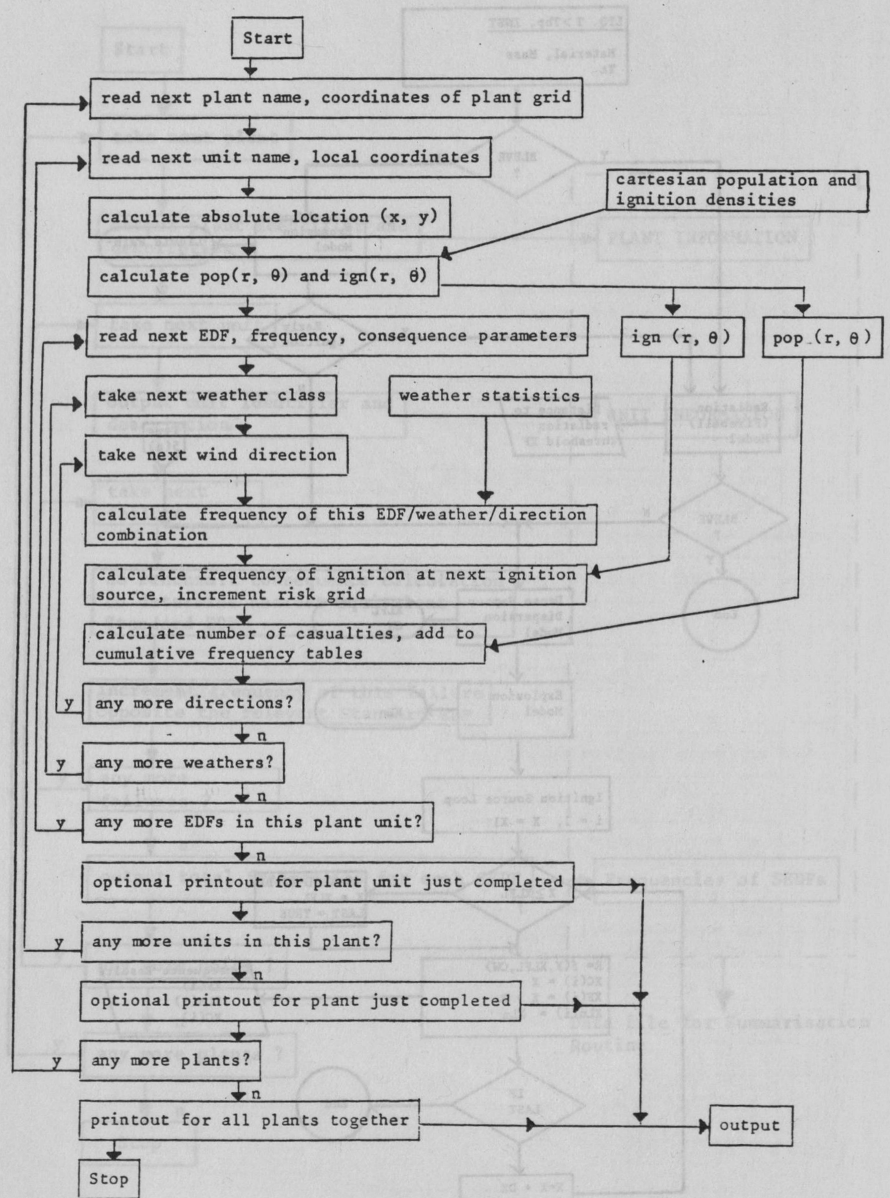

FIGURE 6 : OVERALL FLOWSCHEME FOR SUMMARISATION ROUTINE

AN EXAMPLE OF HSE'S ASSESSMENT OF MAJOR HAZARDS AS AN AID TO PLANNING CONTROL BY LOCAL AUTHORITIES

Dr M F Pantony and Dr L M Smith*

The first part of the paper describes the relationship between the Health and Safety Executive and local planning authorities concerning the control of new developments in the vicinity of Major Hazard installations. The second part outlines the work of the Major Hazards Assessment Unit within HSE and an example from actual casework gives an assessment of 5 inter-related major hazard sites and the suggested planning controls.

INTRODUCTION

The work of the Major Hazards Assessment Unit (MHAU) of the Health and Safety Executive (HSE) is based on the concept that some separation should be maintained between sites storing and processing certain hazardous substances in bulk and people living and working in the vicinity of such sites.

The problem was highlighted by the Chief Inspector of Factories in his report for 1967 (Ref 1). He pointed out that the scale of modern manufacture was increasing rapidly and hazardous materials were being introduced in large quantities. He saw the development of a class of major hazard from these new industries. Thus the concept of a major hazard arising from the bulk storage and use of flammable, explosive or toxic materials was promulgated in the UK. Government Departments considered the matter and it was decided that steps should be taken to control the number of people exposed to the risk. This was to be done using existing legislation, the Town and Country Planning Act (TCPA) 1971. Under this Act local authorities are empowered to grant or refuse permission for new developments on the basis amongst other things of the compatability of the proposals with existing and planned land use. The local authorities were advised to take safety into account when judging proposals for new major hazard plant or for developments near existing major hazard plant.

The result was an official circular issued in 1972 to local authorities (Ref 2) setting out criteria for situations where, if a major incident occurred there would be a potential for loss of life or serious injury outside the confines of the workplace. These sites, known as Listed Major Hazards (LMH), are defined in terms of storage of large quantities of highly flammable

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or toxic materials or certain hazardous processes, these are set out in Appendix 1. The Department of the Environment, and the Scottish and Welsh Offices made a voluntary arrangement whereby local planning authorities (LPA) could consult HMFI (now HSE) before permitting new major hazards or new development on land nearby existing LMH sites. HMFI were also to inform the authorities of the existence of any major hazards in their areas, and suggest a definition of "the vicinity" within which safety could be an important factor. Thus the safety aspects of LMH sites were to be treated as an aspect of land use policy in addition to the normal control of safe working under Health and Safety legislation. It was to be regarded as desirable to stabilise or reduce the population at risk from LMH, whenever the opportunity arose under planning law.

At first advice to planning authorities was prepared by the Risk Appraisal Group, an ad hoc committee set up within the Factory Inspectorate. Today this advice is given by the Major Hazards Assessment Unit which is part of the Hazardous Installations Group of HSE. Sadly the Chief Inspector's fears were realised in 1974 with the explosion at Flixborough.

THE WORK OF MHAU

MHAU comprises a multi-disciplinary team of inspectors and support staff, who prepare advice about the 497 LMH sites in Great Britain. LPAs are invited to consult HSE about applications for new developments within 2 km of these sites. In 1980, some 3,500 cases were referred to HSE. Most cases (87%) were dealt with directly by HSE Area Offices, the remaining 450 were referred to MHAU. It is believed that LPAs only send a fraction of cases within 2 km of LMH to HSE, they are able to operate a filter on the basis of precedence from previous HSE advice.

Developments in the Vicinity of Major Hazards

The scope of the work undertaken by MHAU is limited by the resources which are available. For planning applications involving housing or industrial developments in the vicinity of an existing LMH, MHAU will normally carry out the hazard assessment and formulate the response and advice for the LPA. Typical problems which demonstrate the range of work are:

i An application for a large new liquefied petroleum gas (LPG) installation to fuel modernised kilns in a traditional ceramics works site set on the edge of a residential area.

ii A scheme to rejuvenate the dying centre of a town with ambitious plans for housing and leisure facilities within a few hundred metres of an extensive bulk ammonia facility.

iii A local authority scheme for an oil refinery and associated chemical works and an airfield adjacent to one another.

iv Assistance to a planning authority in the formulation of a local development plan around a major refinery complex as part of the county's structure plan. This example is discussed in detail in this paper.

In these cases MHAU consider that the consequences of a release of hazardous material can be predicted with some confidence, using, for example, the methodology described by Roberts (4). The question of probability is dealt with by considering that the chance of a major incident

or failure is low in a plant which complies with the Health and Safety at Work Act. However the risk cannot be discounted entirely. Steps are being taken to quantify the frequency with which various release scenarios may occur. For single vessels or simple systems some estimate of the probability of failure may be determined from historical reliability data. These estimates become more and more difficult and less and less reliable as the complexity of the plant increases.

Proposals for new major hazards

Where proposals for new major hazards or other complex projects are concerned assessments of this type become very costly in the use of resources available to HSE. In these cases MHAU may request the developer to undertake the hazard assessment, which is then monitored at all stages. Actual examples of these cases have included:

i Re-commissioning of a gas works storage facility close to housing.

ii Use of an off-shore anchorage for ship to ship transfer of LPG.

iii Siting of several plants to fractionate natural gas liquids.

iv Use of hazard assessment to check the design and siting of a natural gas liquids separation plant, ethylene cracker and jetty facilities where planning permission has been given.

v Siting of a large underground cavern storage facility for LPG.

In these cases the assessments were either undertaken by the companies themselves or by consultants. MHAU were involved to set the scope, check the consequence models and to recommend how the final report should be presented. The experience gained in doing hazard assessments on less complex plant was invaluable and represented an additional validation for use of resources in undertaking this type of work. HSE's involvement will nearly always come about as a request from a third party, usually the local authority concerned, to advise on the safety implications of the proposed development. In most cases the hazard assessment was undertaken as a voluntary exercise to demonstrate prior to the planning application being considered that the plant could be sited safely. The local authority is unlikely to give planning permission without assurance from the HSE on this matter. HSE could not give an informed opinion unless a hazard assessment was undertaken. In some cases where planning permission had already been given or was not required, pressure from the local authority, public pressure and pressure from HSE played a significant part in ensuring that firms were willing to demonstrate by use of hazard assessment techniques that their proposals did not represent a significant off-site risk.

In each of these cases the hazard assessment report was used to make a judgement on whether or not the proposed development should be permitted. It is stressed that the final judgement is for the planning authority to make as it is their responsibility and moreover they are better placed than HSE to make such judgements. LPAs have a closer knowledge of local considerations and greater sensitivity to local views on safety. However to assist the LPAs to give proper weight to the factor of safety, HSE uses its expertise to make a specific recommendation rather than a neutral assessment.

EXAMPLE OF AN ASSESSMENT OF A MAJOR REFINERY AND ASSOCIATED DOWN-STREAM INDUSTRIES FOR A DISTRICT COUNCIL AND A SUGGESTION FOR A DEVELOPMENT CONTROL PLAN FOR THE SURROUNDING AREA

This example of the work of MHAU is drawn from an actual case study, but a fictitious map and names have been used to preserve confidentiality. The District Council (DC) concerned wished to update their local plans in the vicinity of the Riverside complex, which consists of a major oil refinery, chemical works and associated down-stream industries. Local plans are required under the Town and Country Planning Act (TCPA) 1968. These plans look forward about 15 years and elaborate the general policies and proposals in the County Structure Plan. It provides detailed guidance for development control and co-ordinating the development and use of precise areas of land. It includes a proposal map and written statement, illustrations etc and aims to bring local and detailed planning issues before the public. The DC is required to consult with interested parties, Government Departments, etc before producing the plan.

The DC approached HSE for guidance, as the Riverside complex contains five LMH sites. At a meeting between the planning officials of the DC and HSE, the scope of the project was agreed. MHAU would carry out an assessment of each LMH site, identify the hazardous processes and storages and use models to predict the hazard ranges and consequences. The DC would identify the areas for potential new developments in the vicinity. This would be the basis of the development control advice. The companies concerned would be kept informed about the background and findings of the project. It was explained to DC that the assessment would be based on the consequences of a major incident at the Riverside complex, because HSE do not have the resources or sufficient data to undertake a full analysis of the probabilities of the events, which in any case may be of doubtful value in preparing development control advice. In other words we would not undertake a 'Canvey' type assessment.

The DC appreciated our assistance because although they had talked to the individual companies involved, they have no expertise for assessing the information obtained. Only HSE is in the position to provide an impartial and objective overview of the 5 LMH sites, each involving a separate company.

Description of the Riverside Complex and its environs

The Riverside Complex is a well established industrial area located on the coast, on fairly flat land with well developed communications and infrastructure. There are extensive areas of traditional housing and associated amenities adjacent to the complex and some areas of new housing, built before the consultation arrangements between HSE and LPAs were effective. There is scope for further development of both housing and industry in the area.

There are 5 LMH amongst the many companies occupying sites in the Riverside complex. Site A is a refinery with a marine terminal, the associated site B is a petrochemical works which supplies feedstocks for export and to sites C, D and E, who manufacture downstream products, chemicals, plastics, etc. Major hazard processes listed as petrochemical manufacture in DoE circular 1/72 include manufacture of propane, butane, ethylene (ethene), propylene (propene), butenes, butadiene, C_5 olefins and diolefins, petrol and other aromatic type solvents, alcohols, etc.

Materials stored in major hazard quantities include LPG and similar materials, chlorine, ethylene oxide and acrylonitrile. Some of the LPG storage installations are very large with individual pressurised storage spheres of 1,000 tonnes capacity and refrigerated tanks of several thousand tonnes capacity.

Three of the sites are LMH by virtue of the manufacture of plastic polymers; there are sizeable facilities for the storage of monomers including, ethylene (ethene), butadiene, acrylonitrile and styrene.

The arrangements of the sites and environs is shown in the attached map. Figure 1.

Each LMH site was visited to explain the project, to gather the information required for the assessment and to seek the companies' views of the hazards. All the companies concerned co-operated fully, in spite of reservations about the philosophy of the assessment. The first step was to identify the major hazard storages and processes. For each plant the largest inventory in any one section of the process was recorded together with the operating conditions so that the type of release and the proportion of material which would form a vapour cloud could be estimated. For storage vessels the location, capacity, temperature and pressure were noted, together with the size of the inlet/outlet pipes and the protective devices provided, bunding, water spray etc. The positions and operating conditions of any pipelines were also noted. This data was then used as the basis for the hazard assessment, which covered firstly fire and explosion hazards and secondly toxic hazards.

ASSESSMENT OF FIRE AND EXPLOSION HAZARDS

In the Riverside complex flammable materials were stored in a variety of different circumstances:

i Flammable liquids in tanks operating at ambient temperature and pressure, these included acrylonitrile, naphtha, crude oil etc. The main hazard would be a prolonged fire in the tank or bund.

ii Liquefied flammable gases in pressure vessels at ambient temperature. Loss of containment could result in a pool fire in a catchment pit or bund; a jet flame or flare; a drifting vapour cloud and subsequent flash fire; flame engulfment of the vessel leading to a BLEVE fireball or a fireball and vapour cloud explosion. Some of the older vessels, constructed 20 years ago or more might be more susceptible to BLEVE than modern installations because of closer spacing and bunding which would retain spillages in the vicinity of the vessels.

iii Fully refrigerated storage vessels operating at atmospheric pressure and a temperature just below the boiling point of the material stored. Any spillage would be retained in the bund and vapourise slowly. The result could be a flash fire followed by a prolonged pool fire. It is not considered that this method of storage would give rise to a fireball or UVCE.

The injurious effects of the events described above would include, engulfment in the flames of a flash fire or fireball, heat radiation received directly over a considerable distance from the event with the possible initiation of secondary fires and in the case of a UVCE, blast overpressure. For each type of event the consequences can be estimated, it is likely that anyone within a flash fire or fireball would be killed and anyone close by would suffer severe burns. For events of short duration the distance at which the total received radiation dose would be 200 k J/m^2 was calculated, ie a received radiation level of 20 kW/m^2 from a fireball with duration 10 seconds. This level of heat radiation would be expected to cause 3rd degree burns to exposed skin if evasive action is not taken (3). For prolonged fires the distance at which the received radiation has attenuated to 6.3 kW/m^2 was calculated; ie 200 k J/m^2 would be received after 32 seconds. This level of received radiation will be referred to as the "thermal radiation threshold". The levels of thermal radiation were calculated by the methods given and discussed by Roberts in the paper to this symposium (4). For events resulting in an explosion the distance at which the blast overpressure is expected to have attenuated to 0.07 bar (1 psi) was estimated using the method given in the 2nd Report of the Advisory Committee on Major Hazards (5).

The following results were obtained when applied to some of the storage facilities in the Riverside complex. The thermal radiation and overpressure thresholds for each major hazard storage or process were marked on a plan. (Figure 1)

Pool Fire

TABLE 1 - Distance from various pool fires to the thermal radiation threshold

Storage facility	Fire diameter (metres)	Distance to thermal radiation radiation threshold (metres)
Naphtha	40	100
Naphtha	100	250
Refrigerated LPG	60	220

Flash Fire

TABLE 2 - Predictions of axial distances (metres) from release point to ½ LFL using SRD dispersion models DENZ and CRUNCH (6)

Release Quantity	Pasquil Category Wind speed (m/sec)	D 3	D 7	D 15	F 2
Continuous					
3 tonnes/min		300	180	130	740
Instantaneous					
20 tonnes		520	490	470	730
64 tonnes		800	720	810	1130
115 tonnes		1010	930	880	1440

It is assumed that the maximum extent of a flash fire would not exceed these distances, as described in reference (4).

BLEVE Fireball

This event can only occur when a pressure vessel is subjected to fire engulfment or prolonged heating from a jet flame. In the Riverside Complex LPG and similar materials were stored in spheres with capacities of the order of 100 tonnes on sites A, B and D and also in horizontal cylindrical vessels of 100 t capacity. If the BLEVE fireball occurred when the vessels were half full the following consequences can be postulated:

TABLE 3 - Consequences of BLEVE fireball

Vessel Capacity (tonnes)	Fireball Mass (tonnes)	Radius (metres)	Duration (secs)	Radiation Threshold (kW/m^2)	Distance to thermal radiation threshold (metres)
100	50	105	16.5	12.1	500
1000	500	230	36	6.3	1200

The figures for the very large event should be viewed with caution as they are based on an extrapolation from experimental fireballs involving only a few kilograms of material.

Vapour Cloud Explosion

In the very unlikely event of a sudden release of LPG from a pressurised storage vessel the following overpressures could be postulated.

TABLE 4 - Consequences of UVCE

Vessel capacity (tonnes)	Mass in vapour cloud (tonnes)	Distance (metres) to an overpressure of 0.07 bar
100	60	500
1000	500	1000

Process Plant

The fire and explosion hazards from the main process plants were estimated by assuming that the entire contents were released suddenly, that a proportion of the release (depending on operating conditions) formed a vapour cloud and on ignition burned as an ariel fireball or as a UVCE. A selection of the results are in the table 5.

TABLE 5 - Consequences of process plant incident

Material	Inventory (tonnes)	Mass in vapour cloud (tonnes)	Fireball* radius (metres)	Fireball* duration (secs)	Thermal radiation threshold q (kw/m^2)	Thermal radiation threshold L (metres)	UVCE distance to 0.07 bar (metres)
Hot Naphtha	17.4	15.7	75	11	18	310	325
LPG	10.9	10.6	65	10	20	260	285
Naphtha and LPG	67.4	20.3	80	12	17	340	355
Propylene	30	30	90	14	14	420	400
Butenes	45	13.5	69	10.7	19	290	310
Mexane	55	55	110	17	11.6	480	495

Fireball calculation: $\frac{\exp(-kL)}{L^2} = \frac{q}{3.5 \cdot 10^3 RG}$ $R = 0.4$, $G = 2.2\,M^{\frac{1}{3}}$

$$q = \frac{\text{radiation threshold } (200 \text{ k J/m}^2)}{\text{duration of fireball (secs)}}$$

ASSESSMENT OF TOXIC HAZARDS

Chlorine

Company B receives bulk chlorine by rail, it is stored and used at two locations on the site. The bulk vessels only have top connections. Liquid chlorine is transferred via a 25 mm outlet and 19 mm fixed pipework to a vapouriser and thence to the user plant.

TABLE 6 - Estimated release rates following full bore failure of 19 mm liquid line

Single phase liquid discharge	Liquid temperature/vapour pressure in storage vessel			
	0^oC/40 psig	10^oC/60 psig	20^oC/82 psig	15^oC/120 psig*
kg/sec	6.1	7.6	9.0	11
m^3/sec**	1.7	2.1	2.5	3.0
Two phase Flashing flow				
kg/sec	1.2	1.6	2.0	x
m^3/sec**	0.3	0.4	0.6	x

* Applied pressure (padding pressure)
x Applied pressure likely to prevent flashing flow
** Assuming initial vapour temperature of 239^oK (-34^oC)

I. CHEM. E. SYMPOSIUM SERIES NO. 71

These figures indicate that breach of the liquid chlorine line could give a release rate of between 1.2 and 11 kg/sec, (between 0.3 and 3.0 m^3/sec). A spillage of the entire contents of one vessel, 36 tonnes, might be expected to give rise to a vapour cloud containing about 9 tonnes chlorine vapour initially, (assuming 25% flash). Table 7 shows the predicted chlorine concentrations at 3 distances downwind of a release.

TABLE 7 - Predicted chlorine concentrations

Pasquill category	wind speed m/sec	Release: Sudden release of 30 tonnes chlorine vapour	Sudden release of 7 tonnes chlorine vapour	Continuous release of chlorine vapour at $4m^3$/sec	Continuous release of chlorine vapour at $18m^3$/sec
A 500 metres downwind of release point:					
D	4.3	4200 ppm	1700	400	1800
D	6.7	4800	2600	250	1200
F	2.4	4200	2900	2000	12000
B 800 metres downwind of release point:					
D	4.3	1700 ppm	1000	160	750
D	6.7	1900	1400	90	430
F	2.4	2600	1300	1100	5400
C 1250 metres downwind of release point:					
D	4.3	750 ppm	450	70	300
D	6.7	1100	500	40	170
F	2.4	1200	800	600	1800

These figures were computed using the DENZ and CRUNCH models for dispersion of instantaneous and continuous release of gas. (6).

Depending on the duration of the exposure and the concentrations involved, inhalation of chlorine gas can result in irritation of the respiratory tract, difficulty in breathing, chest pain, increased bronchial secretion and pulmonary oedema. Exposure to about 100 ppm chlorine for one minute or 30 ppm for 10 minutes is considered "dangerous", ie causes severe distress and the death of the minority of those exposed.

Thus the risk from an incident which leads to a chlorine concentration of 30 ppm or less at a particular site is likely to be low (either the duration will be too short to cause significant harm or there will be time to escape before succumbing). For higher concentrations the risk could be substantial. In this case a release of $3m^3/sec$ would give a concentration of 68 ppm at 800 metres and 30 ppm at 1200 metres downwind in category D conditions with 6.2 m/sec wind speed.

Other toxic materials

Various other toxic materials including bromine, ammonia, sulphur dioxide, hydrogen sulphide, and acrylonitrile, are stored and used in the Riverside Complex, but none in major hazard quantities. The consequences of spillage and dispersion of these materials was assessed using a similar methodology to that described for chlorine, in two cases supplied by the companies concerned. In our opinion none of the specific installations considered posed a hazard to the public beyond the respective site boundary.

Conclusion

The result of the exercise was a map of the 5 sites showing a series of circles within which the public might be seriously affected in the unlikely event of the potential hazard being realised. MHAU advised the DC to restrict certain types of new developments such as housing, schools, within these areas. The types of development which we advised should or should not be permitted were described in some detail. The full text is contained in Appendix 2. It was also pointed out that the affected areas of land were smaller than they might be because of the companies' policy of locating hazardous storages and processes deep inside their sites. In addition MHAU invited the DC to consider applying controls to a further area of land to take into account future developments at the LMH sites. This is because the changing nature of refining and associated operations often necessitate the relocation or rebuilding of plant. Such changes can be made under general development orders and often do not require specific planning permission. Some of these changes may pose an additional hazard to the public beyond the limit already highlighted. MHAU therefore invited the DC to consider applying controls to an additional area of land adjacent to the boundaries of the LMH sites to ensure hazardous plant and processes could be relocated without increasing the risk to the public. Also any of the companies may wish to seek permission to expand or alter their operations and the presence of incompatible developments close to the sites may inhibit these plans with serious implications for the companies and employment prospects. Restriction of new housing and similar developments would allow flexibility in this respect.

The full text of the planning control advice given by HSE to DC is at Appendix 2. At the time of writing this paper DC's response is not known. We hope to be able to report the outcome of further discussions at the symposium.

APPENDIX 1 - DEPARTMENT OF THE ENVIRONMENT CIRCULAR 1/72 (2)

The criteria set out below show those industries, processes and materials which have been identified as constituting a major hazard where the quantities stated are present.

INDUSTRY	MATERIALS INVOLVING RISK	TOTAL STORAGE QUANTITY REQUIRING DETAILED INVESTIGATION
Petrochemical* and plastic polymer manufacture	All	ϕ
Other chemical works	Acrylonitrile Ammonia Bromine Chlorine Ethylene Oxide Hydrogen Cyanide Phosgene Sulphur Dioxide	50 Tons 250 Tons 100 Tons 25 Tons 20 Tons 50 Tons 5 Tons 50 Tons
Fertiliser manufacture	Ammonia	250 Tons
Aluminium and magnesium powder production	All	ϕ
Aluminium refining	Chlorine	25 Tons
Paper pulp manufacture	Chlorine Sulphur Dioxide	25 Tons 50 Tons
Air liquification plants and steel works	Liquid Oxygen	135 Tons
Flour and sugar silos	Flour Refined white sugar	200 Tons 200 Tons
All	Liquified Petroleum Gas	100 Tons

ϕ Economic size of plant would involve such quantities of materials that the risk would invariably be present.

* Petrochemical manufacture is defined as the manufacture of chemicals from an oil refinery product or from natural gas.

APPENDIX 1 - Continued

PETROCHEMICAL MANUFACTURE

"Petrochemical manufacture" means the manufacture of chemicals from an oil refinery product or from natural gas.

The manufacture of the items listed below are included within the definition of "petrochemical manufacture".

Methane
Ethane
Propane
Butane
Ethylene
Propylene
Butene
Butadiene
C_5 Clefines and di-olefines
Higher olefines as product and feedstock

Ethylene Oxide
Ethylene glycol and other ethylene oxide derivatives
Propylene oxide
Propylene glycol and other propylene oxide derivatives

Benzene
Toluene
Xylenes and paraxylene
Ethylbenzene
Styrene

Petrol and aromatic type solvents
Cyclohexane
Cyclohexanone
Cyclohexanol

Phenol
Diphenyl oxide and other phenolic derivatives

Methanol
Ethanol
Propanols
Butanols
Higher alcohols
Hexamethylene diamine
Adipic Acid

Terephthalic acid and esters
Phthalic anhydride

Acetic acid and other carboxylic acids and di-acids

Rubber intermediate di-olefines

Acetone
Acrylates
Methacrylates
Vinyl chloride monomer
Chlorinated solvents — ethylene derived
Chlorinated paraffin wax
Chlorinated hydrocarbons
PVC Plasticisers
Cumene

APPENDIX 2 - TEXT OF MHAU'S ADVICE TO THE PLANNING AUTHORITY RESPONSIBLE FOR THE RIVERSIDE COMPLEX

Probability of occurrence of the hazardous incidents

Consideration of the risks to the public arising from the activities on the major hazard sites in the Riverside complex includes both the concept of an outcome described in some way, and the chance of that outcome. The previous paragraphs have described the potential consequences of various incidents, these events have to be put in perspective by consideration of the probability that such events might occur. MHAU consider that although there is the potential to cause deaths and serious injuries to people outside the complex the chance of this happening is very low. Very few incidents of the types described have occurred in Britain or in the rest of the world. However, MHAU consider that such events cannot be discounted entirely. MHAU recommend that the Local Authority should take this into account when considering proposals for certain types of new developments in the vicinity of the Riverside complex.

Advice on the siting of future developments in the vicinity of the major hazard premises in the Riverside complex

The preceding sections have summarised the assessment of the main hazards arising from the operations of the Riverside chemicals complex. The Maps* indicate the areas outside the works which could be affected by a major incident. The composite Map 4* shows the envelope of these areas. It will be noted that although some of the storages and processes have the potential to cause harm over considerable distances, in some cases up to 1200 metres, many are located deep inside LMH premises thus minimising the off-site consequences. It is the company's policy to attempt to locate such facilities as far from the boundary as possible. However it is not possible to locate all the hazardous processes and storages in this way and the areas which could be affected by a major incident at one or more of the LMH sites are shown in Map 4*. MHAU consider that the risks to the public in these areas are low, however we advise the planning authority not to increase the numbers of people exposed to this low risk. This may be most easily accomplished by controlling certain types of new development in these areas as detailed below.

In addition MHAU invite the Local Authority to consider applying controls to a further area of land to take into account future developments at the major hazard sites. The operations at refineries and chemical works are constantly changing, the existing hazardous storages and processes may be relocated closer to the boundary or new storages and processes could be introduced which do not specifically require planning permission. Either of these circumstances may pose an additional hazard to the public beyond the envelope already mentioned. Also any of the companies may wish to seek permission to expand or alter their operations and the presence of incompatable developments close to the site may inhibit their plans. The implications could be serious not only for the companies but also for the community, if for example employment prospects are affected. Having regard to these possibilities one solution the Local Authority may care to consider is the control of new housing and similar developments which are within 500 metres of the boundary fences of the 5 major hazard sites. Details of such a scheme are outlined below.

* These maps are not included here, they will be shown at the symposium.

MHAU have distinguished between various types of development on the basis of the following factors:

i whether residential, workplaces, recreational, commercial;

ii length of time occupants may be present;

iii number of people who may be present;

iv ease of evacuation;

v inherent vulnerability of exposed population, eg children, disabled and elderly people;

vi other factors affecting risk, eg height of building, materials of construction, etc.

Bearing these factors in mind and also taking into account the need for ease of administration, two broad categories of development have been identified as follows:

Category A - These are developments where the number of people is substantial, evacuation or other emergency action at short notice might be difficult, and occupancy-time may be high. They include situations where people would be present most of the time, or where large numbers of people could be present at any one time if only for a short period or where people are particularly vulnerable. Examples include: housing estates, shopping centres and very large shops, sports stadia, multi-storey office blocks, large factories with high employment density, substantial developments in congested areas or where access is restricted, etc.

Category B - This includes developments where occupancy may be regular but not usually full-time, residence is moderate and the number of people is limited but may not be small. People might be present for a considerable part of each day yet could be readily made part of an emergency scheme, or there may be larger numbers of people using the development intermittently with access preventable at short notice. Examples include: single-storey industrial or warehouse buildings with relatively low-density employment and their associated small offices in buildings not exceeding two storeys in height, a motorway or busy main road or a railway, isolated low density housing (but not unlimited in-fill housing or piecemeal development of a large area), farm buildings and sports club houses.

MHAU advise the planning authority not to grant planning permission for new developments in Category A within 500 metres of the major hazard sites in the Riverside complex. We advise that developments in Category B could be permitted within this distance but it would clearly be prudent to ensure that occupied buildings within this category at any particular development site are located as far from the major hazard installation as possible. We also consider a third category of development which comprises special cases for which an exceptionally high standard of safety is necessary or for which there might be particular difficulties in securing quick evacuation in the event of an emergency. Examples might include populations that might require

particular protection such as institutions, hospitals and schools. We advise the planning authority to consult HSE about any such development within 1,000 metres of the major hazard sites in the complex.

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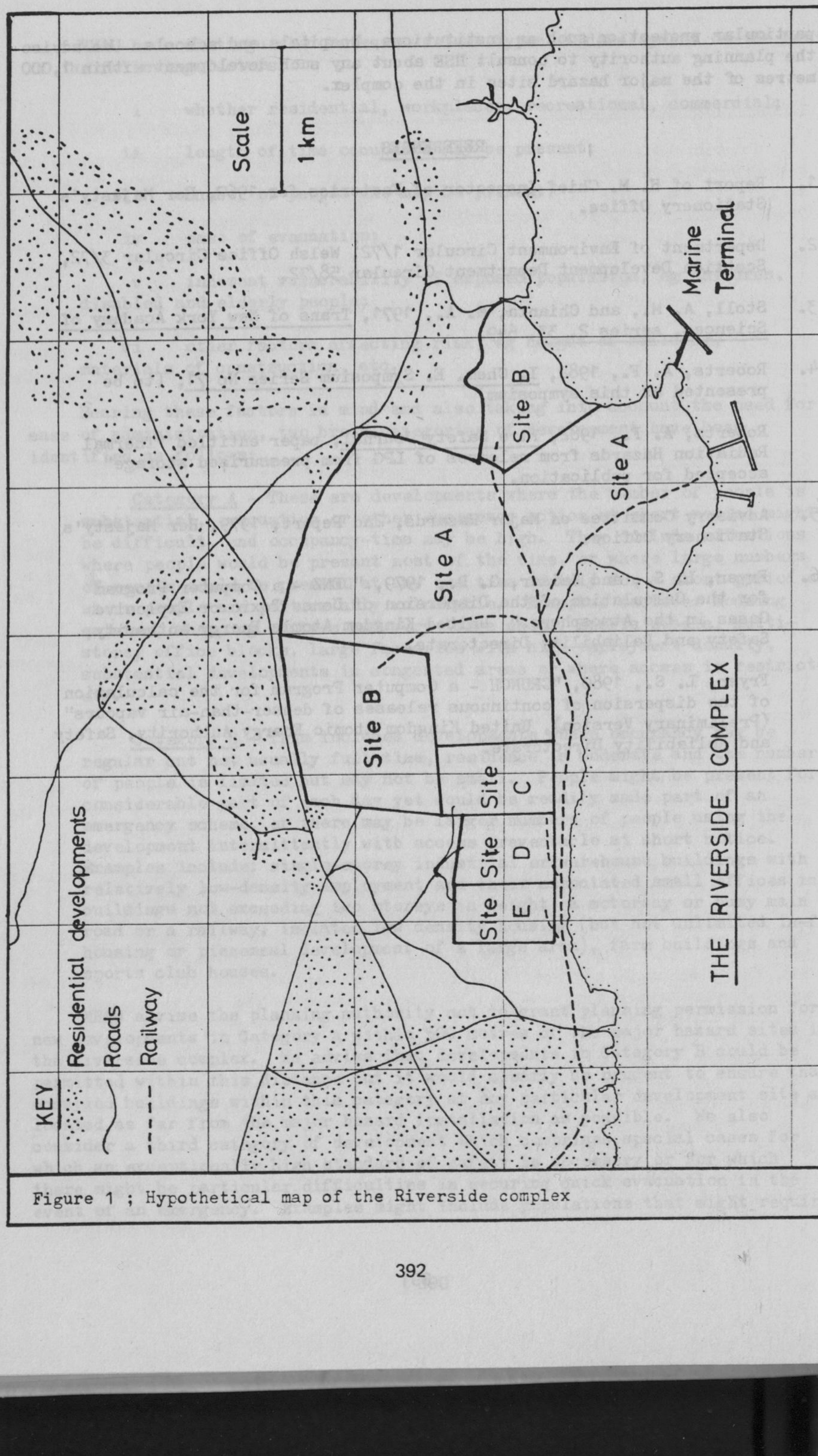

Figure 1 ; Hypothetical map of the Riverside complex

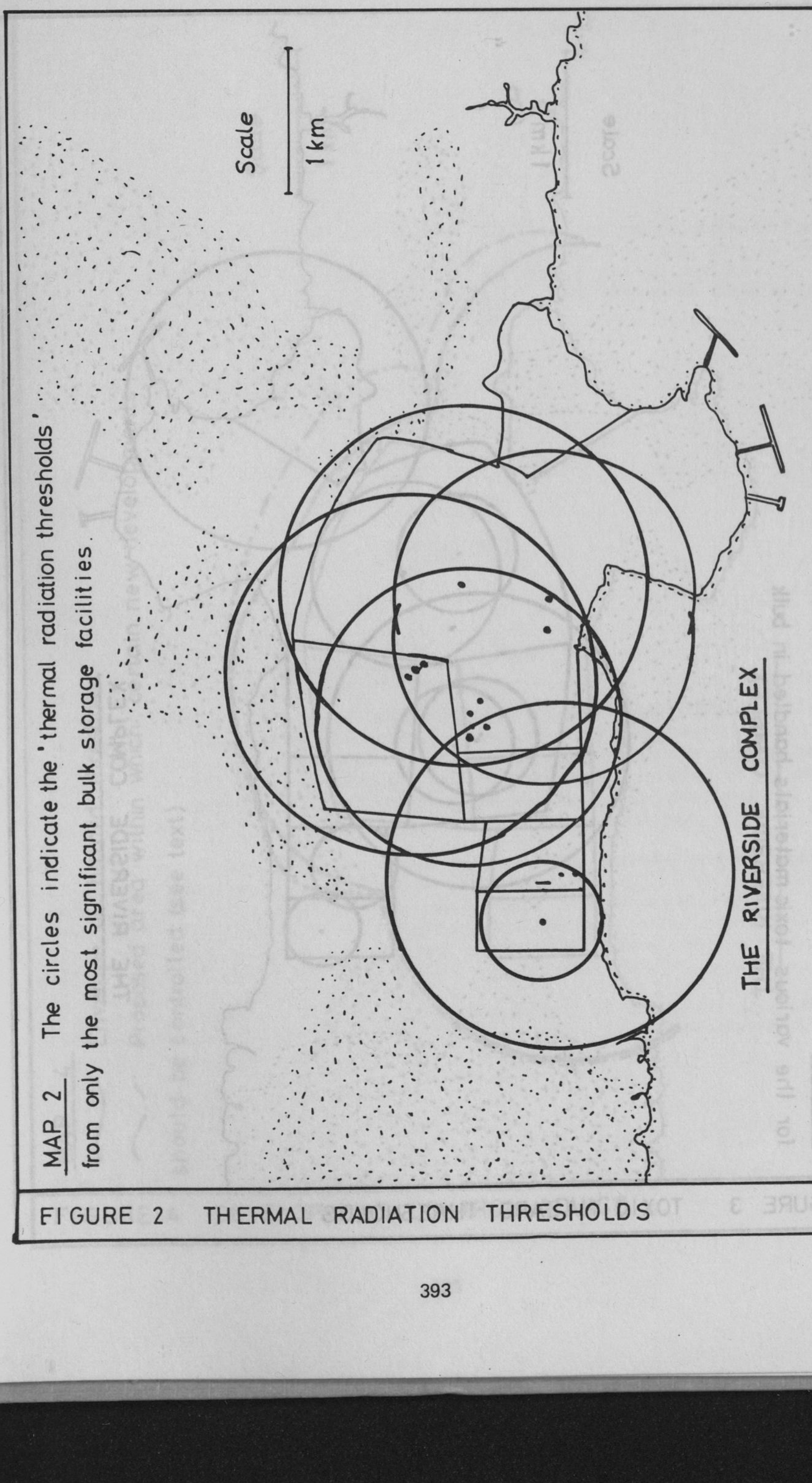

FIGURE 2 THERMAL RADIATION THRESHOLDS

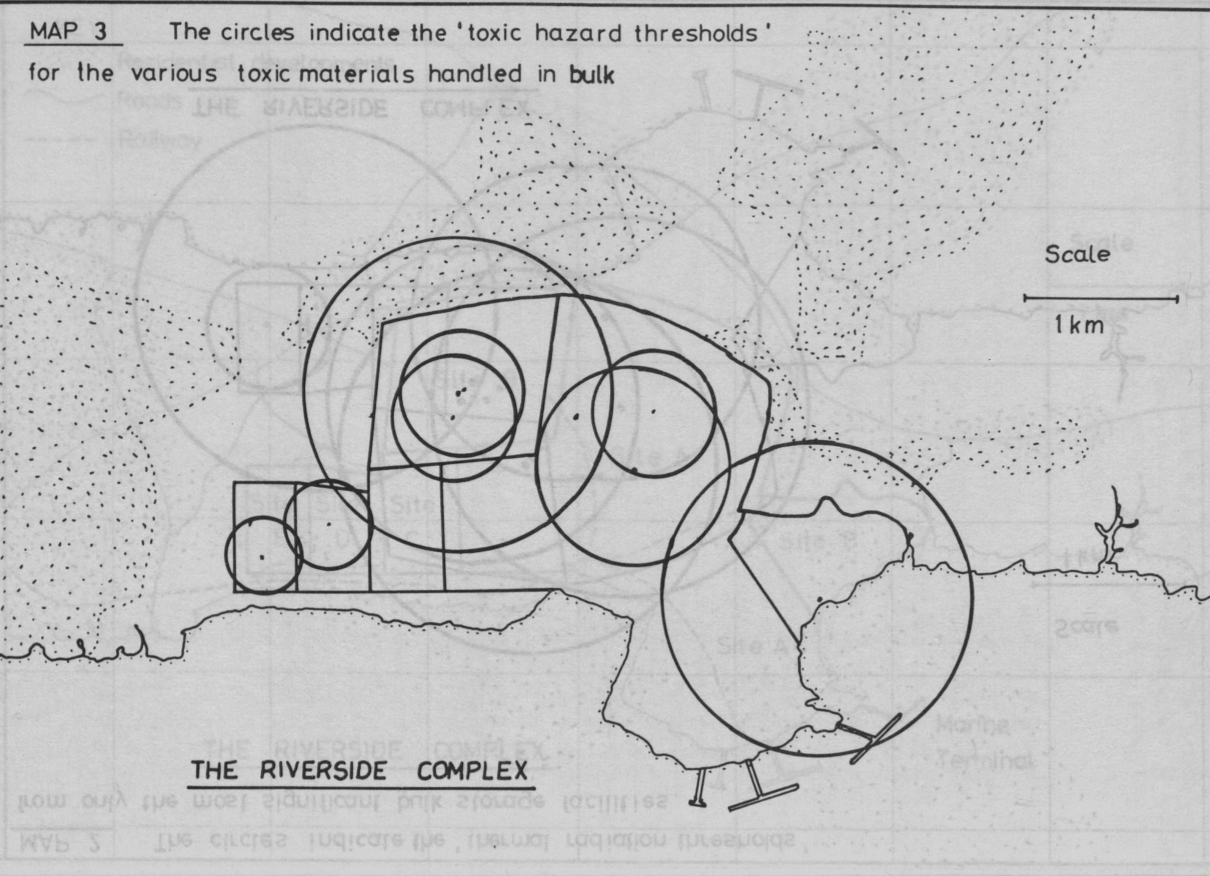

FIGURE 3 TOXIC HAZARD THRESHOLDS

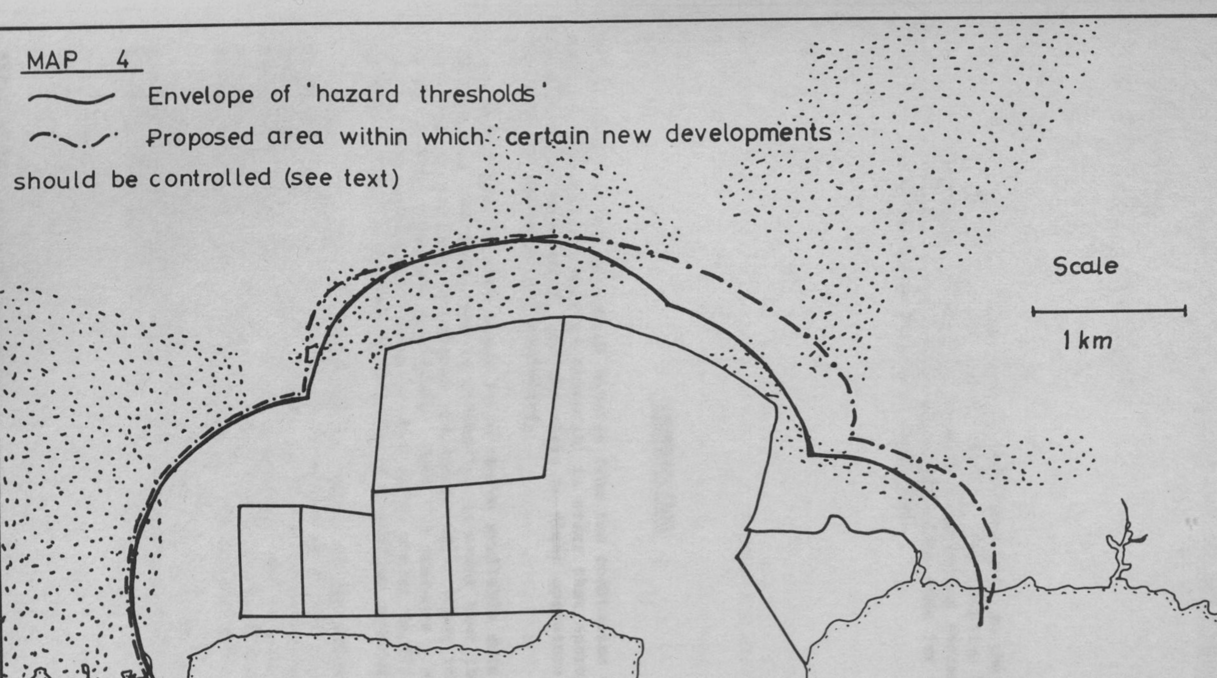

FIGURE 4 DEVELOPMENT CONTROL ADVICE