

# Study of the ECCS Water's pH Agent(TSP) Neutralizing Ability Performance Test

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## 1. Introduction

Tri Sodium Phosphate(TSP) relating to the OPR1000 and APR1400 Operating Technical Specification is stored in a rack on the floor inside the reactor building and dissolved in the recirculation tank during recirculation after LOCA, and sustained the pH 7 or more. This prevents sodium phosphate from volatilizing the iodine dissolved in the reactor coolant into the containment (CV) atmosphere and suppressing stress corrosion cracking (SCC) of an austenitic stainless steel in the reactor building material during the recycle phase. Technical review of the Operating Technical Specification and periodic inspection procedures of the OPR1000 nuclear power plant was conducted. Periodic inspection procedures were prepared according to the TSP limits and technical background of most operating technical specification. However, there are differences in some items, and the results of the review and discussion are described.

## 2. Background

### 2.1 OPR1000 NPP's ECCS Neutralizing Agent

In SRP 6.5.2, fission products (especially iodine) can be removed from the containment building atmosphere without pH adjustment of the containment tank water in the containment building sump tank. In recirculation mode, the Emergency Core Cooling System (ECCS) water from the cooling water to the containment building inside air, it is necessary to keep the pH of the containment sump coolant at above 7.0 before the recirculation mode is started because it is necessary to prevent iodine re-volatilization.

OPR1000's "ECCS Trisodium Phosphate Inspection Procedure" is designed and prepared to ensure that iodine dissolved in the reactor coolant does not recur after the reactor coolant loss event (LOCA). Procedures have been established to check the storage capacity of sodium and its ability to control pH.

1) Checking the storage status

Perform visual inspection of the structural deformation or corrosion state of the trisodium phosphate storage box and check the storage condition of the chemical(TSP).

To confirm that the minimum amount of TSP, TSP stored in the total trisodium phosphate storage tank is more than 23.5 m<sup>3</sup>, measure the height of each storage box, convert the volume into total volume, record it in the TSP test record .

Storage volume(V) : 1.193 (m) x 1.193 (m) x trisodium phosphate height (m)

2) TSP Sampling

Take approximately 50 g of dry TSP from each of the 4 TSP storage racks and place in the sample bottles

Open the outlet valve of the Boric Acid Makeup Pump in operation according to the 1st system sampling procedure and collect about 15.1 L in the pre-filled sample bottle.

3) Solubility test

Put 3.61 ~ 3.99 liters of the total volume in a suitable container.

Heat the entire reheating water to a temperature of 60.0 ~ 65.6 °C with a heating plate.

Measure the temperature and pH of the reconstituted whole water and record it on the trisodium phosphate test record.

20.4 to 21.4 g of solid trisodium phosphate is immersed in the central surface of the heated recharge water and immersed, and the time is recorded.

Record the time taken for the pH to be 7.0 or higher in the trisodium phosphate test record.

## 3. Discussion on the Plant's Procedures and Technical Specification

### 3.1 OPR1000 nuclear power plant

As a result of reviewing technical guidelines of OPR1000 nuclear power plant and periodical inspection procedures of power plant to implement them, periodic inspection procedures were written according to TSP limits and technical background of most operational technical manuals. However, there are differences in some items.

#### 1) Check quantity of TSP storage box

In the operating technical manual, the representative samples were taken from one storage box and checked. However, in the procedure, samples are collected from four storage boxes according to the recommendation of the regulatory agency.

However, the storage amount of TSP is designed to be sufficiently conservative that the pH can be raised to 7 or more, and accordingly, it is proper to analyze one sample as it is stored accordingly.

If periodic inspections require the regulator inspectors to measure the pH of one or more storage compartments, it is advisable to ask for further confirmation. (For the regular inspection results of Hanul 5,6, 30 cases were satisfied with pH reaching time)

#### 2) Stirring method for checking neutralization ability

The operating technical manual prohibits stirring because proper standards for the stirring method are not provided. However, in the general chemical experiment, stirring is carried out using a magnet rod or the like in order to minimize the measurement error in pH measurement or neutralization process. Therefore, for the safety of the power plant, it is necessary to accurately measure the neutralizing ability of the pH, which is the chemical ability of the TSP. This can prevent unnecessary measures due to unsatisfactory periodical inspection due to pH measurement error, thus lowering safety reliability of the power plant.

#### 3) Measures when dissatisfied with TSP limit

In the Operating Technical Guideline, measures should be taken to restore the limit of the TSP, the pH dissolution time, and the failure of the pH reaching time. However, one of the regular inspection procedures is that if the pH is less than 7 within 25 minutes, the whole storage TSP should be replaced so that it can not be resolved by finding the cause. If you need to replace the TSP so that it can be recovered beyond the limit (volume)

## 4. Conclusions

In order to neutralize the pH of the boric acid solution, pH 4.2, in the emergency core cooling system of OPR1000 from acidic to neutral, the contents of periodic inspection of the TSP installed in the reactor building reviewed.

The results of review are as follows.

### 4.1 OPR1000 nuclear power plant

#### 1) Quantity to be sampled by TSP storage rack

Since the representative samples were collected from one storage box in the operating technical manual, the representative samples were collected from one storage box, and periodical experiments were carried out. When necessary, or when the regulator inspectors measured the pH neutralization capacity of one or more storage boxes If so, it is advisable to carry out additional checks at this time.

#### 2) Stirring method for checking neutralization ability

In general chemical experiments, stirring is carried out using a magnet rod or the like in order to minimize measurement errors in pH measurement or neutralization process. Therefore, for the safety of the power plant, it is necessary to accurately measure the neutralizing ability of pH, which is the chemical ability of TSP, and it is desirable to allow stirring.

#### 3) Measures when dissatisfied with TSP limit

In the Operating Technical Guideline, measures should be taken to restore the limit of the TSP, the pH dissolution time, and the failure of the pH reaching time.

However, one of the regular inspection procedures is that if the pH is less than 7 within 25 minutes, the whole storage TSP should be replaced so that it can not be resolved by finding the cause. It is advisable to carry out TSP replacement if necessary, so that it can be recovered beyond the limit value (volume) after finding the cause in the manual.

## REFERENCES

- [1] ShinKori 1,2 power station TSP inspection procedure.
- [2] SRP 6.5.
- [3] Plant's Technical Specification.