



Ricerca di Sistema elettrico

Rapporto finale “Engineering Validation and Engineering Design Activities” Contratto ENEA-RFX del 07/08/2012

Giuseppe Pruneri (Consorzio RFX)

RAPPORTO FINALE “ENGINEERING VALIDATION AND ENGINEERING DESIGN ACTIVITIES” CONTRATTO ENEA-
RFX DEL 07/08/2012

Giuseppe Pruneri (Consorzio RFX)

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Report Ricerca di Sistema Elettrico

Accordo di Programma Ministero dello Sviluppo Economico - ENEA

Piano Annuale di Realizzazione 2012

Area: Produzione di energia elettrica e protezione dell'ambiente

Progetto: Attività di fisica della fusione complementari a ITER

Obiettivo: b1. *Campagna sperimentale dei sistemi di monitoring online per la misura delle impurezze in litio e per i fenomeni di cavitazione per l'impianto EVEDA di Oarai (Giappone) e costruzione del bersaglio a baionetta*

Responsabile del Progetto: Ing. Aldo Pizzuto, ENEA



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Ricerca Formazione Innovazione

**Contratto di appalto per Engineering Validation e Engineering
Design Activities**

Contratto ENEA-RFX del 07/08/2012

Relazione finale

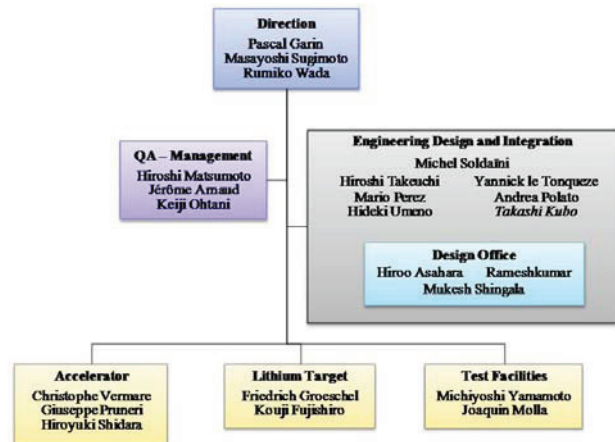
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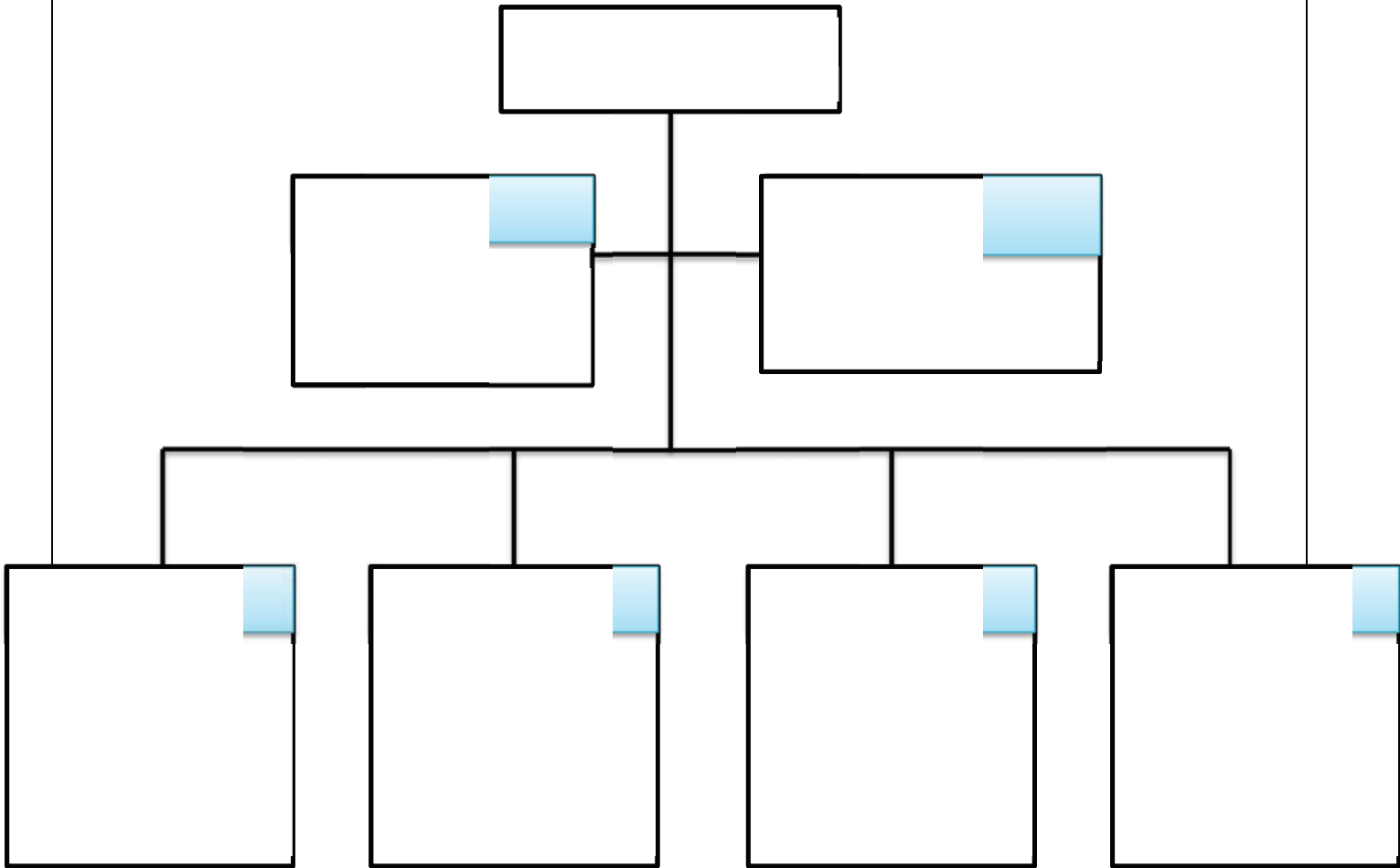
- Relazione di attività 2012 presso IFMIF EVEDA project in Rokkasho (Giappone) di Giuseppe Pruneri
- System Design Description Document (DDD) – Service Water System
- DDD – Service Gas System
- DDD – Heating Ventilation and Air Conditioning System
- DDD – Electrical Power System
- DDD – Heat Rejection System

Relazione attivita' 2012 presso IFMIF EVEA project in Rokkasho (Japan)

La mia posizione da Settembre 2011 a oggi e' stata aggiornata dal PL (Project Leader) Inizialmente mi occupavo quasi esclusivamente di EVEDA; " attivita' relative alla realizzazione dell'acceleratore prototipo da 9MeV i cui componenti in costruzione all'estero nei vari laboratori Europei e il Building e tutte le strutture convenzionali realizzate e in realizzazione in Giappone. La mia mansione orientata al coordinamento di tutte le attivita' di ingegneria; civile, meccanica, elettrica per lo stesso acceleratore. Prevalentemente le attività convenzionali ovviamente correlate soprattutto all'installazione componenti dell'acceleratore (Responsabile delle interfacce tecniche) Qui a lato L'organigramma base ove la mia precedente posizione e' collocata nella casella "Acceleratore".

A partire da Settembre 2011 a oggi la mia nuova posizione e' stata consolidata come "PLANT GROUP MANAGER", per l'Acceleratore prototipo e IFMIF plant, qui sotto l'organigramma attuale.





PLANT GROUP MANAGER, comporta varie nuove attivita' da svolgere qui di seguito elencate:

1. Dare effettivo supporto tecnico a tutte le attività relative alla validazione dell' Acceleratore (durante la fase di ingegneria, acquisti componenti, spedizione, installazione e collaudi)

2. Seguire e mitigare le attività di interfaccia tra i colleghi Europei e Giapponesi e intervenire attivamente organizzando riunioni tecniche dedicate a risolvere le interferenze, la redazione delle minute delle riunioni e seguirle fino a completa mitigazione.
3. Fornire tutto il necessario supporto tecnico al Design office orientato alla gestione delle attività di ingegneria e particolarmente la realizzazione del Building 3D model, processo di validazione e le relative attività di integrazione dei sottosistemi dell'acceleratore con tutti i sistemi relativi agli impianti convenzionali.
4. Supporto tecnico a "IFMIF Engineer Design Activities" e in particolare responsabile per le attività identificate come "Conventional Facilities" Responsible officer per i seguenti sistemi:
 - a. **HVAC:** Heating Ventilation Air conditioning.
 - b. **EPS:** Electrical Power Supply.
 - c. **SWS:** Service Water System.
 - d. **SGS:** Service Gas System.
 - e. **HRS:** Heat Rejection System.
 - f. IFMIF Building Layout
5. Studio e sviluppo della struttura base del sistema di controllo IFMIF. (Central Control System)

Premesso quanto sopra qui' di seguito una sintesi delle attivita' principali svolte nel periodo 2012:

ACCELERATORE:

Con regolarità bisettimanale organizzo Videoconferenza tra F4E/EU-HT/JP-HT e PT della durata di circa due ore ove vengono trattati vari argomenti contemplati nella lista delle azioni (LLOA's- LIPAc's List of Action) redatta sulla base degli argomenti irrisolti emersi dalle varie riunioni precedenti o notificati dai responsabili di sistema o implementing agency EU-JP. Lo scopo primario quello di validare le azioni e identificare la data di realizzazione e appartenenza. Qualora non si giunge a una definizione logica del problema trattato viene inoltrato a responsabilita' superiore direttamente a PL o alto livello se insufficiente.

Settimanalmente partecipo al "Weekly meeting PT" ove si discute quanto prodotto durante la settimana precedente e si presenta l'attività che verrà prodotta la settimana successiva.

Settimanalmente organizzo la riunione coordinamento con JAEA per le attività relative agli impianti convenzionali di responsabilità JAEA ma che comunque hanno un pesante impatto con l'ingegneria dell'acceleratore e suoi sistemi.

Settimanalmente organizzo il progress meeting per le attività civili meccaniche ed elettriche dell'Acceleratore.

Ogni settimana organizzo riunioni per le attività di ingegneria presso l'ufficio CAD ove sono responsabile per la realizzazione del modello 3D, nella stessa riunione discutiamo anche riguardo la progettazione di IFMIF per il quale offro una consulenza per il coordinamento delle attività meccaniche nel conteso Civile con lo scopo di ottimizzare il piano di ingegneria.

A cadenza mensile do le necessarie istruzioni al CAD office per l'aggiornamento del Modello 3D dell'Acceleratore a seguito di vari meetings con JAEA- F4E ove vengono acquisite le varie informazioni per l'aggiornamento. Il modello viene regolarmente caricato nel sistema DMS e sottoposto a revisione e approvazione. Successivamente F4E procede all'implementazione della parte dei sottosistemi dell'acceleratore passando per lo stesso processo di validazione attraverso DMS. Conseguentemente spetta a me (con il supporto del CAD Office) l'integrazione del sottosistema nel modello Accelerator Building 3D e verificarne la corretta integrazione. Il mese successivo l'operazione si ripete implementando così il livello di ingegneria.

Ogni sei mesi organizzo una riunione tecnica generale per l'Acceleratore LTM (LIPAc Technical Meeting) della durata di una settimana ove si svolgono delle intense riunioni giornaliere e presentazioni da parte dei vari responsabili dei sistemi. Normalmente partecipano tutti i *responsible officers*, F4E, JP-HT e PT. Lo scopo quello fare un punto sullo stato della realizzazione dei componenti l'acceleratore e verificarne le interfacce e programmi di realizzazione sulla base del master program. A seguito, relazione e lista di azioni da seguire viene preparata. Nel caso emergano ritardi consistenti o problematiche evidenti, preparo usualmente un piano di recupero da sottoscrivere e validare tra le parti. La lista di azioni redatta viene integrata alla LLoA's menzionata in questo rapporto.

Durante il mese di Settembre, Ottobre e Novembre 2012 ho lavorato alla preparazione dei meetings di coordinamento per chiarire tutte le attività necessarie all'installazione dell'*Injector*, primo componente dell'Acceleratore il cui arrivo a Rokkasho previsto per la fine di Marzo 2013. Nel contesto sto' lavorando alla preparazione dei disegni di montaggio e interfaccia con le attività convenzionali sempre per l'*Injector*.

IFMIF Design activity:

Da Settembre 2011 ho iniziato a collaborare intensamente per lo studio e l'elaborazione dell'ingegneria IFMIF (Conventional Facility) Ho seguito e sto' tuttora seguendo in prima persona le attività relative ai seguenti sistemi:

- HVAC (Heating Ventilation and Air Conditioning)
- EPS (Electrical Power Supply)
- SGS (Service Gas System)
- HRS (Heat Rejection System)
- SWS (Service Water System)

Ho scritto i documenti tecnici DDDII (Design Description Documents II) dopo aver elaborato con JGC (Ditta di ingegneria Giapponese) il progetto di ingegneria IFMIF per i sistemi menzionati, interazione con JGC durata circa 5 mesi con intensivi scambi di informazioni tecniche e frequenti riunioni in Giappone e altrove. I documenti DDDII sono completi di descrizione tecnica del sistema, interfaccia con altri sistemi disegni tecnici PFD e P&ID, analisi sicurezza, sistemi di controllo, lista componenti da fornire e loro ingombri, analisi funzionale, layout tubazioni, canaline ecc.

I documenti DDDII sono ora disponibili nel sistema IFMIF- DMS (IFMIF Document Management System) e in fase di revisione, prevedo di aggiornarli (dopo aver ricevuto tutti i commenti dai revisori) entro la fine di Febbraio 2013. Un estratto della documentazione DDDII è stato presentato durante il recente Workshop tenutosi a Bologna, Brasimone e Padova.

Oltre ai sistemi sopra menzionati dedico del tempo alla consulenza per la realizzazione del layout IFMIF.

Quanto sopra descritto rappresenta una serie di attività per le quali sono impegnato a cadenze regolari, ovviamente giornalmente ho diverse altre attività di routine che mi occupano buona parte della giornata, per esempio la revisione di documenti presenti nel DMS e per i quali sono stato incaricato alla revisione, redazione di documentazione di qualità, redazione minute dei meetings, preparazione di presentazioni e meeting operativi tecnici.

Considero inoltre nel contesto, due rientri all'anno con riposo di almeno 2 settimane ciascuno e una media di 2 missioni all'anno per riunioni all'estero (Workshop, LTM ecc.)

FINE.

System Design Description Document (DDD)

Service Water System (SWS)

PBS 5.3.4.

Abstract: This document describes the Service Water System (SWS) considered belonging to the Conventional Facilities. Key functions of the system as well as: interfaces with other facilities/systems, PFD, P&ID's, equipment layout, equipment list, flow diagrams, piping layout and input data requirement for the design of the system.

Reference of the document: BA_D_22Y8S7

Index of revision: 1.1

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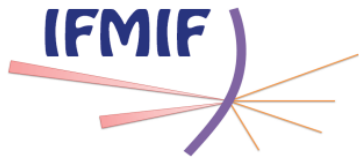
Record of Modifications

Version	Date	Modification
1.0	31 st August 2012	Initial Release
1.1	21 st September 2012	Updating of the reviewers and approver



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1. System Functions and Basic Configuration

1.1 System Functions

The service Water System produces, stores, supplies, and distributes service water at sufficient quality, quantity, and at sufficient pressure to client systems.

To accomplish the above mentioned functions, The SWS are composed by the following three (3) subsystems:

- Potable Water System (**indicated on present DDD’s PBS, shall be proposed to be implemented the next updated IFMIF PBS (CF section)**)
- Demineralization Water service system
- Industrial Water Service System

1.2 System Basic Configuration

PBS, proposed for the plant, and summarized in Table 1, locates the SWS System within the Conventional Facilities/ Plant services.

PBS Number						PBS Item
1	2	3	4	5	6	
5	0	0	0	0	0	Conventional Facilities
		3	0	0	0	Plant Services
			4	0	0	Service Water System (SWS)
			1	0	0	Potable Water System
			2	0	0	Demineralized Water Service System
			3	0	0	Industrial Service Water System

Table 1: Service Water System (SWS) PBS breakdown

To enter in further details we can divide the SWS into three main subsystems even do potable water is not included in the general IFMIF PBS, is in our proposal to upgrade on the next phase III as already mentioned. Meanwhile the subsystem it is hereby described in this DDD’s even represented on the tables and drawings enclosed:

- Potable Water Service System
- Demineralised Water Service System
- Industrial Water Service System

Here below short descriptions:



1.2.1 Potable Water Service System

Potable water system supplies and distributes water suitable for human consumption throughout the IFMIF Site, including among other service: usage in kitchen and drinking fountains, lavatories and showers for personnel, industrial water necessities, make-up water for Demineralized Water System.(cfr. Ref. PFD Figure 6-1-)

1.2.2 Demineralized Water Service System

Demineralized Water Service System produces, stores, supplies and distributes demineralized water in sufficient quality, quantity, and in a sufficient pressure to client system for processes use, as make-up closed primary cooling loops. Demineralized water is derived from potable water¹. A demineralized water production plant is part of the subsystem consisting of: a filtration process; a purification process (ion exchange resin cartridges); a de-aeration process; buffer storage tank; and piping/distribution equipment and components.

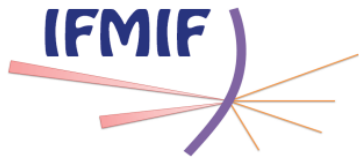
1.2.3 Industrial Water Service System

Industrial water is supplied to the secondary loops of the Cooling towers and to the secondary loops of the chilled water. Industrial water will fill first the two water reserve tanks; one of 1000 m³ for the HRS Cooling Towers water supply while the second of 765 m³ for the Fire Fighting System to fill the water pond. Both water storage reserve tanks are located outdoor IFMIF (cfr. Ref. Figure 4-1: IFMIF Overall View, SWS Outdoor Water Storage Tanks)

2. Interfaces (boundaries)

The interfaces with other systems may be physical and functional or both. Additional information about SWS interfaces is provided in Systems Interface (Ref. Table 2 : SWS, Interface table) Characteristics of the components for the SWS is indicated on the Table 5: SWS Equipment list. There is a multiple interface between SWS Facilities (hosted mainly in the R307) and Building. A generic multiple interface was defined to overcome this issue. SWS system interfaces at the same time with Conventional Facilities (in the sense of the Building) and with the equipment for Heat Rejection System and Fire Fighting System.

¹ Potable water is usually selected as raw water for demineralized water make up, especially for small user such as IFMIF. The potable water is treated by a charcoal filter and ion-exchanger resin cartridges to make demineralized water.



Interface Table SWS (Service Water System)		
System A	System B	Title
Cooling System	Service Water System	Demineralized Water Service system of Service Water System has to provide demineralized water to: Cooling system
Main Building	Service Water System	Main Building has to accommodate demineralize, piping and etc. of : Service Water System
High Radioactive Waste Treatment Cell	Service Water System	Demineralized Water Service System of Service water system has to provide demineralized water to: R007 High Radioactive Waste Treatment Cell
Electrical Power System	Service Water System	Electric Power System has to provide service to: Demineralized Water Service System of Service Water System
Heat Rejection System	Service Water System	Service water System has to supply demineralized and industrial water to: Heat Rejection System
Service gas System	Service Water System	Service Gas System has to provide instrumentation air to: Service Water System
Industrial Water Drainage	Service Water System	Nonradioactive waste water of Service Water System has to be collected to: Industrial Water Drainage

Table 2 : SWS, Interface table

2.1 SWS Boundaries of interface.

2.1.1 Potable Water vs. Lithium Facility

Not applicable.

2.1.2 Potable Water vs. Accelerator facility

Potable Water System will serve the conventional rooms (i.e. toilets and kitchen) of the AF.



The boundary between SWS and CF is set at the internal wall of the enclosure. Connection flanges and afterward equipment are considered within the scope of the Building Conventional Facility.

2.1.3 Potable Water vs. Test Facility

Potable Water System will serve the conventional rooms (i.e. toilets and kitchen) of the TF.

The boundary between SWS and CF is set at the internal wall of the enclosure. Connection flanges and afterward equipment are considered within the scope of Building Conventional Facility.

2.1.4 Potable Water vs. PIE Facility

Potable Water System will serve the conventional rooms (i.e. toilets and kitchen) of the PIE Facility.

The boundary between SWS and PIE facility is set at the internal wall of the enclosure. Connection flanges and afterward equipment are considered within the scope of Building Conventional Facility.

2.1.5 Potable Water vs. Conventional facility

Potable Water System will serve the Conventional Facility (i.e. toilets and kitchen).

The boundary between SWS and Conventional Facility is set at the internal wall of the enclosure. Connection flanges and afterward equipment are considered within the scope of Building Conventional Facility.

2.1.6 Demineralized Water vs. Lithium Facility

Not applicable

2.1.7 Demineralized Water vs. Accelerator facility

Demineralized water System will serve the AF primary loop and expansion tanks for the AF cooling systems.

The boundary between SWS and AF is set at the internal wall of the enclosure close to the cooling skids; connection flanges and afterward equipment are considered within the scope of AF.

2.1.8 Demineralized Water vs. Test Facility

Demineralized water System will serve the TF primary loop and expansion tanks for the TF cooling systems.



The boundary between SWS and TF is set at the internal wall of the enclosure close to the cooling skids heat exchangers; connection flanges and afterward equipment are considered within the scope of TF.

2.1.9 Demineralized Water vs. PIE Facility

Demineralized water System will serve the PIE Facility primary loop and expansion tanks for the PIE Facility cooling systems.

The boundary between SWS and PIE Facility is set at the internal wall of the enclosure close to the cooling skids heat exchangers; connection flanges and afterward equipment are considered within the scope of PIEF.

2.1.10 Demineralized Water vs. Conventional facility

Demineralized water System will serve the CF chilled water closed loop for HRS.

The boundary between SWS and CF is set at the internal wall of the enclosure; connection flanges and afterward equipment are considered within the scope of HRS, CF.

2.1.11 Industrial Water vs. Lithium Facility

Industrial Water System will serve the LF through the HRS Cooling tower.

The boundary between SWS and LF is set at the Cooling Towers inlet water valves; connection flanges and afterward equipment are considered within the scope of LF HRS.

2.1.12 Industrial Water vs. Accelerator facility

Industrial Water System will serve the AF through the HRS Cooling tower.

The boundary between SWS and AF-HRS is set at the Cooling Towers inlet water valves; connection flanges and afterward equipment are considered within the scope of AF HRS.

2.1.13 Industrial Water vs. Test Facility

Industrial Water System will serve the TF through the HRS Cooling tower.

The boundary between SWS and TF- HRS is set at the Cooling Towers inlet water valves; connection flanges and afterward equipment are considered within the scope of TF- HRS.



2.1.14 Industrial Water vs. PIE Facility

Industrial Water System will serve the PIE Facility through the HRS Cooling tower

The boundary between SWS and PIEF- HRS is set at the Cooling Towers inlet water valves; connection flanges and afterward equipment are considered within the scope of PIEF- HRS.

2.1.15 Industrial Water vs. Conventional facility

Industrial Water System will serve the Conventional Facility through the HRS Cooling tower and FFS (Fire Fighting System) through water storage pond.

The boundary between SWS and Conventional Facility-HRS and FFS water storage pond is set at the inlet water valves for the cooling towers and FFS water storage reserve; connection flanges and afterward equipment are considered within the scope of CF- HRS and FFS.

3. System Design Requirements

3.1 General requirements

3.2 Engineering Requirements

According to the classification proposed in Safety Specifications (cfr. ref [1]) and Safety Important Class-SIC, Methodology, Classification & Requirements (cfr. Ref. to Doc. BA_D_228V5Q Version 1.2 ref [6] ;

The system has been classified as follows:

3.2.1 Potable Service Water System

- SIC (Safety Important Components) SR/non-SIC
- **Availability:** The system has no active equipment.
- **Supply conditions:**
 - Pressure from another facility $\geq 0.5\text{MPa(G)}$
 - Temperature: Room Temperature

3.2.2 Demineralized Service Water System

- SIC: SR/non-SIC.
- **Availability:** The system has no active equipment.
- **Supplying Conditions:**
 - Pressure from another facility $\geq 0.35\text{MPa(G)}$
 - Temperature: Room Temperature
 - Conductivity : $1 \mu \text{ S/cm}$

3.2.3 Industrial Service Water System

- **SIC:** SR/non-SIC.
- **Availability:** The system has no active equipment.
- **Supplying Conditions:**
 - Pressure from another facility $\geq 0.5\text{MPa(G)}$
 - Supplying Pressure: $P \geq 0.5\text{MPa(G)}$
 - Temperature: Room Temperature

3.3 Safety Design Requirements

The general Safety approach for the design execution of SWS is based on the general Safety specification for the Engineering Design Activities of IFMIF

- The IFMIF's Safety objectives, principles and criteria.
 - The Hazard evaluation techniques, to be implemented on the next design phase
- The entire document is uploaded on DMS: Safety Specifications Ref. doc. BA_D_224X48 Ver.4.0 (cfr. Ref. [1]) and following updating. At the present time the Engineering Design for SWS follow the Safety approach mentioned on the guideline document, nevertheless it can be subject to some deviation or weaves according the final IFMIF site selection. As well as the safety authority could gives some further requirements.

3.4 Operation and Maintenance

Integrative maintenance plan is not yet described on this DDD II, shall be defined clearly after having selected all the components for the SWS plant, preferable the maintenance plan shall be prepared by the suppliers, as well as regulatory maintenance requirements must be identified.

Minimum information required within the maintenance plan is listed below:

- Scheduled operation:
 - Controls
 - Checks
 - Adjustments
 - Calibrations
 - Overhauls
 - Replacements, etc.

Information provided from safety specification, Ref. doc. BA_D_224X48 Ver.4.0 (cfr. Ref. [1]) and of course will be implemented and identified as necessary by the supplier in order to ensure the best operation of the SWS system within its intended operational scenario.

- Critical unscheduled operations:
 - Replacements repair etc.

That may impact IFMIF availability and become essential to evaluate and to introduce an additional important support of recommended spare parts list, (provided by the suppliers) procedures, training, tools and test equipments, infrastructures.

The design of SWS shall accommodate long-term maintenance activities required to support IFMIF plant operation. For maintainability and inspectability, SWS system



shall be designed in such a way that it can facilitate maintenance and, in case of failure, easy diagnostics safe repair or replacement and re-calibration. The SWS maintenance must be an ongoing endeavor. Any lapses in regular maintenance can result in system degradation and obvious loss of efficiency which could arise to serious health issue. Maintenance requirement for SWS system and equipments must be conform to the maintenance period defined for the IFMIF plant (particularly for the facilities that are not reachable during operation period)

3.5 RAMI Requirements

RAMI Specifications guide documents Ref. to doc. 22HA3G from J. Arrojo Feb. 2012. The SWS system have been designed to operate during all modes of IFMIF plant operation as well as shut down period SWS should be reliable for continuous operation, easily accessible for the purpose of operation and maintenance. The SWS have been designed in a way that; maintained and operated will meet the reliability and availability requirements in a preliminary way identified on the conventional facility Safety Report. At this stage of the Project complete RAMI analysis has not been performed (due to the high variability of the parameters, such a procedure has not been considered worthwhile). However several assumptions have been evaluated and taken into consideration based of the standard engineering practice. RAMI assessment and implementation of the engineering process shall be fully integrated on the next phase of the project.

3.6 Applicable Codes and Standard Requirements

International standards have been selected for the design of the SWS in particular:

- The equipment for (SWS) shall be designed according to safety specification for the engineer design activities IFMIF ref. BA_D_224x48 (Le Tonquez Y.[1]) in accordance with the pressure equipment directive (PED) 97/23Ec.
- Code and standards for SWS mechanical components shall follow the general IFMIF specification: Applicable Codes and standards for the CF design, in addition the following codes and standards shall be applied:
 - API 510- testing of valves.
 - ASME B31.3- process piping.
 - ASME B73.2M-Vertical in-line pumps.
 - ASME section IX- welding and brazing qualification.
 - ASME section V- non destructive examination.
 - ASME/ANSI B.16.25- Pipes, valves, fittings and flanges butt weld ends.
 - ASME/ANSI B16.34-Valves, flanges, threaded and welding end.
 - EN 13445 – Pressurized Vessels design;
 - EN 13480 – Metallic Piping;
 - ISO 10648: Containment Enclosure;
 - ISO 4427 and DIN 8074-HDPE pipes.

4. System Design Description

4.1 Design Summary

For this section you can refer to the System Functions and Basic configuration (cfr. Ref. Section;1)

4.2 Safety

Refer to Safety specifications for the Engineering design Activities of IFMIF ref. doc. BA_D_224X48 Ver. 4.0 and following updating (cfr. Ref. [1])

4.3 Assumptions

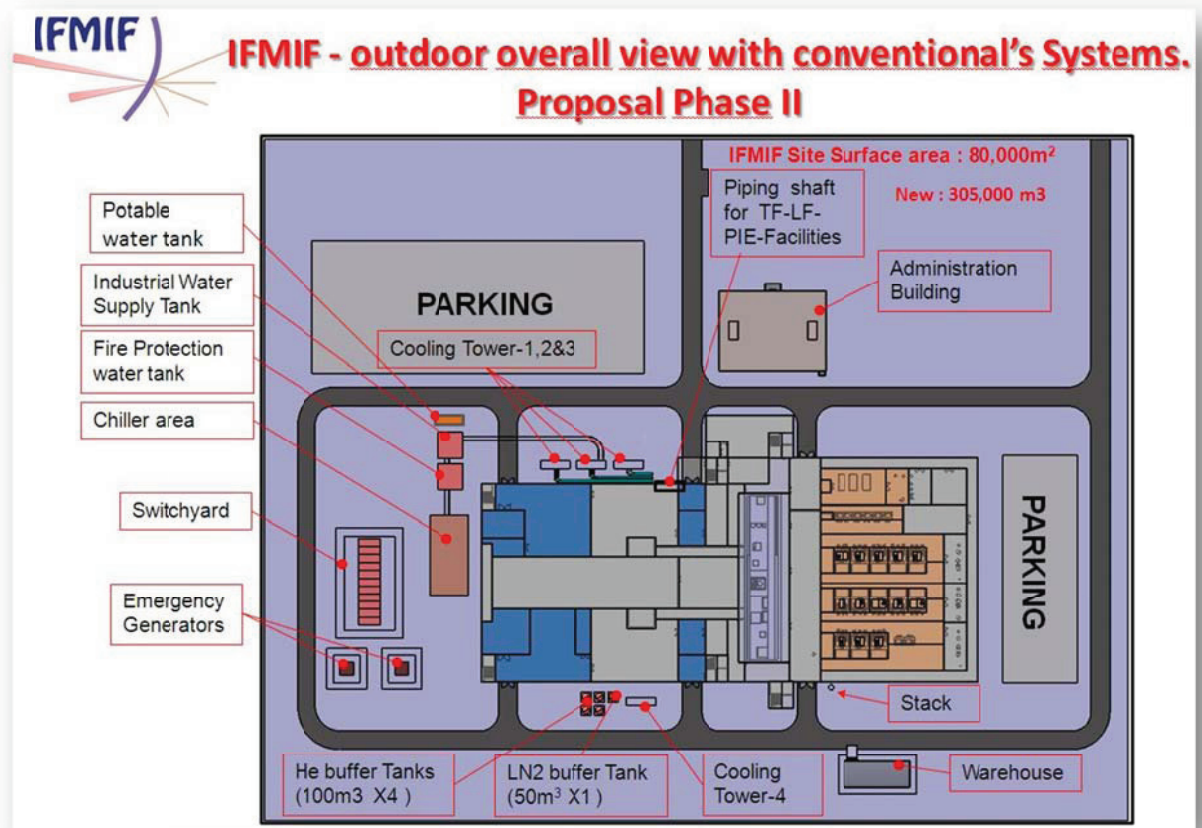


Figure 4-1: IFMIF Overall View, SWS Outdoor Water Storage Tanks

The design of the SWS is based on the following assumptions:

4.3.1 Potable Water Supply

Daily consumption for toilets, Hand wash and showers is 25m³/d considering the IFMIF population of 250 persons composed of: Scientists, Engineers,

Technicians, Management, Maintenance and administration’s staff) An averages of 100 liters of water daily each makes 25m³/d approximately.

Potable water has to ensure the sufficient water demand for to make-up water fort the demineralised water system for to fill-up the primary cooling and chiller water loops at least a pick of 3m³/h for the first time and then to keep up the demineralized storage reserve tank full (1m³) for the further demand of each primary cooling loops. Potable water supply system has a storage tank of 15 m³ to meet the pick water demand from the IFMIF plant any time requested.

4.3.2 Demineralized water Supply

Demineralized will be used for to fill up the primary and chiller water loops.

An estimation of the amount of water (capacity of buffer tanks) for the primary cooling system and chiller water loops for the accelerator has been made, here below the table;

Buffer Tank	Activation Risk	Capacity	
		1 st Phase	2 nd Phase
Name	Yes/No	m ³	
RFQ	Yes	5 *1	5
In Vault	Yes	2 *2	2
RF Cooling Water	No	25 *2	25
Beam Dump	Yes	3 *2	3
Sum		35 *2	35

*1- Based on the Prototype’s information of 2.5 ~5m³ of water with strict temperature control.

Allowable fluctuation range to: ≤ 0.5 °C or more precise.

*2- Strict temperature control is not required, i.e. ≤ ± 1 °C is enough proportional to heat load and inverse proportional to allowable fluctuation range.

Demineralized water is produced by the demineralised water system located on the third floor of the IFMIF (cfr. Ref. Figure 6-3: SWS- Equipment room R307-3Floor, demineralization Water make-up unit and Figure 6-4, 3Floor overall view) and is capable to produce 5m³/h at the required condition of conductivity of 1µS/cm PH at room temperature neutral between 6.5-7.5 degree of alkalinity.

A demineralised water storage tank of 1m³ is provided. Piping distribution net work and generally all components that are vulnerable and exposed to corrosive conditions shall have features that control corrosion or make allowances for corrosion over the expected life of the components.-



4.3.3 Industrial water supply

Industrial water supply has the two main purposes; to store and supply the water to the HRS (Heat Rejection System) Cooling Towers and to the Fire fighting system storage tank. Due to the huge quantity of water consume for HRS evaporation and fire fighting system use on demand; it has been selected the Industrial water for these purpose which is cheaper and usually available in huge quantity.

A storage tanks becomes also necessary for both systems to ensure sufficient reserve of Industrial water for HRS/FFS in case of water supply temporary interruption. (cfr. Ref. PFD Figure 4-1: IFMIF Overall View, SWS Outdoor Water Storage Tanks).In the case of Fire Fighting System the fitted storage tanks is also necessary to fulfill NPA requirements, (cfr. Ref. safety specification [1])

4.3.4 Input data table

Service Water System Assumptions Table			
Parameter	Assessment	Criteria	Level of Criteria
Utilities that need Service Water supply			
	Utilities to be served selected according to the standard engineering practice	Potable Water	Toilets and showers
		Demineralized Water	Primary cooled water loops Primary chilled water loops
		Industrial Water	Cooling towers
			Secondary cooled water loops
			Secondary chilled water loops
Service Water supply conditions			
	Parameters selected according to the standard engineering practice	Potable Water	
		Pressure	≥ 0.5 MPa
		Temperature	Room temperature
		Demineralized Water	
		Pressure	0.35 MPa
		Temperature	Room temperature
		Industrial Water	
		Pressure	0.5 MPa
	Temperature	Room temperature	
Service Water characteristics			
	Parameters selected according to the standard engineering practice	Demineralized Water	
		Conductivity	1 μS/cm
SIC			
	According to the Safety Specifications for the EDA of IFMIF, BA_D_224X48	Potable Water	SR
		Demineralized Water	SR
		Industrial Water	SR
Redundant equipment			
	No formal RAMI studies were performed, but the assumptions made should, according to the standard engineering practice, fulfil the 99.7% of availability mentioned in the CDR.	Redundancy Assumptions	100% x 2
		Redundancy Assumptions if 100% is not available with one machine (considering n machines able to provide 100% capacity)	(100% x n) x (n+1)

Table 3: Input data SWS

4.3.5 Redundant Equipment

Redundancy of the equipment should contribute to the target availability value of the Conventional Facilities (stated into 99.7 % as mentioned in CDR (cfr Ref.[2]). At this stage of the project a complete RAMI Analysis has not been performed (due to the high variability of the parameters, such a procedure has not been considered worthwhile) (Ref. to Sect. 3.5). By the way some assumptions have been made on the base of the standard engineering practice.



Simple redundancy is addressed to components that can cover 100% of the requirements (100% x 2).

Multiple redundancy is considered when requirements can be fulfilled by a set of components (n components) working together ($[100\%/n] \times [n+1]$).

4.4 Detailed Design description

According to the classification proposed in CDR (cfr. Ref. [2]) a further SWS System subdivision has been proposed with slightly changes to meet the safety regulations and system flexibility:

4.5 System Performance Requirements

Not applicable at this engineering stage, anyhow the system performance basic functions/configurations are indicated on the P&ID's of SWS (cfr. Ref. Figure 6-2: D-1225-111-SWS- P&ID)

4.6 System Arrangement

4.6.1 Equipment arrangement Drawings

Refer to the next (Ref. Sect.4.7) Component Design Description

4.7 Component Design Description

For this purpose we have detailed the list of the SWS components necessary for the all SWS system of IFMIF plant, the information are integrated on the document called Equipment List SWS system (cfr. Ref. Table 5) The Equipment List represents all the SWS components, on the list following detailed information are provided:

- Item NO
- Service
- QTY
- Material type
- Type of component
- Specification
- Main Dimension
- Electrical output rate (KW)
- Location on the IFMIF Building (Area/room's number)

4.8 Instrumentation and Control

SWS Central Control System (CCS) shall be conforming to standards, specifications and interfaces as documented in the CCS - DDD II document ref. BA_D236AF7 v1.0.

CCS will ensure the integrated supervision control of overall IFMIF plant and plant system operation. These functions will be available in master control room SWS shall have its own plant control system (PCS) that will allow to know the status of the reserve water storage tanks, flow, pressure, water main parameters conditions SWS -PCS shall integrate the individuals control system of each of the SWS and served IFMIF subsystems in the various facilities of the plant.



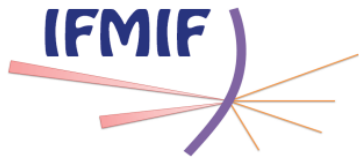
Information from the data is available in the SWS local control system (PCS) shall be transferred to CCS to allow a complete and reliable operation of the SWS. The instrumentation and control components shall include all Computers hardware and software required to control the SWS plant system, including input/output (I/O) interfaces and plant system interlocks. Sufficient instruments shall be included in SWS plant system to monitor components performance within the design envelope and to alarm plant operators on the onset of operation outside design margin (particularly for the Water leakages detection, flow rate, pressure rate, purification efficiency, etc. Instrumentations shall include: pressure and temperature flow sensor to measure/monitor performance and allow independent control of components for the system. Also, instruments shall be installed to monitor all necessary parameters useful for the regular and safety functionality of the SWS, the instrumentations indicated is descriptive but not limited, specific instrumentations and control requirements for SWS system shall be established on the next step DDD III; now we can refer to the SWS P&ID (cfr. Ref. Figure 6-2: D-1225-111-SWS- P&ID)

4.9 Status of R&D activities and future plans

Not applicable for this system.

5. List of References

- [1] Y. Le Tonqueze, *Safety Specifications for the EDA of IFMIF*, BA_D_224X48
- [2] IEA, *IFMIF Comprehensive Design Report*
- [3] Accelerator System Group DDD I, Ref. BA_D_22NF7C v1.0
- [4] M. Ida IFMIF Lithium Target facility, DDD I doc. BA_D_227S7Z rev. 1.0
- [5] F.Arbeiter Test Facility Utility Room DDD I doc. BA_D_22BWBP rev. 4.0
- [6] Y. Le Tonqueze, Safety Important Class-SIC Ref. BA_D_228V5Q rev. 1.2



5.1.1 List of Acronyms

AF	Accelerator Facility
Ar.S	Argon System
BAS	Breathable Air System
CAS	Compressed Air Supply System
CF	Conventional Facilities
CODA	Construction Operation and Decommissioning Activities
DDD	Design Description Document
DVT	Data Validation table
EDS	Emergency Detritiation System
EVEDA	Engineering Validation & Engineering Design Activity
GDS	Glove boxes Detritiation System
HDS	Hot cells Detritiation System
HeS	Helium Supply System
HRS	Heat Rejection System
HVAC	Heating Ventilation Air Conditioning
IFMIF	International Fusion Materials Irradiation Facility
LF	Lithium target Facility
N2S	Liquid Nitrogen System
P&ID	Piping& Instrumentation Diagram
PBS	Plant Breakdown Structure
PFD	Process Flow Diagram
PIE	Post Irradiation Examination
PT	Project Team
RAMI	Reliability, Availability, Maintainability, Inspectability
RF	Radio Frequency
RFQ	Radio Frequency Quadrupole
SIC	Safety Important Component
TF	Test Facility
VDS	Vent gas Detritiation System
WBS	Work Breakdown Structure



6. Appendices

6.1 List of Documents

6.1.1 Drawings (PFD's, P&ID's 2D drawings & Excel file)

PFD and P&ID, together with the IFMIF overall view should help to have a clear picture of the components that takes part in the system definition and of the main interactions among them. (cfr. Ref. Figure 4-1: IFMIF Overall View, SWS Outdoor Water Storage Tanks) Layout Plan for SWS is considered as a preliminary document for the system design, could be slightly modified by a updating in the input data or IFMIF layout changes.

6.2 List of Computer Programs

Not applicable

6.3 Others

Not applicable

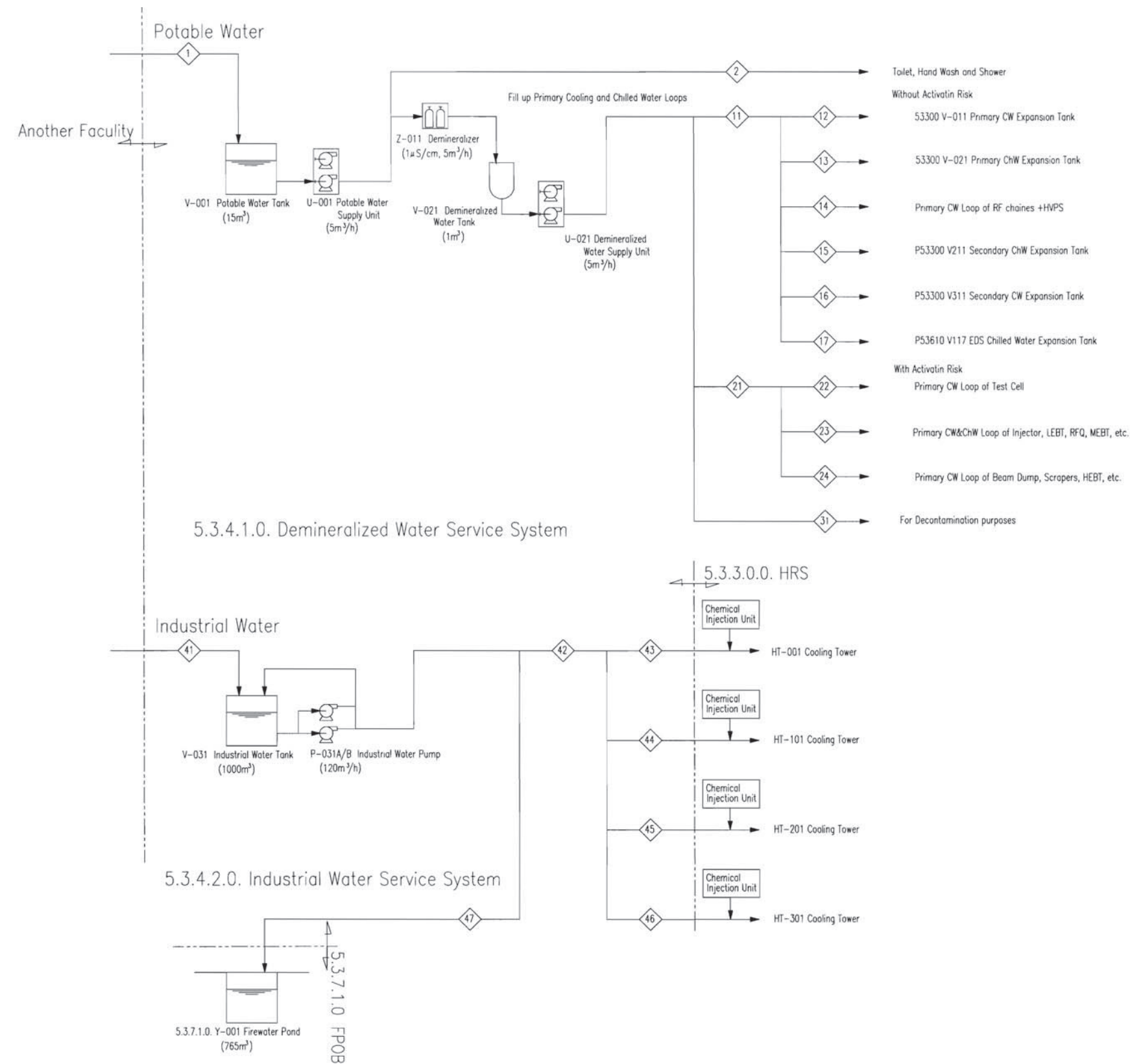
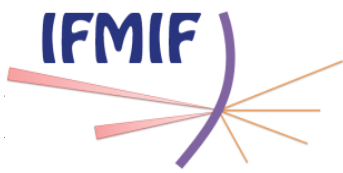


Figure 6-1: D-1223-111-PFD (Process Flow Diagram) SWS



Flow Number	1	2	11	12	13	14	15	16	17	21	22	23	24	31
Fluid	Potable Water	Potable Water	Demineralized Water	Demineralized Water	Demineralized Water	Demineralized Water	Demineralized Water	Demineralized Water	Demineralized Water	Demineralized Water	Demineralized Water	Demineralized Water	Demineralized Water	Demineralized Water
Flow Rate	m ³ /h	-	-	-	-	-	-	-	-	-	-	-	-	-
	m ³ /d	25	25	-	-	-	-	-	-	-	-	-	-	15 m ³ /y
Temperature	°C	AMB	AMB	AMB	AMB	AMB	AMB	AMB	AMB	AMB	AMB	AMB	AMB	AMB
Pressure	MPa	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Remarks			Volume 143 m ³ Time 2 d Flowrate 3 m ³ /h	Volume 10 m ³	Volume 10 m ³	Volume 80 m ³	Volume 20 m ³	Volume 20 m ³	Volume 3 m ³	Volume 30 m ³ Time 0.5 d Flowrate 2.5 m ³ /h	Volume 10 m ³	Volume 14 m ³	Volume 6 m ³	For Decontamination Purposes

41	42	43	44	45	46	47
Industrial Water	Industrial Water	Industrial Water	Industrial Water	Industrial Water	Industrial Water	Industrial Water
82.193	82.2	36.8	33.0	5.9	6.5	-
1973	1973	883	791	142	156	-
AMB	AMB	AMB	AMB	AMB	AMB	AMB
0.5	0.5	0.5	0.5	0.5	0.5	0.5
	Volume 480 m ³ Time 0.5 d Flowrate 40 m ³ /h	Volume 190 m ³	Volume 190 m ³	Volume 50 m ³	Volume 50 m ³	Volume 765 m ³ Time 0.5 d Flowrate 63.8 m ³ /h

Table 4: SWS-PDF's description

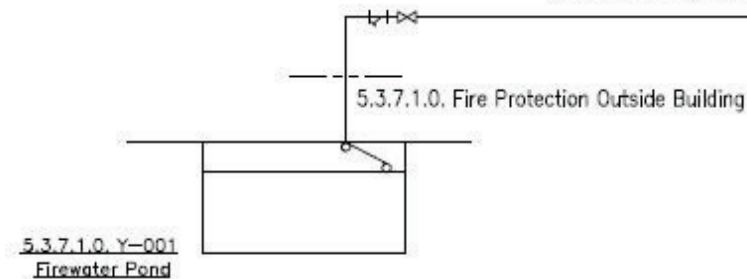
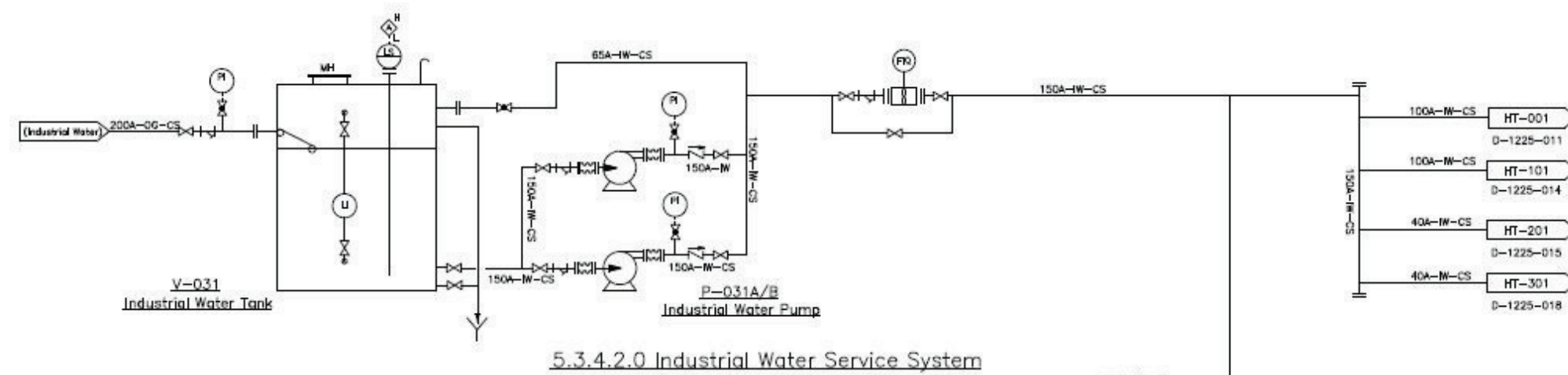
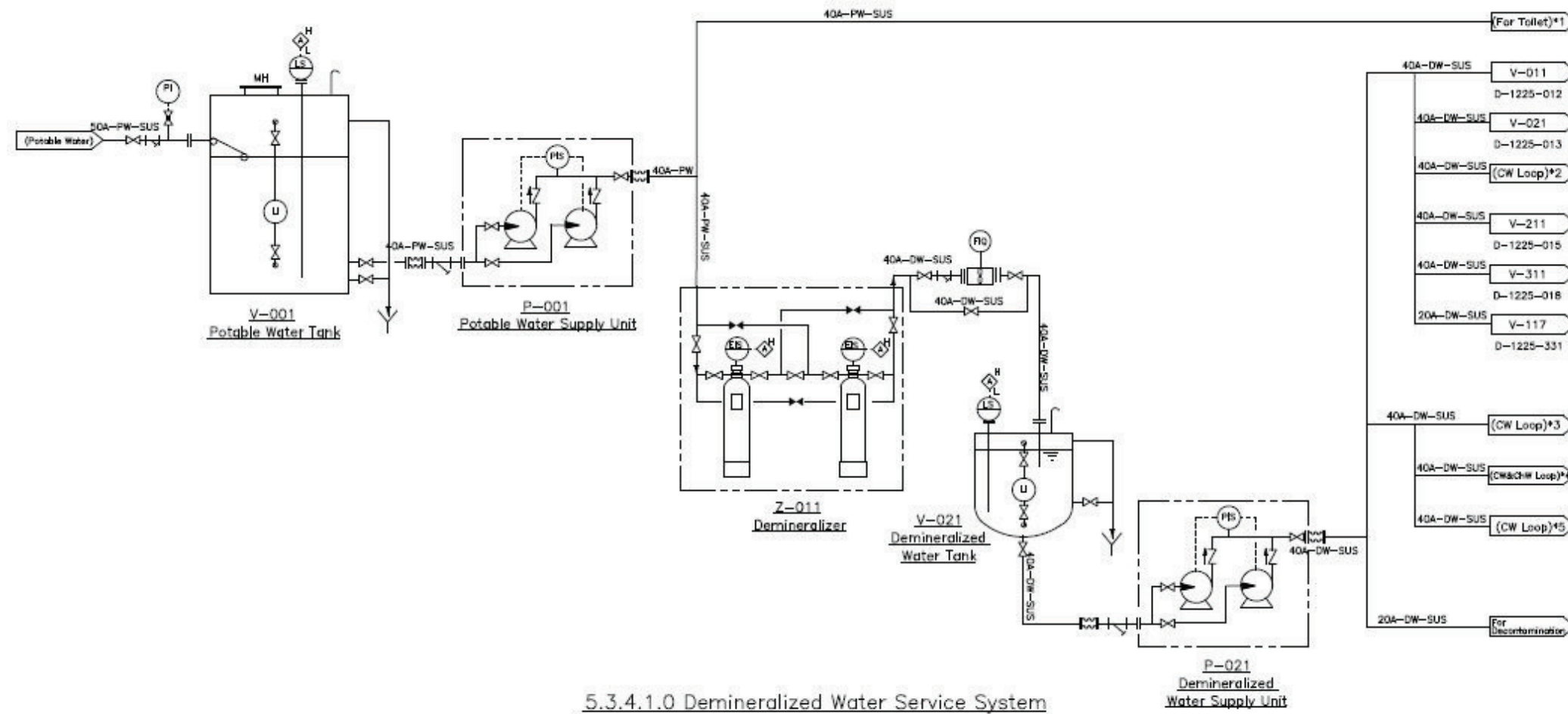
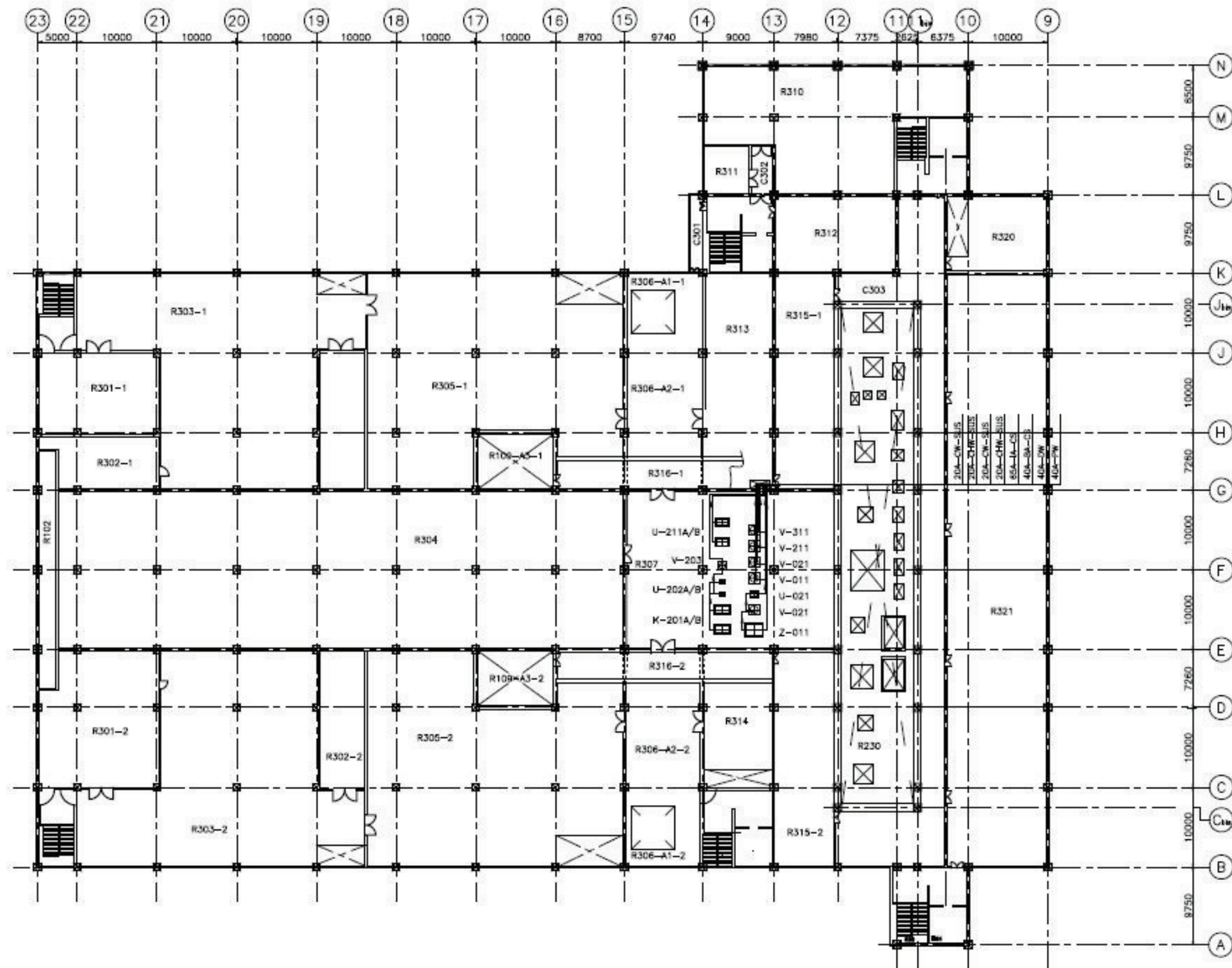


Figure 6-2: D-1225-111-SWS- P&ID

Equipment List for 5.3.4.0.0.

No.	ITEM No.	SERVICE	QTY	MAT'L	TYPE	SPECIFICATION	MAIN DEMENSION	RATED OUTPUT	ACCESSORIES	Installation ROOM No.	REMARKS
1	5.3.4.1.0.-V-001	Potable Water Tank	1	Stainless Steel	Cuboidal	15m ³	W2000XL5000XH2000	-	-	Outdoor	Panel Type
2	5.3.4.1.0.-U-001	Potable Water Supply Unit	1	Stainless Steel	Centrifugal	5m ³ /h, 50m, 50%X2	W850XD600XH600	1.5kWX2 (200V)	-	Outdoor	-
3	5.3.4.1.0.-Z-011	Demineralizer	1	-	Ion Exchange	1 μ S/cm, 5m ³ /h	W1400XL2000XH2100	-	Pre/post filter	R307	200L Cartridge 1 cartridges x 2(series)
4	5.3.4.2.0.-V-021	Demineralized Water Tank	1	Stainless Steel	-	1m ³	Φ1000XH2000 t6	-	-	R307	-
5	5.3.4.2.0.-U-021	Demineralized Water Supply Unit	1	Stainless Steel	Centrifugal	5m ³ /h, 50m, 50%X2	W850XD600XH600	1.5kWX2 (200V)	-	R307	-
6	5.3.4.2.0.-V-031	Industrial Water Tank	1	Stainless Steel	Cuboidal	1000m ³	W8000XL20000XH8000	-	-	Outdoor	Panel Type
7	5.3.4.2.0.-P-031 A/B	Industrial Water Pump	2	Stainless Steel	Centrifugal	120m ³ /h, 50m	W630XL1150XH640	37kW (400V)	-	Outdoor	-
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											
19											
20											

Table 5: SWS Equipment list



3FL:+15000

Figure 6-4: overview of the 3Floor SWS room -R307



System Design Description Document (DDD)

Service Gas System (SGS)

PBS 5.3.5.

Abstract: This document describes the Service Gas System (SGS) considered belonging to the Conventional Facilities. Key functions of the system as well as: interfaces with other facilities/systems, PFD, P&ID's, equipment layout, equipment list, flow diagrams, piping layout and input data requirement for the design of the system.

Reference of the document: BA_D_233HD9

Index of revision: 1.1

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Record of Modifications

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1.0	31 st August 2012	Initial Release
1.1	21 st September 2012	Updating of the reviewers and approver



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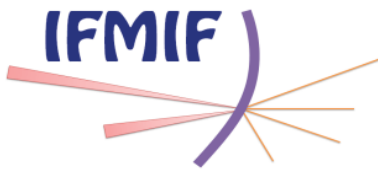


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1. System Functions and Basic Configuration

1.1 System Functions

1.2 System Basic Configuration

The Service Gas System (SGS) stores, supplies and distributes service gases in sufficient quality, quantity, and at sufficient pressure to client’s systems which required such supply within IFMIF Site.

To accomplish the above mentioned functions the SGS is composed by the following main four (4) subsystems:

- Argon Supply System (Ar)
- Helium Supply System (He)
- Compressed Air Supply System (Included; Breathable Air and Compressed Air)
- Nitrogen Supply System (N)

PBS, proposed for the plant, and summarized in Table 1, locates the SGS System within the Conventional Facilities/ Plant services.

PBS Number						PBS Item
1	2	3	4	5	6	
5	0	0	0	0	0	Conventional Facilities
	3	0	0	0	0	Plant Services
		5	0	0	0	Service Gas System (SGS) (Ar,He,Air,N)
			1	0	0	Argon Supply system
				1	0	Storage Tanks
				2	0	Evaporators
				3	0	Fans and Blowers
				4	0	Coolers
				5	0	Purification Equipment
				6	0	Valves & Piping
				7	0	Instruments & sensors
			2	0	0	Helium Supply System
			3	0	0	Compressed Air Supply System
			4	0	0	Breathable Air Supply System
			5	0	0	Nitrogen Supply System

Table 1: SGS PBS location

1.2.1 System Basic Configuration Argon System (Ar.S)

Argon supply System stores, supplies and distributes Argon in sufficient quantity, quality, and at sufficient pressure to client systems which require such supply within the IFMIF Site in order to create the corresponding fire risk free atmospheres. The function

is accomplished by a liquid Argon storage system (tank), a recirculation and cooling system, and a purification system, piping, valves, purification, etc.

- Liquid Storage and Gas Supply System: fluid argon is transported by a track to a liquid argon tank with vacuum insulation. Charged into gaseous form by an air heating evaporator, the argon is supplied to the following:
 - Ar. filled cells: Lithium loop Cell; Lithium Trap Cell; Air Lock chamber for HRWTC; and Target Interface Room.
 - Vacuum Cell (Test Cell)
 - Argon curtain for Access Cell in correspondence to the Test cell Plug during maintenance while the plug is opening.
 - PIE facility

Before operation the argon is supplied to replace the atmosphere of the Ar-filled cells from air to Argon. During operation and to hedge a fire risk at Lithium leakage, fresh Argon is supplied to keep an impurity concentration of the atmosphere below a defined value.

- Argon recirculation and cooling system for atmosphere of Ar-filled cells; to maintain temperature below a defined value, atmosphere of the cells is re-circulated and cooled by chilled water.
- Argon purification system for atmosphere of Ar-filled cells, while impurity concentration can be maintained only by continually supplying fresh argon, argon consumption would be very high under one-through configuration. Therefore a fraction of the argon atmosphere cooled by chilled water is sent to and purified by argon purification system to reduce argon consumption by recycling recovered argon.

1.2.2 System Basic Configuration Helium Supply System (HeS)

Helium supply System stores, supplies and distributes Helium in sufficient quantity, quality, and at sufficient pressure to those client systems which require such supply within the IFMIF Site. The function is accomplished by one or several gas bottles (indoor) and storage tank outdoor (buffer tanks for Accelerator Cryoplant) the system includes related distribution system, piping, valves, instrumentations, etc. (until the subsystem; Accelerator Helium compressor station, Test Cell storage tank for Tritium release module, test cell atmosphere and test module cooling system.

Helium gas is transported by a tank track and filled to the helium storage tanks located outdoor the IFMIF Building, one tank dedicated to the Test facility (one x 25 m³) and the other storage tanks dedicated to the Cryoplant for the accelerators (buffer storage tank 4x 100m³) The helium gas is supplied to:

- TRM (Tritium Release Module) in the test Cell technology room during operation.
- Test Cell Atmosphere during operation
- Test Module Cooling System.
- PIE Laboratory
- Accelerators Cryo-Plant

1.2.3 System Basic Configuration Compressed Air Supply System & Breathable Air Supply System (CAS) & (BAS)

1.2.3.1 Instrumentation Air Supply System

Instrumentation air supply system supplies and distributes clean, dry and oil free instrument air to client systems throughout the IFMIF Site. Compressors and dryers are provided to make instrumentation air. The air is supplied through a buffer tank for various instrumentation purposes (e.g. be among others for pneumatics actuators controls or insulation valves as well as switches and circuit breakers operations or maintenance purpose for flushing or drying)

1.2.3.2 Breathing Air System

Breathing Air System supplies and distributes “Breathing quality” compressed air to a number of consumers throughout the IFMIF Site, to enable personnel wearing pressurized suits or respirators to enter and work in contaminated areas. Breathing air is used also by workers bearing respirators when entering enclosed work locations having inadequate ventilation. This function is accomplished by compressors, air receivers, air-dryers, air distribution, filters, accumulator and air quality devices and other control instrumentations.

1.2.4 System Basic Configuration Nitrogen Gas System (N2)

Nitrogen Supply System supplies and distributes nitrogen to those client systems which require such supply within the IFMIF Site. Liquid Nitrogen is transported by a tank truck to a liquid nitrogen tank with vacuum insulation. Nitrogen Supply System provides:

- Liquid Nitrogen,
Liquid Nitrogen to:
 - Cold Boxes for the Accelerator’s system cold box Helium pre-cooling and for LN2 thermal shield cooling for the Cryostats (SRF Linac Accelerator’s modules)
 - A liquid nitrogen trap of the Accelerator vacuum line of the vacuum system.
 - Oil Removal System (ORS) liquid nitrogen is required once in a year, to perform the charcoal pot drying during its annual maintenance period.(system belong to Accelerator’s Cryo-plant) CF will deliver the liquid nitrogen till the valves of oil removal system (ORS)
- Gaseous Nitrogen,
Gaseous Nitrogen to:
 - Glove Boxes for the Laboratory: to change atmosphere from air to nitrogen
 - Glove Boxes Detritation System: to regenerate a CU Catalyst
 - Target Interface Room

- Dry Pump of each vacuum system for all facilities to purge shaft sealing devices
- Buffer tanks of primary cooling water loops of the accelerators to seal the tanks off from the air; prevent oxygen from dissolving into the primary cooling water; and to retard depletion of in-exchange resin cartridges by easing corrosion environment.

2. Interfaces (boundaries)

The interfaces with other systems may be physical and functional or both. Additional information about SGS interfaces is provided in Systems Interface (Ref. Table 2 : Interface table) Characteristics of the components for the SGS is indicated on the Equipment List (cfr. Ref. Table 15) there is a multiple interface between SGS Facilities (hosted mainly in Lithium loop and TF room) and Building. A generic multiple interface was defined to overcome this issue. SGS system interfaces at the same time with Conventional Facilities (in the sense of the Building) and with the equipment hosted in the rooms (that can be part of the Accelerator, Lithium, Test, PIE and/or of the Conventional Facilities themselves). The sharing of responsibilities will be clarified case by case, but at list this general triple interface includes all the requirements that SGS needs in order to proceed with the design, here below are summarized (at first level) the interfaces related to the SGS.

Interface Table SGS (Service Gas System)		
System A	System B	Title
Test Cell	Service Gas System	Argon with high purity (grade G3) shall be provided to: Test Cell
Tritium Release Module	Service Gas System	Helium shall be provided to: Tritium Release Module
Helium Cooling System	Service Gas System	Helium shall be provided to: Helium Cooling System of Test Facility
Vacuum System	Service Gas System	Nitrogen gas shall be provided to: Vacuum System of Test Facility
PIE Facility	Service Gas System	Argon with high purity (grade G3) shall be provided to: PIE Facility
Glove Boxes	Service Gas System	Nitrogen gas shall be provided to: Glove Boxes of PIE Facility
Vacuum System	Service Gas System	Nitrogen gas shall be provided to: Vacuum System of PIE Facility
Lithium System	Service Gas System	Argon with high purity (grade G3) shall be provided to: Lithium System, also for LF pneumatics valves (instead of Compressed air)
Vacuum System	Service Gas System	Liquid and gaseous nitrogen shall be provided to: Vacuum System of Lithium Target facility
Cooling System	Service Gas System	Nitrogen gas shall be provided to: Cooling System
Vacuum System	Service Gas System	Nitrogen gas shall be provided to: Vacuum System of Accelerators
Cryoplant	Service Gas System	Liquid Nitrogen and Helium shall be provided to: Accelerator's Cryoplant
Main Building	Service Gas System	Main Building has to accommodate compressors, blowers, and etc. of: Service Gas System
Lithium loop Cell	Service Gas System	Argon with high purity (grade G3) shall be provided to: R016, Lithium Loop Cell
Lithium Trap Cell	Service Gas System	Argon with high purity (grade G3) shall be provided to: Lithium Trap Cell adjacent to room R016 (Lithium Loop cell)
Air Lock Chamber for HRWTC	Service Gas System	Argon with high purity (grade G3) shall be provided to: Irradiation Radiation Waste Treatment Cell (HRWTC)R007

Table 2 : Interface table



2.1 Argon Supply System's Interface description

2.1.1 ArS vs. Lithium Target Facility

ArS will serve the Lithium Target Facility rooms:

- *Lithium Loop Cell R016-016bis(Electromagnetic pump & Dump tank)*
- *Lithium Trap Cell*
- *Air Lock Chamber for HRWTC R007*
- All the pneumatic valves and other pneumatic devices located on the Lithium loop and in the area where there is lithium are served by Argon gas instead of common Compressed air.

The boundary between ArS and LF rooms is set at the internal part of the room walls. Inlet/outlet grilles and backward equipment are within the scope of the Argon System.

ArS shall provide its service also to the:

- *Lithium Loop(for maintenance purpose)*

The boundary between ArS and LF is set at the Argon feed and extraction plugs. Connection flanges and afterward equipment are considered within the scope of the Lithium Facility.

2.1.2 ArS vs. Test Facility

ArS will serve:

- *Test Cell R130*

The boundary between ArS and TF is set at the Argon feed and extraction plugs. Connection flanges and afterward equipment are considered within the scope of the Test Facility.

ArS will serve:

- *Target Interface Room R129*

The boundary between ArS and Target Interface Room (TF) is set at the internal part of the room walls. Inlet/outlet grilles and backward equipment for Ag supply are within the scope of the TF.

2.1.3 ArS vs. Post Irradiation Examinations Facility

ArS will serve the Post Irradiation Examination Facility

The boundary between ArS and PIEF rooms is set at the internal part of the room walls, backward equipment are within the scope of the PIE Facility.

2.1.4 ArS vs. Conventional Facilities

ArS will serve some rooms of the IFMIF plant and eventually process enclosures hosted in the rooms.

The boundary between ArS and CF rooms is set at the internal part of the room walls. Inlet and outlet grilles and backward equipment are within the scope of the HVAC System.

The boundary between ArS and CF enclosures is set at the external wall of hot cells/glove boxes. Connection flanges and afterward equipment are considered within the scope of the PIE Facility.



2.2 Helium Supply System Interface description

2.2.1 He Gas S vs. Lithium Facility

Not Applicable.

2.2.2 He Gas S vs. Accelerator Facility

He Gas will serve the Accelerator Facility Cryo plant through the He compressor

The boundary between He and AF enclosures is set inside the Helium compressor's room. Connection flanges and afterward equipment are considered within the scope of the Accelerator Facility.

2.2.3 He Gas S vs. Test facility

He gas will serve the TF Helium room for the tritium release test module system, Test Cell atmosphere control during irradiation campaign and Test Module cooling System.

The boundary between He and TF room's enclosures is set inside the Helium room of the TF. Connection flanges and afterward equipment are considered within the scope of the Test Facility.

2.2.4 He Gas S vs. PIE Facility

He gas will serve the PIEF for the laboratory use.

The boundary between He and PIE Facility enclosures is set at the internal part of the room walls. Connection flanges and afterward equipment are considered within the scope of the PIE Facility.

2.2.5 He Gas S vs. Conventional Facility

He gas system will serve the CF dry pumps for the IFMIF vacuum system.

The boundary between He and CF Vacuum systems are set inside the CF vacuum rooms. Connection flanges and afterward equipment are considered within the scope of the CF.

2.3 Compressed Air Supply System, Interface description

2.3.1 CAS vs Lithium Target Facility

CAS will serve the Lithium Target Facility (LF) rooms, only the area that is not involved with Lithium metal liquid to avoid the possible reaction if occur a direct



contact of Lithium with air (In case of leakages or other circumstances) which may contain unacceptable humidity level; Argon gas shall be provided in such areas.

The boundary between CAS and LF is set at the internal part of the room walls. The equipment downstream of connection point is considered within the scope of the LF.

2.3.2 CAS vs. Accelerator Facility

CAS will serve the Accelerator Facility (AF) rooms.

The boundary between CAS and AF is set at the internal part of the room walls. The equipment downstream of connection point is considered within the scope of the AF.

2.3.3 CAS vs. Test Facility

CAS will serve the Test Facility (TF) rooms.

The boundary between CAS and TF is set at the internal part of the room walls. Connections and the equipment downstream of connection point are considered within the scope of the TF.

2.3.4 CAS vs. Post Irradiation Examination Facility

CAS will serve the Post Irradiation Examination Facility (PIEF) rooms.

The boundary between CAS and PIEF is set at the internal part of the room walls. Connections and the equipments downstream of connection point are considered within the scope of the PIEF.

2.3.5 CAS vs. Conventional Facility

CAS will serve the Conventional Facility (CF) rooms.

The boundary between CAS and CF is set at the internal part of the room walls. Connections and the equipment downstream of connection point are considered within the scope of the CF.

2.4 Nitrogen Supply System Interface description

2.4.1 N Gas S vs. Lithium Facility

LN2 will serve the Lithium Facility to the Liquid nitrogen trap on the lithium room; the LN2 shall be collected from the outdoor LN2 storage tank and transported with adequate portable insulated tank to the Lithium trap area.

The boundary between LN2 and LF is set at the delivery point downstream Liquid Nitrogen tank outdoor, all the equipment to fill transport the LN2 are considered within the scope of LF.

2.4.2 N Gas S vs. Accelerator Facility

Nitrogen Liquid (LN2) will serve the Accelerator facility Cold box and a trap of the accelerator vacuum line of the vacuum system.

Nitrogen gas (N) will serve the Buffer tanks of the primary cooling water loops of the Accelerators to seal the tanks off from the air.

Nitrogen gas will serve the dry pumps for each vacuum system of the AF to purge shaft sealing devices.

The boundary between N-LN2 and AF is set at the internal part of the room wall. The equipment downstream of connection points are considered within the scope of AF.

2.4.3 N Gas S vs. Test Facility

Nitrogen Gas (N) will serve the Test facility R110 Target interface room dry pumps for vacuum.

Nitrogen gas (N) will serve Utility room/ helium room of the TF.

Nitrogen gas (N) will serve the Buffer tanks of the primary cooling water loops of the TF to seal the tanks off from the air.

The boundary between N and TF is set at the internal part of the room wall. The equipment downstream of connection points are considered within the scope of TF.

2.4.4 N Gas S vs. PIE Facility

Nitrogen gas (N) will serve the PIE Facility globe box, to change the atmosphere from air to nitrogen.

The boundary between N and PIEF is set at the internal part of the room wall. The equipment downstream of connection points are considered within the scope of PIEF.

2.4.5 N Gas S vs. Conventional facility

Nitrogen gas (N) will serve the CF globe box detriation system to regenerate a Cu catalyst.

Nitrogen gas (N) will serve the CF vacuum system dry pumps.

The boundary between N and CF is set at the internal part of the room wall. The equipment downstream of connection points are considered within the scope of CF Exhaust Gas Processing System.

3. System Design Requirements

3.1 General requirements

Input Data Requirements are defined as the data necessary to be defined in order to enable a system design that respects all the needs of the interfacing components.

Currently a draft set of data has been proposed. This list is partially complete and assessed by the PT on the base of the current references, of the outcomes of the Engineering Validation activities (i.e. prototypes) and on the standard engineering practice.

Parameters to be defined as *Input Data Requirements* for the SGS are, for each interfacing component:

- Argon grade (G3)
 - Purity (>99.999)
 - O₂ (<0.2 ppm)
 - Dew point (<-70 °C)
- Cooling media: (chilled/cooled water);
- Temperature: (°C);
- Temperature tolerance: (±°C);
- $\Delta T = (\text{outlet temp}) - (\text{inlet temp})$: (°C);
- Supply Gas pressure: (MPa);
- Flow: (Nm³/h);
- Change rate (Vol./h)

The following sections describe in detail the logic that brought to the selection by the PT of the current set of parameters.

Here below are listed the *Input Data Requirements*:

- cfr. Ref.Table 7: Argon Input Data Requirements 1/4
- cfr. Ref.Table 8: Argon Input Data Requirements 2/4
- cfr. Ref.Table 9: Argon Input Data Requirements 3/4
- cfr. Ref.Table 10: Argon Input Data Requirements 4/4
- cfr. Ref.Table 11: Helium Input Data Requirements
- cfr. Ref.Table 12: Compressed Air Input Data Requirements
- cfr. Ref.Table 13: Liquid Nitrogen (LN₂) Input Data Requirements
- cfr. Ref.Table 14: Gaseous Nitrogen (N) Input Data requirements

3.2 Engineering Requirements

3.3 Safety Design Requirements

The general Safety approach for the design execution of SGS is based on the general Safety specification for the Engineering Design Activities of IFMIF

- The IFMIF's Safety objectives, principles and criteria.
- The Hazard evaluation techniques, to be implemented on the next design phase

The entire document is uploaded on DMS: Safety Specifications Ref. doc. BA_D_224X48 Ver.4.0 (cfr. Ref. [1]) and following updating. At the present time the Engineering Design for SGS follow the Safety approach mentioned on the guideline document, nevertheless it can be subject to some deviation or weaves according the final IFMIF site selection. As well as the safety authority could gives some further requirements.

3.4 Operation and Maintenance

Integrative maintenance plan is not yet described on this DDD II, shall be defined clearly after having selected all the components for the SGS plant, preferable the maintenance plan shall be prepared by the suppliers, as well as regulatory maintenance requirements must be identified.

Minimum information required within the maintenance plan is listed below:

- Scheduled operation:
 - Controls
 - Checks
 - Adjustments
 - Calibrations
 - Overhauls
 - Replacements, etc.

Information provided from safety specification, Ref. doc. BA_D_224X48 Ver.4.0 (cfr. Ref. [1]) and of course will be implemented and identified as necessary by the supplier in order to ensure the best operation of the SGS system within its intended operational scenario.

- Critical unscheduled operations:
 - Replacements repair etc.

That may impact IFMIF availability and become essential to evaluate and to introduce an additional important support of recommended spare parts list, (provided by the suppliers) procedures, training, tools and test equipments, infrastructures.

The design of SGS shall accommodate long-term maintenance activities required to support IFMIF plant operation. For maintainability and inspectability, SGS system shall be designed in such a way that it can facilitate maintenance and, in case of failure, easy diagnostics safe repair or replacement and re-calibration. The SGS maintenance must be an ongoing endeavor. Any lapses in regular maintenance can result in system degradation and obvious loss of efficiency which could arose to serious health issue.

Maintenance requirement for SGS system and equipments must be conform to the maintenance period defined for the IFMIF plant (particularly for the facilities that are not reachable during operation period)

3.5 RAMI Requirements

RAMI Specifications guide documents Ref. to doc. 22HA3G from J. Arrojo Feb. 2012. The SGS system have been designed to operate during all modes of IFMIF plant operation as well as shut down period SGS should be reliable for continuous operation, easily accessible for the purpose of operation and maintenance. The SGS have been designed in a way that; maintained and operated will meet the reliability and availability requirements in a preliminary way identified on the conventional facility Safety Report. At this stage of the Project complete RAMI analysis has not been performed (due to the high variability of the parameters, such a procedure has not been considered worthwhile). However several assumptions have been evaluates and taken into consideration based of the standard engineering practice. RAMI assessment and implementation of the engineering process shall be fully integrated on the next phase of the project.

3.6 Applicable Codes and Standard Requirements

International standards have been selected for the design of the SGS in particular:

- The equipment for (SGS) shall be designed according to safety specification for the engineer design activities IFMIF ref. BA_D_224x48 (Le Tonquez Y.[1]) in accordance with the pressure equipment directive (PED) 97/23Ec.
- Code and standards for SGS mechanical components shall follow the general IFMIF specification: Applicable Codes and standards for the CF design, in addition the following codes and standards shall be applied:
 - API 510- testing of valves.
 - ASME B31.3- process piping.
 - ASME B73.2M-Vertical in-line pumps.
 - ASME section IX- welding and brazing qualification.
 - ASME section V- non destructive examination.
 - ASME/ANSI B.16.25- Pipes, valves, fittings and flanges butt weld ends.
 - ASME/ANSI B16.34-Valves, flanges, threaded and welding end.
 - EN 13445 – Pressurized Vessels design;
 - EN 13480 – Metallic Piping;
 - ISO 10648: Containment Enclosure:
 - 10648-1:1997: Design Principle
 - 10648-2:1994: Classification according to leak tightness and associated checking methods.
 - ISO 4427 and DIN 8074-HDPE pipes.

4. System Design Description

4.1 Design Summary

For this section you can refer to the System Functions and Basic configuration (cfr. Ref. Section;1)

4.2 Safety

Refer to Safety specifications for the Engineering design Activities of IFMIF ref. doc. BA_D_224X48 Ver. 4.0 and following updating (cfr. Ref. [1])

4.3 Assumptions

General assumptions / requirements have been considered as per the following:

4.3.1 Argon Supply System PBS - 5.3.5.1.

- Supplying Frequency

The supplying frequency of liquid argon to the main Argon Tank (20m³) have been assumed at once replacement with interval of 4 weeks or less times except for rare cases.

- Supplying Conditions

Pressure 0,8 MPa (G)
Temperature AMB

- Degree of Purity

Argon will be provided Grade 3 for the two purposes:

- General purpose
- High purity

As per the following table:

	Grade 3	Remarks
Purity	> 99.999%	
N₂	-	
O₂	< 0.2ppm	
Dew Point	≅ -70°C	
H₂O	-	

Table 3: Argon Grade 3, characteristics

In accordance with IFMIF Safety Specifications nitrogen; oxygen; and water vapors is to be held under 5 ppm respectively.

- Enclosure Leak Tightness; in accordance with ISO 10648-2 (see below table) Class 1 Leak Tightness is applied to Argon filled cells and glove boxes.

- Impurity concentration of the atmosphere of the Argon filled cells; in accordance with IFMIF Safety Specifications the relative humidity is to be maintained at 2% or lower at 21 °C.

4.3.2 Helium Supply System PBS - 5.3.5.2.

- Supplying Frequency
 - We have two Helium storage tanks: one for the Accelerator Cryo-plan composed of 4 Helium storage tanks each of 100 m³ and the second He tank of 25 m³ for to supply helium to the Test Cell and PIE Laboratory. Helium storage tanks for the Accelerator have the function of buffer tank, there is no a real consumption for these tanks. The He large capacity are necessary for to recover all the purge He gas in case of the machine with a general warming-up (all the liquid He is boiled off and transferred in these tanks) Generally, for this type of He closed loop, a periodically re-filling could be set every 6 months to compensate the small leak (compressors, temporary purging for regeneration of Cold Box absorbers and so on) with an amount of approximately 500 liters of liquid. The supply frequency of helium for the other He tanks of 25m³ is assumed every two-three weeks, hence approximately 20m³ per month or less except for rare cases.
 - Supplying Conditions
 - Pressure 14.7 MPa (G) (stored in the tanks)
 - Supply to the system at 0.8 MPa. (G)
 - Temperature AMB

Degree of Purity

	General Purpose	Remarks
Purity	≧ 99.995%	
N₂	≧ 20ppm	
O₂	≧ 5ppm	
Dew Point	≧ -60°C	
H₂O	(≧ 5.3ppm)	

Table 4. – Degree of Purity of Helium.

4.3.3 Compressed Air Supply System PBS - 5.3.5.3. & Breathable Air System PBS - 5.3.5.4

- Supplying Pressure
 - The assumed supplying pressure is 0.69 MPa (G) or higher.
- Supplying Conditions
 - Pressure 0.69 MPa (G)
 - Temperature AMB
 - Flow rate 200 Nm³/h (for instrumentations)
 - Flow rate 60 Nm³/h (Breathable air Supply 0.085m³/min.pr person, considered 10 at once)

Note: The breathable air distribution is independent and provided with efficient filter for to ensure the high level of quality suitable for to be breathed. Details for the components and its installation are shown on Table 15: S-1224-201- SGS Equipment List - PBS 5.3.5.0.0. And Figure 6-12: Compressed Air technical room, R307

Degree of Purity;

	Instrumental Air	Breathable Air	Remarks
Oil Content	Oil free	-	
Dew Point	≅ -40°C	5°Cat 0.69MPa(G)	
CO₂	-	≅ 1000ppm	
CO	-	≅ 5ppm	
Odor	-	Not recognized	

Table 5. –Degree of Purity of Compressed Air.

4.3.4 Nitrogen Supply System PBS - 5.3.5.4.

Supplying Frequency

The supplying frequency of liquid nitrogen is assumed interval of 6 days for one accelerator and 3 days for two accelerators we have two tanks one of 50m³ for the accelerators without nitrogen evaporator and the second one of 25m³ for the PIE facility

(cold boxes, GDS) Conventional facility and for the primary cooling system buffer tank's seal. For the accelerators consumes of LN2 is not well known for the moment. It depends on the cryostats and cold box consumptions. Nevertheless, a rough estimation leads to a maximum of 300 l/h (including 2 x 130 l/h for He refrigerator plus various utilities) Hence assumption of two or three days of refilling the tank of 50m³.

For the other LN2 storage tank of 25m³ we assume to refill with a frequency of one month.

- Supplying Conditions
 - Pressure 0.8 MPa (G)
 - Temperature AMB

Degree of Purity;

	General Purpose	Remarks
Purity	≧ 99.995%	
O₂	≧ 50ppm	
Dew Point	≧ -60°C	

Table 6: LN2 degree of purity

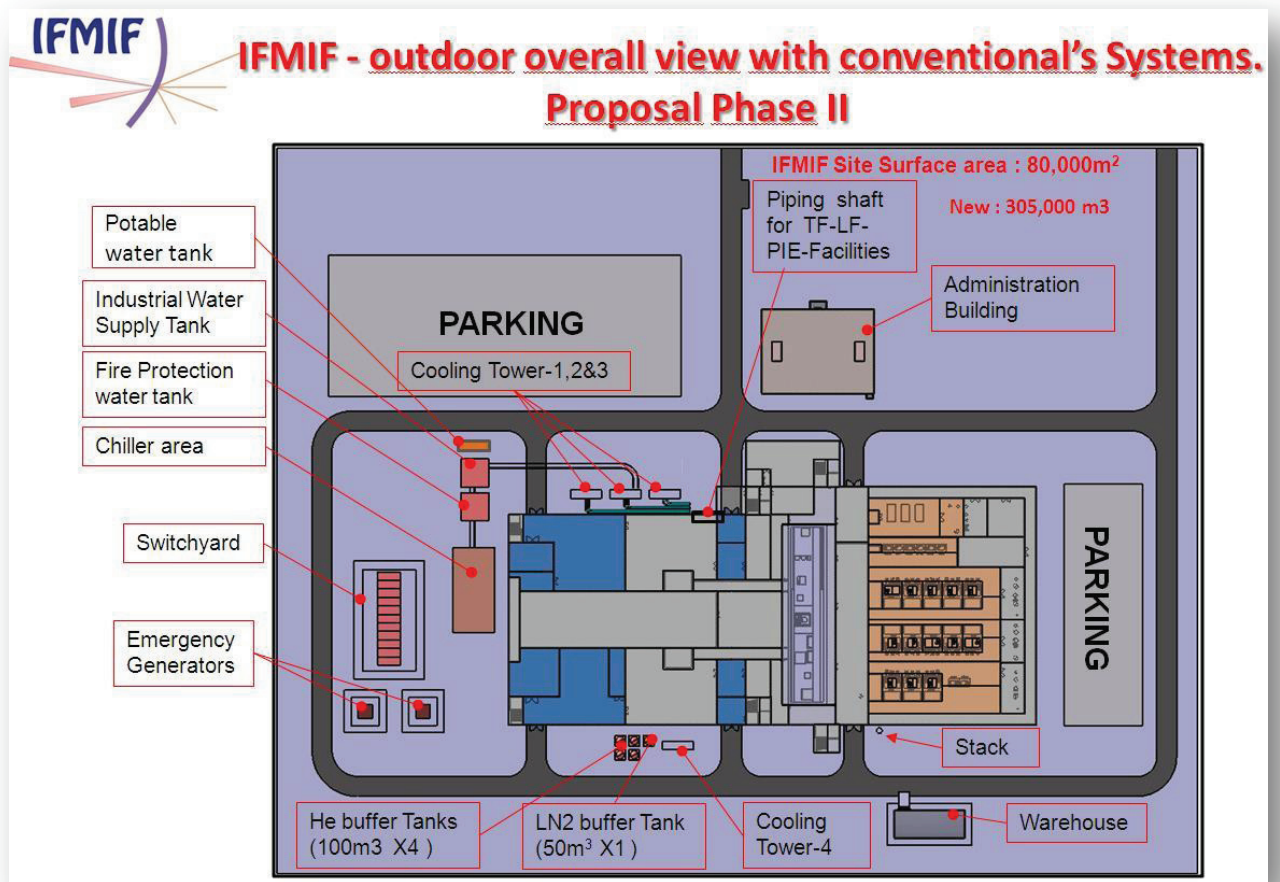


Figure 4-1: IFMIF overall view, outdoor SGS He/LN2 storage tanks configuration.

4.3.5 SIC Classification

According to the classification proposed in Safety Specifications (cfr. ref [1]) and Safety Important Class-SIC, Methodology, Classification & Requirements (cfr. Ref. to Doc. BA_D_228V5Q Version 1.2 ref [6] ;

The system has been classified as follows:

- SIC-1 for **Argon Supply System**. On DDD I we had two type of Ar. Gas: General purpose and High purity (for the maintenance) for the present DDD II we have selected one type of Ar. gas belong to grade 3 that can satisfy both application; High purity Argon System and General Purpose Argon, for this reasons we kept the SIC classification as SIC-1, hence considered conservative range since a direct contact with Lithium might occur.

- The characteristics of Ar.; **Grade 3** are here below described:
 - Argon grade (G3)
 - Purity (>99.999)
 - O₂ (<0.2 ppm)
 - Dew point (<-70 °C)

- SIC- SR/non-SIC for **Helium Supply System**
- SIC-1 for **Compressed Air Supply System**
- SIC-1 for **Breathable Air supply System**
- SIC-SR/non-SIC for **Nitrogen Supply System**

4.3.6 Redundant Equipment

Redundancy of the equipment should contribute to the target availability value of the Conventional Facilities (stated into 99.7 % as mentioned in CDR (cfr Ref.[2]). At this stage of the project a complete RAMI Analysis has not been performed (due to the high variability of the parameters, such a procedure has not been considered worthwhile) (Ref. to Sect. 3.5). By the way some assumptions have been made on the base of the standard engineering practice.

Simple redundancy is addressed to components that can cover 100% of the requirements (100% x 2).

Multiple redundancy is considered when requirements can be fulfilled by a set of components (n components) working together ($[100\%/n] \times [n+1]$).

4.4 Detailed Design description

According to the classification proposed in CDR (cfr. Ref. [2]) a further SGS System subdivision has been proposed with slightly changes to meet the safety regulations and system flexibility:

4.5 System Performance Requirements

Not applicable at this engineering stage, anyhow the system performance basic functions are indicated on the P&ID's of SGS (cfr. Ref. Figure 6-7, Figure 6-8, Figure 6-9 and Figure 6-10)

4.6 System Arrangement

4.6.1 Equipment arrangement Drawings

Refer to the next (Ref. Sect.4.7) Component Design Description

4.7 Component Design Description

For this purpose we have detailed the list of the SGS components necessary for the all SGS system of IFMIF plant, the information are integrated on the document called

Equipment List SGS system (Ref. Table 15: S-1224-201- SGS Equipment List - PBS 5.3.5.0.0.) The Equipment List represents all the SGS components, on the list following detailed information are provided:

- Item NO
- Service
- QTY
- Material type
- Type of component
- Specification
- Main Dimension
- Electrical output rate (KW)
- Location on the IFMIF Building (Area/room's number)

4.8 Instrumentation and Control

SGS Central Control System (CCS) shall be conforming to standards, specifications and interfaces as documented in the CCS - DDD II document ref. BA_D236AF7 v1.0.

CCS will ensure the integrated supervision control of overall IFMIF plant and plant system operation. These functions will be available in master control room SGS shall have its own plant control system (PCS) that will allow to know the status of the reserve storage tanks, flow, pressure, purity conditions of the distributed gases (gaseous or liquid conditions) SGS -PCS shall integrate the individuals control system of each of the SGS and served IFMIF subsystems in the various facilities of the plant.

Information from the data is available in the SGS local control system (PCS) shall be transferred to CCS to allow a complete and reliable operation of the SGS. The instrumentation and control components shall include all Computers hardware and software required to control the SGS plant system, including input/output (I/O) interfaces and plant system interlocks. These requirements shall be established based on the preliminary design of the SGS. Sufficient instruments shall be included in SGS plant system to monitor components performance within the design envelope and to alarm plant operators on the onset of operation outside design margin (particularly for the Gas leakages detection, leak tightness for the cells (in the case of Argon and helium) flow rate, pressure rate, humidity level, purification efficiency, etc. Instrumentations shall include: pressure and temperature flow sensor to measure/monitor performance and allow independent control of components for the system. Also, instruments shall be installed to monitor all necessary parameters useful for the regular and safety functionality of the SGS, the instrumentations indicated is descriptive but not limited, specific instrumentations and control requirements for SGS system shall be established on the next step DDD III; now we can refer to the SGS P&ID (cfr. Ref. Figure 6-7, Figure 6-8, Figure 6-9 and Figure 6-10

4.9 Status of R&D activities and future plans

Not applicable for this system.

5. List of References

- [1] Y. Le Tonqueze, *Safety Specifications for the EDA of IFMIF*, BA_D_224X48
- [2] IEA, *IFMIF Comprehensive Design Report*
- [3] Accelerator System Group DDD I, Ref. BA_D_22NF7C v1.0
- [4] M. Ida IFMIF Lithium Target facility, DDD I doc. BA_D_227S7Z rev. 1.0
- [5] F.Arbeiter Test Facility Utility Room DDD I doc. BA_D_22BWBP rev. 4.0
- [6] Y. Le Tonqueze, Safety Important Class-SIC Ref. BA_D_228V5Q rev. 1.2

5.1.1 List of Acronyms

AF	Accelerator Facility
Ar.S	Argon System
BAS	Breathable Air System
CAS	Compressed Air Supply System
CF	Conventional Facilities
CODA	Construction Operation and Decommissioning Activities
DDD	Design Description Document
DVT	Data Validation table
EDS	Emergency Detritiation System
EVEDA	Engineering Validation & Engineering Design Activity
GDS	Glove boxes Detritiation System
HDS	Hot cells Detritiation System
HeS	Helium Supply System
HRS	Heat Rejection System
HVAC	Heating Ventilation Air Conditioning
IFMIF	International Fusion Materials Irradiation Facility
LF	Lithium target Facility
N2S	Liquid Nitrogen System
P&ID	Piping& Instrumentation Diagram
PBS	Plant Breakdown Structure
PFD	Process Flow Diagram
PIE	Post Irradiation Examination
PT	Project Team
RAMI	Reliability, Availability, Maintainability, Inspectability
RF	Radio Frequency
RFQ	Radio Frequency Quadrupole
SIC	Safety Important Component
TF	Test Facility
VDS	Vent gas Detritiation System
WBS	Work Breakdown Structure

6. Appendices

6.1 List of Documents

6.1.1 Drawings (PFD's, P&ID's 2D drawings & Excel file)

6.1.2 Layout Plan for SGS

This section reports the preliminary SGS layout, main components and outdoor Storage tanks. The layout is divided by floor whenever the SGS components present and is represented the overall dimensions of the SGS's equipment (whenever considered necessary) these layouts enable the Building designer to validate the size of the components for SGS's technical rooms and all the area where are foreseen SGS component's installation.

These drawings together with CF piping layout should help to have a clear picture of the components that take part in the system definition and of the main interactions among them.

Layout Plan for SGS is considered as a preliminary document for the system design, could be slightly modified by a updating in the input data or IFMIF layout changes.

(Ref. to Figure 4-1: IFMIF overall view, outdoor SGS He/LN2 storage tanks configuration).

6.1.3 SGS's Input data requirements.

In Table 7, Table 8, Table 9, Table 10, Table 11, Table 12, Table 13 and Table 14, are shown values assumed for the elaboration of engineering design.

6.1.4 Process Flow Diagram SGS (PFD)

Ref to: Figure 6-1, Figure 6-2, Figure 6-3, Figure 6-4

6.1.5 Equipment List SGS System

Identified on; Table 15: S-1224-201- SGS Equipment List - PBS 5.3.5.0.0.

6.1.6 Equipment Layout, installed on the Conventional rooms.

These Figure shown various components for SGS i.e. mainly storage tanks, evaporators, fans and blowers, coolers, purification equipments etc. that are clearly identified by type on the List of Equipment and are belong to the SGS (Ref. to Figure 6-11: Argon Purification System, Room 228 and Figure 6-12: Compressed Air technical room, R307)

6.2 List of Computer Programs

Not applicable

6.3 Others

Not applicable

IFMIF operational state	Cells to be served	Cell name	References/assessment/assumptions	Cell volume (m ³)	Ar atmosphere change rate (vol/h)	Ar flowrate (Nm ³ /h)	Leak tightness of the cells (h ⁻¹)	Leak rate of air (m ³ /h)	Maximum relative humidity tolerable* (%)	Ar flow necessary to respect the relative humidity in the cell (Nm ³ /h)	Argon purification system efficiency (%)	Recovered argon flow (Nm ³ /h)	Fresh Ar consumption due to the Ar purification system (Nm ³ /h)	Special requirements
Operation	To be defined later	Pit for Electro magnetic pump and dump tank	- During operation a continuous Ar atmosphere is required - Leak tightness and leak rate derived from ISO 10648 classification (see assumptions) - Ar Atmosphere change rate assumed tentatively according to the standard engineering practice - Maximum RH assumed in accordance with " Safety Specifications for EDA of IFMIF " - Ar flow necessary to respect the cell atmosphere derived from the maximum relative humidity admissible inside Ar-filled cells - Fresh Ar consumption derived considering the efficiency of the Ar purification system	?	1-5/h		5.0E-04 h-1		2%	Nm3/h	70%	0. Nm3/h	Nm3/h	
Operation	To be defined later	Lithium loop cell	As pe above	?	1-5/h	--	5.0E-04 h-1		2%	Nm3/h	70%	--	--	
Operaton	To be defined later	Lithium trap cell	As pe above	?	5-10/h	--	5.0E-04 h-1		2%	--	70%	--	--	
Operation	To be defined later	PIE Facility	- Argon Flow should be an outcome of the PIE Facility design - During operation a continuous Ar atmosphere is required - Value tentatively assumed	?	TBD	--	?		2%	--	70%	--	--	
IFMIF operational state	Cells to be served	Cell name	References/assessment/assumptions	Cell volume (m ³)	Ar atmosphere change rate (vol/h)	Ar flowrate (Nm ³ /h)	Leak tightness of the cells (h ⁻¹)	Leak rate of air (m ³ /h)	Maximum relative humidity tolerable* (%)	Ar flow necessary to respect the relative	Argon purification system efficiency	Recovered argon flow (Nm ³ /h)	Fresh Ar consumption due to the Ar purification	Special requirements
Maintenance	To be defined later	Pit for Electro magnetic pump and dump tank	- During maintenance Li Loop is not working. The cell will be ventilated with air, so Ar Supply System is not in charge of the service	?	1-5/h	--	--	--	--	--	--	--	--	
Maintenance	To be defined later	Lithium loop cell	- During maintenance Li Loop is not working. The cell will be ventilated with air, so Ar Supply System is not in charge of the service	?	1-5/h	--	--	--	--	--	--	--	--	

Table 7: Argon Input Data Requirements 1/4

Maintenance	To be defined later	Lithium trap cell	- During maintenance Li Loop is not working. The cell will be ventilated with air, so Ar Supply System is not in charge of the service	?	5-10/h	--	--	--	--	--	--	--	--	
Maintenance	To be defined later	PIE Facility	- It has been assumed that during maintenance, no argon is supplied	?	TBD	--	--	--	--	--	--	--	--	
Maintenance	To be defined later	Test Cell	- Argon Flow should be an outcome of the Test Facility design - During maintenance a continuous Ar supply is assumed to be required - Flow tentatively assumed	?	--	--	--	--	--	--	--	--	--	During maintenance, when open the TC plug, argon flow curtain is required to be ensure keeping the separation from TC - Access cell
IFMIF operational state	Cells to be served	Cell name	References/assessment/assumptions	Cell volume (m³)	Maximum air concentration after atmosphere change (vol%)	Number of atmosphere changes required to change atmosphere	Maximum time required to change atmosphere (days)	Argon supply required (Nm³/h for 2 days)***	Special Requirements					
Atmosphere change from Air to Argon	To be defined later	Pit for Electro magnetic pump and dump tank	- Maximum air concentration assumed - maximum time required to change atmosphere tentatively assumed standard engineering practice	?	1 vol%	5	2 d	?						
Atmosphere change from Air to Argon	To be defined later	Lithium loop cell	- Maximum air concentration assumed - maximum time required to change atmosphere tentatively assumed standard engineering practice	?	1 vol%	5	2 d	?						
Atmosphere change from Air to Argon	To be defined later	Lithium trap cell	- Maximum air concentration assumed - maximum time required to change atmosphere tentatively assumed standard engineering practice	?	1 vol%	5	2 d	?						
Atmosphere change from Air to Argon	To be defined later	PIE Facility	- The assumption is that this room does not take part in the atmosphere change	?	1 vol%	5	2 d	?						
Atmosphere change from Helium to Argon	To be defined later	Test Cell	???	?	1 vol%	--	?	?						During TC experiment test modules replacement
IFMIF operational state	Cells to be served	Cell name	References/assessment/assumptions	Cell volume (m³)	Hazard Material	Number of atmosphere changes required to change atmosphere	Maximum time required to change atmosphere (days)	Argon Supply	Special Requirements					

Table 8: Argon Input Data Requirements 2/4

Operation and maintenance	To be defined later	Cooling/Storage Pit-1	To extinguish the fire in case of accident, mainly caused by Metal Liquid handling (we need to provide Argon gas to the cell with an automatic sprinkler in case of fire detection.(the Ar. Supply should be studied according to Fire protection analysis's, may be independent with dedicated Ar. gas cylinders or centralized with sprinkler net)	?	Metal liquid handling	NA	NA	?	To select the system; Local, dedicated or centralized.					
Operation and maintenance	To be defined later	Cooling/Storage Pit-2	To extinguish the fire in case of accident, mainly caused by Metal Liquid handling (we need to provide Argon gas to the cell with an automatic sprinkler in case of fire detection.(the Ar. Supply should be studied according to Fire protection analysis's, may be independent with dedicated Ar. gas cylinders or centralized with sprinkler net)	?	Metal liquid handling	NA	NA	?	To select the system; Local, dedicated or centralized.					
Operation and maintenance	To be defined later	Cooling/Storage Pit-3	To extinguish the fire in case of accident, mainly caused by Metal Liquid handling (we need to provide Argon gas to the cell with an automatic sprinkler in case of fire detection.(the Ar. Supply should be studied according to Fire protection analysis's, may be independent with dedicated Ar. gas cylinders or centralized with sprinkler net)	?	Metal liquid handling	NA	NA	?	To select the system; Local, dedicated or centralized.					
Operation and maintenance	To be defined later	Tr. Hot Cell	To extinguish the fire in case of accident, mainly caused by Metal Liquid handling (we need to provide Argon gas to the cell with an automatic sprinkler in case of fire detection.(the Ar. Supply should be studied according to Fire protection analysis's, may be independent with dedicated Ar. gas cylinders or centralized with sprinkler net)	?	Metal liquid handling	NA	NA	?	To select the system; Local, dedicated or centralized.					
Operation and maintenance	To be defined later	Component handling Cell	To extinguish the fire in case of accident, mainly caused by Metal Liquid handling (we need to provide Argon gas to the cell with an automatic sprinkler in case of fire detection.(the Ar. Supply should be studied according to Fire protection analysis's, may be independent with dedicated Ar. gas cylinders or centralized with sprinkler net)	?	Metal liquid handling	NA	NA	?	To select the system; Local, dedicated or centralized.					

Table 9: Argon Input Data Requirements 3/4

Operation and maintenance	To be defined later	Rig Handling Cell (RHC)	To extinguish the fire in case of accident, mainly caused by Metal Liquid handling (we need to provide Argon gas to the cell with an automatic sprinkler in case of fire detection.(the Ar. Supply should be studied according to Fire protection analysis's, may be independent with dedicated Ar. gas cylinders or centralized with sprinkler	?	Metal liquid handling	NA	NA	?	To select the system; Local, dedicated or centralized.					
Operation and maintenance	To be defined later	Test Module/Rig Assembling cell (RAC/TMAC)	To extinguish the fire in case of accident, mainly caused by Metal Liquid handling (we need to provide Argon gas to the cell with an automatic sprinkler in case of fire detection.(the Ar. Supply should be studied according to Fire protection analysis's, may be independent with dedicated Ar. gas cylinders or centralized with sprinkler net)	?	Metal liquid handling	NA	NA	?	To select the system; Local, dedicated or centralized.					
Operation and maintenance	To be defined later	Access Cell	To extinguish the fire in case of accident, mainly caused by Metal Liquid handling (we need to provide Argon gas to the cell with an automatic sprinkler in case of fire detection.(the Ar. Supply should be studied according to Fire protection analysis's, may be independent with dedicated Ar. gas cylinders or centralized with sprinkler net)	?	Metal liquid handling	NA	NA	?	To select the system; Local, dedicated or centralized.					

Table 10: Argon Input Data Requirements 4/4

Input Data Requirements SGS (He)							
Facility	IFMIF operational state	Equipment to be supplied	References/assessment/assumptions	Helium consumption (m ³ /h)	Centralize storage tank	He consumed in the supplying interval (m ³)	Special requirements
Test Facility	Operation	Tritium Release Test Modules (TRM)	- Helium Flow should be an outcome of the the Test Facility design	TBC	Yes/local	TBC	8 bar. to the TF
Test Facility	Operation	Cooling of the liner	- Helium Flow should be an outcome of the the Test Facility design	16m ³ h 100% 1 year plus 10% montly integration	Yes/local	16m ³ h 100% 1 year plus 10% montly integration	8 bar. to the TF
Test Facility	Operation	Test cell atmosphere	- Helium Flow should be an outcome of the the Test Facility design	60m ³ h 100% 1 year plus 10% montly integration	Yes/local	60m ³ h 100% 1 year plus 10% montly integration	8 bar. to the TF
Test Facility	Operation	Test module cooling system	- Helium Flow should be an outcome of the the Test Facility design	16m ³ h 100% 1 year plus 10% montly integration	Yes/local	16m ³ h 100% 1 year plus 10% montly integration	8 bar. to the TF
Acceler. Facility	Operation	Cryo plant	- Helium Flow should be an outcome of the the Accelerator Facility design	TBC	Yes/local	400 m ³ Storage	
PIE	Operation	Laboratory use	- Helium Flow should be an outcome of the the PIE Facility design	TBC	Yes/local	TBC	8 bar. to the TF
Facility	IFMIF operational state	Equipment to be supplied	References/assessment/assumptions	Volume to be supplied with Helium (m ³)	Special requirements		
Test Facility	Maintenance	Tritium Release Test Modules (TRM)		NO supply			
Test Facility	Maintenance	Cooling of the liner		NO supply			
Test Facility	Maintenance	Test cell atmosphere		NO supply			
Test Facility	Maintenance	Test module cooling system		NO supply			
Acceler. Facility	Maintenance	Cryo plant		NO supply			
PIE	Maintenance	Laboratory use		NO supply			

Table 11: Helium Input Data Requirements

Reference Assesment /assumption; Value tentatively assumed for the whole plant according to a first assessment based to the standard engineering practice

Breathable air System	Criteria	Maximum number of people to be supplied with Breathable Air	Air required for each person (m ³ /min)	Breathable air system capacity (Nm ³ /h)
	Utilities to be served assumed according to the standard engineering practice	10	0.085 Nm ³ /min	51 Nm ³ /h

Instrument air system	Instrument air flow (Nm ³ /h)	Instrument device's location	Breathable air system capacity (Nm ³ /h)	Breathable air device's location
PIE Facility	35. m3/h	TBD	51. m3/h	TBD
Accelerators	80. m3/h	TBD		TBD
Lithium Loop	20. m3/h	TBD		TBD
Other (TC -CF-etc.)	25. m3/h	TBD		TBD
Total (Nm³/h)	160. m3/h		51. m3/h	

Table 12: Compressed Air Input Data Requirements

Liquid Nitrogen Supply System Main Requirements/Assumptions Table						
Facility	Equipment to be supplied	References/assessment/assumptions	Cold Box volume (m ³ /cold box)	Number of Cold Boxes/accelerator	Cold Boxes heat loss (%vol of N ₂ evaporated per day)	Special requirements
AF	Accelerator DTL cold boxes	<ul style="list-style-type: none"> - Cold Boxes capacity should be an outcome of the Accelerator Facility design - Cold Boxes volume assumed on the base of JGC experience - It is assumed here that the volume of the cold boxes includes all the DTL stages for each accelerator - Heat loss due to N₂ evaporation and nitrogen circulating equipment assumed according to the standard engineering practice - circulating compressors are assumed to be one for each accelerator 	5 m ³	2	0.5 %vol/d	

Table 13: Liquid Nitrogen (LN2) Input Data Requirements

Gaseous Nitrogen Supply System Main Requirements/Assumptions Table

Facility	Equipment to be supplied	References/assessment/assumptions	Glove boxes volume (m ³)	Number of glove boxes	Maximum oxygen concentration tolerable in the glove boxes (%vol)	Time required to change the atmosphere in the glove boxes (h)	Gaseous nitrogen consumption (Nm ³ /h)	Special requirements
PIEF	R-136: Glove Box Laboratory	<ul style="list-style-type: none"> - Number & capacity of the glove boxes should be an outcome of the PIE Facility design - Glove Boxes Volume Assumed according to JGC experience - Number of Glove Boxes Assumed according to JGC experience - Maximum Oxygen Concentration assumed according to JGC experience - Time required to change atmosphere tentatively assumed 	20 m ³	3	0.2 %vol	6 h	50 Nm ³ /h	
Facility	Equipment to be supplied	References/assessment/assumptions	Time required for regeneration (h)	Gaseous nitrogen supply required (Nm ³ /h)	Special requirements			
CF	Glove Boxes Detritiation System Catalyst regeneration	<ul style="list-style-type: none"> - Time required to change atmosphere tentatively assumed according to JGC experience - N₂ flow selected according to the Exhaust Gas detritiation System design 	?	?				
Facility	Equipment to be supplied	References/assessment/assumptions	Nitrogen consumption of each pump (Nm ³ /h)	Number of pumps	Gaseous nitrogen consumption (Nm ³ /h)	Special requirements		
CF	Dry Pumps for Central Vacuum system. Nitrogen necessary to purge shaft sealing devices	<ul style="list-style-type: none"> - Nitrogen consumption of each pump assumed according to JGC experience - Number of pumps selected according to the Central Vacuum System design 	2.25 Nm ³ /h	8	18 Nm ³ /h			
Facility	Equipment to be supplied	References/assessment/assumptions	Buffer tanks capacity (m ³)		Ratio of empty portion inside each buffer tank (%)	Daily temperature fluctuation (°C/d)	Nitrogen consumption (Nm ³ /d)	Special requirements
AF	Seal gas for buffer tanks of primary cooling water loop of accelerator	<ul style="list-style-type: none"> - Buffer Tanks capacities should be an outcome of the Accelerator Facility design; - Buffer Tanks capacity assumed according to JGC experience and according to the actual design of the accelerator prototype - Empty portion of the buffer tanks assumed according to JGC experience 	RFQ Buffer Tank (m ³)		30%	20.0°C	?	

Table 14: Gaseous Nitrogen (N) Input Data requirements

Equipment List for 5.3.5.0.0.

No.	ITEM No.	SERVICE	QTY	MAT'L	TYPE	SPECIFICATION	MAIN DEMENSION	RATED OUTPUT	ACCESSORIES	Installation ROOM No.	REMARKS
1	5.3.5.1.0.-V-001	Liquid Argon Tank	1	Stainless Steel	Vacuum Flask	25m3	Φ2700XH8000	-	-	Outdoor	-
2	5.3.5.1.0.-HA-002	Liquid Argon Evaporator	1	-	Air Heating	400Nm3/h	W1540XL1540XH3026	-	-	Outdoor	Nikkaki's CAV-400-N
3	5.3.5.1.0.-U-003	Argon Purification System	1	-	PSA/TSA	80Nm3/h, 100%X2 for Compressor and Chiller Unit Only	W11000XL15000XH5500	65kW	-	R228	-
4	5.3.5.1.0.-K-004 A/B	Argon Recirculation Blower	2	Stainless Steel	Centrifugal	14000Nm3/h, 6kPa, 100%X2	W1600XL2000XH1200	45kW	-	R228	-
5	5.3.5.1.0.-HX-005	Argon Recirculation Cooler	1	Stainless Steel	Shell & Tube	Duty: 50kW	φ 1000XL2000	-	-	R228	-
6	5.3.5.2.0.-V-101	Helium Tank	1	Carbon Steel	-	25m3	φ 2500XH5000	-	-	Outdoor	-
6	5.3.5.2.0.-V-111 A~D	Helium Tank	4	Carbon Steel	-	100m3 x4	φ 4000XH8000	-	-	Outdoor	-
7	5.3.5.3.0.-K-201 A/B	Instrumentation Air Compressor	2	-	Screw	200Nm3/h, 0.69MPa, 100%X2	W1650XL900XH1500	27.7+0.4=28.1kW	-	R307	KOBELCO's FE370W-5/6
8	5.3.5.3.0.-U-202 A/B	Instrumentation Air Dryer	2	-	PSA	Outlet 160Nm3/h, 100%X2	W220XL570XH1600	-	-	R307	KOBELCO's KE060
9	5.3.5.3.0.-V-203	Instrumentation Air Tank	1	Stainless Steel	-	3.5m3	Φ 1400XH2800	-	-	R307	-
10	5.3.5.3.0.-U-211 A/B	Breathable Air Supply Unit	2	-	-	60Nm3/h, 0.69MPa, 100%X2	W830XL1480XH1520	15KW	-	R307	BAUER's V150-15-5
11	5.3.5.4.0.-V-301	Liquid Nitrogen Tank	1	Stainless Steel	Vacuum Flask	25m3	Φ2700XH8000	-	-	Outdoor	-
12	5.3.5.4.0.-HA-302	Liquid Nitrogen Evaporator	1	-	Air Heating	70Nm3/h	W574XL574XH2346	-	-	Outdoor	Nikkaki's CAV-80
13	5.3.5.4.0.-V-311	Liquid Nitrogen Tank	1	Stainless Steel	Vacuum Flask	50m3	Φ3500XH10000	-	-	Outdoor	-
14											
15											
16											
17											
18											
19											
20											

Table 15: S-1224-201- SGS Equipment List - PBS 5.3.5.0.0.

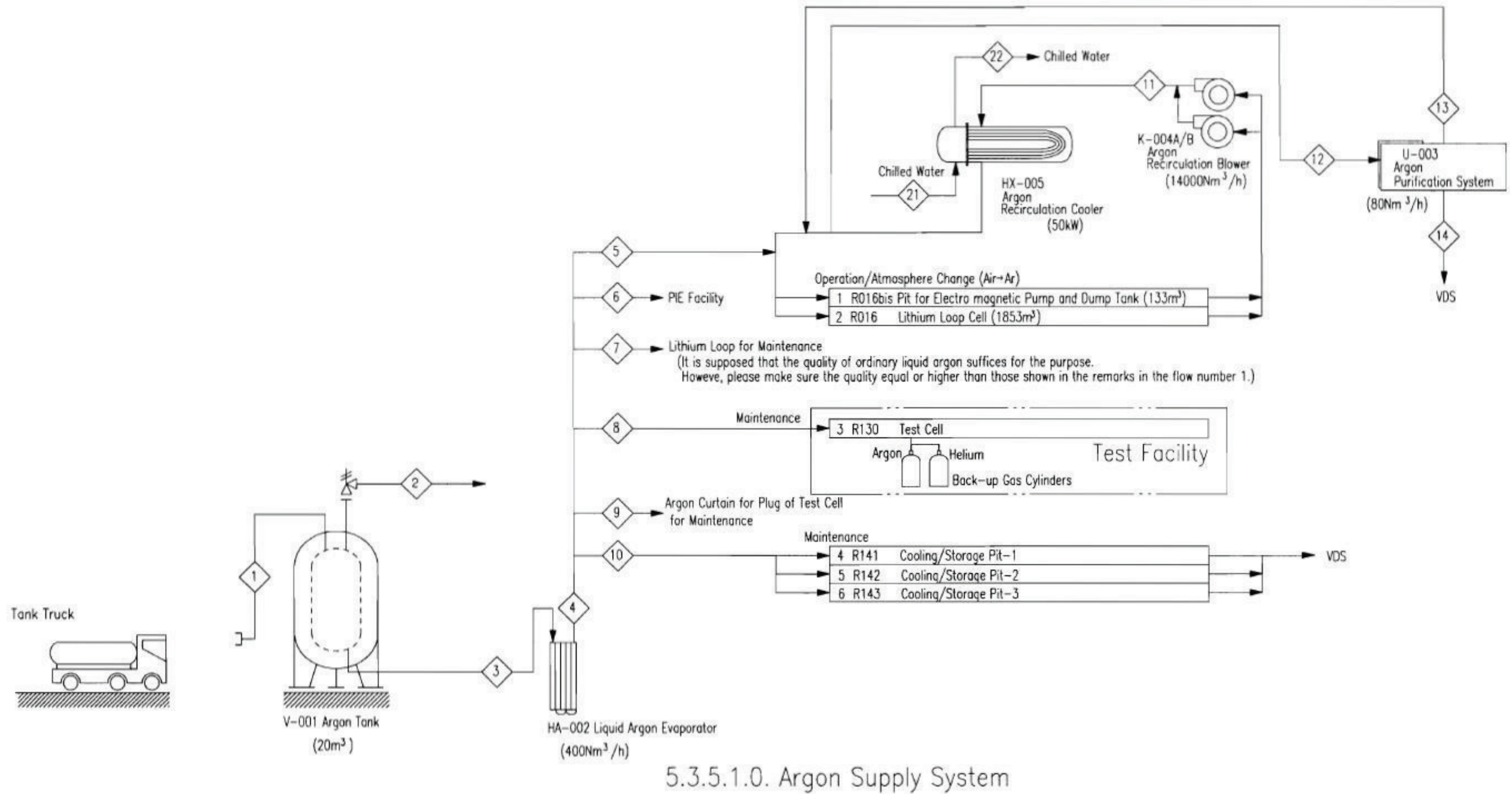
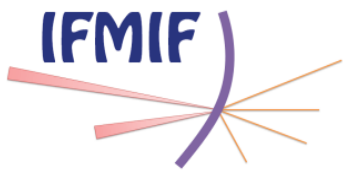


Figure 6-1: Argon Supply System, PFD

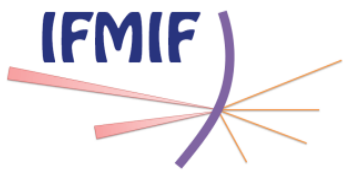
Operation			1	2	3	4	5	6	7	8	9	10	11	12	13	14
Flow Number			Liquid Argon	Relieved Argon Gas	Liquid Argon	Argon Gas	Argon Gas	Argon Gas	Argon Gas	Argon Gas	Argon Gas	Argon Gas	Recirculated Ar to Ar-filled Cells	Exhaust from Ar-filled Cells	Purified Argon Gas	Vent Gas
Flow	Nm ³ /h		6.1 m ³ /week	97 Nm ³ /d	0.031 m ³ /h	24.00	24	TBD	-	-	-	-	14000	80.00	55.03	24.97
Composition	Ar	Nm ³ /h					24							78.92	54.92	24.00
	N2	Nm ³ /h												0.85	0.09	0.77
	O2	Nm ³ /h												0.23	0.02	0.20
	H2O	Nm ³ /h												0.03	0.00	0.02
Main Impurities	H2	Nm ³ /h												-	-	-
	O2	ppm												2825	411	8147
Activity	H2O	ppm												327	48	944
	HT,DT	Bq/h												3.1E+06	2.1E+06	9.6E+05
	HTO,DTO	Bq/h												-	-	-
	HT,DT	Bq/cm ³												3.8E-02	3.8E-02	3.8E-02
Temperature	HTO,DTO	Bq/cm ³												-	-	-
	°C		-186	AMB	-186	AMB	AMB	AMB					30	20	AMB	AMB
Pressure	MPa		0.8	0.8	0.8	0.8	0.8	0.8					-	-	0.3	-
Remarks			Grade G3 Purity >99.999 % O ₂ <0.2 ppm Dew Point <-70 °C Replenishment Interval 4 week	LAr Tank 25 m ³ Evap. rate 0.5 %/d No. of Tanks 1			Argon Purification Capacity 80 Nm ³ /h Recovery rate 70 %						Volume of cells 1986 m ³ Change rate 7.0 Vol/h	Volume of cells 1986 m ³ Leak rate 5.E-04 /h		

Table 16: Argon Supply System, Operation conditions.



Maintenance														
Flow Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Fluid	Liquid Argon	Relieved Argon Gas	Liquid Argon	Argon Gas	Argon Gas	Argon Gas	Argon Gas	Argon Gas	Argon Gas	Argon Gas	Recirculated Ar to Ar-filled Cells	Exhaust from Ar-filled Cells	Purified Argon Gas	Vent Gas
Flow	Nm ³ /h 3.5 m ³ /month	97 Nm ³ /d	0.03854 m ³ /h	30.0	-	TBD	30	TBD	TBD	TBD	-	-	-	-
Temperature	°C -186	AMB	-186	AMB	AMB	AMB	AMB	AMB	AMB	AMB	-	-	-	-
Pressure	MPa 0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	-	-	-	-
Remarks	Replenishment Interval 7 month						3m ³ /B							

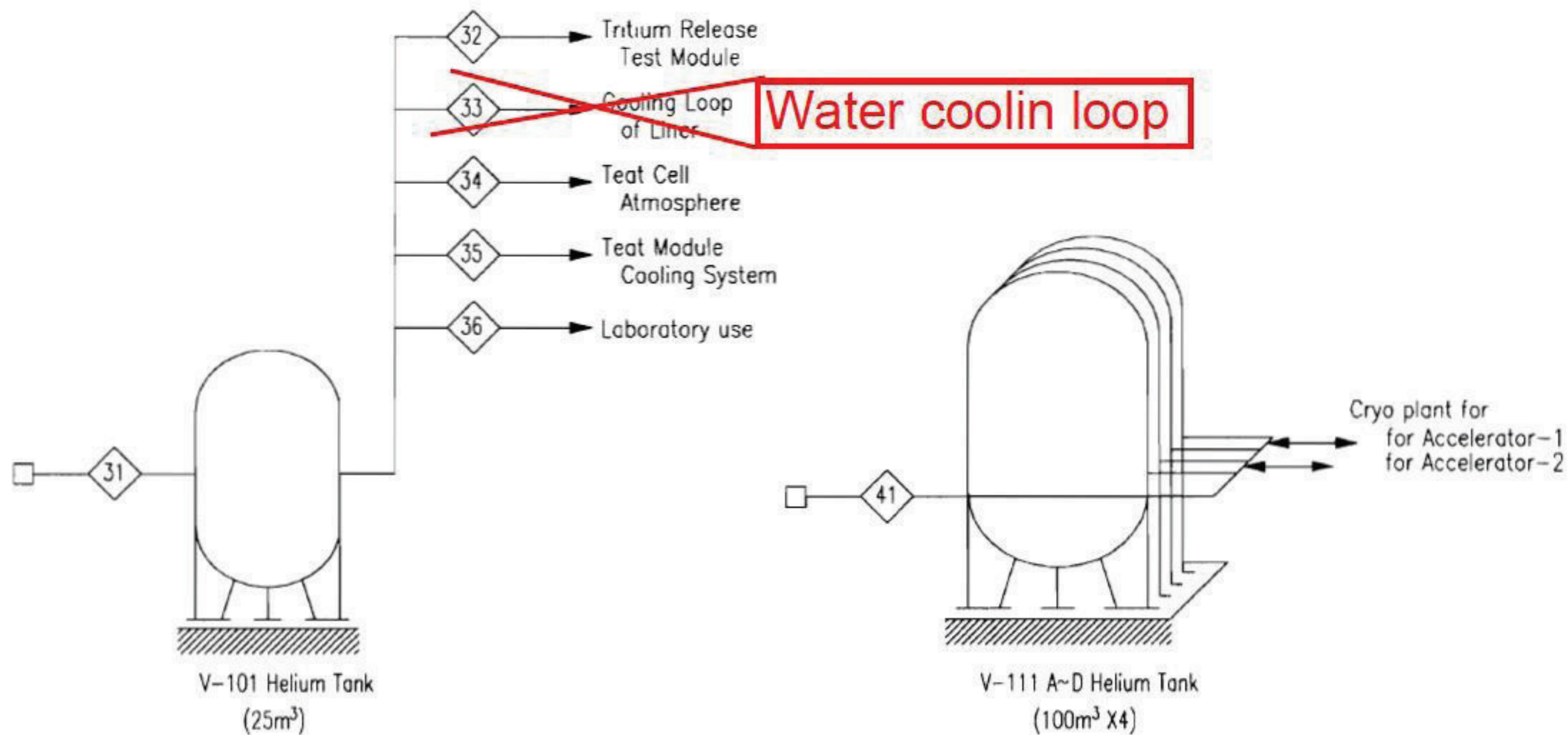
Table 17: Argon Supply System. Maintenance conditions.



Atmosphere Change (Air → Argon)

Flow Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Fluid	Liquid Argon	Relieved Argon Gas	Liquid Argon	Argon Gas	Argon Gas	Argon Gas	Argon Gas	Argon Gas	Argon Gas	Argon Gas	Recirculated Ar to Ar-filled Cells	Exhaust from Ar-filled Cells	Purified Argon Gas	Vent Gas
Flow	Nm ³ /h	9.4 m ³ /d	97 Nm ³ /d	0.39 m ³ /h	300	300	-	-	-	-	14000	-	-	-
Temperature	°C	-186	AMB	-186	AMB	AMB	AMB				30	-	-	-
Pressure	MPa	0.8	0.8	0.8	0.8	0.8					-	-	-	-
Remarks	Replenishment Interval 2 day Duration 1.4 days				Atm. Change of cells Volume 1986 m ³ No. of change 5 - Duration 1.4 d									

Table 18: Argon Supply System. Atmosphere change (Air - Argon)

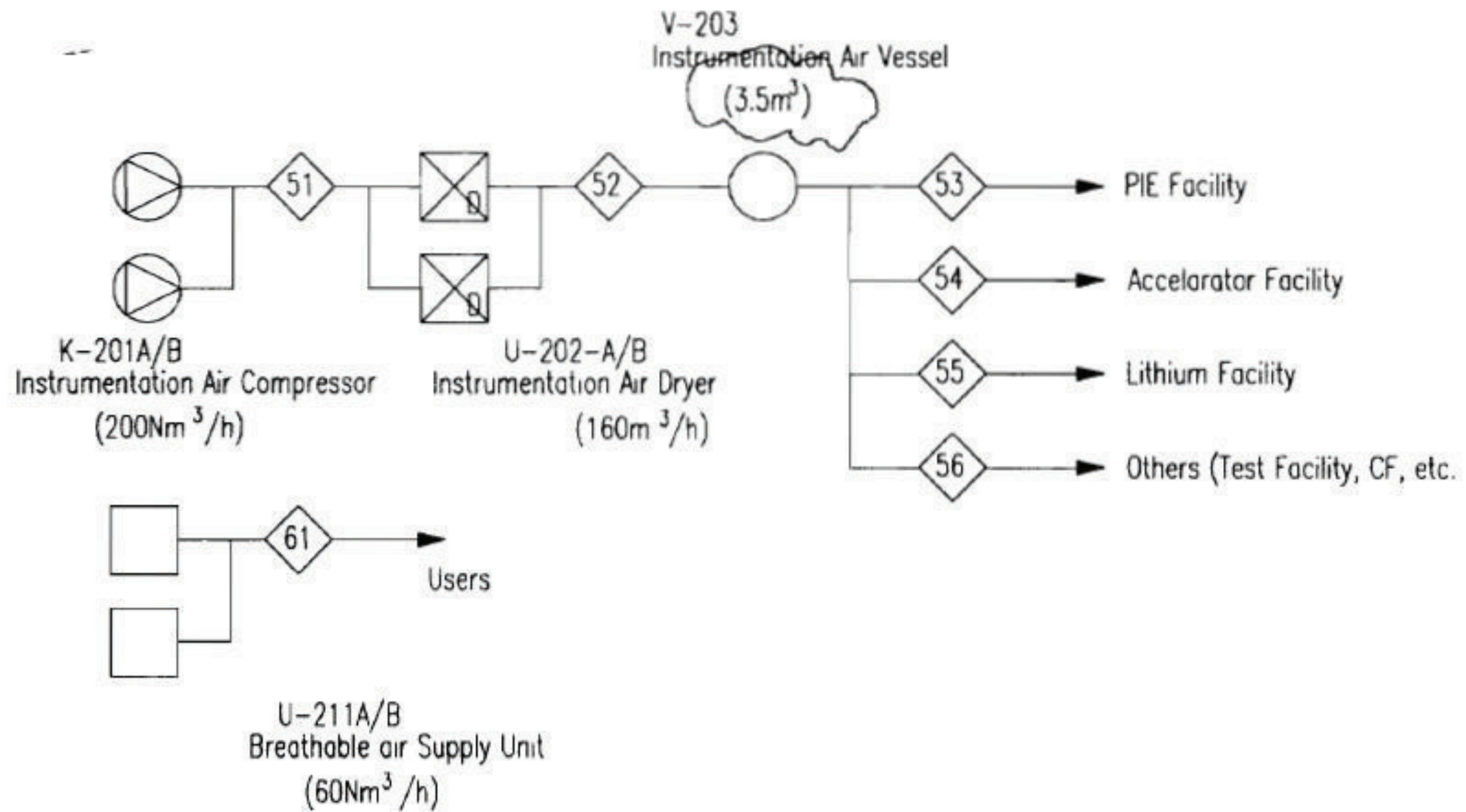


5.3.5.2.0. Helium Supply System

Figure 6-2: Helium Supply System, PFD

Operation		31	32	33	34	35	36
Flow Number		31	32	33	34	35	36
Fluid		Helium Gas	Helium Gas	Helium Gas	Helium Gas	Helium Gas	Helium Gas
Flow Rate	Nm ³ /h	10.1 Nm ³ /week	1.44 Nm ³ /d	16	60	16	TBD
Temperature	°C	AMB	AMB	AMB	AMB	AMB	AMB
Pressure	MPa	0.8	0.8	0.8	0.8	0.8	0.8
Remarks		Replenishment Interval 2 week Consumption 20 Nm ³ 3 Cylinder		Inventory TBD Nm ³ Replenishment TBD %/month	Inventory TBD Nm ³ Replenishment TBD %/month	Inventory TBD Nm ³ Replenishment TBD TBD	

Table 19: Helium Gas Supply system, Operation conditions.



5.3.5.3.0. Compressed Air Supply System

Figure 6-3: Compressed Air Supply System & Breathable Air, PFD

Flow Number		51	52	53	54	55	56
Fluid		Compressed Air	Instrumentation Air	Instrumentation Air	Instrumentation Air	Instrumentation Air	Instrumentation Air
Flow Rate	Nm ³ .h	200	160	35	60	20	25
Temperature	°C	AMB	AMB	AMB	AMB	AMB	AMB
Pressure	MPa	0.69	0.69	0.69	0.69	0.69	0.69
Remarks			Dew Point -40 °C Buffer Vessel (1min) 0.52→0.44MPa				

Table 20: Compressed Air supply system (for Instrumentation) Operation conditions.

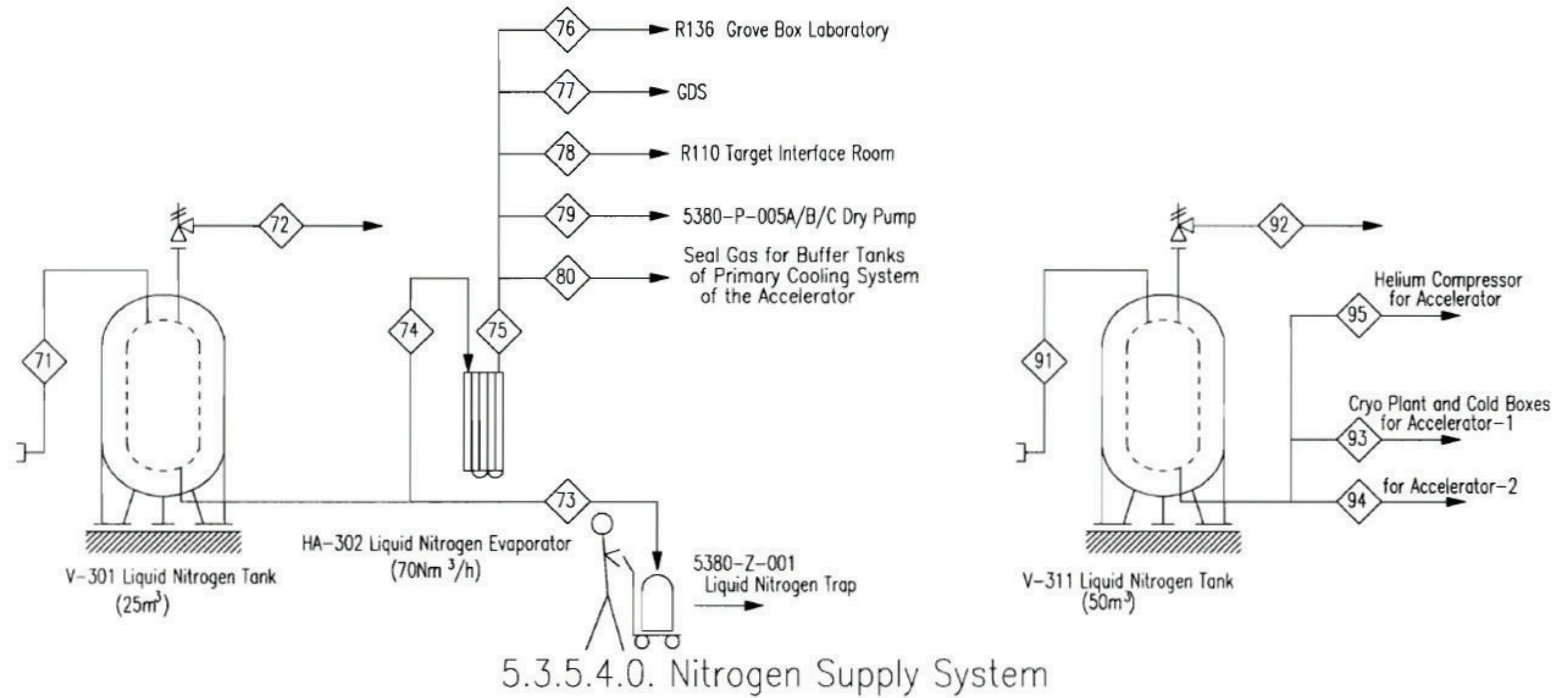


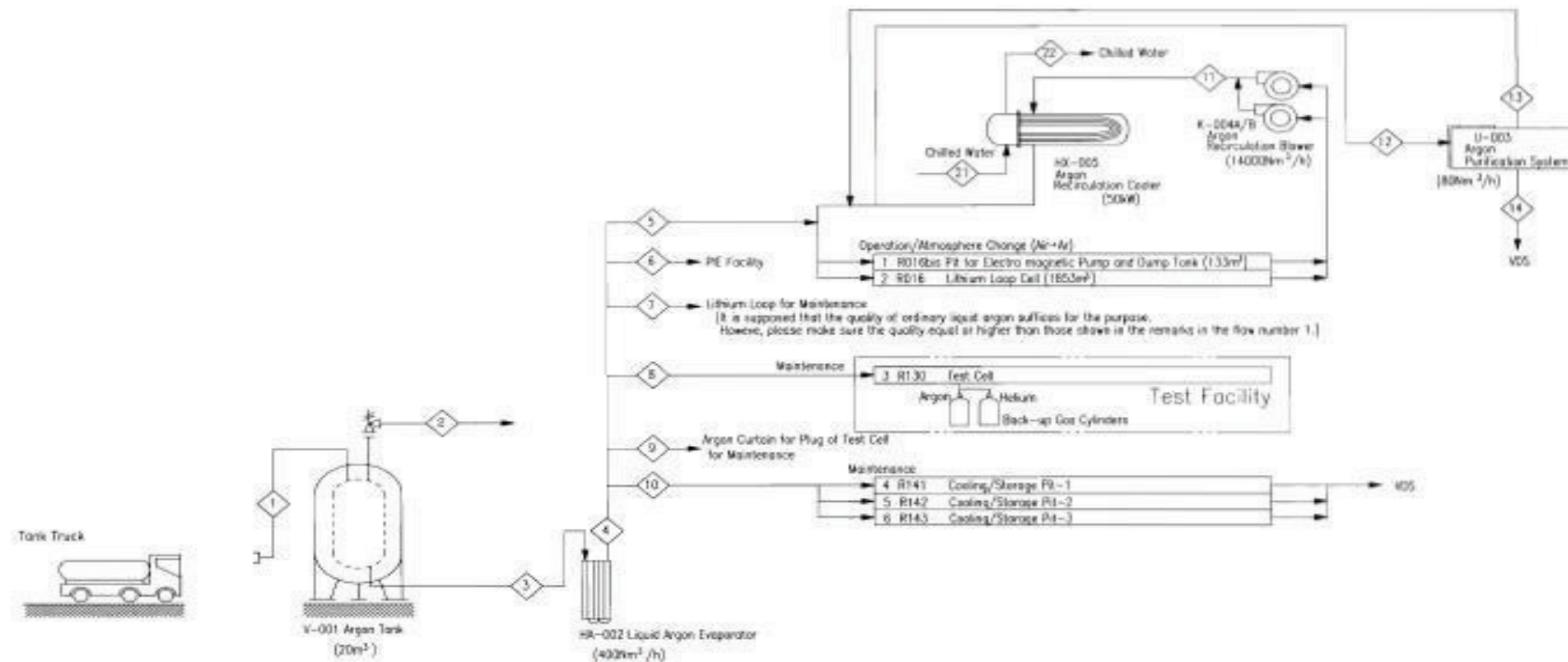
Figure 6-4: Nitrogen Supply System, PFD
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Flow Number	71	72	73	74	75	76	77	78	79	80
Fluid	Liquid Nitrogen	Relieved Nitrogen Gas	Liquid Nitrogen	Liquid Nitrogen	Nitrogen Gas	Nitrogen Gas	Nitrogen Gas	Nitrogen Gas	Nitrogen Gas	Nitrogen Gas
Flow Rate	Nm ³ /h 5.6 m ³ /week	81 Nm ³ /d	0.005 m ³ /d	0.669 m ³ /d	433 Nm ³ /d	50	21.3	-	18	1.4 Nm ³ /d
Temperature	°C -186	AMB	-186	-186	AMB	AMB	AMB	AMB	AMB	AMB
Pressure	MPa 0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Remarks	Replenishment Interval 4 week	LN2 Tank 25 m ³ Evap. rate 0.5 %/d No. of Tanks 1	Size of Cold Trap 1 m ³		Max. 70 Nm ³ /h	Atm. Change of GB Volume 60 m ³ No. of Change 5 - Duration 6 h Frequency 1 /y	Regeneration of Cu and CuO Catalyst For 6h every 180d		N2 for a pump 3 Nm ³ /h No. of pumps 6	Buffer Tank 70 m ³ Empty Volume 30 % Temp. Fluctuation 20 °C

Table 21: Nitrogen Gas Supply Conditions

91	92	93	94
Liquid Nitrogen for an Accelerator	Relieved Nitrogen Gas	Liquid Nitrogen	Liquid Nitrogen
0.3 m ³ .h	162 Nm ³ /d	TBD m ³ /d	TBD m ³ /d
-186	AMB	-186	-186
0.8	0.8	0.8	0.8
Replenishment Interval 6 days for an Accelerator 3 days for two Accelerators	LN2 Tank 50 m ³ Evap. rate 0.5 %/d No. of Tanks 1		

Table 22: Liquid Nitrogen (LN2) Operation conditions



5.3.5.1.0. Argon Supply System

Operation		1	2	3	4	5	6	7	8	9	10	11	12	13	14
Flow Number	Fluid	Liquid Argon	Relieved Argon Gas	Liquid Argon	Argon Gas	Argon Gas	Argon Gas	Argon Gas	Argon Gas	Argon Gas	Recirculated Ar to Ar-filled Cells	Exhaust from Ar-filled Cells	Purified Argon Gas	Vent Gas	
Flow	Nm³/h	6.1 m³/week	97 Nm³/d	0.031 m³/h	24.00	24	TBD	-	-	-	14000	80.00	55.03	24.97	
Composition	N2					24						78.92	54.92	24.00	
	O2											0.85	0.09	0.77	
	H2O											0.23	0.02	0.29	
	H2											0.03	0.05	0.02	
Main Impurities	O2											2925	411	8147	
	H2O											327	48	944	
	Activity	HT.DT	Bq/h									3.1E+06	2.1E+06	9.6E+05	
Activity	HTO.DTO	Bq/h													
	HT.DT	Bq/cm²										3.8E-02	3.8E-02	3.8E-02	
	HTO.DTO	Bq/cm²													
Temperature	°C	-186	AMB	-186	AMB	AMB	AMB				30	20	AMB	AMB	
Pressure	MPa	0.8	0.8	0.8	0.8	0.8	0.8						0.3		
Remarks		Grade G3 Purity >99.999 % O₂ <0.2 ppm Dew Point <-70 °C Replenishment Interval 4 week	LAr Tank 25 m³ Evap. rate 0.5 %/d No. of Tanks 1			Argon Purification Capacity 80 Nm³/h Recovery rate 70 %					Volume of cells 1986 m³ Change rate 7.0 Vol/h	Volume of cells 1986 m³ Leak rate 5E-04 /h			

Flow Number	21	22
Fluid	Chilled Water	Chilled Water
Flow	m³/h	8.4
Temperature	°C	7
Pressure	MPa	0.35
Remarks		

Maintenance		1	2	3	4	5	6	7	8	9	10	11	12	13	14
Flow Number	Fluid	Liquid Argon	Relieved Argon Gas	Liquid Argon	Argon Gas	Argon Gas	Argon Gas	Argon Gas	Argon Gas	Argon Gas	Recirculated Ar to Ar-filled Cells	Exhaust from Ar-filled Cells	Purified Argon Gas	Vent Gas	
Flow	Nm³/h	3.5 m³/month	97 Nm³/d	0.03854 m³/h	30.0	-	TBD	30	TBD	TBD	TBD				
Temperature	°C	-186	AMB	-186	AMB	AMB	AMB	AMB	AMB	AMB					
Pressure	MPa	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8					
Remarks		Replenishment Interval 7 month						3m³/S							

Atmosphere Change (Ar to Ar)		1	2	3	4	5	6	7	8	9	10	11	12	13	14
Flow Number	Fluid	Liquid Argon	Relieved Argon Gas	Liquid Argon	Argon Gas	Argon Gas	Argon Gas	Argon Gas	Argon Gas	Argon Gas	Recirculated Ar to Ar-filled Cells	Exhaust from Ar-filled Cells	Purified Argon Gas	Vent Gas	
Flow	Nm³/h	8.4 m³/d	97 Nm³/d	0.28 m³/h	300	300	-	-	-	-	14000				
Temperature	°C	-186	AMB	-186	AMB	AMB	AMB								
Pressure	MPa	0.8	0.8	0.8	0.8	0.8	0.8								
Remarks		Replenishment Interval 2 day Duration 1.4 days				Atm. Change of cells Volume 1986 m³ No. of change 5 Duration 1.4 d									

Figure 6-5: Argon Supply System PFD with tables

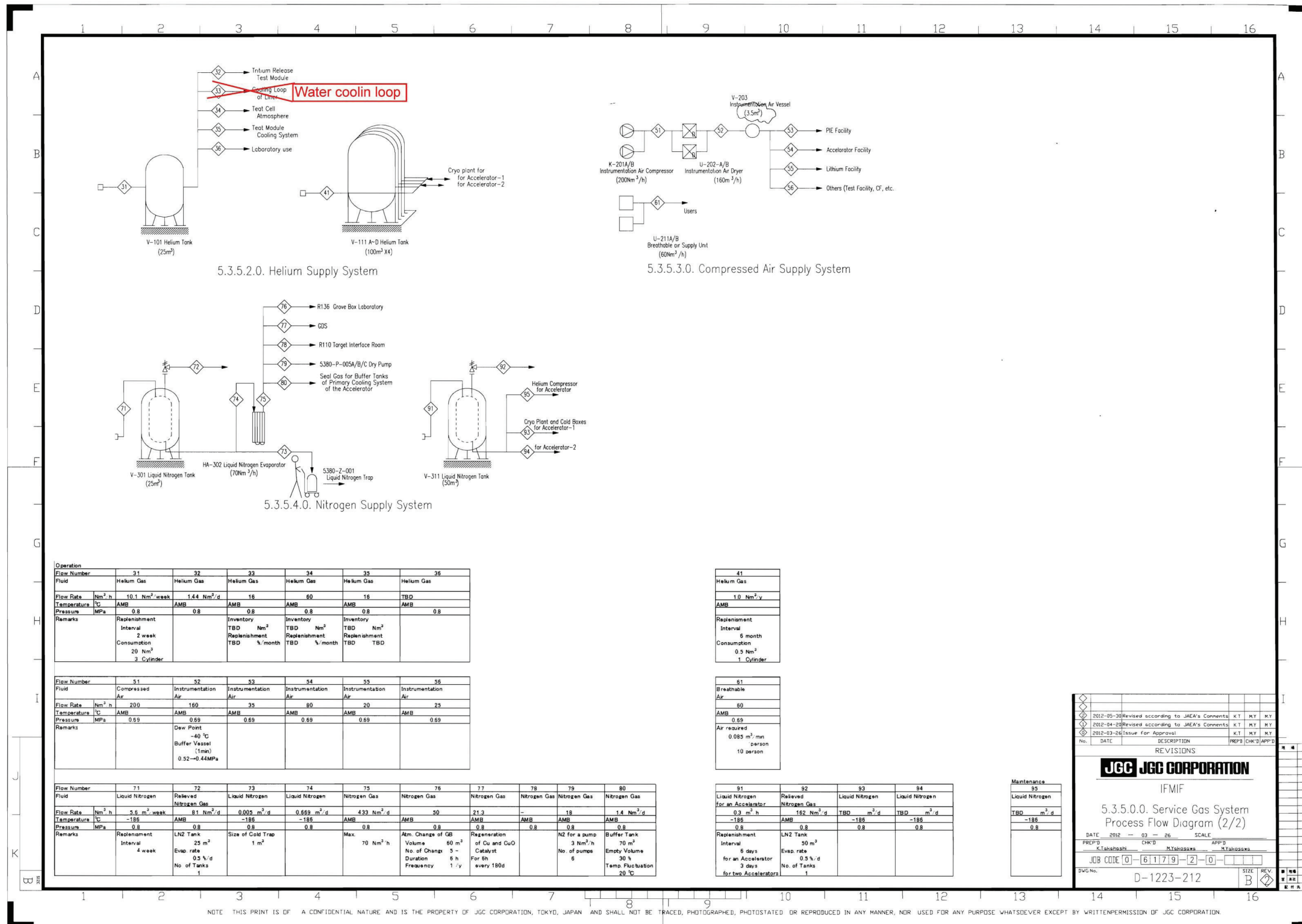


Figure 6-6: Helium- Nitrogen and Compressed Air, PFD with tables.

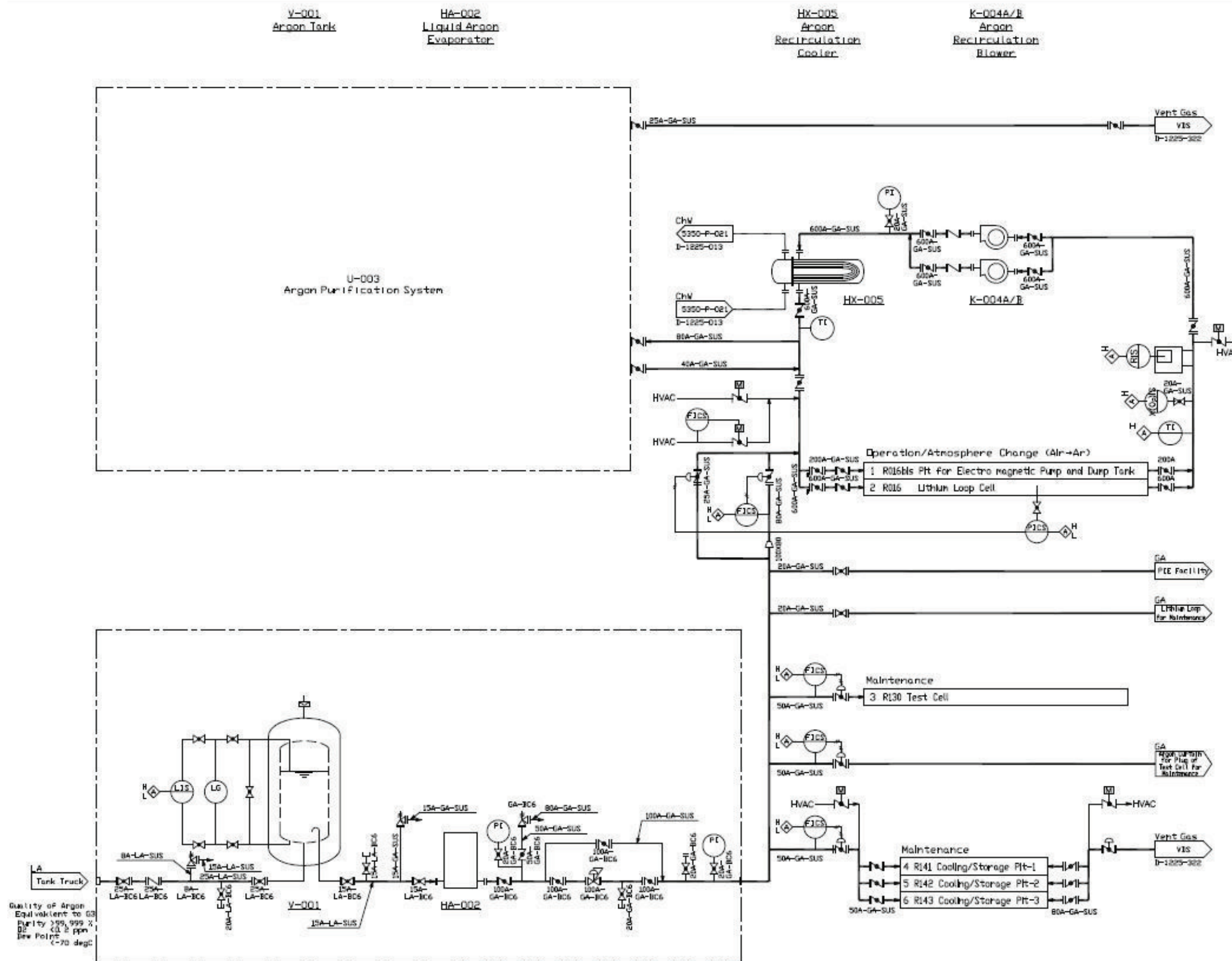


Figure 6-7: D-1225-211- Argon Supply System - P&ID

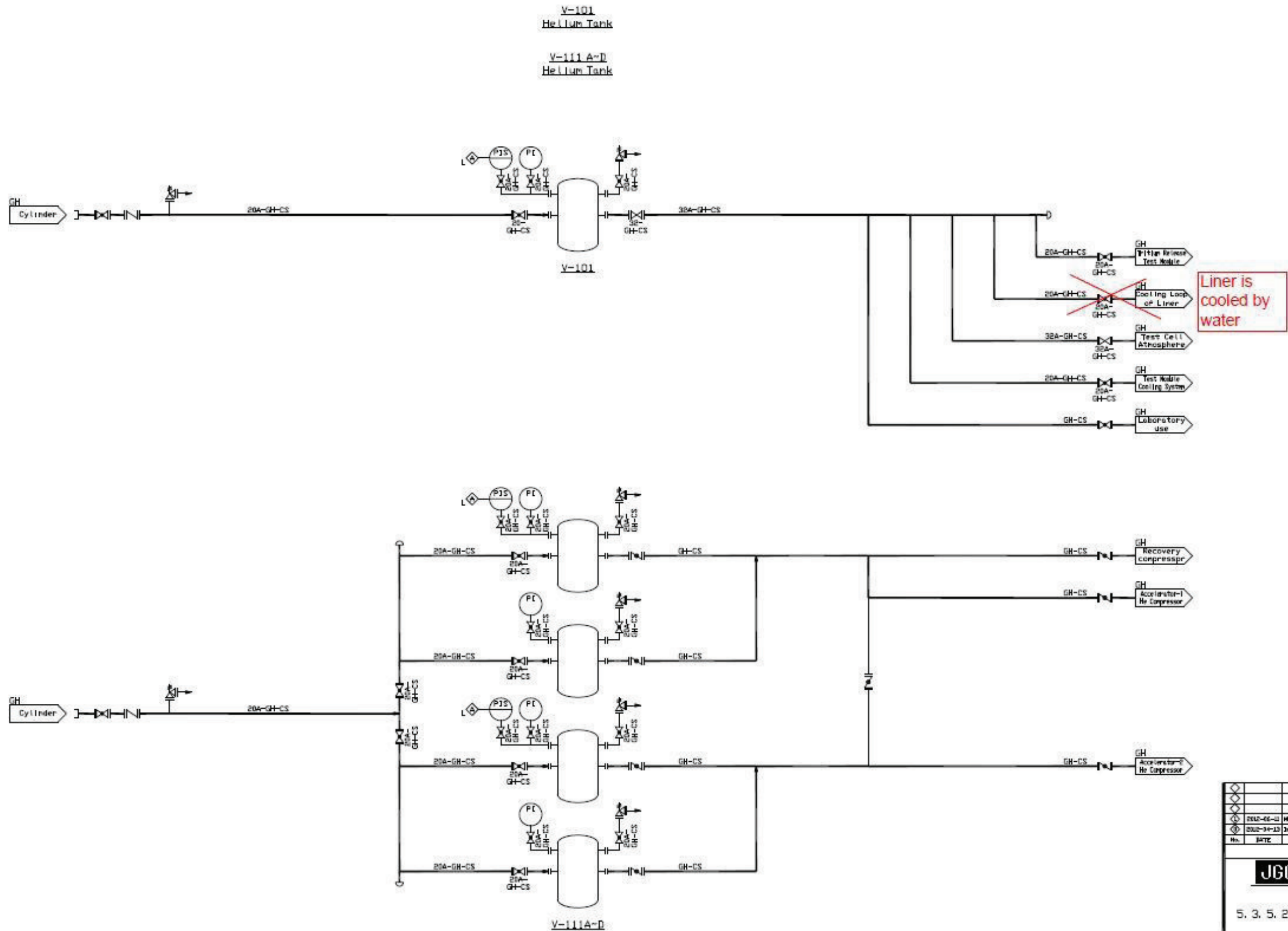
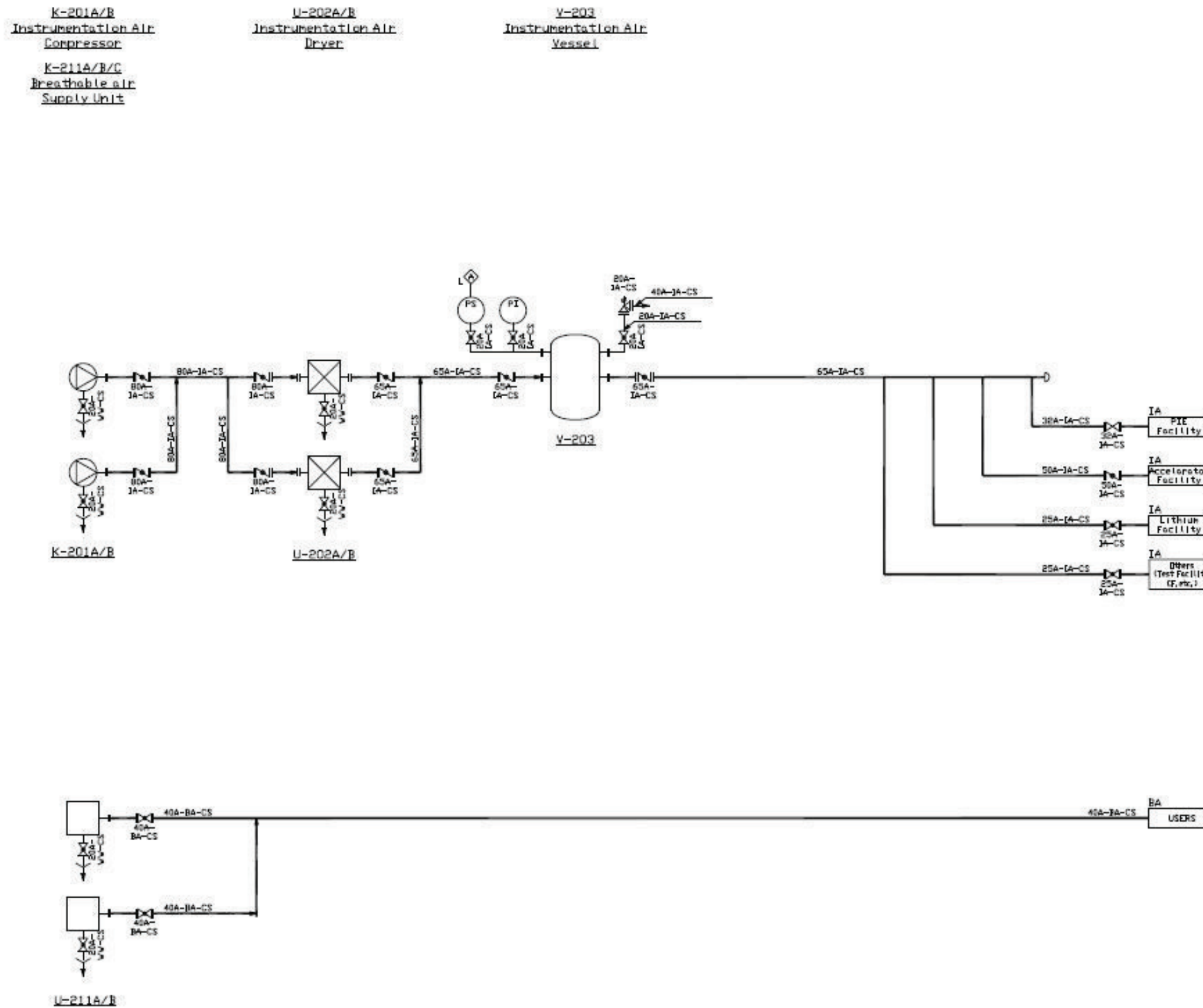


Figure 6-8: D-1225-212-Helium Supply System, P&ID

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Figure 6-9: D-1225-213-Compressed Air Supply System, P&ID

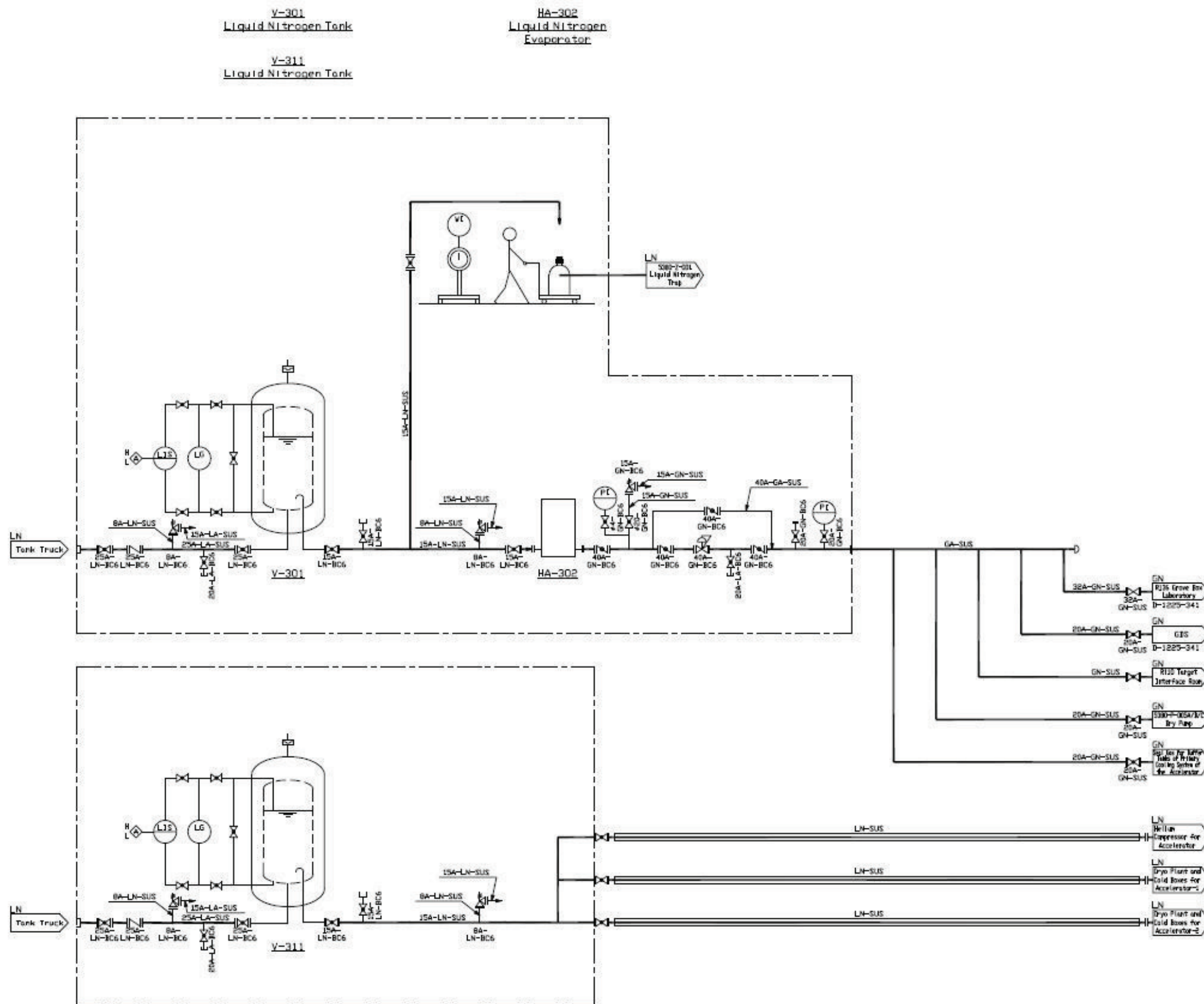


Figure 6-10: D-1225-214- Nitrogen Supply System, P&ID

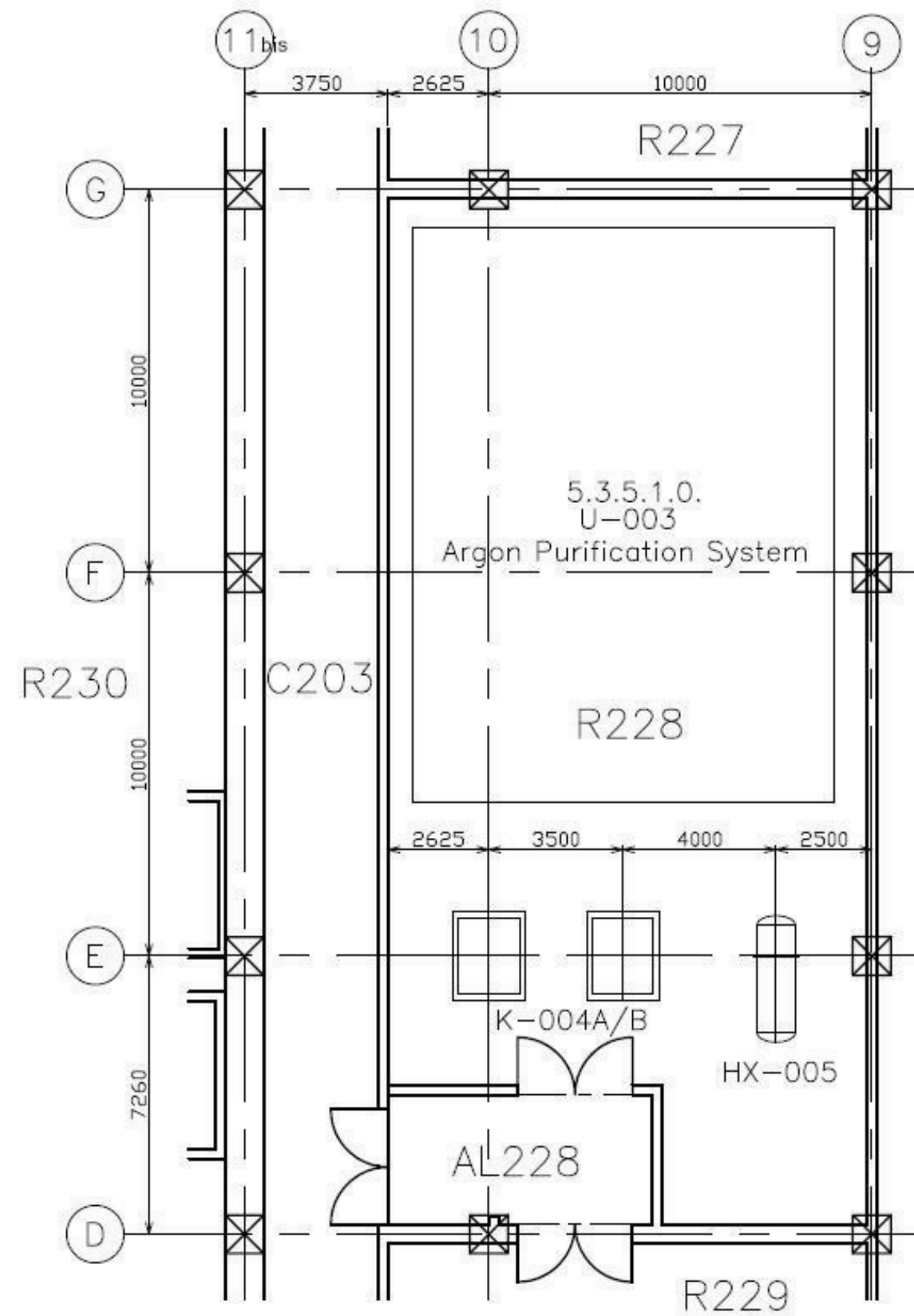


Figure 6-11: Argon Purification System, Room 228

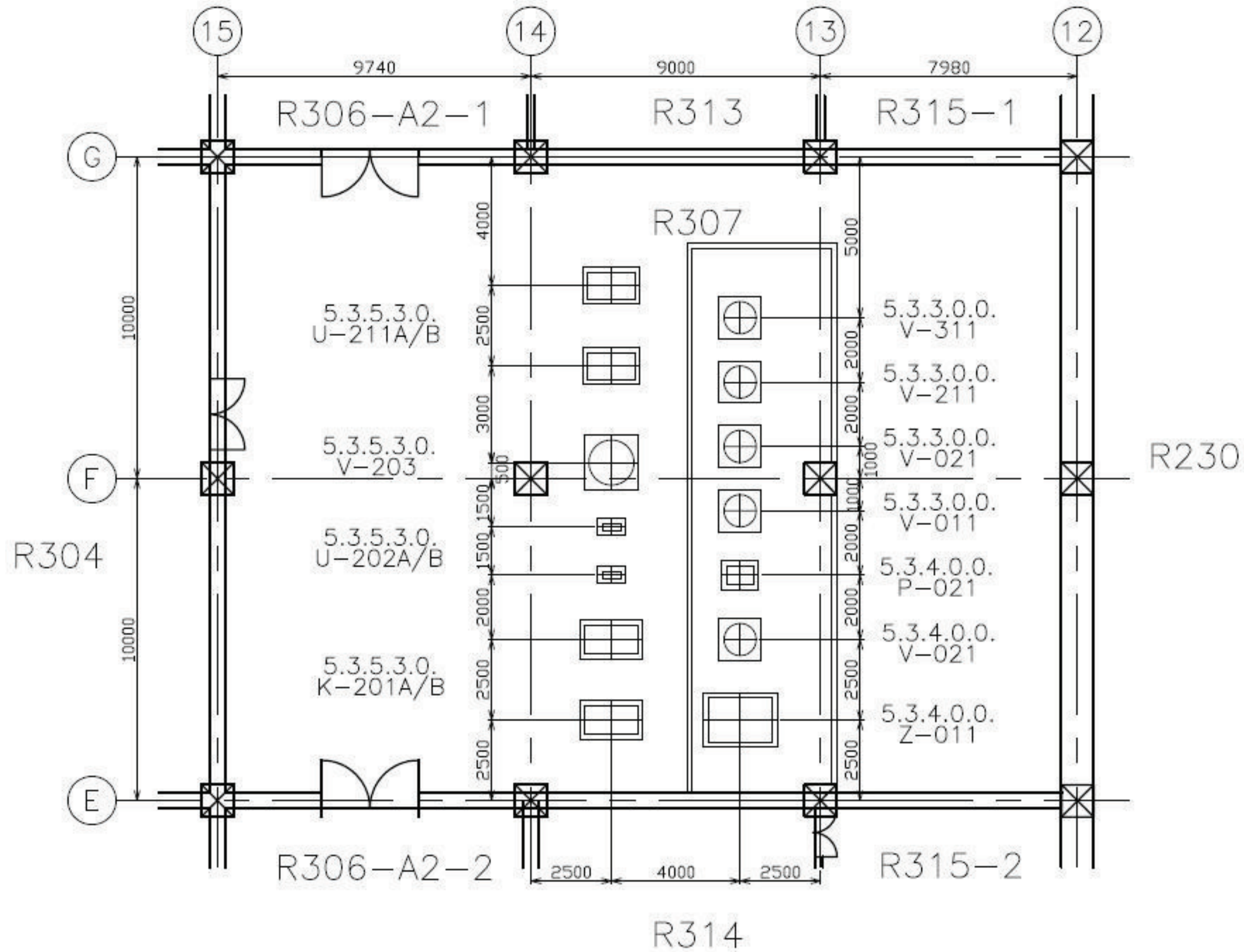
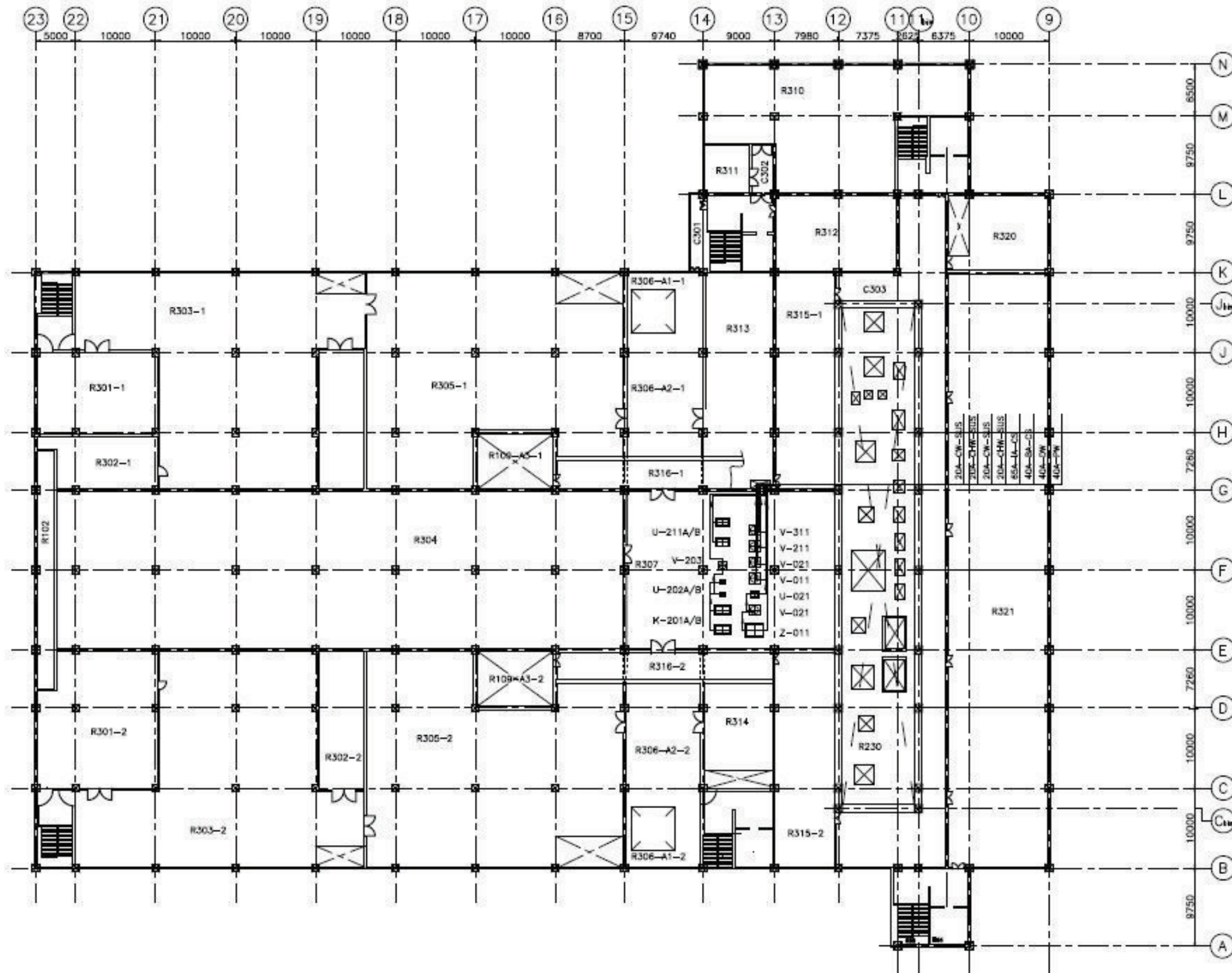
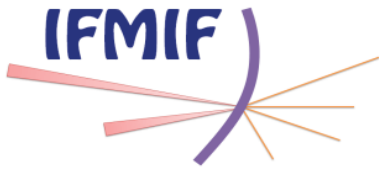


Figure 6-12: Compressed Air technical room, R307



3FL:+15000

Figure 6-13: Compressed Air piping's layout.



System Design Description Document (DDD)

Heating Ventilation and Air Conditioning (HVAC) System

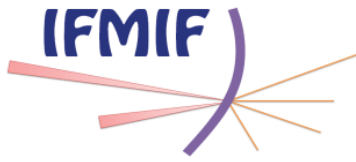
PBS 5.3.1.

Abstract: This document describes the Heating Ventilation and Air Conditioning System (HVAC) System considered belonging to the Conventional Facilities. Key functions of the system as well as: interfaces with other facilities/systems, rooms characteristic, P&ID's, equipment layout, equipment list, flow diagrams, ducting layout and input data requirement for the design of the system.

Reference of the document: BA_D_227JZV

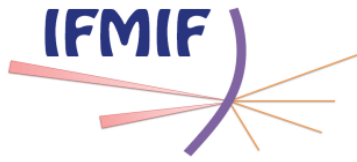
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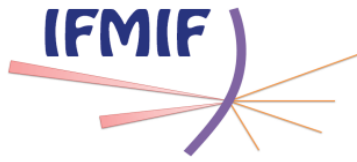


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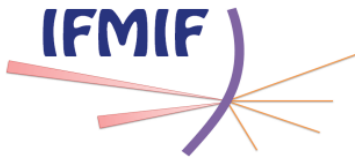
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1. System Functions and Basic Configuration

1.1 System Functions

The main function of the HVAC system is to provide sufficient air throughput to ensure acceptable air quality for continuous access of personnel to some selected areas of the IFMIF Plant. Served areas include the plant areas where the risk of radiological contamination is excluded. The operating areas potentially contaminated by tritium and activation products and the hot cells and glove boxes operating air. HVAC systems in potentially contaminated areas have the safety function to protect both the personnel and the environment from uncontrolled release of radioactive materials. Therefore they are designed for high availability and easy maintenance. The HVAC Systems do not serve the hot cells and glove boxes operating in inert gas atmosphere which needs closed loops with decontamination system to keep under control the contents of tritium and other gas impurities.

The HVAC System shall be capable to ensure comfort environmental conditions for the working staff of the plant and the right thermo hygrometric parameters for the equipment housed in the IFMIF premises.

Furthermore HVAC System shall protect workers personal and environment from the contact with activated particles (in form of chips, dusts, aerosols and activated air) due to the uncontrolled release from high potential and/or permanent contamination hazard rooms to low contamination areas or to the environment (this concept, in ISO 17873:2004 (ref.[4]), is referred as *Dynamic Confinement*).

HVAC System shall thus be designed to perform the following key functions:

- Supply water to the humidification coils of the AHUs;
- Condition air (heating, cooling, humidification and re-heating treatments)
- Supply conditioned and filtered air to the different rooms. Taking into account considerations about:
 - Rooms specific risks;
 - Containment functions;
 - Maintenance of the climatic and hygienic conditions;
- Ensure a negative (gauge) pressure to the rooms characterized by potential/permanent contamination;
- Extract air from the different rooms;
- Filter air that presents the possibility of airborne contamination;
- Release air to environment;
- Provide the capability to intervene on components for easy maintenance and high availability.

To accomplish the above mentioned functions, HVAC system includes cold and hot water generators; Air Handling Units (AHU's) Fans, Filters, valves, dumpers, and grills; air ducts and the corresponding instrumentation and sensors.

NOTE:

According to the materials handled in the plant (liquid metals like Lithium in the lithium loop area that can react with air and humidity in it), some rooms will be kept in inert gas atmosphere (Argon) during operation. The supply and control the purity of noble gas



environment is included in the scope of the (SGS) Service Gas System (Argon see PFD D-1223-211- scheme 1/2- PBS 5.3.5.1[5] Ref. doc. BA_233HD9 v1.0) HVAC system is in charge to supply air/Argon to the different rooms operating on demand for maintenance purpose on “Change over mode” in conjunction to Argon Supply and purification system controlled by Ar. Purification equipment (ref. PBS-5.3.5.1.5 [5]).

1.2 System Basic Configuration

PBS, proposed for the plant, and summarized in Table 1, locates the HVAC System within the Conventional Facilities/ Plant services.

PBS Number						PBS Item
1	2	3	4	5	6	
5	0	0	0	0	0	Conventional Facilities
	3	0	0	0	0	Plant Services
		1	0	0	0	Heating Ventilation and Air Conditioning (HVAC) System
			1	0	0	Nuclear HVAC
			2	0	0	PIE Nuclear HVAC
			3	0	0	Industrial HVAC
			4	0	0	Heat Source System

Table 1: HVAC PBS location

1.2.1 Nuclear HVAC

Nuclear HVAC System serves:

- Areas that present potential or permanent levels of activation
- Areas potentially contaminated by tritium
- Hot cells operating in air (if any)
- Glove boxes operating in air (if any)
- Inert gas hot cells during maintenance period (when they are operated in air)
- Inert gas glove boxes during maintenance period (when they are operated in air).

Intake air is filtered before its distribution to the different areas.

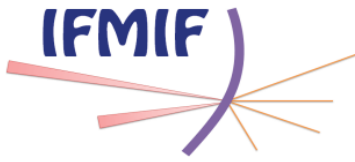
Extracted air is filtered before its exhaust in environment (different filtration stages according to the contamination levels)

Extracted air is released in environment directly or through a stack according to the contamination levels.

1.2.2 PIE Nuclear HVAC System

PIE Nuclear HVAC System serves:

- Areas that present potential or permanent levels of activation inside PIE Facility
- Areas potentially contaminated by tritium inside PIE Facility
- Hot cells operating in air inside PIE Facility



- Glove boxes operating in air inside PIE Facility
- Inert gas hot cells during maintenance period (when they are operated in air) inside PIE Facility;
- Inert gas glove boxes during maintenance period (when they are operated in air) PIE Facility.

The Nuclear HVAC System for the PIE Facility is independent from the general Nuclear HVAC of the IFMIF plant.

Intake air is filtered before its distribution to the different areas.

Extracted air is filtered before its exhaust in environment (different filtration stages according to the contamination levels)

Extracted air shall be released in environment directly or through a stack according to the contamination levels.

1.2.3 Industrial HVAC System

Industrial HVAC System serves:

- Areas free from any permanent contamination or which don't present any contamination hazard
- Data storage rooms, server rooms, data elaboration rooms¹

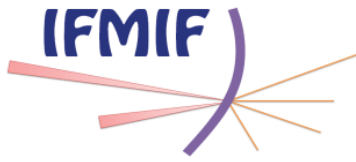
Intake air is filtered before its distribution to the different areas.

Extracted air is directly released in environment.

1.2.4 Heat Source System

Heated and Chilled Water Generators condition and supply water for the heating, cooling and reheating coils of the AHUs.

¹ For these premises a precision cooling system is deemed necessary.

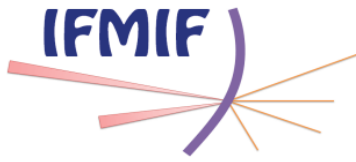


2. Interfaces (boundaries)

The design parameters of the HVAC system for a given room are a combination of the following aspects:

- Activities performed in the room (equipment present, internal heat loads, occupancy, contamination levels etc.);
- Characteristics of the room (volume, openings, orientation of the room, heat fluxes from other rooms, air leakages etc.).

In this sense there is a multiple interface between HVAC, Facilities (hosted in the room) and Building. A generic multiple interface was defined to overcome this issue. HVAC system interfaces at the same time with Conventional Facilities (in the sense of the Building) and with the equipment hosted in the room (that can be part of the Accelerator, Lithium, Test, PIE and/or of the Conventional Facilities themselves). The sharing of responsibilities will be clarified case by case, but at list this general triple interface includes all the requirements that HVAC needs in order to proceed with the design, here below are summarized (at first level) the interfaces related to the HVAC Systems.



Interface Table		
System A	System B	Title
Main Building	HVAC System	HVAC System shall be provided to: Main Building
Administration Building	HVAC System	HVAC system shall be provided to: Administrative Building
Electrical Switchyard Building	HVAC System	HVAC System shall be provided to: Switchyard Building
Personnel Access Control Area	HVAC System	HVAC System shall be provided to: Personnel Access Control Building
Warehouse	HVAC System	HVAC System shall be provided to: Warehouse
Service Water System	HVAC System	HVAC System shall receive service water from: Service Water System
Electric Distribution System	HVAC System	HVAC System shall receive electric power from: Electrical Distribution System
CC&CI	HVAC System	HVAC System shall provide control signal to/from: CC&CI System
Water Drainage	HVAC System	HVAC System shall be provided HVAC drainage to: Water Drainage System
PIE Facility Glove Boxes	HVAC System	HVAC System shall be provided to: Glove Boxes
Argon Supply System	HVAC System	HVAC System shall be provided HVAC drainage to: Argon Supply System
Emergency Detritation System	HVAC System	HVAC System shall be provided HVAC drainage to: Emergency detritation System

Table 2 : Interface table



2.1 HVAC System vs. Lithium Facility

HVAC shall serve the Lithium facility rooms. The boundary between HVAC and LF is set at the internal part of the room walls. (Except the temperature, humidity, pressure, air quality sensors which are located inside the rooms) Inlet/outlet grilles, fire dampers smoke dampers and backward equipment is within the scope of HVAC system. Lithium loop room (room no. R016) and pit for electromagnetic pump and Li. Dump tank (room R016bis) are under Argon atmosphere during operation and air during maintenance, air supply is under HVAC System scope while Argon supply during change over operation during maintenance shall be provided from room R228; Service Gas System (Argon see, PFD D-1223-211 PBS 5.3.5.1(cfr. Ref.[5]) Argon shall be introduced to the LI room by means of Blowers, the temperature controlled by chilled water heat exchanger and purified through Ar. purification system (In order to minimize the consume and maintain the standard quality) Ar. purification system is not scope of HVAC system but Service gas System (SGS) PBS 5.3.5.1.5 identified on Equipment list for SGS Ref. to doc. S-1224-201 rev. 3(cfr. Ref.[5]) The Ar. purification system is located in the room R228.

2.2 HVAC System vs. Accelerator facility

HVAC shall serve the Accelerator Facility rooms. The boundary between HVAC and AF is set at the internal part of the room walls. (Except the temperature, humidity, pressure, air quality sensors which are located inside the rooms) Inlet/outlet grilles, fire dampers smoke dampers and backward equipment is within the scope of HVAC system. Target interface room is supply with Ar. during operation (not in HVAC scope) while air during maintenance. The two vaults shall have the recirculation system (close loop) during operation while open loop during maintenance and air shall be discharged through the common stack after proper decontamination/filtration (through HEPA filters)

2.3 HVAC System vs. Test Facility

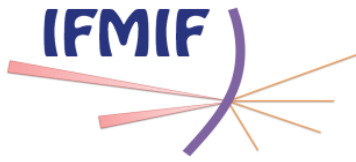
HVAC shall serve the Test Facility rooms. The boundary between HVAC and AF is set at the internal part of the room walls. (Except the temperature, humidity, pressure, air quality sensors which are located inside the rooms) Inlet/outlet grilles, fire dampers smoke dampers and backward equipment is within the scope of HVAC system.

2.4 HVAC System vs. Post Irradiation Examination Facility

HVAC shall serve the post Irradiation Examination Facility rooms, hot cells and glove boxes. The boundary between HVAC and PIEF is set at the internal part of the room walls. (Except the temperature, humidity, pressure, air quality sensors which are located inside the rooms) Inlet/outlet grilles, fire dampers smoke dampers and backward equipment is within the scope of HVAC system. The boundary between HVAC and PIEF hot cells/glove boxes is set at the external wall of the enclosures. Connection flanges and afterward equipment are considered within the scope of the PIE Facility.

2.5 HVAC System vs. Conventional Facilities

HVAC shall serve the Conventional Facility rooms, hot cells and glove boxes. The boundary between HVAC and CF is set at the internal part of the room walls. (Except the temperature, humidity, pressure, air quality sensors which are located inside the rooms) Inlet/outlet grilles, fire dampers smoke dampers and backward equipment is within the scope of HVAC system.



The boundary between HVAC and CF hot cells/glove boxes is set at the external wall of the enclosures.

3. System Design Requirements

3.1 General requirements

General requirements are defined as the data necessary to be defined or assumed in order to enable a system design that respects all the needs of the interfacing components.

Currently a draft set of data has been proposed. This list is partially complete and assessed by the PT on the base of the current references and on the standard engineering practice.

The different parties involved in the definition of the system – system designers and Technical Responsible Officers of the interfacing facilities are active part involved to review and complete this document. Once approved these will become the first approved Design Requirements upon which the design of the system will be further implemented in the next phase.

Parameters proposed as System Design Requirements for the HVAC System have been divided in two categories so that for each room of IFMIF it is possible to set:

- Climatic Input Data Requirements: related to the control of the thermo hygrometric parameters in relation to the activity carried out inside each room;
- Contamination Input Data Requirements: connected to the contamination classification.

The following sections describe in detail the logic that brought to the selection by the PT of the current set of parameters.

Please refer to Assumptions (ref. to sect.4.3), Input Data Requirements: Room characteristics for HVAC (Ref. to: Table 6,Table 7,Table 8,Table 9,Table 10 and Table 11 and Input data requirement Room Characteristics for fire protection (Ref. to: Table 12, Table 13, Table 14, Table 15, Table 16 and Table 17)

3.2 Engineering Requirements

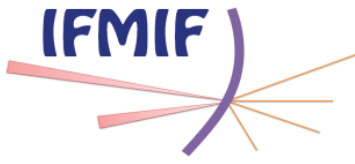
System Design Requirements (Ref. to: sect. 3).

3.3 Safety Design Requirements

The general Safety approach for the design execution of HVAC systems is based on the general Safety specification for the Engineering Design Activities of IFMIF

- The IFMIF's Safety objectives, principles and criteria.
- The Hazard evaluation techniques, to be implemented on the next design phase

The entire document is uploaded on DMS: Safety Specifications Ref. doc. BA_D_224X48 Ver.4.0 (cfr. Ref [2]) and following updating. At the present time the Engineering Design for HVAC system follow the Safety approach mentioned on the guideline document, nevertheless



it can be subject to some deviation or weaves according the final IFMIF site selection. As well as the safety authority could gives some further requirements.

3.4 Operation and Maintenance

Integrative maintenance plan is not yet described on this DDD II, shall be defined clearly after having selected all the components for the HVAC plant, preferable the maintenance plan shall be prepared by the suppliers, as well as regulatory maintenance requirements must be identified.

Minimum information required within the maintenance plan is listed below:

- Scheduled operation:
 - Controls
 - Checks
 - Adjustments
 - Calibrations
 - Overhauls
 - Replacements, etc.

Information provided from safety specification, Ref. doc. BA_D_224X48 Ver.4.0 (cfr. Ref. [2]) and of course will be implemented and identified as necessary by the supplier in order to ensure the best operation of the HVAC system within its intended operational scenario.

- Critical unscheduled operations:
 - Replacements repair etc.

That might impact IFMIF availability and become essential to evaluate and to introduce an additional important support of recommended spare parts list, (provided by the suppliers) procedures, training, tools and test equipments, infrastructures.

The design of HVAC system shall accommodate long-term maintenance activities required to support IFMIF plant operation. For maintainability and inspectability, HVAC system shall be designed in such a way that it can facilitate maintenance and, in case of failure, easy diagnostics safe repair or replacement and re-calibration. The HVAC system maintenance must be an ongoing endeavor. Any lapses in regular maintenance can result in system degradation and obvious loss of efficiency which could arose to serious health issue.

Maintenance requirement for HVAC system and equipments must be conform to the maintenance period defined for the IFMIF plant (particularly for the facilities that are not reachable during operation period)

3.5 RAMI Requirements

RAMI Specifications guide documents Ref. to doc. 22HA3G from J. Arrojo Feb. 2012.

The HVAC system have been designed to operate during all modes of IFMIF plant operation as well as shut down period HVAC should be reliable for continuous operation, easily accessible for the purpose of operation and maintenance. The HVAC have been designed in a

way that; maintained and operated will meet the reliability and availability requirements, in a preliminary way identified on the conventional facility Safety Report.

At this stage of the Project complete RAMI analysis has not been performed (due to the high variability of the parameters, such a procedure has not been considered worthwhile). However several assumptions have been evaluated and taken into consideration based of the standard engineering practice. RAMI assessment and implementation of the engineering process shall be fully integrated on the next phase of the project.

3.6 Applicable Codes and Standard Requirements

International standards have been selected for the design of the HVAC and particularly ventilation system.

In particular:

- ISO 17873:2004: Nuclear facilities - criteria for the design and operation of ventilation systems for nuclear installations other than nuclear reactors;
- ISO 10648: Containment Enclosures
 - 10648-1:1997: Design principles
 - 10648-2:1994: Classification according to leak tightness and associated checking methods.
- ISO 11933: Components for containment enclosures
 - 11933-1:1997: Glove/bag ports, bungs for glove/bag ports, enclosure rings and interchangeable units;
 - 11933-2:1997: Gloves, welded bags, gaiters for remote - handling tongs and for manipulators;
 - 11933-3:1998: Transfer systems such as plain doors, airlock chambers, double door transfer systems, leak tight connections for waste drums;
 - 11933-4:2001: Ventilation and gas-cleaning systems such as filters, traps, safety and regulation valves, control and protection devices;
 - 11933-5:2001: Penetrations for electrical and fluid circuits.

4. System Design Description

4.1 Design Summary

For this section you can refer to the System Functions and Basic configuration (cfr. Section 1.1-1.2)

4.2 Safety

Refer to Safety specifications for the Engineering design Activities of IFMIF ref. doc. BA_D_224X48 Ver. 4.0 and following updating (cfr. Ref. [2])

4.3 Assumptions

4.3.1 Reference Outdoor Conditions

The design of a HVAC system is related to the outdoor summer/winter conditions that indeed have strong influence on the treatments to be performed on external air to have the desired indoor conditions, and hence on the sizing of the HVAC equipment.

On the base of the “ASHRAE Handbook” (cfr. Ref.[1]), we have selected the most constraining summer and winter conditions:

- Summer Dry Bulb Temperature: 30.2°C;
- Winter Dry Bulb Temperature: -11.6°C;
- Summer Wet Bulb Temperature: 23.8°C;
- Winter Wet Bulb Temperature: Not Necessary;
- Time during the year exceeding the above conditions: 0.4%

4.3.2 Reference Indoor Conditions

The indoor environment thermo hygrometric parameters have been assumed according to standard comfort values that find their reference in the standard HVAC design practice.

In particular the following conditions as been taken as a reference:

Normal occupancy Rooms:

- Temperature: Summer: 22°C to 26°C
Winter: 18°C to 22°C
- Relative Humidity: 40% to 60% RH;

Occasional occupancy rooms (only for maintenance purposes):

- Temperature: 10°C to 30°C;
- Relative Humidity: 40% to 60% RH;

No occupancy rooms:

- Temperature: 10°C to 30°C;
- Relative Humidity: RH control not required;

Short time occupancy rooms (stairs, elevators etc.):

- Temperature: 10°C to 40°C;
- Relative Humidity: RH control not required;

Electrical/data storage/control rooms:

- Temperature: 20°C to 25°C;
- Relative Humidity: 40% to 50% RH;

4.3.3 Qualitative Contamination Classification Parameters

ISO 17873:2004 (cfr. Ref. [4]) describes a classification of the different rooms served by the Nuclear HVAC. This classification takes into account surface and airborne contamination

levels. According to these parameters rooms can be classified from C1 to C4 according to increasing values of contamination.

Due to the early stage of the project, it has not been possible to collect data about the contamination levels. To have a first picture of the contamination zoning, a qualitative approach has been selected. This takes as a reference the contents of table 2 of ISO 17873:2004 (cfr. Ref.[4]).

In particular are defined as:

- C1: Clean area free from normal radioactive contamination, where surface or airborne. Only in exceptional situations, a low contamination level can be accepted;
- C2: Area that is substantially clean during normal operation. Only in exceptional circumstances, resulting from an incident or accident situation, is a medium level of surface or airborne contamination acceptable, so appropriate provisions must be made for its control.
- C3: Means an area in which some surface contamination could be present but it is normally free from airborne contamination. In some cases, resulting from an incident or accident situation, there will be a potential for surface or airborne contamination at a medium-high, so that suitable provisions must be made for its control.
- C4: Means an area in which permanent, as well as occasional, contamination levels are so high that there is normally no access permitted for personnel, except with appropriate protective equipment.

4.3.4 Cooling/Heating Equipment Main Features

The main characteristics of the equipment designated to prepare and supply chilled and heated water to the cooling, heating and re-heating coils of the AHUs have been selected according to the standard engineering practice and considering the reference outdoor conditions (Ref. Equipment List HVAC system PBS 5.3.1.0.0. documents S-2226-141; Table 3, Table 4 and Table 5 and Figure 6-1, Figure 6-2, Figure 6-3, Figure 6-4, Figure 6-5, Figure 6-6, Figure 6-7, Figure 6-8, Figure 6-9, Figure 6-10 and Figure 6-11.

In particular main assumptions are referred to the:

- Equipment typology: Air Condensed combined chillers/heat pumps;

4.3.5 SIC Classification

According to the classification proposed in Safety Specifications (cfr. Ref. [2]) [2]) and Safety Important Class-SIC, Methodology, Classification & Requirements (cfr. Ref. to Doc. BA_D_228V5Q Version 1.2 ref [6]) the system has been differently classified according to its function.

In particular:

- Outlet fans for Nuclear HVAC: SIC-1;
- Inlet fans for Nuclear HVAC: SR/non-SIC
- Outlet filters: SIC-1;
- Inlet filters: SIC-1;



- Heaters and chillers: SR/non-SIC
- Industrial HVAC: SR/non-SIC

4.3.6 Redundant Equipment

Redundancy of the equipment should contribute to the target availability value of the Conventional Facilities (stated into 99.7 % as mentioned in CDR (cfr Ref. [3])). At this stage of the project a complete RAMI Analysis has not been performed (due to the high variability of the parameters, such a procedure has not been considered worthwhile) (Ref. to Sect. 3.5). By the way some assumptions have been made on the base of the standard engineering practice.

Simple redundancy is addressed to components that can cover 100% of the requirements (100% x 2).

Multiple redundancy is considered when requirements can be fulfilled by a set of components (n components) working together ($[100\%/n] \times [n+1]$).

4.3.7 Room Volume

Room internal volume has been selected by Project Team according to the latest development of IFMIF building design that defines for each premise a surface and an internal height.

4.3.8 Air Change Rate

A first proposal of the air change rates to be ensured to each room has been assessed by the Project Team according to:

- ISO 17873:2004 Table 4 that defines, for typical compartments inside a nuclear facility, some indicative air change ranges;
- Standard engineering practice;

NOTE:

Section 8.2.5 of ISO 17873:2004 (Proposes an optimization of the air changes that, as a starting point, takes the values of table 4, to be adjusted on the base of:

1. Consideration of specific risks (explosive, inflammable, radioactive gases as well as toxic liquids, or particular thermal constraints due to the process etc.);
2. Study of the containment function (the necessity to maintain the necessary depression in the room that is related to the leak tightness, to the presence of doors and to the opening frequency);
3. Maintenance of the climatic and hygienic conditions (inventory of thermal loadings, thermal contributions/losses etc.).

These steps have been considered partially at this stage of the project and where the information where not available we took our margin of assumption given the value based on best engineering practice, but, they have of course to be confirmed in the next phases particularly for the IFMIF system where the electrical design was not at the advance stage i.e. LF, TF, and PIE facilities.

4.3.9 Air Supply

A first proposal of the air flow to be supplied to the different premises of IFMIF has been assessed by the Project Team combining:

- Room volumes (cfr. Sect.4.3.7);
- Air change rates (cfr. Sect.4.3.8).

According to the content of ISO 17873:2004 and according to the standard practice in these kinds of installations, recirculation of air is not a common practice in Nuclear HVAC, so it has not been considered as a possible solution (only for Industrial HVAC recirculation has been foreseen).

Extracted air can be transferred from rooms characterized by low levels of contamination to higher contaminated zones. This concept moves in the direction of the dynamic confinement mentioned in (cfr. Sect. 1.1) and it also implies a minimization of the fresh air to be treated by the AHUs. A first estimation of transfer air flow has been obtained considering the air supply described in the present chapter minus the typical air flow necessary to maintain constant temperature and humidity levels ($2 \div 3$ vol/h). The future updates of the climatic parameters will refine also the air transfers flows from zone to zone.

4.3.10 Room Temperature and Relative Humidity

A first proposal of the climatic conditions to be ensured to each room during operations and during maintenance has been assessed by the Project Team according to:

- Functional descriptions of the rooms as defined in the building specifications;
- Reference indoor conditions (cfr. Sect. 4.3.2).

Relative humidity and temperature “fluctuation” cells (quantified as °C vs. time and RH% vs. time) have been included in case particular requirements of temperature and humidity precision are required.

4.3.11 Internal Heat Loads²

Heat loads have a strong influence on the HVAC design: they affect the sizing of the AHUs on one side, and, at the same time, they have influence to the air flow to furnish to the different rooms.

According to the standard indoor climate engineering practice internal heat loads have been divided into:

- Sensible heat loads: mainly connected with the electromechanical equipment that is hosted inside each room. The energy increase due to these loads can be quantified as an increase of air temperature.
- Human presence: the energy increase due to workers performing certain activities inside a room can be quantified as a combination of:

² Heat Loads are internal because they have origin inside the room. There are also external heat loads that are the positive or negative heat fluxes related to the exposure of the room to environment, to the mutual position of each room etc. These have not been assumed here. The final input data relative to the external heat loads have to be assessed finally once the plant layout is defined in detail.



- Increase of air temperature (sensible heat loads) due to human body temperature.
- Evaporation of the water related to the human metabolism (breathing, perspiration etc.).

Sensible loads have been categorized as a kW entity in each room

Human presence has been categorized as the number of workers and their activity inside each room.

4.3.12 Special requirements

All the requirements not clearly mentioned in the above sections have to be reported here with particular reference to the HVAC System all the process equipment that needs an HVAC supply (for example glove boxes, enclosures etc.) shall be reported within the Special Requirements.

4.3.13 Contamination Class

A first assessment of the classification selected for each room has been provided by the Project Team according to:

- Functional descriptions of the rooms as defined in the building specifications;
- Qualitative Contamination Classification parameters (cfr. Sect.4.3.3);
- Standard engineering practice;

Classification ranges from *Not Contaminated* to C4 according to increasing contamination levels.

4.3.14 HVAC System

The HVAC System that serves each room (*industrial* or *nuclear* HVAC) has been decided by the Project team according to:

- Room classification (cfr. Sect. 4.3.13);

4.3.15 Surface Contamination in Normal Conditions

In accordance with Annex “A” of ISO 17873:2004 (cfr. Ref. [4]) the surface contamination in normal conditions (expressed as Bq/cm²) is a part of the procedure for the “*classification of working areas according to radiological contamination hazard*”. The evaluation of the surface contamination all along with the airborne contamination (sect. 4.3.16), shall define a quantitative parameter to classify the contamination class of each room.

Table A.1 of ISO 17873:2004 (cfr. Ref.[4]) has to be used to select the containment class according to the contamination level.

In the current stage phase DDD II of the project, PT was not able to find final reference data to assess this parameter, hence was selected based on ISO 17873:2004 (cfr. Ref. [4]) this parameter will be confirmed or implemented on the next phase of the project from the different TRO’s involved in the others Subsystems.

4.3.16 Airborne Contamination in Normal Conditions

In accordance with Annex “A” of ISO 17873:2004 (cfr. Ref.[4]) the airborne contamination in normal conditions (expressed as fractions of DAC³) is a part of the procedure for the “*classification of working areas according to radiological contamination hazard*”.

Table A.2 of ISO 17873:2004 (cfr. Ref.[4]) has to be used to select the containment class according to the contamination level.

In the current stage phase II of the project, PT was not able to find affordable reference data to assess this parameter. This parameter will be confirmed or implemented on the next phase of the project from the different TRO’s involved in the others subsystems.

NOTE:

Annex “A” of ISO 17873:2004 (cfr. Ref.[4]) states that the selection of the containment class shall be made on the base of the comparison between airborne (Table A.2 of ref.[4]) and surface contamination (Table A.1 of ref.[4]). The most stringent containment class shall then be selected.

4.3.17 Level of Airborne Contamination in Normal and Accidental Conditions

In accordance with Annex “B” of ISO 17873:2004 (cfr. Ref.[4]), the airborne level of contamination in normal and accidental conditions (expressed as number of DAC) is the criteria to be adopted for the selection of the *ventilation system configuration*.

Ventilation system configuration is defined as the organization of the HVAC in term

- Intake and exhaust filtering units
- Possibility to accept or not air transferred from other rooms
- Direct release of exhaust air in environment or through a stack etc.

Table B.2 of ISO17873:2004 (cfr. Ref. [4]) has to be used to select the appropriate ventilation system configuration according to the airborne contamination levels.

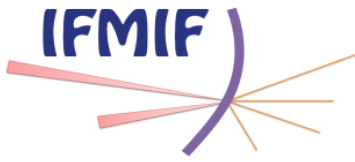
4.3.18 Depressure

A first assessment of the depressure levels inside each room has been provided by the Project Team according to:

- Room classification (cfr. Sect. 4.3.13);
- Depressure ranges according to the containment class (Table 3 of ISO 17873:2004- (ref. Ref.[4])

The abovementioned table sets minimum and maximum levels of depressure that have to be ensured to the different containment classes.

³ DAC is defined as the amount of contamination in air that if breathed for 2000 hours (1 working year) by the typical worker (lung capacity of 1.2 m³/h) would cause the reaching of the Annual Limit of Intake fixed in 20mSv.



The final selection of the depressure value shall be made taking in consideration also the access from areas with a different classification: a differential pressure ≥ 40 Pa shall be ensured between adjacent areas with different classification (cfr. section 8.2.2.2 of ISO17873:2004 (cfr.. Ref.[4])). This further step has not been considered at this stage of the project.

Pressure “fluctuation” cell (quantified as Pa vs. time) has been included in case particular requirements pressure precision is required.

4.4 Detailed Design description

According to the same classification proposed in CDR (cfr. Ref.[3]) a further HVAC System subdivision has been proposed.

In particular for rooms subject to:

- Potential or permanent contamination hazard: Nuclear HVAC
- No hazard and no permanent contamination: Industrial HVAC

4.5 System Performance Requirements.

Not applicable at this engineering stage, anyhow the System description basic functions are identified on the P& ID ref. to: Figure 6-14, Figure 6-15, Figure 6-16, Figure 6-17, Figure 6-18, and Figure 6-19. To System performance itself shall have to be presented when the design will have reached a better level of maturity, tentatively on the third phase of the IFMIF Project (DDD III).

4.6 System Arrangement

4.6.1 Equipment arrangement Drawings

Refer to the next (Ref. Sect.4.7) Component Design Description

4.7 Component Design Description

For this purpose we have detailed the list of the HVAC components necessary for the all HVAC system of IFMIF plant, the information are integrated on the document called Equipment List HVAC system referred to PBS 5.3.1.0.0. Referred to Table 3, Table 4 and Table 5. The Equipment List represents all the HVAC components, on the list following detailed information are provided:

- Item NO
- Service
- QTY
- Material type
- Type of component
- Specification



- Main Dimension
- Electrical output rate (KW)
- Location on the IFMIF Building (room's number)

4.8 Instrumentation and Control

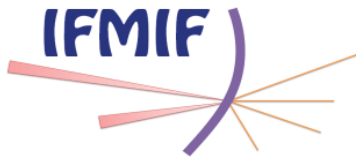
HVAC Central Control System (CCS) shall be conforming to standards, specifications and interfaces as documented in the CCS - DDDII document ref. BA_D236AF7 v1.0.

CCS will ensure the integrated supervision control of overall IFMIF plant and plant system operation. These functions will be available in master control room. HVAC system shall have its own machine protection system (MPS) that shall integrate the individuals control system of each of the HVAC subsystems.

Information from the data is available in the HVAC local control system (MPS) shall be transferred to CCS to allow a complete and reliable operation of the HVAC system. The instrumentation and control components shall include all Computers hardware and software required to control the HVAC plant system, including input/output (I/O) interfaces and plant system interlocks. These requirements shall be established based on the preliminary design of the HVAC system. Sufficient instruments shall be included in HVAC plant system to monitor components performance within the design envelope and to alarm plant operators on the onset of operation outside design margin (particularly for the safety containment barrier conditions). Instrumentations shall include: pressure and temperature flow sensor and humidity control, fire damper, smoke damper infrared sensors detectors, air flow rate detectors, HEPA and pre filter performance status, as well as air blowers and electrical motors sensors, room pressure sensor and air quality sensor, the instrumentations indicated is descriptive but not limited, Specific instrumentations and control requirements for HVAC system shall be established based on the preliminary P&ID HVAC design and customized according to the detailed components selected based also on the component vendor recommendation and specifications.

4.9 Status of R&D activities and future plans

Not applicable for this system.

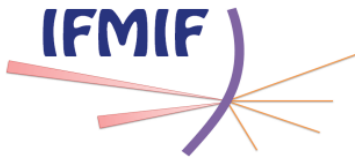


5. List of References

- [1] *2009 ASHRAE Handbook Fundamentals*
- [2] Y. Le Tonqueze, *Safety Specifications for the EDA of IFMIF*, BA_D_224X48
- [3] IEA, *IFMIF Comprehensive Design Report*
- [4] International Organization for Standardization (ISO), *ISO 17873:2004: Nuclear facilities - criteria for the design and operation of ventilation systems for nuclear installations other than nuclear reactors.*
- [5] DDD (ED01JA_CF_535)Service Gas System (SGS)BA_D_233HD9 v1.0 (G.Pruneri)
- [6] Y. Le Tonqueze, *Safety Important Class-SIC Ref.* BA_D_228V5Q rev. 1.2

5.1.1 List of Acronyms

AF	Accelerator Facility
AHU	Air Handling Unit
CF	Conventional Facilities
CODA	Construction Operation and Decommissioning Activities
DAC	Derived Air Concentration
DDD	Design Description Document
DVT	Data Validation table
EVEDA	Engineering Validation & Engineering Design Activity
HVAC	Heating Ventilation Air Conditioning
IFMIF	International Fusion Materials Irradiation Facility
LF	Lithium target Facility
PBS	Plant Breakdown Structure
PFD	Process Flow Diagram
P&ID	Process& Instrumentation diagram
PIE	Post Irradiation Examination
PT	Project Team
RAMI	Reliability, Availability, Maintainability, Inspectability
RH	Relative Humidity
SIC	Safety Important Component
TF	Test Facility
TRO	Technical Responsible Officer
WBS	Work Breakdown Structure



6. Appendices

6.1 List of Documents

6.1.1 Drawings (PFD's, P&ID's 2D drawings & Excel file)

6.1.2 Layout Plan for HVAC Ducts from B1F Floor to 4F Floor

This section reports the preliminary HVAC ducts layout (one line diagram) the layout is divided by floor and is represented the overall dimensions of the HVAC's ducts as well as the flow rate for each branch. These layouts enable the Building designer to validate the size of the technical shafts, corridors, HVAC's technical rooms and all the area where are foreseen air ducts installation.

These drawings together with CF piping layout should help to have a clear picture of the components that take part in the HVAC's system definition and of the main interactions among them.

Layout Plan for HVAC is considered as a preliminary document for the system design, could be slightly modified by a updating in the input data or IFMIF layout changes.

The evolution of these documents (HVAC duct's layout) will be integrate with the detail construction design including all components; fire dumpers, smoke dumpers, control dumpers filters, grilles, diffusers, air ducts sections included shaft details, AHU's blowers HEPA filters packages, instrumentations, air discharge stacks etc. (Ref. Figure 6-1, Figure 6-2, Figure 6-3, Figure 6-4, Figure 6-5, Figure 6-6, Figure 6-7, Figure 6-8 and Figure 6-9)

6.1.3 HVAC Equipment layout

The basic design for the major HVAC components are identified on these drawings. The components have been checked and confirmed their dimensions based on the performance and availability on the HVAC commercial market. The Basic design of Conventional facilities HVAC Equipment layout is identified on Figure 6-10, Figure 6-11, Figure 6-12 and Figure 6-13.

6.1.4 HVAC P&ID Nuclear & Industrial flow diagram (included PIE Facility)

P& ID diagram are shown on the Figure 6-14, Figure 6-15, Figure 6-16, Figure 6-17, Figure 6-18 and Figure 6-19.

6.1.5 Equipment List HVAC System

Equipment components for HVAC Are listed on: Table 3, Table 4 and Table 5.

6.1.6 Room Characteristics for HVAC

Equipment characteristics for HVAC are Identified table: Table 6, Table 7, Table 8, Table 9, Table 10 and Table 11.



6.1.7 Room Characteristics for Fire Protection

Room characteristics for Fire Protection are identified on Table 12, Table 13, Table 14, Table 15, Table 16 and Table 17.

6.2 List of Computer Programs

Not applicable

6.3 Others

Not applicable

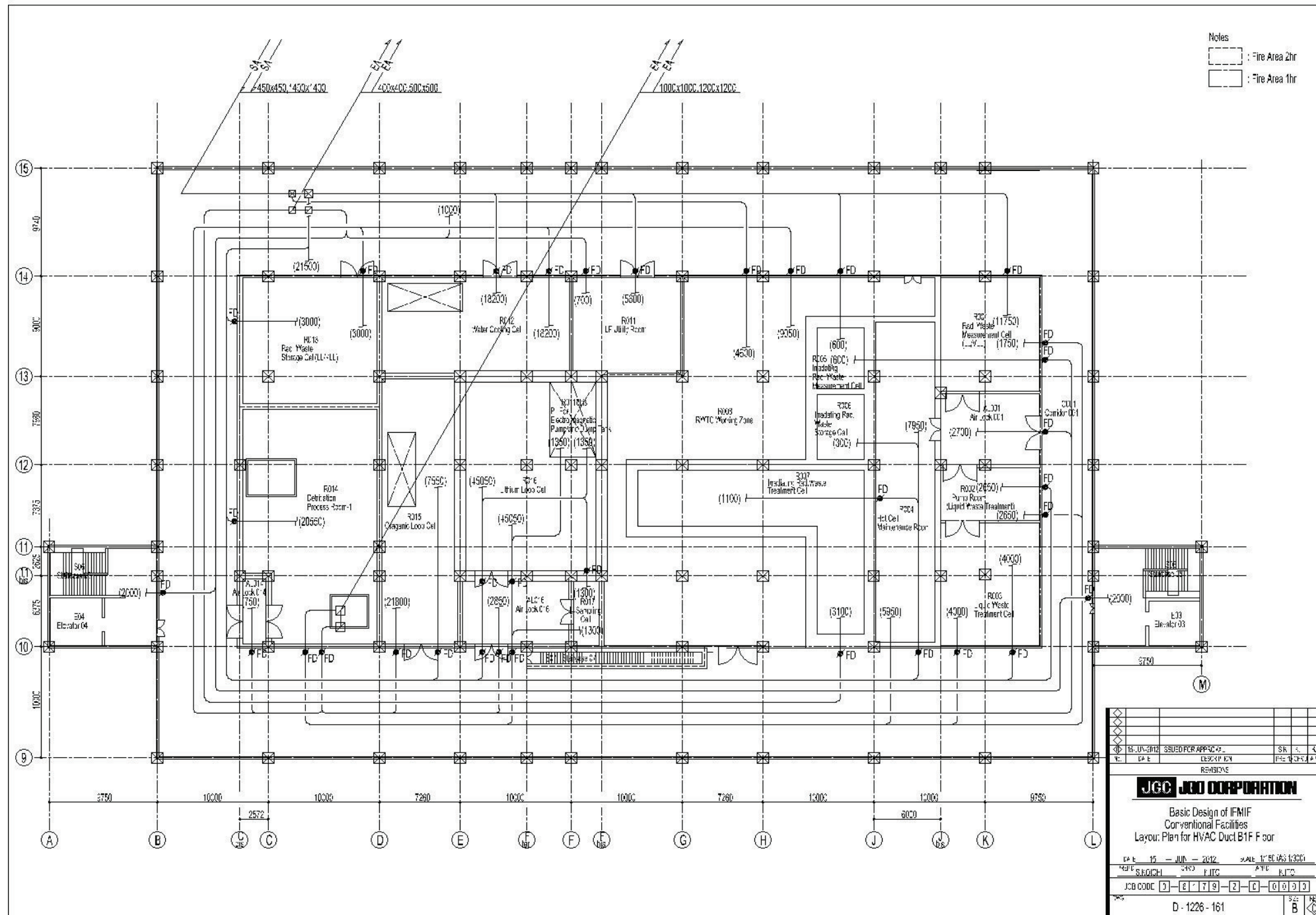


Figure 6-1: D-1226-161-Layout Plan HVAC Ducts B1F Floor

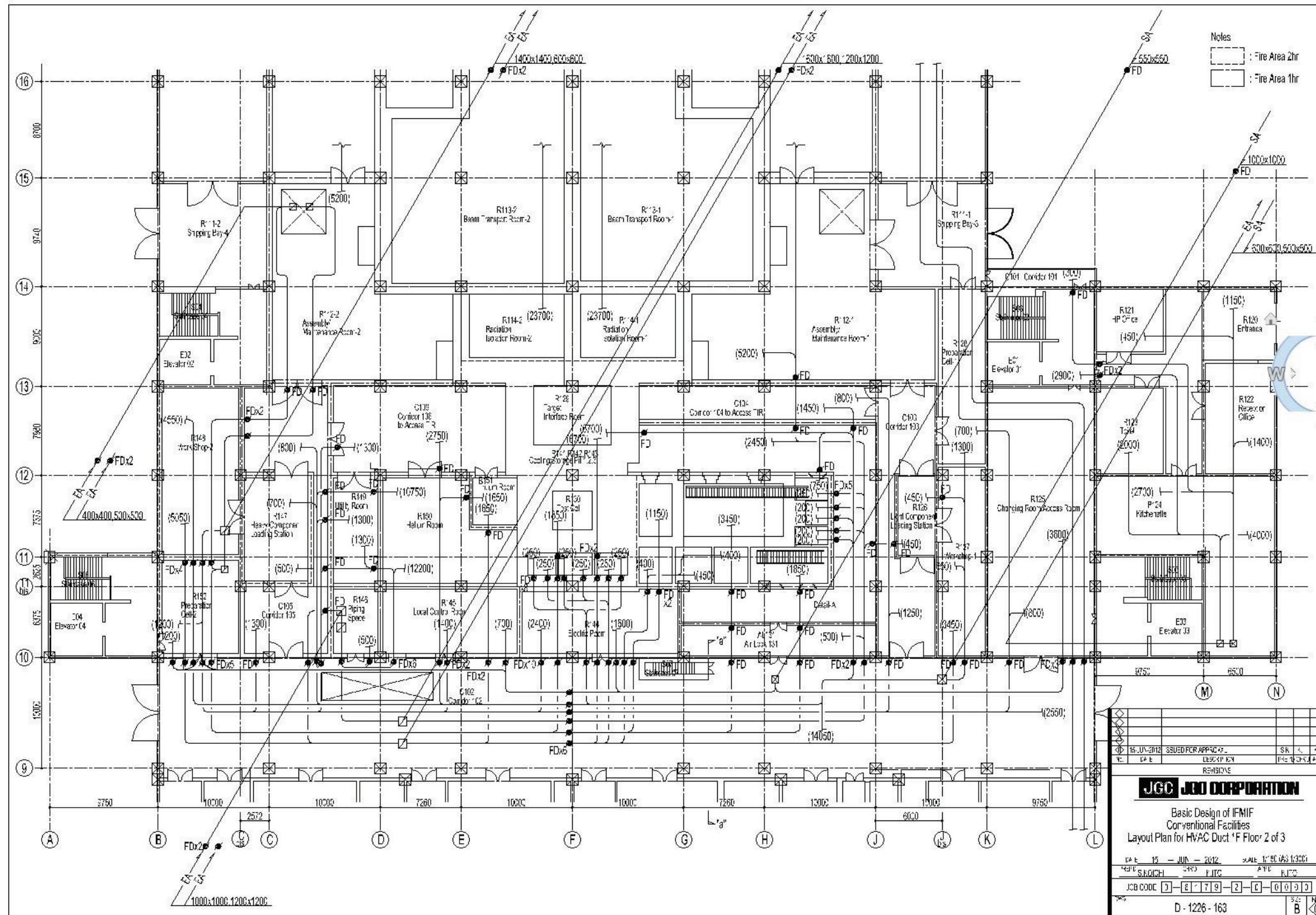


Figure 6-3: D-1226-163- Layout Plan for HVAC Ducts 1F Floor 2/3

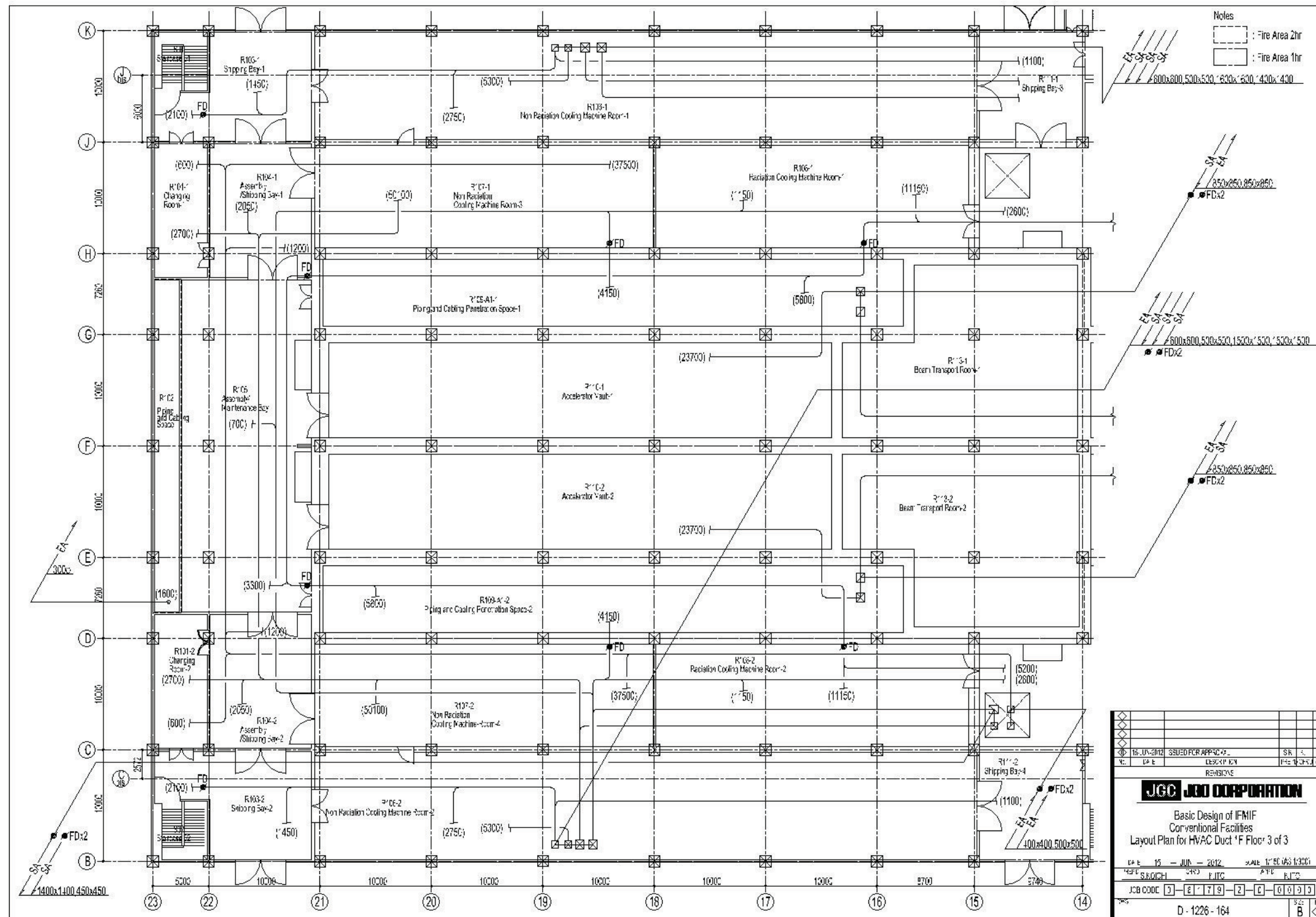


Figure 6-4: D-1226-164-Layout Plan for HVAC Ducts 1F Floor 3/3

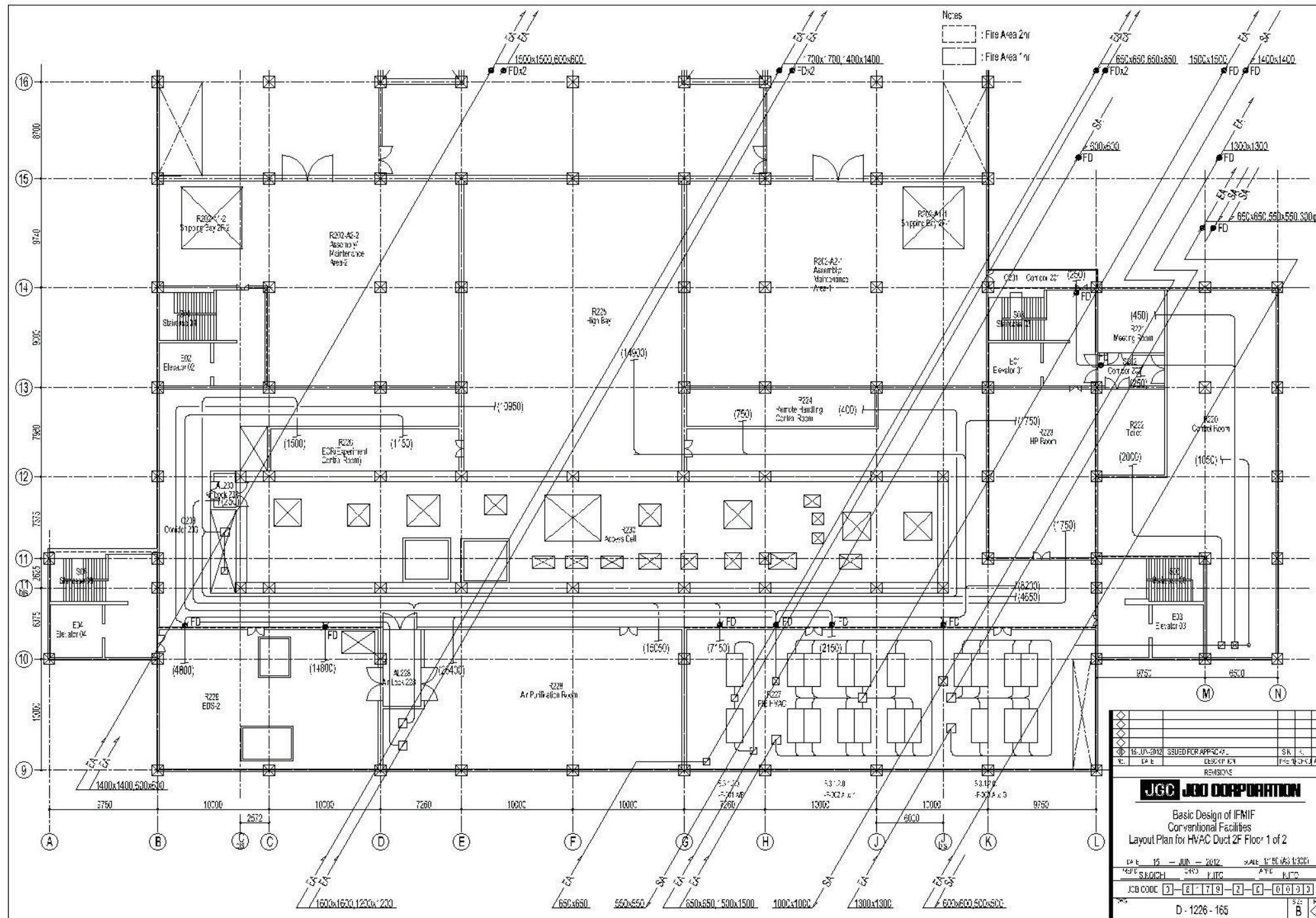


Figure 6-5: D-1226-165- Layout Plan for HVAC Ducts 2F floor 1/2

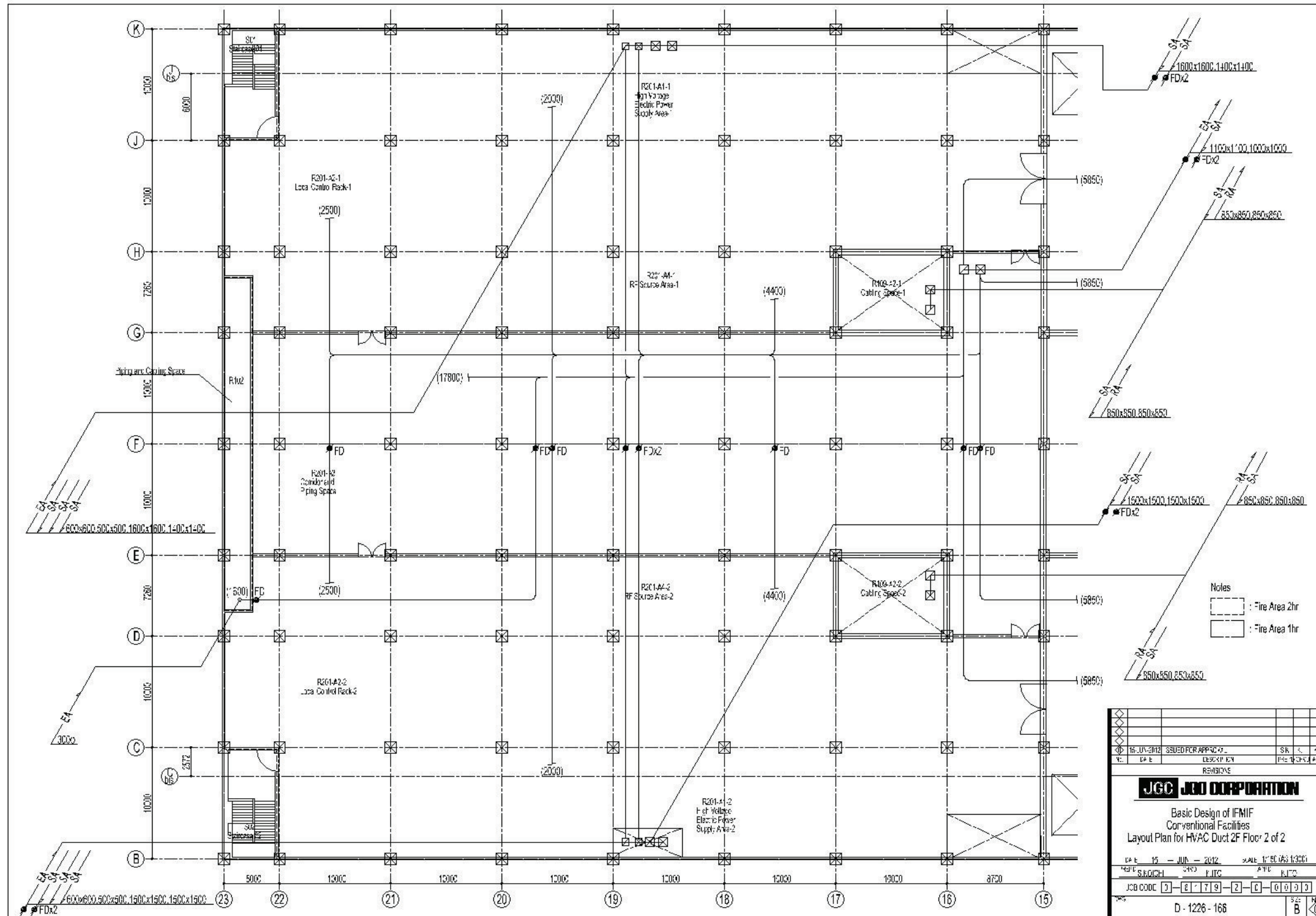


Figure 6-6: D-1226-166- Layout Plan for HVAC Ducts 2F Floor 2/2

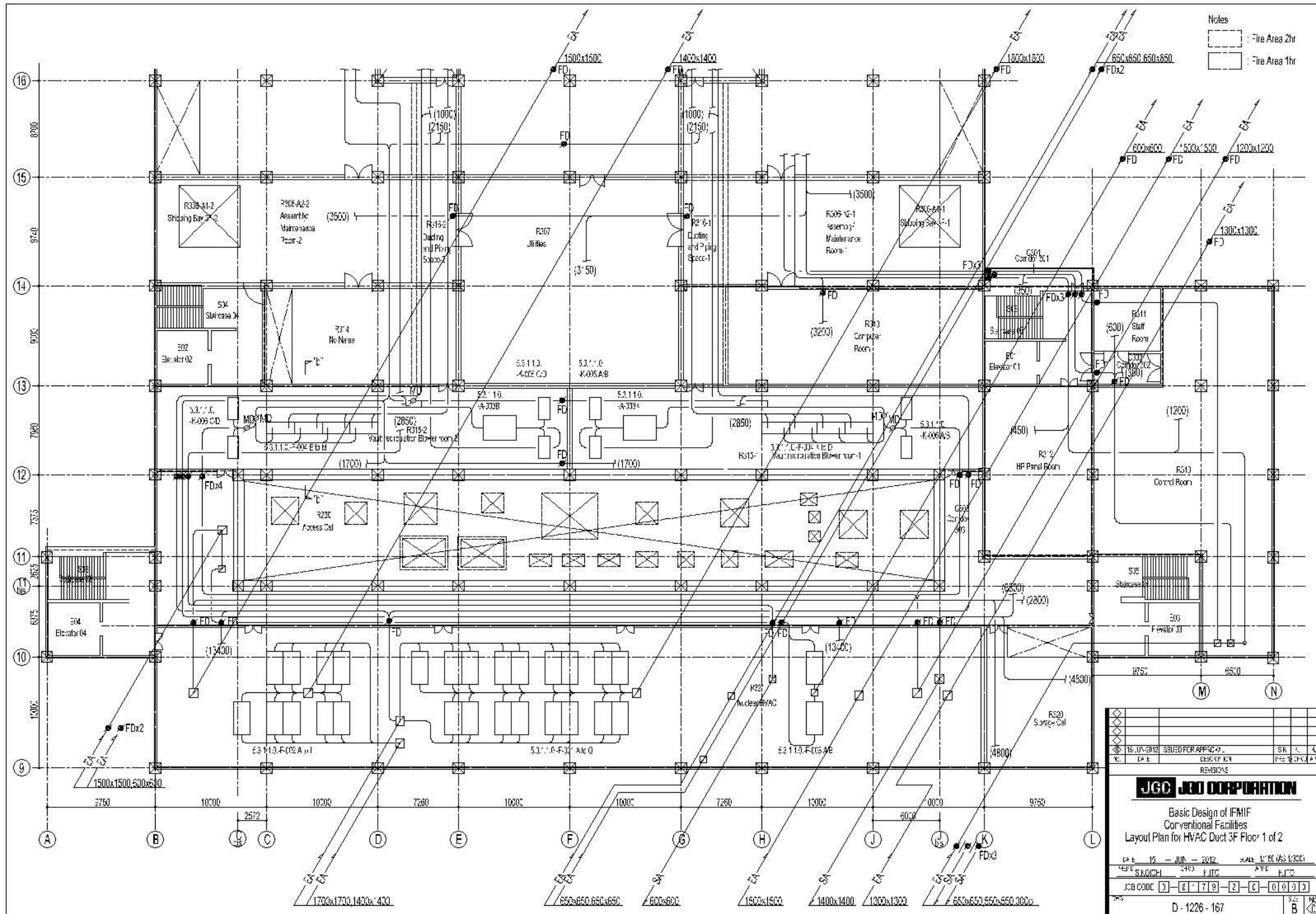


Figure 6-7: D-1226-167- Layout Plan for HVAC Ducts 3F Floor 1/2

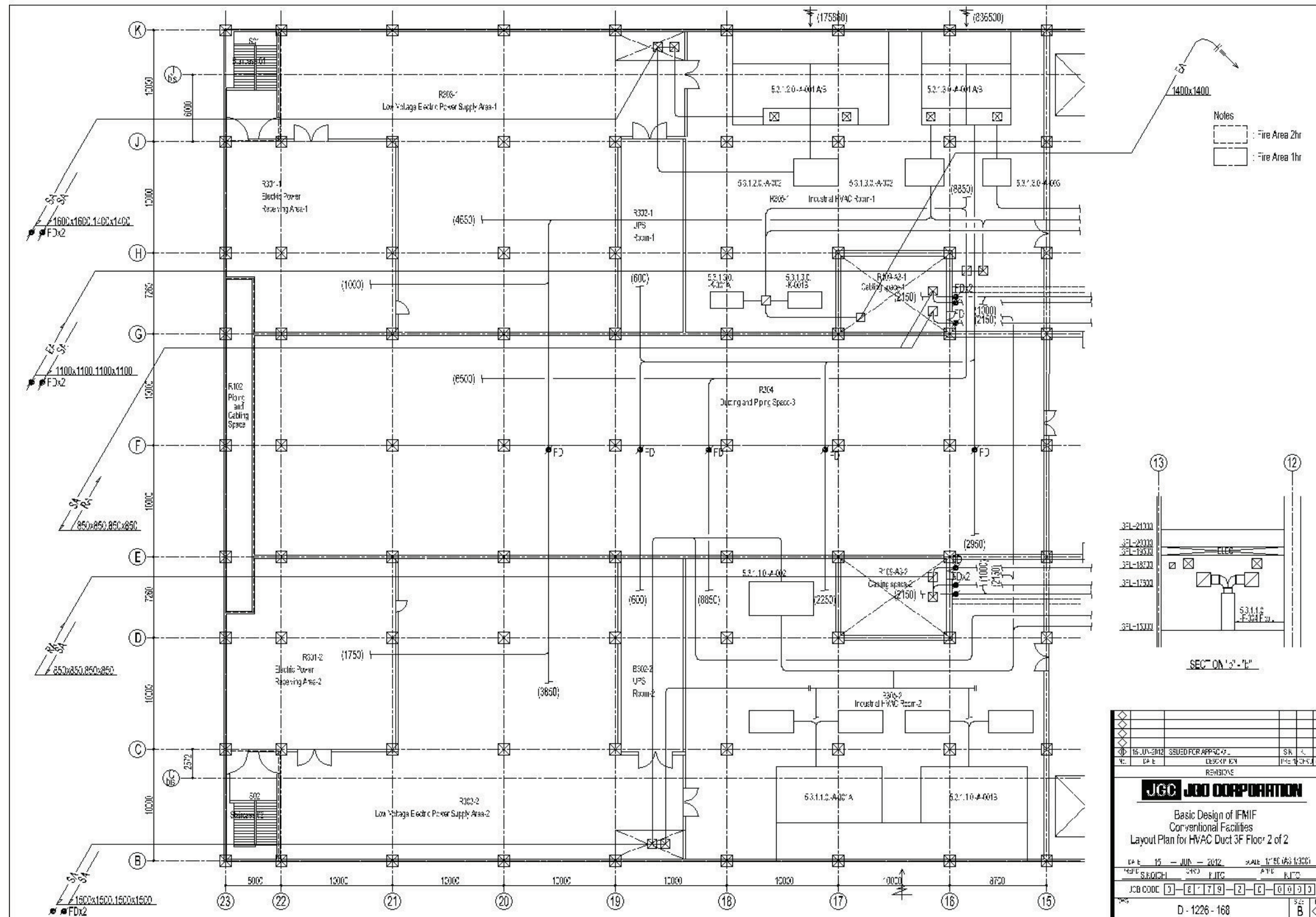
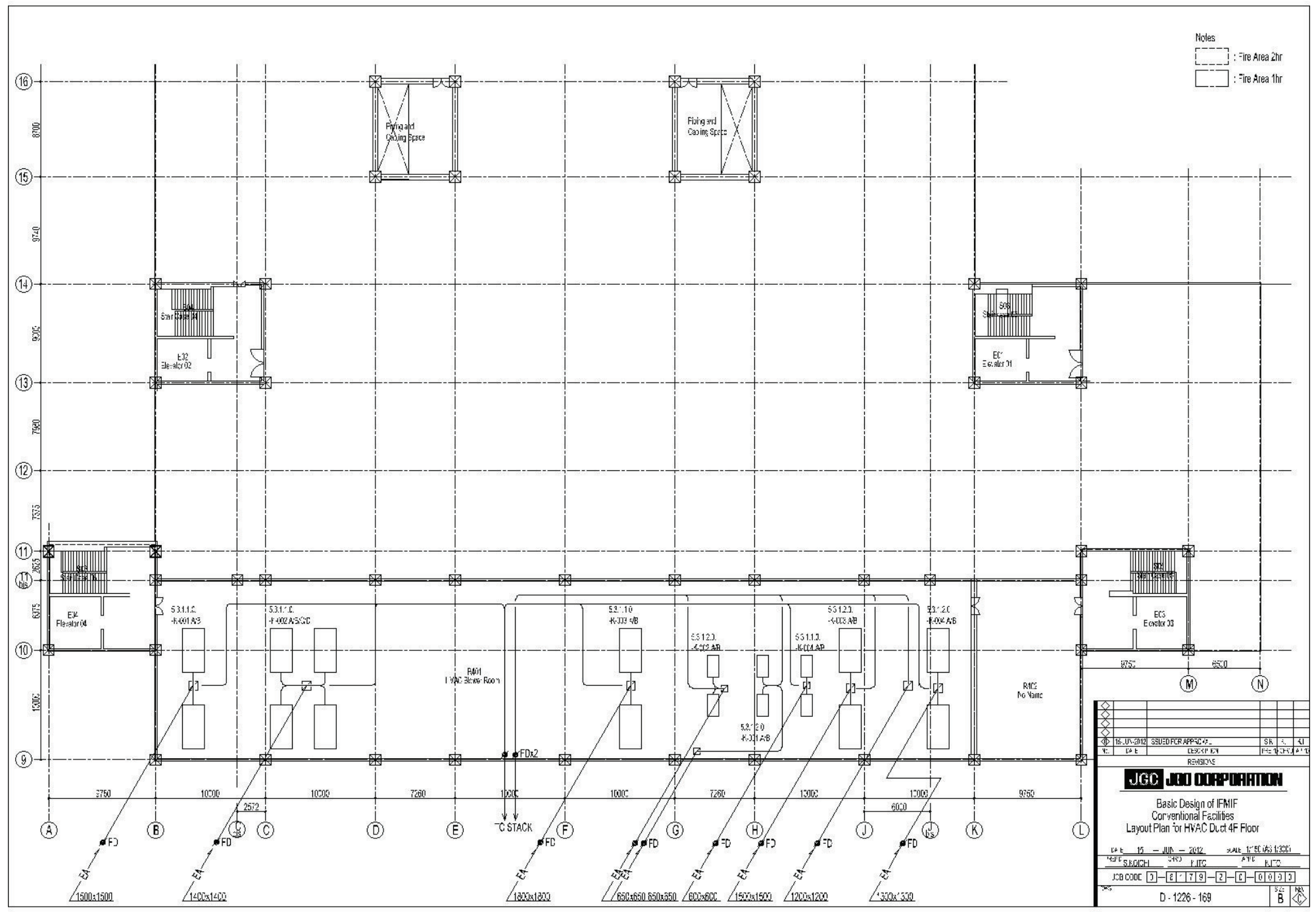


Figure 6-8: D-1226-168- Layout Plan for HVAC Ducts 3F Floor 2/2



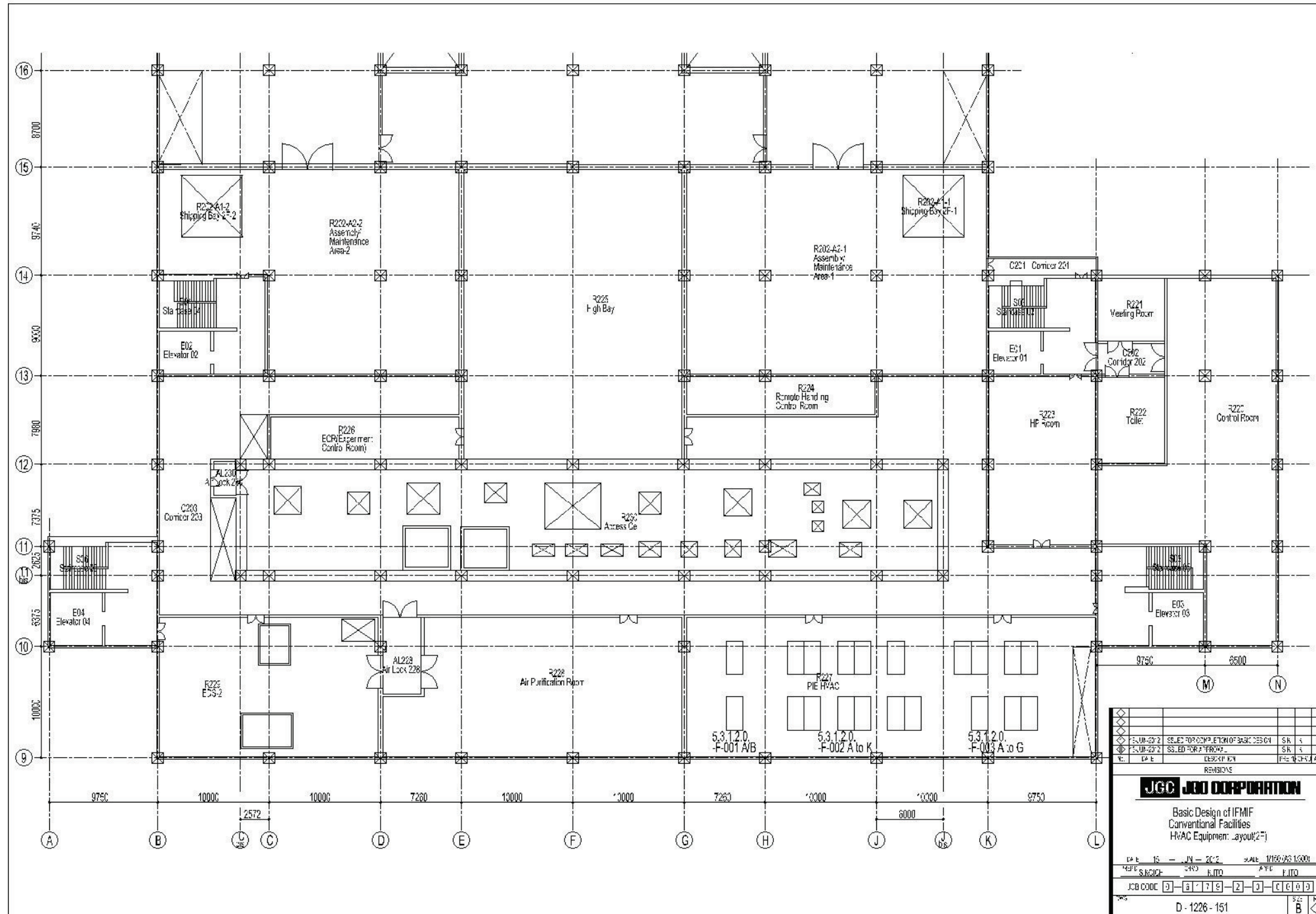


Figure 6-10: D-1226-151- HVAC Equipment Layout 2F Floor

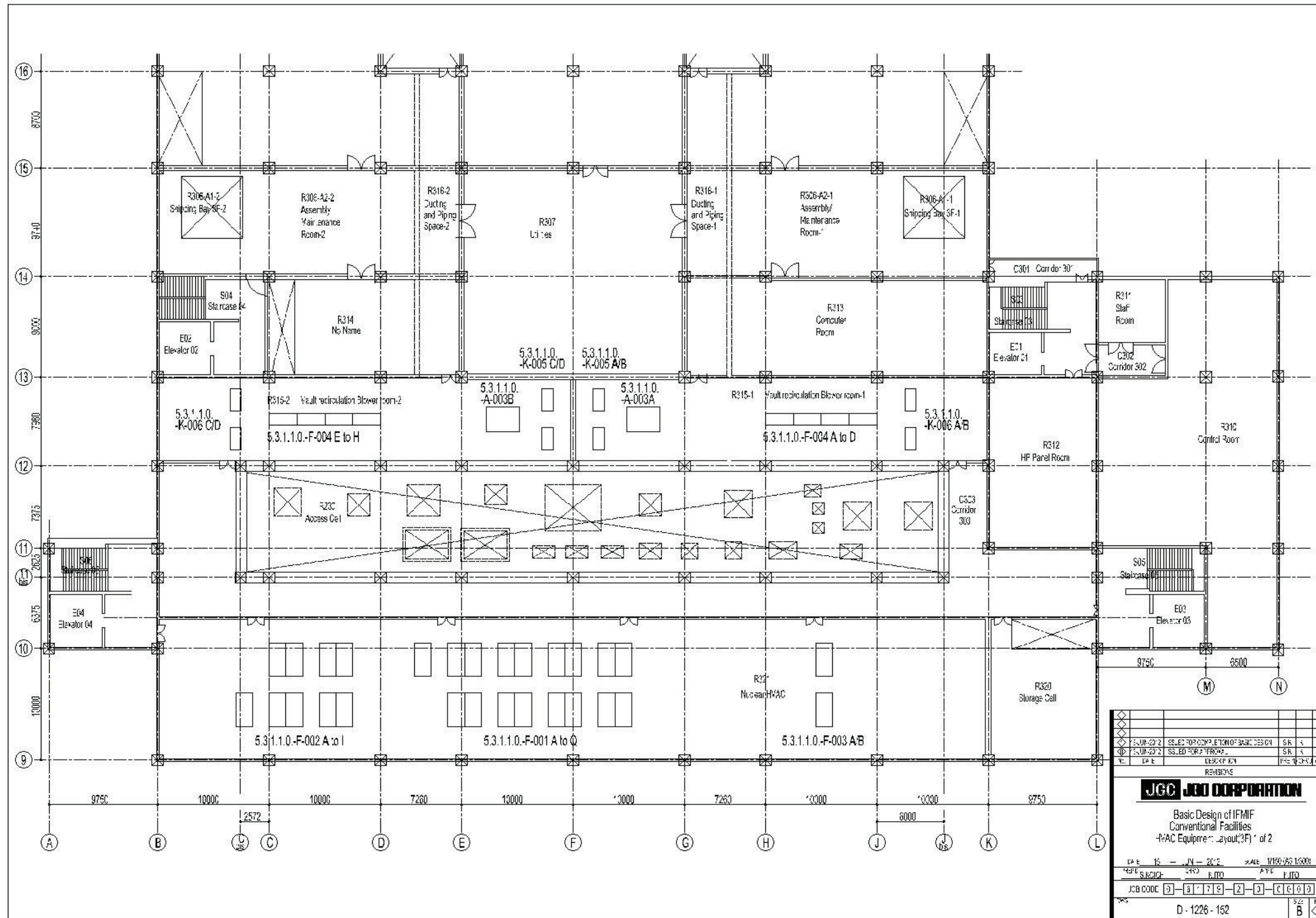
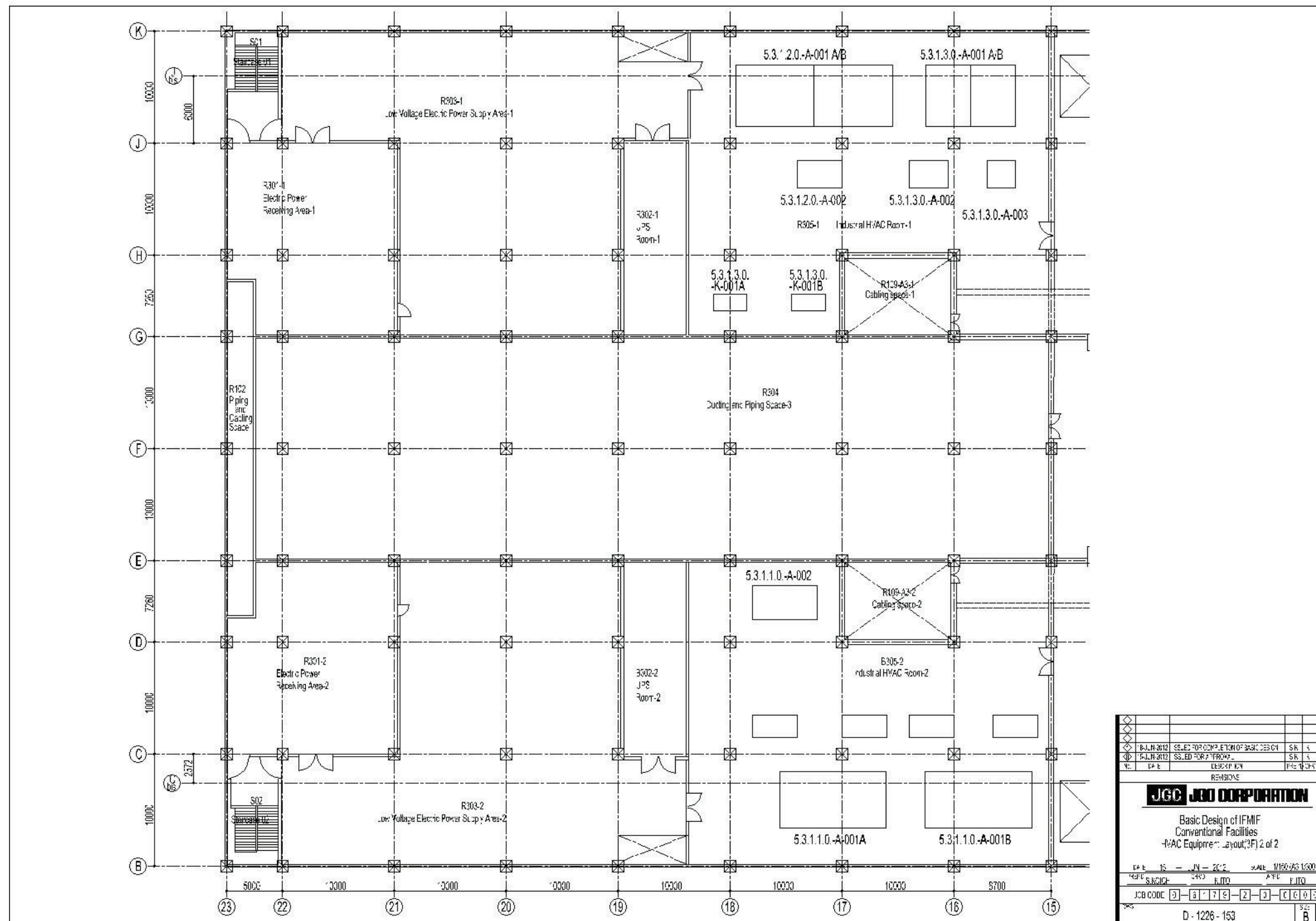


Figure 6-11: D-1226-152-HVAC Equipment Layout 3F Floor 1/2



DATE	BY	CHKD	DATE	BY	CHKD
11/05/2010	SS	11/05/2010	ET	11/05/2010	SS
11/05/2010	SS	11/05/2010	ET	11/05/2010	SS
REVISIONS					
JGC JOB CORPORATION					
Basic Design of IFMIF Conventional Facilities HVAC Equipment Layout (3F) 2 of 2					
DATE	BY	CHKD	DATE	BY	CHKD
11/05/2010	SS	11/05/2010	ET	11/05/2010	SS
11/05/2010	SS	11/05/2010	ET	11/05/2010	SS
JOB CODE: 01-0170-2-2-0101					
D-1226-153					

Figure 6-12: D-1226-153- HVAC Equipment Layout 3F Floor 2/2

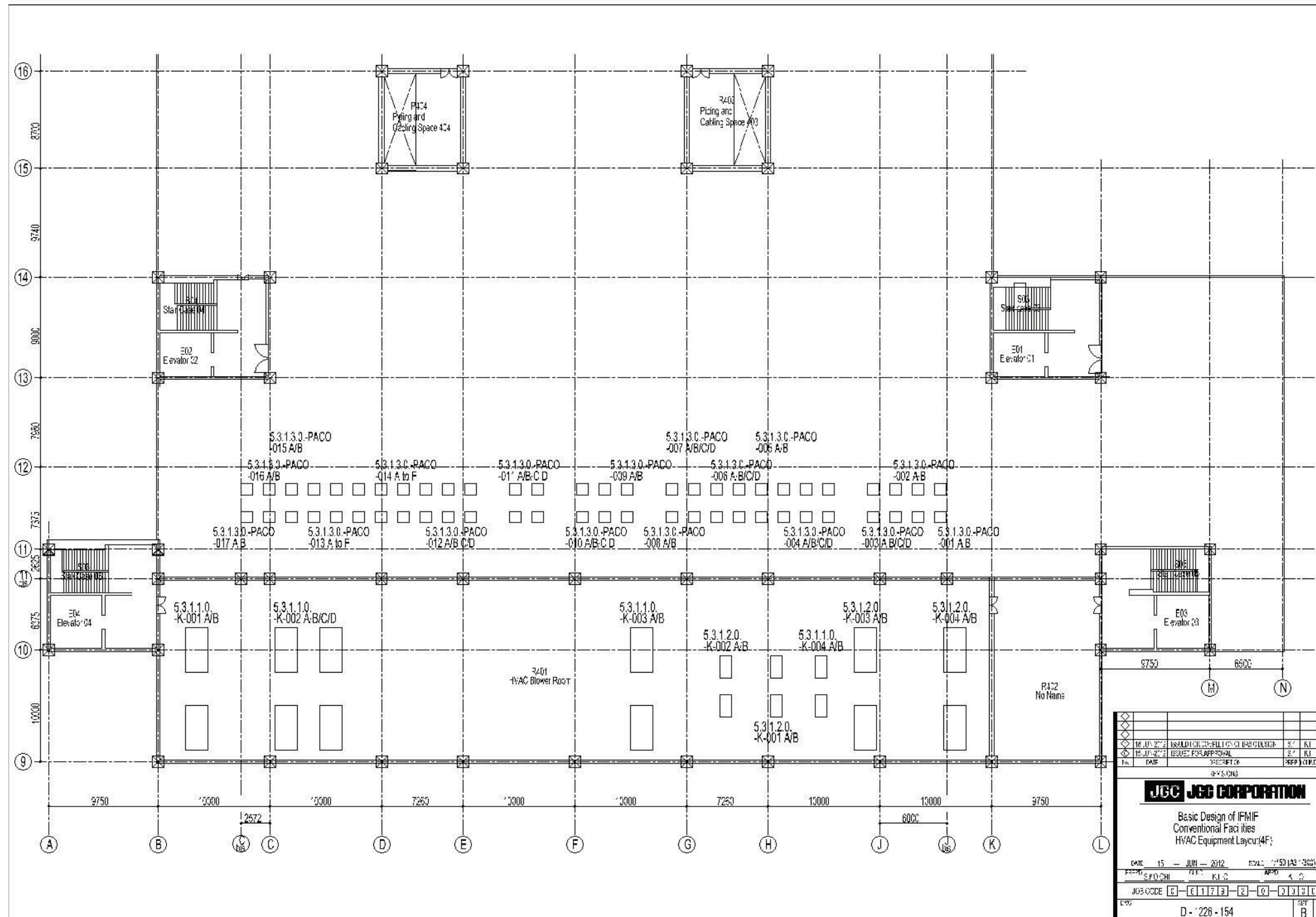


Figure 6-13: D-1226-154-HVAC Equipment Layout 4F Floor

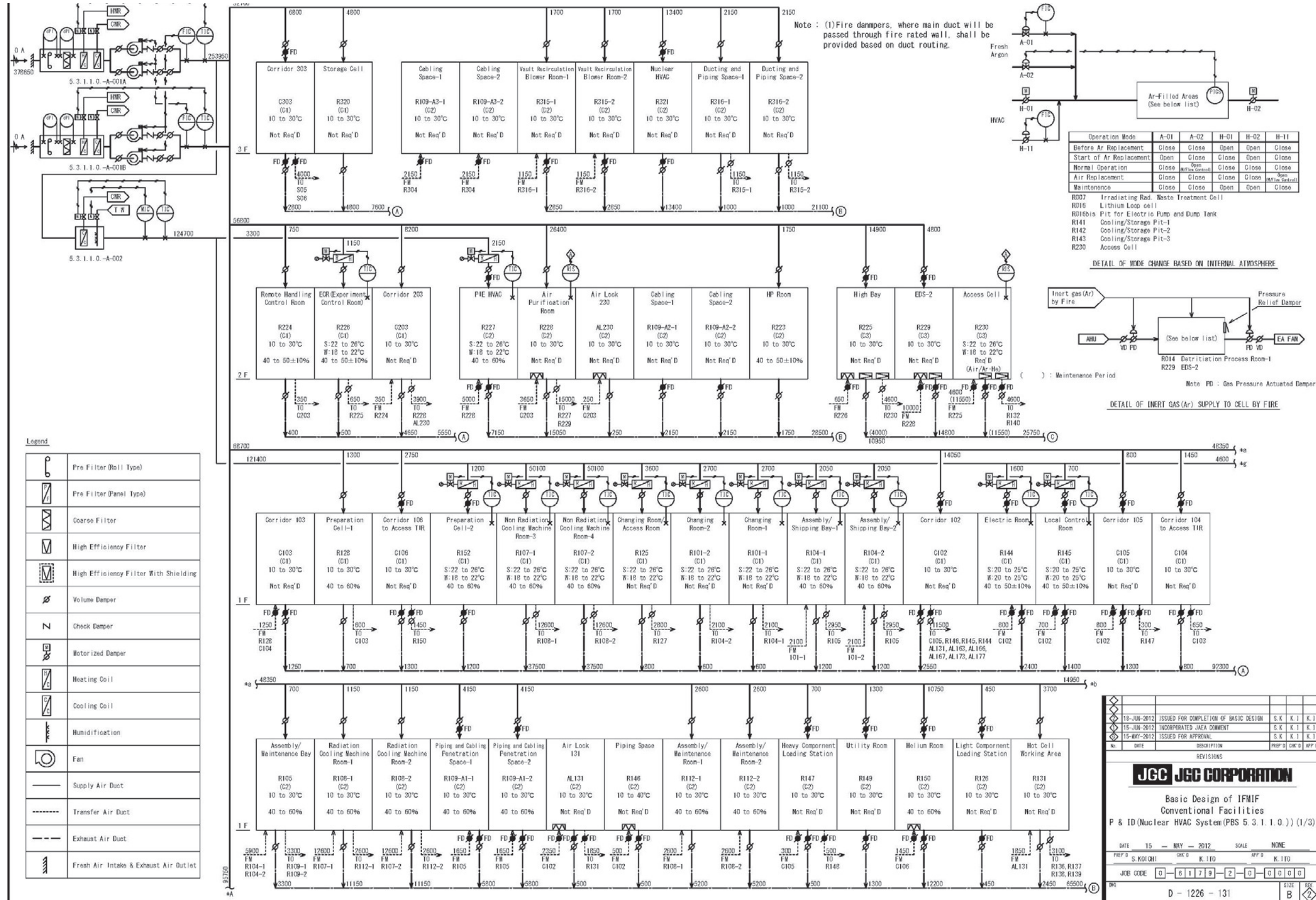


Figure 6-14: D-1226-131- P&ID Nuclear HVAC System 1/3

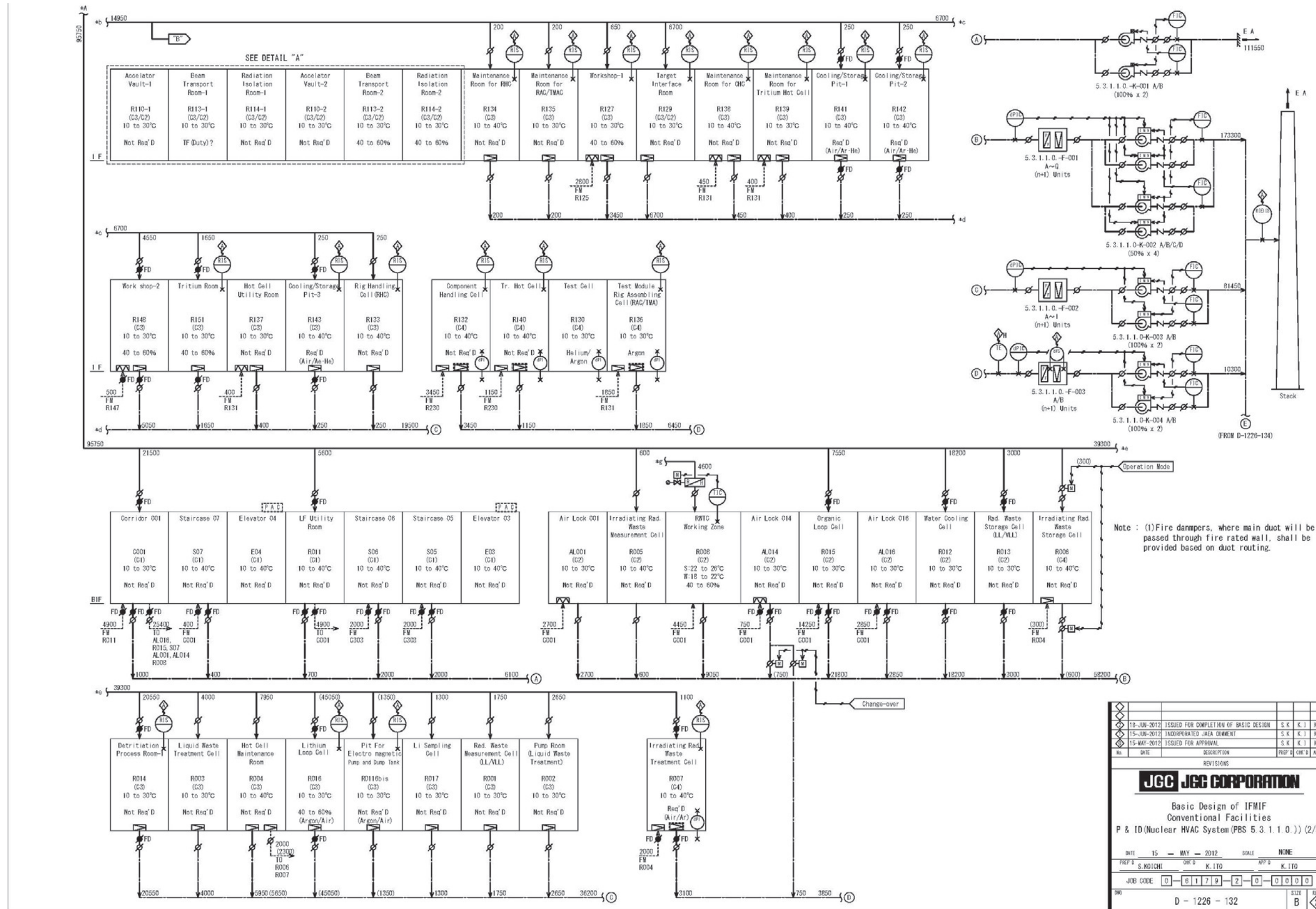
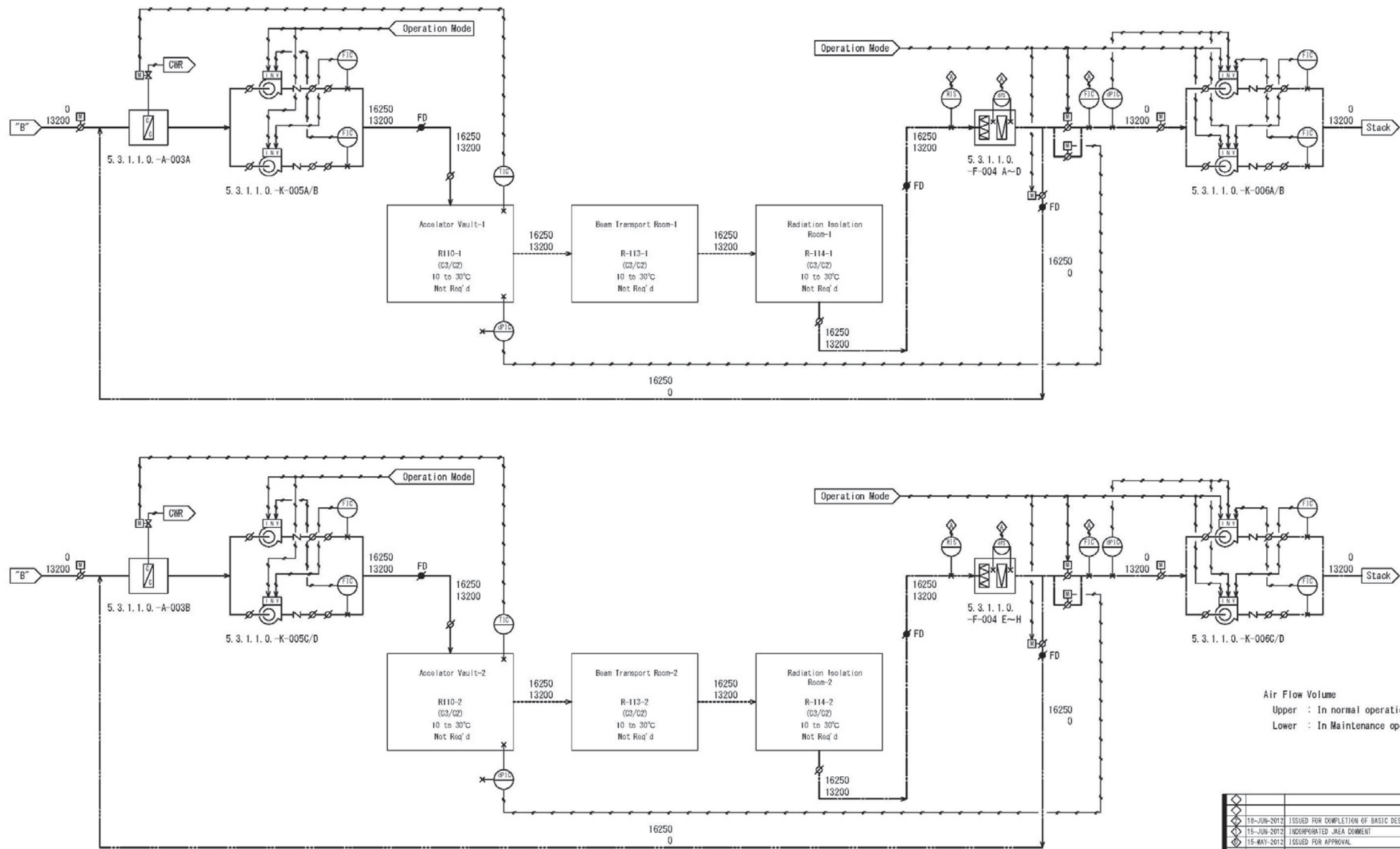


Figure 6-15: D-1226-132-P&ID Nuclear HVAC System 2/3



DETAIL "A"

Note : (1) Fire dampers, where main duct will be passed through fire rated wall, shall be provided based on duct routing.

REVISIONS					
JGC JGC CORPORATION					
Basic Design of IFMIF Conventional Facilities P & ID (Nuclear HVAC System (PBS 5.3.1.1.0.)) (3/3)					
DATE	15	MAY	2012	SCALE	NONE
PREP'D	S. KOTCHI	CHK'D	K. ITO	APP'D	K. ITO
JOB CODE	0-0179-2-0-0000				
NO.	D - 1226 - 133				SIZE B

Figure 6-16: D1226-133-P&ID Nuclear HVAC System 3/3

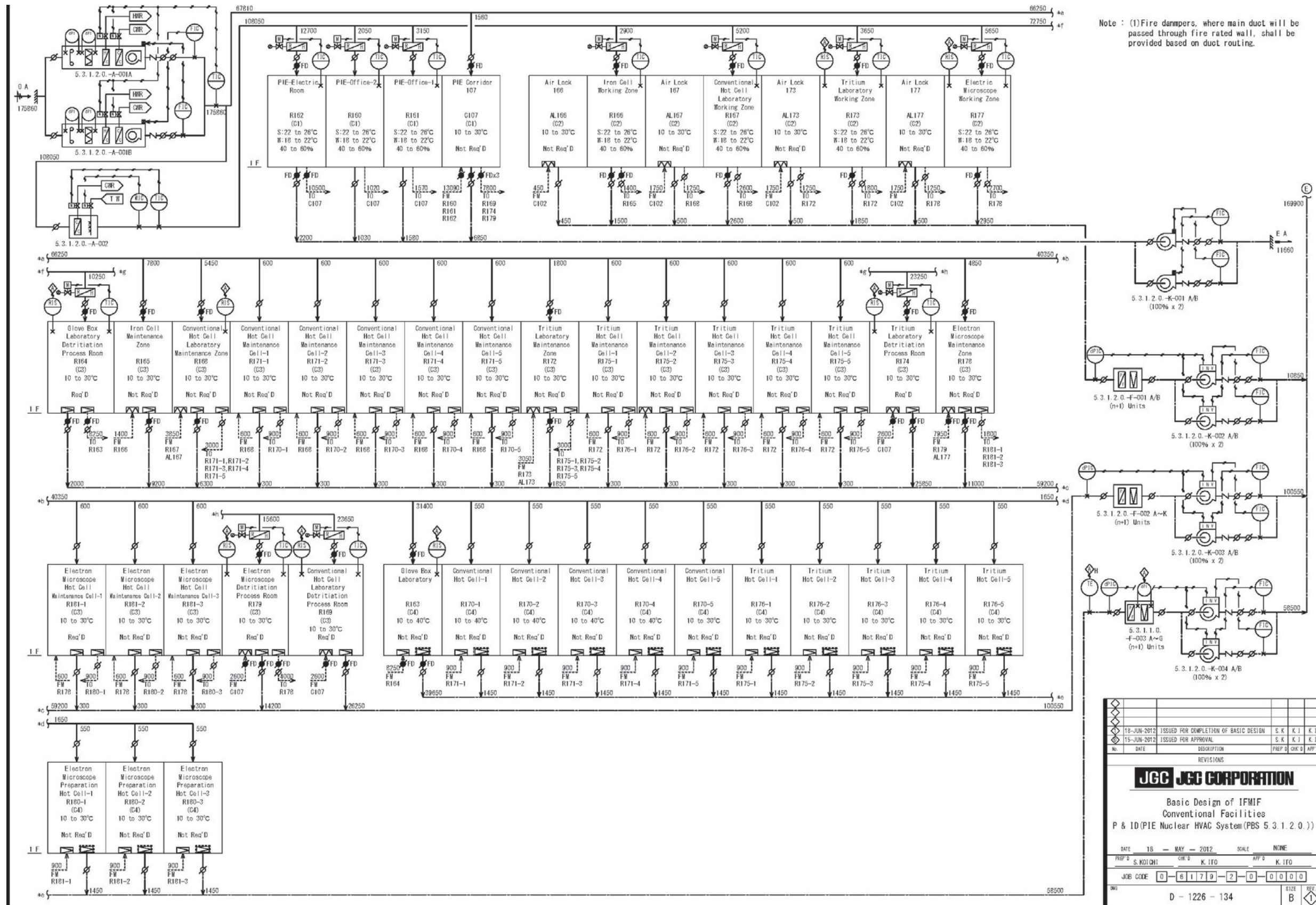


Figure 6-17:D-1226-134-P&ID PIE Facility HVAC System

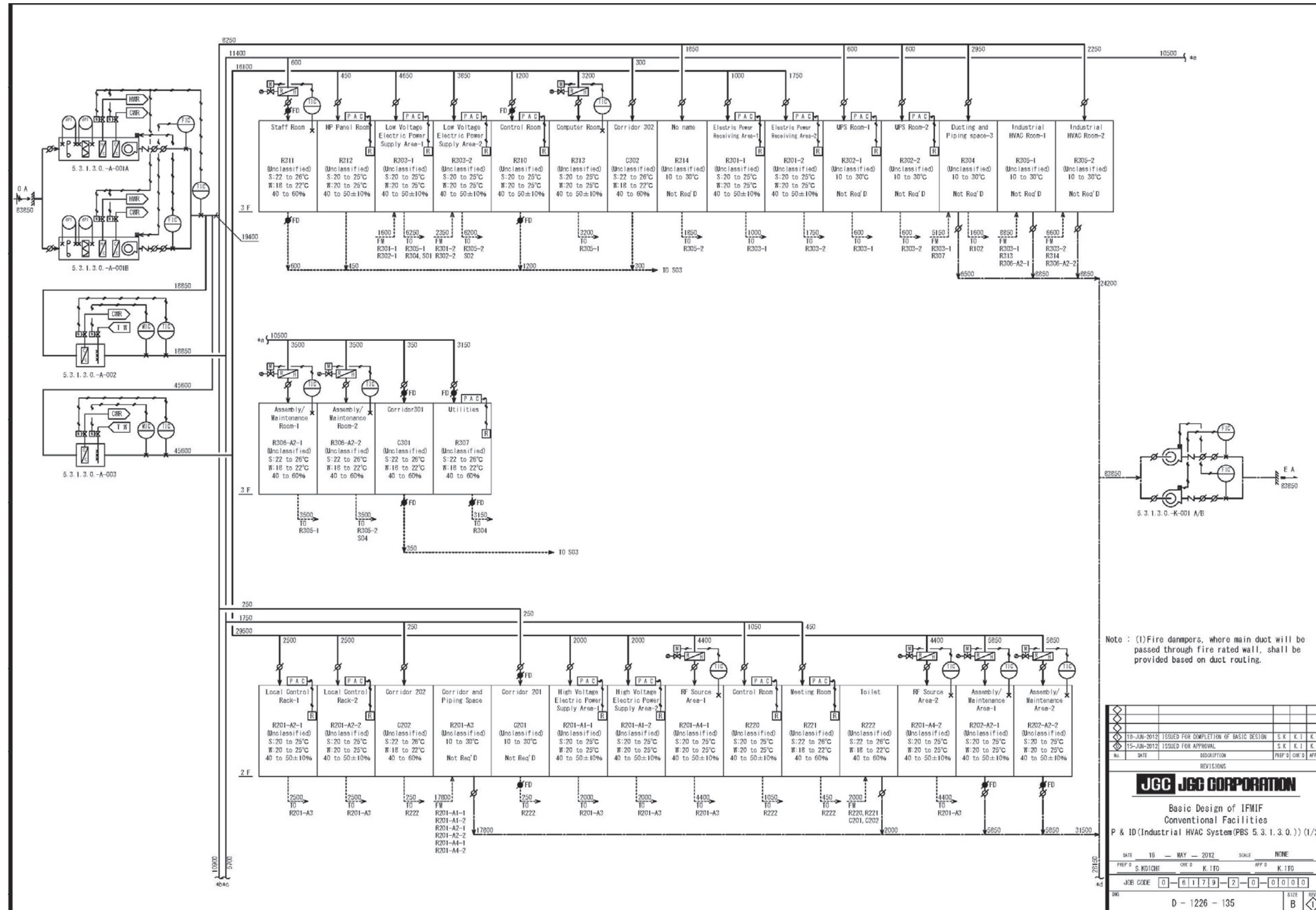
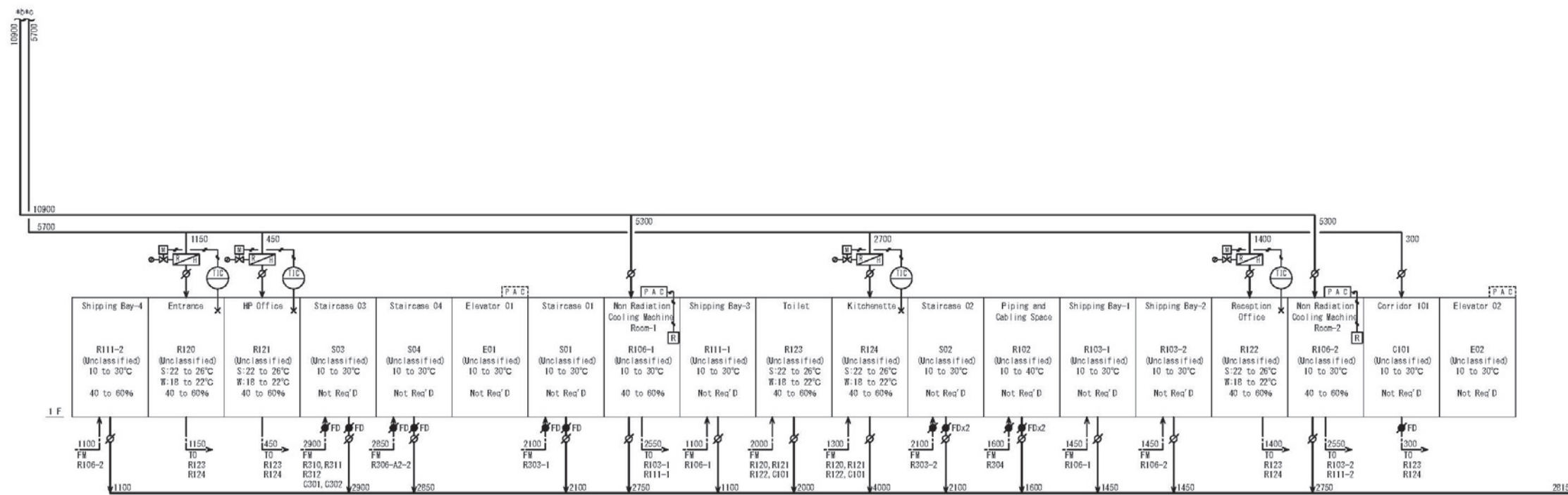


Figure 6-18: D-1226-135-P&ID Industrial HVAC System



Note : (1) Fire dampers, where main duct will be passed through fire rated wall, shall be provided based on duct routing.

No.	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
18-JUN-2012		ISSUED FOR COMPLETION OF BASIC DESIGN	S.K.K.I.	K.I.	K.I.
15-JUN-2012		ISSUED FOR APPROVAL	S.K.K.I.	K.I.	K.I.

JGC JGC CORPORATION

Basic Design of IFMIF
Conventional Facilities
P & ID (Industrial HVAC System (PBS 5.3.1.3.0.)) (2/2)

DATE: 15 MAY 2012 SCALE: NONE

PREP'D: S.K.K.I. CHK'D: K.I.F. APP'D: K.I.F.

JOB CODE: 0-6179-2-0-0000

SIZE: B

D - 1226 - 136

Figure 6-19:D-1226-136-P&ID Industrial HVAC System



NO.	5	3	1	1	0	-	A	-	001	A/B	SERVICE	QTY	MAT'L	TYPE	SPECIFICATION	MAIN DIMENSION	RATED OUTPUT	ACCESSORIES	REMARKS
1											Air Handling Unit for Nuclear HVAC PBS 53110	2	Carbon Steel Plate		· Supply air volume : 189,825 m ³ /h x 2 · Cooling capacity : 2,310 kW · Heating capacity : 4,980 kW	12,000 mm W x 6,000mmH x 6,000mmL	(250+250) kW		In Industrial HVAC Room-2 (R305-2)
2											Air Handling Unit for PIE Nuclear HVAC PBS 53120	2	Carbon Steel Plate		· Supply air volume : 175,860 m ³ /h · Cooling capacity : 900 kW · Heating capacity : 1,940 kW	7,000 mm W x 4,000mmH x 5,000mmL	250 kW		In Industrial HVAC Room-1 (R305-1)
3											Air Handling Unit for Industrial HVAC PBS 53130	2	Carbon Steel Plate		· Supply air volume : 83850 m ³ /h · Cooling capacity : 430 kW · Heating capacity : 920 kW	4,000 mm W x 4,000mmH x 5,000mmL	110 kW		In Industrial HVAC Room-1 (R305-1)
4											Cooling/Humidifying Unit for Nuclear HVAC PBS 53110	1	Carbon Steel Plate		· Supply air volume : 124,700 m ³ /h · Cooling capacity : 940 kW	5,000 mm W x 4,000mmH x 3,000mmL	---		In Industrial HVAC Room-2 (R305-2)
5											Cooling Unit for Accelerator HVAC PBS 53110	2	Carbon Steel Plate		· Supply air volume : 23,700 m ³ /h · Cooling capacity : 100 kW	2,000 mm W x 2,000mmH x 3,000mmL	---		In Vault recirculation blower room-1 (R315-1) In Vault recirculation blower room-2 (R315-2)
6											Cooling/Humidifying Unit for PIE Nuclear HVAC PBS53120	1	Carbon Steel Plate		· Supply air volume : 108,050 m ³ /h · Cooling capacity : 270 kW · Humidifying capacity : 6 Liter/min	2,500 mm W x 2,500mmH x 3,000mmL	---		In Industrial HVAC Room-1 (R305-1)
7											Cooling/Humidifying Unit for Industrial HVAC PBS531300	1	Carbon Steel Plate		· Supply air volume : 18,850 m ³ /h · Cooling capacity : 150 kW · Humidifying capacity : 4 Liter/min	2,000 mm W x 2,000mmH x 3,000mmL	---		In Industrial HVAC Room-1 (R305-1)
8											Cooling/Humidifying Unit for Industrial HVAC PBS53130	1	Carbon Steel Plate		· Supply air volume : 45,600 m ³ /h · Cooling capacity : 430 kW · Humidifying capacity : 9 Liter/min	3,000 mm W x 3,000mmH x 3,000mmL	---		In Industrial HVAC Room-1 (R305-1)
10											Exhaust Fan for Nuclear HVAC PBS 53110 "C1"	2	Carbon Steel Plate	Centrifugal	· Exhaust air volume : 128,950 m ³ /h · Static pressure : 1,500 Pa	4,000 mm W x 3,000mmH x 2,000mmL	110 kW		In HVAC Blower Room (R401)
11											Exhaust Fan for Nuclear HVAC PBS 53110 "C2"	2	Carbon Steel Plate	Centrifugal	· Exhaust air volume : 173,300 m ³ /h · Static pressure : 2,500 Pa	4,000 mm W x 3,000mmH x 2,000mmL	200 kW		In HVAC Blower Room (R401)
12											Exhaust Fan for Nuclear HVAC PBS 53110 "C3"	2	Carbon Steel Plate	Centrifugal	· Exhaust air volume : 81,450 m ³ /h · Static pressure : 2,500 Pa	4,000 mm W x 3,000mmH x 2,000mmL	132 kW		In HVAC Blower Room (R401)
13											Exhaust Fan for Nuclear HVAC PBS 53110 "C4"	2	Carbon Steel Plate	Centrifugal	· Exhaust air volume : 10,300 m ³ /h · Static pressure : 2,500 Pa	2,000 mm W x 1,500mmH x 1,000mmL	18.5 kW		In HVAC Blower Room (R401)
14											Circulation Fan for Accelerator area	4	Carbon Steel Plate	Centrifugal	· Circulation air volume : 16,250 m ³ /h · Static pressure : 2,500 Pa	2,000 mm W x 1,500mmH x 1,000mmL	37 kW		In Vault recirculation blower room-1 (R315-1)
											Exhaust Fan for Accelerator area	4	Carbon Steel Plate	Centrifugal	· Circulation air volume : 13,200 m ³ /h · Static pressure : 2,500 Pa	2,000 mm W x 1,500mmH x 1,000mmL	18.5 kW		In Vault recirculation blower room-2 (R315-2)
16											Exhaust Fan for PIE Nuclear HVAC PBS 53120 "C1"	2	Carbon Steel Plate	Centrifugal	· Exhaust air volume : 11,660 m ³ /h · Static pressure : 1,500 Pa	2,000 mm W x 1,500mmH x 1,000mmL	11 kW		In HVAC Blower Room (R401)
17											Exhaust Fan for PIE Nuclear HVAC PBS 53120 "C2"	2	Carbon Steel Plate	Centrifugal	· Exhaust air volume : 10,850 m ³ /h · Static pressure : 2,500 Pa	2,000 mm W x 1,500mmH x 1,000mmL	18.5 kW		In HVAC Blower Room (R401)
18											Exhaust Fan for PIE Nuclear HVAC PBS 53120 "C3"	2	Carbon Steel Plate	Centrifugal	· Exhaust air volume : 100,500 m ³ /h · Static pressure : 2,500 Pa	4,000 mm W x 3,000mmH x 2,000mmL	185 kW		In HVAC Blower Room (R401)
19											Exhaust Fan for PIE Nuclear HVAC PBS 53120 "C4"	2	Carbon Steel Plate	Centrifugal	· Exhaust air volume : 68,500 m ³ /h · Static pressure : 2,500 Pa	4,000 mm W x 3,000mmH x 2,000mmL	90 kW		In HVAC Blower Room (R401)
20											Exhaust Fan for Industrial HVAC	2	Carbon Steel Plate	Centrifugal	· Exhaust air volume : 83,850 m ³ /h · Static pressure : 1,000 Pa	4,000 mm W x 3,000mmH x 2,000mmL	132 kW		In Industrial HVAC Room-1 (R305-1)
21											Filter Box for Nuclear HVAC PBS 5310 "C2"	17	SEHC	Bag-in/bag-out type	· Filter component : Pre-filter + HEPA filter · Treated air volume : 11,100 m ³ /h	1,500 mm W x 2,600mmH x 2,300mmL	---		In Nuclear HVAC (R321)
22											Filter Box for Nuclear HVAC PBS 5310 "C3"	9	SEHC	Bag-in/bag-out type	· Filter component : Pre-filter + HEPA filter + HEPA filter · Treated air volume : 11,100 m ³ /h	1,800 mm W x 2,600mmH x 2,300mmL	---		In Nuclear HVAC (R321)
23											Filter Box for Nuclear HVAC PBS 5310 "C4"	2	SEHC	Bag-in/bag-out type	· Filter component : Pre-filter + HEPA filter + HEPA filter · Treated air volume : 11,100 m ³ /h	1,500 mm W x 2,600mmH x 2,300mmL	---		In Nuclear HVAC (R321)
24											Filter Box for Accelerator area	8	SEHC	Bag-in/bag-out type	· Filter component : Pre-filter + HEPA filter + HEPA filter · Treated air volume : 5,550 m ³ /h	750 mm W x 2,300mmH x 2,500mmL	---		In Vault recirculation blower room-1((R315-1)
27											Filter Box for PIE Nuclear 53120 "C2"	2	SEHC	Bag-in/bag-out type	· Filter component : Pre-filter + HEPA filter · Treated air volume : 11,100 m ³ /h	1,500 mm W x 2,600mmH x 2,300mmL	---		In PIE HVAC Room (R227)
28											Filter Box for PIE Nuclear 53120 "C3"	11	SEHC	Bag-in/bag-out type	· Filter component : Pre-filter + HEPA filter + HEPA filter · Treated air volume : 11,100 m ³ /h	1,500 mm W x 2,600mmH x 2,300mmL	---		In PIE HVAC Room (R227)
29											Filter Box for PIE Nuclear 53120 "C4"	7	SEHC	Bag-in/bag-out type	· Filter component : Pre-filter + HEPA filter + HEPA filter · Treated air volume : 11,100 m ³ /h	1,500 mm W x 2,600mmH x 2,300mmL	---		In PIE HVAC Room (R227)
30											Chiller for cooling/heating	13	Carbon Steel Plate	Air-cooled heat pump chiller	· Cooling capacity : 1200 kW · Heating capacity : 760kW	12,330 mm W x 3,000 mmL x 2,300mmH	300 kW		Outside on Ground (Beside R102)

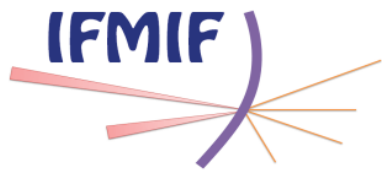


Table 3 : S-1226-141- Equipment List HVAC System 1/3



NO.	ITEMNO	SERVICE	QTY	MAT'L	TYPE	SPECIFICATION	MAIN DIMENSION	RATED OUTPUT	ACCESSORIES	REMARKS
31	5 . 3 . 1 . 4 . 0 . - HC - 002 A/B	Chiller for heating	2	Carbon Steel Plate	Air-cooled heat pump chiller for heating	- Heating capacity : 760 kW	12,330 mm W x 3,000 mm L x 2,300mm H	210 kW		Outside on Ground (Beside R102)
32	5 . 3 . 1 . 4 . 0 . - P - 001 A to M	Cooling/Hot water pump	13	Carbon Steel Plate	Centrifugal	- Water flow rate : 3,500 Liter/min - Total static pressure : 0.4MPa	600 mm W x 1,500mm L x 800mm H	45 kW		Outside on Ground (Beside R102)
33	5 . 3 . 1 . 4 . 0 . - P - 002 A/B	Hot water pump	2	Carbon Steel Plate	Centrifugal	- Water flow rate : 1,100 Liter/min - Total static pressure : 0.4MPa	600 mm W x 1,500mm L x 800mm H	22 kW		Outside on Ground (Beside R102)
34	5 . 3 . 1 . 3 . 0 . - PACI - 001 A/B	Ceiling mounted packaged air-conditioners Indoor unit	2	Carbon Steel Plate	Air-cooled type	- Cooling capacity : 3.6 kW	840 mm W x 840mm D x 258mm H	0.05 kW		In HP Room (R223)
	5 . 3 . 1 . 3 . 0 . - PACO - 001 A/B	Outdoor unit	2	Carbon Steel Plate	Air-cooled type		900mm W x 350mm D x 600mm H	0.83 kW		Outside on Roof
35	5 . 3 . 1 . 3 . 0 . - PACI - 002 A/B	Ceiling mounted packaged air-conditioners Indoor unit	2	Carbon Steel Plate	Air-cooled type	- Cooling capacity : 7.1 kW	840 mm W x 840mm D x 258mm H	0.05 kW		In Control Room (R220)
	5 . 3 . 1 . 3 . 0 . - PACO - 002 A/B	Outdoor unit	2	Carbon Steel Plate	Air-cooled type		900mm W x 350mm D x 600mm H	1.46 kW		Outside on Roof
36	5 . 3 . 1 . 3 . 0 . - PACI - 003 A to H	Ceiling suspended packaged air-conditioners Indoor unit	8	Carbon Steel Plate	Air-cooled type	- Cooling capacity : 37 kW	1,700 mm W x 900mm D x 600mm H	0.26 kW		In Low Voltage Electric Power Supply Area-1 (R303-1)
	5 . 3 . 1 . 3 . 0 . - PACO - 003 A/B/C/D	Outdoor unit	4	Carbon Steel Plate	Air-cooled type		1,220mm W x 760mm D x 1,650mm H	11.36 kW		Outside on Roof
37	5 . 3 . 1 . 3 . 0 . - PACI - 004 A to H	Ceiling suspended packaged air-conditioners Indoor unit	8	Carbon Steel Plate	Air-cooled type	- Cooling capacity : 37 kW	1,700 mm W x 900mm D x 600mm H	0.26 kW		In Low Voltage Electric Power Supply Area-2 (R303-2)
	5 . 3 . 1 . 3 . 0 . - PACO - 004 A/B/C/D	Outdoor unit	4	Carbon Steel Plate	Air-cooled type		1,220mm W x 760mm D x 1,650mm H	11.36 kW		Outside on Roof
38	5 . 3 . 1 . 3 . 0 . - PACI - 005 A/B	Ceiling suspended packaged air-conditioners Indoor unit	2	Carbon Steel Plate	Air-cooled type	- Cooling capacity : 19.5 kW	1,700 mm W x 900mm D x 600mm H	0.26 kW		Control Room (R310)
	5 . 3 . 1 . 3 . 0 . - PACO - 005 A/B	Outdoor unit	2	Carbon Steel Plate	Air-cooled type		920mm W x 760mm D x 1,650mm H	5.75 kW		Outside on Roof
39	5 . 3 . 1 . 3 . 0 . - PACI - 006 A/B/C/D	Ceiling suspended packaged air-conditioners Indoor unit	4	Carbon Steel Plate	Air-cooled type	- Cooling capacity : 19.5 kW	1,700 mm W x 900mm D x 600mm H	0.26 kW		Electric Power Receiving Area-1 (R301-1)
	5 . 3 . 1 . 3 . 0 . - PACO - 006 A/B/C/D	Outdoor unit	4	Carbon Steel Plate	Air-cooled type		920mm W x 760mm D x 1,650mm H	5.75 kW		Outside on Roof
40	5 . 3 . 1 . 3 . 0 . - PACI - 007 A/B/C/D	Ceiling suspended packaged air-conditioners Indoor unit	4	Carbon Steel Plate	Air-cooled type	- Cooling capacity : 19.5 kW	1,700 mm W x 900mm D x 600mm H	0.26 kW		Electric Power Receiving Area-2 (R301-2)
	5 . 3 . 1 . 3 . 0 . - PACO - 007 A/B/C/D	Outdoor unit	4	Carbon Steel Plate	Air-cooled type		920mm W x 760mm D x 1,650mm H	5.75 kW		Outside on Roof
41	5 . 3 . 1 . 3 . 0 . - PACI - 008 A/B	Ceiling suspended packaged air-conditioners Indoor unit	2	Carbon Steel Plate	Air-cooled type	- Cooling capacity : 19.5 kW	1,700 mm W x 900mm D x 600mm H	0.26 kW		UPS Room-1 (R302-1)
	5 . 3 . 1 . 3 . 0 . - PACO - 008 A/B	Outdoor unit	2	Carbon Steel Plate	Air-cooled type		920mm W x 760mm D x 1,650mm H	5.75 kW		Outside on Roof
42	5 . 3 . 1 . 3 . 0 . - PACI - 009 A/B	Ceiling suspended packaged air-conditioners Indoor unit	2	Carbon Steel Plate	Air-cooled type	- Cooling capacity : 19.5 kW	1,700 mm W x 900mm D x 600mm H	0.26 kW		UPS Room-2 (R302-2)
	5 . 3 . 1 . 3 . 0 . - PACO - 009 A/B	Outdoor unit	2	Carbon Steel Plate	Air-cooled type		920mm W x 760mm D x 1,650mm H	5.75 kW		Outside on Roof
43	5 . 3 . 1 . 3 . 0 . - PACI - 010 A/B/C/D	Ceiling suspended packaged air-conditioners Indoor unit	4	Carbon Steel Plate	Air-cooled type	- Cooling capacity : 19.5 kW	1,700 mm W x 900mm D x 600mm H	0.26 kW		Utilities (R307)
	5 . 3 . 1 . 3 . 0 . - PACO - 010 A/B/C/D	Outdoor unit	4	Carbon Steel Plate	Air-cooled type		920mm W x 760mm D x 1,650mm H	5.75 kW		Outside on Roof
44	5 . 3 . 1 . 3 . 0 . - PACI - 011 A/B/C/D	Ceiling suspended packaged air-conditioners Indoor unit	4	Carbon Steel Plate	Air-cooled type	- Cooling capacity : 46 kW	2,000 mm W x 800mm D x 2,000mm H	0.40 kW		Local Control Rack-1 (R201-A2-1)
	5 . 3 . 1 . 3 . 0 . - PACO - 011 A/B/C/D	Outdoor unit	4	Carbon Steel Plate	Air-cooled type		1,000mm W x 800mm D x 1,650mm H	15.7 kW		Outside on Roof
45	5 . 3 . 1 . 3 . 0 . - PACI - 012 A/B/C/D	Ceiling suspended packaged air-conditioners Indoor unit	4	Carbon Steel Plate	Air-cooled type	- Cooling capacity : 46 kW	2,000 mm W x 800mm D x 2,000mm H	0.40 kW		Local Control Rack-2 (R201-A2-2)
	5 . 3 . 1 . 3 . 0 . - PACO - 012 A/B/C/D	Outdoor unit	4	Carbon Steel Plate	Air-cooled type		1,000mm W x 800mm D x 1,650mm H	15.7 kW		Outside on Roof

Table 4: S-1226-141-Equipment List HVAC System 2/3



NO.	5	3	1	3	0	-	PACI	-	013	A to L	SERVICE	QTY	MAT'L	TYPE	SPECIFICATION	MAIN DEMENSION	RATED OUTPUT	ACCESSORIES	REMARKS
46	5	3	1	3	0	-	PACI	-	013	A to L	Ceiling suspended packaged air- conditioners Indoor unit	12	Carbon Steel Plate	Air-cooled type	Cooling capacity : 37 kW	1,700 mmW x 900mm D x 600mmH	0.26 kW		In High Voltage Electric Power Supply Area-1 (R201-A1-1)
											Outdoor unit	6	Carbon Steel Plate	Air-cooled type		1,220mm W x 760mm D x 1,650mmH	11.36 kW		Outside on Roof
47	5	3	1	3	0	-	PACI	-	014	A to L	Ceiling suspended packaged air- conditioners Indoor unit	12	Carbon Steel Plate	Air-cooled type	Cooling capacity : 37 kW	1,700 mmW x 900mm D x 600mmH	0.26 kW		In High Voltage Electric Power Supply Area-2 (R201-A1-2)
											Outdoor unit	6	Carbon Steel Plate	Air-cooled type		1,220mm W x 760mm D x 1,650mmH	11.36 kW		Outside on Roof
48	5	3	1	3	0	-	PACI	-	015	A/B	Ceiling suspended packaged air- conditioners Indoor unit	2	Carbon Steel Plate	Air-cooled type	Cooling capacity : 19.5 kW	1,700 mmW x 900mm D x 600mmH	0.26 kW		Non-Radiation Cooling Machine Room-1 (R107-1)
											Outdoor unit	2	Carbon Steel Plate	Air-cooled type		920mmW x 760mm D x 1,650mmH	5.75 kW		Outside on Roof
49	5	3	1	3	0	-	PACI	-	016	A/B	Ceiling suspended packaged air- conditioners Indoor unit	2	Carbon Steel Plate	Air-cooled type	Cooling capacity : 19.5 kW	1,700 mmW x 900mm D x 600mmH	0.26 kW		Non-Radiation Cooling Machine Room-2 (R107-2)
											Outdoor unit	2	Carbon Steel Plate	Air-cooled type		920mmW x 760mm D x 1,650mmH	5.75 kW		Outside on Roof
50	5	3	1	3	0	-	PACI	-	17	A/B	Ceiling mounted packaged air- conditioners Indoor unit	2	Carbon Steel Plate	Air-cooled type	Cooling capacity : 7.1 kW	840 mmW x 840mm D x 258mmH	0.05 kW		In Computer Room (R313)
											Outdoor unit	2	Carbon Steel Plate	Air-cooled type		900mmW x 350mm D x 600mmH	1.46 kW		Outside on Roof





Floor	Room number	Name of the cell	Containment area classification (ISO 17873:2004 - table 2)	Classification of ventilation (ISO 17873:2004 - table B1)	Air change rate (Time/hr)		Atmosphere/Room pressure		Temperature (C DB)		Humidity (% RH)		Air Flow Volume(m3/h)		Room Area (m2)	Room Height(mm)	Room Volume (m3)
					ISO 17873	According to design	Operation (Pa)	Maintenance (Pa)	Operation	Maintenance	Operation	Maintenance	④ Equipment Load (W/m2)	Max Volume Max(① or ②) (m3/h)			
BI	AL001	Air Lock 001	C2	Nuclear-IIA	4 to 5	5	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	RH not required	RH not required		2,700	61.35	8800	540
BI	R001	Rad. Waste Measurement cell (LL & VLL)	C3	Nuclear-IIB	1 to 5	2	120 to 140	120 to 140	10°C to 30°C	10°C to 30°C	RH not required	RH required		1,750	97.04	8800	854
BI	R002	Pump Room(Liquid Waste Treatment)	C3	Nuclear-IIB	1 to 5	5	120 to 140	120 to 140	10°C to 30°C	10°C to 30°C	RH not required	RH not required	33	2,850	80.19	8800	530
BI	R003	Liquid waste treatment cell	C3	Nuclear-IIB	1 to 5	5	120 to 140	120 to 140	10°C to 30°C	10°C to 30°C	RH not required	RH not required		4,000	90.29	8800	795
BI	R004	Hot Cell maintenance Room	C3	Nuclear-IIB	1 to 5	5	120 to 140	120 to 140	10°C to 40°C	10°C to 40°C	RH not required	RH not required		7,950	179.89	8800	1583
BI	R005	Irradiating Rad. waste measurement cell	C2	Nuclear-IIA	2	2	80 to 100	80 to 100	10°C to 40°C	10°C to 40°C	RH not required	RH not required		800	32.81	8500	279
BI	R006	Irradiating Rad. waste storage cell	C2	Nuclear-IIA	2	2	80 to 100	80 to 100	10°C to 40°C	10°C to 40°C	RH not required	RH not required		800	34.88	8500	295
BI	R007	Irradiating Rad. waste Treatment Cell	C4	Nuclear-IIB	2	2	220 to 300	220 to 300	10°C to 40°C	10°C to 40°C	Argon (RH required)	RH required		3,100	179.5	8500	1526
BI	R008	RWTC working zone	C2	Nuclear-IIA	2	2	80 to 100	80 to 100	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%		9,050	514.11	8800	4524
BI	R011	LF Utility Room	C1	Nuclear-I	1 to 2	2	<60	<60	10°C to 40°C	10°C to 40°C	RH not required	RH not required	134	5,600	88.55	7500	672
BI	R012	Water cooling cell	C2	Nuclear-IIA	1 to 2	2	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	RH not required	RH not required	248	18,200	155.34(16.75)	7500(5500)	1257
BI	R013	Rad. Waste storage cell(LL/VLL)	C2	Nuclear-IIA	1 to 2	2	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	RH not required	RH not required		3,000	168.48	8800	1491
BI	R014	Detritiation Process Room-1	C3	Nuclear-IIB	5 to 10	10	120 to 140	120 to 140	10°C to 30°C	10°C to 30°C	RH not required	RH not required	109	20,550	233.5	8800	2055
BI	AL014	Air Lock 014	C2	Nuclear-IIA	4 to 5	5	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	RH not required	RH not required		750	16.42	8800	144
BI	R015	Organic loop cell	C2	Nuclear-IIA	2	2	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	RH not required	RH not required	267	21,800	176.82(16.75)	8800(5500)	1418
BI	R016	Lithium Loop cell	C3	Nuclear-IIB	1 to 5	1	120 to 140	120 to 140	10°C to 30°C	10°C to 30°C	Argon (RH required)	40% to 60%	489	0	229.25	7000	1053
BI	AL016	Air Lock 016	C2	Nuclear-IIA	4 to 5	5	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	RH not required	RH not required		2,850	63.75	8800	561
BI	R016bis	PK for Electro magnetic Pump and Dump tank	C3	Nuclear-IIB	5 to 10	10	120 to 140	120 to 140	10°C to 30°C	10°C to 30°C	Argon (RH required)	RH not required		1,350	28.56(15.3)	8800 10100(12500)	133
BI	R017	Li sampling Cell	C3	Nuclear-IIB	1 to 5	5	120 to 140	120 to 140	10°C to 30°C	10°C to 30°C	RH not required	RH not required	180	1,300	17.53	8800	154
BI	C001	Corridor 001	C2	Nuclear-IIA	1 to 2	1	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	RH not required	RH not required		22,850	2008.63	8800	17676
BI	S08	Staircase 08	C1	Nuclear-I	1 to 2	1	<60	<60	10°C to 40°C	10°C to 40°C	RH not required	RH not required		2,000	65.76	29800	1980
BI	E04	Elevator 04	C1	Nuclear-I	1 to 2	1	<60	<60	10°C to 40°C	10°C to 40°C	RH not required	RH not required		700	21.99	29800	655
BI	S05	Staircase 05	C1	Nuclear-I	1 to 2	1	<60	<60	10°C to 40°C	10°C to 40°C	RH not required	RH not required		2,000	67.03	29800	1997
BI	E03	Elevator 03	C1	Nuclear-I	1 to 2	1	<60	<60	10°C to 40°C	10°C to 40°C	RH not required	RH not required		650	20.72	29800	617
BI	S07	Staircase 07	C1	Nuclear-I	1 to 2	1	<60	<60	10°C to 40°C	10°C to 40°C	RH not required	RH not required		400	21.87	17800	386
IF	S01	Stair Case 01	Unclassified	Industrial		1	Atm.	Atm.	10°C to 40°C	10°C to 40°C	RH not required	RH not required		1,050	50	20800	1040
IF	S02	Stair Case 02	Unclassified	Industrial		2	Atm.	Atm.	10°C to 40°C	10°C to 40°C	RH not required	RH not required		2,100	50	20800	1040
IF	R101-1	Changing Room-1	C1	Nuclear-I	4 to 5	5	<60	<60	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	RH not required	RH not required		2,700	61.3	8800	539
IF	R101-2	Changing Room-2	C1	Nuclear-I	4 to 5	5	<60	<60	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	RH not required	RH not required		2,700	61.3	8800	539
IF	R102	Piping and Cabling Space	Unclassified	Industrial		1	Atm.	Atm.	10°C to 40°C	10°C to 40°C	RH not required	RH not required		1,600	75	22800	1710
IF	R103-1	Shipping Bay-1	Unclassified	Industrial		1	Atm.	Atm.	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%		1,450	93.65	8800	824
IF	R103-2	Shipping Bay-2	Unclassified	Industrial		1	Atm.	Atm.	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%		1,450	93.65	880	82
IF	R104-1	Assembly/Shipping Bay-1	C1	Nuclear-I	1 to 2	2	<60	<60	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%		2,050	114.81	8800	1010
IF	R104-2	Assembly/Shipping Bay-2	C1	Nuclear-I	1 to 2	2	<60	<60	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%		2,050	114.81	8800	1010
IF	R105	Assembly/Maintenance Bay	C2	Nuclear-IIA	2	2	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	40% to 60%	40% to 60%		6,800	375	8800	3300
IF	R106-1	Non Radiation Cooling Machine Room-1	Unclassified	Industrial		1	Atm.	Atm.	10°C to 30°C	10°C to 30°C	40% to 60%	40% to 60%	64	5,300	597.01	8800	5254
IF	R106-2	Non Radiation Cooling Machine Room-2	Unclassified	Industrial		1	Atm.	Atm.	10°C to 30°C	10°C to 30°C	40% to 60%	40% to 60%	628	550	597.01	8800	5254
IF	R107-1	Non Radiation Cooling Machine Room-3	C1	Nuclear-I	1 to 2	2	<60	<60	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%	402	50,100	305.67	8800	2690
IF	R107-2	Non Radiation Cooling Machine Room-4	C1	Nuclear-I	1 to 2	2	<60	<60	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%	402	50,100	305.67	8800	2690
IF	R108-1	Radiation Cooling Machine Room-1	C2	Nuclear-IIA	2	2	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	40% to 60%	40% to 60%	96	13,750	287	8800	2526
IF	R108-2	Radiation Cooling Machine Room-2	C2	Nuclear-IIA	2	2	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	40% to 60%	40% to 60%	96	13,750	287	8800	2526
IF	R109-A1-1	Piping and Cabling Penetration Space-1	C2	Nuclear-IIA	2	2	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	40% to 60%	40% to 60%		5,800	383.76	7500	2878
IF	R109-A1-2	Piping and Cabling Penetration Space-2	C2	Nuclear-IIA	2	2	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	40% to 60%	40% to 60%		5,800	383.76	7500	2878
IF	R110-1	Accelerator Vault-1	C3/operation C2/maintenance	Nuclear-IIB	1/operation 2/maintenance	2	120 to 140	80 to 100	10°C to 30°C	10°C to 30°C	RH not required	RH not required	34	11,300	464	7500	3480
IF	R110-2	Accelerator Vault-2	C3/operation C2/maintenance	Nuclear-IIB	1/operation 2/maintenance	2	120 to 140	80 to 100	10°C to 30°C	10°C to 30°C	RH not required	RH not required	34	11,300	464	7500	3480

Table 6: S-1226-111-HVAC Room Characteristics 1/6



Floor	Room number	Name of the cell	Containment area classification (ISO 17873:2004 - table 2)	Classification of ventilation (ISO 17873:2004 - table B1)	Air change rate (Time/hr)		Atmosphere/Room pressure		Temperature (C DB)		Humidity (% RH)		Air Flow Volume(m3/h)		Room Area (m2)	Room Height(mm)	Room Volume (m3)
					ISO 17873	According to design	Operation (Pa)	Maintenance (Pa)	Operation	Maintenance	Operation	Maintenance	④ Equipment Load (W/m2)	Max Volume Max(① or ②) (m3/h)			
B1	AL001	Air Lock 001	C2	Nuclear-IIA	4 to 5	5	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	RH not required	RH not required		2,700	61.35	8800	540
B1	R001	Rad. Waste Measurement cell (LL & VLL)	C3	Nuclear-IIB	1 to 5	2	120 to 140	120 to 140	10°C to 30°C	10°C to 30°C	RH not required	RH required		1,750	97.04	8800	854
B1	R002	Pump Room(Liquid Waste Treatment)	C3	Nuclear-IIB	1 to 5	5	120 to 140	120 to 140	10°C to 30°C	10°C to 30°C	RH not required	RH not required	33	2,850	60.19	8800	530
B1	R003	Liquid waste treatment cell	C3	Nuclear-IIB	1 to 5	5	120 to 140	120 to 140	10°C to 30°C	10°C to 30°C	RH not required	RH not required		4,000	90.29	8800	795
B1	R004	Hot Cell maintenance Room	C3	Nuclear-IIB	1 to 5	5	120 to 140	120 to 140	10°C to 40°C	10°C to 40°C	RH not required	RH not required		7,950	179.89	8800	1583
B1	R005	Irradiating Rad. waste measurement cell	C2	Nuclear-IIA	2	2	80 to 100	80 to 100	10°C to 40°C	10°C to 40°C	RH not required	RH not required		600	32.81	8500	279
B1	R006	Irradiating Rad. waste storage cell	C2	Nuclear-IIA	2	2	80 to 100	80 to 100	10°C to 40°C	10°C to 40°C	RH not required	RH not required		600	34.68	8500	295
B1	R007	Irradiating Rad. waste Treatment Cell	C4	Nuclear-IIB	2	2	220 to 300	220 to 300	10°C to 40°C	10°C to 40°C	Argon (RH required)	RH required		3,100	179.5	8500	1526
B1	R008	RWTC working zone	C2	Nuclear-IIA	2	2	80 to 100	80 to 100	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%		9,050	514.11	8800	4524
B1	R011	LF Utility Room	C1	Nuclear-I	1 to 2	2	<60	<60	10°C to 40°C	10°C to 40°C	RH not required	RH not required	134	5,600	89.55	7500	672
B1	R012	Water cooling cell	C2	Nuclear-IIA	1 to 2	2	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	RH not required	RH not required	248	18,200	155.34(16.75)	7500(5500)	1257
B1	R013	Rad. Waste storage cell(LL/VLL)	C2	Nuclear-IIA	1 to 2	2	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	RH not required	RH not required		3,000	168.48	8800	1491
B1	R014	Detritiation Process Room-1	C3	Nuclear-IIB	5 to 10	10	120 to 140	120 to 140	10°C to 30°C	10°C to 30°C	RH not required	RH not required	109	20,550	233.5	8800	2055
B1	AL014	Air Lock 014	C2	Nuclear-IIA	4 to 5	5	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	RH not required	RH not required		750	16.42	8800	144
B1	R015	Organic loop cell	C2	Nuclear-IIA	2	2	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	RH not required	RH not required	267	21,800	176.82(16.75)	8800(5500)	1418
B1	R016	Lithium Loop cell	C3	Nuclear-IIB	1 to 5	1	120 to 140	120 to 140	10°C to 30°C	10°C to 30°C	Argon (RH required)	40% to 60%	489	0	229.25	7000	1053
B1	AL016	Air Lock 016	C2	Nuclear-IIA	4 to 5	5	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	RH not required	RH not required		2,850	63.75	8800	561
B1	R016bis	PK for Electro magnetic Pump and Dump tank	C3	Nuclear-IIB	5 to 10	10	120 to 140	120 to 140	10°C to 30°C	10°C to 30°C	Argon (RH required)	RH not required		1,350	28.56(15.3)	8800 10100(12500)	133
B1	R017	Li sampling Cell	C3	Nuclear-IIB	1 to 5	5	120 to 140	120 to 140	10°C to 30°C	10°C to 30°C	RH not required	RH not required	180	1,300	17.53	8800	154
B1	C001	Corridor 001	C2	Nuclear-IIA	1 to 2	1	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	RH not required	RH not required		22,850	2008.63	8800	17878
B1	S06	Staircase 06	C1	Nuclear-I	1 to 2	1	<60	<60	10°C to 40°C	10°C to 40°C	RH not required	RH not required		2,000	65.76	29800	1980
B1	E04	Elevator 04	C1	Nuclear-I	1 to 2	1	<60	<60	10°C to 40°C	10°C to 40°C	RH not required	RH not required		700	21.99	29800	655
B1	S05	Staircase 05	C1	Nuclear-I	1 to 2	1	<60	<60	10°C to 40°C	10°C to 40°C	RH not required	RH not required		2,000	67.03	29800	1997
B1	E03	Elevator 03	C1	Nuclear-I	1 to 2	1	<60	<60	10°C to 40°C	10°C to 40°C	RH not required	RH not required		650	20.72	29800	617
B1	S07	Staircase 07	C1	Nuclear-I	1 to 2	1	<60	<60	10°C to 40°C	10°C to 40°C	RH not required	RH not required		400	21.67	17800	386
1F	S01	Steir Case 01	Unclassified	Industrial		1	Atm.	Atm.	10°C to 40°C	10°C to 40°C	RH not required	RH not required		1,050	50	20800	1040
1F	S02	Steir Case 02	Unclassified	Industrial		2	Atm.	Atm.	10°C to 40°C	10°C to 40°C	RH not required	RH not required		2,100	50	20800	1040
1F	R101-1	Charging Room-1	C1	Nuclear-I	4 to 5	5	<60	<60	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	RH not required	RH not required		2,700	61.3	8800	539
1F	R101-2	Charging Room-2	C1	Nuclear-I	4 to 5	5	<60	<60	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	RH not required	RH not required		2,700	61.3	8800	539
1F	R102	Piping and Cabling Space	Unclassified	Industrial		1	Atm.	Atm.	10°C to 40°C	10°C to 40°C	RH not required	RH not required		1,600	75	22800	1710
1F	R103-1	Shipping Bay-1	Unclassified	Industrial		1	Atm.	Atm.	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%		1,450	93.65	8800	824
1F	R103-2	Shipping Bay-2	Unclassified	Industrial		1	Atm.	Atm.	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%		1,450	93.65	880	82
1F	R104-1	Assembly/Shipping Bay-1	C1	Nuclear-I	1 to 2	2	<60	<60	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%		2,050	114.81	8800	1010
1F	R104-2	Assembly/Shipping Bay-2	C1	Nuclear-I	1 to 2	2	<60	<60	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%		2,050	114.81	8800	1010
1F	R105	Assembly/Maintenance Bay	C2	Nuclear-IIA	2	2	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	40% to 60%	40% to 60%		6,800	375	8800	3300
1F	R106-1	Non Radiation Cooling Machine Room-1	Unclassified	Industrial		1	Atm.	Atm.	10°C to 30°C	10°C to 30°C	40% to 60%	40% to 60%	64	5,300	597.01	8800	5254
1F	R106-2	Non Radiation Cooling Machine Room-2	Unclassified	Industrial		1	Atm.	Atm.	10°C to 30°C	10°C to 30°C	40% to 60%	40% to 60%	628	550	597.01	8800	5254
1F	R107-1	Non Radiation Cooling Machine Room-3	C1	Nuclear-I	1 to 2	2	<60	<60	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%	402	50,100	305.67	8800	2690
1F	R107-2	Non Radiation Cooling Machine Room-4	C1	Nuclear-I	1 to 2	2	<60	<60	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%	402	50,100	305.67	8800	2690
1F	R108-1	Radiation Cooling Machine Room-1	C2	Nuclear-IIA	2	2	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	40% to 60%	40% to 60%	96	13,750	287	8800	2526
1F	R108-2	Radiation Cooling Machine Room-2	C2	Nuclear-IIA	2	2	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	40% to 60%	40% to 60%	96	13,750	287	8800	2526
1F	R109-A1-1	Piping and Cabling Penetration Space-1	C2	Nuclear-IIA	2	2	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	40% to 60%	40% to 60%		5,800	383.76	7500	2878
1F	R109-A1-2	Piping and Cabling Penetration Space-2	C2	Nuclear-IIA	2	2	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	40% to 60%	40% to 60%		5,800	383.76	7500	2878
1F	R110-1	Accelerator Vault-1	C3/operation C2/maintenance	Nuclear-IIB	1/operation 2/maintenance	2	120 to 140	80 to 100	10°C to 30°C	10°C to 30°C	RH not required	RH not required	34	11,300	464	7500	3480
1F	R110-2	Accelerator Vault-2	C3/operation C2/maintenance	Nuclear-IIB	1/operation 2/maintenance	2	120 to 140	80 to 100	10°C to 30°C	10°C to 30°C	RH not required	RH not required	34	11,300	464	7500	3480

Table 7: S-1226-111-HVAC Room Characteristics 2/6



Floor	Room number	Name of the cell	Containment area classification (ISO 17873:2004 - table B1)	Classification of ventilation (ISO 17873:2004 - table B1)	Air change rate (Time/hr)		Atmosphere/Room pressure		Temperature (C DB)		Humidity (% RH)		Air Flow Volume(m3/h)		Room Area (m2)	Room Height(mm)	Room Volume (m3)
					ISO 17873	According to design	Operation (Pa)	Maintenance (Pa)	Operation	Maintenance	Operation	Maintenance	Equipment Load (W/m2)	Max Volume Max(① or ②) (m3/h)			
1F	R146	Piping space	O2	Nuclear-III A	2	2	80 to 100	80 to 100	10°C to 40°C	10°C to 40°C	RH not required	RH not required		500	28.13	8800	248
1F	C105	Corridor 105	C1	Nuclear-I	1 to 2	1	<60 Pa	<60 Pa	10°C to 30°C	10°C to 30°C	RH not required	RH not required		1,600	136.7	8800	1203
1F	R147	Heavy component loading station	O2	Nuclear-III A	2	2	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	RH not required	RH not required		1,000	61.56	8000	492
1F	R148	Work shop-2	O3	Nuclear-III B	1 to 5	5	120 to 140	120 to 140	10°C to 30°C	10°C to 30°C	40% to 60%	40% to 60%		5,050	114.05	8800	1004
1F	R149	Utility Room	O2	Nuclear-III A	2	2	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	RH not required	RH not required	45	1,300	44.88	8000	359
1F	R150	Helium Room	O2	Nuclear-III A	2	2	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	40% to 60%	40% to 60%	242	10,750	104.41	8000	835
1F	R151	Tritium Room	O3	Nuclear-III B	5 to 10	10	120 to 140	120 to 140	10°C to 30°C	10°C to 30°C	40% to 60%	40% to 60%	112	1,650	20.56	8000	164
1F	C106	Corridor 106 to access TIR	C1	Nuclear-I	1 to 2	1	<60 Pa	<60 Pa	10°C to 30°C	10°C to 30°C	RH not required	RH not required	21	2,750	141.1	8800	1242
1F	R152	Preparation cell-2	C1	Nuclear-I	1 to 2	2	<60 Pa	<60 Pa	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%		1,200	66.38	8800	584
1F	C107	PIE Corridor 107	C1	Nuclear-I	1 to 2	1	<60 Pa	SA	10°C to 30°C	10°C to 30°C	RH not required	RH not required		14,650	772.95	8800	6802
1F	R160	PIE-Office-2	C1	Nuclear-I	1 to 2	2	<60 Pa	<60 Pa	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%		2,050	116.01	8800	1021
1F	R161	PIE-Office-1	C1	Nuclear-I	1 to 2	2	<60 Pa	<60 Pa	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%		3,150	177.38	8800	1561
1F	R162	PIE-Electric Room	C1	Nuclear-I	1 to 2	2	<60 Pa	<60 Pa	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%	105	12,700	248.64	8800	2188
1F	AL163	Air Lock 163	O2	Nuclear-III A	4 to 5	5	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	40% to 60%	40% to 60%		650	14.25	8800	125
1F	R163	Glove Box Laboratory	O4	Nuclear-III B	1 to 30	10	220 to 300	220 to 300	10°C to 40°C	10°C to 40°C	RH not required	RH not required		39,650	450.31	8800	3963
1F	R164	Glove box laboratory decontamination process room	O3	Nuclear-III B	5 to 10	10	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	RH required	RH required	196	10,250	115.98	8800	1021
1F		Iron cells	O4	Nuclear-III B	1 to 30	10	220 to 300	220 to 300	10°C to 40°C	10°C to 40°C	RH not required	RH not required		30			0
1F	R165	Iron Cell Maintenance zone	O3	Nuclear-III B	1 to 5	5	120 to 140	120 to 140	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%		4,600	104.22	8800	917
1F	R166	Iron cells working zone	O2	Nuclear-III A	2	2	80 to 100	80 to 100	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%		2,900	163.08	8800	1435
1F	AL166	Air Lock 166	O2	Nuclear-III A	4 to 5	5	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	RH not required	RH not required		450	9.78	8800	86
1F	R167	Conventional Hot Cell Laboratory working zone	O2	Nuclear-III A	2	2	80 to 100	80 to 100	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%		5,200	293.73	8800	2585
1F	AL167	Air Lock 167	O2	Nuclear-III A	4 to 5	5	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	RH not required	RH not required		1,750	38.89	8800	342
1F	R168	Conventional Hot Cell Laboratory Maintenance zone	O3	Nuclear-III B	1 to 5	5	120 to 140	120 to 140	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%		9,300	210.59	8800	1853
1F	R169	Conventional Hot cell Laboratory Detrition Process room	O3	Nuclear-III B	5 to 10	10	120 to 140	120 to 140	10°C to 30°C	10°C to 30°C	RH required	RH required	404	26,250	159.51	8800	1404
1F	R170-1	Conventional Hot Cell -1	O4	Nuclear-III B	1 to 30	10	220 to 300	220 to 300	10°C to 40°C	10°C to 40°C	RH not required	RH not required		1,450	24	6000	144
1F	R170-2	Conventional Hot Cell -2	O4	Nuclear-III B	1 to 30	10	220 to 300	220 to 300	10°C to 40°C	10°C to 40°C	RH not required	RH not required		1,450	24	6000	144
1F	R170-3	Conventional Hot Cell -3	O4	Nuclear-III B	1 to 30	10	220 to 300	220 to 300	10°C to 40°C	10°C to 40°C	RH not required	RH not required		1,450	24	6000	144
1F	R170-4	Conventional Hot Cell -4	O4	Nuclear-III B	1 to 30	10	220 to 300	220 to 300	10°C to 40°C	10°C to 40°C	RH not required	RH not required		1,450	24	6000	144
1F	R170-5	Conventional Hot Cell -5	O4	Nuclear-III B	1 to 30	10	220 to 300	220 to 300	10°C to 40°C	10°C to 40°C	RH not required	RH not required		1,450	24	6000	144
1F	R171-1	Conventional Hot Cell Maintenance cell-1	O3	Nuclear-III B	1 to 5	5	120 to 140	120 to 140	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%		600	19.5	6000	117
1F	R171-2	Conventional Hot Cell Maintenance cell-2	O3	Nuclear-III B	1 to 5	5	120 to 140	120 to 140	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%		600	19.5	6000	117
1F	R171-3	Conventional Hot Cell Maintenance cell-3	O3	Nuclear-III B	1 to 5	5	120 to 140	120 to 140	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%		600	19.5	6000	117
1F	R171-4	Conventional Hot Cell Maintenance cell-4	O3	Nuclear-III B	1 to 5	5	120 to 140	120 to 140	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%		600	19.5	6000	117
1F	R171-5	Conventional Hot Cell Maintenance cell-5	O3	Nuclear-III B	1 to 5	5	120 to 140	120 to 140	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%		600	19.5	6000	117
1F	R172	Tritium Laboratory Maintenance zone	O3	Nuclear-III B	1 to 5	5	120 to 140	120 to 140	10°C to 30°C	10°C to 30°C	RH not required	RH not required		4,850	109.74	8800	966
1F	R173	Tritium Laboratory working zone	O2	Nuclear-III A	2	2	80 to 100	80 to 100	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%		3,650	206.14	8800	1814
1F	AL173	Air Lock 173	O2	Nuclear-III A	4 to 5	5	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	RH not required	RH not required		1,750	39.63	8800	349
1F	R174	Tritium Laboratory Detrition Process Room	O3	Nuclear-III B	5 to 10	10	120 to 140	120 to 140	10°C to 30°C	10°C to 30°C	RH required	RH required	503	25,850	128.12	8800	1127
1F	R176-1	Tritium Hot cell-1	O4	Nuclear-III B	1 to 30	10	220 to 300	220 to 300	10°C to 30°C	10°C to 30°C	RH not required	RH not required		1,450	24	6000	144
1F	R176-2	Tritium Hot cell-2	O4	Nuclear-III B	1 to 30	10	220 to 300	220 to 300	10°C to 30°C	10°C to 30°C	RH not required	RH not required		1,450	24	6000	144
1F	R176-3	Tritium Hot cell-3	O4	Nuclear-III B	1 to 30	10	220 to 300	220 to 300	10°C to 30°C	10°C to 30°C	RH not required	RH not required		1,450	24	6000	144
1F	R176-4	Tritium Hot cell-4	O4	Nuclear-III B	1 to 30	10	220 to 300	220 to 300	10°C to 30°C	10°C to 30°C	RH not required	RH not required		1,450	24	6000	144
1F	R176-5	Tritium Hot cell-5	O4	Nuclear-III B	1 to 30	10	220 to 300	220 to 300	10°C to 30°C	10°C to 30°C	RH not required	RH not required		1,450	24	6000	144

Table 8: S-1226-111-HVAC Room Characteristics 3/6



Floor	Room number	Name of the cell	Containment area classification (ISO 17873:2004 -	Classification of ventilation (ISO 17873:2004 - table B1)	Air change rate (Time/hr)		Atmosphere/Room pressure		Temperature (C DB)		Humidity (% RH)		Air Flow Volume(m3/h)		Room Area (m2)	Room Height(mm)	Room Volume (m3)
					ISO 17873	According to design	Operation (Pa)	Maintenance (Pa)	Operation	Maintenance	Operation	Maintenance	Equipment Load (W/m2)	Max Volume Max(D or E) (m3/h)			
1F	R146	Piping space	C2	Nuclear-IIA	2	2	80 to 100	80 to 100	10°C to 40°C	10°C to 40°C	RH not required	RH not required		500	28.13	8800	248
1F	C105	Corridor 105	C1	Nuclear-I	1 to 2	1	<60 Pa	<60 Pa	10°C to 30°C	10°C to 30°C	RH not required	RH not required		1,600	136.7	8800	1203
1F	R147	Heavy component loading station	C2	Nuclear-IIA	2	2	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	RH not required	RH not required		1,000	61.56	8000	492
1F	R148	Work shop-2	C3	Nuclear-III B	1 to 5	5	120 to 140	120 to 140	10°C to 30°C	10°C to 30°C	40% to 60%	40% to 60%		5,050	114.05	8800	1004
1F	R149	Utility Room	C2	Nuclear-IIA	2	2	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	RH not required	RH not required	45	1,300	44.88	8000	359
1F	R150	Helium Room	C2	Nuclear-IIA	2	2	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	40% to 60%	40% to 60%	242	10,750	104.41	8000	835
1F	R151	Tritium Room	C3	Nuclear-III B	5 to 10	10	120 to 140	120 to 140	10°C to 30°C	10°C to 30°C	40% to 60%	40% to 60%	112	1,650	20.56	8000	164
1F	C106	Corridor 106 to access TIR	C1	Nuclear-I	1 to 2	1	<60 Pa	<60 Pa	10°C to 30°C	10°C to 30°C	RH not required	RH not required	21	2,750	141.1	8800	1242
1F	R152	Preparation cell-2	C1	Nuclear-I	1 to 2	2	<60 Pa	<60 Pa	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%		1,200	66.38	8800	584
1F	C107	PIE Corridor 107	C1	Nuclear-I	1 to 2	1	<60 Pa	SA	10°C to 30°C	10°C to 30°C	RH not required	RH not required		14,650	772.95	8800	6802
1F	R160	PIE-Office-2	C1	Nuclear-I	1 to 2	2	<60 Pa	<60 Pa	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%		2,050	116.01	8800	1021
1F	R161	PIE-Office-1	C1	Nuclear-I	1 to 2	2	<60 Pa	<60 Pa	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%		3,150	177.38	8800	1561
1F	R162	PIE-Electric Room	C1	Nuclear-I	1 to 2	2	<60 Pa	<60 Pa	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%	105	12,700	248.64	8800	2188
1F	AL163	Air Lock 163	C2	Nuclear-IIA	4 to 5	5	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	40% to 60%	40% to 60%		650	14.25	8800	125
1F	R163	Glove Box Laboratory	C4	Nuclear-III B	1 to 30	10	220 to 300	220 to 300	10°C to 40°C	10°C to 40°C	RH not required	RH not required		39,650	450.31	8800	3963
1F	R164	Glove box laboratory decontamination process room	C3	Nuclear-III B	5 to 10	10	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	RH required	RH required	196	10,250	115.98	8800	1021
1F		Iron cells	C4	Nuclear-III B	1 to 30	10	220 to 300	220 to 300	10°C to 40°C	10°C to 40°C	RH not required	RH not required		30			6
1F	R165	Iron Cell Maintenance zone	C3	Nuclear-III B	1 to 5	5	120 to 140	120 to 140	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%		4,600	104.22	8800	917
1F	R166	Iron cells working zone	C2	Nuclear-IIA	2	2	80 to 100	80 to 100	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%		2,900	163.08	8800	1435
1F	AL166	Air Lock 166	C2	Nuclear-IIA	4 to 5	5	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	RH not required	RH not required		450	9.78	8800	86
1F	R167	Conventional Hot Cell Laboratory working zone	C2	Nuclear-IIA	2	2	80 to 100	80 to 100	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%		5,200	293.73	8800	2585
1F	AL167	Air Lock 167	C2	Nuclear-IIA	4 to 5	5	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	RH not required	RH not required		1,750	38.89	8800	342
1F	R168	Conventional Hot Cell Laboratory Maintenance zone	C3	Nuclear-III B	1 to 5	5	120 to 140	120 to 140	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%		9,300	210.59	8800	1853
1F	R169	Conventional Hot cell Laboratory Detrition Process room	C3	Nuclear-III B	5 to 10	10	120 to 140	120 to 140	10°C to 30°C	10°C to 30°C	RH required	RH required	404	26,250	159.51	8800	1404
1F	R170-1	Conventional Hot Cell -1	C4	Nuclear-III B	1 to 30	10	220 to 300	220 to 300	10°C to 40°C	10°C to 40°C	RH not required	RH not required		1,450	24	6000	144
1F	R170-2	Conventional Hot Cell -2	C4	Nuclear-III B	1 to 30	10	220 to 300	220 to 300	10°C to 40°C	10°C to 40°C	RH not required	RH not required		1,450	24	6000	144
1F	R170-3	Conventional Hot Cell -3	C4	Nuclear-III B	1 to 30	10	220 to 300	220 to 300	10°C to 40°C	10°C to 40°C	RH not required	RH not required		1,450	24	6000	144
1F	R170-4	Conventional Hot Cell -4	C4	Nuclear-III B	1 to 30	10	220 to 300	220 to 300	10°C to 40°C	10°C to 40°C	RH not required	RH not required		1,450	24	6000	144
1F	R170-5	Conventional Hot Cell -5	C4	Nuclear-III B	1 to 30	10	220 to 300	220 to 300	10°C to 40°C	10°C to 40°C	RH not required	RH not required		1,450	24	6000	144
1F	R171-1	Conventional Hot Cell Maintenance cell-1	C3	Nuclear-III B	1 to 5	5	120 to 140	120 to 140	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%		600	19.5	6000	117
1F	R171-2	Conventional Hot Cell Maintenance cell-2	C3	Nuclear-III B	1 to 5	5	120 to 140	120 to 140	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%		600	19.5	6000	117
1F	R171-3	Conventional Hot Cell Maintenance cell-3	C3	Nuclear-III B	1 to 5	5	120 to 140	120 to 140	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%		600	19.5	6000	117
1F	R171-4	Conventional Hot Cell Maintenance cell-4	C3	Nuclear-III B	1 to 5	5	120 to 140	120 to 140	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%		600	19.5	6000	117
1F	R171-5	Conventional Hot Cell Maintenance cell-5	C3	Nuclear-III B	1 to 5	5	120 to 140	120 to 140	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%		600	19.5	6000	117
1F	R172	Tritium Laboratory Maintenance zone	C3	Nuclear-III B	1 to 5	5	120 to 140	120 to 140	10°C to 30°C	10°C to 30°C	RH not required	RH not required		4,850	109.74	8800	966
1F	R173	Tritium Laboratory working zone	C2	Nuclear-IIA	2	2	80 to 100	80 to 100	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%		3,650	206.14	8800	1814
1F	AL173	Air Lock 173	C2	Nuclear-IIA	4 to 5	5	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	RH not required	RH not required		1,750	39.63	8800	349
1F	R174	Tritium Laboratory Detrition Process Room	C3	Nuclear-III B	5 to 10	10	120 to 140	120 to 140	10°C to 30°C	10°C to 30°C	RH required	RH required	503	25,850	128.12	8800	1127
1F	R176-1	Tritium Hot cell-1	C4	Nuclear-III B	1 to 30	10	220 to 300	220 to 300	10°C to 30°C	10°C to 30°C	RH not required	RH not required		1,450	24	6000	144
1F	R176-2	Tritium Hot cell-2	C4	Nuclear-III B	1 to 30	10	220 to 300	220 to 300	10°C to 30°C	10°C to 30°C	RH not required	RH not required		1,450	24	6000	144
1F	R176-3	Tritium Hot cell-3	C4	Nuclear-III B	1 to 30	10	220 to 300	220 to 300	10°C to 30°C	10°C to 30°C	RH not required	RH not required		1,450	24	6000	144
1F	R176-4	Tritium Hot cell-4	C4	Nuclear-III B	1 to 30	10	220 to 300	220 to 300	10°C to 30°C	10°C to 30°C	RH not required	RH not required		1,450	24	6000	144
1F	R176-5	Tritium Hot cell-5	C4	Nuclear-III B	1 to 30	10	220 to 300	220 to 300	10°C to 30°C	10°C to 30°C	RH not required	RH not required		1,450	24	6000	144

Table 9: S-1226-111-HVAC Room Characteristics 4/6



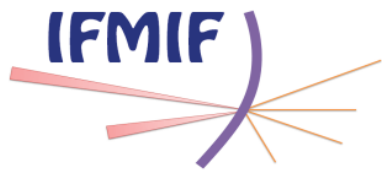
Floor	Room number	Name of the cell	Containment area classification (ISO 17873:2004 - table B1)	Classification of ventilation (ISO 17873:2004 - table B1)	Air change rate (Time/hr)		Atmosphere/Room pressure		Temperature (C DB)		Humidity (% RH)		Air Flow Volume(m3/h)		Room Area (m2)	Room Height(mm)	Room Volume (m3)
					ISO 17873	According to design	Operation (Pa)	Maintenance (Pa)	Operation	Maintenance	Operation	Maintenance	Equipment Load (W/m2)	Max Volume Max(① or ②) (m3/h)			
1F	R175-1	Tritium Hot cell maintenance Cell-1	G3	Nuclear-III	5 to 10	10	120 to 140	120 to 140	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%		1,750	19.5	6000	117
1F	R175-2	Tritium Hot cell maintenance Cell-2	G3	Nuclear-III	5 to 10	10	120 to 140	120 to 140	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%		1,750	19.5	6000	117
1F	R175-3	Tritium Hot cell maintenance Cell-3	G3	Nuclear-III	5 to 10	10	120 to 140	120 to 140	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%		1,750	19.5	6000	117
1F	R175-4	Tritium Hot cell maintenance Cell-4	G3	Nuclear-III	5 to 10	10	120 to 140	120 to 140	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%		1,750	19.5	6000	117
1F	R175-5	Tritium Hot cell maintenance Cell-5	G3	Nuclear-III	5 to 10	10	120 to 140	120 to 140	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%		1,750	19.5	6000	117
1F	R177	Electron microscope working zone	G2	Nuclear-IIA	2	2	80 to 100	80 to 100	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%		5,650	319.18	8800	2809
1F	AL177	Air Lock 177	G2	Nuclear-IIA	4 to 5	5	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	RH not required	RH not required		1,750	290.19	8800	2554
1F	R178	Electron Microscope Maintenance Zone	G3	Nuclear-III	1 to 5	5	120 to 140	120 to 140	10°C to 30°C	10°C to 30°C	RH not required	RH not required		12,800	290.19	8800	2554
1F	R179	Electron Microscope Detritation process room	G3	Nuclear-III	5 to 10	10	120 to 140	120 to 140	10°C to 30°C	10°C to 30°C	RH required	RH required	280	18,200	154.82	8800	1362
1F	R180-1	Electron Microscope Preparation Hot cell-1	G4	Nuclear-III	1 to 30	10	220 to 300	220 to 300	10°C to 30°C	10°C to 30°C	RH not required	RH not required		1,450	24	6000	144
1F	R180-2	Electron Microscope Preparation Hot cell-2	G4	Nuclear-III	1 to 30	10	220 to 300	220 to 300	10°C to 30°C	10°C to 30°C	RH not required	RH not required		1,450	24	6000	144
1F	R180-3	Electron Microscope Preparation Hot cell-3	G4	Nuclear-III	1 to 30	10	220 to 300	220 to 300	10°C to 30°C	10°C to 30°C	RH not required	RH not required		1,450	24	6000	144
1F	R181-1	Electron Microscope Hot cell Maintenance Cell-1	G3	Nuclear-III	1 to 5	5	120 to 140	120 to 140	10°C to 30°C	10°C to 30°C	RH not required	RH not required		600	19.5	6000	117
1F	R181-2	Electron Microscope Hot cell Maintenance Cell-2	G3	Nuclear-III	1 to 5	5	120 to 140	120 to 140	10°C to 30°C	10°C to 30°C	RH not required	RH not required		600	19.5	6000	117
1F	R181-3	Electron Microscope Hot cell Maintenance Cell-3	G3	Nuclear-III	1 to 5	5	120 to 140	120 to 140	10°C to 30°C	10°C to 30°C	RH not required	RH not required		600	19.5	6000	117
2F	R201-A1-1	High Voltage Electric Power Supply Area-1	Unclassified	Industrial		1	Atm.	Atm.	Su-Wi: 20°C to 25°C	Su-Wi: 20°C to 25°C	40% to 50% ±10	40% to 50% ±10	509	2,000	687	5800	3985
2F	R201-A1-2	High Voltage Electric Power Supply Area-2	Unclassified	Industrial		1	Atm.	Atm.	Su-Wi: 20°C to 25°C	Su-Wi: 20°C to 25°C	40% to 50% ±10	40% to 50% ±10	509	2,000	687	5800	3985
2F	R201-A2-1	Local Control Rack-1	Unclassified	Industrial		1	Atm.	Atm.	Su-Wi: 20°C to 25°C	Su-Wi: 20°C to 25°C	40% to 50% ±10	40% to 50% ±10	204	2,500	737	5800	4275
2F	R201-A2-2	Local Control Rack-2	Unclassified	Industrial		1	Atm.	Atm.	Su-Wi: 20°C to 25°C	Su-Wi: 20°C to 25°C	40% to 50% ±10	40% to 50% ±10	204	2,500	737	5800	4275
2F	R201-A3	Corridor and Piping Space	Unclassified	Nuclear-I	1 to 2	1	Atm.	Atm.	10°C to 30°C	10°C to 30°C	RH not required	RH not required		17,650	1551.32	5800	8998
2F	R201-A4-1	RF Source Area-1	Unclassified	Industrial		1	Atm.	Atm.	Su-Wi: 20°C to 25°C	Su-Wi: 20°C to 25°C	40% to 50% ±10	40% to 50% ±10		4,400	386.8	5800	2243
2F	R201-A4-2	RF Source Area-2	Unclassified	Industrial		1	Atm.	Atm.	Su-Wi: 20°C to 25°C	Su-Wi: 20°C to 25°C	40% to 50% ±10	40% to 50% ±10		8,400	386.8	5800	2243
2F	R109-A2-1	Cabling Space-1	G2	Nuclear-IIA	2	2	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	RH not required	RH not required		0	72.6	7500	545
2F	R109-A2-2	Cabling Space-2	G2	Nuclear-IIA	2	2	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	RH not required	RH not required		0	72.6	7500	545
2F	R202-A1-1	Shipping Bay2F-1	Unclassified	Industrial		1	Atm.	Atm.	10°C to 30°C	10°C to 30°C	RH not required	RH not required		350	30.25	5800	175
2F	R202-A1-2	Shipping Bay2F-2	Unclassified	Industrial		1	Atm.	Atm.	10°C to 30°C	10°C to 30°C	RH not required	RH not required		350	30.25	5800	175
2F	R202-A2-1	Assembly/Maintenance Area-1	Unclassified	Industrial		1	Atm.	Atm.	Su-Wi: 20°C to 25°C	Su-Wi: 20°C to 25°C	40% to 50% ±10	40% to 50% ±10		5,500	480.47	5800	2787
2F	R202-A2-2	Assembly/Maintenance Area-2	Unclassified	Industrial		1	Atm.	Atm.	Su-Wi: 20°C to 25°C	Su-Wi: 20°C to 25°C	40% to 50% ±10	40% to 50% ±10		5,500	480.47	5800	2787
2F	C201	Corridor201	Unclassified	Nuclear-I	1 to 2	2	Atm.	Atm.	10°C to 30°C	10°C to 30°C	RH not required	RH not required		250	16.04	5800	93
2F	R220	Control Room	Unclassified	Industrial		1	Atm.	Atm.	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 50% ±10	40% to 50% ±10	1	1,050	345.99	5800	2007
2F	R221	Meeting Room	Unclassified	Industrial		1	Atm.	Atm.	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%		450	36.66	5800	213
2F	C202	Corridor202	Unclassified	Nuclear-I	1 to 2	2	Atm.	Atm.	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%		250	18.74	5800	109
2F	R222	Toilet	Unclassified	Industrial		10	Atm.	Atm.	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%			49.9	5800	289
2F	R223	HP Room	G2	Nuclear-IIA	2	2	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	40% to 50% ±10	40% to 50% ±10		1,750	149.75	5800	869
2F	R224	Remote Handling Control Room	G1	Nuclear-I	1 to 2	2	<60 Pa	<60 Pa	10°C to 30°C	10°C to 30°C	40% to 50% ±10	40% to 50% ±10		750	62.31	5800	361
2F	R225	High Bay	G3	Nuclear-III	1 to 5	5	120 to 140	120 to 140	10°C to 30°C	10°C to 30°C	RH not required	RH not required		15,550	534.9	5800	3102
2F	R226	EOR(Experiment Control Room)	G1	Nuclear-I	1 to 2	2	<60 Pa	<60 Pa	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 50% ±10	40% to 50% ±10	10	1,150	75.49	5800	438
2F	R227	PIE HVAC	G2	Nuclear-IIA	2	2	80 to 100	80 to 100	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%		7,150	471.87	5800	2737
2F	R228	Air Purification Room	G2	Nuclear-IIA	2	2	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	RH not required	RH not required	201	30,400	347.57	5800	2016
2F	AL228	Air Lock 228	G2	Nuclear-IIA	4 to 5	5	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	RH not required	RH not required		350	460	5800	48
2F	AL230	Air Lock 230	G2	Nuclear-IIA	4 to 5	5	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	RH not required	RH not required		250	8.263	5800	48
2F	R229	EDS-2	G3	Nuclear-III	5 to 10	10	120 to 140	120 to 140	10°C to 30°C	10°C to 30°C	RH not required	RH not required	90	14,800	255	5800	1479
2F	C203	Corridor203	G1	Nuclear-I	1 to 2	2	<60 Pa	<60 Pa	10°C to 30°C	10°C to 30°C	RH not required	RH not required		8,550	734.54	5800	4260

Table 10: S-1226-111-HVAC Room Characteristics 5/6



Floor	Room number	Name of the cell	Containment area classification (ISO 17873:2004 - table B1)	Classification of ventilation (ISO 17873:2004 - table B1)	Air change rate (Time/hr)		Atmosphere/Room pressure		Temperature (C DB)		Humidity (% RH)		Air Flow Volume(m3/h)		Room Area (m2)	Room Height(mm)	Room Volume (m3)
					ISO 17873	According to design	Operation (Pa)	Maintenance (Pa)	Operation	Maintenance	Operation	Maintenance	④ Equipment Load (W/m2)	Max Volume Max(① or ②) (m3/h)			
2F	R230	Access Cell	C3	Nuclear-IIIB	1 to 5	5	120 to 140	120 to 140	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	Argon (RH required)	Argon/Helium(RH required)		37,850	630.43	12000	7565
3F	R301-1	Electric Power Receiving Area-1	Unclassified	Industrial		1	Atm.	Atm.	Su-Wi: 20°C to 25°C	Su-Wi: 20°C to 25°C	40% to 50% ±10	40% to 50% ±10	310	1,000	168	5800	974
3F	R301-2	Electric Power Receiving Area-2	Unclassified	Industrial		1	Atm.	Atm.	Su-Wi: 20°C to 25°C	Su-Wi: 20°C to 25°C	40% to 50% ±10	40% to 50% ±10	173	1,750	300.43	5800	1742
3F	R302-1	UPS Room - 1	Unclassified	Industrial		1	Atm.	Atm.	10°C to 30°C	10°C to 30°C	RH not required	RH not required	307	600	97.66	5800	566
3F	R302-2	UPS Room - 2	Unclassified	Industrial		1	Atm.	Atm.	10°C to 30°C	10°C to 30°C	RH not required	RH not required	292	600	102.69	5800	596
3F	R303-1	Low Voltage Electric Power Supply Area-1	Unclassified	Industrial		1	Atm.	Atm.	Su-Wi: 20°C to 25°C	Su-Wi: 20°C to 25°C	40% to 50% ±10	40% to 50% ±10	299	4,650	798.04	5800	4629
3F	R303-2	Low Voltage Electric Power Supply Area-2	Unclassified	Industrial		1	Atm.	Atm.	Su-Wi: 20°C to 25°C	Su-Wi: 20°C to 25°C	40% to 50% ±10	40% to 50% ±10	361	3,850	661.69	5800	3838
3F	R304	Ducting and Piping space-3	Unclassified	Industrial		1	Atm.	Atm.	10°C to 30°C	10°C to 30°C	RH not required	RH not required		10,800	1424	5800	8259
3F	R305-1	Industrial HVAC Room-1	Unclassified	Industrial		1	Atm.	Atm.	10°C to 30°C	10°C to 30°C	RH not required	RH not required		8,850	778.56	5800	4516
3F	R305-2	Industrial HVAC Room-2	Unclassified	Industrial		1	Atm.	Atm.	10°C to 30°C	10°C to 30°C	RH not required	RH not required		8,850	778.56	5800	4516
3F	R109-A3-1	Cabling Space-1	C2	Nuclear-IIIA	4 to 5	5	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	RH not required	RH not required		2,150	72.6	5800	421
3F	R109-A3-2	Cabling Space-2	C2	Nuclear-IIIA	4 to 5	5	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	RH not required	RH not required		2,150	72.6	5800	421
3F	R306-A1-1	Shipping Bay3F-1	Unclassified	Industrial		1	Atm.	Atm.	10°C to 30°C	10°C to 30°C	RH not required	RH not required		500	30.25	5800	175
3F	R306-A1-2	Shipping Bay3F-2	Unclassified	Industrial		1	Atm.	Atm.	10°C to 30°C	10°C to 30°C	RH not required	RH not required		500	30.25	5800	175
3F	R306-A2-1	Assembly/Maintenance Room-1	Unclassified	Industrial		1	Atm.	Atm.	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%	3,000	196.91	5800	1142	
3F	R306-A2-2	Assembly/Maintenance Room-2	Unclassified	Industrial		1	Atm.	Atm.	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%	3,000	196.91	5800	1142	
3F	C301	Corridor301	Unclassified	Industrial		2	Atm.	Atm.	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%	350	480.47	5800	2787	
3F	R307	Utilities	Unclassified	Industrial		1	Atm.	Atm.	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%	80	3,150	534.7	5800	3101
3F	R310	Control Room	Unclassified	Industrial		1	Atm.	Atm.	Su-Wi: 20°C to 25°C	Su-Wi: 20°C to 25°C	40% to 50% ±10	40% to 50% ±10	10	1,200	395.76	5800	2295
3F	R311	Staff Room	Unclassified	Industrial		1	Atm.	Atm.	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%	600	36.72	5800	213	
3F	C302	Corridor302	Unclassified	Industrial		2	Atm.	Atm.	Su: 22°C to 26°C Wi: 18°C to 22°C	Su: 22°C to 26°C Wi: 18°C to 22°C	40% to 60%	40% to 60%	300	18.59	5800	108	
3F	R312	HP Panel Room	Unclassified	Industrial		1	Atm.	Atm.	Su-Wi: 20°C to 25°C	Su-Wi: 20°C to 25°C	40% to 50% ±10	40% to 50% ±10	10	450	149.75	5800	869
3F	C303	Corridor 303	C1	Industrial	1 to 2	1	<60	<60	10°C to 30°C	10°C to 30°C	RH not required	RH not required		6,800	448.2	5800	2600
3F	R313	Computer Room	Unclassified	Industrial		1	Atm.	Atm.	Su-Wi: 20°C to 25°C	Su-Wi: 20°C to 25°C	40% to 50% ±10	40% to 50% ±10	3,200	208.69	5800	1210	
3F	R314	No name	Unclassified	Nuclear-I	1 to 2	1	Atm.	Atm.	10°C to 30°C	10°C to 30°C	RH not required	RH not required		1,850	120.73	5800	700
3F	R315-1	Vault recirculation blower room-1	C2	Nuclear-IIIA	2	2	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	RH not required	RH not required		2,850	186.12	5800	1079
3F	R315-2	Vault recirculation blower room-2	C2	Nuclear-IIIA	2	2	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	RH not required	RH not required		2,850	186.12	5800	1079
3F	R320	Storage cell	C1	Nuclear-I		2	<60 Pa	<60 Pa	10°C to 30°C	10°C to 30°C	RH not required	RH not required		4,800	251.82	5800	1461
3F	R321	Nuclear HVAC	C2	Nuclear-IIIA	2	2	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	RH not required	RH not required		13,400	822.63	5800	4771
3F	R316-1	Ducting and Piping space-1	C2	Nuclear-IIIA	2	2	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	RH not required	RH not required		2,150	141.74	2800	397
3F	R316-2	Ducting and Piping space-2	C2	Nuclear-IIIA	2	2	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	RH not required	RH not required		2,150	141.74	2800	397
4F	R401	HVAC Blower Room	C2	Nuclear-IIIA	2	2	80 to 100	80 to 100	10°C to 30°C	10°C to 30°C	RH not required	RH not required		13,400	822.63	5800	4771
4F	R402	No name	Unclassified	Nuclear-I	1 to 2	1	Atm.	Atm.	10°C to 30°C	10°C to 30°C	RH not required	RH not required		1,850	120.73	5800	700

Table 11:S-1226-111-HVAC Room Characteristics 6/6



S-1241-002

Floor	Room number	Name of the cell	Occupancy room		Access classification		Occupancy classification		Fire sector		Fire protection system				Remarks
			Operation	Regular Maintenance	Classification		IBC	Interpretation	Fire safety target	Fire rated (h)	Fire detection & alarm system		Fire Fighting systemsystem		
					Operation	Maintenance					IBC requirements	According to design	IBC requirements	According to design	
BI	AL001	Air Lock 001	Passage	Y (IM)	Controlled	Controlled	Group B	Group B	N/A	1h-A	Need each one automatic Smoke Detector for Mechanical & Electrical Rooms and Elevator lobbies :IBC Chapter 907.2.18	SD	Need Sprinkler or Alternative Automatic Fire Extinguishing System subject to Code officer approval : IBC Chapter 903.10.1 (Windowless floor or Basement) and Chapter 904 (Alternative Automatic Fire Extinguish System	N/A	Notes
BI	R001	Rad. Waste Measurement cell (LL & VLL)	Y	Y (IM)	Restricted	Restricted	Group B	Group B	N/A	1h-A		SD		FE-#I	*1: During maintenance
BI	R002	Pump Room(Liquid Waste Treatment)	N	Y(LM)	Restricted	Restricted	Group B	Group B	N/A	1h-A		HD		FE	*2: Below free access floor
BI	R003	Liquid waste treatment cell	N	Y(LM)	Restricted	Restricted	Group B	Group B	N/A	1h-A		B-SD		FE	*3: Vendor standard
BI	R004	Hot Cell maintenance Room	Y	Y (IM)	Restricted	Restricted	Group B	Group B	N/A	1h-A		SD		FE-#I	*4: Confined Cable Space if applicable
BI	R005	Irradiating Rad. waste measurement cell	Y ?	Y (IM)	Restricted	Restricted	TBD	Confined cell	N/A	1h-A		SD		FE	*5: If remained in LI trap and/or LI heat exchanger
BI	R006	Irradiating Rad. waste storage cell	Y ?	Y (IM)	Prohibited	Prohibited	TBD	Confined cell	N/A	1h-A		SD		FE	*6: Inside Rig during transportation
BI	R007	Irradiating Rad. waste Treatment Cell	N	Y(LM)	Prohibited	Prohibited	PFHA	Confined cell	Radioactive Material (G4)	2h		ASSD		FE-L*1	
BI	R008	RWTC working zone	Y	Y (IM)	Controlled	Controlled	Group B	Group B	N/A	1h-A		B-SD, MC		FE	
BI	R011	LF Utility Room	Y	Y (IM)	Controlled	Controlled	Group B	Group B	SIC	2h		SD, MC		FE	
BI	R012	Water cooling cell	Y	Y(IM)	Controlled	Controlled	Group B	Group B	N/A	1h-B		B-SD		FE	
BI	R013	Rad. Waste storage cell(LL/VLL)	Y ?	Y (IM)	Restricted	Restricted	TBD	Confined cell	N/A	1h-B		SD		FE	Legend
BI	R014	Detritiation Process Room-1	Y ?	Y (IM)	Controlled	Controlled	Group B	Group B	SIC	2h		SD		CFE, FE	WS Automatic Water Sprinkler
BI	AL014	Air Lock 014	Passage	Y (IM)	Controlled	Controlled	Group B	Group B	N/A	N/A		SD, MC		N/A	DWS Dry Pipe Automatic Water Sprinkler
BI	R015	Organic loop cell	Y	Y(LM)	Controlled	Controlled	Group B	Group B	SIC	2h		B-SD, MC		FE	CFE: Clean Agent (inert gas base) Fire-extinguishing System
BI	R016	Lithium Loop cell	N	Y(LM)	Prohibited	Restricted	PFHA	Confined cell	SIC	2h		ASSD		FE-L*1	CO2 CO2 fire-extinguishing system
BI	AL016	Air Lock 016	Passage	Y (IM)	Controlled	Controlled	Group B	Group B	N/A	1h-A		SD, MC		N/A	HR: Hose Reel
BI	R016bis	Pit for Electro magnetic Pump and Dump tank	N	Y (LM)	Restricted	Restricted	PFHA	Confined cell	SIC	2h		ASSD		FE-L*1	FE: Portable Fire Extinguisher
BI	R017	Li sampling Cell	Y	Y(IM)	Controlled	Controlled	Group B	Group B	Metal liquid	2h		ASSD		FE-L*1	FE-L: Portable Fire Extinguisher for Lithium fire
BI	C001	Comidor 001	Passage	Y (IM)	Controlled	Controlled	Group B	Group B	worker	1h		SD, MC		HR, FE	
BI	S06	Staircase 06	Passage	Y (IM)	supervised	supervised	Group B	Group B	worker	2h		SD, MC		FE	ASSD: Air Sampling Type Smoke Detector
BI	E04	Elevator 04	Passage	Y (IM)	supervised	supervised	Group B	Group B	worker			SD		N/A	SD: Smoke Detector
BI	S05	Staircase 05	Passage	Y (IM)	supervised	supervised	Group B	Group B	worker	2h		SD, MC		FE	B-SD: Beam Type Smoke Detector
BI	E03	Elevator 03	Passage	Y (IM)	supervised	supervised	Group B	Group B	worker		SD	N/A	HD: Heat Detector		
BI	S07	Staircase 07	Passage	Y (IM)	supervised	supervised				2h					
1F	S01	Stair Case 01	Passage	Y(IM)	Normal zone	Normal zone	Group B	Group B	worker	2h	Not required for Group B with below 100 occupants	SD, MC	Automatic Sprinkler (or alternative) system is not required for Group B Occupancy, or required by IBC Chapter 903.10.1 (Windowless floor or Basement)	FE	FMD: Flame Detector
1F	S02	Stair Case 02	Passage	Y(IM)	Normal zone	Normal zone	Group B	Group B	worker	2h		SD, MC		FE	MC: Manual Call Point
1F	R101-1	Changing Room-1	Y	Y(IM)	supervised	supervised	Group B	Group B	N/A	N/A		SD		FE	
1F	R101-2	Changing Room-2	Y	Y(IM)	supervised	supervised	Group B	Group B	N/A	N/A		SD		FE	N/A: Not Applicable
1F	R102	Piping and Cabling Space	Y	Y(IM)	Normal zone	Normal zone	Group B	Group B	Initiator	2h		ASSD		N/A	
1F	R103-1	Shipping Bay-1	Y	Y(IM)	Normal zone	Normal zone	Group B	Group B	N/A	N/A		B-SD		FE	
1F	R103-2	Shipping Bay-2	Y	Y(IM)	Normal zone	Normal zone	Group B	Group B	N/A	N/A		B-SD		FE	
1F	R104-1	Assembly/Shipping Bay-1	Y	Y(IM)	supervised	supervised	Group B	Group B	N/A	N/A		B-SD, MC		HR, FE	
1F	R104-2	Assembly/Shipping Bay-2	Y	Y(IM)	supervised	supervised	Group B	Group B	N/A	N/A		B-SD, MC		HR, FE	
1F	R105	Assembly/Maintenance Bay	Y	Y(IM)	Controlled	Controlled	Group B	Group B	N/A	N/A		SD		FE	

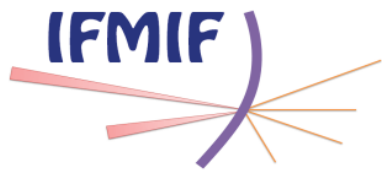
Table 12: S-1241-002- Room Characteristics for Fire Protection 1/6

S-1241-002

Floor	Room number	Name of the cell	Occupancy room		Access classification		Occupancy classification		Fire sector		Fire protection system				Remarks
			Operation	Regular Maintenance	Classification		IBC	Interpretation	Fire safety target	Fire rated (h)	Fire detection & alarm system		Fire Fighting system		
					Operation	Maintenance					IBC requirements	According to design	IBC requirements	According to design	
1F	R106-1	Non Radiation Cooling Machine Room-1	Y	Y(IM)	Normal zone	Normal zone	Group B	Group B	N/A	N/A		SD, MC		HR, FE	
1F	R106-2	Non Radiation Cooling Machine Room-2	Y	Y(IM)	Normal zone	Normal zone	Group B	Group B	N/A	N/A		SD, MC		HR, FE	
1F	R107-1	Non Radiation Cooling Machine Room-3	Y	Y(IM)	supervised	supervised	Group B	Group B	N/A	N/A		SD, MC		FE	
1F	R107-2	Non Radiation Cooling Machine Room-4	Y	Y(IM)	supervised	supervised	Group B	Group B	N/A	N/A		SD, MC		FE	
1F	R108-1	Radiation Cooling Machine Room-1	Y	Y(LM)	Controlled	Controlled	Group B	Group B	N/A	N/A		SD, HD		FE	
1F	R108-2	Radiation Cooling Machine Room-2	Y	Y(LM)	Controlled	Controlled	Group B	Group B	N/A	N/A		SD, HD		FE	
1F	R109-A1-1	Piping and Cabling Penetration Space-1	Y	Y(LM)	Controlled	Controlled	Group B	Group B	Initiator	2h-L		B-SD		FE	
1F	R109-A1-2	Piping and Cabling Penetration Space-2	Y	Y(LM)	Controlled	Controlled	Group B	Group B	Initiator	2h-M		B-SD		FE	
1F	R110-1	Accelerator Vault-1	N	Y(LM)	Prohibited	Controlled	Group B	Group B	N/A	2h-L		SD		FE*1	
1F	R110-2	Accelerator Vault-2	N	Y(LM)	Prohibited	Controlled	Group B	Group B	N/A	2h-M		SD		FE*1	
1F	C101	Corridor 101	Passage	Y(IM)	Normal zone	Normal zone	Group B	Group B	N/A	N/A		SD		N/A	
1F	R111-1	Shipping Bay-3	Y	Y(IM)	Normal zone	Normal zone	Group B	Group B	N/A	N/A		B-SD		FE	
1F	R111-2	Shipping Bay-4	Y	Y(IM)	Normal zone	Normal zone	Group B	Group B	N/A	N/A		B-SD		FE	
1F	R112-1	Assembly/Maintenance Room-1	Y	Y(LM)	Restricted	Restricted	Group B	Group B	N/A	N/A		SD, MC		FE	
1F	R112-2	Assembly/Maintenance Room-2	Y	Y(LM)	Restricted	Restricted	Group B	Group B	N/A	N/A		SD, MC		FE	
1F	R113-1	Beam Transport Room-1	N	Y(LM)	Prohibited	Restricted	Group B	Group B	N/A	2h-L		SD		FE*1	
1F	R113-2	Beam Transport Room-2	N	Y(LM)	Prohibited	Controlled	Group B	Group B	N/A	2h-M		SD		FE*1	
1F	R114-1	Radiation Isolation Room-1	N	Y(LM)	Prohibited	Restricted	TBD	Confined cell	N/A	2h-L		SD		FE*1	
1F	R114-2	Radiation Isolation Room-2	N	Y(LM)	Prohibited	Restricted	TBD	Confined cell	N/A	2h-M		SD		FE*1	
1F	R120	Entrance	Y	Y(IM)	Normal zone	Normal zone	Group B	Group B	N/A	N/A		N/A		FE	
1F	R121	HP Office	Y	Y(IM)	Normal zone	Normal zone	Group B	Group B	SIG	2h		SD		FE	
1F	R122	Reception Office	Y	Y(IM)	Normal zone	Normal zone	Group B	Group B	N/A	N/A		SD		FE	
1F	R123	Toilet	Y	Y(IM)	Normal zone	Normal zone	Group B	Group B	N/A	N/A		N/A		N/A	
1F	R124	Kitchenette	Y	Y(IM)	Normal zone	Normal zone	Group B	Group B	N/A	N/A		SD		FE	
1F	R125	Changing Room/ Access Room	Y	Y(LM)	supervised	supervised	Group B	Group B	N/A	N/A		SD, MC		FE	
1F	S03	Staircase 03	Passage	Y(IM)	supervised	supervised	Group B	Group B	worker	2h		SD		FE	
1F	E01	Elevator 01	Passage	Y(IM)	supervised	supervised	Group B	Group B	worker		SD		N/A		
1F	S04	Staircase 04	Passage	Y(IM)	supervised	supervised	Group B	Group B	worker	2h		SD		FE	
1F	E02	Elevator 02	Passage	Y(IM)	supervised	supervised	Group B	Group B	worker		SD		N/A		
1F	C102	Corridor 102	Y	Y(IM)	Controlled	Controlled	Group B	Group B	N/A	N/A		B-SD, MC		HR, FE	
1F	C103	Corridor 103	Y	Y(IM)	Controlled	Controlled	Group B	Group B	Worker	1h		SD, MC		HR, FE	
1F	R126	Light component Loading station	Y	Y(LM)	Controlled	Controlled	Group B	Group B	N/A	2h		SD		N/A	
1F	R127	Workshop-1	Y	Y(LM)	Controlled	Controlled	Group B	Group B	N/A	N/A		SD		FE	
1F	R128	Preparation cell-1	Y	Y(IM)	Controlled	Controlled	Group B	Group B	N/A	N/A		SD		FE	
1F	C104	Corridor 104 to access TIR	Y	Y(LM)	Controlled	Controlled	Group B	Group B	Worker	1h		SD, MC		FE	
1F	R129	Target Interface Room	N	Y(LM)	Prohibited	Restricted	PFHA	Confined cell	SIG	2h		ASSD		FE-L*1	

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Table 13: S-1241-002- Room Characteristics for Fire Protection 2/6

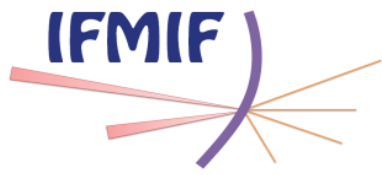


S-1241-002

Floor	Room number	Name of the cell	Occupancy room		Access classification		Occupancy classification		Fire sector		Fire protection system				Remarks
			Operation	Regular Maintenance	Classification		IBC	Interpretation	Fire safety target	Fire rated (h)	Fire detection & alarm system		Fire Fighting system		
					Operation	Maintenance					IBC requirements	According to design	IBC requirements	According to design	
1F	R130	Test Cell	N	N	Prohibited	Prohibited	PFHA	Confined cell	SIG	2h		ASSD		FE	
1F	R131	Hot cell working area	Y	Y(LM)	Controlled	Controlled	Group B	Group B	worker	1h		B-SD, MC		FE	
1F	AL131	Air Lock 131	Passage	Y (IM)	Controlled	Controlled	Group B	Group B	N/A	N/A		SD		N/A	
1F	R132	Component Handling Cell	N	N	Prohibited	Restricted	PFHA	Confined cell	Radioactive Material (G4)	2h-C		ASSD		FE-L*1	
1F	R133	Rig handling Cell (RHC)	N	N	Prohibited	Restricted	PFHA	Confined cell	Radioactive Material (G4)	2h-C		ASSD		FE-L*1	
1F	R134	Maintenance room for RHC	Y	Y (IM)	Restricted	Restricted	Group B	Group B	Radioactive Material (G4)	2h-C		SD		FE	
1F	R135	Maintenance room for RAC/TMAC	Y	Y(IM)	Controlled	Controlled	Group B	Group B	Radioactive Material (G4)	2h-C		SD		FE	
1F	R136	Test Module/Rig Assembling Cell (RAC/TMAC)	N	N	Prohibited	Restricted	PFHA	Confined cell	Radioactive Material (G4)	2h-C		ASSD		FE-L*1	
1F	R137	Hot cell utility room	Y	Y(IM)	Controlled	Controlled	Group B	Group B	Radioactive Material (G4)	2h-C		SD		FE	
1F	R138	Maintenance Room for CHC	Y	Y(LM)	Controlled	Controlled	Group B	Group B	Radioactive Material (G4)	2h-C		SD		FE	
1F	R139	Maintenance Room for Tritium Hot Cell	Y	Y(IM)	Controlled	Controlled	Group B	Group B	Radioactive Material (G4)	2h-C		SD		FE	
1F	R140	Tr. Hot cell	N	N	Prohibited	Restricted	PFHA	Confined cell	Radioactive Material (G4)	2h-C		ASSD		FE*1	
1F	R141	Cooling/Storage Pit-1	N	N	Prohibited	Restricted	PFHA	Confined cell	Metal liquid	2h-D		ASSD		FE-L*1	
1F	R142	Cooling/Storage Pit-2	N	N	Prohibited	Restricted	PFHA	Confined cell	Metal liquid	2h-D		ASSD		FE-L*1	
1F	R143	Cooling/Storage Pit-3	N	N	Prohibited	Restricted	PFHA	Confined cell	Metal liquid	2h-D		ASSD		FE-L*1	
1F	R144	Electric Room	Y	Y(IM)	Controlled	Controlled	Group B	Group B	Initiator	1h		SD		FE	
1F	R145	Local control Room	Y	Y(LM)	Controlled	Controlled	Group B	Group B	N/A	N/A		SD, MC		FE	
1F	R146	Piping space	Y	Y(LM)	Controlled	Controlled	Group B	Group B	N/A	N/A		SD		FE	
1F	C105	Corridor 105	Passage	Y(LM)	Controlled	Controlled	Group B	Group B	Worker	1h		SD, MC		HR, FE	
1F	R147	Heavy component loading station	Y	Y(LM)	Controlled	Controlled	Group B	Group B	N/A	2h		SD		N/A	
1F	R148	Work shop-2	Y	Y(LM)	Controlled	Controlled	Group B	Group B	N/A	N/A		SD		FE	
1F	R149	Utility Room	Y	Y(LM)	Controlled	Controlled	Group B	Group B	N/A	2h		HD		FE	
1F	R150	Helium Room	Y	Y(LM)	Controlled	Controlled	Group B	Group B	N/A	2h		HD		FE	
1F	R151	Tritium Room	Y	Y(IM)	Controlled	Controlled	Group B	Group B	Radioactive Material (G4)	2h		SD		FE	
1F	C106	Corridor 106 to access TIR	Passage	Y(LM)	Controlled	Controlled	Group B	Group B	Worker	1h		SD, MC		FE	
1F	R152	Preparation cell-2	Y	Y(IM)	Controlled	Controlled	Group B	Group B	Worker	1h		SD		FE	
1F	C107	PIE Corridor 107	Passage	Y(IM)	supervised	supervised	Group B	Group B	Worker	1h		SD, MC		HR, FE	
1F	R160	PIE-Office-2	Y	Y(IM)	Controlled	Controlled	Group B	Group B	N/A	1h-E		SD		FE	
1F	R161	PIE-Office-1	Y	Y(IM)	Controlled	Controlled	Group B	Group B	N/A	1h-E		SD		FE	
1F	R162	PIE-Electric Room	Y	Y(IM)	Controlled	Controlled	Group B	Group B	Initiator	1h		SD		FE	
1F	AL163	Air Lock 163	Passage	Y (IM)	Controlled	Controlled	Group B	Group B	N/A	1h-F		SD		N/A	
1F	R163	Glove Box Laboratory	N	Y(LM)	Prohibited	Prohibited	PFHA	Confined cell	Radioactive Material (G4)	1h-F		SD		FE*1	
1F	R164	Glove box laboratory decontamination process room	Y	Y (IM)	Controlled	Controlled	Group B	Group B	SIG	N/A		SD, MC		FE	
1F		Iron cells	N	Y(LM)	Prohibited	Prohibited	PFHA	Confined cell	N/A	N/A		SD		FE*1	
1F	R165	Iron Cell Maintenance zone	Y	Y	Restricted	Restricted	Group B	Group B	Worker	1h-G		SD, MC		FE	
1F	R166	Iron cells working zone	Y	Y(LM)	Controlled	Controlled	Group B	Group B	Worker	1h-G		B-SD, MC		FE	

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Table 14: S-1241-002-Room Characteristics for Fire Protection 3/6



S-1241-002

Floor	Room number	Name of the cell	Occupancy room		Access classification		Occupancy classification		Fire sector		Fire protection system				Remarks
			Operation	Regular Maintenance	Classification		IBC	Interpretation	Fire safety target	Fire rated (h)	Fire detection & alarm system		Fire Fighting systemsystem		
					Operation	Maintenance					IBC requirements	According to design	IBC requirements	According to design	
1F	AL166	Air Lock 166	Passage	Y (IM)	Restricted	Restricted	Group B	Group B	N/A	1h-G		SD		N/A	
1F	R167	Conventional Hot Cell Laboratory working zone	Y	Y (IM)	Controlled	Controlled	Group B	Group B	Worker	1h-H		B-SD, MC		FE	
1F	AL167	Air Lock 167	Passage	Y (IM)	Controlled	Controlled	Group B	Group B	N/A	1h-H		SD		N/A	
1F	R168	Conventional Hot Cell Laboratory Maintenance zone	Y	Y	Restricted	Restricted	Group B	Group B	Worker	1h-H		SD, MC		FE	
1F	R169	Conventional Hot cell Laboratory Detrition Process room	Y	Y (IM)	Controlled	Controlled	Group B	Group B	SIC	1h		SD		FE	
1F	R170-1	Conventional Hot Cell -1	N	Y(LM)	Prohibited	Prohibited	PFHA	Confined cell	Radioactive Material (G4)	N/A		SD		FE*I	
1F	R170-2	Conventional Hot Cell -2	N	Y(LM)	Prohibited	Prohibited	PFHA	Confined cell	Radioactive Material (G4)	N/A		SD		FE*I	
1F	R170-3	Conventional Hot Cell -3	N	Y(LM)	Prohibited	Prohibited	PFHA	Confined cell	Radioactive Material (G4)	N/A		SD		FE*I	
1F	R170-4	Conventional Hot Cell -4	N	Y(LM)	Prohibited	Prohibited	PFHA	Confined cell	Radioactive Material (G4)	N/A		SD		FE*I	
1F	R170-5	Conventional Hot Cell -5	N	Y(LM)	Prohibited	Prohibited	PFHA	Confined cell	Radioactive Material (G4)	N/A		SD		FE*I	
1F	R171-1	Conventional Hot Cell Maintenance cell-1	Y	Y	Restricted	Restricted	TBD	Confined cell	Radioactive Material (G4)	N/A		SD		FE*I	
1F	R171-2	Conventional Hot Cell Maintenance cell-2	Y	Y	Restricted	Restricted	TBD	Confined cell	Radioactive Material (G4)	N/A		SD		FE*I	
1F	R171-3	Conventional Hot Cell Maintenance cell-3	Y	Y	Restricted	Restricted	TBD	Confined cell	Radioactive Material (G4)	N/A		SD		FE*I	
1F	R171-4	Conventional Hot Cell Maintenance cell-4	Y	Y	Restricted	Restricted	TBD	Confined cell	Radioactive Material (G4)	N/A		SD		FE*I	
1F	R171-5	Conventional Hot Cell Maintenance cell-5	Y	Y	Restricted	Restricted	TBD	Confined cell	Radioactive Material (G4)	N/A		SD		FE*I	
1F	R172	Tritium Laboratory Maintenance zone	Y	Y (IM)	Controlled	Controlled	Group B	Group B	Worker	1h-J		SD		FE	
1F	R173	Tritium Laboratory working zone	Y	Y (IM)	Controlled	Controlled	Group B	Group B	Worker	1h-J		B-SD, MC		FE	
1F	AL173	Air Lock 173	Passage	Y (IM)	Controlled	Controlled	Group B	Group B	N/A	1h-J		SD		N/A	
1F	R174	Tritium Laboratory Detrition Process Room	Y	Y (IM)	Controlled	Controlled	Group B	Group B	SIC	1h		SD		FE	
1F	R176-1	Tritium Hot cell-1	Y	Y(LM)	Controlled	Controlled	PFHA	Confined cell	Radioactive Material (G4)	N/A		SD		FE*I	
1F	R176-2	Tritium Hot cell-2	Y	Y(LM)	Controlled	Controlled	PFHA	Confined cell	Radioactive Material (G4)	N/A		SD		FE*I	
1F	R176-3	Tritium Hot cell-3	Y	Y(LM)	Controlled	Controlled	PFHA	Confined cell	Radioactive Material (G4)	N/A		SD		FE*I	
1F	R176-4	Tritium Hot cell-4	Y	Y(LM)	Controlled	Controlled	PFHA	Confined cell	Radioactive Material (G4)	N/A		SD		FE*I	
1F	R176-5	Tritium Hot cell-5	Y	Y(LM)	Controlled	Controlled	PFHA	Confined cell	Radioactive Material (G4)	N/A		SD		FE*I	
1F	R175-1	Tritium Hot cell maintenance Cell-1	Y	Y(LM)	Restricted	Restricted	TBD	Confined cell	Radioactive Material (G4)	N/A		SD		FE*I	
1F	R175-2	Tritium Hot cell maintenance Cell-2	Y	Y(LM)	Restricted	Restricted	TBD	Confined cell	Radioactive Material (G4)	N/A		SD		FE*I	
1F	R175-3	Tritium Hot cell maintenance Cell-3	Y	Y(LM)	Restricted	Restricted	TBD	Confined cell	Radioactive Material (G4)	N/A		SD		FE*I	
1F	R175-4	Tritium Hot cell maintenance Cell-4	Y	Y(LM)	Restricted	Restricted	TBD	Confined cell	Radioactive Material (G4)	N/A		SD		FE*I	
1F	R175-5	Tritium Hot cell maintenance Cell-5	Y	Y(LM)	Restricted	Restricted	TBD	Confined cell	Radioactive Material (G4)	N/A		SD		FE*I	
1F	R177	Electron microscope working zone	Y	Y (IM)	Controlled	Controlled	Group B	Group B	Worker	1h-K		B-SD, MC		FE	
1F	AL177	Air Lock 177	Passage	Y (IM)	Controlled	Controlled	Group B	Group B	N/A	1h-K		SD		N/A	
1F	R178	Electron Microscope Maintenance Zone	Y	Y	Restricted	Restricted	TBD	Confined cell	Worker	1h-K		SD		FE	
1F	R179	Electron Microscope Detritation process room	Y	Y (IM)	Controlled	Controlled	Group B	Group B	SIC	1h		SD		FE	
1F	R180-1	Electron Microscope Preparation Hot cell-1	N	Y	Prohibited	Prohibited	PFHA	Confined cell	Radioactive Material (G4)	N/A		SD		FE*I	
1F	R180-2	Electron Microscope Preparation Hot cell-2	N	Y	Prohibited	Prohibited	PFHA	Confined cell	Radioactive Material (G4)	N/A		SD		FE*I	
1F	R180-3	Electron Microscope Preparation Hot cell-3	N	Y	Prohibited	Prohibited	PFHA	Confined cell	Radioactive Material (G4)	N/A		SD		FE*I	

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Table 15: S-1241-002- Room Characteristics for Fire Protection 4/6

S-1241-002

Floor	Room number	Name of the cell	Occupancy room		Access classification		Occupancy classification		Fire sector		Fire protection system				Remarks
			Operation	Regular Maintenance	Classification		IBC	Interpretation	Fire safety target	Fire rated (h)	Fire detection & alarm system		Fire Fighting system		
					Operation	Maintenance					IBC requirements	According to design	IBC requirements	According to design	
1F	R181-1	Electron Microscope Hot cell Maintenance Cell-1	N	Y	Restricted	Restricted	TBD	Confined cell	Radioactive Material (C4)	N/A		SD		FE*1	
1F	R181-2	Electron Microscope Hot cell Maintenance Cell-2	N	Y	Restricted	Restricted	TBD	Confined cell	Radioactive Material (C4)	N/A		SD		FE*1	
1F	R181-3	Electron Microscope Hot cell Maintenance Cell-3	N	Y	Restricted	Restricted	TBD	Confined cell	Radioactive Material (C4)	N/A		SD		FE*1	
2F	R201-A1-1	High Voltage Electric Power Supply Area-1	Y	Y(IM)	Normal zone	Normal zone	Group B	Group B	N/A	N/A	Not required for Group B with below 100 occupants	B-SD	Automatic Sprinkler (or alternative) system is not required for Group B Occupancy, or required by IBC Chapter 903.10.1 (Windowless floor or Basement)	FE	
2F	R201-A1-2	High Voltage Electric Power Supply Area-2	Y	Y(IM)	Normal zone	Normal zone	Group B	Group B	N/A	N/A		B-SD		FE	
2F	R201-A2-1	Local Control Rack-1	Y	Y(IM)	Normal zone	Normal zone	Group B	Group B	N/A	N/A		SD, MC		FE	
2F	R201-A2-2	Local Control Rack-2	Y	Y(IM)	Normal zone	Normal zone	Group B	Group B	N/A	N/A		SD, MC		FE	
2F	R201-A3	Corridor and Piping Space	Y	Y(IM)	supervised	supervised	Group B	Group B	N/A	N/A		B-SD, MC		FE	
2F	R201-A4-1	RF Source Area-1	Y	Y(IM)	Normal zone	Normal zone	Group B	Group B	N/A	N/A		B-SD		FE	
2F	R201-A4-2	RF Source Area-2	Y	Y(IM)	Normal zone	Normal zone	Group B	Group B	N/A	N/A		B-SD		FE	
2F	R109-A2-1	Cabling Space-1	Y	Y(LM)	Controlled	Controlled	Group B	Group B	Initiator	2h		B-SD		FE	
2F	R109-A2-2	Cabling Space-2	Y	Y(LM)	Controlled	Controlled	Group B	Group B	Initiator	2h		B-SD		FE	
2F	R202-A1-1	Shipping Bay2F-1	Y	Y(IM)	Normal zone	Normal zone	Group B	Group B	N/A	N/A		B-SD		FE	
2F	R202-A1-2	Shipping Bay2F-2	Y	Y(IM)	Normal zone	Normal zone	Group B	Group B	N/A	N/A		B-SD		FE	
2F	R202-A2-1	Assembly/Maintenance Area-1	Y	Y(IM)	Normal zone	Normal zone	Group B	Group B	N/A	N/A		SD, HD, MC		FE	
2F	R202-A2-2	Assembly/Maintenance Area-2	Y	Y(IM)	Normal zone	Normal zone	Group B	Group B	N/A	N/A		SD, HD, MC		FE	
2F	C201	Corridor201	Passage	Y(LM)	Controlled	Controlled	Group B	Group B	N/A	N/A		SD		N/A	
2F	R220	Control Room	Y	Y(IM)	Normal zone	Normal zone	Group B	Group B	Worker	2h		SD, MC		FE	
2F	R221	Meeting Room	Y	Y(IM)	Normal zone	Normal zone	Group B	Group B	N/A	N/A		SD		FE	
2F	C202	Corridor202	Passage	Y(LM)	Controlled	Controlled	Group B	Group B	N/A	N/A		SD, MC		FE	
2F	R222	Toilet	Y	Y(IM)	Normal zone	Normal zone	Group B	Group B	N/A	N/A		N/A		N/A	
2F	R223	HP Room	Y	Y(LM)	Controlled	Controlled	Group B	Group B	SIC	N/A		SD		FE	
2F	R224	Remote Handling Control Room	Y	Y(LM)	Controlled	Controlled	Group B	Group B	N/A	N/A		SD		FE	
2F	R225	High Bay	Y	Y(LM)	Controlled	Controlled	Group B	Group B	N/A	N/A	SD	FE			
2F	R226	ECR(Experiment Control Room)	Y	Y(LM)	Controlled	Controlled	Group B	Group B	N/A	N/A	SD	FE			
2F	R227	PIE HVAC	Y	Y(LM)	Controlled	Controlled	Group B	Group B	SIC	2h	SD	FE			
2F	R228	Ar Purification Room	Y	Y(LM)	Controlled	Controlled	Group B	Group B	SIC	2h	SD	FE			
2F	AL228	Air Lock 228	Passage	Y (IM)	Controlled	Controlled		Group B	N/A	N/A	N/A	N/A			
2F	AL230	Air Lock 230	Passage	Y (IM)	Controlled	Controlled	Group B	Group B	N/A	N/A	SD	N/A			
2F	R229	EDS-2	Y	Y (IM)	Controlled	Controlled	Group B	Group B	SIC	2h	SD	CFE, FE			
2F	C203	Corridor203	Passage	Y(LM)	Controlled	Controlled	Group B	Group B	N/A	N/A	SD, MC	HR, FE			
2F	R230	Access Cell	N	Y(LM)	Prohibited	Restricted	PFHA	Confined cell	Metal liquid	2h	ASSD	FE*LI			
3F	R301-1	Electric Power Receiving Area-1	Y	Y(IM)	Normal zone	Normal zone	Group B	Group B	Initiator	N/A	Not required for Group B with below 100 occupants	SD, MC	Automatic Sprinkler (or alternative) system is not required for Group B Occupancy, or required by IBC Chapter 903.10.1	FE	

Table 16: S-1241-002-Room Characteristics for Fire Protection 5/6

S-1241-002

Floor	Room number	Name of the cell	Occupancy room		Access classification		Occupancy classification		Fire sector		Fire protection system				Remarks
			Operation	Regular Maintenance	Classification		IBC	Interpretation	Fire safety target	Fire rated (h)	Fire detection & alarm system		Fire Fighting system		
					Operation	Maintenance					IBC requirements	According to design	IBC requirements	According to design	
3F	R301-2	Electric Power Receiving Area-2	Y	Y(IM)	Normal zone	Normal zone	Group B	Group B	Initiator	N/A		SD, MC	Chapter 300.10.1 (Windowless floor or Basement)	FE	
3F	R302-1	UPS Room - 1	Y	Y(IM)	Normal zone	Normal zone	Group B	Group B	SIG	N/A		SD		FE	
3F	R302-2	UPS Room - 2	Y	Y(IM)	Normal zone	Normal zone	Group B	Group B	SIG	N/A		SD		FE	
3F	R303-1	Low Voltage Electric Power Supply Area-1	Y	Y(IM)	Normal zone	Normal zone	Group B	Group B	Initiator	N/A		SD		FE	
3F	R303-2	Low Voltage Electric Power Supply Area-2	Y	Y(IM)	Normal zone	Normal zone	Group B	Group B	Initiator	N/A		SD		FE	
3F	R304	Ducting and Piping space-3	Y	Y(IM)	Normal zone	Normal zone	Group B	Group B	N/A	N/A		SD, HD		FE	
3F	R305-1	Industrial HVAC Room-1	Y	Y(IM)	Normal zone	Normal zone	Group B	Group B	N/A	N/A		HD		FE	
3F	R305-2	Industrial HVAC Room-2	Y	Y(IM)	Normal zone	Normal zone	Group B	Group B	N/A	N/A		HD		FE	
3F	R109-A3-1	Cabling Space-1	Y	Y(LM)	Controlled	Controlled	Group B	Group B	Initiator	2h		ASSD		N/A	
3F	R109-A3-2	Cabling Space-2	Y	Y(LM)	Controlled	Controlled	Group B	Group B	Initiator	2h		ASSD		N/A	
3F	R306-A1-1	Shipping Bay3F-1	Y	Y(IM)	Normal zone	Normal zone	Group B	Group B	N/A	N/A		SD		FE	
3F	R306-A1-2	Shipping Bay3F-2	Y	Y(IM)	Normal zone	Normal zone	Group B	Group B	N/A	N/A		SD		FE	
3F	R306-A2-1	Assembly/Maintenance Room-1	Y	Y(IM)	Normal zone	Normal zone	Group B	Group B	N/A	N/A		SD, HD, MC		HR, FE	
3F	R306-A2-2	Assembly/Maintenance Room-2	Y	Y(IM)	Normal zone	Normal zone	Group B	Group B	N/A	N/A		SD, HD, MC		HR, FE	
3F	C301	Comidor301	Passage	Y(IM)	Normal zone	Normal zone	Group B	Group B	N/A	N/A		SD, MC		FE	
3F	R307	Utilities	Y	Y(IM)	Normal zone	Normal zone	Group B	Group B	N/A	N/A		SD, MC		FE	
3F	R310	Control Room	Y	Y(IM)	Normal zone	Normal zone	Group B	Group B	Worker	2h-N		SD		FE	
3F	R311	Staff Room	Y	Y(IM)	Normal zone	Normal zone	Group B	Group B	N/A	N/A		SD		FE	
3F	C302	Comidor302	Passage	Y(IM)	Normal zone	Normal zone	Group B	Group B	N/A	N/A		SD, MC		N/A	
3F	R312	HP Panel Room	Y	Y(IM)	Normal zone	Normal zone	Group B	Group B	SIG	2h-N		SD		FE	
3F	C303	Comidor 303	Passage	Y(IM)	Normal zone	Normal zone	Group B	Group B	N/A	N/A		SD, MC		HR, FE	
3F	R313	Computer Room	Y	Y(IM)	Normal zone	Normal zone	Group B	Group B	Initiator	1h		SD		FE	
3F	R314	No name	Y	Y(IM)	Controlled	Controlled	Group B	Group B	N/A	N/A		SD		FE	
3F	R315-1	Vault recirculation blower room-1	N	Y	Y(LM)	Controlled	Group B	Group B	N/A	N/A		HD		FE	
3F	R315-2	Vault recirculation blower room-2	N	Y	Y(LM)	Controlled	Group B	Group B	N/A	N/A		HD		FE	
3F	R320	Storage cell	Y	Y(IM)	Controlled	Controlled	Group B	Group B	N/A	N/A		SD		FE	
3F	R321	Nuclear HVAC	Y	Y(LM)	Controlled	Controlled	Group B	Group B	SIG	2h		SD, HD		FE	
3F	R316-1	Ducting and Piping space-1	N	Y(IM)	Normal zone	Normal zone	Group B	Group B	Initiator	N/A		HD		N/A	
3F	R316-2	Ducting and Piping space-2	N	Y(IM)	Normal zone	Normal zone	Group B	Group B	Initiator	N/A		HD		N/A	
4F	R401	HVAC Blower Room	Y	Y(LM)	Controlled	Controlled	Group B	Group B	SIG	2h		SD, HD		FE	
4F	R402	No name	Y	Y(IM)	Controlled	Controlled	Group B	Group B	N/A	N/A		SD		FE	

¹ Maintenance: LM (Long maintenance:), IM (Intermediate maintenance:), TY (Ten yearly)

Table 17: S-1241-002-Room Characteristics for Fire Protection 6/6

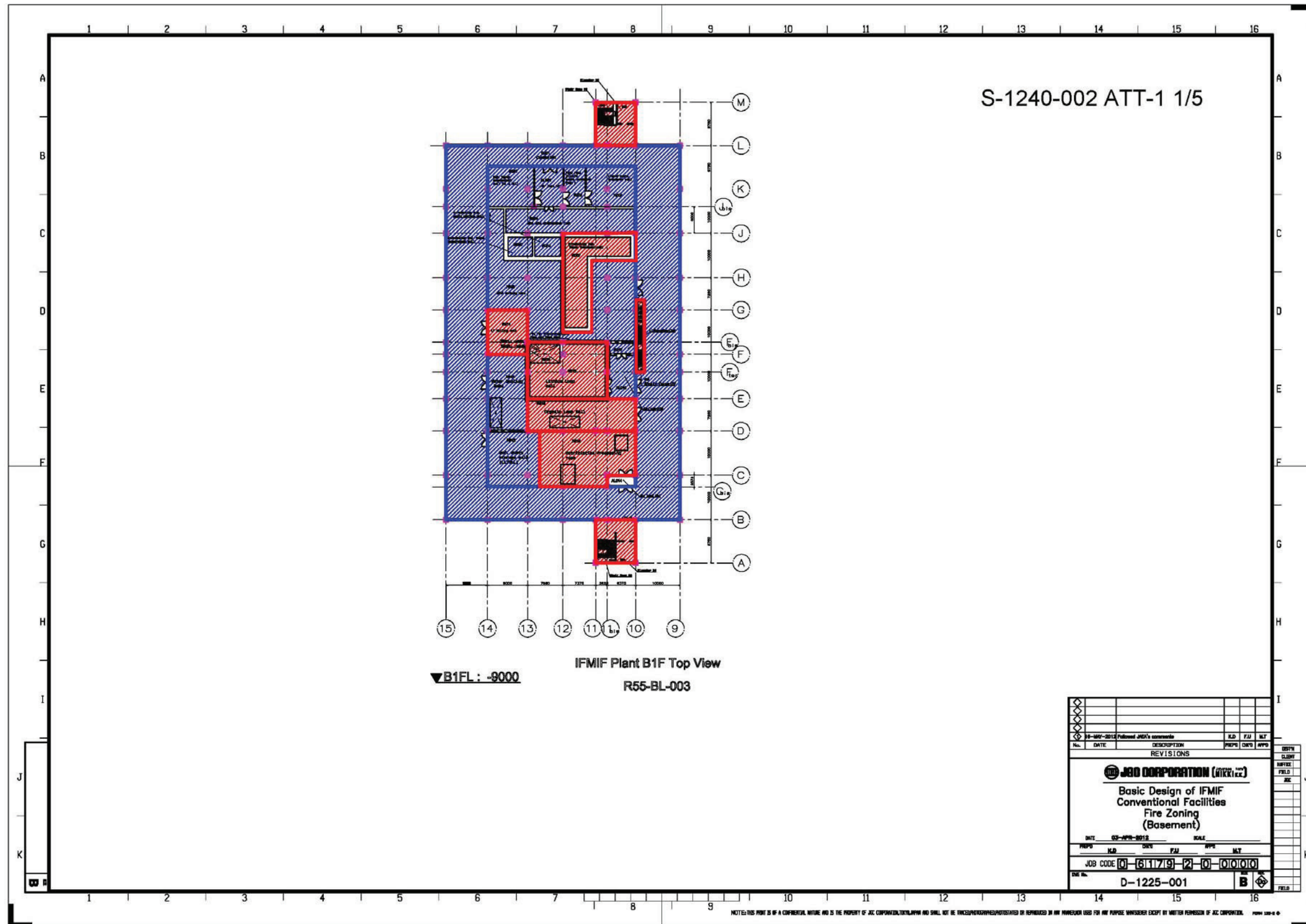


Figure 6-20: Fire Wall Layout (basement) 1/5

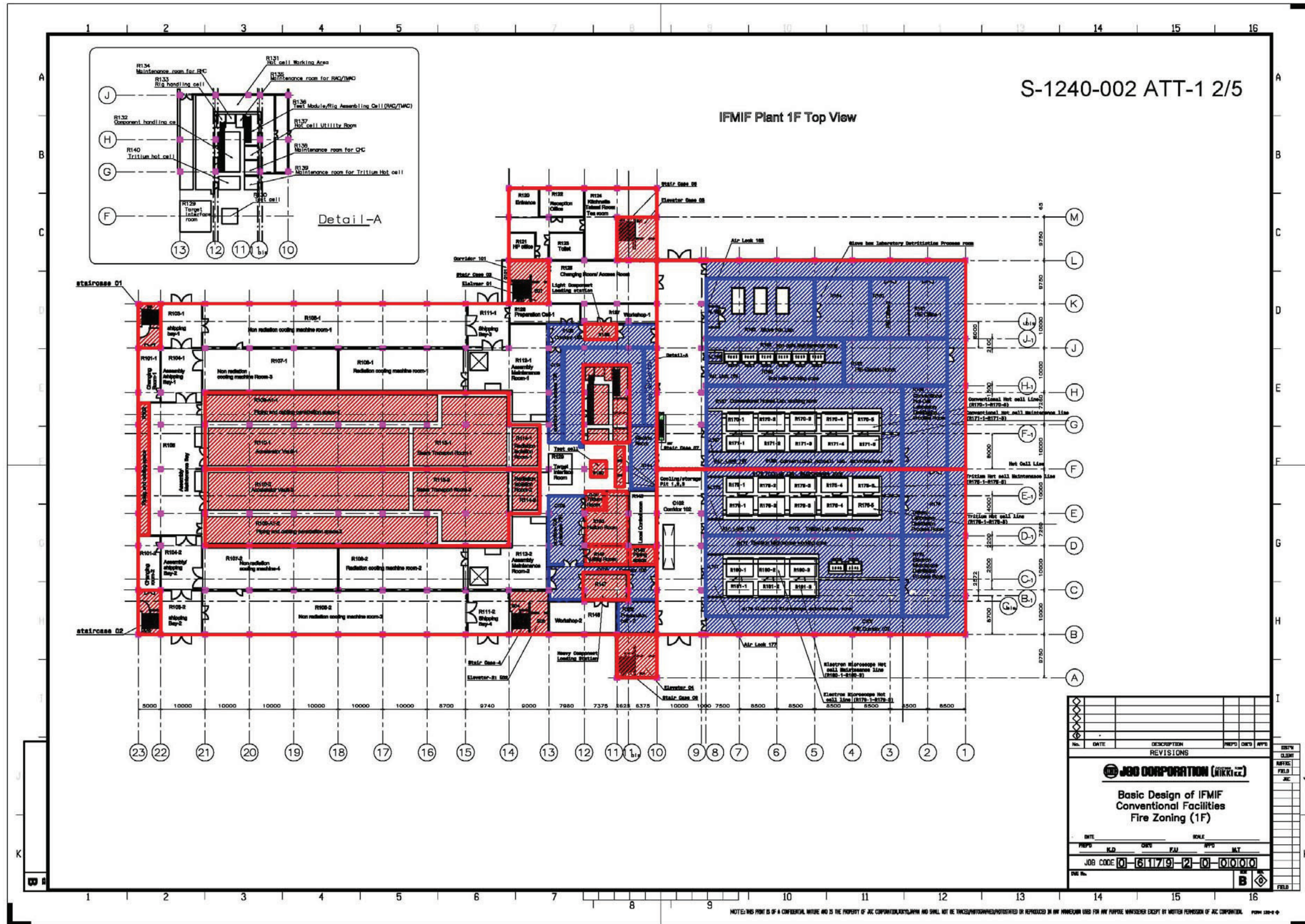


Figure 6-21: Fire Wall Layout (1F) 2/5

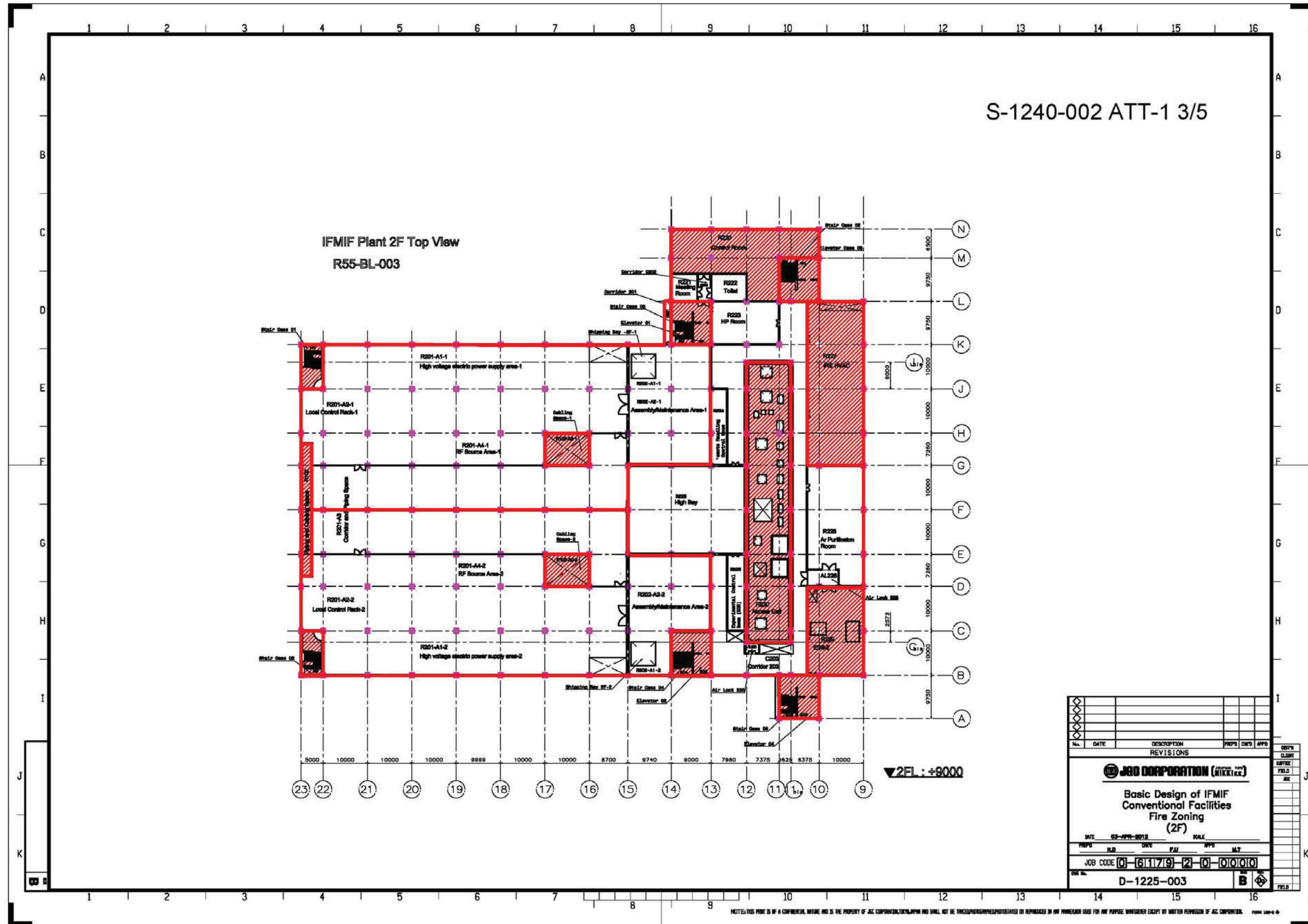


Figure 6-22: Fire Wall Layout (2F) 3/5

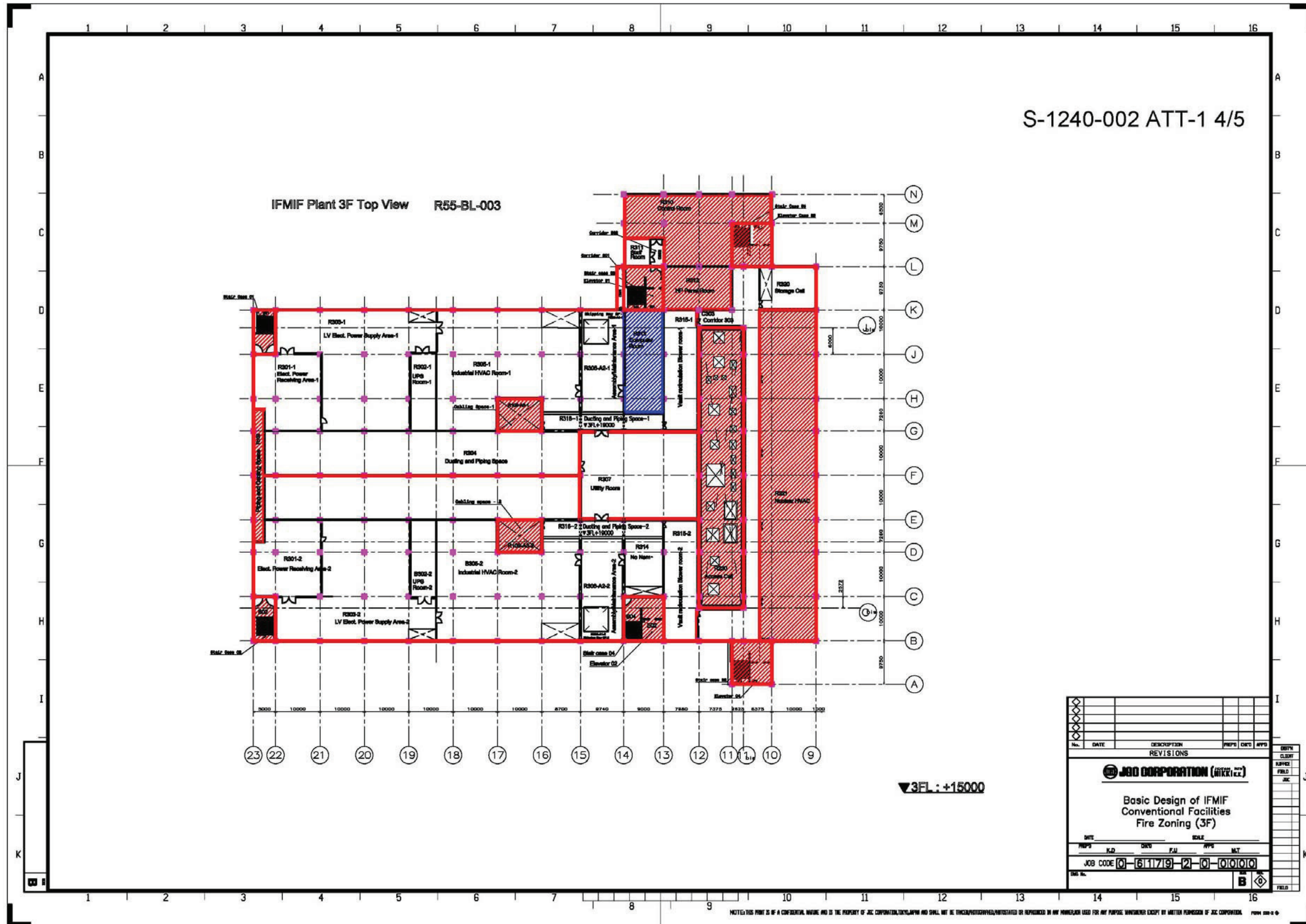


Figure 6-23: Fire Wall Layout (3F) 4/5

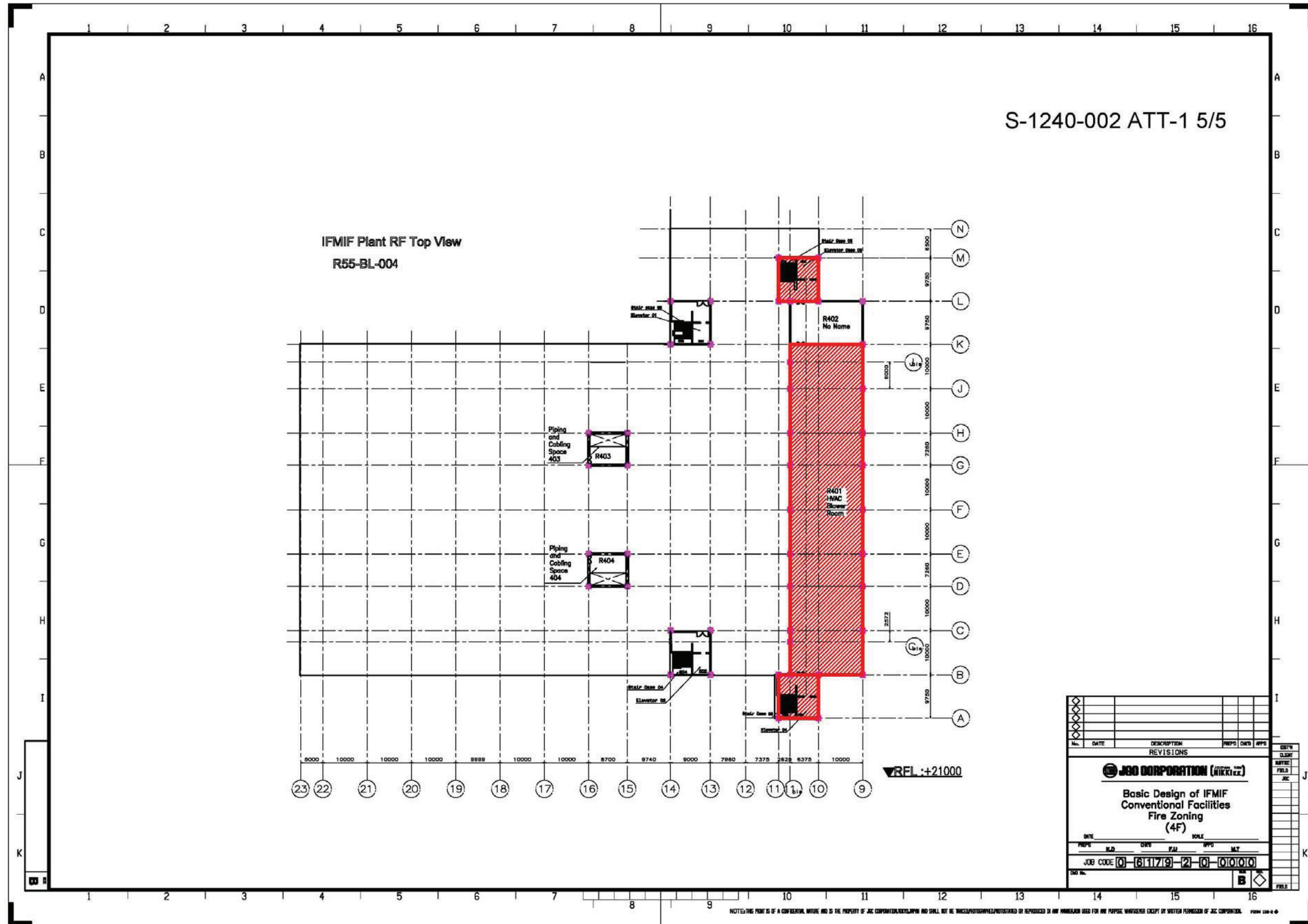


Figure 6-24: Fire Wall Layout (4F) 5/5



System Design Description Document (DDD)

Electrical Power System (EPS)

PBS 5.3.2.0.0

Abstract: This document describes the Electrical Power System (EPS) considered as a system belonging to the Conventional Facilities. Key functions of the system are here presented, as well as interfaces with bounding facilities/systems, main design assumptions and input data necessary for the design of the system.

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Version: 1.0

Date: 06/09/2012

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1. System Functions and Basic Configuration

1.1 System Functions

The Electrical Power System (EPS) has the following main functions:

- It receives the AC power from the commercial transmission grid, transforms it to appropriate voltage levels and distributes it to the IFMIF Facilities / systems requiring steady state electric power. The total power of all connected loads is estimated to be approximately 90 MVA.
- In the event of loss of off-site power, the EPS incorporates on-site emergency power sources (diesel generators, uninterruptible power supply systems and DC batteries) to supply the loads classified as Safety Important Components.
- It compensates the reactive power consumed by the systems / components supplied by the EPS.
- It provides monitoring, control, and protection of electric power sources and distribution including functions of start-up; recovery from interruptions, load prioritization, sequencing, fault protection and fault isolation.
- It provides control and protection of its own components and provides on / off control of electrical power flow to the loads, but do not provide control or protection of the loads themselves, which will be the responsibility of the corresponding systems / components.

To accomplish the above mentioned functions the EPS is composed by the following three (3) subsystems: i) Power System Substation; ii) Emergency Power System; and iii) Electric Distribution System.

1.2 System Basic Configuration

The following Table 1-1 presents the breakdown of the systems into its subsystems (PBS L4).

PBS Number					PBS Item
1	2	3	4	5	
5	0	0	0	0	Conventional Facilities
	3	0	0	0	Plant Services
		2	0	0	<i>Electrical Power System</i>
			1	0	<i>Power System Substation</i>
			2	0	<i>Emergency Power System</i>
			3	0	<i>Electric Distribution System</i>

Table 1-1: EPS PBS Location

1.2.1 Power System Substation (PBS: 5.3.2.1.0)

Power System Substation is the system related to power receiving from commercial grid. Under normal operating condition, IFMIF is fed through the commercial grid by two (2) lines of redundant 66kV (HV: High Voltage) electrical power; 100% x 2. The receiving voltage is step-downed to 6.6kV (MV: Medium Voltage) via HV/MV power transformers, then being distributed to medium voltage switchgears (MV SWGRs) which feed power to MV SWGRs of Emergency Power System and Electric Distribution System. All the equipment related to this system is installed in the dedicated Electrical Switchyard Building.

The system is further breakdown as per the following Table 1-2,

Equipment List (Electrical Power System)							Doc.No. S-1226-031 RI
Building	No.	Equipment No.	Equipment Name	Size (WxDxH) (mm)		Q'ty	SUBSYSTEM
Electrical Switchyard Building	H01	GIS-01	66kV SF6 Gas Insulated Switchgear	x	x	1 Set	Power System Substation
	H02	MTR-01	66kV/6.6kV Main Transformer 30MVA ONAN	x	x	1 Set	//
	H03	MTR-02	66kV/6.6kV Main Transformer 30MVA ONAN	x	x	1 Set	//
	H04	MTR-03	66kV/6.6kV Main Transformer 30MVA ONAN	x	x	1 Set	//
	H05	MC-01	6.6kV 3ph-3W Switchgear	x	x	1 Set	//
	H06	MC-02	6.6kV 3ph-3W Switchgear	x	x	1 Set	//
	H07	MC-03	6.6kV 3ph-3W Switchgear	x	x	1 Set	//
	H08	TR-01A	6.6kV/0.4-0.23kV Transformer 150kVA Dry	x	x	1 Set	//
	H09	LDP-01	0.4-0.23kV LV Distribution Panel	x	x	1 Set	//
Emergency Power Building-1	G11	EG-1A	6.6kV 3ph-3W Emergency Generator 4000kVA(Diesel)	x	x	1 Set	Emergency Power System
	G12	EG-1B	6.6kV 3ph-3W Emergency Generator 4000kVA(Diesel)	x	x	1 Set	//
	G13	MC-EG1M	6.6kV 3ph-3W Switchgear (With Syncro. Panel)	x	x	3 Panel	//
	G14	MC-EG1	6.6kV 3ph-3W Switchgear	x	x	4 Panel	//
Emergency Power Building-2	G21	EG-2A	6.6kV 3ph-3W Emergency Generator 4000kVA(Diesel)	x	x	1 Set	Emergency Power System
	G22	EG-2B	6.6kV 3ph-3W Emergency Generator 4000kVA(Diesel)	x	x	1 Set	//
	G23	MC-EG2M	6.6kV 3ph-3W Switchgear (With Syncro. Panel)	x	x	3 Panel	//
	G24	MC-EG2	6.6kV 3ph-3W Switchgear	x	x	4 Panel	//

Table 1-2: Equipment List for Electric Power System 1/3

1.2.2 Emergency Power System (PBS: 5.3.2.2.0)

Emergency Power System is the system related to emergency power generation. In case of grid power failure, emergency generators will be started and will feed electric power to the loads classified as SIC-1 and SIC-2. Emergency Generators are provided as a redundant system (50% x 2+2). Diesel engine is selected as the driver. The fuel is diesel oil. Each generator and relevant equipment is installed in dedicated buildings, namely: Emergency Power Building 1 and Emergency Power Building 2.

The system is further breakdown as per previous Table 1-2.

1.2.3 Electric Distribution System (PBS: 5.3.2.3.0)

Electric Distribution Systems covers power distribution within the IFMIF. All electrical equipment / components excluding the ones under PBS 5.3.2.1 and PBS 5.3.2.2 are within the scope of this system.

Basically, the system is classified based on Safety Important Class (Ref. [1]) into three (3) groups based upon the loads served,

- SR/Non-SIC loads : Single Power System
- SIC-2 loads : Power System + Emergency Power System
- SIC-1 loads : Redundancy Power System + Emergency Power System

However, the load connected to Emergency Power System also exists by the requirement of each facility besides the above.

Uninterruptible Power Supply (UPS), Direct Current (DC) Battery and Constant Voltage Constant Frequency (CVCF) are needed with each facility are scope of each facility.

UPSs, DC Batteries and CVCFs indicated here are only for Conventional Facility (CF).

The system is further breakdown as per the following Table 1-3 and Table 1-4,

Equipment List (Electrical Power System)							Doc.No. S-1226-031 RI
Building	No.	Equipment No.	Equipment Name	Size (WxDxH) (mm)	Q'ty	SUBSYSTEM	
Main Building	R301-I Elect. Power Receiving Area-I	M11	MC-011	6.6kV 3ph-3W Switchgear	800 x 2000 x 2350	15 Panel	For HVAC-SR
		M12	MC-012	6.6kV 3ph-3W Switchgear	800 x 2000 x 2350	7 Panel	For HRS.SMS.EGDS-SR
		M13	MC-021	6.6kV 3ph-3W Switchgear	800 x 2000 x 2350	7 Panel	For SGS.EGDS-SIC-1(A)
		M14	SC-011	6.6kV Power Capacitor	900 x 1400 x 2100	4 Panel	For HVAC-SR
		M15	SC-012	6.6kV Power Capacitor	900 x 1400 x 2100	3 Panel	For HRS.SMS.EGDS-SR
		M16	SC-021	6.6kV Power Capacitor	900 x 1400 x 2100	3 Panel	For SGS.EGDS-SIC-1(A)
	R302-I UPS Room-I	U11	UPS-A1	AC Uninterrupted Power System-3 φ400V 200kVA	7800 x 1000 x 1950	1 Set	Electric Distribution System
		U12	UPS-A2	AC Uninterrupted Power System-3 φ400V 200kVA	7800 x 1000 x 1950	1 Set	"
		U13	DC-A1	DC Battery & Charger-100V 100Ah	1400 x 1000 x 1950	1 Set	"
		U14	DC-A2	DC Battery & Charger-100V 100Ah	1400 x 1000 x 1950	1 Set	"
	R303-I LV Elect. Power Supply Area-I	T11	TR-011	6.6kV/0.4-0.23kV Transformer 1500kVA Dry	2500 x 1800 x 2350	1 Set	For HVAC-SR
		T12	TR-012	6.6kV/0.4-0.23kV Transformer 1500kVA Dry	2500 x 1800 x 2350	1 Set	For HVAC-SR
		T13	TR-013	6.6kV/0.4-0.23kV Transformer 1500kVA Dry	2500 x 1800 x 2350	1 Set	For HRS.SMS.EGDS-SR
		T14	TR-014	6.6kV/0.4-0.23kV Transformer 1500kVA Dry	2500 x 1800 x 2350	1 Set	For HRS.SMS.EGDS-SR
		T15	TR-015	6.6kV/0.4-0.23kV Transformer 1500kVA Dry	2500 x 1800 x 2350	1 Set	For Building Utility etc-SR
		T16	TR-021A	6.6kV/0.4-0.23kV Transformer 1500kVA Dry	2500 x 1800 x 2350	1 Set	For SGS.EGDS-SIC-1(A)
		T17	TR-022A	6.6kV/0.4-0.23kV Transformer 1500kVA Dry	2500 x 1800 x 2350	1 Set	For SGS.EGDS-SIC-1(A)
		P11	PC-011	0.4-0.23kV 3ph-4W LV Switchgear	900 x 1800 x 2350	4 Panel	For HVAC-SR
		P12	PC-012	0.4-0.23kV 3ph-4W LV Switchgear	900 x 1800 x 2350	4 Panel	For HVAC-SR
		P13	PC-013	0.4-0.23kV 3ph-4W LV Switchgear	900 x 1800 x 2350	8 Panel	For HRS.SMS.EGDS-SR
		P14	PC-014	0.4-0.23kV 3ph-4W LV Switchgear	900 x 1800 x 2350	8 Panel	For HRS.SMS.EGDS-SR
		P15	PC-015	0.4-0.23kV 3ph-4W LV Switchgear	900 x 1800 x 2350	3 Panel	For Building Utility etc-SR
		P16	PC-021	0.4-0.23kV 3ph-4W LV Switchgear	900 x 1800 x 2350	8 Panel	For SGS.EGDS-SIC-1(A)
		G11	MCC-011	0.4-0.23kV Motor Control Center	850 x 600 x 2350	10 Panel	For HVAC-SR
		G12	MCC-012	0.4-0.23kV Motor Control Center	850 x 600 x 2350	10 Panel	For HVAC-SR
		G13	MCC-013	0.4-0.23kV Motor Control Center	850 x 600 x 2350	6 Panel	For HRS.SMS.EGDS-SR
	G14	MCC-014	0.4-0.23kV Motor Control Center	850 x 600 x 2350	6 Panel	For HRS.SMS.EGDS-SR	
	G15	MLP-015	0.4-0.23kV Main Loading Panel	1400 x 600 x 2350	4 Panel	For Building Utility etc-SR	
	G16	MCC-021	0.4-0.23kV Motor Control Center	850 x 600 x 2350	8 Panel	For SGS.EGDS-SIC-1(A)	

Table 1-3: Equipment List for Electric Power System 2/3

Equipment List (Electrical Power System)

DocNo. S-1226-031 RI

Building	No.	Equipment No.	Equipment Name	Size (WxDxH) (mm)	Q'ty	SUBSYSTEM	
Main Building	R301-2 Elect. Power Receiving Area-2	M21	MG-013	6.6kV 3ph-3W Switchgear	800 x 2000 x 2350	3 Panel	For L.F. T.F. P.I.E-SR
		M22	MG-022	6.6kV 3ph-3W Switchgear	800 x 2000 x 2350	7 Panel	For SGS.EGDS-SIC-1(B)
		M23	MG-023	6.6kV 3ph-3W Switchgear	800 x 2000 x 2350	7 Panel	For SGS.EGDS.LWTF.FPS-SIC-2
		M24	SC-022	6.6kV Power Capacitor	900 x 1400 x 2100	3 Panel	For SGS.EGDS-SIC-1(B)
		M25	SC-023	6.6kV Power Capacitor	900 x 1400 x 2100	3 Panel	For SGS.EGDS.LWTF.FPS-SIC-2
	R302-2 UPS Room-2	U21	UPS-B1	AC Uninterrupted Power System-3 φ400V 200kVA	7800 x 1000 x 1950	1 Set	Electric Distribution System
		U22	UPS-B2	AC Uninterrupted Power System-3 φ400V 200kVA	7800 x 1000 x 1950	1 Set	"
		U23	DC-B1	DC Battery & Charger-100V 100Ah	1400 x 1000 x 1950	1 Set	"
		U24	DC-B2	DC Battery & Charger-100V 100Ah	1400 x 1000 x 1950	1 Set	"
	R303-2 LV Elect. Power Supply Area-2	T21	TR-021B	6.6kV/0.4-0.23kV Transformer 1500kVA Dry	2500 x 1800 x 2350	1 Set	For SGS.EGDS-SIC-1(B)
		T22	TR-022B	6.6kV/0.4-0.23kV Transformer 1500kVA Dry	2500 x 1800 x 2350	1 Set	For SGS.EGDS-SIC-1(B)
		T23	TR-023	6.6kV/0.4-0.23kV Transformer 1500kVA Dry	2500 x 1800 x 2350	1 Set	For SGS.EGDS.LWTF.FPS-SIC-2
		T24	TR-024	6.6kV/0.4-0.23kV Transformer 1500kVA Dry	2500 x 1800 x 2350	1 Set	For SGS.EGDS.LWTF.FPS-SIC-2
		T25	TR-025	6.6kV/0.4-0.23kV Transformer 750kVA Dry	2200 x 1500 x 2350	1 Set	For FPS.Building Utility-SIC-2
		P21	PC-022	0.4-0.23kV 3ph-4W LV Switchgear	900 x 1800 x 2350	8 Panel	For SGS.EGDS-SIC-1(B)
		P22	PC-023	0.4-0.23kV 3ph-4W LV Switchgear	900 x 1800 x 2350	4 Panel	For SGS.EGDS.LWTF.FPS-SIC-2
		P23	PC-024	0.4-0.23kV 3ph-4W LV Switchgear	900 x 1800 x 2350	4 Panel	For SGS.EGDS.LWTF.FPS-SIC-2
		P24	PC-025	0.4-0.23kV 3ph-4W LV Switchgear	900 x 1800 x 2350	3 Panel	For FPS.Building Utility-SIC-2
		G21	MCC-022	0.4-0.23kV Motor Control Center	850 x 600 x 2350	8 Panel	For SGS.EGDS-SIC-1(B)
		G22	MCC-023	0.4-0.23kV Motor Control Center	850 x 600 x 2350	14 Panel	For SGS.EGDS.LWTF.FPS-SIC-2
		G23	MCC-024	0.4-0.23kV Motor Control Center	850 x 600 x 2350	14 Panel	For SGS.EGDS.LWTF.FPS-SIC-2
		G24	MLP-025	0.4-0.23kV Main Loading Panel	1400 x 600 x 2350	4 Panel	For FPS.Building Utility-SIC-2

Table 1-4: Equipment List for Electric Power System 3/3

2. Interfaces (Boundaries)

PBS 5.3.2.1.0 Power System Substation

The coverage by the Power System Substation is from the 66 kV (HV) grid power connecting terminals to 6.6 kV (MV) switchgears (SWGRs) terminal end in Electrical Switchyard Building.

Thus the Power System Substation has to feed 6.6 kV (MV) power to the following MV SWGRs:

- 1) Accelerator Facility
- 2) Emergency Power System
- 3) Electric Distribution System

PBS 5.3.2.2.0 Emergency Power System

Emergency Power System receives power from MV SWGRs of the Power System Substation and feed power to MV SIC SWGRs of Electric Distribution System which feeds power to SIC-1 and SIC-2 loads.

PBS 5.3.2.3.0 Electric Distribution System

Other electrical apparatus excluding PBS 5.3.2.1.0 & 5.3.2.2.0 are within Electrical Distribution System scope. Electric Distribution System has to feed power to the following Electric Power Board or sub system of Conventional Facility:

- 1) Lithium Target Facility : 6.6 kV (MV)
- 2) Test Facility : 6.6 kV (MV)
- 3) PIE Facility : 6.6 kV (MV)
- 4) Conventional Facility : 6.6 kV (MV) / 400V(LV) / 230V(LV)
 - Heating, Ventilation and Air Conditioning (HVAC) System
 - Heat Rejection System (HRS)
 - Service Water System (SWS)
 - Service Gas System (SGS)
 - Radioactive Waste Treatment System (RWTS)
 - Fire Protection System (FPS)
 - Central Control & Common Instrumentation (CC&CI)
 - Access Control & Security Systems (ACSS)
 - Radiation Monitoring for Environment & Safety (RAMSES)

Interface Tables		
System A	System B	Title
Accelerator Facility	Power System Substation	Power System Substation has to feed power to Electric Board of Accelerator Facility
Lithium Target Facility	Electric Distribution System	Electric Distribution System has to feed power to Electric Board of Lithium Target Facility
Test Facility	Electric Distribution System	Electric Distribution System has to feed power to Electric Board of Test Facility
PIE Facility	Electric Distribution System	Electric Distribution System has to feed power to Electric Board of PIE Facility
Conventional Facility	Electric Distribution System	Electric System has to feed power to each sub system of Conventional Facility

Table 2-1: Interface Table

2.1 EPS vs Accelerator Facility (AF)

EPS supply 6.6kV power to Accelerator Facility through the:

- MV Electric Power Board for Accelerator Facility
- LV Electric Power Board for Accelerator Facility

The boundary between EPS and AF is set at the terminal of the MV & LV Electric Power Board for Accelerator Facility.

The Power Board for Accelerator Facility including connecting terminal and all the afterwards equipment are within the scope of the Accelerator Facility.

2.2 EPS vs Lithium Target Facility (LF)

EPS supply 6.6kV power to the Lithium Target Facility through the:

- Electric Power Board for Lithium Target Facility

The boundary between EPS and LF is set at the terminal of the Electric Power Board for Lithium Target Facility.

The Power Board for Lithium Target Facility including connecting terminal and all the afterwards equipment are within the scope of the Lithium Target Facility.

2.3 EPS vs Test Facility (TF)

EPS supply 6.6kV power to Test Facility through the:

- Power Board for Test Facility

The boundary between EPS and TF is set at the terminal of the Power Board for Test Facility.

The Power Board for Test Facility including connecting terminal and all the afterwards equipment are within the scope of the Test Facility.

2.4 EPS vs Post Irradiation Irrigation Examination Facility (PIEF)

EPS supply 6.6kV power to Post Irradiation Irrigation Examination Facility through the:

- Power Board for Post Irradiation Irrigation Examination

The boundary between EPS and Post Irradiation Irrigation Examination Facility is set at the terminal of the Power Board for Post Irradiation Irrigation Examination Facility.

The Power Board for Post Irradiation Irrigation Examination Facility including connecting terminal and all the afterwards equipment are within the scope of the Post Irradiation Irrigation Examination Facility.

2.5 EPS vs Conventional Facility (CF)

EPS supply 6.6kV power to Conventional Facility through the:

- HV Electric Power Board for Conventional Facility
- LV Electric Power Board for Conventional Facility

3. System Design requirements

3.1 General Requirements

Input Data Requirements are defined as the data necessary to be defined in order to enable a system design that respects all the needs of the interfacing components. Currently a draft set of data has been proposed. This list is partially complete and assessed by the PT on the base of the current references, of the outcomes of the Engineering Validation Activities (i.e. prototypes) and on the standard engineering practice.

Parameters to be defined as Input Data Requirements for EPS are, for each interfacing component:

- Electric Load (Rated Power) : kW or kVA
- Power Supply Voltage : kV or V
- Load Efficiency : %
- Power Factor : %
- Operation Status : Normal / Emergency / Maintenance
- Emergency Power System : Necessary / Not Necessary
- UPS or DC Battery : Necessary / Not Necessary
- Heat Dissipation : W

Heat Dissipation is important for design of HVAC. But, in this DDD-II, it assumes form the rated electric load.

3.2 Engineering Requirements

3.2.1 Accelerator Facility (AF)

Table 3-1, Table 3-2, Table 3-3, Table 3-4 and Table 3-5 show Electric Load List for Accelerator Facility which was created based on requirements from Accelerator Facility.

The required electric power for Accelerator Facility are ;

- For Rated Power : 52887 kVA
- For Emergency Power : 411 kVA
- For UPS : 411 kVA

Electric Load List for Accelerator Facility

PBS No.	ITEM No.	Service	Rated Power		Efficiency %	Power Factor %	SIC	Redundancy	Normal Operation	Emergency Generator	UPS	Remarks
			6.6 kV (kW)	400V (kW)								
4.1.1.0.0.0		Injector-A		130	90	85	SIC-1		o			
4.1.1.0.0.0		Injector-A Instrumentation		2.5	90	85	SIC-1		o	o	o	
4.9.1.0.0.0		Injector-A Water Cooling Box		20	90	85	No		o			
4.6.1.0.0.0		RF HVPS for RFQ-A-1 (8 X 200kW RF Chains)	400		90	88.889	No		o			400kW HVPS (500 kVA)
4.6.1.0.0.0		RF HVPS for RFQ-A-2 (8 X 200kW RF Chains)	400		90	88.889	No		o			400kW HVPS (500 kVA)
4.6.1.0.0.0		RF HVPS for RFQ-A-3 (8 X 200kW RF Chains)	400		90	88.889	No		o			400kW HVPS (500 kVA)
4.6.1.0.0.0		RF HVPS for RFQ-A-4 (8 X 200kW RF Chains)	400		90	88.889	No		o			400kW HVPS (500 kVA)
4.6.1.0.0.0		RF HVPS for RFQ-A-5 (8 X 200kW RF Chains)	400		90	88.889	No		o			400kW HVPS (500 kVA)
4.6.1.0.0.0		RF HVPS for RFQ-A-6 (8 X 200kW RF Chains)	400		90	88.889	No		o			400kW HVPS (500 kVA)
4.6.1.0.0.0		RF HVPS for RFQ-A-7 (8 X 200kW RF Chains)	400		90	88.889	No		o			400kW HVPS (500 kVA)
4.6.1.0.0.0		RF HVPS for RFQ-A-8 (8 X 200kW RF Chains)	400		90	88.889	No		o			400kW HVPS (500 kVA)
4.2.1.0.0.0		RFQ-A		85	90	85	No		o			
4.9.1.0.0.0		RFQ-A Water Cooling Box		115	90	85	No		o			
4.6.1.0.0.0		RF HVPS for MS-A (2 x 16kW RF Chains)	70		90	85	No		o			
4.3.1.0.0.0		MEBT-A		70	90	85	No		o			
4.3.1.0.0.0		MEBT-A Instrumentation		2.5	90	85	No		o			
4.9.1.0.0.0		MEBT-A Water Cooling Box		16	90	85	No		o			
4.6.1.0.0.0		RF HVPS for SRF Linac-A-1-1 (8 x 105kW RF Chains)	400		90	88.889	No		o			400kW HVPS (500 kVA)
4.6.1.0.0.0		RF HVPS for SRF Linac-A-1-2 (8 x 105kW RF Chains)	400		90	88.889	No		o			400kW HVPS (500 kVA)
4.6.1.0.0.0		RF HVPS for SRF Linac-A-1-3 (8 x 105kW RF Chains)	400		90	88.889	No		o			400kW HVPS (500 kVA)
4.6.1.0.0.0		RF HVPS for SRF Linac-A-1-4 (8 x 105kW RF Chains)	400		90	88.889	No		o			400kW HVPS (500 kVA)
4.6.1.0.0.0		RF HVPS for SRF Linac-A-2-1 (10 x 105kW RF Chains)	400		90	88.889	No		o			400kW HVPS (500 kVA)
4.6.1.0.0.0		RF HVPS for SRF Linac-A-2-2 (10 x 105kW RF Chains)	400		90	88.889	No		o			400kW HVPS (500 kVA)
4.6.1.0.0.0		RF HVPS for SRF Linac-A-2-3 (10 x 105kW RF Chains)	400		90	88.889	No		o			400kW HVPS (500 kVA)
4.6.1.0.0.0		RF HVPS for SRF Linac-A-2-4 (10 x 105kW RF Chains)	400		90	88.889	No		o			400kW HVPS (500 kVA)
4.6.1.0.0.0		RF HVPS for SRF Linac-A-2-5 (10 x 105kW RF Chains)	400		90	88.889	No		o			400kW HVPS (500 kVA)
4.6.1.0.0.0		RF HVPS for SRF Linac-A-3-1 (12 x 200kW RF Chains)	400		90	88.889	No		o			400kW HVPS (500 kVA)
4.6.1.0.0.0		RF HVPS for SRF Linac-A-3-2 (12 x 200kW RF Chains)	400		90	88.889	No		o			400kW HVPS (500 kVA)
4.6.1.0.0.0		RF HVPS for SRF Linac-A-3-3 (12 x 200kW RF Chains)	400		90	88.889	No		o			400kW HVPS (500 kVA)
4.6.1.0.0.0		RF HVPS for SRF Linac-A-3-4 (12 x 200kW RF Chains)	400		90	88.889	No		o			400kW HVPS (500 kVA)
4.6.1.0.0.0		RF HVPS for SRF Linac-A-3-5 (12 x 200kW RF Chains)	400		90	88.889	No		o			400kW HVPS (500 kVA)
4.6.1.0.0.0		RF HVPS for SRF Linac-A-3-6 (12 x 200kW RF Chains)	400		90	88.889	No		o			400kW HVPS (500 kVA)
4.6.1.0.0.0		RF HVPS for SRF Linac-A-3-7 (12 x 200kW RF Chains)	400		90	88.889	No		o			400kW HVPS (500 kVA)
4.6.1.0.0.0		RF HVPS for SRF Linac-A-3-8 (12 x 200kW RF Chains)	400		90	88.889	No		o			400kW HVPS (500 kVA)
4.6.1.0.0.0		RF HVPS for SRF Linac-A-3-9 (12 x 200kW RF Chains)	400		90	88.889	No		o			400kW HVPS (500 kVA)
4.6.1.0.0.0		RF HVPS for SRF Linac-A-3-10 (12 x 200kW RF Chains)	400		90	88.889	No		o			400kW HVPS (500 kVA)
4.6.1.0.0.0		RF HVPS for SRF Linac-A-3-11 (12 x 200kW RF Chains)	400		90	88.889	No		o			400kW HVPS (500 kVA)
4.6.1.0.0.0		RF HVPS for SRF Linac-A-3-12 (12 x 200kW RF Chains)	400		90	88.889	No		o			400kW HVPS (500 kVA)
4.6.1.0.0.0		RF HVPS for SRF Linac-A-4-1 (12 x 200kW RF Chains)	400		90	88.889	No		o			400kW HVPS (500 kVA)
4.6.1.0.0.0		RF HVPS for SRF Linac-A-4-2 (12 x 200kW RF Chains)	400		90	88.889	No		o			400kW HVPS (500 kVA)
4.6.1.0.0.0		RF HVPS for SRF Linac-A-4-3 (12 x 200kW RF Chains)	400		90	88.889	No		o			400kW HVPS (500 kVA)
4.6.1.0.0.0		RF HVPS for SRF Linac-A-4-4 (12 x 200kW RF Chains)	400		90	88.889	No		o			400kW HVPS (500 kVA)
4.6.1.0.0.0		RF HVPS for SRF Linac-A-4-5 (12 x 200kW RF Chains)	400		90	88.889	No		o			400kW HVPS (500 kVA)
4.6.1.0.0.0		RF HVPS for SRF Linac-A-4-6 (12 x 200kW RF Chains)	400		90	88.889	No		o			400kW HVPS (500 kVA)
4.6.1.0.0.0		RF HVPS for SRF Linac-A-4-7 (12 x 200kW RF Chains)	400		90	88.889	No		o			400kW HVPS (500 kVA)
4.6.1.0.0.0		RF HVPS for SRF Linac-A-4-8 (12 x 200kW RF Chains)	400		90	88.889	No		o			400kW HVPS (500 kVA)
4.6.1.0.0.0		RF HVPS for SRF Linac-A-4-9 (12 x 200kW RF Chains)	400		90	88.889	No		o			400kW HVPS (500 kVA)
4.6.1.0.0.0		RF HVPS for SRF Linac-A-4-10 (12 x 200kW RF Chains)	400		90	88.889	No		o			400kW HVPS (500 kVA)
4.6.1.0.0.0		RF HVPS for SRF Linac-A-4-11 (12 x 200kW RF Chains)	400		90	88.889	No		o			400kW HVPS (500 kVA)
4.6.1.0.0.0		RF HVPS for SRF Linac-A-4-12 (12 x 200kW RF Chains)	400		90	88.889	No		o			400kW HVPS (500 kVA)
4.4.1.0.0.0		SRF Linac-A (100 kW solenoid LVPS + 50 kW other)		150	90	85	No		o			
4.5.1.0.0.0		HEBT-A + Beam Dump-A		500	90	85	No		o			

Table 3-1: Electric Load List for Accelerator Facility 1/5

Electric Load List for Accelerator Facility

PBS No.	ITEM No.	Service	Rated Power		Efficiency %	Power Factor %	SIC	Redundancy	Normal Operation	Emergency Generator	UPS	Remarks
			6.6 kV (kW)	400V (kW)								
4.9.1.0.0.0		HEBT-A Water Cooling Box		50	90	85	No		o			
4.9.1.0.0.0		Beam Dump-A Water Cooling Box		60	90	85	SR		o			
4.9.1.0.0.0		He Compressor-A		600	90	85	No		o			
4.4.1.0.0.0		Cold Bot-A		40	90	85	No		o			
4.4.1.0.0.0		Cryo Plant-A (10 kW x 4 = 40 kW)		40	90	85	No		o			
4.6.1.0.0.0		LV for FF SET 1 RFQ		81.855	90	85	No		o			LV for RF module
		LV for FF SET 1 RFQ for emergency		3.06	90	85	No		o	o	o	LV for RF module
4.6.1.0.0.0		LV for FF SET 2 RFQ		81.855	90	85	No		o			LV for RF module
		LV for FF SET 2 RFQ for emergency		3.06	90	85	No		o	o	o	LV for RF module
4.6.1.0.0.0		LV for FF SET 3 RFQ		81.855	90	85	No		o			LV for RF module
		LV for FF SET 3 RFQ for emergency		3.06	90	85	No		o	o	o	LV for RF module
4.6.1.0.0.0		LV for FF SET 4 RFQ		81.855	90	85	No		o			LV for RF module
		LV for FF SET 4 RFQ for emergency		3.06	90	85	No		o	o	o	LV for RF module
4.6.1.0.0.0		LV for FF SET 5 MEBT		62.73	90	85	No		o			LV for RF module
		LV for FF SET 5 MEBT for emergency		3.06	90	85	No		o	o	o	LV for RF module
4.6.1.0.0.0		LV for FF SET 6 Cryo module 1		62.73	90	85	No		o			LV for RF module
		LV for FF SET 6 Cryo module 1 for emergency		3.06	90	85	No		o	o	o	LV for RF module
4.6.1.0.0.0		LV for FF SET 7 Cryo module 1		62.73	90	85	No		o			LV for RF module
		LV for FF SET 7 Cryo module 1 for emergency		3.06	90	85	No		o	o	o	LV for RF module
4.6.1.0.0.0		LV for FF SET 8 Cryo module 1		62.73	90	85	No		o			LV for RF module
		LV for FF SET 8 Cryo module 1 for emergency		3.06	90	85	No		o	o	o	LV for RF module
4.6.1.0.0.0		LV for FF SET 9 Cryo module 1		62.73	90	85	No		o			LV for RF module
		LV for FF SET 9 Cryo module 1 for emergency		3.06	90	85	No		o	o	o	LV for RF module
4.6.1.0.0.0		LV for FF SET 10 Cryo module 2		62.73	90	85	No		o			LV for RF module
		LV for FF SET 10 Cryo module 2 for emergency		3.06	90	85	No		o	o	o	LV for RF module
4.6.1.0.0.0		LV for FF SET 11 Cryo module 2		62.73	90	85	No		o			LV for RF module
		LV for FF SET 11 Cryo module 2 for emergency		3.06	90	85	No		o	o	o	LV for RF module
4.6.1.0.0.0		LV for FF SET 12 Cryo module 2		62.73	90	85	No		o			LV for RF module
		LV for FF SET 12 Cryo module 2 for emergency		3.06	90	85	No		o	o	o	LV for RF module
4.6.1.0.0.0		LV for FF SET 13 Cryo module 2		62.73	90	85	No		o			LV for RF module
		LV for FF SET 13 Cryo module 2 for emergency		3.06	90	85	No		o	o	o	LV for RF module
4.6.1.0.0.0		LV for FF SET 14 Cryo module 2		81.855	90	85	No		o			LV for RF module
		LV for FF SET 14 Cryo module 2 for emergency		3.06	90	85	No		o	o	o	LV for RF module
4.6.1.0.0.0		LV for FF SET 15 Cryo module 3		81.855	90	85	No		o			LV for RF module
		LV for FF SET 15 Cryo module 3 for emergency		3.06	90	85	No		o	o	o	LV for RF module
4.6.1.0.0.0		LV for FF SET 16 Cryo module 3		81.855	90	85	No		o			LV for RF module
		LV for FF SET 16 Cryo module 3 for emergency		3.06	90	85	No		o	o	o	LV for RF module
4.6.1.0.0.0		LV for FF SET 17 Cryo module 3		81.855	90	85	No		o			LV for RF module
		LV for FF SET 17 Cryo module 3 for emergency		3.06	90	85	No		o	o	o	LV for RF module
4.6.1.0.0.0		LV for FF SET 18 Cryo module 3		81.855	90	85	No		o			LV for RF module
		LV for FF SET 18 Cryo module 3 for emergency		3.06	90	85	No		o	o	o	LV for RF module
4.6.1.0.0.0		LV for FF SET 19 Cryo module 3		81.855	90	85	No		o			LV for RF module
		LV for FF SET 19 Cryo module 3 for emergency		3.06	90	85	No		o	o	o	LV for RF module
4.6.1.0.0.0		LV for FF SET 20 Cryo module 3		81.855	90	85	No		o			LV for RF module
		LV for FF SET 20 Cryo module 3 for emergency		3.06	90	85	No		o	o	o	LV for RF module
4.6.1.0.0.0		LV for FF SET 21 Cryo module 4		81.855	90	85	No		o			LV for RF module
		LV for FF SET 21 Cryo module 4 for emergency		3.06	90	85	No		o	o	o	LV for RF module
4.6.1.0.0.0		LV for FF SET 22 Cryo module 4		81.855	90	85	No		o			LV for RF module
		LV for FF SET 22 Cryo module 4 for emergency		3.06	90	85	No		o	o	o	LV for RF module
4.6.1.0.0.0		LV for FF SET 23 Cryo module 4		81.855	90	85	No		o			LV for RF module
		LV for FF SET 23 Cryo module 4 for emergency		3.06	90	85	No		o	o	o	LV for RF module
4.6.1.0.0.0		LV for FF SET 24 Cryo module 4		81.855	90	85	No		o			LV for RF module

Table 3-2: Electric Load List for Accelerator Facility 2/5

Electric Load List for Accelerator Facility

PBS No.	ITEM No.	Service	Rated Power		Efficiency %	Power Factor %	SIC	Redundancy	Normal Operation	Emergency Generator	UPS	Remarks
			6.6 kV (kW)	400V (kW)								
		LV for RF SET 24 Cryo module 4 for emergency		3.06	90	85	No					LV for RF module
4.6.1.0.0.0		LV for RF SET 25 Cryo module 4		81.855	90	85	No					LV for RF module
		LV for RF SET 25 Cryo module 4 for emergency		3.06	90	85	No					LV for RF module
4.6.1.0.0.0		LV for RF SET 26 Cryo module 4		81.855	90	85	No					LV for RF module
		LV for RF SET 26 Cryo module 4 for emergency		3.06	90	85	No					LV for RF module
4.9.1.0.0.0		RF Water Cooling-A (150 kW x 8.4/2.6= 485 kW)		485	90	85	No					9 RF moduled = 150 kW
4.9.1.0.0.0		Instrumentation-A		15	90	85	SR					
4.9.1.0.0.0		PC Box-A		50	90	85	No					
4.1.2.0.0.0		Injector-B		130	90	85	SIC-1					
4.1.2.0.0.0		Injector-B Instrumentation		2.5	90	85	SIC-1					
4.9.2.0.0.0		Injector-B Water Cooling Box		20	90	85	No					
4.6.2.0.0.0		RF HVPS for RFQ-B-1 (8 X 200kW RF Chains)	400		90	88.889	No					400kW HVPS (500 kVA)
4.6.2.0.0.0		RF HVPS for RFQ-B-2 (8 X 200kW RF Chains)	400		90	88.889	No					400kW HVPS (500 kVA)
4.6.2.0.0.0		RF HVPS for RFQ-B-3 (8 X 200kW RF Chains)	400		90	88.889	No					400kW HVPS (500 kVA)
4.6.2.0.0.0		RF HVPS for RFQ-B-4 (8 X 200kW RF Chains)	400		90	88.889	No					400kW HVPS (500 kVA)
4.6.2.0.0.0		RF HVPS for RFQ-B-5 (8 X 200kW RF Chains)	400		90	88.889	No					400kW HVPS (500 kVA)
4.6.2.0.0.0		RF HVPS for RFQ-B-6 (8 X 200kW RF Chains)	400		90	88.889	No					400kW HVPS (500 kVA)
4.6.2.0.0.0		RF HVPS for RFQ-B-7 (8 X 200kW RF Chains)	400		90	88.889	No					400kW HVPS (500 kVA)
4.6.2.0.0.0		RF HVPS for RFQ-B-8 (8 X 200kW RF Chains)	400		90	88.889	No					400kW HVPS (500 kVA)
4.2.2.0.0.0		RFQ-B		85	90	85	No					
4.9.2.0.0.0		RFQ-B Water Cooling Box		115	90	85	No					
4.6.2.0.0.0		RF HVPS for MS-B (2 x 16kW RF Chains)	70		90	85	No					
4.3.2.0.0.0		MEBT-B		70	90	85	No					
4.3.2.0.0.0		MEBT-B Instrumentation		2.5	90	85	No					
4.9.2.0.0.0		MEBT-B Water Cooling Box		16	90	85	No					
4.6.2.0.0.0		RF HVPS for SRF Linac-A-1-1 (8 x 105kW RF Chains)	400		90	88.889	No					400kW HVPS (500 kVA)
4.6.2.0.0.0		RF HVPS for SRF Linac-A-1-2 (8 x 105kW RF Chains)	400		90	88.889	No					400kW HVPS (500 kVA)
4.6.2.0.0.0		RF HVPS for SRF Linac-A-1-3 (8 x 105kW RF Chains)	400		90	88.889	No					400kW HVPS (500 kVA)
4.6.2.0.0.0		RF HVPS for SRF Linac-A-1-4 (8 x 105kW RF Chains)	400		90	88.889	No					400kW HVPS (500 kVA)
4.6.2.0.0.0		RF HVPS for SRF Linac-A-2-1 (10 x 105kW RF Chains)	400		90	88.889	No					400kW HVPS (500 kVA)
4.6.2.0.0.0		RF HVPS for SRF Linac-A-2-2 (10 x 105kW RF Chains)	400		90	88.889	No					400kW HVPS (500 kVA)
4.6.2.0.0.0		RF HVPS for SRF Linac-A-2-3 (10 x 105kW RF Chains)	400		90	88.889	No					400kW HVPS (500 kVA)
4.6.2.0.0.0		RF HVPS for SRF Linac-A-2-4 (10 x 105kW RF Chains)	400		90	88.889	No					400kW HVPS (500 kVA)
4.6.2.0.0.0		RF HVPS for SRF Linac-A-2-5 (10 x 105kW RF Chains)	400		90	88.889	No					400kW HVPS (500 kVA)
4.6.2.0.0.0		RF HVPS for SRF Linac-A-3-1 (12 x 200kW RF Chains)	400		90	88.889	No					400kW HVPS (500 kVA)
4.6.2.0.0.0		RF HVPS for SRF Linac-A-3-2 (12 x 200kW RF Chains)	400		90	88.889	No					400kW HVPS (500 kVA)
4.6.2.0.0.0		RF HVPS for SRF Linac-A-3-3 (12 x 200kW RF Chains)	400		90	88.889	No					400kW HVPS (500 kVA)
4.6.2.0.0.0		RF HVPS for SRF Linac-A-3-4 (12 x 200kW RF Chains)	400		90	88.889	No					400kW HVPS (500 kVA)
4.6.2.0.0.0		RF HVPS for SRF Linac-A-3-5 (12 x 200kW RF Chains)	400		90	88.889	No					400kW HVPS (500 kVA)
4.6.2.0.0.0		RF HVPS for SRF Linac-A-3-6 (12 x 200kW RF Chains)	400		90	88.889	No					400kW HVPS (500 kVA)
4.6.2.0.0.0		RF HVPS for SRF Linac-A-3-7 (12 x 200kW RF Chains)	400		90	88.889	No					400kW HVPS (500 kVA)
4.6.2.0.0.0		RF HVPS for SRF Linac-A-3-8 (12 x 200kW RF Chains)	400		90	88.889	No					400kW HVPS (500 kVA)
4.6.2.0.0.0		RF HVPS for SRF Linac-A-3-9 (12 x 200kW RF Chains)	400		90	88.889	No					400kW HVPS (500 kVA)
4.6.2.0.0.0		RF HVPS for SRF Linac-A-3-10 (12 x 200kW RF Chains)	400		90	88.889	No					400kW HVPS (500 kVA)
4.6.2.0.0.0		RF HVPS for SRF Linac-A-3-11 (12 x 200kW RF Chains)	400		90	88.889	No					400kW HVPS (500 kVA)
4.6.2.0.0.0		RF HVPS for SRF Linac-A-3-12 (12 x 200kW RF Chains)	400		90	88.889	No					400kW HVPS (500 kVA)
4.6.2.0.0.0		RF HVPS for SRF Linac-A-4-1 (12 x 200kW RF Chains)	400		90	88.889	No					400kW HVPS (500 kVA)
4.6.2.0.0.0		RF HVPS for SRF Linac-A-4-2 (12 x 200kW RF Chains)	400		90	88.889	No					400kW HVPS (500 kVA)
4.6.2.0.0.0		RF HVPS for SRF Linac-A-4-3 (12 x 200kW RF Chains)	400		90	88.889	No					400kW HVPS (500 kVA)
4.6.2.0.0.0		RF HVPS for SRF Linac-A-4-4 (12 x 200kW RF Chains)	400		90	88.889	No					400kW HVPS (500 kVA)
4.6.2.0.0.0		RF HVPS for SRF Linac-A-4-5 (12 x 200kW RF Chains)	400		90	88.889	No					400kW HVPS (500 kVA)

Table 3-3: Electric Load List for Accelerator Facility 3/5

Electric Load List for Accelerator Facility

PBS No.	ITEM No.	Service	Rated Power		Efficiency %	Power Factor %	SIC	Redundancy	Normal Operation	Emergency Generator	UPS	Remarks
			6.6 kV (kW)	400V (kW)								
4.6.2.0.0.0		RF HVPS for SRF Linac-A-4-6 (12 x 200kW RF Chains)	400		90	88.889	No		o			400kW HVPS (500 kVA)
4.6.2.0.0.0		RF HVPS for SRF Linac-A-4-7 (12 x 200kW RF Chains)	400		90	88.889	No		o			400kW HVPS (500 kVA)
4.6.2.0.0.0		RF HVPS for SRF Linac-A-4-8 (12 x 200kW RF Chains)	400		90	88.889	No		o			400kW HVPS (500 kVA)
4.6.2.0.0.0		RF HVPS for SRF Linac-A-4-9 (12 x 200kW RF Chains)	400		90	88.889	No		o			400kW HVPS (500 kVA)
4.6.2.0.0.0		RF HVPS for SRF Linac-A-4-10 (12 x 200kW RF Chains)	400		90	88.889	No		o			400kW HVPS (500 kVA)
4.6.2.0.0.0		RF HVPS for SRF Linac-A-4-11 (12 x 200kW RF Chains)	400		90	88.889	No		o			400kW HVPS (500 kVA)
4.6.2.0.0.0		RF HVPS for SRF Linac-A-4-12 (12 x 200kW RF Chains)	400		90	88.889	No		o			400kW HVPS (500 kVA)
4.4.2.0.0.0		SRF Linac-B (100 kW solenoid LVPS + 50 kW other)		150	90	85	No		o			
4.5.1.0.0.0		HEBT-B + Beam Dump-B		500	90	85	No		o			
4.9.2.0.0.0		HEBT-B Water Cooling Box		50	90	85	No		o			
4.9.2.0.0.0		Beam Dump-B Water Cooling Box		60	90	85	SR		o			
4.9.2.0.0.0		He Compressor-B		600	90	85	No		o			
4.4.2.0.0.0		Cold Box-B		40	90	85	No		o			
4.4.2.0.0.0		Cryo Plant-B (10 kW x 4 = 40 kW)		40	90	85	No		o			
4.6.1.0.0.0		LV for RF SET 1 RFQ		81.855	90	85	No		o			LV for RF module
		LV for RF SET 1 RFQ for emergency		3.06	90	85	No		o	o		LV for RF module
4.6.1.0.0.0		LV for RF SET 2 RFQ		81.855	90	85	No		o			LV for RF module
		LV for RF SET 2 RFQ for emergency		3.06	90	85	No		o	o		LV for RF module
4.6.1.0.0.0		LV for RF SET 3 RFQ		81.855	90	85	No		o			LV for RF module
		LV for RF SET 3 RFQ for emergency		3.06	90	85	No		o	o		LV for RF module
4.6.1.0.0.0		LV for RF SET 4 RFQ		81.855	90	85	No		o			LV for RF module
		LV for RF SET 4 RFQ for emergency		3.06	90	85	No		o	o		LV for RF module
4.6.1.0.0.0		LV for RF SET 5 MEBT		62.73	90	85	No		o			LV for RF module
		LV for RF SET 5 MEBT for emergency		3.06	90	85	No		o	o		LV for RF module
4.6.1.0.0.0		LV for RF SET 6 Cryo module 1		62.73	90	85	No		o			LV for RF module
		LV for RF SET 6 Cryo module 1 for emergency		3.06	90	85	No		o	o		LV for RF module
4.6.1.0.0.0		LV for RF SET 7 Cryo module 1		62.73	90	85	No		o			LV for RF module
		LV for RF SET 7 Cryo module 1 for emergency		3.06	90	85	No		o	o		LV for RF module
4.6.1.0.0.0		LV for RF SET 8 Cryo module 1		62.73	90	85	No		o			LV for RF module
		LV for RF SET 8 Cryo module 1 for emergency		3.06	90	85	No		o	o		LV for RF module
4.6.1.0.0.0		LV for RF SET 9 Cryo module 1		62.73	90	85	No		o			LV for RF module
		LV for RF SET 9 Cryo module 1 for emergency		3.06	90	85	No		o	o		LV for RF module
4.6.1.0.0.0		LV for RF SET 10 Cryo module 2		62.73	90	85	No		o			LV for RF module
		LV for RF SET 10 Cryo module 2 for emergency		3.06	90	85	No		o	o		LV for RF module
4.6.1.0.0.0		LV for RF SET 11 Cryo module 2		62.73	90	85	No		o			LV for RF module
		LV for RF SET 11 Cryo module 2 for emergency		3.06	90	85	No		o	o		LV for RF module
4.6.1.0.0.0		LV for RF SET 12 Cryo module 2		62.73	90	85	No		o			LV for RF module
		LV for RF SET 12 Cryo module 2 for emergency		3.06	90	85	No		o	o		LV for RF module
4.6.1.0.0.0		LV for RF SET 13 Cryo module 2		62.73	90	85	No		o			LV for RF module
		LV for RF SET 13 Cryo module 2 for emergency		3.06	90	85	No		o	o		LV for RF module
4.6.1.0.0.0		LV for RF SET 14 Cryo module 2		81.855	90	85	No		o			LV for RF module
		LV for RF SET 14 Cryo module 2 for emergency		3.06	90	85	No		o	o		LV for RF module
4.6.1.0.0.0		LV for RF SET 15 Cryo module 3		81.855	90	85	No		o			LV for RF module
		LV for RF SET 15 Cryo module 3 for emergency		3.06	90	85	No		o	o		LV for RF module
4.6.1.0.0.0		LV for RF SET 16 Cryo module 3		81.855	90	85	No		o			LV for RF module
		LV for RF SET 16 Cryo module 3 for emergency		3.06	90	85	No		o	o		LV for RF module
4.6.1.0.0.0		LV for RF SET 17 Cryo module 3		81.855	90	85	No		o			LV for RF module
		LV for RF SET 17 Cryo module 3 for emergency		3.06	90	85	No		o	o		LV for RF module
4.6.1.0.0.0		LV for RF SET 18 Cryo module 3		81.855	90	85	No		o			LV for RF module
		LV for RF SET 18 Cryo module 3 for emergency		3.06	90	85	No		o	o		LV for RF module
4.6.1.0.0.0		LV for RF SET 19 Cryo module 3		81.855	90	85	No		o			LV for RF module
		LV for RF SET 19 Cryo module 3 for emergency		3.06	90	85	No		o	o		LV for RF module

Table 3-4: Electric Load List for Accelerator Facility 4/5

Electric Load List for Accelerator Facility

PBS No.	ITEM No.	Service	Rated Power		Efficiency	Power Factor	SIC	Redundancy	Normal Operation	Emergency Generator	UPS	Remarks
			6.6 kV (kW)	400V (kW)	%	%						
4.6.1.0.0.0		LV for RF SET 20 Cryo module 3		81.855	90	85	No		o			LV for RF module
		LV for RF SET 20 Cryo module 3 for emergency		3.06	90	85	No		o	o	o	LV for RF module
4.6.1.0.0.0		LV for RF SET 21 Cryo module 4		81.855	90	85	No		o			LV for RF module
		LV for RF SET 21 Cryo module 4 for emergency		3.06	90	85	No		o	o	o	LV for RF module
4.6.1.0.0.0		LV for RF SET 22 Cryo module 4		81.855	90	85	No		o			LV for RF module
		LV for RF SET 22 Cryo module 4 for emergency		3.06	90	85	No		o	o	o	LV for RF module
4.6.1.0.0.0		LV for RF SET 23 Cryo module 4		81.855	90	85	No		o			LV for RF module
		LV for RF SET 23 Cryo module 4 for emergency		3.06	90	85	No		o	o	o	LV for RF module
4.6.1.0.0.0		LV for RF SET 24 Cryo module 4		81.855	90	85	No		o			LV for RF module
		LV for RF SET 24 Cryo module 4 for emergency		3.06	90	85	No		o	o	o	LV for RF module
4.6.1.0.0.0		LV for RF SET 25 Cryo module 4		81.855	90	85	No		o			LV for RF module
		LV for RF SET 25 Cryo module 4 for emergency		3.06	90	85	No		o	o	o	LV for RF module
4.6.1.0.0.0		LV for RF SET 26 Cryo module 4		81.855	90	85	No		o			LV for RF module
		LV for RF SET 26 Cryo module 4 for emergency		3.06	90	85	No		o	o	o	LV for RF module
4.9.2.0.0.0		RF Water Cooling-B (150 kW x 8.4/2.6= 485 kW)		485	90	85	No		o			9 RF moduled = 150 kW
4.9.2.0.0.0		Instrumentation-B		15	90	85	SR		o	o	o	
4.9.2.0.0.0		PC Box-3		50	90	85	No		o	o	o	
4.9.1.0.0.0		AF Control System-A		10	90	85	SIC-2		o	o	o	
4.9.2.0.0.0		AF Control System-B		10	90	85	SIC-2		o	o	o	
		Total	32940	8953.33								

Table 3-5: Electric Load List for Accelerator Facility 5/5

3.2.2 Lithium Target Facility (LF)

Table 3-6 and Table 3-7 show Electric Load List for Lithium Target Facility which was created based on requirements from Lithium Target Facility.

The required electric power for Lithium Target Facility are ;

- For Rated Power : 2595 kVA
- For Emergency Power : 823 kVA
- For UPS : 167 kVA

Electric Load List for Lithium Target Facility

ITEM No.	ITEM No.	Service	Rated Power		Efficiency %	Power Factor %	SIC	Redundancy	Normal Operation	Emergency Generator	UPS	Remarks
			6.6 kV (kW)	400V (kW)								
3.2.1.0.0.0		Heater for Dump Tank		115	100	100	SIC-1		o			
3.2.1.0.0.0		Heater for Quench Tank		54	100	100	SIC-1		o			
3.2.1.0.0.0		Heater for Surge Tank		38	100	100	SIC-1		o			
3.3.2.0.0.0		Heater for Cold Trap-A		40	100	100	SIC-2		o	o		
3.3.2.0.0.0		Heater for Cold Trap-B		40	100	100	SIC-2		o	o		
3.3.2.0.0.0		Economizer Heater for Cold Trap-A		6	100	100	SIC-2		o	o		
3.3.2.0.0.0		Economizer Heater for Cold Trap-B		6	100	100	SIC-2		o	o		
3.3.2.0.0.0		Heater for N-Hot Trap-A		80	100	100	SIC-2		o			
3.3.2.0.0.0		Heater for N-Hot Trap-B		80	100	100	SIC-2		o			
3.3.2.0.0.0		Economizer Heater for N-Hot Trap-A		12	100	100	SIC-2		o			
3.3.2.0.0.0		Economizer Heater for N-Hot Trap-B		12	100	100	SIC-2		o			
3.3.2.0.0.0		Heater for H-Hot Trap-A		80	100	100	SIC-2		o			
3.3.2.0.0.0		Heater for H-Hot Trap-B		80	100	100	SIC-2		o			
3.5.1.0.0.0		Heater for No.1 Mist Trap		8	100	100	SR		o			
3.5.1.0.0.0		Heater for No.2 Mist Trap		8	100	100	SR		o			
3.5.1.0.0.0		Heater for No.3 Mist Trap		8	100	100	SR		o			
3.5.1.0.0.0		Heater for No.4 Mist Trap		8	100	100	SR		o			
3.5.1.0.0.0		Heater for No.1 Vapor Trap		8	100	100	SR		o			
3.5.1.0.0.0		Heater for No.2 Vapor Trap		8	100	100	SR		o			
3.5.1.0.0.0		Heater for No.3 Vapor Trap		8	100	100	SR		o			
3.3.3.0.0.0		Heater for Li Sampling Unit		3	100	100	SIC-2		o	o		
3.2.1.0.0.0		Heater for Main Loop		234	100	100	SIC-1		o			
3.2.1.0.0.0		Heater for Vacuum Line		107	100	100	SIC-1		o			
3.3.2.0.0.0		No.1 Heater for Purification Loop		20	100	100	SIC-2		o	o		
3.3.2.0.0.0		No.2 Heater for Purification Loop		10	100	100	SIC-2		o	o		
3.3.3.0.0.0		Heater for Impurity Monitoring Loop		10	100	100	SIC-2		o	o		
3.2.1.0.0.0		Heater for Motor Valve		95	100	100	SIC-1		o	o		
3.2.2.0.0.0		Heater for Organic Oil Loop		330	100	100	SIC-1		o	o		
3.2.3.0.0.0		Heater for Intermediate Water Loop		315	100	100	SIC-1		o			
3.3.2.0.0.0		Blower for Cold Trap (INV)		7.5	75	75	SIC-2		o	o		
3.2.1.0.0.0		Blower for Dump Tank Pit Ventilation		2.7	75	75	SIC-2		o	o		
3.2.1.0.0.0		Blower for Li Outlet Channel Plug Cooling	45		90	85	SIC-2		o	o		
3.2.1.0.0.0		Blower for Li Inlet Pipe Plug Cooling	45		90	85	SIC-2		o	o		
3.1.5.0.0.0		Vacuum Pump Unit for Beam Duct-1		1,224	90	85	SR		o			
3.1.5.0.0.0		Vacuum Pump Unit for Beam Duct-2		1,224	90	85	SR		o			
3.1.5.0.0.0		Vacuum Pump Unit for Beam Duct-3		1,224	90	85	SR		o			
3.1.5.0.0.0		Vacuum Pump Unit for Beam Duct-4		1,224	90	85	SR		o			
3.1.5.0.0.0		Vacuum Pump Unit for Beam Duct-5		1,224	90	85	SR		o			
3.1.5.0.0.0		Vacuum Pump Unit for Beam Duct-6		1,224	90	85	SR		o			
3.1.5.0.0.0		Booster Pump for Vacuum Pump Unit-1		0.4	90	85	SR		o			
3.1.5.0.0.0		Booster Pump for Vacuum Pump Unit-2		0.4	90	85	SR		o			
3.1.5.0.0.0		Booster Pump for Vacuum Pump Unit-3		0.4	90	85	SR		o			
3.1.5.0.0.0		Booster Pump for Vacuum Pump Unit-4		0.4	90	85	SR		o			
3.1.5.0.0.0		Booster Pump for Vacuum Pump Unit-5		0.4	90	85	SR		o			
3.1.5.0.0.0		Booster Pump for Vacuum Pump Unit-6		0.4	90	85	SR		o			
3.5.2.0.0.0		Vacuum Pump Unit for Quenchi Tank		3.7	100	75	SR		o			
3.5.2.0.0.0		Vacuum Pump Unit for Surge Tank		3.7	100	75	SR		o			
3.5.2.0.0.0		Vacuum Pump Unit for Dump Tank		5.5	100	75	SR		o			
3.2.1.0.0.0		Electric Magnet Pump for Main Loop	260		90	62,222	SIC-1		o			

Table 3-6: Electric Load List for Lithium Target Facility 1/2

3.2.3 Test Facility (TF)

Table 3-8 show Electric Load List for Test Facility which was created based on requirements from Test Facility.

The required electric power for Test Facility are ;

- For Rated Power : 3689 kVA
- For Emergency Power : 238 kVA
- For UPS : 67 kVA

3.2.4 Post Irradiation Examination Facility (PIEF)

Table 3-9 show Electric Load List for Post Irradiation Examination Facility which was created based on requirements from Post Irradiation Examination Facility.

The required electric power for Post Irradiation Examination Facility are ;

- For Rated Power : 1013 kVA
- For Emergency Power : 13 kVA
- For UPS : 13 kVA

Electric Load List for Post Irradiation Examination Facility

PBS No.	ITEM No.	Service	Rated Power		Efficiency %	Power Factor %	SIC	Redundancy	Normal Operation	Emergency Generator	UPS	Remarks
			6.6 kV (kW)	400V (kW)								
6.0.0.0.0		Manipulator			100	100						
6.0.0.0.0		Crane			100	100						
6.0.0.0.0		Transfer System			100	100						
6.0.0.0.0		Testing Equipment for Tensile			100	100						
6.0.0.0.0		Testing Equipment for Fracture Toughness			100	100						
6.0.0.0.0		Testing Equipment for Charpy Impact			100	100						
6.0.0.0.0		Testing Equipment for Fatigue			100	100						
6.0.0.0.0		Testing Equipment for Creep Deformation			100	100						
6.0.0.0.0		Testing Equipment for Creep Rupture			100	100						
6.0.0.0.0		Testing Equipment for Crack Growth Measurement			100	100						
6.0.0.0.0		Testing Equipment for SSRT/SCC			100	100						
6.0.0.0.0		Testing Equipment for Compression			100	100						
6.0.0.0.0		Testing Equipment for Small Punch			100	100						
6.0.0.0.0		Testing Equipment for Hardness			100	100						
6.0.0.0.0		Testing Equipment for Micro-Vickers			100	100						
6.0.0.0.0		Testing Equipment for Nano-Indentation			100	100						
6.0.0.0.0		Testing Equipment for Microstructure Observation			100	100						
6.0.0.0.0		Testing Equipment for Automatic Radiography & Micro Gamma Scanning			100	100						
6.0.0.0.0		Testing Equipment for Chemical Analysis (Gas Element Analysis)			100	100						
6.0.0.0.0		Testing Equipment for Chemical Analysis (Materials Analysis)			100	100						
6.0.0.0.0		Cutting Instrument			100	100						
6.0.0.0.0		Grinding & Etching Instruments			100	100						
6.0.0.0.0		Electrolytic Polishing Equipment			100	100						
6.0.0.0.0		Extraction Residue Device			100	100						
6.0.0.0.0		Testing Equipment for X-Ray Radiography			100	100						
6.0.0.0.0		Testing Equipment for Micro Gamma-Scanning			100	100						
6.0.0.0.0		Testing Equipment for Eddy Current			100	100						
6.0.0.0.0		Leak Detector			100	100						
6.0.0.0.0		Mass Spectrometer			100	100						
6.0.0.0.0		Density Measurement Equipment			100	100						
6.0.0.0.0		Testing Equipment for Magnetic Property			100	100						
6.0.0.0.0		Testing Equipment for Electromagnetic Induction Method			100	100						
6.0.0.0.0		Testing Equipment for Liquid Penetrant			100	100						
6.0.0.0.0		Testing Equipment for Electron Conductivity			100	100						
6.0.0.0.0		PIE Control System		10	90	85			o	o	o	
6.0.0.0.0		Others			100	100						
		Total	0	1010								

Table 3-9: Electric Load List for Post Irradiation Examination Facility

3.2.5 Conventional Facility (CF)

Table 3-10, Table 3-11, Table 3-12, Table 3-13, Table 3-14 and Table 3-15 show Electric Load List for Conventional Facility which was created based on requirements from Conventional Facility.

The required electric power for Conventional Facility are ;

- For Rated Power : 24697 kVA
- For Emergency Power : 4992 kVA
- For UPS : 359 kVA

Electric Load List for Conventional Facility

PBS No.	ITEM No.	Service	Rated Power		Efficiency %	Power Factor %	SIC	Redundancy	Normal Operation	Emergency Generator	UPS	Remarks
			6.6 kV (kW)	400V (kW)								
5.3.1.1.0	5.3.1.1.0-A-001A(1)	Air Handling Unit for Nuclear HVAC	250		90	85	SR	100% x 2	o			In Industrial HVAC Room-2
5.3.1.1.0	5.3.1.1.0-A-001A(2)	Air Handling Unit for Nuclear HVAC	250		90	85	SR					//
5.3.1.1.0	5.3.1.1.0-A-001B(1)	Air Handling Unit for Nuclear HVAC	250		90	85	SR	100% x 2	o			//
5.3.1.1.0	5.3.1.1.0-A-001B(2)	Air Handling Unit for Nuclear HVAC	250		90	85	SR					//
5.3.1.2.0	5.3.1.2.0-A-001A	Air Handling Unit for PIE Nuclear HVAC	250		90	85	SR	100% x 2	o			In Industrial HVAC Room-1
5.3.1.2.0	5.3.1.2.0-A-001B	Air Handling Unit for PIE Nuclear HVAC	250		90	85	SR					//
5.3.1.3.0	5.3.1.3.0-A-001A	Air Handling Unit for Industrial HVAC		110	90	85	SR	100% x 2	o			//
5.3.1.3.0	5.3.1.3.0-A-001B	Air Handling Unit for Industrial HVAC		110	90	85	SR					//
5.3.1.1.0	5.3.1.1.0-K-001A	Exhaust Fan for Nuclear HVAC 'C1'		110	90	85	SIC-1	100% x 2	o	o		In HVAC Blower Room
5.3.1.1.0	5.3.1.1.0-K-001B	Exhaust Fan for Nuclear HVAC 'C1'		110	90	85	SIC-1					//
5.3.1.1.0	5.3.1.1.0-K-002A	Exhaust Fan for Nuclear HVAC 'C2'	200		90	85	SIC-1	50% x 4	o	o		//
5.3.1.1.0	5.3.1.1.0-K-002B	Exhaust Fan for Nuclear HVAC 'C2'	200		90	85	SIC-1					//
5.3.1.1.0	5.3.1.1.0-K-002C	Exhaust Fan for Nuclear HVAC 'C2'	200		90	85	SIC-1		o	o		//
5.3.1.1.0	5.3.1.1.0-K-002D	Exhaust Fan for Nuclear HVAC 'C2'	200		90	85	SIC-1					//
5.3.1.1.0	5.3.1.1.0-K-003A	Exhaust Fan for Nuclear HVAC 'C3'	132		90	85	SIC-1	100% x 2	o	o		//
5.3.1.1.0	5.3.1.1.0-K-003B	Exhaust Fan for Nuclear HVAC 'C3'	132		90	85	SIC-1					//
5.3.1.1.0	5.3.1.1.0-K-004A	Exhaust Fan for Nuclear HVAC 'C4'		19.5	90	85	SIC-1	100% x 2	o	o		//
5.3.1.1.0	5.3.1.1.0-K-004B	Exhaust Fan for Nuclear HVAC 'C4'		19.5	90	85	SIC-1					//
5.3.1.1.0	5.3.1.1.0-K-005A	Circulation Fan for Accelerator Area		37	90	85	SIC-1	50% x 4	o	o		In Vault Recirculation Blower Room-1
5.3.1.1.0	5.3.1.1.0-K-005B	Circulation Fan for Accelerator Area		37	90	85	SIC-1					//
5.3.1.1.0	5.3.1.1.0-K-005C	Circulation Fan for Accelerator Area		37	90	85	SIC-1		o	o		//
5.3.1.1.0	5.3.1.1.0-K-005D	Circulation Fan for Accelerator Area		37	90	85	SIC-1					//
5.3.1.1.0	5.3.1.1.0-K-006A	Exhaust Fan for Accelerator Area		19.5	90	85	SIC-1	50% x 4	o	o		In Vault Recirculation Blower Room-2
5.3.1.1.0	5.3.1.1.0-K-006B	Exhaust Fan for Accelerator Area		19.5	90	85	SIC-1					//
5.3.1.1.0	5.3.1.1.0-K-006C	Exhaust Fan for Accelerator Area		19.5	90	85	SIC-1		o	o		//
5.3.1.1.0	5.3.1.1.0-K-006D	Exhaust Fan for Accelerator Area		19.5	90	85	SIC-1					//
5.3.1.2.0	5.3.1.2.0-K-001A	Exhaust Fan for PIE Nuclear HVAC 'C1'		11	90	85	SIC-1	100% x 2	o	o		In HVAC Blower Room
5.3.1.2.0	5.3.1.2.0-K-001B	Exhaust Fan for PIE Nuclear HVAC 'C1'		11	90	85	SIC-1					//
5.3.1.2.0	5.3.1.2.0-K-002A	Exhaust Fan for PIE Nuclear HVAC 'C2'		18.5	90	85	SIC-1	100% x 2	o	o		//
5.3.1.2.0	5.3.1.2.0-K-002B	Exhaust Fan for PIE Nuclear HVAC 'C2'		18.5	90	85	SIC-1					//
5.3.1.2.0	5.3.1.2.0-K-003A	Exhaust Fan for PIE Nuclear HVAC 'C3'		18.5	90	85	SIC-1	100% x 2	o	o		//
5.3.1.2.0	5.3.1.2.0-K-003B	Exhaust Fan for PIE Nuclear HVAC 'C3'		18.5	90	85	SIC-1					//
5.3.1.2.0	5.3.1.2.0-K-004A	Exhaust Fan for PIE Nuclear HVAC 'C4'		90	90	85	SIC-1	100% x 2	o	o		//
5.3.1.2.0	5.3.1.2.0-K-004B	Exhaust Fan for PIE Nuclear HVAC 'C4'		90	90	85	SIC-1					//
5.3.1.3.0	5.3.1.3.0-K-001A	Exhaust Fan for Industrial HVAC	132		90	85	SR	100% x 2	o	o		In Industrial HVAC Room-1
5.3.1.3.0	5.3.1.3.0-K-001B	Exhaust Fan for Industrial HVAC	132		90	85	SR					//
5.3.1.4.0	5.3.1.4.0-HC-001A	Chiller for Cooling / Heating	300		90	85	SR		o			Outside on Ground
5.3.1.4.0	5.3.1.4.0-HC-001B	Chiller for Cooling / Heating	300		90	85	SR		o			//
5.3.1.4.0	5.3.1.4.0-HC-001C	Chiller for Cooling / Heating	300		90	85	SR		o			//
5.3.1.4.0	5.3.1.4.0-HC-001D	Chiller for Cooling / Heating	300		90	85	SR		o			//
5.3.1.4.0	5.3.1.4.0-HC-001E	Chiller for Cooling / Heating	300		90	85	SR		o			//
5.3.1.4.0	5.3.1.4.0-HC-001F	Chiller for Cooling / Heating	300		90	85	SR		o			//
5.3.1.4.0	5.3.1.4.0-HC-001G	Chiller for Cooling / Heating	300		90	85	SR		o			//
5.3.1.4.0	5.3.1.4.0-HC-001H	Chiller for Cooling / Heating	300		90	85	SR		o			//
5.3.1.4.0	5.3.1.4.0-HC-001I	Chiller for Cooling / Heating	300		90	85	SR		o			//
5.3.1.4.0	5.3.1.4.0-HC-001J	Chiller for Cooling / Heating	300		90	85	SR		o			//
5.3.1.4.0	5.3.1.4.0-HC-001K	Chiller for Cooling / Heating	300		90	85	SR		o			//
5.3.1.4.0	5.3.1.4.0-HC-001L	Chiller for Cooling / Heating	300		90	85	SR		o			//
5.3.1.4.0	5.3.1.4.0-HC-001M	Chiller for Cooling / Heating	300		90	85	SR	(Spare)				//

Table 3-10: Electric Load List for Conventional Facility 1/6

Electric Load List for Conventional Facility

PBS No.	ITEM No.	Service	Rated Power		Efficiency %	Power Factor %	SIC	Redundancy	Normal Operation	Emergency Generator	UPS	Remarks
			6.6 kV (kW)	400V (kW)								
5.3.1.4.0	5.3.1.4.0-HC-002A	Chiller for Heating	210		90	85	SR	100% x 2	o			Outside on Ground
5.3.1.4.0	5.3.1.4.0-HC-002B	Chiller for Heating	210		90	85	SR					#
5.3.1.4.0	5.3.1.4.0-P-001A	Cooling / Hot Water Pump		45	90	85	SR		o			Outside on Ground
5.3.1.4.0	5.3.1.4.0-P-001B	Cooling / Hot Water Pump		45	90	85	SR		o			#
5.3.1.4.0	5.3.1.4.0-P-001C	Cooling / Hot Water Pump		45	90	85	SR		o			#
5.3.1.4.0	5.3.1.4.0-P-001D	Cooling / Hot Water Pump		45	90	85	SR		o			#
5.3.1.4.0	5.3.1.4.0-P-001E	Cooling / Hot Water Pump		45	90	85	SR		o			#
5.3.1.4.0	5.3.1.4.0-P-001F	Cooling / Hot Water Pump		45	90	85	SR		o			#
5.3.1.4.0	5.3.1.4.0-P-001G	Cooling / Hot Water Pump		45	90	85	SR		o			#
5.3.1.4.0	5.3.1.4.0-P-001H	Cooling / Hot Water Pump		45	90	85	SR		o			#
5.3.1.4.0	5.3.1.4.0-P-001I	Cooling / Hot Water Pump		45	90	85	SR		o			#
5.3.1.4.0	5.3.1.4.0-P-001J	Cooling / Hot Water Pump		45	90	85	SR		o			#
5.3.1.4.0	5.3.1.4.0-P-001K	Cooling / Hot Water Pump		45	90	85	SR		o			#
5.3.1.4.0	5.3.1.4.0-P-001L	Cooling / Hot Water Pump		45	90	85	SR		o			#
5.3.1.4.0	5.3.1.4.0-P-001M	Cooling / Hot Water Pump		45	90	85	SR	(Spare)				#
5.3.1.4.0	5.3.1.4.0-P-002A	HotWater Pump		22	90	85	SR	100% x 2	o			#
5.3.1.4.0	5.3.1.4.0-P-002B	HotWater Pump		22	90	85	SR					#
5.3.1.3.0	5.3.1.3.0-PAC-001A	Packaged Air Conditioner (For H/P Panel Room)		0.88	90	85	SR	100% x 2	o			Outside on Roof
5.3.1.3.0	5.3.1.3.0-PAC-001B	Packaged Air Conditioner (For H/P Panel Room)		0.88	90	85	SR					#
5.3.1.3.0	5.3.1.3.0-PAC-002A	Packaged Air Conditioner (For Contol Room)		1.51	90	85	SR	100% x 2	o			#
5.3.1.3.0	5.3.1.3.0-PAC-002B	Packaged Air Conditioner (For Contol Room)		1.51	90	85	SR					#
5.3.1.3.0	5.3.1.3.0-PAC-003A	Packaged Air Conditioner (For LV E.P Supply Area-1)		11.88	90	85	SR	50% x 4	o			#
5.3.1.3.0	5.3.1.3.0-PAC-003B	Packaged Air Conditioner (For LV E.P Supply Area-1)		11.88	90	85	SR					#
5.3.1.3.0	5.3.1.3.0-PAC-003C	Packaged Air Conditioner (For LV E.P Supply Area-1)		11.88	90	85	SR		o			#
5.3.1.3.0	5.3.1.3.0-PAC-003D	Packaged Air Conditioner (For LV E.P Supply Area-1)		11.88	90	85	SR					#
5.3.1.3.0	5.3.1.3.0-PAC-004A	Packaged Air Conditioner (For LV E.P Supply Area-2)		11.88	90	85	SR	50% x 4	o			#
5.3.1.3.0	5.3.1.3.0-PAC-004B	Packaged Air Conditioner (For LV E.P Supply Area-2)		11.88	90	85	SR					#
5.3.1.3.0	5.3.1.3.0-PAC-004C	Packaged Air Conditioner (For LV E.P Supply Area-2)		11.88	90	85	SR		o			#
5.3.1.3.0	5.3.1.3.0-PAC-004D	Packaged Air Conditioner (For LV E.P Supply Area-2)		11.88	90	85	SR					#
5.3.1.3.0	5.3.1.3.0-PAC-005A	Packaged Air Conditioner (For Control Room)		6.01	90	85	SR	100% x 2	o			#
5.3.1.3.0	5.3.1.3.0-PAC-005B	Packaged Air Conditioner (For Control Room)		6.01	90	85	SR					#
5.3.1.3.0	5.3.1.3.0-PAC-006A	Packaged Air Conditioner (For Power Receiving Area-1)		6.01	90	85	SR	50% x 4	o			#
5.3.1.3.0	5.3.1.3.0-PAC-006B	Packaged Air Conditioner (For Power Receiving Area-1)		6.01	90	85	SR					#
5.3.1.3.0	5.3.1.3.0-PAC-006C	Packaged Air Conditioner (For Power Receiving Area-1)		6.01	90	85	SR		o			#
5.3.1.3.0	5.3.1.3.0-PAC-006D	Packaged Air Conditioner (For Power Receiving Area-1)		6.01	90	85	SR					#
5.3.1.3.0	5.3.1.3.0-PAC-007A	Packaged Air Conditioner (For Power Receiving Area-1)		6.01	90	85	SR	50% x 4	o			#
5.3.1.3.0	5.3.1.3.0-PAC-007B	Packaged Air Conditioner (For Power Receiving Area-2)		6.01	90	85	SR					#
5.3.1.3.0	5.3.1.3.0-PAC-007C	Packaged Air Conditioner (For Power Receiving Area-2)		6.01	90	85	SR		o			#
5.3.1.3.0	5.3.1.3.0-PAC-007D	Packaged Air Conditioner (For Power Receiving Area-2)		6.01	90	85	SR					#
5.3.1.3.0	5.3.1.3.0-PAC-008A	Packaged Air Conditioner (For UPS Room-1)		6.01	90	85	SR	100% x 2	o			#
5.3.1.3.0	5.3.1.3.0-PAC-008B	Packaged Air Conditioner (For UPS Room-1)		6.01	90	85	SR					#
5.3.1.3.0	5.3.1.3.0-PAC-009A	Packaged Air Conditioner (For UPS Room-2)		6.01	90	85	SR	100% x 2	o			#
5.3.1.3.0	5.3.1.3.0-PAC-009B	Packaged Air Conditioner (For UPS Room-2)		6.01	90	85	SR					#
5.3.1.3.0	5.3.1.3.0-PAC-010A	Packaged Air Conditioner (For Utilities)		6.01	90	85	SR	50% x 4	o			#
5.3.1.3.0	5.3.1.3.0-PAC-010B	Packaged Air Conditioner (For Utilities)		6.01	90	85	SR					#
5.3.1.3.0	5.3.1.3.0-PAC-010C	Packaged Air Conditioner (For Utilities)		6.01	90	85	SR		o			#
5.3.1.3.0	5.3.1.3.0-PAC-010D	Packaged Air Conditioner (For Utilities)		6.01	90	85	SR					#

Table 3-11: Electric Load List for Conventional Facility 2/6

Electric Load List for Conventional Facility

PBS No.	ITEM No.	Service	Rated Power		Efficiency %	Power Factor %	SIC	Redundancy	Normal Operation	Emergency Generator	UPS	Remarks
			6.6 kV (kW)	400V (kW)								
5.3.1.3.0	5.3.1.3.0-PAC-011A	Packaged Air Conditioner (For Local Control Rack-1)		16.1	90	85	SR	50% x 4	o			Outside on Roof
5.3.1.3.0	5.3.1.3.0-PAC-011B	Packaged Air Conditioner (For Local Control Rack-1)		16.1	90	85	SR					//
5.3.1.3.0	5.3.1.3.0-PAC-011C	Packaged Air Conditioner (For Local Control Rack-1)		16.1	90	85	SR		o			//
5.3.1.3.0	5.3.1.3.0-PAC-011D	Packaged Air Conditioner (For Local Control Rack-1)		16.1	90	85	SR					//
5.3.1.3.0	5.3.1.3.0-PAC-012A	Packaged Air Conditioner (For Local Control Rack-2)		16.1	90	85	SR	50% x 4	o			//
5.3.1.3.0	5.3.1.3.0-PAC-012B	Packaged Air Conditioner (For Local Control Rack-2)		16.1	90	85	SR					//
5.3.1.3.0	5.3.1.3.0-PAC-012C	Packaged Air Conditioner (For Local Control Rack-2)		16.1	90	85	SR		o			//
5.3.1.3.0	5.3.1.3.0-PAC-012D	Packaged Air Conditioner (For Local Control Rack-2)		16.1	90	85	SR					//
5.3.1.3.0	5.3.1.3.0-PAC-013A	Packaged Air Conditioner (For HV E.P. Supply Area-1)		11.88	90	85	SR	33% x 6	o			//
5.3.1.3.0	5.3.1.3.0-PAC-013B	Packaged Air Conditioner (For HV E.P. Supply Area-1)		11.88	90	85	SR					//
5.3.1.3.0	5.3.1.3.0-PAC-013C	Packaged Air Conditioner (For HV E.P. Supply Area-1)		11.88	90	85	SR		o			//
5.3.1.3.0	5.3.1.3.0-PAC-013D	Packaged Air Conditioner (For HV E.P. Supply Area-1)		11.88	90	85	SR					//
5.3.1.3.0	5.3.1.3.0-PAC-013E	Packaged Air Conditioner (For HV E.P. Supply Area-1)		11.88	90	85	SR		o			//
5.3.1.3.0	5.3.1.3.0-PAC-013F	Packaged Air Conditioner (For HV E.P. Supply Area-1)		11.88	90	85	SR					//
5.3.1.3.0	5.3.1.3.0-PAC-014A	Packaged Air Conditioner (For HV E.P. Supply Area-2)		11.88	90	85	SR	33% x 6	o			//
5.3.1.3.0	5.3.1.3.0-PAC-014B	Packaged Air Conditioner (For HV E.P. Supply Area-2)		11.88	90	85	SR					//
5.3.1.3.0	5.3.1.3.0-PAC-014C	Packaged Air Conditioner (For HV E.P. Supply Area-2)		11.88	90	85	SR		o			//
5.3.1.3.0	5.3.1.3.0-PAC-014D	Packaged Air Conditioner (For HV E.P. Supply Area-2)		11.88	90	85	SR					//
5.3.1.3.0	5.3.1.3.0-PAC-014E	Packaged Air Conditioner (For HV E.P. Supply Area-2)		11.88	90	85	SR		o			//
5.3.1.3.0	5.3.1.3.0-PAC-014F	Packaged Air Conditioner (For HV E.P. Supply Area-2)		11.88	90	85	SR					//
5.3.1.3.0	5.3.1.3.0-PAC-015A	Packaged Air Conditioner (For Non-Radi. Cooling Machine Room-1)		6.01	90	85	SR	100% x 2	o			//
5.3.1.3.0	5.3.1.3.0-PAC-015B	Packaged Air Conditioner (For Non-Radi. Cooling Machine Room-1)		6.01	90	85	SR					//
5.3.1.3.0	5.3.1.3.0-PAC-016A	Packaged Air Conditioner (For Non-Radi. Cooling Machine Room-2)		6.01	90	85	SR	100% x 2	o			//
5.3.1.3.0	5.3.1.3.0-PAC-016B	Packaged Air Conditioner (For Non-Radi. Cooling Machine Room-2)		6.01	90	85	SR					//
5.3.1.3.0	5.3.1.3.0-PAC-017A	Packaged Air Conditioner (For Computer Room)		1.51	90	85	SR	100% x 2	o			//
5.3.1.3.0	5.3.1.3.0-PAC-017B	Packaged Air Conditioner (For Computer Room)		1.51	90	85	SR					//
5.3.3.0.0	5.3.3.0.0-HT-001A	Cooling Tower		111	90	85	SR		o			37 kW x 3
5.3.3.0.0	5.3.3.0.0-HT-001B	Cooling Tower		111	90	85	SR		o			37 kW x 3
5.3.3.0.0	5.3.3.0.0-HT-001C	Cooling Tower		111	90	85	SR		o			37 kW x 3
5.3.3.0.0	5.3.3.0.0-HT-001D	Cooling Tower		111	90	85	SR		o			37 kW x 3
5.3.3.0.0	5.3.3.0.0-HT-001E	Cooling Tower		111	90	85	SR		o			37 kW x 3
5.3.3.0.0	5.3.3.0.0-HT-101A	Cooling Tower		111	90	85	SR		o			37 kW x 3
5.3.3.0.0	5.3.3.0.0-HT-101B	Cooling Tower		111	90	85	SR		o			37 kW x 3
5.3.3.0.0	5.3.3.0.0-HT-101C	Cooling Tower		111	90	85	SR		o			37 kW x 3
5.3.3.0.0	5.3.3.0.0-HT-102A	Cooling Tower (2nd Phase)		111	90	85	SR		o			37 kW x 3
5.3.3.0.0	5.3.3.0.0-HT-102B	Cooling Tower (2nd Phase)		111	90	85	SR		o			37 kW x 3
5.3.3.0.0	5.3.3.0.0-HT-201A	Cooling Tower		44	90	85	SR		o			22 kW x 2
5.3.3.0.0	5.3.3.0.0-HT-201B	Cooling Tower		44	90	85	SR		o			22 kW x 2
5.3.3.0.0	5.3.3.0.0-HT-202	Cooling Tower (2nd Phase)		44	90	85	SR		o			22 kW x 2
5.3.3.0.0	5.3.3.0.0-HT-301A	Cooling Tower		74	90	85	SR		o			37 kW x 2
5.3.3.0.0	5.3.3.0.0-HT-301B	Cooling Tower		74	90	85	SR		o			37 kW x 2
5.3.3.0.0	5.3.3.0.0-HT-302	Cooling Tower (2nd Phase)		74	90	85	SR		o			37 kW x 2
5.3.3.0.0	5.3.3.0.0-HC-021A	Primary ChW Chiller	398		90	85	SR	100% x 2	o			
5.3.3.0.0	5.3.3.0.0-HC-021B	Primary ChW Chiller	398		90	85	SR					
5.3.3.0.0	5.3.3.0.0-HC-211A	Secondary ChW Chiller	460		90	85	SR	100% x 2	o			
5.3.3.0.0	5.3.3.0.0-HC-211B	Secondary ChW Chiller	460		90	85	SR					

Table 3-12: Electric Load List for Conventional Facility 3/6

Electric Load List for Conventional Facility

PBS No.	ITEM No.	Service	Rated Power		Efficiency %	Power Factor %	SIC	Redundancy	Normal Operation	Emergency Generator	UPS	Remarks
			6.6 kV (kW)	400V (kW)								
5.3.3.0.0	5.3.3.0.0-P-001A	Secondary CW Pump	400		90	85	SR	100% x 2	o			
5.3.3.0.0	5.3.3.0.0-P-001B	Secondary CW Pump	400		90	85	SR					
5.3.3.0.0	5.3.3.0.0-P-111A	Secondary CW Pump	185		90	85	SR	100% x 2	o			
5.3.3.0.0	5.3.3.0.0-P-111B	Secondary CW Pump	185		90	85	SR					
5.3.3.0.0	5.3.3.0.0-P-201A	Secondary CW Pump		110	90	85	SR	100% x 2	o			
5.3.3.0.0	5.3.3.0.0-P-201B	Secondary CW Pump		110	90	85	SR					
5.3.3.0.0	5.3.3.0.0-P-211A	Secondary ChW Pump		90	90	85	SR	100% x 2	o			
5.3.3.0.0	5.3.3.0.0-P-211B	Secondary ChW Pump		90	90	85	SR					
5.3.3.0.0	5.3.3.0.0-P-011A	Primary CW Pump		120	90	85	SR	100% x 2	o			
5.3.3.0.0	5.3.3.0.0-P-011B	Primary CW Pump		120	90	85	SR					
5.3.3.0.0	5.3.3.0.0-P-021A	Primary ChW Pump		90	90	85	SR	100% x 2	o			
5.3.3.0.0	5.3.3.0.0-P-021B	Primary ChW Pump		90	90	85	SR					
5.3.3.0.0	5.3.3.0.0-P-301A	Tertiary CW Pump		75	90	85	SR	100% x 2	o			
5.3.3.0.0	5.3.3.0.0-P-301B	Tertiary CW Pump		75	90	85	SR					
5.3.3.0.0	5.3.3.0.0-P-311A	Secondary CW Pump		75	90	85	SR	100% x 2	o			
5.3.3.0.0	5.3.3.0.0-P-311B	Secondary CW Pump		75	90	85	SR					
5.3.4.1.0	5.3.4.1.0-U-001	Portabe Water Supply Unit (200V)		3	90	85	SR		o			1.5 kW x 2
5.3.4.2.0	5.3.4.2.0-P-021	Demineralized Water Supply Unit (200V)		3	90	85	SR		o			1.5 kW x 2
5.3.4.2.0	5.3.4.2.0-P-031A	Industrial Water Pump		37	90	85	SR	100% x 2	o			
5.3.4.2.0	5.3.4.2.0-P-031B	Industrial Water Pump		37	90	85	SR					
5.3.5.1.0	5.3.5.1.0-U-003	Argon Purification System		65	90	85	SIC-2		o	o		
5.3.5.1.0	5.3.5.1.0-K-004A	Argon Recirculation Blower		45	90	85	SIC-2	100% x 2	o	o		
5.3.5.1.0	5.3.5.1.0-K-004B	Argon Recirculation Blower		45	90	85	SIC-2					
5.3.5.3.0	5.3.5.3.0-K-201A	Instrumentation Air Compressor		28.1	90	85	SIC-1	100% x 2	o	o		
5.3.5.3.0	5.3.5.3.0-K-201B	Instrumentation Air Compressor		28.1	90	85	SIC-1					
5.3.5.3.0	5.3.5.3.0-U-211A	Breathable Air Supply Unit		15	90	85	SIC-1	100% x 2	o	o		
5.3.5.3.0	5.3.5.3.0-U-211B	Breathable Air Supply Unit		15	90	85	SIC-1					
5.3.6.1.0	5.3.6.1.0-U-002A	VDS Electrolysis Cell		0.4	90	85	SIC-1	100% x 2	o	o		
5.3.6.1.0	5.3.6.1.0-U-002B	VDS Electrolysis Cell		0.4	90	85	SIC-1					
5.3.6.1.0	5.3.6.1.0-HE-003	VDS Electric Heater-1		0.2	100	100	SIC-1		o	o		
5.3.6.1.0	5.3.6.1.0-K-007A	VDS Bower-1		0.14	90	85	SIC-1	100% x 2	o	o		
5.3.6.1.0	5.3.6.1.0-K-007B	VDS Bower-1		0.14	90	85	SIC-1					
5.3.6.1.0	5.3.6.1.0-HE-012	VDS Electric Heater-2		23	100	100	SIC-1		o	o		
5.3.6.1.0	5.3.6.1.0-K-016A	VDS Bower-2		12	90	85	SIC-1	100% x 2	o	o		
5.3.6.1.0	5.3.6.1.0-K-016B	VDS Bower-2		12	90	85	SIC-1					
5.3.6.1.0	5.3.6.1.0-HE-017	VDS Regeneration Electric Heater		44	100	100	SIC-1		o	o		
5.3.6.1.0	5.3.6.1.0-K-019A	VDS Regeneration Blower		12	90	85	SIC-1	100% x 2	o	o		
5.3.6.1.0	5.3.6.1.0-K-019B	VDS Regeneration Blower		12	90	85	SIC-1					
5.3.6.1.0	5.3.6.1.0-P-022A	VDS Tritiated Water Transfer Pump		0.75	90	85	SR	100% x 2	o			
5.3.6.1.0	5.3.6.1.0-P-022B	VDS Tritiated Water Transfer Pump		0.75	90	85	SR					
5.3.6.1.0	5.3.6.1.0-U-023A	VDS Chilled Water Supply Unit		0.8	90	85	SR	100% x 2	o			
5.3.6.1.0	5.3.6.1.0-U-023B	VDS Chilled Water Supply Unit		0.8	90	85	SR					

Table 3-13: Electric Load List for Conventional Facility 4/6

Electric Load List for Conventional Facility

PBS No.	ITEM No.	Service	Rated Power		Efficiency %	Power Factor %	SIC	Redundancy	Normal Operation	Emergency Generator	UPS	Remarks
			6.6 kV (kW)	400V (kW)								
5.3.6.1.0	5.3.6.1.0-HE-101	EDS Electric Heater		28	100	100	SIC-1		o	o		
5.3.6.1.0	5.3.6.1.0-K-105A	EDS Blower		25	90	85	SIC-1	100% x 2	o	o		
5.3.6.1.0	5.3.6.1.0-K-105B	EDS Blower		25	90	85	SIC-1		o	o		
5.3.6.1.0	5.3.6.1.0-K-106A	EDS Vent Blower		0.4	90	85	SIC-1	100% x 2	o	o		
5.3.6.1.0	5.3.6.1.0-K-106B	EDS Vent Blower		0.4	90	85	SIC-1		o	o		
5.3.6.1.0	5.3.6.1.0-K-109A	EDS Regeneration Blower		25	90	85	SIC-1	100% x 2	o	o		
5.3.6.1.0	5.3.6.1.0-K-109B	EDS Regeneration Blower		25	90	85	SIC-1		o	o		
5.3.6.1.0	5.3.6.1.0-HE-107	EDS Regeneration Electric Heater		52	100	100	SIC-1		o	o		
5.3.6.1.0	5.3.6.1.0-P-112A	EDS Tritiated Water Transfer Pump		0.75	90	85	SIC-1	100% x 2	o	o		
5.3.6.1.0	5.3.6.1.0-P-112B	EDS Tritiated Water Transfer Pump		0.75	90	85	SIC-1		o	o		
5.3.6.1.0	5.3.6.1.0-P-116A	EDS ChW Pump		2.5	90	85	SIC-1	100% x 2	o	o		
5.3.6.1.0	5.3.6.1.0-P-116B	EDS ChW Pump		2.5	90	85	SIC-1		o	o		
5.3.6.1.0	5.3.6.1.0-HE-201	GDS Electric Heater		35	100	100	SIC-2		o	o		
5.3.6.1.0	5.3.6.1.0-K-207	GDS Blower		25	90	85	SIC-2		o	o		VSD
5.3.6.1.0	5.3.6.1.0-K-208	GDS Vent Blower		0.23	90	85	SIC-2		o	o		
5.3.6.1.0	5.3.6.1.0-HE-209	GDS Regeneration Electric Heater-1		130	100	100	SIC-2		o	o		
5.3.6.1.0	5.3.6.1.0-K-211	GDS Regeneration Blower-1		25	90	85	SIC-2		o	o		VSD
5.3.6.1.0	5.3.6.1.0-HE-214	GDS Regeneration Electric Heater-2		5	100	100	SIC-2		o	o		
5.3.6.1.0	5.3.6.1.0-K-216	GDS Regeneration Blower-2		5	90	85	SIC-2		o	o		VSD
5.3.6.1.0	5.3.6.1.0-P-217	GDS Tritiated Water Transfer Pump		0.5	90	85	SIC-2		o	o		
5.3.6.1.0	5.3.6.1.0-U-221A	GDS Electrolysis Cell		2.5	90	85	SIC-2	500% x 2	o	o		
5.3.6.1.0	5.3.6.1.0-U-221B	GDS Electrolysis Cell		2.5	90	85	SIC-2		o	o		
5.3.6.1.0	5.3.6.1.0-HE-301	HDS-1 Electric Heater		173	100	100	SIC-2		o	o		
5.3.6.1.0	5.3.6.1.0-K-305	HDS-1 Blower		55	90	85	SIC-2		o	o		VSD
5.3.6.1.0	5.3.6.1.0-K-306	HDS-1 Vent Blower		0.14	90	85	SIC-2		o	o		
5.3.6.1.0	5.3.6.1.0-HE-307	HDS-1 Regeneration Electric Heater		327	100	100	SIC-2		o	o		
5.3.6.1.0	5.3.6.1.0-K-309	HDS-1 Regeneration Blower		55	90	85	SIC-2		o	o		VSD
5.3.6.1.0	5.3.6.1.0-P-312	HDS-1 Tritiated Water Transfer Pump		0.5	90	85	SIC-2		o	o		
5.3.6.1.0	5.3.6.1.0-HE-401	HDS-2 Electric Heater		173	100	100	SIC-2		o	o		
5.3.6.1.0	5.3.6.1.0-K-405	HDS-2 Blower		55	90	85	SIC-2		o	o		VSD
5.3.6.1.0	5.3.6.1.0-K-406	HDS-2 Vent Blower		0.14	90	85	SIC-2		o	o		
5.3.6.1.0	5.3.6.1.0-HE-407	HDS-2 Regeneration Electric Heater		327	100	100	SIC-2		o	o		
5.3.6.1.0	5.3.6.1.0-K-409	HDS-2 Regeneration Blower		55	90	85	SIC-2		o	o		VSD
5.3.6.1.0	5.3.6.1.0-P-412	HDS-2 Tritiated Water Transfer Pump		0.5	90	85	SIC-2		o	o		
5.3.6.1.0	5.3.6.1.0-HE-501	HDS-3 Electric Heater		104	100	100	SIC-2		o	o		
5.3.6.1.0	5.3.6.1.0-K-505	HDS-3 Blower		55	90	85	SIC-2		o	o		VSD
5.3.6.1.0	5.3.6.1.0-K-506	HDS-3 Vent Blower		0.23	90	85	SIC-2		o	o		
5.3.6.1.0	5.3.6.1.0-HE-507	HDS-3 Regeneration Electric Heater		196	100	100	SIC-2		o	o		
5.3.6.1.0	5.3.6.1.0-K-509	HDS-3 Regeneration Blower		55	90	85	SIC-2		o	o		VSD
5.3.6.1.0	5.3.6.1.0-P-512	HDS-3 Tritiated Water Transfer Pump		0.5	90	85	SIC-2		o	o		
5.3.6.1.0	5.3.6.1.0-HE-601	GDS-V Electric Heater		35	100	100	SIC-2		o	o		
5.3.6.1.0	5.3.6.1.0-K-605	GDS-V Blower		25	90	85	SIC-2		o	o		VSD
5.3.6.1.0	5.3.6.1.0-K-606	GDS-V Vent Blower		0.23	90	85	SIC-2		o	o		
5.3.6.1.0	5.3.6.1.0-HE-607	GDS-V Regeneration Electric Heater		65	100	100	SIC-2		o	o		
5.3.6.1.0	5.3.6.1.0-K-609	GDS-V Regeneration Blower		25	90	85	SIC-2		o	o		VSD
5.3.6.1.0	5.3.6.1.0-P-612	GDS-V Tritiated Water Transfer Pump		0.5	90	85	SIC-2		o	o		

Table 3-14: Electric Load List for Conventional Facility 5/6

Electric Load List for Conventional Facility

FBS No.	ITEM No.	Service	Rated Power		Efficiency %	Power Factor %	SIC	Redundancy	Normal Operation	Emergency Generator	UPS	Remarks
			6.6 kV (kW)	400V (kW)								
53.6.1.0	5.3.6.1.0-HE-701	GDS-E Electric Heater		12	100	100	SIC-2		o	o		
53.6.1.0	5.3.6.1.0-K-705	GDS-E Blower		25	90	85	SIC-2		o	o		VSD
53.6.1.0	5.3.6.1.0-K-706	GDS-E Vent Blower		0.14	90	85	SIC-2		o	o		
53.6.1.0	5.3.6.1.0-HE-707	GDS-E Regeneration Electric Heater		25	100	100	SIC-2		o	o		
53.6.1.0	5.3.6.1.0-K-709	GDS-E Regeneration Blower		25	90	85	SIC-2		o	o		VSD
53.6.1.0	5.3.6.1.0-P-712	GDS-E Tritiated Water Transfer Pump		0.5	90	85	SIC-2		o	o		
53.6.2.0	5.3.6.2.0-P-002A	Activated Cooling Water Pump		7.5	90	85	SIC-2	100% x 2	o	o		
53.6.2.0	5.3.6.2.0-P-002B	Activated Cooling Water Pump		7.5	90	85	SIC-2					
53.6.2.0	5.3.6.2.0-P-012A	Tritiated Water Transfer Pump		0.75	90	85	SIC-2	100% x 2	o	o		
53.6.2.0	5.3.6.2.0-P-012B	Tritiated Water Transfer Pump		0.75	90	85	SIC-2					
53.6.2.0	5.3.6.2.0-P-022A	Liquid Waste Transfer Pump		5.5	90	85	SIC-2	100% x 2	o	o		
53.6.2.0	5.3.6.2.0-P-022B	Liquid Waste Transfer Pump		5.5	90	85	SIC-2					
53.6.2.0	5.3.6.2.0-P-032A	Chemical Waste Water Transfer Pump		0.75	90	85	SIC-2	100% x 2	o	o		
53.6.2.0	5.3.6.2.0-P-032B	Chemical Waste Water Transfer Pump		0.75	90	85	SIC-2					
53.6.2.0	5.3.6.2.0-P-042A	Non-aqueous Liquid Waste Transfer Pump		0.75	90	85	SIC-2	100% x 2	o	o		
53.6.2.0	5.3.6.2.0-P-042B	Non-aqueous Liquid Waste Transfer Pump		0.75	90	85	SIC-2					
53.7.1.0	5.3.7.1.0-P-001A	Firewater Jokey Pump		11	90	85	SIC-2	100% x 2		o		Skid Mounted
53.7.1.0	5.3.7.1.0-P-001B	Firewater Jokey Pump		11	90	85	SIC-2					"B" is a spare
53.7.1.0	5.3.7.1.0-P-002	Motor Driven Firewater Pump	150		90	85	SIC-2			o		UL Approval / FM Listed
53.7.1.0	5.3.7.1.0-P-003	Diesel Driven Firewater Pump					SIC-2					Diesel Engine Pump
		Fire Protection System		20	90	85	SIC-2		o	o		
		Central Control System		100	90	85	SR		o			
		Central Control System for Emergency		50	90	85	SIC-1		o	o	o	
		Instrumentation		50	90	85	SR		o			
		Instrumentation for Emergency		25	90	85	SIC-1		o	o	o	
		Monitoring and Security Camera		50	90	85	SIC-1		o	o	o	
		Access Control & Security System		50	90	85	SIC-1		o	o	o	
		RAMSES		100	90	85	SIC-1		o	o	o	
		Handling System (Crane, Telemanipulators, etc)		400	90	85	SR		o			
		Building Utility (Lights, Sockets, etc.)		400	90	85	SR		o			
		Building Utility (Lights, Sockets, etc.) for Emergency		400	90	85	SIC-2		o	o		
		Total	10184	9120.91								

Table 3-15: Electric Load List for Conventional Facility 6/6

3.2.6 IFMIF Total Electric Load

Table 3-16 show Total Electric Load for IFMIF.

- For Rated Power : 84880 kVA
- For Emergency Power : 6478 kVA
- For UPS : 1017 kVA

Electric Load List

	Total Rated Power				Normal Operation Power				Emergency Generator				UPS			
	6.6 kV (kW)	400V (kW)	6.6 kV (kVA)	400V (kVA)	6.6 kV (kW)	400V (kW)	6.6 kV (kVA)	400V (kVA)	6.6 kV (kW)	400V (kW)	6.6 kV (kVA)	400V (kVA)	6.6 kV (kW)	400V (kW)	6.6 kV (kVA)	400V (kVA)
Accelerator Facility	32940	8153	41183	11704	32940	8953	41183	11704	0	314	0	411	0	314	0	411
Lithium Target Facility	600	1104	915	1680	600	1680	915	1723	180	559	238	585	90	29	120	47
Test Facility	2256	668	2947	742	2147	468	2806	611	108	75	141	97	0	51	0	67
Post Irradiation Facility	0	1110	0	1013	0	1010	0	1013	0	10	0	13	0	10	0	13
Conventional Facility	10184	9121	13313	11384	6667	7511	8716	9280	664	3567	868	4124	0	275	0	359
Total	45979	21656	58358	26522	42354	19622	53619	24331	952	4525	1247	5231	90	679	120	897

Table 3-16: Total Electric Load of IFMIF

3.3 Safety Design Requirements

The general Safety approach for the design execution of EPS is based on the general Safety specification for the Engineering Design Activities of IFMIF.

- The IFMIF’s Safety objectives, principles and criteria.
- The Hazard evaluation techniques, to be implemented on the next design phase

The entire document is uploaded on DMS: Safety Specifications (Ref. [2]) and following updating. At the present time the Engineering Design for EPS follow the Safety approach mentioned on the guideline document, nevertheless it can be subject to some deviation or weaves according the final IFMIF site selection. As well as the safety authority could gives some further requirements.

3.4 Operation and Maintenance

3.4.1 Operation

Operation of Electric Power System is usually automatically performed from IFMIF Central Control Room. Grid change in an emergency and starting of the emergency generator are also performed automatically from Central Control Room.

The operational status of Electric Power System, voltage values, and current values are monitored and recorded in IFMFI Central Control Room.

Also the operational status of Electric Power System, voltage values, and current values are shown on the front panel of each electric power board.

At an emergency or the time of maintenance, the manual operative method can be carried out from each electric power board.

HV and MV electric power board

From safety point of view, HV and MV electric power board should be considered so that people may not come close during operation.

3.4.2 Maintenance

Integrative maintenance plan is not yet described on this DDD II. It shall be defined clearly after having selected all the components for Electric Power System, preferable the maintenance plan shall be prepared by the suppliers, as well as regulatory maintenance requirements must be identified.

Minimum information required within the maintenance plan is listed below:

- Scheduled Operation
- Controls
- Checks
- Adjustments
- Calibrations
- Overhauls
- Replacements

Information provided from safety specification (Ref. [2]), and of course will be implemented and identified as necessary by the supplier in order to ensure the best operation of Electric Power System within its intended operational scenario.

That may impact IFMIF availability and become essential to evaluate and to introduce an additional important support of recommended spare parts list, (provided by the suppliers) procedures, training, tools and test equipments, infrastructures.

The design of Electric Power System shall accommodate long-term maintenance activities required to support IFMIF plant operation. For maintainability and inspectability, Electric Power System shall be designed in such a way that it can facilitate maintenance and, in case of failure, easy diagnostics safe repair or replacement and re-calibration. The maintenance of Electric Power System must be an ongoing endeavor. Any lapses in regular maintenance can result in system degradation and obvious loss of efficiency which could arise to serious health issue.

Maintenance requirement for Electric Power System and equipments must be conform to the maintenance period defined for the IFMIF plant (particularly for the facilities that are not reachable during operation period)

3.5 RAMI requirements

Electric Power System is analyzed by RAMI Specifications (Ref. [3]). Electric Power System should be designed for all modes of IFMIF plant operation as well as shut down period. Electric Power System should be reliable design for continuous operation, easily accessible for the purpose of operation and maintenance. Maintaining and Operating of Electric Power System have to be designed by reliability and availability requirements identified on the conventional facility Safety Report. At this stage of the Project complete RAMI analysis has not been performed (due to the high variability of the parameters, such a procedure has not been considered worthwhile). However several assumptions have been evaluated and taken into consideration based of the standard engineering practice. RAMI assessment and implementation of the engineering process shall be fully integrated on the next phase of the project.

3.6 Applicable Codes and Standards

Applicable Codes and Standards for EPS as follows,

- 1) International Electrotechnical Commission (IEC)
- 2) European Standards (EN)
- 3) ANSI/EE Standards
- 4) IFMIF safety specification for EDA : BA_D_22AB9R
- 5) Electrical Power supply needs from the nuclear safety point of view : BA_D_22GZSB
- 6) RAMI Specifications : BA_D_22HA3G

4. System Design Description

4.1 Design Summary

Electric Power System is designed based on the requirements (Sec.3.), IFMIF specifications, codes and standards. Result of design is shown Sec.1 and Key One Line Diagram.

The Electric Power System supplies electric power to facilities, sub systems and equipments in IFMIF. It has to be taken into account safety requirements, receiving power conditions, safety margin, SIC specifications, etc.

4.2 Safety

Refer to Safety specifications for the Engineering design Activities of IFMIF (Ref. [2]), Safety Important Class – SIC Methodology (Ref. [1]) and Electrical Power supply needs from the nuclear safety point of view (Ref. [4]).

4.3 Assumptions

Receiving Power Conditions from commercial grid are assumed as follows,

Current Type	:	Alternating Current
Cabling System	:	Three - Phase Three Wire
Feeding System	:	2 Feeding System (Primary and Secondary)
Incoming Voltage	:	66 kV
Voltage Permissible Range	:	$\pm 7 \%$
Supply System	:	Steel Tower with Over Head Cables
Frequency	:	50 Hz
Frequency Permissible Range	:	$\pm 2 \text{ Hz}$
Supply Voltage Stop (<10sec,)	:	Less than 1 per year
Supply Voltage Drop (<20 %, < 1sec)	:	Less than 5 per year
Supply Voltage Generation Type (Ideal)	:	Coal Thermal or Gas Thermal or Nuclear
Harmonic current (in feeding wire)	:	as lower as possible

4.4 Detailed Design Description

4.4.1 Power Supply Voltage Classification

International Standard IEC 60038 defines a set of standard voltages for use in low voltage and high voltage electricity supply systems.

The definition of voltage level is as follows,

- 1) Alternating Current (AC)
 - High Voltage (HV) : >1000Vrms
 - Low Voltage (LV) : 25-1000Vrms
 - Extra Low Voltage (ELV) : < 25Vrms

- 2) Direct Current (DC)
 - High Voltage (HV) : > 1500V
 - Low Voltage (LV) : 60-1500V
 - Extra Low Voltage (ELV) : <60V

In IFMIF, AC Power Supply Voltage is defined as follows,

- High Voltage (HV) : > 66000Vrms
- Medium Voltage (MV) : 6600Vrms
- Low Voltage (LV) : 230-400Vrms

4.4.2 Equipment Margin

A safety margin for the EPS equipment has been assumed according to the standard engineering practice.

In general a margin in the design has to be assumed in order to allow some flexibility to the system.

In particular:

- For all equipment except circuit breaker, margin takes into account +10 to 20 % of the rated power.
- For circuit breaker, margin does not take into account. But it is selected according to the electric load capacity of the equipment connected downstream.

4.4.3 SIC Classification

According to the classification proposed in Safety Specifications (Ref. [2]) and Safety Important Class-SIC, Methodology, Classification & Requirements (Ref. [1]).

But, SIC is not specified when it thinks Electric Power System independent.

However, Electric Power System have to be designed according to the SIC class of facilities, sub systems and equipments connected to it.

4.4.4 Redundant Equipment

Redundancy of the equipment should contribute to the target availability value of the Conventional Facilities (stated into 99.7 % as mentioned in CDR (Ref. [5])). At this stage of the project a complete RAMI Analysis has not been performed (due to the high variability of the parameters, such a procedure has not been considered worthwhile). By the way some assumptions have been made on the base of the standard engineering practice.

Accordingly, from view point of availability, following measures shall be taken.

- Redundant Emergency Generators (50% x 2 x 2) shall be installed.

4.4.5 Power System Substation (PBS: 5.3.2.1.0)

Power System Substation was designed based on Electric Load List (Sec.3.2)
The power supply capacity required from each facility is as follows,

- AF : 52.9 MVA
- LF : 2.6 MVA
- TF : 3.7 MVA
- PIEF : 1.0 MVA
- CF : 24.7 MVA
- Total : 84.9 MVA

From the result of above, 20MVA x 3 transformers (66kV/6.6kV) were installed.
In consideration of the stole of the external commercial grid, two-line power receiving of the commercial external grid was adopted.

4.4.6 Emergency Power System (PBS: 5.3.2.2.0)

Emergency Power System was designed based on Electric Load List (Sec.3.2)
The emergency power supply capacity required from each apparatus is as follows,

- AF : 411 kVA
- LF : 823 kVA
- TF : 238 kVA
- PIEF : 13 kVA
- CF : 4992 kVA
- Total : 6478 kVA

From the result of above, 4000kVA x 2 emergency power generators were installed and 4000kVA x 2 emergency power generators were prepared as full back-up.
The reason 4000kVA emergency generator was chosen is flexible as commercial products. Emergency power is supplied through Electric Distribution System to equipments which classified SIC-1 and SIC-2.

4.4.7 Electric Distribution System (PBS: 5.3.2.3.0)

Electric Distribution System was designed by requirements of SIC classification as follows,

- SR/Non-SIC loads : Single Power System
- SIC-2 loads : Power System + Emergency Power System
- SIC-1 loads : Redundancy Power System + Emergency Power System

4.5 System Performance Requirements

Not applicable at this engineering stage, anyhow the system performance basic functions are indicated on Key One Line Diagram as follows,

- Figure 6-1 : Key One Line Diagram 1/2
- Figure 6-2 : Key One Line Diagram 2/2

4.6 System Arrangement

4.6.1 Equipment Arrangement Drawings

Equipments arrangement for EPS is as follows,

- Electric Power Boards for LT, TF and CF are installed in same room of “R303-2 LV Elect. Power Supply Area-2”.
- UPS and DC Batteries for LT, TF and CF are installed in same room of “R302-1/2 UPS Room-1/2”.
- Electric Power Boards including UPSs, DC Batteries and CVCF for PIE F are installed “R162 PIE-Electric Room”.
- For AF, Transformers for RF HVPS are installed on the roof of the IFMIF building. Electric Power Boards including UPSs, DC Batteries and CVCF for AF are installed “R201-A1-1/2 High Voltage Electric Power Supply Area-1/2”.

Equipments arrangement drawings for EPS is as follows,

- Figure 6-3 : IFMIF Outdoor Overall View, Switchyard, Emergency Generators
- Figure 6-4 : Equipment Layout for Electric Power System 1/6
- Figure 6-5 : Equipment Layout for Electric Power System 2/6
- Figure 6-6 : Equipment Layout for Electric Power System 3/6
- Figure 6-7 : Equipment Layout for Electric Power System 4/6
- Figure 6-8 : Equipment Layout for Electric Power System 5/6
- Figure 6-9 : Equipment Layout for Electric Power System 6/6

4.6.2 Equipment Lists (Parts/Components)

Refer to Sec.1.2 System Basic Configuration.

5. List of Reference

5.1 List of Reference

- [1] Y.Le Tonqueze, Safety Important Class - SIC Methodology, classification & requirements. BA_D_228V5Q.
- [2] Y.Le Tonqueze, Safety Specification for the EDA of IFMIF. BA_D_224X48.
- [3] J. Arroyo, RAMI Specifications. BA_D_22HA3G.
- [4] Y.Le Tonqueze, Electrical Power supply needs from the nuclear safety point of view. BA_D_22GZSB.
- [5] IEA, IFMIF Comprehensive Design Report.

5.2 List of Acronyms

AF	Accelerator Facility
AC	Alternating Current
ACSS	Access Control & Security System
BFD	Block Flow Diagram
CC&CI	Central Control & Common Instrumentation
CDA	IFMIF Conceptual Design Activity
CDR	IFMIF Comprehensive Design Report
CF	Conventional Facilities
CVCF	Constant Voltage Constant Frequency
DC	Direct Current
DDD	Design Description Document
DVT	Data Validation Table
EPS	Electrical Power System
FPS	Fire Protection System
HV	High Voltage
HVAC	Heating Ventilation Air Conditioning
HRS	Heart Rejection System
EVEDA	Engineering Validation & Engineering Design Activity
IFMIF	International Fusion Materials Irradiation Facility
LF	Lithium Target Facility
LV	Low Voltage
MCC	Motor Control Center
MV	Medium Voltage
OLD	One Line Diagram
PBS	Plant Breakdown Structure
PIEF	Post Irradiation Examination Facility
PT	Project Team
RAMI	Reliability, Availability, Maintainability, Inspectability
RAMSES	Radiation Monitoring System for Environment & Safety
RWTS	Radioactive Waste Treatment System
SGS	Service Gas System

SIC	Safety Important Component
SWGR	Switchgear
SWS	Service Water System
UPS	Uninterruptible Power Supply
TF	Test Facility
WBS	Work Breakdown Structure

6. Appendices

6.1 List of Documents

Figure 6-1: Key One Line Diagram 1/2

Figure 6-2: Key One Line Diagram 2/2

Figure 6-3: IFMIF Outdoor Overall View, Switchyard, Emergency Generators

Figure 6-4: Equipment Layout for Electric Power System 1/6

Figure 6-5: Equipment Layout for Electric Power System 2/6

Figure 6-6: Equipment Layout for Electric Power System 3/6

Figure 6-7: Equipment Layout for Electric Power System 4/6

Figure 6-8: Equipment Layout for Electric Power System 5/6

Figure 6-9: Equipment Layout for Electric Power System 6/6

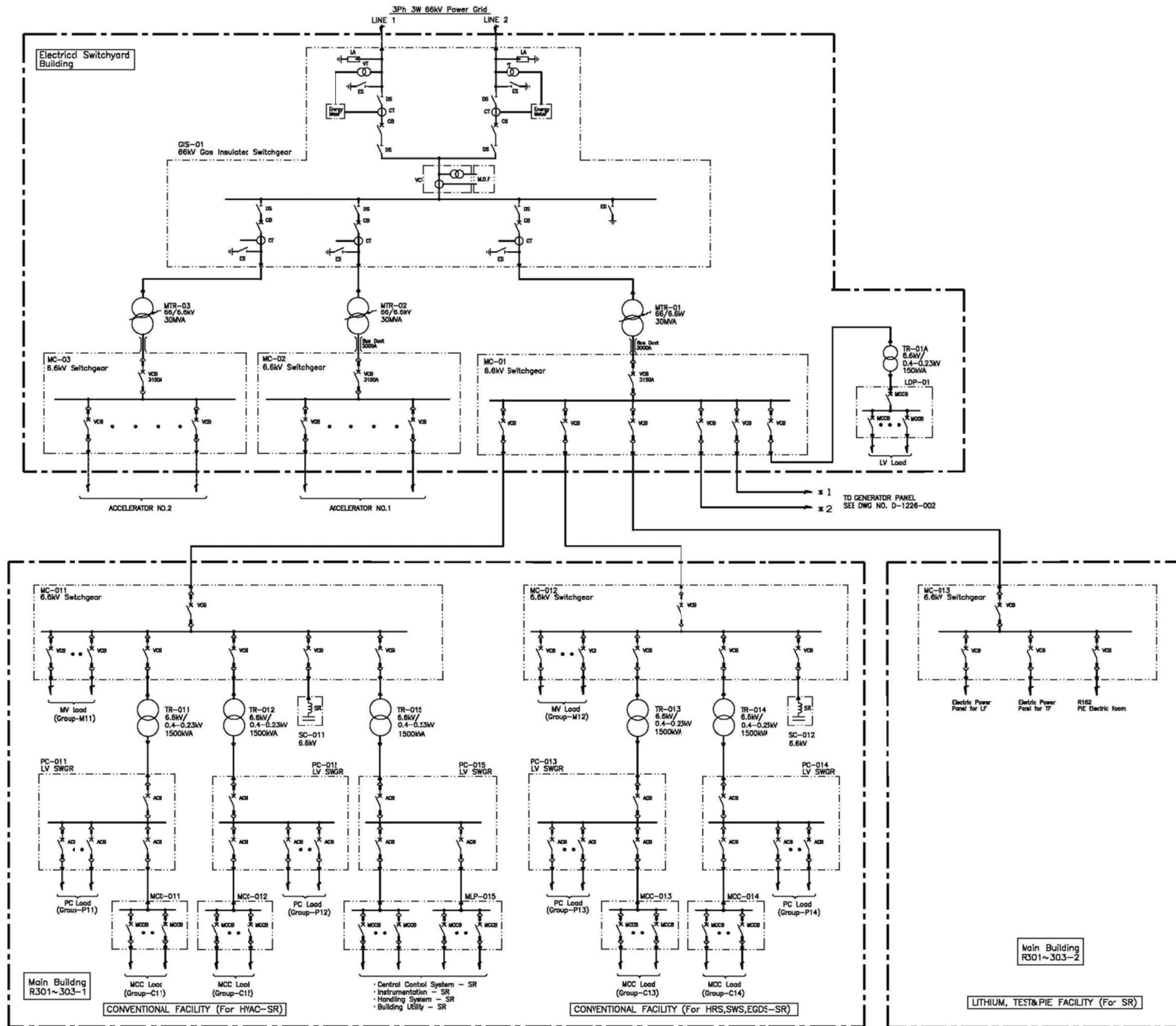


Figure 6-1: Key One Line Diagram 1/2

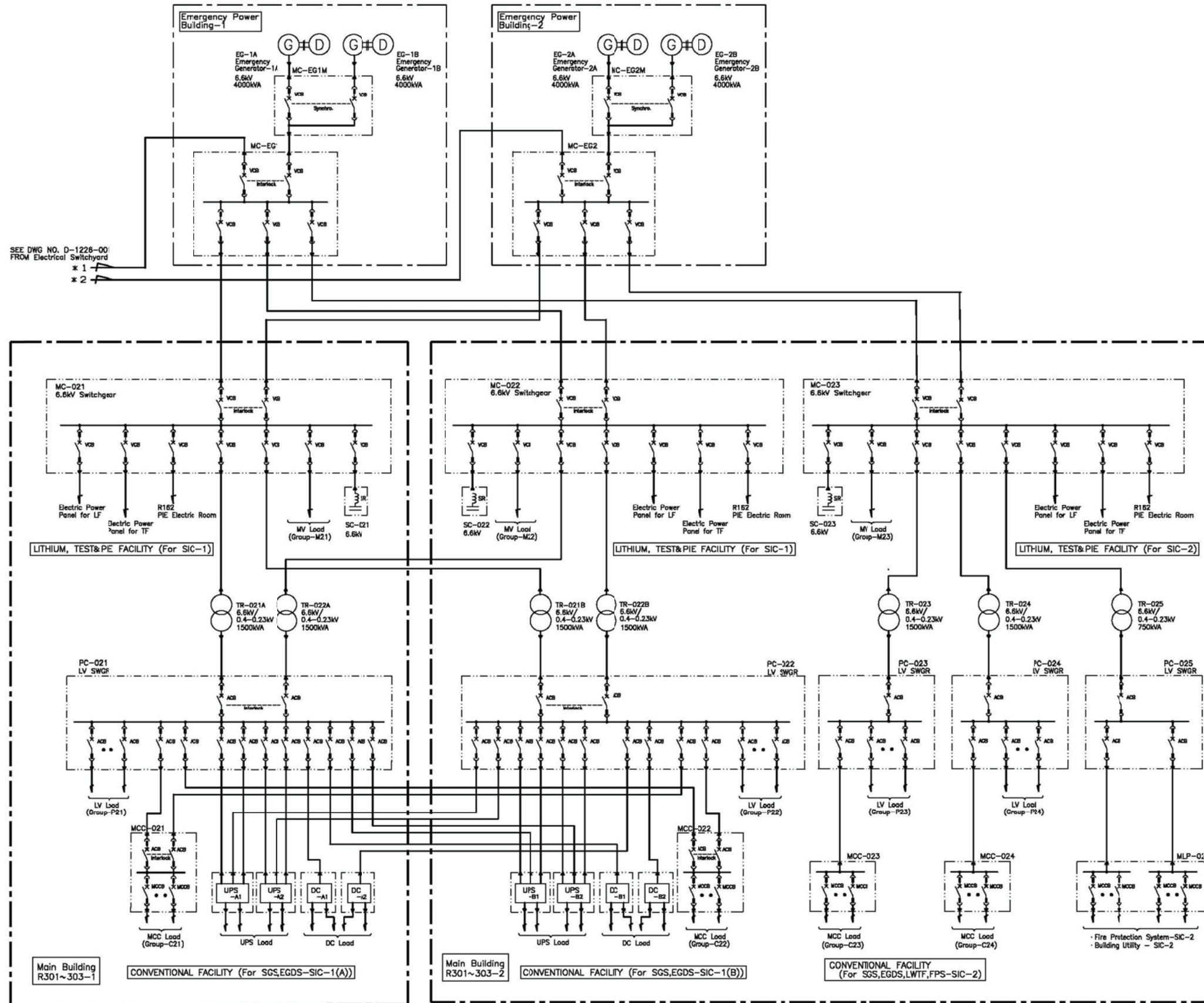
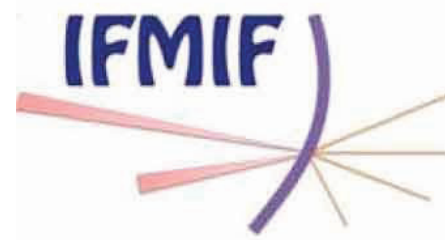


Figure 6-2: Key One Line Diagram 2/2



IFMIF - outdoor overall view with conventional's Systems. Proposal Phase II

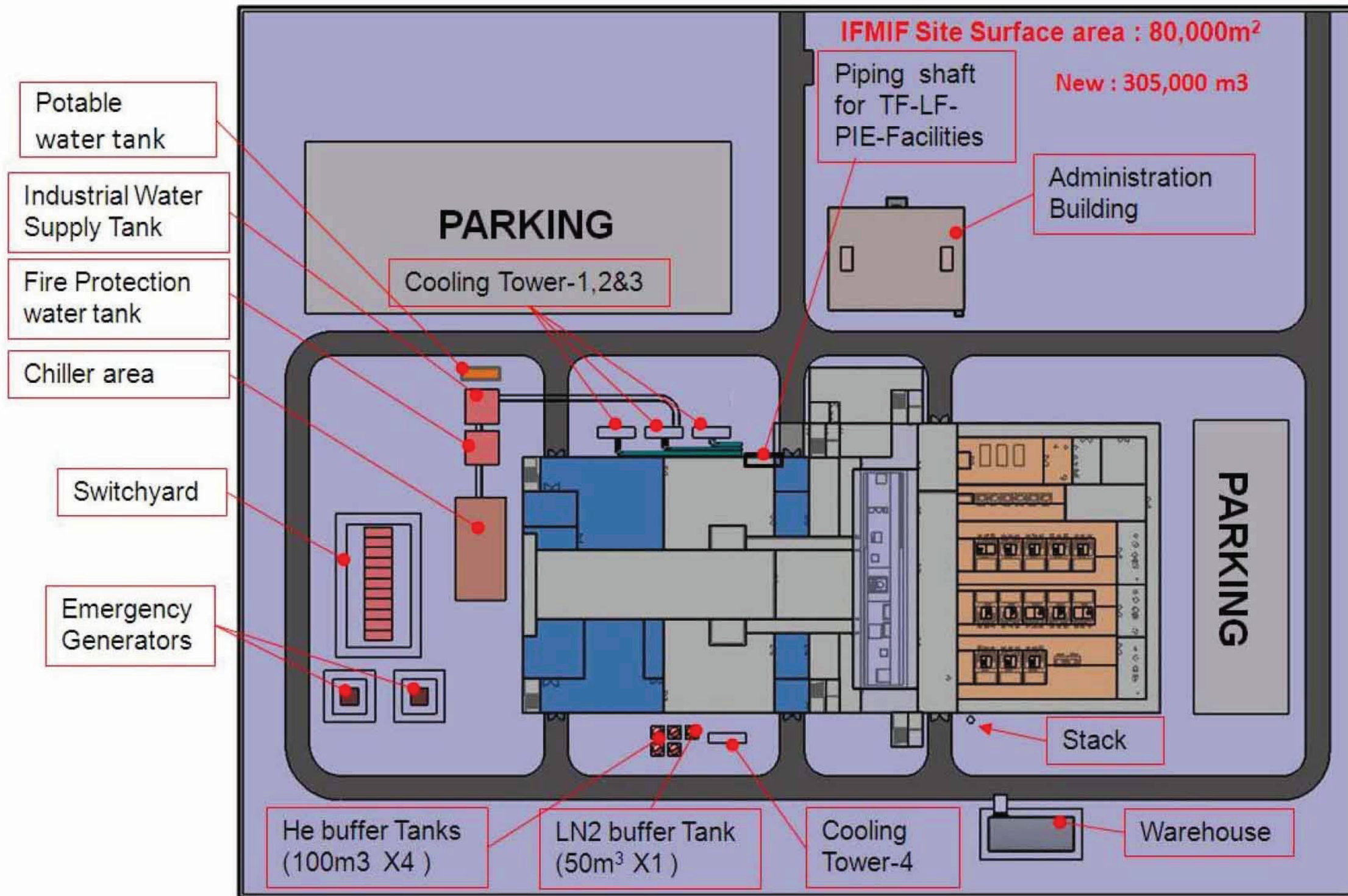


Figure 6-3: IFMIF Outdoor Overall View, Switchyard, Emergency Generators

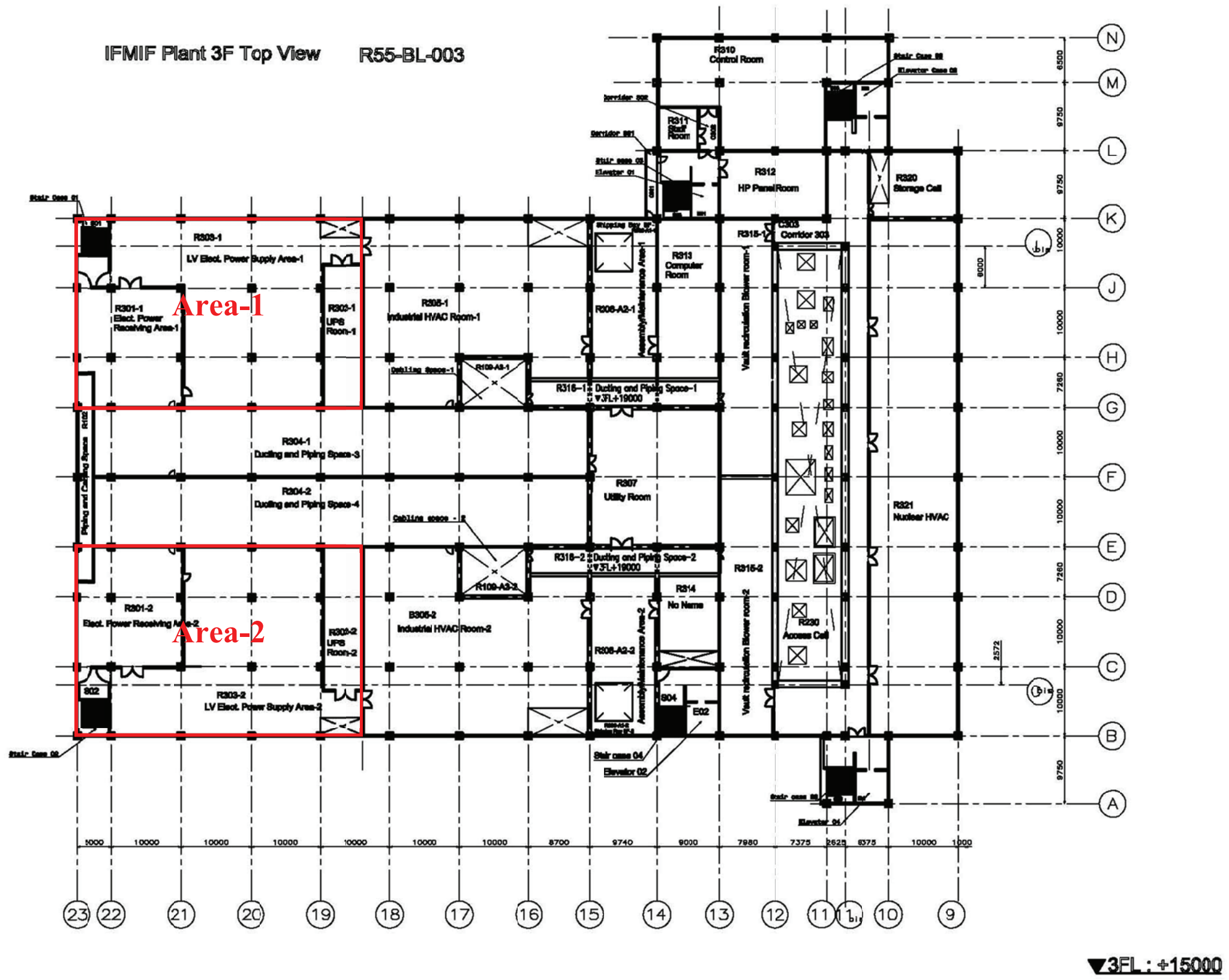
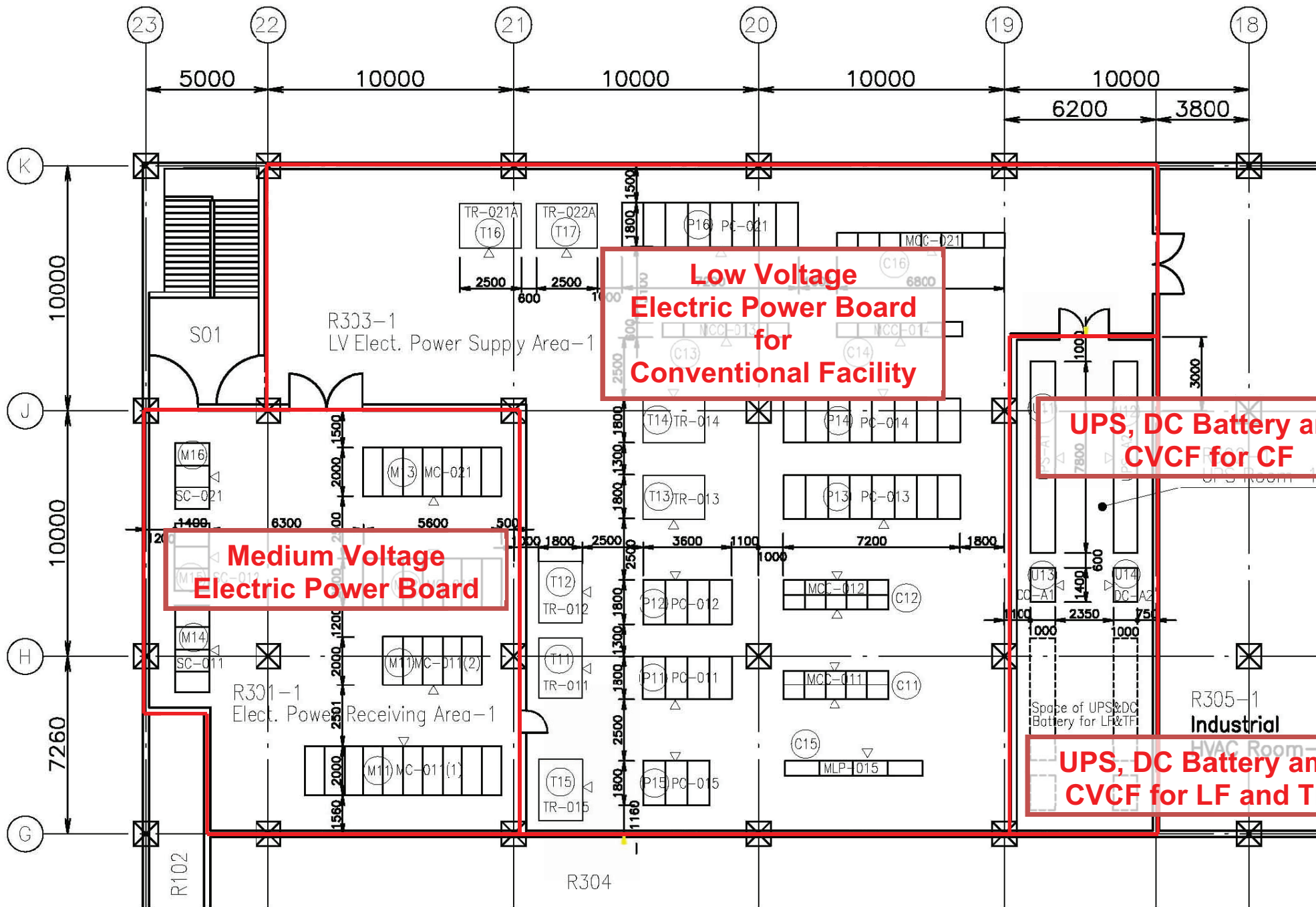


Figure 6-4: Equipment Layout for Electric Power System 1/6



▼3FL : +15000

EQUIPMENT LIST (ELECTRICAL)

No.	EQUIPMENT No.	EQUIPMENT NAME	SIZE (WxDxH) (mm)	Q'TY	REMARKS
M11	MC-011	6.6kV 3ph-3W, Switchgear	800 x 2000 x 2350	15	
M12	MC-012	6.6kV 3ph-3W, Switchgear	800 x 2000 x 2350	7	
M13	MC-021	6.6kV 3ph-3W, Switchgear	800 x 2000 x 2350	7	
M14	SC-011	6.6kV Power Capacitor	900 x 1400 x 2100	4	
M15	SC-012	6.6kV Power Capacitor	900 x 1400 x 2100	3	
M16	SC-021	6.6kV Power Capacitor	900 x 1400 x 2100	3	
U11	UPS-A1	AC Uninterrupted Power System-3φ 400V 200kVA	7800 x 1000 x 1950	1 Set	
U12	UPS-A2	AC Uninterrupted Power System-3φ 400V 200kVA	7800 x 1000 x 1950	1 Set	
U13	DC-A1	DC Battery & Charger-100V 100Ah	1400 x 1000 x 1950	1 Set	
U14	DC-A2	DC Battery & Charger-100V 100Ah	1400 x 1000 x 1950	1 Set	
T11	TR-011	6.6/0.4-0.23kV Transformer 1500kVA Dry	2500 x 1800 x 2350	1	
T12	TR-012	6.6/0.4-0.23kV Transformer 1500kVA Dry	2500 x 1800 x 2350	1	
T13	TR-013	6.6/0.4-0.23kV Transformer 1500kVA Dry	2500 x 1800 x 2350	1	
T14	TR-014	6.6/0.4-0.23kV Transformer 1500kVA Dry	2500 x 1800 x 2350	1	
T15	TR-015	6.6/0.4-0.23kV Transformer 1500kVA Dry	2500 x 1800 x 2350	1	
T16	TR-021A	6.6/0.4-0.23kV Transformer 1500kVA Dry	2500 x 1800 x 2350	1	
T17	TR-022A	6.6/0.4-0.23kV Transformer 1500kVA Dry	2500 x 1800 x 2350	1	
P11	PC-011	0.4-0.23kV, 3ph-4W, LV Switchgear	900 x 1800 x 2350	4	
P12	PC-012	0.4-0.23kV, 3ph-4W, LV Switchgear	900 x 1800 x 2350	4	
P13	PC-013	0.4-0.23kV, 3ph-4W, LV Switchgear	900 x 1800 x 2350	8	
P14	PC-014	0.4-0.23kV, 3ph-4W, LV Switchgear	900 x 1800 x 2350	8	
P15	PC-015	0.4-0.23kV, 3ph-4W, LV Switchgear	900 x 1800 x 2350	3	
P16	PC-021	0.4-0.23kV, 3ph-4W, LV Switchgear	900 x 1800 x 2350	8	
C11	MCC-011	0.4-0.23kV, Motor Control Center	850 x 600 x 2350	10	
C12	MCC-012	0.4-0.23kV, Motor Control Center	850 x 600 x 2350	10	
C13	MCC-013	0.4-0.23kV, Motor Control Center	850 x 600 x 2350	6	
C14	MCC-014	0.4-0.23kV, Motor Control Center	850 x 600 x 2350	6	
C15	MLP-015	0.4-0.23kV, Main Loading Panel	1400 x 600 x 2350	4	
C16	MCC-021	0.4-0.23kV, Motor Control Center	850 x 600 x 2350	8	

Figure 6-5: Equipment Layout for Electric Power System 2/6

EQUIPMENT LIST (ELECTRICAL)

No.	EQUIPMENT No.	EQUIPMENT NAME	SIZE (WxDxH) (mm)	Q'TY	REMARKS
M21	MC-013	6.6kV 3ph-3W, Switchgear	800 x 2000 x 2350	3	
M22	MC-022	6.6kV 3ph-3W, Switchgear	800 x 2000 x 2350	7	
M23	MC-023	6.6kV 3ph-3W, Switchgear	800 x 2000 x 2350	7	
M24	SC-022	6.6kV Power Capacitor	900 x 1400 x 2100	3	
M25	SC-023	6.6kV Power Capacitor	900 x 1400 x 2100	3	
U21	UPS-B1	AC Uninterrupted Power System-3 ϕ 40V 200kVA	7800 x 1000 x 1950	1 Set	
U22	UPS-B2	AC Uninterrupted Power System-3 ϕ 40V 200kVA	7800 x 1000 x 1950	1 Set	
U23	DC-B1	DC Battery & Charger-100V 100Ah	1400 x 1000 x 1950	1 Set	
U24	DC-B2	DC Battery & Charger-100V 100Ah	1400 x 1000 x 1950	1 Set	
T21	TR-021B	6.6/0.4-0.23kV Transformer 1500kVA Dry	2500 x 1800 x 2350	1	
T22	TR-022B	6.6/0.4-0.23kV Transformer 1500kVA Dry	2500 x 1800 x 2350	1	
T23	R-023	6.6/0.4-0.23kV Transformer 1500kVA Dry	2500 x 1800 x 2350	1	
T24	R-024	6.6/0.4-0.23kV Transformer 1500kVA Dry	2500 x 1800 x 2350	1	
T25	R-025	6.6/0.4-0.23kV Transformer 750kVA Dry	2200 x 1500 x 2350	1	
P21	C-021	0.4-0.23kV, 3ph-4W, LV Switchgear	900 x 1800 x 2350	8	
P22	PC-023	0.4-0.23kV, 3ph-4W, LV Switchgear	900 x 1800 x 2350	4	
P23	PC-024	0.4-0.23kV, 3ph-4W, LV Switchgear	900 x 1800 x 2350	4	
P24	PC-025	0.4-0.23kV, 3ph-4W, LV Switchgear	900 x 1800 x 2350	3	
C12	MCC-012	0.4-0.23kV, Motor Control Center	850 x 600 x 2350	8	
C22	MCC-023	0.4-0.23kV, Motor Control Center	850 x 600 x 2350	14	
C23	MCC-024	0.4-0.23kV, Motor Control Center	850 x 600 x 2350	14	
C24	MLP-025	0.4-0.23kV, Main Loading Panel	1400 x 600 x 2350	4	

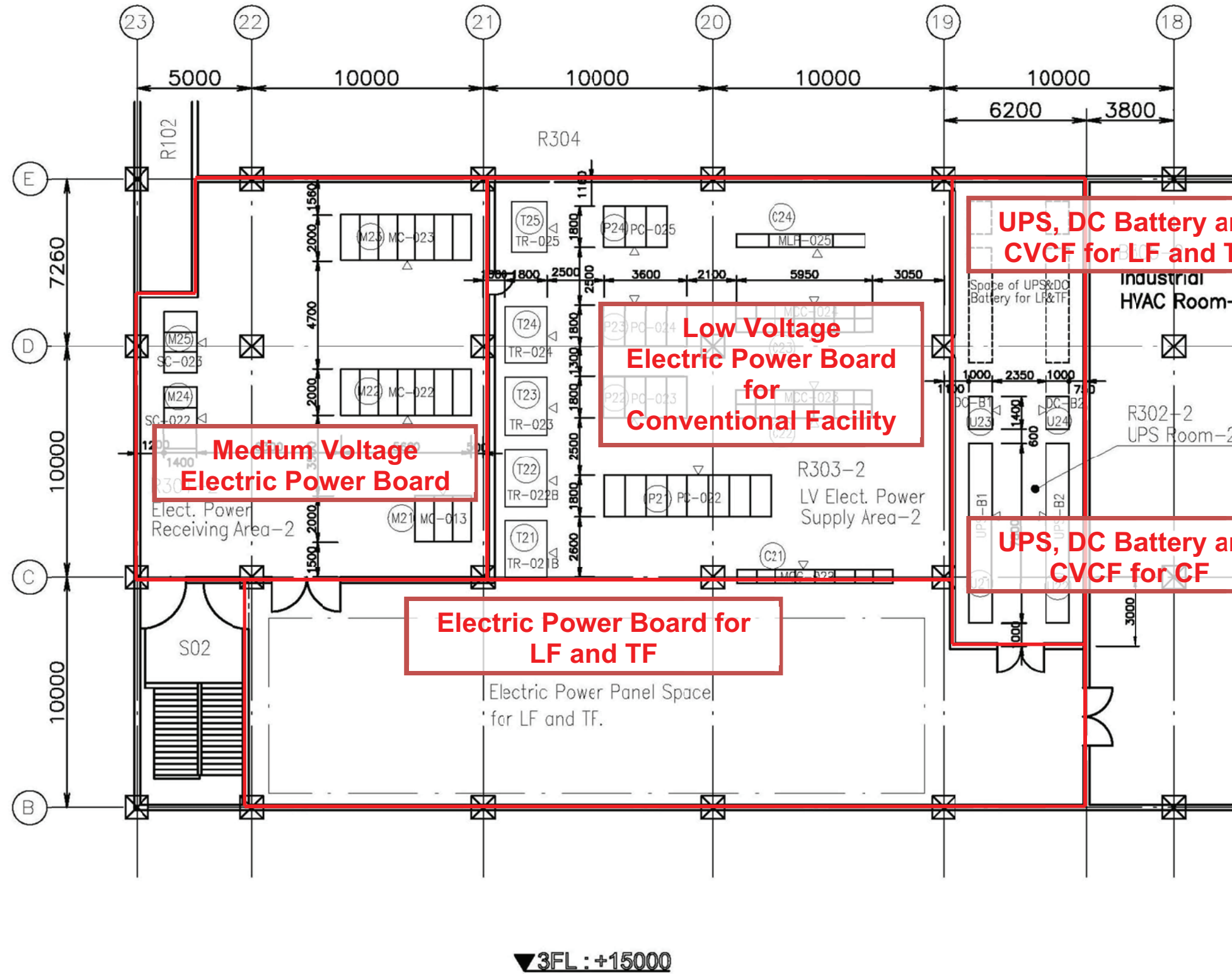


Figure 6-6: Equipment Layout for Electric Power System 3/6

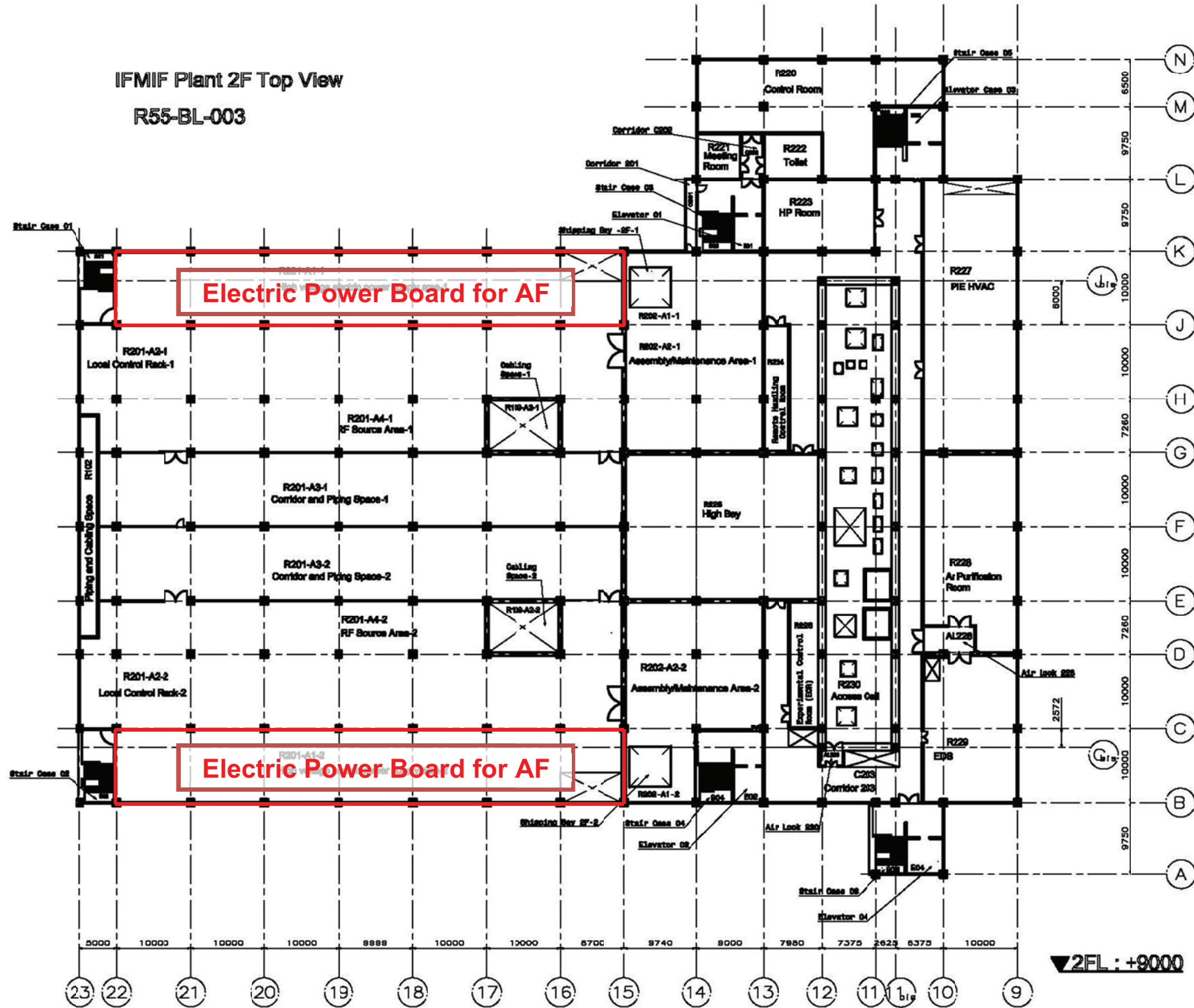


Figure 6-7: Equipment Layout for Electric Power System 4/6

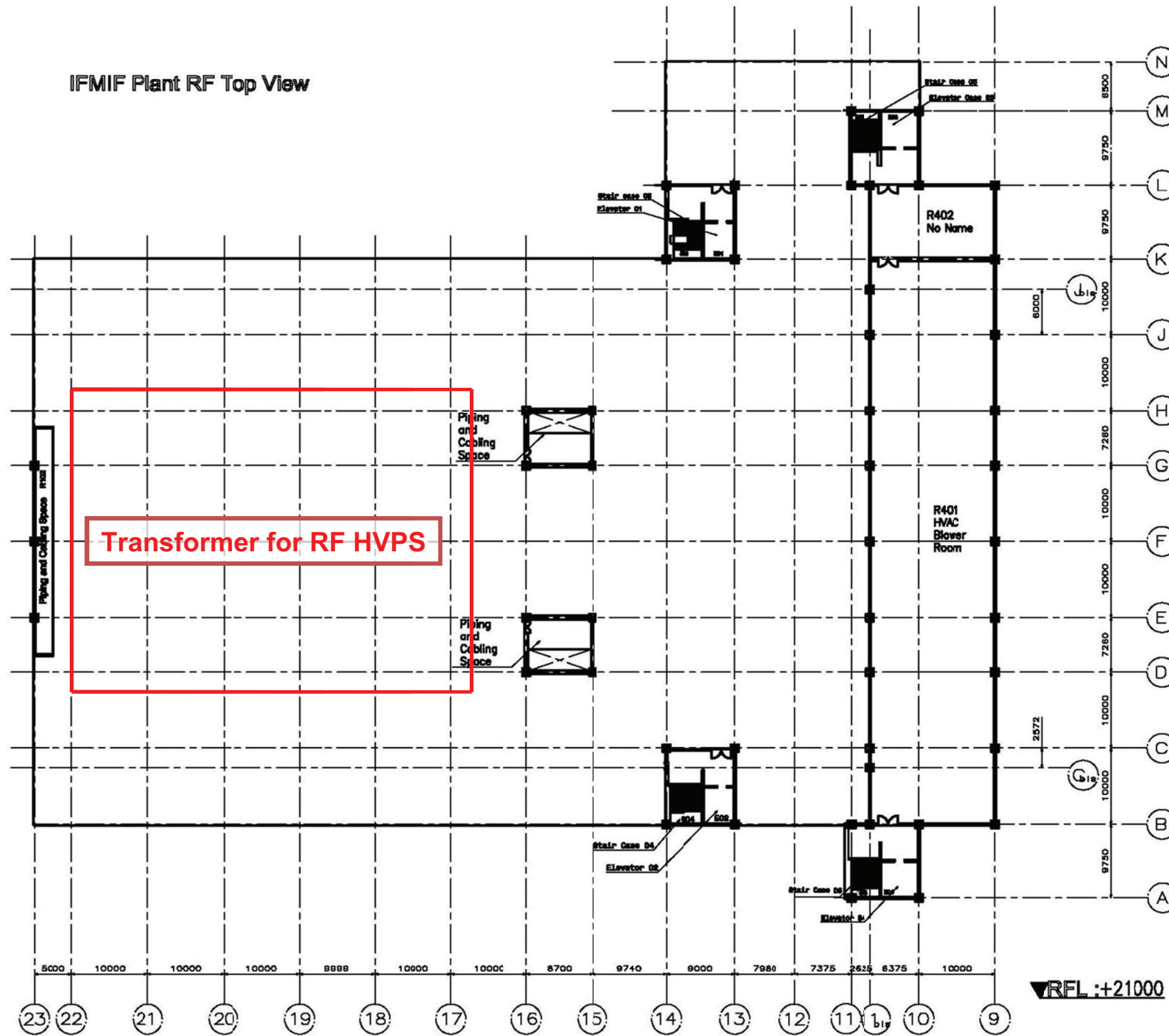


Figure 6-8: Equipment Layout for Electric Power System 5/6

System Design Description Document (DDD)

Heat Rejection System (HRS)

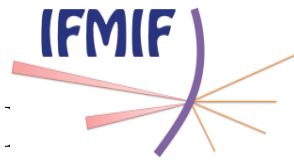
PBS 5.3.3.

Abstract: This document describes the Heat Rejection System (HRS) considered belonging to the Conventional Facilities. Key functions of the system as well as: interfaces with other facilities/systems, PFD, P&ID's, equipment layout, equipment list, flow diagrams, piping layout and input data requirement for the design of the system.

Reference of the document: BA_D_22LA7T

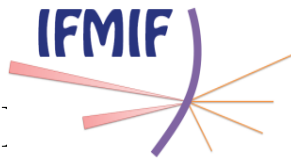
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Approver	G. Pruneri	IFMIF/EVEDA PT



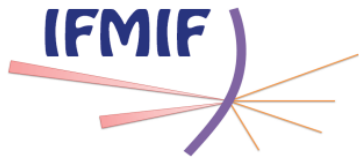
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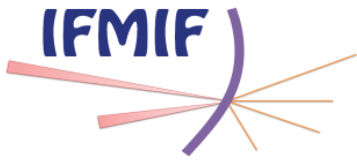
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1. System Functions and Basic Configuration

1.1 System Functions

The Heat Rejection System shall include the following Subsystem;

The main function of the heat Rejection System (HRS) is to be capable of transferring heat from the Cooling Water System of the different components of the process facilities. The HRS is thus designed to perform the following key functions:

- Prepare and supply coolant to primary and secondary cooled and chilled loops;
- Transfer the heat generated in the different systems/components of the process facilities to the coolant;
- Maintain coolant temperatures, pressures, and flow rate to ensure components temperatures and thermal margins maintained during the operation campaign;
- Provide the capability to drain and refill the HRS components for maintenance.

The HRS is designed as an open system consisting of cooling towers, circulation water pumps, heat exchangers, chillers, valves, water storage tank and instruments including sensors and interconnected piping.

The HRS comprised the following four (4) cooling loops:

- 1) **Cooling Water Loop** for TF (Test Facility), LF (Lithium Facility), PIE (Post Irradiation Examination facility) and CF (Conventional facility) the loop is shown on PFD (Process Flow Diagram) (cfr. Ref. D-1223-011-Figure 6-6: D-1223-011, Process Flow Diagram HRS (TF-LF-PIE-CF) 1/4)
- 2) **Secondary Cooling Water Loop-1 for Accelerator.** This loop is shown on PFD (cfr. Ref. Figure 6-8: D-1223-D-013-Process Flow Diagram HRS (Accelerator Facility)3/4)
- 3) **Secondary Cooling Water Loop-2 for Accelerator.** This loop is shown on PFD (cfr.Ref. Figure 6-8: D-1223-D-013-Process Flow Diagram HRS (Accelerator Facility)3/4)
- 4) **Tertiary Cooling Water Loop for Accelerator** This loop is shown on PFD (cfr.Ref. Figure 6-9: D-1223-D-014- Process Flow Diagram HRS (Accelerator facility) 4/4)

The circulation water pumps shall be used to pump water from the Cooling Tower to the Heat exchanges for the subsystem to cool down. The cooling Tower basin acts as a first buffer to meet the heat load fluctuations.

The hot water return to the C.T. spray header that is located near the top of the Cooling Tower. The ancillary system include blow down system, make-up water system, water storage reserve tank, (1000 m³) suitable filtration system and chemical dosing arrangement. The chemical dosing system shall be capable to prevent the corrosion, (since due to the huge consume of water for evaporation we selected industrial water

and not demineralized water) scaling and biological growth (including legionella) by adding anti-corrosive, anti-scaling chemical, pH control additives and biocides in the Cooling tower basin water.

1.2 System Basic Configuration

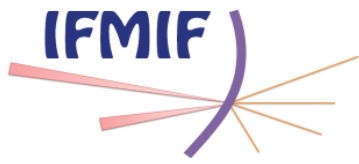
PBS, additional items have been proposed during Pre-Design review meeting in Garching (Germany, held from June 25th-to 29th, 2012) here below summarized in Table 1, HRS System within the Conventional Facilities/ Plant services you can noted new PBS item 1.5.3.3. And proposed additional (1-2-3-4 and 5)

PBS Number						PBS Item
1	2	3	4	5	6	
5	0	0	0	0	0	Conventional Facilities
	3	0	0	0	0	Plant Services
		3	0	0	0	Heat Rejection System (HRS)
			1	0	0	<i>Accelerator Facility</i>
			2	0	0	<i>Test Facility</i>
			3	0	0	<i>PIE Facility</i>
			4	0	0	<i>Conventional Facility</i>
			5	0	0	<i>Piping layout</i>

Table 1: HRS PBS location

2. Interfaces (boundaries)

The interfaces with other systems may be physical and functional or both. Additional information about HRS interfaces is provided in Systems Interface (Ref. Table 2 : Interface table) Characteristics of the components for the HRS is indicated on the Equipment List (cfr. Ref. Table 7: S-1224-001- HRS Equipment List) There is a multiple interface between HRS, Facilities (hosted mainly in the Heat Exchanger rooms) and Building. A generic multiple interface was defined to overcome this issue. HRS system interfaces at the same time with Conventional Facilities (in the sense of the Building) and with the equipment hosted in the rooms (that can be part of the Accelerator, Lithium, Test, PIE and/or of the Conventional Facilities themselves). The sharing of responsibilities will be clarified case by case, but at list this general triple interface includes all the requirements that HRS needs in order to proceed with the design, here below are summarized (at first level) the interfaces related to the HRS .



Interface Table HRS (Heat Rejection System)		
System A	System B	Title
Test Facility	Heat Rejection System	Heat Rejection System has to provide secondary cooling water to: Test Facility
PIE Facility	Heat Rejection System	Heat rejection System has to provide primary cooling water to: PIE Facility.
Lithium Target Facility	Heat Rejection System	Heat Rejection System has to provide secondary cooling water to: Lithium Target Facility
Accelerator Facility	Heat Rejection System	Heat Rejection System has to provide secondary cooling and chilled water to: Accelerator Facility
Main Building	Heat Rejection System	Main building has to accommodate heat exchangers, chillers, piping and pumps of: Heat Rejection System and water storage tank (1000 m ³)
Cooling Tower Area	Heat Rejection System	Cooling Tower area has to be accommodate cooling towers and pumps of: Heat Rejection System
Electrical Power System	Heat Rejection System	Electric Power Supply has to provide electric power to: Heat Rejection System
Service Water System	Heat Rejection System	Service Water System has to provide demineralized and industrial water to: Heat Rejection System
Service Gas System	Heat Rejection System	Service Gas System has to provide instrumentation air and nitrogen gas to: Heat Rejection System Heat Rejection System has to provide primary chilled water to: Service Gas System
Exhaust Gas Processing System	Heat Rejection System	Heat Rejection System System has to provide primary chilled water to: <ul style="list-style-type: none"> • VDS (vent Gas Detritiation System) • GDS-V(GDS for 1st stage VDS) • EDS (Emergency Detritiation System) • GDS-E (GDS for EDS) • HDS (Hot cell Detritiation System) • GDS (Glove boxe Detritiation System) of Exhaust Gas Processing System
Liquid waste Treatment System	Heat Rejection System	When contamination in water of primary cooling and chilled water loop of Heat Rejection System is detected, the waste water has to be sent to: Liquid waste Treatment System

Table 2 : Interface table

2.1 HRS System vs. Lithium Facility

The boundary between HRS and LF is set at the interception valves of the Tertiary Heat Exchanger, interception valves and all the afterwards equipment are within the scope of the Lithium Target Facility (Ref. Figure 2-1: Heat mass balance of Heat removal (Extracted from DDD I, IFMIF LTF Ref. BA_D_227S7Z).

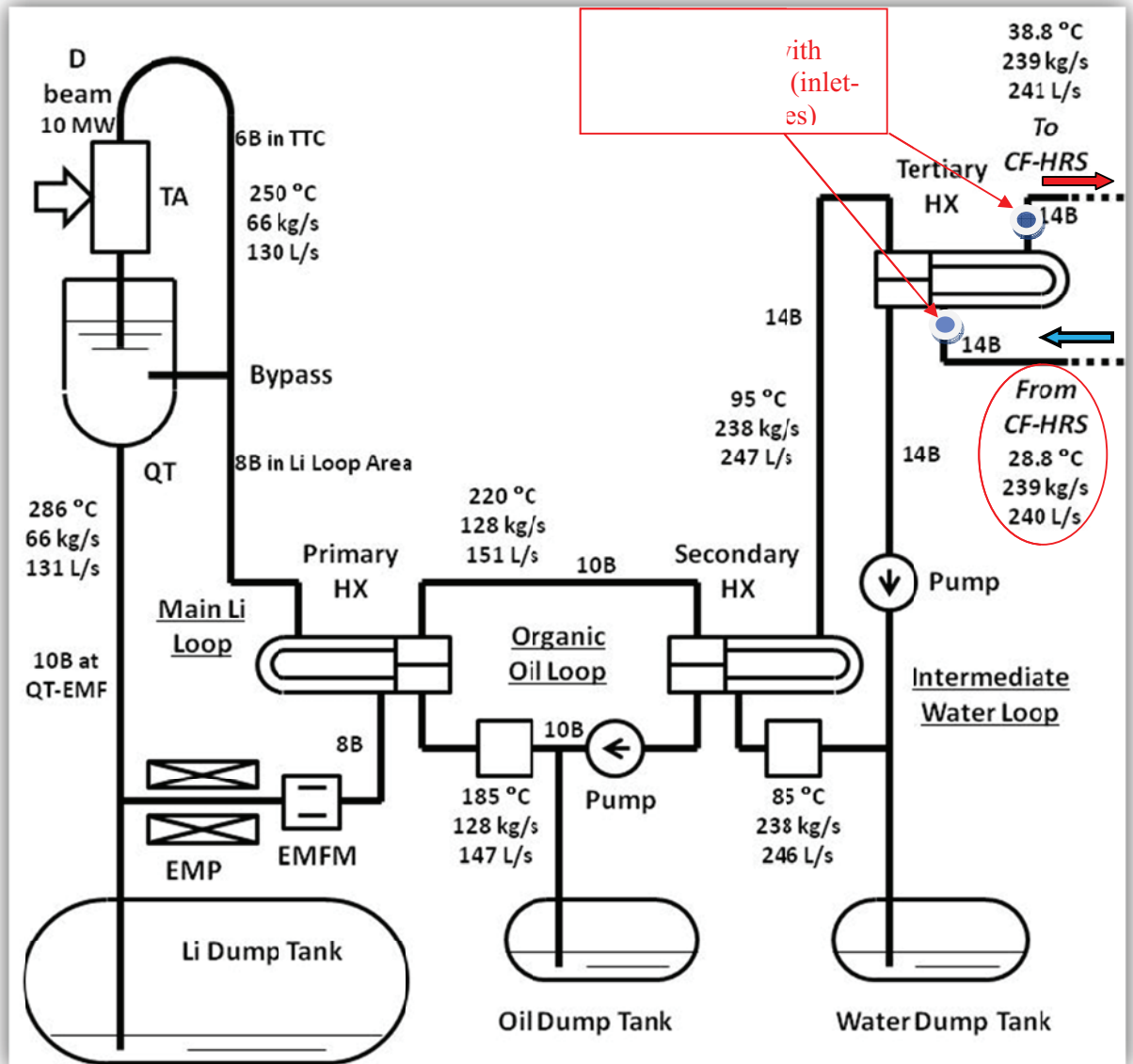


Figure 2-1: Heat mass balance of Heat removal (Extracted from DDD I, IFMIF LTF Ref. BA_D_227S7Z)

2.2 HRS System vs. Accelerator facility¹

HRS will serve the Accelerator Facility through the:

- RFQ chiller skid
- RF & Auxiliary cooling skid (Out Vault Equipment)
- In Vault Equipment cooling skid
- Beam Dump Scraper & HEBT-BTR-RIR cooling skid

Ref. to Figure 2-2: Accelerator's Heat loads scheme (cfr. Ref. [7])

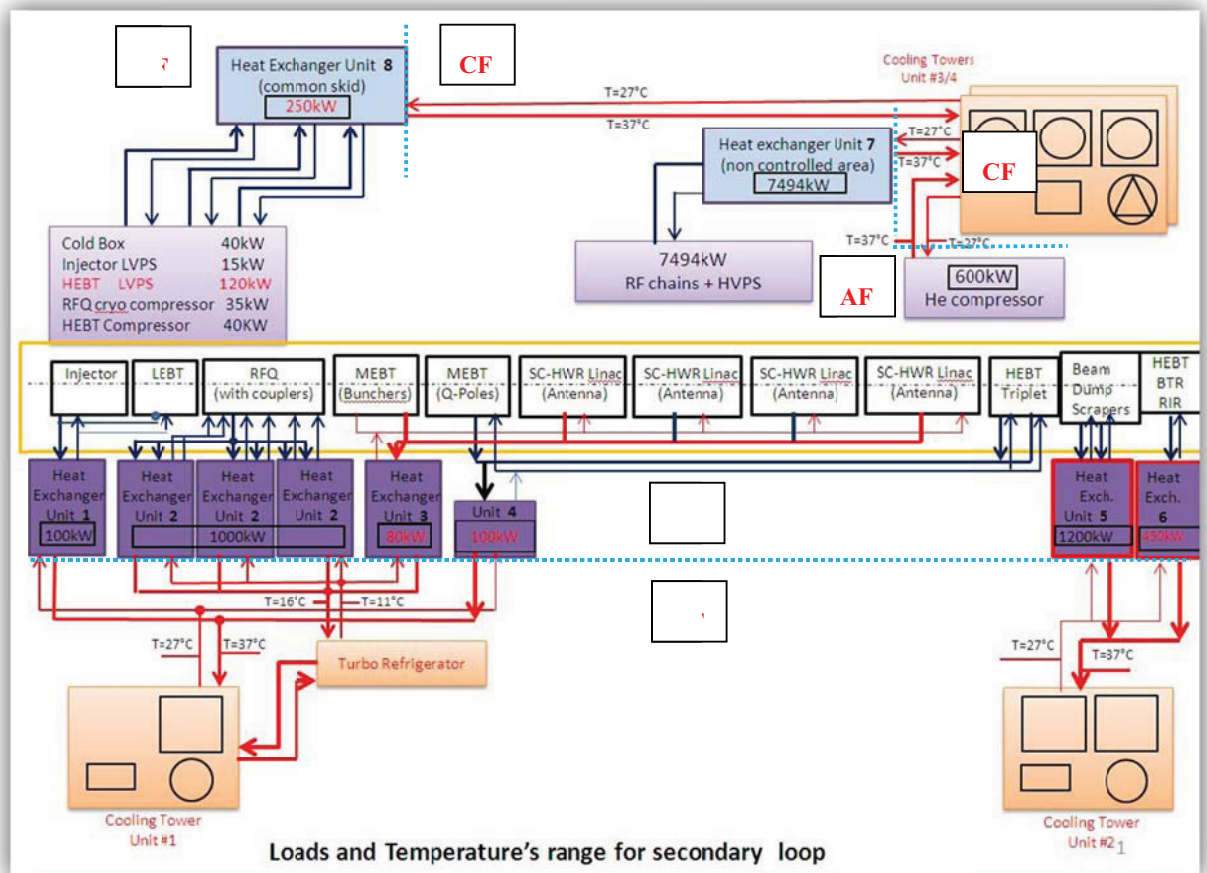


Figure 2-2: Accelerator's Heat loads scheme

¹ According to the same approach used in the Accelerator prototype it has been considered that the primary cooling loop (the ones in direct contact with the Accelerator's components) of the Accelerators belong to the Accelerator facility.



2.3 HRS System vs. Test Facility

HRS shall serve the Test facility through the:

- Test cell water exchanger for to cool the concrete shield wall
- Test cell Helium exchangers for to cool the test module.
- Test cell argon and Helium exchangers for to cool TC atmosphere argon/helium blower.
- Test cell water exchanger for to cool TC liner (cooled by water, new concept progress of DDD I concept with Helium cooling system)

The boundary between HRS and TF is set at the interception valves of the cooling exchanger's interception valves and all the afterwards equipments are within the scope of Test Facility (Ref. to Figure 2-3 : Test Facility HRS, (Extracted from PFD- D-1223-011)).

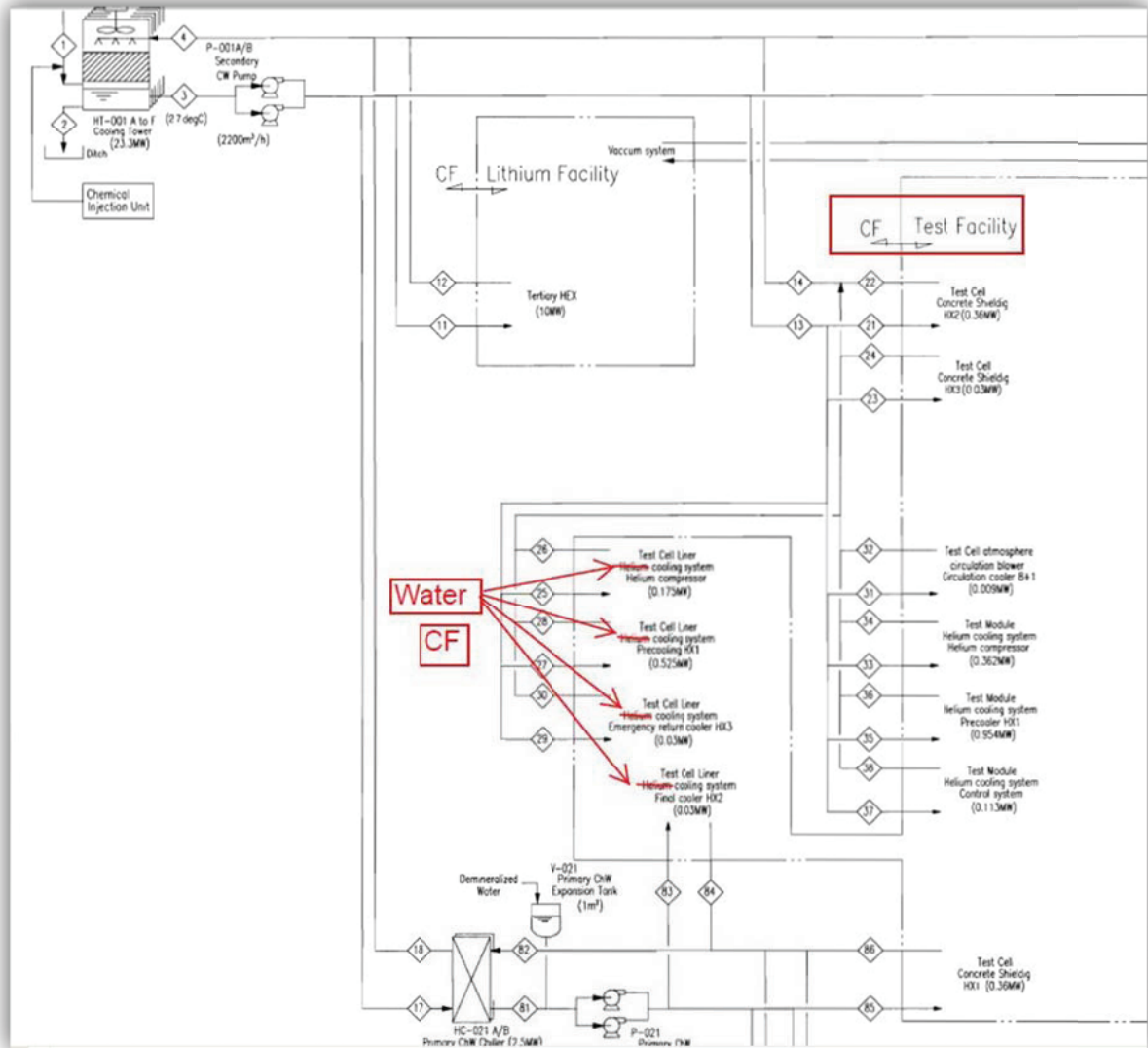


Figure 2-3 : Test Facility HRS, (Extracted from PFD- D-1223-011)

2.4 HRS System vs. Post Irradiation Examination Facility

(Ref. Figure: 2-4: PIE Facility, HRS (Extracted from HRS PDF-D- 1223-011) Extract from PFD, D-1223-011.

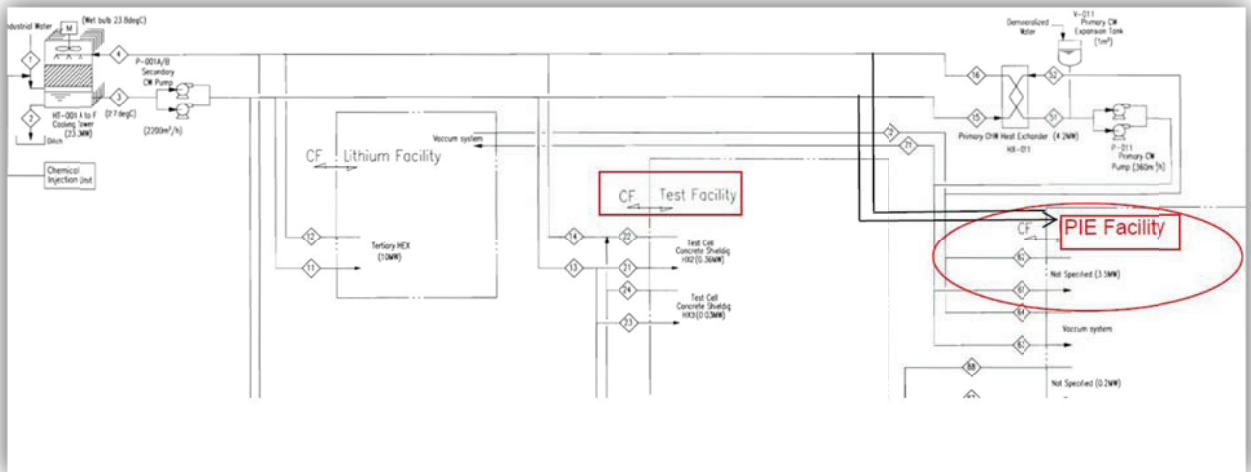


Figure: 2-4: PIE Facility, HRS (Extracted from HRS PDF-D- 1223-011)

2.5 HRS System vs. Conventional Facilities

Heat Rejection System System has to provide primary chilled water to:

- VDS (vent Gas Detritiation System)
- GDS-V(GDS for 1st stage VDS)
- EDS (Emergency Detritiation System)
- GDS-E (GDS for EDS)
- HDS (Hot cell Detritiation System)
- GDS (Glove boxe Detritiation System) of Exhaust Gas Processing System

(Ref. Figure 2-5: Conventional Facility HRS (Extracted from HRS-PDF D-1223-011),

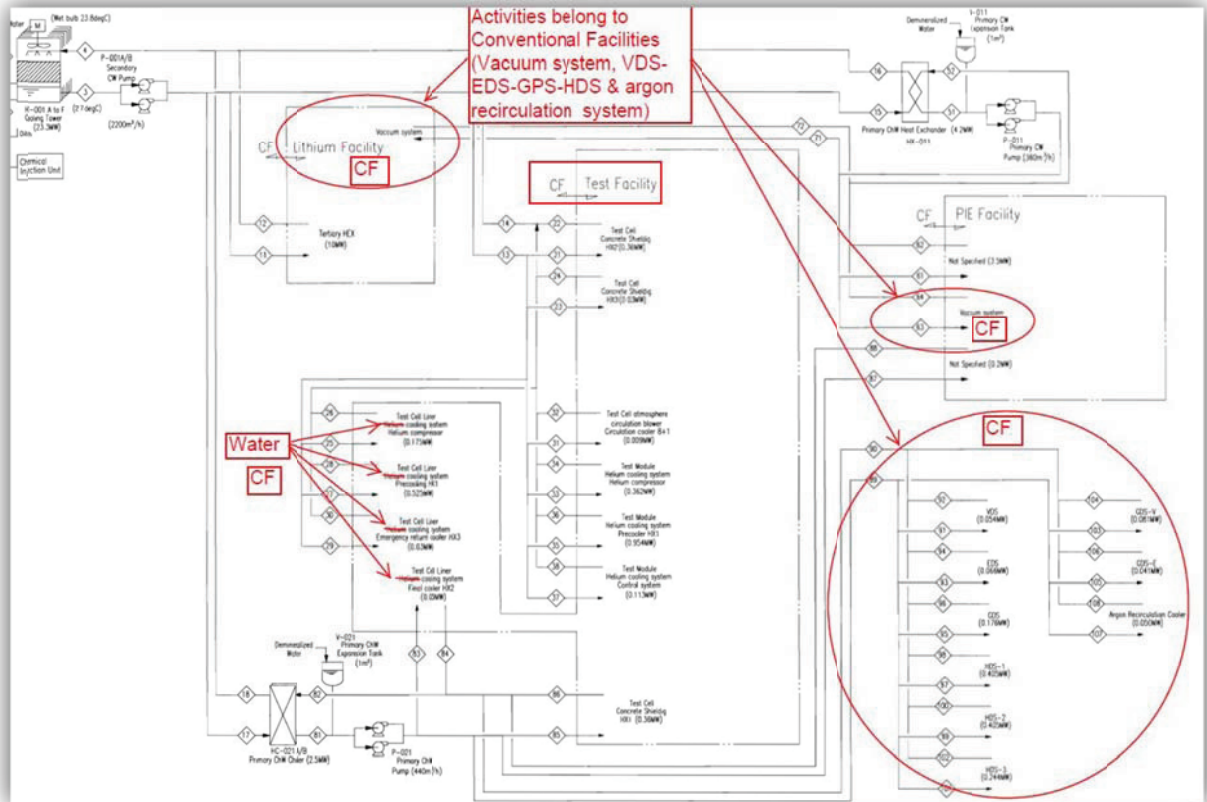


Figure 2-5: Conventional Facility HRS (Extracted from HRS-PDF D-1223-011)

3. System Design Requirements

3.1 General requirements

Input Data Requirements are defined as the data necessary to be defined in order to enable a system design that respects all the needs of the interfacing components.

Currently a draft set of data has been proposed. This list is partially complete and assessed by the PT on the base of the current references, of the outcomes of the Engineering Validation activities (i.e. prototypes) and on the standard engineering practice.

Parameters to be defined as *Input Data Requirements* for the HRS are, for each interfacing component:

- Heat load to be removed: (MW);
- Cooling media: (chilled/cooled water);
- Inlet water temperature: (°C);
- Temperature tolerance: (±°C);
- $\Delta T = (\text{outlet temp}) - (\text{inlet temp})$: (°C);



- Supply water pressure: (MPa);
- Water Pressure drop after the passage in the skid: (MPa);
- Coolant Flow²: (m³/h).

The following sections describe in detail the logic that brought to the selection by the PT of the current set of parameters.

Here below are listed the *Input Data Requirements*:

- Figure 3-1: Input data requirements for LF Heat Loads
- Table 3: Input data requirements, Accelerator's Heat Loads (for each Accelerator)
- Table 4: Input Data Requirements TF heat loads
- Table 5: Input Data Requirement for PIE Facility Heat Loads.
- Table 6: Input Data Requirement for Conventional Facility Heat Loads.

3.2 Engineering Requirements

3.2.1 Lithium Facility

The current status of LT Facility input data requirement are indicated on the Ref. Figure 3-1: Input data requirements for LF Heat Loads, the value has been assessed by the Project Team according to:

- Facility Description of CDR (ref. [3])
- Standard engineer practice
- LF DDD I, HRS Heat mass balance of Heat removal (Extracted from DDD I, IFMIF LTF Ref. BA_D_227S7Z) (ref. [6])

² Coolant flow is a consequences of the definition of following parameters:

1. Cooling media
2. Heat loads
3. ΔT

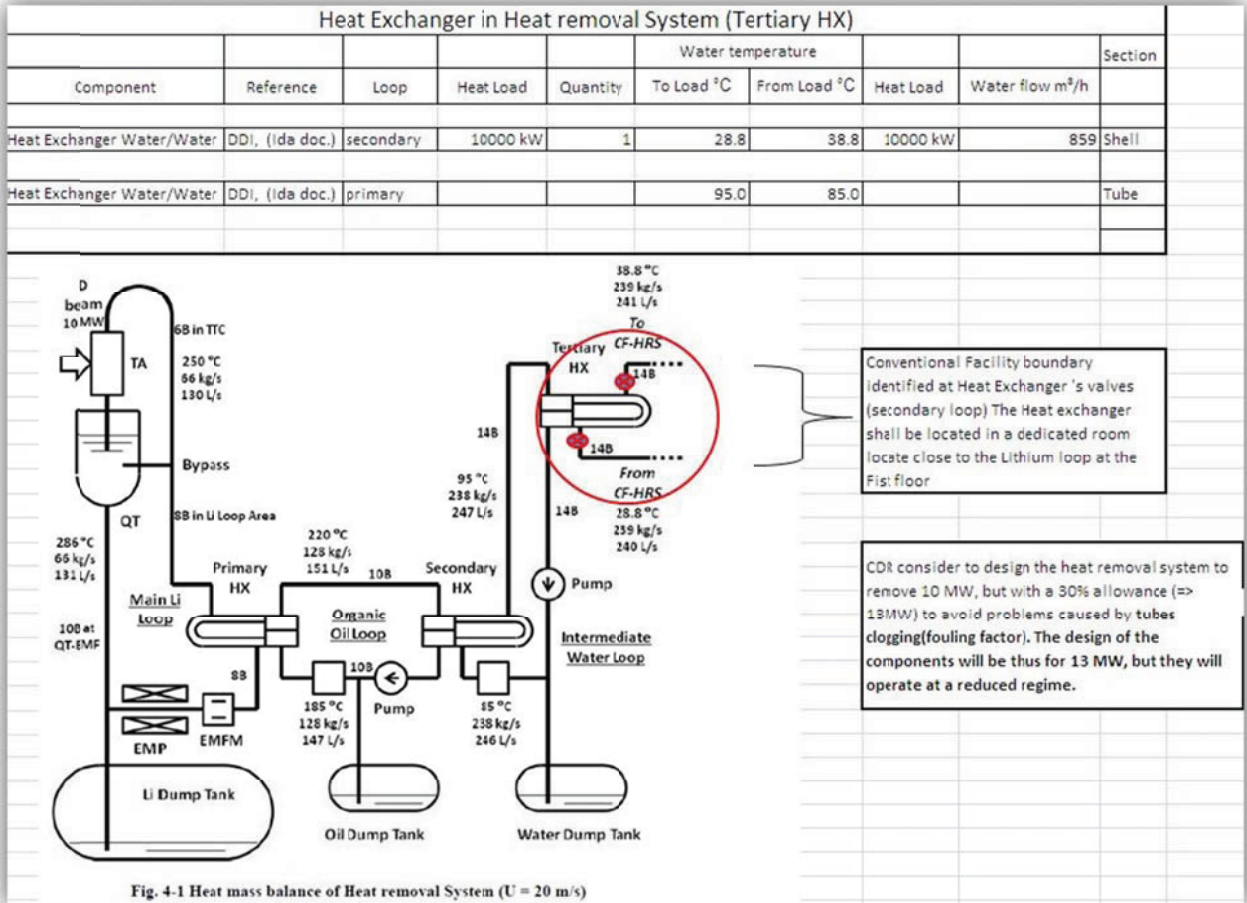
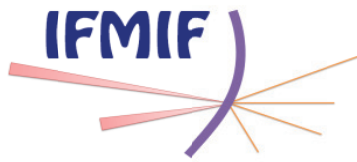


Figure 3-1: Input data requirements for LF Heat Loads

3.2.2 Accelerator Facility

The current status of both Accelerators Facility input data requirement are indicated on the Ref. Table: 3 (The values indicated on the Table are referred to one Accelerator only) the values have been assessed by the Project Team according to:

- Facility Description of CDR (ref. [3])
- Standard engineer practice.
- Heat loads scheme (Ref. to Figure 6-2: Accelerator's Heat Loads scheme. [7])
- Accelerator Facility DDD I heat Loads (Ref.[4])
 - Sect. 4.3.2.6.(cfr. Ref.[4]) RF Power System- c2 Water Cooling System
 - Sect. 4.3.2.9.1.8. (cfr. Ref. [4]) LHe Cryogenic System
 - Sect. 4.3.2.9.2.8. (cfr. Ref. [4]) Cryoplant



Accelerator #1 "In Vault Components" Heat Loads										Comments and Assumptions	
Item	Component	Reference	Unitary Heat Load	Quantity	Secondary loops Water Conditions (from Heat Exchanger to Cooling System)				Water Flow Rate		
					Water temperatures						
					To Load	From Load	Heat Load				
1	Injector + LBET		100 k/W	1	27°C	27°C	100 k/W	3 m ³ /h	Same Heat Load and Temperature of the Prototype		
2	RFQ		1000 k/W	1	11°C	16°C	1000 k/W	72 m ³ /h	Same Heat Load and Temperature of the Prototype		
3	MEBT Buncher		20 k/W	2	11°C	16°C	40 k/W	6.9 m ³ /h	Same Heat Load and Temperature of the Prototype (new design of buncher -> 20 k/W/buncher)		
4	MEBT Quadrupoles		3 k/W	5	27°C	37°C	15 k/W	13 m ³ /h	Same Heat Load and Temperature of the Prototype (5 Quadrupoles cooling, 3 k/W/dipole)		
5	SF6 LINAC #1 antenna (5 to 9 MeV)		3 k/W	8	11°C	16°C	24 k/W	4 m ³ /h	Same Heat Load and Temperature of the Prototype (each antenna needs a 3 k/W cooling)		
6	SF6 LINAC #2 antenna (9 to 14.5 MeV)		3 k/W	10	11°C	16°C	30 k/W	5 m ³ /h	Each antenna needs a 3 kW cooling. The number of antennas comes from the "Superconducting HVR alternative.pdf" document discussed with Accelerator facility people		
7	SF6 LINAC #3 antenna (14.5 to 26 MeV)		3 k/W	12	11°C	16°C	36 k/W	6 m ³ /h	Each antenna needs a 3 kW cooling. The number of antennas comes from the "Superconducting HVR alternative.pdf" document discussed with Accelerator facility people		
8	SF6 LINAC #4 antenna (14 to 40 MeV)		3 k/W	12	11°C	16°C	36 k/W	6 m ³ /h	Each antenna needs a 3 kW cooling. The number of antennas comes from the "Superconducting HVR alternative.pdf" document discussed with Accelerator facility people		
9	HEBT Focusing/Shaping Elements		500 k/W	1	27°C	37°C	500 k/W	43 m ³ /h	The Heat value comes from discussion with Accelerator facility people. Probably a bit overestimated but as I do not have any magnet power value today, it is wise to let like this. We will update for the CDR		
	Beam Dump	Acc Prototype	1200 k/W	1	27°C	37°C	1200 k/W	03 m ³ /h	CDR considers a Beam Dump Capable of 5 MV (in order to stop all the beam), but nowadays the IFMIF beam dump will be dimensioned on the given value of 1200 k/W (discussion with Accelerator Facility People). Beam Dump use will be limited to beam start-up periods, so a dedicated cooling scheme for this item seems a reasonable solution. It has to be considered also that the limited power of this item forces the accelerator to work at a reduced duty factor (pull-in working regime). Even 1200 k/W is probably overestimated, we will probably use the beam dump with duty cycles lower than 10-2 but today it is not formally decided, it is thus preferable to let like this, it will be updated later.		
Total Heat Loads in Vault components							2981 kW				
Accelerator #1 "Out-Vault Components" Heat Loads										Comments and Assumptions	
	Component	Reference	Support to	Unitary Heat	Quantity	Secondary loops Water Conditions (from Heat Exchanger to Cooling System)				Water Flow Rate	
						Water temperatures					
						To Load	From Load	Heat Load			
10	Injector LVPS	Acc Prototype	Injector	15 k/W	1	27°C	37°C	15 k/W	1 m ³ /h	Part of the common skid	
11	RFQ Cryo Compressor	Acc Prototype	RFQ	35 k/W	1	27°C	37°C	35 k/W	3 m ³ /h	Part of the common skid	
12	Cold box	Acc Prototype	Cry plant	40 k/W	1	27°C	37°C	40 k/W	3 m ³ /h	Part of the common skid (considered 4 times bigger than LPAc)	
13	HEBT Compressor	Acc Prototype	HEBT	40 k/W	1	27°C	37°C	40 k/W	3 m ³ /h	Part of the common skid (considered double than LPAc)	
14	He Compressor	Acc Prototype	Cryoplant	150 k/W	4	27°C	37°C	600 k/W	52 m ³ /h	LPAc 150 k/W (we considered at least 4 times bigger 600 k/W) probably we will need only RFQ + RF Chains: 350k/W ± 0.5 × 8 Chains = 400k/W. MEBT + RF Chains: 24k/W ± 0.5 × 12 Chains = 24k/W. Cryomodule 1 RF Chains: 170k/W ± 0.5 × 8 Chains = 680 k/W. Cryomodule 2 RF Chains: 170k/W ± 0.5 × 10 Chains = 850 k/W. Cryomodule 3 RF Chains: 310k/W ± 0.5 × 12 Chains = 1860 k/W. Cryomodule 4 RF Chains: 310k/W ± 0.5 × 12 Chains = 1860 k/W. Thermal power to be dissipated for each source is around 20k/W ± 41 for each Linac × 820 kW.	
Total Heat Loads out Vault components							8224 kW				
Grand total for each accelerator (Heat Loads)							11205 kW	~ 11.3MW			

Table 3: Input data requirements, Accelerator's Heat Loads (for each Accelerator)

3.2.3 Test Facility

The current Heat status of the Test Facility input data requirement are indicated on the Table: 4, the values have been assessed by the Project Team according to:

- Facility Description of CDR (ref. [3])
- Standard engineer practice.
- Heat loads scheme (Ref. Table 4: Input Data Requirements TF heat loads [8])
- Test Facility Utility Room DDD I (Ref. [8]) and further meetings and discussion.

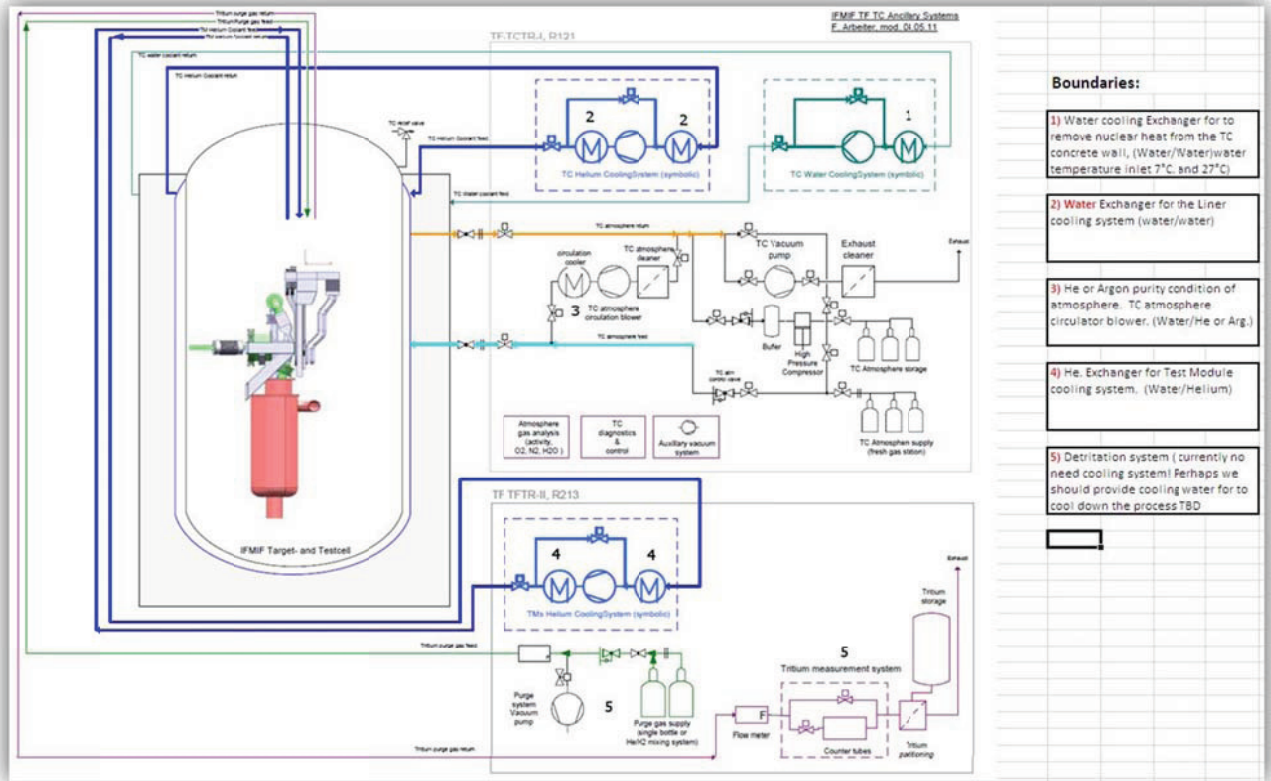
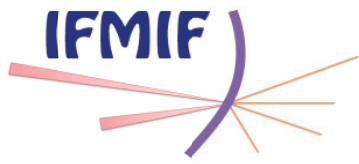


Figure 3-2: TF Cooling scheme (cfr. Ref. F. Arbeiter DDD II [8])



Test Facility Input Data Requirements (HRS)												
Item	Cooling system	Reference (KIT scheme)	Primary loop				Secondary Water loops				Heat Load	Water Flow Rate
			Unitary Heat Load	Quantity	To Load	From Load	Type of fluid or gases	To Load	From Load	Type of fluid or gases		
1	Test Cell, Concrete shielding, Water cooling system (to remove from the concrete nuclear heat generated) HX 1	KIT - DDD I (1) Attachment 2	360 kW	1	40°C	80°C	Water	7°C	12°C	Cooled water	360 kW	62 m³/h
2	Test Cell, Concrete shielding, Water cooling system (to remove from the concrete nuclear heat generated) HX 2 (use 0,00274)	KIT - DDD I (1) Attachment 2	360 kW	1	40°C	80°C	Water	27°C	37°C	Cooled water	360 kW	31 m³/h
3	Test Cell, Concrete shielding, Water cooling system (to remove from the concrete nuclear heat generated) HX 3 (use 0,0137)	KIT - DDD I (1) Attachment 2	30 kW	1	40°C	80°C	Water	27°C	37°C	Cooled water	30 kW	3 m³/h
4	Test Cell Liner water cooling system, Helium compressor (2 parallel machine)	KIT - DDD I (2) Attachment 3	175 kW	1	?	?	Water	27°C	37°C	Cooled water	175 kW	15 m³/h
5	Test Cell Liner water cooling system, Precooling HX 1 (compression heat removal)	KIT - DDD I (2) Attachment 3	525 kW	1	?	?	Water	27°C	37°C	Cooled water	525 kW	45 m³/h
6	Test Cell, Liner water cooling system, Final cooler HX 2	KIT - DDD I (2) Attachment 3	30 kW	1	?	?	Water	7°C	12°C	Chilled water	30 kW	5.2 m³/h
7	Test Cell Liner water cooling system, Emergency return cooler HX 3 (protect compressor for excess T1 (use 0,0137)	KIT - DDD I (2) Attachment 3	30 kW	1	?	?	Water	27°C	37°C	Cooled water	30 kW	2.6 m³/h
8	Test Cell atmosphere circulation blower (Supply inert gas (Ar.) for a protective "curtain" to prevent ingress/accumulation of reactive gases inside TC, when the TC is opened to the AC. Supply of He when test cell is closed, after proper purge of all Ar. gas (Circulation cooler 8+1)	KIT - DDD I (3) Attachment 1	9 kW	1	30°C	25°C	Argon or helium	27°C	37°C	Cooled water	9 kW	1 m³/h
9	Test Module helium cooling system (Helium compressor 5 parallel machines)	KIT - DDD I (4) Attachment 4	362 kW	1			Helium	27°C	37°C	Cooled water	362 kW	31 m³/h
10	Test Module helium cooling system (pre-cooler HX1 (compression heat removal)	KIT - DDD I (4) Attachment 4	954 kW	1	?	?	Helium	27°C	37°C	Cooled water	954 kW	82 m³/h
11	Test Module helium cooling system (control system)	KIT - DDD I (4) Attachment 4	113 kW	1	?	?	Helium	27°C	37°C	Cooled water	113 kW	10 m³/h
Total Heat Loads											2948 kW	

Table 4: Input Data Requirements TF heat loads

3.2.4 Post Irradiation Examination Facility (PIE)

The current status of PIE Facility input data requirement are indicated on the Table 5: Input Data Requirement for PIE Facility Heat Loads. The values have been assessed by the Project Team according to:

- Facility Description of CDR (ref. [3])
- Standard engineer practice.

For the PIE facility a proper value was not available, since now PIE function requirements and layout arrangement (for optimization) is still under study, nevertheless an assumption have been made and the value of Heat load have been summarised on the Table 5: Input Data Requirement for PIE Facility Heat Loads. Represented on PDF ref. Figure 6-6: D-1223-011, Process Flow Diagram HRS (TF-LF-PIE-CF) 1/4

PIE Facilities (HRS)											
Input Data Requirements (HRS)											
Item	Component	References/assessment/assumptions	Heat load (max/MW)	Cooling media	Inlet temperature (°C)	Temperature tolerance (±°C)	ΔT (°C)	Suppl. water pressure (MPa [g])	Water pressure drop (MPa)	Coolant flow (m ³ /h)	Special requirements
1	PIE cooling system	Heat Loads assumption	3.5	Cooled water	37.0°C		10°C	0.35MPa		0.8 m ³ /h	
1	PIE cooling system	Assumption	0.2	Chilled water	7.0°C		5°C	0.35MPa		0.05 m ³ /h	
NB: This table is not detailed and should be considered as an assumptions. (we do not have additional input so we keep the values as per Phase I)											

Table 5: Input Data Requirement for PIE Facility Heat Loads.

3.2.5 Conventional Facility (CF)

The current status of Conventional Facility input data requirement are indicated on the Ref. Table 6: Input Data Requirement for Conventional Facility Heat Loads. These values have been assessed by the Project Team according to:

- Facility Description of CDR (ref. [3])
- Standard engineer practice.

- Heat loads scheme (Ref to Table 6: Input Data Requirement for Conventional Facility Heat Loads. and Figure 2-5: Conventional Facility HRS (Extracted from HRS-PDF D-1223-011))

HRS for CF is referred to the following systems:

- Exhaust Gas Detritation System
- Service Gas System (Argon/Helium heat exchanger’s cooling)
- Central Vacuum System

Conventional facilities (HRS)											
Input Data Requirements (HRS)											
Item	Component	References/assessment/assumptions	Heat load (max/MW)	Cooling media	Inlet temperature (°C)	Temperature tolerance (±°C)	ΔT (°C)	Supply water pressure (MPa) [G]	Water pressure drop (MPa)	Coolant flow (m ³ /h)	Special requirements
1	Exhaust Gas Detritation System**	- Water flows selected according to the Exhaust Gas Detritation System design**	0.276MW	Chilled Water	7.0°C		5°C	0.35MPa		Water Flows: VDS-1= 7.9 m ³ /h VDS-2= 10.4 m ³ /h EDS= 11.1 * 2=22.6 m ³ /h HDS= 20.9 m ³ /h GDS= 7.4 m ³ /h TOTAL= 69.4 m ³ /h	
2	Service Gas System	- Heat Load selected according to the Service Gas System (Ar Supply System) design.	0.05 MW	Chilled Water	7.0°C		5°C	0.35MPa		8.6 m ³ /h	
3	Central Vacuum System	- Coolant flow selected according to the Central Vacuum design	0.0111 MW	Cooled Water	37.0°C		10°C	0.35MPa		Water Flows/unit= 0.004 m ³ (min*unit) no. of unit= 8 units TOTAL= 1.92 m ³ /h	

NB: This table is not detailed and should be considered as an assumptions, unchanged from phase I

Table 6: Input Data Requirement for Conventional Facility Heat Loads.

3.3 Safety Design Requirements

The general Safety approach for the design execution of HRS is based on the general Safety specification for the Engineering Design Activities of IFMIF

- The IFMIF’s Safety objectives, principles and criteria.
- The Hazard evaluation techniques, to be implemented on the next design phase

The entire document is uploaded on DMS: Safety Specifications Ref. doc. BA_D_224X48 Ver.4.0 (cfr. Ref. [2]) and following updating. At the present time the Engineering Design for HRS follow the Safety approach mentioned on the guideline document, nevertheless it can be subject to some deviation or weaves according the final IFMIF site selection. As well as the safety authority could gives some further requirements.



3.4 Operation and Maintenance

Integrative maintenance plan is not yet described on this DDD II, shall be defined clearly after having selected all the components for the HRS plant, preferable the maintenance plan shall be prepared by the suppliers, as well as regulatory maintenance requirements must be identified.

Minimum information required within the maintenance plan is listed below:

- Scheduled operation:
 - Controls
 - Checks
 - Adjustments
 - Calibrations
 - Overhauls
 - Replacements, etc.

Information provided from safety specification, Ref. doc. BA_D_224X48 Ver.4.0 (cfr. Ref. [2]) and of course will be implemented and identified as necessary by the supplier in order to ensure the best operation of the HRS system within its intended operational scenario.

- Critical unscheduled operations:
 - Replacements repair etc.

That may impact IFMIF availability and become essential to evaluate and to introduce an additional important support of recommended spare parts list, (provided by the suppliers) procedures, training, tools and test equipments, infrastructures.

The design of HRS shall accommodate long-term maintenance activities required to support IFMIF plant operation. For maintainability and inspectability, HRS system shall be designed in such a way that it can facilitate maintenance and, in case of failure, easy diagnostics safe repair or replacement and re-calibration. The HRS' maintenance must be an ongoing endeavor. Any lapses in regular maintenance can result in system degradation and obvious loss of efficiency which could arise to serious health issue.

Maintenance requirement for HRS system and equipments must be conform to the maintenance period defined for the IFMIF plant (particularly for the facilities that are not reachable during operation period)

3.5 RAMI Requirements

RAMI Specifications guide documents Ref. to doc. 22HA3G from J. Arroyo Feb. 2012.

The HRS system have been designed to operate during all modes of IFMIF plant operation as well as shut down period HRS should be reliable for continuous operation, easily accessible for the purpose of operation and maintenance. The HRS have been designed in a way that; maintained and operated will meet the reliability and availability requirements a preliminary way identified on the conventional facility Safety Report.



At this stage of the Project complete RAMI analysis has not been performed (due to the high variability of the parameters, such a procedure has not been considered worthwhile). However several assumptions have been evaluated and taken into consideration based on the standard engineering practice. RAMI assessment and implementation of the engineering process shall be fully integrated on the next phase of the project.

3.6 Applicable Codes and Standard Requirements

International standards have been selected for the design of the HRS in particular:

- The equipment for (HRS) shall be designed according to safety specification for the engineer design activities IFMIF ref. BA_D_224x48 (Le Tonquez Y.[2]) in accordance with the pressure equipment directive (PED) 97/23Ec.
- Code and standards for HRS mechanical components shall follow the general IFMIF specification: Applicable Codes and standards for the CF design, in addition the following codes and standards shall be applied:
 - ASME/ANSI B16.34-Valves, flanges, threaded and welding end.
 - ASME B31.3- process piping.
 - ASME/ANSI B.16.25- Pipes, valves, fittings and flanges butt weld ends.
 - ISO 4427 and DIN 8074-HDPE pipes.
 - ASME B73.2M-Vertical in-line pumps.
 - CTI standard-Cooling Towers.
 - ASME section IX- welding and brazing qualification.
 - ASME section V- non destructive examination.
 - API 510- testing of valves.
 - EN 13445 – Pressurized Vessels design;
 - EN 13480 – Metallic Piping;

4. System Design Description

4.1 Design Summary

For this section you can refer to the System Functions and Basic configuration (cfr. Sect. 1-1.1)

4.2 Safety

Refer to Safety specifications for the Engineering design Activities of IFMIF ref. doc. BA_D_224X48 Ver. 4.0 and following updating (cfr. Ref. [2])

4.3 Assumptions

4.3.1 Reference Outdoor Conditions

The design of a Heat Rejection System is related to the outdoor summer conditions that indeed have strong influence on the selection of the equipment to reject the removed heat in the environment (cooling towers).

The most constraining summer conditions were taken from ASHRAE Handbook (cfr. ref [1]):

- ✓ Summer Dry Bulb Temperature: 30.2°C;
- ✓ Summer Wet Bulb Temperature: 23.8°C;
- ✓ Time during the year exceeding the above conditions: 0.4%

4.3.2 Equipment Margin

A safety margin for the HRS equipment has been assumed according to the standard engineering practice; generally the design has to be assumed in order to allow some flexibility to the system.

In particular:

- ✓ For pumps, margin takes into account the heat generated by the pumps themselves. This has been quantified in a +10% of the flow rate;
- ✓ For heat exchange equipment, margin takes into account the partial clogging up of the heat exchange surfaces (pipes and/or plates). This has been quantified in a +10% of the exchanged heat.

4.3.3 Environment-Water Heat Exchangers Main Features

The main characteristics of the equipment designated to transfer heat from the cooling media to the environment have been selected according to the standard engineering practice and considering the reference outdoor conditions (cfr. Sect.4.3.1)

In particular main assumptions are referred to the:

- Equipment typology:
 - Open circuit Cooling Tower
- Equipment configuration:
 - Modular Layout of Cooling System (Cooling Towers in Parallel) mainly divided into 4 main (four) loops as follows:
 - a) Loop 1 Accelerator (components inside Vault) Cooling Tower 1, capacity 1.8 MW referred to the first phase only for 1 accelerator.
 - b) Loop 2 for LF-TF-PIE-CF Cooling Tower 2, capacity 22.1 MW one phase only)

- c) Loop 3 for Accelerator’s Beam Dump & scrapers and HEBT-BTR-RIR (risk of contamination) Cooling Tower 3, capacity of 2.0 MW referred to the first phase only, for 1 accelerator.
- d) Loop 4 for Accelerator auxiliaries (i.e. He. compressor, RF& HVRS and common skid) Cooling Tower 4, capacity of 10.0MW referred to phase one only, for 1 accelerator.

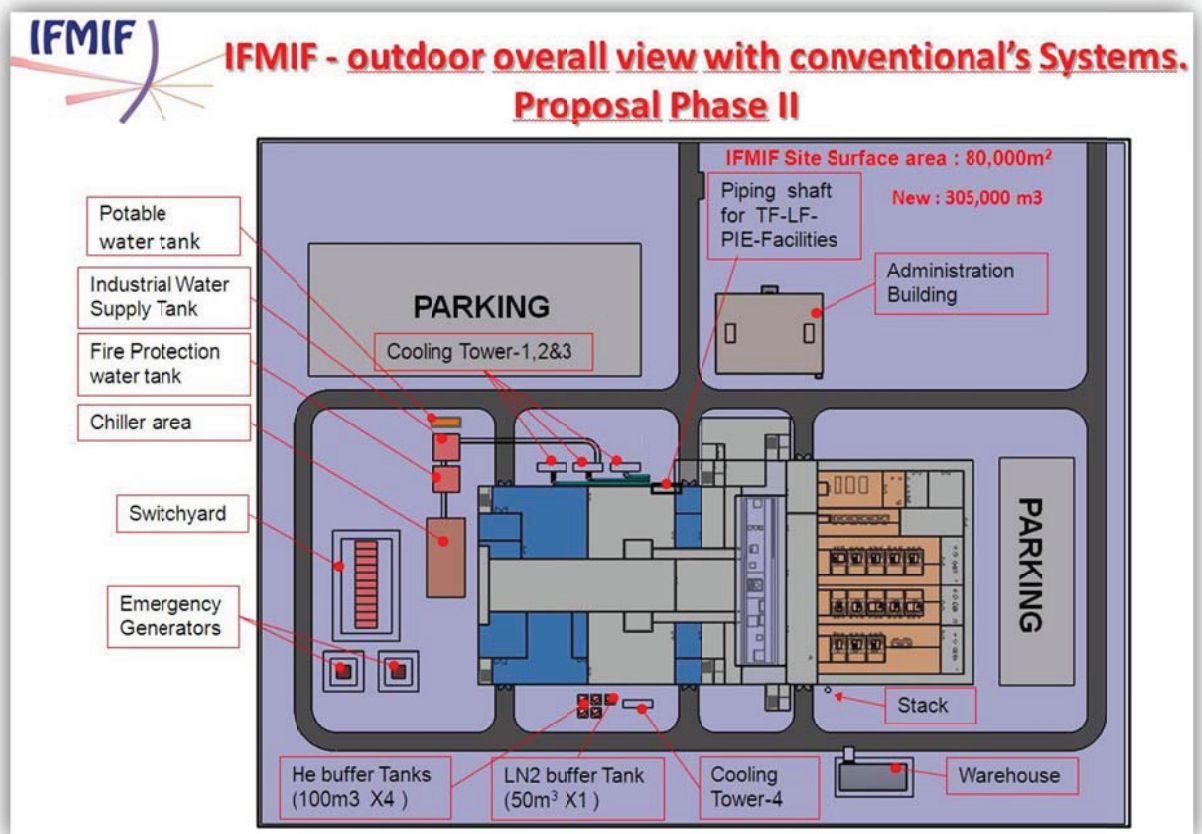


Figure 4-1: Overall view HRS outdoor.

4.3.4 Water Chillers Main Features

The main characteristics of the equipment designated to supply chilled cooling media to the different components have been selected according to the standard engineering practice.

In particular main assumptions are referred to the:

- Equipment typology: Water Condensed Chillers.
- Chiller compressor type:
 - Centrifugal ≥ 700 KW
 - Reciptocal ≤ 500 KW

4.3.5 Water/Water Heat Exchangers main characteristics

The main characteristics of the equipment designated to transfer heat from one heat removal loop into another one have been selected according to the standard engineering practice.

In particular main assumptions are referred to the:

- Equipment typology;
 - Plate Heat Exchanger

4.3.6 Accelerator Heat Removal Skids

The different heat exchange stations that supply the Accelerator Facility have been selected following the same approach that is characteristic of the accelerator prototype.

In general the current design considers that there are different heat removal skids for the different part of the accelerator. The main reasons of this choice are:

- to respect the differences in the cooling parameters of each accelerator component
- To isolate the potentially activated loops from the ones that do not present water activation hazard.

According to the above statements the following skids have been considered:

- RFQ Chilling skid: Radio Frequency Quadrupole (this needs a very precise supply temperature and accuracy);
- RF & He C. & Auxiliaries cooling skid: RF Chains and all the auxiliaries located outside the vault;
- In Vault Equipment Cooling skid: all the equipment located inside the vault that doesn't need a precise water temperature and/or accuracy;
- Beam Dump and HEBT Cooling skid: Separate skids for High risk of contamination.

4.3.7 SIC Classification

According to the classification proposed in Safety Specifications (cfr. ref [2]) and Safety Important Class-SIC, Methodology, Classification & Requirements (cfr. Ref. to Doc. BA_D_228V5Q Version 1.2 ref [9])

The system has been classified as SR/ non- SIC

4.3.8 Redundant Equipment

Redundancy of the equipment should contribute to the target availability value of the Conventional Facilities (stated into 99.7 % as mentioned in CDR (cfr Ref.[3]). At this stage of the project a complete RAMI Analysis has not been performed (due to the high variability of the parameters, such a procedure has not been considered worthwhile) (Ref. to Sect. 3.5). By the way some assumptions have been made on the base of the standard engineering practice.

Simple redundancy is addressed to components that can cover 100% of the requirements (100% x 2).

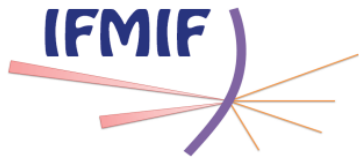
Multiple redundancy is considered when requirements can be fulfilled by a set of components (n components) working together ($(100\%/n) \times [n+1]$).

4.4 Detailed Design description

According to the classification proposed in CDR (cfr. Ref. [3]) a further HRS System subdivision has been proposed with slightly changes to meet the safety regulations and system flexibility:

The HRS has been selected into two main category of cooling tower's Loops:

- **Potential risk of water contamination**
 - **Beam Dump scrapers cooling skid, HEBT-BTR-BTR-RIR cooling skid.** For these cooling skid and intermediate Heat exchanger was necessary in order to avoid the possibility of water cooling contamination due to accidental leakages (due to foreseen height activation of these primary cooling water loop) Intermediate heat exchanger will act as effective new safety barrier to prevent such situation of water contamination.(see drawing Figure 6-9: D-1223-D-014- Process Flow Diagram HRS (Accelerator facility) 4/4)
 - **Lithium Facility**, Tertiary water exchanger. This exchanger is not part of the HRS, HRS have the interface point to the inlet out let valves of the heat exchanger (Tertiary Heat Exchanger), nevertheless the contamination protection is ensured since the tertiary heat exchanger for the cooling Lithium loop use water as coolant fluid into close circuit and



the heat is extracted from the oil loop which in turn the oil extract heat from liquid metal Lithium by means of another heat exchanger Ref. to Figure 6-6: D-1223-011, Process Flow Diagram HRS (TF-LF-PIE-CF) 1/4) and the Figure 3-1: Input data requirements for LF Heat Loads

- **Low risk of water contamination**
 - Accelerator's components cooling skids Inside the vault: Injector, RFQ, MEBT (Buncher) SRF Linac antennas and Accelerator's components cooling skids outside the vault: Helium compressors, RF chain & HVPS, Cold box, Injector's LVPS, HEBT- LVPS, RFQ and HEBT Cryo compressors, Vacuum system, Ref. Figure 6-8: D-1223-D-013-Process Flow Diagram HRS (Accelerator Facility)3/4 and Figure 6-7: D-123-012- Process Flow Diagram HRS (Accelerator Facility) 2/4

4.5 System Performance Requirements

Not applicable at this engineering stage, anyhow the system performance basic functions are indicated on the P&ID's of HRS designs Ref:

- Figure 6-10: D-1225-011- P&ID HRS 1/10
- Figure 6-11: D-1225-012-P&ID HRS 2/10
- Figure 6-12: D-1225-013-P&ID HRS 3/10
- Figure 6-13: D-1225-014-P&ID HRS 4/10
- Figure 6-14: D-1225-015- P&ID HRS 5/10
- Figure 6-15: D-1225-016- P&ID HRS 6/10
- Figure 6-16: D-1225-017-P&ID HRS 7/10
- Figure 6-17: d-1225-018-P&ID HRS 8/10
- Figure 6-18: D-1225-019-P&ID HRS 9/10
- Figure 6-19: D1225-020 P&ID HRS 10/10

4.6 System Arrangement

4.6.1 Equipment arrangement Drawings

Refer to the next (Ref. Sect.4.7) Component Design Description

4.7 Component Design Description

For this purpose we have detailed the list of the HRS components necessary for the all HRS system of IFMIF plant, the information are integrated on the document called Equipment List HRS system referred to PBS 5.3.3.3.0.Ref. Table 7: S-1224-001- HRS Equipment List. The Equipment List represents all the HRS components, on the list following detailed information are provided:



- Item NO
- Service
- QTY
- Material type
- Type of component
- Specification
- Main Dimension
- Electrical output rate (KW)
- Location on the IFMIF Building (Area/room's number)

4.8 Instrumentation and Control

HRS Central Control System (CCS) shall be conforming to standards, specifications and interfaces as documented in the CCS - DDD II document ref. BA_D236AF7 v1.0.

CCS will ensure the integrated supervision control of overall IFMIF plant and plant system operation. These functions will be available in master control room. HRS shall have its own plant control system (MPS) machine protection system that shall integrate the individuals control system of each of the HRS subsystems.

Information from the data is available in the HRS local control system (MPS) shall be transferred to CCS to allow a complete and reliable operation of the HRS. The instrumentation and control components shall include all Computers hardware and software required to control the HRS plant system, including input/output (I/O) interfaces and plant system interlocks. These requirements shall be established based on the preliminary design of the HRS. Sufficient instruments shall be included in HRS plant system to monitor components performance within the design envelope and to alarm plant operators on the onset of operation outside design margin (particularly for the water leakages detection and water quality conditions). Instrumentations shall include: pressure and temperature flow sensor to measure/monitor performance and allow independent control of components for the system. Also, instruments shall be installed to monitor water chemistry, temperature of blow down and the Cooling Tower basin, the instrumentations indicated is descriptive but not limited, specific instrumentations and control requirements for HRS system shall be established on the next step DDD III; now we can refer to the HRS P&ID (Ref. documents D-1225- 011 to 019 Figures: 6:10 to 6:19)

4.9 Status of R&D activities and future plans

Not applicable for this system.

5. List of References

- [1] 2009 ASHRAE Handbook Fundamentals
- [2] Y. Le Tonqueze, *Safety Specifications for the EDA of IFMIF*, BA_D_224X48
- [3] IEA, *IFMIF Comprehensive Design Report*
- [4] Accelerator System Group DDD I, Ref. BA_D_22NF7C v1.0
- [5] G. Pruneri Heat Loads Input data In Vault components.
- [6] M. Ida IFMIF Lithium Target facility, DD I doc. BA_D_227S7Z rev. 1.0
- [7] G. Pruneri /Pierre-Yves Beauvais: Accelerator Heat Rejection System Scheme
- [8] F.Arbeiter Test Facility Utility Room DDD I doc. BA_D_22BWBP rev. 4.0
- [9] Y. Le Tonqueze, Safety Important Class-SIC Ref. BA_D_228V5Q rev. 1.2

5.1.1 List of Acronyms

AF	Accelerator Facility
CF	Conventional Facilities
CODA	Construction Operation and Decommissioning Activities
DDD	Design Description Document
DVT	Data Validation table
EDS	Emergency Detritiation System
EVEDA	Engineering Validation & Engineering Design Activity
GDS	Glove boxes Detritiation System
HDS	Hot cells Detritiation System
HRS	Heat Rejection System
HVAC	Heating Ventilation Air Conditioning
IFMIF	International Fusion Materials Irradiation Facility
LF	Lithium target Facility
PBS	Plant Breakdown Structure
PFD	Process Flow Diagram
P&ID	Piping& Instrumentation Diagram
PIE	Post Irradiation Examination
PT	Project Team
RAMI	Reliability, Availability, Maintainability, Inspectability
RF	Radio Frequency
RFQ	Radio Frequency Quadrupole
SIC	Safety Important Component



TF	Test Facility
VDS	Vent gas Detritiation System
WBS	Work Breakdown Structure

6. Appendices

6.1 List of Documents

6.1.1 Drawings (PFD's, P&ID's 2D drawings & Excel file)

6.1.2 Layout Plan for HRS

This section reports the preliminary HRS layout, main components outdoor Cooling Towers. The layout is divided by floor and is represented the overall dimensions of the HRS's piping and equipment. These layouts enable the Building designer to validate the size of the technical shafts, corridors, HRS's technical rooms and all the area where are foreseen heat exchangers and HRS component's installation.

These drawings together with CF piping layout should help to have a clear picture of the components that take part in the system definition and of the main interactions among them.

Layout Plan for HRS is considered as a preliminary document for the system design, could be slightly modified by a updating in the input data or IFMIF layout changes. Ref. to Figure 6-1: Overall View, outdoor cooling Tower main configuration.

6.1.3 HRS's Heat Loads scheme.

In the Figure 6-1 to 6-5 are shown the different configurations selected for each HRS based upon the engineering design have been developed.

6.1.4 Process Flow Diagram (PFD)

Ref to Figure 6-6 to 6-9

6.1.5 Equipment List HRS System

Identified on Table 7: S-1224-001- HRS Equipment List

6.1.6 HRS P&ID

The basic design for the major HRS components is identified on these drawings. The components have been checked and confirmed their dimensions based on the performance and availability on the HRS commercial market. The Basic design of HRS's Equipment layout is identified from (Figure 6-10 to 6-19) Figure 6-10, Figure 6-11, Figure 6-12, Figure 6-13, Figure 6-14, Figure 6-15, Figure 6-16, Figure 6-17, Figure 6-18 and Figure 6-19.



6.1.7 Equipment Layout, displaced on Conventional room.

These Figure 6-20, Figure 6-21, Figure 6-22, Figure 6-23, Figure 6-24, Figure 6-25, Figure 6-26 and Figure 6-27, show various components of HRS i.e. located in a different technical rooms of IFMIF plant, mainly Heat exchangers, pumps etc. that are also clearly identified by type on the List of Equipment and are belong to the HRS, some of them as part of the Detritation but still served by HRS System . (Ref. to: Figure 6-20, Figure 6-21, Figure 6-22, Figure 6-23, Figure 6-24, Figure 6-25, Figure 6-26 and Figure 6-27.)

6.1.8 Layout Plan for main piping of Conventional Facility

(Ref. Figure 2-1,Figure 6-29,Figure 6-30,Figure 6-31)

6.2 List of Computer Programs

Not applicable

6.3 Others

Not applicable

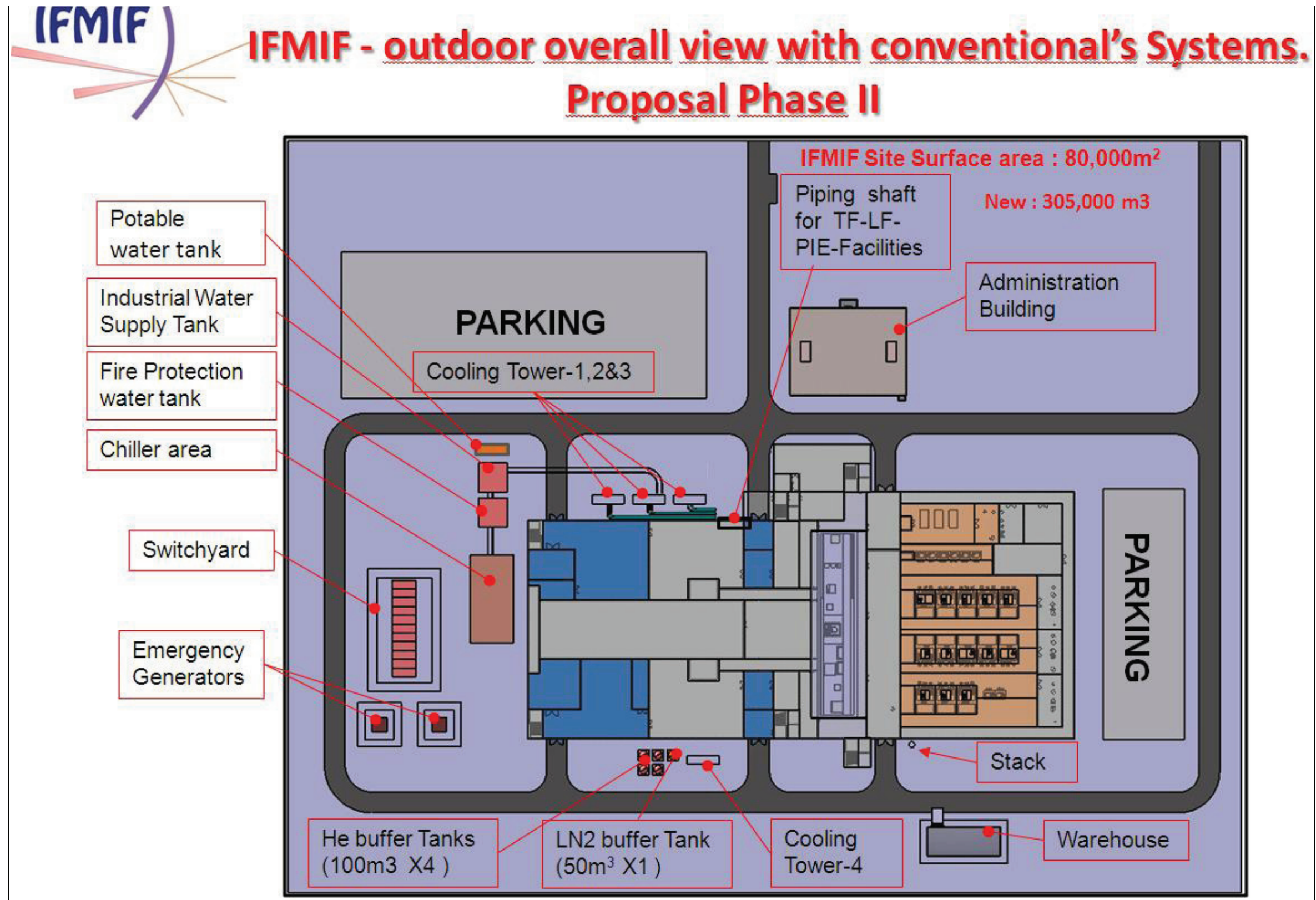


Figure 6-1: Overall View, outdoor cooling Tower main configuration.

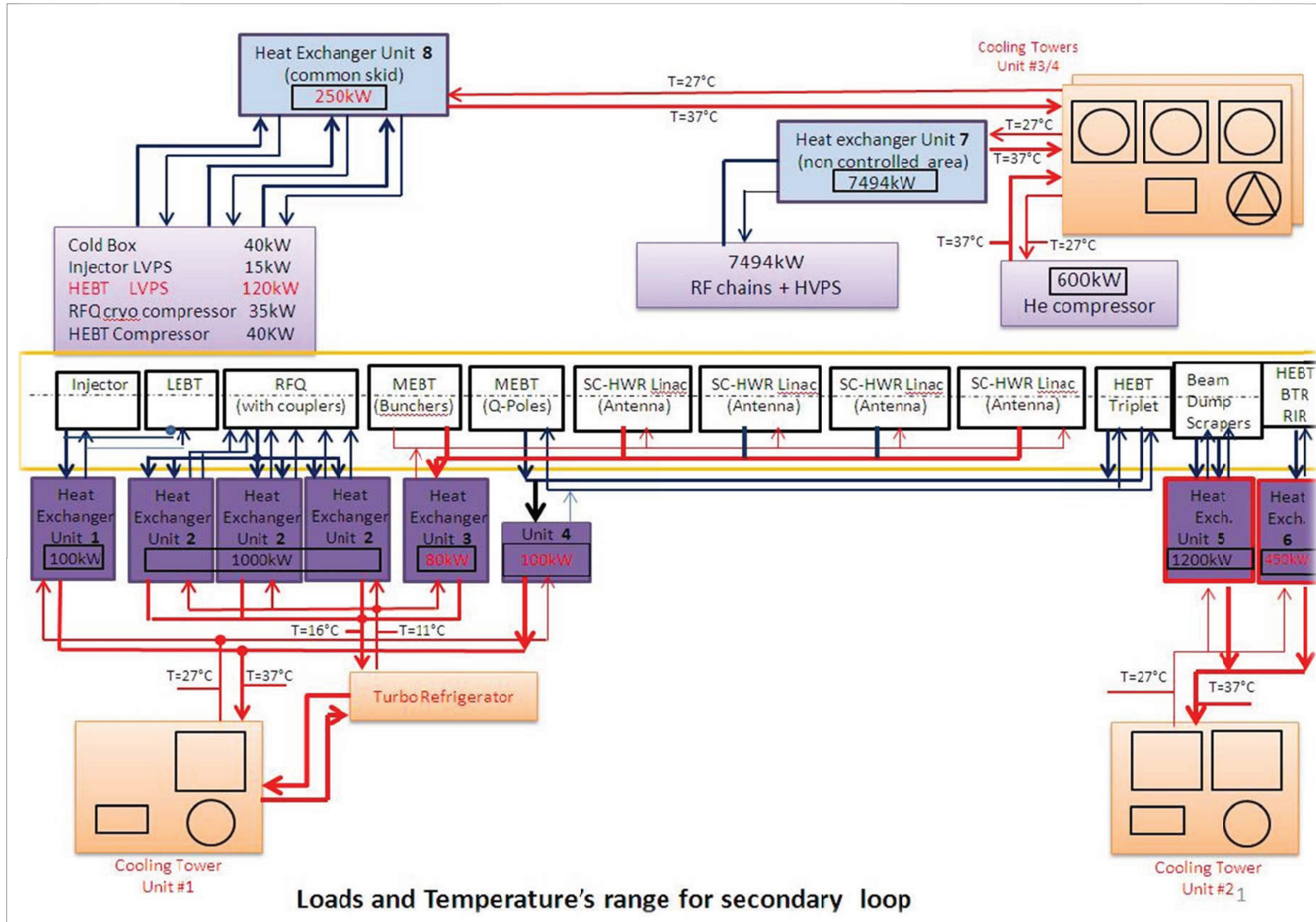


Figure 6-2: Accelerator's Heat Loads scheme.

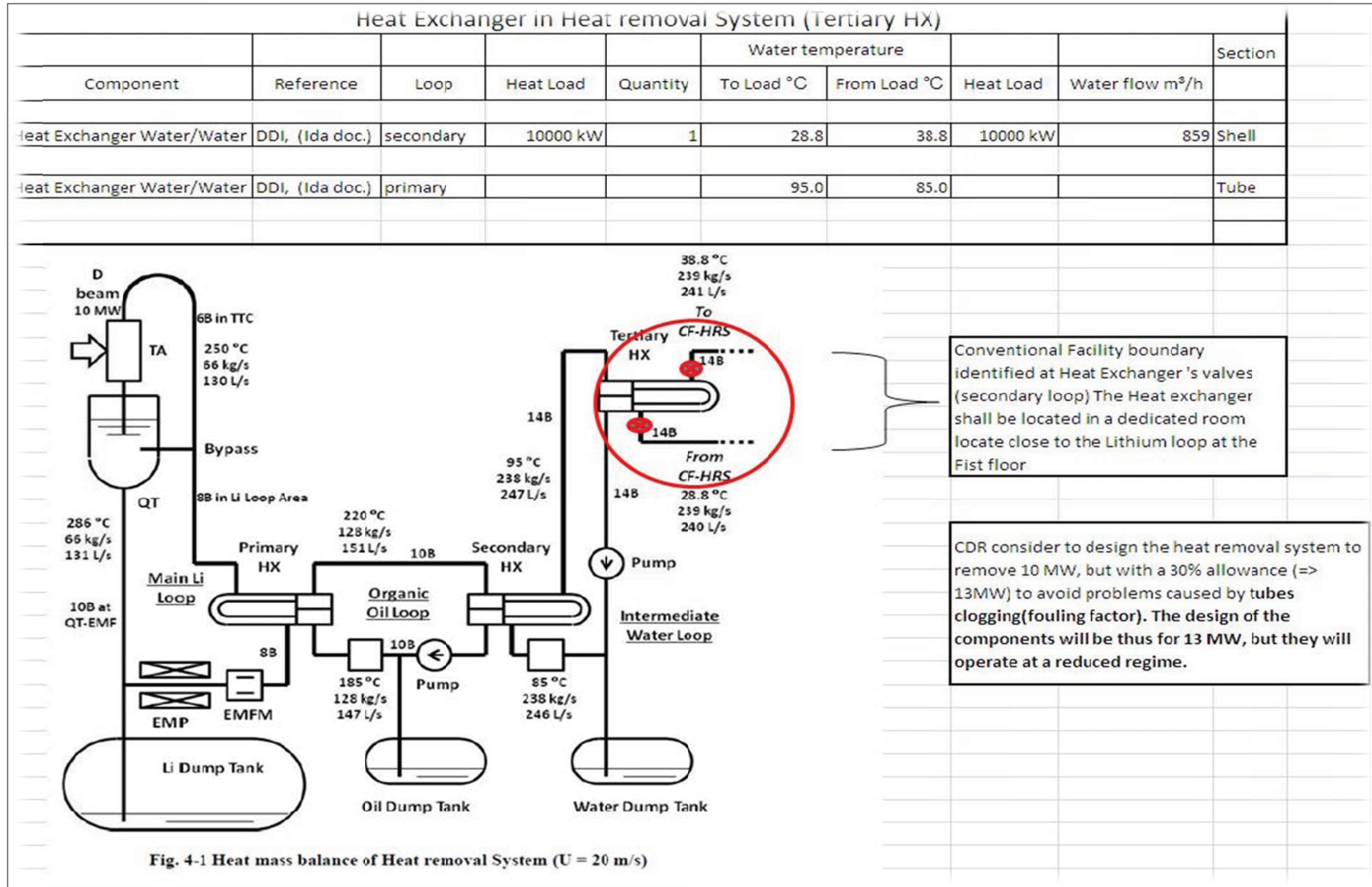
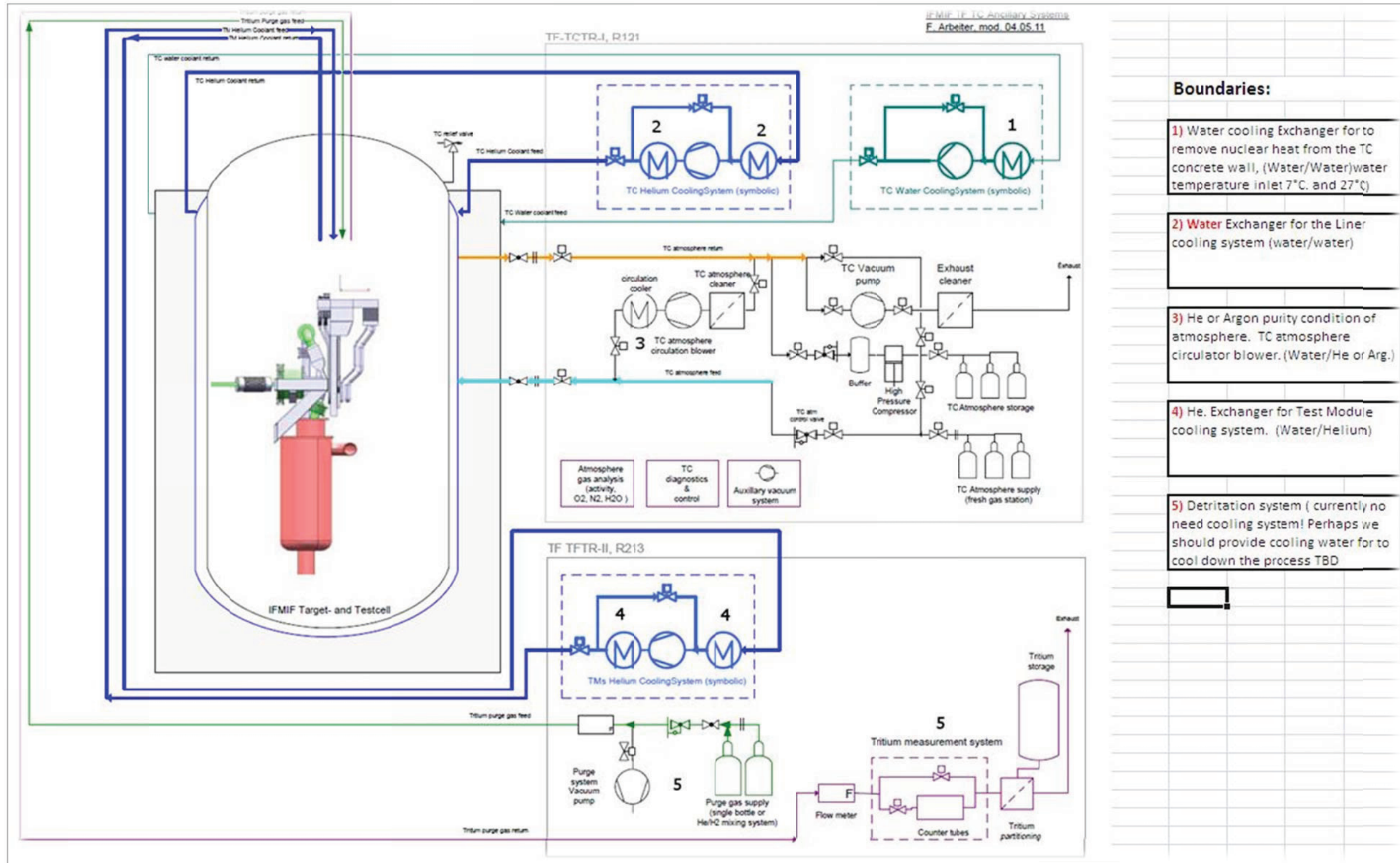


Figure 6-3: LF Heat Loads scheme.



Boundaries:

1) Water cooling exchanger for to remove nuclear heat from the TC concrete wall, (Water/Water)water temperature inlet 7°C. and 27°C)

2) Water Exchanger for the Liner cooling system (water/water)

3) He or Argon purity condition of atmosphere. TC atmosphere circulator blower. (Water/He or Arg.)

4) He. Exchanger for Test Module cooling system. (Water/Helium)

5) Detritiation system (currently no need cooling system! Perhaps we should provide cooling water for to cool down the process TBD

Figure 6-4: TF, HRS scheme.

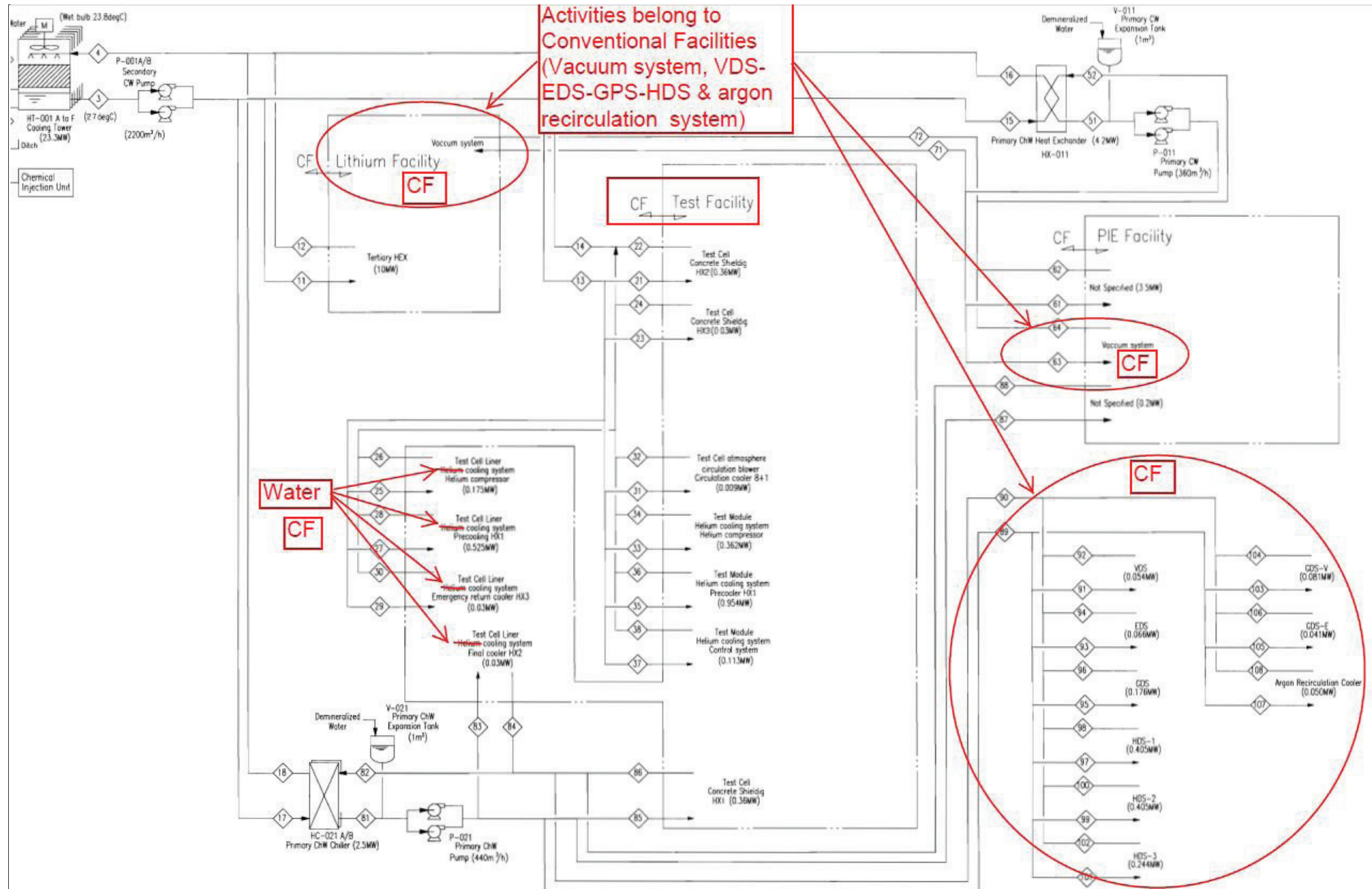


Figure 6-5: CF Heat Loads scheme

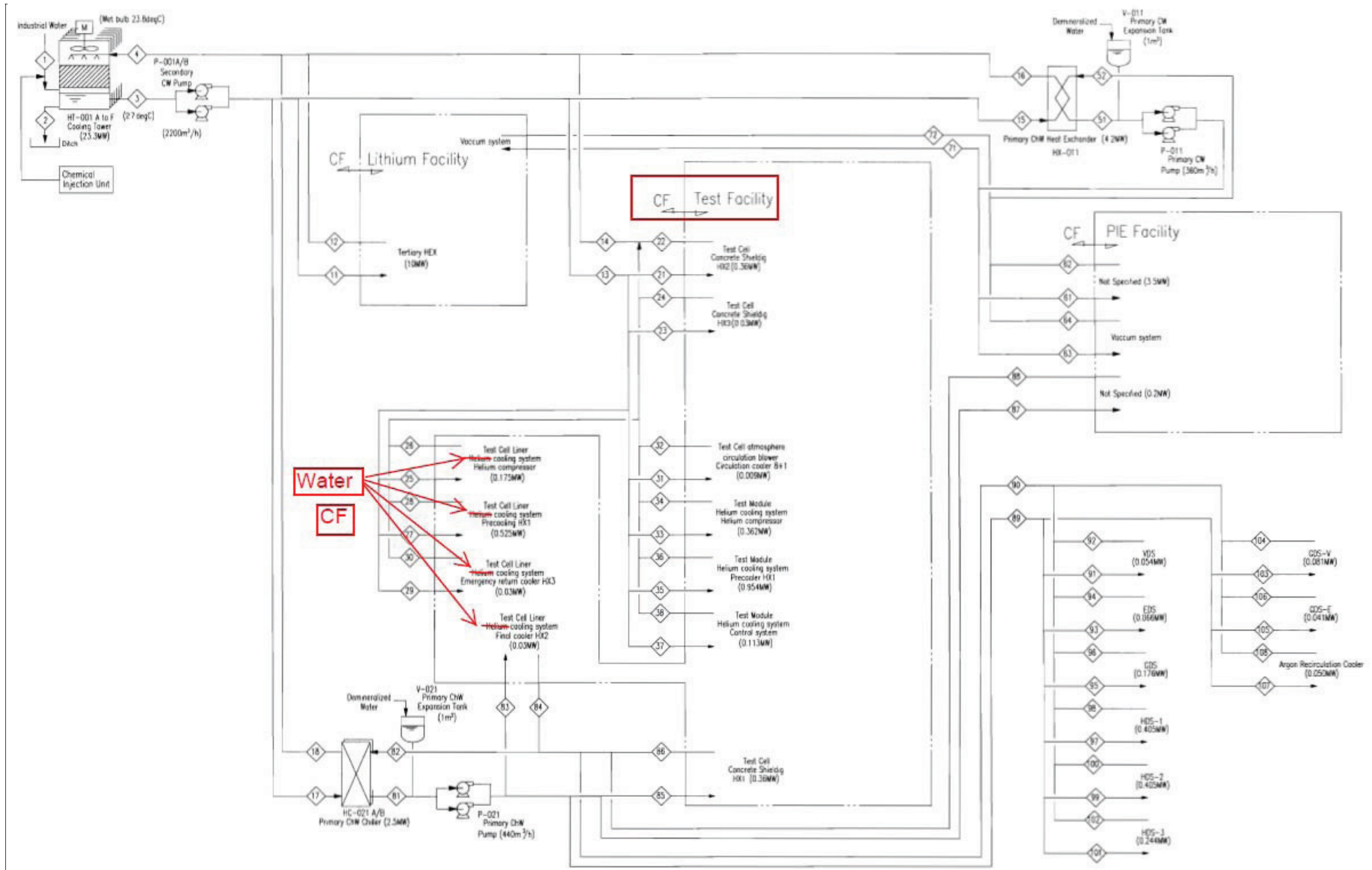
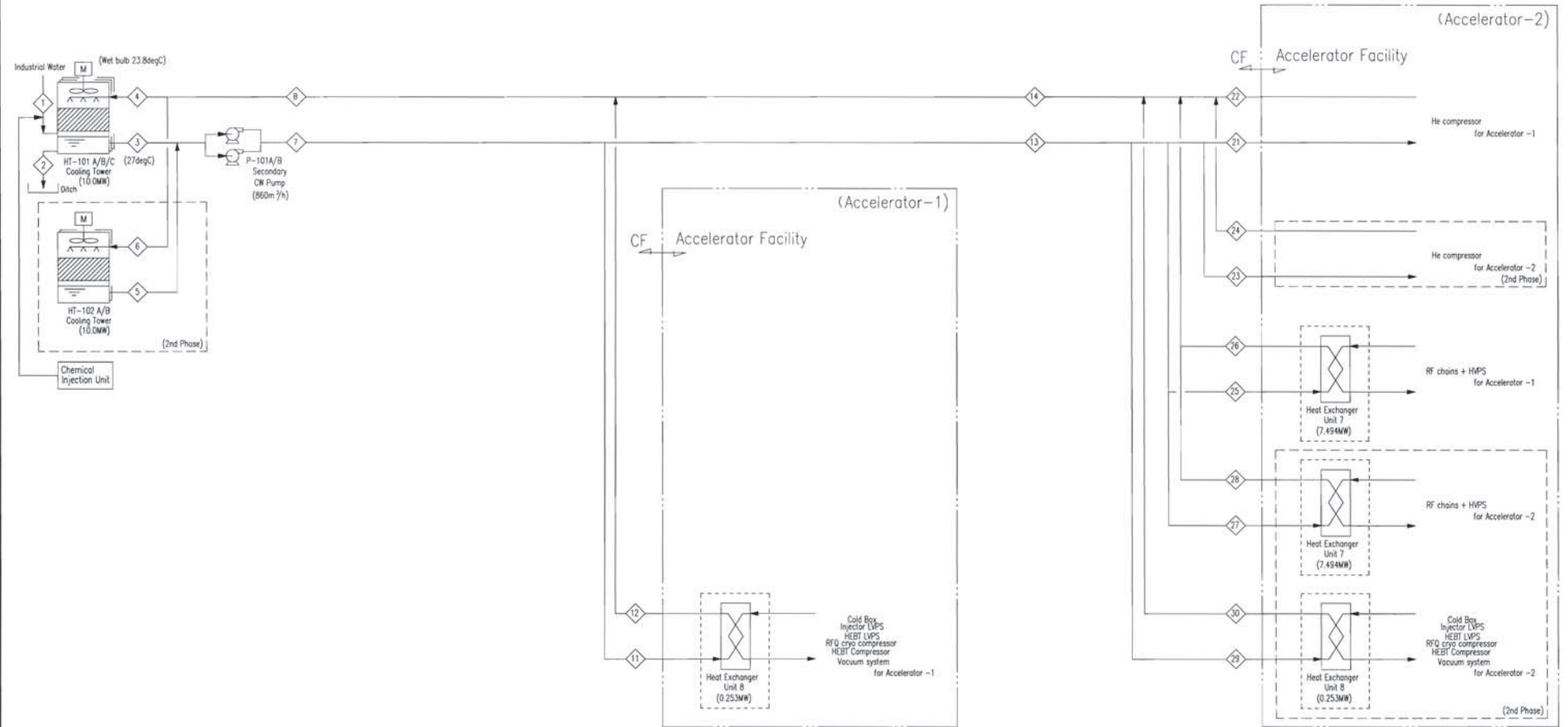


Figure 6-6: D-1223-011, Process Flow Diagram HRS (TF-LF-PIE-CF) 1/4



*1 Wey Bulb 23.8°C. Approach 3.2°C

Flow Number	1	2	3	4	5	6	7	8
Fluid	Industrial Water	Secondary Cooling Water	Secondary Cooling Water	Secondary Cooling Water	Secondary Cooling Water	Secondary Cooling Water	Secondary Cooling Water	Secondary Cooling Water
Water Flow	m ³ /h 33.0	8.2	718	718	718	718	1436	1436
Temperature	°C AMB	27 *1	27	37	27	37	27	37
Pressure	MPa -		0.5		0.5		0.5	
Remarks		Conc. Ratio 4 -	8.347 MW		8.347 MW		16.694 MW	

Flow Number	11	12	13	14
Fluid	Secondary Cooling Water	Secondary Cooling Water	Secondary Cooling Water	Secondary Cooling Water
Water Flow	m ³ /h 21.7	21.7	1413.9	1413.9
Temperature	°C 27	37	27	37
Pressure	MPa		0.5	
Remarks	0.253 MW		16.441 MW	

Flow Number	21	22	23	24	25	26	27	28	29	30
Fluid	Secondary Cooling Water	Secondary Cooling Water	Secondary Cooling Water	Secondary Cooling Water	Secondary Cooling Water	Secondary Cooling Water	Secondary Cooling Water	Secondary Cooling Water	Secondary Cooling Water	Secondary Cooling Water
Water Flow	m ³ /h 51.6	51.6	51.6	51.6	644.5	644.5	644.5	644.5	21.7	21.7
Temperature	°C 27	37	27	37	27	37	27	37	27	37
Pressure	MPa 0.5		0.5				0		0	
Remarks	0.6 MW		0.6 MW		7.494 MW		7.494 MW		0.253 MW	

No.	DATE	DESCRIPTION	PREP	CHK'D	APP'D
2012-06-18		Revised According to JAEA's Comments	K.T	N.Y	N.Y
2012-05-30		Minor change such as drawing number	K.T	N.Y	N.Y
2012-03-26		Issue For Approval	K.T	N.Y	N.Y

REVISIONS

JGC CORPORATION

IFMIF
53300 Heat Rejection System
/cooling system
Process Flow Diagram (2/4)

DATE 2012-03-26 SCALE

PREP'D: K.Taharaishi, CHK'D: M.Yasukawa, APP'D: M.Yasukawa

JOB CODE 0-611719-2-0

FIG.No. D-1223-012

Figure 6-7: D-123-012- Process Flow Diagram HRS (Accelerator Facility) 2/4

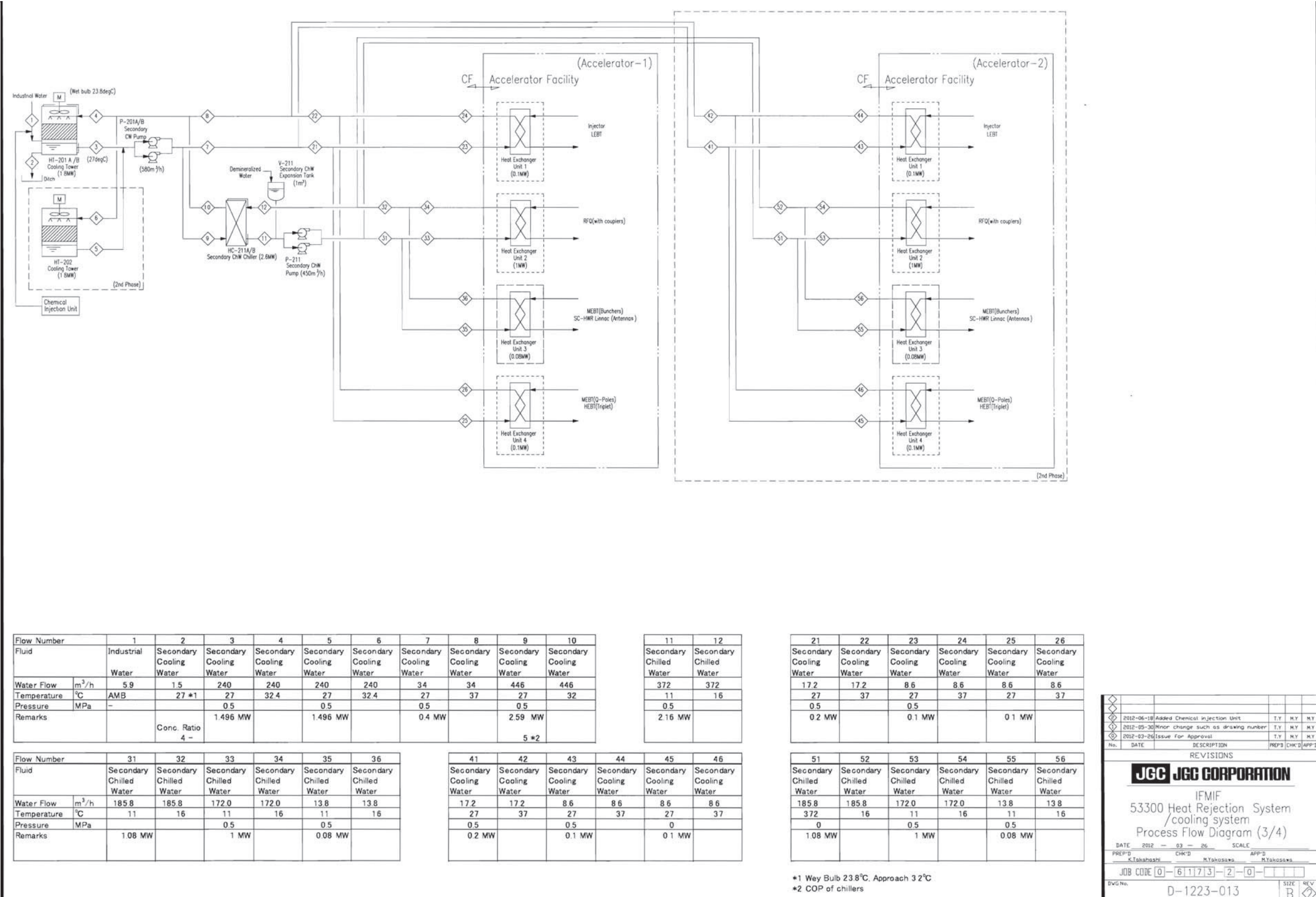
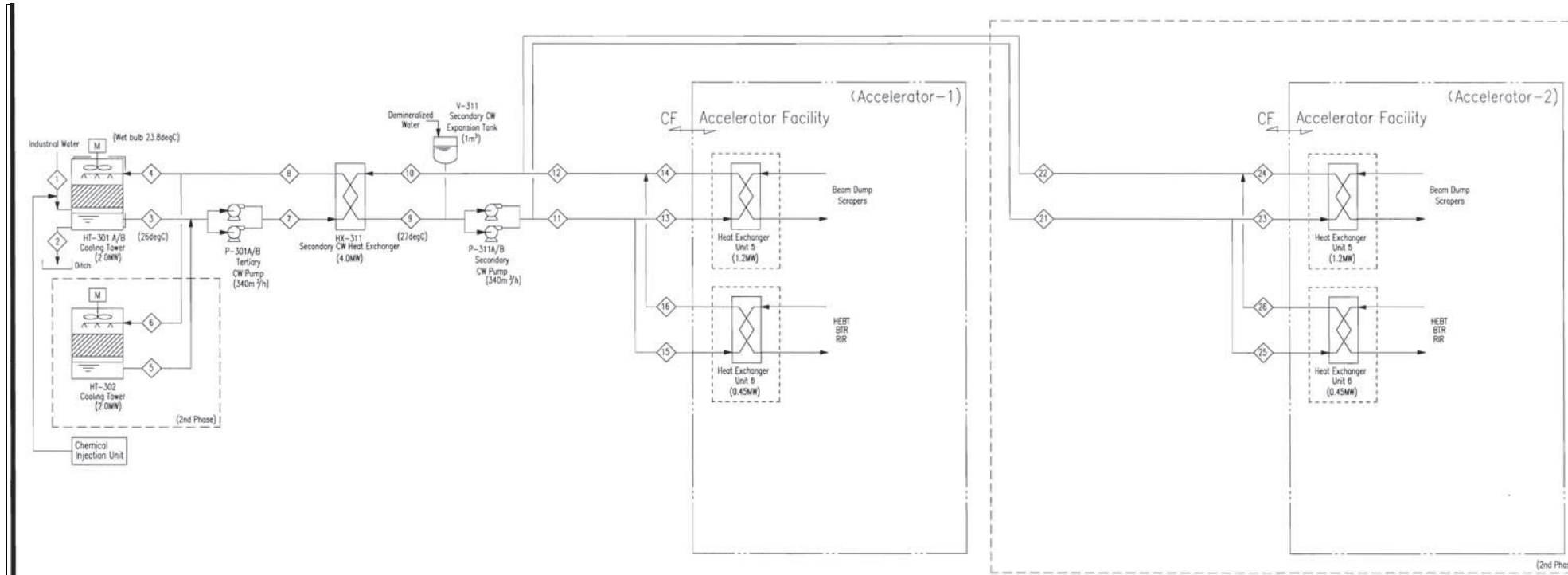


Figure 6-8: D-1223-D-013-Process Flow Diagram HRS (Accelerator Facility)3/4



Flow Number	1	2	3	4	5	6	7	8	9	10
Fluid	Industrial Water	Secondary Cooling Water	Secondary Cooling Water	Secondary Cooling Water	Secondary Cooling Water	Secondary Cooling Water	Secondary Cooling Water	Secondary Cooling Water	Secondary Cooling Water	Secondary Cooling Water
Water Flow	6.5 m ³ /h	1.6	142	142	142	142	284	284	284	284
Temperature	AMB	26 *1	26	36	26	36	26	36	27	37
Pressure	-	-	0.5	-	0.5	-	0.5	-	0.5	-
Remarks	-	Conc. Ratio 4 -	1.65 MW	-	1.65 MW	-	3.3 MW	-	3.3 MW	-

*1 Wey Bulb 23.8°C, Approach 3.2°C

Flow Number	11	12	13	14	15	16
Fluid	Secondary Cooling Water	Secondary Cooling Water	Secondary Cooling Water	Secondary Cooling Water	Secondary Cooling Water	Secondary Cooling Water
Water Flow	141.9 m ³ /h	141.9	103.2	103.2	38.7	38.7
Temperature	27 °C	37	27	37	27	37
Pressure	0.5 MPa	-	0.5	-	-	-
Remarks	1.65 MW	-	1.2 MW	-	0.45 MW	-

Flow Number	21	22	23	24	25	26
Fluid	Secondary Cooling Water	Secondary Cooling Water	Secondary Cooling Water	Secondary Cooling Water	Secondary Cooling Water	Secondary Cooling Water
Water Flow	141.9 m ³ /h	141.9	103.2	103.2	38.7	38.7
Temperature	27 °C	37	27	37	27	37
Pressure	0.5 MPa	-	0.5	-	0	-
Remarks	1.65 MW	-	1.2 MW	-	0.45 MW	-

No.	DATE	DESCRIPTION	PREP	CHK	APP
1	2012-06-18	Added Chemical Injection Unit	K.T	N.Y	N.Y
2	2012-05-30	Minor change such as drawing number	K.T	N.Y	N.Y
3	2012-03-26	Issue for Approval	K.T	N.Y	N.Y

REVISIONS

JGC CORPORATION

IFMIF
53300 Heat Rejection System
/cooling system
Process Flow Diagram (4/4)

DATE: 2012-03-26 SCALE: APP'D: K.Tahabashi, M.Tanaka, M.Tanaka

JOB CODE: 0-611713-2-0

DWG No.: D-1223-014

Figure 6-9: D-1223-D-014- Process Flow Diagram HRS (Accelerator facility) 4/4

Equipment List for 5.3.3.0.0. 7333.333333

No.	ITEM No.	SERVICE	QTY	MAT'L	TYPE	SPECIFICATION	MAIN DEMENSION	RATED OUTPUT	ACCESSORIES	Installation ROOM No.	REMARKS
1	5.3.3.0.0.-HT-001 A to E	Cooling Tower	5	Carbon Steel	Open	Exchanged heat quantity: 23.3MW Secondary CW Flow rate: 2200m ³ /h Temperature: 35.8→27°C 20%X5+1	W11000XL3000XH5000	FAN 37kW x 3/Unit (400V)	-	Outdoor	Wet bulbe 23.8°C BAC's VXT-1200
2	5.3.3.0.0.-P-001 A/B	Secondary CW Pump	2	Carbon Steel	Centrifugal	2200m ³ /h, 50m, 100%X2	W1600XL4000XH1700	400kW (6.6kV)	-	Outdoor	-
3	5.3.3.0.0.-HX-011	Primary CW Heat Exchanger	1	Stainless Steel	Plate	Exchanged heat quantity: 4.2MW Secondary CW Flow rate: 360m ³ /h Temperature: 27→37°C Primary CW Flow rate: 360m ³ /h Temperature: 30→40°C Area of heat transfer surface: 470m ²	W780XL3900XH2300	-	-	R106-1	ALFA LAVAL's T20
4	5.3.3.0.0.-P-011 A/B	Primary CW Pump	2	Stainless Steel	Centrifugal	440m ³ /h, 50m, 100%X2	W780XL1650XH1180	132kW (400V)	-	R106-1	-
5	5.3.3.0.0.-V-011	Primary CW Expansion Tank	1	Stainless Steel	-	1m ³	Φ 1000XH2000 t6	-	-	R307	-
6	5.3.3.0.0.-HC-021 A/B	Primary ChW Chiller	2	Cu, Carbon Steel	Centrifugal	Exchanged heat quantity: 2.5MW Secondary CW Flow rate: 520m ³ /h Temperature: 27→32°C Primary ChW Flow rate: 440m ³ /h Temperature: 12→7°C 100%X2	W2330XL4380XH2640	460kW (6.6kV)	-	R106-1	DAIKIN's HT800MB
7	5.3.3.0.0.-P-021 A/B	Primary ChW Pump	2	Stainless Steel	Centrifugal	270m ³ /h, 50m, 100%X2	W750XL1400XH1000	90kW (400V)	-	R106-1	-
8	5.3.3.0.0.-V-021	Primary ChW Expansion Tank	1	Stainless Steel	-	1m ³	Φ 1000XH2000 t6	-	-	R307	-
9	5.3.3.0.0.-HT-101 A/B/G	Cooling Tower	3	Carbon Steel	Open	Exchanged heat quantity: 10.0MW Secondary CW Flow rate: 860m ³ /h Temperature: 37→27°C 25%X2+1	W11000XL3000XH5000	FAN 37kW x 3/Unit (400V)	-	-	Wet bulbe 23.8°C BAC's VXT-1200
10	5.3.3.0.0.-HT-102 A/B	Cooling Tower (2nd Phase)	2	Carbon Steel	Open	Exchanged heat quantity: 10.0MW Secondary CW Flow rate: 860m ³ /h Temperature: 37→27°C 25%X2	W11000XL3000XH5000	FAN 37kW x 3/Unit (400V)	-	Outdoor	Wet bulbe 23.8°C BAC's VXT-1200
11	5.3.3.0.0.-P-101 A/B	Secondary CW Pump	2	Carbon Steel	Centrifugal	860m ³ /h, 50m, 100%X2	W900XL2200XH1100	185kW (6.6kV)	-	Outdoor	-
12	5.3.3.0.0.-HT-201 A/B	Cooling Tower	2	Carbon Steel	Open	Exchanged heat quantity: 1.8MW Secondary CW Flow rate: 290m ³ /h Temperature: 32.4→27°C 50%X1+1	W5500XL3000XH5000	FAN 22kW x 2/Unit (400V)	-	Outdoor	Wet bulbe 23.8°C BAC's VXT-560
13	5.3.3.0.0.-HT-202	Cooling Tower (2nd Phase)	1	Carbon Steel	Open	Exchanged heat quantity: 1.8MW Secondary CW Flow rate: 290m ³ /h Temperature: 32.4→27°C 50%X1	W5500XL3000XH5000	FAN 22kW x 2/Unit (400V)	-	Outdoor	Wet bulbe 23.8°C BAC's VXT-560
14	5.3.3.0.0.-P-201 A/B	Secondary CW Pump	2	Carbon Steel	Centrifugal	580m ³ /h, 50m, 100% X2	W750XL1800XH950 X2	110kW (400V)	-	Outdoor	-
15	5.3.3.0.0.-HC-211 A/B	Secondary ChW Chiller	2	Cu, Carbon Steel	Centrifugal	Exchanged heat quantity: 2.6MW Secondary CW Flow rate: 540m ³ /h Temperature: 27→32°C Secondary ChW Flow rate: 450m ³ /h Temperature: 11→16°C 100%X2	W2330XL4380XH2640	460kW (6.6kV)	-	R106-1	DAIKIN's HT800MB
16	5.3.3.0.0.-P-211 A/B	Secondary ChW Pump	2	Stainless Steel	Centrifugal	450m ³ /h, 50m, 100%X2	W700XL1600XH900	90kW (400V)	-	R106-1	-
17	5.3.3.0.0.-V-211	Secondary ChW Expansion Tank	1	Stainless Steel	-	1m ³	Φ 1000XH2000 t6	-	-	R307	-
18	5.3.3.0.0.-HT-301 A/B	Cooling Tower	2	Carbon Steel	Open	Exchanged heat quantity: 2.0MW Secondary CW Flow rate: 170m ³ /h Temperature: 36→26°C 50%X1+1	W74000XL3000XH5000	FAN 37kW x 2/Unit (400V)	-	Outdoor	Wet bulbe 23.8°C BAC's VXI-800
19	5.3.3.0.0.-HT-302	Cooling Tower (2nd Phase)	1	Carbon Steel	Open	Exchanged heat quantity: 2.0MW Secondary CW Flow rate: 170m ³ /h Temperature: 36→26°C 50%X1	W74000XL3000XH5000	FAN 37kW x 2/Unit (400V)	-	Outdoor	Wet bulbe 23.8°C BAC's VXI-800
20	5.3.3.0.0.-P-301 A/B	Tertiary CW Pump	2	Carbon Steel	Centrifugal	340m ³ /h, 50m, 100%X2	W650XL1500XH750	75kW (400V)	-	Outdoor	-
21	5.3.3.0.0.-HX-311	Secondary CW Heat Exchanger	1	Stainless Steel	Plate	Exchanged heat quantity: 4.0MW Secondary CW Flow rate: 340m ³ /h Temperature: 26→36°C Secondary CW Flow rate: 340m ³ /h Temperature: 37→27°C Area of heat transfer surface: 1330m ²	W1150XL5200XH3100	-	-	R106-1	ALFA LAVAL's M30
22	5.3.3.0.0.-P-311 A/B	Secondary CW Pump	2	Stainless Steel	Centrifugal	340m ³ /h, 30m, 100%X2	W800XL1400XH1200	75kW (400V)	-	R106-1	-
23	5.3.3.0.0.-V-311	Secondary CW Expansion Tank	1	Stainless Steel	-	1m ³	Φ 1000XH2000 t6	-	-	R307	-
24											
25											



Table 7: S-1224-001- HRS Equipment List

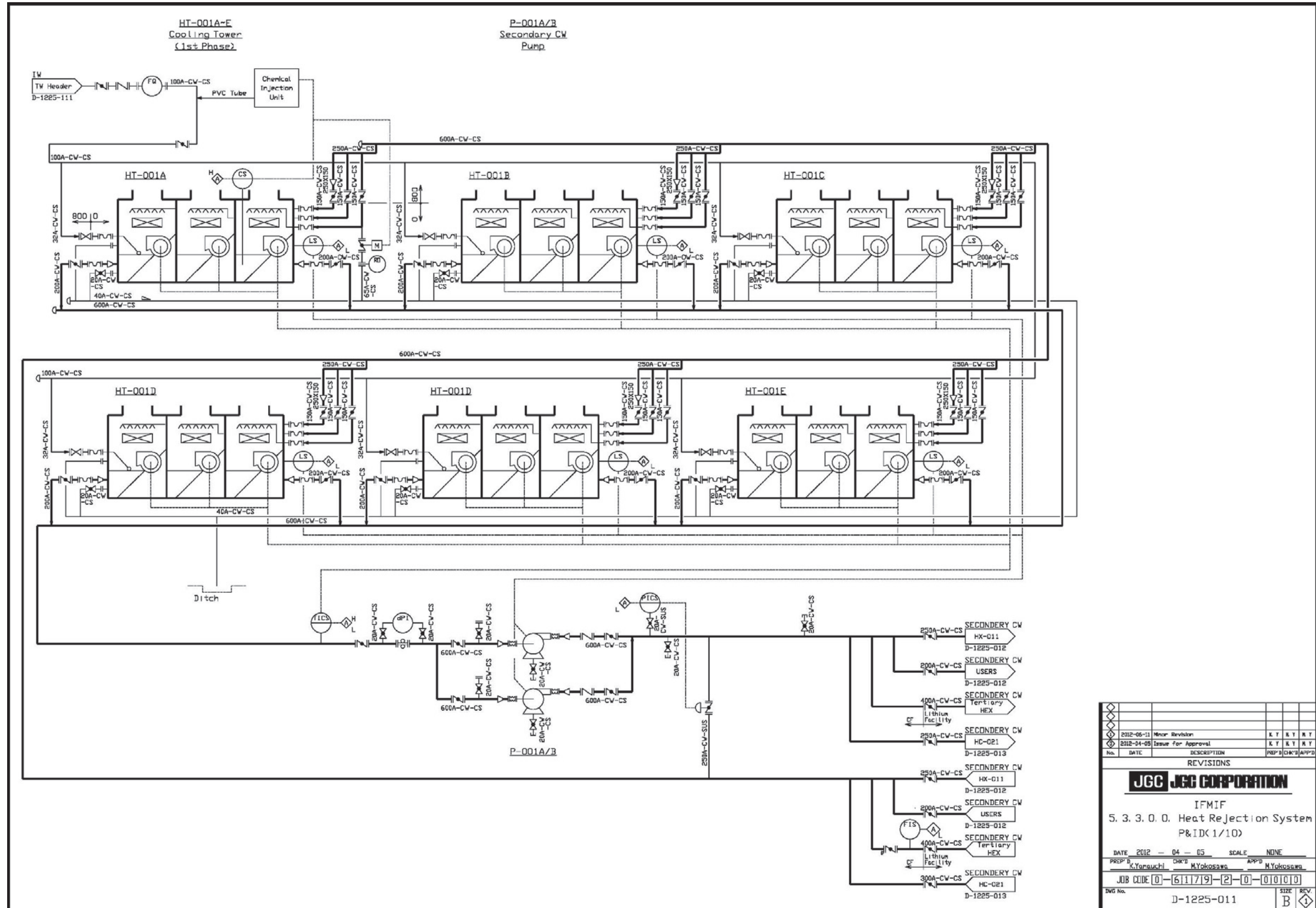


Figure 6-10: D-1225-011- P&ID HRS 1/10

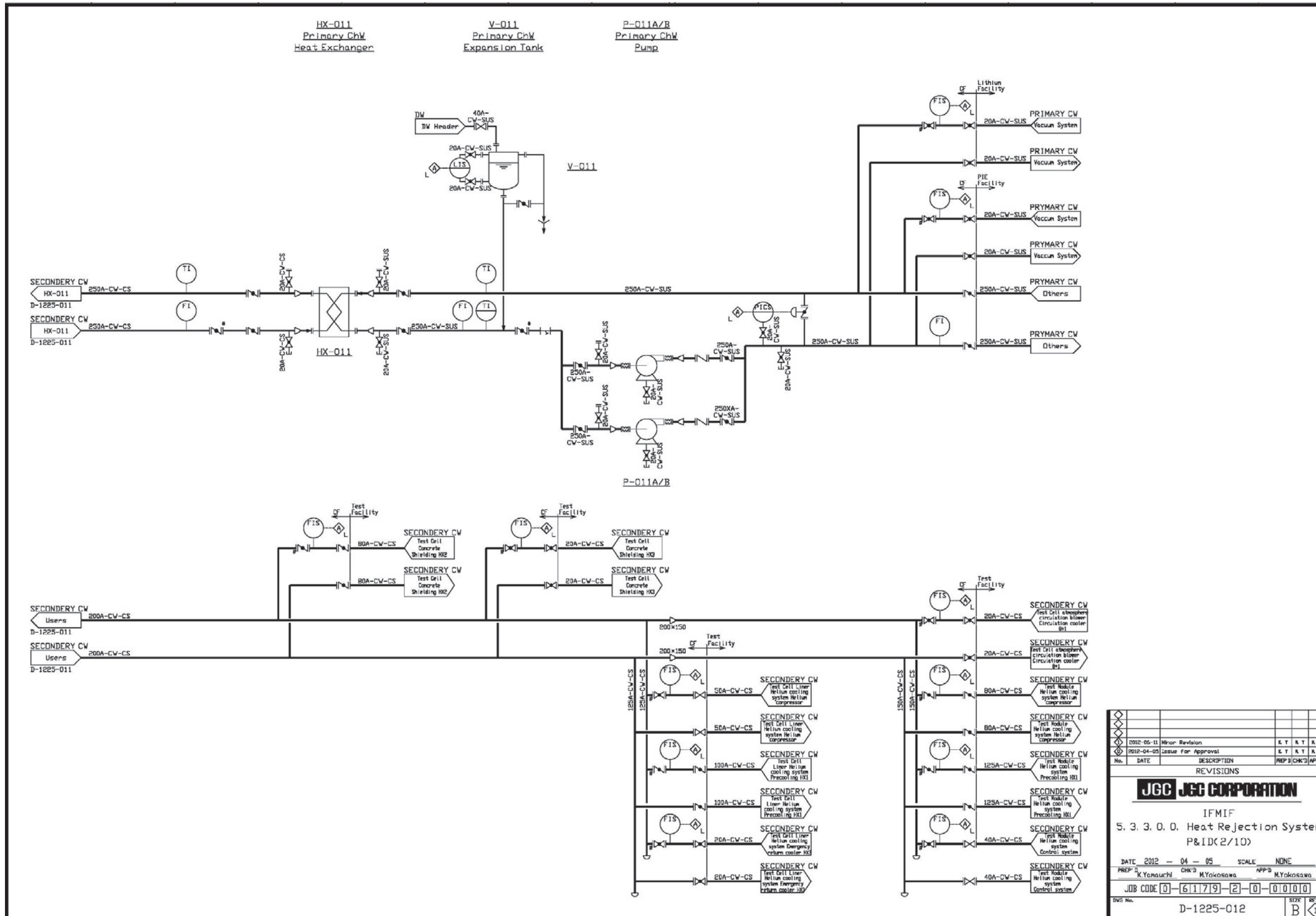


Figure 6-11: D-1225-012-P&ID HRS 2/10

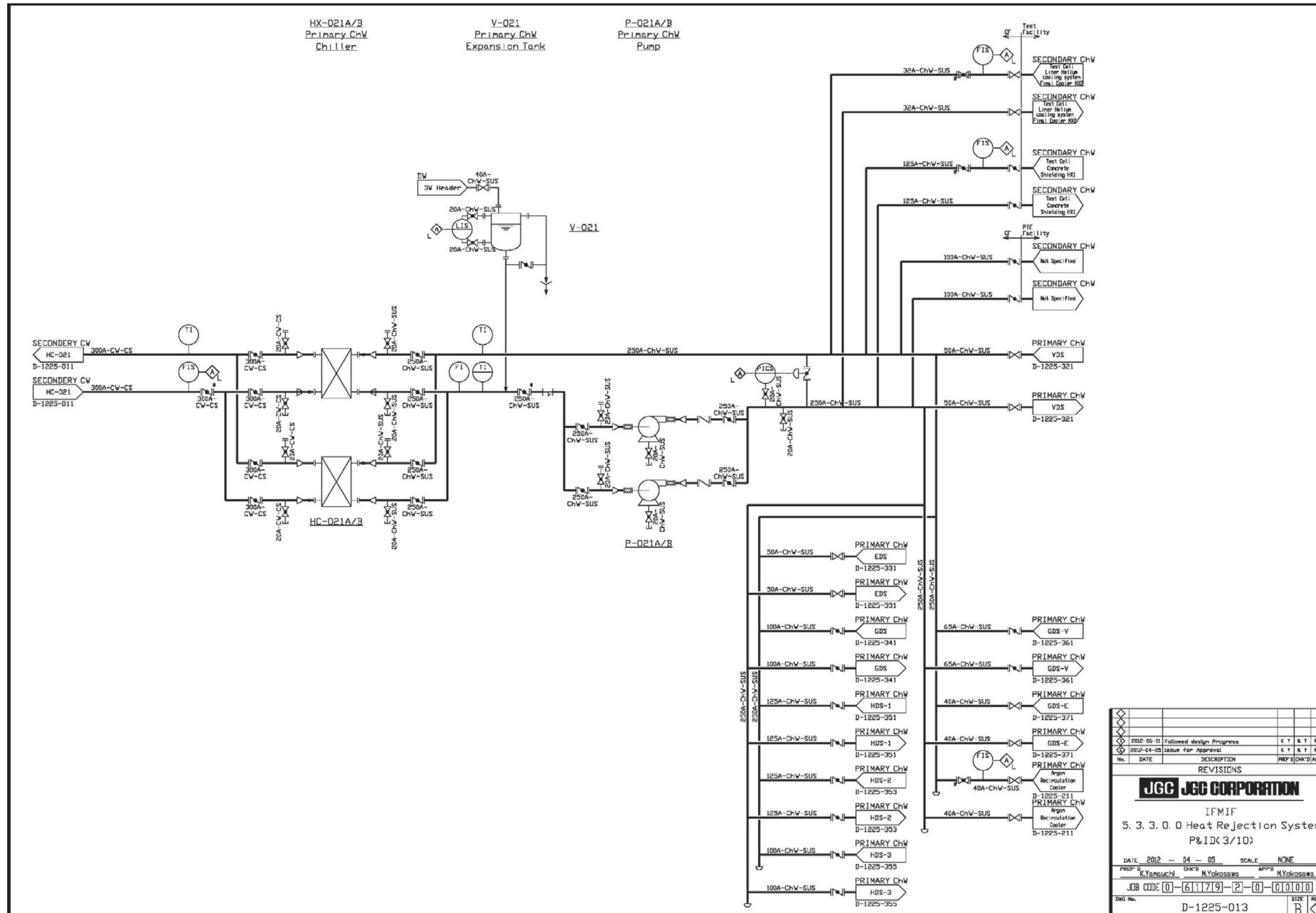


Figure 6-12: D-1225-013-P&ID HRS 3/10

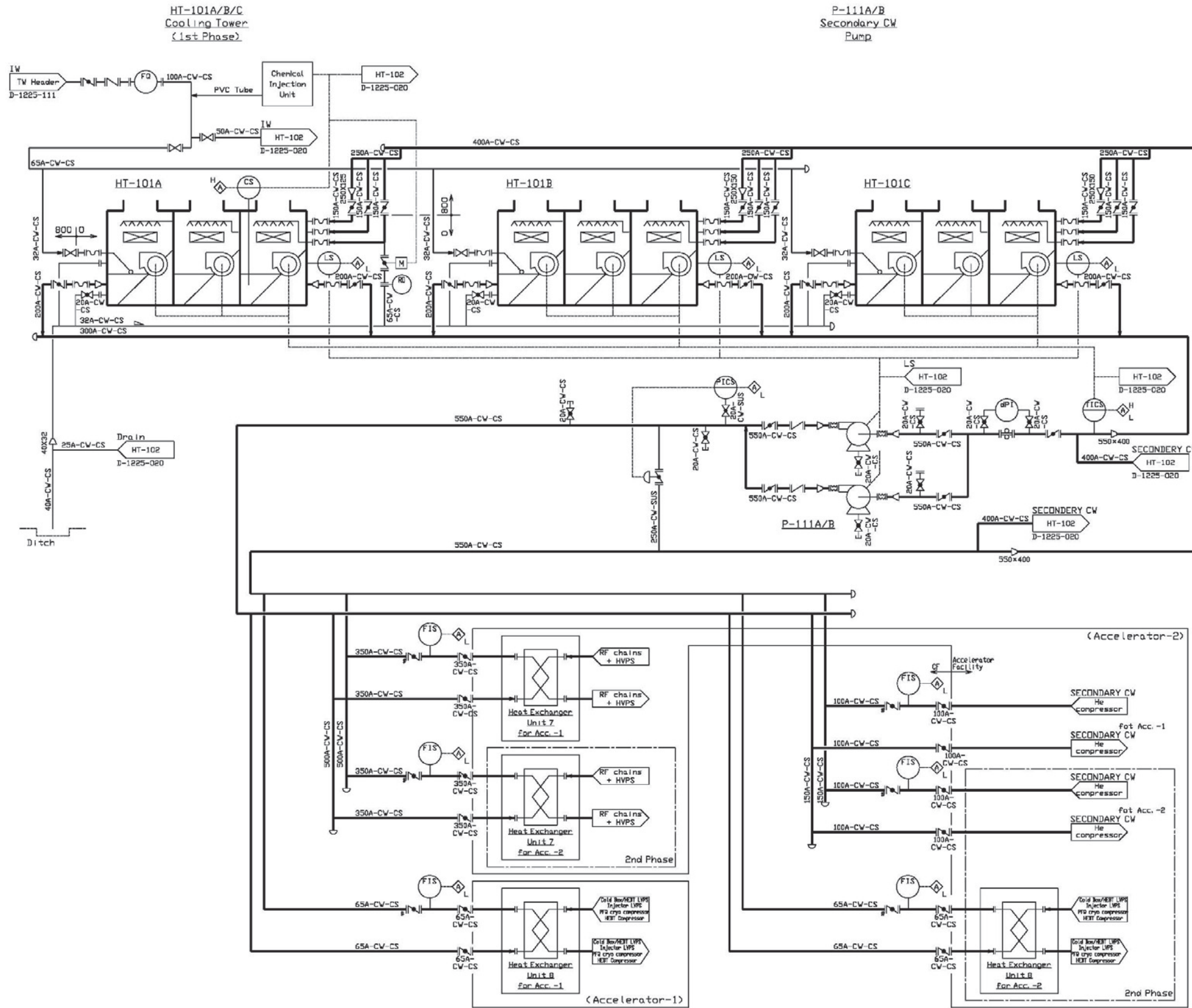
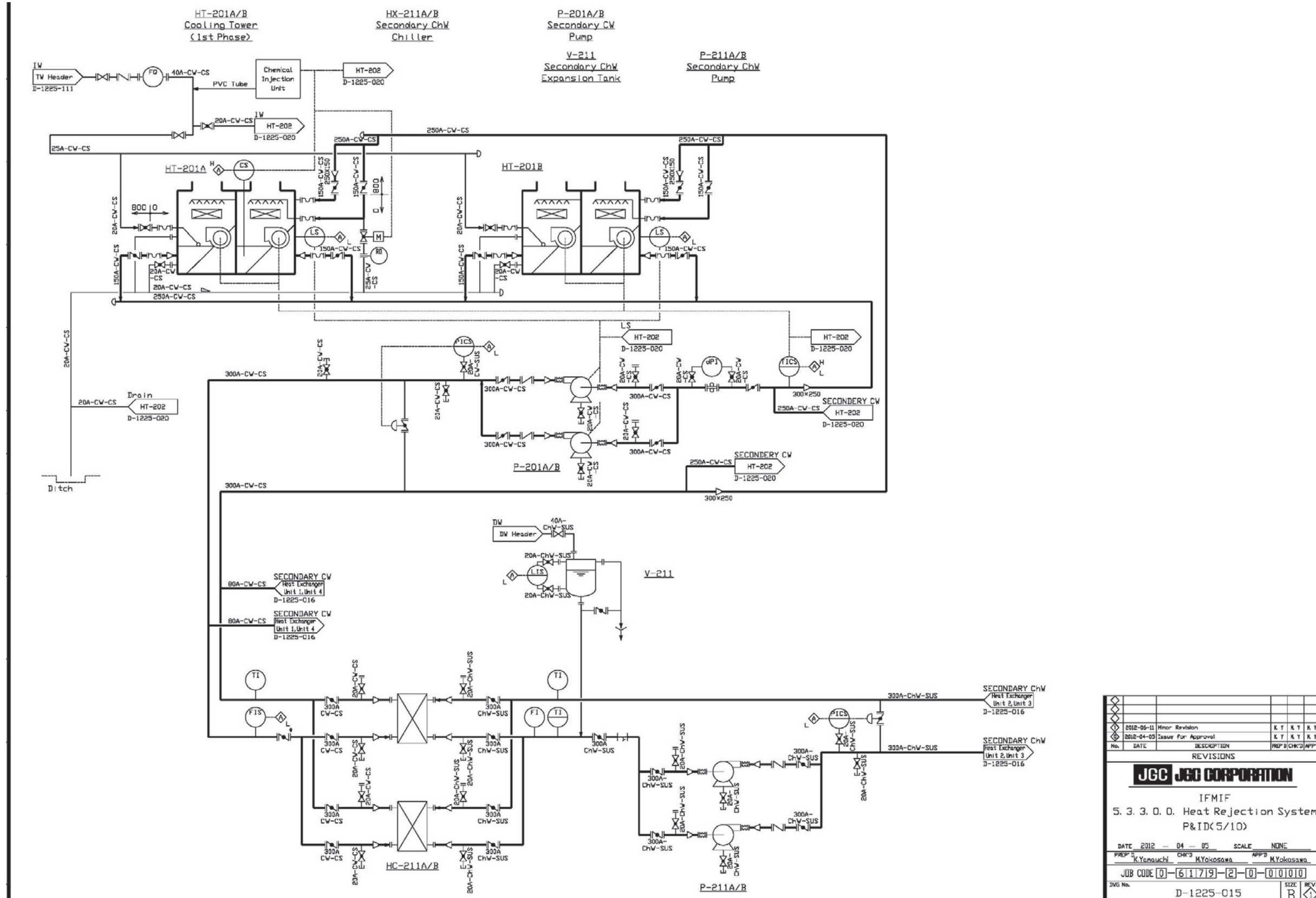


Figure 6-13: D-1225-014-P&ID HRS 4/10

2012-05-11	Revised According to JICA's Comment	K.T	K.T	K.T	
2012-04-05	Issue for Approval	K.T	K.T	K.T	
No.	DATE	DESCRIPTION	PREP	CHEK	APP
REVISIONS					
JGC CORPORATION					
IFMIF					
5.3.3.0.0 Heat Rejection System					
P&ID(4/10)					
DATE	2012-04-05	SCALE	NONE		
PREP	K.Yanuchi	CHEK	M.Yokosawa	APP	M.Yokosawa
JOB CODE	0-61179-2-0-0000				
SWG No.	D-1225-014	SIZE	B	REV.	



2012-06-11	Minor Revision	K.Y.	K.Y.	K.Y.	
2012-04-05	Issue For Approval	K.Y.	K.Y.	K.Y.	
No.	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
REVISIONS					
JGC CORPORATION					
IFMIF					
S. 3. 3. 0. 0. Heat Rejection System					
P&ID(5/10)					
DATE 2012-04-05		SCALE NONE			
PREP'D	CHK'D	APP'D			
K.Yanouchi	M.Yokosawa	M.Yokosawa			
JOB CODE 0-611719-2-0-01010					
DWG No. D-1225-015					

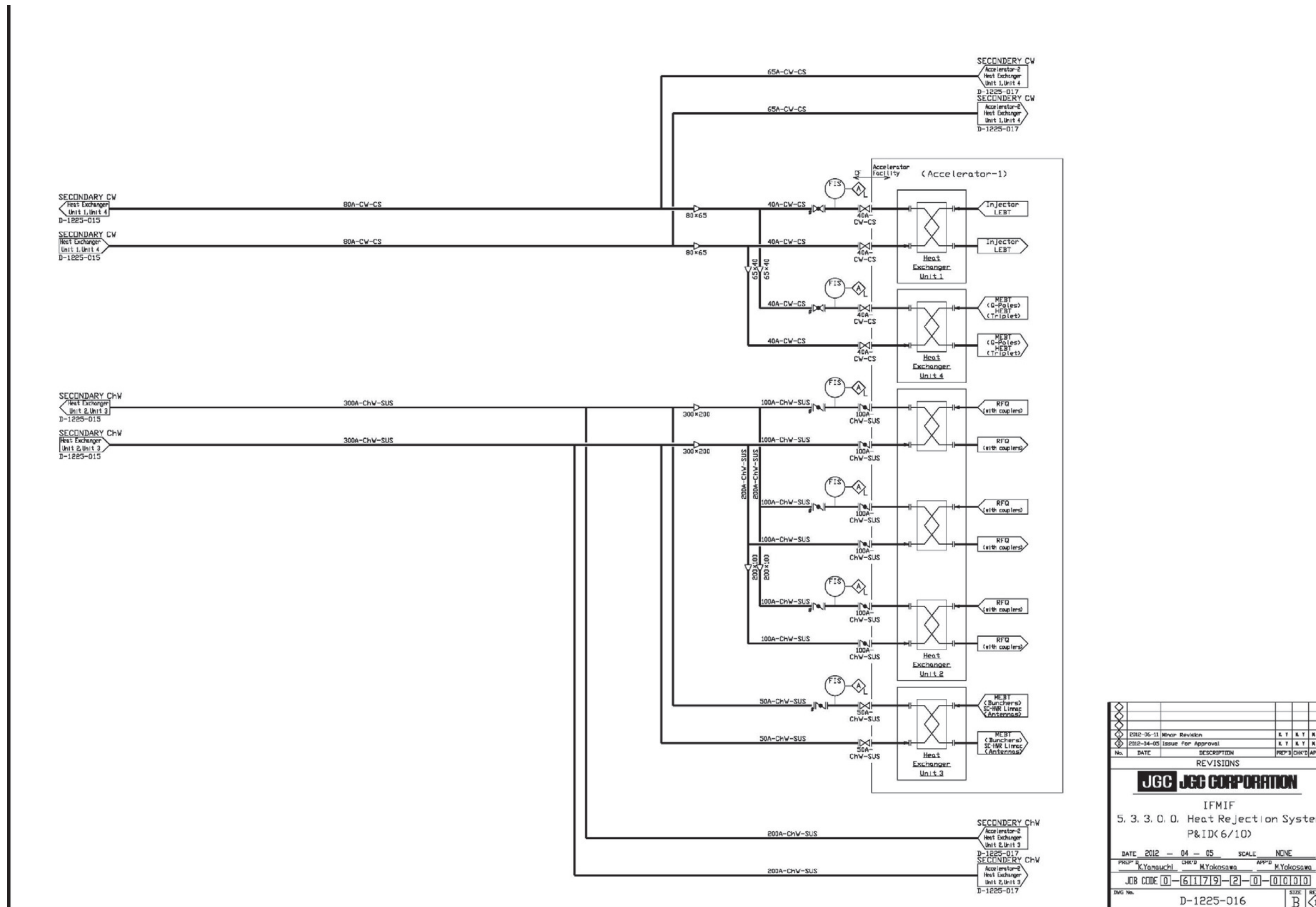
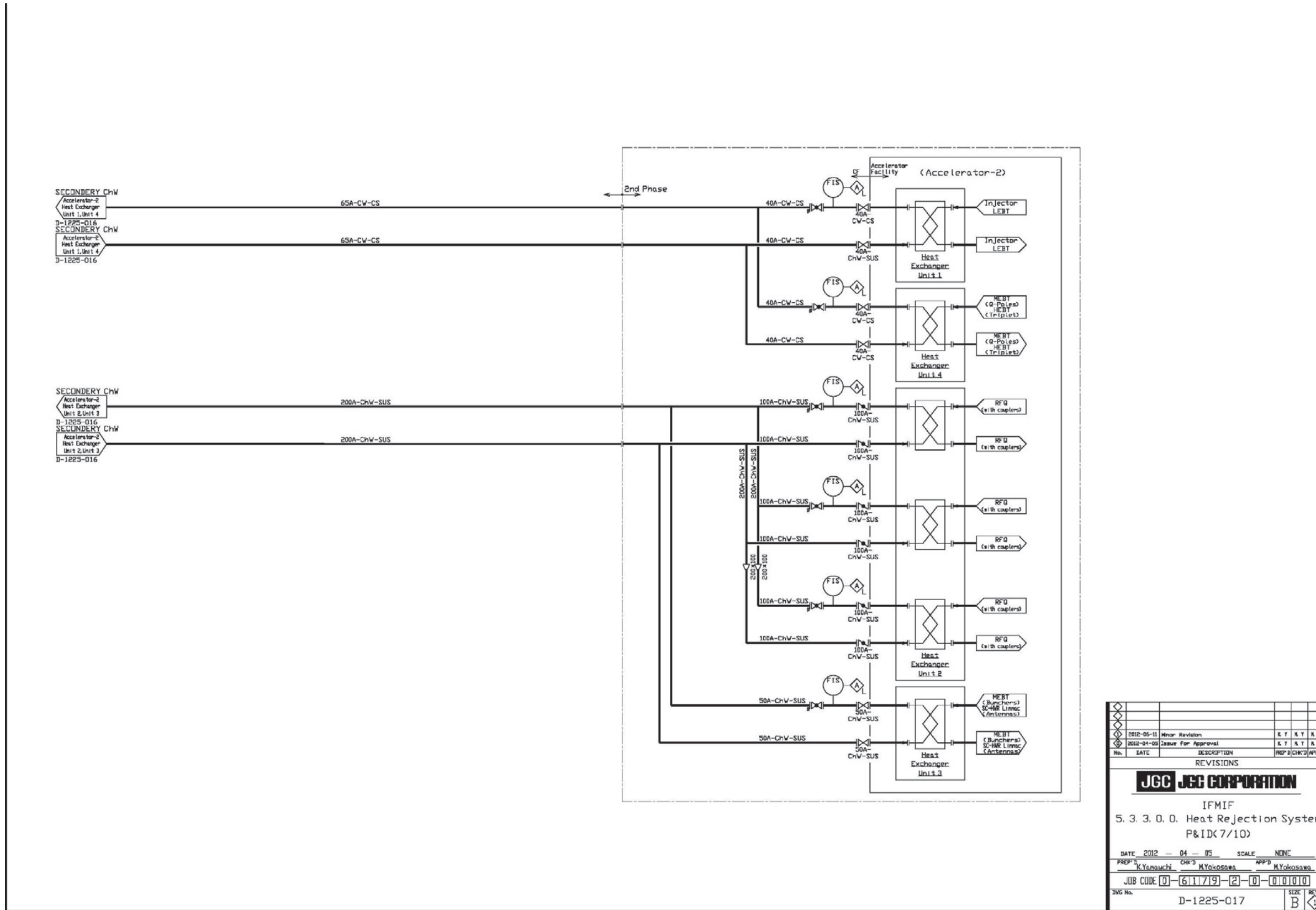


Figure 6-15: D-1225-016- P&ID HRS 6/10



No.	DATE	DESCRIPTION	PREP	CHK	APP
1	2012-05-11	Minor Revision	K.T	K.T	K.T
2	2012-04-05	Issue For Approval	K.T	K.T	K.T

REVISIONS

JGC CORPORATION

IFMIF
5.3.3.0.0. Heat Rejection System
P&ID(7/10)

DATE: 2012-04-05 SCALE: NONE

PREP: K.Yanouchi CHK: M.Yokosawa APP: M.Yokosawa

JOB CODE: 0-611719-2-0-01010

DWG No. D-1225-017 SIZE: B REV: 0

Figure 6-16: D-1225-017-P&ID HRS 7/10

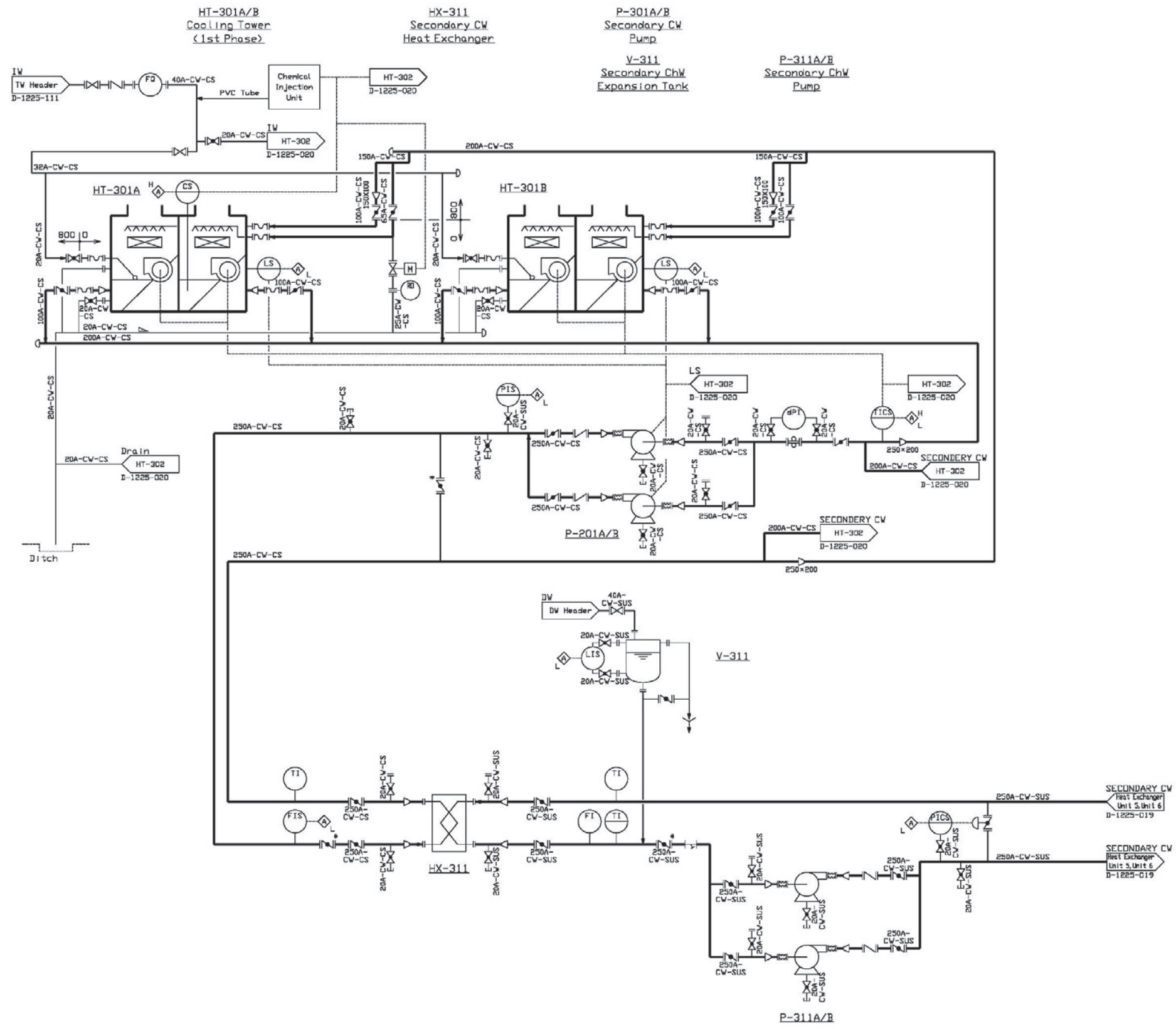
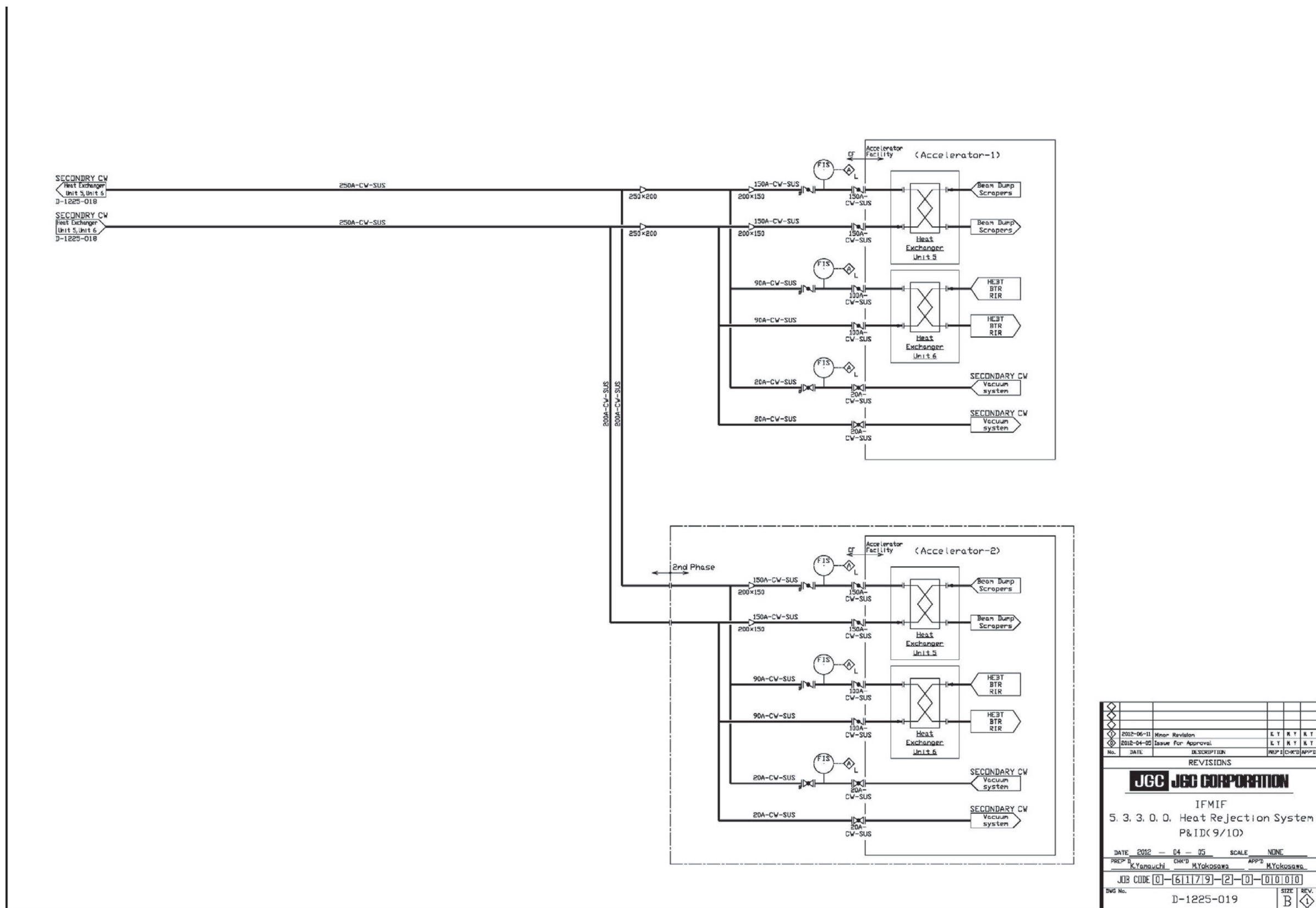


Figure 6-17: d-1225-018-P&ID HRS 8/10

No.	DATE	DESCRIPTION	REP	CHK'D	APP'D
REVISIONS					
JGC CORPORATION					
IFMIF 5.3.3.0.0. Heat Rejection System P&ID(8/10)					
DATE	2012-04-05	SCALE	NONE		
PREP'D	K.Yanouchi	CHK'D	M.Yokosawa	APP'D	M.Yokosawa
JOB CODE	01-611719-2-0-01010				
DWG No.	D-1225-018		SIZE	B	



No.	DATE	DESCRIPTION	PROJ	CHKD	APPR
1	2012-06-11	Minor Revision		K.T	K.T
2	2012-04-05	Issue For Approval		K.T	K.T

REVISIONS

JGC JGC CORPORATION

IFMIF
S. 3. 3. 0. 0. Heat Rejection System
P&ID(9/10)

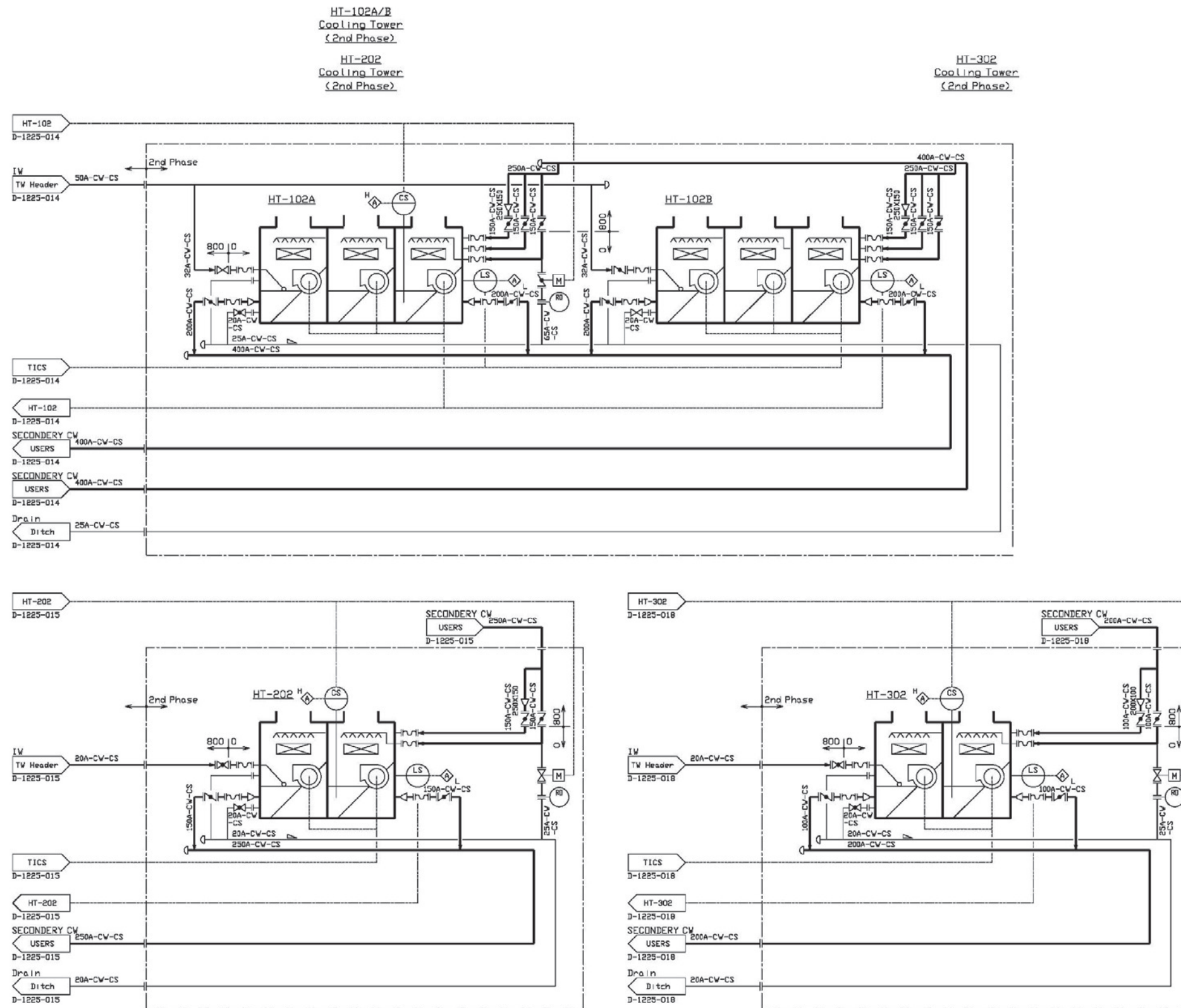
DATE 2012-04-05 SCALE NONE

PREP K.Yanouchi CHK'D MYokosawa APP'D MYokosawa

JOB CODE 0-611719-2-0-01010

DWG No. D-1225-019 SIZE B REV. 1

Figure 6-18: D-1225-019-P&ID HRS 9/10



No.	DATE	DESCRIPTION	PREP	CHKD	APP'D
1	2012-06-11	Minor Revision			
2	2012-04-05	Issue for Approval			

REVISIONS

JGC JGC CORPORATION

IFMIF
5.3.3.0.0. Heat Rejection System
P&ID(10/10)

DATE: 2012-04-05 SCALE: NONE

PREP: K.Yanouchi CHKD: M.Yokosawa APP'D: M.Yokosawa

JOB CODE: 0-61179-2-0-01010

DWG No. D-1225-020 SIZE: B REV. 1

Figure 6-19: D1225-020 P&ID HRS 10/10

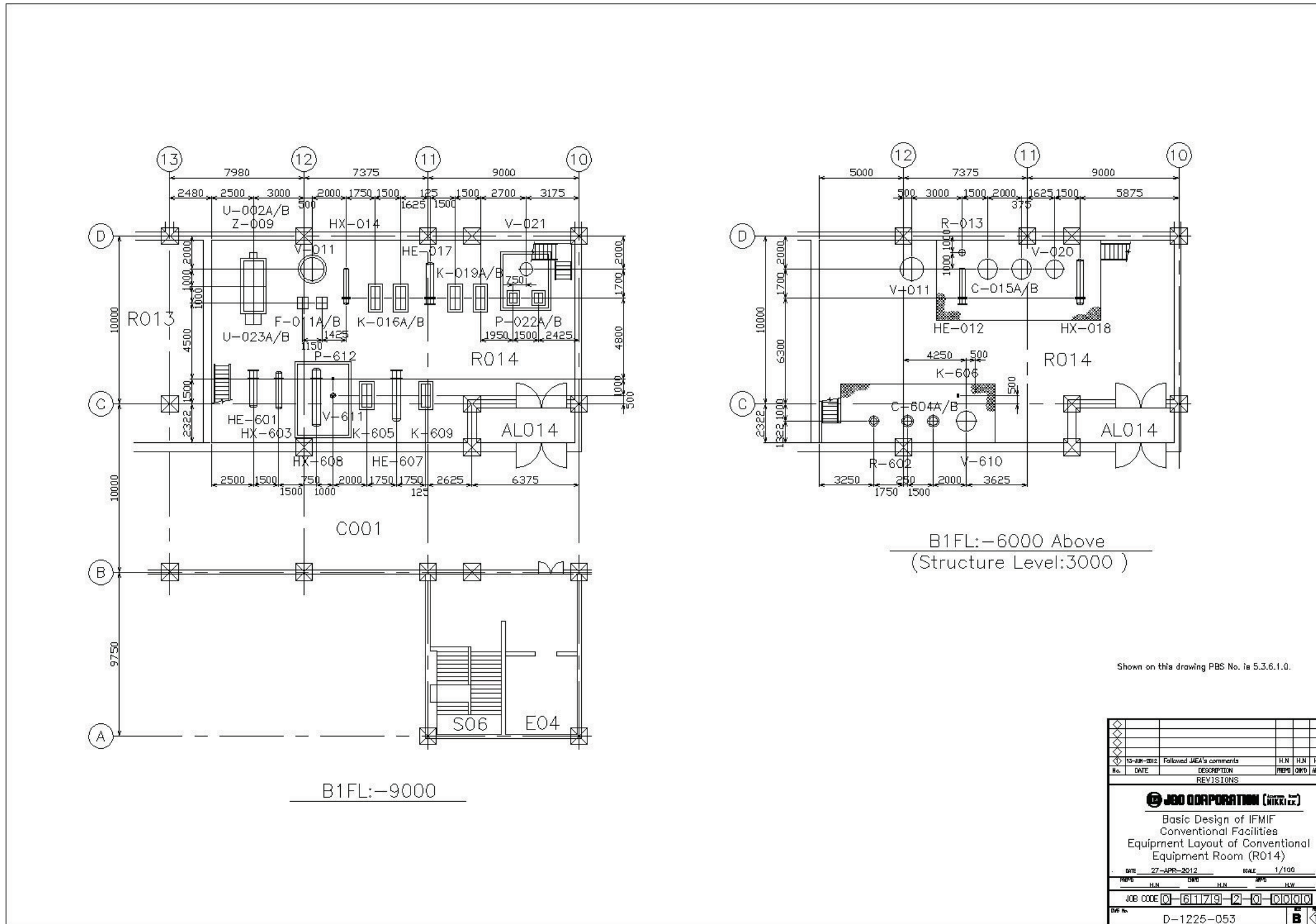


Figure 6-20: D-1225-053-HRS Equipment Layout (room R014)

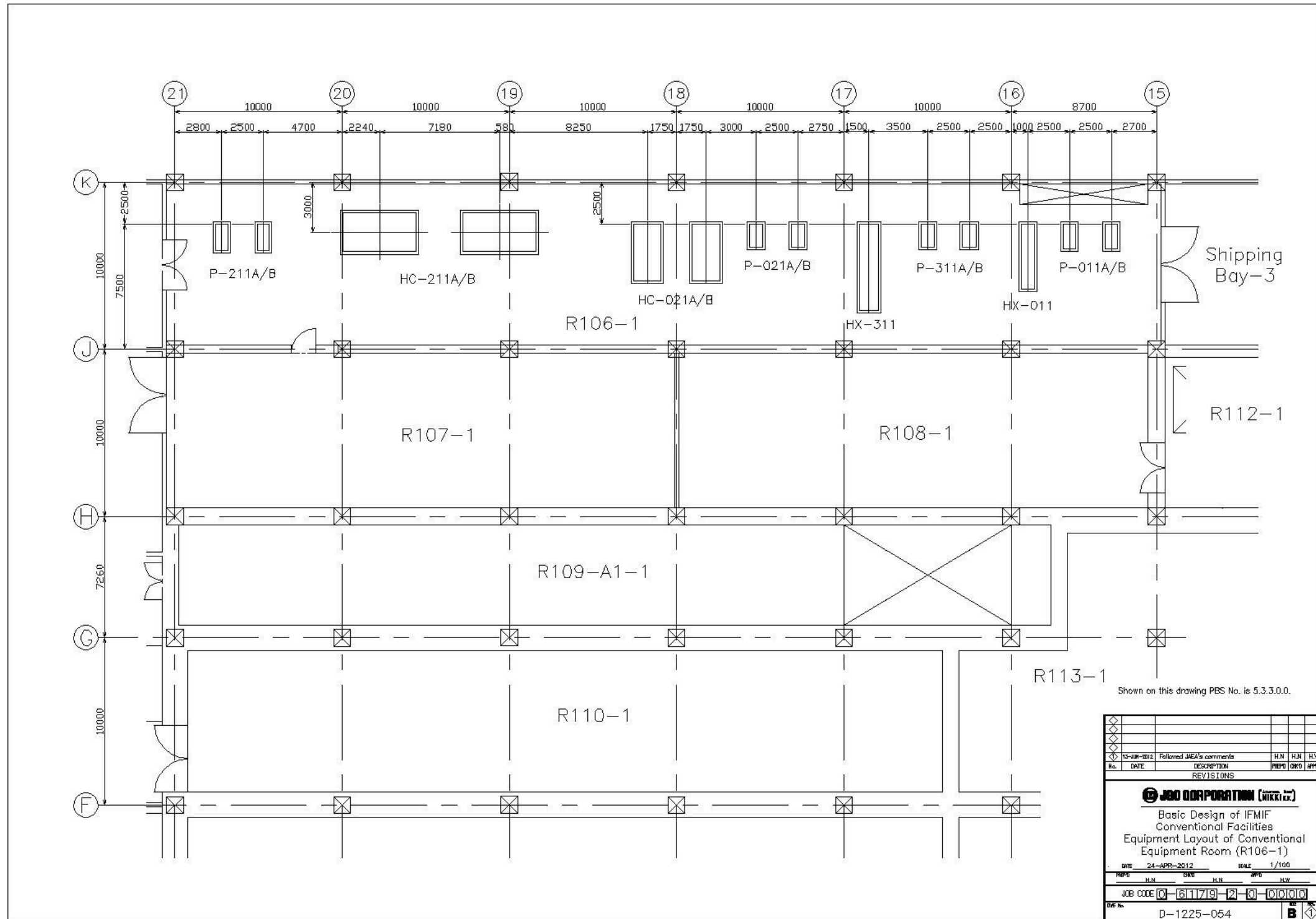


Figure 6-21: D-1225-054- HRS Equipment Layout (room R106-1)

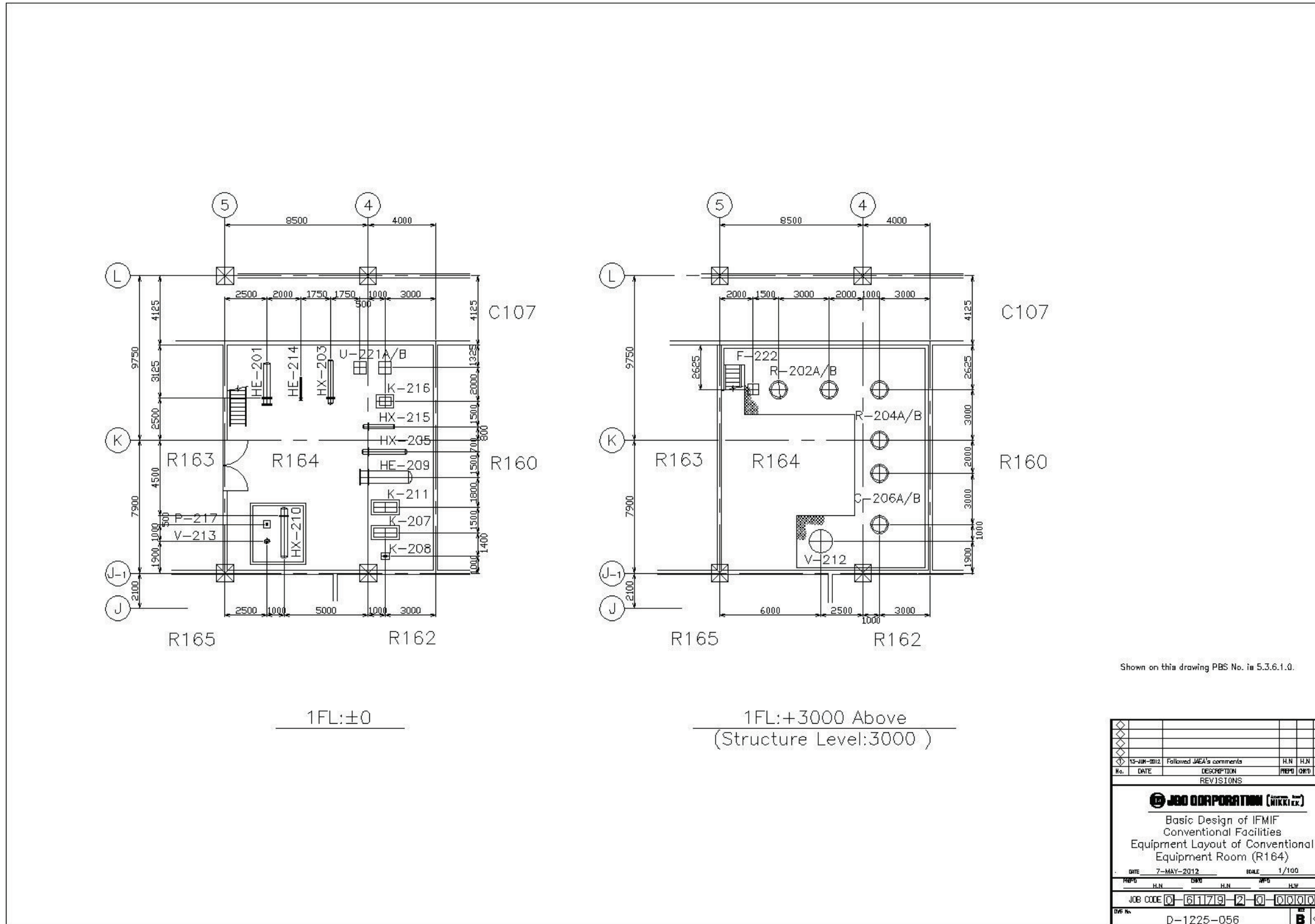


Figure 6-22: D-1225-056 Equipment Layout HRS (room R164)

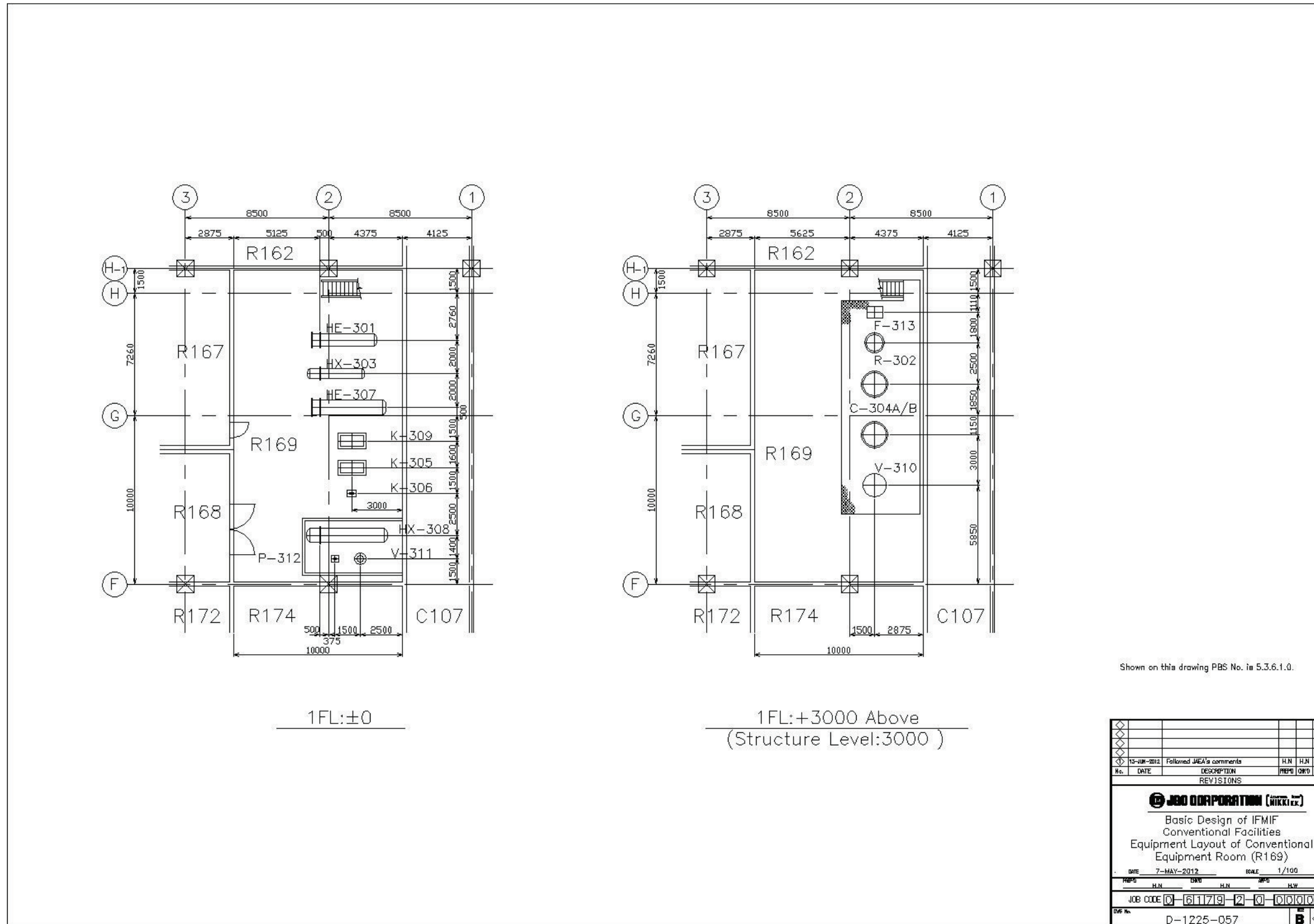


Figure 6-23: D-1225-057- Equipment Layout HRS (room R169)

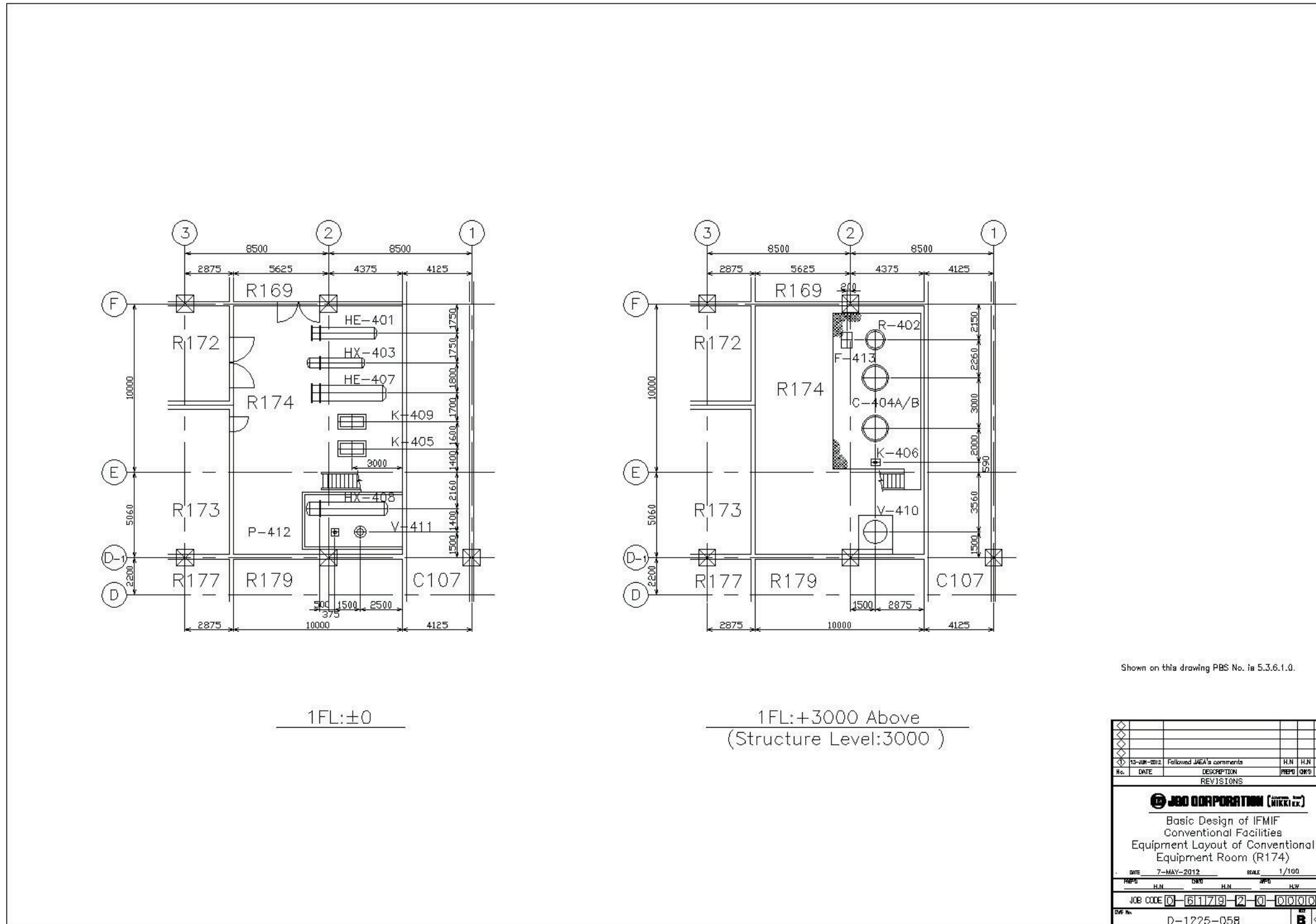


Figure 6-24: D-1225-058- Equipment Layout HRS (room R174)

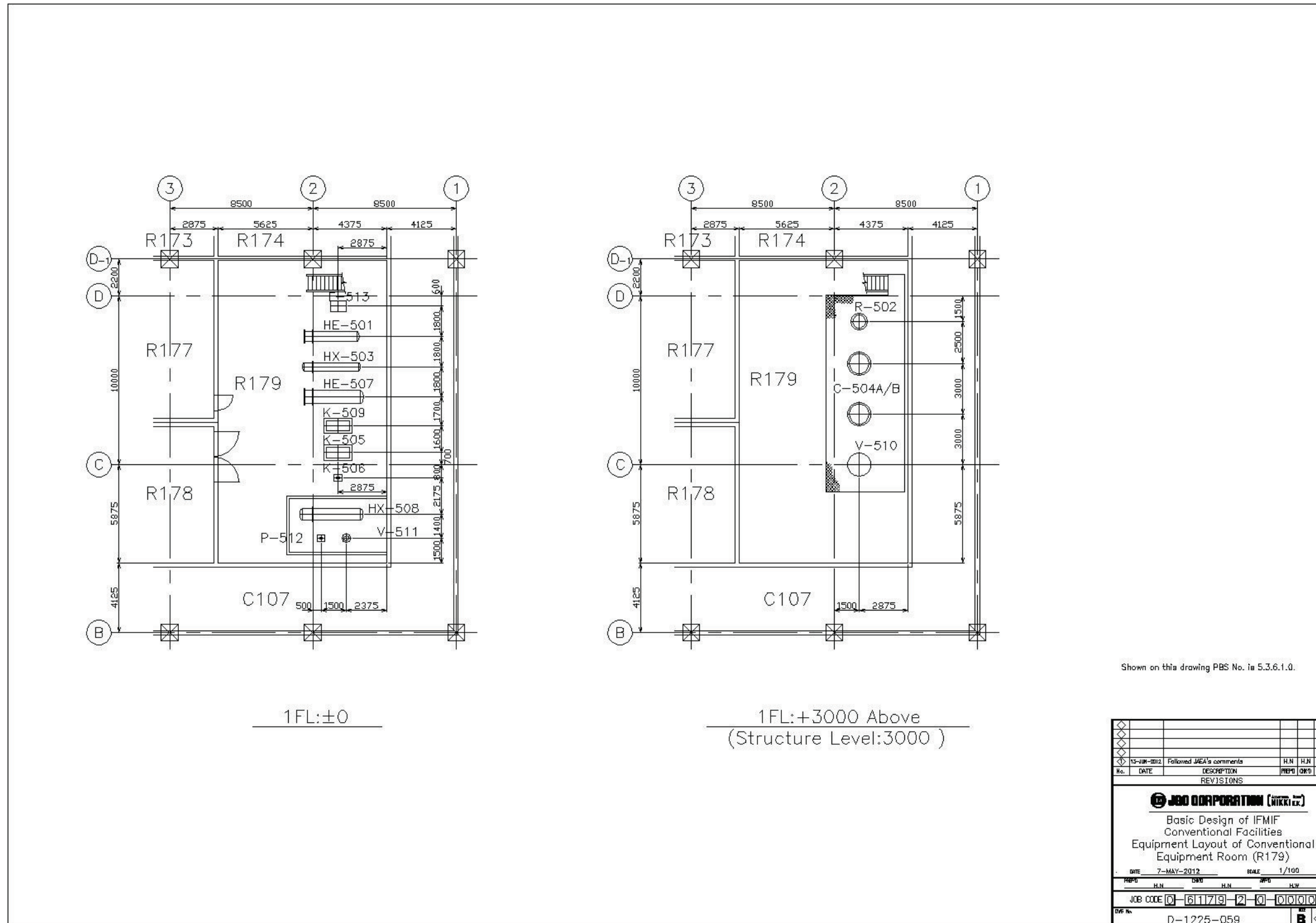


Figure 6-25: D1225-059- Equipment Layout HRS (room R179)

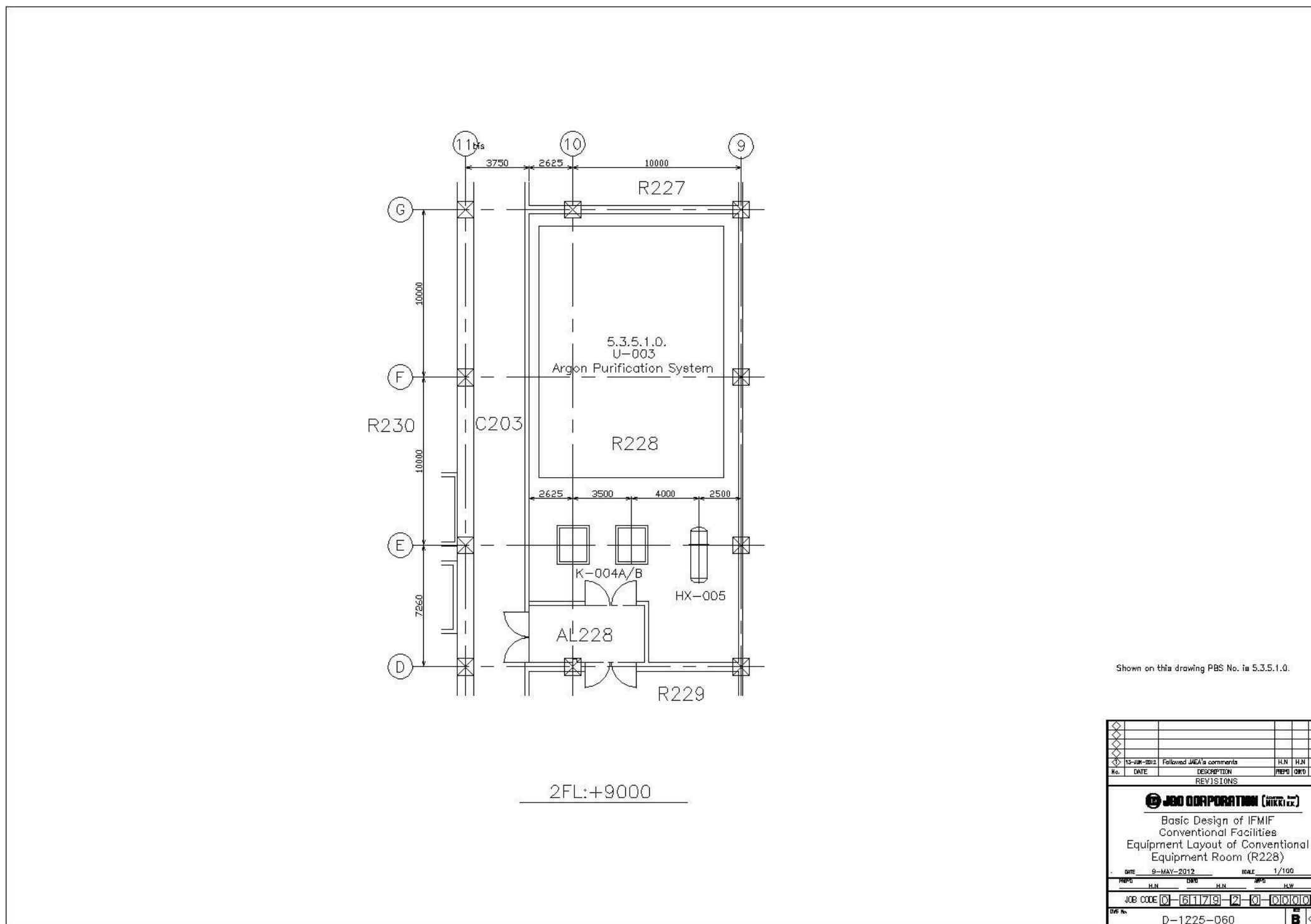


Figure 6-26: D-1125-060- Equipment Layout HRS (room R228)

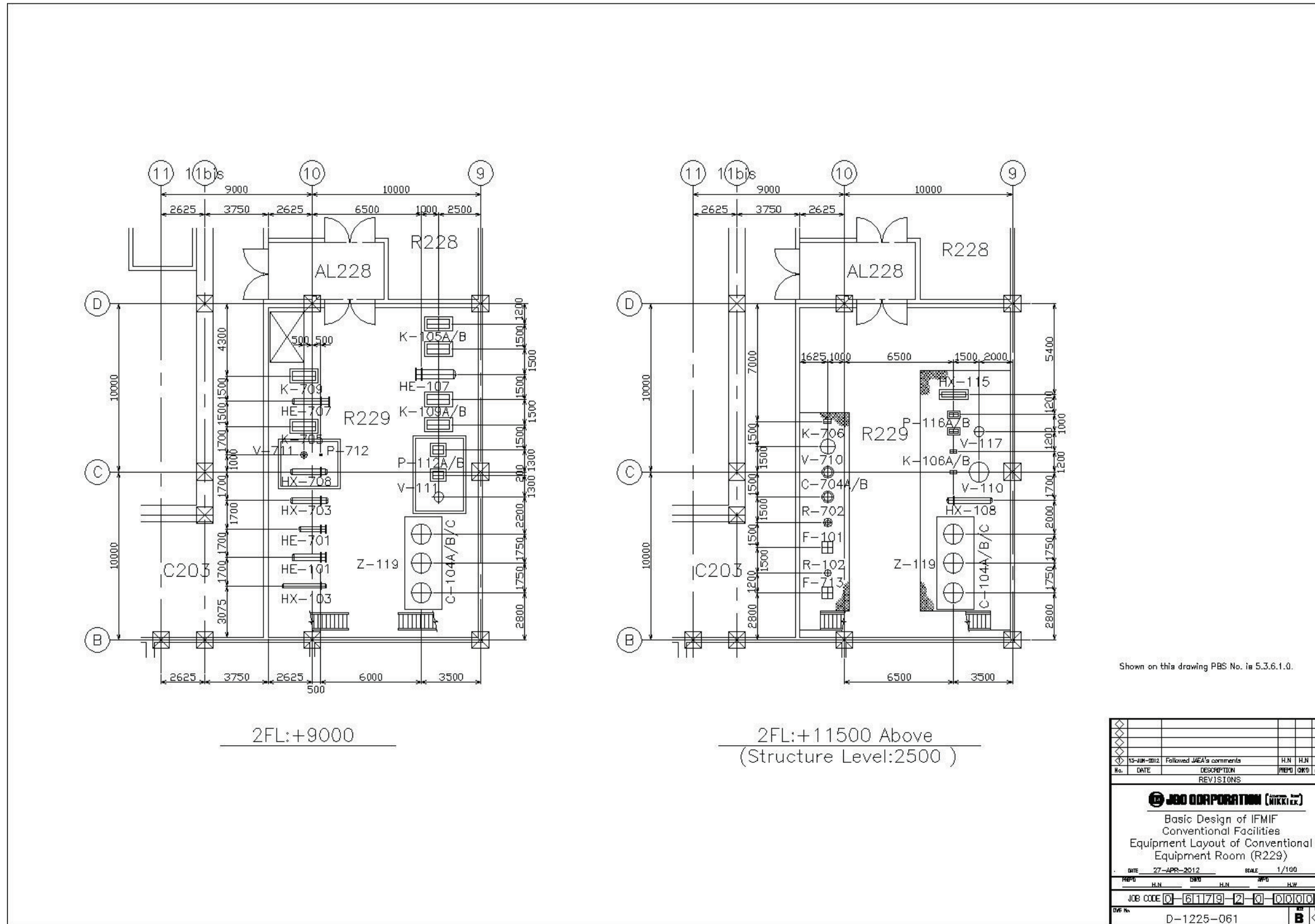


Figure 6-27: D-1225-061- Equipment Layout HRS (room R229)

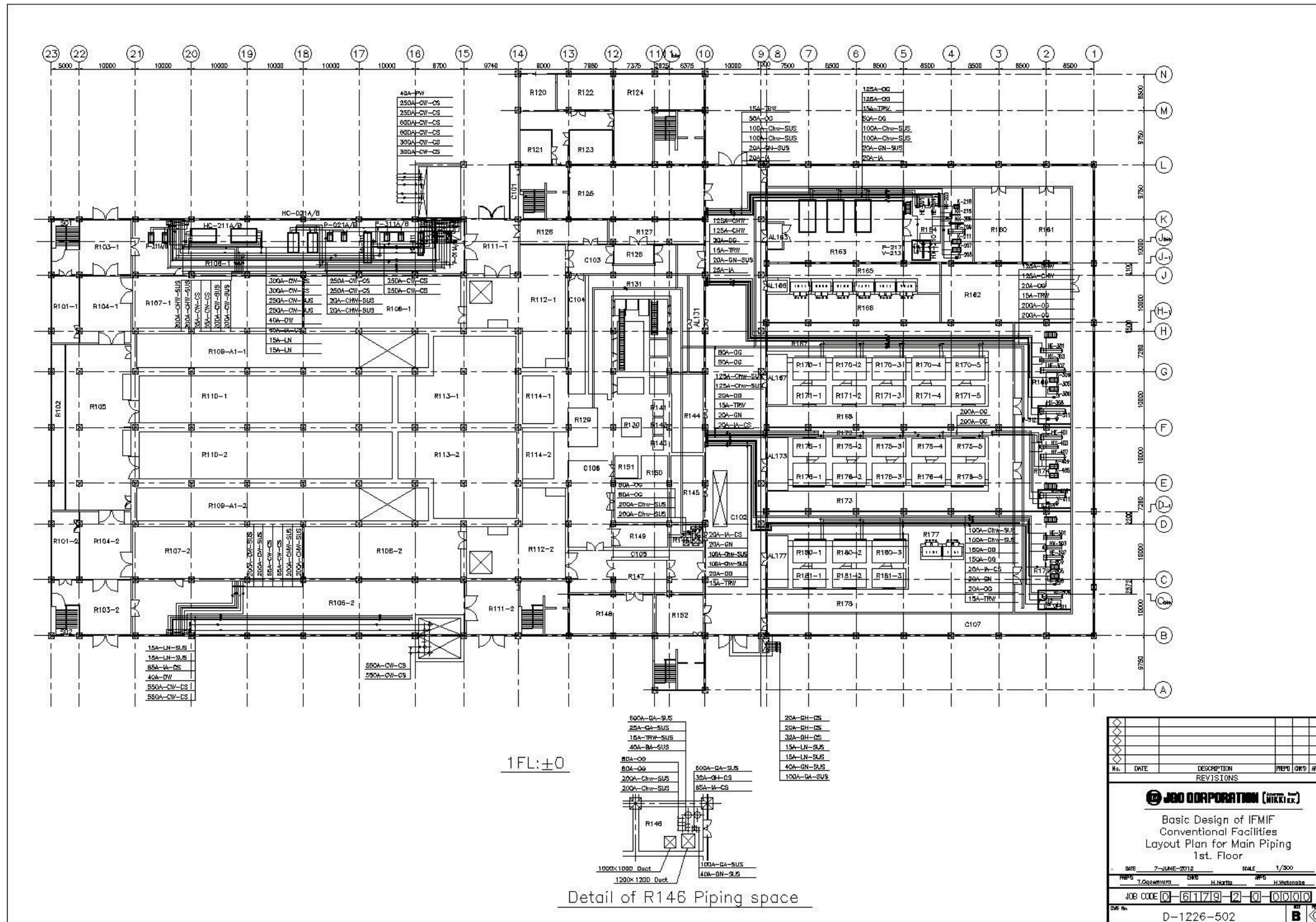


Figure 6-29: D-1226-502- Layout Plan for Main Piping (HRS 1st Floor)

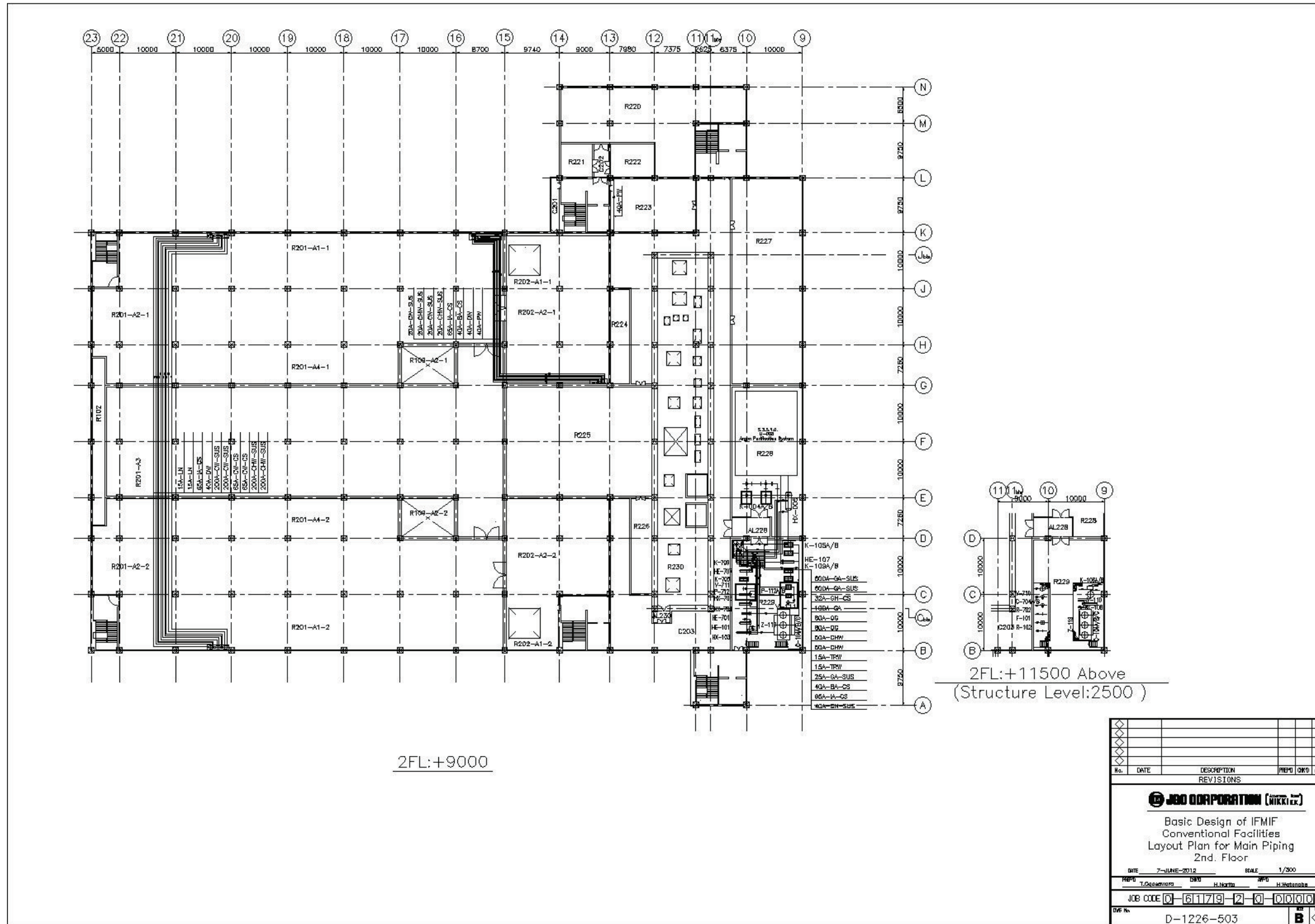


Figure 6-30: D-1226-503- Layout Plan for Main Piping (HRS 2nd Floor)

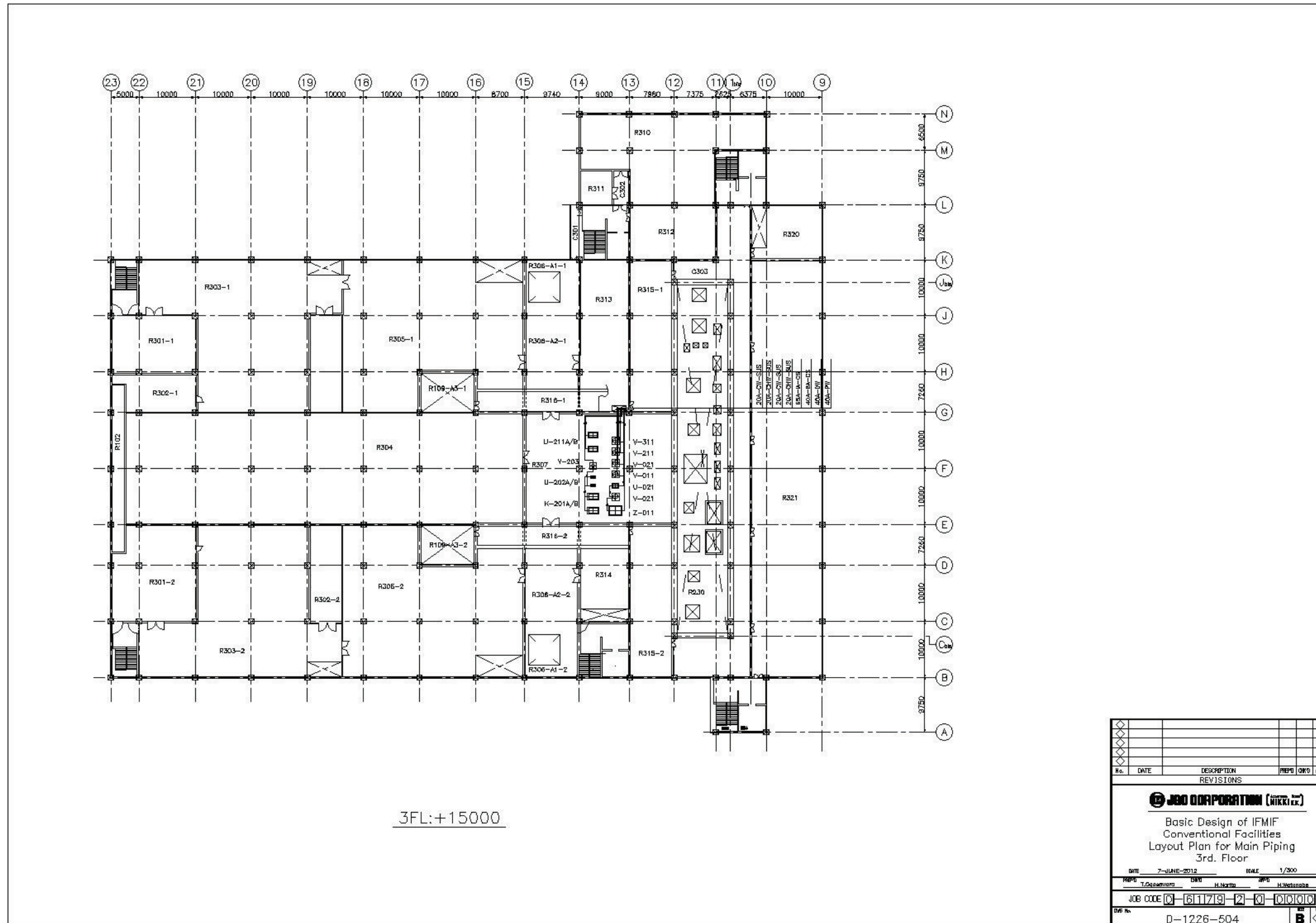


Figure 6-31: D-1226-501- Layout Plan for Main Piping (HRS 3rd Floor)

