-----Original Message-----
From: Michael Ernst [mailto:Michael.Ernst@TRANSENERGIEUS.com]
Sent: Friday, November 15, 2002 5:41 PM
To: Stephens, VA; Montagna, Ronald
Cc: Epifani, Lisa
Subject: Cross-Sound Cable Project

Please find attached a description of the Cross-Sound Cable Project. We would appreciate the assistance of the Task Force in streamlining the final approval of this project. Thank you very much for your assistance.
<<Request to WHTFEPS Nov 14.doc>> <<Letter to DEP_July_24.pdf>>
Sincerely,

Michael D. Ernst, Esq.
Director of Siting
TransÉnergie U.S. Ltd.
110 Turnpike Road, Suite 300
Westborough, MA 01581-2864
(508)-870-9900, ext. 111 - voice
(508)-870-9903 - fax
(508)-245-7767 - mobile
e-mail: michael.ernst@transenergieus.com

CROSS-SOUND CABLE COMPANY, LLC

110 Turnpike Road, Suite 300
Westborough, MA 01581
Tel: (508) 870-9900
Fax: (508) 870-9903

November 15, 2002

Ms. Virginia Stephens, Director
White House Task Force on Energy Project Streamlining
WH-1, Room 8E044
1000 Independence Avenue, SW
Washington, DC 20585

Re: Cross-Sound Cable Project

Dear Ms. Stephens:

Per the request of your staff, Cross-Sound Cable Company LLC hereby provides a brief description of the Cross-Sound Cable Project, its sponsors, and the agencies with jurisdiction over the project.

Cross-Sound Cable Company LLC is a joint venture of TransÉnergie U.S. Ltd., United Capital Investments and TransÉnergie HQ, Inc. TransÉnergie U.S. Ltd. is the U.S.-based project development subsidiary of TransÉnergie HQ, Inc., which is the transmission division of Hydro-Québec, the electric utility owned by the province of Québec. United Capital Investments, Inc. is an unregulated subsidiary of UIL Holdings Corporation, the parent company of United Illuminating Company, an electric utility in Connecticut.

The Cross-Sound Cable Project is a high voltage direct current (HVDC) submarine electric transmission and fiber optic cable system buried under the bottom of Long Island Sound to interconnect the electric transmission grids of New England and New York. More specifically the cable system will include two 4-inch diameter cables, one fiber optic cable and two AC/DC converter stations at each end of the cable to interconnect with the high voltage transmission systems at New Haven, Connecticut and Brookhaven, Long Island. The cable system already has been constructed and tested and can operate with no harm to the environment, fishing industry or local shipping.

The Cross-Sound Cable Project received approval for the Open Season auction of transmission rights from the Federal Energy Regulatory Commission on June 1, 2000; approval from the New York Public Service Commission under Article VII on June 27, 2001; approval from the Connecticut Siting Council on January 3, 2002; approval from the Connecticut Department of Public Utility Control on January 4, 2002; a permit from the Connecticut Department of Environmental Protection (CTDEP) on March 17, 2002; and a permit from the U.S. Army Corps of Engineers (ACOE) on March 19, 2002. The Project also has received all other necessary permits to operate, *i.e.,* the City of New Haven temporary building permits, including sidewalk and excavation permits, and New Haven City Plan Commission coastal site plan approvals, including soil erosion and sediment control approvals.

The initial phase of the Cross-Sound cable installation process was conducted in May of 2002 using a remotely-operated water jetting installation tool. The cable was buried 6 feet below the seabed across Long Island Sound. However, the ACOE and CTDEP permits required deeper burial under the bottom of the federal navigation channel in New Haven Harbor in anticipation of possible deepening of the channel in the future. Thus, the permits require the cable to rest at a depth of 48 feet below the water surface (mean lower low water or MLLW), which is about 13 feet below the current bottom of the channel. Absent the – 48 ft. requirement relative to the water surface, the cable's burial 6 feet below the seabed throughout the channel would have sufficed under the ACOE and CTDEP permits

Following the cable laying and burial, Cross-Sound's contractor determined that several short sections of the cable under the New Haven Harbor federal navigation channel (comprising less than 10% of the cable length under the channel) were not installed to the burial depth set forth in the permits. Cross-Sound immediately notified the ACOE and CTDEP and began investigations to characterize the conditions that prevented the cable from reaching that depth. The results of the studies indicated that all but one of these cable sections were resting in areas of relatively soft sediments, *i.e.,* sands and clays. Cross-Sound is in the process of notifying the ACOE and CTDEP that work crews are mobilizing another jetting tool to achieve the permitted cable burial depth in these sections.

In one other area the cable is resting on hard rock. Additional characterization studies performed show that the subbottom is hard granite. Cross-Sound is currently seeking proposals from qualified contractors to determine whether and how the cable can be lowered to achieve a depth of 48 feet below MLLW .

As detailed in Cross-Sound's letter dated July 24, 2002 to CTDEP and copied to ACOE [copy attached], the cable in its current position poses no adverse environmental impacts with respect to: electromagnetic field effects on finfish and crustaceans; electromagnetic field effect on compass deflection; temperature effects on shellfish and finfish; and impacts to navigation, including through anchor strikes.

The cable has been tested successfully and is now capable of transmitting power in both directions upon Cross-Sound receiving permission to do so. During the August heat waves, Long Island Power Authority sought and received an Emergency Order from the U.S. Department of Energy to require operation of the cable in an electric emergency until the Order expired October 1, 2002. Although the cable is ready to operate, the ongoing permitting delays are costing Cross-Sound a substantial amount of money each day.

At a meeting on September 27, 2002, the staff of the ACOE-New England Office acknowledged to Cross-Sound representatives that even if Cross-Sound blasted the rock now to lower the cable to – 48 feet, that the ACOE would still have to blast the entire granite dome later if the channel is ever expanded. Therefore, depending on the final proposals from the contractors on November

18th, Cross-Sound proposes to operate the cable on the granite dome 6 or more feet below the current channel bottom until the channel is expanded, thereby creating at most just one additional environmental event in the channel. Cross-Sound commits to finance further burial of the cable at that time.

Therefore, we respectfully request the assistance of the White House Task Force on Energy Project Streamlining to help resolve this issue expeditiously. We suggest that representatives of the ACOE, National Marine Fisheries Service and DOE would be interested in the outcome and thus likely will participate in the resolution of this matter. Given the heavy economic losses from not operating this approved cable and the lack of environmental impact from operating the cable in its current location, Cross-Sound respectfully requests that this issue be resolved by the end of the month so that a final approval can then be obtained from the CTDEP before the winter holidays when the lowering of the cable in the softer areas should be completed.

We are ready and willing to participate in meetings in Washington, D.C. or New England if either or both would be helpful. If you have any questions or require further information about the Cross-Sound Cable Project, please do not hesitate to contact me at (508) 870-9900 ext. 111 or (508) 245-7767.

Thank you very much for your assistance and attention to this matter.

Sincerely,

Michael D. Ernst
Director of Siting
TransÉnergie U.S. Ltd

cc: Ron Montagna

CROSS-SOUND CABLE COMPANY, LLC

110 Turnpike Road, Suite 300
Westborough, MA 01581
Tel: (508) 870-9900
Fax: (508) 870-9903

July 24, 2002

Jane K. Stahl
Deputy Commissioner
Connecticut Department of Environmental Protection
79 Elm Street
Hartford, CT 06106-5127

Re: Cross-Sound Cable Project: Response to CT DEP Letter Dated July 22, 2002

Dear Deputy Commissioner Stahl:

I write in response to your letter of July 22, 2002 concerning the Cross Sound Cable project. Cross-Sound Cable Company, LLC ("Cross-Sound") appreciates the Connecticut Department of Environmental Protection's ("DEP") on-going efforts concerning the Cross Sound Cable project.

Your letter asks that Cross-Sound demonstrate that installation and operation of the cable at burial depths other than –6' would be environmentally acceptable with respect to (i) no adverse electromagnetic field effect on finfish and crustaceans; (ii) no electromagnetic field interference with compass deflection and navigation; (iii) no adverse temperature effects on shellfish and finfish; and (iv) no adverse impacts to navigation through anchor strikes. The Connecticut Siting Council and the DEP considered these issues as part of the permit process, and the existing record establishes the lack of adverse environmental impacts of cable operation at the current depth, as more fully described below.

1. Cable installation and operation will not produce an electromagnetic field that will adversely affect the movement of finfish and crustaceans within New Haven Harbor and the Sound.

Operation of the cable does not have magnetic or electric field impacts, regardless of burial depth. As the Siting Council found, the cable design effectively eliminates magnetic impacts, since each of the two bundled cables produces magnetic fields that effectively cancel each other out. Siting Council Findings of Fact ¶82. The cable creates a very weak magnetic field source, far weaker than household appliances and about equal to an ordinary iron-containing object. Siting Council Findings of Fact ¶¶80-81 (and sources cited therein). Since soil and sediment of the seabed were not considered or utilized to shield magnetic fields, the fact that in a few places the cable has not yet achieved the final expected burial depth makes no difference.

As set forth in the attached July 23, 2002 letter from Dr. William H. Bailey, operation of the cable at the current depth does not change the analysis. Expanding upon the initial conclusions in Appendix 4, Section D.2.a of Cross-Sound's application to OLISP regarding the lack of magnetic field impacts, Dr. Bailey examines a range of burial depths from –1' to –12' and concludes that from a "magnetic field perspective, there is nothing critical about the burial depth." No matter at what depth the cable system is buried, the magnetic field that would be produced by the cable "will not exceed naturally occurring levels produced by the earth at distances greater than three feet from the cable system." The DC magnetic fields associated with the cable once it is in operation will have no adverse environmental impact on finfish, shellfish, marine mammals or other marine species in the New Haven Harbor or elsewhere in Long Island Sound. Cross-Sound Application to the Office of Long Island Sound Programs, Appendix 4, at 8. We would be happy to make Dr. Bailey available to you should you wish to inquire more on this topic.

2. Cable installation and operation at a depth or depths other than the permitted depths will not create a magnetic compass deflection that will interfere with navigation.

The cable will have even less deflection impact on magnetic compasses because the cable system is situated deeper, relative to MLLW, than the initially evaluated depth in the Siting Council decision. Based on an assumed depth of –35' MLLW, the Siting Council determined that the "maximum projected increase in DC magnetic field levels produced by the proposed cable system would diminish with distance, and would be too weak to pose any risk to public health, marine species, or magnetic navigation equipment." Opinion at 4.

As stated in Cross-Sound's application to the Office of Long Island Sound Programs (OLISP), the intensity of the magnetic field produced by the cable at the surface of the water varies with water depth, relative placement of the cables and proximity to the cable. See Appendix 4, Section D.2.b. See also Cross-Sound's Application to the Connecticut Siting Council at 8-13. The design of the cable effectively eliminates magnetic impacts on navigation. Calculations indicate that the maximum magnetic compass deflection caused by the cable system would be less than 0.05 degree in water depths of 35 feet in the Federal Navigation Channel. Siting Council Finding of Fact #82. As set forth in Table 5.3 of our "Post-Installation Cable & Obstruction Survey" report dated July 19, 2002, the cable system elevation at the investigated areas is all at least 41 feet beneath the water's surface. Therefore, the anticipated impact of the cables on a magnetic compass will be less than the de minimis impact previously considered by DEP.

3. Cable installation and operation will not increase the temperature of the seafloor directly over the cable system such that shellfish and/or finfish are adversely impacted.

The DEP and Siting Council specifically found that at an average of six feet under the seabed, the cable would have a de minimis thermal impact at the seabed surface. Siting Council Findings of Fact ¶27 (and sources cited therein); October 22, 2001 letter from Commissioner Rocque to Mortimer Gelston. The installed cable will have a de minimis thermal impact that is essentially identical.[1] In any event, the Siting Council found that any heat at the seabed surface would rapidly be dissipated by hydrodynamic processes. Siting Council Findings of Fact ¶27 (and sources cited therein). There is no change to the conclusion of no thermal impact.

The attached letter from Dr. Roger Mann, Professor of Marine Sciences, addresses the issue of cable operation at seabed burial depths less than the six feet. In evaluating the potential impacts associated with ten more shallow burial depth locations, Dr. Mann reiterates the information provided in our application to OLISP. The thermal signature of the cable will be negligible relative to background variability and the cable system will operate at a temperature that will not adversely impact benthic resources, shellfish, finfish or water quality. At a burial depth less than six feet, water at the sediment interface directly above the cable and the hydrodynamic processes within New Haven Harbor will rapidly dissipate the de minimis thermal impacts of the cable system at the seabed surface. We would be happy to make Dr. Mann available to you should you wish to inquire more on this topic.

4. Cable installation and operation at a depth or depths other than the permitted depths will not impact navigation by creating a situation where anchor strikes are likely and the ability of large ships to stop is compromised.

Operation of the cable does not increase the likelihood of an anchor strike. In the remote event one were to occur, the effects would be no different if the cable was in operation. The voltage on the surface of the cable, even before burial, is zero. Siting Council Findings of Fact ¶28 (and sources cited therein). The voltage remains zero no matter how deep the cable is buried. The zero voltage results from the cable design, which insulates the conductor with several layers of material. Id. The outermost layer is galvanized steel armoring that protects the cable from impacts. Id. Even if something somehow pierces the armoring, the cable contains an internal grounding system and a redundant protective relaying system that would turn the cable off in less than a tenth of a second. Id. Damage to the cable from an anchor drop would thus result in displacement of energy to the ground, not to the anchor line or ship. Id. at ¶29 (and sources cited therein). Moreover, the cable as installed will not impede an anchor's ability to stop a vessel. ACOE has explicitly determined that "there will be no . . . interference with navigation with the cable in its present location until full burial depth can be achieved." ACOE News Release No CT 2002-82 (June 7, 2002). Operation of the zero-surface-voltage cable is unrelated to whether the cable would impede an anchor's ability to stop a vessel.

Under the terms of the Project's DEP and USACE permits, there also will be no liability to any person, firm, or corporation that strikes the cable since they will not be held liable for damage to the cable system (unless the damage is caused by gross negligence or willful or intentional actions).

[1] Thermal impact of the as-installed cable can be calculated by using equations approved by the Siting Council. *See* Siting Council Findings of Fact ¶27 (and sources cited therein). Calculations of thermal impact at depths of less than 6' below the seabed are attached.

We believe that the facts establish that current operation will have no adverse environmental impacts. We look forward to the opportunity to discuss these matters further with you.

Sincerely,

James P. Nash
Project Director

cc: Christine Godfrey, Diane Ray: ACOE
Charles Evans, Betsey Wingfield, Robin Bray, Micheal P. Grzywinski: OLISP
Michael Ludwig: NMFS
Liz Gowell: ESS
Bruce McDermott; Linda Randell: Wiggin & Dana

Exponent

Exponent
420 Lexington Avenue
Suite 408
New York, NY 10170

telephone 212-972-1500
facsimile 212-972-9480
www.exponent.com

July 23, 2002

James Nash
Cross-Sound Cable Company, LLC
110 Turnpike Road
Suite 300
Westborough, MA 01581

Subject: Magnetic Field Levels and Cable System Burial Depth
Project No. NY10053.000

Dear Mr. Nash:

In order to provide additional information to the Connecticut Department of Environmental Protection, Cross-Sound Cable Company has asked me to comment on the effect of the burial depth of the cable system on the magnetic field. In our earlier report, we had provided calculated magnetic field profiles for the cable system for a burial depth of six feet.

In the table below, I have provided additional calculations of the maximum magnetic field at various assumed burial depths, including that provided in our report.

Distance from Seabed Surface (feet)	**Magnetic Field (Gauss)**
-12	0.04
-11	0.05
-10	0.06
-9	0.07
-8	0.09
-7	0.12
-6*	**0.165**
-5	0.24
-4	0.37
-3	0.65
-2	1.43
-1	5.10

*Depth indicated in report & Application

To put these numbers in context, the occupational Threshold Limit Value for DC magnetic fields is 600 G.

From a magnetic field perspective, there is nothing critical about the burial depth. The seabed and sea water have similar magnetic permeabilities so the magnetic field is not influenced by the medium surrounding the cable system. The magnetic field at the seabed and water column above the cable is not a factor that impacts the selection of the planned burial depth below the sea bed. A conclusion in our report, *Electric and Magnetic Field Assessment: Cross Sound Cable Project*, was

> The levels of the DC magnetic field calculated directly over the cable during maximum power transfer are too weak to pose any risk to public health on land,

adverse environmental impacts on marine species in the Sound, or interference to compass-based navigation.

In reaching that conclusion we evaluated conditions where the cable system would be located in water as deep as 135 ft or as shallow as 10 ft. It should be further noted that, *no matter at what depth the cable system is buried, the magnetic field from the cable will not exceed naturally occurring levels produced by the earth at distances greater than three feet from the cable system*. At the water depths along the route of the cable, variations in the burial depth would have no significant effect on the magnetic field at the surface with regard to the use of compasses for navigation.

In summary, I hope the above information will be useful in understanding that variations in the burial depth of the cable do not change the conclusions set forth in my earlier report.

As noted in my earlier report, the fields from DC electric transmission lines are not the same as those from AC transmission lines. That, of course, has nothing to do with burial depth.

Sincerely yours,

William H. Bailey

William H. Bailey, Ph.D.
Principal Scientist

Ex

Roger Mann
P.O. Box 1303
Gloucester Point, VA 23062

July 19, 2002

To: Bruce L. McDermott
Wiggin & Dana LLP
One Century Tower
New Haven, CT 06508-1832
Tel: 203.498.4340
Fax: 203.782.2889
E-mail: bmcdermott@wiggin.com

Dear Bruce,

Please find the below the requested commentary on biological impacts of the Cross-Sound Cable in operational mode.

Cross-Sound Cable Company, LLC recently installed a bipolar HVDC cable in the navigation channel of New Haven Harbor, CT as part of a larger installation crossing Long Island Sound. In typical operation the cable is a source of heat. The question is posed: what is the biological impact on the biota of the channel and the overlaying water of the thermal signature associated with operation of the cable at depths less than 6' below the seabed?

Two features define the thermal signature of the cable – the quantity of heat emanating from the cable and its dissipation into the overlaying water column, and the absolute increase in temperature in the vicinity of the cable in equilibrium operation? Heat production from the cable in operation is 21.4 Watts per meter length of cable for each conductor. Two conductors are present for a total output of 42.8 Watts per meter of cable or 13 watts per foot (approximating the heat output of a typical car tail light.) Heat dissipates upwards from the cable and through the sediment in a pattern that can be described as an inverted cone, grading to a cylinder with increasing burial depth. With increasing depth of burial the width of the inverted cone at the sediment water interface, at right angles to the orientation of the cable, also increases. Thus the thermal signature is more diffuse with increasing burial depth – a constant source of heat literally spread over a greater distance. Calculations provided by the cable manufacturers (ABB, Sweden) estimate an equilibrium increase in temperature at the sediment water interface directly above the cable of 0.27 degrees F at a burial depth, for example, of 2 feet, decreasing to a temperature increase of 0.14 degrees F at 6 feet burial depth. With further increase in burial depth little further change in the thermal signature is expected. Now consider these two characteristic features of the thermal signature in the context of the posed question.

Quantitative heat dissipation into the overlaying water will depend on the volume of water and its thermal characteristics. The dimensions of the New Haven Harbor Channel are approximately 21,000 feet long, 400 feet wide, and conservatively 40 feet in average depth. The calculated volume is thus approximately 336 million cubic feet. Each linear foot of the channel contains a volume of 16,000 cubic feet of water. Into this volume of water, which is approximately that of a typical two floor, four bedroom house filled with water to the ceiling of the second floor, the operating cable will dissipate the heat output of a car tail light bulb – effectively a miniscule heat input to an infinite volume of water. Heat is rapidly dispersed into the water body by conduction. Further, this analogy is conservative in that it ignores lateral heat dissipation associates with tidal exchange in a north-south direction along the channel axis, and both tidal and wind driven circulation in the shallow depths that flank the channel. Additionally, gravitational circulation, that associated with the rotation of the Earth, serves to mix the water in the shallow regions of the harbor in a swirling fashion and contribute to heat dissipation. Finally, the temperature differential of the colder water deep in the channel, and that of the warmer shallow flanking regions of greatest biological diversity, richness and productivity, insures that effectively no discernable thermal signal from the cable will be present in the shallow regions of the harbor. Given the vast disparity in the quantity of heat input versus the size of the dissipative heat sink formed by the water column, the expectation of no biological impact is well founded. Note that this conclusion is independent of cable burial depth because the quantity of heat production per unit length of operating is constant no matter what burial depth is being considered.

The thermal signature of the operating cable can be described as a narrow strip of sediment water interface, directly above the cable, with a constant, elevated temperature relative to that of the adjacent sediments. Consider the previously quoted temperature increases directly over the cable – 0.14 to 0.27 degrees F. Are these of biological significance as absolute values? The answer to this is no. The vast majority of marine organisms do not regulate their body temperature (a few, such as some large sharks maintain their brains above ambient water temperature, but no such organisms are present in the year around residents of New Haven Harbor). A general rule of physiology for animals whose body temperature conforms to that of the surrounding water is that physiological rate doubles for each 10 degree Centigrade in temperature, that is a doubling for each 18 degrees F. A temperature increase of 0.27 degrees F corresponds to a 1.5% increase in physiological rate. Current methods of physiological testing cannot discriminate such an increase from natural variability both over time at the individual level (multiple sequential measurements of one individual) or within a population (multiple simultaneous measurements of individuals of the same size within a population), or measurement error. Again the conclusion of no biological impact is well founded. Again, this analogy is conservative in that the temperature increments estimated by ABB for a cable in operation assume no water movement and heat dissipation by convection only. Given the arguments articulated in the previous paragraph the expectation of a sediment water interface thermal signature well below that estimated by ABB is realistic.

To reiterate the question as posed: what is the biological impact of the thermal signature associated with operation of the cable on the biota of the channel and the overlaying water?

To summarize the answer: there is no biological impact associated with cable operation at depths less than 6' below the seabed.

Should you have any further questions please do not hesitate to contact me.

Sincerely

Roger Mann

Roger Mann
Professor of Marine Science

Temperature rise of bottom surface above the cable Cross Sound

1. Method of calculation

This document calculates the temperature impact from a bipolar HVDC cable on the surface of the sea bottom. The cable losses are 21.4 W/m×core at rating current.

The temperature is calculated assuming no water streams above the surface of the bottom. Cooling is assumed through natural convection only. This is a pessimistic approach that probably does not exist.

The temperature is calculated vertically above the cable. The temperature decreases side wards from the vertical line intersecting the surface of the bottom.

The temperature rise is defined as the temperature rise of the water transition layer in contact with the bottom surface.

Calculation of the temperature rise of the transition layer through natural convection is found in:

Introduction to Heat Transfer
Second Edition
Frank P. Incropera
David P. De Witt

The calculation is done in two steps:

1. Calculate the heat flow in W/m² vertically above the cable.
2. Calculate the temperature rise of the transition layer.

2. Heat flow q vertically above the cable

The vertical heat flow q at the surface of the bottom vertically above the cable, see figure 1

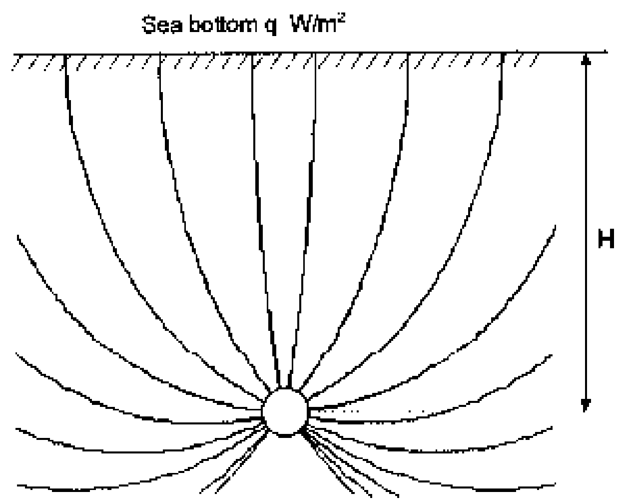


Figure 1

The heat flow q is calculated of 1 m^2 surface above the cable:

$$q = \frac{W}{2\pi}\int_{-0.5}^{0.5}\frac{2H}{x^2+H^2}dx = \frac{2\cdot W}{\pi}\,atan(\frac{0.5}{H}) \quad W/m^2$$

where:

H m	cable burial depth
W W/m	total cable losses at rating current

Origin of the co-ordinate system is in centre of the cable.

3. Temperature rise of the transition layer

The heat transfer to the water is through natural convection. The equation for heat transfer is:

$$q = h\cdot\Delta T$$

where:

h W/m²×K	the convection heat transfer coefficient
ΔT K	temperature difference sea bottom and surrounding water

The sea bottom will reach a temperature that gives such values of ΔT and h that the equation is fulfilled.

The size of convection coefficient h is in the range 50 – 20000. The size of the heat coefficient is depending of the size of the heat flow q. From handbooks the temperature rise of a horizontal heat-dissipating surface can be calculated accordingly:

$$\begin{cases} q = h\cdot\Delta T \\ \dfrac{h\cdot L}{k} = 0.54\cdot R_a^{1/4} & 10^4 \le R_a \le 10^7 \\ \dfrac{h\cdot L}{k} = 0.15\cdot R_a^{1/3} & 10^7 < R_a \le 10^{11} \\ R_a = \dfrac{g\cdot\beta\cdot\Delta T\cdot L^3}{\nu\cdot\alpha} \end{cases}$$

where:

$q = 3.8$ W/m²	vertical heat flow from sea bottom
h W/K×m²	convection coefficient
$k = 0.606$ W//K×m	conductivity water
$\beta = 227.5\times10^{-6}$ 1/K	expansion coefficient water
$\alpha = 1.1449\times10^{-7}$ m²/s	thermal diffusivity water
$\nu = 959\times10^{-9}$ m²/s	kinematic viscosity water
L = 1 m	characteristic length
R_a =	Rayleigh number

The equations give the temperature rise of the sea bottom for $10^4 \le R_a \le 10^7$:

$$\Delta T = \sqrt[5]{\frac{q^4}{k^4\cdot 0.54^4}\cdot\frac{L\cdot\nu\cdot\alpha}{g\cdot\beta}} \quad K$$

and for $10^7 < R_a \le 10^{11}$:

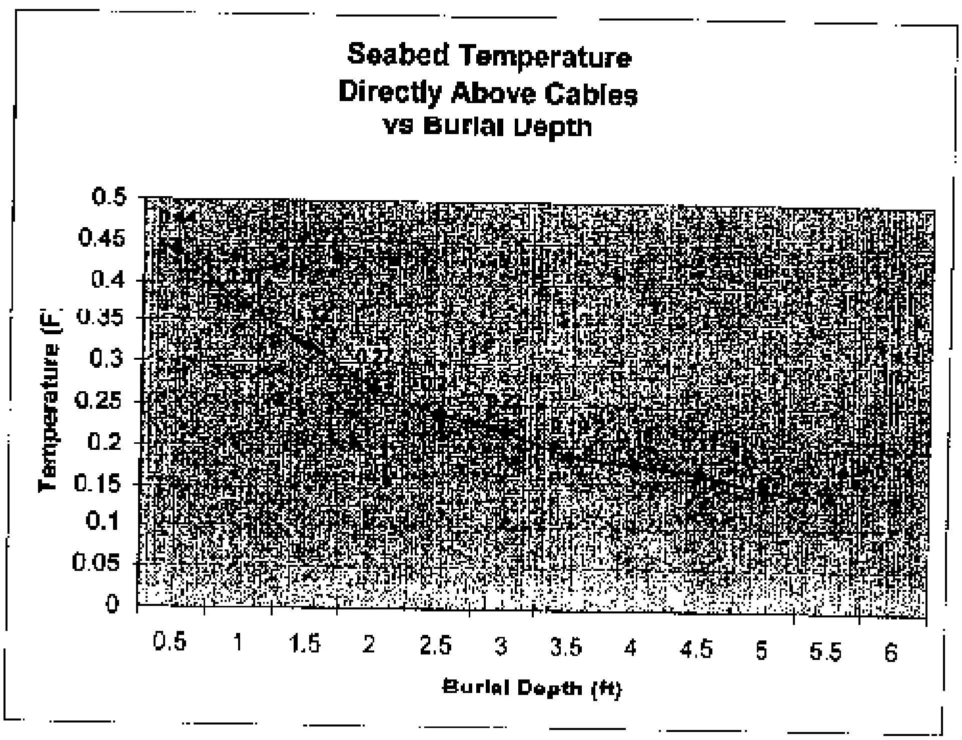
$$\Delta T = \sqrt[4]{\frac{q^3 \cdot \nu \cdot \alpha}{k^3 \cdot 0.15^3 \cdot g \cdot \beta}} \quad K$$

Calculated temperature rise of bottom surface:

W = 2x21.4 W/m, two cables touching

Calculated surface temperatures at laying depths 0.5 – 6 feet:

Burial depth		R_a	q	h	Temperature rise	
feet	m		W/m²	W/Kxm²	K	F
0.5	0.1524	3.9×10^9	17.4	143	0.24	0.44
1.0	0.3048	3.3×10^9	13.9	135	0.21	0.37
1.5	0.4572	2.8×10^9	11.3	128	0.18	0.32
2.0	0.6096	2.5×10^9	9.4	123	0.15	0.27
2.5	0.7620	2.2×10^9	7.9	118	0.13	0.24
3.0	0.9144	1.9×10^9	6.6	113	0.12	0.22
3.5	1.0668	1.8×10^9	6.0	110	0.11	0.19
4.0	1.2192	1.6×10^9	5.3	106	0.10	0.18
4.5	1.3716	1.5×10^9	4.8	104	0.09	0.17
5.0	1.5240	1.4×10^9	4.3	101	0.09	0.15
5.5	1.6764	1.3×10^9	3.9	99	0.08	0.14
6.0	1.8288	1.2×10^9	3.6	97	0.08	0.14



1 K = temperature difference in the Celsius temperature scale

When the cable is laid direct on the sea bottom, there is only a temperature rise of the transition layer close to the cable surface.