QRA Criteria Guidelines

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Contents

1 Purpose of a QRA

A QRA is intended to achieve the following outcomes:

1. identify hazards and quantify risks related to the use, storage and transport of hazardous materials;
2. determine hazards/risks due to possible fire, explosion and toxic release outcomes;
3. recommend measures to address major hazards/risks and to keep remaining hazards/risks to as low a level as reasonably practicable (ALARP);
4. facilitate the development of emergency response plans;
5. facilitate land planning decisions.

2 Types of QRAs

There are 3 main types of QRAs:

2.1 Fixed Installation QRA (iQRA)

Applicable installations are those which use and/or store hazardous materials.

2.2 Pipeline QRA (pQRA)

Applicable pipelines are those which convey any hazardous materials.

2.3 Bulk Transport QRA (tQRA)

Applicable bulk transport routes are those which convey any hazardous materials by road in bulk, for example in ISO containers (road tankers) or loads comprising multiple intermediate bulk containers (IBCs), or packaged hazardous materials.

3 Requirements for QRA

A QRA may be required under Section 26 of the Environmental Protection and Management Act (EPMA), and under the Fire Safety Act and Fire Safety (Petroleum and Flammable Materials) Regulations for the use, transport or storage of hazardous materials in the lists of controlled substances.

Should any of the QRA triggers included in, but not limited to, Sections 3.1 and 3.2 be met, the Responsible Party shall initiate a pre-consultation with MHD to determine if a QRA is needed.

3.1 Hazardous Materials

Use, storage or transport of hazardous materials in the lists of controlled substances but not limited to the lists found in the links below:

For Toxic Materials:

- http://app2.nea.gov.sg/anti-pollution-radiation-protection/chemical-safety/hazardous-substances

For Petroleum & Flammable Materials (P&FM):

- http://www.scdf.gov.sg/content/scdf_internet/en/building-professionals/fire-safety-licensing-and-enforcement.html (under 'Complete List of Licensable Chemicals')

The QRA should consider all risk sources and inventory and not just the controlled substances identified above.

3.2 Fixed Installation, Pipeline or Bulk Transport

For Fixed Installation:

- Construction of new installations or expansion of existing installations on greenfield land;
- *Changes to existing installations.

For Pipeline:

- Construction of new pipelines;
- *Changes to existing pipelines.

For Bulk Transport:

- Commencement of new transport;
- *Changes to existing transport.

For existing installations undergoing changes/expansion, the Responsible Party shall initiate a pre-consultation with MHD to determine the scope and approach for the QRA (refer to Section 12 of the QRA Technical Guidance).

*Changes refer to those resulting in an increase or transfer (e.g. due to location change of hazard source) of risks relative to the last approved QRA (if there is a prior approved QRA) or resulting in an increase or transfer of risks (if there is no prior approved QRA). Increase in risks may arise from, including but not limited to, changes in process conditions, increase in hazardous material inventories and changes in hazardous material/process locations. Changes do not include like-for-like replacement of equipment parts.

3.3 Conduct of QRA study

The Responsible Party shall appoint a Registered Consultant to conduct the QRA.

The list of Registered Consultants can be found in the link below:
http://app2.nea.gov.sg/anti-pollution-radiation-protection/central-building-planning

4 Criteria Thresholds

4.1 Fixed Installations

For the QRA results presented, the following risk-based criteria thresholds apply. These are made up of criteria relating to sensitive receptors, boundaries and land types (refer to the list of development types and sensitive receptors in Section 13 of the QRA Technical Guidance).

The risk-based criteria thresholds shall also apply to a cluster of Installations, where a cluster consists of 2 or more neighbouring Installations operated by a single commercial entity, and where one or more of the following apply (non-exhaustive list below):

- Installations separated by road, canal and/or shared corridors (e.g. pipeline corridors);
- Installations are in close proximity;
- Control and process systems for the Installations are linked and/or operated by the same entity.

In such cases, the Boundary of the cluster, for which criteria are to be met as an additional requirement, shall be the combined outline of the Installations within the cluster.

4.1.1 Individual Risk (Fatality)

The IR (Fatality) criteria corresponding to the iso-contours are set out in Table 1.

Table 1 IR (fatality) criteria

IR (fatality) **(Cumulative risk of fatality/year)**	**Criteria**
$5x10^{-5}$	Confined within Boundary
$5x10^{-6}$	Confined to industrial developments only

4.1.2 Individual Risk (Injury)

The IR (Injury) criteria corresponding to the iso-contours are set out in Table 2.

Table 2 IR (injury) criteria

IR (injury) **(Cumulative risk of injury/year)**	**Criteria**
$3x10^{-7}$	Confined to industrial and commercial developments only and shall not reach sensitive receptors

4.1.3 Cumulative Escalation

The cumulative escalation criteria corresponding to the iso-contours are set out in Table 3.

Table 3 Cumulative Escalation Criteria

Cumulative Escalation **(Cumulative risk of escalation/year)**	**Criteria**
$1x10^{-4}$	Confined within Boundary

4.1.4 Occupied Buildings

For Fixed Installations, for each of the occupied buildings on site, the IR (fatality) to an individual present in the building should be compared with the criteria in Table 4.

Table 4 Occupied building criteria

IR (Fatality) for On-site Occupied Buildings **(Cumulative risk of fatality/year)**	Criteria
$1x10^{-3}$	Shall not be exceeded

4.2 Pipeline

For the QRA results presented, the following risk-based criteria thresholds apply. These are made up of criteria relating to sensitive receptors, boundaries and land types (refer to the list of development types and sensitive receptors in Section 13 of the QRA Technical Guidance).

4.2.1 Individual Risk (Fatality)

The IR (Fatality) criteria corresponding to the iso-contours are set out in Table 5.

Table 5 IR (fatality) criteria

IR (fatality) (Cumulative risk of fatality/year)	**Criteria**
$5x10^{-6}$	Confined within Boundary
$5x10^{-7}$	Confined to industrial developments only

4.2.2 Individual Risk (Injury)

The IR (Injury) criteria corresponding to the iso-contours are set out in Table 6.

Table 6 IR (injury) criteria

IR (injury) (Cumulative risk of injury/year)	**Criteria**
$3x10^{-8}$	Confined to industrial and commercial developments only and shall not reach sensitive receptors

4.2.3 Cumulative Escalation

The cumulative escalation criteria corresponding to the iso-contours are set out in Table 7.

Table 7 Cumulative Escalation Criteria

Cumulative Escalation (Cumulative risk of escalation/year)	**Criteria**
$1x10^{-5}$	Confined within Boundary

4.3 Bulk Transport

For the QRA results presented, the following risk-based thresholds and consequence-based criteria apply. These are made up of criteria relating to sensitive receptors, boundaries and land types (refer to the list of development types and sensitive receptors in Section 13 of the QRA Technical Guidance).

4.3.1 Individual Risk (Fatality)

The IR (Fatality) criteria corresponding to the iso-contours are set out in Table 8.

Table 8 IR (fatality) criteria

IR (fatality) **(Cumulative risk of fatality/year)**	**Criteria**
$5x10^{-6}$	Confined within Boundary
$5x10^{-7}$	Confined to industrial developments only

4.3.2 Individual Risk (Injury)

The IR (Injury) criteria corresponding to the iso-contours are set out in Table 9.

Table 9 IR (injury) criteria

IR (injury) **(Cumulative risk of injury/year)**	**Criteria**
$3x10^{-8}$	Confined to industrial and commercial developments only and shall not reach sensitive receptors

4.3.3 Cumulative Escalation

The cumulative escalation (sensitive receptors) criteria corresponding to the iso-contours are set out in Table 10.

Table 10 Cumulative Escalation Criteria

Cumulative Escalation **(Cumulative risk of escalation/year)**	**Criteria**
$1x10^{-5}$	Confined within Boundary

4.3.4 Worst Case Scenario-Offsite

The consequence-based criteria are set out in Table 11.

Table 11 WCS-Offsite Criteria

Worst Case Scenario-Offsite[1]	**Criteria**
Hazard zone for the outcome which gives the largest injury harm distance relative to the Boundary (toxic release, fire and explosion)[2]	Confined to industrial and commercial developments only and shall not reach sensitive receptors

[1] Refer to Section 13 of the QRA Technical Guidance.
[2] Refer to harm levels in Table 7 of the QRA Technical Guidance.

5 Post QRA Requirements

1. The Responsible Party shall develop an Emergency Response Plan (ERP) to address all hazard outcomes identified in the QRA study. The ERP shall be submitted to NEA (PCD) for information and to SCDF (CED).

2. The Responsible Party may be required to conduct a Process Hazard Analysis (PHA) to identify all feasible and practical: safety/mitigation measures that should be incorporated into the detailed design. Such measures should take into consideration results from the QRA. The PHA study shall be submitted to MOM (OSHD).

3. To engage a Qualified Person (QP) to identify fire prevention/detection/protection strategies and measures that should be incorporated into the detailed fire safety plan. The fire safety plan shall be submitted to SCDF (FSSD).

4. Pollution impact study to (1) identify any new sources of emission of air pollutants, discharge of trade effluent, generation of wastes and emission of noise and (2) to propose measures to reduce pollution and to mitigate adverse pollution impact on surrounding land use. The pollution impact study shall be submitted to NEA (CBPD).

5. The Responsible Party shall be required to consider the top risk contributors identified in the QRA report in subsequent prioritisation for ALARP demonstration. Please refer to Section 9 of the QRA Technical Guidance for further information.