

The Common Inaccessible Phenomena and Solving Suggestion of In-service Inspection in PWR Plant

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ABSTRACT

This paper introduces the standards and specifications requirements of in-service inspection in PWR plant, and it also introduces the common inaccessible phenomena and instances of in-service inspection, it provides the solutions to solve the inaccessible phenomena in nuclear power plant design and implementation stages, such as nondestructive testing method of substitution, etc.

INTRODUCTION

In the operation of nuclear power plant, the device would inevitably influenced by temperature, stress, irradiation, hydrogen adsorption, corrosion, vibration and wear factors, it cause the decline of component performance, and leads to the deterioration of the equipment material performance, affect the normal operation of equipment and systems, and even affect the nuclear safety. Therefore, the nondestructive in-service inspection methods is necessary, it can found the defective equipment in time, and eliminate accident hidden danger, ensure normal operation and safety of the nuclear power unit. It should consider the accessibility requirements when in the implementation of the inspection work, if the equipment or piping do not have enough accessibility, it will not be able to implement nondestructive testing, thus it will have impact on service inspection plan the implementation of the outline, which may affect the safety of nuclear power plant operation, so it is necessary to do further research on accessibility problems of nuclear power plant in service inspection .This article mainly from the following three aspects to discuss the accessibility problems of nuclear power plant in service inspection .

IN SERVICE ACCESSIBILITY STANDARDS AND SPECIFICATIONS

Currently, for nuclear power plant in service inspection of accessibility standards and regulations at home and abroad mainly include: RCC - M Z appendix ZS "in service inspection accessibility requirements in the design of pressurized water reactor nuclear power plant machinery and equipment" (2000 edition) 2000 + 2002 addenda, [1] NB/T 20191-2012 "in service inspection accessibility guidelines in the

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design of the pressurized water reactor nuclear power plant structure” [2]. Standard of NB/T 20191-2012 “in service inspection accessibility guidelines in the design of the pressurized water reactor nuclear power plant structure” mainly refer to the RCC - M (2000 + 2000 addenda) “the design and construction rules of pressurized water reactor nuclear power plant nuclear mechanical equipment” relevant section of the appendix ZS.

NB/T 20191-2012 “in service inspection accessibility guidelines in the design of the pressurized water reactor nuclear power plant structure” stipulate the design service accessibility principle for PWR nuclear power plant system, equipment, parts and layout of the check. It rules the design, manufacture, installation and insulation layer and the support of accessibility requirements, in the design stage it should consider the testing accessibility of system, equipment, parts and decorate, and meet the specific requirements of special test equipment; In the manufacturing stage, it should give full consideration to the tested area scope, the requirement of identification tags, surface state, repair, standard test block factors accessibility requirements; In the installation stage, it should consider the health care physical measures (radiation protection), the space requirements of inspect area, scaffolding, pipes and other factors.

A COMMON INACCESSIBLE PHENOMENON OF CPR1000 NUCLEAR POWER PLANT

Although the relevant standards and norms of the nuclear power plant stipulate the detailed requirements of equipment inspection accessibility, in the actual site inspection there are many inaccessible phenomena due to various factors, this article summarizes common inaccessible phenomenon in a domestic CPR1000 nuclear power plant of in service inspection, and analyzes its inaccessible cause.

Support Block

The inaccessible inspection process mainly concentrated in the penetration test and X-ray test caused by the support block, and the inaccessible phenomenon caused by the support block exists in many systems, such as RCV, ARE, ASG, RRA system of pipeline and support weld, and between the ARE valve and steam generator system of girth weld, etc.

Narrow Space

The inaccessible inspection process caused by narrow space concentrated in the penetration test and X-ray test, the inaccessible penetration test mainly exist in the ASG system pipeline and support weld, and also exist in RRA system valve connection weld. X-ray inaccessible inspection mainly exists in the RCP and RCV system weld, because of the space is narrow, the inaccessible areas proportion is about 30% of the test area.

Structure

The inaccessible inspection process mainly concentrated in the penetration test and ultrasonic test caused by the structure, and the inaccessible phenomenon caused by the support block exists in ultrasonic testing of steam generator secondary side

safe end and the main steam pipe mouth weld, RPV head lug and head weld ultrasonic inspection, the steam generator support leg chamfering penetrant inspection, support skirt, etc. Specific see table 1:

Table 1. Common inaccessible phenomena caused by the structure.

<i>serial number</i>	<i>Check position</i>	<i>Equipment/weld</i>	<i>inspection method</i>
1	<i>The exhaust pipe and head</i>	<i>Four thermocouples pipe run and a guide funnel weld</i>	<i>CCTV</i>
2	<i>Lug and head weld</i>	<i>S/K327-78° S/K327-198° S/K327-318°</i>	<i>PT</i>
3	<i>The steam generator support leg chamfering</i>	<i>3 sets of steam generator support legs</i>	<i>PT</i>
4	<i>Support under head weld</i>	<i>Support under head weld S/K101</i>	<i>UT</i>
5	<i>Support and relief valve cylinder of welds</i>	<i>S/K103-4° S/K103-69°S/K103-184° S/K103-297°</i>	<i>PT</i>
6	<i>12 inch tee of RRA system section (hot and cold water mixed flow section)</i>	<i>RRA0011 pipeline</i>	<i>UT</i>
7	<i>Security side and the main steam nozzle welds</i>	<i>The steam generator security side and the main steam nozzle welds S/C004</i>	<i>UT</i>
8	<i>Feed water pipe (ARE) and cylinder of weld</i>	<i>Feed water pipe (ARE) and cylinder of steam generator weld S/T001</i>	<i>UT</i>

Weld Design

The inaccessible inspection process caused by weld design primarily focused on ultrasonic inspection of ASG nozzle and ARE nozzle weld, the steam generator and the main steam pipe downstream first bend or u-shaped bend section between the girth weld ultrasonic inspection, weld tube plate and the head (including the transitional connection area 1 a) of the ultrasonic inspection, etc.

Other Inaccessible Phenomena

In addition, there are some other inaccessible reasons, such as the inaccessible penetration test of nuclear safety level one pipeline girth weld which is caused by bolt block, the inaccessible penetration test of RIS system pipeline and support weld which is caused by the wall block, the inaccessible radiographic inspection of RCV downstream regulating valve system welding seam and the weld area which is caused by length is not 2 d, etc.

THE CORRESPONDING SOLUTIONS

Through the above analysis of the cause of common inaccessible phenomena of CPR1000 nuclear power station, we put forward the following measures to resolve the problem.

Design Stage

During the design stage, the structure arrangement of inspect pieces should be considered to meet the requirement of checking in service inspection (especially the radiographic inspection and ultrasonic inspection). taking the penetrant inspection for example, we should set aside greater than 600 mm of space between the tested surface and the inspectors, when doing gamma ray inspection, the distance between the radiation source machine and final location shall not exceed 15 m (depending on the maximum length of the cable tube between the X-ray source and inspect device).In the weld design, we should give full consideration to the scene of the actual circumstances, especially we should make the pipe welds arrangement have enough accessibility. At the same time, the design should take the mean of access the inspect area method (platform, scaffolding, operating mechanism, etc.) into account, as well as to the specific requirements of the special test equipment (such as gamma ray source localization). As stated earlier, the part inaccessible of ASG nozzle and ARE nozzle weld ultrasonic inspection is caused by weld design reasons.

Implementation Stage

When the scene couldn't meet the requirements of in service inspection accessibility, we can consider using alternative nondestructive testing method, take the inaccessible X-ray inspection for example, on the premise of meet the inspection requirements, we can consider using ultrasonic inspection method to replace the rays.

When a weld inspection is inaccessible, we can consider by increasing its upstream and downstream weld inspection, to infer whether the working status of this equipment is normal.

CONCLUSION

The accessibility in service inspection in nuclear power plant relates to the safe operation of nuclear power plant, it should be considered in the design and implementation stages of the test, and avoid causes of in accessibility in the design stage as far as possible .This article summarizes the inaccessible reasons, and puts forward some feasible suggestions, it has a certain reference for in service inspection of PWR nuclear power plant.

REFERENCES

- [1] NB/T 20191-2012 “In service inspection accessibility guidelines in the design of the pressurized water reactor nuclear power plant structure” [S].
- [2] RCC-M Design and Construction Rules for Mechanical Components of PWR Nuclear Islands, AFCEN, 2000 edition[S].