Reduction of fish impingement

Best Available Approach for cooling water intakes?

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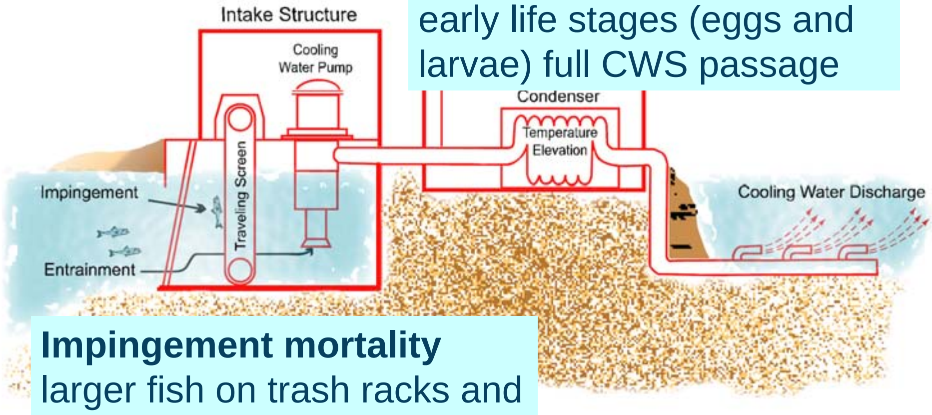
Experience you can trust.

Impingement and entrainment

Entrainment mortality
early life stages (eggs and larvae) full CWS passage



Impingement mortality
larger fish on trash racks and travelling screens

Why do fish get drawn in?

- Intake velocity > swimming capacity
- Early life stages (eggs, larvae, 0+ fish)
  – limited mobility, orientation and swimming capacity
- Juveniles / adult fish are drawn in to lesser extent
  – better swimming capacity
  – rheotaxis (orientation to flow)
  – behaviour: hesitate/avoid passage of trash rack

- Main I&E after spawning season
  – early growth season
  – when fish become larger, less ingress

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Standard I&E protection at intakes

- Trash racks
- Fine screens
  (traveling band screens, drum screens, passive screens,etc)

- Basically for removal of debris

- Suitability for reduction effects of I&E?

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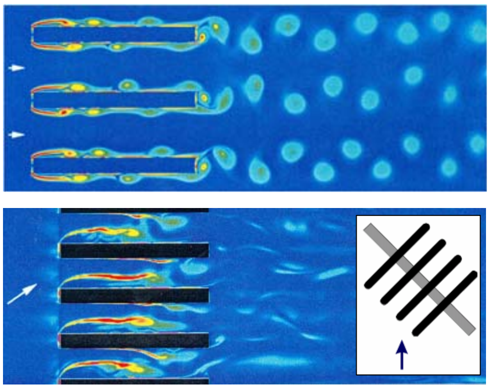
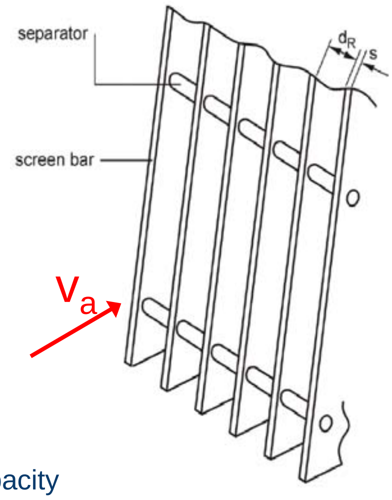
Trash racks





- Fish must be able to escape:
  - approach velocity << swimming capacity
  - ‘escape velocity’ ~2·L_{vis}/s (‘cruising speed’, > 200 min.)
  - escape route / area
  - critical areas

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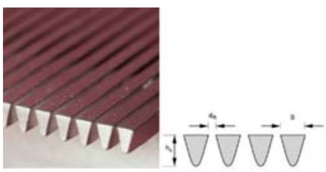
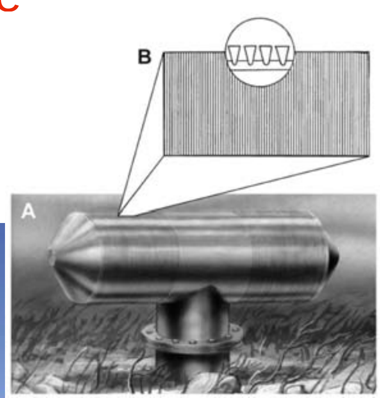
Cylindrical Wedge Wire





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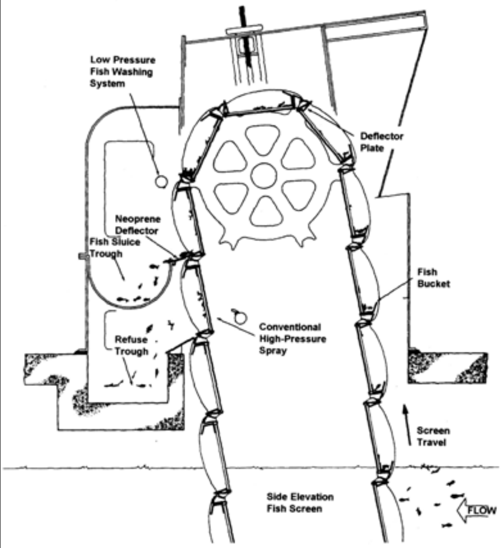
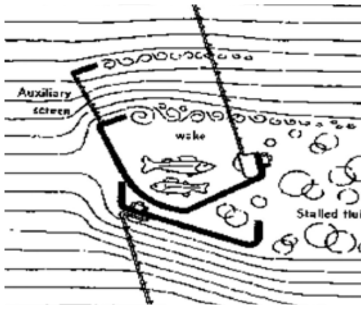
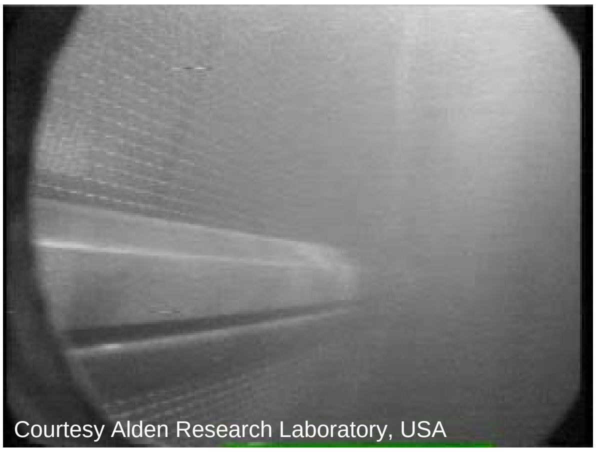
Through-flow and Ristroph screens





- Contact time as short as possible
- Jet spray + return gutter
  - soft spray + smooth surface
  - distance return as far away from intake as possible


Courtesy Alden Research Laboratory, USA

- Modified traveling screen (U.S. Filter – Siemens)
- Striped bass (*Morone saxatilis*), length ~5 cm
- Mesh 6.4 x 12.7 mm
- v_a ~25 – 30 cm/s

Geiger Multi Disc

Fish return system

Doel PP, Belgium

Barking PP, UK

- Quick return of impinged fish
- Return as far as possible from intake

IPPC, BAT and BREF

- European Directive 96/61 EC concerning **I**ntegrated **P**ollution **P**revention and **C**ontrol (IPPC)
- Permit based on Best Available Technology (BAT)
  - **Best**: most effective in achieving a high level of protection of the environment as a whole
  - **Available**: applied under economic and technically viable conditions
  - **Techniques**: design, construction, operation, maintenance and decommissioning
- BAT Reference Document (BREF)

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BAT techniques related to I&E

BREF Industrial Cooling Systems

- No specific BAT for ingress of fish, but:
  - approach velocity < 0,1 – 0,3 m/s
  - continuous operation of fine screens
  - functional fish return system
  - mesh size screens > 5 mm
  - optional: application of light/acoustic deterrence systems
- Biological review of location (species/habitat)
- Technical review (CWS characteristics and operation)

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In permits in the Netherlands

- Maximum approach velocity
  - 0,1 – 0,3 m/s (v_a at 10 cm in front of trash rack
  - exact determination on a case by case scenario (varies per location)
- Fish return system
  - prevent:
    - re-impingement (recirculation of cooling water)
    - fisheries mortality
    - predation by seals and birds
- Inventory fish population
- Investigation of I&E
- Options for possible additional measures

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Available BAT techniques?

- BREF provides general aspects, no general BAT
  - Measures (technical/operational) are location specific
- Which mitigating measures are cost-effective?
- No BAT for reduction I&E
- Focus on a **Best Available Approach** (BAA)
  - seek for ALARA!

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Best Available Approach (BAA)

Step-wise approach with common assumption that:

- Design intake is fish-friendly (new-build intakes)
- Additional measures to reduce I&E and/or increase survival (existing intakes) are available
- Take into account any operational/technical measure
  - is local specific
  - must be cost-effective

BAA new-build locations

- Design intake as 'fish-friendly' as possible
  - consider far/near-field hydraulic conditions, velocities, location, configuration, lay out, fish return, ecology (monitor fish population + habitat), etc
- After COD: determine I&E and efficiency fish return
- Evaluate results and determine need additional measures to
  - prevent I&E
  - increase survival

Design considerations

- Many aspects must be considered to achieve final design and BAT
- The investment is substantial
  – cost-effectiveness must be optimal
  – proven technology??
- Crucially important to take into account:
  – biological considerations (species)
  – environmental considerations
  – design considerations (existing location, new facility)
  – hydrodynamic considerations
  – conceptual design and applicability

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Hydraulic zone

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BAA existing installations

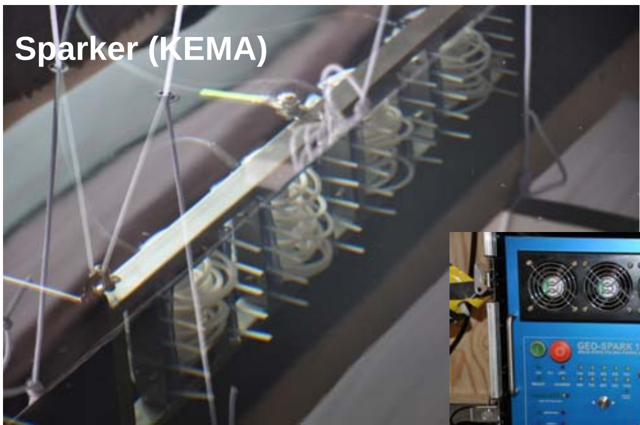
- Evaluate existing intake technically and operational
  - consider far/near-field hydraulic conditions, velocities, location, configuration, lay out, fish return, ecology, etc
  - (if applicable) determine efficiency fish return determine local-specific risk factors for I&E
  - monitor I&E + fish population + habitat
- Evaluate results and determine need additional measures to
  - prevent I&E
  - increase survival

Additional measures

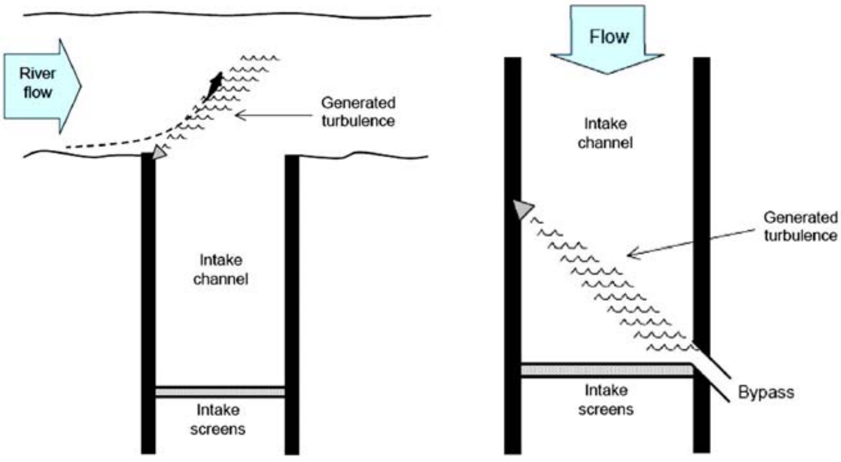
- Potential for additional measures without changing existing intake (flexibility)
  - further mechanical solutions not possible
  - good possibility for behavioural systems / operational measures
- Options determined by specific local conditions, biology and seasonal level of I&E
- Examples:…

Light systems

Acoustic systems



Induced sweeping flows



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Summary

- Reduction of I&E:
  - prevention ingress
  - increase survival
- No general BAT available
  - always location specific
- Fish population study (location specific)
- Follow Best Available Approach (focus on ALARA!)
  - new locations: fish friendly design
  - existing locations: choice optimal additional system
- Measures must in principle be
  - cost-effective
  - proven technology

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Questions to answer…

- What is a population + how to determine?
- Definition of significant effects?
  - mortality rates range from 0.01% - 70%
  - long term effects / short term effects?
- Which party responsible for monitoring what?
- How to evaluate effects according to the relevant legislation for (new) installations (sea/estuary)?
- Which mitigating measures are cost-effective?
- Can the available system(s) be used to meet the (permit) requirements to reduce effects?
- Only to be applied if there is a significant effect!?

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Thank you for your attention

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