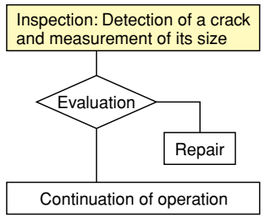
Technology to Detect a Crack and to Measure its Size (sizing)

Background and Objective

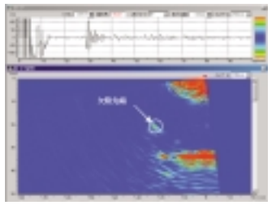
Since October 2003, the evaluation of the integrity system for nuclear power generation facilities has been introduced, and it has become important to measure the size of a crack when it is detected at the periodic inspection. Therefore, the detectability and sizing accuracy of a crack with the technology of non-destructive inspection applied to real plants will be verified, and the guideline will be developed to judge the adequacy of inspection.



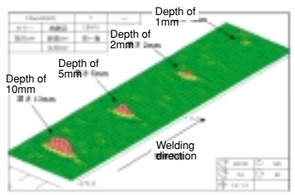
Positioning of inspection on maintenance standards

Features

Using dummy test blocks with artificial cracks simulating ones in real plants, the detectability and sizing accuracy are to be confirmed using the ultrasonic test (UT) now employed at the periodic inspection and the advanced non-destructive inspection technologies (phased array UT method, array ECT method, etc.).



An example of crack detection results, phased array UT



An example of crack detection results, array ECT

Schedule

Program	'95	'96	'97	'98	'99	'00	'01	'02	'03	'04	'05	'06	'07	'08	Name of Program
(1) Confirmation of the UT Method Currently Used at the Periodic Inspection															SGF/UTS
(2) Confirmation of Non-Destructive Inspection Technologies Applied to the Low Carbon Stainless Steel															NSA
(3) Confirmation of Non-Destructive Inspection Technologies Applied to the Nickel-Base Alloy Weld															NNW

SGF / UTS : Development on Standards and Guides for Formation of Up-graded Inspection System on NPP / Ultrasonic Test & Evaluation for Maintenance Standards
NSA : Nondestructive Inspection Technologies for Shroud Integrity Assessments
NNW : Nondestructive Inspection Technologies on the Ni Alloy Welded Joint

Outcomes up to Now and Future Schedule

(1) Confirmation of the UT Method Currently Used at the Periodic Inspection
"Guideline for Sizing of length and depth of defects (provisional draft)" is applied to measure actual defects.

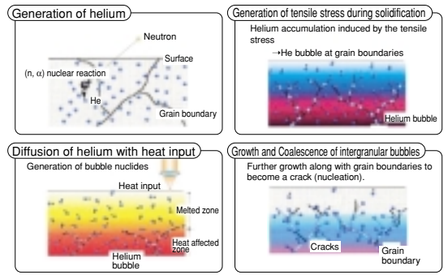
(2) Confirmation of Non-Destructive Inspection Technologies Applied to the Low Carbon Stainless Steel
Proposals of inspection guidelines (for detection and sizing) to be used for the inspection of core shrouds and PLR pipings composed of the low carbon stainless steel will be developed.

(3) Confirmation of Non-Destructive Inspection Technologies Applied to the Nickel-Base Alloy Weld
Proposals of inspection guidelines (for detection and sizing) to be applied to the welded metal of the nickel-base alloy used for reactor internals, safe-ends and RPV penetrations will be developed.

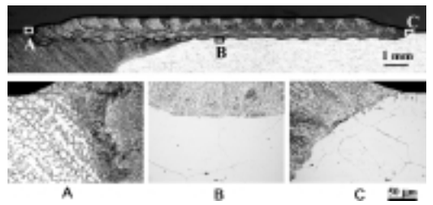
WeldingTechnologies for Aged Materials Ensuring Safety

Background and Objective

Helium (He) atoms are generated from the neutron transformation of boron, nickel etc., which are in steels, when the reactor internal components are neutron-irradiated. When materials such as nuclear reactor components will be welded, cracks may generate with the influence of helium. This research project is a safety-related one to optimize heat inputs corresponding to the amount of helium contained in materials in order to perform welding without generating a crack during the preventive maintenance or repair welding for such materials.



Features



Microstructures of laser clad Type 304 SS containing 2.7 and 7.7 appm He in base metal and weld metal. Laser cladding condition: two times of cladding followed by re-melting with heat input of 6.0 kJ/cm.

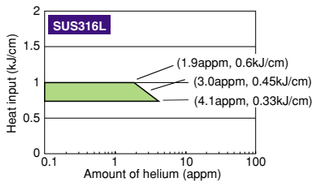
Neutron irradiated test specimens made of stainless steel and low alloy steel containing the helium generated by neutron irradiation are transported to the hot laboratory facility for various kinds of evaluation tests on weld soundness. The major welding methods are YAG-laser welding, which gives low heat input, tungsten inert gas welding and friction welding. After welding, evaluation tests were conducted and welding techniques and heat input conditions were optimized from the view point of prevention of He induced cracks.

Schedule

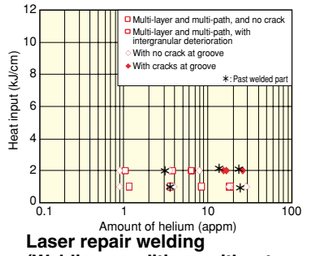
Item	'96	'97	'98	'99	'00	'01	'02	'03	'04
(1) Investigation and Planning									
(2) Design and Manufacturing of Irradiation Test Materials									
(3) Welding Test with Non-Irradiated Materials									
(4) Welding Test with Irradiated Materials									
(5) Evaluation Test on Weld Properties									
(6) Comprehensive Evaluation									

- Preparing neutron irradiated test specimen of stainless steel, low alloy steel with cladding of nickel base alloy
- Soundness test of the surface modification technique by laser cladding & laser welding
- Mechanical evaluation test of the repair weldment by bending test, tensile tension test

Outcomes up to Now and Future Schedule



Surface modification (laser cladding) Dack area: optimized Welding conditions without causing helium induced cracks



Laser repair welding (Welding conditions without causing helium induced cracks)

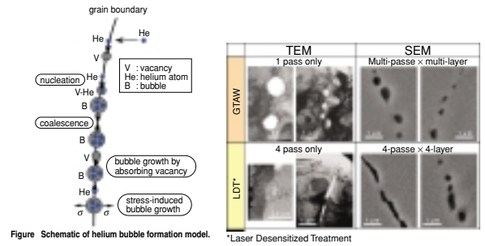


Figure Schematic of helium bubble formation model.

*Laser Desensitized Treatment

Optimizetion of welding conditions for no crack through evaluation of helium induced crack susceptibility due to the difference of material and heat treatment, and comparison of experimental results with the helium l crack analytica model (generation and growth of helium bubbles).