ACCEPTANCE TEST FOR GRAPHITE COMPONENTS AND CONSTRUCTION STATUS OF HTTR

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Abstract

In March 1991, the Japan Atomic Energy Research Institute(JAERI) started to construct the High Temperature engineering Test Reactor(HTTR) which is a 30-MW(thermal) helium gas-cooled reactor with a core composed of prismatic graphite blocks piled on the core support graphite structures. Two types of graphite materials are used in the HTTR. One is the grade IG-110, isotropic fine grain graphite, another is the grade PGX, medium-to-fine grained molded graphite. These materials were selected on the basis of the appropriate properties required by the HTTR reactor design.

Industry-wide standards for an acceptance test of graphite materials used as main components of a nuclear reactor had not been established. The acceptance standard for graphite components of the HTTR, therefore, was drafted by JAERI and reviewed by specialists outside JAERI. The acceptance standard consists of the material testing, non-destructive examination such as the ultrasonic and eddy current testings, dimensional and visual inspections and assembly test. Ultrasonic and eddy current testings are applied to graphite logs to detect an internal flaw and to graphite components to detect a surface flaw, respectively. The assembly test is performed at the works, prior to their installation in the reactor pressure vessel, to examine fabricating precision of each component and alignment of piled-up structures.

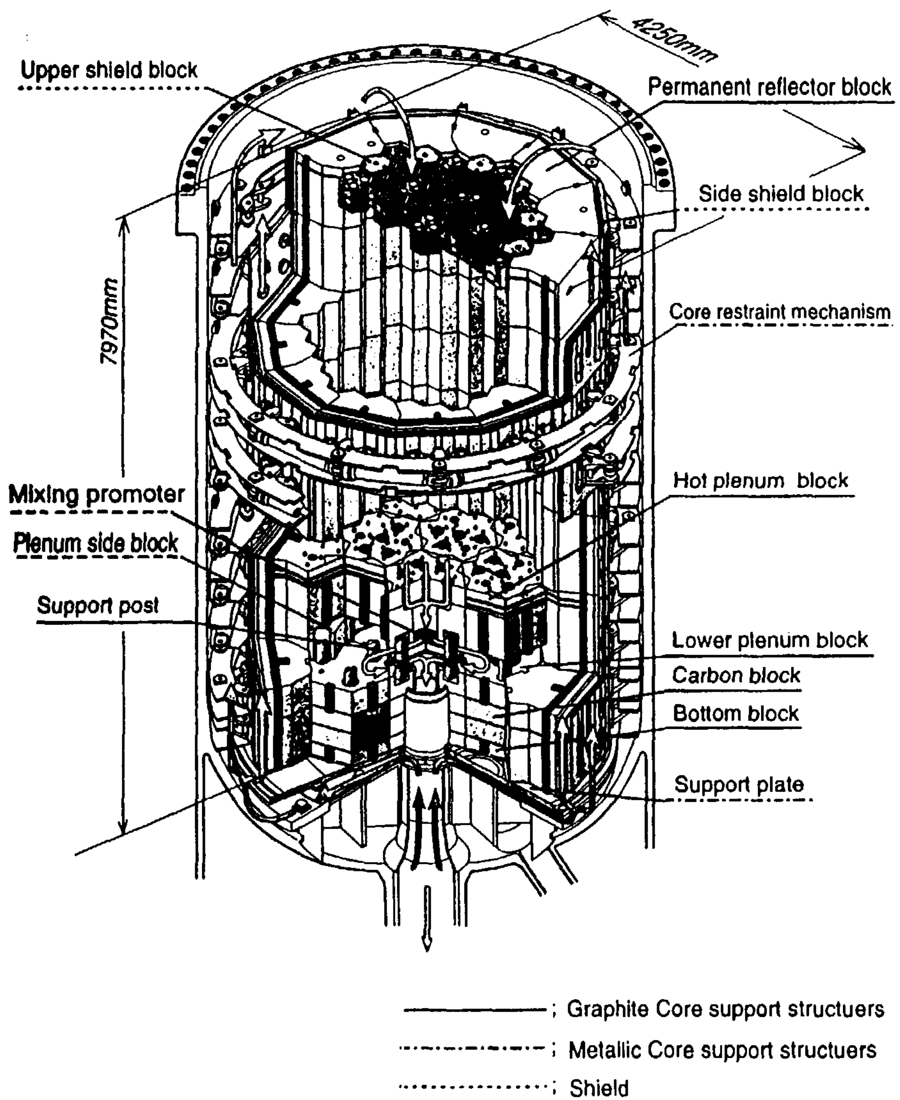
The graphite components of the HTTR had been tested on the basis of the acceptance standard. It was confirmed that the graphite manufacturing process was well controlled and high quality graphite components were provided to the HTTR. All graphite components except for the fuel graphite blocks are to be installed in the reactor pressure vessel of the HTTR in September 1995. The paper describes the construction status of the HTTR focusing on the graphite components. The acceptance test results are also presented in this paper.

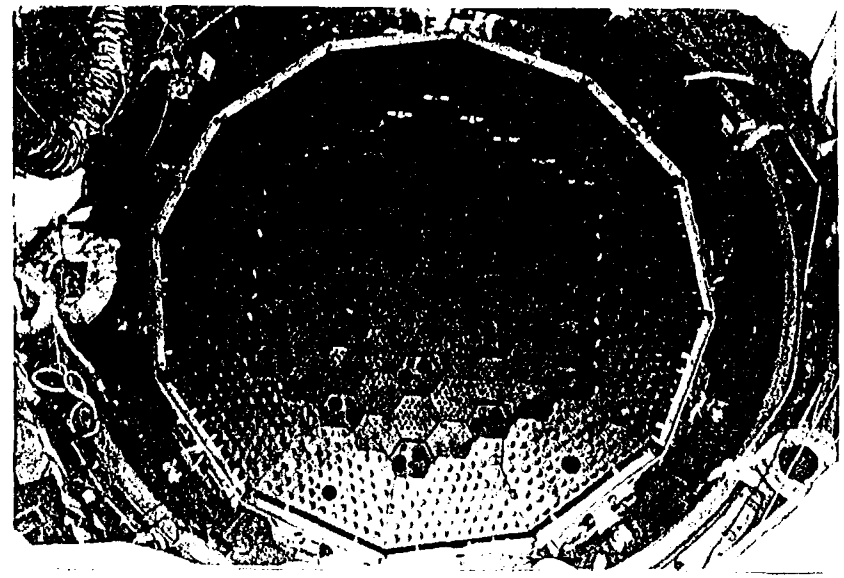
INTRODUCTION

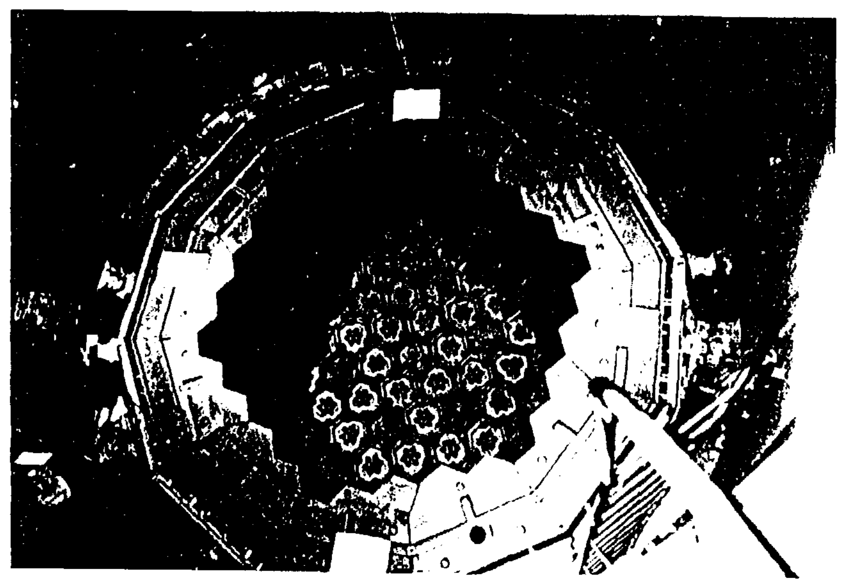
In March 1991, the Japan Atomic Energy Research Institute(JAERI) started to construct the High Temperature engineering Test Reactor(HTTR) which is a high temperature gas cooled test reactor with thermal output of 30MW and the highest reactor outlet coolant temperature of 950℃. The HTTR is utilized for establishing and upgrading the technology basis for advanced HTGRs including the nuclear heat application and various innovative high temperature basic researches.

The core of the HTTR consists of prismatic graphite blocks piled on the core support graphite structures. Industry-wide standards for an acceptance test of graphite materials used as main components of a nuclear reactor had not been established. The acceptance standard for graphite components of the HTTR, therefore, was drafted by JAERI and reviewed by specialists outside JAERI. The acceptance standard consists of the material inspection, non-destructive examination such as the ultrasonic and eddy current testings, dimensional and visual inspections and assembly test.

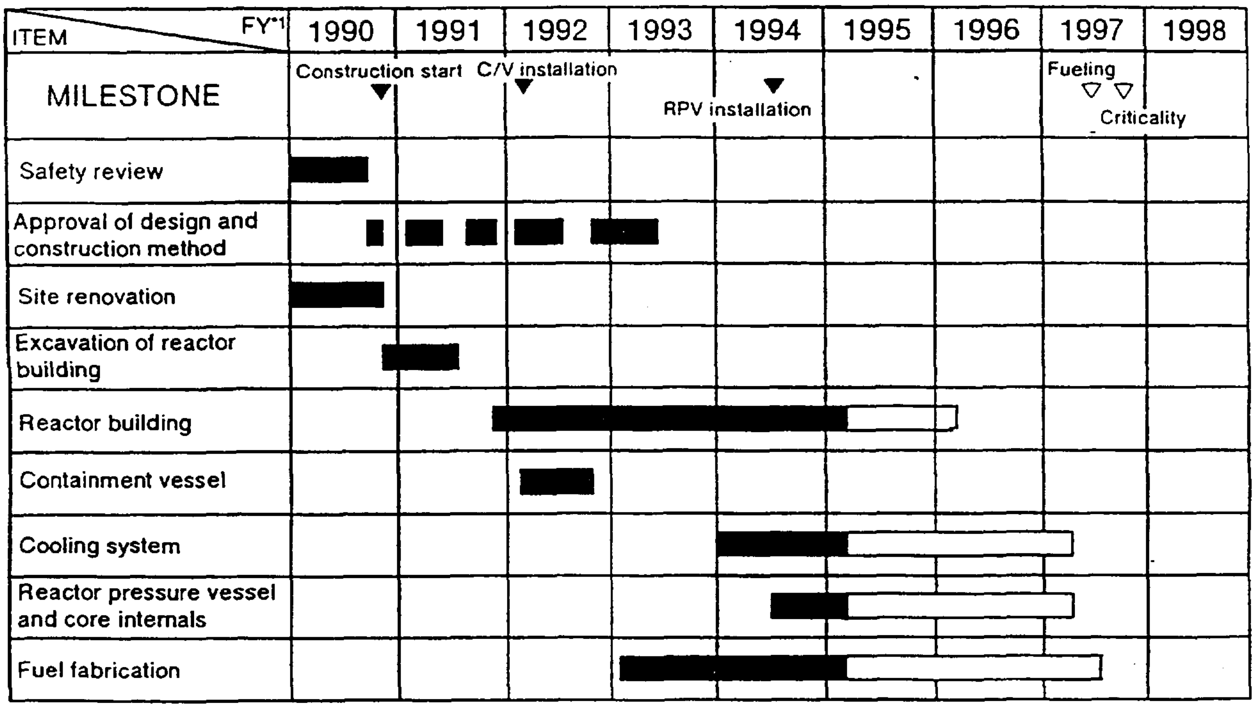
HTTR Core internal structure







Construction Schedule of HTTR



*1 Fiscal year of Japan starts in April and ends in March

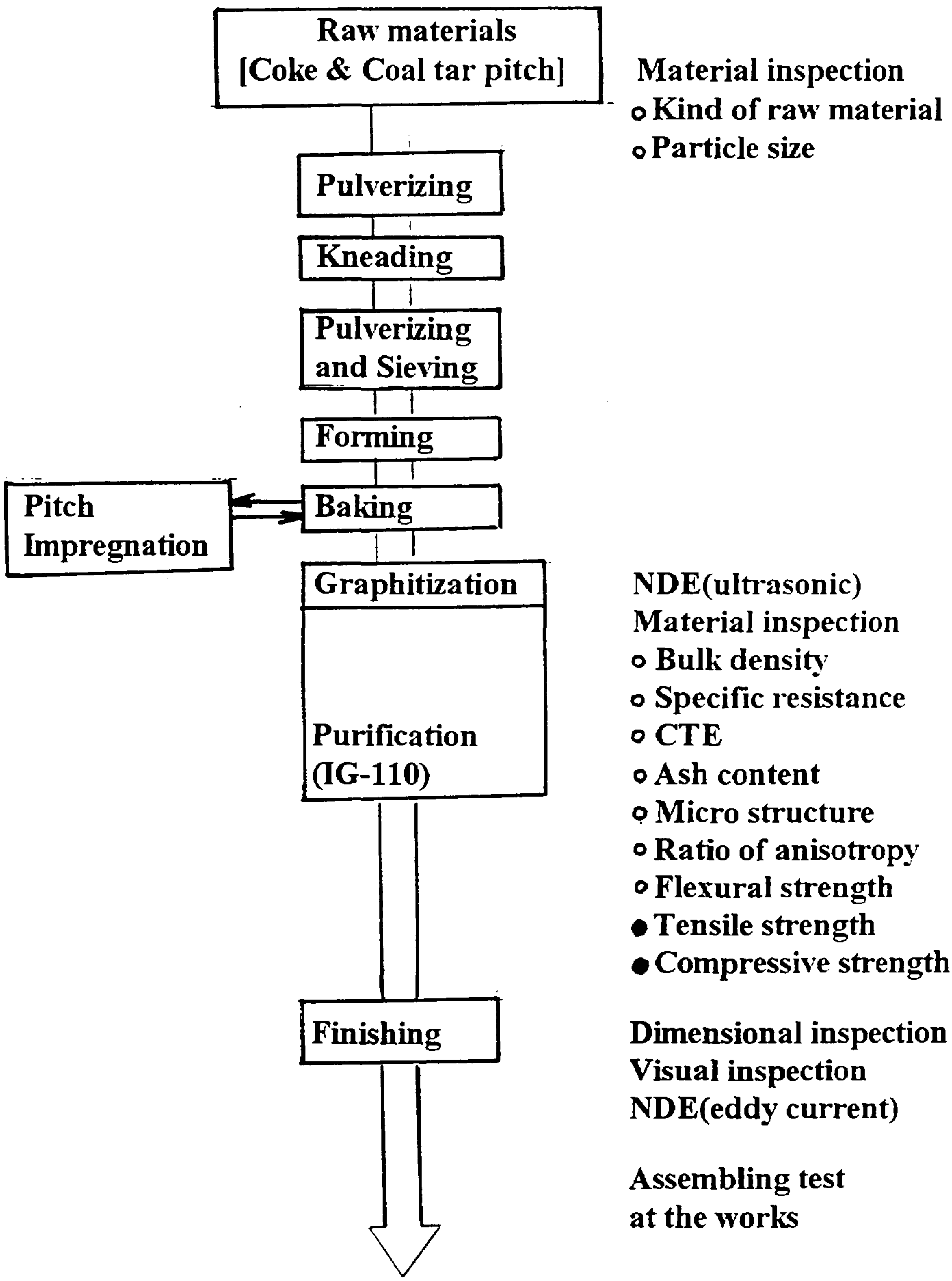
Major specification of HTTR

Thermal power	30 MW
Outlet coolant temperature	850 / 950 ℃
Inlet coolant temperature	395 ℃
Fuel	Low-enriched UO_2
Fuel element type	Prismatic block
Direction of coolant flow	Downward flow
Pressure vessel	Steel
Primary coolant pressure	4 MPa
Containment type	Steel containment
Plant lifetime	20 years

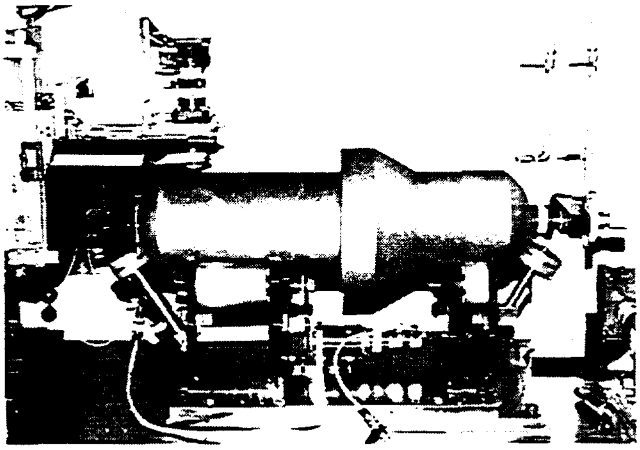
Typical mechanical properties for IG-110 and PGX graphites

Mechanical property	IG-110 graphite	PGX graphite
Bulk density (kg/m^3)	$1.78x10^3$	$1.73x10^3$
Tensile strength (MPa)	25.3	8.1
Compressive strength (MPa)	76.8	30.6
Bending strength (MPa)	36.8	13.2
Young's modulus (GPa)	8.3	6.8
Grain size (mm)	mean 0.02	maximum 0.8

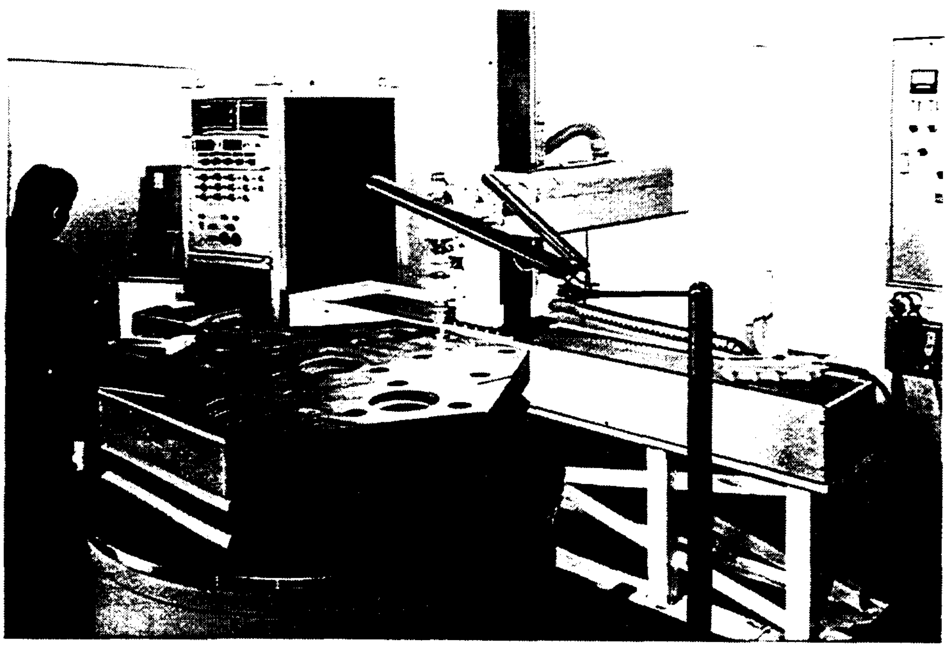
Inspection items for graphite material



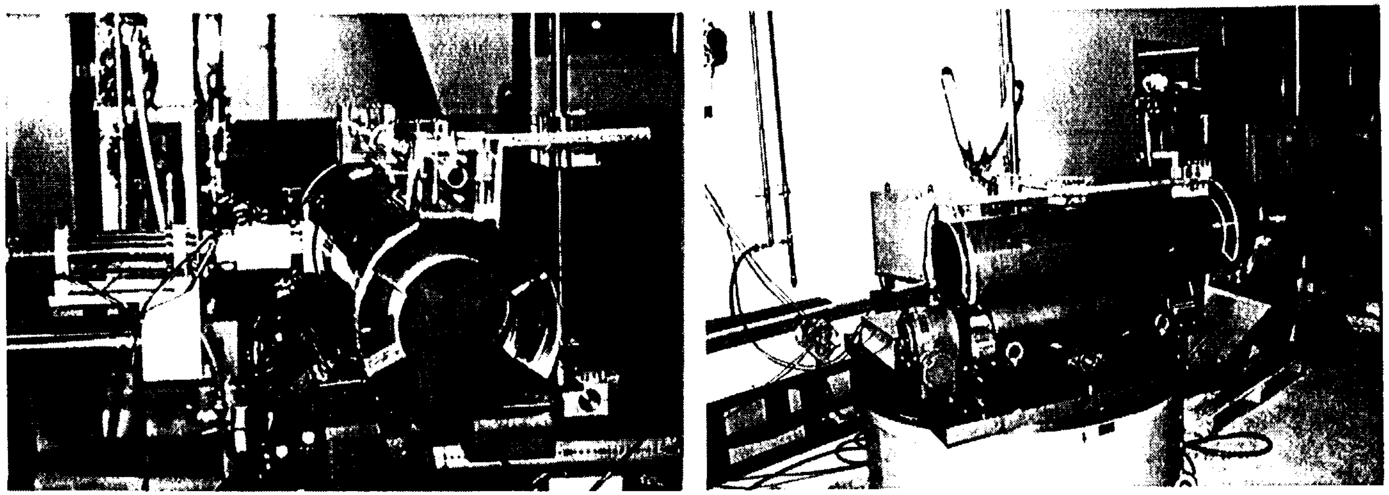
NDE ; Non destructive examination
CTE ; Coefficient of thermal expansion



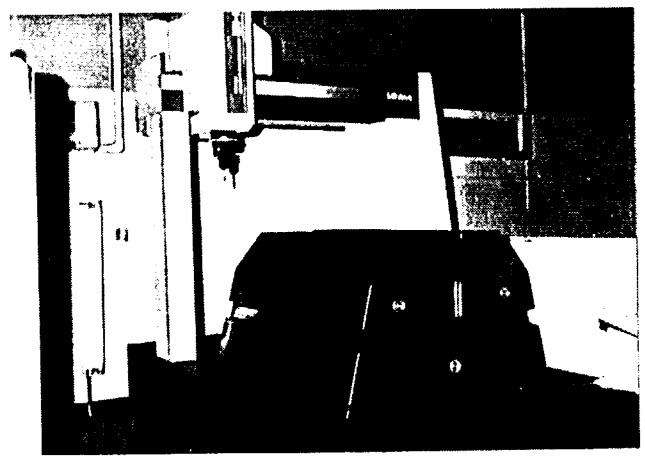
Eddy current testing scene for support post made of IG-110 graphite



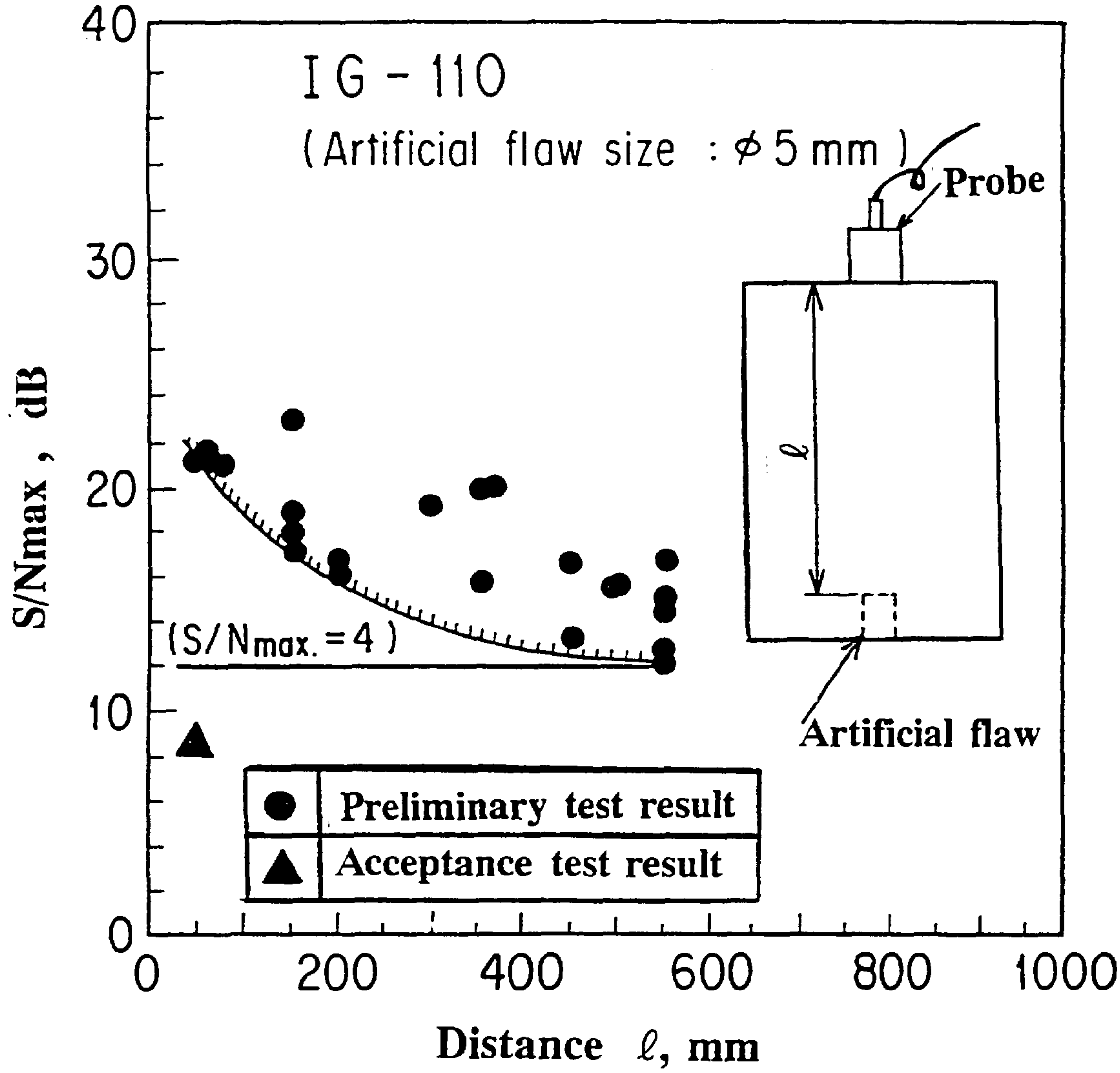
Eddy current testing scene for hot plenum block made of PGX graphite



Ultrasonic testing scene for IG-110 graphite log

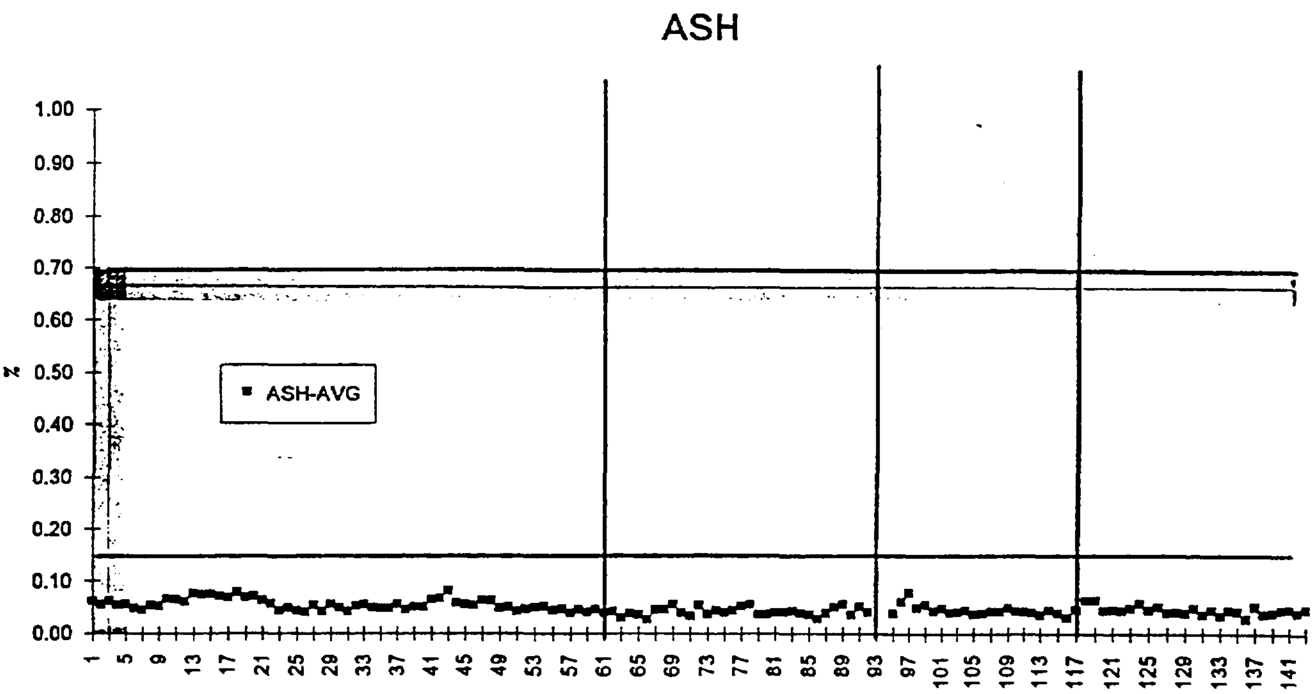


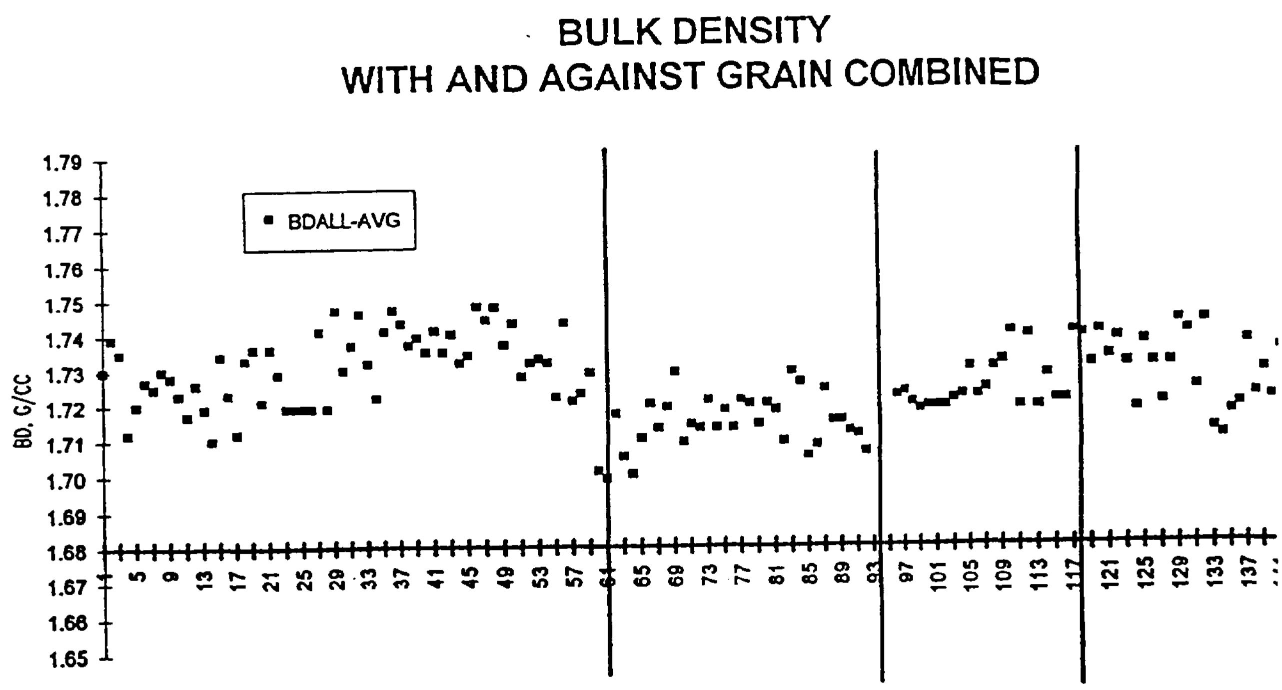
Dimensional measurement scene for permanent reflector block



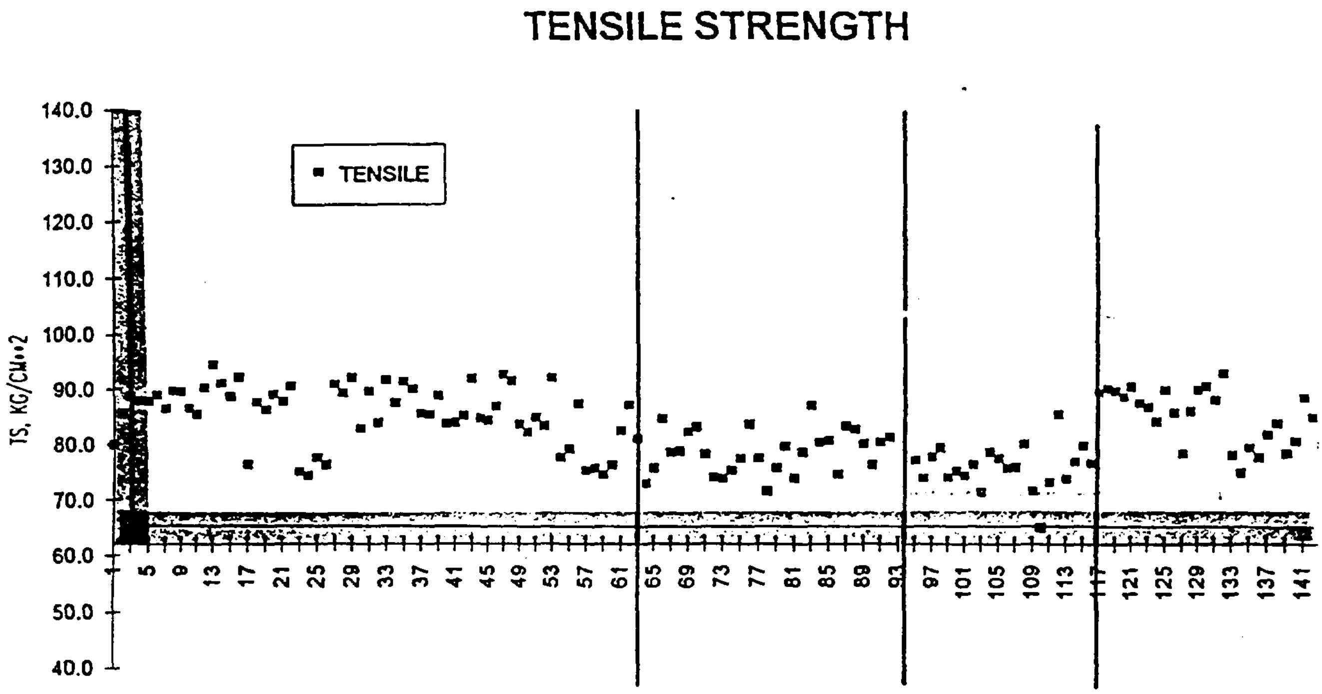
Ultrasonic testing result(Flaw detectability of IG-110 graphite)
S ; Flaw echo-height, Nmax ; Maximum noise-echo height

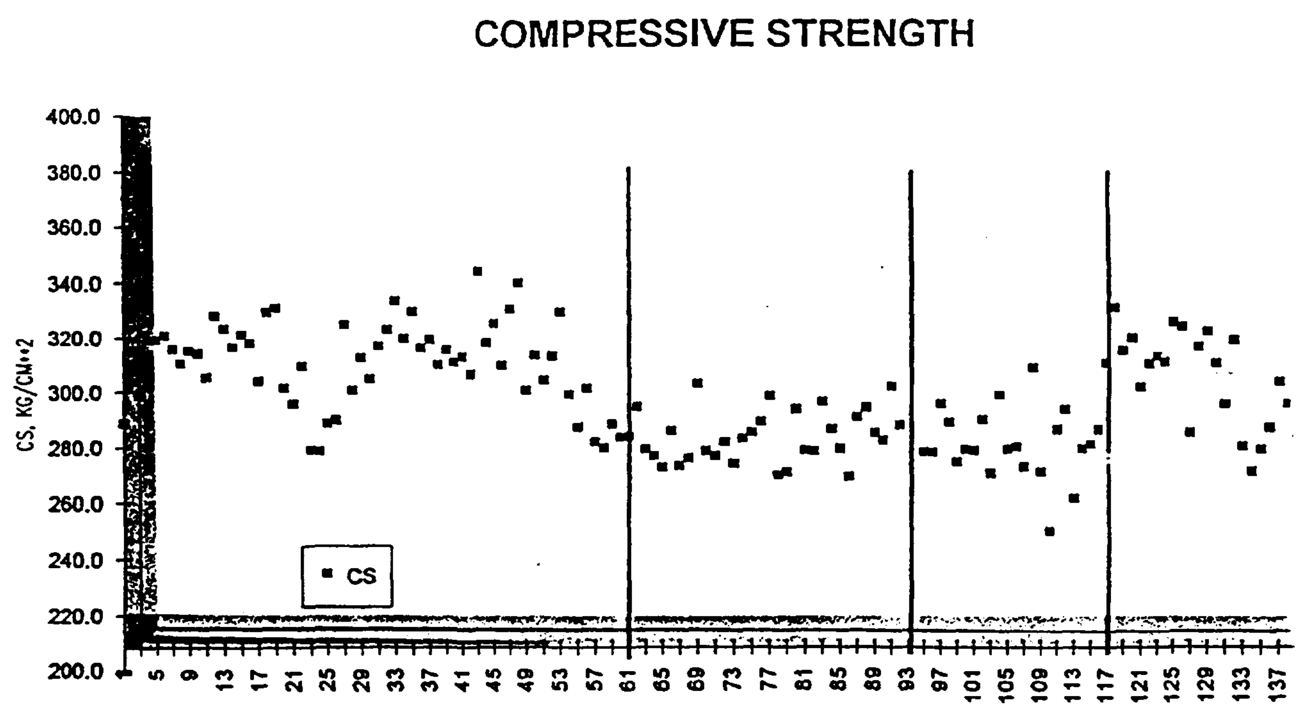
Pass/fail criteria are regulated such that the graphite block is failed in the test when the flaw-echo height exceeds the 4Nmax. The maximum detected flaw-echo height was 2.6Nmax, which corresponds to the equivalent flaw size of about 2mm.





Typical material inspection results for PGX graphite





Typical material inspection results for PGX graphite

CONCLUSION

The graphite components of the HTTR had been tested on the basis of the acceptance standard. It was confirmed that the graphite manufacturing process was well controlled and high quality graphite components were provided to the HTTR. All graphite components with the exception of fuel graphite blocks were installed in the reactor pressure vessel of the HTTR in August 1995. The first criticality of the HTTR will be attained in 1997.