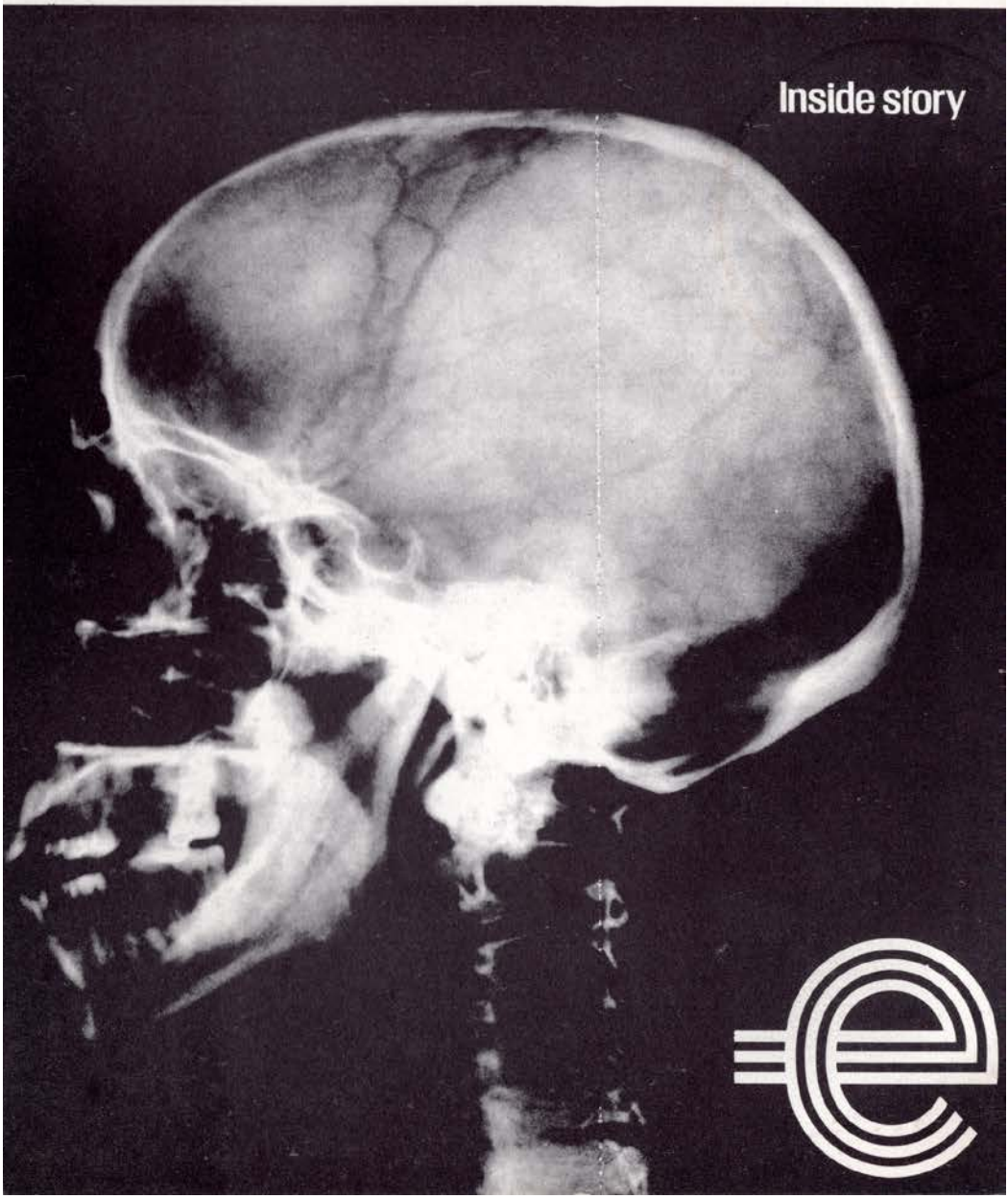
RATCLIFFE-ON-SOAR 400kV SUBSTATION

Nottingham Transmission District



WELCOME TO:

RATCLIFFE 400kV SUBSTATION

I hope that a brief explanation of the equipment you are about to see will add interest to your visit and widen your appreciation of the work carried out by the Transmission Department.

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THERE ARE A FEW 'TRANSMISSION' FACTS I WOULD LIKE TO PUT TO YOU:-

1. The "Transmission Department" is a kind of "High Speed Energy" transport business. One over head line out of this substation transports energy equivalent to 140,000 tons of coal each week, without noise or dirt.

i.e. 7000 coal lorries of 20 tons each week

extra on the roads of the Midlands for each Overhead Transmission Line leaving this building

2. The switchgear is the largest size made, there are however, several other installation of equal capacity. Each switch is capable of dealing with 35,000 MVA or the total generating capacity of the country at the end of the war.

3. This substation is handling 10 times the power capacity of the Cross Channel Link.

4. One transmission tower carries the power of 18 original towers at 132,000 volts. Remember one of these towers equals 18 of the earlier towers.

5. The cost of "undergrounding" these transmission lines would be 16 times more than overhead and sterilize good land as wide as a motorway.

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Please take advantage of the Safety Equipment provided and use both the ear muffs and the safety helmet. If a switch should operate there will be a loud 'bang' there is no need for you to be alarmed this is a normal occurance.

District Engineer,
D.K. Latham.

CENTRAL ELECTRICITY GENERATING BOARD

NOTTINGHAM TRANSMISSION DISTRICT

R A T C L I F F E 4 0 0 k V S U B S T A T I O N

GENERAL

Low level double bus bar substation divided into four sections. The main bus bar "wraps around" the reserve bar in the form of an 'H'.

The building which is aluminium clad and lined with fibrous board cover a floor area of approximately $7\frac{1}{2}$ acres.

The first circuit was commissioned in June, 1967.

CIRCUITS

6	Feeders
3	Supergrid Transformers 240 MVA 400/132kV
4	Generators 570 MVA 500 MW 400/22kV
3	Bus Sections
2	Bus Couplers
18	TOTAL

Provision is made for extending the Sub-station at a future date if required.

AIR BLAST CIRCUIT BREAKERS

AEI Manufacture Type GSA 12
12 Breaks per phase giving total break of $12\frac{3}{4}$ inches. Rating 35000 MVA breaking capacity, normal full load current 4000 amps.

Operating times - average trip time 45 m secs.
average close time 98 m secs.
Air receivers capacity 480 cu. ft. at 430 p.s.i.
Air consumption for trip is 1600 cu. ft. at atmospheric pressure giving pressure drop of 50 p.s.i. and 5 cu. ft. with no measurable pressure drop on closing.
Air in breaker is sufficient for make-break-make-break
Pressure switches give lockout to closing at 375 p.s.i. and to tripping at 360 p.s.i.

As contacts are held open by air pressure, a pressure switch is arranged to give a forced close at 220 p.s.i. in event of loss of air compressions whilst at 290 p.s.i. D.A.R. is inhibited for feeders and sequential isolation takes place, and on generators a bus bar protection injection clears the section of bars to which machine is selected.

Condition air on ABCB is at 10-20 p.s.i. and has consumption of 60 cu. ft per hour.

Total weight of ABCB is 72 tons.

EARTH SWITCHES — These may be integral with isolators and are of hand operated pantograph type of AEI manufacture type RCP. Inter-locking is arranged to prevent incorrect operation with circuits alive. There are 49 earth switches in the sub-station.

ISOLATORS — 51 motor driven hydraulic isolators AEI manufacture Type MLG05. 3 phase $\frac{3}{4}$ HP motor driving a hydraulic motor
Double break isolator with rotary action which locks when blades are fully closed. Operating time 15 to 20 seconds approximately.
All isolators are covered by a comprehensive inter-locking scheme.

MAINTENANCE EARTHS — These devices, interlocked with the earth switches, are hand wound with three sections per poker, weight top 18 lbs middle 26 lbs bottom 50 lbs. 78 earth devices are arranged at suitable points in Substation.

BUS BARS — $5\frac{1}{2}$" OD $4\frac{3}{4}$" ID Aluminium tube current carrying capacity 4000 amps.
Welded fittings with 7" PCD bolted flanges.

VOLTAGE TRANSFORMERS — These are of AEI manufacture of the capacitor type 50 VA per phase

CURRENT TRANSFORMERS — Current transformers are housed in wall bushings in an air insulated chamber. Ratios are 2000/1000/1 in all cases except for bus bar protection which are single ratio 2000/1. The bushings are oil filled, nitrogen pressurised and weigh approximately $3\frac{1}{2}$ cwt.

SUPER-GRID TRANSFORMERS — 3 AEI Auto transformers 240 MVA 400/132kV
Total weight of each transformer 302 tons complete with oil.
Total quantity of oil 23,620 gallons.

The main windings are auto-star with delta tertiary at 132kV.
Tap change is on LV side with 15 taps of 1.43% (-5% to +15%).

PROTECTION METERING, ETC. Each circuit has its own relay block house, which contains open rack type panels for protection, control, and local metering. 110V supplies for these equipments is obtained from a self contained battery and charger unit.

a) Feeders Each feeder is equipped with 1st main and 2nd main protection. The latter being of the distance impedance type incorporating its own back up feature. The first main is either a carrier type, rented pilot type or distance type protection having a unit protection feature. Carrier supplies are obtained from a motor/generator unit adjacent to the block house. This unit is normally driven from an a.c. motor with a d.c. standby machine. A Masson Fault recorder is installed in each circuit which gives a chart showing a.c. values and equipment operations, triggered off by the trip relays. Delayed Auto reclose is obtained for dead line charging or check synchronising on all feeders. Bus Zone relays, both a.c. and d.c. are per circuit and mounted in the relay house.

b) Generators Most of the generator protection is accommodated in the Generating Station. In the 400kV Substation relay room we have overcurrent, interlocked overcurrent and bus bar protection. The sequential isolator control circuitry is also found in this relay room. The generator autosynchronising unit is located in the substation relay room and is of the solid state type of equipment. It automatically adjusts the governor, excitation, and tap change position of the main transformer. The synchroniser checks a few cycles of synchronism for voltage matching and phase angle before closing the 400kV ABCB. Should the air pressure in the ABCB fall due to air leaks either with the breaker open or closed a pressure switch set at 290 p.s.i. causes a voltage to be injected into all bus zone relays of circuits selected to the same bus bar as the generator thus clearing the bus bar.

c) Supergrid Transformers Overall Balance and two stage overcurrent form the main and back up protection on these circuits. Bus bar protection is similar to other circuits. Buchholz and winding temperature is of type usually associated with transformer circuits.

d) Bus Section and Bus Couplers These circuits are equipped with overcurrent and bus zone protection only.

COMPRESSORS AND AIR PLANT The air used in the circuit breakers is supplied by two Hamworthy type 4TH8 compressors each driven by a 120 HP three phase motor. Compressor speed 500 r.p.m. with a delivery pressure of 3,300 p.s.i. at 155 cu. ft. per minute. Water cooling by radiators.

Stage pressure	1st	40 p.s.i.
	2nd	200 p.s.i.
	3rd	800 p.s.i.
	4th	3300 p.s.i.
Lubricating oil pressure		40 p.s.i.

The air is dried by 'Rimer' dryer banks which

pass air through activated carbon to remove oil and "alumina" - (aluminion oxide) to remove water.

Two main air receivers weighing 7 tons at 3000 p.s.i. each holding 50 cu. ft. supply reservoir. Air is throttled to 430 p.s.i. to ensure no moisture passes into air ring round substation.

DIESEL STANDBY GENERATORS AND M.V.A.C. SUPPLIES

The 415 volt auxilliary supplies are normally derived from two 2 MVA 3kV/415kV transformers. In the event of a complete failure of supplies, the diesel standby generators are arranged to supply the essential services load and are run-up and loaded automatically. Diesels are E.E. Co. type 6RK - 518 BHP each six cylinders in line with compressed air start supplied by auxilliary compressors. Engine is governed to 750 r.p.m. Fuel tank holds 500 gallons suitable for about 40 hours running. Generators are 8 pole machines of 330kW capacity fitted with bushless exciter and solid-state AVR.

GENERAL

Total lighting load in substation is in excess of 500 kW.

General Services 110V Battery is of 800 Ah capacity.

NTD 13.