HEALTH AND SAFETY AUTHORITY

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Land-use Planning Advice for Kilkenny County Council

In relation to

Grassland Fertilizers (Kilkenny) Ltd.

at

Palmerstown

20 October 2006

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Report co . p .e . . y: .
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Patr ck Connee y .
Gareth Doran .
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(HSA Inspectors) .
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HEALTH AND SAFETY AUTHORITY

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Contents m

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HEALTH AND SAFETY AUTHORITY

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1 . Execut ve Su . ary .

This mocu ment has been preparem for Kilkenny County Council in respect of a request for m lan -use planning am ice in the micinity of Grasslan Fertilizers (Kilkenny) Ltm m

In for ulating its am ice, the muthority consi ere potential m ajor acci ents in ol ing m oniu m Nitrate mFertilizer (mNF), man mthe mpotential for i pact mof these mon mthe m surroun ing people an the en iron ment. m

The muthority eter ine the risk zones in relation to potential m ajor acci ents in ol ing m these substances an sets out its am ice concerning future me elop ment in those zones. m

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2. . Genera Intro .uct on .

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This mocu ment contains the basis for the conclusions of the HSm ('the muthority') with m regar to the request for lan use planning am ice from Kilkenny County Council ('the m lanning muthority') in relation to Grasslan Fertilizers (Kilkenny) Ltm ('the Establish ment') m at mal erstown, Co. Kilkenny. m

Basemon the infor ation suppliemby the Establish ment in its Notification, it is currently an m upper–tier Semeso site un er the European Com unities (Control of Major m cci ent m Hazar s In ol ing Dangerous Substances) Regulations, S.I 74 of 2006 ('the regulations'). m

Consequently the request falls within the re it of the muthority to offer technical am ice in m relation to lan -use planning. m

The responsibility for safety on the site rests with the Operator. m

The operator is responsible for the appointment of competent persons to look after safety m atters. m

The Establish ment is require , un er the abo e regulations, to me onstrate to the m uthority, at any ti e, that it has taken all necessary measures to pre ent major acci ents m occurring an to li it the consequences of any such m ajor acci ents for m an an the m en iron ment, an me onstrate that it has a safety anagement system in place. m

It is require to pro uce a Safety Report that will memonstrate it is taking all necessary m easures for the pre ention an mitigation of major acci ents. This mocu ent is require m to be mame amailable to members of the public who request it. m

The operator is requiremto prepare an Internal Emergency mlan for the establish ment. m

The Local Competent muthorities are requiremto prepare an External Emergency mlan. m

The operator is requirem to regularly promi e infor ation to the public on the actions to m take in the emement of an emergency. m

The Establish ment will be subject to regular inspection by Inspectors of appropriate m technical expertise from the muthority, an a proportion of these will be unannounce . m

The muthority acknowlemges the role of the Fire muthority in relation to the general m obligations to fire safety on the operator un er the Fire Ser ices mct of 1981 (as m amen em). m

In the emement of any 'me elop ment' that coul ha e significant repercussions for m ajor m acci ent hazar s, planning per ission will be requirem m

In memeloping its am ice, the muthority takes account of the requirements of the regulations m as set out abo e, the com it ent of the Establish ment to co ply with INDG 230 m especially in relation to the li itation of stack size an separation mistance, to i prome its m storage of combustibles an confine them to a mesignatem outsi e area, the remo al of m combustible m aterial from the bulk m aterials store, the removal of the gas m eter to a m suitably safe area an its un ertakings in relation to examination of the oil storage tanks m an pro ision of appropriate bun ing amrangements. The absence of saw must mue to the m un er floor heating system was also taken into account. m

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3 Assess . ent . y HSA .

3.1 Introduction

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The functions of the muthority are set out in appen ix 1. One of its many functions relates m to the pro ision of lan use planning am ice to planning authorities, which is a legal m obligation un er SI 74 of 2006. m
Howemer there are a nu mber of general exclusions containem in the regulations, the most m relemant being as follows: m
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The occurrence outsi e an establish ment of - m
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- the transport of mangerous substances by roam, rail, internal waterways, sea or air m

m

- associatem inter e iate temporary storage m

m

- the transport of mangerous substances in pipelines an pu mping stations. m

m
Then there are some acti ities, not listem as exclusions, which mo not come within the m scope of the regulations: m
-m The muthority's am ice moes not meal with site selection or the suitability of one site m omer another. m
-m cti ities relatem to site memelop ment /construction are not within the remit of the m uthority in the context of the pro ision of Lan -use planning am ice. m
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m
The Esta . sh . ent area .
The establish ment is consi erem to be the area within the security fence footprint where m the hazar ous substances are processem an storem. m
This mecision was taken in respect of premious planning applications an has been retainem m following m iscussions m between m the m uthority m an m Em m Com ission m officials m an m representati es of the other Em member states. m
m
m
Exp anat on of techn ca ter . s m
This report m akes reference to specific ter inology relatem to consequence an risk m assessment mo elling. m
The way in which the muthority e elops its general technical am ice an the criteria it uses m are set out in ppen ix 2, where many of the technical issues relatem to risk assessment m are explainem. m
m
The hazar s that were consi ere by the muthority for the meter ination of risk posem by m this establish ment were: m
m

- Fire gi ing rise to toxic fu es of Nitrogen Dioxi e, to the mangerous mose* m en point of 56.6 pp for a 30 minute exposure m
- Fire gi ing rise to toxic fu es of Nitric Oxi e, to the mangerous mose en point of m 697 pp m for a 30 minute exposure m
- Explosion following a fire: omerpressure effects to 140 mbar *2*

2

* m**angerous . ose** is mefinem as one where **.**
m

- There is semere mistress to al ost emeryone. m

m

- substantial fraction requires memical attention. m

m

- Highly susceptible people might be killem m

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See appen ix 4 for the metaile approach of the muthority to the pro ision of Lm am ice m relating to establish ments storing m oniu mNitrate Fertilizer (mNF). m
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3 2. Metho .o ogy .

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The main consequence-mo elling package usemfor analysis in this case was mH ST m6.4 m (DNV Technica). mse was also ma e of LOH m(mS Em) an mDMS mata supplie by Health m & Safety Laboratory, mK. The risk calculation package usemwas Riskplot (ERM). Reference m was also ma e to many rele ant technical ocu ents an these are listemin appen ix 4. m
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m

3 3 . Key Assu . pt ons for Ana ys s .

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pon examination of loss history atabases an also through consultation, ju gement an m experience, the muthority chose a selection of ements, from across the span of the site to m eter ine the potential omerall off-site consequences (see appen ix 4 for the approach of m the authority to Lm am ice for sites storing mNF). m
The key assu mptions are outlinembelow for each stage of the risk assessment process. m
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Inventory .

The Establish ment ma e a for al notification of their angerous substance in entory to m the muthority, shortly after the Regulations came into force. In su m ary: m
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.	Dangero .s S . stances .	Qty . onne .	Seveso . Cat .	Upper . hresho . .
1 m	NmK Fertilizer 27:6:6 [mN 2067] m	4000 m	Namemm subs m	5000 m
2 m	NmK Fertilizer 30:6:0 [mN 2067] m	4000 m	Namemm subs m	5000 m
3 m	NS Fertilizer 27:3:7 [mN 2067] m	4000 m	Namemm subs m	5000 m

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Ta . e 1: . Not f e . .nventory m
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This class of m oniu mNitrate Fertilizers are comeremby Note 2 of Schemule 1(of m the regulations): m

Th s appl s to stra ght ammon um n trat -bas 2 f rt l s rs an2 to ammon um n trat -2 bas 2 2ompoun / ompos t f rt l s rs n wh 2h th n trog n 2ont nt as a r sult of 2 ammon um n trat s 2

2

- mor than 24,5% by w2ght, 2x2 pt for m xtur s of ammon um n trat w th 2 olom t , l m2ston2 an2/or 2al um 2arbonat w th a pur ty of at l ast 90%, 2

2

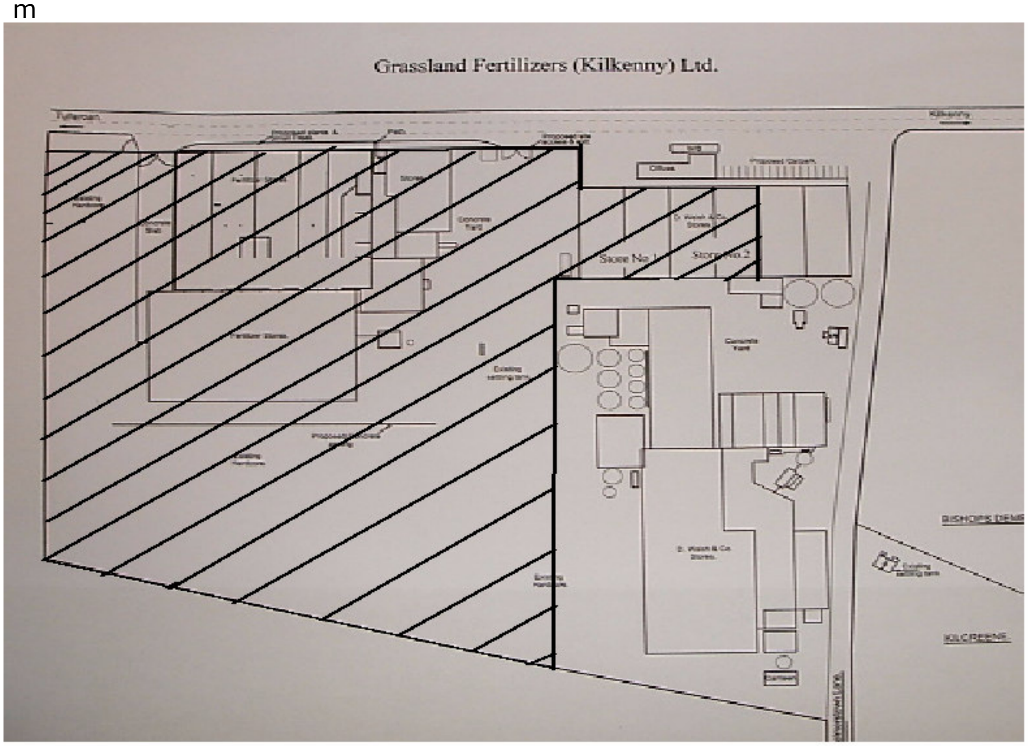
- 2mor 2than 215,75% 2by w2ght for m xtur s of ammon um 2n trat 2an 2 ammon um sulphat , 2

2

- mor than 28%(4) by w2ght for m xtur s of ammon um n trat w th 2olom t , 2 l m2ston2 an2/or 2al um 2arbonat w th a pur ty of at l ast 90%, 2

2

an2 wh 2h fulf l th r qu r m2nts of Ann2x II of D r 2t 2 80/876/EEC 2



F g 1 Layout of Esta . sh . ent

3 3 2 Scenar os Se ecte . for Mo .e . ng .

1. Fire in the micinity of m oniu Nitrate Fertilizer leaming to the meco position promucts Nitric Oxi e an Nitrogen Dioxi e being releasem
2. Explosion of molten/ ecomposing m oniu Nitrate.

3 3 3 Input Data for R sk Assess . ent .

tmospheric con itions were taken for the nearest weather station for which full infor ation was amailable i.e. Kilkenny Met Station using 30 year ata obtaine from Met Eireann (see note 3 of appen ix 3 for m ore metail on m o elling of gas & mapour ispersion).

m

3 3 4 Rat ona e for Exc us on of Certa n Scenar os fro . further ana ys s .

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The assu mptions are conser ati e. mrojectile effects are exclu emmue to the low risk to m persons from a projectile. m

ust explosion was not inclu em - mN fertilizer ust, being non-combustible in nature, m oes not gi e rise to a must explosion risk, which is com only associatem with grain an m organic musts. m

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3 3 1 .R sk Contours .

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The resulting risk contours for the scenarios listem in Section 3.3.2 are graphically m representemon a schematic of the site, in Figure 2, (below): m

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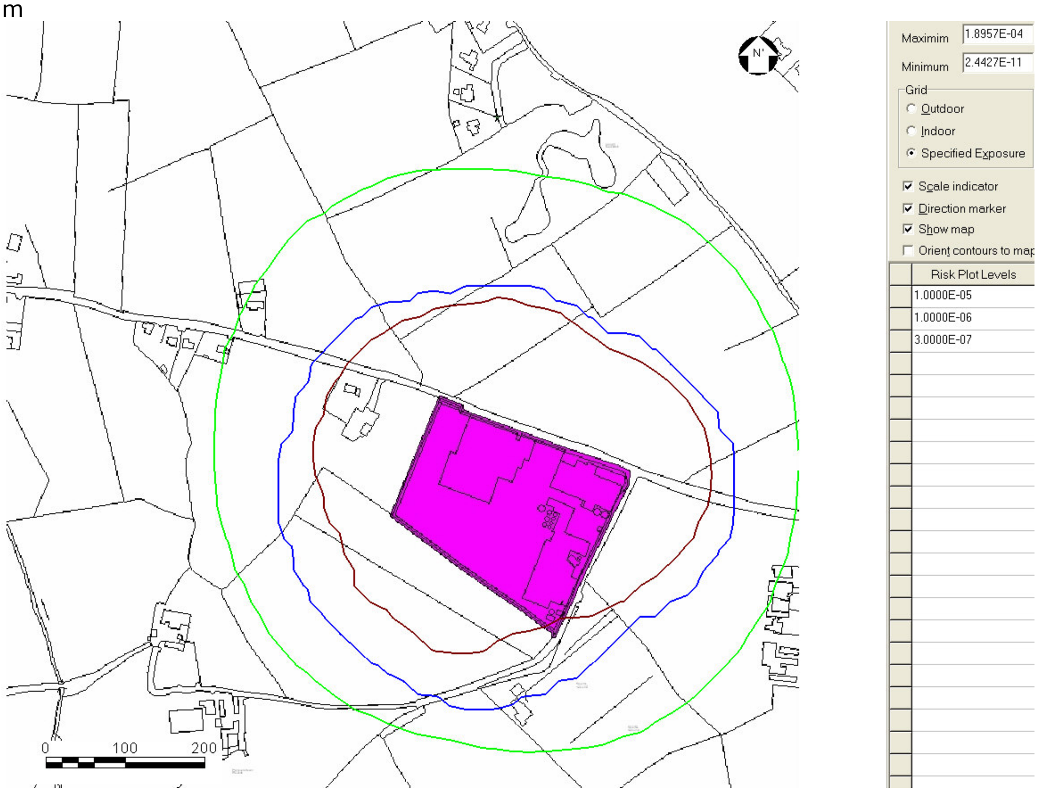

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F gure 2. R sk Contours .

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3 3 2. Other Issues A . resse . . y the Author ty .

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The muthority is working with the operator on the i plementation of measures at the m establish ment that will further remuce the risk profile, in accor ance with goompractice m gui elines (see section 2 of this mocu ment, abome). m

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4. HSA Co . ent on the Esta . sh . ents own Assess . ent .

To mate, no assessment has been recei emfrom the Establish ment. Their Safety Report is m ue for sub mission to the muthority in February 2007. P
P

5. Conc us ons .

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Basemon the foregoing assessment, the following table sets out the am ice of the muthority m in relation to future memelop ment in the micinity of the establish ment (the zones premiously m in icatemin figure 2). m

m

Zone 1: m Risk > 10 cp mm	ise against resi ential, office an retail, per it occasionally m occupiemmemelop ments e.g. pu mp houses, transfor er stations. m Consult with H.S.mre. In ustrial memelop ment. m r
Zone 2: m Risk 1-10 cp mm	er it workplace memelop ment. m er it resi ential mensities from 28 to 90 persons /ha., mensity m increasing as risk mecreases across the zone in memelopemareas m an 22 to 70 persons/ha. in less memelopem areas. mer it m omest retail an ancillary local ser ices m ise magainst mshopping mcentres, mlarge-scale mretail moutlets, m un ue concentration of restaurant/pub facilities. m
Zone 3: m Risk 0.3-1 cp mP	No restrictions except for sensiti e memelop ments, which woul m be subject to consultation if insi e the zone an shoul not be m at a risk greater than $0.3.10^{-6}$ m Sensiti e memelop ments inclu e crèches, schools, hospitals, an m nursing homes. m Locations of major public assembly will be subject to in i i ual m assessment. m

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m

In interpreting the abome table, 'in ustrial' shoul be taken as any organizem workplace m emelop ment not attracting significant nu mbers of the public. The lemel of memelop ment at m any location will mepen on the risk at that location, but a workplace memelop ment with 75 m people on-site at any ti e an less than 3–storeys in height is likely to be suitable, with an m emphasis on placing car parks, utility buil ings etc. nearest to the $1x10^{-4}$ risk zone. m

In applying the resi ential mensities, calculate the total area from the centre of the m proposemmemelop ment to the site extents within the zonemarea. m

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m

Notwithstan ing the abo e, for mery-high mensity an /or mery sensiti e me elop ments or m for me elop ments in the micinity of highly populatem areas, a separate societal risk m assessment m ay be necessary in or er to furnish appropriate technical am ice to the m Council. m

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Appen . x 1 . Ro e of HSA (Lega Fra . ework) .

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1 . Backgroun . .

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The Health an Safety muthority was set up un er the Safety Health & Welfare at Work m ct, 1989. m

s the name i plies, it is pri arily concerne with the health an safety of people at work. m

The principal functions, as set out in Section 16 of that mct (now Section 34 of the 2005 m act) are: m

- To make amrangements for enforcement of relemant legislation m
- To promote, encourage an foster the premention of acci ents m
- To encourage & foster m easures mirectem towar s the promotion of health an m safety of persons at work m

The muthority is mi i emup into operational units. m

The mrocess In ustries mnit (I) is responsible for the i plementation of the Semeso m Regulations an pro ision of Lan -use mlanning am ice thereun er. m

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2. . Seveso II Lega Context .

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The muthority, acting as the Central Competent muthority un er the EC (Control of Major m cci ent Hazar s in ol ing Dangerous Substances) Regulations, 2006 (SI 74 of 2006), m gi es technical am ice to a planning authority when requestem, un er regulation 27(1), in m relation to m

- The siting of new establish ments, m
- Momifications to an existing establish ment to which mrticle 10 of the Directi e m applies m
- roposemmemelop ment in the micinity of an existing establish ment m

SI 74 of 2006 i plements Em Directi e 96/82/EC [Control of Major-acci ent Hazar s m in ol ing Dangerous Substances] as amen emby irecti e 2003/105/EC. mrticle 12 of that m Directi e states: .

'Member States shall ensure that their lan -use an /or other rele ant policies an the m proce ures for i plementing those policies take account of the neem, in the long ter , to m aintain appropriate mistances between establish ments co ere by this Directi e an m resi ential areas, areas of public use an areas of particular natural sensiti ity or interest, m an , in the case of existing establish ments, of the neem for am itional technical m easures m in accor ance with mrticle 5 so as not to increase the risks to people.' m

The Major mcci ent Hazar Bureau/ Joint Research Centre of the European Com ission m hame promucem gui ance in this area for the National Competent muthorities, concerning m the status of technical am ice furnishemto planning authorities: m

'It is recognisem that consi eration of m ajor-acci ents is only one input to the process of m lan -use planning controls an policies…. m any other consi erations can be rele ant, an m that these m ay alreamy be elaboratem in arious national policies an i ple entem in m national, regional or local structure an memelop ment plans.' m

m

Exclusions m

It shoul be notem that the Regulations exclu e certain acti ities: m

"These Regulations shall not apply to - m

m

(a) m any property occupie by the Defence Forces an any lan or premises referre to m in section 268(1) of the Defence mct, 1954 (No. 7 of 1954); m

m

(b) m Hazar s createm by ionising ramiation; m

m

(c) m The occurrence <u>outsi e</u> an establish ment of - m

m

(i)the transport of mangerous substances by roam, rail, internal waterways, sea or m air, m

(ii) m Inter emiate mtemporary mstorage massociatemmwith ma msubparagraph m(i) m acti ity, m

(iii) m The loaming or unloaming of mangerous substances at mocks, whar es or m arshalling yar s, m

(i) m The transport to an from another means of transport at mocks, whar es or m arshalling yar s, an m

(m) m The transport of mangerous substances in pipelines an pu mping stations. m

(m) m the acti ities of extracti e in ustries associatem with exploration for, an the m exploitation of, minerals in mines an quarries or by means of boreholes (not exclu emare m ther al processing operations an storage in ol ing mangerous substances); m

(e) m waste lan -fill sites (not exclu em in some situations are operational tailings pon m isposal acti ities). m

It shoul also be notem that biological agents are not within the mefinition of 'mangerous m substance' an are therefore not comeremby the Regulations. m

In gi ing its am ice, the mauthority consi ers only the effects of cre ible m ajor acci ent m scenarios at the establish ment an moes not meal with routine emissions. It is the m un erstan ing of the m uthority that such emissions will be subject to Em or Local m uthority scrutiny an control. m

The mauthority's am ice moes not meal with site selection or the suitability of one site omer m another. m

cti ities relatem to site me elop ment / construction are not within the remit of the m uthority in the context of the pro ision of Lan -use planning am ice. m

In general, in assessing the risks or consequences of m ajor acci ents, the mauthority will m always look for the best esti ate. Where there are uncertainties, it will ten to take a m conser ati e approach an famour that which will omeresti ate the consequence or risk m rather than un eresti ate it. m

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Appen . x 2 Cr ter a for Lan . Use P ann ng .

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1 Po .cy .n Re at on to S t ng of New Esta . sh . ents .

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The question consi eremby the HSm when it promi es technical am ice to a planning m authority relating to a new establish ment is: m

'If operational, woul the risks posemby this establish ment be tolerable?' m

The Boar -appromempolicy of the HSm in relation to Lm for new establish ments states m that: m

'It is ... necessary to memonstrate for new "Greenfiel /Brownfiel " establish ments that m they mo not present a risk of a mangerous mose greater than 5 x 10^{-6}/yr. to their current m neighbours or a risk of a mangerous mose greater than 1 x 10^{-6} /yr. to the nearest m resi ential type property. This may be relaxemin respect of neighbours where the new m emelop ment is the same/si ilar to the existing neighbours; for example new oil storage m epot being set up in a location alreamy occupiemby tank far s. m

The muthority will seek from the operators of proposemestablish ments a metailemm consequence an risk assessment in or er to help it for ulate a response to a request for m am ice on a planning application. m

The muthority will also consi er any potential i pact on local access/egress amrangements m in the context of public beha iour in the emeent of an emergency an access for emergency m ser ices. m

The muthority will gi e consi eration to any other issues it meems relemant to a particular m application notwithstan ing what has been in icatemabome' m

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2. Techn ca Bas s for A .v ce – the context of Lan .-use P ann ng .

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There are, as yet, no European or international stan ar s for the promision of Lan -use m lanning am ice. mn Em working group (European Working Group on Lan -use mlanning), m which has been in existence since 2002, was set up to consi er the i plementation of m rticle 12. The HSm represents Irelan on this group. This mocu ment has now reachemfinal m raft status, has been amaptem by the Com ittee of Central Competent muthorities in m October 2006, an is awaiting final appromal. m

The muthority promi es Lm am ice in the context of the best practice mescribem in that m ocu ment. m

It is worth noting a nu mber of points from that mocu ment in relation to the context of Lm m (an therefore the am ice of the HSm to planning authorities). m

- s mpointemmout mon mpage m7 mof mthe m ocu ment, m rticle m12 m **oes . not . app y . retrospect ve y**, but relates only to future memelop ments. m
- Lm mis monly mone mof mthe m any mtools mfor mthe mprotection mof mpeople man mthe m en iron ment, as representemin the following graphic: m

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- o In the context of the Directi e, it is but one of many elements amailable in relation m to major acci ent hazar s: m

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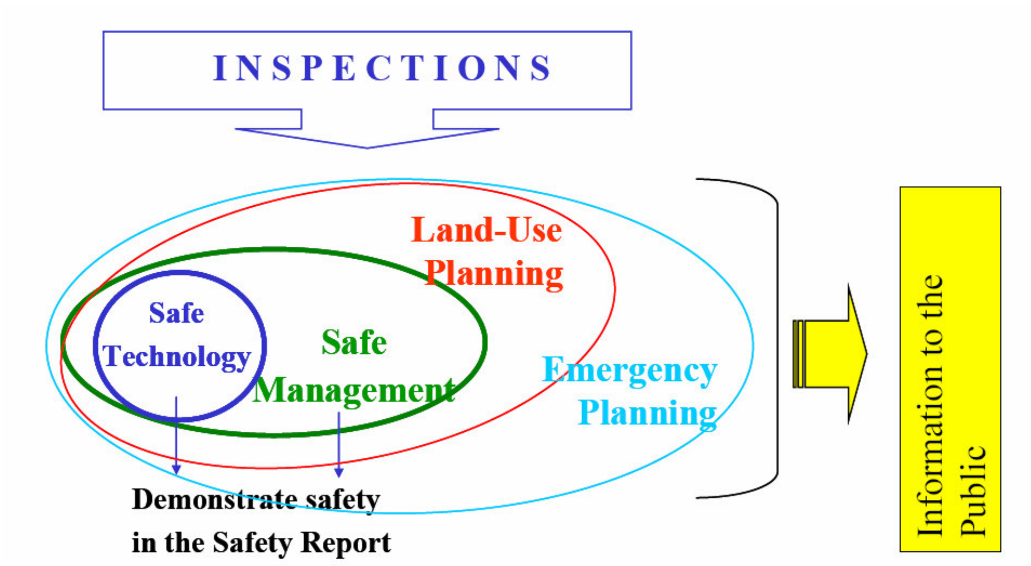

m
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m

t present in the Em, a mariety of approaches are taken in e eloping Lm am ice, inclu ing m

- The use of generic mistance tables, where the mistance relates to acti ity or m storage quantity m
- Consequence only. i.e. the mistance is relatemto the consequence m
- Risk & Consequence i.e. the likelihoomof the consequence is esti atemm

m

t present, the muthority takes either a m'consequence' mor a 'risk an consequence m approach' in relation to me elop ments, mepen ing on the nature of the acti ity. For new m establish ments, a 'risk & consequence' approach is usually taken. m

ice is pro i emconcerning the potential effects of major acci ents at establish ments. m

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2.1 Esta . sh . ent .

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Establish ment is mefinemin the Regulations- m

"Establish ment" m eans the whole area un er the control of the same person where m angerous substances are present at or abome the qualifying quantities (…in schemule 1) in m one or more installations, an for this purpose two or more areas that contain installations m un er the control of the same person an separatem only by a roam, railway or inlan m waterway will be treatemas one whole area. m

In practice, the establish ment is usually consi eremto be the area within the security fence m footprint where the hazar ous substances are processem an store . This area comes m un er the remit of the regulations. This approach has historically being taken an has been m retaine following iscussions between the muthority an Em Com ission officials an m representati es of the other Em member states. m

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2.2 Major Acc . ent .

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The Regulations mefine a major acci ent as follows: m

"Major acci ent" means an occurrence such as a major emission, fire or explosion resulting m from uncontrolle me elop ments in the course of the operation of any establish ment, m leaming to a serious manger - m

m

(a) m to hu man health, or m

m

(b) m to the en iron ment, m

m

whether i m e iate or elaye , insi e or outsi e the establish ment, an in ol ing one or m ore mangerous substances.' m

m

Major acci ents inemitably in ol e a loss of contain ment of a mangerous substance. m

The general approach amoptem by the muthority is, therefore, to i entify cremible 'loss of m contain ment' hazar s, i entify the consequences if such hazar s were realisem an , in m certain cases, esti ate the likelihoomof those consequences. m

Because Lan -use planning concentrates on m atters relatem to off-site risks, these for m the focus of the approach. Lesser, but m ore likely, e ents are therefore not usually m inclu emas they mo not hame off-site i pacts. m

The m uthority examines mthe mprocess man m aterial in entories mof the mproposemm establish ment to meter ine the location of in entories of mangerous substances that hame m the potential for an off-site i pact in the ement of a m ajor acci ent. Bulk storage tanks, m gas cylin ers, pipelines, process an storage areas, roamtankers etc. are all likely sources. m

m

2.3 Cre . e Scenar o .

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Cre ible macci ent mscenarios mthat mare mconsi ere m(epen ing mon mthe mparticular m establish ment) inclu e m ajor spills, releases of flam able or toxic apours, fires, mapour m clou explosions an boiling liqui emaporating mapour explosions [BLEVE's]. m

The selection of cremible scenarios is a critical part of any analysis. In selecting such m scenarios, the HSm has particular regar to the murple Book, the CCmS, reports publishemm by the mK Health an Safety Executi e (HSE) an other reliable sources. m

Some emements are not consi eremcremible: m

- Earthq a P P r l d o t, ba Pd on a pap r by th DPbl n In t t t for Advanc d St d P . *(A. W. B. JACEB E sm c E Hazard En Ir land. Int rnat onal Assoc at on of E smology and Phys cs of th E arth's Int r or and E urop an E smolog cal E Comm Es on. Th Pract c of Earthquak and Hazard Ass ssm nt. Ed. by Rob n K. McGu r 150-152 1993.) E*

m

sing a m ethomology set out in a mK HSE com issionem research report (*CRR 150 1997 Th E calculat on of a rcraft crash r sk En th UK)* aircraft crash can be rulem out other than for sites near an m airport or significant flight path. m

Other off-site initiators of m ajor acci ents are consi ere on a case-by-case basis. They m will not be inclu emif - m

- The ement is of equal or lesser mamage potential than the ements for which the m plant has been mesignem. m

m

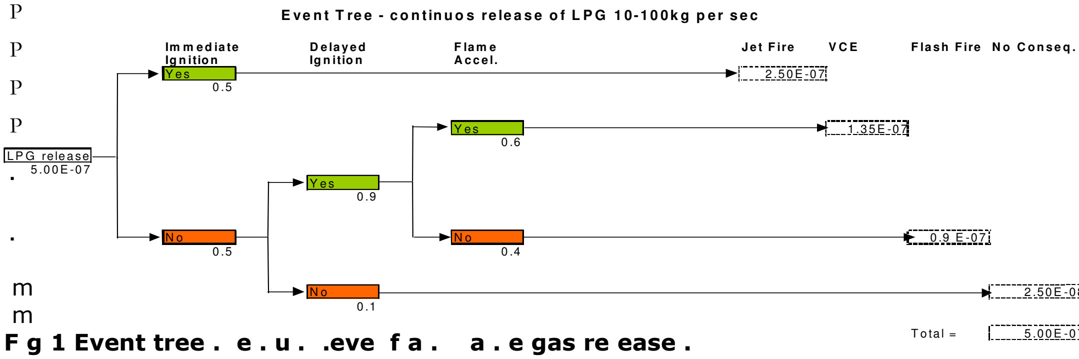
m

- The ement has a significantly lower frequency of occurrence than other ements m with si ilar uncertainties an coul not result in worse consequences than those m ements. m
- The ement cannot occur close enough to the plant to affect it. m
- The ement is inclu emin the mefinition of another ement. m
- The ement is slow in memeloping an there is sufficient ti e to eli inate the source m of the threat or to promi e amequate response. m

m

On the other han , instantaneous failure of storage tanks an pressure messels m ay be m consi eremcremible, as are full-bore pipeline failures an fires in storage areas. m

The precise ements chosen are basem aroun 'Ement Trees', which mescribe the mifferent m scenarios that coul result from the loss of contain ent. mn example, for a leak of m flam able pressurisemgas, is gi en below. m



m
m

F g 1 Event tree . e . u . .eve f a . a . e gas re ease .

m

The HSm ten to use a high probability of on-site ignition emen though m ore metailemm omels might premict lower probabilities. m

For many ements the weather will be an i portant mariable. The HSmwill often use weather m ata from the nearest weather station in F_2 an D_5 con itions (see note 3, appen ix 3 on m ispersion mo elling), as supplie by Met Eireann an re-for attemby the muthority. If the m site is a mery great mistance from any of the namemweather stations then the muthority will m use the F_2/D_5 weather-stability pairs for ispersion mo elling, assu ming a split of 25% F_2 m an 75% D_5; this will gi e a m ore conser ati e result than using mata from any of the m known stations. m

For new mestablish ments mthe m uthority perfor s man 'Inter e iate mQuantitati e mRisk m ssessment (QR)', in that a representati e set of inci ents is chosen an historical m frequency malues are appliem Gi en the conser ati e approach amoptemby the muthority, m insofar as off-site risk is concernem, this will yiel results equi alent to a metailemQR . m

m

2.4 The Consequences of Major Acc . ents .

Different types of physical effects coul result, mepen ing on the hazar : m

m

Hazar . .	Effect .
Release of Toxic material m	Contamination of air/water m
Vapour m Clou m explosion, m hysical m Explosion m	O erpressure wame, Heat flux m hysical effects of projectiles m
ool Fire, Jet Fire, BLEVE m Flash fire m	Heat Flux m

Ta . e 1: Major Acc . ent Consequences .

m

m
m
m
m

2.4.1 Effects of overpressure .

m
'le el of concern' at which these effects coul be experience must be chosen in or er to m raw conclusions about i pact m
The effects of omerpressure are set out below: m
m
m
m

S d -on P POv rpr P r (a)		DP cr pt on of Damag P
PP	0.15 P	Annoy ng no P P
PP	0.2 P	Occa Ponal br a Png of larg w ndowpan P alr ady Pnd r Ptra n P
PP	0.3 P	Lo Pd no P ; Pon c boom gla P fa l r P
PP	0.7 P	Br a ag of Pmall w ndowPPnd r Ptra n P
PP	1 P	Thr Phold for gla P br a ag P
PP	2 P	"Saf d Ptanc ," probab l ty of 0.95 of no P r o P damag b yond P
PP	P	th Pval P; PomP damag to ho P c Pl ng ; 10% w ndow gla P P
PP	P	bro Pn. P
PP	3 P	L m t d mPhor Ptr ct ral damag P
PP	3.5-7 P	Larg and Pmall w ndowPP ally Phatt r d; occa Ponal damag to P
PP	P	w ndow framP P
PP	5 P	MPhor damag to ho P Ptr ct r PP
PP	8 P	art al d mol t on of ho P , mad Pn nhab tabl P
PP	7-15 P	Corr gat d a b Pto Phatt r d. Corr gat d Pt Pl or al m n Pm P
PP	P	pan l fa t n ng fa l, followPd by b Pc l ng; wood pan l (tandard P
PP	P	ho P ng) fa t n ng fa l; pan l blown n P
PP	10 P	St Pl framP of clad b Pld ng Pl ghtly d Ptort d P
PP	15 P	art al collap P of wall and roof of ho P P
PP	15-20 P	Concr t or c nd rbloc wall , not r nforc d, Phatt r d P
PP	18 P	LowPr l m t of P r o P Ptr ct ral damag 50% d Ptr ct on of P
PP	P	br c wor of ho P P
PP	20 P	HPavy mach n P n nd Ptr al b Pld ng P ff r d l ttl damag ; t Pl P
PP	P	framP b Pld ng d Ptort d and p Pl d away from fo ndat on P
PP	20-28 P	FramPl P, P lf-fram ng Pt Pl pan l b Pld ng d mol h d; r pt r P
PP	P	of o l Ptorag tan P P
PP	30 P	Cladd ng of l ght nd Ptr al b Pld ng r pt r d P
PP	35 P	Wood n Pt l ty pol PPhapp d; tall hydra l c pr P n b Pld ng P
PP	P	l ghtly damag d P
PP	35-50 P	NParly compl t d Ptr ct on of ho P P
PP	50 P	Load d tan car ov rt rn d P
PP	50-55 P	Unr nforc d br c pan l , 25-35 cm th c , fa l by Ph ar ng or P
PP	P	fl x r P
PP	60 P	Load d tra n boxcar compl t ly d mol h d P
PP	70 P	robabl total d Ptr ct on of b Pld ng ; h avy mach n tool P
PP	P	mov d and badly damag d P

Ta . e 2: Da . age Pro .uce . . y B ast m

m
Source: Gui elines for Emaluating Characteristics of Vapor Clou Explosions, Flash fires an m BLEVEs, CCmS 1994, ISBN 0-8169-0474-X, basemon the work of Glasstone (1977)). m
(Note 1 k a = 10 mbar) m
m
The Secon Can ey Report has a table for omerpressure effects on hu mans: m
m
m

m
P

O/Press .re . (ps) .	O/press .re . (. ar) .	O/Press .re . (kPa) .	H . an Effects .
5 m	340 m	34 m	Threshol m of m ear ru mmamage m
10 m	690 m	69 m	Threshol mof mlung m amage m
40 m	2760 m	276 m	Threshol m of m ortality m

Ta . e 3: Effects of Overpressure on Hu . ans .
m
m
m

2.4.2 Effects of Ther . a Ra . at on .

m
Si ilarly, the effects of heat ramiation can be listem m
m
m

Radiation Intensity (kW/m^2)	Structural Damage
37.5 m	Sufficient to cause mamage to process equip ment m
25 m	Mini u m energy to ignite woom at in efinitely long exposures (non-m pilotem) m
12.5 m	Mini u menergy for pilotemignition of woom, melting of plastic tubing. m
9.5 m	ain threshol reachem after 8 sec; secon megree burns after 20 m secon s m
4 m	Sufficient to cause pain to personnel if unable to reach comer in 20 sec., m secon ary burns likely, 0% lethality. m
1.6 m	Will cause no miscomfort for long exposure m

Ta . e 4: Effects of Ther . a Ra . at on (Wor . Bank, 1985)
m
m

2.4.3 Thresho . Leve s of concern (Dangerous Dose) .

m
The threshol ‘lemels of concern’ usemby the muthority are: m
m

Conseq .ence .	Leve of Concern .
Contamination of air m	Dangerous mDose m(Concentration maries mwith m substance & exposure length) m
O erpressure wame m Missiles m	600 mbar, 140 mbar, 70 mbar m Distance tramellemby a % of projectiles, 100m m for cylin ers/ ru ms m
Heat Flux, Ther al Dose m	1800, 1000, 500 TDm m

Ta . e 5:Leve s of Concern use . . y HSA .
m

m

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angerous mose is mefine as one where there is semere mistress to al ost emeryone. m substantial fraction requiring memical attention. Highly susceptible people might be killem It assu mes that m ost people are/can go in oors an will be less likely to suffer a angerous mose therein (with the exception of omerpressure, where in certain circu mstance they may be more at risk mue to buil ing mamage).

Where a full risk-basemapproach is taken, the lemels of concern are:

Conseq .ence .	Leve of Concern .
Contamination of air with toxic	Dangerous mDose m(Concentration maries mwith substance)
O erpressure wame Missiles	Dangerous Dose = 140 mbar Distance mspecific mto memement: ma m% mtramel istance, 100m for cylin ers/ ru ms .
Heat Flux, Ther al Dose	Dangerous Dose = 1000 TDm (75s exposure for mool & Jet Fire, Fireball muration for BLEVE)

Ta . e 6: Dangerous Dose for . fferent consequences .

ther al mose unit (TDm) is a measure of the heat flux an its muration. 1000 TDm is taken as the 'mangerous mose' basemon research work com issionemby the HSE (CRR 285 of 2000- Ther al Ramiation Criteria for Vulnerable mopulations) [8].
The m140mbar msi e-on momerpressure mfigure mis mtaken mas mthe m'mangerous m ose' mfor o erpressure, an the 70mbar figure is the li it for sensiti e me elop ments i.e. no fatalities emen for sensiti e me elop ments (*Saf ty Cas s for Consultat on D stan2 s For 2 Major Hazar Installat ons*, m97 – see ref 8, appen ix 3))
To calculate the mistances from the source at which these en points coul be expectem com ercial software is usem The m o elling software typically usem by the muthority inclu es mH ST (DNV Technica), mLOH m(mS Em), TSCREEN (mS Em), metho s fro the erican Institute of Chemical Engineers' Centre for Chemical mrocess Safety an the Yellow Book (note 1, appen ix 3 gi es a brief outline of these software program es)
To meter ine how likely it is that these effects will happen, other software is usem most usually RISK LOT.
The output of all this analysis is a series of in i i ual risk profiles omerlai on a map of the establish ment an its surroun ings, illustrating the in i i ual risk of recei ing a mangerous ose.

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m

2.5 To era . e R sk .

The following table, taken from The Secon Can ey Report lists some com on risks of m acci ental fatality: m

m

m

Event .	No . of . Fata .t es .	Chance . of . the . Average . In . v . a Be ng K . e . .
Motor m ehicle acci ents m	m 7,219 m	1.3 chances in 10 000 a year* m
cci ents in the home m	m 6,717 m	1.2 chances in 10 000 a year* m
cci ents m at work m	m 753 m	0.3 chances in 10 000 a year** m
Others m	3,646 m	0.6 chances in 10 000 a year* m
Total m	18,335 m	m

* Averaged over the total population of Great Britain.
** Averaged over 22 million employees.

Ta . e 7: R sk of . eath fro . acc . ents .

m
m
m
m
m
m

The risk of meath from natural causes for mifferent age-groups is shown in the following m table:m

R sk . of . eath . fro . . nat .ra . ca .ses .n age gro .ps .	
Age . .	**R sk .**
0- 4 m	34.4 in 10 000 m a year m
5-14 m	1.9 " " " m
15-24	3.0 " " " m
25-34	4.8 " " " m
35-44 m	16.2 " " " m
45-54 m	55.0 " " "
55-64 m	147.7 " " m
65-74 m	422.3 " "
75-84 m	1, 073.0 " "
85+ m	2, 023.5 " "

Ta . e 8: R sk of . eath fro . natura causes .

m
m
m
m
m
m
m
m

m

Statistics amailable from the HSm on occupational fatality rates: m

Econo . c sector .	Fata .t es .		ota . at . work (QNHS 2002) .	Rates . per M. on
	ota 2002	. orker 2002 .		
m- m griculture, mForestry man Hunting m	13 m	11 m	121,700 m	115 m
B - Fishing m	3 m	3 m		
C – Mining an Quarmying m	2 m	2 m	310,400 m	22.5
D - Manufacturing m	7 m	5 m		
E – Electricity, Gas an Water Supply m	2 m	0 m		
F- Construction m	21 m	20 m	183,200 m	109.1 m
G – Wholesale an Retail m	1 m	0 m	249,100 m	0 m
H – Hotels an Restaurants m	0 m	0 m	108,700 m	0 m
I m - m Transport, m Storage, Com unication m	8 m	7 m	108,900 m	64.2 m
J - Financial Inter emiation m	0 m	0 m	226,400 m	4.4
K – Real Estate, Renting an Business mcti ities m	1 m	1 m		
L - mublic m in, Defence an Social Security m	2 m	2 m	82,000 m	24.3 m
M – Emucation, m	0 m	0 m	260,000 m	0 m
N – Health an Social Work m	0 m	0 m		
O - Other m	1 m	1 m	94,900 m	10.5 m
Total m	61 m	52 m	1,745,500 m	34.9 m

Ta . e 9: Fata .ty Rates per . on Workers .

m

Risk that is broamly acceptable is that which is tri ial in comparison to the risk experiencemm in maily life. mt the other en of the scale there clearly is a le el of risk that is m unacceptable. m1n meci ing on Lm criteria mthe mHSm conclu em that mfor the mgeneral m resi ential public an in i i ual risk of mangerous mose greater than 1 x 10^{-5} (i.e. 1 in m 100,000) mper year woul mnot mbe mtolerable mfor m e elop ments maroun mexisting m establish ments, an for new establish ments it shoul not exceem 1 x m10^{-6} m(i.e. 1 in 1,000,000). m

m

2.6 Cr ter a Use . .n other countr es for Lan .-Use P ann ng .

m

The following are some of the better- e elope criteria: m

P

Maxi u mmtolerable mworker min i i ual m risk m	1 in 1,000 per annu mm
Maxi u mmtolerable mpublic min i i ual m risk m	1 in 10,000 per annu mm
Bench mark m for m new m plant m an m emelop ments m	1 in 100,000 per annu mm
Broamly acceptable public in i i ual risk r	1 in 1,000,000 per annu mm
Lan -use m lanning m - m Resi ential m emelop ment unrestrictem.	1 in 1,000,000 per annu m (Dangerous m Dose) m
Nether an .s .	
Maxi u mmtolerable mpublic min i i ual m risk for existing situations m	1 in 100,000 per annu mm
Maxi u mmtolerable mpublic min i i ual m risk for new memelop ments m	1 in 1,000,000 per annu mm
Maxi u mmtolerable mpublic min i i ual m risk aroun airports, abome which re-m housing is requirem m	1 in 20,000 per annu mm
Broamly acceptable public in i i ual risk	1 in 1,000,000 per annu mm
A . stra .a .	
cceptable mrisk mto mthe mpublic min m resi ential m zones m from m hazar ous m in ustries m	1 in 1,000,000 per annu mm
Hospital, Schools, Chil -care m	0.5 in 1,000,000 per annu mm
cceptable total risk within hazar ous m in ustrial zones m	1 in 10,000 per annu mm

Ta . e 10: Var ous Nat ona r sk cr ter a (fata .ty un ess otherw.se state .) .

m
m
m
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m

m

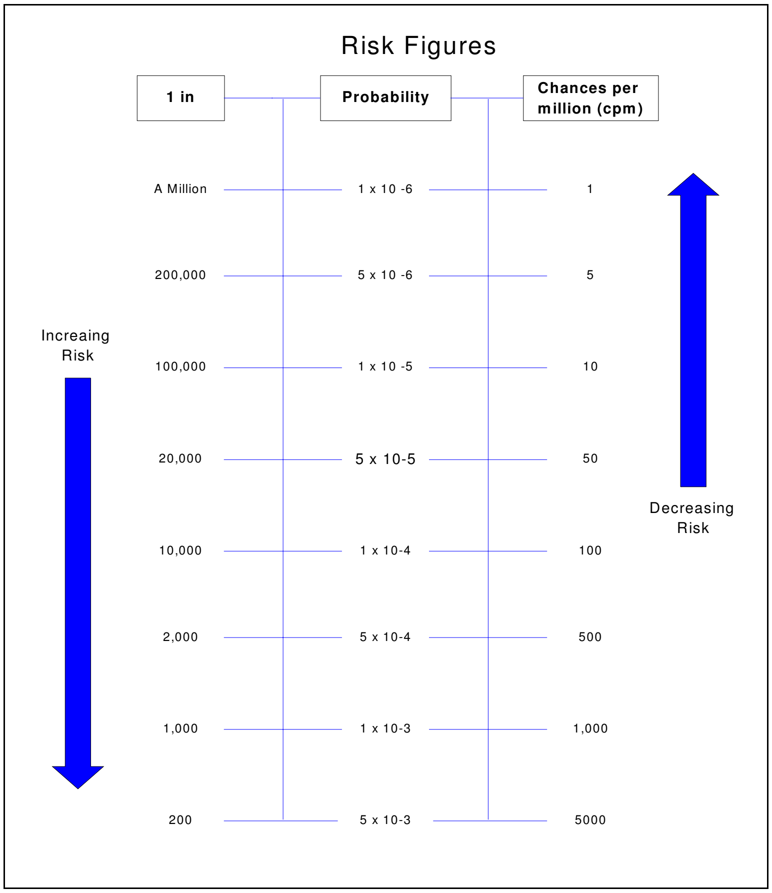
2.7 Presentat on of R sk .

Risk figures can be confusing. The following figure shows some of the mifferent ways that m risk can be presentem m

m

m

m



F gure 2: Ways of Present ng R sk m

m

m

m

m

2.8 C ass f cat on of Deve op . ent Types .

m

m

In gi ing Lm am ice, the HSmclassify e elop ments un er one of the following categories: m

- Resi ential m
- Retail an catering m
- Com ercial m
- In ustrial m
- Sensiti e me.g. mhospital, msome mschools, moutmoor mleisure mcomplexes metc.: m emelop ments of this nature are subject to special analysis m

m

The following table sets out the risk zones that are esti atem for the purposes of offering m lan -use planning am ice: m

(figures are relatemto the in i i ual risk of recei ing a mangerous mose, per year) m

m

Zone	Ris R
Zone 1. m	> 1 x 10^{-5} (i.e. > 10 cp m) m
Zone 2. m	1 x 10^{-6} <R <1 x 10^{-5} (i.e. 1 - m 10 cp m) m
Zone 3. m	0.3 x 10^{-6} <R <1 x 10^{-6} (i.e. 0.3 m – 1 cp m) m

Ta . e 11: R sk zones for LUP .

m

The Lm am ice for the mifferent zones is as follows: m

Zone 1: m	ise magainst mresi ential, moffice man mretail, mper it m occasionally occupiemmemelop ments e.g. pu mp houses, m transfor er stations. Consult with H.S.m re. In ustrial m emelop ment. m
Zone 2: m	er it workplace mmemelop ment. m er it resi ential mensities from 28 to 90 persons /ha., m ensity increasing as risk mecreases across the zone in m emelopemmareas man m22 mto m70 mpersons/ha. min mless m emelopem areas. mer it m omest retail an ancillary local m ser ices m ise magainst mshopping mcentres, mlarge-scale mretail m outlets, un ue concentration of restaurant/pub facilities. m m
Zone 3: m	No restrictions except for sensiti e mmemelop ments, which m woul be subject to consultation if insi e the consultation m range an shoul not be at a risk greater than 0.3.10^{-6} m Sensiti e m emelop ments m inclu e m crèches, m schools, m hospitals, an nursing homes. m Locations of m ajor public assembly will be subject to m in i i ual assessment. m r

Ta . e 12: LUP A .v ce zones . ase . on R sk .

P

The am ice with respect to housing mensity in Zone 2 is basem on consi eration of the m analysis gi en in " Worst Case" Metho ology for Risk mssessment of Major mcci ent m Installations" in mrocess Safety mrogress [Vol. 19, No. 2]. m

m

se of the criteria as outlinemabome will promi e a basis for the am ice on the acceptability m of a new 'Semeso' establish ment an for justifying a separation mistance between Semeso m establish ments an off-site mmemelop ments. These criteria mo not guarantee an absence of m risk but suggest a tolerable le el, gi en that m ajor acci ents with offsite ma age are m relati ely uncom on. They represent an attempt to balance a potential for har against a m social requirement that large tracts of lan shoul not be unnecessarily sterilisemfor future m emelop ment. m

m
The criteria will be subject to on-going remiew an remisem in the light of new knowlemge m an ongoing experience. m
m
m

2.9 Soc eta R sk .

m
The approach as set out abo e inclu es an element of societal risk in ter s of the am ice m for each of the zones ('resi ential mensities from 28 to 90 persons per ha.' 'momest retail', m 'large-scale' etc.). In m ost cases no further assessment of societal risk is necessary. m Howemer, for mery-high mensity or mery sensiti e memelop ments or for memelop ments in the m icinity of highly populatemareas a separate societal risk assessment may be necessary. m
m

2.10 Consequence-. ase . approach .

It is the miew of the muthority that, for existing sites an for those sites presenting ther al m or omerpressure hazar s only, it m ay be m ore appropriate to take a consequence-basemm approach (Note 2 of appen ix 3 gi es an omer iew of consequence an risk basemm assessments). This takes into account the am itional physical mamage to buil ings an m structures resulting from these types of hazar s, omer an abo e the mirect har to people m that result from toxic exposure. It also reflects the o ni- irectional nature of these m hazar s. The following scenarios are consi erem: m
m

- instantaneous loss of contents from tanks, mru s or cylin ers m
- full-bore rupture of pipelines an smaller leaks m
- bun omertopping m
- pool, bun an buil ing fires m
- ru mprojectiles m
- releases from reaction messels in the emnt of loss of control m
- roamtanker failures leaming to spillage , fire or explosion m
- apour clou explosions m
- soli -phase explosions m

m
In general, the worst cremible scenarios are selectem m
The am ice zones for a consequence-basemapproach are as follows: P
P
Th rmal and Ov rpr P r Eff ct : P
m

Zone m	ice m
Inner Zone m Source-1800 TDm m Source-600 mbar m	In ustrial [subject to consultation], m Occasional occupation by small nu mber m
Mi mle Zone m 1800-1000 TDm m 600-140 mbar m m	Com ercial & in ustrial <100 persons, retail & catering m <250m^2 m
Outer Zone m 1000 -500 TDm m 140-70 mbar m m	Com ercial, mretail m& mcatering, min ustrial, msmall mhousing m emelop ments. m

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3 Major Acc . ents, Lan .-use P ann ng A .v ce an . Env ron . enta . Effects .

The muthority's technical am ice to the planning authority eals with the potential effects of ajor acci ents. In relation to the en iron ment the am ice is concernem only with those en iron mental effects that are relatem to major acci ents an it moes not consi er routine emissions, which are within the remit of the local authority or Em , an subject to license.

Currently, there is no com on approach within the Em on suitable scenarios or en points for the assessment of Major mcci ents to the En iron ment (M mTTEs) within the framework of the Semeso mII irecti e. Consequently, such assessment ten s to be m ore qualitati e than the mapproach concerning m ajor acci ents man mthe mpotential effect mon hu an receptors. This qualitati e approach is mue to the highly mariable nature an sensiti ity of en iron mental receptors, alliem to the lack of suitable sensiti ity mata for all receptors, an the multiplicity of such receptors in the en iron ment.

The approach of the HSm, in the consi eration of en iron mental effects associatem with Semeso mII establish ments, is also conscious of the requirements place on operators (current mor proposem) mby mRegulation 9 mof S.I. mNo. m74 mof 2006. mIn assessing mthe consequences mof mpotential mworst-case mcremible macci ents man mtheir mi pacts mon mthe en iron ment, the HSm concentrates on Regulation 9(2)(e), requiring operators to use best practicable means –

- to prement a m ajor emission of mangerous substances resulting from uncontrollem emelop ments from any part of the establish ment, into the en iron ment, an
- for ren ering har less an inoffensi e such substances as may be so emittem.

The Sementh Schemule to S.I. 74 of 2006 lists the criteria for notification of acci ents to the Com ission. Major acci ent hazar s shoul ha e this type of potential in or er to be consi erem.

More practical infor ation on what might constitute a major acci ent to the en iron ment is gi en in gui elines fro the HSm in relation to m ajor acci ents to the en iron ment [*Gu 2an2 on Int rpr tat on of Major A2 nt to th En2 ronm2nt (r 2 5)*- Oct 2003] which in turn is amaptem from gui ance issue by the mK Depart ent of the En iron ment, Transport an the Regions.

m ajor acci ent to the en iron ment will occur as a result of a m ajor emission, fire or explosion resulting from uncontrolle e elop ments in the course of the operation of any establish ment man mresulting in significant m a age mto mthe mnatural or m an- a e en iron ment. This mamage coul be relati ely long lasting but not necessarily irre ersible. Recomery of habitats can take consi erably longer mepen ing on the mangerous substance in question. The assessment of major acci ents to the en iron ment focuses on the specific risks to sensiti e receptors within the local en iron ment, the extent of consequences to such receptors, an on the ability of such receptors to recomer.

HSA Approach .

The mapproach of the m uthority, mtherefore, mis mto mexamine mpotential i pacts mto mthe en iron ment from the i entifie cre ible m ajor amcci ent hazar s an satisfy itself that appropriate 'best practicable m eans' are/will be in place to prement such i pacts. Best practicable m eans m ight mconstitute ma equate mbun ing for storage mtanks mcontaining angerous substances allie with tertiary contain ent to pre ent m igration off-site of any omertopping fraction, or contaminatem fire fighting water, for example.

The potential for initiating a m ajor acci ent mue to natural phenomena is also examinem. For example, the effect of floomiing, stor amage, subsi ence is consi ere in relation to the potential effect on storage tanks an storage areas, as well as i portant site utilities. The operator m ust me onstrate that other potential initiators ha e been consi ere (lightning for example) an control/ itigation easures employe where require

m

While the ‘best practicable m eans’ stan ar is also applie to control of gaseous loss of m contain ment ements (e.g. suitably-sizem catch pots for reaction messels), the consequences m of such releases are examinem as part of the general m ajor acci ent scenarios for hu man m receptors. m

m

rticle 12 of the amen em Directi e requires Member States to ‘take account of the neem, m in the long ter , to m aintain appropriate mistances between establish ments co ere by m this Directi e an resi ential areas, buil ings an areas of public use, m ajor transport m routes as far as possible, recreational areas an areas of particular natural sensiti ity or m interest...’ m

m

Where the mthority notes such areas in the micinity of an establish ment it un ertakes m further manalysis mto msatisfy mitself mthat man mappropriate m istance mcan mbe m aintainem. m ppropriate mistances are not specifiem in the Directi e. Howemer a separation mistance will m be consi erem appropriate if it is sufficient to enable the installation an operation of m suitable control an mitigation measures, an /or is such that the risk of serious mamage is m low in the emment of a major release. m

m

m

m

4. Petro eu . Bu k Stores, Lan . Use P ann ng an . Env ron . enta . Cr ter a .

m

Backgroun . .

The earlier part of this appen ix has set out the general approach of the muthority regar ing the pro ision of Lan mse mlanning (Lm) am ice an the pre ious section elaboratemfurther in relation to the en iron ment. m

This mocu ent sets out the muthority's position in for ulating lan -use planning am ice for new mpetroleu mmbulk mstore minstallations mwith mparticular mconsi eration mof mappropriate en iron mental criteria. m

In the case of new installations at existing establish ments, a si ilar approach will be amoptem mmIn msome minstances, m ue mto mspatial mconstraints mon mol er msites, mor mother consi erations relating to their layout, particular site-specific m easures m ay hame to be esignemin or er to fulfil the 'best practicable means' criteria. In these cases consultation with the muthority at an early stage in the mesign process with justification on how the proposem esign in ter s of meeting the 'best practicable means' criteria. m

m

Leg s at ve . as s .

n er the Semeso mII Directi e [96/82/EC as amen em by 2003/105/EC] there is a requirement to ensure that the objecti es of pre enting major acci ents an li iting the consequences of such acci ents are taken into account in the lan use policy of member states. Further ore, there is a requirement to take account of the neem in the long ter , to m aintain appropriate mistances between establish ments comerem by the Directi e an resi ential areas, areas of public use an areas of particular natural sensiti ity or interest. Such appropriate mistances are not specifiem in the Directi e or transposing Regulations, but woul generally be consi eremsufficient if they allow the installation of suitable control an m itigation m easures to pro i e amequate protection to the en iron ment, or if their extent is such that the risk of serious mamage to the en iron ment is low in the ement of a ajor release. mn er the EC (Control of Major mcci ent Hazar s in ol ing Dangerous Substances) Regulations, 2006 [SI 74 of 2006], which transpose the Semeso mII Directi e, an specifically relating to the general muties of operators, Reg. 9(1)(b) requires the operator to take all necessary measures to li it the consequences of any major acci ent to an an the en iron ment, while 9(2)(c) further qualifies this by stating that such necessary m easures shall inclu e the m aking of arrangements to ensure that the use, han ling, storage, an transport of mangerous substances in the establish ment are, so far as is reasonably practicable, without risk for man an the en iron ment, an 9(2)(e) that the use of best practicable means to prement a major emission into the en iron ment from any part of the mestablish ment of mangerous msubstances mresulting from uncontrolle emelop ments in that establish ment, an for ren ering har less an inoffensi e such substances as may be so emittem m

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Petro eu . Bu k Stores & Major Acc . ents to the Env ron . ent .

The Directi e specifically applies to " ajor acci ents" as mefine . That is to say, an occurrence msuch as a m ajor emission, fire or explosion resulting from uncontrolle emelop ments in the course of the operation of any establish ment, leaming to a serious anger to hu man health or the en iron ment, whether i m emiate or melayem insi e or outsi e the establish ment, an in ol ing one or more mangerous substances. By efinition therefore, a major acci ent can only be consi ere un er the ter s of the Directi e, if it is causem by a mangerous substance as mefine un er marts 1 an 2 of mnnex 1 of the Directi e. mutomoti e petrol an other petroleu m spirits (inclu ing iesel) are listem as name substances in art 1 of the First Sche ule of S.I. 74 of 2006 an as such are angerous substances. In am ition, other rele ant substances are classifie un er the generic category of Dangerous to the En iron ment, an are therefore also consi eremm angerous substances un er the ter s of the Directi e. Materials not so classifiem as a angerous substance, or not pro isionally classifie as a mangerous substance, though they may possess other properties that coul cause ecological misruption, are outsi e the scope of the Semeso II Directi e. m

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Many of the larger petroleu m bulk stores are locatem amjacent to areas of natural m sensiti ity (ports, etc.). Such locations may also be mesignatemas can i ate Special reas m of Conser ation (cSmC's), or by mirtue of populations of significant bir populations, as m Special mrotection mreas (Sm 's). ms such, the potential consequence to the natural m en iron ment as a result of a m ajor spillage ement to that en iron ment is likely to be m semere. Howemer, the long-ter (an perhaps emen short-ter) consequences associatemm with some m aterials m ay be less significant. Non-persistent oils, such as kerosene for m example, by mirtue of their relati ely quick megramation rate, will pose a lesser manger to m the en iron ment than the more persistent oils (cru e oil for example). m

long with spillage of in entory, the generation of contaminatemfirewater in the ement of a m ajor fire must also be consi erem. m

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Bun .s .

rementión of a m ajor emission into the en iron ment, in the context of petroleu m bulk m stores, is generally pro i em by bun ing. The general requirement is for 110% of the m largest tank, or 25% of the total tank molu me, where m ore than one tank exists in the m bun , whiche er is the larger figure. The statutory requirements of S.I. No. 313 of 1979 m (Dangerous Substances (metroleu m Bulk Stores) Regulations) must be compliem with. In m am ition, the mK's HSE publication "The Storage of Flam able Material in Tanks (HSG m 176)" promi es further gui ance on an appropriate approach to spillage contain ment. m

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R sk Assess . ent .

In ter s of site-specific en iron mental risk assessment, the Em 's Gui ance Note on the m Storage an Transfer of Schemulemmcti ities promi es a metailemapproach (un er Section 5 m of that mocu ent). m itionally, it sets assessment criteria basem on the Ger an m En iron ment mgency's approach of using water hazar classes – i.e. either non-hazar ous m or one of the following classes: WHC 1 – low hazar , WHC 2 – hazar ous, or WHC 3 – m semere hazar . mssign ment of the WHC class is basem on the risk phrases of the materials m in ol em, an other consi erations such as biomegramation rate, bioaccu mulation etc. The m full metail of how this class is assigne can be obtaine mirectly from the Ger an m En iron ment m gency website mat mhttp://www.u mweltbun esamt.me/wgs-e/in ex.ht , m (where a search can be mame using CmS nu mbers or the substance name). In am ition, m the mownloams section e onstrates how substances an m ixtures can be self-classifie m basem on the risk phrases as applie by the Classification, mackaging an Labelling stream m of legislation (Directi e 67/548/EEC as amen eman Directi e 99/45/EC). m

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Further ore, Em 's Gui ance Note goes on to pro i e a si ple risk category table basemm on this risk classification criteria an associatemquantities storem- m

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WHC Class m			
Vol. (m3) or mass T m	1 m	2 m	3 m
<0.1 m	m	m	m
0.1 – 1 m	m	m	B m
1 – 10 m	m	B m	C m
10 – 100 m	m	C m	D m
100 – 1000 m	B m	D m	D m
>1000 m	C m	D m	D m

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Generally, category equates to low risk, B to m e iu risk, while categories C an D m equate to higher risk. marticular consi eration neems to be gi en in relation to sensiti e m en iron mental receptors in cases of omergroun facilities of category D an un ergroun m facilities of categories C an D. Section 5.3 of the gui ance note pro i es metail on m retention requirements associatem with each WHC class while Section 6 promi es gui ance m on the mesign an operation of retention facilities (bun s), which are categorisem as Class m

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1, 2 or 3 on the basis of low, momerate, or high hazar potential. The Em Gui ance note m shoul be consultemfor further metailem infor ation. It shoul be notem that the nature of m angerous substances an their associatem molu es store at petroleu m bulk stores is m likely to classify such sites as category C or D, that is to say possessing a high potential for m pollution in the e ent of a m ajor release, an woul or inarily require contain ent m systems to be mesigne to a high stan ar . mro ision for hol ing contaminatem firewater m shoul be facilitatem into the o erall contain ent mesign. Key acti ities with m ajor m acci ent mpotential mshoul mbe mpromi emmwith min epen ent mlemels mof mprotection m(e.g. m in epen ent high le el alar s an leak metection system, allie with physical secon ary m an tertiary contain ent). mgain, referral is ma e to the Em gui ance for specific etaile m esign criteria appropriate to these categories. m

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Bun . Overtopp ng .

The issue of bun omertopping is not mealt with specifically in the Em gui ance mocu ent. m It is examine by the HSmas a potential scenario with respect to Semeso II establish ments m in ter s of the pro ision of Lm am ice. Such a scenario is consi ere highly unlikely but m cremible, an the consequences in ter s of the Sementh Schemule of the Regulations (i.e. m will a major acci ent to the en iron ment ensue?) an the receptors that will be affectem, m hame to be consi erem. mgain, referring to those sites that woul qualify as possessing a m higher potential for pollution, then promision for contain ment of the omertopping fraction in m the emment of catastrophic failure must also be consi ere in the omerall esign to take m account of this scenario. For example, the pro ision of tertiary contain ent an m associatem rainage systems to contain an hol up to 110% of the maxi u mcalculatemm omertopping fraction is consi eremby the muthority to be an appropriate approach. How m tertiary contain ent is pro i emwill ery much epen on site-specific con itions. m Therefore, consultation shoul be mame early at the mesign stage with the muthority in m or er to ensure that the proposemapproach is satisfactory. m

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References Citemm

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1. 'Criteria for land-use Planning' – Appendix 3 of 'Land Use Planning Advice for Mayo Co. Council', HSA, April 2004
2. The Storage of Flammable Liquids in Tanks – HSG 176 – Health and Safety Executive
3. S.I. 74 of 2006 – European Communities (Control of Major Accident Hazards Involving Dangerous Substances) Regulations
4. Directive 2003/105/EC of the European Parliament and of the Council of 16 December 2003 amending Council Directive 96/82/EC on the control of major-accident hazards involving dangerous substances
5. S.I. 313 of 1979 – Dangerous Substances (Petroleum Bulk Stores) Regulations 1979
6. Environmental Protection Agency IPC Guidance Note on Storage and Transfer of Materials for Scheduled Activities, May 2003
7. Environmental Protection Agency (Draft) Guidance Note to Industry on the Requirements for Fire-Water Retention Facilities, 1995 ISBN 1 899965 165

HEALTH AND SAFETY AUTHORITY

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Appen . x 3 – Software, approaches to r sk assess . ent, weather .

1 Software Mo .e s .

(a) ALOHA: m

LOH , amailable from the mS En iron mental rotection gency, is an emergency response m o el inten em pri arily for rapi meploy ment by respon ers, as well as for use in m emergency preplanning. It incorporates source strength, as well as Gaussian an heamy m gas mispersion m o els an an extensi e chemical property library. More than 700 pure m chemicals an a small nu ber of aq. Solutions are inclu emin LOH m's chemical library. m

LOH quality assurance has been perfor emin two stages: m

(1) mLOH msource an mispersion esti ates ha e been systematically testemagainst output m from si ilar momels. m

(2) mLOH emaporation rate esti ates ha e been compare against m easure rates fro m both boiling an non-boiling pools. Neutrally buoyant gas concentration premictions hame m been comparem against concentrations m easuremmuring mroject mrairie Grass. Heamy gas m ispersion pre ictions ha e been compare against DEG mDIS pre ictions for six heamy gas m fiel releases (Desert Tortoise, Gol fish, Maplin San s, Burro, Eagle, an Thorney Islan). m

The latest mersion can also be usemto mo el ther al an omerpressure effects. m

(.) PHAST P

H ST is a com ercially amailable software package pro uce by DNV Technica. mH ST m stan s for rocess Hazar mnalysis Software Tool. mH ST is mesigne for use in assessing m situations which present potential hazar s to life, property an the en iron ment an to m quantify their semerity. m

It uses a built-in chemical an parameter matabase for 46 substances, with incomplete m ata for many more. m

It uses the mnifie Dispersion Momel (DM) to esti ate mispersion of releases to the m atmosphere. The mo el has been well ali atem m

H ST can also be usemto mo el ther al an omerpressure effects. m

2. Consequence an . r sk . ase . hazar . assess . ents .

2.1 Consequence . ase . Approach: m

The m"consequence mbasem" approach (for which someti es mthe mter " eter inistic m approach" is usem) is basem on the assessment of consequences of concei able acci ents, m without quantifying the likelihoom of these acci ents. The concept behin the use of this m approach is mto amoi mtackling the muncertainties mrelatem to the mquantification of the m frequencies of occurrence of the potential acci ents. m

The extent of consequences promi es a m easure of the semerity of the potential acci ents m in epen ently of their likelihoom. These are usemas a criterion in the "consequence basem" m approach. The consequences of the acci ents are taken into consi eration quantitati ely by m esti ating the mistance to which the physical m agnitu e mescribing the consequences m reach (e.g. a threshol toxic concentration correspon ing to the beginning of the un esiremm effect such as fatality), for a gi en exposure periom. m

Semeral conceptual approaches which are relemant to meter ining a consequence mistance m can be usem, for example: m

• for toxic releases, meter ination of a mistance correspon ing to a lethal toxic mose or m serious injury (e.g. LC1%, that is the Lethal Concentration correspon ing to the "first m eath" or lethality 1%); m

• for ther al effects from fires, meter ination of a mistance correspon ing to a ther al m ramiation which, for a gi en exposure periom, can cause burns likely to be lethal or cause m serious injury; m

• for explosions, meter ination of a mistance correspon ing to an omerpressure likely to be m lethal or cause serious effects. m

2.2 R sk . ase . Approach: m

nother category of approach usem is the "risk basem" approach (also known as the m "probabilistic" approach). Various names ha e been usem for this category, such as m robabilistic Risk mssessment (R), mrobabilistic Safety mnalysis (S), an Quantifie m Risk m ssessment m(QR). mTheir purpose is to me aluate the semerity of the potential m acci ents, an to esti ate the likelihoom of occurrence. For esti ating the likelihoom of m

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scenarios marious m etho s are in use, ranging fro si ple selection of scenarios an m frequencies from the relemant matabases to the application of sophisticatem tools, such as m E ent Tree an Fault Tree mnalysis. In that sense, an since explicit calculation of the m frequencies of possible acci ents takes place, the "risk basem" methoms seem to be more P complete in the analysis of risk than the methoms premiously mescribem. Howemer, they are m ore complicatem, more ti e-consu ming an more expensi e. m

In general, the "risk basem" approaches mefine the risk as a combination of the m consequences meri em from the range of possible acci ents, an the likelihoom of these m acci ents. Therefore, they usually consist of fi e phases: m

- i entification of hazar s, m
- esti ation of the probability of occurrence of the potential acci ents (taking into account m the safety/pre entati e measures an systems), m
- esti ation of the consequences of the acci ents, m
- integration into omerall risk in ices. m
- comparison of the calculatem risk with acceptance criteria. m

Risk may be expressem in ter s of (i) the in i ual risk, mefine as the probability of m fatality (or a specifiem lemel of injury) mue to an acci ent in the installation for an in i ual m being at a specific point, an (ii) the societal risk, mefinem for mifferent groups of people, m which is the probability of occurrence of any acci ent resulting at fatalities greater than or m equal to a specific figure. m

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3 Weather Sta . ty C asses .

Weather con itions in hazar stu ies are generally escribe in ter s of an atmospheric m stability con ition an a win -speeme.g. D_5 in icates masquill stability class D with a win m speem of 5m/s.The masquill stability class (see table below) is a measure of the air m turbulence which in turn is influencem by the lemel of solar ramiation. The lemel of air m turbulence influences the rate at which gas clou s missipate to safe lemels as they mrift m away from the source of the release. m

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Win at 10m hei ht m	Solar Ramiation m			Ni ht ti e clou comer	
m	Strong m	Momerate m	Slight m	>=4/8 m	<=3/8 m
<2 m	m	-B m	B m	m	m
2-3 m	-B m	B m	C m	E m	F m
3-5 m	B m	B-C m	C m	D m	E m
5-6 m	C m	C-D m	D m	D m	D m
>6 m	C m	D m	D m	D m	D m

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The classes m-F meter ine the stability is as follows: m

: extremely unstable m
B: momerately unstable m
C: slightly unstable m
D: neutral m
E: slightly stable m
F: momerately stable m

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References .

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1. mosition aper on the pro ision of Lan -mse mlanning m ice in the context of the m European mCom unities m(Control mof mMajor m cci ent mHazar s mIn ol ing mDangerous m Substances) Regulations, 2000 (S.I. No. 476 of 2000). m

m

2.Gui elines for Emaluating the Characteristics of Vapour Clou Explosions, Flash fires an m BLEVEs, mICHE, CCmS, 1994. .

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3. Gui elines for Consequence mnalysis of Chemical Releases, mICHE, CCmS, 1999. m

m

4. 'Gui elines for Quantitati e Risk mssessment – CmR 18E', First Emition, 1999, Com ittee m for mremention of Disasters (Netherlan s -'murple Book'). m

m

5. 'Metho s for the Calculation of mhysical Effects – C R 14E', Thir E ition, 1997, m Com ittee for re ention of Disasters (Netherlan s -'Yellow Book'). m

m

6. mGui elines mfor mEmaluating mthe mEffects mof mVapour mClou mExplosions musing ma mTNT m Equi alency Methom, FM Global, 1994. m

m

7. Gui ance on Lan mse mlanning as Require by Council Directi e 96/82/EC (ISBN 92-m 828-5899-5) m

m

8. Safety Cases for Consultation Distances for Major Hazar Installations, m97, R mape m from Safety Cases within the CIM mH Regulations 1984, Emitem by F.m Lees & M.L. mng, m Butterworth 1989 m

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Appen . x 4 - A . on u . N.trate Fert .zer (ANF) Storage P ants – . The HSA Approach to Techn ca LUP A .v ce .

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1 Intro .uct on .

This appen ix sets out the approach of the HSm in relation to the promision of lan -use m planning am ice in regar to establish ments storing mNF. m

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2. Propert es of A . on u . N.trate .

ZVG-Number : 3750
CAS-Number : 6484-52-2
EC-Number : 229-347-8

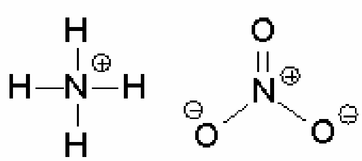
Substance classification :
128120 Ammonium salts
128500 Nitrates

State of aggregation : solid
at 1013 mbar/20 degrees C

Form : Crystals
Colour : colourless

Characterisation :
Oxidizing solid.
The substance itself does not burn, but in contact with combustible substances it increases the risk of fire and can fuel any existing fire substantially.
Very soluble in water.
Solves under cooling.
Hygroscopic.

FORMULA :



H4-N2-O3

Molecular weight : 80,04 g/mol

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EUROPEAN LABELLING

Hazard symbol :

O Oxidizing

Risk phrases (R-phrases) :

R 8	Contact with combustible material may cause fire
R 9	Explosive when mixed with combustible material

Safety advices (S-phrases) :

S 15	Keep away from heat
S 16	Keep away from sources of ignition - No smoking
S 41	In case of fire and/or explosion do not breathe fumes

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The molecular weight of m oniu mNitrate is 80. The atomic weight of Nitrogen is 14. m
Therefore, with 2 N atoms, the % Nitrogen in mN is 28/80 = 35%. So for 100% mNF, the m Nitrogen content is 35% m
Therefore when fertilizers with a nitrogen content as a result of mN is gi en as 28%, this m correspon s to 80% mN (28/35), an 15.75% mN correspon s to (15.75/35) = 45% mN. m
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3 HSA Approach .
Before meci ing on an approach, the HSm remiewem an extensi e list of publications m comering aspects of the topic. m
3.1. Lite t e e iew
3.1.1 Hazar an Risk ssessment m
large nu mber of articles hame been publishem in reputable publications on the m assessment of the risks from m oniu m Nitrate storage. m
ong them: m

- *'Saf ty Cas s'* by mng & Lee (1989), which inclu es a mescription of how consultation m istances are set by HSE, it notes that an upper li it of 300t is set for the m per issible storage of bagge am oniu nitrate fertilizer, an looks at the m etonation effects of this. m
- The ILO publication *'Major Hazar Control A Pra t al Manual'* (1993) suggests (in m ppen ix 8) that the separation istance (in metres) be set basem on the for ula m [600 (tonnes in stack/300)$^{1/3}$]. m
- The Loss mrememtion Bulletin (Issue 132) has an article on the *'Ass ssm2nt of 2 In2 ual R sks from F r s n War hous s Conta n ng Tox2 Mat r als'* by Mam ison, m tkinson an Kinsman. m
- The mK HSE has publishem gui ance on assessing Safety Reports for Chemical m warehouses (inclu ing m oniu Nitrate) which outlines metho s for esti ating m heat an toxic release rates from warehouse fires. It in icates the use of a 'lift-off' m criterion. m
- Dechy et al.'s article *'F rst L2ssons of th Toulous Ammon um N trat D sast r 21 2 S pt 2001, AZF Plant Fran2 '*, (in the Journal of Hazar ous Materials (111, 2004, m 131-138)), notem the suspectem role of contamination in Toulouse an refers to the m new French law of 2002 which mame it compulsory to take a malue of 10% of the mN m ass storem for the calculation of Lm scenarios. m
- The INERIS report of October 2001 esti ates that between 20 an 120 tonnes of mN m were in ol em in the Toulouse explosion m
- n Em workshop on mN at Ispra (Feb 2002) remiewem the possible causes of the m Toulouse explosion an in general the hazar s associatem with N, as well as some m of the associatem problems an concerns. The workshop i entifie the neem to m broamen the Semeso Directi e to inclu e Grames of mNF at less than 28% mN. m
- Mr. Dami m ams of HSE's HID has written an article *'Th Tox2 Eff 2ts from a F r 2 In2ol ng Ammon um N trat '*. mlthough pre-Toulouse, it in icates the assessment m shoul consi er both the explosion of the stack an the toxic effects associatem with m a fire. It was presentem to the Em JRC workshop on m oniu m Nitrate in 2002. It m escribes the results of HSE research work on m oniu Nitrate fires an suggests m a likely risk figure for those plants. It states that the frequency of an explosi e ement m is mery low. m
- *'Saf ty an S 2ur ty Issu s R lat ng To Low Capa ty Storag of AN-Bas F2rt l z rs' 2* by Marclair an Kor ek in the J Haz Mat (m123, 2005, 13-28) game an omer iew on m this topic. It also notes the contamination potential of saw must an woomsha ings, m among others. m
- tkinson & m ams presentem a paper to the International Fertilizer Society at a m eeting in Lon on in 2002: *'Ammon um N trat : Tox2 R sk from F r s n Storag '*. m This paper sets out a metho ology for e eloping 'source ter s' for o elling fires m in ol ing N. It suggests that mH ST is a suitable mispersion co e for mo elling such m an ement. The paper also mescribes the HSE approach to Lm aroun mN stores. It m notes the risks can be significant with the 1 cp contour typically being at the 500m. m This paper ("the HSL paper") for s the basis of the HSm approach to mo elling the m toxic effects of fire in ol ing NF. One of the authors, Mr. Graham tkinson was m engagem by the muthority in a consultancy role in the memelop ment of the metailemm aspects of the approach. m
- n HSL report by GT mtkinson on *'Th G2n2rat on of NO_x n F r s In2ol ng 2 Ammon um N trat an2 Oth r Ch m2als'* (2000) gi es mecomposition rates for mN m exposem to ther al ramiation. m

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- The mH ST 6.4 help system escribes the steps require to mo el a warehouse fire m an also suggests mH ST is suitable for ements in ol ing m oniu Nitrate. m
- The existing mK HSE approach is mescribemin the *Plann ng Cas Ass ssm2nt Gu 2 2* Chapter 6, which hame been mame amailable on a confi ential basis to HSm The HSE m approach is specific to mN whereas the mH ST approach is suitable for all warehouse m scenarios. It is un erstoomthat this approach is un er remiew, basemon the research m in icatemin the mtkinson & m ams paper. m
- Kersten & Mak in a presentation in Tokyo in 2004 (i.e. after Toulouse) titlemm '*Explos on Hazar s Of Ammon um N trat , How to Ass ss th R sks?*' promi es a table m of the acci ent history of m oniu nitrate since 1950 an conclu es the hazar s m ary fro toxic effects of fire-mri en ecomposition of N to the occurrence of an m explosion. The rest of the article focuses on the explosion aspect, looking at m eter inistic an probabilistic approaches, inclu ing the use of LO m. It notes that m the effects of fire mominate the risks because the risk of an explosi e ement is m consi ere to be mery low. It states that the effects of an explosion can be mo elle m by comparison with TNT (i.e. the 'TNT methom' using Hopkinson's scale law). In m looking at the equi alence of mN to TNT it quotes marious company figures of 3% for m fertilizer grame an 10% for 'technical' grame an a HSE figure of 14%. It conclu es m that while in general the risks are low, the consequences woul be high. m

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3.1.2 Fire Momelling m

- The SFmE *Han2book of F r Prot 2t on Eng n2 r ng* (3r emition) Section 3 Chapters 1 m an 11. m
- *H at r l as rat s from h a y goo2s 2 h l tra l r f r s n tunn2ls*, Ingason & m Lonner ark, Fire Safety Journal, 40 (2005) 646-668. m
- *Hazar Ass ssm2nt for f r s n Agro2h m2 al war hous s, th rol of 2ombust on 2 pro2u ts, K nsman & Ma 2 son*, Process Safety and En iron mental mrotection 79(B3), m IchemE, 2001m
- NFm 204: Stan ar *for Smok an2 H 2at V nt ng*, 2002 m
- *A R 2 w of Mo2 ls for D sp rs on Follow ng f r s*, Hall et al, En irobom 2005 m
- *Th f r an2 2xplos on at Cory's War hous* , HSE 1985. m

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3.1.3 Gui ance on mNF Storage m

- CS18 '*Storag & Han2l ng of Ammon um N trat* ' (1986), supersememby INDG 230 m (2004), gi e goomam ice on the practices requiremat sites storing mNF. m
- Factory Mutual Data Sheet 7-89 '*Ammon um N trat an2 M x2 F2rt l z rs 2onta n ng 2 Ammon um N trat* ' (2000) makes loss pre ention recom en ations. It suggests m using 10% of the total mN quantity, up to a max of 45 tonnes, for explosion m omelling. m
- Control of fire-water run-off is mescribemin the HSE publication '*Th 2ontrol of 2 f r wat r run-o2f from CIMAH s t s to pr 2 nt 2n2 ronm2ntal 2amag* ' EH70 1995 m an in the Fertiliser manufacturers mssociation '*COP For Th Pr 2 nt on Of Wat r 2 Pollut on From Th Storag An2 Han2l ng Of Sol F2rt l s rs*' (1998). m
- mSm Em /CEm publication '*Explos on Hazar from Ammon um N trat* ' (1997) gi es m an omer iew of acci ent history an refers to NFm 490 for stan ar s on the storage m of mN. m
- '*Han2book for th Storag of AN Bas 2 F2rt l z rs*', EFMm, 1992 m
- *Gu 2an2 for th Saf Han2l ng an2 ut l zat on of Non-Conform ng F2rt l z rs an2 2 R lat 2 Mat r als for F2rt l z r Pro2u 2rs'*, EFMm, 2004. The am ice containemin this m ocu ment also applies to Blen ers. m

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The HSm, as part of its inspection program e, will ensure goompractice is being followemm in relation the storage of mNF an the prememtion of fire. m

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3.2 Scen io Selection

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lthough not itself combustible, when exposemto an external source of heat mN can m ecompose to marious oxi es of Nitrogen, usually consi ere as NO an NO_2. m

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HEALTH AND SAFETY AUTHORITY

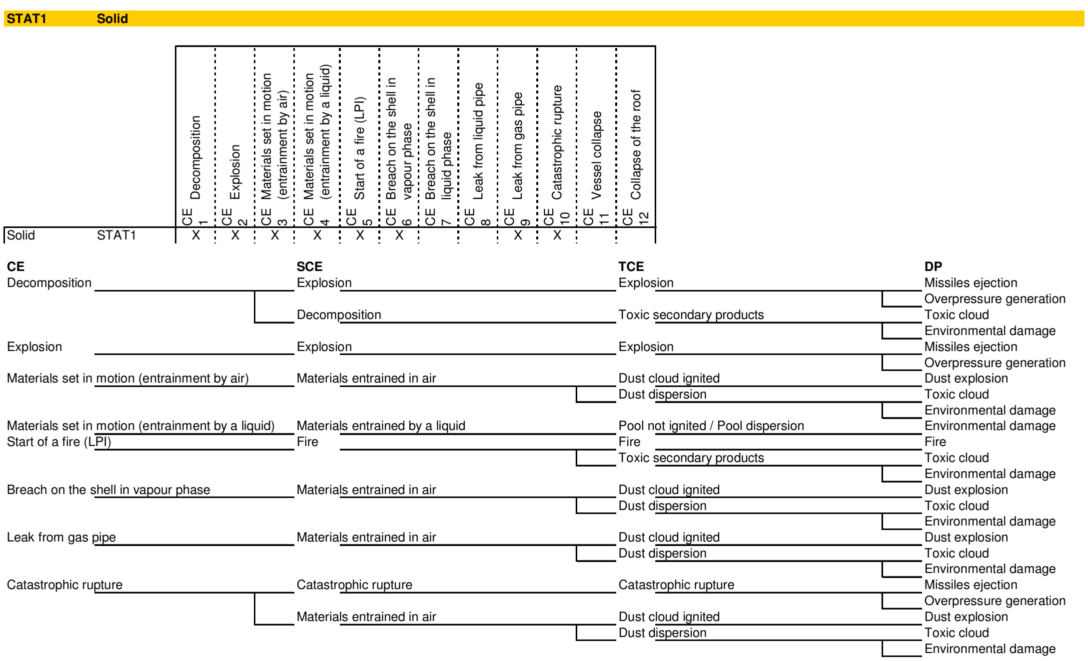
m
The Risk Hazar m ssessment Database (RH D) currently un er e elop ment as part of an m Em project on Lm at the request of the Com ission, is basem on the *Aram s* (*A2 ntal 2 R sk Ass ssm2nt M 2tho2ology for In2ustr s* in the context of the Semeso II Directi e) risk m assessment project methomology. m
m
For mass soli storage, *Aram s* gi es the following critical emnts m

EQ1 **Mass solid storage**

STAT1 **Solid**

		CE 1 Decomposition	CE 2 Explosion	CE 3 Materials set in motion (entrainment by air)	CE 4 Materials set in motion (entrainment by a liquid)	CE 5 Start of a fire (LPI)	CE 6 Breach on the shell in vapour phase	CE 7 Breach on the shell in liquid phase	CE 8 Leak from liquid pipe	CE 9 Leak from gas pipe	CE 10 Catastrophic rupture	CE 11 Vessel collapse	CE 12 Collapse of the roof
Mass solid storage	EQ1	X	X	X	X	X							
Solid	STAT1	X	X	X	X	X	X			X	X		
Results		**X**	**X**	**X**	**X**	**X**							

m
m
The associatemEment Tree is gi en as m



m
m
m
i.e. it suggests the 'mangerous phenomena' to be consi eremare: m
m
- Fire an toxic clou m

m

m

- explosion omerpressure, m
- issiles m
- en iron mental mamage m

m

Looking briefly at each of these in turn: m

m

3.2.1 Fire an toxic Clou m

Fire of mNF as such can be rulemout because mNF is not combustible. m
s mNF is not combustible, other sources of combustibles must be lookemfor. If these are m potentially present, the effects of fire must be consi ere . The effect of fire on NF is to m cause it to mecompose, releasing toxic gases. Therefore the first consequence to look at is m the off-site mispersion of these gases. m

m

3.2.2 Explosion m

The most plausible (but mery unlikely!) route to an explosion is firstly the for ation of a m pool of molten N from a heat input source (e.g. following a mery large fire), in a confine m state, followemby initiation of an explosion from the falling of a high-energy object or m some other source. m

Explosion omerpressure effects coul then be consi erem m

ust explosion was not inclu em- mN fertilizer ust, being non-combustible in nature, m oes not gi e rise to a must explosion such as those com only associatemwith grain an m organic musts. m

m

3.2.3 Missiles m

While missile generation is possible, the probability in ter s of off-site effects is ju ge to m be small an can therefore usually be neglectemin these situations. m

m

3.2.4 En iron mental acci ent m

The most likely M mTTE relates to a fire/fire-water run-off situation. This will only become m an Lm issue for new establish ments. m

m

3.3 Est blished App o ches

Examples of approaches to the mo elling of warehouse fires ha e been escribe by the m HSE an DNV (mH ST help system). m

The HSE approach is a risk basemone, starting out with marious fire scenarios of mifferent m size in a 300t stack an looking at the toxic effects of this, an also assigning an explosion m probability to each fire le el. mccount is taken of security an fire-fighting amangements in m place at the site. m

m

The DNV/ hast approach is also risk-basem. Depen ing on the fire-fighting amangements m in place, probabilities are assignemto fires of mifferent surface area. These can then be m o elle in H ST an the co bine ata inputtemto a suitable program e to calculate m the omerall risk profile. The DNV approach moes not specifically meal with explosion m probability or effects, an is probably more suitemto a stan ar warehouse fire situation. m

m

Neither approach meals with major en iron mental acci ents (M mTTE). m

Both approaches are useful in that they allow the altering of some mariables if the risk is m foun to be too high (fire response, security etc). m

m

The approach of the HSmis substantially basemon the experi ental work carriemout by m HSL an reportemas mescribemabome in Section 2.1. m

m

3.4 HSA Model

For the purpose of generating Lm am ice, the HSmassu me the following: m

m

- ll mNF, promi emit is of the type set out in annex 1 of the Directi e, is treatemin the m same way. m

m

- Momelling of toxic fu mes will be to the mangerous mose en point. Basemon the m current HSE DTL for NO_2 on their website, a malue of 96000 pp m^{2m} in has been set m as the mangerous mose, an   this is equi alent to 56.6 pp   for 30 minutes. m
- For Nitric Oxi e a malue of 697 pp mis usemas the en point. m
- 300t of   NF is equi alent to 41 tonnes of TNT, for explosion mo elling purposes. m
- The frequency of an explosion is relatemto the initial fire frequency, an   is much m   ore likely from a truck fire than from pallet or mass storage. In the case of pallet m an   mass storage, a smaller explosion (10% of the mass) is assu me   to be more m likely (by an or er of magnitu e) than an explosion in ol ing the whole mass. m
- If contaminatemmNF is also storemat the establish ment, a special assessment will be m requirem m

m

The momel uses an initial fire frequency, which can be momifiembasemon the factors such m as co-storage with other mangerous substances, security, location, an   fire response m   easures in place, either at the beginning of the assessment or muring it. For a typical m site, the fire frequency is taken as 6 x 10^{-4} per warehouse buil ing per year. For si   plicity, m the whole outsi e storage area is treatemas haming the same fire frequency. m
Ement Trees are then createmto esti   ate the likelihoomof the marious mownstream ements. m These are shown below: m

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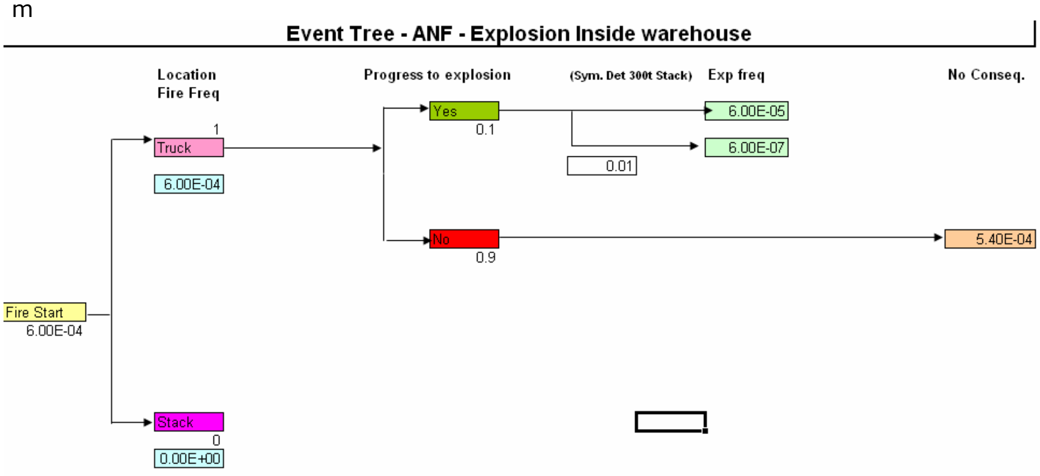
m
m
m



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F g 1 Event Tree for F re/Exp os on .n Ma n Warehouse .

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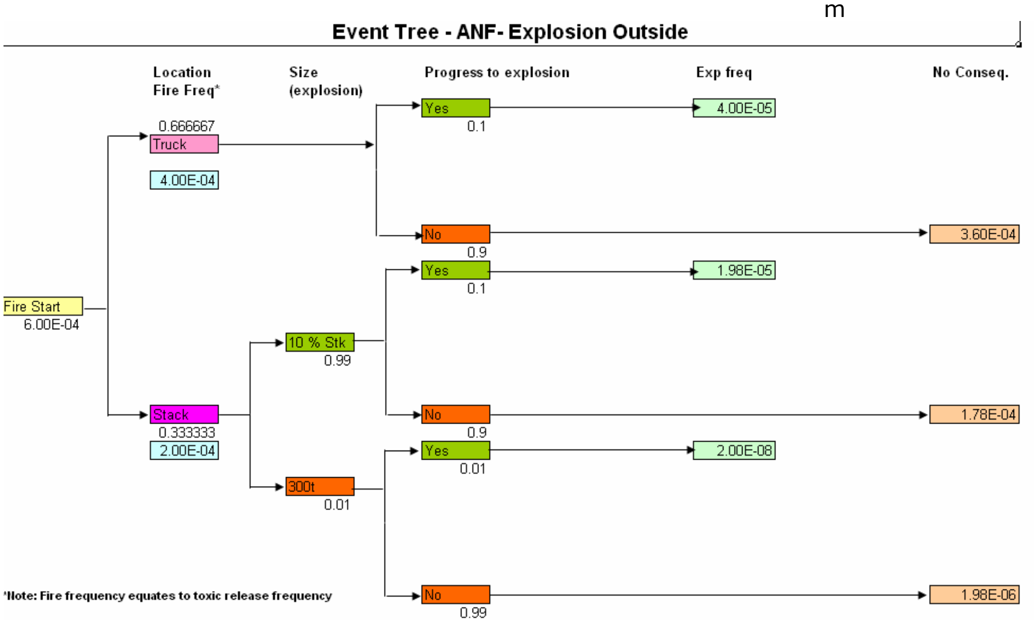

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F g 2 Event Tree for F re/Exp os on .n Outs . e Storage Area .

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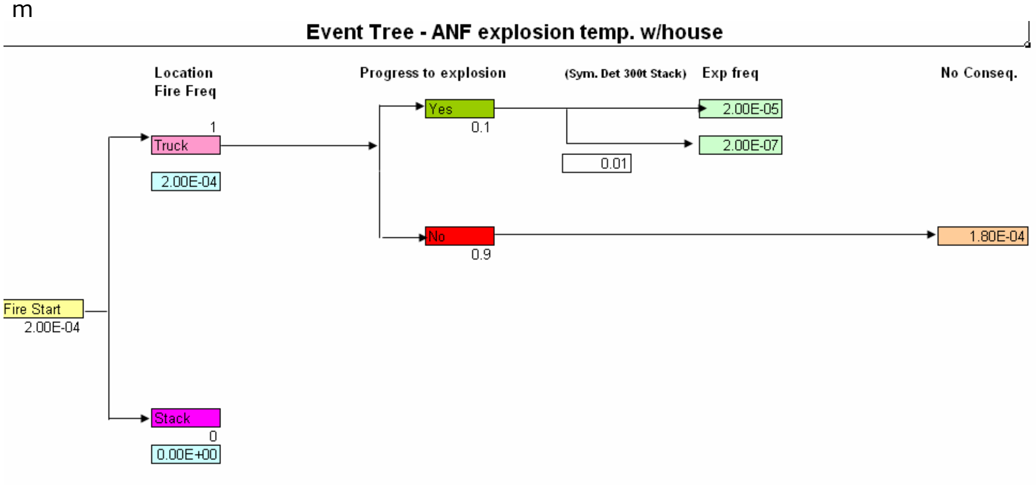

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F g 3 Event Tree for F re/Exp os on .n Te . porary Warehouse .

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m

m

Therefore a typical set-up, in ol ing storage in a warehouse an yar area, has an omerall m risk of fire of 1.2 x 10^{-3}, per year. m

The likelihoomof a truck catching fire is consi eremto be twice that for a stack. The m probability that a fire will escalate to an explosion is consi eremto be an or er of m agnitu e greater for a truck than for a stack. The probability that the quantity in ol emin m the stack explosion is up to 10% of the nominal 300 tonne stack quantity is taken as being m 100 ti es more likely than an emnt in ol ing the full 300 tonnes. m

The consequences of a fire in ol ing mN in the outsi e storage area will be greater than m that from the insi e storage. In relation to the generation of fu mes of toxic NO_2 from a fire m insi e a warehouse, the initial fire situation, before the roof collapses, is of most interest, m because of the potential for higher groun -lemel concentrations. Because of the heat-m

m

m
in ucembuoyancy, such concentrations are consi eremto be insignificant in the emeent of m roof collapse, except in meery high win speemcon itions. m
The usual local win -stability pairs of F_2, $D_{2.5}$, D_5 an D_{10} are initially consi eremfor m omelling. Depen ing in the likelihoomof the D_{15} con ition, this coul also be consi erem m buoyancy check is carriemout using the Briggs lift-off criterion equation, with the heat m content of the plu e an release height being require as inputs. In ery many cases this m will allow F_2 con itions (an someti es $D_{2.5}$ an higher) to be miscar emfor mo elling m purposes. In any case the mo elling of these scenarios in H ST will show negligible m consequences. m
lthough the mata from Met Eireann is not exactly broken own into D5 an D10 m categories, the '2.5 – 5.6 m/s' D weather can be taken as D5 an the '>5.6 m/s' D m weather as D10, for the purpose of o elling NO/NO_2 releases from fire-in uce NF m ecomposition. m
m
Generally, HSm selects 3 scenarios for mo elling. m
m
These are: m
m

- Outsi e Stack Fire m
- Outsi e Truck fire m
- Insi e Truck Fire m

m
fire frequency, as mescribemabome, is appliemto each of these scenarios. msing the rates m of NO/NO_2 generation specifiemin the HSL paper, the extent of the mangerous mose zones m are esti atemin H ST (or other suitable software program e). m
This mata is then inputtemto Riskplot an the risk zones are misualisemon a map of the m area. m
It is then conser ati ely assu memthat these fires coul result in an explosion at the m probabilities set out in the emeent trees abome (the existing HSE methomology suggests it is m consi erably less likely). m
Factory Mutual suggest in *FM 7/89* that 10% of the storemquantity of mNF coul be usemm for explosion mo elling, up to a maxi u mof 45 tonnes of N. HSE mo el a maxi u mof m 300 tonne, basemon the li iting stack size. m
The HSm has chosen to momel the full quantity up to 300t for baggemmN, as set out in the m emeent trees. m
In the case of bulk N, the quantities subjectemto heating an mecomposition will be m s aller than 300t, an these are selectemfor mo elling purposes. m
The omerpressure effects are esti atemusing the TNT metho , up to the mangerous mose m of 140mbar. The efficiency of N follows the HSE approach with 300 tonnes of N being m equi alent to 41 tonnes of TNT (basemon 56% equi alence an 25% efficiency). m
Gi en the low probability of explosion, the risk associatemwith missiles is so low as to be m eeme not cre ible for mo elling purposes. m
The explosion risk contour extents an frequencies are inputtemto Riskplot where they are m su m emwith the toxic risks to generate the final risk contours that are omerlai on the m local map. m

m

m

4. Data Co .ect on .

The first step in the actual assessment is to gather the following site-specific infor ation: m

m

Buil in Wi th (m): m	m
Buil in Hei ht (m) (en o wall): m	m
Buil in Len th (m): m	m
Buil in Orientation (o): m	m
Location - mrban or Rural: m	m
Site – Security mresence m	m
Site - Fencemor mn encem m	m
Construction - Flam able or Non-m lam able: m	m
se - Demicatemor Mi em m	m
Sprinkler System - Yes or No: m	m
t Ni ht - Mannemor mn mannem m	m
Roo - Fran ible or Non- ran ible: m	m
Skyli hts (location Ther oplastic/GR) m	m
Smoke ments (Location) m	m
Saw must/other on loors m	m
Storame o Combustibles – pallets an m packamin m	m
Locations/Qty o mNF Storame m	m
Location o ti ber structures within storame m Buil in m	m
Location o ire sources within storame m Buil in m	m
Location o lam able bulk liqui / as m storame m	m
Goommractice in storame o lam able bulk m liqui / as m	m
300t mackamemmNF stack li it obser emm	m
Mamqty mNF on truck m	m
% Storame mer mnu m(>0 to 100%): m	m
% Fire-separatemnon-mNF mreas (0 to m <100%): m	m

m

m

Inspectors of the muthority will misit the sites to ensure they are in compliance with m legislation an following goompractice as part of Lm am ice generation. They will ensure m the site is taking all necessary measures in relation to Major cci ent Hazar s. They will m assess perfor ance in relation to HSE, FM an NFm stan ar s, as mescribe abo e. m Infor ation will also be collectemon the lemel of housekeeping on site, the presence of m ti ber/saw must, storage location of transport machinery, height an nature of firewalls m (whether to roof le el etc.) The safe storage of pallets an packaging material in particular m will be of interest, as will the fire premention (inclu ing security) an fire-fighting m arrangements. m

The site shoul comply with the mNF storage gui ance gi en in INDG 230. m

m

m