Memorandum

U.S. Department
of Transportation
**Volpe National
Transportation
Systems Center**

Subject:	Validation of Rolls-Royce RR-BK01Digital Recording and 1/3 Octave Analysis System for Use in Support of Aircraft Noise Certification Efforts in Compliance with 14 CFR Part 36; Letter Report: V324-FB48B3-LR4	Date:	23OCT2017
From:	Dave Read, IT Specialist, Acoustics, Volpe Center, Environmental Measurement and Modeling Division	Reply to Attn. of:	V324

To: Rebecca Cointin; FAA AEE-100

In support of the Federal Aviation Administration's Office of Environment and Energy, the Volpe Center Environmental Measurement and Modeling Division (Volpe) has completed validation of the digital recording and 1/3 octave band analysis components of Rolls-Royce Corp.'s (RR) RR-BK01 instrumentation system (RR-BK01).

Based on review and evaluation of a technical report provided by RR, *Rolls-Royce Technical Report EIR 3286: Test Report on System Compliance of B&K Recording and Analysis System used for Engine Noise Certification – 59 Bed Stennis* (EIR 3286), and on discussions with the applicant, Volpe has determined that the RR-BK01 system meets all applicable requirements - pertaining to the measurement and analysis of static engine noise testing - of Title 14 CFR Part 36 (Amdt. 30), and is suitable for use in support of aircraft noise certification. Volpe has also determined that RR have developed appropriate setup and operation protocols, also detailed in EIR 3286.

The attached Volpe Checklist documents the testing that has been performed, as well as the validated instrument configuration and key performance characteristics of the RR-BK01 System.

If you have any comments or questions, please do not hesitate to contact me.

Attachment

cc: M. Marsan; FAA, AEE-100
S. Liu; FAA, AEE-100
B. Conze; FAA, AIR-672
C. Cutler; Volpe, V324
C. Roof; Volpe, V324
C.S.Y. Lee, V-324
C. Reherman, Volpe, V320
G. Fleming, Volpe, V320
R. Samiljan, Volpe (CTR), V90R

U.S. Department
of Transportation
Volpe National
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Systems Center

Aircraft Noise Certification
Audio Recording / Analysis System
Validation Report Checklist

Recording/Analysis System ID:	**RR-BK01**

STATUS NOTES: **COMPLETED**

Date Initiated: 15SEP2017

Date Updated: 23OCT2017

Date Completed: 23OCT2017

Volpe Point-of-contact:	Basis for Validation:
Dave Read Assisted by Bob Samiljan	Rolls-Royce Technical Report EIR 3286: "Test Report on System Compliance of B&K Recording and Analysis System used for Engine Noise Certification – 59 Bed Stennis" and manufacturer's published data

Point-of-contact:
Jeff Peters
Acoustics Specialist   Performance & Aerothermal Systems

Tech POC: Chris Knighton   Civil Experimental – Experimental Engineering – Noise
DF84 & C2 Annex – Noise Lab
A Site, Victory Road
Rolls-Royce plc, SinA-11, PO Box 31, Derby. DE24 8BJ
Telephone: (01332) 823708
christopher.knighton@rolls-royce.com

Address: Rolls-Royce Corp. (Indianapolis) street city, state, country, zip	**Telephone:** (317) 358-6974
	Email: jeffrey.peters@rolls-royce.com

Instrumentation Specifics:

Manufacturer: **Bruel & Kjaer**, others
Model Designation: **RR-BK01**
Firmware Version: **2.7.0.900 (B&K front end)**
Version ID: **Noise System Version M.1.1**
Other: System based around B&K PULSE LAN-XI Instrumentation _ Noise System Version number references:

M – Located in Stennis Measurement Room off the Arena;
1 – System Inputs – Connected to existing Calibration Switch Unit / Primary Matrix Switch;
1 – Hardware/Software Components Release Tested & Validated to include:

Hardware:
-   B&K Frames 3660-D-100;
-   B&K Modules 3160 and 3050;
-   B&K Signal Conditioning UA-2100-060-BNC;
-   B&K LAN-XI Firmware released for PULSE 21;
Software:
-   DAQ-H 21.05 Installation;
-   PULSE 21 Installation;
-   Windows 2016 Server & Windows 10 Operating Systems

Configuration being validated:

Number of simultaneous channels: 128
Bandwidth (per channel), Hz (range of nominal center frequencies): 25,600 Hz (50 Hz to 10 kHz 1/3 O.B.s)
Sample Rate (per channel), Hz: 65,536
Bit-depth (per channel): 24

Spectrum output interval, ms: **N/A** (Report section 2.1.5.e provides strange answer: "The level in each 1/3 octave band is accumulated and output at a rate given by the B&K Filtering Algorithm"…)

Note that this validation is for a system used in engine static-testing, and so the questions about output interval and time-averaging do not apply.

Filter octave frequency ratio: ☐ Base 2   ☒ Base 10

Time-averaging mode: **N/A**   ☐ Linear   ☐ Exponential
Applicant states they use 30-second linear time averages
Averaging time-period, seconds: **N/A**
Averaging time-constant, seconds: **N/A**

Filter design type:

6-pole Butterworth Proto-Type for Low-Pass and Chebychev for Band-Pass, IEC61260-1995 Class 1

Media type: Internal Hard Disk and USB3 Encrypted HDs

Data format:

- 1/3 O.B. data in .csv-compatible format;
- Input raw recorded data format – B&K *.PTI;
- Output recorded data format (DATX) – used for add'l data analysis and retention of raw data

Power source: AC Mains

Overall Analyzer IEC61260-1 conformance: ☐ class 2   ☒ class 1   ☐ class 0 (previous standard)

Analyzer conformance specifics:	Pass	Fail
☒ Relative attenuation (filter response shape) [see EIR 3286 section 2.1.7.i]	☒	☐
☒ Filter Integrated Response ("bandwidth error") [see EIR 3286 section 2.1.7.j]	☒	☐
☒ Real-time operation [see EIR 3286 section 2.1.7.k]	☒	☐
☒ Summation of output signals [see EIR 3286 section 2.1.7.l]	☒	☐
☒ Output resolution equal to or better than 0.1 dB [see EIR 3286 section 2.1.7.m]	☒	☐
☐ Linear time integration within ±5ms of 500ms	**N/A**	
☐ Slow exponential time interval within ±5ms of 500ms	**N/A**	
☐ Data loss < 5ms per 500 ms sample	**N/A**	
☒ Response @ center frequencies , 50 Hz – 10 kHz within ±1.5 dB [see EIR 3286 section 2.2.9]	☒	☐

System conformance specifics:		
☒ Amplitude linearity [see EIR 3286 section 2.2.4]	☒	☐
☒ Anti-aliasing [see EIR 3286 section 2.2.8]	☒	☐
☒ Analog anti-aliasing filter prior to digitization [see EIR 3286 2.1.7.h response: "…Butterworth analog anti-aliasing filters"]	☒	☐
☒ Frequency response [see EIR 3286 section 2.2.9]	☒	☐
☐ Quantify level range steps	**N/A**	
☒ Maximum input signal / Overload characteristics [see EIR 3286 section 2.2.5]	☒	☐
☒ Full-scale identification	☒	☐
☒ Noise floor [see EIR 3286 section 2.2.6]	☒	☐
☒ Inter-channel crosstalk [see EIR 3286 section 2.2.10]	☒	☐
☐ Environmental sensitivity	**N/A**	
☐ Power supply check	**N/A**	
☒ Data validation [see EIR 3286 section 2.1.9]	☒	☐
☐ Other (specify):		

Performance summary:

Approximate usable dynamic range, dB: >80 dB
Approximate usable frequency bandwidth, Hz: >20 kHz

Limitations, unique capabilities, etc. :

Dyn-X autoranging capability is not used. [see EIR 3286 section 2.2.12.6.f]

Comments:

Section 2.1.10 of applicant's EIR 3286 report provides formalized protocols for setup and operation of the system.

Validation Activity History:

Date	Initiator		Action
	Applicant	Volpe	
April2017	☒	☐	Jeff Peters emailed Bruce Conze about intent to validate new system at Stennis
25AUG2017	☒	☐	Jeff Peters asks Conze if there's someone from Volpe that should be involved.
25AUG2017	☐	☐	Conze identifies Dave Read from Volpe
25AUG2017	☒	☐	Jeff Peters contacts Dave Read about a telecon
25AUG2017	☐	☒	Read provides availability
25AUG2017	☒	☐	Jeff Peters sent file of presentation
29AUG2017	☒	☐	Call Scheduled
8SEP2017	☒	☐	Telecon with RR, EASA, Bombardier, Transport Canada and Volpe (Read & Samiljan) (Cutler & Conze were not able to participate)
8SEP2017	☐	☒	Email to Cointin & Marsan with info about call – Read informed applicant that validation would require formalized instrumentation performance characteristics and setup & operation protocols – RR want to do a test Mid-October, and are looking for tentative or conditional approval. Volpe is waiting to send instrumentation validation data submittal package – waiting for FAA/AEE approval
15SEP2017	☐	☐	FAA/AEE gave conditional approval – will not accept data / report from RR without completing Volpe evaluation first.
15SEP2017	☐	☒	Read sent Data Submittal Package to applicant (Jeff Peters)
15SEP2017	☐	☒	Read sent copy of data submittal package to Mario Mitschke at EASA as courtesy
15SEP2017	☒	☐	Applicant acknowledged receipt of data submittal package and of FAA/AEE conditional approval.
9OCT2017	☒	☐	Chris Knighton (RR) emails Read asking for a 1:1 call
9OCT2017	☒	☐	Chris Knighton emails an outline of instrumentation testing, etc. looking for feedback.
10OCT2017	☐	☒	Read responds (9th was holiday) –provided comments and clarifications
10OCT2017	☒	☐	Knighton provides additional anti-aliasing details
10OCT2017	☐	☒	Read provides comments on anti-aliasing discussion
10OCT2017	☒	☐	Knighton sends PDF Draft report in three parts to Read, Samiljan, Cutler
10OCT2017	☐	☒	Read confirms receipt of draft report
13OCT2017	☒	☐	Final report will be finished soon.
16OCT2017	☒	☐	Final report – reduced size graphics sent
16OCT2017	☐	☒	Read acknowledges receipt, provides credentials for box.com folder to upload full-size report.

17OCT2017	☐	☒	Read sent email to Peters & Knighton: need hi-rez version of report (some info only provided as tiny text in graphics); Need a system designation and version ID, and system and variants need to be defined.
18OCT2017	☒	☐	Knighton posted full-rez version of EIR 3286 report on Box.com; Read downloaded and acknowledged receipt
18OCT2017	☒	☐	Email from Knighton specifying System name and version number, as well as explanation of where in EIR 3286 information is presented about configuration(s)
23OCT2017	☐	☒	Request for B&K PULSE / LAN-XI Firmware #
23OCT2017	☒	☐	Firmware # provided via email
23OCT2017	☐	☒	**VALIDATION COMPLETE**
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