melbourne city council

peak cooling load analysis

Prepared for:
Melbourne City Council

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1 INTRODUCTION

This report has been prepared by Advanced Environmental Concepts to examine the frequency of peak cooling loads for the new offices for Melbourne City Council offices using weather data collected from 10 actual years in Melbourne City.

Each year's cooling loads have been analysed in order to establish the design cooling capacity for the Phase Change Material and to ensure that the quantity selected is economical and sufficient for any year in Melbourne.

The design capacity of the Phase Change Material is of great importance because it is expected to handle most of the building's cooling requirements for the year. During our modelling, however, it was noticed that for approximately 4 days of the year, the cooling requirement would increase by about 18%.

The Phase Change Material concept works by charging the phase change battery overnight through the running of cooling towers. Enough "coolth" is stored in the battery to provide a low energy supply of cooling to the office areas during the day. Further details of the phase change material concept can be found in AEC's report titled "PCM-Based Cooling".

2 APPROACH

Using computer simulations of the model, peak cooling loads were analysed on a daily basis using Melbourne weather data files collected from 1971, 1973, 1976, 1978, 1980, 1982, 1983, 1985, 1986, 1987 and a Test Reference Year. A Test Reference Year is a weather file nominated by the American Society of Heating Ventilation and Air-Conditioning (ASHRAE) which represents most typical weather conditions using years of collected weather data.

The objective was to confirm the design capacity of the Phase Change Material during a Melbourne Test Reference Year using a 98% percentile ie for 98% of the year the cooling requirements are met by the Phase Change Material. It is proposed that for the remaining 2% of the year (approximately four days), the main chiller in the central plant be used to compensate the extra cooling required.

This cooling capacity determined by the Test Reference Year was compared with the cooling capacity from each of the 10 years modelled and the results shown on graphs in the Results Section.

3 RESULTS

3.1 Test Reference Year

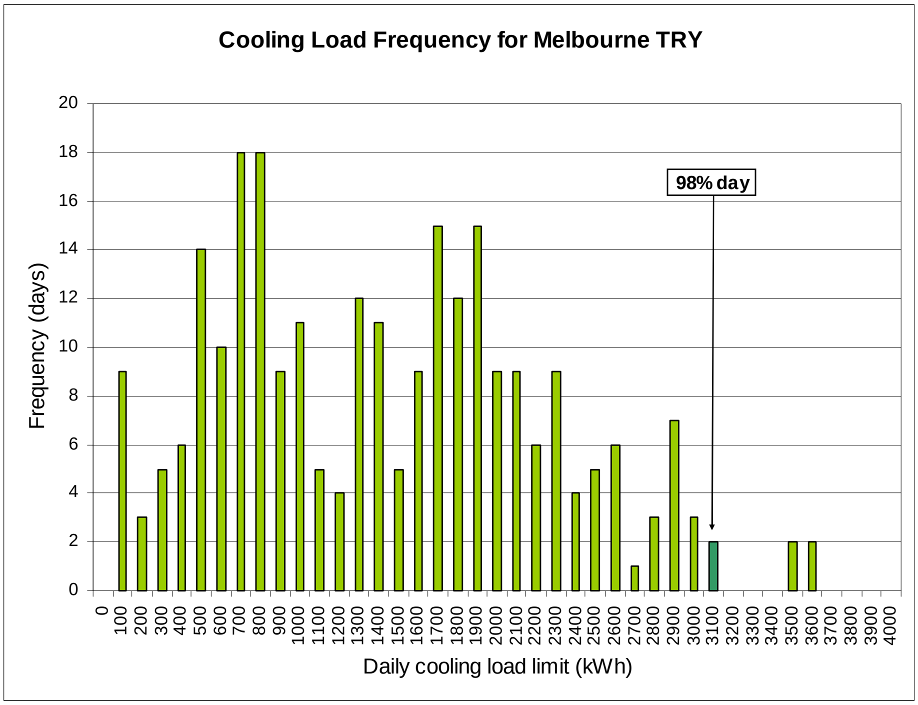

Figure 1. Test Reference Year daily cooling loads

The Test Reference Year design requirements for 98% percentile year gives us 3100 kWh cooling capacity. We can see that there are 4 days of the year where cooling requirements jump significantly.

3.2 Ten years

The results from 1971, 1973, 1976, 1978, 1980, 1982, 1983, 1985, 1986 and 1987 were collected into one graph with the following results.

We can see that for a 98% percentile year, the peak cooling load is 3100 kW which is exceeded for 41 days over these 10 years.

These identical results allow us to assume that the Test Reference Year does represent typical weather conditions and that the thermal analysis carried out using the Test Reference Year is a reliable representation of a typical year's weather in Melbourne.

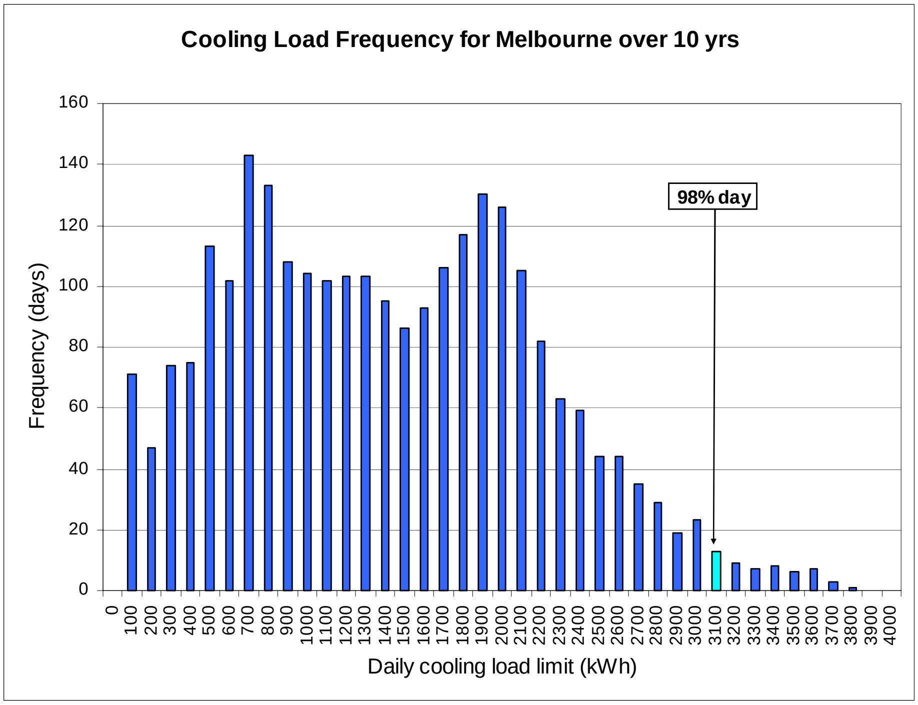

Figure 2. 10 year daily cooling loads

The following results will show the peak cooling loads for each year separately. We can see that the 98% design day is:

- 2700 kW in 1987
- 2800 kW in 1985
- 2900 kW in 1976, 1978, 1986
- 3000 kW in 1980
- 3100 kW in 1971, 1973
- 3400 kW in 1983
- 3600 kW in 1982

We can also see that in, for example 1971 there are four days where there is a large jump in the cooling load requirement. In 1973, 2 days, in 1976, 1 day, etc.

3.2.1 1971

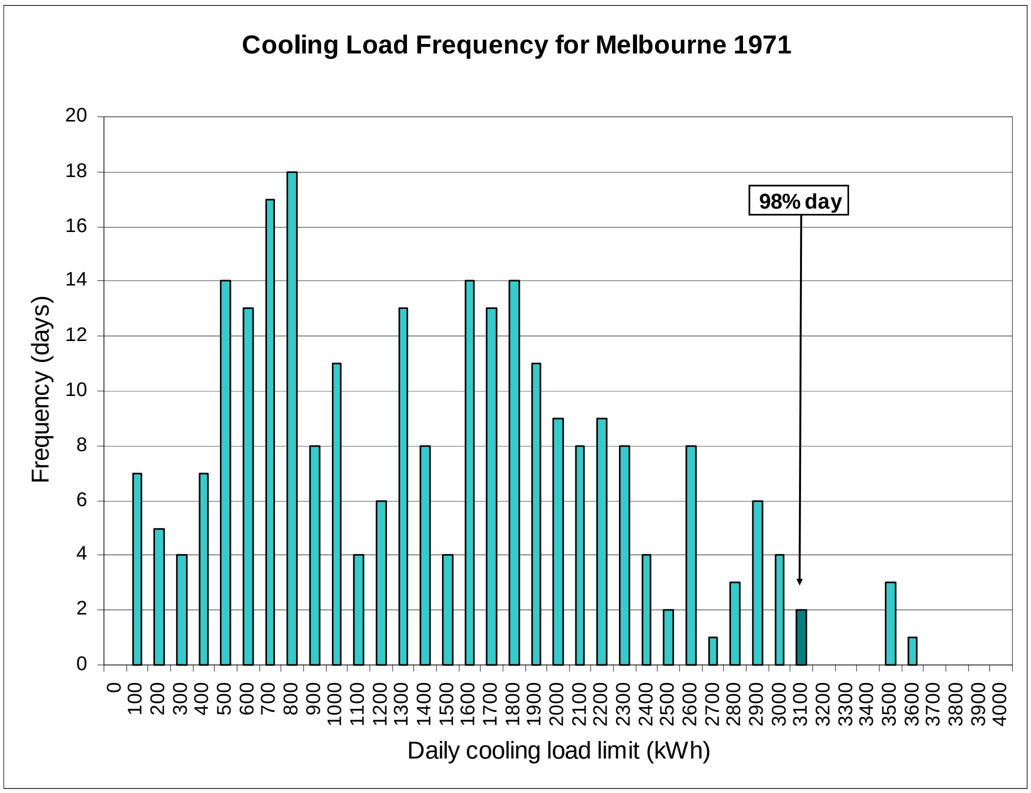

Figure 3. 1971 daily cooling loads

3.2.2 1973

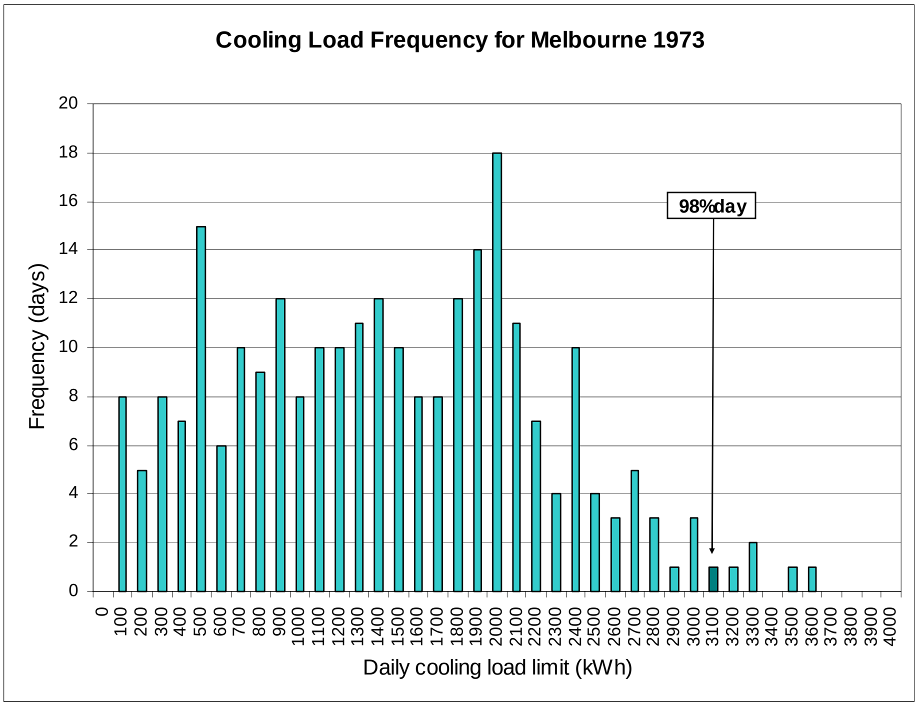

Figure 4. 1973 daily cooling loads

3.2.3 1976

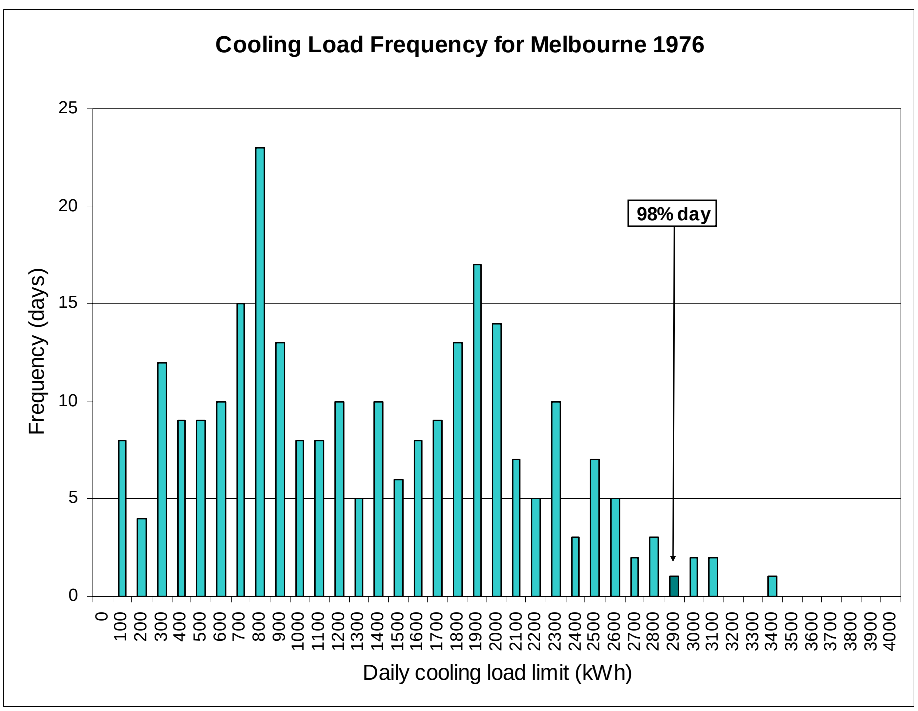

Figure 5. 1976 daily cooling loads

3.2.4 1978

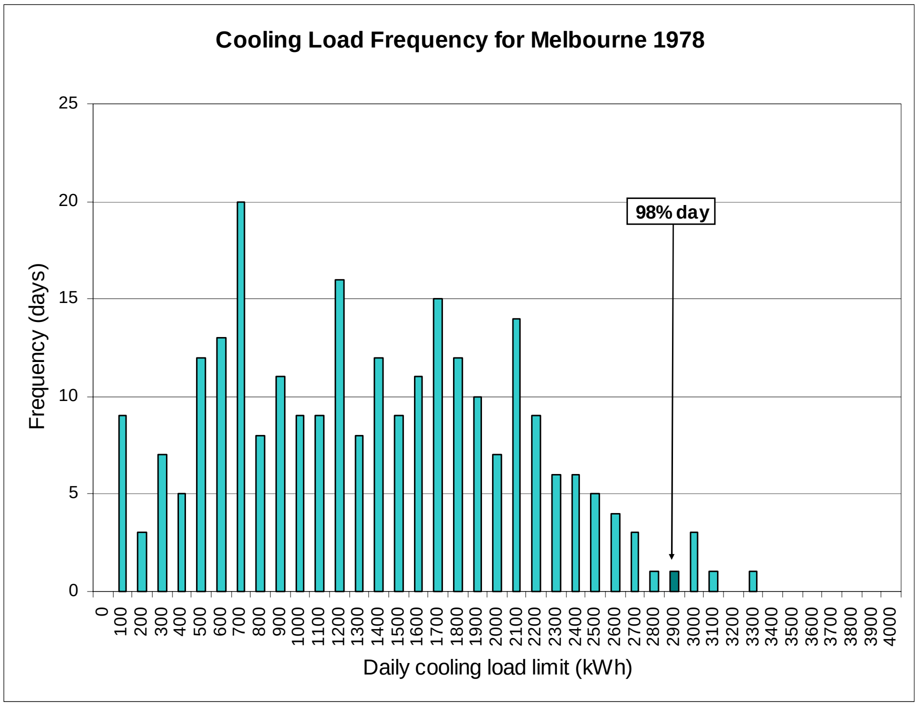

Figure 6. 1978 daily cooling loads

3.2.5 1980

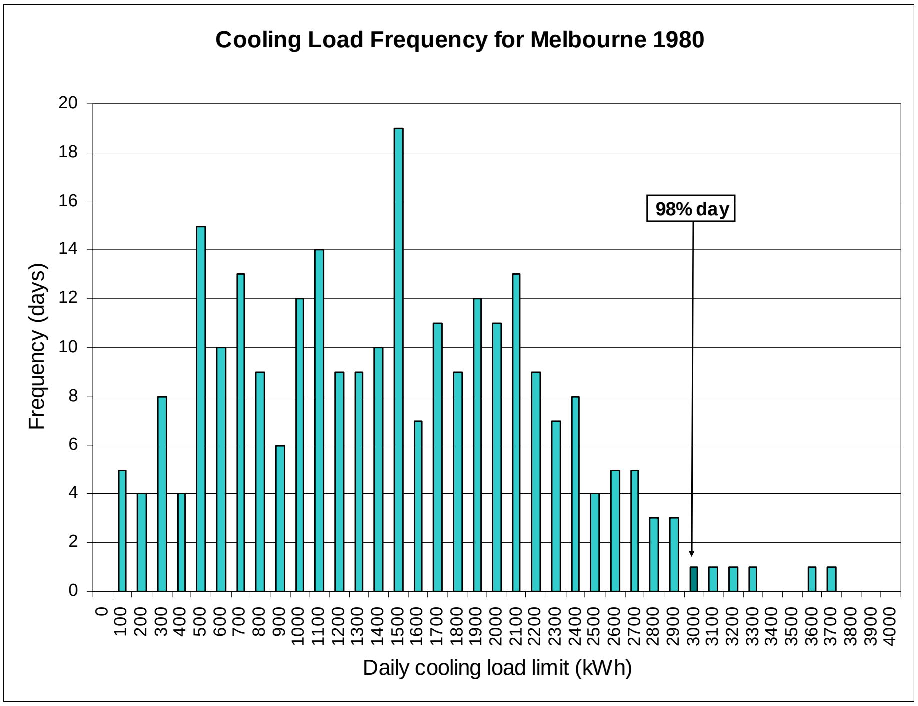

Figure 7. 1980 daily cooling loads

3.2.6 1982

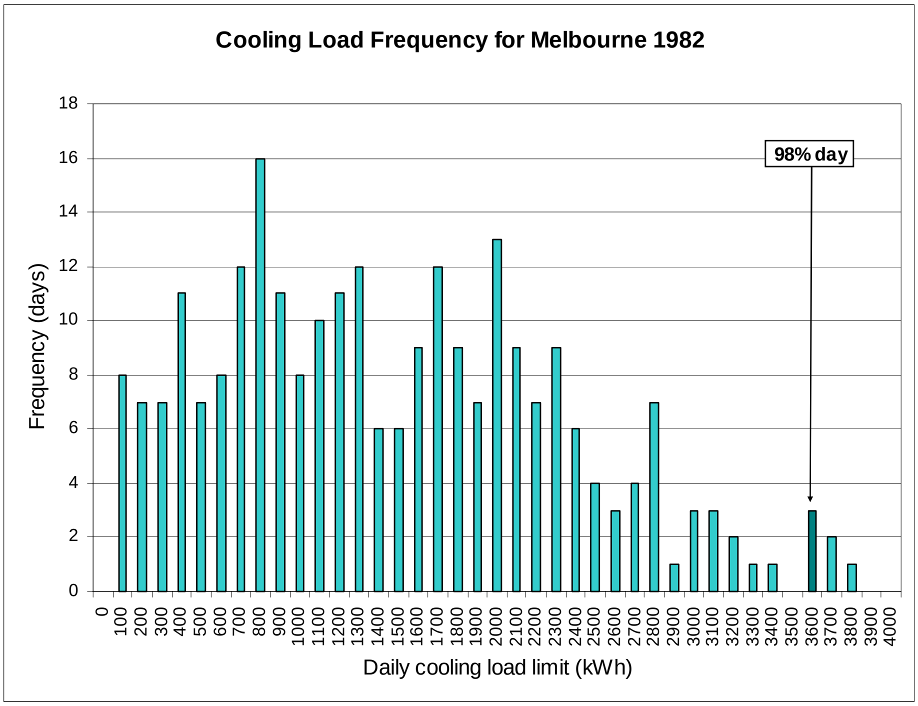

Figure 8. 1982 daily cooling loads

3.2.7 1983

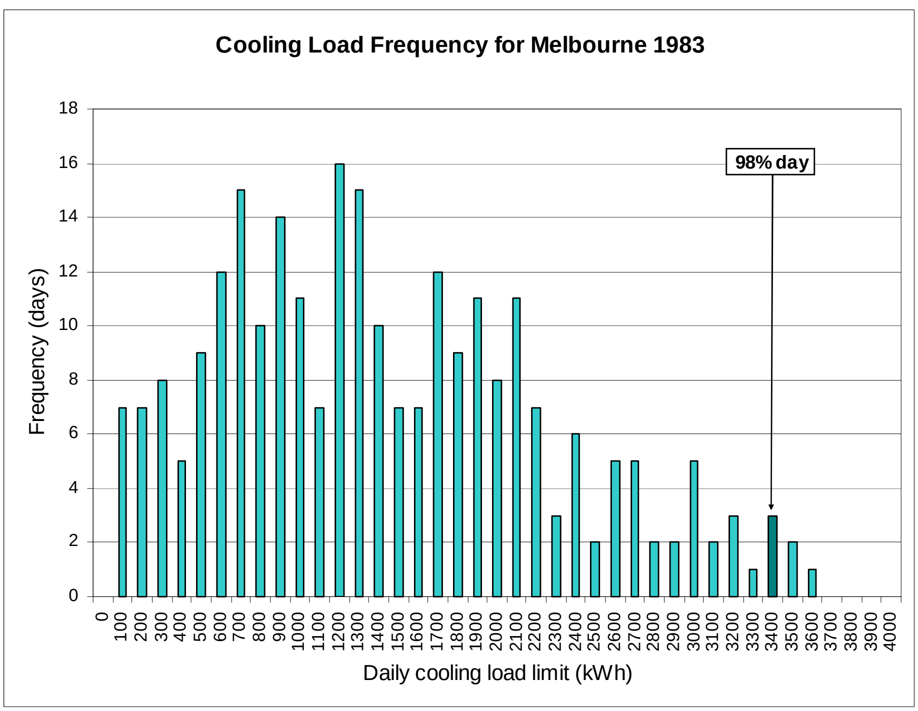

Figure 9. 1983 daily cooling loads

3.2.8 1985

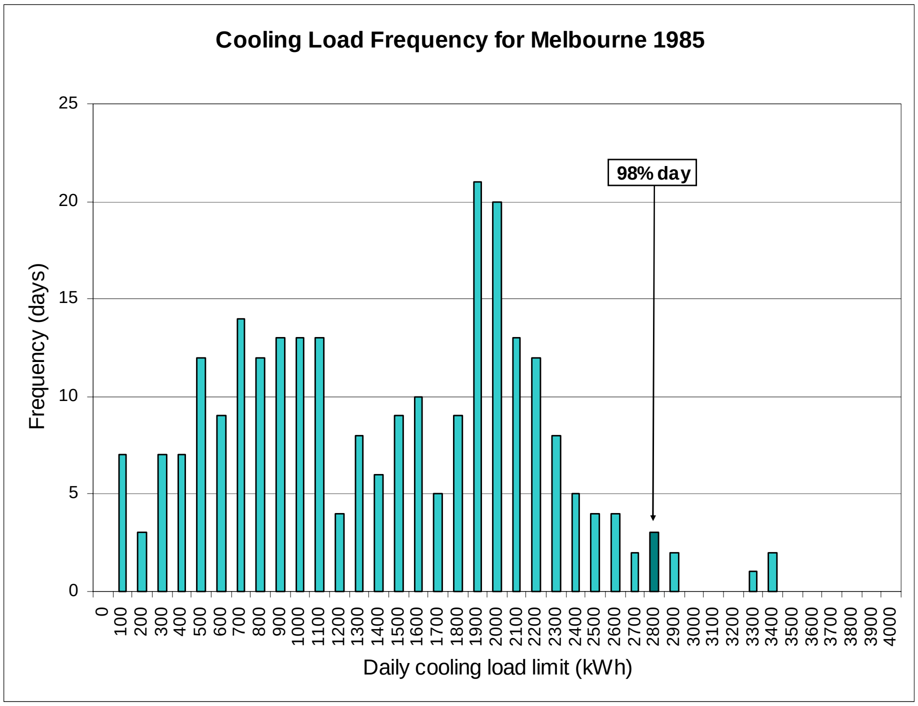

Figure 10. 1985 daily cooling loads

3.2.9 1986

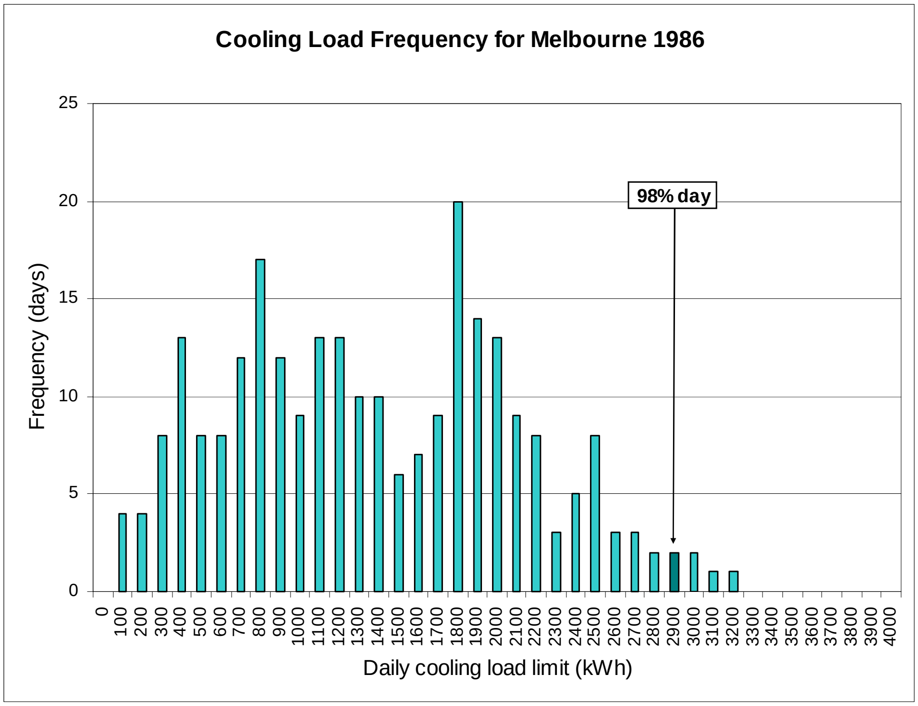

Figure 11. 1986 daily cooling loads

3.2.10 1987

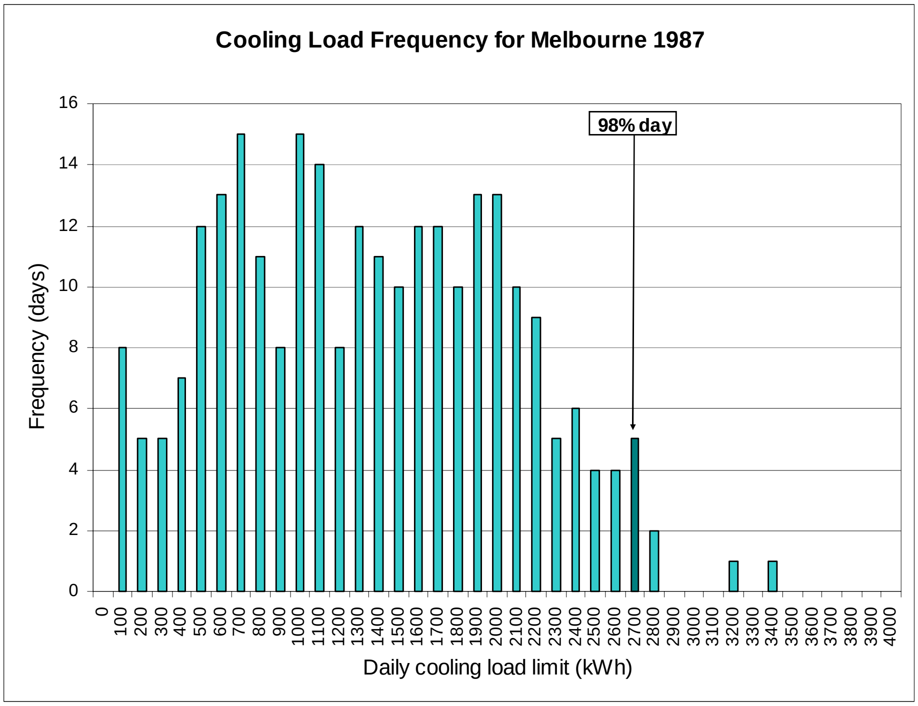

Figure 12. 1987 daily cooling loads

4 CONCLUSIONS

In carefully designing the cooling capacity of the Phase Change Material to be used in the proposed Melbourne City Council offices, it has been discovered that 3100 kW in capacity is sufficient to cope with 98% of the year's cooling requirements.

These results have also been supported by studies during 10 separate years in Melbourne which reach the same 3100kW cooling requirements for the Phase Change Material.

It does not seem feasible in both economical or design aspects to increase the Phase Change Material cooling load capacity for four days of the year as it would require an increase in building space and increases costs by around AUD$140 000.

For the remaining 2% of the year, which is approximately 4 days, it is suggested that the extra cooling load be compensated by the main chiller.

These results also show that the Test Reference Year which is used for most thermal analysis is reliable in representing a typical year's weather data.