adding the AWP components (EWP, PWP, CWP and IWP) and physical divisions. Also, levels are rearranged to consist similar category criteria, allowing customization by eliminating and selecting levels based on project-specific needs.

5. Challenges and Future Studies.

Future research on AWP in nuclear construction should focus on improving integration with engineering, procurement, and construction workflows. Studies should explore optimizing work package sequencing to reduce inefficiencies caused by labor constraints and material availability. The digitalization of AWP processes through AI, BIM, and real-time data tracking can enhance scheduling accuracy and resource allocation. Investigating modularization strategies within AWP could improve productivity by enabling parallel construction processes. Additionally, pilot projects should be conducted to quantify AWP's impact on cost reduction, schedule acceleration, and construction quality compared to traditional methods. Developing adaptive project management models that incorporate dynamic workforce planning and real-time execution adjustments will further enhance the effectiveness of AWP in nuclear projects.

Acknowledgment

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