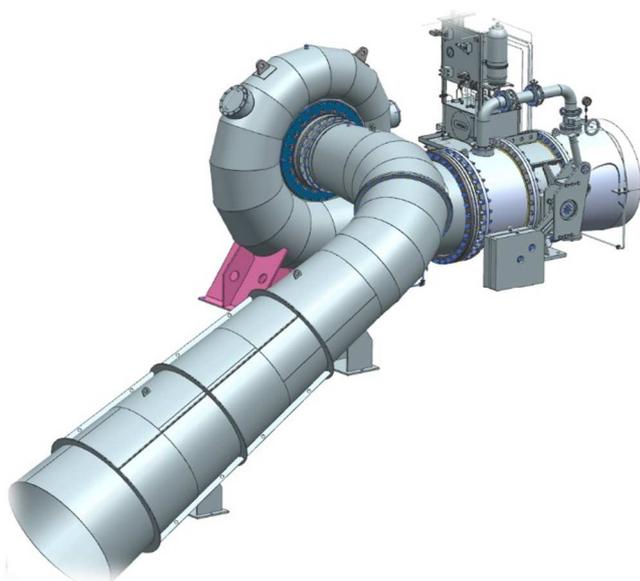


SITE: **SHPP DEBEDA**  
INVESTOR: **Hydrolea**



# INSTRUCTION MANUAL

**TURBINE FRANCIS  
HORIZONTAL SHAFT  
P<sub>max</sub> 1777 kW**

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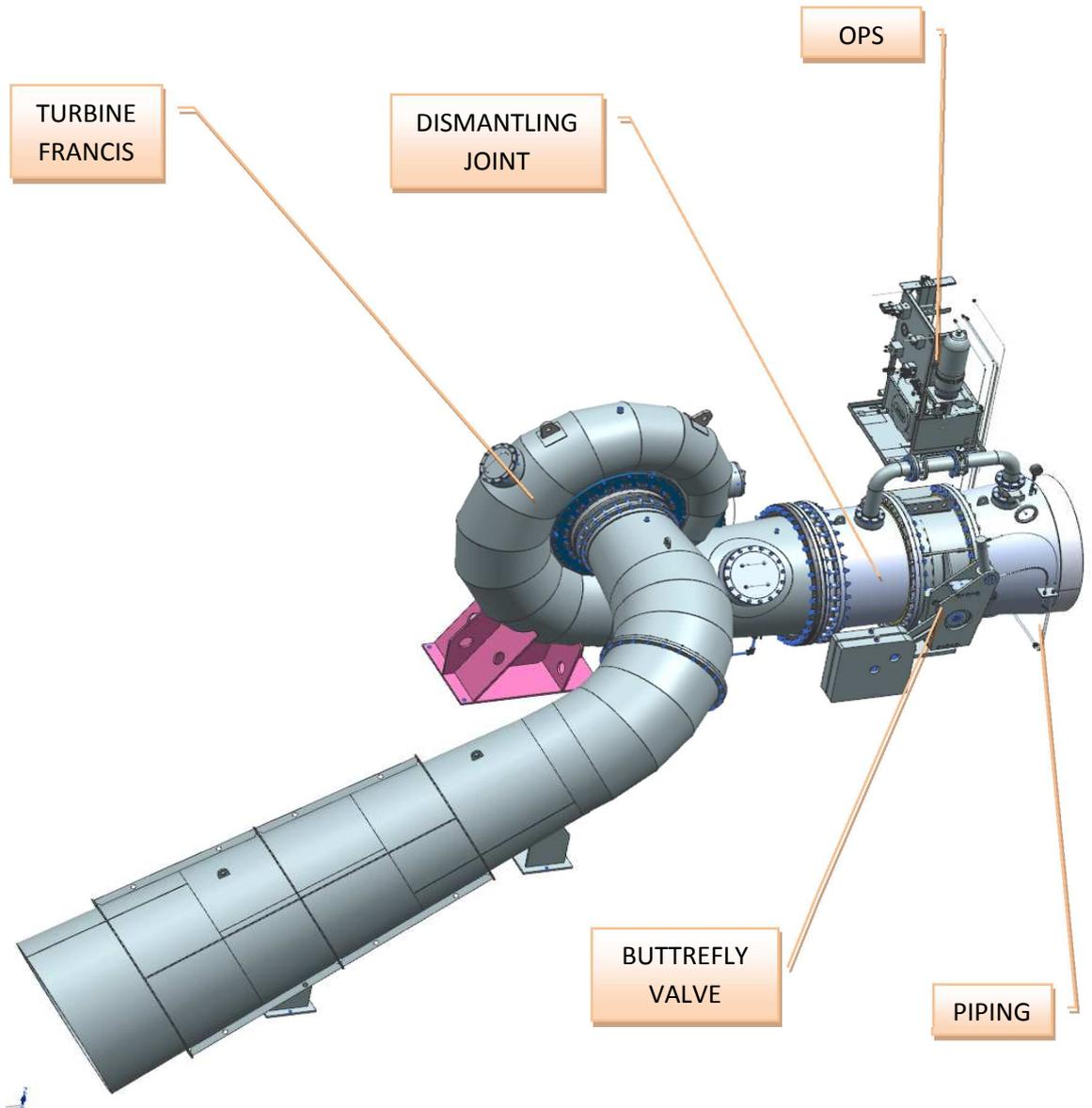
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**JUNE 2012**

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## A. PASSPORT

### I. TECHNICAL DATA

1.	Turbine type	Francis, horizontal shaft
2.	Rated Head	49.5 m
3.	Water flow:	
	• rated	4.00 m <sup>3</sup> /s
	• maximum	4.21 m <sup>3</sup> /s
4.	Power:	
	• rated	1584 kW
	• maximum	1777 kW
5.	Speed:	
	• nominal	750 min <sup>-1</sup>
	• run	1843 min <sup>-1</sup>
6.	Guaranteed Efficiency	acc. to characteristic
7.	Maximum admissible draft height, metered from turbine axes to the lower water level	0.9 m
8.	Direction of turbine shaft rotation	CCW, viewed from generator side
9.	Runner:	
	• diameter	740 mm
	• number of vanes	16
10.	Guide Apparatus height	233 mm
11.	Inner Diameter of the Spiral	1100 mm
12.	Turbine inlet gate structure	Butterfly valve DN1100 PN10
13.	Turbine dimensions and mass (without draft tube):	
	• length	3200 mm
	• width	1340 mm
	• height	3000mm
	• mass	4200 kg

14. Generator:
- type synchronous
  - power 1892 kWA
  - voltage 6.3 KV
  - nominal speed 750 min<sup>-1</sup>
  - length 3860 mm
  - width 1840 mm
  - height 1970 mm
  - mass 15500 kg

## II. TURBINE CONTROL SYSTEM

- Type Siemens PLS, VAPTECH Ltd
- Guide apparatus closing time min 45 s
- Guide apparatus open time min 45 s
- Butterfly valve closing time min 60 s
- Butterfly valve open time min 45 s

The Butterfly Valve open should be done at equalized pressure condition (max differential pressure  $\Delta p=1$  bar).

## III. GENERAL DESCRIPTION

The Turbine is Francis type with horizontal shaft and metal Spiral – welded construction. The Runner is made of stainless steel and is mounted directly to the generator shaft. The Guide apparatus consists of 20 guide vanes and levers and links. It is driven by servomotor which is connected to Oil Pressure System. The guide vanes bearing is made of self - lubricated bushings type PAP. For balancing the axial force during the turbine operation there is piping 5" which connects the space behind the Runner with lower channel.

The water from the Penstock trough the Main inlet valve flows into the Spiral and after that through the Guide apparatus into the Runner where the waterpower converts into mechanical power and by the generator shaft converts into electrical power. After that, the water flows through Draft Tube into lower channel.

Main inlet valve is Butterfly Valve which is erected on inlet side of the Turbine. Its function is to stop the water, flowing to the Turbine if the Aggregate is disconnected from the electrical grid. Between the Butterfly Valve and the Spiral is mounted Dismantling Joint. Its function is to compensate the wet parts possible linear deviations.

The turbine aggregate is composed from the following main groups and parts: Spiral, Runner, Upper Cover, Lower Cover, Inner Cover, Seal Rings, Guide Apparatus, Draft Tube, Shaft Seal, Dismantling Joint, Bypass, Oil Pressure System, Butterfly Valve and Piping.

The turbine inspections, erection and dismantle can be carry out after dismantling of the draft tube bend.

#### IV. SCOPE OF SUPPLY

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The Turbine is supplied fully equipped acc. to technical documentation, contract and list of the components

#### V. CONCLUSION

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On the basis of the results of the control quality measurements and workshop test protocols the Turbine type Francis #T440 with horizontal shaft manufactured in year 2012 and equipped acc. to the technical specification and contract requirements **is fit for transportation and site erection.**

#### VI. ENCLOSURES

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1. Turbine workshop acceptance protocols
2. Materials quality certificates
3. Component's List
4. Design documentation
5. Instruction manual

## B. DESCRIPTION

### I. FUNCTION

The turbine is designed for **HPP Debeda**.  
 Application field should be according to Operation characteristic.

### II. TECHNICAL DATA

1.	Turbine type	Francis, horizontal shaft
2.	Rated Head	49.5 m
3.	Water flow:	
	• rated	4.00 m <sup>3</sup> /s
	• maximum	4.21 m <sup>3</sup> /s
4.	Power:	
	• rated	1584 kW
	• maximum	1777 kW
5.	Speed:	
	• nominal	750 min <sup>-1</sup>
	• run	1843 min <sup>-1</sup>
6.	Guaranteed Efficiency	acc. to characteristic
7.	Maximum admissible draft height, metered from turbine axes to the lower water level	0.9 m
8.	Direction of turbine shaft rotation	CCW, viewed from generator side
9.	Runner:	
	• diameter	740 mm
	• number of vanes	16
10.	Guide Apparatus height	233 mm
11.	Inner Diameter of the Spiral	1100 mm
12.	Turbine inlet gate structure	Butterfly valve DN1100 PN10
13.	Turbine dimensions and mass (without draft tube):	
	• length	3200 mm
	• width	1340 mm
	• height	3000mm
	• mass	4200 kg

14. Generator:	
• type	synchronous
• power	1892 kWA
• voltage	6.3 KV
• nominal speed	750 min <sup>-1</sup>
• length	3860 mm
• width	1840 mm
• height	1970 mm
• mass	15500 kg

### III. TURBINE CONTROL SYSTEM

• Type	Siemens PLS, VAPTECH Ltd
• Guide apparatus closing time	min 45 s
• Guide apparatus open time	min 45 s
• Butterfly valve closing time	min 60 s
• Butterfly valve open time	min 45 s

The Butterfly Valve open should be done at equalized pressure condition (max differential pressure  $\Delta p=1$  bar).

### IV. CONSTRUCTION DESCRIPTION

The Turbine is Francis type with horizontal shaft, steel Spiral and stainless steel Runner. The runner is mounted to the generator shaft by means of conical end. The torque is given by means of two parallel cotters. The hydraulic axes forces so the runner weight forces are carried of the generator bearings. For balancing of the axial force during the turbine operation there is piping 5" which connects the space behind the Runner and lower channel. The Guide apparatus consists of 20 guide vanes and levers and links. It is driven by servomotor which is fed by Oil Pressure System. The guide vanes bearing is made by means of self - lubricated bushings type PAP P10.

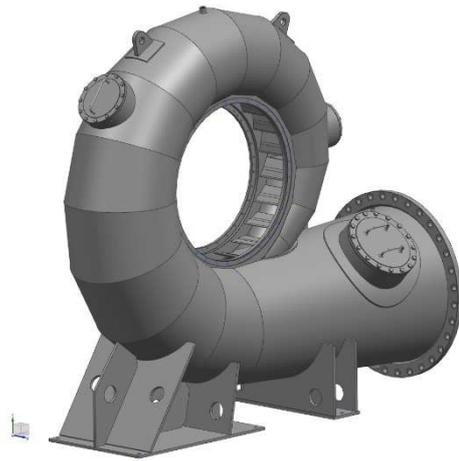
The water from the Penstock trough the Main inlet valve flows into the Spiral and after that through the Guide apparatus into the Runner where the waterpower converts into mechanical power and by the generator shaft converts into electrical power. After that, the water flows through Draft Bend and Draft Tube into lower channel.

Main inlet valve is Butterfly Valve which is erected on inlet side of the turbine. Its function is to stop the water, flowing to the turbine in case of the aggregate is disconnected from the electrical grid. Between the Butterfly Valve and the Spiral is mounted Dismantling Joint. Its function is to compensate the possible linear deviations.

The turbine inspections, erection and dismantle can be carry out after dismantling the draft tube bend.

The turbine is composed from the following main groups and parts:

## 1. Spiral Casing



Spiral casing's function is to lead and uniformly distribute the water from the Penstock to the Guide Apparatus so as to equalise the water speed and pressure values at the guide apparatus inlet along the whole distance.

The Spiral is made of quality construction steel S355J2, EN10025 - welded construction. The Spiral is mounted by flange to Dismantling Joint and then to the Penstock. The Spiral is placed to the foundation on two feet elements. After final centering and levelling the support plates under the Spiral are welded to the foundation plates. The Spiral is bolted to the foundation by the connection elements. At the Spiral inlet there is one nipple G3/8" and one nipple G1/4" in the intermediate section for control measurements and one nipple G1" for deaeration valve.

Three manholes DN250, DN320 and DN450 are provided for inspections. The Spiral Stator has twenty stay vanes with a profile which is provided in advance water flow direction with minimum hydraulic losses. On the stator plate from the generator side are drilled four holes M16 providing Upper Cover dismantling.

## 2. Guide Apparatus



Guide Apparatus' function is to lead the water flow to the Runner and to regulate the water flow according to the power and to stop the water flow in case of turbine turn off.

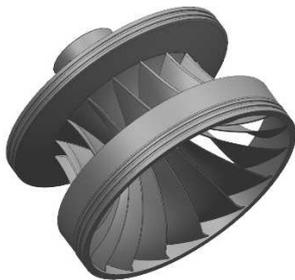
It consists of guide vanes, levers and links which form permanent cinematic circuit. They are driven by servomotor connected to Oil pressure system. The guide vanes are made of stainless steel. The levers and links are made of quality construction steel. The bearing bushings are self - lubricated type PAP P10.

### 3. Dismantling Joint



Dismantling joint is composed of four flanges and one cylinder that are made of construction steel S355J2, EN10025. Thirty-two studs M33x360, 41Cr4, EN10083-1 and one hundred twenty-eight hot dipped galvanized nuts M33-8 are provided for assembling. Dismantling joint is mounted between the Butterfly valve and Spiral Casing.

### 4. Runner



Its function is to convert the kinetic and potential waterpower into mechanical power of the turbine shaft. It is connected to the aggregate shaft by means of cylindrical end and one friction shim. The Runner is tightened to the aggregate shaft by means of twelve screws M24 to avoid the axial dislocation. At the finally erection the screws must be secured with Loctite 243. The conical connection between the Runner and the Shaft provides better centering and partially unloads the cotters and

makes Runner dismantling easier. To avoid the critical minimum pressure values in the draft part of the Runner hub there are provided six holes Ø10 for aeration the space under the runner. The Runner is fully made from stainless steel GX4CrNiMo16-5-1, EN10213-2 – welded construction. The Runner consists of hub, ring and seventeen profiled blades.

### 5. Upper Cover and Lower Cover

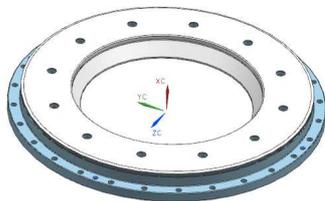
Their function is to close the Spiral from its both sides. Between them is formed the guide apparatus channel.

#### Upper Cover



It is mounted to the Spiral from generator side. It is made of quality construction steel S355J2, EN10025. The surface from the guide vanes side is made of stainless steel AISI316L clad welded. On the cover are drilled the holes for bearing bushings PAP type. The upper seal ring is mounted to the cover inner side by twenty bolts M12. On the outer side of the cover there is a seat for inner cover fixing.

## 6. Lower Cover



It is mounted to the Spiral from draft tube side. It is made from quality construction steel S355J2, EN10025. The surface from the guide vanes side is made of is stainless steel AISI316L clad welded. On the cover are drilled the holes for bearing bushings PAP type. The lower seal ring is mounted to the cover. On the outer side of the cover are drilled twenty-four holes M16 for mounting the draft tube to the turbine and four holes M16 for the lower seal ring mounting in advance. There are provided two holes M16 on the periphery for lifting and erection and four holes M16 for dismantling.

## 6. Inner Cover

It is mounted to the Upper Cover by means of twenty bolts M12. It is made of quality construction steel S355J2, EN10025. The shaft seal is mounted to the outer side of the cover by means of eight bolts M10. To the cover outer side is connected the pipe 5" for balancing the axial forces.

## 7. Bypass



Bypass DN125 has a function to equalize the Butterfly valve both sides pressure. Maximum admissible differential pressure is 1 bar. If this condition is provided Butterfly valve can be open. The Bypass is mounted on the Bend and Dismantling joint. The Bypass consists of tube with flanges, manually driven valve DN125 and electrically driven valve DN125.

## 8. Draft Tube

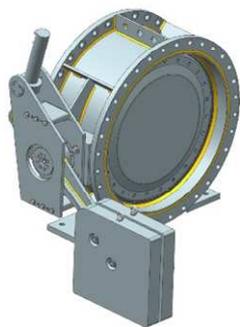
It consists of draft bend and straight draft tube. Its function is to lead the water flow from the Runner to the lower channel with minimum power losses.



**Draft Bend** - It is conical bend tube which has flanges on its both ends for connection to Lower Cover and to Straight draft tube. The flanges are not fixed to provide easier erection and dismantle.

**Straight Draft Tube** - It is conical tube. It is mounted on angle 30° in relation to horizontal axes and after finally centering is concreted.

The draft bend should be dismantled in case of runner inspections.



## 9. **Butterfly Valve**

Butterfly valve should stop the water flow to the turbine in case of aggregate grid disconnection or at turbine normal stop condition.

The Butterfly valve is monoplan type and is equipped with rubber seal which can be tightened during the operation without valve's disassembling. Its opening is carried out by means of servomotor and its closing – by means of counterweight. The Butterfly valve can close at full water flow (open Guide apparatus) in case of emergency.

**10. Shaft Seal**

Shaft seal is a part of Inner Cover and it consists of two rings made of bronze. Shaft seal's function is to collect the water leakage through the upper seal and to aerate the space under the Runner. There is a pipe from the seal to the drain tank. The ends of this pipe **should not be submerged**.

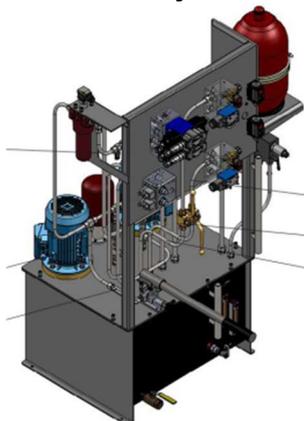
**11. Seal Rings**

There are Upper and Lower ones. Their function is to provide the minimum volume losses during the turbine operation. They are made of bronze casts G-CuAl10Ni DIN1714.

**12. Piping**

It consists of discharging pipe 5" (for connection the space behind the Runner with water pumping shaft, pipes for leading the leakage from the shaft seal, connection pipes between Guide apparatus servomotor and Oil pressure system.

**13. Oil Pressure System**



It is composed from two electrical motors 1.1 kW, four digital and two proportional direction valves. One ten liters volume hydro accumulator is mounted to OPS. This hydro accumulator provides oil giving to the operation devices in case of the absence of a feeding voltage.

## **V. PLATING AND PAINTING**

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1. For corrosion protection all of the inner and outer surfaces which are not machined and not assembled should to be painted acc. to Painting specification 10899PS.
  - Wet turbine surfaces are painted with epoxy paint – min layer thickness 400 µm.
  - Outer not machined and not assembled surfaces are painted with epoxy paint plus polyurethane RAL 5002 – general layer thickness min 200 µm.
  - The Guide apparatus parts are painted with epoxy paint plus polyurethane RAL 5002 – general layer thickness min 100 µm.

The parts must be cleaned to metal brilliance, free of oil and primer plated in advance.
2. All of the connecting elements – bolts, screws, nuts and washers are hot dipped galvanized or are made of stainless steel.

## **VI. ACCEPTANCE CRITERIA**

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The turbine acceptance is carried out from the Investor in the presence of the manufacturer Representative twice:

1. Acceptance in advance after the turbine erection at the workshop – to check the quality and for preparing of the handling protocol.
2. The final acceptance after the turbine erection at HPP – to check the erection quality and the rated technical data. At the final erection the acceptance commission must pay special attention to the following:
  - Completion of the workshop supply
  - Erection quality – if all of the groups are mounted acc. to the drawings, if the radial tolerances between seal rings and the Runner are the same as rated so the axial runner location.
  - Right operation of all of the turbine parts
  - Generator axial and angle fixing
  - Turbine vibration – it is allowed double vibration amplitudes according to ISO10816-5:2000
  - Power and efficiency

## **C. INSTRUCTION MANUAL**

### **I. TURBINE ERECTION**

#### **1. At workshop**

##### **1.1. General**

All of the parts for assembly must to be free of grits, weld metal etc. Before the entire workshop assembly must to be carried out the main units' assembly as pointed in the units' drawings. It is necessary on purpose to check the right assembly of the parts.

##### **1.2. Entire workshop assembly**

The Spiral is placed at horizontal position and the Upper Cover is mounted. After tightening of the Cover to the Spiral casing Inner cover and Upper seal ring are mounted to the Upper Cover. The Lower Cover control assembly is carried out and  $B_0$  is checked. If there is dimension deviation the Cover should be disassembled and turned following the designer instructions. All of the guide vanes are mounted to the Upper Cover bearings. The pressure test ring equipped with respectively seals is placed. The Lower cover is mounted to the Guide vanes. The pressure test cover is mounted so and manholes and plugs with respectively rubber seals.

The equipped Turbine is placed on the pressure test platform. The Spiral is placed on the prisms and supports to provide access from all of the sides for inspection during the pressure test. The pressure test carries out acc. to the workshop hydraulic turbine test procedure. The Quality department protocol should be filled.

After the hydraulic test the turbine parts should be disassembled and painted acc. to Painting specification and prepared for final assembly.

Upper cover with Upper seal ring, Inner cover, Guide vanes, and all of the O-rings and rubber rings are mounted consecutively. Round the Guide vanes blades is placed the steel cord. After the lower cover assembly the steel cord stretches pressing the guide vanes blades as long as no clearance exists. This clearance and the clearances between covers and guide vanes blades are measured. The assembled turbine is placed on the borer or radial machine because the holes for pins between covers and support of the vane for servomotor lever to be drilled. The pins should be placed.

The Guide apparatus is mounted in the following sequence: the servomotor's lever is mounted on position acc. to the drawing, the levers and rods are mounted on its both sides consecutively. The rod should not to be mounted between two levers situated opposite of the servomotor's lever. The lever's connection to the all of the twenty guide vanes is carried out by means of clampex type TLK. The servomotor plate is mounted and welded to the Spiral.

If there are some defects in painting as a result of assembly they should be repaired.

## 2. At site

The turbine is supplied assembled excepting the rotor part – Runner (Upper cover, Lower cover, Guide vanes, and Guide apparatus). The Runner, Draft tube, Dismantling joint, Inlet bend and Butterfly Valve are supplied as single parts. The erection is carried out in the following order:

- 2.1. The Turbine, Draft tube and Butterfly Valve axes and levels of foundation plates check - acc. to dwg.1997200.
- 2.2. The Spiral casing positioning – the Turbine is placed on the defined place and the inlet flange is orientated on Penstock and is levelled acc. to dwg.1997100.
- 2.3. The Draft Tube positioning - the draft tube consist of conical part and bend including dismantling flanges. The Draft Tube is placed on the defined place after the bend is connected to the turbine Lower cover acc. to dwg.1995500 and dwg.1995600. During the bend assembly the 5 mm clearance between lower seal ring and the bend inlet should be provided.
- 2.4. Spiral Casing and Draft Tube concreting – it is carried out after metering and after the level acceptance protocol is filled. The measurements are repeated after concreting to determine the possible deviations.
- 2.5. Butterfly valve positioning on the foundation – it should be carried out after Dismantling Joint connecting.
- 2.6. Intermediate Cylinder connecting – the cone is fixed to the Butterfly Valve, the Penstock is grazed to the Cone and the Piping is welded.
- 2.7. The Generator positioning –the Generator is fixed to the turbine axes using Upper and Lower covers and the Frame is fixed after that. For precise fixing to the Runner the possibility for angle and axial (min 5 mm) deviation of the Generator should be available.
- 2.8. After precise check for good centering of assembled units the secondary concreting should be carried out acc. to foundation plan.
- 2.9. The Runner erection – the Draft tube bend and Lower cover are dismantled. The Runner is mounted to the generator shaft. The clearances between the Runner and Upper Seal Ring are measured. The additional generator positioning is carried out if it is necessary. The runner screws 12xM24 must be secured with Loctite 243.
- 2.10. The Lower Cover and Lower Seal Ring assembly – the Lower Cover is mounted to the Spiral Casing. The Lower Seal Ring is mounted and is centered this way that the clearance to the Runner to be the same as the specified in the drawing.
- 2.11. The Draft Tube Bend assembly
- 2.12. The Dismantling Joint final assembly
- 2.13. The turbine Piping assembly – the discharging pipe 5" from Upper cover to the lower channel, draining pipes from the Shaft seal and Dismantling Joint are mounted.
- 2.14. The Oil pressure system positioning and connecting the Oil pressure system to the Butterfly Valve and Turbine servomotors  
This way the Aggregate is ready for starting up tests.

## II. **STARTING UP TESTS**

The purpose of the starting up tests is turbine manufacture quality and right site erection to be checked so the joint action of the Aggregate single parts.

### 1. **Tests at Turbine turned off**

- 1.1. If the turbine is empty (no water before Guide apparatus)  
During the workshop assembly the clearances between the Guide Vanes face surfaces and Turbine Covers so and the density between two guide vanes should be filled in the protocols.

During the site assembly the shaft measurements (radial and axial deviations) so and measured clearances in seal rings should be filled in protocols.

Oil pressure system is checked and if it is in good condition can be turned on.

The dry tests of Butterfly valve open and closing is carried out so the open and closing of the Guide Apparatus.

- 1.2. If the spiral is full of water and at static pressure conditions  
The turbine seals, the Butterfly valve and Dismantling joint are checked. No leakages through the flanges are allowed.

### 2. **Tests at Turbine no load conditions**

The Guide Apparatus is open until nominal speed on no load (without generator excitation) is reached.

- 2.1. The generator shaft deviation on nominal speed should be checked so at speed lower and higher than nominal.  
2.2. The protections should be checked.

### 3. **Tests at Turbine on load conditions**

- 3.1. The generator bearings temperature should be observed.  
3.2. The generator shaft vibration should be measured on load 1/4, 2/4, 3/4 and 4/4 of nominal speed.  
3.3. The speed variations on constant load and regulation system servomotor piston fluctuation on different turbine loads should be observed.  
3.4. The final sensor and Guide apparatus activation is carried out on purpose to limit the maximum turbine power to prevent the generator overload.  
3.5. The turbine power depending of Guide apparatus open is observed.  
3.6. The generator is turned off on purpose to check the regulation limits if the turbine is fully discharged.

### III. OPERATION INSTRUCTION

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#### 1. General

- 1.1. The Aggregate (turbine + generator) must be mounted on place providing calculated values of head, water flow and draft height which are pointed in documents.
- 1.2. All of the Aggregate units and parts and the engine room must be cleaned.
- 1.3. Periodically to do careful check of the connections: nuts, bolts, screws and studs. The damaged parts must be substituted with new ones.
- 1.4. Periodically but no longer than ones per six month to do check of the Runner – through the spiral manholes so from the draft tube side after dismantling the draft bends.
- 1.5. During the periodic inspections to pay special attention to the following units:
  - Runner and its strengthening
  - Guide vanes and the Guide apparatus single parts – levers and links
  - Seals status and reliability
- 1.6. To follow-up for strict observance of safety rules during the operation.

#### 2. Bearings service

The Bearing service must to do acc. to the generator Instruction manual.

#### 3. Turbine turning on

- 3.1. The whole turbine inspection is necessary to do before turbine turning on. The special attention should be paid to the connection of Guide apparatus.
- 3.2. The Butterfly valve open and closing should be done so and Guide Apparatus.
- 3.3. The Penstock should be water filled.
- 3.4. The Butterfly Valve open – by means of Bypass the equalizing the Butterfly valve' both sides pressure is done and after that Butterfly valve can be fully open.
- 3.5. The Guide Apparatus starts opening. The Aggregate shaft starts rotating on no load conditions and the Generator is ready to be paralleled.

#### 4. Turbine maintenance

- 4.1. The bearings temperature must not exceed the defined one in the generator Instruction manual. In case of overheating the Butterfly Valve must to be closed.
- 4.2. No oil leakage from Oil pressure system is allowed.
- 4.3. The turbine inlet pressure can be controlled by means of manometer and the Draft tube vacuum – by means of vacuum meter (if necessary).
- 4.4. The Turbine operation should be observed. In case of abnormal noise or vibrations the Turbine must be turned off immediately.

#### 5. Turbine turning off

- 5.1. At Normal conditions – by means of Guide Apparatus closing.

- 5.2. At Emergency conditions – by means of automatic Butterfly Valve which stops the water flow to the Spiral.
- 5.3. If the Aggregate will be turned off for a long time it is necessary to empty the Spiral through the manhole.

#### **6. Turbine periodical inspections**

- 6.1. The Aggregate inspections should be done once per year. In the beginning the Runner inspection is recommended to do at first 100, 200 and 500 operation hours.
- 6.2. During the inspections should be checked about mechanical wear out and wet details cavitations so and seal ring and seals states, etc.
- 6.3. During the Aggregate operation the bearings temperature permanent control should be carried out. The good condition of the Control System providing the Butterfly Valve closing should be observed.

#### **IV. ADDITIONAL INSTRUCTIONS**

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1. All of the small Aggregate parts including Draft tube, Butterfly Valve, Turbine, Dismantling Joint, Inlet Cylinder and Generator are designed for disassembly. It is done on purpose to use the existing rail way if the big turbine repair is necessary.
2. If the small turbine is disassembled – the Cover for the Tube with Flange (to the main Penstock) to be provided while the big Turbine is operating. This cover is necessary to use if the Butterfly Valve is not connected to the Dismantling Joint, Spiral and intermediate body as it is normally for a small Aggregate.
3. If the rail way is used for disassembly of the big Turbine Draft Tube Cone the all of the small Turbine Draft Tube parts (including the Bend), Butterfly Valve, Turbine, Dismantling Joint and Inlet Cylinder should be disassembled in advance.

## **D. SAFETY AND ENVIRONMENTAL PROTECTION INSTRUCTIONS**

### **I. SAFETY INSTRUCTIONS**

The precondition for safe operation of whole turbine hydro aggregate is the personnel to be acquainted with safety instructions and prescriptions of all of the included components.

Pay special attention to the sound, generated of the system as a whole. It can help you to avoid defects, which could cause serious damages if they are not found in time.

Turbine is designed and manufactured according to the safety rules. Despite of it, if the unit is used incorrectly during the operation, a danger of health and life of the personnel are possible so third person's losses/damages.



*Do not use the unit in presence of loose pipe or flange connections and cables with damaged isolation.*



*Every starting-up or other actions should be carried out by trained and authorized technical personnel.*

1. Electrical power supply and electrical equipment maintenance should be done by qualified electrical technician. Electrical equipment should be checked periodically. Bare cables and cables with damaged isolation should be replaced with new ones immediately.
2. Equipment operation is not allowed in case of presence of oil leakages from hydraulic system (flexible and pipe connections, control blocks of servomotors, servomotors and hydraulic aggregates).
3. Atmosphere influences caused aging of flexible connections (high pressure hoses). To avoid the danger of their destroying during the operation, they should be replaced by new ones every four years.
4. Special attention should be paid to "manual mode" of control especially emergency closing of Butterfly valve by OPS manual valve. In this case the closing speed should be regulated by position of open of this valve to avoid water hammer in the penstock.



*Never disassemble hydraulic system under pressure!  
Release the pressure in hydro accumulator before disassembling or servicing!*

5. All of the aggregate elements (cables, sensors, relays and switches) located outside the HPP building should be thunder protected.



*At emergency conditions aggregate should be turned off immediately so electrical power supply should be disconnected!*



**VAPTECH**

Make what the Planet  
Needs!

## II. HYDRO AGGREGATE PRESERVATION IN A STORE / AGGREGATE OUT OF OPERATION

Whole inspection of the aggregate should be done before a long period preservation in a store. In a presence of unpreserved surfaces or damaged ones they should be treated by conservator.

Aggregate should be stored in a clean and dry premises (without condense). Preservation temperature should be more than 0°C and up to +50°C.

Aggregate should be covered with proper source against dust. All of the hydraulic and automatic elements are very sensitive to dust.

All of the elements should be placed into the supplier packing.



*It is absolutely inadmissible to preserve the units in the open air and in distribution centres.*



*After an idle period longer than six months, whole re-conservation of the elements should be done.*

## III. DISPOSAL OF HYDRO AGGREGATE AS A WASTE PRODUCT

After aggregate dismantle and separation of its elements they should be disposed as a waste product or should be recycled in accordance of the local standards.

If necessary, write to us at:

[service@vaptech.bg](mailto:service@vaptech.bg)

Our Service Center remains at your disposal at all times, weekends and official holidays inclusive.

In emergency cases, please call Service mobile: +359 886 223 535.

Our clients' satisfaction is VAPTECH's priority.

Project: H14190	Investor: <b>C.M.M. FRATELLI RIZZI SRL</b> Site : <b>Debeda</b> Turbine Francis horizontal shaft $Q_r = 4.00 \text{ m}^3/\text{s}$ , $n_r = 750\text{rpm}$ , $H_r = 49.5 \text{ m}$	Page: 1 Total pages: 1
Date: 29.06.2015		<b>Enclosure 1</b>
Sign: Arabadzhiev		Revision: 0

**Q- $\eta$  curve**

