Configuration Management Information System for Korean NPP

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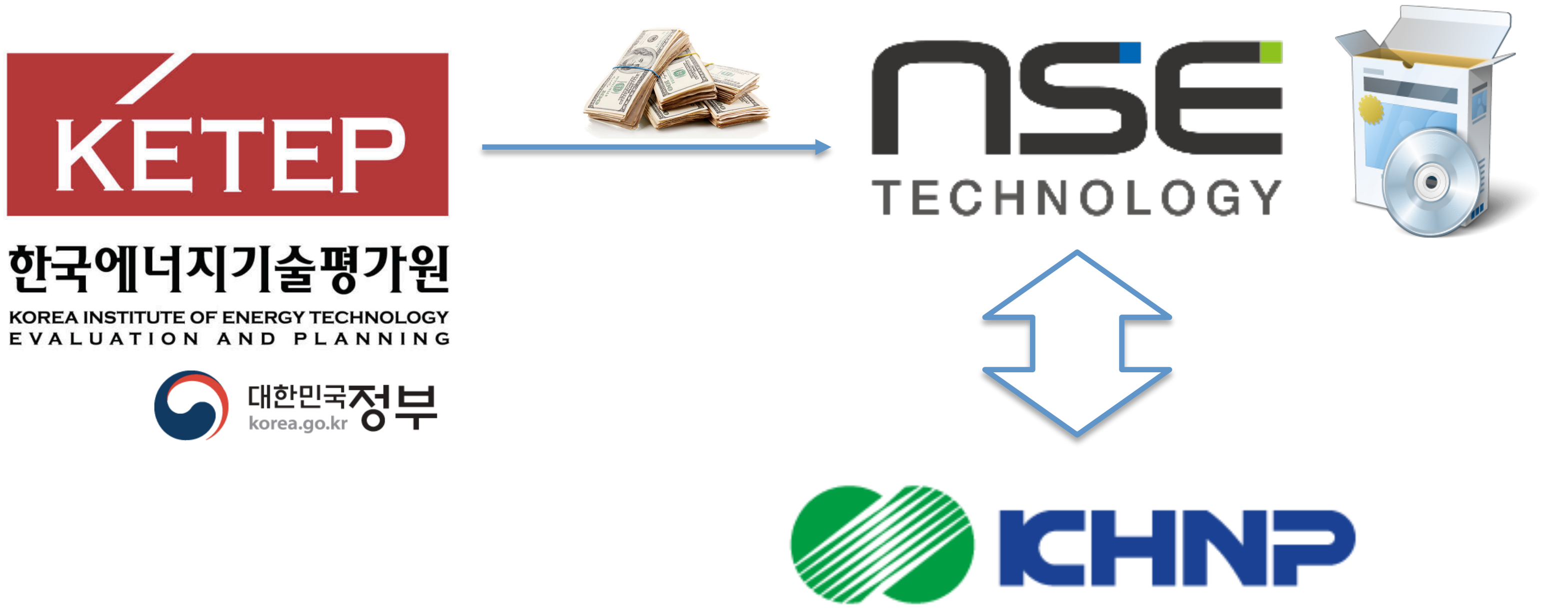
2017. 6. 14

1. Overview

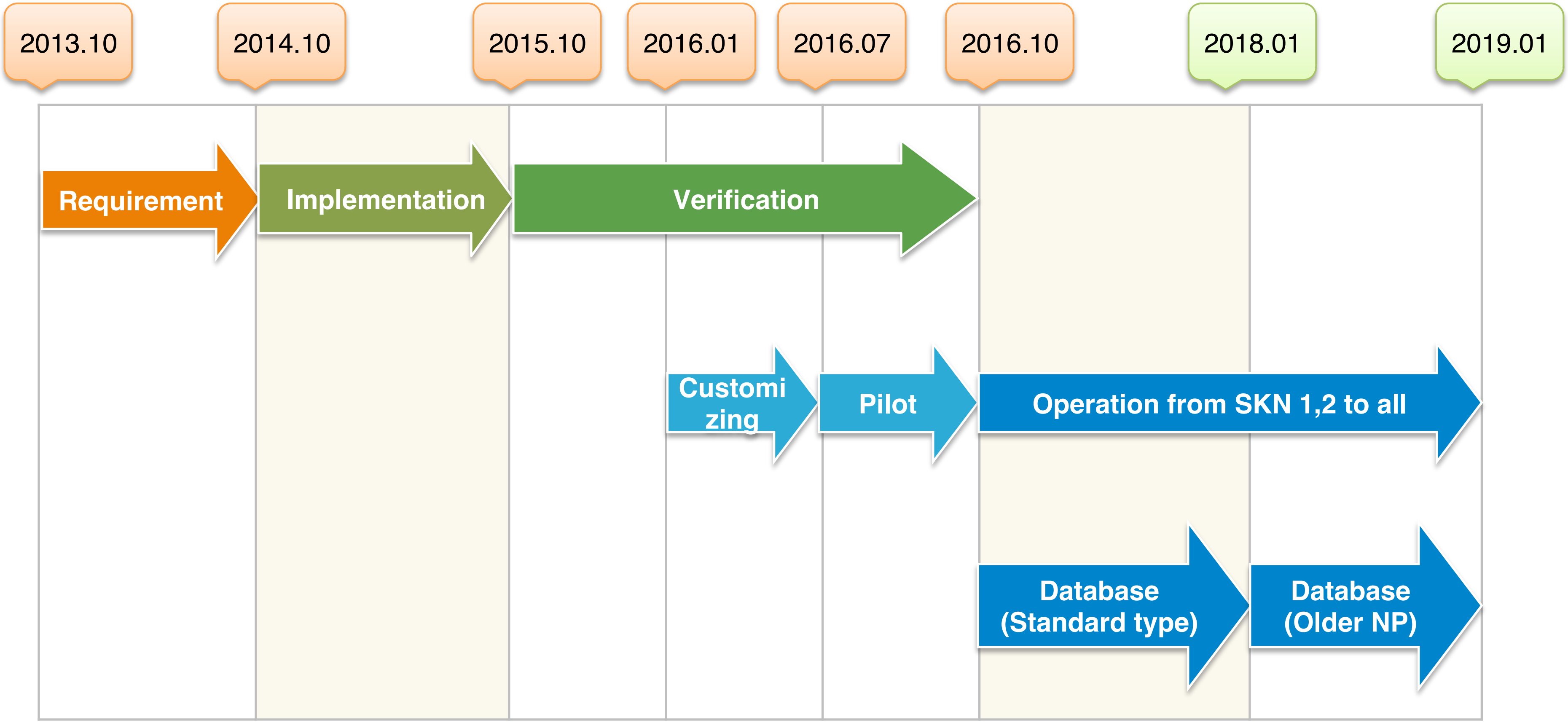
1. Project Overview

Development of Configuration Management Platform for Operating NPP

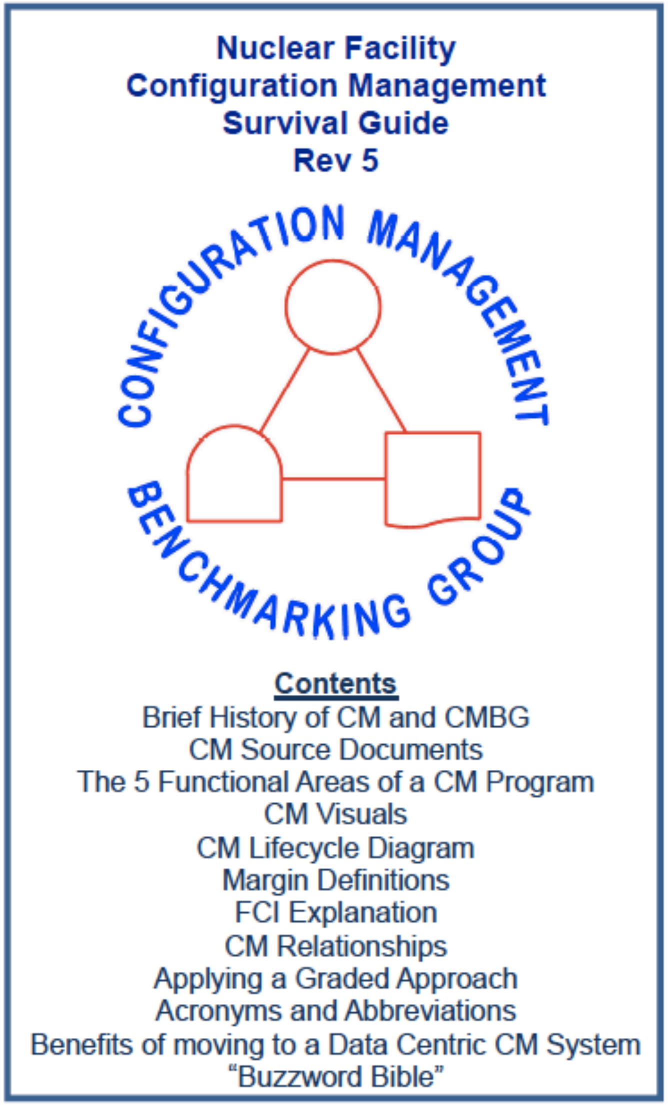

KETEP
한국에너지기술평가원
KOREA INSTITUTE OF ENERGY TECHNOLOGY EVALUATION AND PLANNING
대한민국정부
korea.go.kr
NSE TECHNOLOGY
KHNP

2. Project Schedule

Development of Configuration Management Platform for Operating NPP


2013.10
2014.10
2015.10
2016.01
2016.07
2016.10
2018.01
2019.01
Requirement
Implementation
Verification
Customi zing
Pilot
Operation from SKN 1,2 to all
Database (Standard type)
Database (Older NP)

3. Design Principles



Nuclear Facility
Configuration Management
Survival Guide
Rev 5

CONFIGURATION MANAGEMENT
BENCHMARKING GROUP

Contents

Brief History of CM and CMBG
CM Source Documents
The 5 Functional Areas of a CM Program
CM Visuals
CM Lifecycle Diagram
Margin Definitions
FCI Explanation
CM Relationships
Applying a Graded Approach
Acronyms and Abbreviations
Benefits of moving to a Data Centric CM System
"Buzzword Bible"

CM Visuals
(CM Equilibrium & INPO AP-929)

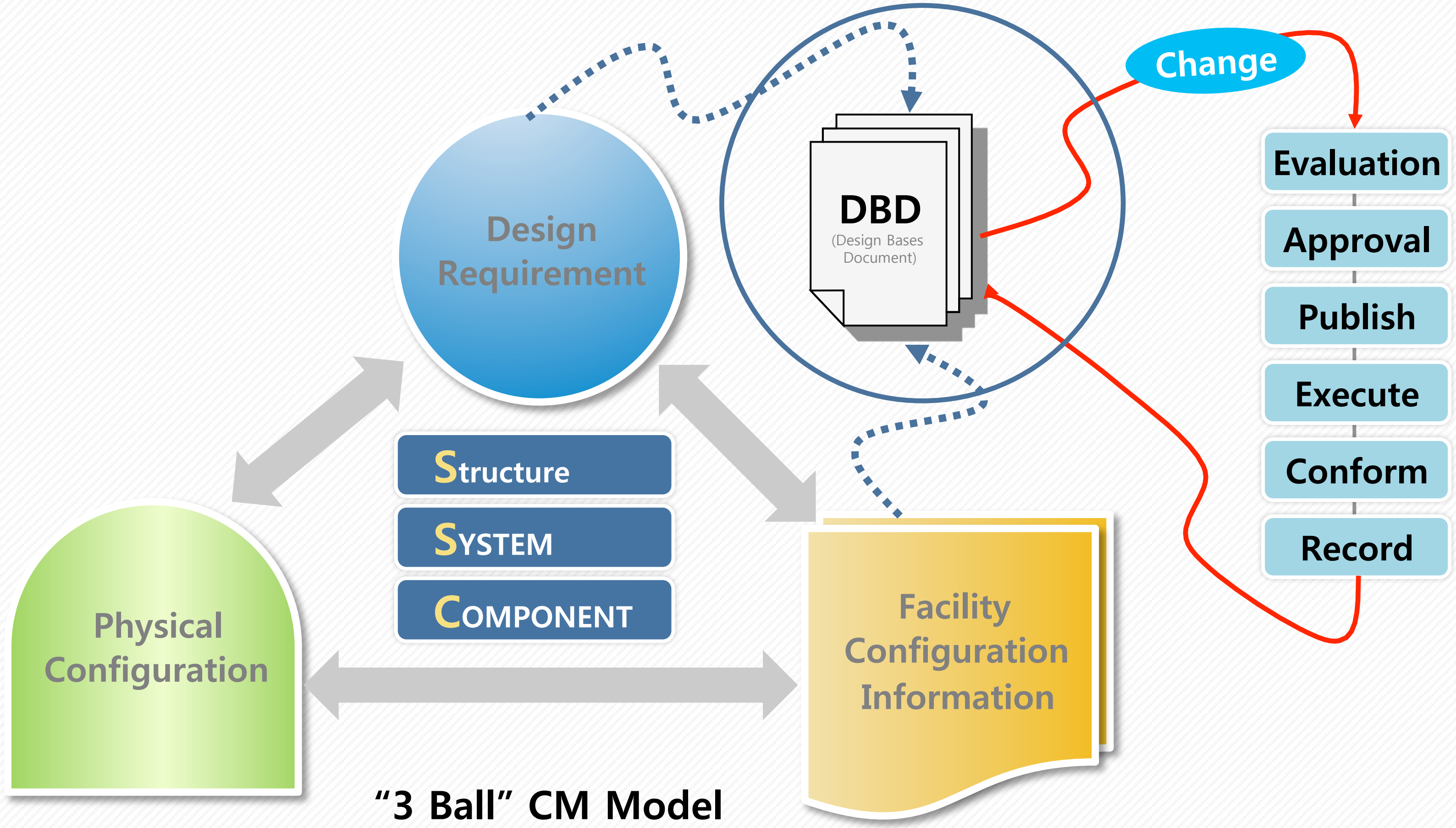
CM Life Cycle Diagram

Margin Definitions

Benefits of moving to
a Data Centric CM System

4. Project Goals

❖ CM Equilibrium

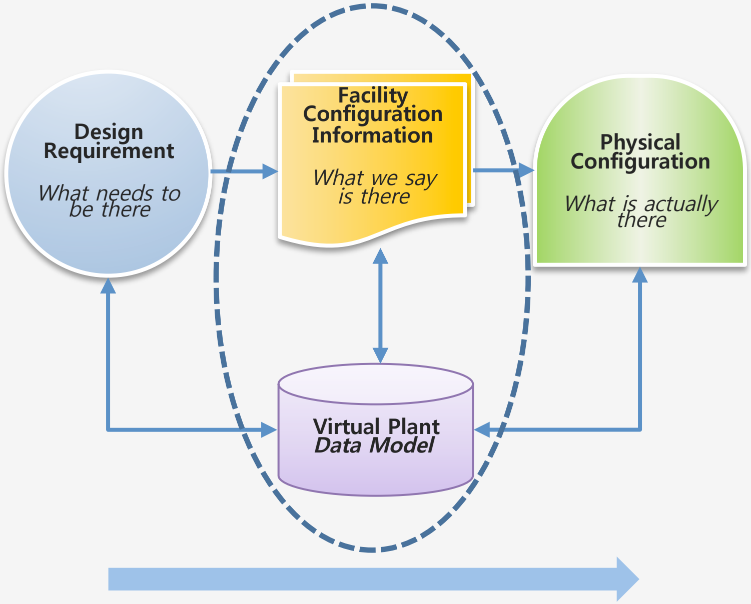
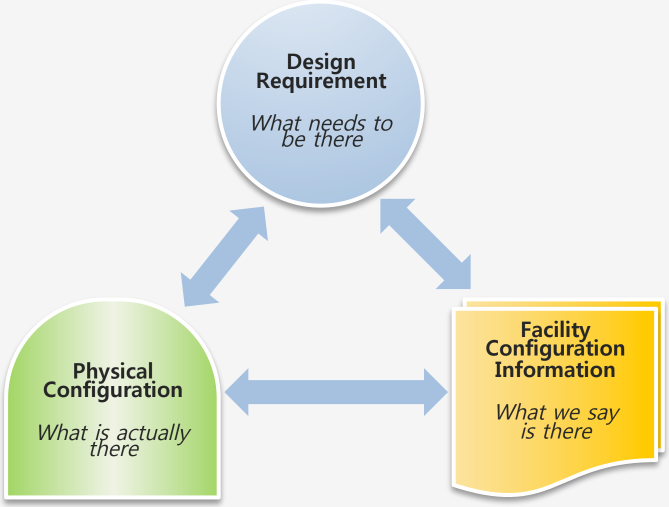

Design Requirement
DBD
(Design Bases Document)
Change
Evaluation
Approval
Publish
Execute
Conform
Record
Structure
SYSTEM
COMPONENT
Physical Configuration
Facility Configuration Information

"3 Ball" CM Model

(ANSI/NIRMAR, IAEA-TECDOC 1335, INPO 87-006)

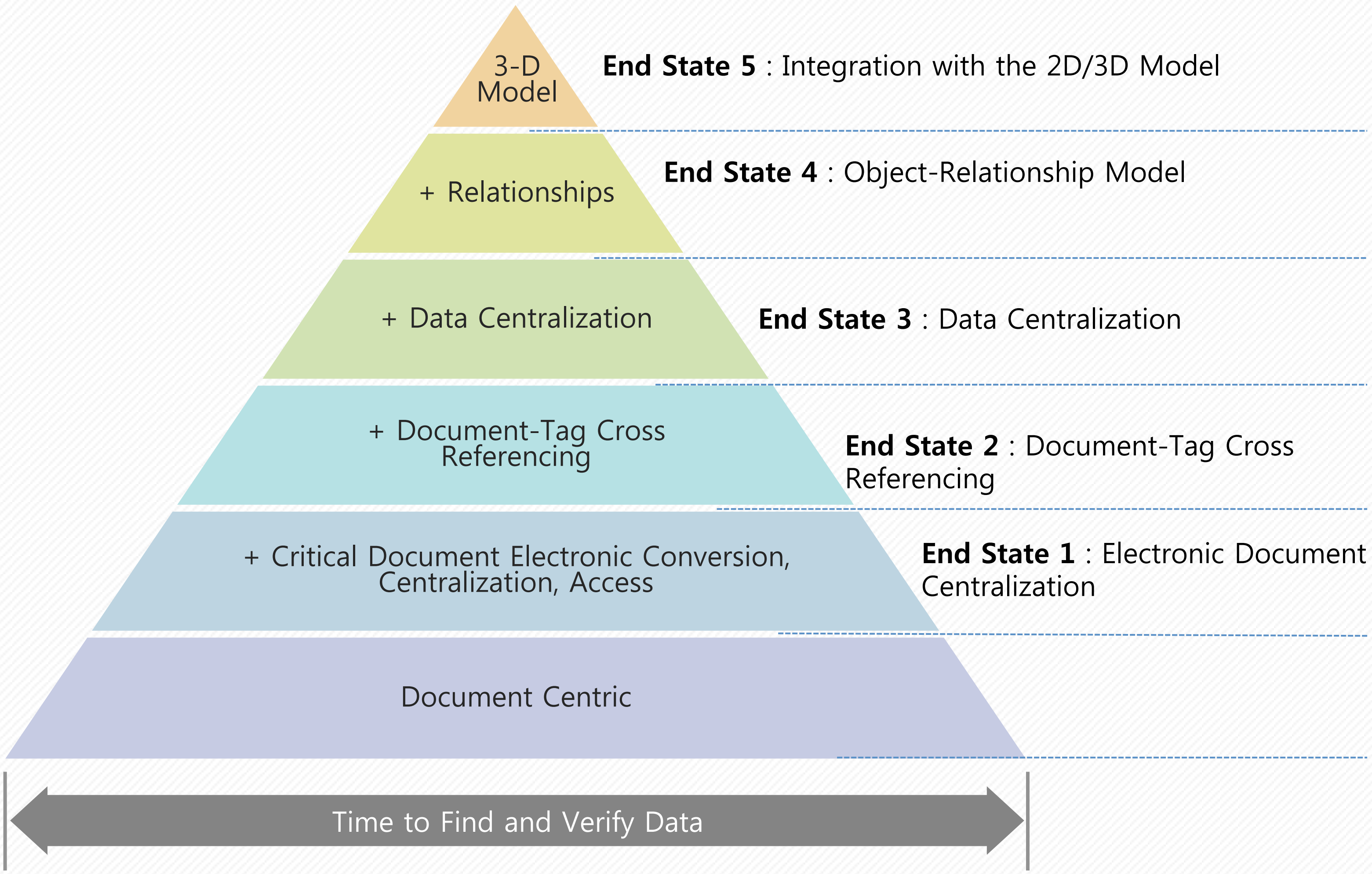
4. Project Goals

❖ Construction vs. Operation

구분	New Built	Operation
Model	 **Design Requirement** *What needs to be there* **Facility Configuration Information** *What we say is there* **Physical Configuration** *What is actually there* **Virtual Plant *Data Model***	 **Design Requirement** *What needs to be there* **Physical Configuration** *What is actually there* **Facility Configuration Information** *What we say is there*
Viewpoint	• Making Configuration based on Requirement • Focus on Requirement Management from design requirements to FCI including 3-D model	• Managing Configuration to be equilibrium • Focus on Change management

4. Project Goals

❖ Configuration Management Pyramid



3-D Model

+ Relationships

+ Data Centralization

+ Document-Tag Cross Referencing

+ Critical Document Electronic Conversion, Centralization, Access

Document Centric

End State 5 : Integration with the 2D/3D Model

End State 4 : Object-Relationship Model

End State 3 : Data Centralization

End State 2 : Document-Tag Cross Referencing

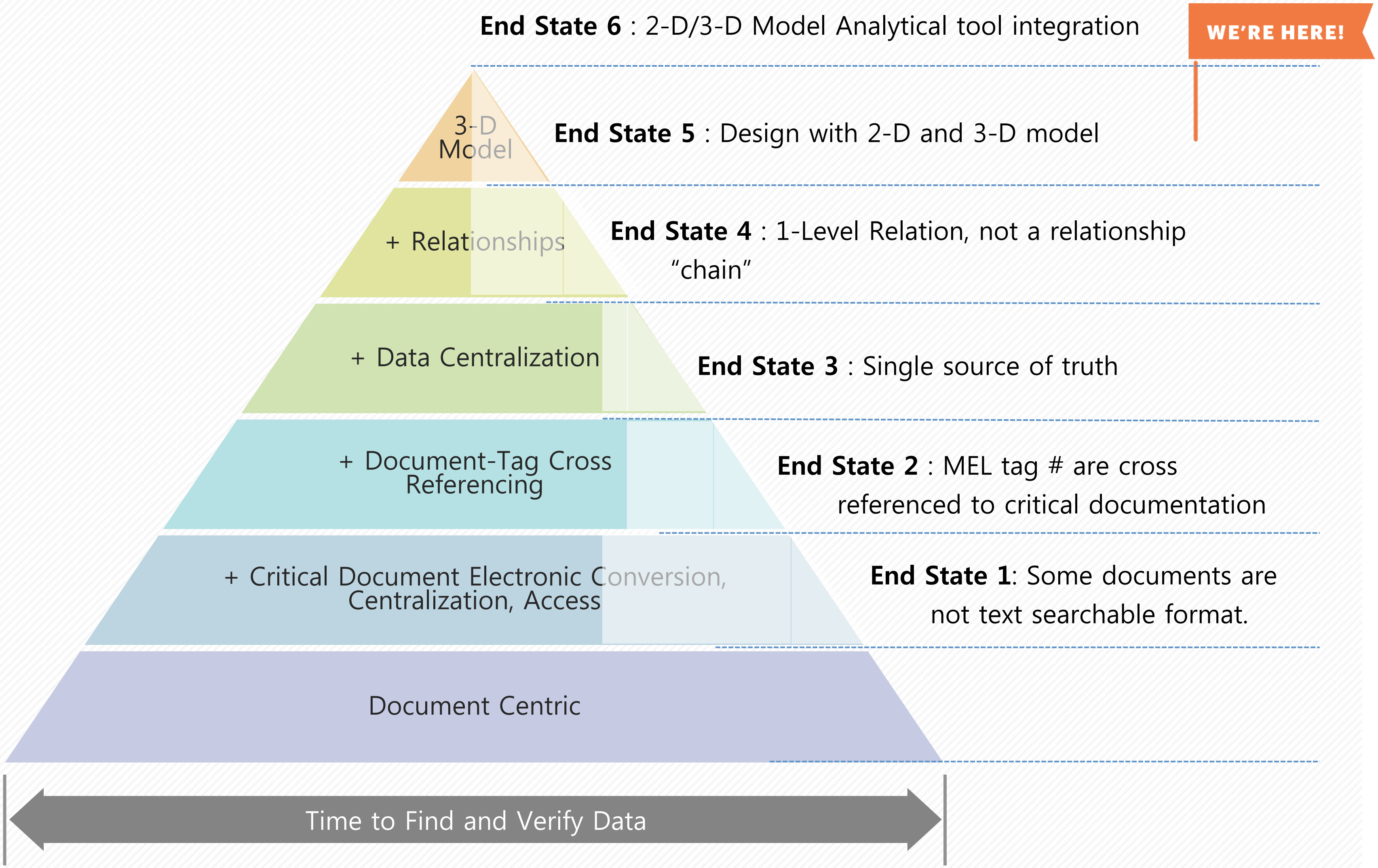
End State 1 : Electronic Document Centralization

Time to Find and Verify Data

Data-centric configuration management
By Kenneth Barry, Robert Renuart, andThomas Esselman

5. Where we are

❖ Configuration Management Pyramid



End State 6 : 2-D/3-D Model Analytical tool integration

3-D Model — **End State 5** : Design with 2-D and 3-D model

+ Relationships — **End State 4** : 1-Level Relation, not a relationship "chain"

+ Data Centralization — **End State 3** : Single source of truth

+ Document-Tag Cross Referencing — **End State 2** : MEL tag # are cross referenced to critical documentation

+ Critical Document Electronic Conversion, Centralization, Access — **End State 1**: Some documents are not text searchable format.

Document Centric

Time to Find and Verify Data

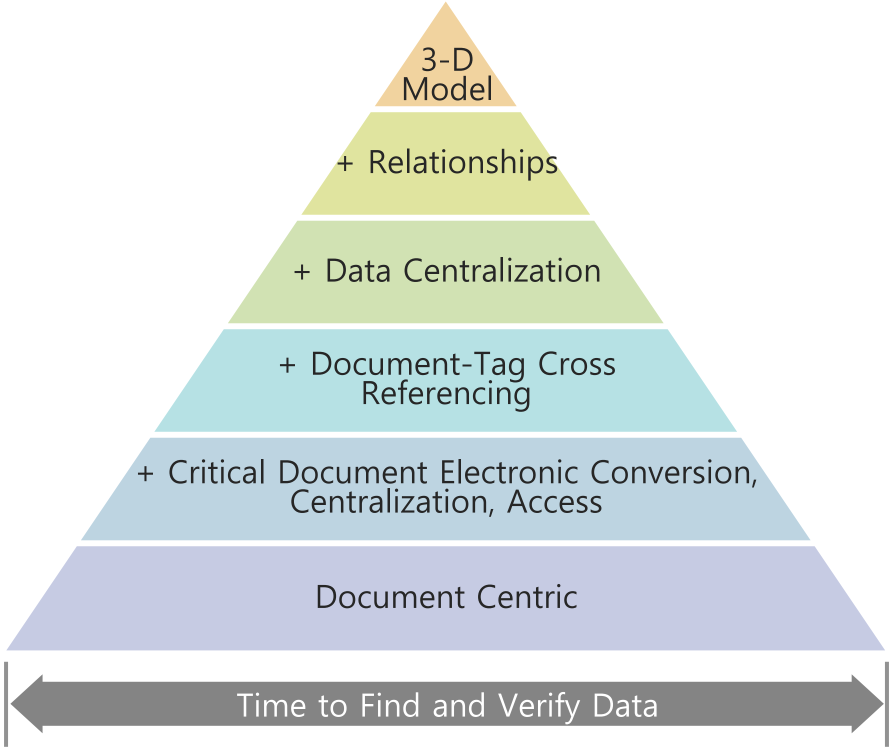
5. Where we are

Reactor / Classification		Reactor Type	Capacity	Commercial operation
Kori	#1	PWR	587	78. 4.29
	#2		650	83. 7.25
	#3		950	85. 9.30
	#4		950	86. 4.29
Shin-Kori	#1		1,000	11. 2.28
	#2		1,000	12. 7.20
	#3	APR1400	1,400	16.12.20
Wolsong	#1	PHWR	679	83. 4.22
	#2		700	97. 7. 1
	#3		700	98. 7. 1
	#4		700	99.10. 1
Shin-Wolsong	#1	PWR	1,000	12. 7.31
	#2		1,000	15. 7.24

Reactor / Classification		Reactor Type	Capacity	Commercial operation
Hanbit	#1	PWR	950	86. 8.25
	#2		950	87. 6.10
	#3		1,000	95. 3.31
	#4		1,000	96. 1. 1
	#5		1,000	02. 5.21
	#6		1,000	02.12.24
Hanul	#1	PWR	950	88. 9.10
	#2		950	89. 9.30
	#3		1,000	98. 8.11
	#4		1,000	99.12.31
	#5		1,000	04. 7.29
	#6		1,000	05. 4.22

Westinghouse BECHTEL FRAMATOME Candu KEPCO E&C

2. Building a CM Pyramid



3-D Model

+ Relationships

+ Data Centralization

+ Document-Tag Cross Referencing

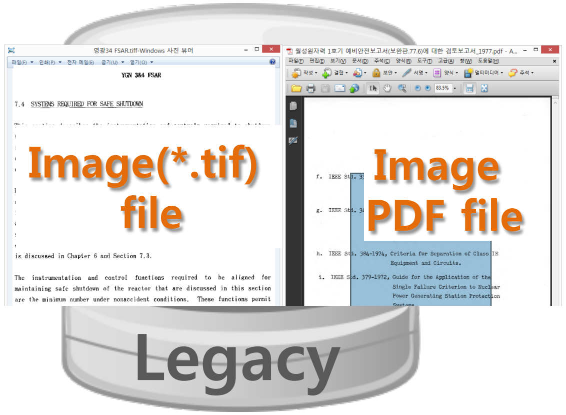
+ Critical Document Electronic Conversion, Centralization, Access

Document Centric

Time to Find and Verify Data

End State 1: Electronic Document Centralization

❖ **Document Conversion (Text seachable format)**


Image(*.tif) file
Image PDF file
Legacy

SILKROAD
CMIS
Configuration Management Information System

End State 2: Document-Tag Cross Referencing

❖ **Cross referencing**

Equipment & Drawing

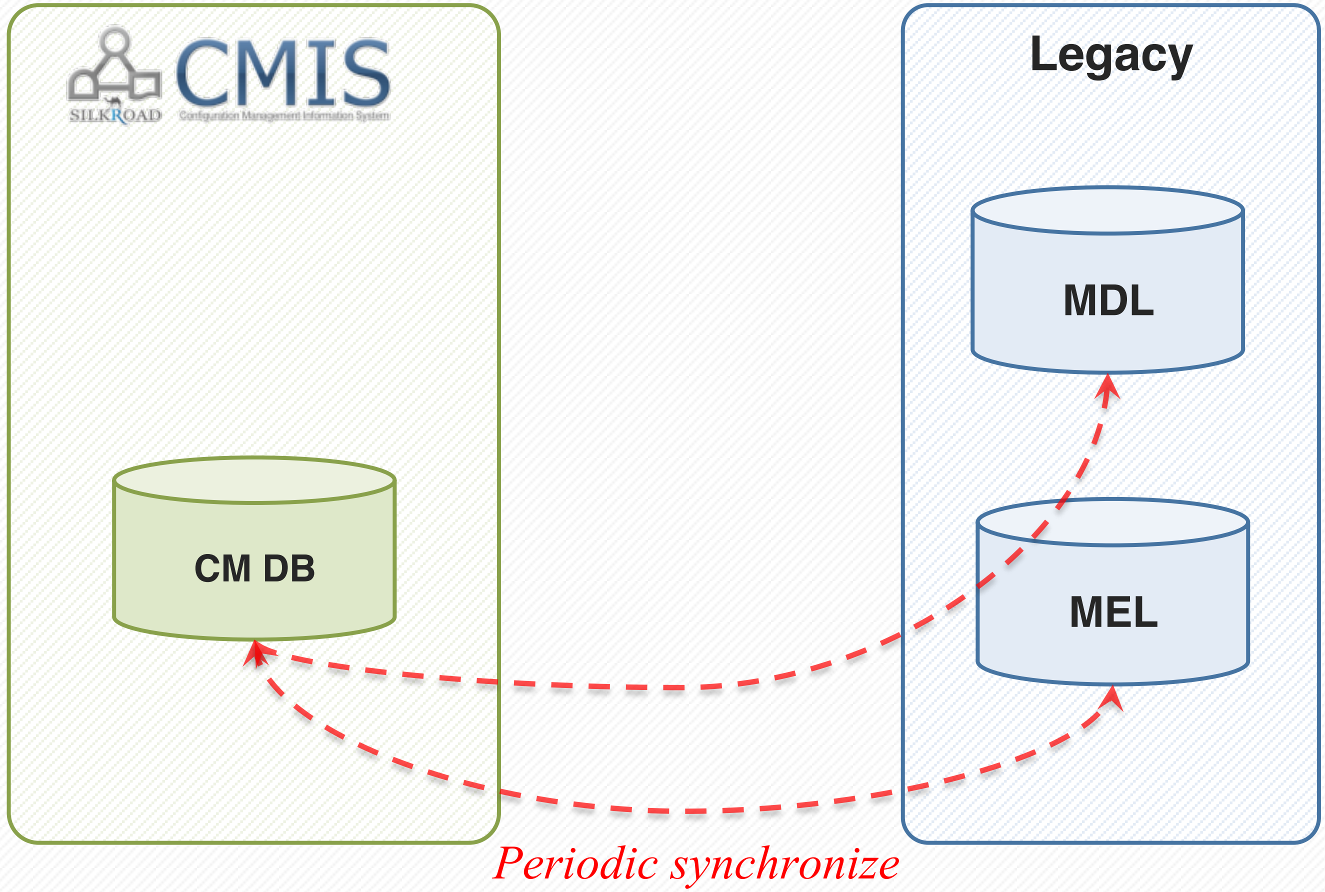
Requirement & Document

Requirement & Equipment

Equipment & Document

End State 3: Single source of truth

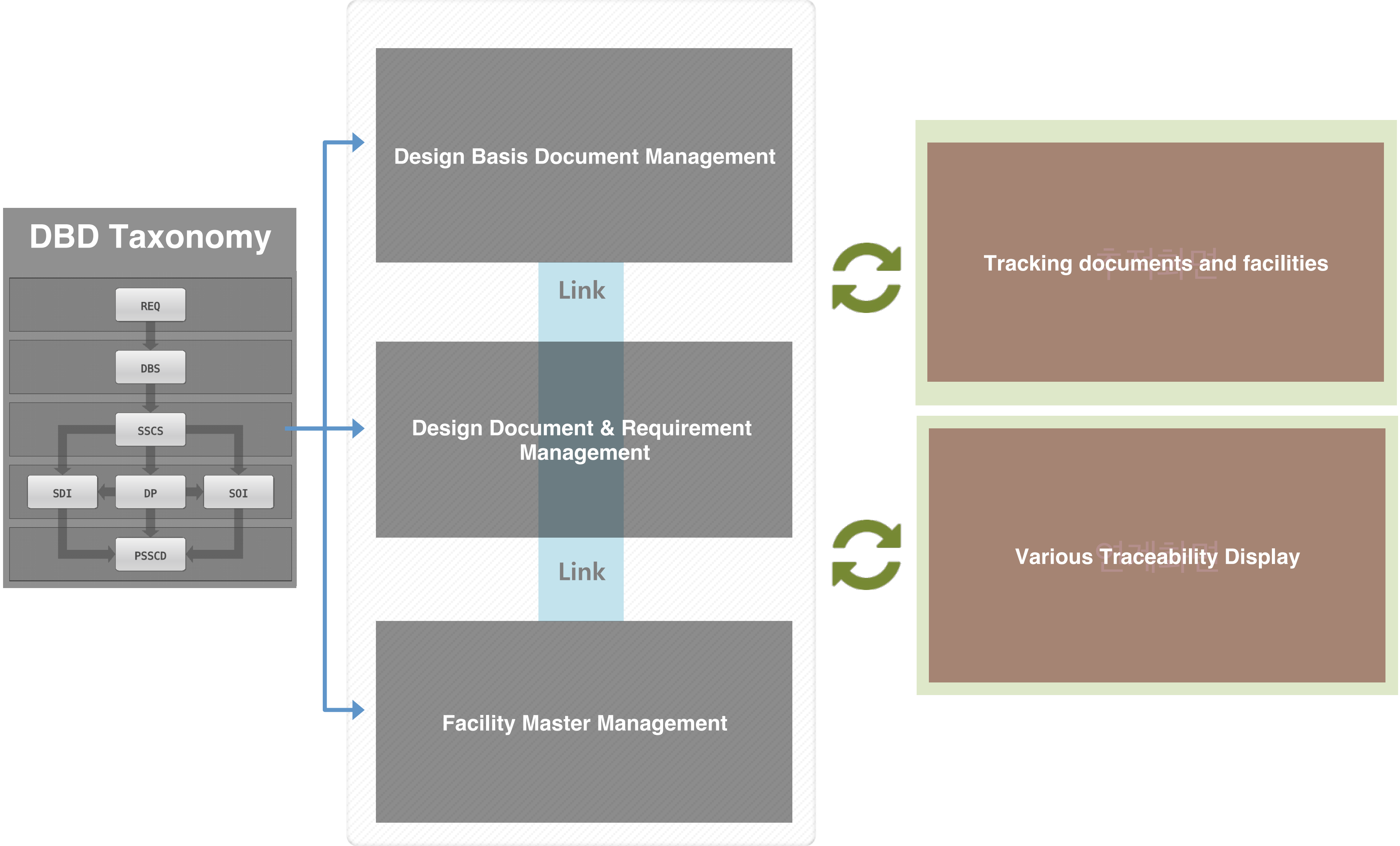
- ❖ **Single database**


CMIS
SILKROAD
Configuration Management Information System
CM DB
Legacy
MDL
MEL

Periodic synchronize

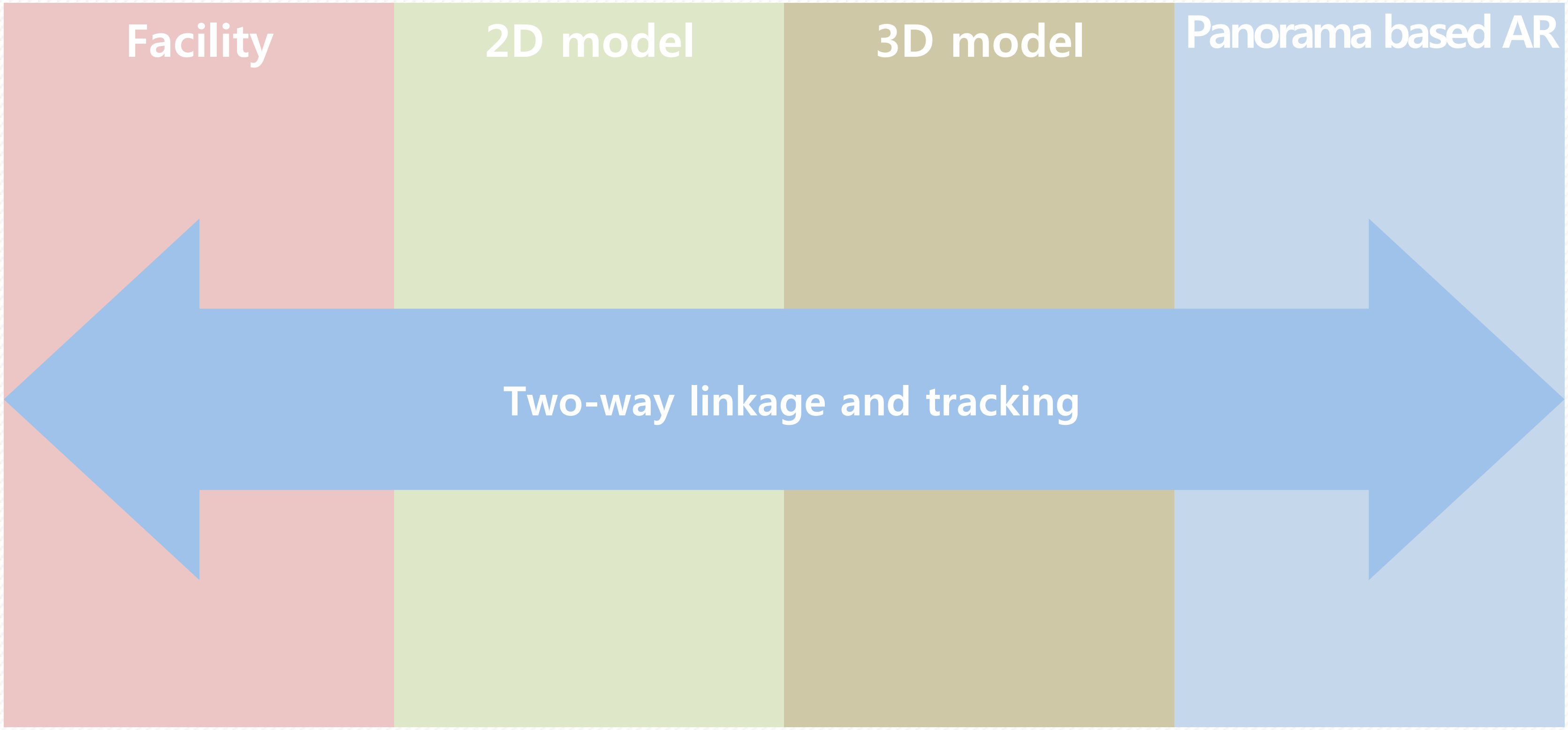
End State 4: Object-Relationship Model

❖ Relationship “chain”


DBD Taxonomy
REQ
DBS
SSCS
SDI
DP
SOI
PSSCD
Design Basis Document Management
Link
Design Document & Requirement Management
Link
Facility Master Management
Tracking documents and facilities
추적화면
Various Traceability Display
연계화면

End State 5: Integration with the 2D/3D Model

❖ **Integration Facility, 2D model, 3D model and Panorama**



Facility
2D model
3D model
Panorama based AR
Two-way linkage and tracking

3. Design Requirement Management

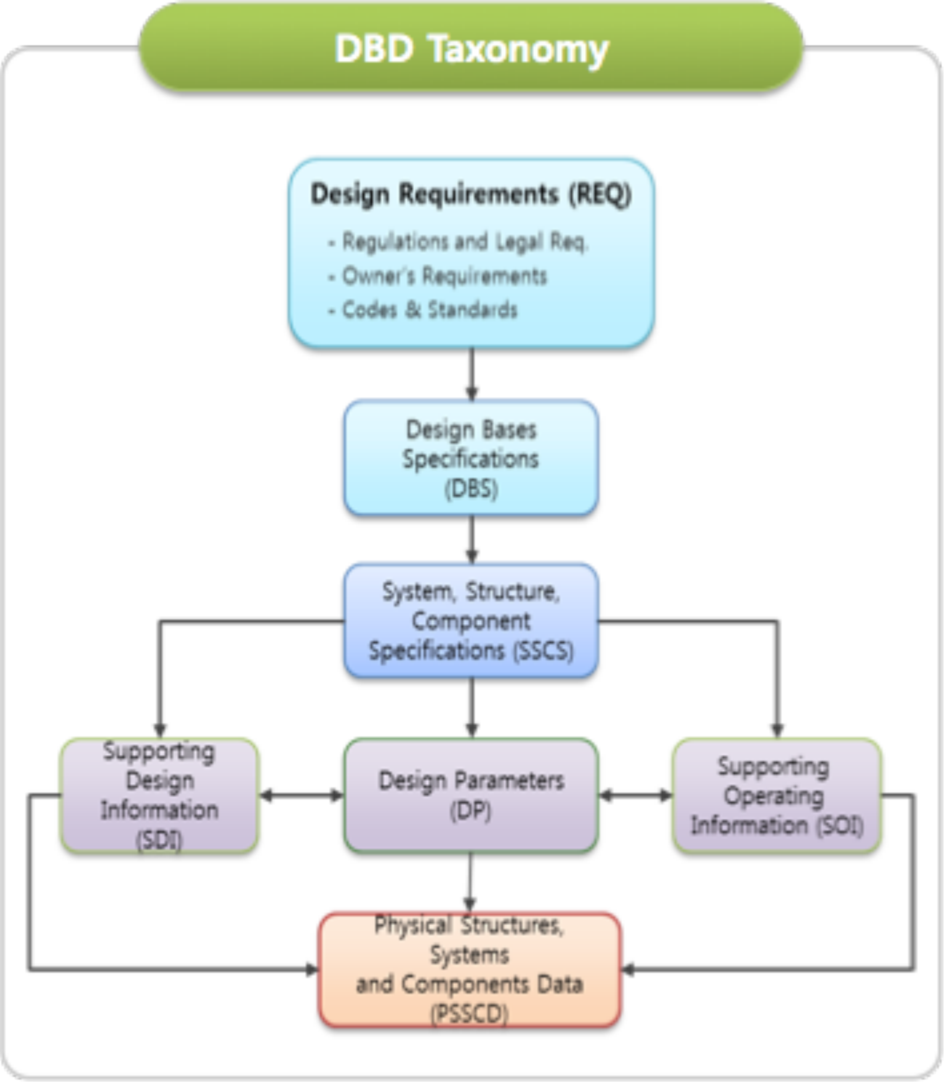
❖ What is the best DBD(Design Bases Document) taxonomy for us?

❖ Can utility person make the DBD for old NPP themselves?
Could we request the original EPC to make the DBD for old NPP?

❖ Can we have EPRI PIM views for impact analysis?

1. DBD Taxonomy

❖ DBD Taxonomy



DBD Taxonomy

Design Requirements (REQ)
- Regulations and Legal Req.
- Owner's Requirements
- Codes & Standards

Design Bases Specifications (DBS)

System, Structure, Component Specifications (SSCS)

Supporting Design Information (SDI)

Design Parameters (DP)

Supporting Operating Information (SOI)

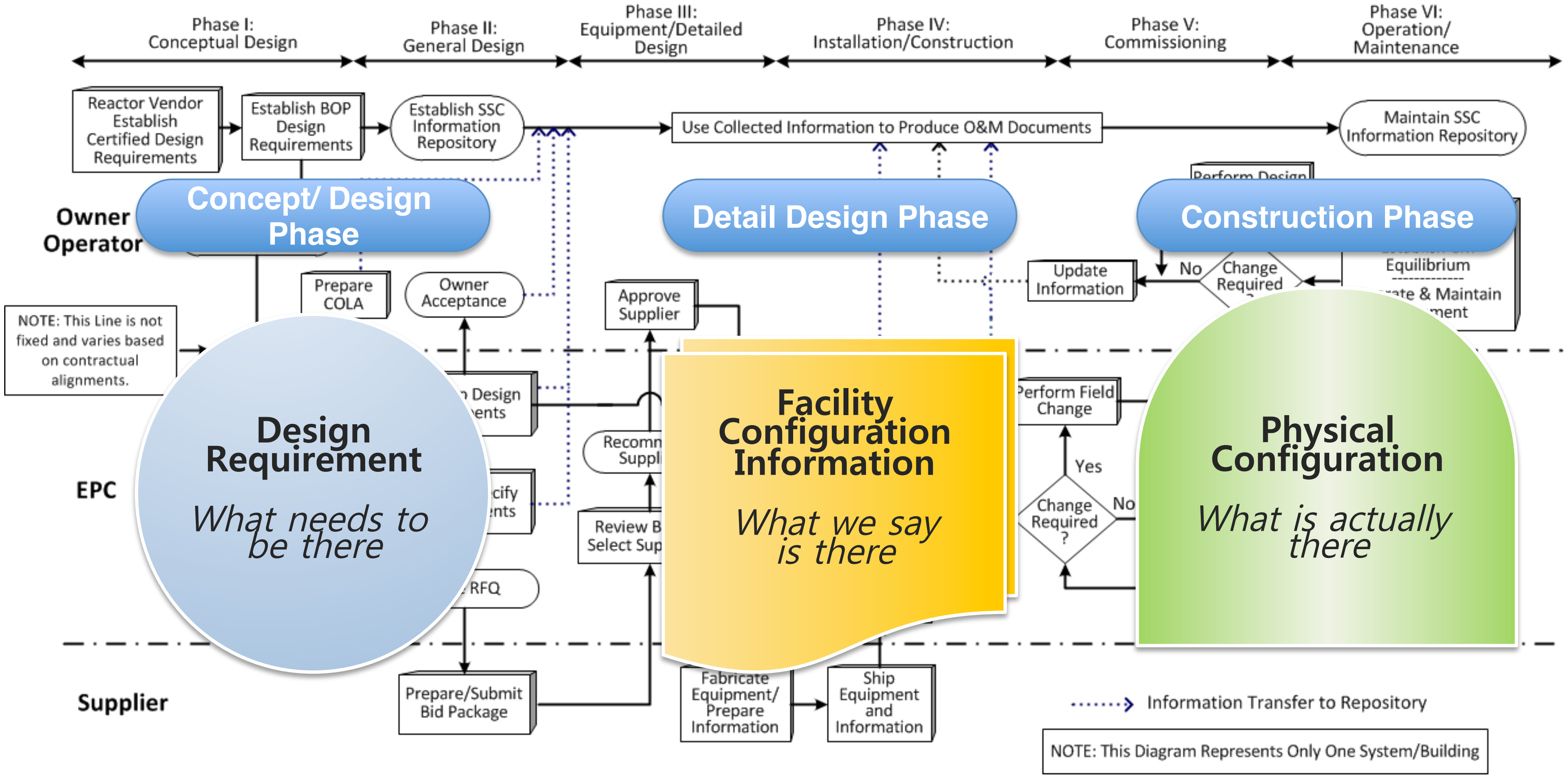
Physical Structures, Systems and Components Data (PSSCD)

2. Design Bases Document

- **How long / How much ?**

2. Design Bases Document

❖ CM Lifecycle Diagram


Phase I: Conceptual Design
Phase II: General Design
Phase III: Equipment/Detailed Design
Phase IV: Installation/Construction
Phase V: Commissioning
Phase VI: Operation/ Maintenance
Reactor Vendor Establish Certified Design Requirements
Establish BOP Design Requirements
Establish SSC Information Repository
Use Collected Information to Produce O&M Documents
Maintain SSC Information Repository
Perform Design
Owner Operator
Concept/ Design Phase
Detail Design Phase
Construction Phase
Update Information
No
Change Required
Equilibrium
Operate & Maintain Equipment
Prepare COLA
Owner Acceptance
Approve Supplier
NOTE: This Line is not fixed and varies based on contractual alignments.
Design Requirements
Specify Requirements
Recommend Supplier
Review Bids / Select Supplier
RFQ
EPC
Design Requirement
What needs to be there
Facility Configuration Information
What we say is there
Physical Configuration
What is actually there
Perform Field Change
Yes
Change Required ?
No
Supplier
Prepare/Submit Bid Package
Fabricate Equipment/ Prepare Information
Ship Equipment and Information
Information Transfer to Repository
NOTE: This Diagram Represents Only One System/Building

2. Design Based Document

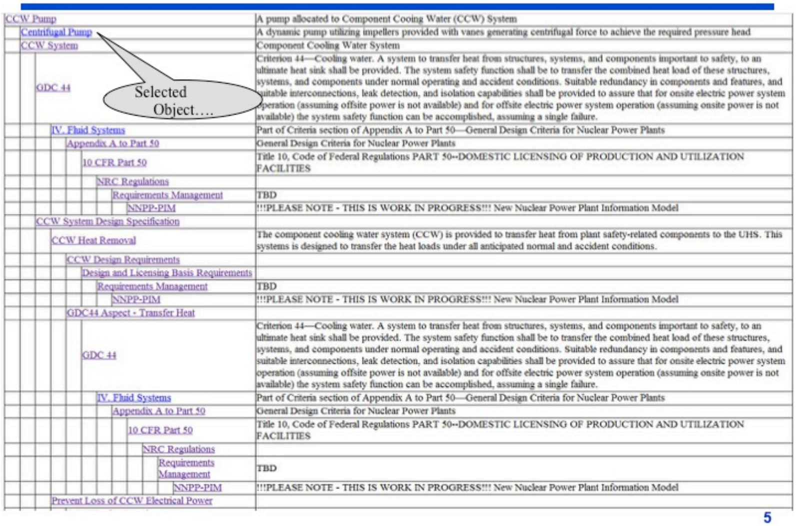
❖ Terminology

U-DBD	**Unit Requirement Based DBD**
F-DBD	**File Based DBD**
H-DBD	**Hybrid Based DBD**

3. Impact Analysis

❖ EPRI PIM (2012 CMBG - EPRI PIM Workshop)

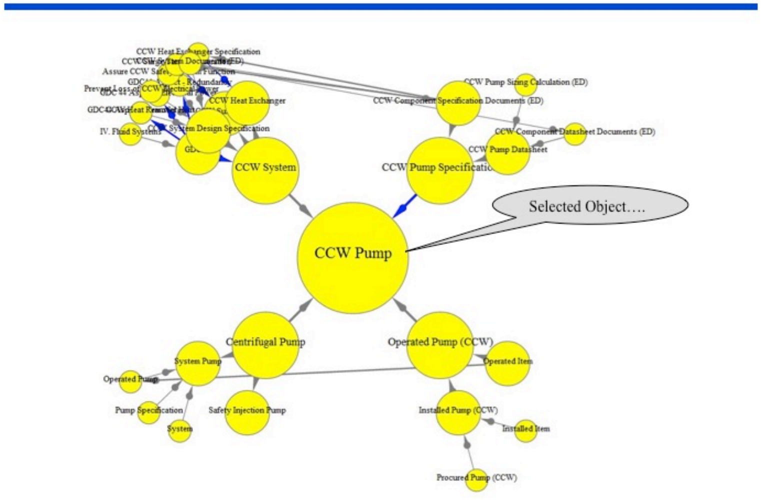
PIM View – Dynamic Reports



CCW Pump	A pump allocated to Component Cooing Water (CCW) System
Centrifugal Pump	A dynamic pump utilizing impellers provided with vanes generating centrifugal force to achieve the required pressure head
CCW System	Component Cooling Water System
GDC 44	Criterion 44—Cooling water. A system to transfer heat from structures, systems, and components important to safety, to an ultimate heat sink shall be provided. The system safety function shall be to transfer the combined heat load of these structures, systems, and components under normal operating and accident conditions. Suitable redundancy in components and features, and suitable interconnections, leak detection, and isolation capabilities shall be provided to assure that for onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming onsite power is not available) the system safety function can be accomplished, assuming a single failure.
IV. Fluid Systems	Part of Criteria section of Appendix A to Part 50—General Design Criteria for Nuclear Power Plants
Appendix A to Part 50	General Design Criteria for Nuclear Power Plants
10 CFR Part 50	Title 10, Code of Federal Regulations PART 50--DOMESTIC LICENSING OF PRODUCTION AND UTILIZATION FACILITIES
NRC Regulations	
Requirements Management	TBD
NNPP-PIM	!!!PLEASE NOTE - THIS IS WORK IN PROGRESS!!! New Nuclear Power Plant Information Model
CCW System Design Specification	
CCW Heat Removal	The component cooling water system (CCW) is provided to transfer heat from plant safety-related components to the UHS. This systems is designed to transfer the heat loads under all anticipated normal and accident conditions.
CCW Design Requirements	
Design and Licensing Basis Requirements	
Requirements Management	TBD
NNPP-PIM	!!!PLEASE NOTE - THIS IS WORK IN PROGRESS!!! New Nuclear Power Plant Information Model
GDC44 Aspect - Transfer Heat	
GDC 44	Criterion 44—Cooling water. A system to transfer heat from structures, systems, and components important to safety, to an ultimate heat sink shall be provided. The system safety function shall be to transfer the combined heat load of these structures, systems, and components under normal operating and accident conditions. Suitable redundancy in components and features, and suitable interconnections, leak detection, and isolation capabilities shall be provided to assure that for onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming onsite power is not available) the system safety function can be accomplished, assuming a single failure.
IV. Fluid Systems	Part of Criteria section of Appendix A to Part 50—General Design Criteria for Nuclear Power Plants
Appendix A to Part 50	General Design Criteria for Nuclear Power Plants
10 CFR Part 50	Title 10, Code of Federal Regulations PART 50--DOMESTIC LICENSING OF PRODUCTION AND UTILIZATION FACILITIES
NRC Regulations	
Requirements Management	TBD
NNPP-PIM	!!!PLEASE NOTE - THIS IS WORK IN PROGRESS!!! New Nuclear Power Plant Information Model
Prevent Loss of CCW Electrical Power	

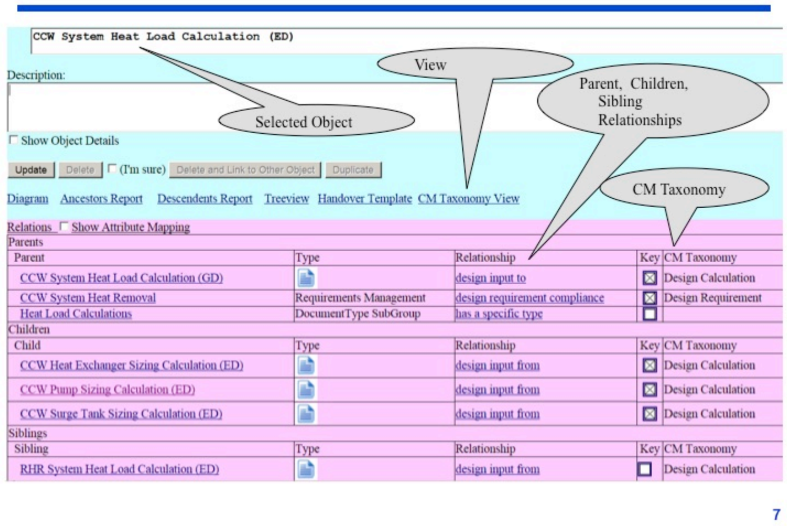
Selected
Object….

PIM View – Dynamic Radial Diagram



CCW Heat Exchanger Specification
CCW System Documentation (ED)
Assure CCW Safety System Function
GDC 44 Aspect - Redundancy
Prevent Loss of CCW Electrical Power
GDC 44 Aspect - Electrical Power
GDC44 Aspect
CCW Heat Removal
CCW Heat Exchanger
IV. Fluid Systems
CCW System Design Specification
GDC
CCW System
CCW Pump Sizing Calculation (ED)
CCW Component Specification Documents (ED)
CCW Component Datasheet Documents (ED)
CCW Pump Datasheet
CCW Pump Specification
Selected Object….
CCW Pump
Centrifugal Pump
Operated Pump (CCW)
System Pump
Operated Item
Operated Pump
Pump Specification
Safety Injection Pump
System
Installed Pump (CCW)
Installed Item
Procured Pump (CCW)

PIM Example – CM Taxonomy Relationships



CCW System Heat Load Calculation (ED)

Description:

☐ Show Object Details

Update | Delete | ☐ (I'm sure) | Delete and Link to Other Object | Duplicate

Diagram Ancestors Report Descendents Report Treeview Handover Template CM Taxonomy View

Relations ☐ Show Attribute Mapping

Parents

Parent	Type	Relationship	Key	CM Taxonomy
CCW System Heat Load Calculation (GD)		design input to	☒	Design Calculation
CCW System Heat Removal	Requirements Management	design requirement compliance	☒	Design Requirement
Heat Load Calculations	DocumentType SubGroup	has a specific type	☐	

Children

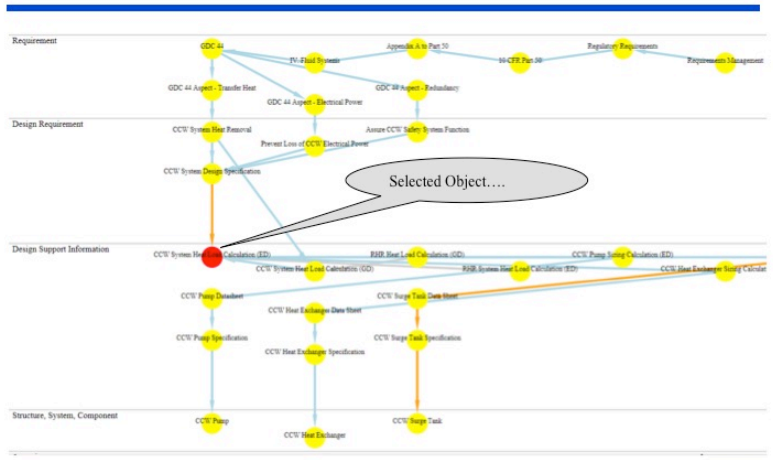
Child	Type	Relationship	Key	CM Taxonomy
CCW Heat Exchanger Sizing Calculation (ED)		design input from	☒	Design Calculation
CCW Pump Sizing Calculation (ED)		design input from	☒	Design Calculation
CCW Surge Tank Sizing Calculation (ED)		design input from	☒	Design Calculation

Siblings

Sibling	Type	Relationship	Key	CM Taxonomy
RHR System Heat Load Calculation (ED)		design input from	☐	Design Calculation

View
Selected Object
Parent, Children, Sibling Relationships
CM Taxonomy

PIM View – Dynamic CM Taxonomy View



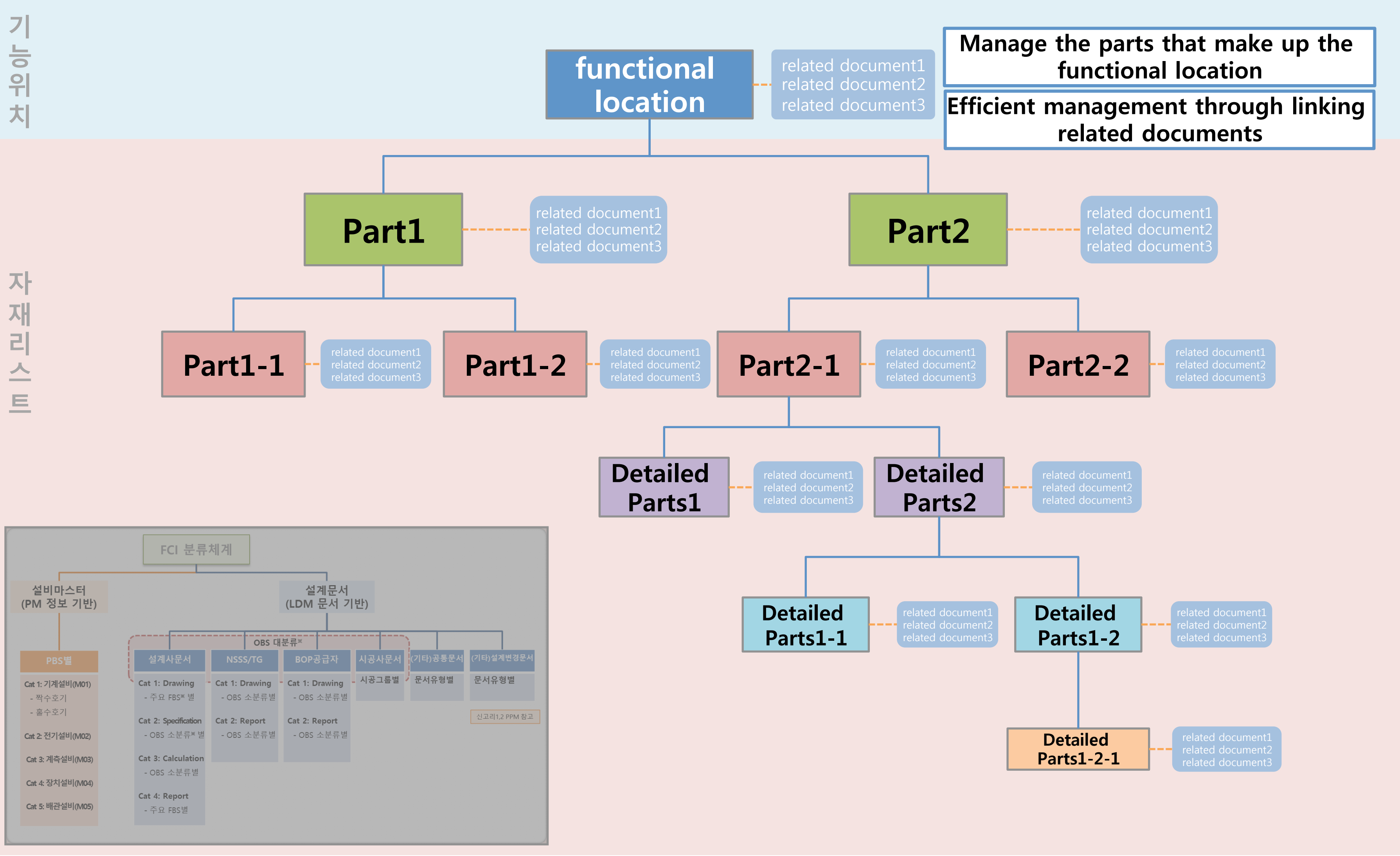
Requirement
GDC 44
IV. Fluid Systems
Appendix A to Part 50
10 CFR Part 50
Regulatory Requirements
Requirements Management
GDC 44 Aspect - Transfer Heat
GDC 44 Aspect - Electrical Power
GDC 44 Aspect - Redundancy
Design Requirement
CCW System Heat Removal
Prevent Loss of CCW Electrical Power
Assure CCW Safety System Function
CCW System Design Specification
Selected Object….
Design Support Information
CCW System Heat Load Calculation (ED)
CCW System Heat Load Calculation (GD)
RHR Heat Load Calculation (GD)
RHR System Heat Load Calculation (ED)
CCW Pump Sizing Calculation (ED)
CCW Heat Exchanger Sizing Calculat
CCW Pump Datasheet
CCW Heat Exchanger Data Sheet
CCW Surge Tank Data Sheet
CCW Pump Specification
CCW Heat Exchanger Specification
CCW Surge Tank Specification
Structure, System, Component
CCW Pump
CCW Heat Exchanger
CCW Surge Tank

4. Facility Configuration Information Management

- Can we manage both MDL and MEL in one system?
- Can we handle simultaneous design change requests in an equipment?
- Can we look up all kind of data within the system?
- How to manage Margins ?

1. Single Database

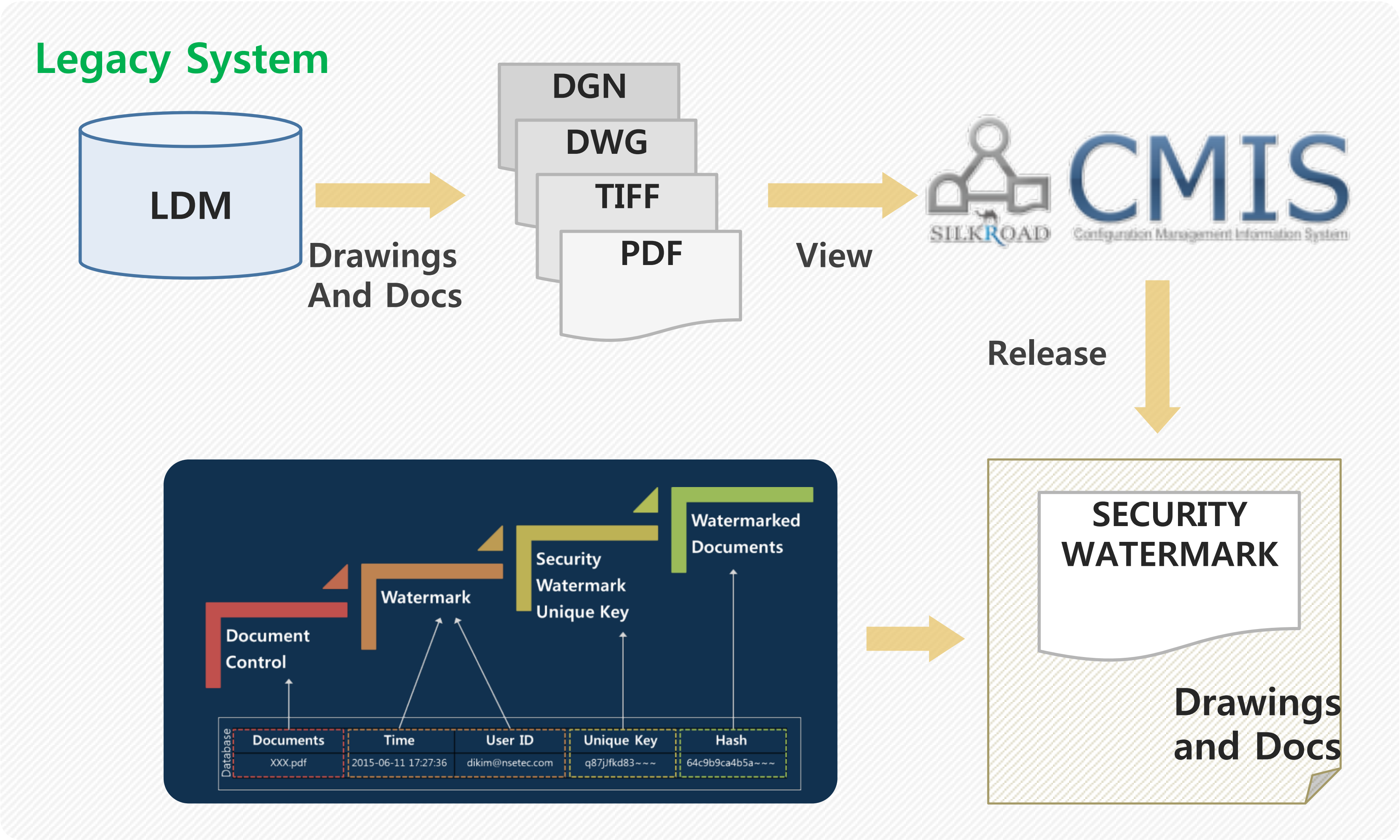
❖ BOM


기능위치
자재리스트
functional location
related document1
related document2
related document3
Part1
Part2
Part1-1
Part1-2
Part2-1
Part2-2
Detailed Parts1
Detailed Parts2
Detailed Parts1-1
Detailed Parts1-2
Detailed Parts1-2-1
FCI 분류체계
설비마스터 (PM 정보 기반)
설계문서 (LDM 문서 기반)
OBS 대분류※
PBS별
Cat 1: 기계설비(M01)
- 짝수호기
- 홀수호기
Cat 2: 전기설비(M02)
Cat 3: 계측설비(M03)
Cat 4: 장치설비(M04)
Cat 5: 배관설비(M05)
설계사문서
Cat 1: Drawing
- 주요 FBS※ 별
Cat 2: Specification
- OBS 소분류※ 별
Cat 3: Calculation
- OBS 소분류별
Cat 4: Report
- 주요 FBS별
NSSS/TG
Cat 1: Drawing
- OBS 소분류별
Cat 2: Report
- OBS 소분류별
BOP공급자
Cat 1: Drawing
- OBS 소분류별
Cat 2: Report
- OBS 소분류별
시공사문서
시공그룹별
(기타)공통문서
문서유형별
(기타)설계변경문서
문서유형별
신고리1,2 PPM 참고

Manage the parts that make up the functional location

Efficient management through linking related documents

3. Single viewer for various format



Legacy System

LDM

Drawings
And Docs

DGN

DWG

TIFF

PDF

View

SILKROAD

CMIS

Configuration Management Information System

Release

Document Control

Watermark

Security Watermark Unique Key

Watermarked Documents

Database

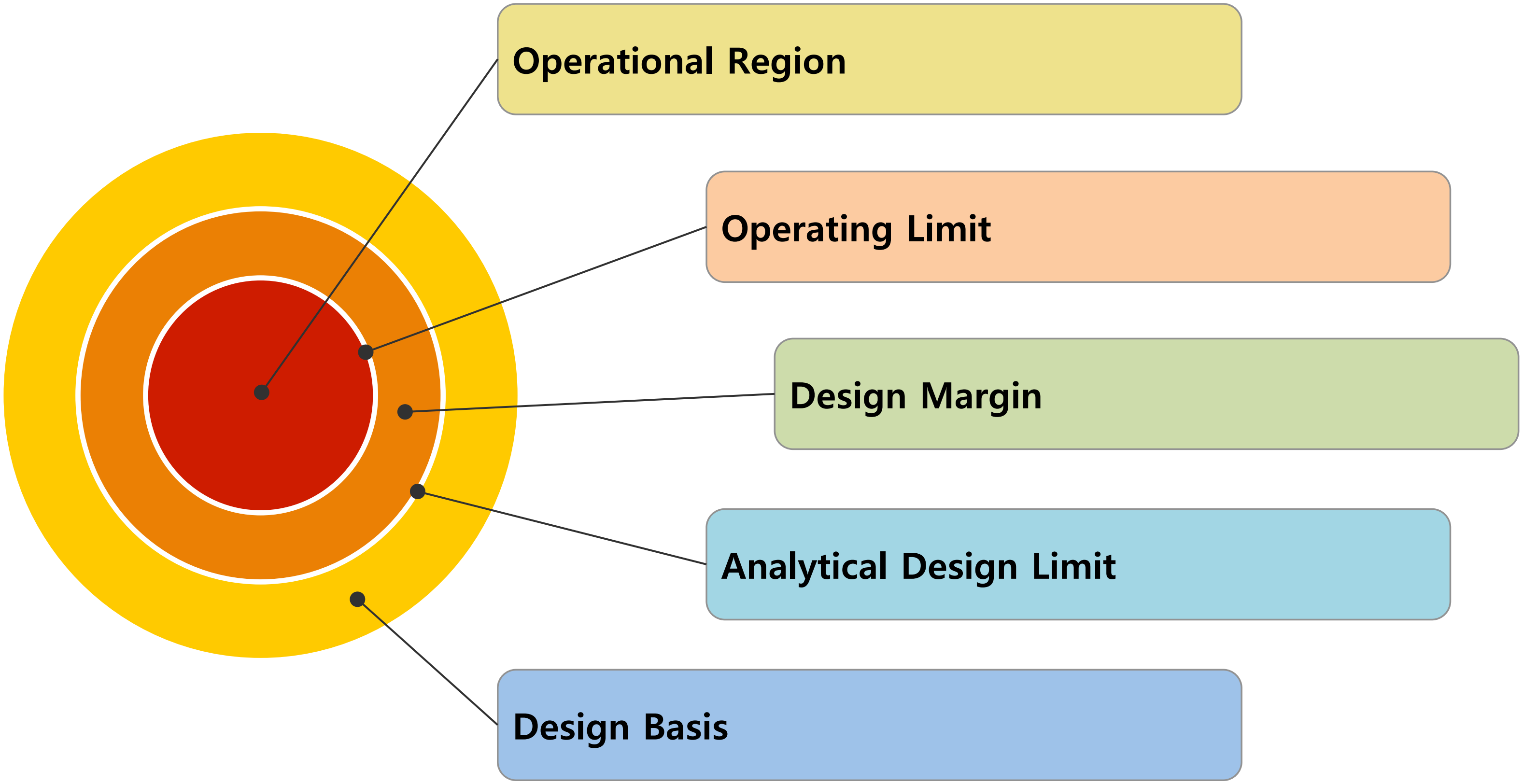
Documents	Time	User ID	Unique Key	Hash
XXX.pdf	2015-06-11 17:27:36	dikim@nsetec.com	q87jJfkd83~~~	64c9b9ca4b5a~~~

SECURITY
WATERMARK

Drawings
and Docs

4. Margin Management

❖ Margin Configuration Management



Operational Region

Operating Limit

Design Margin

Analytical Design Limit

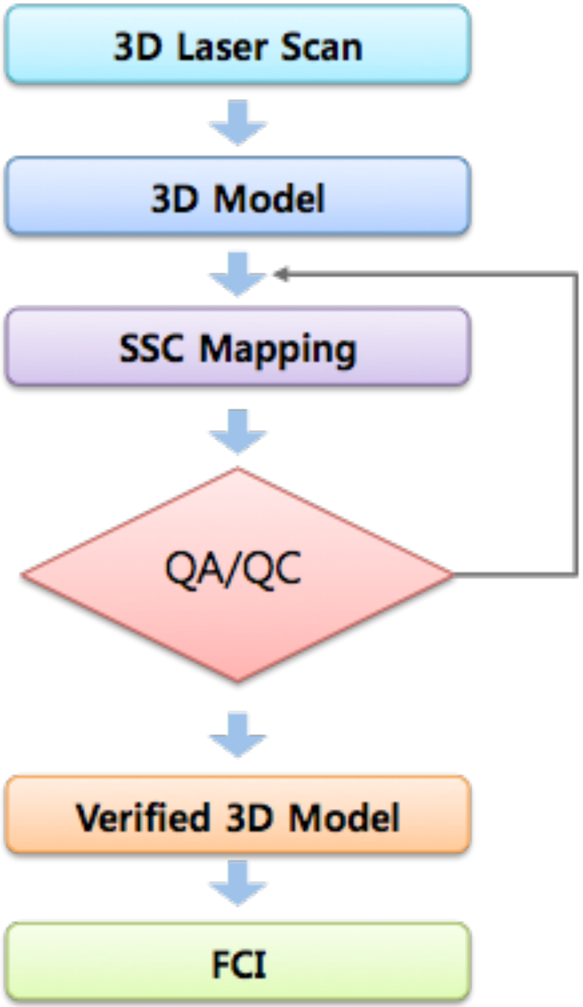
Design Basis

5. Physical Configuration Management

- ❖ **What is the physical configuration in a SW system ?**

1. Physical CM of Operating NPP

❖ **Reverse engineering with 3D Laser Scan**



3D Laser Scan

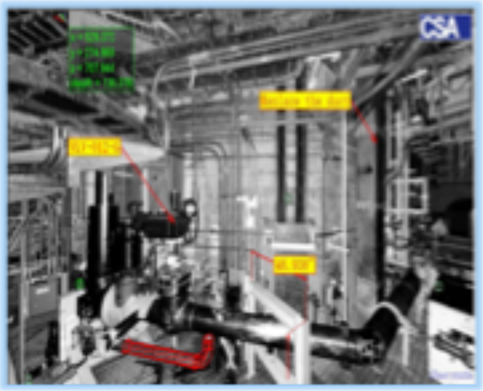
3D Model

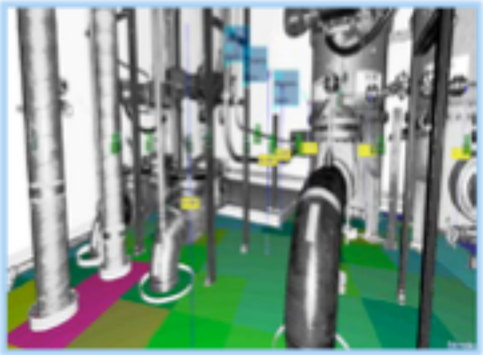
SSC Mapping

QA/QC

Verified 3D Model

FCI



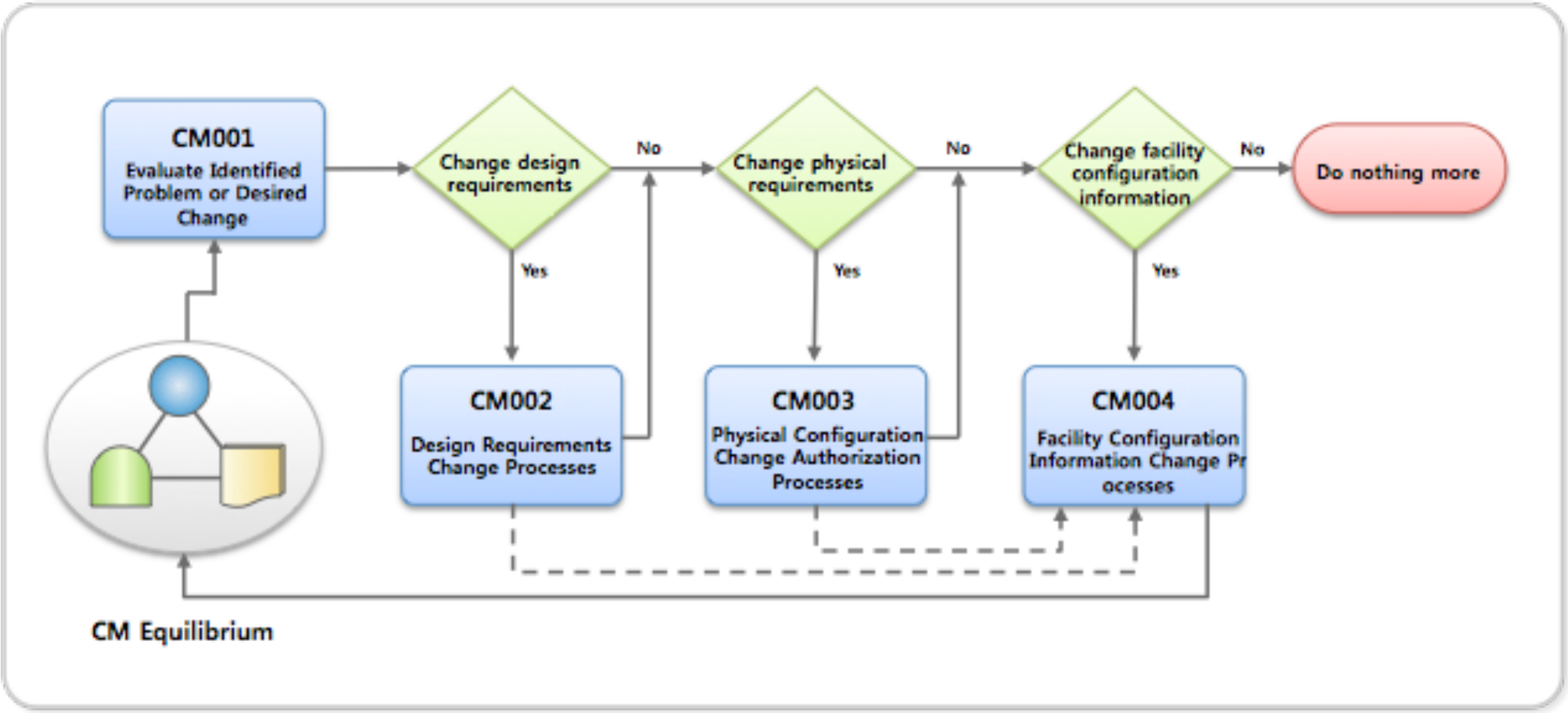


6. Change Management

- Is the change process of KHNP followed by AP-929?
- Can we have paperless working environment ?
- Can we monitor the process ?
- Can we do design change review ?
- How can the system help for seamless process ?

1. Standard Design Change Process

❖ **INPO AP-929**


CM001
Evaluate Identified Problem or Desired Change
Change design requirements
No
Yes
Change physical requirements
No
Yes
Change facility configuration information
No
Yes
Do nothing more
CM002
Design Requirements Change Processes
CM003
Physical Configuration Change Authorization Processes
CM004
Facility Configuration Information Change Pr ocesses
CM Equilibrium

7. Demo

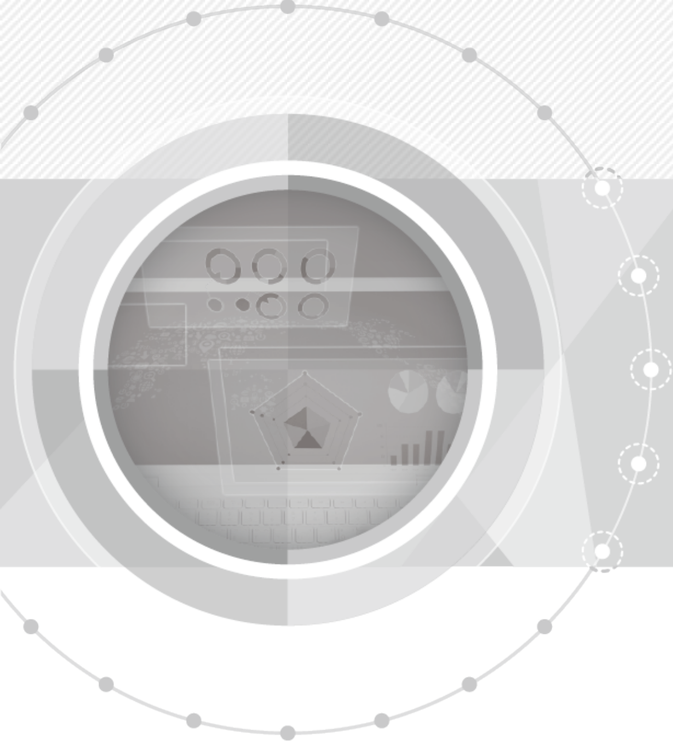
2. Demo

Configuration Management Information System

CMIS
SILKROAD
Configuration Management Information System

8. Questions and Answers

Thank you



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