
Report on

**STRESS-CORROSION CRACKING
OF AUSTENITIC CHROMIUM-NICKEL
STAINLESS STEELS**

[Sponsored jointly by ASTM Committee A-10 on Iron-Chromium, Iron-Chromium-Nickel and Related Alloys,
and NACE Committee T-5E on Stress-Corrosion Cracking of Austenitic Stainless Steels.]



Published by the
AMERICAN SOCIETY FOR TESTING MATERIALS
1916 Race St., Philadelphia 3, Pa.

ASTM Special Technical Publication No. 264

Report on
STRESS-CORROSION CRACKING
OF
AUSTENITIC CHROMIUM-NICKEL
STAINLESS STEELS

[Sponsored jointly by ASTM Committee A-10 on Iron-Chromium, Iron-Chromium-Nickel and Related Alloys,
and NACE Unit Committee T-5E on Stress-Corrosion Cracking of Austenitic Stainless Steels.]



Reg. U.S. Pat. Off.

ASTM Special Technical Publication No. 264

Price \$6.00; to Members \$4.80

Published by the
AMERICAN SOCIETY FOR TESTING MATERIALS
1916 Race St., Philadelphia 3, Pa.

© BY AMERICAN SOCIETY FOR TESTING MATERIALS 1960

Library of Congress Catalog Card Number: 60-11322

Printed in Baltimore, Md.

March, 1960

CONTENTS

	PAGE
Part I. Review of Case Histories	
Introductory Summary—F. L. LaQue.....	1
General Information—A. W. Dana, Jr., and W. Z. Friend.....	4
Equipment, Mode, Location of Fractures, and Associated Conditions—E. E. Denhard.	5
Classification of Materials and Stress Conditions—F. K. Bloom.....	7
Classification of Corrosion Conditions—W. B. Brooks and M. E. Holmberg.....	9
Steps Taken to Overcome Cracking—F. K. Bloom.....	12
Part II. Present Status of Research Effort	
Survey of Current Research Activities—A. W. Dana, Jr., and W. Z. Friend.....	17
The Mechanism of Stress-Corrosion Cracking of Austenitic Stainless Steels—Julius J. Harwood.....	22
Appendices	
Case History Data from U.S.A.....	25
Case History Data from United Kingdom.....	55
Annotated Bibliography 1935 to June 1959.....	69

NOTE—The Society is not responsible, as a body, for the statements
and opinions advanced in this publication.

FOREWORD

At the 1955 semi-annual meeting of Subcommittee IV on Methods of Corrosion Testing of ASTM Committee A-10 on Iron-Chromium, Iron-Chromium-Nickel and Related Alloys, a task group was appointed to review the subject of stress-corrosion cracking of austenitic chromium-nickel stainless steels. They were asked to advise the committee whether this problem appeared to be of sufficient magnitude to warrant special attention, the extent of research activity in this field, and the manner in which the committee could best cooperate in such an effort.

It was learned shortly after this meeting that the National Assn. of Corrosion Engineers had also formed a Unit Committee, T-5E, on Stress Corrosion Cracking of Austenitic Stainless Steel, with substantially the same objectives. The two committees agreed to work together, and a joint task group was organized. The group invited others known to be active in this field to join them, and the final committee included two corresponding members from England and two consulting members from this country.

It was believed that the most direct approach to establishing the magnitude of the problem and determining the extent of current research on stress-corrosion cracking would be to circulate a questionnaire to all the members of ASTM Committee A-10 and to those of NACE Unit Committee T-5E since they included a representative cross-section of both producers and consumers of stainless steel. Through the collection and analysis of data on a number of actual case histories it was thought that a good indication would be obtained of the types of service where stress-corrosion cracking is most often encountered, the grades of steel most often involved, and whether the media or service conditions had features in common. In addition, it was felt that it would be instructive to know what steps are being taken to combat cracking.

A questionnaire form was agreed upon and sent out by the task force in May, 1956. A total of 142 companies or individuals were invited to participate. Fifty-three replies were received. Of these, 24 companies reported they had no experience with stress-corrosion cracking; five reported that they had experienced trouble but had no case history data. The remaining 24 submitted a total of 129 case histories.

As the first step in analyzing this large volume of data so generously furnished to the task group, each of the case histories was retabulated in summary form. These summaries are included in this report beginning on p. 25. The data were separated into five broad sections, and various members of the task group then prepared a separate review of each section. These reviews are combined in Part I of this report, which begins with an Introductory Summary of the five sections.

Part II of the report covers information which the task group has been able to obtain on current research activities in the field of stress corrosion. This information was obtained in part from the questionnaires and was supplemented by writing separately to all large companies, research institutions, and universities where there was reason to believe that work in this area might be in progress. In addition, through the foreign correspondents of the Inter-Society Corrosion Committee, the names of foreign investigators were secured. Part II also includes a review of the present knowledge of the basic mechanism of this phenomenon in austenitic chromium-nickel steels which J. J. Harwood very kindly prepared for the task group.

The case history data from the United Kingdom contains summaries of 16 case histories obtained from six companies in the United Kingdom. R. Butcher arranged to circulate questionnaires to 12 firms, of which nine replied, three indicating that they had no experience. These data were re-

ceived too late to be included in case history analyses prepared by the committee. Inspection of the information given, however, indicates that the failures involve in each instance conditions substantially identical to those in the service histories covered in the review.

The annotated bibliography of all pertinent literature published from 1935 up to June of 1959, was originally prepared by R. M. Fuller, G. T. Paul, and A. J. Marron of the Corrosion Engineering Section of The International Nickel Co. It was carefully reviewed by W. Z. Friend, A. W. Dana, Jr., and by E. E. Denhard and L. Rajkay, who added further references and edited it for the task group.

The committee would like to express their appreciation to the numerous contributors to this report, and particularly to those who furnished the detailed information requested in the case histories:

For Subcommittee IV of ASTM Committee A-10:

F. K. Bloom (Chairman), Armco Steel Corp.
M. H. Brown, E. I. du Pont de Nemours & Co., Inc.
M. A. Cordovi, The International Nickel Co., Inc.
A. W. Dana, Jr., E. I. du Pont de Nemours & Co., Inc.
O. B. Ellis, Armco Steel Corp.
W. Z. Friend, The International Nickel Co., Inc.
F. L. LaQue, The International Nickel Co., Inc.

For NACE Unit Committee T-5E:

L. M. Rogers (Chairman), Carbide and Carbon Chemicals Co.
M. E. Holmberg, Consultant.
W. B. Brooks, The Dow Chemical Co.

Corresponding members:

R. Butcher, The Mond Nickel Co., London, England.
C. Edeleanu, Tube Investments Research Laboratories, Essex, England.

Consulting members:

M. G. Fontana, Ohio State University.
J. J. Harwood, Office of Naval Research.

