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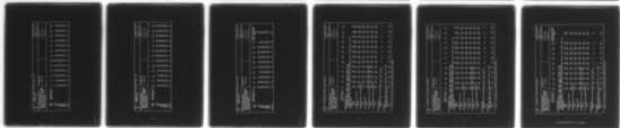
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Volume 112

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**USAF BIOENVIRONMENTAL NOISE DATA
HANDBOOK,**

Volume 112,

HDU-13/M Heater, Explosion Proof,
Duct Type, Portable.

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JAN 25 1976
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10 Nick A. Farinacci

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AEROSPACE MEDICAL RESEARCH LABORATORY
AEROSPACE MEDICAL DIVISION
AIR FORCE SYSTEMS COMMAND
WRIGHT-PATTERSON AIR FORCE BASE, OHIO 45433

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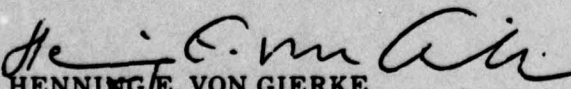
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This technical report has been reviewed and is approved for publication.

FOR THE COMMANDER


HENNING E. VON GIERKE
Director
Biodynamics and Bionics Division
Aerospace Medical Research Laboratory

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The HDU-13/M Heater is an explosion-proof, electric motor-driven, portable ground heater designed to provide heat and ventilating output while operating in an explosive atmosphere such as encountered in the purging of aircraft fuel tanks. This report provides measured data defining the bioacoustic environments produced by this unit operating inside a large aircraft hanger at normal rated conditions. Near-field data are reported for 37 locations in a wide variety of physical and psychoacoustic measures: overall and band sound			

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pressure levels, C-weighted and A-weighted sound levels, preferred speech interference level, perceived noise level, and limiting times for total daily exposure of personnel with and without standard Air Force ear protectors. Refer to Volume 1 of this handbook, "USAF Bioenvironmental Noise Data Handbook, Vol. 1: Organization, Content and Application", AMRL-TR-75-50(1) 1975, for discussion of the objective and design of the handbook, the types of data presented, measurement procedures, instrumentation, data processing, definitions of quantities, symbols, equations, applications, limitations, etc.

PREFACE

This report was prepared by the Biodynamic Environment Branch, Aerospace Medical Research Laboratory, under Project/Task 723104, Measurement and Prediction of Noise Environments of Air Force Operations.

The author acknowledges the efforts of Mr. Robert T. England and Mr. Robert G. Powell who conducted the field measurements, and Mr. John N. Cole who established the data analysis requirements and assisted in the preparation of this report. Mr. Henry Mohlman and Mr. David Eilerman of the University of Dayton assisted in the mechanics of data processing, and Mrs. Norma Peachey typed and prepared the graphics.

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NEAR-FIELD NOISE

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INTRODUCTION

The HDU-13/M Heater is an explosion-proof, electric motor-driven portable ground heater designed to provide heat and ventilating output while operating in an explosive atmosphere such as encountered in the purging of aircraft fuel tanks. This unit is manufactured by the American Air Filter Company, Inc.

This volume provides measured data defining the bioacoustic environments produced by this unit. Such data are essential to evaluate ear protection requirements, limiting personnel exposure times, voice communication capabilities, and annoyance problems associated with operations of the HDU-13/M heater.

This volume is one of a series published by the Aerospace Medical Research Laboratory (AMRL) under the same report number (AMRL-TR-75-50) as a multi-volume handbook that quantifies the noise environments produced at flight/ground crew locations and in surrounding communities by operations of Air Force aircraft and ground support equipment. The far-field, community-type, noise data in the handbook describe the noise produced during *ground operations* of aircraft, ground support equipment, and other ground-based equipment or facilities.

Volume 1 of this handbook discusses the objectives and design of the handbook, the types of data presented, measurement procedures, instrumentation, data processing, definitions of quantities, symbols, equations, applications, limitations, etc. Volume 2 provides a method and data for adjusting the handbook's far-field noise data, which are for standard meteorological conditions (15C temperature, 70% rel humidity, 0.760 meters Hg barometric pressure) to derive comparable data for other meteorological conditions. *Refer to Volumes 1 and 2* (references 1 and 2) for such information because it is not repeated in other handbook volumes.

A cumulative index lists those aerospace systems contained in the handbook, and identifies the specific volumes containing each type of environmental noise data available (i.e., inflight/flight crew and passenger noise, near-field/ground crew noise, far-field/community noise). Volume numbers are assigned sequentially as individual volumes are published. This index is periodically updated as individual volumes are published, and is available upon request from AMRL/BBE, Wright-Patterson AFB, OH 45433. Organizations on the distribution list for the handbook will automatically receive a copy of the updated index as it is generated.

Direct any questions concerning the technical data in this report and other handbook volumes to: AMRL/BBE, Wright-Patterson AFB, OH 45433; Autovon 78-53675 or 78-53664; Commercial (513) 255-3675 or (513) 255-3664.

1. Cole, John N., *USAF Bioenvironmental Noise Data Handbook, Volume 1: Organization, Content and Application*, AMRL-TR-75-50 (1), Aerospace Medical Research Laboratory, Wright-Patterson Air Force Base, Ohio, 1975.
2. Cole, John N., *USAF Bioenvironmental Noise Data Handbook, Volume 2: Procedure to Evaluate Effects of Non-standard Meteorological Conditions on Far-Field Noise*, AMRL-TR-75-50 (2), AMRL, WPAFB, OH, 1975.

NEAR-FIELD NOISE

MEASUREMENTS

A standard HDU-13/M Heater was operated inside, and approximately in the center of a large aircraft hanger (167.6 m 36.5 m wide × 18.3 m high) on a concrete floor at a normal rated condition of 3500 RPM. The hanger walls and ceiling were not acoustically treated. No aircraft were in the vicinity of the unit while being measured. No far-field acoustic data were acquired because of the relatively close proximity of the hanger walls.

Figure 1 identifies 36 noise measurement locations at a height of 1.5 meters above the concrete apron (nominal ear level of ground crew). The 0 degree reference direction passes through the tow bar. These locations are in the acoustic near-field of the source where the sound wave fronts generally do not spherically diverge and the source appears to be spatially distributed (i.e., not a point source). Consequently, these near-field data cannot be extrapolated to longer distances but do properly define the levels at locations close to the unit.

Near-field measurements were also made at ear level at the operator control panel. Table 1 lists the numeric/alphabetic designators used on the data pages in this report to identify the operator measurement location and test conditions. The designator 1/A means operator location 1 and test condition A. Such a descriptor is essential in many handbook volumes that involve multiple combinations of locations/conditions. It is used in this report to maintain format consistency.

RESULTS

The measured data presented in Table 2 define the sound pressure levels (SPL) produced by the HDU-13/M unit at the 37 specified, near-field locations. This table includes the overall, 1/3 octave band, and octave band levels. From these data one can calculate the variety of measures in Table 3 which are widely used to assess the effects of noise on personnel and their performance.

For data at other intermediate near-field locations (i.e., for radial distances less than 4 meters) you can interpolate between the 36 measured data points.

TABLE 1

MEASUREMENT LOCATION AND TEST CONDITION FOR OPERATOR NOISE MEASUREMENTS

HDU-13/M Heater, Explosion Proof, Duct Type, Portable
Wright Patterson AFB, 2 Nov 1972
FSN 4520-817-1793

Measurement Location

1 Operator Control Panel

Operation

A 3500 RPM

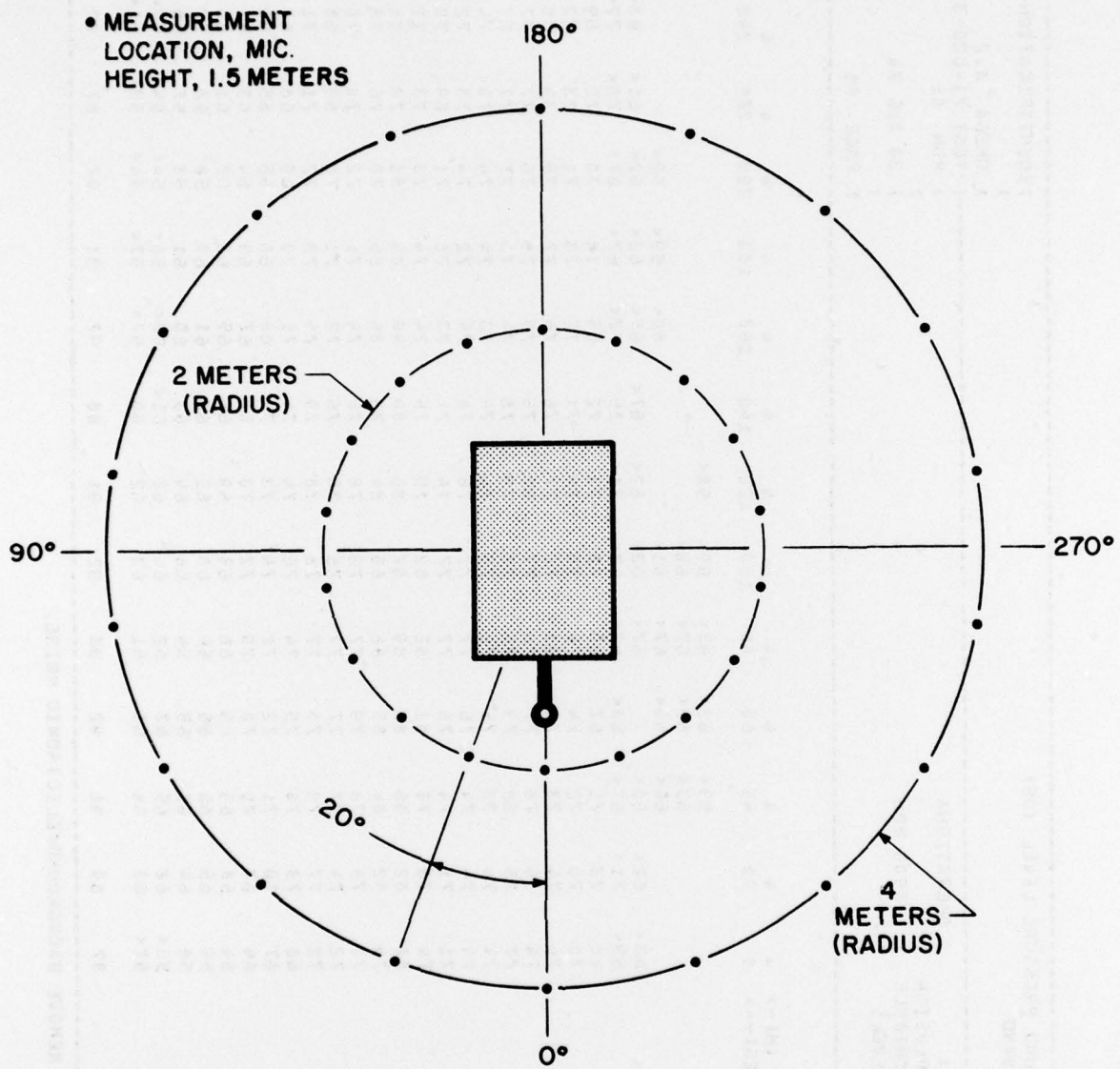


Figure 1. Measurement Locations

TABLE: MEASURED SOUND PRESSURE LEVEL (DB) 1/3 OCTAVE BAND		IDENTIFICATION:												
2		OMEGA 3.2 TEST 71-020-370 RUN 01 20 AUG 74 PAGE F1												
NOISE SOURCE/SUBJECT: (OPERATION:														
MDU-13/H HEATER-EXPLOSION (
PROOF, DUCT TYPE PORTABLE (3500 RPM														
NEAR FIELD NOISE LEVELS (
(INSIDE HANGER) (
FREQ (HZ)	DISTANCE (M)-->	4	20	40	60	80	100	120	140	160	180	200	220	240
25				59<	62<	68<	59<	58<						
31.5				63<	63<	67<	60<							
40				66<	65<	67<	61<							
50		63<	62<	60<	63<	67<	62<	62<	67<	60<	59<	59<	61<	63<
63		69<	71<	67<	67<	67<	67<	71<	75	72<	67<	67<	70<	72<
80		68	73	71	67	68	70	73	72	69	70	70	71	69
100		70	70	72	74	74	75	74	71	72	73	71	73	72
125		76	74	73	79	81	78	77	76	76	77	75	79	78
160		74	76	78	77	78	77	80	75	75	76	76	77	77
200		77	75	80	79	75	77	79	78	74	76	77	77	77
250		74	74	73	76	76	75	74	74	73	74	74	75	74
315		74	74	74	76	77	77	76	74	74	72	74	73	72
400		71	71	74	76	77	77	74	71	73	71	71	69	70
500		74	73	78	82	82	82	75	75	74	74	73	73	72
630		81	82	86	86	89	87	85	80	90	89	81	79	81
800		78	82	84	85	86	85	84	79	86	85	78	76	78
1000		73	79	78	79	77	79	78	76	74	71	72	70	70
1250		72	74	77	77	77	76	76	76	72	71	70	69	68
1600		72	77	79	78	77	78	78	79	75	73	72	71	71
2000		68	73	74	75	74	76	74	74	71	70	69	68	67
2500		67	70	71	72	72	74	73	71	68	68	65	65	63
3150		64	67	70	70	70	72	70	67	67	65	64	63	61
4000		64	68	69	69	68	69	69	66	65	63	62	61	60
5000		59	65	66	66	66	68	65	63	61	60	58	58	57
6300		58	64	65	65	64	66	64	63	60	61	58	57	56
8000		56<	62	65	63	62	64	62	61<	58<	58<	54<	54<	52<
10000		57<	63	64	61	61	63	62	60	57<	57<	54<	53<	51<
OVERALL		87	89	91	92	93	92	91	88	92	91	87	87	87

< LEVEL CORRECTED TO REMOVE BACKGROUND/ELECTRONIC NOISE.

TABLE: MEASURED SOUND PRESSURE LEVEL (DB)		IDENTIFICATION:																				
1/3 OCTAVE BAND																						
2		OMEGA 3.2																				
		TEST 71-020-370																				
		RUN 02																				
		20 AUG 74																				
		PAGE F2																				
NOISE SOURCE/SUBJECT: (OPERATION:)																						
HOU-13/M HEATER-EXPLOSION ()																						
PROOF, DUCT TYPE PORTABLE (3500 RPM)																						
NEAR FIELD NOISE LEVELS ()																						
(INSIDE HANGER) ()																						
FREQ (HZ)	DISTANCE (M)-->	4	260	4	280	4	300	4	320	4	340	2	0	2	20	40	60	80	100	120	140	2
ANGLE (DEG)-->	4	260	4	280	4	300	4	320	4	340	2	0	2	20	40	60	80	100	120	140	2	
25												58<	59<	59<	61<	60<	63<	62<	62<	61<	61<	61<
31.5												60<	64<	64<	61<	61<	60<	60<	60<	60<	60<	61<
40												65<	64<	64<	64<	65<	65<	65<	65<	65<	64<	64<
50												67<	69<	69<	70<	70<	70<	70<	71<	70<	70<	68<
63												71<	74<	74<	75<	74<	75<	76<	76<	76<	74<	73<
80												73<	70<	70<	70<	70<	70<	70<	71<	71<	71<	73<
100												72<	72<	72<	72<	72<	76<	76<	76<	74<	74<	74<
125												75<	76<	76<	75<	82<	81<	80<	80<	80<	78<	76<
160												76<	78<	78<	81<	82<	83<	82<	82<	82<	80<	80<
200												77<	82<	82<	86<	85<	85<	85<	85<	84<	83<	82<
250												78<	80<	80<	82<	85<	85<	85<	84<	84<	83<	82<
315												72<	79<	79<	79<	82<	81<	82<	81<	82<	81<	82<
400												73<	73<	73<	74<	76<	76<	76<	75<	75<	75<	74<
500												76<	77<	77<	79<	80<	81<	80<	80<	80<	82<	76<
630												77<	77<	77<	79<	98<	100<	99<	99<	90<	88<	85<
800												79<	88<	88<	91<	94<	96<	95<	95<	87<	85<	85<
1000												79<	88<	88<	91<	94<	96<	95<	95<	87<	85<	85<
1250												73<	79<	79<	83<	83<	83<	83<	81<	81<	79<	78<
1600												73<	80<	80<	83<	84<	82<	82<	82<	80<	80<	78<
2000												69<	73<	73<	77<	78<	78<	78<	77<	77<	77<	74<
2500												66<	69<	69<	74<	76<	75<	76<	76<	76<	76<	73<
3150												63<	66<	66<	71<	73<	73<	73<	74<	74<	72<	72<
4000												61<	65<	65<	72<	74<	73<	73<	74<	74<	71<	70<
5000												61<	62<	65<	69<	71<	70<	70<	71<	71<	68<	67<
6300												58<	59<	63<	69<	70<	69<	69<	69<	69<	67<	65<
8000												56<	58<	61<	67<	70<	68<	68<	67<	65<	63<	63<
10000												55<	55<	59<	65<	68<	67<	67<	67<	64<	62<	62<
OVERALL												86	86	87	88	94	100	102	101	95	93	93

< LEVEL CORRECTED TO REMOVE BACKGROUND/ELECTRONIC NOISE.

TABLE: MEASURED SOUND PRESSURE LEVEL (DB)		OCTAVE BAND										IDENTIFICATION:		
2		20	40	60	80	100	120	140	160	180	200	220	240	
NOISE SOURCE/SUBJECT:	(OPERATION:													
HDU-13/M HEATER-EXPLOSION ((OMEGA 3.2
PROOF, DUCT TYPE PORTABLE ((3500 RPM													TEST 71-020-370
NEAR FIELD NOISE LEVELS ((RUN 01
(INSIDE HANGER)	(20 AUG 74
														PAGE J1
FREQ (HZ)	DISTANCE (M)-->	4	4	4	4	4	4	4	4	4	4	4	4	
	ANGLE (DEG)-->	0	0	0	0	0	0	0	0	0	0	0	0	
31.5		72	75	69	72	65	75	77	74	72	72	73	74	
63		79	80	82	83	81	82	79	79	80	79	82	81	
125		80	79	82	81	81	82	81	78	79	80	80	79	
250		82	83	87	90	88	86	81	90	89	82	80	82	
500		80	84	86	87	86	85	82	86	85	80	78	79	
1000		74	79	80	80	81	80	81	77	75	74	73	73	
2000		68	71	73	73	74	73	70	70	68	67	66	65	
4000		62	68	69	67	69	68	66	63	63	61	60	58	
8000														
OVERALL		87	89	91	93	92	91	88	92	91	87	87	87	

TABLE: MEASURES OF HUMAN NOISE EXPOSURE

										IDENTIFICATION:									
										OMEGA 3.2									
										TEST 71-020-370									
										RUN 02									
										20 AUG 74									
										PAGE H2									
NOISE SOURCE/SUBJECT: (OPERATION:)																			
HOU-13/M HEATER-EXPLOSION ()																			
PROOF, DUCT TYPE PORTABLE (3500 RPM)																			
NEAR FIELD NOISE LEVELS ()																			
(INSIDE HANGER) ()																			
DISTANCE (M)--> 4 4 4 4 4 4 4 4 4 4																			
ANGLE (DEG)--> 260 280 300 320 340 0 20 40 60 80 100 120 140																			
HAZARD/PROTECTION																			
C-WEIGHTED OVERALL SOUND LEVEL (OASLC IN DBC) AT EAR																			
A-WEIGHTED OVERALL SOUND LEVEL (OASLA IN DBA) AT EAR																			
MAXIMUM PERMISSIBLE TIME (T IN MINUTES) FOR ONE EXPOSURE PER DAY (AFR 161-35, JULY 73)																			
NO PROTECTION																			
OASLC																			
OASLA																			
T																			
MINIMUM QPL EAR MUFFS																			
OASLA*																			
T																			
AMERICAN OPTICAL 1700 EAR MUFFS																			
OASLA*																			
T																			
V-51R EAR PLUGS																			
OASLA*																			
T																			
AMERICAN OPTICAL 1700 EAR MUFFS PLUS V-51R EAR PLUGS																			
OASLA*																			
T																			
H-133 GROUND COMMUNICATION UNIT																			
OASLA*																			
T																			
COMMUNICATION																			
PREFERRED SPEECH INTERFERENCE LEVEL (PSIL IN DB)																			
PSIL																			
ANNNOYANCE																			
PERCEIVED NOISE LEVEL, TONE CORRECTED (PNLT IN PNDB)																			
TONE CORRECTION (C IN DB)																			
PNLT																			
C																			

* BASED ON CALCULATED SPL SPECTRUM UNDER PROTECTIVE DEVICE.

TABLE: MEASURES OF HUMAN NOISE EXPOSURE													IDENTIFICATION:
3													OMEGA 3.2
NOISE SOURCE/SUBJECT# (OPERATION)													TEST 71-020-370
HDU-13/M HEATER-EXPLOSION ()													RUN 03
PROOF, DUCT TYPE PORTABLE (3500 RPM)													20 AUG 74
NEAR FIELD NOISE LEVELS ()													PAGE H3
(INSIDE HANGER) ()													
DISTANCE (M)--> 2 2 2 2 2 2 2 2 2 2 2 2 2													2
ANGLE (DEG)--> 160 180 200 220 240 260 280 300 320 340													2
HAZARD/PROTECTION													OPERATOR LOCATION
C-WEIGHTED OVERALL SOUND LEVEL (OASLC IN DB) AT EAR													1/A
A-WEIGHTED OVERALL SOUND LEVEL (OASLA IN DB) AT EAR													
MAXIMUM PERMISSIBLE TIME (T IN MINUTES) FOR ONE EXPOSURE PER DAY (AFR 161-35, JULY 73)													
NO PROTECTION													
OASLC	93	94	93	89	89	88	87	87	88	90	101		
OASLA	91	91	90	84	83	82	82	83	84	88	99		
T	143	143	170	480	571	679	679	571	480	240	36		
MINIMUM QPL EAR MUFFS													
OASLA*	68	69	68	66	66	65	64	63	64	66	76		
T	960	960	960	960	960	960	960	960	960	960	960		
AMERICAN OPTICAL 1700 EAR MUFFS													
OASLA*	63	63	63	61	61	61	59	59	59	61	70		
T	960	960	960	960	960	960	960	960	960	960	960		
V-51R EAR PLUGS													
OASLA*	68	68	67	60	60	59	59	59	61	64	75		
T	960	960	960	960	960	960	960	960	960	960	960		
AMERICAN OPTICAL 1700 EAR MUFFS PLUS V-51R EAR PLUGS													
OASLA*	53	53	53	47	46	46	45	45	46	50	61		
T	960	960	960	960	960	960	960	960	960	960	960		
H-133 GROUND COMMUNICATION UNIT													
OASLA*	61	61	60	57	56	56	55	55	56	58	68		
T	960	960	960	960	960	960	960	960	960	960	960		
COMMUNICATION													
PREFERRED SPEECH INTERFERENCE LEVEL (PSIL IN DB)													
PSIL	85	85	84	78	78	77	77	77	79	82	93		
ANNOYANCE													
PERCEIVED NOISE LEVEL, TONE CORRECTED (PNLT IN PNDB)													
TONE CORRECTION (C IN DB)													
PNLT	104	104	103	97	97	96	94	96	97	100	111		
C	3	2	2	2	2	1	0	1	2	2	3		

* BASED ON CALCULATED SPL SPECTRUM UNDER PROTECTIVE DEVICE.