For the future of our environment

WAT-SG-85 Guidance on Authorising Thermal Discharges v5.0

July 2023

Update Summary

Table 1: Update Summary

Version	Description
v1.0	First issue for Water Use reference using approved content from the following documents: [*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
V4.0	Guidance on applying standards to permits
V5.0	Changed title from “Application of Standards to Thermal Discharges” to “Guidance on Authorising Thermal Discharges”. Added Annex 2 on how to calculate the end of pipe standard to meet the environmental standards. Added that in the absence of site-specific data we recommend the use of Marine Scotland data for river temperatures. Removed paragraphs 3-5 of key points as covered in CAR practical guide. Simplified and updated text.

1. Introduction

This document provides guidance on the authorisation of both existing and new thermal discharges.

The discharge of thermal effluent is a controlled activity that is regulated under the Water Environment (Controlled Activities) (Scotland) Regulations (CAR) 2011. The CAR Practical Guide defines the levels of authorisation for these discharges.

2. Environmental Standards for Temperature

2.1 Environmental Standards - Rivers

The Scotland River Basin District (Standards) Directions 2014 set out the Scottish Government temperature standards for rivers for use in classification and in regulating discharges. The temperature requirements are expressed in three forms as explained below.

2.1.1 Absolute Temperature Requirement (see Table 2)

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

2.1.2 Increase/Decrease over/under Ambient Temperature (see Table 2)

A discharge should not change 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 after mixing. These values are to be used in regulation of discharges but are not used in classification. This change in temperature applies to both increase in temperature or reduction in river temperature. For example, release of water to rivers from the cold depths of reservoirs or from gasification plants at liquid gas terminals, where cold water may be discharged.

2.1.3 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] Reference to 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 2: Temperature Standards for Rivers

	High		Good		Moderate		Poor	
River Temperature Type	*Salmonid*	*Cyprinid*	*Salmonid*	*Cyprinid*	*Salmonid*	*Cyprinid*	*Salmonid*	*Cyprinid*
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.

2.2 Environmental Standards – Marine Waters

There are no temperature standards for marine waters in the Scottish Government Directions. However, the British Energy Estuarine and Marine Studies have produced Scientific Advisory Report Series 2011 no. 008, which establishes thermal standards for marine waters[2]. These are set out in Table 3.

We will use these as operational environmental standards until the Scottish Government directions include a temperature standard for marine waters or further evidence becomes available.

Table 3: Temperature Standards for Transitional and Coastal Waters

	Normative definition boundary positions (as annual 98%ile)			
	High	Good	Moderate	Poor
Maximum Allowable Temperature	23°C	23°C	28°C	30°C
Maximum Allowable Temperature Uplift	+2°C	+3°C	+3°C	+3°C

Note - these values were produced for England and Wales

3. Application of Standards

All thermal discharges should be assessed after mixing. Examples of how to do this are set out in Annex 1&2.

[2] Scientific Advisory Report Series 2011 no.008 https://www.cefas.co.uk/publications/environment/beems-scientific-advisory-report-no-008.pdf

3.1 New Discharges

Apply regulatory standards relevant to existing temperature class of water body if High or Good Ecological Status to ensure no deterioration. For example, for a salmonid 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 change from ambient temperature and 10°C maximum during the breeding season. If existing temperature status is less than good, apply discharge limits to meet good status.

If a water body is at High status for temperature 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 Scottish Government's 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. If the receiving water body is a water dependant Special Area of Conservation, follow SEPA Conservation Procedure for CAR activities in Freshwater SAC, SPAs and SSSIs.

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

3.2 Existing Discharges into Rivers

For discharges to rivers permit review assessments will be made against the maximum and °C change in temperature regulatory standards[3] relevant to the existing temperature class of water body. Where the discharge has been in place since before 2008 (the start of river basin planning) then you should assess against the good standards since local deterioration may have already occurred and restoration to good is what is required. The first step is to do some mass balance calculations using simple data. If the standards are not met, you should recalculate

[3] If these standards are met the 10°C standard for the salmon breeding season is also likely to be met.

based on more site-specific data. For example, you could use measured actual effluent discharge rate and actual effluent temperature.

However, even the best environmental standards are not perfectly matched to ecological risk. Therefore, rather than taking action based on the temperature standards alone, operators have the option to determine if there has been an ecological impact. This could include an ecology survey and information from District Salmon Fishery Board or Fisheries Trust.

Figure 1 sets out the review process for existing licensed thermal discharges to rivers to establish an end of pipe temperature limit[4]. Annex 2 gives some worked examples.

Where changes to the permit are required, you should discuss with the operator how they can alter the temperature of their discharge so that once mixed in the river it will meet the environmental standards. There is a two-stage process:

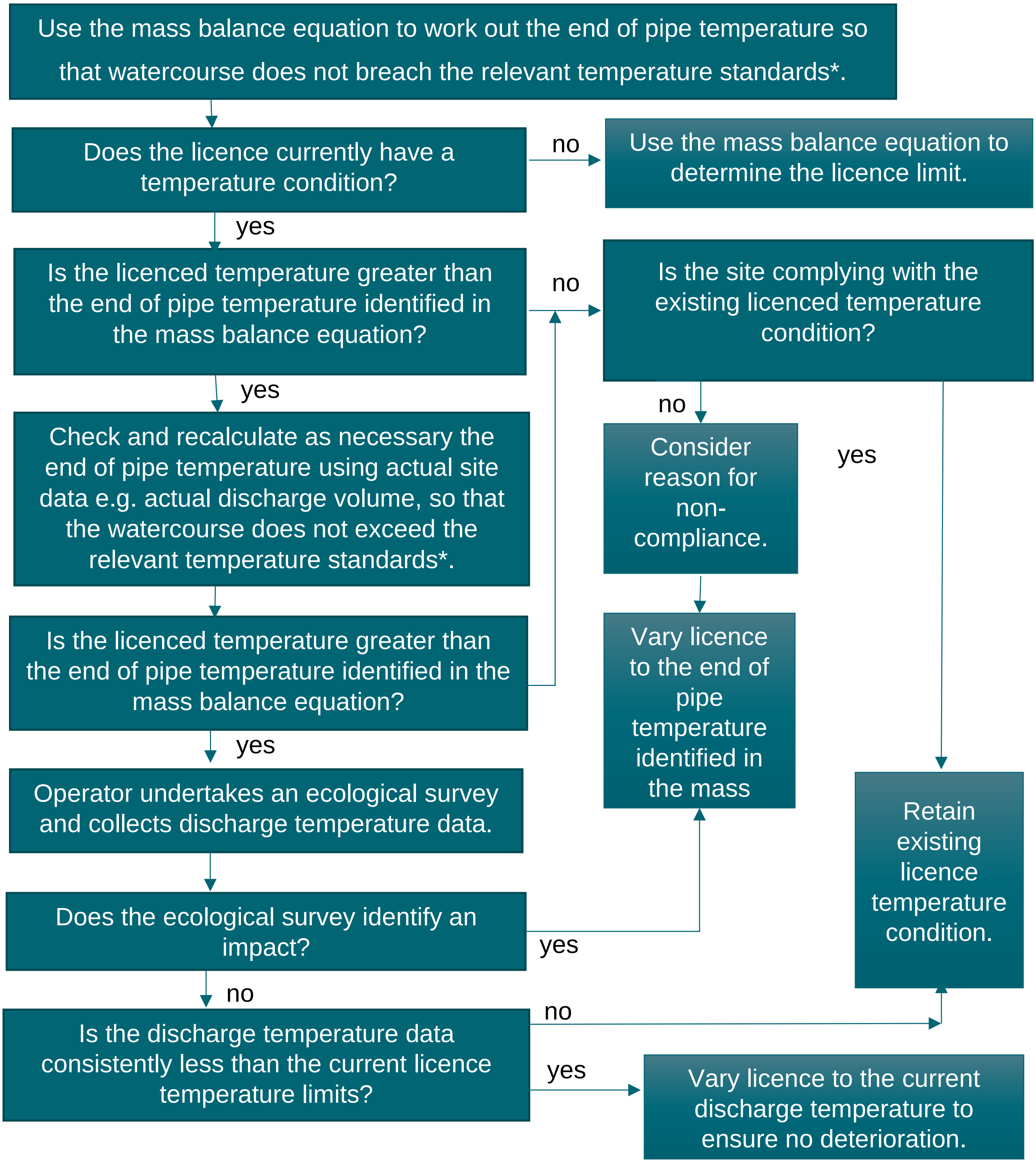
i. Work with operator, to find a low-cost solution to make operational changes to reduce peak temperatures e.g., when stills are driving;

ii. Work with operator to consider technical improvements requiring capital investment to reduce peak temperatures e.g., heat recovery systems, cooling ponds, cooling towers (where step i does not work)[5];

[4] Assessment of this end of pipe standard could be at a suitable point close the end of pipe.

[5] The operator also has the option to apply for a derogation in line with WAT-RM-41

Figure 1: Process for Assessing Discharges



* This should be the maximum permitted temperature and the uplift/reduction in temperature.

Annex 1: Estimating temperature change in receiving waters from a proposed thermal discharge.

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_R, can be calculated using equation 1.

$T_R = (Q_W T_W + Q_D T_D) / (Q_W + Q_D)$ (equation 1)

where,

T_R = resultant temperature in the watercourse (˚C),

Q_W = flow rate in the watercourse(m^3/day). When calculating if the maximum river temperature will be exceeded you should use the Q95 flow. This is because the 98th percentile water temperature in a river is most likely to occur when flows are low. If a spawning period temperature change is to be calculated a Q50 flow should be used as flows are not likely to be very low during spawning season.

Q_D = flow rate of the discharge (m^3/day). For distillery discharges this could be based on maximum daily abstraction volume (m^3/day).

T_W= temperature of the watercourse (˚C). When calculating if the maximum river temperature will be exceeded you should use a maximum or Q98 temperature. In the absence of local collected temperature data SEPA recommends that applicants use the temperature data from Marine Scotland's Information webpage[6] 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. If a spawning period temperature change is to be

[6] Marine Scotland's Scotland River Temperature Monitoring Network http://marine.gov.scot/information/scotland-river-temperature-monitoring-network-srtmn-predictions-river-temperature-and Either use the 98%ile of the hottest day of the 20 year dataset or the max of the 2015/16 dataset. Click on the relevant river and then expand the "SRTMN" on the "Feature Information" pop up box.

calculated use a maximum or Q95 temperature for an appropriate month. If this is not available SEPA recommends using a river temperature of 8.5°C.

T_D =max temperature of the effluent (98% ile)

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

Example of calculating the thermal change of a proposed discharge

86.4m^3/d of effluent at 40˚C is proposed to be discharged into a stream. The receiving water course has an estimated Q_{95} of 864m^3/d and the 98th percentile ambient water temperature is 16˚C.

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

T_R = ((864*16) + (40*86.4)) / (86.4+864)

therefore,

T_R = 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, the proposed discharge would comply with the good status environmental standard (3˚C) for temperature increase.

Annex 2: Calculating the end of pipe temperature limit required to meet the river temperature standards.

For a discharge, we can calculate the absolute end of pipe temperature limit which would ensure the river temperature complies with the regulatory standards.

To do this we can rearrange the mass balance equation in the section above as follows:

$T_D = (T_R (Q_W + Q_D) – (Q_W \times T_W)) / Q_D$

T_R=resultant temperature in the river (˚C),

Q_W = flow rate in the watercourse (m^3/day)

Q_D = flow rate of the discharge (m^3/day)

T_W= temperature of the watercourse (˚C)

T_D =max temperature of the effluent (˚C) as 98%ile.

Example of calculating the thermal discharge limit for a new discharge

800m^3/day of effluent is proposed to be discharged into a natural stream. The receiving water course has an estimated Q_{95} of 1000m^3/day and the max ambient water temperature is 20˚C (from Marine Scotland)

This is a good status waterbody so the maximum river temperature must not exceed 23°C.T_R= 23°C

Q_W = 1000 m^3/day

Q_D = 800 m^3/day

T_W= 20°

$T_D = (T_R (Q_W + Q_D) – (Q_W \times T_W)) / Q_D$

$T_D = (23 (800+ 1000) – (1000 \times 20)) / 800$

$= (23 \times 1800) – 20000) /800$

$= 26.8$ °C

The uplift is 3°C (the difference between the max ambient water temp 20°C – and the 23°C water temperature limit).

The discharge limit should be set at 26.8°C to ensure the temperature in the river remains below 23 °C. If the operator would like the option to discharge smaller amounts at a higher temperature, then a variable temperature/discharge table can be included in the licence. Table 4 sets out how this may look. If the operator requests this then the operator will be required to monitor the daily flow rate and daily maximum temperature of their discharge.

Table 4: Example of load-based discharge/temperature limits.

Maximum daily discharge rate	Daily maximum temperature of the discharge
800m^3/d	26.8°C
600m^3/d	28.0°C
400m^3/d	30.5°C
200m^3/d	38.0°C

Where the ambient temperature of the receiving water is above 23°C contact SEPA to discuss.

Examples of Reviewing Whisky Distillery Cooling Water Discharge Licences

Example 1

A Whisky distillery has an existing CAR licence with a cooling water temperature limit of 20°C. There is a CAR licence for the cooling water abstraction (max 2000m^3/day), the ambient river temperature of the river at the discharge point is 19°C (Marine Scotland) and the Q95 at the discharge point is 1900 m^3/day.

The discharge is into a good status waterbody so the temperature in the watercourse must remain below 23°C. The uplift should not be greater than 3°C. The ambient river temperature is 19°C. The permitted uplift must be no more than 3°C so the end of pipe standard we are calculating below is based on meeting a river temperature standard of 22°C (19+3°C as this is less than 23°C).

1. Use the mass balance equation to calculate the end of pipe standards

$T_D = (T_R\ (Q_W + Q_D) – (Q_W \times T_W))\ /\ Q_D$

$T_D = (22\ (2000+ 1900) – (2000 \times 19))\ /\ 1900$

= (22 (3900) –38000) /1900

= (85000-38000) /1900

= 25.16°C = 25°C

The temperature of the effluent to ensure that the watercourse temperature does not exceed 23°C and the uplift is less than 3°C, is 25°C.

2. Is the licenced temperature greater than the end of pipe temperature identified in the mass balance equation?

No, the licensed temperature (20°C) is not greater than the calculated temperature of 25°C

3. Is the site is complying with the licence limit of 20°C?

Yes, retain the limit of 20°C in the licence.

Example 2

A Whisky distillery has an existing CAR licence with a cooling water temperature limit of 27°C. There is an existing CAR licence for the cooling water abstraction (max 280m^3/day), the ambient river temperature at the discharge point is 21˚C (Marine Scotland) and the Q95 in the watercourse at the discharge point is 1,500 m^3/day.

The discharge is into a good status waterbody so the temperature in the watercourse must remain below 23°C and the uplift should not be greater than 3°C. The end of pipe standards we are calculating below are based on meeting a river temperature standard of 23°C. The ambient river temperature is 21°C. The uplift will be (23-21 < 3°C) so the calculations below will meet this 3°C requirement.

1. Use the mass balance equation to calculate the end of pipe standards

$$T_D = (T_R\ (Q_W + Q_D) – (Q_W \times T_W)) / Q_D$$

$$T_D = (23\ (280+ 1500) – (280 \times 21)) / 1500$$

$$= (23\ (1780) – 5880) /1500$$

$$= (40940-5880) / 1500$$

$$= 23.37°C$$

The temperature of the effluent to ensure that the watercourse temperature does not exceed 23°C and the uplift is less than 3°C, is 23.37°C .

2. Is the licenced temperature greater than the end of pipe temperature identified in the mass balance equation?

Yes, the licensed temperature (27°C) is greater than the calculated temperature of 23.37°C

3. Check and recalculate as necessary the end of pipe temperature using actual site data

The site has reliable data on the intake temperature, close to the abstraction point. This provides an accurate mean ambient temperature of the watercourse which can be used instead of the Marine Scotland temperature. This is 18°C

$T_D = (T_R (Q_W + Q_D) – (Q_W \times T_D)) / Q_D$

$T_D = (23 (280+ 1500) – (280 \times 18)) / 1500$

$= (23 (1780) – 5040) /1500$

$= (40940-5040) / 1500$

$= 23.93°C = 24°C$

4. Is the licenced temperature greater than the recalculated end of pipe temperature identified in the mass balance equation?

Yes, the licenced temperature (27°C) remains greater than the recalculated figure (24°C).

The operator undertakes an ecological survey.

5. Does the ecological survey identify an impact?

No, no ecological impact is identified in the watercourse.

6. Is the discharge temperature data consistently less than the current licence temperature limits?

Yes, the discharge temperature is always less than the 27˚C limit and never above 25˚C.

The new licence limit will be 25°C.

Example 3

A whisky distillery has an existing CAR licence with a cooling water temperature limit of 25°C. There is an existing CAR licence for the cooling water abstraction (max 3000m^3/day), the ambient river temperature at the discharge point is 21°C (Marine Scotland) and the Q95 in the watercourse at the discharge point is 1,500 m^3/day.

The discharge is into a good status waterbody so the temperature in the watercourse must remain below 23°C and the uplift should not be greater than 3°C. The end of pipe standards we are calculating below are based on meeting a river temperature standard of 23°C. The ambient river temperature is 21°C. The uplift will be (23-21 < 3°C) so the calculations below will meet this 3°C requirement.

1. Use the mass balance equation to calculate the end of pipe standards

$T_D = (T_R (Q_W + Q_D) – (Q_W \times T_D)) / Q_D$

$T_D = (23 (3000+ 1500) – (3000 \times 21)) / 1500$

= (23 (4580) – 5880) /1500

= (105340-63000) / 1500

= 28.2°C

The temperature of the effluent to ensure that the watercourse temperature does not exceed 23°C and the uplift is less than 3°C, is 28.2°C.

2. Is the licenced temperature greater than the end of pipe temperature identified in the mass balance equation?

No, the licensed temperature (25°C) is not greater than the calculated temperature of 28.2°C.

3. Is the site complying with the existing licenced temperature condition?

No, there have been breaches of the 25°C limit over the past 3 years.

Consider reason for non-compliance and in discussion with the operator, the licence can be varied to 28°C.

Note that if the operator would like the option to discharge smaller amounts at a higher temperature, then a variable temperature/discharge limits may be considered. Table 4 provides an example of how this might look. If the operator requests this then the operator will be required to monitor the daily flow rate and daily maximum temperature of their discharge.

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