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HSE's LAND USE PLANNING ADVICE TO LOCAL PLANNING AUTHORITIES FOR MAJOR ACCIDENT HAZARD PIPELINES.

Summary.

Regulations 20, 21 and 22 of the Pipeline Safety Regulations 1996 (**PSR**) and Condition 8 of a Public Gas Transporters licence require details of new and major changes to existing Major Accident Hazard Pipelines (**MAHP**) to be notified to the Health and Safety Executive (**HSE**). HSE is also consulted by DTI in issuing Pipeline Construction Authorizations under the Pipeline Act 1962 (**PLA**).

In addition to triggering assessment of technical integrity and safety arrangements, the HSE is required as a statutory consultee to Planning Authorities (**LPA's**) to provide land use planning (**LUP**) advice for preservation of safety of persons in the vicinity of major accident hazard pipelines.

This paper describes the background to HSE's LUP methodology and decision criteria, its development and explains how this is used to provide information to the LPA upon which LUP controls may be established.

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The views expressed in this paper are those of the author and should not be taken as a definitive statement of HSE policy.

Legislative background for land use planning.

Arrangements have been in place since 1972 for Local Planning Authorities (**LPA's**) to obtain advice about risks associated with major hazards and the potential effects on the local population from the HSE after it was established under the Health and Safety at Work Act in 1974 and its predecessor before that date. One outcome of the 1973 Flixborough disaster, was the setting up of the Advisory Committee on Major Hazards (**ACMH**) by the Health and Safety Commission (**HSC**). ACMH exists today as the Advisory Committee on Dangerous Substances (**ACDS**), a panel of independent experts to consider and make recommendations to HSC on safety controls for siting and operation of major accident hazard sites.

Between 1976 and 1984, ACMH produced three reports which together provide the basis for HSE's approach to Land Use Planning (**LUP**) and its harm criteria developed for major hazard installations. These were implemented in the 1982 NIHHS and 1984 CIMAH regulations. Before the advent of the Pipeline Safety Regulations 1996 (**PSR**), NIHHS and the Pipe-lines Act 1962 (**PLA**) defined the major accident hazard pipelines to which LUP safety controls apply.

Formal consultation arrangements under which the HSE advises LPA's on safety aspects of land use planning generally are provided in Article 18 of the Town and Country Planning (General Development Procedure) Order 1988 (updated 1995). Over the years, the administrative arrangements and legal framework for planning controls have been developed and modified. The Department of Environment Circular 9/84 (updated 11/92), Welsh Office Circular 17/84 and Scottish Development Department Circular 9/84 (updated 5/93) introduced the consultation arrangements for proposed new developments in the vicinity of major hazards. Under these, HSE is charged with providing safety advice that the risks to persons affected are given proper consideration within the planning process exercised by LPA's on behalf of their local communities. These are hazardous installations licensed under the Planning (Hazardous Substances) Regulations 1992, Planning (Hazardous Substances)(Scotland) Regulations 1993 (the so called 'consents regs') and Notifications of Installations Handling Hazardous Substances 1992 (NIHHS) for hazardous pipelines. Gas transmission pipelines constructed under the Gas Act were separately notified under that Act and are now subject to notification to HSE under Condition 8 of the Public Gas Transporters operating license as well as PSR.

Circular 20/92 set out the principles that have guided HSE policies in considering new planning developments in the vicinity of existing installations and pipelines, these are :

- i) risks considered are residual risks after all reasonable measures have been taken in order to comply with the Health and Safety at Work Act 1974.
- ii) where appropriate, risk are considered as well as hazards, i.e. likelihood as well as consequences of an accident event.
- iii) account is taken of the size and nature of the development, i.e. inherent vulnerability of exposed population, ease of evacuation, emergency procedures, existing surrounding land use, residential, large estates, industrial, sheltered accommodation, schools, hospitals, etc.
- iv) risk of serious as well as fatal injury, particularly the potential for large numbers of casualties is considered.

LPA - HSE Consultation Process.

Not all pipelines attract LUP controls, just those defined under Section 2 of PSR as ‘major accident hazard pipelines’ (**MAHP’s**) and subject to notification to HSE due to the hazardous substance conveyed, as defined in Schedule 5.

For new pipelines notified under Reg.20, HSE calculates and advises to the LPA a band of interest centred on the pipeline extending a specified distance on either side called the ‘Consultation Distance’ (**CD**) within which new occupied developments attract attention on grounds of safety. HSE provide LPA’s with simple decision guidelines based on three safety zone boundaries and occupied buildings categorisations from which can be determined ‘advise against/not advise against’ decisions and to filter out those cases to be referred to HSE under the formal LUP consultation arrangements.

The cases referred to HSE for consultation are sent to the relevant HSE local Hazardous Installations Directorate (**HID**) Land Division (**LD**) office there to be adjudicated against codified decision methodology which is then summarized in an LUP advice response letter back to the LPA. Those cases either not covered by the methodology or more complex in nature, may require advice as to the residual risk levels and in formulating LUP advice from HID Methods Standards Development Unit (**MSDU**) prior to responding to the LPA.

Assessment of these more complex cases by MSDU seeks to ensure that all reasonable tests and considerations are made which might permit the development. Final analysis of the few cases where residual risk levels are still outwith HSE’s acceptance criteria for harm will usually be made by quantified risk assessment using MSDU’s MSHAP assessment software. There is also the facility for peer review examination of these cases by MSDU ‘Panel’ comprising of relevant discipline specialists who arrive at a final outcome which is documented and advised to the HID LD office.

Should an LPA, after weighing the relevant factors of the case, be minded to set aside HSE’s ‘advise against’ advice and where HSE considers the case for safety particularly strong, it may under English law, request the Secretary of State to ‘Call In’ the case. In Scotland, calling in is automatic where an LPA goes against HSE’s safety advice. Calling in really permits more time and focus for discussion between all the parties concerned to achieve a resolution. It is extremely rare for HSE to exercise this option, the test being that HSE is satisfied that its advice was given due consideration in the planning process. More likely in such cases, is for the affected parties to call for a Public Inquiry to be held and the Reporter to make recommendations to the Secretary of State or Scottish Secretary. HSE provide support to the LPA by written depositions and oral vidence at the inquiry. Unless there are particular national issues, the Scottish Secretary devolves the final decision to the LPA which usually accepts the inquiry Report’s findings.

HSE’s LUP advice.

Upon notification of a new pipeline by the Operator, HSE advises to the LPA the initial CD which has within it two, or in some cases one, further zone boundary. The three-zone boundaries are, inner zone (**IZ**), middle zone (**MZ**) and outer zone (**OZ**)(also the CD) beyond which, in HSE’s view, risk of harm would not be sufficient to support advising against a specified category of development on safety grounds.

The IZ is often hazard based, according to the particular pipeline parameters, robustness of available frequency data and assessment model and the prevailing uncertainties.

Once set, the LPA applies the advised CD and guidelines provided to assess planning applications and in most cases provide a decision without further reference to HSE, leaving the minority of cases to be decided in consultation with HSE.

HSE Categories of occupied buildings.

For LUP purposes, developments HSE grades buildings according to general size/type criteria:

- residential accommodation;
- more than 250 m² of retail floor space;
- more than 500 m² of office floor space;
- more than 750 m² of industrial floor space;
- developments that could increase the risk or consequences of hazards, eg: likely to result in material increase in numbers of persons living/working within the CD, eg: schools, hospitals, etc; modifications to existing establishments which significantly increase residents; transport links, locations frequented by the public, new residential areas in the vicinity of existing establishments where the siting or development is such as to increase the risk or consequences of a major accident.

These grades of building are further categorised by HSE for its assessment purposes according to the perceived vulnerability of the occupants:

- A** Residential housing, hotels, holiday accommodation, some outdoor leisure facilities.
- B** Workplaces, parking areas.
- C** Retail outlets, community and leisure facilities.
- D** Institutional establishments, special accommodation (schools, hospitals, old peoples homes).

HSE's risk based decision matrices use these development categories and IZ/MZ/OZ to Determine a planning application's acceptability as summarised in Table 1:

General pipeline LUP decision matrix.

Development category	Consultation zone		
	to IZ boundary	to MZ boundary	to OZ boundary
A	Advise against	Consult	Don't advise against
B	Don't advise against	Don't advise against	Don't advise against
C	Consult	Consult	Don't advise against
D	Advise against	Consult	Consult

HSE's Assessment Criteria.

HSE rates individual risk of thermal, toxic or overpressure harm in chances per million (**cpm**) of the 'typical occupier/user of a building being exposed to a 'dangerous dose or worse' (**ddw**) from a range of possible events, but for the purposes of this paper, methodology and criteria for assessment of thermal hazards only will be examined.

HSE defines ddw as that dose which has the potential to cause death, but will not necessarily do so, having the following effects among typical affected populations :

- severe distress to almost everyone affected;
- a substantial fraction require medical attention;
- some people are seriously injured and require prolonged treatment;
- highly susceptible people might die.

Another criteria, 'significant likelihood of death' (**slod**) based upon approximation of 50% fatalities is receiving consideration, but has not been adopted so for pipelines. For the purposes of this paper, methodology and criteria for assessment of thermal hazards only will be examined. HSE prefers the concept of ddw over slod because it has been shown that society is concerned about risks of levels of serious injury as well as death. There are also technical difficulties in calculating risk of death to individual members of a population having widely differing vulnerabilities.

The use made of buildings will vary with occupants pattern of living, but very broadly will fall into daily or intermittent use. For residential premises Cat A, it is reasonable to assume use 100% of the time, but most of it spent indoors. For places of work, commercial and leisure facilities Cats B, C and D, occupancy will be part-time and, depending on the activity, indoor

and outdoor time can be apportioned.

The Royal Society Study Group and HSE's document 'The tolerability of risk from nuclear power stations' suggest that most people would regard as trivial a hazard whose risk was below about 1 in a million per year chance of death. Since it is not clear whether this relates to a 'typical' individual of a group or the most exposed or most vulnerable, HSE adopts this figure for the lower risk bound in relation to typical pattern of user behaviour receiving a ddw.

For the upper risk bound, allowances should be made for 'voluntariness' in the risk, ie. where those at risk may be gaining some community benefit. But for hazards which are involuntary with little immediate benefit to the people at risk, HSE believe a more stringent criteria of 10 cpm of receiving a ddw should be applied for developments above a certain size. Here, automatic negligible risk would be indicated for proposals below the lower bound for developments e.g. housing Cat.A where occupant might be present most of the time. Equally, HSE would automatically indicate 'substantial risk' for proposals with a substantial number of people (defined as 25 or more) above the upper bound, since there can reasonably be expected to be one or more highly vulnerable people in such a number. These criteria are risk values estimated by a 'cautious best estimate' and where significant uncertainties exist, subject to some sensitivity testing.

As discussed, for the proportion of highly vulnerable people in an 'average' population, ddw will probably be fatal. HSE studies suggest that a safe limit corresponds to a risk of about 1/3 cpm a year of them receiving a ddw would be trivial. HSE takes this as the lowest level of risk and defines the OZ/CD accordingly.

These harm criteria are expressed in Table 2 in terms of the three IZ/MZ/OZ zones.

Table 2
Individual risk criteria for the occupied buildings in the vicinity of MAHP's

Hazardous Fluid	Inner Zone boundary	Middle Zone boundary	Outer zone (CD) boundary
Natural gas (PGT's pipelines)	Zone boundaries defined by multiples of the IGE RP TD1 building proximity distance (BPD)		
(1) Other flammable fluids	10 cpm or fireball radius	1 cpm	4/3 middle zone or 0.3 cpm
Toxic fluids	10 cpm	1 cpm	0.3 cpm

Table

Note 1. For 'Other flammable fluids', the distance to the OZ(CD) boundary is defined as the lesser of 0.3 cpm ddw or 4/3 the distance to the MZ boundary. The reason being that for these fluids, it has been found that the individual risk transect in many cases is extremely flat beyond the MZ leading to excessively large OZ distances before 0.3 cpm is reached. The 4/3 MZ cut-off is introduced to avoid over conservatism. The IZ on the other hand, reflects the advocated

cautious best estimate approach wherein a hazard based fireball radius is adopted where sufficient uncertainties prevail.

Public Gas Transporters (PGT's) pipelines.

Although there are other PGT's, Transco owns and operates almost all the 18,000 plus kilometers of high pressure gas transmission pipelines on mainland UK. Over the years, HSE has pursued a policy of reaching some understanding with BG and subsequently Transco on how to treat the residual risk after the IGE TD1- Gas Transmission and Distribution recommendations criteria have been applied. HSE's models employ much of the data derived from the extensive tests that were conducted by BG which were built in to TD1. As a result, although HSE's harm criteria for public protection differs from Transco's, we have been able to correlate IZ/MZ/OZ criteria with the Building Proximity Distances (**BPD's**) found in Figs.2 and 3 of TD1 to define LUP boundaries by multiples of BPD. Decision matrices for LUP advice for developments in the vicinity of PGT's rural (R class) pipelines designed and operated to IGE TD1 are shown in Tables 3 and 4. Note that although shown as 'not advise against' in the matrices, we notify that the LPA must consult the PGT on developments within 1 BPD, since although the risk to persons may be small, the risk to the pipeline from activities connected with the development may be such that the PGT might wish make representations to preserve the integrity of their pipeline.

Table 2, Pipeline decision matrix for BPD less than 13.5 metres

Development category	Consultation zone	
	to IZ boundary	to OZ boundary
A&C	Consult	Don't advise against
B	Don't advise against	Don't advise against
D	Consult	Consult

Table 3, Pipeline decision matrix for BPD more than 13.5 metres

Development category	Consultation zone		
	to IZ boundary	to MZ boundary	to OZ boundary
A&C	Consult	Consult	Don't advise against
B	Don't advise against	Don't advise against	Don't advise against
D	Consult	Consult	Consult

Pipeline design and operating codes.

HSE defines 'Residual risk' as risks remaining after all requirements of the governing code have been correctly applied. HSE's assessment processes have been set up to use the pipeline designs established by BS 8010 Part 2, Section 2.8 for pipelines on land and IGE recommendations TD1 for natural gas transmission pipelines on land. Both of these codes designate pipelines by construction 'classes'.

BS 8010 rural class 1 wherein an upper limit is placed on recorded population density of 2.5 persons per hectare, and suburban class 2 greater than 2.5 persons per hectare.

TD1 expresses these two classes as 'R' rural and 'S' suburban construction with same density Criteria. There is also 'T' town class, but these are covered by a different code, TD3.

A general limit of not greater than 0.72 design factor is placed on class1/R locations and 0.3 design factor (<0.5 if wall thickness is >19.1mm), where it can be demonstrated that likelihood of fracture propagation is extremely low, for class2/S locations. New TD1 Edition 3, Supplement 3 and Edition 4 permit design factors < 0.8 and risk assessment in determining wall thickness.

Both codes contain requirements for a risk based separation distance for occupied buildings from the pipeline, mainly to guide route selection but also for assessing future infringements. BS 8010 has minimum building distance (MBD) and TD1 building proximity distance (BPD), both based upon British Gas research into pipe geometry and failure probability. HSE has to an extent codified its LUP assessment methodology for natural gas pipelines to align with TD1, but with the cautious approach to public protection described previously.

An important feature of HSE's assessment methodology is the division between design factor Less than and greater than 0.3 described in the codes which it accepts as the practical point separating stable puncture from potential propagating fracture. This permits elimination of the rupture scenario in modelling which yields a drastic reduction in IZ to 3 metres and OZ (CD) 6 metres for natural gas pipelines

HSE's approach to risk assessment.

HSE's direct involvement in hazards and risks from pipelines began about the time of the safety evaluation report for the St Fergus to Mossmorran NGL and St Fergus to Boddam gas pipeline in 1978. The third (1984) ACMH report set out HSE's overall approach for control of risks from major industrial hazards, namely:

- identification of the hazard,
- assessment of the risks,
- control of the risks,
- reduction of the residual risk to as low as reasonable practical.

Development of the risk principles and criteria that HSE bases its advice to LPA's on are set out in HSE's document 'Risk criteria for land-use planning in the vicinity of major industrial hazards' published in 1989. Risk assessment is applied by HSE to set the CD's for pipelines carrying substances other than natural gas or for complex planning cases specifically referred to MSDU for assessment.

HSE also developed its first Pipeline Risk Assessment Method (PRAM) in 1989 for assessing Rural cross-country pipelines conveying flammable substances. PRAM took a representative sample of 7 main events described in an event tree according to the expectations on release:

rupture - fireball followed by a jet or trench fire - or - jet/trench fire alone – or - flash fire followed by jet or trench fire in neutral stable weather.

puncture- similar to rupture scenario but with fireball omitted.

PRAM calculated the frequencies of the 7 events and multiplied these by the ‘interaction lengths’ (a function of the distance of a target to the pipeline) to provide risk levels at various distances from the event location.

Further development of PRAM resulted in its replacement by MISHAP, new software which allows access to various component models in a logical sequence. MISHAP, adopted for use in 1998, makes use of the PSR notified pipeline details and calculates the consequences of a representative set of failure events ranging, at the users discretion, from double ended full bore rupture down to small punctures. MISHAP combines these with frequencies of the failure events to obtain estimates of individual and societal risk. Failure frequencies may be constructed using relationships available within MISHAP or import from HSE’s pipeline integrity program PIPIN.

PIPIN contains data sets from various sources, EGIG, CONCAWE, Transco and worldwide data which can be selected within an historical operational database to provide operational experience based failure frequencies. It also contains a predictive model based upon SYSREL, a proprietary structural reliability model using FORM and SORM. Where the operational experience datasets are robust and accurately, these results are adopted, but if significant extrapolation or interpolation is required to fit the pipeline, the predictive results are also considered to add confidence to the result. The latest version of PIPIN will also take account of extra protective measures which can reduce the occurrence of impact damage

Conclusions.

HSE has over the years developed an approach which provides consistent and prudent LUP advice which it attempts to applied uniformly across the UK. A development programme spanning 1995-2000 has delivered the models presently used.

HSE’s LUP advice, particularly if adverse to the legitimate desires for urban development, continues to be challenged, and HSE will continuously seek to improve its understanding of the underlying risks and how to effectively protect the public and others from them.

HSE’s first duty in its consultative land use planning role is health and safety of potentially affected persons. This it must discharge by providing consistent and prudent safety advice to the Local Planning Authorities while seeking to minimise the land affected by its advice by reasonable and publicly defensible means.