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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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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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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.