3 The electricity supply industry and the Central Electricity Generating Board

The electricity supply industry (ESI)

3.1. The present structure of the ESI in Great Britain is by and large a post-war creation. The Electricity Act 1947, which nationalised the industry, set up the British Electricity Authority (BEA) and 14 Area Boards; it also established a Consultative Council for each of the Area Boards. Two of the Area Boards served the south of Scotland. These were formed, together with the BEA's generation activities in the region, into the South of Scotland Electricity Board (SSEB) by the Electricity Reorganisation (Scotland) Act 1954, under which the BEA was renamed the Central Electricity Authority. The north of Scotland has been served since 1943 by the North of Scotland Hydro-Electric Board (NSHEB).

3.2. The principal innovation of the Electricity Act 1957 was the Electricity Council; however, this Act also turned the Central Electricity Authority into the Central Electricity Generating Board (CEGB).

3.3. The only significant change since then has been the establishment by the Government in 1977 of the Electricity Consumers' Council, which became a statutory body under the Energy Act 1983.

3.4. These statutory bodies have the following responsibilities:

(*a*) the CEGB is required to develop and maintain an efficient, co-ordinated and economical system of supply of electricity in bulk to all parts of England and Wales. To this end it generates electricity and transmits it, through the high voltage power lines and cables of its national grid, to Area Boards and direct to a few large industrial users;

(*b*) the 12 Area Boards buy bulk supplies of electricity from the CEGB and distribute it to consumers in their area;

(*c*) the Electricity Council, the co-ordinating body of the ESI, advises the Secretary of State on matters affecting the industry, and promotes and assists the development and maintenance by the CEGB and Area Boards of an efficient, co-ordinated and economical system of electricity supply;

(*d*) the 12 Electricity Consultative Councils represent the interests of consumers in their area, and monitor the Area Boards' standards of service; and

(*e*) the Electricity Consumers' Council represents consumer interests at the national level, and may make representations concerning them to the ESI and to the Secretary of State. It must be informed by the Electricity Council of the general plans and arrangements of both the Electricity Council and the CEGB, and in particular any proposal by the CEGB to vary a tariff.

The Plowden Report

3.5. A report on 'The Structure of the Electricity Supply Industry in England and Wales' (known as the Plowden Report) was published in 1976. The Report recommended the establishment of a single statutory body to take over the functions of the CEGB, the Area Boards and the Electricity Council; this was intended to deal with the finding of the committee of inquiry that the industry lacked central direction. In 1978 the Government of the day published a draft bill implementing the recommendation, but it had not been introduced by the time of

the general election in 1979. In July 1980 the new Government announced that the recommendation would not be implemented; instead they would look for improved co-operation and working relations, within the existing statutory framework, between the organisations making up the industry.

3.6. The Department of Energy told us that there were no plans to resurrect Plowden's recommendations.

Previous reports on the ESI by the Commission

3.7. We have already published several reports on parts of the ESI referred to us under section 11 of the Competition Act 1980. The first of these, published in 1981, was our earlier report on the CEGB itself (HC 315). It covers transmission in paragraphs 6.75 to 6.104, but by and large the report concentrates on the CEGB's generation activities. We refer to the findings of our earlier report in our discussion of the CEGB's management information systems (see Chapter 5), its organisation (see Chapter 6), and its manpower (see Chapter 7).

3.8. In 1983 and 1984 we published reports on the efficiency and costs of, respectively, the Yorkshire Electricity Board (Cmnd 9014) and the South Wales Electricity Board (Cmnd 9165). In 1985 we reported on the revenue collection systems of the East Midlands, South Eastern, North Eastern and South Western Electricity Boards (Cmnd 9427). In the same year we published a report on the North of Scotland Hydro-Electric Board (Cmnd 9628), and followed this with a report in 1986 on the South of Scotland Electricity Board (Cmnd 9868).

3.9. Under section 5 of the Competition Act 1980 we reported in 1983 on the retailing activities of the London Electricity Board (Cmnd 8812).

Organisation

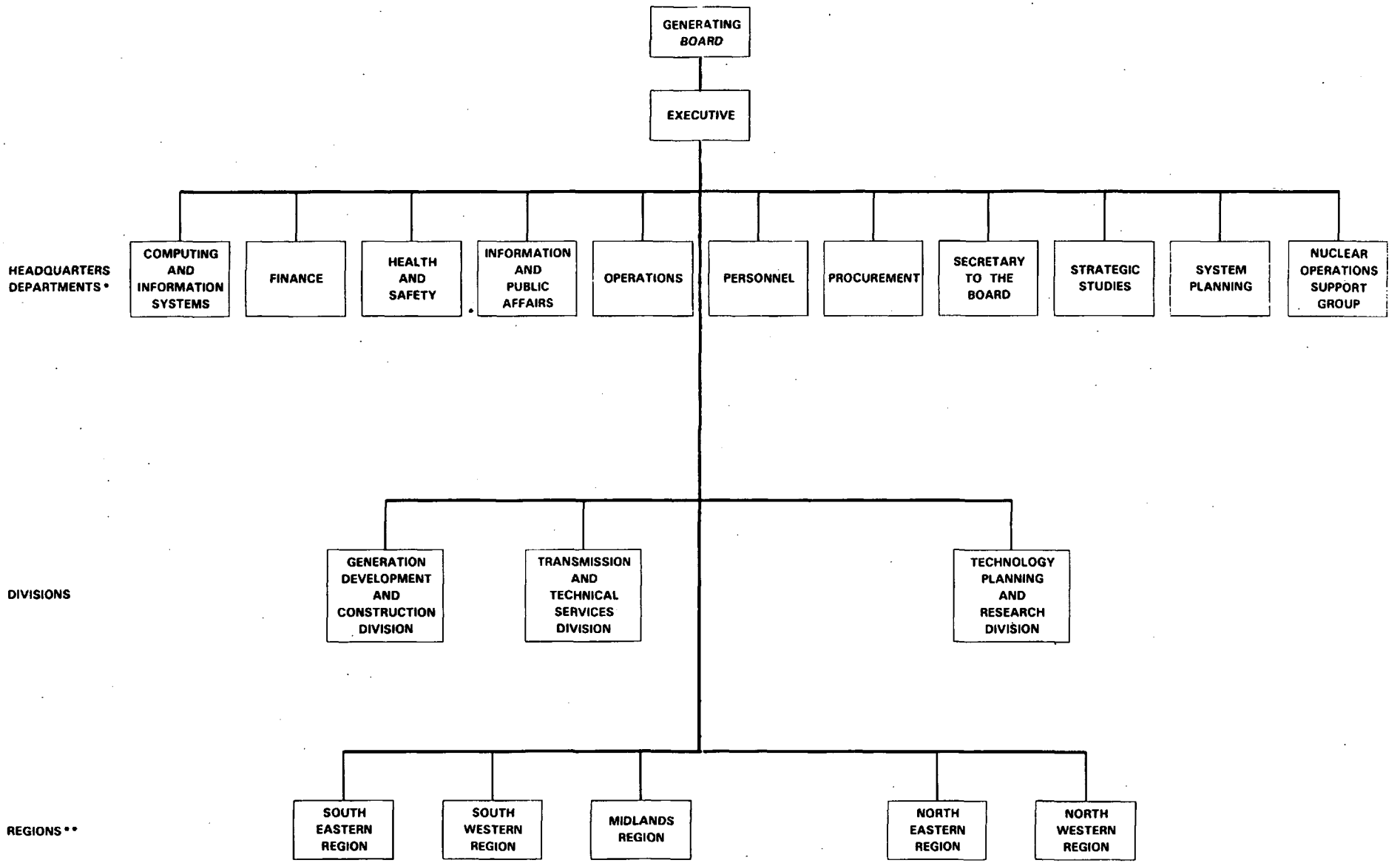
3.10. While our inquiry was taking place the CEGB was in the process of reorganising its production activities. The reorganisation is considered in some detail in Chapter 6. The present chapter does no more than outline the past and future structure of the organisation.

3.11. The Board consists of five full-time Members, including the Chairman and Deputy Chairman, and three part-time Members, one of whom has special responsibility for environmental and conservancy matters. The Board has authorised its full-time members to act as its Executive and take whatever action they consider necessary, between Board meetings, to secure the achievement of the Board's objectives. There are no plans to change the role and structure of the Board as part of the reorganisation, although some of the Members' responsibilities have been re-defined to take account of it.

3.12. Essentially what the reorganisation involves is a change from a regional organisation to a functional organisation. Since 1971 there have been five Regions, each with responsibility for both power generation and transmission in its area. Under this regional organisation the development, design and construction of new power stations was the responsibility of the Generation Development and Construction Division; the development, design and construction of the transmission system was the responsibility of the Transmission and Technical Services Division; and the Technology Planning and Research Division was responsible for research and development. Each Region and Division was headed by a Director-General reporting to the Executive. In addition there were ten Headquarters Departments: the Secretary's Department, and the Departments of Operations, System Planning, Strategic Studies, Finance, Personnel, Procurement, Computing and Information Systems, Health and Safety, and Information and Public Affairs, each headed by a chief officer. A Nuclear Operations Support Group provided a focus for the technological and engineering effort required to support the CEGB's nuclear operations. Each chief officer was responsible to the Executive, and had the right to be consulted by the Directors-General on any matter of significance within his functional interest. Directors-General and chief officers enjoyed a high degree of delegated authority. Figure 3.1 shows this structure.

FIGURE 3.1

Central Electricity Generating Board—structure before reorganisation



*Departments, principally located at CEGB headquarters, responsible for provision of a service to the Board and the Executive and for supplying specialist services and guidance to the whole of the CEGB's organisation.

3.13. The CEGB decided in 1983 to move towards an organisational structure for production based on the four activities principally involved in the production of electricity. There are accordingly now four Production Divisions, responsible for Operations, Operational Engineering, Generation, and Transmission; there is also a Nuclear Co-ordination Group. The Directors of the Divisions and Group together form the Production Directorate, chaired by a Board Member, which co-ordinates their activities. The Generation Development and Construction Division and the Technology Planning and Research Division remain as general management formations, although their structure is under review. There are also a number of corporate functions, headed by corporate directors. The new organisational structure is shown in Figure 3.2. Staff who formerly reported to regional management now report to one of the Production Divisions or a corporate function.

3.14. The new structure was implemented with effect from 1 February 1986, when the four new Divisional Directors and other senior staff were appointed. The Divisions took full management control at the end of 1986; the corporate functions will have done the same by 1 May 1987.

3.15. The new Transmission Division has three departments, dealing with Operations and Maintenance, Technical Development, and Construction. The Operations and Maintenance Department is responsible for the 20 transmission districts, which were formerly part of the regional structure. The districts control the day-to-day management of the transmission system within their area. The organisation and activities of the Transmission Division and transmission districts are described in greater detail in paragraph 6.18 *et seq.*

The transmission system

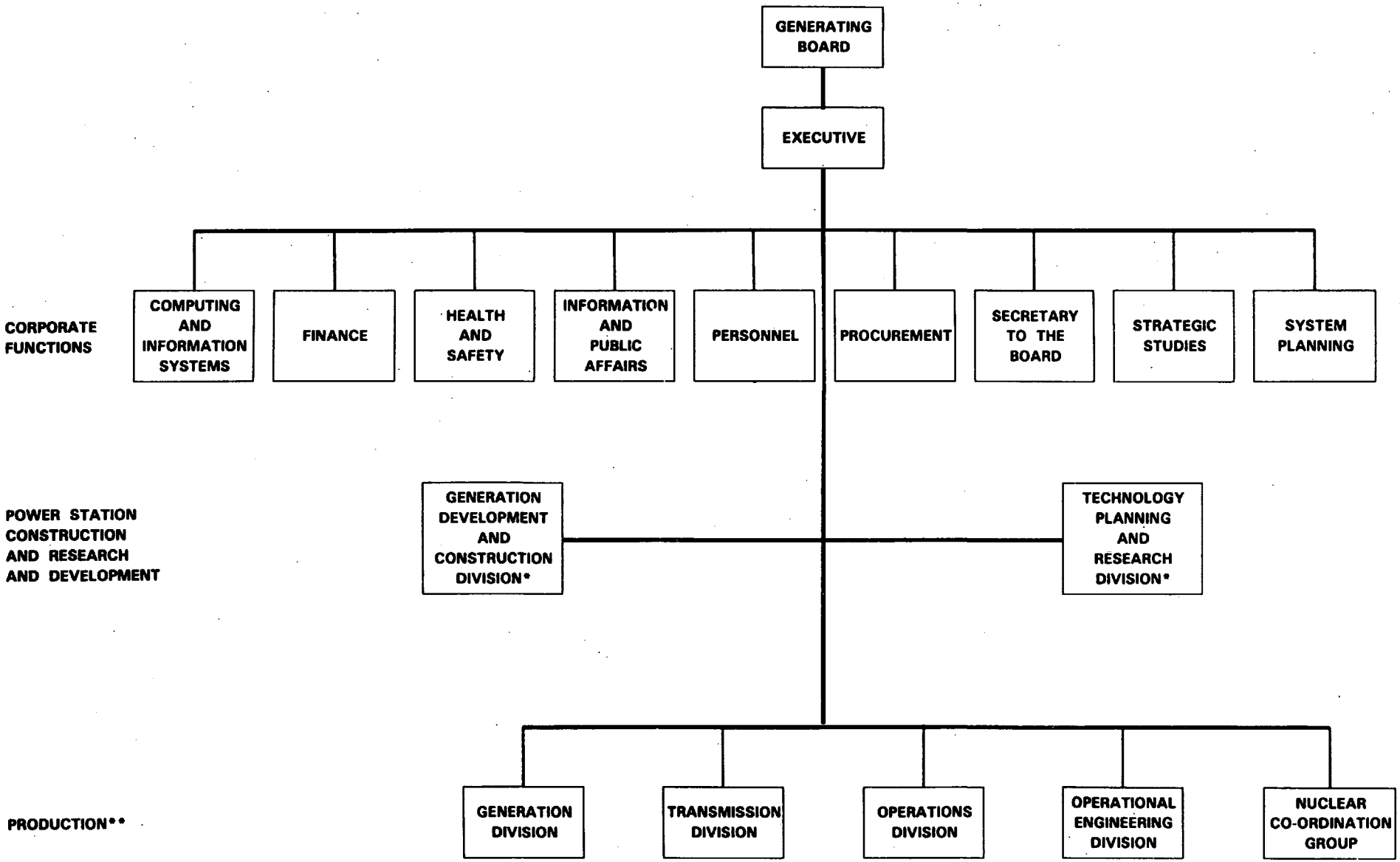
3.16. Figure 3.3 shows how electricity is conveyed from power stations to end-users. The CEGB's transmission activities, which are the subject of our present inquiry, comprise the part of the system between the power stations and the bulk supply points (which are located in sub-stations, at which electricity is sold to the Area Boards for distribution to the end-user. Electricity is generated at voltages within the range 6·6 to 23 kV; it is transmitted by the CEGB at 400 kV, 275 kV and, on some circuits, 132 kV; and it is distributed by the Area Boards at voltages ranging from 132 kV, 66 kV (for some large industrial users), through 33 kV, 11 kV, and 415 V, down to 240 V (for domestic users).

3.17. The origins of the transmission system lie with the CEGB's first corporate predecessor, the Central Electricity Board, which was established by the Electricity (Supply) Act 1926 to co-ordinate the activities of the numerous electricity undertakings, some of them private and some municipally owned which had come into being over the previous 30 years. The Central Electricity Board connected the most efficient of these undertakings by building a 'gridiron' of 132 kV overhead transmission lines, which was completed in 1933. This was not originally intended to be a national grid but a series of regional grids supplying local demand; they were, however, interlinked, so that regions could help each other out in supply emergencies. In 1938 they began operating as a national system.

3.18. The Electricity Act 1947 gave the Central Electricity Board's successor, the BEA (see paragraph 3.1), the responsibility for generating electricity as well as transmitting it. The construction of power stations with a greater capacity, generally nearer sources of fuel (such as coalfields and oil refineries) and further from centres of demand, made it necessary to increase the capacity of the transmission system. This was done by building, in the 1950s, a 275 kV supergrid and, in the late 1960s, a 400 kV supergrid (part of which consisted of up-rated 275 kV power lines). Figure 3.4 shows a plan of the supergrid; inset are the operating voltages of the whole transmission system. The cost of generating electricity varies with the type of fuel used and the thermal efficiency of the generating plant. At present, power stations generating it most cheaply tend to be in the north; there are thus very heavy flows of electricity from the north to the major centres of demand in the south. Figure 3.5 shows the power flows on the system, and

FIGURE 3.2

Central Electricity Generating Board—structure April 1987



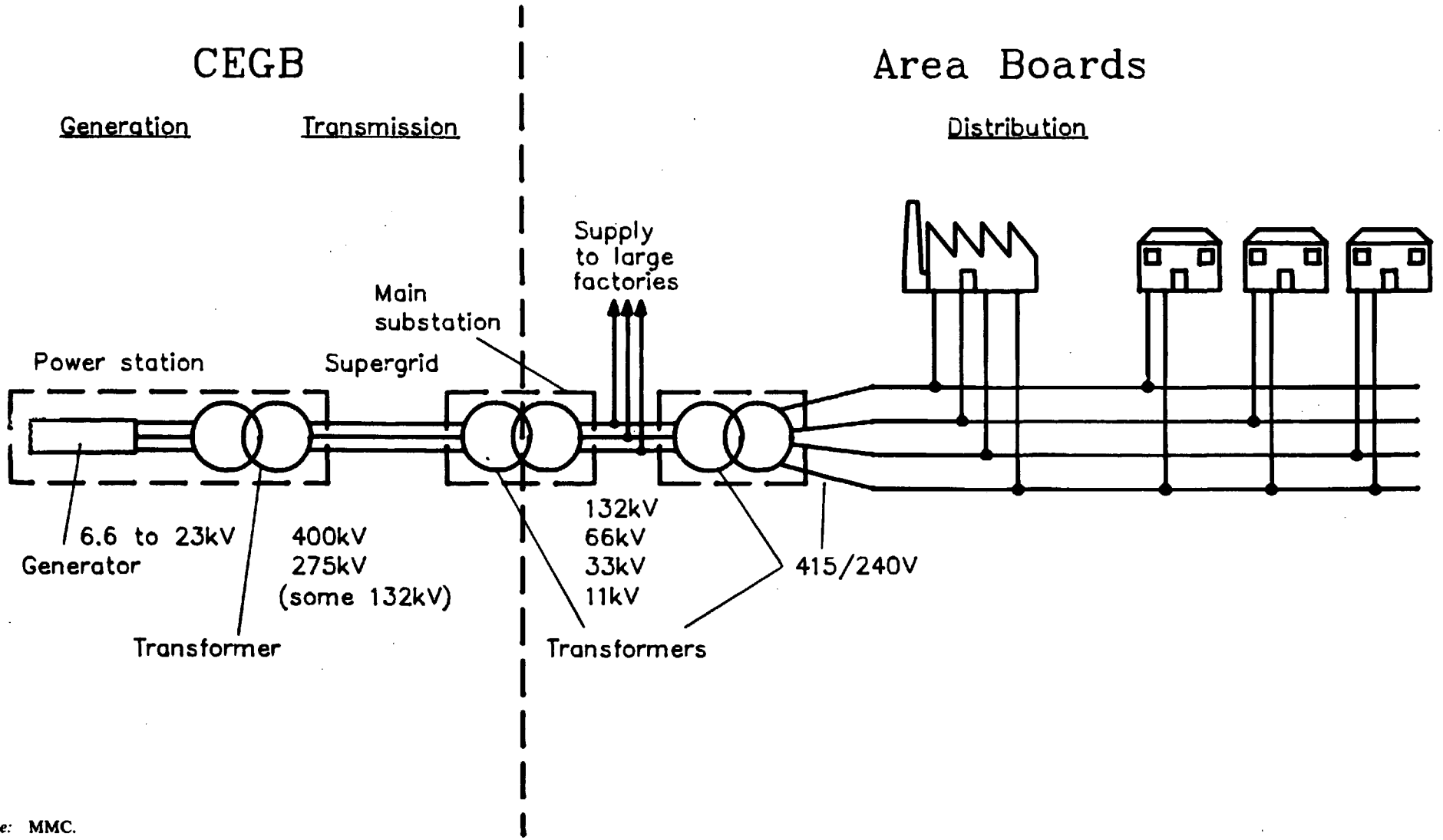
Source: The CEGB.

*The organisational structure of these formations is under review.

**The Divisional Directors for Production and the Director of the Nuclear Co-ordination Group together form the Production Directorate under the Chairmanship of a Board member.

FIGURE 3.3

How electricity is conveyed from the power station to the consumer

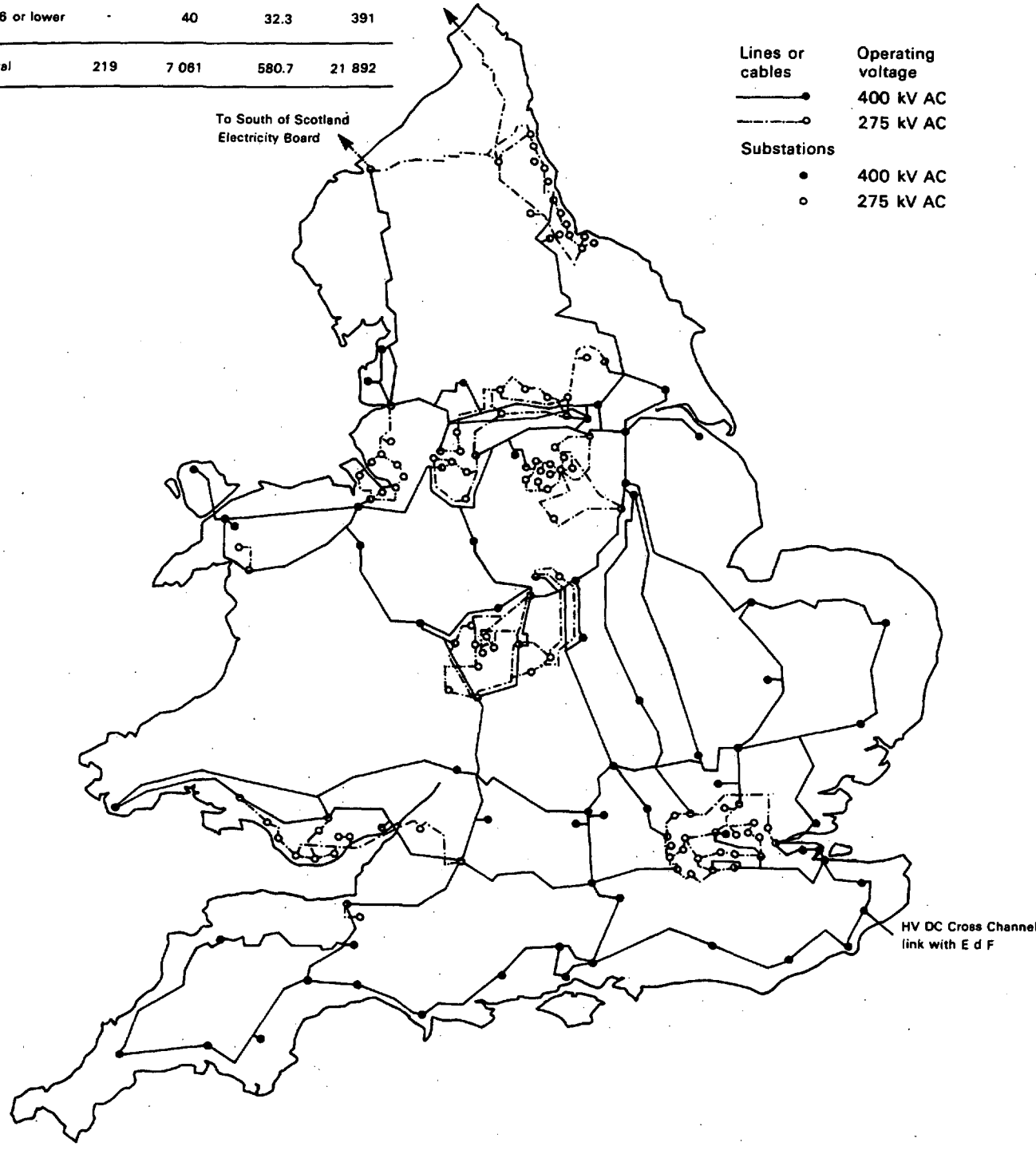


Source: MMC.

FIGURE 3.4

CEGB supergrid at 31 March 1986

Operating voltage kV	No. of substations	Length of overhead lines, route km	Length of underground cables, route km	No. of towers
400	95	5 063	122.5	15 166
275	114	1 736	293.0	5 552
132	10	222	132.9	783
66 or lower	-	40	32.3	391
Total	219	7 061	580.7	21 892



Source: The CEGB.

transmission limits across key boundaries, which the CEGB expects in 1990. No major extension of the supergrid is planned other than that consequent on the connection of new or enlarged power stations. The CEGB considers 400 kV to be the most cost-effective supergrid voltage at present and expects to transmit at this voltage into the next century; grids at higher voltages, for example 735 kV, are operated in some countries.

3.19. Electricity is transmitted for the most part along overhead lines. Figure 3.6 shows a typical 400 kV supergrid overhead line, consisting of two circuits carried side by side. Each circuit has three phases, one above the other; in the figure each phase has two conductors, but they may also have four. Each bundle of conductors, and each individual conductor, is spaced at some distance from the next to prevent flashovers. It is the conductors which carry the current; they are made of high-strength aluminium strands (see Figure 3.7), or aluminium strands strengthened by a steel wire core.

3.20. Overhead lines are supported by steel transmission towers, popularly known as pylons. The conductors are suspended from the cross-arms of the towers by insulator strings made of porcelain or toughened glass. The height of the towers, and the length of the insulator strings, increase with the voltage carried by the conductor. Lines are given some protection from lightning strikes by an earthed wire running along the tops of the towers.

3.21. Electricity may also be carried by underground cables; here the conductor is usually made of copper. A cable costs up to 20 times more than an equivalent overhead line, not only because of the associated excavation costs but because of the design of the cable itself (see Figure 3.7). Conductors heat up as they carry electricity (giving rise to some transmission losses); with overhead lines this heat is dissipated into the air, but extra insulation has to be built into cables, which may also need to be cooled by water at intervals en route. Cables are therefore only used when necessary for technical reasons or when overhead lines are environmentally unacceptable.

3.22. Other important components of the transmission system are power transformers and switchgear. Transformers raise the voltage of supply from the generators to transmission levels and reduce it again at sub-stations. Modern transformers can handle power flows of up to 1,000 MVA and can weigh more than 300 tonnes. Power losses in transformers have been steadily reduced over the years with the development of new core materials.

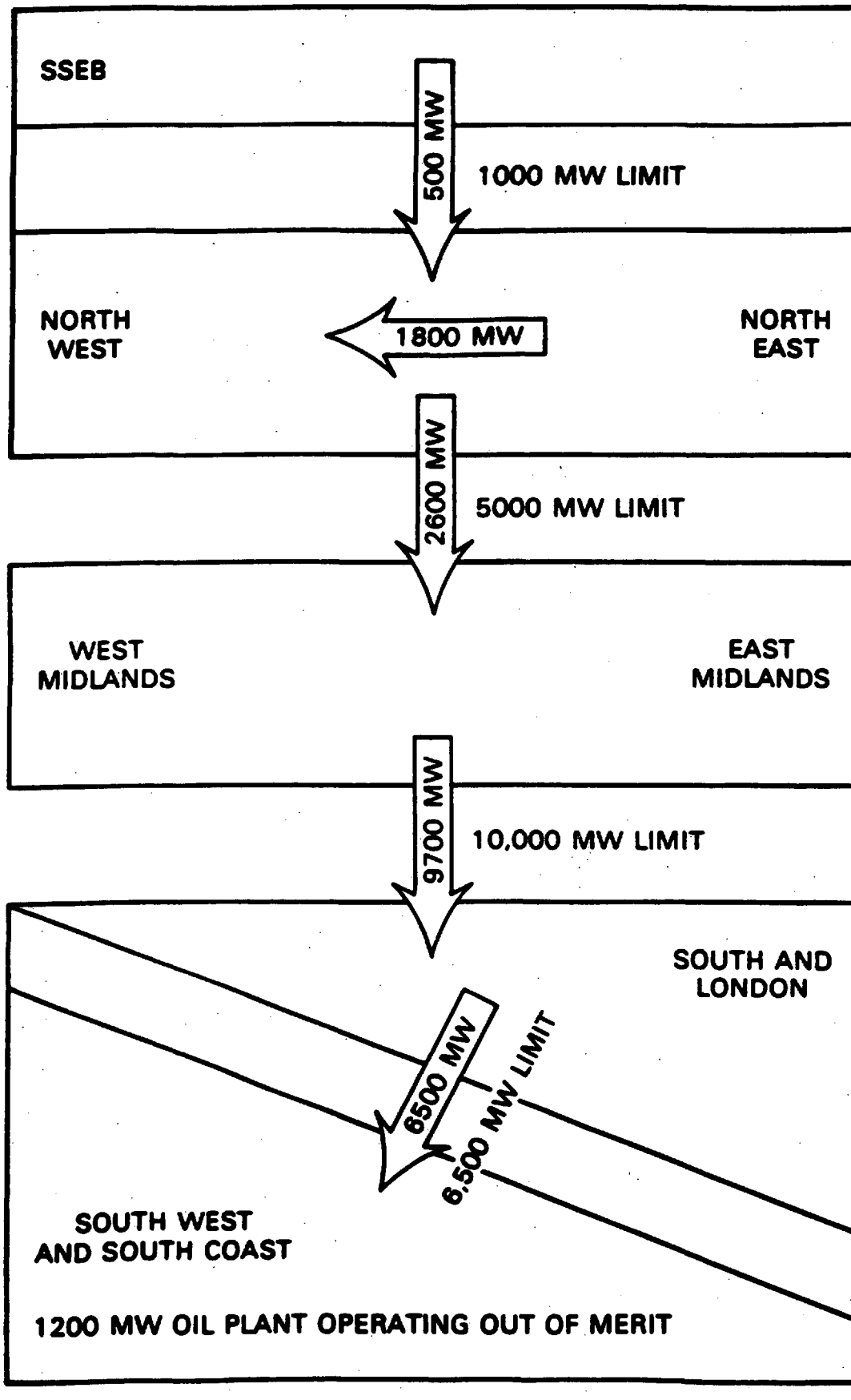
3.23. Switchgear is used to route the power supply; to isolate lines for repair and maintenance; to switch out faulty equipment; and to provide circuit protection. Developments in switchgear, particularly the replacement of blasts of air by sulphur hexafluoride gas (SF6) as the medium used to quench arcs which form when switches are opened, have led to dramatic reductions in size, weight and complexity. About 10 per cent of the switchgear on the CEGB's transmission system is modern SF6; the rest is oil-break, air-blast, or SF6 of older design.

National and area grid control

3.24. The transmission system is controlled by six Area Grid Control Centres, co-ordinated in London by the National Control Centre (NCC). The Area Grid Control Centres are responsible for programme implementation, plant safety management, and the security of the local systems; the NCC has as its prime responsibility the secure and economic operation of the main interconnected transmission system. The operators at the NCC meet consumer demand by adjusting power transfers between grid control areas; Area Control Centres issue instructions to generating stations on the power required from them from one minute to the next. The objective is to respond to, and anticipate, changes in consumer demand over all parts of the system in a way which ensures that it continues to operate economically, securely and safely. To meet these changes in demand the CEGB needs to predict continuously, and as accurately as possible, levels of demand over the next 24 hours. It does this using demand forecasts based on analyses of past weather observations, past levels of demand and special

FIGURE 3.5

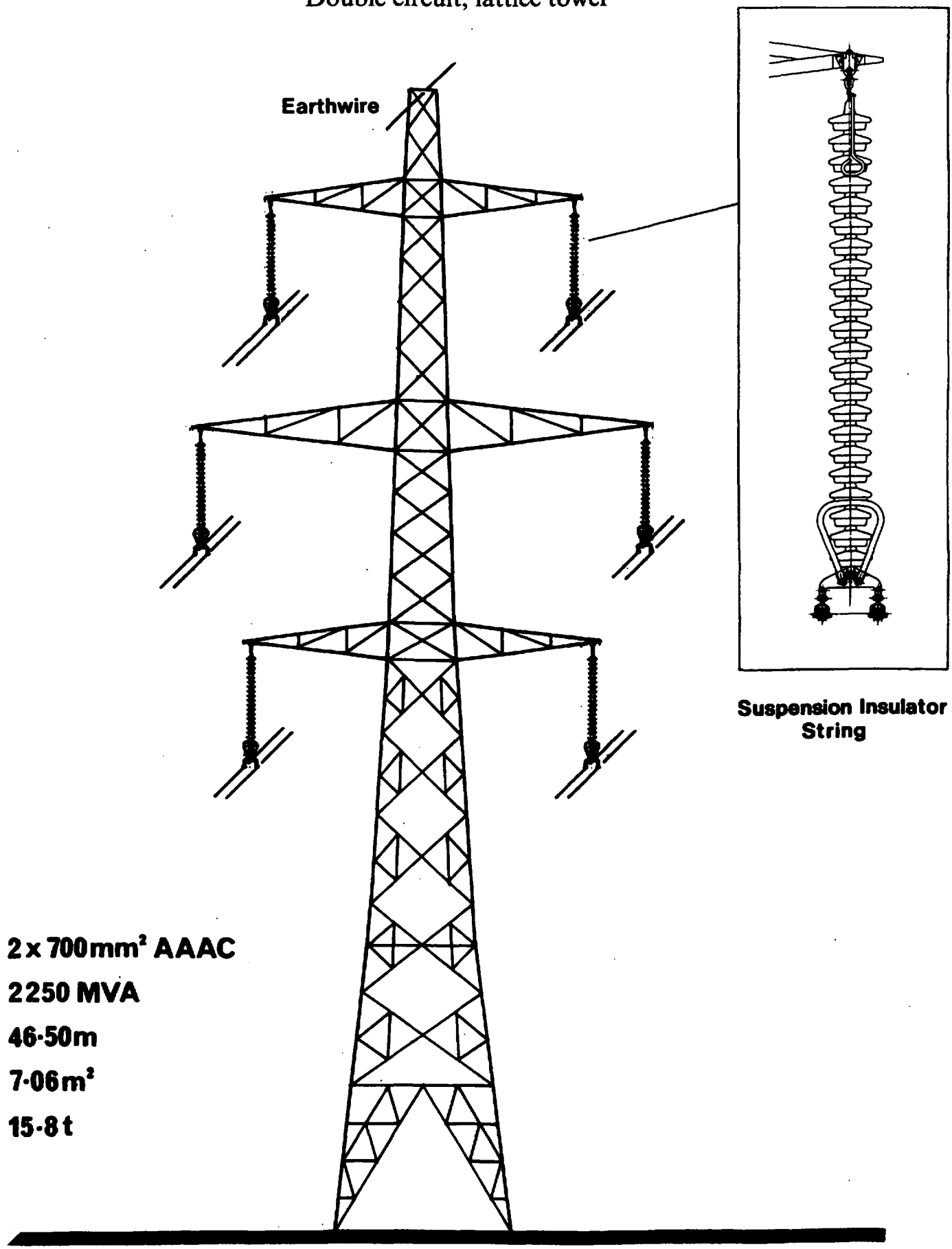
System power flows across key transmission boundaries expected in 1990



Source: The CEGB.

FIGURE 3.6

Double circuit, lattice tower



Source: The CEGB.

circumstances. When these are combined in a computer program with the latest information about the performance of generating and transmission plant, a generation schedule is produced for the period in question. A small reserve is included to cover forecast errors or plant failures.

Other suppliers to the grid

3.25. When the transmission system was first constructed in the 1930s it extended into the south of Scotland. Since 1954 the supply of electricity to Scotland has been separate from the supply to England and Wales (see paragraph 3.1), but the physical link remains and has indeed been reinforced. The CEGB and SSEB take advantage of this to trade electricity with each other, with the object of reducing the generating costs of both Boards and providing a secure supply. The NCC is in direct communication with SSEB's Grid Control Centre at Kirkintilloch. Table 3.1 shows that over the last five years the CEGB has purchased much more than it has sold. Purchases were particularly high following the 1984–85 miners' strike.

TABLE 3.1. **Trading in electricity between the CEGB and SSEB, 1982 to 1986**

GWh

	1982	*1983*	*1984*	*1985*	*1986*
Sales by the CEGB	101	306	176	2	108
Sales by SSEB	1,856	2,031	2,763	6,696	2,192

Source: The CEGB.

Note: Figures are for accounting years ended 31 March.

3.26. The CEGB has for some time purchased electricity from organisations generating electricity for their own use, and selling their excess production to the grid. There are provisions in the Energy Act 1983 which are designed to facilitate trade between such private generators and the CEGB or Area Boards; under the same act the Boards were also given the duty of encouraging schemes for the combined production of heat and power (CHP). Table 3.2 suggests that the provisions of the Act have not yet had much effect; the 1984–85 miners' strike was a more significant factor. The CEGB expects its purchases of electricity to remain broadly at present levels over the next five years.

TABLE 3.2. **Purchases of electricity by the CEGB from outside sources in England and Wales, 1982 to 1986**

GWh

1982	*1983*	*1984*	*1985*	*1986*
1,987	2,186	2,451	2,223	2,243

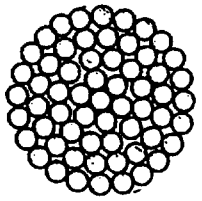
Source: The CEGB.

Note: Figures are for accounting years ended 31 March.

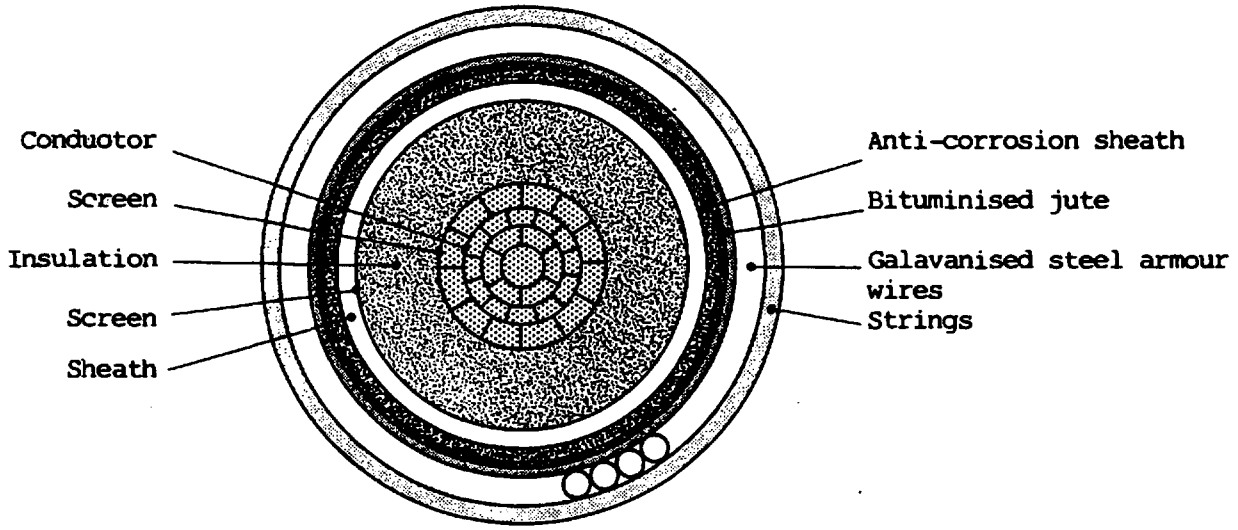
3.27. For some 20 years to 1982 there was a direct current link, with a capacity of 160 MW, between England and France. The cables for this lay on the bed of the English Channel and were occasionally damaged by ships' anchors and trawls. A new direct current link with a much greater capacity (2,000 MW) was completed in October 1986; this has been laid in trenches in the bed of the Channel for protection (a cross-section of submarine cable is shown in Figure 3.7). At present the flow is mostly from France to England, reflecting the lower marginal cost of electricity in France. Similar links with other national utilities are under consideration, although there are no plans to proceed with these at present.

FIGURE 3.7

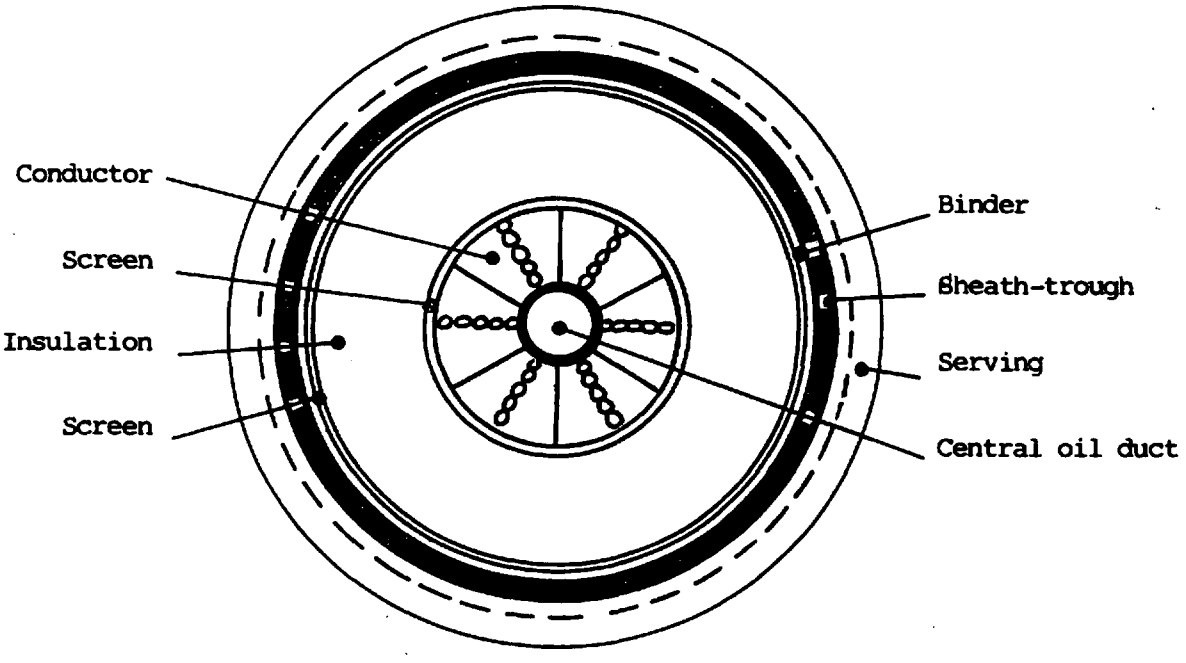
Cross-section of conductor and cables used for carrying electric current



All aluminium alloy conductor (Diameter 37.26mm)



900mm^2 270 kv DC submarine cable for Cross-Channel link (Overall diameter 104.2mm)



2,500 mm^2 400 kv oil-filled land cable (Overall diameter 131mm)

Source: The CEGB.