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## 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.:** 405-8497  
**SRP Section:** 08.02 – Offsite Power System  
**Application Section:** 08.02  
**Date of RAI Issue:** 02/11/2016

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### **Question No. 08.02-9**

By letter dated October 21, 2015, the applicant provided a response to RAI 8093, Question 08.02-6. In the response, the applicant stated that the protection schemes including overcurrent, differential current, sudden pressure and ground fault protection for large power transformers (MT, UATs, SATs) are provided in accordance with recommendations in IEEE Std. 666-1991.

However, Table 7.1, “Transformer Protection Devices” in IEEE Std. 666-1991, includes thermal overload relay (49). Please confirm whether or not the thermal overload relay is included in the MT, UATs, and SATs protective relays.

Furthermore, IEEE Std. 666-1991, Section 7.4.2, “Transformer Protection” states that “when the unit service transformer and generator step-up power transformers are connected to the generator terminals, an overall unit differential relay is often provided for backup protection of the equipment. This relay zone includes the neutral side of the generator and the high-voltage side of the unit service and generator step-up and power transformers. Frequently, this zone is extended to include the generator high-voltage circuit breaker(s). A fault occurring anywhere in this zone requires immediate shutdown of the unit.” The applicant stated that device number 87U, the unit overall differential relay, is only provided for the main transformer and not in the list of UAT protective relays. As stated above, IEEE Std. 666-1991 recommends that the relay zone include the high voltage side of the unit service transformer (in the APR1400 design this is defined as Unit Aux Transformer or UAT). Furthermore, DCD Tier 2 Section 8.1.3.3 states that the electric power system is designed to meet industry standards and lists IEEE Std. 242-2001, “IEEE Recommended Practice for Protection and Coordination of Commercial and Industrial Power Systems.” IEEE Std. 242-2001 discusses overall differential backup protection in Section 12.5.3.2.3, such that the overall differential scheme has the capability to detect severe faults. Please discuss why the unit overall differential relay is also not included for the UAT or provide an alternate means of providing generator overall differential protection.

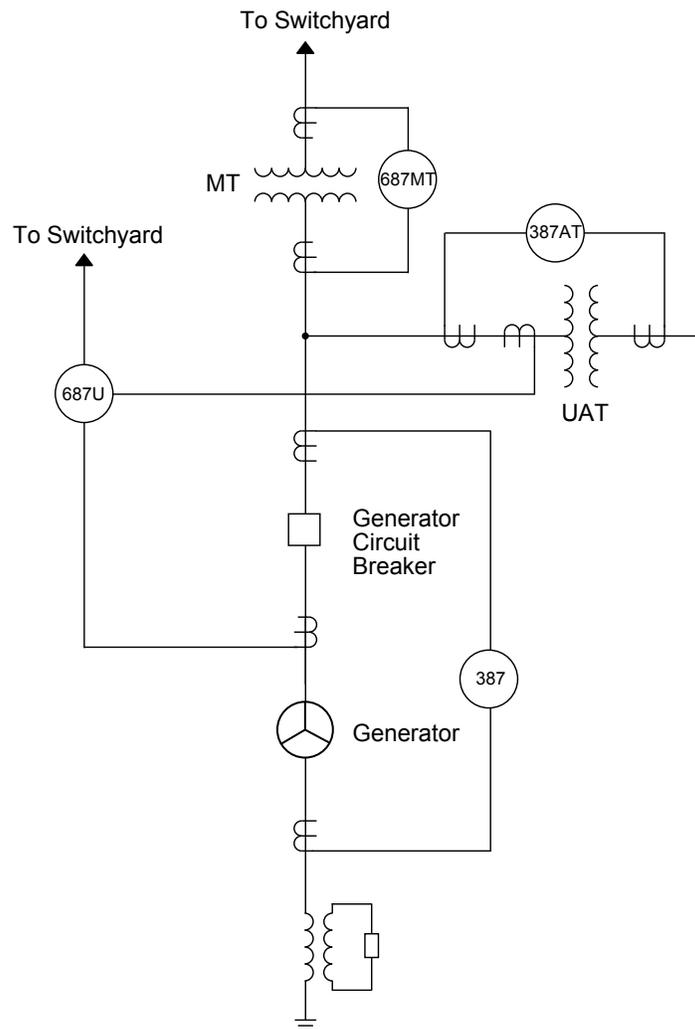
The proposed revision to DCD Tier 2, Section 8.2.1.3 should provide details how the MT, UATs, and SATs protection schemes' are in accordance with the recommendations in IEEE Std. 666-1991. Please provide the list of protective relays for the MT, UATs, and SATs, in the DCD as how the APR1400 design meets the recommendations in IEEE Std. 666-1991.

## **Response**

The thermal overload protection function (49) has been considered for the MT, UATs, and SATs in the reference plant of the APR1400 as part of the supplier furnished provisions.

Therefore, the thermal overload protection function (49) will be included as part of the protection functions for the MT, UATs, and SATs of the APR1400.

The protection zone of the unit overall differential relay (687U) in the APR1400 encompasses the high voltage side of UAT as shown in the figure below. This is consistent with the recommendations of IEEE Std. 666-1991.



[Figure] Overall differential scheme of MT and UAT in the APR1400

In order to ensure proper protection of the UAT during a severe fault, the UAT differential protection relay (387AT) includes an unrestrained instantaneous differential overcurrent function that is set above the maximum expected magnetizing inrush current value (e.g., three times rated current), but below the current value that might result in CT ac saturation (e.g., 20 times rated current). Moreover, the overcurrent relay (350/351) is provided for the UAT back-up protection.

Therefore, extension of the unit overall differential protection (687U) zone to the low voltage side of UAT is not necessary.

DCD Tier 2, Table 8.2-2 will be added to provide a list of protective relays for the MT, UATs, and SATs, which complies with the recommendations of IEEE Std. 666-1991. Relay device numbers in Table 8.2-2 are re-numbered by adding a prefix to distinguish between the different protection relays that have the same function numbers for the MT, UATs, and SATs.

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### **Impact on DCD**

DCD Tier 2, Subsection 8.2.1.3 will be revised and Table 8.2-2 will be added as shown in the Attachment.

### **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**

There is no impact on any Technical, Topical, or Environmental Report.

## APR1400 DCD TIER 2

The protective relay list of the MT, UATs, and SATs is shown in Table 8.2-2.

RAI 405-8497\_ Question 08.02-9

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closed and the MG is connected to the transmission system through the MT and also supplies power to the UATs. The alternate preferred circuit is connected to the high-voltage side of the SATs. In case the power supply is unavailable from the UATs, the power supply is maintained because the onsite non-safety-related and safety-related bus connections are transferred automatically from the UATs to the SATs. When the normal preferred power supply is restored, the transfer from the SATs to the UATs is accomplished manually. The UATs and SATs are three-winding transformers connected to the onsite non-safety-related and safety-related buses through their low-voltage side windings. Both non-safety-related and safety-related buses are normally supplied from the UATs.

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The IPB is used to connect the MG to the GCB. The IPB provides the electrical connection among the GCB, the MT, and the two UATs. The MT is composed of three single-phase transformers that are connected to the two UATs through the IPB.

The GCB is used as a means of providing immediate access of the onsite ac power systems to the offsite power system by isolating the MG from the MT and the UATs and allowing backfeeding of offsite power to the onsite ac power system. The GCB is capable of interrupting normal load current and maximum fault current during transient and various fault conditions. The APR1400 is designed to follow the guidance in Appendix A of Standard Review Plan (SRP) Section 8.2 (Reference 6). After the MT is connected to the transmission network by closing the switchyard breakers with the GCB open, the UATs supply plant startup power to auxiliary and service loads of the APR1400. As part of the normal turbine-generator shutdown process, the GCB is opened to separate the MG from the switchyard when the MG output has been reduced to almost no-load condition. After the MG is disconnected from the switchyard by opening the GCB, the MT remains connected to the network system and backfeeds plant shutdown power to the APR1400 through the UATs during plant shutdown.

The COL applicant is to design the offsite power system to detect, alarm, and automatically clear a single-phase open circuit condition at the primary sides of MT or SATs in accordance with NRC BL-2012-01 (COL 8.2(7)) (Reference 7).

The COL applicant is to describe how testing is performed on the offsite power system components (COL 8.2(8)). The ratings of the MG, GCB, MT, UATs, SATs, and IPB are shown in Table 8.2-1.

The protection schemes including overcurrent, differential current, sudden pressure and ground fault protection for the MT, UATs, and SATs are provided in accordance with the recommendations in IEEE Std. 666 (Reference 23).

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Table 8.2-2

Protective Relay List of the MT, UATs, and SATs

Application	Relay Device No. <sup>(1)</sup>	Description	Remark
MT	687MT	MT differential relay	Protection and alarm
MT	687GMT	MT ground differential relay	Protection and alarm
MT	650/651GN	MT neutral ground overcurrent relay	Alarm and supervision of out-of-step relay
MT	359GB	Isolated phase bus ground fault relay	Protection and alarm
MT	650B	Sudden pressure relay blocking relay	Alarm and supervision of 663MT
MT	663MT	MT sudden pressure relay	Protection and alarm
MT	687U	Unit overall differential relay	Protection and alarm
MT	--	Thermal overload protection <sup>(2)</sup>	Protection and alarm
UAT	151GN	UAT neutral ground overcurrent relay	Protection and alarm
UAT	251GN	UAT neutral ground overcurrent relay	Protection and alarm
UAT	387AT	UAT differential relay	Protection and alarm
UAT	350/351	UAT overcurrent relay	Protection and alarm
UAT	363AT	UAT sudden pressure relay	Protection and alarm
UAT	--	Thermal overload protection <sup>(2)</sup>	Protection and alarm
SAT	151GN	SAT neutral ground overcurrent relay	Protection and alarm
SAT	251GN	SAT neutral ground overcurrent relay	Protection and alarm
SAT	451GN	SAT neutral ground overcurrent relay with instantaneous element	Alarm only
SAT	450/451	SAT overcurrent relay with instantaneous element	Protection and alarm
SAT	487ST	SAT differential relay	Protection and alarm
SAT	487GT	SAT ground differential relay	Protection and alarm
SAT	463ST	SAT sudden pressure relay	Protection and alarm
SAT	--	Thermal overload protection <sup>(2)</sup>	Protection and alarm

(1) Relay device prefix codes represent the voltage levels as follows :

- 1 : 4.16kV
- 2 : 13.8kV
- 3 : 24kV
- 4 : High voltage side of SAT
- 6 : High voltage side of MT

(2) The thermal overload protection function is included as part of supplier furnished provisions.