

# Soluções em PCH's

Andréia Antloga

Ricardo C. De Vasconcellos

25/04/2007

POWER SYSTEMS |

**ALSTOM**

# Agenda

- PCH's ALSTOM
- Turbinas Pelton
- Turbinas Francis
- Turbinas Kaplan
- Turbinas Poço
- Engenharia de Aplicação

PCH's ALSTOM

# PEQUENAS CENTRAIS HIDROELÉTRICAS

C. Emboque



Antas II



N. Sinceridade



Braço Norte II



Mello



Costa Rica



Pirajú



# PCH's ALSTOM



o mais amplo range de máquinas e equipamentos para pequenas e médias usinas

 5 MW	 17,1 MW	 2,6 MW	 10,8 MW	 18,3 MW	 9,4 MW	 8,4 MW	 4,9 MW
 24,4 MW	 21,4 MW	 17,1 MW	 7 MW	 8,4 MW	 3,35 MW	 5,8 MW	 3,1 MW
 14 MW	 10,8 MW	 3,8 MW	 24,4 MW	 15,8 MW	 45,9 MW	 16,1 MW	 12,8 MW
 15,6 MW	 8,2 MW	 5,5 MW	 22,7 MW	 12,4 MW	 10,8 MW	 15 MW	 1,27 MW
 2,5 MW	 5 MW	 55 MW	<p><b>Em andamento:</b></p> <ul style="list-style-type: none"> <li>UHE Espora - 3 Turbinas Francis - 32,7 MW</li> <li>PCH Braço Norte IV - 2 Turbinas Kaplan "S" - 15 MW</li> <li>PCH Garganta da Jararaca - 2 Turbinas Kaplan 30 MW</li> <li>PCH Canoa Quebrada - 3 Turbinas Kaplan - 30 MW</li> <li>PCH Paranatinga II - 3 Turbinas Kaplan 30 MW</li> <li>PCH Cuyamapa - 3 Turbinas Pelton - 12,8 MW</li> <li>PCH Sacre II (Salto Belo) - 3 Turbinas Francis - 30 MW</li> <li>PCH Ombreiras - 2 Turbinas Kaplan "S" - 27 MW</li> <li>PCH Plano Alto - 2 Turbinas Francis - 22 MW</li> <li>PCH Alto Irani - 2 Turbinas Francis - 16 MW</li> </ul>		<ul style="list-style-type: none"> <li>PCH Bonfante - 1 Turbina Poço - 19 MW</li> <li>PCH Monte Serrat - 2 Turbinas Poço - 25 MW</li> <li>PCH São Pedro - 3 Turbinas Francis - 30 MW</li> <li>PCH São Simão - 3 Turbinas Francis - 27 MW</li> <li>PCH Caçador - 3 Turbinas Francis - 22,5 MW</li> <li>PCH Da Ilha - 3 Turbinas Francis - 26 MW</li> <li>PCH Jararaca - 3 Turbinas Francis - 27,3 MW</li> <li>PCH Santa Fé - 2 Turbinas Kaplan "S" - 30 MW</li> <li>PCH Buriti - 2 Turbinas Kaplan "S" - 30 MW</li> </ul>		
 14,4 MW	 30 MW						

# PCH's ALSTOM

**Nº MÁQUINAS**



**160**

**POTÊNCIA  
TOTAL**

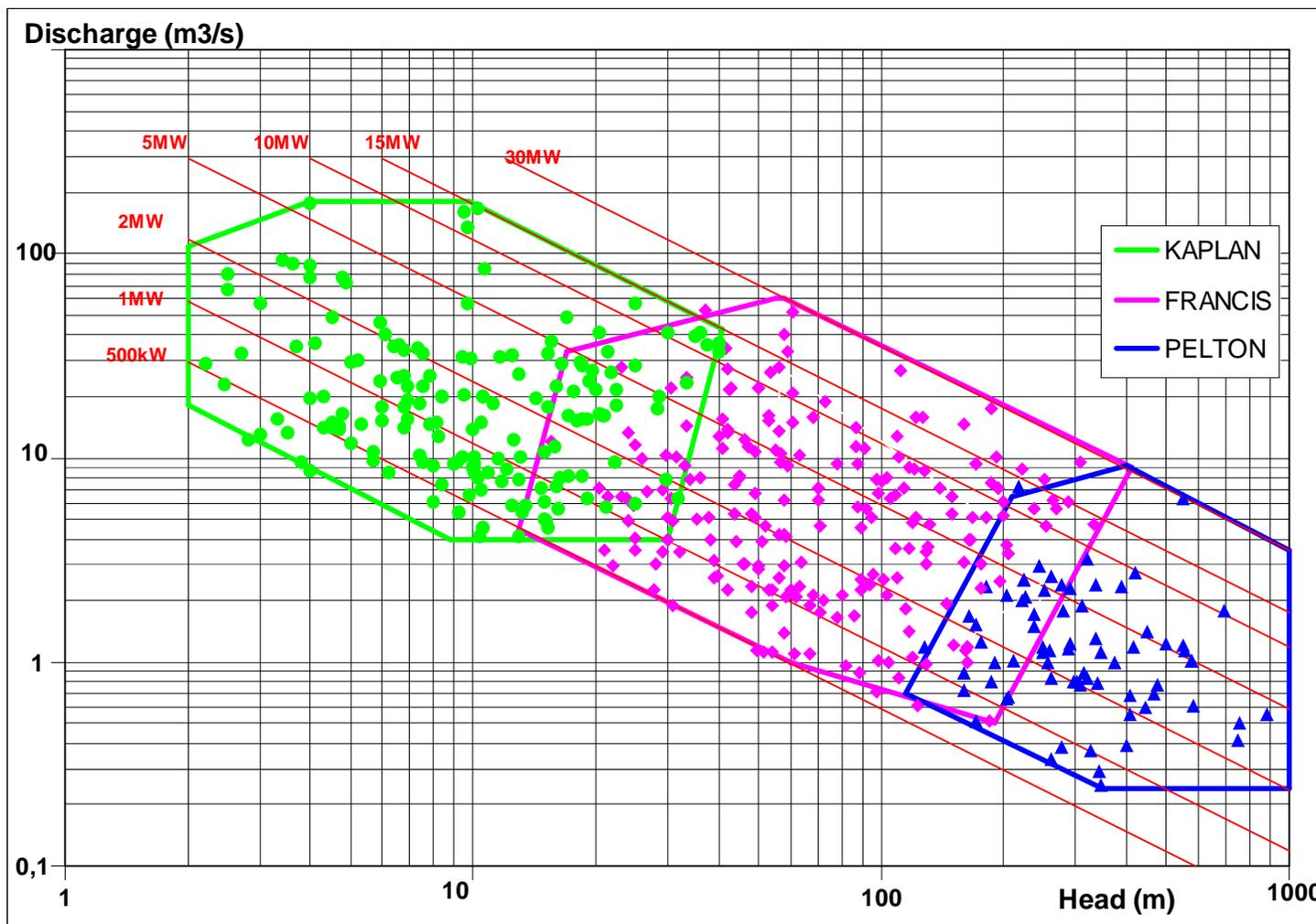


**1.112.000 kW**

# PCH's ALSTOM



# PCH's ALSTOM



Experiência acumulada nos últimos 10 anos

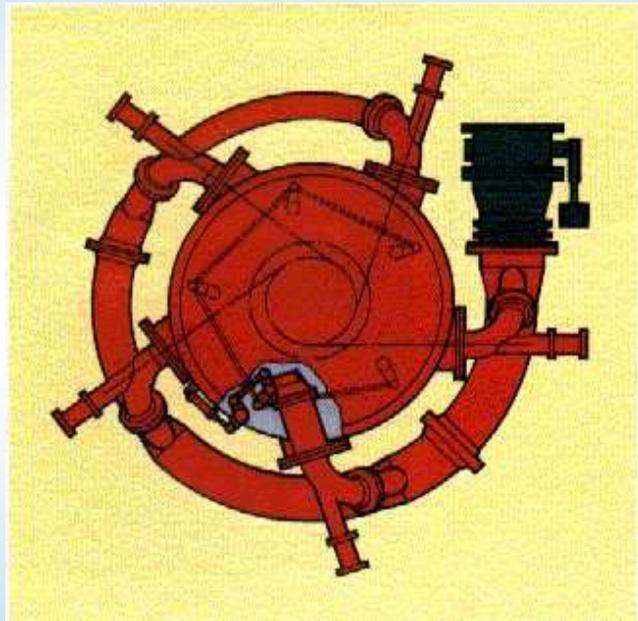
# PCH's ALSTOM

## DEFINIMOS 4 ZONAS DE APLICAÇÃO:

		<u>Queda</u>	<u>Turbina</u>
Queda muito baixa	➤	2m > 12m	Kaplan Pit + kaf
Baixa queda	➤	6m > 30m	Kaplan Sam
Média queda	➤	20m > 300m	Francis
Alta queda	➤	150m > 1000m	Pelton

# Turbinas Pelton

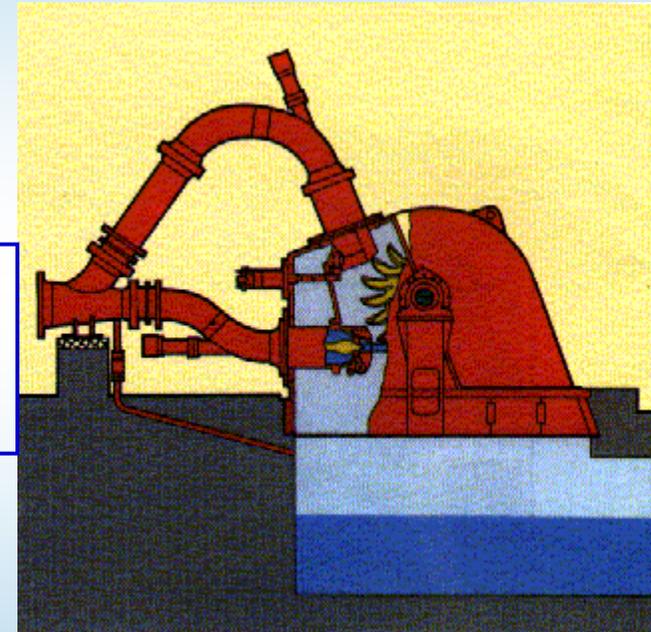
## TURBINAS PELTON



**VERTICAL**

Potência unitária  $\leq 30$  MW

Diâmetro de Roda  $\leq 2,5$ m



**HORIZONTAL**

Turbinas Pelton

# PCH KILPANI - 5.800 kW



**Cliente:**  
**Empresa Eléctrica**  
**Valle Hermoso S.A.**

**Local: Bolívia**

**Tipo: Pelton**  
**1 x 5.800 kW**

**Ano: 1999**

# Turbinas Pelton

## PCH ERVÁLIA - 7.000 kW



**Cliente:**  
Companhia Força e Luz  
Cataguazes-Leopoldina

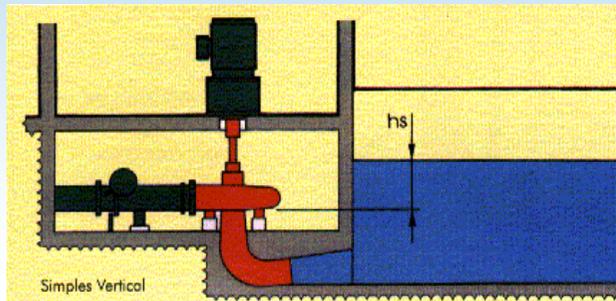
**Local:**  
Ervália - MG  
Brasil

**Tipo:** Pelton  
1 x 7.000 kW

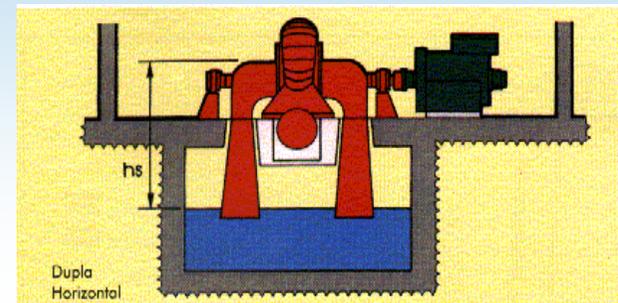
**Ano:** 1997

# Turbinas Francis

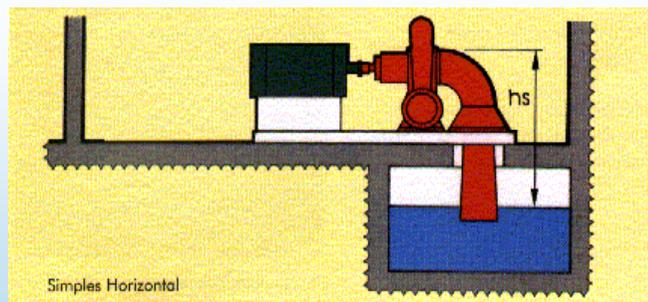
## TURBINAS FRANCIS



**VERTICAL**



**HORIZONTAL DUPLA**

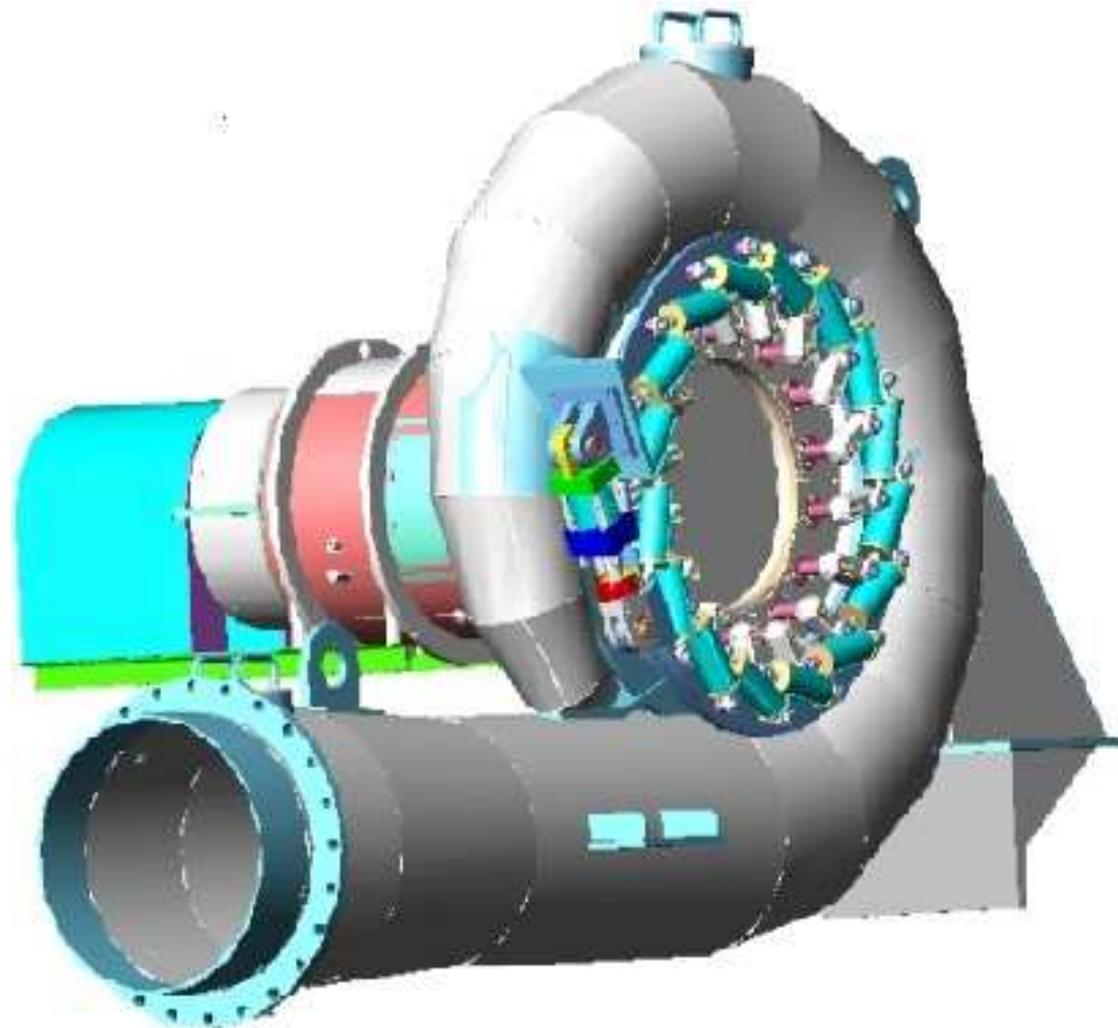


**HORIZONTAL SIMPLES**

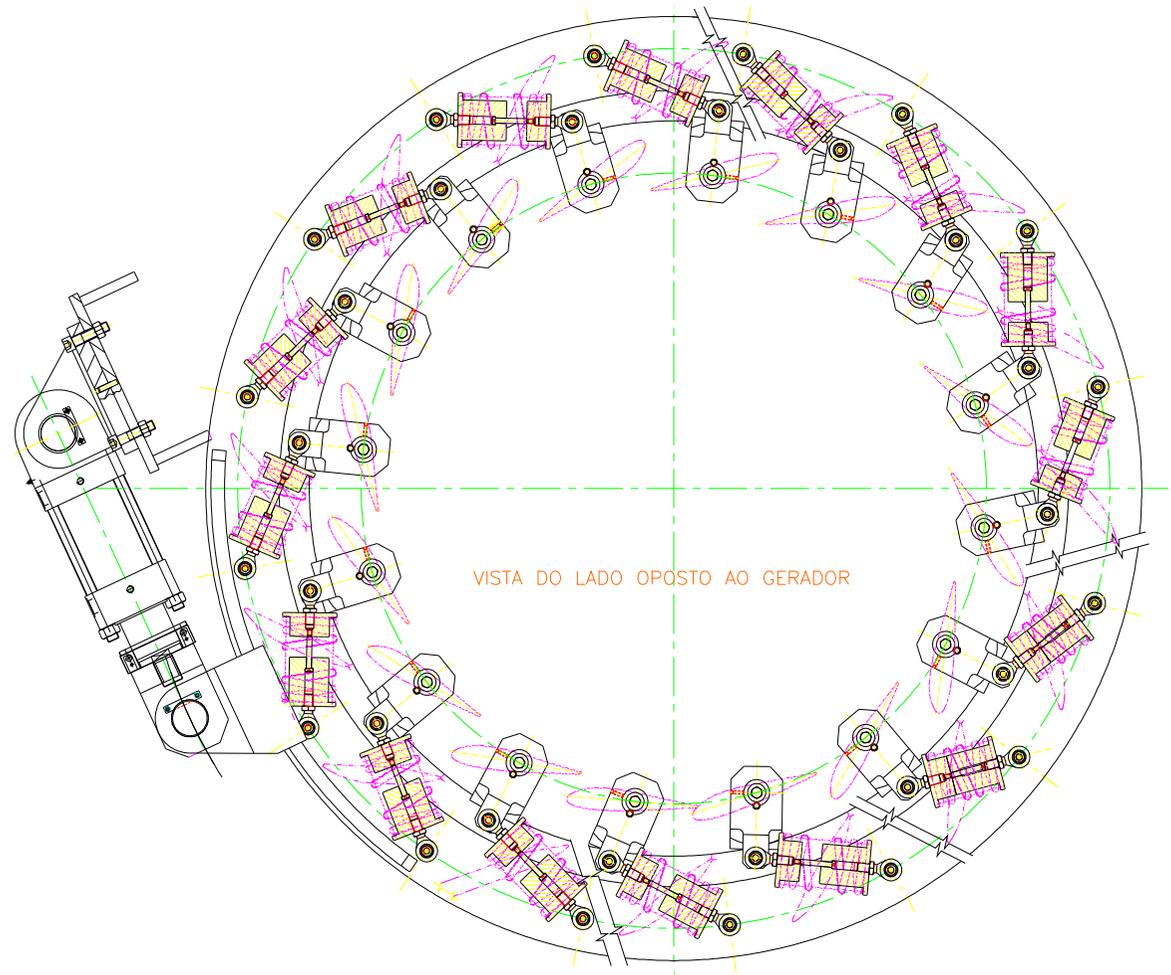
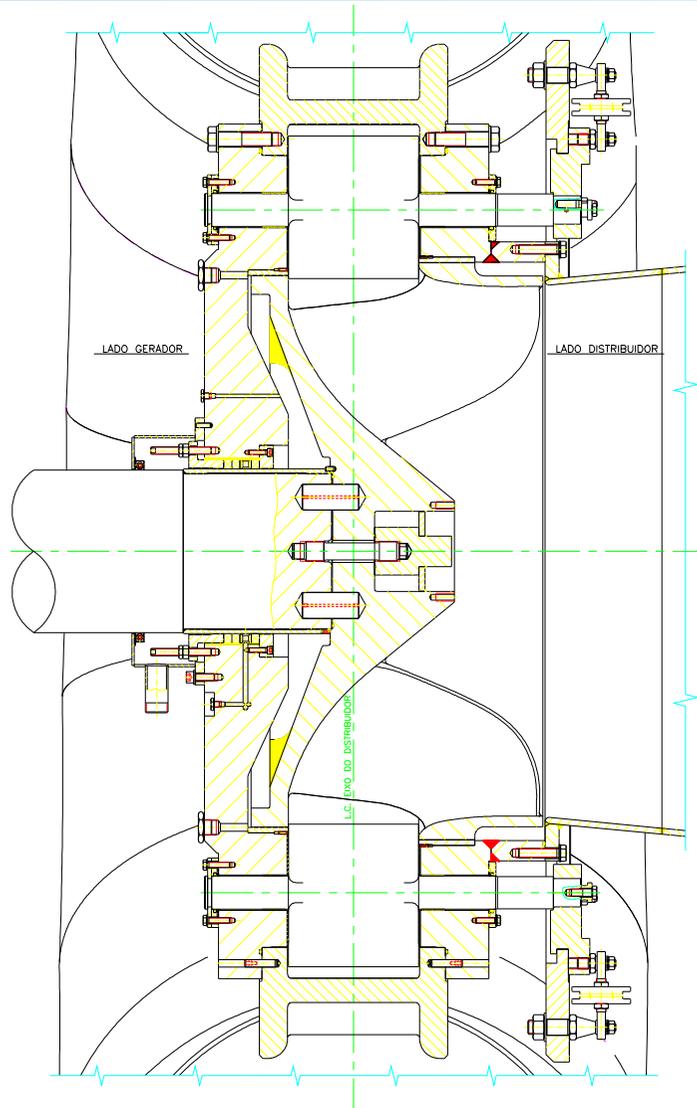
Potência unitária  
 $\leq 30 \text{ MW}$

Diâmetro de Roda  
 $\leq 2,5 \text{ m}$

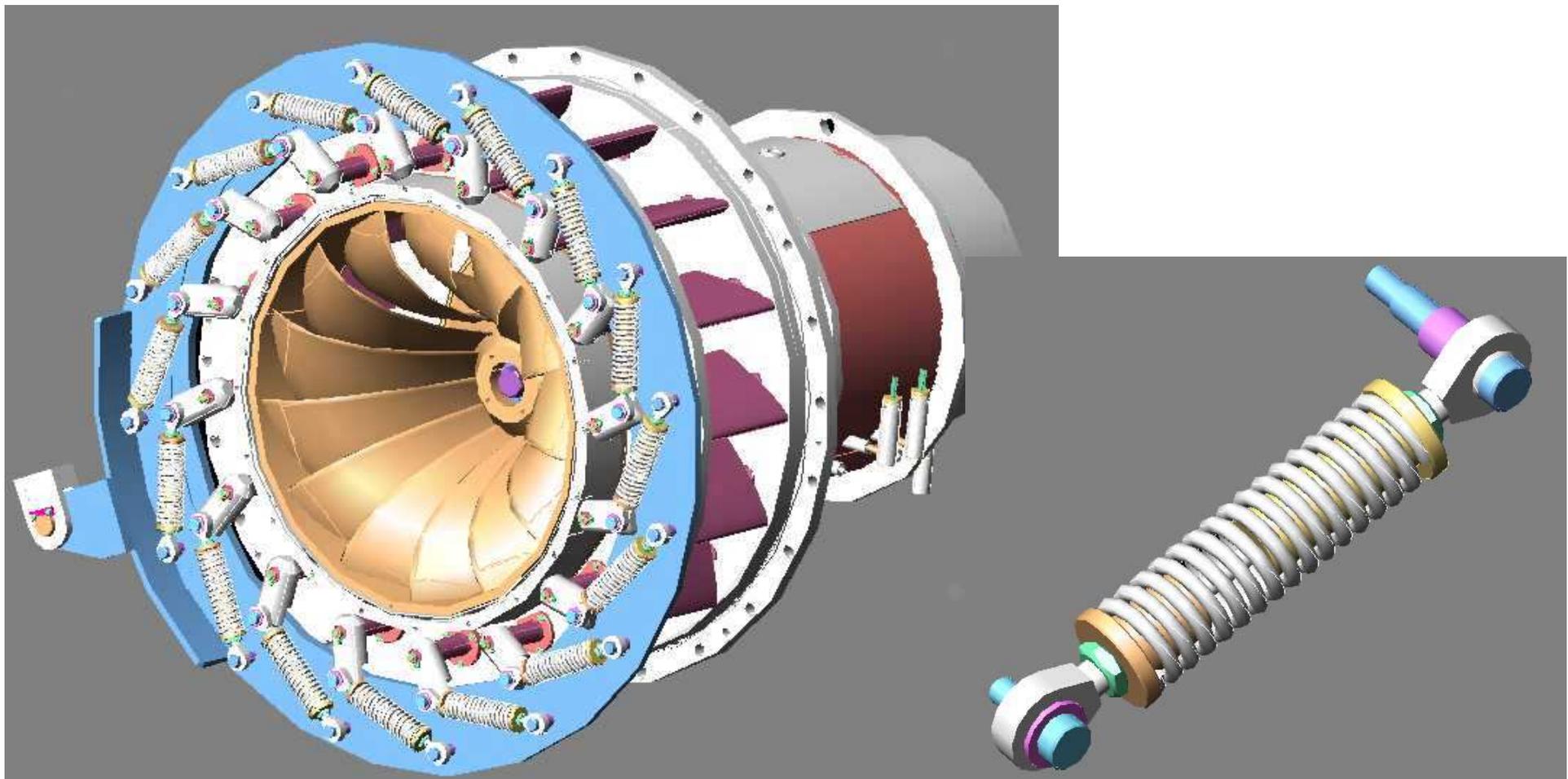
# Turbinas Francis



# Turbinas Francis



# Turbinas Francis



Turbinas Francis

# PCH CACHOEIRA DO EMBOQUE - 21.400 kW



**Cliente:**  
Companhia Força e Luz  
Cataguazes-Leopoldina

**Local:**  
Raul Soares - MG  
Brasil

**Tipo:** Francis  
2 x 10.700 kW

**Ano:** 1997

Turbinas Francis

# PCH ROLADOR - 8.682 kW



**Cliente:**  
**DME**

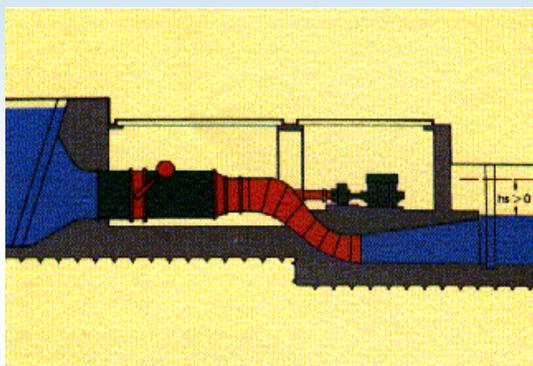
**Local:**  
**Poços de Caldas - MG**  
**Brasil**

**Tipo: Francis**  
**3 x 2.894 kW**

**Ano: 1998**

# Turbinas Kaplan

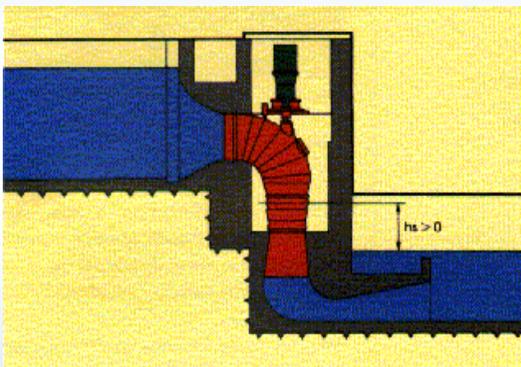
## TURBINAS KAPLAN "S"



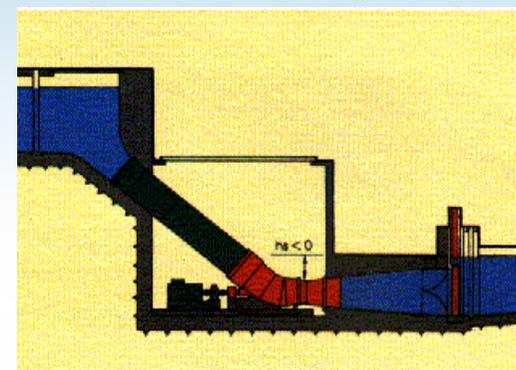
"S" JUSANTE

Potência unitária

≤ 15 MW



"S" SAXO

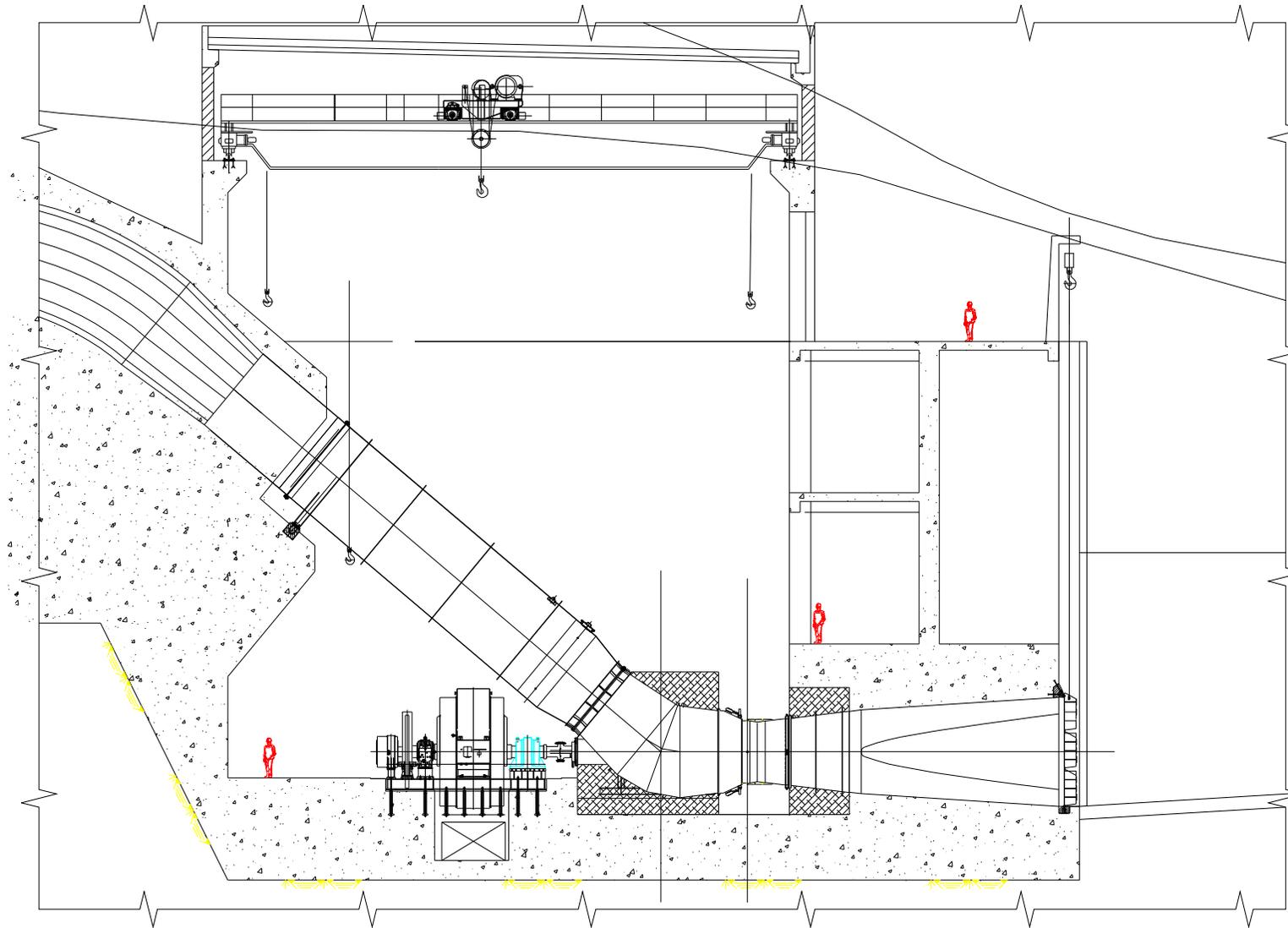


"S" MONTANTE

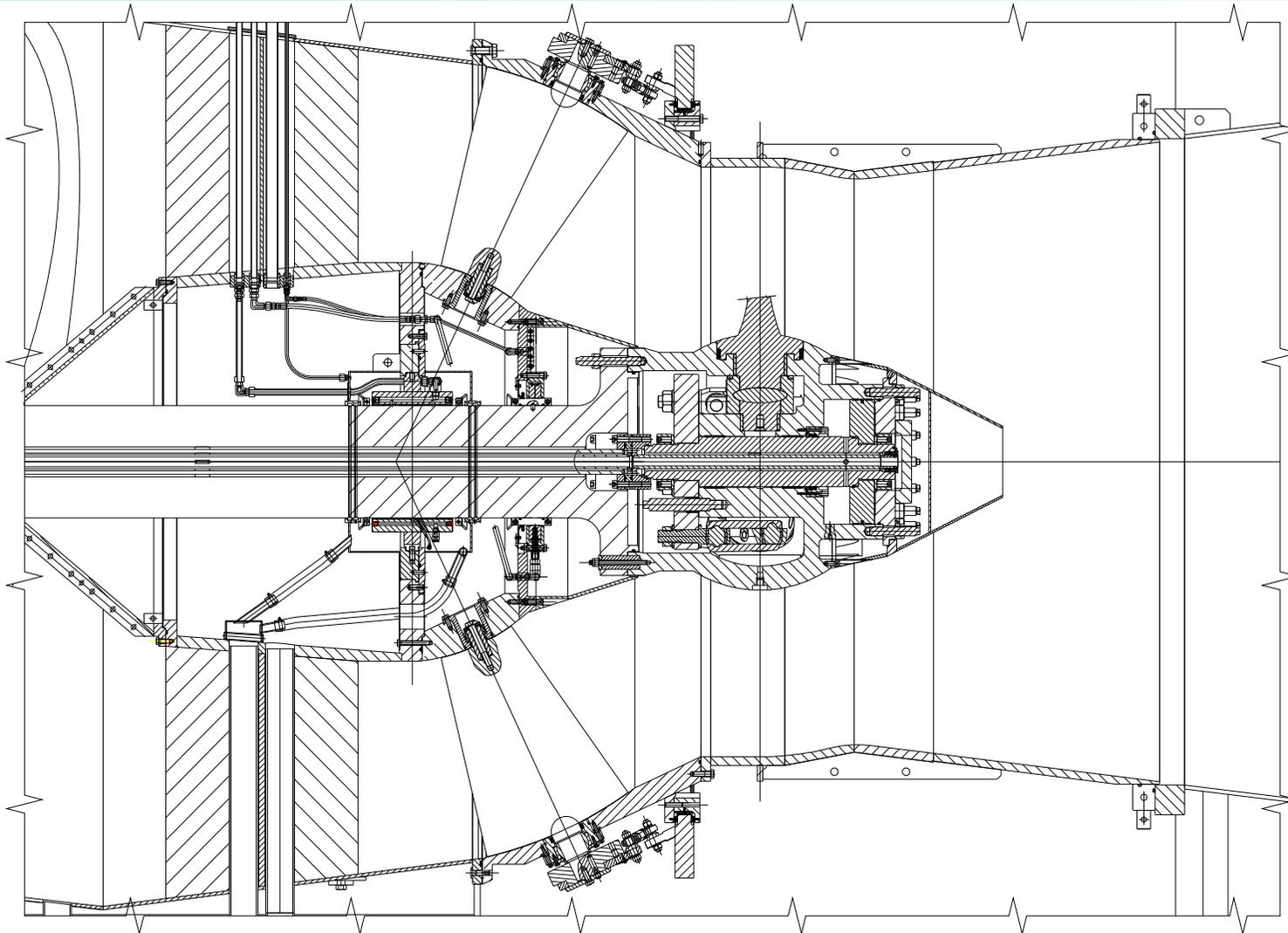
Diâmetro de Roda

≤ 3,55 m

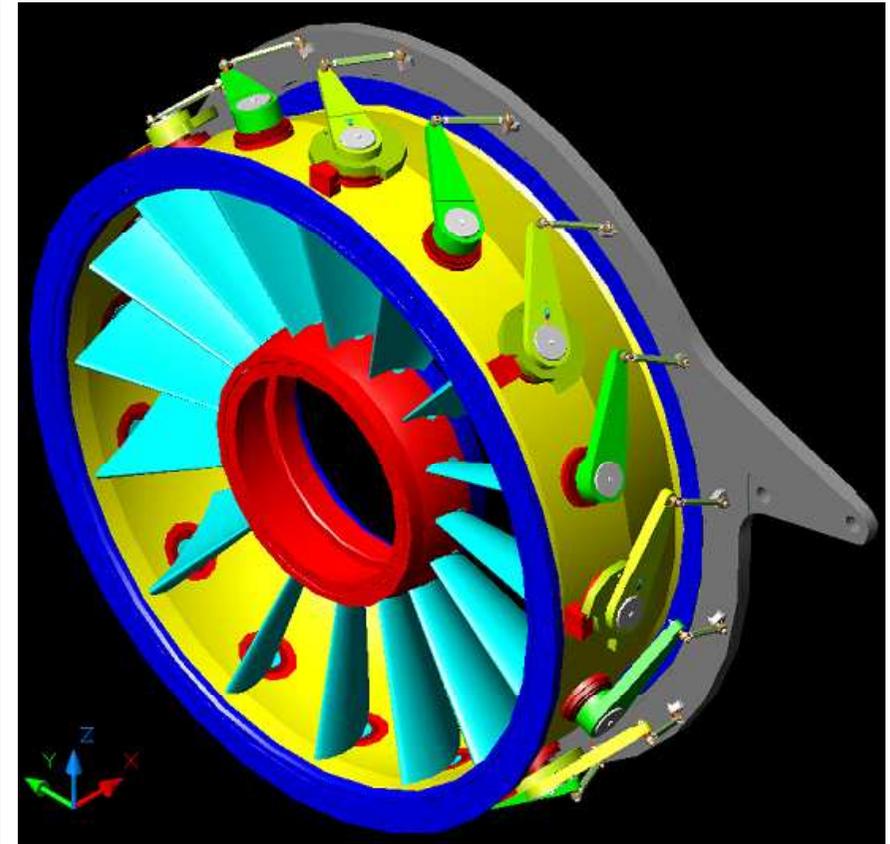
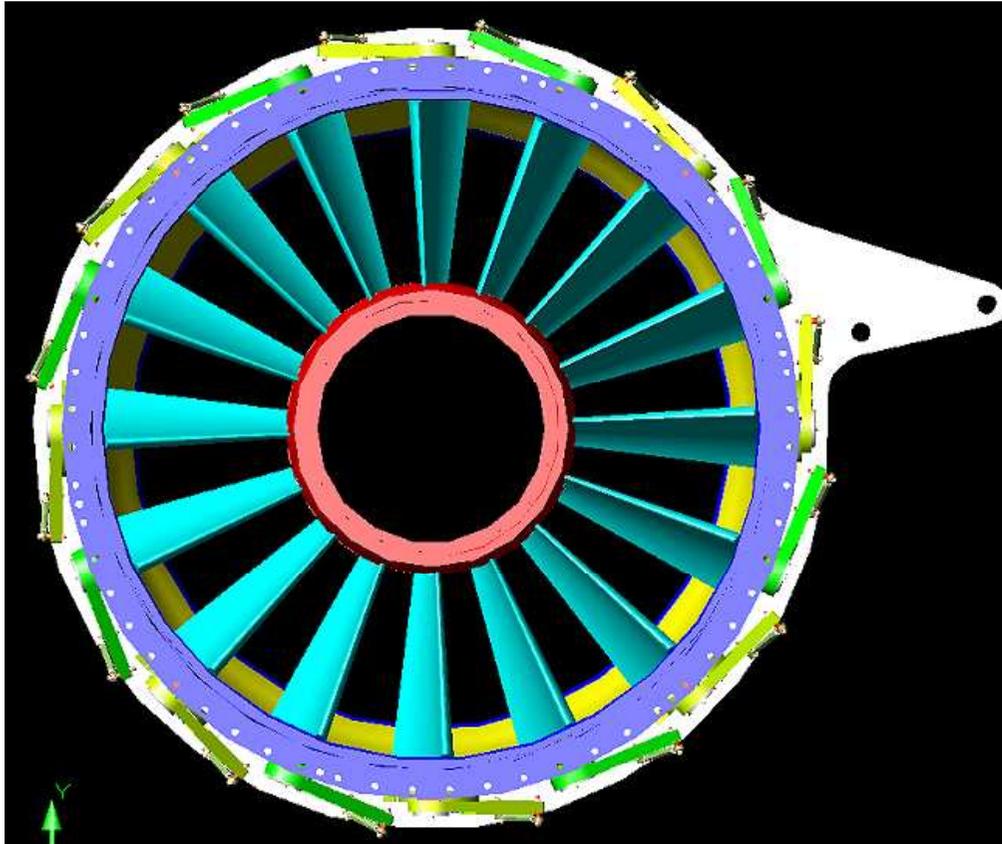
# Turbinas Kaplan



# Turbinas Kaplan



# Turbinas Kaplan



# Turbinas Kaplan

## PCH TRIUNFO - 24.400 kW



**Cliente:**  
Cat-Leo Energia Ltda.

**Local:** Brasil

**Tipo:** Kaplan "Sam"  
2 x 12.200 kW

**Ano:** 2001

# Turbinas Kaplan

## PCH BARUITO - 18.300 kW



**Cliente:**  
**Global Energia**  
**Elétrica S.A**

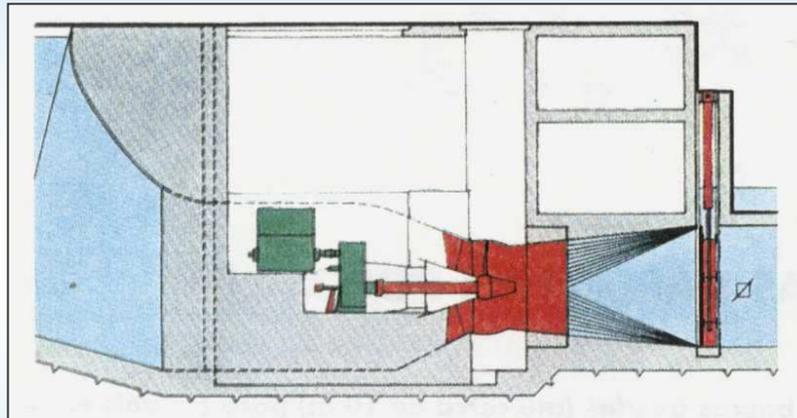
**Local:**  
**Campos Novos dos**  
**Parecis - MT - Brasil**

**Tipo: Kaplan**  
**3 x 6.100 kW**

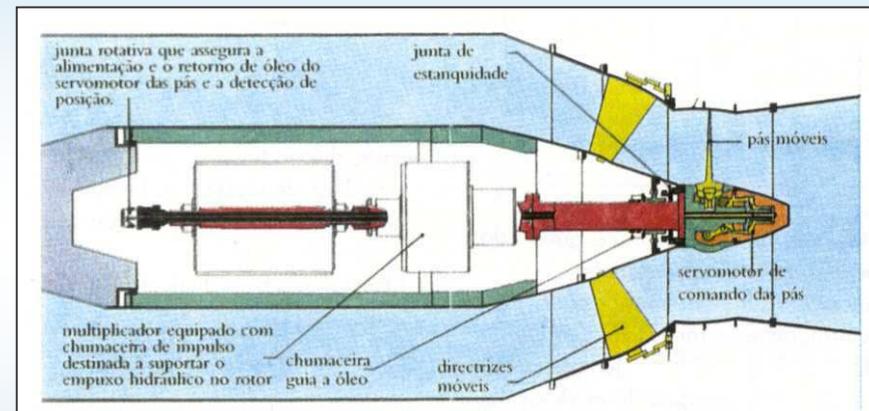
**Ano: 1999**

# Turbinas Poço

## TURBINAS POÇO

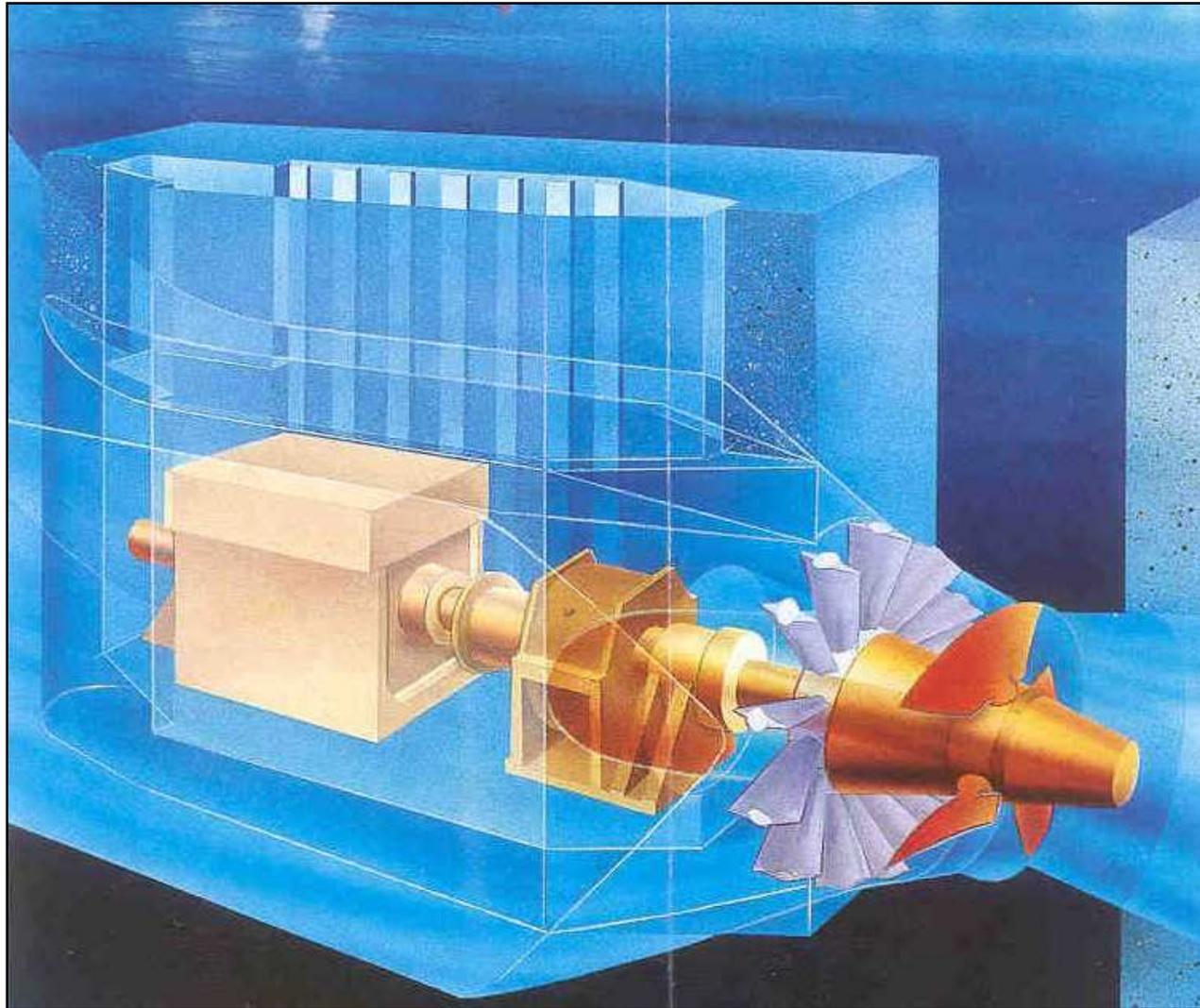


Potência unitária  $\leq 15$  MW

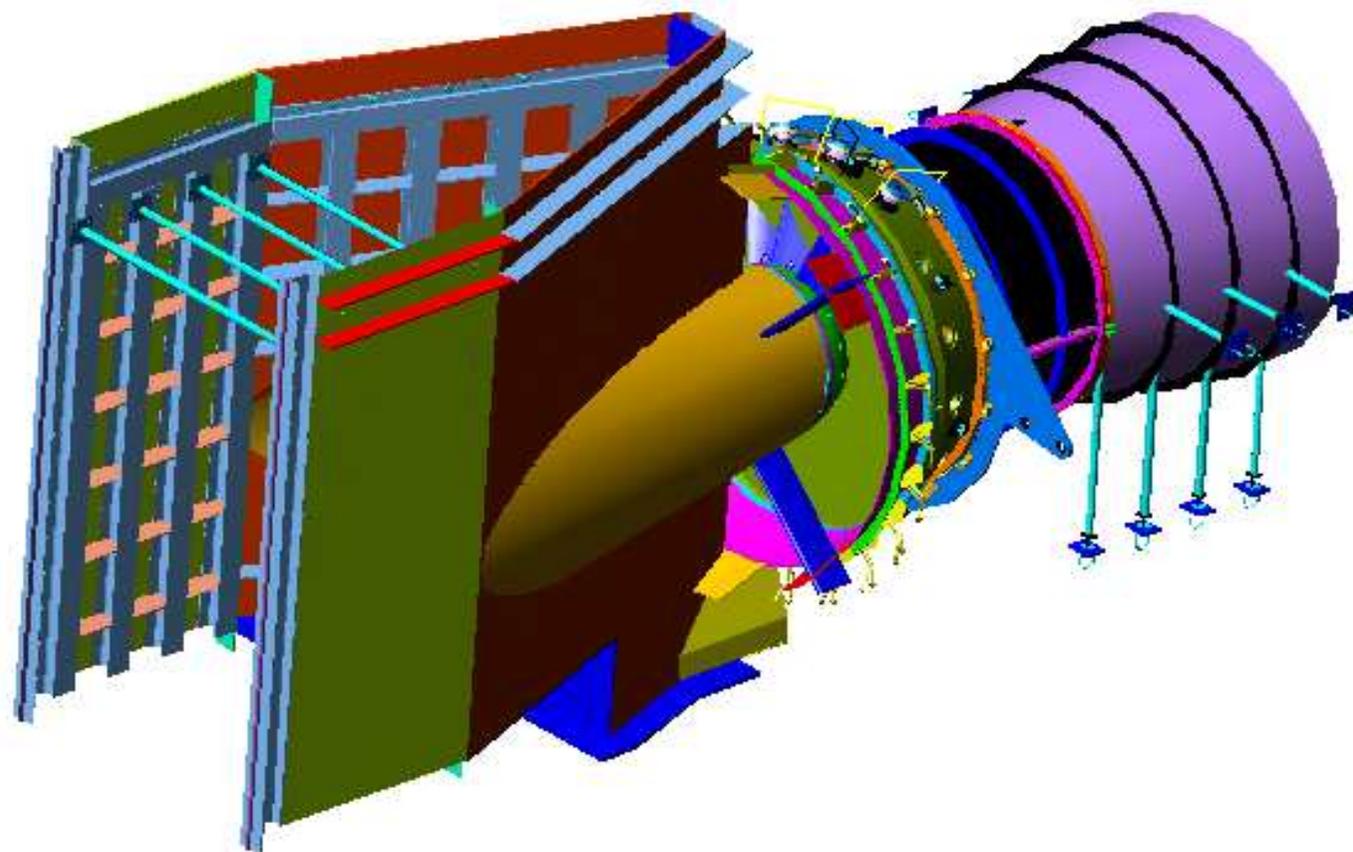


Diâmetro de Roda  $\leq 4,5$  m

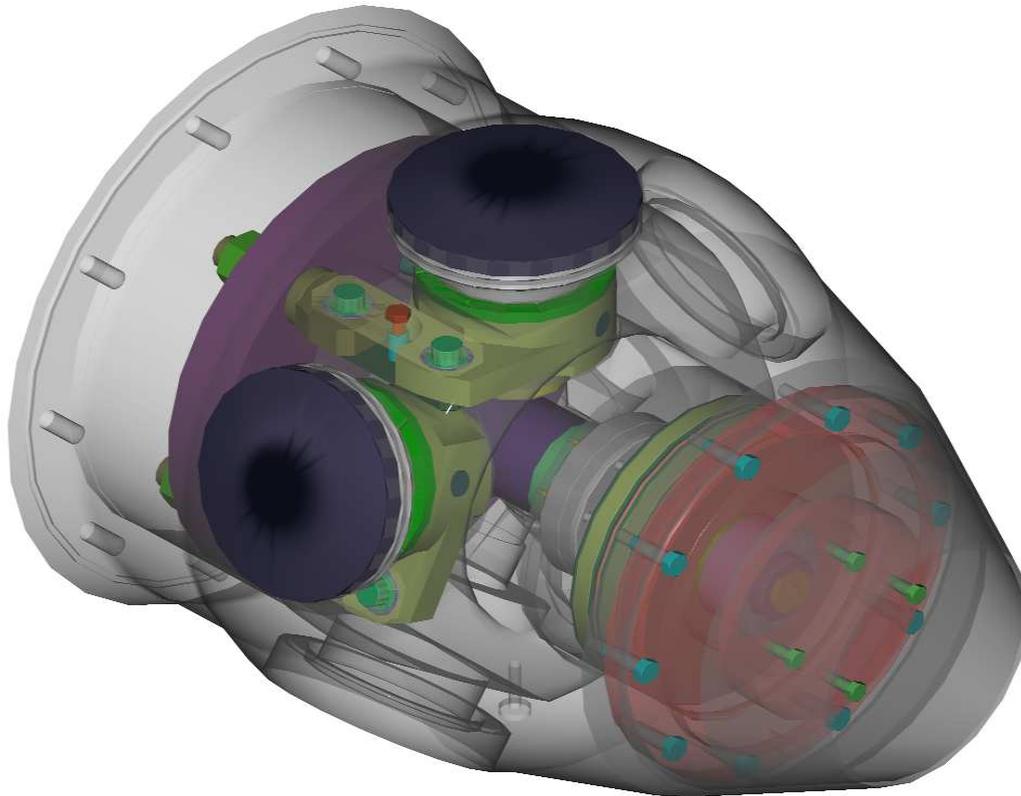
# Turbinas Poço



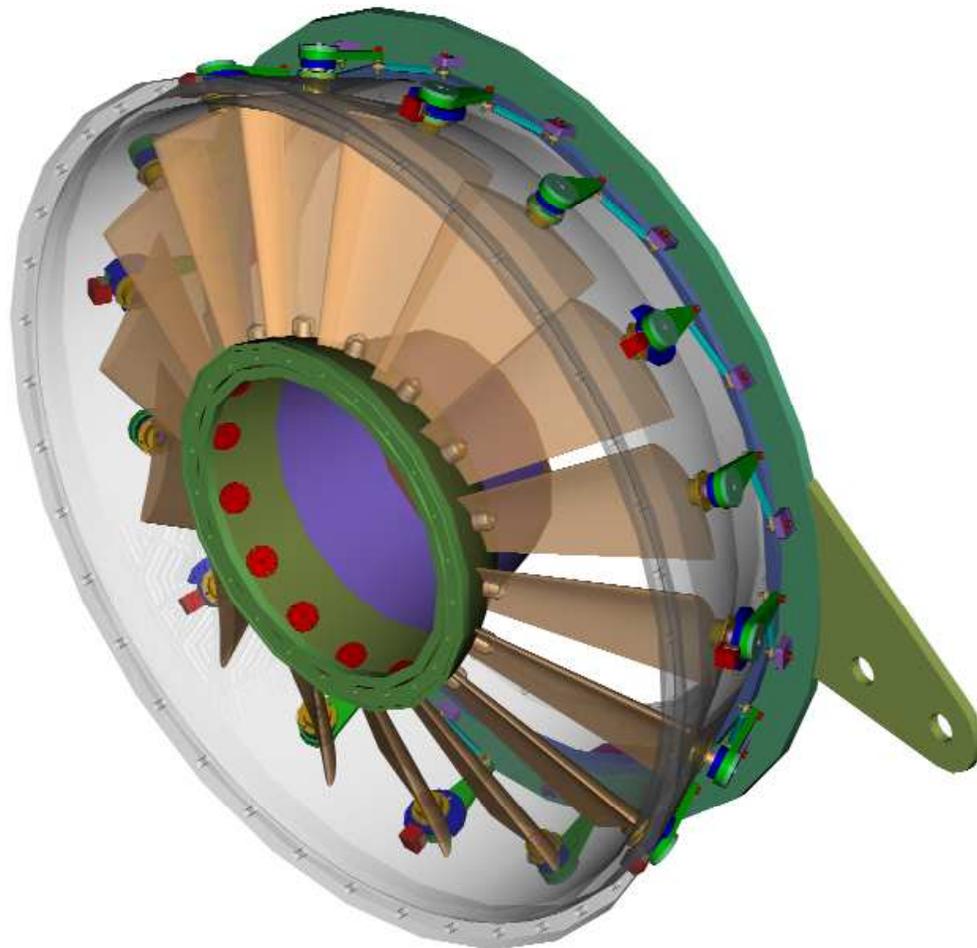
# Turbinas Poço



# Turbinas Poço



# Turbinas Poço



# Turbinas Poço

## UHE OURINHOS 45000 kW



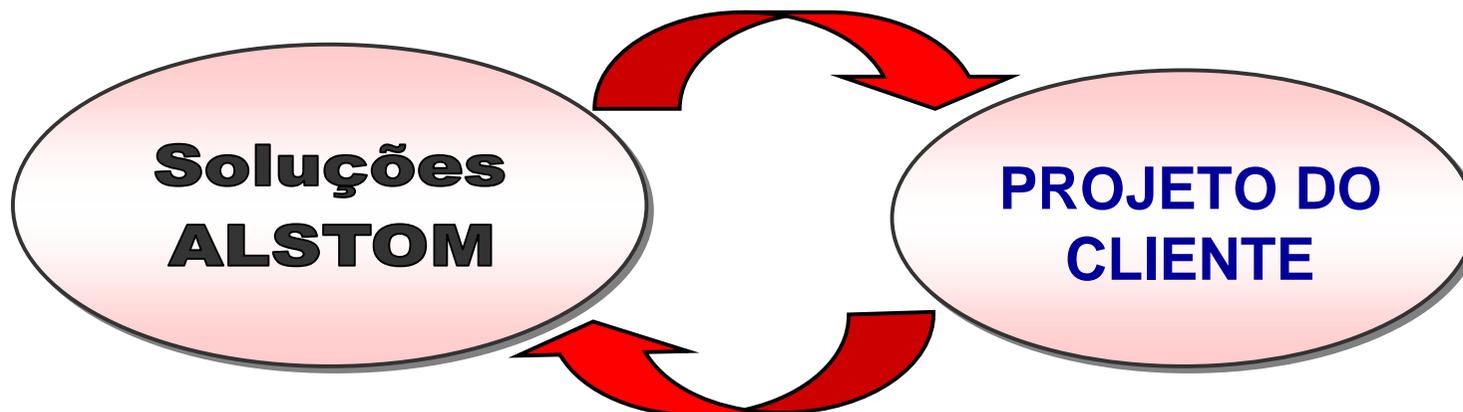
**Cliente:**  
CBA / VOTORANTIM

**Local:**  
Ourinhos - SP  
Brasil

**Tipo: Poço**  
3 x 15.000kW

**ALSTOM**

# Engenharia de Aplicação



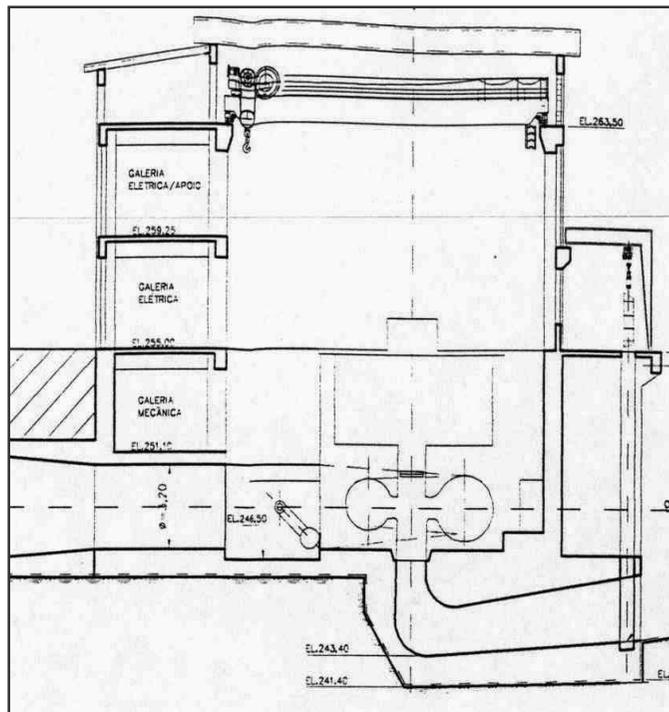
## Considera:

- Investimento
- Prazo de execução
- Condições de Operação
- Restrições e/ou otimização da obra civil
- Experiência do cliente

# Engenharia de Aplicação

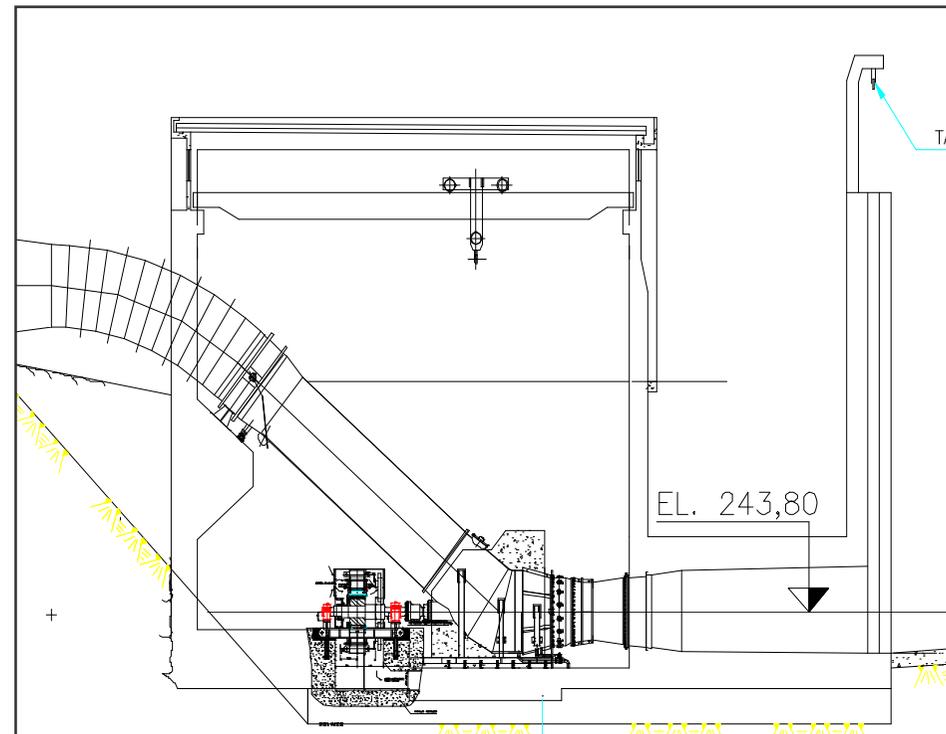
## PCH TRIUNFO 24.400 kW

**ANTES**



**2 FRANCIS VERTICAIS**

**DEPOIS**



**2 KAPLAN "S" MONTANTES**

# Síntese das Zonas de Aplicação

TIPO	TURBINA	CONCEPÇÃO	POTÊNCIA POR UNIDADE	MÁXIMO DIAM. DA RODA (mm)
KAPLAN	Sam Sav	Horizontal	5-15 MW	3.550
	Saxo	Vertical		
	KAF	Vertical	3-8 MW	3.750
	Pit	Horizontal	5-15 MW	4.500
FRANCIS & PELTON		Horizontal	>5 MW	----
		Vertical	5-30 MW	2.500

[www.alstom.com](http://www.alstom.com)

**ALSTOM**