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SO. LUMINAIRE DAYLIGHTING SYSTEMS CORP.
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Los Angeles, CA 90744

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Subject of Report: Summary of U-value and Shading Coefficient Tests and Heat Gain Calculations.

Abstract

This report summarizes U-value and Shading Coefficient tests made at the Yellott Solar Energy Laboratory in Phoenix, Arizona. A 2 ft by 2 ft So-Luminaire skylight was used to determine the winter U-value, (heat flow up) and also a summer U-value (heat flow down). A 4 ft by 4 ft So-Luminaire skylight was used for the Shading Coefficient test, with and without the shade screen.

Introduction

In order to determine the energy loss or gain through a window or skylight, it is necessary to know the U-value, the Shading Coefficient, the area, the orientation, and the weather characteristics for its geographical location.

U-value

The apparatus used in the YSEL testing program for determining the U-value is a Guarded Hot-Plate. The guarded hot-plate consists of an electrically-heated 2 ft by 2 ft sheet of 1/8 in. clear glass, with an aperture of 24 in. by 24 in. The glass is surrounded on the sides, bottom and back by both insulation and secondary heat sources to minimize or eliminate heat loss.

The objective of the guarded hot-plate tests is to determine the magnitude of the thermal resistance from the inner air of the test apparatus through the product to the room air.

Shading Coefficients

The Shading Coefficient tests are made with three identical water flow solar calorimeters, identified as A, B and C. The calorimeters face due west and the solar radiation falling on their 48 in. square apertures is measured with a calibrated silicon cell pyranometer which is connected to a Biddle precision millivolt meter.

The objective of the tests is to determine the Shading Coefficients of the products which are mounted on the face of the calorimeters. This is accomplished by comparing the solar heat gain through each product with the solar heat gain which would be experienced with the ASHRAE reference glass under the same conditions of incident angle and solar irradiance.

Tests are run at approximately fifteen minute intervals throughout an entire afternoon, and each product is subjected to two afternoons of testing to ensure that the test results are consistent and reproducible.

Table 1- Summary of U-value and Shading Coefficient Test for the So-Luminaire Skylight.

Summer Shading Coefficient (see note A)	0.36
Winter Shading Coefficient (see note B)	0.52
Summer U-value (see note C)	0.34
Winter U-value (see note D)	0.45

Note A: Screen in place, without reflector.
Note B: No screen or reflector.
Note C: Screen in place, without reflector.
Note D: No screen, reflector closed in normal manner.

Heat Gain

The heat gain or loss for any fenestration system can be determined once the U-value and the Shading Coefficient are known, and the environmental conditions are specified. To analyze the So-Luminaire skylight, one must also take into account the effect of the reflector. In actuallity, the reflector will add additional sunlight to the bubble at times, and at other times, it will shade a small portion of the bubble.

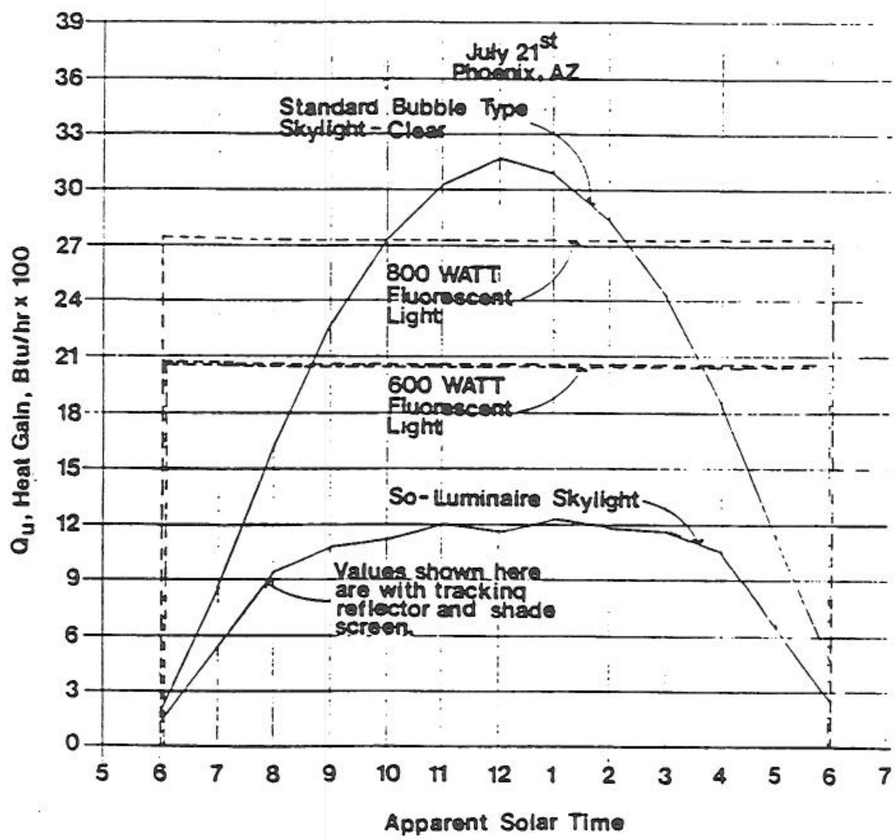
To complicate the situation still more, the shade that is created by the mechanical hardware of the system must also be taken into account. To solve this problem, we determined Reflection Factors and Shade Factors for every possible combination of the solar altitude and azimuth angles.

Table 2 - Estimated Heat Gains in the Horizontal Position under Clear Sky Conditions for the So-Luminaire Skylight including a reflector and a Standard Skylight (Clear bubble type, no Diffuser, both at the same Height Ratio) in Phoenix, AZ, on July 21st, Compared with Heat Gains from 600 Watt and 800 Watt Fluorescent Electric Lights.

Apparent Solar Time	So-Luminaire Skylight w/ Reflector	Standard Skylight	600 Watt Fluor.	800 Watt Fluor.
6:00 to 6:30	59.9	87.8	1023.9	1365.2
6:30 to 7:30	527.0	853.2	2047.8	2730.4
7:30 to 8:30	943.0	1612.0	2047.8	2730.4
8:30 to 9:30	1082.3	2259.7	2047.8	2730.4
9:30 to 10:30	1120.2	2719.1	2047.8	2730.4
10:30 to 11:30	1200.6	3039.3	2047.8	2730.4
11:30 to 12:30	1160.8	3170.0	2047.8	2730.4
12:30 to 1:30	1227.9	3095.3	2047.8	2730.4
1:30 to 2:30	1180.0	2842.3	2047.8	2730.4
2:30 to 3:30	1163.9	2427.7	2047.8	2730.4
3:30 to 4:30	1062.9	1858.4	2047.8	2730.4
4:30 to 5:30	663.0	1133.2	2047.8	2730.4
5:30 to 6:00	110.6	233.4	1023.9	1365.2
Daylong total, Btu 1 Hr. Intervals	11502.1	25331.4	24573.6	32764.8

Summary

Figure 1, below shows the heat gain results in plotted form. By examination of Figure 1, it is apparent that the So-Luminaire skylight has a marked reduction in the heat gain as compared to a conventional bubble type skylight, as well as the 600 and 800 Watt fluorescent lights. The difference in the heat gains between the So-Luminaire and conventional skylight is attributed to the lower Shading Coefficient and U-value of the So-Luminaire skylight. The reduction below the heat gains for the fluorescent luminaires is due to the higher efficacy (lumens per Watt) of sunlight as compared with the light emitted by fluorescent lamps.



DAY-LONG VARIATION OF HOURLY RATE OF HEAT GAIN.

Respectfully submitted,

Yellott Solar Energy Laboratory

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Born, Bel Air, MD 10/25/08. Johns Hopkins Univ., B.S., 1931, M.M.E., 1933. Member, Tau Beta Pi, Sigma Xi, Pi Tau Sigma (Gold Medal, 1940).

1933 - 1945 Engineering Education	Instructor, Mech. Eng., Univ. of Rochester; Instr., Ass't and Assoc. Prof. Mech. Eng. Stevens Inst. of Tech.; Prof. and Dept. Head, M.E., Illinois Inst. of Tech; Director, Inst. of Gas Technology, Chicago.
1945 - 1955 Industrial	Dir. of Research, Coal-Fired Gas Turbine Project, Bituminous Coal Research, Inc.
1955 . . . Solar Energy	Executive Director, Association for Applied Solar Energy, 1955-1958; Director, Yellott Solar Energy Laboratory (YSEL) 1958 . . .
1966 - 1973 Teaching, Research	Visiting Lecturer, College of Architecture, Arizona State University; Director, YSEL
1973 - 1980	Distinguished Visiting Prof. in Architecture, Arizona State University. Author and consultant in solar energy and sun control, Director, YSEL.
1980 . . .	Professor Emeritus, Arizona State University. Director, YSEL.

Fellow: ASME, ASHRAE, AAAS, AZ Acad. of Sci., Royal Soc. of Arts, London. Member Int. Solar Energy Soc. Served as Chairman ASME Solar Energy Div., ASHRAE Tech. Committees on Fenestration and Solar Energy Utilization. Chairman, Solar Collector Test Code Com. 93-77

Participant: 1955 Phoenix World Solar Energy Symposium; 1961 Rome Conf. on New Sources of Energy; ISES 1970 meeting, Melbourne; 1973 Conf. Paris. Member Nat'l. Advisory Com., Solar Energy Research Institute, 1978-84. Listed in Who's Who in America, Who's Who in Engineering, American Men of Science. Member Order of the British Empire, Commander Brother, Order of the Hospital of St. John of Jerusalem.

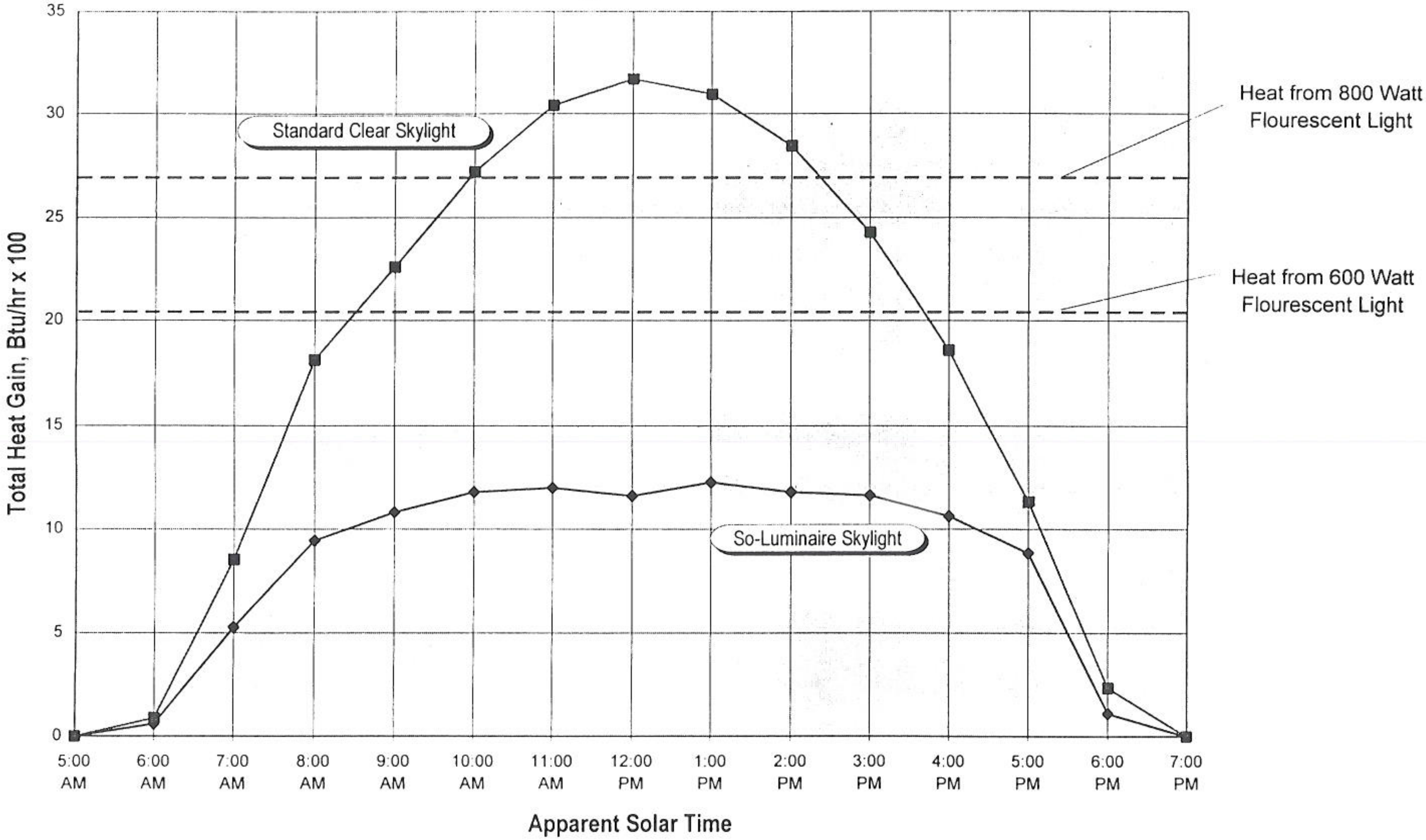
Publications: Encyclopedia Brit. articles on Supersaturated Steam, Pulverized Coal, Solar Energy Utilization. Solar Energy sections of Marks' Mech. Engr. Handbook and McGraw-Hill Encyclopedia of Science. Also author of many articles on energy use and conservation in publications of ASME, ASHRAE, and the American Solar Energy Society.

Honors: 1940, ASME, Junior Member Award; Centennial Medallion, 1980. ASHRAE Distinguishe Fellow Award, 1980; Stevens Institute Alumni Award, 1980.

Consulting Clients: Castec, Inc.; Clark & Van Voorhis; Camvac, Ltd. (England), Cornoyer-Hedrick Architects; Corning Glass Works; Foster Associates (Hong Kong) Dan Pal Plastics (Israel), Janus Associates Architects; Kool Shade, Inc.; Lawrence Berkeley Laboratory; Model Glass Co.; Opus Southwest; Piper Hydro; PHE Proprietary (Australia); P.P.G. Industri Inc. Rauenhorst, Inc.; Shatterproof Glass Co.; Southern California Edison; Smith-Edwards Architects; Sullivan & Masson Engineers; So-Luminaire; 3M Corporation; U.S. Dept. of Commerce and U.S. Dept. of Energy.

So-Luminaire™ DAYLIGHTING SYSTEMS CORP.

Maximum Light with Minimum Heat Gain



Test results are based on avg. hourly temperatures recorded for the month of July in Phoenix, AZ.