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THE PROVISION OF POLICE AND FIRE SERVICE COMMUNICATIONS FACILITIES

ALLIED ENGINEERING SERVICES

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Introduction

The above heading includes the supporting services such as buildings, towers, power and safety which embrace the disciplines of Civil Mechanical and electrical engineering. These activities are so wide-ranging that this paper attempts only to highlight some of the many features of the work.

Aerial Towers

These are dealt with first for no reason other than that they form the first and final link in the radio station chain of activities, that is, the "Receipt" and "Despatch" ends of the business. To the layman, these towers appear to be crude and often ungainly or even unsightly structures. They are however, in common with other parts of the system, subject to the laws of nature and their design and construction present problems no less difficult to solve.

The greater part of the load borne by these towers is due to high winds and the resulting pressures exerted on both structure and aerials. It is well known that winds are rarely steady either in direction or strength. In addition, the air stream is considerably influenced by local features such as valleys, hills, plantations and buildings. Also and particularly under storm conditions, squalls or gusts occur often of a few seconds duration only that are of much greater violence than the main air stream. The elastic properties of the materials used allow the towers to sway or deflect under load, the amount of deflection being a measure of the load. When the load is removed, the tower moves back past the vertical and in a manner similar to the action of a pendulum, this movement or oscillation continues until damped out. This natural period of oscillation is determined by the design and the materials used as is the damping characteristic and both are important in determining the structure's response to wind. For example, if the duration of a high intensity gust is sufficient to deflect the structure to the maximum extent (within the elastic limits of the materials) to one side of its vertical position namely, one half the maximum amplitude of oscillation, maximum load conditions result. A tower with a natural period of oscillation of 6 seconds could be seriously affected by a wind gust of only 3 seconds' duration. The dimensions (spatial) of such gusts are also important since they determine whether a part or the whole of the structure is affected. Towers which are designed to withstand main stream conditions could, under the influence of gusts whose speeds may be up to fifty per cent greater than the main air stream, be subjected to wind loads some 3 or 4 times the designed maximum.

The total wind loading is the sum of the load on the structure itself and that on the aerials and cables. However, the designed "Pay-load" is usually only some 15 to 20 per cent of the total as may be appreciated by comparing the relative sizes of structure and aerials. Under the conditions mentioned therefore, serious overloading may result from the windage of the structure itself without the aerial loads.

In addition to these "Static" loads, other "Dynamic" loads may be imposed on the structure. Under certain conditions, and depending upon wind speed and shape of structure, vortices in the air stream form and break at the edges of the structure. As a result, an alternating load is imposed. Should such phenomena occur with a frequency corresponding to the natural frequency of the structure, the build-up in magnitude could be such as to cause failure. It may be interesting to note the similarity between this phenomenon and that of resonance in electrical circuits. Such dynamic loads have been the cause of major disasters for example, the collapse of the Tacoma Narrows bridge in 1940. No failures from such effects have, so far as is known, been experienced on towers in which we are particularly interested and this may be due to the non-occurrence (as yet) of the right conditions or, and more likely, the aerodynamic damping properties inherent in these structures. However, slender structures such as may be considered desirable from an appearance aspect and more acceptable to the fulfilment of planning requirements are particularly prone to oscillation and expert advice should be obtained before proceeding with a project involving such types.

Structures are usually designed with a factor of safety such that the chances of failure through fatigue are negligible. Where serious overloading occurs, as might be the case of structures designed for conditions less severe than those appertaining to the site, the risk of fatigue failure is greatly increased. Unfortunately, site weather records do not exist in sufficient detail to enable any evaluation of safe life to be made.

The effects of corrosion and the loss of strength due to the wasting away of the structure are well known. What may not be so well known is the fact that the surface condition of the steel has a marked effect on its resistance to fatigue so that, where corrosion has taken place, the chances of fatigue failure are enhanced. It should be noted also that whereas the products of corrosion (rust) can be removed, the effects (pitting etc) cannot be eliminated. The importance of protecting the structure against corrosion at the beginning and throughout its life cannot be over-emphasised. In the case of older towers, regular inspection and maintenance is vital.

For the future, the increasing interest in site - sharing and the increasing loads due both to numbers and types of aerials will inevitably lead to a demand for heavier and more complicated towers with a corresponding rise in costs.

Buildings

In common with towers, buildings are likely to increase in size to house the additional equipment being called for now. In addition future development must be taken into account.

Advantages are to be gained, on both maintenance and first cost grounds, by the standardisation of equipment and layout and, if this can be achieved, buildings could also be standardised. Standard building modules could be developed with expansion capabilities for future requirements at minimum cost and interference with existing services. In the first instance, the basic unit is dependent upon equipment layout and maintenance needs. However, the following aspects may also influence the design.

Increasing loads and, possibly, heights of towers will increase the ground space required for these structures. In addition, it is necessary to provide access to the site and hard standing and manoeuvring room for maintenance vehicles and re-fuelling tankers where stand-by generating plant is installed. In some cases site accessibility may prove to be impracticable for such vehicles but wherever possible it should be provided to reduce operating costs. Some idea of the space needed is given by the following details of a typical 2,500 gallon tanker.

Overall length	24 feet
" width	up to 8 feet
Turning Circle	60 feet

On some sites, particularly small single-tower ones, conditions may well become impossibly cramped. One solution to alleviate the position would be to site the equipment buildings directly beneath the tower, a final development being the integration of tower and equipment rooms. In either case, the design and layout would essentially be dealt with as a unit and some compromise might result from stability and other possibly conflicting requirements. It may be of interest to know that this solution is already being considered for one site under development.

After buildings, the standardisation of heating, lighting and ventilation units could be achieved. In equipment rooms where heat build-up may be high particularly in warm weather, air conditioning or temperature control is necessary. In general, single storey brick buildings, without windows (un-manned sites) are preferred. Internal surfaces should be treated to minimise the dust hazard and floors should have an insulated covering. Underfloor ducting is not favoured since such installations present problems particularly when alterations or additions to equipment or layout become necessary. Overhead or wall trunking provides a more flexible method.

Protection against fire hazards needs careful consideration and where, as in the case of equipment rooms a risk of fire exists, automatic extinguishing units should be installed. In remote un-manned stations, the simple failure of, for example, a unit fan could be disastrous. Diesel-engined generating sets are considered to be safe but explosions and fire are not unknown often through fractures in fuel lines and fuel being sprayed onto areas at ignition temperature such as exhaust manifolds. The safety of maintenance personnel must also be considered. Where only one means of access to a room exists the possibility of escape being blocked by fire must be considered and provision of an alternative escape route may be necessary.

Consideration should be given to the provision of toilet, changing and drying room, canteen and first aid facilities. Maintenance personnel are likely to have to spend considerable periods on site, often under adverse weather conditions and the provision of such facilities is considered to be justified on economic as well as purely humanitarian grounds. Experience has shown, too, that accident risks increase with prolonged discomfort.

Power Supply

The possibility of a mains power failure exists for a number of reasons, and the consequent shutting down of a station is by no means remote as recent experiences have shown. There is a real need, therefore, for the provision of stand-by generating sets as an insurance against such eventualities.

The sets should be of adequate power not only for the maintenance of communications but also for the other ancillary services, lighting, ventilation etc. Choice of plant is influenced by operating conditions and, on un-manned sites, preference has been given to air-cooled diesel-engined generators. Other types should, however, be considered according to availability and cost.

Stand-by sets are designed to come on-load when the mains voltage falls below that necessary for efficient operation of the equipment. Starting is achieved by batteries maintained at full charge by chargers. In view of the comparatively short life and other characteristics of lead-acid batteries, nickle-iron type batteries are preferred at present. It is suggested that additional battery capacity be provided as an alternative source of emergency power for transistorised radio equipment when installed.

In common with other parts of the station, reserve generator capacity to cover future developments should be taken into account. However, there are both technical and economic objections to the installation of a set with a reserve capacity such that it is run under light load for some time and until the reserve is taken up. Consideration should be given to the alternative, that is, provision for the installation of a second set at a later date.

Fuel storage capacity usually presents something of a problem since the duration of a mains failure is unknown. The availability of tankers and delays in re-fuelling must be taken into account as well as site accessibility under adverse weather conditions. A general recommendation is that the minimum storage capacity should be calculated either

a. by taking 3 weeks' supply at the maximum rate of consumption

or b. 2 weeks' supply at the maximum consumption rate, plus the usual and most economic quantity supplied in one delivery.

The distillate grades of fuel used may be stored and handled at ambient temperatures and do not require heating facilities to be provided in storage tanks and handling systems. However, exposure to extreme cold for long periods should be avoided since oil flow from the tank may become slightly restricted. This is particularly important in the case of stand-by generating plant where summer cloud point specifications fuel may be in both tank and feed lines during the most severe winter weather. Such systems should therefore be lagged.

Storage tanks should, preferably, be above ground, on brick or reinforced cradles with a layer of bitumised felt between cradle and tank. Where overfilling or leakage would contribute to a fire hazard or contaminate sewers, or areas under cultivation, a catch-pit should be constructed around the tank. In addition to the engine's system, a filtration system should be incorporated in the handling system. This should be placed in the draw-off line as near to the storage tank as possible.

Considerable quantities of air are required for cooling and combustion purposes and the engine room must be designed to incorporate adequate venting, both in size and location. Vents must be safequarded against restrictions caused through snow drifts and wind-borne debris or flood water, as well as reverse draughts, particularly if severe storm conditions are likely on site.

Exhaust gases must be removed by the most direct route for efficient operation and to avoid the build-up of temperature in the engine room. Sharp bends in exhaust lines should be avoided particularly near manifolds since the resulting back pressures impair efficiency and could lead to premature failure.

Fail-safe devices are provided to guard against major damage to or destruction of the set through the malfunctioning or failure of cooling, lubricating and other systems.

Due to the comparatively heavy vibration inherent in this type of prime mover, control gear and delicate instruments should be installed away from such effects and not attached to the set or its mountings.

Safety

Some aspects of safety have been briefly mentioned in other parts of this paper. Apart from humane considerations the continued functioning of the station is dependent upon good maintenance and the availability of trained personnel to carry out such work. So far, man's ingenuity has failed to render himself unnecessary, so that his continuing services must be assured. Safety engineering is, therefore, yet another essential discipline justifying its own heading.

In radio stations, not least among the hazards are those occasioned when men are working at heights on towers. On such structures reasonably safe access must, wherever possible, be provided to the working areas in the form of guarded ladders and rest platforms at intervals. Hinged traps or toe-boards, are not acceptable as rest platforms. Much of the work is carried out away from the ladder and platforms and safety gear such as personal harness safety lines and arresting devices should be used. The need for arresting or "Fall-breaking" devices can be illustrated by the following example.

A man equipped with belt and 6 feet of safety line would, in the event of a fall, be travelling at a speed of approximately thirteen and a half miles an hour by the time (little over half a second) the slack in the line was taken up. The distance in which he would be brought to rest, assuming the line held, would be dependent upon the amount of stretch available in the line. If this amounted to, say, 3 inches, the decelerating force on the man would be some 24 times that of gravity ie 24 g. The provision of some simple arresting device that would bring the man to rest in 2 feet would reduce the decelerating force to 3g. The effects at the other end of the line, that is, the structural member to which it is made fast must also be considered.

The effects of corrosion have already been mentioned and, in the author's own experience it has caused fatal accidents. Concealed surfaces between members and internal surfaces of hollow tubes and fastenings are particularly dangerous. Again, adequate inspection and maintenance is essential and under no circumstances should climbing be permitted before the officer responsible has satisfied himself that it is safe to do so.

On structures where no guarded ladders and platforms are provided, permanent arresting gear fittings should be installed.

At ground level, the most common hazards are fire and shock from electrical equipment due to defects, bad earthing etc. Care must be taken both in installation and maintenance to reduce risks to a minimum. Another by no means rare source of accident arises from over-economy of space, that is cramped working and access space.

Conclusion

The services described briefly are in the nature of a supporting role in the telecommunications field. As in other activities, however, defects or omissions of any of these "Props" can seriously affect the results and, indeed, ruin the whole project. The old adage of the message that failed to arrive because of the missing shoe nail is equally applicable today.

Mr G R K Richards graduated in Engineering at Cambridge University. He served an apprenticeship and had further training in production and heavy engineering industries (motor, mining, steel), metallurgical research and special projects. Commissioned 1937 (TA) and service with BEF Western Desert Force, 8th Army and US 5th Army. His post-war work was in the steel industry as works engineer and new works planning engineer. He came into Government service in 1949 and joined the Directorate of Telecommunications in 1970 as Main Grade Engineer responsible for Works services.