CHAPTER 9

The refurbishment of the distribution system

Reliability of the distribution system

9.1. Detailed statistics on faults and interruptions to supply are maintained through the National Fault and Interruption Reporting Scheme (NAFIRS) which covers the 12 Area Boards in England and Wales as well as the two Scottish Boards. NAFIRS data show that in 1984–85 the number of faults per 100 km of the North Board's system was similar to the national average (Table 9.1) although in terms of consumer interruptions and minutes lost per connected consumer performance was considerably worse (Table 9.2).

TABLE 9.1 **Fault rates: NSHEB and national averages, 1984–85**

	Faults per 100 km of system length		
	EHV	*HV*	*LV*
National average	6·0	9·9	28·7
NSHEB	7·5	10·0	9·0

Source: NAFIRS.

TABLE 9.2 **Consumer interruptions and time lost, NSHEB and national averages, 1984–85**

	Consumer interruptions per 100 consumers			*Minutes lost per connected consumer*		
	Faults	*Pre-arranged outages*	*All*	*Faults*	*Pre-arranged outages*	*All*
National average	71·2	8·4	79·5	51·2	23·5	82·7
NSHEB	214·1	28·4	242·5	227·9	72·6	300·5

Source: NAFIRS.

9.2. The North Board pointed out that because of the sparsely populated nature of its territory there is about three times as much overhead line per consumer as the national average. Moreover in the more remote areas of northern Scotland spur lines are used to connect consumers. Because of the additional length of line and the expected voltage drop on interconnections it is frequently not economic to provide interconnections. When a fault occurs or maintenance work is carried out on the line there is usually no alternative means of supplying consumers who are therefore disconnected. As Table 9.3 illustrates, the duration of consumer interruptions is significantly longer than the national average.

TABLE 9.3 **Duration of consumer interruptions, NSHEB and national averages, 1984–85**

	Average duration of consumer interruptions (minutes)		
	EHV	*HV*	*LV*
National	63	88	159
NSHEB	145	132	776

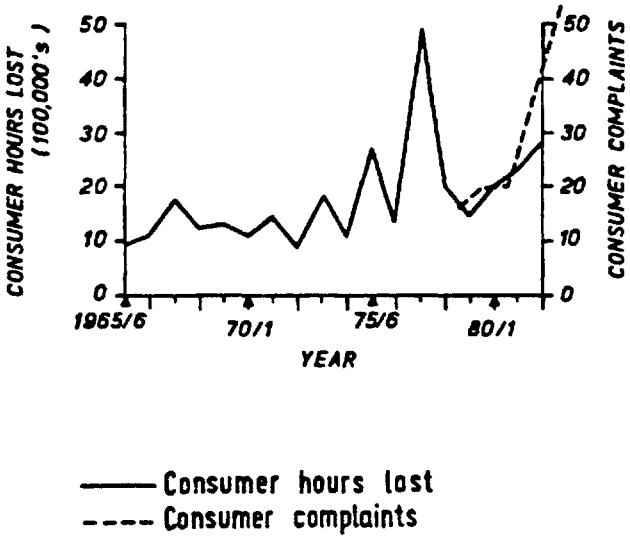
Source: NAFIRS.

The North Board told us that although maintenance staff are located strategically travelling distances are nevertheless often considerable and adverse weather conditions can further delay the arrival of staff at the site of a fault.

9.3. Compared with the national average some difference in the performance of the North Board's system may be expected but comparisons over time indicate a marked deterioration in system performance. Since the early 1970s consumer interruptions and minutes lost per connected consumer have risen relative to the national average (Figures 9.1 and 9.2). The increasing number of consumers hours lost each year has been accompanied by a rise in consumer complaints (Figure 9.3).

FIGURE 9.3

System performance: consumer hours lost



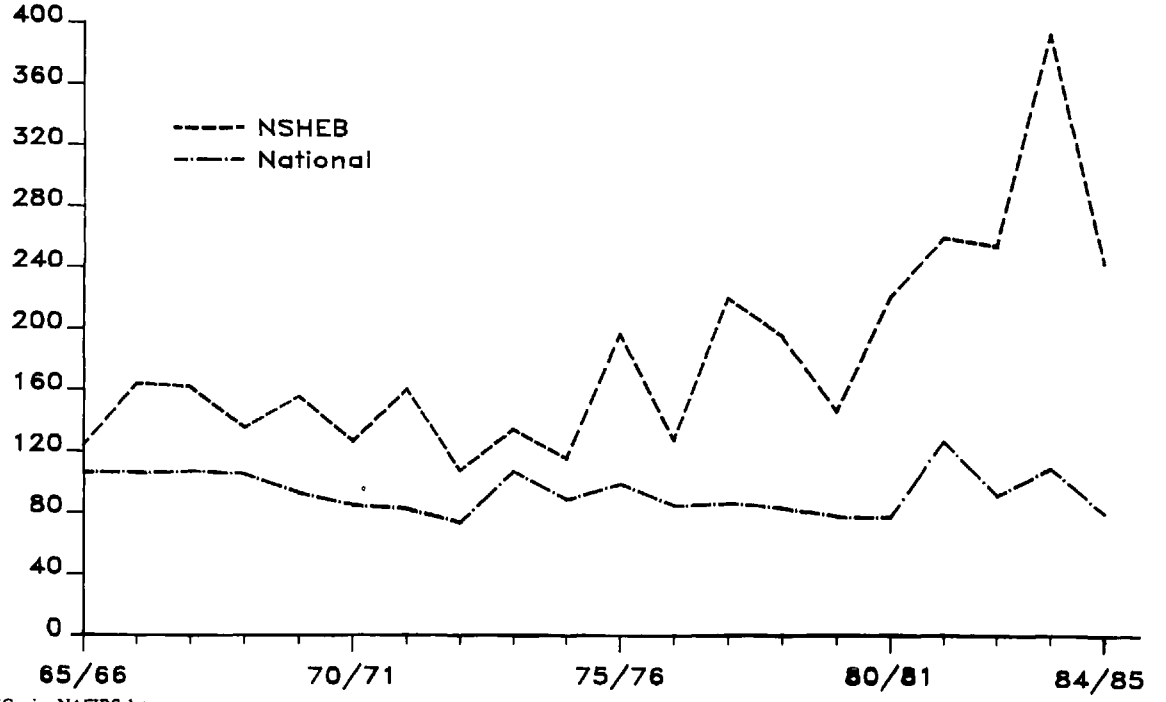
Source: NSHEB.

Apart from costs to the consumer from a deterioration in the quality of supply the North Board has experienced increasing losses of revenue from outages and the higher costs associated with more frequent and often emergency maintenance or replacement.

9.4. Before drawing up a refurbishment plan in 1983 the North Board looked at the main causes of consumer interruptions in 1981–82. In common with other industry supply systems most of the total number of consumer hours lost in 1981–82 resulted from distribution system faults and outages (see Table 9.4).

FIGURE 9.1

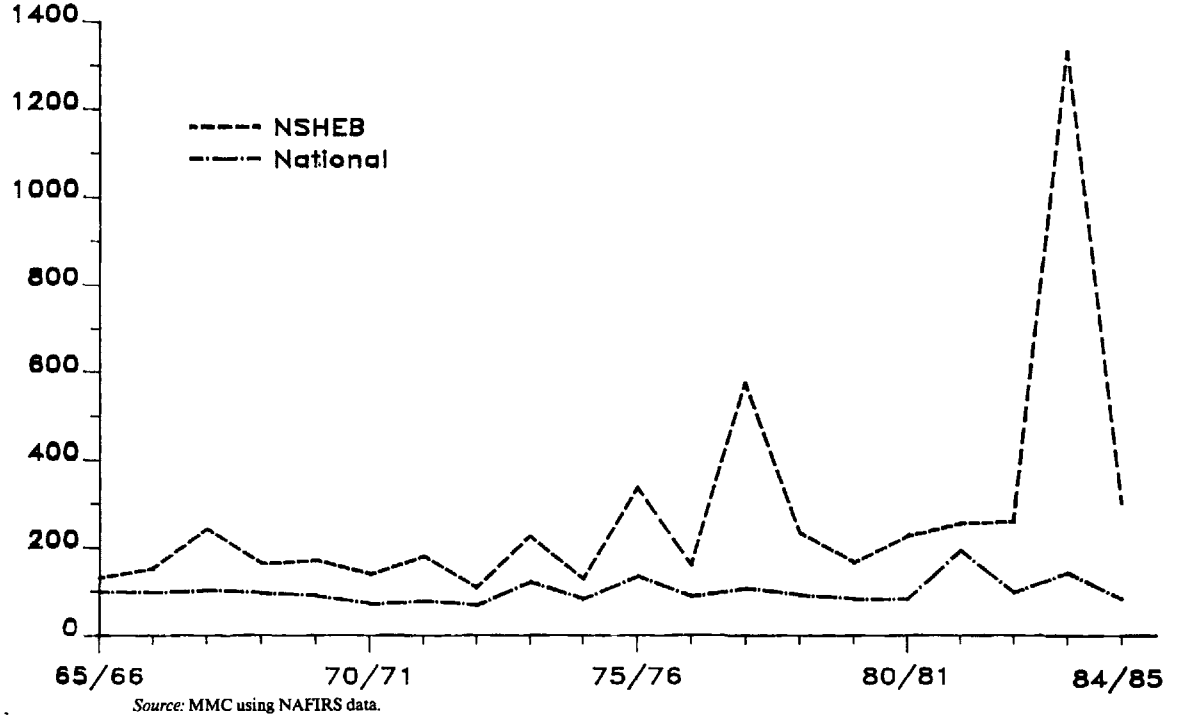
Consumer interruptions per 100 consumers 1965–66 to 1984–85



Source: MMC using NAFIRS data.

FIGURE 9.2

Minutes lost per connected consumer 1965–66 to 1984–85



Source: MMC using NAFIRS data.

TABLE 9.4 **Typical principal fault and interruption statistics in NSHEB, 1981–82**

		% of total
Incidents		
The total number of incidents or outages reported during the year:		
Failures of supply from generation	—	—
Consumer involved 132 kV system faults	25	0·41
Distribution system faults and outages	6,044	99·59
Total	6,069	100·0
Consumer interruptions		
The total number of consumer interruptions reported during the year:		
Failures of supply from generation	—	—
132 kV system faults	225,113	15·87
Distribution system faults and outages	1,193,576	84·13
Total	1,418,689	100·0
Consumer hours lost		
The total number of consumer hours lost reported during the year:		
Failures of supply from generation	—	—
132 kV system faults	63,234	2·72
Distribution system faults and outages	2,261,701	97·28
Total	2,324,935	100·0

Source: NSHEB.

9.5. The North Board's investigation of faults showed that they had been caused principally by deterioration through age of the distribution equipment, some of which dates from the 1920s. Deterioration was also evident in the newer lines and equipment installed in the post-war period and during the intensive programme of rural electrification carried out by the North Board in the period between 1950 and 1960. The main weaknesses identified are:

(*a*) *Overhead lines*

The number of faults on overhead lines doubled between 1970 and 1981–82 and accounted for over half the annual level of consumer hours lost in that year. Wood pole decay is a major problem. This has been attributed to the use of poor quality poles in the post-war period up to 1961 and the inadequate preservative treatment given to these poles. Also, although many have been replaced there are still lines in service which were built to the standards introduced in 1946.[1] The ice loading criteria specified by three standards have proved inadequate in recent severe winters and aluminium and steel conductors have been found to be unreliable in coastal areas because of their susceptibility to salt corrosion. In 1955 the North Board adopted a higher standard

[1]British Standard 1320.

of construction for its overhead lines and only recently has this been selectively adopted by other parts of the supply industry.

(*b*) *Underground cable*

The overall trend of cable faults shows a moderate increase. Cables which have been up-rated from 6·6 kV to 11 kV are working at higher stresses than those for which they were designed and are subject to increasing failure. A number of problems are also arising with oil-filled 33 kV cable.

(*c*) *Submarine cables*

Even under good conditions submarine cables have comparatively short lives but some of the earlier cables were laid on rocky beds with high tide speeds and were of light construction. Replacement is necessary to avoid an increasing number of major failures and high repair costs.

(*d*) *Transformers*

The number of transformer failures has doubled since the early 1970s. The main problem is corrosion and general deterioration with age.

(*e*) *Switchgear*

There are currently three times as many switchgear faults as in 1970. The problem is again largely one of age. Outdoor switchgear suffers particularly from corrosion and mechanism wear and incurs high maintenance costs as it gets older.

The North Board's refurbishment programme

9.6. In 1983 the North Board drew up a detailed age profile of its total distribution assets. The expected average life for each category of asset was derived from working experience. These are shown in Table 9.5 which also gives a comparison with published depreciation periods.

TABLE 9.5 **Asset lives**

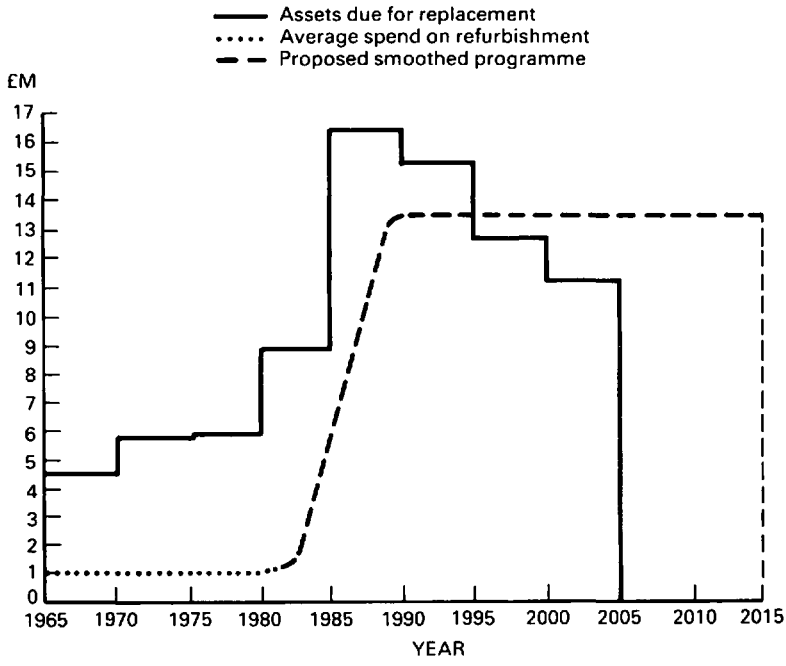
	Depreciation period	*years* *Normal expected life*
Overhead lines	30	35
Underground cables	40	50
Submarine cables	15	20
Transformers	25	40
Switchgear	25	30

Source: NSHEB.

9.7. Some replacement of assets has already taken place and allowing for this the North Board has derived a profile of replacement requirements. This is shown in Figure 9.4 together with the average annual level of spend on the refurbishment of the distribution system to 1983 and the proposed future programme.

9.8. Figure 9.4 illustrates the factors underlying the marked deterioration in the performance of the system. The peaks in pre- and post-war development of the network are reflected in a bunching of assets requiring replacement in the 1980s and 1990s. Added to this the postponement of refurbishment during the 1970s and early 1980s has led to the accumulation of a significant backlog of lines and other equipment in need of replacement. The North Board's 1983 review estimated that about £90 million should have been spent on asset replacement since the 1960s compared with the actual spend of approximately £30 million.

FIGURE 9.4 **Replacement programme**



Source: NSHEB.

9.9. The North Board told us that since the mid-1970s it has been under pressure from the Government to contain costs. Until 1982 the refurbishment of the distribution system (except where this was incidental to capital expenditure) was financed out of current expenditure and it was on operating costs that the North Board felt under particular pressure. Rather than cutting back more in other areas the North Board responded by curtailing expenditure on the reinforcement and refurbishment of the distribution system.

9.10. The North Board's current view is that although there has been considerable investment to improve security in generation and transmission there has been comparatively little investment in the reinforcement of the distribution system. There is thus a need to ensure that the general state of

distribution assets is not allowed to deteriorate significantly. The North Board's programme for the refurbishment of the distribution system proposes a commitment to expenditure on refurbishment which will rise to £13·5 million at September 1983 prices in 1989–90 and continue at that level through to 2015 (Figure 9.4). The programme assumes a five-year build up of resources to allow for recruitment and training from 1984, although a considerable proportion of the work will be put out to contractors.

9.11. Planned refurbishment expenditure by type of asset is shown in Table 9.6.

TABLE 9.6 **Refurbishment programme–financial**

£ million (1983 prices)

	Overhead lines	*Underground cables*	*Submarine cables*	*Transformer*	*Switchgear*	*Total*
1984–85	3·216	1·554	0·096	0·684	0·450	6·000
1985–86	4·289	2·072	0·128	0·911	0·620	8·000
1986–87	5·626	2·720	0·168	1·198	0·788	10·500
1987–88	6·700	3·237	0·200	1·425	0·938	12·500
1988–89	6·968	3·367	0·208	1·482	0·975	13·000
1989–90	7·236	3·479	0·216	1·539	1·012	13·500
Total five-year periods 1990–2015	36·180	17·482	1·080	7·696	5·062	67·500

Source: NSHEB.

9.12. About half of the total proposed expenditure is allocated to the refurbishment of overhead lines. Some 500,000 wooden poles are used by the North Board to carry overhead circuits, and their condition is assessed by special sampling studies that enable decay rates to be estimated. The North Board has recognised from these assessments that the useable life of wood poles is dependent strongly on the period during which the poles were harvested and impregnated. Studies indicate that the average useable life of pre-war pole is 49 years and for an early post-war pole 33 years. The data also support the North Board's decision to provide intermediate on-site treatment of poles greater than 18 years old by a specialist preservation contractor coincident with that contractor's pole inspections. Preservation treatment and replacement of individual rotten poles has helped to contain the problem of pole decay but full-scale refurbishment is seen as necessary. The North Board told us that it needs to replace poles at the rate of 10,000 a year. The rate of replacement is currently 7,000 to 8,000 a year though it is possible that the rate might reach 10,000 in three to four years' time. Lines built to British Standard 1320 will be upgraded (similar work is currently being undertaken by Boards in England and Wales) and aluminium and steel conductors replaced with copper conductors.

9.13. Underground cables have a comparatively long expected life (see Table 9.5) and the North Board anticipates that the need for replacement will be relatively modest until the turn of the century. Considerable importance is attached to replacing ageing switchgear and transformers because of the expected increase in the amount of this equipment reaching the end of its useful life over the next ten years and the significant impact failure of

switchgear and transformers can have on system performance. There will also be benefits in the form of reduced system losses and maintenance costs as old equipment is replaced by equipment of modern design.

9.14. We understand that the refurbishment programme has not been subject to an economic appraisal. In developing a strategy for refurbishment the North Board's three objectives are to:

(*a*) enhance the benefit from the natural spread of replacement by effort to attenuate the peaks of resource requirement by smoothing work over a longer period where feasible;

(*b*) begin refurbishment immediately in order to avoid excessive increases in repair costs; and

(*c*) complete the programme of initial replacement within a realistic period.

However, it is recognised that the programme proposed will mean that the volume of assets overdue for refurbishment will continue to increase until 1995 and a possible lower standard of supply and higher security risk is anticipated during this period. Efforts will be made to minimise these risks by replacing those assets in the worst state of repair first.

Implementation of refurbishment

9.15. The programme of refurbishment drawn up in 1983 is based on an aggregate analysis of the age and life of overhead lines, underground and submarine cables, switchgear and transformers rather than on a detailed survey of this equipment at Area or district level. The North Board told us that since then considerable work has been undertaken on the identification of particular lines in need of attention. We were also told that the implementation of the programme is based on the detailed authorisation of these works costing over £50,000 which the Areas put forward for Head Office approval. Guidelines for establishing priorities between projects have very recently been drawn up but there is not yet in place any consistent method for establishing priorities between projects at either Area or Head Office level (see paragraph 7.51). The current procedure for allocating refurbishment resources to Areas (which will be largely responsible for implementing the programme) is to make an initial tentative budget allocation and to reallocate in the event of the emergence of a different pattern of spend.

9.16. The first full year of the distribution refurbishment programme is 1984–85 but some figures are also available for Area spend on refurbishment in 1983–84. The annual plans for Areas contain the expenditure targets and actual spend: figures for 1983–84 and 1984–85 are shown in Table 9.7.

TABLE 9.7 **Refurbishment expenditure for transmission and distribution system**

					£'000
		Aberdeen	*Highland*	*South Caledonia*	*Dundee*
Target	1983–84	623	879	1,256	861
Actual	1983–84	310	591	857	840
Target	1984–85	1,060	1,018	1,018	1,060
Actual	1984–85	677	1,183	1,379	999

Source: NSHEB.

In 1983–84 Aberdeen achieved only 50 per cent of its plan and Highland only 67 per cent. Aberdeen and Highland claimed shortage of resources and pre-occupation with storm repair work as the contributory factors. In 1984–85 the total spend for the four Areas was £4·24 million compared with a target of £4·16 million but the expenditure of Aberdeen again fell well below the target.

Overview

9.17. It is clear that refurbishment will be an increasingly dominant feature of the North Board's expenditure and that there is a strong commitment to implementing the refurbishment programme. The North Board has told us that it was only in the early 1980s that deterioration in service to consumers became clearly apparent and that it responded to this in 1983 by a general review of its assets and the development of the expenditure plans which are now being put into effect. This investment is now being given the highest priority in its planning and new methods are being developed to guide implementation at Area level.

Conclusions

9.18. We recognise that the geography of the North Board's territory will affect the performance of its distribution system. Nonetheless since the early 1970s there has been an absolute decline in the standard of service to consumers and the gap between that of the North Board and the national average has widened. This decline has been the result of inadequate expenditure on the refurbishment of the distribution system, a symptom of which is the growing backlog of equipment in need of replacement. There have been increased costs to the North Board due to emergency maintenance. We are particularly concerned that the North Board did not anticipate the need for a planned programme of replacement of distribution equipment and that such a programme was not drawn up until 1983 by which time the standard of service to the consumer had shown significant deterioration. We recommend that recognition of the maturity of the North Board's system and the increasing emphasis on replacement should be given top priority in the Corporate Plan.

9.19. A comprehensive programme for the refurbishment of the distribution system was drawn up by the North Board in 1983. However, given the backlog of refurbishment identified we are concerned that resources allocated under this programme may be insufficient to prevent the standard of service to the North Board's consumers from declining further for a number of years. We question whether the current programme is an adequate response to the need for the replacement of ageing distribution equipment.

9.20. In these circumstances it is surprising that allocation of the refurbishment budget between Areas appears to be on an *ad hoc* basis with reallocation between Areas during the course of each year. Area spend against budget may thus be a poor indicator of the rate of progress compared with what is desirable. We note that in 1983–84 all Areas underspent against budget, by 50 per cent in one case, and that only 72 per cent of the total Area

refurbishment budget was spent. In 1984–85 the overall expenditure target was achieved, but a reallocation of resources between Areas due, in part, to the impact of storm damage on one of them resulted in Area spend varying from 64 per cent to 136 per cent of the original budgets. We consider that the North Board should develop and use its priority assessment and monitoring procedures to ensure that refurbishment expenditure is devoted to areas of greatest need.