

# A COMMENT ON ELECTRICAL POWER DISRUPTIONS

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## INTRODUCTION

In most tea processing factories machinery are run by electricity from the National Grid. Some small factories particularly in remote areas, are equipped with slow speed diesel powered engines and alternators or, more often, a network of line shafts for direct driving of equipment. A few factories are also equipped with more modern high speed diesel powered generators. These are mostly used as "stand-by" generators, in the event of disruptions to power. A very small number of factories are equipped with generators driven by minihydro power. However the Ceylon Electricity Board (CEB), remains the major supplier of electrical power to tea processing factories. It is estimated that over 95% of the tea production depends on electricity supplied by the CEB.

All consumers of electricity from the National Grid, including those in the tea processing sector, rely on the CEB for a continuous supply of electrical power. There are two aspects to reliability. Firstly, electricity must have the standard voltage, 230 volts - single phase or 400 volts - three phase and standard frequency 50 Hertz, with least fluctuations. These are achieved by sophisticated control equipment. The second aspect of reliability is the availability of electricity when required by the consumer. The consumer expects the supply to be available 24 hours of the day, every day of the year, with no disruptions whatsoever. All aspects of electrical supply namely, planning, generation, control, management, distribution, etc are geared towards ensuring this reliability. However, sometimes, disruptions to power occur due to factors beyond the control of the CEB.

While the consumers must learn to appreciate the need for these power cuts, the authorities concerned should be aware of the degree of inconvenience caused to the consumer as well as the effectiveness of power cuts.

### **Types of Power disruptions**

Electrical power disruption faced by consumers, including tea processing sector, can be generally categorised into three groups:

- a) Planned power cuts due to inadequacy of generating capability to meet the supply. The limiting factor in this instance is the maximum generated power, Mega Watts (MW). These power cuts were common particularly during the late seventies and early eighties. This was due to the sudden increase in demand for electrical power by new industries as well as due to an increase in demand in the domestic sector. However, the available generating capability was insufficient to cope with this demand, particularly to deal with the peak demand during early evening hours, i.e. from 6 to 9 p.m. Sudden breakdown of electrical power plants has also been a cause for this short supply of power. When such situations occur all consumer sectors are requested to minimise consumption during peak demand hours. When the expected reduction in demand is not achieved, the CEB has no option but to enforce a power cut. All consumer sectors are made to bear the inconvenience on a rotational basis while available generating capacity is used to the maximum. The objective of these power cuts is to keep the maximum demand (MW) within the total available supply. In these instances energy (MWhr) is not necessarily a limiting factor.

- b) Planned power cuts due to inadequacy of available energy. Water stored in hydro reservoirs can be accounted in terms of units of energy (Mega Watt Hours (MWhr)), that it is capable of generating. The limiting factor in this instance is that level of MWhr in store. The water stored in the hydro reservoirs may be adequate to meet an unrestricted demand for a few weeks. However, when it becomes apparent that such an unrestricted supply cannot be sustained over the months to come, the CEB has no option but to enforce power cuts of this nature. Power cuts of this nature were enforced during 1983 and in the second half of 1987. Available thermal power generators were run to their maximum capacity and a degree of restraint was exercised in the use of water from hydro reservoirs. In this situation, the unit cost of electricity at the point of generation increases and this is recovered, at least in part, by a "fuel adjustment charge". Probable inflow to and evaporation from hydro reservoirs and many other technical as well as social and economic factors are considered by the CEB in scheduling these power cuts. The ultimate objective is to reduce the consumption of energy (MWhr), thereby save water and ensure some degree of reliability in the long term. Available total generator capacity (MW), hydro and thermal power, is not necessarily a limiting factor in this instance.

- c) **Unscheduled power cuts, usually due to localised problems in supply. These are disruptions not only in the power supply but also to scheduled activities of the consumer. As far as industrial consumer sector is concerned these power failures are most undesirable as they result in considerable loss of revenue. Both the CEB as well as the consumer would like to see a supply without disruptions of this category.**

### **Electrical power requirement**

Tea processing factories need electrical power for two purposes. Firstly to provide motive power, i.e. to drive motors, and secondly to provide lighting for the factory and its surroundings. Forty to fifty years ago most tea factories have been equipped with mini hydro plants and/or slow speed diesel powered engines. Often power had been transmitted to processing equipment through line shafts. Further, in most factories engines have been connected to small alternators for obtaining electricity mainly for lighting. Today only a handful of factories, and that too only those with a very small annual production capacity, are equipped with the above system. Complete electrification of factory equipment and obtaining connections to the National Electricity Grid had been priority items in most modernisation programmes of tea factories. It is estimated that currently at least 95% of the tea production depends on the National Grid.

Electrical power requirement, i.e. the KVA demand, as well as the energy requirement, i.e. the KWhr units, depends on the production level of the factory. Billing is done monthly, based on the actual units (KWhr) consumed and the maximum KVA demand. The maximum KVA demand is the maximum power consumed over any duration of 15 minutes during that month. Typically, the maximum KVA demand is in the range of 60-180 KVA depending on the size of the factory and the daily production level. An average size factory with an annual production capacity of 400,000 kg made tea will have a maximum demand of about 110-120 KVA during an average cropping month.

The units of electricity consumed in tea processing is estimated to be about 0.90-1.00 KWhr/kg made tea. If we take 1986 as an example:

$$\begin{aligned}
 \text{Total tea production} &= 211.3 \times 10^6 \text{ kgMT} \\
 \text{Electricity consumption in} \\
 \text{tea factories} &= 211.3 \times 10^6 \times 0.9 \times \frac{95}{100} \\
 &\quad \text{KWhr} \\
 \text{Total generated electricity} &= 2652.8 \times 10^6 \text{ KWhr} \\
 \text{Percentage consumed in} \\
 \text{tea factories} &= \frac{211.3 \times 10^6 \times 0.9 \times 95 \times 100}{2652.8 \times 10^6 \times 100} \\
 &= 6.81
 \end{aligned}$$

Tea processing sector thus consumes about 7% of the total energy generated by the CEB. In comparison, in 1986, the industrial sector as a whole had consumed 41.5% of the total generated energy. Thus the tea processing sector can be considered a major industrial sector consumer of electricity (Review, Central Bank, 1986). Out of the consumption of 0.90-1.00 KWhr/kg made tea, about 50% is spent on driving withering fans, about 40% on rolling and dryer room machinery and less than 10% on grading equipment, other miscellaneous equipment and lighting.

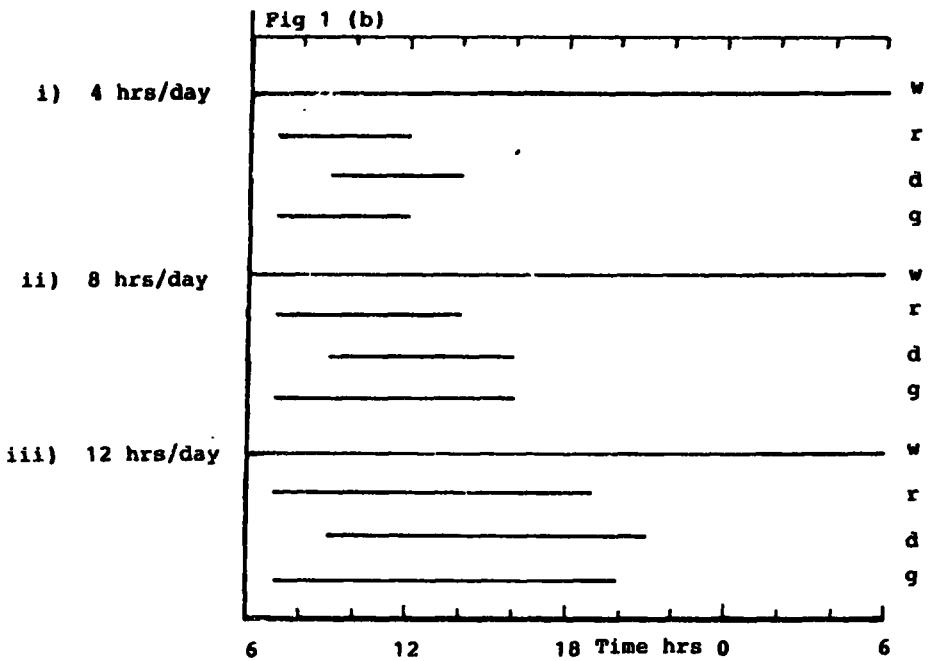
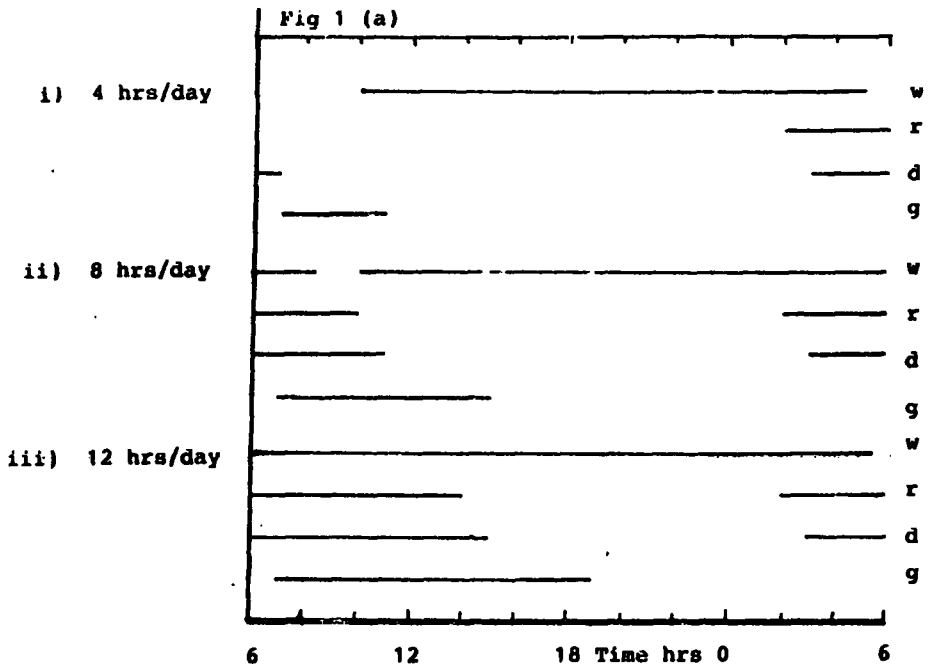
### Electrical Power Usage

All stages of tea processing require electrical power. Durations of each processing stage depends on the quantity of tea processed in relation to availability of machinery in the factory. Due to considerable variation in daily quantity of harvest, even in well developed tea factories the duration of different stages of processing vary quite significantly. Factories are developed to complete its drying operation in 7-8 hours when handling average daily crops. Due to natural variation in daily crop, drying may be completed in

4 hours or even less per day during lean cropping periods and as much as 16 hours per day during rush cropping periods. The duration of the leaf withering stage which is usually about 16 hours can also vary somewhat. For example during dry months of the year, the atmosphere being dry and leaf being already part withered at the time of receipt in the factory, the withering period can be as low as 6-8 hours. On the other hand during wet periods the duration can extend upto 24 hours. Electrical power usage too vary according to those factors mentioned above. This is also illustrated in the time schedule given in Fig. 1 (a) and (b) for a typical Up/Mid Country and a Low Country factory respectively. For each situation, schedules for three cropping levels, namely, low crop - 4 hrs/day, average crop - 8 hrs/day and rush crop - 12 hrs/day have been given.

### Power Disruption during Processing

Most tea factories are equipped with withering troughs where about one foot thick layer of green leaf is exposed to a flow of air. The rate of loss of moisture from leaf in a trough is almost proportional to the flow rate of air. Therefore, during a power disruption, when the flow stops, evaporation of moisture too reduces to a negligible level. Thus when the power is resumed either the withering period has to be extended almost to compensate for the lost time, or accelerated by artificially increasing the hydrometric difference of air which is achieved by mixing warm air from an air heater. This is an additional cost on energy. The option of extending the withering period may also have limitations based on other considerations in tea processing. The duration of the power disruption is also very important. Longer the duration there is a higher risk of leaf spoilage because of increase in leaf temperature and lack of aeration. It had been found that the rate of spoilage of leaf at 25°C is 2.48% per hour, which increases to 5.02% per hour at 30°C, and 9.06% per hour at 35°C and so on. Ref.(2). Since



**Fig. 1. Typical working schedules of tea factories**

a) Up and Mid Country

b) Low Country

w=Withering, r=Rolling, d=Drying, g=Grading

withering operation lasts 16 hours or sometimes up to 24 hours any planned power disruption must include this period of the process. If the duration of power disruption is short, say less than 2 hours, harmful effects are relatively small. Any extension of the duration of the disruption can however lead to considerable loss of value of the produce.

The withering stage is followed by rolling room operations and then by dryer room operations. These are the most important stages in tea processing particularly in respect of timing and organization. Any disruption to continuity of operations during these stages can be quite costly. For example, if a power disruption were to occur while rolling or drying work is in progress the leaf mass being handled is very likely to receive undue fermentation. If the duration of the disruption is less than 15 minutes the effects can be only marginal whereas any disruption lasting a longer duration can lead to easily recognisable adverse character in made teas. This is particularly so in Up/Mid country teas. The loss in value and hence the revenue to the estate as well as to the country can, in these circumstances, be quite significant. Thus any planned power disruptions must exclude periods where these stages in processing are likely to be in progress. If known in advance, work in the factories can be re-scheduled in order to avoid disruptions during these stages in processing.

During the grading stage in processing the effect of power disruptions is quite minimal. Other than the inconvenience caused there is no particular adverse effect that cannot be minimised.

### **Scheduling of power disruptions**

The necessity for planned power disruptions during certain periods in some years have been established. It is also considered that as far as industries are concerned the scheduling of power disruptions is done in order to minimise its adverse effects. As far as the

tea industry is concerned, it is considered without any reservation that the power disruption will not result in a situation where the producer is forced to limit the production capacity. Therefore scheduled power disruptions will always lead to re-scheduling of factory operations to minimise any adverse effects.

If the planned power disruption is for the purpose of limiting peak load power i.e. from 1800 hours to 2100 hours, then in almost all tea factories, except when the crop harvested is at its peak, withering of leaf is the only scheduled process that will get affected. This is seen in Fig. 1 (a) and (b). The duration of such power disruptions should preferably be limited to say, two hours at a stretch, so as to minimise any heat build up and resulting spoilage of withering leaf. Thus the object of the disruption can be achieved with least loss of revenue to the consumer. On the other hand, if the power disruption is for the purpose of reducing energy consumption, then the scheduling is not straightforward. It can be seen in Fig. 1 (a) and (b) that processes such as rolling, drying and grading take only a few hours of the day. Therefore these processes can be re-scheduled if necessary. Withering process too can cope with a power disruption particularly if the duration is not unduly long. The schedule of planned power disruption during October 1987, given in Table 1, shows that the authorities concerned have made an attempt to schedule the power disruptions to coincide with the "non-manufacture" time of the day. The objective of the power cut, namely saving of energy, is however not realised because of re-scheduling of processes and consumption of more or less the same quantity of energy for performing that much of work.

**TABLE 1 - Schedule of Power Cuts in  
major Tea Growing Areas (October 1987)**

Area	Hour	
	From	To
Galle	0800	1130
Avissawella	0900	1230
Nuwara Eliya	1430	1800
Deniyaya	1430	1800
Balangoda	1430	1800
Ukuwela	1430	1800
Norton Bridge	1430	1800
Badulla	1430	1800
Eriyagama	0600	0930
Matugama	0830	1200

Thus the saving achieved from tea processing factories by enforcing a power disruption during day time is likely to be quite negligible. In most tea growing districts, tea factories are the major consumers of energy. Further, the saving of energy from the domestic sector by imposing a power cut during a period such as 1430 hours to 1800 hours also must be negligible. Total saving of energy accrued by enforcement of a power cut in tea growing districts as done in October 1987 is therefore likely to be very small. Thus the object of the planned power disruption is not achieved in practice and on the other hand it has been an inconvenience to tea factory operations.

Only a few tea factories have adequate standby minihydro power or standby diesel fuelled generator power. Only those factories with such standby power can carry on with processing without disruption. Also they alone are in a position to reduce the consumption of energy during times of National Grid crisis.

There are many similar industrial processes with inherent slack time where re-scheduling of operations is possible. Unless a reduction in the production level is agreed upon or forced on the industries concerned, no significant saving of energy can be expected from enforcement of a power disruption on them.

### CONCLUSION

When the problem is the reduction of peak demand, the CEB can enforce a power disruption during peak hours and effectively achieve the desired objective. On the other hand, when the problem is the reduction of energy consumption, as far as energy consumed by tea processing sector (and by many other industries) is concerned, a power disruption does not achieve the objective, because,

- i) no reduction in tea production is considered, and
- ii) only a handful of factories are equipped with standby generator facilities.

It is therefore suggested that a re-evaluation of the effectiveness of power cuts, is necessary.

If maintaining the level of tea production is a pre-requisite, then the only way to reduce the consumption of electrical energy generated from hydro power is to increase the consumption of electricity generated from non-hydro power. This can be achieved

- i) by equipping more factories with standby diesel fuelled generators, or
- ii) by increasing the non-hydro power generation capability of the CEB.

In a broader sense both options are the same as they involve new capital equipment and increased use of imported costly sources of fuel. Both options ultimately lead to rise in cost of electric power to the consumer.

### BIBLIOGRAPHY

1. Review of the Economy, Central Bank of Sri Lanka (1986).
2. Report of the Technology Division. Annual Report of the Tea Research Institute of Sri Lanka (1982) p 78-79.