REVISED RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

APR1400 Design Certification Review - 52-046

Korea Hydro & Nuclear Power Co., LTD

Docket No. 52-046

RAI No.:	**264-8243**
SRP Section:	**06.02.05 – Combustible Gas Control in Containment**
Application Section:	
Date of RAI Issue:	**10/22/2015**

Question No. 06.02.05-6

10 CFR Part 50 (c)(3) Equipment Survivability. Containments that do not rely upon an inerted atmosphere to control combustible gases must be able to establish and maintain safe shutdown and containment structural integrity with systems and components capable of performing their functions during and after exposure to the environmental conditions created by the burning of hydrogen. Environmental conditions caused by local detonations of hydrogen must also be included, unless such detonations can be shown unlikely to occur. The amount of hydrogen to be considered must be equivalent to that generated from a fuel clad-coolant reaction involving 100 percent of the fuel cladding surrounding the active fuel region.

Containment integrity depends on hydrogen control and mitigation because hydrogen burns can create short but extreme temperature conditions in containment. The systems and components required to establish and maintain safe shutdown and containment structural integrity following a severe accident are identified in DCD Tier 2, Table 19.2.3-4," Systems and Equipment/Instrumentation Required for Equipment Survivability Assessments." This table currently includes the passive autocatalytic recombiners (PAR), and the hydrogen igniters (HI) from the hydrogen mitigation system. Maintaining the physical integrity of the piping penetration assemblies, including the penetration seals, is required to maintain containment integrity. The piping penetrations, including but not limited to the seals, should also be added to the list of containment penetrations in Table 19.2.3-4.

In the equipment survivability analysis described in DCD Tier 2, Section 19.2.3, credit is taken for maintaining the containment pressure below the factored load category of 123 psia, per DCD Tier 2, Section 19.2.4.2.3, by relying on the emergency containment spray backup system (ECSBS). See DCD Tier 2, Figure 19.1-3, Simplified Diagram – Containment Spray System. This is a single train system, with its own dedicated ECSBS spray ring header and an inside containment isolation check valve, V1014. This backup spray function is the basis provided for

limiting the equipment survivability analysis to 24 hrs, as stated in DCD Tier 2, Section 19.2.3.3.7.2, “Determination of Severe Accident Environmental Conditions.” This valve should be shown to meet the equipment survivability conditions, including surviving a hydrogen burn and remaining open. This valve should be added to DCD Tier 2, Table 19.2.3-4.

Please confirm that all of the check valves shown in DCD Figure 19.1-3, Simplified Diagram – Containment Spray System, are depicted correctly to indicate the direction of flow. Check valves V1014, V1008, and V1007 appear to be shown in an inconsistent direction as compared to V101 and V100. Adding flow direction arrows below the check valve symbol, as done in DCD Tier 2, Table 6.2.4-1, would provide clarification.

As part of your response, please revise all the affected DCD text, tables, and figures accordingly.

Response – (Rev. 2)

In the event of a severe accident, the piping penetration assemblies are required to function in order to maintain containment integrity. Therefore, DCD Table 19.2.3-4 will be revised to include ‘Mechanical Penetration Assembly,’ as shown in Attachment 1 to this response.

The purpose of the Equipment Survivability (ES) assessment is to show that there is reasonable assurance that the equipment and instrumentation used to mitigate and monitor severe accident progression will perform their intended functions (such as, hydrogen mitigation, containment monitoring, reactor cavity flooding, etc.) under the harsh environmental conditions of severe accidents. Check valve V1014 for ECSBS has a containment isolation function during normal operation and design basis accidents. In the severe accidents, the containment isolation function can be maintained by the ECSBS containment isolation valve (V1013) which is installed outside of containment, as shown in DCD Tier 2, Figure 6.2.2-1.

The check valve has another function of water delivery to the ECSBS header during severe accidents. However, the ES evaluation of the check valve is the as same as piping its water delivery function to the ECSBS header, because of the following reasons:

- The check valve resists damage due to temperature increases because it consists of only metallic parts. The metallic parts resist thermal damage according due to the hydrogen burn or continuous temperature rise which results from decay heat.

- It is expected that the check valve continues to function due to its simple structure, as shown in Figure 1.

Therefore, it is not necessary to evaluate the survivability of check valve V1014, but the valve will be added to Table 19.2.3-4, as shown in Attachment 1 to this response. The discussion of the valve’s resistance to thermal degradation will be relocated to a new section within 19.2.3.3.7.4 since the valve is not located outside containment which is the heading of the valve’s current discussion.

DCD Tier 2, Figure 19.1-3 will be revised to correct the directions of flow for check valves (V100, V101, V1007, V1008 and V1014), as shown in Attachment 2 to this response.

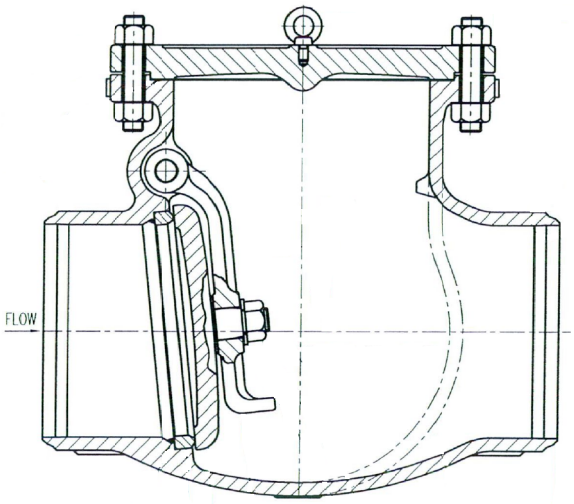

Figure 1 Schematic Diagram for ECSBS Check Valve

In addition, COL item 19.2(1) in Section 19.2.7 will be revised, as shown in Attachment 1.

Impact on DCD

DCD Tier 2, Figure 19.1-3 and Table 19.2.3-4 will be revised, as indicated in the attachments associated with this response. A new Section 1 19.2.3.3.7.4.13 will be added to the DCD and the existing section along with subsequent sections will be renumbered accordingly.

In addition, COL item 19.2(1) will be revised as indicated in the attachments.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

Appendix F of the technical report for the severe accident analysis (Doc. No. APR1400-E-P-NR-14003) will be revised to reflect the contents of the response to this RAI.

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Table 1.8-2 (28 of 29)

Item No.	Description
COL 19.1(11)	The COL applicant is to develop the fire barrier management procedures that direct the appropriate use of a fire watch and use of the isolation devices with a quick-disconnect mechanism for hose and cables that bleach a fire barrier.
COL 19.1(12)	The COL applicant is to develop procedures and operator training for reliance (during fire response) on undamaged instrumentation (when the location of the fire is known).
COL 19.1(13)	The COL applicant is to develop procedures specifying that a fire watch be present when hot work is being performed.
COL 19.1(14)	The COL applicant is to establish procedures for closing the containment hatch (after being opened during during LPSD operations) to promptly re-establish the containment as a barrier to fission product release. This guidance must include steps that allow for sealing of the hatch with four bolts (versus the 40 bolts used to secure the hatch during at-power operation); four bolts are sufficient to secure the hatch so that no visible gap can be seen between the seals and the sealing surface.
COL 19.1(15)	The COL applicant is to develop a configuration control program requiring that, during Modes 4, 5, and 6, the watertight flood doors and fire doors be maintained closed in at least one quadrant. Furthermore, the COL applicant is to incorporate, as part of the aforementioned configuration control program, a provision that if the flood or fire doors to this designated quadrant must be opened for reasons other than normal ingress/egress, a flood or fire watch must be established for the affected doors.
	The COL applicant is to develop outage management procedures that limit planned maintenance that can potentially impair one or both SC trains during the shutdown modes.
COL 19.1(16)	The COL applicant is to develop procedures and a configuration management strategy to address the period of time when one SC train is unexpectedly unavailable (including the termination of any testing or maintenance that can affect the remaining train and restoration of all equipment to its nominal availability).
COL 19.2(1)	The COL applicant is to perform and submit site-specific equipment survivability assessment in accordance with 10 CFR 50.34(f) and 10 CFR 50.44 which reflects the equipment identified and the containment atmospheric assessments of temperature, pressure and radiation described in DCD section 19.2.3.3.7.
COL 19.2(2)	The COL applicant is to develop and submit an accident management plan.

recovery. Individual unheated junction thermocouples may also trend the progression of core degradation by monitoring the reactor vessel upper plenum gas temperature.

The HJTC probes use heated and unheated junction type K thermocouples. Unlike the core-exit thermocouple, the RVLMS thermocouple string is top mounted and it does not pass through the core. These thermocouples are calibrated to operate at very high temperature, in accordance with the RVLMS design requirements. Hence, these instruments are expected to function far into core degradation.

Core-Exit Thermocouples (CETs) and Resistance Temperature Detectors (RTDs)

The CETs and RTDs used to monitor RCS inventory are expected to survive well past design basis conditions and they provide useful information until their temperature limits are exceeded.

Pressurizer Pressure Sensors and Steam Generator Level Monitors

RCS pressure monitoring is necessary to trend RCS depressurization following operator action taken to either establish feed-and-bleed operation or confirm sufficiently low pressure to enter SC operation. In the event the operator has to depressurize the RCS via the steam generator, the water level in the steam generator is monitored to provide reasonable assurance of the presence of steam generator secondary side inventory.

All pressure-transmitting devices are located outside the secondary shield wall. A small, long tube connects the RCS to the high-pressure side of the pressure transmitter. The sensor tap of these pressure-transmitting devices is typically filled with stagnant fluid. The su
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19.2.3.3.7.4.13 Emergency Containment Spray Backup System Check Valve

The check valve at the ECSBS spray headers is located inside containment, but it contains no organic material susceptible to thermal degradation.

~~19.2.3.3.7.4.13~~ Equipment Located Outside Containment

19.2.3.3.7.4.14

The active components of the following equipment required for severe accident mitigation and monitoring are located outside containment. They are not subjected to the harsh environment of a severe accident.

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a. SIS

b. AFWS

c. CSS

(Delete)

~~d. ECSBS~~

e. SCS

f. Containment hydrogen monitors

g. Containment pressure sensor

h. IRWST water level sensors

(Delete)

~~The check valve at the ECSBS spray headers is located inside containment, but it contains no organic materials that are susceptible to thermal degradation.~~

~~19.2.3.3.7.4.14~~ Radiation Dose ES Results

19.2.3.3.8

The EQ report for safety-related equipment contains radiation test data. All safety-related equipment was tested under at least five times the bounding radiation dose in the containment during severe accidents as shown in Table 19.2.3-6.

For most equipment and instrumentation, it is concluded there is reasonable assurance that instrumentation and equipment required to mitigate a severe accident and achieve a safe stable state perform their function as intended under severe accident environmental conditions.

19.2.3.3.9

~~19.2.3.3.8~~ Other Severe Accident Mitigation Features

According to 10 CFR 50.34(f)(3)(iv), a design is required to "provide one or more dedicated containment penetrations, equivalent in size to a single 3-foot diameter opening, in order not to preclude future installation of systems to prevent containment failure, such as a filtered vented containment system." The APR1400 design meets this requirement by providing a dedicated containment penetration to allow for installation of a filtered vent system.

Table 19.2.3-4

Systems and Equipment/Instrumentation Required
for Equipment Survivability Assessments

Security-Related Information – Withhold Under 10 CFR 2.390

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19.2.6.7 Conclusions

The analyses described in the previous sections analyzed conceptual alternatives for mitigating severe accident impacts in the APR1400 design. Preliminary screening eliminated all SAMDA candidates from further consideration, based on inapplicability to the design, design features that have already been incorporated into the design, inapplicability to a design certification stage, or extremely high cost of the alternatives considered.

The analysis using a 7% discount rate showed that no design changes to reduce risk associated with contributors to plant risk would be cost-beneficial to implement. A second baseline maximum benefit calculation using a 3% discount rate showed only minor variations in the calculated benefits. Therefore, it is concluded that no design changes would provide a positive cost-benefit if included in the APR1400 design.

19.2.7 Combined License Information

COL 19.2(1) The COL applicant is to perform and submit site-specific equipment survivability assessment in accordance with 10 CFR 50.34(f) and 10 CFR 50.44.

COL 19.2(2) The COL applicant is to develop and submit an accident management plan.

which reflects the equipment identified and the containment atmospheric assessments of temperature, pressure and radiation described in DCD section 19.2.3.3.7.

19.2.8 References

1. SECY-93-087, “Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor (ALWR) Designs,” U.S. Nuclear Regulatory Commission, April 1993.

2. 10 CFR Part 100, “Reactor Site Criteria,” U.S. Nuclear Regulatory Commission.

3. 10 CFR Part 50, Appendix A, “General Design Criteria for Nuclear Power Plants,” Title 10, Code of Federal Regulations, ,U.S. Nuclear Regulatory Commission.

4. 10 CFR 50.34, “Contents of Applications; Technical Information,” U.S. Nuclear Regulatory Commission.

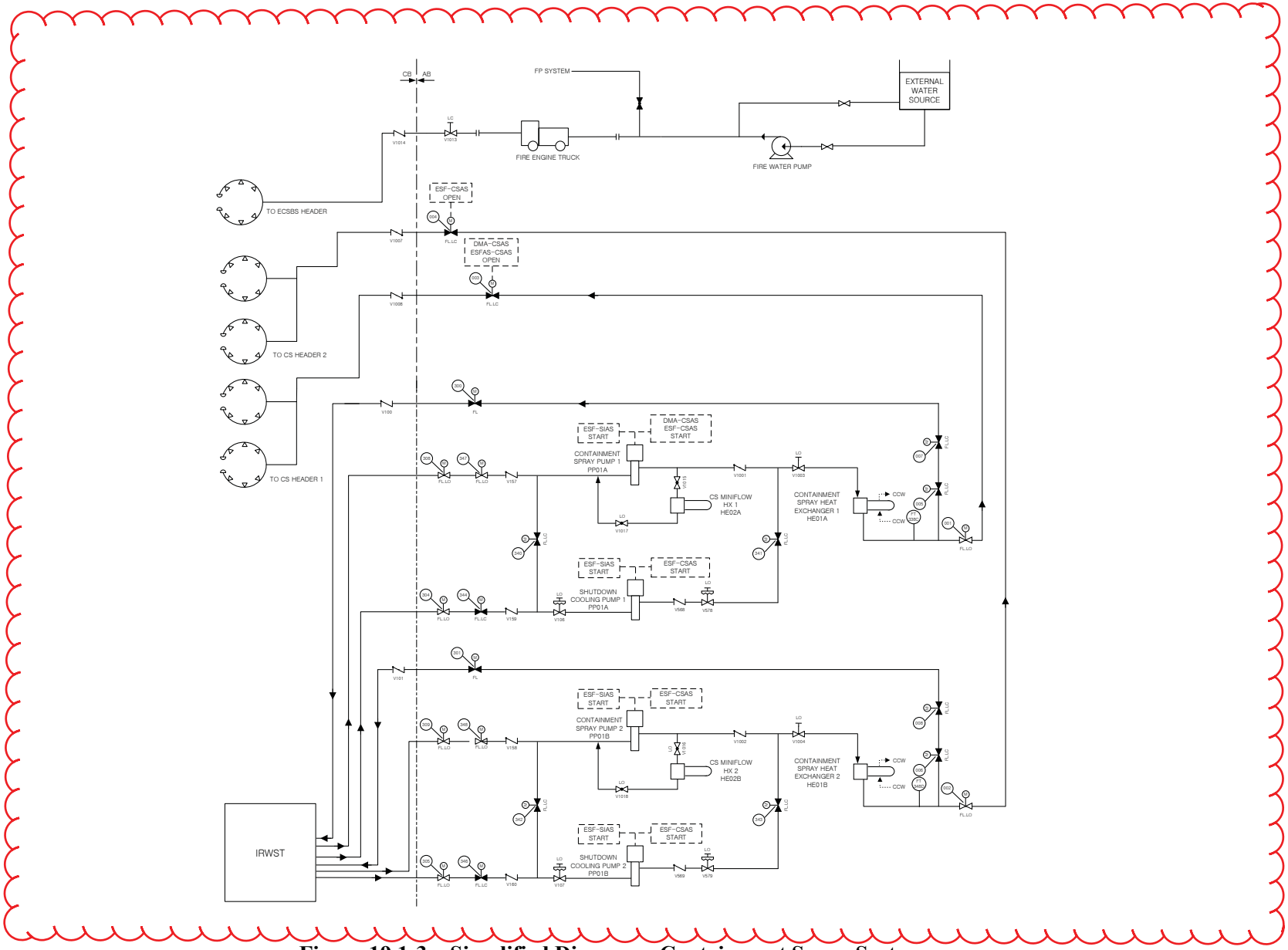

Figure 19.1-3 Simplified Diagram - Containment Spray System

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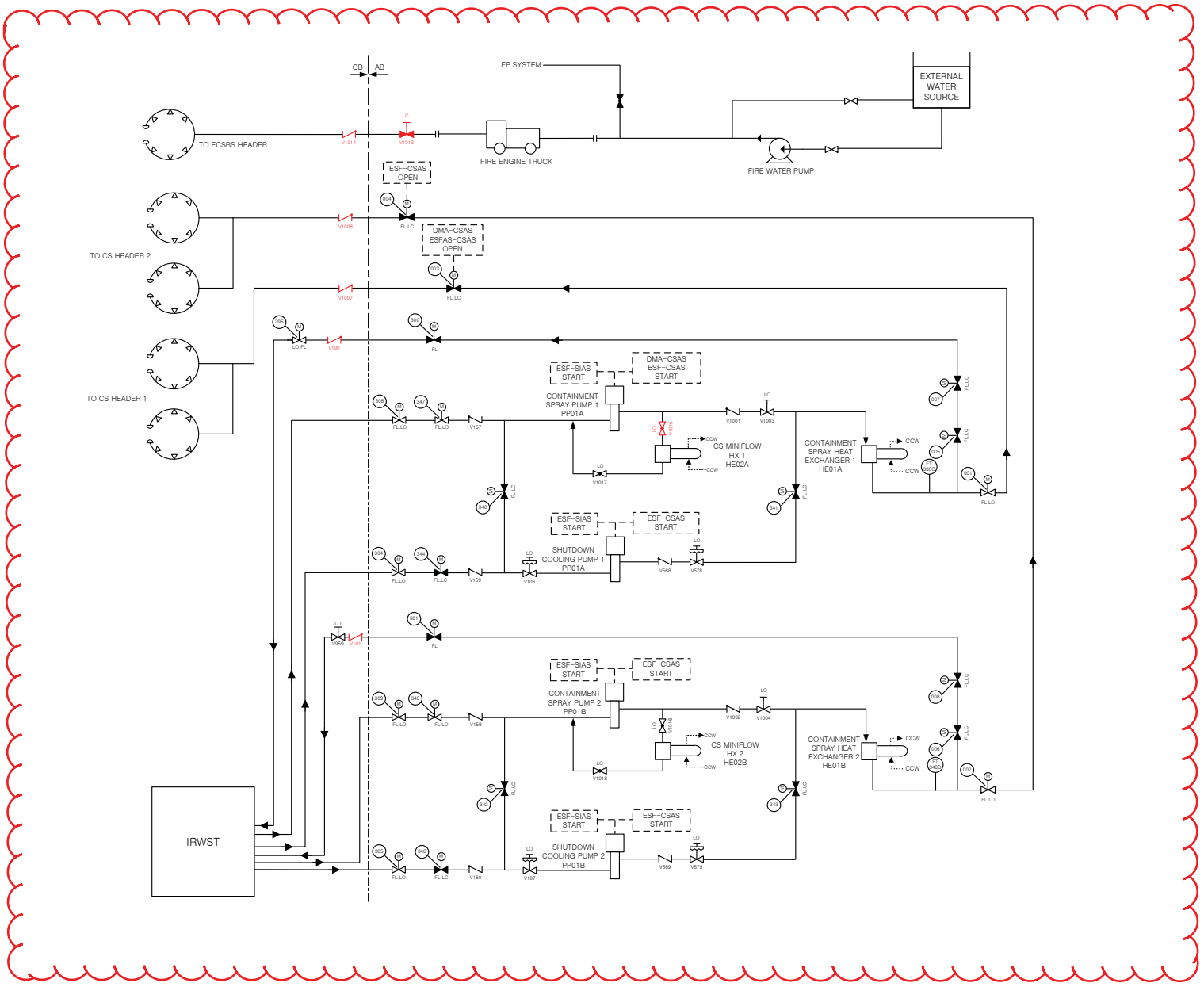
CB
AB
FP SYSTEM
EXTERNAL WATER SOURCE
TO ECSBS HEADER
FIRE ENGINE TRUCK
FIRE WATER PUMP
ESF-CSAS OPEN
DMA-CSAS ESFAS-CSAS OPEN
TO CS HEADER 2
TO CS HEADER 1
ESF-SIAS START
DMA-CSAS ESF-CSAS START
CONTAINMENT SPRAY PUMP 1 PP01A
CS MINIFLOW HX 1 HE02A
CONTAINMENT SPRAY HEAT EXCHANGER 1 HE01A
ESF-CSAS START
SHUTDOWN COOLING PUMP 1 PP01A
CONTAINMENT SPRAY PUMP 2 PP01B
CS MINIFLOW HX 2 HE02B
CONTAINMENT SPRAY HEAT EXCHANGER 2 HE01B
SHUTDOWN COOLING PUMP 2 PP01B
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