RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

APR1400 Design Certification

Korea Electric Power Corporation / Korea Hydro & Nuclear Power Co., LTD

Docket No. 52-046

RAI No.:	**323-8281**
SRP Section:	**7.3**
Application Section:	**07.03 – Engineered Safety Features Systems**
Date of RAI Issue:	**11/30/2015**

Question No. 07.03-14

Describe how safety-related modulating control functions are implemented for the ESF components.

10 CFR 50.55a(h)(3) states “Applications filed on or after May 13, 1999, for construction permits and operating licenses under this part, and for design approvals, design certifications, and combined licenses under Part 52 of this chapter, must meet the requirements for safety systems in IEEE Std. 603-1991 and the correction sheet dated January 30, 1995.” Clause 5.2, "Completion of Protective Action," of IEEE 603-1991 requires safety systems be designed so that, once initiated automatically or manually, the intended sequence of protective actions of the execute features shall continue until completion.

Figure 7.3-1, "Simplified Functional Diagram of the ESF-CCS," in APR1400 FSAR Tier 2, Section 7.3, and Figure 4-13, "ESF-CCS Functional Configuration," in Technical Report APR1400-Z-J-NR-14001-P, Rev. 0, “Safety I&C System,” illustrate the CIM being used to actuate all ESF components without differentiation between on-off and modulating ESF components. Figure 5.3-1, "Priority Logic Configuration in the CIM for the APR1400," of Technical Report APR1400-E-J-NR-14001-P, Rev. 0, “Component Interface Module,” shows discrete inputs only to the priority logic section of the CIM for the ESF components. In the APR1400 application there is lack of design information on how safety-related control functions are implemented in the ESF-CCS system for ESF modulating components. Provide a clear description on how modulating control functions for certain ESF components are accomplished and update the technical report and FSAR figures and descriptions accordingly.

Response

The engineered safety features-component control system (ESF-CCS) provides modulating control functions of safety-related components. For modulating control in ESF-CCS, the sensors and actuators for modulating control are directly interfaced to the analog input (AI) module and the analog output (AO) module in the ESF-CCS loop controller (LC). Any non-discrete

components which require modulation are controlled via the analog output (AO) module in the ESF-CCS LC without the CIM. The ESF-CCS soft control module (ESCM) provides the means for manual modulating control of safety-related components.

The ESCM sends component control signals to the control channel gateway (CCG) through the safety system data network (SDN). The CCG sends component control signals to the ESF-CCS LC through the SDN.

The ESCM sends manual operator demands such as auto/manual mode change, setpoint value in auto mode, and output value in manual mode, to the ESF-CCS LC through the CCG, and the ESF-CCS LC sends the actuator demand output. The component interface module (CIM) is bypassed.

Section 7.3.1 and Figure 7.3-1 of APR1400 DCD Tier 2 will be revised to present how safety-related control functions are implemented in the ESF-CCS system for ESF modulating components, as indicated in the attachment associated with this response.

Section 5.3 of the Component Interface Module technical report, APR1400-E-J-NR-14001-NP, Rev. 0 and Figure 4-13 of the Safety I&C System technical report, APR1400-Z-J-NR-14001-NP, Rev.0 will be revised as indicated in the attached mark-up in the attachment associated with this response.

Impact on DCD

Section 7.3.1 and Figure 7.3-1 of APR1400 DCD Tier 2 will be revised, as indicated in the attachment associated with this response.

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

Section 5.3 of the Component Interface Module technical report, APR1400-E-J-NR-14001-NP, Rev. 0 and Figure 4-13 of the Safety I&C System technical report, APR1400-Z-J-NR-14001-NP, Rev.0 will be revised, as indicated in the attachment associated with this response.

7.3 Engineered Safety Features Systems

7.3.1 System Description

The engineered safety features (ESF) system consists of four channels of sensors, and the auxiliary process cabinet-safety (APC-S), and for divisions of the engineered safety features actuation system (ESFAS) portion of the plant protection system (PPS), the safety portion of radiation monitoring system (RMS), and the engineered safety features-component control system (ESF-CCS). The safety instrumentation and controls of the ESF systems consist of the electrical and mechanical devices and circuitry from sensors to actuation device input terminals that are involved in generating signals that actuate the required ESF systems.

The ESFAS portion of the PPS includes the following functions: bistable trip logic, local coincidence logic (LCL), ESFAS initiation, and testing function.

The ESF-CCS receives ESFAS initiation signals from the PPS and RMS, electrical panel, or from the operators. The ESF-CCS generates ESF actuation signals to actuate the ESF system equipment. The ESF-CCS also generates emergency diesel generator (EDG) loading sequencer signals following loss of offsite power. The control circuitry for the components provides the proper sequencing and operation of the ESF systems.

The ESF-CCS provides discrete and continuous control of the safety systems as well as automatic or manual actuation of the ESF systems components. The ESF-CCS controls breaker/relay operated components (e.g., pumps, fans, heaters, motor-operated valves), solenoid operated components (e.g., pneumatic, electro-pneumatic, direct-operated valves), and control valves. The ESF-CCS also controls continuous control devices such as modulating valves. The ESF actuation and component control logics are located in the ESF-CCS cabinets.

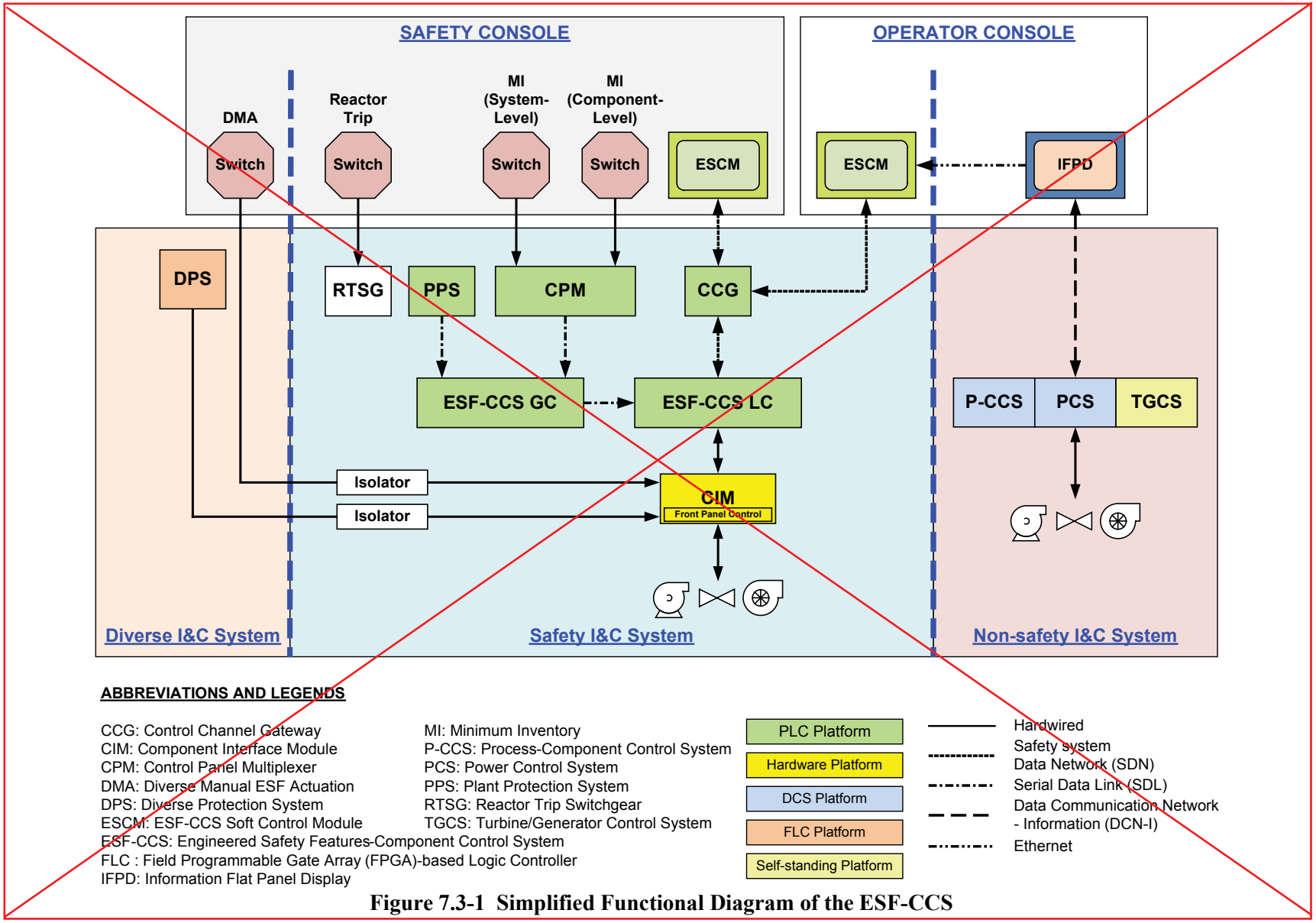
Upon receipt of ESFAS initiation signals, the ESF-CCS generates ESF actuation signals.

The simplified functional diagram and the block diagram of the ESF-CCS are shown in Figures 7.3-1 and 7.3-2, respectively.

a. ESF-CCS configuration

For modulating control in the ESF-CCS, the sensors and actuators for modulating control are directly interfaced to the analog input module and the analog output module in the ESF-CCS loop controller (LC). Any non-discrete components which require modulation are controlled via the analog output module in the ESF-CCS LC. The component interface module (CIM) is bypassed.

replaced with following page



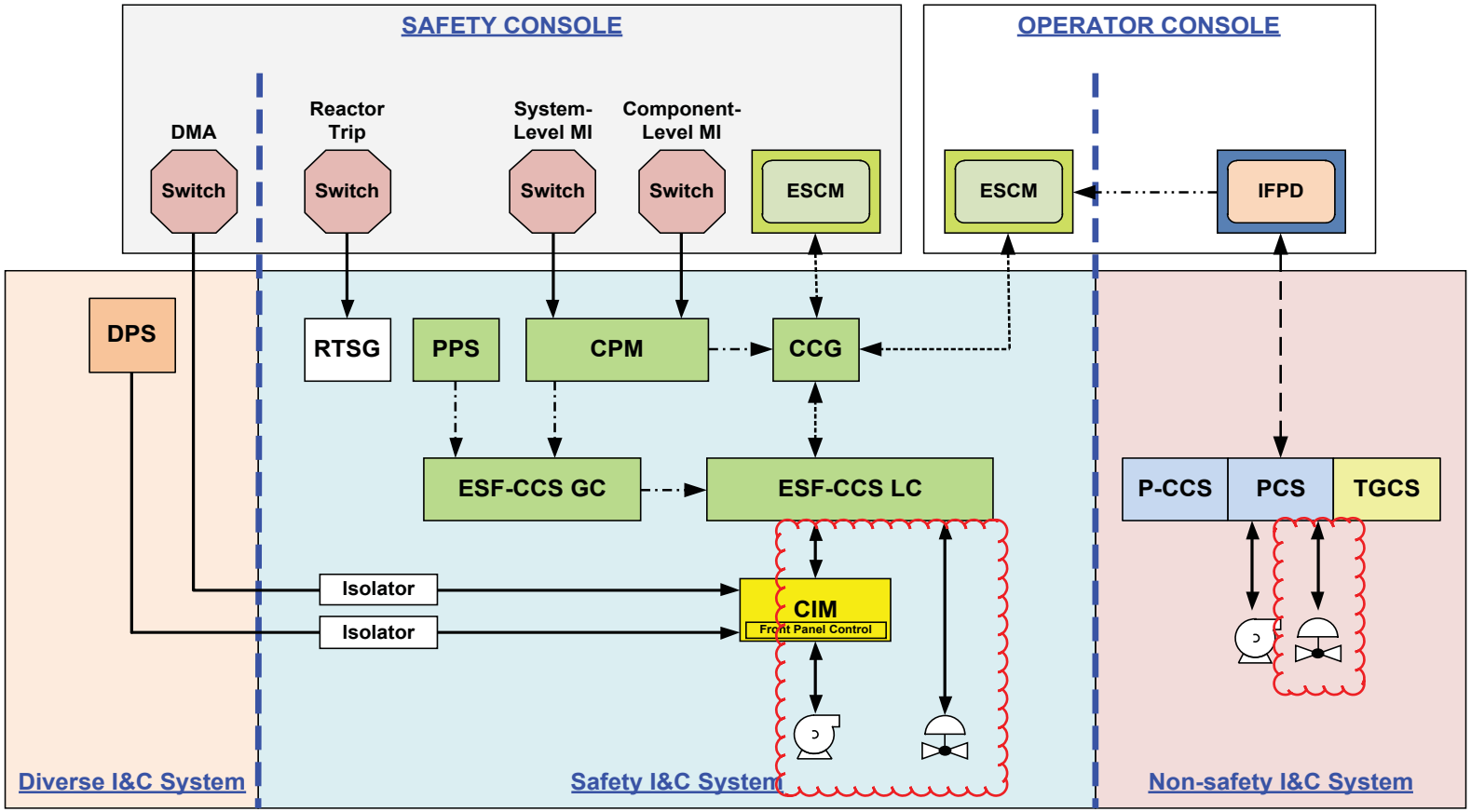
ABBREVIATIONS AND LEGENDS

CCG: Control Channel Gateway
CIM: Component Interface Module
CPM: Control Panel Multiplexer
DMA: Diverse Manual ESF Actuation
DPS: Diverse Protection System
ESCM: ESF-CCS Soft Control Module
ESF-CCS: Engineered Safety Features-Component Control System
FLC : Field Programmable Gate Array (FPGA)-based Logic Controller
IFPD: Information Flat Panel Display
MI: Minimum Inventory
P-CCS: Process-Component Control System
PCS: Power Control System
PPS: Plant Protection System
RTSG: Reactor Trip Switchgear
TGCS: Turbine/Generator Control System

PLC Platform
Hardware Platform
DCS Platform
FLC Platform
Self-standing Platform

Hardwired
Safety system Data Network (SDN)
Serial Data Link (SDL)
Data Communication Network - Information (DCN-I)
Ethernet

Figure 7.3-1 Simplified Functional Diagram of the ESF-CCS



ABBREVIATIONS AND LEGENDS

CCG: Control Channel Gateway
CIM: Component Interface Module
CPM: Control Panel Multiplexer
DMA: Diverse Manual ESF Actuation
DPS: Diverse Protection System
ESCM: ESF-CCS Soft Control Module
ESF-CCS: Engineered Safety Features-Component Control System
FLC : Field Programmable Gate Array (FPGA)-based Logic Controller
IFPD: Information Flat Panel Display
MI: Minimum Inventory
P-CCS: Process-Component Control System
PCS: Power Control System
PPS: Plant Protection System
RTSG: Reactor Trip Switchgear
TGCS: Turbine/Generator Control System

PLC Platform
Hardware Platform
DCS Platform
FLC Platform
Self-standing Platform

Hardwired
Safety system Data Network (SDN)
Serial Data Link (SDL)
Data Communication Network - Information (DCN-I)
Ethernet

TS

Figure 5.2-1 Priority Logic Section

5.3. Priority Logic Configuration

TS

TS

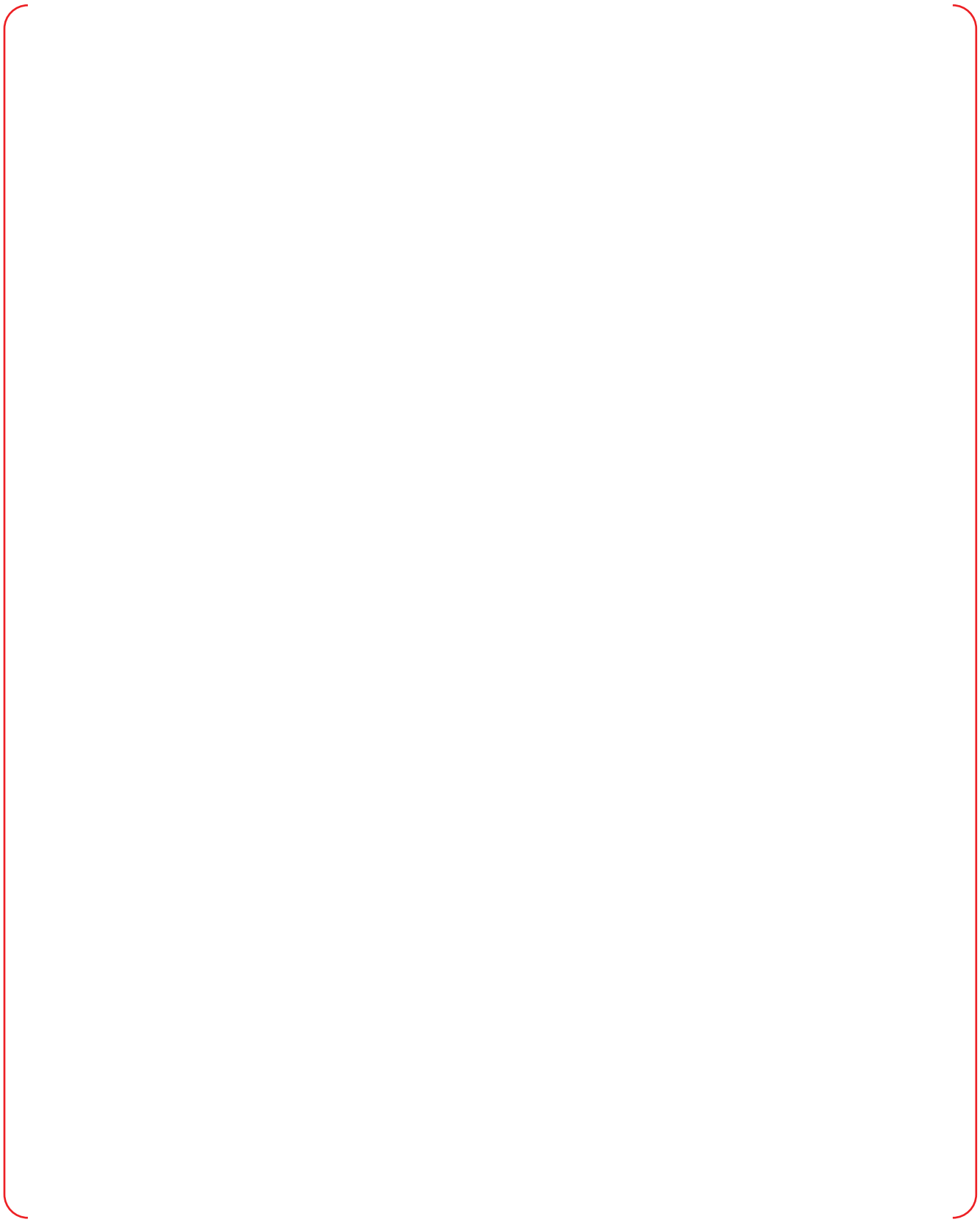


Figure 4-13 ESF-CCS Functional Configuration

TS

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

APR1400 Design Certification

Korea Electric Power Corporation / Korea Hydro & Nuclear Power Co., LTD

Docket No. 52-046

RAI No.: **323-8281**

SRP Section: **07.03 – Engineered Safety Features Systems**

Application Section:

Date of RAI Issue: **11/30/2015**

Question No. 07.03-16

Provide necessary design information to clarify the inputs of component control logic for the ESF systems in Figure 4-15, "Simplified Component Control Logic," in Technical Report APR1400-Z-J-NR-14001-P, Rev. 0, “Safety I&C System.” Also provide design information on how each specific component control logic given in Section 7.3.1.4, "Component Control Logic," of APR1400 FSAR Tier 2 are used with logic shown in the above Figure 4-15.

10 CFR 52.47(a)(2) requires, in part, that the description of the structures, systems, and components shall be sufficient to permit understanding of the system designs and their relationship to the safety evaluations. The guidance of SRP Appendix 7.1-C, “Guidance for Evaluation of Conformance to IEEE Std. 603”, Section 4, “Safety System Designation”, states that information provided for each design basis item should be sufficient to enable the detailed design of the I&C system to be carried out, and all functional requirements for the I&C system and the operational environment for the I&C system should be described.

Figure 4-15 in Technical Report APR1400-Z-J-NR-14001-P, Rev. 0, “Safety I&C System”, shows the simplified component control logic for ESF components. However, there is lack of definition or descriptive information in the APR1400 application for some logic inputs showing in the above diagram, such as process control (auto start), auxiliary stop, etc. Provide definition and functional description of logic inputs shown in Figure 4-15 which are not included in the application. Section 7.3.1.4 and its related component logic diagrams (CLD) in Figures 7.3-12 to 7.3.20 of APR1400 FSAR Tier 2 show the actuation logic for each type of ESF components. But, there is lack of design information on what relationship exists between those CLD figures and Figure 4-15 in the above Technical Report. Describe how each specific type of component logic diagram given in Section 7.3.1.4 of APR1400 FSAR Tier 2 is to be applied together with Figure 4.15 in the Safety I&C Technical Report.

Response

The input signals shown in Figure 4-15 of Safety I&C System technical report, APR1400-Z-J-NR-14001-NP, Rev.0 are described as follows:

- Auxiliary start/stop: This input indicates the signal to start/stop the component when the process condition requires starting/stopping the component. For example, the stop status of the component cooling water pump (CCWP) 01A acts as an auxiliary start signal of the CCWP 01C.

- Permissive command: This input indicates the permissive condition to start/stop the component when the permissive command is present. For example, the stop status of the low speed fan in the fan cooler acts as a permissive command to start the high speed fan in the fan cooler.

- Process control (auto start/stop): This input indicates the interlock signal to start/stop the component which is in auto mode. For example, level low status acts as a process control signal to automatically start the makeup pump of the tank which is in auto mode.

The relationships between Figures 7.3-12 to 7.3-18, and 7.3-20 of DCD Tier 2 and Figure 4-15 of the Safety I&C System TeR, APR1400-Z-J-NR-14001-NP, Rev.0 will be provided, as indicated in the attachment associated with this response. DCD Tier 2, Figure 7.3-19 has no relationship to Figure 4-15 of the Safety I&C System TeR.

Section 4.4.2 of the Safety I&C System TeR, APR1400-Z-J-NR-14001-NP, Rev.0 will be revised, as indicated in the attachment associated with this response.

Impact on DCD

Figure 7.3-16 of DCD Tier 2 will be revised, as indicated in the attachment associated with this response.

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

Section 4.4.2 of the Safety I&C System TeR, APR1400-Z-J-NR-14001-NP, Rev.0 will be revised, as indicated in the attachment associated with this response.

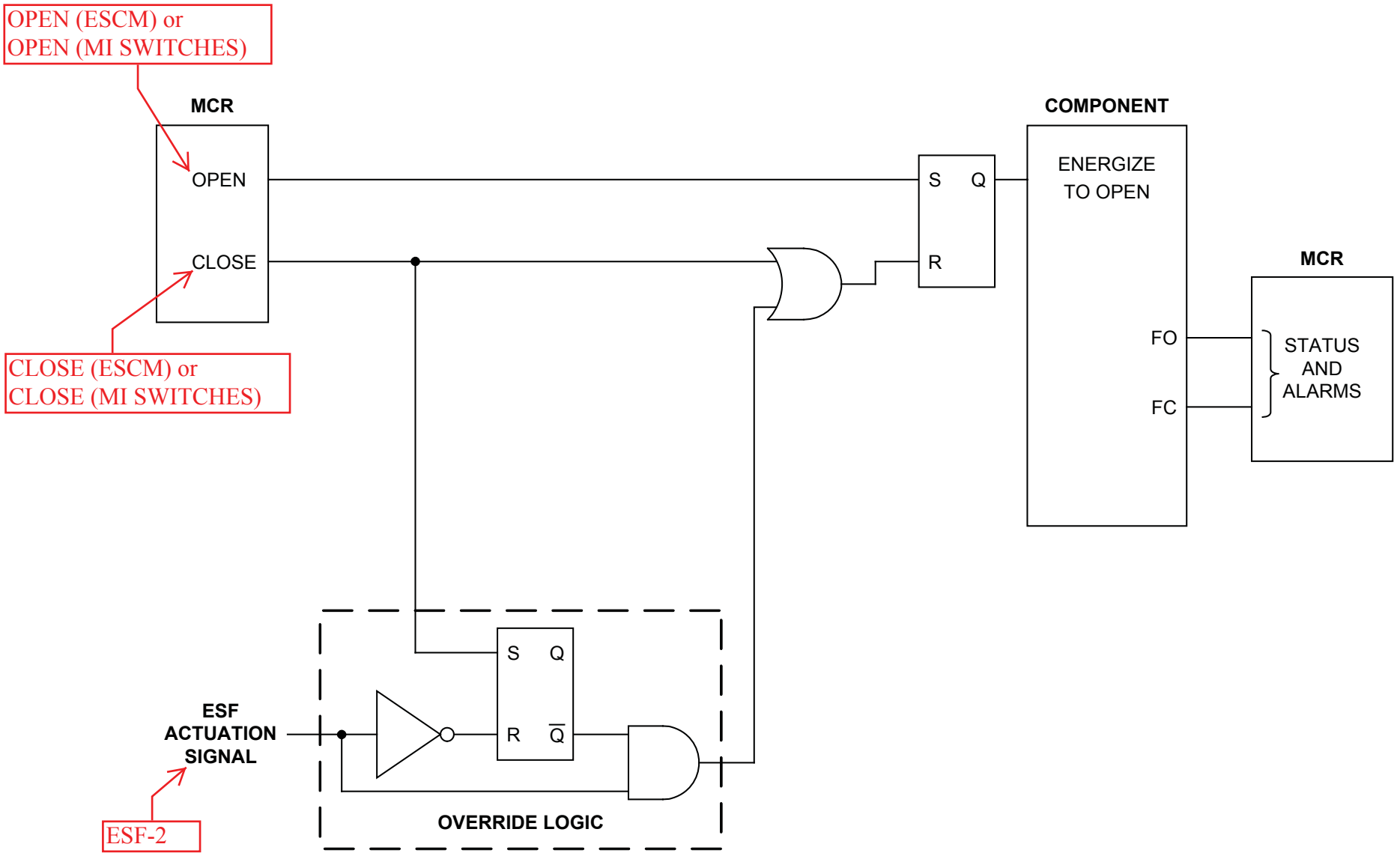


Figure 7.3-12 CLD for a Solenoid-Operated Valve

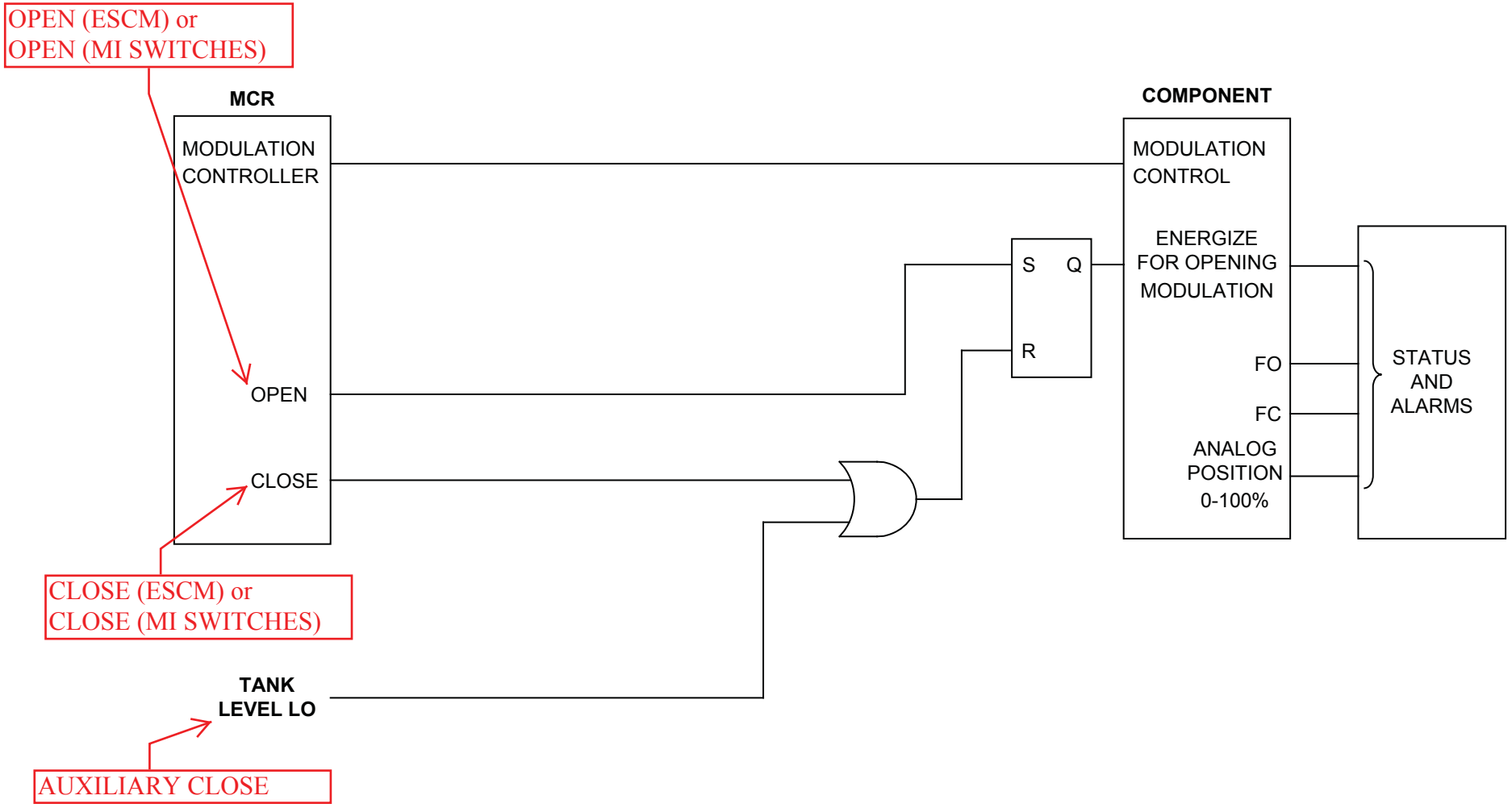


Figure 7.3-13 CLD for a Modulating Valve with Solenoid Operator

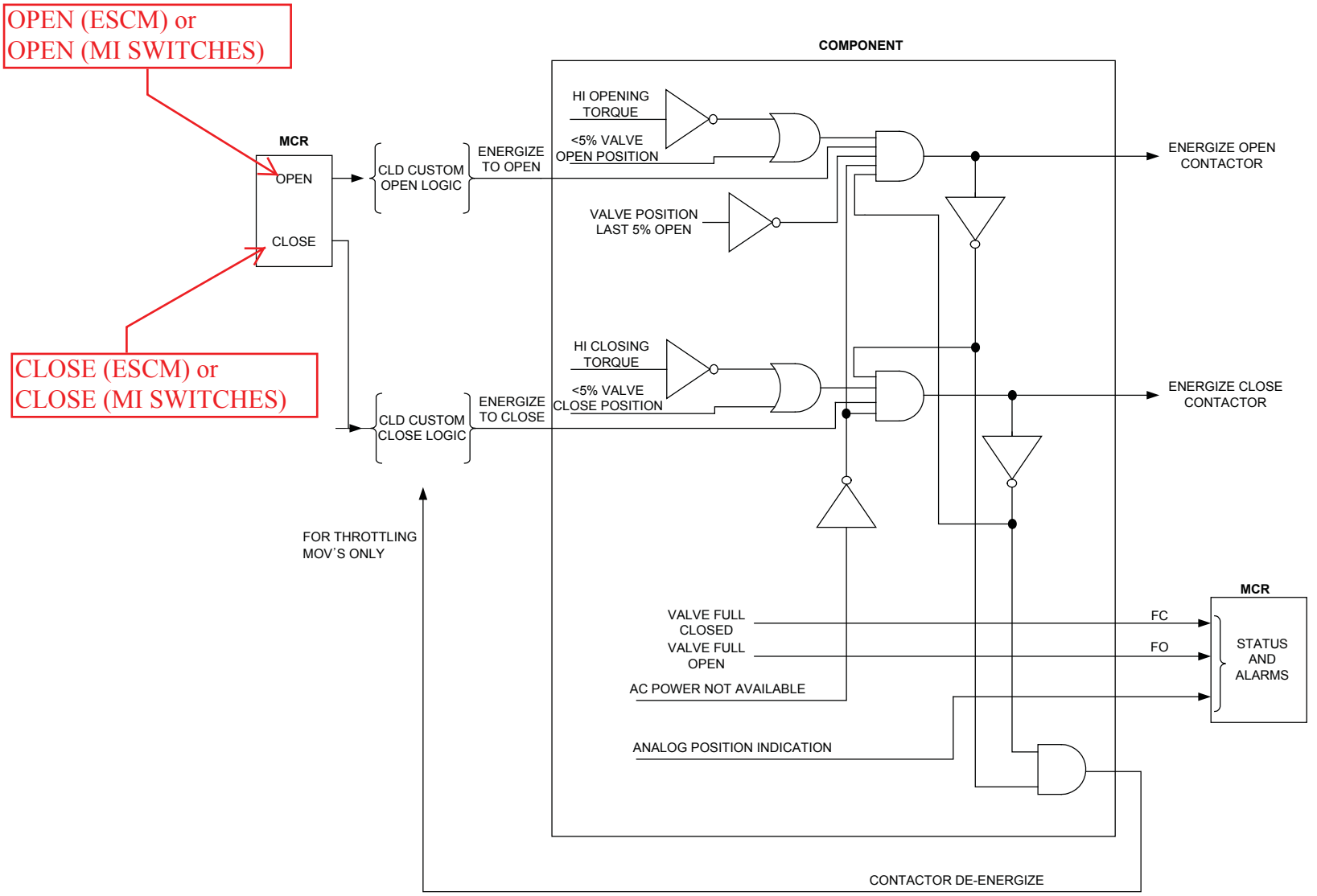


Figure 7.3-14 Motor-Operated Valve Functional Interface Design

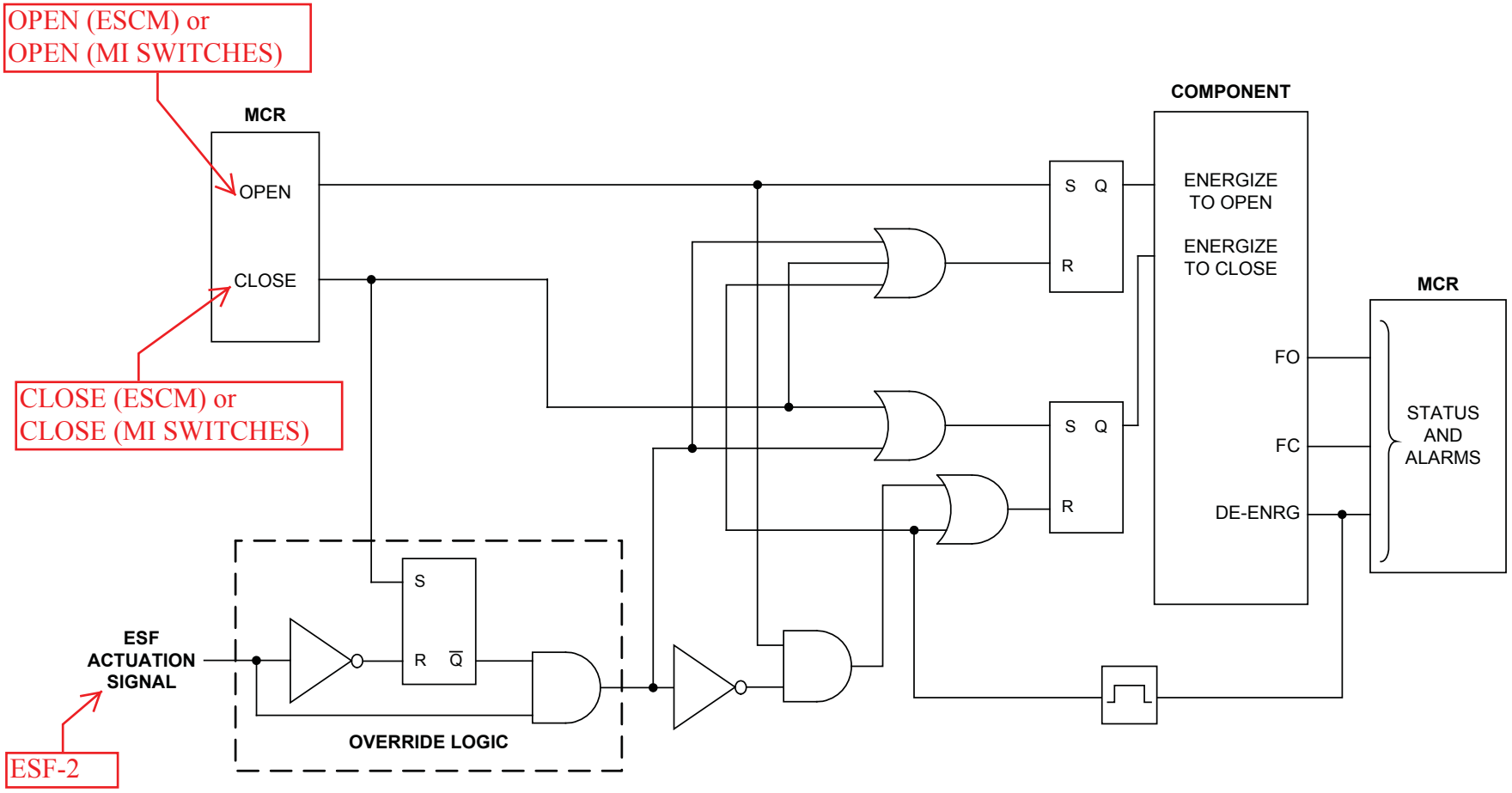


Figure 7.3-15 CLD for a Full Stroke Motor-Operated Valve

Replaced with following page

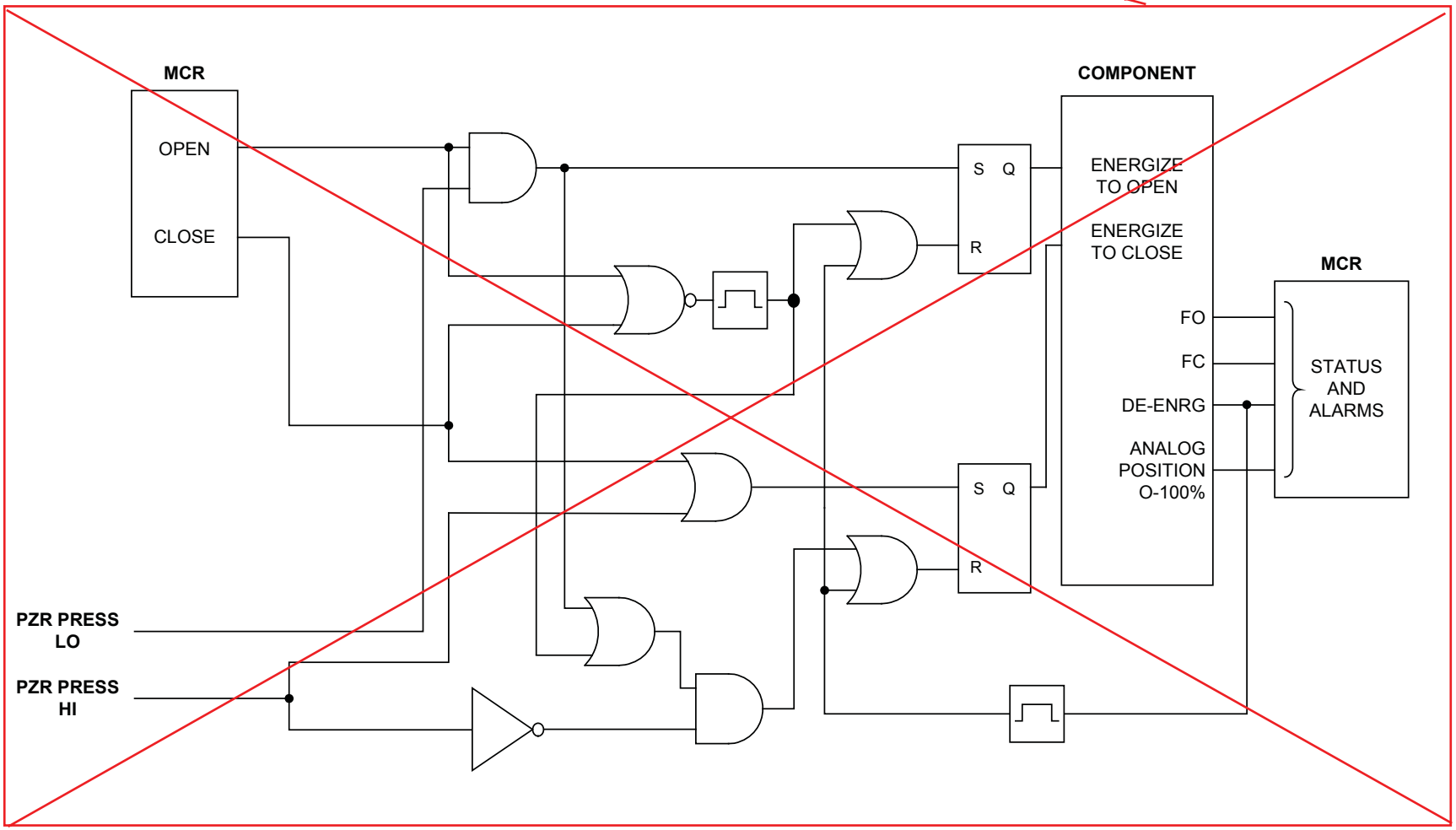
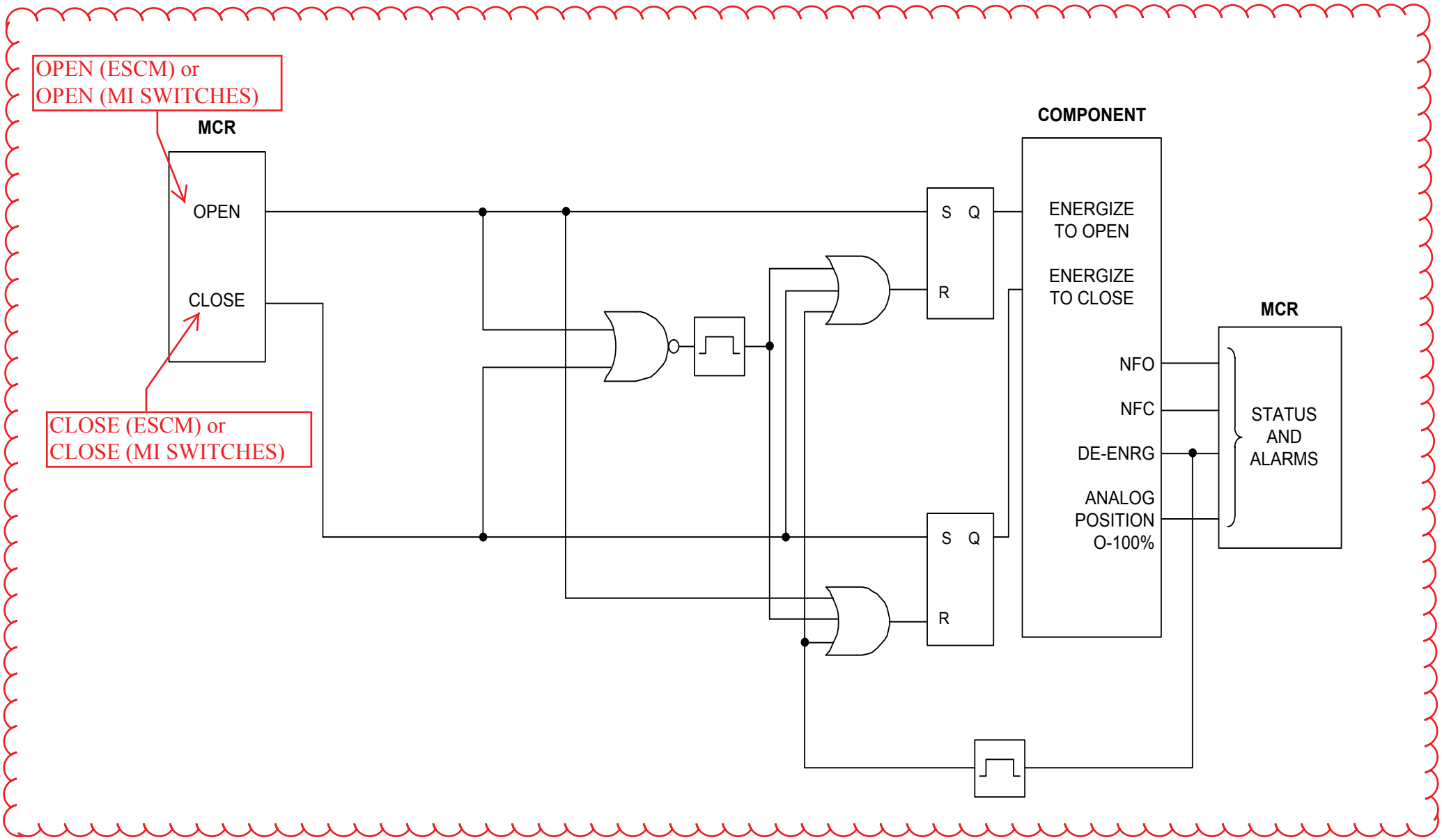


Figure 7.3-16 CLD for a Throttling Motor-Operated Valve


OPEN (ESCM) or
OPEN (MI SWITCHES)
MCR
OPEN
CLOSE
CLOSE (ESCM) or
CLOSE (MI SWITCHES)
S Q
R
S Q
R
COMPONENT
ENERGIZE
TO OPEN
ENERGIZE
TO CLOSE
NFO
NFC
DE-ENRG
ANALOG
POSITION
O-100%
MCR
STATUS
AND
ALARMS

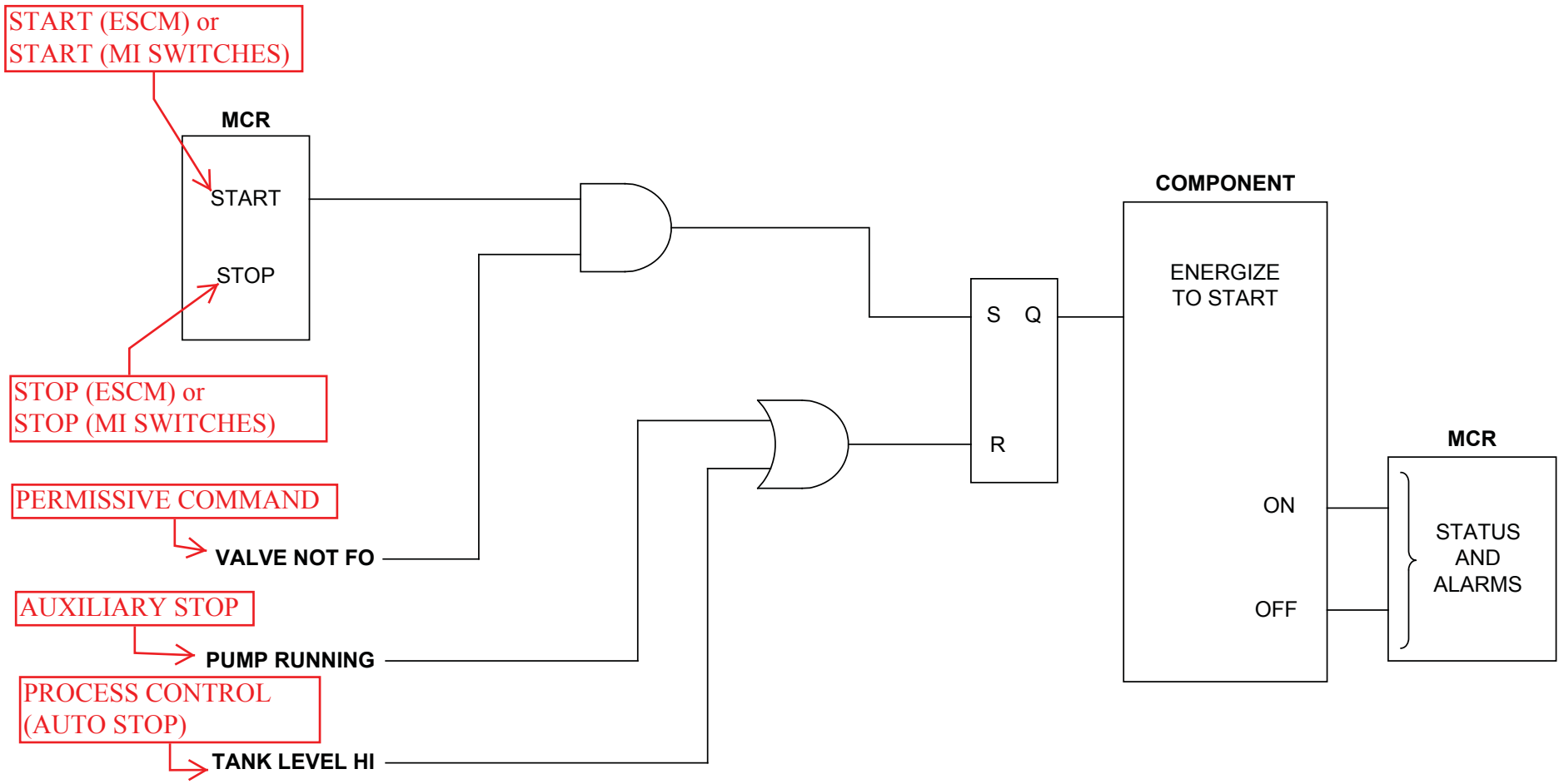


Figure 7.3-17 CLD for a Non-reversing Motor Starter Operated Component

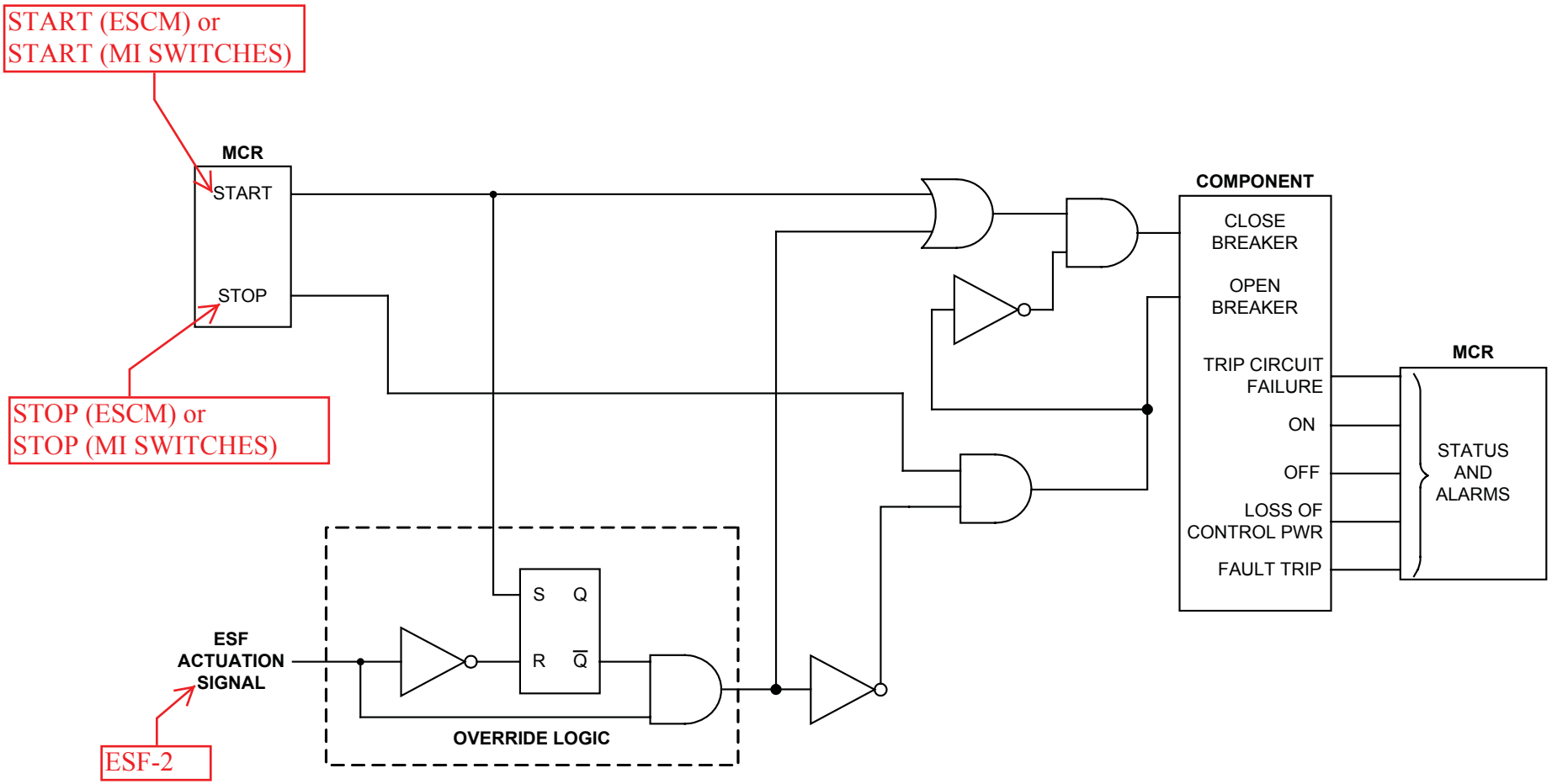


Figure 7.3-18 CLD for a Circuit Breaker Operated Component

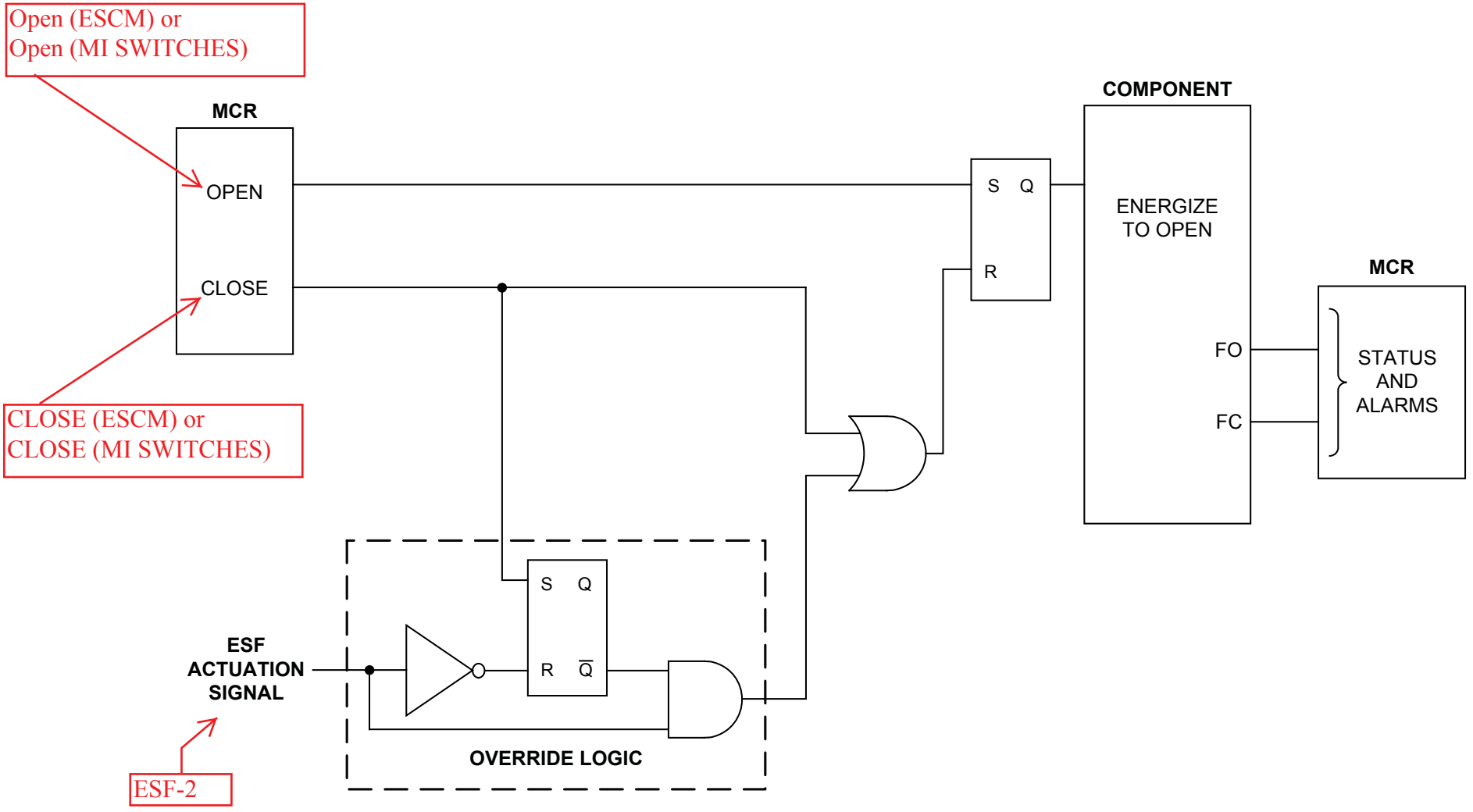


Figure 7.3-20 CLD for a Electro-Hydraulic Motor Damper

TS

TS

4.4.3 Architecture Description

TS