Water Use

Supporting Guidance (WAT-SG-57)

Toxicity Screening for Discharges

Version: v2

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Copyright and Legal Information

Update Summary

Version	Description
v1	First issue for Water Use reference using approved content from the following documents: *WAT SG 57- Direct Toxicity Assessment (JH).doc*
v2	DTA schedules and conditions added from `LIC/COPA/DTA`

Notes

References: Linked references to other documents have been disabled in this web version of the document. See the References section for details of all referenced documents.

Printing the Document: This document is uncontrolled if printed and is only intended to be viewed online.

If you do need to print the document, the best results are achieved using Booklet printing or else double-sided, Duplex (2-on-1) A4 printing (both four pages per A4 sheet).

Always refer to the online document for accurate and up-to-date information.

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1. Key Points

The aim of this document is to provide Guidance for SEPA Operations staff on how to assess whether or not a discharge should be **screened for toxicity**, in order to protect the aquatic environment, either fresh water or marine.

This work should be carried out by the responsible person/operator and the results submitted to SEPA. If the toxicity screening identifies a possible risk to the environment, the responsible person/operator will be required to carry out a series of additional tests to further characterise the toxicity of the effluent and a refined risk assessment. If the results of this further characterisation and assessment indicates that there is likely to be a risk to the aquatic environment, then the responsible person/operator will need to take action to reduce the effluent toxicity and/or a toxicity condition will be inserted into the discharge licence.

Guidance and assistance from Marine Science staff are available to assist Operations staff in implementing the process.

This Guidance is designed to be used in conjunction with *The Water Environment (Controlled Activities)(Scotland) Regulations 2011*, hereafter referred to as CAR.

1.1 Key internal and external documents:

- *WAT-SG-11: Modelling Discharges to Coastal and Transitional Waters* (Incorporating SEPA Policy No. 28)

2. Introduction

The toxicity screening process is a simple risk assessment to assess whether there is an unacceptable risk of acute (short-term) toxicity in the receiving environment. This process should be carried out by the responsible person/operator and the results submitted to SEPA. If such a risk is not found, then there is no need for the effluent toxicity to be considered further. However, if there is an unacceptable risk of acute toxicity, then the toxicity of the discharge needs to be assessed further and a refined risk assessment completed.

The toxicity screening process is the first stage in Direct Toxicity Assessment (DTA), the process used to measure the environmental toxicity of a discharge through the assessment of the effluent toxicity using standardised aquatic toxicity tests.

2.1 Use of Direct Toxicity Assessment

SEPA plans to target the use of DTA to help deliver environmental improvements; not to assess and control every industrial or sewage effluent discharge. SEPA will pursue the implementation of DTA through three routes which have equal priority:

- Applying to licences

SEPA will use the following approaches for CAR discharges:

- The SEPA Ecotoxicology National Centre which provides advice as appropriate, particularly on the scientific and technical issues.
- SEPA's CAR Water Manual on Licensing Discharges to Surface Waters.
- Specifically, SEPA's WAT-SG-11: Modelling Discharges to Coastal and Transitional Waters which applies toxicity-based criteria for new or modified discharges to estuarine and coastal waters. These criteria stipulate that there should be no acute toxicity after initial dilution and also safeguard against chronic toxicity beyond the boundary of the specified mixing zone.

- PPC Installations

Applications for PPC permits should include the use of DTA within risk assessments to identify the likely impact of the discharge on the environment. Where the impact can be identified by simple chemical parameters it will not be necessary to employ DTA.

SEPA will require that operators of relevant Pollution Prevention and Control (PPC) installations provide data on the aquatic toxicity of their discharges as part of their licence application or variation to the process unless they can justify that such data are unnecessary, for example where an impact could be identified by simple chemical parameters, to the satisfaction of SEPA.

- Action Plans

Where acute toxicity is detected in a water body and its source cannot be identified by chemical specific parameters, SEPA will use DTA to help identify the source of the toxicity. Where this can be linked to a particular discharge, SEPA will require that appropriate action is taken by the responsible person/operator to reduce the toxicity of the discharge to a level consistent with protecting aquatic life in the water body. Such investigations will be conducted as part of SEPA's ongoing regulatory duties and powers and will be targeted and prioritised via Action Plans.

3. The Toxicity Screening Process

The toxicity screening process has the following steps:

- *Select discharges to be screened*
- *Assess the effluent character and variability*
- *Carry out toxicity screening*
- *Carry out risk assessment*

3.1 Select discharges to be screened

This is carried out on the basis of

- whether a Complex Licence is required under CAR and
- whether the effluent composition may be regarded as “simple”

The CAR regulations indicate in Section 3 on Point Source Pollution Control that a Complex Licence should be issued for:

- sewage and organic effluents which, prior to treatment, have an organic loading with a population equivalent (p.e.) >100
- sewage effluent from storm tanks and combined storm sewage overflows that are not considered to be low risk
- effluent from emergency overflows
- freshwater cage fish farms producing >2 tonnes of fish in any year
- marine cage fish farms or effluents from marine tanks which hold >50 tonnes in weight of fish at any time
- inorganic effluents and other effluents (including those from mines and quarries, landfill leachates and other effluents) which prior to treatment have a daily maximum volume >100m^3 or an organic loading, prior to treatment of >100 p.e.

Any discharge falling into the above categories should be **considered for toxicity screening**, to assess whether a toxicity clause should be included in the Complex Licence.

The second criterion that needs to be considered is derived from the UK guidelines already agreed for the application of the DTA approach, that discharges need not be considered further if:

- the discharge volume is less than 100m^3 in any 24hr period or
- the effluent composition is “simple”

A “simple” effluent is one where all the components have been identified and where the toxicity can be explained by the chemical properties of the components, including any potential for combined effects.

This means that an effluent cannot be considered as “simple” if there is no information available on the “safe” levels or aquatic toxicology of the likely

combination of chemicals present in the effluent, even if information on their individual toxicities is available.

Similarly, an effluent which is likely to contain unknown chemicals, either as a result of a process, breakdown or treatment cannot be considered as "simple".

DTA is not suitable for the control of simple effluents because many of the benefits of this approach are not realised in situations where the hazard of an effluent can be cheaply and easily monitored and controlled by the chemical analysis of toxicologically well characterised determinands.

To summarise, if the discharge is going to have a "Complex Licence" issued **and** the effluent composition is not simple, then the effluent should be screened for toxicity and the responsible person/operator should be asked to carry out an assessment of the effluent character and variability, and the toxicity screening process, and to submit the results to SEPA.

3.2 Assess the effluent character and variability

Assessment of the effluent character and variability is required to ensure that samples collected to assess the toxicity of the effluent are fully representative of the effluent produced. This is dependent on the consistency of the industrial or other process that causes the effluent to be produced, so knowledge of these processes and the way in which they are likely to affect the effluent quality is required.

In order to be fully protective of the receiving environment, DTA requires that risk assessments are based on the worst case toxicity of each whole effluent, as discharged, so it follows that this assessment should consider effluent having contaminant concentrations at the high end of the observed ranges.

This stage of the screening process should be carried out by the responsible person/operator by reviewing temporal changes in effluent composition, using simple surrogate measurements of parameters such as COD or BOD to assess variations in effluent toxicity.

If it is not possible to confidently predict the likely period of worst toxicity using existing data or knowledge, the only course of action is to perform some preliminary toxicity testing over different periods, to generate the necessary information.

3.3 Toxicity Screening

Sufficient samples are required to adequately understand the temporal variability in the toxicity of the effluent, which will depend on the nature of the industrial processes that give rise to the effluent. For an effluent with variable composition and hence variable toxicity, it would be reasonable to expect that over a period of not less than 4 weeks, individual 24hr composite samples should be collected **weekly** for analysis.

The DTA Guidance states that 2 test methods are required for each effluent being screened. For discharges to fresh waters, abbreviated algal growth inhibition and *Daphnia* immobilisation tests are required, while for the marine environment, algal growth tests are supplemented by either oyster embryo larval tests or tests using the copepod *Tisbe battagliai*. These requirements are summarised in Table 1.

Table 1 DTA Test Methods Required for Toxicity Screening

Freshwater Receiving Environment	Marine Receiving Environment
Freshwater Algal Growth Inhibition Test	Marine Algal Growth Inhibition Test
Daphnia magna Immobilisation Test	Oyster Embryo Larval Development Test, or *Tisbe battagliai* Mortality Test

It is important that results for both test species (algae and invertebrates) are obtained for each sampling occasion, as the most sensitive species will depend on the toxic mode of action of the substances present, and may change between sampling occasions, depending on the variability of the effluent. The most sensitive species cannot be confirmed until the full programme of DTA testing has been completed.

The aim of these DTA tests is to obtain a value for the highest effluent concentration causing no measurable acute toxicity effects; this is referred to as the Toxicity Threshold, and is expressed in terms of % effluent.

3.4 Risk Assessment

The toxicity data generated during the toxicity screening stage indicates the intrinsic hazard posed to the receiving environment by the effluent. Effluent flow data would assist in deriving an estimate of the "toxicity burden" but in order to assess possible risks to receiving water quality, the subsequent dilution in the receiving water also needs to be taken into account.

The risk assessment is therefore a two-stage process whereby the worst case risk for each effluent is calculated on the basis of:

- an estimation of the toxicity of the effluent and
- the available dilution, based on the rate at which the effluent is discharged and the extent of initial dilution available at the point of discharge.

The risk assessment should be carried out by the responsible person/ operator, with the results submitted to SEPA. Marine Science staff can assist SEPA Operations staff with the risk assessment process. These staff can be contacted by emailing the Marine Helpdesk.

3.5 Assessment of Discharge Toxicity

The Marine Science staff will consider the effluent toxicity and the available dilution, and the results and conclusions produced by the responsible person/ operator. The Marine Science staff will come back to the SEPA Operations staff member with a recommendation on whether the effluent presents an acute (short-term) toxicity risk to the aquatic environment. The Marine Science staff will also indicate on the basis of this information whether or not the effluent requires to have its toxicity assessed further.

If the toxicity screening identifies a possible risk to the environment, then the responsible person/ operator will need to carry out a series of additional tests to further characterise the toxicity of the effluent and carry out a refined risk assessment. If there is unlikely to be a problem with the discharge, then a toxicity condition is not required.

See Appendix 1for a summary of the Toxicity Screening process.

4. Further Characterisation of Effluent Toxicity

The further characterisation of the toxicity of the effluent and the refined risk assessment should be carried out by the responsible person/ operator according to the procedures outlined in the Environment Agency guidance document on the use of Direct Toxicity Assessment in PPC Impact Assessments. The SEPA guidelines on initial dilution and mixing outlined in *WAT-SG-11: Modelling Discharges to Coastal and Transitional Waters* should also be met.

Marine Science staff will work with the SEPA Operations staff member and the responsible person/ operator to agree the procedures that should be adopted for the further characterisation of the effluent, and to assess the results of the refined risk assessment.

On the basis of these results, if there is a risk to the aquatic environment, then the responsible person/ operator will be asked to reduce the effluent toxicity and/or a toxicity condition may be required in the discharge licence, in order to protect the receiving water environment.

If there is no risk, then a toxicity condition will not be required.

References

NOTE: Linked references to other documents have been disabled in this web version of the document.

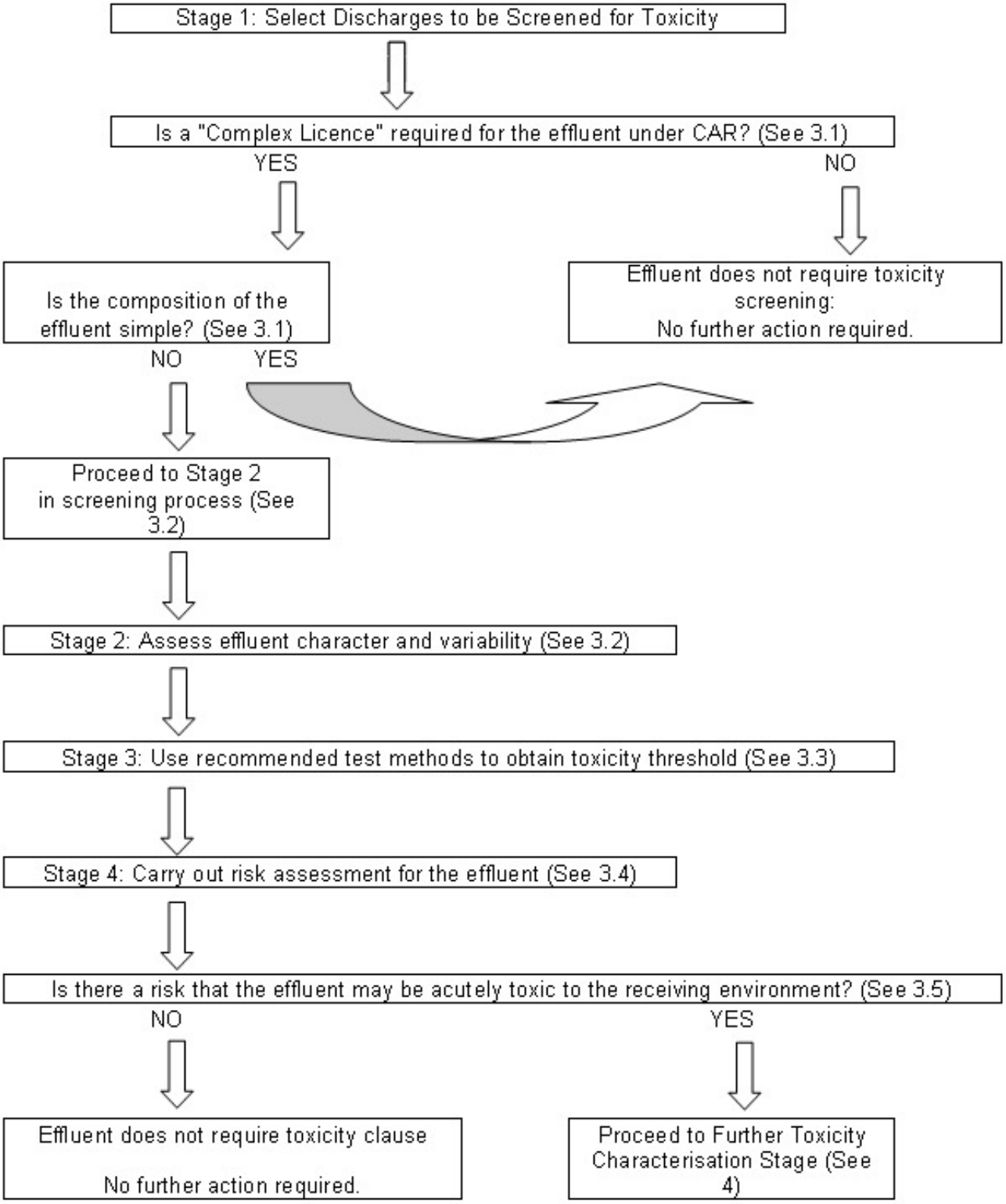
See the Water >Guidance pages of the SEPA website for Guidance and other documentation (*www.sepa.org.uk/water/water_regulation/guidance.aspx*).

All references to external documents are listed on this page along with an indicative URL to help locate the document. The full path is not provided as SEPA can not guarantee its future location.

- *WAT-SG-11: Modelling Discharges to Coastal and Transitional Waters* (Incorporating Policy No. 28), SEPA (2006)
- *The Water Environment (Controlled Activities)(Scotland) Regulations 2005* (http://www.sepa.org.uk/water/water_regulation.aspx)

Appendix 1: Toxicity Screening Process Summary

Figure 1 Summary of the Toxicity Screening Process



Appendix 2: Direct Toxicity Assessment Schedules

This appendix contains agreed text for use when adding a Toxicity Assessment Schedule and conditions to a licence.

When using this text to create your licence, please ensure you apply the correct condition numbering and formatting before issue.

There are three bodies of text you must include in your licence:

Definitions text for Discharge Toxicity Assessment

Schedule(s) of conditions

Explanatory Notes

Definitions

Add these definitions to the Interpretation of Terms section of your licence

"Toxicity Threshold Level" or "TTL" shall mean the concentration of effluent (expressed as % v/v effluent) derived from a risk assessment such that the discharge does not cause acute toxicity after initial dilution.

Toxicity Test Terminology:

"IC50" shall mean the concentration of a sample (expressed as % v/v effluent) that causes a 50% inhibition of activity in a standard toxicity test on the specified species over the specified period of time.

"EC50" shall mean the concentration of a sample (expressed as % v/v effluent) that causes a 50% effect (e.g. immobilisation or abnormal development) in a standard toxicity test on the specified species over the specified period of time.

"LC50" shall mean the concentration of a sample (expressed as % v/v effluent) that causes 50% mortality in a standard toxicity test on the specified species over the specified period of time.

Schedules

Add Schedule 1 Toxicity Conditions to your licence, plus the Contingency Plan schedule when appropriate. Ensure that you update the numbering and formatting according to your specific licence.

SCHEDULE 1. TOXICITY CONDITIONS

EITHER use 1.1

1.1 The Toxicity Threshold Level (TTL) for the discharge shall be <<X>>% v/v effluent

OR for situations where a toxicity reduction plan is required, use 1.1.1., 1.1.2 and 1.1.3

1.1.1 The <<responsible person/operator>> shall submit a toxicity reduction plan to SEPA by <<date B>> demonstrating how compliance with the Toxicity Threshold Level (TTL) of <<X>>% v/v effluent will be achieved by <<date C>>.

1.1.2 Following approval of the said plan by SEPA, the <<responsible person/operator>> shall implement it without delay.

1.1.3 After <<date C>> the TTL for the discharge shall be <<X>>% v/v effluent.

1.2 The <<responsible person/operator>> shall sample and test the toxicity of the discharge a minimum of <<X>> times per annum <<and at such intervals as shall be agreed by SEPA in writing>>.

1.3 The sampling and toxicity testing shall be undertaken in accordance with methods and standards that have been agreed by SEPA in writing.

1.4 The toxicity test results shall be submitted to SEPA in an agreed format every <<X>> months and within one month of the end of the <<X>> month period to which they relate.

EITHER use 1.5

1.5 In the event of any sample of the discharge breaching the TTL, the <<responsible person/operator>> shall implement without delay the contingency plan contained in Appendix <<X>> to this <<licence/permit>>.

OR for a licence review where the contingency plan has still to be provided, use 1.5.1 and 1.5.2

1.5.1 The <<responsbile person/operator>> shall submit to SEPA by <<date A>> a contingency plan detailing the action to be undertaken by the <<responsible person/operator>> in the event of a breach of the TTL.

1.5.2 In the event of any sample of the discharge breaching the TTL after <<date A>>, the <<responsible person/operator>> shall implement without delay the said contingency plan.

1.6 No sample of the discharge shall have a <<time period>> <<EC50/LC50/IC50>> value of less than <<X>>% v/v effluent when tested for toxicity to species.

SCHEDULE 2. APPENDIX <<X>> CONTINGENCY PLAN

2.1 The <<responsible person/operator>> shall report to SEPA any toxicity test result disclosing a breach of the TTL within two working days of receipt and the <<responsible person/operator>> shall at the same time commence investigating the cause and/or source of the increased toxicity of the discharge.

2.2 The <<responsible person/operator>> shall arrange to re-sample and re-test the toxicity of the discharge within two working days of receipt of the toxicity test result disclosing the breach.

2.3 If, on re-sampling and re-testing the toxicity of the discharge, the TTL is not breached, the <<responsible person/operator>> shall inform SEPA of the toxicity re-test result within five working days of completion of the said re-test, and shall submit to SEPA within a further 20 working days a written report on the investigation carried out under Condition 2.1 above. The sampling, testing and reporting regime shall then revert to that required by Conditions <<1.2 to 1.4>> of the <<licence/permit>>.

2.4 If on re-sampling and re-testing the toxicity of the discharge the TTL is still breached, the <<responsible person/operator>> shall inform SEPA of the toxicity re-test result within two working days of receipt and the <<responsible person/operator>> shall at the same time advise SEPA of the steps the <<responsible person/operator>> will take to reduce the toxicity of the discharge to meet the TTL.

Explanatory Notes

Add the following text at the end of the Explanatory Notes section of your licence.

The results of toxicity tests are typically expressed as an effect on a standard test species following exposure of that species to a given test substance (e.g. chemical or effluent) for a given period of time. The toxicity criteria are interpolated from observations made during the test, for example:

15 min IC50 to Microtox = concentration causing 50% inhibition of bioluminescence in standard 15-minute test on Microtox bacteria.

48 h LC50 to Tisbe battaglaia = concentration causing 50% mortality in standard 48 hour test on the marine copepod Tisbe battagliai.

24 h EC50 to oyster (Crassostrea gigas) embryos = concentration causing a 50% sub-lethal effect (e.g. abnormal development) in standard 24-hour test on the embryos of the Pacific oyster Crassostrea gigas.

Other terms often reported include:

NOEC = The No Observed Effect Concentration. This is the highest exposure concentration of a test substance that does not cause any observed and statistically significant adverse effects compared to the control(s).

LOEC = The Lowest Observed Effect Concentration. This is the lowest exposure concentration of a test substance that causes observed and statistically significant adverse effects compared to the control(s).

MATC = The Maximum Acceptable Threshold Concentration. This is determined as the geometric mean of the LOEC and NOEC.