AIMS PERFORMANCE REQUIREMENTS

The AIMS Performance Requirements are designed to ensure a high standard of performance for field trial AIMS installations, and lead to the broad commercial success of highly efficient residential mechanical equipment in the marketplace.

NOTE: Commentary on individual requirements is provided in italics.

1.0 SCOPE

There are a number of technical requirements for AIMS products included in this project.

1.1 The requirements are intended to allow a wide range of technologies to be used to reach the AIMS Performance Requirements.

1.2 The efficiency requirements are intended to allow manufacturers to trade off efficiencies in different modes provided that the overall impact on GHG emissions remains the same. A reference house has been used to ensure a fair comparison of products. The same GHG emissions factors (associated with natural gas fuel use and electrical use) will be used for all AIMS products.

This is not to be confused with the rating system that will be developed by the Product Evaluation working group. Their rating system will be based on energy consumption and possibly associated costs and or GHG emissions.

1.3 To start comparing AIMS to common existing products, technical requirement efficiency criteria reference standards for the most common type of equipment serving a particular function.

2.0 GENERAL AIMS PERFORMANCE AND ATTRIBUTES

2.1 SIZE

All AIMS products and any vertical plenum ducting and piping surrounding them must fit within a rectangular closet with a floor space of 1.5 m2 (16ft2). Total height must not exceed 2.34 m (7.7 feet).

Minimizing impact on useable floor space can be a large factor in decisions regarding HVAC equipment, particularly in some targeted markets such as: in-suite applications in multis, retrofits, and new small homes with finished basements. Manufacturers are encouraged to *take advantage of market opportunities by designing AIMS units that are considerably smaller than the maximum size constraint for the project.*

2.2 INDUSTRIAL DESIGN

Field trial products are to be produced such that their appearance has a 'finished look' that is at least the equivalent of those supplied by high volume furnace and DHW heater manufacturers.

Attention to the look of products is especially important as a large fraction of initial sales is expected to be for apartments and homes where the product will be on the main floor. Some foreign integrated products have been developed to ensure that they are aesthetically acceptable for main floor applications.

2.3 CONTROLS

2.3.1 Integration

Space conditioning and ventilation functions must be integrated into the master control unit.

While there are many systems that combine space and DHW heating, the integration of ventilation with these functions is only just emerging. A major technical focus of this initiative is cost-effective integration of efficient ventilation. DHW heating controls may also be integrated where it is advantageous to the design of the particular manufacturer.

2.3.2 User Interface

The user interfaces for AIMS must be simple. They must be based upon current levels of user (home occupant) understanding. They should be no more complicated than the controls interfaces that are typically used for existing equipment.

Home occupants are often confused by existing control interfaces. Adding new features should not lead to control interfaces becoming more difficult for home occupants to understand.

2.3.3 Diagnostics

A simple main floor display must be provided to inform dwelling occupants when a primary function is no longer operating appropriately. This applies to a minimum of space heating, DHW heating and ventilation.

Occupants are often unaware when there is a problem with a main feature of some current product types. For instance, if HRV air flows are unbalanced due to a failed motor or an intake plugged with debris, today's typical installations do not have any indicator of such problems on the main floor.

2.3.4 Prioritization of Functions

Where concurrent space and DHW heating loads occur, priority is to be given to meeting DHW heating loads. A strategy is to be in place to meet early morning loads for occupants that reduce thermostat settings overnight and have high early morning DHW heating loads.

Manufacturers are encouraged to provide controls that enable occupants to increase house temperatures prior to morning DHW demands.

2.3.5 Ignition

The natural gas ignition system can not use a standing pilot light or any other technique that continuously uses natural gas fuel.

This eliminates the potential for pilot light associated combustion products entering the living space when there is no call for heat and the combustion air inducing fan is not operating. It is also consistent with the project objective of reducing GHG emissions.

2.3.6 Ventilation Controls

Low speed fan operation flow rate is to be between 40 and 60 percent of high speed fan operation flow rate for an installation. The main floor user interface is to make it possible for occupants to switch between the minimum ventilation capacity flow rate and this reduced capacity flow rate.

It is expected that equipment will be set to operate at the minimum ventilation capacity on high speed. The low speed setting is intended to prevent homes from being over-ventilated. Manufacturers are encouraged to use control strategies to prevent homes from being over-ventilated during heating and cooling seasons. AIMS products that use a single fan for air circulation and the provision of fresh air may be susceptible to over-ventilation, unless additional control strategies are used.

2.3.7 Ventilation - Defrost Mechanism

Electric defrost mechanisms are not permitted.

This is consistent with the project objective of reducing GHG emissions. There are defrost technologies in current usage that require less energy use.

2.4 CAPACITIES

***Note:** This section discusses the framework upon which capacities and draw schedules will be established by the product evaluation working group once the project commences.*

2.4.1 Combined Mode Capacities

Combined mode heating requirements will be based upon a framework that will include:

- *HRAI sizing guidelines*
- *Control strategies for prioritization of DHW heating, space heating, and ventilation*
- *Existing capacities of current typical equipment choices*
- *Draw schedules in standards for existing water heaters in space heating, DHW heating and ventilation modes*
- *Determination of appropriate safety factors*

2.4.2 Space Heating Capacity

AIMS products are to be capable of satisfying the design heat load for the reference house of 14 KW.

The intent is that products have sufficient capacity to gain market share in a wide variety of Canadian housing.

2.4.3 Water Heating Capacity

Water heating capacities are to be greater than or equal to those for a typical 151 litre (40 gallon) natural gas induced draft DHW heater.

The AIMS function most likely to result in an occupant complaint due to insufficient capacity is water heating. In order to avoid complaint, capabilities must be similar to what occupants are familiar with. One possible set of criteria is as follows. This would be developed in the context of the items listed in Section 2.5.1, Combined Mode Capabilities.

Water Temperature	*Run Time*	*Flow Rate*
57•C (135•F)	*continuous*	*2.6 l/min (0.7 gpm)*
57•C (135•F)	*30 min*	*5.3 l/min (1.4 gpm)*
57•C (135•F)	*10 min*	*11.7 l/min (3.1 gpm)*
42•C (108•F)	*10 min (2 showers)*	*18.9 l/min (5.0 gpm)*

Note: based upon a cold water supply temperature of 18•C (65•F) and a temperature rise of 39•C (71•F) for a 'typical' 151 litre (40 gallon) natural gas induced draft DHW heater.

2.4.4 Ventilation Capacity

Ventilation equipment must have the capacity to exchange indoor air with outdoor air in parallel airstreams at 70 l/s on high speed against:

- a cold side external static pressure of at least 50 Pa (0.2 inches water gauge). Note that where intrinsically required by product design, the minimum cold side external static pressure will be increased.
- static pressures across the main circulation fan typical for its distribution system, but no less than 100 Pa (0.4 inches water gauge). (This static pressure is external to the entire AIMS product.)

The intent is that AIMS equipment have similar ventilation capacities to heat recovery ventilators (HRVs) serving the small and medium sized home market. AIMS are to be designed to meet the intent of CAN/CSA-F326-M91, Residential Mechanical Ventilation Systems, a standard referenced by the National Building Code and the R-2000 Program.

Minimum static pressures are listed to account for variations in installation practice. AIMS equipment must meet capacity requirements in the field. The cold side static pressure requirements can be reduced where it can be shown that the particular unit is designed to fit directly into an exterior wall (such as could be possible with an AIMS that includes a fireplace).

2.5 COMFORT

2.5.1 Heating Mode Supply Air Temperature

While at full capacity in heating mode, supply air temperature to be maintained at or above 47•C (assuming house air temperature of 18•C). Where burner modulation is used concurrently with supply air flow modulation, supply air temperatures can be reduced on lower speed settings.

To obtain higher AFUE values, some manufacturers have increased air flow across the heat exchanger, increasing fan operating cost and in some instances leading to occupant complaints regarding 'cold' air during the heating season. This can be a particular concern with hot water based fan coil heating systems where the temperature of the heating element is much less than it is in a typical furnace. This requirement is intended to address this potential problem.

2.5.2 Heating Mode Start-up and Shut Down

Start-up heating mode supply flow rates are to be lower than continuous heating mode operating flow rates until the fan coil is fully heated. Similarly, the supply air flow rate is to be reduced once heating demands are met.

"Cold-air" complaints can relate to startup and shutoff transient supply air temperatures when the fan is operating at the heating mode speed setting.

2.5.3 Acoustics

AIMS should be quiet relative to typical HVAC equipment.

AIMS will operate continuously and frequently be installed in an in-suite location close to occupant functions. Noise has the potential to be a greater source of complaints with AIMS equipment than with traditional equipment and must be focussed upon during product development.

Though there are no specific acoustic requirements, noise associated with AIMS operation will be included in the testing protocol, and determined during field trials. (A noise rating will also be included in the equipment listings.)

2.6 SAFETY

2.6.1 General

Products will be tested to the safety requirements developed as part of the Industry Consortium Project. These requirements will be based on common industry standards for furnaces, water heaters, boilers and HRVs.

All prototype products will be tested in accordance with product safety testing protocols. All will have to meet the safety requirements prior to being replicated for field trials.

2.6.2 Combustion Product Venting

All combustion equipment must be direct vent or induced draft. Equipment must have no spillage of combustion products into the living space when the living space is depressurized relative to outdoors. Induced draft vented appliances must be capable of positive shutdown in the case of a venting blockage.

With the longstanding trend towards reducing drafts in new homes, houses are more likely to be substantially depressurized during the operation of exhaust equipment. Naturally aspirating equipment is likely to be combustion spillage susceptible in these conditions. AIMS equipment is to be non-spillage susceptible when a home is depressurized by at least 30 Pascals. More specific criteria to be developed by the product evaluation working group.

As technology develops to ensure that equipment shuts down due to a wider range of venting problems, manufacturers will be encouraged to utilize these developments as well as those that currently exist for venting blockage.

2.6.3 DHW supply temperature

Potable hot water temperature must be maintained between a minimum of 45•C (113•F) and a maximum of 60•C (140•F). Where an anti-scald valve is required to ensure DHW supply temperature does not exceed 60•C (140•F), it will be supplied as part of the manufacturer's AIMS product.

The water temperature requirements are consistent with HRAI's Student Reference Guide for Integrated (Combo) Systems. Low flow rate conditions are most difficult for manufacturers of anti-scald devices and instantaneous water heaters to meet. The product evaluation working group will determine the flow rate at which to test.

2.6.4 Water Circulation

Non-segregated water heating equipment where DHW is used directly for space heating must circulate water through the space heating system when the heating system is not operational.

Some jurisdictions are requiring this measure so it should be built into AIMS products. Specifics to be determined by the product evaluation working group.

2.7 DURABILITY

Components and systems are expected to be of a durability that is at least the equivalent of current market good practice.

Independent evaluators will assess the durability and quality of construction prior to products being included in the field trials phase. Products must not only pass test requirements, but also appear to be sufficiently durable to last for an expected service life of at least 15 years with relatively few repairs. Evaluators will assess the cost of removing and replacing components. Manufacturers are encouraged to compartmentalize so that components can be easily replaced without replacing the entire product or system within the product.

2.8 FILTRATION

All air being circulated through the house or into the house by an AIMS product must pass through a filter with an upstream to downstream removal efficiency of 20 per cent for particles below a size of 1 μm.

This equates to a high quality one inch pleated filter in a 'typical' furnace installation. As efficiency depends upon the fraction of the supply air that passes through it and air velocity, this is a difficult requirement for manufacturers to evaluate. The product evaluation working groups will clarify this further once the project commences. The CMHC report, Evaluation of Residential Furnace Filters, will be one of the references for the development of this requirement.

2.10 STORAGE TANKS

All hot water storage tanks, whether part of a water heater or separate from the combustion process, shall have a standby loss not exceeding 65 Watts measured in accordance with CSA C191 Series M1983.

This is the required minimum for the R-2000 Program. Standby losses will be included in the evaluation of products so the more efficient the storage tank, the higher a product will be rated against its competitors.

2.9 COST GUIDELINE

The target cost guideline is a builder installed price of $3000 for a non-condensing AIMS unit, and $3,500 to $4,000 for a condensing AIMS product.

The purpose of the cost guideline is to set price targets for manufacturers and distributors to work towards in order to gain significant market share. Manufacturers will work with installation companies and utilities to determine price thresholds for products in their specific target market. Current thinking is that widespread market acceptance is based on a new tract house installed price in the $3,000 plus range for ‘current better practice’ in delivering space heating, DHW heating and heat recovery ventilation. A $500 to $1000 premium can be added to this where condensing equipment is installed. Initial manufacturer production run appliances, including distribution and installation stakeholder shares, should target a price range no more than 10 to 15 per cent more than this in markets where small appliance footprint is important.

3.0 AIMS EFFICIENCY

3.1 CONTEXT

The natural gas AIMS efficiency requirements are based upon the new small home market targeted in the field trials. They are intended to put AIMS efficiency on a par with current best practice for space heating and heat recovery ventilation, and utilize the potential advantages of integration to increase typical DHW heating efficiencies and reduce total electrical consumption.

The project must be viewed in the context of impending regulation. It is likely that by 2005, the natural-gas fueled residential furnaces installed in Canadian homes will be required to have an Annual Fuel Utilization Efficiency (AFUE) of approximately 90 per cent. The minimum Energy Factor (EF) for natural gas fueled DHW is not expected to rise as substantially due to the change in technology that this would require. (Current minimum EF is 0.55 for a 151 litre (40 gallon) tank for example.)

Product development should focus on the marketplace of 2005 and beyond. Annual natural gas usage should be the same or lower than that required for a 90% AFUE furnace and DHW heater to satisfy space and DHW heating demands. This initiative focuses on increasing DHW heating efficiency in the small home market where DHW heating is typically a higher percentage of the total space and DHW heating load. Manufacturers are encouraged to increase the efficiency of their products beyond the minimum performance requirements, or create products that can be easily modified to further improve efficiency later.

3.2 COMPLIANCE MECHANISM

For a specific reference house, the ventilation, space heating and DHW heating associated GHG emissions must not exceed those of equipment meeting the minimum specifications detailed in this section. This house has specific GHG emissions associated with natural gas use and the marginal unit of electrical generation.

The 'reference house' has been taken to be the 'test house' (or 'reference' house) at the Canadian Centre for Housing Technology (CCHT) in Ottawa. This house was chosen due to the opportunity it provides to test home HVAC equipment, monitor its performance, and compare it to equipment used in an identical reference home with calibrated heating differentials during the same time period. In order to service a broad section of the market, products will have to be able to meet these load requirements. The 'base case' HOT2000 simulation models the test house with HVAC equipment meeting the minimum efficiency levels discussed above.

For reference house purposes, loads have been established to be as follows:

Loads	Metric	Imperial
Space Heating		
Design Heat Loss	14 KW	48,000 Btu/hr
Yearly Heating Load	64,200 MJ	61,000,000 Btu
DHW Heating		
Daily Consumption	225 litres	59 gallons (U.S.)
Yearly Heating Load	16,100 MJ	15,300,000 Btu
Ventilation		
Minimum Ventilation Capacity	70 l/s	148 cfm

To be eligible for field trials, products must be shown to produce less GHG emissions than the base case in the reference home using HOT2000 Version 8. Additional calculations will be accepted where HOT2000 does not adequately model an innovative product function. Additional methods of heat recovery (such as gray-water) may also be used to offset other requirements.

The compliance mechanism was chosen to ensure a level playing field between manufacturers by allowing trade-offs in the requirements below provided the total effect on GHG emissions is less than that of equipment meeting each of the following requirements specifically.

3.3 SPACE HEATING

The minimum performance required is to be the equivalent of an 81% Annual Fuel Utilization Efficiency (AFUE) in accordance with CAN/CGA-2.3-M93, Gas-Fired Central Furnaces. This requirement is based upon being tested in space heating mode only with no consideration for incorporating water heating test results in its determination.

This value equates to the higher efficiency range of mid efficiency furnaces. The intent is to allow the use of non-condensing equipment. However, the use of condensing equipment is encouraged as is the use of equipment that can readily be adapted to reach a higher efficiency at a later date. The rating system that will be developed to compare AIMS products is one form of this encouragement.

This project will establish mechanisms by which typical AIMS combustion equipment (such as DHW heaters, boilers, and instantaneous water heaters) can be discussed in terms of an equivalent AFUE as part of a complete AIMS package.

3.4 DOMESTIC HOT WATER HEATING

The minimum appliance performance required is an Energy Factor of .75, in accordance with CAN/CSA-P.3-98, Testing Method for Measuring Energy Consumption and Determining Efficiencies of Gas-Fired Water Heaters. This requirement is based upon being tested in water heating mode only with no consideration for incorporating space heating test results in its determination.

It is expected that the same burner will be used for space and DHW heating. Therefore the requirements place water heating efficiency near par with space heating efficiency. During the project, methods will be developed to establish equivalency ratings for different types of water heating equipment for AIMS applications.

3.5 COMBINED SPACE AND DHW HEATING EFFICIENCY

Combined space and DHW heating mode draw schedule and efficiency to be defined during test protocol development.

3.6 VENTILATION

In accordance with the intent of CAN/CSA-C439-88, Standard Methods of Test for Rating the Performance of Heat Recovery Ventilators, the following minimum performance requirements are based upon a flow rate of 30 l/s[3].

- at 0 C, a sensible recovery efficiency of 60%.
- at -25 C, a sensible recovery efficiency of 60%.
- a low temperature reduction factor that does not to exceed 10%.

Context: For the small home sector, this equates to typical HRV ratings for input into HOT2000. The method of establishing compliance will be developed during the testing phase as the C439 standard is not directly applicable to AIMS products. For instance, fan energy will have to be attributed to air streams in ventilation, heating/ventilation, and cooling/ventilation modes.

3.7 ELECTRICAL POWER CONSUMPTION

Total electrical power consumption includes all fans (examples: ventilation, circulation, combustion), all pumps (examples: for heat exchangers and hydronic loops) and all parasitic power (example: hot surface ignition). Total Electrical Power is not to exceed the values given in the following chart for varying modes of operation.

MODE	ANNUAL OPERATION (hours)	POWER (Watts)
HEATING	1200	575
VENTILATION	7560	250

Note: To be able to make a fair comparison of AIMS products at the reference house, any cooling mode operation will be assumed to be ventilation mode operation in the rating of forecasted annual energy use.

Total power consumption to the appliance will be determined in accordance with CGA P.2-1991 Testing Method for Measuring Annual Fuel Utilization Efficiency.

The performance requirement criteria are based on total power to simplify comparison of forced air and hydronic systems. Also, different AIMS strategies and heat distribution strategies will lead to changes in the length of time systems operate in heating and ventilation modes. The principle alternative, using a power to airflow ratio approach for setting heat distribution performance criteria, can lead to a bias in favour of increased air flow, instead of improved heat exchangers.

For forced air systems, this will require whole house distribution fans to operate more efficiently in ventilation mode, the mode they operate in most of the time. The upgrade in performance can be met using strategies such as the following: integration of functions, improvements in motor fan set performance, reducing static pressure head across the equipment itself, distribution system design, and demand controlled ventilation.

The specific criteria are based upon the following enhancements for a typical forced air system that uses the furnace fan to circulate ventilation air. It is as follows.

- *Operating in heating mode utilizing 400 W for heating air distribution with an additional 75 W for operating the combustion air fan for 1200 hours per year.*
- *Operating a distribution fan continuously at 150 W for the remainder of the year.*
- *Operating an HRV at 100 W continuously throughout the entire year.*
- *Negligible parasitic losses such as those associated with hot surface ignition.*

Manufacturers are encouraged to reduce electrical consumption further than the values listed above. This would lead to an annual GHG production credit that could be applied in other areas to meet the overall maximum GHG emission limit set for AIMS products in the reference house.

3.8 CONTROLS

Where manufacturers can prove that their controls and sensors ensure that houses are not over ventilated during cold weather and under ventilated during warm weather, it may be possible to receive energy (and GHG) credits.

Once the project has commenced, the working groups will determine by what means this may be possible and the extent of the associated credits.

3.9 AIR CONDITIONING

The Seasonal Energy Efficiency Ratio (SEER) of any cooling equipment installed must be greater that or equal to 14, when rated in accordance with:

- CAN/CSA-C273.3-M91, Performance Standard for Split-System Central Air-Conditioners and Heat Pumps; or if and where applicable,
- CAN/CSA-C656-M92, Performance Standard for Single Package Central Air-Conditioners and Heat Pumps.

Though cooling is not specifically part of the project, it should also be efficient where it is installed. Energy efficiency blower choices are also promoted by minimum SEER values. Inefficient blowers not only use energy but also give off heat that then has to be extracted by cooling equipment.