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**Specification for Installation of  
Hydraulic Turbine Generator Units  
水轮发电机组安装技术规范**

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# **Specification for**

## **Installation of Hydraulic Turbine Generator Units**

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### **1 Scope**

This national standard regulates the installation, debugging of hydraulic turbine generator units and the requirements of test. It is applicable to the installation and/or acceptance of hydraulic turbine generator units in compliance with the following conditions:

- a) Unit capacity of 15MW and/or higher
- b) Impulse hydraulic turbine with its nominal diameter of runner at 1.5m and/or above
- c) Radial-axial flow turbine with its nominal diameter of runner at 2.0 m and/or above
- d) Axial flow, mixed flow variable pitch turbine, and tubular turbine, with nominal diameter of runner at 3.0m and/or above.

Hydraulic turbine generator units with unit capacity smaller than 15MW and units with nominal diameter of turbine runner smaller than that specified in b), c), and d).

This national standard is applicable to the installation and/or acceptance of reversible pump storage unit.

### **2 Normative standards**

The following normative documents contain provisions, which, through reference in this text, constitute provisions of this national standard. For dated reference, subsequent amendments to, or revisions of, any of these publications do not apply. However, it is recommended parties reaching agreement according to this national standard carry out a study on if the most updated version of these documents may be applied or not. For undated reference, the latest edition of the normative document referred to applies.

GB3323 Methods for radiographic inspection and classification of radiographs for fusion welded butt joints in steel

GB/T7409.3 Excitation system for synchronous electrical machines-Technical requirements of excitation system for large and medium synchronous generators;

GB/T7894 Fundamental technical requirements for hydraulic turbine generators;

GB/T9652.1 Specifications of governors and Pressure oil supply units for hydraulic turbines;

GB/T9652.2 Test acceptance codes of governors and pressure oil supply units for hydro-turbines;

GB/T10969 Specifications for water passage components of hydraulic turbines;

GB/T11120L-TSA Turbine Oil;

GB11345 Method for manual ultrasonic testing and classification of testing results for ferritic steel welds;

GB/T18482 Start - up test code for reversible pump - storage units;  
GB50150 Emending explanation of Standard for hand-over test of electric equipment electric equipment;  
GB50168 Code for construction and acceptance of cable levels electric equipment installation engineering;  
GB50171 Acceptance of switchboard outfit complete cubicle and secondary Circuit Electric Machine;  
DL/T507 Start-up test code for hydraulic-turbine and generator units;  
DL/T679 Code for welder technical qualification;  
DL/T827 Start-up test code for bulb tubular hydraulic-turbine and generator units;  
JB/T4709 Welding specification for steel pressure vessels;  
JB/T6204 Specification for withstand voltage test on stator coil and winding insulation of high voltage AC machines;  
JB/T8439 Technical requirements on suppress corona of high-tension machines used in high altitude areas  
JB/T8660 Standard for hydroelectric set packing, transportation and preservation

### **3 General principles**

3.1 Installation of water-turbine generator set shall proceed according to this national standard in compliance with the installation drawing approved by design organization and manufacturer as well as related technical documents. Special requirements raised by the manufacturer shall be satisfied according to related technical documents. Supplementary provisions for requirements not listed in this standard and technical documents of manufacturer shall be specified additionally. In case of a conflict between the technical requirements from the manufacturer and this standard, generally, the requirements of the manufacturer shall proceed. Otherwise, consult with the manufacturer for a settlement.

3.2 Other than this national standard, installation of unit and its auxiliary facilities shall also comply with current related specifications on safety, environmental protection, fire control, and so on issued by the state or related authorities.

3.3 Equipment for water-turbine generator units shall be in accordance with the regulations of current national standard and purchase contract. After the equipment arrives at the acceptance spot, the installation party may participate in unpacking, counting, checking the supply list and random packing list, and then operate according to JB/T8660.

The following documents shall be taken as important evidence for acceptance of both unit and it auxiliary equipment as well as quality acceptance.

- a) Equipment installation, operation, instruction on operation and maintenance and technical documentation;
- b) All random drawing materials (including equipment installation drawing and structure drawing of spare parts);
- c) Certificate of analysis, inspection and test records;
- d) Material quality and performance certificate of vital parts.

3.4 Before the installation, read design drawing, factory inspection record and related technical documents carefully and be familiar with them, and then make out a logical construction design in compliance with the actual conditions.

3.5 Before the installation, read related civil design drawing and participate in the acceptance of the delivered civil construction parts. For places with flaws, the installation must be carried out after treatment.

3.6 All materials used in the installation of water-turbine generator unit shall be in accordance with design requirements. Primary materials must possess inspection certificate and certificate of analysis.

3.7 Plan the installation field integrated. The following requirements shall be met:

a) Installation field shall be windproof, rainproof and dustproof. Unit installation must proceed after the completion of the factory building roofs of this unit and adjacent units are sealed.

b) Generally, the temperature shall not be lower than 5°C. Relative humidity of air shall not be higher than 85%. For other equipments and parts that have requirements over temperature, humidity and other special conditions, the installations shall be implemented according to the design specifications.

c) Enough illumination shall be provided on the construction field;

d) Safety facilities for construction in compliance with requirements must be equipped on site. Places to put flammable, high explosive items must have corresponding safety provisions;

e) Civilize production. Installation equipment, construction tools and materials shall be placed in order. The construction site shall keep clean. Passage remains to be smooth. Clear the site on the completion of work.

3.8 After the completion of the installation of water-turbine generator set, proceed the test run according to this national standard and DL/T507. Comprehensively check the quality of design, fabrication and installation. After the test run is proved qualified, proceed the acceptance of the unloading phase of this unit. Hand over related materials according to the requirements of Annex A.

## **4 General regulations**

4.1 Before installation, clear and inspect the equipment overall. Check the main dimensions and/or tolerance of primary parts according to the drawing requirements as well as ex-factory records.

Equipment inspection and flaw treatment shall have records and licenses.

Packed equipment under warranty may not have to be dis-integrated.

4.2 Generally, deviation of the elevation of entombment of equipment foundation bedplate shall not exceed - 5mm ~ 0mm. Deviation of the center and azimuth distribution shall not be greater than 10mm. Horizontal deviation is no greater than 1mm/m.

4.3 After fitting entombment part, reinforce it. Foundation bolt, lifting jack, fastener, wedge, and floor plate shall all be spot-welded and fixed. The built-in fitting and the concrete binding surface shall be free of oil sludge and serious rustiness.

4.4 Installation of the anchor bolt shall comply with the following requirements:

a) Check if the anchor bolt hole is in the right position. The inner wall of the hole shall be roughened and cleaned. Deviation of the screw center line and base center line shall not be greater than 10mm; the elevation and depth of the bolt shall be in compliance with the design requirement; squareness deviation of bolt hole wall shall not be greater than  $L/200$  ( $L$  refers to the length of anchor bolt mm, the same for the following context) and shall be smaller than 10mm.

b) Centre of second phase concrete direct burial and casing flush type anchor bolt shall comply with design requirement. The deviation of center shall not be greater than 2mm. The discrepancy in elevation shall not be greater than 0mm ~ +3mm. Squareness deviation shall be smaller than  $L/450$ .

c) Anchor bolt adopts embedded bar. Welding of screw on it shall conform to the following requirement:

1) Material quality of embedded bar shall agree with the material quality of anchor bolt basically;

2) Cross-sectional area of embedded bar shall be greater than that of bolt, and the embedded bar shall be upright;

3) When the bolt and embedded bar adopts double side welding, the weld length shall not be smaller than 5 times the diameter of the anchor bolt. When single side welding is adopted, the weld length shall not be smaller than 10 times the diameter of anchor bolt.

4.5 Use wedge plate pairs and the overlapping length shall be  $2/3$  upwards. For the wedge plate that bears important parts, inspect the contact situation with 0.05mm feeler gauge. The contact length of each side shall be greater than 70%.

4.6 Install the equipment after the substructure concrete intensity reaches 70% of the design value. Second term concrete on the floor plate shall be poured and compacted.

4.7 The coupling surfaces of equipment shall be smooth and burr free. For joint close clearance, measure with 0.05mm feeler gauge and the gauge shall not pass through. Partial clearance is allowed. Check with 0.10mm feeler gauge and the depth shall not exceed  $1/3$  the width of plane of composition. The total length shall not exceed 20% of the perimeter. No clearance shall exist around the assembling bolt and pin bolt.

Generally, fitting surface at the combination slot staggering shall not exceed 0.10 mm.

4.8 Match marks shall be considered during component installation. When a lot of machines are installed together, each machine shall be assembled with the part marked with the same series design.

The serial numbering in the installation record of same kind of installation or survey points for fixed parts shall begin from +Y and be numbered clockwise (begin from generator end, same for the following context); for rotating installation, begin from the position of No.1 polar of rotor. Except that the survey point on the jigger is numbered counterclockwise, others are all numbered clockwise. Attention shall be paid to the above numbering regulations of the manufacturer.

4.9 For connecting bolt with pre-tightening force requirement, the pre-tightening force deviation shall not exceed the 10% of the set value. If not specified by the manufacturer, preliminary tension shall not be smaller than twice the design work stress and shall not exceed 3/4 of the yield strength of materials.

During the installation of closely-pitched connecting bolt, the screw thread shall be applied with lubricant. Connecting bolt shall be fastened evenly by many times. Adopt thermal state screwed bolt. After fastening, spot check the pretension of around 20% bolt.

After each part is installed, drill hinge pin tack hole and fit pin bolt according to design requirement.

Lock and fasten the bolt, bolt cap, and pin bolt according to design requirements.

4.10 Universality measurement of the unit shall conform to the following requirements:

a) Check and adjust all measuring tools in the qualified metrological examination departments.

b) Deviation of X, Y datum line and height point used in the installation of unit against the data mark of factory building shall not exceed  $\pm 1\text{mm}$ .

c) Measuring error of the height deviation of each part shall not exceed  $\pm 0.5\text{mm}$ .

d) Horizontal survey deviation shall not exceed  $0.02\text{mm/m}$ .

e) Generally, diameter of the steel wire used by the center is  $0.3\text{mm} \sim 0.4\text{mm}$ . Its tension stress shall not be smaller than  $1200\text{MPa}$ .

f) No matter which method to take in measuring the center or roundness of the unit, the measuring error shall not be greater than  $0.05\text{mm}$ ;

g) Pay attention to the impact on the surveying accuracy by temperature fluctuation. Amend the measured number according to the changes of temperature during the measuring.

4.11 In the intensity waterproof test for field manufactured bearing equipment and bridge pieces, the test pressure is 1.5 times the nominal operating pressure, but the minimal pressure shall not be smaller than  $0.4\text{MPa}$ . Sustain for 10 minutes, no leakage or crackles, and so on.

During the tightness compression test of equipment and its bridge pieces, the test pressure is 1.25 times the actual working pressure. Sustain for 30 minutes, no leakage phenomena. During the leakage test, the test pressure is actual working pressure, sustain for 8 hours, no leakage phenomena.

Carry out the waterproof test of single cooler according to design requirement. If not regulated, the test pressure shall be twice the working pressure, but no lower than  $0.4\text{Mpa}$ . Sustain for 30min, no leakage phenomena.

4.12 In the kerosene leakage test of vessel, sustain at least 4h. If no leakage phenomena, do not dismantle the vessel after finishing the leakage test.

4.13 Single keystroke shall coordinate with keystroke for the examination. The tolerance shall comply with design specification. Keystrokes in-pair shall be checked in pair. The parallelism shall meet the design requirements.

4.14 Welding of assembling unit and its auxiliary facilities shall comply with the following requirements:

a) Welders of assembling unit and its auxiliary facilities shall attend special item training and examination regularly as required by the manufacturer. They must hold certificate to take the position after they pass examinations and are licensed.

b) All the length and height of the welding seams shall meet the drawing requirements. Welding quality shall be checked as required by the design drawing.

c) For important components, welding shall proceed according to the welding process or welding procedure specification specified by the manufacturer after the qualification of welding procedure.

4.15 Trademark of turbine lubricating used by assembling unit and speed-regulating system shall comply with the design regulations. See Annex F.

4.16 All monitoring equipment and automation components of the assembling unit shall be check and qualified according to the ex-factory specifications.

4.17 Assembling and general installation of the water-turbine generator as well as installation shall all be kept clean. After the installation of assembling unit, clean and check carefully both inside and outside the unit. No impurities or nastiness shall exist.

4.18 Antisepsis painting of each part of the water-turbine generator set shall satisfy the following requirements:

a) Each part of the assembling unit shall be pre-treated and painted in the manufacturing factory according to the design drawing.

b) Installation (including site-welding seams) needs to be painted with final coating on site shall proceed according to the design requirements. If the color and factory building ornament do not agree, except for the tube color, colors of other parts are changeable.

c) During the installation process, if the finish coat is damaged partially, fix it according to the requirements of original coating.

d) Coating of the site operation shall be homogeneous, bubble free, wrinkle free and with the same color.

e) Installation that needs to be varnished on site according to contract or required specially shall comply with regulations.

## **5 Installation of vertical type reaction turbine**

### **5.1 Installation of built-in fitting**

5.1.1 Installation of the steel liner on the nose of the splitter wall of draft pipe shall comply with the following requirements:

a) Range deviation from the top of nose steel liner to the X-axis of assembling unit  $\pm 30\text{mm}$ ;

b) Range deviation from the nose steel liner side to Y-axis of assembling unit  $\pm 15\text{mm}$ ;

c) Discrepancy in elevation from the top of the nose steel liner (or bottom)  $\pm 10\text{mm}$ ;

d) Squareness deviation of the nose steel liner 10mm.

5.1.2 Permissible deviation of installation of draft tube liner shall conform to the requirements of Table 1.

8.2.9 Record relation curve of input and output signals (electric current and electric pressure) of speed detector. Within the scope of  $\pm 10\%$  nominal speed, static characteristic curve shall be rounded as straight line and its speed dead band shall meet the design set value. Within the scope of  $\pm 2\%$  of nominal speed, deviation of the measured amplification coefficient shall not be greater than  $\pm 5\%$  of design value.

### **8.3 Oil filling adjustment test of speed regulating system**

8.3.1 Switch on oscillating current. Examine the oscillating quantity of electrohydraulic conversion device, which shall meet the design requirements.

8.3.2 Examine the zero deflection and null shift of pressure of electrohydraulic conversion device. Generally, its zero deflection shall not be greater than 5% of nominal value of output quantity (electric current, electric pressure); within the working oil pressure scope, the pressure null shift shall not create overt shift of servomotor.

8.3.3 Record the relationship transfer curve of incoming frequency and the electricity-liquid or electricity- machine conversion device output. Dead volume and amplification coefficient shall meet the design requirements.

8.3.4 Determine the relation curve between the output voltage (electric current) of feedback transducer and servomotor stroke. Within the total excursion range of servomotor, it shall be linear and its characteristics shall meet the design requirements.

8.3.5 The first oil charge of speed regulating system shall proceed slowly. Generally, oil charge pressure shall not exceed 50% of the nominal pressure. Servomotor actuates several times the entire stroke. No abnormal phenomena shall exist.

Operation switching of speed governor between manually, automatically or different kinds of control modes shall be tested. The actuating mechanism shall be normal. Servomotor has no evident swing.

Oil pipeline and bearing components shall take proof test as required by 4.11.

8.3.6 Manually operate the opening restriction of wicket gate servomotor; check the indicated value on the indicator of mechanic cabinet. The indicated value shall be in compliance with the stroke of wicket gate servomotor and servomotor of runner blade. Deviation shall not be greater than 1% of the entire stroke of plunger for the former and for the latter the deviation shall not be greater than  $0.5^\circ$ .

8.3.7 Time for emergency shutdown and opening of guide blade and runner blade as well as step closure stroke, time and design value of guide blade shall not exceed  $\pm 5\%$  of the design value, but ultimately it shall satisfy the requirements of calculation of guaranteed regulation. Generally, time of shutdown and starting shall adopt twice the needed time for 75% ~ 25% opening.

8.3.8 Deviation of time and design value of the shutdown of guide blade by accident regulation valve shall not exceed  $\pm 5\%$  of the design value, but ultimately it shall satisfy the requirements of calculation of guaranteed regulation.

8.3.9 Examine the dead-stroke of reversion mechanism. Generally, the value shall not be greater than 0.2% of the entire stroke of servomotor.

8.3.10 Plot the relation curve of wicket gate servomotor stroke and guide vane opening from starting and closing directions. Measure 4~8 guide vane openings for each point. Adopt the average value. When the guide blade is wide open, measure the opening of all the guide blades. Generally, the deviation shall not exceed  $\pm 2\%$  of the design value.

8.3.11 Plot the relation curve and switch rule of wicket gate servomotor stroke and runner blade servomotor stroke under different water head on-cam relationship from the starting and closing directions. It shall meet the design requirements. The inaccuracy of its runner blade servosystem shall be smaller than 1.5% of the entire stroke.

8.3.12 Setting of the practical open-loop gain of servosystem: time for the switch-on and closure of servomotor has been adjusted and meet the design requirements. Set amplification coefficient and lever ratio as the maximum design value. Input step-function signal into servosystem equivalent to 10% of the entire stroke of servomotor. Observe the movement of servomotor; the maximal amplification coefficient and lever ratio that can keep the servosystem stable and not over control are the practical open-loop gain.

8.3.13 Record the static characteristic curve of speed regulating system when permanent speed droop  $b_p = 6\%$ , static characteristic curve shall be approximated as straight line. Speed dead band is no greater than 0.04%. For speed regulating system of Kaplan turbine, inaccuracy of its runner blade servosystem shall not be greater than 1.5%.

8.3.14 When the spiral case is anhydrous, record the pressure of overhead tank of low oil pressure closedown and drop-out value of oil level.

8.3.15 When the spiral case is anhydrous, measure the minimal operation oil pressure of guide blade and runner blade operating mechanism. Generally, it shall not be greater than 16% of the nominal oil pressure.

8.3.16 Speed regulating system of impulse turbine shall take oil charge adjusting test according to related test items and standards in Article 8.3.

#### **8.4 Simulation test of speed regulating system**

8.4.1 Simulate all kinds of malfunctions of speed regulating system. Protective devices shall be secure. The actuating mechanism and alarm signals are correct.

8.4.2 Carry out the starting, shutting down, and emergency stop simulation test by manually operation and in automatic mode. The actuating mechanism of speed regulating system shall be normal. Alarm signal shall be correct.

### **9 Installation of vertical type hydrogenerator**

#### **9.1 Combination of framework**

9.1.1 After the combination of bracket arms of combined type framework, check the joint close clearance, which shall meet the requirements of Article 4.7.

Top of bearing framework and combination slots of bracket arms shall be checked with 0.05mm clearance gage. Partial discontinuous length shall not exceed 10% of the total length of the top.

9.1.2 Combination of welded type framework shall meet the following requirements:

a) After the fastness of the bearing of central body, adjust the level, measure the planeness on plane of composition, which shall not be greater than 0.04mm/m.

b) After bracket arm is coupled with the central body, check if the following items, which shall all meet the design requirements.

1) Undercut of the joint face of each bracket arm and central body

2) Skew of each bracket arm (namely squareness);

3) Height difference between interface of each bracket arm sub-frame and plane of composition of central body.

- 4) Middle ordinate of the exterior margin of each bracket arm;
- c) Weld as required by the manufacturer. If no definite requirements are raised out by manufacturer, regulations of 4.14 shall be met.
- d) Carry out the appearance examination and non-destructive inspection over the butt-welded seam as required by drawing or technological documents provided by manufacturer. If no definite requirements are raised by the manufacturer, examine over weld appearance according to Table 5 and assess the non-destructive test according to the following standards:
  - 1) When radiographic inspection is adopted, assess according to GB3323 standard. If the weighted butt weld is no lower than Grade II, ratio of radiographic inspection welding seam is 50%; generally butt weld shall not be lower than Grade III. Ratio of radiographic inspection welding seam is 25%;
  - 2) When supersonic flaw detecting is adopted, assess according to GB11345 standard. If the weighted butt weld is no lower than Grade II, ratio of supersonic flaw detecting is 100%; generally butt weld shall not be lower than Grade BI. Ratio of supersonic flaw detecting is 50%;
- e) After the weld of bracket arm, the central body maintains level condition of below 0.04mm/m. Examine the height difference of middle ordinate of exterior margin key groove of each bracket arm as well as sub-frame interface of each bracket arm and the upper plane of central body, which shall meet the requirements of design drawing.

9.1.3 After the combination of support abutment of leaf typethrust bearing, check the planeness of bearing installation plane, and the deviation shall not be greater than 0.2mm. Clearance of the joint close surfaces shall conform to the requirements of Article 4.7.

9.1.4 As for leaf type bearing framework, group welding of its central body and bracket arm may proceed according to requirements of Article 9.1.2 and 9.1.3.

## **9.2 Grounding and scraping of bearing shell**

9.2.1 Thrust bearing pad shall be free of flaws including cracks, slag inclusion and concentrated porosity. The total area of partial peel-back area of tiling materials of bearing shell and metal base billet shall not be greater than 5% of the tiling surface. If necessary, ultrasonic or other methods may be used in the examination.

Try the bearing shell thermometer, high-pressure oil jacking conduit with bearing shell and examine.

9.2.2 Working face of rotating plate shall be free of scars and rustiness. Its roughness and rigidity shall meet the requirements. If necessary, examine the parallelism of two planes and planeness of working face according to the drawing.

9.2.3 Thrust bearing pad grounded and scraped on site as required by manufacturer shall meet the following requirements after the grounding and scraping:

- a) On the tiling surface, within each 1cm<sup>2</sup>, 1~3 contact points shall exist;
- b) Partial non-contact area on the surface, each part shall not be greater than 2% area of bearing shell, but the maximal shall not be greater than 16cm<sup>2</sup>. The total shall not be greater than 5% of the bearing shell area;
- c) Fuel inlet side shall be scraped as required by manufacturer;
- d) As for bearing shell of strut bolt thrust bearing without filler plate shall, after reaching the requirements of a) and b), scrape the middle part of tiling lower. Around the strut bolt, on

the round parts with  $\frac{2}{3}$  the tile length as diameter, clear away the contact points (feather contact points may be sustained). Scrape for one round, and then minimize the scope. Around the strut bolt, on the round part with  $\frac{1}{3}$  length of tile as diameter, scrap for the second time in 90° direction with the previous scraping;

e) After the unit jigger, draw out thrust pad to examine osculation conditions, which shall meet the requirements of a) and b);

f) Jacking oil container by high-pressure oil shall be examined or grounded and scraped according to design requirements.

g) As for the thrust bearing with double tile structure, contact surface between thin tile and pillow shall meet the design requirements. If no definite requirements are raised on design, contact surface of thin tile and pillow shall be over 70% and the contact surface shall distribute evenly. When thrust pad is under strained condition, examine the gaps between thin tile and pillow with 0.02mm clearance gage, there shall be zero clearance.

9.2.4 guide-blocks need to be grounded and scraped on site shall be in compliance with related requirements of Article 5.6.1.

### **9.3 Stator installation**

9.3.1 After the combination of split stator of laminations inside the manufacturer, the following requirements shall be met:

a) Check the clearance of combination seam of sub-frame with 0.05mm clearance gage, and the gage shall not pass through at around the screw bolt and/or assembling pin;

b) Pad the iron core commissures as required. After padding, iron core commissure shall have no clearance at the commissure of iron core;

c) Radial undercuts at the slot bottom of iron core commissure shall not be greater than 0.3mm;

d) Trunking width of commissure shall meet the design requirements;

e) Combination of magnet yoke and sub-frame shall meet the requirements of Article 4.7.

9.3.2 The roundness of stator of lamination built-up by leaf inside the manufacturer, difference between each actually measured radius and average radius shall not be greater than  $\pm 4\%$  of the design air interstice value. Generally, along the stacking height direction, select one surveyed cross-section every 1m and each section shall have at least measuring points. Each section of each flap shall have least 3 points. Commissure shall have measuring points. Roundness of the iron core of one-piece stator shall also meet the aforesaid requirements.

9.3.3 Combination of magnet yoke of lamination on site shall proceed according to the regulations of manufacturer. If no definite regulations are raised, the following requirements shall be met.

a) Arrange, adjust and pack the buttress and wedge plate according to the indexing azimuth and radius of extent. Packing buttress shall be fastened temporarily, and height difference of top surface of wedge plate shall be within 2mm.

b) Installation of central cyclometer shall be secure. When measuring the circle, various exogenous influences shall be avoided.

The squareness of central axis of cyclometer shall not be greater than 0.02mm/m. The maximal inclination within the measuring range shall not be greater than 0.05mm.

9.3.4 After the welding, examine and adjust the sub-frame, requirements of 9.3.3d (1) (2) shall be met. The absolute size dimension of each radius shall not be greater than  $\pm 2\text{mm}$ .

After the sub-frame of the localization rib welded in the manufacturer is group welded on site, deviation of the radius of localization rib measured at each circumferential lamellae and the design value shall be within  $\pm 2\%$  of the air interstice. But the maximum allowable offset shall not go beyond  $\pm 0.5\text{mm}$  of the design value.

9.3.5 Installation of the localization rib shall conform to the following requirements;

a) Align the localization rib before installation. Examine with leveling rule at least 1.5m long. Linearity of the localization rib in both radial and peripheral direction shall not be greater than 0.1mm. If the localization rib is smaller than 1.5m, examine with leveling rule no shorter than the length of the localization rib;

b) After localization (or lap welding) of the reference rib of localization rib, the deviation of its radius and design value shall be within  $\pm 0.8\%$  of the design air interstice. Peripheral and radial inclination maximum deviation shall not exceed  $\pm 0.5\text{mm}$  of the design value no greater than 0.15mm;

c) After the entire welding of the localization ribs, deviation of the localization rib radius and the design value shall be within  $\pm 2\%$  of the design air interstice. Maximum deviation shall not exceed  $\pm 0.5\text{mm}$  of the design value. Deviation of radius of the two neighboring localization ribs at the same height shall not be greater than 0.6% of the design air interstice. For the same localization rib at the same height, difference of radius resulted by surface skew shall not be greater than 0.10mm;

d) Deviation for the middle ordinate of localization rib at the same height and the average value shall not be greater than  $\pm 0.25\text{mm}$ , but the cumulative departure shall not be greater than 0.4mm;

e) Vergence direction of the installed localization rib in peripheral direction and inclination value shall meet the design requirements.

f) Generally, zero clearance shall exist between cradle and field ring plate of the localization rib;

g) Even the localization rib has been welded in the manufacturer; it shall still take an examination on site according to the above requirements. Those that go beyond the standards shall be disposed.;

9.3.6 The installation of lower tooth press plate shall meet the following requirements:

a) Height difference of each finger plate shall not be greater than 2mm. Height difference between the pressure fingers of each two neighboring finger plates shall not be greater than 1mm. For the structure of denticle press plate, pressure finger of each finger plate and the inner circle of cross section are 1mm ~ 3.5mm. higher than the ex-circle, which depends on the piling height of iron core, structure and articulation of lower tooth press plate. Generally, the higher the stator core is, the higher the inside of lower tooth press plate is compared with its outer side. When the stacking height is over 2.5m, upper value shall be adopted.

b) Take the shallow tooth punching as the template. Adjust the deviation of pressure finger centre and the punching tooth centre. The deviation shall not be greater than 2mm. Radial distance of finger plate teeth end and punching teeth end shall meet the drawing requirements.

9.3.7 Stator-core lamination shall meet the following requirements:

- a) Core stamping shall be clean, nondestructive, leveling off, and with perfect lacquer film;
- b) Stack up stator core punching according to the procedure required by the manufacturer. Control different punching segments and stack-up height of each subsection. Paint bonding agent between the punchings of upper and lower ends of lamination according to the manufacturer;
- c) As required by the manufacturer, lamination shall abut against the localization rib or radial clearance is left. If clearance is left, then the left clearance shall be even.
- d) During the lamination of iron core, each punching shall be fitted with at 2 slot rods and slot-wedge slot rods to locate as required by the manufacturer and shall be reshaped with dressing stick;
- e) According to the deviation of stacking height and waveness measured after the compaction of lamination by section. In each lamination, amount of deviation shall not be greater than 0mm ~ +1mm. Make altitude compensation as specified by the manufacturer;
- f) Stacking height of iron core shall consider the amount of reduction of entire impaction and thermal pressure. Generally, the amount of reduction of thermal pressure should be considered according to 0.2%~0.3% of the stacking height, and shall be evenly distributed into each lamination segment;
- g) During the stacking of iron core, check frequently and adjust the roundness.

9.3.8 Impaction of stator core shall meet the following requirements:

- a) Pressure bolt outside the iron core shall be installed according to the design requirements. Over 2mm spacing shall be maintained between it and iron core.

Core-through pressure bolt shall maintain insulated and nondestructive, secure, and the belleville spring gasket shall be in good condition.

- b) The iron core shall be segmented and impacted entirely. The subsectional crush height and times shall meet the requirements of manufacturer. If not specified by the manufacturer, subsectional crush height shall be determined by the structure of iron core. Generally, each segment should not exceed 600mm;

- c) Packing force of the segmental impaction of iron core and entire compaction should meet the requirements of manufacturer;

- d) Packing force over iron core shall be built up in sequence by times until it reaches the specified numerical value of the manufacturer. Check the impacted average pressure with the method of measuring the elongation of evenly distributed impacted impaction screw. The number of screws measured on the entire circle shall not be fewer than 10;

- e) For stator core required to be thermally impacted, the thermal impaction shall proceed after the entire impaction of iron core and before the core flux test. Heat up according to the requirements of the manufacturer. Cool down to ambient temperature naturally. Impact according to the requirements of c) and d); f) impact and examine according to requirements of d) of this article after the core flux test; g) Before and after the core test, examine the grounding insulation of core through screw and the insulating value shall meet the requirements of manufacturer.

9.3.9 After the completion of lamination and subsectional impaction, proceeds the installation of upper press plate. After the complete installation and emplacement of

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