Journal of Power Sources, *28* (1989) 201 - 205

LEAD/ACID STATIONARY BATTERIES FOR POWER SECTOR IN INDIA

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Introduction

Lead/acid storage batteries are used for a variety of stationary applications. As in the case of portable service, the range of uses has increased year by year and the pattern of applications has also changed significantly. One long-dated service has been the supply of standby power in power stations. This involves supplying fairly heavy loads for short periods, in the event of a power failure. In recent years, the pattern of service has changed from a deep cycling regime to switch operation and other ancillary services. Stationary batteries also supply emergency lighting in public buildings of all types (*e.g.*, theatres, cinemas, hospitals) and power for telephone exchanges. Storage batteries are also in competition with other systems to store off-peak base-load energy for delivery during peak demand periods (load levelling) and to provide uninterruptible power supplies (UPS) to ensure absolute continuity of operation of computerised control systems.

When a storage battery is used as a stationary battery in a power station or a sub-station, during most of the time it does not deliver energy continuously but remains in readiness to be used on demand. In other words, the stationary battery in power stations and sub-stations is a standby power source. It can be said that during normal periods a stationary battery is in a state of 'passiveness', becoming active in emergency conditions. It is this aspect of the stationary battery that causes most users to be less concerned about its correct selection and maintenance after installation. Nevertheless, the selection and maintenance of stationary batteries should be a matter of very great importance since battery failure could lead to grave consequences. Since protection of power station equipment is dependent on the stationary battery, it assumes higher dimensions of importance than a battery used in other applications.

Selecting the correct size

Many factors have to be considered before deciding upon the capacity of the battery as well as upon the voltage system. The following details need to be made available by the user so as to arrive at the correct capacity required:

0378-7753/89/$3.50

(i) voltage system

(ii) maximum permissible upper limit of the voltage and power acceptable to the system

(iii) details of various momentary loads with their duration and frequency

(iv) details of constant load with duration

(v) the maximum and minimum ambient temperatures at the site where the battery is to be installed.

(vi) the size and location of the battery room.

Once the above details are available, the battery capacity can be calculated and, after applying the temperature correction factor and ageing factor, the final capacity of the battery bank can be determined.

Temperature correction factor

This is generally taken as 1% decrease in performance with 1 °C decrease in temperature, taking the ambient at 27 °C. If the ambient temperature is 15 °C, which is 12° lower than 27 °C, the calculated capacity should be increased by 12%.

Ageing factor

Since the battery is supposed to meet the duty cycle even on the last day of its service, and since the end-of-life is taken as 80% (point of reaching its rated capacity), it is required to introduce an ageing factor while arriving at the battery capacity. The ageing factor thus becomes 1.25.

Maintenance

Selection of the correct battery also demands a knowledge of a few of the maintenance aspects that are relevant to the battery and the charging equipment, such as: (a) 'floating' the batteries; (b) adjusting charger current to battery; (c) effect of floating battery at higher than optimum voltage; (d) need to stabilise d.c. output of float charger; (e) the importance of maintaining good ventilation in the battery room.

Other features of battery selection

Since protection is the sole reason for the provision of a stationary battery, no chances are taken about ensuring its health. One of the chief contributors to the battery health is the battery charging equipment. Despite taking extreme care in the selection and design of batteries, a battery charging equipment that is not selected optimally can easily ruin the battery and also undermine the protection of the power station. Attention to the charging procedure ensures battery health and enhances the protection of the station. The importance, therefore, of a properly designed charging system needs hardly to be emphasised. Control and monitoring instrumentation relating to battery charging equipment, as well as attention to the care and maintenance of a stationary battery, are equally important for trouble-free operation and a reliable system.

In a situation where catastrophic system failure could result in substantial financial loss, sole reliance on a single source of power would be detrimental to the system's reliability. Apart from the possibility of random power cuts, the consumer mains supply is often vulnerable to unauthorised tampering and interruption. In such circumstances, standby power may become a mandatory requirement in order to maintain a high degree of confidence from the users. Finally, there are safety considerations with respect to protection of the electrical components that are energised by the battery as well as protection of the battery pack itself. There are essentially three aspects of safety that must be considered in the design of the battery pack, *viz.*, (i) spark ignition, (ii) hot surface ignition, and (iii) production of inflammable gas.

Production figures and demand projection

The current annual production of lead/acid batteries in the organised sector is 20 lakh nos. The production of industrial batteries from the organised sector (30% of the above figure) is 6.67 lakh nos. The share of stationary batteries among all types of industrial batteries is 25% or 1.67 lakh nos. Taking into account the production of stationary cells and batteries from medium and small sectors, the current total production will satisfy the present demand (see Table 1). Batteries of size 20, 40, 60, 80, 120 A h are used for small exchanges while batteries of 200, 300, 400, 600, 800, 1000, 2000, 5000 A h are employed in the power sector.

TABLE 1

Estimated demand of stationary cells in India (in 000s)[a]

Year	Demand
1988-89	206
1989-90	230
1990-91	258
1991-92	289

[a]Figures correspond to an estimated increase in demand of 12% per year. The standard unit is taken as 2 V, 300 A h.

Electric utilities

Power generation in the Seventh (five-year) Plan period (1985 - 90)

The total power generation is estimated to be 66 100 MW during 1985 - 90 by the three conventional modes, *viz.*, hydro-, thermal and nuclear (see Table 2). The number of power generating stations and plans for expansion are given in Table 3.

TABLE 2

Power generation (MW)

Type	Installed capacity	Target (1990)
Hydro	16189	20000
Thermal	32276	44293
Nuclear	1330	1800
Total	49795	66093

TABLE 3

Population of power generation stations (1985 - 86) and plan for addition

Range (MW)	1985 - 86	1990 - 91
500	14	20
200 - 500	50	85
100 - 200	100	110
50 - 100	100	110
<50	50	120

Hydro and thermal power projects in the Eighth (1990 - 95) and Ninth (1995 - 2000) Plan periods

The setting up of an aggregate generating capacity of 6000 MW is proposed with the assistance of the Soviet Union. This capacity includes both hydro and thermal modes of power generation. Of this, 4500 MW is envisaged to be commissioned by March 1995 (the end of the Eighth Plan period) and the balance in the Ninth Plan period. Initial work which would yield benefits in the Eighth Plan period will commence by March 1990.

On-going projects include the Tehri hydro-power complex and Super-thermal power stations at Vindhyachal in Madhya Pradesh (6 × 210 MW) and Kahalgaon in Bihar (4 × 210 MW). Second and third units of 210 MW each in the Vindhyachal project are scheduled for completion in 1989. The first unit has already been coomissioned. Stage II (2 × 500 MW) of this power project is likely to be taken up with super critical parameters. The first unit at Kahalgaon is to be commissioned in 1990-91.

Nuclear power expansion programme

The nuclear power generation capacity proposed by the Nuclear Power Corporation under the Department of Atomic Energy is 10 000 MW by the year 2000.

Battery needs of power stations

On an average, each power station will have a 220 V battery bank for each generator set as well as one 240 or 360 V battery for UPS facilities. This is the new trend over the last 7 or 8 years. Each generator will also have one 48 V battery for a control circuit.

Battery capacity will be based on generator capacity, *e.g.*, a 210 MW thermal unit will have a 500 A h battery, a 500 MW will have 2500 to 3000 A h, and hydro will have 300 to 350 A h battery sets. The battery requirements of sub-stations and the UPS and power sectors at large are given in Tables 4 and 5, respectively.

TABLE 4

Sub-station requirements targetted during the period 1985 - 90

Range (kV)	Nos.
400	49
220	135
132	1000
66	900

TABLE 5

Estimated demand for stationary cells for power sector and UPS (in 000s)[a]

Year	1988	1989	1990	1995
Power	76.4	82.8	89.8	145
UPS	33.1	33.1	38.6	65

[a]Figures correspond to an estimated increase in demand of 12% per year. The standard unit is taken as 2 V, 300 A h.

Conclusions

From the foregoing, it can be seen that at present the power sector alone accounts for 37% while the power and UPS sectors together take a share of 53.5% of the total stationary battery production. The remaining 46.5% is used for photovoltaic systems, telecommunications and a host of other miscellaneous applications.