HAWAII DEEP WATER CABLE (HDWC) PROGRAM

CABLE OVERLOADABILITY STUDY

Prepared by

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March, 1986

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1. GENERAL

The scope of this study is to determine the short term overload capability of Cable No. 116 in the event of the loss of one pole of the dc transmission system. Such a loss would result in the loss of 250 MW of transmitted power. This exceeds the spinning reserve capability of the Hawaiian Electric Company on Oahu. The maximum allowable first contingency power loss which can be accommodated by the available spinning reserve while maintaining the integrity of the system is 125 MW. The loss of one pole of the dc system would therefore require an increase of 50 percent in the transmitted power on the remaining pole for a period of time up to 4 hours. The surviving pole conductor during this period must therefore carry 150 percent of rated power, i.e. 375 MW corresponding to 1250 amps. The findings are included in this report.

2. CONCLUSIONS

1. Cable No. 116 can sustain 150% of rated load for greater than 4 hours from the thermal and thermomechanical aspects, i.e. not exceeding the maximum allowable conductor temperature of 85°C and not exceeding a 60°C temperature difference between conductor and ambient, respectively.

2. Cable No. 116 can sustain 150% of rated load for greater than 4 hours from the hydraulic aspect providing that a second contingency, i.e. interruption of load or severance of the cable, does not occur during the overload period.

3. In the event of a second contingency occurrence during the overload period, some length of cable would have to be replaced. The length would be limited by the presence of oil flow restrictors in the cable oil duct. On this basis, an overload corresponding to 150% of rated load can be considered acceptable.

4. For the case of an impulse voltage superimposed on dc voltage during the overload condition a reduction in safety margin of the BIL from 20% to 12% would be required to reduce the electrical stress on the outside of the insulation from 68.8 to the acceptable value of 65 kV/mm.

These conclusions apply to the Alenuihaha Channel and to the Maui to Oahu routes except that for the latter route the feeding pressure must be reduced from 30 to 22 kg/cm^2 and minor changes in cable design should be considered.

3. CABLE DATA

The cable considered in this study is a 1x1600 mm^2 aluminum conductor, paper insulated, lead alloy sheathed, metal tape reinforced, PE jacketed, double galvanized steel flat wire armored, PPE served self contained oil filled cable rated 300 kV d.c.

The complete cable characteristics are shown in the document entitled "Hawaii Deep Water Cable Program - Phase II - Cable Construction Specification" dated September 1985. This document describes the final design of the cable designated "Solution 116" in the document "Hawaii Deep Water Cable (HDWC) Program - Phase II - Final Report - Cable Design Parametric Study" dated May, 1985.

As specifically requested, the overload capability of the cable has been determined for time durations of 15 minutes, 1 hour, 2 hours and 4 hours. For reasons of completeness and for investigation other time durations are also shown.

4. THERMAL CALCULATIONS

4.1 Thermal Conditions

In accordance with the above mentioned documents, the following assumed thermal conditions for the design of the cable, were used in this study:

Cable Location	Thermal Resistivity ($^{o}C.m/W$)	Ambient Temperature (^{o}C)	Cover Depth (m)
- Sea bottom (BOT)	1.5	3	100
- Intermediate (INT)	1.5	14	10
- Shallow water (SHA)	1.5	25	3
- Average assumed for hydraulic purposes (HYD)	0.7	3	0.3

NOTE: Calculations of hydraulic transients are based on an average cable temperature along the cable route. The cable route may include naturally or artificially embedded sections as well as sections where the cables are not embedded. In order to establish an average conductor temperature for calculation of hydraulic transient, the above conservative HYD conditions were utilized.

4.2 Conductor Temperatures at Rated Power and 100% Load Factor

The calculation of the conductor temperatures at the rated power (250 MW corresponding to 833 Amps) was made employing final cable design dimensions and a rigorous method of calculation in accordance with the IEC 287 Publication. This is in contrast with the calculations for the Parametric Study in which the cable dimensions were not yet finalized and the method of calculation included some minor approximations.

The computer program for the calculations was written in such manner that the conductor temperature is the input and the current carrying capacity at 100% load factor (continuous load) is the calculation result. Therefore an iterative method was used and only the final computer printout (CP) is shown.

In this manner the following temperatures were obtained for rated power under continuous load under steady state conditions:

	Conductor Temperature	Temperature Drop Conductor to Ambient	
.. BOT	40 °C	37 °C	(see CP 1)
.. INT	40 °C	26 °C	(see CP 2)
.. SHA	47 °C	22 °C	(see CP 3)
.. HYD	12 °C	9 °C	(see CP 4)

4.3 Conductor Temperature at 150% Rated Power and 100% Load Factor

Calculations were performed at 150% of rated power (375 MW corresponding to 1250 Amps) and 100% load factor (continuous load). The purpose of these calculations was to select the thermal conditions for further study under transient conditions since if the cable temperature is acceptable under continuous load, it will be acceptable for any time duration.

The calculated results are as follows:

.. BOT 108°C and temperature drop 105°C (CP 5)
Unacceptable for both thermal (conductor temperature exceeds 85°C) and thermomechanical constraints (temperature drop between conductor and ambient exceeds 60°C). Further study required for transient conditions.

.. INT 80°C and temperature drop 66°C (CP 6)
Unacceptable for thermomechanical reasons.
Further study required for transient conditions.

.. SHA 81°C and temperature drop 56°C (CP 7)
Acceptable; no further study is required.

.. HYD $23^{o}C$ and temperature drop $20^{o}C$ (CP 8)
Acceptable from a thermal point of view. However these conditions must be investigated considering the hydraulic constraints. Therefore, further study under transient conditions is required.

4.4 Thermal Transient Conditions

The computer calculations are based on the theory described in the CIGRE paper "Current Ratings of Cables for Cyclic and Emergency Loads" - Electra No. 24, 1972. For engineering information the thermal transient for BOT, INT and HYD at rated load are shown in CP 9, CP 10 & CP 11, respectively. It will be noted that the steady state (*********) values of conductor temperature are in agreement with the values shown in CP 1, CP 2 and CP 4, respectively.

The next step was the calculation of the thermal transient in the cable starting with the conductor temperature under steady state conditions (shown in the CP's as TAMB) with the application of 150% of rated load (1250 amps).

The following results were obtained. (*)

	Duration	Conductor Temperature
BOT (CP 12)	15 min	43 ^{o}C
	1 hour	50 ^{o}C
	2 hours	55 ^{o}C
	4 hours	59 ^{o}C
	12 hours	64 ^{o}C (**)
	24 hours	67 ^{o}C (**)
	Steady state	108 ^{o}C (**)

	Duration	Conductor Temperature
INT (CP 13)	15 min	43 ^{o}C
	1 hour	50 ^{o}C
	2 hours	56 ^{o}C
	4 hours	60 ^{o}C
	12 hours	64 ^{o}C
	24 hours	67 ^{o}C
	Steady state	80 ^{o}C (**)

(*) The results shown are rounded off. The calculations were performed with many decimal digits.

SHA No investigation required (See para. 4.3)

HYD Discussed in next section.

Under BOT and INT conditions, the conductor temperatures are very similar and acceptable except for the BOT condition beyond at least 24 hours. The temperatures marked (**) are not acceptable based on thermomechanical constraints.

It can therefore be stated that from the thermal aspect only, the required overload capability is acceptable.

With reference to CP 12 and CP 13, it will be noted that the steady state temperatures were not printed out.

5. HYDRAULIC CALCULATIONS

The computer programs are based on the theory shown in the CIGRE paper "Transient Pressure Variations in Submarine Cables of the Self Contained Oil Filled Type" - Electra No. 89, 1983.

During the heating and cooling phases, which correspond to the application of load and to the postulated interruption of load respectively, the maximum transient oil pressure variation in the cable occurs at the middle of the route. In order to determine the pressure difference between the oil in the cable and the surrounding water, the difference between the water head and oil head, due to difference in densities has been calculated at the water depth midway in the route for the heating phase (200 m for Maui to Oahu and 1000 m for the Alenuihaha Channel) and at the maximum water depth for the cooling phase (700 m for Maui to Oahu and 1915 m for the Alenuihaha Channel) This approach yields conservative results.

5.1 Transient Conditions at Rated Load

Cable No. 116 was selected from the Parametric Study for Route 2, i.e. one section of 100 km across the Alenuihaha Channel and another section of 152 km from Maui to Oahu.

In the Parametric Study, the maximum feeding length for Cable No. 116 is given as 190 km. Further, in the Parametric Study the requirements were such that the anomolous condition of having the coexistance of the maximum length and maximum depth was considered. In this study, the suitability of the hydraulic design is investigated, using the actual characteristics of the cable and routes.

5.1.1 Maui to Oahu

CP 14 indicates the following:

1) Thermal transient identical to CP 11 but with a time interval of 0.5 hour.

2) The maximum positive pressure transient variation during the heating phase occurs after 120 minutes into the heating phase at a value of approximately 13 kg/cm^2 (185 psi). The maximum difference between the water/oil head is 1 kg/cm^2 (14.2 psi), and the cable feeding pressure is 30 kg/cm^2 (426 psi), the oil pressure is higher than the water pressure by approximately 42 kg/cm^2 (596 psi), i.e. (30+13-1). This is an acceptable value since it is below the qualification test internal pressure withstand value with a sufficient margin.

3) The maximum negative pressure transient variation during the worst possible cooling phase was selected by the computer among all possible transients when the load is switched off 1020 minutes after the beginning of the heating phase. Under this condition, the maximum value of pressure variation is approximately 15 kg/cm^2 (213 psi) after 150 minutes of the cooling phase. This is not evident in CP 14 but was confirmed using a 1 hour time step. The maximum difference between water/oil head along the longest section of Route 2 is 5 kg/cm^2 (71 psi), and the cable feeding pressure is 30 kg/cm^2 (426 psi), the oil pressure is higher than the water pressure by approximately 10 kg/cm^2 (142 psi), i.e. 30-15-5. The safety margin is larger than usual due to the anomolous design conditions assumed in the Parametric Study (See 5.1).

4) In case of a severance accident at one end of the cable, the positive oil pressure gradient at the severance point is 0.14 kg/cm^2/km (3.2 psi/mi) which is larger than the minimum required by experience (0.03).

The results in 3) and 4) suggest the possibility that the feeding pressure may be significantly reduced. This aspect will be addressed later in the report.

5.1.2 Alenuihaha Channel

Similarly, CP 15 indicates the following for the Alenuihaha Channel.

1. The thermal transient is the same as shown in CP 11 except for the 0.5 hour time step.

2. The maximum positive pressure transient variation during the heating phase occurs after 90 minutes into the heating phase at a value of approximately 10 kg/cm^2 (142 psi). This is an acceptable value.

3. The maximum negative pressure transient during the worst possible cooling phase was selected by the computer among all possible transients when the load switched off 1020 minutes after the beginning of the heating phase as in the previous case. Under this condition, the maximum value of pressure variation is approximately 11 kg/cm^2 (156 psi) after 120 minutes of the cooling phase. Since the maximum difference between water/oil head is 10 kg/cm^2 (142 psi), and the cable feeding pressure is 30 kg/cm^2 (426 psi), the oil pressure is higher than the water pressure by approximately 9 kg/cm^2 (128 psi), i.e. 30-11-10=9. As before, this pressure is higher than usual.

4. In the event of a severance accident at one end of the cable, the positive oil pressure gradient at the severance point is 0.21 kg/cm^2/km (4.8 psi/mi). This value is larger than in the previous case.

The results in 3) and 4) suggest the possibility that the feeding pressure may be significantly reduced. This aspect will be addressed to later in this report.

5.2 Transient Conditions During 150% of Rated Load

Two different conditions of starting conductor temperature were considered, 12°C and 3°C. The 12°C starting conductor temperature is realistic since it is the steady state temperature determined in Section 4.2. The 3°C starting conductor temperature is highly conservative. At the instant of the loss of a pole, the cable could be cooler than 12°C. For example, when the load is reduced overnight, then increased to full load and after a few minutes, before reaching steady state conditions, there is the loss of a pole. The 3°C starting conductor temperature is an extreme case and can be considered unrealistic. A possible case would be intermediate between 3°C and 12°C.

5.2.1 Alenuihaha Channel - Starting Conductor Temperature 12°C (TAMB in CP 16)

CP 16 indicates the following:

1. The thermal transient is not particularly significant since the assumed thermal conditions for HYD are not stringent from a thermal point of view. They are very stringent based on hydraulic considerations.

2. The maximum positive pressure transient variation during the heating phase occurs after 60 minutes into the heating phase at a value of approximately 17 kg/cm^2 (241 psi). The difference between the water/oil head is conservatively 5 kg/cm^2 (71 psi). Hence, at this location the oil pressure is higher than the water pressure by approximately 42 kg/cm^2 (596 psi), i.e. 30+17-5, which is an acceptable value.

3. During the cooling phase, the maximum acceptable negative value of transient pressure variation for this program under regular conditions is 18 kg/cm^2 (255 psi). The value of 18 was determined by subtracting from the oil feeding pressure of 30 kg/cm^2 (426 psi) the value of 10 kg/cm^2 (147 psi) corresponding to the maximum difference of water/oil head and the factor of safety of 2 kg/cm^2 (28 psi).

Based on preliminary calculations it was shown that in some cooling transients the 18 kg/cm^2 maximum acceptable negative value of transient variation was reached. For this reason, CP 16 was run with a long series of cooling transients. The results indicate that the limit value of 18 kg/cm^2 (255 psi) is reached if the load is interrupted after 3 1/2 hours into the heating (overload) phase, 90 minutes after the beginning of the cooling phase. If interruption of the load occurs up to 4 hours from the beginning of the heating phase, the safety margin is reduced but no dangerous pressures appear. Further discussion on this point is reserved until examination of the next transient condition in paragraph 5.2.2.

4. The last page of CP 16 shows that the oil pressure gradient at the severance point of this route is negative at -0.1283 kg/cm^2/km (-2.93 psi/mi). This means that in the case of a severance accident at the far end of the route (100 km) during the overload, the sea water will enter the cable and some length of the cable will have to replaced.

5.2.2 Alenuihaha Channel - Starting Conductor Temperature 3°C (TAMB in CP 17)

CP 17 indicates the following:

1. The thermal transient is not particularly significant for the reasons cited previously.

2. The maximum positive pressure variation during the heating phase occurs after 75 minutes into heating (overload) phase at a value of approximately 20 kg/cm^2 (284 psi). The difference between the water/oil head is conservatively 5 kg/cm^2 (71 psi). Hence, at this location the oil pressure is higher than the water pressure by approximately 45 kg/cm^2 (639 psi), i.e. 30+20-5. This is an acceptable value.

3. The maximum acceptable value of negative transient variation of 18 kg/cm^2 (255 psi) during the cooling phase is reached if the load is interrupted approximately 2 hours into the heating (overload) phase and approximately 2 hours after the beginning of the cooling phase. If the load is interrupted after an overload duration longer than 2 hours dangerous pressure variations can occur, i.e. the water pressure will be higher than the oil pressure. If the load is not interrupted but is gradually decreased, this danger does not exist. As a first approximation it can be proposed that the load be decreased at the end of the overload to

the rated value of 250 MW over at least the same period of time as the overload duration. After this period, the load could be switched off, if necessary.

4. In the case of cable severance during overload, the situation is worse than indicated in paragraph 5.2.1.

5.2.3 Maui to Oahu-Starting Conductor Temperature 12°C (TAMB in CP 18)

CP 18 indicates the following:

1. The thermal transient is not particularly significant for the reasons cited previously.

2. The maximum positive pressure variation during the heating phase occurs after 90 minutes into heating (overload) phase at a value of approximately 25.5 kg/cm^2 (362 psi). The difference between the water head and oil head is approximately 1 kg/cm^2 (14.2 psi). Hence, at this location the oil pressure is higher than the water pressure by approximately 54.5 kg/cm^2 (774 psi), i.e. (30+25.5-1). This is in excess of the test value and is not acceptable.

3. During the cooling phase, the maximum acceptable negative value of transient pressure variation for this program under regular conditions is 24.5 kg/cm^2 (348 psi). The value of 24.5 was determined by subtracting from the oil feeding pressure of 30 kg/cm^2 (426 psi) the value of 3.5 kg/cm^2 (50 psi) corresponding to the maximum difference between the water/oil head and the factor of safety of 2 kg/cm^2 (28 psi).

   The maximum acceptable negative value of transient pressure variation of 24.5 kg/cm^2 (348 psi) is reached if the load is interrupted 3 1/2 hours into the heating (overload) phase, 150 minutes after the beginning of the cooling phase.

   Another limiting value of 16.5 kg/cm^2 (234 psi), which will be explained in paragraph 5.2.5, is reached if the load is interrupted 2 hours into the heating (overload) phase, 150 minutes after the beginning of the cooling phase.

4. The last page of CP 18 shows that the oil pressure gradient at the severance point is negative. This means that in case of a severance accident during the overload, the sea water enters the cable and a length of the cable will have to be replaced.

5.2.4 Maui to Oahu - Starting Conductor Temperature 3°C (TAMB in CP 19)

CP 19 indicates the following:

1. The thermal transient is not particularly significant for the reasons cited previously.

2. The maximum positive pressure variation during the heating phase occurs after 90 minutes into heating (overload) phase at a value of approximately 28 kg/cm^2 (397 psi). The difference between the water/oil head is approximately 1 kg/cm^2 (14.2 psi). Hence, at this location the oil pressure is higher than the water pressure by approximate 57 kg/cm^2 (809 psi), i.e. 30+28-1. This is in excess of the qualification test internal pressure withstand value and is not acceptable.

3. During the cooling phase, the maximum acceptable negative value of transient pressure variation for this program under regular conditions is 24.5 kg/cm^2 (348 psi). The figure of 24.5 plus 3.5, the maximum difference between water head and oil head plus 2, minimum acceptable safety margin, equals 30 kg/cm^2 (426 psi) the feeding pressure.

   The maximum acceptable negative value of transient pressure variation of 24.5 kg/cm^2 (348 psi) is reached if the load is interrupted 3 hours into the heating (overload) phase, 180 minutes after the beginning of the cooling phase.

   If the load is switched off after an overload duration longer than 3 hours, dangerous pressure variations can occur, that is the water pressure will be higher than the oil pressure. If the load is not switched off but it is gradually decreased, this danger does not exist.

   The second limit considered of 16.5 kg/cm^2 (234 psi) is reached when the load is interrupted 110 minutes into the heating (overload) phase and approximately 3 hours after the beginning of the cooling phase. These values were determined through interpolation of the data in CP 19.

4. The last page of CP 19 shows that the oil pressure gradient at the severance point is negative. This means that in case of a severance accident during the overload, the sea water enters the cable and a length of the cable will have to be abandoned.

5.2.5 Maui to Oahu. Reduced Oil Feeding Pressure Effects on Overload Conditions.

As shown in paragraph 5.1.1., when feeding at 30 kg/cm^2 the safety margin for both conditions:

.. difference between water head and oil head during the worst possible cooling transient phase and,
.. oil pressure gradient in case of severance accident

are much larger than usual.

Of the two conditions cited above, the results of calculations indicate that the condition of maintaining acceptable oil pressure gradient in the case of a severance accident is controlling with regard to a reduction in oil feeding pressure.

In $CP_2$20 it is shown that the feeding pressure of 22 kg/cm^2 (312 psi) could assure at the severance point an oil pressure gradient of 0.032 $kg/cm^2/km$ (0.731 psi/mi) which is an acceptable value. With a feeding oil pressure of 22 kg/cm^2 (312 psi), adjusting for the water/oil head pressure differential of 3.5 kg/cm^2 (50 psi) and the factor of safety of 2, the maximum acceptable value of transient pressure variation during cooling is 16.5 kg/cm^2 (234 psi). Therefore the value of 13 kg/cm^2 (185 psi) shown in paragraph 5.1.1 for the positive pressure transient variation during the heating phase under rated load is acceptable.

This is the basis for having made reference to the 16.5 kg/cm^2 (234 psi) value in 5.2.3 and 5.2.4.

Adopting 22 kg/cm^2 (312 psi) shown in paragraph 5.1.1 for the positive pressure transient variation during the heating phase under rated load is acceptable.

This is the basis for having made reference to the 16.5 kg/cm^2 (234 psi) value in 5.2.3 and 5.2.4

Adopting 22 kg/cm^2 (312 psi) as the oil feeding pressure, the maximum positive pressure variation, during the heating (overload) phase is added to 21 kg/cm^2 (298 psi) of imposed static pressure, i.e. 22 kg/cm^2 minus 1 kg/cm^2 for the water/oil head difference resulting in pressure differentials between oil and water of 46.5 kg/cm^2 (660 psi) and 49 kg/cm^2 (695 psi) for the conditions shown in 5.2.3 and 5.2.4, respectively. These values are below the test value although the safety margin is low. However, it is possible that with minor changes in the cable design, e.g. a small increase in the conductor core diameter, a reasonable margin of safety could be achieved.

There are of course more elegant solutions for the link between Maui to Oahu, e.g. intermediate landing in Molokai, different type cable, but they are outside the scope of this study.

6. ELECTRICAL CALCULATIONS

The results of a complete set of electrical calculations are shown for Cable No. 116. The results are more detailed than in the Parametric Study because both the cable characteristics and required performances are now well defined.

6.1 Rated Load Conditions (833 Amps)

Hottest thermal conditions (SHA).
Temperature drop across the insulation (including shields) = 4 deg. C.

Electrical stress (kV/mm)	Inside Insul.	Outside Insul.
Capacitive	32.8	23.3
Resistive (in operation), cold	30.1	25.2
Resistive (in operation), hot	26.7	28.2
Resistive (load cycle test), cold	58.5	51.9
Resistive (load cycle test), hot	53.9	56.0
Impulse with no d.c.	84.7	60.2
Impulse superposed d.c. opp. pol., cold	87.3	58.2
Impulse superposed d.c. opp. pol., hot	90.7	55.2
Impulse superposed d.c. same pol., cold	81.9	62.0
Impulse superposed d.c. same pol., hot	78.5	65.0
Polarity reversal (at 1.5 Uo), cold	54.0	31.4
Polarity reversal (at 1.5 Uo), hot	58.1	17.8

All the above values are acceptable.

6.2 Overload conditions (1250 Amps)

The worst thermal conditions were chosen for the calculations: INT, where after 4 hours overload the conductor temperature is around 60 deg C with a temperature drop across the insulation (including shields) around 11 deg C (CP 13).

Electrical stress (kV/mm)	Inside Insul.	Outside Insul.
Capacitive	32.8	23.3
Resistive (in operation), cold	30.1	25.2
Resistive (in operation), hot	22.8	32.0
Resistive (load cycle test), cold	58.5	51.9
Resistive (load cycle test), hot	48.5	60.9
Impulse with no d.c.	84.7	60.2

Impulse superposed d.c. opp. pol., cold	87.3	58.2
Impulse superposed d.c. opp. pol., hot	94.6	51.4
Impulse superposed d.c. same pol., cold	81.9	62.0
Impulse superposed d.c. same pol., hot	74.6	68.8 *
Polarity reversal (at 1.5 Uo), cold	54.0	31.4
Polarity reversal (at 1.5 Uo), hot	62.9	23.3

(*) All the above values are acceptable, except the one marked with an asterisk. The maximum allowable value for that condition is 65.0.

6.3 Possible Test Conditions

If tests under overload conditions are required, the load cycle and polarity reversal test should be carried out at 90°C conductor temperature and 1250 amps load. These conditions could be obtained by inserting around the cable additional material having high thermal resistance, e.g. asbestos tape.

The relevant electrical stress values under the test conditions with the cable hot are indicated below. The results in case of cold cable would be unchanged.

Electrical stress (kV/mm)	Inside Insul.	Outside Insul.
Resistive (load cycle test)	49.2	60.3
Impulse superposed d.c. opp. pol.	94.1	51.9
Polarity reversal (at 1.5 Uo)	62.3	23.9

The above values are acceptable.

7. DISCUSSION OF RESULTS

Cable No. 116 can sustain 150% of rated load for greater than 4 hours from the thermal and thermomechanical aspects. The hydraulic and electrical constraints are more stringent and require consideration of possible contingencies that may occur simultaneously.

In the following the significance of these contingencies will be discussed to enable the system engineer to consider the likelihood of their occurrence and to evaluate the consequences thereof.

7.1 Cable Severance

The probability of a simultaneous cable severance at one end during overload due to loss of a pole must be evaluated. Since complete cable severance is a rare event *(once during the cable life) during loss of a pole (first contingency) must be considered as a low order of probability.

However, in the event of cable severance, oil leakage could occur. Some length of cable would have to be replaced in this event due to ingress of water. The quantity of cable to be replaced would be limited by the presence of oil flow restrictors in the cable.

7.2 Water Pressure Higher Than Oil Pressure During Cooling Phase After Overload

This is of concern since in the case of previous external damage to the lead sheath instead of oil leakage from the cable, which would not impair its serviceability, the water could gain ingress to the insulation precipitating an electrical failure. In this event, some length of cable would have to be replaced limited, as before, by the presence of oil restrictors in the cable oil duct.

The likelihood of water gaining ingress to the insulation as described above is contingent on the probabilities of the following simultaneous conditions:

- The existence of previous external damage to the lead sheath.

- The location of this damage in the lead sheath to a cable section of high depth, i.e. water pressure higher than oil pressure. In this regard, based on experience the likelihood of external damage to the lead sheath in deep water is very small.

*Submarine cable failure statistics are available in CIGRE papers. The latest paper soon to be published is CIGRE 1986 Paper 21/12 entitled "Methods to Prevent External Damage to Submarine Cables". Reference can also be made to PCC document "Hawaii Deep Water Cable (HDWC) Program - Draft Cable Repair Rationale.

- The duration of the overload condition for more than 2 hours starting from a cold cable.

- A second contingency forcing sudden interruption of the overload rather than a gradual decrease in the load as discussed in 5.2.2.

7.3 Electrical Stress

The electrical stress on the outside of the insulation in the case of impulse superimposed on dc of the same polarity with the cable operating in the overload mode is 68 kV/mm compared to the maximum acceptable value of 65 kV/mm. The first consideration in this regard is the probability of the cable being subjected to impulse while in the overload mode of operation. A second consideration is as follows:

The electrical calculations involving impulse were performed at the required BIL of 775 kV, i.e. 2.58 Uo.

The lightning arrestor level is 2.15 Uo. The 2.58 Uo BIL corresponds to 2.15 Uo plus a safety factor of 20%.

Using 2.15 Uo, the electrical stress under consideration is 58.8 kV/mm, an acceptable value, compared to the value of 68.8 kV/mm corresponding to 2.58 Uo. The maximum acceptable stress level of 60 kV/mm corresponds to 2.408 Uo which corresponds to a factor of safety of 12%.

MAUI to Oahu-Rated Load		MAUI to Oahu-150% Rated Load Starting Conductor Temperature Tc=12°C	MAUI to Oahu-15 Starting Conduc
Thermal	O.K.	O.K.	O.K.
Heating Phase	42 kg/cm^2 oil to water pressure differential. Acceptable	54.5 kg/cm^2 oil to water pressure differential after 90 minutes into overload phase not acceptable; excess of test value	57 kg/cm^2 oil t differential af overload phase excess of test
Cooling Phase	10 kg/cm^2 oil to water pressure differential. Higher than normal	Safety factor of 2 kg/cm^2 if load is interrupted after 3.5 hours of the overload phase; 150 minutes after beginning of cooling phase	Safety factor o is interrupted the overload ph after beginning
Severance	Positive oil pressure in case of severance	Negative oil pressure gradient in case of severance during overload condition	Negative oil pr case of severan condition

ALENUIHAHA CHANNEL - RATED LOAD		ALENUIHAHA CHANNEL - 150% RATED LOAD Starting Conductor Temperature Tc=12°C	ALENUIHAHA CHAN Starting Conduc
Thermal	O.K.	O.K.	O.K.
Heating Phase	35 kg/cm^2 oil to water pressure differential. Acceptable	42 kg/cm^2 oil to water pressure differential. Acceptable	45 kg/cm^2 oil t differential. Acceptable
Cooling Phase	9 kg/cm^2 oil to water pressure differential. Higher than normal	Safety factor of 2 kg/cm^2 if load is interrupted after 3.5 hours of the overload phase; 90 minutes after beginning of cooling phase. Interruption of load 4 hours into overload phase also acceptable	Safety factor o interrupted af load phase; 12(of cooling phas later than 2 ho pressure is hig Not acceptable

8. SUMMARY DATA (CONT'D)

ALENUIHAHA CHANNEL - RATED LOAD		ALENUIHAHA CHANNEL - 150% RATED LOAD Starting Conductor Temperature Tc=12oC	ALENUIHAHA CHANNEL - Starting Conductor Te
Severance	Positive oil pressure gradient in case of	Negative oil pressure gradient in case of severance during overload condition	Negative oil pressure of severance during o

-- 12/11/85 --

DESIGN DATA

CABLE TYPE (Pirelli's designation) = AC3HLB1ENJZJZJ/ 300
1x1600 mm2 300.0 kV 0 Hz
ELECTRICAL RESISTANCES AT 20 °C (ohm/km) :
cond.= 0.01060 screen=******* sheath= 0.2599 armour= 0.3333

CONSTRUCTIONAL DATA

DIAMETERS (mm) : oil duct cond. cond.scr. insul. core scr. sheath/scr.
25.00 51.90 53.10 75.00 76.10 82.00

inside reinforcement	= 83.40	
reinforcement	= 84.60	
PE sheath	= 93.50	thermal res.= 3.5 °C.m/W
TAPES armour	= 94.40	
JUTE or PPE bedding	= 96.60	thermal res.= 4.0 °C.m/W
FLAT WIRES armour	= 102.60	
JUTE or PPE bedding	= 105.80	thermal res.= 4.0 °C.m/W
FLAT WIRES armour	= 111.80	
JUTE or PPE bedding	= 118.40	thermal res.= 4.0 °C.m/W

THERMAL AND ELECTRICAL DATA OF THE CABLE MATERIALS

THERMAL RESISTIVITIES (°C.m/W) : insulation = 5.0 ground = 1.5
TEMPER.COEFF. (1/°C) : cond.= .00403 sheath/scr.= .00400 reinf./arm.= .003
MAX. OPERATION TEMPERATURES (°C) : conductor = 40 ambient = 3
RELATIVE PERMITTIVITY = 3.50 TAN DELTA AT OPERATING TEMP. = .0026

ENVIRONMENTAL CONDITIONS

DAILY LOAD FACTOR = 1.00 - DIRECT BURIED CABLES : laying depth = 100.00 m
Laid in FLAT FORMATION SHEATHES = SOLID BONDED

CABLES n°	LAID ARRANGEMENT (mm) depth	interax.distance
1	100000	0
2	100000	60000

THERMAL AND ELECTRICAL CALCULATIONS

ELECTRICAL RESISTANCE OF THE REINFORCEMENT at 20 °C = 0.227 ohm/km
INCREASE IN THERMAL RESISTANCE DUE TO MUTUAL HEATING (°C.m/W) :
calculated respect of cable n° 1 = .2977 - of cable n° 2 = .2977
CONDUCTOR RESISTANCE at 40 °C : in d.c. = 0.0201 ohm/km
CAPACITANCE : .566 microF/km - DIELECTRIC LOSSES : 0.000 W/m
CABLE THERMAL RESISTANCES : T1= .3054 T2=0.0000 T3= .1265 °C.m/W

SCR./SHEATH/REINF.: RESIST. AT 36.0 °C = .1287 REACT. = 0.0000 ohm/km
SCR./SHEATH/REINF.: RESIST. AT 36.0 °C = .1287 REACT. = 0.0000 ohm/km
LOSS FACTOR centre cable = 0.0000 ***
" " outer cable leading phase = 0.0000 ***
" " " " lagging " = 0.0000 ***
ARMOUR : RESIST. AT 36.0 °C = 0.3543 ohm/km
GROUND THERMAL RESISTANCE T4 = 1.940 °C.m/W (daily l.f. being considered)
EQUIVALENT MUTUAL HEATING : .298 °C.m/W (daily l.f. being considered)
(and each cable with its own losses being considered)
LOSSES : CONDUCTOR = 13.97 W/m (for each phase)
EXTERNAL TEMPERATURE OF THE CABLE = 34.3 °C
STAR REACTANCE = 0.000 ohm/km

CURRENT CARRYING CAPACITY = 833 A

-- 12/11/85 --

DESIGN DATA

CABLE TYPE (Pirelli's designation) = AC3HLB1ENJZJZJ/ 300
1x1600 mm2 300.0 kV 0 Hz
ELECTRICAL RESISTANCES AT 20 °C (ohm/km) :
cond.= 0.01860 screen=******** sheath= 0.2589 armour= 0.3333

CONSTRUCTIONAL DATA

DIAMETERS (mm) : oil duct cond. cond.scr. insul. core scr. sheath/scr.
25.00 51.90 53.18 75.00 76.18 82.80

inside reinforcement	= 83.40	
reinforcement	= 84.60	
PE sheath	= 93.50	thermal res.= 3.5 °C.m/W
TAPES armour	= 94.40	
JUTE or PPE bedding	= 96.60	thermal res.= 4.0 °C.m/W
FLAT WIRES armour	= 102.60	
JUTE or PPE bedding	= 105.80	thermal res.= 4.0 °C.m/W
FLAT WIRES armour	= 111.80	
JUTE or PPE bedding	= 118.40	thermal res.= 4.0 °C.m/W

THERMAL AND ELECTRICAL DATA OF THE CABLE MATERIALS

THERMAL RESISTIVITIES (°C.m/W) : insulation = 5.0 ground = 1.5
TEMPER.COEFF. (1/°C) : cond.= .00403 sheath/scr.= .00400 reinf./arm.= .001
MAX. OPERATION TEMPERATURES (°C) : conductor = 40 ambient = 14
RELATIVE PERMITTIVITY = 3.50 TAN DELTA AT OPERATING TEMP. = .0026

ENVIRONMENTAL CONDITIONS

DAILY LOAD FACTOR = 1.00 - DIRECT BURIED CABLES : laying depth = 10.00 m
Laid in FLAT FORMATION SHEATHES = SOLID BONDED

CABLES n°	LAID ARRANGEMENT (mm) depth	interax.distance
1	10000	0
2	10000	60000

THERMAL AND ELECTRICAL CALCULATIONS

ELECTRICAL RESISTANCE OF THE REINFORCEMENT at 20 °C = 0.227 ohm/km
INCREASE IN THERMAL RESISTANCE DUE TO MUTUAL HEATING (°C.m/W) :
calculated respect of cable n° 1 = .0126 - of cable n° 2 = .0126
CONDUCTOR RESISTANCE at 40 °C : in d.c. = 0.0201 ohm/km
CAPACITANCE : .566 microF/km - DIELECTRIC LOSSES : 0.000 W/m
CABLE THERMAL RESISTANCES : T1= .3054 T2=0.0000 T3= .1265 °C.m/W

SCR./SHEATH/REINF.: RESIST. AT 35.3 °C = .1284 REACT. = 0.0000 ohm/km
SCR./SHEATH/REINF.: RESIST. AT 35.3 °C = .1284 REACT. = 0.0000 ohm/km
LOSS FACTOR centre cable = 0.0000 ***
" " outer cable leading phase = 0.0000 ***
" " " " lagging " = 0.0000 ***
ARMOUR : RESIST. AT 35.3 °C = 0.3534 ohm/km
GROUND THERMAL RESISTANCE T4 = 1.390 °C.m/W (daily l.f. being considered)
EQUIVALENT MUTUAL HEATING : .013 °C.m/W (daily l.f. being considered)
(and each cable with its own losses being considered)
LOSSES : CONDUCTOR = 13.93 W/m (for each phase)
EXTERNAL TEMPERATURE OF THE CABLE = 33.5 °C
STAR REACTANCE = 0.000 ohm/km

CURRENT CARRYING CAPACITY = 833 A

-- 12/11/85 --

DESIGN DATA

CABLE TYPE (Pirelli's designation) = AC3HLB1ENJZJZJ/ 300
1x1600 mm2 300.0 kV 0 Hz
ELECTRICAL RESISTANCES AT 20 °C (ohm/km) :
cond.= 0.01860 screen=******* sheath= 0.2589 armour= 0.3333

CONSTRUCTIONAL DATA

DIAMETERS (mm) : oil duct cond. cond.scr. insul. core scr. sheath/scr.
25.00 51.90 53.18 75.00 76.18 82.80

inside reinforcement	= 83.40	
reinforcement	= 84.60	
PE sheath	= 93.50	thermal res.= 3.5 °C.m/W
TAPES armour	= 94.40	
JUTE or PPE bedding	= 96.60	thermal res.= 4.0 °C.m/W
FLAT WIRES armour	= 102.60	
JUTE or PPE bedding	= 105.80	thermal res.= 4.0 °C.m/W
FLAT WIRES armour	= 111.80	
JUTE or PPE bedding	= 118.40	thermal res.= 4.0 °C.m/W

THERMAL AND ELECTRICAL DATA OF THE CABLE MATERIALS

THERMAL RESISTIVITIES (°C.m/W) : insulation = 5.0 ground = 1.5
TEMPER.COEFF. (1/°C) : cond.= .00403 sheath/scr.= .00400 reinf./arm.= .003
MAX. OPERATION TEMPERATURES (°C) : conductor = 47 ambient = 25
RELATIVE PERMITTIVITY = 3.50 TAN DELTA AT OPERATING TEMP. = .0026

ENVIRONMENTAL CONDITIONS

DAILY LOAD FACTOR = 1.00 - DIRECT BURIED CABLES : laying depth = 3.00 m
Laid in FLAT FORMATION SHEATHES = SOLID BONDED

CABLES n°	LAID ARRANGEMENT (mm) depth	interax.distance
1	3000	0
2	3000	60000

THERMAL AND ELECTRICAL CALCULATIONS

ELECTRICAL RESISTANCE OF THE REINFORCEMENT at 20 °C = 0.227 ohm/km
INCREASE IN THERMAL RESISTANCE DUE TO MUTUAL HEATING (°C.m/W)
calculated respect of cable n° 1 = .0012 - of cable n° 2 = .0012
CONDUCTOR RESISTANCE at 47 °C : in d.c. = 0.0206 ohm/km
CAPACITANCE : .566 microF/km - DIELECTRIC LOSSES : 0.000 W/m
CABLE THERMAL RESISTANCES : T1= .3054 T2=0.0000 T3= .1265 °C.m/W

SCR./SHEATH/REINF.: RESIST. AT 42.6 °C = .1319 REACT. = 0.0000 ohm/km
SCR./SHEATH/REINF.: RESIST. AT 42.6 °C = .1319 REACT. = 0.0000 ohm/km
LOSS FACTOR centre cable = 0.0000 ***
" " outer cable leading phase = 0.0000 ***
" " " lagging " = 0.0000 ***
ARMOUR : RESIST. AT 42.6 °C = 0.3630 ohm/km
GROUND THERMAL RESISTANCE T4 = 1.103 °C.m/W (daily l.f. being considered)
EQUIVALENT MUTUAL HEATING : .001 °C.m/W (daily l.f. being considered)
(and each cable with its own losses being considered)
LOSSES : CONDUCTOR = 14.33 W/m (for each phase)
EXTERNAL TEMPERATURE OF THE CABLE = 40.8 °C
STAR REACTANCE = 0.000 ohm/km

CURRENT CARRYING CAPACITY = 833 A

-- 12/11/85 --

DESIGN DATA

CABLE TYPE (Pirelli's designation) = AC3HLB1ENJZJZJ/ 300
1x1600 mm2 300.0 kV 0 Hz
ELECTRICAL RESISTANCES AT 20 °C (ohm/km) :
cond.= 0.01860 screen=******* sheath= 0.2569 armour= 0.3333

CONSTRUCTIONAL DATA

DIAMETERS (mm) : oil duct cond. cond.scr. insul. core scr. sheath/scr.
25.00 51.90 53.18 75.00 76.18 82.80

inside reinforcement	= 83.40	
reinforcement	= 84.60	
PE sheath	= 93.50	thermal res.= 3.5 °C.m/W
TAPES armour	= 94.40	
JUTE or PPE bedding	= 96.60	thermal res.= 4.0 °C.m/W
FLAT WIRES armour	= 102.60	
JUTE or PPE bedding	= 105.80	thermal res.= 4.0 °C.m/W
FLAT WIRES armour	= 111.80	
JUTE or PPE bedding	= 118.40	thermal res.= 4.0 °C.m/W

THERMAL AND ELECTRICAL DATA OF THE CABLE MATERIALS

THERMAL RESISTIVITIES (°C.m/W) : insulation = 5.0 ground = .7
TEMPER.COEFF. (1/°C) : cond.= .00403 sheath/scr.= .00400 reinf./arm.= .003
MAX. OPERATION TEMPERATURES (°C) : conductor = 12 ambient = 3
RELATIVE PERMITTIVITY = 3.50 TAN DELTA AT OPERATING TEMP. = .0026

ENVIRONMENTAL CONDITIONS

DAILY LOAD FACTOR = 1.00 - DIRECT BURIED CABLES : laying depth = .30 m
Laid in FLAT FORMATION SHEATHES = SOLID BONDED

CABLES n°	LAID ARRANGEMENT (mm) depth	interax.distance
1	300	0
2	300	60000

THERMAL AND ELECTRICAL CALCULATIONS

ELECTRICAL RESISTANCE OF THE REINFORCEMENT at 20 °C = 0.227 ohm/km
INCREASE IN THERMAL RESISTANCE DUE TO MUTUAL HEATING (°C.m/W) :
calculated respect of cable n° 1 = .0000 - of cable n° 2 = .0000
CONDUCTOR RESISTANCE at 12 °C : in d.c. = 0.0180 ohm/km
CAPACITANCE : .566 microF/km - DIELECTRIC LOSSES : 0.000 W/m
CABLE THERMAL RESISTANCES : T1= .3054 T2=0.0000 T3= .1265 °C.m/W

SCR./SHEATH/REINF.: RESIST. AT 7.8 °C = .1152 REACT. = 0.0000 ohm/km
SCR./SHEATH/REINF.: RESIST. AT 7.8 °C = .1152 REACT. = 0.0000 ohm/km
LOSS FACTOR centre cable = 0.0000 ***
" " outer cable leading phase = 0.0000 ***
" " " lagging " = 0.0000 ***
ARMOUR : RESIST. AT 7.8 °C = 0.3173 ohm/km
GROUND THERMAL RESISTANCE T4 = .257 °C.m/W (daily l.f. being considered)
EQUIVALENT MUTUAL HEATING : .000 °C.m/W (daily l.f. being considered)
(and each cable with its own losses being considered)
LOSSES : CONDUCTOR = 12.46 W/m (for each phase)
EXTERNAL TEMPERATURE OF THE CABLE = 6.2 °C
STAR REACTANCE = 0.000 ohm/km

CURRENT CARRYING CAPACITY = 833 A

PROGRAM : IECDV --- DATE : 21/01/86

DESIGN DATA

CABLE TYPE (Pirelli's designation) = AC3HLB1ENJZJZJ/ 300
1x1600 mm2 300.0 kV 0 Hz
ELECTRICAL RESISTANCES AT 20 °C (ohm/km) :
cond.= 0.01860 screen=******* sheath= 0.2589 armour= 0.3333

CONSTRUCTIONAL DATA

DIAMETERS (mm) : oil duct cond. cond.scr. insul. core scr. sheath/scr.
25.00 51.90 53.18 75.00 76.18 82.80

inside reinforcement	= 83.40		
reinforcement	= 84.60		
PE sheath	= 93.50	thermal res.= 3.5	°C.m/W
TAPES armour	= 94.40		
JUTE or PPE bedding	= 96.60	thermal res.= 4.0	°C.m/W
FLAT WIRES armour	= 102.60		
JUTE or PPE bedding	= 105.80	thermal res.= 4.0	°C.m/W
FLAT WIRES armour	= 111.80		
JUTE or PPE bedding	= 118.40	thermal res.= 4.0	°C.m/W

THERMAL AND ELECTRICAL DATA OF THE CABLE MATERIALS

THERMAL RESISTIVITIES (°C.m/W) : insulation = 5.0 ground = 1.5

TEMPER.COEFF. (1/°C) : cond.= .00403 sheath/scr.= .00400 reinf./arm.= .0039
MAX. OPERATION TEMPERATURES (°C) : conductor = 108 ambient = 3
RELATIVE PERMITTIVITY = 3.50 TAN DELTA AT OPERATING TEMP. = .0026

ENVIRONMENTAL CONDITIONS

DAILY LOAD FACTOR = 1.00 - DIRECT BURIED CABLES : laying depth = 100.00 m
Laid in FLAT FORMATION SHEATHES = SOLID BONDED

CABLES n°	LAID ARRANGEMENT (mm) depth	interax.distance
1	100000	0
2	100000	60000

THERMAL AND ELECTRICAL CALCULATIONS

ELECTRICAL RESISTANCE OF THE REINFORCEMENT at 20 °C = 0.227 ohm/km
INCREASE IN THERMAL RESISTANCE DUE TO MUTUAL HEATING (°C.m/W) :
calculated respect of cable n° 1 = .2977 - of cable n° 2 = .2977
CONDUCTOR RESISTANCE at 108 °C : in d.c. = 0.0252 ohm/km
CAPACITANCE : .566 microF/km - DIELECTRIC LOSSES : 0.000 W/m
CABLE THERMAL RESISTANCES : T1= .3054 T2=0.0000 T3= .1265 °C.m/W

SCR./SHEATH/REINF.: RESIST. AT 96.2 °C = .1576 REACT. = 0.0000 ohm/km
SCR./SHEATH/REINF.: RESIST. AT 96.2 °C = .1576 REACT. = 0.0000 ohm/km
LOSS FACTOR centre cable = 0.0000 ***
" " outer cable leading phase = 0.0000 ***
" " " " lagging " = 0.0000 ***
ARMOUR : RESIST. AT 96.2 °C = 0.4331 ohm/km
GROUND THERMAL RESISTANCE T4 = 1.940 °C.m/W (daily l.f. being considered)
EQUIVALENT MUTUAL HEATING : .298 °C.m/W (daily l.f. being considered)
(and each cable with its own losses being considered)
LOSSES : CONDUCTOR = 39.41 W/m (for each phase)
EXTERNAL TEMPERATURE OF THE CABLE = 91.2 °C
STAR REACTANCE = 0.000 ohm/km

CURRENT CARRYING CAPACITY = 1250 A

DESIGN DATA

CABLE TYPE (Pirelli's designation) = AC3HLB1ENJZJZJ/ 300
1x1600 mm2 300.0 kV 0 Hz
ELECTRICAL RESISTANCES AT 20 °C (ohm/km) :
cond.= 0.01860 screen=******* sheath= 0.2589 armour= 0.3333

CONSTRUCTIONAL DATA

DIAMETERS (mm) : oil duct cond. cond.scr. insul. core scr. sheath/scr.
25.00 51.90 53.18 75.00 76.18 82.80

inside reinforcement	= 83.40	
reinforcement	= 84.60	
PE sheath	= 93.50	thermal res.= 3.5 °C.m/W
TAPES armour	= 94.40	
JUTE or PPE bedding	= 96.60	thermal res.= 4.0 °C.m/W
FLAT WIRES armour	= 102.60	
JUTE or PPE bedding	= 105.80	thermal res.= 4.0 °C.m/W
FLAT WIRES armour	= 111.80	
JUTE or PPE bedding	= 118.40	thermal res.= 4.0 °C.m/W

THERMAL AND ELECTRICAL DATA OF THE CABLE MATERIALS

THERMAL RESISTIVITIES (°C.m/W) : insulation = 5.0 ground = 1.5
TEMPER.COEFF. (1/°C) : cond.= .00403 sheath/scr.= .00400 reinf./arm.= .0039
MAX. OPERATION TEMPERATURES (°C) : conductor = 80 ambient = 14
RELATIVE PERMITTIVITY = 3.50 TAN DELTA AT OPERATING TEMP. = .0026

ENVIRONMENTAL CONDITIONS

DAILY LOAD FACTOR = 1.00 - DIRECT BURIED CABLES : laying depth = 10.00 m
Laid in FLAT FORMATION SHEATHES = SOLID BONDED

CABLES n°	LAID ARRANGEMENT (mm) depth	interax.distance
1	10000	0
2	10000	60000

THERMAL AND ELECTRICAL CALCULATIONS

ELECTRICAL RESISTANCE OF THE REINFORCEMENT at 20 °C = 0.227 ohm/km
INCREASE IN THERMAL RESISTANCE DUE TO MUTUAL HEATING (°C.m/W) :
calculated respect of cable n° 1 = .0126 - of cable n° 2 = .0126
CONDUCTOR RESISTANCE at 80 °C : in d.c. = 0.0231 ohm/km
CAPACITANCE : .566 microF/km - DIELECTRIC LOSSES : 0.000 W/m
CABLE THERMAL RESISTANCES : T1= .3054 T2=0.0000 T3= .1265 °C.m/W

SCR./SHEATH/REINF.: RESIST. AT 69.3 °C = .1447 REACT. = 0.0000 ohm/km
SCR./SHEATH/REINF.: RESIST. AT 69.3 °C = .1447 REACT. = 0.0000 ohm/km
LOSS FACTOR centre cable = 0.0000 ***
" " outer cable leading phase = 0.0000 ***
" " " lagging " = 0.0000 ***
ARMOUR : RESIST. AT 69.3 °C = 0.3979 ohm/km
GROUND THERMAL RESISTANCE T4 = 1.390 °C.m/W (daily l.f. being considered)
EQUIVALENT MUTUAL HEATING : .013 °C.m/W (daily l.f. being considered)
(and each cable with its own losses being considered)
LOSSES : CONDUCTOR = 36.14 W/m (for each phase)
EXTERNAL TEMPERATURE OF THE CABLE = 64.7 °C
STAR REACTANCE = 0.000 ohm/km

CURRENT CARRYING CAPACITY = 1250 A

DESIGN DATA

CABLE TYPE (Pirelli's designation) = AC3HLB1ENJZJZJ/ 300
1x1600 mm2 300.0 kV 0 Hz
ELECTRICAL RESISTANCES AT 20 °C (ohm/km) :
cond.= 0.01860 screen=******* sheath= 0.2589 armour= 0.3333

CONSTRUCTIONAL DATA

DIAMETERS (mm) : oil duct cond. cond.scr. insul. core scr. sheath/scr.
25.00 51.90 53.18 75.00 76.18 82.80

inside reinforcement	= 83.40	
reinforcement	= 84.60	
PE sheath	= 93.50	thermal res.= 3.5 °C.m/W
TAPES armour	= 94.40	
JUTE or PPE bedding	= 96.60	thermal res.= 4.0 °C.m/W
FLAT WIRES armour	= 102.60	
JUTE or PPE bedding	= 105.80	thermal res.= 4.0 °C.m/W
FLAT WIRES armour	= 111.80	
JUTE or PPE bedding	= 118.40	thermal res.= 4.0 °C.m/W

THERMAL AND ELECTRICAL DATA OF THE CABLE MATERIALS

THERMAL RESISTIVITIES (°C.m/W) : insulation = 5.0 ground = 1.5
TEMPER.COEFF. (1/°C) : cond.= .00403 sheath/scr.= .00400 reinf./arm.= .0039
MAX. OPERATION TEMPERATURES (°C) : conductor = 81 ambient = 25
RELATIVE PERMITTIVITY = 3.50 TAN DELTA AT OPERATING TEMP. = .0026

ENVIRONMENTAL CONDITIONS

DAILY LOAD FACTOR = 1.00 - DIRECT BURIED CABLES : laying depth = 3.00 m
Laid in FLAT FORMATION SHEATHES = SOLID BONDED

CABLES n°	LAID ARRANGEMENT (mm) depth	interax.distance
1	3000	0
2	3000	60000

THERMAL AND ELECTRICAL CALCULATIONS

ELECTRICAL RESISTANCE OF THE REINFORCEMENT at 20 °C = 0.227 ohm/km
INCREASE IN THERMAL RESISTANCE DUE TO MUTUAL HEATING (°C.m/W) :
calculated respect of cable n° 1 = .0012 - of cable n° 2 = .0012
CONDUCTOR RESISTANCE at 81 °C : in d.c. = 0.0231 ohm/km
CAPACITANCE : .566 microF/km - DIELECTRIC LOSSES : 0.000 W/m
CABLE THERMAL RESISTANCES : T1= .3054 T2=0.0000 T3= .1265 °C.m/W

SCR./SHEATH/REINF.: RESIST. AT 69.5 °C = .1448 REACT. = 0.0000 ohm/km
SCR./SHEATH/REINF.: RESIST. AT 69.5 °C = .1448 REACT. = 0.0000 ohm/km
LOSS FACTOR centre cable = 0.0000 ***
" " outer cable leading phase = 0.0000 ***
" " " lagging " = 0.0000 ***
ARMOUR : RESIST. AT 69.5 °C = 0.3981 ohm/km
GROUND THERMAL RESISTANCE T4 = 1.103 °C.m/W (daily l.f. being considered)
EQUIVALENT MUTUAL HEATING : .001 °C.m/W (daily l.f. being considered)
(and each cable with its own losses being considered)
LOSSES : CONDUCTOR = 36.14 W/m (for each phase)
EXTERNAL TEMPERATURE OF THE CABLE = 64.9 °C
STAR REACTANCE = 0.000 ohm/km

CURRENT CARRYING CAPACITY = 1250 A

DESIGN DATA

CABLE TYPE (Pirelli's designation) = AC3HLB1ENJZJZJ/ 300
1x1600 mm2 300.0 kV 0 Hz
ELECTRICAL RESISTANCES AT 20 °C (ohm/km) :
cond.= 0.01860 screen=******* sheath= 0.2589 armour= 0.3333

CONSTRUCTIONAL DATA

DIAMETERS (mm) : oil duct cond. cond.scr. insul. core scr. sheath/scr.
25.00 51.90 53.18 75.00 76.18 82.80

inside reinforcement	= 83.40		
reinforcement	= 84.60		
PE sheath	= 93.50	thermal res.= 3.5	°C.m/W
TAPES armour	= 94.40		
JUTE or PPE bedding	= 96.60	thermal res.= 4.0	°C.m/W
FLAT WIRES armour	= 102.60		
JUTE or PPE bedding	= 105.80	thermal res.= 4.0	°C.m/W
FLAT WIRES armour	= 111.80		
JUTE or PPE bedding	= 118.40	thermal res.= 4.0	°C.m/W

THERMAL AND ELECTRICAL DATA OF THE CABLE MATERIALS

THERMAL RESISTIVITIES (°C.m/W) : insulation = 5.0 ground = .7
TEMPER.COEFF. (1/°C) : cond.= .00403 sheath/scr.= .00400 reinf./arm.= .0039
MAX. OPERATION TEMPERATURES (°C) : conductor = 23 ambient = 3
RELATIVE PERMITTIVITY = 3.50 TAN DELTA AT OPERATING TEMP. = .0026

ENVIRONMENTAL CONDITIONS

DAILY LOAD FACTOR = 1.00 - DIRECT BURIED CABLES : laying depth = 0.30 m
Laid in FLAT FORMATION SHEATHES = SOLID BONDED

CABLES n°	LAID ARRANGEMENT (mm) depth	interax.distance
1	300	0
2	300	60000

THERMAL AND ELECTRICAL CALCULATIONS

ELECTRICAL RESISTANCE OF THE REINFORCEMENT at 20 °C = 0.227 ohm/km
INCREASE IN THERMAL RESISTANCE DUE TO MUTUAL HEATING (°C.m/W) :
calculated respect of cable n° 1 = .0000 - of cable n° 2 = .0000
CONDUCTOR RESISTANCE at 23 °C : in d.c. = 0.0188 ohm/km
CAPACITANCE .566 microF/km - DIELECTRIC LOSSES 0.000 W/m
CABLE THERMAL RESISTANCES : T1= .3054 T2=0.0000 T3= .1265 °C.m/W

SCR./SHEATH/REINF.: RESIST. AT 14.3 °C = .1183 REACT. = 0.0000 ohm/km
SCR./SHEATH/REINF.: RESIST. AT 14.3 °C = .1183 REACT. = 0.0000 ohm/km
LOSS FACTOR centre cable = 0.0000 ***
" " outer cable leading phase = 0.0000 ***
" " " " lagging " = 0.0000 ***
ARMOUR : RESIST. AT 14.3 °C = 0.3259 ohm/km
GROUND THERMAL RESISTANCE T4 = .257 °C.m/W (daily l.f. being considered)
EQUIVALENT MUTUAL HEATING : .000 °C.m/W (daily l.f. being considered)
(and each cable with its own losses being considered)
LOSSES : CONDUCTOR = 29.47 W/m (for each phase)
EXTERNAL TEMPERATURE OF THE CABLE = 10.6 °C
STAR REACTANCE = 0.000 ohm/km

CURRENT CARRYING CAPACITY = 1250 A

PROGRAM : TRANSAEH --- DATE : 22/01/86

HERMAL TRANSIENT

R.SECT.	CURRENT	VOLTAGE
1600	833	300

ARAMETERS

G1= 4.7200000000E-04 G2= 0
G3= 6.9400000000E-04 G4= 5.5600000000E-04
G5= 4.0300000000E-04 G6= 9.4400000000E-04
G7= 6.6700000000E-04

CU	ASCH	RHOPB	RHOBL
4.0300000000E-03	4.0000000000E-03	214	1000000

H1	RH2	RH4	ALFA	TAMB
500	695	150	1218.47647853795	3

= 1.8600000000E-02 EPS= 0 TAND= 0 F= 0

APACITANCE= 0 MICROFARAD/km

XIAL DISTANCE = 60000. mm EMBEDDING DEPTH = 100000 mm

Temperature variations (°C)

Heat.time(hours)	Conductor	Dielectric	Sheath
0.25	4.3	3.7	3.3
0.50	5.3	4.3	3.7
0.75	6.2	4.9	4.0
1.00	6.9	5.4	4.3
1.50	7.9	6.2	4.8
2.00	8.7	6.7	5.2
3.00	9.5	7.5	5.8
4.00	10.0	7.9	6.2
12.00	11.6	9.5	7.8
24.00	12.6	10.5	8.8
**********	40.0	37.6	35.6

otal cable Joule losses/conductor losses = 1.000

PROGRAM : TRANSAEH --- DATE : 22/01/86

THERMAL TRANSIENT

CR.SECT.	CURRENT	VOLTAGE
1600	833	300

PARAMETERS

G1= 4.7200000000E-04 G2= 0
G3= 6.9400000000E-04 G4= 5.5600000000E-04
G5= 4.0300000000E-04 G6= 9.4400000000E-04
G7= 6.6700000000E-04

ACU	ASCH	RHOPB	RHOBL	
4.0300000000E-03	4.0000000000E-03	214	1000000	
RH1	**RH2**	**RH4**	**ALFA**	**TAMB**
500	795	150	1218.47647853795	14

R= 1.8600000000E-02 EPS= 0 TAND= 0 F= 0

CAPACITANCE= 0 MICROFARAD/km

AXIAL DISTANCE = 60000. mm EMBEDDING DEPTH = 10000 mm

Temperature variations (°C)

Heat.time(hours)	Conductor	Dielectric	Sheath
0.25	15.4	14.7	14.4
0.50	16.4	15.4	14.7
0.75	17.3	16.0	15.0
1.00	18.1	16.6	15.3
1.50	19.2	17.4	15.9
2.00	20.0	18.0	16.3
3.00	21.0	18.8	17.0
4.00	21.6	19.3	17.4
12.00	23.2	21.0	19.0
24.00	24.3	22.1	20.1
**********	39.5	37.1	35.1

Total cable Joule losses/conductor losses = 1.000

PROGRAM : TRANSAEH --- DATE : 22/01/86

THERMAL TRANSIENT

CR.SECT.	CURRENT	VOLTAGE
1600	833	300

PARAMETERS

G1= 4.7200000000E-04 G2= 0
G3= 6.9400000000E-04 G4= 5.5600000000E-04
G5= 4.0300000000E-04 G6= 9.4400000000E-04
G7= 6.6700000000E-04

ACU	ASCH	RHOPB	RHOBL	
4.0300000000E-03	4.0000000000E-03	214	1000000	

RH1	RH2	RH4	ALFA	TAMB
500	795	70	2241.87670967476	3

R= 1.8600000000E-02 EPS= 0 TAND= 0 F= 0

CAPACITANCE= 0 MICROFARAD/km

AXIAL DISTANCE = 60000 mm EMBEDDING DEPTH = 300 mm

Temperature variations (°C)

Heat.time(hours)	Conductor	Dielectric	Sheath
0.25	4.3	3.7	3.3
0.50	5.4	4.4	3.7
0.75	6.2	4.9	4.0
1.00	6.9	5.4	4.2
1.50	7.9	6.1	4.7
2.00	8.5	6.6	5.0
3.00	9.2	7.1	5.4
4.00	9.5	7.4	5.6
12.00	10.3	8.2	6.4
24.00	10.8	8.6	6.8
**********	11.6	9.5	7.6

Total cable Joule losses/conductor losses = 1.000

PROGRAM : TRANSAEH --- DATE : 22/01/86

THERMAL TRANSIENT

CR.SECT.	CURRENT	VOLTAGE
1600	1250	300

PARAMETERS

G1= 4.7200000000E-04 G2= 0
G3= 6.9400000000E-04 G4= 5.5600000000E-04
G5= 4.0300000000E-04 G6= 9.4400000000E-04
G7= 6.6700000000E-04

ACU	ASCH	RHOPB	RHOBL
4.0300000000E-03	4.0000000000E-03	214	1000000

RH1	RH2	RH4	ALFA	TAMB
500	695	150	1218.47647853795	40

R= 1.8600000000E-02 EPS= 0 TAND= 0 F= 0

CAPACITANCE= 0 MICROFARAD/km

AXIAL DISTANCE = 60000. mm EMBEDDING DEPTH = 100000 mm

Temperature variations (°C)

Heat.time(hours)	Conductor	Dielectric	Sheath
0.25	43.4	41.8	40.9
0.50	46.1	43.5	41.7
0.75	48.4	45.0	42.6
1.00	50.3	46.4	43.4
1.50	53.2	48.5	44.8
2.00	55.2	50.1	46.0
3.00	57.7	52.1	47.6
4.00	59.1	53.3	48.8
12.00	63.6	57.7	53.0
24.00	66.6	60.6	55.9

Total cable Joule losses/conductor losses = 1.000

PROGRAM : TRANSAEH --- DATE : 22/01/86

THERMAL TRANSIENT

CR.SECT.	CURRENT	VOLTAGE
1600	1250	300

PARAMETERS

G1= 4.7200000000E-04 G2= 0
G3= 6.9400000000E-04 G4= 5.5600000000E-04
G5= 4.0300000000E-04 G6= 9.4400000000E-04
G7= 6.6700000000E-04

ACU	ASCH	RHOPB	RHOBL
4.0300000000E-03	4.0000000000E-03	214	1000000

RH1	RH2	RH4	ALFA	TAMB
500	795	150	1218.47647853795	40

R= 1.8600000000E-02 EPS= 0 TAND= 0 F= 0

CAPACITANCE= 0 MICROFARAD/km

AXIAL DISTANCE = 60000. mm EMBEDDING DEPTH = 10000 mm

Temperature variations (°C)

Heat.time(hours)	Conductor	Dielectric	Sheath
0.25	43.4	41.8	40.9
0.50	46.2	43.6	41.7
0.75	48.5	45.1	42.6
1.00	50.4	46.5	43.4
1.50	53.4	48.7	44.8
2.00	55.5	50.4	46.0
3.00	58.1	52.5	47.7
4.00	59.6	53.9	48.9
12.00	64.2	58.3	53.2
24.00	67.2	61.2	56.1

Total cable Joule losses/conductor losses = 1.000

TRANSIENT TEMPERATURE AND PRESSURE VARIATIONS IN OIL FILLED CABLE IN CASE OF SEVERANCE

HIGH DENSITY OIL

THERMAL TRANSIENT

CR.SECT.	CURRENT	VOLTAGE
1600	833	300

PARAMETERS

G1= 4.7200000000E-04 G2= 0
G3= 6.9400000000E-04 G4= 5.5600000000E-04
G5= 4.0300000000E-04 G6= 9.4400000000E-04
G7= 6.6700000000E-04

ACU	ASCH	RHOPB	RHOBL
4.0300000000E-03	4.0000000000E-03	214	1000000

RH1	RH2	RH4	ALFA	TAMB
500	795	70	2241.87670967476	3

R= 1.8600000000E-02 EPS= 0 TAND= 0 F= 0

CAPACITANCE= 0 MICROFARAD/KM

AXIAL DISTANCE = 60000 MM EMBEDDING DEPTH = 300 MM

TEMPERATURE VARIATIONS (°C)

HEAT.TIME(HOURS)	CONDUCTOR	DIELECTRIC	SHEATH
0.50	5.4	4.4	3.7
1.00	6.9	5.4	4.2
1.50	7.9	6.1	4.7
2.00	8.5	6.6	5.0
2.50	8.9	6.9	5.2
3.00	9.2	7.1	5.4
3.50	9.4	7.3	5.5
4.00	9.5	7.4	5.6
4.50	9.6	7.5	5.7
5.00	9.7	7.6	5.8
**********	11.6	9.5	7.6

Total cable Joule losses/conductor losses = 1.000

PRESSURE TRANSIENT VARIATIONS

Reinforc.thick. = 0.600 (mm) Cable half length = 76.000 (km)
Oil duct diam. = 25.00 (mm)
Modulus of elasticity of the reinforcement = 1640000000 (g/sq.cm)

****
Dielectric oil volume = 1148 litri/km (Actual value)

Total cable oil volume = 1651 litri/km (Actual value)

****

Starting phase of the heating

HEATING TIME (minutes)	PRESS. VARIATION (kg/sq.cm)	OIL FLOW (dm3/hour*km)
30	6.66	0.45
60	10.61	0.78
90	12.51	0.96
120	13.10	1.05
150	12.94	1.06
180	12.36	1.02
210	11.58	0.97
240	10.72	0.90
270	9.84	0.83
300	8.99	0.77
330	8.19	0.70
360	7.46	0.64
390	6.78	0.58
420	6.16	0.53
450	5.60	0.48
480	5.09	0.44
510	4.63	0.40
540	4.22	0.37
570	3.84	0.33
600	3.50	0.31
630	3.20	0.28
660	2.93	0.26
690	2.68	0.23
720	2.46	0.22
750	2.26	0.20
780	2.08	0.18
810	1.91	0.17
840	1.76	0.16
870	1.63	0.14
900	1.51	0.13
930	1.40	0.12

Worst cooling pressure transient variations

Starting at 1020 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	1.14	7.57	0.10
30	-4.51	5.23	-0.36
60	-9.48	3.72	-0.69
90	-12.80	2.76	-0.88
120	-14.52	2.14	-0.97
150	-15.06	1.74	-0.98

CIRCEE O TRANSE ?
?
circee
Oil density = .987 kg/dm3
Experimental coefficient due to restrictor device

```
inserted in the oil duct =  .471

Feeding pressure (normal pump relief pressure) (kg/cm2)?
30
Starting pressure = 30.0  kg/cm2

Cable length up to severance point = 152.0  km
Sea water pressure at severance point =  1.00   kg/cm2
Operating pump
distance between two restrictor devices =  2000  m
Inside diameter of restrictor device =  7.0  mm
Oil pressure gradient at the severance point =  0.1404(kg/cm2/km)
Worst oil pressure distribution from the severance accident= 450.0 (min.)
Oil flow (dm3/hour) at the severance point based on
pressure gradient =    26.201

          TRANSIENT PRESSURE DROP

Severance point  Pressure along the      Oil flow
distance (km)    cable (kg/cm2)         (dm3/hour)
      0.00             1.00                27.0
     13.82             3.00                28.6
     27.64             5.12                30.1
     41.45             7.35                31.6
     55.27             9.69                33.1
     69.09            12.14                34.7
     82.91            14.71                36.7
     96.73            17.43                38.9
    110.55            20.31                41.3
    124.36            23.37                43.7
    138.18            26.60                45.8
    152.00            30.00
?
stop
```

TRANSIENT TEMPERATURE AND PRESSURE VARIATIONS
IN OIL FILLED CABLE IN CASE OF SEVERANCE

HIGH DENSITY OIL

THERMAL TRANSIENT

CR.SECT.	CURRENT	VOLTAGE
1600	833	300

PARAMETERS

G1= 4.7200000000E-04 G2= 0
G3= 6.9400000000E-04 G4= 5.5600000000E-04
G5= 4.0300000000E-04 G6= 9.4400000000E-04
G7= 6.6700000000E-04

ACU	ASCH	RHOPB	RHOBL
4.0300000000E-03	4.0000000000E-03	214	1000000

RH1	RH2	RH4	ALFA	TAMB
500	795	70	2241.87670967476	3

R= 1.8600000000E-02 EPS= 0 TAND= 0 F= 0

CAPACITANCE= 0 MICROFARAD/km

AXIAL DISTANCE = 60000 mm EMBEDDING DEPTH = 300 mm

Temperature variations (°C)

Heat.time(hours)	Conductor	Dielectric	Sheath
0.50	5.4	4.4	3.7
1.00	6.9	5.4	4.2
1.50	7.9	6.1	4.7
2.00	8.5	6.6	5.0
2.50	8.9	6.9	5.2
3.00	9.2	7.1	5.4
3.50	9.4	7.3	5.5
4.00	9.5	7.4	5.6
4.50	9.6	7.5	5.7
5.00	9.7	7.6	5.8
**********	11.6	9.5	7.6

Total cable Joule losses/conductor losses = 1.000

PRESSURE TRANSIENT VARIATIONS

Reinforc.thick. = 0.600 (mm) Cable half length = 50.000 (km)
Oil duct diam. = 25.00 (mm)
Modulus of elasticity of the reinforcement = 1640000000 (g/sq.cm)

****
Dielectric oil volume = 1148 litri/km (Actual value)

Total cable oil volume = 1651 litri/km (Actual value)

****

Starting phase of the heating

HEATING TIME (minutes)	PRESS. VARIATION (kg/sq.cm)	OIL FLOW (dm3/hour*km)
30	5.93	0.92
60	8.78	1.49
90	9.54	1.70
120	9.14	1.69
150	8.22	1.55
180	7.12	1.36
210	6.03	1.17
240	5.04	0.98
270	4.19	0.82
300	3.47	0.68
330	2.87	0.57
360	2.39	0.47
390	2.00	0.40
420	1.68	0.34
450	1.43	0.29
480	1.22	0.24
510	1.06	0.21

Worst cooling pressure transient variations

Starting at 1020 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	0.28	7.57	0.06
30	-4.79	5.23	-0.87
60	-8.55	3.72	-1.43
90	-10.37	2.76	-1.65
120	-10.64	2.14	-1.64
150	-9.98	1.74	-1.50

CIRCEE O TRANSE ?
?
circee
Oil density = .987 kg/dm3
Experimental coefficient due to restrictor device
inserted in the oil duct = .471

Feeding pressure (normal pump relief pressure) (kg/cm2)?
30
Starting pressure = 30.0 kg/cm2

Cable length up to severance point = 100.0 km
Sea water pressure at severance point = 1.00 kg/cm2
Operating pump
distance between two restrictor devices = 2000 m
Inside diameter of restrictor device = 7.0 mm
Oil pressure gradient at the severance point = 0.2085(kg/cm2/km)
Worst oil pressure distribution from the severance accident= 240.0 (min.)
Oil flow (dm3/hour) at the severance point based on

```
pressure gradient =     39.940

          TRANSIENT PRESSURE DROP

Severance point   Pressure along the      Oil flow
distance (km)     cable (kg/cm2)          (dm3/hour)
      0.00              1.00                41.5
      9.09              2.97                44.6
     18.18              5.09                47.4
     27.27              7.34                49.9
     36.36              9.70                52.2
     45.45             12.18                54.6
     54.55             14.78                57.3
     63.64             17.50                60.4
     72.73             20.36                63.9
     81.82             23.40                67.6
     90.91             26.61                71.3
    100.00             30.00
?
stop
```

TRANSIENT TEMPERATURE AND PRESSURE VARIATIONS IN OIL FILLED CABLE IN CASE OF SEVERANCE

HIGH DENSITY OIL

THERMAL TRANSIENT

CR.SECT.	CURRENT	VOLTAGE
1600	1250	300

PARAMETERS

G1= 4.7200000000E-04 G2= 0
G3= 6.9400000000E-04 G4= 5.5600000000E-04
G5= 4.0300000000E-04 G6= 9.4400000000E-04
G7= 6.6700000000E-04

ACU	ASCH	RHOPB	RHOBL
4.0300000000E-03	4.0000000000E-03	214	1000000

RH1	RH2	RH4	ALFA	TAMB
500	795	70	2241.87670967476	11.6

R= 1.8600000000E-02 EPS= 0 TAND= 0 F= 0

CAPACITANCE= 0 MICROFARAD/KM

AXIAL DISTANCE = 60000 MM EMBEDDING DEPTH = 300 MM

TEMPERATURE VARIATIONS (°C)

HEAT.TIME(HOURS)	CONDUCTOR	DIELECTRIC	SHEATH
0.25	14.7	13.3	12.4
0.50	17.2	14.8	13.2
0.75	19.2	16.2	13.9
1.00	20.9	17.4	14.6
1.25	22.2	18.3	15.1
1.50	23.3	19.1	15.6
1.75	24.1	19.7	16.0
2.00	24.8	20.2	16.4
2.25	25.4	20.7	16.7
2.50	25.9	21.0	16.9
2.75	26.2	21.3	17.1
3.00	26.6	21.6	17.3
3.25	26.8	21.8	17.5
**********	32.7	27.4	22.9

Total cable Joule losses/conductor losses = 1.000

PRESSURE TRANSIENT VARIATIONS

Reinforc.thick. = 0.600 (mm) Cable half length = 50.000 (km)
Oil duct diam. = 25.00 (mm)

Modulus of elasticity of the reinforcement = 1640000000 (g/sq.cm)

****
Dielectric oil volume = 1148 litri/km (Actual value)
Total cable oil volume = 1651 litri/km (Actual value)
****

Starting phase of the heating

HEATING TIME (minutes)	PRESS. VARIATION (kg/sq.cm)	OIL FLOW (dm3/hour*km)
15	7.77	1.96
30	13.05	3.68
45	16.07	4.92
60	17.31	5.65
90	16.47	5.87
105	15.18	5.57
120	13.67	5.13
135	12.09	4.63
150	10.57	4.11
165	9.15	3.60
180	7.87	3.13
195	6.74	2.70
210	5.77	2.33
225	4.93	2.00
240	4.22	1.72
255	3.62	1.49
270	3.12	1.28
285	2.70	1.12
300	2.33	0.97
315	2.05	0.85
330	1.81	0.76

Worst cooling pressure transient variations

Starting at 15 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	7.78	3.09	1.96
15	7.01	2.48	1.72
30	5.20	2.03	1.25
45	3.10	1.65	0.73
60	1.20	1.34	0.28
75	-0.28	1.08	-0.06
90	-1.31	0.87	-0.30
105	-1.95	0.70	-0.44
120	-2.26	0.57	-0.50
135	-2.35	0.46	-0.52
150	-2.29	0.38	-0.51
165	-2.14	0.32	-0.47
180	-1.93	0.27	-0.42
195	-1.71	0.22	-0.37
210	-1.49	0.19	-0.33
225	-1.28	0.17	-0.28

240	-1.09	0.15	-0.24
255	-0.92	0.13	-0.20
270	-0.77	0.12	-0.17
285	-0.68	0.10	-0.15
300	-0.53	0.10	-0.12
315	-0.44	0.09	-0.10
330	-0.37	0.08	-0.08
345	-0.31	0.08	-0.07
360	-0.26	0.07	-0.06
375	-0.22	0.07	-0.05
390	-0.18	0.07	-0.04
405	-0.16	0.06	-0.03
420	-0.13	0.06	-0.03
435	-0.11	0.06	-0.02
450	-0.10	0.06	-0.02
465	-0.09	0.05	-0.02
480	-0.08	0.05	-0.02
495	-0.07	0.05	-0.01
510	-0.06	0.05	-0.01
525	-0.05	0.05	-0.01
540	-0.05	0.05	-0.01
555	-0.04	0.05	-0.01
570	-0.04	0.04	-0.01

Starting at 30 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	13.06	5.57	3.68
15	11.02	4.51	2.96
30	7.62	3.68	1.98
45	4.01	2.99	1.01
60	0.87	2.41	0.21
75	-1.52	1.94	-0.36
90	-3.13	1.57	-0.73
105	-4.08	1.27	-0.94
120	-4.50	1.03	-1.03
135	-4.55	0.85	-1.03
150	-4.35	0.70	-0.98
165	-4.01	0.58	-0.90
180	-3.60	0.49	-0.80
195	-3.17	0.42	-0.70
210	-2.74	0.36	-0.61
225	-2.35	0.31	-0.52
240	-2.00	0.28	-0.44
255	-1.68	0.25	-0.37
270	-1.44	0.22	-0.32
285	-1.21	0.20	-0.26
300	-0.97	0.19	-0.21
315	-0.81	0.17	-0.18
330	-0.68	0.16	-0.15
345	-0.57	0.15	-0.12
360	-0.48	0.14	-0.10
375	-0.40	0.14	-0.09
390	-0.34	0.13	-0.07
405	-0.29	0.13	-0.06
420	-0.25	0.12	-0.05
435	-0.21	0.12	-0.05

450	-0.18	0.11	-0.04
465	-0.16	0.11	-0.04
480	-0.14	0.10	-0.03
495	-0.13	0.10	-0.03
510	-0.11	0.10	-0.02
525	-0.10	0.10	-0.02
540	-0.09	0.09	-0.02
555	-0.08	0.09	-0.02

Starting at 45 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	16.07	7.60	4.93
15	12.78	6.16	3.69
30	8.19	5.02	2.25
45	3.57	4.06	0.94
60	-0.33	3.28	-0.08
75	-3.24	2.64	-0.80
90	-5.14	2.14	-1.24
105	-6.19	1.73	-1.46
120	-6.59	1.41	-1.53
135	-6.52	1.16	-1.50
150	-6.16	0.96	-1.40
165	-5.63	0.81	-1.27
180	-5.02	0.68	-1.13
195	-4.39	0.58	-0.98
210	-3.79	0.51	-0.84
225	-3.24	0.44	-0.72
240	-2.75	0.39	-0.61
255	-2.35	0.35	-0.52
270	-1.96	0.31	-0.43
285	-1.64	0.29	-0.36
300	-1.33	0.27	-0.29
315	-1.11	0.25	-0.24
330	-0.93	0.24	-0.20
345	-0.78	0.22	-0.17
360	-0.66	0.21	-0.14
375	-0.56	0.20	-0.12
390	-0.47	0.19	-0.10
405	-0.40	0.18	-0.09
420	-0.34	0.18	-0.08
435	-0.30	0.17	-0.06
450	-0.26	0.16	-0.06
465	-0.23	0.16	-0.05
480	-0.20	0.15	-0.04
495	-0.18	0.15	-0.04
510	-0.16	0.15	-0.03
525	-0.14	0.14	-0.03
540	-0.13	0.14	-0.03

Starting at 60 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	17.31	9.25	5.65

15	13.01	7.50	3.97
30	7.59	6.10	2.19
45	2.35	4.93	0.64
60	-1.98	3.98	-0.52
75	-5.14	3.21	-1.30
90	-7.15	2.60	-1.76
105	-8.18	2.11	-1.97
120	-8.48	1.73	-2.00
135	-8.26	1.43	-1.92
150	-7.72	1.19	-1.78
165	-7.00	1.00	-1.60
180	-6.21	0.85	-1.41
195	-5.42	0.73	-1.22
210	-4.67	0.64	-1.04
225	-3.98	0.56	-0.89
240	-3.40	0.49	-0.76
255	-2.86	0.44	-0.63
270	-2.39	0.40	-0.53
285	-2.00	0.37	-0.44
300	-1.63	0.35	-0.36
315	-1.37	0.33	-0.30
330	-1.15	0.31	-0.25
345	-0.96	0.29	-0.21
360	-0.81	0.28	-0.18
375	-0.69	0.26	-0.15
390	-0.58	0.25	-0.13
405	-0.50	0.24	-0.11
420	-0.43	0.23	-0.09
435	-0.37	0.22	-0.08
450	-0.32	0.22	-0.07
465	-0.28	0.21	-0.06
480	-0.25	0.20	-0.06
495	-0.23	0.20	-0.05
510	-0.20	0.19	-0.04
525	-0.18	0.19	-0.04

Starting at 75 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	17.30	10.59	5.93
15	12.27	8.57	3.91
30	6.33	6.96	1.89
45	0.73	5.63	0.21
60	-3.81	4.55	-1.03
75	-7.05	3.68	-1.83
90	-9.04	2.98	-2.27
105	-9.99	2.43	-2.44
120	-10.15	2.00	-2.43
135	-9.77	1.65	-2.30
150	-9.05	1.38	-2.10
165	-8.16	1.16	-1.88
180	-7.21	1.00	-1.64
195	-6.27	0.86	-1.42
210	-5.39	0.75	-1.21
225	-4.62	0.66	-1.03
240	-3.90	0.59	-0.87
255	-3.28	0.53	-0.73

270	-2.74	0.49	-0.61
285	-2.29	0.45	-0.51
300	-1.88	0.42	-0.42
315	-1.58	0.40	-0.35
330	-1.32	0.37	-0.29
345	-1.11	0.35	-0.25
360	-0.94	0.34	-0.21
375	-0.80	0.32	-0.18
390	-0.68	0.31	-0.15
405	-0.58	0.30	-0.13
420	-0.50	0.29	-0.11
435	-0.44	0.28	-0.10
450	-0.38	0.27	-0.08
465	-0.34	0.26	-0.07
480	-0.30	0.25	-0.07
495	-0.27	0.24	-0.06
510	-0.24	0.24	-0.05

Starting at 90 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	16.48	11.66	5.87
15	10.97	9.44	3.61
30	4.73	7.66	1.45
45	-1.03	6.20	-0.30
60	-5.63	5.01	-1.55
75	-8.85	4.06	-2.33
90	-10.75	3.30	-2.74
105	-11.58	2.70	-2.86
120	-11.59	2.22	-2.80
135	-11.05	1.84	-2.62
150	-10.17	1.55	-2.38
165	-9.13	1.31	-2.11
180	-8.04	1.13	-1.84
195	-6.98	0.98	-1.59
210	-6.01	0.85	-1.36
225	-5.11	0.76	-1.15
240	-4.31	0.68	-0.97
255	-3.62	0.62	-0.81
270	-3.04	0.57	-0.68
285	-2.54	0.52	-0.56
300	-2.09	0.50	-0.46
315	-1.75	0.46	-0.39
330	-1.47	0.44	-0.33
345	-1.24	0.42	-0.27
360	-1.05	0.40	-0.23
375	-0.89	0.38	-0.20
390	-0.76	0.36	-0.17
405	-0.65	0.35	-0.14
420	-0.57	0.34	-0.12
435	-0.49	0.32	-0.11
450	-0.43	0.31	-0.10
465	-0.38	0.30	-0.08
480	-0.34	0.30	-0.08
495	-0.31	0.29	-0.07

Starting at 105 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	15.19	12.53	5.57
15	9.40	10.14	3.17
30	3.02	8.23	0.95
45	-2.78	6.66	-0.82
60	-7.34	5.39	-2.05
75	-10.48	4.37	-2.80
90	-12.27	3.56	-3.16
105	-12.95	2.92	-3.24
120	-12.82	2.41	-3.13
135	-12.13	2.01	-2.90
150	-11.11	1.69	-2.62
165	-9.94	1.44	-2.31
180	-8.73	1.24	-2.01
195	-7.59	1.08	-1.74
210	-6.50	0.95	-1.48
225	-5.52	0.85	-1.25
240	-4.65	0.76	-1.05
255	-3.91	0.70	-0.88
270	-3.28	0.64	-0.73
285	-2.74	0.59	-0.61
300	-2.26	0.56	-0.50
315	-1.90	0.53	-0.42
330	-1.60	0.50	-0.36
345	-1.35	0.48	-0.30
360	-1.14	0.45	-0.25
375	-0.97	0.43	-0.22
390	-0.83	0.42	-0.18
405	-0.72	0.40	-0.16
420	-0.62	0.39	-0.14
435	-0.54	0.37	-0.12
450	-0.48	0.36	-0.11
465	-0.43	0.35	-0.09
480	-0.38	0.34	-0.08

Starting at 120 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	13.67	13.23	5.13
15	7.74	10.71	2.67
30	1.34	8.70	0.43
45	-4.42	7.05	-1.33
60	-8.90	5.71	-2.52
75	-11.93	4.64	-3.23
90	-13.58	3.79	-3.54
105	-14.13	3.11	-3.57
120	-13.85	2.58	-3.41
135	-13.03	2.16	-3.14
150	-11.89	1.82	-2.82
165	-10.60	1.56	-2.48
180	-9.32	1.34	-2.16
195	-8.06	1.17	-1.85
210	-6.89	1.04	-1.57

225	-5.85	0.93	-1.33
240	-4.93	0.84	-1.12
255	-4.15	0.77	-0.93
270	-3.48	0.71	-0.78
285	-2.91	0.66	-0.65
300	-2.41	0.63	-0.54
315	-2.02	0.59	-0.45
330	-1.70	0.56	-0.38
345	-1.44	0.53	-0.32
360	-1.22	0.51	-0.27
375	-1.04	0.49	-0.23
390	-0.90	0.47	-0.20
405	-0.77	0.45	-0.17
420	-0.67	0.43	-0.15
435	-0.59	0.42	-0.13
450	-0.52	0.41	-0.12
465	-0.46	0.39	-0.10

Starting at 135 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	12.10	13.80	4.63
15	6.13	11.17	2.14
30	-0.24	9.08	-0.08
45	-5.92	7.36	-1.80
60	-10.29	5.98	-2.95
75	-13.18	4.86	-3.60
90	-14.71	3.98	-3.86
105	-15.12	3.28	-3.84
120	-14.71	2.73	-3.65
135	-13.77	2.29	-3.34
150	-12.53	1.94	-2.99
165	-11.18	1.66	-2.63
180	-9.77	1.44	-2.28
195	-8.44	1.26	-1.95
210	-7.21	1.12	-1.65
225	-6.12	1.01	-1.40
240	-5.16	0.92	-1.17
255	-4.34	0.84	-0.98
270	-3.64	0.78	-0.82
285	-3.05	0.73	-0.69
300	-2.53	0.69	-0.57
315	-2.13	0.65	-0.48
330	-1.80	0.62	-0.40
345	-1.52	0.59	-0.34
360	-1.29	0.56	-0.29
375	-1.11	0.54	-0.25
390	-0.95	0.52	-0.21
405	-0.82	0.50	-0.18
420	-0.72	0.48	-0.16
435	-0.63	0.47	-0.14
450	-0.56	0.45	-0.12

Starting at 150 (minutes) of heating phase

Cooling time	Pres.variation	Temp.variation	Oil flow

(minutes)	(kg/sq.cm)	(°C)	(dm3/hour*km)
0	10.57	14.26	4.11
15	4.62	11.55	1.64
30	-1.67	9.39	-0.55
45	-7.24	7.63	-2.22
60	-11.48	6.20	-3.32
75	-14.25	5.06	-3.93
90	-15.65	4.15	-4.14
105	-15.95	3.43	-4.08
120	-15.43	2.86	-3.85
135	-14.39	2.40	-3.51
150	-13.08	2.04	-3.14
165	-11.61	1.76	-2.75
180	-10.14	1.53	-2.37
195	-8.75	1.35	-2.03
210	-7.48	1.20	-1.72
225	-6.34	1.08	-1.45
240	-5.36	0.99	-1.22
255	-4.50	0.91	-1.02
270	-3.78	0.84	-0.86
285	-3.17	0.79	-0.72
300	-2.63	0.75	-0.59
315	-2.22	0.71	-0.50
330	-1.87	0.67	-0.42
345	-1.59	0.64	-0.36
360	-1.35	0.61	-0.30
375	-1.16	0.59	-0.26
390	-1.00	0.57	-0.22
405	-0.87	0.55	-0.19
420	-0.76	0.53	-0.17
435	-0.67	0.51	-0.15

Starting at 165 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	9.15	14.65	3.60
15	3.26	11.87	1.17
30	-2.94	9.66	-0.97
45	-8.38	7.85	-2.60
60	-12.51	6.39	-3.65
75	-15.16	5.22	-4.21
90	-16.44	4.29	-4.38
105	-16.63	3.56	-4.28
120	-16.02	2.97	-4.02
135	-14.92	2.50	-3.66
150	-13.50	2.14	-3.25
165	-11.97	1.85	-2.84
180	-10.45	1.61	-2.45
195	-9.01	1.43	-2.10
210	-7.69	1.28	-1.78
225	-6.53	1.15	-1.50
240	-5.51	1.06	-1.26
255	-4.64	0.97	-1.06
270	-3.90	0.90	-0.88
285	-3.27	0.85	-0.74
300	-2.72	0.80	-0.61

315	-2.29	0.76	-0.52
330	-1.94	0.72	-0.44
345	-1.65	0.69	-0.37
360	-1.41	0.66	-0.32
375	-1.21	0.64	-0.27
390	-1.05	0.61	-0.23
405	-0.91	0.59	-0.20
420	-0.80	0.57	-0.18

Starting at 180 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	7.88	14.96	3.13
15	2.06	12.14	0.74
30	-4.03	9.88	-1.35
45	-9.37	8.04	-2.92
60	-13.37	6.56	-3.93
75	-15.91	5.37	-4.44
90	-17.10	4.42	-4.58
105	-17.19	3.67	-4.45
120	-16.53	3.07	-4.16
135	-15.32	2.60	-3.77
150	-13.84	2.23	-3.35
165	-12.26	1.93	-2.92
180	-10.69	1.69	-2.52
195	-9.22	1.50	-2.15
210	-7.87	1.35	-1.83
225	-6.68	1.22	-1.54
240	-5.64	1.12	-1.29
255	-4.75	1.03	-1.08
270	-4.00	0.96	-0.91
285	-3.36	0.90	-0.76
300	-2.79	0.86	-0.63
315	-2.36	0.81	-0.53
330	-2.00	0.78	-0.45
345	-1.70	0.74	-0.38
360	-1.46	0.71	-0.33
375	-1.25	0.68	-0.28
390	-1.09	0.66	-0.24
405	-0.95	0.64	-0.21

Starting at 195 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	6.75	15.23	2.71
15	1.01	12.36	0.37
30	-4.97	10.08	-1.67
45	-10.20	8.21	-3.20
60	-14.10	6.71	-4.17
75	-16.54	5.50	-4.65
90	-17.63	4.54	-4.75
105	-17.68	3.77	-4.60
120	-16.91	3.17	-4.28
135	-15.65	2.69	-3.87

150	-14.12	2.31	-3.43
165	-12.49	2.01	-2.99
180	-10.89	1.77	-2.58
195	-9.39	1.57	-2.20
210	-8.02	1.41	-1.87
225	-6.81	1.29	-1.57
240	-5.75	1.18	-1.32
255	-4.85	1.09	-1.11
270	-4.08	1.02	-0.93
285	-3.43	0.96	-0.78
300	-2.86	0.91	-0.65
315	-2.42	0.87	-0.55
330	-2.05	0.83	-0.46
345	-1.75	0.79	-0.39
360	-1.50	0.76	-0.34
375	-1.29	0.73	-0.29
390	-1.12	0.70	-0.25

Starting at 210 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	5.77	15.45	2.33
15	0.12	12.55	0.04
30	-5.77	10.24	-1.95
45	-10.89	8.36	-3.44
60	-14.70	6.84	-4.37
75	-17.05	5.62	-4.81
90	-18.10	4.64	-4.90
105	-18.05	3.87	-4.72
120	-17.22	3.26	-4.38
135	-15.91	2.77	-3.95
150	-14.34	2.39	-3.50
165	-12.68	2.08	-3.05
180	-11.05	1.84	-2.62
195	-9.53	1.64	-2.24
210	-8.14	1.48	-1.90
225	-6.91	1.35	-1.60
240	-5.84	1.24	-1.35
255	-4.93	1.15	-1.13
270	-4.15	1.07	-0.95
285	-3.49	1.01	-0.80
300	-2.92	0.96	-0.66
315	-2.47	0.92	-0.56
330	-2.10	0.87	-0.48
345	-1.79	0.84	-0.41
360	-1.54	0.80	-0.35
375	-1.33	0.77	-0.30

Starting at 225 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	4.93	15.64	2.00
15	-0.64	12.72	-0.24
30	-6.44	10.39	-2.19

45	-11.47	8.49	-3.64
60	-15.19	6.95	-4.54
75	-17.50	5.72	-4.96
90	-18.45	4.74	-5.01
105	-18.34	3.96	-4.81
120	-17.47	3.34	-4.46
135	-16.12	2.85	-4.02
150	-14.52	2.46	-3.55
165	-12.84	2.15	-3.10
180	-11.19	1.90	-2.66
195	-9.64	1.70	-2.27
210	-8.24	1.54	-1.93
225	-7.00	1.41	-1.63
240	-5.92	1.30	-1.37
255	-4.99	1.20	-1.15
270	-4.21	1.13	-0.97
285	-3.55	1.06	-0.81
300	-2.97	1.01	-0.68
315	-2.51	0.96	-0.57
330	-2.14	0.92	-0.49
345	-1.83	0.88	-0.41
360	-1.57	0.85	-0.36

Starting at 240 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	4.22	15.81	1.72
15	-1.28	12.87	-0.47
30	-7.00	10.52	-2.39
45	-11.95	8.60	-3.81
60	-15.63	7.05	-4.68
75	-17.83	5.81	-5.08
90	-18.73	4.83	-5.11
105	-18.58	4.04	-4.89
120	-17.67	3.42	-4.52
135	-16.29	2.93	-4.08
150	-14.67	2.53	-3.60
165	-12.96	2.22	-3.14
180	-11.29	1.97	-2.70
195	-9.73	1.76	-2.30
210	-8.32	1.60	-1.95
225	-7.07	1.46	-1.65
240	-5.98	1.35	-1.39
255	-5.05	1.26	-1.17
270	-4.26	1.18	-0.98
285	-3.60	1.11	-0.82
300	-3.01	1.06	-0.69
315	-2.55	1.01	-0.58
330	-2.18	0.97	-0.50
345	-1.86	0.93	-0.42

Starting at 255 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)

0	3.62	15.96	1.49
15	-1.81	13.00	-0.68
30	-7.46	10.64	-2.56
45	-12.37	8.70	-3.96
60	-15.95	7.15	-4.80
75	-18.10	5.90	-5.17
90	-18.96	4.91	-5.19
105	-18.76	4.12	-4.96
120	-17.83	3.50	-4.58
135	-16.43	3.00	-4.12
150	-14.78	2.60	-3.64
165	-13.06	2.28	-3.17
180	-11.38	2.03	-2.73
195	-9.81	1.82	-2.33
210	-8.39	1.66	-1.97
225	-7.13	1.52	-1.67
240	-6.04	1.40	-1.40
255	-5.10	1.31	-1.18
270	-4.31	1.23	-0.99
285	-3.64	1.16	-0.84
300	-3.05	1.11	-0.70
315	-2.59	1.06	-0.59
330	-2.21	1.01	-0.50

Starting at 270 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	3.12	16.09	1.29
15	-2.26	13.11	-0.84
30	-7.86	10.74	-2.71
45	-12.68	8.80	-4.07
60	-16.21	7.24	-4.90
75	-18.32	5.99	-5.26
90	-19.14	4.99	-5.26
105	-18.92	4.20	-5.02
120	-17.96	3.57	-4.63
135	-16.54	3.07	-4.16
150	-14.88	2.67	-3.68
165	-13.14	2.35	-3.20
180	-11.45	2.09	-2.75
195	-9.87	1.88	-2.35
210	-8.45	1.71	-1.99
225	-7.18	1.57	-1.68
240	-6.09	1.46	-1.42
255	-5.15	1.36	-1.19
270	-4.35	1.28	-1.00
285	-3.67	1.21	-0.85
300	-3.08	1.15	-0.71
315	-2.62	1.10	-0.60

Starting at 285 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	2.70	16.20	1.12

15	-2.64	13.21	-0.99
30	-8.17	10.83	-2.83
45	-12.94	8.89	-4.17
60	-16.42	7.32	-4.98
75	-18.49	6.07	-5.32
90	-19.28	5.06	-5.31
105	-19.03	4.27	-5.06
120	-18.06	3.63	-4.67
135	-16.62	3.13	-4.20
150	-14.95	2.73	-3.70
165	-13.21	2.40	-3.22
180	-11.51	2.15	-2.77
195	-9.93	1.93	-2.37
210	-8.49	1.76	-2.01
225	-7.23	1.62	-1.70
240	-6.13	1.51	-1.43
255	-5.18	1.41	-1.20
270	-4.38	1.32	-1.01
285	-3.71	1.25	-0.86
300	-3.11	1.20	-0.72

Starting at 300 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	2.34	16.30	0.97
15	-2.94	13.31	-1.11
30	-8.42	10.92	-2.92
45	-13.15	8.98	-4.25
60	-16.59	7.40	-5.05
75	-18.63	6.14	-5.38
90	-19.39	5.14	-5.36
105	-19.13	4.33	-5.10
120	-18.13	3.70	-4.70
135	-16.69	3.19	-4.23
150	-15.01	2.79	-3.73
165	-13.26	2.46	-3.24
180	-11.56	2.20	-2.79
195	-9.97	1.99	-2.38
210	-8.53	1.81	-2.02
225	-7.26	1.67	-1.71
240	-6.16	1.55	-1.44
255	-5.22	1.45	-1.22
270	-4.41	1.37	-1.02
285	-3.74	1.30	-0.86

Starting at 315 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	2.05	16.40	0.85
15	-3.19	13.40	-1.20
30	-8.63	11.01	-3.00
45	-13.31	9.05	-4.32
60	-16.73	7.48	-5.10
75	-18.74	6.21	-5.43

90	-19.48	5.20	-5.40
105	-19.20	4.40	-5.14
120	-18.19	3.76	-4.73
135	-16.74	3.25	-4.25
150	-15.05	2.84	-3.75
165	-13.30	2.52	-3.26
180	-11.59	2.25	-2.81
195	-10.00	2.04	-2.40
210	-8.57	1.86	-2.04
225	-7.30	1.72	-1.72
240	-6.19	1.60	-1.45
255	-5.24	1.50	-1.22
270	-4.44	1.41	-1.03

Starting at 330 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	1.81	16.49	0.76
15	-3.39	13.48	-1.28
30	-8.80	11.09	-3.07
45	-13.45	9.13	-4.37
60	-16.84	7.55	-5.15
75	-18.83	6.28	-5.47
90	-19.55	5.27	-5.44
105	-19.25	4.46	-5.17
120	-18.24	3.82	-4.76
135	-16.78	3.31	-4.27
150	-15.09	2.90	-3.77
165	-13.33	2.57	-3.28
180	-11.63	2.30	-2.82
195	-10.03	2.09	-2.41
210	-8.59	1.91	-2.05
225	-7.32	1.77	-1.73
240	-6.22	1.65	-1.46
255	-5.27	1.54	-1.23

Starting at 345 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	1.62	16.58	0.68
15	-3.56	13.56	-1.35
30	-8.94	11.16	-3.13
45	-13.56	9.20	-4.42
60	-16.92	7.61	-5.19
75	-18.89	6.34	-5.50
90	-19.60	5.33	-5.47
105	-19.29	4.52	-5.19
120	-18.28	3.88	-4.78
135	-16.81	3.36	-4.29
150	-15.12	2.95	-3.79
165	-13.36	2.62	-3.29
180	-11.65	2.35	-2.84
195	-10.06	2.14	-2.42
210	-8.62	1.96	-2.06

225	-7.35	1.81	-1.74
240	-6.24	1.69	-1.47

Starting at 360 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	1.45	16.65	0.61
15	-3.70	13.64	-1.41
30	-9.05	11.23	-3.17
45	-13.65	9.27	-4.46
60	-16.99	7.68	-5.22
75	-18.94	6.40	-5.53
90	-19.64	5.39	-5.49
105	-19.33	4.58	-5.21
120	-18.30	3.93	-4.80
135	-16.83	3.41	-4.31
150	-15.14	3.00	-3.80
165	-13.38	2.67	-3.31
180	-11.67	2.40	-2.85
195	-10.08	2.18	-2.43
210	-8.64	2.01	-2.07
225	-7.37	1.86	-1.75

Starting at 375 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	1.31	16.73	0.55
15	-3.82	13.71	-1.46
30	-9.14	11.30	-3.21
45	-13.72	9.33	-4.49
60	-17.04	7.74	-5.25
75	-18.98	6.46	-5.55
90	-19.67	5.44	-5.51
105	-19.35	4.63	-5.23
120	-18.32	3.98	-4.81
135	-16.85	3.47	-4.32
150	-15.15	3.05	-3.81
165	-13.40	2.72	-3.32
180	-11.69	2.45	-2.86
195	-10.10	2.23	-2.44
210	-8.66	2.05	-2.08

Starting at 390 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	1.20	16.80	0.50
15	-3.91	13.77	-1.50
30	-9.22	11.36	-3.25
45	-13.78	9.39	-4.52
60	-17.08	7.80	-5.28
75	-19.01	6.52	-5.58

90	-19.68	5.50	-5.53
105	-19.36	4.68	-5.25
120	-18.33	4.03	-4.83
135	-16.86	3.52	-4.33
150	-15.16	3.10	-3.82
165	-13.41	2.77	-3.33
180	-11.70	2.50	-2.87
195	-10.11	2.27	-2.45

Starting at 405 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	1.10	16.87	0.46
15	-4.00	13.84	-1.53
30	-9.28	11.42	-3.28
45	-13.82	9.45	-4.55
60	-17.11	7.86	-5.30
75	-19.03	6.57	-5.59
90	-19.70	5.55	-5.55
105	-19.37	4.74	-5.26
120	-18.34	4.08	-4.84
135	-16.87	3.56	-4.35
150	-15.17	3.15	-3.83
165	-13.42	2.81	-3.34
180	-11.71	2.54	-2.88

Starting at 420 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	1.02	16.93	0.43
15	-4.06	13.90	-1.56
30	-9.33	11.48	-3.30
45	-13.86	9.51	-4.57
60	-17.14	7.91	-5.32
75	-19.04	6.63	-5.61
90	-19.71	5.60	-5.56
105	-19.38	4.79	-5.28
120	-18.34	4.13	-4.85
135	-16.87	3.61	-4.36
150	-15.18	3.19	-3.84
165	-13.43	2.86	-3.35

Starting at 435 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	0.95	16.99	0.40
15	-4.12	13.96	-1.58
30	-9.37	11.54	-3.32
45	-13.89	9.56	-4.59
60	-17.15	7.96	-5.33
75	-19.05	6.68	-5.63

90	-19.71	5.65	-5.57
105	-19.38	4.83	-5.29
120	-18.34	4.18	-4.86
135	-16.87	3.66	-4.37
150	-15.18	3.24	-3.85

Starting at 450 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	0.89	17.05	0.38
15	-4.17	14.02	-1.61
30	-9.41	11.59	-3.34
45	-13.91	9.62	-4.60
60	-17.17	8.01	-5.35
75	-19.06	6.73	-5.64
90	-19.71	5.70	-5.59
105	-19.38	4.88	-5.30
120	-18.34	4.23	-4.87
135	-16.87	3.70	-4.38

Starting at 465 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	0.84	17.11	0.36
15	-4.21	14.07	-1.62
30	-9.44	11.65	-3.36
45	-13.93	9.67	-4.62
60	-17.17	8.06	-5.36
75	-19.06	6.78	-5.65
90	-19.71	5.75	-5.60
105	-19.37	4.93	-5.31
120	-18.34	4.27	-4.88

Starting at 480 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	0.79	17.16	0.34
15	-4.24	14.12	-1.64
30	-9.46	11.70	-3.37
45	-13.94	9.72	-4.63
60	-17.18	8.11	-5.37
75	-19.06	6.82	-5.66
90	-19.70	5.79	-5.61
105	-19.36	4.97	-5.32

Starting at 495 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)

0	0.75	17.22	0.32
15	-4.27	14.17	-1.66
30	-9.48	11.75	-3.39
45	-13.95	9.77	-4.64
60	-17.18	8.16	-5.38
75	-19.05	6.87	-5.67
90	-19.70	5.84	-5.61

Starting at 510 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	0.72	17.27	0.31
15	-4.30	14.22	-1.67
30	-9.50	11.80	-3.40
45	-13.96	9.81	-4.65
60	-17.18	8.21	-5.39
75	-19.05	6.91	-5.68

Starting at 525 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	0.68	17.32	0.29
15	-4.32	14.27	-1.68
30	-9.51	11.84	-3.41
45	-13.96	9.86	-4.66
60	-17.18	8.25	-5.40

Starting at 540 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	0.66	17.37	0.28
15	-4.34	14.32	-1.69
30	-9.52	11.89	-3.42
45	-13.97	9.90	-4.67

Starting at 555 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	0.63	17.41	0.27
15	-4.36	14.37	-1.70
30	-9.53	11.93	-3.43

Starting at 570 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)

```
          0              0.61            17.46            0.26
         15             -4.38            14.41           -1.71
CIRCEE O TRANSE ?
?
circee
Oil density =  .987 kg/dm3
Experimental coefficient due to restrictor device
inserted in the oil duct =  .471

Feeding pressure (normal pump relief pressure) (kg/cm2)?
30
Starting pressure = 30.0  kg/cm2

Cable length up to severance point = 100.0  km
Sea water pressure at severance point =  1.00   kg/cm2
Operating pump
distance between two restrictor devices =  2000  m
Inside diameter of restrictor device =  7.0  mm
Oil pressure gradient at the severance point = -0.1283(kg/cm2/km)
Worst oil pressure distribution from the severance accident= 105.0 (min.)
Oil flow (dm3/hour) at the severance point based on
pressure gradient =   -50.871

          TRANSIENT PRESSURE DROP

Severance point  Pressure along the      Oil flow
distance (km)    cable (kg/cm2)       (dm3/hour)
     0.00             1.00               -33.9
     9.09             0.22                 0.1
    18.18             0.22                31.2
    27.27             0.94                59.4
    36.36             2.31                85.6
    45.45             4.28               111.1
    54.55             6.84               137.4
    63.64            10.02               165.7
    72.73            13.86               196.8
    81.82            18.42               230.5
    90.91            23.79               266.1
   100.00            30.00
?
stop
```

TRANSIENT TEMPERATURE AND PRESSURE VARIATIONS IN OIL FILLED CABLE IN CASE OF SEVERANCE

HIGH DENSITY OIL

THERMAL TRANSIENT

CR.SECT.	CURRENT	VOLTAGE
1600	1250	300

PARAMETERS

G1= 4.7200000000E-04 G2= 0
G3= 6.9400000000E-04 G4= 5.5600000000E-04
G5= 4.0300000000E-04 G6= 9.4400000000E-04
G7= 6.6700000000E-04

ACU	ASCH	RHOPB	RHOBL
4.0300000000E-03	4.0000000000E-03	214	1000000

RH1	RH2	RH4	ALFA	TAMB
500	795	70	2241.87670967476	3

R= 1.8600000000E-02 EPS= 0 TAND= 0 F= 0

CAPACITANCE= 0 MICROFARAD/km

AXIAL DISTANCE = 60000 mm EMBEDDING DEPTH = 300 mm

Temperature variations (°C)

Heat.time(hours)	Conductor	Dielectric	Sheath
0.25	6.0	4.6	3.8
0.50	8.4	6.1	4.5
0.75	10.3	7.4	5.2
1.00	11.9	8.6	5.9
1.25	13.2	9.5	6.4
1.50	14.2	10.2	6.9
1.75	15.1	10.8	7.3
2.00	15.8	11.3	7.6
2.25	16.3	11.8	7.9
2.50	16.8	12.1	8.1
2.75	17.1	12.4	8.3
3.00	17.4	12.6	8.5
3.25	17.7	12.9	8.7
**********	23.3	18.3	13.9

Total cable Joule losses/conductor losses = 1.000

PRESSURE TRANSIENT VARIATIONS

Reinforc.thick. = 0.600 (mm) Cable half length = 50.000 (km)
Oil duct diam. = 25.00 (mm)

MODULUS OF ELASTICITY OF THE REINFORCEMENT = 1640000000 (G/SQ.CM)

****
DIELECTRIC OIL VOLUME = 1148 LITRI/KM (ACTUAL VALUE)
TOTAL CABLE OIL VOLUME = 1651 LITRI/KM (ACTUAL VALUE)
****

STARTING PHASE OF THE HEATING

HEATING TIME (MINUTES)	PRESS. VARIATION (KG/SQ.CM)	OIL FLOW (DM3/HOUR*KM)
15	7.96	1.28
30	13.83	2.53
45	17.64	3.58
60	19.70	4.34
75	20.40	4.79
90	20.14	4.97
105	19.23	4.94
120	17.92	4.75
135	16.41	4.45
150	14.83	4.10
165	13.26	3.73
180	11.77	3.35
195	10.38	2.99
210	9.13	2.65
225	8.00	2.34
240	7.00	2.07
255	6.13	1.82
270	5.36	1.60
285	4.70	1.41
300	4.12	1.24
315	3.63	1.10
330	3.21	0.97
345	2.85	0.87
360	2.55	0.78
375	2.28	0.70
390	2.06	0.63

WORST COOLING PRESSURE TRANSIENT VARIATIONS

STARTING AT 15 (MINUTES) OF HEATING PHASE

COOLING TIME (MINUTES)	PRES.VARIATION (KG/SQ.CM)	TEMP.VARIATION (°C)	OIL FLOW (DM3/HOUR*KM)
0	7.97	2.98	1.28
15	8.01	2.39	1.25
30	6.87	1.96	1.05
45	5.06	1.59	0.76
60	3.07	1.29	0.45
75	1.24	1.04	0.18
90	-0.24	0.84	-0.03
105	-1.34	0.68	-0.19
120	-2.07	0.55	-0.29
135	-2.49	0.45	-0.35
150	-2.68	0.37	-0.37

165	-2.70	0.30	-0.38
180	-2.60	0.26	-0.36
195	-2.44	0.22	-0.34
210	-2.23	0.19	-0.31
225	-2.01	0.16	-0.28
240	-1.79	0.14	-0.25
255	-1.58	0.13	-0.22
270	-1.38	0.11	-0.19
285	-1.24	0.10	-0.17
300	-1.03	0.09	-0.14
315	-0.89	0.09	-0.12
330	-0.77	0.08	-0.11
345	-0.66	0.08	-0.09
360	-0.57	0.07	-0.08
375	-0.49	0.07	-0.07
390	-0.42	0.06	-0.06
405	-0.36	0.06	-0.05
420	-0.31	0.06	-0.04
435	-0.27	0.06	-0.04
450	-0.23	0.05	-0.03
465	-0.20	0.05	-0.03
480	-0.18	0.05	-0.02
495	-0.15	0.05	-0.02
510	-0.14	0.05	-0.02
525	-0.12	0.05	-0.02
540	-0.11	0.05	-0.01
555	-0.09	0.04	-0.01
570	-0.09	0.04	-0.01

Starting at 30 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	13.84	5.37	2.53
15	13.25	4.35	2.30
30	10.86	3.55	1.80
45	7.54	2.88	1.21
60	4.07	2.33	0.63
75	0.96	1.87	0.15
90	-1.51	1.51	-0.23
105	-3.29	1.22	-0.48
120	-4.43	1.00	-0.64
135	-5.05	0.81	-0.72
150	-5.28	0.67	-0.75
165	-5.22	0.56	-0.74
180	-4.97	0.47	-0.70
195	-4.62	0.40	-0.65
210	-4.21	0.35	-0.59
225	-3.77	0.30	-0.53
240	-3.35	0.27	-0.47
255	-2.94	0.24	-0.41
270	-2.61	0.21	-0.36
285	-2.26	0.19	-0.31
300	-1.91	0.18	-0.26
315	-1.65	0.17	-0.23
330	-1.42	0.16	-0.20
345	-1.22	0.15	-0.17
360	-1.05	0.14	-0.14

375	-0.90	0.13	-0.12
390	-0.77	0.13	-0.11
405	-0.67	0.12	-0.09
420	-0.57	0.12	-0.08
435	-0.50	0.11	-0.07
450	-0.43	0.11	-0.06
465	-0.38	0.10	-0.05
480	-0.33	0.10	-0.05
495	-0.29	0.10	-0.04
510	-0.25	0.09	-0.03
525	-0.22	0.09	-0.03
540	-0.20	0.09	-0.03
555	-0.18	0.09	-0.02

Starting at 45 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	17.65	7.33	3.58
15	16.18	5.94	3.06
30	12.67	4.84	2.26
45	8.20	3.92	1.39
60	3.67	3.16	0.60
75	-0.29	2.55	-0.04
90	-3.37	2.06	-0.52
105	-5.54	1.67	-0.83
120	-6.88	1.36	-1.02
135	-7.55	1.12	-1.10
150	-7.71	0.93	-1.11
165	-7.52	0.78	-1.08
180	-7.10	0.66	-1.01
195	-6.55	0.56	-0.93
210	-5.93	0.49	-0.84
225	-5.30	0.43	-0.74
240	-4.69	0.38	-0.66
255	-4.15	0.33	-0.58
270	-3.61	0.30	-0.50
285	-3.13	0.28	-0.44
300	-2.66	0.26	-0.37
315	-2.29	0.24	-0.32
330	-1.97	0.23	-0.27
345	-1.70	0.22	-0.24
360	-1.46	0.20	-0.20
375	-1.25	0.19	-0.17
390	-1.08	0.19	-0.15
405	-0.93	0.18	-0.13
420	-0.80	0.17	-0.11
435	-0.70	0.16	-0.10
450	-0.60	0.16	-0.08
465	-0.53	0.15	-0.07
480	-0.46	0.15	-0.06
495	-0.41	0.14	-0.06
510	-0.36	0.14	-0.05
525	-0.32	0.14	-0.04
540	-0.28	0.13	-0.04

Starting at 60 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	19.70	8.92	4.34
15	17.36	7.23	3.51
30	12.95	5.88	2.44
45	7.64	4.75	1.35
60	2.41	3.84	0.41
75	-2.08	3.10	-0.34
90	-5.52	2.51	-0.87
105	-7.88	2.04	-1.21
120	-9.28	1.67	-1.39
135	-9.90	1.38	-1.46
150	-9.94	1.14	-1.45
165	-9.59	0.96	-1.39
180	-8.98	0.82	-1.29
195	-8.24	0.70	-1.17
210	-7.43	0.61	-1.05
225	-6.62	0.54	-0.93
240	-5.88	0.48	-0.83
255	-5.14	0.43	-0.72
270	-4.47	0.39	-0.63
285	-3.87	0.36	-0.54
300	-3.30	0.34	-0.46
315	-2.84	0.32	-0.40
330	-2.45	0.30	-0.34
345	-2.10	0.28	-0.29
360	-1.81	0.27	-0.25
375	-1.56	0.25	-0.22
390	-1.34	0.24	-0.19
405	-1.16	0.23	-0.16
420	-1.00	0.22	-0.14
435	-0.87	0.22	-0.12
450	-0.75	0.21	-0.10
465	-0.66	0.20	-0.09
480	-0.58	0.20	-0.08
495	-0.51	0.19	-0.07
510	-0.45	0.18	-0.06
525	-0.40	0.18	-0.06

Starting at 75 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	20.41	10.21	4.79
15	17.31	8.26	3.69
30	12.22	6.71	2.40
45	6.33	5.43	1.16
60	0.66	4.39	0.11
75	-4.13	3.55	-0.69
90	-7.75	2.88	-1.24
105	-10.17	2.34	-1.58
120	-11.53	1.92	-1.75
135	-12.04	1.59	-1.80
150	-11.94	1.33	-1.76
165	-11.41	1.12	-1.66
180	-10.63	0.96	-1.54

195	-9.70	0.83	-1.39
210	-8.72	0.73	-1.24
225	-7.79	0.64	-1.11
240	-6.85	0.57	-0.97
255	-5.99	0.51	-0.84
270	-5.20	0.47	-0.73
285	-4.50	0.43	-0.63
300	-3.84	0.41	-0.54
315	-3.31	0.38	-0.46
330	-2.85	0.36	-0.40
345	-2.45	0.34	-0.34
360	-2.11	0.33	-0.29
375	-1.81	0.31	-0.25
390	-1.56	0.30	-0.22
405	-1.35	0.29	-0.19
420	-1.17	0.27	-0.16
435	-1.02	0.27	-0.14
450	-0.89	0.26	-0.12
465	-0.78	0.25	-0.11
480	-0.68	0.24	-0.09
495	-0.60	0.23	-0.08
510	-0.54	0.23	-0.07

Starting at 90 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	20.14	11.25	4.97
15	16.43	9.10	3.65
30	10.86	7.39	2.21
45	4.61	5.98	0.87
60	-1.32	4.83	-0.24
75	-6.26	3.91	-1.06
90	-9.93	3.18	-1.62
105	-12.32	2.60	-1.95
120	-13.59	2.14	-2.09
135	-13.97	1.78	-2.11
150	-13.71	1.49	-2.04
165	-13.01	1.26	-1.91
180	-12.05	1.08	-1.75
195	-10.96	0.94	-1.58
210	-9.87	0.82	-1.42
225	-8.75	0.73	-1.25
240	-7.68	0.66	-1.09
255	-6.71	0.60	-0.95
270	-5.82	0.55	-0.82
285	-5.03	0.51	-0.71
300	-4.30	0.48	-0.61
315	-3.71	0.45	-0.52
330	-3.19	0.42	-0.45
345	-2.75	0.40	-0.38
360	-2.36	0.38	-0.33
375	-2.04	0.37	-0.28
390	-1.76	0.35	-0.25
405	-1.52	0.34	-0.21
420	-1.32	0.32	-0.18
435	-1.15	0.31	-0.16
450	-1.00	0.30	-0.14

465	-0.88	0.29	-0.12
480	-0.77	0.28	-0.11
495	-0.69	0.28	-0.10

Starting at 105 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	19.23	12.08	4.94
15	15.06	9.78	3.46
30	9.16	7.94	1.92
45	2.69	6.43	0.52
60	-3.36	5.20	-0.61
75	-8.35	4.22	-1.44
90	-11.99	3.44	-1.98
105	-14.29	2.82	-2.28
120	-15.44	2.33	-2.40
135	-15.68	1.94	-2.39
150	-15.26	1.63	-2.29
165	-14.40	1.39	-2.13
180	-13.28	1.20	-1.94
195	-12.08	1.04	-1.75
210	-10.80	0.92	-1.56
225	-9.56	0.82	-1.37
240	-8.39	0.74	-1.20
255	-7.32	0.67	-1.04
270	-6.35	0.62	-0.90
285	-5.49	0.57	-0.78
300	-4.69	0.54	-0.66
315	-4.04	0.51	-0.57
330	-3.48	0.48	-0.49
345	-3.00	0.46	-0.42
360	-2.58	0.44	-0.36
375	-2.23	0.42	-0.31
390	-1.92	0.40	-0.27
405	-1.67	0.39	-0.23
420	-1.45	0.37	-0.20
435	-1.26	0.36	-0.18
450	-1.10	0.35	-0.15
465	-0.97	0.34	-0.14
480	-0.86	0.33	-0.12

Starting at 120 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	17.93	12.76	4.75
15	13.42	10.32	3.17
30	7.32	8.38	1.57
45	0.75	6.79	0.15
60	-5.34	5.51	-0.99
75	-10.30	4.47	-1.80
90	-13.87	3.65	-2.32
105	-16.07	3.00	-2.59
120	-17.08	2.49	-2.68
135	-17.17	2.08	-2.64

150	-16.60	1.76	-2.50
165	-15.59	1.50	-2.32
180	-14.38	1.29	-2.12
195	-13.00	1.13	-1.90
210	-11.60	1.00	-1.68
225	-10.25	0.90	-1.48
240	-8.99	0.81	-1.29
255	-7.83	0.74	-1.12
270	-6.79	0.69	-0.97
285	-5.87	0.64	-0.83
300	-5.03	0.60	-0.71
315	-4.33	0.57	-0.61
330	-3.73	0.54	-0.53
345	-3.22	0.51	-0.45
360	-2.77	0.49	-0.39
375	-2.39	0.47	-0.34
390	-2.07	0.45	-0.29
405	-1.79	0.43	-0.25
420	-1.56	0.42	-0.22
435	-1.36	0.41	-0.19
450	-1.19	0.39	-0.17
465	-1.05	0.38	-0.15

Starting at 135 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	16.42	13.31	4.45
15	11.69	10.77	2.82
30	5.47	8.75	1.20
45	-1.14	7.10	-0.23
60	-7.21	5.76	-1.35
75	-12.10	4.69	-2.14
90	-15.57	3.84	-2.63
105	-17.64	3.16	-2.87
120	-18.52	2.63	-2.93
135	-18.47	2.20	-2.85
150	-17.75	1.87	-2.70
165	-16.65	1.60	-2.49
180	-15.27	1.39	-2.26
195	-13.77	1.22	-2.02
210	-12.27	1.08	-1.79
225	-10.83	0.97	-1.57
240	-9.49	0.88	-1.37
255	-8.27	0.81	-1.19
270	-7.17	0.75	-1.02
285	-6.20	0.70	-0.88
300	-5.31	0.66	-0.76
315	-4.58	0.63	-0.65
330	-3.95	0.59	-0.56
345	-3.40	0.57	-0.48
360	-2.93	0.54	-0.41
375	-2.54	0.52	-0.36
390	-2.20	0.50	-0.31
405	-1.91	0.48	-0.27
420	-1.66	0.46	-0.23
435	-1.45	0.45	-0.20
450	-1.27	0.43	-0.18

Starting at 150 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	14.83	13.75	4.10
15	9.96	11.14	2.45
30	3.69	9.06	0.82
45	-2.91	7.35	-0.59
60	-8.91	5.98	-1.69
75	-13.72	4.88	-2.45
90	-17.07	4.00	-2.91
105	-19.02	3.30	-3.12
120	-19.76	2.75	-3.15
135	-19.58	2.32	-3.05
150	-18.78	1.97	-2.87
165	-17.52	1.69	-2.63
180	-16.02	1.47	-2.38
195	-14.43	1.30	-2.12
210	-12.84	1.16	-1.88
225	-11.33	1.05	-1.64
240	-9.92	0.95	-1.43
255	-8.64	0.88	-1.24
270	-7.49	0.81	-1.07
285	-6.48	0.76	-0.93
300	-5.55	0.72	-0.79
315	-4.79	0.68	-0.68
330	-4.13	0.65	-0.59
345	-3.56	0.62	-0.51
360	-3.08	0.59	-0.44
375	-2.66	0.57	-0.38
390	-2.31	0.55	-0.33
405	-2.01	0.53	-0.28
420	-1.75	0.51	-0.25
435	-1.53	0.49	-0.22

Starting at 165 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	13.27	14.12	3.73
15	8.31	11.44	2.07
30	2.04	9.31	0.46
45	-4.52	7.57	-0.93
60	-10.44	6.16	-2.00
75	-15.15	5.04	-2.73
90	-18.39	4.14	-3.15
105	-20.21	3.43	-3.34
120	-20.83	2.87	-3.34
135	-20.57	2.41	-3.22
150	-19.62	2.06	-3.01
165	-18.25	1.78	-2.76
180	-16.66	1.56	-2.49
195	-14.98	1.38	-2.21
210	-13.33	1.23	-1.95
225	-11.75	1.11	-1.71

240	-10.28	1.02	-1.49
255	-8.95	0.94	-1.29
270	-7.77	0.87	-1.12
285	-6.72	0.82	-0.96
300	-5.76	0.77	-0.82
315	-4.97	0.73	-0.71
330	-4.29	0.70	-0.61
345	-3.70	0.67	-0.53
360	-3.20	0.64	-0.45
375	-2.77	0.61	-0.39
390	-2.40	0.59	-0.34
405	-2.09	0.57	-0.30
420	-1.83	0.55	-0.26

Starting at 180 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	11.77	14.43	3.35
15	6.77	11.70	1.71
30	0.52	9.53	0.12
45	-5.97	7.76	-1.24
60	-11.80	6.32	-2.27
75	-16.40	5.18	-2.97
90	-19.53	4.26	-3.37
105	-21.24	3.54	-3.53
120	-21.79	2.96	-3.51
135	-21.37	2.51	-3.36
150	-20.32	2.15	-3.13
165	-18.86	1.86	-2.86
180	-17.19	1.63	-2.58
195	-15.45	1.45	-2.29
210	-13.73	1.30	-2.02
225	-12.10	1.18	-1.77
240	-10.59	1.08	-1.54
255	-9.22	1.00	-1.34
270	-8.00	0.93	-1.15
285	-6.92	0.87	-0.99
300	-5.93	0.83	-0.85
315	-5.12	0.78	-0.73
330	-4.42	0.75	-0.63
345	-3.82	0.71	-0.54
360	-3.31	0.69	-0.47
375	-2.87	0.66	-0.41
390	-2.49	0.63	-0.35
405	-2.17	0.61	-0.31

Starting at 195 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	10.39	14.68	2.99
15	5.38	11.92	1.37
30	-0.83	9.71	-0.19
45	-7.25	7.92	-1.52
60	-12.99	6.46	-2.52

75	-17.48	5.30	-3.19
90	-20.51	4.38	-3.56
105	-22.15	3.64	-3.70
120	-22.56	3.06	-3.65
135	-22.05	2.59	-3.48
150	-20.91	2.23	-3.24
165	-19.38	1.94	-2.95
180	-17.64	1.70	-2.65
195	-15.84	1.52	-2.36
210	-14.07	1.36	-2.08
225	-12.40	1.24	-1.82
240	-10.85	1.14	-1.58
255	-9.44	1.05	-1.37
270	-8.19	0.98	-1.19
285	-7.09	0.92	-1.02
300	-6.09	0.88	-0.88
315	-5.26	0.83	-0.75
330	-4.54	0.80	-0.65
345	-3.93	0.76	-0.56
360	-3.40	0.73	-0.49
375	-2.95	0.70	-0.42
390	-2.57	0.68	-0.37

Starting at 210 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	9.13	14.90	2.65
15	4.13	12.10	1.06
30	-2.03	9.88	-0.47
45	-8.37	8.06	-1.76
60	-14.02	6.59	-2.74
75	-18.42	5.42	-3.38
90	-21.38	4.47	-3.73
105	-22.89	3.73	-3.84
120	-23.21	3.14	-3.77
135	-22.62	2.68	-3.59
150	-21.41	2.30	-3.33
165	-19.81	2.01	-3.03
180	-18.02	1.77	-2.72
195	-16.17	1.58	-2.42
210	-14.36	1.43	-2.13
225	-12.65	1.30	-1.86
240	-11.06	1.20	-1.62
255	-9.64	1.11	-1.40
270	-8.36	1.04	-1.21
285	-7.24	0.97	-1.05
300	-6.22	0.93	-0.90
315	-5.37	0.88	-0.77
330	-4.64	0.84	-0.67
345	-4.02	0.81	-0.58
360	-3.48	0.77	-0.50
375	-3.03	0.75	-0.43

Starting at 225 (minutes) of heating phase

Cooling time	Pres.variation	Temp.variation	Oil flow

(minutes)	(kg/sq.cm)	(°C)	(dm3/hour*km)
0	8.01	15.08	2.34
15	3.02	12.26	0.78
30	-3.08	10.02	-0.72
45	-9.34	8.18	-1.98
60	-14.91	6.70	-2.93
75	-19.25	5.51	-3.55
90	-22.08	4.57	-3.88
105	-23.51	3.82	-3.96
120	-23.75	3.22	-3.88
135	-23.10	2.75	-3.68
150	-21.83	2.38	-3.40
165	-20.18	2.08	-3.10
180	-18.34	1.84	-2.78
195	-16.45	1.64	-2.47
210	-14.60	1.48	-2.17
225	-12.86	1.36	-1.90
240	-11.25	1.25	-1.65
255	-9.80	1.16	-1.43
270	-8.50	1.09	-1.24
285	-7.36	1.02	-1.07
300	-6.33	0.98	-0.92
315	-5.47	0.93	-0.79
330	-4.73	0.89	-0.68
345	-4.10	0.85	-0.59
360	-3.56	0.82	-0.51

Starting at 240 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	7.01	15.24	2.07
15	2.05	12.40	0.53
30	-3.99	10.14	-0.93
45	-10.18	8.30	-2.17
60	-15.70	6.80	-3.10
75	-19.92	5.61	-3.70
90	-22.68	4.65	-4.00
105	-24.03	3.90	-4.07
120	-24.21	3.30	-3.97
135	-23.50	2.82	-3.75
150	-22.17	2.44	-3.47
165	-20.48	2.14	-3.15
180	-18.60	1.90	-2.83
195	-16.68	1.70	-2.51
210	-14.80	1.54	-2.21
225	-13.03	1.41	-1.93
240	-11.40	1.30	-1.68
255	-9.93	1.21	-1.46
270	-8.62	1.14	-1.26
285	-7.47	1.07	-1.09
300	-6.43	1.02	-0.93
315	-5.56	0.97	-0.80
330	-4.81	0.93	-0.69
345	-4.17	0.89	-0.60

Starting at 255 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	6.13	15.39	1.02
15	1.21	12.53	0.32
30	-4.78	10.25	-1.13
45	-10.93	8.39	-2.34
60	-16.34	6.89	-3.24
75	-20.49	5.69	-3.82
90	-23.17	4.74	-4.10
105	-24.46	3.98	-4.16
120	-24.59	3.37	-4.05
135	-23.83	2.89	-3.82
150	-22.46	2.51	-3.53
165	-20.73	2.20	-3.20
180	-18.82	1.96	-2.87
195	-16.87	1.76	-2.55
210	-14.97	1.60	-2.24
225	-13.18	1.46	-1.96
240	-11.54	1.35	-1.70
255	-10.05	1.26	-1.48
270	-8.73	1.18	-1.28
285	-7.57	1.12	-1.10
300	-6.51	1.07	-0.95
315	-5.64	1.02	-0.82
330	-4.88	0.97	-0.71

Starting at 270 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	5.37	15.51	1.60
15	0.47	12.64	0.13
30	-5.48	10.35	-1.30
45	-11.54	8.49	-2.49
60	-16.88	6.98	-3.37
75	-20.96	5.77	-3.92
90	-23.59	4.81	-4.19
105	-24.83	4.05	-4.24
120	-24.90	3.44	-4.11
135	-24.10	2.96	-3.88
150	-22.70	2.57	-3.58
165	-20.94	2.26	-3.25
180	-19.00	2.01	-2.91
195	-17.03	1.81	-2.58
210	-15.11	1.65	-2.27
225	-13.31	1.51	-1.98
240	-11.65	1.40	-1.72
255	-10.15	1.31	-1.50
270	-8.82	1.23	-1.29
285	-7.65	1.16	-1.12
300	-6.58	1.11	-0.96
315	-5.70	1.06	-0.83

Starting at 285 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	4.71	15.62	1.41
15	-0.17	12.74	-0.05
30	-6.06	10.44	-1.44
45	-12.05	8.57	-2.61
60	-17.34	7.06	-3.47
75	-21.36	5.85	-4.01
90	-23.94	4.88	-4.27
105	-25.13	4.11	-4.30
120	-25.16	3.50	-4.17
135	-24.33	3.02	-3.93
150	-22.90	2.63	-3.62
165	-21.11	2.32	-3.28
180	-19.16	2.07	-2.94
195	-17.16	1.87	-2.60
210	-15.23	1.70	-2.29
225	-13.41	1.56	-2.00
240	-11.74	1.45	-1.74
255	-10.24	1.36	-1.51
270	-8.90	1.28	-1.31
285	-7.72	1.21	-1.13
300	-6.65	1.15	-0.97

Starting at 300 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	4.12	15.72	1.24
15	-0.71	12.83	-0.19
30	-6.54	10.53	-1.56
45	-12.49	8.65	-2.71
60	-17.72	7.14	-3.56
75	-21.70	5.92	-4.09
90	-24.22	4.95	-4.34
105	-25.37	4.18	-4.36
120	-25.38	3.57	-4.22
135	-24.51	3.08	-3.97
150	-23.06	2.69	-3.66
165	-21.25	2.37	-3.32
180	-19.28	2.12	-2.97
195	-17.28	1.92	-2.63
210	-15.33	1.75	-2.31
225	-13.50	1.61	-2.02
240	-11.82	1.50	-1.76
255	-10.31	1.40	-1.53
270	-8.96	1.32	-1.32
285	-7.78	1.25	-1.14

Starting at 315 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	3.63	15.81	1.10

15	-1.17	12.92	-0.31
30	-6.96	10.61	-1.67
45	-12.86	8.73	-2.81
60	-18.04	7.21	-3.64
75	-21.97	5.99	-4.16
90	-24.46	5.02	-4.40
105	-25.58	4.24	-4.41
120	-25.55	3.62	-4.26
135	-24.66	3.13	-4.01
150	-23.19	2.74	-3.69
165	-21.37	2.43	-3.34
180	-19.38	2.17	-2.99
195	-17.37	1.97	-2.65
210	-15.41	1.80	-2.33
225	-13.58	1.66	-2.04
240	-11.89	1.54	-1.77
255	-10.37	1.45	-1.54
270	-9.02	1.36	-1.33

Starting at 330 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	3.22	15.90	0.97
15	-1.55	13.00	-0.42
30	-7.31	10.69	-1.76
45	-13.17	8.80	-2.88
60	-18.31	7.28	-3.71
75	-22.20	6.05	-4.22
90	-24.65	5.08	-4.45
105	-25.74	4.30	-4.45
120	-25.69	3.68	-4.30
135	-24.79	3.19	-4.04
150	-23.30	2.79	-3.72
165	-21.46	2.48	-3.37
180	-19.47	2.22	-3.01
195	-17.44	2.01	-2.67
210	-15.48	1.84	-2.35
225	-13.64	1.70	-2.05
240	-11.95	1.59	-1.79
255	-10.43	1.49	-1.55

Starting at 345 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	2.86	15.98	0.87
15	-1.89	13.08	-0.51
30	-7.61	10.76	-1.84
45	-13.43	8.87	-2.95
60	-18.53	7.34	-3.76
75	-22.39	6.12	-4.27
90	-24.81	5.14	-4.49
105	-25.88	4.36	-4.49
120	-25.81	3.74	-4.33
135	-24.88	3.24	-4.07

150	-23.38	2.84	-3.74
165	-21.54	2.53	-3.39
180	-19.54	2.27	-3.03
195	-17.51	2.06	-2.69
210	-15.54	1.89	-2.36
225	-13.69	1.75	-2.07
240	-12.00	1.63	-1.80

Starting at 360 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	2.55	16.06	0.78
15	-2.17	13.15	-0.58
30	-7.86	10.83	-1.90
45	-13.64	8.93	-3.01
60	-18.71	7.40	-3.81
75	-22.54	6.17	-4.31
90	-24.94	5.19	-4.53
105	-25.98	4.41	-4.52
120	-25.90	3.79	-4.36
135	-24.96	3.29	-4.09
150	-23.45	2.89	-3.76
165	-21.60	2.57	-3.41
180	-19.59	2.32	-3.05
195	-17.56	2.11	-2.70
210	-15.59	1.93	-2.37
225	-13.74	1.79	-2.08

Starting at 375 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	2.29	16.13	0.70
15	-2.41	13.22	-0.65
30	-8.07	10.89	-1.96
45	-13.83	9.00	-3.06
60	-18.86	7.46	-3.86
75	-22.66	6.23	-4.35
90	-25.04	5.25	-4.56
105	-26.07	4.46	-4.55
120	-25.97	3.84	-4.38
135	-25.03	3.34	-4.11
150	-23.51	2.94	-3.78
165	-21.65	2.62	-3.42
180	-19.64	2.36	-3.06
195	-17.60	2.15	-2.71
210	-15.63	1.98	-2.39

Starting at 390 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	2.07	16.20	0.63

15	-2.62	13.28	-0.71
30	-8.25	10.95	-2.01
45	-13.98	9.06	-3.10
60	-18.99	7.52	-3.89
75	-22.76	6.29	-4.38
90	-25.12	5.30	-4.59
105	-26.13	4.52	-4.57
120	-26.02	3.89	-4.40
135	-25.07	3.39	-4.13
150	-23.55	2.99	-3.80
165	-21.69	2.67	-3.44
180	-19.68	2.41	-3.07
195	-17.64	2.19	-2.72

Starting at 405 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	1.87	16.26	0.58
15	-2.79	13.34	-0.76
30	-8.40	11.01	-2.05
45	-14.10	9.11	-3.14
60	-19.09	7.57	-3.92
75	-22.84	6.34	-4.40
90	-25.19	5.35	-4.61
105	-26.19	4.57	-4.60
120	-26.07	3.94	-4.42
135	-25.11	3.44	-4.15
150	-23.58	3.03	-3.81
165	-21.72	2.71	-3.45
180	-19.71	2.45	-3.09

Starting at 420 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	1.71	16.32	0.53
15	-2.94	13.40	-0.80
30	-8.53	11.07	-2.09
45	-14.21	9.17	-3.17
60	-19.17	7.63	-3.95
75	-22.91	6.39	-4.43
90	-25.23	5.40	-4.63
105	-26.22	4.61	-4.61
120	-26.10	3.98	-4.44
135	-25.14	3.48	-4.16
150	-23.61	3.08	-3.83
165	-21.75	2.75	-3.46

Starting at 435 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	1.57	16.38	0.48

15	-3.07	13.46	-0.84
30	-8.64	11.13	-2.12
45	-14.29	9.22	-3.20
60	-19.24	7.68	-3.98
75	-22.96	6.44	-4.45
90	-25.27	5.45	-4.65
105	-26.25	4.66	-4.63
120	-26.12	4.03	-4.45
135	-25.16	3.53	-4.18
150	-23.63	3.12	-3.84

Starting at 450 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	1.44	16.44	0.45
15	-3.18	13.51	-0.87
30	-8.73	11.18	-2.15
45	-14.36	9.27	-3.22
60	-19.29	7.73	-4.00
75	-22.99	6.49	-4.47
90	-25.30	5.50	-4.67
105	-26.27	4.71	-4.64
120	-26.14	4.07	-4.47
135	-25.17	3.57	-4.19

Starting at 465 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	1.34	16.49	0.41
15	-3.27	13.57	-0.90
30	-8.81	11.23	-2.17
45	-14.42	9.32	-3.24
60	-19.33	7.78	-4.02
75	-23.02	6.53	-4.48
90	-25.32	5.54	-4.68
105	-26.28	4.75	-4.66
120	-26.14	4.12	-4.48

Starting at 480 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	1.25	16.55	0.39
15	-3.35	13.62	-0.92
30	-8.87	11.28	-2.19
45	-14.47	9.37	-3.26
60	-19.36	7.82	-4.03
75	-23.04	6.58	-4.50
90	-25.33	5.59	-4.69
105	-26.29	4.79	-4.67

Starting at 495 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	1.17	16.60	0.36
15	-3.42	13.67	-0.94
30	-8.92	11.33	-2.21
45	-14.51	9.41	-3.28
60	-19.39	7.87	-4.05
75	-23.06	6.62	-4.51
90	-25.33	5.63	-4.70

Starting at 510 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	1.10	16.65	0.34
15	-3.48	13.71	-0.96
30	-8.97	11.37	-2.23
45	-14.54	9.46	-3.29
60	-19.41	7.91	-4.06
75	-23.06	6.67	-4.52

Starting at 525 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	1.03	16.70	0.32
15	-3.53	13.76	-0.98
30	-9.01	11.42	-2.24
45	-14.57	9.50	-3.30
60	-19.42	7.95	-4.07

Starting at 540 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	0.98	16.74	0.31
15	-3.58	13.81	-0.99
30	-9.04	11.46	-2.26
45	-14.59	9.55	-3.32

Starting at 555 (minutes) of heating phase

Cooling time (minutes)	Pres.variation (kg/sq.cm)	Temp.variation (°C)	Oil flow (dm3/hour*km)
0	0.93	16.79	0.29
15	-3.62	13.85	-1.01
30	-9.07	11.51	-2.27