Onshore Converter Station

Operational Noise Insulation Scheme

(Applicable to Work Number 67)

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Revision Summary				
Rev	**Date**	**Prepared by**	**Checked by**	**Approved by**
1	22/02/21	Kay Griffin	Christian Bolanos	David Boyd
2	24/01/22	Trevor Olver	Phil Rew Williamson	Gareth Mills
3	18/03/22	Kay Griffin	Phil Rew Williamson	Gareth Mills

Description of Revisions			
Rev	**Page**	**Section**	**Description**
1	ALL	ALL	New Document
2	ALL	ALL	Amended in accordance with comments received on the Interim Draft Document from MSDC (24/3/21) and followin greceipt of design information
3	4 5 9 11	1.1 1.2 6 8.1	Amended in accordance with comments received on the Final Draft Document from MSDC (10/02/22) and followin greceipt of design information

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1. INTRODUCTION AND SCOPE

1.1. Project Overview

1. East Anglia Three Limited (EATL) was awarded a Development Consent Order (DCO) by the Secretary of State, Department of Business, Energy & Industrial Strategy (DBEIS) on 7 August 2017 for the East Anglia THREE Offshore Windfarm (EA THREE). The DCO granted consent for the development of a 1200MW offshore windfarm and associated infrastructure and is live until 28 August 2022. The DCO has now been subject to three non-material variations:

- In March 2019 EATL submitted a non-material change application to DBEIS to amend the consent to increase the maximum generating capacity from 1,200MW to 1,400MW and to limit the maximum number of gravity base foundations to 100. In June 2019 DBEIS authorised the proposed change application and issued an Amendments Order.
- In July 2020 EATL submitted a second non-material change application to DBEIS to amend the parameters of its offshore substations (reducing the number of these to one) and wind turbines (a decrease in the number of turbines and an increase in their hub height and rotor radius). On 15 April 2021 DBEIS authorised this proposed change application and issued an Amendments Order.
- In August 2021 EATL submitted a third non-material change application to DBEIS to amend the consent to remove the maximum generating capacity of 1,400MW and to amend the parameters of its wind turbines (a decrease in the number of turbines and an increase in their hub height and rotor radius). The application is currently in the consultation phase.

2. The onshore construction works associated with EA THREE will have a capacity of 1400MW and transmission connection of 1320MW. The construction works will be spread across a 37km corridor between the Suffolk coast at Bawdsey and the converter station at Bramford, passing the northern side of Ipswich. As a result of the strategic approach taken, the cables will be pulled through pre-installed ducts laid during the onshore works for East Anglia ONE Offshore Windfarm (EA ONE), thereby substantially reducing the impacts of connecting to the National Grid (NG) at the same location. The infrastructure to be installed for EA THREE, therefore, comprises:

- The landfall site with one associated transition bay location with two transition bays containing the connection between the offshore and onshore cables;
- Two onshore electrical cables (single core);
- Up to 62 jointing bay locations each with up to two jointing bays;
- One onshore converter station, adjacent to the EA ONE Substation;
- Three cables to link the converter station to the National Grid Bramford Substation;
- Up to three onshore fibre optic cables; and
- Landscaping and tree planting around the onshore converter station location.

3. Since the granting of the DCO, the decision has been made that the electrical connection for EA THREE will comprise a high voltage direct current (HVDC) cable rather than a high voltage alternating current cable and, therefore, the type of substation that will be required is a HVDC converter station. The substation will be referred to here as a 'converter station' and this amended terminology has been agreed with the relevant authorities on 15 October 2020. It has also been determined that only one converter station will be constructed rather than two and that the converter station will be installed in a single construction phase.

1.2. Purpose and Scope

4. This Operational Noise and Insulation Scheme (ONIS) sets out the mitigation and control measures to be applied to the operation of the EA THREE onshore converter station to minimise potential noise and vibration impacts on nearby residents and other sensitive receptors. This plan has been produced to fulfil DCO Requirement 26 (1) which states:

> ***26***.—*(1) No part of Work No. 67 may commence until written details that provide for the insulation of that part against the transmission of noise and vibration have been submitted to and approved by the relevant planning authority. Work No. 67 must thereafter be implemented in accordance with the approved details.*

5. The scope of this document relates to the ONIS associated with the onshore converter station comprising Work No. 67, located to the north of the existing NG substation and adjacent to the EA ONE Substation (Figure 1 Site Context Plan). In addition, Construction Noise and Vibration Management Schemes (CNVMSs) have been produced for the converter station (EA3-GRD-CON-PLN-IBR-000113) and each stage of the onshore connection works and are provided under separate cover.

6. Construction works at the Converter Station will be some of the first onshore connection works to commence. The access track and temporary laydown will be constructed in Summer 2022 with the remaining works being undertaken from Q2 2022.

7. Vibration management is not considered within the scope of this plan as no impact, with respect to vibration, is expected at any nearby receptors, as stated in Volume 1 Chapter 26 of East Anglia THREE Offshore Windfarm Environmental Statement (ES), 2015.

8. The objectives of this ONIS are to:

- Identify and assess the potential activities associated with the operation of the onshore converter station that could lead to noise impacts.
- Identify and evaluate noise mitigation measures, in order to ensure compliance with relevant UK legislation, DCO Requirements, environmental commitments as set out in the Environmental Statement (ES), and best practice. These measures will only be revised with the agreement of Mid Suffolk District Council (MSDC).

1.3. Background

9. An Operational Noise Assessment was carried out during the Environmental Statement (ES) process of the East Anglia THREE Project. The impacts of the operation were assessed with reference to the existing environment (the baseline) as represented by noise monitoring undertaken around the converter station.

10. Following the detailed design of the onshore converter station, the noise assessment has now been repeated. The noise from the onshore converter station was predicted by modelling the noise sources using Cadna-A noise modelling software. Cadna-A incorporates the prediction methodology within ISO 9613-2:1996 'Acoustics. Attenuation of sound during propagation outdoors'. The need for additional mitigation was identified and the noise modelling repeated to ensure compliance with the relevant DCO limits (see Section 4 of this report).

11. In order to ensure no significant impact from noise levels during the operation of the onshore converter station the DCO Requirement 26 (2) states that:

> **26** (2) *the rating level of operational noise immissions (including any relevant penalties for tonal or impulsive noise in accordance with BS4142:2014) from Work No. 67 alone (including transformers, air handling units and cooling fans) must not exceed 5dB above the background (LA90,1hr) level during the daytime (07:00 – 23:00) and 35 dB LAeq,15 min during the night time (23:00 – 07:00) at Bullenhall Farm (610287, 246601) Hill Farm (609088, 245652) and Woodlands Farm (609597, 246806).*
>
> *(3) Sub-paragraph (2) does not apply to any emergency event, maintenance and repairs or to any commissioning or testing event previously notified to the relevant planning authority.*

12. Furthermore, DCO Requirement 26 (4), requires a noise monitoring survey to confirm these levels as follows:

> ***26** 4) Within three months of the completion of commissioning of any part of Work No. 67, the undertaker must submit measurements to the relevant planning authority taken in the vicinity of the relevant property or properties specified at sub-paragraph (2) to confirm the rating level of operational noise immissions do not exceed the levels specified in sub-paragraph (2), including details of any remedial works and a programme of implementation should the immissions exceed the stated levels.*
>
> *(5) Measurements must be undertaken in accordance with the equipment specifications, measurement procedures and monitoring equipment positioning guidelines outlined in BS 4142:2014.*
>
> *(6) For the purposes of this requirement, "completion of commissioning" means the date when the circuits have been fully tested and verified that they are able to transmit their rated power capacity to the grid connection point and National Grid has issued an FON (final operation notification) to the generator.*

2. ABBREVIATIONS

CNVMS	Construction Noise and Vibration Management Scheme
CLO	Community Liaison Officer
CoPA	Control of Pollution Act 1974
DBEIS	Department of Business, Energy and Industrial Strategy
DC	Direct Current
DCO	Development Consent Order
EA ONE	East Anglia ONE Offshore Windfarm
EA THREE	East Anglia THREE Offshore Windfarm
EATL	East Anglia THREE Limited
ES	Environmental Statement
FON	Final operation notification
GIS	Gas insulated switchgear
HVDC	High Voltage Direct Current
MSDC	Mid Suffolk District Council
MW	Megawatt
NG	National Grid
OFTO	Offshore Transmission Owner
ONIS	Operational Noise Insulation Scheme
SLM	Sound level meter
STATCOM	Static Synchronous Compensator

3. PROJECT DESCRIPTION

3.1. Site Location and Surrounding Area

13. The newly built EA ONE Substation and the National Grid (NG) Bramford Substation are key features in the local landscape. These are located to the west and to the southeast respectively of the EA THREE Converter Station compound. The landscape around these is predominantly farmed agricultural land. Large open fields feature extensively around the site, which are mainly used for arable crops. Field boundaries are often hedgerows occasionally with hedgerow trees and intermittent woodlands or woodland shelterbelts.

14. The main settlement pattern in the area is of isolated farmsteads and small villages, which are scattered throughout the landscape and often situated within the valleys. The local area interspersed with farm buildings, barns and residential houses. To the east, lies the western edge of Ipswich, which is visible in long views from elevated positions across the area.

15. Transport links include the busy A14 to the east and A1071 to the south, the rail line through the Gipping valley and a network of minor roads, tracks and footpaths in the west of the area.

16. In terms of baseline noise, the onshore converter station site is situated in a quiet, rural area and as such there are few dominant noise sources. During daytime hours, increased traffic levels on the nearby A14 and A1071 make a significant contribution to the ambient and background noise levels. Peak noise levels generally result from individual vehicles passing close to a receptor location, farm vehicles in the fields, or noise from animals such as dogs or geese.

17. Currently at night, the existing NG Bramford Substation is a noise feature in the area, but this is less so during the daytime. Other noise sources are high altitude aircraft, wind in the trees and birds. Observations made as part of the Operational Noise Monitoring Assessment for the recently built EA ONE Substation (Onshore Substation Operational Noise Assessment DCO Requirement 24 Final for Discharge, August 2020, Document Reference EA1-GRD-N-OWC-238737) indicated that the sound from the substation was inaudible at the sensitive rectors in its vicinity.

3.2. Onshore Converter Station Description

18. The onshore converter station can be divided into the following five systems, in accordance with the Converter Station Layout Plan included in Figure 1 and Table 3-1 shows the technical features of each of these systems:

- Converter and Control Buildings
- DC Yard 1+2
- Converter Feeder Area
- Transformer Area
- AC Switch Yard
- Outdoor Cooler Platform

Table 3-1 Onshore Converter Station Systems

Description	Units	Approximate Height (m) Maximum
Converter and Control Buildings		
Converter Building with Electircal Equipment	1	20.8
Control Building with Switchgears, Control and Auxilliary rooms	2	6.8
DC Yard 1+2		
DC Reactors	6	7.5
Surge Arrestor	22	7.5
Cable Sealing End	2	8
DC Disconnector with Earthing Switch	2	10.5
DC Voltage Measuring Devise	2	6
DC Chopper Reactor	2	8.5
Converter Feeder Area		
AC Disconector with Earthing Switch	3	13
Capacitive Voltage Divider	3	10
Surge Arrestor	3	11.5
Transformer Area		
Converter Transformer (with noise enclosure)	3+1	10
Surge Arrestor	3	14
Star Point Current Transformer	1	11.2

Description	Units	Approximate Maximum Height (m)
Star Point Surge Arrestor Battery	1	4.5
Star Point Reactor	1	8.5
Star Point Resistor	1	5
AC Switchyard		
PLC Capacitor Tower	3	7.5
PLC Reactor	3	8.5
Insertion Resistor	3	12.5
Insertion Resistor Disconnector	3	10.7
AC Circuit Breaker	3	7.3
Current Transformer	3	8.2
Surge Arrestor	3	7.5
AC Cable Sealing Ends	6	8
Outdoor Cooler Platform		
CWC Cooler Banks	9	8.5

4. LEGISLATION AND GUIDELINES

19. The following legislation and guidelines are relevant to the operational noise assessment:

- Noise and Statutory Nuisance Act 1993;
- Environmental Protection Act 1990;
- Control of Pollution Act 1974 (CoPA);
- BS 4142:2014 +A1:2019 'Method for rating industrial noise affecting mixed residential and industrial areas'; and
- ISO 9613-2:1996 'Acoustics. Attenuation of sound during propagation outdoors'.

5. OPERATIONAL NOISE AND INSULATION SCHEME GOVERNANCE

20. Ensuring compliance with the ONIS will be the responsibility of responsibility of EATL until the divestment of the facility to the Offshore Transmission Owner (OFTO)[1].

6. LOCAL COMMUNITY LIAISON

21. EATL is committed to providing clear communication to local residents and will manage public relations with local residents and businesses. Proactive community liaison will be maintained, keeping local residents informed of the type and timing of works

[1] Although the EA THREE onshore transmission works will be constructed by EATL, in the UK, separate Offshore Transmission Owners (OFTOs) take responsibility for offshore transmission assets, such as the EA THREE Converter Station under long-term OFTO licences. The converter station will, therefore, be operated following divestment, by an OFTO

involved. A combination of communication mechanisms such as posters, notices, exhibitions, letters, newsletters, website updates and parish council meetings will be employed to keep local residents and businesses informed.

22. A designated EA THREE Community Liaison Officer will field and respond to any public concerns, queries or complaints in a professional and diligent manner as set out in the Community Liaison and Public Relations Procedure. The Complaints Procedure will be publicised and complaints will be directed to the EATL Community Liaison Officer. All enquiries will be logged, investigated and rectifying actions taken when deemed appropriate. Enquiries will be dealt with in an expedient and courteous manner. Details of complaints will be reported to MSDC within 48 hours.

7. OPERATIONAL NOISE ASSESSMENT

7.1. Assessment Methodology

23. An operational noise assessment has been undertaken and is included as Appendix 1. The document is summarised here for completeness. In order to perform the operational noise assessment, a 3D model has been created to predict the noise levels that will arise from the operation of the new onshore converter station.

24. The noise model has been created using Cadna-A, a computer-based noise propagation modelling package which incorporates the calculation procedure set out in ISO 9613-2:1996. This calculation procedure is recommended by the European Commission to determine noise from industrial sources.

25. Cadna-A has been created to estimate the contribution to noise levels at each noise sensitive receptors location, taking into account the following corrections:

- Distance propagation;
- Directivity effects;
- Screening effects, due to existing buildings or other structures; and
- Ground effects.

26. Finally the estimated noise levels have been compared with the noise criteria.

7.2. Noise Sensitive Receptors

27. The ES and DCO Requirement 26 (1) identify a number of receptors that are potentially sensitive to noise impacts during operational stage of the onshore converter station. These are shown in Table 7-1 and Figure 2.

Table 7-1 Noise Sensitive Receptors – Onshore Converter Station

Receptor	Co-ordinates	
	Easting	Northing
Bullenhall Farm	610287	246601
Hill Farm House	609088	245652
Woodlands Farm	609597	246806

7.3. Noise Criteria

28. This ONIS has been produced to fulfil DCO Requirement 26 (1). With respect to the limits presented in DCO Requirement 26 (2) (as set out paragraph 10, it is the night time noise limit that is the more stringent and it is this that was considered in the operational noise assessment, as summarised in Table 7-2.

Table 7-2 Noise Criteria

Noise sensitive receptor	Limit value ($L_{Aeq, 5min}$) (including any relevant penalties for tonal or impulsive noise, in accordance with Section 8 of BS4142:2014)
Bullenhall Farm	35 dB(A)
Hill Farm	35 dB(A)
Woodlands Farm	35 dB(A)

7.4. Main Noise Sources

29. The main noise sources, during the operational stage of the onshore converter station, have been identified and are listed in Table 7-3 along with their apportioned noise limits:

Table 7-3 Main Noise Sources

Component	Assumed Noise Protection Measures	Noise Limit
Transformer (each box)	Completely enclosed Transforer. Three sides shall be covered by fire protection walls, front wall and roof by removable noise protection panels.	**L**W <= 88 dB(A)
Reactor , each (2x3)	Outdoor Sound Enclosure	LW <= 80 dB(A)
Converter cooling fans, in all	Appropriate sound mitigation measures	LW <= 95 dB(A)
HVAC cooling fans (1 cooler bank)	Appropriate sound mitigation measures, installed on Converter Cooling Rack	LW <= 85 dB(A)
Converter transformer cooler, per transformer	Appropriate sound mitigation measures / Low Design for Fans	LW <= 88 dB(A)
Auxillary Transformer (each)	Appropriate sound mitigation measures by supplier/ Alternatively completely enclosed transformers installed at technical building	LW <= 78 dB(A)
AC Filter (All Filters, 3phase)	Appropriate sound mitigation measures by supplier	LW <= 88 dB(A)
PLC Filter (All filters and reactors, 3phase)	Appropriate sound mitigation measures by supplier	LW <= 85 dB(A)
Air ventilations units/fans	Appropriate sound mitigation measures	LW <= 75 dB(A)
Air ventilation openings (exhaust), in all	Appropriate sound mitigation measures	LW <= 75 dB(A)
4 Air ventilations supply units/fans, total (2x 100%)	Appropriate sound mitigation measures	LW <= 83 dB(A)
1 Air handling unit (1x 100%)	Appropriate sound mitigation measures	LW <= 75 dB(A)
1 Dry cooler unit	Appropriate sound mitigation measures	LW <= 80 dB(A)
4 Air supply/exhaust fans, each	Appropriate sound mitigation measures	LW <= 71 dB(A)
HVAC systems, in all	Appropriate sound mitigation measures	LW <= 75 dB(A)

7.5. Assumptions

30. The following assumptions have been made when preparing the noise model, to consider the worst case:

- Noise emission levels have been incorporated into the model as area sources or punctual sources;
- The noise levels of noise sources have been given in octave spectrum of 31.5 or 63 Hz to 8 kHz;
- The modelling has assumed that each receptor is subjected to favourable sound propagation from each sound source. That is, each receptor will be assumed to be downwind from all sources simultaneously. Thus, the worst case will be assessed;
- The ground absorption factor G will be set to 0.5;
- The number of reflections allowed in the model will set to 2;
- Atmospheric sound absorption effects were calculated for 10ºC and 70% relative humidity; and

- All the noise sources will operate for 24 hours in steady conditions.

7.6. Noise Results

31. The results of the CadnaA predictions, based on the above methodology and considering the additional mitigation, were compared with the noise criteria set out in the DCO. Appendix 2 of this document shows noise maps of the estimated noise levels at the receptor sites and the results are presented in Table 7-4.

Table 7-4 Noise Results

Onshore Converter Station Operational Noise Assessment						
ID Name	Receptor	Sensitivity	Predicted Noise Level dB(A)	Rating Level dB(A)	Noise Criteria dB(A)	Fulfilment
R1	Cones Farm	High	30	33	-	-
R2	Hill Farm	High	32	35	35	Yes
R3	Black Cottage	High	25	28	-	-
R4	Woodlands Farm	High	30	33	35	Yes
R5	Willow Cottage	High	29	32	-	-
R6	Bullenhall Farm	High	32	35	35	Yes
R7	Burstall Hall	High	28	31	-	-
R8	Walnut Tree Farm	High	28	31	-	-

7.7. Conclusion

32. The results show that estimated noise levels (including any relevant penalties for tonal or impulsive noise in accordance with section 8 of BS4142:2014) at all receptors will be below the noise criteria stated in the Requirement 26 (2) of the DCO.

8. RECOMMENDATIONS

8.1. Operational Noise Monitoring

33. As required by DCO Requirement 26 (4), within three months of the completion of the commissioning of the onshore converter station, noise measurements will be taken at agreed locations in the vicinity of Bullenhall Farm, Hill Farm and Woodlands Farm to verify that noise levels at each location do not exceed the requirement stated in Requirements 26 (2). A Commissioning Noise Report will be submitted to MSDC setting out the monitored noise levels and including a comparison with the levels set within the DCO.

34. Should noise from the converter station not be the dominant source at the receptors, additional monitoring would be undertaken closer to the converter station to determine a source level. Further calculations would be undertaken to determine the noise level from the site at the receptors.

35. Furthermore, should complaints be received as a result of noise from the operation of the onshore converter station, where deemed necessary additional noise measurements will be undertaken to identify whether the noise level criteria is being exceeded (see Requirement 26 (2) of the DCO).

36. Measurements will be taken by a suitably qualified acoustician in the vicinity of the property or properties. Where access to a property is not granted to undertake such measurements, measurements shall be undertaken at a location that is considered by the acoustician to be representative of noise levels at the property or properties in question.

37. Measurements will be taken for a period of an hour, during the quietest part of the night (assumed 12:00-04:00), during a time when the onshore converter station is known to be fully operational.

38. Where appropriate, any transient noise sources, other than those from the onshore converter station, will be identified where possible, isolated and removed from the measurements. In addition, consideration will be given to logarithmically subtracting baseline background noise levels.

39. Measurements would be taken in accordance with procedures within BS 7445: Description and measurement of environmental noise, using a suitably calibrated Type 1 / Class 1 sound level measuring equipment.

40. The results of the measurements would be documented in a format suitable for submission to the MSDC. If a significant impact was identified, mitigation measures would be recommended to reduce the noise levels. Further compliance testing would be undertaken to identify whether the additional mitigation measures had successfully reduced the noise levels such that the noise impact was then deemed compliant and not significant to the receptors.

9. REFERENCES

The British Standards Institution, 2014, amended 2019, BS *4142:2014 +A1:2019 'Method for rating industrial noise affecting mixed residential and industrial areas',* London, BSI

APPENDIX 1 OPERATIONAL NOISE ASSESSSMENT

Audible Noise Study - ONCS

Work Package

Revision	Date	Reason for Issue
1	09.08.2021	First issue
2	05.10.2021	Comments incorporated (V2.0) Calculation updated (V3.0)
3	05.11.2021	Meeting Comments incorporated (V4.0) and additional Comment Sheet requirements incorporated (V5.0)
Summary of Changes (latest revision only)		
- Customer comments incorporated		

Audible Noise Study - ONCS

Onshore:

Audible Noise (OTC=32031)

Safety Study (DCC=BQB010)

SPR Doc. ID: EA3-OND-ENV-STU-SAS-000001

Siemens Doc. ID:
P-017961_EC_ 32031#EA32-BQB010_001

East Anglia 3

1320MW

Customer: Scottish Power Renewables

Contract No. tbn

Doc. ID: E4A000000999063

Technical Classification:

ECCN: N	AL: N

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Index of Revisions

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02	05.10.2021	Update V2.0 & V3.0	M. Juettner	M. Schoenhut	T. Basic
03	05.11.2021	Update V4.0 & V5.0	M. Juettner	M. Schoenhut	T. Basic

Enclosure

No	Document number	Title
01	EA3 &BDB070 0972	Noise Protection Concept/ Noise Study

SIEMENS energy

Ref. (Department/Year/Serial No.)

Report

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Subject/Title

Noise Protection Concept/ Noise Study

Place	Date
Erlangen	2021-08-09

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Project

East Anglia 3 Converter Station

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This concept is only valid with the principle plant designs shown in drawings
P-016692_EC_32101_EA32_Noise°Input V2 and
P-016692_EC_32101_EA32_BLD010_Rev00_181011_02

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See version sheet next page				

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Document Version Sheet

Date, Version	Description	Department, Name
2021-08-09 V1.0	Version 1.0 replaces all previous versions (uncontrolled documents)	SE GP G SO EN PLCE ACO, Jüttner
2021-09-16 V2.0	Version 2.0 updated version: - Customer comments included - Results of EA1 noise readings included in the discussion - Construction noise removed	SE GP G SO EN PLCE ACO, Jüttner
2021-10-05 V3.0	Version 3.0 updated version: - Site coordinates converted - Additional receptors inlcuded - Calculation updated	SE GP G SO EN PLCE ACO, Jüttner
2021-10-21 V4.0	Version 4.0 updated version: - Additional comments considered	SE GP G SO EN PLCE ACO, Jüttner
2021-11-05 V5.0	Version 5.0 updated version: - Additional comments considered - Accreditation added	SE GP G SO EN PLCE ACO, Jüttner

Content

1 Introduction and task description

Siemens Energy Acoustics Erlangen (SE GP G SO EN PLCE ACO) was contracted by SE GP T HG HVDC ENEC PI EX to perform a noise study for the East Anglia 3 Converter Station project.

The Converter Station East Anglia 3 is located in England approximately 6km away from the town Ipswich in eastern direction.

The nearest residential receptors are located at a distance of about 600m located to the north side, about 700m to the south-west side and about 550m to the north-east side from the site boundary, namely Bullenhall Farm (610287, 246601) Hill Farm (609088, 245652) and Woodlands Farm (609597, 246806) .

The noise emitted from the converter station shall not exceed the general noise requirements, described in chapter 4 of this report.

The noise protection concept / noise study shall comprise:

- Individual acoustic requirements specified for noise relevant machines and components which have to be considered by the responsible contractors / suppliers.
- Assumptions and descriptions of sound protection measures to be provided for noise relevant machines and components in order to meet the individual noise requirements respectively the general noise specifications.
- Results of 3D noise modelling
- Information about prognoses uncertainty

Client Internal (Siemens Energy)	Client External/ Site Adress
Michael Schönhut Siemens Energy Global GmbH & Co. KG Transmission Plant Infrastructure SE GP T HG HVDC ENEC PI EX Freyeslebenstr. 1 91058 Erlangen, Deutschland	EAST ANGLIA THREE LIMITED 1 Tudor Street, London EC4Y 0AH Approx. site coordinates (WGS84 UTM31N) Easting 609691.8233 Northing 246092.1743

2 Terminology, symbols, definitions

Acoustic terms are explained in [9] to [32].

The following symbols are mainly used in this work report:

L_W	is the sound power level in dB(A), re 10^{-12} W
L_P	is the sound pressure level in dB(A), re $2*10^{-5}$ Pa
$\overline{L_p}$	is the surface time-averaged sound pressure level in dB(A), re $2*10^{-5}$ Pa
L_{eq}	is the equivalent continuous sound pressure level in dB(A), re $2*10^{-5}$ Pa
R_w ($R_{w,p}$)	is the rated sound reduction index, R, in dB (as tested)
R'_w	is the weighted apparent sound reduction index in dB (as built)
D_e	is the insertion loss value in dB

(Further symbols are defined in the report.)

3 Documents and guidelines

The noise protection concept is based on the following documents and guidelines:

Project specific documents, contractual documents and drawings

[1] 2017 No. 826 INFRASTRUCTURE PLANNING The East Anglia THREE Offshore Wind Farm Order 2017 , August 2017

[2] EA3-GRD-CON-PLM-IBR-000114_ONCS_Interim_Op_Noise_Rev01East Anglia THREE Offshore Windfarm Onshore Converter Station Operational Noise Insulation Scheme, 22-02-21, Scottishpower Renewables

[3] EN010056-000439-6.1.26 Volume 1 Chapter 26 Noise and Vibration - Environmental Statement Volume 1 Document Reference – 6.1.26, RevA dated Nov 2015, Royal HaskoningDHV

[4] Proposed EA1 & EA3 substation noise modelling - Updated noise modelling, Reference: I&BPB4842R001D01, Revision: 01/Final, 23 August 2018 by HASKONINGDHV UK LTD

[5] East Anglia One Offshore Windfarm Onshore Substation Operational Noise Assessment – DCO requirement 24 Final for Discharge, EA1-GRD-N-OWC-238737, ScottishPower Renewables, September 2020 (Rev2 Final for Discharge)

[6] East Anglia One Offshore Windfarm East Anglia ONE Baseline Noise Data Report – FINAL 296926-01(00) EA1 Onshore Enabling Works (ONCA & ONSS), EA1-GRD-F-RDB-116819 Rev0 ONCA & ONSS , ScottishPower Renewables, October 2017

[7] General arrangement drawings
P-016692_EC_32101_EA32_Noise Input _V2
P-016692_EC_32101_EA32_BLD010_Rev00_181011_02

[8] Results of Siemens noise measurement tests at comparable converter stations

Guidelines and software documentation

[9] WEA Geräuscherlass, Amt für Immissionsschutz des Landes Brandenburg, (wind turbine noise decree, Office for Immission Control of the State of Brandenburg), from 31. Juli 2003

[10] Berechnung der Unsicherheiten bei Immissionspegelprognosen nach TA-Lärm (Calculation of uncertainties for noise propagation calculations according to TA-Lärm), from Propst W, Accon-Datakustik, April 2009

[11] Prüfprotokoll nach DIN 45687 und ISO 17534 für das Softwareprogramm Cadna A (conformitation certificate according to DIN 45687 and ISO 17534 for Software Cadna A), from Data-Kustik GmbH, latest version.

Standards

[12] ISO 14163, 1998
Acoustics – Guidelines for noise control by silencers

[13] ISO 15665, 2003
Acoustics - Acoustic insulation pipes, valves and flanges

[14] ISO 11654, 1997
Acoustics – Sound absorbers for use in buildings – Rating of sound absorbers

[15] ISO 10140-2, 2010
Acoustics – Laboratory measurement of sound insulation of building elements - Part 2: Measurements of airborne sound insulation

[16] ISO 717-1, 2013
Acoustics – Rating of sound insulation in buildings and of building elements
Part 1: Airborne sound insulation

[17] ISO 354, 2003
Acoustics – Measurement of sound absorption in a reverberation room

[18] DIN 45641, 1990
Averaging of sound levels

[19] DIN 45630-1: 1971
Principles of noise measurements, Physical and subjective magnitudes of sound

[20] DIN 45635-1, 1984
Measurement of noise emitted by machines
Airborne noise emission, Enveloping surface method, Basic method, divided into 3 grades of accuracy

[21] IEC 60076-10, 2016
Power transformers – Part 10: Determination of sound levels

[22] DIN EN ISO 3740, 2019
Acoustics - Determination of sound power levels of noise sources -
Guidelines for the use of basic standards

[23] DIN EN ISO 3744, 2011
Acoustics - Determination of sound power levels and sound energy levels of noise sources using sound pressure - Engineering method for an essentially free field over a reflecting plane

[24] DIN EN ISO 3746, 2011
Acoustics - Determination of sound power levels and sound energy levels of noise sources using sound pressure - Survey method using an enveloping measurement surface over a reflecting plane

[25] DIN ISO 8297, 2000
Acoustics – Determination of sound power levels of multisource industrial plants for evaluation of sound pressure levels in the environment – Engineering method

[26] ISO 1996-1, 2016
Acoustics - Description, measurement and assessment of environmental noise - Part 1: Basic quantities and assessment procedures

[27] ISO 1996-2, 2017
Acoustics - Description, measurement and assessment of environmental noise - Part 2: Determination of sound pressure levels

[28] ISO 9613-1, 1993
Acoustics – Attenuation of sound during propagation outdoors – Part1: Calculation of the absorption of sound by the atmosphere

[29] ISO 9613-2, 1996
Acoustics – Attenuation of sound during propagation outdoors – Part2: General method of calculation

[30] DIN EN ISO 9614-1, 2009
Acoustics- Determination of sound power levels of noise sources using sound intensity – Part 1: Measurement at discrete points

[31] DIN EN ISO 9614-2, 1996
Acoustics- Determination of sound power levels of noise sources using sound intensity – Part 2: Measurement by scanning

[32] DIN EN ISO 3382-2, 2008
Acoustics – Measurement of room acoustic parameters, Part 2: Reverberation time in ordinary rooms

[33] BS8233, 2014
Guidance on sound insulation and noise reduction for buildings

[34] BS7445-1, 2003
Description and measurement of environmental noise - Guide to quantities and procedures

[35] BS7445-2, 1991
Description and measurement of environmental noise. Guide to the acquisition of data pertinent to land use

[36] BS7445-3, 1991
Description and measurement of environmental noise. Guide to application to noise limits

[37] BS4142, 2014
Methods for rating and assessing industrial and commercial sound

4 General acoustic requirements and criteria

4.1 Noise Limits offsite

The noise limits and conditions described in [1] to [4] are the base for this acoustical assessment.

The far field noise requirements can be summarized as given in part 3 condition 26:

Control of noise during operational phase

26.—(1) No part of Work No. 67 may commence until written details that provide for the insulation of that part against the transmission of noise and vibration have been submitted to and approved by the relevant planning authority. Work No. 67 must thereafter be implemented in accordance with the approved details.

(2) The rating level of operational noise immissions (including any relevant penalties for tonal or impulsive noise in accordance with BS4142:2014) from Work No. 67 alone (including transformers, air handling units and cooling fans) must not exceed 5dB above the background ($L_{A90,1hr}$) level during the daytime (07:00 – 23:00) and 35 dB $L_{Aeq,15\ min}$ during the night time (23:00 – 07:00) at Bullenhall Farm (610287, 246601) Hill Farm (609088, 245652) and Woodlands Farm (609597, 246806).

(3) Sub-paragraph (2) does not apply to any emergency event, maintenance and repairs or to any commissioning or testing event previously notified to the relevant planning authority.

(4) Within three months of the completion of commissioning of any part of Work No. 67, the undertaker must submit measurements to the relevant planning authority taken in the vicinity of the relevant property or properties specified at sub-paragraph (2) to confirm the rating level of operational noise immissions do not exceed the levels specified in sub-paragraph (2), including details of any remedial works and a programme of implementation should the immissions exceed the stated levels.

Note:
With regard to [5] and [6] the nighttime noise limits will most stringent and be basis for the acoustical design.

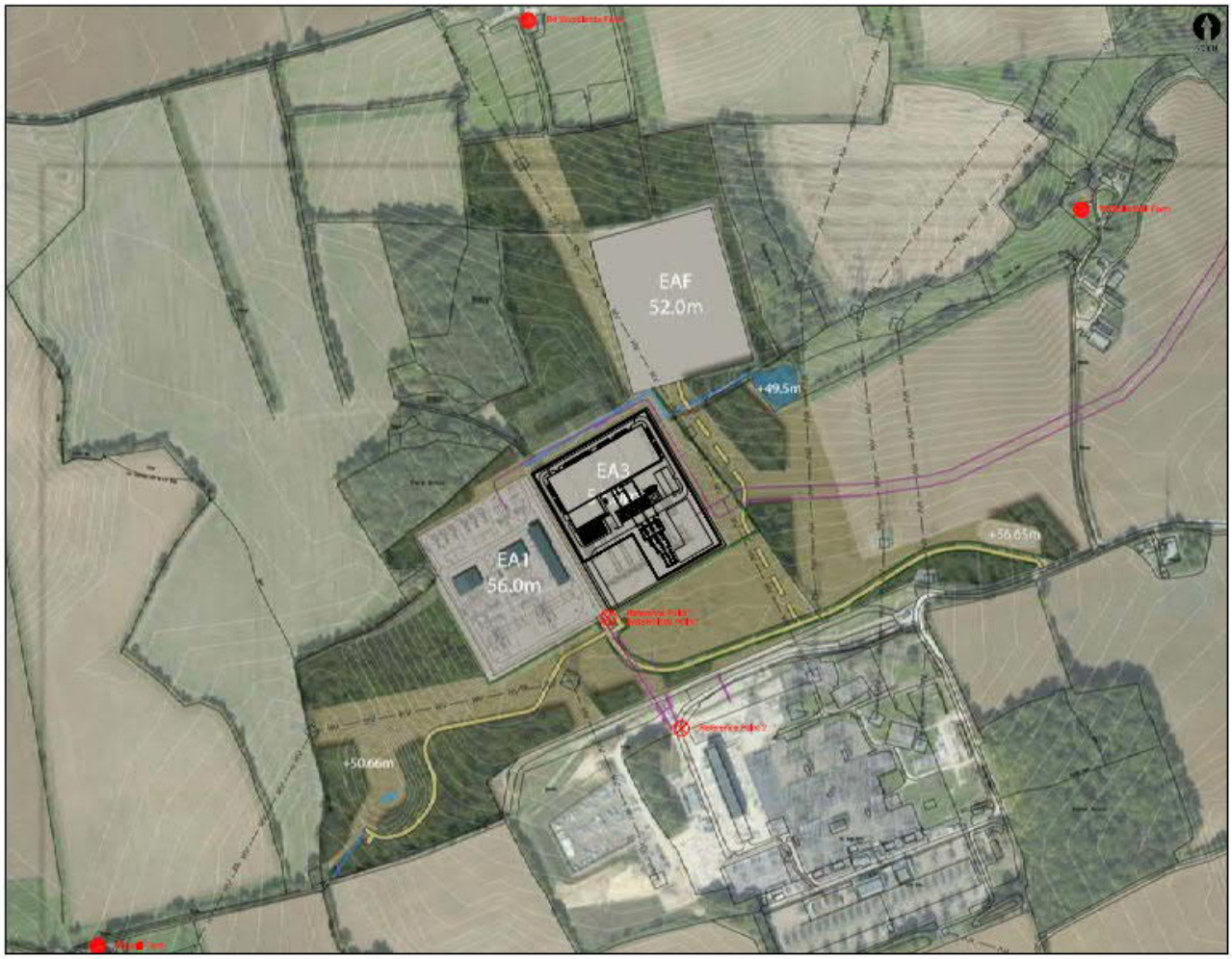


Figure 1: Position of receptor locations (acc.[7])

Based on the explanations from the documentation and above, the following noise limits caused solely by the operation of the East Anglia THREE converter station (without background noise) are considered for the Noise Sensitive Receptors

Receptor Location	*Lr in (dB(A))*
IP_2 Hill Farm	*35*
IP_4 Woodlands Farm	*35*
IP_6 Bullenhall Farm	*35*

4.2 Noise Levels onsite

There are no specified noise requirements onsite available.

The following noise levels are considered for the design of the converter station:

A-weighted sound pressure levels (L_{eq}) inside below mentioned rooms within control building:

- In resting and office room: 45 dB(A)
- In control room: 50 dB(A)
- In protection equipment and telecommunication room: 65dB(A)
- In locker room, cleaning store, showers and toilets: 55 dB(A)
- In battery and pressure supply room, workshop and store: 55 dB(A)
- In rooms for cooling equipment and fans, etc.: 85dB(A)

4.3 General remarks

Corresponding to the aforementioned general noise specifications, acoustical design concepts shall be developed and noise limits shall be established for the individual machines, components and installations of the Converter Station which result in an acoustical design which will meet the requirements.

Each contractor/supplier is free to design his own noise protection measures, presupposed that the individual noise limits will be met.

In the event the supplier elects to take exception to any portion of the specified and assumed / recommended acoustic performance, a list of all exceptions, as well as the alternative offerings, shall be provided by the supplier in writing to SIEMENS Energy. In the event that no written exceptions are taken to the acoustic requirements, it will be assumed / recommended that the supplier will provide the whole scope of supply that is fully compliant with the acoustic performance described in this report.

Descriptions, calculations, test results etc. of the acoustic design shall be submitted in writing to SIEMENS Energy for review, and the components, installations, walls etc. shall not be fabricated until SIEMENS Energy has indicated approval in writing of the proposed design. Calculations and/or test data from similar or existing units may be submitted for approval. All subsequent units that are duplicates of a previously accepted acoustical design do not require re-approval. The design information only needs to be submitted for the first unit. Approval by SIEMENS Energy, however, shall not relieve the equipment supplier from meeting the acoustical requirements of the first unit or any subsequent units.

Acoustic compliance testing shall be performed as necessary by SIEMENS Energy personnel qualified by training and experience (acoustic engineering group). The sound test procedure to be used shall be mutually agreeable to the equipment supplier and to SIEMENS Energy and shall generally conform to the requirements of recognised industry standards such as ANSI, ISO and DIN.

5 Specific noise requirements and sound protection measures

5.1 Sound emission inside buildings

5.1.1 Sound emissions inside converter hall

To meet the general noise limits as described in chapter 4, the following specific noise limits shall not be exceeded:

Component	Assumed / recommended noise protection measures	Noise Limit
DC converter	Standard design	$L_P \leq$ 81 dB(A) *)
HVAC systems	Please refer to chapter 5.3	

- The surface time-averaged sound pressure levels and/or sound power levels mentioned above are defined as described in ISO 3740-46 (Surface time-averaged sound pressure levels to be measured at a distance of 1m from the component and its sound attenuation device respectively.). Sound levels are valid per component, if not indicated otherwise.
- **Deductions of measurement uncertainties are not allowed in the scope of individual suppliers acoustic testing.**

*) Spatially averaged sound pressure level caused solely by the power modules

5.1.2 Sound emissions inside office building/ technical building

To meet the general noise limits as described in chapter chapter 4, the following specific noise limits shall not be exceeded:

Component	Assumed / recommended noise protection measures	Noise Limit
Converter cooling pump skid	Appropriate sound mitigation measures. In order to minimize structure borne noise. vibration isolation material should be fitted at pipe acc. [13]	$\overline{L_p} \leq$ 80 dB(A)
Control cubical systems	Appropriate sound mitigation measures for control cubicles incl. ventilation systems	$L_P \leq$ 65 dB(A) *)
Electronic data processing equipment (e.g. computer) within offices and control room	Low noise design or noise damped case/box or separate server room	$L_P \leq$ 40 dB(A) *)
HVAC systems	Please refer to chapter 5.3	

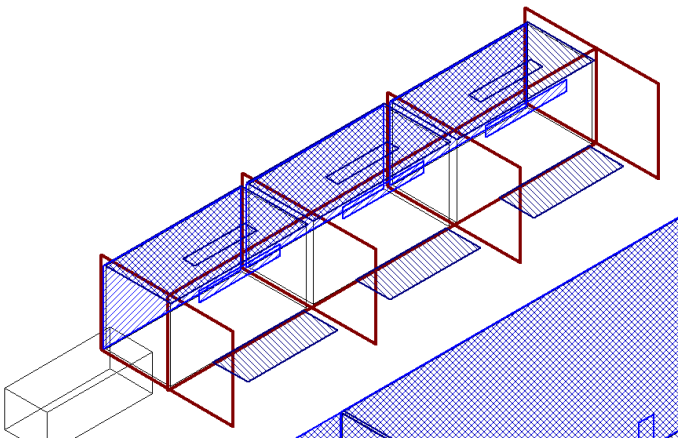
- The surface time-averaged sound pressure levels and/or sound power levels mentioned above are defined as described in ISO 3740-46 (Surface time-averaged sound pressure levels to be measured at a distance of 1m from the component and its sound attenuation device respectively.). Sound levels are valid per component, if not indicated otherwise.
- **Deductions of measurement uncertainties are not allowed in the scope of individual suppliers acoustic testing.**

*) Spatially averaged sound pressure level inside rooms caused by installed equipment without HVAC systems,

5.2 Outdoor sound emissions

5.2.1 Converter transformer

To meet the general noise limits as described in chapter 4, the following specific noise limits shall not be exceeded:

Component	Assumed / recommended noise protection measures	Noise Limit
Transformer (each box)	Completely enclosed transformer. Three sides shall be covered by fire protection walls, front wall and roof by removable noise protection panels (details see below) Inclusive required HVAC Systems of the enclosure Sketch: 	$L_W \leq 88$ dB(A) *)

- The surface time-averaged sound pressure levels and/or sound power levels mentioned above are defined as described in ISO 3740-46 (Surface time-averaged sound pressure levels to be measured at a distance of 1m from the component and its sound attenuation device respectively.). Sound levels are valid per component, if not indicated otherwise.
- **Deductions of measurement uncertainties are not allowed in the scope of individual suppliers acoustic testing.**

*) Including HVAC systems of the enclosure, doors/gate and facades

The following frequency-dependent A-weighted sound power levels, expected at the transformer, shall be used to design the sound enclosure:

F_{oct}	32	63	125	250	500	1000	2000	4000	8000	Hz	Overall	
L_{WA}	44,3	53,5	93,0	94,4	94,3	81,8	66,5	54,8	49,8	dB(A)	99	dB(A)
Remark: Any expected uncertainty shall be provided by transformer department												
Legend: „F_{oct} “ are the octave band centre frequencies. „L_W“ are the octave band sound power levels expected at the transformer. re 10^{-12} W.												

The following frequency dependent insertion loss values are assumed for the sound enclosure:

F_{oct}	32	63	125	250	500	1000	2000	4000	8000	Hz
D_{min}	1	5	14	18	22	24	25	26	27	dB

The given insertion loss is based on an sound enclosure made of 1mm perforated steel sheet + 50mm mineral wool + 1mm steel sheet with air ventilation openings for calculation purpose. Specific solutions and calculations shall be presented by suppliers in order to represent their detailed design.

5.2.2 Sound emissions DC Reactors

To meet the general noise limits as described in chapter 4, the following specific noise limits shall not be exceeded:

Component	Assumed / recommended noise protection measures	Noise Limit
Reactor, each (2x3)	Appropriate sound mitigation measures// Outdoor **Sound enclosures**	**$L_W \leq$ 80 dB(A) *1**

- The surface time-averaged sound pressure levels and/or sound power levels mentioned above are defined as described in ISO 3740-46 (Surface time-averaged sound pressure levels to be measured at a distance of 1m from the component and its sound attenuation device respectively.). Sound levels are valid per component, if not indicated otherwise.
- **Deductions of measurement uncertainties are not allowed in the scope of acoustic testing.**

*1 the noise limit given is with consideration of the of the harmonic noise emission under site and load conditions

5.2.3 Cooling systems

To meet the general noise limits as described in chapter 4, the following specific noise limits shall not be exceeded:

Component	Assumed / recommended noise protection measures	Noise Limit
Converter cooling fans. in all	Appropriate sound mitigation measures	$L_W \leq 95$ dB(A)
HVAC cooling fans. (1 cooler bank)	Appropriate sound mitigation measures, installed on Converter Cooling Rack	$L_W \leq 85$ dB(A)
Converter transformer cooler , per transformer	Appropriate sound mitigation measures/ Low Noise Design for the Fans	$L_W \leq 89$ dB(A)
Cooling System for Office building, in all	See 5.3	

- The surface time-averaged sound pressure levels and/or sound power levels mentioned above are defined as described in ISO 3740-46 (Surface time-averaged sound pressure levels to be measured at a distance of 1m from the component and its sound attenuation device respectively.). Sound levels are valid per component, if not indicated otherwise.
- **Deductions of measurement uncertainties are not allowed in the scope of individual suppliers acoustic testing.**

5.2.4 Auxiliary Transformer

To meet the general noise limits as described in chapter 4, the following specific noise limits shall not be exceeded:

Component	Assumed / recommended noise protection measures	Noise Limit
Auxiliary Transformer (each)	Appropriate sound reduction measures by supplier/ Alternatively completely enclosed transformers installed at technical building.	$L_W \leq 78$ dB(A) *)

- The surface time-averaged sound pressure levels and/or sound power levels mentioned above are defined as described in ISO 3740-46 (Surface time-averaged sound pressure levels to be measured at a distance of 1m from the component and its sound attenuation device respectively.). Sound levels are valid per component, if not indicated otherwise.
- **Deductions of measurement uncertainties are not allowed in the scope of individual suppliers acoustic testing.**

*) Including HVAC systems of the enclosure, doors/gate and facades if applicable

5.2.5 AC Filters (optional)

To meet the general noise limits as described in chapter 4, the following specific noise limits shall not be exceeded:

Component	Assumed / recommended noise protection measures	Noise Limit
AC Filter (ALL Filters, 3phase)	Appropriate sound reduction measures by supplier	$L_W \leq 88$ dB(A)

- The surface time-averaged sound pressure levels and/or sound power levels mentioned above are defined as described in ISO 3740-46 (Surface time-averaged sound pressure levels to be measured at a distance of 1m from the component and its sound attenuation device respectively.). Sound levels are valid per component, if not indicated otherwise.
- **Deductions of measurement uncertainties are not allowed in the scope of individual suppliers acoustic testing.**

5.2.6 PLC Filters

To meet the general noise limits as described in chapter 4, the following specific noise limits shall not be exceeded:

Component	Assumed / recommended noise protection measures	Noise Limit
PLC Filter (ALL Filters and Reactors, 3phase)	Appropriate sound reduction measures by supplier	$L_W \leq 85$ dB(A)

- The surface time-averaged sound pressure levels and/or sound power levels mentioned above are defined as described in ISO 3740-46 (Surface time-averaged sound pressure levels to be measured at a distance of 1m from the component and its sound attenuation device respectively.). Sound levels are valid per component, if not indicated otherwise.
- **Deductions of measurement uncertainties are not allowed in the scope of individual suppliers acoustic testing.**

5.2.7 Emergency Diesel Generator

To meet the general noise limits as described in chapter 4, the following specific noise limits shall not be exceeded:

Component	Assumed / recommended noise protection measures	Noise Limit
Emergency Diesel Generator (ISO container), inclusive load bank **At full load operation**	Appropriate sound reduction measures by supplier, Emergency use only, testing during daytime only (not considered for operational noise) Basis of design is to meet an averaged sound pressure level of 85dB(A) around the installation	$L_W \leq$ 105 dB(A)

- The surface time-averaged sound pressure levels and/or sound power levels mentioned above are defined as described in ISO 3740-46 (Surface time-averaged sound pressure levels to be measured at a distance of 1m from the component and its sound attenuation device respectively.). Sound levels are valid per component, if not indicated otherwise.
- **Deductions of measurement uncertainties are not allowed in the scope of individual suppliers acoustic testing.**

NOTE:
The Emergency Diesel Generator is intended to operate as a Blackstart system in case of a required system start.
As a worst case scenario, the EDG and the station will operate together only for a limited time (some minutes) until the systems and the station have been stabilized.

5.3 Air ventilation systems inside and outside buildings

5.3.1 Air ventilation systems of converter hall

5.3.1.1 Air ventilation systems inside converter hall

To meet the general noise limits as described in chapter 4, the following specific noise limits shall not be exceeded:

Component	Assumed / recommended noise protection measures	Noise Limit
Air ventilations units/fans	Appropriate sound reduction measures	$L_P \leq 75$ dB(A) *1)

- The surface time-averaged sound pressure levels and/or sound power levels mentioned above are defined as described in ISO 3740-46 (Surface time-averaged sound pressure levels to be measured at a distance of 1m from the component and its sound attenuation device respectively.). Sound levels are valid per component, if not indicated otherwise.
- **Deductions of measurement uncertainties are not allowed in the scope of individual suppliers acoustic testing.**

*1) Spatially averaged sound pressure level inside rooms caused by HVAC systems,

5.3.1.2 Air ventilation systems outside converter hall

To meet the general noise limits as described in chapter 4, the following specific noise limits shall not be exceeded:

Component	Assumed / recommended noise protection measures	Noise Limit
Air ventilation openings (exhaust), in all	Appropriate sound reduction measures	$L_W \leq 75$ dB(A) *)
4 Air ventilations supply units/fans, total (2x100%)	Appropriate sound reduction measures	$L_W \leq 83$ dB(A)

- The surface time-averaged sound pressure levels and/or sound power levels mentioned above are defined as described in ISO 3740-46 (Surface time-averaged sound pressure levels to be measured at a distance of 1m from the component and its sound attenuation device respectively.). Sound levels are valid per component, if not indicated otherwise.
- **Deductions of measurement uncertainties are not allowed in the scope of individual suppliers acoustic testing.**

*) The following frequency-dependent A-weighted spatially averaged sound pressure levels shall be used to specify the insertion loss of silencers.

F_{oct}	32	63	125	250	500	1000	2000	4000	8000	Hz
L_P	40	58	65	72	78	74	67	60	53	dB(A)
Legend: „F_{oct} “ are the octave band centre frequencies. „L_P“ are the octave band sound pressure level limits emitted inside converter hall. re $2*10^{-5}$ Pa.										

5.3.2 Air ventilation systems of office building / technical building

5.3.2.1 Air ventilation systems inside office building / technical building

To meet the general noise limits as described in chapter 4, the following specific noise limits shall not be exceeded:

Component	Assumed / recommended noise protection measures	Noise Limit
HVAC system for office incl. air condition unit	Appropriate sound reduction measures	$L_P \leq 40$ dB(A) *1)
HVAC system for control room incl. air condition unit	Appropriate sound reduction measures	$L_P \leq 45$ dB(A) *1
HVAC system for control and protection room incl. air condition unit *)	Appropriate sound reduction measures	$L_P \leq 60$ dB(A) *1)
HVAC system for building service room and toilets	Appropriate sound reduction measures	$L_P \leq 50$ dB(A) *1)
HVAC system for battery. workshop and storage room	Appropriate sound reduction measures	$L_P \leq 50$ dB(A) *1)
HVAC system for pump skid room	Appropriate sound reduction measures	$L_P \leq 75$ dB(A) *1)

- The surface time-averaged sound pressure levels and/or sound power levels mentioned above are defined as described in ISO 3740-46 (Surface time-averaged sound pressure levels to be measured at a distance of 1m from the component and its sound attenuation device respectively.). Sound levels are valid per component, if not indicated otherwise.
- **Deductions of measurement uncertainties are not allowed in the scope of individual suppliers acoustic testing.**

*) Only low fan speed setting shall be applied to achieve the specified noise limits.

*1) Spatially averaged sound pressure level inside rooms caused by HVAC systems,

5.3.2.2 Air ventilation systems outside office building / technical building

To meet the general noise limits as described in chapter 4, the following specific noise limits shall not be exceeded:

Component	Assumed / recommended noise protection measures	Noise Limit
1 Air handling unit (1x100%)	Appropriate sound mitigation measures	$L_W \leq 75$ dB(A)
1 Dry cooler unit	Appropriate sound mitigation measures	$L_W \leq 80$ dB(A)
4 Air supply/exhaust fans, each	Appropriate sound mitigation measures	$L_W \leq 71$ dB(A)

- The surface time-averaged sound pressure levels and/or sound power levels mentioned above are defined as described in ISO 3740-46 (Surface time-averaged sound pressure levels to be measured at a distance of 1m from the component and its sound attenuation device respectively.). Sound levels are valid per component, if not indicated otherwise.
- **Deductions of measurement uncertainties are not allowed in the scope of individual suppliers acoustic testing.**

5.4 Air ventilation systems of spare part building

5.4.1.1 Air ventilation systems inside spare part building

To meet the general noise limits as described in chapter 4, the following specific noise limits shall not be exceeded:

Component	Assumed / recommended noise protection measures	Noise Limit
HVAC systems	Appropriate sound reduction measures	$L_P \leq 50$ dB(A) *1)

- The surface time-averaged sound pressure levels and/or sound power levels mentioned above are defined as described in ISO 3740-46 (Surface time-averaged sound pressure levels to be measured at a distance of 1m from the component and its sound attenuation device respectively.). Sound levels are valid per component, if not indicated otherwise.
- **Deductions of measurement uncertainties are not allowed in the scope of individual suppliers acoustic testing.**

*1) Spatially averaged sound pressure level inside rooms caused by HVAC systems,

5.4.1.2 Air ventilation systems outside spare part building

To meet the general noise limits as described in chapter 4, the following specific noise limits shall not be exceeded:

Component	Assumed / recommended noise protection measures	Noise Limit
HVAC systems, in all	Appropriate sound mitigation measures	$L_W \leq 75$ dB(A)

- The surface time-averaged sound pressure levels and/or sound power levels mentioned above are defined as described in ISO 3740-46 (Surface time-averaged sound pressure levels to be measured at a distance of 1m from the component and its sound attenuation device respectively.). Sound levels are valid per component, if not indicated otherwise.
- **Deductions of measurement uncertainties are not allowed in the scope of individual suppliers acoustic testing.**

6 Civil Design of Buildings

From the acoustical point of view the relevant noise sources for the buildings are the air ventilation / air conditioning systems. In addition the walls, roofs, windows and doors of the building shall be designed to avoid sound transmission from the environment into the rooms.

To meet the general noise limits as described in chapter 4, the following civil design and the corresponding weighted sound reduction index are assumed for the buildings as minimum requirement in as-built, functioning condition:

Building part	Assumed Civil Design	Weighted sound reduction index *1) (as built):	Apparent weighted Sound reduction index *2) (tested)
Converter hall			
Facades	Trapezoidal steel sheet filled with mineral wool (e.g. Kingspan wall KS1000_RW40_I_L)	$R'_W \geq 36$ dB	$Rw \geq 38$ dB
Roof	Trapezoidal steel sheet filled with mineral wool (e.g. Kingspan roof KS1000_RW40_I_L)	$R'_W \geq 42$ dB	$Rw \geq 44$ dB
Doors/Gates	Double steel sheet doors and gates with rubber sealing at the frames and ground	$R'_W \geq 24$ dB	$Rw \geq 29$ dB
Office building / Technical Building			
Roof and facades	Concrete walls or masonry/ brickwork	$R'_W \geq 45$ dB	$Rw \geq 47$ dB
Gates, pump room	Double steel sheet with rubber joint	$R'_W \geq 24$ dB	$Rw \geq 29$ dB
Windows	Double glazed windows	$R'_W \geq 25$ dB	$Rw \geq 30$ dB
Inside doors (especially to technical rooms)	Double steel sheet with rubber joint	$R'_W \geq 24$ dB	$Rw \geq 29$ dB
Internals	Sound absorbent ceiling and needlefelt floor shall be installed at least within control room, office room, meeting room as applicable		
Spare Part building			
Roof and facades	trapezoidal steel sheet	$R'_W \geq 26$ dB	$Rw \geq 28$ dB
Gates,	steel door with rubber joint	$R'_W \geq 11$ dB	$Rw \geq 16$ dB
Windows	Standard double glazed windows	$R'_W \geq 15$ dB	$Rw \geq 20$ dB

The following corresponding weighted sound reduction index [***1) (as built)**] are assumed for the building facade.

F_{oct}	32	63	125	250	500	1000	2000	4000	8000	Hz	Weighted sound reduction index R'_W
Converter Wall $R'w_{min}$	5	11	12	27	36	-	-	-	-	dB	36 dB
Converter Roof $R'w_{min}$	6	9	17	34	46	-	-	-	-	dB	42 dB

Remarks:

*1) ISO 717-1, 2013 [16]
Acoustics – Rating of sound insulation in buildings and of building elements
Part 1: Airborne sound insulation

*2) ISO 10140-2 [15],
Acoustics – Laboratory Sound Measurements of Building Elements

The used Civil Design for the structure must be verified by supplier with official test certificate as per ISO 10140 showing Rw in 1/3rd octave bands.

The “extended” test certificate (50Hz to 5kHz) for each façade, roof, door and gate specified, shall be submitted to Acoustics Erlangen for review. Deviating values shall be reviewed by acoustical modelling.

A conceptional release of the acoustic design and calculation by the referenced department Acoustics Erlangen is mandatory. Deviating values shall be checked with the acoustical model.

7 Noise Emission to the Environment

The calculation of far field sound pressure levels expected in the surrounding and caused by the converter station depends on the sound power levels of the individual noise sources, the specific noise levels specified for the individual noise sources are described in this report, the determination of the sound power levels emitted to the environment is based on the following input data:

- Technical data provided by contractors/subcontractors of noise relevant machines, components and installations.
- Sound protection measures for outdoor installed components as assumed in this report.
- Design of civil structures as assumed in this report.

The calculation of the sound power levels emitted to the environment from the functional groups was performed for the octave band centre frequencies from 31.5 Hz to 8000 Hz.

The sound power levels and surface time-averaged sound pressure levels as described this report are the basis for the calculation of the sound pressure levels expected at the far field.

Taking into account the assumed noise control installations, the essential functional groups of the converter station will emit sound power levels to the environment as listed in the appendix.

In addition a table has been drawn up which show the determined sound pressure levels at the receptor locations which is also given in more detail in the appendix.

7.1 Sound power levels to the environment

Table: Total sound power levels (L_W) emitted to the environment from the functional groups of the converter station during stable operation under site conditions:

Noise Source	**Total A**
East Anglia 3	100
Enclosed Transformers	93
Coolers of transformers	94
Converter Cooler	95
Converter Hall	89
DC Reactors	88
PLC Filter	85
AC Filter	88
Control and SpareP Buildings	84

7.2 Far Field Noise Prognosis

On the basis of the noise emission data as given in this report, a sound propagation calculation was carried out for the converter station East Anglia 3, the calculation of the far field sound pressure levels was carried out in accordance with ISO9613-2 [29]. For the calculation of the distance-dependent sound level reduction the following effects were taken into account:

- Attenuation due to geometrical divergence
- Attenuation due to atmospheric absorption (air temperature 10°C. relative humidity 70%)
- Attenuation due to ground effects (frequency-dependent)
- Attenuation due to meteorology effects
- Attenuation effects due to a barrier

Strong temperature inversion which may occur e.g. over water surfaces at evening/morning times have not been considered.

The following ground absorption factors according [28] have been considered:

Ground Description	Ground Type	Absorption Factor
Overall terrain	Mixed ground	0,5
Converter Station Site	Mixed ground	0,5

An order of two has been taken into account for multiple reflections. In addition transient conditions, e.g. the circuit breaker closing/opening operation, are not taken into account because of the short duration. Emergency diesel generator operation is considered as abnormal operating condition.

7.3 Sound pressure levels at the receptors

A noise calculation is performed for the 3 nearest receptors as required by DCO [1]. In addition, further receptors as mentioned in the EIA [3] have been considered for the calculation for information. Due to missing existing information on existing noise climate, detailed assessment is limited to the nearest residential receptors as requested by the DCO [1].

Table: Determined sound pressure levels at the receptor location (h= 4m) during stable operation under site conditions:

Receptor Location	**Specific sound level Leq in (dB(A)) *1)**
IP_1 Cones Farm	30
IP_2 Hill Farm	**32**
IP_3 Black Cottage	25
IP_4 Woodlands Farm	**30**
IP_5 Willow Cottage	29
IP_6 Bullenhall Farm	**32**
IP_7 Burstall Hall	28
IP_8 Walnut Tree Farm	28

*1) The Calculated Converter Station impact (inclusive propagation uncertainty with upper limit of 90% confidence) is based on the current acoustical design of the converter station

The sound of the Station can be considered as continuous. The rated sound pressure levels as indicated are without any further consideration of any tonal, impulsive or intermittend adjustments.
The calculation and assessment shows that tonals are not expected according to BS4142 Annex C - One third octave method. Main tonal contributors such as the transformers will be properly housed in order to avoid any tonal impact.

In order to consider 'other sound characteristics' at the receptors compared to the low background noise levels, a rating penalty of 3dB for the calculated values is considered.

Table: Assessment against existing noise climate at the receptor location (h= 4m) during stable operation under site conditions:

Receptor Location	**EA3 operational Noise (specific sound incl. 3dB rating penalty)** **Lr in dB(A)** *1)
IP_2 Hill Farm	35
IP_4 Woodlands Farm	33
IP_6 Bullenhall Farm	35

*1) The Calculated Converter Station impact (inclusive propagation uncertainty with upper limit of 90% confidence) is based on the current acoustical design of the converter station

From the initial baseline noise report for EA1 [6], background noise levels of 32 to 33dB(A) have been determined at the receptors during daytime. Compared to the determined specific operational noise of EA3, the increase is determined below 5dB.

8 Quality of prognosis

The quality of the noise prognosis depends on the accuracy of the input data used for source modeling, the acoustical propagation model and the estimated propagation factors like ground ab-sorption or weather conditions.
Input data (sound power levels) is taken from supplier datasheets as far as available for the project as well as former projects, measurements at comparable installations and established experiences under consideration of applicable noise reduction measures.

The combined uncertainty for the far field calculation has been considered as follows:

- For the sound power levels of noise sources a standard deviation of 3dB according to ISO 3746 (accuracy class 3) [24] has been considered.
- For the far field noise propagation the standard deviation has been considered according to [10] and [9].
- A combined overall confidence interval of 90% has been considered for the results of the far field calculation.

9 Indoor noise levels

Contractor noted the A-weighted sound pressure levels (L_{eq}) inside below mentioned rooms within control building:

- In resting and office room: 45 dB(A)
- In control room: 50 dB(A)
- In protection equipment and telecommunication room: 65dB(A)
- In locker room, cleaning store, showers and toilets: 55 dB(A)
- In battery and pressure supply room, workshop and store: 55 dB(A)
- In rooms for cooling equipment, mechanical roos and fans, etc.: 85dB(A)

Remark:

The local sound pressure levels at different locations inside the process buildings can be lower or higher, but the average of the local sound pressure levels will be approximately the values mentioned below.

Inside Process Buildings a permanent presence of staff is not required.

On the assumption that the individual noise limits will not be exceeded and civil structures are considered, the following general noise levels are expected:

The spatially averaged sound pressure levels expected inside the **offices** will be mainly influenced by the sound emission of the HVAC systems, The spatially averaged sound pressure level caused by HVAC systems shall not exceed $L_{eq} \leq 40$ dB(A), the spatially averaged total sound pressure level caused by HVAC systems, structure born noise and noise emitted from outside is expected not to exceed **$L_{eq} \leq 45$ dB(A).**

The spatially averaged sound pressure levels expected inside the **control room** will be mainly influenced by the sound emission of the HVAC systems, The spatially averaged sound pressure level caused by HVAC systems shall not exceed $L_{eq} \leq 45$ dB(A), the spatially averaged total sound pressure level caused by HVAC systems, structure born noise and noise emitted from outside is expected not to exceed **$L_{eq} \leq 50$ dB(A).**

The spatially averaged sound pressure levels expected inside the **control and protection room** will be mainly influenced by the sound emission of the air ventilation systems of the control cubicles, the spatially averaged sound pressure level caused by those air ventilation fans is expected not to exceed $L_{eq} \leq 62$ dB(A) and the averaged sound pressure level caused by HVAC systems shall not exceed $L_{eq} \leq 60$ dB(A), the spatially averaged total sound pressure level caused by HVAC systems, structure born noise and noise emitted from outside is expected not to exceed **$L_{eq} \leq 65$ dB(A).**

The spatially averaged sound pressure levels expected inside the **building service room and toilets** will be mainly influenced by the sound emission of the HVAC systems, The spatially averaged sound pressure level caused by HVAC system is expected not to exceed $L_{eq} \leq 50$ dB(A), the spatially averaged total sound pressure level caused by HVAC systems, structure born noise and noise emitted from outside is expected not to exceed **$L_{eq} \leq 55$ dB(A).**

The spatially averaged sound pressure levels expected inside the **battery, storage and workshop room,** will be mainly influenced by the sound emission of the HVAC systems, The spatially averaged sound pressure level caused by HVAC system is expected not to exceed $L_{eq} \leq 50$ dB(A), the spatially averaged total sound pressure level caused by HVAC systems, structure born noise and noise emitted from outside is expected not to exceed **$L_{eq} \leq 55$ dB(A).**

The spatially averaged sound pressure levels expected inside the **pump skid room** will be mainly influenced by the sound emission of the pump sets and HVAC systems, The spatially averaged sound pressure level caused by HVAC system is expected not to exceed $L_{eq} \leq 65$ dB(A) and the spatially averaged sound pressure level caused by pump sets is 80dB(A), the spatially averaged total sound pressure level caused by HVAC systems, structure born noise and noise emitted from outside is expected not to exceed **$L_{eq} \leq 85$ dB(A).**

10 Concluding remarks

The individual noise limits specified for the noise relevant machines and components of the converter station will be met with the noise control installations described in this report.
On the assumption that the individual noise limits will not be exceeded, the general noise limits as stated in chapter 4.1 will be met.

For noise reduction measures, only permanent installed noise enclosures or shieldings, respectively low noise components (low noise design implemented in the components design itself) are used as applicable. According to this the long term effectiveness of these reduction measures will remain and no changes in effectiveness is expected over the years.

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Appendix

Appendix 1 : Arrangement drawing acc. [7]

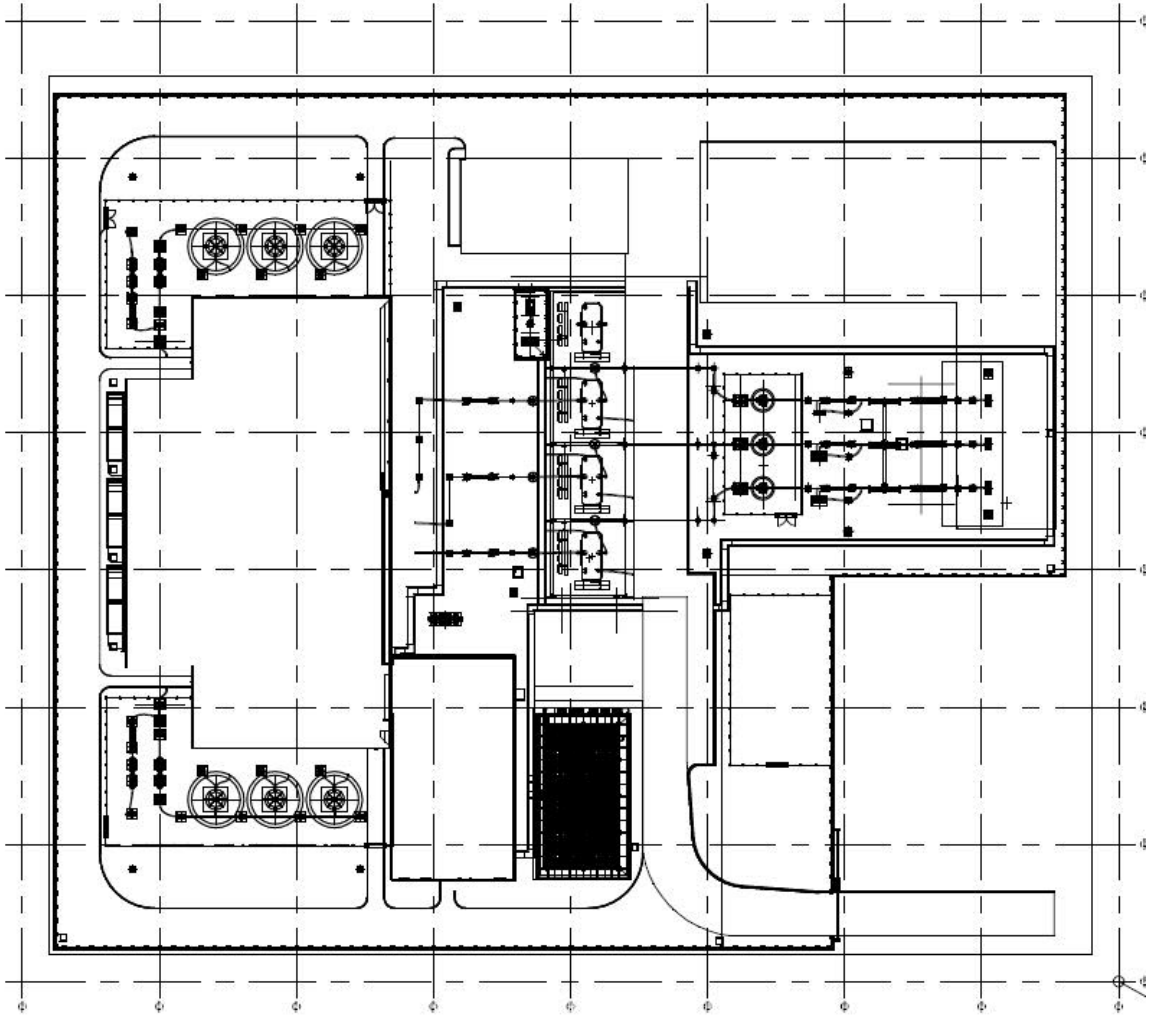
Appendix 2 : 3D view of sound propagation model

Appendix 3 : Sound Power Levels used for the modeling

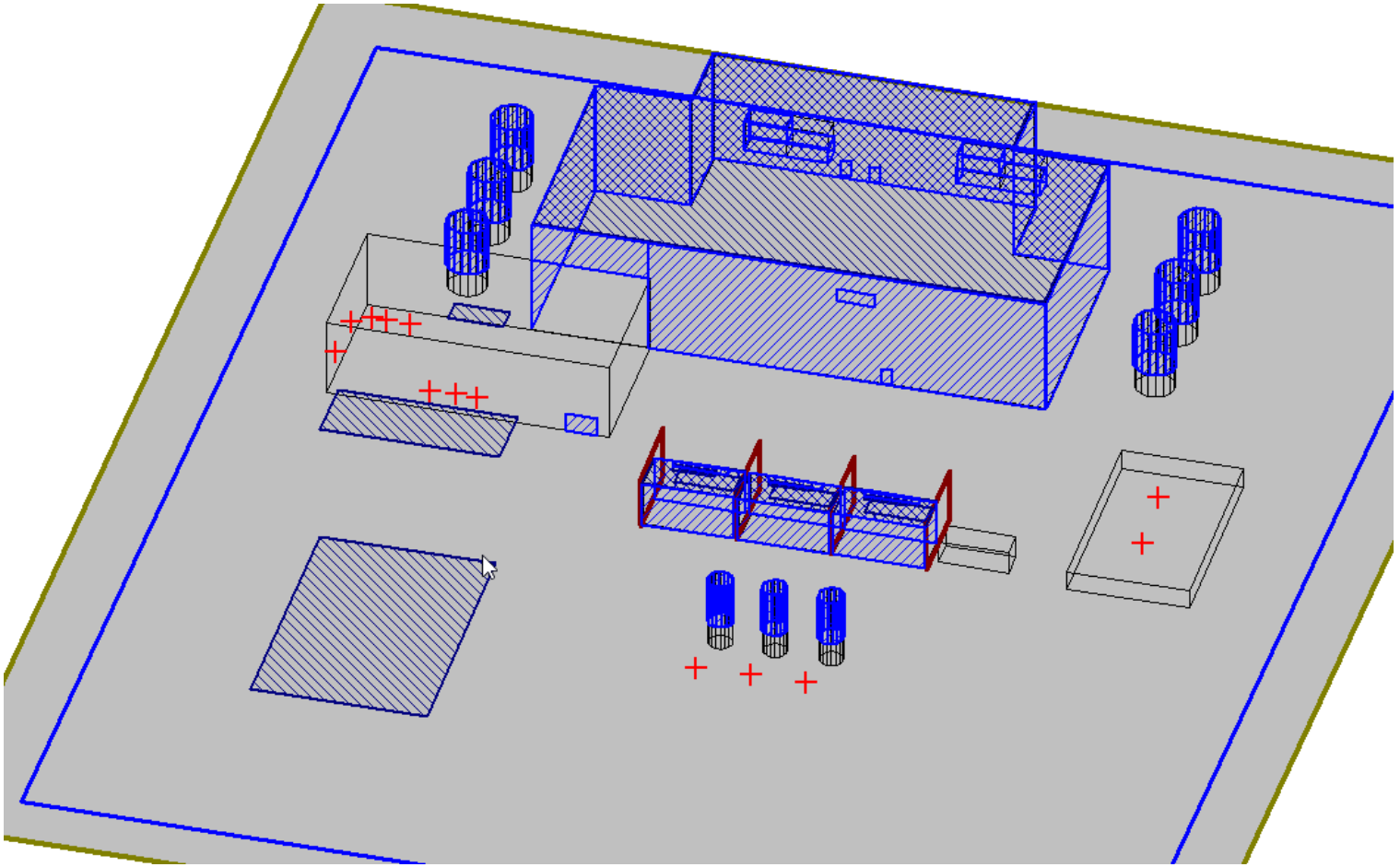
Appendix 4 : Calculation results at receptor location (without propagation uncertainty)

Appendix 5 : Noise contour map at 4m height (Converter station East Anglia 3 operating)

Appendix 1: Arrangement drawing acc. [7]



Appendix 2: Isometric view of sound propagation model



Appendix 3 : Sound Power Levels used for the modeling

Noise Source	Sound Power Level (dB(A))									Sum
	31,5	63	125	250	500	1000	2000	4000	8000	
Root	71	84	93	92	94	93	93	84	81	100
EastAnglia3	71	84	93	92	94	92	92	84	81	100
DC Reactors Outdoor	66	72	82	78	85	64	69	73	78	88
DCR A1_1	59	65	75	71	78	52	46	41	36	80
DCR A1_2	55	49	39	43	36	62	68	73	78	80
DCR A1_3	59	65	75	71	78	52	46	41	36	80
DCR A1_4	59	65	75	71	78	52	46	41	36	80
DCR A1_5	59	65	75	71	78	52	46	41	36	80
DCR A1_6	59	65	75	71	78	52	46	41	36	80
Enclosed Transformers	57	61	91	88	82	67	51	37	32	93
Unit 3	53	57	86	83	77	62	46	33	27	88
TransformatorAir Outlet 3 A	36	41	74	68	49	21	13	16	18	75
TransformatorCR 3 A	47	51	80	77	72	57	41	27	20	83
Transformator Air Vent Inlet 3 A	37	42	75	69	50	22	14	17	19	76
Transformator CF 3 A	48	52	81	78	73	58	42	28	21	83
Transformator CF 3 B	48	52	81	78	73	58	42	28	21	83
Unit 2	53	57	86	83	77	62	46	33	27	88
TransformatorAir Outlet 2 A	36	41	74	68	49	21	13	16	18	75
TransformatorCR 2 A	47	51	80	77	72	57	41	27	20	83
Transformator Air Vent Inlet 2 A	37	42	75	69	50	22	14	17	19	76
Transformator CF 2 A	48	52	81	78	73	58	42	28	21	83
Transformator CF 2 B	48	52	81	78	73	58	42	28	21	83
Unit 1	53	57	86	83	77	62	46	33	27	88

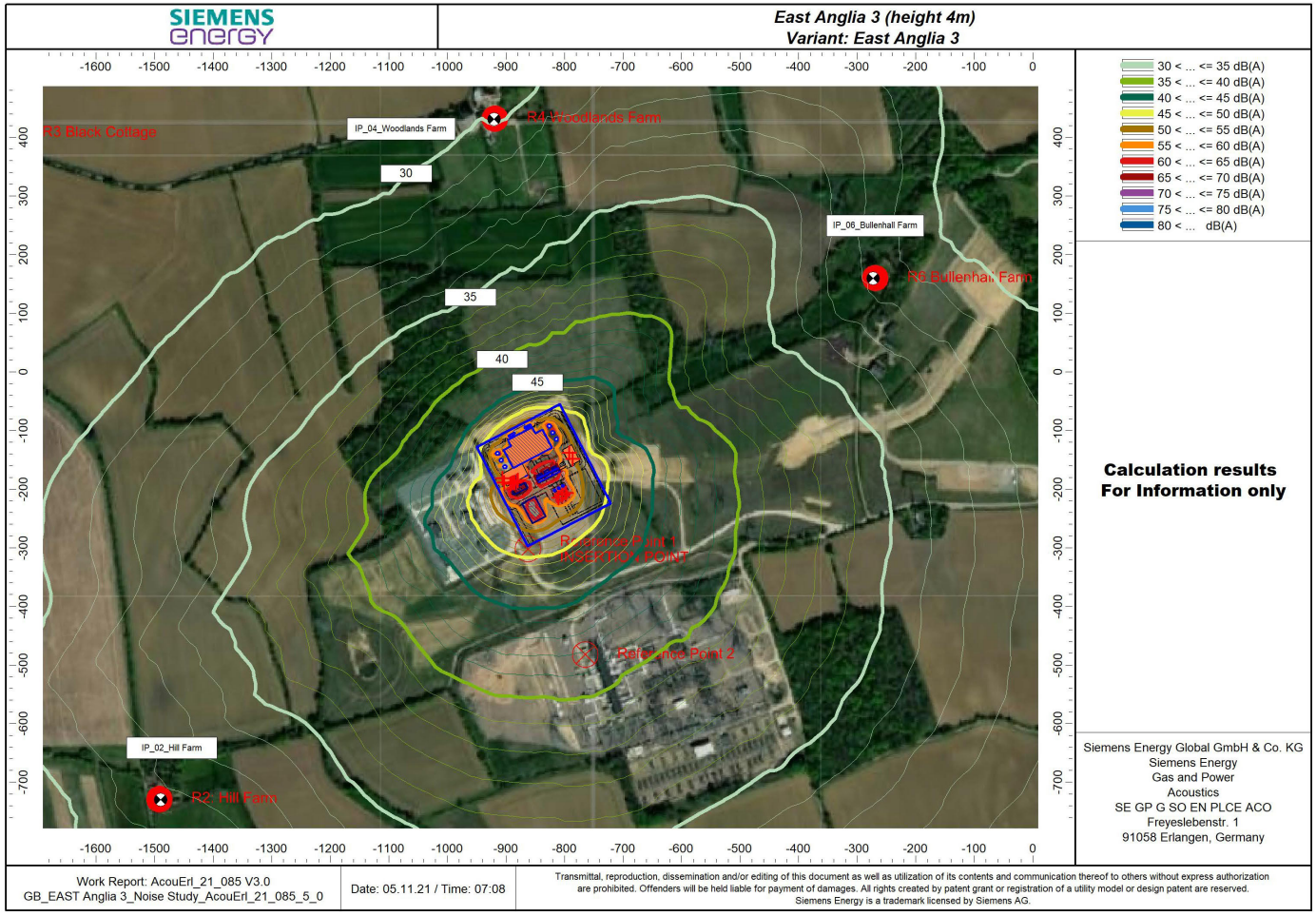
Noise Source	Sound Power Level (dB(A))									Sum
	31,5	63	125	250	500	1000	2000	4000	8000	
TransformatorAir Outlet 1 A	36	41	74	68	49	21	13	16	18	75
TransformatorCR 1 A	47	51	80	77	72	57	41	27	20	83
Transformator Air Vent Inlet 1 A	37	42	75	69	50	22	14	17	19	76
Transformator CF 1 A	48	52	81	78	73	58	42	28	21	83
Transformator CF 1 B	48	52	81	78	73	58	42	28	21	83
Coolers of transformers	52	62	79	87	90	89	79	71	68	94
Transformer Cooler 1	48	58	74	82	86	84	75	67	64	89
Transformer Cooler 2	48	58	74	82	86	84	75	67	64	89
Transformer Cooler 3	48	58	74	82	86	84	75	67	64	89
Converter Cooler	58	63	81	87	89	89	88	83	77	95
Converter Cooler	58	63	81	87	89	89	88	83	77	95
Converter Hall	68	81	85	82	83	78	70	63	57	89
Air Ventilation Openings	45	62	66	73	79	73	65	57	49	81
Converter Hall air ventilation opening south (exhaust)	45	62	66	73	79	73	65	57	49	81
AHU 1	56	60	74	77	77	73	65	59	53	82
AHU 2	56	60	74	77	77	73	65	59	53	82
Civil Structures	67	81	84	76	73	67	54	39	34	87
ConverterHall Roof	63	78	77	67	61	51	37	17	29	81
Converter Door 2	33	46	48	55	58	53	36	30	22	61
Converter Door 1	33	46	48	55	58	53	36	30	22	61
Converter Door 3	33	46	48	55	58	53	36	30	22	61
Converter Hall Facade South 2	59	72	77	70	67	61	48	31	24	79
Converter Hall Facade North	62	74	79	72	69	63	50	33	26	81
Converter Hall Facade South 1	49	61	67	59	57	50	38	21	14	69
Converter Hall Facade W	57	69	75	67	64	58	46	29	22	77
Converter Hall Facade E	57	69	75	67	64	58	46	29	22	77

Noise Source	Sound Power Level (dB(A))									Sum
	31,5	63	125	250	500	1000	2000	4000	8000	
Aux Transformers	46	70	77	65	58	56	55	54	52	78
PLC Filter	62	80	82	69	70	79	87	68	65	89
AC Filter	13	27	39	57	64	79	87	63	43	88
Control and SpareP Buildings	52	59	66	75	77	79	77	72	65	84
1 Spare Part Building/ air supply/exhaust fan	35	48	58	62	67	67	68	66	59	74
Control Building Fan 1	35	36	44	61	62	67	65	59	52	71
Control Building Fan 2	35	36	44	61	62	67	65	59	52	71
Control Building Fan 3	35	36	44	61	62	67	65	59	52	71
Control Building Fan 4	35	36	44	61	62	67	65	59	52	71
AHU Control Building 1	39	40	48	65	66	72	69	63	56	75
2 Spare Part Building/ air supply/exhaust fan	35	48	58	62	67	67	68	66	59	74
Cooling System for Control Building	52	58	64	73	74	76	73	66	53	80
Control Building Gate	27	37	52	59	65	67	61	57	50	71

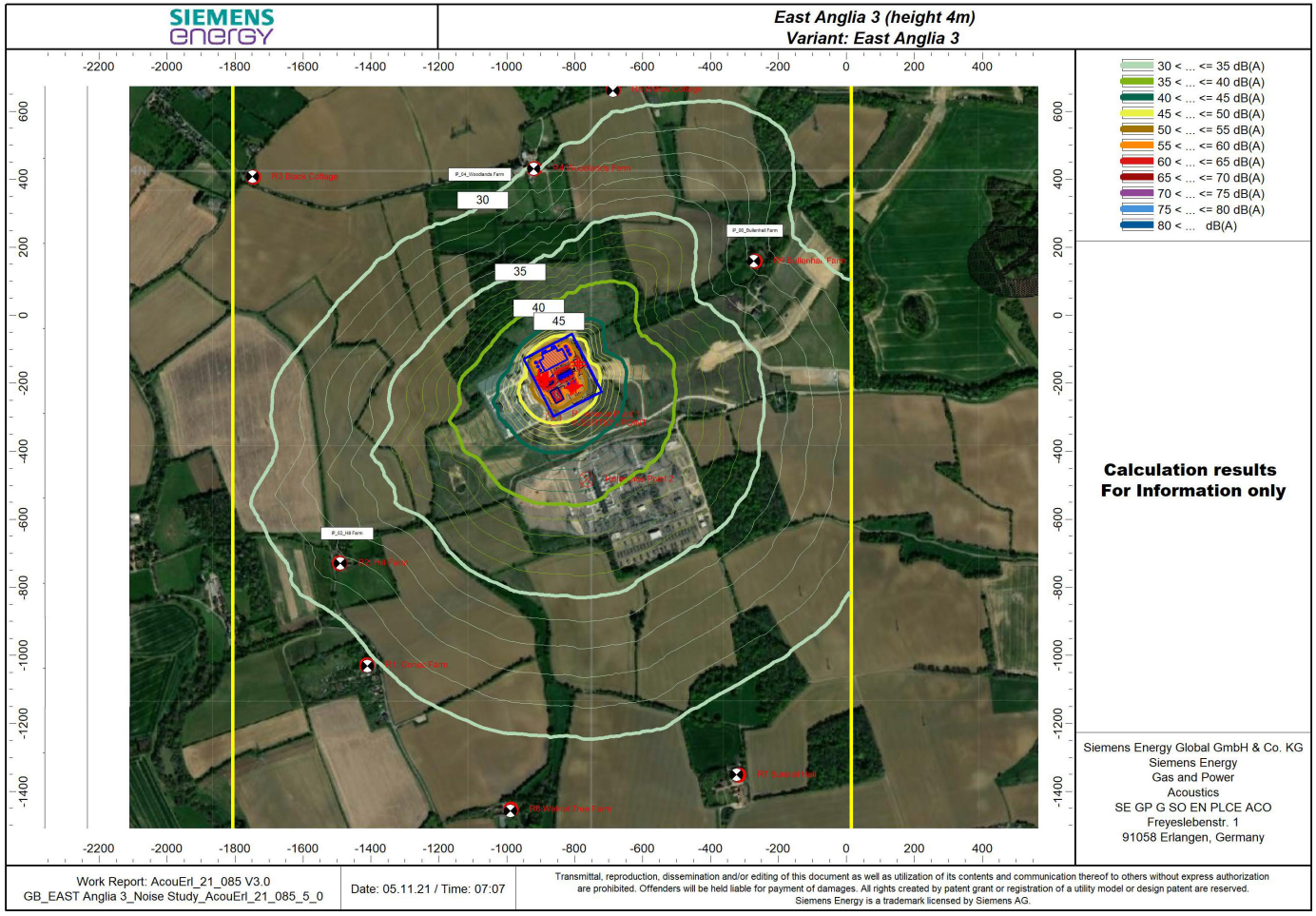
Appendix 4 : Calculation results at reference location (without propagation uncertainty)

Noise Source	IP_02_Hill Farm	IP_04_Woodlands Farm	IP_06_Bullenhall Farm
	Leq (dB(A))	Leq (dB(A))	Leq (dB(A))
Root	31	29	31
EastAnglia3	31	29	31
DC Reactors Outdoor	19	24	23
Enclosed Transformers	24	18	24
Coolers of transformers	20	15	21
Converter Cooler	27	10	23
Converter Hall	20	26	23
Aux Transformer	12	-6	7
PLC Filter	21	19	24
AC Filter	15	-1	16
Control and SpareP Buildings	14	10	15

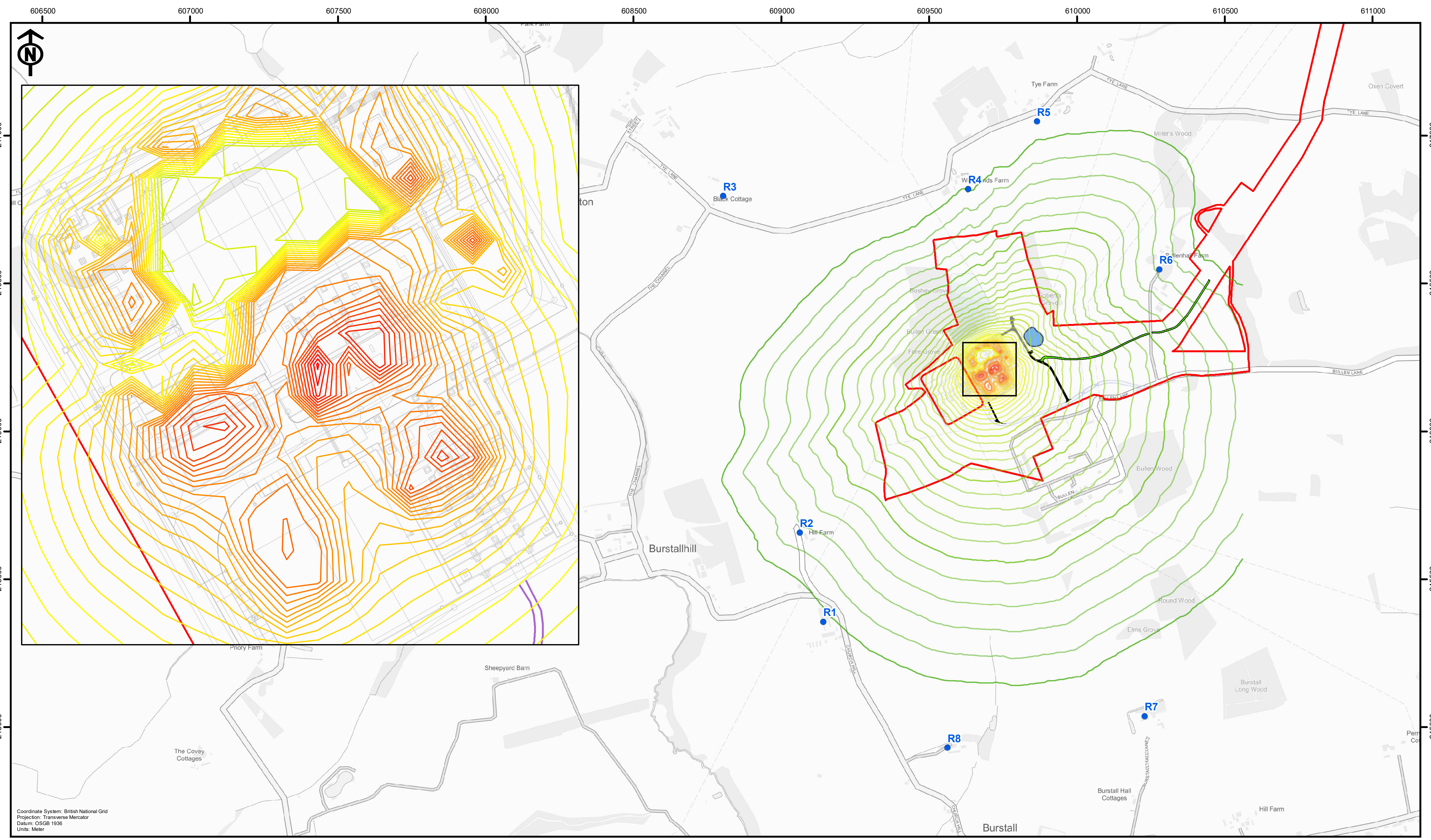
Appendix 5 -1: Noise contour map at 4m height (Converter station East Anglia 3 operating) for nearest receptors



Appendix 5 -2: Noise contour map at 4m height (Converter station East Anglia 3 operating) including distant receptors



APPENDIX 2 NOISE MAPS



EA THREE DCO Corridor	**EA THREE Onshore Converter Station Access Roads**	**EA THREE Cable Access Road**	**Noise Contours**
EA THREE Onshore Converter Station Layout Detail	Permanent	Haul Road	**Noise Level (dB)**
	Temporary	EA THREE Onshore Converter Station SUDs Pond	30, 35, 40, 45, 50, 55, 60, 65, 70, 75
		Noise Receptor	

GoBe consultants

Rev	Date	By	Comment
B	07/04/2022	PW	Second Issue
A	24/01/2022	PW	First Issue

Original A3 Plot Scale 1:12,500

0 250 500 Metres

Onshore Converter Station Stage

Appendix: Noise Countours

Drg No	05356.00006.12.00058.1 Noise Contours
Rev	2
Date	07/04/2022
Layout	N/A

Document Path: P:\05356 - GoBe Consultants Ltd\00006 East Anglia Three\Tech\GIS\Dwgs\Wking\EA3\Onshore Substation\Doc Ref EA3-GRD-CON-PLN-IBR-000114\5356.00006.12.00058.1 Appendix Noise Contours Maps.mxd

609000 609500 610000 610500

246500 246000

Track Track Track BULLEN LANE BULLEN LANE Track Track

Coordinate System: British National Grid
Projection: Transverse Mercator
Datum: OSGB 1936
Units: Meter

Works No.s Overview

Tye Lane Woodlands Farm Black Cottage Tye Lane Bullen Hall Farm Channel Hill Farm Burstallhill

69 65 64 67 62 63 66 68

EA THREE DCO Corridor
EA THREE Onshore Converter Station Layout Detail
EA THREE Onshore Converter Station Temporary Site Facilities Detail

EA THREE Converter Substation to National Grid Substation Cable Route
400kV AC Cable - Open Cut Section
400kV AC Cable - Ducted Section

EA THREE Onshore Converter Station Access Roads
Permanent
Temporary

EA THREE Cable Access Road
Haul Road
EA THREE Onshore Converter Station SUDs Pond
EA THREE Area to be Reprofiled

EA ONE Onshore Converter Station Access Road

Works No.s
65 62 66 63 67 64 68 69

GoBe consultants

Rev	Date	By	Comment
B	04/04/2022	PW	Second Issue
A	31/03/2022	JRS	First Issue

Original A3 Plot Scale 1:5,000

0 100 200 Metres

Onshore Converter Station Stage

Figure 1: Site Context Plan

Drg No	05356.00006.12.0001.1 ONCS Site Context Plan
Rev	2
Date	04/04/2022
Layout	N/A

Document Path: P:\05356 - GoBe Consultants Ltd\00006 East Anglia Three\Tech\GIS\Dwgs\Wking\EA3\Onshore Substation\ONCS and Commencement Master\5356.00006.12.0020.1 ONCS Site Context.mxd

606000 607000 608000 609000 610000 611000 612000 613000

248000 247000 246000 245000 244000

MP1 Bullenhall Farm

MP2 Hill Farm House

MP3 Burstall Hall

Flowton

Burstallhill

Burstall

Bramford

Sproughton

Coordinate System: British National Grid
Projection: Transverse Mercator
Datum: OSGB 1936
Units: Meter

EA THREE DCO Corridor
EA THREE Onshore Converter Station Layout Detail
EA THREE Onshore Converter Station Temporary Site Facilities Detail

EA THREE Converter Substation to National Grid Substation Cable Route
400kV AC Cable - Open Cut Section
400kV AC Cable - Ducted Section

EA THREE Onshore Converter Station Access Roads
Permanent
Temporary

EA THREE Cable Access Road
Haul Road

EA THREE Area to be Reprofiled
EA THREE Onshore Converter Station SUDs Pond
EA ONE Onshore Converter Station Access Road
MP Locations

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Rev	Date	By	Comment
B	07/04/2022	PW	Second Issue
A	06/01/2022	PW	First Issue

Original A3 Plot Scale 1:20,000

0 400 800 Metres

Onshore Converter Station Stage

Figure 2: Sensitive Receptors

Drg No	05356.00006.12.00055.1 Sensitive Receptors NMP
Rev	2
Date	07/04/2022
Layout	N/A

Document Path: P:\05356 - GoBe Consultants Ltd\00006 East Anglia Three\Tech\GIS\Dwgs\Wking\EA3\Onshore Substation\Doc Ref EA3-GRD-CON-PLN-IBR-000114\5356.00006.12.00057.1 Sensitive Receptors NMP Operational.mxd