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Discussion Paper: CCAC Policy on Vehicle Air-conditioning

Consommation
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Consumer and
Corporate Affairs
Canada

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March 1989

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EXHIBITS

Annexes (available under separate cover)

EXECUTIVE SUMMARY

Purpose of this report

This report addresses the question of whether the Deputy Minister should exercise his discretion to authorize the acquisition of vehicle air-conditioning.

Background

Treasury Board sets guidelines for vehicle procurement through the Administrative Policy Manual. Departments are responsible "for determining, within the policy constraints provided, the types and quantities of motor vehicles needed and the method of acquisition."

Air-conditioning is not explicitly referred to in TB policy, but the policy is widely interpreted as implicitly rejecting vehicle air-conditioning on the grounds that it contradicts the basic objectives of cost-minimization and energy conservation.

Issues

The issues pertinent to vehicle air-conditioning acquisition policy may be summarized as follows:

-choices facing CCAC given present policies, requirements, and the discretionary power of the Deputy Minister;

-cost implications for initial purchase, operating and resale value;

-safety and efficiency of vehicle-using employees, in the context of recent weather conditions;

-normal fleet practice;

-impact of air-conditioning on fuel consumption;

-equitable treatment of employees, whether office-bound or vehicle users;

-effect of air-conditioned vehicles in the CCAC fleet on the image of CCAC held by the public;

-trends in the automobile industry to make extra cost options, such as air-conditioning, standard features;

-environmental concern over the use of chlorofluorocarbons as refrigerants in automotive applications.

Findings

1. Present policies and requirements:

There is no formal government (Treasury Board or Departmental) policy on vehicle air-conditioning at this time. The Deputy Minister can authorize the acquisition of air-conditioning, although justification may be sought by Treasury Board.

2. Cost considerations:

The cost of automobile air-conditioning is masked when provided as a standard feature (i.e. part of an options package) and is about $1150 when optional. Maintenance costs would be at least $60 for the air-conditioning alone over the vehicle's service life. Some other vehicle service costs, front-end collision repairs for example, would also increase. Increased costs would be offset to some extent by higher resale values (typically $400-$500). The cost to CCAC of a selective acquisition policy would average $24,000 to $36,000 per year based on the average weather of the past five years.

3. Safety and efficiency:

As temperature and humidity rise (measured by the Temperature-Humidity Index), the scientifically accepted correlation between heat stress and human performance is first discomfort, then rapidly decreasing work efficiency, then extreme danger. Such weather conditions have occurred over the past five years in parts of Canada (e.g. Toronto). Estimates suggest that the efficiency loss has averaged 0.53 to 1.32 person-years per year over the 1984 - 1988 period.

4. Normal fleet practices:

Some private sector companies rely on air-conditioned vehicles to help their employees (computer maintenance technicians, for example) maintain a professional appearance. Other companies have not provided air-conditioning in their vehicle fleets.

5. Fuel consumption:

Air-conditioning has a modest impact on fuel economy which varies by vehicle and according to conditions. At highway speeds air-conditioning is the most efficient means of reducing interior temperatures.

6. Equity:

Standards for exposure to temperature extremes exist for government office buildings. These, in conjunction with the TH Index, provide objective and reasonable criteria for justifying

the acquisition of vehicle air-conditioning. Organized labour has not yet brought vehicle air-conditioning to the bargaining table and negotiated for it as a work environment issue.

7. Image:

Overall public reaction to government vehicle air-conditioning cannot be predicted.

8. Manufacturer trends:

Significant improvements in automobile fuel economy have been made through a variety of technical developments such as engine design and aerodynamics. The impact of air-conditioning on fuel economy is diminishing as vehicle efficiency improves.

9. Environmental concern:

The use of ozone-destroying chlorofluorocarbons as refrigerants in automotive applications has recently become an issue for the public. It may be obviated in the near future by recent and pending technical developments.

Conclusion

There are substantive arguments in favour of providing air-conditioned vehicles which go beyond existing Treasury Board policy and support the exercise of Deputy Ministerial discretion.

The decision to authorize air-conditioning can be based on the consistent recurrence of excessive temperature and humidity conditions.

If, for example, monthly average temperature-humidity index values of 73 or higher are experienced for at least two months in two consecutive years, then vehicle air-conditioning can be justified on the grounds of employee efficiency and safety.

Recommendation

It is recommended that the Deputy Minister consider authorizing the acquisition of air-conditioned vehicles on a selective basis. The decision on whether or not to acquire air-conditioning for a given vehicle should take into consideration recent temperature and humidity conditions in the area where the vehicle will be used.

1. Introduction

1.1 Purpose of this report

This report addresses the question of whether the Deputy Minister should exercise his discretion to authorize the acquisition of vehicle air-conditioning.

The Management Services Branch of the Bureau of Consumer Affairs, which is responsible for managing the CCAC fleet, completed a preliminary study on this subject in October, 1988. This report, undertaken with their cooperation, builds on that study.

1.2 Background information

Treasury Board sets guidelines and directives for departmental vehicle procurement practices. Air-conditioning is not explicitly referred to in TB policy, but the policy is widely interpreted as implicitly rejecting vehicle air-conditioning on the grounds that it contradicts the basic objectives of cost-minimization and energy conservation. Every Deputy Head can authorize deviations from TB policy.

CCAC has generally followed TB policy with respect to cost-minimization for vehicle purchases although recent events have caused the matter of vehicle air-conditioning to come under review. CCAC recently acquired 12 air-conditioned Chevrolet Cavalier compact station wagons. These are equipped with air-conditioning as a standard feature with the V6 engine package. This vehicle is the only compact station wagon available with an engine larger than 2.2 litres displacement; it is also the smallest vehicle with sufficient power for operational needs. Furthermore, the Chrysler compact station wagons previously acquired with large displacement four cylinder engines are no longer manufactured. Departmental employees in some regional offices have expressed an interest in having air-conditioning and voiced this through the ADM of Consumer Affairs in the summer of 1988.

2. Issues

2.1 Present policies and requirements

Treasury Board sets guidelines for vehicle procurement through the Administrative Policy Manual (APM) Chapter 230 - Motor Vehicles. Departments are given responsibility "for determining, within the policy constraints provided, the types and quantities of motor vehicles needed and the method of acquisition." (APM, Ch.230, .2)

Under the heading of "Requirements determination", a directive is given (.2.2.1) that the "conservation of energy shall be a

primary consideration when acquiring motor vehicles." TB approval is needed for any deviation from the directive.

With respect to the analysis of economic alternatives (.2.1.4) the APM offers a guideline on the selection of options:

> The option chosen should be the most economical when all costs of that alternative are considered (i.e. initial and operating costs of the vehicle, as well as the effect on employee productivity).

Deviations from guidelines do not require prior TB approval. Appendix A of the APM, Motor Vehicle Selection Criteria, states that:

> The choice of a vehicle is determined by the load, task and environmental requirements; the smallest vehicle capable of satisfying those requirements shall be chosen.

There are no government specifications for a vehicular working environment, however, the Personnel Management Manual, Chapter 3 Part 8, specifies Environmental Conditions for government office buildings. Specifically,

> ... temperatures during work hours shall be maintained within the range of 20°C to 26°C, except that temperatures ... up to 29°C are acceptable for up to 120 hours annually... provided that any incursion does not last longer than 3 hours per day. (Amendment 87-4 p.3).

Treasury Board directives and guidelines do not address air-conditioning directly, rather they are generally interpreted as placing emphasis on cost and energy conservation in a manner prejudicial to the acquisition of vehicle air-conditioning.

Several other factors relevant to the policy on vehicle costs should be mentioned. Cost minimization is a long-standing objective of all Treasury Board policies which has assumed particular importance in the recent "down-sizing" years. Vehicles purchased for government use are invariably of domestic manufacture for reasons of cost and to support domestic industry. Vehicles purchased through the Department of Supply and Services, which are ordered according to Government Motor Vehicle Specifications, are about 15% cheaper than normal retail.

The growing popularity of air-conditioning as an option in automobiles has led to it becoming a standard feature in some cars not in the luxury class. Canadian manufacturers refuse to divulge exact figures for competitive reasons, but the Management Services Branch (Consumer Affairs) compared 1987 automobile sales

in Canada to receipts by Revenue Canada of the $100 excise tax and concluded that about 61% of new cars sold were equipped with air-conditioning. If the extreme heat and humidity of the summer of 1988 is repeated, it is likely that air-conditioning will accelerate in popularity as an option and may become a standard feature for a broader range of vehicles.

2.2 Cost considerations

Air-conditioning has cost implications for the Departmental fleet in terms of initial purchase price, operating and maintenance costs, collision repair costs, resale value and use of personal vehicles. The cost of the acquisition is primarily dependent on the replacement cycle, since retrofitting the existing fleet can be ruled out as overly expensive.

Where air-conditioning is not offered as part of an options package (i.e. the usual case), it adds from $1050 to $1200 to the vehicle's retail price (see Annex G).

The impact of air-conditioning on maintenance costs cannot be accurately predicted. According to the automotive air-conditioning service trade, the system should be serviced at least bi-annually at a cost of about $60. Since most Departmental vehicles are replaced on a four-year cycle, this represents a maintenance cost of $60-$120. The cost of extensive repairs, if needed, would depend on the particulars of the situation. Other mechanical repairs are often complicated by the presence of air-conditioning equipment.

Another possible cost to CCAC could arise if employees who presently use their personal vehicles would prefer to use air-conditioned departmental vehicles.

On the other hand, air-conditioning adds $400-$500 to the resale value of 5 and 4 year old domestic automobiles, respectively.

Costs would be maximized if every new departmental vehicle were equipped with air-conditioning and all remaining vehicles in the fleet were retrofitted. A very conservative estimate for this would be $605 per vehicle ($1200 for the air conditioning, plus $120 for maintenance, less $400 for increased resale value) for 501 vehicles = $460,920.

Minimum costs would arise from limiting the addition of air-conditioning to areas of demonstrated need (e.g. Quebec, Ontario, and Manitoba) and certain vehicle types (e.g. compact station wagons and mid-size cars), at the normal time of replacement (presently every four years). These costs may be estimated at $605 net per vehicle ($1045 for the air conditioning, plus $60 for maintenance, less $500 for increased resale value) with 132 vehicles = $79,860 over 4 years or $19,965 per year.

The above figures represent a small proportion of the overall departmental expenditures. For fiscal year 1985/86, the maximum cost (i.e. retrofit approach) represents 9.03% of capital expenditures. The minimum cost (i.e. limited acquisition approach) represents 0.39% of the capital expenditures for that same year.

It should be noted that the Government, not the Department, would recoup some of the costs from the resale of the vehicles. Costs to the Department are as follows: maximum cost (501 vehicles at $1320 per vehicle) is $661,320 (12.95% of capital expenditures FY 1985/86); minimum cost (132 vehicles at $1105 per vehicle) is $145,860 (2.85% of capital expenditures FY 1985/86). Put in another way, the minimum cost plan involving 132 vehicles could be implemented for about the same cost as replacing one heavy-weight vehicle ($150,000).

Exhibit 1

Consumer and Corporate Affairs Expenditures FY82/83 to FY85/86

(Actual expenditures taken from the Estimates Section III Supplementary Information -- Analysis by Object. All values are expressed in $000's.)

	82/83	83/84	84/85	85/86
Personnel	81,539	90,736	94,058	93,891
Goods & services	35,263	40,619	35,721	26,348
Total operating	116,802	131,355	129,779	120,239
Transfers	39,672	125,264	58,204	29,594
Capital	3,265	5,141	5,768	5,105
Total expenditures	159,740	261,760	193,751	154,938

At the operational level, there is concern over the cost and difficulty of monitoring the selection criteria, should only part of the fleet be air-conditioned. According to the 1987 Annual Report, the Department has 56 field offices. The Management Services "National Vehicle Inventory" lists 31 locations to which vehicles have been assigned, of which 12 are from Winnipeg to Montreal, and 7 of those are in the Toronto region. The meteorological criteria specified below are based on the existence of climatic regions. It would not be necessary to monitor separately each office; e.g. Toronto, Scarborough, and Don Mills all have the same climate.

2.3 Heat stress and health

The heat stress index used in this study is the Temperature - Humidity Index (THI). This index displays equivalent sensations of warmth or discomfort for different degrees of sheltered air temperature and relative humidity. THI does not take into account heating by radiation or the cooling effects of the wind.

One heat stress index, the Wet Bulb Globe Temperature (WBGT) does take into account radiant heat and wind speed, but is not a perfect predictor of physiological strain. Other indices are similarly flawed. One study recommends the use of three indices simultaneously to adequately describe the effects of the four crucial climatic factors: air temperature, humidity, radiant heat, and air velocity. Unfortunately, the meteorological data required for this task is not collected for the cities in this study.

Despite the lack of radiant heat and air velocity data, the THI index is helpful because those two factors moderate each other at temperatures lower than 35^{o} C. Radiant heat adds to the heat in the environment, while air movement has a cooling effect by aiding evaporation of sweat from the skin. At temperatures higher than 35^{o} C with high humidity, this effect is reversed. Saturated air can no longer remove moisture, and thus air movement has a heating effect.

The use of air temperature in a sheltered environment (the available data) understates the temperatures of an enclosed environment such as a car. Radiant heat can produce alarmingly high temperatures in cars. The Hamilton driver recorded starting temperatures as high as 50^{o} C. The THI values calculated in this study are thus very conservative estimates of the exposure to heat conditions by CCAC employees.

Exposure to heat may have a number of effects depending upon the severity of the heat and the tolerance to heat by an individual. In extreme heat, the body core temperature rises, followed by circulatory failure, loss of consciousness, and death. At lower temperatures, heat exhaustion is more common. A person suffers extreme fatigue, nausea, headache or light-headedness. The skin becomes clammy and moist. Pulse is rapid and blood pressure is low. Heat exhaustion is caused by lack of acclimatization, continuous exertion in heat, and the failure to replace water and salt lost in sweat.

Individual tolerance to heat stress varies greatly. Some factors influencing tolerance are described in Exhibit 2 below.

Exhibit 2

Factors Influencing Tolerance to Heat

1.	Sex	Men tolerate heat better than women because of a lower body core temperature and better sweating ability.
2.	Age	After 40 years of age, the cardio - vascular system has less capability for adaptation, and the onset of sweating is retarded.
3.	Body type, weight	Obese and stocky people have a lower tolerance because heat production varies with weight but heat loss varies with surface area.
4.	Fitness level	Fit people are better able to deal with the physiological effects of heat stress such as a high pulse rate.
5.	Acclimatization	The body adjusts to regular exposure to heat. New employees, people returning to work following sickness or holidays, and people who do not normally work in hot areas are more vulnerable to heat stress than individuals who are regularly exposed to high heat levels.

Management can do little to influence employee tolerance to heat stress. The strain to the body can be lessened by work/rest schedules that allow for at least two hours of exposure to heat for a week. If the heat spell is short, acclimatization will not be complete and in fact will not be needed as temperatures return to normal levels.

In climates where hot weather is normal, the body adapts to the heat by lowering body temperature and increasing sweating for better cooling. Acclimatization has the perverse effect of making people feel better, but look worse. This was a concern raised by the Bureau of Competition Policy. A neat appearance is necessary for employees as representatives of the department and the government.

Acclimatization is lost quickly, to some degree even over a weekend. After a week, body temperature and sweat rates return to previous levels. If the heat returns, the body is again susceptible to heat stress and fatigue. Depending upon the exposure to hot weather from duties and personal activities, an employee may or may not be acclimatized.

Exhibit 3 shows the temperature and work load to avoid heat collapse after one hour of exposure to heat. Heat collapse is the first stage of heat stroke. As people work harder, heat collapse occurs at lower temperatures, although individual endurance varies with tolerance level and other environmental factors (e.g. smog, noise). The work loads below were calculated for a 154 lb./70 kg man.

Exhibit 3

Heat Endurance For Unacclimatized Men

Metabolic Heat Production Joules/second	Associated Activity	Temperature (saturated) °C	°F
90	sitting at ease, moderate hand work	39.5	103.1
210	light arm & leg work, driving	36.5	97.7
315	moderate arm work while walking	35.5	95.9
420	lifting, carrying heavy loads	31.5	88.7

Exposure should be limited to two-thirds to three-quarters of average endurance times (i.e. 40 to 45 minutes) to avoid heat collapse in half of the population.

Exposure should also be decreased if other environmental stressors are present. The combination of heat and carbon monoxide (CO) has a greater effect than either stress alone. Symptoms, including persistent headaches, anorexia, irritability, depression and general malaise, are more severe in the hours following the exposure, i.e when an employee is working on site. The combination of heat and noise has also been found to decrease performance.

2.4 Exposure Data

A limited amount of exposure data for June 1988 was collected by a CCAC inspector in the Hamilton office (Exhibit 4). Although the data was incomplete, it does help to put into perspective the degree and frequency of exposure to actual in-vehicle temperatures.

Exhibit 4

Duration and Severity of Actual Exposure to Heat

Average trip length (in minutes)	30
Average number of trips	3.2
Average daily time in car (in minutes)	90
Number of days recorded by survey	15
Number of days with exposure to 35° heat or above	10
Number of days with exposure to 40° heat or above	7

Other data such as on-site conditions, and the physical activity (i.e. driving only, lifting) of the employee was not provided.

In Exhibit 5, meteorological summaries for the summer months (June, July and August) of eight cities over five years (1984-1988) are analyzed. The vehicles assigned to these cities represent 55% of the total fleet. **Note: THI values are for still air with no radiant heating, thus underestimating the heat stress in enclosed environments (see section 2.3).**

According to available studies, discomfort is associated with THI values of 73-83; inefficiency is associated with THI values of 84-91; and extreme danger is associated with values of 92-96.

Exhibit 5

Number of Exposure Days with Various THI values

THI value:	-73	74-78	79-83	84-85	86-87	88-89	90+
Vancouver	71.0	16.5	4.5	0.0	0.3	0.0	0.0
Prince George	63.8	17.4	8.2	1.6	0.8	0.2	0.0
Calgary	59.8	20.6	9.4	1.8	0.4	0.0	0.0
Winnipeg	33.2	22.2	21.2	4.8	4.4	2.6	3.6
Toronto	33.2	25.0	20.4	4.2	3.6	2.8	2.8
Montreal	34.4	24.4	22.0	5.0	2.6	2.6	1.0
Quebec City	68.4	12.0	7.0	2.4	0.4	1.0	0.8
Halifax	65.4	18.6	6.8	1.2	0.0	0.0	0.0

2.5 Heat Stress and Work Efficiency

Heat stress decreases productivity. At temperatures higher than 29° C (saturated) discomfort increases sharply. The number of errors and minor accidents increase, particularly when the work involves higher mental processes. Strydom (1975, 1963) estimates the loss of productivity to be significant at temperatures higher than 30° C (saturated).

Exhibit 6

Performance Loss

% Drop in Performance	Temperature °C (saturated)	THI
5	29	84
10	30	86
17	31	88
30	32	90

Using the above estimates, the loss of productivity for the eight cities is given in Annex I. Calculations are based on maximum temperature, maximum humidity THI values over five years (over four years for Vancouver). For an explanation of the calculation, see annex H.

The results of Annex I show a small but significant loss in performance -- from 0.53 to 1.32 person-years per year depending upon the amount of driving time per day. Most of the loss (90%) occurs in the Winnipeg, Toronto, and Montreal regions. It should be noted that the temperatures used in the calculations are air temperatures collected by Environment Canada. Actual conditions inside a vehicle will produce higher temperatures.

2.4 Normal fleet practice

Some data on North American fleet practice is available in the 8th (1980) Dartnell Survey of Business Car Allowances, Controls and Fleet Management Practices. The survey involved about 100 Canadian and 500 American firms which maintained fleets for executive and sales personnel. Industry types represented included manufacturing, service, insurance, distribution, wholesale, and education.

Only 13% of the sample fleets had 500 or more automobiles (the CCAC fleet has exceeded 500 mixed vehicles since 1985/86). In the Dartnell survey, air-conditioning was a feature of 94% of the automobiles. Automatic transmission, power steering and power brakes were similarly popular.

A typical set of specifications for a fleet recommended air-conditioning as part of the basic equipment for average fleet use (i.e. intermediate or compact six cylinder, 29,000-40,000 km annually, combined rural, suburban and urban use with moderate trunk load of 100 kg). Air-conditioning was considered less essential for a vehicle dedicated to urban use (compact or sub-compact four or six cylinder, less than 29,000 km per year, stop and go driving, moderate trunk load not more than 100 kg).

Based on discussions with External Affairs about vehicle procurement abroad, it appears they have no fixed or formal policy to determine whether air-conditioning is provided or not. The users are simply asked whether they feel it is necessary and that decides the matter. Departmental automobiles in the Ottawa area are equipped with air-conditioning as a courtesy to foreign dignitaries who may be transported in those vehicles. No other department has air-conditioning except for specialized vehicles.

Exhibit 7

Vehicle Distribution by Region and Vehicle Type

	Atl	Que	Ont	Pra	Pac
Box truck		1	2	2	2
Cargo van			7	7	3
Compact station w.	18	42	69	41	21
Full-size car					1
Heavy truck	2	2	4	7	2
Hydraulic h. truck			1		
Light truck	28	55	80	47	19
Mid-size car	6	6	3	6	2
Medium truck	1	2	2	3	
Others	1	1	5		
Totals	56	109	173	113	50

Information in greater detail on the CCAC fleet are in annexes D through F.

2.5 Fuel consumption

Energy conservation became an issue in the early 1970's when OPEC first created oil shortages. OPEC has since suffered the usual difficulties of a cartel, i.e. inability to secure complete cooperation from all members of the cartel. Oil prices declined dramatically from the highs of the early 1970's to less than $10US per barrel and recent American oil industry forecasts suggest prices of $15-$20US per barrel for the next five years.

Automobile fuel economy has improved markedly over the past 15 years with a shift toward smaller engines, more sophisticated designs, and growing reliance on comprehensive electronic engine management control systems. Speculation in the late 1970's that the American V8 engine would be forever obsolete has been refuted. American manufacturers continue to refine older designs while introducing new V8 engines. The Japanese manufacturers are planning to introduce V8 engines for up-market automobiles in the

next 2 years. Some traditional European makers are now either building or planning V12 engines (Jaguar, BMW, Mercedes-Benz) for their top-line models.

Within the auto industry the focus has shifted away from energy consumption and towards means of achieving higher power-to-weight ratios. This is not to say that fuel consumption has been or even could be abandoned as an objective. The American government is still enforcing the Corporate Average Fuel Economy standards implemented during the "oil crisis". The CAFE standards call for manufacturers selling cars in the U.S. to average 27.5 miles per U.S. gallon for both 1989 and 1990 models. A fine is levied against manufacturers failing to meet the standard based on the amount of the deviation and the number of vehicles involved. Manufacturers are compelled to continue pursuing improvements in fuel economy by both the CAFE standards and by consumers who are still sensitive to operating costs.

It is generally accepted that automotive aerodynamic effects are not significant at speeds below 70 km/h. At higher speeds, the additional drag caused by open windows, for example, becomes a factor in fuel consumption. At normal highway speeds air-conditioning is believed to be more efficient than cooling by open windows, although the degree varies by vehicle and according to circumstances.

With continuing pressure on manufacturers for improvements in fuel economy, the impact of air-conditioning on vehicle energy consumption generally is diminishing.

There is a general agreement that the major improvements in automobile energy consumption have been made and future improvements will be made in small, expensive increments. This line of thought is now evident at the regulatory level. For example, Transport Canada has recently introduced regulations requiring day-time lights on all motor vehicles. The regulations were worded to prevent manufacturers from taking the least-cost solution (i.e. hard-wiring all lights to come on when the engine is started) because it would have been the greatest-cost solution for the consumer. The additional electro-magnetic drag at the alternator induced by the continuous use of all lights would have caused an unacceptable increase in fuel consumption. The regulations have been written to effectively force manufacturers to use a more expensive and sophisticated device to feed reduced current through high-beam filaments to meet the new standard.

2.6 Equity

Equity is a work environment issue which is the natural domain of organized labour groups. Public service unions have not yet successfully negotiated for air-conditioned vehicles. The reasons for this are unclear. It may not be perceived to be a

major issue, or it may be felt that securing air-conditioned vehicles also implies the expectation of measurable improvements in productivity.

It is unclear whether the selective provision of air-conditioning would result in low morale in areas where vehicles were not so equipped. Preliminary analysis of the meteorological data suggests that the provision of air-conditioning would be most useful in a certain climatic region, i.e. inland but near a large body of water. Thus it is unlikely that an employee with an air-conditioned vehicle would work in a neighbouring district to an employee whose vehicle is not air-conditioned. With a climate-based decision rule, some discontent may occur on a regional basis, i.e. Western and Atlantic Canada versus Central Canada.

2.7 Image

Some private sector companies (Honeywell Bull, for example) regard employee appearance, especially for sales personnel, to be critical to profitability. O.C. Transpo accepts air-conditioning for inspector's cars only if it is a standard feature, but not as an extra cost option. The key difference here is that Honeywell Bull sales people are dealing with clients and want to project a professional appearance, whereas O.C. Transpo inspectors are seen by the public (their clients) but are not dedicated to client service in the same way.

While a fresh appearance can obviously have a positive impact, the general public may take exception to the notion that public employees are provided with air-conditioned vehicles, given the long-standing association between air-conditioning and luxury. This perception may be negative, particularly in a time of government restraint.

There has been no public outcry against air-conditioning in public office buildings.

Although some objection would likely be raised, there is no clear indication of how the public might react, on balance, to the air-conditioning of government vehicles.

2.8 Manufacturer trends

In an effort to improve driveability and performance, automobile manufacturers are devoting greater attention to accessory systems such as air-conditioning, having already reached cost-effective limits on size/weight reduction, basic aerodynamics and fundamental engine design. Air-conditioning compressors are driven through a clutch so that when the air-conditioning is turned off the engine is encumbered only by the weight of the air-conditioning system and does not also continue to drive a compressor not in use.

In terms of engine power, the specific output per unit displacement has been rising since the late 1970's. In the early 1970's American manufacturers were pressed by their government to reduce pollution levels while the market demanded improvements in fuel economy. Initially these appeared to be conflicting objectives, but advances in many areas (electronic engine management systems, for example) have led to a new generation of engines which are significantly more efficient in every measure: less pollution, improved fuel economy, and higher power per unit displacement.

Air-conditioning systems too have undergone refinements and other aspects of automobile design have been adjusted to complement the driver's ability to control the environment inside the automobile. New automotive glass technology (e.g. tinting) has been developed to limit heat build-up in the car, making for lighter loads on air-conditioning systems which, in turn, can be reduced in size, weight and power requirements.

2.9 Environmental concern

Automotive air-conditioning systems presently rely on chlorofluorocarbon (specifically CFC-12) gases as refrigerants. The refrigerant is contained in a sealed system and is released into the atmosphere only in the case of a leak (component failure or accident damage) and when the vehicle is scrapped. Ozone is threatened by the presence of chlorine in CFCs and, consequently, an international agreement was reached in late 1988 to impose controls on CFCs and encourage the development of inoffensive substitutes. There has been growing political interest in this issue in early 1989.

Considerable public attention has been drawn to the CFC/ozone issue. In response, manufacturers have been developing replacements for the CFC refrigerants currently in use. Progress has already been made on two fronts. A temporary substitute for CFC-12 has been developed which is less threatening, and permanent non-threatening replacements have also been developed.

Akzo Chemicals Inc. had completed major tests in July, 1988, on a new refrigerant compound it calls "Demeon" 13/87. Demeon is a blend of dimethylether (DME) and CFC-12. DME does not pose a threat to ozone by itself, and when blended with CFC-12, the resulting compound reportedly can reduce the ozone hazard by 20% (compared to pure CFC-12) and increases refrigeration efficiency by 4-5%. Demeon is described as being a drop-in replacement for CFC-12. In the U.S., Pennwalt Corporation has been marketing a low ozone-depleting CFC (relative to CFC-12) as a substitute for CFC-12 in refrigeration applications.

Tetrafluoroethane, commonly referred to as HFC-134a, is a permanent replacement for CFC-12 and is harmless to ozone. At least three manufacturers are working with 134a (Allied-Signal Inc., Showa Denko K.K., and Du Pont). Du Pont is developing the large-scale manufacturing technology for the production of 134a. Commercial production could begin as early as late 1992.

Because it is difficult to produce, 134a is estimated to ultimately cost three to five times as much as CFC-12 (which is fairly simple to produce). HFC-134a is being specifically targeted for household refrigerators and automobile air-conditioners.

The ozone-damaging potential of automotive air-conditioning systems will diminish as substitute and permanent replacement refrigerants are adopted. While the timetable for this shift is uncertain, users of CFC refrigerants are under considerable an growing pressure to abandon CFC-12 as substitutes become available.

3. Findings

There is no formal government (Treasury Board or Departmental) policy on vehicle air-conditioning at this time.

The Deputy Minister may authorize deviations from TB policy, including the acquisition of vehicle air-conditioning.

The initial cost of air-conditioning is masked when part of an options package, but averages $1150 as a separate option. Maintenance costs for a typical vehicle with a normal four-year service life would be at least $60 for the air-conditioning alone. Some other vehicle service costs would also increase.

Air-conditioning has become a standard feature of some vehicle types in use by CCAC. It cannot be deleted from these vehicles.

Where air-conditioning is optional, the retail cost is $1050 to $1200.

Minimum maintenance costs for air-conditioning would amount to about $60 every two years (i.e. $60-$120 over the service life of the vehicle).

Repair costs cannot be predicted since the probable frequency of breakdown and probable type of failure are unknown and may vary between manufacturers and models.

Routine maintenance costs (e.g. engine oil and filter changes) may be slightly affected for some vehicles. Major service and accident repairs could be significantly more expensive if the

air-conditioning unit is damaged or if it blocks access to damaged components.

The minimum cost of authorizing the acquisition of air-conditioning according to observed temperature and humidity readings would be about $145,000 for CCAC (about $80,000 for the government). This represents an annual diversion of capital from other areas averaging $24,000 to $36,000 (depending on 6 or 4 year automobile service life respectively).

Some areas of the country have experienced temperature and humidity conditions that warrant consideration of the subsequent effects on worker safety and performance. These conditions and corresponding impact on human performance can be objectively measured using the temperature-humidity index.

Depending on the length and frequency of exposure to particular temperature and humidity conditions as described above, vehicle air-conditioning can be construed as prudent.

Significant improvements in automobile fuel economy have been made; the proportional impact of air-conditioning on fuel economy is diminishing as increasing engine efficiency leads to higher specific output levels and new types of automotive glass are used to moderate heat build-up in the vehicle.

Air-conditioning has a modest impact on fuel economy which varies by vehicle and according to conditions. At highway speeds air-conditioning is the most efficient means of reducing interior temperatures.

CCAC may wish to take the lead on this issue, or await a formal expression of interest by organized labour.

Some private sector companies rely on air-conditioned vehicles to help their employees maintain a professional appearance.

Overall public reaction to government vehicle air-conditioning cannot be predicted.

As engine power levels increase, the proportion of power needed to drive an air-conditioner decreases and the impact of air-conditioning on fuel economy is similarly diminished.

The use of CFCs as refrigerants is an issue of growing concern. It may, however, be obviated in the near future by the developments described above.

4. Conclusions

There are substantive arguments in favour of providing air-conditioned vehicles. These arguments go beyond existing

Treasury Board policy and support the exercise of Deputy Ministerial discretion.

Air-conditioning is not explicitly referred to in TB policy, but the policy is widely interpreted as implicitly rejecting vehicle air-conditioning on the grounds that it contradicts the basic objectives of cost-minimization and energy conservation.

If the lowest-cost vehicle meeting requirements is equipped with air-conditioning as a standard feature, then it would be difficult to justify purchasing a more expensive vehicle for the sake of avoiding the air-conditioning issue.

Neither Treasury Board nor any department presently appears to have a policy setting out the criteria which should be applied to determine whether air-conditioning is appropriate for a given set of circumstances.

The present rules of thumb set by Treasury Board on cost minimization and energy conservation do not preclude air-conditioning for departmental vehicles. The Treasury Board rules, moreover, fail to recognize the benefits accruing from air-conditioning. A cost-benefit analysis may not yield the same decision as would be drawn from the strict application of present Treasury Board rules.

It is apparent from the meteorological data that summer weather conditions in certain parts of Canada are such that the productivity and possibly the safety of Departmental employees is affected. Since the THI provides an objective measure of weather conditions, and since THI values higher than 73 are associated with effects on employee productivity and safety, it is appropriate to use the THI as a criterion in determining whether to authorize air-conditioning in CCAC vehicles.

Any decision-making rule for air-conditioning must allow for changing weather patterns. It would be difficult to justify the acquisition of air-conditioning for a vehicle on the basis of a singularly hot and humid month or summer. Since weather forecasting is an imperfect art, the rule should be based on actual experience relying on Environment Canada data for average daily maximum temperature and humidity readings, as these normally occur in the middle of the working day.

There is insufficient evidence at present to establish the amount of exposure departmental employees experience under these sub-optimal conditions. If the Hamilton data is representative of the actual driving conditions, however, exposure levels are consistently high enough to cause discomfort and occasionally high enough to be a threat to health.

5. Options

5.1 Option 1:

Maintaining the status quo would allow deferring a decision on the issue of vehicle air-conditioning, possibly until some point in the future when it may be raised in union-management negotiations.

An advantage of maintaining the status quo is that Treasury Board is very concerned about a single Department setting a precedent which would have serious cost implications for the government as a whole.

The disadvantage of this approach is that there are good reasons for revising existing policy. Furthermore, the 4-5 year service life for Departmental vehicles implies a long adjustment period following a policy change.

5.2 Option 2:

The Deputy Minister may choose to authorize the acquisition of air-conditioned vehicles under specific circumstances, thereby taking the lead on the vehicle air-conditioning issue.

The advantage of this approach is that it would provide a framework for decision-making and would supercede the arbitrary existing policy. The decision to authorize the acquisition of air-conditioning for a particular Departmental vehicle would be based on the normal amount and frequency of exposure to temperature and humidity conditions which are scientifically recognized as impairing employee safety and efficiency. Employee morale would likely improve.

The disadvantage of authorizing such acquisitions lies on the cost side. The cost of fleet management, maintenance and vehicle acquisition would be obviously increased. Management Services feels that the O&M budget is already strained. Some employees may prefer to stop using their private vehicles if air-conditioned Departmental vehicles become available, putting a greater burden on the CCAC fleet.

Treasury Board Secretariat is particularly concerned that a precedent set by CCAC, even if justified by overall cost-benefit considerations, could have substantial cost implications for fleets government-wide.

Setting a threshold temperature-humidity index value of 73 corresponds to Public Works' (i.e. American Society of Heating, Refrigeration and Air-conditioning Engineers) standards and the known effects of excessive temperature and humidity conditions on

human performance (efficiency and safety). At values in excess of 73, the length of exposure ceases to be relevant.

Consistency of weather, for the purposes of decision-making, can be assured by requiring that the monthly average TH Index is at least 73 (implying some days well in excess of the threshold), and that at least two months in two consecutive years meet the first requirement. The TH Index values used should be based on the daily maximum temperature and humidity readings since these normally occur in the middle of the work day.

6. Recommendation

It is recommended that the Deputy Minister consider authorizing the acquisition of air-conditioned vehicles on a selective basis. The decision on whether or not to authorize air-conditioning for a given vehicle should take into consideration recent temperature and humidity conditions in the area where the vehicle will be used.

ANNEXES FOR DISCUSSION PAPER: CCAC POLICY ON VEHICLE AIR-CONDITIONING

Program Evaluation Division
Consumer and Corporate Affairs

ANNEX A

GUIDE TO THE USE OF THE TEMPERATURE-HUMIDITY INDEX

The Temperature-Humidity Index shown on the following table is taken from the Weather Almanac by the Gale Research Company of Detroit, Michigan.

TEMPERATURE-HUMIDITY INDEX

A useful guide to summer time comfort is the Temperature-Humidity Index. A single number can be used to approximately express the reaction of most people to the heat-humidity complex, although it is known that individual responses vary considerably from person to person and from time to time. Table 1 relates various degrees of sheltered air temperature and relative humidity to equivalent THI values. The table is read in the manner of some road map mileage tables and provides index values to the nearest whole number. A brief discussion of the index is also provided.

Table 1 The Temperature-Humidity Index

TEMPERATURE	RELATIVE HUMIDITY										
	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%	
66°F	62	63	63	63	64	64	65	65	66	66	
67°	63	63	64	64	65	65	66	66	67	67	
68°	63	64	64	65	65	66	67	67	68	68	
69°	64	64	65	65	66	67	67	68	68	69	few people
70°	64	65	65	66	67	67	68	69	69	70	feel uncomfortable
71°	65	65	66	67	67	68	69	70	70	71	↓
72°	65	66	67	67	68	69	70	71	71	72	↓
73°	66	66	67	68	69	70	70	71	72	73	
74°	66	67	68	69	70	71	71	72	73	74	about one-half of all
75°	67	67	68	69	70	71	72	73	74	75	people feel uncomfortable
76°	67	68	69	70	71	72	73	74	75	76	↓
77°	68	69	70	71	72	73	74	75	76	77	↓
78°	68	69	70	71	73	74	75	76	77	78	nearly everyone feels
79°	69	70	71	72	73	74	76	77	78	79	uncomfortable
80°	69	70	72	73	74	75	76	78	79	80	↓
81°	70	71	72	73	75	76	77	78	80	81	↓
82°	70	72	73	74	75	77	78	79	81	82	
83°	71	72	73	75	76	78	79	80	82	83	
84°	71	73	74	75	77	78	79	81	83	84	rapidly decreasing
85°	72	73	75	76	78	79	80	82	84	85	work efficiency
86°	72	74	75	77	78	80	81	83	84	86	↓
87°	73	74	76	77	79	81	82	84	85	87	↓
88°	73	75	76	78	80	81	83	85	86	88	
89°	74	75	77	79	81	82	84	86	87	89	
90°	74	76	77	79	81	83	85	87	88	90	
91°	75	76	78	80	82	84	85	87	89	91	extreme danger
92°	75	77	79	81	83	85	86	88	90	92	↓
93°	76	78	80	81	83	85	87	89	91	93	
94°	76	78	80	82	84	86	88	90	92	94	
95°	77	79	81	83	85	87	89	91	93	95	
96°	77	79	81	84	86	88	90	92	94	96	
97°	78	80	82	84	86	88	91	93	95	97	
98°	78	80	83	85	87	89	91	93	96	98	
99°	79	81	83	85	88	90	92	94	97	99	
100°	79	82	84	86	89	91	93	95	98	100	
101°	80	82	84	87	89	91	94	96	99	101	
102°	80	83	85	88	90	93	95	98	100	103	
103°	81	83	86	88	91	93	96	98	101	104	
104°	81	84	86	89	91	94	96	99	102	104	
105°	82	84	87	90	92	95	97	100	103	105	
106°	82	85	87	90	93	95	98	101	103	106	
107°	83	85	88	91	94	96	99	101	104	107	
108°	83	86	89	92	94	97	100	102	105	108	
109°	84	87	89	92	95	98	100	103	106	109	
110°	84	87	90	93	96	98	101	104	107	110	

The table progresses downward and to the right from a zone of comfort to a zone of dangerous heat stress. The values are for appropriately clothed persons engaged in sedentary activities in nearly calm air.

ANNEX B

TEMPERATURE-HUMIDITY READINGS FOR
VANCOUVER, PRINCE GEORGE, CALGARY, WINNIPEG, TORONTO,
QUEBEC CITY, MONTREAL, HALIFAX

These summary tables of THI values were calculated from information provided by the Atmospheric Environment Service of Environment Canada. In addition the full database (120 pages) is available for study from the Program Evaluation Division.

The formula used to calculate the Temperature-Humidity Index (THI) is shown below:

$$THI = td\ (0.55 - 0.55(RH)).(td - 58)$$

where,

td = dry bulb temperature in ^{o}F
RH = relative humidity expressed in decimal form

As indicated in ANNEX A, the three important ranges are as follows:

THI 79 to 83 = nearly everyone feels uncomfortable
THI 84 to 91 = rapidly decreasing work efficiency
THI 92 to 96 = extreme danger

VANCOUVER THI VALUES SUMMER 1984 - 1988

	1984			1985			1986			1987			1988		
	JUN	JUL	AUG	JUN	JUL	AUG	JUN	JUL	AUG	JUN	JUL	AUG	JUN	JUL	AUG
1	61.5	64.4		65.7	68.3	62.4	64.1	62.4	74.5	61.7	72.0	69.9	55.3	62.1	71.2
2	59.9	64.9		63.8	79.2	67.8	64.4	69.4	75.9	63.6	68.2	70.5	57.7	71.4	73.7
3	60.5	69.3		64.9	79.4	76.7	71.7	60.7	73.6	68.5	69.4	72.2	63.5	66.5	75.4
4	56.5	62.4		66.9	78.1	70.8	66.8	66.1	70.2	74.2	61.5	72.4	62.8	65.1	77.6
5	59.5	60.3		63.3	71.1	73.6	69.4	66.7	71.2	63.6	60.4	71.2	62.1	59.8	68.4
6	58.5	59.4		59.9	73.4	71.1	66.8	70.8	73.6	64.2	65.8	71.2	61.4	66.6	65.9
7	60.3	58.4		64.0	78.3	68.2	64.4	76.2	77.1	69.1	66.7	72.4	63.5	69.1	71.0
8	63.9	60.8		61.3	79.2	70.5	65.2	71.4	76.3	62.6	62.1	72.0	63.1	73.6	69.5
9	71.8	71.6		64.8	82.1	64.9	66.8	68.3	80.6	61.0	64.7	71.8	63.8	73.2	71.8
10	70.6	67.8		69.0	78.1	69.9	71.7	67.5	67.8	60.8	71.2	67.0	63.1	70.1	69.7
11	75.6	71.8		69.6	78.1	68.9	65.8	65.2	69.6	69.0	74.4	73.2	63.1	62.6	70.3
12	76.9	63.9		67.7	70.6	69.4	70.4	67.0	70.5	69.8	76.6	71.2	66.3	61.3	71.3
13	74.5	63.6		64.6	70.9	78.1	76.8	69.1	72.9	68.2	73.9	61.7	69.2	67.6	71.7
14	68.3	70.1		68.7	72.9	73.4	68.5	67.2	72.0	67.5	72.2	70.1	77.1	68.2	68.9
15	67.4	74.2		63.3	71.6	76.4	65.3	59.1	66.6	63.9	67.8	67.1	76.4	71.2	60.6
16	58.7	76.4		65.2	74.3	79.1	66.0	58.1	66.7	62.8	68.1	66.5	69.9	70.4	66.9
17	58.6	68.2		71.6	74.8	76.3	63.5	61.9	69.6	66.6	74.4	66.4	60.3	70.0	69.1
18	57.9	68.1		75.6	80.6	72.0	61.5	66.6	74.5	68.8	74.5	68.7	68.7	73.9	71.2
19	54.5	59.4		70.9	80.6	64.1	62.3	70.1	70.5	71.9	68.6	68.2	66.7	82.1	68.5
20	69.1	64.0		68.3	80.0	66.7	63.1	71.5	73.2	61.3	72.2	66.7	70.9	80.8	66.8
21	72.9	68.5		69.2	76.9	69.0	69.1	72.0	73.8	61.7	74.5	67.6	71.0	73.4	67.7
22	74.5	74.5		66.0	77.6	70.6	69.8	67.5	75.0	65.9	69.4	71.2	70.5	71.3	71.3
23	73.5	81.5		60.2	72.6	73.6	70.9	67.3	73.7	65.4	70.0	73.7	63.0	73.8	73.1
24	65.9	83.5		63.4	72.7	72.9	68.4	68.9	73.7	69.0	73.7	79.1	67.2	75.8	78.5
25	64.5	88.4		68.5	73.4	67.8	65.5	68.9	73.6	74.3	66.0	80.7	76.4	86.7	71.3
26	62.2	85.3		67.8	73.6	69.9	66.5	66.7	77.8	75.5	71.3	76.1	66.8	77.5	71.0
27	54.1	71.7		65.4	75.4	71.2	71.9	67.7	76.6	73.4	69.6	75.9	66.4	73.3	74.7
28	62.4	75.6		68.3	75.2	66.7	70.5	68.7	75.1	75.0	71.8	71.5	64.3	71.0	81.1
29	53.1	79.4		65.7	78.6	68.5	61.6	68.5	64.8	79.9	72.4	72.4	67.8	74.5	73.6
30	59.7	85.8		69.0	70.2	66.4	68.0	69.2	68.2	81.4	70.7	77.4	67.6	71.6	68.9
31		86.5			70.5	70.0		72.0	70.9		69.8	78.1		69.7	69.8
AVG	64.3	71.0		66.4	75.4	70.6	67.2	67.5	72.6	68.1	69.9	71.4	66.2	71.2	71.0

* Data unavailable for August, 1984

PRINCE GEORGE THI VALUES SUMMER 1984 - 1988

	1984			1985			1986			1987			1988		
	JUN	JUL	AUG	JUN	JUL	AUG	JUN	JUL	AUG	JUN	JUL	AUG	JUN	JUL	AUG
1	61.5	64.4	79.4	74.9	70.1	80.8	66.0	68.5	77.1	56.8	85.1	61.8	52.4	69.2	69.7
2	59.9	64.9	83.3	75.7	76.8	71.2	65.0	61.9	79.9	61.9	79.3	62.3	61.9	65.0	78.5
3	60.5	69.3	81.8	76.4	80.2	71.1	68.2	56.4	76.3	66.3	76.5	70.0	62.5	62.8	80.0
4	56.5	62.4	78.1	61.2	86.0	66.7	72.7	59.9	68.2	75.0	66.7	61.7	62.1	65.3	69.6
5	59.5	60.3	81.8	57.8	70.5	70.2	70.6	69.9	72.5	73.1	71.5	75.0	60.0	69.5	69.4
6	58.5	59.4	65.3	61.2	71.1	72.9	71.0	70.2	77.6	62.9	70.5	76.1	64.0	70.7	68.0
7	60.3	58.4	69.6	60.3	76.5	65.1	66.6	75.2	77.5	73.5	64.8	77.6	63.9	69.1	74.1
8	63.9	60.8	82.5	60.2	81.5	70.9	66.7	72.1	75.6	81.0	56.1	76.1	59.3	78.5	58.6
9	71.8	71.6	69.6	57.3	86.3	61.2	64.9	73.6	76.4	70.1	64.2	64.0	60.3	72.0	65.8
10	70.6	67.8	70.3	64.8	75.7	65.4	58.8	64.5	82.4	60.9	73.4	66.3	57.9	76.8	61.9
11	75.6	71.8	78.8	67.7	66.7	70.3	62.4	63.5	80.4	65.2	77.3	68.5	60.9	57.7	71.2
12	76.9	63.9	76.6	61.6	64.6	68.6	67.6	66.4	73.6	64.2	76.6	62.8	63.1	62.8	77.7
13	74.5	63.6	67.3	57.2	69.2	75.2	72.5	67.0	77.3	62.9	76.7	67.4	72.1	62.8	66.2
14	68.3	70.1	63.9	59.7	72.6	75.4	78.6	66.6	66.2	67.7	66.3	69.5	77.8	62.4	64.0
15	67.4	74.2	66.7	57.3	73.1	67.8	59.0	57.6	63.8	64.7	64.3	62.1	70.7	64.3	65.1
16	58.7	76.4	78.0	63.2	75.3	75.9	62.4	68.7	70.2	64.9	67.3	62.9	70.2	67.3	64.4
17	58.6	68.2	68.5	73.8	78.5	76.7	64.4	64.0	71.9	68.8	73.2	63.1	69.7	63.2	68.9
18	57.9	68.1	63.0	81.0	78.4	73.7	63.8	73.2	62.4	71.6	74.7	62.6	61.6	74.0	62.1
19	54.5	59.4	58.5	70.1	78.7	67.7	61.2	78.7	65.7	76.4	78.8	62.1	61.1	81.0	58.8
20	69.1	64.0	67.5	67.4	85.0	68.7	63.7	80.8	70.3	79.1	68.3	52.0	66.2	82.1	59.5
21	72.9	68.5	76.1	61.7	81.8	67.4	61.5	81.3	69.6	61.4	66.2	63.7	73.5	75.7	67.7
22	74.5	74.5	69.2	56.6	67.5	70.6	69.9	74.3	76.8	60.1	78.1	70.2	72.6	65.9	58.3
23	73.5	81.5	66.1	59.7	72.9	74.8	62.8	73.7	69.4	59.7	82.6	72.3	63.6	62.3	75.0
24	65.9	83.5	65.5	67.8	67.9	74.3	64.2	68.8	64.4	71.1	80.0	74.3	64.7	64.2	76.1
25	64.5	88.4	60.4	71.6	69.0	62.0	63.4	68.1	69.4	75.1	75.3	71.8	73.7	69.6	82.2
26	62.2	85.3	70.2	67.5	69.8	69.8	69.0	69.3	77.1	76.3	76.4	74.2	72.5	71.9	79.2
27	54.1	71.7	58.1	67.3	75.0	73.6	72.3	63.1	82.0	75.3	75.4	68.2	65.8	68.3	82.5
28	62.4	75.6	53.9	70.3	77.0	70.3	77.6	60.3	82.8	80.8	76.8	62.6	66.6	69.8	83.7
29	53.1	79.4	60.4	78.8	80.0	68.7	77.1	57.6	76.9	84.0	76.2	67.3	68.0	61.8	65.0
30	59.7	85.8	64.8	69.9	84.0	61.2	75.8	69.8	70.3	77.3	75.5	64.7	61.7	66.5	64.9
31		86.5	59.0		85.2	59.9		73.6	71.1		60.4	74.7		65.9	68.5
AVG	64.3	71.0	69.5	66.0	75.7	69.9	67.5	68.4	73.4	69.7	72.8	67.3	65.5	68.5	69.6

CALGARY THI VALUES SUMMER 1984 - 1988

	1984			1985			1986			1987			1988		
	JUN	JUL	AUG	JUN	JUL	AUG	JUN	JUL	AUG	JUN	JUL	AUG	JUN	JUL	AUG
1	60.9	67.1	77.9	59.1	78.7	80.0	83.3	75.3	73.9	61.8	76.4	64.9	63.7	68.3	51.9
2	63.1	69.0	77.2	62.8	85.0	77.0	70.4	72.8	76.3	63.0	81.7	65.9	65.5	69.3	65.3
3	64.2	69.0	79.3	58.4	76.3	79.3	64.9	64.4	79.5	69.9	71.2	67.1	73.5	66.5	72.7
4	66.4	70.3	76.6	68.7	79.4	81.0	70.4	57.8	71.5	74.4	56.3	78.0	73.4	61.6	80.0
5	58.1	75.0	80.6	64.9	83.2	73.5	60.6	62.5	62.3	75.6	60.0	66.2	61.3	57.4	69.3
6	61.9	71.3	75.7	66.3	84.5	72.5	66.9	70.4	73.0	66.5	65.6	72.4	65.2	60.9	59.8
7	61.9	67.5	73.9	71.8	81.4	75.7	71.2	71.4	75.3	72.1	69.3	74.8	61.0	69.1	64.3
8	49.9	68.0	74.8	57.4	77.5	55.7	60.7	74.0	65.8	70.9	68.0	63.3	63.7	70.2	72.4
9	49.2	72.0	82.1	60.8	82.2	67.3	69.1	70.2	67.8	75.8	63.4	75.5	68.4	74.3	76.4
10	61.6	75.8	77.7	59.6	84.5	52.6	76.1	71.0	76.8	70.4	60.3	57.6	71.6	74.8	65.1
11	66.0	75.1	75.6	72.0	83.0	67.0	66.0	70.3	78.3	74.3	68.6	55.6	65.7	74.0	59.0
12	68.4	74.6	75.5	69.2	67.0	56.1	62.9	65.6	73.0	76.7	73.6	66.2	64.6	66.6	73.5
13	71.1	69.9	72.0	65.1	66.4	63.9	68.5	67.6	71.1	77.9	76.5	49.6	64.1	68.9	77.8
14	73.7	69.9	70.0	72.3	76.1	68.7	68.3	72.3	77.4	83.9	84.8	50.3	66.3	64.8	68.7
15	66.5	77.7	76.1	69.3	70.3	53.9	68.5	60.5	67.5	80.7	68.3	64.9	75.9	69.3	66.5
16	68.6	75.9	78.4	64.0	70.8	63.1	70.3	62.2	66.1	61.6	55.9	62.3	80.3	70.5	66.8
17	65.7	79.0	81.1	66.9	61.2	71.6	83.1	53.1	79.7	70.7	57.3	59.7	72.8	64.8	68.0
18	69.1	75.3	74.2	74.6	75.5	75.1	72.9	64.6	79.7	75.6	54.1	66.4	72.8	68.5	68.7
19	62.9	80.0	70.0	80.8	68.8	76.9	63.3	69.0	62.9	73.7	59.3	63.1	79.2	72.3	65.1
20	62.3	63.4	69.1	60.6	75.9	57.2	64.9	72.7	71.5	68.7	68.7	67.4	76.5	81.4	54.3
21	57.3	59.4	71.7	70.6	83.9	48.6	67.5	77.6	65.3	72.7	68.8	61.5	70.2	84.1	66.1
22	64.2	67.6	80.4	59.4	86.3	70.2	72.1	75.6	75.3	66.4	63.7	65.3	76.3	77.0	68.7
23	74.2	75.5	78.4	72.8	70.9	72.7	77.0	65.2	77.1	62.9	73.1	68.1	75.4	75.4	75.8
24	71.1	78.4	75.5	54.0	68.8	76.7	66.6	72.9	70.8	68.2	77.1	63.6	72.1	81.7	72.2
25	72.8	81.5	74.5	65.3	75.1	68.9	79.7	65.4	63.8	76.9	80.7	60.9	80.0	79.3	75.1
26	78.8	84.2	74.0	69.9	67.9	62.4	65.9	60.6	73.1	79.1	76.8	68.5	79.6	86.0	59.9
27	71.6	76.9	70.1	77.6	68.7	69.3	68.5	63.6	77.4	74.9	83.2	72.9	76.6	74.1	70.0
28	79.5	80.6	60.9	78.2	71.9	62.8	71.3	69.1	82.6	71.9	82.1	64.9	69.9	64.9	78.1
29	66.3	68.7	64.4	69.9	63.1	75.1	60.0	60.3	80.4	76.4	84.7	59.5	65.5	81.1	81.7
30	63.2	71.8	63.3	77.6	75.0	75.3	62.6	65.2	62.4	65.3	83.0	71.6	67.5	69.4	71.5
31		76.1	60.3		74.0	64.4		67.0	67.3		82.3	77.1		70.7	69.0
AVG	65.9	73.2	73.8	67.6	75.7	68.5	69.3	67.4	72.5	72.0	71.0	65.4	70.8	71.7	69.1

WINNIPEG THI VALUES SUMMER 1984 - 1988

	1984			1985			1986			1987			1988		
	JUN	JUL	AUG	JUN	JUL	AUG	JUN	JUL	AUG	JUN	JUL	AUG	JUN	JUL	AUG
1	67.0	73.9	84.3	52.2	72.5	85.7	63.3	75.1	71.5	75.9	72.1	84.2	90.5	78.9	72.6
2	70.3	79.5	87.7	57.4	78.8	78.9	78.4	73.7	72.2	66.5	77.4	88.3	87.0	81.3	73.1
3	71.5	74.3	86.3	68.0	82.8	77.1	77.1	87.0	78.2	66.1	78.7	69.7	89.3	85.0	70.7
4	66.3	71.8	86.3	55.3	78.9	72.5	64.5	77.7	81.2	64.8	79.9	71.4	87.5	82.0	71.0
5	60.4	65.3	88.7	69.1	84.4	77.5	68.1	76.9	81.3	74.8	82.9	82.3	90.3	85.2	78.2
6	63.6	69.3	84.8	76.8	87.7	78.1	79.3	69.1	81.7	80.8	82.4	75.4	90.1	83.4	81.5
7	77.7	70.1	80.6	77.3	89.4	73.1	70.1	74.8	75.7	73.9	79.3	83.7	89.8	78.3	80.3
8	64.6	78.3	78.3	77.9	79.9	84.9	69.0	79.0	80.3	68.0	75.6	86.5	73.8	82.5	73.9
9	54.5	82.4	73.9	64.1	74.2	67.8	76.2	76.6	70.8	72.0	84.7	76.0	77.8	72.6	81.6
10	64.6	80.1	70.5	64.1	71.7	67.3	68.7	67.1	68.7	75.4	79.9	84.2	82.7	68.3	88.0
11	71.0	82.3	86.0	64.7	78.1	66.2	71.3	69.2	73.1	80.2	65.5	76.1	96.3	74.0	83.1
12	60.8	84.5	84.3	71.5	82.4	60.8	69.9	60.0	79.3	83.0	67.6	67.4	79.8	82.5	80.4
13	67.4	80.4	93.1	73.5	80.1	62.0	70.9	68.1	80.1	91.0	71.5	71.2	78.8	81.9	78.1
14	69.1	74.1	85.2	66.6	73.4	64.0	66.8	76.8	82.5	79.5	70.0	69.1	60.1	71.1	85.0
15	68.2	76.1	74.2	70.5	75.9	68.0	65.1	81.7	88.7	87.5	77.0	70.7	64.6	77.3	91.0
16	79.6	71.7	85.8	66.7	84.8	68.0	63.8	80.5	75.2	89.5	83.4	65.8	74.7	79.3	83.3
17	79.6	75.6	82.9	60.6	77.0	56.8	74.5	80.7	70.7	86.2	75.4	72.0	90.1	79.6	78.5
18	71.1	84.6	83.0	69.5	76.4	56.1	85.5	81.5	79.9	81.7	68.4	69.5	88.5	78.3	76.0
19	73.5	76.9	85.9	77.1	81.1	63.7	88.9	75.7	85.5	82.4	72.1	73.4	82.4	78.8	78.7
20	77.0	79.5	76.2	78.4	70.2	68.9	76.4	72.1	68.5	86.1	80.5	75.7	86.6	80.4	81.2
21	78.6	82.1	69.2	70.7	69.3	70.0	80.1	79.3	72.5	86.4	67.6	68.6	84.8	84.1	80.0
22	79.2	76.8	69.4	54.5	75.4	73.6	73.4	78.5	67.4	89.6	74.3	64.2	75.2	87.6	79.4
23	70.0	76.0	76.8	68.4	75.5	65.3	63.8	84.6	77.2	78.7	75.9	67.7	79.4	80.5	68.4
24	73.3	79.1	81.2	67.0	68.7	75.2	74.6	78.2	71.3	78.1	81.5	73.3	89.6	78.8	81.2
25	84.5	81.6	90.2	70.3	73.7	75.2	79.0	80.7	67.0	69.7	81.5	69.8	77.9	86.4	71.1
26	72.2	80.1	95.1	67.1	78.1	76.6	75.9	75.2	59.7	71.0	81.5	73.0	81.1	86.7	76.6
27	75.4	83.7	90.0	53.8	79.4	66.9	73.8	77.2	63.8	76.2	85.8	76.3	88.2	90.3	58.4
28	76.6	85.5	84.7	62.2	69.2	63.9	73.6	75.0	70.2	70.3	91.6	79.5	76.2	91.7	63.3
29	76.1	78.7	72.9	67.0	76.3	69.4	67.7	81.3	79.7	74.6	89.6	73.4	74.1	84.2	69.8
30	78.6	78.4	66.7	74.4	76.2	73.2	69.2	73.4	81.2	76.5	85.5	62.3	78.3	84.4	76.4
31		81.7	64.3		82.5	76.1		74.8	72.5		77.7	69.6		80.4	77.5
AVG	71.5	77.9	81.3	67.4	77.6	70.5	72.7	76.2	75.1	78.1	78.0	73.9	82.5	81.3	78.7

TORONTO THI VALUES SUMMER 1984 - 1988

	1984			1985			1986			1987			1988		
	JUN	JUL	AUG	JUN	JUL	AUG	JUN	JUL	AUG	JUN	JUL	AUG	JUN	JUL	AUG
1	70.9	75.7	83.5	69.5	75.2	76.0	81.4	72.8	78.0	79.2	73.3	75.8	74.8	70.0	80.9
2	70.8	79.0	76.9	75.9	78.1	73.0	59.2	75.8	78.6	78.6	67.0	74.2	61.2	75.7	86.5
3	72.6	83.1	78.8	65.7	79.4	78.2	62.8	66.2	73.7	80.6	74.7	83.5	62.8	77.2	89.7
4	77.9	78.7	80.8	64.5	81.7	80.7	76.0	73.9	74.5	71.7	76.4	85.5	68.2	75.8	88.9
5	75.0	75.7	82.2	66.3	80.2	81.0	63.0	84.7	79.9	68.4	79.7	70.9	77.0	80.5	87.2
6	83.8	67.4	82.1	68.7	70.9	79.5	63.5	86.3	77.9	67.7	81.3	73.9	78.5	86.4	85.3
7	82.2	62.2	82.7	65.7	72.6	75.4	67.5	85.3	71.5	72.2	82.5	81.6	63.6	90.8	77.2
8	81.2	70.1	80.5	75.0	74.4	81.7	75.7	76.1	75.4	81.1	86.8	77.9	60.7	90.9	83.9
9	85.0	71.4	83.0	81.5	84.0	83.1	66.3	76.8	78.3	60.2	88.2	66.1	60.3	91.1	88.7
10	81.6	70.1	81.8	69.9	78.4	81.0	74.0	73.4	73.8	68.0	88.0	78.3	65.2	96.6	82.1
11	71.7	77.1	77.4	58.3	73.7	75.1	69.1	68.2	68.5	68.5	92.0	70.6	76.1	85.2	80.6
12	74.3	80.6	76.8	64.1	71.1	70.5	61.2	64.5	72.0	86.2	90.1	73.3	82.7	77.6	87.3
13	82.8	82.3	78.6	57.5	80.2	81.6	71.7	80.0	74.4	75.7	86.2	77.9	83.0	77.3	90.6
14	69.9	85.8	82.4	66.1	77.0	83.2	71.1	74.9	74.7	90.6	71.7	81.7	87.6	88.9	88.7
15	60.7	79.4	85.3	69.0	73.9	70.3	67.6	76.8	82.9	79.6	67.2	87.5	88.1	77.4	78.7
16	64.4	76.7	81.9	66.4	72.9	76.8	79.5	77.0	80.1	82.4	72.9	89.1	73.0	94.9	87.5
17	67.0	72.5	71.9	68.5	73.8	80.1	63.9	78.5	81.9	71.0	79.6	85.8	68.3	82.6	88.7
18	83.9	71.8	73.6	70.2	77.5	77.8	70.2	82.7	78.9	76.4	90.7	81.8	74.7	83.7	67.8
19	78.1	76.5	72.4	68.0	81.4	72.8	70.1	78.5	77.2	84.1	75.7	81.5	79.7	84.0	70.6
20	66.8	77.6	70.0	70.3	83.1	68.2	70.4	82.4	77.5	69.6	89.1	75.8	87.1	75.4	74.9
21	71.0	78.2	75.0	73.6	76.3	67.2	76.0	70.1	76.6	76.3	88.2	80.7	82.5	78.6	71.3
22	68.4	80.2	72.7	79.5	72.4	71.4	80.8	75.7	69.5	70.4	87.0	81.5	86.3	79.5	68.0
23	73.0	85.8	65.7	76.6	69.9	71.9	80.9	83.1	72.4	80.8	89.6	69.4	67.5	74.5	65.9
24	74.3	78.7	73.7	68.7	76.4	67.5	64.4	84.3	68.3	86.8	92.8	68.5	70.0	76.5	73.7
25	68.1	71.0	75.1	72.1	83.9	72.8	66.6	83.7	71.7	85.7	85.0	74.7	87.0	80.5	74.4
26	68.6	70.7	77.0	67.0	77.1	73.6	73.2	76.6	74.6	79.3	82.5	68.2	69.1	76.5	74.4
27	72.2	69.6	79.6	71.7	76.0	78.2	76.6	78.6	65.2	72.0	78.7	68.3	70.7	80.2	73.7
28	74.8	72.2	74.0	78.0	76.3	75.3	79.0	80.2	61.1	74.5	71.2	66.8	79.7	84.4	70.1
29	71.0	74.2	79.6	70.7	82.9	65.1	78.2	76.8	66.6	79.2	78.6	70.7	68.2	93.3	68.1
30	72.7	78.8	76.3	72.0	75.1	63.9	70.6	77.2	69.8	75.3	82.7	75.6	65.2	84.0	71.1
31		80.2	73.6		67.1	62.3		74.8	64.8		74.0	72.4		80.2	72.2
AVG	73.8	75.9	77.6	69.7	76.5	74.7	71.0	77.3	73.9	76.5	81.3	76.4	74.1	82.4	78.9

MONTREAL THI VALUES SUMMER 1984 - 1988

	1984			1985			1986			1987			1988		
	JUN	JUL	AUG	JUN	JUL	AUG	JUN	JUL	AUG	JUN	JUL	AUG	JUN	JUL	AUG
1	68.0	82.8	72.5	66.3	82.4	75.2	59.0	73.2	70.2	80.2	72.2	74.5	66.7	61.8	86.8
2	75.0	85.2	82.2	76.8	78.1	76.9	56.4	68.7	77.7	78.5	75.5	79.3	61.8	74.1	87.9
3	67.0	79.6	86.5	67.5	75.2	78.8	62.5	63.3	79.0	77.6	70.9	79.5	63.4	76.6	89.7
4	76.5	75.7	87.7	66.9	80.4	81.3	72.7	69.4	75.0	70.5	75.3	77.9	71.8	80.8	89.4
5	77.2	77.1	87.3	61.3	84.3	84.9	65.1	71.8	78.3	70.6	80.9	70.0	76.3	82.9	89.2
6	76.4	83.9	83.3	63.9	79.3	84.0	67.4	76.9	78.8	65.1	82.9	76.4	70.7	80.3	80.7
7	83.5	74.1	83.7	71.6	74.1	80.2	74.6	83.4	72.5	68.5	77.8	78.9	67.7	83.8	81.0
8	83.1	72.2	81.9	68.4	74.5	78.6	80.2	81.1	69.4	66.4	83.2	78.1	63.0	85.1	83.7
9	82.2	80.7	81.4	73.6	81.3	84.6	71.5	74.4	77.0	66.9	88.9	73.9	59.6	88.0	80.3
10	79.7	81.5	86.5	70.4	72.4	87.9	76.1	63.4	79.0	70.2	89.1	74.7	67.6	87.3	84.8
11	76.9	71.1	76.9	67.0	71.2	80.3	69.8	68.6	72.4	72.2	88.4	73.0	75.3	79.6	83.3
12	75.9	84.2	81.1	57.9	74.4	74.6	61.6	69.7	70.9	64.2	88.7	74.4	78.4	81.2	85.2
13	73.2	81.4	83.6	61.2	79.5	75.3	65.8	64.0	74.1	72.7	90.4	81.1	81.4	77.1	88.2
14	76.1	81.6	85.6	59.5	77.7	85.8	72.7	70.3	78.4	77.8	84.2	70.8	81.5	78.8	75.4
15	64.6	81.1	80.6	67.8	80.2	74.3	74.1	76.1	75.2	79.9	70.3	74.8	86.3	73.6	79.5
16	72.0	80.0	80.6	67.7	79.9	78.4	82.5	79.7	79.9	69.4	74.2	89.6	75.7	76.2	72.4
17	77.8	76.3	66.7	75.4	79.0	77.6	60.1	79.9	84.0	73.4	76.7	89.7	73.5	73.9	73.2
18	71.2	72.5	70.9	76.8	78.5	82.0	68.5	82.1	78.1	76.9	81.6	81.6	79.0	88.3	70.2
19	79.3	78.1	71.7	65.7	79.1	72.2	71.6	85.3	75.2	80.4	74.6	79.1	82.0	75.2	72.4
20	71.4	80.5	69.0	72.0	80.8	73.1	71.8	80.2	78.1	70.0	69.3	72.9	84.0	77.2	70.1
21	74.2	81.5	74.2	76.5	81.6	75.6	73.7	71.2	76.7	78.8	76.2	77.4	79.3	72.6	64.9
22	72.5	84.2	77.9	78.5	73.4	72.7	78.2	74.5	71.2	75.9	86.3	76.0	77.4	82.0	64.3
23	73.0	82.4	65.5	80.0	74.6	73.1	79.5	78.7	68.4	80.3	86.7	65.9	66.2	83.0	69.5
24	66.1	75.9	75.6	65.6	79.1	69.6	65.9	83.7	62.3	86.8	86.8	62.8	69.2	82.0	61.8
25	71.5	74.4	75.7	58.6	85.4	64.4	60.4	88.4	69.9	72.0	84.0	68.2	70.3	80.1	69.6
26	71.1	73.1	77.8	68.7	82.1	71.3	67.0	79.0	75.6	75.7	77.8	64.4	66.5	81.2	74.8
27	76.0	65.5	79.3	72.4	73.9	77.0	68.0	76.4	71.6	72.0	73.7	70.0	74.8	80.9	74.6
28	75.5	76.3	78.6	69.7	74.7	75.6	79.3	80.1	57.9	71.2	65.7	71.7	69.7	84.2	71.8
29	80.6	80.4	83.7	72.9	83.1	63.8	72.9	75.9	65.4	73.6	70.2	67.1	60.0	87.3	65.5
30	80.0	76.7	81.3	79.5	76.5	58.8	72.6	70.6	70.4	76.9	75.3	75.6	57.2	90.7	69.8
31		79.6	75.6		70.9	65.5		64.0	71.8		73.8	79.3		82.5	72.0
AVG	74.9	78.4	78.9	69.3	78.0	75.9	70.0	75.0	73.6	73.9	79.0	75.1	72.2	80.3	77.0

QUEBEC CITY THI VALUES SUMMER 1984 - 1988

	1984			1985			1986			1987			1988		
	JUN	JUL	AUG	JUN	JUL	AUG	JUN	JUL	AUG	JUN	JUL	AUG	JUN	JUL	AUG
1	61.9	70.1	65.2	60.0	69.9	62.7	53.4	73.4	67.3	76.2	72.6	71.4	59.2	57.9	83.5
2	64.0	71.5	68.1	66.6	66.1	66.9	55.7	69.1	68.6	73.4	73.8	75.3	56.1	62.8	83.7
3	58.3	70.6	70.9	63.4	65.7	67.8	59.6	67.2	77.1	74.0	62.7	69.6	63.4	78.7	71.8
4	61.9	66.1	71.3	61.6	69.1	68.7	55.6	65.8	73.2	72.6	68.5	73.7	70.3	79.0	89.6
5	64.5	67.2	70.8	58.5	71.2	70.8	66.6	61.7	76.1	69.3	77.9	68.5	71.3	79.4	81.8
6	64.0	70.2	69.1	59.6	67.6	71.0	61.7	69.5	76.2	65.5	82.1	72.2	72.4	77.7	85.5
7	65.1	66.1	69.5	67.0	63.3	69.9	72.6	84.1	72.3	69.1	81.0	79.7	63.0	85.1	77.4
8	70.7	62.9	68.8	64.6	60.2	67.4	77.3	79.0	72.6	60.9	81.5	77.0	59.0	89.2	81.4
9	72.0	68.7	65.8	67.0	68.0	67.7	65.4	70.2	66.5	61.3	83.8	74.9	60.7	90.5	76.0
10	66.8	69.0	69.2	62.2	64.8	69.9	72.9	64.7	77.7	69.8	81.2	73.8	67.7	87.8	84.2
11	68.6	66.9	65.3	61.9	63.2	67.8	63.1	65.5	75.9	71.8	84.5	69.2	73.3	73.3	81.8
12	67.2	68.3	63.6	59.1	64.6	64.6	65.1	67.3	67.5	59.6	87.7	71.6	82.5	79.6	84.7
13	65.0	67.5	68.3	56.4	67.8	61.9	56.6	71.9	71.9	71.1	89.2	77.1	79.7	77.9	70.8
14	58.0	66.1	67.8	58.4	65.8	69.2	69.4	61.7	73.7	76.4	85.1	73.0	83.5	76.9	61.3
15	59.0	62.8	68.7	63.6	67.5	66.1	73.2	69.0	71.6	77.1	67.8	76.9	90.9	69.0	71.8
16	64.4	67.8	66.7	65.3	67.0	66.1	77.4	79.2	78.7	64.2	73.0	76.0	80.6	61.9	66.3
17	66.6	65.6	63.1	66.9	67.4	64.4	58.2	81.7	78.0	73.6	73.9	87.0	72.0	72.6	72.2
18	65.9	63.1	63.5	60.0	68.9	66.0	65.0	81.5	71.0	75.0	71.0	78.4	76.0	83.0	67.9
19	67.2	66.1	64.0	61.1	65.4	68.7	67.0	74.3	67.9	72.6	75.7	75.7	80.3	73.9	70.1
20	64.0	67.4	64.3	61.2	67.9	64.8	67.6	76.3	73.7	71.0	61.9	71.0	81.4	75.1	67.6
21	61.7	67.4	65.3	65.7	67.0	63.7	73.6	70.2	77.9	75.3	67.1	73.2	80.6	76.5	62.7
22	64.4	68.1	66.6	68.3	65.7	63.6	76.4	74.1	70.3	68.7	80.6	69.4	79.4	79.9	65.6
23	61.2	65.8	62.7	68.8	64.6	64.0	76.9	78.3	65.7	77.3	72.1	64.1	63.2	80.7	69.3
24	61.6	64.3	63.9	63.8	65.9	64.9	67.2	81.8	60.0	80.2	88.2	64.0	69.1	77.4	68.4
25	62.8	65.0	66.6	58.1	70.1	61.0	58.4	85.1	66.8	62.9	81.7	63.8	62.4	75.1	62.3
26	63.6	64.4	67.2	61.4	67.1	61.6	68.4	71.4	70.8	72.9	68.7	63.5	63.6	79.1	73.2
27	58.5	61.4	68.6	65.2	63.3	63.2	57.6	71.6	67.2	62.7	66.8	66.3	73.7	78.9	74.1
28	67.0	64.1	67.4	62.5	63.6	65.7	76.7	70.9	55.6	69.2	62.8	70.9	63.6	82.6	69.2
29	68.0	67.4	67.1	62.5	66.2	61.6	68.8	64.1	61.4	71.6	68.3	62.3	60.5	84.4	65.2
30	67.8	67.8	66.5	68.0	67.3	61.8	70.9	63.4	66.7	76.4	69.0	74.3	63.8	89.8	68.3
31		67.6	64.8		63.1	63.7		58.4	65.6		68.6	76.0		80.7	74.1
AVG	64.4	66.7	66.8	63.0	66.3	65.7	66.6	71.7	70.4	70.7	75.0	72.2	70.6	77.9	73.6

HALIFAX THI VALUES SUMMER 1984 - 1988

	1984			1985			1986			1987			1988		
	JUN	JUL	AUG	JUN	JUL	AUG	JUN	JUL	AUG	JUN	JUL	AUG	JUN	JUL	AUG
1	59.0	79.9	75.7	58.3	76.5	58.3	55.4	69.4	65.1	72.9	76.9	70.0	57.6	58.6	68.9
2	61.9	84.2	81.8	70.4	75.2	69.1	55.2	65.8	64.8	66.5	73.9	70.4	48.7	60.8	77.5
3	53.3	73.6	78.8	65.1	67.8	68.3	56.0	59.7	68.0	56.9	59.4	68.9	55.7	66.2	71.6
4	62.2	69.3	82.5	61.3	74.3	75.1	56.9	69.3	77.7	58.8	57.4	76.8	53.5	70.0	78.8
5	64.0	69.5	83.6	67.2	80.9	81.0	63.3	57.9	77.4	54.2	70.2	82.6	52.5	68.2	85.3
6	70.7	70.7	82.2	55.4	73.0	77.0	58.5	67.7	80.1	52.0	69.0	68.3	58.6	75.4	84.2
7	55.0	72.0	70.3	56.2	64.4	78.1	54.1	63.3	73.4	70.7	72.7	69.8	59.1	75.8	74.5
8	63.9	65.3	75.9	70.5	62.4	72.9	61.0	79.9	72.0	57.0	71.6	66.6	60.6	73.1	70.0
9	83.5	63.9	76.8	64.0	72.3	74.5	65.7	73.3	72.1	56.5	68.4	67.2	64.8	77.1	78.8
10	80.6	64.6	68.9	67.5	68.0	71.5	70.6	68.5	73.9	54.7	76.1	69.8	54.9	76.1	76.8
11	65.0	71.2	75.9	70.6	66.4	67.4	63.3	68.0	68.0	69.9	67.6	66.5	65.0	74.5	80.6
12	77.3	64.4	77.9	65.8	70.7	65.1	57.8	70.1	76.3	59.3	73.9	73.4	62.9	70.3	84.6
13	72.6	76.9	79.7	49.1	72.1	69.8	51.3	64.6	72.6	66.6	78.3	72.9	75.1	81.0	83.0
14	69.8	79.3	79.9	61.2	73.0	70.1	64.6	55.8	72.2	52.7	72.9	77.0	60.6	58.5	74.1
15	58.1	79.6	76.6	65.9	66.2	81.9	68.4	61.7	70.7	75.7	70.9	82.5	63.3	75.0	61.0
16	64.4	72.7	75.2	68.9	66.9	77.2	70.2	74.6	68.7	69.1	75.2	74.5	79.6	68.9	69.8
17	64.1	77.5	78.0	59.0	70.7	76.4	67.1	73.8	71.2	67.7	72.3	81.5	63.7	68.2	66.7
18	64.9	73.2	72.7	64.3	68.2	70.1	64.2	66.8	69.5	70.0	77.9	78.4	66.6	78.6	72.9
19	61.2	74.5	75.3	62.6	75.5	66.8	68.6	68.6	64.9	74.2	77.4	80.0	70.1	76.4	67.8
20	71.1	78.3	68.0	70.7	78.0	68.5	67.0	73.9	70.8	75.4	74.6	76.6	64.4	77.1	71.1
21	69.3	74.1	70.0	74.0	80.4	71.7	68.6	66.2	74.6	68.4	75.1	75.3	77.7	64.9	72.1
22	62.4	80.2	78.3	72.1	67.8	68.4	68.2	71.7	71.1	76.8	68.1	76.4	71.8	66.9	66.6
23	61.4	79.3	73.4	54.1	76.1	67.7	57.7	74.1	66.8	61.3	70.9	71.6	62.1	70.7	64.2
24	58.1	82.6	68.7	58.1	74.1	70.6	69.6	72.7	62.7	69.0	72.3	65.5	63.9	62.4	64.4
25	57.7	71.6	69.8	57.2	72.7	69.4	66.4	76.4	64.7	66.3	82.9	65.2	59.7	70.0	63.1
26	56.1	75.0	69.6	55.0	72.9	64.7	63.8	77.0	68.7	59.7	73.6	68.5	58.6	72.7	65.7
27	63.5	69.0	73.9	54.1	77.0	65.3	66.5	76.3	65.5	55.8	74.5	67.4	61.2	64.0	69.6
28	66.6	68.7	73.2	61.9	71.5	74.1	59.4	61.7	66.6	70.0	72.6	66.0	59.2	71.6	72.9
29	74.1	71.7	75.5	68.9	71.1	66.0	65.8	69.6	60.6	76.6	72.0	64.3	60.4	75.7	79.7
30	71.8	68.4	76.1	73.0	79.0	66.5	70.3	63.9	65.0	68.2	70.9	69.3	56.3	76.3	70.0
31		79.0	73.9		72.9	54.4		58.3	64.5		66.9	74.8		75.2	72.2
AVG	65.5	73.6	75.4	63.5	72.3	70.4	63.3	68.5	69.7	65.2	72.2	72.2	62.3	71.1	72.8

ANNEX C

IN-VEHICLE TEMPERATURES FOR HAMILTON AREA, JUNE 1988

The following readings were taken by an officer from the CCAC regional office in Hamilton.

His record is not complete, which accounts for the apparent inconsistency of entering the car twice without leaving (and vice versa).

DATE	ENTER/ LEAVE VEHICLE	TIME	TEMPoC	TEMPoF
1	ENTER	1:20	30.0	86.0
1	LEAVE	1:34	27.0	80.6
1	ENTER	3:47	29.0	84.2
1	LEAVE	4:31	25.0	77.0
2	ENTER	7:50	16.0	60.8
2	LEAVE	8:07	15.0	59.0
2	ENTER	8:45	17.0	62.6
2	LEAVE	9:12	20.0	68.0
2	ENTER	11:07	28.0	82.4
2	LEAVE	11:15	25.0	77.0
2	ENTER	12:10	25.0	77.0
2	LEAVE	12:30	25.0	77.0
2	ENTER	1:15	35.0	95.0
2	LEAVE	1:20	28.0	82.4
2	ENTER	1:49	35.0	95.0
2	LEAVE	2:00	32.0	89.6
2	ENTER	2:18	37.0	98.6
2	LEAVE	2:30	29.0	84.2
6	ENTER	7:30	18.0	64.4
6	LEAVE	8:38	26.0	78.8
6	ENTER	4:45	44.0	111.2
6	LEAVE	5:55	34.0	93.2
7	ENTER	7:55	18.0	64.4
7	ENTER	10:00	24.0	75.2
7	ENTER	10:30	25.0	77.0
7	LEAVE	10:40	20.0	68.0
7	ENTER	10:50	24.0	75.2
7	LEAVE	11:05	21.0	69.8
7	LEAVE	11:16	23.0	73.4
7	ENTER	11:26	24.0	75.2
7	LEAVE	11:36	25.0	77.0
7	ENTER	12:35	23.0	73.4
9	ENTER	7:30	13.0	55.4
9	ENTER	4:15	34.0	93.2
9	LEAVE	5:10	24.0	75.2
13	ENTER	7:40	21.0	69.8
13	LEAVE	8:30	28.0	82.4
13	ENTER	3:15	35.0	95.0
13	LEAVE	4:30	38.0	100.4
14	ENTER	8:00	25.0	77.0
14	LEAVE	8:22	28.0	82.4
14	ENTER	8:53	28.0	82.4
14	LEAVE	8:55	29.0	84.2
14	ENTER	12:45	50.0	122.0
14	LEAVE	12:57	44.0	111.2
14	ENTER	1:36	48.0	118.4
14	LEAVE	1:45	37.0	98.6

DATE	ENTER/ LEAVE VEHICLE	TIME	TEMPoC	TEMPoF
15	ENTER	7:30	25.0	77.0
15	LEAVE	8:15	27.0	80.6
15	ENTER	3:30	42.0	107.6
15	LEAVE	4:24	38.0	100.4
16	ENTER	5:45	20.0	68.0
16	LEAVE	6:55	24.0	75.2
16	ENTER	8:55	25.0	77.0
16	LEAVE	9:04	25.0	77.0
16	ENTER	11:03	40.0	104.0
16	LEAVE	11:20	34.0	93.2
16	ENTER	12:40	38.0	100.4
16	LEAVE	1:00	34.0	93.2
16	ENTER	1:40	45.0	113.0
16	LEAVE	2:00	30.0	86.0
16	ENTER	2:46	34.0	93.2
16	LEAVE	3:10	30.0	86.0
20	ENTER	7:30	25.0	77.0
20	LEAVE	8:35	32.0	89.6
20	ENTER	4:00	37.0	98.6
20	LEAVE	5:00	38.0	100.4
21	ENTER	8:00	23.0	73.4
21	LEAVE	9:00	27.0	80.6
21	ENTER	12:55	45.0	113.0
21	LEAVE	1:00	40.0	104.0
21	ENTER	1:30	38.0	100.4
21	LEAVE	1:40	37.0	98.6
21	ENTER	4:05	47.0	116.6
21	LEAVE	4:30	38.0	100.4
22	ENTER	7:45	25.0	77.0
22	LEAVE	8:45	28.0	82.4
22	ENTER	12:51	44.0	111.2
22	LEAVE	1:15	38.0	100.4
22	ENTER	3:15	40.0	104.0
22	LEAVE	3:45	38.0	100.4
23	ENTER	7:45	25.0	77.0
23	LEAVE	8:45	25.0	77.0
23	ENTER	9:45	28.0	82.4
23	LEAVE	10:05	25.0	77.0
27	ENTER	7:00	16.0	60.8
27	LEAVE	8:00	23.0	73.4
27	ENTER	4:00	24.0	75.2
27	LEAVE		27.0	80.6
28	ENTER	8:30	16.0	60.8
28	LEAVE	8:45	20.0	68.0
28	ENTER	12:55	40.0	104.0

ANNEX D

CCAC FLEET VEHICLE TYPES BY SUB-ACTIVITY AND REGION

CCAC FLEET VEHICLE TYPES BY SUB-ACTIVITY AND REGION

VEHICLE TYPE	TOTAL IN FLEET	DISTRIBUTION BY SUB-ACTIVITY	DISTRIBUTION BY CCAC REGION
BOX TRUCK	7	WEIGHTS AND MEASURES 7	ONTARIO 2 PACIFIC 2 PRAIRIES 2 QUEBEC 1
CARGO VAN	17	CONSUMER PRODUCTS 1 ELECTRICITY & GAS 7 LEGAL METROLOGY 2 PRODUCT SAFETY 1 WEIGHTS AND MEASURES 6	NT'L H-QUARTERS 2 ONTARIO 5 PACIFIC 3 PRAIRIES 7
COMPACT STATION WAGON	191	CONSUMER PRODUCTS 124 ELECTRICITY & GAS 26 MARKETING PRACTICES 18 PRODUCT SAFETY 15 REGIONAL OFFICE ADMIN. 1 WEIGHTS AND MEASURES 7	ATLANTIC 18 ONTARIO 69 PACIFIC 21 PRAIRIES 41 QUEBEC 42
FULL-SIZE AUTOMOBILE	1	ELECTRICITY & GAS 1	PACIFIC 1
HEAVY TRUCK	17	WEIGHTS AND MEASURES 17	ATLANTIC 2 ONTARIO 4 PACIFIC 2 PRAIRIES 7 QUEBEC 2
HYDRAULIC EQUIP. TRUCK	1	WEIGHTS AND MEASURES 1	ONTARIO 1
LIGHT TRUCK	229	CONSUMER PRODUCTS 26 ELECTRICITY & GAS 23 LEGAL METROLOGY 1 PRODUCT SAFETY 5 WEIGHTS AND MEASURES 174	ATLANTIC 28 NT'L H-QUARTERS 2 ONTARIO 78 PACIFIC 19 PRAIRIES 47 QUEBEC 55
MID-SIZE AUTOMOBILE	23	CONSUMER PRODUCTS 9 DEPUTY MINISTER 1 ELECTRICITY & GAS 4 MARKETING PRACTICES 7 WEIGHTS AND MEASURES 2	ATLANTIC 6 NT'L H-QUARTERS 1 ONTARIO 2 PACIFIC 2 PRAIRIES 6 QUEBEC 6
MEDIUM TRUCK	8	WEIGHTS AND MEASURES 8	ATLANTIC 1 ONTARIO 2 PRAIRIES 3 QUEBEC 2
OTHERS	7	LEGAL METROLOGY 1 MINISTER 1 MARKETING PRACTICES 1 WEIGHTS AND MEASURES 4	ATLANTIC 1 NT'L H-QUARTERS 2 ONTARIO 3 QUEBEC 1

ANNEX E

CCAC FLEET BY VEHICLE MODEL YEAR AND VEHICLE TYPE

CCAC FLEET BY VEHICLE MODEL YEAR AND VEHICLE TYPE

MODEL YEAR	TOTAL IN FLEET	VEHICLE TYPE
1977	1	HEAVY TRUCK 1
1978	3	HEAVY TRUCK 1
		BOX TRUCK 1
		HYDRAULIC EQUIP. TRUCK 1
1979	3	HEAVY TRUCK 2
		BOX TRUCK 1
1980	3	HEAVY TRUCK 2
		MEDIUM TRUCK 1
1981	8	CARGO VAN 2
		FULL-SIZE AUTOMOBILE 1
		HEAVY TRUCK 4
		BOX TRUCK 1
1982	28	BOX TRUCK 2
		COMPACT STATION WAGON 11
		HEAVY TRUCK 2
		LIGHT TRUCK 12
		MEDIUM TRUCK 1
1983	49	CARGO VAN 1
		COMPACT STATION WAGON 21
		HEAVY TRUCK 1
		LIGHT TRUCK 21
		MID-SIZE AUTOMOBILE 2
		MEDIUM TRUCK 2
		OTHERS 1
1984	89	CARGO VAN 3
		COMPACT STATION WAGON 38
		LIGHT TRUCK 42
		MID-SIZE AUTOMOBILE 5
		MEDIUM TRUCK 1
1985	84	CARGO VAN 5
		COMPACT STATION WAGON 37
		LIGHT TRUCK 33
		MID-SIZE AUTOMOBILE 8
		MEDIUM TRUCK 1
1986	83	CARGO VAN 2
		COMPACT STATION WAGON 35
		HEAVY TRUCK 1
		LIGHT TRUCK 40
		MID-SIZE AUTOMOBILE 4
		MEDIUM TRUCK 1

MODEL YEAR	TOTAL IN FLEET	VEHICLE TYPE
1987	112	BOX TRUCK 2
		CARGO VAN 4
		COMPACT STATION WAGON 34
		HEAVY TRUCK 3
		LIGHT TRUCK 62
		MID-SIZE AUTOMOBILE 4
		OTHERS 3
1988	38	COMPACT STATION WAGON 15
		LIGHT TRUCK 19
		MEDIUM TRUCK 1
		OTHERS 3

ANNEX F

CCAC FLEET INVENTORY PRICE DISTRIBUTION

CCAC FLEET INVENTORY PRICE DISTRIBUTION

INVENTORY PRICE DISTRIBUTION *		TOTAL IN FLEET
FROM	TO	
	$3,700.00	1
$7,348.00	$7,959.00	15
$8,118.00	$8,991.00	34
$9,000.00	$9,982.00	112
$10,002.00	$10,913.00	82
$11,004.00	$11,951.00	53
$12,000.00	$12,950.00	50
$13,033.00	$13,963.00	43
$14,003.00	$14,974.00	35
$15,103.00	$15,998.00	20
$16,001.00	$16,943.00	15
$17,260.00	$17,606.00	3
$18,042.00	$18,557.00	3
$21,500.00	$27,929.00	6
$31,145.00	$39,940.00	12
$40,835.00	$49,070.00	6
$52,295.00	$56,998.00	3
$61,494.00	$68,243.00	4
$72,020.00	$72,096.00	2
$81,617.00	$87,528.00	2

* nominal cost to CCAC at time of purchase (i.e. 1977 to 1988)

ANNEX G

RETAIL OPTIONAL AIR-CONDITIONING PRICES

RETAIL OPTIONAL AIR-CONDITIONING PRICES

VEHICLE MANUFACTURER	MODEL	DESCRIPTION	BASE PRICE	RETAIL OPTIONAL AIR-CONDITIONING
CHEVROLET	CAVALIER	COMPACT STATION WAGON	$11,448.00	$1,045.00 (for four cylinder models; no cost with V6 engine option)
	S-10	COMPACT PICK-UP TRUCK	$11,398.00	$1,045.00
	C-15	FULL-SIZE PICK-UP TRUCK	$11,750.00	$1,045.00
CHRYSLER	K CAR	COMPACT SEDAN	$10,000.00	$2,900.00 (package includes air-conditioning, cruise-control, & tilt-steering)
	RAM D-50	COMPACT PICK-UP TRUCK	$10,200.00	$1,200.00
	DODGE CARAVAN	MINI-VAN	$15,000.00	$1,111.00
	PLYMOUTH VOYAGER	MINI-VAN	$15,000.00	$1,111.00

Note: Vehicles purchased from DSS are 15% lower than prices shown above.

ANNEX H

CALCULATION OF PERFORMANCE LOSS

CALCULATION OF PERFORMANCE LOSS DUE TO TEMPERATURE

Performance loss is calculated by multiplying the vehicle use by the THI factor. The THI factor is the sum of: the number of days for each THI level of 84 and above multiplied by the performance loss in hours for each level.

Performance loss	5%	10%	17%	30%	THI factor
Vancouver	0.0	0.3	0.0	0.0	0.1875
Prince George	1.6	0.8	0.2	0.0	1.4550
Calgary	1.8	0.4	0.0	0.0	0.9750
Winnipeg	4.8	4.4	2.6	3.6	16.5150
Toronto	4.2	3.6	2.8	2.8	14.1450
Montreal	5.0	2.6	2.6	1.0	9.3900
Quebec City	2.4	0.4	1.0	0.8	4.2750
Halifax	1.2	0.0	0.0	0.0	0.4500

Example: For Vancouver, the THI factor is calculated as follows:

THI factor = (7.5*0.05*0.0)+(7.5*0.1*0.3)+(7.5*0.17*0.0)+(7.5*0.3*0.0)

ANNEX I

PERFORMANCE LOSS PER YEAR BY REGION

PERFORMANCE LOSS PER YEAR BY REGION

	# of vehicles	20% use (1.5 hr)	25% use (1.875 hr)	30% use (2.25 hr)	50% use (3.75 hr)	THI factor	Performance loss 20%	Performance loss 25%	Performance loss 30%	Performance loss 50%
Vancouver & Coast	33	6.60	8.25	9.90	16.50	0.1875	1.238	1.547	1.856	3.094
Pr.George & Int.	17	3.40	4.25	5.10	8.50	1.4550	4.947	6.184	7.421	12.368
Calgary & AB/SK	60	12.00	15.00	18.00	30.00	3.6750	44.100	55.125	66.150	110.250
Winnipeg & AB/SK	53	10.60	13.25	15.90	26.50	16.5150	175.059	218.824	262.589	437.648
Toronto & ON	173	34.60	43.25	51.90	86.50	14.1450	489.417	611.771	734.126	1223.543
Montreal	76	15.20	19.00	22.80	38.00	9.3900	142.728	178.410	214.092	356.820
Quebec City & PQ	33	6.60	8.25	9.90	16.50	4.2750	28.215	35.269	42.323	70.538
Halifax & Atlantic	56	11.20	14.00	16.80	28.00	0.4500	5.040	6.300	7.560	12.600
Total Performance Loss in Hours							890.744	1113.429	1336.115	2226.859
Total Performance Loss in Person Years							0.53	0.66	0.79	1.32

NOTES: One person year equals 1687.5 hours.
Usage factors are based on hourly driving time per day.
Performance Loss is calculated by multiplying the THI factor by the usage factor.