

Fatigue TN Curves for Chain, Wire, and Polyester Mooring Lines (Including Corrections for High-tension Ranges)

API TECHNICAL REPORT 2FC-2
FIRST EDITION, JANUARY 2020



AMERICAN PETROLEUM INSTITUTE

Special Notes

API publications necessarily address problems of a general nature. With respect to particular circumstances, local, state, and federal laws and regulations should be reviewed.

Neither API nor any of API's employees, subcontractors, consultants, committees, or other assignees make any warranty or representation, either express or implied, with respect to the accuracy, completeness, or usefulness of the information contained herein, or assume any liability or responsibility for any use, or the results of such use, of any information or process disclosed in this publication. Neither API nor any of API's employees, subcontractors, consultants, or other assignees represent that use of this publication would not infringe upon privately owned rights.

Users of this Technical Report should not rely exclusively on the information contained in this document. Sound business, scientific, engineering, and safety judgement should be used in employing information contained herein.

Shall: As used in this standard "shall" denotes a minimum requirement to conform to the specification.

Should: As used in a standard "should" denotes a recommendation or that which is advised but not required to conform to the specification.

API publications may be used by anyone desiring to do so. Every effort has been made by the Institute to assure the accuracy and reliability of the data contained in them; however, the Institute makes no representation, warranty, or guarantee in connection with this publication and hereby expressly disclaims any liability or responsibility for loss or damage resulting from its use or for the violation of any authorities having jurisdiction with which this publication may conflict.

API publications are published to facilitate the broad availability of proven, sound engineering and operating practices. These publications are not intended to obviate the need for applying sound engineering judgment regarding when and where these publications should be used. The formulation and publication of API publications is not intended in any way to inhibit anyone from using any other practices.

Any manufacturer marking equipment or materials in conformance with the marking requirements of an API standard is solely responsible for complying with all the applicable requirements of that standard. API does not represent, warrant, or guarantee that such products do in fact conform to the applicable API standard.

All rights reserved. No part of this work may be reproduced, translated, stored in a retrieval system, or transmitted by any means, electronic, mechanical, photocopying, recording, or otherwise, without prior written permission from the publisher. Contact the Publisher, API Publishing Services, 200 Massachusetts Avenue, NW, Suite 1100, Washington, DC 20001-5571.

Foreword

Nothing contained in any API publication is to be construed as granting any right, by implication or otherwise, for the manufacture, sale, or use of any method, apparatus, or product covered by letters patent. Neither should anything contained in the publication be construed as insuring anyone against liability for infringement of letters patent.

This document was produced under API standardization procedures that ensure appropriate notification and participation in the developmental process and is designated as an API standard. Questions concerning the interpretation of the content of this publication or comments and questions concerning the procedures under which this publication was developed should be directed in writing to the Director of Standards, American Petroleum Institute, 200 Massachusetts Avenue, NW, Suite 1100, Washington, DC 20001. Requests for permission to reproduce or translate all or any part of the material published herein should also be addressed to the director.

Generally, API standards are reviewed and revised, reaffirmed, or withdrawn at least every five years. A one-time extension of up to two years may be added to this review cycle. Status of the publication can be ascertained from the API Standards Department, telephone (202) 682-8000. A catalog of API publications and materials is published annually by API, 200 Massachusetts, NW, Suite 1100, Washington, DC 20001.

Suggested revisions are invited and should be submitted to the Standards Department, API, 200 Massachusetts NW, Suite 1100, Washington, DC 20001, standards@api.org.

Contents

	Page
1 Introduction.....	1
2 Chain TN Fatigue Curves	1
3 Steel Wire Rope TN Fatigue Curves	7
4 Polyester Rope Fatigue Curves	8
Annex A (informative) Polyester Rope Fatigue Test Data.....	12
Bibliography.....	18

Figures

1 Proposed High-load Range/Low-cycle Corrections to API's TN Curves for Chain and Wire Rope, and Polyester TN Curves including Spiral Strand × 6	1
2 High-load Range Correction for R4 Studless Chain Based on API's TN Curve for Studless Chain and Minimum Yield Stress for R4 Steel Grade	4
3 Upper Bound, High-load Range Correction for R4 Studless Chain Based on the Mean Regression Curve for Studless Chain and a Yield Stress of 821 N/mm ² for R4 Steel.....	5
4 High-load Range Corrections for R3 and R4 Studless Chain Based on API's TN Curve for Studless Chain and Minimum Yield Stresses for R3 and R4 Steel Grades.....	6
5 High-load Range Corrections for R3 and R4 Studlink Chain Based on API's TN Curve for Studlink Chain and Minimum Yield Stresses for R3 and R4 Steel Grades.....	6
6 High-load Range Corrections for IWRC and Spiral Strand Wire Based on API's TN Curves and Elastic Tension Range Limits of 40 % and 50 % of CBS.....	8
7 Polyester Rope Durability JIP Test Results for 10-tonne Rope Normalized by CBS and Average Break Strength (ABS).....	9
8 Polyester Rope Durability JIP Residuals (see Figure 7) for 10-tonne Rope Normalized by CBS and Average Break Strength (ABS).....	9
9 Polyester Rope Fatigue Test Results Normalized by CBS compared with API 2SK's TN Fatigue Curve for Spiral Strand Steel Wire Rope and Six Times API's Spiral Strand Rope TN Curve	11

Tables

1 API Studlink and Studless TN Fatigue Curve Parameters	2
2 Minimum IACS Requirements for Studlink and Studless Chain	3
3 API IWRC and Spiral Strand Wire TN Fatigue Curve Parameters	7
4 <i>Polyester Rope Durability</i> JIP—Loading Regime for 10-tonne Fatigue Tests (28).....	10
5 Polyester Rope Durability 10-tonne Fatigue Curve Parameters	11
A.1 Polyester Rope Durability JIP Fatigue Data for 10-tonne Ropes by Manufacturer A (NEL Table 6.2.1).....	13
A.2 Polyester Rope Durability JIP Fatigue Data for 10-tonne Ropes by Manufacturer B (NEL Table 6.2.2)	14
A.3 Polyester Rope Durability JIP Fatigue Data for 10-tonne Ropes by Manufacturer C (NEL Table 6.2.3).....	15
A.4 Polyester Rope Durability JIP Fatigue Data for 6-tonne Sub-ropes (ND Slide 3).....	16
A.5 Polyester Rope Fatigue Data in API 2SM, First Edition	17

Fatigue TN Curves for Chain, Wire, and Polyester Mooring Lines (Including Corrections for High-tension Ranges)

1 Introduction

This report summarizes the derivation of high-load range, low-cycle corrections to API 2SK, Third Edition studlink and studless chain fatigue curves, and in this respect supplements the derivation of standard fatigue curves reported in API TR 2FC-1, First Edition. In addition, low-cycle, high-load range corrections to API 2SK's independent wire rope core (IWRC) and spiral strand (SS) wire rope fatigue curves are proposed, and polyester rope fatigue data are reviewed and compared with the recommendations presently contained in API 2SM, API 2SK, and ISO 19901-7. The proposed corrections to API's TN curves and the chain and polyester fatigue test data are shown in Figure 1. The lower part of the piecewise linear TN curves (in the log-log space) are the same as in API 2SK, while the upper part is the correction or change proposed.

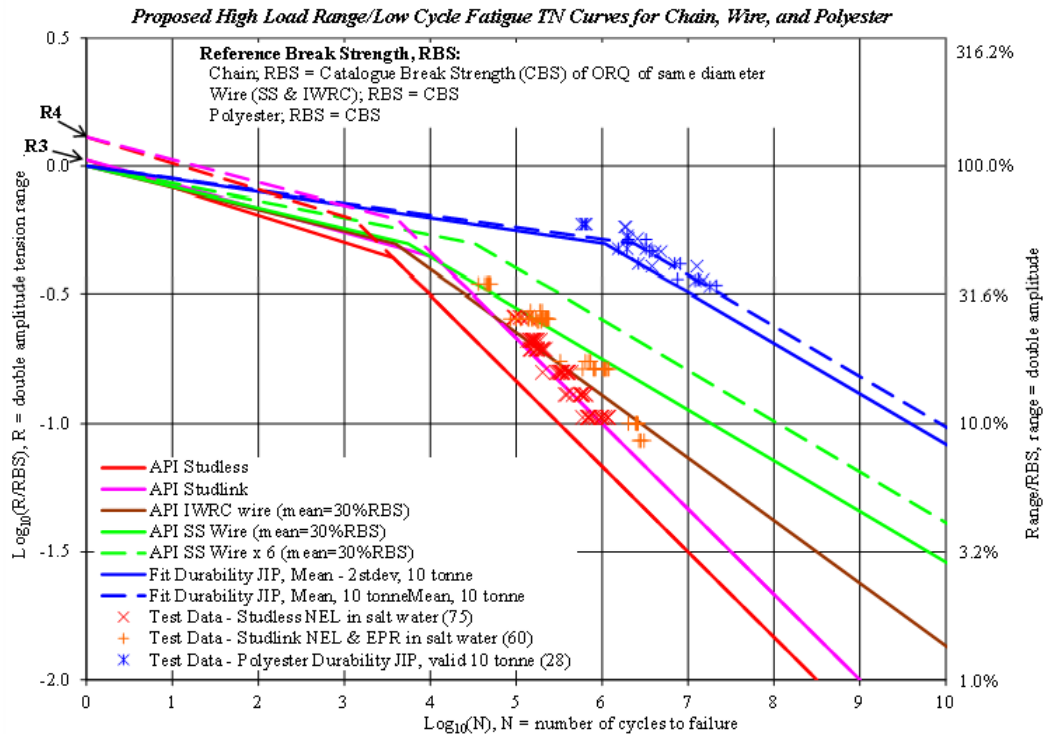


Figure 1—Proposed High-load Range/Low-cycle Corrections to API’s TN Curves for Chain and Wire Rope, and Polyester TN Curves including Spiral Strand × 6

Large tension ranges resulting from vortex induced motions of a Gulf of Mexico spar first led to the identification of the need to add a correction for high-tension range, low-cycle fatigue damage to the existing fatigue curves contained in API 2SK, Appendix H. More recently, a “Cyclic Integrity Test (20-hurricane test)” consisting of 20,000 cycles between 15 % and 45 % of the ropes break strength has been proposed for polyester ropes. Consequently, it seems appropriate at this time to review existing fatigue curves and test data, and propose corrections for low-cycle, high-tension range fatigue damage.

2 Chain TN Fatigue Curves

Equation (1) expresses API 2SK’s TN curves for chain mooring lines in tension as:

$$\log_{10}(N) = m \log_{10}(T) + \log_{10}(a) \tag{1}$$