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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.

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

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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 erosion−corrosion, 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 reactor−years [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.

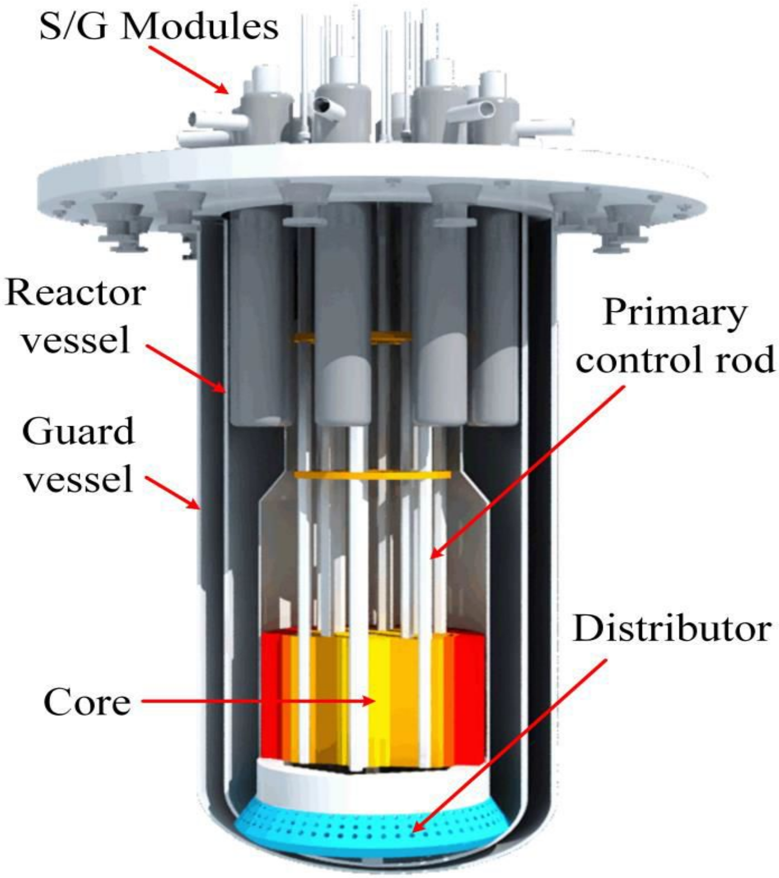


Figure 1.2 Bird view of URANUS [5].

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 product-oriented 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.

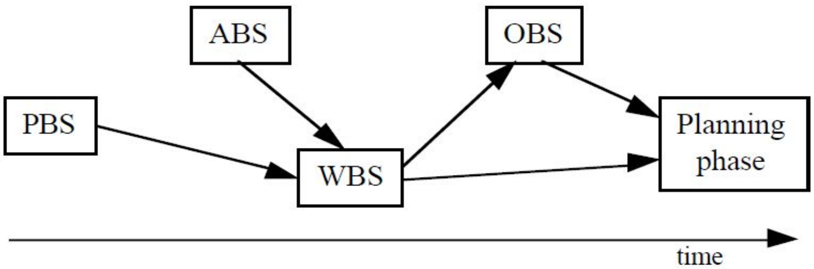


Figure 1.3 Relationship of PBS and CBS [7, 8].

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.

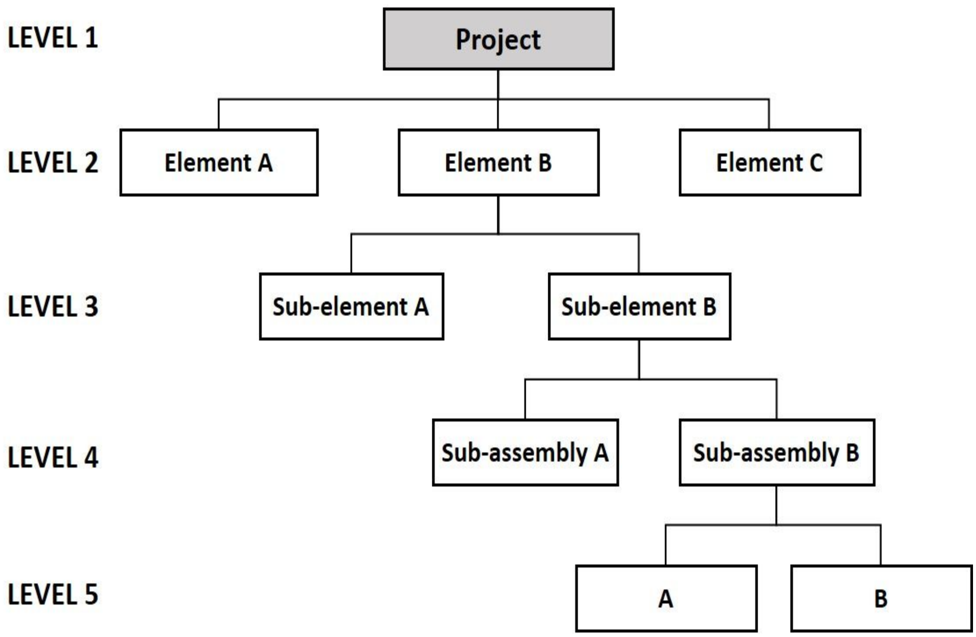


Figure 1.4 Hierarchical structure of WBS.

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.

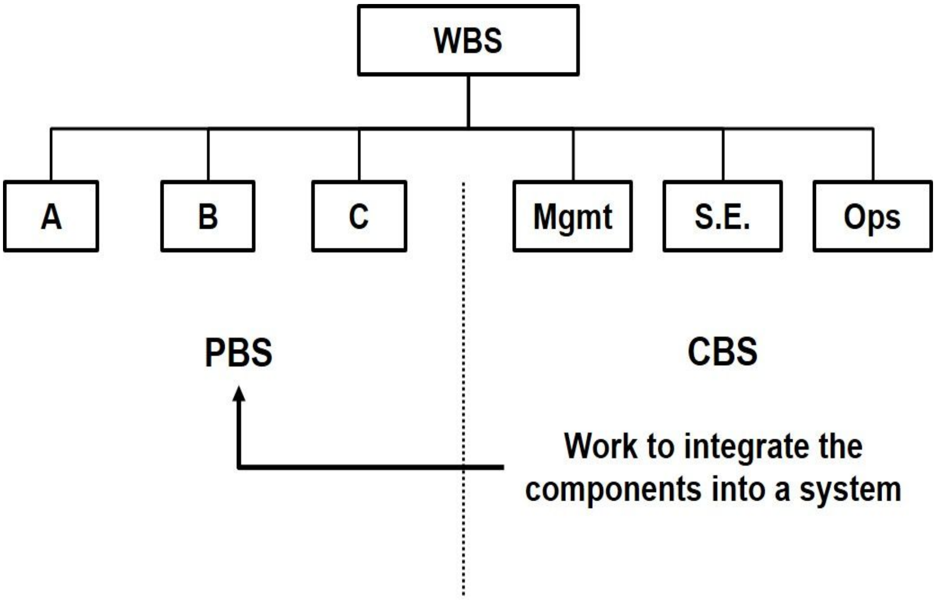


Figure 1.5 Relationship of PBS and CBS [8].

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 non-construction 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].

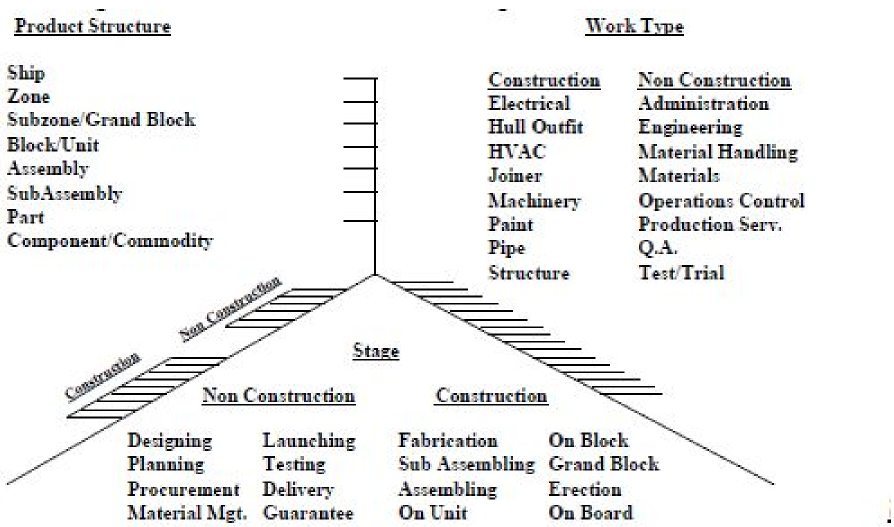


Figure 2.1 GPWBS system [10].

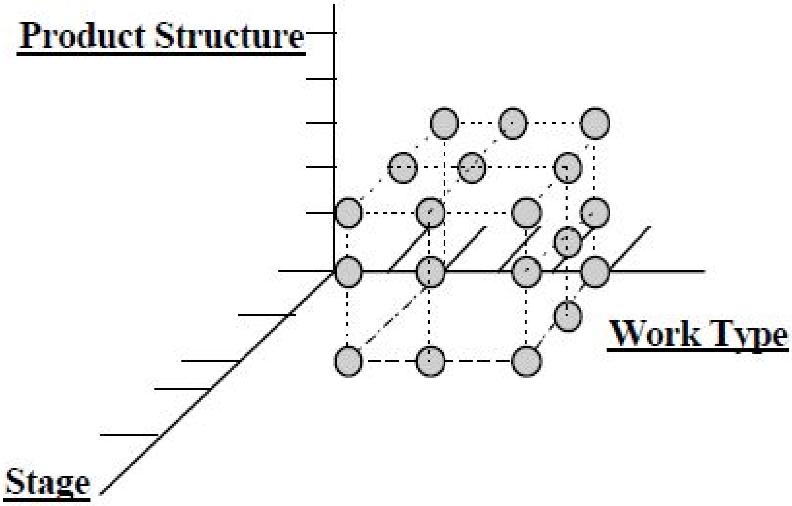


Figure 2.2 Interim products with multiple stage and work types [10].

2.2. Generic-Yacht WBS (Generic-YWBS)

The Generic-YWBS is developed for assisting sailing yachts construction and arranging contents about product and process-oriented 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].

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

<table>
<tr><th>Code</th><th>Digit</th><th colspan="2">Description</th></tr>
<tr><td>Group number</td><td>1</td><td colspan="2">Represent the group number of target item</td></tr>
<tr><td rowspan="4">Ship type</td><td rowspan="4">1</td><td colspan="2">Represent the type of target ship</td></tr>
<tr><td>C</td><td>Common vessel</td></tr>
<tr><td>S</td><td>Sailing yacht</td></tr>
<tr><td>P</td><td>Power yacht</td></tr>
<tr><td>Level 1 Item</td><td>3</td><td colspan="2">• Three-letter code
• Represent the category(Lv.1) of target item</td></tr>
<tr><td>Level 2 Item</td><td>3</td><td colspan="2">• Three-letter code
• Represent the category(Lv.2) of target item</td></tr>
<tr><td>Level 3 Item</td><td>3</td><td colspan="2">• Three-letter code
• Represent the category(Lv.3) of target item</td></tr>
<tr><td>Serial number</td><td>6</td><td colspan="2">• Six-digit number code</td></tr>
</table>

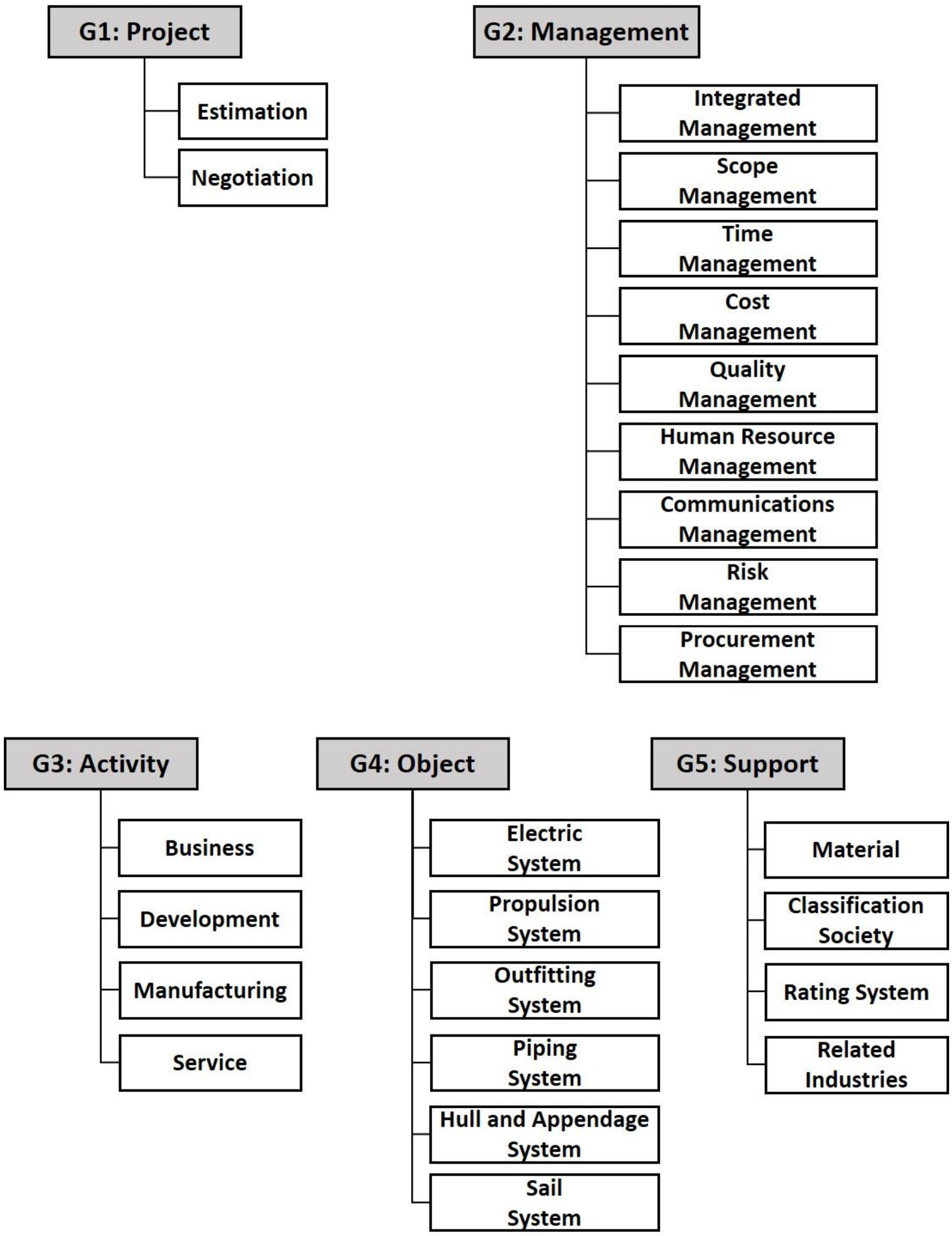


Figure 2.3 WBS elements of Generic−YWBS [11].

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.

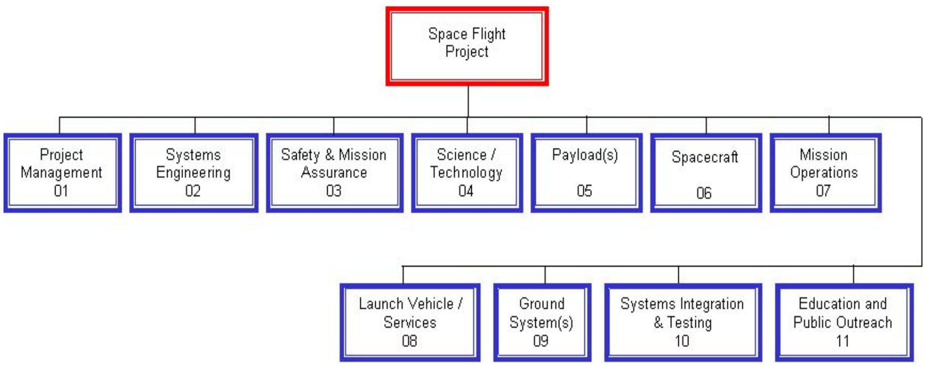


Figure 2.4 NASA standard WBS template [6].

WBS Dictionary

WBS Element Title: Develop Prototype Code	**WBS Element No:** 123456.08.05.09.01.03
Parent WBS No: 123456.08.05.09.01 **Parent WBS Title:** Develop Prototype	**WBS Level:** 6 **Scope Def. Ref:** 02.01.01
Project: Project XYZ Software Development	**Originator:** Samuel L. Kates

WBS Element Description:

The scope of this element includes the development of all necessary software code required to satisfy the functional requirements established for prototype software. This 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.

Technical Specification Document:

SPEC-SW-AA000765-1

SPEC-SW-AB000767-2

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

WBS Index: See pages 16-18

Revision No: 01c **Revision Date:** 11/30/2009	**Page** 15 **of** 31 **WBS Element No:** 123456.08.05.09.01.03

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].

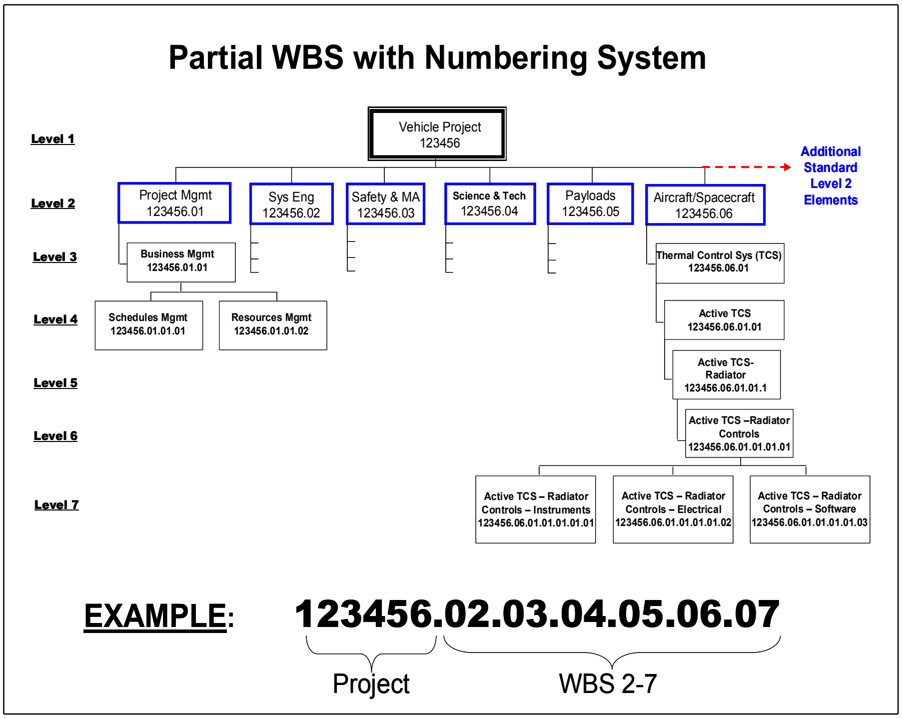


Figure 2.6 Partial WBS with numbering system [6].

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].

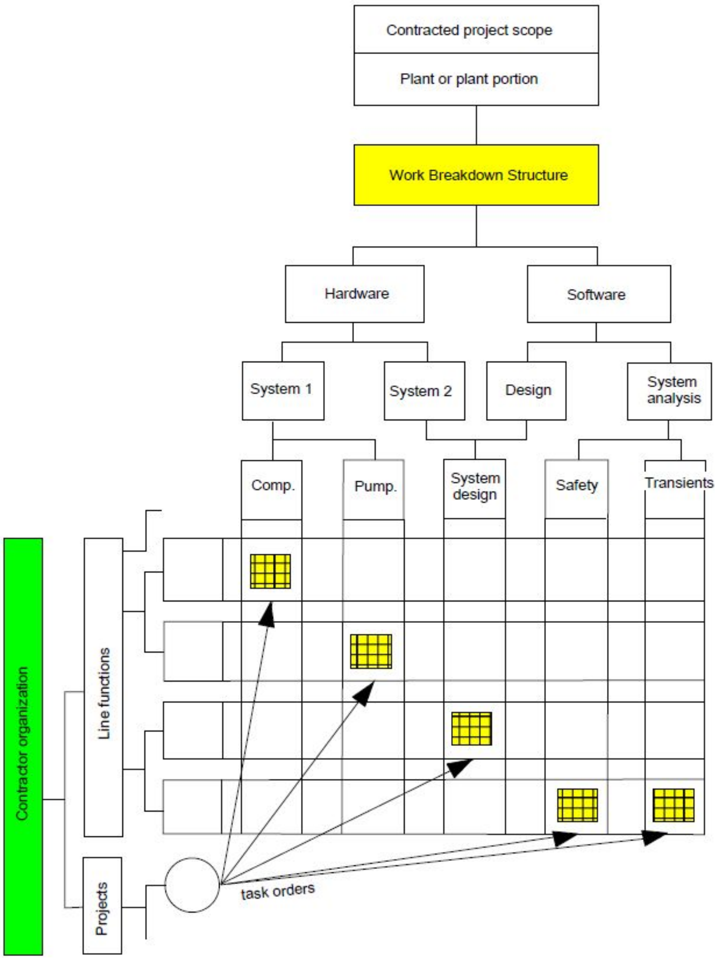


Figure 2.7 Responsibility assignment matrix [13].

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.

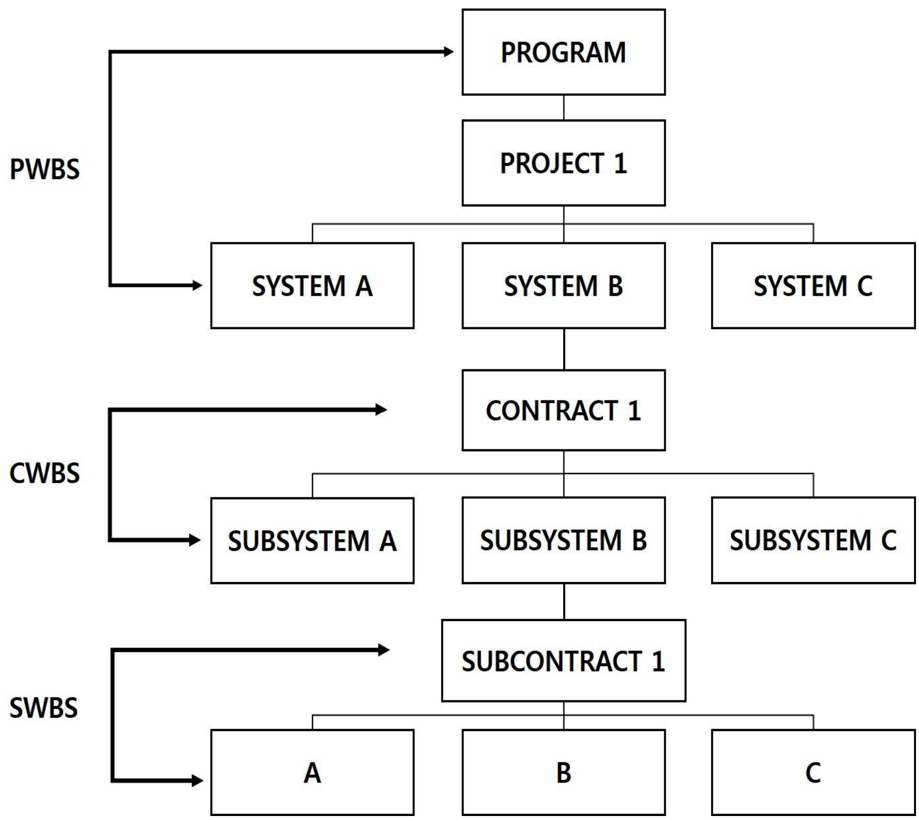


Figure 2.8 Relationship of PWBS/CWBS/SWBS.

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].

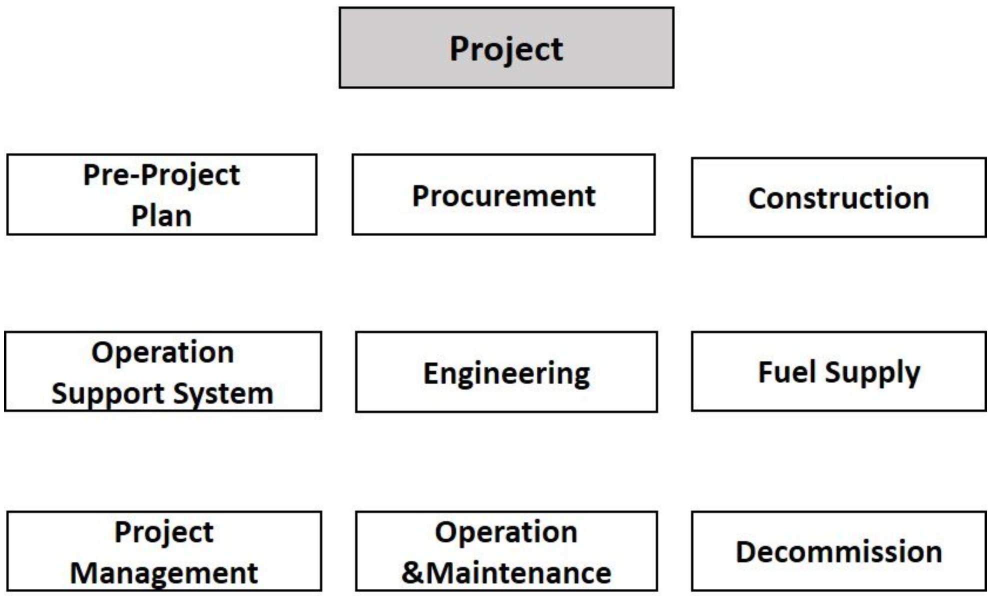


Figure 2.9 Main WBS elements of developing [15].

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.

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

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		9 Cooling tower	
	10 Fuel rail			

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

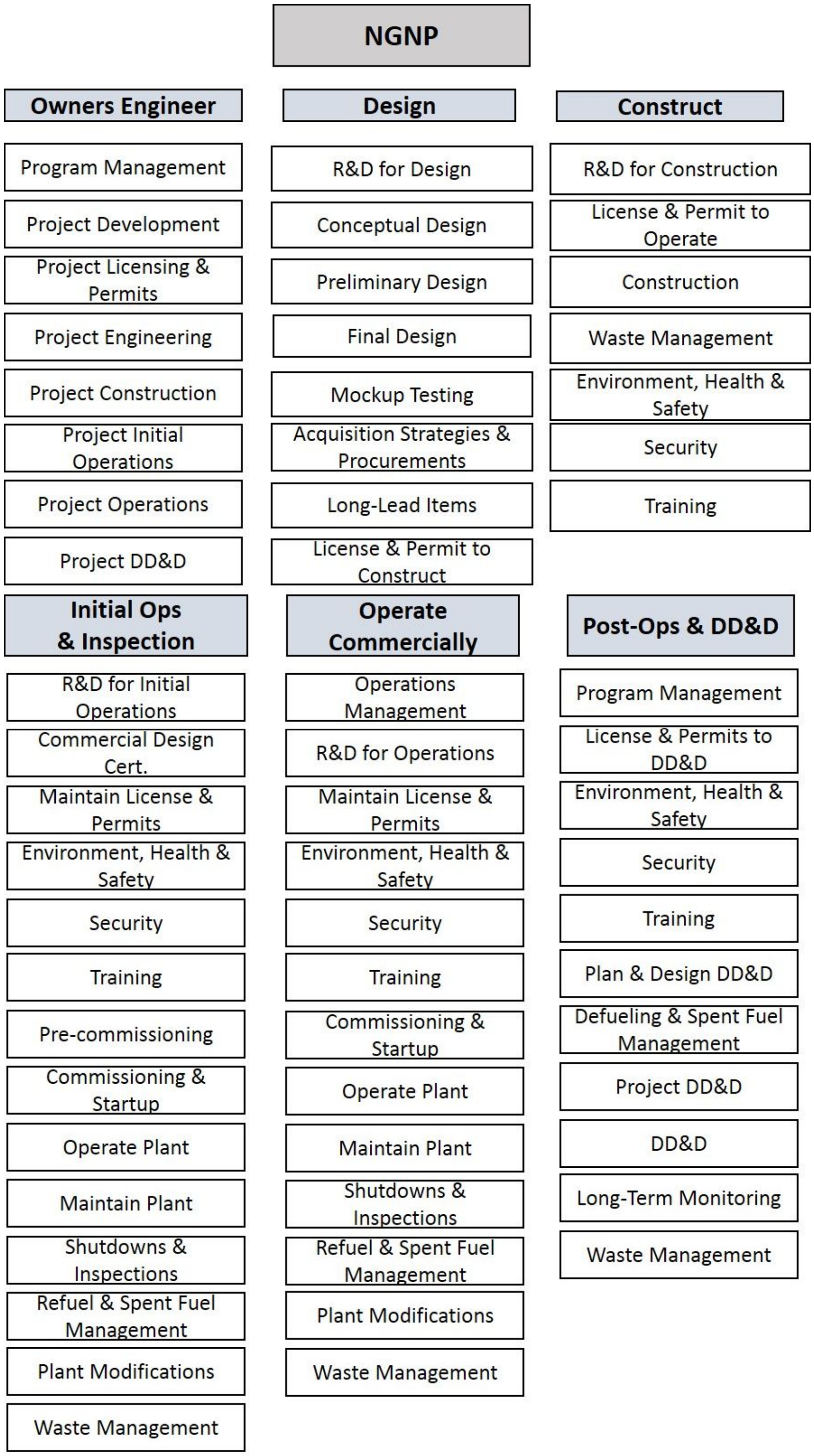


Figure 2.10 NGNP WBS [17].

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 manager can manage through overall life cycle of SMR 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

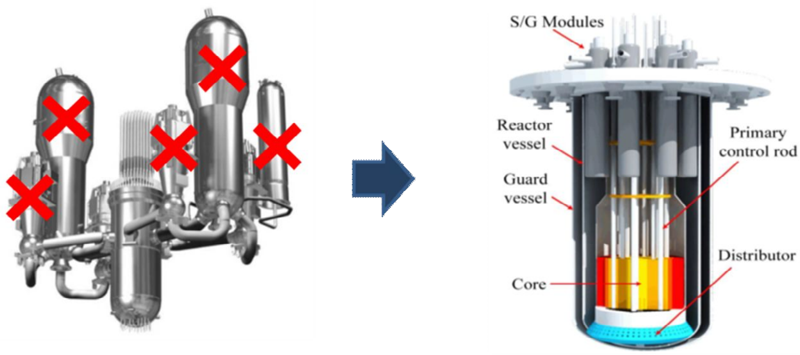
2) **Unique modular design:** Module concept design based on functional sorting (not by discipline)

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.



Characteristics of SMR design

- 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.

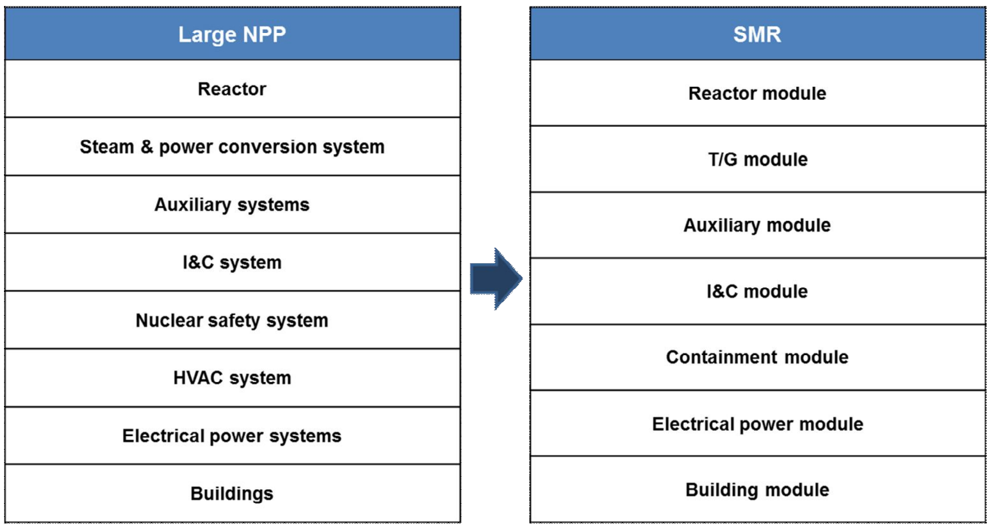


Figure 3.2 Modular feature of SMR.

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. Well-defined 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.

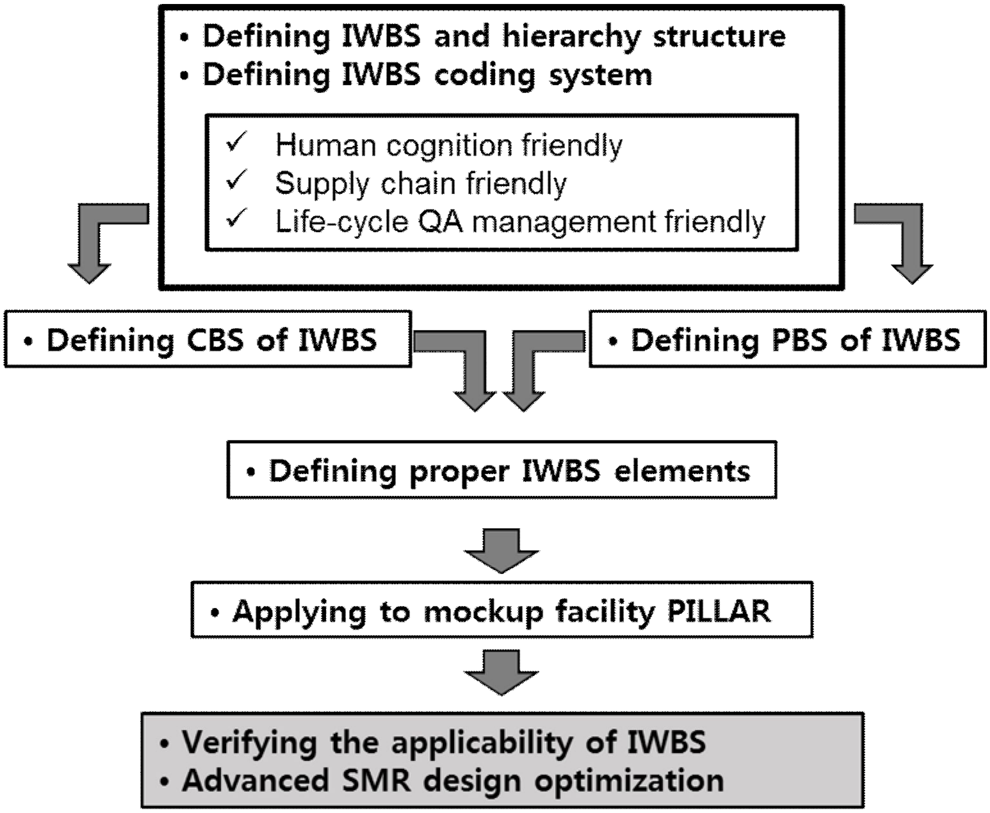


Figure 3.3 Diagram for IWBS defining study.

Chapter 4. Integrated Work Breakdown Structure 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.

Table 4.1 Key design parameters of URANUS [5].

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 internal structure	758 (ton)

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.

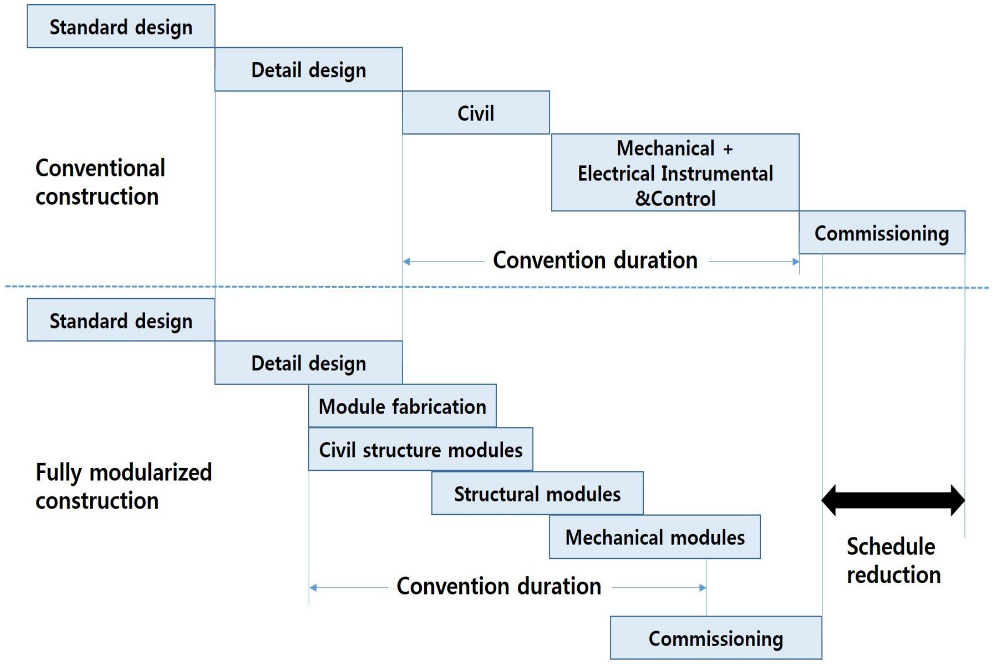


Figure 4.1 Gains in modularized construction plan [20].

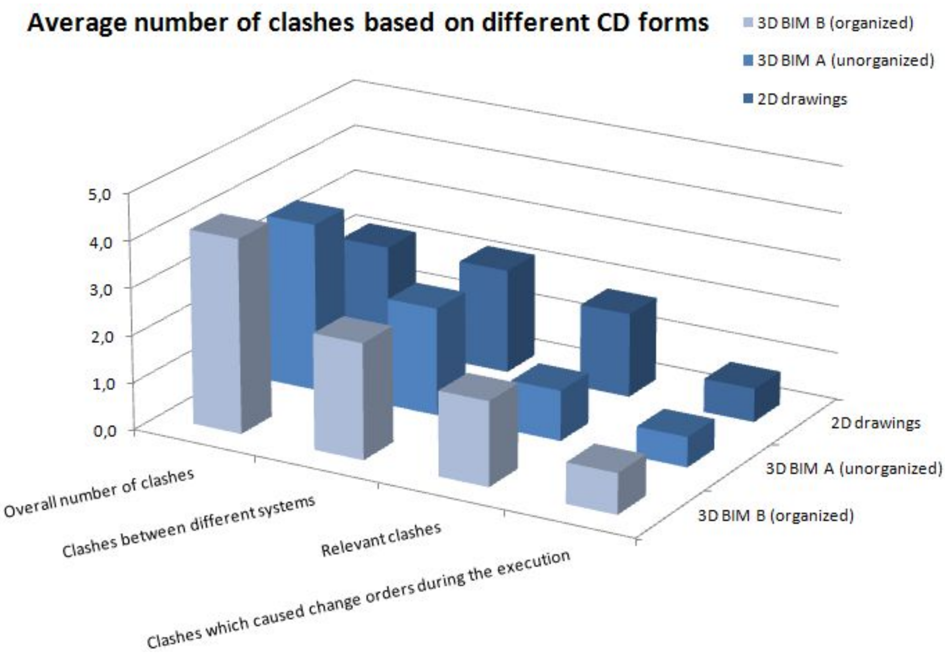


Figure 4.2 Average number of clashes based on different Clash detection forms [21].

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.

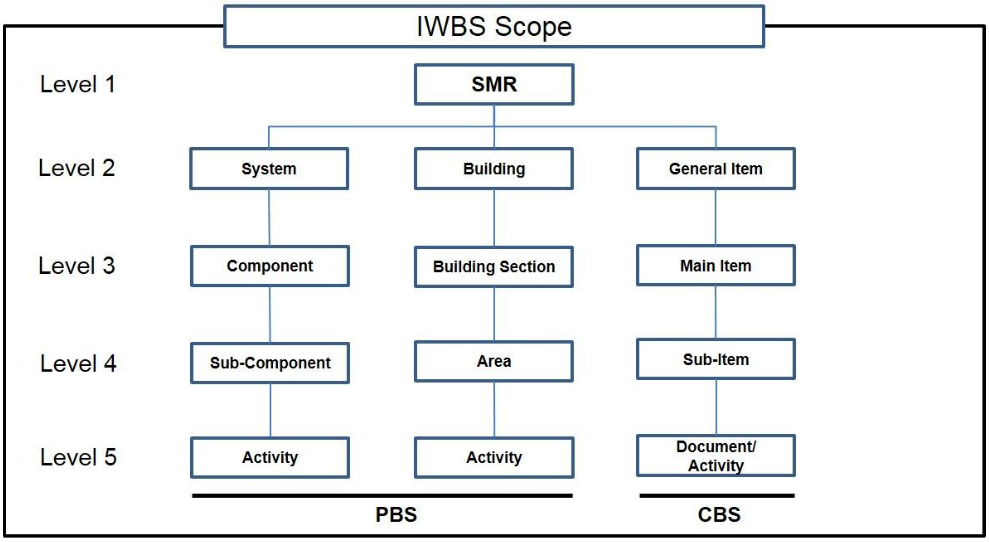


Figure 4.3 IWBS scope.

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.

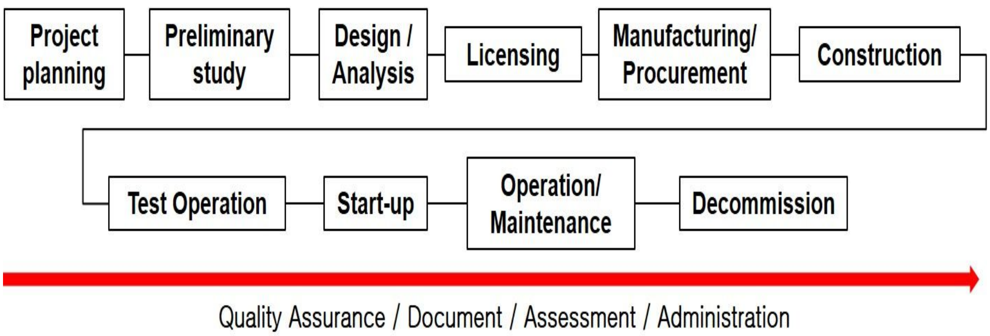


Figure 4.4 SMR project process flow.

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.

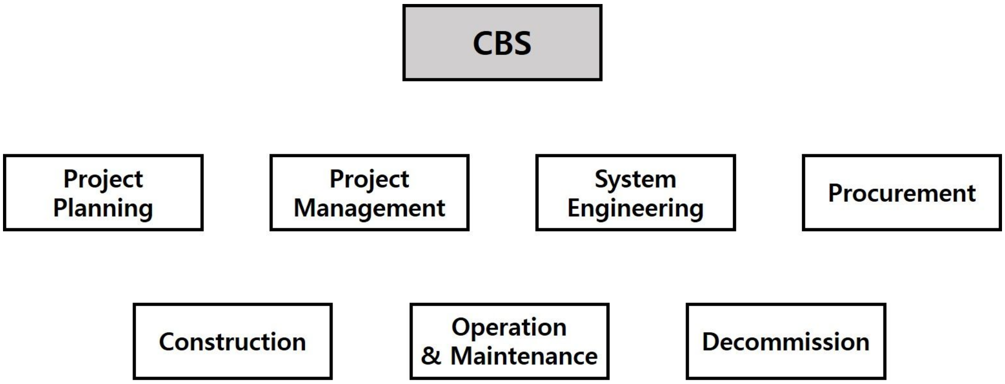


Figure 4.5 Level two categories of CBS.

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.

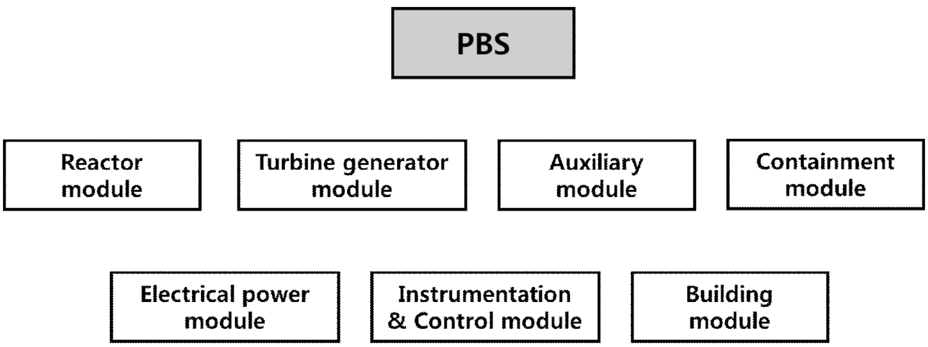


Figure 4.6 Level two categories of PBS.

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.

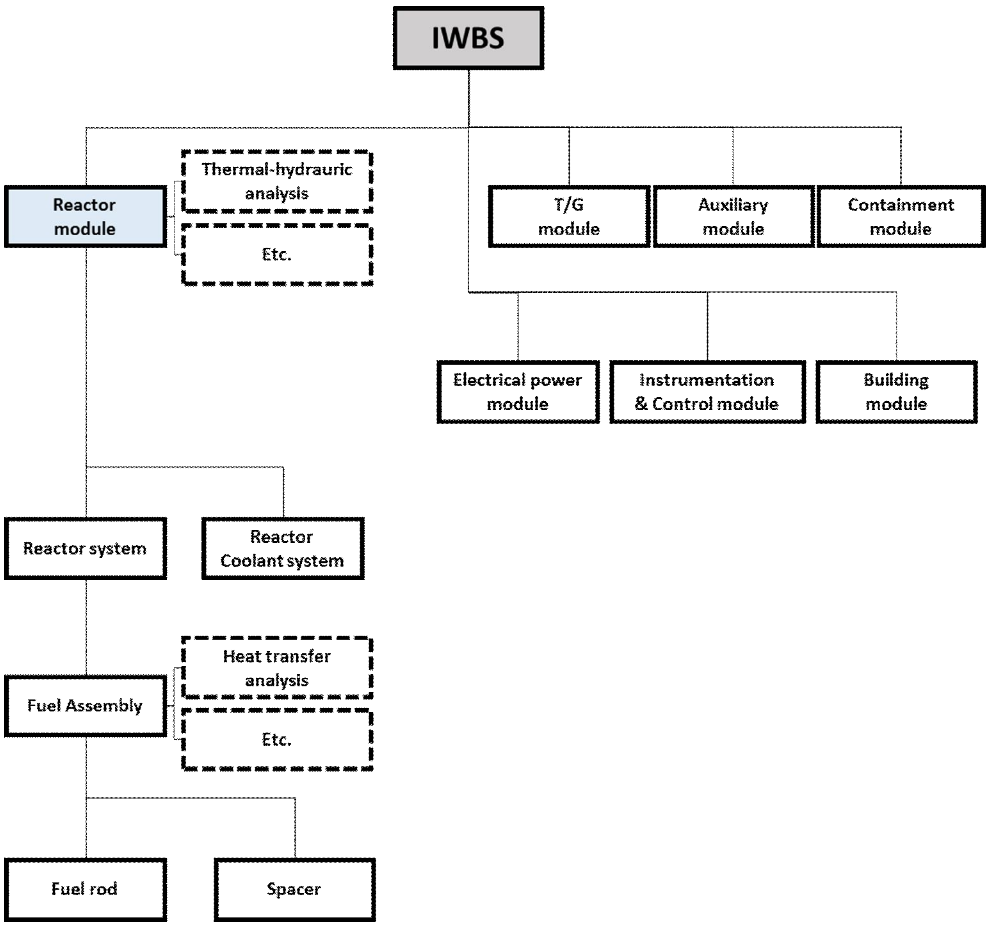


Figure 4.7 Concept of IWBS hierarchy structure.

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.

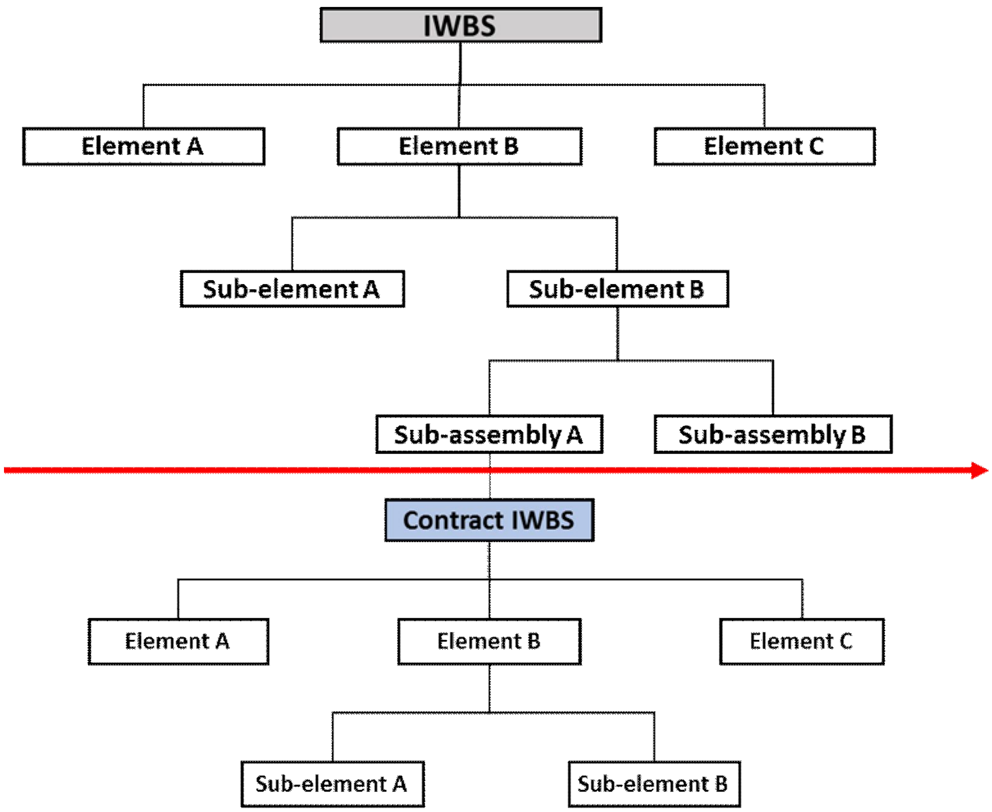


Figure 4.8 Concept of IWBS and contract IWBS relationship.

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.

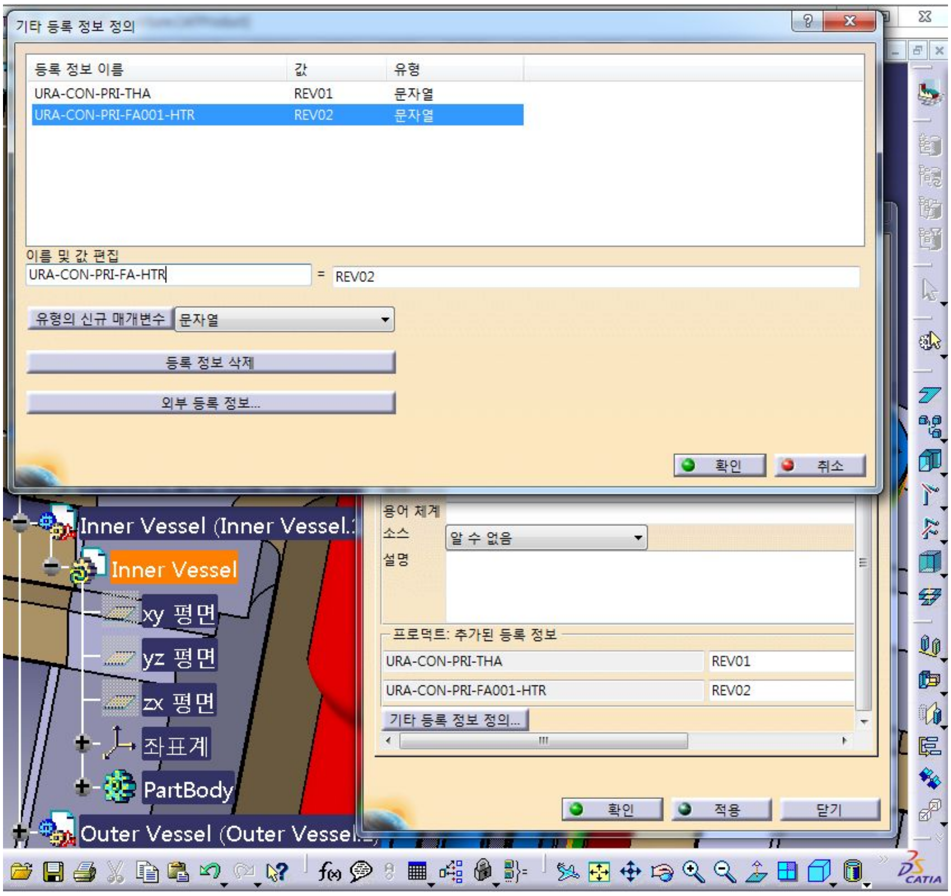


Figure 4.9 Concept of IWBS and 3D model coupling.

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.

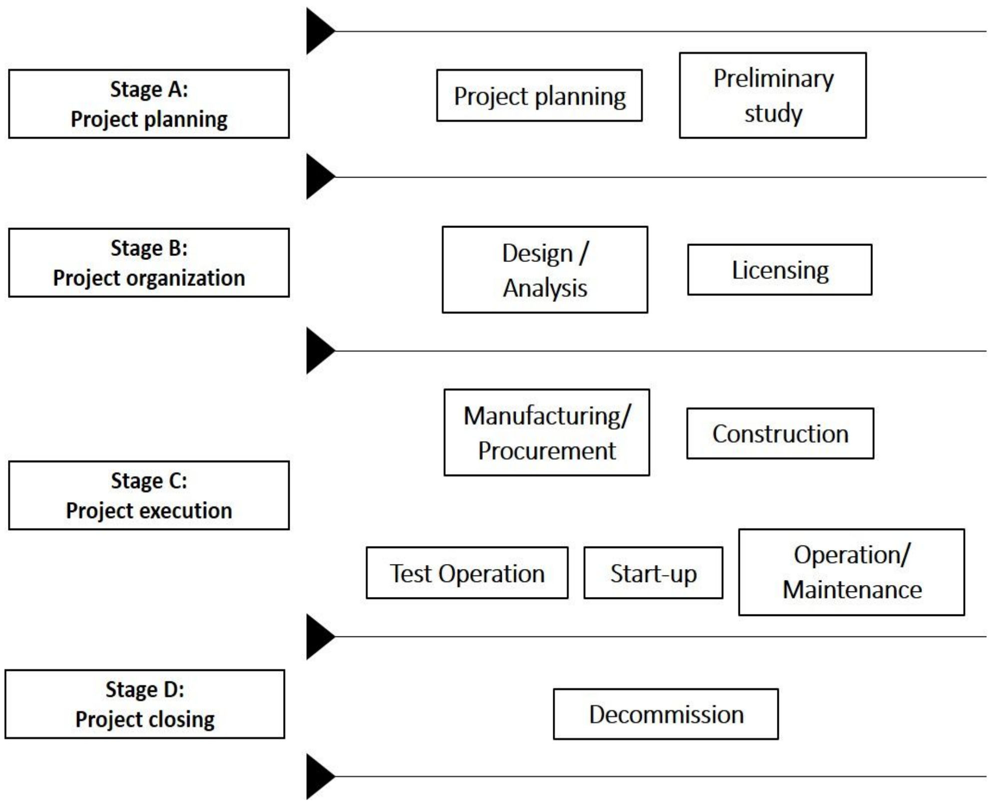


Figure 4.10 Four stages of SMR project.

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. Sub-elements 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.

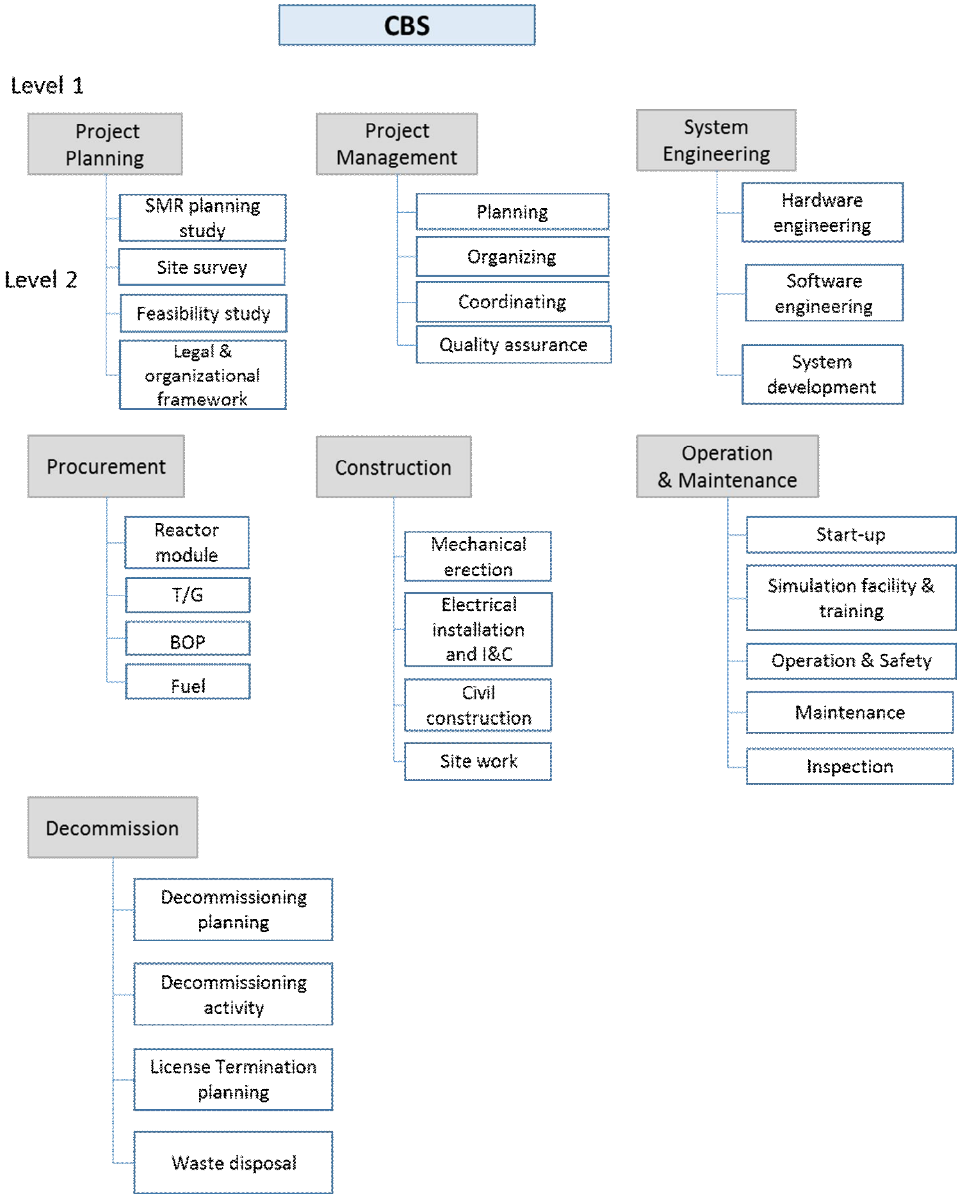


Figure 4.11 CBS of SMR.

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.

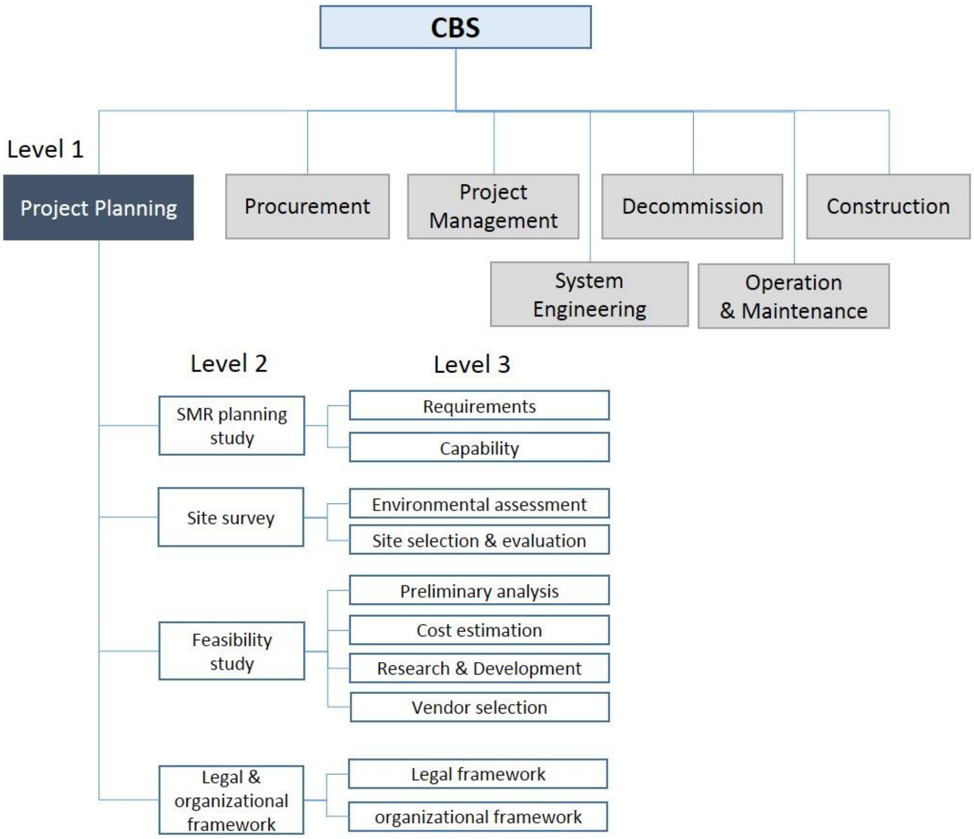


Figure 4.12 CBS of project planning for SMR.

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.

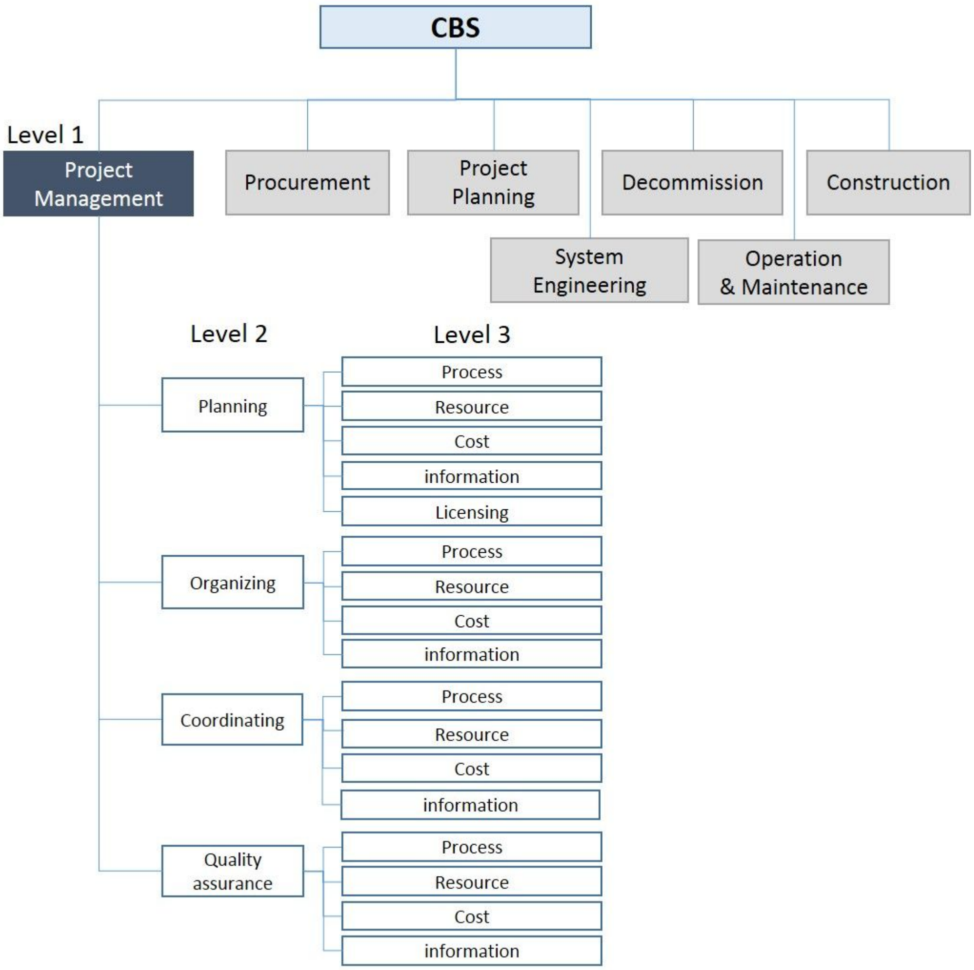


Figure 4.13 CBS of project management for SMR.

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.

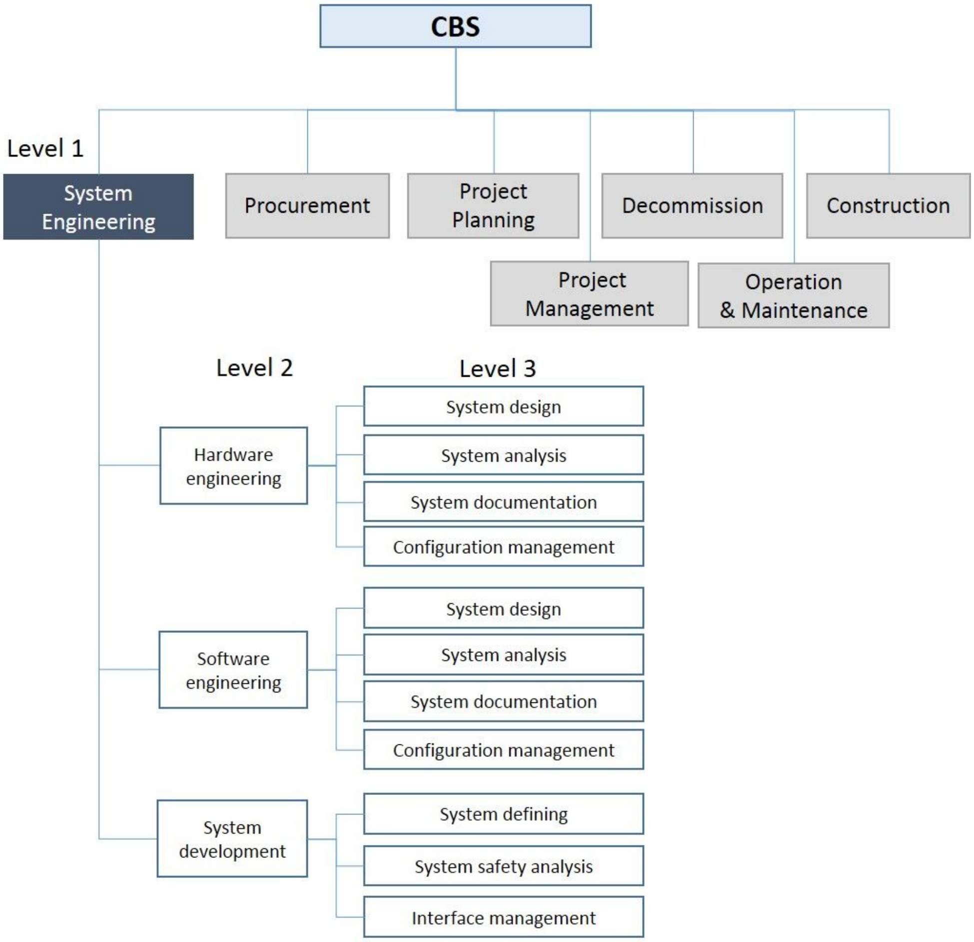


Figure 4.14 CBS of system engineering for SMR.

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.

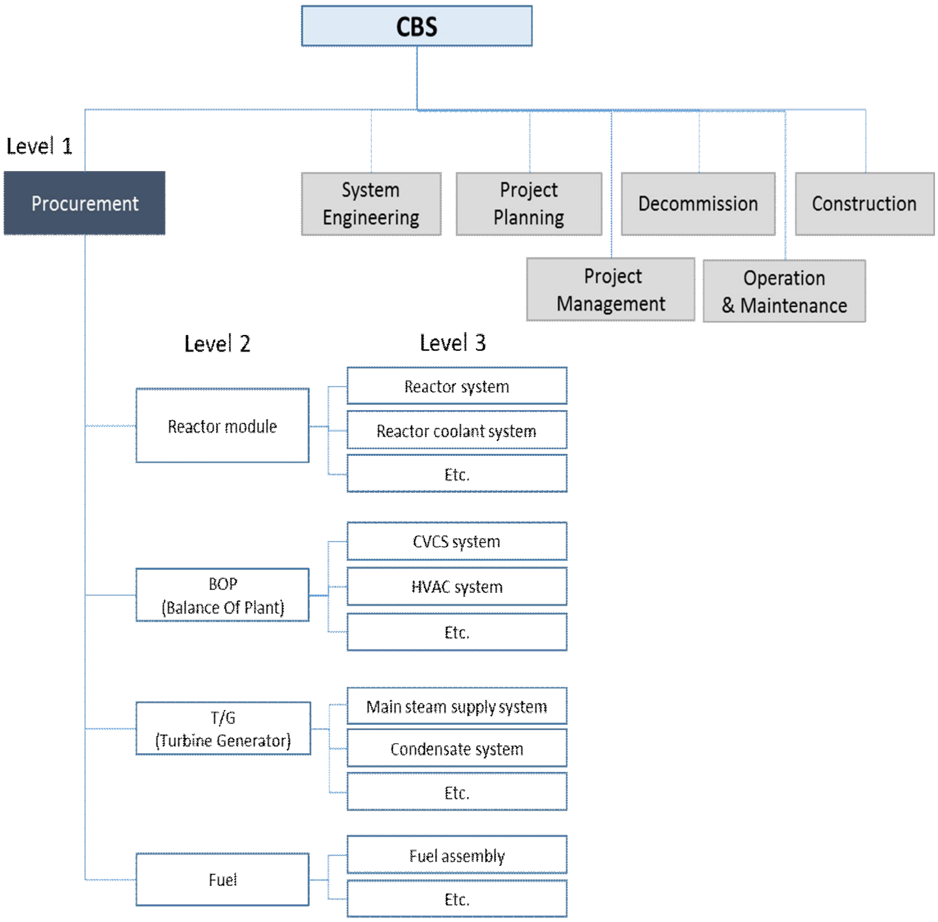


Figure 4.15 CBS of procurement for SMR.

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.

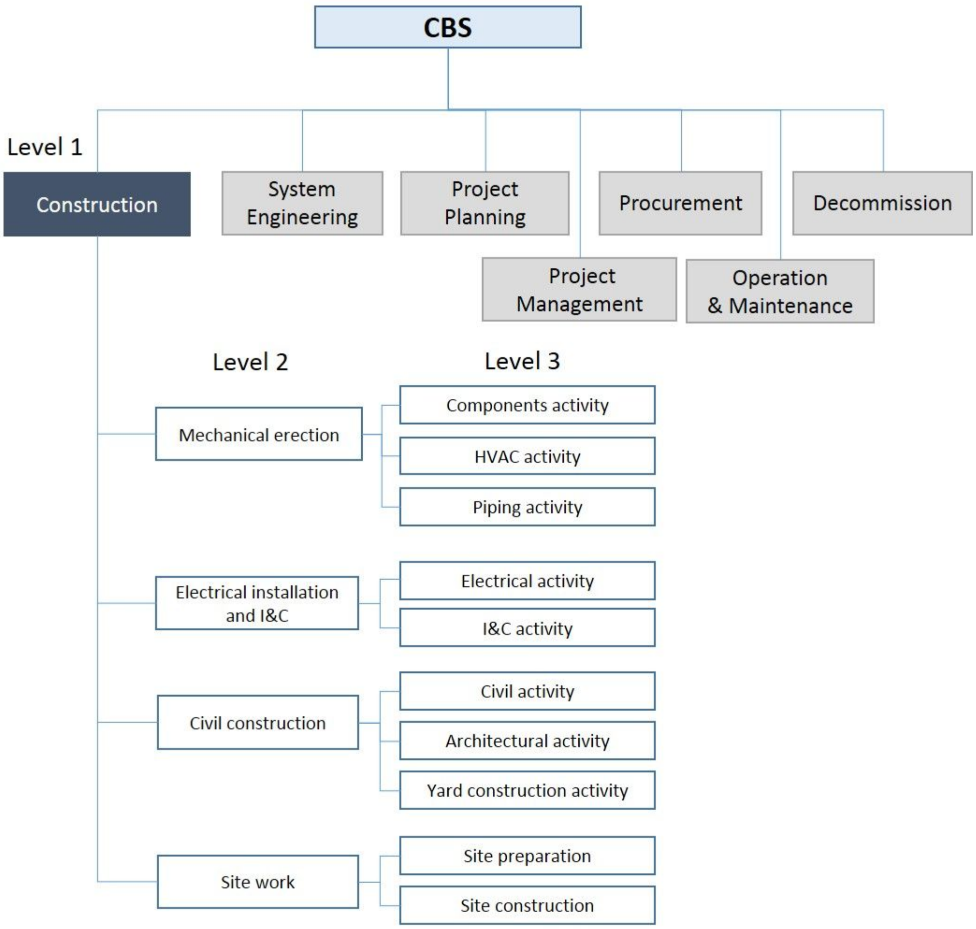


Figure 4.16 CBS of construction for SMR.

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. In-service inspection is for checking the safety of SMR during normal operation. Periodic external inspection is planed inspection activities for safety.

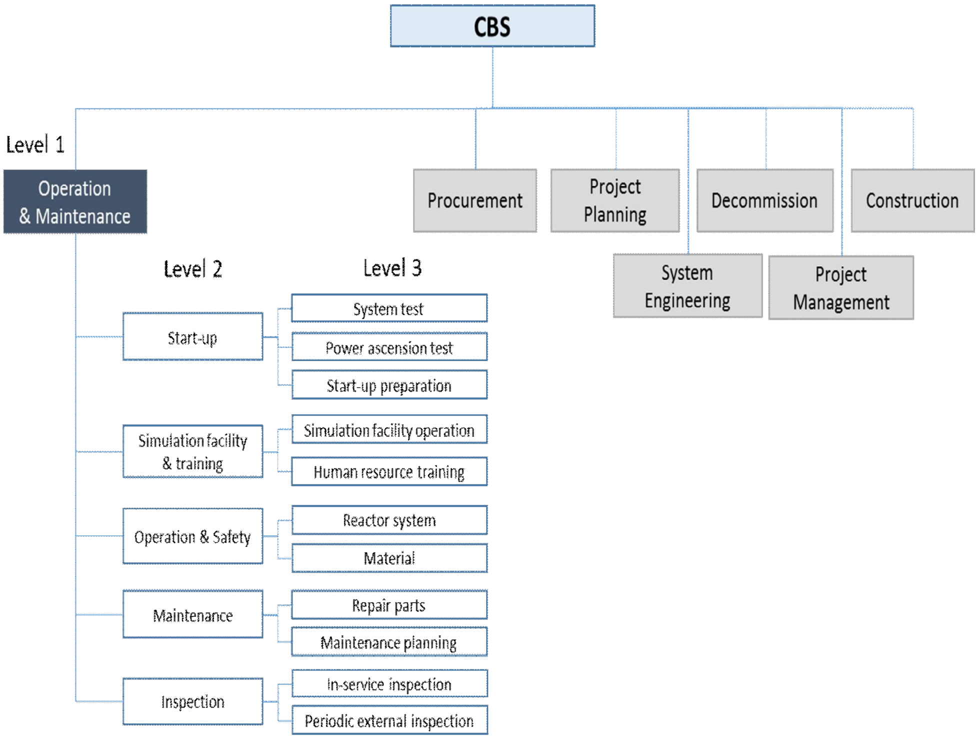


Figure 4.17 CBS of operation & maintenance for SMR.

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.

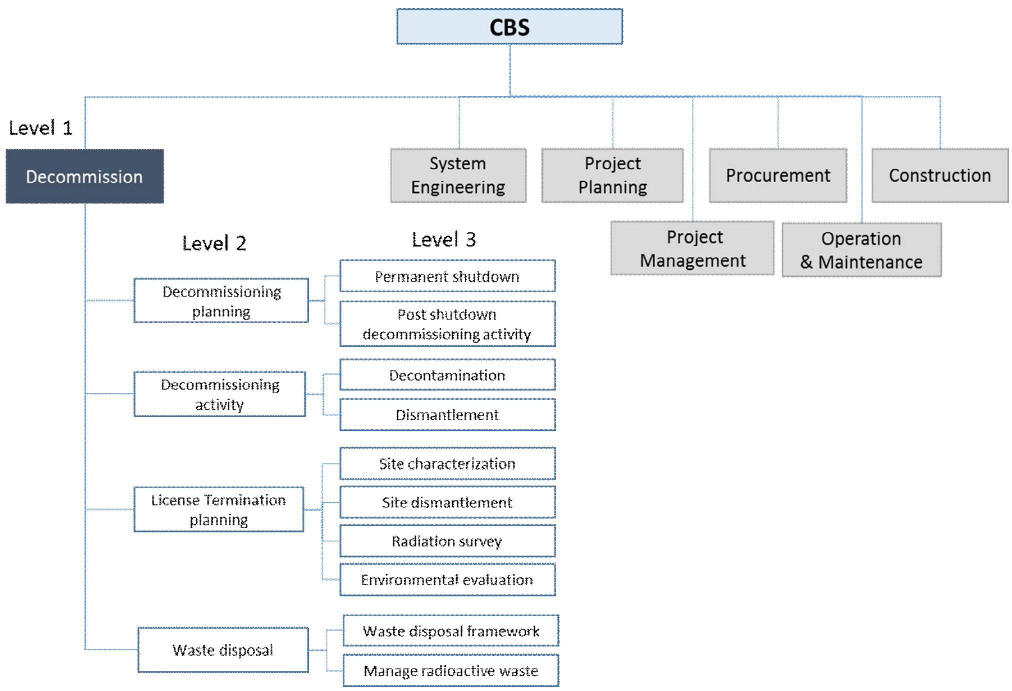


Figure 4.18 CBS of decommission for SMR.

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.

Table 4.2 General description of draft PBS of URANUS.

PBS		Description
Reactor module	Reactor system	Reactor core
	Reactor coolant system	Reactor internals and S/G
Turbine generator module	Turbine system	Converting the thermal energy of reactor
	Main steam supply system	Supplying steam to T/G system
	Condensate system	Controlling water condition and flow
	Auxiliary system	System for ensuring safety and water feeding
Auxiliary module	Chemical & volume control system	Controlling LBE purity, volume, etc. of the reactor
	HVAC system	Air conditioning of SMR site and controlling ventilation of radionuclide
	LBE heating & supply system	Conditioning the LBE coolant 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

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

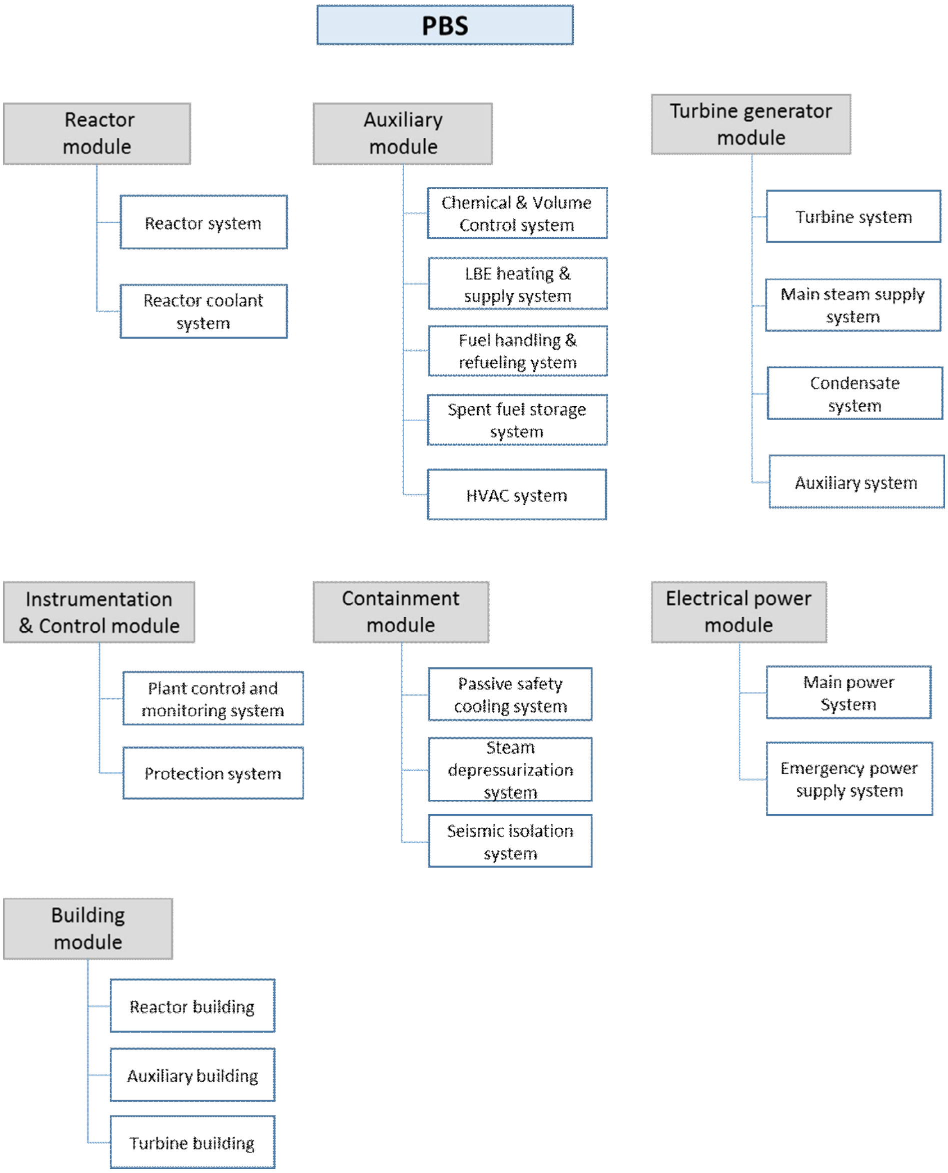


Figure 4.19 Draft PBS of URANUS.

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.

Table 4.3 General description of coding systems [10].

Coding system	Description
Monocode	• Hierarchical code and tree structure • The 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

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 life-cycle, 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.

Table 4.4 Coding system of IWBS.

Code	Description		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)

		with project and SMR	

Table 4.5 Example of IWBS coding result.

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−PRI−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

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.

<table>
<tr><th colspan="8">IWBS Dictionary</th></tr>
<tr><td rowspan="2">IWBS code</td><td>Level 1</td><td>Level 2</td><td>Level 3</td><td>Level 4</td><td>Level 5</td><td>Level 6</td><td>Level 7</td></tr>
<tr><td>SMR01</td><td>PRX</td><td>PRI</td><td>REC</td><td>FA001</td><td>CO001</td><td>TAN</td></tr>
<tr><td>IWBS
Code title</td><td colspan="7">Fuel rod thermal−hydraulic analysis</td></tr>
<tr><td>Effective date
(origin)</td><td colspan="7"></td></tr>
<tr><td>IWBS
deliverables</td><td colspan="7">Thermal−hydraulic analysis result report</td></tr>
<tr><td>Originator</td><td colspan="7">S.R. Park</td></tr>
<tr><td>Related
Document</td><td colspan="7">Design requirement report</td></tr>
<tr><td rowspan="3">Related
work</td><td colspan="2">Analysis</td><td colspan="5">Primary system thermal−hydraulic analysis</td></tr>
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<tr><td colspan="2">Install</td><td colspan="5"></td></tr>
<tr><td rowspan="3">Revision
history</td><td colspan="2">Revision date</td><td colspan="5">Description</td></tr>
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Chapter 5.Application of IWBS for mockup facility

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.

Table 5.1 Design constraints of PILLAR.

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

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.

Table 5.2 Design parameters of PILLAR.

Item	Unit	Proto; p	Mockup; m	Scaling 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

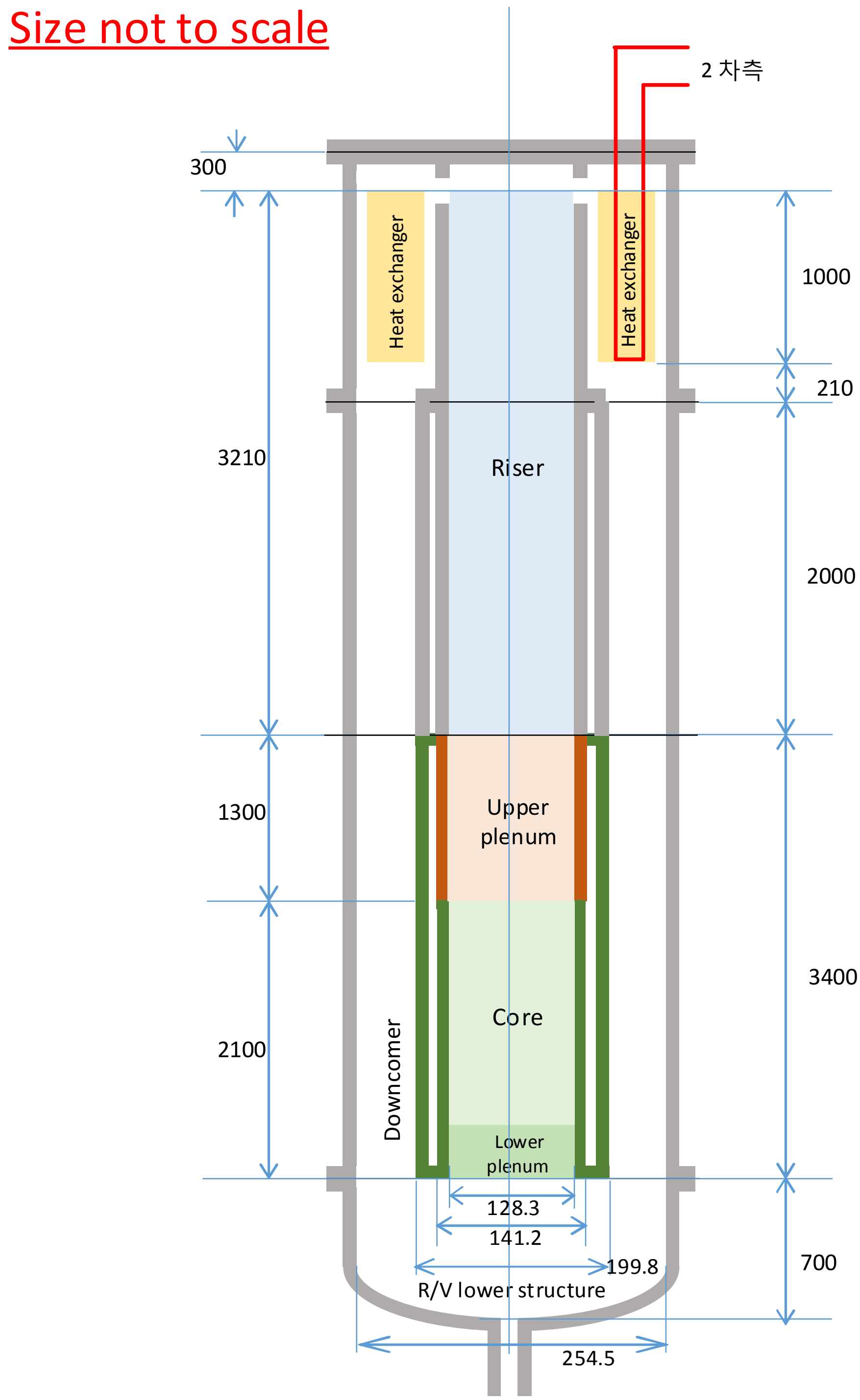

Figure 5.1 Schematic of mockup facility PILLAR.

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.

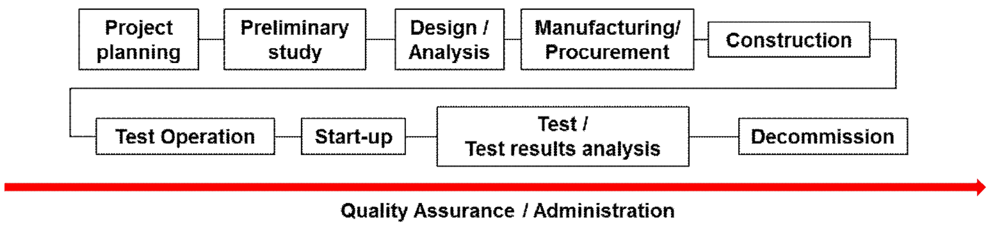

Figure 5.2 PILLAR project process flow.

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.

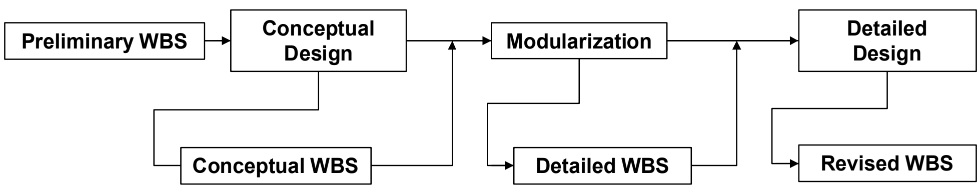

Figure 5.3 Actualization process of IWBS for PILLAR project.

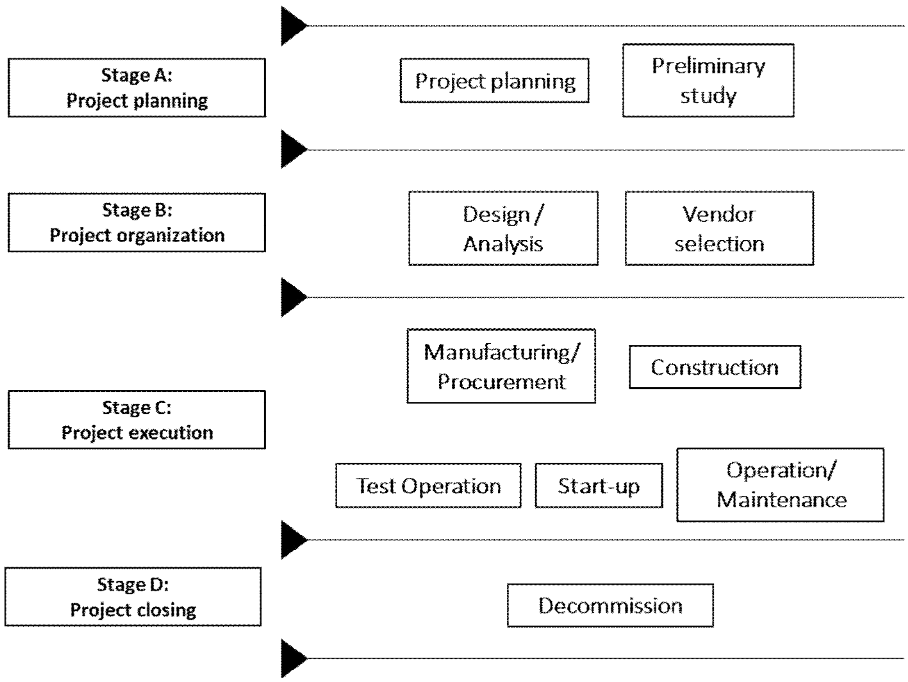

Figure 5.4 Four stages of PILLAR project.

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.

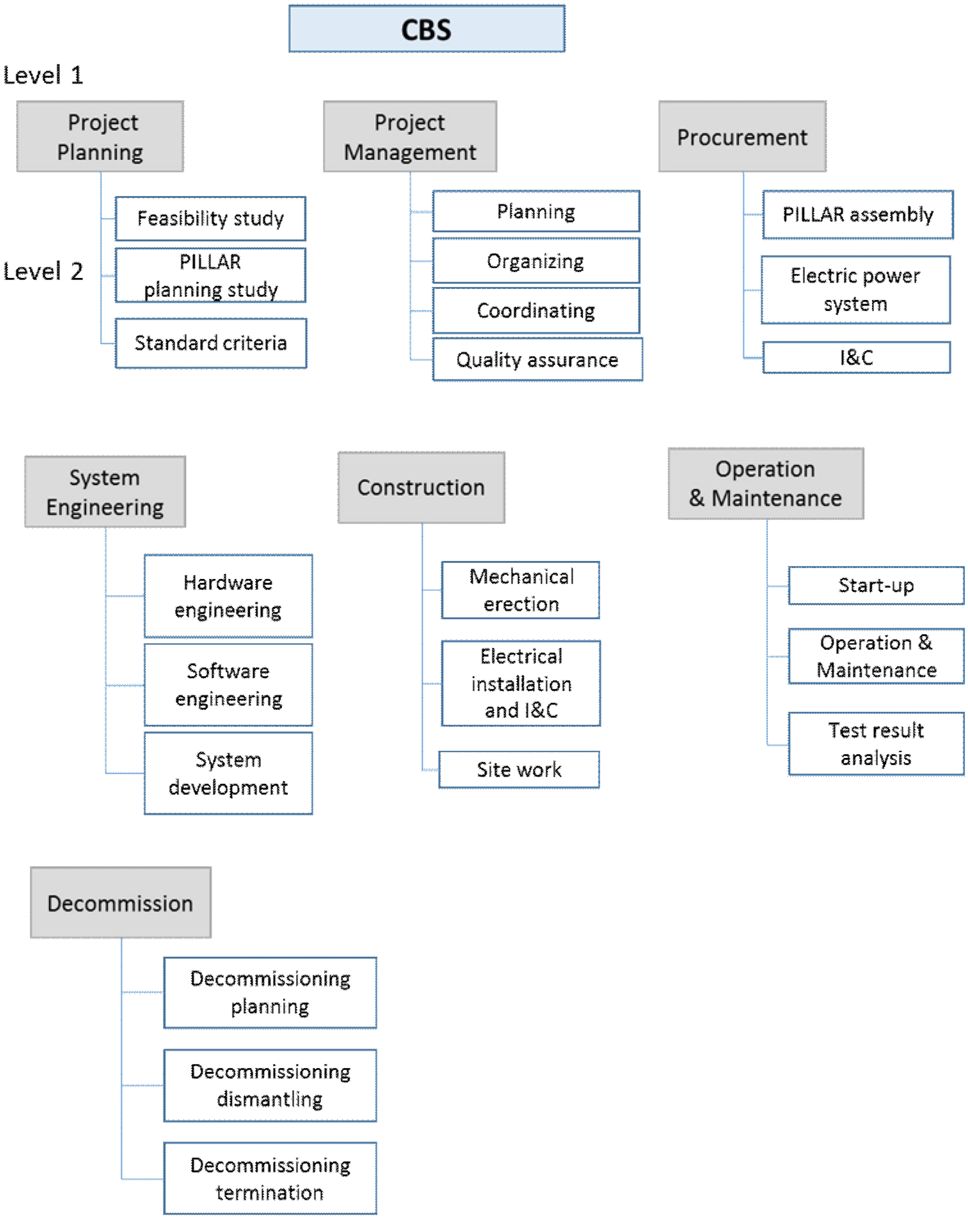

Figure 5.5 CBS elements of IWBS for PILLAR.

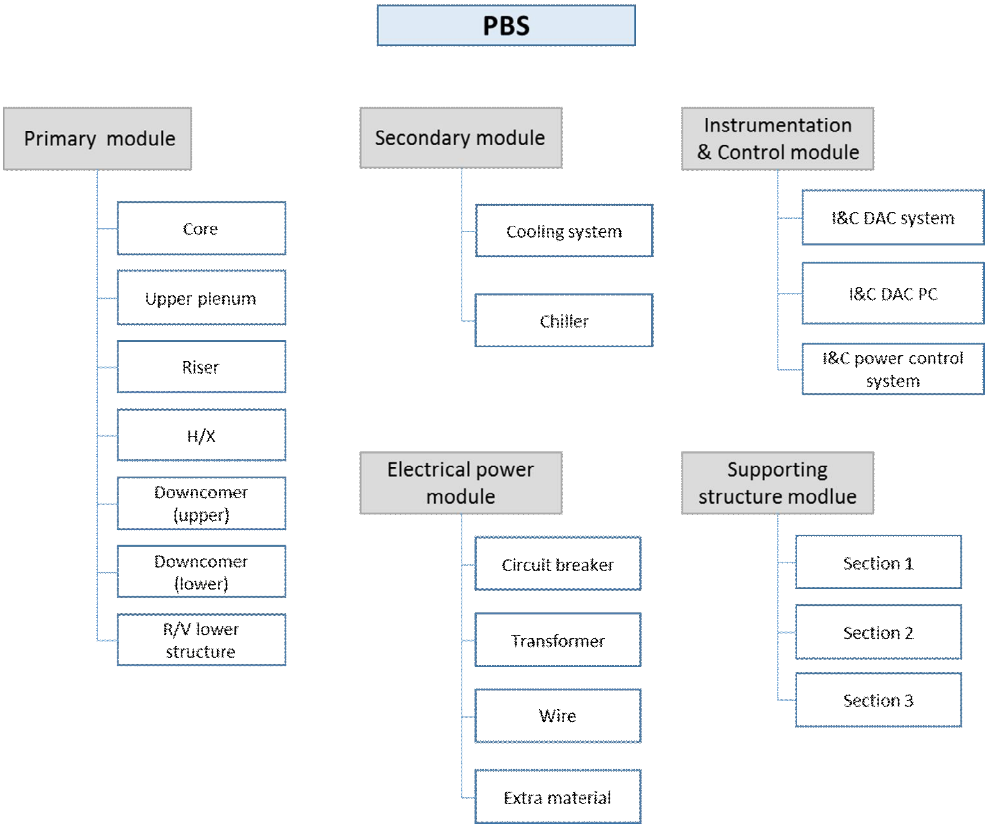

Figure 5.6 PBS elements of IWBS for PILLAR.

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.

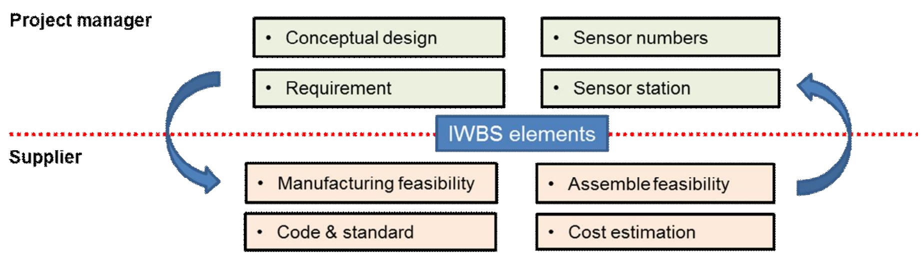

Figure 5.7 Interaction relation of project manager and supplier.

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.

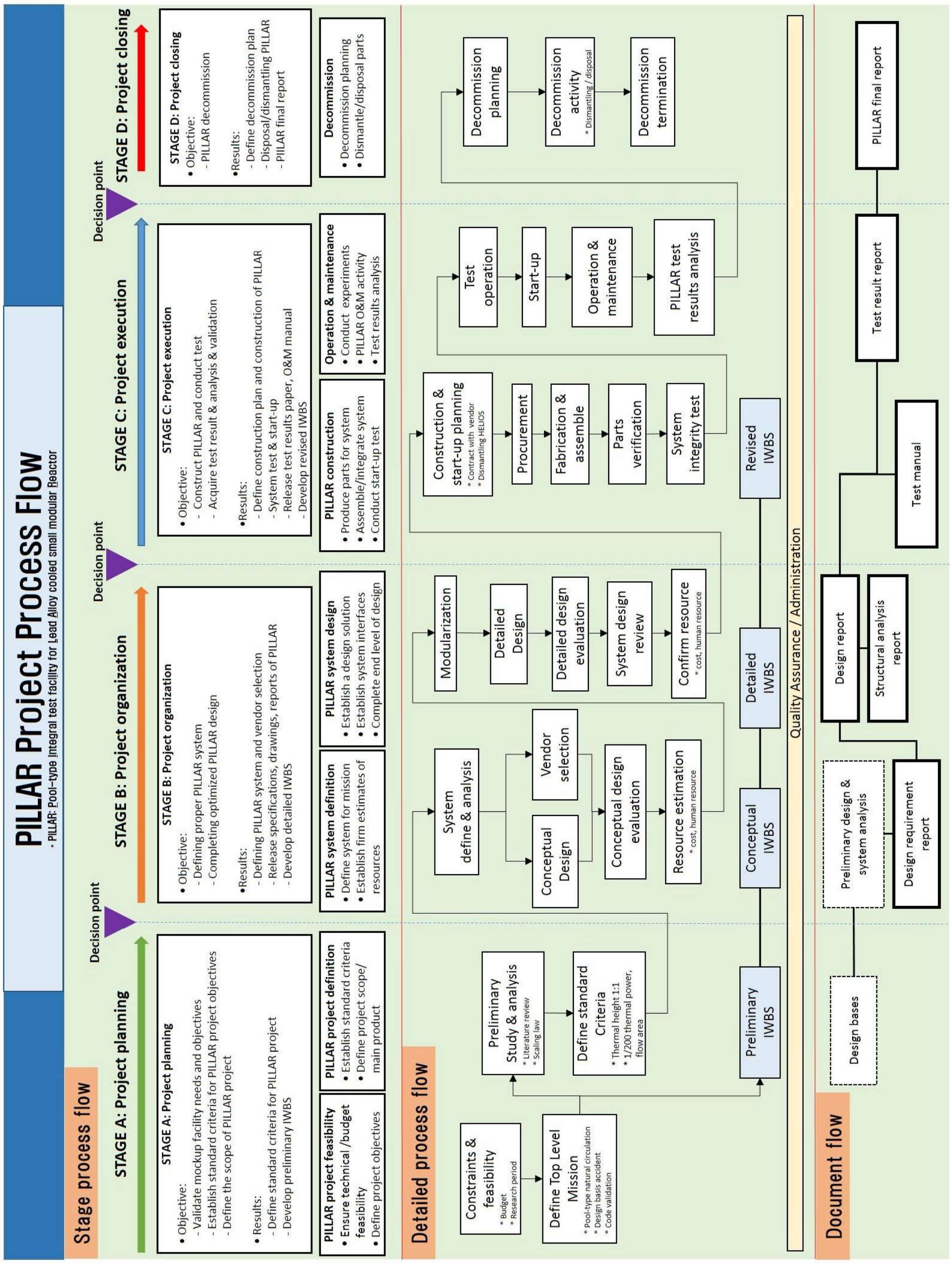

Figure 5.8 Process flow chart of PILLAR project.

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)

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Appendix

PILLAR(Pool-type Intergral test facility for Lead Alloy cooled small modular Reactor) Integrated Work Breakdown Structure

FULL DESCRIPTION											
LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4	LEVEL 5	LEVEL 6	LEVEL 7	Description	SUB De1	SUB De2	related Doc	note
Product	Stage	Island	System	Structure	Component	Requirement					
MOC							PILLAR				
MOC	PRO					CDE	PILLAR conceptual design	conceptual	design	Design requirement report, review Doc	Design result
MOC	PRO					SDE	PILLAR detailed design	detailed	design	Design report, review Doc	Design result
MOC	PRE					PSA	PILLAR preliminary study&analysis	preliminary	analysis	analysis result document	Literature review, scaling method
MOC	PRE					SCR	PILLAR standard criteria	standard	criteria	standard criteria document	define standard criteria
MOC	PRO					TAN	PILLAR thermal-hydraulic analysis	thermal-hydraulic	analysis	analysis result document	T/H analysis data
MOC	PRE					PWB	PILLAR perliminary IWBS	preliminary	IWBS	preliminary IWBS document	define preliminary IWBS
MOC	PRO					CWB	PILLAR conceptual IWBS	conceptual	IWBS	conceptual IWBS document	define conceptual IWBS
MOC	PRO					DWB	PILLAR detailed IWBS	detailed	IWBS	detailed IWBS document	define detailed IWBS
MOC	PRX					RWB	PILLAR revised IWBS	revised	IWBS	revised IWBS document	define revised IWBS
MOC	PRO					DRR	PILLAR design requirement report	design requirement	report	design requirement report	design requirement
MOC	PRO					DER	PILLAR design report	design	report	design report	design result
MOC	PRX					OMA	PILLAR operation manual	operation	manual	manual handbook	define operation procedure
MOC	PRE					PFW	PILLAR planning process flow	planning	process flow	flow chart	define flow chart
MOC	PRE					WFW	PILLAR work process flow	work	process flow	flow chart	define flow chart
MOC	PRO					PFW	PILLAR planning process flow	planning	process flow	flow chart	define flow chart
MOC	PRO					WFW	PILLAR work process flow	work	process flow	flow chart	define flow chart
MOC	PRX					PFW	PILLAR construction planning process flow	planning	process flow	flow chart	define flow chart
MOC	PRX					WFW	PILLAR construction work process flow	work	process flow	flow chart	define flow chart
MOC	PRC					PFW	PILLAR planning process flow	planning	process flow	flow chart	define flow chart
MOC	PRC					WFW	PILLAR work process flow	work	process flow	flow chart	define flow chart
MOC	PRE					QNA	PILLAR quality assurance		QA	QA Document	QA result
MOC	PRO					QNA	PILLAR quality assurance		QA	QA Document	QA result
MOC	PRX					QNA	PILLAR quality assurance		QA	QA Document	QA result
MOC	PRC					QNA	PILLAR quality assurance		QA	QA Document	QA result
MOC	PRE					PFE	PILLAR project feasibiltiy	project	feasibility	design bases	feasibiltiy analysis
MOC	PRE					BFE	PILLAR budget feasibiltiy	budget	feasibility	design bases	feasibiltiy analysis
MOC	PRO					VSE	PILLAR vendor selection	vendor	selection	specifications	selecting vendor
MOC	PRO					AFE	PILLAR assemble feasibiltiy	assemble	feasibility	feasibility analysis result	feasibiltiy analysis
MOC	PRO					SDA	PILLAR system define&analysis	define	analysis	Design report, review Doc	define&analysis system
MOC	PRO					RET	PILLAR resource estimation	resource	estimation	resource estimation result	resource estimation
MOC	PRO					REC	PILLAR resource confirm	resource	confirm	resource confirm result	resource confirm
MOC	PRO					DRE	PILLAR design review	review	design	design review result	design review
MOC	PRX					PVE	PILLAR part verification	part	verification	verification result document	verification
MOC	PRX					TOP	PILLAR test operation	test	operation	test result document	test operation
MOC	PRX					ONM	PILLAR operation & maintenance (O&M)	actual	operation	operation & maintenance activity	operation & maintenance
MOC	PRX					ONA	PILLAR operation & maintenance (O&M) manual	manual	operation	operation & maintenance manual	O&M procurement
MOC	PRX					CFM	PILLAR configuration management	configuration	management	configuration management result	configuration management
MOC	PRX					TRA	PILLAR test result analysis	test	analysis	test result analysis report	test result analysis
MOC	PRX					ITE	PILLAR integrity test	integrity	test	test result	system integrity test
MOC	PRX					STU	PILLAR start-up test	start-up	test	test procedure, test result	start-up test
MOC	PRO					SCO	PILLAR sum cost	sum	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO					MCO	PILLAR material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO					WCO	PILLAR manpower cost	manpower	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRC					FRE	PILLAR final report	final	report	final report	finalization activity
MOC	PRC					DCT	PILLAR decommissioning termination	decommissioning	termination	termination plan	termination planning
MOC	PRC					DCP	PILLAR decommissioning planning	decommissioning	planning	result document	establish planning
MOC	PRC					DCD	PILLAR decommissioning dismantling	decommissioning	dismantling	result document	establish dismatling planning
MOC		PRI					PILLAR primary				
MOC	PRO	PRI				CDE	PILLAR primary conceptual design	conceptual	design	Desigh requirement report, review Doc	Design result
MOC	PRO	PRI				SDE	PILLAR primary specific design	detailed	design	Desigh report, review Doc	Design result
MOC	PRO	PRI				TAN	PILLAR primary thermal-hydrauric analysis	thermal-hydrauric	analysis	result document	T/H analysis data
MOC	PRX	PRI				OMA	PILLAR primary operation manual	operation	manual	manual handbook	define operation procedure
MOC	PRE	PRI				PFW	PILLAR primary planning process flow	planning	process flow	flow chart	define flow chart
MOC	PRE	PRI				WFW	PILLAR primary work process flow	work	process flow	flow chart	define flow chart
MOC	PRO	PRI				PFW	PILLAR primary planning process flow	planning	process flow	flow chart	define flow chart
MOC	PRO	PRI				WFW	PILLAR primary work process flow	work	process flow	flow chart	define flow chart
MOC	PRX	PRI				PFW	PILLAR construction primary planning process flow	planning	process flow	flow chart	define flow chart
MOC	PRX	PRI				WFW	PILLAR construction primary work process flow	work	process flow	flow chart	define flow chart
MOC	PRC	PRI				PFW	PILLAR primary planning process flow	planning	process flow	flow chart	define flow chart
MOC	PRC	PRI				WFW	PILLAR primary work process flow	work	process flow	flow chart	define flow chart
MOC	PRE	PRI				QNA	PILLAR primary quality assurance		QA	QA Document	QA result
MOC	PRO	PRI				QNA	PILLAR primary quality assurance		QA	QA Document	QA result
MOC	PRX	PRI				QNA	PILLAR primary quality assurance		QA	QA Document	QA result
MOC	PRC	PRI				QNA	PILLAR primary quality assurance		QA	QA Document	QA result
MOC	PRO	PRI				AFE	PILLAR primary assemble feasibility	assemble	feasibility	feasibility analysis result	feasibility analysis

PILLAR(Pool-type Intergral test facility for Lead Alloy cooled small modular Reactor) Integrated Work Breakdown Structure

FULL DESCRIPTION											
LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4	LEVEL 5	LEVEL 6	LEVEL 7	Description	SUB De1	SUB De2	related Doc	note
Product	Stage	Island	System	Structure	Component	Requirement					
MOC	PRX	PRI				ITE	PILLAR primary integity test	integrity	test	test result	system integrity test
MOC	PRO	PRI				SCO	PILLAR primary cost sum	sum	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI				MCO	PILLAR primary material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI				WCO	PILLAR primary manpower cost	manpower	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRC	PRI				DCT	PILLAR decommissioning termination	decommissioning	termination	termination plan	termination planning
MOC	PRC	PRI				DCP	PILLAR primary decommissioning planning	decommissioning	planning	result document	establish planning
MOC	PRC	PRI				DCD	PILLAR primary decommissioning dismantling	decommissioning	dismantling	result document	establish dismatling planning
MOC	PRO	PRI	ST001				Storage tank				
MOC	PRO	PRI	ST001			MCO	Storage tank material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	ST001			GIN	Storage tank general information	general	information		general feature
MOC	PRO	PRI	ST001	TA001			Tank				
MOC	PRO	PRI	ST001	TA001		MCO	Tank	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	ST001	TA001		DRW	Tank drawing		drawing	Drawing	part drawing
MOC	PRX	PRI	ST001	TA001		ASM	Tank assemble work		assemble	related drawing	connecting part, date
MOC	PRX	PRI	ST001	TA001		PRM	Tank procurement		procurement	estimate sheet, statement of delivery	supplier, date, info
MOC	PRO	PRI	ST001	PI001			Pipe				
MOC	PRO	PRI	ST001	PI001		MCO	Pipe	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	ST001	PI001		DRW	Pipe drawing		drawing	Drawing	part drawing
MOC	PRX	PRI	ST001	PI001		ASM	Pipe assemble work		assemble	related drawing	connecting part, date
MOC	PRX	PRI	ST001	PI001		PRM	Pipe procurement		procurement	estimate sheet, statement of delivery	supplier, date, info
MOC	PRO	PRI	ST001	IN001			Insulation				
MOC	PRO	PRI	ST001	IN001		MCO	Insulation	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	ST001	IN001		GIN	Insulation general information	general	information		general feature
MOC	PRX	PRI	ST001	IN001		ASM	Insulation assemble work		assemble	related drawing	connecting part, date
MOC	PRX	PRI	ST001	IN001		PRM	Insulation procurement		procurement	estimate sheet, statement of delivery	supplier, date, info
MOC	PRO	PRI	ST001	MO001			MOV (Motor-Operated Valve)				
MOC	PRO	PRI	ST001	MO001		MCO	MOV (Motor-Operated Valve)	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	ST001	MO001		DRW	MOV drawing		drawing	Drawing	part drawing
MOC	PRX	PRI	ST001	MO001		ASM	MOV assemble work		assemble	related drawing	connecting part, date
MOC	PRX	PRI	ST001	MO001		PRM	MOV procurement		procurement	estimate sheet, statement of delivery	supplier, date, info
MOC	PRO	PRI	ST001	MO001	CN001		MOV controller				
MOC	PRO	PRI	ST001	MO001	CN001	MCO	MOV controller	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	ST001	MO001	CN001	DRW	MOV controller drawing		drawing	Drawing	part drawing
MOC	PRX	PRI	ST001	MO001	CN001	ASM	MOV controller assemble work		assemble	related drawing	connecting part, date
MOC	PRX	PRI	ST001	MO001	CN001	PRM	MOV controller procurement		procurement	estimate sheet, statement of delivery	supplier, date, info
MOC	PRO	PRI	ST001	HS001			Heating system				
MOC	PRO	PRI	ST001	HS001		MCO	Heating system	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	ST001	HS001		GIN	Heating system general information	general	information		general feature
MOC	PRO	PRI	ST001	HS001	SH001		Storage tank heater				
MOC	PRO	PRI	ST001	HS001	SH001	MCO	Storage tank heater	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	ST001	HS001	SH001	GIN	Storage tank heater general information	general	information		general feature
MOC	PRO	PRI	ST001	HS001	SH001	DRW	Storage tank heater drawing		drawing	Drawing	part drawing
MOC	PRX	PRI	ST001	HS001	SH001	ASM	Storage tank heater assemble work		assemble	related drawing	connecting part, date
MOC	PRX	PRI	ST001	HS001	SH001	PRM	Storage tank heater procurement		procurement	estimate sheet, statement of delivery	supplier, date, info
MOC	PRO	PRI	ST001	HS001	CN001		Heating system controller				
MOC	PRO	PRI	ST001	HS001	CN001	MCO	Heating system controller	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	ST001	HS001	CN001	GIN	Heating system controller general information	general	information		general feature
MOC	PRO	PRI	ST001	LV001			Storage tank level sensor				
MOC	PRO	PRI	ST001	LV001		MCO	Storage tank level sensor	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	ST001	LV001		GIN	Storage tank level sensor general information	general	information		general feature
MOC	PRO	PRI	ST001	LV001		DRW	Storage tank level sensor drawing		drawing	Drawing	part drawing
MOC	PRX	PRI	ST001	LV001		ASM	Storage tank level sensor assemble work		assemble	related drawing	connecting part, date
MOC	PRX	PRI	ST001	LV001		PRM	Storage tank level sensor procurement		procurement	estimate sheet, statement of delivery	supplier, date, info
MOC	PRO	PRI	ST001	WS001			Storage tank weighting sensor				
MOC	PRO	PRI	ST001	WS001		MCO	Storage tank weighting sensor	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	ST001	WS001		GIN	Storage tank weighting sensor general information	general	information		general feature
MOC	PRO	PRI	ST001	WS001		DRW	Storage tank weighting sensor drawing		drawing	Drawing	part drawing
MOC	PRX	PRI	ST001	WS001		ASM	Storage tank weighting sensor assemble work		assemble	related drawing	connecting part, date
MOC	PRX	PRI	ST001	WS001		PRM	Storage tank weighting sensor procurement		procurement	estimate sheet, statement of delivery	supplier, date, info

PILLAR(Pool-type Intergral test facility for Lead Alloy cooled small modular Reactor) Integrated Work Breakdown Structure

FULL DESCRIPTION

LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4	LEVEL 5	LEVEL 6	LEVEL 7	Description	SUB De1	SUB De2	related Doc	note
Product	Stage	Island	System	Structure	Component	Requirement					
MOC	PRO	PRI	ST001	VA001			Cover gas inlet valve				
MOC	PRO	PRI	ST001	VA001		MCO	Cover gas inlet valve	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	ST001	VA001		GIN	Cover gas inlet valve general information	general	information		general feature
MOC	PRO	PRI	ST001	VA001		DRW	Cover gas inlet valve drawing		drawing	Drawing	part drawing
MOC	PRX	PRI	ST001	VA001		ASM	Cover gas inlet valve assemble work		assemble	related drawing	connecting part, date
MOC	PRX	PRI	ST001	VA001		PRM	Cover gas inlet valve procurement		procurement	estimate sheet, statement of delivery	supplier, date, info
MOC	PRO	PRI	ST001	TC001			Thermocouple				
MOC	PRO	PRI	ST001	TC001		MCO	Thermocouple	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	ST001	TC001		DRW	Thermocouple drawing		drawing	Drawing	part drawing
MOC	PRX	PRI	ST001	TC001		ASM	Thermocouple assemble work		assemble	related drawing	connecting part, date
MOC	PRX	PRI	ST001	TC001		PRM	Thermocouple procurement		procurement	estimate sheet, statement of delivery	supplier, date, info
MOC	PRO	PRI	CO001				Core				
MOC	PRO	PRI	CO001			MCO	Core material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001			GIN	Core general information	general	information		general feature
MOC	PRO	PRI	CO001	BA001			Core barrel				
MOC	PRO	PRI	CO001	BA001		MCO	Core barrel material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	BA001		GIN	Core barrel general information	general	information		general feature
MOC	PRO	PRI	CO001	BA001		DRW	Core barrel drawing		drawing	Drawing	part drawing
MOC	PRX	PRI	CO001	BA001		ASM	Core barrel assemble work		assemble	related drawing	connecting part, date
MOC	PRX	PRI	CO001	BA001		PRM	Core barrel procurement		procurement	estimate sheet, statement of delivery	supplier, date, info
MOC	PRO	PRI	CO001	HS001	HE		Core main heater assembly				37ea
MOC	PRO	PRI	CO001	HS001	HE	GIN	Core main heater assembly general information	general	information		general feature
MOC	PRO	PRI	CO001	HS001	HE	DRW	Core main heater assembly drawing		drawing	Drawing	part drawing
MOC	PRX	PRI	CO001	HS001	HE	ASM	Core main heater assembly assemble work		assemble	related drawing	connecting part, date
MOC	PRX	PRI	CO001	HS001	HE	PRM	Core main heater assembly procurement		procurement	estimate sheet, statement of delivery	supplier, date, info
MOC	PRO	PRI	CO001	HS001	HE001	MCO	Core main heater 1	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	HS001	HE002	MCO	Core main heater 2	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	HS001	HE003	MCO	Core main heater 3	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	HS001	HE004	MCO	Core main heater 4	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	HS001	HE005	MCO	Core main heater 5	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	HS001	HE006	MCO	Core main heater 6	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	HS001	HE007	MCO	Core main heater 7	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	HS001	HE008	MCO	Core main heater 8	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	HS001	HE009	MCO	Core main heater 9	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	HS001	HE010	MCO	Core main heater 10	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	HS001	HE011	MCO	Core main heater 11	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	HS001	HE012	MCO	Core main heater 12	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	HS001	HE013	MCO	Core main heater 13	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	HS001	HE014	MCO	Core main heater 14	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	HS001	HE015	MCO	Core main heater 15	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	HS001	HE016	MCO	Core main heater 16	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	HS001	HE017	MCO	Core main heater 17	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	HS001	HE018	MCO	Core main heater 18	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	HS001	HE019	MCO	Core main heater 19	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	HS001	HE020	MCO	Core main heater 20	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	HS001	HE021	MCO	Core main heater 21	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	HS001	HE022	MCO	Core main heater 22	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	HS001	HE023	MCO	Core main heater 23	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	HS001	HE024	MCO	Core main heater 24	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	HS001	HE025	MCO	Core main heater 25	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	HS001	HE026	MCO	Core main heater 26	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	HS001	HE027	MCO	Core main heater 27	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	HS001	HE028	MCO	Core main heater 28	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	HS001	HE029	MCO	Core main heater 29	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	HS001	HE030	MCO	Core main heater 30	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	HS001	HE031	MCO	Core main heater 31	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	HS001	HE032	MCO	Core main heater 32	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	HS001	HE033	MCO	Core main heater 33	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	HS001	HE034	MCO	Core main heater 34	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	HS001	HE035	MCO	Core main heater 35	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	HS001	HE036	MCO	Core main heater 36	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	HS001	HE037	MCO	Core main heater 37	material	cost	estimate sheet, statement of delivery	supplier, date

PILLAR(Pool-type Intergral test facility for Lead Alloy cooled small modular Reactor) Integrated Work Breakdown Structure

FULL DESCRIPTION											
LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4	LEVEL 5	LEVEL 6	LEVEL 7	Description	SUB De1	SUB De2	related Doc	note
Product	Stage	Island	System	Structure	Component	Requirement					
MOC	PRO	PRI	CO001	HS001	CN001		Heating system controller				
MOC	PRO	PRI	CO001	HS001	CN001	MCO	Heating system controller	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	HS001	CN001	GIN	Heating system controller general information	general	information		general feature
MOC	PRO	PRI	CO001	SP001			Spacer				
MOC	PRO	PRI	CO001	SP001		MCO	Spacer	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	SP001		GIN	Spacer general information	general	information		general feature
MOC	PRO	PRI	CO001	SP001		DRW	Spacer drawing		drawing	Drawing	part drawing
MOC	PRX	PRI	CO001	SP001		ASM	Spacer assemble work		assemble	related drawing	connecting part, date
MOC	PRX	PRI	CO001	SP001		PRM	Spacer procurement		procurement	estimate sheet, statement of delivery	supplier, date, info
MOC	PRO	PRI	CO001	TC			Thermocouple assembly				45ea
MOC	PRO	PRI	CO001	TC		GIN	Thermocouple assembly general information	general	information		general feature
MOC	PRO	PRI	CO001	TC		DRW	Thermocouple assembly drawing		drawing	Drawing	part drawing
MOC	PRX	PRI	CO001	TC		ASM	Thermocouple assembly assemble work		assemble	related drawing	connecting part, date
MOC	PRX	PRI	CO001	TC		PRM	Thermocouple assembly procurement		procurement	estimate sheet, statement of delivery	supplier, date, info
MOC	PRO	PRI	CO001	TC001		MCO	Core Top Section Temp #1	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	TC002		MCO	Core Top Section Temp #2	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	TC003		MCO	Core Top Section Temp #3	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	TC004		MCO	Core Top Section Temp #4	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	TC005		MCO	Core Top Section Temp #5	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	TC006		MCO	Core Top Section Temp #6	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	TC007		MCO	Core Top Section Temp #7	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	TC008		MCO	Core Top Section Temp #8	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	TC009		MCO	Core Top Section Temp #9	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	TC010		MCO	Core Top Section Temp #10	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	TC011		MCO	Core Top Section Temp #11	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	TC012		MCO	Core Top Section Temp #12	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	TC013		MCO	Core Top Section Temp #13	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	TC014		MCO	Core Top Section Temp #14	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	TC015		MCO	Core Top Section Temp #15	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	TC016		MCO	Core Middle Section Temp #1	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	TC017		MCO	Core Middle Section Temp #2	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	TC018		MCO	Core Middle Section Temp #3	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	TC019		MCO	Core Middle Section Temp #4	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	TC020		MCO	Core Middle Section Temp #5	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	TC021		MCO	Core Middle Section Temp #6	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	TC022		MCO	Core Middle Section Temp #7	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	TC023		MCO	Core Middle Section Temp #8	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	TC024		MCO	Core Middle Section Temp #9	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	TC025		MCO	Core Middle Section Temp #10	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	TC026		MCO	Core Middle Section Temp #11	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	TC027		MCO	Core Middle Section Temp #12	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	TC028		MCO	Core Middle Section Temp #13	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	TC029		MCO	Core Middle Section Temp #14	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	TC030		MCO	Core Middle Section Temp #15	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	TC031		MCO	Core Bottom Section Temp #1	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	TC032		MCO	Core Bottom Section Temp #2	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	TC033		MCO	Core Bottom Section Temp #3	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	TC034		MCO	Core Bottom Section Temp #4	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	TC035		MCO	Core Bottom Section Temp #5	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	TC036		MCO	Core Bottom Section Temp #6	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	TC037		MCO	Core Bottom Section Temp #7	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	TC038		MCO	Core Bottom Section Temp #8	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	TC039		MCO	Core Bottom Section Temp #9	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	TC040		MCO	Core Bottom Section Temp #10	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	TC041		MCO	Core Bottom Section Temp #11	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	TC042		MCO	Core Bottom Section Temp #12	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	TC043		MCO	Core Bottom Section Temp #13	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	TC044		MCO	Core Bottom Section Temp #14	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CO001	TC045		MCO	Core Bottom Section Temp #15	material	cost	estimate sheet, statement of delivery	supplier, date

PILLAR(Pool-type Intergral test facility for Lead Alloy cooled small modular Reactor) Integrated Work Breakdown Structure

FULL DESCRIPTION											
LEVEL 1 Product	LEVEL 2 Stage	LEVEL 3 Island	LEVEL 4 System	LEVEL 5 Structure	LEVEL 6 Component	LEVEL 7 Requirement	Description	SUB De1	SUB De2	related Doc	note
MOC	PRO	PRI	UP001				Upper plenum				
MOC	PRO	PRI	UP001			MCO	Upper plenum material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	UP001			GIN	Upper plenum general information	general	information		general feature
MOC	PRO	PRI	UP001	BA001			Upper plenum barrel				
MOC	PRO	PRI	UP001	BA001		MCO	Upper plenum barrel material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	UP001	BA001		DRW	Upper plenum barrel drawing		drawing	Drawing	part drawing
MOC	PRX	PRI	UP001	BA001		ASM	Upper plenum barrel assemble work		assemble	related drawing	connecting part, date
MOC	PRX	PRI	UP001	BA001		PRM	Upper plenum barrel procurement		procurement	estimate sheet, statement of delivery	supplier, date, info
MOC	PRO	PRI	UP001	PI001			Upper plenum Pipe				
MOC	PRO	PRI	UP001	PI001		MCO	Upper plenum Pipe material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	UP001	PI001		DRW	Upper plenum Pipe drawing		drawing	Drawing	part drawing
MOC	PRX	PRI	UP001	PI001		ASM	Upper plenum Pipe assemble work		assemble	related drawing	connecting part, date
MOC	PRX	PRI	UP001	PI001		PRM	Upper plenum Pipe procurement		procurement	estimate sheet, statement of delivery	supplier, date, info
MOC	PRO	PRI	UP001	TC			Thermocouple assembly				4ea
MOC	PRO	PRI	UP001	TC		GIN	Thermocouple assembly general information	general	information		general feature
MOC	PRO	PRI	UP001	TC		DRW	Thermocouple assembly drawing		drawing	Drawing	part drawing
MOC	PRX	PRI	UP001	TC		ASM	Thermocouple assembly assemble work		assemble	related drawing	connecting part, date
MOC	PRX	PRI	UP001	TC		PRM	Thermocouple assembly procurement		procurement	estimate sheet, statement of delivery	supplier, date, info
MOC	PRO	PRI	UP001	TC001		MCO	Upper Plenum Upper section Upstream Temp. #1	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	UP001	TC002		MCO	Upper Plenum Upper section Upstream Temp. #2	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	UP001	TC003		MCO	Upper Plenum Bottom section Upstream Temp. #1	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	UP001	TC004		MCO	Upper Plenum Bottom section Upstream Temp. #2	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	UP001	DP001			D/P meter(to R/V structure)				
MOC	PRO	PRI	UP001	DP001		MCO	D/P meter	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	UP001	DP001		GIN	D/P meter general information	general	information		general feature
MOC	PRO	PRI	UP001	DP001		DRW	D/P meter drawing		drawing	Drawing	part drawing
MOC	PRX	PRI	UP001	DP001		ASM	D/P meter assemble work		assemble	related drawing	connecting part, date
MOC	PRX	PRI	UP001	DP001		PRM	D/P meter procurement		procurement	estimate sheet, statement of delivery	supplier, date, info
MOC	PRO	PRI	UP001	HS001	HE001		Surface heater				
MOC	PRO	PRI	UP001	HS001	HE001	MCO	Surface heater matreial cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	ST001	HS001	HE001	GIN	Surface heater general information	general	information		general feature
MOC	PRO	PRI	ST001	HS001	HE001	DRW	Surface heater drawing		drawing	Drawing	part drawing
MOC	PRX	PRI	ST001	HS001	HE001	ASM	Surface heater assemble work		assemble	related drawing	connecting part, date
MOC	PRX	PRI	ST001	HS001	HE001	PRM	Surface heater procurement		procurement	estimate sheet, statement of delivery	supplier, date, info
MOC	PRO	PRI	UP001	HS001	CN001		Heating system controller				
MOC	PRO	PRI	UP001	HS001	CN001	MCO	Heating system controller material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	UP001	HS001	CN001	GIN	Heating system controller general information	general	information		general feature
MOC	PRO	PRI	UP001	IN001			Insulation				
MOC	PRO	PRI	UP001	IN001		MCO	Insulation material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	UP001	IN001		GIN	Insulation general information	general	information		general feature
MOC	PRX	PRI	UP001	IN001		ASM	Insulation assemble work		assemble	related drawing	connecting part, date
MOC	PRX	PRI	UP001	IN001		PRM	Insulation procurement		procurement	estimate sheet, statement of delivery	supplier, date, info
MOC	PRO	PRI	RI001				Riser				
MOC	PRO	PRI	RI001			MCO	Riser material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RI001			GIN	Riser general information	general	information		general feature
MOC	PRO	PRI	RI001	PI001			Riser Pipe				
MOC	PRO	PRI	RI001	PI001		MCO	Riser Pipe material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RI001	PI001		DRW	Riser Pipe drawing		drawing	Drawing	part drawing
MOC	PRX	PRI	RI001	PI001		ASM	Riser Pipe assemble work		assemble	related drawing	connecting part, date
MOC	PRX	PRI	RI001	PI001		PRM	Riser Pipe procurement		procurement	estimate sheet, statement of delivery	supplier, date, info
MOC	PRO	PRI	RI001	HS001	HE001		Surface heater				
MOC	PRO	PRI	RI001	HS001	HE001	MCO	Surface heater material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RI001	HS001	HE001	GIN	Surface heater general information	general	information		general feature
MOC	PRO	PRI	RI001	HS001	HE001	DRW	Surface heater drawing		drawing	Drawing	part drawing
MOC	PRX	PRI	RI001	HS001	HE001	ASM	Surface heater assemble work		assemble	related drawing	connecting part, date
MOC	PRX	PRI	RI001	HS001	HE001	PRM	Surface heater procurement		procurement	estimate sheet, statement of delivery	supplier, date, info

PILLAR(Pool-type Intergral test facility for Lead Alloy cooled small modular Reactor) Integrated Work Breakdown Structure

LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4	LEVEL 5	LEVEL 6	LEVEL 7	FULL DESCRIPTION				
Product	Stage	Island	System	Structure	Component	Requirement	Description	SUB De1	SUB De2	related Doc	note
MOC	PRO	PRI	RI001	HS001	CN001		Heating system controller				
MOC	PRO	PRI	RI001	HS001	CN001	MCO	Heating system controller material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RI001	HS001	CN001	GIN	Heating system controller general information	general	information		general feature
MOC	PRO	PRI	RI001	TC			Thermocouple assembly				3ea
MOC	PRO	PRI	RI001	TC		GIN	Thermocouple assembly general information	general	information		general feature
MOC	PRO	PRI	RI001	TC		DRW	Thermocouple assembly drawing		drawing	Drawing	part drawing
MOC	PRX	PRI	RI001	TC		ASM	Thermocouple assembly assemble work		assemble	related drawing	connecting part, date
MOC	PRX	PRI	RI001	TC		PRM	Thermocouple assembly procurement		procurement	estimate sheet, statement of delivery	supplier, date, info
MOC	PRO	PRI	RI001	TC001		MCO	Riser Top Level Upstream Temp.	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RI001	TC002		MCO	Riser Middle Level upstream Temp.				
MOC	PRO	PRI	RI001	TC003		MCO	Riser bottom Level upstream Temp.	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RI001	LV001			Riser level sensor				
MOC	PRO	PRI	RI001	LV001		MCO	Riser level sensor	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RI001	LV001		GIN	Riser level sensor general information	general	information		general feature
MOC	PRO	PRI	RI001	LV001		DRW	Riser level sensor drawing		drawing	Drawing	part drawing
MOC	PRX	PRI	RI001	LV001		ASM	Riser level sensor assemble work		assemble	related drawing	connecting part, date
MOC	PRX	PRI	RI001	LV001		PRM	Riser level sensor procurement		procurement	estimate sheet, statement of delivery	supplier, date, info
MOC	PRO	PRI	RI001	OM001			Oxygen monitoring system				
MOC	PRO	PRI	RI001	OM001		GIN	Oxygen monitoring system general information	general	information		general feature
MOC	PRO	PRI	RI001	OM001		DRW	Oxygen monitoring system drawing		drawing	Drawing	part drawing
MOC	PRX	PRI	RI001	OM001		ASM	Oxygen monitoring system assemble work		assemble	related drawing	connecting part, date
MOC	PRX	PRI	RI001	OM001		PRM	Oxygen monitoring system procurement		procurement	estimate sheet, statement of delivery	supplier, date, info
MOC	PRO	PRI	RI001	OM001	OS001		Oxygen sensor				
MOC	PRO	PRI	RI001	OM001	OS001	MCO	Oxygen sensor material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RI001	OM001	OS001	GIN	Oxygen sensor general information	general	information		general feature
MOC	PRO	PRI	RI001	OM001	CN001		Oxygen moniter controller				
MOC	PRO	PRI	RI001	OM001	CN001	MCO	Oxygen moniter controller material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RI001	OM001	CN001	GIN	Oxygen moniter controller general information	general	information		general feature
MOC	PRO	PRI	RI001	IN001			Insulation				
MOC	PRO	PRI	RI001	IN001		MCO	Insulation material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RI001	IN001		GIN	Insulation general information	general	information		general feature
MOC	PRX	PRI	RI001	IN001		ASM	Insulation assemble work		assemble	related drawing	connecting part, date
MOC	PRX	PRI	RI001	IN001		PRM	Insulation procurement		procurement	estimate sheet, statement of delivery	supplier, date, info
MOC	PRO	PRI	RI001	VA001			Cover gas outlet valve				
MOC	PRO	PRI	RI001	VA001		MCO	Cover gas outlet valve	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RI001	VA001		GIN	Cover gas outlet valve general information	general	information		general feature
MOC	PRO	PRI	RI001	VA001		DRW	Cover gas outlet valve drawing		drawing	Drawing	part drawing
MOC	PRX	PRI	RI001	VA001		ASM	Cover gas outlet valve assemble work		assemble	related drawing	connecting part, date
MOC	PRX	PRI	RI001	VA001		PRM	Cover gas outlet valve procurement		procurement	estimate sheet, statement of delivery	supplier, date, info
MOC	PRO	PRI	HX001				Heat exchanger				
MOC	PRO	PRI	HX001			MCO	Heat exchanger material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	HX001			GIN	Heat exchanger general information	general	information		general feature
MOC	PRO	PRI	HX001	PI001			Heat exchanger Pipe				
MOC	PRO	PRI	HX001	PI001		MCO	Heat exchanger Pipe material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	HX001	PI001		DRW	Heat exchanger Pipe drawing		drawing	Drawing	part drawing
MOC	PRX	PRI	HX001	PI001		ASM	Heat exchanger Pipe assemble work		assemble	related drawing	connecting part, date
MOC	PRX	PRI	HX001	PI001		PRM	Heat exchanger Pipe procurement		procurement	estimate sheet, statement of delivery	supplier, date, info
MOC	PRO	PRI	HX001	TC			Thermocouple assembly				4ea
MOC	PRO	PRI	HX001	TC		GIN	Thermocouple assembly general information	general	information		general feature
MOC	PRO	PRI	HX001	TC		DRW	Thermocouple assembly drawing		drawing	Drawing	part drawing
MOC	PRX	PRI	HX001	TC		ASM	Thermocouple assembly assemble work		assemble	related drawing	connecting part, date
MOC	PRX	PRI	HX001	TC		PRM	Thermocouple assembly procurement		procurement	estimate sheet, statement of delivery	supplier, date, info
MOC	PRO	PRI	HX001	TC001		MCO	Heat Exchanger Area #1 Top Level Temp.	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	HX001	TC002		MCO	Heat Exchanger Area #1 Bottom Level Temp.	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	HX002	TC003		MCO	Heat Exchanger Area #2 Top Level Temp.	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	HX003	TC004		MCO	Heat Exchanger Area #2 Bottom Level Temp.	material	cost	estimate sheet, statement of delivery	supplier, date

PILLAR(Pool-type Intergral test facility for Lead Alloy cooled small modular Reactor) Integrated Work Breakdown Structure

LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4	LEVEL 5	LEVEL 6	LEVEL 7	FULL DESCRIPTION				
Product	Stage	Island	System	Structure	Component	Requirement	Description	SUB De1	SUB De2	related Doc	note
MOC	PRO	PRI	HX001	DP			H/X D/P assembly				2ea
MOC	PRO	PRI	HX001	DP		GIN	H/X D/P assembly general information	general	information		general feature
MOC	PRO	PRI	HX001	DP		DRW	H/X D/P assembly drawing		drawing	Drawing	part drawing
MOC	PRX	PRI	HX001	DP		ASM	H/X D/P assembly assemble work		assemble	related drawing	connecting part, date
MOC	PRX	PRI	HX001	DP		PRM	H/X D/P assembly procurement		procurement	estimate sheet, statement of delivery	supplier, date, info
MOC	PRO	PRI	HX001	DP001		MCO	Heat Exchanger Area #1 Differential Pressure (top-bottom)	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	HX001	DP002		MCO	Heat Exchanger Area #2 Differential Pressure (top-bottom)	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	HX001	HS001	HE001		Surface heater				
MOC	PRO	PRI	HX001	HS001	HE001	MCO	Surface heater material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	HX001	HS001	HE001	GIN	Surface heater general information	general	information		general feature
MOC	PRO	PRI	HX001	HS001	HE001	DRW	Surface heater drawing		drawing	Drawing	part drawing
MOC	PRX	PRI	HX001	HS001	HE001	ASM	Surface heater assemble work		assemble	related drawing	connecting part, date
MOC	PRX	PRI	HX001	HS001	HE001	PRM	Surface heater procurement		procurement	estimate sheet, statement of delivery	supplier, date, info
MOC	PRO	PRI	HX001	HS001	CN001		Heating system controller				
MOC	PRO	PRI	HX001	HS001	CN001	MCO	Heating system controller material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	HX001	HS001	CN001	GIN	Heating system controller general information	general	information		general feature
MOC	PRO	PRI	HX001	IN001			Insulation				
MOC	PRO	PRI	HX001	IN001		MCO	Insulation material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	HX001	IN001		GIN	Insulation general information	general	information		general feature
MOC	PRX	PRI	HX001	IN001		ASM	Insulation assemble work		assemble	related drawing	connecting part, date
MOC	PRX	PRI	HX001	IN001		PRM	Insulation procurement		procurement	estimate sheet, statement of delivery	supplier, date, info
MOC	PRO	PRI	DU001				Downcomer upper				
MOC	PRO	PRI	DU001			MCO	Downcomer upper material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	DU001			GIN	Downcomer upper general information	general	information		general feature
MOC	PRO	PRI	DU001	PI001			Downcomer upper Pipe				
MOC	PRO	PRI	DU001	PI001		MCO	Downcomer upper Pipe material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	DU001	PI001		DRW	Downcomer upper Pipe drawing		drawing	Drawing	part drawing
MOC	PRX	PRI	DU001	PI001		ASM	Downcomer upper Pipe assemble work		assemble	related drawing	connecting part, date
MOC	PRX	PRI	DU001	PI001		PRM	Downcomer upper Pipe procurement		procurement	estimate sheet, statement of delivery	supplier, date, info
MOC	PRO	PRI	DU001	MF001			Mass flow meter				
MOC	PRO	PRI	DU001	MF001		MCO	Mass flow meter material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	DU001	MF001		DRW	Mass flow meter drawing		drawing	Drawing	part drawing
MOC	PRX	PRI	DU001	MF001		ASM	Mass flow meterassemble work		assemble	related drawing	connecting part, date
MOC	PRX	PRI	DU001	MF001		PRM	Mass flow meter procurement		procurement	estimate sheet, statement of delivery	supplier, date, info
MOC	PRO	PRI	DU001	TC			Thermocouple assembly				4ea
MOC	PRO	PRI	DU001	TC		GIN	Thermocouple assembly general information	general	information		general feature
MOC	PRO	PRI	DU001	TC		DRW	Thermocouple assembly drawing		drawing	Drawing	part drawing
MOC	PRX	PRI	DU001	TC		ASM	Thermocouple assembly assemble work		assemble	related drawing	connecting part, date
MOC	PRX	PRI	DU001	TC		PRM	Thermocouple assembly procurement		procurement	estimate sheet, statement of delivery	supplier, date, info
MOC	PRO	PRI	DU001	TC001		MCO	Downcomer Area #1 Top Level Temp.	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	DU001	TC002		MCO	Downcomer Area #1 Bottom Level Temp.	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	DU001	TC003		MCO	Downcomer Area #2 Top Level Temp.	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	DU001	TC004		MCO	Downcomer Area #2 Bottom Level Temp.	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	DU001	HS001	HE001		Surface heater				
MOC	PRO	PRI	DU001	HS001	HE001	MCO	Surface heater material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	DU001	HS001	HE001	GIN	Surface heater general information	general	information		general feature
MOC	PRO	PRI	DU001	HS001	HE001	DRW	Surface heater drawing		drawing	Drawing	part drawing
MOC	PRX	PRI	DU001	HS001	HE001	ASM	Surface heater assemble work		assemble	related drawing	connecting part, date
MOC	PRX	PRI	DU001	HS001	HE001	PRM	Surface heater procurement		procurement	estimate sheet, statement of delivery	supplier, date, info
MOC	PRO	PRI	DU001	HS001	CN001		Heating system controller				
MOC	PRO	PRI	DU001	HS001	CN001	MCO	Heating system controller	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	DU001	HS001	CN001	GIN	Heating system controller general information	general	information		general feature
MOC	PRO	PRI	DU001	IN001			Insulation				
MOC	PRO	PRI	DU001	IN001		MCO	Insulation material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	DU001	IN001		GIN	Insulation general information	general	information		general feature
MOC	PRX	PRI	DU001	IN001		ASM	Insulation assemble work		assemble	related drawing	connecting part, date
MOC	PRX	PRI	DU001	IN001		PRM	Insulation procurement		procurement	estimate sheet, statement of delivery	supplier, date, info
MOC	PRO	PRI	DU001	EP001			EM pump				
MOC	PRO	PRI	DU001	EP001		GIN	EM pump general information	general	information		general feature
MOC	PRO	PRI	DU001	EP001		MCO	EM pump material cost	material	cost	estimate sheet, statement of delivery	supplier, date

PILLAR(Pool-type Intergral test facility for Lead Alloy cooled small modular Reactor) Integrated Work Breakdown Structure

FULL DESCRIPTION											
LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4	LEVEL 5	LEVEL 6	LEVEL 7	Description	SUB De1	SUB De2	related Doc	note
Product	Stage	Island	System	Structure	Component	Requirement					
MOC	PRO	PRI	DB001				Downcomer lower				
MOC	PRO	PRI	DB001			MCO	Downcomer lower material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	DB001			GIN	Downcomer lower general information	general	information		general feature
MOC	PRO	PRI	DB001	BA001			Downcomer barrel				
MOC	PRO	PRI	DB001	BA001		MCO	Downcomer barrel material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	DB001	HS001	HE001		Surface heater				
MOC	PRO	PRI	DB001	HS001	HE001	MCO	Surface heater material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	DB001	HS001	HE001	GIN	Surface heater general information	general	information		general feature
MOC	PRO	PRI	DB001	HS001	HE001	DRW	Surface heater drawing		drawing	Drawing	part drawing
MOC	PRX	PRI	DB001	HS001	HE001	ASM	Surface heater assemble work		assemble	related drawing	connecting part, date
MOC	PRX	PRI	DB001	HS001	HE001	PRM	Surface heater procurement		procurement	estimate sheet, statement of delivery	supplier, date, info
MOC	PRO	PRI	DB001	HS001	CN001		Heating system controller				
MOC	PRO	PRI	DB001	HS001	CN001	MCO	Heating system controller material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	DB001	HS001	CN001	GIN	Heating system controller general information	general	information		general feature
MOC	PRO	PRI	DB001	IN001			Insulation				
MOC	PRO	PRI	DB001	IN001		MCO	Insulation material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	DB001	IN001		GIN	Insulation general information	general	information		general feature
MOC	PRX	PRI	DB001	IN001		ASM	Insulation assemble work		assemble	related drawing	connecting part, date
MOC	PRX	PRI	DB001	IN001		PRM	Insulation procurement		procurement	estimate sheet, statement of delivery	supplier, date, info
MOC	PRO	PRI	RS001				R/V lower structure				
MOC	PRO	PRI	RS001			MCO	R/V lower structure material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001			GIN	R/V lower structure general information	general	information		general feature
MOC	PRO	PRI	RS001	BA001			R/V lower structure barrel				
MOC	PRO	PRI	RS001	BA001		MCO	R/V lower structure barrel material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	HS001	HE001		Surface heater				
MOC	PRO	PRI	RS001	HS001	HE001	MCO	Surface heater material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	HS001	HE001	GIN	Surface heater general information	general	information		general feature
MOC	PRO	PRI	RS001	HS001	HE001	DRW	Surface heater drawing		drawing	Drawing	part drawing
MOC	PRX	PRI	RS001	HS001	HE001	ASM	Surface heater assemble work		assemble	related drawing	connecting part, date
MOC	PRX	PRI	RS001	HS001	HE001	PRM	Surface heater procurement		procurement	estimate sheet, statement of delivery	supplier, date, info
MOC	PRO	PRI	RS001	HS001	CN001		Heating system controller				
MOC	PRO	PRI	RS001	HS001	CN001	MCO	Heating system controller material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	HS001	CN001	GIN	Heating system controller general information	general	information		general feature
MOC	PRO	PRI	RS001	TC			Thermocouple assembly				92ea
MOC	PRO	PRI	RS001	TC		GIN	Thermocouple assembly general information	general	information		general feature
MOC	PRO	PRI	RS001	TC		DRW	Thermocouple assembly drawing		drawing	Drawing	part drawing
MOC	PRX	PRI	RS001	TC		ASM	Thermocouple assembly assemble work		assemble	related drawing	connecting part, date
MOC	PRX	PRI	RS001	TC		PRM	Thermocouple assembly procurement		procurement	estimate sheet, statement of delivery	supplier, date, info
MOC	PRO	PRI	RS001	TC001		MCO	R/V 1st Section Temp #1	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC002		MCO	R/V 1st Section Temp #2	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC003		MCO	R/V 1st Section Temp #3	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC004		MCO	R/V 1st Section Temp #4	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC005		MCO	R/V 2nd Section Temp #1	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC006		MCO	R/V 2nd Section Temp #2	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC007		MCO	R/V 2nd Section Temp #3	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC008		MCO	R/V 2nd Section Temp #4	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC009		MCO	R/V 2nd Section Temp #5	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC010		MCO	R/V 2nd Section Temp #6	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC011		MCO	R/V 2nd Section Temp #7	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC012		MCO	R/V 2nd Section Temp #8	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC013		MCO	R/V 2nd Section Temp #9	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC014		MCO	R/V 2nd Section Temp #10	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC015		MCO	R/V 2nd Section Temp #11	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC016		MCO	R/V 2nd Section Temp #12	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC017		MCO	R/V 2nd Section Temp #13	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC018		MCO	R/V 2nd Section Temp #14	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC019		MCO	R/V 2nd Section Temp #15	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC020		MCO	R/V 2nd Section Temp #16	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC021		MCO	R/V 3rd Section Temp #1	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC022		MCO	R/V 3rd Section Temp #2	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC023		MCO	R/V 3rd Section Temp #3	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC024		MCO	R/V 3rd Section Temp #4	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC025		MCO	R/V 3rd Section Temp #5	material	cost	estimate sheet, statement of delivery	supplier, date

PILLAR(Pool-type Intergral test facility for Lead Alloy cooled small modular Reactor) Integrated Work Breakdown Structure

FULL DESCRIPTION											
LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4	LEVEL 5	LEVEL 6	LEVEL 7	Description	SUB De1	SUB De2	related Doc	note
Product	Stage	Island	System	Structure	Component	Requirement					
MOC	PRO	PRI	RS001	TC026		MCO	R/V 3rd Section Temp #6	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC027		MCO	R/V 3rd Section Temp #7	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC028		MCO	R/V 3rd Section Temp #8	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC029		MCO	R/V 3rd Section Temp #9	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC030		MCO	R/V 3rd Section Temp #10	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC031		MCO	R/V 3rd Section Temp #11	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC032		MCO	R/V 3rd Section Temp #12	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC033		MCO	R/V 3rd Section Temp #13	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC034		MCO	R/V 3rd Section Temp #14	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC035		MCO	R/V 3rd Section Temp #15	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC036		MCO	R/V 3rd Section Temp #16	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC037		MCO	R/V 3rd Section Temp #17	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC038		MCO	R/V 3rd Section Temp #18	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC039		MCO	R/V 3rd Section Temp #19	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC040		MCO	R/V 3rd Section Temp #20	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC041		MCO	R/V 3rd Section Temp #21	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC042		MCO	R/V 3rd Section Temp #22	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC043		MCO	R/V 3rd Section Temp #23	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC044		MCO	R/V 3rd Section Temp #24	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC045		MCO	R/V 4th Section Temp #1	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC046		MCO	R/V 4th Section Temp #2	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC047		MCO	R/V 4th Section Temp #3	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC048		MCO	R/V 4th Section Temp #4	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC049		MCO	R/V 4th Section Temp #5	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC050		MCO	R/V 4th Section Temp #6	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC051		MCO	R/V 4th Section Temp #7	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC052		MCO	R/V 4th Section Temp #8	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC053		MCO	R/V 4th Section Temp #9	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC054		MCO	R/V 4th Section Temp #10	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC055		MCO	R/V 4th Section Temp #11	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC056		MCO	R/V 4th Section Temp #12	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC057		MCO	R/V 4th Section Temp #13	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC058		MCO	R/V 4th Section Temp #14	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC059		MCO	R/V 4th Section Temp #15	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC060		MCO	R/V 4th Section Temp #16	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC061		MCO	R/V 4th Section Temp #17	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC062		MCO	R/V 4th Section Temp #18	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC063		MCO	R/V 4th Section Temp #19	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC064		MCO	R/V 4th Section Temp #20	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC065		MCO	R/V 4th Section Temp #21	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC066		MCO	R/V 4th Section Temp #22	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC067		MCO	R/V 4th Section Temp #23	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC068		MCO	R/V 4th Section Temp #24	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC069		MCO	R/V 5th Section Temp #1	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC070		MCO	R/V 5th Section Temp #2	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC071		MCO	R/V 5th Section Temp #3	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC072		MCO	R/V 5th Section Temp #4	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC073		MCO	R/V 5th Section Temp #5	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC074		MCO	R/V 5th Section Temp #6	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC075		MCO	R/V 5th Section Temp #7	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC076		MCO	R/V 5th Section Temp #8	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC077		MCO	R/V 5th Section Temp #9	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC078		MCO	R/V 5th Section Temp #10	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC079		MCO	R/V 5th Section Temp #11	material	cost	estimate sheet, statement of delivery	supplier, date

PILLAR(Pool-type Intergral test facility for Lead Alloy cooled small modular Reactor) Integrated Work Breakdown Structure

FULL DESCRIPTION											
LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4	LEVEL 5	LEVEL 6	LEVEL 7	Description	SUB De1	SUB De2	related Doc	note
Product	Stage	Island	System	Structure	Component	Requirement					
MOC	PRO	PRI	RS001	TC080		MCO	R/V 5th Section Temp #12	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC081		MCO	R/V 5th Section Temp #13	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC082		MCO	R/V 5th Section Temp #14	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC083		MCO	R/V 5th Section Temp #15	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC084		MCO	R/V 5th Section Temp #16	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC085		MCO	R/V 5th Section Temp #17	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC086		MCO	R/V 5th Section Temp #18	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC087		MCO	R/V 5th Section Temp #19	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC088		MCO	R/V 5th Section Temp #20	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC089		MCO	R/V 5th Section Temp #21	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC090		MCO	R/V 5th Section Temp #22	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC091		MCO	R/V 5th Section Temp #23	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	TC092		MCO	R/V 5th Section Temp #24	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	IN001			Insulation				
MOC	PRO	PRI	RS001	IN001		MCO	Insulation material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	RS001	IN001		GIN	Insulation general information	general	information		general feature
MOC	PRX	PRI	RS001	IN001		ASM	Insulation assemble work		assemble	related drawing	connecting part, date
MOC	PRX	PRI	RS001	IN001		PRM	Insulation procurement		procurement	estimate sheet, statement of delivery	supplier, date, info
MOC	PRO	PRI	CL001				LBE coolant				
MOC	PRO	PRI	CL001			MCO	LBE coolant material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	PRI	CL001			GIN	LBE coolant general information	general	information		general feature
MOC		SEC					PILLAR secondary				
MOC	PRO	SEC				CDE	PILLAR secondary conceptual design	conceptual	design	Desigh requirement report, review Doc	Design result
MOC	PRO	SEC				SDE	PILLAR secondary specific design	detailed	design	Desigh report, review Doc	Design result
MOC	PRO	SEC				TAN	PILLAR secondary thermal-hydraulic analysis	thermal-hydraulic	analysis	result document	T/H analysis data
MOC	PRX	SEC				OMA	PILLAR secondary operation manual	operation	manual	manual handbook	define operation procedure
MOC	PRE	SEC				PFW	PILLAR secondary planning process flow	planning	process flow	flow chart	define flow chart
MOC	PRE	SEC				WFW	PILLAR secondary work process flow	work	process flow	flow chart	define flow chart
MOC	PRO	SEC				PFW	PILLAR secondary planning process flow	planning	process flow	flow chart	define flow chart
MOC	PRO	SEC				WFW	PILLAR secondary work process flow	work	process flow	flow chart	define flow chart
MOC	PRX	SEC				PFW	PILLAR construction secondary planning process flow	planning	process flow	flow chart	define flow chart
MOC	PRX	SEC				WFW	PILLAR construction secondary work process flow	work	process flow	flow chart	define flow chart
MOC	PRC	SEC				PFW	PILLAR secondary planning process flow	planning	process flow	flow chart	define flow chart
MOC	PRC	SEC				WFW	PILLAR secondary work process flow	work	process flow	flow chart	define flow chart
MOC	PRE	SEC				QNA	PILLAR secondary quality assurance		QA	QA Document	QA result
MOC	PRO	SEC				QNA	PILLAR secondary quality assurance		QA	QA Document	QA result
MOC	PRX	SEC				QNA	PILLAR secondary quality assurance		QA	QA Document	QA result
MOC	PRC	SEC				QNA	PILLAR secondary quality assurance		QA	QA Document	QA result
MOC	PRO	SEC				AFE	PILLAR secondary assemble feasibility	assemble	feasibility	feasibility analysis result	feasibility analysis
MOC	PRX	SEC				ITE	PILLAR secondary integity test	integrity	test	test result	system integrity test
MOC	PRO	SEC				SCO	PILLAR secondary cost sum	sum	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	SEC				MCO	PILLAR secondary material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	SEC				WCO	PILLAR secondary manpower cost	man power	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRC	SEC				DCT	PILLAR decommissioning termination	decommissioning	termination	termination plan	termination planning
MOC	PRC	SEC				DCP	PILLAR secondary decommissioning planning	decommissioning	planning	result document	establish planning
MOC	PRC	SEC				DCD	PILLAR secondary decommissioning dismantling	decommissioning	dismantling	result document	establish dismatling planning
MOC	PRO	SEC	CS001				Cooling system				
MOC	PRO	SEC	CS001			MCO	Cooling system material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	SEC	CS001			GIN	Cooling system general information	general	information		general feature
MOC	PRO	SEC	CS001	PI001			Cooling system Pipe				
MOC	PRO	SEC	CS001	PI001		MCO	Cooling system Pipe material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	SEC	CS001	PI001		DRW	Cooling system Pipe drawing		drawing	Drawing	part drawing
MOC	PRX	SEC	CS001	PI001		ASM	Cooling system Pipe assemble work		assemble	related drawing	connecting part, date
MOC	PRX	SEC	CS001	PI001		PRM	Cooling system Pipe procurement		procurement	estimate sheet, statement of delivery	supplier, date, info

PILLAR(Pool-type Intergral test facility for Lead Alloy cooled small modular Reactor) Integrated Work Breakdown Structure

LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4	LEVEL 5	LEVEL 6	LEVEL 7	FULL DESCRIPTION				
Product	Stage	Island	System	Structure	Component	Requirement	Description	SUB De1	SUB De2	related Doc	note
MOC	PRO	SEC	CS001	TC			Thermocouple assembly				2ea
MOC	PRO	SEC	CS001	TC		GIN	Thermocouple assembly general information	general	information		general feature
MOC	PRO	SEC	CS001	TC		DRW	Thermocouple assembly drawing		drawing	Drawing	part drawing
MOC	PRX	SEC	CS001	TC		ASM	Thermocouple assembly assemble work		assemble	related drawing	connecting part, date
MOC	PRX	SEC	CS001	TC		PRM	Thermocouple assembly procurement		procurement	estimate sheet, statement of delivery	supplier, date, info
MOC	PRO	SEC	CS001	TC001		MCO	Outlet Coolant Temperature	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	SEC	CS001	TC002		MCO	Inlet Coolant Temperature	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	SEC	CS001	MF001			Mass flow meter				
MOC	PRO	SEC	CS001	MF001		MCO	Mass flow meter material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	SEC	CS001	MF001		DRW	Mass flow meter drawing		drawing	Drawing	part drawing
MOC	PRX	SEC	CS001	MF001		ASM	Mass flow meterassemble work		assemble	related drawing	connecting part, date
MOC	PRX	SEC	CS001	MF001		PRM	Mass flow meter procurement		procurement	estimate sheet, statement of delivery	supplier, date, info
MOC	PRO	SEC	CS001	PU001			No.1 pump				
MOC	PRO	SEC	CS001	PU001		MCO	No.1 pump material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	SEC	CS001	PU001		DRW	No.1 pump drawing		drawing	Drawing	part drawing
MOC	PRX	SEC	CS001	PU001		ASM	No.1 pump assemble work		assemble	related drawing	connecting part, date
MOC	PRX	SEC	CS001	PU001		PRM	No.1 pump procurement		procurement	estimate sheet, statement of delivery	supplier, date, info
MOC	PRO	SEC	CH001				No.1 chiller				
MOC	PRO	SEC	CH001			MCO	No.1 chiller material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	SEC	CH001			GIN	No.1 chiller general information	general	information		general feature
MOC	PRO	SEC	CH001			DRW	No.1 chiller drawing		drawing	Drawing	part drawing
MOC	PRX	SEC	CH001			ASM	No.1 chiller assemble work		assemble	related drawing	connecting part, date
MOC	PRX	SEC	CH001			PRM	No.1 chiller procurement		procurement	estimate sheet, statement of delivery	supplier, date, info
MOC	PRO	SEC	CH001	CN001		MCO	No.1 chiller control system	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	SEC	CH001	CN001		GIN	No.1 chiller control system general information	general	information		general feature
MOC	PRO	SEC	CS001	IN001			Insulation				
MOC	PRO	SEC	CS001	IN001		MCO	Insulation material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRX	SEC	CS001	IN001		ASM	Insulation assemble work		assemble	related drawing	connecting part, date
MOC	PRX	SEC	CS001	IN001		PRM	Insulation procurement		procurement	estimate sheet, statement of delivery	supplier, date, info
MOC	PRO	SEC	CL001				Secondary coolant				
MOC	PRO	SEC	CL001			MCO	Secondary coolant material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	SEC	CL001			GIN	Secondary coolant general information	general	information		general feature
MOC		INC					PILLAR I&C				
MOC	PRO	INC				CDE	PILLAR I&C conceptual design	conceptual	design	Desigh requirement report	Design result
MOC	PRO	INC				SDE	PILLAR I&C detailed design	detailed	design	Desigh report	Design result
MOC	PRX	INC				OMA	PILLAR I&C operation manual	operation	manual	manual handbook	define operation procedure
MOC	PRE	INC				PFW	PILLAR I&C planning process flow	planning	process flow	flow chart	define flow chart
MOC	PRE	INC				WFW	PILLAR I&C work process flow	work	process flow	flow chart	define flow chart
MOC	PRO	INC				PFW	PILLAR I&C planning process flow	planning	process flow	flow chart	define flow chart
MOC	PRO	INC				WFW	PILLAR I&C work process flow	work	process flow	flow chart	define flow chart
MOC	PRX	INC				PFW	PILLAR I&C planning process flow	planning	process flow	flow chart	define flow chart
MOC	PRX	INC				WFW	PILLAR I&C work process flow	work	process flow	flow chart	define flow chart
MOC	PRC	INC				PFW	PILLAR I&C planning process flow	planning	process flow	flow chart	define flow chart
MOC	PRC	INC				WFW	PILLAR I&C work process flow	work	process flow	flow chart	define flow chart
MOC	PRX	INC				QNA	PILLAR I&C quality assurance		QA	QA Document	QA result
MOC	PRO	INC				AFE	PILLAR I&C assemble feasibility	assemble	feasibility	feasibility analysis result	feasibility analysis
MOC	PRX	INC				ITE	PILLAR I&C integity test	integrity	test	test result	system integrity test
MOC	PRO	INC				SCO	PILLAR I&C sum cost	sum	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	INC				MCO	PILLAR I&C material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	INC				WCO	PILLAR I&C manpower cost	manpower	cost	estimate sheet, statement of delivery	supplier, date

PILLAR(Pool-type Intergral test facility for Lead Alloy cooled small modular Reactor) Integrated Work Breakdown Structure

FULL DESCRIPTION

LEVEL 1 Product	LEVEL 2 Stage	LEVEL 3 Island	LEVEL 4 System	LEVEL 5 Structure	LEVEL 6 Component	LEVEL 7 Requirement	Description	SUB De1	SUB De2	related Doc	note
MOC	PRO	INC	DA001	DS001			PILLAR I&C DAC (Data Acquisition & Control) system				
MOC	PRO	INC	DA001	DS001		MCO	PILLAR I&C DAC system material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	INC	DA001	DS001		GIN	PILLAR I&C DAC system general information	general	information		general feature
MOC	PRX	INC	DA001	DS001		PRM	PILLAR I&C DAC system procurement		procurement	estimate sheet, statement of delivery	supplier, date, info
MOC	PRO	INC	DA001	DC001			PILLAR I&C DAC PC				
MOC	PRO	INC	DA001	DC001		MCO	PILLAR I&C DAC PC material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	INC	DA001	DC001		GIN	PILLAR I&C DAC PC general information	general	information		general feature
MOC	PRX	INC	DA001	DC001		PRM	PILLAR I&C DAC PC procurement		procurement	estimate sheet, statement of delivery	supplier, date, info
MOC	PRO	INC	DA001	PS001			PILLAR I&C power control system				
MOC	PRO	INC	DA001	PS001		MCO	PILLAR I&C power control system material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	INC	DA001	PS001		GIN	PILLAR I&C power control system general information	general	information		general feature
MOC	PRO	INC	DA001	PS001		DRW	PILLAR I&C power control system drawing		drawing	Drawing	part drawing
MOC	PRX	INC	DA001	PS001		ASM	PILLAR I&C power control system assemble work		assemble	related drawing	connecting part, date
MOC	PRX	INC	DA001	PS001		PRM	PILLAR I&C power control system procurement		procurement	estimate sheet, statement of delivery	supplier, date, info
MOC	PRC	INC				DCT	PILLAR I&C decommissioning termination	decommissioning	termination	termination plan	termination planning
MOC	PRC	INC				DCP	PILLAR I&C decommissioning planning	decommissioning	planning	result document	establish planning
MOC	PRC	INC				DCD	PILLAR I&C decommissioning dismantling	decommissioning	dismantling	result document	establish dismatling planning
MOC		EPS					Electrical power systems				
MOC	PRO	EPS				CDE	Electrical power systems conceptual design	conceptual	design	Desigh requirement report	Design result
MOC	PRO	EPS				SDE	Electrical power systems detailed design	detailed	design	Desigh report	Design result
MOC	PRE	EPS				PFW	Electrical power systems planning process flow	planning	process flow	flow chart	define flow chart
MOC	PRE	EPS				WFW	Electrical power systems work process flow	work	process flow	flow chart	define flow chart
MOC	PRO	EPS				PFW	Electrical power systems planning process flow	planning	process flow	flow chart	define flow chart
MOC	PRO	EPS				WFW	Electrical power systems work process flow	work	process flow	flow chart	define flow chart
MOC	PRX	EPS				QNA	Electrical power systems quality assurance		QA	QA Document	QA result
MOC	PRO	EPS				AFE	Electrical power systems assemble feasibility	assemble	feasibility	feasibility analysis result	feasibility analysis
MOC	PRO	EPS				MCO	Electrical power systems material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	EPS				GIN	Electrical power systems general information	general	information		general feature
MOC	PRO	EPS				DRW	Electrical power systems drawing		drawing	Drawing	part drawing
MOC	PRX	EPS				ASM	Electrical power systems assemble work		assemble	related drawing	connecting part, date
MOC	PRX	EPS				PRM	Electrical power systems procurement		procurement	estimate sheet, statement of delivery	supplier, date, info
MOC	PRO	EPS				SCO	Electrical power systems cost sum	sum	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	EPS				MCO	Electrical power systems material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	EPS				WCO	Electrical power systems manpower cost	manpower	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	EPS	HS001	VC001		MCO	High voltage vaccum circuit breaker	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	EPS	HS001	AC001		MCO	No.1 High voltage air circuit breaker	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	EPS	HS001	AC002		MCO	No.2 High voltage air circuit breaker	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	EPS	HS001	AC003		MCO	No.3 High voltage air circuit breaker	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	EPS	HS001	TR001		MCO	380V 3 phase transformer material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	EPS	HS001	TR002		MCO	220V 3 phase transformer material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	EPS	HS001	TR003		MCO	110V 1 phase transformer material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	EPS	HS001	TR004		MCO	460V 3 phase transformer material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	EPS	HS001	WI001		MCO	Wire material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	EPS	HS001	ET001		MCO	Extra material material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC		SST					PILLAR supporting structure				
MOC	PRO	SST				CDE	PILLAR supporting structure conceptual design	conceptual	design	Desigh requirement report	Design result
MOC	PRO	SST				SDE	PILLAR supporting structure specific design	detailed	design	Desigh report	Design result
MOC	PRO	SST				STA	PILLAR supporting structure structural analysis report	structural	report	structural analysis report	structural analysis
MOC	PRE	SST				PFW	PILLAR supporting structure planning process flow	planning	process flow	flow chart	define flow chart
MOC	PRE	SST				WFW	PILLAR supporting structure work process flow	work	process flow	flow chart	define flow chart
MOC	PRO	SST				PFW	PILLAR supporting structure planning process flow	planning	process flow	flow chart	define flow chart
MOC	PRO	SST				WFW	PILLAR supporting structure work process flow	work	process flow	flow chart	define flow chart
MOC	PRX	SST				QNA	PILLAR supporting structure quality assurance		QA	QA Document	QA result
MOC	PRO	SST				AFE	PILLAR supporting structure assemble feasibility	assemble	feasibility	feasibility analysis result	feasibility analysis
MOC	PRO	SST				SAN	PILLAR supporting structural analysis	structural	analysis	result document	strutural analysis data
MOC	PRO	SST				SCO	PILLAR supporting structure sum cost	sum	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	SST				MCO	PILLAR supporting structure material cost	material	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	SST				WCO	PILLAR supporting structure manpower cost	manpower	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRO	SST				GIN	PILLAR supporting structure general information	general	information		general feature
MOC	PRO	SST				DRW	PILLAR supporting structure drawing		drawing	Drawing	part drawing
MOC	PRX	SST				ASM	PILLAR supporting structure assemble work		assemble	related drawing	connecting part, date
MOC	PRX	SST				PRM	PILLAR supporting structure procurement		procurement	estimate sheet, statement of delivery	supplier, date, info
MOC	PRO	SST				WCO	HELIOS dismantling work manpower cost	manpower	cost	estimate sheet, statement of delivery	supplier, date
MOC	PRC	SST				DCT	PILLAR supporting structure decommissioning termination	decommissioning	termination	termination plan	termination planning
MOC	PRC	SST				DCP	PILLAR supporting structure decommissioning planning	decommissioning	planning	result document	establish planning
MOC	PRC	SST				DCD	PILLAR supporting structure decommissioning dismantling	decommissioning	dismantling	result document	establish dismatling planning

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 부하추종 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 프로젝트를 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

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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