1 INTRODUCTION

The National Aerospace Laboratory (NLR) report, Ref. [1], gives a comparative assessment of F-35 and Saab Gripen NG. Aircraft F-16 MLU is used as a reference. The comparison and the associated conclusions are based on maximum A-weighted noise levels, LAmax. Several noise metrics are used to measure aircraft noise. For sake of clarity commonly-used A-weighted noise metrics are described below:

• **Maximum Sound Level (LAmax):** Maximum noise level that occurs during an individual noise event, such as an aircraft flyover. It is the peak instantaneous noise level heard during the event. **LAmax is most useful for describing noises that are very short in duration such as a car backfire or gun shot**

• **Sound Exposure Level (SEL):** Total sound energy of an individual noise event, incorporating intensity, frequency, and duration. Unlike LAmax, this measure is normalized to a referenced duration of one second, allowing events of different durations to be compared. **For single events that are longer in duration, such as an aircraft operation, the peak noise is better described using SEL.** SEL describes the sound level experienced if all sound energy of an aircraft flyover occurred in just one second. Thus, SEL enables direct comparison of noise events that span different durations. **As SEL accounts for noise duration, the SEL may result in a higher noise level than LAmax.**

• **Equivalent Sound Level (Leq):** Time-average of the total sound energy over a given period of time. Unlike LAmax and SEL, Leq may account for multiple noise events.

The above metrics are useful in describing aircraft noise. However, the **Day-Night Average Noise Level (DNL)** metric, which is a variation of Leq, is predominately used in airport noise studies.

USA Federal regulations require the use of the DNL, rather than other noise metrics, to determine if aircraft noise impacts are "significant." The Federal Aviation Administration (FAA) uses a DNL of 65 dB to determine if non-compatible activities exist in the vicinity of an airport.

2 NOISE DATA

In this section the data as used by NLR are reviewed.

F-16 MLU: Noise data are measured by NLR at air force base Leeuwarden.

F-35: NLR has used the data as measured at Edwards air force base. One gets the impression that the actual measurements were carried out by AFRL (Air Force Research Laboratory) and NLR was just an "active" observer. It is surprising to note a remark in the report (Page 19) that the measurements were carried out in a highly professional manner whereas in describing the measurement activity at Saab (Page 20) no appreciation is offered.

Furthermore, a question arises as to why other data (X-35 data and Mineral Wells data) available at NLR are discarded simply by saying that data was not of sufficient quality (Page 19). One would like to know the real reasons.

Gripen NG: NLR has used only an extremely limited data namely (1) one fly-over at 1000 ft with a speed of 300 kts and (2) one take-off in military thrust at 1000 ft with a speed of 240 kts. In fact, three repeated fly-over measurements and two repeated take off MIL measurements were performed at Saab, but the NLR report states the use of only one data set for each flight case (Page 22, item 1). Additional Gripen A-D Noise Power Distance (NPD) database, Ref. [2], provided by Saab was not used even when in a report, Ref. [3], provided to NLR it was shown that currently available NPD database for the Gripen A-D versions is directly applicable also to the Gripen NG. NLR even raises a point (Page 26) that Gripen demo aircraft is not representative for use as envisaged in the Netherlands. No such observation is made for F-35 aircraft.

Moreover, the average LAmax value as presented for Gripen NG at T/O MIL in Ref. [3] is disregarded with the comment that the maximum value of the used microphones is more correct to use (Page 23, item 3). Obviously, NLR have later used the maximum LAmax value of Gripen NG, 109 dB(A) instead of the average 108 dB(A), in the comparisons between the aircraft. As a consequence it would be of great interest to know how the LAmax values have been deduced for the other aircraft. This is not clear.

NLR has heavily criticized the Saab measurements regarding both the use and accuracy (Pages 20-26) and in light of this it would have been both logical and honest for NLR not to pursue with the present comparative study. Instead of demanding relevant tests they anyhow used the Saab data to reach a conclusion. Furthermore it is surprising that representative of NLR at Saab during the measurements of November 2008 did not raise any issues concerning the measurements.

3 CONCLUDING REMARKS

1. Based on extremely limited data of Gripen (MIL Power) and deduced AB Power from F-18 E/F (Page 43) NLR has drawn conclusions not worthy of an independent scientific research institute. It is further noted in NLR report (Page 19) that it will take about 3 months to analyze the Edward Air Force Base data. In addition information available for Gripen NG was not complete as it should be. One fails to see the reason of performing the comparative study at this juncture and producing rather dubious results.
2. The deduction of AB power for Gripen (1 engine) from F-18 (2-engines) is questionable and needs further explanation.
3. LAmax as used by NLR in comparing F-35/Gripen NG does not describe in any way the noise impact around the airport. One needs to determine SEL and DNL for take-off as well as approach conditions for all the aircraft. If there is no sufficient data for comparison purposes additional measurement should be planned.
4. In Ref. [4], Table E-7, one reads that SEL under the flight track of an F-35A performing a T/O MIL is 121 dB at 1000 ft distance. Based on the information provided in Ref. [3] it is possible to approximate SEL for Gripen NG by using LAmax and duration, see Figure 4 in Ref. [3], where the variation of LAS (overall A-weighted sound level, time weighting slow) is given for the repeated T/O MIL with Gripen NG. The duration appears to be about 8 seconds for the take offs. SEL may be approximated using the following expression, Ref. [5]:

$$SEL \approx 10 \cdot \log_{10}(\frac{T}{2}) + L_{A\max} \qquad (1)$$

   where T is the time interval (or duration) where the A-weighted sound level is within 10 dB (A) of the maximum value, LAmax.

   By using eq. (1) above, SEL is found to be approximately 114 dB for Gripen NG at T/O MIL. Although this is an approximation of SEL, this is substantially lower than the 121 dB stated for the F-35A in Ref. [4]. This is remarkable. Could it be so that F-35 is giving comparatively low LAmax values as compared to SEL? If this is the case, this indicates that (1) the duration of F-35 is much longer than the duration of Gripen NG and/or (2) that the noise event looks very different in F-35A compared to Gripen NG (not a “triangular” shape like in Gripen NG case) and/or (3) that the noise data used in Ref. [4] are not representative for the F-35 version to be used in the Netherlands.
5. The scatter shown in Figures 1, 3 and 4 of Ref. [1] is not based on statistical analyses but on so-called physical assumptions. It is not made transparent about the effect of individual assumptions on the noise itself.

4 REFERENCES

[1] NLR-CR-2009-053 Beordeling geluidsgegevens kandidaattoestellen VF-16, Status beschikbarge gegevens d.d. februari 2009, T.A. van Veen, M.C. van Sijll en W.F. Lammen, 2009-03-09

[2] ACDA-03.061 Noise Database for the Saab JAS39 Gripen for Determining the Noise Exposure at and around Airfields (incl. Appendix 1. Noise Database for the Saab JAS39 Gripen Aircraft), Ericsson, L., 2003-09-01

[3] A2Z-R-08-033 Exterior noise measurements of Gripen NG Demonstrator, Ericsson, L., Österström, N., 2008-11-21

[4] AFD-081016-108 2005 BRAC Decisions and Related Actions Final Environmental Impact Statement Eglin Air Force Base, Florida, Appendix E Noise

[5] NASA CR-3406 Handbook of Aircraft Noise Metrics, Bolt, Beranek and Newman Inc., 1981