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14. ABSTRACT An acoustical assessment was performed on nine different bucking bars that are being considered for purchase at Tinker AFB, OK. Peak sound pressure levels (SPLs) and 30-second equivalent continuous levels (L_{eq}) were measured during three different riveting processes. The data, in conjunction with other data, such as hand and arm vibration measurements, procurement and maintenance costs, worker acceptability, etc., will be used by Tinker AFB to select the tools that are best suited to the work environment. USAFSAM recommends selecting bucking bars that transmit the lowest peak SPL and L_{eq} to limit workers' noise exposure.					
15. SUBJECT TERMS Impulse noise, impact noise, bucking bar, riveting, hearing, acoustics, noise, sound pressure level, equivalent continuous level					
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DEPARTMENT OF THE AIR FORCE
USAF SCHOOL OF AEROSPACE MEDICINE (AFMC)
WRIGHT-PATTERSON AFB OH

14 November 2013

MEMORANDUM FOR 72 AMDS/SGPB

ATTN: LT COL JEFFREY STINSON
8941 ENTRANCE ROAD A
TINKER AFB, OK 73145

FROM: USAFSAM/OEC
2510 Fifth Street
Wright-Patterson AFB, OH 45433

SUBJECT: Consultative Letter, AFRL-SA-WP-CL-2013-0022, Acoustical Evaluation of
Bucking Bars during Riveting Operations in Bldg 9001, Tinker AFB, Oklahoma

1. INTRODUCTION:

a. *Purpose:* From 14-16 May 2013, the United States Air Force School of Aerospace Medicine, Consultative Services Division (USAFSAM/OEC), at the request of 72 AMDS/SGPB, conducted an acoustical evaluation of nine different rivet bucking bars during three separate riveting operations in Bldg 9001 at Tinker AFB, Oklahoma, while the National Institute for Occupational Safety and Health (NIOSH) Physical Effects Research Team (PERT) conducted a field vibration study of the bucking bars. The process of assessing impulse noise during riveting operations is a very complex task using specialized equipment to assess hazardous noise environments. USAFSAM/OEC is the only AF bioenvironmental engineering resource with both the skilled personnel and equipment to accomplish these risk management/mitigation surveys. The purpose of this assessment was to collect acoustical data on nine bucking bars that are under consideration for Tinker AFB to possibly purchase for maintenance use. These data will support DoD/NIOSH research on tool selection and assist Tinker AFB personnel in the selection or replacement of rivet bucking bars for sheet metal mechanics.

b. *Survey Personnel:*

- (1) Subject Matter Expert, Noise, USAFSAM/OEC
- (2) Industrial Hygiene Consultant, USAFSAM/OEC

c. *Personnel Contacted:*

- (1) Flight Commander, 72 AMDS/SGPB
- (2) Industrial Hygienist, 72 AMDS/SGPB
- (3) Division Supervisor, 551 CMMXS/MXDPBB
- (4) Work center Supervisor, 551 CMMXS/MXDPBA
- (5) Work center Supervisor, 551 CMMXS/MXDPAC
- (6) Work center Supervisor, 551 CMMXS/MXDPAA

d. *Equipment:*

- (1) B&K PULSE Analyzer, Type 3052-A-030, SN: 3052-105138
- (2) B&K Microphone, Type 4938-A-011, SN: 2570818, 2570819
- (3) B&K Microphone, Type 4941-A-001, SN: 2570642
- (5) Quest Calibrator, Model # QC-20, SN QF8050050

2. BACKGROUND:

a. In 2010, USAFSAM/OEHT (now USAFSAM/OET) partnered with the NIOSH PERT, the Tinker AFB Bioenvironmental Engineering Flight (72 AMDS/SGPB), and personnel representing Air Force Skill Code 3806, Sheet Metal Mechanics, to conduct field measurements of vibration at the handles of selected rivet hammers during three separate tasks. See consultative letter [AFRL-SA-BR-CL-2010-0054](#) for full details. However, the 2010 assessment was strictly of the rivet hammer and not the bucking bars.

b. This 2013 assessment of the bucking bars was to collect acoustical data on nine potential options for purchase. This comparative study was solely to collect the data and not to provide a health risk assessment of bucking bar operations, since the processes evaluated are not currently utilizing these tools.

3. METHODOLOGY:

a. *Process Description:* Sheet metal mechanics conduct a wide variety of riveting operations during aircraft component refurbishment. During this assessment, three specific processes were evaluated: B-52 side cowl panel riveting, KC-135 spoiler panel riveting, and KC-135 elevator panel riveting. During each process, the respective work center supervisor identified a team of four personnel: one person to operate the rivet hammer for the duration of the assessment and three bucking bar operators.

b. A bucking bar is a tool that aids in the setting of a rivet. It is used on one side of a rivet to provide a counter force to the rivet hammer's impact. The metal used for the bucking bar has a higher strength than that of the rivet, allowing the fastener to expand against the face of the bucking bar. Bucking bars come in a variety of shapes and sizes and are selected based on their application. A bucking bar can be either a formed piece of metal used alone, see Figure 1, or the dolly portion of a dampened bucking bar, see Figure 2.

c. *Sample Procedure:* Peak sound pressure levels (SPLs) and equivalent continuous levels (L_{eq}) corresponding to the rivet hammer operator and bucking bar operator exposures were measured with 1/8-inch microphones placed at each worker's ear level. The peak SPL and L_{eq} were collected over a 30-second duration. This sampling time aligned with the PERT's protocol for assessing hand and arm vibration (HAV) exposure to the bucking bar operator. During each process, one sheet metal mechanic was selected to operate the rivet hammer and three individuals were selected to use each of the nine bucking bars. All of the bucking bars were designated with a letter, A – I. Table 1 is a cross-reference aligning the study ID of each bucking bar with the manufacturer and model.



Figure 1. Example of Formed Bucking Bars

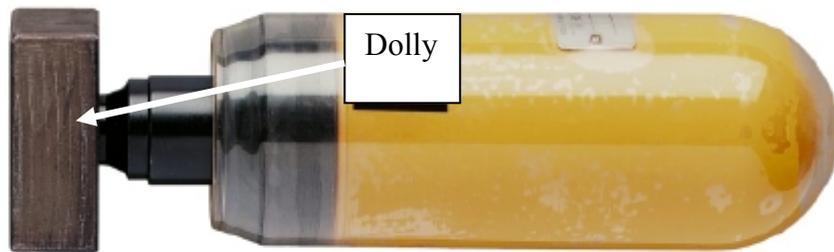


Figure 2. Example of a Dampened Bucking Bar

d. During the data collection period of each process assessed, peak SPL and L_{eq} data were collected while a rivet hammer operator and bucking bar operator set five rivets within a 30-second period. If the workers failed to set all five rivets in the time allotted, the NIOSH HAV data were discarded and the workers began the protocol again. USAFSAM acoustical data collection mirrored NIOSH data as closely as conditions allowed. If the data were acceptable to NIOSH, the process was repeated with the next set of 5 rivets, until 15 total rivets were set with the selected bucking bar. Each worker set a total of 15 rivets with each of the 9 bucking bars, 135 total rivets for each of the three processes.

Table 1. Bucking Bar Identification

Bucking Bar ID	Manufacturer	Model
A	ATI Tools	AT760B-10
B	ATI Tools	AT639
C	ATI Tools	AT692
D	Honsa	TBBT760B-10T
E	Honsa	TBBT639T
F	Honsa	TBBT692T
G	Atlas-Copco	RBB 04SP-06
H	Atlas-Copco	RBB10SP
I	U.S. Industrial Tool	TP111R (handle) TP1510A (dolly)

4. RESULTS: Assessment data for all three processes are displayed in Figures 3, 4, and 5. These data sets include: rivet hammer operator average L_{eq} , rivet hammer operator peak SPL, bucking bar operator average L_{eq} , and bucking bar operator peak SPL for each bucking bar used. A summary of the data displayed in Figures 3, 4, and 5 can be found in Table 2.

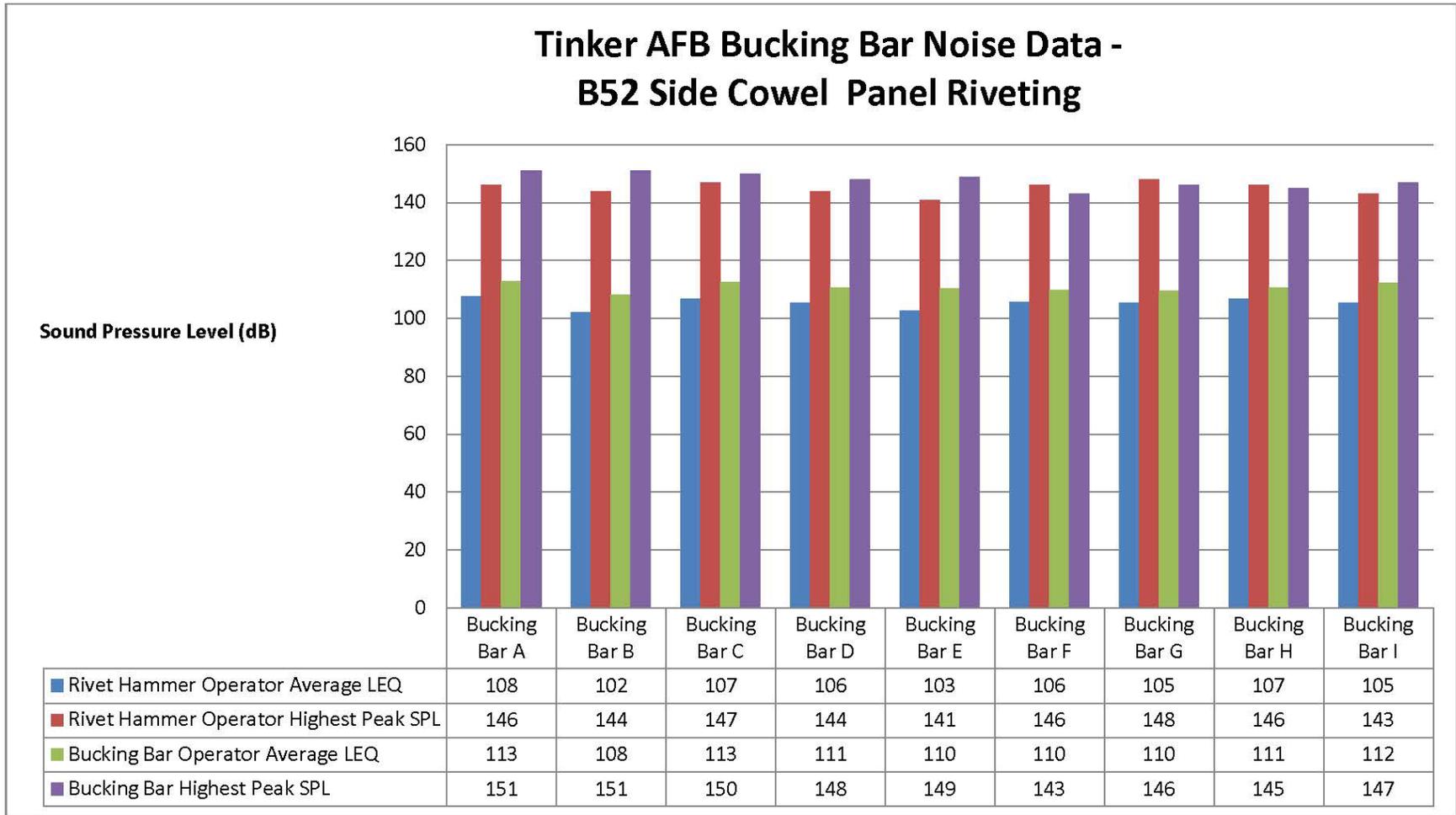


Figure 3. B-52 Side Cowel Panel Riveting Noise Data

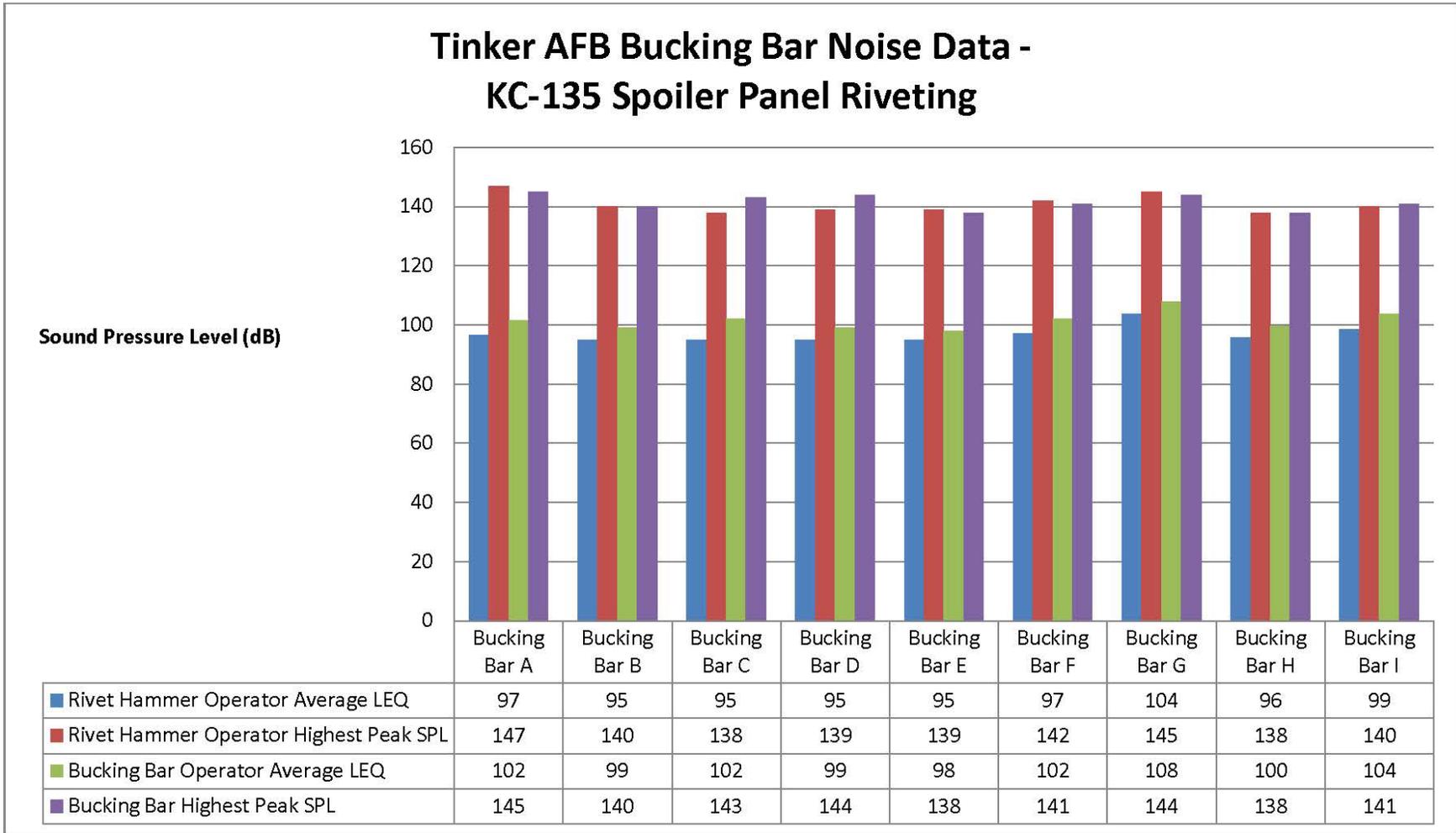


Figure 4. KC-135 Spoiler Panel Riveting Noise Data

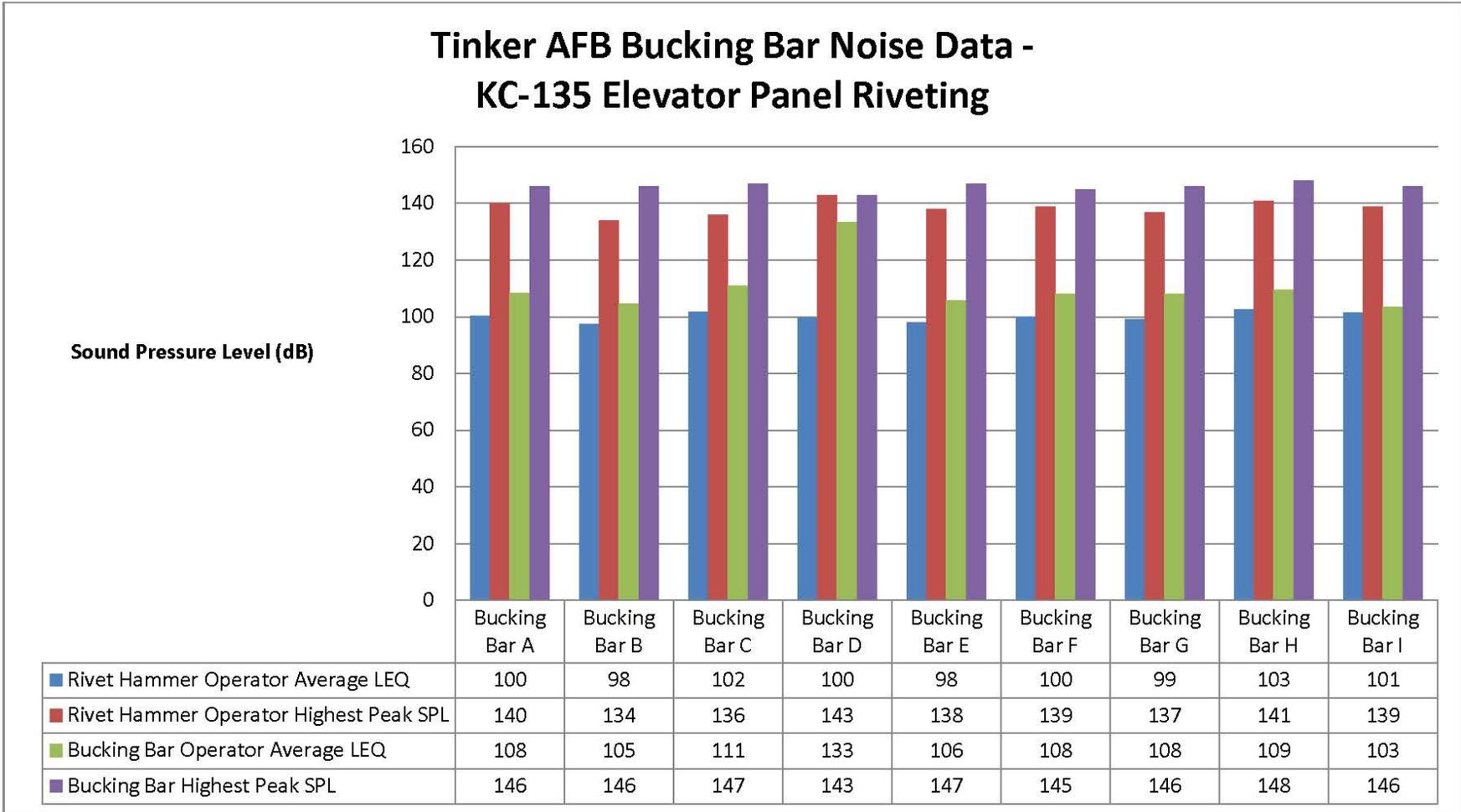


Figure 5. KC-135 Elevator Panel Riveting Noise Data

Table 2. Summary of Bucking Bar Noise Data

Process	Rivet Hammer Operator Avg L_{EQ} Range (dB)	Bucking Bar Operator Avg L_{EQ} Range (dB)	Rivet Hammer Operator Highest Peak SPL Range (dB)	Bucking Bar Operator Highest Peak SPL Range (dB)	Peak SPL Standard (dB)
B-52 Side Cowl Panel Riveting	102 – 108	108 – 113	141 – 148	143 – 151	140
KC-135 Spoiler Panel Riveting	95 – 104	98 – 108	138 – 147	138 – 145	140
KC-135 Elevator Panel Riveting	98 – 103	103 – 111	134 – 143	143 – 148	140

5. CONCLUSION:

a. For the B-52 side cowl panel riveting process, the rivet hammer operator position peak SPLs ranged from 141 – 148 dB and the bucking bar operator peak SPLs ranged from 143 – 151 dB. All nine bucking bars exceeded the impact noise SPL standard of 140 dB, per AFOSH Standard 48-20, at both the rivet and bucking bar operator positions.

b. For the KC-135 spoiler panel riveting process, the rivet hammer operator peak SPLs ranged from 138 – 147 dB and the bucking bar operator position peak SPLs ranged from 138 – 145 dB. At the rivet hammer operator position, all bucking bars exceeded the impact noise standard of 140 dB except bucking bars C, D, E, and H. At the bucking bar operator position, all bucking bars exceeded 140 dB except E and H.

c. For the KC-135 elevator panel riveting process, the rivet hammer operator peak SPLs ranged from 134 – 143 dB and the bucking bar operator position peak SPLs ranged from 143 – 148 dB. At the rivet hammer operator position, all bucking bars exceeded the impact noise standard of 140 dB except bucking bars B, C, E, F, G, and I. At the bucking bar operator position, all bucking bars exceeded 140 dB.

d. Tool selection should not be based solely on the acoustical data provided in this report. A number of other factors, such as HAV data and recommendation from NIOSH, worker acceptability, tool performance, initial purchase price and maintenance/replacement costs, tool life-cycle, etc. need to be considered in that decision.

e. Operators and the survey team involved in this bucking bar assessment wore appropriate hearing protection.

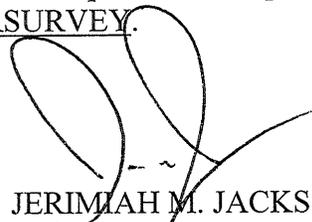
6. RECOMMENDATIONS:

a. USAFSAM recommends choosing the bucking bars that transmit the lowest peak SPL and lowest L_{eq} to limit workers' noise exposure.

b. Due to the nature of riveting operations, there are no practicable engineering controls that can be generally recommended for all the bucking bars evaluated. USAFSAM recommends retrofitting the panel preparation fixtures with attachments that are spring dampened and using rubber grips that hold the panel in place. USAFSAM also recommends engineering controls that can be applied during the riveting process that effectively control the vibration of the work-piece. For example, these vibrations may be controlled by adding resonance dampening attachments to the fixture that slide or swing into place. These controls will reduce peak SPLs that are transmitted to the workers and surrounding environment. The objective of any engineering noise control designed for riveting operations is to reduce peak SPLs below 140 dB in accordance with AFOOSH Standard 48-20, paragraph 2.11.3.1., as well as to reduce the 8-hour time-weighted average below 85 dB(A).

c. USAFSAM recommends 72 AMDS/SGPB request an additional acoustical evaluation and associated health risk assessment if 551 CMMXS purchases new bucking bars.

7. If you have any further questions regarding this report, please contact TSgt Jerimiah Jackson at DSN 798-3312 or jerimiah.jackson@us.af.mil. Please direct any questions or comments regarding Industrial Hygiene Consultative support to Maj Alan Hale at DSN 798-3862 or alan.hale@us.af.mil. To improve our services, please complete the critique located at <https://www.surveymonkey.com/s/OECUSTOMERSURVEY>.



JERIMIAH M. JACKSON, TSgt, USAF
Industrial Hygiene Consultant