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INSTRUMENTATION FOR PERFORMANCE EVALUATION OF ENVIRONMENTAL SYSTEMS IN BUILDINGS

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1.0 INTRODUCTION

1.1 General Remarks

This publication is a technical support document to DRM 10-7/51, Building Design, and is primarily intended as a guideline for Building Services design engineers and technologists, field engineering and service staff and engineering consultants.

1.2 Definition

In this guideline "instrument" means a device which, by visual or audible means, indicates a condition, status or situation relating to the function of a building space conditioning system.

Note: Controls or safety devices which perform a function in the operation of a space conditioning system are not dealt with in this guideline.

1.3 Purpose

The purpose of this guideline is to establish a minimum level of instrumentation to be installed on environmental systems in departmental buildings.

1.4 Scope

This publication describes current instrumentation technology for the observation and monitoring of heating, ventilating and air conditioning systems in departmental buildings. Appendices A-C identify, in chart form, the instruments required for the various systems and equipment items involved.

2.0 INSTRUMENTS

2.1 Instrumentation Levels

This document recommends the minimum instrumentation levels required for observing the operation of building space conditioning systems. Special requirements of provincial, regional and local codes and by-laws have not been included. The user is cautioned to consult these regulations and apply any additional instruments which may be required.

2.2 Instruments - Type, Quality and Suitability

2.2.1 Liquid Filled or Mechanically Operated Instruments

In order to select the most suitable type and quality of instrument for the observation of a particular function, the conditions under which it may be applied on the space conditioning system must be known. The severity of service conditions (including degree of exposure to heat, cold, corrosion, and vibration) and the accuracy of instrument "read out" are some of the considerations necessary to ensure that "instrument life" is compatible with the normal life of the system on which it is installed.

The cost of the instrument will be directly proportional to the instrument's sensitivity and readout capability. Most space conditioning systems do not require a laboratory or testing quality type of instrument, but there are great variations required in the sensitivity and readout capability of the instruments which are used on these systems.

In all classes and groups of instruments, such as thermometers and gauges, direct reading instruments are considerably less expensive and have fewer maintenance problems than remote reading instruments. It is suggested that the remote reading type be avoided whenever possible. In some inaccessible locations requiring instrumentation, where frequent read-out of the instrument is necessary, a remote reading unit with a capillary tube will be more suitable.

2.2.2 Electrical/Electronic Instruments

A variety of remote instruments are available for central monitoring syslems (CMS). These are usually of the electronic type and have digital indicator type panels. Where printed records are required, manual or time actuated automatic printers can be used to record the instruments' remote sensor readings on a paper tape. These systems are always required where central automated control systems are used to operate space conditioning systems. In these cases, the monitoring system is usually combined with the control system in a central control and monitoring system (CCMS).

2.3 System-mounted Instruments

2.3.1 Tables

Instruments for mounting on, or attachment to, space conditioning systems and to system components are listed in tabular form in the appendices:

Appendix A Fuel Systems;
Appendix B Steam/Hydronic System and Equipment
Appendix C Air Systems and Equipment.

2.3.2 Fittings and Accessories

2.3.2.1 Separable Wells

All temperature-sensing instruments installed on liquid systems should be fitted with "separable wells" to facilitate replacement without having to drain the system. Most instrument manufacturers market a separable well with their product. A complete line of "standardized thermowells" to suit all instrument applications is available from the major instrument suppliers and manufacturers.

2.3.2.2 "Pitot Tube Openings - Instrument Test Ports"

Openings in air ducts, smoke breechings and flue pipes for test use with portable instruments should be fitted with "test port openings" manufactured expressly for the purpose. Three different types and

qualities are available commercially. The least expensive of these is very suitable for all low pressure air duct systems, has a cast alloy body and a screw cap. When used on smoke breechings and flues, replace the neoprene gasket with an asbestos gasket.

2.4 Building-mounted Instruments for Measurement of Thermal Comfort

2.4.1 General

Most space conditioning systems are installed for human comfort. It is important, therefore, to take measurements from which man's thermal sensations can be predicted.

Thermal comfort in a conditioned space depends to some extent on clothing and activity. It also depends on four physical parameters: air temperature; air humidity; air velocity; and mean radiant temperature. Of these four, air temperature and air humidity have the greatest impact on thermal comfort in a building, and are the easiest to measure and observe. Instruments for their observation and prediction should be provided in most human occupancy environments found in departmental buildings, including residences.

2.4.2 Air Temperature Measurement

Most room thermostats (for control of the room, zone, or building's space conditioning system) contain a bi-metallic dial type or mercury column type thermometer. For the majority of temperature sensing applications these are satisfactory. Where temperature observations are required in areas without thermostats or where more accurate instruments are required, a separate thermometer should be provided. In all cases, mercury-glass thermometers should be used as they are more precise than the bi-metallic dial thermometer, which can err by as much as 3% at average room temperatures.

2.4.3 Air Humidity Measurement

Humidity measurements in most buildings can be taken in one location, as the vapour pressure will be fairly uniform in connecting occupied rooms, spaces and zones. Exceptions include large multi-storey buildings and buildings with air-tight fire separations, or where specific structural zones have been established for varying humidity control levels.

Hygrometers used for humidity measurement have moisture-sensitive elements of nylon ribbon, human hair or similar material.

Hygrometers should be supplied as an integral part of the space conditioning humidity controller which, in the case of central air systems, is either mounted on the wall of an occupied space or on the main supply air duct from the humidifier.

2.4.4 Air Velocity Measurement

Discharge air velocity from a register or diffuser is measured by an instrument known as a velometer. The sensation of comfort on the human body by air velocity results from an increase in the rate of heat removal by convection over the skin surface. Too high a velocity of the air creates overcooling, a sensation of drafts, especially in air temperatures below 26.7°C (80°F).

2.4.5 Mean Radiant Temperature Measurement

The mean radiant temperature has a strong influence on the feeling of comfort. When the surface temperature of the outside walls begins to deviate excessively from the ambient air temperature of the space, it becomes increasingly difficult for convective systems to counteract the discomfort resulting from the cold or hot walls. For physiological thermal comfort, the heat exchange between man's skin surface mean temperature and the radiant environment temperature should be in balance. The nearest measurement of mean radiant temperature would be that of the inside surfaces of the enclosure taken by a thermometer in contact with or very close to the surface.

2.4.6 Energy Consumption Measurement

To permit ongoing evaluation of the energy conservation level of a building and to provide operational and maintenance base data, accurate fuel consumption records are required. All departmental buildings having an hourly design heat loss in excess of 50 kW should be equipped with totalizing fuel consumption meters. A separate metering device is not required for each heat generating unit in the building, but one should be provided for the total consumption of each type of fuel used. In large buildings, domestic water heating energy consumption should be recorded independently of the space heating fuel consumption as should energy for process applications. Schools and other buildings with high energy consumption for ventilation air tempering should record the fuel consumption for this activity independently of the heating load wherever possible. Where electricity is the fuel, the electrical panel board circuiting should be specifically designed to permit the above metering arrangements.

Appendix A

INSTRUMENTATION FOR PERFORMANCE EVALUATION OF SPACE CONDITIONING SYSTEMS FUEL SYSTEMS

1. STORAGE TANKS-VENTED
   - INSIDE TANKS
   - OUTSIDE TANKS-ABOVE GRADE HEATED
   - OUTSIDE TANKS-ABOVE GRADE NON-HEATED
   - BURIED TANKS-HEATED
   - BURIED TANKS-NON-HEATED

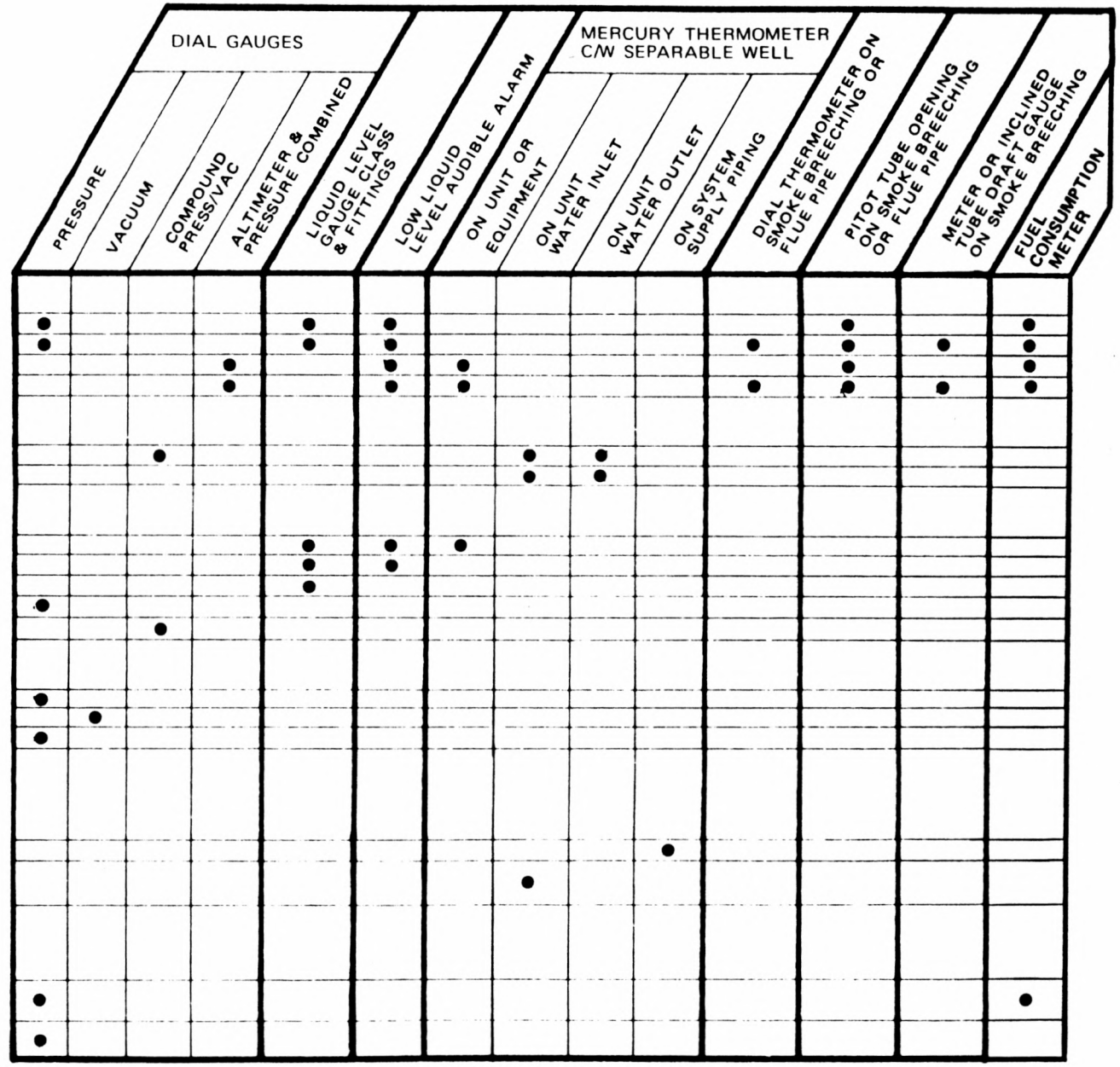
2. STORAGE TANKS-PRESSURIZED
   - BULK TANKS

3. FUEL PUMPING & PIPING
   - TRANSFER PUMPS
   - PIPING PRESSURIZED HOT

LIQUID FUEL LEVEL GAUGE			HIGH LIQUID FUEL LEVEL ALARM	MERCURY THERMOMETER WITH GUARD	THERMOMETER REMOTE READING	PRESSURE GAUGE
FLOAT TYPE	REMOTE READING	STICK TYPE				
●			●			
●				●		
●						
	●	●	●		●	
	●	●	●			
●						
						●
				●		

Appendix B

INSTRUMENTATION FOR PERFORMANCE EVALUATION OF SPACE CONDITIONING SYSTEMS STEAM/HYDRONIC SYSTEMS AND EQUIPMENT



1. **BOILERS**
   - STEAM-SPACE HEATING-UP TO 500 kw
   - STEAM-SPACE HEATING-OVER 500 Kw
   - WATER-SPACE HEATING-UP TO 500 Kw
   - WATER-SPACE HEATING-OVER 500 Kw

2. **HEAT EXCHANGERS** (SHELL & TUBE)
   - STEAM IN SHELL-WATER IN TUBES
   - WATER TO WATER

3. **TANKS**
   - VENTED LIQUID-HOT CONDENSATE
   - VENTED LIQUID-COLD WATER
   - HYDROPNEUMATIC-AIR CUSHION
   - PNEUMATIC-AIR STORAGE
   - VACUUM

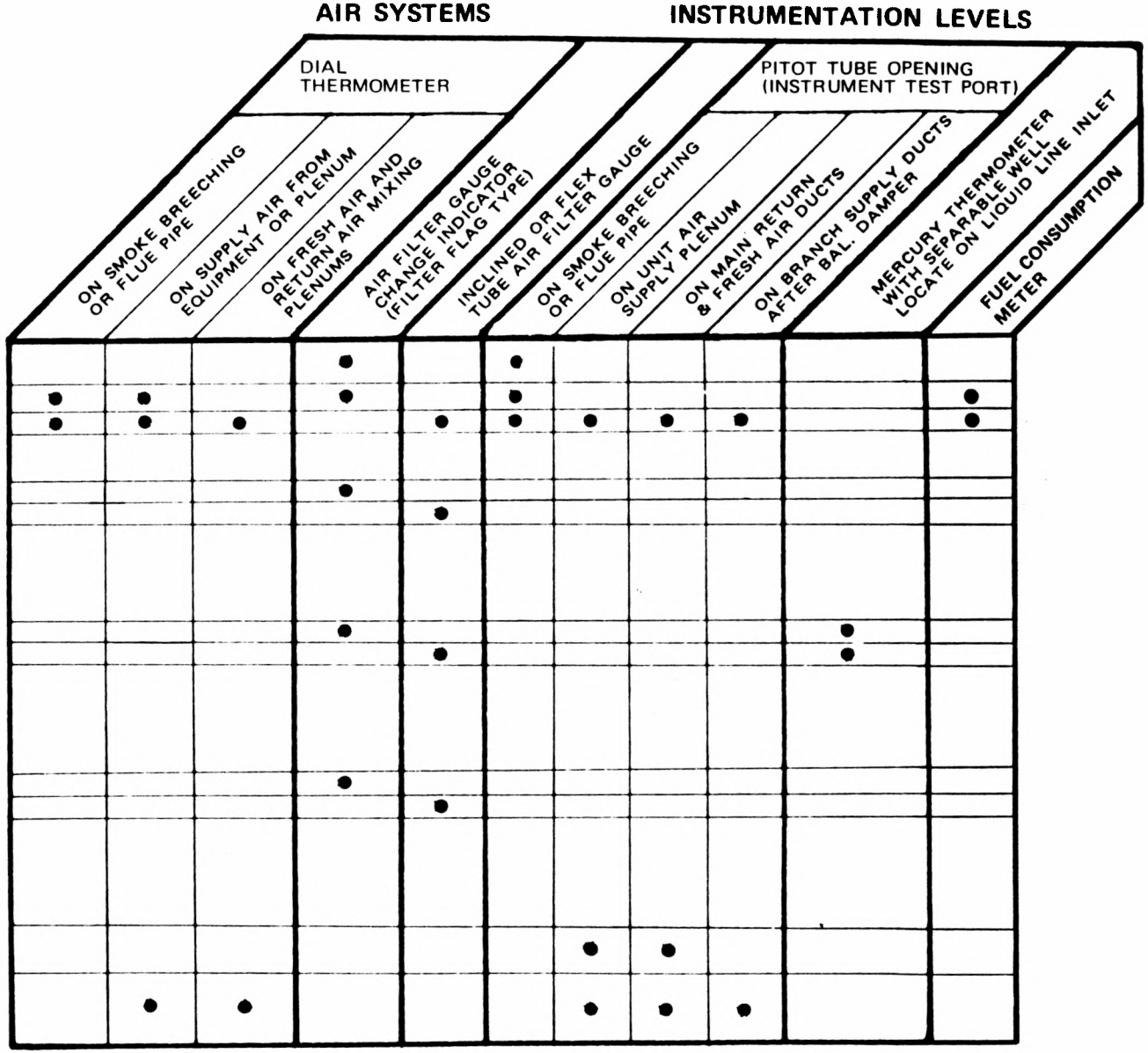
4. **PUMPS & COMPRESSORS**
   - CONDENSATE PUMPS-DISCHARGE
   - VACUUM PUMPS-SUCTION
   - AIR COMPRESSORS DISCHARGE

5. **HYDRONIC PIPING SYSTEMS**
   - MIXED FLUID DISCHARGE FROM MIXING TYPE CONTROL VALVES
     a) ZONED PIPING SYSTEMS
     b) AIR COILS AND OTHER HEATING EXCHANGE EQUIPMENT

6. **STEAM PIPING SYSTEMS**
   - DISTRICT HEAT-BUILDING SERVICE ENTRANCE
   - P.R.V. DISCHARGE

Appendix C

INSTRUMENTATION FOR PERFORMANCE EVALUATION OF SPACE CONDITIONING SYSTEMS



1. FURNACES
   - RESIDENTIAL (ALL) – UP TO 87 kw
   - COMMERCIAL (NON-DUCTED) – OVER 87 kw
   - COMMERCIAL (DUCTED) – OVER 87 kw

2. FAN & FILTER UNITS
   - UP TO 1420 L/s (DM^3)
   - OVER 1420 L/s (DM^3)

3. FAN & FILTER UNITS WITH LIQUID HEATING AND/OR COOLING COIL(S)
   - UP TO 1420 L/s (DM^3)
   - OVER 1420 L/s (DM^3)

4. FAN & FILTER UNITS WITH STEAM HEATING COILS
   - UP TO 1420 L/s (DM)
   - OVER 1420 L/s (DM)

5. AIR SUPPLY DUCT SYSTEMS FOR FAN UNITS
   - DELIVERED AIR VOLUME UP TO 142_ L/s (DM^3)
   - DELIVERED AIR VOLUME EXCEEDING 1420 L/s (DM^3)