



공학석사 학위논문

Development of Integrated Work Breakdown Structure for Small Modular Reactor Project

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Abstract

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Due to negative perception increased about nuclear power generation after Fukushima Daiichi nuclear power plant accident in 2011, the importance of advanced nuclear reactor development is emphasized for innovative safety and security. Among Generation-IV systems, lead cooled fast reactor (LFR) has attracted most researchers because of safety characteristic of lead coolant. Lead coolant has inherent stability due to chemical inertness with air/water and high boiling point. Moreover, The Russian Federation has released impressive experiences of lead cooled reactor operation with ALFA-class nuclear propulsion submarine as well as key knowledge for the safety of LFR. Those experiences serve as one of principal bases in the commercialization of LFR. Small modular type of LFRs that are one of reference types of Gen-IV systems is suitable for load-follow operations for distributed power grid systems. Furthermore, LFRs can prove high maneuverability when they are employed as power sources for low-carbon ship propulsion, because of its excellent innate safety and long lasting core operation life.

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However, when an R&D team plans a project to develop safe Small Modular Reactors (SMRs) and to carry out their commercial production, work breakdown structure (WBS) can be utilized for systematic and efficient approach. Main functions of WBS include, but not limited to, 1) defining the project scope, 2) schedule adjustment and 3) budget management. However, reference standard WBS for nuclear power plant (NPP) is not yet proposed.

Literature review and analysis about the earlier WBS studies were conducted for development of standard WBS for NPP. On the basis of product oriented WBS system, NPP WBS of Korea and other country were searched. Based on these results, study about WBS for SMR project was proceeded. As a result, integrated WBS (IWBS) for SMR is suggested and IWBS coding system for this IWBS is defined.

To verify IWBS for SMR, URANUS (Ubiquitous, Rugged, Accident-forgiving, Non-proliferating, and Ultra-lasting Sustainer) that was designed by NUTREK (Nuclear Transmutation Research Center of Korea) is selected for application of IWBS. URANUS is 100MWt conceptual reactor that adapts lead-bismuth eutectic (LBE) coolant and natural circulation at primary system for inherent safety feature. In addition, IWBS is applied on pool-type mockup facility of URANUS construction project for more specific verification of usability.

Through this study, ongoing study about WBS is analyzed and standard IWBS for SMR is proposed. Therefore, this study will give unity direction for SMR projects.

Keywords: Work Breakdown Structure, LFR, LBE, URANUS, SMR, Mockup facility Student Number: 2014–20534

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Chapter 1. Introduction

1.1. Background

Low carbon dioxide emission and sustainable energy source for human being are source of growth for the future. Nuclear power is most promising candidate of that. Fukushima Daiichi accident in 2011 calmed down this expectation for a while, however, alternative energy source did not appear. Furthermore, concepts of advanced nuclear power plant (NPP) which is strengthen the safety feature are proposed. Generation–IV reactor types are advanced nuclear reactor for next generation.

Generation-IV international forum (GIF) suggests four goals; sustainability, safety and reliability, economic competitiveness, proliferation resistance and physical protection and GIF selects six systems as generation-IV technology [1].

Lead cooled fast reactor (LFR) is one of these six systems. LFR uses lead or lead-bismuth eutectic (LBE) as coolant and operation pressure is atmospheric pressure. Lead and LBE have several excellent properties. They are chemically inert with air/water and have high boiling point, high heat capacity and low neutron moderation capabilities [1]. Due to these characteristics, LFR could adapt natural circulation for reactor primary and secondary system such as steam generator which is integrated in reactor vessel. However, several obstacles should be surmounted, such as oxygen control technology to prevent lead erosioncorrosion, reactor in-core inspection during reactor operation and coolant solidification [1]. In the early 1950s, LBE coolant was selected for the development project of Russian Federation's nuclear submarine. As a result, LBE cooled reactor was used in ALFA-class submarine. Russian Federation has LBE reactor facility, and its operating experience in all modes is ~80 reactoryears [2]. Although this experience is valuable reference, vital problems are needed to be solved for generation-IV system.



Figure 1.1 ALFA-class nuclear propulsion submarine [2].

Small modular type LFR is one of reference type of GIF. SSTAR (Small Secure Transportable Autonomous Reactor) which is designed in USA is being developed under this program. Small modular reactor (SMR) is rational power source for distributed grid and suits to developing nations and meager infrastructures [3].

Electronic power of SMR is less than 300MW and several types of SMR are developing in worldwide, such as light water cooled reactors, high temperature gas cooled reactors, molten salt reactors and liquid metal cooled reactors [4].

The conceptual reactor URANUS (Ubiquitous, Rugged, Accident-forgiving, Non-proliferating, and Ultra-lasting Sustainer) is LBE cooled 100MWth SMR adapting natural circulation and was designed by NUTRECK (Nuclear Transmutation Research Center of Korea). Bird view of URANUS is shown in Figure 1.2.

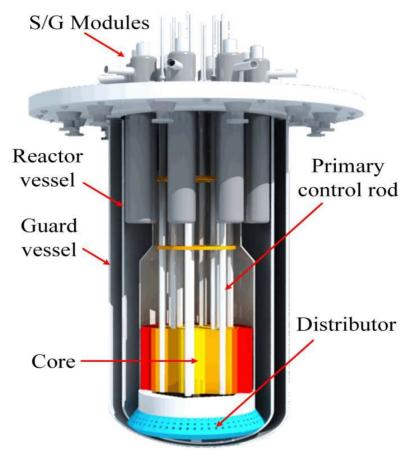


Figure 1.2 Bird view of URANUS [5].

Technical problems of LFR are actively studied. In addition to these activities, new NPP development project and commercializing project are needed to inaugurate the era of next generation nuclear power. Well defined work breakdown structure (WBS) is key part of these projects' management. WBS is defined as a productoriented hierarchical structure that identifies the all deliverables required to obtain an end project objective [6]. PBS (Product breakdown structure) and ABS (Assembly breakdown structure) are base elements of defining WBS. PBS describes the complete configuration of the product and ABS is sequence of activities needed to be taken to complete. To achieve goal of project, WBS need to working organization is assigned to OBS (Organizational breakdown structure) that is detailed framework of organization [7]. Through this process, whole project planning and schedule is determined.

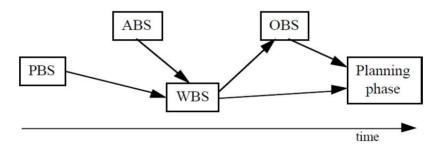


Figure 1.3 Relationship of PBS and CBS [7, 8].

Benefits of using WBS follows [9];

- 1. Defines scope of project and facilitates for effective scheduling.
- 2. Segregates a project item into its component parts, clarifying the relationship among the parts and the relationship between the tasks to be completed both to each other and to the end product.
- 3. Aids status tracking of entire works of project, risks, resource allocations, and cost/schedule/performance.

However, WBS research for next generation reactor is under just preliminary step and standard WBS is not founded.

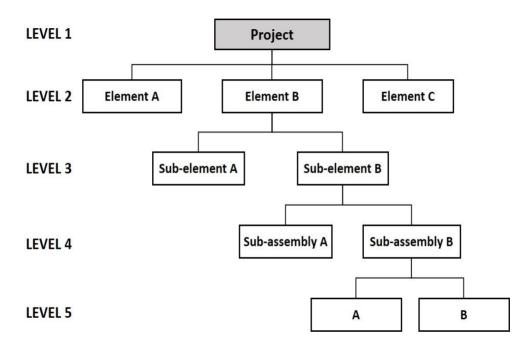


Figure 1.4 Hierarchical structure of WBS.

1.2. Objective and Scope

The main objective of this thesis is defining the WBS for SMR and verifying the effectiveness of this proposed WBS. The LBE cooled SMR called URANUS and scaled mockup facility of this reactor were used in this process.

WBS is common element of project management and applied to many fields like spaceship, shipbuilding and military projects. Selecting the common WBS elements applied to nuclear field is preceding work of this study. In addition, existing WBS studies for next NPP are searched and unique WBS elements are chosen.

URANUS is the reference reactor to develop standard WBS. First step of WBS is dividing URANUS project to specific parts. This work could be defined as two structures. Partial breakdown structure (PBS) is hierarchy structure of NPP components and common elements breakdown structure (CBS) is hierarchy structure of supporting activity part of project. These breakdown structures are integrated into one structure shown in Figure 1.5, and it is called Integrated WBS (IWBS). This IWBS arrange WBS elements based on PBS. This approach could make diminishing missing parts and make possible an intuitive cognition.

In order to verifying applicability of IWBS, project for mockup facility of URANUS is selected. This project is ongoing project and its purpose is to test thermo-hydraulic, material and design based accidents by constructing integrated LBE test facility of scaled mockup facility of URANUS. Processing of this project is based on IWBS for SMR and more specific WBS elements defined.

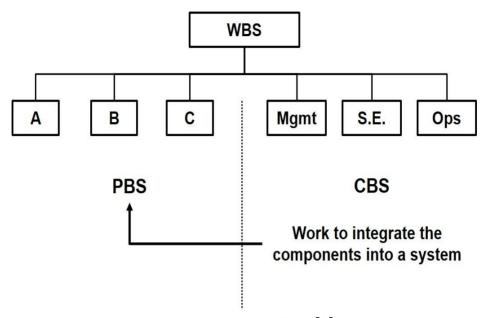


Figure 1.5 Relationship of PBS and CBS $\cite[8]$.

Chapter 2. Literature Review

2.1. Generic Product-oriented WBS (GPWBS)

GPWBS is developed for generic application of WBS to various shipyards. This GPWBS is consisted with three-axes which are respectively product structure, stage and work type. Combination of element of each axis makes work package of shipbuilding project.

Product structure of GPWBS is a eight level hierarchical framework that arranged to identify interim products and their related components [10].

Stages are divided into two main categories which are nonconstruction and construction that include whole cycle of shipbuilding stages [10].

Work type identifies the work by components relating works and general requiring efforts for shipbuilding process [10].

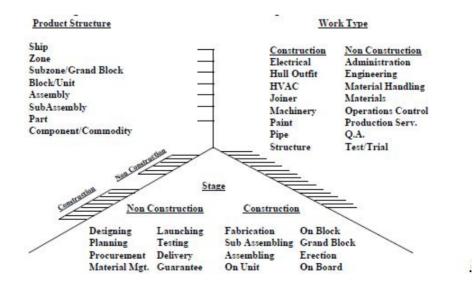


Figure 2.1 GPWBS system [10].

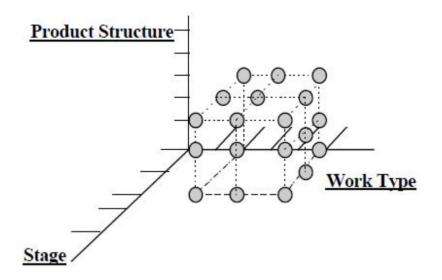


Figure 2.2 Interim products with multiple stage and work types [10].

2.2. Generic-Yacht WBS (Generic-YWBS)

The Generic-YWBS is developed for assisting sailing yachts construction and arranging contents about product and processoriented information of sailing yachts [11]. The Generic-YWBS is determined by WBS development processes and various rules for sailing yachts such as preexisting sailing yachts' equipment information, ISAF (International Sailing Federation) equipment rule and IRC rating rule, and common project elements which is considering sailing yacht life cycle [11]. As a result, five WBS main categories that are shown in Figure 2.3 are selected. Detailed WBS elements are determined by cross point of maximum three WBS main categories. In addition, detailed code system (Table 2.1) for Generic-YWBS is proposed to manage contents of this system [11].

Code	Digit	Description		
Group number	1	Represent the group number of target item		
		Represent the type of target ship		
Ship type	1	С	Common vessel	
Shiptype	T	S	Sailing yacht	
		Р	Power yacht	
Level 1 Item	2	 3 • Three-letter code • Represent the category (Lv.1) of target item 		
Level 1 Itelli	5			
Level 2 Item	3	• Three-letter code		
Level 2 Item	3	• Represent the category(Lv.2) of target item		
Level 3 Item 3		• Three-letter code		
		• Represent the category (Lv.3) of target item		
Serial	6	• Six_dirit number and		
number	0	• Six-digit number code		

Table 2.1 Item code system of Generic-YWBS [11].

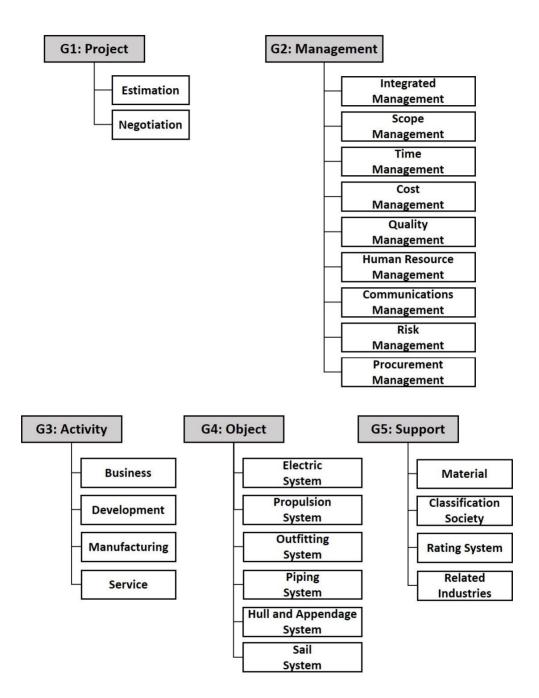


Figure 2.3 WBS elements of Generic-YWBS [11].

2.3. NASA WBS

The WBS is the key part of NASA project management and this is developed as part of the activities to characterize the complex project and scope of the project in early phase of project [12]. NASA WBS is divided into 11 main components and these main components divided into 7 levels. Level 1 is name of the project and level 2 and below elements, which is correspond to the product deliverables plus other related common elements for completing the project, are determined by project manager [12]. The standard WBS template is defined up to level 2 as shown in Figure 2.4 and meaning of each WBS element is described in WBS dictionary. Example of WBS dictionary is shown in Figure 2.5.

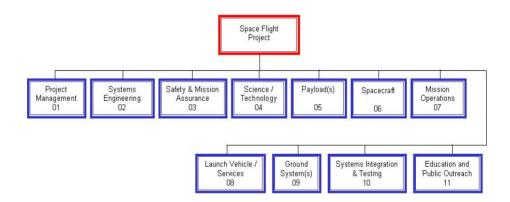


Figure 2.4 NASA standard WBS template [6].

<u></u>	BS Dictionary		
WBS Element Title:	WBS Element No:		
Develop Prototype Code 123456.08.05.09.01.03			
Parent WBS No: 123456.08.05.09.	01 WBS Level: 6		
Parent WBS Titler Develop Prototype Scope Def. Ref: 02.0			
Project	Originator:		
Project XYZ Software Development	Samuel L Kates		
WBS Element Description:			
effort will include the identification of all prototype use-case functions, code development for all identified use-case functions, informal use-case testing, integration of all use-case code, and software preparation for full prototype user testing. <u>Technical Specification Document</u> : SPEC-SW-AA000765-1 SPEC-SW-AB000767-2 <u>Procurement Packages</u> : None <u>Related Work Excluded</u>			
Procurement Packages: None			
Procurement Packages: None Related Work Excluded: 1) Associated supervision			
Procurem ent Packages: None Related Work Excluded: 1) Associated supervision 2) Prototype requirements validation			
Procurement Packages: None Related Work Excluded: 1) Associated supervision 2) Prototype requirements validation 3) PP&C planning and control effort			
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Procurement Packages: None Related Work Excluded: 1) Associated supervision 2) Prototype requirements validation 3) PP&C planning and control effort Requirements Doc. No: NASA SRD-BR549-01			
Procurement Packages: None Related Work Excluded	Page <u>15</u> of <u>31</u>		

Figure 2.5 NASA WBS Dictionary [6].

For organizing and controlling the WBS, NASA defined WBS numbering system. This numbering discipline is named the NASA Structure Management (NSM) system. For each project processing, the WBS defined by the project must use this NSM system and also must correlate exactly through level seven [6].

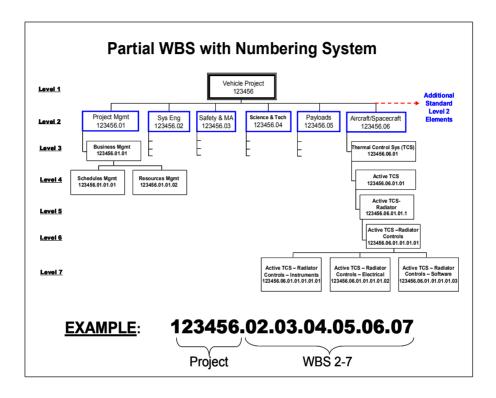


Figure 2.6 Partial WBS with numbering system [6].

2.4. Nuclear Power Plant WBS

2.4.1. Previous Nuclear Power Plant WBS

IAEA describes importance of WBS in project management of NPP construction. The WBS and the work orders resulted from it, is applied as a tool of project management. The concept of responsibility assignment matrix (RAM) that is shown in Figure 2.7 clarifies the association between WBS elements and contractor organization working for project [13]. There are two approaches suggested for WBS; product-oriented (fuel, primary / auxiliary systems, etc.) and discipline-oriented (core analysis, safety analysis, etc.) [13].

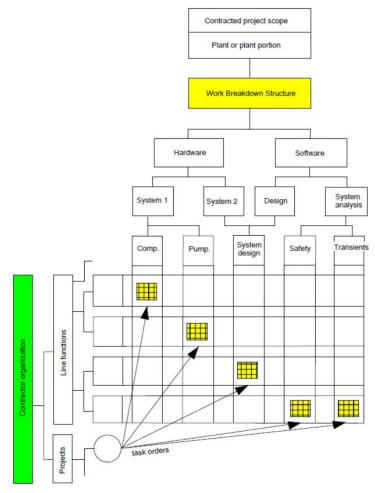


Figure 2.7 Responsibility assignment matrix [13].

D.O.E. (US) provides suggested direction and various practices on the development of product-oriented WBS applied to all project of D.O.E. [14]. WBS system of D.O.E. is consisted with three fundamental WBS levels that define the project scope by level of responsibility and detail: the PWBS (Project WBS), the CWBS (Contract WBS), and the SWBS (Subcontract WBS) [14]. These three WBS systems observe guidelines which are the same product-oriented approach at varying levels of detail [14].

The PWBS includes an entire effort which meets overall project objectives and CWBS is the approved WBS structure for the contract scope [14]. The SWBS is sub-element of CWBS for more specific contract and responsibility. The relationship of these three WBS system is shown in Figure 2.8. In addition, D.O.E. gives some WBS templates for system breakdown and common elements are related with energy power plant part.

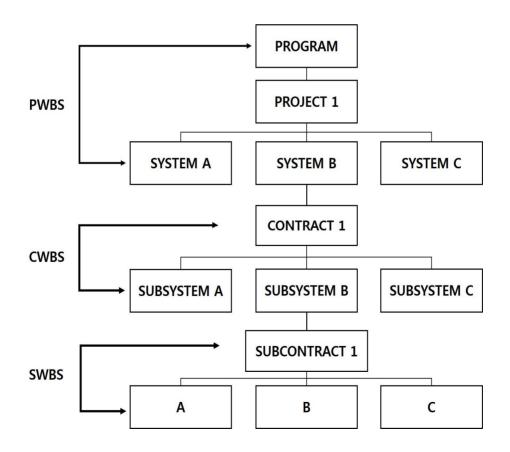


Figure 2.8 Relationship of PWBS/CWBS/SWBS.

In case of R.O.K., WBS for NPP is under development as part of NPP construction management system. Based on the project information in the progress and performance measurement system (PPMS) of UAE's Barakha Nuclear Power Plant (BNPP) projects, an attempt was made to make a new WBS. This new WBS provides 5 hierarchical levels of the total project scope of NPP construction and it is opposing to project numbering system (PNS) in Korean NPP projects that is considered as the WBS [15].

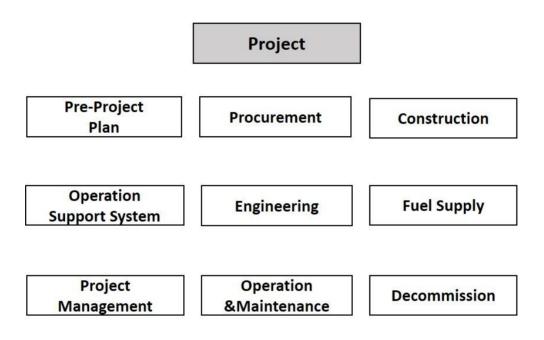


Figure 2.9 Main WBS elements of developing [15].

2.4.2. Next Generation Nuclear Power Plant WBS

Preliminary study about WBS for SMR was conducted based on large NPP project arrangement. This study distinguishes similar points and different points of large NPP and SMR. Significant differences are related with innovate technology and different usage of SMR [16]. This study just show conceptual WBS for SMR as Table 2.2.

As a part of next generation nuclear plant (NGNP) project that is focusing on high temperature gas-cooled reactor (HTGR), more specific project WBS is developed up to four level [17]. This project WBS is shown in Figure 2.10.

Site		Reactor - Megawatt-Class SMR		
1-Site selection	2-Site preparation	3-Ante-reactor module	4-Reactor	5-Post-reactor module
1 Business case analysis	1 Excavation	1 Construct module assembly building	1 Nuclear island	1 Rad waste building
2 Environmental impact statement	2 Utilities and backup power generators	2 Reactor system and C/V procurement and module fabrication	2 Internal concrete/steel modules	2 Functional tests
3 Data collection	3 construction	3 Auxiliary building, spent fuel pool	3 Set primary equipment	3 Fuel load
4 Design and engineering	4 Construction support	4 Site security	4 Control room/building	4 Startup period
5 Financing and contracts	5 Heavy lift equipment moved on site		5 I&C, HMI	5 ITAAC
6 Early site permit	6 Switching station		6 Turbine island	6 Simulator and training
7 License application	7 Transmission lines		7 Set turbine generator	7 Emergency management and response
	8 Laydown buildings		8 Diesel generator system	8 Maintenance building
	9 Firewater protection system 10 Fuel rail		9 Cooling tower	

Table 2.2 High-level conceptual WBS for a SMR [16].

Power generation/Decommissioning			
6-Power	7-Decommissioning		
production			
1 Commercial	1 Decommissioning		
operation	planning		
2 Refueling	2 Used fuel removal/		
	management		
3 Maintenance /			
spare parts			

	NGNP	
Owners Engineer	Design	Construct
Program Management	R&D for Design	R&D for Construction
Project Development	Conceptual Design	License & Permit to Operate
Project Licensing & Permits	Preliminary Design	Construction
Project Engineering	Final Design	Waste Management
Project Construction	Mockup Testing	Environment, Health & Safety
Project Initial Operations	Acquisition Strategies & Procurements	Security
Project Operations	Long-Lead Items	Training
Project DD&D	License & Permit to Construct	
Initial Ops & Inspection	Operate Commercially	Post-Ops & DD&D
R&D for Initial Operations	Operations Management	Program Management
Commercial Design Cert.	R&D for Operations	License & Permits to DD&D
Maintain License & Permits	Maintain License & Permits	Environment, Health & Safety
Environment, Health & Safety	Environment, Health & Safety	Security
Security	Security	Training
Training	Training	Plan & Design DD&D
Pre-commissioning	Commissioning & Startup	Defueling & Spent Fuel Management
Commissioning & Startup	Operate Plant	Project DD&D
Operate Plant	Maintain Plant	DD&D
Maintain Plant	Shutdowns & Inspections	Long-Term Monitoring
Shutdowns & Inspections	Refuel & Spent Fuel Management	Waste Management
Refuel & Spent Fuel Management	Plant Modifications	
Plant Modifications	Waste Management	
Waste Management		

Figure 2.10 NGNP WBS [17].

Chapter 3. Rationale and Approach

3.1. Rationale

Previous WBS for gigawatt class NPP is defined by discipline paradigm which leads to complicated WBS. Complicated WBS system causes management problem. For example, one project management team cannot manage overall project process by using previous WBS. For that reason, it is difficult for gigawatt class NPP project to solve clash problems of interface boundary. Considering WBS for gigawatt class NPP to be applied directly to SMR, SMR can suffer same problems with gigawatt class NPP during project process. For that reason, needs of new WBS for SMR are arisen for efficient project management. Demanding characteristics of WBS for SMR are 1) human cognition friendliness, which means that project efficiently, 2) functional module paradigm which reflects modular design to reduce interface problems.

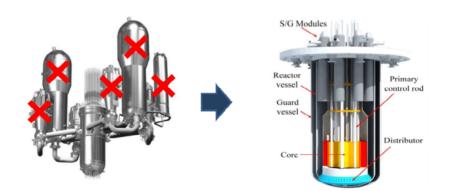
To satisfy these demands, WBS which applies new paradigm is necessary based on previous WBS for gigawatt class NPP. For example, Generic-YWBS that is described in previous chapter is developed for needs of proper WBS for small sailing yacht building. Generic-YWBS is based on GPWBS that is for large ship building, however, characteristics of Generic-YWBS is very different from GPWBS.

Previous researches about WBS of SMRs just have been focused on sorting the common elements for project management. Actually, SMR has different features when compared with gigawatt class NPP as followings;

1) **Superior quality control**: One-site factory fabrication under controlled environment

- 2) **Unique modular design**: Module concept design based on functional sorting (not by discipline)
- 3) **Passive safety design**: Adapt passive safety measure in normal operation and accident situation for sustainability
- 4) **Economic construction**; Financial cost is reduced because of small number of SMR components to fabricate and shorten construction time compared to large NPP
- 5) **Reduced site work**: Except building construction, SMR modules are transported after fabrication, then they are assembled in SMR site

Simple comparison of large NPP and SMR is shown in Figure 3.1.





- · Use of only few simple drives for control and safety rods
- Elimination of A-class control room
- · Reduction of required emergency power by natural circulation cooling
- Simplified design
 - Modular design
 - No pump, pressurizer
 - No pipe, etc.

Figure 3.1 Comparison of large NPP and SMR [18].

SMR projects need new approaches, because they have many challenging issues compared to gigawatt class NPP. Especially, WBS of SMR needs to aid in identifying new module concept design, due to SMR adapts passive safety measures and modular design. Specific differences of SMR are shown in Figure 3.2 based on final safety evaluation report (FSER) [19] of gigawatt class NPP. Previous NPP is divided into sub-system by discipline. In contrast, SMR is divided into modules by integrated function. For this reason, demanding of well-defined WBS is bigger than ever to organize SMR project.

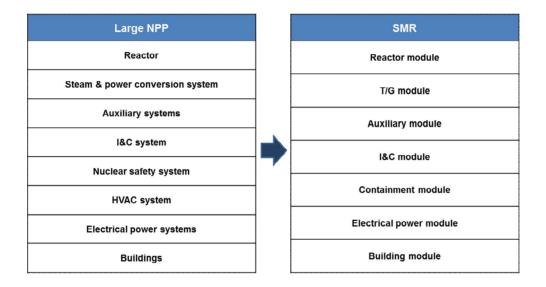


Figure 3.2 Modular feature of SMR.

3.2. Goals

The main goal of this thesis is defining the IWBS for SMR project and verifying the effectiveness of this proposed IWBS. To achieve the goal, URANUS and scaled mockup facility are utilized in this corroborative step. The necessary tasks are defined as follows.

The common elements of IWBS for SMR are defined. In order for proper adaptation, existing WBS elements are considered and some of that are modified for SMR project.

The proposal for method of integrating common elements and partial component to define work packages is one of main goal of this thesis. Through this processing, the frame of well-defined IWBS is established and IWBS coding system is also proposed. Features of IWBS are friendliness for human cognition, supply chain and life-cycle QA management.

Verifying the utility of IWBS is key objective. To proceed this work, LBE cooled pool-type reactor called URANUS is used. First step of this work is dividing URANUS project to detail parts. Welldefined hierarchy structure of real components of URANUS and common elements of project are presented. The scope of this work is up to the level that could be standardized. Whole application of IWBS is shown in mockup facility construction project.

3.3. Approach

The thesis study approach is shown in Figure 3.3. To define IWBS for SMR and prove its utility, first of all, existing WBS is analyzed and problems that can be occurred when these WBS is applied to IWBS is distinguished. Based on this work, appropriate IWBS and its coding system are confirmed.

After that, proving process of IWBS is conducted with project for mockup facility of URANUS. Up to work package level, whole IWBS is defined. In addition, adequacy of definition of IWBS elements and applicability of IWBS will be checked.

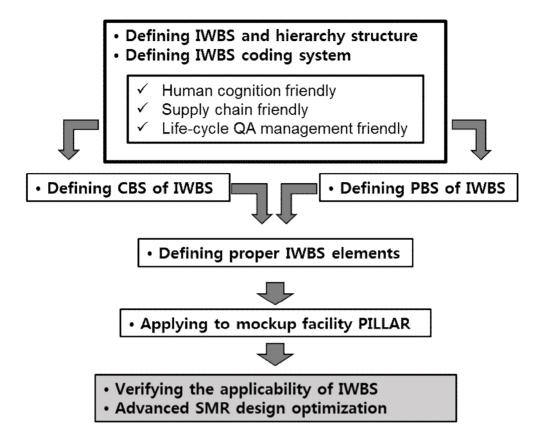


Figure 3.3 Diagram for IWBS defining study.

Chapter 4. Integrated Work Breakdown Struct ure for Small Modular Reactor

4.1. Design feature of URANUS

A pool-type SMR called URANUS is designed as generating 100MW thermal power. URANUS is suited to regions where wide energy grid system cannot be constructed in. Transportable characteristic gives versatile application of URANUS, such as electricity generation for region, desalination and commercial ship/warship propulsion power source. Long lasting operation period of 20 years per one fueling strengthens non-proliferation feature of URANUS.

In addition, URANUS adapts natural circulation as primary system cooling mode by removing primary cooling pump. This design is based on excellent natural circulation ability of LBE coolant. Due to this fully passive cooling ability of primary system, safety feature of URANUS is strengthened than forced circulation system and insures accident resistance ability in normal operation and accident condition. Furthermore, this simple heat transport system reduces production cost and relaxes safety concerns. Key design parameters of URANUS are shown in Table 4.1.

Design parameters	Values or characteristics
Thermal power	100 MWt
Average core power density	$19.42 (MW/m^3)$
Refueling interval	20 years
Plant design lifetime	60 years
Primary coolant	LBE
Primary heat transport system	Pool type
Core configuration	Open hexagonal array
Primary normal cooling mode	Fully natural circulation
Normal decay heat removal	Primary: natural circulation
	Secondary: forced circulation
Abnormal decay heat removal	Reactor vessel auxiliary cooling
	by air
Fuel	UO2
Cladding	HT-9 or T-91 overlaid with Al
	containing ferritic steels
Steam generators	8 modules of straight shell-tube
	type
Secondary water/steam cycle	Rankine cycle with superheated
	steam
Feed water temperature	252.0 (°C)
Steam outlet temperature	356.0 (°C)
Steam flow rate	188.1 (kg/s)
Seismic design	3D based isolators
Inner diameter of shell	3,741 (mm)
Wall thickness of shell	50 (mm)
Total height of inside	9,860 (mm)
Total weight with LBE and	758 (ton)
internal structure	

Table 4.1 Key design parameters of URANUS [5].

4.2. Development of IWBS

4.2.1. Development approach of IWBS

Previous NPP projects are huge and complicated projects. For that reason, many contractors are associated with one project and project management is also complicated process to project director. However, in many points, scale of SMR project is smaller than that of large NPP project and SMR pursues simple design feature for safety, adaption of new technology/modular concept and various using purpose. In that point, WBS of large NPP project is not suitable to SMR project.

SMR project needs proper WBS to achieve project objectives. Goal of SMR project is constructing, managing and decommissioning SMR without minor and severe accident. This goal is similar to NASA space flight project that uses WBS since 1962. NASA WBS handles from project planning to spaceship disposal. Therefore, IWBS for SMR is developed based on NASA WBS considering characteristics of nuclear power plant. Scope of defining WBS elements is from project planning to decommission.

SMR adapts innovative system and new designed system needs to clarify relationship between components and remove missing components. For intuitive understanding and simplifying of WBS, IWBS uses component centric arrangement. Based on PBS, CBS elements are integrated into matched PBS elements. IWBS coding system is also related with this concept.

Complicated 3D model like SMR can make missing parts and it is hard to manage construction schedule. This problem can be overcome using WBS method. According to modular design feature, SMR parts are divided into main components. As shown in Figure 4.1, modularized concept construction allows parallel work process possible [20] and 3D design programs are used in this process. Combination of 3D model and WBS elements is efficient tool for designing and project management. In building engineering, this approach attempted for organizing 3D building information model [21]. As a result of this attempt, WBS performed key role in clash detection of 3D model (Figure 4.2). IWBS uses this approach for WBS elements and reactor design management.

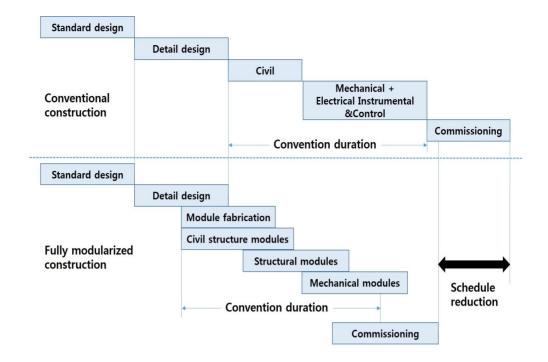


Figure 4.1 Gains in modularized construction plan [20].

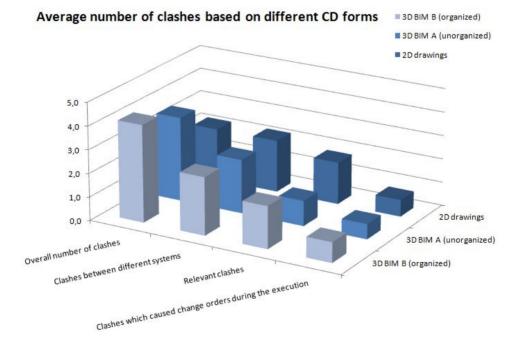


Figure 4.2 Average number of clashes based on different Clash detection forms [21].

4.2.2. IWBS concept

Defining CBS and PBS is previous step to define proper IWBS. Each CBS/PBS elements are defined for generic applicability. IWBS tree is divided into maximum five levels as shown in Figure 4.3. Defining IWBS elements to manageable level is key point.

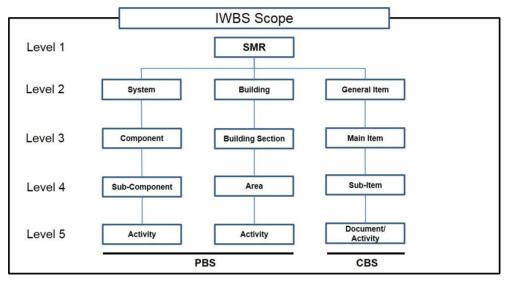
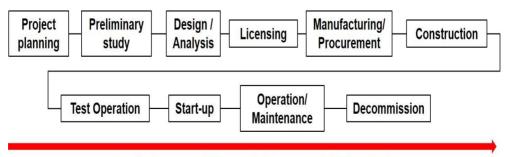


Figure 4.3 IWBS scope.

IWBS for SMR is defining IWBS elements from project planning to decommission. In that point, NPP life cycle [22] and generic implement stage of project [13] are considered to select proper CBS. Based on this, SMR project process flow (Figure 4.4) is selected.



Quality Assurance / Document / Assessment / Administration

Figure 4.4 SMR project process flow.

Level two categories of CBS are selected from SMR project process flow. There are seven categories (Figure 4.5); project planning, project management, system engineering, procurement, construction, operation & maintenance and decommission. Detailed definition of lower level categories is described in next chapter.

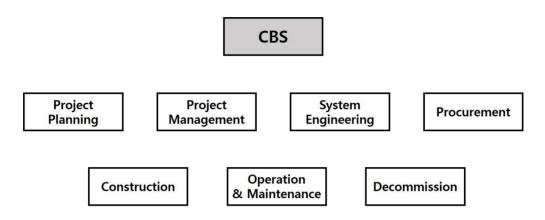


Figure 4.5 Level two categories of CBS.

In IWBS concept, PBS has flexibility. According to various developing system of SMR, PBS level categories and elements could change. In this thesis, PBS is defined following URANUS. URANUS is developing concept SMR and many specific components are not defined yet. For that reason, seven module categories are defined following developing status; reactor module, turbine generator module, auxiliary module, containment module, electrical power module, instrumentation & control module and building module.

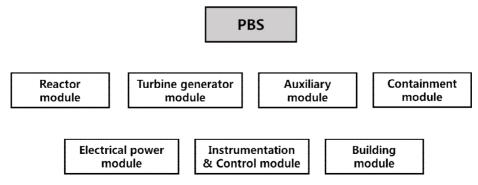


Figure 4.6 Level two categories of PBS.

IWBS have integrated structure to arrange IWBS elements. CBS elements that are related with PBS produce new IWBS elements. These are expanded to demanding level for project process.

For example, primary system thermo-dynamics analysis and fuel rod heat transfer analysis can be expressed like Figure 4.7. Through these arrangements, work to do for system and components can be recognized easily.

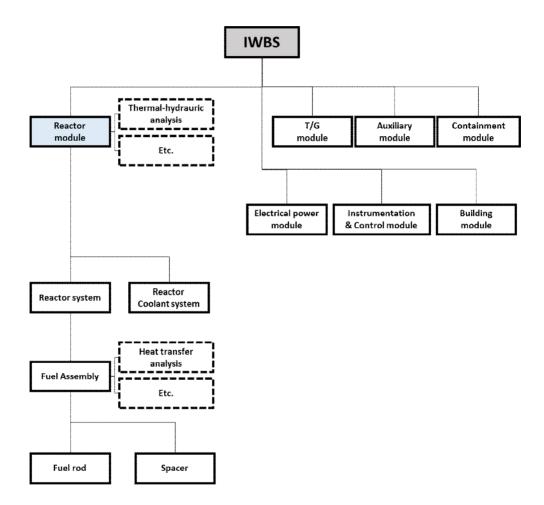


Figure 4.7 Concept of IWBS hierarchy structure.

Relationship of IWBS and supply chain is shown in Figure 4.8. IWBS describes work package for SMR project. To actualize IWBS elements, designated work packages are connected to supplier and contractor by contract IWBS (CIWBS). IWBS gives frame for contract activity.

Below elements of CIWBS are achieved by suppliers and contractors and this CIWBS also has hierarchical structure determined by suppliers and contractors for accomplishment of IWBS elements.

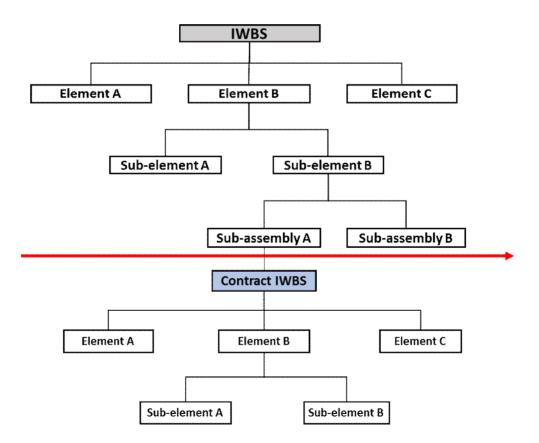


Figure 4.8 Concept of IWBS and contract IWBS relationship.

Using 3D model for IWBS is preliminary considered. CATIA[®] is used in this thesis. Coupling of IWBS concept and 3D model is inserted into extra property to 3D model parts of SMR. During SMR parts design, defining IWBS elements of system and parts in the same time makes IWBS-3D model coupling clear. This approach is shown in Figure 4.9.

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Figure 4.9 Concept of IWBS and 3D model coupling.

4.2.3. Detailed definition of IWBS

IWBS for SMR consists of CBS and PBS. IWBS elements are defined, based on life cycle of NPP and features of NPP project. In this thesis, four stages are defined based on life cycle of SMR project as shown in Figure 4.10.

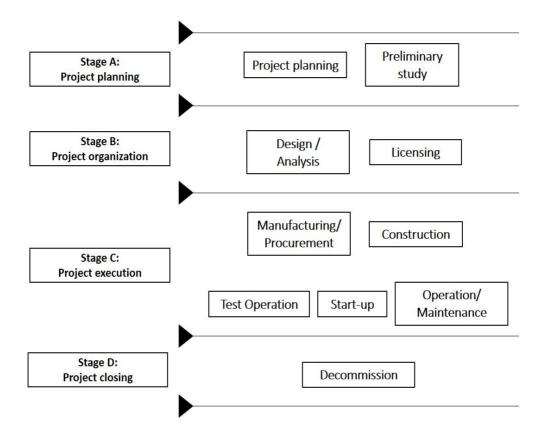


Figure 4.10 Four stages of SMR project.

Main objectives of each stage are as follow; Stage A: Project planning

- Judge project feasibility
- Define project scope and objectives

Stage B: Project organization

- Define system and estimating resource
- Conduct system design & analysis

Stage C: Project execution

- NPP construction
- Start operation & maintenance

Stage D: Project closing

- Decommission NPP
- Terminate NPP license

Following project management guidance [12, 13] and previous NPP WBS and CBS that define activities about SMR, project is divided into seven categories as shown in Figure 4.11; project planning, system engineering, project management, operation & maintenance, procurement, construction and decommission.

Each main category has subordinate CBS elements. Subelements that compose the third level of the IWBS for SMR need to identify all CBS elements associated with the upper level elements [12] and subordinate elements related with hardware, software and project activities. In this thesis, CBS will be defined up to level 3 and more specific sub-level elements are needed to be developed following each feature of project.

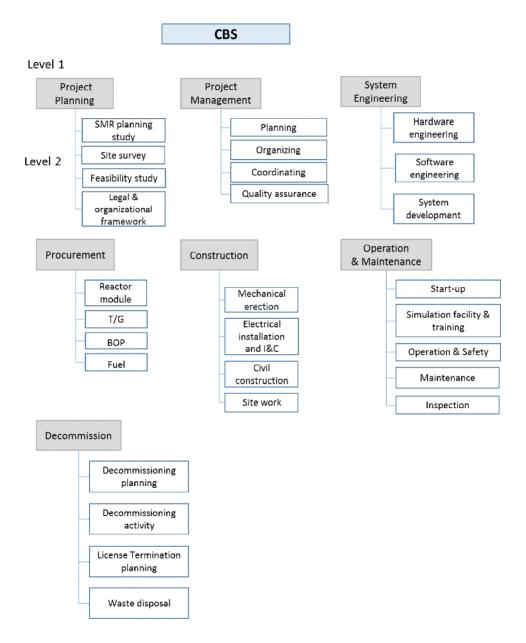


Figure 4.11 CBS of SMR.

Main objectives of project planning are preparation of SMR construction and conducting feasibility study. Based on project management book [13] of international atomic energy agency (IAEA), level 2 elements are defined. Level 2 is consisted with SMR planning study, site survey, feasibility study and legal & organizational framework.

SMR planning study evaluates requirements of new SMR considering national energy supply plan and electric power system plan, etc. Another element is capability of country. To construct SMR, enough infrastructures of nation, financing condition and technology status are needed to be considered.

Site survey is important part of project planning. Via environmental assessment, characteristics of site, suitability of additional construction and cooling capacity, etc. are considered and site candidates are selected. Another item is public acceptance. Amicable perspective of residents is one of key factor. After determination of SMR construction, feasibility study is needed to be conducted. This study sets up a specific action plan for SMR project. Preliminary analysis, cost estimation, research & development and vendor selection are big four parts of feasibility study.

Based on previous study about SMR project, preliminary analysis is conducted including SMR size, site consideration, project development and human resource. Cost estimation considers whole cost related with from SMR construction to decommission. Research & development is activity related with new technology development. Vendor selection is ready for procurement of SMR. Bid invitation specifications and potential vendor identification are included in vendor selection.

Legal & organization framework provides an institutional strategy for SMR. New legal & organization framework for SMR is needed as preceding conditions. Simple structure of project planning is shown in Figure 4.12.

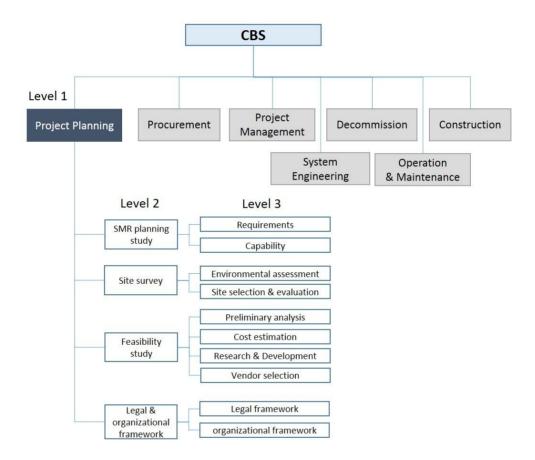


Figure 4.12 CBS of project planning for SMR.

Project management is main part of SMR project. During overall processing of SMR project, proper project management activities are demanded. Key parts of project management are planning, organizing, coordinating and quality assurance. Planning about process, resource, cost, information and licensing is important. This planning gives direction and scope of project management. In the organizing process, subordinating activities of planning are actualized. Coordinating prevents interference of each part. Quality assurance (QA) is important activity to achieve objective of SMR project. Through QA, quality of overall activities related with SMR project life-cycle can be managed.

Level 3 elements of each level 2 elements are as follow. Process element controls administration, contract, construction, etc. Resource element has subordinating items such as human resource, material and infrastructure. Cost element is related with financing activity for SMR project. Information element manages document, drawing and 3D modeling produced during SMR project. Licensing element includes planning licensing strategy and methodology. Licensing SMR is challenging section of SMR project [23]. Simple structure of project management is shown in Figure 4.13.

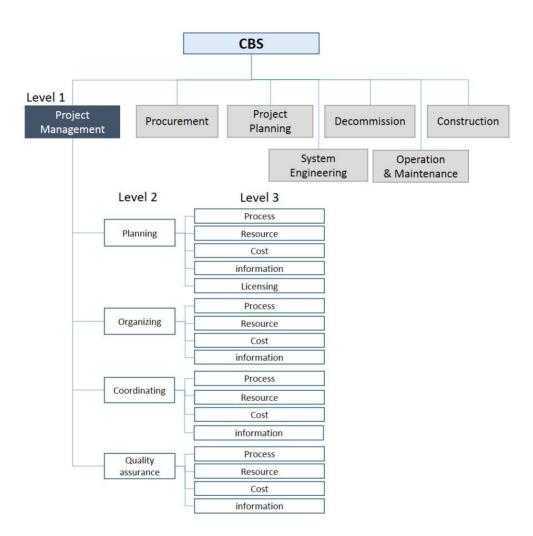


Figure 4.13 CBS of project management for SMR.

System engineering is a defining approach for the design, integration of sub-systems, configuration management, operations, and decommission of a system [8]. SMR system is composed of elements to meet requirement of SMR project. Main activities of system engineering are system defining and system realization. Level 2 elements of system engineering are hardware engineering, software engineering and system development.

Hardware engineering is related with overall activities about obtaining SMR hardware components. Level 3 elements of hardware engineering are as follows. System design is for defining configuration and specification considering requirements of SMR and technical problems. System analysis is for analyzing characteristics of design and distinguishing potential problems. System documentation is for proposing management tool of information which is produced in hardware engineering process such as drawings, reports, etc. Configuration management is for managing form and information of system, structure and components. Software engineering has same level 3 elements.

System development is for analyzing and coordinating activities to obtain system and level 3 elements of system development including system defining, system design analysis, system safety analysis and interface management. System defining is for defining system configuration to achieve goal of SMR project. System design analysis is for evaluating integrated system and modifying design to satisfy system requirements. System safety analysis is for evaluating safety of integrated system for SMR licensing. Interface management is insuring proper interface infrastructure between hardware and software. Simple structure of system engineering is shown in Figure 4.14.

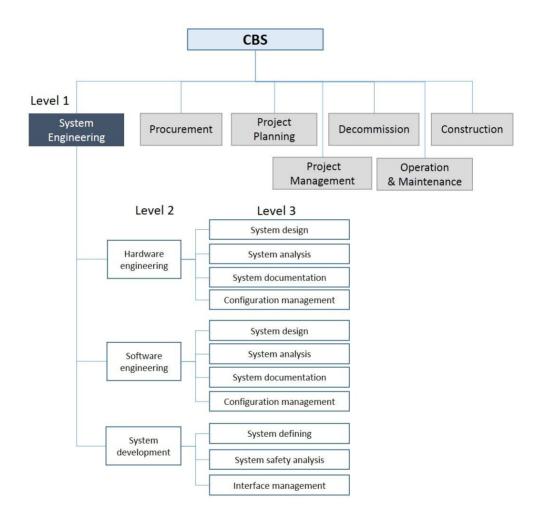


Figure 4.14 CBS of system engineering for SMR.

Procurement is related with supply chain of nuclear power plant industry. Through procurement, construction of SMR is conducted. Considering conventional NPP supply chain and new suppliers, supply chain for SMR project can be determined correctly.

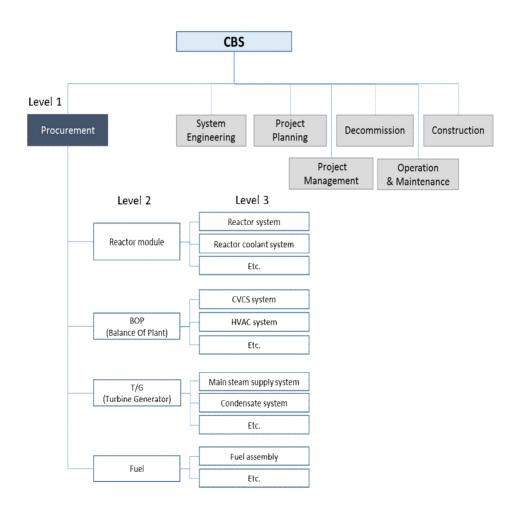


Figure 4.15 CBS of procurement for SMR.

Construction is important and complicated work. In SMR project, modular manufacturing in construction factory is expected. This way will reduce on site work and product price. Specific works related with construction which are reference IAEA construction management guide [13] are divided as Figure 4.16.

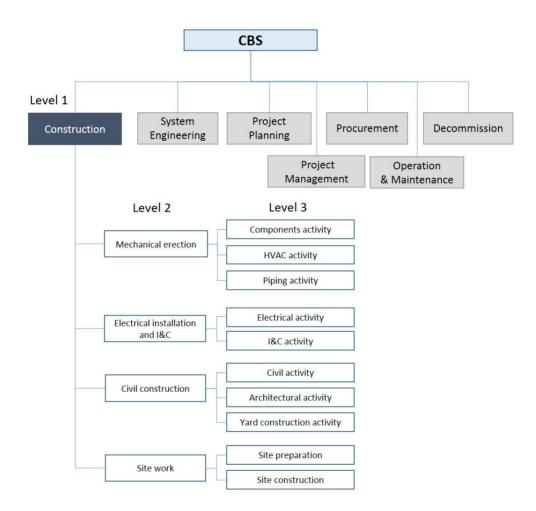


Figure 4.16 CBS of construction for SMR.

Operation & maintenance is for including overall activities about SMR operation & maintenance and training people for SMR operation. Level 2 elements are start-up, simulation facility & training, operation & safety, maintenance and inspection.

Start-up is for checking the operation readiness condition and consisted of system test, power ascension test and start-up preparation. System test is for confirming integrity of SMR system and distinguishing flaw after construction. Power ascension test is for checking the safety and integrity of SMR after nuclear fuel loading for commercial operation. Start-up preparation is level of efforts such as administration and quality assurance activities for start-up.

Simulation facility & training is related with training activity for SMR operator. Simulation facility operation is activity for maintenance and scheduling the facility operation plan. Human resource training is activity for SMR operator education / practical training and human resource management.

Operation & safety is for managing reactor system and material without severe accident. Managing reactor system is related with activities about operating SMR and checking safety. Managing material is related with activities about checking material code & standard and material condition.

Maintenance is consisted with managing repair part and planning about maintenance. Managing repair part is for managing extra parts for repairing and planning logistic support of repair parts. Maintenance planning is related with activities about planned maintenance system and temporary repair.

Inspection is an important activity for SMR operation. Inservice inspection is for checking the safety of SMR during normal operation. Periodic external inspection is planed inspection activities for safety.

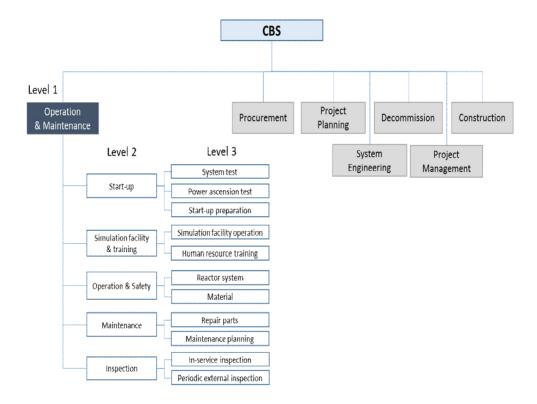


Figure 4.17 CBS of operation & maintenance for SMR.

Decommissioning of SMR is one of important parts of SMR operation. Based on regulatory guide documents [24, 25] of U.S nuclear regulatory commission (NRC), specific CBS elements are defined. Level 2 elements are divided into three elements by time phase of decommission activities.

Decommissioning planning includes overall initial activity such as permanent shutdown and post shutdown decommissioning activity. Certificate of permanent shutdown and fuel removal, considering decommissioning method of SMR and preparing decommissioning are conducted in these elements.

Decommissioning activity is main phase of decommissioning. Overall activities related with decontamination and dismantlement of SMR are included.

License termination planning focuses on evaluating residual radioactive material. Site characterization/dismantlement, radiation survey and environmental evaluation are included in this element.

Waste disposal is making framework for radioactive waste and managing activity about radioactive waste.

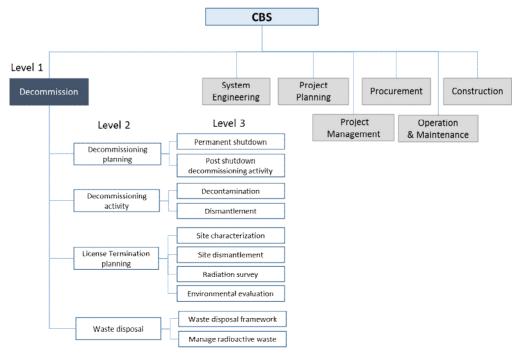


Figure 4.18 CBS of decommission for SMR.

URANUS is LBE cooled pool-type SMR utilizing natural circulation. Specific system design of URANUS is not determined yet. In this thesis, draft PBS of URANUS is described shown as Table4.2. Based on FSER [19] of gigawatt class NPP, features of URANUS are reflected.

Main modules of URANUS can be divided into seven; reactor module, turbine generator module, auxiliary module, I&C module, containment module, electrical power module and building module.

Reactor module controls fission reaction and transfer core heat to coolant system. This is consisted of reactor system, reactor coolant system. URANUS uses natural circulation for heat removal and operation pressure is atmospheric pressure.

Turbine generator module is related with generating electric power. This is consisted of turbine system, main steam supply system, condensate system and auxiliary system.

Auxiliary module supports overall NPP operation and coolant control system. LBE coolant has different feature compared with water coolant, so URANUS needs substantially different auxiliary system related with coolant control. Chemical & volume control system (CVCS) including polonium removal & decay, LBE heating & supply system, fuel handling & refueling system, spent fuel storage system and heating, ventilation and air conditioning (HVAC) system will be needed in auxiliary module.

Containment module insures safety of NPP. This module is including passive safety cooling system, steam depressurization system and seismic isolation system.

Instrumentation & control (I&C) module is monitoring NPP operation and controlling instruments of NPP. I&C is consist of plant control and monitoring system, protection system.

Electrical power module is supplying electricity to SMR in normal operation and accident situation. This system including main power system and emergency power supply system.

Building module is used for supporting and protecting reactor structures. Reactor building, auxiliary building and turbine building are needed.

	PBS	Description
Reactor	Reactor system	Reactor core
module	Reactor coolant system	Reactor internals and S/G
	Turbine system	Converting the thermal energy of reactor
Turbine generator	Main steam supply system	Supplying steam to T/G system
module	Condensate system	Controlling water condition and flow
	Auxiliary system	System for ensuring safety and water feeding
	Chemical & volume	Controlling LBE purity, volume,
	control system	etc. of the reactor
	HVAC system	Air conditioning of SMR site and controlling ventilation of radionuclide
Auxiliary	LBE heating & supply	Conditioning the LBE coolant
module	system	temperature for operation
	Fuel handling & refueling system	Installing and refueling fuel assemblies
	Spent fuel storage system	Management onsite spent nuclear fuel condition
I&C module	Plant control and monitoring system	Controlling SMR operation and monitoring instruments

Table 4.2 General description of draft PBS of URANUS.

	Protection system	Ensuring safety of SMR and mitigating emergency condition
PBS		Description
	Passive safety cooling system	Decay heat removal system for normal operation and accident
Containment module	Steam depressurization system	Relaxation system for S/G leak accident
	Seismic isolation system	System for eliminating or significantly reducing seismic damage
Electrical	Main power System	Supplying electrical power (A/C, D/C) for SMR operation
power module	emergency power supply system	Supplying emergency power when accident condition
	Reactor building	Including containment and shielding building
Building module	Auxiliary building	Including control room and fuel storage system, etc.
	Turbine building	Including T/G system and related with T/G

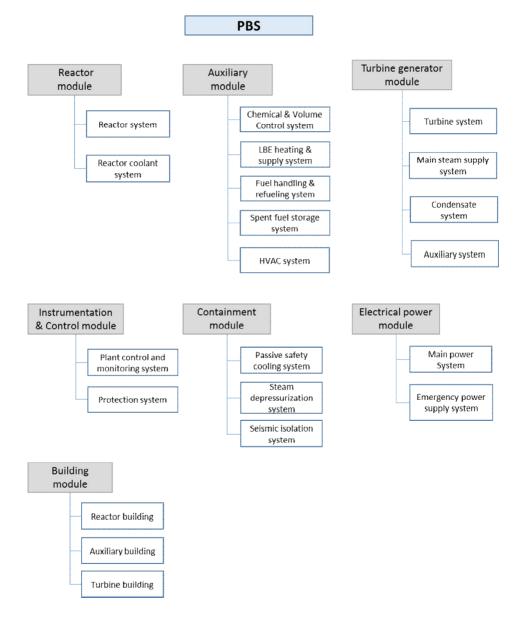


Figure 4.19 Draft PBS of URANUS.

4.3. IWBS Coding System

To manage IWBS elements, IWBS coding system is needed and this system must include all information as hierarchy structure. General coding systems are divided into three categories as listed in Table 4.3. Each coding system can use number, alphabet for coding information fields.

Coding system	Description
Monocode	Hierarchical code and tree structureThe digits at one level determine the subsequent digits of next level
Polycode (or chain code)	 Non-hierarchical code Each digits is matched in the fields of information
Hybrid code (or mixed code)	 Combination of the mono/poly coding structures To arrange mixed associative and non- associative information

Table 4.3 General description of coding systems	[10].	
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To include all information and relationship of IWBS elements, hybrid coding system is adapted and this system is divided into three main aspects as project phase which is following project lifecycle, partial component information and common elements related with SMR project and partial component. Every IWBS element needs to match coding system. Level of coding system is maximum seven levels and distinguishes each level by dash. The specific explanation of coding system for IWBS for SMR is as follows.

IWBS coding system has seven level and component centric structure. Three figure alphabet code of project phase and five level of hierarchy structure of SMR system which is combination of each maximum three figure number/alphabet is defined. Last of three figure alphabet code is common elements of project/SMR system. Detailed coding system is listed in Table 4.4 and example is shown in Table 4.5.

Plant code is indicates SMR type and unit number and first level of SMR product structure. Stage code is divided into four stage from project planning to project closing and each stage has own objectives and product. Island code is second level of SMR system and system code is sub-level of island code. Structure code indicates sub-level product of system and number figures are used for distinguishing when having many same components. In addition, only alphabet figures are used to express generally applicable components. Component code expresses devices that are used in component and this code applies same coding method with structure code. Information code includes information of common elements related with SMR project and SMR system and this code can be related with from plant code to component code to show information of IWBS elements. From code level 3 to level 6, "GEN" code can be inserted when information code (level 7) expresses information of upper level directly.

Code	Ľ	Digit	
Level 1	Plant code	SMR type and unit number	AAA(NN)
Level 2	Stage code	Following project life-cycle	AAA
Level 3	Island code	Island indicator of SMR	AAA
Level 4	System code	Indicator of sub-level product of island	AAA
Level 5	Structure code	Indicator of sub-level product of system	AA(NNN)
Level 6	Component code	Indicator of sub-level product of structure	AA(NNN)
Level 7	Information code	Common elements related	AAA(NN)

Table 4.4	Coding	system	of	IWBS.
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	with project and SMR	

5	SMR01-PRE-PRI-REC-FA001-CO001-TAN				
Level 1	Plant code	SMR01	SMR 01 unit		
Level 2	Stage code	PRE	Project planning stage		
Level 3	Island code	PRI	Primary system		
Level 4	System code	REC	Reactor vessel		
Level 5	Structure code	FA001	No.1 fuel assembly		
Level 6	Component code	CO001	No.1 fuel of No.1 F/A		
Level 7	Information code	TAN	Thermal-hydraulic analysis		
	SMR01-PRX-PI	RI-GEN-(GEN-GEN-ONM		
Level 1	Plant code	SMR01	SMR 01 unit		
Level 2	Stage code	PRE	Project execution		
Level 3	Island code	PRI	Primary system		
Level 4	System code	GEN	_		
Level 5	Structure code	GEN	_		
Level 6	Component code	GEN	-		
Level 7	Information code	ONM	Operation & Maintenance activity		

Table 4.5 Example of IWBS coding result.

To define correct IWBS element contents, IWBS dictionary is used. This dictionary includes clear statement about IWBS elements and additional information for management activities such as related IWBS elements and work to achieve objectives. In this thesis, format of IWBS dictionary refers to NASA WBS dictionary [6] and Generic-YWBS sample specification document [11]. Example of IWBS dictionary is shown in Table 4.6.

Table 4.6 Example of IWBS dictionary.

	IWBS Dictionary						
IWBS code	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7
	SMR01	PRX	PRI	REC	FA001	CO001	TAN
IWBS		Fuel rod thermal-hydraulic analysis					
Code title							
Effective date							
(origin)							
IWBS		The	mal-hydra	ulic analys	sis result r	eport	
deliverables							
Originator				S.R. Park			
Related			Design	requiremer	nt report		
Document							
	Analysis Primary system thermal-hydraulic analysis			ysis			
Related work	Procurement						
	Instal	1					
	Revision	date		De	scription		
Revision history							
Note							

Chapter 5.Application of IWBS for mockup fa cility

5.1. Mockup Facility of URANUS Design

A pool-type mockup facility of URANUS named as PILLAR (Pool-type Integral test facility for Lead Alloy cooled small modular Reactor) has been designed to verify natural circulation capability of URANUS and to conduct design basis accident (DBA) experiment. In addition, computational fluid dynamics (CFD) code and experiment results of this facility will be compared. To satisfy these mission of PILLAR, an area-averaged scaling law [26] is adapted to design this scaled mockup facility and design constraints are decided as listed in Table 5.1.

Constraints	Values / Requirements
Thermal height ratio	1:1
Flow area ratio	Satisfying thermodynamic similarityA limit on LBE stock (< 1/100)
LBE stock	4 ton
Core outlet velocity	> 10 cm/s
Pressure proof	10 bar

Table	5.1	Design	constraints	of PILLAR.
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Key parameters such as mass flow rate, area scaling ratio, temperature difference, etc. were decided preliminary as 1:200 scaling ratio of thermal power and flow area. Scaling results of design parameters are shown in Table 5.2.

Based on scaling results, design of specific parts and validation of overall design results are proceeded. MARS-LBE code will be applied for validation of mockup design [27]. Accuracy of this code has been validated by a benchmarking program under OECD/NEA [28]. Additory mutual verification of mockup design and MARS-LBE code will be conducted to determine final design.

Item	Unit	Proto;	Mockup;	Scaling
		p	m	ratio; m/p
Thermal power	kW	100000	411	37/9000
LBE stock	ton	470	2.32	1/200
Thermal height	m	5.21	5.21	1
Inlet/outlet temperature Difference	K	153	133.8	0.88
Core inlet temperature	K	304	304	_
Core outlet Temperature	K	457	439	_
Core rod number	_	9000	37	37/9000
Core rod diameter	m	0.0135	0.0135	1
Core outlet velocity	m/s	0.3123	0.2924	~0.94
Pressure loss	Pa	9743.5	8456.5	~0.88
LBE mass flow rate	kg/s	4546.0	22.63	0.00468

Table 5.2 Design parameters of PILLAR.

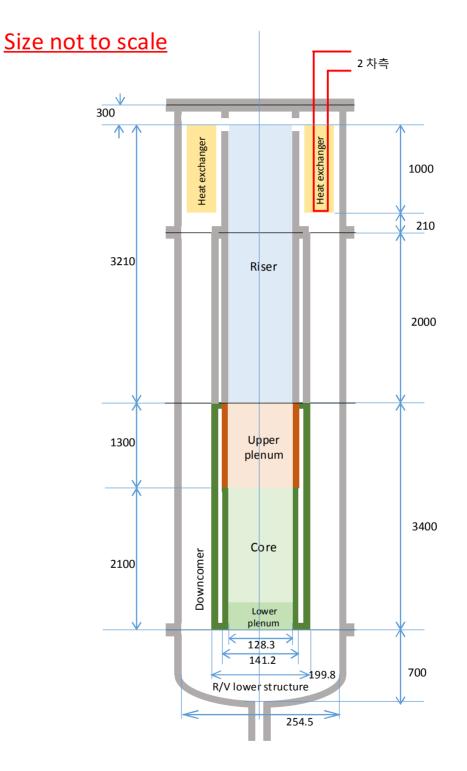
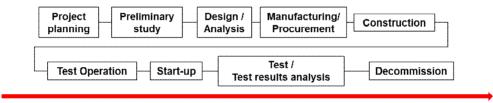


Figure 5.1 Schematic of mockup facility PILLAR.

5.2. Application of IWBS

For PILLAR project, IWBS for SMR project is adjusted to achieve objectives of project. To apply IWBS for SMR project, PILLAR project process flow is determined then IWBS for PILLAR project actualization process work is conducted to define IWBS elements. IWBS code and documents are also defined. These process is described in this chapter.

Based on SMR project process flow, PILLAR project process flow is determined as shown in Figure 5.2. General process of PILLAR project is same as SMR project, however, licensing is merged into design/analysis step and operation & maintenance is changed as test/test results analysis.



Quality Assurance / Administration

Figure 5.2 PILLAR project process flow.

Actualization process of IWBS for PILLAR project is related with design process. By project planning, preliminary IWBS is determined. Detailed components and specific PILLAR design are determined through interaction between designer and supplier. Concretization of design and actualization of IWBS are conducted in parallel as shown in Figure 5.3.

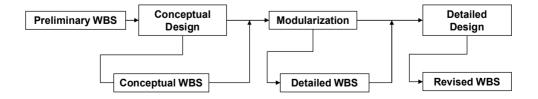


Figure 5.3 Actualization process of IWBS for PILLAR project.

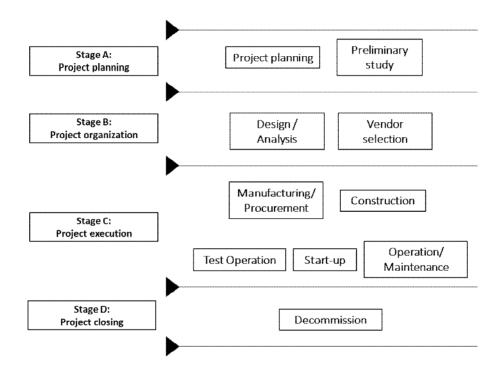


Figure 5.4 Four stages of PILLAR project.

Based on CBS of IWBS for SMR project, CBS elements are determined. Level 1 elements are same as following; project planning, project management, procurement, system engineering, construction, operation & maintenance, decommission.

Almost level 2 elements are same as SMR project, however, some elements have difference with SMR project. In project planning, standard criteria is determined by considering constraints and requirements for achieving project goal. Procurement is divided into PILLAR assembly, electric power system and I&C according to contract with suppliers. Operation & maintenance is including test result analysis. Specific CBS elements of PILLAR project are shown in Figure 5.5.

PBS of PILLAR project selected based on PBS of IWBS for SMR project. PILLAR is more simple facility than SMR. In this point, PBS elements are categorized into five categories; primary module, secondary module, I&C module, electrical power module, supporting structure module. Components of primary module of PILLAR is actualized through judging assemble feasibility and manufacturing feasibility. This process is closely connected with supply chain. Other PBS elements are also determined by this process. Detailed PBS elements are shown in Figure 5.6.

IWBS for PILLAR project is defined by CBS and PBS elements. This IWBS elements are including general information, technical information, documents, etc. Overall defined IWBS element of PILLAR project are listed in Appendix. During defining IWBS, using assembly concept to reduce unnecessary IWBS elements. For example, thermocouples of core are too many repeated parts. For that reason, using assembly concept, thermocouples are bound into one assembly. General information is entered into assembly level and specific information is entered into sub-level. Identifying works and documents to accomplish IWBS elements.

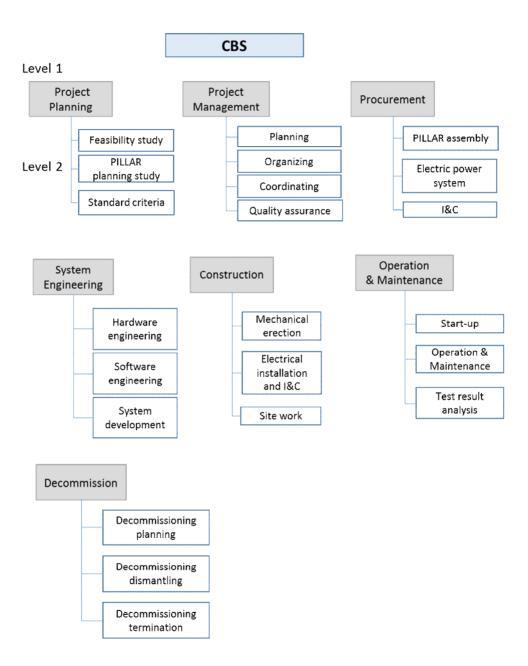


Figure 5.5 CBS elements of IWBS for PILLAR.

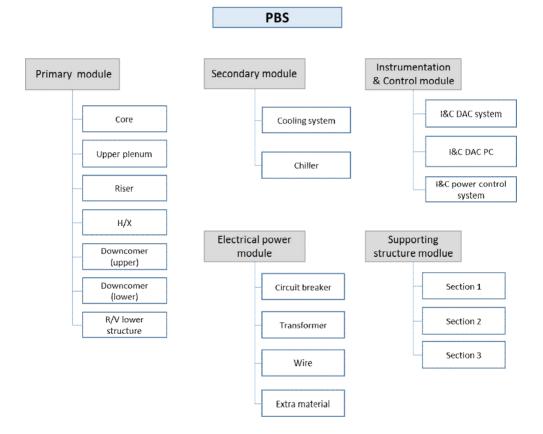


Figure 5.6 PBS elements of IWBS for PILLAR.

IWBS for PILLAR project is determined. Through IWBS elements, project manager and stakeholders such as supplier could have unity conversation passage and IWBS elements are revised for accomplishing objectives of project. Schematic of this interaction is shown in Figure 5.7.

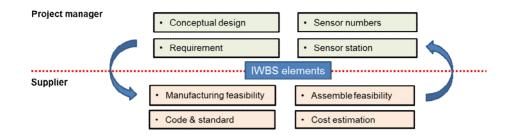


Figure 5.7 Interaction relation of project manager and supplier.

Benefits of IWBS for PILLAR project are as following; identifying works/products and suggesting PILLAR project guideline, identifying components and instrumentation of PILLAR and estimating evolving resource easily. For project management, PILLAR project process flow can be determined through IWBS elements as shown in Figure 5.8. In addition, CATIA[®] 3D model of PILLAR and IWBS can be connected for better management of PILLAR.

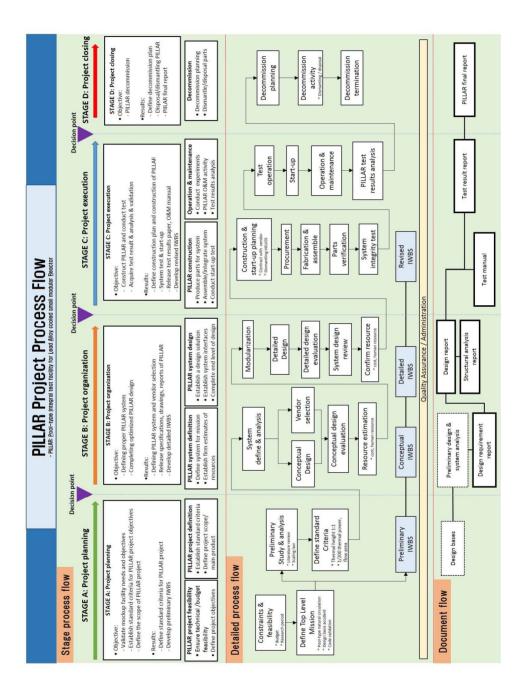


Figure 5.8 Process flow chart of PILLAR project.

Chapter 6. Conclusion

Generation-IV reactor systems are considered to have outstanding safety and efficiency features than present NPP. SMR receives attention due to its features of versatile application and safety features. For that reason, many conceptual SMRs are designed in worldwide. However, researches about WBS for SMR are just first stage of development. Therefore, needs of proper WBS are increasing to push ahead SMR project.

IWBS is based on product-oriented WBS. Features of IWBS are 1) human cognition friendliness 2) supply chain friendliness. Hierarchical structure based on functional module of reactor components is backbone and common elements are integrated to this structure. Definition of IWBS elements is proposed and proper IWBS coding system is also presented. IWBS coding system is based on defined parts of URANUS. This functional module based approach is unfamiliar in gigawatt class NPP project, however, SMR is smaller project than those huge projects and new developing parts and technologies are adapted. In this point, functional module based arrangement is good to check missing parts and reduce the difficulty of understanding whole project. In addition, lowest level of IWBS is connected to WBS of supply chain and IWBS act like interaction channel for achieving objectives. In this thesis, IWBS is defined up to generally applicable level about SMR and more specific parts are treated in mockup facility part.

The scaled mockup facility of URANUS called PILLAR is used to verify IWBS. This full height mockup facility uses LBE as working fluid. From design to operation of mockup facility, IWBS is applied. Based on 3D design of mockup facility, PILLAR is divided into five modules. To define the work packages, IWBS is used to each hierarchical component level. Actually, PILLAR is not reactor system and much smaller than reactor, so perfect application of developed IWBS is not possible. However, due to application of IWBS, mockup facility project is well organized and practicality of IWBS is proven as project management tool.

IWBS for SMR project is one of preliminarily study for SMR development project. Through this study, standard IWBS is proposed and applied to mockup facility project. Further application of IWBS to other projects will improve this research result and contribute to strengthen the basis of SMR projects.

Chapter 7. Future work

IWBS for SMR project is developed under design of URANUS and its mockup facility. IWBS have some problems needed to be solved for general application.

- 1. Generality of IWBS
 - A. Agreement of expert group needed for IWBS application
 - B. More case study about IWBS demanded to check generality of IWBS
- 2. Management system
 - A. Suitable IWBS electronic management system
 - B. Suitable document management system
- 3. Enterprise Resource Planning (ERP)
 - A. Define ERP system for SMR project
 - B. Introduction of concept of earned value management system (EVMS)

Bibliography

1. GENERATION-IV INTERNATIONAL FORUM, Technology Roa dmap Update for Generation IV Nuclear Energy Systems, OECD/ NEA (2014).

2. G. I. TOSHINSKY and V. PETROCHENKO, "Modular Lead-bis muth Fast Reactors in Nuclear Power," Sustainability, **4**, 9, 2293 -2316 (2012).

3. C. F. SMITH, W. G. HALSEY, et al., "SSTAR: The US lead-c ooled fast reactor (LFR)," Journal of Nuclear Materials, **376**, 3, 255-259 (2008).

4. Z. LIU and J. FAN, "Technology readiness assessment of sma Il modular reactor (SMR) designs," Prog. Nucl. Energ., **70**, 20-2 8 (2014).

5. Y.-H. SHIN, S. CHOI, et al., "Advanced Passive Design of Sm all Modular Reactor Cooled by Heavy Liquid Metal Natural Circul ation," Prog. Nucl. Energ., **83**, (2015).

6. NASA/SP-2010-3404, NASA Work Breakdown Structure (W BS) Handbook, NASA (2010).

7. G. BACHY and A.-P. HAMERI, "What to be implemented at th e early stage of a large-scale project," International Journal of P roject Management, **15**, 4, 211-218 (1997).

8. NASA/SP-2007-6105. REV1, NASA Systems Engineering Ha ndbook NASA (2007).

9. U. D. O. DEFENSE, WORK BREAKDOWN STRUCTURES FOR DEFENSE MATERIEL ITEMS, 2011.

10. P. C. KOENIG, P. L. MACDONALD, et al., The National Ship building Research Program. 1997 Ship Production Symposium, Pa per Number 16: Towards a Generic Product-Oriented Work Brea kdown Structure for Shipbuilding, 1997. 11. L. DONG KUN, N. SEUNG HOON, et al., "Development of a Generic-YWBS for Engineering Integrated Management of Sailing Yacht," Journal of the Society of Naval Architects of Korea, **51**, 1, 16-25 (2014).

12. NASA/SP-2014-3705, NASA Space Flight Program and Project Management Handbook, NASA (2014).

13. IAEA, Project Management in Nuclear Power Plant Constructi on: Guidelines and Experience, 2012.

14. U. S. D. O. ENERGY, WORK BREAKDOWN STRUCTURE HA NDBOOK, (2012).

15. CHO, H. YEONG, et al., "Development of Work Breakdown St ructure for Nuclear Power Plant," 2014, 52-53, The Korea In stitute of Building Construction

 T. J. HARRISON, R. J. MOSES, et al., "Preliminary Developm ent of a Work Breakdown Structure for Small Modular Reactors," (2014).

17. L. DEMICK and D. VANDEL, Next generation nuclear plant p re-conceptual design report, 2007.

18. S.-S. LEE, S.-H. KIM, et al., "The design features of the ad vanced power reactor 1400," Nucl Eng Technol, **41**, 995-1004 (2009).

19. U. S. N. R. COMMISSION, Final safety Evaluation Report Rel ated to Certification of the AP1000 Standard Design, September 2011.

20. IAEA, Preparation of a Feasibility Study for New Nuclear Power Projects, Report No. NG-T-3.3 2014.

21. S. GIJEZEN, "Organizing 3D building information models with the help of work breakdown structures to improve the clash det ection process," (2010).

22. IAEA, Safe and effective nuclear power plant life cycle mana gement towards decommissioning, 2002.

23. M. RAMANA, L. B. HOPKINS, et al., "Licensing small modula r reactors," Energy, 61, 555-564 (2013).
24. U. S. N. R. COMMISSION, Decommissioning of Nuclear Powe r Reactors, October 2013.

25. U. S. N. R. COMMISSION, Standard Review Plan for Evaluati ng Nuclear Power Reactor License Termination Plans, April 2003.

26. M. ISHII, S. REVANKAR, et al., "The three-level scaling app roach with application to the Purdue University Multi-Dimensiona l Integral Test Assembly (PUMA)," Nuclear Engineering and Des ign, **186**, 1, 177-211 (1998).

27. KOREA ATOMIC ENERGY RESEARCH INSTITUTE, MARS C ode Manual Volume I – Code Structure, System Models and 28 Solution Methods, Daejeon, Republic of Korea (2006).

28. J. H. CHO, A. BATTA, et al., "Benchmarking of thermal hydr aulic loop models for Lead-Alloy Cooled Advanced Nuclear Ener gy System (LACANES), phase-I: Isothermal steady state forced convection," Journal of Nuclear Materials, **415**,3,404-414(2011).

	note	Decign result	Design result	Literature review, scaling method	define standard criteria	I/H analysis data	define preliminary IWBS define concentual IWBS	define detailed IWBS	define revised IWBS	design requirement	design result	define operation procedure	define flow chart	define flow chart	define flow chart	define flow chart	define flow chart	define flow chart	define flow chart	QA result	OA result	OA result	feasibiltiy analysis	feasibiltiy analysis	selecting vendor	definetionalysis	resource estimation	resource confirm	design review	verification	neration & maintenance	O&M procurement	configuration management	test result analysis	system integrity test	supplier, date	supplier, date	supplier, date		establish planning	establish dismatling planning		Design result	T/H analysis data	define operation procedure	define flow chart	define flow chart	define flow chart	define flow chart	define flow chart	define flow chart	define flow chart	QA result	uners us	OA secole
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PRI ST001 VA001 ASM	PRI ST001 VA001 ASM	VA001 ASM	ASM			Cover gas inlet valve	assemble work		assemble	related drawing	connecting part, date
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PRI STOOL TCOOL MCO	ST001 TC001 MC0 1	TC001 MC0 1	MCO	1	1	Thermocouple		material	cost	estimate sheet, statement of delivery	supplier, date
PRI STOOL TCOOL DRW	PRI STOOL TCOOL DRW	TC001 DRW	DRW	-	-	Thermocouple drav	ving		drawing	Drawing	part drawing
X PRI ST001 TC001 ASM Thermocouple assemble work	ST001 TC001 ASM	TC001 ASM	ASM	ľ.	ľ.	Thermocouple asse	emble work		assemble	related drawing	connecting part, date
PRI	PRI ST001 TC001 PRM	TC001 PRM	PRM			Thermocouple pro	curement		procurement	estimate sheet, statement of delivery	supplier, date, info
PRI CO001	PRI CO001		-	-	-	Core					
PRI CO001 MCO	PRI CO001 MCO	MCO	-	-	-	Core material cost		material	cost	estimate sheet, statement of delivery	supplier, date
PRI CO001 GIN	PRI CO001 GIN	NIS	BIN	1	1	Core general inform	ation	general	information		general feature
PRI CO001 BA001	PRI CO001 BA001	BA001				Core barrel					
PRI CO001 BA001 MC0	PRI CO001 BA001 MC0	BA001 MCO	MCO	-	-	Core barrel material co	ost	matenal	cost	estimate sheet, statement of delivery	supplier, date
PRI CO001 BA001 GIN	PRI CO001 BA001 GIN	BA001 GIN	GIN	-	-	Core barrel general infor	mation	general	information		general feature
PRI CO001 BA001 DRW	CO001 BA001 DRW	BA001 DRW	DRW	-	-	Core barrel drawing			drawing	Drawing	part drawing
PRI CO001 BA001 ASM	PRI CO001 BA001 ASM	BA001 ASM	ASM	-	-	Core barrel assemble work		_	assemble	related drawing	connecting part, date
0X PRI CO001 BA001 PRM Core barrel procurement	CO001 BA001 PRM	BA001 PRM	PRM			Core barrel procurement			procurement	estimate sheet, statement of delivery	supplier, date, info
PRI CO001 HS001	CO001 HS001 HE	HE HE	Ŧ		Core main heater assembly	Core main heater assembly					37ea
PRI CO001 HS001 HE GIN	CO001 HS001 HE GIN	HS001 HE GIN	HE GIN	GIN	Ē	Core main heater assembly	general information	general	information		general feature
PRI CO001 HS001 HE	CO001 HS001 HE DRW	HS001 HE DRW	HE DRW	DRW	-	Core main heater assembly	drawing		drawing	Drawing	part drawing
PRI CODD1 HSD01 HE ASM	PRI CODD1 HSD01 HE ASM	HS001 HE ASM	HE ASM	ASM	T	Core main heater assembly	assemble work		assemble	related drawing	connecting part date
DRI COMI HEADI HE DRM	COODI HEODI HE DRM	HE DRM	HEDRM	DRM	T	Core main heater accombly	proclirament		nrocirement	actimate cheat statement of delivery	sumilar data info
			infront hard	0.00	Ť	Concentration includes a second secon	biocarcinette		the second		approx, and me
LIVE COULT FILIANT FILIANT MICO	LIVE COULT FILIANT FILIANT MICO		HEOUL MICO	NOO.				IIIqualiqu	1001	escillate street, statement of univery	and in the second
MIN ROAL TOUCH TOUCH INC	MIN ROAL TOUCH TOUCH INC	MCO MICO	HEUUZ MICO	MCO	1	COIE MAIN NEALER 2		Induction	CON	esumate steet, statement of delivery	and in a subbuller, use
PKI CO001 HS001 HE003 MC0	PKI CO001 HS001 HE003 MC0	HS001 HE003 MCO	HE003 MCO	MCO		Core main neater 3		matenal	COST	estimate sheet, statement of delivery	supplier, date
PRI CO001 HS001 HE004 MC0	CO001 HS001 HE004 MC0	HS001 HE004 MCO	HE004 MCO	MCO	1	Core main heater 4		matenal	cost	estimate sheet, statement of delivery	supplier, date
PRI CO001 HS001 HE005	PRI CO001 HS001 HE005 MCO	HS001 HE005 MCO	HE005 MCO	MCO	-	Core main heater 5		material	cost	estimate sheet, statement of delivery	supplier, date
O PRI CO001 HS001 HE006 MCO Core main heater 6	CO001 HS001 HE006 MC0	HS001 HE006 MCO	HE006 MCO	MCO	-	Core main heater 6		material	cost	estimate sheet, statement of delivery	supplier, date
O PRI CO001 HS001 HE007 MCO Core main heater 7	CO001 HS001 HE007 MCO	HS001 HE007 MCO	HE007 MCO	MCO	-	Core main heater 7		material	cost	estimate sheet, statement of delivery	supplier, date
PRI CO001 HS001 HE008	PRI CO001 HS001 HE008 MC0	HS001 HE008 MCO	HE008 MCO	MCO	-	Core main heater 8		material	cost	estimate sheet, statement of delivery	supplier, date
PRI CO001 HS001 HE009	PRI CODOI HSDOI HEOD9 MCO	HS001 HE009 MCO	HE009 MCO	MCO		Core main heater 9		material	cost	estimate sheet, statement of delivery	supplier, date
O PRI CO001 HS001 HE010 MCO Core main heater 10	CO001 HS001 HE010 MCO	HS001 HE010 MCO	HEOLO MCO	MCO	Ť	Core main heater 10		material	cost	estimate sheet, statement of delivery	supplier, date
O PRI CO001 HS001 HE011 MCO Core main heater 11	CO001 HS001 HE011 MCO	HS001 HE011 MCO	HE011 MCO	MCO	Ť	Core main heater 11		material	cost	estimate sheet, statement of delivery	supplier, date
O PRI CO001 HS001 HE012 MCO Core main heater 12	CO001 HS001 HE012 MCO	HS001 HE012 MCO	HE012 MCO	MCO		Core main heater	12	material	cost	estimate sheet, statement of delivery	supplier, date
O PRI CO001 HS001 HE013 MCO Core main heater 13	CO001 HS001 HE013 MCO	HS001 HE013 MCO	HE013 MCO	MCO		Core main heater	13	material	cost	estimate sheet, statement of delivery	supplier, date
PRI	PRI CO001 HS001 HE014 MCO	HS001 HE014 MCO	HE014 MCO	MCO		Core main heater	- 14	material	cost	estimate sheet, statement of delivery	supplier, date
CO PRI CO001 HS001 HE015 MCO Core main heater 15	CO001 HS001 HE015 MCO	HS001 HE015 MCO	HE015 MCO	MCO		Core main heater	15	material	cost	estimate sheet, statement of delivery	supplier, date
PRI CODDI HSDDI HEDIG MCD	PRI CODDI HSDDI HEDIG MCD	HSD01 HE016 MCD	HE016 MCD	MCO	T	Core main heater	16	material	cost	estimate sheet statement of delivery	sumilier date
	DDI COMI LIENTI LIENT		UE017 MCO	MCO	Т	Core main heater	12	matarial	cont	actimate cheat statement of delivery	curreliar data
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		LISUUL PLEUTO MUCO	LIEULO MICO	INICO	T	T IDIATE IIIAIII IICALCI T		Inidiation	COST	contrigere offect, succertainert of univery	anhhuis' nate
PRI COUUI HSUOI HEUI9 MCO	PRI CO001 HS001 HE019 MCO	HS001 HE019 MCO	HE019 MCO	MCO	1	Core main heater 1	0	matenal	cost	estimate sheet, statement of delivery	supplier, date
PRI CO001 HS001 HE020 MCO	PRI CO001 HS001 HE020 MCO	HS001 HE020 MCO	HE020 MCO	MCO	-	Core main heater 2	0	material	cost	estimate sheet, statement of delivery	supplier, date
PRI	PRI CO001 HS001 HE021 MCO	HS001 HE021 MCO	HE021 MCO	MCO	-	Core main heater 2:		material	cost	estimate sheet, statement of delivery	supplier, date
PRI CO001 HS001 HE022 MCO	CO001 HS001 HE022 MCO	HS001 HE022 MCO	HE022 MCO	MCO	Ĩ	Core main heater 2:	2	material	cost	estimate sheet, statement of delivery	supplier date
DRI COMI HEAR HEAR	DRI COMI HEAR HEAR	HCODI HEO23 MCO	HE023 MCO	MCO	T	Core main heater 7		matorial	cnet	actimate chaot statement of delivery	cumiliar data
DDT COMI LICON MCO	DDT COMI LICON MCO		LEO2A MCO	MCO	T	Core main heater 2/		mataria	cost	actimita chaat statament of dalivari	cumular data
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PRI CO001 HS001 HE025 MC0	PRI CO001 HS001 HE025 MC0	HS001 HE025 MC0	HE025 MCO	MCO	1	Core main heater 2		matenal	cost	estimate sheet, statement of delivery	supplier, date
PRI CO001 HS001 HE026 MCO	PRI CO001 HS001 HE026 MCO	HS001 HE026 MCO	HE026 MCO	MCO	-	Core main heater 26		material	cost	estimate sheet, statement of delivery	supplier, date
CO PRI CO001 HS001 HE027 MCO Core main heater 27	CO001 HS001 HE027 MC0	HS001 HE027 MCO	HE027 MCO	MCO	-	Core main heater 2		material	cost	estimate sheet, statement of delivery	supplier, date
PRI CO001 HS001 HE028 MCO	PRI CO001 HS001 HE028 MCO	HS001 HE028 MCO	HE028 MCO	MCO	-	Core main heater 2	00	material	cost	estimate sheet statement of delivery	supplier date
			LECTO MICO	MCO	T	Coro main hostor		matorial	cont	actimita chaat stitament of dalivari	enouline data
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PKI COUDI HSUUI HEUSU MCO	PKI COUUL HSUUL HEUSU MCO	HSU01 HE030 MCO	HEU3U MCO	MCO		Core main neater	30	matenal	COST	estimate sheet, statement of delivery	supplier, date
PRI	PRI CO001 HS001 HE031 MCO	HS001 HE031 MCO	HE031 MCO	MCO	-	Core main heater	- 31	material	cost	estimate sheet, statement of delivery	supplier, date
O PRI CO001 HS001 HE032 MCO Core main heater 32	CO001 HS001 HE032 MCO	HS001 HE032 MCO	HE032 MCO	MCO	-	Core main heate	r 32	material	cost	estimate sheet, statement of delivery	supplier, date
PRI COODI HSOOT HEO33 MCO	PRI COODI HSOOT HED33 MCO	HS001 HF033 MCO	HE033 MCO	MCO	f	Core main heate	r 33	material	cost	estimate sheet statement of delivery	sumplier date
DRI COMI HEMA MCO	DRI COMI HEMA MCO	HE001 HE024 MCO	HE034 MCO	MCO	T	Core main heater	24	material	cod	actimate cheat statement of delivery	sumiliar data
DDI COMI LICUM LICUM	DDI COMI LICUM LICUM		Incrose MCO	MCO	T	Coro main hostor	26	matoria	cort	actimute cheat statement of delivery	errorian data
PNI COULI TSUUL TEUSS MCO	PNI COULI TSUUL TEUSS MCO		LECOS MCO	WCO	T	Coro main horton	50 ar	material	cost	ESUITIBLE SILECT, STATEMENT OF AUTONIA	supplier, uste
PRI CO001 HS001 HE036 MCO	PRI CO001 HS001 HE036 MCO	HS001 HE036 MCO	HE036 MCO	MCO		Lore main neater	36	matenal	COST	estimate sheet, statement of delivery	supplier, date
C PRI CO001 HS001 HE037 MCO Core main heater 37	CO001 HS001 HE037 MCO	HS001 HE037 MCO	HE037 MCO	MCO		Core main heate	r 37	material	cost	estimate sheet, statement of delivery	supplier, date
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Island System Structure C	System Structure Component	Structure Component		Requirement		Description	SUB Del	SUB De2	related Doc	note
HS001 CN001 HS001	HS001 CN001 HS001	CNOOL	0.71		Heating	Heating system controller	la stanta	tere	antimete desse sets and all some	attailer data
PRI CO001 HS001 CN001 GIN	HS001 CN001 GIN	CN00T BIN	GIN		Heating sy	Heating system controller general information	general	information	בסתווופרב מובבל מתוכנוובוור הו תבווגבול	general feature
PRO PRI CO001 SP001 SP001 Spacer	SP001 MCO	WCD			Spacer		material	crot	estimate sheet statement of delivery	sunnlier date
PRI COOOI SPOOI GIN	SPOIL GIN	GIN	T	T	Spacer gene	Spacer general information	general	information		general feature
PRI CO001 SP001	SP001 DRW	DRW			Spacer draw	ing		drawing	Drawing	part drawing
PRI CO001 SP001	SP001 ASM	ASM			Spacer asse	mble work		assemble	related drawing	connecting part, date
PRI CO001 SP001 PRM	SPOOL PRM	PRM			Spacer proct	urement		procurement	estimate sheet, statement of delivery	supplier, date, info
PRI COOMI IC GIN	IC GIN	CIN			Thermocoul	I hermocouple assembly Thermocouple assembly reneral information	nanara	information		45ea neneral feature
CO001 TC DRW	TC DRW	DRW	1	1	Thermocour	Thermocouple assembly general information		drawing	Drawing	part drawing
PRI CO001 TC ASM	TC ASM	ASM			Thermocoup	Thermocouple assembly assemble work		assemble	related drawing	connecting part, date
CO001 TC PRM	TC PRM	PRM			Thermocoup	Thermocouple assembly procurement		procurement	estimate sheet, statement of delivery	supplier, date, info
PRI CO001 TC001 MCO	TC001 MCO	MCO			Core Top Se	Core Top Section Temp #1	material	cost	estimate sheet, statement of delivery	supplier, date
PRO PRI COULI ICUUZ INCO CORE TOP SEC DBO DDT COOM TOM2 MICO Core TOP SEC	TCM2 MCO	WLO			Core Top Sec	Core Top Section Temp #2	material	cost	esumate sneet, statement of delivery	supplier, date
DBI COMI TCMM MCO	TCOM	WLO			Core Ton Sectio	n Termo #4	matarial	cost	estimate cheet statement of delivery	supplier, date
CO001 TC005 MCO	TC005 MCO	MCO			Core Top Section	Temp #5	material	cost	estimate sheet, statement of delivery	supplier, date
PRI CO001 TC006 MCO	TC006 MCO	MCO			Core Top Section	Temp #6	material	cost	estimate sheet, statement of delivery	supplier, date
PRO PRI CO001 TC007 MCO Core Top Section Temp #7	TC007 MCO	MCO			Core Top Section	Temp #7	material	cost	estimate sheet, statement of delivery	supplier, date
	TC008 MCO	MCO			Core Top Section	i Temp #8	material	cost	estimate sheet, statement of delivery	supplier, date
PRI CO001 TC009 MCO	TC009 MCO	MCO			Core Top Section	i Temp #9	material	cost	estimate sheet, statement of delivery	supplier, date
PRI CO001 TC010 MCO	TC010 MCO	MCO			Core Top Section	Temp #10	material	cost	estimate sheet, statement of delivery	supplier, date
PRI CO001 TC011 MCO	TC011 MCO	MCO			Core Top Section	i Temp #11	material	cost	estimate sheet, statement of delivery	supplier, date
PRI CO001 TC012 MCO	TC012 MCO	MCO			Core Top Section	Temp #12	material	cost	estimate sheet, statement of delivery	supplier, date
PRI COOOI TCOI3 MCO	TC013 MCO	WCO			Core Top Section	1 Temp #13	material	cost	estimate sheet, statement of delivery	supplier, date
C0001 1C014 MCO	TC014 MCO	WCO			Core Top Section	n lemp #14	material	COST	estimate sheet, statement of delivery	supplier, date
CT# duta Lighter of and Only CT# duta Lighter of and Only CT# duta Lighter of and Only CT# duta Lighter of an Only CT#		MICO			Core 10p section	CT+ dual -	material	COSL	esumate sheet, statement of delivery	supplier, date
DBI COON TCOID MCO	TC017 MCO	WCO			Core Middle Sec	tion Temp #2	material	cost	estimate sheet statement of delivery	subhier, date
PRI COOOI TCO18 MCO	TC018 MCO	WCO			Core Middle Sec	tion Temp #3	material	cost	estimate sheet, statement of delivery	supplier, date
PRI CO001 TC019 MCO	TC019 MCO	MCO			Core Middle St	Core Middle Section Temp #4	material	cost	estimate sheet, statement of delivery	supplier, date
PRI CO001 TC020 MCO	TC020 MCO	MCO			Core Middle	Core Middle Section Temp #5	material	cost	estimate sheet, statement of delivery	supplier, date
PRI CO001 TC021 MCO	TC021 MCO	MCO			Core Middle	Core Middle Section Temp #6	material	cost	estimate sheet, statement of delivery	supplier, date
	10022 MICO	WCO	T	T	Core Middle	Core Middle Section Temp #/	material	COST	estimate sheet, statement of delivery	supplier, date
PRI COMI TC024 MCO	TC024 MCO	WCD	T	T	Core Middle	Core Middle Section Temp #9	material	cost	estimate sheet, statement of delivery	supplier, date
PRI COODI TCD5 MCO	TC025 MCO	WCO	T	T	Core Middle	Core Middle Section Temp #10	material	cost	estimate sheet statement of delivery	supplier date
PRI CO001 TC026 MCO	TC026 MCO	MCO	1	1	Core Middle	Core Middle Section Temp #11	material	cost	estimate sheet, statement of delivery	supplier, date
PRI CO001 TC027 MCO	TC027 MCO	MCO			Core Middle	Core Middle Section Temp #12	material	cost	estimate sheet, statement of delivery	supplier, date
TC028 MCO	TC028 MCO	MCO			Core Middle	Core Middle Section Temp #13	material	cost	estimate sheet, statement of delivery	supplier, date
PRI CO001 TC029 MCO	TC029 MCO	MCO			Core Middle	Core Middle Section Temp #14	material	cost	estimate sheet, statement of delivery	supplier, date
PRI CO001 TC030 MCO	TC030 MCO	MCO			Core Middle	Core Middle Section Temp #15	material	cost	estimate sheet, statement of delivery	supplier, date
PRI CO001 TC031 MC0	TC031 MCO	MCO			Core Bottom	Core Bottom Section Temp #1	material	cost	estimate sheet, statement of delivery	supplier, date
PRI CO001 TC032 MCO	TC032 MCO	MCO			Core Bottom	Core Bottom Section Temp #2	material	cost	estimate sheet, statement of delivery	supplier, date
PRI CO001 TC033 MCO	TC033 MCO	MCO			Core Bottom	Core Bottom Section Temp #3	material	cost	estimate sheet, statement of delivery	supplier, date
PRI CO001 TC034 MCO	TC034 MCO	MCO			Core Bottom	Core Bottom Section Temp #4	material	cost	estimate sheet, statement of delivery	supplier, date
CO001 TC035 MCO	TC035 MCO	MCO			Core Bottom	Core Bottom Section Temp #5	material	cost	estimate sheet, statement of delivery	supplier, date
PRI CO001 TC036 MCO	TC036 MCO	MCO			Core Bottom	Core Bottom Section Temp #6	material	cost	estimate sheet, statement of delivery	supplier, date
PRI CO001 TC037 MCO	TC037 MC0	MCO			Core Botton	Core Bottom Section Temp #7	material	cost	estimate sheet, statement of delivery	supplier, date
CO001 TC038 MCO	TC038 MCO	MCO			Core Botto	Core Bottom Section Temp #8	material	cost	estimate sheet, statement of delivery	supplier, date
PRI CO001 1C039 MCO	1C039 MCO	MCO			Core Bott	Core Bottom Section Temp #9	material	cost	estimate sheet, statement of delivery	supplier, date
PRI CO001 TC040 MCO	TC040 MCO	MCO			Core Bott	Core Bottom Section Temp #10	material	cost	estimate sheet, statement of delivery	supplier, date
		MICO			Core Bott	Core Bottom Section Temp #13	material	COSL	esumate sheet, statement of delivery	supplier, uate
PRI COODI TCORS MCO	TCD43 MCO	WCO			Core Boths	Core Bottom Section Temp #12 Core Bottom Section Temp #13	material	cost	estimate sheet, statement of delivery	supplier, date supplier, date
PRI CO001 TC044 MC0	CO001 TC044 MCO	MCO			Core Botto	Core Bottom Section Temp #14	material	cost	estimate sheet, statement of delivery	supplier, date
CO001 TC045 MCO	CO001 TC045 MCO	MCO			Core Botton	Core Bottom Section Temp #15	material	cost	estimate sheet, statement of delivery	supplier, date

	note		supplier, date	general feature	cumiliar data	part drawing	connecting part, date	supplier, date, info		supplier, date	part drawing	connecting part, date	supplier, date, irii o dea	general feature	part drawing	connecting part, date	supplier, date, info	supplier, date	supplier, date	supprier, uste	over foundation	supplier, date	general feature	part drawing	connecting part, date	onphiler, uate, itilio	supplier, date	general feature	part drawing	connecting part, date	מהקטוופו, עוגנכ, ווווט	supplier, date	general feature		supplier, date	general reature	connecung part, uate supplier, date, info		supplier, date	general feature	cumular data	part drawing	connecting part, date	supplier, date, info	•	supplier, date	general feature	natt drawing
	related Doc		estimate sheet, statement of delivery		actimate cheet statement of delivery	Drawing	related drawing	estimate sheet, statement of delivery		estimate sheet, statement of delivery	Drawing	related drawing	estimate sueet, statement of delivery		Drawing	related drawing	estimate sheet, statement of delivery		estimate sheet, statement of delivery		Drawing	related drawing	Annual street, statement of delivery	estimate sheet, statement of delivery		Drawing	related drawing	contribute orrect organistic or neilvery	estimate sheet, statement of delivery			estimate sheet, statement of delivery	and the description of	estimate sheet statement of delivery		estimate sheet, statement of delivery		actimate chart statement of delivers	Commerce street, statement of denivery	related drawing	estimate sheet, statement of delivery		estimate sheet, statement of delivery		Drawing			
	SUB De2		cost	information	cost	drawing	assemble	procurement		cost	drawing	assemble	bi ocurement	information	drawing	assemble	procurement	cost	COST	COSt		cost	information	drawing	assemble	hinculeitiette	cost	information	drawing	assemble	hi nomi ci li ci li	cost	information		cost	Information	brocurement		cost	information	toot	drawing	assemble	procurement		cost	information	drawing
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FULL DESCRIPTION	Description	-	Upper plenum material cost	Upper plenum general information	Upper prenum barrel Ilinner rilenum harrel material mot	Upper plenum barrel drawing	Upper plenum barrel assemble work	Upper plenum barrel procurement	Upper plenum Pipe	Upper plenum Pipe material cost	Upper plenum Pipe drawing	Upper plenum Pipe assemble Work	Upper prenum ripe procurement	Thermocouple assembly general information	Thermocouple assembly drawing	Thermocouple assembly assemble work		-	1	Upper Plenum bottom section Upstream Temp. #1	D/P meter(to R/V structure)	D/P meter	D/P meter general information	D/P meter drawing	D/P meter assemble work	D/P Interer procurement	Surface heater matreial cost	Surface heater general information	Surface heater drawing	Surface heater assemble Work Surface heater procurement	Builder indexe procurement. Heating system controller			Insulation	Insulation material cost	Insulation general information	Insulation procurement	Riser			Riser Pipe	Riser Pipe drawing	Riser Pipe assemble work	Riser Pipe procurement	Surface heater	Surface heater material cost	Surface heater general information	Curface heater drawing
	LEVEL 7 t Requirement		MCO	BIN	WCO	DRW	ASM	PRM		MCO	DRW	ASM	MIN	GIN	DRW	ASM	PRM	MCO	MCO	WCO		MCO	GIN	DRW	ASM	NIN	MCO	GIN	DRW	ASM	LINA	MCO	GIN		MCO	0IN	PRM		MCO	GIN	VUUN	DRW	ASM	PRM		MCO	GIN	DRW
	Component																									HEOOT	HE001	HE001	HEOOT	HEOOT	CN001	CN001	CN001												HE001	HEOOI	HE001	HEODI
	LEVEL 5 Structure			D A OOT	BADDI	BAOOL	BA001	BA001	PIOOI	TOOId	PICOL	TOOL	LC	TC	TC	TC	TC	TC001	TCOOD	TCOM	DPOOL	DPOOL	DP001	DPOOL	DPOOL	HSOOT	HSOOL	HS001	TOOSH	HSOOT	TOOSH	HSOOL	HS001	INOOI	TOONT	TOONT	TOONI				1001d	DIOOI	PIOOI	PIOOI	HSOOL	HSOOL	100SH	HCOON
	System	100 d N	100 d N	TOOP	TIDUUI	TOODAN	100 d N	100dU	LIOOAU	100 d N	100dD	TINNAN	IDUUT	100dD	TOOdN	100 d N	100 d n	TOOdn	Trondo	Tipout	TODAD	100 d N	100 d N	TOOD	TOODI	100dn	TOOdO	ST001	ST001	STOOL	TODIC	100 d N	TOOdn	100dD	TIDON	TIONAN	TODAD	RIOOL	RIOOI	RIOOI	RIDOI	RIDOI	RIOOI	RIOOI	RIOOI	RIOOL	RIOOI	RIOOT
	LEVEL 3 Island	PRI	PRI	PRI	DRT	PRI	PRI	PRI	PRI	PRI	PRI	PKI	DRI	PRI	PRI	PRI	PRI	PRI	PKI	DDI	PRI	PRI	PRI	PRI	PRI	PRI	PRI	PRI	PRI	PKI	PRI	PRI	PRI	PRI	DH4	IN/	PRI	PRI	PRI	PRI	PKI	per	PRI	PRI	PRI	PRI	PRI	DRT
	LEVEL 2 Stage	PRO	PRO	PRO	DRO	PRO	PRX	PRX	PRO	PRO	PRO	PKX	DRO	PRO	PRO	PRX	PRX	PRO	PRO	Dan	PRO	PRO	PRO	PRO	PRX	PRO	PRO	PRO	PRO	PKX	PRO	PRO	PRO	PRO	DRO	PKO	PRX	PRO	PRO	PRO	PRO	PRO	PRX	PRX	PRO	PRO	PRO	Cod
	Product	MOC	MOC	MOC	MOC	MOC	MOC	MOC	MOC	MOC	MOC	NUC	MOC	MOC	MOC	MOC	MOC	MOC	MUC	NOC	MOC	MOC	MOC	MOC	MOC	MOC	MOC	MOC	MOC	MOC	MOC	MOC	MOC	MOC	MOC	MUC	MOC	MOC	MOC	MOC	MOC	MOC	MOC	MOC	MOC	MOC	MOC	MOC

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FULL DESCRIPTION	Description	R/V 3rd Section Temp #6	R/V 3rd Section Temp #7	N/V srd section Temp #8	R/V 3rd Section Temp #3	R/V 3rd Section Temp #11	R/V 3rd Section Temp #12	R/V 3rd Section Temp #13 R/V 3rd Section Temp #14	R/V 3rd Section Temp #15	R/V 3rd Section Temp #16	R/V 3rd Section Temp #17	R/V 3rd Section Temp #18	R/V 3rd Section Temp #19	D A/ 3rd Section Temp #21	R/V 3rd Section Temp #22	R/V 3rd Section Temp #23	R/V 3rd Section Temp #24	R/V 4th Section Temp #1	R/V 4th Section Temp #2	R/V 4th Section Temp #3 R/V 2th Section Temp #4	R/V 4th Section Temp #5	R/V 4th Section Temp #6	R/V 4th Section Temp #7	R/V 4th Section Temp #8	R/V 4th Section Temp #9 R/V 4th Section Temp #10	R/V 4th Section Temp #11	R/V 4th Section Temp #12	R/V 4th Section Temp #13	R/V 4th Section Temp #14 B A/ Ath Section Temp #15	R/V 4th Section Temp #16	R/V 4th Section Temp #17	R/V 4th Section Temp #18	R/V 4th Section Temp #19 R/V 4th Section Temp #20	R/V 4th Section Temp #21	R/V 4th Section Temp #22	R/V 4th Section Temp #23	R/V 4th Section Temp #24	R/V 5th Section Temp #1	K/V 5th Section Temp #2	R/V 5th section Temp #3 R/V 5th Section Temp #4	R/V 5th Section Temp #5	R/V 5th Section Temp #6	R/V 5th Section Temp #7	R/V 5th Section Temp #8	D A/ 5th Cartion Tomo #0
	LEVEL 7 Requirement	MCO	MCO	MICO	MCO	MCO	MCO	MCO	MCO	MCO	MCO	MCO	MCO	WCO	MCO	MCO	MCO	MCO	MCO	MCO	MCO	MCO	MCO	MCO	MCO	MCO	MCO	MCO	MCO	MCO	MCO	MCO	MCO	MCO	MCO	MCO	MCO	MCO	MICO	MCO	MCO	MCO	MCO	MCO	MCO
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	LEVEL 4 System	RSOOL	RSOOL	TODSA	LOOCA RSOOL	RSOOL	RSOOL	RSOOL	RSOOL	RSOOL	RSOOL	RS001	RSOOL	DCUUI	RSOOL	RS001	RSOOL	RSOOL	RSOOL	RS001	RSOOL	RSOOL	RSOOL	RS001	RSOOL	RSOOL	RSOOL	RSOOL	RSOOL	LOO2A	RSOOL	RSOOL	RSOOL	RSOOL	RSOOL	RSOOL	RSOOL	RSOOL	TODSA	RSOOL	LOOSA	RSOOL	RSOOL	RSOOL	RSOOT
	LEVEL 3 Island	PRI	PRI	PKI	PRI	PRI	PRI	PRI	PRI	PRI	PRI	PRI	PRI	DOT	PRI	PRI	PRI	PRI	PKI	PRI	PRI	PRI	PRI	PRI	PRI	PRI	PRI	PRI	PKI	PRI	PRI	PRI	PRI	PRI	PRI	PRI	PRI	PRI 100	INI	PRI	PRI	PRI	PRI	PRI	pri
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EULL DESCRIPTION	Description	R/V 5th Section Temp #12	R/V 5th Section Temp #13	R/V 5th Section Temp #14	R/V 5th Section Temp #15	N/V 5th Section Temp #17	N/V JUI SECUOI TEIN #10	R/V 5th Section Temp #19	R/V 5th Section Temp #20	R/V 5th Section Temp #21	R/V 5th Section Temp #22	R/V 5th Section Temp #23	R/V 5th Section Temp #24 Transference	Insulation material cost	Insulation general information	Insulation assemble work	Insulation procurement	LBE coolant matarial cost	LBE coolant general information	PILLAR secondary	PILLAR secondary conceptual design	PILLAR secondary specific design	PILLAR secondary thermal-hydraulic analysis	PILLAR secondary operation manual	PILLAR secondary planning process flow	PILLAR secondary work process now PILLAR secondary planning process flow	PILLAR secondary work process flow	PILLAR construction secondary planning process flow	PILLAR construction secondary work process flow	PILLAR secondary planning process flow	PILLAR secondary work process flow	PILLAR secondary quanty assurance	PILLAR secondary quality assurance	PILLAR secondary quality assurance	PILLAR secondary assemble feasibility	PILLAR secondary integity test	PILLAR secondary cost sum	PILLAR secondary material cost	PILLAR secondary manpower cost	PILLAR decommissioning termination	Dil 1 AB secondary decommissioning planming	Cooling system	Cooling system material cost	Cooling system general information	Cooling system Pipe	Cooling system Pipe Cooling system Pipe material cost
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	PILLAR(Pool-type Intergral test facility for Lead Alloy cooled small modular Reactor) Integrated Work Breakdown Structure		The second secon		FULL DESCRIPTION				
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	TC		+	DRW	Thermocouple assembly drawing		drawing	Drawing	part drawing
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					PILLAR I&C				
			1		PILLAR I&C conceptual design	conceptual	design	Desigh requirement report	Design result
				SDE	PILLAR I&C detailed design	detailed	design	Desigh report	Design result
					PILLAR 1&C operation manual	operation	manual	manual handbook	define operation procedure
					PILLAR I&C planning process flow	planning	process flow	flow chart	define flow chart
					PILLAR I&C work process flow	work	process flow	flow chart	define flow chart
					PILLAR I&C planning process flow	planning	process flow	flow chart	define flow chart
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				PFW	PILLAR I&C planning process flow	planning	process flow	flow chart	define flow chart
					PILLAR I&C work process flow	work	process flow	flow chart	define flow chart
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			1.12		PILLAR I&C work process flow	work	process flow	flow chart	define flow chart
					PILLAR I&C quality assurance		QA	QA Document	QA result
			1	AFE	PILLAR I&C assemble feasibility	assemble	feasibility	feasibility analysis result	feasibility analysis
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					PILLAR I&C sum cost	uns	cost	estimate sheet, statement of delivery	supplier, date
				MCO	PILLAR I&C material cost	material	cost	estimate sheet, statement of delivery	supplier, date
					PILLAR I&C manpower cost	manpower	COST	estimate sheet, statement of delivery	supplier, date

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FULL DESCRIPTION	Description	PILLAR I&C DAC (Data Acquisition & Control) system	PILLAR I&C DAC system material cost	PILLAR LOCUTAC System general miormation Dill AR T&C DAC system producement	PILLAR I&C DAC PC	PILLAR 1&C DAC PC material cost	PILLAR I&C DAC PC general information	PILLAR I&C DAC PC procurement	PILLAR I&C power control system PILLAR I&C nower control system material cost	Pill AR 18/C nower control system general information	PILLAR I&C power control system drawing	PILLAR I&C power control system assemble work	PILLAR I&C power control system procurement	PILLAR I&C decommissioning termination	PILLAR I&C decommissioning planning	PILLAR I&C decommissioning dismantling Hartrical nonvar systems	Electrical power systems conceptual design	Electrical power systems detailed design	Electrical power systems planning process flow	Electrical power systems work process flow	Electrical power systems planning process flow	Electrical power systems work process flow	Electrical power systems quality assurance Electrical power overame secondulo fascibility.	Electrical power systems material cost	Electrical power systems general information	Electrical power systems drawing	Electrical power systems assemble work	decirical power systems procurement. Hechrical nower systems cost sum	Electrical power systems material cost	Electrical power systems manpower cost	High voltage vaccum circuit breaker	No.1 High voltage air circuit breaker No.2 High voltage air circuit breaker	No.3 High voltage air circuit breaker	380V 3 phase transformer material cost	220V 3 phase transformer material cost	110V 1 phase transformer material cost	460V 3 phase transformer material cost	etra material material cost	PILLAR supporting structure	PILLAR supporting structure conceptual design	PILLAR supporting structure specific design	PILLAR supporting structure structural analysis report	Fitters supporting structure pranning process now Dill AR supporting structure work process flow	PILLAR supporting structure planning process flow	PILLAR supporting structure work process flow	PILLAR supporting structure quality assurance	PILLAR supporting structure assemble feasibility	Filler supporting structure sum cost	PILLAR supporting structure material cost	PILLAR supporting structure manpower cost	PILLAR supporting structure general information	PILLAR supporting structure arawing PILLAR supporting structure assemble work	PILLAR supporting structure procurement	HELIOS dismantling work manpower cost	PILLAR supporting structure decommissioning termination	functional and a second descent and a second descen
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국문 초록

2011년 후쿠시마 원자력발전소 사고 이후로 원자력발전에 대한 부정적인 인식이 증가함에 따라 혁신적인 안전성과 보안성을 갖추기 위한 차세대 원자로 개발의 중요성이 강조되고 있다. Gen-IV 원자로 시스템 중 납 냉각 고속로는 납 냉각재의 안전한 특징 때문에 많은 개발자들의 주목을 끌고 있다. 납 냉각재는 화학적 안정성을 가지고 있어 공기 및 물과 반응하지 않고 높은 끓는점을 가지고 있다. 더욱이 러시아에서 알파급 핵추진 잠수함에 납 냉각 원자로를 채택하여 사용한 인상적인 경험뿐만 아니라 납 냉각 고속로의 안전성에 대한 주요 지식을 공표했다. 이러한 경험들은 납 냉각 고속로의 상용화에 있어 원칙적인 기반 중 하나로 생각된다. 소형 모듈형 타입의 납 냉각 고속로는 Gen-IV 연구 시스템 가운데 분산형 전원시스템에서 부하추중 운전에 적합한 형태 중 하나이다. 더욱이 납 냉각 고속로들은 저탄소 선박 추진 동력원으로 사용시 높은 고유 안전성과 장주기 운전가능 특성으로 높은 기동성을 증명할 수 있다.

하지만 연구개발팀이 안전한 소형 모듈형 원자로를 개발하고 상업화 생산을 실시하기 위한 프로젝트롤 계획할 때 작업분류체계는 체계적이고 효율적인 접근을 위한 수단으로 사용될 수 있다. 작업분류체계의 주요 기능들은 프로젝트의 범위를 정하고 일정조정, 예산관리를 하는 것이다. 하지만 원자력발전소를 위한 참조되는 표준 작업분류체계는 아직 제시되지 못하고 있다.

이에 따라, 원자력발전소를 위한 작업분류체계 개발을 위해서 기존에 연구된 작업분류체계에 대해서 조사 및 분석을 진행하였다. 생산물 기반의 작업분류체계 시스템을 기반으로 한국의 원자력발전소 작업분류체계 및 외국의 사례를 조사하였다. 이러한 결과를 기반으로 소형 모듈형 원자로 프로젝트에 맞는 업무분류체계를 구성하기 위한 연구를 진행하였다. 그 결과 이러한 연구에서 제시된 핵심적인 부분을 확인하고 적용이 가능한 부분을 식별하여 통합 작업분류체계를 구성하였다. 또한, 작업분류체계의 코딩방식을 정의하여 각 업무들이 정리될 수 있도록 하였다.

본 연구에서 제시된 소형 모듈형 원자로 통합 작업분류체계의 실효성을 확인하기 위해 핵변환에너지연구센터에서 설계한 LBE (Lead-Bismuth Eutectic)를 냉각재로 사용하는 개념 원자로인

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100MWt 출력의 URANUS (Ubiquitous, Rugged, Accident-forgiving, Non-proliferating, and Ultra-lasting Sustainer)를 선정하였다. 또한, 이 원자로의 납-비스무스 공융물 자연순환 축소실험시설을 제작하는 프로젝트에 적용하여 본 논문을 통해 연구된 통합작업분류체계의 실효성을 확인하였다.

이 연구를 통해서 현재 수행되고 있는 작업분류체계관련 내용을 분석하고 소형 모듈형 원자로에 적용할 수 있는 표준적인 통합 작업분류체계를 제안함에 따라 이 노형을 상용화하기 위한 프로젝트를 진행할 때 통일된 방향을 제시하는 역할을 수행할 수 있을 것으로 기대된다.

키워드: Work Breakdown Structure, LFR, SMR, LBE, URANUS, Mockup facility

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