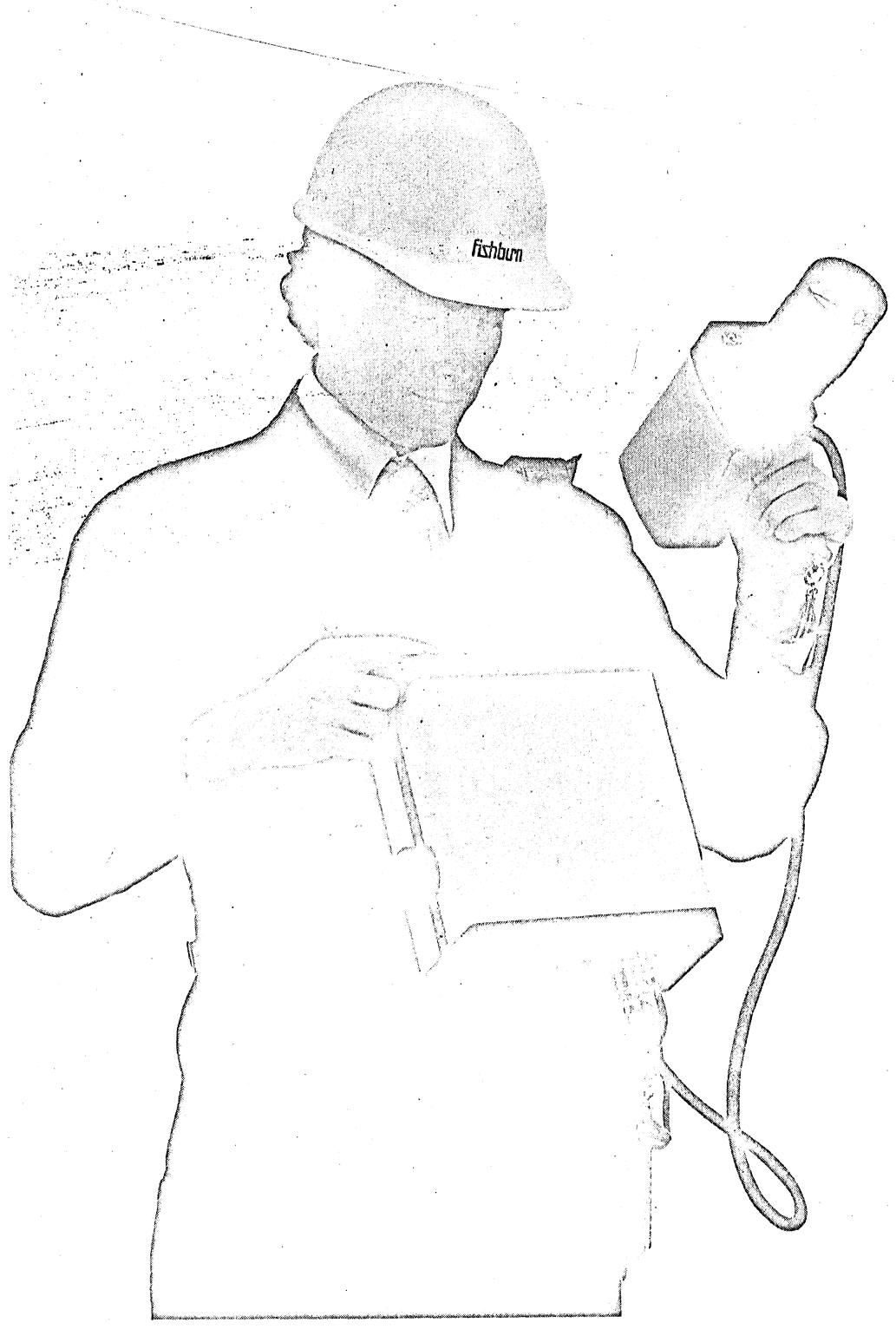
Wall Thermography

This is the second in a series of three articles presented to familiarize the reader with the subject of thermography. Electrical & Mechanical Thermography will be featured in a subsequent issue.



Douglas Fishburn

A study of Canada's energy requirements reveals that 15 per cent of our energy resources goes into heating buildings, and with the great emphasis on energy conservation, architects and engineers play an increasingly important role in providing thermally effective designs.

Although the heat transfer through building components can be calculated, the overall performance of the exterior skin has relied on the passage of time to ensure that the thermal resistance and airtight quality of the building has been achieved. Today, with the availability of new materials and construction methods, the rate of change has increased dramatically. It is no longer adequate to wait for time to determine the thermal integrity of any design, for in the interim many more buildings will have been built.

Now, with the advent of thermography—an effective, economical and non-destructive test facility—wall materials and assemblies in new or existing buildings can be accurately and quickly evaluated for thermal performance. Walls can be surveyed to detect and pin-point the location of heat losses, thermal bridging, wet or inadequate insulation, areas of air or moisture infiltration and other serious, thermally related construction defects.

Background

Wall thermography has been advanced in Canada by Fishburn Thermography Group Ltd., Hornby, Ontario.

Frustrated by the inaccuracy of conventional inspection procedures, Fishburn investigated the use of infrared techniques to detect sub-surface moisture and thermal defects in walls. In-depth examination indicated that the sophistication of infrared or thermal scanning

equipment exhibited great potential, and presently a model 750 Thermal Vision system from Agatronics of Sweden is employed for wall thermography surveys.

Thermal Scanning

All physical objects—rocks—trees —our bodies give off constant electromagnetic radiation in proportion to their temperature.

Thermography, or thermal scanning, is based upon the ability of a specialized infrared (IR) camera to detect any variations in temperature radiating from a surface, convert it to an electrical signal and instantaneously display and record it as a video heat image called a "thermogram". The image is displayed as a real life picture, similar to that produced by an aging black and white T.V. set, which evaluates the entire wall construction, including restricted and obscure spaces such as pipe spaces, wall cavities, hidden junctures and doors and windows.

For our super-technical-oriented reader, a more detailed explanation of what occurs follows:
In the thermal image, the density is a function of energy emitted and therefore also of the temperature of the different parts of the surface under examination. The temperature range of the IR-camera is approximately −30°C to +2000°C, and near +30°C the camera measures the temperature with a resolution that is better than 0.2°C.

In order to facilitate measurement of differences in temperature between different parts of the surface in the thermography, the IR-camera has been equipped with an isotherm function. With the aid of this, parts of the surface which have the same temperature can be made to glow in the thermograph—isotherms are imposed on the frame and an isotherm image is obtained. The isotherms can be set at any temperature and a variable temperature range can be covered in the image. Some types of cameras are equipped with two isotherm functions in order to determine temperature differences. The temperature level thus revealed is determined by the position of the isotherm marking (white) on the gray scale of the thermograph.

The isotherm mechanism can either be used in general control of the distribution of temperature over a given surface or to determine the difference in surface temperature between the points selected on the surface studied. The difference between the isotherm markings can be read off on the thermograph's gray scale (bottom). If this value is multiplied by the value for the current area of study, the isotherm differential in terms of isotherm units can be obtained. The corresponding difference in degrees Celcius is obtained if the current values are inserted in the camera's calibration mechanism.

If it is required to determine the absolute temperature distribution over the surface being studied, it is necessary to know the true temperature of a point of reference inside the measurement surface, the emissivity of the reference surface and of the whole object of measurement, and the temperature function and calibration curves of the camera.

Thermograms are normally black and white. However they can also be produced using a specialized colour monitor which provides a quantized image of the gray-tone thermal picture, with individually colour-coded isotherms superimposed. Up to ten discrete isotherms can be displayed on the 9" screen simultaneously in any colour vs. temperature sequence.

Information can be stored on video tape or paper film for proofing purposes. Photos are taken in segments and composites representing large wall areas are stripped together in the Fishburn laboratory. These photographic records are then used to accurately pin-point problem wall areas.

Wall configuration or type does not present any survey problems due to the remote sensing ability of the equipment being used. Surveys are performed from the exterior or interior depending on the type of building construction and information desired.

Favourable weather conditions are generally required, however high winds and solar gain can have an adverse effect on the results of exterior surveys. Thermal scanning can also be used to trace the origin of both water and air leaks. Up until now, many building owners have been forced to live with water and air infiltration of unknown origin. In addition, it is also possible to determine responsibility for same, e.g. whether from windows, doors, spandrel, caulking, roofing, poorly-installed insulation, penetrating wall water, etc. Early correction usually eliminates latent defects normally excluded by warranties.

Thermography programmes are employed for all types of wall constructions in commercial, industrial, institutional and residential buildings.

Program Direction

Wall thermography is being chiefly promoted in two areas of building:

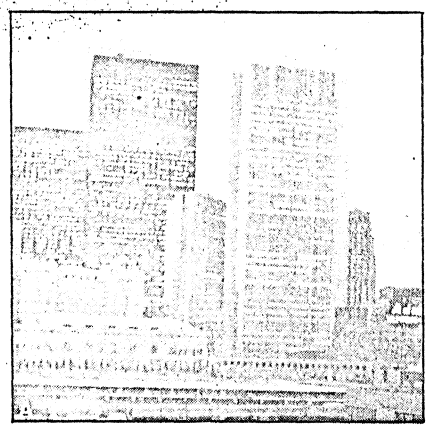
1. *As an instrument for quality control of new wall construction.*

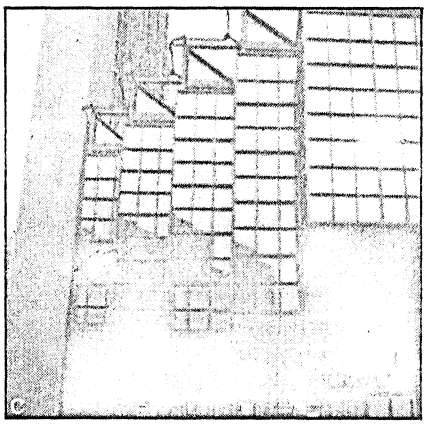
Physical damage, poor workmanship and high humidity levels during construction can impair wall performance from the beginning. There are also several other factors which contribute to the reduced thermal integrity of walls.

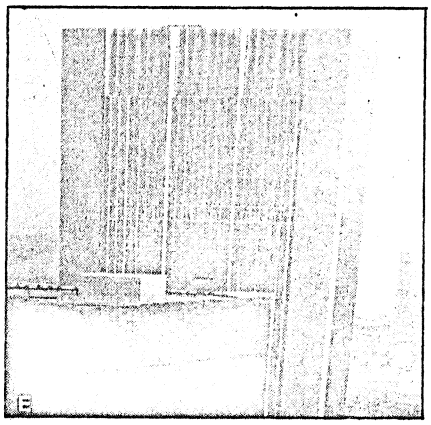
Thermography however, transcends all of these factors and provides a quick, reliable method for qualifying

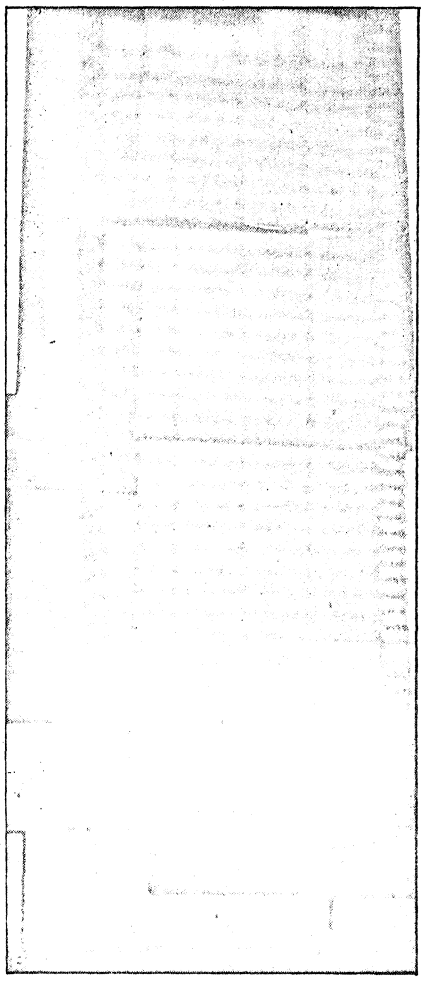
Photos

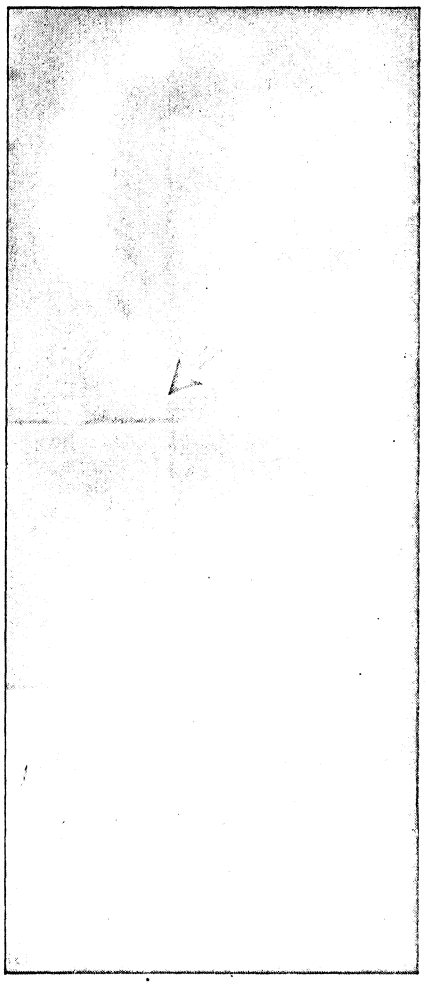
A. Conventional photo of recently constructed office building in Downtown Toronto which was the subject of a wall thermography survey.
B. Composite thermogram (south face of building) depicting thermal performance of curtain wall construction. Thermal image indicates uniform thermal performance and no air leakage.
C. Conventional photo showing granite and curtain wall interface.
D. Composite thermogram depicting heat loss situation at granite and curtain wall interface.
E. Conventional photo of curtain wall construction (north-west face of building).
F. Composite, close-up thermogram of curtain wall. Lack of flaring (white, fire-like flashes) at mullions indicates absence of air leakage.

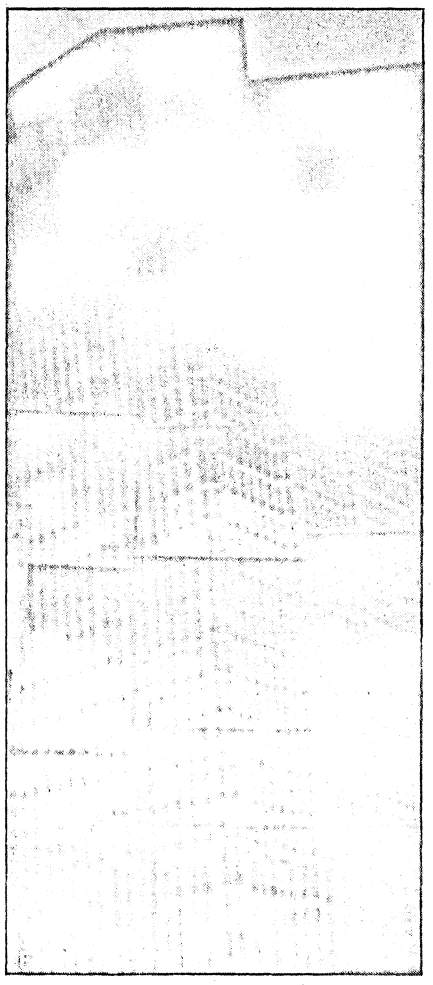












walls prior to acceptance and ensures that trades are doing their job properly and that walls are left without defects. Thermography goes beyond surface inspection procedures and enables all hidden, thermally-oriented deficiencies to be located.

In addition, wall materials and workmanship guarantees are maximized by providing a precise up-to-date check of walls prior to termination of those guarantees. Maximum control over design and construction is achieved while negating litigation frequently brought on by building owners when the wall system does not perform as intended or defects occur, even when careful design and supervisory procedures are employed.

Thermography is also an excellent means for verifying wall assemblies by providing the designer with thermal data to confirm efficient wall design. Thermal scanning reveals the effects of moisture control, wall cavities, jointing and sealing methods, etc. Wall material and wall system manufacturers can also be furnished with means for testing the thermal integrity of their products.

2. *As an instrument for the thermal upgrading of walls.*

Thermography is ideal for thermal upgrading and maintaining a high standard of quality control in the re-insulation of existing buildings.

Infrared findings provide the necessary data for analyzing the thermal performance of existing walls by:

- pinpointing poorly- or uninsulated wall areas, wet insulation, leaks through windows, walls and otherwise inaccessible areas (air leakage in many cases accounts for as much as 25-30 per cent heat loss).
- locating cavities and blind wall spaces for injection of insulation.
- detecting thermal bridges which produce the effect of making buildings unpleasant during winter.
- revealing the effects of breaks in vapour barriers that account for reduced thermal values due to a build-up of moisture condensation.

The thermal upgrading of walls is a logical and vitally important method for reducing our energy requirements. It is also anticipated that thermography will encourage new development based on evaluating existing wall construction techniques.

Thermography as a tool for energy conservation, has and is being utilized by different levels of government, commerce and industry.

Specification Notes

The paragraphs below are representative of a typical wall thermography specification, for inclusion under the Field Quality Control section of Part 3 (Execution) of the CSC 3-Part Specification Format:

Wall Thermography Tests:

Upon closure of building and prior to final inspection by Architect, Fishburn Thermography Group Ltd. shall be appointed to conduct a thermography survey to ensure that thermal integrity of exterior walls has been achieved. Survey shall be conducted while heating or air conditioning system is in operation and at a time period dictated by atmospheric conditions and as determined by thermography consultant.

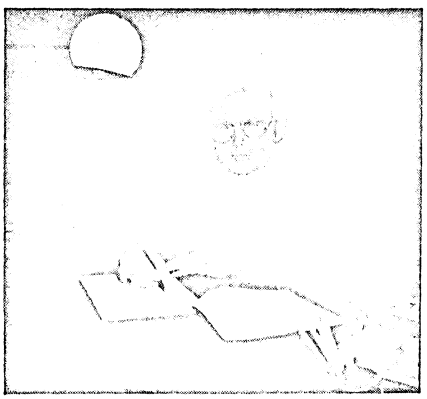
Within eight working days of the survey, submit a written and photographic report of wall condition to the Architect. Conventional photos, 3" × 5" (76 × 127mm) Polaroid or equal, shall accompany thermogram photos.

The General Contractor to the satisfaction of the Architect, shall repair, replace or make good any wall component found defective by the wall thermography survey. Upon completion of remedial work, provide additional follow-up thermography to verify correct installation.

Conclusion

With thermography, it is now possible for a contractor, architect or building owner to pinpoint thermally related problem wall areas from instantly obtainable infrared data, with previously undreamed of accuracy.

There is no question that thermography will continue to gain in popularity. It has been and will continue to be too expensive to do otherwise. Thermography, utilizing electronic means to "visualize the invisible", is providing the construction industry with the technological tool necessary at a time when maintenance, rising fuel costs and energy conservation are rapidly becoming a way of life. ■



Douglas Fishburn is President of Fishburn Thermography Group Ltd., a consulting firm in the new field of thermography as it applies to building construction. Mr. Fishburn is also a roof consultant of renown in the southern Ontario region.