GENERATION ADEQUACY
and
LOSS OF LOAD EXPECTATION

INTRODUCTION

Generation System Adequacy is determined as Loss of Load Expectation (LOLE) and is expressed as hours per year. This is a measure of how long, on average, the available capacity is likely to fall short of the demand. LOLE is a statistical measure of the likelihood of failure and does not quantify the extent to which supply fails to meet demand. The use of LOLE to assess Generation Adequacy is an internationally accepted practice. (With an hourly load model as used in these studies the LOLE will be equal to and is sometimes called the loss of load probability (LOLP) but this term is more properly reserved for the dimensionless probability values).

The calculated adequacy level is then compared to a standard to assess the adequacy of the system. The current standard is a value of 8 hours per year. If the LOLE is greater than 8 hours/year then the system fails to meet the adequacy standard and more plant is required. If the LOLE is less that 8 hours/year then the system is within standard. A very small LOLE value is indicative of a system with excess capacity in terms of meeting the adequacy standard.

To calculate the LOLE for a year, a computer programme evaluates the LOLE at every hour throughout the year. The LOLE for the year then is the sum of all these hourly contributions.

RESULTS

To illustrate the variation of LOLE throughout a year, three studies from the Generation Adequacy Statement 2001-2007 (issued May 2001) are presented in detail here. (These studies are described further in page 32 of that report).

	LOLE (hours per year)	**Plant (MW) Requirement** (approximate)	**Comment**
❑ Year 2003 Median Growth	9.02	20	System 'Adequate'
❑ Year 2004 Median Growth	30.05	216	Plant Required
❑ Year 2003 Low Growth	3.80	-114	Plant Surplus

The studies were selected to present a range of Generation Adequacy values. In the first, the system adequacy for 2003 is near the criterion (8 hours per year). The next study, for the year 2004, shows that due to projected growth in demand the system

requires additional plant and there is a high LOLE. Finally, in the third study, a low growth scenario from the report is selected and it shows that plant is not required to meet the criterion.

A spreadsheet is attached - a worksheet for each of the three studies - which details the LOLEs for all 168 hours for each of the 52 weeks in the year. Also listed for each of the three studies are statistics for the LOLE, listing the maximum, minimum, average and the standard deviation. Two graphs are also included to show how the LOLE may vary throughout the hours of a week. The week where the maximum of the LOLE occurs and another week in the middle of the summer season are presented.

It is to be noted that LOLE is a very volatile and non-linear parameter. Thus, the value at a peak load may be many more times the value at a minimum load. To show this graphically, a fourth worksheet shows the distribution of LOLE over all the hours in a year. These results are for the first study ; Year 2003 Median Growth. This graph is presented twice with the exact same data. The only change is that a logarithmic scale is used in the second version to make the results more visible. In the first graph it is seen that the peak value is 0.068 and that values of LOLE in excess of 0.01 occur only for a very small fraction of the 8736 hours. This is more visible in the second graph with the logarithmic scale. Here it can be more readily seen that for less than 100 of the 8736 hours that the LOLE exceeds 0.01. This shows how the yearly LOLE (total of 9.02 hours/year) is really accrued over a small percentage of the total time.

The attached embedded excel file '***LOLEs from GAS Report.xls'*** contains the following 4 worksheets;

Worksheet	**Contents**
2003 Median Growth	LOLEs for 168 hours for each of 52 weeks
2004 Median Growth	LOLEs for 168 hours for each of 52 weeks
2003 Low Growth	LOLEs for 168 hours for each of 52 weeks
2003 Median Growth LOLE vs Time	LOLEs for 2003 (Median Growth) over all hours

DATA

The data behind these studies was that used in the Generation Adequacy Statement (GAS). It was collected at the start of 2001. The estimation of future electricity demand is based largely on the general growth in the economy. Since the GAS report was prepared there has been a significant revision in the broad economic outlook. This will affect the projection of electrical demand. For example, at the time, there was considerable optimism about the rapidly developing telecommunication and e-commerce industry and various parties had projected the arrival of significant amounts of Internet Data Centres which have a very high electrical demand.

The availability data for generation plant in these three studies was as for the median case in the GAS report. That data too will have to be revised. Finally, any changes to the amount of new Small Scale Generation assumed in the GAS report and the

possibility of any closures of existing plant would impact on the expected adequacy results.

CONCLUSION

While the data and the scenarios in the GAS report need revision, the studies here demonstrate the variation of LOLE through a year. It is particularly to be noted that the LOLE is very non-linear. This means that most of the 'failures' occur at the time of the peak loads. Values of LOLE at off-peak times may be considerably less than at peaks. This is a broad generalisation and the impact of plant maintenance has to be considered also. The computer programme does take all these factors into account. The predicted values of adequacy for the next seven years will be revised in a forthcoming Generation Adequacy Statement.

"LOLEs from GAS report.xls"