Executive summary

The IFA2 Project is a 1000 MW High Voltage Direct Current (HVDC) Interconnector between France and Great Britain (GB). The interconnection will be achieved by one HVDC link with a rated active power of 1000 MW, based on Voltage Sourced Converter (VSC) technology. The HVDC system will be a symmetrical monopole.

This document provides an assessment of the audible noise produced by the HVDC installation and a description of the measures to mitigate it, in order to be compliant with Outline Planning condition 12 (as detailed in italics below) and applicable standards and regulations.

The rating level of noise emitted from the converter station buildings shall not exceed whichever is the greater of the existing background noise level or 30dB(A) when measured at the boundaries of any surrounding residential properties. The measurements and assessment of noise levels shall be made in accordance with BS 4142:2014. REASON: To ensure that the use of the converter buildings does not cause any noise nuisance to nearby residential properties.

The mitigation in summary, will be a combination of enhanced building acoustic shielding, low noise equipment and convertor configuration to achieve this condition.

Further reassurance will take the form of on-site measurement during early convertor operation to reaffirm compliance. If this condition is not met, IFA2 with its Contractor shall perform the necessary modification to address.

Contents

1 General

The IFA2 Project is a 1000 MW HVDC Interconnector between France and Great Britain (GB). The interconnection will be achieved by one HVDC link with a rated active power of 1000 MW, based on Voltage Sourced Converter (VSC) technology. The HVDC system will be a symmetrical monopole.

This document provides an assessment of the audible noise produced by the HVDC installation and a description of the measures to mitigate it, in order to be compliant with the planning condition 12, applicable standards and regulations

2 Audible noise contributors and their main characteristics

Generally, a HVDC converter station includes a number of sources generating audible noise.

Main contributors are:

- Converter transformers and associated coolers with fans;
- Shunt reactor;
- Cooling fans for valve cooling system;
- Converter reactors;
- AC filter components;
- DC equipment;
- All cooling and ventilation auxiliary equipment (HVAC)

Equipment	***Frequency range of emission***	***Type of noise/typical sound power level Lw***	***Constant/ Intermittent***	***Reduction achieved by means of use of mitigation action i.e. acoustical enclosure***
Converter transformers (tank)	100-2000 Hz	Indoors, tonal Lw<106 dBA/unit	Constant	>20 dBA
Converter transformer cooling (cooler fans)	50-10000 Hz	Outdoors, broad band Lw< 85 dBA/unit	Constant, but intensity depending on power transmission level	Low noise type
Shunt Reactor	100-2000 Hz	Indoors, tonal Lw< 92 dBA/unit	Constant	>20 dBA
Valve coolers fans	50-10000 Hz	Outdoors, broad band Lw< 100 dBA for whole cooling bank	Constant, but intensity depending on power transmission level	Low noise type
Converter Reactors	100-2000 Hz	Indoors, tonal Lw< 95 dBA/unit	Constant, but intensity depending on power transmission level	>25 dBA
AC filter	100-2000 Hz	Indoors, tonal Lw< 90 dBA	Constant	>25 dBA
DC equipment	100-2000 Hz	Indoors, insignificant source Lw< 70 dBA	Constant	>25 dBA
All cooling and ventilation auxiliary equipment (HVAC)	50-10000 Hz	Outdoors, broad band Lw< 75-85 dBA/unit	Constant, but intensity depending on power transmission level and ambient temperature.	Low noise type

The listed equipment can be physically identified in the layout shown in Figure 1 below.

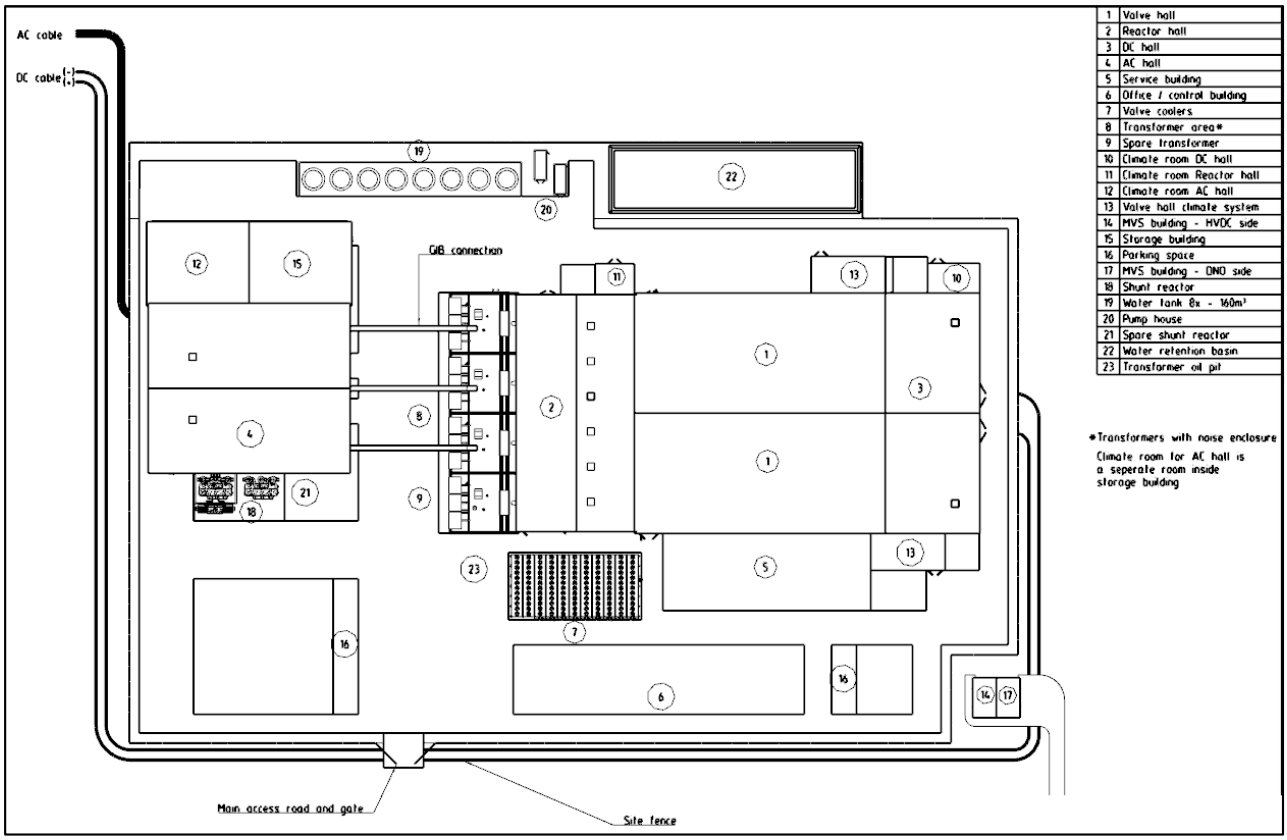

Figure 1– Detailed equipment layout of Daedalus HVDC station

The most prominent sound sources, which are mainly electrical circuit apparatus and equipment, will be located inside the station buildings or protected by audible noise enclosures.

The most significant noise heard in the surroundings of the station will be generated by the sources of noise located outdoors, i.e. transformers, the shunt reactor and the cooler fans in the valve cooling system.

The station does not contain equipment that gives high level contributions at low acoustical frequencies. The converter transformers contribute most noise in the frequency range of 300-500 Hz, other equipment gives only a very low level of noise in low frequency range. Please see the preliminary contribution spectrums at the closest receptor in Cl. 4.4.2.1.

3 Calculation Method Description

3.1 Simulation Methods

The simulations have been done in the sound calculation program, Sound PLAN 7.3 of Braunstein+Berndt GmbH. This program is used by ABB AB – HVDC as a sound calculation tool. This tool was used over the last 18 years for all HVDC projects delivered by ABB around the globe.

The Audible Noise performance of HVDC converter plants, recently delivered using same technology as the proposed Daedalus site, have been simulated with this tool. It is worth to mention the following: Dolwin1 and Dolwin 2 in Germany, NordBalt in Scandinavia and CMS in UK.

This tool has been designed for sound calculation around industrial plants and it follows some of the most common international sound calculation standards: BS-EN-ISO 9613-2:1996 (International), DIN18005 (Germany), NF S31-133 (France), TA-Lärm (Germany), ASJ CN-Model (Japan), HJ 2.4-2009 (China). All these calculation standards are very similar in their physical approach therefore the results may, depending on which standard is used, only insignificantly differ.

For calculation of audible sound around the Daedalus converter station the Sound PLAN tool has been set according to the widely internationally recognized sound calculation standard, BS-EN-ISO 9613-2:2006.

The long term experience for this kind of installation is that the results of the final sound performance measurements may differ in a range of 1-3 dB compared to the calculated values.

The measurements and assessment of noise levels will be carried out in accordance with BS 4142:2014.

3.2 Computation model

In order to predict the sound pressure levels caused by the converter stations, all the significant sound sources, i.e. noisiest equipment and apparatus, have been modelled.

The calculation model of the station has been created as a 3D model in Sound PLAN 7.3 tool.

At this stage of the design, sound propagation maps for the IFA2 HVDC Interconnector Project are based on the station layout which is located on the flat model of terrain at the station area. That means the height of the terrain (terrain level) for the surrounding houses/walls/structures is the same as terrain level for the station buildings. This a reasonable approximation since the shape of the ground does not show bigger height differences than 3m in the area of interest.

It should be noted that the converter station will be surrounded by a landscape mitigation mound (a bund with trees/bushes on the top) which will provide a significant mitigation of noise at the closest receptors.

This mound on the northern and eastern edge of the Daedalus converter plant is included in the model and therefore its mitigation effect is taken into consideration as well as the absorptive properties of the terrain around the station.

The absorption properties of the ground in the station area are good, therefore the all surrounding surfaces as well as the mound are absorptive in the calculation model (absorption coefficient = 1).

Note: the mound is conservatively taken into account without any vegetation/soft landscaping.

3.3 Power Load level

Noise calculations, have been calculated with the HVDC station in operation, at the maximum rated level of active and reactive power.

In these conditions, all the equipment and machinery of the HVDC plant will work at maximum operational performance and will generate the worst steady state noise profile.

4 Noise impact from converter stations

4.1 Noise requirements

4.1.1 Outdoor noise requirements

According to the IFA2 contract and the Planning Condition (12) for the HVDC plant construction, the rating level of noise emitted from the converter station buildings shall not exceed whichever is the greater of the existing background noise level or 30dB(A) when measured at the boundaries of any surrounding residential properties.

The measurements and assessment of noise levels will be made in accordance with BS 4142:2014.

In relation to this requirement, the most sensitive receivers have been identified (see Figure 2).

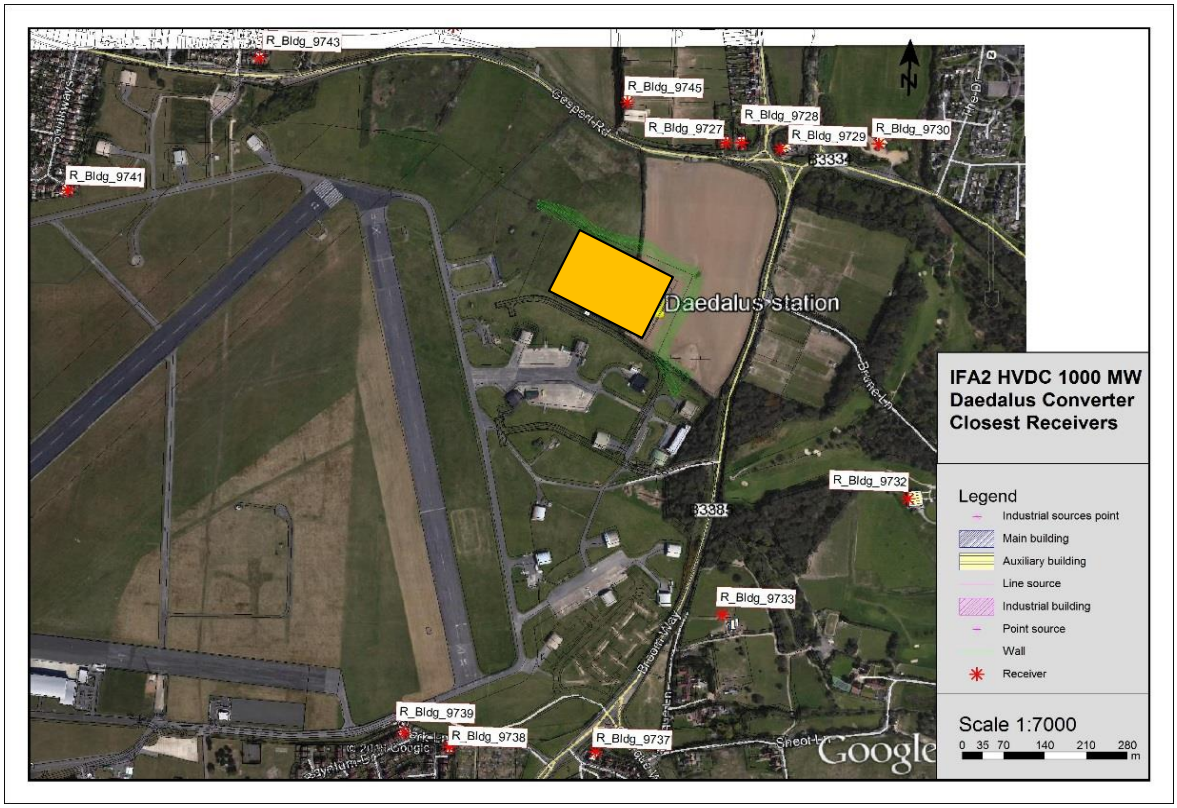

Figure 2 – Closest receptors locations, with relevant building number used in the present study as a reference.

4.2 Attenuation measures

The following noise limiting measures will be used for the Daedalus converter station:

- Station layout is strongly optimized to minimize the noise impact from the station at the sensitive noise receptor locations. Position of equipment within the site with high noise contributions is designed to direct away from the sensitive receptors. For example, the

position of valve cooling and shunt reactor is toward the south, the transformer coolers are toward west, partially screened by other station structures/facilities;

- Converter transformers tanks will be located in specially designed acoustical enclosures (see an example in Figure 3)

Figure 3 - Example of power transformer contained by audible noise enclosure

- Fans for converter transformer coolers will be of low noise type;

- Shunt reactor tank will be located in an acoustical enclosure (solution similar to the one used for transformer, see Figure 3);

- Cooling fans for valve cooling system will be of low noise type and optimized for use in this station;

- Converter reactors will be located indoors, i.e. inside the reactor-hall with heavy damping walls and roof;

- AC filter components will be installed indoors, inside the AC-Halls with a sufficient acoustical damping properties;

- DC equipment will be installed indoors, inside the DC-Halls with a sufficient acoustical damping properties;

- All cooling and ventilation auxiliary equipment (HVAC) used for the Daedalus station buildings will be acoustically optimized and noise production attenuated by means of use of low noise motors and fans.

4.3 Environmental conditions

For the purpose of the modelling, the presence of wind with a velocity between 0 and 3 m/s has been taken into account.

4.4 Predicted results

4.4.1 Indoor ambient

4.4.2 External areas

The noise levels caused by the Daedalus HVDC converter are shown as coloured isophones in the map below. The result map is located on the aerial pictures of the station area.

Each colour in the map represents the equal sound pressure level generated by the sources in the station (contribution levels).

The audible noise impact from the sound sources in the Daedalus converter, after application of the measures described in precedent paragraph, is presented in Figure 4 below.

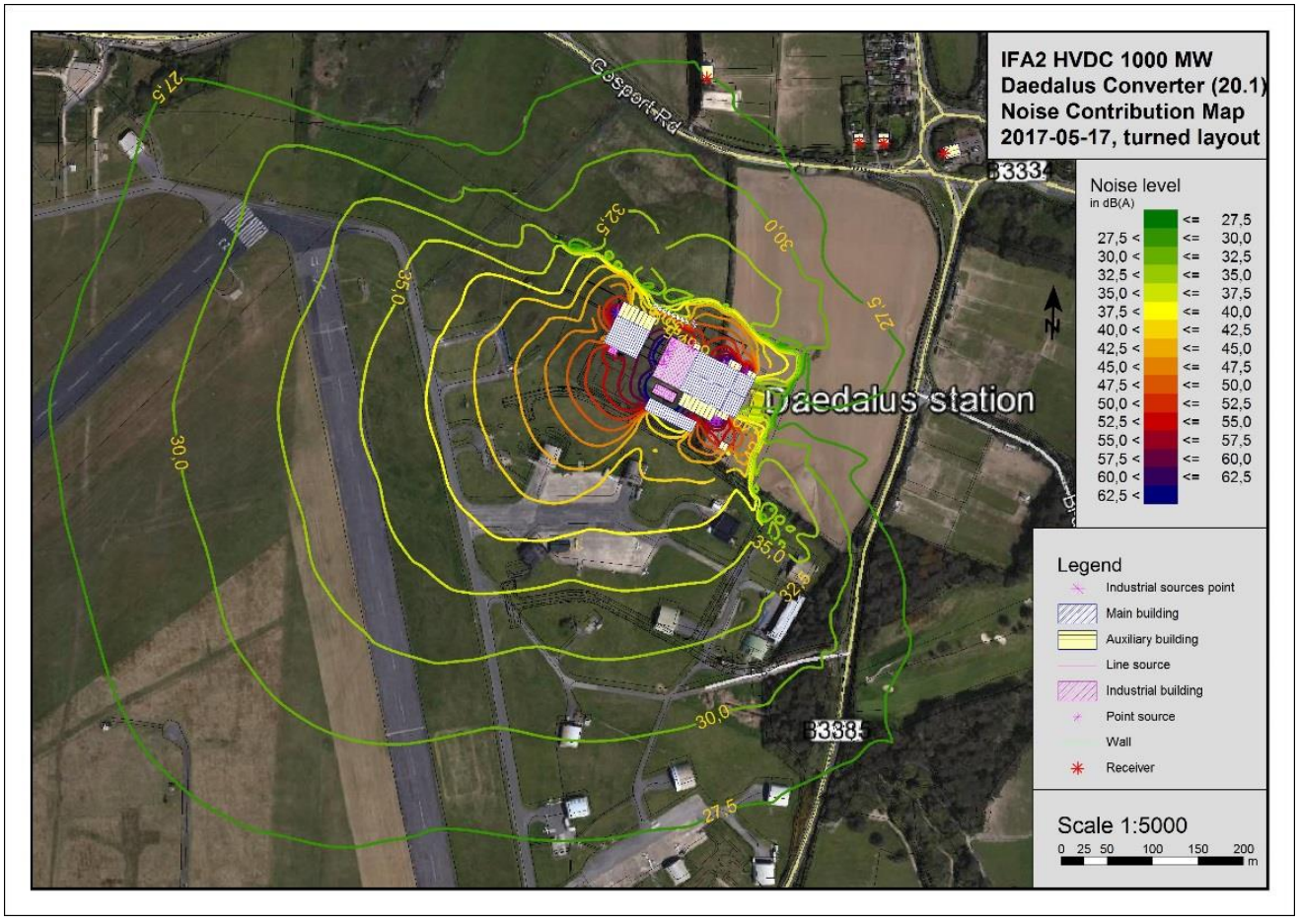

Figure 4 - Noise contribution from the Daedalus converter station, noise levels at 2 m above ground

4.4.2.1 Closest receptors

The preliminary sound contribution values from the converter station at the closest most sensitive receptor locations to the north (indicated with red spots in the map) are shown in the table below

Location	Assumed background sound level L_{90}	Sound Contribution level Leq
Building 9743	30 dBA	24.9 dBA
Building 9744	30 dBA	23.0 dBA
Building 9745	30 dBA	26.9 dBA
Building 9727	30 dBA	23.1 dBA
Building 9729	30 dBA	21.9 dBA
Building 9730	30 dBA	20.0 dBA
Building 9732	30 dBA	22.0 dBA
Building 9733	30 dBA	25.1 dBA
Building 9737	30 dBA	22.4 dBA
Building 9738	30 dBA	23.1 dBA
Building 9739	30 dBA	23.1 dBA

An assessment of the tonality from the converter station and in particular the main source (basically: converter transformer) has been conducted. The levels shown do not indicate any significant tonal contribution.

The sound contribution spectrums for the closest most sensitive receptor locations to the north of the converter station are shown in the table below, (all values in dBA).

Frequency Hz	Building 9743	Building 9744	Building 9745	Building 9727
Total Sound Contribution level Leq	24.9	23.0	26.9	23.1
50 HZ	5.8	6.4	8.4	6.4
63 HZ	11.7	12.2	14.2	12.2

80 HZ	12.9	13.3	16.6	13.2
100 HZ	8.0	10.7	14.6	11.5
125 HZ	7.0	10.0	13.8	10.3
160 HZ	6.8	10.5	14.7	11.1
200 HZ	10.9	8.8	11.3	7.7
250 HZ	11.4	8.6	10.9	7.0
315 HZ	11.3	15.1	18.9	13.7
400 HZ	15.6	13.6	17.4	13.2
500 Hz	14.3	11.0	15.2	11.8
630 HZ	12.5	10.4	15.4	11.0
800 HZ	12.8	9.1	14.5	9.9
1000 HZ	15.4	8.9	14.6	9.9
1250 HZ	16.2	7.3	12.6	7.8
1600 HZ	14.7	5.7	11.2	6.5
2000 Hz	8.0	2.2	8.4	3.4
2500 HZ	4.4	-3.2	4.2	-0.8
3150 HZ	-1.9	-9.7	-1.6	-6.2
4000 HZ	-15.0	-17.5	-7.7	-12.6

5 Conclusion

Regarding the external areas in the vicinity of the HVDC Daedalus station, in particular for the closest receptor locations, the assessment indicates that Planning Condition 12 will be fully met.

6 References

[1] CIGRÉ - Technical Brochure No 202, “HVDC Stations Audible Noise”, working group 14.26, April 2002.

7 Revision history

Rev.	Prepared	Approved
A	*Piotr Login*	
Revision text: *Rephrased and corrected based on RoR comments. Cl.4.4.2.1 added*		
Rev.	Prepared	Approved
-	*Piotr Login*	*Alberto Persico*
Revision text: *First issue*		