GUIDE FOR

SPECTRAL-BASED FATIGUE ANALYSIS FOR VESSELS JUNE 2016

NOTICE NO. 2 – October 2017

The following changes were approved by the ABS Rules Committee on 4 October 2017 and become **EFFECTIVE AS OF 1 OCTOBER 2017.**

(See http://www.eagle.org for the consolidated version of the Guide for Spectral-Based Fatigue Analysis for Vessels, 2016, with all Notices and Corrigenda incorporated.)

Notes - *The date in the parentheses means the date that the Rule becomes effective for new construction based on the contract date for construction. (See 1-1-4/3.3 of the ABS Rules for Conditions of Classification (Part 1).)*

FOREWORD

(Revise Foreword, as follows.)

Foreword *(1 October 2017)*

This Guide provides information about the optional classification notations, 'Spectral Fatigue Analysis' – **SFA (*years*)** and **SFA (*years*, *WWT*) –** which are available to qualifying vessels as described in 1-1-3/21 of the ABS *Rules for Conditions of Classification (Part 1).*

(Following text remains unchanged.)

SECTION 1 INTRODUCTION

1 Purpose and Applicability *(1 October 2017)*

(Revise Subsection 1/1, as follows.)

Part 5C of the ABS *Rules for Building and Classing Steel Vessels (Steel Vessel Rules)* includes the fatigue assessment criteria for the classification of various types of specialized vessels covered by the Rules. Part 5A and 5B of the ABS *Rules for Building and Classing Steel Vessels (Steel Vessel Rules)* contains fatigue assessment guidance for vessels subject to the "Common Structural Rules for Bulk Carriers and Oil Tankers". A brief description of the background and objectives of these fatigue criteria is given in Subsection 1/3.

In addition to the simplified fatigue strength criteria required for classification by ABS, the Owner may wish to apply more extensive Spectral-based Fatigue Analysis (SFA) techniques to the vessel's structural systems. It may be an added objective of these Spectral-based Fatigue Analyses to demonstrate a longer design fatigue life than that required for classification.

Spectral-based Fatigue Analysis techniques are used in addition to the SafeHull Fatigue Assessment technique, a Permissible Stress Range method (discussed in Subsection 1/3). The fatigue life of each critical location in the structural system is assessed for adequacy. The critical locations are to be selected using the results of the SafeHull Fatigue Assessment technique which is to be employed in the overall structural design and analysis effort.

The list of critical structural locations which are to be subjected to Spectral-based Fatigue Analysis is to be submitted to ABS for approval.

Provided that Spectral-based Fatigue Analysis is conducted in accordance with the procedures included in this Guide or equivalent, ABS will grant the optional classification notation, **SFA (*years*)** or **SFA (*years*, *WWT*)**. In either case, as a minimum, a vessel is to meet the fatigue strength criteria in the *Steel Vessel Rules* as described above. The **SFA (*years*)** notation is granted if the design fatigue life value is equal to 20 years or greater under the wave conditions of unrestricted service defined in Section 5, Table 1. The **SFA (*years*, *WWT*)** notation is granted if the design fatigue life value is equal to 40 years or greater under the wave conditions of worldwide trading service defined in Section 5, Table 2.

If a vessel is primarily operating in seas that exceed the worldwide trading pattern (i.e., a vessel operating half or more than half of its life in onerous seas including North Atlantic or North Pacific), **SFA (*years, WWT*)** is not applicable. It should be noted that the calculated fatigue lives for different design wave conditions may produce significantly different fatigue lives.

The value in parentheses is the design fatigue life in years specified by the applicant in 5-year increments starting at 20 for **SFA (*years*)** and 40 for **SFA (*years, WWT*)**. The structural system as a whole is analyzed to verify that the calculated fatigue life values for the entire system meet or exceed the design fatigue life. The actual service life of a vessel is dependent on many factors such as initial design, operational and maintenance schemes. The **SFA (*years*)** or **SFA (*years*, *WWT*)** notation denotes the design fatigue life of a vessel and is not a guarantee that the vessel or structure will achieve the design fatigue life.

In order to obtain the **SFA (*years*)** or **SFA (*years*, *WWT*)** notations, SFA methods must be applied to the entire vessel.

For vessels complying with Part 5A and 5B "Common Structural Rules for Bulk Carriers and Oil Tankers" of the *Steel Vessel Rules*, the design fatigue life for Spectral-based Fatigue Analysis is equal to 25 years or greater in 5-year increments.

3 Background *(1 October 2017)*

(Revise Subsection 1/3, as follows.

In the application of Part 5C of the *Steel Vessel Rules*, the SafeHull Fatigue Assessment technique is typically used to evaluate fatigue strength. The SafeHull Fatigue Assessment technique is a permissible stress range approach that is readily applied to large portions of a vessel's hull structure. The technique is required for certain vessels such as an oil tanker with a Rule length greater than 150 m for which the technique is detailed in Appendix 5C-1-A1 of the *Steel Vessel Rules*. The technique was derived considering unrestricted ocean service wave loads representing the North Atlantic and a design fatigue life of 20 years.

Part 5A and 5B "Common Structural Rules for Bulk Carriers and Oil Tankers" of the *Steel Vessel Rules* requires a design fatigue life of 25 years with wave loads representing the North Atlantic and multiple fatigue assessment techniques are employed. A simplified stress analysis method based on beam theory is presented in Part 5A, Pt 1, Ch 9, Sec 4 of the *Steel Vessel Rules*, a finite element stress analysis approach is described in Part 5A, Pt 1, Ch 9, Sec 5 of the *Steel Vessel Rules* and structural design following the detailed design standards is discussed in Part 5A, Pt 1, Ch 9, Sec 6 of the *Steel Vessel Rules*.

Supplementary to the SafeHull Fatigue Assessment technique or methods employed for vessels complying with Part 5C of the *Steel Vessel Rules*, ABS may require the use of additional or alternative techniques to demonstrate the fatigue strength adequacy of structural components. These techniques may include Spectral-based Fatigue Analysis methods. In many instances the structural details cannot be adequately analyzed via the permissible stress range fatigue assessment approach. An optional classification notation, **FL (*years*)**, may be requested in cases in which the owner or designer increases the target fatigue lives of some or all of the structural components above the 20 year minimum value. This notation is discussed in the *Steel Vessel Rules* and does not require the use of SFA methods.

SECTION 2 SPECTRAL-BASED FATIGUE ANALYSIS PROCEDURE OVERVIEW

1 General

1.7 Fatigue Strength Assessment (Section 6)

(Correct numbering and revise Subparagraph 2/1.7.3, as follows.)

1.7.3 Acceptance Criteria (Subsection 6/9) *(1 October 2017)*

To meet the requirements of the **SFA (*years*)** or **SFA (*years*, *WWT*)** notations, the calculated fatigue life is to be equal to or greater than the design fatigue life.

SECTION 4 STRUCTURAL ANALYSIS

1 General *(1 October 2017)*

(Revise fifth paragraph of Subsection 4/1, as follows. Remainder of text and Figure 1 are unchanged.)

The effect of sloshing loads due to fluid in partially filled tanks is not within the scope of the **SFA (*years*)** or **SFA (*years*, *WWT*)** classification notations. However, the designer is encouraged to perform and submit such calculations, if deemed important.

SECTION 5 SPECTRAL ANALYSIS

3 Wave Spectra and Wave Scatter Diagram *(1 October 2017)*

(Revise last paragraph of Subsection 5/3, as follows. Remainder of text is unchanged.)

Section 5, Tables 1 and 2 present the wave scatter diagram data that is to be used in the spectral-based fatigue analysis of a vessel classed for unrestricted service and for world-wide trading service, respectively. It can be assumed that there is an equal probability of each vessel heading relative to the direction of the waves.

(Revise title of Section 5, Table 1, as follows. Table is unchanged.)

TABLE 1
ABS Wave Scatter Diagram for Unrestricted Service Classification
(Representing the North Atlantic)

(Add new Section 5, Table 2, as follows.)

TABLE 2
ABS Wave Scatter Diagram for World-Wide Trading Service Classification *(1 October 2017)*

* Wave heights taken as significant values, H_s

** Wave periods taken as zero crossing values, T_z

		*Wave Period (sec)***											*Sum Over All Periods*
		3.50	4.50	5.50	6.50	7.50	8.50	9.50	10.50	11.50	12.50	13.50	
*Wave Height (m)**	0.5	1888	5417	5836	3392	1260	313	55	8	1			18170
	1.5	493	3739	8374	9339	6517	2985	940	219	41	6	1	32654
	2.5	96	1128	3682	5934	6159	4216	1930	629	158	33	6	23971
	3.5	18	294	1217	2439	3269	2959	1769	734	229	57	12	12997
	4.5	4	79	388	893	1417	1568	1142	568	208	60	15	6342
	5.5	1	23	130	328	581	745	631	361	150	49	13	3012
	6.5		8	47	126	239	341	325	208	96	34	10	1434
	7.5		2	18	51	101	156	163	115	58	22	7	693
	8.5		1	7	21	44	72	82	63	34	14	5	343
	9.5			3	10	20	34	42	34	20	9	3	175
	10.5			1	5	10	17	22	19	11	5	2	92
	11.5			1	2	5	9	12	10	7	3	1	50
	12.5				1	3	5	6	6	4	2	1	28
	13.5				1	1	2	3	4	3	1	1	16
	>14.5				1	2	3	5	5	4	2	1	23
Sum over All Heights		2500	10691	19704	22543	19628	13425	7127	2983	1024	297	78	100000

SECTION 6 FATIGUE STRENGTH ASSESSMENT

(Revise Subsection 6/9, as follows.)

9 Acceptance Criteria *(1 October 2017)*

The minimum required fatigue life for a spectral-based approach is customarily stated as either a damage ratio (D) or a design fatigue life (L). The latter is employed in this Guide. To meet the requirements of the **SFA (*years*)** or **SFA (*years*, *WWT*)** notations, the calculated fatigue life is to be equal to or greater than the design fatigue life.

APPENDIX 2 FATIGUE STRENGTH ASSESSMENT

(Revise Note (1), as follows. Note (2) remains unchanged.)

Notes:

(1) *(1 October 2017)* This Appendix is referred to in Section 6. It is provided to describe the formulations comprising a Spectral-based Fatigue Analysis approach, which can be employed to satisfy the criteria to obtain the **SFA (*years*)** or **SFA (*years*, *WWT*)** Classification notations. However, it is at this formulation level that there are multiple valid methods that may be selected. For that reason, it is emphasized that the contents of this Appendix are provided primarily to illustrate principle rather than to give mandatory steps for the Spectral-based Fatigue method.