REVISED 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.:	**50-7911**
SRP Section:	**07.02 – Reactor Trip System**
Application Section:	**07.02**
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Question No. 07.02-1

For all figures in:

- APR1400 Final Safety Analysis Report (FSAR), Tier 2, Chapter 7, Rev. 0,
- Technical Report APR1400-Z-J-NR-14001, Revision 0, "Safety I&C System," and
- Technical Report APR1400-F-C-NR-14003, Rev. 0, "Functional Design Requirement for a CPCS [Core Protection Calculator System] for APR1400,"

where the figures display only one division/channel (i.e., FSAR, Tier 2, Figure 7.2-10, "PPS Channel A Trip Path Diagram") and where the schematics or diagrams of the figure display differences between the divisions/channels (i.e., FSAR, Tier 2, Figure 7.2-32, "Functional Logic Diagram for CWP"), insert a caption on the figures explaining whether the schematic or diagram shown is identical for all divisions/channels or insert a caption that describes what the differences are between the divisions/channels.

The regulatory requirements of 10 CFR 52.47(a)(2) state that the design "…descriptions shall be sufficient to permit understanding of the system designs and their relationship to the safety evaluations." Standard Review Plan (SRP) Appendix 7.1-C, "Guidance for Evaluation of Conformance to IEEE Std. 603," Section 4, "Safety System Designation," states that the design basis information provided for each design basis item, taken alone and in combination, should have one and only one interpretation and that information provided for the design basis items should be technically accurate. The NRC staff was not able to understand the system design or system functional design requirements for figures displaying differences between divisions/channels and for figures displaying only one division/channel of safety system functionality. Update the FSAR and technical reports accordingly.

Response – (Rev. 1)

The schematics or diagrams, not identifying whether it applies to all channels or divisions, in the figures of DCD Tier 2 Chapter 7, Safety I&C Technical Report, and Functional Design Requirement for a Core Protection Calculator System (CPCS) are identical for all channels or divisions.

The trip path shown in Figure 7.2-10 of DCD Tier 2 is identical for all PPS channels. The functional logic diagram for CWP in Figure 7.2-32 of DCD Tier 2 identifies the difference between divisions in the figure. Therefore, no caption or description is required to be inserted to these cases.

The description of identification is inserted into Figure 7.2-28 of DCD Tier 2 as shown in the attached mark-up for the case where some portion of the diagram shown in the figure is specific to certain channels or divisions. In this case, the manual reactor trip in RSR is applicable only for PPS divisions A and B. The remaining portion of the diagram in this figure is identical for all PPS divisions.

No additional figures in DCD Tier 2 are found to be applicable to have a caption describing the differences between channels or divisions.

No figures in Safety I&C System Technical Report are found to be applicable to have a caption describing the differences between channels or divisions.

No figures in Functional Design Requirement for a CPCS for APR1400 are found to be applicable to have a caption describing the differences between channels or divisions.

The following phrase is added to Section 7.1 of DCD Tier 2:
"All figures provided in Chapter 7 are identical for all channels or divisions. If a figure provided is not identical for all channels or divisions, a note is provided to indicate the difference."

The following phrase is added to Section 4.1 of Safety I&C System Technical Report:
"All figures provided in Section 4 are identical for all channels or divisions. If a figure provided is not identical for all channels or divisions, a note is provided to indicate the difference."

The following phrase is added to Section 3 of Functional Design Requirement for a CPCS for the APR1400 rather than Section 1.2 because the following phrase is not relevant to the document scope, but rather to Section 3 where the general description of system requirements is contained:
"All figures provided in this document are identical for all channels or divisions. If a figure provided is not identical for all channeils or divisions, a note is provided to indicate the difference."

Impact on DCD

Section 7.1 and Figure 7.2-28 of DCD Tier 2 will be revised as indicated on the attached mark-up.

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 4.1 of the Safety I&C System Technical Report (APR1400-Z-J-NR-14001-P, Rev.0) will be revised as indicated on the attached mark-up.

Section 3 of Functional Design Requirement for a CPCS for APR1400 (APR1400-F-C-NR-14003-P, Rev.0) will be revised as indicated on the attached mark-up.

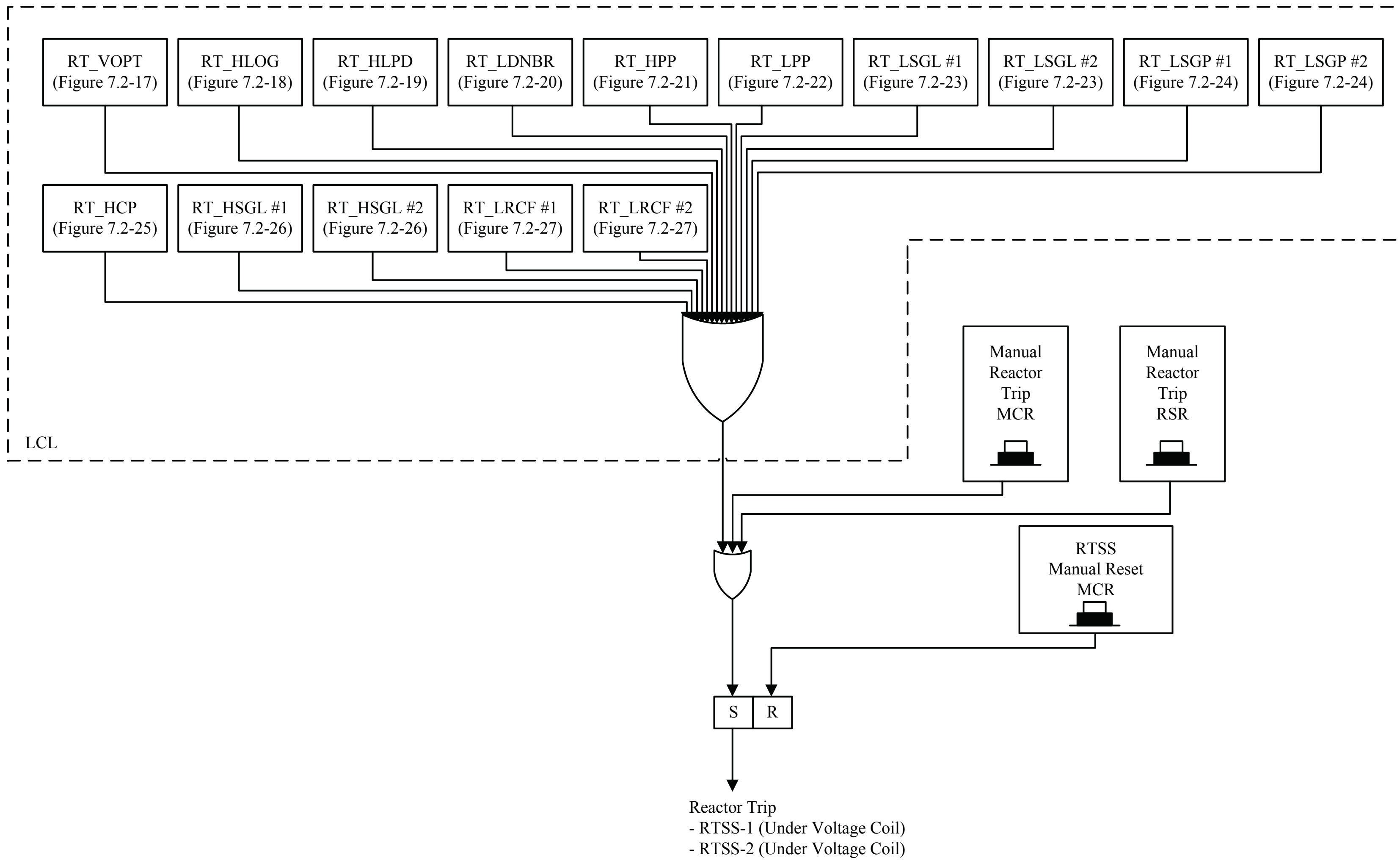

Figure 7.2-28 Functional Logic Diagram for Reactor Trip Signal Generation

Note:
The manual reactor trip switches in the RSR are provided only for divisions A and B.

CHAPTER 7 – INSTRUMENTATION AND CONTROLS

7.1 Introduction

The APR1400 instrumentation and control (I&C) system uses advanced design features such as digital data communication, a network-based distributed digital control system, and a compact workstation-based human-system interface (HSI) in the control room.

The I&C architecture of the APR1400 is implemented by two major independent and diverse platforms: (1) safety-qualified programmable logic controller (PLC) platform for the safety systems and (2) non-qualified distributed control system (DCS) platform for the data processing system and non-safety control systems. In addition, independent systems such as the turbine/generator (T/G) control and protection system, the nuclear steam supply system (NSSS) monitoring system, and the balance of plant (BOP) monitoring system perform the required functions of a portion of the I&C systems.

Table 3.2-1 provides the safety classifications and quality groups of the APR1400 systems.

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Safety Systems

The safety systems are implemented by safety-grade hardware and previously developed software components that are dedicated or qualified for use in nuclear power plants. The PLC platform is loaded with the APR1400-specific application software to implement various safety functions.

The components of the safety system are qualified to satisfy nuclear requirements such as environmental, seismic, electromagnetic interference (EMI), and radio frequency interference (RFI) qualifications. The safety system software is designed, verified, and validated using the industry standard for software development and the verification and validation (V&V) process as described in the Software Program Manual Technical Report (Reference 1). The qualified PLC platform applies to the following safety systems:

a. Plant protection system (PPS)

b. Core protection calculator system (CPCS)

c. Engineered safety features – component control system (ESF-CCS) communication via the serial data link (SDL, i.e., HSL) from safety systems to non-safety systems (i.e., QIAS-N) and buffering circuit using dual-ported memory are commonly used to prevent endangering the safety function. The other means from safety to non-safety data communication is via the plant computer datalink using the unidirectional protocol from the MTP.

- The DPS is diverse from the safety I&C system in aspects of trip mechanism, hardware and software.

- In addition to the DPS, the hardwired DMA switches and the DIS are provided on the MCR SC to cope with CCF of the safety I&C system.

4.1.1 Safety I&C Systems

4.1.1.1 Plant Protection System

The PPS consists of four redundant divisions that perform the necessary bistable, coincidence, initiation logic, maintenance and test function.

The PPS initiates reactor trip and system-level ESF actuation functions when a safety limit is exceeded by the plant conditions. To detect such conditions, the system utilizes measurements of the reactor core, reactor coolant system, main steam supply system, and containment building parameters.

Each PPS redundant division receives the process and discrete signals directly from field sensors or via the APC-S, ENFMS, and CPCS. The PPS provides the reactor trip signals to the RTSS using hardwired cables and ESFAS initiation signals to the ESF-CCS via fiber optic SDLs.

4.1.1.2 Engineered Safety Features - Component Control System

The ESF-CCS consists of four independent divisions that perform additional 2-out-of-4 voting logic, component control logic, and priority logic function.

The group controller (GC) of each ESF-CCS division receives four division ESFAS initiation signals derived from the ESFAS portion of the PPS and performs additional selective 2-out-of-4 coincidence logic to generate the ESF actuation signal. The GC also receives two division ESFAS initiation signals derived from the radiation monitoring system (RMS) and performs 1-out-of-2 logic to generate the ESF actuation signal. The ESF actuation signals are transmitted to the loop controller (LC) of the ESF-CCS. The LC executes the component control logic and outputs the component control signal to the CIM. The component control logic includes the priority logic for the operator's manual control signal and ESF actuation signal. The ESF-CCS soft control module (ESCM) on the operator console generates a component control signal of safety components by manual operator actions.

4.1.1.3 Core Protection Calculator System

The CPCS has four redundant channels that compute the DNBR and LPD values using process values, reactor coolant pump (RCP) speed, CEA position and ex-core neutron flux.

The CPCS compares the DNBR and LPD values against setpoints to determine if fuel design limits are exceeded. When these values exceed a safety limit, a trip signal is transmitted to the PPS using hardwired cables.

4.1.1.4 Qualified Indication and Alarm System - P

The QIAS-P, which has two independent divisions A and B, is implemented on the common PLC platform for the safety system. The QIAS-P processes the plant parameters that are input from the safety I&C

All figures provided in Section 4 are identical for all channels or divisions. If a figure provided is not identical for all channels or divisions, a note is provided in the figure to indicate the difference.

1.0 INTRODUCTION

1.1 PURPOSE

The purpose of this document is to provide a description of the Core Protection Calculator System (CPCS) Algorithm functional design with Common Qualified (Common Q) platform. The Functional Design Requirements described in this document when implemented with appropriate data base and addressable constants meet the design bases for CPCS given in Section 2.

1.2 SCOPE

The CPCS design consists of three major components: executive software, application software, and hardware. This functional design requirements document provides the following:

1) A description of reactor protection algorithms to be implemented as the application software,

2) The requirements on protection program interfaces, system interfaces, protection program timing, and system initialization,

3) A description of CEA Penalty Factor Algorithm to be implemented in the Core Protection Calculator System of the Reactor Protection System,

4) A description of algorithms to initiate alarms for CEA sensor failure and CEA deviation,

5) A description of diagnostic failed sensor data stack,

Items (1) through (5) establish functional requirements affecting the three major CPCS components.

1.3 APPLICABILITY

This document is a generic description of CPCS Functional Design Requirements. This document is prepared based on the Ref. 1.4.1.

It is currently applicable to Advanced Power Reactor 1400 (APR1400).

1.4 REQUIRED REFERENCES

1.4.1 KNF, "Functional Design Requirements for a Core Protection Calculator System for Shinkori Nuclear Power Plant Units 3&4," KNF-S34ICD-08005, Rev. 01, September 2010.

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3. SYSTEM REQUIREMENTS

The following sections describe the system elements required for performance of the CPC protection function. Section 3.1 describes the input and output signals that must be provided to the CPC protection programs. The structure and interaction of CPC protection algorithms is described in Sections 3.2 through 3.4. These sections provide information regarding the structure of protection software, the execution frequency of each protection program, sampling rates for input parameters, and communication among protection programs. Section 3.5 describes the necessary provisions for operator interaction with the CPC System. The requirements for initialization of CPC algorithms are specified in Section 3.6. Interlocks and permissives required for the system are described in Section 3.7.

3.1 Inputs and Outputs

Table 3-1 lists the CPC process input signals for each channel and the CEAC process input signal for each CEAC/CPP. Figure 3-1 is a system diagram that shows the allocation of input signals to each channel. Each CPC channel is required to have appropriate signal processing to provide four digital words accessible to the FLOW program (refer to Section 4.1). Each digital word must represent a value that is inversely proportional to the speed of one of the four reactor coolant pumps.

The temperature, pressure, excore detector, and CEA position inputs shall be analog signals proportional to the value of the respective measured process variable. The accuracy requirements in Table 3-1 establish the maximum allowable uncertainty that can be introduced by the conversion of input signals to internal binary format. The accuracy requirements given in Table 3-1 are based on the total uncertainties attributable to the following:

1) loading effects

2) reference voltage supply regulation

3) electrical noise

4) linearity

5) A/D converter power supply sensitivity

6) quantization.

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