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ENERGY EFFICIENCY IN CANADIAN MULTI RESIDENTIAL SECTOR

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INTRODUCTION

The energy efficiency of multi residential buildings in Canada has not kept pace with energy efficiency improvements in other commercial building sectors. Energy efficiency is subordinated to a dedication to reduce first cost of buildings in this sector. Lower first cost and energy efficiency are not mutually exclusive, however, building designers will have to learn to work together to achieve optimum results. The current practice and energy use of new buildings are reviewed in this paper. Suggestions for increased energy efficiency are explored together with their impact on first cost for the building.

ENERGY USE OF A TYPICAL APARTMENT BUILDING

The energy use breakdown for a typical apartment building in the City of Toronto is shown in Figure 1. Toronto has 3645 degree days (Celsius) based on a balance point temperature of 18°C. Canadian cities have heating degree days from 3030 in Vancouver (west coast) to 5990 in Edmonton (interior) to 4025 in Halifax (east coast). Toronto is a city with typical Canadian weather conditions.

The building can be described as follows:

100 unit rental apartment building

10,000m^2 floor area

1140m^2 glass area RSI-0.30, double glazed, thermally broken frames

4725m^2 wall area RSI-2.65

Heating system consists of two gas-fired atmospheric boilers serving fan coil units in the suites. Temperature control at each fan coil unit for each major zone.

Cooling system consists of one centrifugal chiller sized for 175 tons of cooling load.

Domestic hot water system is recirculation type with one gas-fired atmospheric boiler and 1400L storage tank.

Corridor ventilation system with 3500 L/sec delivered to corridors or 35 L/sec per apartment. Toilet exhaust and kitchen exhaust are exhausted locally through the wall. Ventilation supply to corridors is operated continuously.

The frequency distributions for energy use in multires buildings [1] in Toronto are shown in Figures 2 and 3. Figure 2 shows the energy use for fuel in units of ekWh/m^2/yr. Fuel use is primarily natural gas and the total energy content of the fuel is shown in the energy use data in Figure 2. Fuel use shown in Figure 2 relates to the end uses of space heating and service hot water. The typical apartment building with a fuel EUI (energy utilization index) of 209.9 ekWh/m^2/yr. is lower than the mode of this distribution.

The electrical energy use frequency distribution shown in Figure 3 is based on buildings in Toronto with no electric heating and with 100% electric air conditioning. The typical apartment building with an electric EUI of 52.8 kWh/m^2/yr. is below the mode for this distribution.

The energy use in our typical apartment building can be further disaggregated into the energy end use shown in Table 1.

TABLE 1 - ENERGY USE TYPICAL BUILDING			
FUEL		ELECTRIC	
Ventilation	50.0	Cooling	10.8
Infiltration	34.5	Lighting	8.6
Windows	42.0	HVAC Motors	6.5
Walls/Roof	35.0	Cooking	6.5
Service Hot Water	48.4	Other	10.7
TOTAL	209.9	TOTAL	52.8

STRATEGIES FOR ENERGY EFFICIENCY

The strategies for energy efficiency can be related directly to the categories of end use in Table 1.

Ventilation

Ventilation loads can be reduced by using heat reclaim for ventilation air. Local exhausts will have to be redesigned in favour of central exhaust in order to accomplish this reduction. Local exhausts are not desirable from a building envelope integrity standpoint. Heat wheel technology can provide up to 70% recovery efficiency.

Ventilation can also be scheduled according to occupancy and/or exhaust requirements. Variable speed drive technology can be used for motors on ventilation and exhaust fans to accomplish this control.

Infiltration

The infiltration loadds experienced in apartment buildings are due in large part to inadequate air barrier and vapour barrier details. Figures 4, 5 and 6 show typical problems with air barrier details in apartment buildings[2]:

Figure 4	Air Barrier Discontinuous at Partition Walls
Figure 5	Air Barrier Discontinuous at Bulkheads
Figure 6	Air Barrier Discontinuous at Windows

The correct detail for the air barrier is also shown in each figure.

Better design and construction of air vapour barriers are expected to reduce infiltration rates by at least 50% in typical buildings.

Windows

The window technology available today will permit window conduction losses up to 66% compared to the typical double glazed unit. More attention must be given to the design of movable window sections to reduce infiltration rates for windows.

Walls/Roof

The insulation level can be increased to reduce envelope loss from walls and roof. More depth of insulation and better quality insulation are the two strategies available. Reductions of up to 50% are still economically achievable in this area.

Service Hot Water

Service hot water energy use can be reduced through better insulation of storage tanks and piping distribution. Reductions can also be accomplished with low flow showerheads, better appliances which use less hot water and demand sensors for tap use.

Service hot water preheating can also be provided by condensor heat from chiller, grey water heat reclaim and/or solar energy. Total reductions of 50% are possible for typical buildings.

Combustion Efficiency

The load reductions estimated for fuel fired loads did not include combustion efficiency improvements. Typical boilers operate for 70% seasonal efficiency. High efficiency boilers can manage a 90% seasonal efficiency rating. The result will be a further 22% improvement in fuel energy use numbers.

Overall Fuel Energy Efficiency

The result of an application of all the available efficiency improvements will result in a reduction of the EUI from 209.9 to an EUI of 50 ekWh/m^2/yr. The greatest potential for energy efficiency improvements in the typical building will come from better design based on better information on new technologies and better design process to eliminate design problems.

Cooling

Cooling energy use will be reduced through a number of factors:-

- better window orientation/shading
- better window RSI value
- lower window leakage rates
- better wall/roof insulation
- better ventilation design and heat reclaim
- more efficient lighting technology
- more efficient appliances in suite
- more efficient refrigeration machine/system

The final result will be cooling energy reductions of about 60%.

Lighting

The application of more efficient lighting technologies will save at least 50% and more likely 75% in years to come. Fluorescent technology can be used now and the induction lamp technology will be used in future years.

HVAC Motors

Energy efficient motors can be used for all applications. Energy savings vary from 2% in large motors to more than 7% in smaller motors. The greatest savings in motor energy will come from a redesign of HVAC pumping and fanning systems. Variable speed drives allow systems to be redesigned to use less motor energy. Savings from variable speed drives are expected to average 65% over constant speed system design.

Cooking

The cooking in the typical apartment building is electric. More efficient appliances will increase efficiency and savings. Provision of microwave technology will also reduce energy use. Reductions are expected to be around 30%.

Refrigeration

Refrigeration efficiency can be improved with more efficient appliances. Reductions expected are about 50%.

Other

The major load in the other category is the elevator energy use. More efficient elevator technology will reduce this category of energy use by about 40%.

Overall Electric Energy Efficiency

The result of the application of all available efficiency improvements will be the reduction of the EUI from 52.8 to about 26.8 $kWh/m^2/yr$.

References

1. Energy use database developed by Engineering Interface Limited based on actual utility bills and audited floor areas for buildings.

2. Figures on air barrier problems provided by Robert Hallsal & Associates based on building science practice in Southern Ontario.

FIGURE 1
TYPICAL RENTAL APARTMENT BUILDING
262.7 ekWh/sqm/Year Energy Use in Toronto

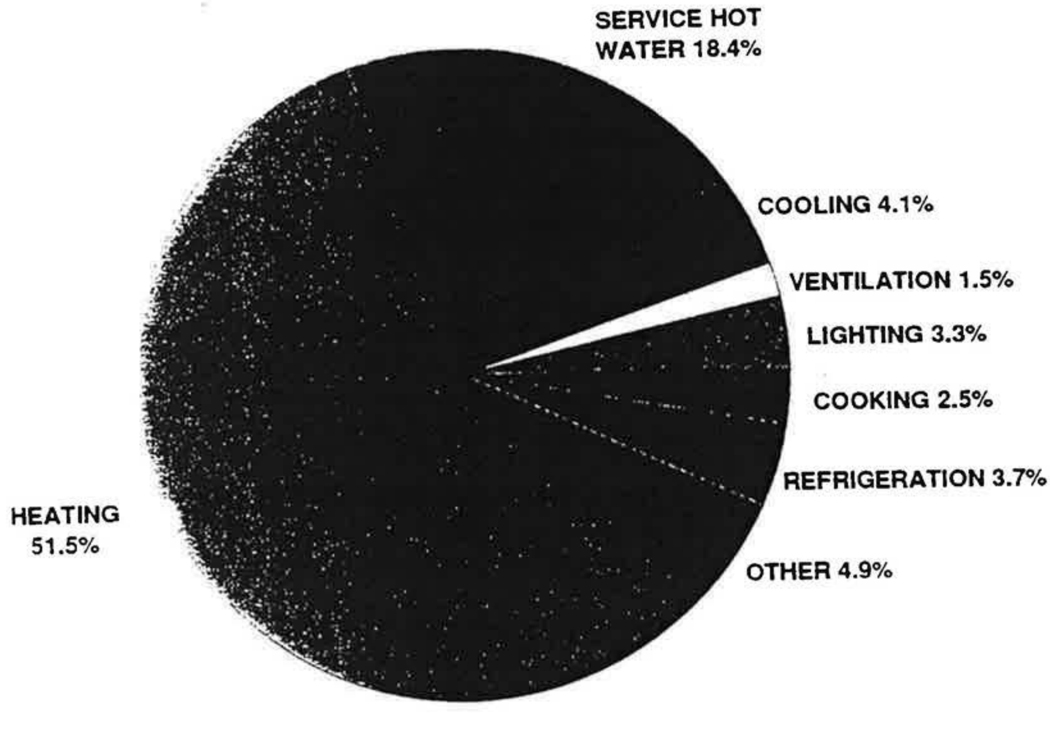


FIGURE 2
FUEL EUI FOR APARTMENT BUILDING IN TORONTO
Based on 40 Buildings in EIL database

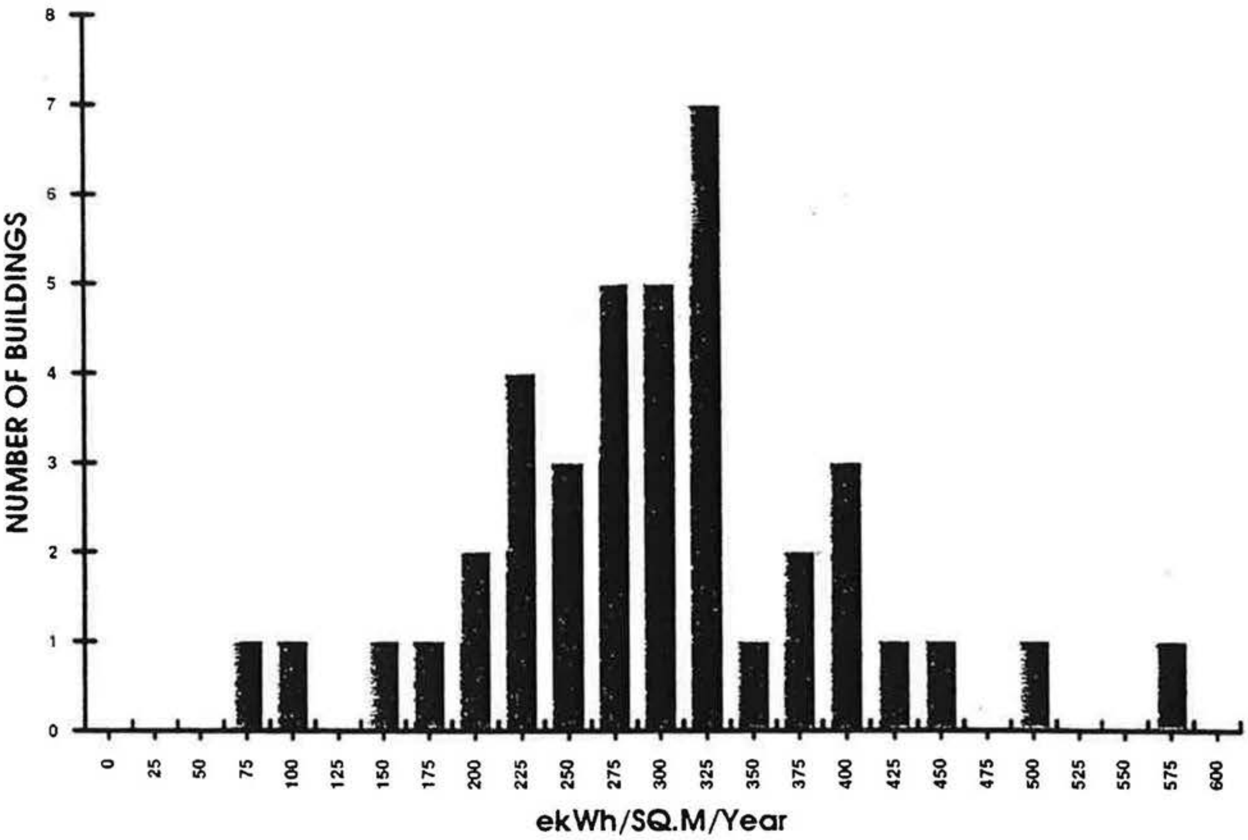
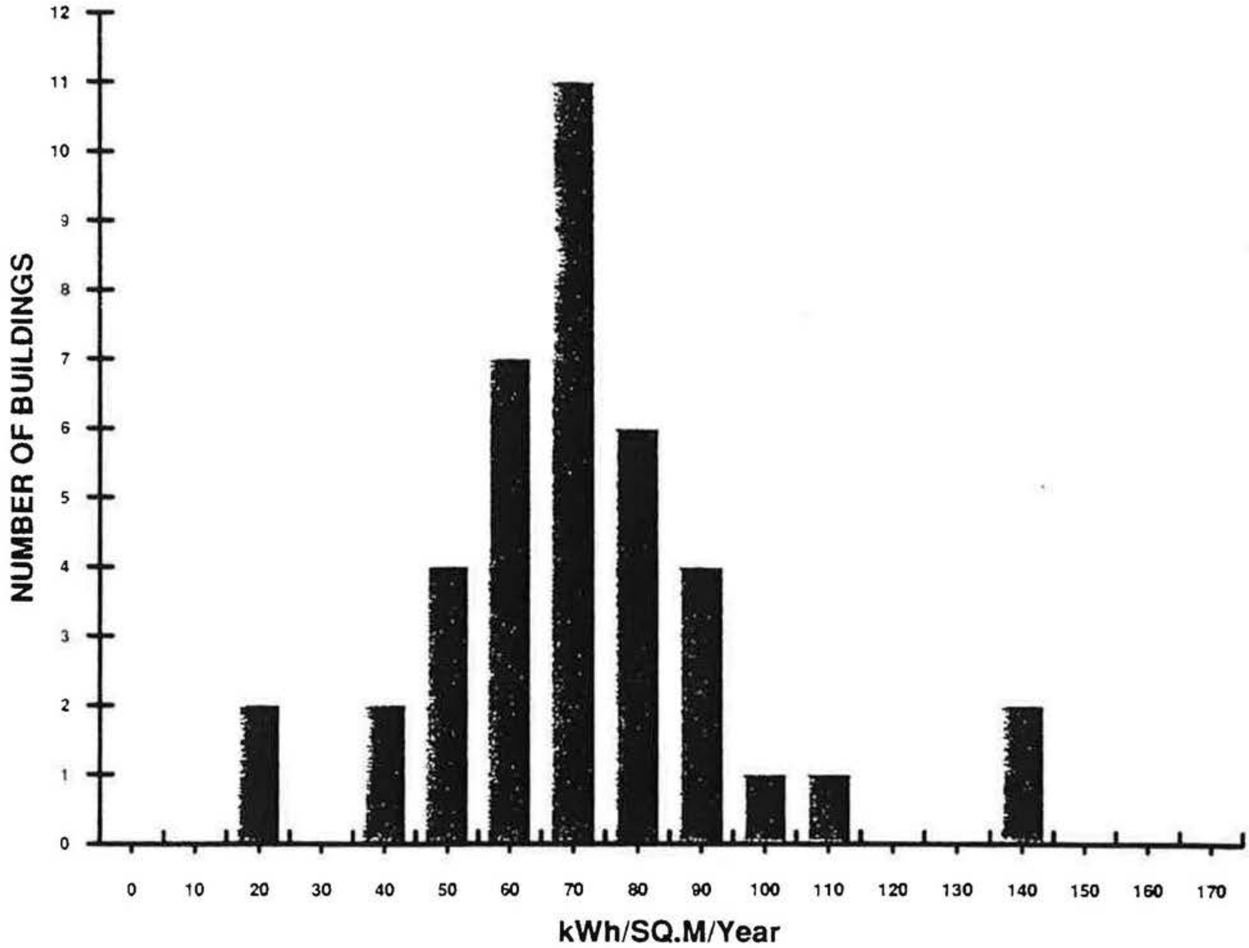


FIGURE 3
ELECTRIC EUI FOR APARTMENT BUILDING IN TORONTO
Based on 40 Buildings in EIL database



AIR BARRIER DISCONTINUOUS AT PARTITION WALLS
FIGURE 4

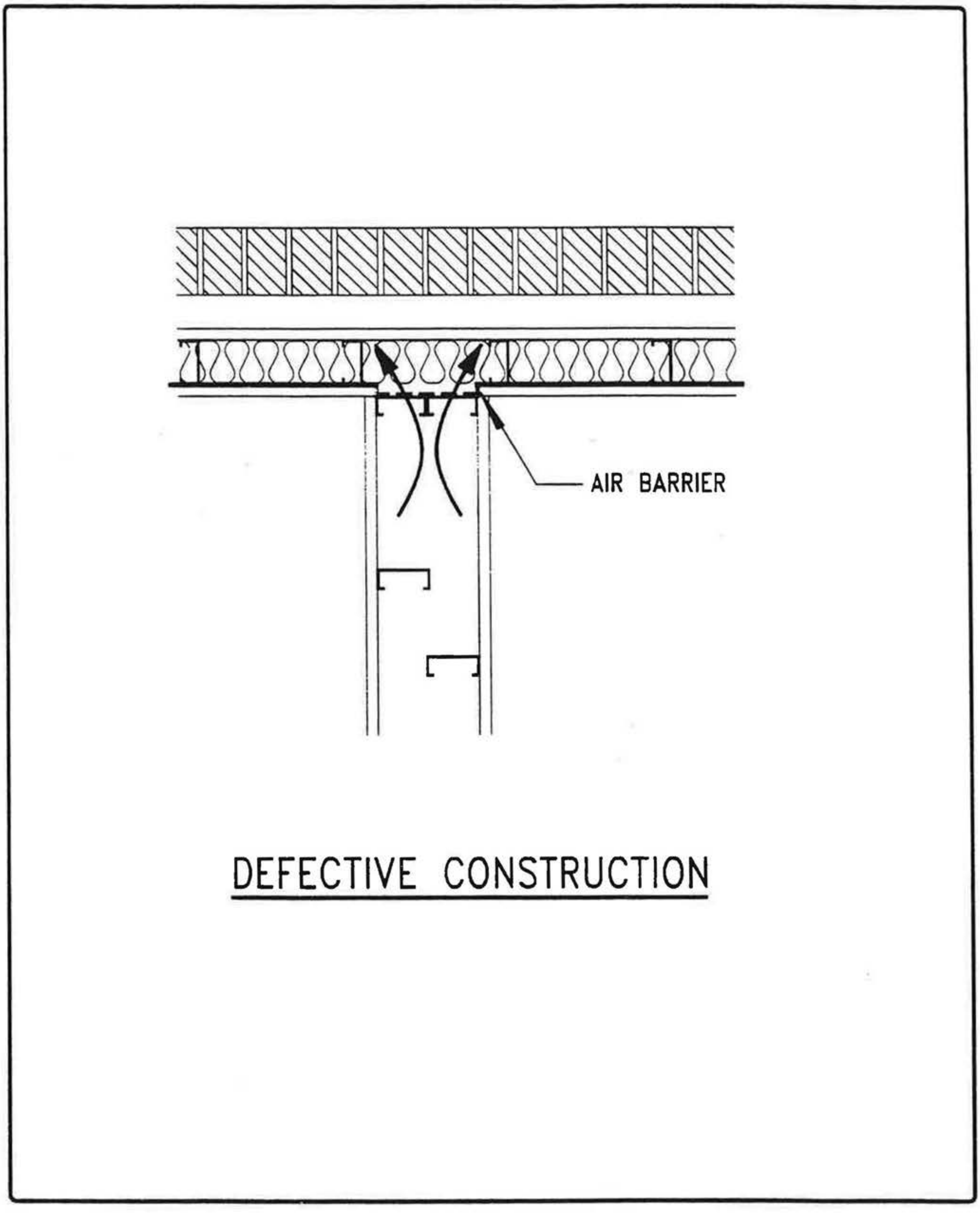
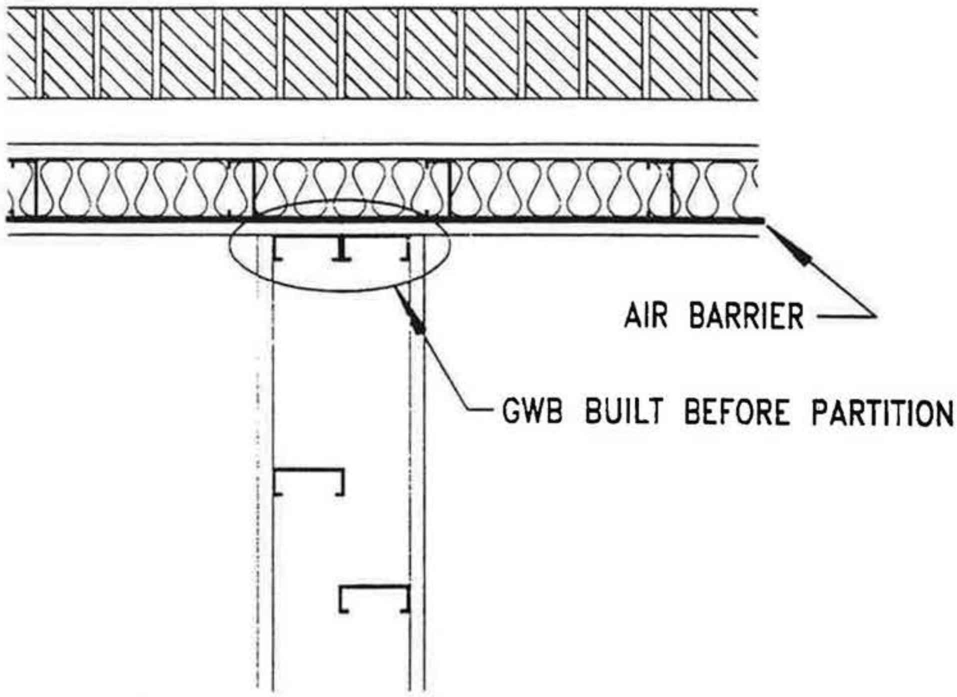


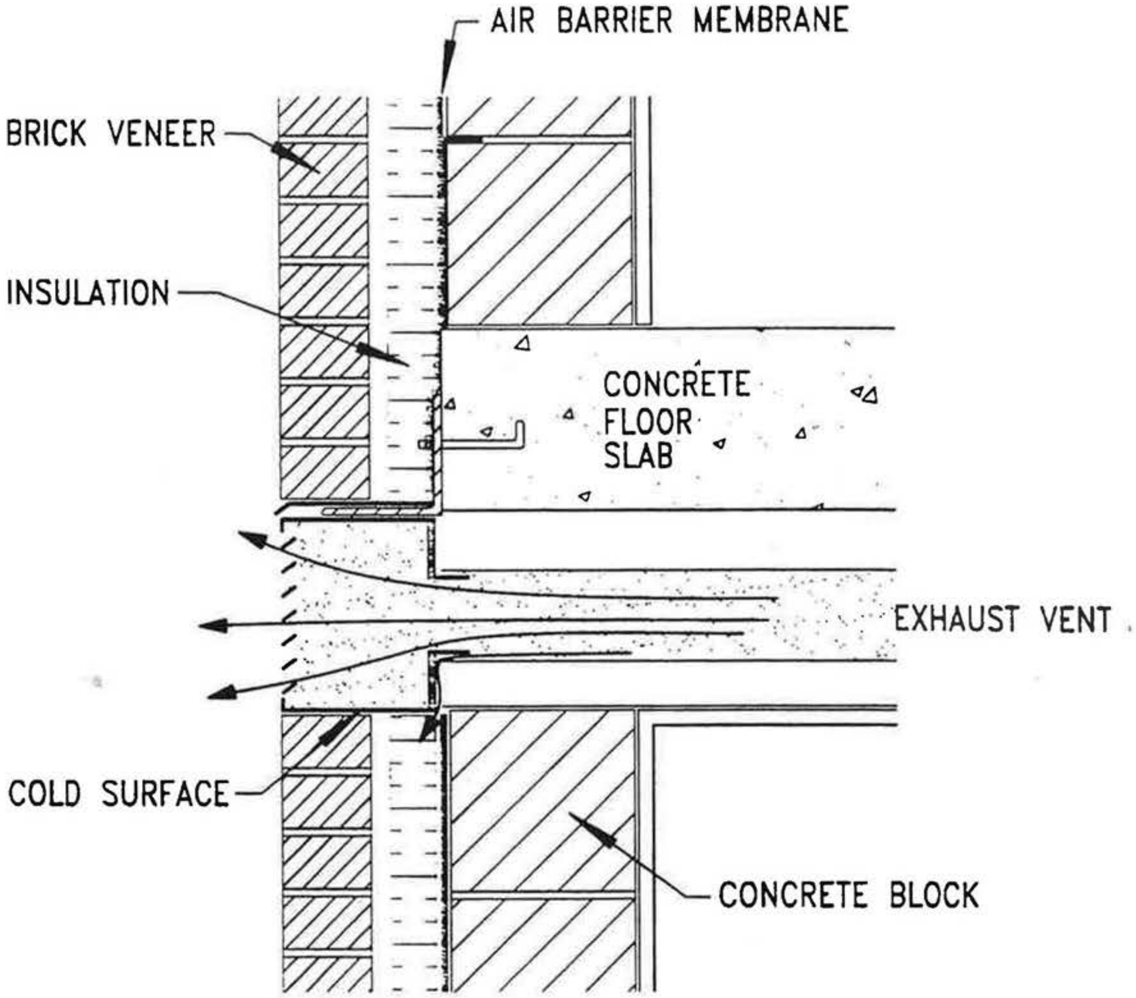
FIGURE 4A



CONTINUOUS AIR BARRIER
PAST PARTITIONS

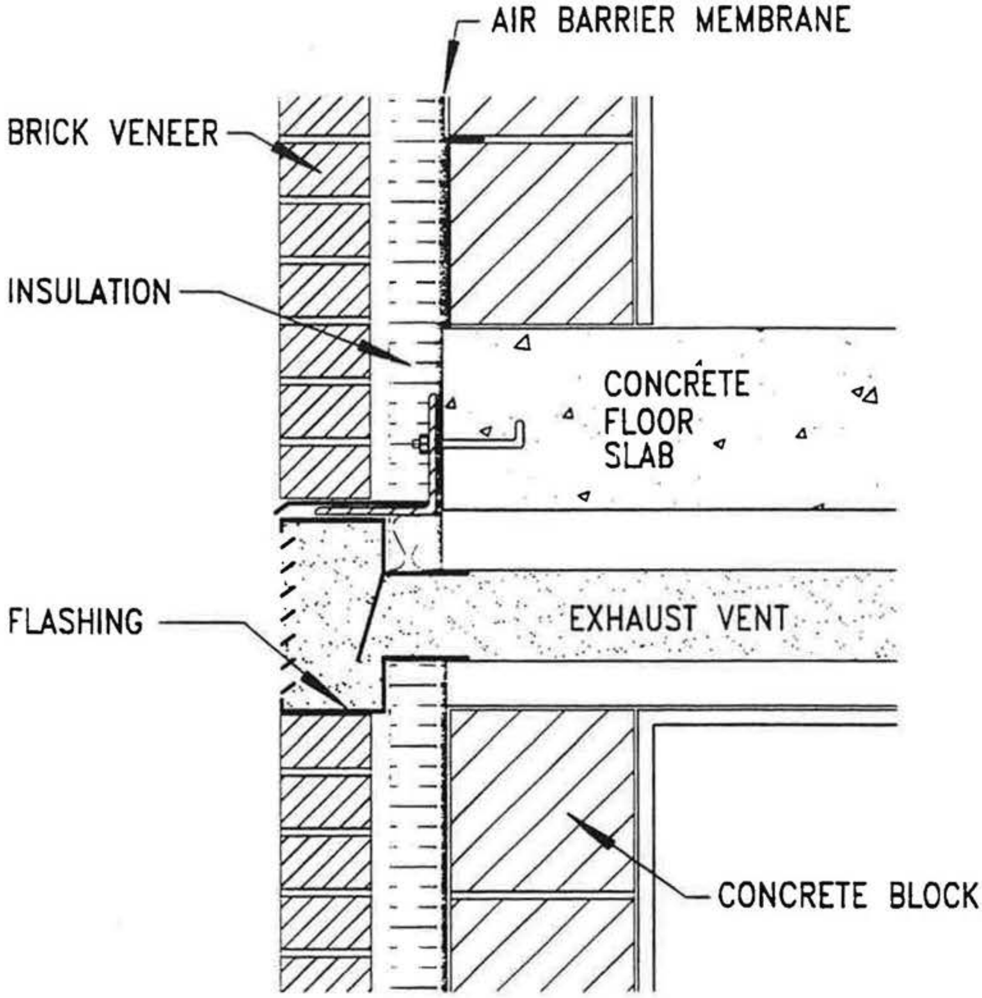
AIR BARRIER DISCONTINUOUS AT BULKHEADS

FIGURE 5



DEFECTIVE CONSTRUCTION

FIGURE 5A



CONTINUOUS AIR BARRIER AT
WALL PENETRATION BULKHEADS

AIR BARRIER DISCONTINUOUS AT WINDOWS
FIGURE 6

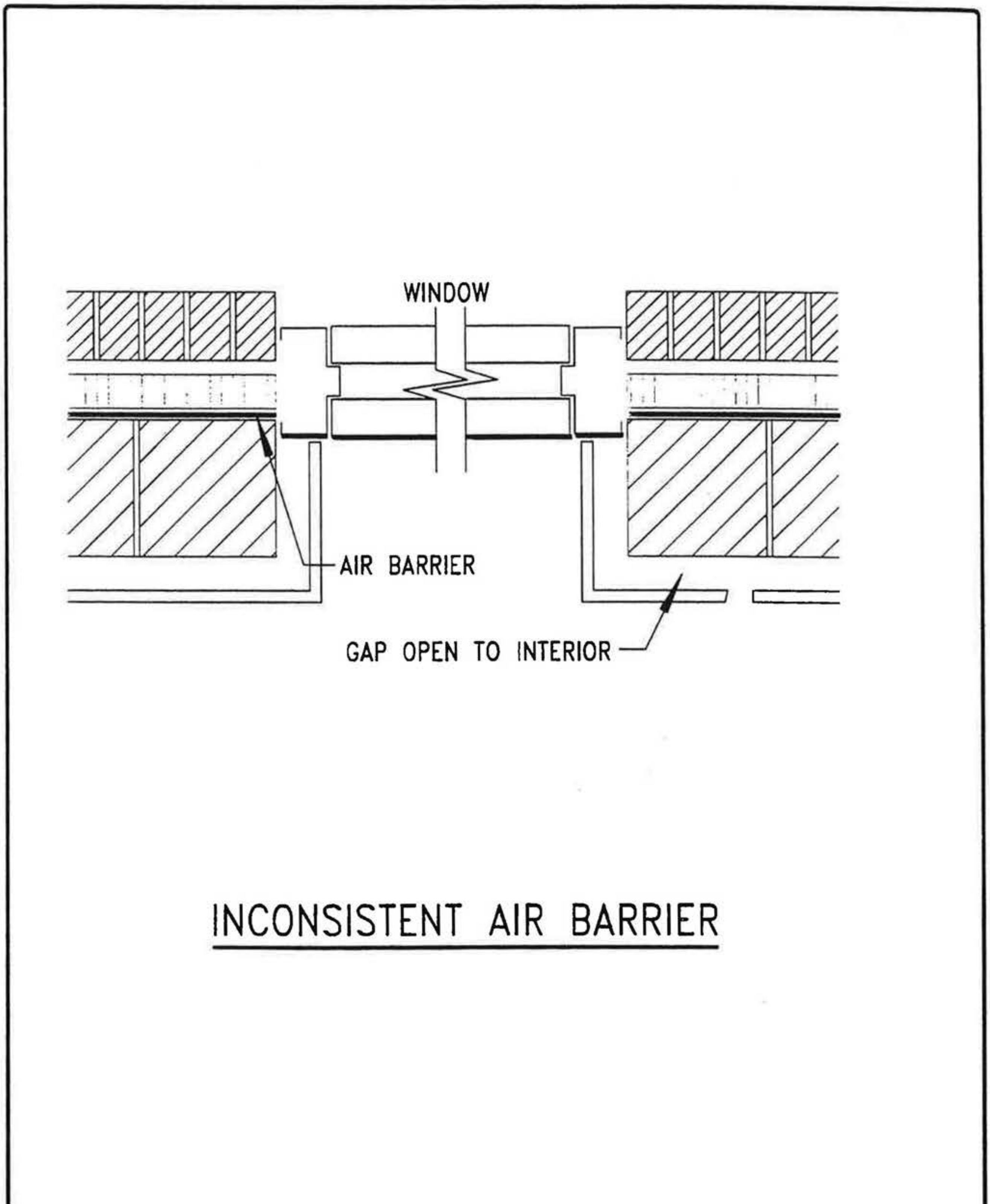
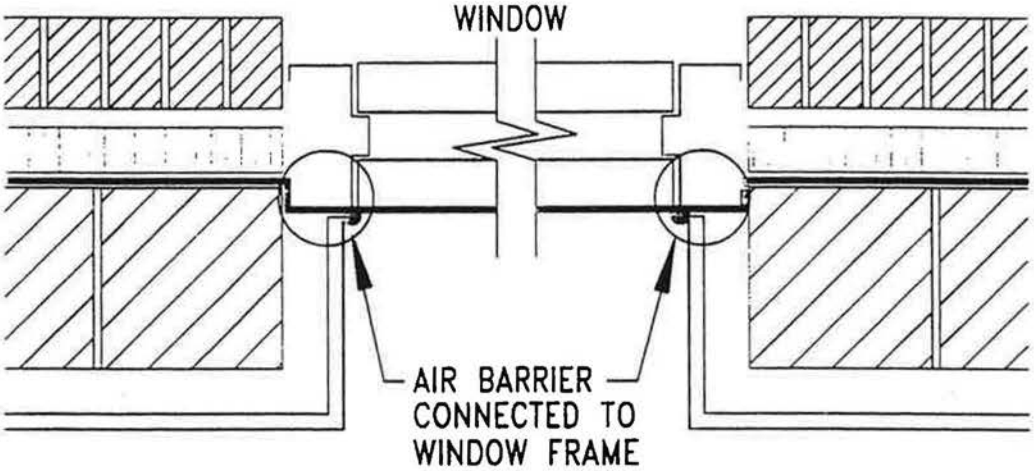


FIGURE 6A



PROVIDE AIR BARRIER
AT ONE PLANE