Unit 2, Genkai Nuclear Power Plant

Replacement Works for the Steam Generator and the Reactor Pressure Vessel Upper Head

Replacement works for the above components were conducted at Unit 2 of the Genkai Nuclear Power Plant during its 16th scheduled inspection (between March and October 2001).

In the following, the details of the replacement works are described.
Outline of the Replacement Work for the Steam Generator of Unit 2 of the Genkai Nuclear Power Plant

Former steam generator (model 51M)

- Improvement of the steady arms
- Increase in reinforcement from a two-arm assembly to a three-arm one

New steam generator (model 54F)

- Improvement of the small-radius U-bend
  - Heat-treatment-based reduction of residual stress

- Enlargement of the heat transfer area
  (An increase in the number of tube support plates from seven to eight)

- Improvement of the heat transfer tube material
  - Replacement of alloy MA600 with alloy TT690
  - Improvement of the tube support plates
  - Replacement of round holes with four-wing-shaped holes
  - Replacement of carbon steel material with stainless steel material

- Change in the tube plate enlargement work method
  - Use of a roller in combination with an enlargement of the tube with rubber was replaced by use of hydraulic pressure in combination with an enlargement of the tube with a roller
Map Showing the Route of Transportation of the Former Steam Generator in the Site
Measures Taken to Reduce the Dose during the Replacement Work for the Steam Generator of Unit 2 of the Genkai Nuclear Power Plant

* Decontamination of the inner surface of the reactor coolant main pipe and application of a shielding plug to it after cutting of the pipe

* Application of lead shielding onto the outer surface of the reactor coolant main pipe

* Use of remote-operated automatic machines (automatic cutting machines, automatic edge preparation machines, and automatic welding machines for piping use)*1

*1: This includes the effect of operability improvement resulting from training on mockups.
Decontamination of the Inner Surface of the Reactor Coolant Main Pipe and Application of a Shielding Plug to It
Application of Lead Shielding onto the Outer Surface of the Reactor Coolant Main Pipe
Use of Automatic Remote-operated Machines

Automatic cutting machine

Automatic welding machine

Fixed frame

Feed motor

Gear box

Rotary frame

Tool holder

Anchor block

Hydraulic motor

Reactor coolant main pipe

Inside the loop chamber

Power supply

Cutting tool

Tool holder

Anchor block

Hydraulic cutting motor

Fastening fittings

Reaction coolant main pipe

Ultra-compact camera

Welding wire

Movable carriage

Light

Rail

Welding torch
Outline of the Replacement Work for the Reactor Pressure Vessel
Upper Head of Unit 2 of the Genkai Nuclear Power Plant

- Former reactor pressure vessel upper head
- New reactor pressure vessel upper head

Control rod cluster drive mechanism (CRDM)
Part length control rod cluster drive mechanism
Spare nipple
Spare control rod cluster drive mechanism

Removal

- Elimination of canopy seals
  - CRDM housing
  - Change of material
    - SUS F316 replacing a material equivalent to SUS 304
- Change of spares
  - Spare CRDM instead of spare nipples
- Change in the nipple material
  - INCONEL 690 replacing INCONEL 600

Forged monoblock structure
Measures taken to reduce the dose during the replacement work for the reactor pressure vessel upper head of Unit 2 of the Genkai Nuclear Power Plant

* Reduction in working hours through the use of the automatic reactor vessel stud hole brushing machine

* Reduction in working hours through the use of the fully-automatic reactor vessel stud bolt handling machine

* Reduction in working hours through the integration of reactor vessel upper internals
Use of the Automatic Reactor Vessel Stud Hole Brushing Machine
Use of the Fully-automatic Reactor Vessel Stud Bolt Handling Machine
Integration of Reactor Vessel Upper Internals

- Movable cable bridge
- Joining duct
- Missile shield
- Ring duct
# Measures Taken to Reduce the Dose in Unit 2 of the Genkai Nuclear Power Plant and the Effects Achieved by the Measures Taken

<table>
<thead>
<tr>
<th>Description</th>
<th>Before the measure was taken</th>
<th>After the measure was taken</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decontamination of the inner surface of the reactor coolant main pipe and application of a shielding plug to it</td>
<td>651.15</td>
<td>49.98</td>
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<tr>
<td>Application of lead shielding on the outer surface of the reactor coolant main pipe</td>
<td>869.98</td>
<td>403.83</td>
</tr>
<tr>
<td>Use of remote-operated automatic machines (automatic cutting machines, automatic edge preparation machines, and automatic welding machines for piping use)*1</td>
<td>128.59</td>
<td>47.58</td>
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<tr>
<td>Reduction in working hours through the use of the automatic reactor vessel stud hole brushing machine</td>
<td>2.49</td>
<td>0.87</td>
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<tr>
<td>Reduction in working hours through the use of the fully-automatic reactor vessel stud bolt handling machine</td>
<td>16.50</td>
<td>9.22</td>
</tr>
<tr>
<td>Reduction in working hours through the integration of reactor vessel upper internals</td>
<td>17.55</td>
<td>7.62</td>
</tr>
</tbody>
</table>

*1: This includes the effect of operability improvement resulting from training on mockups.

*2: Values calculated on the basis of exposure track records (dose values) under the assumption that the dose reduction measures are not taken.
Measures in Chemical Control Taken to Reduce the Dose in Unit 2 of the Genkai Nuclear Power Plant

• Early removal of dissolved oxygen
  At the startup (at the time of filling RCS with water), vacuum venting machines and gas stripper packages are used to remove dissolved oxygen at an early stage, thereby making the atmosphere reductive to suppress the elution of Ni and Cr from the new steam generator.

• Control of dissolved hydrogen at a low level
  By keeping the dissolved hydrogen concentration at a lower level during power operation, the amount of Ni on the fuel surface is lowered.

• Removal of new outer layer clad
  By adding $\text{H}_2\text{O}_2$ at shutdown (when the cold shutdown state is reached) to keep the dissolved hydrogen concentration at a lower level, the removal of Ni and Co-58 is accelerated.
Graph Showing the Change in Dose at Scheduled Inspections for Unit 2 of the Genkai Nuclear Power Plant
Summary

• In the replacement works described above, taking different dose reduction measures suitable to individual work specifics allowed us to achieve greater dose reduction effectiveness.

• Recently, factors contributing to an increase in dose associated with inspection and maintenance activities have occurred; in ordinary scheduled inspections, however, taking various dose reduction measures as described above helps to secure dose reduction effectiveness.

• We will continue studying new dose reduction measures to further cut down on dosage.

KYUSHU ELECTRIC POWER CO., INC.