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| Action: | The Upgrade of the Iron Gate I Navigational Lock |
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**CORRIGENDUM NO 5 TO TD**

|  |
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| **Volume 3-Part 3-PARTICULAR EMPLOYERS REQUIREMENTS****Section 2, 5.1.1.3.1. pg 10** |

**The former text**

* + - * 1. **Hydraulic cylinders**

*5.1.1.3.1.1.Upper lock head*

Main characteristics of the hydraulic cylinders are presented in Table 5.1.-1.

*Table 5.1.-1: Main characteristics of hydraulic cylinders*

|  | Unit | Emergency-maintenance gate | Service gate | Service gallery gate |
| --- | --- | --- | --- | --- |
| Number of hydraulic cylinders |  | 2 | 2 | 2 |
| Lifting force | Mp | 400 | 225 | 300 |
| Lowering force (holding of gates) | normal | Mp | 250 | 225 | 70 |
| emergency | 270 |
| Piston diameter | mm | 600 | 500 | 600 |
| Rod diameter | mm | 220 | 200 | 220 |
| Piston operating stroke | mm | 12.685 | 12.100 | 6.700 |
| Piston full stroke | mm | 12.685 | 13.500 | 6.900 |
| Lifting time | min. | 5÷6 | 3,5 | 4-8 |
| Lowering time | normal | min. | 3,5÷6 | 3,5 | 2 |
| emergency | 1 |
| Operating pressure | lowering | kp/cm2 | 106 | 148 | 110 |
| lifting | 183 | 153 | 139 |
| Maximal pressure | kp/cm2 | 200 | 200 | 200 |
| Test pressure | kp/cm2 | 270 | 270 | 270 |
| Safety factor for cylinder barrel and bottom of the hydraulic cylinder  |  | 2,7 |
| Safety factor for piston rod |  | 2,5 |
| Safety factor for bolts connecting the head and hydraulic cylinder  |  | 3 |
| Safety factor for mounts |  | 3 |
| Mounting position |  | Vertical |

Hydraulic cylinders of emergency-maintenance gates provide for:

* gate lowering and lifting in still water,
* gate lifting in water stream – emergency,
* stopping and maintaining the gates in intermediate positions,
* gate lifting to the overhaul position,
* gate locking at the ultimate upper position.

Hydraulic cylinders of service gates provide for:

* gate lowering and lifting in dry,
* gate lowering and lifting in still water,
* gate locking at the ultimate upper position, and
* stopping and maintaining the gates in intermediate positions.

Hydraulic cylinders of service gallery gates provide for:

* lowering and lifting of gates in dry,
* lowering and lifting of gates in still water,
* lowering and lifting of gates in water stream,
* stopping and maintaining the gates in intermediate positions,
* maintaining the gates in the upper position.

*5.1.1.3.1.2. Middle lock head*

Main characteristics of the hydraulic cylinders as presented in Table 5.1.-2.

*Table 5.1.-2: Main characteristics of hydraulic cylinders*

|  |  |  |  |
| --- | --- | --- | --- |
|  | Unit | Service gate | Service gallery gate |
| Upper section | Lower section |
| Number of hydraulic cylinders |  | 2 | 2 | 2 |
| Lifting force | Mp | 125 | 425 | 150 |
| Lowering force (holding of gate) | Mp | 100 | 350 | 150 |
| Piston diameter | mm | 400 | 600 | 400 |
| Rod diameter | mm | 160 | 220 | 160 |
| Piston operating stroke | mm | 4100 | 14655 | 5700 |
| Piston full stroke | mm | 4110 | 16230 | 5900 |
| Lifting time | min | 1÷1,5 | 5 | 4-8 |
| Lowering time | normal | min | 1÷1,5 | 5 | 2 |
| emergency | 1 |
| Operating pressure | lowering | kp/cm2 | 138 | 195 | 155 |
| lifting | 98 | 160 | 142 |
| Maximal pressure | kp/cm2 | 200 | 200 | 200 |
| Test pressure | kp/cm2 | 240 | 270 | 270 |
| Safety factor for cylinder barrel and bottom of the hydraulic cylinder  |  | 2,7 |
| Safety factor for piston rod |  | 2,5 |
| Safety factor for bolts connecting the head and hydraulic cylinder  |  | 3 |
| Safety factor for mounts |  | 3 |
| Mounting position |  | Vertical |

The hydraulic cylinders of the service gallery gates provides for:

* gate lowering and lifting in dry,
* gate lowering and lifting in still water,
* gate lowering and lifting in water stream,
* maintaining the gate in lifted position,
* maintaining the gate in an intermediate position.

Hydraulic cylinders of the upper and lower gate section provide for:

* gate lowering and lifting in dry,
* gate lowering and lifting in dry and in still water. The lower gate section may be lowered at the maximum delevelling in chambers of 300 mm,
* stopping and maintaining the gate at intermediate positions,
* gate locking at the ultimate upper position.

*5.1.1.3.1.3. Lower lock head*

Main characteristics of the hydraulic cylinders as presented in Table 5.1.-3.

Table 5.1.-3: Main characteristics of hydraulic cylinders

|  | Unit | Service gate | Service gallery gate |
| --- | --- | --- | --- |
| Number of hydraulic cylinders |  | 2 | 2 |
| Opening/Lifting force | Mp | 200 | 300 |
| Closing force | Mp | 250 |  |
| Lowering force (holding of gate) | normal | Mp |  | 70 |
| emergency | 270 |
| Piston diameter | mm | 500 | 600 |
| Rod diameter | mm | 260 | 220 |
| Piston operating stroke | mm | 6200 | 6700 |
| Piston full stroke | mm | 6300 | 6900 |
| Opening/Lifting time | min. | 3 | 5 |
| Closing/Lowering time | normal | min. | 4 | 2 |
| emergency | 1 |
| Operating pressure | closing/lowering | kp/cm2 | 170 | 130 |
| opening/lifting | 130 | 110 |
| Maximal pressure | kp/cm2 | 200 | 200 |
| Testing pressure | kp/cm2 | 270 | 270 |
| Safety factor for cylinder barrel and bottom of the hydraulic cylinder  |  | 2,7 |
| Safety factor for piston rod |  | 2,5 |
| Safety factor for bolts connecting the head and hydraulic cylinder  |  | 3 |
| Safety factor for mounts |  | 3 |
| Mounting position |  | Horizontal | Vertical |

Characteristics for hydraulic cylinder of service miter gate are presented for original design before gate leaf structures was reconstructed and additional weight was added. Contractor will design new hydraulic cylinders by taking existing weight of gate structure in consideration.

Hydraulic cylinders of the service miter gate provide for:

* opening and closing of each gate leaf by a 70° angle in still water and in dry;
* at open or closed gate position, hydraulic holding of gate due to occurrence of surge waves;
* gate operation according to the program: gate leaf pivoting in both directions for the first 10° at the speed of V1, the next 50° at the speed of 2V1, and the last 10° again at the speed of V1.

Hydraulic cylinders of service gallery gates provide for:

* gate lowering and lifting in dry,
* gate lowering and lifting in still water,
* gate lowering and lifting in water stream,
* stopping and maintaining the gate in intermediate positions,
* maintaining the gate at the upper position.

**The new text**

* + - * 1. **Hydraulic cylinders**

*5.1.1.3.1.1.Upper lock head*

Main characteristics of the hydraulic cylinders are presented in Table 5.1.-1.

*Table 5.1.-1: Main characteristics of hydraulic cylinders*

|  | Unit | Emergency-maintenance gate | Service gate | Service gallery gate |
| --- | --- | --- | --- | --- |
| Number of hydraulic cylinders |  | 2 | 2 | 2 |
| Lifting force | Mp | 400 | 225 | 300 |
| Lowering force (holding of gates) | normal | Mp | 250 | 225 | 70 |
| emergency | 270 |
| Piston diameter | mm | 600 | 500 | 600 |
| Rod diameter | mm | 220 | 200 | 220 |
| Piston operating stroke | mm | 12.685 | 12.100 | 6.700 |
| Piston full stroke | mm | 12.685 | 13.500 | 6.900 |
| Lifting time | min. | 5÷6 | 3,5 | 4-8 |
| Lowering time | normal | min. | 3,5÷6 | 3,5 | 2 |
| emergency | 1 |
| Operating pressure | lowering | kp/cm2 | 106 | 148 | 110 |
| lifting | 183 | 153 | 139 |
| Maximal pressure | kp/cm2 | 200 | 200 | 200 |
| Test pressure | kp/cm2 | 270 | 270 | 270 |
| Safety factor for cylinder barrel and bottom of the hydraulic cylinder  |  | EN 1993 (Eurocode 3) and DIN 19704 |
| Safety factor for piston rod |  |
| Safety factor for bolts connecting the head and hydraulic cylinder  |  |
| Safety factor for mounts |  |
| Mounting position |  | Vertical |

Hydraulic cylinders of emergency-maintenance gates provide for:

* gate lowering and lifting in still water,
* gate lifting in water stream – emergency,
* stopping and maintaining the gates in intermediate positions,
* gate lifting to the overhaul position,
* gate locking at the ultimate upper position.

Hydraulic cylinders of service gates provide for:

* gate lowering and lifting in dry,
* gate lowering and lifting in still water,
* gate locking at the ultimate upper position, and
* stopping and maintaining the gates in intermediate positions.

Hydraulic cylinders of service gallery gates provide for:

* lowering and lifting of gates in dry,
* lowering and lifting of gates in still water,
* lowering and lifting of gates in water stream,
* stopping and maintaining the gates in intermediate positions,
* maintaining the gates in the upper position.

*5.1.1.3.1.2. Middle lock head*

Main characteristics of the hydraulic cylinders as presented in Table 5.1.-2.

*Table 5.1.-2: Main characteristics of hydraulic cylinders*

|  |  |  |  |
| --- | --- | --- | --- |
|  | Unit | Service gate | Service gallery gate |
| Upper section | Lower section |
| Number of hydraulic cylinders |  | 2 | 2 | 2 |
| Lifting force | Mp | 125 | 425 | 150 |
| Lowering force (holding of gate) | Mp | 100 | 350 | 150 |
| Piston diameter | mm | 400 | 600 | 400 |
| Rod diameter | mm | 160 | 220 | 160 |
| Piston operating stroke | mm | 4100 | 14655 | 5700 |
| Piston full stroke | mm | 4110 | 16230 | 5900 |
| Lifting time | min | 1÷1,5 | 5 | 4-8 |
| Lowering time | normal | min | 1÷1,5 | 5 | 2 |
| emergency | 1 |
| Operating pressure | lowering | kp/cm2 | 138 | 195 | 155 |
| lifting | 98 | 160 | 142 |
| Maximal pressure | kp/cm2 | 200 | 200 | 200 |
| Test pressure | kp/cm2 | 240 | 270 | 270 |
| Safety factor for cylinder barrel and bottom of the hydraulic cylinder  |  | EN 1993 (Eurocode 3) and DIN 19704 |
| Safety factor for piston rod |  |
| Safety factor for bolts connecting the head and hydraulic cylinder  |  |
| Safety factor for mounts |  |
| Mounting position |  | Vertical |

The hydraulic cylinders of the service gallery gates provides for:

* gate lowering and lifting in dry,
* gate lowering and lifting in still water,
* gate lowering and lifting in water stream,
* maintaining the gate in lifted position,
* maintaining the gate in an intermediate position.

Hydraulic cylinders of the upper and lower gate section provide for:

* gate lowering and lifting in dry,
* gate lowering and lifting in dry and in still water. The lower gate section may be lowered at the maximum delevelling in chambers of 300 mm,
* stopping and maintaining the gate at intermediate positions,
* gate locking at the ultimate upper position.

*5.1.1.3.1.3. Lower lock head*

Main characteristics of the hydraulic cylinders as presented in Table 5.1.-3.

Table 5.1.-3: Main characteristics of hydraulic cylinders

|  | Unit | Service gate | Service gallery gate |
| --- | --- | --- | --- |
| Number of hydraulic cylinders |  | 2 | 2 |
| Opening/Lifting force | Mp | 200 | 300 |
| Closing force | Mp | 250 |  |
| Lowering force (holding of gate) | normal | Mp |  | 70 |
| emergency | 270 |
| Piston diameter | mm | 500 | 600 |
| Rod diameter | mm | 260 | 220 |
| Piston operating stroke | mm | 6200 | 6700 |
| Piston full stroke | mm | 6300 | 6900 |
| Opening/Lifting time | min. | 3 | 5 |
| Closing/Lowering time | normal | min. | 4 | 2 |
| emergency | 1 |
| Operating pressure | closing/lowering | kp/cm2 | 170 | 130 |
| opening/lifting | 130 | 110 |
| Maximal pressure | kp/cm2 | 200 | 200 |
| Testing pressure | kp/cm2 | 270 | 270 |
| Safety factor for cylinder barrel and bottom of the hydraulic cylinder  |  | EN 1993 (Eurocode 3) and DIN 19704 |
| Safety factor for piston rod |  |
| Safety factor for bolts connecting the head and hydraulic cylinder  |  |
| Safety factor for mounts |  |
| Mounting position |  | Horizontal | Vertical |

Characteristics for hydraulic cylinder of service miter gate are presented for original design before gate leaf structures was reconstructed and additional weight was added. Contractor will design new hydraulic cylinders by taking existing weight of gate structure in consideration.

Hydraulic cylinders of the service miter gate provide for:

* opening and closing of each gate leaf by a 70° angle in still water and in dry;
* at open or closed gate position, hydraulic holding of gate due to occurrence of surge waves;
* gate operation according to the program: gate leaf pivoting in both directions for the first 10° at the speed of V1, the next 50° at the speed of 2V1, and the last 10° again at the speed of V1.

Hydraulic cylinders of service gallery gates provide for:

* gate lowering and lifting in dry,
* gate lowering and lifting in still water,
* gate lowering and lifting in water stream,
* stopping and maintaining the gate in intermediate positions,
* maintaining the gate at the upper position.

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| **Volume 3-Part 3-PARTICULAR EMPLOYERS REQUIREMENTS****Section 2, 5.1.5.3.1. pg 26** |

**The former text**

**5.1.5.3.1. Hydraulic cylinders**

Regarding the chemical composition, mechanical properties and purpose, the selected materials must be of first class, in compliance with applicable standards, and they shall meet the design requirements in all respects.

Constituent parts of hydraulic cylinders and mounts shall be made of such material which, according to its mechanical properties and purpose, should possess the same or better mechanical properties than those specified herein.

All materials must be selected in compliance with applicable standards or other codes approved by the Engineer, which ensure a higher quality and consequently the reliability of the equipment.

The piston rod shall be forged as a single piece, with the latest generation coating with not less than 10 years of proved operation in similar application, using a technology which ensures long-time quality warranty.

Underneath the coating, the integrated position measuring system has to be fitted on the piston rod, which enables stroke measurement with accuracy of min. ±1.0mm. The length of the running part of the piston rod which has to be coated must be approved by the Engineer.

Contactor must provide test reports issued by recognized institutes for metallographic testing, on testing of hardness, porosity, adhesion and corrosion resistance of the hydraulic cylinder piston rod coating.

The guiding and sealing components must be made of up-to-date artificial materials, i.e. multi-layered components, able to withstand the envisaged loads while causing minimum frictional resistance. They should be selected so as to satisfy:

* design pressure according to Tables 5.1-1, 5.1-2 and 5.1-3 of these TS;
* temperature (-30°C ÷ +50°C);
* lowering speed according to Tables 5.1-1, 5.1-2 and 5.1-3 of these TS.

provided that the design pressure for the hydraulic cylinder of the service miter gate shall be defined for operation in existing conditions with burdened structure of gate leaves.

Guides of the piston and piston rod should be of a new type, made of an artificial material with minimum friction.

Bolts and nuts for connection should be made of stainless steel and secured against loosening by means of lock washers.

**The new text**

**5.1.5.3.1. Hydraulic cylinders**

Regarding the chemical composition, mechanical properties and purpose, the selected materials must be of first class, in compliance with applicable standards, and they shall meet the design requirements in all respects.

Constituent parts of hydraulic cylinders and mounts shall be made of such material which, according to its mechanical properties and purpose, should possess the same or better mechanical properties than those specified herein.

All materials must be selected in compliance with applicable standards or other codes approved by the Engineer, which ensure a higher quality and consequently the reliability of the equipment.

The piston rod shall be forged or milled as a single piece, with the latest generation coating with not less than 10 years of proved operation in similar application, using a technology which ensures long-time quality warranty.

Underneath the coating, the integrated position measuring system has to be fitted on the piston rod, which enables stroke measurement with accuracy of min. ±1.0mm. The length of the running part of the piston rod which has to be coated must be approved by the Engineer.

Contactor must provide test reports issued by recognized institutes for metallographic testing, on testing of hardness, porosity, adhesion and corrosion resistance of the hydraulic cylinder piston rod coating.

The guiding and sealing components must be made of up-to-date artificial materials, i.e. multi-layered components, able to withstand the envisaged loads while causing minimum frictional resistance. They should be selected so as to satisfy:

* design pressure according to Tables 5.1-1, 5.1-2 and 5.1-3 of these TS;
* temperature (-30°C ÷ +50°C);
* lowering speed according to Tables 5.1-1, 5.1-2 and 5.1-3 of these TS.

provided that the design pressure for the hydraulic cylinder of the service miter gate shall be defined for operation in existing conditions with burdened structure of gate leaves.

Guides of the piston and piston rod should be of a new type, made of an artificial material with minimum friction.

Bolts and nuts for connection should be made of stainless steel and secured against loosening by means of lock washers.

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| **Volume 3-Part 3-PARTICULAR EMPLOYERS REQUIREMENTS****Section 2, 5.1.6.1.1. pg 33** |

**The former text**

**5.1.6.1.1. Forged Parts**

These Employer’s Requirements apply to the items of hydraulic cylinders defined in Tables 5.1-5, 5.1-6 and 5.1-7. (hereinafter: Forgings, produced by forging) and they are prepared on the basis of technical documentation, attests for earlier used materials, applicable Serbian and European standards and experience gained on occasion of controls in the course of manufacture of similar parts.

*Table 5.1.-5: Items and technical documentation for hydraulic cylinders on the upstream lock head*

| HYDRAULIC CYLINDER PART | DRAWING NUMBER |
| --- | --- |
| SERVICE GATE | EMERGENCY-MAINTENANCE GATE | SERVICE GALLERY GATES |
|  | M-S2-SS5.1-46-1 | M-S2-SS5.1-67-1 | M-S2-SS5.1-82-1 |
| PISTON ROD | M-S2-SS5.1-45-1 | M-S2-SS5.1-66-1 | M-S2-SS5.1-80-1 |
| NUT | M-S2-SS5.1-41-1M-S2-SS5.1-40-1 | M-S2-SS5.1-61-1M-S2-SS5.1-60-1 | M-S2-SS5.1-60-1M-S2-SS5.1-61-1 |
| COUPLING | M-S2-SS5.1-39-1 | M-S2-SS5.1-59-1 | M-S2-SS5.1-59-1 |
| CLEVIS | M-S2-SS5.1-38-1 | M-S2-SS5.1-58-1 | M-S2-SS5.1-75-1 |
| CYLINDER BARREL MOUNT | M-S2-SS5.1-48-1 | M-S2-SS5.1-70-1 | M-S2-SS5.1-85-1 |
| CYLINDER BARREL FLANGE | M-S2-SS5.1-47-1 | M-S2-SS5.1-69-1M-S2-SS5.1-68-1 | M-S2-SS5.1-84-1 |
| CYLINDER BARREL HEAD | - | - | - |
| PISTON | M-S2-SS5.1-35-1 | M-S2-SS5.1-81-1 | M-S2-SS5.1-81-1 |
| THROTTLE BUSHING | M-S2-SS5.1-36-1 | M-S2-SS5.1-83-1 | M-S2-SS5.1-83-1 |
| CYLINDER BOTTOM | M-S2-SS5.1-42-1 | M-S2-SS5.1-62-1 | M-S2-SS5.1-76-1 |

*Table 5.1.-6: Items and technical documentation for hydraulic cylinders on the middle lock head*

| HYDRAULIC CYLINDER PART | DRAWING NUMBER |
| --- | --- |
| LOWER SECTION OF SERVICE GATE | UPPER SECTION OF SERVICE GATE | SERVICE GALLERY GATES |
|  | M-S2-SS5.1-74-1 | M-S2-SS5.1-34-1 | M-S2-SS5.1-27-1 |
| PISTON ROD | M-S2-SS5.1-73-1 | M-S2-SS5.1-33-1 | M-S2-SS5.1-26-1 |
| NUT | M-S2-SS5.1-60-1M-S2-SS5.1-61-1 | M-S2-SS5.1-21-1M-S2-SS5.1-22-1 | M-S2-SS5.1-21-1M-S2-SS5.1-22-1 |
| COUPLING | M-S2-SS5.1-59-1 | M-S2-SS5.1-20-1 | M-S2-SS5.1-20-1 |
| CLEVIS | M-S2-SS5.1-71-1 | M-S2-SS5.1-29-1 | M-S2-SS5.1-19-1 |
| CYLINDER BARREL MOUNT | M-S2-SS5.1-70-1 | M-S2-SS5.1-18-1 | M-S2-SS5.1-28-1 |
| CYLINDER BARREL FLANGE | M-S2-SS5.1-68-1 | M-S2-SS5.1-17-1 | M-S2-SS5.1-17-1 |
| CYLINDER BARREL HEAD | - | - | - |
| PISTON | M-S2-SS5.1-81-1 | M-S2-SS5.1-15-1 | M-S2-SS5.1-15-1 |
| THROTTLE BUSHING | M-S2-SS5.1-83-1 | M-S2-SS5.1-16-1 | M-S2-SS5.1-16-1 |
| CYLINDER BARREL BOTTOM | M-S2-SS5.1-76-1 | M-S2-SS5.1-14-1 | M-S2-SS5.1-14-1 |

*Table 5.1.-7: Items and technical documentation for hydraulic cylinders on the downstream lock head*

| HYDRAULIC CYLINDER PART | DRAWING NUMBER |
| --- | --- |
| SERVICE MITER GATE | SERVICE GALLERY GATES |
|  | M-S2-SS5.1-55-1 | M-S2-SS5.1-82-1 |
| PISTON ROD | M-S2-SS5.1-53-1 | M-S2-SS5.1-80-1 |
| NUT | - | [M-S2-SS5.1-60-1](file:///C%3A%5CUsers%5CPC%5CDownloads%5CAdaptacija%20BP%20HEDJ1_Hidraulicki%20cilindri%5CTabela%206%5C2456_D.pdf) M-S2-SS5.1-61-1 |
| COUPLING | M-S2-SS5.1-49-1 | M-S2-SS5.1-59-1 |
| CLEVIS | - | M-S2-SS5.1-75-1 |
| CYLINDER BARREL MOUNT | M-S2-SS5.1-56-1 | M-S2-SS5.1-85-1 |
| CYLINDER BARREL FLANGE | M-S2-SS5.1-37-1M-S2-SS5.1-57-1 | M-S2-SS5.1-84-1 |
| CYLINDER BARREL HEAD | - | - |
| PISTON | M-S2-SS5.1-54-1 | M-S2-SS5.1-81-1 |
| THROTTLE BUSHING | - | M-S2-SS5.1-83-1 |
| CYLINDER BARREL BOTTOM | M-S2-SS5.1-50-1 | M-S2-SS5.1-76-1 |

Subject items shall be made of materials which, according to their mechanical properties and purpose, should possess the same or better mechanical properties than those specified in Table 5.1.-12 of these TS. When forming the Table 5.1.-12: additional requirements from technical documentation for old hydraulic cylinders made by the company “Walter Hunger” Lohr am Main, related to mechanical properties of materials, were taken into account.

It is recommended to produce the piston rods, nuts, couplings and clevises of the material 34CrNiMo6 according to SRPS EN 10250-3:2012.

Materials for production of new items shall be selected in accordance with the standard SRPS EN 10250-1:2012, Parts 1 to 4.

All items shall be produced by forging according to the Contractor’s forging production technology.

The piston rod shall be made as a single piece.

The material of forgings must be killed (de-oxidized).

For selected materials of forgings, it is necessary to obtain the written approval of the Engineer.

The Contractor is obliged to order the forgings of cylinder barrel flanges from one and the same manufacturer.

The type of heat treatment shall be determined by the Contractor.

Two repeated complete heat treatments are allowed, in case of unsatisfactory results of mechanical properties testing, in other words, the total of three complete heat treatments.

The number of additional tempering rounds is not limited.

The Contractor is obliged to produce drawings of forging (stock) taking into account the technical documentation (Drawings) and requirements from TS regarding the additions for checking of mechanical properties.

The shape, dimensions, tolerance limits for shape and position and quality of surfaces of items produced should match the requirements from the technical drawing and measurement checklist which has to be filled out.

Forgings should bear the following marks:

* the name and trade mark of the Contractor,
* drawing number,
* steel designation,
* batch number,
* hydraulic cylinder number,
* identification number of the item (link with the document on control),
* stamp of the quality control.

Temporary corrosion protection of metallic surfaces of forgings shall be achieved by application of conserving grease and placing of protective foils.

**The new text**

**5.1.6.1.1. Forged Parts**

These Employer’s Requirements apply to the items of hydraulic cylinders defined in Tables 5.1-5, 5.1-6 and 5.1-7. (hereinafter: Forgings, produced by forging) and they are prepared on the basis of technical documentation, attests for earlier used materials, applicable Serbian and European standards and experience gained on occasion of controls in the course of manufacture of similar parts.

*Table 5.1.-5: Items and technical documentation for hydraulic cylinders on the upstream lock head*

| HYDRAULIC CYLINDER PART | DRAWING NUMBER |
| --- | --- |
| SERVICE GATE | EMERGENCY-MAINTENANCE GATE | SERVICE GALLERY GATES |
|  | M-S2-SS5.1-46-1 | M-S2-SS5.1-67-1 | M-S2-SS5.1-82-1 |
| PISTON ROD | M-S2-SS5.1-45-1 | M-S2-SS5.1-66-1 | M-S2-SS5.1-80-1 |
| NUT | M-S2-SS5.1-41-1M-S2-SS5.1-40-1 | M-S2-SS5.1-61-1M-S2-SS5.1-60-1 | M-S2-SS5.1-60-1M-S2-SS5.1-61-1 |
| COUPLING | M-S2-SS5.1-39-1 | M-S2-SS5.1-59-1 | M-S2-SS5.1-59-1 |
| CLEVIS | M-S2-SS5.1-38-1 | M-S2-SS5.1-58-1 | M-S2-SS5.1-75-1 |
| CYLINDER BARREL MOUNT | M-S2-SS5.1-48-1 | M-S2-SS5.1-70-1 | M-S2-SS5.1-85-1 |
| CYLINDER BARREL FLANGE | M-S2-SS5.1-47-1 | M-S2-SS5.1-69-1M-S2-SS5.1-68-1 | M-S2-SS5.1-84-1 |
| CYLINDER BARREL HEAD | - | - | - |
| PISTON | M-S2-SS5.1-35-1 | M-S2-SS5.1-81-1 | M-S2-SS5.1-81-1 |
| THROTTLE BUSHING | M-S2-SS5.1-36-1 | M-S2-SS5.1-83-1 | M-S2-SS5.1-83-1 |
| CYLINDER BOTTOM | M-S2-SS5.1-42-1 | M-S2-SS5.1-62-1 | M-S2-SS5.1-76-1 |

*Table 5.1.-6: Items and technical documentation for hydraulic cylinders on the middle lock head*

| HYDRAULIC CYLINDER PART | DRAWING NUMBER |
| --- | --- |
| LOWER SECTION OF SERVICE GATE | UPPER SECTION OF SERVICE GATE | SERVICE GALLERY GATES |
|  | M-S2-SS5.1-74-1 | M-S2-SS5.1-34-1 | M-S2-SS5.1-27-1 |
| PISTON ROD | M-S2-SS5.1-73-1 | M-S2-SS5.1-33-1 | M-S2-SS5.1-26-1 |
| NUT | M-S2-SS5.1-60-1M-S2-SS5.1-61-1 | M-S2-SS5.1-21-1M-S2-SS5.1-22-1 | M-S2-SS5.1-21-1M-S2-SS5.1-22-1 |
| COUPLING | M-S2-SS5.1-59-1 | M-S2-SS5.1-20-1 | M-S2-SS5.1-20-1 |
| CLEVIS | M-S2-SS5.1-71-1 | M-S2-SS5.1-29-1 | M-S2-SS5.1-19-1 |
| CYLINDER BARREL MOUNT | M-S2-SS5.1-70-1 | M-S2-SS5.1-18-1 | M-S2-SS5.1-28-1 |
| CYLINDER BARREL FLANGE | M-S2-SS5.1-68-1 | M-S2-SS5.1-17-1 | M-S2-SS5.1-17-1 |
| CYLINDER BARREL HEAD | - | - | - |
| PISTON | M-S2-SS5.1-81-1 | M-S2-SS5.1-15-1 | M-S2-SS5.1-15-1 |
| THROTTLE BUSHING | M-S2-SS5.1-83-1 | M-S2-SS5.1-16-1 | M-S2-SS5.1-16-1 |
| CYLINDER BARREL BOTTOM | M-S2-SS5.1-76-1 | M-S2-SS5.1-14-1 | M-S2-SS5.1-14-1 |

*Table 5.1.-7: Items and technical documentation for hydraulic cylinders on the downstream lock head*

| HYDRAULIC CYLINDER PART | DRAWING NUMBER |
| --- | --- |
| SERVICE MITER GATE | SERVICE GALLERY GATES |
|  | M-S2-SS5.1-55-1 | M-S2-SS5.1-82-1 |
| PISTON ROD | M-S2-SS5.1-53-1 | M-S2-SS5.1-80-1 |
| NUT | - | [M-S2-SS5.1-60-1](file:///C%3A%5CUsers%5CPC%5CDownloads%5CAdaptacija%20BP%20HEDJ1_Hidraulicki%20cilindri%5CTabela%206%5C2456_D.pdf) M-S2-SS5.1-61-1 |
| COUPLING | M-S2-SS5.1-49-1 | M-S2-SS5.1-59-1 |
| CLEVIS | - | M-S2-SS5.1-75-1 |
| CYLINDER BARREL MOUNT | M-S2-SS5.1-56-1 | M-S2-SS5.1-85-1 |
| CYLINDER BARREL FLANGE | M-S2-SS5.1-37-1M-S2-SS5.1-57-1 | M-S2-SS5.1-84-1 |
| CYLINDER BARREL HEAD | - | - |
| PISTON | M-S2-SS5.1-54-1 | M-S2-SS5.1-81-1 |
| THROTTLE BUSHING | - | M-S2-SS5.1-83-1 |
| CYLINDER BARREL BOTTOM | M-S2-SS5.1-50-1 | M-S2-SS5.1-76-1 |

Subject items shall be made of materials which, according to their mechanical properties and purpose, should possess the same or better mechanical properties than those specified in Table 5.1.-12 of these TS. When forming the Table 5.1.-12: additional requirements from technical documentation for old hydraulic cylinders made by the company “Walter Hunger” Lohr am Main, related to mechanical properties of materials, were taken into account.

It is recommended to produce the piston rods, nuts, couplings and clevises of the material 42CrMo4 according to SRPS EN 10250-3:2012.

Materials for production of new items shall be selected in accordance with the standard SRPS EN 10250-1:2012, Parts 1 to 4.

All items shall be produced by forging according to the Contractor’s forging production technology.

The piston rod shall be made as a single piece.

The material of forgings must be killed (de-oxidized).

For selected materials of forgings, it is necessary to obtain the written approval of the Engineer.

The Contractor is obliged to order the forgings of cylinder barrel flanges from one and the same manufacturer.

The type of heat treatment shall be determined by the Contractor.

Two repeated complete heat treatments are allowed, in case of unsatisfactory results of mechanical properties testing, in other words, the total of three complete heat treatments.

The number of additional tempering rounds is not limited.

The Contractor is obliged to produce drawings of forging (stock) taking into account the technical documentation (Drawings) and requirements from TS regarding the additions for checking of mechanical properties.

The shape, dimensions, tolerance limits for shape and position and quality of surfaces of items produced should match the requirements from the technical drawing and measurement checklist which has to be filled out.

Forgings should bear the following marks:

* the name and trade mark of the Contractor,
* drawing number,
* steel designation,
* batch number,
* hydraulic cylinder number,
* identification number of the item (link with the document on control),
* stamp of the quality control.

Temporary corrosion protection of metallic surfaces of forgings shall be achieved by application of conserving grease and placing of protective foils.

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| **Volume 3-Part 3-PARTICULAR EMPLOYERS REQUIREMENTS****Section 2, 5.1.6.2.1. pg 42** |

**The former text**

* + - * 1. **Pumps of the main hydraulic circuit**

In general, pumps should be of the state-of-the-art technical solution with all necessary latest devices (for regulation, measurement, control and monitoring of flow, capacity, pressure, power, current, etc.), subject to Engineer’s approval.

Pumps of the pumping unit of the main hydraulic circuit should be:

* For mineral oil as operating medium, high-speed version;
* Variable displacement axial piston pump, i.e. with proportional flow control (from zero flow rate to maximum flow rate of 250cm3 per revolution, i.e. 375 l/min.) depending on the speed and demand for operation. The pump shall be fitted with a controllable swashplate;

The direction of rotation shall be to the right, visibly marked on the pump.

* With primary proportional flow control and secondary power regulator, meaning that the pump should be equipped with:
* System of control devices for regulation, adjustment and control of the following technical characteristics:
* flow (Q) – flow controller to regulate the flow,
* pressure (p) – pressure gauges for regulation (and limitation, as a safety valve of the pump), control and monitoring of pressure; Maximum allowable operating pressure of the pump is controlled in the pump,
* with proportional directional control valve with (3+1) positions – the fourth position is when there is no feeding – emergency position.
* capacity (V) – permanent (active) capacity for 375 l/min. (250 cm3/rev.),
* electronic measurement of plate inclination angle (scaled) via rotation angle sensor with indication of data on the pump rotation angle. Minimum and maximum rotation angle limitation is to be adjustable mechanically up to 50%;
* maximum hysteresis of capacity ≤±2% of Vg velocity;
* minimum repeatability ≤±1.5% of Vg velocity;
* power regulation (for emergency situations), controlled flow reduction by the value of pressure rise, provided that the rated power of the electric motor of 132 kW is not exceeded;
* secondary regulation in the pump via power regulation;
* Precisely determined type of pump flow controller (state-of-the-art solution), mounted on the pump.

Pump regulator should control the swashplate of the pump from 0 to maximum angle, via proportional directional control valve with linear force motor. For the zero control signal, the output flow is zero. Feedback should be according to the plate inclination angle, not by direct measuring of angle but by the position of the cylinder which moves it, and the feedback in the controlling directional valve should exist according to the position of the control piston, and the accuracy of flow control (i.e. error in operation) should be less than 1% at full range.

The pump regulator is hydraulically fed with external hydraulic oil, from the control circuit.

Checking of the quality of function and (if required) adjustment of the flow controller shall be performed during testing of pumping units on the test table of the pump manufacturer, and the same data shall be checked and adjusted, if required, during testing in operating conditions at the site. During testing, the control parameters for required flows need to be tested and checked.

Pump startup is always with zero flow, and then the flow grows depending on demand.

* Pressure controller with parallel action;

Operating pressure up to 220 bar, rated pressure 350 bar, maximum pressure of the pump 400 bar, short-term maximum pressure of the pump 450 bar;

The duration of operation at the short-term maximum pressure should be maximum 5 min;

* Flow controller as specified:
* Maximum allowable deviation (210 cm3/rev.) of operating capacity;
* Power regulator with display on hyperbolic curve;
* The pump shall be driven by a 132 kW electric motor.

Depending on the requirements of the electrohydraulic installation, some operations require zero position of the pump swashplate, i.e. reducing the pump flow in the installation to 0 l/min. at a particular moment (e.g. at the upper position during activation of limit switches while awaiting locking of hydraulic cylinder, or during lowering while awaiting unlocking of hydraulic cylinder). If the specified condition is necessary, a solenoid directional control valve (4/2) shall be provided between the pump and the proportional directional control valve, intended for interruption of oil feed to the proportional directional control valve and thus reducing the pump flow to 0, or else the proportional directional control valve with linear motor should be envisaged with zero position, which shall bring the pump swashplate to the zero position. If the described variants are not executed, it is necessary that the logic element on the pressure-reducing valve is designed with a solenoid, so that each pump is relieved. This way, it is possible to prevent the gate from moving without shutting down the pump during gate stopping at an intermediate position.

In existing installation, the pump reduces the flow to 0 (the pump plate is brought to the zero position by disconnection of solenoid directional control valve), when the limit switch activates and awaits locking or unlocking of hydraulic cylinder, but the electric motor does not switch off. The pump’s electric motor switches off at the moment when the gate locking operation ends (during gate closing operation). During gate opening operation, the pump switches on, activates the limit switch and reaches the zero position (the electric motor is running). It remains in the zero position until the unlocking operation ends. When the signal that the unlocking operation has ended is received, the pump restarts and the gate starts opening.

The concept of the digital electrohydraulic pump control system implies:

* pressure control, and
* power limitation.

The diagram of the digital electrohydraulic pump control system is presented within hydraulic diagrams enclosed with Drawings (Volume 5, Part 2, Section 1). The final hydraulic diagram of devices (components) content and arrangement for pump control and reception of data from the pump shall be submitted by the Contractor for Engineer’ approval. All components to be mounted on the pump should be suited for operation with the adopted pump, and their parameters, their operation and harmonization with the pump shall be tested individually and during the entire pumping unit testing on the test table of the pump manufacturer.

The pump should be equipped with all attachments and devices according to the diagram for electrohydraulic pump control system.

The Contractor shall take into account the need for retrofitting of additional devices (not specified herein) on the pump, as required by the electrohydraulic installations for gate closing and opening operations.

All devices to be mounted on the pump should conform to safety lists from the standard SRPS ISO 13849-1:2017.

The Contractor is obliged to specify in his quotation the complete pump reference mark with technical data for all components. Due to the place of installation and arrangement of pumps in engine rooms, the outline dimensions of the pumps should be such that the width (between two furthermost points on outer elements) is not greater than 500 mm and the length (perpendicular to the width) is not greater than 450 mm.

Technical data, properties and workmanship of new pumps of the main hydraulic circuit should meet the following requirements:

* Excellent suction properties;
* With accurately defined pressure on the suction line to be provided by the installation, but not lower than 0.8 bar;
* To allow for radial and axial load (forces) on the driving shaft. The technical documentation should be supported with the design value of load;
* To be of functional, simple structure, uniform for the entire electrohydraulic drive of the lock gates, also uniform in terms that they can be easily found on the marked;

The pump should be composed of parts made of high-quality materials (inox steels resistant to corrosion and wear) with high-level treatment and adequate heat treatments, all together ensuring high reliability of pump operation (especially the rotating parts of the pump – assembly of pistons with lugs in the block on the pump swashplate) at high pressures and flow rates. All pump bearings should be made of high-quality materials produced by renowned manufacturers.

The Contractor is obliged to submit the statement on availability of pumping units and spare parts, by which he warrants for the existence of selected pumps and spare parts in the next ten (10) years from the date of issuing the Taking Over Certificate.

For sealing elements of all pumps of the operating circuit delivered under this Contract, the Contractor shall submit the declaration with the date of production, not older than twelve (12) months from the date of issuing the Taking Over Certificate.

* Pumps should be low-noise – maximum allowable noise level of 90 dB at operating pressures up to 160 bar;
* Long service life. The Contractor should support the pump documentation with declared number of operating hours of the pump;
* Efficiency coefficient of the pump in all operating regimes should not be below 0.9;
* With optional (manual) control of the flow, minimum and maximum flow rate for particular operations:
* decelerated lifting of gates (during overhaul or testing) for inspection of leakage, sealing set, valve blocks, and inspection after overhaul or other works;
* It is recommendable to have grooved output shaft towards the coupling for connection to the electric motor (according to ISO 3019-1, SAE F 50-4);
* All pump attachments with required devices shall conform to DIN 3852-1 for maximum pressures the same as the pump;
* The pump and electric motor shall be connected via an adequate elastic coupling. The coupling shall be protected by bell housing which is at the same time the pump mount. The bell housing shall have side openings (two to four), for inspection of leakage on the lip seal. The bell housing shall be made of cast aluminium alloy. No vibrations due to errors cause by inadequate coupling or wrongful installation (connection) of electric motor and pump via the coupling shall be allowed;

The pump and electric motor shall be connected by an adequate coupling. The Contractor shall select the coupling based on the torque, speed and diameter of the motor and pump shafts. Protection for the coupling of each pump shall be envisaged and mounted. The pumping unit must not experience any vibrations due to (possible) misbalance of the electric motor rotor, errors made during installation of the coupling or pump. During mounting, the Contractor shall align the pump and guarantee for proper operation of the pump-coupling-electric motor assembly. Vibrations shall range within allowable limits (not greater than 2.3 mm), according to the standard SRPS ISO 10816-3:2013;

* For mounting on a stable foundation (made of concrete) on the room floor; Fabrication of new supports shall be according to dimensions and weight of new pumps. The variant implying pump mounting on the hydraulic tank is not allowed;
* The pumping unit is requested to be mounted horizontally;

The Contractor shall check the status of old pedestals and, if required, dismantle the existing ones and fabricate new pedestals suitable for new pumping units. Pedestal of each pump shall be mandatorily checked by geodetic surveying before mounting, including corrections to proper dimensions within the allowable tolerance limits.

* To be suitable for operating ambient temperatures from -20ºC to +50ºC; At these temperatures, the pump structure shall be suitable for possible frequent startups (during testing, overhaul) due to more frequent operations;
* It shall be suitable for operation with the operating medium (mineral hydraulic oil);
* Pump dimensions shall be match the required parameters of the system, as above described;

It is necessary that the pump should have adjusted fittings for suction, discharge and drain lines, and other devices. The proposal of necessary devices and attachments to be mounted on the pump shall be submitted for Engineer’s approval.

* Openings on the suction, discharge and return (drain) line shall be suitable for flanges of adequate pressures:
* SAE in high-pressure series (max. 420 bar),
* SAE in low-pressure series, on the suction line and drain line (if this line is to be flanged);

For adequate pressures with adequate threaded connections, diameter, number and depth of threads in the pump body.

Complete suction, discharge and drainage line of each pump shall be suited for the point of installation, pump pedestal and connection with hydraulic installations of the piping. Connection of pump lines with pipeline (suction, discharge and drain line) shall be executed with steel pipeline of adequate pipes, flanges, clamping plates and bolts, all of them made of high-quality stainless steel.

The distance of the fluid tank, from which the pump is fed during operation, must not affect the suction performance of the pump. In this case, pumps are in the same room where the tank is supposed to be mounted, in the immediate vicinity of the tank.

Each pump, in addition to the openings for the above mentioned lines, has to be equipped with any other required fittings (for various attachments, measuring couplings). All fittings shall be for the maximum pressure (450 bar) and secured against leakage.

* In hydraulic installations, the condition that the tank bottom is at the height of minimum 200 mm above the pump suction shall be met.
* All sealing materials of the pump shall be made of high-quality rubber with high parameters of resistance at high and low temperatures and high degree of tightness (up to 100%), hardness of 80RHc to 90RHc.
* At the lowest point of the pump, there shall be a bolt (valve, for release of entire oil quantity from the pump). The bolt shall be accessible for dismantling. This condition should be kept in mind during planning of the pump pedestal and connection of the pump with the lines;
* At the top point of the pump, or on a part of pump where air might accumulate after filling following an overhaul, and adequate bolt (valve) shall be provided for pump aeration. Each part on the pump should have the possibility of aeration after pump emptying and replenishment with oil.

**The new text**

* + - * 1. **Pumps of the main hydraulic circuit**

In general, pumps should be of the state-of-the-art technical solution with all necessary latest devices (for regulation, measurement, control and monitoring of flow, capacity, pressure, power, current, etc.), subject to Engineer’s approval.

Pumps of the pumping unit of the main hydraulic circuit should be:

* For mineral oil as operating medium, high-speed version;
* Variable displacement axial piston pump, i.e. with proportional flow control (from zero flow rate to maximum flow rate of 250cm3 per revolution, i.e. 375 l/min.) depending on the speed and demand for operation. The pump shall be fitted with a controllable swashplate;

The direction of rotation shall be to the right, visibly marked on the pump.

* With primary proportional flow control and secondary power regulator, meaning that the pump should be equipped with:
* System of control devices for regulation, adjustment and control of the following technical characteristics:
* flow (Q) – flow controller to regulate the flow,
* pressure (p) – pressure gauges for regulation (and limitation, as a safety valve of the pump), control and monitoring of pressure; Maximum allowable operating pressure of the pump is controlled in the pump,
* with proportional directional control valve with (3+1) positions – the fourth position is when there is no feeding – emergency position.
* capacity (V) – permanent (active) capacity for 375 l/min. (250 cm3/rev.),
* electronic measurement of plate inclination angle (scaled) via rotation angle sensor with indication of data on the pump rotation angle. Minimum and maximum rotation angle limitation is to be adjustable mechanically up to 50%;
* maximum hysteresis of capacity ≤±2% of Vg velocity;
* minimum repeatability ≤±1.5% of Vg velocity;
* power regulation (for emergency situations), controlled flow reduction by the value of pressure rise, provided that the rated power of the electric motor of 132 kW is not exceeded;
* secondary regulation in the pump via power regulation;
* Precisely determined type of pump flow controller (state-of-the-art solution), mounted on the pump.

Pump regulator should control the swashplate of the pump from 0 to maximum angle, via proportional directional control valve with linear force motor. For the zero control signal, the output flow is zero. Feedback should be according to the plate inclination angle, not by direct measuring of angle but by the position of the cylinder which moves it, and the feedback in the controlling directional valve should exist according to the position of the control piston, and the accuracy of flow control (i.e. error in operation) should be less than 1% at full range.

The pump regulator is hydraulically fed with external hydraulic oil, from the control circuit.

Checking of the quality of function and (if required) adjustment of the flow controller shall be performed during testing of pumping units on the test table of the pump manufacturer, and the same data shall be checked and adjusted, if required, during testing in operating conditions at the site. During testing, the control parameters for required flows need to be tested and checked.

Pump startup is always with zero flow, and then the flow grows depending on demand.

* Pressure controller with parallel action;

Operating pressure up to 220 bar, rated pressure 350 bar;

* Flow controller as specified:
* Maximum allowable deviation (210 cm3/rev.) of operating capacity;
* Power regulator with display on hyperbolic curve;
* The pump shall be driven by a 132 kW electric motor.

Depending on the requirements of the electrohydraulic installation, some operations require zero position of the pump swashplate, i.e. reducing the pump flow in the installation to 0 l/min. at a particular moment (e.g. at the upper position during activation of limit switches while awaiting locking of hydraulic cylinder, or during lowering while awaiting unlocking of hydraulic cylinder). If the specified condition is necessary, a solenoid directional control valve (4/2) shall be provided between the pump and the proportional directional control valve, intended for interruption of oil feed to the proportional directional control valve and thus reducing the pump flow to 0, or else the proportional directional control valve with linear motor should be envisaged with zero position, which shall bring the pump swashplate to the zero position. If the described variants are not executed, it is necessary that the logic element on the pressure-reducing valve is designed with a solenoid, so that each pump is relieved. This way, it is possible to prevent the gate from moving without shutting down the pump during gate stopping at an intermediate position.

In existing installation, the pump reduces the flow to 0 (the pump plate is brought to the zero position by disconnection of solenoid directional control valve), when the limit switch activates and awaits locking or unlocking of hydraulic cylinder, but the electric motor does not switch off. The pump’s electric motor switches off at the moment when the gate locking operation ends (during gate closing operation). During gate opening operation, the pump switches on, activates the limit switch and reaches the zero position (the electric motor is running). It remains in the zero position until the unlocking operation ends. When the signal that the unlocking operation has ended is received, the pump restarts and the gate starts opening.

The concept of the digital electrohydraulic pump control system implies:

* pressure control, and
* power limitation.

The diagram of the digital electrohydraulic pump control system is presented within hydraulic diagrams enclosed with Drawings (Volume 5, Part 2, Section 1). The final hydraulic diagram of devices (components) content and arrangement for pump control and reception of data from the pump shall be submitted by the Contractor for Engineer’ approval. All components to be mounted on the pump should be suited for operation with the adopted pump, and their parameters, their operation and harmonization with the pump shall be tested individually and during the entire pumping unit testing on the test table of the pump manufacturer.

The pump should be equipped with all attachments and devices according to the diagram for electrohydraulic pump control system.

The Contractor shall take into account the need for retrofitting of additional devices (not specified herein) on the pump, as required by the electrohydraulic installations for gate closing and opening operations.

All devices to be mounted on the pump should conform to safety lists from the standard SRPS ISO 13849-1:2017.

The Contractor is obliged to specify in his quotation the complete pump reference mark with technical data for all components. Due to the place of installation and arrangement of pumps in engine rooms, the outline dimensions of the pumps should be such that the width (between two furthermost points on outer elements) is not greater than 500 mm and the length (perpendicular to the width) is not greater than 450 mm.

Technical data, properties and workmanship of new pumps of the main hydraulic circuit should meet the following requirements:

* Excellent suction properties;
* With accurately defined pressure on the suction line to be provided by the installation, but not lower than 0.8 bar;
* To allow for radial and axial load (forces) on the driving shaft. The technical documentation should be supported with the design value of load;
* To be of functional, simple structure, uniform for the entire electrohydraulic drive of the lock gates, also uniform in terms that they can be easily found on the marked;

The pump should be composed of parts made of high-quality materials with high-level treatment and adequate heat treatments, all together ensuring high reliability of pump operation (especially the rotating parts of the pump – assembly of pistons with lugs in the block on the pump swashplate) at high pressures and flow rates. All pump bearings should be made of high-quality materials produced by renowned manufacturers.

The Contractor is obliged to submit the statement on availability of pumping units and spare parts, by which he warrants for the existence of selected pumps and spare parts in the next ten (10) years from the date of issuing the Taking Over Certificate.

For sealing elements of all pumps of the operating circuit delivered under this Contract, the Contractor shall submit the declaration with the date of production, not older than twelve (12) months from the date of issuing the Taking Over Certificate.

* Pumps should be low-noise – maximum allowable noise level of 90 dB at operating pressures up to 160 bar;
* Long service life. The Contractor should support the pump documentation with declared number of operating hours of the pump;
* Efficiency coefficient of the pump in all operating regimes should not be below 0.9;
* With optional (manual) control of the flow, minimum and maximum flow rate for particular operations:
* decelerated lifting of gates (during overhaul or testing) for inspection of leakage, sealing set, valve blocks, and inspection after overhaul or other works;
* It is recommendable to have grooved output shaft towards the coupling for connection to the electric motor (according to ISO 3019-1, SAE F 50-4);
* All pump attachments with required devices shall conform to DIN 3852-1 for maximum pressures the same as the pump;
* The pump and electric motor shall be connected via an adequate elastic coupling. The coupling shall be protected by bell housing which is at the same time the pump mount. The bell housing shall have side openings (two to four), for inspection of leakage on the lip seal. The bell housing shall be made of cast aluminium alloy. No vibrations due to errors cause by inadequate coupling or wrongful installation (connection) of electric motor and pump via the coupling shall be allowed;

The pump and electric motor shall be connected by an adequate coupling. The Contractor shall select the coupling based on the torque, speed and diameter of the motor and pump shafts. Protection for the coupling of each pump shall be envisaged and mounted. The pumping unit must not experience any vibrations due to (possible) misbalance of the electric motor rotor, errors made during installation of the coupling or pump. During mounting, the Contractor shall align the pump and guarantee for proper operation of the pump-coupling-electric motor assembly. Vibrations shall range within allowable limits (not greater than 2.3 mm), according to the standard SRPS ISO 10816-3:2013;

* For mounting on a stable foundation (made of concrete) on the room floor; Fabrication of new supports shall be according to dimensions and weight of new pumps. The variant implying pump mounting on the hydraulic tank is not allowed;
* The pumping unit is requested to be mounted horizontally;

The Contractor shall check the status of old pedestals and, if required, dismantle the existing ones and fabricate new pedestals suitable for new pumping units. Pedestal of each pump shall be mandatorily checked by geodetic surveying before mounting, including corrections to proper dimensions within the allowable tolerance limits.

* To be suitable for operating ambient temperatures from -20ºC to +50ºC; At these temperatures, the pump structure shall be suitable for possible frequent startups (during testing, overhaul) due to more frequent operations;
* It shall be suitable for operation with the operating medium (mineral hydraulic oil);
* Pump dimensions shall be match the required parameters of the system, as above described;

It is necessary that the pump should have adjusted fittings for suction, discharge and drain lines, and other devices. The proposal of necessary devices and attachments to be mounted on the pump shall be submitted for Engineer’s approval.

* Openings on the suction, discharge and return (drain) line shall be suitable for flanges of adequate pressures:
* SAE in high-pressure series (max. 420 bar),
* SAE in low-pressure series, on the suction line and drain line (if this line is to be flanged);

For adequate pressures with adequate threaded connections, diameter, number and depth of threads in the pump body.

Complete suction, discharge and drainage line of each pump shall be suited for the point of installation, pump pedestal and connection with hydraulic installations of the piping. Connection of pump lines with pipeline (suction, discharge and drain line) shall be executed with steel pipeline of adequate pipes, flanges, clamping plates and bolts, all of them made of high-quality stainless steel.

The distance of the fluid tank, from which the pump is fed during operation, must not affect the suction performance of the pump. In this case, pumps are in the same room where the tank is supposed to be mounted, in the immediate vicinity of the tank.

Each pump, in addition to the openings for the above mentioned lines, has to be equipped with any other required fittings (for various attachments, measuring couplings). All fittings shall be secured against leakage.

* In hydraulic installations, the condition that the tank bottom is at the height of minimum 200 mm above the pump suction shall be met.
* All sealing materials of the pump shall be made of high-quality rubber with high parameters of resistance at high and low temperatures and high degree of tightness (up to 100%), hardness of 80RHc to 90RHc.
* At the lowest point of the pump, there shall be a bolt (valve, for release of entire oil quantity from the pump). The bolt shall be accessible for dismantling. This condition should be kept in mind during planning of the pump pedestal and connection of the pump with the lines;
* At the top point of the pump, or on a part of pump where air might accumulate after filling following an overhaul, and adequate bolt (valve) shall be provided for pump aeration. Each part on the pump should have the possibility of aeration after pump emptying and replenishment with oil.

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| **Volume 3-Part 3-PARTICULAR EMPLOYERS REQUIREMENTS****Section 2, 5.1.7.2.2.2.2. pg 94** |

**The former text**

Mechanical testing of materials

Mechanical tests shall be performed after the last heat treatment or additional tempering on each forging.

The material for mechanical testing shall be cut mechanically from additional samples, after stamping by the Engineer and Contractor. The stamps shall be always transferred, to stamping of test pieces themselves.

On Engineer’s request, the Contractor shall provide the material for additional mechanical control tests in his laboratories.

Locations for sampling for test pieces preparation shall be determined according to SRPS ЕN 10250-1: 2012 Clause 11.3. and SRPS ЕN ISO 377:2018.

Mechanical tests on piston rod material shall be performed on a doubled number of test pieces, taken from both ends of the forging.

The Contractor is obliged to prepare drawings of forgings and to envisage sampling for testing by destructive methods with longitudinal character of test pieces, except for forgings from Table 5.1-12 of these TS, for which transverse test pieces are required.

Mechanical properties of selected material of forgings after the last heat treatment (HT) or additional tempering shall have the values defined in Table 5.1.-12, as a minimum.

*Table 5.1.-12: Minimum required values of mechanical properties of materials for forgings*

|  | Yield pointRe min.[МPa] | Tensile strength Rm min. [МPa] | ElongationА min.[%] | Impact energyКV min[Ј] |
| --- | --- | --- | --- | --- |
| Piston rod | 600 | 800 | >16 | ≥27 at - 50°C |
| Nut | 600 | 800 | >13 | ≥27 at - 50°C |
| Coupling | 600 | 800 | >13 | ≥27 at - 50°C |
| Clevis | 490 | 700 | >15 | ≥24 at - 50°C |
| Mount, flanges and cylinder barrel head  | 350 | 520‑620 | Transverse direction>22 | Transverse direction≥32 at - 40°C  |
| Piston | 280 | 500-600 | >20 | ≥27 at - 40°C |
| Throttle bushing | 320 | 550 | >20 | ≥27 at - 40°C |
| Cylinder bottom | 300 | 520 | >20 | ≥32 at - 40°C |

1. Tensile testing

Tensile testing shall conform to SRPS ЕN ISO 15913:2009. „Metallic materials – Tensile testing – Part 1: Test method at room temperature”.

Test pieces shall be prepared in compliance with SRPS ЕN ISO 15913:2009.

Values of mechanical properties, during tensile testing, should match the values in Table 5.1-12 for subject material in these TS.

1. Charpy impact testing

Charpy impact testing shall conform to SRPS EN ISO 148-1:2017. – „Metallic materials – Charpy pendulum impact testing – Part 1: Test method”.

Characteristics of apparatus shall conform to SRPS EN ISO 1482:2014.

Standard size test pieces with V-notch shall be used in standard conditions, at the test temperature in compliance with Table 1 within these TS.

Impact energy КV in [Ј] at the test temperature shall be presented.

Mean value of impact energy, for each group of 3 test pieces, should match the values provided in Table 5.1-12 within these TS, for selected materials. Individual values should not be smaller than 70% of the set value from Table 5.1-12 within these TS.

The test report shall present: dimensions of test pieces, measured impact energy for each test piece, and the mean value.

1. Hardness measurement

It is performed for the purpose of assessment of the heat treatment successfulness.

Measuring is performed on the surface of a forging, at the middle and on ends, with three measuring points each and three measuring rounds per each measuring point, and on residual test pieces for toughness testing.

Quality degree of the measuring point treatment: Rа = 0.8 µm.

The hardness of a measuring point is the mean arithmetic value of three measurement rounds, wherein no individual measurement should deviate from the mean hardness value by more than 10%.

Mean arithmetic hardness values should be uniform and range within the limits specified in SRPS EN ISO 18265:2014 „Metallic materials – Conversion of hardness values”.

Mean arithmetic hardness values, per sections, for the piston rod, should be uniform and range within the limits of 230-260 HB.

Lower and higher mean values in the middle zone require additional measurement, comparison with hardness values on ends, consideration of values of achieved mechanical properties and approval of the Engineer.

**The new text**

Mechanical testing of materials

Mechanical tests shall be performed after the last heat treatment or additional tempering on each forging.

The material for mechanical testing shall be cut mechanically from additional samples, after stamping by the Engineer and Contractor. The stamps shall be always transferred, to stamping of test pieces themselves.

On Engineer’s request, the Contractor shall provide the material for additional mechanical control tests in his laboratories.

Locations for sampling for test pieces preparation shall be determined according to SRPS ЕN 10250-1: 2012 Clause 11.3. and SRPS ЕN ISO 377:2018.

Mechanical tests on piston rod material shall be performed on a doubled number of test pieces, taken from both ends of the forging.

The Contractor is obliged to prepare drawings of forgings and to envisage sampling for testing by destructive methods with longitudinal character of test pieces, except for forgings from Table 5.1-12 of these TS, for which transverse test pieces are required.

Mechanical properties of selected material of forgings after the last heat treatment (HT) or additional tempering shall have the values defined in Table 5.1.-12, as a minimum.

*Table 5.1.-12: Minimum required values of mechanical properties of materials for forgings*

|  | Yield pointRe min.[МPa] | Tensile strength Rm min. [МPa] | ElongationА min.[%] | Impact energyin longitudinal directionКV min[Ј] |
| --- | --- | --- | --- | --- |
| Piston rod | 600 | 800 | >16 | ≥27 at - 20°C |
| Nut | 600 | 800 | >13 | ≥27 at - 20°C |
| Coupling | 600 | 800 | >13 | ≥27 at - 20°C |
| Clevis | 490 | 700 | >15 | ≥24 at - 20°C |
| Mount, flanges and cylinder barrel head  | 350 | 520‑620 | >22 | ≥32 at - 20°C  |
| Piston | 280 | 500-600 | >20 | ≥27 at - 20°C |
| Throttle bushing | 320 | 550 | >20 | ≥27 at - 20°C |
| Cylinder bottom | 300 | 520 | >20 | ≥32 at - 20°C |

1. Tensile testing

Tensile testing shall conform to SRPS ЕN ISO 15913:2009. „Metallic materials – Tensile testing – Part 1: Test method at room temperature”.

Test pieces shall be prepared in compliance with SRPS ЕN ISO 15913:2009.

Values of mechanical properties, during tensile testing, should match the values in Table 5.1-12 for subject material in these TS.

1. Charpy impact testing

Charpy impact testing shall conform to SRPS EN ISO 148-1:2017. – „Metallic materials – Charpy pendulum impact testing – Part 1: Test method”.

Characteristics of apparatus shall conform to SRPS EN ISO 1482:2014.

Standard size test pieces with V-notch shall be used in standard conditions, at the test temperature in compliance with Table 1 within these TS.

Impact energy КV in [Ј] at the test temperature shall be presented.

Mean value of impact energy, for each group of 3 test pieces, should match the values provided in Table 5.1-12 within these TS, for selected materials. Individual values should not be smaller than 70% of the set value from Table 5.1-12 within these TS.

The test report shall present: dimensions of test pieces, measured impact energy for each test piece, and the mean value.

1. Hardness measurement

It is performed for the purpose of assessment of the heat treatment successfulness.

Measuring is performed on the surface of a forging, at the middle and on ends, with three measuring points each and three measuring rounds per each measuring point, and on residual test pieces for toughness testing.

Quality degree of the measuring point treatment: Rа = 0.8 µm.

The hardness of a measuring point is the mean arithmetic value of three measurement rounds, wherein no individual measurement should deviate from the mean hardness value by more than 10%.

Mean arithmetic hardness values should be uniform and range within the limits specified in SRPS EN ISO 18265:2014 „Metallic materials – Conversion of hardness values”.

Mean arithmetic hardness values, per sections, for the piston rod, should be uniform and range within the limits of 230-260 HB.

Lower and higher mean values in the middle zone require additional measurement, comparison with hardness values on ends, consideration of values of achieved mechanical properties and approval of the Engineer.

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| **Volume 3-Part 3-PARTICULAR EMPLOYERS REQUIREMENTS****Section 2, 5.1.7.2.2.3.4. pg 98** |

**The former text**

Mechanical testing of tube material

Mechanical properties of selected material of cylindrical parts of the hydraulic cylinder barrel should possess the values defined in Table 5.1-13, as a minimum.

*Table 5.1.-13: Minimum required values of mechanical properties of materials for cylindrical parts of hydraulic cylinder barrels*

|  | Yield pointRe min.[Мpa] | Tensile strength Rm min. Мpa] | ElongationА min.[%] | Impact energyКV [Ј]min. |
| --- | --- | --- | --- | --- |
| Cylindrical parts of cylinder barrel | 350 | 550‑680 | Transverse direction>18 | Transverse direction≥32 at -40°C |

1. Tensile testing

Tensile testing should conform to SRPS EN ISO 6892-1:2017, and it should determine:

* Tensile strength (Rm),
* Upper yield point (ReX), or, if it is not pronounced, conventional yield strength (Rp0,2),
* Percentage-stated elongation after break in relation to the initial length Lo (Lo=5.65). In case of unproportioned test pieces, the elongation should be converted to the values for proportional ones, with the aid of tables from SRPS EN ISO 2566-1:2012.
1. Charpy impact test

Impact testing should conform to SRPS EN ISO 148-1:2017 at the temperature of -40°C, according to the requirements of the Contractor.

Mean value of impact energy of three test pieces should meet the requirements specified in Table 13 in these TS. Individual values must not be lower than 70% of the values from Table 13.

If the previous requirement fails to be fulfilled, three new test pieces shall be taken, from the same sample, and tested under the following conditions:

* mean value of impact energy for six test pieces should be greater than or equal to the mean specified value,
* no more than two individual values of impact energy may be lower than the specified mean value,
* only for one test piece, the impact energy may be lower than 70% of the specified mean value.

The following shall be presented: dimensions of test pieces, measured impact energy for each test piece, and the mean value.

If results are unsatisfactory, the tube shall be discarded.

**The new text**

Mechanical testing of tube material

Mechanical properties of selected material of cylindrical parts of the hydraulic cylinder barrel should possess the values defined in Table 5.1-13, as a minimum.

*Table 5.1.-13: Minimum required values of mechanical properties of materials for cylindrical parts of hydraulic cylinder barrels*

|  | Yield pointRe min.[Мpa] | Tensile strength Rm min. Мpa] | ElongationА min.[%] | Impact energyКV [Ј]min. |
| --- | --- | --- | --- | --- |
| Cylindrical parts of cylinder barrel | 350 | 550‑680 | Transverse direction>18 | Transverse direction≥32 at -20°C |

1. Tensile testing

Tensile testing should conform to SRPS EN ISO 6892-1:2017, and it should determine:

* Tensile strength (Rm),
* Upper yield point (ReX), or, if it is not pronounced, conventional yield strength (Rp0,2),
* Percentage-stated elongation after break in relation to the initial length Lo (Lo=5.65). In case of unproportioned test pieces, the elongation should be converted to the values for proportional ones, with the aid of tables from SRPS EN ISO 2566-1:2012.
1. Charpy impact test

Impact testing should conform to SRPS EN ISO 148-1:2017 at the temperature of -20°C, according to the requirements of the Contractor.

Mean value of impact energy of three test pieces should meet the requirements specified in Table 13 in these TS. Individual values must not be lower than 70% of the values from Table 13.

If the previous requirement fails to be fulfilled, three new test pieces shall be taken, from the same sample, and tested under the following conditions:

* mean value of impact energy for six test pieces should be greater than or equal to the mean specified value,
* no more than two individual values of impact energy may be lower than the specified mean value,
* only for one test piece, the impact energy may be lower than 70% of the specified mean value.

The following shall be presented: dimensions of test pieces, measured impact energy for each test piece, and the mean value.

If results are unsatisfactory, the tube shall be discarded.

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| **Volume 3-Part 3-PARTICULAR EMPLOYERS REQUIREMENTS****Section 2, 5.1.7.2.2.5.2. pg 102** |

**The former text**

Mechanical testing of material

The Contractor is obliged to provide, for each batch, the material for additional mechanical control tests in an independent accredited laboratory, in the presence of the Engineer, for verification of results specified in Contractor’s certificates.

Tensile testing for verification of mechanical properties of steel S355J2 is performed at room temperature of +20°С, in compliance with the standard SRPS EN ISO 6892-1:2017. (Metallic materials – Tensile testing – Part 1: Test method at room temperature). The obtained results must conform to the standard SRPS EN 10025-2:2011 (Table 7).

Testing by impact energy is performed in compliance with the standard SRPS EN ISO 148-1:2017. (Metallic materials – Charpy pendulum impact testing – Part 1: Test method). A test piece with V- notch is used for the testing. Material S355Ј2 must possess the minimum impact energy value of 27Ј at the test temperature of -40°C.

Samples for mechanical testing shall be taken in compliance with the standard SRPS EN ISO 377:2018 (Steel and steel products – Location and preparation of samples and test pieces for mechanical testing).

For sheets and strips of material thickness ≤30mm, in compliance with the standard SRPS EN 10164:2014 (Steel products with improved deformation properties perpendicular to the surface of the product - Technical delivery conditions), the quality class Z35 has to be ensured.

**The new text**

Mechanical testing of material

The Contractor is obliged to provide, for each batch, the material for additional mechanical control tests in an independent accredited laboratory, in the presence of the Engineer, for verification of results specified in Contractor’s certificates.

Tensile testing for verification of mechanical properties of steel S355J2 is performed at room temperature of +20°С, in compliance with the standard SRPS EN ISO 6892-1:2017. (Metallic materials – Tensile testing – Part 1: Test method at room temperature). The obtained results must conform to the standard SRPS EN 10025-2:2011 (Table 7).

Testing by impact energy is performed in compliance with the standard SRPS EN ISO 148-1:2017. (Metallic materials – Charpy pendulum impact testing – Part 1: Test method). A test piece with V- notch is used for the testing. Material S355Ј2 must possess the minimum impact energy value of 27Ј at the test temperature of -20°C.

Samples for mechanical testing shall be taken in compliance with the standard SRPS EN ISO 377:2018 (Steel and steel products – Location and preparation of samples and test pieces for mechanical testing).

For sheets and strips of material thickness ≤30mm, in compliance with the standard SRPS EN 10164:2014 (Steel products with improved deformation properties perpendicular to the surface of the product - Technical delivery conditions), the quality class Z35 has to be ensured.

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| **Volume 3-Part 3-PARTICULAR EMPLOYERS REQUIREMENTS****Section 2, 5.1.7.2.2.6.3. pg 104** |

**The former text**

5.1.7.2.2.6.3. Non-destructive testing

1. Half-disc bearing housing, drawing number M-S2-SS5.1-96-1, material G 320:
* Visual inspection of 100% scope. All fine-machined surfaces (two triangles on the drawing) must be of quality class 2, and rough-machined surfaces (one triangle on the drawing) of quality class 3;
* Machined surfaces shall be penetrant tested. Fine-machined surfaces must be of quality class 2, and rough-machined ones of quality class 3;
* Magnetic particle testing within 100% scope. Fine-machined surfaces must be of quality class 1, and rough-machined ones of quality class 2. Non-machined surfaces shall be of quality class 3;
* Ultrasonic testing within 100% scope. Volumetric homogeneity of the part must match the quality class 3.
1. Mount, drawing number M-S2-SS5.1-96-1, material G42CrMo4;
* Visual inspection within 100% scope. All fine-machined surfaces (two triangles on the drawing) must be of quality class 1, and rough-machined ones (one triangle on the drawing) of quality class 2.
* Machined surfaces shall be penetrant tested. Fine-machined surfaces shall be of quality class 2, and rough-machined ones of quality class 3.
* Magnetic particle testing of 100% scope. Fine-machined surfaces must be of quality class 1, and rough-machined ones of quality class 2. Non-machined surfaces must match the quality class 3.
* Ultrasonic testing of 100% scope. Volumetric homogeneity of trunnions and part of mount body in the trunnion zone (100mm width around trunnions) must be of quality class 1, and the rest of the mount of quality class 2.

Non-destructive testing shall be carried out in compliance with European standards listed in Table *5.1.-14*.

*Table 5.1.-14:* Non-destructive testing

| Testing method | Symbol | General principles | Testing conditions |
| --- | --- | --- | --- |
| Visual | VT | SRPS EN 13018:2017 | SRPS EN 1370:2013 |
| Liquid penetrant | PT | SRPS EN ISO 3452-1:2017 | SRPS EN 1317-1:2013 SRPS EN 1317-2:2013 |
| Magnetic particle | MT | SRPS EN ISO 9934-1:2017 | SRPS EN 1369:2017 |
| Ultrasonic | UT | SRPS EN ISO 16810:2016 | SRPS EN 12680-1:2010 SRPS EN 12680-2:2012 |
| Radiographic | RT | SRPS EN ISO 5579:2017SRPS EN ISO 19232-1:2014SRPS EN ISO 14784-1:2010SRPS EN ISO 14784-2:2010 | SRPS EN12681:2017 |

Non-destructive testing may be performed by certified personnel in accordance with SRPS EN ISO 9712.

**The new text**

5.1.7.2.2.6.3. Non-destructive testing

1. Half-disc bearing housing, drawing number M-S2-SS5.1-96-1:
* Visual inspection of 100% scope. All fine-machined surfaces (two triangles on the drawing) must be of quality class 2, and rough-machined surfaces (one triangle on the drawing) of quality class 3;
* Machined surfaces shall be penetrant tested. Fine-machined surfaces must be of quality class 2, and rough-machined ones of quality class 3;
* Magnetic particle testing within 100% scope. Fine-machined surfaces must be of quality class 1, and rough-machined ones of quality class 2. Non-machined surfaces shall be of quality class 3;
* Ultrasonic testing within 100% scope. Volumetric homogeneity of the part must match the quality class 3.
1. Mount, drawing number M-S2-SS5.1-96-1:
* Visual inspection within 100% scope. All fine-machined surfaces (two triangles on the drawing) must be of quality class 1, and rough-machined ones (one triangle on the drawing) of quality class 2.
* Machined surfaces shall be penetrant tested. Fine-machined surfaces shall be of quality class 2, and rough-machined ones of quality class 3.
* Magnetic particle testing of 100% scope. Fine-machined surfaces must be of quality class 1, and rough-machined ones of quality class 2. Non-machined surfaces must match the quality class 3.
* Ultrasonic testing of 100% scope. Volumetric homogeneity of trunnions and part of mount body in the trunnion zone (100mm width around trunnions) must be of quality class 1, and the rest of the mount of quality class 2.

Non-destructive testing shall be carried out in compliance with European standards listed in Table *5.1.-14*.

*Table 5.1.-14:* Non-destructive testing

| Testing method | Symbol | General principles | Testing conditions |
| --- | --- | --- | --- |
| Visual | VT | SRPS EN 13018:2017 | SRPS EN 1370:2013 |
| Liquid penetrant | PT | SRPS EN ISO 3452-1:2017 | SRPS EN 1317-1:2013 SRPS EN 1317-2:2013 |
| Magnetic particle | MT | SRPS EN ISO 9934-1:2017 | SRPS EN 1369:2017 |
| Ultrasonic | UT | SRPS EN ISO 16810:2016 | SRPS EN 12680-1:2010 SRPS EN 12680-2:2012 |

Non-destructive testing may be performed by certified personnel in accordance with SRPS EN ISO 9712.

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| **Volume 3-Part 3-PARTICULAR EMPLOYERS REQUIREMENTS****Section 2, 5.2.5.15. pg 147** |

**The former text**

* + - 1. **Programmable logic controllers**

General requirements for PLCs shall be in accordance with SRPS EN 61131-1.

All envisaged PLCs shall be from the same manufacturer and shall be foreseen for applications in medium and large performance range with medium and large-size quantity structures. Integrated interfaces for decentralized periphery shall be needed.

PLCs shall be in modular design. All PLC modules shall comply with SRPS EN 61131-2. It shall be possible to replace the PLC module in operation, without power off. The limitations in the number of signals by PLC modules are as follows:

* Digital input modules shall not have more than 32 signals per module;
* Digital output modules shall not have more than 16 signals per module;
* Analog input modules shall not have more than 8 isolated signals per module;
* Analog output modules shall not have more than 4 isolated signals per module.

PLC programming shall be possible in any of the programming languages ​​supported by SRPS EN 61131-3.

All PLCs shall be equipped with:

* A memory card for permanent data storage;
* A back-up battery for storing a program for a certain time;
* Real time clock, which shall be synchronized with the time synchronization system;
* A communication port for setting up an IP address and recording firmware;
* Built-in display for plaintext diagnosis and basic settings (operation, diagnostic information, change of IP address, user language selectable, password protection, etc.);
* Visual signalization of the current status of the module.

Redundancy of PLCs shall be realized as a hardware solution by the manufacturer. Software redundancy solutions shall not be allowed. Switching to the redundant module in case of failure of the primary module shall be automatic and without disturbance.

The automatic start of the PLC operation shall be ensured after interrupting or re-establishing the power supply.

It shall be enabled to monitor and modify the application software in on-line mode, without losing data.

Self-diagnostic functions of PLCs shall be standard hardware and software solutions from the manufacturer.

Minimal technical requirements for PLCs shall be as follows:

* Memory:
	+ Integrated work memory (for program): 500 kB;
	+ Integrated work memory (for data): 3000 kB;
	+ Load memory: 32 MByte;
* CPU processing time:
	+ For bit operations, typical: 0.03 µs;
	+ For word operations, typical: 0.036 µs;
	+ For fixed-point arithmetic, typical: 0.048 µs;
	+ For floating-point arithmetic, typical: 0.192 µs;
* Inputs/outputs:
	+ Inputs/outputs modularly expandable;
	+ Periphery address area inputs: 32 kB;
	+ Periphery address area outputs: 32 kB.

The connection of digital inputs and outputs of digital input and output modules shall be implemented completely via auxiliary relays in order to protect the modules from passing through possible overvoltages from the plant.

Measurements that are introduced into analog input modules via miliamper loops and come from longer distances shall be introduced into analog input modules via mA / mA galvanic separations.

Current signals 4-20 mA that are introduced into multiple locations/devices shall be multiplied by galvanically isolated signal multiplicators. Serial connection of multiple devices on one current signal source shall not be allowed.

Operating systems of PLCs shall be proven in practice and from the renowned manufacturers supported real-time operating systems.

**The new text**

* + - 1. **Programmable logic controllers**

General requirements for PLCs shall be in accordance with SRPS EN 61131-1.

All envisaged PLCs shall be from the same manufacturer and shall be foreseen for applications in medium and large performance range.

PLCs shall be in modular design. All PLC modules shall comply with SRPS EN 61131-2. It shall be possible to replace the PLC module in operation, without power off. The limitations in the number of signals by PLC modules are as follows:

* Digital input modules shall not have more than 32 signals per module;
* Digital output modules shall not have more than 16 signals per module;
* Analog input modules shall not have more than 8 isolated signals per module;
* Analog output modules shall not have more than 4 isolated signals per module.

PLC programming shall be possible in any of the programming languages supported by SRPS EN 61131-3.

All PLCs shall be equipped with:

* A memory card for permanent data storage;
* A back-up battery for storing a program for a certain time;
* Real time clock, which shall be synchronized with the time synchronization system;
* A communication port for setting up an IP address and recording firmware;
* Visual signalization of the current status of the module.

Redundancy of PLCs shall be realized as a hardware solution by the manufacturer. Software redundancy solutions shall not be allowed. Switching to the redundant module in case of failure of the primary module shall be automatic and without disturbance.

The automatic start of the PLC operation shall be ensured after interrupting or re-establishing the power supply.

It shall be enabled to monitor and modify the application software in on-line mode, without losing data.

Self-diagnostic functions of PLCs shall be standard hardware and software solutions from the manufacturer.

The connection of digital inputs and outputs of digital input and output modules shall be implemented completely via auxiliary relays in order to protect the modules from passing through possible overvoltages from the plant.

Measurements that are introduced into analog input modules via miliamper loops and come from longer distances shall be introduced into analog input modules via mA / mA galvanic separations.

Current signals 4-20 mA that are introduced into multiple locations/devices shall be multiplied by galvanically isolated signal multiplicators. Serial connection of multiple devices on one current signal source shall not be allowed.

Operating systems of PLCs shall be proven in practice and from the renowned manufacturers supported real-time operating systems.

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| **Volume 3-Part 3-PARTICULAR EMPLOYERS REQUIREMENTS****Section 2, 6.2.5.10. pg 402** |

**The former text**

* + - 1. **Programmable logic controllers**

General requirements for PLCs shall be in accordance with SRPS EN 61131-1.

All envisaged PLCs shall be from the same manufacturer and shall be foreseen for applications in medium and large performance range with medium and large-size quantity structures. Integrated interfaces for decentralized periphery shall be needed.

PLCs shall be in modular design. All PLC modules shall comply with SRPS EN 61131-2. It shall be possible to replace the PLC module in operation, without power off. The limitations in the number of signals by PLC modules are as follows:

* Digital input modules shall not have more than 32 signals per module;
* Digital output modules shall not have more than 16 signals per module;
* Analog input modules shall not have more than 8 isolated signals per module;
* Analog output modules shall not have more than 4 isolated signals per module.

PLC programming shall be possible in any of the programming languages ​​supported by SRPS EN 61131-3.

All PLCs shall be equipped with:

* A memory card for permanent data storage;
* A back-up battery for storing a program for a certain time;
* Real time clock, which shall be synchronized with the time synchronization system;
* A communication port for setting up an IP address and recording firmware;
* Built-in display for plaintext diagnosis and basic settings (operation, diagnostic information, change of IP address, user language selectable, password protection, etc.);
* Visual signalization of the current status of the module.

The automatic start of the PLC operation shall be ensured after interrupting or re-establishing the power supply.

It shall be enabled to monitor and modify the application software in on-line mode, without losing data.

Self-diagnostic functions of PLCs shall be standard hardware and software solutions from the manufacturer.

Minimal technical requirements for PLCs shall be as follows:

* Memory:
	+ Integrated work memory (for program): 500 kB;
	+ Integrated work memory (for data): 3000 kB;
	+ Load memory: 32 MByte;
* CPU processing time:
	+ For bit operations, typical: 0.03 µs;
	+ For word operations, typical: 0.036 µs;
	+ For fixed-point arithmetic, typical: 0.048 µs;
	+ For floating-point arithmetic, typical: 0.192 µs;
* Inputs/outputs:
	+ Inputs/outputs modularly expandable;
	+ Periphery address area inputs: 32 kB;
	+ Periphery address area outputs: 32 kB.

The connection of digital inputs and outputs of digital input and output modules shall be implemented completely via auxiliary relays in order to protect the modules from passing through possible overvoltages from the plant.

Measurements that are introduced into analog input modules via miliamper loops and come from longer distances shall be introduced into analog input modules via mA / mA galvanic separations.

Current signals 4-20 mA that are introduced into multiple locations/devices shall be multiplied by galvanically isolated signal multiplicators. Serial connection of multiple devices on one current signal source shall not be allowed.

Operating systems of PLCs shall be proven in practice and from the renowned manufacturers supported real-time operating systems.

**The new text**

* + - 1. **Programmable logic controllers**

General requirements for PLCs shall be in accordance with SRPS EN 61131-1.

All envisaged PLCs shall be from the same manufacturer and shall be foreseen for applications in medium and large performance range.

PLCs shall be in modular design. All PLC modules shall comply with SRPS EN 61131-2. It shall be possible to replace the PLC module in operation, without power off. The limitations in the number of signals by PLC modules are as follows:

* Digital input modules shall not have more than 32 signals per module;
* Digital output modules shall not have more than 16 signals per module;
* Analog input modules shall not have more than 8 isolated signals per module;
* Analog output modules shall not have more than 4 isolated signals per module.

PLC programming shall be possible in any of the programming languages ​​supported by SRPS EN 61131-3.

All PLCs shall be equipped with:

* A memory card for permanent data storage;
* A back-up battery for storing a program for a certain time;
* Real time clock, which shall be synchronized with the time synchronization system;
* A communication port for setting up an IP address and recording firmware;
* Visual signalization of the current status of the module.

The automatic start of the PLC operation shall be ensured after interrupting or re-establishing the power supply.

It shall be enabled to monitor and modify the application software in on-line mode, without losing data.

Self-diagnostic functions of PLCs shall be standard hardware and software solutions from the manufacturer.

The connection of digital inputs and outputs of digital input and output modules shall be implemented completely via auxiliary relays in order to protect the modules from passing through possible overvoltages from the plant.

Measurements that are introduced into analog input modules via miliamper loops and come from longer distances shall be introduced into analog input modules via mA / mA galvanic separations.

Current signals 4-20 mA that are introduced into multiple locations/devices shall be multiplied by galvanically isolated signal multiplicators. Serial connection of multiple devices on one current signal source shall not be allowed.

Operating systems of PLCs shall be proven in practice and from the renowned manufacturers supported real-time operating systems.

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| **Volume 3-Part 3-PARTICULAR EMPLOYERS REQUIREMENTS****Section 3, 7.5.2. pg 16** |

**The former text**

* + 1. **Design Stress**

Standard safety factors shall be applied throughout the design or through checking of the existing equipment, particularly for parts subject to alternating stress, vibration, impact or shock.

Under normal operation, including any kind of manipulation, stresses in the materials shall nowhere exceed 50% of the yield point.

Under the exceptional load conditions corresponding stresses shall not exceed 75% of the yield point.

For hydrostatic pressure tests of the equipment corresponding stresses shall not exceed 75% of the yield point.

All components shall comply with earthquake conditions as indicated in the General Employer’s Requirements.

All required and necessary calculations and checking, with full information and comments on admitted stresses in any part of the equipment, shall be presented to the Engineer for review and approval.

**The new text**

* + 1. **Design Stress**

Design stress will be calculated according to EN 1993 (Eurocode 3) and DIN 19704:2014.