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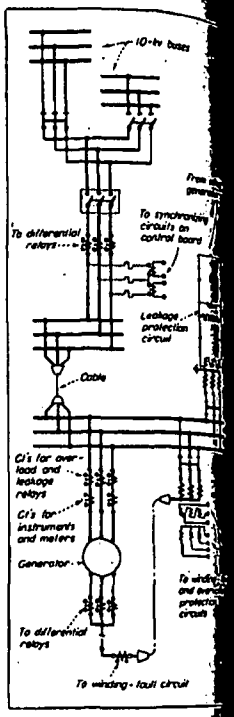

RELAY CIRCUITS kept intact during except for insertion of test instru

Electrical Test Program Holds Down Hydro-Plant Outages

With reserve capacity in Ireland's Ardnacrusha Hydro Station cut to bare minimum during last war, maintenance assumed major importance. Here is the electrical side of their successful maintenance plan covering 115,000 kva of generating capacity

By P BYRNE, *Engineer, Ardnacrusha Hydro Station, Ireland*

► The Shannon River winds th 230 miles in South Ireland before ing into the sea. During its tra flows through three lakes and has a fall of 300 ft. Ardnacrusha Station, powered by the Shan equipped with four generators ha combined rating of 115,000 kva. section of the plant went into op in 1929. By 1939 when World started, much of the equipment some major maintenance.

Largest job to date has bee complete rebuilding of three ge stators. A serious increase in cor ing over the years made this nec Before the war, equipment manuf ers offered advice plus use of lab ries and work shops on major ma nance jobs. In fact, they were ha the entire work on most of the jobs dealing with generating equi

Three Degrees of Generator Maintenance in Ardnacrusha Station

	Monthly Check	Annual Overhaul	Major Overhaul—Every 4-7 Years
Commutator	Cleaned; polarity reversed if required	Cleaned; turned down if required	Turned down, or replaced if required
Brushes	Cleaned; worn brushes replaced	Cleaned and adjusted; worn brushes replaced	Cleaned and adjusted; worn brushes replaced
Field coils	Tested with megohmmeter	Cleaned where possible, but not removed. Tested with megohmmeter	Removed and cleaned. Pole bolts tested for permanent set and for tightness. Pole windings reclamped if protruding mica shows looseness between turns
Stator	Not attended to	Cleaned where possible. Tested with megohmmeter. Both bindings and wedges inspected	Air passages cleared. Loose bindings made good; and connections varnished. Checked for coil deformation or displacement, for wedge slip. Laminations' condition examined as far as possible. Core bolts tightened if necessary.

the war changed this picture. personnel were thrown on their for major repairs. And further problems were presented. For instance, reserve capacity was reduced from norm of about 20,000 kw to essen- zero at certain times of the day. meant allowable time for mainte- was generally channeled into pe- outside normal working hours: and early mornings.

Maintenance Objectives. Before look- the specific plan used at Ard- let us consider maintenance general. Normally, maintenance is a for preserving plant and structure efficient working condition. But with shortage of reserve generating ca- faced, aims took on a slightly different hue. In brief, *quality of main- had to be upped to the point incipient faults were located by inspection or test. A large proportion probable faults just had to be anticipated.

To illustrate, let's consider a single generator. It is equipped with protective devices to prevent or limit fault dam- But even though these protective devices perform their design function the system is temporarily short-handed, ca- more value, by the unit being tripped of the line. To prevent this we made a routine effort to detect faults in their embryonic stage. And the results were good. Yardstick was the comparative freedom from serious power interruptions over the past years, even in the face of an increased number of faults.

These faults varied from a low of 15 in 1944 to a peak of 61 in 1949. Potential trouble sources, even though detected before failure occurred, are listed here as faults. Typical faults were lightning damage to station bus, punctured transformer bushing, failure of 110-kv insulators, water (5 gal) in tank of 110-kv ocb, relay defects spotted during overhaul.

Maintenance Plan. Extended maintenance could be carried out only during period from April to September, when water inflow normally dropped. *And even during this season only one of* the four units could be taken out of service. Other times available for work, without wasting water or losing load, were weekends or early morning hours. So to meet this double need—maximum availability and maximum reliability—the following maintenance plan was evolved for the four main generating units.

Monthly checks consisting of a mechanical and electrical once-over, take between 6 and 8 hr. In addition each unit receives an annual *general overhaul*. This includes a detailed inspection for wear, thorough cleaning of exciter, purification of lubricating and servomotor oils, cleaning of generator stator, plus a general electrical checkup. It does not include general disassembly of parts. This overhaul takes about 14 days.

Major overhaul for each machine comes once every 4 to 7 years. Unit is completely disassembled and all worn parts renewed. After reassembly the generator is dried out. This work takes 3 to 4 months.

Electrical Tests. At one time, instruments and protective relays were taken down and sent to a central point for bench testing while the machine was being overhauled. But we ran into some difficulties. For instance, delicate relays and instruments, having been tested in the central lab, were occasionally damaged during transportation or reinstallation. And since they received no further check the damage sometimes passed unnoticed till the relay was called on to operate.

Furthermore, taking relays down and reinstalling after testing opened up possibility of mistakes in reconnecting. Relays that are gravity controlled may be tested in one position and installed in another, affecting operation.

These problems were neatly sidestepped by testing all relays in position