

## THIRD ENERGY UK GAS LIMITED

### Air quality review of existing planning consents and impact of lifetime extension

Carried out for:

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Knapton Generation Station  
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Date 13 March 2018

Report No. LSO180237

Issue 1

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## ISSUE HISTORY

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Issue	Date	Approved
180237,1	13 March 2018	
First issue		

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## 0 SUMMARY

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Third Energy UK Gas Limited currently operate the Knapton Generation Station near Malton, which consists of an open cycle gas turbine power plant burning sour gas to produce electricity. Natural gas is supplied from six wellsites via a connecting pipeline network. Third Energy are seeking to extend the life time of the existing plant, production sites and pipeline infrastructure. As part of the planning application process it is necessary to demonstrate that the air quality impact of these continuing operations is acceptable.

The original planning consents for these installations were supported by assessments of air quality impact to demonstrate acceptability. This review has considered the relevance of these assessments with regard to current operating practices and refinements to assessment methodologies and acceptability criteria.

Releases of nitrogen dioxide from natural gas combustion at the Knapton Generation Station were considered to be the most significant threat to air quality within the original assessment. It was found that the assumptions made in this assessment generally provided an overestimate of air quality impact when compared with current operating practices.

A revised assessment using current acceptability criteria indicated that the air quality impact of process contributions of nitrogen dioxide at the nearest residential locations was insignificant. An assessment of the process contribution at the nearest statutory designated nature conservation site indicated an insignificant impact with regard to critical levels for nitrogen oxides and critical loads for nitrogen and acid deposition.

Releases of nitrogen dioxide from the Knapton Generation Station are considered insignificant with regard to impacts on human health and ecology and an extension of the current consent is unlikely to pose any significant risk to the continued attainment of air quality standards and critical levels and loads. The assumptions made to undertake the original modelling are considered to have the effect of overestimating the process contribution to ambient concentrations in practice. It is therefore considered that the predicted process impact on ambient pollutant concentrations reported herein is a conservative assessment and the conclusions reached therefore incorporate a reasonable margin of comfort in spite of the inevitable uncertainty of such modelling studies.

Natural gases losses from the well sites and associated pipeline network were considered to be adequately controlled by the current loss prevention measures. It is not anticipated that an extension of the planning consent will pose any significant risk of greater losses than those originally consented.

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# 1 INTRODUCTION

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Third Energy UK Gas Limited (Third Energy) placed a contract with SOCOTEC UK Limited (SOCOTEC) to undertake a review of the air quality impact of current planning consents relating to the Knapton Generation Station, the well sites serving the Station and the associated pipeline network. The aim was to identify any significant additional impacts associated with an extension to the current consents.

## 1.1 Background

Third Energy currently operate the Knapton Generation Station near Malton. The station consist of an open cycle gas turbine power plant burning sour gas to produce electricity. The rated thermal input is 99 MW with an electrical output 41.5 MW. The Station is supplied by six wellsites via a connecting pipeline network. Third Energy are seeking to extend the life time of the existing plant, production sites and pipeline infrastructure and as such are required to submit planning applications. Other than the time limiting condition, Third Energy are not seeking any variation of the existing consents.

As part of these applications it is necessary to demonstrate the acceptability of the impact on air quality in the vicinity of these installations resulting from a lifetime extension.

## 1.2 Approach to the review

The original planning consents for the affected installations were supported by assessments of air quality impact to demonstrate their acceptability. The approach adopted in this review is to consider the original air quality impact assessment in the context of the current situation to determine any significant detrimental changes. Since the original assessment, methodologies for the assessment of air quality impact have advanced and the associated assessment and acceptability criteria have been refined.

The review focusses on the following installations for which lifetime extension are sought:

- Knapton Generation Station comprising the gas turbine and 600 m overhead line transmitting electricity produced to the National Grid
- Six wellsites producing natural gas – Kirby Misperton A and B, Malton A and B, Marishes and Pickering
- The pipeline network connecting the wellsites to the Generation Station and transferring condensates to Kirby Misperton A for re-injection.

With regard to air quality impact releases from the gas turbine operations at Knapton Generating Station are considered to be by far the most significant. At the wellsites there is no combustion of natural gas and releases to atmosphere are most likely to be fugitive releases of natural gas resulting from leakages in the pipeline network. In the original air quality assessment for these installation negligible air quality impact was expected. This review therefore concentrates on the operations at Knapton Generation Station.

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## 2 Knapton Generation Station

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As part of the environmental permitting application in 2006, the impact on air quality of operations at the Knapton Generation Station was assessed<sup>1</sup>. The assessment concluded that *‘The AERMOD dispersion model strongly suggests that emissions for oxides of nitrogen do not contribute to an exceedance of the air quality criterion and that at the worse case location the Process Environment Contribution (PEC) is less than half the Environment Assessment Level (EAL) for Nitrogen Dioxide. Maximum predictions are close to the installation boundary and fall short of the key residential and ecological receptors identified..’*

Other pollutants from the gas turbine such as sulphur dioxide and carbon monoxide were screened out from the detailed assessment using Environment Agency screening criteria.

The assessment has been examined in the context of current practice and conditions to determine whether this conclusion is still valid.

### 2.1 Methodology

The assessment undertaken used the United States Environmental Protection Agency (US EPA) AERMOD modelling system to determine the process contributions to ground level concentrations of nitrogen dioxide over the area surrounding the Knapton Generation Station. The assessment used meteorological data from the RAF Leeming measurement station (1996 to 2001). The AERMOD modelling system, along with the UK ADMS model, are accepted by the Environment Agency and UK Local Authorities for the examination of dispersion from single and multiple industrial sources. The installation modelled is a relatively simple example of a single industrial source with a well defined release point and a single building influencing dispersion. While the AERMOD model has been subject to upgrading since the assessment in 2006 it is not considered that the changes would have significantly altered the results from the modelling of this relatively simple source.

### 2.2 Sensitive receptors

To determine the significance of impact in terms of human health the assessment considered the process contributions at specific locations corresponding to the residential locations closest to the Generation Station:

Ochre Farm Bungalow	650 north east
Guild Farm East	1000 m south west
Knapton Railway Cottages	1500 m west

An examination of the area indicates that there have been no new residential developments closer to the Station. These locations continue to be the nearest residential locations to Knapton Generation Station.

The ecological impact of process releases was assessed at the nearest statutory nature conservation sites. A review using the MAGIC database (<http://magic.defra.gov.uk>) indicates that there are no sites within 2 km of the Station. The nearest Site of Special Scientific Interest (SSSI) is Wintringham Marsh at a distance of 3.6 km (south) and the closest European designated site is the River Derwent Special Area of Conservation (SAC) around 6 km to the west. This corresponds to the original assessment. There are no new designations since 2006 which are any closer to Knapton Generation Station.

## 2.3 Air quality standards and assessment criteria

The UK's air quality strategy is based on meeting obligations within the European Union (EU) Ambient Air Quality Directive (2008/50/EC, 21 May 2008)<sup>2</sup> and the Fourth Daughter Directive (relating to metals and hydrocarbons)<sup>3</sup>. The Air Quality (Standards) Regulations 2010<sup>4</sup> transpose into English law the requirements of Directives 2008/50/EC and 2004/107/EC on ambient air quality.

Table 2.1 summarises the applicable limit values for nitrogen dioxide as at 2018.

**Table 2.1 Ambient Air Directive Limit Values**

Pollutant	Basis	Concentration
Nitrogen dioxide (NO <sub>2</sub> )	1 hour mean (99.79 percentile – 18 exceedences per year)	200 µg/m <sup>3</sup>
	annual mean	40 µg/m <sup>3</sup>

These correspond to the air quality standards used in the original assessment.

The Environment Agency<sup>5</sup> provide a methodology for assessing the impact and determining the acceptability of emissions to atmosphere on ambient air quality for human health and nature conservation areas. Based on atmospheric dispersion modelling taking into account the factors which influence dispersion and ambient impact (e.g. meteorology, release conditions, locations of sensitive receptors, etc.) process pollutant contributions and predicted environmental concentrations are compared with assessment criteria. Where conditions for excluding the release from further consideration cannot be made a detailed cost benefit assessment is necessary.

With regard to human health the contribution of the process (PC) to the ambient concentration of a given pollutant is considered insignificant, and requiring no further assessment, if both of the following conditions are met:

- the long term PC is less than 1% of the long term environmental standard
- the short term PC is less than 10% of the short term environmental standard

If these conditions are not met then the corresponding predicted environmental concentration (PEC, PC + background concentration) should be assessed. The process contribution is considered insignificant and requiring no further assessment, if both of the following conditions are met:

- the short-term PC is less than 20% of the short term standard minus twice the long term background concentration
- the long-term PEC is less than 70% of the long-term environmental standard

If these conditions are not met then the compliance of the process with Best Available Technique (BAT) will need to be assessed. No further action is necessary if it can be demonstrated that both of the following apply:

- proposed emissions comply with BAT associated emission levels (AELs) or the equivalent requirements where there is no BAT AEL
- the resulting PECs won't exceed environmental standards

Similar criteria apply to statutory nature conservation sites.

It is not clear from the original assessment that the acceptability of the air quality impact was assessed against criteria comparable to those currently applicable. Based on the conclusion it appears that compliance with the air quality benchmark was the criteria for acceptance.

## 2.4 Background pollutant concentrations

In the original assessment background concentrations for nitrogen dioxide were obtained from the DEFRA archive for 2004 and 2005. The most recent estimated background concentrations for the area covering a radius of 1 km with the Generation Station at the centre area for the calendar year 2015 were obtained from the DEFRA archive (<http://uk-air.defra.gov.uk/data/pcm-data>). A comparison of the original and current background levels are shown in Table 2.2.

**Table 2.2 Background concentrations of nitrogen dioxide**

Year	Nitrogen dioxide annual mean concentration ( $\mu\text{g}/\text{m}^3$ )	
	2004/2005	2015
Maximum	11.9	8.3
Mean	10.6	7.1

It may be noted that current background levels of nitrogen dioxide are somewhat lower than those employed in the original assessment and as such it would be expected that current predicted environmental concentrations of nitrogen dioxide would be lower than those originally assessed.

## 2.5 Pollutant releases

Exhaust gas release conditions and pollutant release rates are the most significant factors affecting the impact of a process on ground level pollutant concentrations. Table 2.3 summarises the exhaust gas conditions employed in the original assessment and those reported for operation during the period January to December 2017.

**Table 2.3 Modelled and current exhaust gas conditions**

Parameter		Original assessment	2017 <sup>c</sup>
Stack height	m	15	15
Exhaust gas velocity	m/s	15	20
Exhaust gas temperature	°C	455	455
Stack diameter	m	3.0	4.0
Full load thermal input	MW	110	98.9
Operating hours	h/year	8760	193 <sup>a</sup>
Nitrogen dioxide release rate	$\text{gNO}_2/\text{s}$	8.1	4.3 <sup>b</sup>

a. Full load equivalent operating hours determined from actual annual thermal input and rated thermal input.

b. Based on reported annual mass  $\text{NO}_2$  release and full load equivalent operating hours.

c. Values from Third Energy IED (Industrial Emissions Directive) report on Energy Usage and Emissions for 2017.

The comparison above shows some significant differences between the conditions assumed in the original assessment and current operating conditions:

- The operational period for 2017 was around 2% of the equivalent full load operation assumed in the original study. This indicates a significant reduction in the air quality impact over a long term averaging basis (annual mean). The operating period in 2017 reflects a shortage of gas and for the proposed consent extension full time full load operation is intended as originally modelled.
- The exhaust gas velocity is somewhat higher than in the original assessment. An increase in velocity would be expected to have a beneficial effect on dispersion of releases due to increased plume momentum and result in a reduction in process contributions to ground level concentrations, particularly at the most affected locations.
- The release rate of nitrogen dioxide is around a half of that originally modelled. This is a significant consideration since, assuming all other conditions are the same, a reduction in release rate will result in a proportional reduction in process contributions to ground level concentrations. The lower release rate reflects current operation and compliance with the permitted monthly average emission limit value of 50 mgNO<sub>2</sub>/m<sup>3</sup>. The original modelling was based on a higher exhaust gas concentration of nitrogen dioxide of 80 mgNO<sub>2</sub>/m<sup>3</sup>.

For a gas turbine firing natural gas the majority of oxides of nitrogen released will be in the form of nitrogen monoxide. While conversion to nitrogen dioxide will occur in the atmosphere it is unlikely that all of the nitrogen oxides in the flue emission will be in the form of nitrogen dioxide at ground level. In the original assessment conversion rates of 50% and 100% were assumed for short and long term air quality impacts respectively. It may be noted that for a detailed modelling assessment the Environment Agency<sup>5</sup> currently recommend that short term and long term conversion rates of 35% and 70% respectively be considered. These are considered quite conservative estimates and other methodologies such as that developed by Janssen et al<sup>6</sup> indicate substantially lower conversion rates over distances of 1 to 2 km. This suggests that the process contributions determined in the original assessment were enhanced by conservative assumptions on conversion rates.

## 2.6 Air quality impact

An examination of the original assessment and the current conditions indicates that the results represent a substantial over estimate of the process contributions to ground level concentrations of nitrogen dioxide from current operations at the Knapton Generation Station.

The results of the original study have been considered in the context of current assessment criteria to determine acceptability. Table 2.4 summarises the predicted air quality impact at Ochre Farm, which is the most affected residential location.

**Table 2.4 Air quality impact at Ochre Farm**

Condition	Nitrogen dioxide			
	99.79 percentile of hourly means		Annual mean	
	µg/m <sup>3</sup>	% AAD limit	µg/m <sup>3</sup>	% AAD limit
Process contribution	12	6	0.7	2
Predicted environmental concentration	36	18	12.7	32

Based on current Environment Agency assessment criteria the process contribution to nitrogen dioxide at the most affected residential location is insignificant and requires no further assessment (i.e. the short term PC is less

than 20% of the short term standard minus twice the long term background concentration and the long term PEC is less than 70% of the long-term environmental standard).

The original assessment does not provide an analysis of the impact of nitrogen oxides process contributions at the nearest nature conservation site. In Table 2.5, the estimated impact at the nearest conservation site is assessed. It is assumed that the site will experience an annual mean process contribution of less than  $0.2 \mu\text{gNO}_2/\text{m}^3$  based on an assessment of the area contour plots presented in the original assessment. The determination was undertaken in accordance with the guidance in AQTAG 06<sup>7</sup> and considered dry deposition only. Guidance indicates that wet deposition over relatively short distances is unlikely to be significant.

**Table 2.5 Ecological impact at the nearest nature conservation site**

Conservation site		Wintringham Marsh SSSI
<b>Nitrogen oxides to air</b>		
Annual mean $\text{NO}_x$ critical level	$\mu\text{gNO}_2/\text{m}^3$	30
Maximum annual mean process contribution	$\mu\text{gNO}_2/\text{m}^3$	0.2
	% critical level	0.7
Background concentration	$\mu\text{gNO}_2/\text{m}^3$	9.9
Predicted environmental concentration	$\mu\text{gNO}_2/\text{m}^3$	10.1
	% critical level	34
<b>Nitrogen deposition</b>		
Most sensitive habitat		Fen, marsh and swamp
Critical load for nitrogen deposition	$\text{kgN/ha/y}$	15-30
Process contribution to nitrogen deposition	$\mu\text{gNO}_2/\text{m}^2 \text{ s}$	0.0006
	$\text{kgN/ha y}$	0.0576
	% critical load	0.4
Background deposition	$\text{kgN/ha y}$	22.26
Predicted environmental concentration	$\text{kgN/ha y}$	22.32
	% critical load	149
<b>Acid deposition</b>		
Most sensitive habitat		Fen, marsh and swamp
Minimum CLminN	keq	0.440
Minimum CLmaxS	keq	0.223
Minimum CLmaxN	keq	0.663
Process contribution to nitrogen deposition	$\text{keq/ha y}$	0.0041
	% critical load	0.6
Background nitrogen acid deposition	$\text{keq/ha y}$	1.59
Background nitrogen acid deposition	$\text{keq/ha y}$	0.29
Predicted environmental concentration	$\text{keq/ha y}$	1.88
	% critical load	284

The assessment indicates that the process contribution to nitrogen oxides, nitrogen deposition and acid deposition is less than 1% of the critical level or critical load and as such is considered insignificant based on Environment Agency assessment criteria. While there is exceedance of the critical loads for nitrogen and acid deposition, this is due to an existing large background deposition and the process contribution is not considered to have any significant influence on critical load compliance.

It is concluded that releases of nitrogen dioxide from the Knapton Generation Station are insignificant with regard to impacts on human health and ecology and pose no significant risk to the continued attainment of air quality standards and critical levels and loads. The assumptions made to undertake the original modelling are considered to have the effect of overestimating the process contribution to ambient concentrations in practice. It is therefore considered that the predicted process impact on ambient pollutant concentrations reported herein is a conservative assessment and the conclusions reached therefore incorporate a reasonable margin of comfort in spite of the inevitable uncertainty of such modelling studies.

The Knapton Generation Station was planned to have a total capacity of 60 MW<sub>e</sub> rather than current permitted capacity of 41 MW<sub>e</sub>. The above analysis indicates that an increase in capacity of around 50% to 60 MW<sub>e</sub>, with a corresponding increase in pollutant discharges, would not significantly alter the conclusions of this assessment.

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### 3 WELL SITES AND PIPELINE INFRASTRUCTURE

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The original consent for the six wellsites and the associated pipeline took into account the potential for releases of natural gas during well workover and also as a fugitive release through leakages in pipework, valves, connectors etc. The main impacts of a release of natural gas are related to health and nuisance.

The main mitigation is in the loss prevention procedures which were adopted at the commencement of the well site and pipeline development and which continued in the subsequent operations. Third Energy operate a loss prevention programme which entails:

- Prevention activities and solutions to avoid natural gas leaks from happening in the first place through proper design, construction, operation, maintenance, training, and education.
- Detection activities to quickly identify any potential leaks at an early stage and undertake effective corrective action.

This is coupled with precautions during well workover to minimise the potential for natural gas release.

During the operation of these facilities there have been no significant incidents relating to natural gas release.

Losses will continue to be controlled through prevention and detection activities and as such it is not considered that an extension to the current consent will pose any significant additional risk with respect to continued operation of the well sites and the associated pipeline network.

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## 4 CONCLUSIONS

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Third Energy UK Gas Limited currently operate the Knapton Generation Station near Malton, which consists of an open cycle gas turbine power plant burning sour gas to produce electricity. Natural gas is supplied from six wellsites via a connecting pipeline network. Third Energy are seeking to extend the life time of the existing plant, production sites and pipeline infrastructure. As part of the planning application process it is necessary to demonstrate that the air quality impact of these continuing operations is acceptable.

The original planning consents for these installations were supported by assessments of air quality impact to demonstrate acceptability. This review has considered the relevance of these assessments with regard to current operating practices and refinements to assessment methodologies and acceptability criteria.

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A revised assessment using current acceptability criteria indicated that the air quality impact of process contributions of nitrogen dioxide at the nearest residential locations was insignificant. An assessment of the process contribution at the nearest statutory designated nature conservation site indicated an insignificant impact with regard to critical levels for nitrogen oxides and critical loads for nitrogen and acid deposition.

Releases of nitrogen dioxide from the Knapton Generation Station are considered insignificant with regard to impacts on human health and ecology and an extension of the current consent is unlikely to pose any significant risk to the continued attainment of air quality standards and critical levels and loads. The assumptions made to undertake the original modelling are considered to have the effect of overestimating the process contribution to ambient concentrations in practice. It is therefore considered that the predicted process impact on ambient pollutant concentrations reported herein is a conservative assessment and the conclusions reached therefore incorporate a reasonable margin of comfort in spite of the inevitable uncertainty of such modelling studies.

Natural gases losses from the well sites and associated pipeline network were considered to be adequately controlled by the current loss prevention measures. It is not anticipated that an extension of the planning consent will pose any significant risk of greater losses than those originally consented.

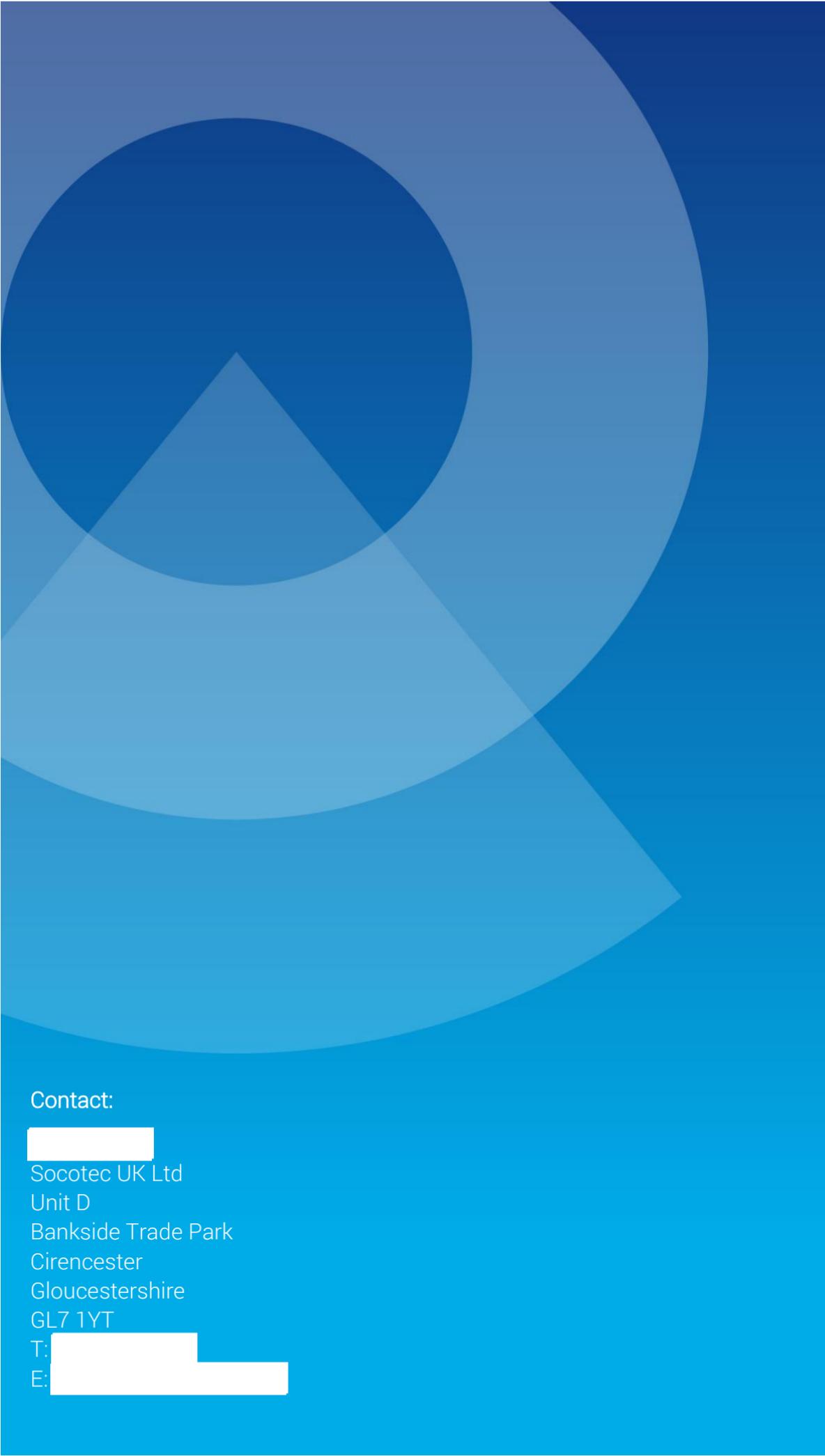
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