ASME 3977-2—2000
(Identical to ISO 3977-2: 1997)

GAS TURBINES: PROCUREMENT

Part 2: Standard Reference Conditions and Ratings

AN AMERICAN NATIONAL STANDARD

The American Society of Mechanical Engineers

The American Society of Mechanical Engineers

AN AMERICAN NATIONAL STANDARD

GAS TURBINES: PROCUREMENT

Part 2: Standard Reference Conditions and Ratings

ASME 3977-2—2000
(Identical to ISO 3977-2: 1997)

Date of Issuance: November 17, 2000

This Standard will be revised when the Society approves the issuance of a new edition. There will be no addenda issued to this edition.

ASME will issue written replies to inquiries concerning interpretations of technical aspects of this Standard.

The American Society of Mechanical Engineers
Three Park Avenue, New York, NY 10016-5990

FOREWORD

The purpose of the ASME 3977 standards is to facilitate preparation of, and response to, gas turbine procurement specifications. They are generally applicable to gas turbines for electrical power generation and industrial generator and mechanical drive service.

Commencing in 1977, the B133 Standards Committee of ASME produced a set of gas turbine procurement specifications, covering all aspects of the process from specification preparation to maintenance and safety. In 1988 the International Standards Organization (ISO) established Technical Committee TC 192, Gas Turbines, which proceeded to develop a set of procurement specifications documented as ISO 3977. In view of the international nature of the gas turbine marketplace, the B133 Committee elected to support the ISO effort, and a Technical Advisory Group (TAG) under B133 was formed to coordinate this support.

Through the participation of the US TAG in the preparation of the ISO 3977 documents, the intent is to adopt the various parts of ISO 3977 as ASME standards.

The purpose of this Standard, Part 2: Standard Reference Conditions and Ratings, is to provide a basis for a defined set of standard reference conditions and ratings pertinent to the ASME 3977 series of gas turbine standards.

ASME 3977-2–2000 is an identical national adoption of ISO 3977-2: 1997 and was approved as an American National Standard on June 7, 2000.

ASME B133 COMMITTEE
Gas Turbine Procurement

(The following is the roster of the Committee at the time of approval of this Standard.)

OFFICERS

R. G. Narula, *Chair*
R. P. Allen, *Vice Chair*
R. L. Crane, *Secretary*

COMMITTEE PERSONNEL

R. P. Allen, Consultant
R. L. Crane, The American Society of Mechanical Engineers
S. M. Decorso, Power Tech Associates, Inc.
S. A. Dellavilla, Strategic Power Systems, Inc.
G. S. Howard, Consultant
W. S. Hung, Consultant
R. Kurz, Solar Turbines, Inc.
R. G. Narula, Bechtel Power Corp.
K. M. Hyam, *Alternate,* Bechtel Power Corp.
G. Opdyke, Jr., Dykewood Enterprises
D. J. Parzych, Power Acoustics, Inc.
W. I. Rowen, Turbine Engineering Consultancy
D. J. Ugolini, Bechtel Power Corp.
J. M. Vaught, Vaught Engineering, Inc.

SUBCOMMITTEE 1 — BASIC GAS TURBINE AND PERFORMANCE

G. S. Howard, *Chair,* Consultant
R. P. Allen, Consultant
S. T. Cloyd, Westinghouse Electric Corp.
S. M. Decorso, Power Tech Associates, Inc.
R. Kurz, Solar Turbines, Inc.
F. J. Mulato, Consultant
R. G. Narula, Bechtel Power Corp.
G. Opdyke, Jr., Dykewood Enterprises
M. E. Osborne, Naval Sea Systems Command
V. Rosen, Siemens Power Corp.
W. I. Rowen, Turbine Engineering Consultancy
E. J. Willson, Jr., Consultant

US TAG TO ISO/TC 192

R. G. Narula, *Chair,* Bechtel Power Corp.
R. P. Allen, Consultant
R. L. Crane, The American Society of Mechanical Engineers
S. A. Dellavilla, Strategic Power Systems, Inc.
G. S. Howard, Consultant
W. S. Hung, Consultant

R. Kurz, Solar Turbines, Inc.
D. J. Parzych, Power Acoustics, Inc.
B. W. Rising, Siemens Westinghouse
W. I. Rowen, Turbine Engineering Consultancy
D. J. Ugolini, Bechtel Power Corp.

CORRESPONDENCE WITH B133 COMMITTEE

General. ASME Standards are developed and maintained with the intent to represent the consensus of concerned interests. As such, users of this Standard may interact with the Committee by requesting interpretations, proposing revisions, and attending Committee meetings. Correspondence should be addressed to:

Secretary, B133 Standards Committee
The American Society of Mechanical Engineers
Three Park Avenue
New York, NY 10016-5990

Proposing Revisions. Revisions are made periodically to the Standard to incorporate changes that appear necessary or desirable, as demonstrated by the experience gained from the application of the Standard. Approved revisions will be published periodically.

The Committee welcomes proposals for revisions to this Standard. Such proposals should be as specific as possible, citing the paragraph number(s), the proposed wording, and a detailed description of the reasons for the proposal, including any pertinent documentation.

Interpretations. Upon request, the B133 Committee will render an interpretation of any requirement of the Standard. Interpretations can only be rendered in response to a written request sent to the Secretary of the B133 Standards Committee.

The request for interpretation should be clear and unambiguous. It is further recommended that the inquirer submit his/her request in the following format:

Subject: Cite the applicable paragraph number(s) and the topic of the inquiry.

Edition: Cite the applicable edition of the Standard for which the interpretation is being requested.

Question: Phrase the question as a request for an interpretation of a specific requirement suitable for general understanding and use, not as a request for an approval of a proprietary design or situation. The inquirer may also include any plans or drawings, which are necessary to explain the question; however, they should not contain proprietary names or information.

Requests that are not in this format will be rewritten in this format by the Committee prior to being answered, which may inadvertently change the intent of the original request.

ASME procedures provide for reconsideration of any interpretation when or if additional information that might affect an interpretation is available. Further, persons aggrieved by an interpretation may appeal to the cognizant ASME Committee or Subcommittee. ASME does not "approve," "certify," "rate," or "endorse" any item, construction, proprietary device, or activity.

Attending Committee Meetings. The B133 Standards Committee regularly holds meetings, which are open to the public. Persons wishing to attend any meeting should contact the Secretary of the B133 Standards Committee.

CONTENTS

INTRODUCTION

ASME 3977 provides technical information to be used for the procurement of gas turbine systems, including combined-cycle systems and their auxiliaries, by a purchaser from a manufacturer.

NOTE: Where the term "manufacturer" is used in this Standard, it is deemed to mean the gas turbine manufacturer or the appropriate responsible contractor.

This Standard provides a basis for the submission of proposals in line with the different environmental and safety requirements. It also specifies, wherever possible, criteria to establish whether these are met. It does not attempt to deal with local or national legal requirements to which the installation may be required to conform.

Because of the very widely varying operating modes for gas turbines in practice, distinct categories of operating modes are specified with which a "standard" rating can be associated. These ratings are made on the basis of the ISO standard ambient reference conditions.

The various parts of ASME 3977 define a standard framework for dealing with questions of fuel and other matters, such as the minimum information to be provided by both the purchaser and the manufacturer. They do not, however, purport to include all necessary information for a contract and each gas turbine installation should be considered in its entirety. Attention is drawn to the need for technical consultation between the manufacturer and the purchaser to ensure compatibility of equipment being supplied, particularly where the responsibility for supply is divided.

ASME 3977 is applicable to open-cycle gas turbine power plant using combustion systems, and to closed-cycle, semiclosed-cycle, and combined-cycle gas turbine power plants. In the case of turbines using free piston gas generators or special heat sources (e.g., chemical process, nuclear reactors, furnaces for super-charged boilers), it may be used as a basis but will need to be suitably modified.

This Standard is not applicable to gas turbines used to propel aircraft, road construction and earth-moving machines, agricultural and industrial types of tractors, and road vehicles.

GAS TURBINES: PROCUREMENT

PART 2: STANDARD REFERENCE CONDITIONS AND RATINGS

1 SCOPE

This Part of ASME 3977 specifies the standard reference conditions and ISO standard ratings for gas turbines.

2 NORMATIVE REFERENCE

The following standard contains provisions which, through reference in this text, constitute provisions of this Part of ASME 3977. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this Part of ASME 3977 are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below.

ISO 2314: 1989, Gas turbines — Acceptance Tests.

3 STANDARD REFERENCE CONDITIONS

The standard reference conditions on which power, efficiency, heat rate, and specific fuel consumption are based are as specified in 3.1 through 3.4.

3.1 Air Intake Conditions

For the intake air at the compressor flange (alternatively, the compressor intake flare), as described in ISO 2314: 1989, 6.6.2, the conditions shall be:

(a) a total pressure of 101.3 kPa (14.696 psia);

(b) a total temperature of 15°C (59°F);

(c) a relative humidity of 60%.

3.2 Exhaust Conditions

For the exhaust at the turbine exhaust flange (or regenerator outlet, if a regenerative cycle is used), the static pressure shall be 101.3 kPa (14.696 psia).

3.3 Cooling Water Conditions (if Applicable)

The inlet water temperature shall be 15°C (59°F) if cooling of the working fluid is used.

3.4 Working Fluid Heater or Cooler

Where a heater or a cooler is used that uses ambient air, the standard reference conditions of the ambient air shall be 15°C (59°F) and 101.3 kPa (14.696 psia).

4 RATINGS

4.1 General

4.1.1 The output power of a given gas turbine at a given reference turbine inlet temperature is, in general, proportional to the absolute ambient pressure and is also greatly dependent on the air intake temperature (normally outside dry bulb temperature). Likewise, the output at a given air intake temperature is dependent on the reference turbine inlet temperature. To achieve a rating, it is necessary to adopt standard conditions of ambient temperature and pressure, but gas turbine ratings will nevertheless vary considerably owing to the differing operational modes demanded of them as well as the varying criteria used in the design of the basic elements. ISO standard ratings neglect pressure drop at the inlet and exhaust but site ratings allow for these losses.

NOTE: Steam or water injection may be used to increase the power output and to reduce the NO_x emissions.

4.1.2 The performance ratings of gas turbines shall be assessed on the net specific energy of the fuel used, as follows:

(a) turbines intended for use on liquid fuel: 42 000 kJ/kg (18,060 btu/lbm);

(b) turbines intended for use on gaseous fuel (100% methane): 50 000 kJ/kg (21,500 btu/lbm).

The specific energy at constant pressure of the fuel, whether liquid, gaseous, or solid, is based on a pressure of 101.3 kPa (14.696 psia) and a temperature of 15°C (59°F).

4.1.3 If the fuel to be used for testing the gas turbine is different from that agreed between the purchaser and the manufacturer for service operation, a test fuel of a mutually agreed specification shall be used.

NOTE: Further information will be given in ISO 3977-4, now in course of preparation.

4.2 Operational Modes

Unless specially agreed upon between the purchaser and the manufacturer, the net power rating of a gas turbine shall be specified under a combination of one of the classes specified in 4.2.1 together with one of the ranges of average number of starts per annum specified in 4.2.2.

EXAMPLE: B II (Class B, Range II) refers to operation of up to 2 000 h per annum associated with any number of starts up to 500 per annum.

The manufacturer shall state the type, frequency, and degree of inspection and/or maintenance required for the relevant operational mode.

NOTE: Further information will be given in ISO 3977-4, now in course of preparation.

4.2.1 Classes

(a) Class A: operation up to and including 500 h per annum at reserve peak power rating.

(b) Class B: operation up to and including 2 000 h per annum at peak power rating.

(c) Class C: operation up to and including 6 000 h per annum at semi-base power rating.

(d) Class D: operation up to and including 8 760 h per annum at base power rating.

NOTE: It should be recognized that some gas turbine applications will operate with a combination of the classes given in 4.2.1. In such cases, the purchaser should specify the anticipated number of annual hours of operation at the specified net power ratings in each class. Operation outside these specified net power ratings/operational modes could materially affect the inspection intervals and maintenance required.

4.2.2 Ranges

(a) Range I: over 500 starts per annum average;

(b) Range II: up to 500 starts per annum average;

(c) Range III: up to 100 starts per annum average;

(d) Range IV: up to 25 starts per annum average;

(e) Range V: continuous operation without planned shutdown for inspection and/or maintenance within a specified period.

4.3 ISO Standard Ratings

The manufacturer shall declare standard ratings, based on electrical power at the generator terminals or on turbine output shaft power under the standard reference conditions defined in clause 3, associated with the following operational modes:

(a) ISO standard peak load rating (2 000 h and 500 starts per annum average) Class B: Range II;

(b) ISO standard base load rating (8 760 h and 25 starts per annum average) Class D: Range IV.

In each case, the manufacturer shall state the type, frequency, and degree of inspection and/or maintenance required.

4.4 Site Ratings

The site power rating shall be specified by the manufacturer as follows.

(a) Generating plant: the net electrical power at the generator terminals, with adjustment for auxiliary power as given in ISO 2314: 1989, 8.1.2.

(b) Mechanical drives: the net shaft power, adjusted for any auxiliaries not driven directly by the turbine (as defined in ISO 2314: 1989, 8.1.1).

In either case, the site power rating shall relate to specified site conditions of the installation (such as ambient pressure and temperature, and pressure losses, steam and water injection, etc.) and operating modes under which the plant is intended to run in service.

When the gas generator is supplied separately, its site power shall be expressed as the gas power arising from the isentropic expansion of the gas generator exhaust flow (using total pressure and temperature) to the ambient atmospheric pressure when it is operated under the specified site conditions of the installation and operating modes under which the plant is intended to run in service (see ISO 2314: 1989, 6.3.5).

ASME Services

ASME is committed to developing and delivering technical information. At ASME's Information Central, we make every effort to answer your questions and expedite your orders. Our representatives are ready to assist you in the following areas:

ASME Press
Codes & Standards
Credit Card Orders
IMechE Publications
Meetings & Conferences
Member Dues Status
Member Services & Benefits
Other ASME Programs
Payment Inquiries
Professional Development
Short Courses
Publications
Public Information
Self-Study Courses
Shipping Information
Subscriptions/Journals/Magazines
Symposia Volumes
Technical Papers

How can you reach us? It's easier than ever!

There are four options for making inquiries* or placing orders. Simply mail, phone, fax, or E-mail us and an Information Central representative will handle your request.

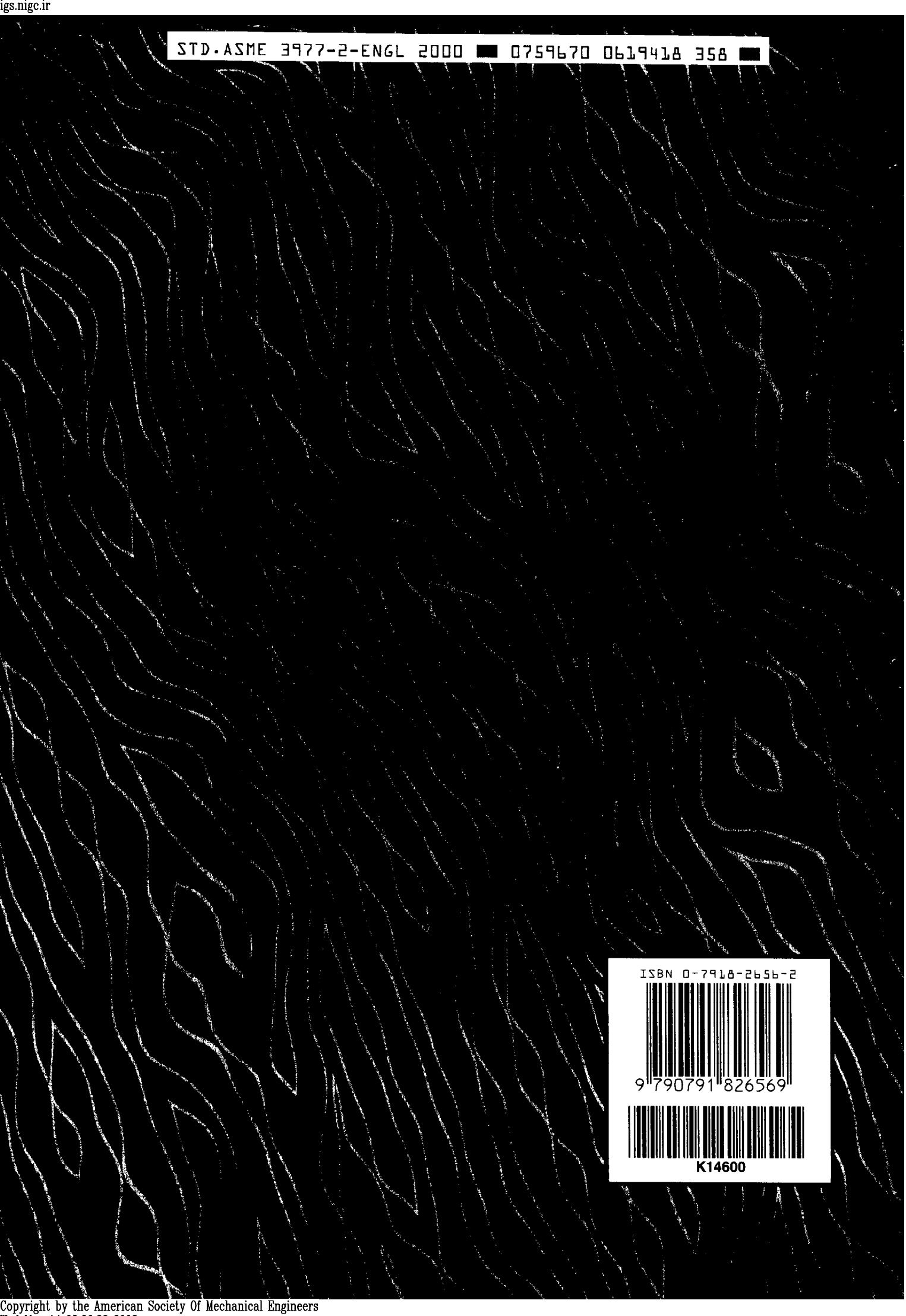
Mail
ASME
22 Law Drive, Box 2900
Fairfield, New Jersey
07007-2900

Call Toll Free
US & Canada: 800-THE-ASME
(800-843-2763)
Mexico: 95-800-THE-ASME
(95-800-843-2763)
Universal: 973-882-1167

Fax—24 hours
973-882-1717
973-882-5155

E-Mail—
24 hours
Infocentral@asme.org

* Information Central staff are not permitted to answer inquiries about the technical content of this code or standard. Information as to whether or not technical inquiries are issued to this code or standard is shown on the copyright page. All technical inquiries must be submitted in writing to the staff secretary. Additional procedures for inquiries may be listed within.



ISBN 0-7918-2656-2