



HYDRO TURBINE GENERATING SET FOR VERY LOW HEAD

Presentation Hydroenergia 2006

June 2006



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Presentation

Project Organisation

Description of the Product

Fish Friendliness

Alternative Technologies

Demonstration Site
Millau
Navigation Channel Lock





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Presentation

Project
Organisation

Description of
the Product

Fish Friendliness

Alternative Technologies

Demonstration Site
Millau
Navigation Channel Lock

Why a new type of hydroelectric turbine?





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Presentation

Project
Organisation

Description of
the Product

Fish Friendliness

Alternative Technologies

Demonstration Site
Millau
Navigation Channel Lock

As specialists of hydroelectric field we acknowledge:

- No Manufacturer in the world offers a Turbine fitted for heads of less than 2 m.
- The most profitable sites are already built in developed countries.
- The remaining potential is located below 2 m gross head.
- Same comments are valid worldwide





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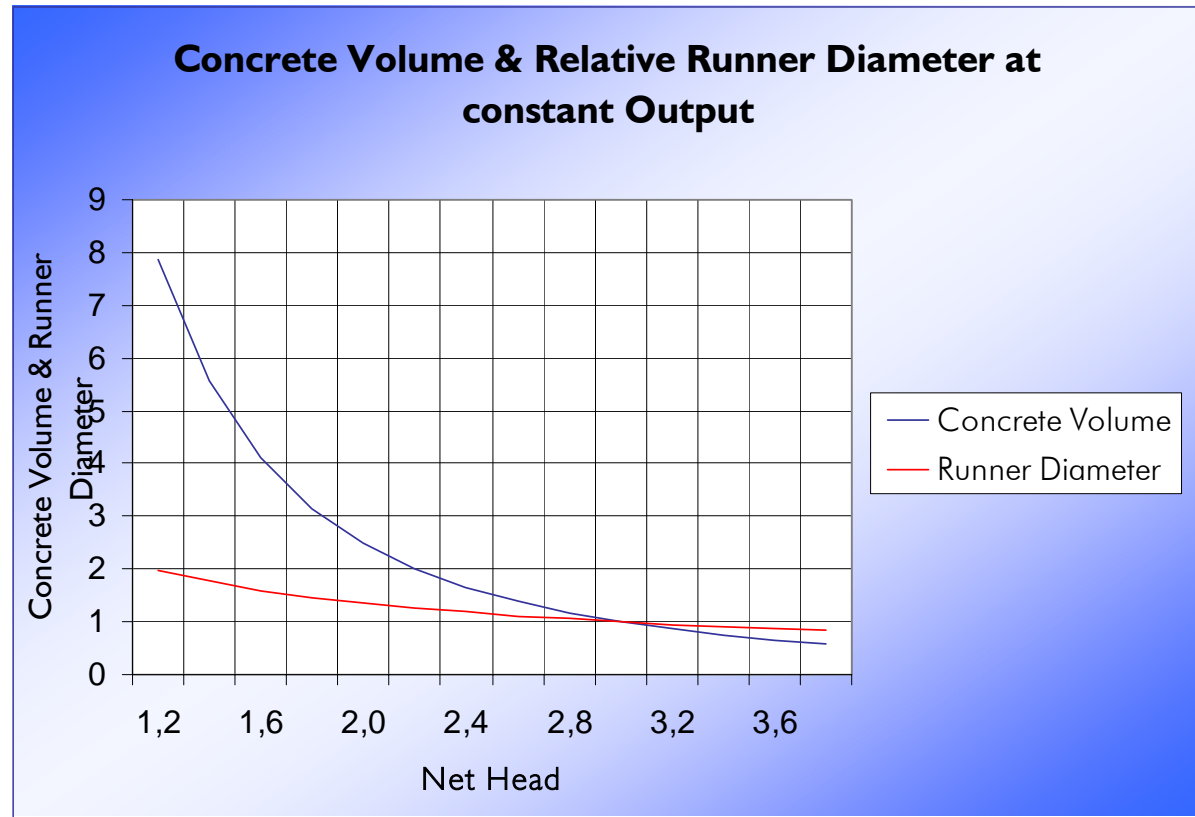
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Organisation

Description of
the Product

Fish Friendliness

Alternative Technologies

Demonstration Site
Millau
Navigation Channel Lock



Civil Work cost is 5 times higher under 1,5m head than under 3 m head





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- Harnessing very small heads requires very high flows which must be treated in infrastructures of considerable size.
- Manufacturers have always given priority to reduction of equipment size and costs, forgetting civil works.
- Civil work costs becomes dissuasive regarding the installed output and the related expected turn over of the plant.

Harnessing very low heads is technically feasible but unprofitable with the available technologies.

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Project Organisation

Description of the Product

Fish Friendliness

Alternative Technologies

Demonstration Site
Millau
Navigation Channel Lock

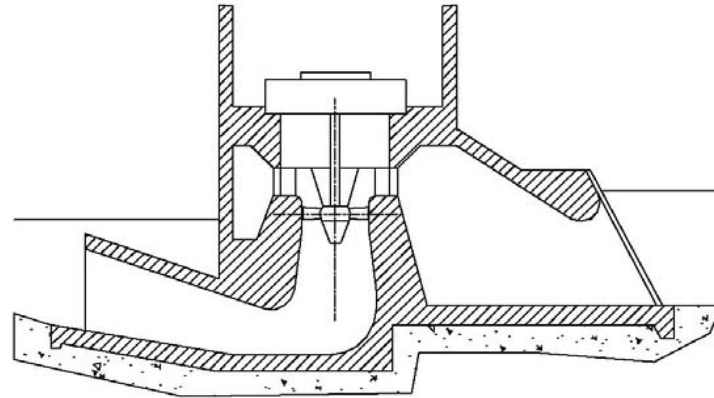




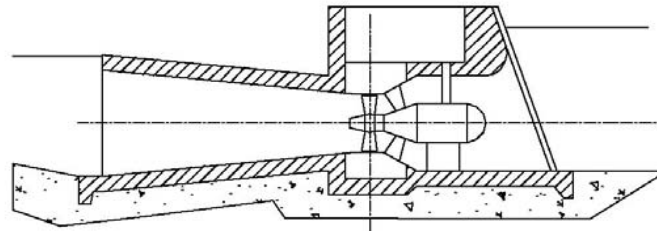
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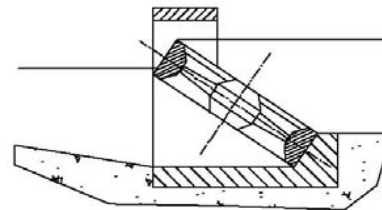
Vertical Siphon
Kaplan
Single
regulation



Bulb Turbine Set
Fully Underwater



Very Low Head
Turbine Generating
Set



Presentation

Project
Organisation

Description of
the Product

Fish Friendliness

Alternative Technologies

Demonstration Site
Millau
Navigation Channel Lock





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Presentation

Project
Organisation

Description of
the Product

Fish Friendliness

Alternative Technologies

Demonstration Site
Millau
Navigation Channel Lock

Project Organisation





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Presentation

Project
Organisation

Description of
the Product

Fish Friendliness

Alternative Technologies

Demonstration Site
Millau
Navigation Channel Lock

Operating Firm MJ2 (Created April 2004)

Marketing & Sales

Design and project Management

May sell licences

Manufacturing:

Fully subcontracted in Western Europe for
local market

Partly subcontracted locally for overseas
markets





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Project Progress & schedule end of may 2006

- French patent applied in November 2003, International extension in progress
- Hydraulic profile optimisation by CFD finished
- Hydraulic tests
 - . December 2004 river tests of distributor behaviour under different inclination angles
 - . December 2005 to June 2006 laboratory small scale model testing
- Prototype Site construction to begin June 2006
- VLH prototype erection and commissioning November 2006
- Launching of industrial production and progressive production step up mid 2007

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Project Organisation

Description of the Product

Fish Friendliness

Alternative Technologies

Demonstration Site
Millau
Navigation Channel Lock



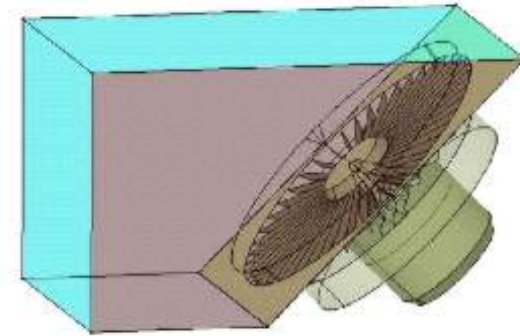


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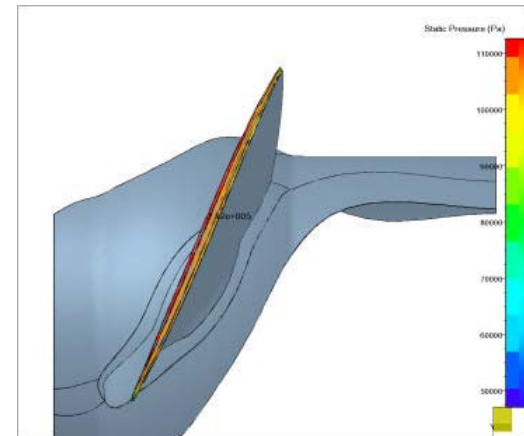


CFD optimisation examples

3D generating set simulation



3D simulation of the water flow on a runner blade



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Example of finite element calculations and simulation

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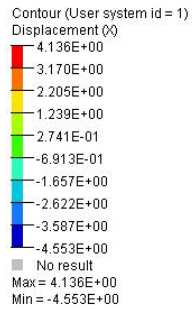
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Description of the Product

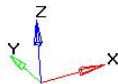
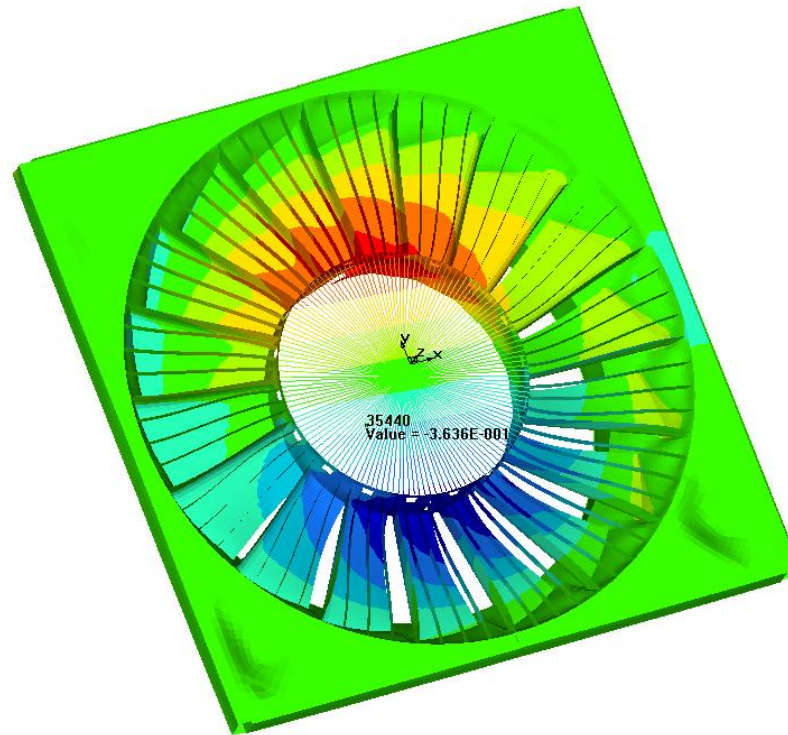
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Simulation 1





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Small Scale Model test at Laval University Hydraulic laboratory in Quebec

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Project
Organisation

Description of
the Product

Fish Friendliness

Alternative Technologies

Demonstration Site
Millau
Navigation Channel Lock

Test Rig





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Small Scale Model test at Laval University Hydraulic laboratory in Quebec

Upstream view
of Small Scale
Model in the
test rig



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Project
Organisation

Description of
the Product

Fish Friendliness

Alternative Technologies

Demonstration Site
Millau
Navigation Channel Lock





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Small Scale Model test at Laval University Hydraulic laboratory in Quebec

Small scale Model
downstream view



Small Scale Model
Runner in closed
position



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Project
Organisation

Description of
the Product

Fish Friendliness

Alternative Technologies

Demonstration Site
Millau
Navigation Channel Lock





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Product Description

Very Low Head turbine

Presentation

Project
Organisation

Description of
the Product

Fish Friendliness

Alternative Technologies

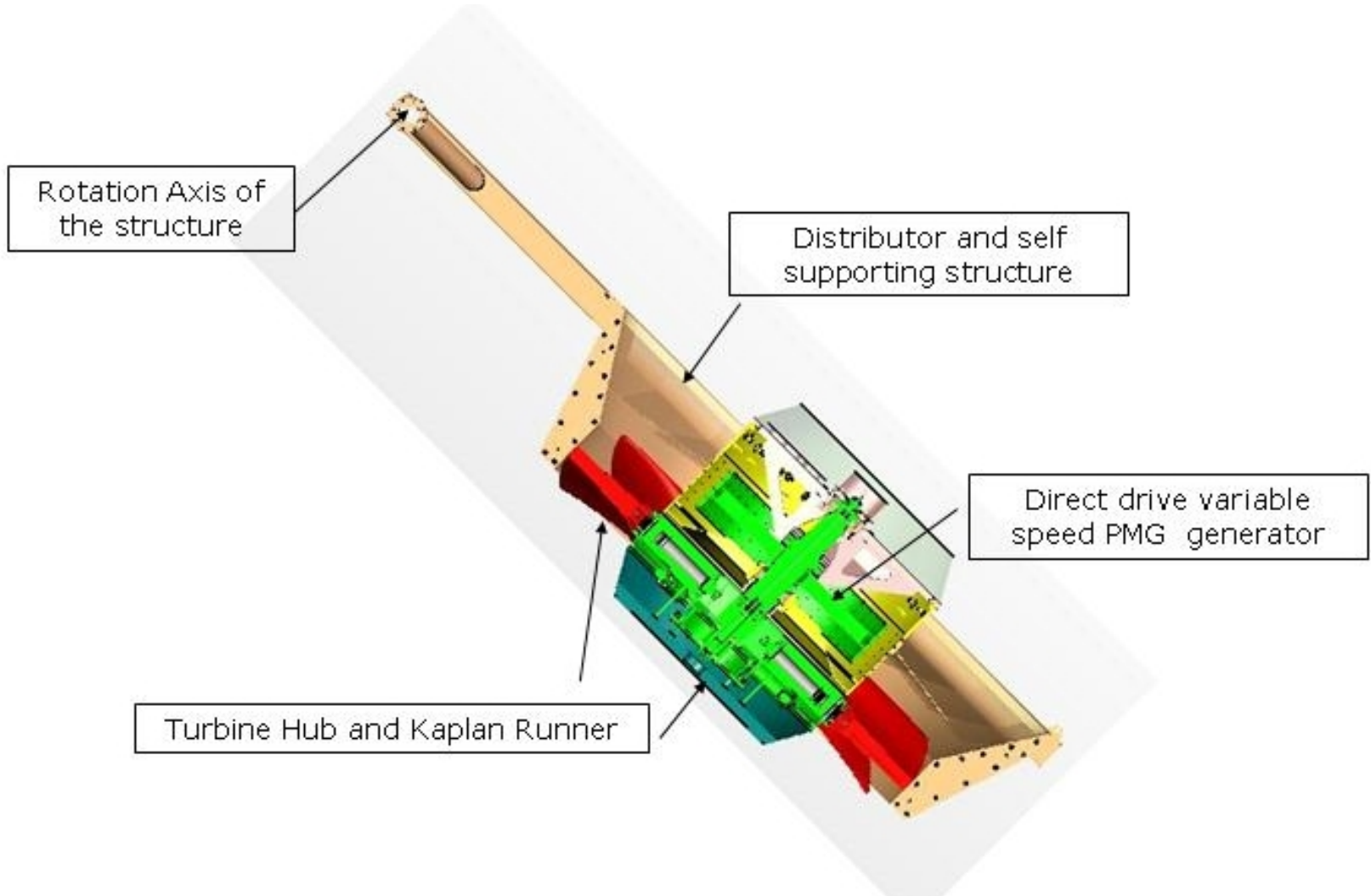
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The VLH® is patented worldwide





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The VLH Turbo generator concept is Patented worldwide



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Project Organisation

Description of the Product

Fish Friendliness

Alternative Technology

Demonstration Site
Millau
Navigation Channel Lock



HYDRO TURBINE GENERATING SET FOR VERY LOW HEAD



Main Features

- Integrated Generating set for very low heads
- Optimally reduced Civil Works
- Simple ,reliable & silent
- Directly Driven Permanent Magnet Generator with variable speed => Well suited for big head variation
- Completely Fish friendly
- Completely Submersible
- No Visual Impact
- Fitted for heads bellow 1,8 m
- Integrated Water to Wire generating Set
- Fitted for Isolated Network operation

Presentation

Project Organisation

Description of the Product

Fish Friendliness

Alternative Technologies

Demonstration Site
Millau
Navigation Channel Lock





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Product Range:

- 5 diameters (3550, 4000, 4500, 5000, 5600 mm)

Gross Head Range:

- From 1,4 to 2,8 m and more

Flow Range:

- From 10 to 30 m³/s

Output Range:

- From 100 to 500 kW (At Generator Terminal Box)

Presentation

Project
Organisation

Description of
the Product

Fish Friendliness

Alternative Technologies

Demonstration Site
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Navigation Channel Lock





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Turbine Set Extraction for Heavy Maintenance and flood protection

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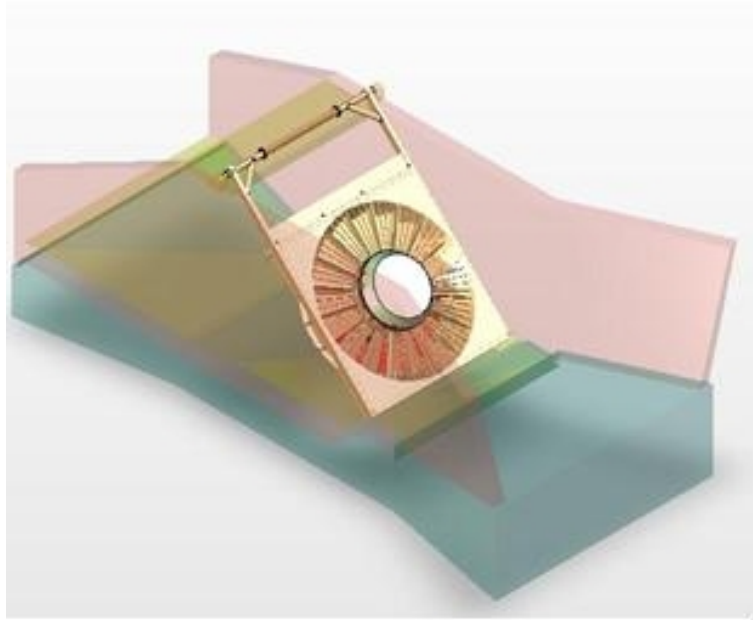
Project
Organisation

Description of
the Product

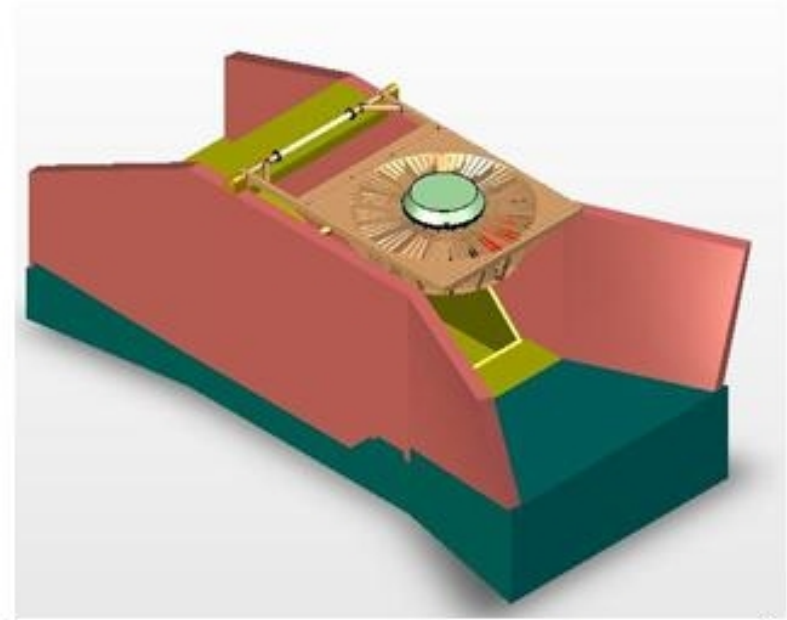
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Alternative Technologies

Demonstration Site
Millau
Navigation Channel Lock



Turbine in working position

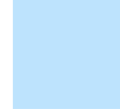


Turbine in withdrawn position





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Fish Friendliness of the Very Low Head Turbine

Presentation

Project
Organisation

Description of
the Product

Fish Friendliness

Alternative Technologies

Demonstration Site
Millau
Navigation Channel Lock





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Idaho National Engineering and Environmental Laboratory

Biological Design Criteria and Final Model Results for the DOE Fish-Friendly Turbine Prototype

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Project Organisation

Description of the Product

Fish Friendly

Alternative

Demonstration Millau Navigator

Biological Design Criteria	Design Value	Comments	Final Results
Hydraulic Parameters	Flow = 1,000 cfs (28 cms) Head = 75 – 100 ft. (23 – 30 m)	Representative averages for U. S. installed hydro projects	Flow = 1,000 cfs (28.3 cms) Head = 40 & 80 ft. (12 & 24 m)
Turbine Efficiency	≥ 85% (Conservative)	Most presently installed US turbines: 90% - 93%	≈ 90%
Blade Tip Speed	20 – 40 fps (6 – 12 mps)	Reduces Strike Injury & Minimizes Shear Stresses / Vortices Between Moving & Stationary Parts	≈ 68 fps (≈21 mps)
Minimum Exposure Pressure	10 psia (69 kPa)	Downstream migrating fish typically acclimated @ 30 psia (210kPa) NOTE: $\{(Exposure\ Pressure)/(Acclimation\ Pressure)\} \leq 0.3$	8.6 psia (60 kPa) (affects 0.0001% of total water flow volume)
Pressure Rate of Change	< 80 psia/sec (< 550 kPa/sec) (Conservative)	Injury of Sensitive Fish Indicated to Occur in Kaplan Turbines @ 160 psia/sec (1,100 kPa/sec) [less sensitive salmon and American shad have survived rates of change as high as 500 psia/sec (3,450 kPa/sec)]	1% of total volume of flow passages <80 psi/sec (550 kPa) [small percentage of this 1% up to 500 psia/sec (3,450 kPa/sec)]
Shear Stress Indicator (Rate of Strain)	< 15 fps/in (<1.8 mps/cm)	Tests of fragile Alewives noted no injury @ 15 fps/in (5mps)	< 2 fps/in (<0.24 msp/cm)
Length / Number of Blades	Minimize	Reduce probability of strike compared to current turbines; presently, Kaplan turbines have 3 – 6 blades	13 ft. (4 m) runner dia. 3 blades
Blade / Housing Clearance	≤ 2 mm	3mm typical of new Kaplan turbines	< 2 mm
Flow Passage Opening	Maximize	More water volume around fish within turbine passageway should reduce abrasion to passing fish	36 in (0.9 m)
Fish Survival	98%+	Existing field study results show an average 95% survival in the Columbia River Basin for present Kaplan design*	95% - 98% range**

* 15 separate studies of Salmon passing through present generation Kaplan turbines at Lower Granite and Wanapum dams.

** Studies conducted over two years with 40,000 fish of 6 different species.



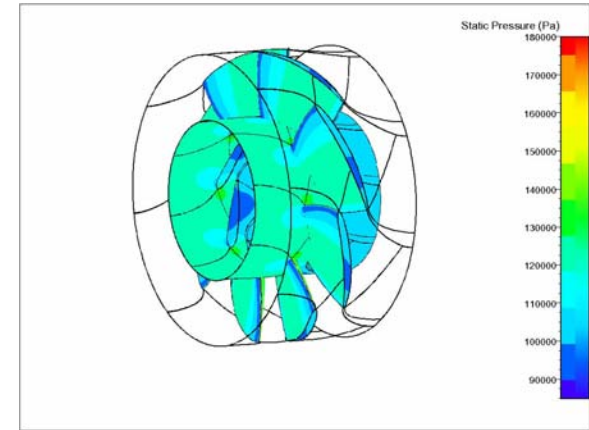
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The VLH fulfils all but one criteria of Fish friendliness

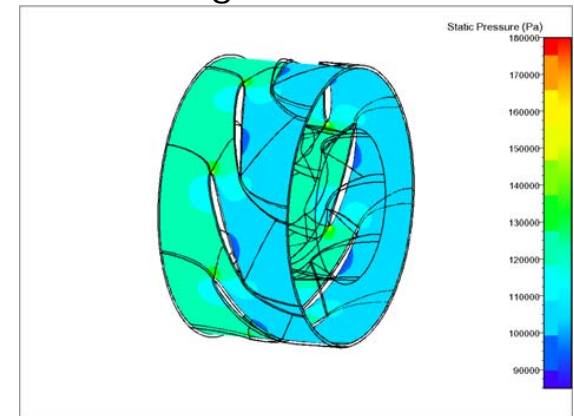
CFD calculations shows fulfilment of all but one criteria of fish friendliness

- n° 1:** Peripheral speedness
Acceptable: 6 to 12 m/s VLH: 4.5 à 8 m/s
- n° 2 :** Minimum pressure
Acceptable : 69 kPa VLH: 94 kPa
- n° 3:** Maximum pressure variation
Acceptable: <550 kPa/s VLH: 80 kPa/s
- n° 4:** Max flow speedness variation
Acceptable: <180 m/s/m VLH: 10 m/s/m
- n° 5:** Blade to discharge ring gap
Acceptable: <2.0 mm Valeur VLH: 4.5 mm
(This criteria is not fulfilled but the very low average flow speed < 2 m/s is assumed to allow fishes to avoid periphery of the runner)

The "Conseil Supérieur de la Pêche" has accepted these conclusions for our demo site



Pressure values on runner according to hub distance



- Presentatiim
- Project Organisation
- Description of the Product
- Fish Friendliness
- Alternative Technologies
- Demonstration Site
Millau
Navigation Channel Lock





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Presentation

Project
Organisation

Description of
the Product

Fish Friendliness

Alternative Technologies

Demonstration Site
Millau
Navigation Channel Lock

1st Demonstration Site

(2,20m head - 450 kW - Ø4.500 mm - 50 Hz)

Millau
(France)

« Usine élévatoire du Troussy »

(Pumping Station of Troussy)





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Main Building



Presentation

Project
Organisation

Description of
the Product

Fish Friendliness

Alternative Technologies

Demonstration Site
Millau
Navigation Channel Lock





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Pumping Station – Derivation Dam



Presentation

Project
Organisation

Description of
the Product

Fish Friendliness

Alternative Technologies

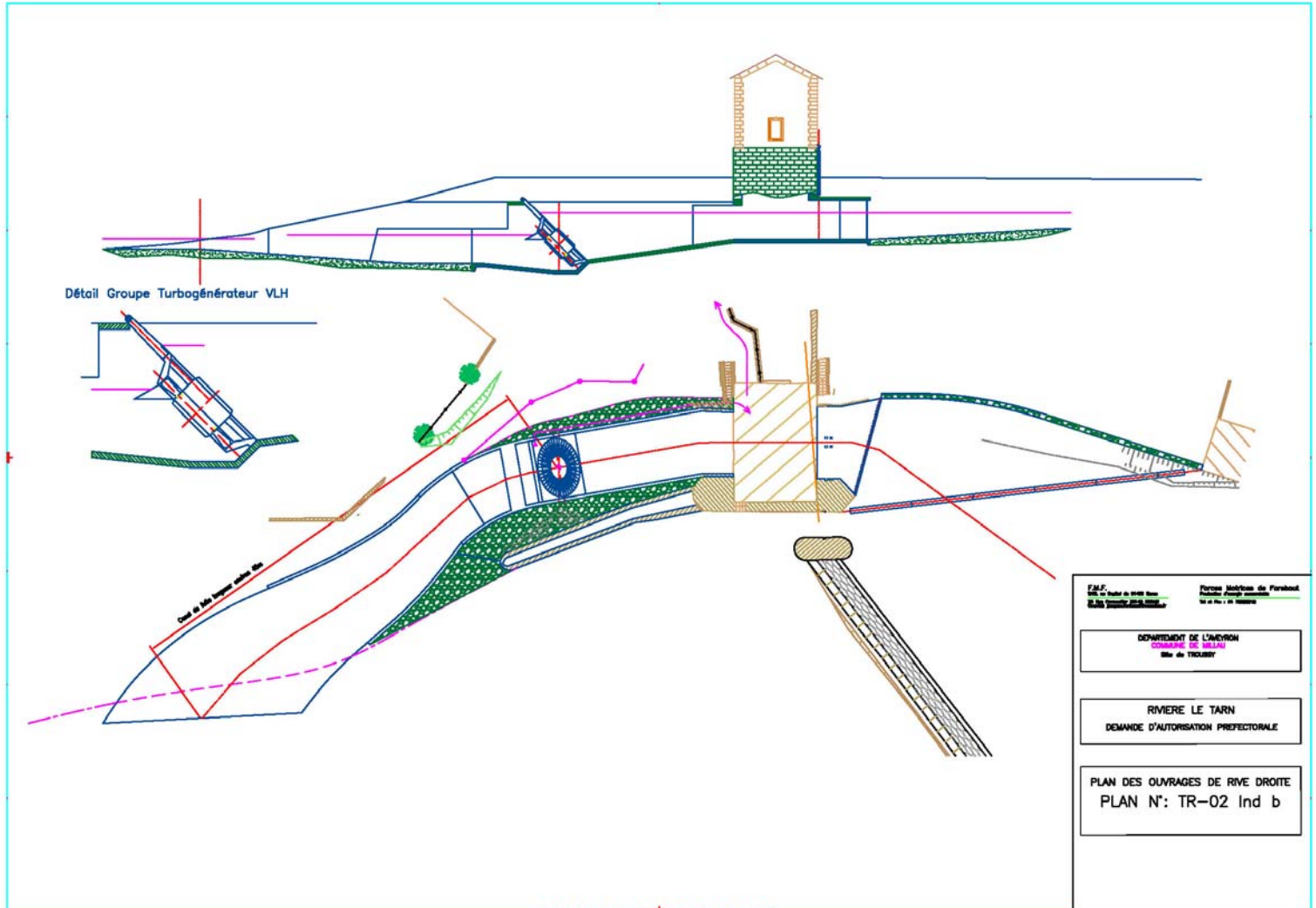
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Navigation Channel Lock





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Millau Lay out of the VLH Turbine location



Presentation

Project
Organisation

Description of
the Product

Fish Friendliness

Alternative Technologies

Demonstration Site
Millau
Navigation Channel Lock





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Lay Out in a Navigation Lock

Site de Canal de Huningue (Colmar, France)

Voies Navigables de France

Presentation

Project
Organisation

Description of
the Product

Fish Friendliness

Alternative Technologies

Demonstration Site
Millau
Navigation Channel Lock





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Presentation

Project
Organisation

Description of
the Product

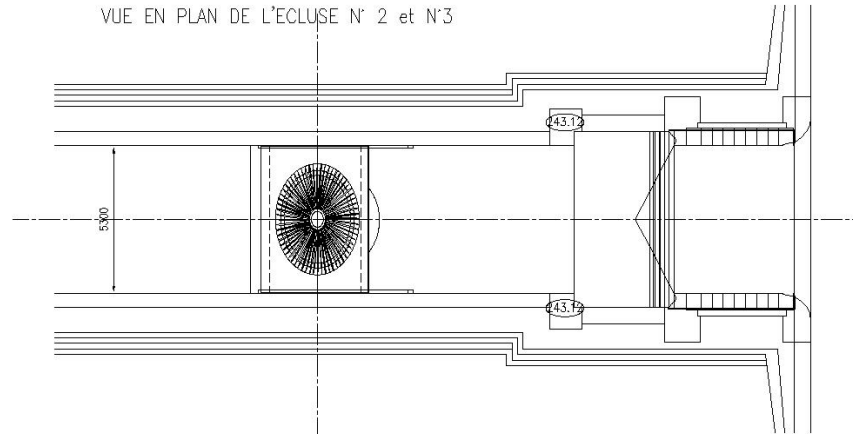
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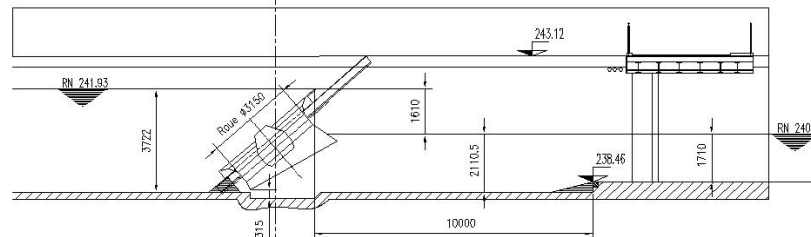
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Navigation Channel Lock

Detailed Lay Out

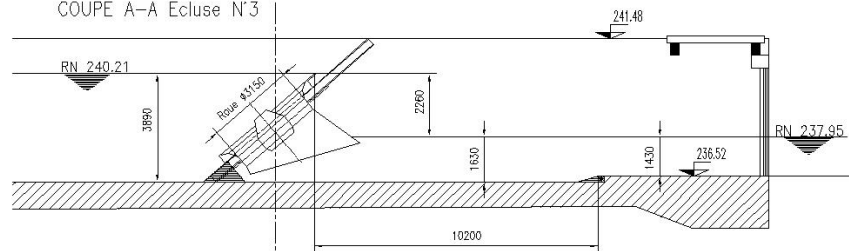
VUE EN PLAN DE L'ECLUSE N° 2 et N°3



COUPE A-A Ecluse N°2



COUPE A-A Ecluse N°3





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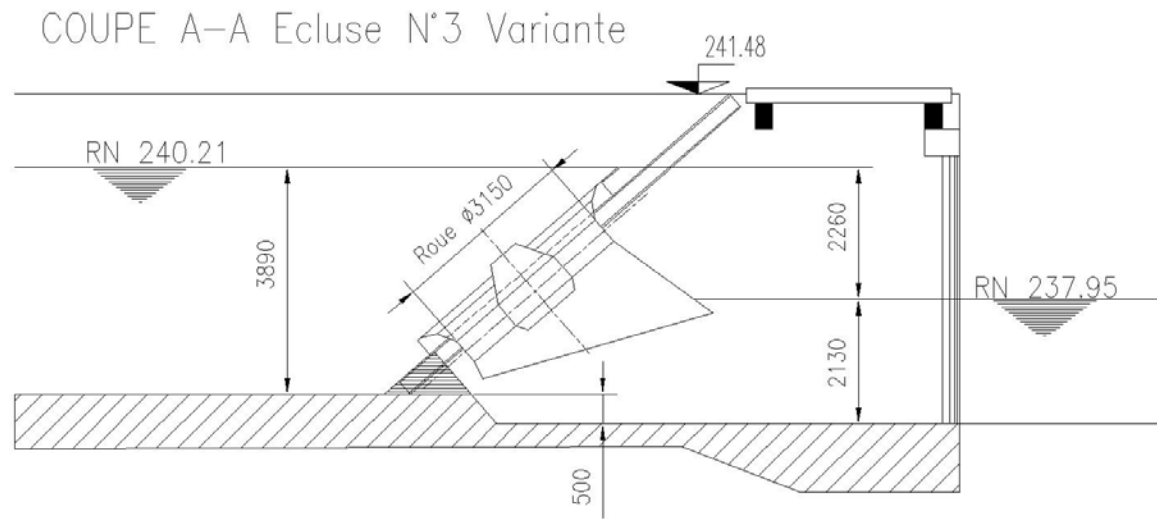
Project
Organisation

Description of
the Product

Fish Friendliness

Alternative Technologies

Demonstration Site
Millau
Navigation Channel Lock



Detailed Lay Out Alternative Lock n°3





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Presentation

Project
Organisation

Description of
the Product

Fish Friendliness

Alternative Technologies

Demonstration Site
Millau
Navigation Channel Lock

Thank you very much for your attention

**For those who wish to have more information
regarding the VLH project a more detailed
presentation will be held tomorrow morning**

**MJ2 technologies is looking for agents and partners
worldwide**

