

THE HEALTH AND SAFETY EXECUTIVE'S ENFORCEMENT POLICY FOR THE REPLACEMENT OF IRON GAS MAINS

Background

1. There is a high level of societal concern about the potential consequences of gas mains failure. The Health and Safety Executive (HSE) is therefore requiring Transco to take further prudent and practicable steps to reduce this risk. The Office of Gas and Electricity Markets (Ofgem) has agreed that if HSE requires Transco to accelerate its current mains replacement programme it will adjust Transco's price control to allow for this.

2. The principal risk associated with the integrity of the gas mains supply is the risk of injuries, fatalities, and damage to property caused by gas releases and subsequent explosions. An accelerating rate of pipe fracture could lead to widespread failure in the integrity of the network. The combination of widespread failure and a catastrophic incident could affect public confidence to the extent that risks are re-evaluated and deemed unacceptable.

3. Transco obtains limited information each time there is a failure and this informs the risk models used to determine priority programmes for mains replacement. However, the only way they could obtain comprehensive information on the mechanical condition of the mains would be to excavate the whole of the 'at risk' network. This would create major problems of practicability and new health and safety risks.

4. There are about 91,000km of remaining iron mains within 30m of buildings ('at risk' mains) which may give rise to a risk to people. The majority of these - some 78,000km - are cast iron mains, the remaining 13,000km being low pressure ductile iron mains (see Appendix 1). Each year these mains suffer about 23,000 fractures and corrosion failures leading to 600 'gas-in-building' events causing on average 3 to 4 major incidents (fires and explosions) resulting in the deaths of 1 to 2 people annually. However, each gas release incident has the potential - depending on location - to cause multiple fatalities: for example Putney (in 1985 - 8 fatalities), Rutherglen (in 1985 - 5 fatalities) and Larkhall (in 1999 - 4 fatalities).

The risks and their containment

The need for a precautionary approach

5. Iron pipes make up slightly less than 50% of the Transco network, the remainder being made of polyethylene or steel. Most of the iron pipes are over 40 years old; some are more than 100 years old. Transco prioritises the replacement of these these pipes using a system developed in conjunction with the HSE but there is considerable uncertainty about their exact condition and future integrity. It is, however, conceivable that within the next 20 to 30 years parts of the network may reach the end of their reliable mechanical life. If this point is reached, a rapid increase may occur in both the rate of failure and the number of incidents, some of which could well involve multiple fatalities, even though the risk cannot be quantified accurately at this stage. In such circumstances, which would be likely to arise in the winter months, the only option might be to shut down the particular network and cut off the gas supply to both commercial and domestic consumers.

6. There would be considerable pressure to replace the failing network as quickly as possible. But this in itself entails risk. Such work is often carried out in the middle of busy roads. Where construction activity in such locations is carried out on an emergency basis without the opportunity for careful and detailed planning, experience shows that those involved in the replacement activity are exposed to a significantly increased risk of fatalities and serious injuries.

7. A significant safety risk also arises in reconnection, as unless all appliances are properly purged gas/air mixtures can arise resulting in more explosions. To give an idea of the scale of the challenge, to reconnect 3,000 consumers safely can take at least two weeks provided there are sufficient trained staff available. Reconnection delays in the event of a major programme of work following an emergency could induce unqualified consumers to attempt to relight their own appliances, thereby increasing risks to health and safety still further.

8. Given the history of the development of the system and the extent of the buried network, Transco cannot realistically be expected to know the exact condition of all its iron mains. A precautionary approach to the issue of accelerating the replacement programme is therefore needed. The approach is based on the principles of risk aversion under conditions of uncertainty and substantial societal concern, and the need to avoid a foreseeable, unacceptable harm (in this case the potential consequences of a catastrophic failure of a gas main in a populated area) unless the costs of such avoidance can be shown to be grossly disproportionate.

The historical position

9. Since 1977 there has been a targeted programme of replacing these 'at risk' mains. Over this period 61,000 km have been replaced with a highest annual rate of replacement of 3,300 km/year. Over the past 5 years the average rate of replacement necessary to achieve the agreed safety outputs was 1,840 km/year and at this rate it would take a further 51 years to replace all of the 'at risk' metal mains.

10. This targeted programme together with gas release reporting and emergency response has reduced the number of incidents (involving death or serious injury to people or major damage to property) from an average of 25 per year in the 1970s to the current figure of 3.5 per year. However the fracture rate has shown a slightly rising trend, having increased from about 13 per 100 km in 1977 to about 14.5 per 100 km in 1999. This could be a signal that the network is deteriorating, although the number of incidents is not rising correspondingly due to the current level of replacement activity.

11. The historic rate of replacement since 1977 averages out at 2,650 km/year. To return to this rate which is higher than that achieved in the last 5 years (1,840 km/year) would mean replacement of the 'at risk' mains in 35 years. If the rate of deterioration of the network does not increase, about 52 major incidents can be predicted to occur during this period.

12. The Monopolies and Mergers Commission (MMC) agreed in its 1997 report on Transco's price control that there should be no deterioration in Transco's safety standards, defined by HSE at the time as the minimum legal requirement. It also noted, though it did not fully support, Transco's proposal to replace mains at a rate

of 2,650 km/yr over the 5-year period from 1997, compared with 2,250 km/yr achieved over the the previous 5 years, commenting that some further gradual improvement in standards would seem appropriate until HSE, Transco and the economic regulator (now Ofgem) decided on a new programme.

The legal position

13. The Health and Safety at Work etc. Act 1974 (HSWA), section 3(1), requires Transco to conduct its undertaking to ensure, so far as is reasonably practicable, that persons not in its employment are not exposed to risks to their health and safety. In making a judgement on what is 'reasonably practicable' the courts will take into account standards which have been achieved in the past. HSE's view is that it is reasonably practicable for Transco to increase its replacement activity to at least the historical average.

14 However, in addition, the Pipelines Safety Regulations 1996 (PSR) require (regulation 8) that pipelines be composed of material that is suitable; (regulation 9) that it has been constructed so as to be sound and fit for purpose; and (regulation 13) for the operator (Transco) to ensure that a pipeline is maintained in an efficient state, in efficient working order and in good repair. All of these duties are absolute, with a limited defence if a breach is caused by a third party.

15 HSE is currently developing proposals for amending the PSR regulations so as to provide an explicit legal underpinning for any programme approved and agreed with Transco. In accordance with the normal practice of the Health and Safety Commission, any proposals for legislative change in this area will be the subject of full public consultation.

Transco's Replacement Policy from 2000

16. Transco currently applies a risk-based methodology agreed with HSE and Ofgem to inform its mains replacement programme. The effect of the current approach to maintaining existing safety standards could require only a few hundred kilometres of cast iron mains to be replaced each year gradually decreasing to a very low level. Following review, HSE no longer considers the programme to be an acceptable course of action because it:

- a. does not constitute adequate action to comply with the requirements of health and safety legislation;
- b. does not address the likelihood and severity of the health and safety (and social and economic) consequences should a rapid deterioration of the network occur.

Options

17. The aims of a replacement policy are:

- a. first, to pre-empt as far as possible a sudden deterioration in the integrity of the network, such as would entail unplanned emergency action and the associated risks described above;
- b. to enable Transco to react more effectively than would otherwise be the case in the event of a sudden deterioration taking place before the completion of the targeted programme.

18. The quicker the 'at risk' mains can be replaced the smaller the chance of the onset of rapid deterioration. As the replacement proceeded, the scope for disruption and danger in any situation that did develop would progressively diminish. Thus, the extra cost incurred in replacing mains faster than the historic replacement rate is essentially an insurance premium to avoid the adverse consequences of rapid deterioration, and also to prevent the incidents that would occur even without this deterioration because the public would be exposed to risk for a shorter time.

19. All options for Transco to reduce the period within which the mains are replaced involve 3 stages: a steady increase in the replacement rate over a period of years to a maximum; maintenance of that maximum rate for a number of years; and then progressive reduction of this rate to zero over the final few years of the replacement programme. This profile is needed to deal with the logistics of recruiting and training staff to do the work and then reducing the workforce towards the end of the programme. HSE considered a number of options to see what might be practically achievable.

A 35 year Programme

20. This is the programme that Transco would achieve if the replacement rate were increased to match the historic average replacement rate of 2,650 km/year described above. According to cost projections made by Transco, the gross cost of the programme would be £15.1 billion over 35 years (see Appendix 2). However, much of this expenditure is well into the future. Forecast gross costs over the next five years would be £2.16 billion (including service pipe replacement). The present value of total costs, taking into account cost savings, is £5.8 billion over thirty-five years. In HSE's judgement, this would be the minimum programme needed to enable Transco to comply with HSWA.

A 25 year Programme

21. This would require an increase in the replacement rate over 5 years to a plateau of 4,300 km/year for 15 years and then a gradual decrease in the rate over the next 5 years. Transco has estimated that, compared to a 35 year programme, a 25 year programme would cost over the period an extra £1.5 billion (net present cost). Over the next 5 years the forecast total cost would be £3.8 billion (including service pipe replacement).

22. However, a rate of 4,300 km/year is far greater than has ever been achieved. Major constraints include the difficulty of ensuring the availability of sufficient numbers of trained personnel and logistical problems associated with organising large-scale pipe-laying operations in urban areas. Moreover, the reaction of the public and commerce to the inconvenience and widespread disruption of supply is unknown but could be very strong. On these grounds **a 25 year programme does not appear, in our present state of knowledge, to be practically achievable.**

A 30 year Programme

23. This would require an increase in the rate over 5 years to a plateau of 3,580 km/year for 20 years and then a gradual decrease over the next 5 years. On the basis of figures provided by Transco, compared to a 35 year programme a 30 year

programme would cost approximately an extra £650 million (net present cost) over the period. With some rephasing of the more expensive large diameter mains replacement, the total forecast cost for the next five years would be contained to £2.27 billion, that is an additional £110 million on the cost that would be incurred in the first five years of the 35 year programme. Transco has achieved rates of the order of 3,300 km/year previously and the associated disruption was tolerated by the public and commerce. **Therefore this option is practicable.**

24 Ofgem and Transco are now considering how best to manage the funding of necessary expenditure in the period 2002/3 - 2006/7. HSE's decision has taken into account Transco's cost estimates. However, the HSE notes that Ofgem is currently scrutinising these costs and may make its own assessment of the efficient costs of the work programme in setting the allowed revenues for Transco's price control from April 2002. The outcome of these considerations will determine the effect on consumer prices. Ofgem is expected to announce its decisions on 26 September 2001.

25 Against the cost, there will be the benefit of significantly reducing the likelihood of incidents due to rapid deterioration of the network and the consequences of any emergency repair programme undertaken as a result of deteriorating safety levels. In addition, there will be the benefit of avoiding the four incidents that could be expected if the incident rate continued at the current level.

HSE's Decisions

26 HSE considers it realistic and practicable for Transco to speed up its rate of mains replacement over the next 5 years so as to be in a position to complete the replacement of all the remaining 'at risk' iron mains within a total of 30 years at most. This precautionary approach is in line with the principles of risk aversion under conditions of uncertainty and the duty to avoid unacceptable harm unless the costs of doing so can be shown to be grossly disproportionate.

27 However, given the uncertainty surrounding this issue, HSE recognises that it will need to keep the policy under review as implementation proceeds. HSE accordingly intends to review the position before the end of the first 5 years, so that an agreed programme can be confirmed for the following period. HSE will also require Transco to undertake further work within the initial 5-year period to reduce the uncertainty by carrying out research to enable the risks to be assessed more accurately.

28. HSE is also developing proposals for amending the law with a view to facilitating the implementation of the new programme (see paragraph 15). The intention is that legislative proposals will be put to the Health and Safety Commission (HSC) who will issue a consultative document for public comment. Following consideration of the responses to this consultation, the HSC will then in accordance with normal practice advise Ministers on any appropriate legislative changes.

APPENDIX 1

'AT RISK' POPULATION

Material	Length of Low Pressure (Km's 000s)	Length of Medium Pressure (Km's 000s)	Total Length (Km's 000s)
Cast Iron	73.0	4.7	77.8
Ductile Iron	13.0	-	13.0
Totals	86.0	4.7	90.8

TOTAL IRON MAINS POPULATION BY DIAMETER & MATERIAL

Pipe Size	Pit Cast Iron (Km's 000s)	Spun Cast Iron (Km's 000s)	Ductile Iron (Km's 000s)
Diameter <=3"	3.1	2.2	0.1
Diameter 4-5"	21.8	23.1	8.8
Diameter 6-7"	16.9	13.2	7.7
Diameter 8-11"	6.3	3.9	1.7
Diameter >=12"	4.1	2.2	1.6
Totals	52.2	44.7	19.9

APPENDIX 2

IRON GAS MAINS REPLACEMENT

COSTS AND BENEFITS

Risks

1. The principal risk associated with the integrity of the gas mains supply is the risk of injuries, fatalities, and damage to property caused by gas releases and subsequent explosions. An accelerating rate of pipe fracture could lead to widespread failure in the integrity of the network. The combination of widespread failure and a catastrophic incident could affect public confidence to the extent that risks are re-evaluated and deemed unacceptable.

2. If as a result risks are suddenly considered unacceptable, then the only recourse may be to temporarily shut down part of the network using the remaining cast-iron pipelines, and implement an emergency replacement programme. (The most dense populations would be targeted first, and supply to critical sites, such as hospitals and large process plants would either be maintained, or disruption greatly minimised. Many of these sites would also have emergency back-up facilities, or be able to switch between gas and heavy fuel oil.) The need to adopt emergency measures is reduced as the mains replacement programme is accelerated.

Costs of accelerating the replacement programme

3. Transco have estimated that the costs of the replacement programme would be £16 billion over twenty five years, £15.8 billion over thirty years and £15.1 billion over thirty five years. These are undiscounted total costs, in current (year 2001) prices.

4. However, more rapid replacement brings benefits in terms of a more reliable system. Discounted at 6% in line with HM Treasury guidelines, the net costs of the programme are £7.3 billion over twenty five years, £6.5 billion over thirty years and £5.8 billion over thirty five years. The difference in costs between the thirty and thirty five year programme is around £650 million in present value terms - if both programmes were completed as scheduled.

Balance of costs and benefits

5. Accelerating the replacement programme to thirty years should reduce the number of incidents from faulty gas mains, even if there is no increase over current failure rates. However, the number of incidents prevented (around four) has to be set against the additional cost of £650 million in present values. This results in a cost for each incident avoided of around £160 million (with the potential for a greater number of incidents associated with a deteriorating network).

6. However, accelerating the programme would have two other possible outcomes:

(a) the need for emergency remedial programmes would be avoided if a part of the network had been replaced, before widespread failures of that part would have occurred under the 35 year programme.

(b) even if such emergency programmes were to prove necessary before 30 years, a higher rate of replacement would mean less of the network would comprise iron mains. Hence an emergency programme of repair would be less extensive and less costly.

7. As examples of the costs that could be avoided under these two different scenarios, the effects of an emergency replacement programme which would involve around 11% of the low and medium pressure network (some 27,000 kms) over two years have been estimated. (These costs are based on discussion with Transco about the scope and implications of such a programme, but should be regarded as indicative only.) Costs arise through the pipeline works, but also through the inevitable disruption to supply affecting domestic and commercial/industrial users. The present value of such costs depends on their timing: undiscounted they are estimated at some £12.1 billion, at 20 years hence the present cost is £3.8 billion, at 25 years hence, £2.8 billion. These costs would be entirely avoided if outcome (a) was a consequence of accelerated replacement.

8. If (b) were the outcome, there could still be a benefit of faster replacement. The 30 year programme replaces the 'at-risk' cast-iron mains at a rate around 17% higher than a 35 year programme. At year 25 of the 30 year programme, there would be only 6% of the network left to replace. Under a 35 year programme there would still be around 11% left to replace. The difference between the extent of emergency programmes under these circumstances (the present value benefit of the higher rate of replacement) would be some £1.3 billion.