TECHNICAL REPORT

SUMMARY OF AN INDEPENDENT STUDY DOCUMENTING THE ADVANTAGES OF TWO-STAGE INFRARED HEATING

INTRODUCTION:

Brant Radiant Heaters Limited (the Company) developed and introduced the RE-VERBER-RAY Two-Stage (high-low) **HL Series** in early 1993. A study was undertaken to objectively document the benefits of two-stage infrared heating RDM Engineering, an independent research firm, was engaged in October 1993 to monitor a test and demonstration of the new product introduction to Canada.

The patented design of the **HL Series** encompasses a "low fire" mode for moderately cold days, and a "high fire" mode for only the coldest of Canadian Winter days when 100 percent of the typical building's designed heating capacity is actually needed. Background data incorporated in the HL Series design had showed that based on 25 year weather records a typical industrial or commercial building in Canada requires 100 percent of its designed heating capacity-the "high fire" mode-for only 5.6 to 9.7 percent of the time, depending on geographic location. For the remaining part of the heating seson, a "low fire" mode operating at only 70 percent of designed heating capacity is all that is required. Based on this and related data the Company developed the HL Series.

The inside of the test site, representing a typical industrial building and showing the RE-VERBER-RAY Two-Stage HL Series. This heating system objectively documented a minimum of 12% additional energy savings - and a 35% reduction in "On and Off Cycles" - when compared to a single input system.

THE TEST SITE:

The test site selected in October 1993 to objectively document the benefits of the RE-VERBER-RAY Two-Stage HL Series by an independent research firm.

The test facility was carefully selected to reflect not only typical industrial building construction, but also a commitment by management and staff that consistent work patterns would be maintained during the test period. A detailed heat loss study of the test facility prior to the start of the test period documented a total building heat loss of 200,000 BTU/H.

[Installation Details - Ceiling: 20' high, R20 insulation, steel interior sheathing and fiberglass, tar and gravel roof. Walls: 8" concrete block, non-insulated. Doors: Two 3' x 8' exterior doors, one 10' x 12' overhead. Windows: none. Use: HVAC contractor, equipment repair and storage.]

TEST PROCEDURE:

Two 100/70 BTU/h Re-Verber-Ray two-stage, high-low HL Series infrared HL Series were installed along with Honeywell T775-A1019 controllers.

For this "real world" test, the heaters operated on alternate days one of two ways: [1] On "auto", whereby the heaters were either "off", or allowed to switch automatically between the "low fire" mode (70,000 BTU/h) and the "high fire" mode (100,000 BTU/h) or; [2] on "high", whereby the heaters were either "off", or run only on the "high fire" mode (100,000 BTU/h).

The two alternate operating possibilities of "auto" and "high," as noted above, were switched on a controlled 24-hour cycle, with the level of heat output based on actual building heating demand. This methodology provided the necessary controls to objectively compare the two alternative heating methods.

HL SERIES

State-of-the-art, two-stage gas-fired infrared heater

RESULTS: As the findings below will attest, the RE-VERBER-RAY *HL Series* has proven cost-saving benefits over single-stage infrared heaters. Documented fuel savings, reductions in on/off cycles, faster recoveries and increased comfort levels are some of the benefits that one can expect by using the *HL Series*.

THE RESULTS:

The test period ran from October 15, 1993, to April 15, 1994 (184 days or 1/2 year). During this time, the "high" portion of the test (where the heaters ran only at 100,000 BTU/h) and the "auto" portion of the test (where the heaters were allowed to switch between 70,000 BTU/h and 100,000 BTU/h based on heating demand) were each in operation for 92 days. The average outside temperature for the "auto" portion was -2.3ºC (28ºF) and for the "two-stage" portion -1.3ºC (29.5ºF).

The first of the RE-VERBER-RAY **HL Series** units had an average cycle time of 39.5 minutes on "high," and 69.5 minutes on "auto," again demonstrating longer heater operation on "low fire." On the first unit, the number of on/off cycles was reduced by 35%.

The second of the two RE-VERBER-RAY HL Series units had an average cycly time of 44.0 minutes on "high" and 78.1 minutes on "auto" demonstrating again longer heater operations on "low fire". On the second unit the overall number of on/off cycles was reduced by 36.5%.

Natural gas consumption was reduced using the "auto" operation for the two HL Series units by 12% during the six-month period - a savings of 23,018 cubic feet of natural gas.

CONCLUSION:

The RE-VERBER-RAY Two-Stage HL Series has been shown to be a more efficient heating system than standard single-stage infrared heaters.

A minimum savings of 12% in energy usage was documented using the HL Series. This is in comparison to single-stage infrared heaters. Other benefits that this study revealed were:

- 35% reduction in on/off cycles, resulting in improved employee comfort (see figures 1 and 2).
- Improved product life due to the reduction in on/off cycles.
- Overall improved operating efficiency, reducing carbon dioxide emissions.
- Faster recoveries. Energy is not wasted reheating the exchangers when "high-fire" is called for.
- Design benefits. The HL Series allows you to design your building in accordance with "worst case" design temperature. Realistically, this rarely occurs and the heater will make the appropriate adjustments.

Figure 1

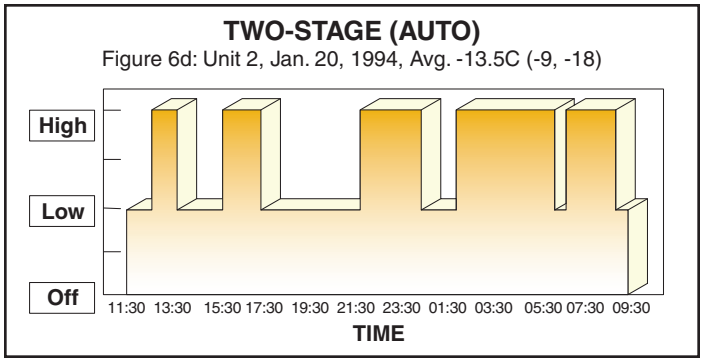
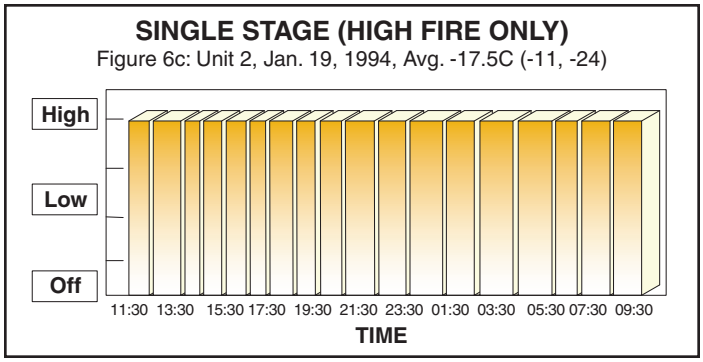


Figure 2



These two graphs, reproduced with permission from the RDM Engineering Report, dramatically demonstrate the operating differences between the two-stage and single-stage input infrared alternatives.

RDM ENGINEERING

Over the past 12 years, Guelph, Ontario based R.D. Mac Donald, P.E., and RDM Engineering have researched and produced a number of scientific, technical and informational papers on the subject of energy efficiency, as well as tested and reported on other energy matters for a wide variety of clients. Serving as an Energy Advisor and Energy Specialist to government, major utilities and private sector clients, Mr. Mac Donald and RDM Engineering remain actively involved in a broad spectrum of energy matters, including their recent testing and reporting on the RE-VERBER-RAY Two-Stage, High-Low *HL Series* detailed in this Technical Report.

Printed by Brant Radiant Heaters Limited based on an independent test report prepared by RDM Engineering.

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