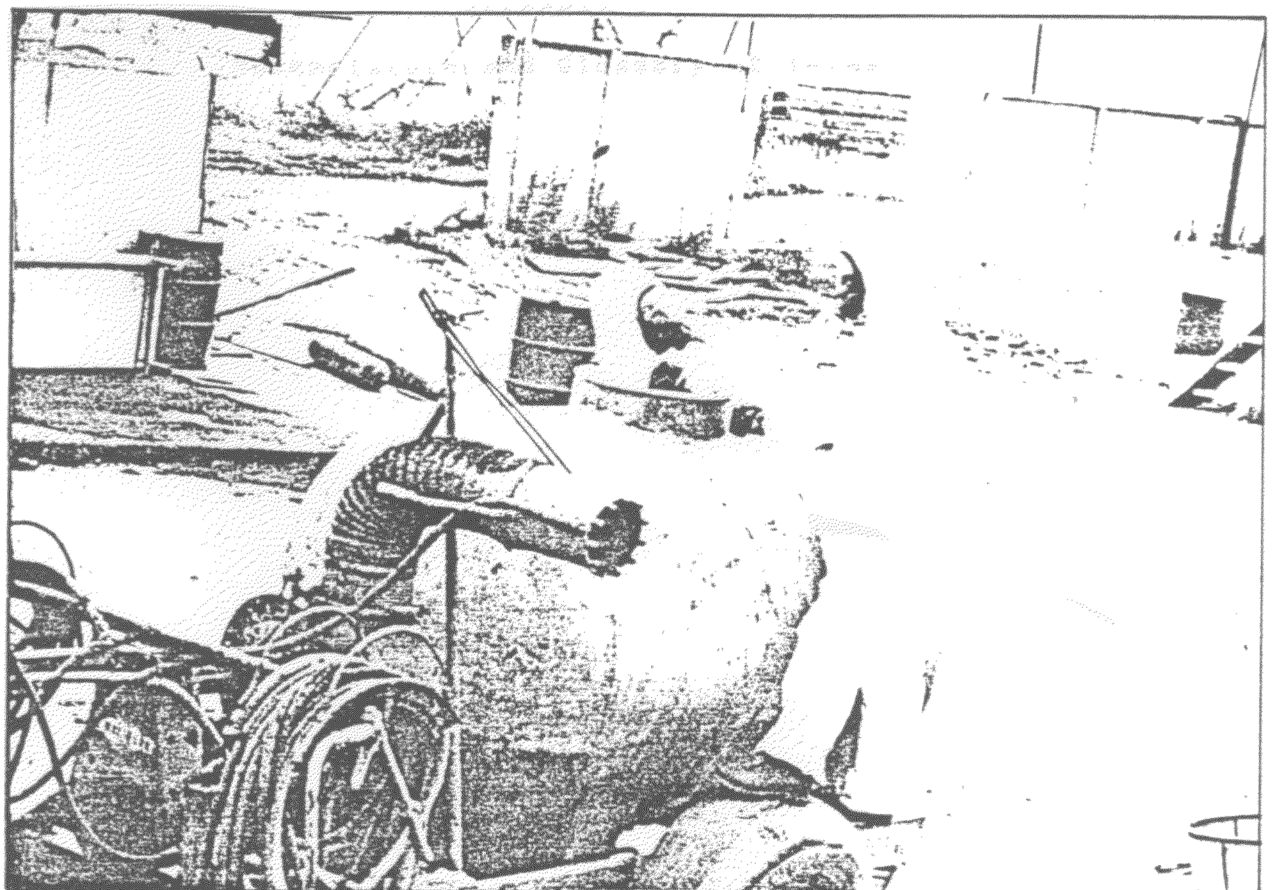
Appendices



APPENDIX I

Nomenclature and Glossary of Terms

NOTATION USED IN SECTION 4

Symbol	Description	UNITS
a_s	thermal diffusivity of substrate	m^2/s
A_r	area of release	m^2
A	constant in entrainment equation	-
A	major semi-axis of vapour cloud	m
A_p	area of a pool of spilled liquid	m^2
A_t	material dependent toxicity parameter	-
B	minor semi-axis of vapour cloud	m
b_1, b_2	concentration profile shape parameter	-
B_t	material dependent toxicity parameters	-
C_{pl}	specific heat of liquid at constant pressure	J/kg/K
C_d	discharge coefficient	-
C_e	liquid pool evaporation factor	-
C_A	ambient concentration (volume fraction)	-
C_O	theoretical concentration	-
C_T	true concentration	kg/m^3
C_V	volume fraction of vapour in initial mixture	kg/m^3
C_v	heat capacity at constant volume	J/kgK
C_s	thermal conductivity substrate	W/mK
C	local concentration of pollutant	kg/m^3
C(S)	damage coefficient in DSM model for a damage level of S defined in categories 1,2 and 3	-
D	diffusion coefficient	m^2/s
d_m	equivalent diameter of initial vapour/air mixture	m
D_a	density of air	kg/m^3
D_i	initial density of explosive mixture	kG/M^3
D_l	liquid density	kg/m^3
D_m	mean density of liquid/vapour mixture	kg/m^3
D_p	local plume density	k/m^3
D_v	vapour density	kg/m^3
D_w	water density	kg/m^3
D_o	vapour density under initial conditions	kg/m^3
e	liquid pool spreading factor having a value of between 1 and 6	-
E	energy of the explosion	joules

E_e	energy of expansion	J/kg
F	buoyancy factor	-
F_{vap}	fraction of liquid flashed to vapour	-
G	Cp/Cv (ratio of specific heats for gas or mixture)	-
g	gravitional acceleration	m/s^2
h	height of liquid in tank above discharge point	m
H	cloud depth	m
H_l	enthalpy of liquid per unit mass	J/kg
H_v	enthalpy of vapour per unit mass	J/kg
H_{vap}	enthalpy of evaporation	J/kg
J_c	core concentration	kg/m^3
H_c	heat of combustion	J/kg
I	incident heat	kW/m^2
j_c	LFL (Lower Flammable Limit) concentration	kg/m^3
J	edge mixing entrainment coefficient	-
k	constant in spreading equation	-
K	rate of energy by released due to combustion	J/s
K_d	turbulent deffusion coefficient	m^2s^{-1}
l	characteristic turbulence length scale	m
M	molecular weight	
$\frac{dm}{dt}$	mass burning rate	kg/m^2s
n	material dependendent toxicity parameter	-
N	yield factor for vapour cloud explosion	-
P	pressure	N/m2
P_a	ambient pressure	N/m_2
P_l	pressure of reservoir or process pressure	N/m_2
P_c	pressure at release plane	N/m_2
P_r	toxicity probit	
Q	mass released or release rate as appropriate	kg or kg/s
Q_e	air entrainment rate	m^3/s
q	heat flux	kW/m^2
R	radius	m
$\frac{dr}{dt}$	rate of spreading of pool	m/s
$\frac{dR}{dt}$	rate of lateral spreading of a dense gas cloud	-
r_c	radius of core of cloud	m

R_f	fireball radius	m
$R(S)$	distance from cloud centre to damage level S defined in categories 1,2 and 3	m
r	distance from fire centre	m
$\sigma x,y,z$	dispersion standard deviation parameter (Gaussian dispersion model for plume spread)	m
S	damage level, DSM model	-
S_l	entropy of liquid per unit mass	J/K kg
S_v	entropy of gas per unit mass	J/K kg
t_e	exposure time to a toxic gas or vapour	minutes
T	transmissivity of air path	-
t	time	s
T_b	boiling point	K
T_c	saturation temperature of liquid at release plane pressure	K
T_l	initial temperature	K
T_s	temperature of substrate	K
U_l	internal energy of the liquid per unit mass	J/kg
U_v	internal energy of the vapour per unit mass	J/kg
u_l	mean wind velocity	m/s
U_e	entrainment velocity	m/s
U_f	friction velocity	m/s
V	volume	m^3
V_{go}	volume of the gas at standard temperature and pressure	m^3
x,y,z	space co-ordinates	m
X_E	fraction of combustion heat emitted as radiation	-
X_g	jet-flame emissivity factor, typically taken to be 0.2	
e	liquid spreading rate constant	-
c_e	evaporation constant	$kg/m^2s^{1/2}$
A_p	surface area of pool	m^2
pi	constant	3.14
U_1	initial internal energy	j/kg
U_2	internal energy after expansion	j/kg
T_2	temperature after expansion	k
f_2	vapour fraction	-
T_3	cloud temperature after air entrainment	k
M_{air}	mass of air	kg
C_a	heat capacity of air	j/kg k
s.v.p.	saturated vapour pressure	N/m^2

R_i	Richardson number	-
a,b,c,d	dispersion deviation parameters	-
L_p	Briggs parameter	s^2/m
t_f	fireball duration	s
Pr	probit function	-

APPENDIX 2

Extract of World·Bank Guidelines for Identifying, Analysing and Controlling Major Hazard Installations in Developing Contries

"WORLD BANK GUIDELINES FOR IDENTIFYING,
ANALYZING AND CONTROLLING MAJOR HAZARD INSTALLATIONS
IN DEVELOPING COUNTRIES"

September 1985

Office of Environment and Scientific Affairs
Projects Policy Department

WORLD BANK
Washington, D.C.

September 1985

WORLD BANK GUIDELINES FOR IDENTIFYING, ANALYZING, AND CONTROLLING MAJOR HAZARD INSTALLATIONS IN DEVELOPING COUNTRIES

Preamble

The European Economic Community have taken a lead in developing guidelines controlling major accident hazards of certain industrial activities. The Environmental Council of the Economic Community met on June 24, 1982 and adopted such a directive which member states were required to comply with by January 8, 1984.

Impetus was given to the European Community to consider the need to control major hazards by, in particular, four serious industrial accidents; the Flixborough explosion in 1974 killed 28 workers, injured 89 people and caused widespread damage to housing in the vicinity of the plant; the disaster at Beek in Holland in 1975, an explosion and fire killed 14 people on site following the release of propylene at the refinery. The two other cases were at Seveso and Manfredonia in Italy in 1976, where highly toxic substances were released contaminating the surrounding districts, and raising implications regarding the health of people exposed to the toxic releases.

Recently the explosion of natural gas in Mexico City killing some 450 people and the toxic gas release at Bhopal in India killing more than 2,500 people has highlighted the urgent need for the World Bank to adopt similar guidelines to those developed by the EEC. These latter two incidents illustrate the even greater risks that must be controlled in installations producing hazardous substances in developing countries.

TABLE OF CONTENTS

1.0 Introduction

1. These guidelines are based substantially on the EEC directive on the major accident hazards of certain industrial activities and regulations promulgated under the United Kingdom Health and Safety at Work Act. Parts of this guidelines have been quoted directly from "A Guide to Control of Industrial Major Accident Hazards Regulations 1984", UK Health and Safety Booklet HS (R)-21. (published by HMSO, London).

2. Industrial activities involving certain dangerous substances have the potential to give rise to serious injury or damage beyond the immediate vicinity of the work place. These activities have commonly come to be known as "Major Hazards". These guidelines are concerned with the protection of the health and safety of persons in the workplace and persons outside the plant boundary, as well as the protection of the environment. Furthermore, they apply generally to industrial processes, storage and transport of hazardous material, but do not apply to nuclear or to extraction or mining operations or to licensed hazardous waste disposal sites. According to the guidelines, persons in control of activities involving certain dangerous, explosive, flammable and toxic substances must demonstrate that major accident hazards have been recognized, and that measures have been taken to prevent accidents and to control and minimize the consequences of those that do occur.

3. It is the object of these guidelines to provide a framework in which a developer can supply evidence and justification for the safe operation of the proposed industrial activity. It is not the objective of these guidelines to provide details or specific methods of analysis, safe operating procedures, etc., which are the contents of the World Bank Manual of Industrial Hazard Assessment Techniques.

4. In summary, these guidelines provide the criteria for identifying acutely toxic, flammable, explosive and reactive hazards, as well as providing an indicative list of these hazardous chemicals. In addition threshold quantities are specified, which require the developer to undertake a major hazard assessment and to implement measures to control major hazards that are identified in such an assessment.

2.0 Potential Industrial Hazards

5. Although 'major hazard (or major accident)' is defined in the guidelines and includes the phrase 'a major emission, fire or explosion', the definition uses a number of phrases which need to be interpreted. An occurrence will be a major accident if it meets the following conditions.

(a) that it leads to a serious danger to people or the environment;

(b) that it results from uncontrolled events in the course of an 'industrial activity'; and

(c) that it involves one or more 'dangerous substances'.

6. 'Serious danger to persons' should be taken to mean death or serious injury including to health, or the threat of death or serious injury, whether caused immediately by the accident (e.g., collapse of a populated building caused by an explosion) or as a delayed effect (e.g., pulmonary oedema following some hours after exposure to a toxic gas), and affecting or potentially affecting people inside and outside the installation. It is emphasized that the accidents, actual or potential, should be major ones distinguished from other serious accidents not onlv by the severity of the casualties but by the numbers of them, or by the physical extent of the damage.

7. The reference to delayed effects is not intended to include the cumulative effects of frequent exposure to small amounts of the dangerous substance and, therefore, brief excursions slightly above the routine control limits for toxic substances should not be considered as major accidents.

8. 'Serious danger to the environment' should be taken to mean a significant, relatively long-lasting (but not necessarily irreversible) effect on plants or animals on land, in the air or in the water which has the potential to lead to a serious danger to man. For example, serious pollution by a toxic substance of a water course used for drinking water could pose a threat to man.

9. 'Uncontrolled developments' should be taken to mean that the occurrences of concern are likely to develop quickly; to be outside the normally expected range of operating problems; to present only limited opportunity for preventive action; and to require any such action to be in the nature of an emergency response. It also serves to indicate that the guidelines are concerned with acute rather than chronic events, i.e., uncovenanted or unusual rather than covenanted or regular releases of the dangerous substance. Similarly, 'a major emission' refers to a relatively large, sudden and unconvenanted release of the dangerous substance from its normal containment.

10. It is clearly possible to identify, using a pragmatic approach, the installations and activities that pose the main threat of a major accident. It is also relatively easy to decide whether an event was a major accident after it has occurred. It is much less easy to define 'major accident' for the purpose of making predictions, as the developer is required to do in his major hazard assessment as

an essential step in demonstrating the adequacy of the measures taken to prevent such accidents. The following examples outline events which may be taken, prima facie, as major accidents:

(a) any major fire giving rise to thermal radiation at the site or plant boundary exceeding 5 kw/m^2 for several seconds;

(b) any release actual or potential, of a hazardous substance where the total quantity released is a significant proportion of the quantity which invokes the guidelines, e.g., releases of kilogram quantities of Group A toxic substances; ton quantities of other toxic substances; ton quantities of pressurized or refrigerated flammable gases; or tens of tons of flammable liquid;

(c) any vapour or gas explosion which could give rise to blast overpressures at the site or plant boundary exceeding 0.5 bar; and/or

(d) any explosion of a reactive or explosive substance which could cause damage to buildings or plant outside the immediate vicinity sufficient to render them or it inoperative for weeks.

11. These estimates should include all the quantities of each substance present whether it is in pure form or part of a mixture. However, the substances should be in a form capable of giving rise to major accident hazards, e.g., no account should be taken of ammonia unless it is anhydrous or is in water solution containing more than 50% by weight, nor should account be taken of stored chlorinated potable water.

12. For the purpose of these guidelines a "developer" is defined as a manufacturer, distributor, transporter or end-user, who manufactures, processes, stores, or transports hazardous chemicals in threshold quantities greater than those identified in Appendix II and III of this document.

3.0 Identification System for Major Hazards

3.1 Introduction

13. The proposed system for identifying major hazards is based on the quantity (or inventory) of hazardous substance stored or processed at an industrial site or in transit. In this context the term "installation' is used to describe the general activity which may result in a major accident hazard. The term "installation" is defined further in Appendix I.

14. - The threshold quantities specified in Section 3.2 relate to the total quantity of substance held on site. A developer may be involved in an activity in which the quantity of a hazardous substance varies over a period, due either to seasonal demand, or because the site is complex and includes a number of processes each of which has an inventory which varies from day to day or even hour to hour. In such cases the manufacturer should make an estimate of the quantity of each substance liable to be on site and a decision as to whether the requirements of Sections 4, 5, and 6, apply should be based on the maximum anticipated quantity.

15. The estimation of the quantity of a substance at a site should include all the amounts which are likely to be on the site under the control of the same manufacturer. In the case of production and process activities, this will include quantitites in manufacture, use or processing, and associated storage (i.e., the storage that is used in connection with the process). Account should also be taken of any quantities in pipelines on the site and in internal transport operations. These estimates should include all quantities of any dangerous substance whether the substance is in pure form or part of a mixture or present as a by-product. For example, if a chemical plant manufactures a hazardous substance, the estimate of the total quantity should take account of the quantities which are present in reaction mixtures and purification processes together with the quantities which are present in storage. In certain processes there may be circumstances where a significant quantity of a dangerous substance can only be produced if abnormal conditions develop in the plant. If such an event can reasonably be predicted, then this should be taken into account in estimating the overall quantity of the substance on a site. An example of this type of situation was the production of a significant quantity of TCDD (dioxin) when conditions of excess temperature and pressure developed in a plant producing 2,4,5-trichlorophenol at Seveso.

16. It should be noted that when estimating the quantity of hazardous substance to assess whether the site becomes subject to these requirements, it is necessary to add the quantity of substance in process to the quantity in associated storage together with any amounts of the same substance in any installation within 500 metres owned by the same manufacturer. If the nearby installation is more than 500 metres away then it is only necessary to add the quantities if these are such that there could be, in foreseeable circumstances, an aggravation of the major accident hazard. It is realized that in some cases interpretation of this 500 meter requirement might be difficult but reasons for inclusion or exclusion should be clearly specified.

17. Although an industrial activity involves, or is liable to involve, hazardous substances, this does not of itself make the activity subject to these World Bank guidelines. The hazardous substance

must be present under circumstances which could give rise to a major accident. Thus, it may be possible for a developer to argue that a major accident cannot, in fact, arise. It may be that the physical state of a substance or the way in which it is distributed round the site may avoid the possibility of some types of accidents. This may be particularly relevant to many of the toxic substances which are involatile liquids or solids. These may not have the potential to cause a major accident unless some special factor, such as energy contained in a pressurized system, is present, although spillage into water courses may still remain a problem.

3.2 Threshold Quantities for a Major Hazard Assessment

18. The criteria for hazardous substances and the quantities above which a major hazard assessment is required by the World Bank are presented in Appendix II. This Appendix is divided into four sections, namely:

(A) very toxic substances;

(B) other toxic substances;

(C) highly reactive substances and explosives; and

(D) flammable substances.

19. The criteria for the two groups of toxic substances, namely groups (A) and (B) of the Schedule are given in terms of the toxic effects on populations of specified experimental animals, though in two cases in addition to fulfilling these criteria the substances must have physical and chemical properties capable of entailing major accident hazards. This is taken to mean that the properties are such that the toxic substance could be easily distributed throughout the environment if containment is breached, for example, a gas or highly volatile liquid or a solid which might be ejected from a pressurized reactor. A substance has to satisfy only one of the three criteria for ingestion, percutaneous (i.e., through the skin) or inhalation toxicity in the tables to qualify. In the case of Class (A) substances a major hazard assessment is required irrespective of the quantity involved.

20. In the case of Class (B) toxic substances quantities have been specified for some of the more common substances. However, for those unnamed substances which fall into the indicative criteria given in Appendix II, quantities exceeding 1 ton would require a major hazard assessment.

21. A major hazard assessment also is required for any process using plant at a pressure greater than 50 bars when the product of the volume of the pressure system in cubic meters and the pressure in bars exceeds 10,000. Likewise for highly reactive chemicals (Class (C))

and flammable substances (Class (D)), threshold quantities are given in Appendix II which would require a major hazard assessment for the purpose of these World Bank Guidelines.

22. To assist in identifying major hazard chemicals an indicative list of acutely toxic and reactive chemicals in Classes (A), (B) and (C) have been listed in Appendix III.

4.0 Implementation of the Guidelines

23. The guidelines require that proof of safe operation be available at any time. Developers must show that they have identified the major accident hazards arising from their activities and have taken adequate steps to prevent such major accidents in design, lay-out and siting, that they will provide adequate steps to prevent such major accidents during operations and will provide people on-site with the information, training and equipment to ensure their safety.

4.1 Requirements for a Major Hazard Assessment

24. For major hazard installations handling dangerous materials in excess of the quantities listed in Appendix II a major hazard assessment is required. This study must show that the activity will be carried on safely; it includes a description of the major accident hazards that could arise from a manufacturer's activities and the controls that are exercised to prevent them or to limit their consequences. 'Major accident' is defined in Section 2 and guidance is given on the definition in this section. The guidance that follows discusses some of the general issues that bear on the major hazard assessment.

4.1.1 Objectives

25. The objectives of the major hazard assessment are:

(a) to identify the nature and scale of the use of dangerous substances at the installation;

(b) to give an account of the arrangements for safe operation of the installation, for control of serious deviations that could lead to a major accident and for emergency procedures at the site;

(c) to identify the type, relative likelihood, and broad consequences of major accidents that might occur; and

(d) to demonstrate that the developer has appreciated the major hazard potential of the company's activities and has considered whether the controls are adequate.

26. In addition, the work that the developer does in preparing his assessment should enable him to provide the competent authority responsible for making emergency plans outside the installation with an estimate of the scale and consequences of the realization of the hazards, in accordance with the requirements of these guidelines (see Section 5).

4.1.2 The Content of the Major Hazard Assessment

27. A major hazard assessment is essentially an abstract of relevant information about the major hazard aspects of the activities from a much more extensive body of information. This body of information will include plant design specifications, operating documents, maintenance procedures, and information derived from the examination of the major hazard potential by means of techniques such as discribed in the World Bank Manual of Industrial Hazard Assessment Techniques.

28. The information required in the major hazard assessment falls into two broad categories: firstly, factual information about the site, its activities and surroundings, and secondly, (the core of the assessment) estimates of the scale of potential major accidents which may occur at the installation and the means to prevent these hazards being realized.

29. It is not possible to specify precisely what the second part of the major hazard assessment should contain because the complexity of the potential hazards will vary greatly from site to site. However, the World Bank manual provides detailed guideance on the methodology for carrying out such an assessment. The essence of the major hazard assessment, and the reason behind the choice of that term, is that the onus lies on the developer to assess his own hazards, take measures to control them adequately, and then to present his conclusions to the World Bank.

30. The major hazard assessment should, therefore, contain sufficient information about the major accident potential of the developer's activities to enable judgment to be made whether the significant hazards have been identified and are being properly managed. In some instances it may be necessary to ask for information in the assessment to be supplemented by further information, but ideally the aim should be to provide an analysis which stands on its own as a demonstration that major accident hazards are being adequately controlled.

31. The major hazard assessment should provide adequate justification for its conclusions, either by setting out the sources of the evidence for a particular argument, or by recording the principal assumptions in sufficient detail to enable them to be

challenged if it emerges that they are critical to the conclusions of the assessment. For example, a major hazard assessment may state that the integrity of pressure vessels has been assured by the strict application of appropriate design codes, operating duties, maintenance and inspection procedures, in support of an assumption that the sudden failure of pressure vessels has been dismissed as a possible cause of a major accident. A major hazard assessment may also perhaps indicate that the risk of an aircraft crashing on the installation is insignificant in comparison with other causes of a major accident, because the site is well separated fom the nearest airport and air traffic lanes. Clearly, the amount of evidence required on each aspect of the major hazard assessment will vary according to the importance of that aspect and in particular the consequences of the particular accident being considered.

4.1.3 Information to be Included in a Major Hazard Assessment

32. The report shall contain the following:

4.1.3.1. Information relating to substances listed in Appendix II and III:

(i) The name of the substance as given in Appendix III or for substances included in Appendix II under a general designation, the name corresponding to the chemical formula of the substance;

(ii) A general description of the analytical methods available to the developer for determining the presence of the substance, or references to such methods in the scientific literature;

(iii) A brief description of the hazards from the substance.

(iv) In cases where the substance may be isolated from process vessels, its percentage concentration, and the main impurities and their percentages.

(v) Where there is a potential for runaway reactions a full discription is required such as given in the example in Appendix V, and the consequences of runaway reaction determined as part of the major hazard assessment. This may involve computer modelling, as well as data from bench scale testing e.g. as detailed in references (8) and (10).

4.1.3.2 **Information relating to the installation:**

(i) A map of the site and its surrounding area to a scale large enough to show any features that may be significant in the assessment of the hazard or risk associated with the site.

(ii) A scale plan of the site showing the locations and quantities of all significant inventories of the hazardous substances.

(iii) A description of the processes or storage involving the hazardous substance and an indication of the conditions under which it is normally held.

(iv) The maximum number of persons likely to be present on site.

(v) Information about the nature of the land use and the size and distribution of the population in the vicinity of the activity to which the major hazard assessment relates.

4.1.3.3 **Information relating to the management system for controlling the activity:**

(i) The staffing arrangements for controlling the activity with the name(s) of the person(s), and if appropriate his (their) deputies or the competent body responsible for safety and authorized to set emergency procedures in motion and to inform outside authorities.

(ii) The arrangements made to ensure that the means provided for the safe operation of the activity are properly designed, constructed, tested, operated and maintained.

(iii) The arrangements for training of persons working on the site.

4.1.3.4 **Information relating to the potential major hazard accidents:**

(i) A description of the potential sources of a major accident and the conditions or events which could be significant in bringing one about.

(ii) A diagram of any plant or plants in which the activities are carried on sufficient to show the features which are significant as regards the potential for a major accident or its prevention or control.

(iii) A description of the measures taken to prevent, control or minimize the consequences of any major accident.

(iv) Methods of sizing and capacities of emergancy relief systems, blow-down tanks, emergency scrubber systems, vent flares, etc., especially to handle two-phase flow conditions (i.e. the subject of a forthcoming American Institute of Chemical Engineers publication).

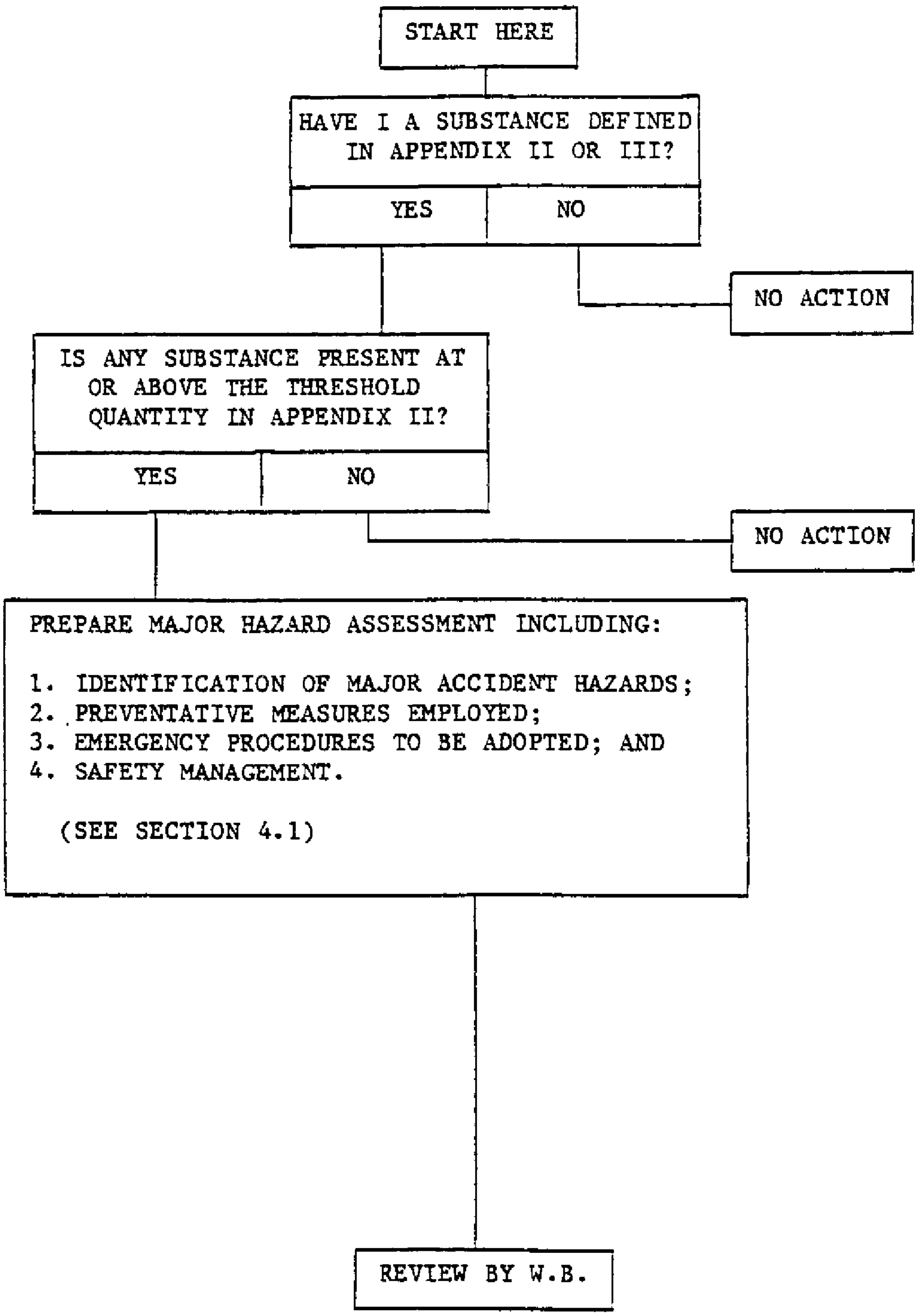
(v) Information about the emergency procedures laid down for dealing with a major accident occuring at the site.

(vi) Information about prevailing meteorological conditions in the vicinity of the site.

(vii) An estimate of the number of people on site who may be particularly exposed to the hazards considered in the written report.

33. Further details on these items are given in Appendix IV, and the World Bank Manual of Industrial Hazard Assessment Techniques. A flow chart (Figure 1) summarizes the procedures outlined above in Section 4.

Figure 1: Procedures for Major Hazard Assessment and Control Of Major Hazard Installation



5.0 Emergency Plans

34. These guidelines require developers to prepare an adequate emergency plan for dealing with major accidents that may occur on their sites.

5.1 On-Site Emergency Plan

35. It is not the intention of these guidance notes to explain in detail how to prepare an on-site emergency plan. The detail and scope of the emergency plan will vary according to the complexity of the site and it is, therefore, not appropriate to prescribe here precisely what the plan should cover. The developer will need to consider the potential major accidents which are identified in the major hazard assessment (Section 4) to ensure that the plan takes account of them. Useful guidance in preparing the emergency plan may be found in the booklet 'Recommended Procedures for Handling Major Emergencies' published by the UK Chemical Industries Association, and the US EPA "Community Preparedness for Chemical Hazards, Part 3: A Guide for Contingency Planning" (1985).

36. The developer should ensure that the on-site emergency plan is compatible with the off-site emergency plan which should be drawn up by the local authority. The on-site and off-site plans should be interlocked to ensure that they provide a comprehensive and effective response to emergencies.

37. The plan should include the name of the person responsible for safety on the site (usually the site or plant manager) and, if different, the name of the person who is authorized to set the plan in action.

38. The developer should keep the on-site emergency plan up-to-date, and to ensure that it takes account of any changes in operations on the site that might have a significant effect on the plan. The developer is also required to make sure that people on the site who are affected by the plan are informed of its relevant provisions. This should include not only those people who may have duties under the plan, but also those who may need to be evacuated from the site in an emergency, including contractors and visitors.

5.2 Off-Site Emergency Plan

39. The intention is that emergency plans should be drawn up or amended by the local authority after consultation with bodies who might be able to contribute information or advice. Such consultation is seen as an important aspect in the preparation of adequate emergency plans - this has been well demonstrated in the case of plans which are in operation in many areas of the world. Obviously the developer must be consulted about the major accident hazards and the

possible consequences, and any special emergency measures. The results of major hazard assessment discussed in Section 4 will provide useful data for drawing up these emergency plans.

40. A two-way flow of information is required between the developer and the local authority. Information from the developer is needed to enable the authority to draw up the off-site emergency plan; information from the authority should be available to the developer when he prepares the on-site emergency plan.

6.0 Restrictions on Development in the Vicinity of Major Hazard Installations

41. The extent of the safety buffer zone or restrictive development zone that may be required for a major hazard installation should be determined on a "case-by-case" basis. The importance of maintaining a restricted development, safety buffer zone is clearly shown by the experience in Mexico City and Bhopal, as well as at other hazardous installations around the world.

42. The results of the major hazard assessment may indicate certain critical areas around the plant boundary where restrictions should be imposed on further development, taking into account local factors, as well as site storage, process, and management factors etc. Planning authorities may restrict the land use in these safety buffer zones to warehousing, light industry or agricultural use, but exclude residential, shanty towns, hospitals, schools and commercial development. Some developers are purchasing safety buffer zones and are planting a dense tree cover as a safety screen, as well as to prevent squatting and shanty town developments.

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