APPENDIX A

TEMPERATURE/INSOLATION CORRECTION NOMOGRAPHS

INTRODUCTION

Originally, FSEC collector output rating was not envisioned as a system sizing tool It was developed for the purpose of giving a comparative ranking to different solar collectors That ranking is determined by collector output calculated under a standard set of insolation and temperature conditions

However, in the absence of a better sizing tool, it can be adapted to predict the low temperature performance of specific collectors under a variety of insolation and temperature conditions. The adaptation developed will yield reasonabley accurate results if the collector inlet temperature remains relatively constant throughout the period of use for which the system is designed, and if the temperature rise through the collector is small Fortunately, those criteria usually are met by commercial swimming pools and spas A combination of solar and conventionally fired backup heaters is used to maintain their temperature at some predetermined value -- often 78°-80°F in the case of swimming pools

IDENTIFICATION OF NOMOGRAPHS

Figures A.1 through A.6 may be used to modify FSEC low-temperature ratings for unglazed collectors to reflect a variety of insolation and temperature conditions

Figures A.8 through A.13 may be used to modify the FSEC low-temperature ratings for glazed collectors to accomplish the same pur-

pose In both cases the low-temperature rating is entered on the vertical axis of the nomograph that has the appropriate Δt designation, a horizontal line is drawn to the appropriate insolation reference diagonal, the corrected rating is read from the intersection of the horizontal axis and a vertical line from the first reference point Figures A.5, A.12 and A.13 contain arrows and dotted lines which identify paths through those nomographs

A.2 DEVELOPMENTAL METHODOLOGY

The method for evaluating collector output for each of the ten increments assigned to a Florida standard day (See Table 5.2, Page 5 described in detail in FSEC GP 6-80 During the development of nomographs, the ten hourly increments were fitted with new temperature (and subsequently insolation) profiles New fluid paramaters were developed for each hour under a matrix of the following conditions collector inlet temperature, 95°F; Daily average Δt (t_i t_a)—(°F): 5, 14, 25, 35, 45, 55; insolation rates (Btu/ft^{2}day) 1000, 1200, 1400, 1600, 1800, 2000 The fractional incremental temperature and insolation variations in Table 5.2, Page 5-8 were applied to the appropriate daily mean values

In developing nomographs for unglazed collectors, performance ratings were developed for each of the eight unglazed collectors most widely used in Florida. The collectors are those constructed of plastic sheet, or metal deck and tube, or EPDM rubber. Using each combination of conditions in the matrix, the new ratings were plotted against original low-temperature ratings in the form of a linear regression (least squares fit) line This was accomplished by the considerable efforts of FSEC's James Huggins, and Gerald Land, using a PDP 11/34 computer

same process was followed to generate the correction nomographs for glazed collectors In this case, the thermal performance equations of more than 300 glazed collectors were used to obtain the reference points

In a departure from the "Standard Day" FSEC rating procedure first order ASHRAE performance equations were used rather than second order National Bureau of Standards equations Under the low temperature conditions encountered in pool and spa heating applications differences between the two are of academic rather than real interest

Standard deviations from the mean are given in Table A.1 The point distribution pattern for $\Delta T = 35°F$ and insolation rates of 800-2000 $Btu/ft^2 \cdot day$ for the eight unglazed collectors is shown in Figure A.7 That for $\Delta T = 35°F$, insolation rate = 1600 $Btu/ft^2 \cdot day$ for glazed collectors is shown in Figure A.14

a higher degree of accuracy, some designers may wish to generate a table of values corresponding to the insolation/temperature matrix (Table 5.2) for specific collectors. The described methodology and a programmable calculator may be used to accomplish such a task It is recommended that FSEC GP 6-80 be consulted to clarify the energy summation methodology

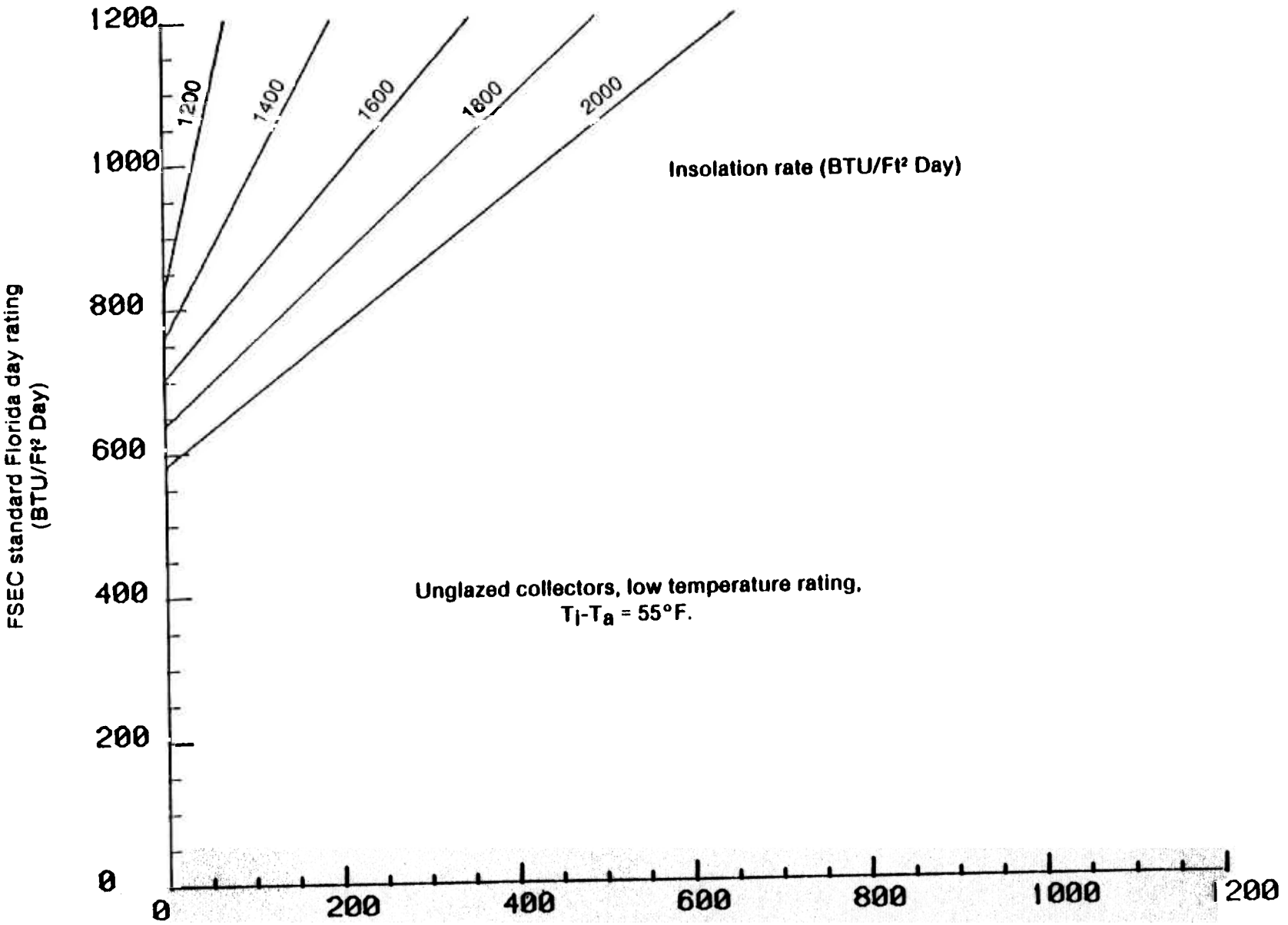
Table A.1
Standard Deviations from Mean (Btu/ft^2·day)
for Temperature/Insolation Correction Nomographs

Unglazed Collectors
Insolation Rates (Btu/ft^2·day)

$\frac{\Delta T}{(^\circ F}$	1000	1200	1400	1600	1800	2000
55	output = 0	17.0	16.0	15.5	15.3	13.7
45	18.6	17.4	15.0	13.8	12.6	11.2
35	15.9	13.4	12.2	10.4	9.1	8.0
25	11.4	9.4	7.8	5.7	5.1	3.9
14	3.9	2.6	1.0	0.0	1.1	2.0
5	5.9	6.8	6.6	7.2	7.7	8.1

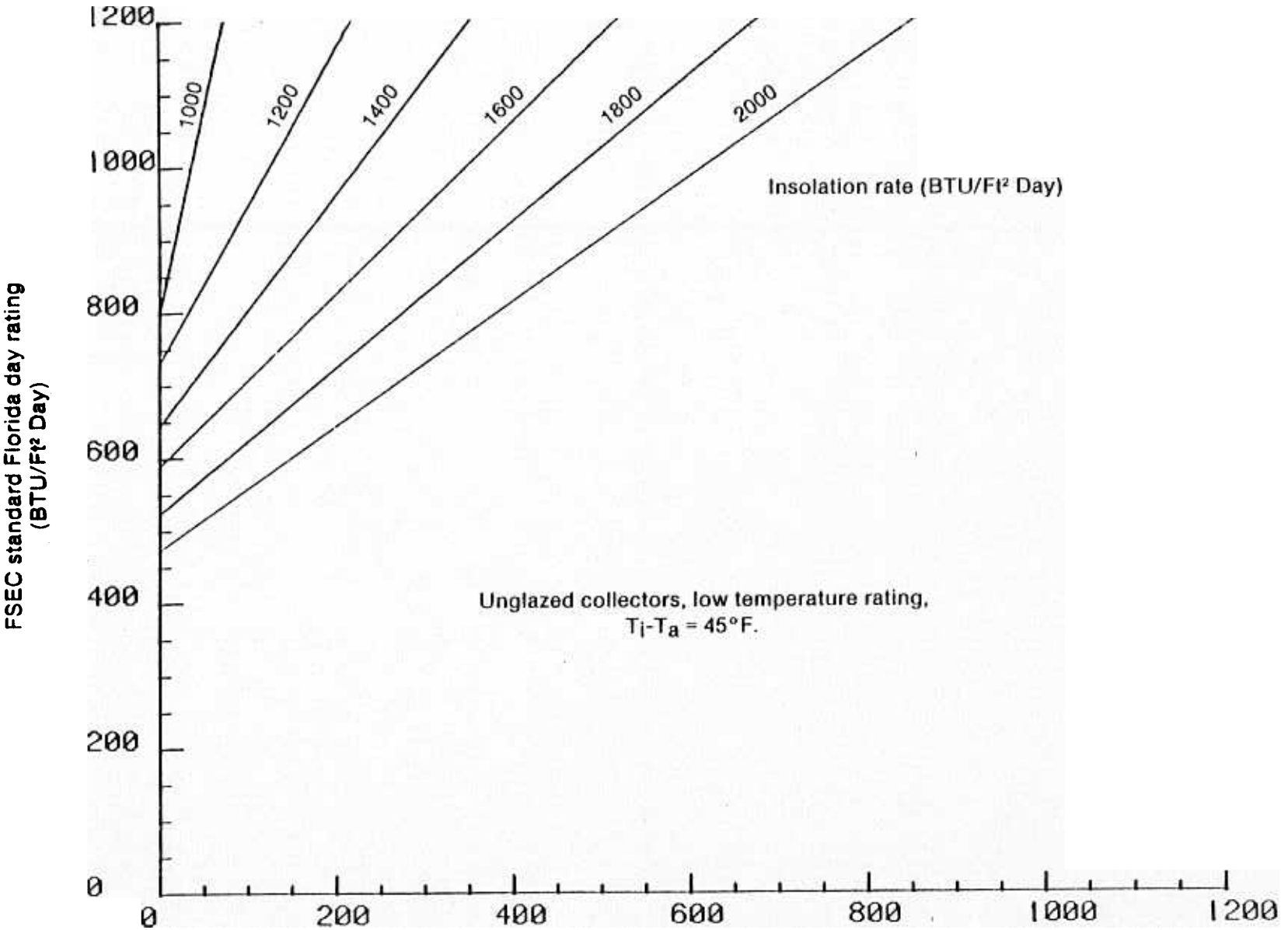
Glazed Collectors
Insolation Rates (Btu/ft^2·day)

$\frac{\Delta T}{(^\circ F)}$	1000	1200	1400	1600	1800	2000
55	76.2	69.2	63.4	58.1	63.4	53.5
45	68.0	61.1	54.9	49.8	44.9	40.3
35	57.6	50.4	44.2	38.4	33.4	29.0
25	42.8	35.1	28.6	23.3	18.4	14.0
14	17.4	10.4	4.6	0.0	3.9	7.1
5	19.5	22.3	24.4	25.9	27.0	28.1

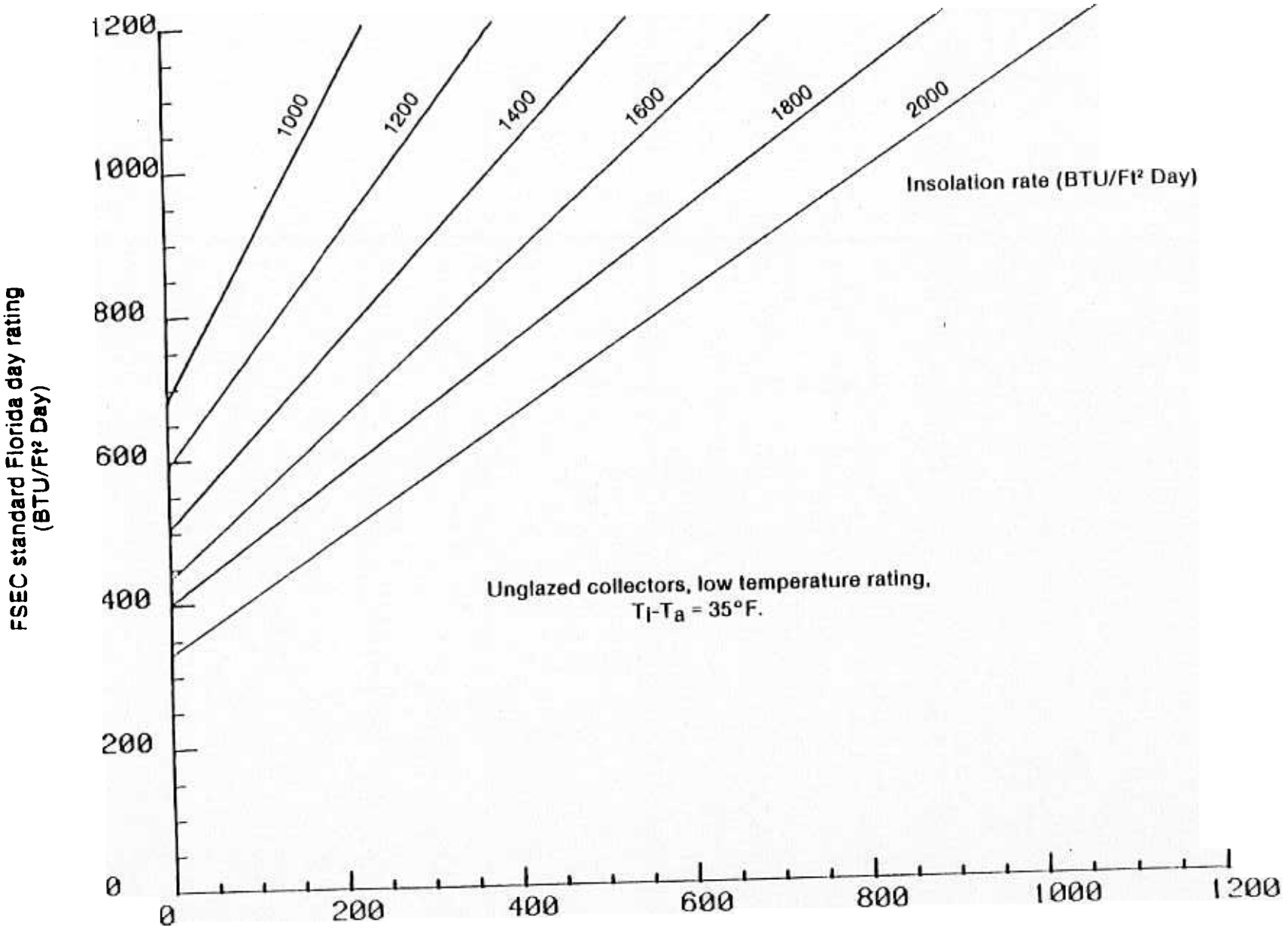


Temperature/insolation correction graph

Figure A.1

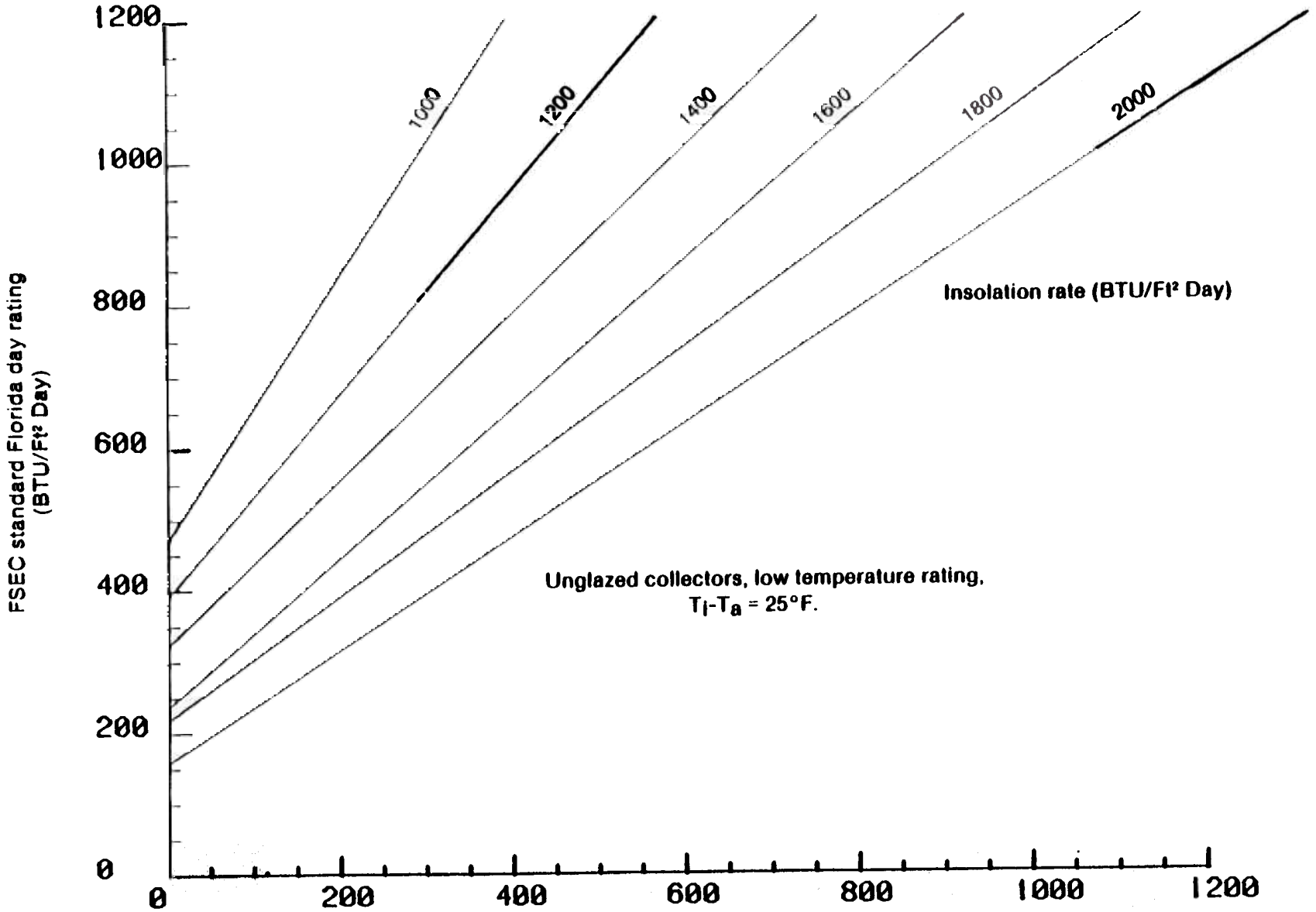


Temperature/insolation correction graph
Figure A.2

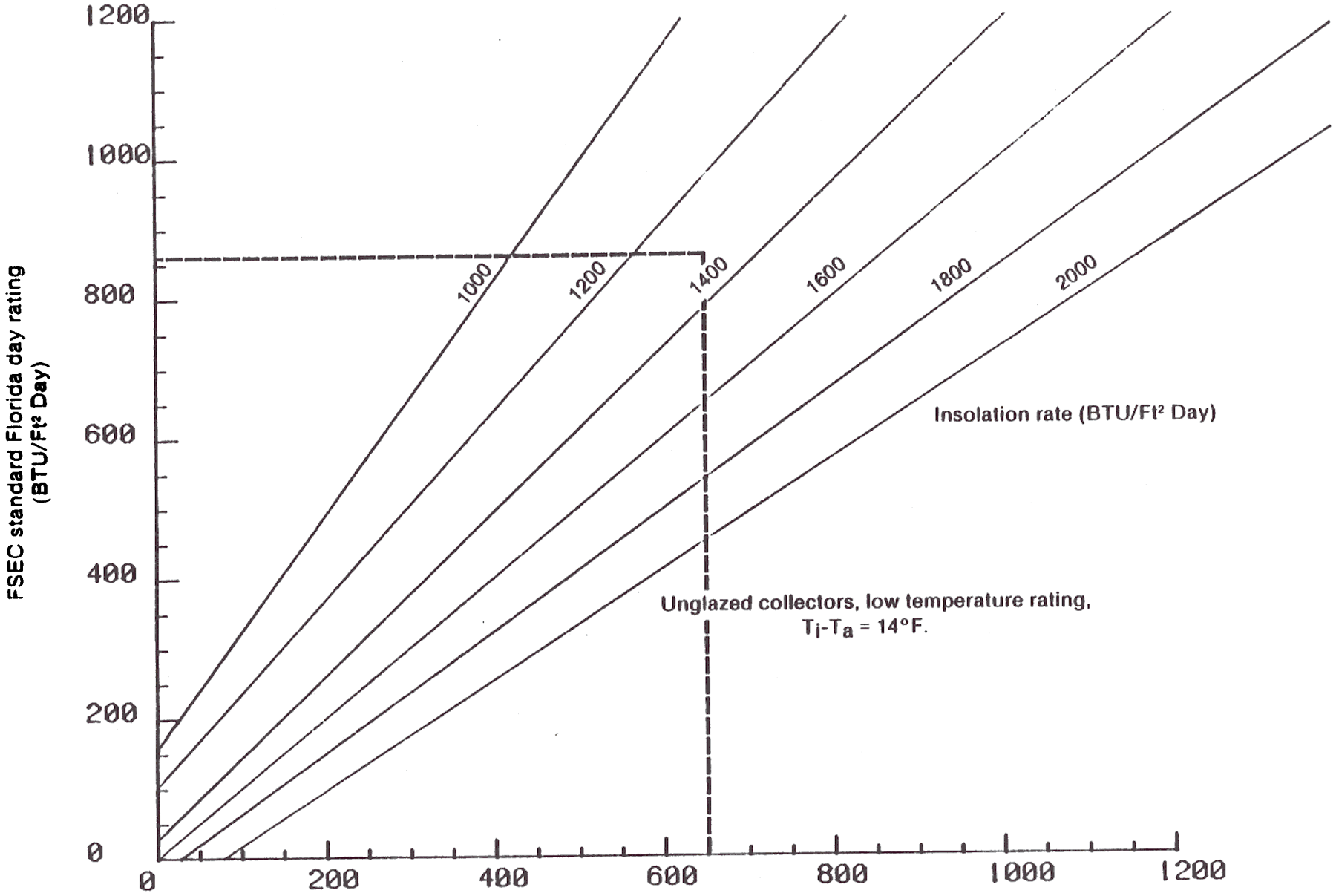


Temperature/insolation correction graph

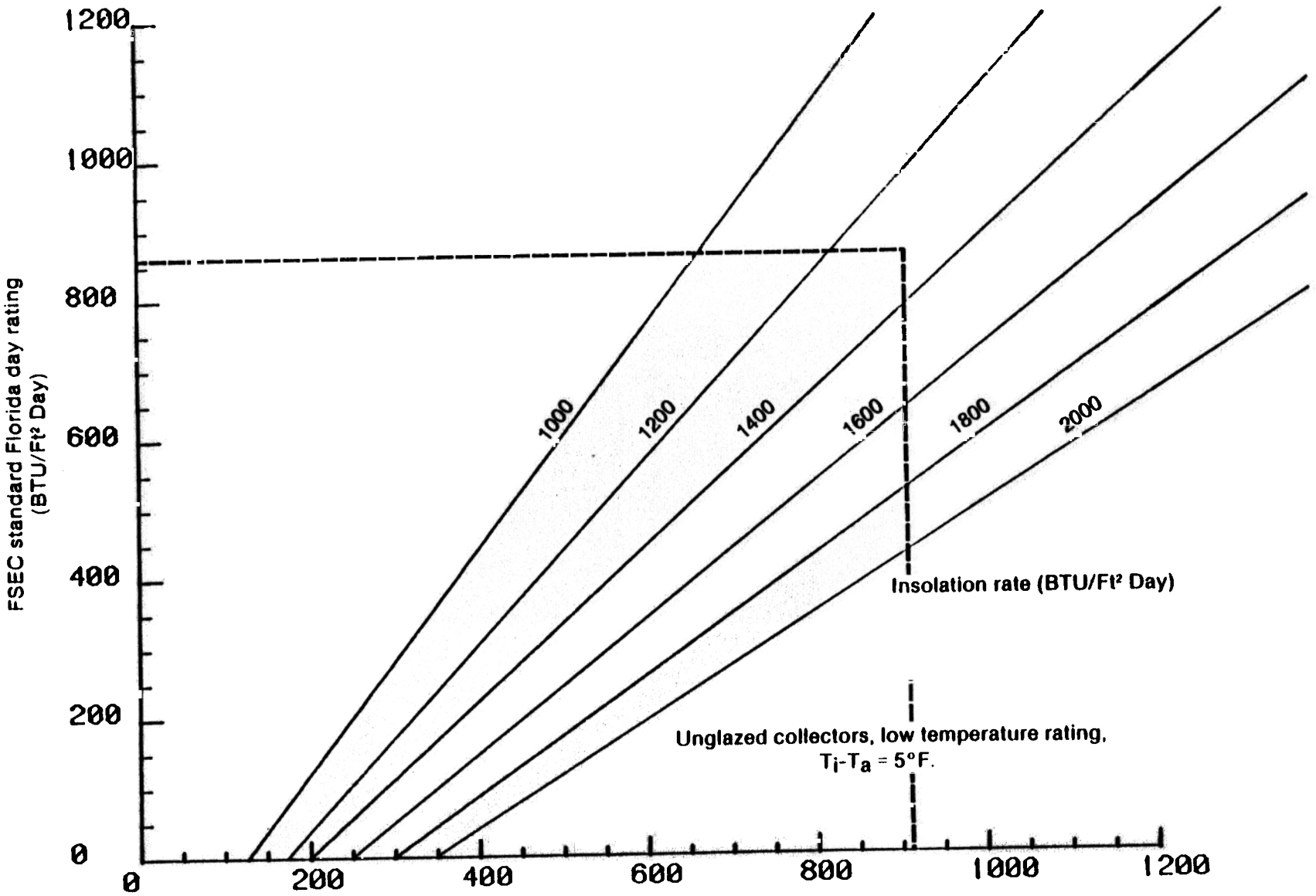
Figure A.3



Temperature/insolation correction graph
Figure A.4

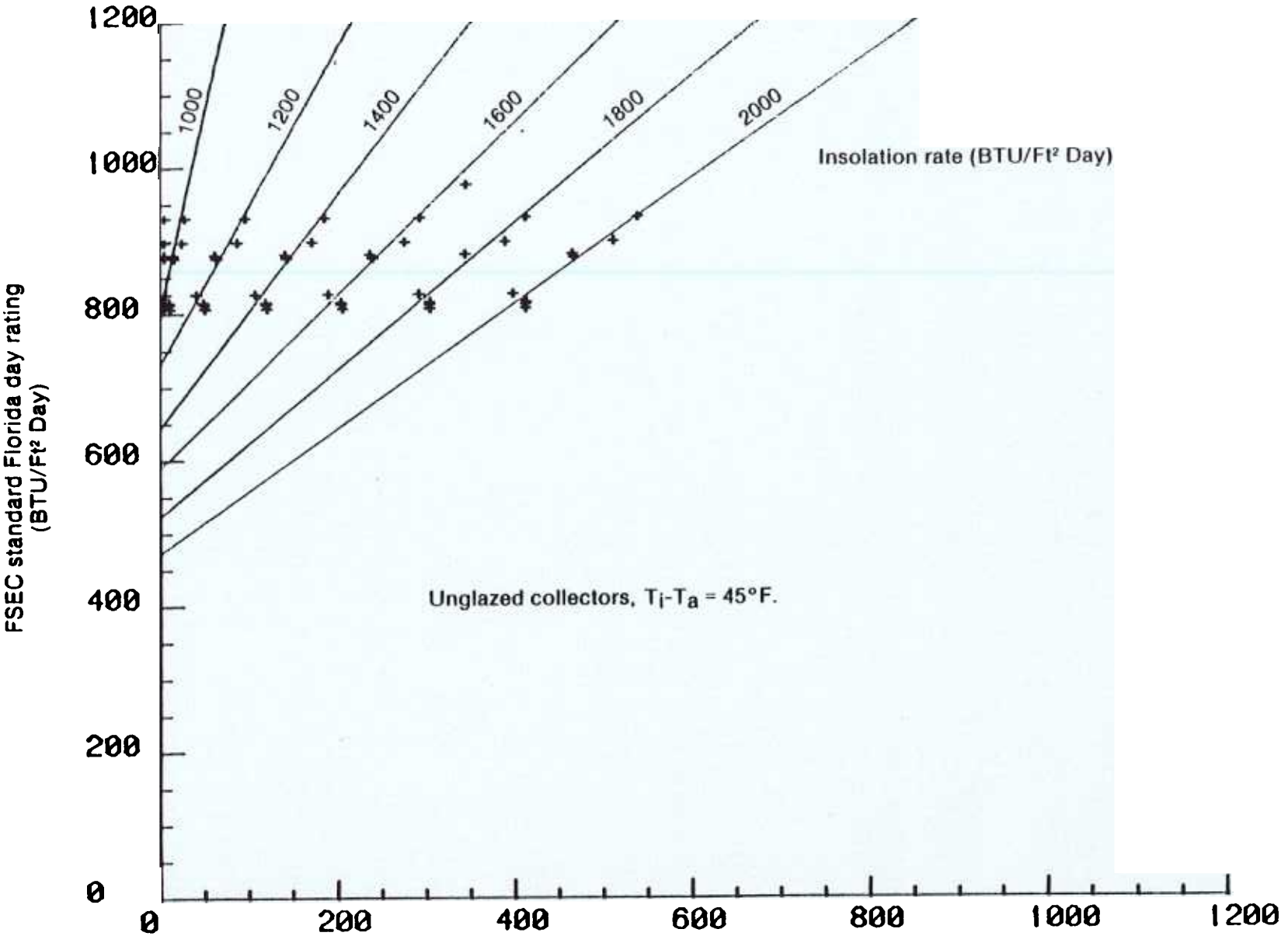


Temperature/insolation correction graph
Figure A.5



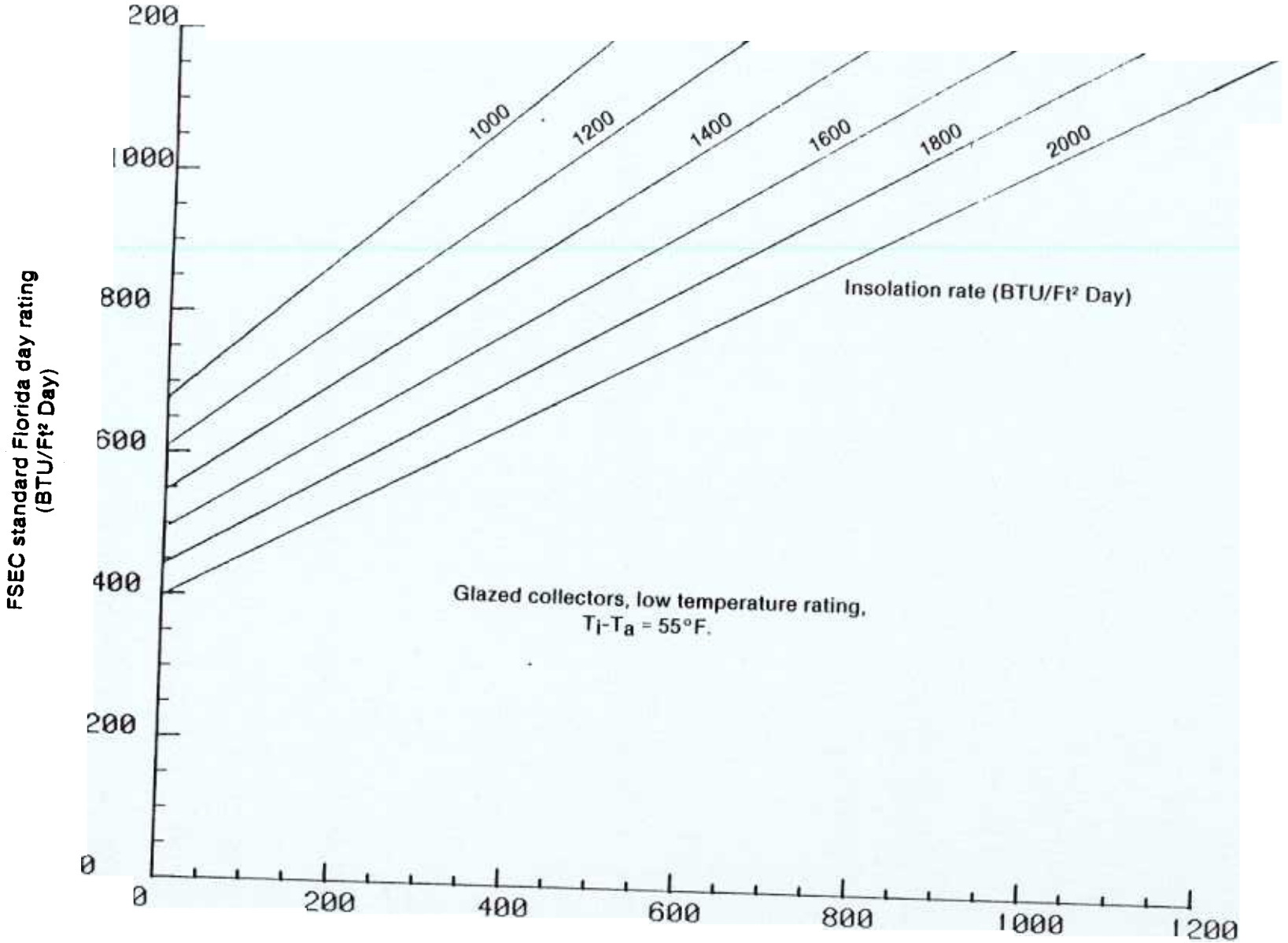
Temperature/insolation correction graph

Figure A.6

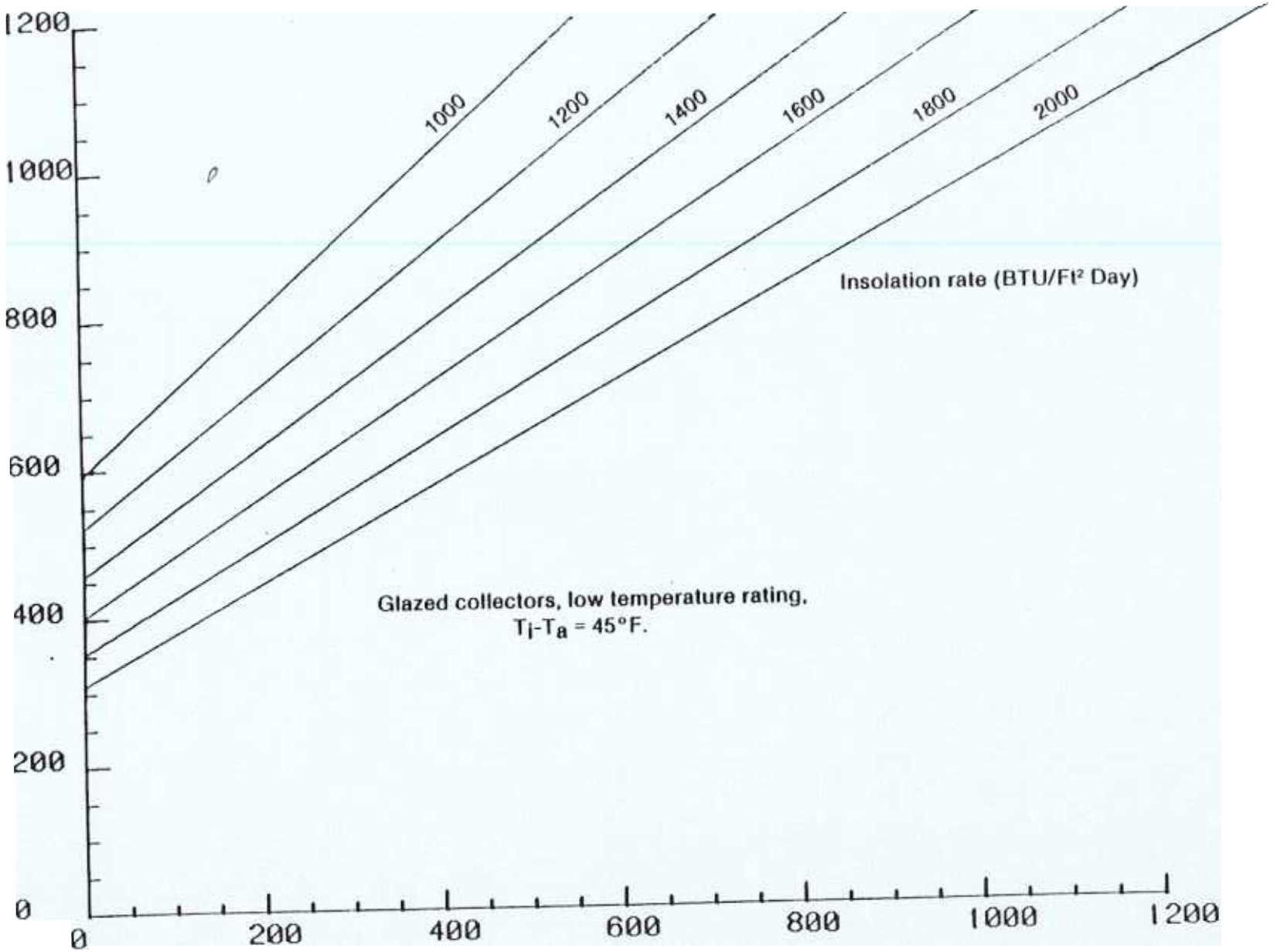


Temperature/insolation correction graph
Typical point spread for unglazed collector rerating
(low temperature operation)

Figure A.7

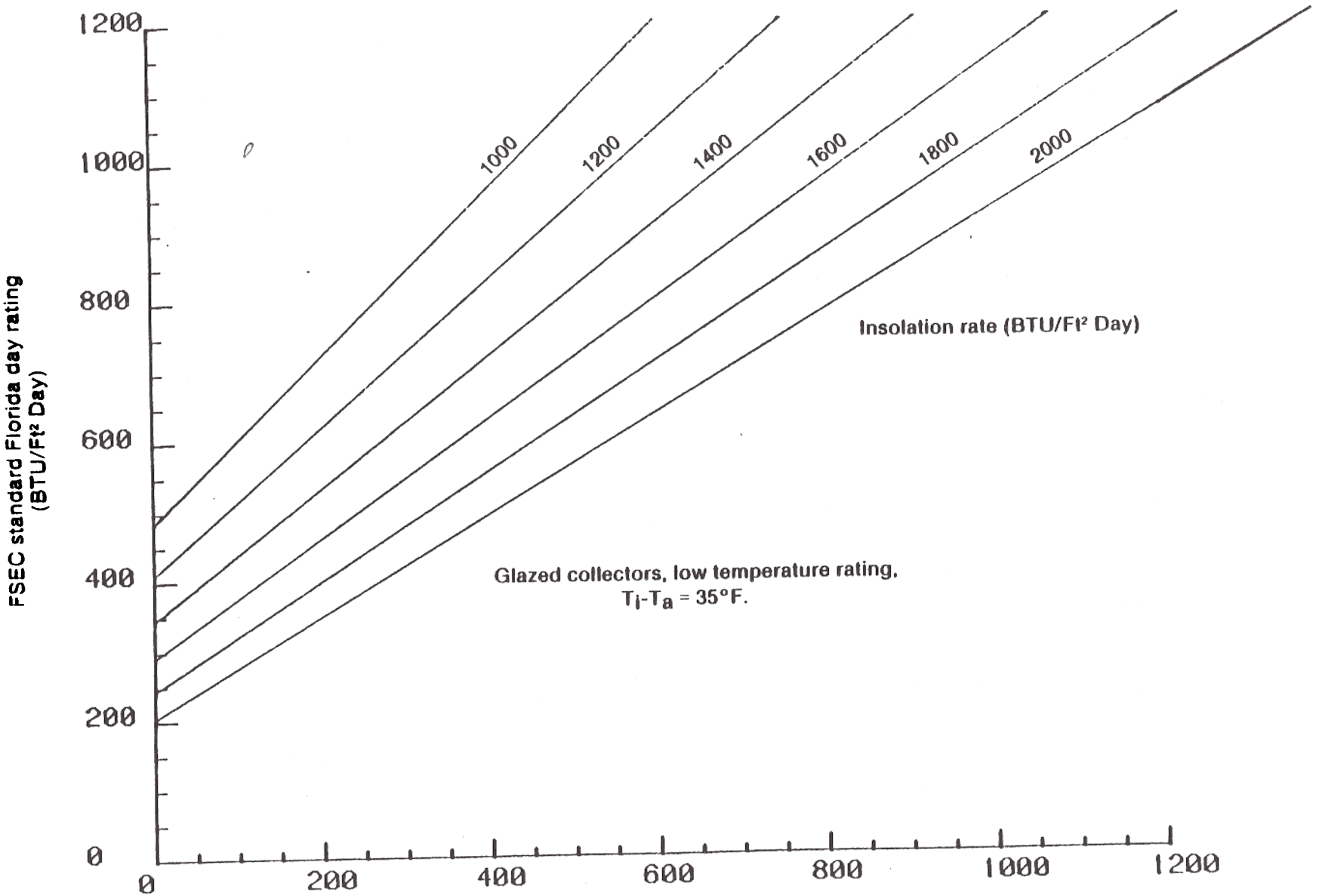


Temperature/insolation correction graph
Figure A.8

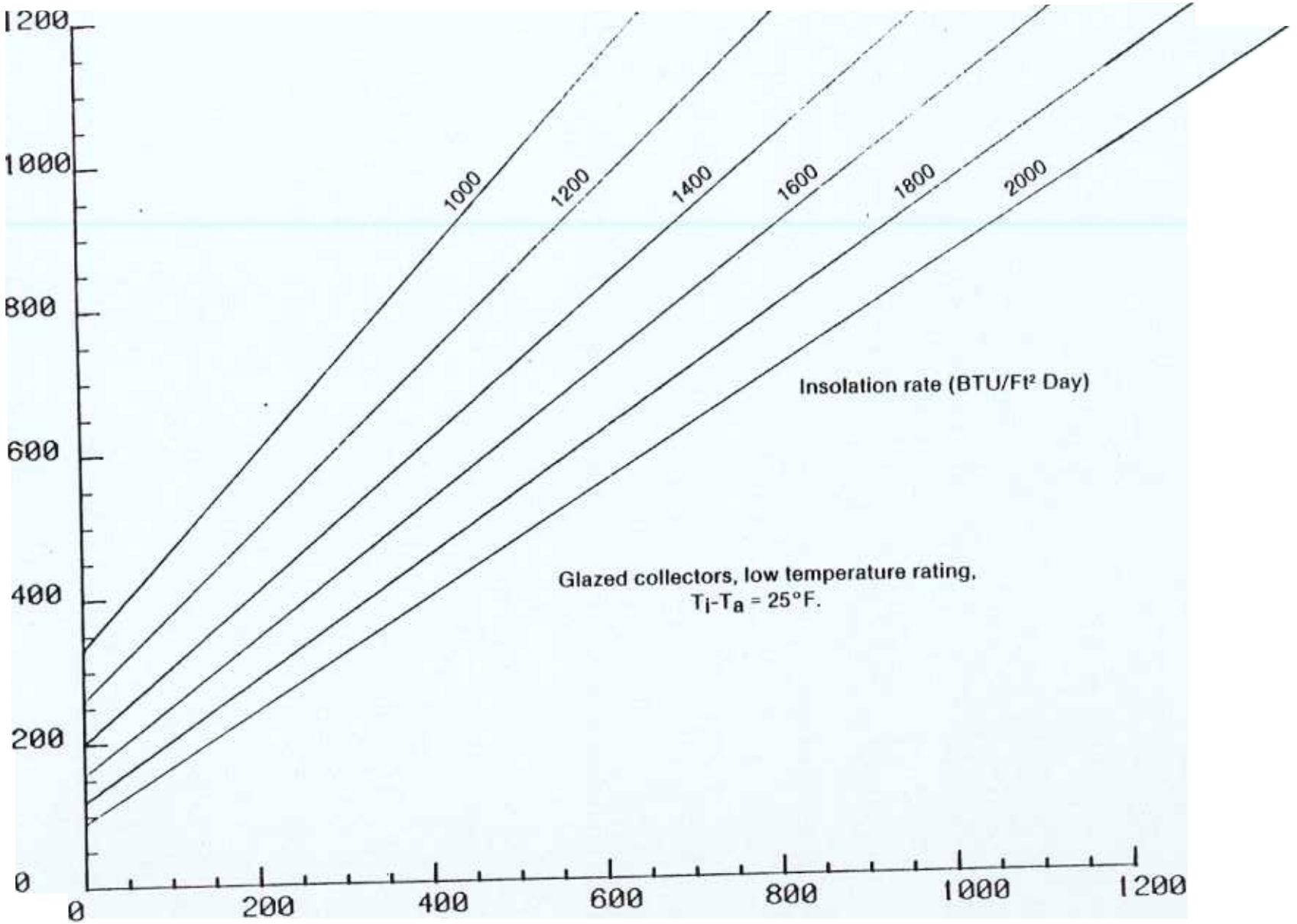


Temperature/insolation correction graph

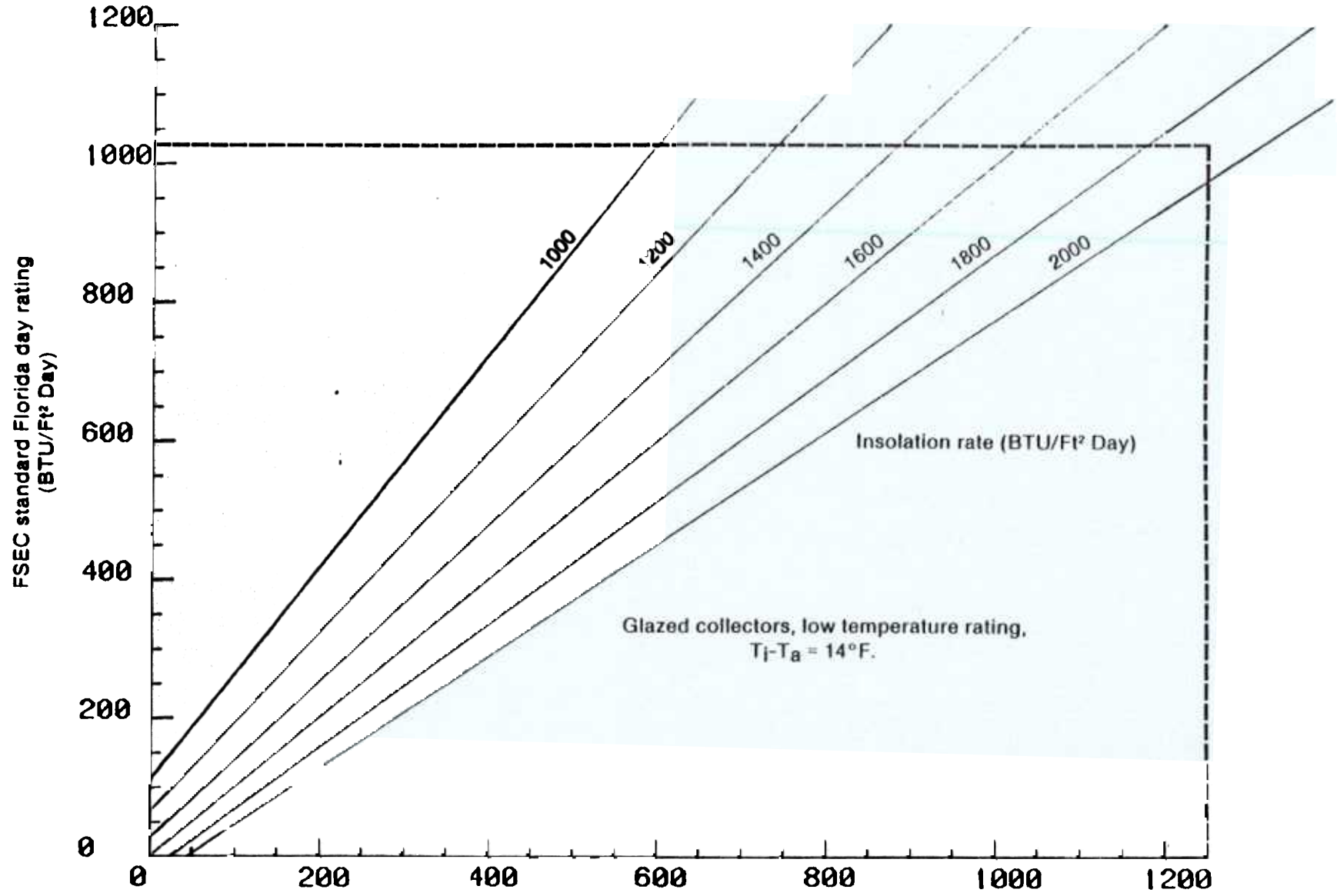
Figure A.9



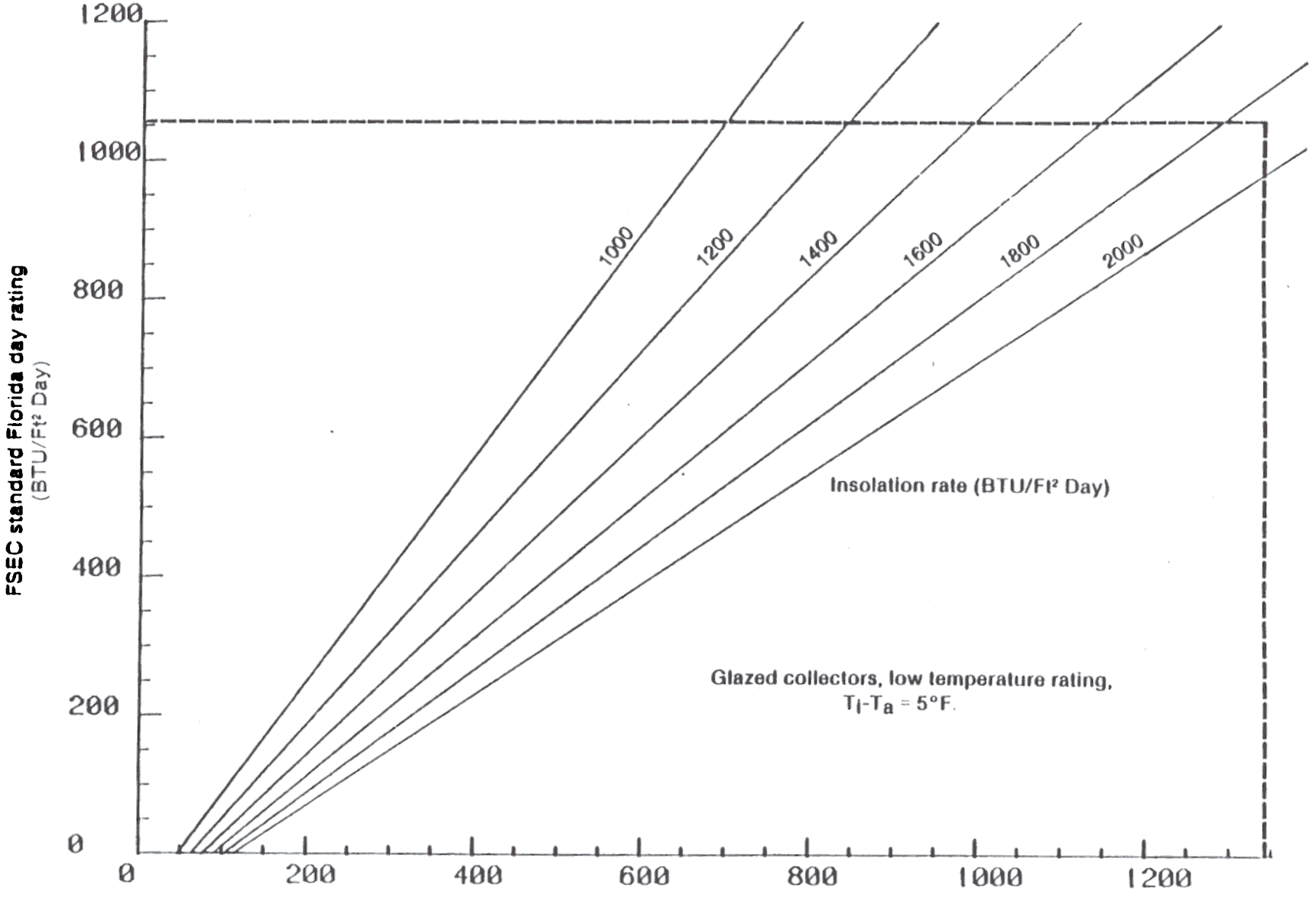
Temperature/insolation correction graph
Figure A.10



Temperature/insolation correction graph
Figure A.11

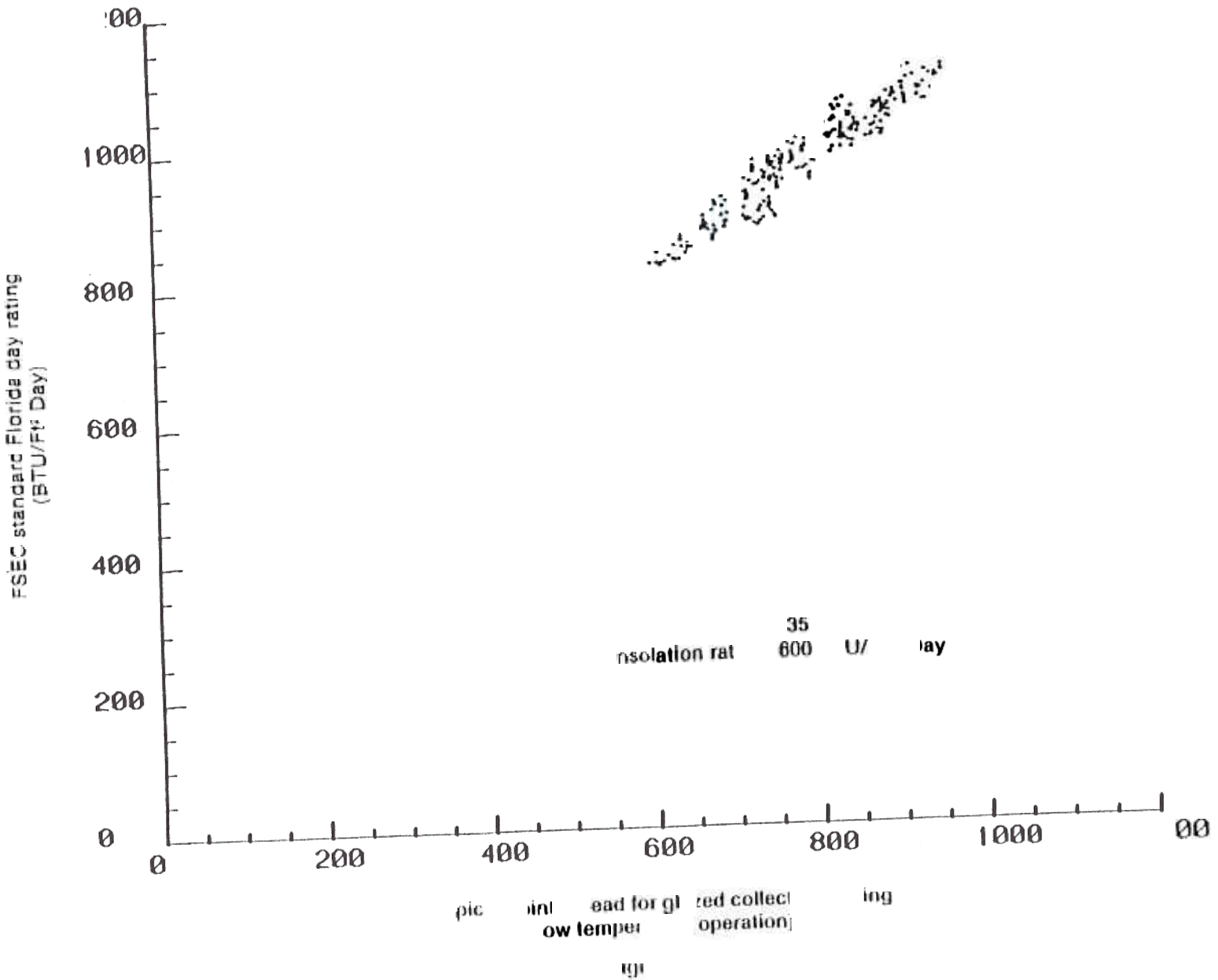


Temperature/insolation correction graph
Figure A.12



Temperature/insolation correction graph

Figure A.13


FSEC standard Florida day rating
(BTU/Ft² Day)
1000
800
600
400
200
0
0
200
400
600
800
1000
00
35
600
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