

Standard Practice

Prevention, Detection, and Correction of Deaerator Cracking

This NACE International standard represents a consensus of those individual members who have reviewed this document, its scope, and provisions. Its acceptance does not in any respect preclude anyone, whether he or she has adopted the standard or not, from manufacturing, marketing, purchasing, or using products, processes, or procedures not in conformance with this standard. Nothing contained in this NACE standard is to be construed as granting any right, by implication or otherwise, to manufacture, sell, or use in connection with any method, apparatus, or product covered by letters patent, or as indemnifying or protecting anyone against liability for infringement of letters patent. This standard represents minimum requirements and should in no way be interpreted as a restriction on the use of better procedures or materials. Neither is this standard intended to apply in all cases relating to the subject. Unpredictable circumstances may negate the usefulness of this standard in specific instances. NACE assumes no responsibility for the interpretation or use of this standard by other parties and accepts responsibility for only those official NACE interpretations issued by NACE in accordance with its governing procedures and policies which preclude the issuance of interpretations by individual volunteers.

Users of this NACE standard are responsible for reviewing appropriate health, safety, environmental, and regulatory documents and for determining their applicability in relation to this standard prior to its use. This NACE standard may not necessarily address all potential health and safety problems or environmental hazards associated with the use of materials, equipment, and/or operations detailed or referred to within this standard. Users of this NACE standard are also responsible for establishing appropriate health, safety, and environmental protection practices, in consultation with appropriate regulatory authorities if necessary, to achieve compliance with any existing applicable regulatory requirements prior to the use of this standard.

CAUTIONARY NOTICE: NACE standards are subject to periodic review, and may be revised or withdrawn at any time in accordance with NACE technical committee procedures. NACE requires that action be taken to reaffirm, revise, or withdraw this standard no later than five years from the date of initial publication and subsequently from the date of each reaffirmation or revision. The user is cautioned to obtain the latest edition. Purchasers of NACE standards may receive current information on all standards and other NACE publications by contacting the NACE *FirstService* Department, 15835 Park Ten Place, Houston, TX 77084-5145 (telephone +1 281-228-6200).

Reaffirmed 2015-02-24
Revised 2007-03-10
Revised 1996-03-30
Approved April 1990
NACE International
15835 Park Ten Place
Houston, Texas 77084-5145
+1 281-228-6200

ISBN 1-57590-0111-4
© 2015 NACE International

Foreword

NACE Task Group (TG) T-7H-7 on Deaerator Cracking (now TG 244, “Deaerators: Prevention, Detection, and Correction of Cracking—Revision of NACE SP0590”) was formed in 1984 to conduct an organized study into the cause of the high incidence of serious deaerator cracking problems in steam generating plants. The task group had previously sponsored technical symposia in which several papers were published on deaerator cracking.¹⁻⁸

This standard is intended to be the primary source of information on deaerator cracking and is directed toward operators and designers of deaerator equipment used in steam generation. Information presented in this standard reflects the work of the many individuals involved in documenting the deaerator cracking problem and is based on studies of carbon steel units. Similar cracking has been found in blowdown flash tanks, sedimentation tanks, hot water storage/disengaging vessels, and steam and feedwater piping.

In developing this standard, the TG considered the case of a southeastern U.S. paper mill that had experienced loss of life as a result of a ruptured deaerator storage tank. The catastrophic failure resulted in an increase in deaerator inspections and widespread concern for vessel reliability and personnel safety. A “Deaerator Advisory,” published by the Engineering Division of TAPPI,⁽¹⁾ reported that 68 vessels (approximately 50% of the vessels inspected in 1983) showed cracking in welds and adjacent heat-affected zones (HAZ) resulting from corrosion fatigue.⁹ Of the three reported storage vessel ruptures, one resulted in fatalities and considerable plant downtime. Other literature on deterioration of deaerators noted that investigations of various systems indicated that cracks in the welds and HAZ of longitudinal and circumferential seams were the cause of some of the problems.¹⁰ Corrosion, another major cause, had occurred at a more rapid rate in the weld HAZ in some instances, and problems had reportedly occurred in both the welds and the base metal caused by shell thinning to levels that could not support the load. Periodic internal inspections combined with nondestructive examinations (NDE) were recommended to detect deaerator deterioration. Other reports of the seriousness of deaerator weld cracking also were published at this time.¹¹⁻¹⁵ The root causes of deaerator cracking have not been determined; therefore, this standard is based on good practices.

This standard practice was originally prepared in 1990 by Task Group T-7H-7 under the guidance of NACE Unit Committee T-7H on Corrosion and Its Control in Steam Generating Systems and issued by NACE under the auspices of NACE Group Committee T-7 on Corrosion by Waters. It was revised by Task Group T-7H-7 in 1996 and in 2006 by TG 244, “Deaerators: Prevention, Detection, and Correction of Cracking—Review of NACE SP0590”. It was reaffirmed in 2015 by TG 244. TG 244 is administered by Specific Technology Group (STG) 11, “Water Treatment,” and is sponsored by STG 34, “Petroleum Refining and Gas Processing,” STG 36, “Process Industry: Materials Performance in Chemicals,” STG 38, “Process Industry: Pulp and Paper,” STG 41, “Energy Generation,” and STG 60, “Corrosion Mechanisms.” This standard is issued by NACE International under the auspices of STG 11.

In NACE standards, the terms *shall*, *must*, *should*, and *may* are used in accordance with the definitions of these terms in the *NACE Publications Style Manual*. *Shall* and *must* are used to state mandatory requirements. *Should* is used to state something considered good and is recommended but is not mandatory. *May* is used to state something considered optional.

⁽¹⁾ TAPPI, formerly the Technical Association of the Pulp and Paper Industry, 15 Technology Parkway South, Suite 115, Peachtree Corners, GA 30092.

**NACE International
Standard Practice**

**Prevention, Detection, and Correction of
Deaerator Cracking**

Contents

1. General	1
2. Crack Characteristics.....	4
3. Nondestructive Detection of Cracks	4
4. Repair, Design, and Fabrication	7
5. Operation and Water Chemistry	9
6. Conclusions	12
7. References	13
8. Bibliography	14
9. Glossary of Acronyms.....	14
10. Appendix A: Analysis of Data Collected Through Industry Surveys (Refer to Paragraph 1.5) (Nonmandatory).....	15
FIGURES	
Figure 1(a): Typical Mechanical Feedwater Deaerator.....	1
Figure 1(b): Weld areas Associated with Typical Unit.....	1
Figure 1(c): Saddle-Type Mechanical Deaerator.	2
Figure 1(d): Weld Areas Associated with Saddle-Type Unit.	2
Figure 2: Suggestions for Returning Condensate to the Deaerator to Protect the Deaerator from Damage.	10
Figure A1: Deaerator Cracking Mini-Survey Sample Distribution by Years in Service	16
Figure A2: Cracking Distribution in Mini-Survey by Degree. (When More Than One Crack Was Reported, Only the Most Severe Discontinuity Was Included.)	17
Figure A3: Type C Cracks Detected in Mini-Survey as a Percentage of Deaerators Inspected by Age Category.	17
Figure A4: Total Cracks Detected in Mini-Survey by Vessel Age.	18
Figure A5: Re-inspection Intervals vs. Cracking Results Excluding Mud/Steam Drums. .	18
Figure A6: Inspection Interval vs. Discontinuity Category.	19
Figure A7: Deaerator Inspection and Repair Flow Chart.	20
TABLES	
Table A1: Typical Performance of Oxygen Removal Equipment.....	15
Table A2: Inspection Statistics of Oxygen Removal Equipment by Industry.....	15
Table A3: Discontinuity Terms Used in Statistical Study Only	16
