Limitations of Simplified Load Calculation Procedures

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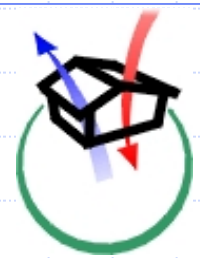


Introduction

- Limitations – what limitations?
- Simplified Procedures
- ASHRAE 942-RP
- Examples (Primarily with RTS)

Approximations to the Heat Balance Method

- Transfer Function Method (TFM)
- CLTD/SCL/CLF *
- TETD/TA *
- Radiant Time Series Method
- Admittance Method

* Both of these methods use data that are derived from TFM

Approximations to the Heat Balance Method

- In general, simplified methods:
  - Treat radiation and convection heat transfer together (particularly questionable when large glazing areas are involved).
  - For the exterior surface, this involves the use of a sol-air temperature.
  - The interior surfaces are assumed to convect and radiate to the room air temperature.

Approximations to the Heat Balance Method

- In general, simplified methods:
  - Use some form of precalculated response for energy storage/release in the zone.
  - Often simplify treatment of transient conduction heat transfer through walls.
  - Assume all heat gain becomes cooling load; i.e. no heat gain is conducted back out of the space.
  - Tend to overpredict cooling loads.

Approximations to the Heat Balance Method

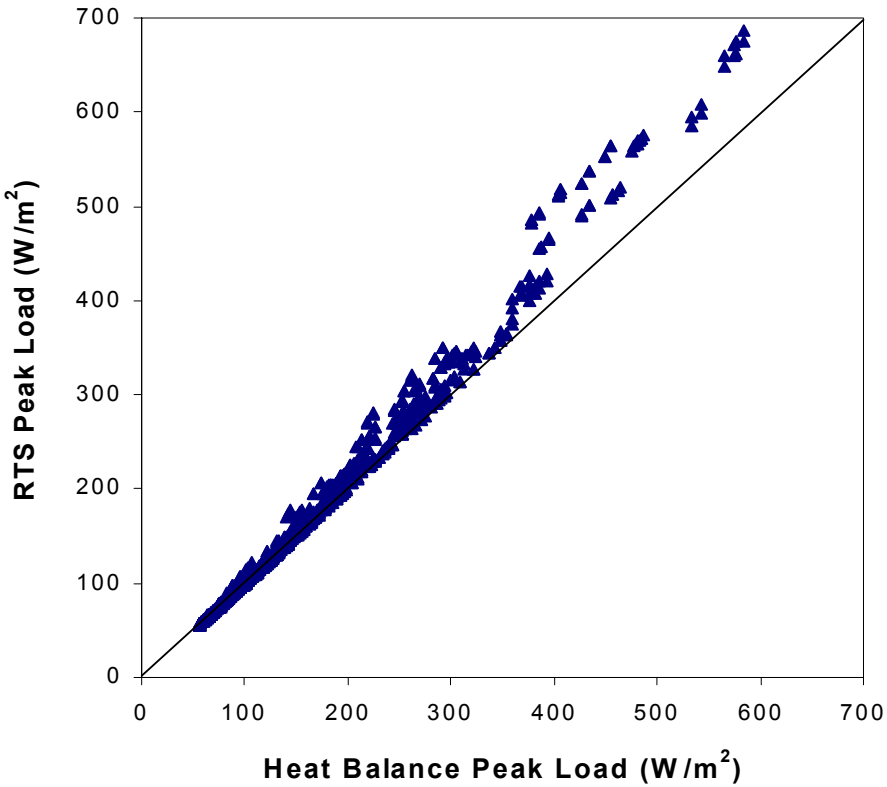
- Benefits of approximate methods:
  - Simpler to use
  - Give component loads.
  - Tend to overpredict cooling loads. ☺

ASHRAE 942-RP

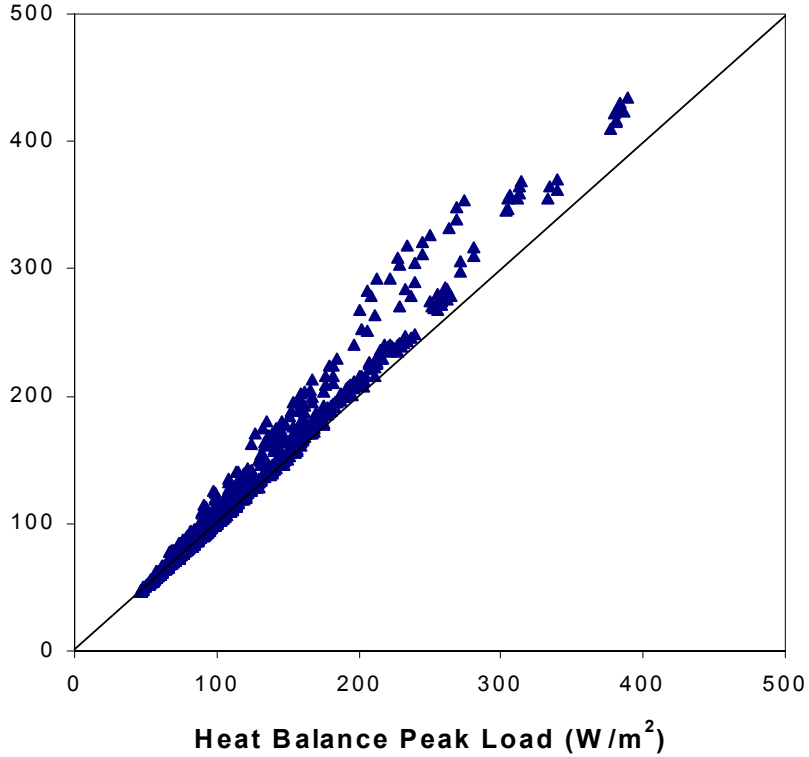
- Comparison of ASHRAE and CIBSE load calculation procedures.
- Compared results of procedures for thousands of different zones.

Sample Results

Lightweight Zones



Heavyweight Zones

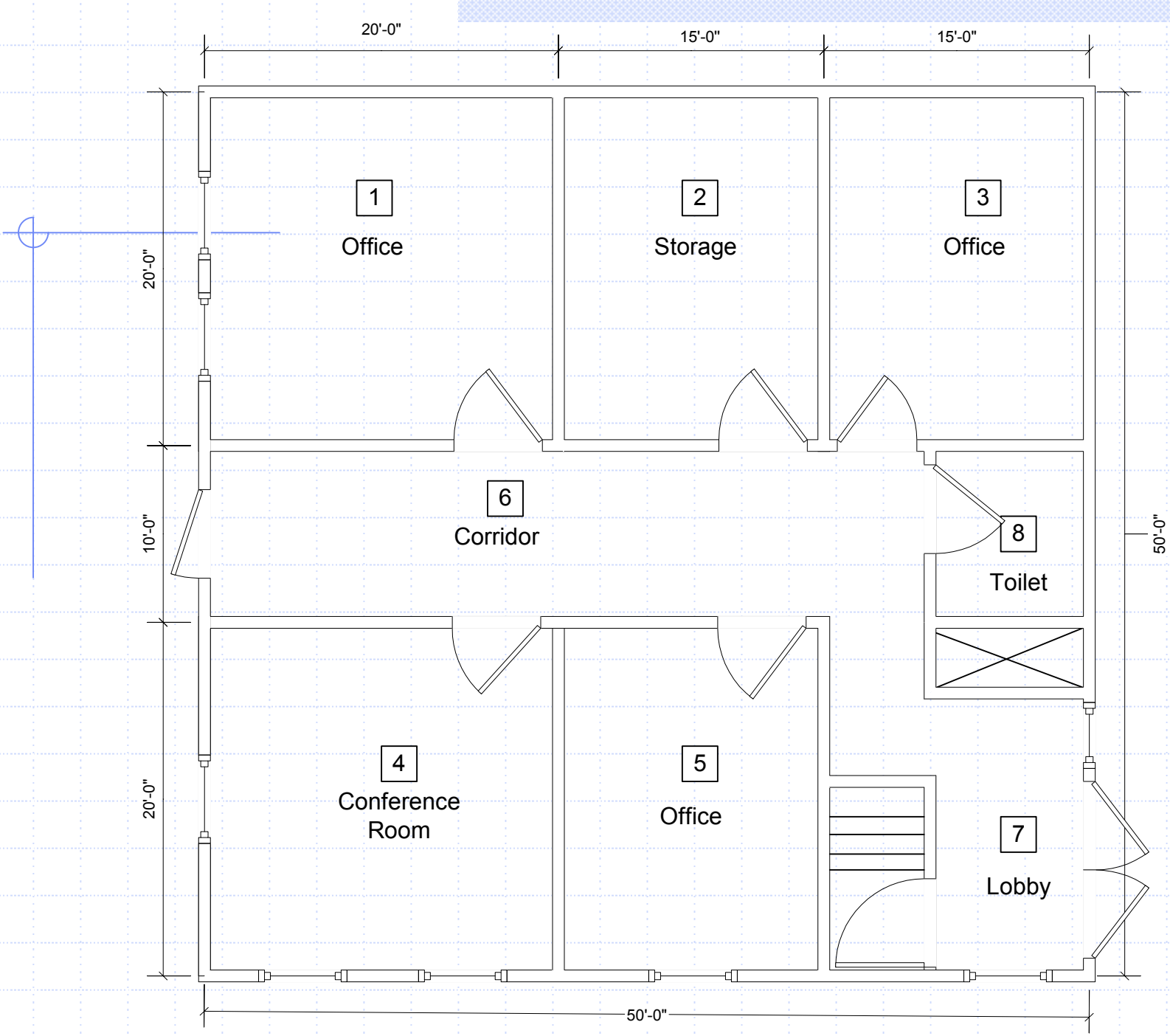


Why does RTS over-predict?

- The RTS procedure over-predicts most noticeably for cases with high % of single pane glazing.
- Two conditions must be present for significant over-prediction
  - Large amount of high conductance wall or window
  - Large amount of radiant heat gain

Example

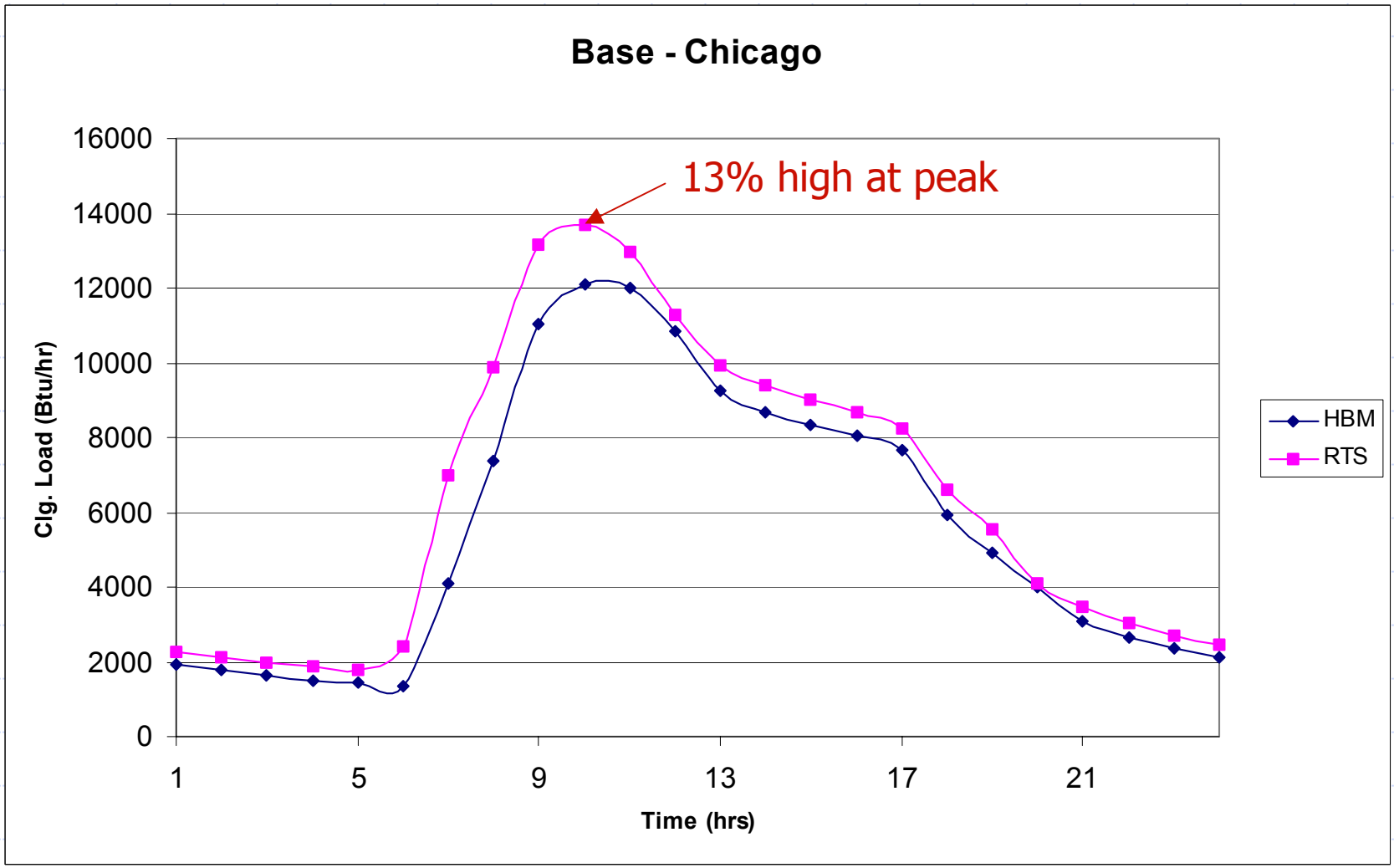
- Two-story (+ basement) office building located in Chicago. Look at first floor, Northeast zone.
- Heavyweight walls: brick/concrete block
- Floor: Lightweight layer on top of 4” concrete
- Ceiling: 4” concrete, airspace, acoustic tile
- Lightweight partitions: gypsum/studs


20'-0"
15'-0"
15'-0"
1
Office
2
Storage
3
Office
20'-0"
6
Corridor
8
Toilet
10'-0"
50'-0"
4
Conference Room
5
Office
7
Lobby
20'-0"
50'-0"

Example

- North wall (150 sq. ft. total) has 40 sq. ft. of double-pane windows
- East wall (200 sq. ft. total) has 60 sq. ft. of double-pane windows.
- 4 people on office schedule
- 1 W/sq. ft. equipment on office schedule
- 1 W/sq. ft. fluorescent lighting
- No infiltration.
- Overly high design condition: high of 96 F, 19 F range

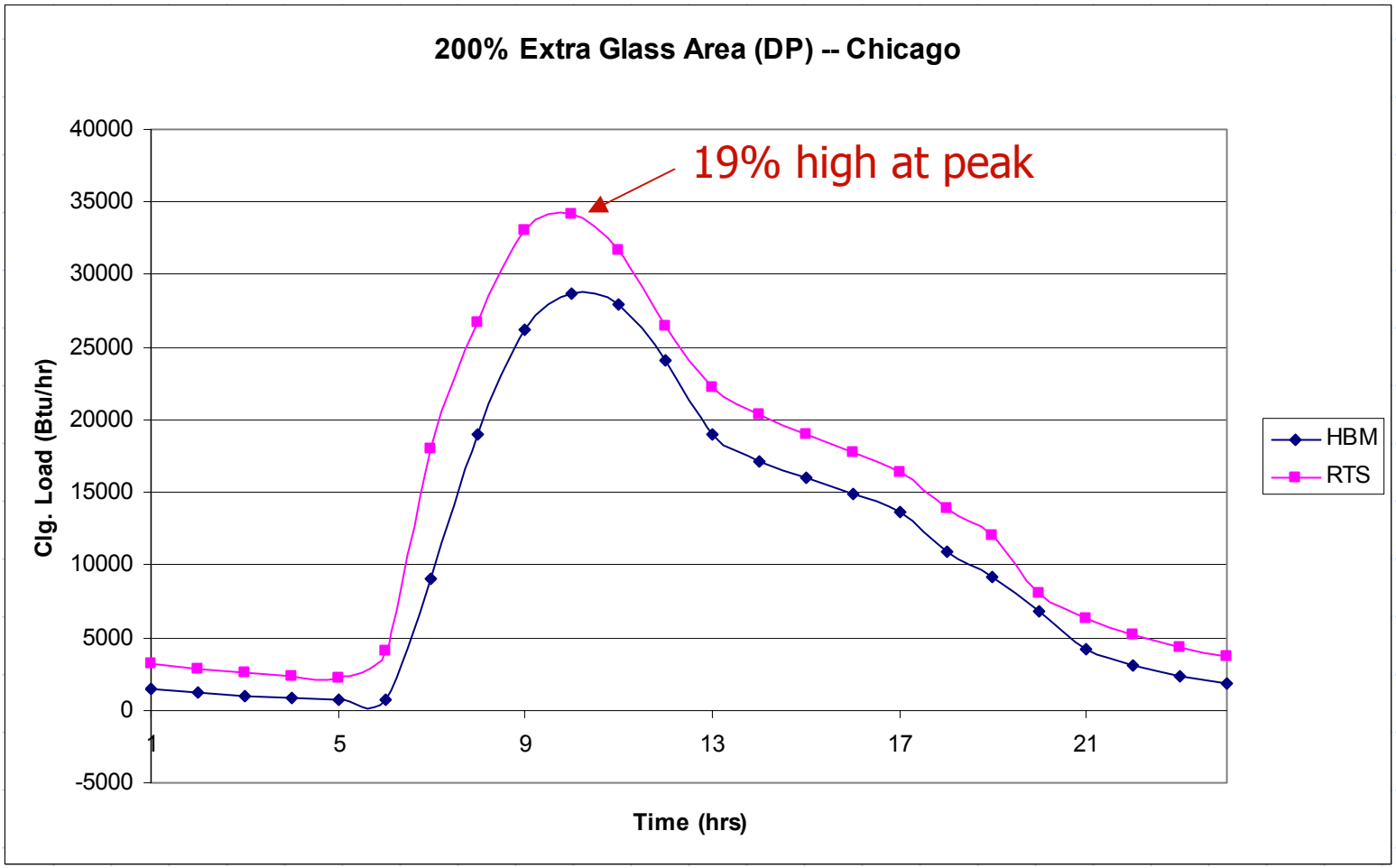
Base case


Base - Chicago
13% high at peak
Clg. Load (Btu/hr)
16000
14000
12000
10000
8000
6000
4000
2000
0
1
5
9
13
17
21
Time (hrs)
HBM
RTS

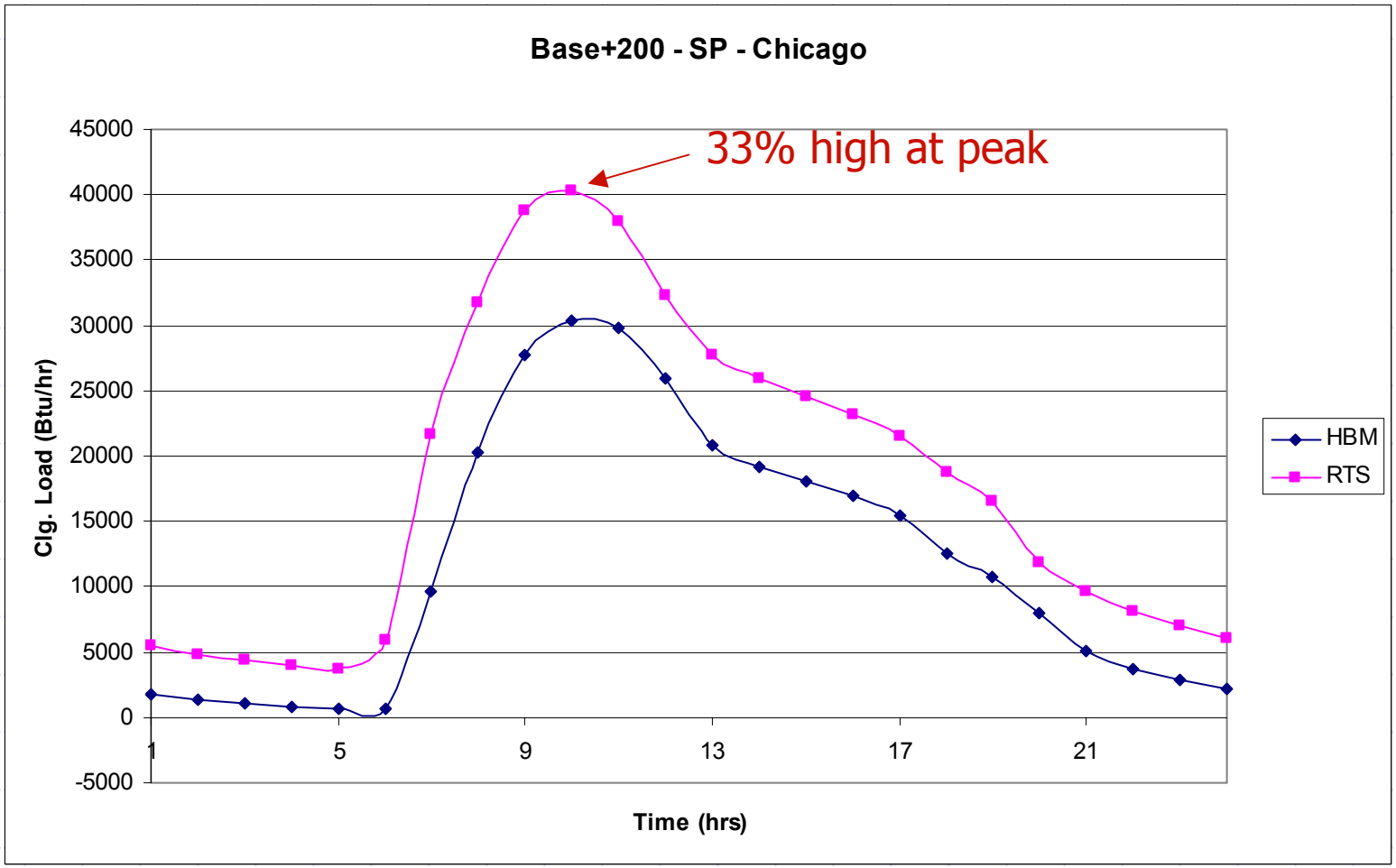
Glazing area and type

- More glass: 50%, 100%, 200% more.
- Change glass from double pane to single pane.

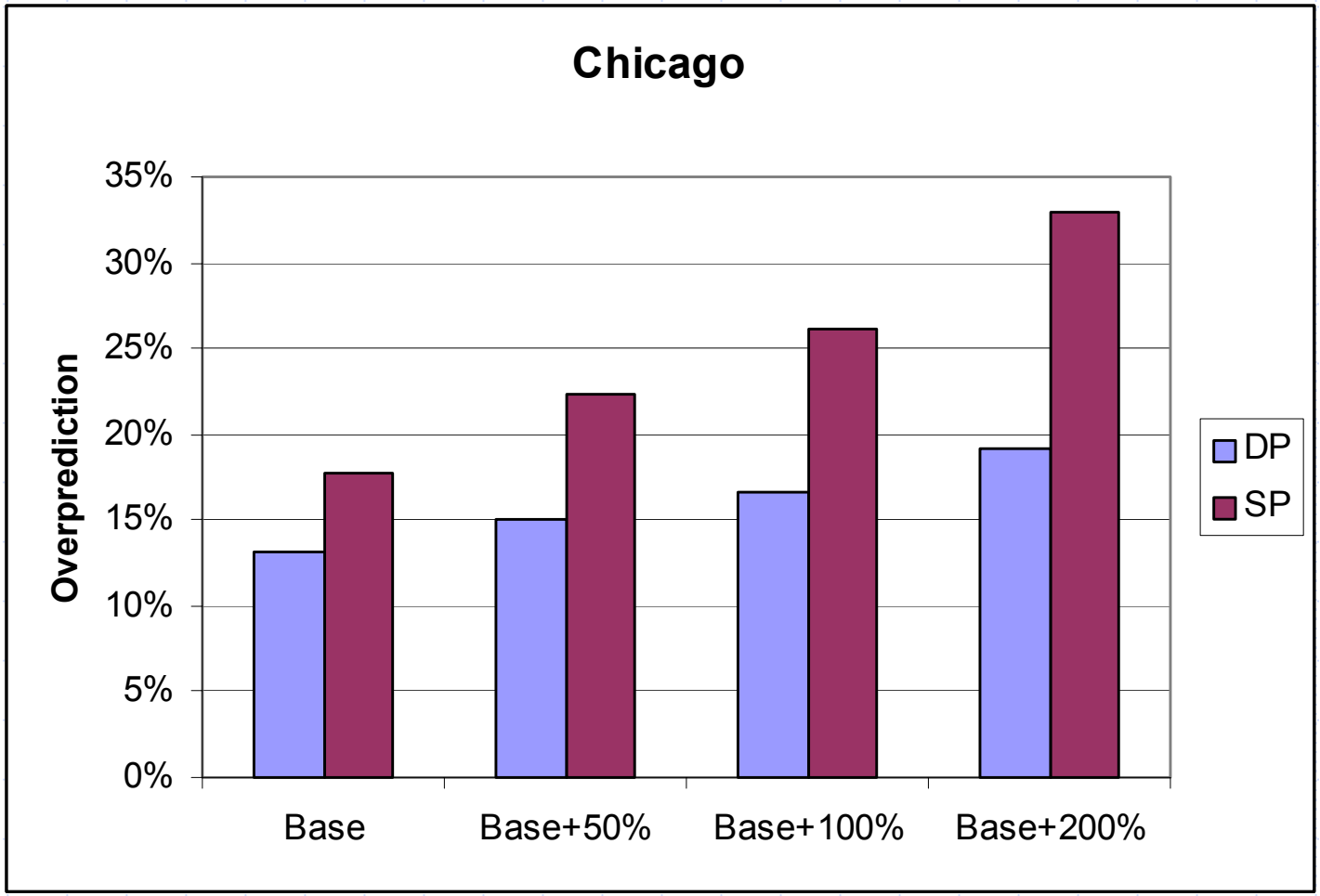
Mostly glass facade



Single pane glass facade



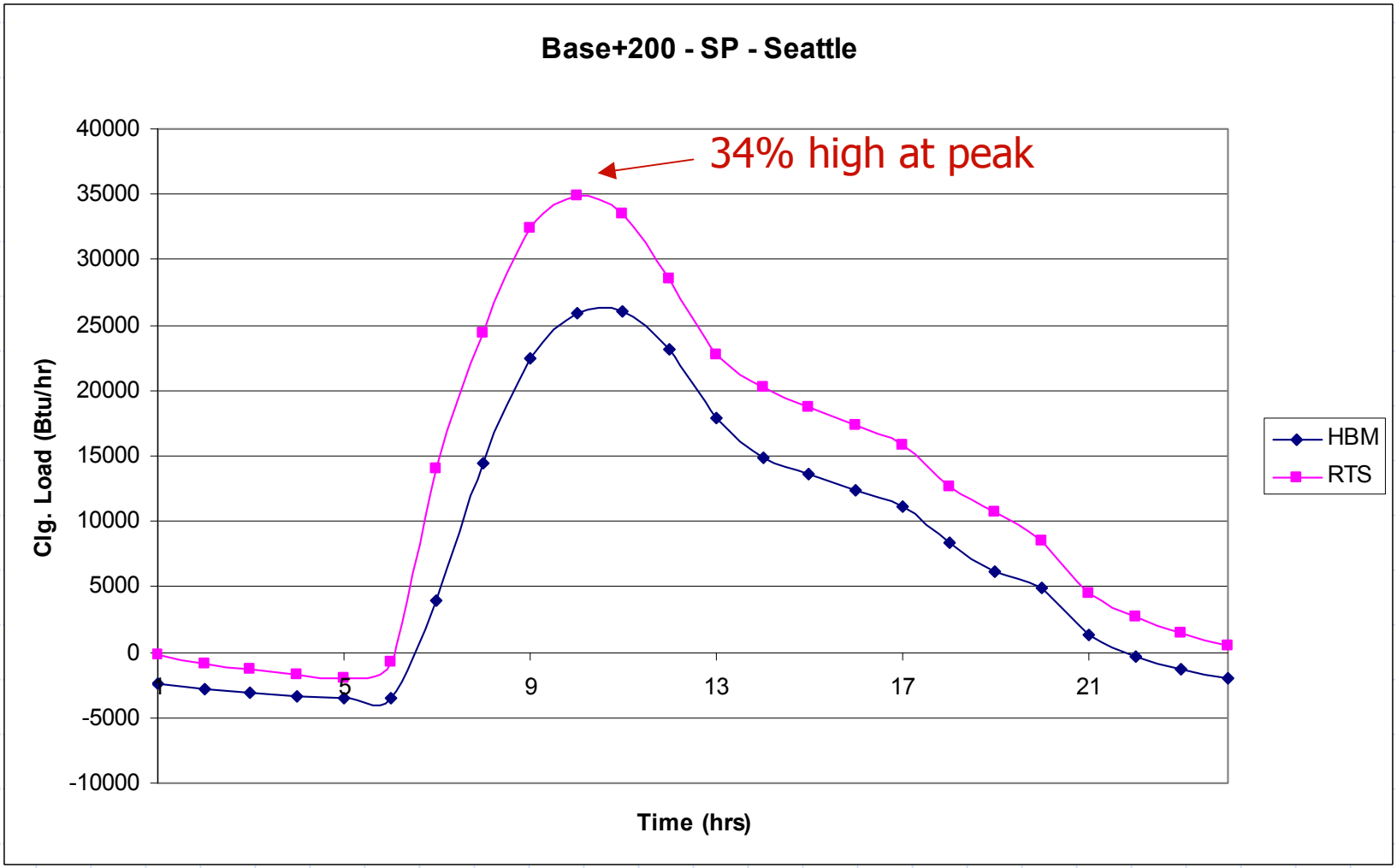
Summary - Chicago



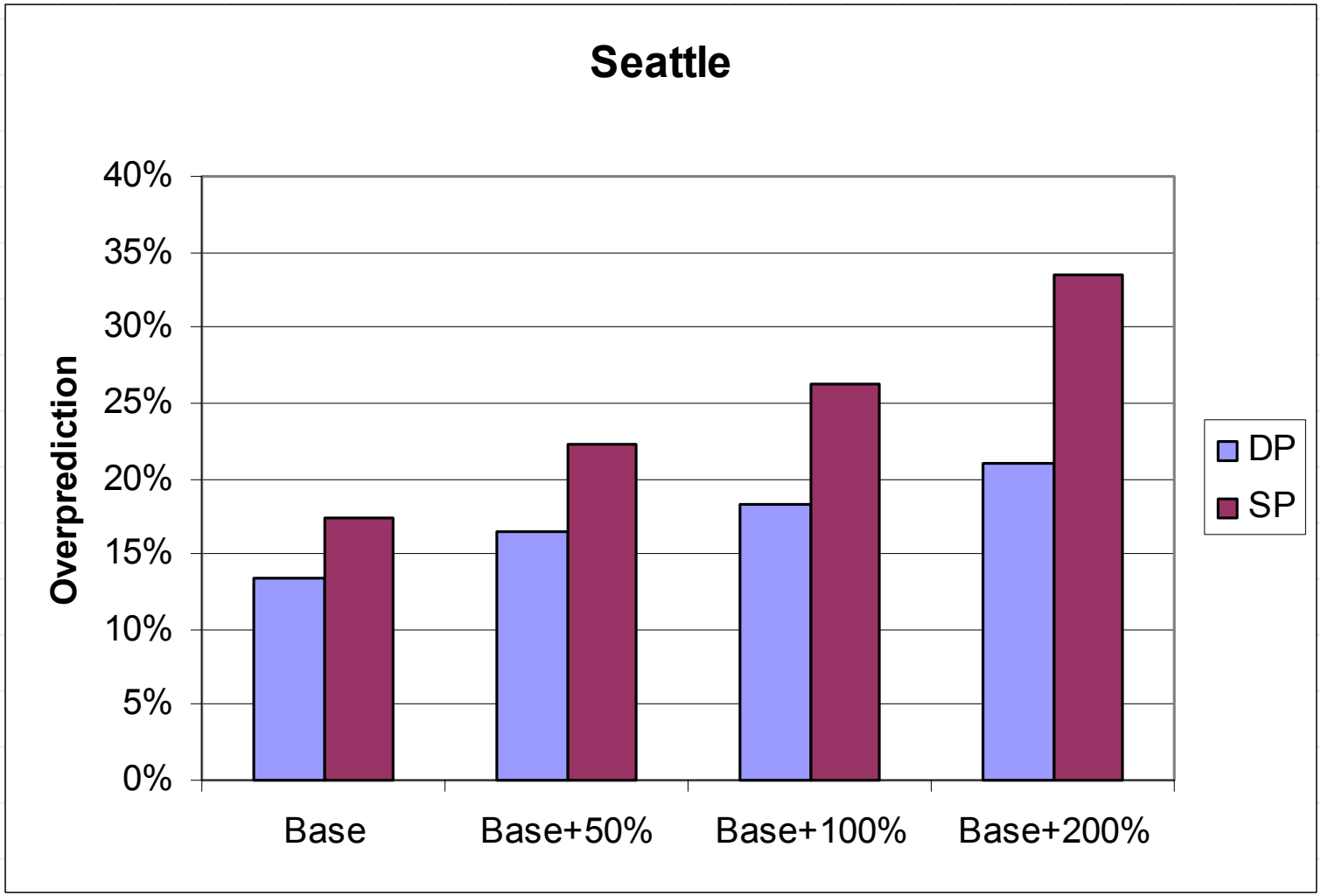
Move Building to Seattle

- Chicago had a high temperature of 96 F, low of 77 F
- Using Seattle 2% design conditions: high of 78 F, low of 60 F
- Note that a similar effect might be obtained for zones with winter peaks.

Seattle – SP Glass Facade



Seattle Summary



What about TFM?

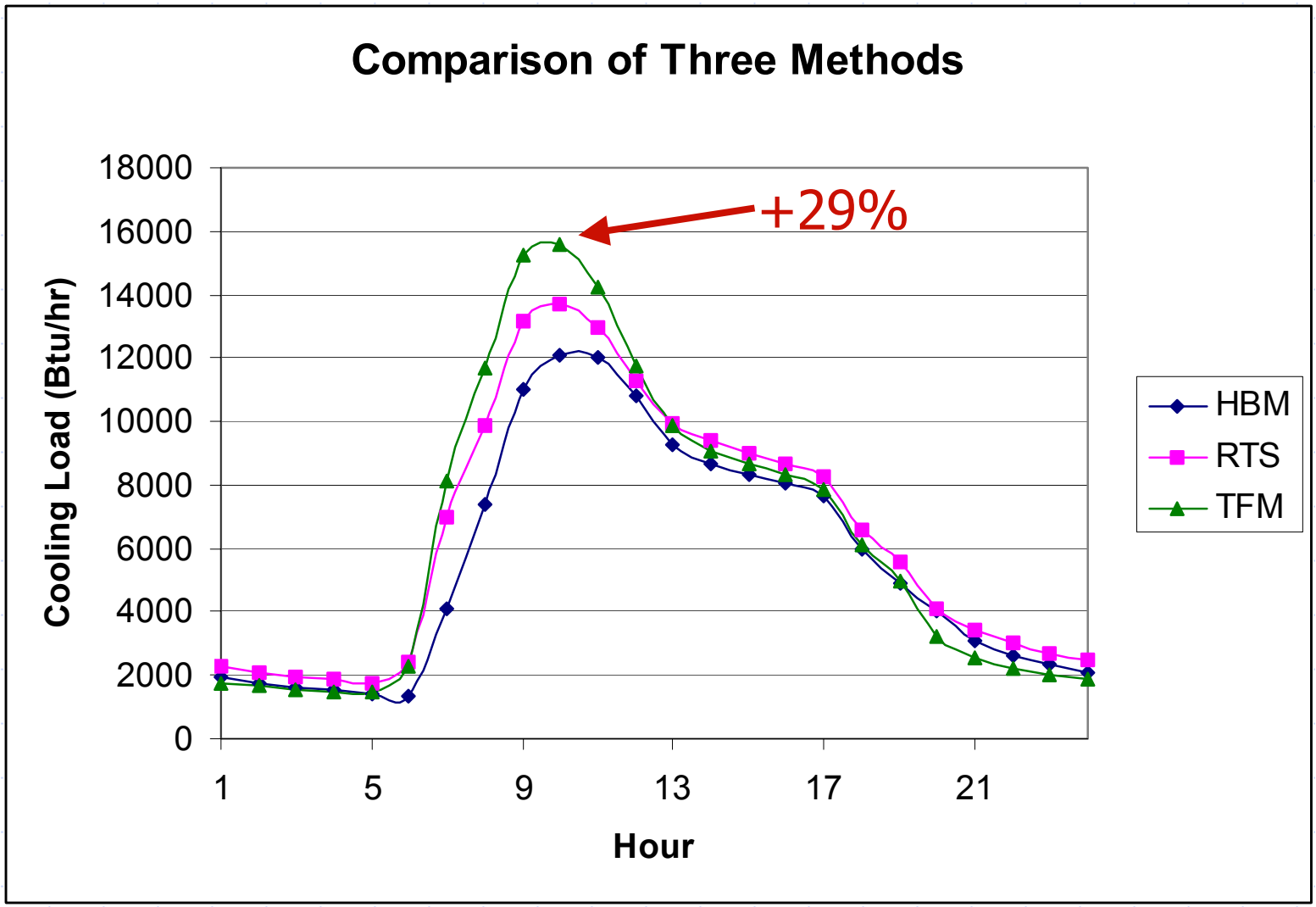
- Difference between RTS and TFM depend primarily on tabulated factors.
- How close is actual zone to tabulated zones?
- Weighting factors were grouped, adding another (variable) overprediction.

626-RP Tabulated WF

TABLE 9
Zone Parametric Level Definitions

No.	Parameter	Meaning	Levels (given in normal order)
1	ZG	Zone Geometry	100 ft. x 20 ft., 15 ft x 15 ft. 100 ft x 100 ft.
2	ZH	Zone Height	8 ft, 10 ft. 20 ft
3	NW	Num. Ext. Walls	1, 2, 3, 4, 0
4	IS	Interior Shade	100, 50, 0 percent
5	FN	Furniture	With, Without
6	EC	Ext. Wall Cons.	1, 2, 3, 4
7	PT	Partition Type	5/8 in. Gyp-Air-5/8 in. Gyp, 8 in. Conc. Blk.
8	ZL	Zone Location	Single-story, Top flr, Bot. flr, Mid flr.
9	MF	Mid Flr Type	8 in. Conc., 2.5 in. Conc., 1 in. Wood
10	ST	Slab Type	Mid flr Type, 4 in slab on 12 in soil
11	CT	Ceiling Type	3/4 in Acoustic tile & Air space, w/o ceiling
12	RT	Roof Type	1,2,3,4
13	FC	Floor Covering	Carpet with rubber pad, vinyl tile
14	GL	Glass Percent	10, 50, 90

Chicago Base Case



Conclusions

- RTS procedure works well for many zones.
- RTS procedure may over predict for zones with high amounts of glazing
- Exacerbating factors include:
  - Single pane glass
  - Low outdoor design temperatures