Capella in a Golden Thread Implementation

Requirements Engineering and Safety Assurance Network (RESAN)

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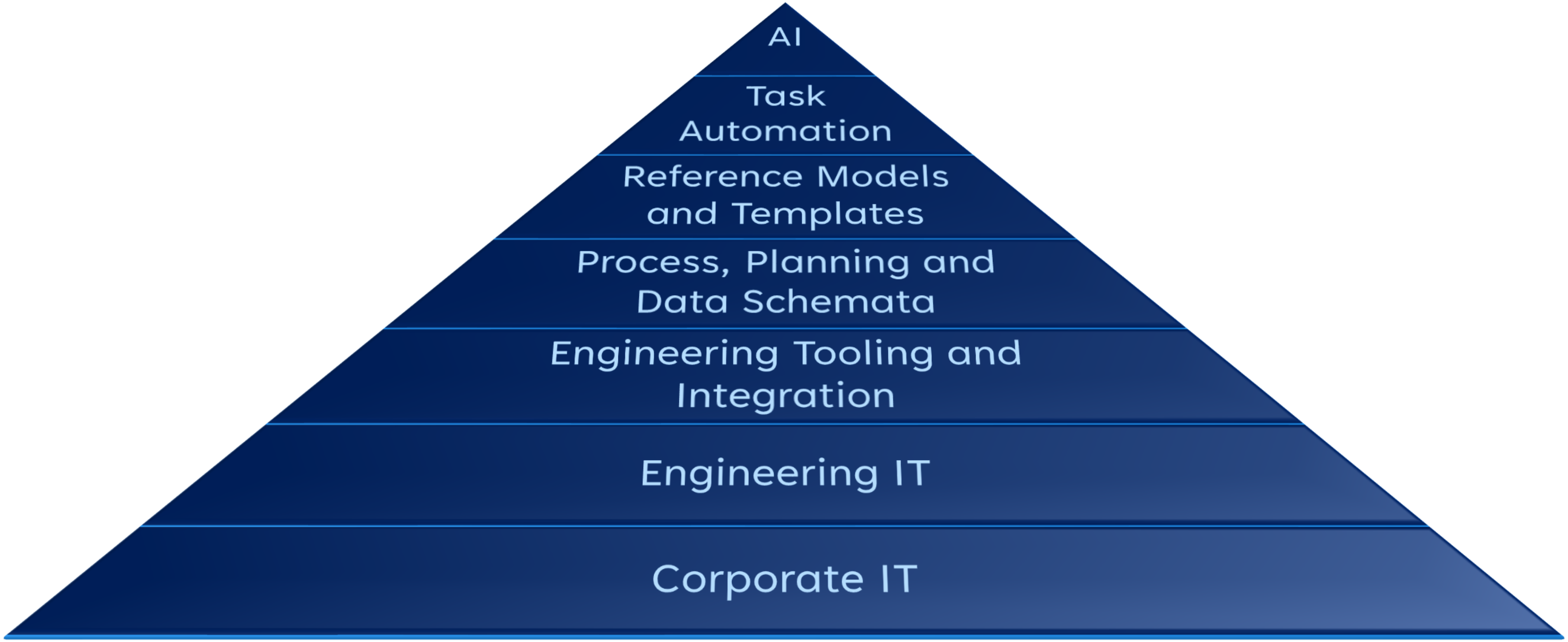
Digital Pyramid



- RESAN Concept

RESAN – **R**equirements **E**ngineering and **S**afety **A**ssurance **N**etwork.

RESAN Visual: Data Integration Model

RESAN

RESAN – **R**equirements **E**ngineering and **S**afety **A**ssurance **N**etwork.

Powered By:

ProjectWise python node

Interactive Dashboards

Design Engineering

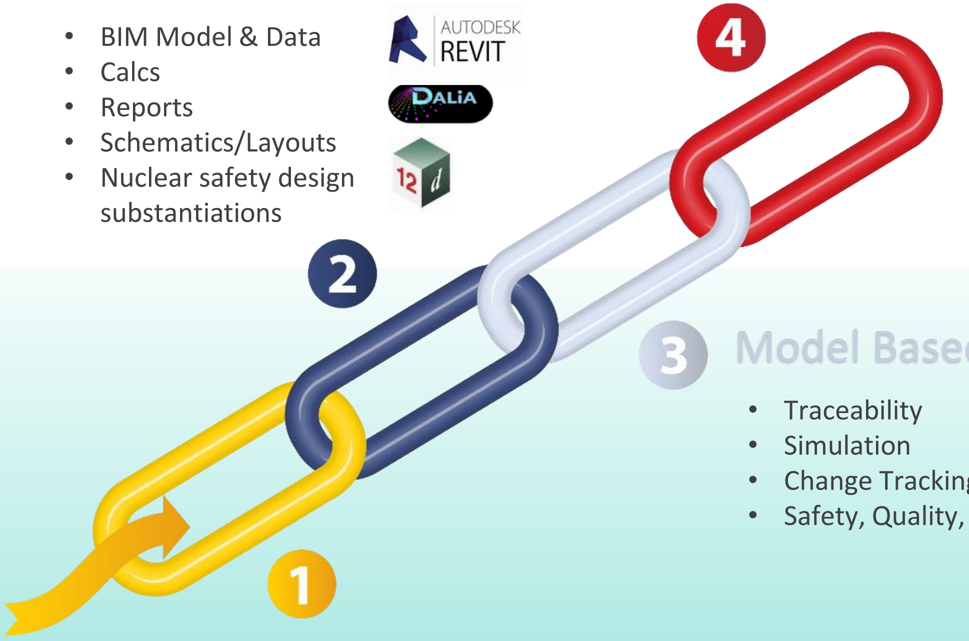
- BIM Model & Data
- Calcs
- Reports
- Schematics/Layouts
- Nuclear safety design substantiations

AUTODESK REVIT
DALIA
12d

Digital Engineering

- Visuals
- Federated Models
- Analytic dashboards
- Quality Control

AUTODESK NAVISWORKS
Revizto BIM software platform
PowerApps



Model Based Systems Engineering

- Traceability
- Simulation
- Change Tracking
- Safety, Quality, Compliance

GENESYS
Capella

Data Input

python

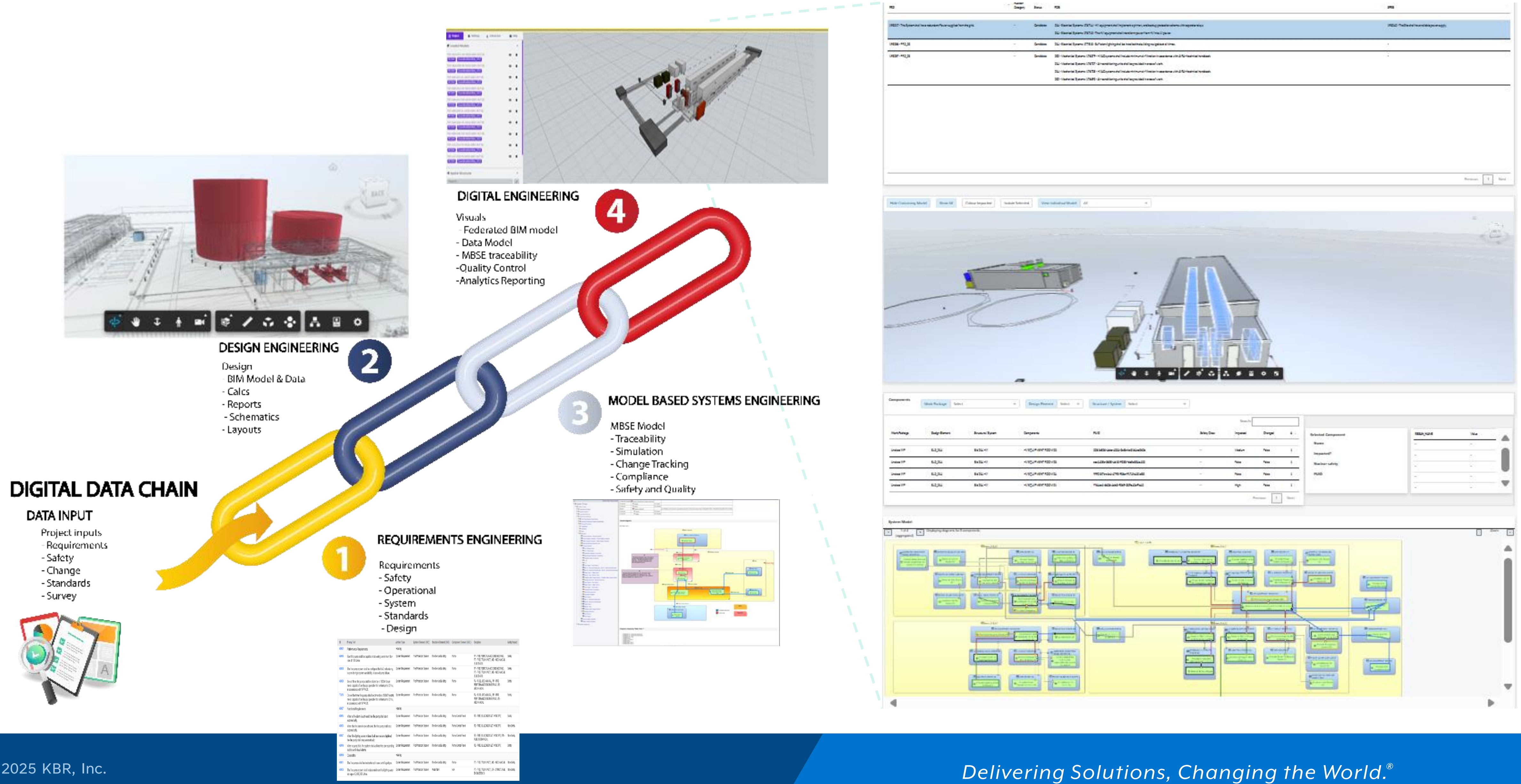
- ASA Functional Requirements
- Derived Safety Case Requirements
- Regulations & Standards
- Site Data (Survey, Geotechnical, etc.)
- … then with ongoing changes to the above

Requirements Engineering

- Safety
- Operational
- Systems
- Standards
- Design

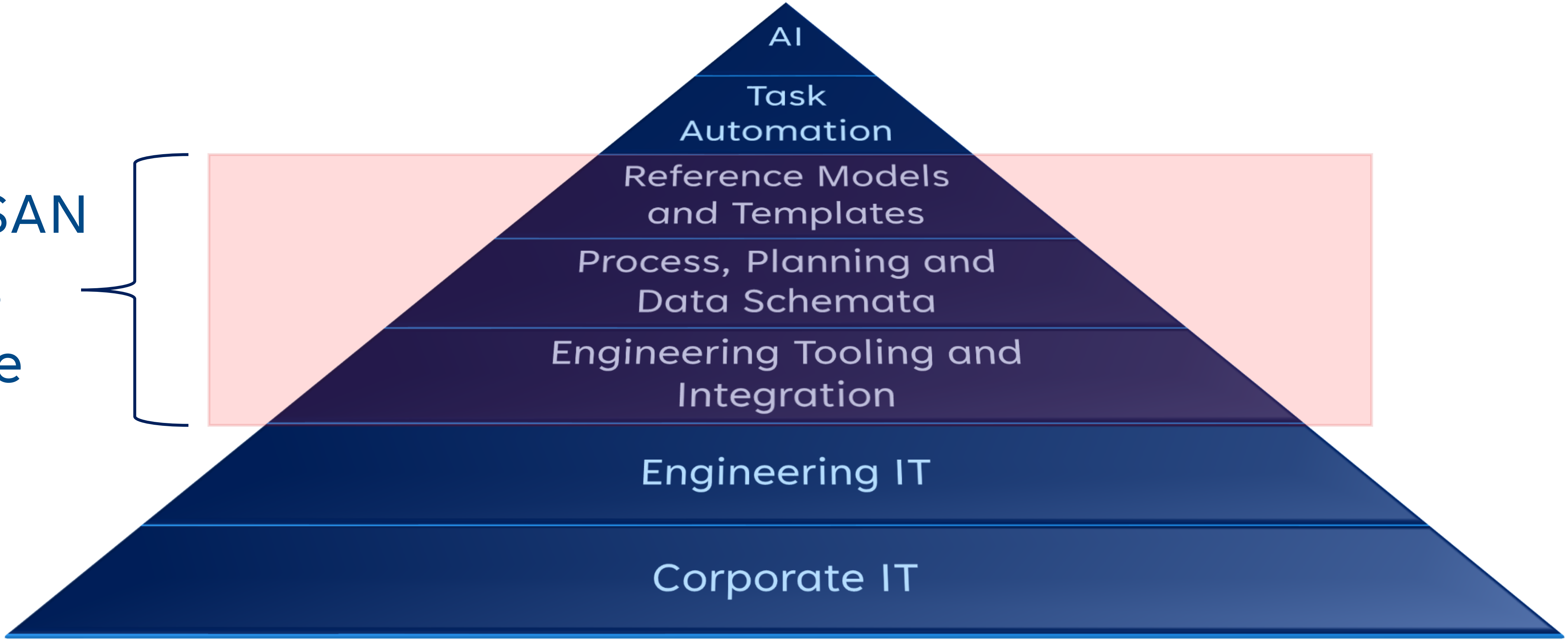
IBM DOORS

RESAN Golden Thread Data Chain



Digital Pyramid

RESAN Fits here



Use Cases

The data that RESAN assembles has a number of key use cases that benefit the client:

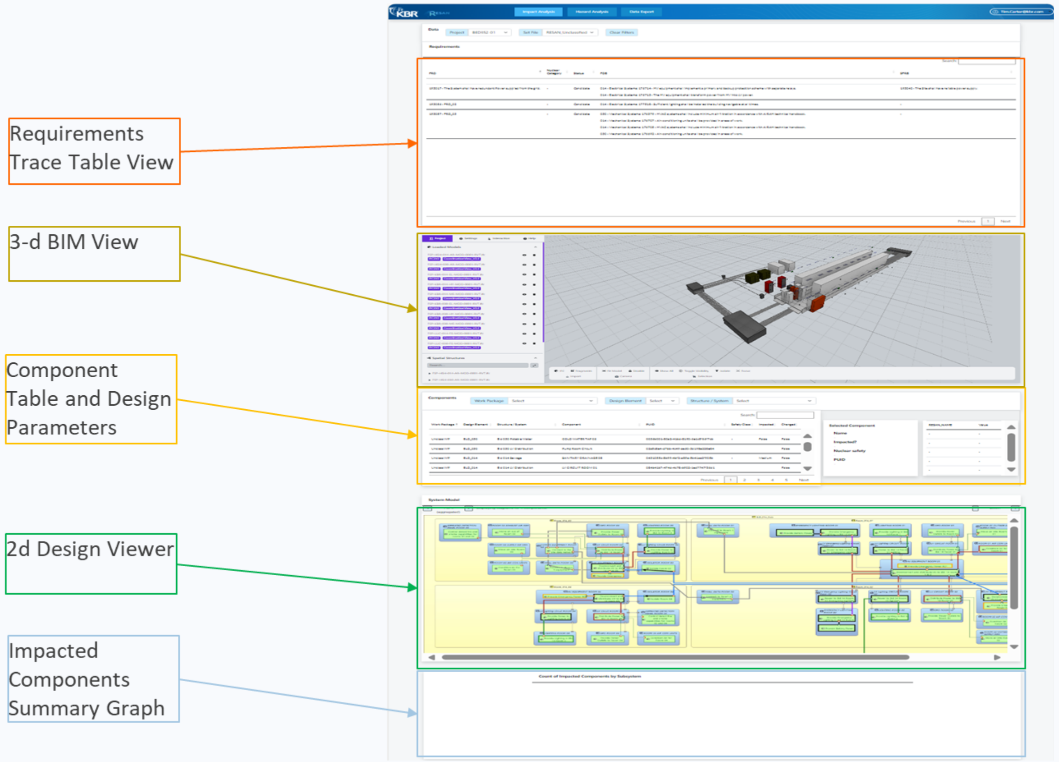
Support the System Engineering Team to show we have met the brief by:

- Requirement impact analysis
  - Digitise and visualise the impact analysis to speed up the process reducing errors and risk
- Construction changes, obsolescence
- Safety case support (inc. HAZOPS)
- Technical specification performance requirements definition support
- Asset Management Information System initialisation
- Requirements Dashboard and traceability viewing

Requirements Impact Analysis

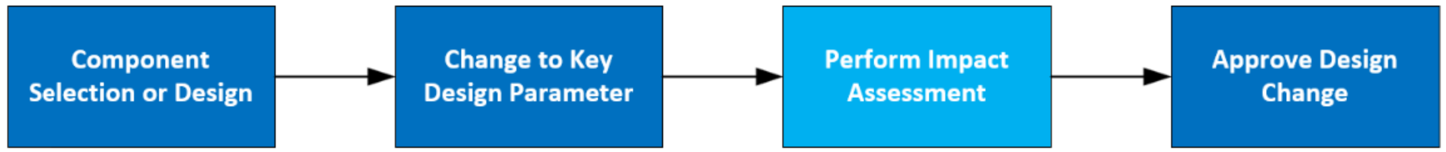
Someone wants to change a requirement; we want to understand what that will impact

- Select the relevant requirements
- See:
  - Related 3d BIM models
  - Related components and key design parameters
  - Related schematics and system architecture views
  - Summaries of components marked for impact
- Export Data to support impact analysis reports for the Change Control Board

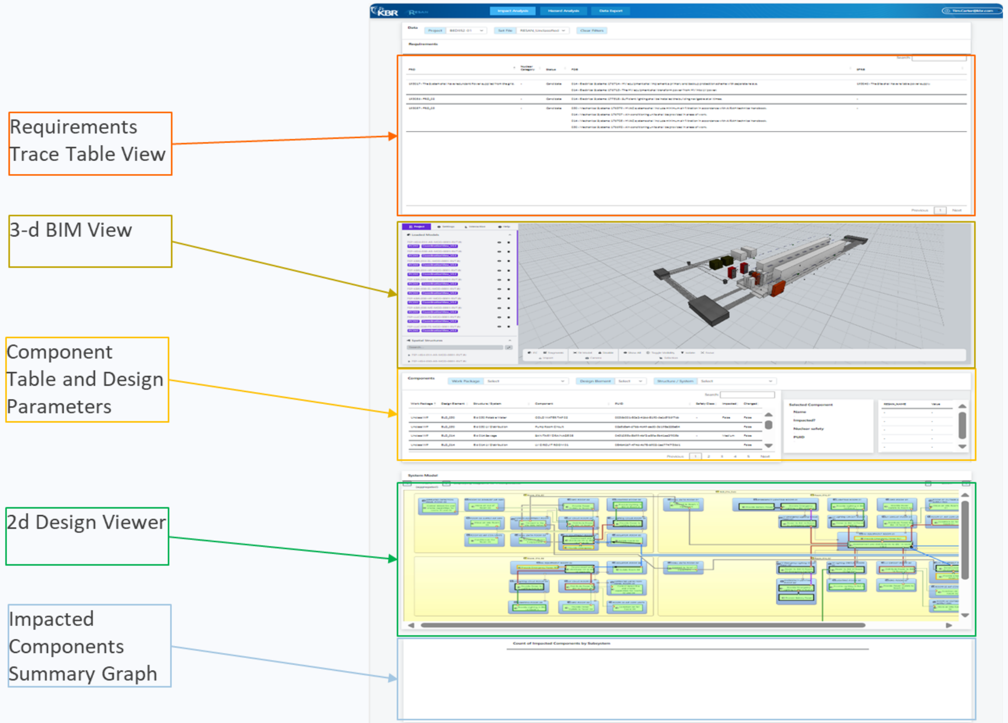


Design Change Impact Analysis

Someone wants to change a component due to obsolescence, ease of construction, cost, etc… We want to understand if requirements or capability are affected



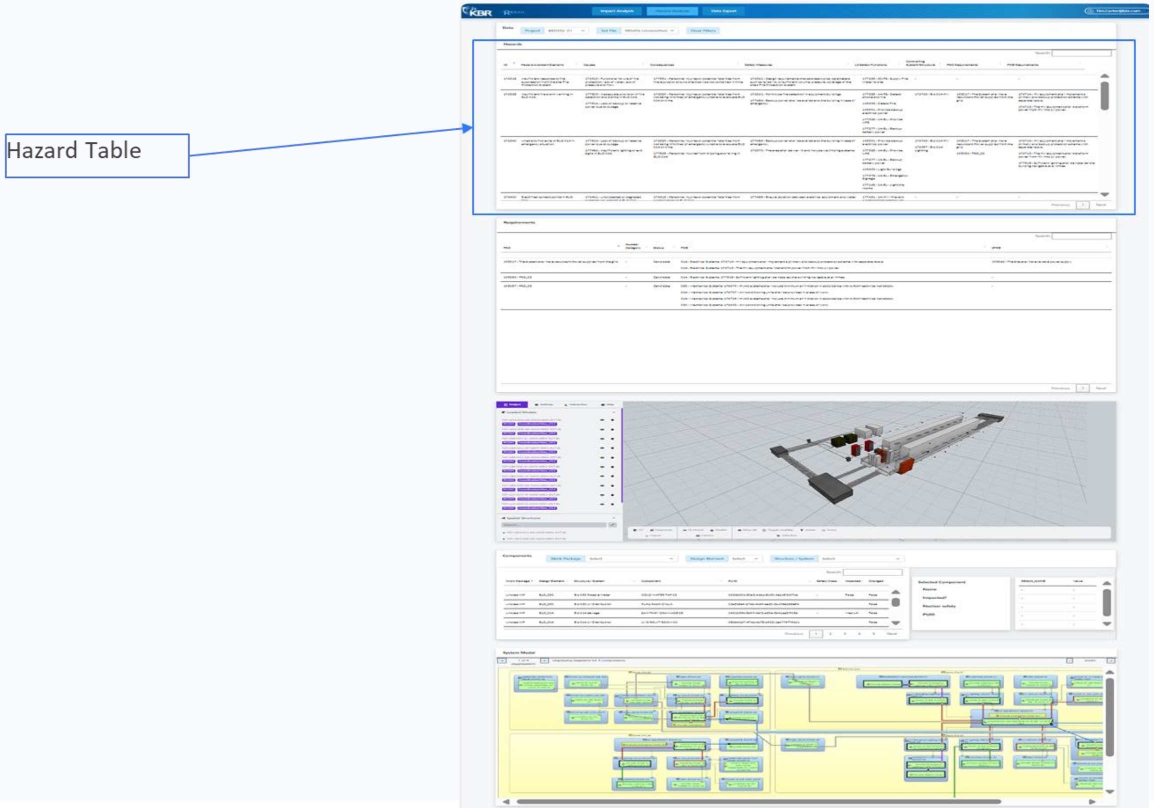
- Select the relevant component
- See:
  - Component key design parameters
  - nearby components in the BIM model
  - Functionally related components in the schematic and Sys. Arch. diagrams
  - Related requirements at all levels, including customer requirements and capability needs
- Export Data to support impact analysis reports for the Change Control Board



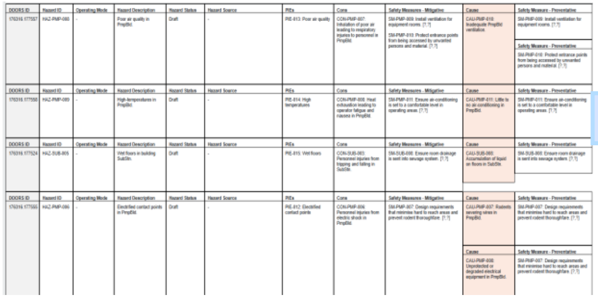
Safety Case/HAZOPS support

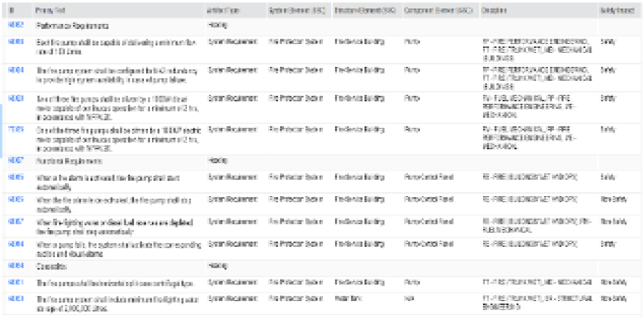
We want to investigate if all safety measures related to a hazard have been fully designed or see check for other potential design dependant hazards

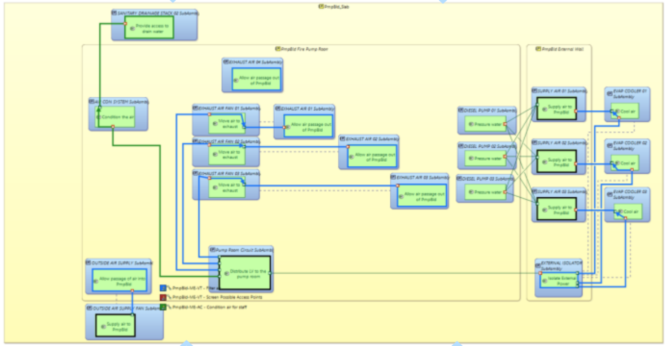
- Select the relevant hazard
- See:
  - Related safety requirements
  - Physically and functionally related components through the Schematic/Sys. Arch. design and 3d BIM model
- Export Data to support Verification arguments against the safety requirements
- Export data to initialise Fault/Engineering schedules

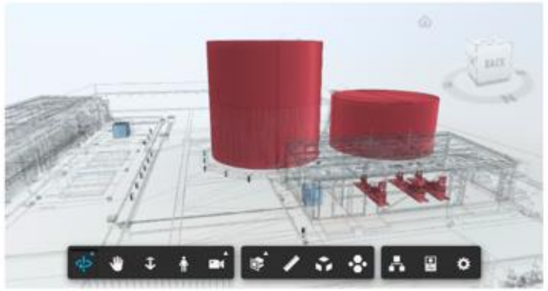


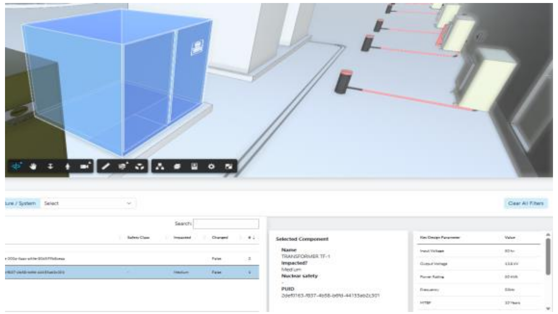
Model Based System Architecting at the centre of the data model







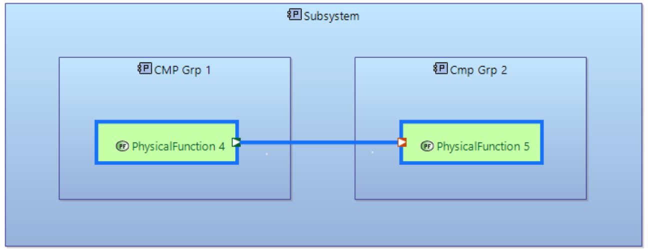


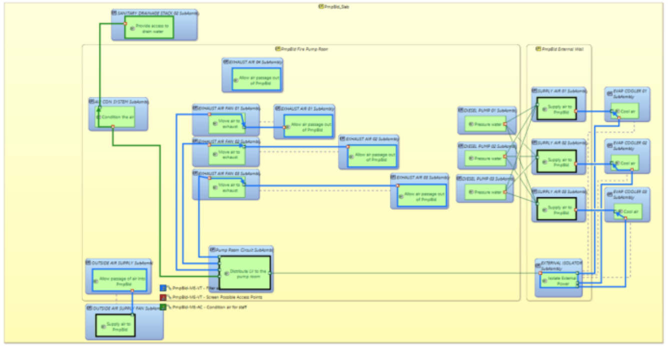


Why Capella and not another tool?

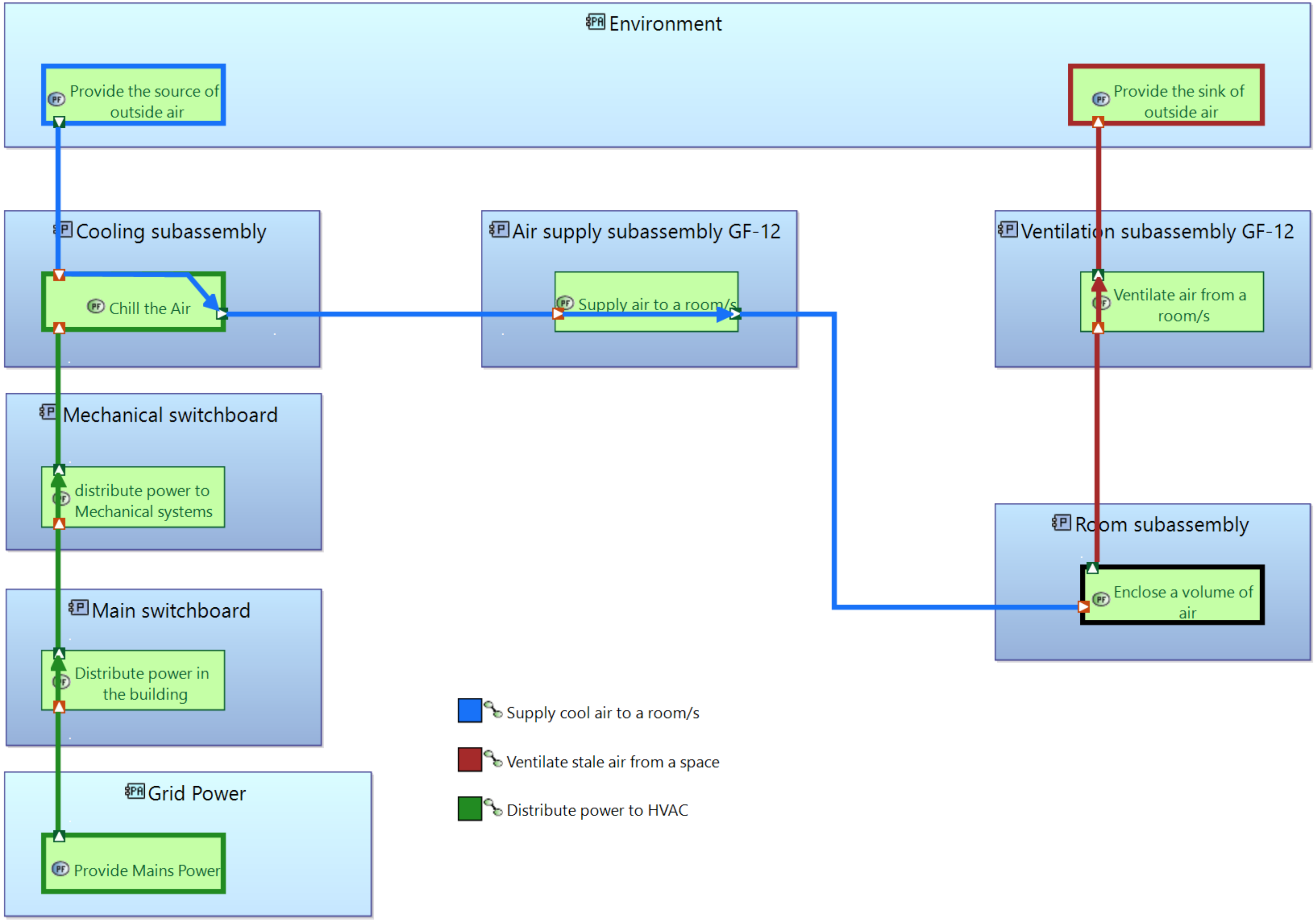
Capella has 3 key advantages

- The Functional Chain modelling paradigm is ideal suited to showing how subassemblies work together
- The Python For Capella Interface is Ideal for complex interactions with the MBSE tools data imports and exports
- The REC/RPL paradigm works very well with repetitive system architectures in Infrastructure projects





Consider the example of a simplified HVAC system



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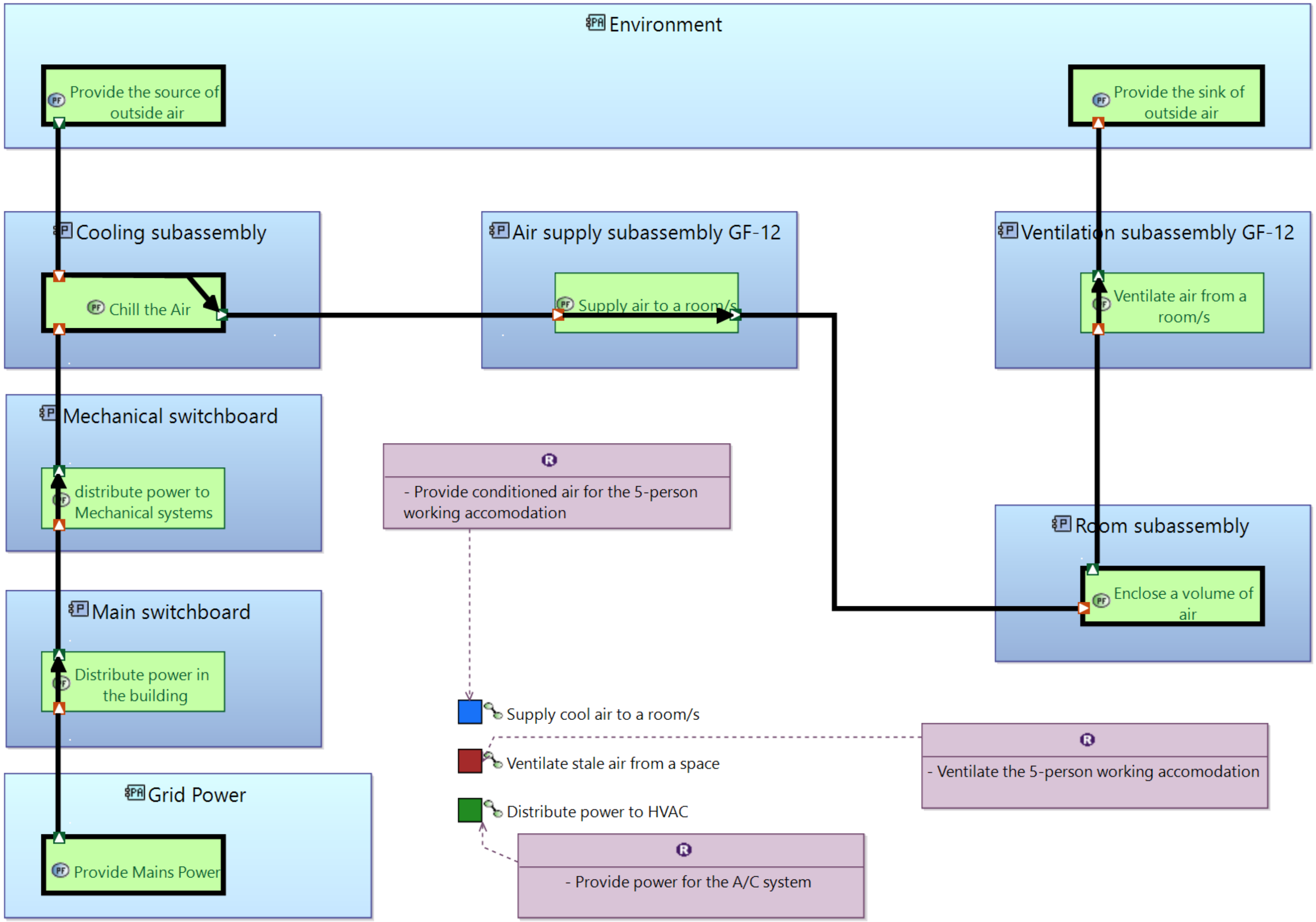

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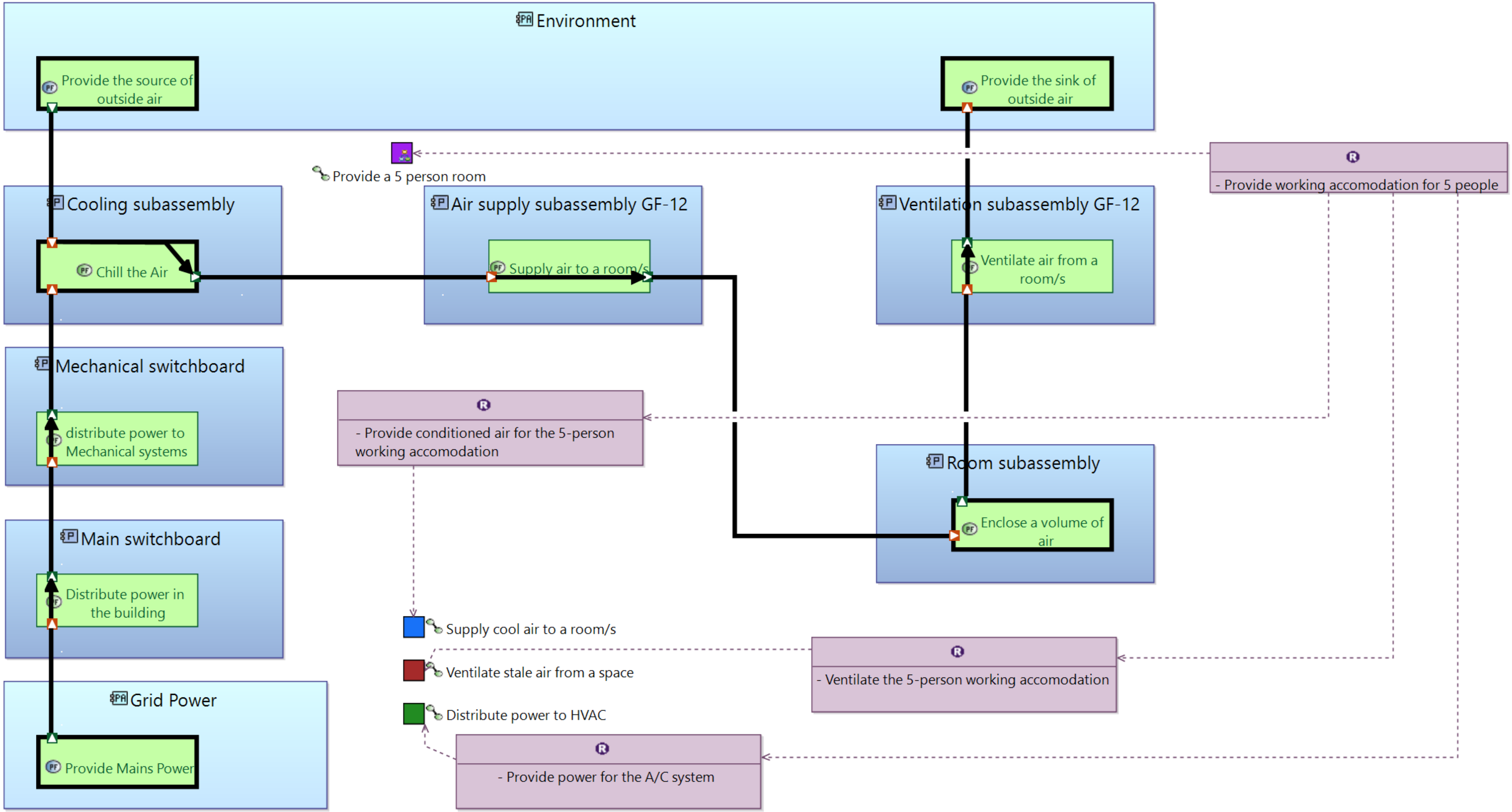
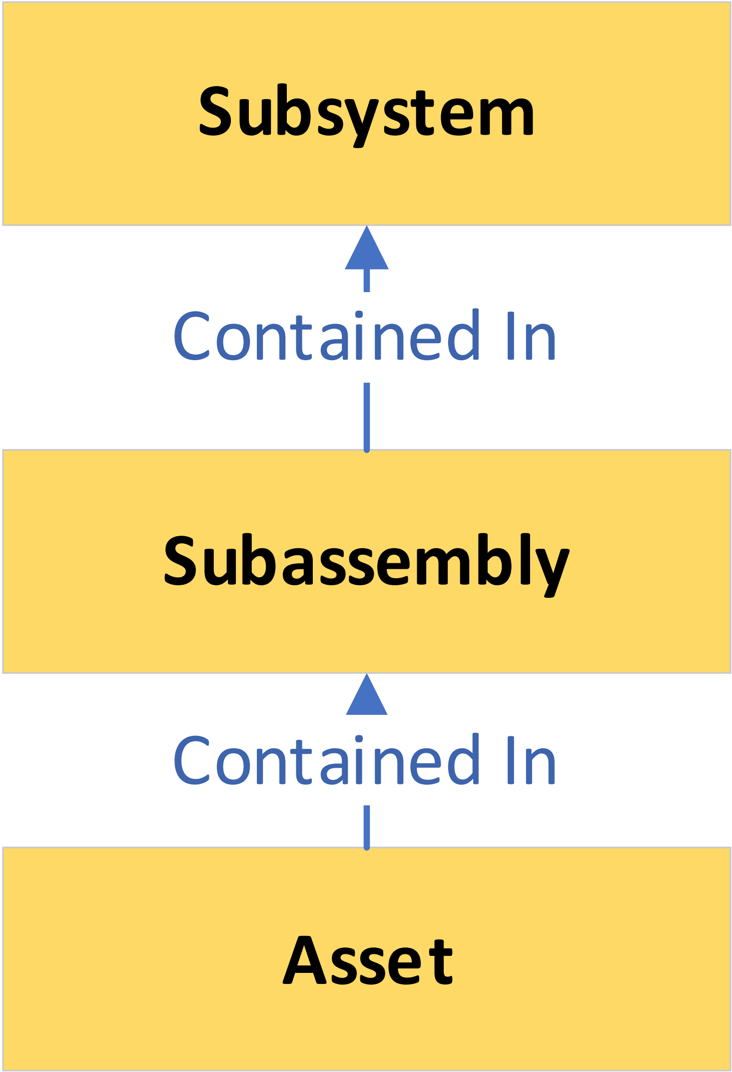


Consider the example of a simplified HVAC system

- HVAC
  - Ventilation subassembly GF-12
    - [Component Functional Allocation] to Ventilate air from a room/s
    - Air Terminal
    - Ventilation Duct
    - Fan
  - Air supply subassembly GF-12
    - [Component Functional Allocation] to Supply air to a room/s
    - A/C to Air Handling Unit Duct
    - Air Handling Unit
    - AHU to Room Duct
    - Air Terminal



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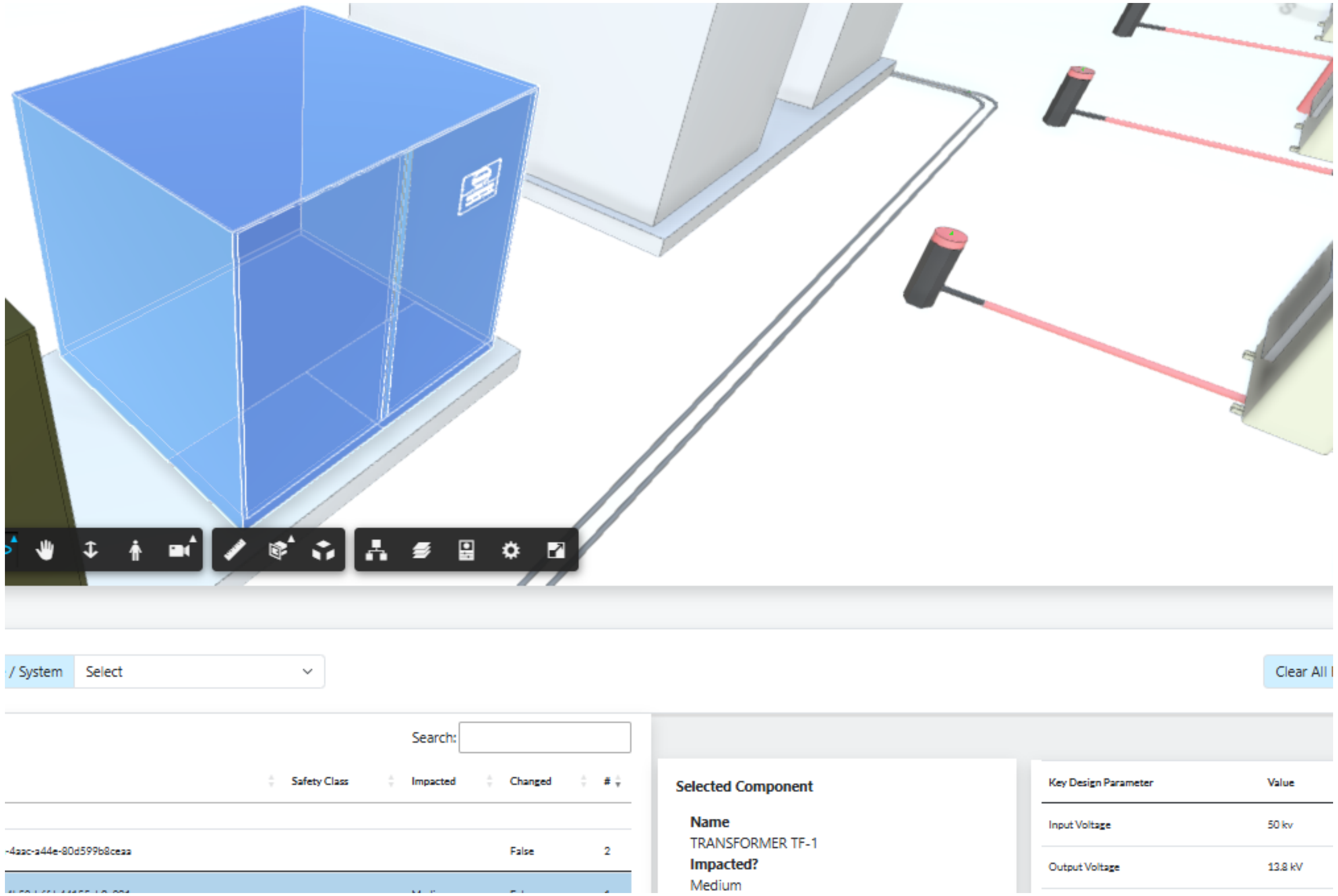
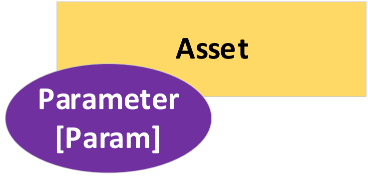




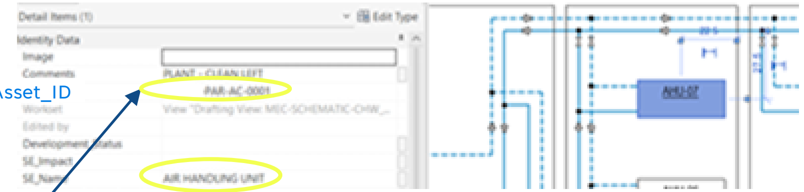
- TRANSFORMER TF-1
  - RESAN_Domain.RESAN_Data
    - PUID = <undefined>
    - SE_RESAN_1_Name = Input Voltage
    - SE_RESAN_1_Value = 50 kv
    - SE_RESAN_2_Name = Output Voltage
    - SE_RESAN_2_Value = 13.8 kV
    - SE_RESAN_3_Name = Power Rating
    - SE_RESAN_3_Value = 50 kVA
    - SE_RESAN_4_Name = Frequency
    - SE_RESAN_4_Value = 50Hz
    - SE_RESAN_5_Name = MTBF
    - SE_RESAN_5_Value = 10 Years

Key Design Parameters captured in the 3-d Models and 2-s schematics

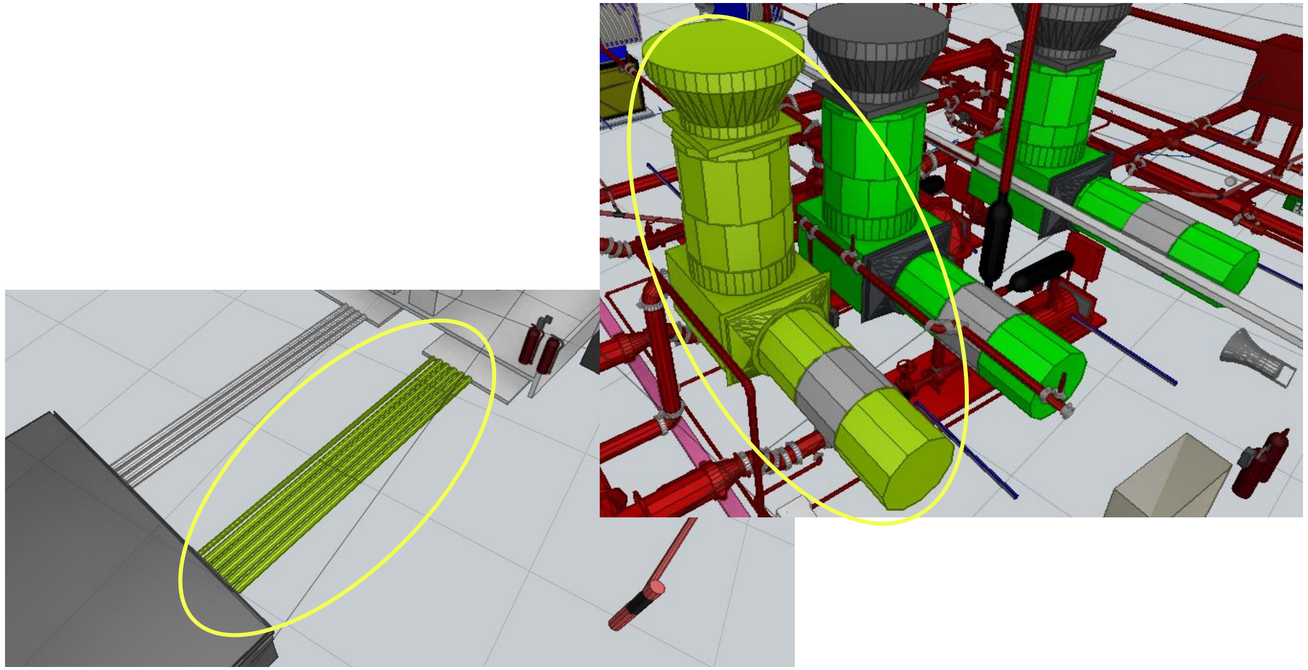
Annotation			
EQUIPMENT			
AREA-SBS-XX-NNNN[A]	eg	AET-CP-0001	
Where:			
AREA	Area number	use the Design Element code, this will be replaced by the Building Number in a later phase	
SBS	System breakdown structure		
XX	Equipment type (per Equipment tab)		
NNNN	Unique number		
[A]	Duty/Standby/Assist Equipment		

ACS-AH-0007?

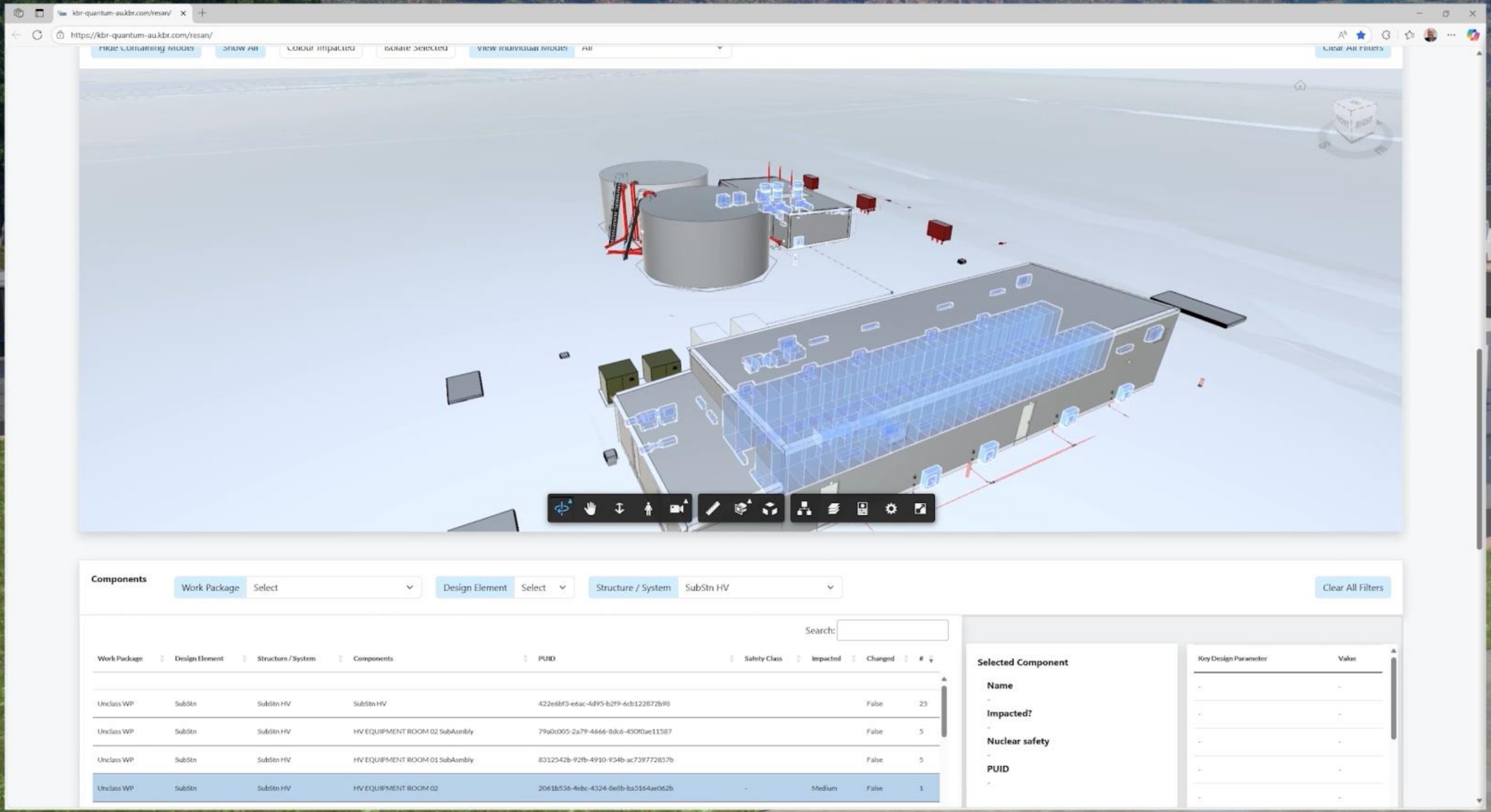
Asset_ID



Component Type	Key Design Parameter 1	Key Design Parameter 2	Key Design Parameter 3	Key Design Parameter 4	Key Design Parameter 5
AIC Controller - UV	Low Low Alarm Set Point	Low Alarm Set Point			
Air Compressor	Volume Flowrate	Dew Point	Reliability	Oil Free (True/False)	Design Pressure
AIT Sensor - Conductivity	Normal Operating Range	High Alarm Set Point	High High Alarm Set point	Reliability	
AIT Sensor - Radioactivity	Normal Operating Range	High Alarm Set Point	High High Alarm Set point	Reliability	
Bund	Capacity	Earthquake Rating			
Carboy	Volume	Design Flowrate	Attenuation		
Cartridge Filter	Particle size	Design Flowrate	Design Pressure Drop	Operating temperature	Changeout Frequency
Coupling					
Evaporator	Capacity	Power	Evaporation Rate	Reliability	Material construction
FIT Flow Meter	Reliability	Type	Design Flowrate		
FIT Sensor - Flowrate	Low Alarm Set Point	High Alarm Set Point	High High Alarm Set point	Reliability	
FSH Sensor - Flow Switch	Nominal Bore Pipe Diameter	Material	Schedule Thickness		
HEPA Filter	Filtration Efficiency	Design Flowrate	Design Pressure Drop	Operating temperature	Humidity Resistance
Hose Coupling	Diameter	Male/Female	Type		
Ion Exchange Media	Charge Volume	Design Bed Flux	Resin Material	Changeout Frequency	Activity Limit (Bq)
Level Guage	Low Alarm Set Point	Reliability			
LIT Sensor - Level	Low Alarm Set Point	High Alarm Set Point	High High Alarm Set point	Reliability	
LSH Sensor - Level Switch	High Alarm Set Point	Reliability		Reliability	
LWCT	Max Working Volume	Design Flowrate	Max Operating Temperature	Attenuation	
Motor	Motor Rating	Reliability	Shaft Torque	Design Speed	
Motor - wiper	Motor Rating	Reliability			
PDIT Sensor - Differenttial Pressure	Low Alarm Set Point	High Alarm Set Point	High High Alarm Set point	Reliability	
PI Sensor - Pressure	Low Alarm Set Point	High Alarm Set Point	High High Alarm Set point	Reliability	
Pipe	Nominal Bore Pipe Diameter	Material	Schedule Thickness		
PIT Sensor - Pressure	Low Alarm Set Point	High Alarm Set Point	High High Alarm Set point	Reliability	
Programmable Logic Controller	MTBF (Mean Time Between Failures)	Operating Temperature	Power		
Pump	Pump Type (Centri/PD)	Design Flowrate	Design Head	Reliability (per year of operation)	Mechanical Seal
Sampling Tool	Size				
SCADA	MTBF (Mean Time Between Failures)	Operating Temperature	Power		
Shielding	Material	Thickness	Attenuation		
Switch - Flow	Low Alarm Set Point	Reliability			
Switch - Hand	Reliability				
Tank	Working Volume	Total Capacity	Material	Thickness	
TIT Sensor - UV	High Alarm Set Point	High High Alarm Set point			
UV - Ultraviolet Unit	Design Flowrate	Design Pressure	Max Intensity (uWs/cm^2)	Reliability	
Valve - Ball	Valve Diameter	Design Pressure	Reliability	Actions Per Year	Operating temperature
Valve - Non-Return	Valve Diameter	Design Pressure	Reliability (per year)	Design Differential Pressure	
Valve - Release	Orifice Diameter	Set Point	Back Pressure	Reliability	Release Capacity
Vessel	Capacity	Design Pressure	Design Temperature		



RESAN ties each link of the digital chain together



- Connected Digital Thread
- Linked BIM & Schematic Design
- Change & Impact Detection
- Key Asset Data
- Traced Requirements & Hazards
- Dependency Dectection
- Complete Digital Thread

DIGITAL DATA CHAIN

Now a slower time look at the interface

Lessons – Successes + Opportunities

- **Organisational / Planning**
  - Designers contribute effectively when future value is clearly communicated.
  - Early budgeting and planning are essential for successful delivery of new initiatives. RESAN is no different.
  - Maintaining consistent communication supports alignment and progress.
- **Technical**
  - An agreed Ontology including the SBS and naming convention is a must have
  - RESAN is adaptable to what is important
- **Value**
  - The customer was excited by the through life support use cases
  - The engineering team members had views on what is important based on their roles
  - It is difficult, but not impossible to show value early
    - A focus on requirements early helps
    - A focus on subsystems architectures soon after is an opportunity
    - The later in the lifecycle, the more traceability there is and therefore the value it shows

Thank You