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Space systems — Non-destructive testing — Automatic ultrasonic inspection method of graphite ingot for solid rocket motors

Systèmes spatiaux — Essais non destructifs — Méthode par injection ultrasonique du bloc graphite pour les moteurs de fusée à combustible solide

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Foreword

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Introduction

In February 2000, the Institute of Space and Astronautical Science (now Japan Aerospace Exploration Agency) launched an M-V-4 rocket that experienced an unexpected failure. An intensive post-flight study was carried out. It was finally concluded that the failure originated from the fracture of a nozzle throat insert made of graphite[1]. Then, a study of non-destructive inspection was initiated, and the ultrasonic inspection method specified in this International Standard was developed for use on the throat inserts of solid rocket motors.

Graphite materials have been utilized without quantitative non-destructive inspection in many applications, except for one example of the core structure of the High Temperature Engineering Test Reactor (HTTR) of the Japan Atomic Energy Research Institute[2]. There, planar flaws perpendicular to the top, bottom or side surfaces in a cylindrical ingot were targeted. However, for aerospace applications, it is necessary to detect internal planar flaws oriented in various directions.

The method is based on a single-probe, pulse-echo and immersion technique utilizing normal and angle-beam techniques to detect internal planar flaws oriented in various directions. The wave velocity and the attenuation coefficient in the test object are measured before inspection to determine the differences in acoustic properties from ingot to ingot. Incident-angle scanning is adopted in addition to the common beam-axis scanning to detect flaws that can be oriented in various directions. This inspection technique is necessary for inspection of sintered materials in general, including ceramics, and not only for graphite used in solid rocket motors.

The method was first published as JIS Z 2356[3] in 2006 by the Japanese Industrial Standards Committee.