ERGONOMIC FACTORS AT SECWA

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Ergonomics

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1. Introduction

The old SECWA power station operated from 1948 to 1972. It required 55 men and generated 55 megawatts. Economically, the system was inefficient when compared with the Kwinana power station which used the same man power to produce 900 megawatts. Because of the plant's age, inefficiency and cost, it was replaced by the current system. This paper reviews human factors associated with the operation of the current system including stress associated with estimating electricity demand, use of displays, and controls, communications and safety.

2. Determining Electrical Demand

Any job requiring accurate estimation of a numerical quantity based on changing variables increases mental workload and imposes stress. The function of the operators in the SECWA operation in East Perth is to estimate the electrical need of the metropolitan region and to ensure that this demand is met. This is done by notifying the supporting power stations such as the Kwinana power station. This station operates efficient gas turbines which require six to eight hours to warm up and come on line. Consequently, electrical demand is estimated in advance for each day, using data from similar days or from the previous year with a ten percent loading factor added.

Demand is determined by the time of day, day of the week and the month of the year. Peak periods are from 6 to 8 am and 5.30 to 8.30 pm. In summer the peak period is the hottest time of day, around 2 pm before the sea breeze. The estimation process includes factors related to demand such as the temperature and weather forecast. Gauges of temperatures, graphs, and historical data assist the operators. Nevertheless, unseasonable very hot or cold weather arriving unexpectedly may change demand due to heating or air conditioning consumption of power. Inaccurate estimation may lead to a shortage of power or uneconomical excess production of power. A sophisticated mathematical model incorporating additional factors for estimating power demand would shed some of the guesswork and mental workload for the operators.

3. Problem Diagnosis

Problems in power management encountered by SECWA include power poles being shorted due to falling trees, or cars knocking down poles. There may be mechanical breakdown of the turbines. The function of the East Perth station is to monitor the power grid, diagnose faults quickly, and to take action to rectify the faults by isolating problem areas. The size and complexity of the grid makes the task challenging.

The power station controller is operated by two men who ensure an adequate supply of power for the grid. They work 12 hour shifts, either from 7 am to 7 pm or 7 pm to 7 am. Two nights are worked consecutively. At nights, unless a storm is occurring, there may be long quiet periods. During this time the controllers may rest or use the exercise bike to reduce stress and maintain alertness. Alertness is most required at the beginning and end of shifts. The boredom associated with reduced arousal during long shifts and the effects of being awakened from a sleep may tend to mitigate against rapid diagnosis of faults during periods of stress.

A twelve hour break occurs between nights and days, followed by two days of work. Twelve hours is a minimal period to allow sleep patterns to readjust. Men coming onto day shift may be fatigued and are more likely to commit errors.

A five day break separates each four day cycle. This break is sufficiently long for a rest, but may allow the controllers to reduce their expectations about the probability of unexpected events.

The job requires substantial training to work out a number of time factors including minimum and maximum capacities twelve hours in advance and the length of time since previous turbine runs to determine warm up. Eventual addition of turbines with a shorter warm up period may assist to overcome stress associated with the estimation game.

Isolation of controllers in the power station is reduced and training facilitated through sending controllers to work in other power stations in WA. This exchange process is sound from a human factors point of view. This process reduces boredom and broadens skills. It broadens familiarity of the network, the machines and procedures. By fostering communication it permits the creation of a pool of trained operators who may fit into other power stations should the need arise.

4. Control Room Displays and Controls

The operators are seated at ergonomically designed semi-circular desks, nearly Y shaped to permit optimal work surface and reach. Two monitors, one large for the electrical network, and one small to monitor gas are mounted on each desk. Communication between shifts is by log book, kept continuously to note ongoing events, and by notes on the computer. The proximity of the two operators permit them to talk to each other to share information and stay alert. Communications with other power stations is by telephone and fax.

Display panels on the walls provide some information on the power stations while other information is found on the computer. The computer is currently overloaded and must be supplemented by the wall displays. The displays are protected from power failure by battery for six to eight hours, then by diesel generators on the site.

Attention is maintained for crucial events such as the entry or exit of turbines on or off line by provision of warning buzzers and alarms. Buzzers are ideal devices for demanding attention and immediate remedial action, provided excessive use is not made of the device.

Critical controls such as circuit breakers are colour coded and show green if open and red when closed. The location of the switch parallel with the circuit when closed and at right angles when open provides a secondary indicator. To change a breaker, the computer cursor is moved to a breaker on the screen, and the execute command is used to change status. This process is quicker than manually pulling heavy switches.

The whole power grid is available on the VDU but only a small section can be seen at once. Included are the 330 megawatt Kwinana grid and 220 megawatt Muja grid. The power produced is shown on a paper graph and electronic 'clock' clearly visible to the chief operator. Operators must be able to accurately select the needed displays when they are needed. Training and practice is needed to develop proficiency in the use of the computer programme. The computer is slow to respond, causing delays in diagnoses and response.

Computer displays are supplemented by wall displays. There are some problems with the displays. Wall panels require selective attention, exercised by scanning gauges in addition to the VDU. Selective attention is enhanced when displays are reduced in number and placed side by side. The number of displays would make the task of locating a single flashing warning light difficult especially since most of the walls are covered with panels. Constant scanning of the meters is needed to ascertain the levels of current flowing through various lines. Such scanning may prevent focussed attention. Without intensive training, the amount of displays could lead to information overload and delays in diagnosing problems.

5. Safety Factors

Safety from electrical shock is obtained in a variety of ways. A document must be completed to explain the equipment area being repaired, and date and time started and finished. The equipment is marked off with bunting on site. A special key is retained in a locked cupboard and written permission must be obtained to get the key to operate controls. Tags are also placed on the isolated terminals at the control to prevent inadvertent use.

6. Job Selection and Training

Selection and training as controllers is demanding, requiring a trade background in power station and power transmission. A TAFE diploma is needed rather than a power engineering degree. This decision is wise since the type of job would not extend the talents and training of a power engineer with skills in design.

A simulator is planned for embedded training for the controllers. Such training will allow the controllers practice in diagnosing simulated faults and emergencies during quiet periods. Increasing the frequency of diagnosing increases expectations of faults, builds arousal and polishes diagnosis, decision making and action. The probability of errors of commission or omission are reduced.

7. Planned Changes

The new terminal arrangement will possess three VDU per desk to give three simultaneously views of current situations. Furthermore, more data is visible at once, simultaneously. By providing all the relevant information ~~in~~ close together, scanning times are reduced and focussed attention is possible. Such focussed and informed attention leads to more rapid diagnosis, accurate decision making and correct actions.

The proposed wall board is located close to the users and will be dark when conditions are normal. The board will light up to show and assist in diagnosing problems. This process enhances the effectiveness of flashing lights for visibility and contrast. Nevertheless, the sheer size of wallboards make them cumbersome and difficult to interpret. The direction for the future is for computers to display, analyse and to assist in prioritising problems to speed the diagnosis.

8. Environmental Factors

Provision of air conditioning, natural and artificial light, and low noise levels provide attractive conditions in which to work. Such conditions reduce errors caused by environmental stresses.

9. Conclusion

The SECWA system is an example of a system in which human factors is vital for the efficiency and competence of the human operators. The station is continuing to maximise human factors through redesign of controls and displays and through more modern computerisation. By centralising information management, diagnosis and accurate decision making is speeded up.