# MEMORANDUM OF UNDERSTANDING

# ON

# DEVELOPMENT OF RESIDUAL HEAT DISTRIBUTION SYSTEMS

BETWEEN

THE GOVERNMENT
OF THE NORTHWEST TERRITORIES

AND

THE NORTHWEST TERRITORIES
POWER CORPORATION

MARCH 16, 1998

Northwest Territories Public Works and Services

NORTHWEST TERRITORIES POWER CORPORATION

Northwest Territories

98-025

# GNWT and NWT Power Corporation Partner to Develop Heat Opportunities

**Yellowknife (March 17) - The Department of Public Works and Services and the NWT Power Corporation have been working since 1997 to develop concepts and systems to capture the residual heat from power generating stations and use it to heat buildings.**

Under a Memorandum of Understanding signed yesterday, the NWT Government and the NWT Power Corporation will cooperate in identifying opportunities to develop new systems which can be economically beneficial to both parties. In the coming months, community power plants and government and commercial buildings across the NWT will be analysed to identify potential project opportunities.

Set up as commercial businesses, the projects will create new revenues for the Power Corporation from the sale of the heat. Over time, this may slightly offset overall community electrical rates, while direct customers may save as much as 30 per cent in heating costs over as many years.

"The savings will be in the millions of dollars in long term heating costs. It's a good program, at a time when public infrastructure funding is getting tighter," said Minister of Public Works and Services Jim Antoine.

Leon Cournoyea, President and CEO of the Power Corporation, said the Corporation will be encouraging local development groups and government agencies to participate in the ownership and management of the systems on a business basis. Where no local involvement is available, the Corporation would own and manage the systems.

A commercial operation involving the Gwich'in Development Corporation and the NWT Power Corporation is already in operation in Fort McPherson, where a $1 million system heats six buildings including a school, arena and water treatment plant.

"Customers are guaranteed a ten per cent start-up advantage over running their own boilers," said Mr. Cournoyea. "As the cost of the system is paid down, that advantage will increase. Extra funds would go toward the overall cost of electricity in that community. Local electricity rates will not increase because of these systems.

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The Minister responsible for the NWT Power Corporation Charles Dent says he is especially pleased with the environmental benefits that will result from handling and burning less fuel.

"These kinds of partnerships are the wave of the future and a positive step towards responsible energy management," he adds.

Residual heating systems can reduce fuel consumption by several thousands of barrels of fuel every year. Greenhouse gas emissions are reduced, along with hazards of transporting and storing fuel.

For example, in Fort McPherson, the system has reduced the community's annual heating fuel consumption by twelve per cent. Carbon dioxide emissions have been cut by 132,000 kilograms, and sulphur dioxide, the main cause of acid rain, by almost 15,000 kilograms.

As many as thirty communities, especially those where power plants are already located close to large buildings, could be candidates for new systems. Another eight existing systems will be assessed for upgrading. The Corporation will have a territory-wide survey ready for further evaluation by the fall of 1998.

Public Works and Services and the NWT Power Corporation will work with community planners and developers on a community-by-community basis. Local governments will be consulted on the construction of each system before commitments are made.

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The MOU document is available on request.

# Memorandum of Understanding

## Development of Residual Heat Systems

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# Memorandum of Understanding

## Development of Residual Heat Systems

### EXECUTIVE SUMMARY

The NWT Power Corporation operates diesel generating plants in 47 communities in the Northwest Territories. Residual heat from the diesel engines used in generation of electrical power can be used to provide building heating or process heating for water treatment, tempering or other processes, thereby providing many benefits both economic and environmental.

Systems to capture and distribute residual heat can be designed in several different ways, depending on variables such as building heating system design, reliability goals, and building operator preference.

There are presently several communities in the NWT where the concept of residual heat distribution is being used. Systems in these communities were built during the 1980's, and are due for upgrade. There are several more communities where the location of the power plant relative to commercial or institutional buildings provides the opportunity for future development of residual heat systems. Many of these buildings are owned or operated by agencies of the GNWT. In recognition of the opportunities available, the Northwest Territories Power Corporation and the Territorial Government Department of Public Works and Services has developed a Memorandum of Understanding outlining future cooperation in identifying and exploiting these opportunities.

The Memorandum sets out the following key points of cooperation:

- identifying opportunities for existing and new systems
- planning for fuel storage facilities
- technical design of upgrades and new heating systems
- NWTPC will co-ordinate construction, ownership and management
- Public Works and Services will provide technical expertise to customers
- local developers or governments will be encouraged to participate as business partners
- rates will initially be assessed at a 10 per cent saving of avoided fuel costs
- rates will be adjusted to reflect changes in fuel prices and capital costs

The Department of Public Works and Services will be the key resource for planning, and assisting existing and new customers with their technical co-ordination.

The Power Corporation will conduct a survey of existing plants, and the potential and priority for development of a district heating system in each likely community. This should be completed by the fall of 1998.

**Memorandum of Understanding**

**Development of Residual Heat Systems**

## 1. BACKGROUND INFORMATION

### 1.1. Introduction

1.1.1. The NWT Power Corporation (NWTPC) operates diesel generating plants in 47 communities in the Northwest Territories. These plants typically produce electrical energy at an overall thermal efficiency of about 35%. That is, the plant uses about 35% of the thermal energy in the diesel fuel to produce electrical energy - the balance of energy in the fuel is dissipated into the atmosphere in the form of heat. Much of this rejected energy can be captured and used for space heating or process heating. Use of this energy would reduce use of fossil fuels for heating, providing economic benefits which include heating fuel cost savings and environmental benefits including reduction of greenhouse gas emissions and reduced risk of fuel spills. In 1996/97, NWTPC diesel plants generated approximately 249,498 MWh of electrical energy, using approximately 71,285,000 litres of diesel fuel in the process.

1.1.2. There are a number of communities in the NWT which are possible candidates for construction and distribution of residual heat from the Corporation. Several of the buildings in these communities are owned and/or operated by the Government of the NWT (GNWT). In recognition of the economic and environmental benefits available to both parties, this document outlines a proposal for the cooperation between the GNWT and NWTPC for development of new residual heat systems connecting GNWT assets, as well as assessment and upgrading of existing residual heat systems connecting GNWT assets. New and expanded existing systems may also connect non GNWT customers. Such arrangements would not change the basic concepts outlined in this document.

1.1.3. NWTPC uses residual heat from the generation process in several locations for heating the plant and attached offices. NWTPC has, in past years, also allowed free access to the residual heat in several plants for use by GNWT agencies. Under the policy, the GNWT agency was responsible for all aspects of the system, including design, construction, operation and maintenance. There were several small systems constructed under the policy including Rankin Inlet, Cambridge Bay, Pelly Bay, Igloolik, Fort Simpson and Wha Ti. The formal agreements which resulted from this policy all expired on March 31, 1993. None were renewed. Systems are still operating in the above settlements.

1.1.4. The past policy allowed access to residual heat from the Corporation's plants at no cost to the user, provided there was no cost incurred by the Corporation in making the heat available. The Corporation is presently moving toward a policy which recognizes the value of this energy, and which will see fair market value received for energy delivered, for both new and existing systems. NWTPC would like to develop new

systems which would eventually allow for full recovery of development cost through a fair charge for energy delivered. The Corporation is also interested in reviewing the existing systems and upgrading them to improve efficiency and perhaps broaden customer base. Residual heat distribution systems not only represent revenue potential for NWTPC, but also have the potential of benefitting users in a number of ways, both economic and environmental.

## 1.2. System Benefits

1.2.1. Use of residual heat as an alternative source for building space heating has several benefits, both economic and environmental. Benefits include:

1.2.1.1. Direct cost savings

1.2.1.1.1. Where the total costs of building and operating a residual heat distribution system allow the energy to be sold to the customer at a rate which is less than the customer's cost of equivalent heating fuel, a direct savings is realized in annual building operating costs.

1.2.1.1.2. If a system can provide enough energy to significantly reduce operation of the customer boiler system, the customer may realize a savings in boiler maintenance and replacement costs.

1.2.1.1.3. Once the capital costs of the system have been recovered, energy charges to the customer can be reduced, allowing greater savings to building operators.

1.2.1.1.4. There is often a direct benefit to NWTPC realized in lower station service requirements due to less frequent operation of radiator fans. This can result in an increase in net plant efficiency.

1.2.1.2. Long term community infrastructure cost savings

1.2.1.2.1. A system providing thermal energy to buildings normally supplied by oil-fired heat can cause a significant deferral of fuel storage facility upgrades.

1.2.1.3. Local economic benefits

1.2.1.3.1. Local economy can undergo a boost during construction by hiring of local forces, increased business to the local hotel, etc.

1.2.1.3.2. All of the savings realized, and in some cases a portion of the energy revenue from the system, remain within the region rather than being spent outside the

NWT on fuel resupply.

1.2.1.4. Environmental concerns

1.2.1.4.1. Production of greenhouse gas emissions and other pollutants is directly related to the amount of fossil fuel consumed by the community. A given percentage reduction in consumption of fossil fuels results in an identical decrease in emissions. There is no increase in electrical production fuel required by the power plant.

1.2.1.4.2. There is some reduction of transportation and handling hazard, especially where fuel is brought in regularly by truckload.

1.2.1.4.3. Noise pollution caused by radiator fans is often reduced substantially, especially during the winter, when thermal demand on the system is greatest.

## 1.3. System Design Options

1.3.1. System Types

1.3.1.1. There are two basic approaches to distribution of residual heat through a district heating system. The supply can be interruptible or uninterruptible.

1.3.1.2. Interruptible (Supplementary) Systems

1.3.1.2.1. An interruptible or supplementary system is installed with the existing building boiler system, and supplies thermal energy into the system whenever surplus thermal energy is available from the electrical generation process. The building boiler system operates whenever building thermal demand exceeds energy available from the residual system. The thermal output of the plant is directly related to the electrical demand on the plant and, since NWTPC has little or no control over the electrical demand, no guarantee of thermal energy available can be given. Quite often with this type of system, the peak heating demand does not coincide with the peak electrical demand, and, since the system will normally be designed to balance maximization of the amount of energy exported with maximization of individual customer savings, it usually will supply only part of the customers' thermal energy requirements. There may be special situations where the residual heat alone is sufficient to supply 100% of a building thermal requirements, but it would still be recommended practice for the building to maintain its boiler system, at least in the short term.

1.3.1.2.2. Supplementary systems require special attention to controls to avoid the possibility of the customer boiler supplying the system. Controls can also be programmed to integrate the customer boiler, so that the boiler firing is blocked unless the system is not capable of supplying the required load. The residual heat supply and customer boiler system can also be put on an outdoor reset schedule which governs the delivery or firing temperature according to outdoor air temperature.

1.3.1.2.3. The optimum connection for a supplementary system is at a point where the temperature difference between the customer system and the delivery system is at a maximum, therefore allowing the residual heat distribution system to feed the customer system throughout a range of supply temperatures caused by fluctuating loads, both electrical and thermal. In cases where the building system is on an outdoor reset schedule, the supply into the individual building can be controlled to match that schedule.

1.3.1.3. Uninterruptible System

1.3.1.3.1. A system is considered uninterruptible if supply of the design heating load of the customer building is guaranteed to the extent that the cogen plant was producing (same guarantee as the electrical supply). An uninterruptible heating system using residual heat normally requires one or two small peaking boilers, allowing the system design load to be served regardless of electrical demand on the power plant. Usually two small boilers would be considered to insure that the thermal demand could still be met during an outage of one of the boilers or problems with the heat recovery equipment on the diesel generators. This type of system allows the building owner to remove the boilers, or plan the building without boilers.

1.3.1.3.2. Consideration for thermal energy supply during an electrical outage is usually not an issue since, in most cases, the customer building heating system is inoperable during an electrical outage. The exception to this would be where a building had been designated an emergency shelter, in which case it would require a stand alone heating plant and emergency standby generator set. Such buildings would not generally be considered for uninterruptible supply.

1.3.2. Building Connections

1.3.2.1. There are two main options for connection of the customer building to the system. These options apply to both interruptible and uninterruptible systems.

1.3.2.2. Direct Connected

1.3.2.2.1. The building heating system is connected as a branch of the distribution system. No heat exchanger is used between the distribution system and the building heating system. The building may still have individual outdoor reset capabilities, and in some instances may operate without primary circuit pumping, which would be provided by the distribution system pumps. This is the most economical connection, as no additional heat exchanger is required except for domestic hot water heat, if supplied. The major disadvantage to direct connection is the sharing of the transport medium between the building system and the distribution system.

1.3.2.3. Indirect Connection

1.3.2.3.1. The building heating system is isolated from the distribution system by a heat exchanger usually located in the customer building mechanical room. This type of connection is more costly than a direct connection, and has a loss of quality associated since energy is exchanged between two transport media via the building heat exchanger. This type of system allows for more control flexibility while eliminating concerns arising from sharing of glycol between the building and the distribution system.

1.3.2.3.2. In most cases an indirect connection is recommended, as it eliminates concerns with shared glycol, allows for more control flexibility, and eliminates problems arising with maintenance, leak repair and glycol replacement.

## 1.4. System Ownership Options

1.4.1. Existing and planned residual heat systems represent several different ownership options. Small systems presently in the planning or construction stages (Taloyoak Water Treatment Plant, Kugluktuk Water Treatment Plant) will be entirely owned and operated by NWTPC up to the point of energy exchange with the customer system. Several existing systems (Rankin, Cambridge, Holman, Pelly Bay) are owned and operated by the customer.

1.4.2. NWTPC is currently involved with one jointly owned and operated system. This system is operating in Fort McPherson, and was built by Aadrii Ltd., a joint venture between the Gwich'in Development Corporation and NWT Power Corporation. The rate structure of the system allows a 10% savings of avoided cost to the customers, with the remaining 90% of avoided costs applied to the capital and operating costs of the system. These costs include a charge for thermal energy paid by Aadrii to NWTPC. Once the capital costs have been recovered, Aadrii and the customer will

share the savings, resulting in an estimated 25% savings to the customer. This system was constructed without capital contribution from any of the customers, but it was felt that some immediate benefit to the customer was required in order to generate interest. The capital recovery period for the Fort McPherson system is estimated at about 18 years, assuming a 2% fuel escalation rate.

1.4.3. Although ownership could fall into any of the above categories, NWTPC does require that all equipment in contact with primary engine coolant or exhaust is owned, installed and maintained by NWTPC, who also reserves the right to control the specification of such equipment and review the primary distribution system design. The cost of installation or upgrading of the equipment in the NWTPC plant is partially recovered by an energy charge to the system operator.

## 1.5. Energy Rates

1.5.1. The main factors in the charges for residual heat are capital cost, capital contribution by the customer, and customer avoided fuel cost. Usually the customer desires to see an immediate benefit to connecting to the system, even when a capital contribution is not required. In most northern communities, the commercial/industrial buildings have small unattended automatic boiler systems, therefore benefits such as reduced operating manpower costs are not readily available. These facts result in the requirement that all benefits come in the form of savings in fuel. This results in an energy rate for customers being limited by the avoided cost of heating oil.

1.5.2. For a supplementary system a charge per unit energy delivered is the simplest approach. A typical energy charge would take the form of

$$Rate\ (\$/kWh) = \frac{Cost\ Factor \times Fuel\ Cost\ (\$/l) \times ETS\ Efficiency}{Fuel\ Net\ Heat\ Content\ (kWh/l) \times Average\ Annual\ Efficiency}$$

1.5.3. The energy rate equation is an example of how the thermal energy rate can be tied to the price of fuel and the actual meter readings at an ETS. The equation was initially developed for Fort McPherson to allow the heating company to realize the maximum return available while insuring that the customer was getting a specified saving in energy cost. In addition, there was a desire to enable the heating company to show the customer the savings by connecting the rate directly to what the customer would be paying to provide heat to the building through its existing system. The equation was further developed after monitoring performance of a working system.

1.5.4. A brief description of each of the components of the equation is given below.

1.5.4.1. Cost Factor

1.5.4.1.1. The cost factor ties the cost of heat supplied by the residual heat system to the price of fuel in the community. It is the percentage of *avoided cost* the customer can expect to pay for thermal energy delivered by the heating system. It is driven mainly by the cost of the system and size of connected load, and would normally be less than 100%. The cost factor could possibly exceed 100% in an uninterruptible system where the benefits to the customer would be far greater than simply fuel, i.e., no boiler capital, maintenance or replacement costs, no fuel system capital or maintenance costs, no fuel spill risk or fuel fire risk, no primary pumping costs, no costs associated with control systems for boilers, fuel system, primary pumps or secondary temperature control, and no building space allotment required for any of the above.

1.5.4.2. Fuel Cost

1.5.4.2.1. The fuel cost is the actual price per litre of heating fuel in the community, and is adjusted on a predetermined schedule, normally annually at the time the heating oil prices are set by Petroleum Products Division of the GNWT.

1.5.4.3. Energy Transfer Station Efficiency

1.5.4.3.1. This efficiency accounts for losses across the ETS heat exchanger(s). The energy is metered on the distribution side of ETS, and there are some losses through radiation which are absorbed by the heating company. It also accounts for losses assumed to result from the location of the ETS in the heating system. In installations where the ETS is heating water as it returns to the boiler, for example, some heat loss is experienced across the boiler(s). This inefficiency is absorbed in the rate equation. The ETS efficiency will usually be building specific like the Average Annual Efficiency, and in buildings where the ETS is on the secondary loop (in buildings which have primary-secondary systems) the ETS efficiency will usually be very close to 100%. In buildings where the ETS is on the boiler return line, this efficiency can be reduced due to losses across the boiler.

1.5.4.4. Average Energy Efficiency

1.5.4.4.1. This is also called boiler efficiency, and is the average efficiency with which the building boiler converts energy in fuel into heat distributed to the building. This figure is estimated either by the building designer or, for retrofit, by looking at fuel consumption records and size of installed heating

plant. Normally average annual efficiency is around 70%.

1.5.4.5. Net Heat Content of Fuel

1.5.4.5.1. This is the lower heating value or lower calorific value of the fuel available in the community. This can be determined from the supplier data sheet for the fuel.

1.5.5. Since the efficiencies in the rate equation are initially estimates, in all cases the performance of the system should be reviewed after a year of operation to insure that the customer is getting the benefit advertised.

1.5.6. Initial energy rates remain in effect until the capital cost of the system has been recovered, after which they can be reduced to allow the customer a larger savings. The operator must recover O&M costs for the system, which are usually driven mainly by pumping costs. Extraordinary maintenance costs must be provided for, especially as the age of the system increases.

## 2. GUIDELINES FOR AGREEMENT BETWEEN NWTPC AND THE GNWT

Whereas the GNWT and the NWTPC agree that both organizations can benefit from the development of residual heat projects, the parties agree to use the following guidelines in developing future projects.

### 2.1. Identifying Opportunities

2.1.1. NWTPC and GNWT will cooperate in identifying opportunities for development of new systems which can be shown to be economically beneficial to both parties.

2.1.2. NWTPC will develop a study of existing power plants including plant demand data and available thermal energy, potential loads and identification of building owner/operator, condition of plant with regard to energy export capabilities, and assignment of a priority level for development. This study is scheduled to be completed for September, 1998, and will be made available to the GNWT.

2.1.3. GNWT will notify NWTPC of plans for construction of new buildings within a 500m radius of an existing NWTPC power plant, and initiate discussions for development of residual heat distribution to such buildings.

2.1.4. GNWT will notify NWTPC of plans for expansion of fuel storage facilities which may be deferred or cancelled by the development of residual heat distribution systems. Such projects may change the priority level established by 2.1.2 above.

## 2.2. System Design

2.2.1. Unless specific conditions or situations indicate otherwise, all systems connecting GNWT assets will be considered interruptible supply systems.

2.2.2. Unless specific conditions or situations indicate otherwise, new systems connecting GNWT assets will be indirect connected, consisting of an Energy Transfer Station in the customer building, sized consistent with the design load of the building and/or the thermal energy available from the residual heat system.

2.2.3. NWTPC and GNWT will collaborate on the technical aspects of the system such as:

2.2.3.1. determination of building loads to be served,

2.2.3.2. location of heat transfer equipment in the building system,

2.2.3.3. sizing of building heat transfer equipment and equipment specifications for the Energy Transfer Station and controls,

2.2.3.4. integration of control of the building system and residual heat system.

2.2.4. Wherever possible, design of the residual heat systems will be carried out by NWTPC in-house.

2.2.5. Construction work will normally be tendered in accordance with the NWTPC Tender Policy, with involvement of local forces encouraged.

## 2.3. System Ownership

2.3.1. NWTPC will specify, install, own and maintain all equipment in contact with primary engine coolant.

2.3.2. NWTPC will own and operate the residual heat systems unless a local development group or local government body expresses interest in ownership or joint ownership.

2.3.3. Notwithstanding 2.3.2 above, NWTPC will be responsible for coordinating the final design and construction of the residual heat production, distribution and building energy transfer systems.

## 2.4. System Commissioning

2.4.1. NWTPC will be responsible for commissioning of the system up to the building energy transfer station.

2.4.2. NWTPC and GNWT will jointly commission the building energy transfer system and any integrated control systems.

## 2.5. System Operation and Maintenance

2.5.1. The system will be operated and maintained by the system owner. Operation includes meter reading, billing, and other administrative activities.

2.5.2. Operation and maintenance of the system including the customer ETS will normally require that the system owner have access to the customer building on a routine basis for meter reading and ETS maintenance.

2.5.3. An agreement may be reached between the system owner and GNWT or the organization responsible for operation and maintenance of the facility for routine system maintenance to be carried out by the building operator.

## 2.6. System Expansion (Addition of Customers)

2.6.1. NWTPC will notify GNWT, and any other customers initially connected or proposed in the original system plan, of any plans to add customers to a system established to heat GNWT assets as the primary customer.

2.6.2. NWTPC will insure during the design phase that expansion of systems originally established to heat GNWT assets will not adversely impact savings realized by the GNWT, or any other customers initially connected or proposed for original system design, within established limitations.

2.6.3. It is recommended that limitations be established for expansion of the originally planned system to allow a decrease of up to 25% of the energy delivered to any or all customers in the original connection plans.

2.6.4. NWTPC will present expansion plans to GNWT for review and confirmation that expansion limitations are not exceeded in the expansion design.

2.6.5. Expansion limitations may be exceeded on individual systems with the agreement of GNWT.

2.6.6. Rates negotiated with new customers and the incremental capital recovery of expansion projects will not adversely affect original customers. If addition of new customers has a beneficial impact on the original capital recovery period, that impact will be acknowledged and the benefits to all customers adjusted accordingly.

## 2.7. Existing Systems Owned and Operated by the GNWT

2.7.1. All existing systems owned and operated by the GNWT will be assessed by representatives of both NWTPC and GNWT. Assessments will include:

2.7.1.1. present load on system,

2.7.1.2. available energy from plant,

2.7.1.3. determination of effectiveness of the present system, and agreement on objectives of any upgrading,

2.7.1.4. determination of scope of upgrade, if required,

2.7.1.5. determination of components of system which may be re-used in any upgrade,

2.7.1.6. evaluation of components of existing system which will be maintained or re-used.

2.7.2. In the evaluation, consideration will be given to the age and condition of components as well as the value of elimination of such components or sections of existing system from scope of supply during upgrading work.

2.7.3. Agreement will be reached regarding the evaluation in 2.7.1 and 2.7.2, and the value will be considered a capital contribution to the project by the owner(s) of the existing equipment.

2.7.4. Suggested priority for the assessment of existing systems is as follows:

A. Rankin Inlet
B. Pelly Bay
C. Cambridge Bay
D. Fort Simpson
E. Wha Ti
F. Igloolik
G. Holman

## 2.8. Energy Rates

2.8.1. All calculations done for the purpose of establishing rates or evaluation performance will use the Net (or Lower) Heating Value of the fuel, as determined by the density or specific gravity declared on the suppliers inspection sheet and the American Petroleum Institute tabulated Heating Values.

2.8.2. Fuel price used in the energy rate equation will be adjusted annually, normally on November 1, to reflect the cost of heating fuel delivered to the customer at the time of the adjustment.

2.8.3. Net Heat Content (or Lower Heating Value) of the fuel will be assessed and adjusted annually, using the fuel supplier data sheets and American Petroleum Institute charts, to reflect the Net Heat Content of the fuel delivered to the community.

2.8.4. Initial Average Annual Efficiency used in the rate equation will be set to the building design value, or, where such a value is not available, to 70%.

2.8.5. New or Existing Systems with no Capital Contribution from Customer

2.8.5.1. The proposed rate for thermal energy delivered to GNWT building heating systems where there was no capital contribution to the system by the customer will allow for a savings to the building operator of 10% of avoided fuel costs, i.e., the Cost Factor in the Rate Equation on page 6, will be 90%.

2.8.6. New Systems with Capital Contribution from GNWT

2.8.6.1. Where GNWT has agreed to provide a capital contribution to the development of a new system, an energy rate will be calculated to allow the GNWT savings of 10% of avoided fuel costs, plus additional savings calculated to result in a capital recovery period for the GNWT capital contribution which is the same as that estimated for the developer of the system.

2.8.6.2. An economic analysis for the planned system, indicating capital cost recovery periods for both GNWT and the system developer will be made available to the GNWT for review. Sample analyses are given in Appendix I, showing the possible effects of varying levels of capital contributions on a proposed project.

2.8.7. Existing Systems Owned by GNWT

2.8.7.1. Where an existing system, currently owned by the GNWT, has been evaluated

for upgrading, the assigned value in 2.7.3 above will be considered a capital contribution to the project by GNWT, and treated the same as in section 2.8.6 above.

2.8.8. Performance Evaluation

2.8.8.1. NWTPC will carry out a performance evaluation of all customers connected to the system after 1 complete year of operation. The evaluation will use historical fuel consumption data before and after connection to the system, plus system energy consumption, to determine the accuracy of the rate calculation in providing the customer the savings in avoided costs indicated by the Cost Factor in the rate equation.

2.8.8.2. GNWT and NWTPC will collaborate to determine a mutually acceptable method and format for the evaluation. An sample performance evaluation is given in Appendix II.

2.8.8.3. The energy rate will be adjusted to reflect the results of the performance evaluation.

2.8.8.4. Over- or under-payments for the first year of operation, as determined by the performance evaluation, will be corrected by a one-time payment or refund.

2.8.8.5. Performance evaluations after the first year of operation may be requested on an annual basis if it is felt by the customer that the system performance has changed.

2.8.9. Joint ownership systems or systems owned and operated by other than the NWTPC (see 2.3.2 above) will be subject to a rate for energy payable to the NWTPC by the operator of the system. This rate will not impact the rate as set forth in this section for energy charged to the customers of the system by the system operator.

## 2.9. Metering

2.9.1. Utility grade energy meters will be installed at each building, measuring flow and temperature of the inlet and outlet flows on the distribution side (residual heat supply side) of the ETS.

2.9.2. Meters will calculate instantaneous load and total energy consumption, and display a minimum of instantaneous flow in litres per second, temperature difference in °C, instantaneous load in kW or MW, and total energy consumption in kWh or MWh.

2.9.3. If possible, meters will be specified to store total energy value at 00:01 on the first day of each month, with the stored figure available for access at the meter for the duration of the month.

## 2.10. Customer Supply Contracts

2.10.1. All targeted customers of a proposed system will be required to sign a Heat Supply Agreement prior to work commencing on the final design and construction of the system. A sample Heat Supply Agreement is attached as Appendix III.

## 2.11. Invoicing

2.11.1. Customers will be invoiced monthly for energy delivered by the system.

2.11.2. Invoices will show energy rate, current and previous meter readings, multiplier(s) used to correct meter readings as required by the transport medium used, actual energy consumed and total amount owing for the month.

Signed at Yellowknife. this 16th day of March, 1998

Leon Courneya, President and CEO, NWT Power Corporation

Ken Lovely, Deputy Minister, Public Works and Services, Government of the NWT

## APPENDIX I - Sample Economic Analyses

# APPENDIX I

**Proposed Pangnirtung Residual Heat - Sole Ownership by NWTPC**
**- No Capital Contribution from Customer**

| | | | | | |
|---|---|---|---|---|---|
| Capital Cost: | 750,000 | Initial Annual O&M: | 29,076 | Interest rate (initial): | 7.00% |
| Initial Equity: | 0% | 0 Initial O&M Period (years): | 25 | (final): | 7.00% |
| Cost Factor (% avoided cost): | 90% | O&M Increase (1998$): | 2,000 | Interest Rate Break (years): | 5 |
| Profit Factor | 80% | Fuel LHV (kW/L): | 9.79 | Depreciation Cycle (years): | 40 |
| Initial Return to Equity | 10.00% | 7500 Fuel Cost ($/L): | 0.5800 | Depreciation Base: | 1.05 |
| NWTPC Blended ROR: | 10.755% | General Inflation: | 2.00% | Production Fuel Tax ($/l): | 0.031 |
| Customer Capital Contribution (%) | 0.00% | Fuel Escalation: | 2.00% | Production Fuel used per Year (litr | 1,536,790 |
| | | | | Production Specific Heat Rate (kW | 3.221 |

Table 1 - Customer Information

| Customers | Boiler Efficiency | Heat Delivered (MWh) | Fuel Displaced (Litres) | Fuel Displaced (1997 $) | Initial Rate ($/kWh) | Initial Revenue (1997 $) |
|---|---|---|---|---|---|---|
| High School | 0.7 | 917.17 | 133,835 | 77,624 | 0.0762 | 69,862 |
| Elementary School | 0.7 | 353.76 | 51,621 | 29,940 | 0.0762 | 26,946 |
| | | | 0 | 0 | 0.0000 | 0 |
| | | | 0 | 0 | 0.0000 | 0 |
| | | | 0 | 0 | 0.0000 | 0 |
| | | | 0 | 0 | 0.0000 | 0 |
| | | | 0 | 0 | 0.0000 | 0 |
| | | | 0 | 0 | 0.0000 | 0 |
| **Totals** | | **1,270.93** | **185,456** | **107,564** | **0.0762** | **96,808** |

Table 2 - Possible Customer Savings as a Percentage of Avoided Costs

| Year | Avoided Fuel Cost ($/kWh) | Average Heat Rate ($/kWh) | Customer Savings (%) |
|---|---|---|---|
| 15 | 0.1117 | 0.1005 | 10.0 |
| 20 | 0.1233 | 0.0986 | 20.0 |
| 25 | 0.1361 | 0.1089 | 20.0 |
| 30 | 0.1503 | 0.1202 | 20.0 |

| Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Financing and Operating Expenses** | | | | | | | | | | | | | | | | |
| Opening Balance | | (750,000) | (730,744) | (708,785) | (683,907) | (655,878) | (631,950) | (604,880) | (574,420) | (540,302) | (502,240) | (459,927) | (413,032) | (361,204) | (304,063) | (241,204) |
| Interest Expense | | (52,500) | (51,152) | (49,615) | (47,873) | (45,911) | (44,236) | (42,342) | (40,209) | (37,821) | (35,157) | (32,195) | (28,912) | (25,284) | (21,284) | (16,884) |
| Operating and Maintenance Cost | | (29,076) | (29,658) | (30,251) | (30,856) | (31,473) | (32,102) | (32,744) | (33,399) | (34,067) | (34,749) | (35,443) | (36,152) | (36,875) | (37,613) | (38,365) |
| Total Annual Expense | | (81,576) | (80,810) | (79,866) | (78,729) | (77,384) | (76,339) | (75,086) | (73,609) | (71,888) | (69,905) | (67,638) | (65,065) | (62,160) | (58,897) | (55,249) |
| **Revenues** | | | | | | | | | | | | | | | | |
| Annual Avoided Cost | | 107,564 | 109,716 | 111,910 | 114,148 | 116,431 | 118,760 | 121,135 | 123,558 | 126,029 | 128,550 | 131,121 | 133,743 | 136,418 | 139,146 | 141,929 |
| Total Annual Revenue | | 96,808 | 98,744 | 100,719 | 102,733 | 104,788 | 106,884 | 109,022 | 111,202 | 113,426 | 115,695 | 118,008 | 120,369 | 122,776 | 125,232 | 127,736 |
| Total Annual Expense | | (81,576) | (80,810) | (79,866) | (78,729) | (77,384) | (76,339) | (75,086) | (73,609) | (71,888) | (69,905) | (67,638) | (65,065) | (62,160) | (58,897) | (55,249) |
| Production Fuel Tax Savings | | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 |
| Net Revenue Before Tax & Depreciation | | 19,256 | 21,959 | 24,878 | 28,029 | 31,428 | 34,570 | 37,960 | 41,618 | 45,562 | 49,814 | 54,395 | 59,328 | 64,641 | 70,359 | 76,511 |
| Depreciation | | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) |
| Net Revenue | | (431) | 2,272 | 5,190 | 8,341 | 11,741 | 14,882 | 18,273 | 21,930 | 25,875 | 30,126 | 34,707 | 39,641 | 44,953 | 50,671 | 56,824 |
| Dividend or Retained Income | | 0 | 0 | 0 | 0 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Average Energy Rate Required | | 0.0762 | 0.0777 | 0.0792 | 0.0808 | 0.0824 | 0.0841 | 0.0858 | 0.0875 | 0.0892 | 0.0910 | 0.0929 | 0.0947 | 0.0966 | 0.0985 | 0.1005 |
| **NPV Calculations at NWTPC ROR** | | | | | | | | | | | | | | | | |
| Cumulative NPV Net Income | 0 | 0 | 0 | 0 | 0 | 4,500 | 8,564 | 12,232 | 15,545 | 18,536 | 21,236 | 23,674 | 25,876 | 27,863 | 29,658 | 31,278 |
| Cumulative NPV Project | (750,000) | (688,845) | (632,525) | (580,656) | (532,887) | (488,895) | (448,380) | (411,068) | (376,705) | (345,059) | (315,914) | (289,073) | (264,353) | (241,588) | (220,622) | (201,314) |
| **Project Internal Rate of Return** | **10.300%** | 152 | | | | | | | | | | | | | | |
| **Customer Benefit Analysis** | | | | | | | | | | | | | | | | |
| Customer Annual Savings | | 10,756 | 10,972 | 11,191 | 11,415 | 11,643 | 11,876 | 12,114 | 12,356 | 12,603 | 12,855 | 13,112 | 13,374 | 13,642 | 13,915 | 14,193 |
| Cumulative Annual Savings | | 10,756 | 21,728 | 32,919 | 44,334 | 55,977 | 67,853 | 79,966 | 92,322 | 104,925 | 117,780 | 130,892 | 144,266 | 157,908 | 171,823 | 186,016 |
| Customer Capital Recovery | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Customer NPV @ 2nd Interest Rate | 0 | 10,053 | 19,636 | 28,771 | 37,479 | 45,781 | 53,694 | 61,238 | 68,429 | 75,284 | 81,819 | 88,048 | 93,987 | 99,648 | 105,044 | 110,188 |

# APPENDIX I

**Proposed Pangnirtung Residual Heat - Sole Ownership by NWTPC**
**- No Capital Contribution from Customer**

| | | | | | |
|---|---|---|---|---|---|
| Capital Cost: | 750,000 | Initial Annual O&M: | 29,076 | Interest rate (initial): | 7.00% |
| Initial Equity: | 0% | 0 Initial O&M Period (years): | 25 | (final): | 7.00% |
| Cost Factor (% avoided cost): | 90% | O&M Increase (1998$): | 2,000 | Interest Rate Break (years): | 5 |
| Profit Factor | 80% | Fuel LHV (kW/L): | 9.79 | Depreciation Cycle (years): | 40 |
| Initial Return to Equity | 10.00% | 7500 Fuel Cost ($/L): | 0.5800 | Depreciation Base: | 1.05 |
| NWTPC Blended ROR: | 10.755% | General Inflation: | 2.00% | Production Fuel Tax ($/l): | 0.031 |
| Customer Capital Contribution (%) | 0.00% | Fuel Escalation: | 2.00% | Production Fuel used per Year (litr | 1,536,790 |
| | | | | Production Specific Heat Rate (kW | 3.221 |

Table 1 - Customer Information

| Customers | Boiler Efficiency | Heat Delivered (MWh) | Fuel Displaced (Litres) | Fuel Displaced (1997 $) | Initial Rate ($/kWh) | Initial Revenue (1997 $) |
|---|---|---|---|---|---|---|
| High School | 0.7 | 917.17 | 133,835 | 77,624 | 0.0762 | 69,862 |
| Elementary School | 0.7 | 353.76 | 51,621 | 29,940 | 0.0762 | 26,946 |
| | | | 0 | 0 | 0.0000 | 0 |
| | | | 0 | 0 | 0.0000 | 0 |
| | | | 0 | 0 | 0.0000 | 0 |
| | | | 0 | 0 | 0.0000 | 0 |
| | | | 0 | 0 | 0.0000 | 0 |
| | | | 0 | 0 | 0.0000 | 0 |
| **Totals** | | **1,270.93** | **185,456** | **107,564** | **0.0762** | **96,808** |

Table 2 - Possible Customer Savings as a Percentage of Avoided Costs

| Year | Avoided Fuel Cost ($/kWh) | Average Heat Rate ($/kWh) | Customer Savings (%) |
|---|---|---|---|
| 15 | 0.1117 | 0.1005 | 10.0 |
| 20 | 0.1233 | 0.0986 | 20.0 |
| 25 | 0.1361 | 0.1089 | 20.0 |
| 30 | 0.1503 | 0.1202 | 20.0 |

| Year | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Financing and Operating Expenses** | | | | | | | | | | | | | | | |
| Opening Balance | (172,193) | (96,564) | (13,817) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Interest Expense | (12,054) | (6,759) | (967) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Operating and Maintenance Cost | (39,132) | (39,915) | (40,713) | (41,528) | (42,358) | (43,205) | (44,070) | (44,951) | (45,850) | (46,767) | (50,983) | (52,003) | (53,043) | (54,104) | (55,186) |
| Total Annual Expense | (51,186) | (46,675) | (41,681) | (41,528) | (42,358) | (43,205) | (44,070) | (44,951) | (45,850) | (46,767) | (50,983) | (52,003) | (53,043) | (54,104) | (55,186) |
| **Revenues** | | | | | | | | | | | | | | | |
| Annual Avoided Cost | 144,768 | 147,663 | 150,616 | 153,629 | 156,701 | 159,835 | 163,032 | 166,293 | 169,618 | 173,011 | 176,471 | 180,000 | 183,600 | 187,272 | 191,018 |
| Total Annual Revenue | 130,291 | 132,897 | 124,981 | 122,903 | 125,361 | 127,868 | 130,425 | 133,034 | 135,695 | 138,409 | 141,177 | 144,000 | 146,880 | 149,818 | 152,814 |
| Total Annual Expense | (51,186) | (46,675) | (41,681) | (41,528) | (42,358) | (43,205) | (44,070) | (44,951) | (45,850) | (46,767) | (50,983) | (52,003) | (53,043) | (54,104) | (55,186) |
| Production Fuel Tax Savings | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 |
| Net Revenue Before Tax & Depreciatio | 83,129 | 90,246 | 87,325 | 85,400 | 87,027 | 88,687 | 90,380 | 92,107 | 93,869 | 95,666 | 94,218 | 96,022 | 97,861 | 99,738 | 101,652 |
| Depreciation | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) |
| Net Revenue | 63,442 | 70,559 | 67,637 | 65,712 | 67,340 | 69,000 | 70,693 | 72,420 | 74,182 | 75,979 | 74,530 | 76,334 | 78,174 | 80,051 | 81,965 |
| Dividend or Retained Income | 7,500 | 7,500 | 69,483 | 81,375 | 83,003 | 84,663 | 86,356 | 88,083 | 89,845 | 91,642 | 90,193 | 91,997 | 93,837 | 95,714 | 97,628 |
| Average Energy Rate Required | 0.1025 | 0.1046 | 0.0983 | 0.0967 | 0.0986 | 0.1006 | 0.1026 | 0.1047 | 0.1068 | 0.1089 | 0.1111 | 0.1133 | 0.1156 | 0.1179 | 0.1202 |
| **NPV Calculations at NWTPC ROR** | | | | | | | | | | | | | | | |
| Cumulative NPV Net Income | 32,741 | 34,062 | 45,112 | 56,796 | 67,556 | 77,466 | 86,592 | 94,997 | 102,738 | 109,866 | 116,201 | 122,035 | 127,408 | 132,356 | 136,913 |
| Cumulative NPV Project | (183,532) | (167,155) | (153,755) | (142,071) | (131,311) | (121,401) | (112,275) | (103,870) | (96,129) | (89,000) | (82,666) | (76,832) | (71,459) | (66,511) | (61,954) |
| **Project Internal Rate of Return** | | | | | | | | | | | | | | | |
| **Customer Benefit Analysis** | | | | | | | | | | | | | | | |
| Customer Annual Savings | 14,477 | 14,766 | 25,635 | 30,726 | 31,340 | 31,967 | 32,606 | 33,259 | 33,924 | 34,602 | 35,294 | 36,000 | 36,720 | 37,454 | 38,204 |
| Cumulative Annual Savings | 200,493 | 215,259 | 240,894 | 271,620 | 302,960 | 334,927 | 367,534 | 400,792 | 434,716 | 469,318 | 504,612 | 540,612 | 577,332 | 614,787 | 652,990 |
| Customer Capital Recovery | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Customer NPV @ 2nd Interest Rate | 115,092 | 119,766 | 127,351 | 135,847 | 143,946 | 151,666 | 159,026 | 166,042 | 172,730 | 179,105 | 185,183 | 190,976 | 196,499 | 201,764 | 206,782 |

# APPENDIX I

**Proposed Pangnirtung Residual Heat - Sole Ownership by NWTPC**
**- 10% Capital Contribution from Customer**

| | | | | | |
|---|---|---|---|---|---|
| Capital Cost: | 750,000 | Initial Annual O&M: | 29,076 | Interest rate (initial): | 7.00% |
| Initial Equity: | 0% | 0 Initial O&M Period (years): | 25 | (final): | 7.00% |
| Cost Factor (% avoided cost): | 90% | O&M Increase (1998$): | 2,000 | Interest Rate Break (years): | 5 |
| Profit Factor | 80% | Fuel LHV (kW/L): | 9.79 | Depreciation Cycle (years): | 40 |
| Initial Return to Equity | 10.00% | 7500 Fuel Cost ($/L): | 0.5800 | Depreciation Base: | 1.05 |
| NWTPC Blended ROR: | 10.755% | General Inflation: | 2.00% | Production Fuel Tax ($/l): | 0.031 |
| Customer Capital Contribution (% | 10.00% | Fuel Escalation: | 2.00% | Production Fuel used per Year (lit | 1,536,790 |
| | | | | Production Specific Heat Rate (k | 3.221 |

Table 1 - Customer Information

| Customers | Boiler Efficiency | Heat Delivered (MWh) | Fuel Displaced (Litres) | Fuel Displaced (1997 $) | Initial Rate ($/kWh) | Initial Revenue (1997 $) |
|---|---|---|---|---|---|---|
| High School | 0.7 | 917.17 | 133,835 | 77,624 | 0.0762 | 69,862 |
| Elementary School | 0.7 | 353.76 | 51,621 | 29,940 | 0.0762 | 26,946 |
| | | | 0 | 0 | 0.0000 | 0 |
| | | | 0 | 0 | 0.0000 | 0 |
| | | | 0 | 0 | 0.0000 | 0 |
| | | | 0 | 0 | 0.0000 | 0 |
| | | | 0 | 0 | 0.0000 | 0 |
| | | | 0 | 0 | 0.0000 | 0 |
| **Totals** | | **1,270.93** | **185,456** | **107,564** | **0.0762** | **96,808** |

Table 2 - Possible Customer Savings as a Percentage of Avoided Costs

| Year | Avoided Fuel Cost ($/kWh) | Average Heat Rate ($/kWh) | Customer Savings (%) |
|---|---|---|---|
| 15 | 0.1117 | 0.1013 | 9.3 |
| 20 | 0.1233 | 0.0986 | 20.0 |
| 25 | 0.1361 | 0.1089 | 20.0 |
| 30 | 0.1503 | 0.1202 | 20.0 |

| Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Financing and Operating Expenses** | | | | | | | | | | | | | | | | |
| Opening Balance | | (675,000) | (650,494) | (622,917) | (592,028) | (565,068) | (534,783) | (500,912) | (463,174) | (421,269) | (374,875) | (323,646) | (267,211) | (205,176) | (137,113) | (62,568) |
| Interest Expense | | (47,250) | (45,535) | (43,604) | (41,442) | (39,555) | (37,435) | (35,064) | (32,422) | (29,489) | (26,241) | (22,655) | (18,705) | (14,362) | (9,598) | (4,380) |
| Operating and Maintenance Cost | | (29,076) | (29,658) | (30,251) | (30,856) | (31,473) | (32,102) | (32,744) | (33,399) | (34,067) | (34,749) | (35,443) | (36,152) | (36,875) | (37,613) | (38,365) |
| Total Annual Expense | | (76,326) | (75,192) | (73,855) | (72,298) | (71,028) | (69,537) | (67,808) | (65,821) | (63,556) | (60,990) | (58,099) | (54,857) | (51,238) | (47,211) | (42,745) |
| **Revenues** | | | | | | | | | | | | | | | | |
| Annual Avoided Cost | | 107,564 | 109,716 | 111,910 | 114,148 | 116,431 | 118,760 | 121,135 | 123,558 | 126,029 | 128,550 | 131,121 | 133,743 | 136,418 | 139,146 | 141,929 |
| Total Annual Revenue | | 96,808 | 98,744 | 100,719 | 102,733 | 104,788 | 106,884 | 109,022 | 111,202 | 113,426 | 115,695 | 118,008 | 120,369 | 122,776 | 125,232 | 128,689 |
| Total Annual Expense | | (76,326) | (75,192) | (73,855) | (72,298) | (71,028) | (69,537) | (67,808) | (65,821) | (63,556) | (60,990) | (58,099) | (54,857) | (51,238) | (47,211) | (42,745) |
| Production Fuel Tax Savings | | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 |
| Net Revenue Before Tax & Depreciation | | 24,506 | 27,577 | 30,889 | 34,460 | 37,785 | 41,371 | 45,238 | 49,405 | 53,894 | 58,729 | 63,934 | 69,536 | 75,563 | 82,045 | 89,968 |
| Depreciation | | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) |
| Net Revenue | | 4,819 | 7,889 | 11,201 | 14,773 | 18,097 | 21,684 | 25,550 | 29,718 | 34,207 | 39,042 | 44,247 | 49,848 | 55,875 | 62,358 | 70,281 |
| Dividend or Retained Income | | 0 | 0 | 0 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 23,376 |
| Average Energy Rate Required | | 0.0762 | 0.0777 | 0.0792 | 0.0808 | 0.0824 | 0.0841 | 0.0858 | 0.0875 | 0.0892 | 0.0910 | 0.0929 | 0.0947 | 0.0966 | 0.0985 | 0.1013 |
| **NPV Calculations at NWTPC ROR** | | | | | | | | | | | | | | | | |
| Cumulative NPV Net Income | 0 | 0 | 0 | 0 | 4,984 | 9,485 | 13,548 | 17,217 | 20,529 | 23,520 | 26,220 | 28,659 | 30,860 | 32,848 | 34,642 | 39,693 |
| Cumulative NPV Project | (675,000) | (613,845) | (557,525) | (505,656) | (457,887) | (413,895) | (373,380) | (336,068) | (301,705) | (270,059) | (240,914) | (214,073) | (189,353) | (166,588) | (145,622) | (126,108) |
| **Project Internal Rate of Return** | **11.33%** | 15 | | | | | | | | | | | | | | |
| **Customer Benefit Analysis** | | | | | | | | | | | | | | | | |
| Customer Annual Savings | | 10,756 | 10,972 | 11,191 | 11,415 | 11,643 | 11,876 | 12,114 | 12,356 | 12,603 | 12,855 | 13,112 | 13,374 | 13,642 | 13,915 | 13,240 |
| Cumulative Annual Savings | | 10,756 | 21,728 | 32,919 | 44,334 | 55,977 | 67,853 | 79,966 | 92,322 | 104,925 | 117,780 | 130,892 | 144,266 | 157,908 | 171,823 | 185,063 |
| Customer Capital Recovery | | 80,250 | 82,964 | 85,737 | 88,568 | 91,459 | 94,408 | 97,415 | 100,481 | 103,603 | 106,783 | 110,019 | 113,312 | 116,660 | 120,062 | 123,519 |
| Customer NPV @ 2nd Interest Rate | (75,000) | (64,947) | (55,364) | (46,229) | (37,521) | (29,219) | (21,306) | (13,762) | (6,571) | 284 | 6,819 | 13,048 | 18,987 | 24,648 | 30,044 | 34,843 |
| Customer Internal Rate of Return | **17.88%** | | | | | | | | | | | | | | | |

# APPENDIX I

**Proposed Pangnirtung Residual Heat - Sole Ownership by NWTPC**
**- 10% Capital Contribution from Customer**

| | | | | | |
|---|---|---|---|---|---|
| Capital Cost: | 750,000 | | Initial Annual O&M: | 29,076 | Interest rate (initial): | 7.00% |
| Initial Equity: | 0% | 0 | Initial O&M Period (years): | 25 | (final): | 7.00% |
| Cost Factor (% avoided cost): | 90% | | O&M Increase (1998$): | 2,000 | Interest Rate Break (years): | 5 |
| Profit Factor | 80% | | Fuel LHV (kW/L): | 9.79 | Depreciation Cycle (years): | 40 |
| Initial Return to Equity | 10.00% | 7500 | Fuel Cost ($/L): | 0.5800 | Depreciation Base: | 1.05 |
| NWTPC Blended ROR: | 10.755% | | General Inflation: | 2.00% | Production Fuel Tax ($/l): | 0.031 |
| Customer Capital Contribution (% | 10.00% | | Fuel Escalation: | 2.00% | Production Fuel used per Year (lit | 1,536,790 |
| | | | | | Production Specific Heat Rate (kW | 3.221 |

Table 1 - Customer Information

| Customers | Boiler Efficiency | Heat Delivered (MWh) | Fuel Displaced (Litres) | Fuel Displaced (1997 $) | Initial Rate ($/kWh) | Initial Revenue (1997 $) |
|---|---|---|---|---|---|---|
| High School | 0.7 | 917.17 | 133,835 | 77,624 | 0.0762 | 69,862 |
| Elementary School | 0.7 | 353.76 | 51,621 | 29,940 | 0.0762 | 26,946 |
| | | | 0 | 0 | 0.0000 | 0 |
| | | | 0 | 0 | 0.0000 | 0 |
| | | | 0 | 0 | 0.0000 | 0 |
| | | | 0 | 0 | 0.0000 | 0 |
| | | | 0 | 0 | 0.0000 | 0 |
| | | | 0 | 0 | 0.0000 | 0 |
| **Totals** | | **1,270.93** | **185,456** | **107,564** | **0.0762** | **96,808** |

Table 2 - Possible Customer Savings as a Percentage of Avoided Costs

| Year | Avoided Fuel Cost ($/kWh) | Average Heat Rate ($/kWh) | Customer Savings (%) |
|---|---|---|---|
| 15 | 0.1117 | 0.1013 | 9.3 |
| 20 | 0.1233 | 0.0986 | 20.0 |
| 25 | 0.1361 | 0.1089 | 20.0 |
| 30 | 0.1503 | 0.1202 | 20.0 |

| Year | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Financing and Operating Expenses** | | | | | | | | | | | | | | | |
| Opening Balance | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Interest Expense | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Operating and Maintenance Cost | (39,132) | (39,915) | (40,713) | (41,528) | (42,358) | (43,205) | (44,070) | (44,951) | (45,850) | (46,767) | (50,983) | (52,003) | (53,043) | (54,104) | (55,186) |
| Total Annual Expense | (39,132) | (39,915) | (40,713) | (41,528) | (42,358) | (43,205) | (44,070) | (44,951) | (45,850) | (46,767) | (50,983) | (52,003) | (53,043) | (54,104) | (55,186) |
| **Revenues** | | | | | | | | | | | | | | | |
| Annual Avoided Cost | 144,768 | 147,663 | 150,616 | 153,629 | 156,701 | 159,835 | 163,032 | 166,293 | 169,618 | 173,011 | 176,471 | 180,000 | 183,600 | 187,272 | 191,018 |
| Total Annual Revenue | 115,814 | 118,130 | 120,493 | 122,903 | 125,361 | 127,868 | 130,425 | 133,034 | 135,695 | 138,409 | 141,177 | 144,000 | 146,880 | 149,818 | 152,814 |
| Total Annual Expense | (39,132) | (39,915) | (40,713) | (41,528) | (42,358) | (43,205) | (44,070) | (44,951) | (45,850) | (46,767) | (50,983) | (52,003) | (53,043) | (54,104) | (55,186) |
| Production Fuel Tax Savings | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 |
| Net Revenue Before Tax & Depreciatio | 80,706 | 82,240 | 83,804 | 85,400 | 87,027 | 88,687 | 90,380 | 92,107 | 93,869 | 95,666 | 94,218 | 96,022 | 97,861 | 99,738 | 101,652 |
| Depreciation | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) |
| Net Revenue | 61,019 | 62,552 | 64,116 | 65,712 | 67,340 | 69,000 | 70,693 | 72,420 | 74,182 | 75,979 | 74,530 | 76,334 | 78,174 | 80,051 | 81,965 |
| Dividend or Retained Income | 76,682 | 78,215 | 79,780 | 81,375 | 83,003 | 84,663 | 86,356 | 88,083 | 89,845 | 91,642 | 90,193 | 91,997 | 93,837 | 95,714 | 97,628 |
| Average Energy Rate Required | 0.0911 | 0.0929 | 0.0948 | 0.0967 | 0.0986 | 0.1006 | 0.1026 | 0.1047 | 0.1068 | [illegible] | 0.1111 | 0.1133 | 0.1156 | 0.1179 | 0.1202 |
| **NPV Calculations at NWTPC ROR** | | | | | | | | | | | | | | | |
| Cumulative NPV Net Income | 54,651 | 68,427 | 81,113 | 92,797 | 103,558 | 113,467 | 122,594 | 130,999 | 138,739 | 145,868 | 152,203 | 158,037 | 163,409 | 168,358 | 172,914 |
| Cumulative NPV Project | (111,150) | (97,374) | (84,687) | (73,004) | (62,243) | (52,333) | (43,207) | (34,802) | (27,062) | (19,933) | (13,598) | (7,764) | (2,391) | 2,557 | 7,114 |
| **Project Internal Rate of Return** | | | | | | | | | | | | | | | |
| **Customer Benefit Analysis** | | | | | | | | | | | | | | | |
| Customer Annual Savings | 28,954 | 29,533 | 30,123 | 30,726 | 31,340 | 31,967 | 32,606 | 33,259 | 33,924 | 34,602 | 35,294 | 36,000 | 36,720 | 37,454 | 38,204 |
| Cumulative Annual Savings | 214,016 | 243,549 | 273,672 | 304,398 | 335,738 | 367,705 | 400,312 | 433,570 | 467,494 | 502,096 | 537,390 | 573,390 | 610,110 | 647,565 | 685,768 |
| Customer Capital Recovery | 127,029 | 130,592 | 134,207 | 137,873 | 141,589 | 145,355 | 149,170 | 153,032 | 156,940 | 160,895 | 164,894 | 168,937 | 173,023 | 177,151 | 181,319 |
| Customer NPV @ 2nd Interest Rate | 44,650 | 54,000 | 62,912 | 71,408 | 79,507 | 87,227 | 94,587 | 101,603 | 108,291 | 114,666 | 120,744 | 126,537 | 132,060 | 137,325 | 142,343 |
| Customer Internal Rate of Return | | | | | | | | | | | | | | | |

# APPENDIX I

**Proposed Pangnirtung Residual Heat - Sole Ownership by NWTPC**
**- 25% Capital Contribution from Customer**

| | | | | | | |
|---|---|---|---|---|---|---|
| Capital Cost: | 750,000 | | Initial Annual O&M: | 29,076 | Interest rate (initial): | 7.00% |
| Initial Equity: | 0% | 0 | Initial O&M Period (years): | 25 | (final): | 7.00% |
| Cost Factor (% avoided cost): | 85% | | O&M Increase (1998$): | 2,000 | Interest Rate Break (years): | 5 |
| Profit Factor | 75% | | Fuel LHV (kW/L): | 9.79 | Depreciation Cycle (years): | 40 |
| Initial Return to Equity | 10.00% | 7500 | Fuel Cost ($/L): | 0.5800 | Depreciation Base: | 1.05 |
| NWTPC Blended ROR: | 10.755% | | General Inflation: | 2.00% | Production Fuel Tax ($/l): | 0.031 |
| Customer Capital Contribution (% | 25.00% | | Fuel Escalation: | 2.00% | Production Fuel used per Year (lit | 1,536,790 |
| | | | | | Production Specific Heat Rate (k | 3.221 |

Table 1 - Customer Information

| Customers | Boiler Efficiency | Heat Delivered (MWh) | Fuel Displaced (Litres) | Fuel Displaced (1997 $) | Initial Rate ($/kWh) | Initial Revenue (1997 $) |
|---|---|---|---|---|---|---|
| High School | 0.7 | 917.17 | 133,835 | 77,624 | 0.0719 | 65,981 |
| Elementary School | 0.7 | 353.76 | 51,621 | 29,940 | 0.0719 | 25,449 |
| | | | 0 | 0 | 0.0000 | 0 |
| | | | 0 | 0 | 0.0000 | 0 |
| | | | 0 | 0 | 0.0000 | 0 |
| | | | 0 | 0 | 0.0000 | 0 |
| | | | 0 | 0 | 0.0000 | 0 |
| | | | 0 | 0 | 0.0000 | 0 |
| **Totals** | | **1,270.93** | **185,456** | **107,564** | **0.0719** | **91,430** |

Table 2 - Possible Customer Savings as a Percentage of Avoided Costs

| Year | Avoided Fuel Cost ($/kWh) | Average Heat Rate ($/kWh) | Customer Savings (%) |
|---|---|---|---|
| 15 | 0.1117 | 0.0838 | 25.0 |
| 20 | 0.1233 | 0.0925 | 25.0 |
| 25 | 0.1361 | 0.1021 | 25.0 |
| 30 | 0.1503 | 0.1127 | 25.0 |

| Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Financing and Operating Expenses** | | | | | | | | | | | | | | | | |
| Opening Balance | | (562,500) | (535,497) | (505,356) | (479,334) | (450,193) | (417,688) | (381,558) | (341,522) | (297,279) | (248,507) | (194,860) | (135,966) | (71,431) | (827) | 0 |
| Interest Expense | | (39,375) | (37,485) | (35,375) | (33,553) | (31,513) | (29,238) | (26,709) | (23,907) | (20,810) | (17,395) | (13,640) | (9,518) | (5,000) | (58) | 0 |
| Operating and Maintenance Cost | | (29,076) | (29,658) | (30,251) | (30,856) | (31,473) | (32,102) | (32,744) | (33,399) | (34,067) | (34,749) | (35,443) | (36,152) | (36,875) | (37,613) | (38,365) |
| Total Annual Expense | | (68,451) | (67,142) | (65,626) | (64,409) | (62,986) | (61,340) | (59,453) | (57,306) | (54,877) | (52,144) | (49,084) | (45,670) | (41,876) | (37,671) | (38,365) |
| **Revenues** | | | | | | | | | | | | | | | | |
| Annual Avoided Cost | | 107,564 | 109,716 | 111,910 | 114,148 | 116,431 | 118,760 | 121,135 | 123,558 | 126,029 | 128,550 | 131,121 | 133,743 | 136,418 | 139,146 | 141,929 |
| Total Annual Revenue | | 91,430 | 93,258 | 95,124 | 97,026 | 98,967 | 100,946 | 102,965 | 105,024 | 107,125 | 109,267 | 111,452 | 113,681 | 115,955 | 105,127 | 106,447 |
| Total Annual Expense | | (68,451) | (67,142) | (65,626) | (64,409) | (62,986) | (61,340) | (59,453) | (57,306) | (54,877) | (52,144) | (49,084) | (45,670) | (41,876) | (37,671) | (38,365) |
| Production Fuel Tax Savings | | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 |
| Net Revenue Before Tax & Depreciation | | 27,003 | 30,141 | 33,522 | 36,641 | 40,005 | 43,630 | 47,536 | 51,743 | 56,272 | 61,147 | 66,393 | 72,036 | 78,104 | 71,480 | 72,106 |
| Depreciation | | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) |
| Net Revenue | | 7,316 | 10,453 | 13,835 | 16,954 | 20,317 | 23,942 | 27,848 | 32,055 | 36,585 | 41,460 | 46,706 | 52,348 | 58,416 | 51,793 | 52,419 |
| Dividend or Retained Income | | 0 | 0 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 66,630 | 68,082 |
| Average Energy Rate Required | | 0.0719 | 0.0734 | 0.0748 | 0.0763 | 0.0779 | 0.0794 | 0.0810 | 0.0826 | 0.0843 | 0.0860 | 0.0877 | 0.0894 | 0.0912 | 0.0827 | 0.0838 |
| **NPV Calculations at NWTPC ROR** | | | | | | | | | | | | | | | | |
| Cumulative NPV Net Income | 0 | 0 | 0 | 5,520 | 10,505 | 15,005 | 19,068 | 22,737 | 26,050 | 29,040 | 31,741 | 34,179 | 36,380 | 38,368 | 54,311 | 69,020 |
| Cumulative NPV Project | (562,500) | (506,201) | (454,353) | (406,603) | (362,627) | (322,128) | (284,830) | (250,481) | (218,846) | (189,713) | (162,882) | (138,172) | (115,416) | (94,458) | (78,303) | (63,594) |
| **Project Internal Rate of Return** | **12.32%** | 23 | | | | | | | | | | | | | | |
| **Customer Benefit Analysis** | | | | | | | | | | | | | | | | |
| Customer Annual Savings | | 16,135 | 16,457 | 16,787 | 17,122 | 17,465 | 17,814 | 18,170 | 18,534 | 18,904 | 19,282 | 19,668 | 20,061 | 20,463 | 34,019 | 35,482 |
| Cumulative Annual Savings | | 16,135 | 32,592 | 49,379 | 66,501 | 83,965 | 101,779 | 119,950 | 138,483 | 157,388 | 176,670 | 196,338 | 216,400 | 236,862 | 270,882 | 306,364 |
| Customer Capital Recovery | | 200,625 | 207,409 | 214,342 | 221,421 | 228,648 | 236,020 | 243,539 | 251,202 | 259,008 | 266,958 | 275,049 | 283,279 | 291,649 | 300,155 | 308,797 |
| Customer NPV @ 2nd Interest Rate | (187,500) | (172,421) | (158,046) | (144,344) | (131,281) | (118,829) | (106,959) | (95,643) | (84,857) | (74,574) | (64,772) | (55,427) | (46,520) | (38,029) | (24,835) | (11,975) |
| Customer Internal Rate of Return | **11.96%** | 4 | | | | | | | | | | | | | | |

# APPENDIX I

**Proposed Pangnirtung Residual Heat - Sole Ownership by NWTPC**
**- 25% Capital Contribution from Customer**

| | | | | | |
|---|---|---|---|---|---|
| Capital Cost: | 750,000 | | Initial Annual O&M: | 29,076 | |
| Initial Equity: | 0% | 0 | Initial O&M Period (years): | 25 | |
| Cost Factor (% avoided cost): | 85% | | O&M Increase (1998$): | 2,000 | |
| Profit Factor | 75% | | Fuel LHV (kW/L): | 9.79 | |
| Initial Return to Equity | 10.00% | 7500 | Fuel Cost ($/L): | 0.5800 | |
| NWTPC Blended ROR: | 10.755% | | General Inflation: | 2.00% | |
| Customer Capital Contribution (%): | 25.00% | | Fuel Escalation: | 2.00% | |

| | |
|---|---|
| Interest rate (initial): | 7.00% |
| (final): | 7.00% |
| Interest Rate Break (years): | 5 |
| Depreciation Cycle (years): | 40 |
| Depreciation Base: | 1.05 |
| Production Fuel Tax ($/l): | 0.031 |
| Production Fuel used per Year (litres): | 1,536,790 |
| Production Specific Heat Rate (kWh/l): | 3.221 |

Table 1 - Customer Information

| Customers | Boiler Efficiency | Heat Delivered (MWh) | Fuel Displaced (Litres) | Fuel Displaced (1997 $) | Initial Rate ($/kWh) | Initial Revenue (1997 $) |
|---|---|---|---|---|---|---|
| High School | 0.7 | 917.17 | 133,835 | 77,624 | 0.0719 | 65,981 |
| Elementary School | 0.7 | 353.76 | 51,621 | 29,940 | 0.0719 | 25,449 |
| | | | 0 | 0 | 0.0000 | 0 |
| | | | 0 | 0 | 0.0000 | 0 |
| | | | 0 | 0 | 0.0000 | 0 |
| | | | 0 | 0 | 0.0000 | 0 |
| | | | 0 | 0 | 0.0000 | 0 |
| | | | 0 | 0 | 0.0000 | 0 |
| **Totals** | | **1,270.93** | **185,456** | **107,564** | **0.0719** | **91,430** |

Table 2 - Possible Customer Savings as a Percentage of Avoided Costs

| Year | Avoided Fuel Cost ($/kWh) | Average Heat Rate ($/kWh) | Customer Savings (%) |
|---|---|---|---|
| 15 | 0.1117 | 0.0838 | 25.0 |
| 20 | 0.1233 | 0.0925 | 25.0 |
| 25 | 0.1361 | 0.1021 | 25.0 |
| 30 | 0.1503 | 0.1127 | 25.0 |

| Year | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Financing and Operating Expenses** | | | | | | | | | | | | | | | |
| Opening Balance | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Interest Expense | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Operating and Maintenance Cost | (39,132) | (39,915) | (40,713) | (41,528) | (42,358) | (43,205) | (44,070) | (44,951) | (45,850) | (46,767) | (50,983) | (52,003) | (53,043) | (54,104) | (55,186) |
| Total Annual Expense | (39,132) | (39,915) | (40,713) | (41,528) | (42,358) | (43,205) | (44,070) | (44,951) | (45,850) | (46,767) | (50,983) | (52,003) | (53,043) | (54,104) | (55,186) |
| **Revenues** | | | | | | | | | | | | | | | |
| Annual Avoided Cost | 144,768 | 147,663 | 150,616 | 153,629 | 156,701 | 159,835 | 163,032 | 166,293 | 169,618 | 173,011 | 176,471 | 180,000 | 183,600 | 187,272 | 191,018 |
| Total Annual Revenue | 108,576 | 110,747 | 112,962 | 115,221 | 117,526 | 119,876 | 122,274 | 124,719 | 127,214 | 129,758 | 132,353 | 135,000 | 137,700 | 140,454 | 143,263 |
| Total Annual Expense | (39,132) | (39,915) | (40,713) | (41,528) | (42,358) | (43,205) | (44,070) | (44,951) | (45,850) | (46,767) | (50,983) | (52,003) | (53,043) | (54,104) | (55,186) |
| Production Fuel Tax Savings | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 |
| Net Revenue Before Tax & Depreciatio | 73,468 | 74,857 | 76,273 | 77,718 | 79,192 | 80,695 | 82,229 | 83,793 | 85,388 | 87,016 | 85,394 | 87,022 | 88,681 | 90,375 | 92,102 |
| Depreciation | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) |
| Net Revenue | 53,780 | 55,169 | 56,586 | 58,031 | 59,505 | 61,008 | 62,541 | 64,105 | 65,701 | 67,328 | 65,707 | 67,334 | 68,994 | 70,687 | 72,414 |
| Dividend or Retained Income | 69,443 | 70,832 | 72,249 | 73,694 | 75,168 | 76,671 | 78,204 | 79,768 | 81,364 | 82,991 | 81,370 | 82,997 | 84,657 | 86,350 | 88,077 |
| Average Energy Rate Required | 0.0854 | 0.0871 | 0.0889 | 0.0907 | 0.0925 | 0.0943 | 0.0962 | 0.0981 | 0.1001 | 0.1021 | 0.1041 | 0.1062 | 0.1083 | 0.1105 | 0.1127 |
| **NPV Calculations at NWTPC ROR** | | | | | | | | | | | | | | | |
| Cumulative NPV Net Income | 82,567 | 95,042 | 106,531 | 117,112 | 126,857 | 135,831 | 144,096 | 151,707 | 158,717 | 165,173 | 170,888 | 176,151 | 180,999 | 185,463 | 189,574 |
| Cumulative NPV Project | (50,048) | (37,573) | (26,084) | (15,503) | (5,758) | 3,216 | 11,481 | 19,093 | 26,103 | 32,558 | 38,273 | 43,537 | 48,384 | 52,848 | 56,959 |
| **Project Internal Rate of Return** | | | | | | | | | | | | | | | |
| **Customer Benefit Analysis** | | | | | | | | | | | | | | | |
| Customer Annual Savings | 36,192 | 36,916 | 37,654 | 38,407 | 39,175 | 39,959 | 40,758 | 41,573 | 42,405 | 43,253 | 44,118 | 45,000 | 45,900 | 46,818 | 47,754 |
| Cumulative Annual Savings | 342,556 | 379,472 | 417,126 | 455,533 | 494,708 | 534,667 | 575,425 | 616,998 | 659,402 | 702,655 | 746,773 | 791,773 | 837,673 | 884,491 | 932,246 |
| Customer Capital Recovery | 317,573 | 326,480 | 335,518 | 344,683 | 353,973 | 363,388 | 372,924 | 382,579 | 392,351 | 402,237 | 412,235 | 422,343 | 432,558 | 442,877 | 453,299 |
| Customer NPV @ 2nd Interest Rate | 284 | 11,971 | 23,112 | 33,731 | 43,855 | 53,506 | 62,705 | 71,475 | 79,835 | 87,804 | 95,401 | 102,643 | 109,546 | 116,127 | 122,401 |
| Customer Internal Rate of Return | | | | | | | | | | | | | | | |

# APPENDIX I

**Proposed Pangnirtung Residual Heat - Sole Ownership by NWTPC**
**- 50% Capital Contribution from Customer**

| | | | | | |
|---|---|---|---|---|---|
| Capital Cost: | 750,000 | Initial Annual O&M: | 29,076 | Interest rate (initial): | 7.00% |
| Initial Equity: | 0% | 0 Initial O&M Period (years): | 25 | (final): | 7.00% |
| Cost Factor (% avoided cost): | 65% | O&M Increase (1998$): | 2,000 | Interest Rate Break (years): | 5 |
| Profit Factor | 60% | Fuel LHV (kW/L): | 9.79 | Depreciation Cycle (years): | 40 |
| Initial Return to Equity | 10.00% | 7500 Fuel Cost ($/L): | 0.5800 | Depreciation Base: | 1.05 |
| NWTPC Blended ROR: | 10.755% | General Inflation: | 2.00% | Production Fuel Tax ($/l): | 0.031 |
| Customer Capital Contribution (% | 50.00% | Fuel Escalation: | 2.00% | Production Fuel used per Year (lit | 1,536,790 |
| | | | | Production Specific Heat Rate (k | 3.221 |

Table 1 - Customer Information

| Customers | Boiler Efficiency | Heat Delivered (MWh) | Fuel Displaced (Litres) | Fuel Displaced (1997 $) | Initial Rate ($/kWh) | Initial Revenue (1997 $) |
|---|---|---|---|---|---|---|
| High School | 0.7 | 917.17 | 133,835 | 77,624 | 0.0550 | 50,456 |
| Elementary School | 0.7 | 353.76 | 51,621 | 29,940 | 0.0550 | 19,461 |
| | | | 0 | 0 | 0.0000 | 0 |
| | | | 0 | 0 | 0.0000 | 0 |
| | | | 0 | 0 | 0.0000 | 0 |
| | | | 0 | 0 | 0.0000 | 0 |
| | | | 0 | 0 | 0.0000 | 0 |
| | | | 0 | 0 | 0.0000 | 0 |
| **Totals** | | **1,270.93** | **185,456** | **107,564** | **0.0550** | **69,917** |

Table 2 - Possible Customer Savings as a Percentage of Avoided Costs

| Year | Avoided Fuel Cost ($/kWh) | Average Heat Rate ($/kWh) | Customer Savings (%) |
|---|---|---|---|
| 15 | 0.1117 | 0.0670 | 40.0 |
| 20 | 0.1233 | 0.0740 | 40.0 |
| 25 | 0.1361 | 0.0817 | 40.0 |
| 30 | 0.1503 | 0.0902 | 40.0 |

| Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Financing and Operating Expenses** | | | | | | | | | | | | | | | | |
| Opening Balance | | (375,000) | (356,385) | (335,649) | (312,630) | (287,149) | (259,017) | (228,032) | (201,477) | (172,142) | (139,816) | (104,270) | (65,260) | (22,523) | 0 | 0 |
| Interest Expense | | (26,250) | (24,947) | (23,495) | (21,884) | (20,100) | (18,131) | (15,962) | (14,103) | (12,050) | (9,787) | (7,299) | (4,568) | (1,577) | 0 | 0 |
| Operating and Maintenance Cost | | (29,076) | (29,658) | (30,251) | (30,856) | (31,473) | (32,102) | (32,744) | (33,399) | (34,067) | (34,749) | (35,443) | (36,152) | (36,875) | (37,613) | (38,365) |
| Total Annual Expense | | (55,326) | (54,604) | (53,746) | (52,740) | (51,573) | (50,233) | (48,707) | (47,503) | (46,117) | (44,536) | (42,742) | (40,721) | (38,452) | (37,613) | (38,365) |
| **Revenues** | | | | | | | | | | | | | | | | |
| Annual Avoided Cost | | 107,564 | 109,716 | 111,910 | 114,148 | 116,431 | 118,760 | 121,135 | 123,558 | 126,029 | 128,550 | 131,121 | 133,743 | 136,418 | 139,146 | 141,929 |
| Total Annual Revenue | | 69,917 | 71,315 | 72,742 | 74,196 | 75,680 | 77,194 | 78,738 | 80,313 | 81,919 | 83,557 | 85,228 | 86,933 | 88,468 | 83,488 | 85,157 |
| Total Annual Expense | | (55,326) | (54,604) | (53,746) | (52,740) | (51,573) | (50,233) | (48,707) | (47,503) | (46,117) | (44,536) | (42,742) | (40,721) | (38,452) | (37,613) | (38,365) |
| Production Fuel Tax Savings | | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 |
| Net Revenue Before Tax & Depreciation | | 18,615 | 20,735 | 23,020 | 25,481 | 28,132 | 30,985 | 34,056 | 36,834 | 39,826 | 43,046 | 46,510 | 50,237 | 54,040 | 49,899 | 50,817 |
| Depreciation | | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) |
| Net Revenue | | (1,072) | 1,048 | 3,332 | 5,794 | 8,444 | 11,297 | 14,368 | 17,147 | 20,139 | 23,358 | 26,823 | 30,549 | 34,353 | 30,212 | 31,129 |
| Dividend or Retained Income | | 0 | 0 | 0 | 0 | 0 | 0 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 27,493 | 45,875 | 46,792 |
| Average Energy Rate Required | | 0.0550 | 0.0561 | 0.0572 | 0.0584 | 0.0595 | 0.0607 | 0.0620 | 0.0632 | 0.0645 | 0.0657 | 0.0671 | 0.0684 | 0.0696 | 0.0657 | 0.0670 |
| **NPV Calculations at NWTPC ROR** | | | | | | | | | | | | | | | | |
| Cumulative NPV Net Income | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3,669 | 6,981 | 9,972 | 12,672 | 15,111 | 17,312 | 24,598 | 35,575 | 45,685 |
| Cumulative NPV Project | (375,000) | (338,125) | (304,165) | (272,889) | (244,086) | (217,559) | (193,130) | (170,631) | (149,911) | (130,829) | (113,256) | (97,071) | (82,166) | (68,493) | (57,516) | (47,406) |
| **Project Internal Rate of Return** | **12.23%** | (1) | | | | | | | | | | | | | | |
| **Customer Benefit Analysis** | | | | | | | | | | | | | | | | |
| Customer Annual Savings | | 37,648 | 38,401 | 39,169 | 39,952 | 40,751 | 41,566 | 42,397 | 43,245 | 44,110 | 44,992 | 45,892 | 46,810 | 47,950 | 55,658 | 56,772 |
| Cumulative Annual Savings | | 37,648 | 76,048 | 115,217 | 155,169 | 195,919 | 237,485 | 279,883 | 323,128 | 367,238 | 412,230 | 458,123 | 504,933 | 552,882 | 608,541 | 665,312 |
| Customer Capital Recovery | | 401,250 | 414,819 | 428,683 | 442,842 | 457,295 | 472,041 | 487,077 | 502,403 | 518,017 | 533,916 | 550,097 | 566,559 | 583,298 | 600,311 | 617,595 |
| Customer NPV @ 2nd Interest Rate | (375,000) | (339,815) | (306,275) | (274,302) | (243,823) | (214,768) | (187,071) | (160,668) | (135,499) | (111,506) | (88,634) | (66,831) | (46,046) | (26,149) | (4,564) | 16,013 |
| Customer Internal Rate of Return | **12.20%** | (13) | | | | | | | | | | | | | | |

# APPENDIX I

**Proposed Pangnirtung Residual Heat - Sole Ownership by NWTPC**
**- 50% Capital Contribution from Customer**

| | | | | | |
|---|---|---|---|---|---|
| Capital Cost: | 750,000 | | Initial Annual O&M: | 29,076 | Interest rate (initial): | 7.00% |
| Initial Equity: | 0% | 0 | Initial O&M Period (years): | 25 | (final): | 7.00% |
| Cost Factor (% avoided cost): | 65% | | O&M Increase (1998$): | 2,000 | Interest Rate Break (years): | 5 |
| Profit Factor | 60% | | Fuel LHV (kW/L): | 9.79 | Depreciation Cycle (years): | 40 |
| Initial Return to Equity | 10.00% | 7500 | Fuel Cost ($/L): | 0.5800 | Depreciation Base: | 1.05 |
| NWTPC Blended ROR: | 10.755% | | General Inflation: | 2.00% | Production Fuel Tax ($/l): | 0.031 |
| Customer Capital Contribution (%) | 50.00% | | Fuel Escalation: | 2.00% | Production Fuel used per Year (litr | 1,536,790 |
| | | | | | Production Specific Heat Rate (kW | 3.221 |

Table 1 - Customer Information

| Customers | Boiler Efficiency | Heat Delivered (MWh) | Fuel Displaced (Litres) | Fuel Displaced (1997 $) | Initial Rate ($/kWh) | Initial Revenue (1997 $) |
|---|---|---|---|---|---|---|
| High School | 0.7 | 917.17 | 133,835 | 77,624 | 0.0550 | 50,456 |
| Elementary School | 0.7 | 353.76 | 51,621 | 29,940 | 0.0550 | 19,461 |
| | | | 0 | 0 | 0.0000 | 0 |
| | | | 0 | 0 | 0.0000 | 0 |
| | | | 0 | 0 | 0.0000 | 0 |
| | | | 0 | 0 | 0.0000 | 0 |
| | | | 0 | 0 | 0.0000 | 0 |
| | | | 0 | 0 | 0.0000 | 0 |
| **Totals** | | **1,270.93** | **185,456** | **107,564** | **0.0550** | **69,917** |

Table 2 - Possible Customer Savings as a Percentage of Avoided Costs

| Year | Avoided Fuel Cost ($/kWh) | Average Heat Rate ($/kWh) | Customer Savings (%) |
|---|---|---|---|
| 15 | 0.1117 | 0.0670 | 40.0 |
| 20 | 0.1233 | 0.0740 | 40.0 |
| 25 | 0.1361 | 0.0817 | 40.0 |
| 30 | 0.1503 | 0.0902 | 40.0 |

| Year | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Financing and Operating Expenses** | | | | | | | | | | | | | | | |
| Opening Balance | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Interest Expense | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Operating and Maintenance Cost | (39,132) | (39,915) | (40,713) | (41,528) | (42,358) | (43,205) | (44,070) | (44,951) | (45,850) | (46,767) | (50,983) | (52,003) | (53,043) | (54,104) | (55,186) |
| Total Annual Expense | (39,132) | (39,915) | (40,713) | (41,528) | (42,358) | (43,205) | (44,070) | (44,951) | (45,850) | (46,767) | (50,983) | (52,003) | (53,043) | (54,104) | (55,186) |
| **Revenues** | | | | | | | | | | | | | | | |
| Annual Avoided Cost | 144,768 | 147,663 | 150,616 | 153,629 | 156,701 | 159,835 | 163,032 | 166,293 | 169,618 | 173,011 | 176,471 | 180,000 | 183,600 | 187,272 | 191,018 |
| Total Annual Revenue | 86,861 | 88,598 | 90,370 | 92,177 | 94,021 | 95,901 | 97,819 | 99,776 | 101,771 | 103,806 | 105,883 | 108,000 | 110,160 | 112,363 | 114,611 |
| Total Annual Expense | (39,132) | (39,915) | (40,713) | (41,528) | (42,358) | (43,205) | (44,070) | (44,951) | (45,850) | (46,767) | (50,983) | (52,003) | (53,043) | (54,104) | (55,186) |
| Production Fuel Tax Savings | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 | 4,024 |
| Net Revenue Before Tax & Depreciatio | 51,753 | 52,707 | 53,681 | 54,674 | 55,687 | 56,720 | 57,774 | 58,849 | 59,945 | 61,064 | 58,923 | 60,021 | 61,141 | 62,284 | 63,449 |
| Depreciation | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) | (19,688) |
| Net Revenue | 32,065 | 33,020 | 33,993 | 34,986 | 35,999 | 37,033 | 38,087 | 39,161 | 40,258 | 41,376 | 39,236 | 40,334 | 41,454 | 42,596 | 43,761 |
| Dividend or Retained Income | 47,728 | 48,683 | 49,656 | 50,649 | 51,662 | 52,696 | 53,750 | 54,825 | 55,921 | 57,040 | 54,899 | 55,997 | 57,117 | 58,259 | 59,425 |
| Average Energy Rate Required | 0.0683 | 0.0697 | 0.0711 | 0.0725 | 0.0740 | 0.0755 | 0.0770 | 0.0785 | 0.0801 | 0.0817 | 0.0833 | 0.0850 | 0.0867 | 0.0884 | 0.0902 |
| **NPV Calculations at NWTPC ROR** | | | | | | | | | | | | | | | |
| Cumulative NPV Net Income | 54,995 | 63,569 | 71,466 | 78,738 | 85,435 | 91,603 | 97,284 | 102,515 | 107,333 | 111,770 | 115,626 | 119,177 | 122,447 | 125,459 | 128,233 |
| Cumulative NPV Project | (38,096) | (29,522) | (21,625) | (14,353) | (7,656) | (1,488) | 4,193 | 9,424 | 14,242 | 18,679 | 22,535 | 26,086 | 29,356 | 32,368 | 35,142 |
| **Project Internal Rate of Return** | | | | | | | | | | | | | | | |
| **Customer Benefit Analysis** | | | | | | | | | | | | | | | |
| Customer Annual Savings | 57,907 | 59,065 | 60,246 | 61,451 | 62,680 | 63,934 | 65,213 | 66,517 | 67,847 | 69,204 | 70,588 | 72,000 | 73,440 | 74,909 | 76,407 |
| Cumulative Annual Savings | 723,219 | 782,285 | 842,531 | 903,983 | 966,663 | 1,030,597 | 1,095,810 | 1,162,327 | 1,230,174 | 1,299,378 | 1,369,967 | 1,441,967 | 1,515,407 | 1,590,316 | 1,666,723 |
| Customer Capital Recovery | 635,146 | 652,961 | 671,035 | 689,365 | 707,947 | 726,776 | 745,848 | 765,158 | 784,701 | 804,474 | 824,470 | 844,686 | 865,115 | 885,754 | 906,597 |
| Customer NPV @ 2nd Interest Rate | 35,628 | 54,327 | 72,151 | 89,143 | 105,341 | 120,782 | 135,501 | 149,533 | 162,909 | 175,660 | 187,815 | 199,402 | 210,447 | 220,977 | 231,014 |

## APPENDIX II - Sample Performance Evaluation for Residual Heat System

## Fort McPherson Water Treatment Plant

Residual Heat System Performance Analysis

| | | | |
|---|---|---|---|
| Connection Date: | 01-Feb-97 | Fuel Price used in Rate Formula ($/L) | |
| Fuel Heating Value (kWh/L): | 9.79 | Nov-97 | 0.5971 GST In |
| Building System Efficiency: | 0.7 | | |
| DHS Energy Charge ($/kWh): | 0.0698 | Fuel Price Charged to WTP | |
| DHS Delivery Efficiency: | 0.8900 | | 0.5600 GST Out |

| Period | | | Fuel Delivered (litres) | Heating Deg Days (18°C) | Litres per Deg Day | Cost per Deg Day ('97$) | Number of Days | Litres per Day | Cost per Day ('97$) |
|---|---|---|---|---|---|---|---|---|---|
| 29-May-95 | to | 20-Jun-96 | 117,243 | 9,056 | 12.95 | 7.25 | 388 | 302.17 | 169.22 |
| 01-Sep-95 | to | 02-Sep-96 | 111,597 | 9,033 | 12.35 | 6.92 | 367 | 304.08 | 170.28 |
| 06-Nov-95 | to | 04-Nov-96 | 106,087 | 9,316 | 11.39 | 6.38 | 364 | 291.45 | 163.21 |
| 18-Dec-95 | to | 19-Dec-96 | 102,334 | 9,398 | 10.89 | 6.10 | 367 | 278.84 | 156.15 |
| 11-Jan-96 | to | 07-Jan-97 | 93,930 | 9,319 | 10.08 | 5.64 | 362 | 259.48 | 145.31 |
| 06-Feb-96 | to | 04-Feb-97 | 88,427 | 9,486 | 9.32 | 5.22 | 364 | 242.93 | 136.04 |
| **Averages** | | | **103,270** | **9,268** | **11.14** | **6.24** | **369** | **280.12** | **156.87** |
| 04-Feb-97 | to | 10-Dec-97 | 10,948 | 6,185 | 1.77 | 0.99 | 309 | 35.43 | 19.84 |

**05-Feb-97 to 10-Dec-97**

| | | | |
|---|---|---|---|
| DHS Heat (kWh): | 404,347 | Cost per Day Savings (Average) | 32.94% |
| Price to WTP, no GST ($/kWh): | 0.0652 | As percent of Avoided Fuel Costs | 37.71% |
| Total Fuel Cost ($): | 6,130.88 | | |
| Total DHS Heat Cost ($): | 26,373.61 | Cost per Day Savings (Lowest Year) | 22.68% |
| Total Cost for Period ($): | 32,504.49 | As percent of Avoided Fuel Costs | 26.55% |
| Cost per DD ($/DD): | 5.2550 | | |
| Cost per Day ($/Day): | 105.1925 | Cost per Day Savings (Highest Year) | 38.23% |
| | | As percent of Avoided Fuel Costs | 43.27% |

Notes:

1. All periods start and end on the date of a fuel delivery.
2. Fuel delivered for the period does not include delivery on the first day of the period, therefore tank can be assumed to be full at the beginning of the period, and filled on the last day of the period.
3. Fuel delivery quantities supplied by Petroleum Products Division

The above sample performance analysis is from actual performance of the system in Fort McPherson. The analysis is not complete as there is not yet one full year of data for the Water Treatment Plant operating on the residual heat system.

## APPENDIX III - Sample Copy of Heat Supply Agreement

# HEAT SUPPLY AGREEMENT

**THIS HEAT SUPPLY AGREEMENT** made as of this ● day of ●, 19●

**BETWEEN**

**Northwest Territories Power Corporation ("Corporation")**

- and -

● ("**Customer**")

**WHEREAS**the Corporation owns and operates a system to distribute Heat for domestic heating purposes to customers within ● in the Northwest Territories; and

**WHEREAS** Customer wishes to purchase from the Corporation, and the Corporation is willing to supply and sell to Customer, Heat for domestic heating purposes on the terms set forth herein;

**NOW THEREFORE THIS AGREEMENT WITNESSES** that, in consideration of the premises and the terms and conditions hereinafter set forth, the parties covenant and agree as follows:

## 1. Definitions

1.1 The following terms, when used in this Agreement, have the meanings and definitions set out below:

"**Commencement Date**" means the date the installation of the Connecting Facilities is complete and the Connecting Facilities are placed in service by The Corporation;

"**Connecting Facilities**" means the piping and other facilities necessary to connect Customer's Heating Plant to the Residual Heating System;

"**Customer's Building**" means the building or structure described in Part 1 of Schedule "A" attached to this Agreement;

"**Customer's Heating Plant**" means equipment and facilities located in Customer's Building used for the production, distribution and control of Heat within Customer's

Building;

"**Delivery Point**" means the point of connection between Connecting Facilities and Customer's Heating Plant where the transfer of Heat from the Residual Heating System to the Customer's Heating Plant takes place;

"**Residual Heating System**" means the piping and other facilities owned and operated by the Corporation necessary to deliver Heat to Customer at the Delivery Point;

"**Heat**" means thermal energy;

"**Heating Fuel**" means P-50 diesel fuel or such other fuel the Corporation reasonably determines is readily available in ● for use by Customer as a fuel in Customer's Heating Plant;

"**Hot Water**" means a mixture of heated water and propylene glycol;

"**Public Utilities Board**" means the Northwest Territories Public Utilities Board or any other person or body having authority to approve or determine the Corporation's rates and terms and conditions of service from time to time; and

"**Rate**" means the charge for the supply of Heat determined pursuant to the provisions of this Agreement.

## 2. Supply Obligation

2.1 Subject to the other terms and conditions of this Agreement, commencing on the Commencement Date the Corporation will make available and sell to Customer at the Delivery Point, and Customer shall take delivery of and purchase from the Corporation, such Heat as may be required by Customer for heating purposes and as may be available from time to time from the Residual Heating System;

2.2 Customer acknowledges and agrees that the amount of Heat available to the Corporation for distribution to its customers will vary from time to time and, as a result, the amount of Heat delivered to Customer will also vary. The Corporation is not obligated to deliver any amount of Heat, or any Heat at all, to Customer.

2.3 The Corporation shall proceed, at its own cost, to design and install the Connecting Facilities and shall own and be responsible for all costs of operating and maintaining the Connecting Facilities. Customer shall own and be responsible for all costs of operating and maintaining Customer's Heating Plant.

2.4 Customer acknowledges and understands that the Heat supply available to the

Corporation can be interrupted, curtailed or reduced at any time and from time to time or terminated, and that the Corporation may from time to time interrupt, curtail or reduce operation of the Residual Heating System including the Connecting Facilities when Heat is not available to the Corporation, or to effect repairs, maintenance, replacement or upgrading or other work related to its facilities and that as a result the supply of Heat available to Customer may interrupted, curtailed or reduced from time to time or terminated without prior notice to Customer.

2.5 The Corporation shall have no liability to Customer for any damages, expenses, losses or other liabilities (including, without limitation, financial losses or inconvenience) caused by, arising from or relating to, directly or indirectly:

(a) any interruption, curtailment or reduction from time to time or termination of the supply of Heat, howsoever caused; and

(b) the operation of Customer's Heating Plant or any cleanup in relation to Hot Water within Customer's Building or originating from Customer's Heating Plant.

## 3. Purchase Price of Heat Supplied

3.1 The Corporation shall invoice Customer once in each calendar month for Heat supplied pursuant to this Agreement during the preceding calendar month, an amount calculated by multiplying the metered amount of Heat received by Customer, adjusted as the Corporation reasonably determines appropriate, by the Rate applicable under this Agreement. The metered amount of Heat received by Customer shall be the amount of Heat, expressed in $kWh_{Thermal}$, measured by the Corporation as having been delivered to Customer at the Delivery Point.

3.2 Subject to section 3.3 and Article 10, the Rate payable by Customer to the Corporation for Heat supplied pursuant to the provisions of this Agreement shall be calculated as follows:

$$Rate\ (\$/kWh) = \frac{Cost\ Factor \times Fuel\ Cost\ (\$/l) \times ETS\ Efficiency}{Net\ Heat\ Content\ of\ fuel\ (kWh/l) \times Average\ Annual\ Efficiency}$$

For the period ●(signing date) to ●(date of next normal fuel price setting) where:

| | | |
|---|---|---|
| Cost Factor | = | 0.90 |
| Fuel Cost | = | ●/litre |
| ETS Efficiency | = | ● |
| Net Heat Content | = | ● kWh/litre |
| Average Annual Efficiency | = | ● |

where:

"**Fuel Cost**" is the price for Heating Fuel delivered to Customer in ●, expressed in dollars per litre, as set from time to time by the Government of the Northwest Territories Petroleum Products Division, or its successor, or the GNWT contracted delivery price from the private sector, such price being set as of the date of this Agreement annually upon completion of the annual resupply of fuel throughout the Northwest Territories;

"**Net Heat Content of Fuel**" is the lower heating value of Heating Fuel as indicated on the applicable inspection data sheet issued by the refinery that supplied the Heating Fuel, expressed in kWh per litre;

"**Average Annual Boiler Efficiency**" is the efficiency, as determined by the Corporation, with which the Customer's Heating Plant converts Heating Fuel into Heat for use in Customer's Building. The Average Annual Boiler Efficiency will initially be the efficiency described in Part 2 of Schedule "A" attacked to this Agreement, and will be adjusted as provided for in section 3.4.

3.3 Subject to Article 10 and notwithstanding the provisions of section 3.2, if at any time during the term of this Agreement The Corporation reasonably determines that its capital investment in the Residual Heating System has been fully recovered the Rate payable under this Agreement shall be calculated in the same manner as described in section 3.2, with the sole exception that "0.80" shall be substituted for "0.90" in the formula set out in section 3.2.

3.4 For the purposes of sections 3.2 and 3.3, after the first full twelve (12) calendar months following the Commencement Date, the Corporation will, at its own cost, determine the boiler efficiency of Customer's Heating Plant during such twelve (12) month period. The boiler efficiency so determined shall be deemed for all purposes to be the Average Annual Boiler Efficiency to be used in all calculations under sections 3.2 and 3.3 for the balance of the term of this Agreement. As well, the Corporation shall utilize the Average Annual Boiler Efficiency so determined to recalculate the Rate in effect and the amount payable under each of the invoices rendered to Customer for each month during such twelve (12) month period, and shall reflect any adjustment arising from such redetermination in a subsequent invoice to Customer. No interest shall be payable for the twelve (12) month period in respect of any adjustment.

## 4. Payment for Heat Supplied

4.1 Customer will pay the Corporation the amount set forth in each invoice for Heat supplied upon receipt of the invoice referred to in Article 3 of this Agreement within thirty (30) days after receipt of the invoice. Any amount owing to the Corporation which is not paid

within such thirty (30) day period shall be subject to interest charges at a rate equal to the rate generally in effect for the Northwest Territories Power Corporation's customers in accordance with that Corporation's terms and conditions of electrical power service, as they may be amended from time to time by the Public Utilities Board.

4.2 If it is determined that at any time or times Customer has been over-charged or under-charged for Hot Water and has paid the invoices containing such over-charge or under-charge, then within thirty (30) days after the amount of such over-charge or under-charge has been determined, the Corporation shall refund the amount of any such over-charge or Customer shall pay the amount of any such under-charge, as the case may be, with interest thereon at the rate referred to in section 4.1, from the date such over-charge was paid or the date payment was due under the invoice containing such under-charge to the date of refund or payment, as the case may be, provided that adjustments to errors in billing will only be made if the error is discovered within twelve (12) months of the time such error was made and a claim or notification for adjustment is made within sixty (60) days of the date of discovery of the error.

## 5. Metering

5.1 The Corporation shall provide, install and maintain at its own cost, suitable meters as required for the measurement of Heat delivered to Customer at the Delivery Point. If at any time the Corporation's metering apparatus is found to be defective or registering inaccurately, the Corporation shall, without delay, cause such metering apparatus to be readjusted, repaired or replaced. If the metering apparatus is defective or registering inaccurately, then the volume of Hot Water or the temperature thereof will be determined by using the first of the following methods that are available:

(a) use of other temperature and flow measurements within the Residual Heating System adjusted to compensate for estimated losses between the location of such measurements and the Corporation's meters at the Delivery Point;

(b) comparison with delivery under similar conditions when the Corporation's metering was registering accurately; or

(c) such other method as may be agreed upon by the Corporation and Customer.

## 6. Remedy for Payment Default

6.1 In the event Customer fails to make payment or payments required to be made to the Corporation pursuant to section 4.1 of this Agreement, including payment of interest charges, within the time provided in that section, the Corporation may, in addition to any other remedy available to it, after giving Customer not less than thirty (30) days prior notice of same, discontinue the supply of Heat to Customer until any and all such amounts are paid.

6.2 Without limitation to any other remedies the Corporation may have under this Agreement or otherwise, the Corporation may elect in writing to terminate this Agreement effective upon notice to Customer if Customer fails to make payment or payments required to be made to the Corporation pursuant to section 4.1 within the time provided for in section 6.1, including the payment of interest charges, provided that such termination shall not relieve Customer from any of its obligations under this Agreement, including without limitation its obligation to pay any sum then payable under this Agreement.

## 7. Access

7.1 Customer will permit the Corporation to install the Connecting Facilities on its premises for the term of this Agreement and will permit the Corporation and its employees, servants, agents or contractors access to its premises and Customer's Heating Plant at all reasonable times to install, inspect, repair, replace, maintain or remove the Connecting Facilities.

## 8. Term and Termination

8.1 The term of this Agreement shall commence upon execution hereof by the parties hereto and shall continue for a period of fifteen (15) years from the Commencement Date, and for so long thereafter as Customer and the Corporation may agree. Either Customer or the Corporation may terminate this Agreement prior to the expiration of its term on six (6) months prior written notice to the other party to this Agreement.

## 9. Indemnity

9.1 Each of the parties (the "indemnifying party") shall be responsible for and shall indemnify and save harmless the other party from claims of third parties for any damages, expenses, losses, injuries or loss of life resulting from the indemnifying party's own negligence, or the negligence of its employees, servants, agents or contractors in the performance of obligations or the exercise of its rights under this Agreement, provided that the Corporation will not in any circumstances be responsible for, and will not indemnify Customer from, claims for any damages, expenses, losses or injuries (including, without limitation, claims for financial losses or inconvenience) caused by, arising from or related to, directly or indirectly, the supply of Heat or any interruption, curtailment, reduction, termination or other failure or default in the supply of Heat, howsoever caused.

## 10. Jurisdiction of Public Utilities Board

10.1 Notwithstanding any provision of this Agreement:

(a) this Agreement is subject to the jurisdiction of the Public Utilities Board, and such orders as the Board may issue from time to time; and

(b) Customer acknowledges that the Corporation may apply to the Public Utilities Board from time to time if the Corporation determines that it is in the public interest that the Rate, or the terms and conditions of service, then in effect should be reviewed and adjusted.

## 11. Waiver

11.1 Any waiver by either party, or failure by a party to exercise any of its rights or to enforce any of its remedies, will be limited to the particular instance and will not constitute a waiver of any other rights or remedies or extend to any other matter hereunder, or in any way affect the validity or modify the meaning or intent of, any provision of this Agreement. The exercise by a party of any remedy provided for by this Agreement will not operate to prevent such party from pursuing any other remedy to which it is entitled.

## 12. Governing Law

12.1 The provisions of this Agreement shall be governed by and construed in accordance with the laws in force from time to time in the Northwest Territories and, subject to Article 10 of this Agreement, the Courts of the Northwest Territories shall have exclusive jurisdiction to entertain any action arising in connection therewith.

## 13. Entire Agreement

13.1 This Agreement forms the entire contract between and Customer and contains all of the agreements between the Corporation and Customer relating to the supply of Heat by the Corporation to Customer at the Delivery Point and any representation or statement not contained in this Agreement shall not be binding upon either party.

**IN WITNESS WHEREOF** the Corporation and Customer have hereunto executed this Agreement as of the date first written above.

**Northwest Territories Power Corporation.**

Per: _____

●

Per: _____

## Schedule "A" to Heat Supply Agreement
## Between NWT Power Corporation. and ● made as of ●, 1997

### Part 1 - Description of Customer's Building

Customer's Building as defined in section 1.1 of this Heat Supply Agreement means the building or premises known as ●, owned by ● and located at ● in the Hamlet of ●.

### Part 2 - Average Annual Boiler Efficiency

The Average Annual Boiler Efficiency referred to in section 3.2 of this Heat Supply Agreement will initially be ●.