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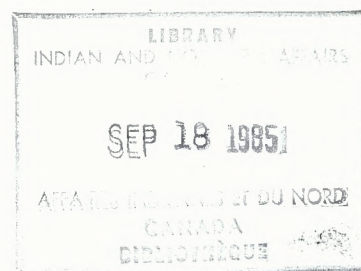
TECHNICAL SUPPORT DOCUMENT

THERMOGRAPHIC INVESTIGATION OF BUILDINGS

June 1985

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THERMOGRAPHIC INVESTIGATION OF BUILDINGS

June 1985

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THERMOGRAPHIC INVESTIGATION OF BUILDINGS

Table of Contents

1.0	INTRODUCTION
1.1	Background
1.2	Purpose
2.0	APPLICATION OF THERMOGRAPHY
2.1	Energy Conservation
2.2	Quality Assurance
2.3	Preventive Maintenance
3.0	PHYSICAL AND ATMOSPHERIC REQUIREMENTS
4.0	STEPS IN A THERMOGRAPHIC SURVEY
5.0	REFERENCES

THERMOGRAPHIC INVESTIGATION OF BUILDINGS

1.0 INTRODUCTION

1.1 Purpose

This document is published in support of DRM 10-7/53, Building Operation and Maintenance, and also DRM 10-7/52, Building Construction.

It is intended to describe, in general terms, the technique of thermography and its applicability to construction and maintenance activities related to departmental buildings. It outlines the technical considerations, conditions and situations where the technique may be utilized.

1.2 Scope

This publication can be used for quality assurance purposes. It gives guidance to field engineering and architecture staff.

1.3 Background

Improvements in equipment design and portability during the past ten years have stimulated the use of thermography in the building construction and maintenance industry. The technique involves the detection of heat radiated from an object, for example, a wall, by the use of an infra-red scanner which in turn is connected to a video screen. The heat radiated (invisible infra-red radiation) is converted into electrical signals and presented on the screen as a thermal profile of the object being scanned.

The thermal profile of the object on the screen ranges in shade from black to gray to white depending on whether the portion or area is cool or warm. Where the area is cool it will appear black. Various shades will indicate the surface temperatures in between these limits.

The image on the screen may be photographed to provide a permanent record of the surface temperatures. An ordinary camera or polaroid may be used. The photograph obtained is called a thermogram.

2.0 APPLICATION OF THERMOGRAPHY

2.1 Energy Conservation

Thermography is a useful method of determining the energy efficiency of a building. Many structures constructed in the past, although functional, do not meet present day building design and construction requirements for insulation values and air infiltration rates. Consequently, the cost of operating these buildings may be high to the point of being unacceptable. A thermographic investigation would help determine the location and extent of energy losses and the need for corrective action.

2.2 Quality Assurance

A second application of thermography is in the quality assurance field related to building construction and retrofit. The technique can be applied while the job is in progress or shortly after completion as a method to ensure that design and quality of work is satisfactory. Air leakage or thermal bridging defects which may be inherent in the design or related to the selection of materials can be readily detected as well as poor quality of work associated with the placement of insulation in walls, ceilings, etc. In retrofit insulation jobs where injected foam is used, thermography is a proven method of determining the effectiveness of the installation. The success of this type of retrofit can be demonstrated when the area is scanned and photographed before starting the job and after completion.

2.3 Preventive Maintenance

This application is more related to plant or electrical, mechanical utility installations. If an aerial thermogram is taken of a particular site, temperature patterns on the thermograms can be related to objects or systems on the ground.

The technique may be used to check piping systems buried in the ground which are carrying hot gasses or liquids. Any abnormal heat losses due to the deterioration of pipe insulation or leaks in the piping system can be pinpointed.

Aerial thermographs can also be used to identify roof problems associated with wet or insufficient insulation. Interpretation of the thermogram will involve comparing known or similar installations and relating the resultant thermal pattern of the roof area to a condition of either dry or moisture damaged insulation. Other factors must also be considered when interpreting aerial thermograms such as whether the roof is pitched or flat; and whether the effects of radiation from the general physical surroundings is influencing the results of the thermographs.

Thermography can also be utilized in electrical and mechanical maintenance inspections. Electrical substations, transformers, fusing installations or other electrical components may become defective and overheat. Steam traps or refractory material may be defective. These installations can be inspected with the use of thermography and maintenance work planned thus preventing plant failure and shut downs.

3.0 PHYSICAL AND ATMOSPHERIC REQUIREMENTS

There are a number of physical, atmospheric and climatic conditions that are a prerequisite to the successful use of thermography. The following is a discussion of those main requirements:

- a. The temperature difference across a wall should be sufficient to permit significant contrasts in the surface temperature pattern. During the measurement period the temperature difference

across the structure should be at least 10°C. As much as possible, differences across the structure should be consistent during the measurement period. Any fluctuations in the interior and exterior readings during the measurement period should be noted.

The air temperature drop should not be more than 30% of the existing temperature measured in degrees Celsius at the beginning of the measurement period and approximately 12 hours before the measurement period. In addition the surfaces of the building should not be exposed to solar radiation.

- b. Other factors which may affect the measurements are wet wall surfaces, changing wind conditions and the air flow over the wall surface. For these reasons, thermography should be conducted inside the building and preferably at night, so disturbing factors are at a minimum.
- c. Determining surface temperatures from the thermogram can also be a problem. The reason for this is that surrounding environmental and material conditions can affect the emissivities of materials and the camera's accuracy in interpreting the surface temperature. Condensation, pollutants, reflected radiation, distortions of camera interpretations, that is, angle of the camera to the plane of the material being measured, and material roughness can also affect quantitative temperature deductions. In some cases, temperature variations shown by the thermogram can be due to variations in surface resistance rather than defects in insulation.
- d. Aerial thermographic surveys should be done during the heating season and for reliable data should be carried out under the following conditions:
 - (1) The survey should not commence earlier than three hours after sunset and should finish before the early morning dew or frost formation -- probably no later than two hours after dawn, depending on cloud cover.

- (2) The night air temperature should be no higher than 3°C. The day air temperature should be no more than 6°C; low humidity levels, light winds and moderate cloud cover should also prevail.
- (3) Roof tops should be relatively free of moisture.
- e. A knowledge of building science fundamentals is necessary to correctly interpret thermographic data. A practical understanding of building construction details, materials and wall assemblies, the mechanisms of heat transfer (conduction, convection, radiation) and the effects of moisture in buildings is also essential. This background is necessary to correctly identify air leakage, heat transfer problems, condensation, water flow into the interior and poor insulation.

4.0 STEPS IN A THERMOGRAPHIC SURVEY

In field surveys to date, where a large number of buildings are under consideration in a particular area, the aerial application has been used to identify the problem buildings and set priorities for further evaluation. The second step involves thermographic surveys to examine the exterior of buildings to more closely identify the problem areas. Once this has been done, hand-held thermographic equipment can be used to scan interior building surfaces and with building science methods determine the severity of the problem.

Note:

Specialized instruction in thermographic survey techniques would normally be required. The degree of instruction would depend on the equipment being used and the structure under investigation. For this department the service normally would be purchased.

5.0 REFERENCES

5.1 CGSB Publications

The Canadian General Standard Board is developing standards to control the quality of thermographic surveys. These are:

CAN-149.2-M, Thermographic Analysis of Building Enclosures.

This is a manual which sets down the procedures and requirements for a thermographic survey as well as a discussion of those factors that affect the survey.

CAN2-149.3, Qualitative Detection of Thermal Patterns.

This standard specifies a qualitative method, by thermographic examination, for detecting thermal patterns. This method is used to identify wide variations in the thermal properties, including air tightness and potential moisture content.

CAN2-149.1-M84, Infrared Thermographic Survey Personnel.

This standard defines criteria for personnel who perform qualitative infrared thermographic surveys. The standard establishes the minimum levels of education, training and experience needed to qualify as an Infrared, Thermographer, Level 1.

5.2 Other References

Ivar Paljak, Bertil Petterson, Swedish Council for Building Research. Thermography of Buildings. Box 1403, 5-11184 Stockholm.

Public Works Canada. Development of PWC Capability In Thermographic Diagnosis of Building Envelope Deficiencies. Architecture Division - Report Series No. 26.