




National Grid International Limited

**UK – Norway Electricity
Interconnector NSN Link**

Coal Mining Risk Assessment

RP001.Geo.Mining

Draft 1 | 12 November 2013



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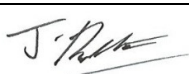

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1 Introduction

The proposed UK – Norway Electricity Interconnector NSN Link (NSN Link) project comprises UK onshore elements, subsea cables in UK and Norwegian waters and the Norwegian onshore infrastructure.

The proposed interconnector will comprise a high voltage direct current submarine electricity cable link designed to transmit electrical power in both directions across the North Sea between the high voltage grid systems in the UK and Norway.

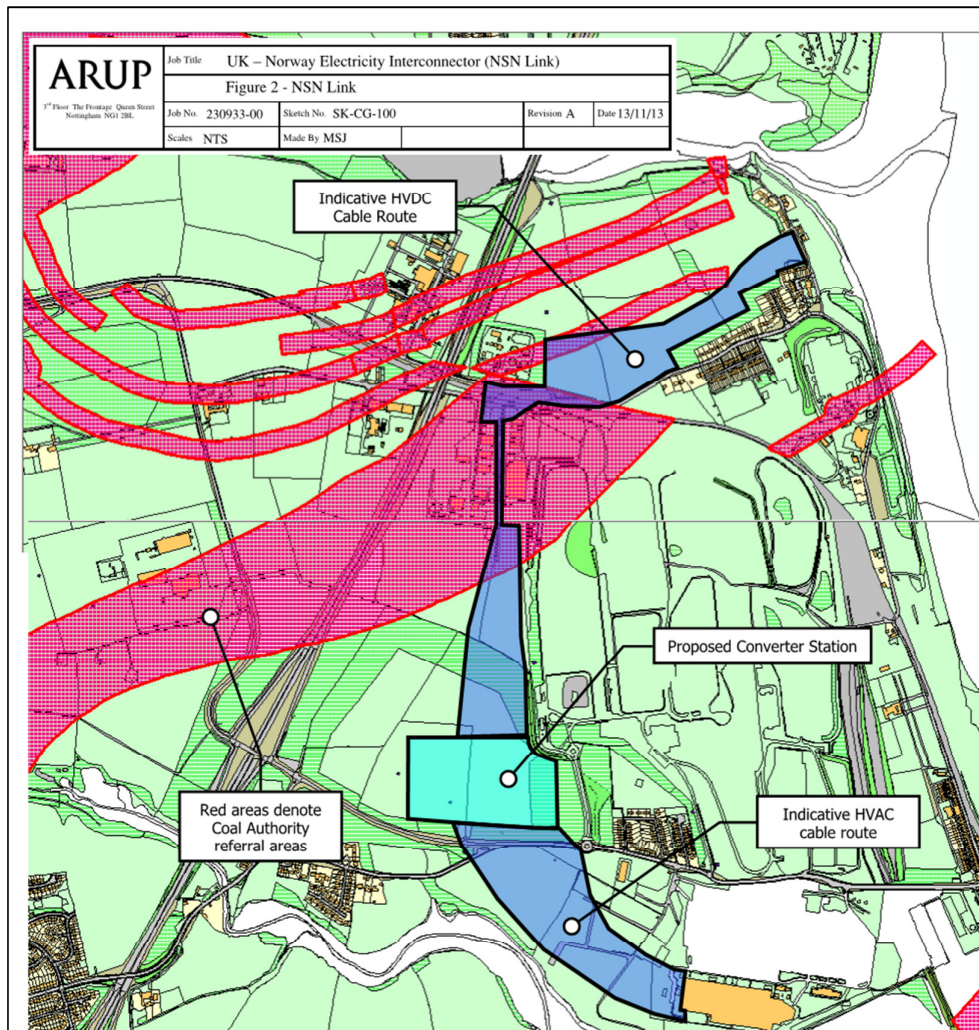


Figure 1 – Schematic layout for NSN Link (onshore section – indicative only)

The UK components comprise:

- Two high voltage direct current (HVDC) subsea cables between landfall and the mean low water mark (MLWM);

- Two HVDC onshore underground cables from the converter station to the landfall on the coast at Cambois Bay slipway where they will be joined to the subsea HVDC cables;
- A HVDC converter station in East Sleekburn, on land adjacent to the former Blyth Power Station coal stocking area, which would convert the HVDC power used in the link to high voltage alternating current (HVAC) for use in the national transmission system and vice-versa; and
- Six 400 kilovolts (kV) HVAC underground electricity land cables to connect the above HVDC converter station to the existing 400kV North Blyth electricity substation.

The Norway-UK interconnector link will operate at a nominal voltage of $\pm 515\text{kV}$.

The Converter Station site and HVAC connections to the existing substation lie within land covered by Coal Authority Standing Advice. A section of the HVDC onshore cabling route lies within the Coal Authority Referral Areas, as shown on Figure 1.

This report presents the assessment of potential risks related to coal mining for the UK onshore sections of the NSN Link project.

2 Data Reviewed

In addition to a site walkover the following information has been reviewed as part of this assessment:

- Envirocheck Report;
- 1: 10 000 Geological Maps NZ 28 SE, and NZ 38 SW;
- Coal Authority Mining Reports 51000295880001 and 51000302965001;
- BGS borehole records NZ 28 SE / 20 and / 27;
- Local History Source: www.sixtownships.org.uk/memories-of-cambois--beyond.html;
- Exploration Associates October 1992, Interpretive Report on Ground Investigation for the Cambois Industrial Zone.
- Mining Report by N Tomlin for Northumberland County Council; and
- Relevant Mining Records held by the Coal Authority Mining Records Office.

A ground investigation, to cover all of the onshore UK sections of the NSN Link, has been specified and is presently nearing completion on site. This investigation includes consideration of potential mining related issues.

3 Desk Study

3.1 Geological Maps

Published geological maps indicate that the site of the Converter Station is underlain by Glacial Till (Drift Deposits), which overlie Middle Coal Measures bedrock consisting of an interbedded sequence of sandstone, siltstone, mudstone and coal seams which dip to the northwest.

There is no Made Ground indicated to be present on the Converter Station site. Made Ground is indicated to be present immediately adjacent to the western boundary of the site, associated with embankments on the A189 and to the north and east associated with a depot and railway sidings. Rockhead is indicated to be approximately -15m OD beneath this section of the site.

The uppermost recognisable (named) coal seam in the vicinity of the site area is the High Main, but this has not been worked under the Converter Station site. The Geological Map indicates that the next named seam in the Coal Measures sequence above the High Main Coal is the Moorland Coal, which can be up to 1.17m thick, but is not shown to be present under this section of the site.

The worked (named) seams in this area are tabulated in Section 3.5.

3.2 Historic BGS boreholes

The depth of drift from historical logs is summarised on Figure 2 below. Blue numbers indicate the thickness of Drift below ground level in metres and the black numbers indicate the depth of a significant coal seam in metres. The logs confirm the Drift comprises Glacial Till together some laminated clay in the southeast part of the site.

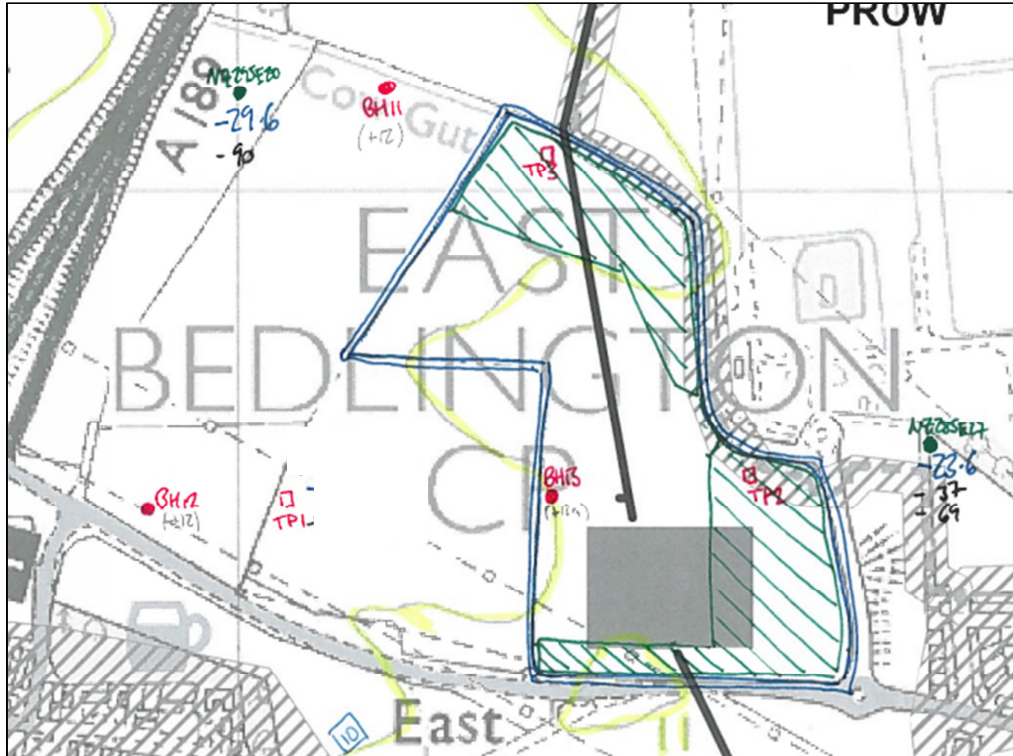


Figure 2 – Historic Boreholes near Converter Station site

Glacial Till deposits are indicated to be approximately 24m thick in the east of the site area, increasing to over 30m thick in the northwest of the site. In general, Drift appears to be thicker in the north of the site area.

The historical borehole logs for the area primarily relate to coal exploration. The two relevant borehole logs available within the immediate vicinity of the site indicate the following coal seams are present:

- A moderately thin band, 28 cm thick, associated with the High Main Shell Bed is present 38 m below ground (to the east of the site only)
- High Main Seam: 1.0 to 1.9 m thick, is present about 70 m below ground beneath the east edge of the site, increasing to 91 m below ground beneath the northwest corner of the site. The seam is poor quality with much interbedded mudstone.
- The horizon of the underlying Top Main Seam, which comprises about 1.8 m of mudstone and thin beds of coal, is present 3 to 5m below the High Main Seam, about 53 m below ground in the southern portion of the site to 97 m below ground in the northwest.
- The Moorland Coal Seam is indicated to subcrop across the north west part of the site and to be present at shallow depth below Drift cover to the north and north west of the site.
- Other seams lie below 100 m depth, including the Five Quarter Seam, Bentinck Seam, Yard Seam, Bensham Seam (and Upper Bensham), Low Main Seam, Plessey Seam and the Harvey Seam.

3.3 Exploration Associates Investigation in 1992

A ground investigation was carried out by Exploration Associates in September 1992, covering the southern area of the site, to the south of Cow Gut (see Figure 2). This comprised three boreholes to a depth of 12m bgl, three pits to a depth of 3m bgl and insitu and laboratory geotechnical testing.

The Drift deposits encountered comprised Glacial Till and a layer of laminated clay. The Glacial Till was described as firm to stiff silty slightly sandy clay, with occasional gravel consisting of limestone, sandstone and mudstone. The laminated clay was encountered at depths of 3.5m to 4.8m bgl and was found to be 1m to 2.75m thick, comprising of firm thinly to thickly laminated clay with occasional limestone gravel and also described as soft in some places. Exploratory holes indicated that the laminated clay potentially covers a greater area of the site than indicated by geological maps.

Bedrock was not encountered in any of the exploratory holes. No groundwater was recorded in any of these exploratory holes.

3.4 Coal Authority Mining Report

The Coal Authority Mining report references eight seams of coal having been worked at depths of between 80m and 340m depth under the Converter Station site, with the last working in 1967. It acknowledges the possibility of coal at or close to the surface, which may have been worked at some time in the past, and that records may be incomplete with the possibility of unrecorded mine entries.

It states that any ground movement from the recorded workings should have ceased by now.

3.5 Coal Authority Mining records

The following mining records were subsequently inspected at the Coal Authority Mining Records Office and comments are included in the right hand column.

Seam Name	Coal Authority Plan Reference	Details beneath Converter Station Area.
Top Main (F1)	NC644 45/2883	Adjacent workings to west 1943 and 1969, none beneath site.
Yard	NC335 45/2883	Extensively worked early 20 th Century
Upper Bensham	13647	Limited workings early 20 th Century
Bensham	NC457 45/2883	Worked beneath western part of Site 1930s
Low Main	NC458 45/2883	Extensive workings late 19 th Century
Plessey	NC388 45/2883	Extensive workings 1940s
Harvey / Beaumont (N)	NC737 45/2883 NC606 45/2883	Adjacent workings 1942 and 1966

3.6 Local History Source

Further references to ancient mining in the Converter Station area are outlined in a local history source - www.sixtownships.org.uk/memories-of-cambois--

beyond.html. This source references a short lived late 18th century mine sunk near the coast (Gee's House) about 1.0km to the east of the site. The source also references 'scratch' (probably Bell Pit) mining of Coal in the Cambois area from the fifteenth century.

3.7 Mining Report by N Tomlin

The mining report by N Tomlin discusses the possibility of ancient shallow mine workings in the Converter Station area, noting that ancient (unrecorded) mine workings had been encountered to the northwest of the project area at Stakeford (NZ 270 850) and possibly just west of the A189 (NZ 288 840) It is noted on the Geological map that this is in the general area where the Moorland and the overlying Ryhope Coals come to crop beneath Drift cover, and may have been the target for ancient mining.

4 Consideration of Mining Related Risks

4.1 Converter Station

The Converter Station is essentially a series of very large buildings which house specialist electrical equipment. These are expected to be steel framed structures which are likely to be founded on piles. Heavily loaded equipment and equipment sensitive to settlement are also expected to be piled. The piles may need to extend into the upper section of the Coal Measures, which lie at depth under a significant cover of low permeability Drift Deposits (Glacial Till). There will be smaller ancillary structures and some external plant and equipment.

There are no significant underground structures or basements anticipated to be required related to these structures.

A relatively small amount of cut and fill will be required to provide a large, generally level, platform for the development.

4.2 Cable routes

The onshore HVAC and HVDC cable routes comprise the installation of approximately 150mm diameter cables (nominally 2 No for HVDC and 6 No for HVAC) in trenches at relatively shallow depth (about 1.2m).

Where the cable route crosses physical obstructions (such as the railway line and any streams) it may be necessary to drill under these and install ducts to allow the cables to be subsequently pulled through using trenchless technology such as Horizontal Directional Drilling (HDD). The depth of these drills will be reasonably shallow.

4.3 Geology and Mining

Due to the dip of the strata the Moorland and Ryhope seams do not occur beneath the location of the proposed Converter Station site, therefore the slight concern expressed by N Tomlin, (for the Cambois Industrial zone) and the Coal Authority Mining report, cannot be specifically assigned to the site of the Converter Station. No potentially workable Coal Seams are identified as being present above the horizon of the High Main Coal, but the possibility of (trial) shafts being sunk through the drift cover cannot be entirely ruled out.

The HVAC cable route from the Converter Station (south eastwards) has a similar mining status to the Converter Station site, as described above.

However, the HVDC cable routes (to the north and then east) traverses part of the Northumberland / Durham Coalfield, from just south of the railway spur, east north eastward to the coast. This area is somewhat different from further south, as outlined below.

Beneath part of this section of the HVDC cable route the Moorland Coal is at shallow depth below the Drift cover, and the alignment passes close to the location of the Cambois Colliery.

Based on adjacent BGS boreholes, the drift cover is generally thick (27 - 30m), similar to the Converter Station area.

There is some indication of ancient unrecorded ‘scratch’ mine workings in the Cambois area from local history sources (see above), possibly in areas where the Moorland Coal is present at shallow / moderate depth. In Borehole NZ28SE/5 (which is close to the pipeline route) a 2.0m zone of broken ground is recorded at a depth of 46m just above a 1.0m intact section of the Moorland Coal. This type of occurrence is alluded to in the Mining Report by N Tomlin for the Cambois industrial zone, which acknowledged the presence of ancient mine workings in the seams above the High Main Seam.

The indicated depth of the Moorland Coal and the possible ancient mine workings (below 40m), should not significantly affect stability along the cable route, but the possibility of unrecorded mine entries accessing these workings cannot be ruled out.

4.4 Potential Implications and Assessment

As noted by the Coal Authority, the potential impacts on the scheme from historic coal mining include ground instability, as result of subsidence from various causes including shallow workings, as well as potential impacts from mine gases and unrecorded shafts and adits.

4.4.1 Converter Station Site

The only significant structures for the onshore UK section of the NSN Link are on the Converter Station site. These significant structures, and heavy or settlement sensitive plant and equipment, are expected to be supported on piles which may be taken into the top of the Coal Measures.

The Converter Station site lies in an area covered by Coal Authority Standing Advice (ie not a Referral Area) and our review confirms that no potentially workable Coal Seams are present above the High Main Coal in the Converter Station site area. Potential issues related to subsidence are therefore not anticipated. The current ground investigation will allow confirmation of the anticipated geological sequence across this section of the site.

The possibility of (trial) shafts being sunk through the drift cover cannot be entirely be ruled out. If present, these would most likely be encountered during enabling works (cuts and fill) or during piling, but would be expected to be very localised features.

By their nature, most of the structures are not particularly sensitive with respect to gas migration (large open areas surrounding electrical equipment) and there is a significant cover of lower permeability Drift deposits - much cohesive Boulder Clay (Glacial Till) – over the Coal Measures. There are no significant relatively shallow coal seams beneath the Converter Station site area, leading to an extremely low risk of gas migration potential. However, for completeness gas monitoring will be undertaken during the current ground investigation. Although considered extremely unlikely, if mine gases can migrate to beneath the structures, the foundations can be designed to mitigate for this using appropriate gas protection measures.

4.4.2 Cable Routes

The cables will generally be placed in shallow trenches and backfilled and will have significantly less sensitivity to ground movements than the Converter Station buildings and ancillary structures.

The HVAC cables lie within an area covered by Coal Authority Standing Advice, similar to the Converter Station. For the reasons noted above in Section 4.1.1 for the Converter Station there are no particular concerns from mining related to the HVAC cable route.

A section of the HVDC cable route lies over a Coal Authority Referral Area as shown on Figure 1. As noted above, as for most other services, the cables will not be as settlement sensitive as the structures and would be expected to tolerate some “dishing” of the ground as a result of deeper subsidence. The onshore cables have some protective armouring (less than the offshore cables) but if major, localised, ground movements occurred then it is possible that some damage could be caused and a localised repair would be required. However, given the significant depth of Drift cover anticipated in this section, this is not considered a high risk.

Additionally, there are many structures, hardstandings and associated infrastructure within Ferguson’s industrial area as well as a significant number of services running west – east near the road and railway in this sector, and we are not aware of any subsidence related issues.

Ground gases will not be of concern for completed cable trenches, but normal precautions should be taken when entering into any excavation. In this area this should include routine gas monitoring.

The ground investigation includes trial pits along the cable routes, which will extend below the base depth of the proposed trenches.

4.5 Current Ground Investigation

An intrusive ground investigation is presently being undertaken along all areas of the onshore NSN Link project. Consideration has been given to mining related issues and includes:

- Boreholes extending into the Coal Measures beneath the converter station site. They will allow the general stratigraphy under the site area to be confirmed and they will include gas and groundwater monitoring standpipes.
- Boreholes at locations where any HDD or other crossings may be required to allow the ground conditions to be determined below the depth of any possible drill.
- Trial pits along the route of the HVAC and HVDC cables.

The ground investigation on the Converter Station site is nearing completion and has confirmed the general findings from the Desk study.

5 Summary and Conclusions

Our assessment of risk related to historic Coal mining indicates that there are expected to be a very low risk of significant impact on the proposed Converter Station buildings, HVAC and HVDC cable routes.

Part of the HVDC cable route traverses a Coal Authority Referral Area and the possibility of encountering very shallow unrecorded workings or mine entries, locally broken/fissured ground or mine gas cannot be completely ruled out, although the Desk Study indicates a reasonably thick cover of Drift deposits in this section. The cable route is of much relatively lower sensitivity to these potential mining related risks than the Converter Station structures.

Appropriate mitigation is described below:

- One of the objectives in the current ground investigation is to confirm the sequence of Coal Measures strata present beneath the drift cover, for the convertor station area. This is indicated to be the strata some 20m below the Moorland seam, as referenced in the adjacent BGS borehole NZ 28 SE / 27, and includes two thin un-named coals and a mussel band (High Main Marine Band). Initial results from the current ground investigation confirm the Desk Study findings and subsidence is not considered an issue for piled, or other, foundations.
- The current ground investigation will also include monitoring for ground (and mine) gases in standpipes installed in boreholes taken into the Coal Measures. For the reasons described above mine gas is not considered to be an issue for the Converter Station site, but it is noted the foundations could be readily designed to mitigate for this using appropriate gas protections measures.
- As the possibility of unrecorded mine shafts affecting the Converter Station site cannot be entirely ruled out, it is recommended that observations are made when the development platform formation is exposed for any feature that may reflect a former (trial) mineshaft. This is standard practise for new developments in mining areas.
- As with the Converter Station buildings, it is recommended that during excavation, observations are made for any feature that may reflect a former mine shaft along the cable routes.
- Routine gas monitoring should be undertaken in any trenches where man entry is proposed. This will be particularly important in the Coal Authority Referral Areas.