S. 37

File With Section.

SECTION 131 FORM

Appeal NO:_PL 16.207212. **Defer Re O/H** ☐

TO:SEO

Having considered the contents of the submission dated/ received 30/06/04. from Brian Coyle. I recommend that section 131 of the Planning and Development Act, 2000 be/not be invoked at this stage for the following reason(s):. No new issues.

E.O.: Kieran Somers. **Date:** 06/07/04.

To EO:_____

Section 131 not to be invoked at this stage. ☑

Section 131 to be invoked – allow 2/4 weeks for reply ☐

S.E.O.: M Dunlea **Date:** 6/7/04

S.A.O:_____ **Date:**_____

M _____

Please prepare BP _____ **- Section 131 notice enclosing a copy of the attached submission**

to: _____

Allow 2/4weeks – BP_____

EO: _____ **Date:** _____

AA: _____ **Date:** _____

J:abp\forms\2000ActForms(s37)

CORRESPONDENCE FORM

Appeal No: PL 16.207212

M r Heffernan.

Please treat correspondence received on 30/06/04 **as follows:**

1. Update database with new agent for Applicant/Appellant _____	
2. Acknowledge with BP 20	**1. RETURN TO SENDER with BP** _____
3. Keep copy of Board's Letter ☐	2 Keep Envelope: ☐
3rd party appellant's response to appeals.	3. Keep Copy of Board's letter ☐

Amendments/Comments

4. Attach to file	**RETURN TO EO** ☑
(a) R/S ☐ (d) Screening ☐	
(b) Mapping ☐ (e) Inspectorate ☐	
(c) Processing ☐	

	Plans Date Stamped ☐ Date Stamped Filled in ☐
EO: Kieran Somers.	**AA:** Michael HS
Date: 06/07/04.	**Date:** 06/07/04.

Brian Coyle
Block 1, 2nd floor,
GFSC,
Moneenageisha Road
Galway.

29th June 2004

Our Ref 04-025-040629-01L

An Bord Pleanála
64 Marlborough Street
Dublin 1

Re: Submission to An Bord Pleanála: PI Ref No. P03/3343

To whom it may concern,

Please see enclosed my submission following receipt of documentation from An Bord Pleanála dated the 3rd of June 2004. Also enclosed for the Boards information is the HSE (U.K) Safety Report Assessment Guide: LPG. This contains some relevant information in relation to safety assessment for LPG.

I attach an aerial photograph indicating the proposed high pressure pipeline route adjacent to residents and workplaces that further highlight the concerns that local people have.

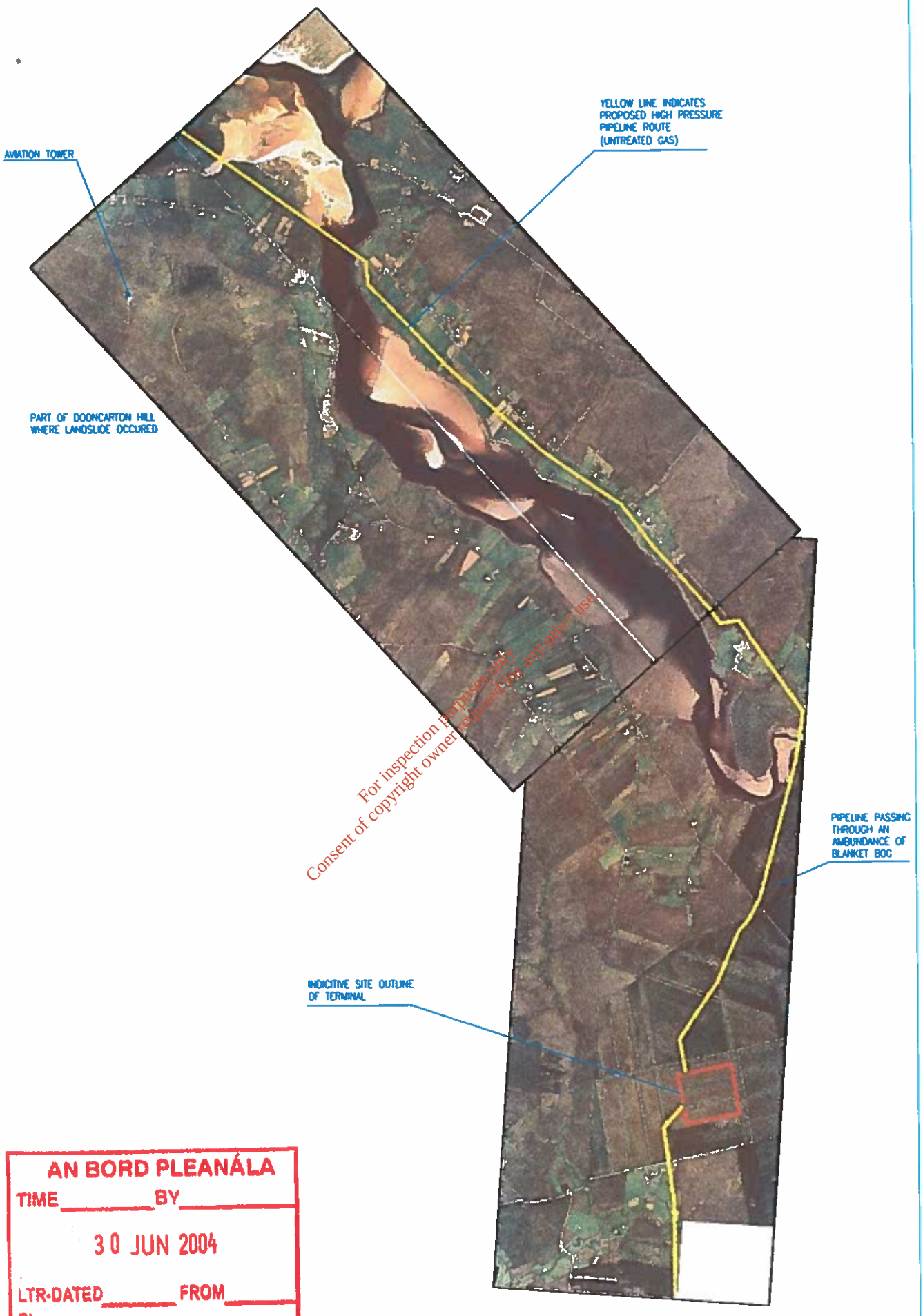
Trusting that the Boards decision will seriously address all the appeals made.

Please acknowledge receipt for same.

Yours sincerely,

Signed: _____
Brian Coyle BE CEng MIEI MIStructE

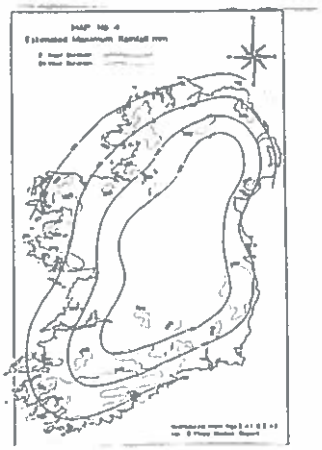
Encl.



INDICITIVE ROUTE FOR UPSTREAM HIGH PRESSURE UNTREATED GAS PIPELINE

BRIAN COYLE SUBMISSION TO AN BORD PLEANALA

29th June 2004



Submission

Following receipt

of

Documentation from An Bord Pleanála dated the 3rd of June 2004.

In relation to the

Proposed Gas Terminal

for the

Corrib Gas Field

BP Ref : PL 16. 207212
PA.Reg.Ref P03/2343

The Content of this report is written without prejudice and is for information purposes only

By Brian Coyle,
BE, CEng, MIEI, MIStructE

Chartered Consulting
Civil & Structural Engineer
Director of COYLE KENNEDY LTD
Consulting Engineers

The following commentary/submission is made following receipt of documentation from An Bord Pleanála dated the 3rd of June 2004.

Following receipt and examination of other appeals from An Bord Pleanála it is clear that a majority of people are concerned about their safety from the terminal, high-pressure import pipeline, landfall and discharge pipeline, contaimination of Carrowmore Lake, silting of lakes streams and rivers and the threat that this development poses to people in the transportation and deposition of the Peat.

National and Local policies have been well identified, considered and reported in the appeal by Micheál Ó Seighin and Others. It is an excellent document in that regard. It is obvious that this proposed large industrial development on a green field site in an exceptional environmental sensitive area, does not come close to meeting or fulfilling either National or Local policies.

Prior to this and the previous planning application, residents residing close to the high-pressure pipeline believed that their safety from the high-pressure pipeline would be examined and concluded upon under the scope of the EU Directive (Seveso II) and SI 476 Regulation as the pipelines would be considered to be within the area of the 'establishment'.

To date this has not happened as the applicant and the HSA are doing their endeavour to limit the area within the definition of the word 'ESTABLISHMENT'. The simple reason is that the HSA or any other Authority cannot justify local residents safety. For this proposed development, the risks of high-pressure pipeline failure are greatly increased because it passes through an abundance of blanket bog that can easily subside. The peat itself is not capable of supporting the pipelines or any structures that is proposed to support them.

It is not statistics that local people want produced; it is a commitment and AN indication that they are safe on their land and in their homes. No 'purple book' can justify this overwhelming risk. A document prepared by the HSE (UK) titled 'Safety Report Assessment Guide: LPG' states that *the consequences of all accidents must be identified irrespective of there probability of occurrence.*

Any length of pipeline or supporting/relevant structure can become unsupported in blanket bog thus increasing bending, shear, torsion and axial stresses in the structure/pipeline. The required structural capacity and hence thickness will depend on the unsupported length of the structure. The subsidence nature of blanket bog, the ease in which the blanket bog can move and erode makes the design and performance of structures in blanket bog unpredictable.

For many months now, Mr. John Colreavy (HSA) tried to convince me that pipelines are excluded from the Directive and Regulations and therefore the HSA would not be considering pipelines in their advice under land-use planning. It has taken many discussions, phone calls and letters to get the written proof that pipelines and pumping stations within establishments are all to be considered and included within the scope of both the EU Directives and SI 476 Regulations.

Since it has been identified that pipelines within establishments must be considered, the HSA are now trying to swindle their way around dealing with their responsibilities and human safety by distinguish between pipelines above ground (in the pipe rack) and pipelines below ground (cross-country pipelines) within an establishment. I would ask the Board to be specific and cautious about the terminologies used.

A letter from Mr. Frank Fahey's Department of Enterprise, Trade and Employment is included in Appendix A. The Minister has responded to my letter based on advice from the HSA. Basically we are dealing with the same people (i.e. the HSA) ever time we raise an issue or a concern. To this end if we are unhappy with the advice of the HSA we write to our ministers to outline our concerns who will then revert back to the HSA for their advice. Why bother!

The content of the letter states, what I already concluded some months ago and identified in my first submission to Mayo County Council that pipelines and pumping stations within establishments must be considered.

- In the letter, the HSA view the 'establishment' similar to that stated in their report. No surprise there!
- The HSA have now put a name on the pipeline and then stated that this named pipeline is outside the scope of

the Directive. This is not allowed and is in breach of EU Directives and Irish Legislation. It is another attempt of ignoring the safety of the people residing adjacent to the high-pressure pipeline. At the very least all pipelines within establishments must be considered.

- Once again the HSA will not consider the presence and treatment of gas containing Hydrogen Sulphide, even though it is as likely to be present as not in a gas supply i.e. a biogas. I am not surprised. This toxic substance has been found off the Irish Coast as identified in my appeal.

The SI 476 regulations does not allow a redefinition of the term establishment like that considered by the HSA and does not allow the naming of pipelines for the benefit of excluding them from their advice. Also, the EU Directive does not allow the presence of an anticipated substance to be dealt with under a different planning application.

The HSA have now started naming pipelines (e.g. cross-country pipelines, pipelines in the pipe rack, slugcatcher pipe, and sales gas export pipeline at the pig launcher) hoping that this terminology will exclude them from examining the 'cross-country' pipeline within the establishment.

I would like to advise the Board that the EU Directive (Seveso II) and SI 476 regulation clearly identifies that if a pipeline is within an establishment and transports a dangerous substance (actual or anticipated) then the consequences of such must be identified and considered.

.

The Area within the term 'Establishment'
In the previous Oral Hearing the HSA concluded that the 'establishment' is the area within the security fence of the terminal footprint. It is now stated by the HSA that this definitions is based on DISCUSSIONS with other EU Commission officials. I do not believe that the full picture of this proposed development including the route for the pipeline can be conveyed accurately through discussions.

I cannot believe that the location of a security fence is what is dictating the area to be considered by the HSA. Failure of components and installations can occur inside and outside a security fence. The term establishment is clear, unambiguous and legally defined in the Irish Regulations and doesn't mention anything about a security fence or the area inside it. My discussions with a EU official concluded that a security fence has no act or part in defining the area of an establishment. The HSE (UK) states that off-site accident initiators should be considered.

Previous Oral Hearing
In the previous application, Mr. Moore (An Bord Pleanála) states that '*he does not accept that the Board can readily determine that the establishment is that area that falls within the security fence of the gas processing facility.*'

Legally Definition
Legally the 'establishment' is the whole area under the control of the operator where dangerous substances are present

Tánaiste Ms. Mary Harney T.D. Dail Question No. 111, Q&A Refer to Appendix A for Copy

Ms Mary Harney T.D. considered the term 'establishment' to be the site within the overall landholding of an undertaking where dangerous substances are present in one or more installations. Refer to Appendix A.

Dangerous substances are present in the pipeline from the terminal building to the site boundary and from the site boundary to the landfall. Local residents were lead to believe that this issue i.e. their health and safety from the pipeline that cross their land would be examined and concluded upon during the planning process for the Gas Terminal under the scope of the SI 476 Regulations i.e. the pipeline route would be part of the establishment. Surely they have a constitutional right to have this aspect fully examined and verified. My appeal to An Bord Pleanála included a report relating to a pipeline explosion. It stated that the consequences and affected area of an explosion from a 46Bar pressure pipeline was equivalent to placing, 5.7tonne of TNT in the ground with temperatures in excess of 1100°C from the pipeline explosion.

How would you feel if 5.7tonne of TNT was placed only a few meters from your residence not knowing if and when it will explode?

The reality is that people are not at a safe distance from this proposed development and its related infrastructure.

A letter from the HSA dated the 15th of June 2004 in response to my letter dated the 27th of May 2004, concludes that the HSA has will not accede to my request i.e. treatment of gas containing Hydrogen Sulphide or providing advice on the failure of the high-pressure pipeline. They are only considering the safety of construction workers involved with the pipeline construction. This is complete lack of competence and is discriminative to the local residents concerned about their children's and their own safety. A copy of the HSA letter is included in Appendix B.

Safety Assessment for People Residing Adjacent to the Proposed High Pressure Pipeline is the responsibility of An Bord Pleanála

Dr. Rory O'Hanlon (Ceann Comhairle)
In a letter to Mr. Paddy McHugh T.D. dated 31st of May 2004 Dr. Rory O'Hanlon, identifies that the safety assessment for persons residing adjacent to the proposed high-pressure pipeline transporting dangerous substances to the proposed Gas Terminal is a matter which falls within the statutory remit of An Bord Pleanála. A copy of his letter is included in Appendix B.

Recent Amendments to the Seveso Directive 16th December 2003
Recent amendments to the Seveso Directive due to recent major accidents state that advice and guidelines relating to land-use planning is expected to be available by 31st of December 2006. I attach this document for the Boards information. I am confident that the content of these guidelines will certainly identify that this proposed site including the pipeline route is certainly wrong and that the process to date is in breach of EU Legislation especially the withholding of the HSA report until a decision was made by MCC.

As stated in my previous observations and submissions, Directives, Guidelines and Regulations keep changing to incorporate the consequences and effects of recent events. This is why the Seveso II Directive was amended. The consequences of an explosion even similar to the one that occurred at Dublin Port are unimaginable. This explosion occurred at an already established industrial site. The explosion/fire occurred from an Oil based product. Imagine what the consequences of such an event would be if it was gas (more explosive and vigorous than oil), surrounded with forestry, heather and blanket bog. The consequences of this type of an event, in an area deficient in services, will become a reality some day if this project gets the green light.

Rainfall Intensity Inadequate based on Flood Studies Estimation and Recent Events. Ground Instability and Water Contamination, now a serious concern

The remarks made by Mr. Iain Douglas relating to *Risk of Landslides* on page 46 of the planners report is questionable and doesn't form an encouraging basis to rule out the risk of landslides at the Gas Terminal. He states that the rainfall intensity of (45mm/hr) was chosen for the design of the site drainage at the proposed Gas Terminal Site at Bellanaboy and in his opinion and others this forms a conservative and somewhat sound solution to the issue of landslides, as it is based on the worst known event.
This is incorrect as the worse known event in Ireland is 97mm of rainfall in one hour, An event of this type can happen almost anywhere in Ireland.

Recent Report for Mayo County Council into the events of September the 19th 2003.
The examination and report carried out by Tobin Consulting Engineers for Mayo County Council (issued the 29/10/03, approx six week before Shell made their recent submission) into the reported 40 separate Landslides at Dooncartoon, Glenglad, Barnahuille, and Pollathomais County Mayo states in the executive summary that;

*'Analysis of the rainfall event from several perspectives supports the view that **not less** 80mm of rainfall fell on the slopes of Dooncartoon and Barnachuille mountains with a space of time less than two hours on that night'*

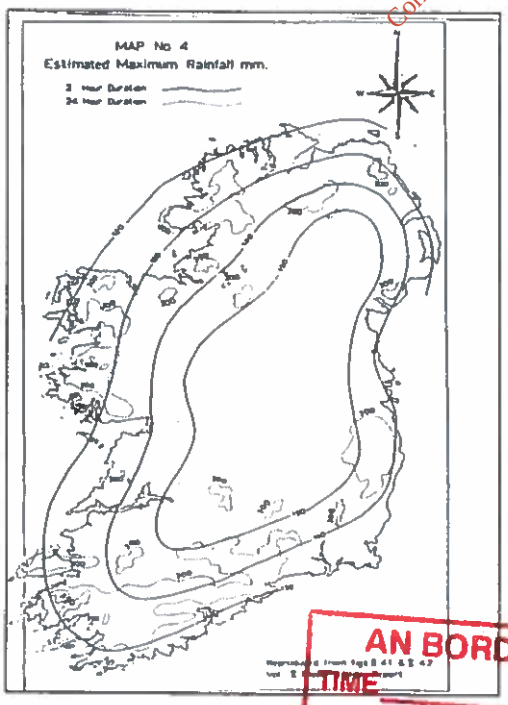
This statement suggests that the rainfall intensity on the 19th of September 2003 could have varied from 40-80mm over an unspecified

time of less than two hours. This fact is supported with reference to the Flood Studies Report and other reports published in recent times. Tobin Consulting Engineers are also a member of the design team for the proposed Gas Terminal. This I fee is a conflict of interest as it is unlikely that they would report an event that could ultimately result in the refusal of the proposed Gas Terminal. The Flood Studies Report was prepared by the Institute of Hydrology and determines the expected estimated rainfall throughout Ireland.

Flood Studies Report

Synopsis Contained in the Institution of Engineers of Ireland Flood Estimation following the Flood Studies Report written by *Professor **Conleth Cunnane BE, Ph D, M.I.E.I NUI Galway and M.A. Lynn M.E., B. Sc., CEng., FIEI.***

The flood studies report was published in April 1975, and dealt with an investigation carried out since 1970 at the Institute of Hydrology, Wallingford and Meteorological Office, Bracknell. The Irish Office of Public Works and Meteorological Service participated in the studies and supplied data on floods and rainfall in Ireland for inclusion in the analysis. The results are accordingly applicable in this country and provide improved bases for flood estimation.



Map No. 4 of the flood studies report shows the estimated maximum rainfall in a period of 2 and 24 hours throughout Ireland. It is clear from this Map that the upper rainfall intensity in the vicinity of the proposed Gas Terminal can vary from 60-120mm per hour based on Flood Studies Report estimation. My discussions with other Hydrologists support these findings. Since this Flood Studies Report has been published, weather conditions have become more severs i.e. more intense dry and wet weather conditions.

The so-called 'conservative' surface water system design is underestimated based on the Flood Studies Report and this can have major consequences on risk of landslides, and pollution to streams, rivers, and Carrowmore Lake.

Therefore, as proposed the surface water drainage system is not a pro-active one.

On the 19th of September Cornhill Bridge (South of Dooncartoon Hill) was completely covered with the huge volumes of water that flowed down the south side of Dooncarton hill and over the bridge. The channel width and volume of water that passed over this bridge was frightening.

Peat slopes have failed due to third party interference, inadequate drainage, steep slopes, and intense rainfall. Where is the assessment and conclusion on these events?

Condensate

On page 7 of the planner report, Mr. Iain Douglas has identified that the 'incoming gas is separated from the condensate, water and methanol' the recovered condensate is stabilised and used as fuel.

The threshold quantities of materials have changed in the recent amendment to the Seveso II directive dated 16th of December 2003. Petroleum products have now been defined and quantified and I would ask the Board to consider the volume of condensate that will be recovered stabilised, stored on site and used as fuel.

EU Directive (Seveso II) Article 12

Land-use planning

1. Member States shall ensure that the objectives of preventing major accidents and limiting the consequences of such accidents are taken into account in their land use policies and/or other relevant policies. They shall pursue those objectives through controls on :

a. the siting of new establishments,
b. modifications to existing establishments covered by Article 10,
c. new developments such as transport links, locations frequented by the public and residential areas in the vicinity of existing establishments, where the siting or developments are such as to increase the risk or consequences of a major accident.

Member States shall ensure that their land-use and/or other relevant policies **and the procedures for implementing those policies** take account of the need, in the long term, to maintain appropriate distances between establishments covered by this Directive and residential areas, areas of public use and areas of particular natural sensitivity or interest, and, in the case of existing establishments, of the need for additional technical measures in accordance with Article 5 so as not to increase the risks to people.

2. Member States shall ensure that all competent authorities and planning authorities responsible for decisions in this area set up appropriate consultation procedures to facilitate implementation of the policies established under paragraph 1. **The procedures shall be designed to ensure that technical advice on the risks arising from the establishment is available, either on a case-by-case or on a generic basis, when decisions are taken.**

Term Dangerous Substances

According to the Seveso II directive the presence of dangerous substances is the **actual** or **anticipated** presence of a substance. This is a legal obligation that must be considered now. The directive does not allow anticipated substances to be dealt with under a separate planning application. I advise the Board that adopting such a process and route will be in serious breach of EU Directive legislation. All anticipated substances must be considered now, e.g. Hydrogen Sulphide, Condensate etc.

HSE Safety Report Assessment Guide LPG Attached

The HSA Report makes reference to the UK HSE (Health and Safety Executive). I attach a report titled Safety Report Assessment Guide: LPG for the Boards information

This document is available on the http://www.hse.gov.uk/comah/sragIpg/srag.htm .

THE HSE DOCUMENT STATES THAT THE CONSEQUENCES OF AN ACCIDENT MUST BE DETERMINED IRRESPECTIVE OF ITS PROBABILITY OF THE ACCIDENT.

Refer to Criterion 3.4.1 on page 22 of the HSE attached report. Please refer to Table 1 page 16 and Table 2 Page 23 of the attached report identifying the off-site Accident Initiators. The HSA (Ireland) has only considered a few of these proposals and there are many more yet to consider and advise upon.

Off-Site Accident Initiators (HSE UK)
According to the HSE (UK) document the following Off-site Accident Initiators should be carefully examined and reported on.

Landslip
Hazardous Substance pipeline rupture
Missile from off-site
Fire or Explosion at adjoining sites
Subsidence
Flooding
Severe Environment Conditions;
Abnormal Rainfall
Abnormal Snowfall
Very Low Temperature

High Termperature
Gale Force Winds

Lightning Strike
Aircraft Impact
Other
Sesimic Event

Detailed assessment should be carried out on initiators that are relevant to the site. e.g. *if a site is located far away from an airport or flight path then it is acceptable for the safety report to refer to the background crash rate. On the other hand, if the site is located close to a busy airport a much more detailed assessment of aircraft should be carried out.*

Applying the same analogy to initiators that are associated to this site implies that detailed assessment must be carried out for Off-Site initiators of Landslip, Hazardous Substance Pipeline Rupture, Fire or Explosion of the Section of Pipeline Off-site, Missile from off-site that could arise from pipeline explosion, arson or sabotage, Subsidence, Flooding, Severe Environment Conditions, Other e.g. Forest Fires.

Availability of a Public Safety Report (HSA Technical Advice) Prior to Mayo County Councils Decision

The technical advice on the risks arising from the establishment (HSA safety report) was not available to the public when Mayo County Council made their decision. Withholding such information is contrary to Seveso II Directive Article 12 *Land Use Planning* when it states that procedures under land use planning;

shall be designed to ensure that technical advice on the risks arising from the establishment ***is available****, either on a case-by-case or on a generic basis, when decisions are taken.*

I attach a copy of a letter from Mr. Iain Douglas SP to me dated 23rd of June explaining his interpretation of the Acts and Regulations. A copy of his letter is included in Appendix E.

The technical advice was submitted to Mayo County Council in the form of a document, therefore it's a submission. Why should Local Authorities withhold such important information from a National Authority in relation to the safety assessment of a planning application until a decision is made? Like all other prescribed bodies, the HSA document or other relevant document should have been available to the public. This document should have considered all the risks and be available for examination and verification before Mayo County Council made their decision?

In this instance, I believe the procedures adopted by Mayo County Council were set up to force the planning through irrespective of public opinion on the HSA safety report. This is another breach of EU legislation.

Forest Fires

The HSA report does not identify the risk contours or possible affected areas arising from a Pipeline Failure/Explosion for the pipeline even for the section of pipeline within the site boundaries and inside the security fence. Certainly all areas within the site boundaries are under the control of the operator therefore an area of the establishment. They are proposing to place this high-pressure pipeline in blanket bog amongst tress. What happens if the pipeline fails releasing gas, igniting, and hence forest fires (Domino Effect)? According to the HSE (UK) *The consequences of all accidents must be determined irrespective of their probability of occurrence.*

Design and Build Contract proposed for Onshore Pipelines is Worrying. Refer to Appendix F for a printout of the Notice

Shell has recently issued a Qualification System for the Provision of onshore Gas Pipeline **Design Verification/Completion** and **Construction** services for the Corrib Gas Field Development. It is no wonder that information requested by me and subsequently by Mayo County Council on the structural stability of the pipeline in peat was not readily available or produced as it is now clear that the applicant is requesting a design and build package for the onshore high-pressure pipelines.

I am concerned that a design and build contract is proposed for this section of the work. The adopted contract may not ultimately be the safest one. How is the contract awarded? Who controls who, the contractor or

the engineer? How does Shell fit in to all this? Do they really care?
Who determines which design is right or wrong, since this has never been done before?
When constructed, it will be too late for the designers to revert back to their design if they find that the pipeline or terminal is not stable enough. Remember the Millennium Foot Bridge in London had to be dampened/strengthened because of unforeseen events that arose. With such a prestige project, I am sure with all the best will in the world the engineers of the Millennium Bridge didn't want that to happen.

Fluid/Air pressure testing prior to commissioning will not equate to the hoop, bending, shear, torsion, and axial stresses that will be experienced during operations and arising from external forces.

In a design and build contract, will quality and workmanship suffer if a contract of this nature is loosing money?

The objection of Shells qualification system states that Shell has completed much of the existing design work, however, THE APPLICANT WILL BE REQUIRED TO **VERIFY THE EXISTING DESIGN** and complete outstanding items such as crossings, special construction area, valve foundations etc. This is not encouraging. Here we have Shell admitting that their own design work must now be verified and basically passed onto some else. Talk about a 'cop out'. This is a clear indication that Shell does not want any act or part and will shed their responsibilities as long as Authorities and Companies keep accepting their proposals and invitations.

Brian Coyle BE CEng MIEI MIStructE
Chartered Engineer

Appendix A

Tánaiste Ms. Mary Harney T.D.

Dail Question No. 111

And

Correspondance from Mr. Frank Fahey's Office

DAIL QUESTION

NO.111

To ask the Tánaiste and Minister for Enterprise, Trade and Employment the reason pipelines and pumping stations within establishments are excluded from the scope of SI 476/2000 which was implemented by her on 21 December 2000, in view of the potential of such pipelines and pumping stations involving dangerous substances to create major accidents as recognised under council Directive 96/82/EC which does not exclude pipelines and pumping stations within establishments; and if she will make a statement on the matter.

- Paddy McHugh.

* For WRITTEN answer on Tuesday, 1st June, 2004.

Ref No: 16618/04

REPLY

Tánaiste and Minister for Enterprise, Trade and Employment (Ms Harney)

Statutory Instrument S.I. 476 of 2000 the 'European Communities (Control of Major Accident Hazards Involving Dangerous Substances) Regulations 2000' transposed into Irish law Article 4(d) of Council Directive 96/82/EC of 9 December 1996 on the control of major-accident hazards involving dangerous substances.

Neither S.I. No. 476 of 2000 nor Directive 96/82/EC exclude pipelines and pumping stations within establishments covered by the Directive and the Regulations.

For purposes of the Directive and the S.I. an establishment is considered to be the site within the overall landholding of an undertaking where dangerous substances are present in one or more installations.

ID

Department of Enterprise, Trade and Employment
Roinn Fiontar Trádálá agus Fostaíochta

Office of the Minister for Labour Affairs

Our Ref: 040290/MLA

22 June 2004

Mr. Brian Coyle
Block 1-1st Floor
GFSC
Moneenageisha Road
Galway

Dear Mr. Coyle,

Mr. Frank Fahey, T.D. Minister for Labour Affairs has asked me to refer to your letter of 12th May 2004, which you wrote to An Tánaiste, Ms. Mary Harney T.D. and which was subsequently passed to him for reply in regard to S.I. 476 of 2000 and Council Directive 96/82/EC. Minster Fahey has responsibility for matters relating to safety, health and welfare at work. The Minister has contacted the Health and Safety Authority (HSA) in regard to your letter and has asked me to reply as follows following receipt of the advice of the Authority.

In your letter you say there is a discrepancy between SI 476 of 2000 and Directive 96/82/EC. You are correct in quoting Regulation 4(2)(v) but it needs to be read in conjunction with the other part of that Regulation i.e. 4(2)(c) which reflects the intent of the Directives. Your point is addressed by reading Regulation 4 as follows:

4. (1) Subject to paragraph (2) of this Regulation, these Regulations shall apply to …..

(2) These Regulations shall not apply to— ……

(*c*) the occurrence outside an establishment of—

(v) the transport of dangerous substances in pipelines and pumping stations.

In regard to suitability of the location for the proposed gas terminal, Mayo County Council has granted planning permission subject to conditions. The HSA provided advice to the planning authority in the context of the requirements of SI 476 of 2000. In the event that one wishes to raise objections to the grant of permission there is recourse to An Bord Pleanála which is the normal channel for a review of planning decisions.

C:\notes5\data\TempAttachments\040290MLA.doc
Davitt House, Adelaide Road, Dublin 2, Ireland
Tel: 353 1 631 3221 Fax: 353 1 631 3265 www.entemp.ie
Lo-Call telephone service (if calling from outside (01) area) - 1890 220222

The HSA view that the "establishment" is the terminal footprint, is one that was discussed and agreed with EU officials and other member states and the Authority has no reason to change its view.

The authorisation for the pipeline to the terminal was administered by the Department of Communications, Marine and Natural Resources and the HSA did not have a role in that regard. The HSA exercises an advisory role in land-use planning in the context of the application of Directive 96/82/EC and, as can be seen from the first point above, cross county- pipelines are outside the scope of this Directive.

On the basis of the evidence supplied by the applicant, Hydrogen Sulphide is not anticipated in the supply to the proposed terminal. If the terminal becomes operational and if the applicant wishes to process a gas stream containing Hydrogen Sulphide, it will require new planning permission from the local authority.

I understand a letter dated 20th May 2004 has already been sent to you from the HSA about the commissioning of the HSA to examine the effects and consequences of a pipeline failure.

I trust that the above clarifies the position in regard to your queries.

Yours sincerely,

AOIBHEANN NÍ SHUILLEABHAIN
PRIVATE SECRETARY

Appendix B

Copy of Letter from Dr. Rory O'Hanlon (Ceann Comhairle)

Regarding

Safety

of the

People from the Pipeline

A Copy of a letter received

from the HSA

Identifying their stance

on the safety of the people from the pipeline

OIFIG AN CHEANN COMHAIRLE
(Office of the Chairman of Dáil Eireann)

TEACH LAIGHEAN
(Leinster House)

BAILE ÁTHA CLIATH 2
(Dublin 2)

Paddy McHugh, T.D.,
Leinster House.

Ref.: 16620/04

31 May, 2004

Dear Paddy,

I regret that I have had to disallow the following question tabled by you :

> To ask the Minister for the Environment, Heritage and Local Government if he will communicate with Mayo County Council to ensure that a safety assessment is carried out for persons residing adjacent to the proposed high-pressure pipeline transporting dangerous substances to the proposed Gas Terminal at Bellanaboy, County Mayo adjacent to the already unstable Dooncarton Hill; and if he will make a statement on the matter.
>
> (this proposed pipeline is through blanket bog that will not effectively resist the forces in the pipeline)

The Minister has no official responsibility to Dáil Éireann for this matter which falls within the statutory remit of an Bord Pleanála.

Yours sincerely,

Dr. Rory O'Hanlon, T.D.,
Ceann Comhairle.

HEALTH AND SAFETY AUTHORITY

10 Hogan Place, Dublin 2, Ireland.
Telephone: 01-614 7000 Fax: 01-614 7020 Website: http://www.hsa.ie/osh

Mr. Brian Coyle,
Block 1,2nd Floor,
GFSC
Moneenageisha Road,
Galway.

June 15th 2004.

Dear Brian,

I acknowledge receipt of your letter ,dated 27th May 2004.

The issues associated with cross-country pipelines, apart from the safety of construction workers involved with their construction, are outside the remit of the HSA as the regulation of such activities lies with another body.

Any aspects that may relate to the proposed terminal have to be seen in the context that this matter is now before An Bord Pleanála and the Authority will not be commenting on any matter that is before the Bord..

Accordingly the Authority is not in a position to accede to your request.

Yours sincerely,

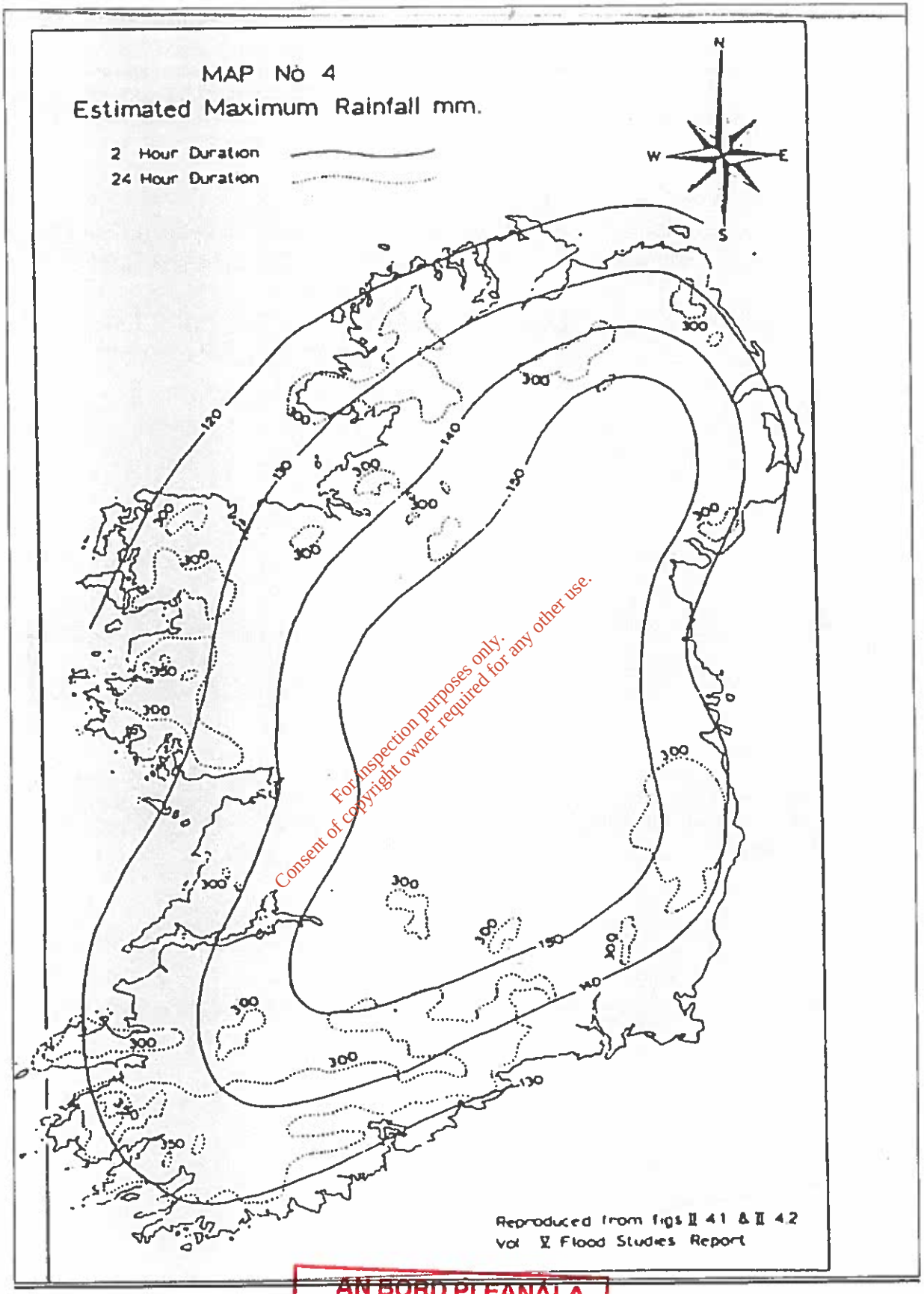
John Colreavy,
Process Industries Unit.

Appendix C

Flood Studies Report

Map No. 4 Enlarged

Note Rainfall Intensity at Terminal could vary from 60 –120mm/hr



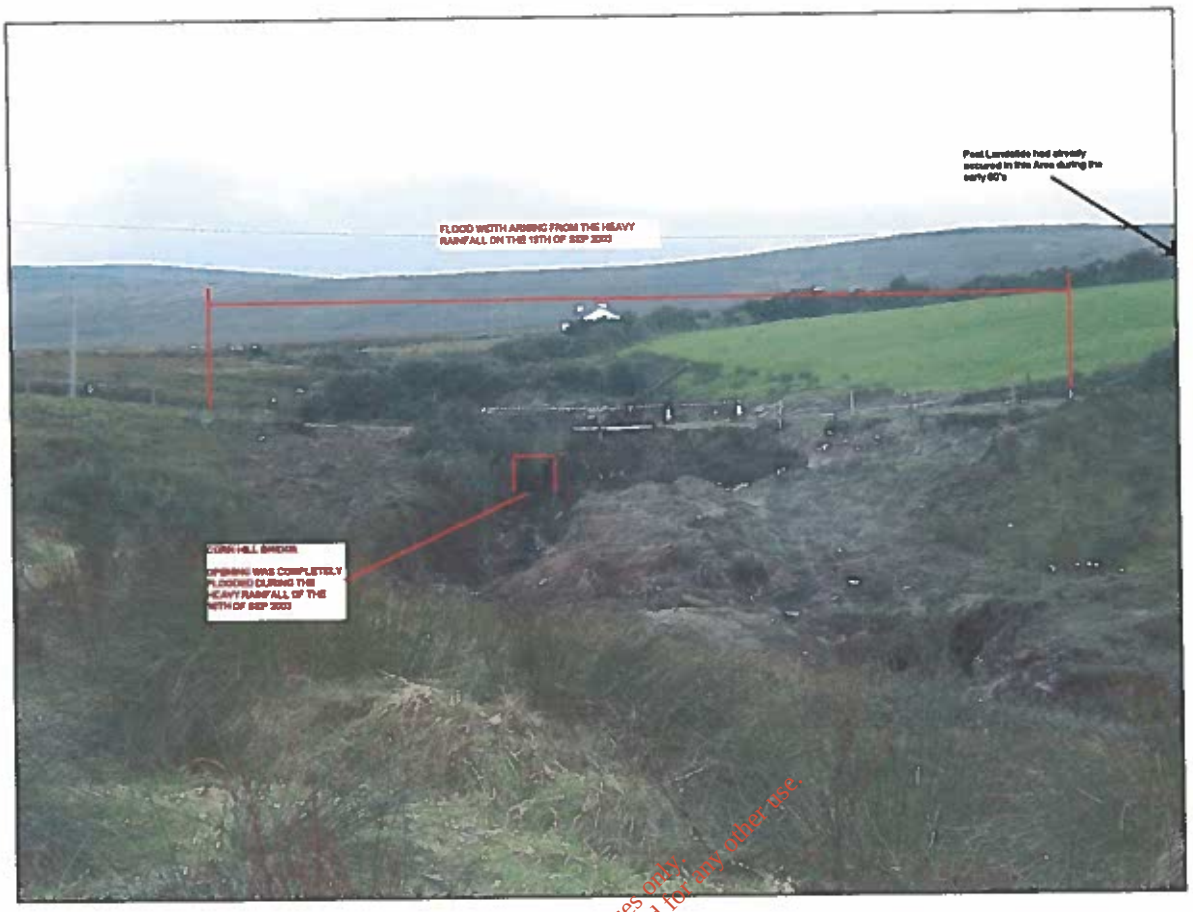
Appendix D

Large Scale Picture of Flooding arising

from a

rainfall duration of less than two hours on the 19th of September 2003,

Note Rainfall Intensity at Terminal could vary from 60 –120mm/hr



Appendix E

A copy of the response from

Mr. Iain Douglas (SP MCC)

in relation to initial request dated

20th of April 2004,

My subsequent reminder letters on the 28th of April and 8th of June 2004

It took Two Months and Three Letters to obtain this information

COMHAIRLE CONTAE MHAIGH EO

Aras an Chontae, Caislean a 'Bharraigh, Contae Mhaigh Eo.
Teileafóin (094) 90 24444 Fax (094) 90 23937
www.mayococo.ie

Your Ref. Our Ref.

23rd June, 2004

Mr Brian Coyle,
Block 1m, 2nd Floor,
GFSC,
Moneenageisha Road,
GALWAY

3 - Attempts to obtain this Information.

Dear Mr Coyle, 20th April 2004
28th April 2004

Further to your letter of the 8th June, 2004, regarding the Health and Safety Authority report and its availability to the public prior to the Planning Authorities decision.

Section 38 (3) of the Planning and Development Act 2000 specifically states that copies only of:

(a) the permission documents and publications
(b) submission or observations

shall be made available for inspection during a planning application.

The HSA is required to provide "Technical Advice" as stated in Section 34(8) of the Planning and Development Act 2000 and Article 137 (3) (f) of the Planning and Development Regulations 2001. Thus, the technical advice of the Health and Safety Authority is specifically not a submission or observation under Section 38 (1) (b) of the Planning and Development Act 2000.

Yours sincerely,

pp Iain Douglas
Iain Douglas
Senior Planner

ID/DG

21

Appendix F

Copy of the

Public Notice by Shell

for the

Onshore Gas Pipeline,

Verification Completion and Construction

Searching

View Notice

Details of the selected notice are shown below.
If you wish to express an interest in this notice Express your interest now.

Quick Links

Gaeilge

Title: IRL-Dublin: construction work for gas pipelines
Awarding Authority: Shell E & P Ireland Limited
Publication date: 04-Jun-2004
Application Deadline:
Tender Deadline Date: 18-Jun-2004
Tender Deadline Time:
Notice Type: Tenders
Has Documents: No
Abstract: Title attributed to the qualification system by the contracting entity:
Onshore Gas Pipeline Design Verification/Completion and Construction
Services.
To enable Shell E&P Ireland Limited ('Shell') or any of its affiliates
(the awarding authority) to identify a list of suitably qualified
contractors who may subsequently be selected to bid or negotiate
contract(s) for the provision of design verification, design completion
and construction services in connection with the 9 km onshore gas
transmission pipeline for the Corrib Project, West of Ireland.
The project is subject to approval by the relevant Irish planning
authorities and this process is currently underway.
CPV: 45231220.

Additional Documents

There are no additional documents attached to this notice.

Contact Information

Main Contact: jim.mcmanus@shell.com
Admin Contact: N/a
Technical Contact: N/a
Other Contact: N/a

Full Notice Text

QUALIFICATION SYSTEM - UTILITIES
Services
Contracts are covered by the Government Procurement Agreement (GPA): No.
SECTION I: CONTRACTING ENTITY
I.1) Official name and address of the contracting entity: Shell E&P Ireland Limited, Att: Mr J. McManus, Corrib House, 52 Lower Leeson Street, IRL-Dublin 2. Tel.: +353 (0) 1 603 4804. Fax: +353 (0) 1 603 4840. E-mail: jim.mcmanus@shell.com.
I.2) Address from which further information can be obtained: As in I.1.
I.3) Address from which documentation may be obtained: As in I.1.
I.4) Address to which requests to participate/candidatures must be sent: As in I.1.
SECTION II: OBJECT OF THE QUALIFICATION SYSTEM

II.1) Description
II.1.1) Title attributed to the qualification system by the contracting entity: Onshore Gas Pipeline Design Verification/Completion and Construction Services.
II.1.2) Object of the qualification system - description of the goods, services or works: To enable Shell E&P Ireland Limited ('Shell') or any of its affiliates (the awarding authority) to identify a list of suitably qualified contractors who may subsequently be selected to bid or negotiate contract(s) for the provision of design verification, design completion and construction services in connection with the 9 km onshore gas transmission pipeline for the Corrib Project, West of Ireland.
The project is subject to approval by the relevant Irish planning authorities and this process is currently underway.
II.1.3) Conditions to be fulfilled by suppliers, contractors or service providers in view of their qualification and methods according to which each of those conditions will be verified: Potential contractors wishing to qualify for the provision of such services must, as a minimum, be able to demonstrate that they have the expertise, experience, properly qualified personnel and capability to undertake all of the following:
a) the design verification and design completion of the 9 km onshore gas transmission pipeline in County Mayo. Shell has completed much of the design work and the successful applicant will be required to verify the existing design and complete outstanding items such as crossings, special construction areas, valve foundations etc; to a standard sufficient to meet the operational, commercial and legal controls required;
b) all activities associated with the installation of the 9 km of onshore gas transmission pipeline, outfall pipeline and onshore umbilical for the Corrib project. The pipeline route includes 2 estuary/river crossings, a significant length of peat bog, an area of undisturbed blanket bog, and a number of designated special areas of conservation;
c) all pressure containing steel pipe, fittings and control umbilical elements will be free-issued. There will be a need to procure polyethylene outfall pipe and umbilical conduit as part of the permanent works together with temporary works and installation aids;
d) the management of technical and operational interfaces with Shell's pipeline/outfall/umbilical landfall and the onshore host terminal facilities contractors;
e) the collation and presentation of all as-built documentation by way of final alignment sheets, material and fabrication records, including testing, and summary data books.
In order to complete the construction activities to coincide with the work of other contractors associated with this project, potential contractors wishing to qualify must be in a position to carry out these activities commencing no later than 31.1.2005.
II.1.4) Nomenclature
II.1.4.1) Common Procurement Vocabulary (CPV): 45231220.
SECTION IV: PROCEDURE
IV.1) Administrative information
IV.1.1) Reference number attributed to the file by the contracting entity: Corrib/104.04.
IV.1.2) This notice is a call for competition: Yes.
IV.1.3) Duration of the qualification system: Other.
IV.1.4) Formalities for renewal of the qualification system: [illegible]
SECTION VI: OTHER INFORMATION
VI.1) Non-mandatory notice: No.
VI.2) One of the contracts relate to a project/programme financed by EU funds: No.
VI.3) Additional information: This notice indicates the existence of a qualification system.
A questionnaire for completion and the rules of the qualification system may be obtained by applying in writing to the address in I.1.
Such requests, if made by facsimile or any electronic means, must be confirmed by letter.
Contractors are required to complete and submit a questionnaire by the due time specified by the awarding authority in order that the awarding authority may identify which contractors qualify according to the requirements of the qualification system, established solely for this contract, and to decide from the list of such qualified contractors who will be selected and invited to participate in any contract award procedure for this service.
All communications shall be in English.
Application to receive the questionnaire and system rules should be made within 15 calendar days of the publication of this notice.
IV.1.3) Duration of the qualification system: whichever is the earlier,

24

the award of the contract for the above or 31.1.2005, subject to amendment or termination at the discretion of the awarding authority.
VI.4) Date of dispatch of this notice: 26.5.2004.

Further Information

No further information has been uploaded.

25

Appendix G

Amendments to the Seveso II Directive

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

THE EUROPEAN PARLIAMENT AND THE COUNCIL OF THE EUROPEAN UNION,

Having regard to the Treaty establishing the European Community, and in particular Article 175(1) thereof,

Having regard to the proposal from the Commission [1],

Having regard to the opinion of the European Economic and Social Committee [2],

After consulting the Committee of the Regions,

Acting in accordance with the procedure laid down in Article 251 of the Treaty in the light of the joint text approved by the Conciliation Committee on 22 October 2003 [3],

Whereas:

(1) Directive 96/82/EC [4] aims at the prevention of major accidents which involve dangerous substances and the limitation of their consequences for man and the environment, with a view to ensuring high levels of protection throughout the Community in a consistent and effective manner.

(2) In the light of recent industrial accidents and studies on carcinogens and substances dangerous for the environment carried out by the Commission at the Council's request, the scope of Directive 96/82/EC should be extended.

(3) The cyanide spill that polluted the Danube following the accident at Baia Mare in Romania in January 2000 has demonstrated that certain storage and processing activities in mining, especially tailings disposal facilities, including tailing ponds or dams, have potential to produce very serious consequences. The Commission communications on the safe operation of mining activities and on the sixth environment action programme of the European Community have therefore highlighted the need for an extension of the scope of Directive 96/82/EC. In its resolution of 5 July 2001 [5] on the Commission Communication on the safe operation of mining activities, the European Parliament also welcomed the extension of the scope of that Directive to cover risks arising from storage and processing activities in mining.

(4) The proposal for a directive on the management of waste from the extractive industries may be a relevant framework for measures relating to those waste management facilities which present an accident risk but which are not covered by the present Directive.

(5) The 'fireworks accident' at Enschede in the Netherlands in May 2000 has demonstrated the major accident potential arising from storage and manufacture of pyrotechnic and explosive substances. The definition of such substances in Directive 96/82/EC should therefore be clarified and simplified.

(6) The explosion at a fertiliser plant in Toulouse in September 2001 has raised awareness of the accident potential arising from the storage of ammonium nitrate and ammonium nitrate-based fertilisers, in particular of material rejected during the manufacturing process or returned to the manufacturer (off-specs). The existing categories of ammonium nitrate and ammonium nitrate-based fertilisers in Directive 96/82/EC should therefore be reviewed with a view to include 'off-specs' material.

(7) Directive 96/82/EC should not be applied to sites of end-users where ammonium nitrate and ammonium nitrate-based fertilisers, which on delivery conformed to the specification in that Directive but subsequently have become degraded or contaminated, are temporarily present prior to removal for reprocessing or destruction.

(8) Studies carried out by the Commission in close cooperation with the Member States support extending the list of carcinogens with appropriate qualifying quantities and significantly lowering the qualifying quantities assigned to substances dangerous for the environment in Directive 96/82/EC.

(9) For establishments which subsequently fall within the scope of Directive 96/82/EC, it has been shown necessary to introduce minimum periods for notifications and the establishment of major accident prevention policies, safety reports and emergency plans.

(10) The experience and knowledge of relevant staff in the establishment can greatly assist in the drawing up of emergency plans, and all staff in an establishment and persons likely to be affected should be appropriately informed on safety measures and actions.

[1] OJ C 75 E, 26.3.2002, p. 357 and OJ C 20 E, 28.1.2003, p. 255.
[2] OJ C 149, 21.6.2002, p. 13.
[3] Opinion of the European Parliament of 3 July 2002 (OJ C 271 E, 12.11.2003, p. 315), Council common position of 20 February 2003 (OJ C 102 E, 29.4.2003, p. 1) and position of the European Parliament of 19 June 2003 (not yet published in the Official Journal). Legislative resolution of the European Parliament of 19 November 2003 (not yet published in the Official Journal) and decision of the Council of 1 December 2003.
[4] OJ L 10, 14.1.1997, p. 13.
[5] OJ C 65 E, 14.3.2002, p. 382.

27

(11) The adoption of Council Decision 2001/792/EC, Euratom of 23 October 2001 establishing a Community mechanism to facilitate reinforced cooperation in civil protection assistance interventions (1) highlights the need to facilitate reinforced cooperation in civil protection assistance interventions.

(12) It is useful, in order to facilitate land-use planning, to draw up guidelines defining a database to be used for assessing the compatibility between the establishments covered by Directive 96/82/EC and the areas described in Article 12(1) of that Directive.

(13) There should be an obligation on Member States to supply the Commission with minimum information concerning the establishments covered by Directive 96/82/EC.

(14) It is appropriate at the same time to clarify certain passages in Directive 96/82/EC.

(15) The measures provided for in this Directive have been the subject of a public consultation process involving interested parties.

(16) Directive 96/82/EC should therefore be amended accordingly,

HAVE ADOPTED THIS DIRECTIVE:

Article 1

Directive 96/82/EC is hereby amended as follows:

1. Article 4 is amended as follows:

(a) Points (e) and (f) are replaced by the following:

'(e) the exploitation (exploration, extraction and processing) of minerals in mines, quarries, or by means of boreholes, with the exception of chemical and thermal processing operations and storage related to those operations which involve dangerous substances, as defined in Annex I;

(f) the offshore exploration and exploitation of minerals, including hydrocarbons;'

(b) The following point shall be added:

'(g) waste land-fill sites, with the exception of operational tailings disposal facilities, including tailing ponds or dams, containing dangerous substances as defined in Annex I, in particular when used in connection with the chemical and thermal processing of minerals.'

2. Article 6 is amended as follows:

(a) The following indent is added in paragraph 1:

'— for establishments which subsequently fall within the scope of this Directive, within three months after the date on which this Directive applies to the establishment concerned, as laid down in the first subparagraph of Article 2(1).'

(b) The following indent is inserted after the first indent of Article 6(4):

'— modification of an establishment or an installation which could have significant repercussions on major accident hazards, or'.

3. The following paragraph is inserted in Article 7:

'1a. For establishments which subsequently fall within the scope of this Directive, the document referred to in paragraph 1 shall be drawn up without delay, but at all events within three months after the date on which this Directive applies to the establishment concerned, as laid down in the first subparagraph of Article 2(1).'

4. Article 8(2)(b) is replaced by the following:

'(b) provision is made for cooperation in informing the public and in supplying information to the authority responsible for the preparation of external emergency plans.'

5. Article 9 is amended as follows:

(a) The first subparagraph of paragraph 2 is replaced by the following:

'2. The safety report shall contain at least the data and information listed in Annex II. It shall name the relevant organisations involved in the drawing up of the report. It shall also contain an updated inventory of the dangerous substances present in the establishment.'

(b) The following indent is inserted between the third and fourth indents of paragraph 3:

'— for establishments which subsequently fall within the scope of this Directive, without delay, but at all events within one year after the date on which this Directive applies to the establishment concerned, as laid down in the first subparagraph of Article 2(1).'

(c) In paragraph 4, the reference to 'the second, third, and fourth indents' becomes 'the second, third, fourth and fifth indents' respectively.

(d) The following point is added to Article 9(6):

'(d) The Commission is invited to review by 31 December 2006 in close cooperation with the Member States, the existing "Guidance on the Preparation of a Safety Report".'

6. Article 11 is amended as follows:

(a) The following indent is added to points (a) and (b) of paragraph 1:

'— for establishments which subsequently fall within the scope of this Directive, without delay, but at all events within one year after the date on which this Directive applies to the establishment concerned, as laid down in the first subparagraph of Article 2(1).'

(1) OJ L 297, 15.11.2001, p. 7.

28

(b) Paragraph 3 is replaced by the following:

'3. Without prejudice to the obligations of the competent authorities, Member States shall ensure that the internal emergency plans provided for in this Directive are drawn up in consultation with the personnel working inside the establishment, including long-term relevant subcontracted personnel, and that the public is consulted on external emergency plans when they are established or updated.'

(c) The following paragraph is inserted:

'4a. With regard to external emergency plans, Member States should take into account the need to facilitate enhanced cooperation in civil protection assistance in major emergencies.'

7. Article 12 is amended as follows:

(a) The second subparagraph of paragraph 1 is replaced by the following:

'Member States shall ensure that their land-use and/or other relevant policies and the procedures for implementing those policies take account of the need, in the long term, to maintain appropriate distances between establishments covered by this Directive and residential areas, buildings and areas of public use, major transport routes as far as possible, recreational areas and areas of particular natural sensitivity or interest and, in the case of existing establishments, of the need for additional technical measures in accordance with Article 5 so as not to increase the risks to people.'

(b) The following paragraph is inserted:

'1a. The Commission is invited by 31 December 2006, in close cooperation with the Member States, to draw up guidelines defining a technical database including risk data and risk scenarios, to be used for assessing the compatibility between the establishments covered by this Directive and the areas described in paragraph 1. The definition of this database shall as far as possible take account of the evaluations made by the competent authorities, the information obtained from operators and all other relevant information such as the socioeconomic benefits of development and the mitigating effects of emergency plans.'

8. Article 13 is amended as follows:

(a) The first subparagraph of paragraph 1 is replaced by the following:

'1. Member States shall ensure that information on safety measures and on the requisite behaviour in the event of an accident is supplied regularly and in the most appropriate form, without their having to request it, to all persons and all establishments serving the public (such as schools and hospitals) liable to be affected by a major accident originating in an establishment covered by Article 9.'

(b) Paragraph 6 is replaced by the following:

'6. In the case of establishments subject to the provisions of Article 9, Member States shall ensure that the inventory of dangerous substances provided for in Article 9(2) is made available to the public subject to the provisions of paragraph 4 of this Article and Article 20.'

9. The following paragraph is inserted in Article 19:

'1a. For establishments covered by this Directive, Member States shall supply the Commission with at least the following information:

(a) the name or trade name of the operator and the full address of the establishment concerned; and

(b) the activity or activities of the establishment.

The Commission shall set up and keep up to date a database containing the information supplied by the Member States. Access to the database shall be reserved to persons authorised by the Commission or the competent authorities of the Member States.'

10. Annex I is amended as set out in the Annex.

11. In Annex II, point IV part B is replaced by the following:

'B. Assessment of the extent and severity of the consequences of identified major accidents including maps, images or, as appropriate, equivalent descriptions, showing areas which are liable to be affected by such accidents arising from the establishment, subject to the provisions of Articles 13(4) and 20.'

12. In Annex III, point (c) is amended as follows:

(a) point (i) is replaced by the following:

'(i) organisation and personnel — the roles and responsibilities of personnel involved in the management of major hazards at all levels in the organisation. The identification of training needs of such personnel and the provision of the training so identified. The involvement of employees and of subcontracted personnel working in the establishment.'

(b) point (v) is replaced by the following:

'(v) Planning for emergencies — adoption and implementation of procedures to identify foreseeable emergencies by systematic analysis, to prepare, test and review emergency plans to respond to such emergencies and to provide specific training for the staff concerned. Such training shall be given to all personnel working in the establishment, including relevant subcontracted personnel.'

Article 2

1. Member States shall bring into force the laws, regulations and administrative provisions necessary to comply with this Directive before 1 July 2005. They shall forthwith inform the Commission thereof.

When Member States adopt these measures, they shall contain a reference to this Directive or shall be accompanied by such a reference on the occasion of their official publication. The methods of making such reference shall be laid down by Member States.

2. Member States shall communicate to the Commission the text of the main provisions of national law which they adopt in the field covered by this Directive.

Article 3

This Directive shall enter into force on the day of its publication in the *Official Journal of the European Union*.

Article 4

This Directive is addressed to the Member States.

Done at Brussels, 16 December 2003.

For the European Parliament	*For the Council*
The President	*The President*
P. COX	G. ALEMANNO

ANNEX

Annex I to Directive 96/82/EC is hereby amended as follows:

1. The following points are added to the introduction:

'6. For the purposes of this Directive, a gas is any substance that has an absolute vapour pressure equal to or greater than 101,3 kPa at a temperature of 20 ° C.

7. For the purposes of this Directive, a liquid is any substance that is not defined as a gas and that is not in the solid state at a temperature of 20 ° C and at a standard pressure of 101,3 kPa.'

2. In the table in Part 1:

(a) the entries relating to 'Ammonium nitrate' are replaced by the following:

'Ammonium nitrate (see note 1)	5 000	10 000
Ammonium nitrate (see note 2)	1 250	5 000
Ammonium nitrate (see note 3)	350	2 500
Ammonium nitrate (see note 4)	10	50'

(b) the following entries are inserted after the entries relating to 'Ammonium nitrate':

'Potassium nitrate (see note 5)	5 000	10 000
Potassium nitrate (see note 6)	1 250	5 000'

(c) the entry relating to 'The following CARCINOGENS' is replaced by the following:

'The following CARCINOGENS at concentrations above 5 % by weight: 4-Aminobiphenyl and/or its salts, Benzotrichloride, Benzidine and/or salts, Bis (chloromethyl) ether, Chloromethyl methyl ether, 1,2-Dibromoethane, Diethyl sulphate, Dimethyl sulphate, Dimethylcarbamoyl chloride, 1,2-Dibromo-3-chloropropane, 1,2-Dimethylhydrazine, Dimethylnitrosamine, Hexamethylphosphoric triamide, Hydrazine, 2- Naphthylamine and/or salts, 4-Nitrodiphenyl, and 1,3 Propanesultone	0,5	2'

(d) the entry relating to 'Automotive petrol and other petroleum spirits' is replaced by the following:

'Petroleum products: (a) gasolines and naphthas, (b) kerosenes (including jet fuels), (c) gas oils (including diesel fuels, home heating oils and gas oil blending streams)	2 500	25 000

(e) (i) Notes 1 and 2 are replaced by the following:

'1. Ammonium nitrate (5 000/10 000): fertilisers capable of self-sustaining decomposition

This applies to ammonium nitrate-based compound/composite fertilisers (compound/composite fertilisers containing ammonium nitrate with phosphate and/or potash) in which the nitrogen content as a result of ammonium nitrate is

— between 15,75 % (1) and 24,5 % (2) by weight, and either with not more than 0,4 % total combustible/organic materials or which fulfil the requirements of Annex II of Directive 80/876/EEC,

— 15,75 % (3) by weight or less and unrestricted combustible materials,

and which are capable of self-sustaining decomposition according to the UN Trough Test (see United Nations Recommendations on the Transport of Dangerous Goods: Manual of Tests and Criteria, Part III, subsection 38.2).

31

2. Ammonium nitrate (1 250/5 000): fertiliser grade

This applies to straight ammonium nitrate-based fertilisers and to ammonium nitrate-based compound/composite fertilisers in which the nitrogen content as a result of ammonium nitrate is

— more than 24,5 % by weight, except for mixtures of ammonium nitrate with dolomite, limestone and/or calcium carbonate with a purity of at least 90 %,

— more than 15,75 % by weight for mixtures of ammonium nitrate and ammonium sulphate,

— more than 28 % (4) by weight for mixtures of ammonium nitrate with dolomite, limestone and/or calcium carbonate with a purity of at least 90 %,

and which fulfil the requirements of Annex II of Directive 80/876/EEC.

3. Ammonium nitrate (350/2500): technical grade

This applies to:

— ammonium nitrate and preparations of ammonium nitrate in which the nitrogen content as a result of the ammonium nitrate is

— between 24,5 % and 28 % by weight, and which contain not more than 0,4 % combustible substances,

— more than 28 % by weight, and which contain not more than 0,2 % combustible substances,

— aqueous ammonium nitrate solutions in which the concentration of ammonium nitrate is more than 80 % by weight.

4. Ammonium nitrate (10/50): "off-specs" material and fertilisers not fulfilling the detonation test

This applies to:

— material rejected during the manufacturing process and to ammonium nitrate and preparations of ammonium nitrate, straight ammonium nitrate-based fertilisers and ammonium nitrate-based compound/composite fertilisers referred to in Notes 2 and 3, that are being or have been returned from the final user to a manufacturer, temporary storage or reprocessing plant for reworking, recycling or treatment for safe use, because they no longer comply with the specifications of Notes 2 and 3;

— fertilisers referred to in note 1, first indent, and Note 2 which do not fulfil the requirements of Annex II of Directive 80/876/EEC.

5. Potassium nitrate (5 000/10 000): composite potassium-nitrate based fertilisers composed of potassium nitrate in prilled/granular form.

6. Potassium nitrate (1 250/5 000): composite potassium-nitrate based fertilisers composed of potassium nitrate in crystalline form.'

(ii) the note relating to polychlorodibenzofurans and polychlorodibenzodioxins becomes note 7.

(iii) the following footnotes appear below the table entitled 'International Toxic Equivalent Factors (ITEF) for the congeners of concern (NATO/CCMS)':

'(1) 15,75 % nitrogen content by weight as a result of ammonium nitrate corresponds to 45 % ammonium nitrate.

(3) 24,5 % nitrogen content by weight as a result of ammonium nitrate corresponds to 70 % ammonium nitrate.

(3) 15,75 % nitrogen content by weight as a result of ammonium nitrate corresponds to 45 % ammonium nitrate.

(4) 28 % nitrogen content by weight as a result of ammonium nitrate corresponds to 80 % ammonium nitrate.'

3. In Part 2:

(a) entries 4 and 5 are replaced by the following:

'4. EXPLOSIVE (see note 2) where the substance, preparation or article falls under UN/ADR Division 1.4	50	200
5. EXPLOSIVE (see note 2) where the substance, preparation or article falls under any of: UN/ADR Divisions 1.1, 1.2, 1.3, 1.5 or 1.6 or risk phrase R2 or R3	10	50'

(b) entry 9 is replaced by the following:

'9. DANGEROUS FOR THE ENVIRONMENT risk phrases:		
i) R50: "Very toxic to aquatic organisms" (including R50/53)	100	200
ii) R51/53: "Toxic to aquatic organisms; may cause long term adverse effects in the aquatic environment"	200	500'

(c) In the notes:

(i) Note 1 is replaced by the following:

'1. Substances and preparations are classified according to the following Directives and their current adaptation to technical progress:

Council Directive 67/548/EEC of 27 June 1967 on the approximation of the laws, regulations and administrative provisions relating to the classification, packaging and labelling of dangerous substances(1),

Directive 1999/45/EC of the European Parliament and of the Council of 31 May 1999 concerning the approximation of laws, regulations and administrative provisions of the Member States relating to the classification, packaging and labelling of dangerous preparations (2).

In the case of substances and preparations which are not classified as dangerous according to either of the above directives, for example waste, but which nevertheless are present, or are likely to be present, in an establishment and which possess or are likely to possess, under the conditions found at the establishment, equivalent properties in terms of major accident potential, the procedures for provisional classification shall be followed in accordance with the relevant article of the appropriate Directive.

In the case of substances and preparations with properties giving rise to more than one classification, for the purposes of this Directive the lowest qualifying quantities shall apply. However, for the application of the rule in Note 4, the qualifying quantity used shall always be the one corresponding to the classification concerned.

For the purposes of this Directive, the Commission shall establish and keep up to date a list of substances which have been classified into the above categories by a harmonised Decision in accordance with Directive 67/548/EEC.'

(ii) Note 2 is replaced by the following:

'2. An "explosive" means:

— a substance or preparation which creates the risk of an explosion by shock, friction, fire or other sources of ignition (risk phrase R2),

— a substance or preparation which creates extreme risks of explosion by shock, friction, fire or other sources of ignition (risk phrase R3), or

— a substance, preparation or article covered by Class 1 of the European Agreement concerning the International Carriage of Dangerous Goods by Road (UN/ADR), concluded on 30 September 1957, as amended, as transposed by Council Directive 94/55/EC of 21 November 1994 on the approximation of the laws of the Member States with regard to the transport of dangerous goods by road (3).

Included in this definition are pyrotechnics, which for the purposes of this Directive are defined as substances (or mixtures of substances) designated to produce heat, light, sound, gas or smoke or a combination of such effects through self-sustained exothermic chemical reactions. Where a substance or preparation is classified by both UN/ADR and risk phase R2 or R3, the UN/ADR classification shall take precedence over assignment of risk phrases.

Substances and articles of Class 1 are classified in any of the divisions 1.1 to 1.6 in accordance with the UN/ADR classification scheme. The divisions concerned are:

Division 1.1: "Substances and articles which have a mass explosion hazard (a mass explosion is an explosion which affects almost the entire load virtually instantaneously).

Division 1.2: "Substances and articles which have a projection hazard but not a mass explosion hazard."

33

Division 1.3: "Substances and articles which have a fire hazard and either a minor blast hazard or a minor projection hazard or both, but not a mass explosion hazard:

(a) combustion of which gives rise to considerable radiant heat; or

(b) which burn one after another, producing minor blast or projection effects or both."

Division 1.4: "Substances and articles which present only a slight risk in the event of ignition or initiation during carriage. The effects are largely confined to the package and no projection of fragments of appreciable size or range is to be expected. An external fire shall not cause virtually instantaneous explosion of virtually the entire contents of the package."

Division 1.5: "Very insensitive substances having a mass explosion hazard which are so insensitive that there is very little probability of initiation or of transition from burning to detonation under normal conditions of carriage. As a minimum requirement they shall not explode in the external fire test."

Division 1.6: "Extremely insensitive articles which do not have a mass explosion hazard. The articles contain only extremely insensitive detonating substances and demonstrate a negligible probability of accidental initiation or propagation. The risk is limited to the explosion of a single article."

Included in this definition are also explosive or pyrotechnic substances or preparations contained in articles. In the case of articles containing explosive or pyrotechnic substances or preparations, if the quantity of the substance or preparation contained is known, that quantity shall be considered for the purposes of this Directive. If the quantity is not known, then, for the purposes of this Directive, the whole article shall be treated as explosive.'

(iii) in note 3(b)(1), the second indent shall be replaced by the following:

'— substances and preparations which have a flash point lower than 55 °C and which remain liquid under pressure, where particular processing conditions, such as high pressure or high temperature, may create major-accident hazards;'

(iv) note 3(c)(2) is replaced by the following:

'2. gases which are flammable in contact with air at ambient temperature and pressure (risk phrase R12, second indent), which are in a gaseous or supercritical state, and'

(v) note 3(c)3 is replaced by the following:

'3. flammable and highly flammable liquid substances and preparations maintained at a temperature above their boiling point.'

(vi) note 4 is replaced by the following:

'4. In the case of an establishment where no individual substance or preparation is present in a quantity above or equal to the relevant qualifying quantities, the following rule shall be applied to determine whether the establishment is covered by the relevant requirements of this Directive.

This Directive shall apply if the sum

$q_1/Q_{U1} + q_2/Q_{U2} + q_3/Q_{U3} + q_4/Q_{U4} + q_5/Q_{U5} + \ldots$ is greater than or equal to 1,

where q_x = the quantity of dangerous substance x (or category of dangerous substances) falling within Parts 1 or 2 of this Annex,

and Q_{UX} = the relevant qualifying quantity for substance or category x from column 3 of Parts 1 or 2.

This Directive shall apply, with the exception of Articles 9, 11 and 13, if the sum

$q_1/Q_{L1} + q_2/Q_{L2} + q_3/Q_{L3} + q_4/Q_{L4} + q_5/Q_{L5} + \ldots$ is greater than or equal to 1,

where q_x = the quantity of dangerous substance x (or category of dangerous substances) falling within Parts 1 or 2 of this Annex,

and Q_{LX} = the relevant qualifying quantity for substance or category x from column 2 of Parts 1 or 2.

This rule shall be used to assess the overall hazards associated with toxicity, flammability, and eco-toxicity. It must therefore be applied three times:

(a) for the addition of substances and preparations named in Part 1 and classified as toxic or very toxic, together with substances and preparations falling into categories 1 or 2;

(b) for the addition of substances and preparations named in Part 1 and classified as oxidising, explosive, flammable, highly flammable, or extremely flammable, together with substances and preparations falling into categories 3, 4, 5, 6, 7a, 7b or 8;

(c) for the addition of substances and preparations named in Part 1 and classified as dangerous for the environment (R50 (including R50/53) or R51/53), together with substances and preparations falling into categories 9(i) or 9(ii);

The relevant provisions of this Directive apply if any of the sums obtained by (a), (b) or (c) is greater than or equal to 1.'

(vii) the following footnotes appear at the end of the notes:

'(1) OJ 196, 16.8.1967, p. 1. Directive as last amended by Regulation (EC) No 807/2003 (OJ L 122, 16.5.2003, p. 36).

(2) OJ L 200, 30.7.1999, p. 1. Directive as amended by Commission Directive 2001/60/EC (OJ L 226, 22.8.2001, p. 5).

(3) OJ L 319, 12.12.1994, p. 7. Directive as last amended by Commission Directive 2003/28/EC (OJ L 90, 8.4.2003, p. 45).'

35

HSE (UK)

HID Safety Report Assessment Guide: LPG

http://www.hse.gov.uk/comah/sraglpg/srag.htm

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PAGE

HID - Safety Report Assessment Guide: LPG

Introduction

The purpose of HSE's assessment of a safety report against the criteria in the SRAM, is to come to a conclusion on whether the requirements and demonstrations in Schedule 4 Part 1 have been met. The extent of the information required for each demonstration to be made will depend on the level of proportionality considerations and the type of safety report required by COMAH Regs. 7 or 8. The different report types include: the initial report for existing establishments, pre-construction (PCSR), pre-operation (POSR), modification and updated reports.

The predictive criteria are designed to help the Assessor make consistent professional judgements about whether the demonstrations in a safety report are adequate. Such demonstrations need to be based on a suitable and sufficient risk assessment. The criteria are necessarily quite general, but sufficiently broad in nature to cover the various types of installation, the range of hazards to be encountered, and the types of risk assessment that might be employed.

The purpose of this document is to describe how Assessors should test whether the criteria that applies to the predictive aspects of COMAH safety reports have been met. It provides an interpretation of the criteria based on useful examples. The information supplements rather than supplants that in the safety report assessment manual.

The initial sections provide important background information, particularly on ALARP decisions and the application of the proportionality principle to the assessment of safety reports. Section 1.2 provides guidance to supplement the explanatory text for the predictive criteria in Part 2, Chapter 3 of the SRAM and should be applied for each safety report assessment.

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TOP PAGE

Contents List

List of Tables

1. INTRODUCTION

The purpose of this document is to describe how Assessors should test whether the criteria that applies to the predictive aspects of. COMAH safety reports have been met. It provides background information on LPG hazards and an interpretation of the criteria based on useful examples. The information supplements rather than supplants that in the safety report assessment manual.

It is assumed that the Assessor is fully familiar with:-

- HSC/E's enforcement policy, the application of the ALARP principle and associated publications (e.g. HSE, 1999; HSE, 1992; Treasury, 1998).
- The COMAH Training Manual.
- The contents of the HID Safety Report Assessment Manual (SRAM), particularly the guiding principles, and the procedures for handling and assessing safety reports.
- The MSDU Planning Case Assessment Guide (PCAG).

The sections below provide important background information, particularly on ALARP decisions and the application of the proportionality principle to the assessment of safety reports. Section 1.2 provides guidance to supplement the explanatory text for the predictive criteria in Part 2, Chapter 3 of the SRAM and should be applied for each safety report assessment.

1.1 Fundamental Considerations

Before assessing a safety report an Assessors needs to be clear about:-

- His/her role in the assessment process and what the safety report Assessment Manager (AM) is expecting from the assessment.
- The degree of proportionality that applies, this determines what can justifiably be expected from the Operator's risk assessment (RA) – i.e. the depth of the arguments supporting the various demonstrations
- HSE's approach to the application of the ALARP principle to on-site (i.e. HSW Act Section 2), and off-site (i.e. Section 3) risks for new and existing establishments.
- How the assessment criteria should be applied and factors, which influence the depth of the assessment process; an important consideration is the type of report being assessed e.g. first submission, or an update report.

These issues are outlined in the remainder of this Introduction and are revisited as appropriate in later sections of the guidance.

1.2 ROLE OF THE ASSESSOR

The predictive assessment is pivotal to the demonstrations required under Schedule 4, Part 1 paragraph 2 of the COMAH Regulations; particularly the need to demonstrate that:-

- all major accident hazards (MAHs) have been identified.
- that all necessary measures to prevent and limit the consequences of these MAHs are identified and implemented.

The Assessor's role relates solely to the risks to people both on-site and off-site. Risks to the environment are for the Environment Agencies and are not addressed here.

When the assessment of the predictive aspects of a safety report is complete, the Assessor should return the completed assessment form to the Assessment Manager giving conclusions about whether:-

- the process of the hazard identification and risk analysis is fit for purpose.
- all MAHs have been identified; any gaps must be recorded on the AF.
- the prevention and mitigation measures make the risks (both on-site and off-site) ALARP (i.e. criterion 3.6). [Safety critical control measures should be listed to help aid the Team's deliberations e.g. on whether the risks are ALARP; what needs to be verified by inspection etc.]. If the risks are judged not to be ALARP any extra controls that should be identified for the benefit of the assessment team (AT).
- the consequence assessment is adequate for the purposes of COMAH i.e. the extent and severity of representative MAs must be quantified (Schedule 4 Part 2, paragraph 4).

The assessment form allows Assessors to comment against each criterion and sub criterion. This guidance is designed to help provide consistent comments and conclusions and is structured in terms of questions, which relate to the criteria and help to identify any weaknesses in the safety report. These should help Assessors to write succinct 'deficiency' statements and make clear what is required e.g. further information or analysis or both.

When filling in the assessment form the paragraph number and page number in the report should be shown for cross-referencing purposes. For example:-

Criterion	Safety report refs	Comments	Issue* Category
3.3 The safety report should identify all potential major accidents and define a representative and sufficient set for risk analysis.	pxx para yy	**The safety report does not identify catastrophic vessel failure leading to total loss of contents as a potential MA. The report fails to meet criterion 3.3; the Operator has to provide more information.**	decided by team at final meeting.

* The Issue Category relates to the inspection plan only.

1.3 Consistency and Proportionality

The assessment approach needs to be proportionate and consistent (HSC 1995; HSE 1999), therefore Assessors should come to a view on proportionality before starting to assess a report against the predictive criteria.

Consistency does not mean uniformity. It means taking a similar approach in similar circumstances to achieve similar ends. For example, HID's codified arrangements for making land use planning (LUP) decisions enables HID to achieve consistency on such matters over protracted time scales. Translated in to terms of risks to people off-site being ALARP it may mean that some residents in older housing in the vicinity of a COMAH site may bear a greater risk, but a still tolerable risk i.e. ALARP for those circumstances), than would be considered tolerable (perhaps on societal risk grounds), for a proposed new housing development in a nearby location. HID would provide the same advice for a similar situations located in another Local Authority. Having said that, one Local Planning Authority may reject HSE's advice, while another accepts it.

There are analogies here with the assessment of safety reports. In some situations professional judgement (Ref SRAM) may need to be exercised in order to come to a decision on whether the demonstrations in the report are fit for purpose when assessed against the predictive criteria. The criteria and the associated guidance are designed to help Assessors exercise this judgement in a consistent way. Occasionally they may need to discuss some issues with HID colleagues who are familiar with the site, the l and use planning situation, or the Operator's approach to discharging his Section 3 responsibilities, before reaching a decision.

The assessment team have a key role to play in achieving consistency in the overall assessment of safety reports and in the drawing of the Competent Authorities' (CAs) Conclusions.

Proportionality is a key element in the enforcement policy of the CAs and underpins European Community Law. It is also a fundamental consideration when exercising judgement on whether assessment criteria are met or not. HSE guidance (HSE 1999b) on the COMAH Regulations (paragraph 74) states that 'there must be some proportionality between the risk and the measures taken to control the risk. The phrase "all measures necessary" will be interpreted to include this principle'.

Proportionality is essentially determined by the severity of the worst possible consequences i.e. those resulting from the worst case scenario, and the levels of risk (individual and societal), that remain after taking account of the prevention and mitigation measures the Operator has put in place. The following factors (see also paragraph 292), of HSG 190), are therefore important:-

a. the scale (inventory, vessel sizes etc) and nature (hazardous properties, toxicity, flammability etc.) of the hazards.

b. the location of the site in relation to off-site populations.

c. the density and types of off-site population (e.g. dwellings, hospitals, schools etc.).

d. the number of people on site.

e. the variation of residual individual risks with distance[1].

Proportionality should influence the aspects on which Assessors focus the most attention i.e. the issues where the occupier is expected to provide convincing arguments to support the demonstrations. Information in the safety report should enable Assessors to fully understand site specific circumstances (on-site and off-site), so that a view on proportionality can be reached. The report should therefore describe the processes, the hazardous substances involved and their effects on people, the distribution of people off-site, and the numbers of people on-site and their distribution in relation to the various installations.

To reach a view on proportionality the Assessor needs to know the potential maximum injury toll. Schedule 4 part 2 paragraph 4(b) requires the Operator to determine the extent and severity of the consequences of identified major accidents. Schedule 7 defines injury severity that constitutes a major accident. The threshold is a single death, six persons on the establishment hospitalised for at least 24 hours; or 1 person off-site hospitalised for at least 24 hrs. Severity therefore includes fatal and serious injury (i.e. hospitalisations) as a minimum. Operators must include the severity of the consequences for the worst case event in terms of expected numbers of fatalities and serious injuries in their accident consequence analysis. Less severe injuries should also be considered e.g. minor injuries.

1.4 Determination of Proportionality

Proportionality will influence the type and level of analysis detail that Assessors might expect to underpin the various demonstrations in the safety report (see paragraph 292 of HSG 190). HSG 190 gives the following RA definitions:-

a. **Qualitative risk assessment** is the comprehensive identification and description of hazards from a specified activity, to people or the environment. The range of possible events may be represented by broad categories, with classification of the likelihood and consequences for comparison and the identification of priorities.

1 [1]Societal risks considerations are implicit in b) and d) above. Although the risks may be ALARP, they could be towards the top end of the band. Such a site would require more evidence and arguments to support the various demonstrations and deserve more inspection/assessment resource than a similar plant where the risks to people were towards the bottom end of the ALARP band.

b. **Semi-quantitative risk assessment** is the systematic identification and analysis of hazards from a specified activity, and their representation by means of qualitative and quantitative descriptions of the frequency and extent of the consequences, to people or the environment. The assessment is informed by a representative selection of specific examples for comparison with standards.

c. **Quantitative risk assessment** is the application of methodology to produce a numerical representation of the frequency and extent of a specified level of exposure or harm, to specified people or the environment, from a specified activity. There is also a comparison of the results with specified criteria.

It is implicit in para 292 of HSG 190 that as proportionality increases from a low level to the highest level, the form of risk assessment is likely to change from qualitative, through semi-quantitative to quantitative risk assessment. It is important for Assessors to realise that QRA does not mean that a detailed and full numerical analysis resulting in iso-risk contours and F/N societal risk curves is needed. Rather the extent of the quantification and the form it takes will depend on the site specific circumstances determining the level of proportionality that applies.

1.5 Deciding whether the risks ALARP?

Criterion 3.6 addresses the "all necessary measures" demonstration, which is essentially an ALARP demonstration. In general, decisions on whether risks are ALARP for major hazard installations are based on the generalised TOR Framework (HSE, 1992; HSE, 1999 - the latter being referred to as R2P2 below). For nuclear hazards there is considerable experience in making such ALARP decisions, but the mechanisms for other hazards are still evolving (see HSE, 1999, particularly paragraph 128 et seq). Nevertheless some companies have adapted the TOR framework to devise their own major hazard risk criteria. Whatever approach is used professional judgement is usually needed; the team approach to assessment should help achieve consistency in such decisions for top-tier COMAH sites.

The Operator's ALARP demonstration should be founded on the degree, to which good practice, engineering standards, recognised codes, guidance and standards etc. have been adopted. The control measures introduced by this process will be usually satisfactory for low hazard sites. In terms of the TOR framework this amount to using **technology-based** criteria for making ALARP decisions, i.e. qualitative risk assessment. Such criteria will usually be sufficient when inherently safe design principles have been adopted because then the scale of the hazard should have been drastically reduced. As the level of proportionality increases a decision has to be made as to whether further risk reduction measures are reasonably practicable as required by the HSW Act. Basically, two questions have to be answered:-

- What additional risk reduction measures are possible?
- Which of these are reasonably practicable to implement, i.e. to make the risks to people (on-site and off-site), ALARP?

If no further measures can be identified, the Operator must have all necessary controls in place; it is then a matter to verify by inspection that this is the case and that the measures are sufficiently reliable. To answer the second question some quantification and CBA is usually required. The degree and rigour of this quantification will depend on the level of proportionality and the site specific circumstances. Guidance is given under Criterion 3.6. Such ALARP decisions usually involve the application of the generalised TOR framework as outlined in paragraphs 128 to 136 of R2P2. The ALARP band is defined by levels of individual fatality risk. For members of the public the corresponding fatality risk levels are 10^{-4} (upper limit of tolerability) to 10-6 (broadly acceptable level) per year.

Societal risks need to meet the criterion in paragraph 124 of R2P2 i.e. the likelihood of a single major industrial activity producing 50 or more fatalities should be less than 1 in 5000 per year i.e. less than 2×10^{-4} per year. This is essentially an **equity-based** criterion (see paragraphs 107 to 127 of R2P2), for societal risk. If the criterion is met for a single plant it is still necessary to judge whether the risks are ALARP for the site, which may have several plants.

To assess whether the societal risks are ALARP **utility-based** criteria are usually applied. These are based on the individual risk levels and a cost benefit analysis to estimate what further risk reduction is costing for each life saved by the introduction of an additional measure. By comparing this 'value of a statistical life' to the value society puts on each life (e.g. £1M) an indication of the level of disproportion is obtained. Judgement on whether this is gross will depend on the site specific circumstances, in particular the nature of the hazard and the likely value of the number of fatalities from the worst case scenario (WCF). For example, if the mean individual risk for an off-site population was 5x10-5 (i.e. close to the upper limit of tolerability), and the WCF was >500, but the risk could be reduced by a factor of 10 by spending money such that the "value of statistical life" saved was say £5M, then given the numbers at risk the ALARP principle would require the money to be spent i.e. a factor of disproportion of 5 is not gross in this situation.

In the case of societal risks, deciding whether the risks are ALARP can be quite onerous, particularly for complex sites. One of the earliest examples, which underlines the complexity of making ALARP decisions, is the Canvey Island Studies, which are documented in two Reports (HSE, 1978; HSE, 1981). The Canvey studies considered the risks to members of the public from a number of major hazard sites operated by different companies and a proposed new refinery.

Individual risk (aggregated for all sites), was predicted at a number of locations together with the Societal risk arising from all operations. The first assessment showed that the risks were unacceptable and Industry accepted that risk reduction measures were needed, despite the fact that no agreement had been reached on risk criteria that were appropriate for major hazards. A second study (about two years later), which took account of the proposed measures and advances in risk assessment methods, showed that the risks were lower by about a factor of 20. The highest individual risk of fatality was about 3.5×10^{-5} i.e. close to the limit of tolerability. However, HSE decided that no further risk reduction was necessary. HSE's decision attracted criticism, which is encapsulated in this extract from the report:- **"We have been criticised for seeming to adopt too high a level of acceptable risk in our conclusions. We concede that others may legitimately question our view of acceptable risk, but we would emphasise that in our opinion decisions about acceptable risks have to be made in the light of the facts of risk, consequences and costs in each individual case. We are not tied to a particular numerical level of acceptable risk, and inferences about what we have judged to be an acceptable risk in particular cases in the Canvey area should not automatically be applied elsewhere."**

This extract from the second Canvey report underlines the site specific nature of ALARP decisions - a vital consistency consideration. An important point stemming from the Canvey studies and the 1992 TOR document is that when several sites contribute to the risk born by an off-site individual, the aggregated fatality risk must be ALARP and less than 10^{-4} per year. This has implications for multi-installation sites and multi-occupier sites, and for the assessment of safety reports at such sites. This issue is not addressed in R2P2. ***Should this type of situation arise in the assessment of COMAH safety reports the team should consult HID OPPG on the way forward?***

In the case of new plant, precedents have been set to apply more stringent ALARP criteria (HSE, 1992). This precedent recognises that most risk reduction opportunities exist at the design stage e.g. through the application of inherent safety principles and the application of new technology.

1.6 How the predictive criteria should be used

The purpose of HSE's assessment of a safety report against the criteria in the SRAM, is to come to a conclusion on whether the requirements and demonstrations in Schedule 4 Part 1 have been met. The extent of the information required for each demonstration to be made will depend on the level of proportionality considerations and the type of safety report required by COMAH Regs. 7 or 8. The different report types include: the initial report for existing establishments, pre-construction (PCSR), pre-operation (POSR), modification and updated reports.

Operators will write the safety report in a structure that suits them. Whatever structure is adopted, the Operator should ensure that the information is linked to the required demonstrations in a transparent way. The Assessor should bear in mind that the same control measures and arguments may apply to more than one demonstration. This means that information to support a demonstration is likely to be found in different parts of a safety report.

The predictive criteria are designed to help you make consistent professional judgements about whether the demonstrations in a safety report are adequate. Such demonstrations need to be based on a suitable and sufficient risk assessment (EU, 1998). The criteria are necessarily quite general, but sufficiently broad in nature to cover the various types of installation, the range of hazards to be encountered, and the types of risk assessment that might be employed. Therefore, not all the predictive criteria may need to be considered in the same detail by the Assessor, but ***all the top level criteria need to be applied***. The issues identified in the assessment plan for close examination should help identify the predictive criteria that are key for a particular assessment. The extent to which the sub-criteria are applied should be proportionate. At the lowest level of proportionality a qualitative risk assessment based on recognised codes or guidance will suffice; no quantification of event probabilities may be needed so that the associated criteria need not be tested rigorously.

The criteria are provided as a guiding framework with in which professional judgements are made: *they are not provided as a tick list*. The assessment form should make clear that the Assessor has tested all the predictive criteria. ***The effort put into the assessment should be proportionate and sufficient for enable valid conclusions to be drawn; the reasons behind these conclusions need to be transparent i.e. recorded for auditing purposes.***

Assessors should bear in mind that Operators may rely on published guidance or standards in seeking to demonstrate compliance. However, Operators who demonstrate compliance using company, or other non-published standards will have to show that they are fit for purpose i.e. they need to be based on a risk assessment. They must also show that they have properly identified all foreseeable hazards and that they have implemented all necessary measures to prevent major accidents. ***This means that the Operator has to demonstrate that HSW Act Section 2 (on-site) and Section 3 (off-site) risks are ALARP.*** The report will therefore have to address any risks that remain after compliance with standards or guidance in order to demonstrate that all the necessary measures have been taken. For example, standards may only address risks to workers, in which case the Operator may (depending on the level of proportionality), need to justify their relevance to making off-site risks ALARP. It is then a matter of judgement whether the risks to people on and off site are ALARP. { Note that the Enforcement Policy Statement (HSE, 1995), emphasis that neither codes or guidance material are in terms which necessarily fit every case.}

The SRAM provides guidance on how to assess the various types of safety report. As a general guide, the Assessor should take a quick overview to gain insight into the sites activities, environs, the scale and nature of the hazards, the range of MAs, the controls in place, and the maximum casualty potential (WCF). This will enable a view to be taken on proportionality and the most important issues. Then the assessment criteria can be used in detail to draw conclusions on the report.

The following points are central to the assessment process:-

a. Above all, an Assessor should ensure that he/she is clear about how the proportionality principle applies. The type of report will be an influence e.g. if it is an update report, or a modification report, the primary focus should be on the new material and how this affects the risk assessment.

b. The Assessor needs to take a view about whether the Operator's approach to risk assessment is proportional to the risks presented by the site. This should be done at an early stage in the whole assessment process because it is key to deciding whether a report contains grossly insufficient information e.g. when some quantification (e.g. of event likelihood's), is needed and only qualitative arguments are used.

c. For existing CIMAH sites there may be outstanding risk assessment issues already raised with the occupier that are fundamental to the COMAH requirements. When the level of proportionality is high, Assessors are advised to check whether there are outstanding issues and whether they have been addressed.

d. All the criteria must be applied in a proportionate and consistent way. For qualitative risk assessments the main focus is on the top level criteria.

e. All safety reports need to demonstrate that the CIA guidelines for occupied building have been applied and met.

f. When the assessment has been completed the HID form should be filled in and the conclusions summarised for the Assessment Manager.

Criterion 3.1

The safety report should clearly describe how the Operator uses risk assessment to help make decisions about the measures necessary to prevent major accidents and to mitigate their consequences.

Assessment against Criterion 3.1

The purpose of this criterion is to help the Assessor determine if the Operator's approach to risk assessment is proportionate and systematic. To this end the following questions and answers may prove useful :-

Has the Operator a policy on risk assessment?

This is an important point because the Operator must demonstrate a risk-based approach to his activities and to the production of the safety report. Failure to provide adequate evidence on this point should be viewed as a failure to comply with both the Management and the COMAH Regulations. The section of the safety report dealing with the major accident prevention policy (MAPP) will inform the Assessor on this issue.

Companies that manage their business with the aid of risk assessment will probably refer to the use of risk assessment in areas of safety management such as COSHH, commissioning (HAZOP) and cost benefit analysis. In these cases there may be reference to one or more formalised methods of determining risks such as event tree, fault tree and FMEA, and the use of risk assessment will probably not be confined to major accident analysis, but be detectable throughout the report. Assessors should not forget that risk does not necessarily involve quantification and that qualitative risk assessment has its place in the demonstration of safe operation.

The non quantified approaches that are acceptable include: -

- Hazard studies.
- Job safety analysis.
- Reference to industry standards.
- Safety reviews.
- Human error identification.

Does the safety report summarise the methods of risk assessment or quantified risk assessment that are used in the report?

Since the regulations call for a risk assessment, the safety report should describe the approach adopted. If a QRA has been undertaken, the information that should be presented includes: -

- The extent of the analysis (plants/processes addressed).
- The method of identifying major accident event sequences (HAZOP).
- The analytical approach (event tree, fault tree, FMEA).
- The source of the base failure rate.

If a non-quantified approach is adopted, the basis for demonstrating that the residual risks are both tolerable and ALARP should be given. One or more of the following is acceptable if supported by well reasoned argument: -

- Industry standard good practise.
- Regulatory guidance.
- Industry association guidance.

- Historical data.

Does the safety report summarise the criteria for use with the risk assessments or quantified risk assessments that are used in the report?

Operators should summarise the criteria used to judge when risks are tolerable. Ideally this should appear near the beginning of the report so that the Assessor can make the following judgements: -

- Are the criteria appropriate?
- Does the safety report demonstrate compliance with its own criteria?

Does the safety report state the basis for judging whether all necessary measures have been taken to prevent major accidents and to limit their consequences?

This question is related to the previous one, but in this case a basis for judging if the safeguards systems are adequate can be suggested: -

1. Demonstrating that the risks are negligible (risk of death of an individual < 10^{-6}/year).

or

2. Demonstrating that risks are tolerable (risk of death of an individual < 10^{-4}/year) and that further improvements cannot be justified on cost benefit grounds - residual risks are ALARP.

or

3. The risk of an accident causing the death of 50 or more people in a small event is less than $2x10^{-4}$/year.

Assessors should not expect to see detailed cost benefit calculations in a COMAH safety report, but Operators should list possible practical improvements and justify why they are not implemented.

Criterion 3.1.1

It should be clear that human factors have been taken into account in the risk analysis.

Assessment against Criterion 3.1.1

When making a judgement about compliance of the safety report with this criterion, Assessors should pose the following questions: -

Has the Operator demonstrated that the risk assessment he has carried out to aid decision-making on the measures necessary to prevent major accidents and to mitigate their consequences includes allowance for human factors?

Risk assessment should not focus exclusively on random failures of hardware, but should also consider all types of operator error that can result in a major accident or a dangerous situation. The Operator should describe the role, operatives play in controlling hazard and show that their potential errors are identified. He should also describe measures that have been taken to reduce their probability and how they are accounted for in the major accident analysis. The safety report should demonstrate that his systems and procedures are fit for purpose and incorporate adequate attention to human factors. This should be evident in the management section dealing with staff training, competence assessment, and the way incidents and near misses are dealt with.

Accounting for human error in risk assessment is not straightforward because some human reliability literature data are not universally applicable. Assessors should primarily be concerned with checking that human reliability is included in the analysis rather than with the accuracy of the data used.

Does the safety report consider an adequate range of human failings?

Inclusion of human factors in risk assessment does not necessarily mean simply accounting for process plant Operators opening the "wrong" valve or failing to control the process properly. The following types of event may warrant be consideration:-

- Failure to successfully carry out a operation that is part of normal duties.
- Bulk tank filling and discharging errors made by the tanker driver.
- Erroneously carrying out an operation that is not part of normal duties.
- Failure to respond correctly to an alarm situation (failure to control or making a situation worse).
- Deliberate or inadvertent degradation of the safety of a plant. (e.g. switch an alarm off, or bypass a safety system).
- Deliberate rule flouting (e.g. smoking in a non-smoking area).
- Failure to detect failed componenets during testing.
- Introduction of failures by damaging equipment or leaving equipment miss-aligned during testing or maintenance.

In practice many safety reports will not address human factors as thoroughly or with as much rigour as engineering issues. This can be understood in the light of traditional approaches to safety and safety reports, but cannot be justified where human reliability plays a critical role.

The following are examples of common omissions in safety reports:-

The potential for an Operator to override designed safety features has not been covered.

There should be some mention of 'violations' or 'breaking the rules' as well as "human error".

The hazard analysis process failed to identify anything more than errors of omission (the Operator failing to act).

Most safety reports need to consider errors of commission (an Operator making an action but the wrong one), or decision making errors.

The role of people other than as front-line Operators (e.g. maintainers, supervisors) is not considered.

Many human failures are the result of actions, omissions and decisions taken by other people including designers and managers. For example, the potential for a maintenance error on a safety related system may not be addressed in the RA process.

There was no consideration of the possibility of a hardware failure with a simultaneous human error.

Some appreciation that when the hardware of a protective system fails the Operator may also not respond in the intended manner.

The Operator is being asked to do a critical task that would probably be more reliably done automatically.

There appears to be undue reliance on an Operator to identify and respond rapidly to an alarm condition.

If so we would need some justification of the human error probability included. This should be justified in relation to the specific design of the system interface they have on site rather than a generic value taken from a table.

There is reliance on 'heroic' acts by Operatives to recover situations e.g. going back to the control room when suffering from effects of toxic gas.

Does the safety report show how human factors are included in the risk assessment?

Data tells us that human failures contribute up to 80% of industrial accidents. Even in oil refineries, which are highly capitalised and automated, the figure is 50%. The implications of this run throughout

the safety report and through many of the assessment criteria, so they will need to be considered by several members or all of the assessment team.

The safety report should consider in a rigorous and proportionate way how Operators may contribute to the initiation of a major accident (see Criterion 3.4.4). It should also describe the part Operators play in controlling hazards and risks. If an Operative is required to take certain actions following an alarm, the risk analysis will need to make assumptions about the likelihood that the correct action is taken. For example if the economic consequences of emergency shutdown are great, the Operator may very well hesitate or fail completely to press the button.

If a task is critical to the prevention of a major hazard and an unrealistically high level of human reliability has to be assumed to make the risks ALARP, this may not be acceptable as it places an undue burden on the Operator. Instead automatic control and protection systems can be used to reduce the reliance on the Operator to intervene correctly. To achieve the required reliability it may be necessary to build redundancy and diversity into the control systems.

Not many safety reports will need to quantify human reliability. The focus should be on demonstrating the quality of the training and supervision. If a human reliability figure is used in a fault tree, the Assessor should check that the top event is not sensitive to the value adopted.

Does the safety report describe the how the probability of Operator error is reduced?

In the context of Operator error and how the company ensures that it is minimised, the safety report should:-

- describe how Operator errors are identified.
- what measures have been taken to reduce their probability.
- how they are accounted for in the major accident analysis.
- demonstrate that the systems and procedures for selection , training and supervision of Operators are fit for purpose.

Criterion 3.1.2

Any criteria for eliminating possible hazardous events from further consideration should be clearly justified

Assessment against Criterion 3.1.2

This criterion deals with the Operator's limitation of accident analysis in the safety report and can be judged by reference to the following: -

Have any major accidents been discounted on probability grounds?

Operators are obliged to demonstrate that low frequency events with severe consequences are adequately controlled - that all necessary measures have been taken to prevent their occurrence. However, most safety reports are unlikely to determine the consequences and frequency of all possible accident scenarios, but it is essential that the risk dominating accidents are dealt with comprehensively. Very improbable accident initiators such as a meteor strike, simultaneous multiple failures of reliable systems and terrorist activity can usually be neglected, but cold catastrophic failure of vessels and guillotine rupture of pipe work should not be discounted.

Assessors should recognise that the COMAH regulations do not call for QRA. Frequency evaluation for highly improbable accidents does not need to be as detailed as that for risk dominating sequences and can be based on historical data, industry standards and regulatory guidance etc.

Does the safety report unjustifiably eliminate "small scale" releases?

It is reasonable for the Operator to reduce the number of release cases by defining a scale of event that will not lead to a MA. For example, the consequence assessment may show that any failure resulting in a release smaller than that equivalent to a 10 mm diameter hole does not produce a hazard to on-site or off-site populations. This provides a basis for defining major accident hazards.

However, Operators may need to take account of smaller flammable releases into confined spaces, which might ignite and explode and trigger a more severe accident. The Operator should also consider any known or foreseeable changes to the sensitivity of the surrounding environment e.g. future dwellings, which may be built nearer to the site boundary as these can affect the decision. Such changes should be also considered whenever the risk assessment is reviewed.

In situations where this 'protection' based approach is not sufficiently limiting i.e. the hazard ranges from very small releases extend into population, a risk based approach may be needed. This requires the contribution to the residual risk of releases of different sizes to be considered so that a justifiable 'cut-off' can be decided. All contributions to release likelihood need to be taken into account otherwise, the 'cut-off' may be overly optimistic.

Has the Operator grouped the consequences of several accidents together?

It is reasonable for Operators to describe in detail the consequences of only a relatively small number of representative accident sequences, provided all significant accidents are identified and ranked according to the risk they pose. Thus, for example, if six different accidents resulted in a similar rate of release of LPG, with similar duration and dispersion characteristics, the consequences of only one of them need be described in the safety report. The relative likelihood of the others should be evaluated in order to demonstrate that the risks are ALARP. Operators have discretion on the way this is done and Assessors should not insist on a particular approach, but the arguments presented must be robust.

Is adequate justification provided for dismissing major accidents on the grounds of low probability?

All accidents that the company has taken measures to prevent occurring should be described. The report should also demonstrate that risks from accidents for which no preventative measures are taken are tolerable. In general, these will be low probability events initiated by an off site event such as an aircraft impact.

The safety report should also demonstrate that risks from accidents, for which no preventative measures are taken are tolerable. In general these will be low probability events initiated by an off-site event such as aircraft impact or an earthquake.

Incredible accidents are not clearly defined in this context, and Assessors are expected to use common sense and professional judgement about events that can be neglected. Examples include meteor strike, terrorist activity and simultaneous failure of several diverse and redundant safety systems.

Has the Operator determined or ranked the frequency of all major accidents?

Assessors should recognise that the COMAH regulations do not call for a full QRA. Frequency evaluation for highly improbable accidents does not need to be as detailed as that for risk dominating sequences and can be based on historical data, industry standards and regulatory guidance etc. However, the statement - "the probability of this accident is judged to be less than 10^{-6}" is not acceptable if they are not backed with supporting evidence. A poorly documented or sparsely detailed frequency analysis that appears somewhat optimistic should be judged as failing to comply with the assessment criteria.

If precautions have been taken to reduce the probability of an accident, then the consequences of the event must be assessed so that they can be balanced against the precautions.

Operators are obliged to demonstrate low frequency events with severe consequences are adequately controlled i.e. that all measures necessary have been taken to prevent their occurrence. if precautions have been taken to reduce the probability of an accident, then the consequences of the event must be assessed so that they can be balanced against the precautions.

If the Operator has not attempted to quantify accident frequencies, but builds a case based on terms such as high, medium and low probability, he should rank the accidents according to their perceived severity. Without any quantification it is difficult to determine if an accident that kills a few people with "medium likelihood" is worse than one that kills many people with "very low likelihood". In such cases, the Operator should determine that both risks are tolerable.

Criterion 3.2

The safety report should demonstrate that the Operator has used information and data that are suitable and sufficient for risk analysis

Assessment against Criterion 3.2

A key requirement of the regulations is that information provided about the site and its hazardous substances is suitable and **sufficient** for a risk assessment. In judging this part of the safety report the assessor should ask if it provides comprehensive answers to the following questions: -

What is the maximum LPG inventory and how and under what conditions is it stored?

The site description must describe the location and type of each storage system and provide information on the maximum inventories of LPG and the conditions (temperature and pressure) under which it is stored. It is important that the report adequately addresses the requirements of Schedule 1 of COMAH and considers all substances qualifying under the aggregation rules. The hazard from each qualifying substance must be assessed.

Does the safety report give a description and explanation of site operations sufficient to enable all potential major accident scenarios to be identified?

The safety report should describe plant and plant operations so that failures and errors having severe consequences can be identified. The detail provided must be sufficient to enable Assessors to determine if the accident analysis is thorough and complete. In addition to a full description of the bulk storage vessels, the safety report should describe the cylinder filling plant (if one is present).

Are there sufficient maps and plans to allow the location of hazard sources and vulnerable populations/habitats to be identified?

The standard of maps and plans is likely to vary from one report to another, but all the information needed to determine risk should be present. Maps and plans should clearly show the location of large methane inventories and populated areas at risk from the installation.

Most accidents at a LPG storage site will not have a significant effect on the natural environment unless the site is located next to a SSSI or SBI. Explosions can damage monuments and listed buildings and blow down trees, therefore these items should be identified on the maps and plans provided. If there are none then this should be stated.

Can the source terms for all accidents be determined from the information provided?

The information in a safety report must be sufficient to enable the Assessor to deduce the approximate source term for each major accident. In other words, sufficient information should be given to allow the Assessor to determine "how much, for how long and from where?" Assessors should take the view that any containment system or item of plant can fail and release its contents, therefore the safety report must provide: -

- The pressure and volume of large vessels and other plant containing significant amounts of LPG.
- The diameter and length of pipe to an isolation valve that can be closed (pipeline failures).
- A list of equipment such as pumps, vaporisers, cylinder filling equipment, together with the operating pressures and temperatures.

A safety report that fails to supply all of this information, fails to comply with the assessment criteria.

Are the assumptions used in the accident analysis adequately justified and clearly stated?

The assumptions referred to here do not relate to mathematical modelling of an accident, but are connected with the operation of a site. For example, if the Operator assumes that an alarm will be seen immediately, or that a hardware failure will be detected immediately, the control room must be permanently manned and the instruments that would detect the failure in question should have a status indicator. Even then, the possibility of a delay before remedial or emergency action is taken

should be considered. Of particular concern are failures that would allow a large release of gas into the atmosphere to go unnoticed.

Any reliability assumptions about the following should be justified : -

- ROSOVs to terminate a release.
- Operators to perform tasks correctly.
- Instruments to detect a dangerous situation.
- Shut down systems that respond on demand.

If a QRA approach has been adopted, are accessible sources provided for base failure frequencies/probabilities?

Key documents that the safety report relies on should be available to the Assessor, ideally by being included as an annex to the main report. Fault tree analysis, for example, should not be based on failure probabilities given in a confidential report unless the company is prepared to provide HSE with a copy. The minimum requirements in this respect is references to published work. An Operator's failure to provide any supporting evidence should be considered a failure to comply with the criteria.

Source documents are targets for the follow-up inspection to validate the report, but Assessors should bear in mind their right to request further information from an Operator to help them assess his safety report.

Does the safety report provide, or reference accessible sources for, the predictive models adopted, including the underlying science?

The safety report should provide information on the methods and models used to predict the consequences of major accidents. If a well know computer program such as PHAST has been used, then only details of the input data and the version number are required. An in-house computer program calculates the consequences of accidents, then the physics on which the predictions are based should be described or reference made to a published article.

Does the safety report describe meteorological conditions, which are appropriate for the site, and in sufficient detail?

A safety report should present wind rose data (wind speed, wind direction and atmospheric stability) for the site in order to establish the frequency and direction of adverse atmospheric conditions. If it presents the consequences of releases under worst conditions identified by wind rose data, an absence of detailed probability data required for a full risk assessment is not a reason for rejecting the report.

Operators should demonstrate awareness of the changes in accident consequences with weather conditions by presenting results for different atmospheric stability and wind speed. They should recognise that the wind direction can vary over 360° and that D5 and F2 do not necessarily encompass the full range of consequences of an accident.

High-pressure releases of LPG tend to form jets in which dilution to below the LFL takes place unless the jet strikes an object. Dispersion calculations for releases of LPG should be based on the assumption that the gas is cold and dense. The rate of dispersion increases with wind speed hence D5 is usually the most appropriate weather condition for daytime accidents involving dispersion. Wind has the effect of reducing the length of a high pressure jet, therefore a 15 m/s wind should be considered for vertical jet fire events, but this should be reduced to 2 m/s wind for horizontal jet fires.

Are the features/systems that may limit the consequences of accidents identified?

Operators should not reduce the severity of the consequences of an accident on the grounds of the presence of a safety system. For example the Operator should not claim that a release will be terminated early by a shutdown system that may fail on demand. Nor should he discount an initiating event on the grounds that a permit-to-work system precludes the necessary conditions.

Ideally, the safety report should quantify the consequences of events with and without safety features operating so that their "value" can be assessed and balanced against their reliability.

Does the safety report contain all the chemical and physical properties needed to assess the risks from the site?

A safety report should present the entire chemical, physical, toxicological and eco-toxicological information that is needed to calculate risk to people and the environment. Toxicity data should also be provided for any toxic substances produced by combustion.

Table 1: Off-site Accident Initiators

Initiator	Method or Model
Aircraft impact.	AEA methodology. [1]
Seismic event.	British Geological survey data.
Lightning strike.	Electricity council data and methodology.
Severe environmental conditions:- abnormal rainfall abnormal snow fall very low temperature high temperature gale force winds	Historical data plus reasoned argument.
Flooding	Site and metoffice data plus reasoned argument.
Subsidence	Historical data plus reasoned argument.
Land slip	Historical data plus reasoned argument.
Fire or Explosion at adjoining plant.	Site environs information plus relevant data where relevant.
Missile from off-site.	Site environs information plus relevant data.
Hazardous substance pipeline rupture.	Site environs information plus relevant data.
Collapse of high voltage cable.	Site environs information plus relevant data.
Impact by out of control road or rail vehicle.	Site environs information plus relevant data.
Other	

The method of measuring the frequency of accidents caused by oof-site events should be fit for purpose. In other words it should be proportionate to the level of risk. Thus, if a site is located far away from any airport or flight path (military or civil), then it is acceptable for the safety report to refer to the background crash rate for the UK. On the other hand, if the site is located close to a busy airport then a much more detailed assessment of aircraft impact should be carried out.

[1] J.P. Byrne, **" The calculation of aircraft crash risk in the UK"**, prepared by AEA Technology plc for the Health and Safety Executive,
1997.

Criterion 3.3

The safety report should identify all potential major accidents and define a representative and sufficient set for the purpose of risk assessment

Assessment against Criterion 3.3

This criterion reminds Assessors that they need to check that:-

- The safety report meets Schedule 4, Part 2, paragraph 4 of the regulations, which requires identification of all possible major accident scenarios.

- If the major accidents are put into groups, the representative accident sequences are suitable and sufficient for risk assessment purposes.

Ideally, the Operator should summarise, in a proportionate way, the results of hazard studies, the methods used and the expertise of the team involved. The scope of the studies and the HAZID process used should also be described. To provide a convincing demonstration that the list of MAs is complete, the process needs to be systematic i.e. each plant and its operational sequences should be considered in turn, including the possibility of interactions. Assessors should judge the completeness and adequacy of the way these issues are dealt with by asking the following questions:-

Is the approach the Operator has adopted to identify all major accidents suitable and fit for purpose?

The report should explain how major accidents have been identified and demonstrate that no important scenarios have been overlooked. When the method of identifying accidents is not systematic or transparent it will be much more difficult to convince the assessor of its completeness. Simple lists of accidents without evidence to show they are comprehensive may be appropriate in some cases, depending on the scale of the risk to off-site populations, but generally Operators will need to demonstrate that no major accident has been overlooked. Assessors should take into account the scale of the hazards when making a decision on this issue (proportionality).

The accidents considered should include those initiated by off site events.

The accident analysis should identify all potential off-site initiators of major accidents and an indication of their likelihood (see Table 3). On-site accident initiators such as over fill of a storage vessel or a pipe break require a more detailed frequency assessment in order to demonstrate the adequacy of installed safeguard systems.

Have all possible sources of major accident hazard been identified?

The majority of LPG sites are unlikely to store other hazard substances, but the accident analysis should not be restricted to the bulk storage vessels. It should include tanker transfers, vaporisers, cylinder filling plant and stacks of cylinders. Leaks, Operator error and fire engulfment should all be addressed.

Are the accidents addressed in the safety report representative of the full spectrum of major hazards presented by the installation?

There is no requirement to repeatedly describe the consequences of accidents that have a similar impact on employees, local populations and the environment. The safety report does not have to describe the consequences of all the major accident hazards, but just to identify them. Instead it may define a representative set of accidents that includes the most severe plant failures and consider all possible consequence (e.g. fireball, jet fire flash fire etc.). In other words, the consequence analysis can be based on a reduced set of accidents that are representative of the hazards from the site.

Does the "representative sample" of major accidents include the risk dominating accidents?

The Assessor must be satisfied that the accidents considered dominate the risk and encompass the complete spectrum of severity. Table 2 identifies plant items that contain, or are connected to, a large inventory of LPG and lists the most obvious potential accidents or failure modes. While it may not be completely exhaustive for all installations, it can be used as a check list to assess the completeness of the accident analysis. If there are any unexplained omissions that would significantly change the predicted risks posed by the site, it should be deemed to fail to comply with the assessment criteria.

Are the descriptions of accidents in the safety report sufficiently comprehensive to allow the adequacy of the methods for preventing major accidents and for limiting their consequences to people and the environment to be assessed?

The safety report should determine the consequences of essentially identical accidents in very similar plant if the consequences are likely to be different. For example, if a pipe failure can release gas at say 20 kg/s and failure of a cylinder filling machine can also give rise to a 20 kg/s release, the safety report should consider both failures because they may have different consequences. The safety report should also consider failures occurring at the "worst locations" which may be on pipelines through a congested area where the possibility of a VCE cannot be ruled out. A safety report that fails to address the "worst case" consequences of representative accidents does not meet the assessment criteria.

Have all the potential consequences of each of the reduced accident set been considered?

Failures of LPG storage systems can give rise to a variety of thermal radiation/explosion hazards that must be addressed in the safety report. For example, the consequences of failure of a large storage tank that should be considered are fireball, jet fire, flash fire, and VCE (if possible). Some of these events are more probable than others, but those contributing little to the total risk should not be ignored.

Has the potential for escalation been properly addressed?

Some accidents at an installation can cause other failures in that they may have as severe or even more severe consequences. The safety report must recognise this possibility and address it by postulating accidents in "worst case" locations. Of particular concern are: -

- Jet flames that impinge on tanks vessels and other plant.
- A VCE that can cause a variety of mechanical failures.
- Pipe whip leading to rupture of nearby pipes or plant.
- Explosions in buildings that can generate blast over pressure and missiles.
- Compressors that can generate missiles.
- Missiles generated by fires in cylinder stacks.

The site description should be detailed enough to enable the Assessor to identify the most hazardous locations for component failures and hence determine if the accidents considered are "worst case".

Criterion 3.3.1

The safety report should demonstrate that a systematic process has been used to identify all foreseeable major accidents.

Assessment against Criterion 3.3.1

In order to judge compliance with this requirement of the regulations, Assessors can ask the following questions: -

Is it obvious that all major accident scenarios have been identified?

Identification of all major accident scenarios is a very important requirement of the regulations and a safety report that fails in this respect should be considered deficient. Systematic approaches to accident identification include HAZOP, event tree analysis and failure modes and effects analysis. However, the regulations do not specifically require their application. An Operator may be able to demonstrate that all major accidents have been identified without resort to formalised methods by providing a detailed description of the plant and by systematically addressing the hazards from each part in turn.

Have all of the hazard phenomena associated with each major release been identified?

A major release of a flammable gas can result in different types of fire depending on the source and time to ignition. A safety report must consider all possible types of fire (fireball, jet fire, flash fire etc.) and the potential for an explosion. If failure of pipe work is identified as a major accident and the report only considers a fireball and jet fire event, the Assessor would be justified in requesting further information on flash fires and explosion potential.

Criterion 3.3.2

The hazard identification methods used should be appropriate for the scale and nature of the hazards.

Assessment against Criterion 3.3.2

Hazard studies employing HAZID techniques are widely used in the chemical industry and can be carried out at various stages during the lifecycle of a plant. They are a systematic way of managing hazard over time, from the business requirement stage through to demolition and disposal. HAZID techniques seek to identify hazards in an absolute or relative way. Relative methods use checklists or hazard indices based on experience and lessons from incidents. Absolute methods are based on deviations from design intent e.g. HAZOP. Details can be founds in Lees (1996), Kletz (1999) and CCPS (1989).

Methods (listed in increasing proportionality) that might be used include:-

- Industry standard or bespoke checklists for hazard identification.
- Safety reviews and studies of the causes of past major accidents and incidents.
- FMEA (Failure Mode and Effect Analysis).
- HAZOP (Hazard and Operability Studies).
- Job safety analysis (e.g. Task Analysis).
- Human error identification methods.

Whatever approach is used, it must be documented as part of the safety report, or separately - in which case the main findings should be summarised in the report. As proportionality increases, and particularly in the case of new novel plant, some use of absolute methods is normally required. Both type of method need to consider 'common cause/mode' failures such as loss of power, or other services.

In order to test compliance with this criterion the Assessor can ask the following questions: -

Does the safety report describe a hazard identification process that instils confidence in its completeness?

The safety report should describe and justify the method used to identify major accident hazards. Assessors who are not convinced that all accident scenarios have been identified should deem the report "non compliant". However, use of a formalised accident identification process is not essential and an approach that is not completely systematic, but is seen as "fit for purpose" is acceptable.

Is the depth and detail of the accident analysis commensurate with the scale of the hazard?

In the main, accidental releases of LPG from high pressure storage systems give rise to fires and possibly explosions, but the hazard ranges associated with them do not always extend off-site. The minimum level of detail in the risk assessment depends on the scale of the risks. In general, the safety report for a site near to a busy shopping centre will need to contain more information than one in an isolated location.

Criterion 3.4

The safety report should contain estimates of the probability (qualitative or quantitative), of each major accident scenario or the conditions under which they occur, including a summary of the initiating events and event sequences (internal and external), which may play a role in triggering each scenario.

Assessment against Criterion 3.4

Criterion 3.4 is about the completeness of the accident analysis and the quantification of probabilities. It focuses on initiators - have all of them been identified and whether the methods used to determine accident sequence probabilities are appropriate.

The depth of the analysis of the event sequences, which determine the likelihood of realising each major accident scenario needs to be proportionate. At the lowest level of proportionality - provided it is demonstrated that a plant is designed, built and operated to current standards - it will usually suffice for qualitative descriptors of likelihood to be assigned to each MA. For example, the CIA's guidance on emergency planning for chlorine installations gives the following frequency categories:-

Extremely	<	10-6/year
Very unlikely		10-6 to 10-5
Unlikely		10-5 to 10-4
Quite unlikely		10-4 to 10-3
Somewhat unlikely		10-3 to 10-2
Fairly probable		10-2 to 10-1
Probable	>	10-1

In order for Assessors to form a judgement on these issues, they should ask the following questions: -

Does the report quantify, albeit with limited accuracy or in qualitative terms, the frequency of each major accident scenario?

Assessors should expect to see all events producing a major accident hazard identified and the frequency of each event sequence determined. There is a requirement to demonstrate that the risk from risk dominating sequences is ALARP. The greater the risk to people off-site, the more reliable must be the quantification.

For single event initiators such as aircraft impact and earthquake, probabilities based on historical data are acceptable. But it is not sufficient for the Operator to use data from published sources for event sequences involving say component failure and Operator error, without justifying their suitability. The safety report should justify the absence of further redundancy and diversity and show that all necessary measures have been taken to minimise Operator error.

Fault tree analysis is not essential to determine accident probability and companies are much more likely to use argument based on the following: -

- Prescriptive legislation.
- Regulatory guidance.
- Standards produced by LPGA and other standard making organisations.
- Industry standard documents.
- Historical data.

It is acceptable for the safety report to refer to world wide failure date on pressure vessels built and operated to equivalent standards, and deduce that the failure frequency of LPG storage vessels on the Operator's site is similar.

However, the evidence in the safety report on construction, maintenance and operation standards would need to be convincing.

Approaches based on well founded argument are acceptable but a safety report that : -

- Discounts some accident sequences.

- Fails to consider worst case locations for breaks.
- Assumes procedures and/or safety systems function perfectly.

should be judged as failing to meet the assessment criteria.

Base event failure rate data are essential components of risk assessments, but they must be relevant and applicable to site circumstances. Simply taking a number from the literature without consideration of whether it applies to the site in question is unlikely to be acceptable. On the other hand, use of a failure rate that is not consistent with historical or relevant generic industry data must be justified. The origin of all probabilities quoted in a safety report should be given so that, where necessary, Assessors can make a judgement on their appropriateness.

Have all the sequences leading up to each major event been identified?

All events/initiators identified in Table 2 should be considered even if some of them are not applicable to the plant in question.

Some events such as aircraft impact, earthquake, dropped load etc. are capable of damaging any item of plant, but a safety report need only consider the event once unless a different hazardous substance can be released, or the severity of the release varies significantly.

The types of fire that may follow a release of LPG are usually obvious and the safety report should calculate the thermal radiation hazard range in each case. The only area of ambiguity concerns VCEs and whether there is sufficient containment or flame accelerating structures to give rise to an explosion. This is a difficult question for the Assessor, particularly as some safety reports may not adopt worst case assumptions. If gas can be released into a confined or congested area, the Assessor should consult the topic specialist about the likelihood and severity of an explosion.

Is the complexity and level of detail of the analysis appropriate to the scale of the hazard?

The frequency of accidents that have severe consequences for local populations need to be determined more precisely than accidents that have only on-site effects and at worst can impact a small number of plant Operators. Thus the frequency of accidents resulting in a large release of gas should be determined more reliably than the frequency of flange leaks on low-pressure pipe work.

Does the accident analysis identify and quantify all event sequences that may result from a single failure?

Accidents that are the result of multiple failures should not be assigned a frequency unless details of the analysis of the mode and probability of each of the failures that comprise the accident sequence are provided. For example, a safety report that simply states that the frequency of over filling an LPG storage vessel is "f" on the basis of historical data should be judged as containing insufficient detail.

Since sites storing LPG for cylinder filling tend to have several pressure vessels, a failure of one of them is likely to affect the others. For example, a jet fire may impinge on a neighbouring vessel and cause it BLEVE. The overpressure and missiles from the explosion are likely damage even more vessels and escalate the accident further. A safety report should consider all possible consequences of an event, particularly those involving escalation, and determine the probability of knock-on effects. However, it is acceptable for the frequency of the initiating event such as rupture of a pipe to be based on historical data.

Where the likelihood of a major accident scenario is not predicted, does the safety report describe the measures to prevent all conditions and events leading to it?

If a safety report does not predict the frequency of one or more major accidents, it must describe the conditions, under which the accidents can occur. It must then show that the installed safeguards ensure that those conditions are very unlikely ever to arise. This demonstration is only possible for certain systems, which have been designed to be intrinsically safe. A system that depends on operators and a mixture of active and passive control systems is always at risk from human and equipment failures.

Sites storing large quantities of LPG in bulk tanks can never be completely intrinsically safe because there are a whole range of events that can cause complete loss of containment. While a major accident would not necessarily follow such an accident, the probability of ignition of the gas cannot be

discounted. However, certain accident sequences may be very improbable on account of the design or location of the plant.

The sort of systems and safeguards where this approach to risk assessment can be adopted include: -

- A vessel unlikely to be pressurised because it is fitted with at least two independent vents to atmosphere.
- A containment system that is too small to generate a major accident.
- A pipe that is unlikely to discharge the contents of a vessel on account of two independent valves that are designed to prevent reverse flow.
- A vessel that is unlikely to be punctured by missiles because it is totally enclosed by a very strong barrier.

Criterion 3.4.1

The report should demonstrate that a systematic process has been used to identify events and event combinations, which could cause MAHs to be realised.

Assessment against Criterion 3.4.1

Here reference should be made to Criterion 3.3 and how it was met by the safety report. Essential for the identification of major accident hazards is a detailed description of the site and all its components, with particular emphasis on those containing or connected to large volumes or high-pressure sources of LPG. The safety report should consider each of these in turn, identifying release scenarios and potential consequences (fireball, jet fire, explosion). It should also provide an estimate of the frequency of each event. It is not necessary for the safety report to quantify the consequences of all of these accidents, but a sufficient and

representative set must be identified. Assessors may find the following questions useful when judging the completeness of the accident scenarios considered.

Has a systematic process been used to identify events that cause the realisation of a major accident?

It is more important for the Assessor to be satisfied with the completeness of the accidents considered than for the report to use a formalised methodology to identify accident scenarios. If the accident analysis deals with each item of plant in turn and identifies all initiators and all types of fire/explosion, then it can be considered systematic. However, if by reference to Table 6, the Assessor can identify scenarios that have been overlooked, the report is deficient. The seriousness of the omission depends on whether the consequences to the public are worse than those from other accidents that are dealt with and whether the risk from the event in question is ALARP.

If, for example, a safety report failed to examine the consequences of a confined explosion in a cylinder filling plant that produces high energy missiles capable of puncturing a storage vessel, then the safety report should be considered as failing to meet the criteria.

Does the safety report consider the effect of failure of automatic or manually operated safety systems in the sequence of events leading to a major accident?

The accident sequence identification and analysis in a safety report should consider the failure of all automatic and manually operated safety systems and evaluate the consequences in each case. For example it should consider sequences consisting of: -

1. A hidden fault (e.g. a failed ROSOV).
2. An initiating event (e.g. pipe rupture).
3. Failure of an operator to respond correctly.

It may use QRA to demonstrate that the probability of such accidents is very low, but their consequences must be determined.

Table 2: Accident initiators requiring consideration in a safety report

Off-site events	Operator error	Abnormal load	Arson or sabotage	Inadequate management	Loss of service
Aircraft impact	system opened	impact by vehicle	fire	corrosion	Loss of electricity.
Seismic event	filled when not closed	impact by missile	explosion	erosion	loss of cooling water.
Subsidence	system overfilled	impact by dropped load	valve opened	vibration failure of process controls.	loss of nitrogen
Extreme environmental conditions abnormal rain fall abnormal snow fall very low temperature high temperature flooding gale force winds lightening strike	containment degraded.	internal temperature or pressure outside design limit.	safety system degraded.	cyclic load inadequate materials or specification.	loss of compressed air
Vehicle/train impact	excess load	external temp/pressure outside design limit.	contamination	inadequate materials or specification.	loss of steam
Land slip	failure to respond correctly to an alarm.	pressurisation.	control system degraded.	chemical attack	
Explosion	incorrect valve action.	under pressure	containment system degraded.	hidden defect in containment system.	
Fire				failure to detect dangerous situation.	
Missile				failure of process controls.	
Pipeline rupture					

Criterion 3.4.2

All safety critical events and associated initiators should be identified.

Assessment against Criterion 3.4.2

Safety critical events are those that dominate the risk at different distances from the plant. For pressurised storage vessels, the event with the greatest hazard range is usually a fireball resulting from immediate ignition of an instantaneous release to atmosphere of the whole contents. The safety critical events for shorter distances are those occurring the most frequently occurring and rise to that particular hazard range. The questions below will help Assessors determine if safety critical events are dealt with appropriately.

Does the safety report define a safety critical event and describe an approach to their identification?

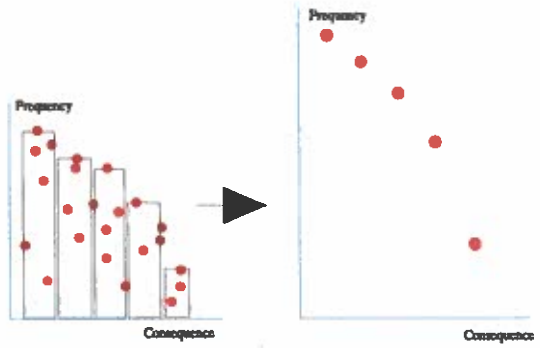
Some safety reports may not make use of the term "safety critical event", but all safety reports will calculate the consequences of a only small fraction of the total accidents a site can suffer. These must be chosen carefully in order to ensure they dominate the risk at increasing distance from the site.

The first step in the identification of these risk-dominating events is the quantification of frequency and approximate consequences of all major accidents. These can be grouped into consequence bands as

indicated below. The accident at the top of each band is the safety critical event for consequences of that particular level of severity. The non-QRA approach would group accident according to likelihood and consequences.

The frequency of all accidents in a band can be added together to provide an estimate of the overall frequency of a particular level of consequences. The safety report should then identify a set of representative accidents and frequencies for more detailed consequence analysis.

A safety report that fails to analyse accidents in this way is not complying with the assessment criteria. However, approaches that are not based on quantification, but never the less rank accidents appropriately, should not be rejected out of hand.



representative accident set for detailed consequence analysis

Does the safety report list the safety critical events that have been identified?

The safety report should list the safety critical events for each group of accidents that have similar consequences. In general these will form the reduced set that are analysed in depth in the report as indicated above where 5 safety critical accidents are used to represent the risk from the site.

Criterion 3.4.3

Estimates of, or assumptions made about, the reliability of protective systems and the time for operators to respond and isolate loss-of-containment accidents etc. need to be realistic and adequately justified.

Assessment against Criterion 3.4.3

Operators should not base their accident analysis on the assumption that all protective systems will perform perfectly and Operators are 100% reliable. For example a excess flow valve may fail to reduce the flow from a ruptured hose during a vessel filling operation. Similarly if a pipe is fitted with a manually operated shut-off valve, the safety report must consider what would happen if it was not closed in the event of a failure down stream. The following questions are designed to provide guidance on this criterion:-

Are appropriate failure probabilities used in the accident analysis?

Operators should not use failure probabilities taken from standard references in their accident analysis without showing that they are applicable to the plant and conditions in question. The Assessor should be particularly concerned about the data used in the determination of the frequency of safety critical accidents. For example, if the hoses failure is double f, an Operator can only claim a similar failure rate if hoses on his site are inspected and maintained to the same standard as the population to which the failure data applies.

If the Operator determines accident likelihood on the basis of historical data or some other method that does not involve a calculation of accident frequency, the Assessor should be convinced that the probabilities are applicable to the plant in question. This implies that good evidence should be presented to show that the plant is designed, operated and maintained to appropriate standards and that the operators controlling it are adequately trained.

Does the accident analysis make use of optimistically short response times for control/safety equipment?

A safety report that does not examine the consequences of prolonged releases (20 minutes or more), on the basis that a valve will be closed and the release terminated within a shorter period should be deemed to contain an optimistic accident consequence analysis.

Are the assumptions made about operator response reasonable?

The safety report may claim that control room Operators will notice an illuminated alarm indicator immediately or will respond to an emergency perfectly and close valves in a matter of seconds. Such assumptions may be optimistic, but their presence does not necessarily signify that the safety report is deficient if the consequences of much longer response times are determined.

Does the Operator claim that some potentially serious failures will not result in a major accident because a single safety/control system will recover the situation?

Since all safety/control systems can fail, Operators should take the view that LPG can escape from its containment system and that releases of 100% of the inventory of storage vessels must be considered in a safety report irrespective of the complexity of the safeguards.

Criterion 3.4.4

The methods used to generate event sequences and estimates of the probabilities of potential major accidents should be appropriate and have been used correctly.

Assessment against Criterion 3.4.4

The conventional methods of determining the frequencies of accidents involving multiple failures are fault tree and event tree analysis or a combination of the two. They are labour intensive and require reliable failure probabilities and experience in their application. Many safety reports adopt a much simpler approach. For example, accident sequences may be broken down into three components - an initiating event, a control system failure and an Operator failure.

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Does the frequency analysis recognise that failures of complex systems and Operators have many components?

If a dangerous situation can occur following a series of Operator and control equipment failures, the Operator will need to identify each of these in order to satisfy the Assessor that his calculated event probability is reasonable. If a break down of the individual events and probabilities is not provided, the Assessor is justified in requesting further information from the Operator.

Does the safety report consider the full range of conditions for each accident?

Accident consequences should not be reduced on the grounds that the probability of the wind blowing in a particular direction is low if very similar consequences arise when the wind is blowing in any

direction. Nor should risk be based on the probability of a failure in a particular location when failures over a whole range of other locations may have similar consequences. The Assessor must decide the weight attached to such omissions.

Does the analysis take into account uncertainties in the estimation process?

The fact that most failures probabilities are not single valued, but distributed about a mean should be accounted for in risk analysis. If there is no information on the probability distribution of the probability, it must be concluded that the upper figure is just as likely as the lower figure.

Does the safety report show that site specific factors have been taken into account in the methods used to generate event sequences and estimates of the probabilities of potential major accidents?

Assessors should be careful not to accept accident analysis from an Operator's "core safety report" if the safety report in question does not take account of site specific information on accident initiators and initiator probability. For example, a core safety report may give a frequency for aircraft impact based on a background crash rate for the whole of the UK. This would not be applicable to a site located close to a busy airport. Likewise the presence of a railway line running along a site boundary increases the probability of an accident caused by a derailment.

In general, off-site accident initiators tend to be site specific, but differences in site management, operation and competence (training) of the staff can also significantly affect accident frequency.

Criterion 3.4.5

The safety report should provide adequate justification for event possibilities that are not consistent with historical or relevant generic industry data.

Assessment against Criterion 3.4.5

Many risk assessments in safety reports make use of industry standard probabilities for events such as pipe rupture, cold catastrophic failure of vessels, Operator response time etc. The Assessor should compare these data against those given in the table below and request the Operator to explain the reasons for any significant difference.

Table 3: Typical Failure frequencies

Event	Probability/frequency
Rupture of pipe on a pressurised storage system.	$1x10^{-6}$/yr
Lightning strike.	$1x10^{-7}$/yr
Severe earthquake capable of rupturing pipe work.	$1x10^{-6}$ - $1x10^{-7}$/yr
Sudden catastrophic failure of vessels.	$3x10^{-6}$/yr [1]
Failure of a ROSOV on demand.	$3x10^{-2}$
Failure of an excess flow control valve on demand.	$1.3x10^{-2}$
Failure of an automatic shutoff valve to close.	$1x10^{-2}$/demand
Failure of a level sensor (sticking).	50 per 10^6 hrs [1]
Failure of a flow sensor.	40 per 10^6 hrs

Generic or industry standard failure probabilities for valves, pumps etc are based on appropriate operation under an industry standard maintenance regime, which may be different from that prevailing at a site. Use of such data in risk calculations in a safety report should therefore be justified. Assessment of the justification can be via the following questions: -

Are the failure data derived from long experience of operation in the same industry and under the same conditions?

Failure rate data from the Operator's own and long established data base can usually be accepted, but if data are based on experience in another industry (e.g. nuclear), the Operator must justify their use in accident analysis by reference to operating conditions, maintenance regimes etc. If this justification is not present, the Assessor may reach the conclusion that the risk assessment is optimistic.

Is the probability of failure of a particular item of plant based on generic data for an identical component or one that closely resembles it in design, manufacture and operation?

The mean failure frequency of plant components should be increased when they are used under conditions that are different from their design operating conditions. Similarly the mean failure rate of a component should be increased if it is assumed to apply to another similar but not identical component. The increase depends on whether the new conditions make more or less demands on failure to recognise such reliability changes can result in an optimistic risk assessment, particularly if the data is used to quantify the frequency of a safety critical sequence.

Table 4: Check list of accident initiators

Accident	Comment
OFF-SITE INITIATORS	
Aircraft impact.	
Seismic event.	
Subsidence.	
Extreme environmental conditions:- abnormal rain fall abnormal snow fall very low temperature high temperature flooding gale force winds lightening strike	
Vehicle impact.	
Land slip.	
Explosion.	
Fire.	
Missile.	
Pipeline rupture.	
OPERATOR ERROR	
system opened.	
filled when not closed.	
system overfilled.	
containment degraded.	
excess load.	
failure to respond correctly to an alarm.	
incorrect valve action.	

ABNORMAL LOAD	
impact by vehicle.	
impact by missile.	
impact by dropped load.	
temperature or pressure outside design limit.	
external temp/pressure outside design limit.	
pressurisation.	
under pressure.	
ARSON/SABOTAGE	
fire.	
explosion.	
valve opened.	
safety system degraded.	
contamination.	
control system degraded.	
containment system degraded.	
MANAGEMENT FAILURE	
corrosion.	
cyclic load.	
inadequate materials or specification.	
chemical attack.	
hidden defect in containment system.	
failure to detect dangerous situation.	
failure of process controls.	
build up of static electricity.	
LOSS OF SERVICE	
Loss of electricity.	
loss of cooling water.	
loss of nitrogen.	
loss of compressed air.	
loss of steam.	

Criterion 3.5

The safety report should provide details to demonstrate that suitable and sufficient consequence assessment for each major accident scenario has been carried out with respect to people and the environment.

Assessment against Criterion 3.5

The principal hazards from LPG storage systems are fires and explosions, resulting from leaks in vessels, pipes and ancillary equipment such as cylinder filling machines. The number of loss of containment-consequence combinations is large but not every one of them needs to be addressed in the safety report. Assessors can test compliance with Criterion 3.5 by asking the following questions:-

Is the Operator's accident consequence assessment thorough and adequately documented?

A safety report should discuss external events and site incidents that range in severity from catastrophic failure of a storage vessel to a small leak. and should identify the measures and precautions taken to reduce their probability.

The accident consequence analysis should be a systematic process comprising the following steps:-

Table 5: Systematic process for criterion 3.5

List the assumptions that will be made about containment failures (size, location).
Describe the essential features of the model that will be used to calculate the rate of outflow of LPG and the duration of the release.
List the assumptions used in the assessment.
Present the results of the assessment to characterise the LPG release.
Identify the model that will be used to determine the characteristics of the thermal radiation source for scenarios involving immediate ignition (fireball and jet fire and pool fire).
List the assumptions used to calculate the radiant flux from the burning gas (emissive power, wind speed etc.).
List the assumptions about the dose received by individuals indoors and outdoors.
Present the results of individual dose calculations.
List the assumptions for LPG gas dispersion (flash fire calculation).
List the assumptions used in the dispersion analysis (stability, wind speed ground roughness).
Describe the essential features of the model used to calculate the dispersion of released LPG.
Present the results of calculations of the dimensions of a flash fire.
Describe the effect of accidents on local populations and the environment.
Justify why a VCE will not occur.

All of the above steps should be clearly documented in the report. However, omission of one or more of them is not a significant failing if overall the consequence analysis is satisfactory.

Has the Operator selected a set of accident scenarios for the safety report that encompass the hazards and risks from the site and that are sufficient to demonstrate that all necessary measures have been taken to minimise risk?

The number of accidents that a site can suffer depends on the number and type of vessels, whether cylinder filling takes place and other site specific features, but all safety reports should determine the consequences of the following minimum set of accidents: -

- Catastrophic failure - 100% of contents released -fireball and flash fire or pool fire.
- Localised failure of a pressure vessel above liquid level - jet flame and flash fire and possible explosion.

- Localised failure of a pressure vessel below liquid level - jet flame and flash fire and possible explosion. Pool fire or flash fire/explosion for a refrigerated vessel failure.
- Pipe failures (rupture, hole diameter equal to pipe radius, flange leak).
- BLEVE of vessels including storage vessel, road tanker, cylinders in a stack.
- Overfilling - ignited pressure relief valve discharge, or spill of liquid if refrigerated.
- Vaporiser leak jet fire, flash fire, explosion.
- Leak inside cylinder filling plant - confined explosion.

Has the full range of consequences been addressed?

The safety report should not discount any scenario unless it can provide good reasons for doing so. If an unconfined explosion of LPG is discounted in a safety report it must be on the grounds of experiment and historical data, that are summarised appropriately.

High pressure pipe work failures should include the formation of a vertical and horizontal jet and the potential for jet flame impingement. In addition leaks into an enclosed space that may result in a confined explosion should not be forgotten.

The number of fatalities and individuals with severe burns from fires and explosions should be determined. The effect of blast should also be quantified in terms of the number of buildings in each of several damage categories and the envelope of a flash fire should be superimposed on a map so that the effect of wind direction on the number of casualties can be assessed. The accident analysis should address the effect of other variables such as time of year, time of day, and day of the week if they have a significant effect on the off-site consequences. A limited analysis that neglects variability in accident consequences does not meet the assessment criteria.

Does the safety report outline the principal features of the mathematical models used in the consequence analysis?

A safety report should include a brief description of the essential features and assumptions of the mathematical models used by the Operator to determine the consequences of major accidents. If the models are part of a well-known software package, then only the name of the software is required, but full details of the input should be provided. In-house models and any validation studies that have been carried out to support them should be described in detail. The main equations of a model should be given in an appendix if they have not been published elsewhere.

The fact that an Operator has used a well-validated model to determine the consequences of an accident does not guarantee that the results are reliable. Assessors should recognise that the predictions of consequence analysis are more important than the means by which they were obtained. Assessors may feel that a safety report that fails to provide input data details for predictions, which appear optimistic, fails to meet the criteria.

Does the severity of the predicted consequences influence the amount of information the Operator should supply on how they were determined?

The level of detail that should be provided on the calculation of the consequences of an accident that do not extend off-site is less than if the hazard range encompassed a large number of people. It is not possible to be prescriptive on this issue and Assessors are expected to use professional judgement when deciding if the Operator has provided sufficient information on his consequence analysis. However, the following examples may help Assessors make a judgement on this issue

If the footprint of a flash fire defined by LFL or a dangerous dose of toxic vapour contour, does not encompass any off-site populations, then the flash fire hazardous area can be equated to this area and the flash fire risk dismissed in one or two sentences. On the other hand, if the LFL footprint encompassed a densely populated area, the Operator should provide a more detailed analysis with a discussion of the most appropriate concentration for risk assessment based on ignition probability. If

the LFL contour fell a few metres short of a densely populated area, then again the Operator should consider the probability of a flash fire extending beyond the LFL boundary.

If the level of thermal radiation at the site boundary from a jetfire as predicted by a simple 4 point radiator model is not hazardous, the safety report does not need to describe the modelling in great detail. However, if a horizontal jetfire is predicted to extend into a densely populated area, the safety report would need to consider the effect of the ground variation in flux.

Criterion 3.5.1

Source terms used should be appropriate and need to have been used correctly for each relevant major accident.

Assessment against Criterion 3.5.1

The source term for an accident sequence expresses "how much", "for how long" and in "what form". For example a high pressure releases from a pipe or vessel is characterised by the release rate, the duration of the release and its form (e.g. liquid or gas and whether as a vertical jet, horizontal jet or obstructed jet). Assessors can use the following questions to test the adequacy of the description of accidents given in a safety report: -

Do the source terms for each accident encompass an adequate range of release rate and include the "worst-case"?

Since release rate is effectively determined by hole size, the accident consequences described in a safety report should encompass a range of hole size and include the largest possible failure. This means guillotine rupture of a pipe and catastrophic failure leading to an instantaneous release of the whole contents of a vessel.

The "worst event" should be assumed to occur under "worst conditions", which are when storage vessels are almost full, when a leak of refrigerated LPG clears the bund wall around the storage vessel, or when a stack of cylinders is at maximum capacity.

Are pessimistic assumptions used to quantify source terms?

The flow rate of LPG through a hole or from a pipe depends on the assumptions made about the discharge coefficient, the pipe roughness, the friction factor etc. The values assigned to these parameters should ensure that the calculated consequences of accidents are not optimistically small. For example, use of a discharge coefficient less than 0.9 for a high pressure release should be justified.

Does the safety report show that site specific factors have been taken into account in the use of source term models?

The source terms for accidents should account for site-specific features. These relate to: -

- The frequency of releases.
- The magnitude of releases.
- The duration of release.

and could include parameters such as: -

- The size and type of storage vessels.
- The maximum stack size of LPG cylinders.
- The number and capacity of road tanker deliveries per year.
- Whether the site is manned 24 hours/day.

- Tank padding pressure and the maximum valve this could rise to in the event of a failure. The maintenance schedule for key safety features such as ROSOVs.

Criterion 3.5.2

The material transport models used should be appropriate and need to have been used correctly for each relevant MAH.

Assessment against Criterion 3.5.2

The transport models used to determine the consequences of accidents at LPG storage sites need to be capable of dealing with jet and dense gas dispersion. The size of a jet fire is often based on the physics of gas jets and mixing coefficients, but correlation's for flame length derived from experiment may be more reliable. This is particularly the case for grounded jets, which because of reduced air entrainment, tend to have a longer flame length than a free jet.

Nearly all models to characterise LPG dispersion are complex and make use of several assumptions and input parameters. Therefore, it is often difficult for an Assessor to reach conclusions about the adequacy of the consequence analysis. Answers to the following questions may provide the basis for an assessment: -

Are the predicted jet fire dimensions in accordance with those calculated by HSE models?

The agreement between hazard range predicted by HSE models and those in a safety report should be within +-50%. Greater differences are acceptable if the consequences do not include fatalities, but when they do, and the reason for a significance discrepancy is not obvious or is due to an inappropriate assumption, Assessors may judge safety report to be deficient.

Is the orientation of jet fires chosen to maximise their consequences?

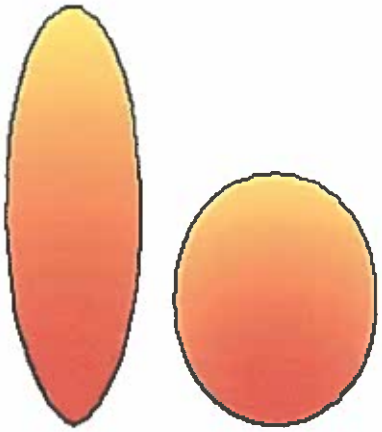
The thermal radiation flux to an object from a jet fire usually reaches a peak when the jet fire is pointing directly towards it. A consequence analysis is therefore optimistic if it only considers the thermal radiation from vertical jet fires.

What sort of dispersion model is used to calculate the dimensions of a flammable cloud of LPG?

Since the molecular weight of LPG is greater than that of air, a dense gas dispersion model is required to determine hazard ranges for ambient and below low temperature releases. Such predictions by passive dispersion models may be optimistic or pessimistic as the diagram below indicates. A safety report that uses a passive dispersion model will over estimate the down wind extent of a flash fire but under estimate its width. Assessors should expect to see a sound justification for the use of a passive dispersion model and a discussion of the inability of the model to correctly predict the width of the flammable cloud.

Does the dispersion model take account of obstacles such as buildings and changes in topography?

LPG released accidentally at ground level has to disperse around site buildings, and in doing so it becomes more dilute. This implies that when gas has to move around buildings the concentration at a particular distance from the release point is lower than that predicted by dispersion over a smooth flat terrain. On the other hand the concentration will be higher if the gas is constrained from dispersing sideways by buildings on either side of a street. Both of these aspects should be addressed in a safety report.



LFL predicted by passive gas dispersion program

LFL predicted by dense gas dispersion program

The safety report should present the consequences of accidents under a variety of weather conditions and for different inventories. In general, high wind speeds produce rapid dispersion and shorter hazard ranges. D5 weather conditions occur frequently in the UK and should be used to calculate the hazard range for daytime releases. Under stable atmospheric conditions dispersion is reduced, hence F2 weather, which characterises night time conditions, generally produces the greatest hazard range. Increases in wind under any stability speed tend to decrease the predicted hazard range unless building wake effects are modelled.

What wind speeds are considered for dispersion calculations?

In general, the higher the wind speeds the more rapid is the dispersion and shorter is the hazard range. D5 weather conditions occur frequently in the UK and should be used to calculate the hazard range for daytime releases. Dispersion is reduced under stable atmospheric conditions, hence F2 weather, which characterises night time conditions, generally produces the greatest hazard range. Under any stability, increases in wind speed tend to decrease the predicted hazard range unless building wake effects are modelled. A safety report should calculate the consequences of accidents under a range of weather conditions including those that maximise the hazard range.

What ground roughness values are used for the dispersion calculation?

The rougher the ground over which a flammable gas is dispersing the more rapid is the rate of air entrainment and the shorter is the flammable hazard range. A ground roughness value of 0.1 corresponding to elements on the ground about 0.5-1 metre high is recommended for dispersion over agricultural land. A roughness value of 0.3 should be used for dispersion over a suburban area. Although higher roughness values may be assigned to some industrial sites, their use results in a reduced hazard range that could, under certain circumstances, be optimistic. An Operator should make a special case for use of a ground roughness value of more than 0.3.

What averaging time is used for dispersion calculations?

Due to the variability of atmospheric conditions a dispersing gas plume meanders and the concentration at a fixed point down wind of a release fluctuates. Most dispersion models account for this phenomena by introducing an averaging period. The longer this is, the more allowance is made for the variations in wind direction and the smaller is the predicted concentration.

There is not a consensus on the most appropriate averaging period for dispersion calculations, but widespread support exists for use of 600 seconds and 10 seconds for continuous and instantaneous releases. In some passive dispersion models the standard deviations are linked to specific averaging times.

Since criteria 3.5.2 is concerned with the appropriateness of transport modelling assumptions, and averaging time can have a significant affect on the predicted hazard range, it is essential that the

Operators state the values used in the dispersion analysis. This requirement is not restricted to averaging time because Operators are obliged under criterion 3.5 to provide details of all important modelling assumptions and input.

Criterion 3.5.3

Other consequence models (e.g. BLEVE, warehouse fire etc), used should be appropriate and need to have been used correctly for each relevant major accident.

Assessment against Criterion 3.5.3

Aside from transport models, the consequence analysis for an LPG storage site needs to include models for thermal radiation from different types of fire and for the over pressure produced by explosions. It is important that these models do not under estimate the hazard range, but it is difficult for an Assessor to make judgements about the level of pessimism in a calculation if full details of the model are not supplied. The following questions may help Assessors judge if the consequence analysis is based on appropriate assumptions: -

What wind speeds are considered for jetfires?

Wind has the effect of shortening and tilting vertical vapour jet fires. Thus the higher the wind speed the greater is the thermal radiation flux falling on down wind targets, and to a lesser extent cross wind, targets, but the smaller is the flux falling on upwind targets. A safety report should determine the consequences of a "vertical" jet fire in a 15 m/s wind otherwise its accident analysis may be deemed optimistic.

A high wind speed tends to shorten the flame length of a horizontal jet fire and may, depending of the relative orientation of the flame and target, reduce the hazard range. A safety report should therefore consider the consequences of horizontal jet fires in a range of wind speeds including 2m/s.

What is the assumed elevation of fireballs resulting from LPG storage vessels?

Fireball events dominate the risk from pressure vessels storing LPG, but the ground level fluxes depend on the modelling assumptions and in particular on the assumed height of the fireball. Increasing its elevation reduces the dose to individuals hence the height of the lower edge is an important parameter. It is reasonable to assume that accidents involving an instantaneous release of the whole contents of a vessel produce a fireball that just touches the ground. Assessors may conclude that hazards based upon greatly elevated fireballs are optimistic.

What atmospheric humidity is assumed for thermal radiation calculations?

The thermal radiation emitted by a fire is attenuated by water vapour in the atmosphere, therefore the flux at a target is inversely proportional to the humidity. In the UK humidity varies considerably, but an average value of 60% is often assumed for hazard calculations. This figure is probably overly pessimistic for F2 weather conditions, but an Operator should justify the use of significantly higher values that could result in optimistic predictions.

What surface emissive power is assumed for LPG fires?

There is general agreement that the surface emissive power of an LPG fireball containing less than 200 tonnes is 270 kW/m^2. The value for a jet fire is around 200 kW/m^2, although models often make use of a correlation derived by Chamberlain to calculate the fraction of the total heat of combustion that is radiated. Typically this is about 0.2. Any thermal radiation calculations that use significant lower emissive powers than these are likely to be optimistic - see Table 6.

What stored energy figure is used in explosion calculations?

There are several methods of calculating blast over pressure from flammable gas explosions, but assessors should be aware that the TNT model is considered over simplistic because natural gas explosions have different characteristics to TNT explosions. The multi-energy method based on lines 2 and 7 is preferred, but if a safety report calculates over pressure on the basis of an equivalent mass of TNT, it is reasonable to set the mass of TNT to twice the mass of gas in the confined or congested volume. Major deviations from this require a good explanation.

Table 4 summarises the above and should enable Assessors to deduce if the input data to consequence models has been chosen appropriately.

Does the safety report show that site specific factors have been taken into account in the use of other models?

The models used to calculate the consequences of BLEVEs, jetfires and explosions should account for site specific factors such as: -

- Pressure relief set point and capacity of pressure relief valves on bulk storage vessels.
- Maximum design operating pressure of bulk storage vessels.
- The presence of import and export pipelines.
- Congested areas.
- Neighbours that could be affected by thermal radiation or overpressure.

Table 6: Effect of input parameters on predicted accident consequences

Parameter	Accident type/phenomena	Acceptable value	Direction to reduce severity of consequences
Wind speed	Passive dispersion	2m/s F stability 5m/s D stability	+ +
	Vertical jet	15m/s towards the target and 5m/s	- +
	Horizontal jet	0-5m/s with and against the jet	
Ground roughness	Dense gas and jet dispersion	0.3m (suburban environment)	+
Averaging period	Dispersion of gas cloud	600s plume 10s puff	+ +
Elevation of fireball	Pressure vessel rupture	touching the ground	+
Humidity	Fireball and jet fire	50% or less	+
Surface emissive power	Fireball Jet fire Pool fire	270kW/m^2 200 kW/m^2 or 0.3 of heat of combustion 200kW/m^2 over half of the flame height	- - -
Stored energy in LPG cloud	VCE	3.5x10 J/m^3	-
Substrate	Vaporising pool	substrate heat capacity (on concrete or tarmac)	+

Criterion 3.5.4

The harm criteria or vulnerability models used to assess the impact of each MAH on people and the environment should be appropriate and have been used correctly for each relevant major accident.

Assessment against Criterion 3.5.4

A safety report should calculate thermal radiation and explosion over pressure hazard ranges and casualties for several severity levels, which for thermal radiation, may include: -

- dangerous dose of thermal radiation for vulnerable people (500 tdu).
- dangerous dose of thermal radiation for average members of society (1000 tdu).
- significant likelihood of death (1800 tdu).
- death from exposure to thermal radiation (3000 tdu).

For over pressure the appropriate hazard ranges correspond to: -

- window breakage (40 mbar).
- houses uninhabitable but repairable (100 mbar).
- severely damaged houses (200 mbar).
- houses completely demolished (500 mbar).

For secondary fires: -

- Spontaneous ignition (25.6 kW/m^2).
- Piloted ignition (14.7 kW/m^2).

It is very important that the full spectrum of casualties is calculated, not only for risk evaluation, but also for emergency planning purposes.

The following questions may assist the Assessor to judge the adequacy of the accident consequence analysis:-

What hazard ranges for thermal radiation has been calculated?

Although HSE has published its thermal radiation criteria, some safety reports calculate hazard ranges to different dose and flux levels. One of these is 300tdu, which is the dose to cause blistering of the skin. It extends beyond the 500tdu range and may be regarded as pessimistic, but any dose implies an exposure duration and Assessors need to understand the assumptions being made before making judgements about acceptability. In particular significant departures from the following assumptions that lead to shorter hazard ranges should be justified:-

- The exposure period for fireballs is the fireball duration (no escape).
- Average members of the public escape from long duration fires at 2.5 m/s.
- The escape speed for the old and very young is closer to 1 m/s.
- The distance to shelter in suburban areas is typically 50 metres.
- The distance in rural areas is more likely to be at least 75 metres.

Individuals escaping from a source of thermal radiation reduce the dose they receive on two counts. Firstly they increase the distance between them and the fire and secondly they can reduce the exposure period by going indoors.

HSE has two criteria for thermal radiation flux to buildings based on the ignition of American Whitewood (see Consequence Assessment in part 2), and while these are useful for assessing risk to occupants of houses, they provide little information on hazard range for LPG fires. In this context the actions of the local fire service are important because they may be able to keep adjacent items of plant cool with water sprays. However, a safety report should assume that plant in the vicinity of a major fire do not receive water spray protection for 20 minutes. Predictions based on a much shorter response time for the fire brigade are likely to be optimistic. Operators must consider the consequences of late arrival of fire fighting services, but it is permissible for them to make judgements about the probability of such an occurrence.

What hazard ranges for blast over pressure is calculated?

The effects of blast over pressure on buildings and on people cannot be predicted precisely, but HSE has published tables of the consequences of a range of side-on over pressure. Different over pressures can be used in consequence calculations provided they convey a realistic picture of the scale and extent of the damage from an explosion. To this end, the following data are useful: -

- 2.5 mbar or 250 Pa - limit of window damage.
- 50mbar or 5000 Pa - limit of damage to doors, cladding and people.
- 150 mbar or 15000 Pa - limit of severe structural damage to buildings.
- 250 mbar or 25000 Pa - limit of significant likelihood of severe injury.

A safety report that presents hazard ranges corresponding to higher over pressures than those above is not providing the full picture of the potential damage caused by explosions following accidental releases of LPG.

Criterion 3.5.5

Are the assumptions in the accident analysis justified and not unduly optimistic.

Assessment against Criterion 3.5.5

The assumptions being referred to here are those made about the response/effectiveness of accident consequence mitigation systems and include such things as the time to detect a large release of gas and the probability that a ROSOV will close on demand. The safety report should determine the consequences of worst accident scenarios on the assumption that all control and mitigation systems fail on demand and operational conditions correspond to worst case. Such a scenario should have a very low probability. The analysis should also consider the effect of various combinations of partial success of the control and mitigation systems in order to determine the risk dominating accidents.

A safety report that minimises accident consequences on the assumption that installed mitigation systems work perfectly is underestimating risk. Assessors can judge this aspect of safety reports by reference to the following questions:-

Are the accident source terms "worst case"?

An LPG storage site safety report should consider an instantaneous release of the whole contents of storage vessels and various other scenarios that result in a continuous release of several 10s of kg/s and give rise to a variety of fires. In addition, it should address failure of associate plant such as the vaporiser and cylinder filling machine giving rise to a variety of hazards including a confined explosion.

Does the accident analysis examine the effect of different conditions and assumptions on the predicted consequences?

The consequences of many severe accidents depend on the environmental conditions, the state of the plant at the moment of failure and the location and type of failure. Since there are many combinations

with roughly equal probability, the safety report must determine the consequences of each accident under a range of conditions that encompass the full severity range.

Both day time and night time conditions should be considered for accidents affected by stability (i.e. those involving dispersion), but because wind speed shortens the hazard range, only D5 and F2 conditions need to be considered. A wide range of wind speeds should be considered for jet fire events.

Accidents can occur any time although their probability is not usually constant. It is important that a safety report describes the consequences of the worst conceivable accidents at a site that occur when a vessel is full. If the accident analysis in a safety report is based on average inventories, it should be judged as incorporating too much optimism.

Failures on plant can occur almost anywhere, but with variable probability. The safety report should consider failures in the "worst" locations, which include jet flames pointing towards vulnerable plant and populated areas, knock-on effects when pressure vessels are in close proximity and explosions in the cylinder filling plant. A safety report that does not calculate the consequences of worst case accidents fails to comply with the assessment criteria.

Does the safety report fully describe the models used to predict accident consequences?

A safety report should describe the mathematical models used to predict the consequences of accidents. If the Operator or his consultant used well known software to calculate the consequences of accidents, information on the input data files should be provided so that Assessors can check its appropriateness and degree of conservatism both of which provide an insight into the Operators approach to accident consequence analysis. If doubts remain, entering the Operator's input data into an HSE model can check the predictions in the safety report.

A difference in opinion about the severity of accident consequences may occur from time to time. It does not imply a major failing of the safety report but one, which the Assessor should try to resolve by communication with the topic specialist and, if necessary, with the Operator.

Criterion 3.5.6

Estimates of the severity and extent of each major accident consequence are realistic.

Assessment against Criterion 3.5.6

Safety reports should determine the consequences of the worst accidents, but the analysis should not be overly conservative. If unrealistic hazard ranges are predicted, the off site emergency plan devised by the Local Authority may be ill conceived and under some circumstances, lives could be put at risk by spreading emergency services too thinly. The Assessor can gauge the degree of conservatism in the calculations by asking the following questions:-

Are the input data for mathematical models reasonable?

Under Criterion 3.5.3 reasonable values for some of the more important input data for accident consequence modelling are shown in Table 2. Assessors should compare these values with those used by the Operator and make judgements about the realism of the consequence predictions.

Criterion 3.6

The findings and conclusions from the predictive risk analysis should summarise the relationship between hazards and risks and demonstrate that the measures adopted to prevent and mitigate major accidents make the risks ALARP.

Assessment against Criterion 3.6

Most safety reports will not present particularly reliable accident probabilities and in many cases the degree of uncertainty attached to consequence predictions will be unknown. This is relatively unimportant if the scenario is not risk dominant, but when it is, or could be, uncertainties should be offset by extra conservatism. Risk calculations based on optimistic assumptions and highly uncertain

data should be treated with great caution, but Assessors should bear in mind the following typical levels of uncertainty: -

Table 7: Typical Uncertainties in Consequence Modelling

Hazard	Typical parameter value	Approximate level of uncertainties
Fireball:		
Mass	100% of release	0-50%
Size	$R=29M^{1/3}$	0-5%
Surface emissive power	$270kW/m^2$	$200-300kW/m^2$
	R	2R-R
Height of centre	$t=4.5M^{1/3}$	0-5%
Duration	Sphere touching ground	+- 25%
View factor		+-50%
Hazard range		
Jet fire:		
Mass release rate	Supersonic jet	+- 30%
Flame length	calculation	+- 50%
Flame shape	Chamberlain approach	+- 50%
Fraction of heat radiated	Chamberlain model	0.1-0.3
	0.2	+-50%
Point radiators	Location and strength	+-50%
Wind effect	Shortening of jet	+-50%
Hazard range		
Flash fire:		
Mass	100% of release	0-50%
Buoyancy	Neglect	0-no hazard due to lift-off of gas
Dispersion	Passive model	+-50% on length and width
Hazard range		+-50%
VCE:		
Volume of congested area	Actual volume	+-30%
	$3.5x10^6J/m^3$	+-20%
Stored energy	7 and 2	9-5 - 3-1
MEM line number	MEM predictions	+-60%
Blast over pressure		+-75%
Hazard range (to x mbar)		
Pool fire:		
Diameter	10m	
Burning rate	0.12 kg/m2s	+-100%
Effective emissive power	250	+-50%
	Windspeed	+-60%
Tilt in wind		+-50%
Blowsing		
Vaporising pool:		
Pool diameter	10m	+-100%
Pool depth	0.1m	+-50%
Substrate		
Ground temperature	288K	+-10%

Irrespective of the mix of argument, semi-quantitative evidence and quantitative analysis used to determine risk, an Assessor should have confidence in the results and concur with the conclusions presented in the safety report.

While the probabilities of worst case scenarios that are not risk dominating do not need to be quantified precisely, the calculation of their consequences should be reasonably reliable so that the emergency services can plan an appropriate response. In this context overly pessimistic predictions are almost as bad as grossly optimistic predictions. The information that emergency planners may require for each accident scenario and for twelve different wind directions is: -

- Probable number of casualties with mild burns or superficial injuries.
- Probable number of people requiring hospitalisation.
- Possible number of deaths.
- The need to evacuate the area around the site.

- Amount of property destruction.

Assessors are required to judge if the risk quantification, risk reduction measures and residual risk meet all the assessment criteria. In effect, they need to take a view on the reliability/accuracy of the predicted hazard ranges and risks and hence upon the acceptability of the predictive analysis. The following set of questions may aid this process:-

Does the safety report combine the magnitude of the various consequences assessed with event frequencies, or the likelihood of initiating conditions, to estimate the risk to the most exposed person or groups of persons, on-site and off-site?

There are several ways, in which the results of a risk assessment can be presented including: -

- Contour plots of individual risk of death based on certain assumptions about the individual (i.e. he is out of doors and he remains out of doors for 30 minutes).
- Risk of death of the individual who is most at risk by being in a certain location for long periods.
- Dose versus distance for accidents with different probability.
- An F/N plot where N is casualties or individuals receiving a dangerous dose.
- A cumulative frequency/N plot.

In order to judge the acceptability of a safety report that presents the results of a QRA, the Assessor may have to make reference to HSE guidance on the tolerability of risk. Since this is expressed in terms of individual risk of death, risk of death is the most useful end point for a risk calculation. However, this does not imply that other representations of risk are unacceptable, merely that they are more difficult to interpret.
A safety report that presents only a table of hazard range and relative likelihood does not comply with the assessment criteria.

Does the safety report show that these risks are negligible or, where not negligible, are ALARP?

The Assessor should check that the accumulated probability of death of the off-site individual most at risk from all accident sequence is less than 10^{-4}. If it is not, it is probable that either the safety systems on the plant are deficient (i.e. risks are not ALARP), or that the accident analysis is overly conservative. In either case the Assessor should reflect his concerns in his assessment report. If the safety report does not present a quantitive risk assessment, but builds a case based on good practice, regulatory guidance and accepted standards then, almost by definition, the risks should be close to if not ALARP.

Situations may occasionally arise when the safety report fulfils the requirements of the regulations, but the Assessor feels that the societal risk from the installation is uncomfortably high. In such cases, the safety report should not be deemed deficient, but the Assessor should convey his/her feelings to the Assessment Manager for the safety report should not be deemed deficient, but the Assessor should convey his/her feelings to the Assessment Manager for the safety report.

Has the Operator demonstrated that additional safety measures cannot be justified on cost benefit grounds?

The Operator should systematically examine the risk dominant accident sequences and identify additional measure that would reduce the residual risk. He should also justify why none of them have been implemented. Such arguments remove the grounds for rejecting the safety report and open up the possibility of a dialogue about which improvements would be cost effective.

Does the safety report use quantitative arguments for the ALARP demonstration - if so are the risk criteria stated and justified?

The level of quantification expected for the various types of risk assessment are dealt with by other criteria. The number of failure cases and the depth of analysis increases with proportionality. For a QRA of a complex site a few hundred different MAs may need to be analysed. The presentation of the quantitative arguments may need to be coupled with cost benefit analysis in order to provide the justification that all measures necessary have been taken.

If quantitative arguments are used the methods, assumptions and the criteria adopted for decision making should be explained. For example in the case of fatality risks to people off-site it is common practice [HSE, 1992] for the maximum tolerable level of individual fatality risk to be set at 10^{-4} per year and for the broadly acceptable level to be set at 10^{-6} per year. The corresponding figures for workers are 10^{-3} and 10^{-6}. There are no commonly agreed criteria for lower severity levels, however, HSE have published harm criteria for LUP purposes for a variety of substances, i.e. the 'dangerous dose' level, which is equivalent to a 1% chance of fatality when a healthy person receives the dose.

Criterion 3.6.1

The safety report should demonstrate that a systematic and sufficiently comprehensive approach to the identification of risk reduction measures has taken place.

Assessment against Criterion 3.6.1

The safety report should identify all major accident sequences and determine their approximate frequency as accurately as is practical. This does not necessarily imply the use of fault tree analysis; because in many cases, reference to historical or industry standard data is acceptable. Once reliable consequences and frequencies of the risk dominant sequences have been determined, reasoned argument should be employed to show that the residual risks are ALARP. This is a stepwise systematic process to demonstrate compliance with the regulations.

Accident risks that fall below the HSE tolerability line are not necessarily ALARP but can be judged by asking the following questions: -

Will any single failure precipitate the accident?

The risks from a plant where a single control system failure or Operator error will result in a major accident may not be ALARP unless the probability of the event is very low. Assessors should look for evidence that: -

- A fork-lift truck driver cannot puncture a storage vessel with the forks of his vehicle while his attention is momentarily diverted away from his driving because the vessel is protected by vehicle impact barriers.

- Failure of a high liquid level indicator will not result in overfilling of the vessel because of the presence of a back up liquid level instrument and other alarm systems and or a procedure that prevents overfilling.

- An explosion in an enclosed building (cylinder filling plant) has a low probability of initiating an even more severe accident because of the separation distance or the presence of blast protection features.

Are the standards employed in the risk assessment relevant and up-to-date?

Operators often refer to standards in their risk assessment. These may be a failure frequency, an HSE guidance document or a plant design and operating standard. In each case, the Assessor should consider if the standard is applicable to the Operator's plant and if it is appropriate, given that HSE guidance and standards are updated from time to time. British Standards are revised at regular intervals and while not all the data in the standard may change, a major accident somewhere in the world can lead to a revision of failure frequencies of certain plant items.

At five-year updates HSE expects Operators to carry out a reappraisal of the risks from their operations and to examine if recent technological advances offer opportunities for risk reduction. Since hardware changes to LPG storage vessels on old sites is likely to be impractical, Assessors should not be concerned if there is very little in the safety report on this aspect of the reappraisal.

Criterion 3.6.2

The main conclusions on the measures necessary to control risks should adequately take account of the sensitivity of the results of the analysis to the critical assumptions and data uncertainties.

Assessment against Criterion 3.6.2

One of the purposes of the risk assessment in a COMAH safety report is to demonstrate that sufficient control measures are in place to reduce the risks from the installation to a tolerable level. This is possible if the Operator has accounted for uncertainty in both the frequency and consequences of accidents. Considerable uncertainty is tolerable in the frequency and consequences of accidents that are, beyond a shadow of doubt, not risk dominating, but Operators should present sensitivity studies that show their predictions for safety critical events are not seriously in error. Assessors can ask the following questions to test compliance with this criterion:-

Has the uncertainty in consequences arising from different mathematical model input data been addressed?

The extent of a flash fire envelope and the volume of a congested plant enveloped by a cloud of LPG depends on the weather conditions assumed for the dispersion process. Since the magnitude of the hazard is inversely proportional to wind speed under both D and F stability, it is important that the consequences are evaluated at typical low wind speeds (F2 and D5). Input data for most other accident scenarios are fairly well defined, with the exception of emissive power. Assessors should check that values used in the accident consequence analysis are close to those shown in Table 2.

Have the uncertainties attached to the risk calculations been addressed and justified?

A safety report that fails to mention uncertainties in the risk estimates should be considered deficient. Individual uncertainties attached to calculated hazard ranges should to be estimated by discussion of both model inadequacies and imprecise input data. The safety report should justify the results, if necessary by reference to confidence levels. Assessors can find uncertainty information in Table 6.

With regard to uncertainty in the reliability of containment and control systems, it is reasonable to assume that standards that have been developed over many years provide adequate protection. However, if a site makes use of new technology, for which an historical database is not available, then the safety report should discuss uncertainty attached to failure probabilities.

Operators who base their safety report on QRA, should take account of the potential for protective devices not to function e.g. remotely operated shut off valves and excess flow devices may fail to operate effectively when called upon. The Operator should recognise that other protective systems may also fail and should describe the measures in place to show that his ranking of risk is not seriously flawed.

Most risk assessments, even those not based on quantification, make use of a variety of input data, which have uncertainties attached to them. Operators should describe the effect uncertainties can have on their predictions and demonstrate, by reasoned arguments, or quantitatively, that even under worst case assumptions the risks are ALARP.

Criterion 3.6.3

The conclusions drawn from the risk analysis with respect to emergency planning should be soundly based.

Assessment against Criterion 3.6.3

A safety report does not need to describe the off-site emergency plan, but it should provide guidance for the Local Authority on the severity of the risk dominant accidents. This information should be presented in an easy to assimilate form such as a table that summarises accident probability and likely numbers of casualties in three severity groups (mild burns or superficial injuries,

hospitalisation and fatalities) for at least two weather conditions. Supplementary data on the effect of seasonal changes and other variables is essential.

Other questions that the assessor should ask include:-

Does the safety report describe a practical and satisfactory on-site emergency plan?

A safety report should describe the on-site emergency plan and detail how severe accidents will be managed and employees protected. Assessors should look for an emergency management structure that accounts for the possibility that key members of staff may be off-site, on holiday or otherwise unavailable. It should clearly detail the evacuation plans and describe alternative assembly points and safe routes to them. Any fire fighting that staff are expected to engage in should also be outlined.

The on-site emergency plan for an unmanned site has to be managed and operated remotely, but its important aspects include: -

- speed of getting someone to the site.
- how long they stay for.
- their duties when they arrive.

Of particular concern is whether the Operator will detect the occurrence of a major escape of gas and be able to take appropriate steps remotely to minimise its consequences. Assessors should be convinced that remote monitoring of all safety-related parameters is adequate and protected by redundant and diverse equipment.

Does the safety report describe the effects of an representative range of possible major accidents across the whole range of likelihood of relevance to emergency planners?

The safety report should provide a sound basis for emergency planning. It should identify a representative set of accidents that spans the severity range and calculate the consequences of each in terms of three levels of impact. These are the number of people receiving minor injuries, the number requiring hospitalisation and the number of fatalities. It should also indicate the number of people likely to be made homeless by the effects of explosions. The information should be tabulated for a representative range of weather conditions and for all wind directions.

the safety report should also indicate any significant differences in the numbers of casualties due to seasonal changes, the accident occurring at week end, at night or on function days. In addition to the consequence information, it should present probability data in order that emergency planners can tailor their resources around the accidents presenting the greatest risk.

Does the safety report give the distances to a range of consequence levels of relevance to emergency planners?

In the event of a major accident the emergency services will want to know where to deploy their staff in order to bring relief to the maximum number of people in the shortest time. Depending on the accident, the consequences could be mainly down wind (flash fire) or isotropically distributed around the site (fireball). In each case the maximum distance out to which people are likely to be injured is of vital importance.