

## **RAW WATER SCREENING TO PROTECT EELS (EEL SCREENS)**

<b>TECHNICAL NOTE REF</b>	<b>:</b>	<b>TRPM – TN009</b>
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## 1.0 INTRODUCTION

The European Commission's Eel Recovery Plan (Council Regulation No. 1100/2007) was initiated to address the decline of European Eel (*Anguilla anguilla*) and return stocks to sustainable levels. The UK and other member states are required to comply with this regulation and take actions to reverse the species decline by means of implementing national Eel Management Plans (EMPs). The Eels Regulations 2009 came into force on 15 January 2010 as a statutory instrument to support policy implementation in England and Wales.

In England, the Environment Agency (EA) is tasked with the implementation and management of EMPs and has the regulatory powers to require installation / maintenance of eel protection measures. The EA may serve notice on an asset owner (e.g. Water Company) to construct an eel pass or remove any such structure where eel passage is likely to be impeded. Once an Eel Pass has been constructed, the asset owner is then obliged to maintain it. The impact of the regulations on abstractions is related to abstractions greater than 20 cubic metres of water in a 24 hour period. Similarly the EA may also serve notice requiring a Water Company to install a suitable screen at any such abstraction structure in order to protect eels. Programme Implementation began in 2013 with the EA providing Water Companies with a prioritised list of all known locations where action was needed to ensure compliance with the eel regulations and wider fish passage requirements under the (Water Framework Directive) WFD.

In January 2015, it became an offence not to have a screen at an intake or outfall unless there was exemption by the EA. The EA advised that screens should be primarily designed to ensure that eels are not impinged or entrained but in certain site-specific circumstances a Fish Recovery Return (FRR) system may be employed to return eels unharmed to the watercourse. Enforcement began in early 2015, which coincided with the start of the Water Industry AMP6 Investment Period.

## 2.0 EA GUIDANCE

In 2010 the EA published the following guidance:

'GEHO0411BTQD-E-E – Screening at Intakes and Outfalls: Measures to Protect Eel', a document commonly referred to as "The Eel Manual".

A PDF version of the document is available on the Environment Agency web site, thus: [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/297342/geho0411btqd-e-e.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/297342/geho0411btqd-e-e.pdf)

(Link information correct as at August 2015).

The Eel Manual provides technical guidance on screenings methods for eel and offered advice on design criteria regarding the various relevant technologies available at the time.

Some of the technology however was unproven, indeed the Eel Manual states (Pg 11) *"The regulatory requirements for screening to protect eel are relatively new. We therefore have only limited information at present. However interest in, and research into, this subject is growing, especially within the European Union.*

*Of necessity, some of the information in this manual is new and does not come from peer reviewed sources. We plan to update and expand the manual as evidence and research become available".*

## 2.0 EA GUIDANCE (CONT)

Eel screening technologies, within Section 4.0 of the Eel Manual, are sub-divided into three broad categories with generic screen types provided for each including:

- Positive exclusion methods for adult eels  
Traditional passive, mesh panel screens  
Bar Rack Screens  
Spillway Screens  
Band and Drum Screens c/w FRR
- Physical screening for elvers and glass eels  
Passive Wedgewire Cylindrical Screens  
Wedgewire Panel Screens  
Self-Cleaning Belt Screens  
Sub Gravel Intakes
- Behavioural barriers and guidance methods  
Louvre screens  
Bubble curtain  
Electric barriers  
Acoustic guidance  
Light-based systems

At the time, most 'Behavioural Barriers' technologies were deemed unsuitable for eel due to the characteristic responses the species exhibits to different stimuli. Eel differ from other species / fish as they tend not to exhibit avoidance responses to screens and can compress bodies to squeeze through apertures. Eels are tactile species and exhibit a searching behaviour upon physical contact with a screen. Eels characteristically exhibit Positive Rheotaxis - tendency to follow water currents at intakes. Eels show Negative Phototaxis – strong tendency away from light. Subsequently, only Light Based Systems were therefore identified as a suitable Behavioural Barrier Technology.

## 3.0 PRACTICAL APPLICATION OF EA GUIDANCE

In anticipation of implementation of the Eel Regulations, and given uncertainties regarding the unproven emerging technologies within the industry, a consortium of UK Water Companies appointed Thompson RPM to investigate the wide of range existing and emerging screen equipment available.

A comprehensive literature review and market research was undertaken. Also a working party was set up (including representatives from the Consortium Water Companies with occasional inputs from the EA and selected screen equipment suppliers) to discuss potential eel screen technologies and explore their suitability for applications / solutions at various locations within a water course.

The working party considered various screen technologies including those from other areas of the Water Industry (for example, wastewater screens) for potential 'cross-over'. Ultimately, equipment and technologies considered as suitable were included in the 'Eel Screens Selection / Design Guide' report reference TRPM – REP273 issued in July 2013.

This report included the identification of numerous screening technologies and their collation by generic type. Various site visits and case studies were conducted and compiled, and the report concluded by offering high-level selection guidance and general design considerations.

### 3.0 PRACTICAL APPLICATION OF EA GUIDANCE (CONT)

#### 3.1. UK (WIMES) Definitions

The equipment considered suitable for use within TRPM – REP273 were classified by generic type, with these types aligned to existing industry terminology as used within the Water Industry Mechanical & Electrical Specifications (WIMES). The WIMES applicable to Eel Screens is WIMES 5.01 – ‘Raw Water Intake Screens’ – Issue 2, published April 2014. Although not specifically for eel, WIMES 5.01 identifies and mentions a number of generic screen types as follows:

- *Grab Screens* are coarse bar screens primarily intended for heavy duty applications on large intakes such as treatment works and power stations. They generally feature a grab with opening / closing jaws to remove screenings from the screen. Units also generally feature an overhead monorail system which traverses the whole width of the screen curtain. Screenings are typically discharged from the grab unit to a remote skip at the far end of the monorail, thus negating the need for an additional screenings transfer system.
- *Raked Bar Screens* are coarse bar screens generally intended for heavy duty applications on medium / small intakes such as culverts or land drainage pumping station schemes. The bar screen curtain is cleaned by a raking mechanism which lifts debris and discharges via scraper blade into a launder trough or conveyor for transfer towards a skip. These types of screens can be split into various sub categories including Hand Raked Bar Screen, Continuous Chain Raked Bar Screens & Straight Bar which can feature front or back rake mechanisms.
- *Static Screens* are non-mechanical units generally incorporating basic wedge wire mesh panels. These can also be sub-divided into categories including Flat WW, PWWC (Passive Wedge Wire Cylinder) or Spillway Coanda type screens which are inherently self cleaning units. PWWC (and now some Flat WW) units are typically designed to be cleaned with backwash flushing systems using compressed air.
- *Bandscreens* have been historically used for high abstraction applications such as treatment works or Power Stations. These screens feature an assembly of panels to form a travelling mesh curtain which elevates and then deposits debris into an internal launder trough for screenings transfer. The screen panels can be cleaned by spray bar or deluge system. Some models can also incorporate a Fish Recovery and Return (FRR) System featuring elevator buckets to safely remove species for deposit into a dedicated launder trough for transfer return to the receiving watercourse unharmed.
- *Drum Screens* are primarily intended for high capacity abstractions such as power stations or treatment works. The large diameter rotating mesh drums are also cleaned by spray bars and deposit debris into an internal launder trough. These can also incorporate FRR.
- *Slotscreens* are self cleaning belt screens typically comprising a number of modular moulded PVC elements providing a continuous articulated belt of fine slots. Captured screenings are elevated and returned to the watercourse by a spray bar system (and possibly by FRR).
- *Disc Screens* feature a number of in-line shafts fitted with overlapping and intermeshing discs driven by a motor / gearbox. Screenings are effectively cleaned by positive transportation along the screen, in the direction of the continuation flow, by the rotation of the inter-meshing shaft and disc assemblies. (These are potentially fatal to fish and deemed unsuitable for eel).

WIMES 5.01 also includes examples of each type of equipment currently available within the UK market, although the list is not intended to be comprehensive, or to indicate preferred suppliers.

#### 4.0 EQUIPMENT SELECTION – OPTIONS

Some Eel Screen Design Considerations discussed in TRPM – REP273 follow below. It should be made clear, and noted by the reader, that the text that follows is the opinion of Thompson RPM Ltd, and is not in any way an attempt to define or describe any regulatory requirement or influence industry practice.

- *Behavioural Barrier Technologies* mostly have been deemed unsuitable for eel. Only light based systems were identified as suitable and only then used either as a supplement for physical screens or where design constraints preclude the use of physical screens
- *Bar Screens (including Grab and Raked Bar Screens)* with narrow spacing's are suitable for adult excluding eel > 50 km above the tidal limit
- *Bar Screens* are suitable as coarse screen protection for finer screens to create a two stage coarse / fine screening system for juvenile eels
- *Spillway Screens* are suitable for juvenile eel but are typically hydraulically limited by topology
- *Bandscreens and Drum Screens* with 2-3 mm mesh apertures can be suitable for juvenile eel but preferably should be modified for FRR
- *PWWC screens* are suitable for juvenile eel but have limited abstraction capacity unless multiple units are used.
- *Slot Screens (Self Cleaning Belt Screens)* are suitable for juvenile eel but PVC versions may require coarse screen protection.

A variety of emerging and other unproven screen technologies not reviewed in The Eel Manual or mentioned in WIMES 5.01 were considered by the Working Party and discussed in TRPM – REP273. It was expected that established suppliers of such equipment would develop innovative product solutions as the implementation of the eel screening programme gathered momentum. Accordingly TRPM – REP273 recommended:

- *The various emerging technologies should be monitored in terms of product development, establishment, market position and performance.*
- *As more information and experiences become available, consideration should be given to periodic revisions / updates to this report.*
- *In particular, emerging and 'cross-over' technologies should be encouraged, and similarly monitored.*
- *Those responsible for the WIMES Initiative should be encouraged to update the existing Specification for Raw Water Intake Screens (WIMES 5.01) to include eel screening technologies.*

## **5.0 FURTHER RECOMMENDATIONS – TEST FACILITY**

Within The Eel Manual Appendix E: Recommendations for further work, the EA mentioned previous proposals (Solomon 1992) for a purpose built facility to test different models and types of fish screens. Also one of the key recommendations from TRPM – REP273 (within Section 10.2) was as follows:

*“Consideration should be given to the establishment of a central (national) evaluation facility at which suppliers of all screens / technologies are given the opportunity to demonstrate regulatory compliance together with product process, structural and mechanical performance.”*

In November 2013, some of the original Consortium Water Company members appointed TRPM to search for a suitable location for such a facility. Although not specifically within the scope of this search, an element of outline design was required prior to any geographical review. Following an industry-wide consultation with regulators, practitioners and equipment suppliers, an outline design was produced identifying the key features / components required at any proposed facility.

Unfortunately due to the limited project budget, only a limited number of locations were identified to conduct physical site visits and none of these were considered suitable as a location for the proposed facility. It is the considered opinion of TRPM that as more technologies emerge some form of equipment evaluation would benefit the industry and enable Water Companies / End Users to form a policy and procurement strategy in response to changes in legislation. Various interested parties including the EA, Water Companies and Equipment Suppliers have shown continued enthusiasm for such an evaluation facility which can provide similar international standard benchmark testing similar to that conducted at the NSEF or NSTETF (see TRPM Website Notes TN001 & TN006).

## **6.0 RECENT DEVELOPMENTS**

In Spring 2015, TRPM were appointed by APEM Ltd on behalf of UKWIR Ltd to update TRPM – REP273. Since the July 2013 publication of TRPM – REP273, a number of new products from existing suppliers were identified, although these tended to be generally similar to previously known examples.

It was found that of those products previously identified as being *‘emerging and worthy of monitoring to determine the potential for future use’*, none had gained any further position in the UK market, thus none could now be considered to be *‘established’*.

It was acknowledged that the recent review broadened the knowledge available to the industry but did not necessarily identify any new or innovative screen technology.

However developments of various Fish Recovery & Return (FRR) Systems utilised by different suppliers were identified and detailed.

The review identified that little or no operational or maintenance experience exists within the industry from which to draw any meaningful or comparative assessment or conclusions.

What few installations have been completed in recent years generally feature comparatively new products, many of which are still being commissioned.

Despite the recent UKWIR review project (conducted by APEM / TRPM) consideration should be given to encourage further collaborative research across the industry in order to meet current and emerging legislation.