Water Use

# Supporting Guidance (WAT-SG-85)

## Application of Standards to Thermal Discharges

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**Update Summary**

| Version | Description |
|---|---|
| v1.0 | First issue for Water Use reference using approved content from the following documents:<br>[*DRAFT SG Thermal Discharges WITMT Final*] |
| v2.0 | Expired CMS links reviewed and updated |
| v3.0 | Improved description of how to apply the mass balance equation, Annex 1 added. |

# Table of Contents

# 1. Key Points

This document provides guidance on the application of environmental standards in relation to both existing and new thermal discharges.

A discharge of thermal effluents is a controlled activity that is regulated under the Water Environment (Controlled Activities) (Scotland) Regulations 2011. The CAR Practical Guide defines the levels of authorisation of a thermal discharge as being either a Registration or Simple Licence.

Registration level thermal discharges, such as cooling waters where there is no chemical addition or, where there are no compliance implications with the thermal standards as described in The Scotland River Basin District (Standards) Directions 2104.

Simple Licence level thermal discharge, such as boiler blow-down discharges, cooling waters with chemical addition or, where there are compliance implications with the thermal standards as described in The Scotland River Basin District (Standards) Directions 2104.

# 2. Environmental Standards for Temperature

The main legislative driver for controlling the impacts of thermal discharges is from The Scotland River Basin District (Standards) Directions 2104. These implement the WFD standards for temperature which SEPA is now using in classification and will now use in regulating discharges. The temperature requirements are expressed in three forms as explained below.

## Absolute temperature requirement (see table 1)

For each class there is an absolute temperature standard applied as an annual 98%ile

## Increase/decrease over/under ambient temperature (see Table 1)

A discharge should not increase the ambient temperature by more than 2°C in waters of high ecological status or 3°C in waters of good ecological status as a 98%ile at the edge of the mixing zone. These uplift values are to be used in regulation of discharges but are not used in classification.

Release of water to rivers from the cold depths of reservoirs may result in reduced downstream river temperatures and adverse effects on ecology. It is proposed that a maximum allowable temperature drop be applied that mirrors the maximum uplift values. A step of 3°C should be used for all cases except for waters of high ecological status. In this case a maximum allowable drop of 2°C is proposed. Limits on the drop in temperature may also be needed for gasification plants at liquid gas terminals, where cold water may be discharged.

## Lower Limit for Spawning

A review of the spawning temperatures of UK species indicates that generally a maximum 10°C[1] during the spawning season should protect spawning of cool water species (i.e. Salmonids). No such limit should be applied to warm water species. This is not for use in classification but used, where appropriate, to regulate the operation of thermal discharges.

[1] Note (ii) from The Scotland River Basin District (Standards) Directions 2014 states: "Where application of a standard for temperature in row 4 would allow the water temperature of the river to exceed 10 °C for more than 2% of the time during the breeding period of salmonid fish species, SEPA must apply a more stringent standard than the standard in row 4 where it considers this necessary to avoid significant adverse impacts on the reproduction of those species."

## Table 1 Temperature Standards for Rivers

| | High | | Good | | Moderate | | Poor | |
|---|---|---|---|---|---|---|---|---|
| River Temperature Type | *Non-* | *Cypr.* | *Non-* | *Cypr.* | *Non-* | *Cypr.* | *Non-* | *Cypr.* |
| River temperature (°C) as an annual 98%ile standard | 20 | 25 | 23 | 28 | 28 | 30 | 30 | 32 |
| Increase / decrease in temperature (°C) in relation to the ambient river temperature, as an annual 98%ile standard | 2 | 2 | 3 | 3 | - | - | - | - |

Note - these values should not be used for lakes, estuaries and coastal waters.
*Non-* = Non-cyprinid, *Cypr.* = Cyprinid

# 3. Application of Standards

All thermal discharges should be assessed immediately below the mixing zone. The mixing zone can be calculated by contacting the ESIU, who are currently working on a new guidance procedure.

## 3.1 New Discharges

Apply regulatory standards relevant to existing class of water body if High or Good Ecological Status to ensure no deterioration. For example for a non-cyprinid watercourse, ensure no breach of 20°C or 23°C as an annual 98%ile, 2°C or 3°C as an annual 98%ile uplift from ambient temperature and 10°C maximum during the breeding season. If existing status is less than good, apply discharge limits to meet good status.

If a water body is at High status and the High/Good boundary temperature limit of 20°C as a 98%ile would be breached by a proposed thermal discharge, this would be contrary to the WFD no deterioration requirement and discharge limits would have to be imposed to prevent this. The same would apply if the discharge would breach the 23°C Good/Moderate boundary. Derogation tests in WAT-RM-34: Derogation Determination - Adverse Impacts on the Water Environment could be applied. If the receiving water body is a water dependant Special Area of Conservation, follow SEPA's Nature Conservation Procedure regarding Appropriate Assessments.

Annex 1 describes how to estimate the temperature uplift and where to access the relevant information needed to make the assessment.

## 3.2 Existing Discharges

If classification standards are met for High or Good Ecological Status, no further action is required unless there is evidence of an ecological impact. If there is ecological damage as a result of the thermal discharge, use discharge limits and licence conditions to meet regulatory standards i.e. no breach of uplift standards and no breach of 10°C during spawning and early emergence for salmon and trout. This is generally taken to be mid October to mid March but river systems vary and advice should be taken from the local Fisheries Trust or District Salmon Fishery Board staff and SEPA Fisheries Scientists.

If classification standards are not met for Good Ecological Status, can the operator provide evidence of no ecological impact attributable to the thermal discharge? SEPA Fisheries Scientists can provide guidance on the evidence required for consideration as proof of no ecological impact. If no ecological impact, no further action.

If still breaching the classification standard and ecological impact proven, tighten discharge limits further or look at cumulative impacts and review upstream thermal inputs.

# 4. Regulatory Process – Existing Discharges

## 4.1 Initial Assessment

Where thermal discharges are monitored the monitoring must include the receiving watercourse downstream of the mixing zone. Compliance with WFD temperature classification standard and no ecological impact shown by SEPA, no further action is required.

If planned sampling shows temperature standard breached, give the option to operator to install continual monitoring (hourly, 7 days per week) to take advantage of the annual 98%ile standard for upper temperature limit and carry out fish studies to show if there is no impact. If compliance with the annual 98%ile classification standard and no ecological impact, no further action.

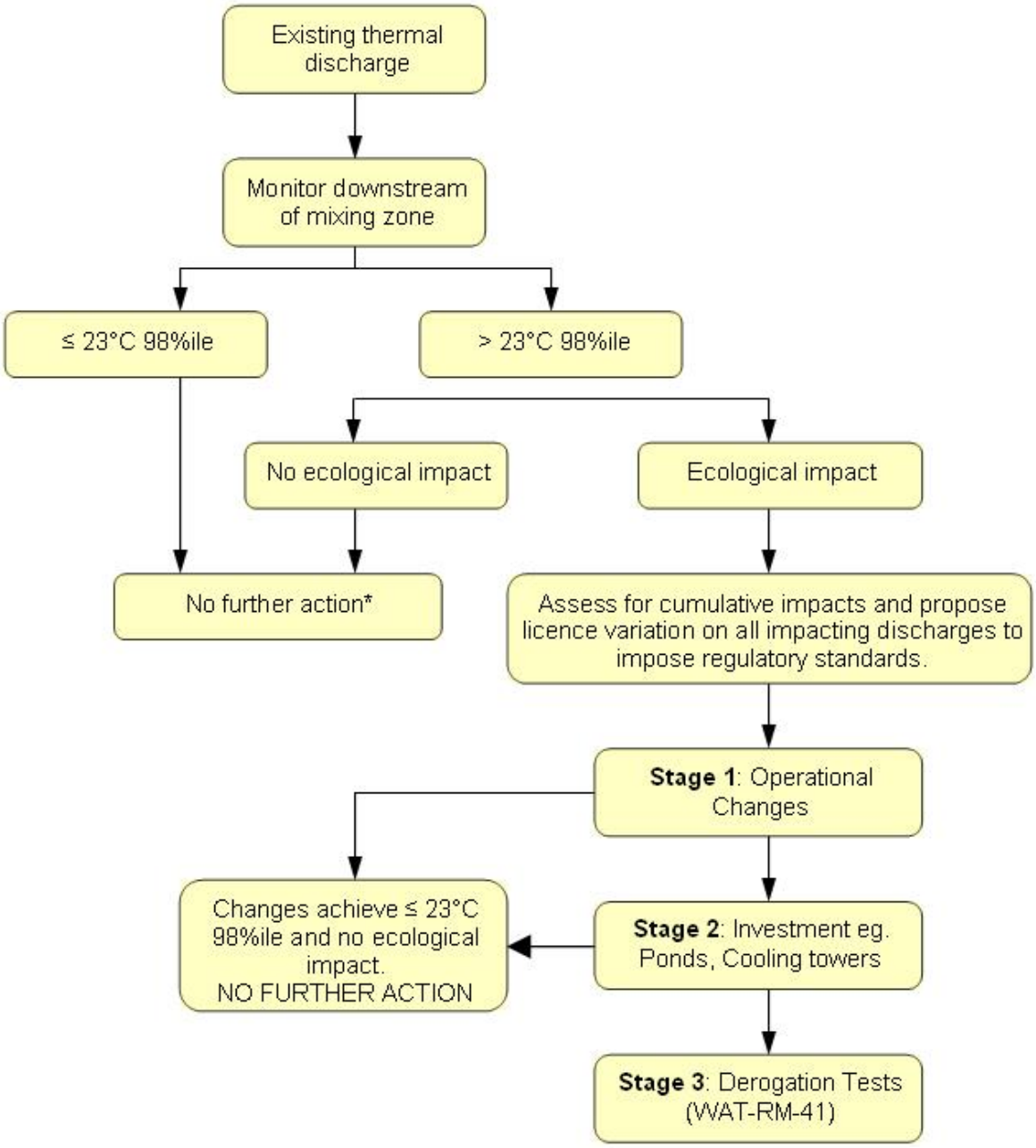
## 4.2 Licence Review Following Assessment Failure

Assuming continual monitoring installed upstream and downstream, assess periods of non-compliance with the environmental standards. Discuss licence review and likely variation to impose uplift standards on discharge with operator. Three stage process, over 3 cycles of RBMP if necessary:

1. Work with operator, for a low cost solution, to make operational changes to reduce peak temperatures eg when stills are driving;
2. Work with operator to consider technical improvements regarding capital investment to reduce peak temperatures eg heat recovery systems, cooling ponds, cooling towers (where step i does not work);
3. Where operator unwilling to take measures i and ii request necessary information from the operator to assess compliance with standard against derogation process as per WAT-RM-34: Derogation Determination - Adverse Impacts on the Water Environment and WAT-RM-41: Derogation Determination – Improvements to the Water Environment; this will be part of the SEPA initiated variation.

Note that failure to meet the WFD temperature standard is a failure of the water body to meet Good Status; however WFD derogations may apply. The tests are set out in *WAT-RM-34* / *WAT-RM-41* and are based on whether meeting the standard is disproportionately expensive or technically feasible. In order for SEPA to properly assess this, the operator must also have shown that all practicable steps are taken to mitigate the adverse impact on the status of the body of water. Therefore the operator must submit information on the first 2 stages in their application to vary their licence.

**Figure 1 Example process for an existing discharge to a good status watercourse**




* Note: Ordinarily no further action is required unless additional information is available eg reports from District Salmon Fishery Board or Fisheries Trust indicating fish data problems. These may be caused by breaches of 10°C limit during spawning/emergence or spikes in discharge temperatures not picked up during routine sampling and further investigations will be necessary. This may take the form of installation of continuous temperature monitoring.

# Annex 1: Estimating temperature uplift in receiving waters from a proposed thermal discharge

## The general mass balance equation

Where a new discharge is proposed it will be necessary to estimate the impact upon the temperature of receiving waters in order to apply the temperature environmental standards.

The resultant temperature of two or more mixed flows of water can be calculated using a mass balance approach such that the final mixed temperature, t, can be calculated using equation 1.

$$t = (Q1\ t1 + Q2\ t2 + ... + Qn\ tn) / (Q1 + Q2 + ... + Qn) \quad \text{(equation 1)}$$

where,

t = final temperature (°C),

Q1..n = flow rates of streams (ls-1),

t1..n = temperatures of flows (°C)

Note: this assumes the streams of water being mixed have the same specific heat capacity

## Choosing the appropriate flow and temperature for the receiving water

The environmental standards are based upon the 98th percentile temperature change i.e. it may be exceeded for no more than 2% of the time. Since the estimation of temperature change is dependent upon flows and temperatures in receiving waters which have their own site-specific frequency distributions it is necessary to choose an appropriate combination of flow and temperature percentiles in receiving waters to determine whether this standard is likely to be breached.

In the absence of local collected temperature data, SEPA recommends that applicants use the temperature data from Anderson et al 2010[2] (available from SEPA Water Resources Unit) for the location of the proposed discharge. Where the proposed discharge is above (i.e. upstream of the last data point) then the applicant is advised to use the closest downstream data point.

Flow and temperature in natural waters are, to some extent, dependent on one another. High natural rivers temperatures are more likely to occur during low flows for both climatological and energy balance reasons. However, the quantifiable nature of their dependence will be unknown unless detailed flow and temperature data are available. The 98th percentile water temperature in

[2] Anderson, H., Futter, M., Oliver, I. Redshaw, J. and Harper, H. 2010. Trends in Scottish river water quality. Scottish Environment Protection Agency report. 15 January 2010.

a river is most likely to occur when flows are low and for the purposes of estimation to determine the likelihood of breaching the thermal standards, the calculation should be based upon the 95th flow percentile. If a seasonal temperature uplift is to be calculated, e.g. during the spawning period, the seasonal 95th flow percentile should be used.

## Example of calculating the thermal uplift of a proposed discharge

An effluent flow rate of 1 ls-1 at 40°C is proposed to be discharged into a natural stream. The receiving water course has an estimated Q95 of 10 ls-1 and the 98th percentile ambient water temperature is 16°C.

The resultant mixed temperature given this discharge can be calculated from equation 1 as:

t = (10 *16) + (40*1) / (10+ 1)

therefore,

t = 18.2°C

So, from this we can see that the estimated 98th percentile increase in temperature above the ambient level will be:

18.2 – 16 = 2.2°C

In this example then, the proposed discharge would lead to a breach of the 2°C high status environmental standard for temperature increase (see bottom row of table 1).

# References

## Key Documents

- WAT-RM-34: Derogation Determination - Adverse Impacts on the Water Environment
- WAT-RM-41: Derogation Determination – Improvements to the Water Environment
- Nature Conservation Procedure SEPA Intranet

*- End of Document -*