STATE OF CONNECTICUT
CONNECTICUT SITING COUNCIL

Northeast Utilities Service Company Application to the Connecticut Siting Council for a Certificate of Environmental Compatibility and Public Need ("Certificate") For The Construction of a New 345-Kv Electric Transmission Line Facility and Associated Facilities Between Scovill Rock Switching Station in Middletown and Norwalk Substation In Norwalk, Including the Reconstruction of Portions of Existing 115-kV and 345-kV Electric Transmission Lines, the Construction of Beseck Switching Station in Wallingford, East Devon Substation in Milford, and Singer Substation in Bridgeport, Modifications at Scovill Rock Switching Station and Norwalk Substation, and the Reconfiguration of Certain Interconnections

Docket No. 272

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November 18, 2004

ANSWERS OF ABB, INC. TO FIRST SET OF INTERROGATORIES OF THE CONNECTICUT LIGHT AND POWER COMPANY AND THE UNITED ILLUMINATING COMPANY DIRECTED TO ABB, INC. DATED NOVEMBER 4, 2004

1) Please confirm that the largest installation of voltage source converter high voltage direct current transmission (VSC-HVDC) in operation at the present time is 352 MW.

The largest VSC-HVDC transmission in operation is the Cross Sound Cable (CSC) project, which is rated 330 MW at the point of interconnection to the receiving AC network. This is the accepted way of specifying the rating of a VSC-HVDC transmission system. The maximum power that can be taken by CSC from the sending AC network is 346 MW.

2) ABB's short-circuit analysis indicates that series reactors would be needed between Bridgeport Harbor Unit 3 and the Pequonnock 115-kV bus to avoid short-circuit duty at Pequonnock from exceeding equipment ratings. Were these series reactors included in ABB's stability simulations?

Given the relatively small size of these series reactors and in light of the stability study results (without the series reactors modeled) that have shown stable system performance, it is expected the inclusion of the series reactors would have a negligible impact on the system performance. This should be confirmed by additional studies.

It should be noted that unlike the addition of AC lines or transformers, which will increase the fault current level, HVDC systems have a significantly less fault current contribution. Fault current contribution from an HVDC system is naturally limited to the load current but can be reduced even further during faults by fast-acting control as would be implemented in the proposed HVDC options. Use of series reactors was considered an acceptable method and is also currently approved for use at Bridgeport Harbor Unit 2 (this reactor was included in the short-circuit data base provided by NU for the Phase II all-AC solution). The ABB proposal used series reactors at Bridgeport Harbor Energy and Bridgeport Harbor Unit 3 in order to meet the study scope criteria to reduce the fault levels at Pequonnock 115-kV bus to about 90% of 63kA. The proposed series reactors are similar in size to the series reactor at Bridgeport Harbor Unit 2. As a reference, with the proposed Phase II all-AC solution, the fault level is 96% of 63kA. Other methods to limit short circuit without series reactors are available, such as the use of ungrounded transformers, and would produce results comparable to levels the Phase II all AC solutions provide.

3) Were the reactors modeled in the short-circuit study considered in the power flow study?

   Given the relatively small size of these series reactors and in light of the power flow study results (without the series reactors modeled), it is expected the inclusion of the series reactors in the generator leads would have a negligible impact on the system performance. This should be confirmed by additional studies.

4) Were the reactors modeled in the short-circuit study considered in the frequency scan study?

   The system condition under minimum local generation dispatch was studied in the frequency scan study to produce conservative results. For the minimum generation dispatch, the Bridgeport Harbor Unit 3 was off line and consequently the modeling of the series reactors has no influence on the frequency scan study results.

5) In ABB's powerflow study, there are a number of overloads that are to be removed through adjustment of the HVDC. Provide all documentation of studies performed by ABB to demonstrate that there would be an HVDC setting for each converter that removes the overloads.

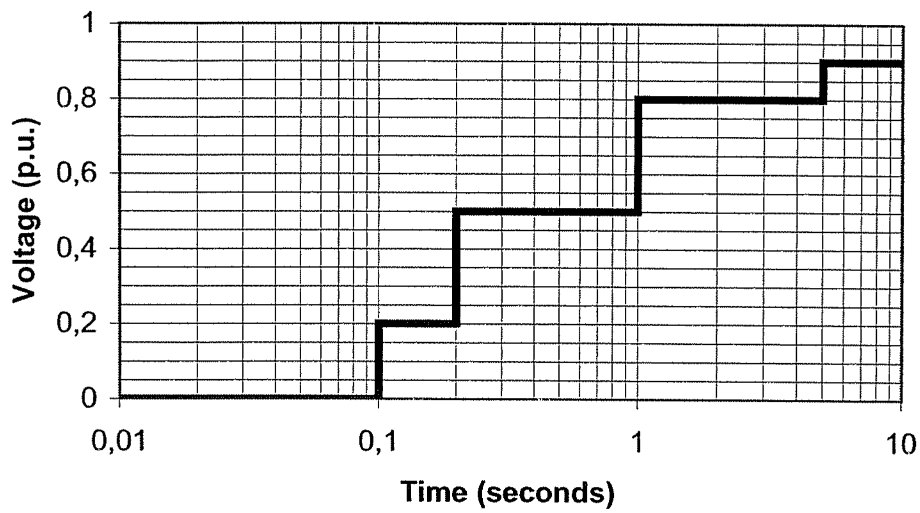
   As noted in the report, only a limited number of contingencies required readjustment of the power schedule following a contingency and results are provided in Attachment B to the report. The overloads are limited to lines that are connected to the terminals and as a result a local measurement for readjustment to the HVDC schedule is one method to alleviate these conditions. In the event that any post-contingency overloads still remain, the HVDC power schedule can be automatically reduced (run back) in response to local signals to limit the observed post-contingent overload. Given the magnitude of the post-contingent overloads determined in the studies, the DC runback required to alleviate the local overloads would be small.

Other methods to eliminate the post-contingency overloads that should also be investigated include determining the extent of upgrade for the limiting components or further optimizing the system model used by the security constrained economic dispatch program with the HVDC.

Studies performed were used to validate major and significant aspects of the proposals within the scope and schedule provided to ABB for this analysis. No actual DC runback cases were performed to determine specific settings for each converter and additional studies should be performed if this is determined as the preferred method.

6) Please provide a curve of voltage versus time that shows the ability of VSC-HVDC converters to "ride through" low voltage events.

The converter will resume full operation after a low-voltage event greater than the limits in the figure below. The duration of the event can be at least as long as shown in the figure. A longer under voltage time can be supplied if required.



7) Was low voltage blocking of the HVDC terminals modeled? If so, provide all documentation of the modeling, including inputs, assumptions and results.

Results of the powerflow and transient stability studies performed by ABB do not show voltage conditions that would trigger low voltage blocking of the HVDC, therefore modeling of low voltage blocking of the HVDC is of no significance.

8) Please specify the length of cable that can reasonably fit on a reel and be transported over public roads to the installation site:

Transporting cargo on the Connecticut roads can be done without permit, escort or time restrictions for cargo within the following limitations.

- Weight: 80,000 lbs gross including the truck.
- Width: 8'-6"
- Height: 13'-6"

The above so-called legal limitations will constitute the following approximate maximum cable reel data.

- Weight of approximately maximum 45,000 lbs
- Width: 8'-3"
- Height: 11' to 12' for a low bed truck or 8' for a flat bed truck

a) For the 330 MW installation 3000 feet of cable can be transported without special equipment, arrangements or permits. This length is also the upper limit for practical cable pulling at site. Thus, there should be no need for larger transport loads.

b) For the 530 MW installation 2000 feet of cable can be transported without special equipment, arrangements or permits. There may be a desire to transport longer cable lengths depending on the site installation conditions. However, approximately 2700 feet is envisaged as the upper limit for practical handling and pulling of this cable at the site. This longer length will in such case exceed the legal limitations with regard the weight only. Permit from CDOT will be required and obtained.

9) The ABB October Report recommends filling the cable conduits with bentonite slurry. Please describe any actual experience with such an installation:

A method description on filling cable conduits with bentonite slurry from a project in Australia in 1999 is attached. See < Supply and place bentonite in AC conduits.pdf >.

The method is based on connecting a filling hose and a venting hose every 200-300 meters. The filling is started from the lowest located end, and is stopped when the bentonite slurry is coming up through the venting hose.

10) How will VSC-HVDC compensate for the loss of reactive power flow during a system contingency such as the loss of an alternating current ("ac") line?

The VSC-HVDC terminals have a P-Q (active power - reactive power) capability similar to that of a synchronous machine. Active and reactive power can be controlled independently within the MVA capability and voltage rating of the converter. Thus a converter operating as an inverter can behave as a virtual generator with power injection determined by dispatch and reactive power determined by an AC voltage regulator. If there is a sudden increase in the reactive power demand due to loss of an AC line, the converter will provide reactive power dynamically in response to a consequential decrease in system voltage. It should also be noted that the VSC-HVDC transmission link itself does not place a reactive power demand on the system like AC transmission or conventional DC transmission. This means that if the DC power transfer is increased to help compensate for the loss of the AC transmission line, the VSC transmission can do so without demanding additional reactive power at its terminals. It can in fact be operated in reactive power control at unity power factor continuously throughout its transfer range so as to have zero reactive power exchange with the network if this is deemed desirable.

The same techniques that are used for static var compensators (SVC) to ensure dynamic reactive power reserve and coordinate with other voltage control devices are applicable to VSC-HVDC. These include a slope in the voltage regulator characteristic, a deadband in the voltage reference and a slow reactive power regulator. The slope helps facilitate sharing with other voltage control devices. The deadband serves to maintain the reactive power capability in reserve until voltage strays outside the deadband following contingencies such as loss of an AC line. The slow reactive power regulator acts to slowly restore the converter to the middle of its reactive power regulating range following a contingency allowing other slower devices such as generators, mechanically switched capacitors and load tap changers to respond.

11) ABB states in the short circuit study included in the ABB October Report that VSC-HVDC does not contribute to the fault current and hence the model assumed zero contribution from the direct current ("DC") system. However, the technical paper included in the ABB October Report has demonstrated that there would be fault current contribution from VSC-HVDC depending on the fault location and the control mode. Please clarify the reason for the study assumption and whether the study modeled the effect of VSC-HVDC performance under different control modes.

In the worst case, the fault current contribution from an HVDC system is naturally limited to the load current but can be reduced even further during faults by fast-acting control. In the short circuit study, it was assumed that fast acting control would be used to reduce the current to zero by the time the circuit breakers open to clear the AC fault.

12) Please provide statistics for outages and for reductions in rated capability for the existing commercially operating VSC-HVDC systems. In addition, please indicate the causes and duration of these outages and reductions in rated capability.

ABB has access to outage data only for the Cross Sound Cable and Murraylink projects. The data recording for these projects was started at commencement of the warranty period. For the outages in both these projects, see the table below.

Cross Sound Cable and Murraylink, VSC-HVDC projects
Forced and Scheduled outages from May 1, 2003 up to Aug 31, 2004

Type of Outage	CIGRE Fault Category	No of Outages	Forced Outage Duration (h)	Scheduled Outage Duration (h)	Capacity Reduction During Outage (%)	CIGRE Fault Category Explanations See also CIGRE Publication 14 - 97 (WG 04)
Scheduled		24		258,06	100	
Forced	AC-E.AX	1	1,35		100	Auxiliary Equipment & Auxiliary Power
Forced	AC-E.CP	1	1,83		100	AC Control and Protection
Forced	AC-E.SW	1	0,50		100	Other AC Switchyard Equipment
Forced	AC-E.TX	2	11,31		100	Convertor Transformer
Forced	C-P.L	7	25,42		100	Local HVDC Control & Protection
Forced	C-P.T	2	7,20		100	Telecommunication Interface /Coding Equipment
Forced	O	7	9,52		100	Other
Forced	V.E	4	79,75		100	Valve, Electrical
Totals		49	136,88	258,06		

13) Has ABB performed type and pre-qualification tests for:
   (a) the cables to be used with the 530 MW converters where the cables are to be installed in duct banks?
   (b) the splices to be used with the cables proposed to be used with the 530 MW converters where the splices are installed in vaults below the surface?
   (c) the integrated cable system proposed to be used with the 530 MW converters in a duct bank?

No. ABB has not performed type and pre-qualification tests on the cables to be used with the 530 MW converters where the cables are to be installed in duct banks.

This fact has to be put into perspective, however. Firstly it has to be noticed that the important aspect of duct installation is the thermo mechanical forces that occur during loading of the cable. These forces are independent of the type of voltage (AC or DC) as well as they are independent of the voltage level (kV). The diameter, weight and maximum temperature of the cable are the most important factors ruling these forces. In other words, installation of VSC-HVDC cables in ducts is not more unique than installation of XLPE AC cables in ducts.

During normal operation the conductor of the cable expands longitudinally if it is not restricted. In buried cable installations this induced movement is restricted by the surrounding soil. In a duct installation the cable is more or less free to move in the duct, depending on the diameter of the duct and the cable. In this case the longitudinal expansion is partly prohibited by the friction between the cable and the duct (see figure 1). This friction functions as a clamp. The remaining expansion is "transmitted" to the end of the cable, typically to the joint in a vault or to the termination. These remaining forces have to be taken care of. This can, for example, be done in the following way (see figure 2). The remaining expansion length is taken care of by allowing the cable to expand (snaking length) in the vault. And, by using clamps on both sides of the joint the longitudinal forces are blocked so that the joint will not "see" these forces and as a result will not be affected. A similar technique can be used for the termination.

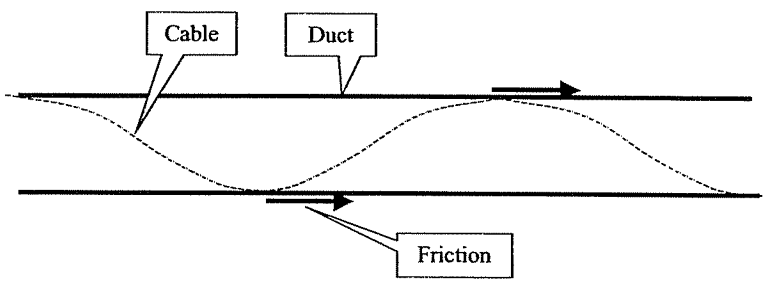


Figure 1. Friction between duct and cable.

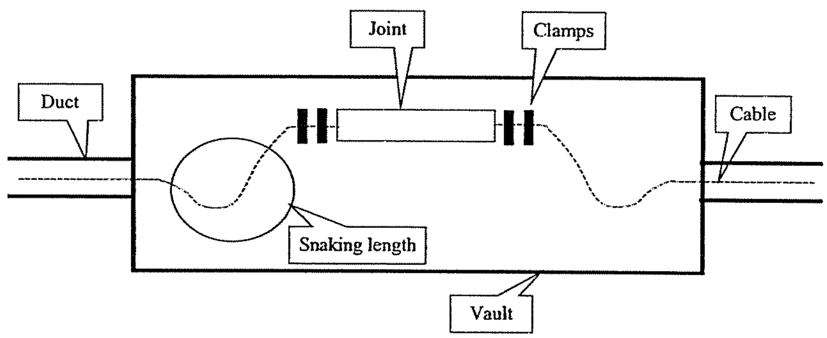


Figure 2. How the longitudinal expansion is taken care of in a vault.

It is mainly the weight, diameter and maximum temperature of the cable and not the type and level of the voltage it is carrying, that are governing these effects. ABB has an ongoing long-term test on a 400 kV XLPE AC cable system, including a cable with 2500 mm^2 copper conductor. Amongst others a duct installation is being simulated within this long-term test. The results of such a long-term test have large significance for VSC-HVDC cable systems with similar construction.

14) Please provide the ampacity calculation performed for the proposed cable size and duct bank configurations.

See attached calculation reports for the 3x370 MW and 2x530 MW configurations.

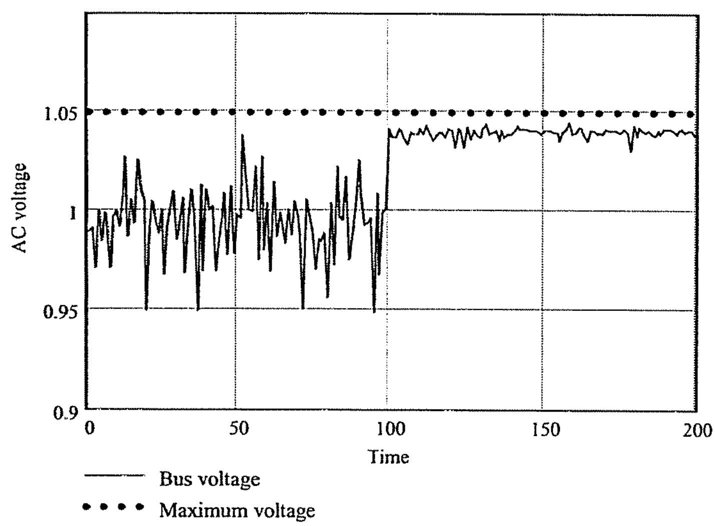
(<Rating calculations 3x370 MW.pdf> and <Rating calculations 2x530 MW.pdf>).

15) Please provide the overall system losses, broken down separately by converter station losses and line losses, as a percentage of rated power for each of the three options proposed in the ABB October Report, at 0%, 10%, 50%, and 100% of load.

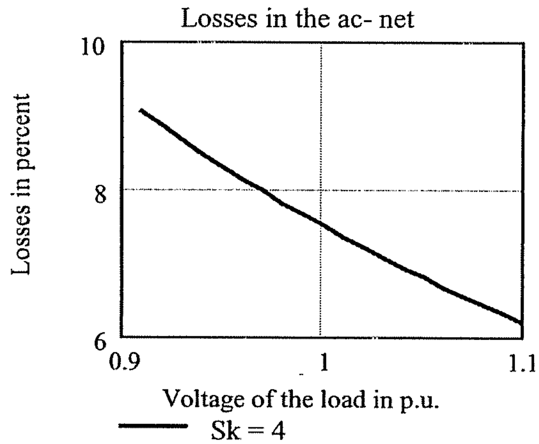
The overall system losses in the South West Connecticut AC system after installation of one of the proposed VSC-HVDC options consists of two parts:

One part is the reduction of losses in the existing AC grid due to use of the VSC-HVDC converters to control the AC voltage. The inherent reactive power compensation capability of the converters can be used to achieve

- Stabilization of the voltage at a higher level, which decreases the active current in the AC lines (see figure below)
- Reduction of reactive current in the AC lines by balancing the load



These current reductions will decrease the losses in the AC grid. The exact amount can not be calculated by ABB at this time, but should be considered when evaluating the overall system losses. A typical relation between losses in the grid versus voltage is shown in the figure below.



The other part of the overall system losses is the expected losses for the five VSC-HVDC options proposed in the ABB October report. These losses are given in the table below.

	Option 1		Option 2		Option 2a		Option 2b		Option 3	
No. of Converters	10		6		6		4		6	
No. of Cable pairs	3		3		3		2		3	
Total Circuit Length (miles)	54		54		54		54		30,4	
Rated Power of Each Link (MW)	370		370		370		530		370	
Total Transfer Troughput (MW)	1110		1110		1110		1060		1110	
Power level, %	Overall System Losses Based on % of Total transfer throughput for Option									
	Stations (%)	Cables (%)	Stations (%)	Cables (%)	Stations (%)	Cables (%)	Stations (%)	Cables (%)	Stations (%)	Cables (%)
0	0,39	0,00	0,24	0,00	0,24	0,00	0,21	0,00	0,24	0,00
10	1,31	0,01	0,79	0,01	0,79	0,01	0,75	0,01	0,79	0,01
50	3,09	0,23	1,85	0,23	1,85	0,23	1,83	0,21	1,85	0,23
100	5,82	0,92	3,49	0,92	3,49	0,92	3,49	0,85	3,49	0,92

The loss figures in the table are related to the total power throughput from Beseck to Norwalk. That means that in Option 1 no power is taken from or injected to the AC buses in East Devon and Singer. For options 2, 2a, and 2b the converters at Singer and East Devon are not transferring any power and are not in operation. There are of course a number of other dispatches, which would result in slightly different loss figures. Many of them could be calculated based on the table above.

At low power levels, the converter losses can be reduced by applying a special control function, that would change the operating point of the DC voltage control. The value of this function should be judged against the expected power levels that the VSC_HVDC would normally operate on.

16) Provide a detailed itemization and description of estimated costs for each of the three options proposed in the ABB October Report. Include the following in your cost estimates:

- Labor
- Material
- Equipment
- Overhead
- Real property acquisition
- All applicable taxes
- Contingency costs
- Unit prices and amounts
- Any other components of your cost estimates

The estimated prices for the different parts of the five options were presented in the ABB October report. The table of estimated budgetary prices from the ABB report is repeated here:

Option	No of converter stations and power	Conv stn price (MUSD)	No of cables	Cable price (MUSD)	Cable installation (see note) (MUSD)	Total price range (MUSD)
Option 1	10x370 MW	510	3x2	90	180-230	780 - 830
Option 2	10x370 MW	510	3x2	90	180-230	780 - 830
Option 2a	8x370 MW	410	3x2	90	180-230	780 - 830
Option 2b	6x530 MW	350	2x2	100	180-230	630 - 680
Option 3	6x370 MW	310	3x2 (short)	55	100-130	465 - 495

Note: The installation price range is based on 100% cable duct installation. This price can be lower if direct burial of the cables is selected as method.

In addition to the lists in the report on what the prices include, the following applies.

The converter prices include:

- Labor
- Material
- Equipment
- Overhead
- Contingency costs

The cable prices include:

- Labor
- Material
- Equipment
- Overhead
- Contingency costs

The cable installation prices include:

- Labor
- Material
- Equipment
- Overhead
- Contingency costs

The following are not included either in converters, cables, or cable installation:

- Real property acquisition
- Applicable taxes
- Applicable permits

The cable installation price range is based on the July 2004 pricing of Phase I, Section II (115 kV UG Cable Bethel to Norwalk), which was tendered by ABB for execution in 2004 and 2005. The use of a range reflects a higher degree of cost uncertainty compared to converter and cable prices. A more precise price would need detailed studies of the actual route.

The basic preconditions for the cable installation price estimations for Phase II have been:

- Totally 253,000 cy of excavation (an approx 54 miles x 6 feet deep x 4 feet wide trench)
- 10% rock volume, removed by means of blasting
- Native backfill above duct-bank encasement
- Similar methods and constraints as for the civil works for Phase I

Based on experiences from other installations, direct burial of the cables can reduce the cable installation price to a level below the price range given in the table above. This alternative has, however, not yet been explored for this project, Southwest Connecticut Phase II. We believe it could be of interest to better investigate how experiences of direct burial, gained in other projects, potentially could be applied in Southwest Connecticut.

This method statement describes the supply and pumping of bentonite into the AC power cable conduits installed over the full length of the cable route between Terranora Substation and Bungalora Convertor Site.

Bentonite grout is a mixture of water, bentonite (in powder form), fine mineral sand and cement and its purpose in this instance is to exclude air from power cable conduits, thereby improving the current carrying capacity of the cable. The equipment required for this work, comprises a bentonite storage tank, grout mixer, agitator and pump unit.

Based on the following dimensions:-

Conduit	= 188 mm. internal diameter
Cable	= 85 mm. diameter

and a bentonite grout mix comprising:-

Water	= 1000 litres (kg)
Bentonite	= 85 kg
Mineral sand	= 55 kg
Cement	= 20 kg

each metre of conduit with cable in it, contains approximately 22.1 litres of bentonite grout.

1. After the cable has been installed in the conduit, it is to be supported and centralised at each conduit end with reclaimed cable sheath or similar material. At both ends, a 25 mm. diameter fibre reinforced PVC pipe 3 m. long is to be inserted 300 mm. into the conduit. The PVC pipes are brought up to above ground level at the conduit ends and temporarily tape sealed. The ends of the conduits with the cable and pipe in them are sealed with a 200 mm. long plug of casting plaster. The plaster is to be moulded into the conduit mouth, ensuring all the interstices between cable, conduit and bentoniting pipe are sealed. The exposed cables are bedded, slabbed and the trench backfilled to within 300 mm. of the surface in the required manner. The lower end of the conduit run if a height difference exists, is the bentonite injection end and the upper end is the vent.

2. Bentonite grout is mixed at the site progressively in the proportions detailed above, in sufficient quantity to complete the amount required to fill the conduits at that location. Within a few hours, liquid bentonite grout, which can be readily pumped, becomes a gel, which does not flow and cannot be easily pumped.

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3. Unseal the PVC pipe leading into the cable conduit and the one at the remote end. Commence pumping and when bentonite begins to flow from the remote pipe, stop pumping and seal it. Seal the pumping grout pipe.

4. Cut and seal all bentonite pipes 300 mm. below the ground surface, backfill and reinstate the surface.

5. Samples of bentonite mix are to be taken from the bowl on a daily basis. The sample is to be collected in a sealed container and handed to the Kilpatrick Green for observation of setting, over a period of one week

Revision No.	Description	Date	Prepared by	PC (Approval)	QAR (Approval)
A1	For approval	15 12 99	C Allen	H Rijsdijk	

Rating Middletown-Norwalk 3x370 MW, HVDC Light 150 kV F(DC)(CA)LJ 1×1800/35 mm²

1. Method of calculation 2
2. Thermal resistivities 2
3. Electrical data 2
4. Cable design 2
5. Laying conditions 3
6. Cable losses at rated current I = 1290 A 3
7. Ducts filled with bentonite 4

1. Method of calculation

Temperature calculation of cables is done with FEM for installation of cables in duct banks according figure 1.

2. Thermal resistivities

Specified thermal resistivities of back fills:

ρ_1 = 0.55 K×m/W thermal resistivity of duct bank, see figure 1
ρ_2 = 0.9 K×m/W thermal resistivity of ambient ground,, see figure 1

3. Electrical data

U_0 = 150 kV DC

Three parallel circuits
One circuit is two bipolar cables
Rating current per circuit 1290 A

4. Cable design

conductor	48.6		1800 mm^2 profiled, copper
tape	0.1		
conductor screen	1.0		
insulation	12.0		
insulation screen	1.0		
bedding	0.10		
screen 60 pc	0.82		35 mm^2
swelling tape	0.47		
Al laminate	0.2		
PE sheath	3.8	87.5	

5. Laying conditions

Cables installed according figure 1. Three circuits are in one duct bank.

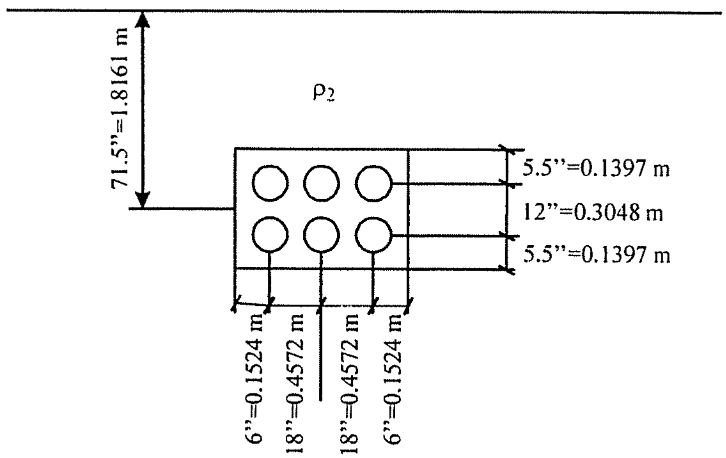

Figure 1

The 150 kV HVDC Light cables are installed in the duct bank in figure 1.

Ducts in duct bank are:

Material PVC
D_o = 6.625"=168.275 mm
D_i = 6.065"=154.051 mm

6. Cable losses at rated current I = 1290 A

Cable losses at 70 °C conductor temperature:

Conductor losses 20.1 W/m×cable

Thermal resistances of cable according IEC 60287:

T1 = 0.2549 K×m/W
T2 = 0.0078 K×m/W
T3 = 0.0506 K×m/W
ΣTk = 0.3133 K×m/W

Temperature drop of cable $\Delta\theta$ = 6.30 K

7. Ducts filled with bentonite

Ducts filled with bentonite, thermal resistivity ρ = 1.2 K×m/W

θ_a = 25 °C ambient temperature of ground

FEM calculation gives contour plot according figure 2. Distance between isotherms is 5 K.

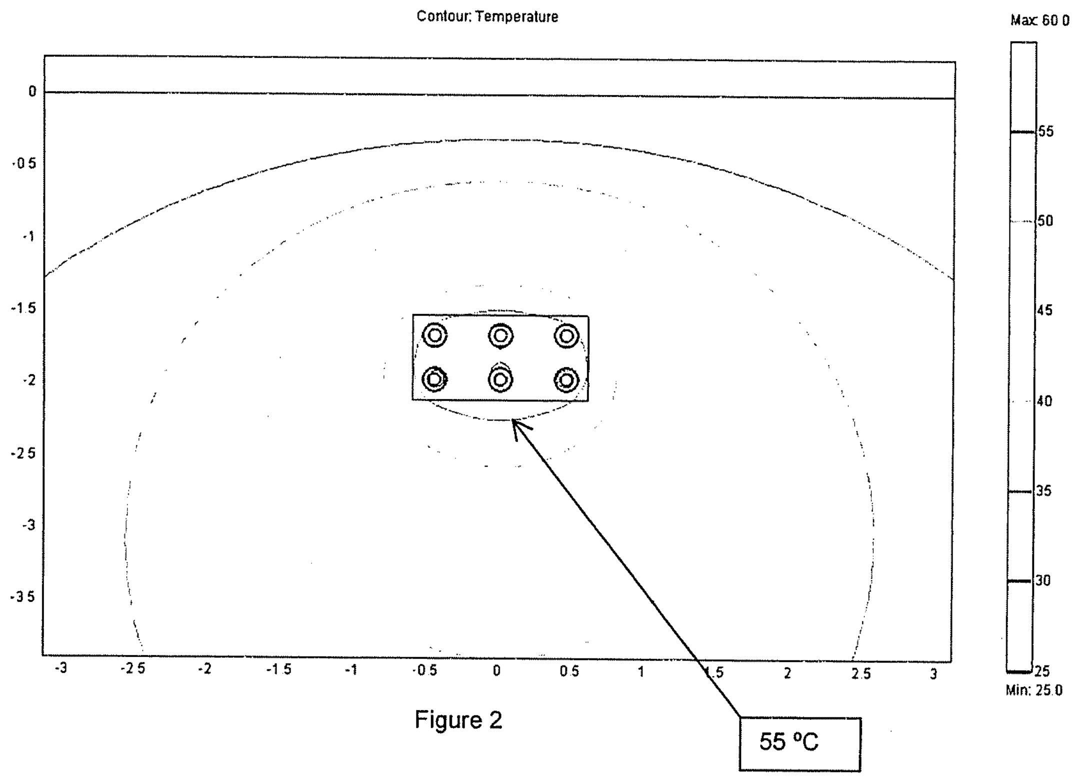

Figure 2

Temperature of cable surface	63.3 °C
Temperature drop cable	6.30 K
Temperature of conductor	69.6 °C

Rating Middletown-Norwalk 2x530 MW, HVDC Light 150 kV F(DC)(CA)LJ 1×2800/35 mm^2

1. Method of calculation 2
2. Thermal resistivities 2
3. Electrical data 2
4. Cable design 2
5. Laying conditions 3
6. Cable losses at rated current I = 1850 A 3
7. Ducts filled with bentonite 4

1. Method of calculation

Temperature calculation of cables is done with FEM for installation of cables in duct banks according figure 1.

2. Thermal resistivities

Specified thermal resistivities of back fills:

ρ_1 = 0.55 K×m/W thermal resistivity of duct bank, see figure 1
ρ_2 = 0.9 K×m/W thermal resistivity of ambient ground,, see figure 1

3. Electrical data

U_0 = 150 kV DC

Three parallel circuits
One circuit is two bipolar cables
Rating current per circuit 1850 A

4. Cable design

conductor		60.6	2800 mm^2 profiled, copper
tape	0.1		
conductor screen	1.0		
insulation	12.0		
insulation screen	1.2		
bedding	0.15		
screen 60 pc	0.82		35 mm^2
swelling tape	1.25		
poypropylene tape	0.6		
Al laminate	0.2		
PE sheath	4.3	103.8	

$R_0 = 0.0065$
$R_{70} = 0.0078$
$W = 0.0078 \cdot 1850^2 \cdot 0.001 = 26.6$ W/m

5. Laying conditions

Cables installed according figure 1. Two circuits are in one duct bank.

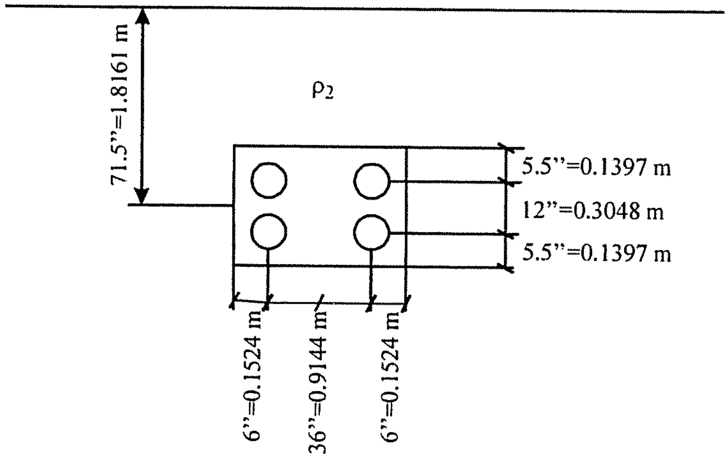

Figure 1

The 150 kV HVDC Light cables are installed in the duct bank in figure 1.

Ducts in duct bank are:

Material PVC

D_o = 6.625"=168.275 mm

D_i = 6.065"=154.051 mm

6. Cable losses at rated current I = 1850 A

Cable losses at 70 °C conductor temperature:

Conductor losses 26.7 W/m×cable

Thermal resistances of cable according IEC 60287:

T1 = 0.215 K×m/W
T2 = 0.024 K×m/W
T3 = 0.048 K×m/W
ΣTk = 0.288 K×m/W

Temperature drop of cable Δθ = 7.69 K

7. Ducts filled with bentonite

Ducts filled with bentonite. Thermal resistivity ρ = 1.2 K×m/W.

θ_a = 25 °C ambient temperature of ground

FEM calculation gives contour plot according figure 2. Distance between isotherms is 5 K.

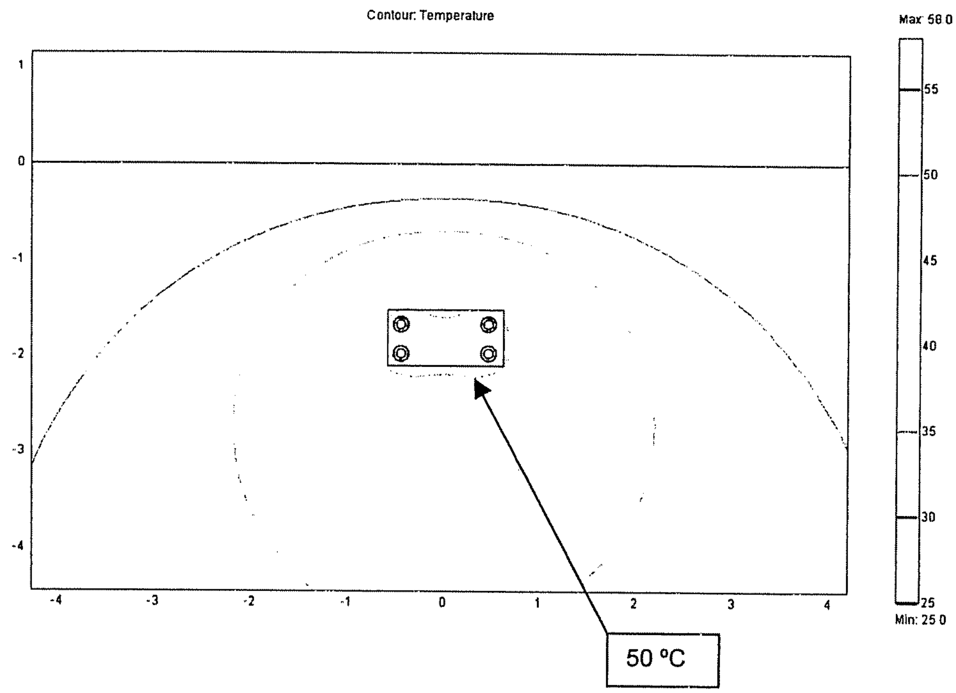

Figure 2

Temperature of cable surface	58.5 °C
Temperature drop cable	7.7 K
Temperature of conductor	66.2 °C