

14.10 OVERHEAD TRAVELLING CRANE

14.10.1 General

The crane shall be complete with bridge girder, cab, main hoist, under-hung hoist, shafting, gearing and complete electrical equipment including motors, control gear, current collecting gear, trolley electrification, hoisting ropes, blocks and hooks, ladders, platforms, guards and handrails, spares, tools and spanners with rack, and other gear and necessities for its proper and efficient operation.

14.10.2 Performance Requirements

The design shall be such that all movements take place smoothly and positively. No slipping or creeping of the loads shall occur at any time.

The crane shall be designed for continuously repeated cycles up to one hour total duration, starting with cold motors and brakes.

Safety factors used in the design shall in no case be less than five (5) unless sated otherwise.

Under normal conditions, momentary operation of the controls shall permit movements not in excess of the following figures:-

Main hoist hook, vertical movement	1 mm
Trolley travel	10 mm
Bridge travel	10 mm

Special care shall be taken to guard against oil or grease dripping from the crane, and where necessary, easily removable catch pans shall be provided.

The crane girders shall be designed so that the vertical deflection caused by the rated load plus all dead loads shall not exceed 1/1000 of the span.

Hook limits from the centre line of rail shall be as follows:

Maximum clearance to main hoist:

front side	2.0 metres
back side	1.5 metres

14.10.3 Capacity

The crane shall be capable of easily handling, during erection and afterwards, the heaviest piece of Plant provided under generator manufacturer.

The lifting capacity of the main hoist shall be 15 metric tons and that of the under-hung hoist, 2 metric tons. The crane shall capable of travelling with its full load suspended in any position.

14.10.4 Longitudinal Crane Rails

On both ends of the rails, rigid stoppers of a height not less than one half of the driving wheel diameter shall be provided.

The Contractor shall furnish the rails and base plates for the rails to distribute the wheel loads on the steel girders within the allowable compressive stress. Necessary anchors for the base plate, and bolts and nuts to fix the rail on the steel plate shall also be furnished and be insulated.

Rails and stoppers shall be erected by the Contractor under supervision of the Architectural Contractor.

14.10.5 Dimensions and Clearances

The span of the crane shall be 10.5 metres, centre to centre of crane rails.

The width between columns above the rail will be 7.5 metres.

The underside of the roof truss will be at EL.107 and the machine floor level will be at EL.87.9. The lower limit of the main hoist and under-hung hoist shall be EL.87.9. The suitable provision shall be made so that all parts of the turbine and generator can be lifted and assembled under the above mentioned conditions. The trolley shall be so designed that in the extreme position of its traverse the hook can hang vertically as close as possible to the crane rail at either end. The actual minimum possible distance of each crane hook from the centreline of rail at each end shall be stated in the tender.

14.10.6 Speed

The various motions of the crane shall have not less than the following speed under full load conditions:-

Bridge longitudinal travel	20 metres per minute
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Trolley cross travel	
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Main hoist	10 metres per minute
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Under-hung hoist	20 metres per minute
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Vertical travel	
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Main hoist	0.9 metres per minute
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Under-hung hoist	6 metres per minute
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14.10.7 Construction

The design shall take into account the lateral stresses due to starting and stopping the crane suddenly when carrying rated load.

The structural members shall be designed so that the calculated stress in the material, based on rated load, shall not exceed 30% of the ultimate strength of the material.

Bridge girders shall be mounted on equalising type trucks with buffers and shall be rigidly attached to the trucks by machine fitted bolts. Heavy gusset plates shall be attached to the bottom of the trucks to keep them square with the main girders. The end trucks shall be designed so that the end reaction from the bridge girders is divided equally between the wheels.

The end of the trucks shall be tied together to prevent spreading in the event that the crane runs into the end of stops. Trucks shall be bored to receive wheel axles.

Safety lugs shall be placed on the trolleys and end trucks to limit the drop in the event of a broken axle, or wheel, unless this emergency is otherwise provided for in the design.

Rail sweeps and buffers shall be provided on both bridge and trolley wheels.

Rails, with buffer of adequate height, shall be provided on the main bridge girders for the trolley travel. Rails shall be secured to the bridge girders in an approved manner and shall have provision to prevent creeping.

14.10.8 Wheels and Axles

Wheel axles shall be of the stationary type, kept from turning in the truck or trolley frame by means of a key fitted in a milled slot in the axle.

Axles shall be made from alloy steel heat treated if necessary, and accurately machined and ground to size to receive the bearing inner races.

Wheels shall be cast, forged or rolled steel, and double flanged of approved contour to suit the longitudinal crane and bridge rails. Wheels are to be accurately ground to exact diameter and are to be mounted on roller bearings.

14.10.9 Bridge and Trolley Driving Machinery

One pair of wheels in each end of the bridge shall be driven by an electric motor driving a cross shaft through a helical, spur, or herring bone gear speed reducer unit mounted near the centre of the bridge. The motor shall be coupled to the reducer by a flexible coupling.

The cross shaft shall be supported on self-aligning bearings along the bridge. Final drive pinions shall be mounted on the shaft section of the shaft and coupled to the main cross shaft for convenience in assembly and replacement of parts.

The motor, speed reducer unit and brake shall be mounted on a common structural steel base, supported from the bridge drive-side girder.

The trolley drives shall be generally as described for the bridge drive except drive to the wheel shafts.

All gearing, other than final drive gears at the wheels shall be enclosed in oil-tight gear cases designed for splash lubrication of the gears and bearings, contained within the case. Adequate inspection openings shall be provided in each case, together with an oil filler plug, drain cock and oil level indicator or dipstick.

14.10.10 Hoist Drums

Hoist drum shall be mounted on the trolley and located so that the hoisted load will at all times be transmitted equally to the crane girders.

Each drum shall be dimensioned so as to receive the required amount of hoisting rope in one layer with at least 1-1/2 turns to spare on each half of the drum with the hook in the maximum raised position. When the hook is in the lowest position at least three full wraps of rope shall remain unwound on each half of the drum.

Hoist drums shall be fabricated or cast with adequate stiffening ribs to prevent deformation and to minimise deflection under all operating conditions. Drum diameters and rope grooves shall be in accordance with the recommendations of the rope manufacturer. All surfaces to come in contact with the rope shall be machined true to approved tolerances to minimise wear and prevent permanent deformation of the rope.

14.10.11 Sheaves

Sheaves shall be of cast steel or cast iron properly dimensioned to suit the recommendations of the rope manufacturer. All surfaces to come in contact with the rope shall be machined true to approved tolerances and surface finish.

All sheaves shall be provided with guard plates to retain slackened rope within the grooves. Ample means for lubricating the bearing shall be provided in easily accessible locations.

14.10.12 Hook Blocks

The main hook shall be of the single standard type. Hooks shall be of forged steel properly annealed after forging and shall be swivelled and designed to turn easily on substantial sealed anti-friction bearings.

14.10.13 Hoisting Ropes

Hoisting ropes shall be of pre-formed, regular lay extra flexible improved plow steel and shall be designed so that the maximum working load including hook block does not exceed one-sixth of the breaking strength of the rope. Hoisting ropes shall be grease impregnated during manufacture.

14.10.14 Lubrication

All bearings requiring grease shall be fitted with grease fittings easily accessible from the crane walkways.

A hand-operated grease gun of ample capacity shall be supplied with all necessary extensions and fittings for greasing the bearings.

The Contractor shall advise the Engineer, in writing, as to the recommended type and make of grease and other lubricating oils to be used. In addition, the Contractor shall recommend a lubricating cycle to guide the Employer's operating staff in their maintenance work. The Contractor shall provide the initial lubrication for all the Plant, including the hoisting ropes.

14.10.15 Brakes

Each hoisting motion of the crane shall be provided with a separate spring-actuated solenoid released brake capable of rapidly decelerating and holding the full test load. The trolley drive shall also have a spring-actuated solenoid released brake capable of rapidly decelerating the trolley to rest from full speed with full load. Each brake shall be so arranged as to become automatically applied when power is cut off and shall also be arranged to release automatically upon application of power to the drive motor.

Each brake shall consist of two brake shoes normally pressed against steel or cast iron drums of ample diameter and width by adjustable helical spring in compression. Each brake shoe shall have an ample thickness of renewable friction lining. Brake drums shall preferably be on the input shaft of the gearbox but where brake drums are on the motor shaft, they shall be so placed that they can be readily removed to change a rotor and so as not to interfere with proper access to the brushes and bearings.

In addition, the main hoists shall be provided with either:-

- a. An electro-hydraulic thruster brake for lowering speed control in slow operation. An over speed safety device shall be incorporated in the hoist controls to interrupt the power supply and operate the spring-actuated solenoid released brake to stop the hoist if overspeed occurs, or
- b. A multiple-disk, self-adjusting mechanical load brake, capable of sustaining the load in the event of power failure or failure of the hoist electro-mechanical brake.

The bridge shall be provided with a friction brake controlled by a foot pedal in the operator's cab, of sufficient capacity to bring the crane quickly to rest from full speed with rated load.

14.10.16 Cab

The operator's cab shall be suspended at the front side. The cab shall be installed facing upstream.

The cab for accommodating the control gear and operator shall be constructed of mild steel sections placed under the end of, and to one side of, the main girders. It shall have ample dimensions be well ventilated with neat half-walls and roof and have liberal open areas to give the operator a clear view of the hoist hooks. It shall also have a comfortable chair. A warning gong, buzzer or bell shall be supplied to indicate to inside movement of the crane.

14.10.17 Electric Motors

The crane shall be supplied from the AC supply panel located in the cubicle room with 380 Volt, 3 phase, 50 Hz current. The longitudinal travel drive, the cross traverse drive, and the main hoist and traverse drives shall be operated by four independent electric motors. Each motor shall be of the totally enclosed, wound rotor, reversing, fan cooled or self cooled type with Class "B" insulation, and suitably impregnated to be non-hygroscopic and unaffected by drift or dust.

Motor lead insulation shall be Class "H". Motors shall be half-hour rated. Motor bearings shall be ball or roller type mounted on the end covers. The traverse and hoist drives for the under-hung hoist shall be operated by two independent electric motors.

14.10.18 Controllers

A separate reversing tramcar type drum controller shall be provided for each motor. Each controller shall be fitted with renewable contact fingers and tips on the drum. Each controller shall be provided with arc shields of incombustible non-hygroscopic material. When in the "OFF" position, the controller shall isolate the motor on all three phases. Each controller shall be provided with a "dead man's button" or spring return to "off" position. Emergency stop buttons convenient to controllers shall be provided. Not less than five steps of speed control shall be provided to allow a gradual speed increase from stand-still to the maximum.

The controllers shall be mounted in the operator's cab and shall be located so as to permit an unobstructed view of the work area below the crane, and to permit convenient operation by the driver when seated.

14.10.19 Switchboards

A steel-enclosed switchboard with doors, suitable for working with six controller shall be provided and mounted in the operator's cab.

The switchboard shall be equipped with circuit breakers, contactors, protective relays, indicating instruments, transformers, fuses and other necessary apparatus.

A main circuit breaker shall be provided to cut off all power to the crane and to lock in the open position. Independent over-current, under-voltage and thermal protection. Independent over-current, under-voltage and thermal protection for each motor shall be provided.

All controls, switches and components shall be adequately labelled and numbered for easy maintenance. A lighting and convenience outlet panel shall be included on the switchboard.

14.10.20 Safety Limit Switches

Automatic reset, totally enclosed, heavy duty, adjustable limit switches shall be provided to limit the travel of the trolley and the bridge. The switches shall disconnect power supply to the motor when either the bridge or the trolley has travelled to within braking distance of its respective stops at either end of the travel. A warning signal, preferably a buzzer installed in the cab, shall alert the crane operator when the trolley approaches its stops. The signal shall be activated before operation of the trolley's limit switch.

A gear driven limit switch, driven from the hoisting drum, shall be provided for each hoist and adjusted to prevent the rope from being completely unwound from the drum, and to prevent over-travel of the hook in the lifting direction.

In addition, a block-actuated limit switch shall be provided for each hoist to prevent over-travel in the lifting direction and damage to the crane, should the gear driven limit switch fail or get out of adjustment.

14.10.21 Runway Conductors and Trolley Conductors

The Contractor shall furnish and install the main runway conductors, including insulators, support brackets, in-feeds, and all other necessary equipment. The Contractor shall also furnish and install the trolley conductors, insulators and accessories required for the complete operating system. The insulators shall be brown glazed porcelain.

The power supply shall be fed to the main runway conductors at one end of the runway girder. The Contractor shall supply on the main runway conductors, connectors of the compression type of suitable size to accept the Contractor's stranded copper feeder cables.

The main runway conductor will be of the rigid type of which copper is enclosed with an insulating sheath. Trolley conductor is a cable with an insulating materials (cable curtain type).

The trolley and main runway conductors shall be of such a size that the crane can be at either end of the runway with the hoists operating continuously at 125% rated load, and with the conductor temperature rise not exceeding 30°C, based on an ambient temperature of 40. Both the main runway and trolley conductors shall be supported by insulators at not greater than 1.5 m intervals.

The crane conductors shall be mounted along the runway. The conductors shall be suitable for operating satisfactorily at the specified speed of bridge travel. They shall be furnished for the total runway length specified or as required.

An additional conductor shall be provided for grounding the trolley to the bridge frame. The conductor shall be well protected to prevent injury to personnel and to guard against mechanical damage.

14.10.22 Collectors

The Contractor shall furnish complete with all necessary accessories, all current collecting equipment for contact with the main runway and trolley conductors.

Collectors shall be of an easily replaceable slide-shoe type, with all non-current carrying exposed metal parts grounded. Design shall be such as to assure continuous contact and prevent overheating.

Reliable operation shall be assured even under conditions of considerable misalignment, both horizontally and vertically. Under no-load conditions, it shall be possible to inspect the collectors by pulling them from the conductor.

14.10.23 Wiring and Conduits

The Contractor shall furnish and install all wiring, cables and conduits on the crane. All wiring shall be installed in rigid galvanised steel conduit, or, where flexibility is required due to vibration, in flexible conduit. All wiring and cable

shall be installed for 600 volts and the minimum size of copper conductor shall be 3.5 square millimetres.

All conduit and cable shall be permanently installed and tagged on the cranes in the manufacturer's shop so that only final connections are required at the site.

The conduits shall form a continuous system and shall be properly supported within the structural framing of the crane. The entire conduit system shall be grounded. The conduit runs shall be installed in such a way as to eliminate accumulation of moisture.

Separate conduit systems shall be provided for the main power supply, control and lighting.

14.10.24 Lighting and Control Transformer

The Contractor shall furnish and install a suitable dry-type transformer rated 380/220 volts, 50 Hz, to supply a 3-phase, 4-wire distribution panel for lighting, receptacles, and control circuits. The distribution panel shall be complete with a moulded case circuit breaker on the incoming supply, and single and three phase branch circuit breakers. All breakers shall be equipped with thermal overload and magnetic trip devices.

14.10.25 Lighting

The Contractor shall furnish and install a suitable lighting fixtures and control switches in the operator's cab, and also inside the crane girders, where control devices and other apparatus are located inside the girders. Flood-light fixtures shall be supplied and installed on the crane to provide an even intensity of illumination under the crane of not less than 200 Lux at a distance of 12 metres below the crane. The lighting and control transformer referred to in Paragraph 14.10.22 will provide the 220 volt supply for the lighting system.

All fixtures, fittings, conduit, switches, wiring and all lighting accessories for the complete installation shall be furnished and installed in the manufacturer's shop and after inspection shall be dismantled as necessary for shipment.

Contractor shall supply and install 220 volt, 20 amp. 2-pole duplex outlets. Outlets shall be of 2-pole, 3-wire, ground and straight blade type. The third grounding pole shall be connected to the metal mounting yoke.

The outlets shall be installed in the following locations:

- a. One (1) outlet in the cab.
- b. Two (2) outlets in the upper part of the crane structure, one (1) on each side.
- c. Two (2) outlets in the lower part of the crane structure, one (1) on each side.
- d. Two (2) outlets inside the crane girders, one (1) on each side, when the control devices and other apparatus are located inside the crane girders.

14.10.26 Accessories

The following shall be provided for the cranes :

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|--|---------|
| a. Name plate | 1 piece |
| The name plate showing the manufacturer's name, rated capacity of crane and other details. | |
| b. Trolley wire, insulators and brackets | 1 lot |
| c. Lubricating oil, grease, machine oil with 50 percent spare | 1 lot |
| d. Wrench and tools for maintenance | 1 lot |
| e. Other necessary accessories | 1 lot |
| f. Hand operated grease gun | 1 lot |

14.10.27 Spare Parts

The following spare parts shall be provided for the crane :-

- | | |
|---|-------------------------------|
| a. Insulators for travelling trolley wires for one line | |
| b. Bearings | 100 % of original requirement |
| c. Brake lining | 100 % of original requirement |
| d. Grease nipples | 2 pcs of each type or size |
| e. Carbon brushes and holders | 100% of original requirement |
| f. Switches, contactors, relays etc. | 100 % of original requirement |
| g. Other necessary spare parts including coils, thermal relays, resistors, capacitor and small part | 100 % of original requirement |
| h. Fingertips and segments for controller | 100 % of original requirement |
| i. Carbon brushes for motors, fuses and lamps | 500 % of original requirement |

14.10.28 Tests

The crane shall be completely assembled at the Contractor's workshop. The following tests shall be carried out and the results shall be certified before shipment:

- a. Structure deflection test.
- b. Full load test (including brake system tests)
- c. Overloading test (125 percent of the rated load)
- d. Operation tests

After complete assembly at the site, the crane shall pass an operation test including brake system test, etc. These tests shall demonstrate that all guarantees have been met and that the entire crane plant meets the

contract requirements and that it is properly installed adjusted to operate correctly and safely.

14.11 TRANSMISSION LINE

14.11.1 General

The 20kV transmission line shall be installed for the aggregate distance of 14 km to transmit electric power from the Jatibarang power station to the Krapyak sub station.

The supports of the transmission line shall consist of 2 steel towers and reinforced or pre-stressed concrete poles.

Overhead line conductors shall be of all aluminium alloy (AAAC) 120 mm².

The telecommunication lines shall consist of telephone cables "CCP-AP-SS-0.65 mm²-10P" mounted on the same supports of 20 kV transmission line and also on the same routes.

14.11.2 Standards

The construction of materials supplied under the Specification shall conform to the latest editions of the recommendation of International Electro Technical Commission (IEC) and/or other any recognised international standards equivalent or higher in quality. If the Specification conflict with any or all of the standards below, the Specification shall have a precedence.

- a. Recommendation of International Electro Technical Commission (IEC)
- b. PLN Standard
- c. Other Standards

14.11.3 Field Operation Program

Within sixty (60) days after the issuance of the Letter of Acceptance the Contractor shall submit to the Engineer for his approval a field operation program, in accordance with the time schedule of the Works included in the Contract Documents, showing in detail the order of procedure and the method by which he proposes to perform the Works, and shall submit particulars in writing of his arrangements for performing the Works and of materials and labour and temporary facilities he intends to furnish, use or construct, as the case may be.

The submission to and approval by the Engineer of such program shall not release the Contractor of any of his obligations or responsibilities under the Contract.

14.11.4 Drawings for Construction and Materials

The Contractor shall make the construction design for the Works. The Contractor shall submit construction drawings of the detailed constructional and dimensioned components to the Engineer for approval. The Contractor shall be ordered to manufacture in conformity to the approved drawings by the Engineer.

14.11.5 Technical Requirements for Fabrication

- a. Workmanship : All material, equipment and parts shall be new, unused, of highest class and most suitable, and shall be finished uniformly in quality and smoothly on the surface to be in conformity to best commercial practice.
- b. Colour standard and painting : Each item of the material shall be painted in accordance with the Specification. All exposed metal surfaces except the terminals, plated surfaces, and non-corrosive metals shall be given primary coating of rust and acid resisting paints before transportation to the site. The touch up finish coating of paints shall be given to the material by the Contractor after installation. The contractor shall include in the Contract the supply of paints necessary for finishing coating on the material in line with the Specification.

14.11.6 Inspection and Testing

- a. The Contractor shall submit to the Engineer for approval the proposals for the method and details of the inspection and testing.
- b. As and when any materials and facilities shall have passed the tests and inspection, the Contractor shall furnish to the Engineer eight (8) copies of the duly certified test reports with test readings.
- c. All deficiencies revealed by testing and inspection shall be rectified by the Contractor at his own expense and to the approval of the Engineer. Rectified components shall be subject to re-testing and re-inspection.

14.11.7 Packing

All the delivery packages shall be clearly marked in accordance with the instructions of the Engineer in addition to the stipulations provided here in.

The contractor shall mark contents, quantity, net and gross weight, name of the Contractor, Contract No., etc., on the outside of each package.

On drums, coil, carton boxes and wooden cases, the following items shall be also marked without omission :

- a. Drums and coils
- b. Carton boxes and wooden cases

These markings shall be protected from fading away in transit or in operation.

14.11.8 Storage of Materials

Materials shall be stored so as to ensure preservation of their specified quality and fitness for the Works. They shall be placed on a hard, clean surface and, when required, they shall be placed under cover.

Stored materials shall be located so as to facilitate prompt inspection. Private property shall not be used for storage purposes without written permission of the owner or lessee and payment to him, if necessary.

14.11.9 Royalties

The Contractor shall be responsible for all compensation and royalties due in respect of quarried materials. No separate payment will be made for the compensation of royalties, but all such costs shall be inclined in the Bid Prices for pay for pay items under the Contract.

14.11.10 Working Area

The Contractor shall make all arrangements, inclusive of payment, if necessary, for the use of any land required for working areas outside the right-of-way, and the Employer will not accept any liability in connection with the use of such land.

14.11.11 Living Quarters, Sheds, Stores and Workshops

The Contractor, shall furnish and maintain for the Contract period all living accommodation, sheds and stores necessary for the prosecution of the Works, and shall make his own arrangements subject to the approval of the Engineer, with the owner of any land required and, if necessary, pay for its use.

14.11.12 Notice of Operations

- a. The Contractor, when required by the Engineer, shall supply in writing full information regarding the localities in which the materials are being obtained and in which the work is being prepared.
- b. No permanent work shall be undertaken without the Engineer's approval. Full and complete notice in writing shall be given to the Engineer sufficiently in advance of the time of the operation for him to be able to make such arrangements as he may deem necessary for its inspection.

14.11.13 Filling in Holes and Trenches

The Contractor, upon completion of any part of the work, shall immediately, at his own expense, fill up all holes and trenches, or carry out the work to them as required by the Engineer, that he may have dug or excavated and are no longer required for the project, and he shall clear away all rubbish and material that is no longer required for the protection of the Works.

14.11.14 Contractor's Responsibility for Work

Where the approval of the Engineer is required under the Specification, such approval shall not relieve the Contractor of his duties or responsibilities under the Contract.

14.11.15 Standard of Workmanship

All workmanship shall be the best of its particular kind, and shall be carried out to the satisfaction of the Engineer.

14.11.16 Safety Measures

The Contractor shall furnish and maintain, at his own cost and expense and to the satisfaction of the Engineer, all requisite watchmen, lights, barricades, safeguards, fences, footpath ladders and other facilities for the protection of the Works and the safety of the general public and of employees of the Employer and of the Contractor. Precaution shall be exercised at all times for the protection of persons and property. The safety provision of applicable laws and codes shall be observed. Machinery and equipment and other hazards shall be properly guarded.

14.11.17 Protection of Works from Weather

The Contractor shall, at his own expense, carefully protect all work and materials from injury by the weather.

14.11.18 Environmental Preservation

- a. The Contractor shall take care to preserve the environment surrounding of the Site during the execution of the Works.
- b. When indicated by the Employer/Engineer, the Contractor shall consider the countermeasures for environment preservation at places is required.
All costs necessary for these measures shall be included in the Contract Price but shall not be paid directly.
- c. In case the environment around the Site shall be destroyed causing by omission of the Contractor during construction, the Contractor shall compensate for the damage and shall execute the restoration work at his own cost.

14.11.19 Units of Measure

All units of measure used in the Specification and in the Bill of Quantities and Schedule of Rates and Prices are according to the standard metric measurement system.

14.11.20 Time Account Work

If, in the opinion of the Engineer, it is necessary or desirable to execute any additional or substituted work or furnish any additional or substituted materials, such work or supply shall be regarded as being on a Daywork basis after written order of the Engineer. The Contractor shall therefore be paid for such work and supply according to the Schedule of Rates and Prices.

The measurements shall be taken jointly and recorded and agreed at the time such work is executed or such material furnished. The Contractor's measurements will not otherwise be recognised by the Engineer.

The Engineer shall always have full access to the Contractor's time records, and may check daily with the Contractor's timekeeper, or otherwise, the time taken in executing any Daywork, but the fact of his agreeing upon any time shall in no way bind the Engineer to value the work other than by measurement.

14.11.21 Orders to Foremen

Whenever the Contractor's authorised representative is not present on any part of the Works where the Engineer may decide to give orders or directions, such orders or directions shall be received and obeyed by the Foreman or other person who is in charge of the particular work concerned.

14.11.22 Drawings

The Drawings of this Work are issued and made as part of the Specification and Contract Documents. It shall be anticipated that revisions of alignment, location and section may be made during the Works.

The Contractor shall perform the Works in accordance with the intent of the Drawings and Specification, and shall take no advantage of any error or omission in the Drawings or discrepancy between the Drawings and Specification. The Engineer will make such corrections and interpretations deemed necessary for the fulfilment of the Specification and Drawings. Where dimensions on Drawings are given or can be computed, scaled measurements shall not be used except when approved by the Engineer. Any deviation from the Drawings due to field conditions shall not be anticipated before it will be determined by the Engineer and authorised in writing.

14.11.23 Progress Reports

The Contractor shall submit to the Engineer monthly progress reports written in English indicating the actual state of progress of all construction expressed in perfect of the Contract Sum during the course of the Contract.

Ten (10) copies of such progress reports shall be submitted by the Contractor to the Employer through the Engineer on or before the tenth day of each calendar month.

14.11.24 Electrical Conductors and Fittings

The electrical conductors and fittings shall be supplied under this clause :-

- a. Stranded conductor
- b. Fitting of conductors
- c. Galvanised steel wire (GSW)
- d. GSW clamp and fittings
 - (i) Stranded conductor

The stranded conductors for main circuit of 20 kV transmission line are shown below.

- Type	AAAC (All Aluminium Alloy Conductor)
- Size	120 mm ²
- Construction	19/2.5 mm
- Standard	DIN 48201 Teil 6

- Diameter 14.0 mm
- cross-sectional area Al:116.99 mm²
- C. resistance at 20 0.286/km
- Min. breaking load 3,332 kg (32.68kN)
- Nominal weight 322 kg/km

(ii) Galvanised steel wire (GSW)

Galvanised steel wires of 55 mm² (7/3.2 mm) shall be used for overhead ground wire. Ultimate strength of wires shall be more than 90 kg/mm².

(iii) GSW clamp and fittings

- Suitable clamps for galvanised steel wire shall be supplied.
- Ground wire tension clamps shall be made of malleable cast iron for 55 mm² GSW, and attached to the top plate of steel structure by mean U-clevises.
- Jumper clamps for fastening the jumper wire shall be made of malleable cast iron for 55 mm² GSW.
- Suspension, tension clamps and dampers for ground wire shall be supplied for 20 kV interconnecting lines.

(iv) Fittings of conductor

- Clamps, terminals for conductors shall be compression type and suitable for the various size conductors. The PG clamps for connection of feeder circuit with 20 kV transmission line shall be free from electrolytic connection.
- Compression tools shall be provided with die sets.
Electrical conductivity of each joint shall not be less than the equivalent value to the conductors.
The compression on tension type joints for conductors shall be kept over 95 percents of the connector strength.
- Compression type clamps and sleeves shall slip strength of not less than 80% of ultimate strength of the conductor.
- Suspension, tension clamps and dampers shall be supplied for 20 kV interconnecting lines.

(v) Tests and inspections

The following tests shall be carried out at manufacturer's workshop :

- Tensile test
- Elongation test
- Resistance test

- Characteristics
- Constructions

14.11.25 Insulators and Fittings

The insulator set shall be provided with all necessary fitting as required.

a. Suspension insulators

The insulator unit for suspension and tension required herein shall conform to the requirement of IEC 305 "Characteristics of string insulator unit of the cap and pin type" and shall have the following characteristics.

The connections between units shall be such as to allow sufficient flexibility for freedom of movement and to prevent the possibility of becoming separated accidentally either during or after the erection.

The interlocking sockets shall be designed to allow easy passage of the ball into the socket and retaining pins or locking devices are required to keep in the socket under all service conditions.

The insulator surface shall be free of bulges hairline cracks and other defects.

Type of coupling	16 mm A Ball and socket
Colour of glaze	Chocolate brown
Materials	Porcelain insulator
Dimension	254 mm x 146 mm
Creepage distance	280 mm
Combined mechanical and electrical strength	12,000 kg

b. Construction

Both of tension insulator strings and suspension insulator strings shall be three (3) insulator units in one string for 20 kV lines without any arcing horn.

c. Supporting insulators

(i) Post support insulators

The support insulators required herein shall conform to the requirement of IEC 273 "Solid Core Station Post Insulators" and shall have the following characteristics.

- Nominal voltage	20 kV
- Colour of glaze	Chocolate brown
- Diameter	<u> * </u> mm * to be advised by the Engineer
- Height	<u> * </u> mm
- Creepage distance	<u> * </u> mm
- Minimum failing load	<u> * </u> kg

- tension * kg
- Bending * kg

(ii) Jumper support insulators

The support insulators are used for holding the jumper wire and shall be of solid core long rod type.

The characteristics of the support insulator shall be as follows :

- Type Under-hanging
- Nominal voltage 20 kV
- Colour of glaze Chocolate brown
- Diameter of shed * mm
- Height * mm
- Leakage distance * mm
- Cantilever strength * kg
- tension * kg
- Bending * kg

(iii) Construction

The support insulators shall be suitable for outdoor use and fitted up with necessary clamp on the top of the insulator and provided with necessary mounting bolts, nuts and washers.

d. Fittings

- (i) All fittings shall be of malleable iron hot deep galvanised and approved by the Engineer.
- (ii) Tensions clamps shall be as light as possible and of approved types. All clamps shall be designed to avoid any possibility of deforming the stranded conductors and separating the individual strands. Tension clamps shall be bolted type, and shall not permit slipping off or damage to conductors or any part thereof.
- (iii) Clamps of insulators shall be as light as possible to avoid any possible deforming and separating of individual strand of conductors.
- (iv) Clamps shall not exhibit excessive heating by magnetising or other reasons.
- (v) U clevises, ball hooks, socket eyes and other necessary fittings required for the above insulators and clamps shall be provided.
- (vi) Fittings and metallic portions of insulator sets shall be coated lightly with approved grease when mounting on the poles.

14.11.26 Steel Towers

The support for the 20 kV transmission line shall use steel towers and local concrete poles.

a. General

The steel towers shall be of self supporting zinc coated steel towers of square based lattice type on concrete foundations, formed of equal-leg angle members for the 20 kV single-conductor 1-circuit line as shown on the drawing.

The steel towers shall be designed in accordance with the following requirements.:

(i) Vertical loading :

The dead weight of all conductors, ground wires, communication cables, 20kV power cables, insulator strings and apparatus attached to the steel towers and the steel tower themselves shall be considered.

(ii) Wind pressure :

– Wind velocity	25 m/sec
– Wind pressure	
• Steel tower	110 kg/m ²
• Conductor, Ground wire	40 kg/m ²
• Communication cable, Power cable	40 kg/m ²
• Insulator strings, Supporting insulator kg/string	20

(iii) Working tensions :

• Conductors	1,000 kg
• Communication cable	800 kg
• Ground wire	1,000 kg

(iv) Seismic force of horizontal component : 0.2 G

(v) Factor of safety :

– Number of broken wires or number of phase plus ground wire, assumed as abnormal condition.	2
– Safety factor to yield point :	
• Normal condition	1.5
• Abnormal condition	1.1

(vi) Ratio of slenderness :

– Leg members and main arm members	200
------------------------------------	-----

- All other compression members 220
- Secondary members for reinforcement of compression members 250

(vii) Minimum member size and minimum bolt size :

- Member size Minimum
- Leg members and main arm members L605
- All other members L 45 4
- Bolt M 16

Flat bars and rods shall not be used as tower members.

- Angle members (thickness is 16 mm or less):

	ss 41	ss 55
• Size to be used less than L70x5	less than L70x5	less than
• Yield point	25 kg/m ²	41 kg/m ²
• Tensile strength	41 kg/m ²	55 kg/m ²

- Bolts :

	ss 41	ss 55
• Size	M16	M20, M22

(viii) Clearance :

The Insulation clearance Of 20 kV transmission line is shown on the attached drawing.

(ix) Foundation stubs of towers

Leg extensions and stub extensions shall be used so as to meet local conditions in mountainous area.

The Contractor shall submit stress diagrams, calculations and drawings for the steel towers to the Engineer for his approval prior to commencing fabrication.

b. Foundations for Steel Tower

- (i) The concrete foundations for the steel towers shall be made by the Contractor.
- (ii) The location of each foundation will be selected by the Engineer. Survey data and maps required for such selection shall be furnished by the Contractor.
- (iii) All anchor bolts, base plates and angles shall be shipped to the site ahead of the other structural members, and shall be installed in the foundation by the Contractor.
- (iv) The design of the foundation will be the responsibility of the Employer. However, to facilitate the design, the Contractor shall

furnish the Contracting Officer with the anchor bolt plan and the magnitude and direction of the forces to be resisted by the foundation.

- (v) Anchor bolts should be designed to provide resistance to all conditions of tension and shear at the bases of the columns, including the net tensile components of any bending moments which may result from fixation or partial fixation of columns.

c. Materials for Steel Towers

All steel employed for the steel towers shall have high yield point and high ultimate tensile strength and shall be subject to the approval of the Engineer.

d. Workmanship for Steel Towers

- (i) The cutting, drilling, punching and bending of all fabricated steel work shall be in accordance with the best practice for the materials being used and subject to the approval of the Engineer.
- (ii) All members shall be hot dip galvanised after fabrication. Bolts and nuts shall also be galvanised.
- (iii) All members shall be stamped or marked in an approved manner with numbers and/or letters corresponding to number and/or letters on drawings or material list approved by the Engineer. The election marks if stamped, shall be stamped before galvanising and shall be clearly visible after galvanising.

e. Tests for Steel Towers

The following tests shall be carried out before shipping.

- (i) Mechanical strength of materials
- (ii) Galvanised test
- (iii) Shop assembly

14.11.27 Concrete Poles

- a. The support for the 20 kV transmission line shall use local concrete poles of round section with steel cross arms for conductors, a ground wire, insulator sets, mounting bases for lightning arresters and disconnecting switch, cable supporter, groundwire fittings and all necessary accessories. The design of the support shall be subject to the Engineer's approval.

The design conditions for the support shall take into consideration the following conditions:

- (i) Vertical loads
 - Weight of supports, conductors, groundwires, insulator, lightning arresters, disconnecting switch, power cable, etc.
 - Vertical loads caused by installation of the guy wires, if any
 - Weight of workers

(ii) Wind loads

- b. The concrete pole of 13m-19cm able to mount two circuits of 20kV overhead transmission lines, shall be embedded in ground of minimum depth equivalent to 1/6 of the height of the pole under normal condition.
- c. Binding for top tie and side tie of line post insulator shall be of a preformed type.
- d. A pole anchor shall be installed for each concrete pole in general, but poles fitted with guy wires shall be provided with two pole anchors.
- e. The guy anchors shall be buried 2.0 m in depth and in opposite direction to the resultant load of overhead lines.
- f. The guy wires shall be provided with strain insulators which keep at least 500 mm clearance above telecommunication cables, even if they hang down straight and vertically from the mounting point on the poles.
- g. Clearance of ground to conductors shall be kept as 6 metre minimum.
- h. Metallic components of mounting poles shall be grounded.

14.11.28 Telecommunication Lines

- a. The telecommunication cable shall be twisted one time per 10 m length for overhead cable lines.
- b. For dead ends and connections of SS type steel wires, performed stranding grips shall be used.
- c. For SS type steel wires at supporting poles consisting of an internal angle less than 170 degrees, same method for dead end shall be applied.
- d. For SS type steel wires at supporting poles consisting of an internal angle between 170 degrees and 180 degrees, clamp shall be used.
- e. Telecommunication cables shall be provided with slacking at supporting poles and both sides of junction boxes.
- f. SS type steel wires and shielding tapes of cables shall be grounded completely.
- g. The Contractor shall submit cabling schedules to the Engineer for approval before the carrying out of cabling sufficiently in advance.
The Contractor may order the telecommunication cables to the manufactures after the approval of the Engineer.
- h. All cable ends shall be treated with plugs and tapes in accordance with the approved manner.
- i. Ends of each SS wire shall be bonded using earth clamps and 25 mm², 600 V insulated electric wire or equivalent.
- j. SS wire shall be grounded through 50 mm², 600 V insulated electric wire at head poles, and intermediate poles at intervals not more than 300 m.

14.11.29 Materials of 20kV Transmission Line

- a. All Aluminium Alloy Conductors (AAAC)

120(mm ²)
Maximum conductor resistance at 20 (ohm/km)
Minimum breaking length (kg)
- b. Galvanised Steel Stranded Wires to be used for guy wires

Strand (mm)	7/3.2 (number/mm)	Overall diameter	9.6
Nominal size (kg/km)	55 (mm ²)	Standard weight	446
Weight of zinc coating (kg)	23 (mg/mm ²)	Tensile strength	4,660
- c. Preformed Binding Grip for AAAC 120 mm²
- d. Preformed Binding Grips for galvanised steel stranded wires
- e. Compression Type Full Tension Sleeves and Line Tap Connectors
- f. Concrete Poles

Total length	13 (m)
Working load	500 (daN)
Minimum transverse load	175 (daN)
- g. Concrete Anchor for concrete poles and guy wire rods
- h. Line post insulators for 20 kV transmission lines

Creeping distance	500 mm
Wet AC withstand voltage for 1 minute	65 (kV)
Lightning impulse withstand voltage	100 (kV)
Mechanical strength	10.7 (kN)
- i. Suspension insulators for 20 kV transmission lines

Diameter	254 (mm)
Height	146 (mm)
Leakage length	292 (mm)
Flashover voltage low freq. Dry	80 (kV)
Flashover voltage low freq. Wet	50 (kV)
Flashover voltage Impulse	125 (kV)
Mechanical-electrical strength	7,000(kg)
- j. Dead-end Clamp
- k. Clevises
- l. 600V Polyvinylchloride Insulated Electric Wires
 - (i) IV 50 mm² (for grounding conductor)

(ii) IV 25 mm² (for lead wire)

m. Ground Rod for grounding

Nominal diameter of rod	25.0 ± 0.5 (mm)
Copper thickness	0.5 (mm)
Length of rod	2,500 +10.0 (mm)
Size of lead wire	50 (mm ²)
Length of lead wire	1,000 +20.0 (mm)

n. Galvanised Steel Crossarms on pole

o. Thimble for Guy Wire

p. Bolts and Nuts for fittings

(i) Square head bolts and nuts

(ii) Hexagon head bolts and nuts

(iii) Step bolts for concrete pole

q. Pole Anchor Bands

r. Pole Mounting Steel Bands

(i) Arm band

(ii) Arm tie band

(iii) Guy wire band

(iv) SS Wire clamping band

s. Cross arm Fittings, SS Wire Clamps and Parallel Links

t. Strain Large Ball Insulators for guy wires

u. Guy wire Rod

v. Washers

(i) Square washers

(ii) Round washers

(iii) Spring washers

w. Vinyl Tubes and Vinyl Tube Bands for telecommunication line

x. Parallel Ground Wire Connectors and Terminal Connectors

y. Telecommunication Cable

(i) Symbol : CCP-AP-SS-0.65mm-10P

(ii) CCP ; Type of cable

(iii) AP ; Shielded of aluminium tape

(iv) SS ; Self suspension type

- (v) 0.65mm ; Diameter of conductor
- (vi) 10P ; 10pairs of conductor
- z. Joint Terminal Boxes for telecommunication lines
- aa. Hand-Operated Compression Tool

14.12 PAYMENT

14.12.1 General

Payment for the Generating Plant will be made at the applicable lump sum prices or rates tendered therefor in the Bill of Quantities (Items in Bill N) which prices shall include the cost of all labour, materials equipment and incidentals for designing, manufacturing, supplying, testing, finishing, painting, packing, insuring, shipping, receiving and custom's clearance, storing, inland transportation, installing, erecting, providing temporary power for testing if necessary, site testing and commissioning of the Generating Plant; for preparing and submitting schedule, drawings, instructions, manuals, reports and photographs, for instructing Employer's personnel and for any other necessary works connected therewith.

14.12.2 Payment for Lump Sum Items

For the purpose of this Sub-Clause a lump sum item shall include those items in the Bill of Quantities which have a quantity of one (1) and have units Set or Lot. (i.e. Items N.1.1, N.1.2, N.1.3, N.1.4, N.1.5, N.1.6, N.1.7, N.1.8, N.1.9, N.1.10, N.1.11, N.2.1, N.2.2, N.2.3, N.2.4, N.3, N.4.1, N.4.2, N.4.3, N.5.1, N.5.2, N.5.3, N.5.4, N.6, N.7.1, N.7.2, N.7.3, N.8.1, N.8.2, N.9, N.10, N.11.3).

For each lump sum item in the Bill of Quantities, the Employer shall pay 65 percent of foreign and local currency portions on completion of manufacture and fabrication and delivery to store at the Site of each item provided that all parts of the lump sum item are delivered and inspected by the Engineer and all inspection certificates have been received and approved by the Engineer.

For each lump sum item in the Bill of Quantities, the Employer shall pay 25 percent of the foreign and local currency portions on completion of installation, erection, testing and all other works associated therewith except final operational commissioning of each item to the approval of the Engineer.

For each lump sum item in the Bill of Quantities, the Employer shall pay the remaining 10 per cent of the foreign and local currency portions on satisfactory completion of each item including operational commissioning, supply of O & M manuals and undertaking all training for that item.

The payments to be made in accordance with this Sub-Clause shall be subject to deductions in accordance with Clause 60 of the Conditions of Contract.

14.12.3 Payment for Unit Rate Items

Payment for unit rate items (i.e. Items N.11.1, 11.2, 11.4, 11.5) shall be made in accordance with the rates tendered therefor in the Bill of Quantities.

The payments to be made in accordance with this Sub-Clause shall be subject to deductions in accordance with Clause 60 of the Conditions of Contract.

1. The first of the two main branches of the
2. The second of the two main branches of the
3. The third of the two main branches of the



**CONSTRUCTION OF THE JATIBARANG MULTIPURPOSE DAM
PACKAGE 1: JATIBARANG MULTIPURPOSE DAM INCLUDING
APPURTENANT STRUCTURES**

SPECIFICATION

SECTION 15. RELOCATION OF POWER TRANSMISSION LINE

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SECTION 15. RELOCATION OF POWER TRANSMISSION LINE

15.1 General

A portion of an existing overhead 150 kV electrical transmission line consisting of towers, overhead cables and a buried fibre optic cable is located partly in the reservoir area of the Works and is required to be relocated.

The Contractor is required to design, construct, test and commission a relocation of the power transmission line and the buried fibre optic cable in accordance with the general details shown on Drawings, this specification, the directions of the Engineer all in complete accordance with the requirements of Perusahaan Listrik Negara (PLN), the State Electricity Company of Indonesia, who shall oversee and be involved in all phases of the work.

The Employer will arrange for the acquisition of land for the relocation of the power transmission line in a timely manner. Work areas shall be deemed to be part of the Site as defined in the General Conditions of Contract.

15.2 Scope of Work

The work includes, but is not limited to the following:

- Demolition and salvaging of 8 existing steel towers;
- Demolition of foundation of those towers which will not be inundated by the reservoir;
- 10 new towers;
- Overhead cables having a length of approx. 48,000 m;
- Fibre optic cable of length approx. 3,400 m;
- All accessories and ancillary components necessary to make the relocation complete in all respects.

15.3 Technical Requirements

General requirements as specified in Section 1 shall apply to the work.

Temporary access roads shall be constructed in accordance with Sub-Clause 1.9.5.

Clearing and grubbing shall be in accordance with Clause 3.2.

Soil conservation measures shall be in accordance with Clause 7.10.

Concrete shall be in accordance with Section 9. The grade of concrete shall be specified by PLN.

Steel towers, overhead cables, fibre optic cables, their specification, installation, testing and commissioning shall be in accordance with PLN requirements which, in the event of conflict with this specification, shall take precedence.

All demolition works shall be performed in a manner which will optimise the amount of salvaged material for those items which PLN require to be salvaged. Items to be salvaged shall include, but not be limited to, steel transmission tower and electric cable. Salvaged material shall be transported to and stacked in locations designated by PLN.

15.4 Measurement and Payment

Payment for the relocation of the power transmission line shall be at the lump sum price tendered therefor in the Bill of Quantities (Item O.1) which shall include the cost of all materials, labour and equipment to complete the work and shall specifically include the cost of access roads, clearing and grubbing, fees and charges by PLN for their input in the design, construction, testing and commissioning of the work, reinstatement of the site of the works, demolition and salvaging all in accordance with the Drawings, the Specification, the directions of the Engineer and PLN requirements.

CONSTRUCTION OF THE JATIBARANG MULTIPURPOSE DAM
PACKAGE 1: JATIBARANG MULTIPURPOSE DAM INCLUDING
APPURTENANT STRUCTURES

SPECIFICATION

SECTION 16. MISCELLANEOUS WORK

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SECTION 16. MISCELLANEOUS WORK

16.1 GENERAL

This section of the Specification covers the requirements for miscellaneous works not specified elsewhere.

16.2 ELASTOMERIC BEARINGS AND RUBBER SHEET

16.2.1 General

The Contractor shall supply and install elastomeric bearing pads and rubber sheet in accordance with the requirements of this Clause and as shown on the Drawings or directed or approved by the Engineer.

The Contractor shall exercise the utmost care in setting out and fixing all bearings in their correct positions, and in ensuring that uniformity is obtained in all bearing surfaces. Bearings shall be handled with care and stored under cover by the Contractor.

Expansion bearings are designed and dimensioned for installation at a nominated temperature. Where the temperature is likely to vary by more than ± 5 degrees Celsius from the nominated temperature, the Contractor shall request the Engineer to give a direction regarding any allowance which shall be made in setting the bearings.

16.2.2 Materials

16.2.2.1 General

All elastomeric bearings shall comply with the requirements of AASHTO M 251 'Laminated Elastomeric Bridge Bearings' except where modified by this Specification.

Bearings shall be made from natural rubber and other materials so compounded and cured as to give the properties specified. However, consideration will be given to the use of elastomeric materials other than natural rubber, subject to approval of the Engineer to any variations proposed to the properties specified. Layers of elastomeric material shall be bonded to the steel plates during the vulcanisation in a mould under pressure. Bearings shall comply with the dimensional and shear and compressive stiffness requirements specified in Tables 16.2.a, 16.2.b, 16.2.c.

Rubber sheet shall consist of elastomer as defined in Sub-Clause 16.2.2.2

16.2.2.2 Elastomer

The elastomer to be used in the manufacture of the bearings shall be tested as set out in Table 16.2.a. These tests shall be done at an approved laboratory and two days notice shall be given so that preparation and/or testing of the specimens may be observed by the Engineer, if so required. Three samples shall be taken from every 250 kg batch of mixed elastomeric material and each sample shall meet the requirements specified.

Materials which does not comply with the requirements stated in Table 16.2.a shall not be used in the manufacture of the bearings.

All testing shall be at the Contractor's expense.

16.2.2.3 Bearings

a. Tolerances on dimension

Bearings shall be manufactured to the dimensions as shown on the Drawings within the tolerances given in Table 16.2.b. Bearings which do not comply with the requirements specified may be rejected.

b. Testing

(i) General

All bearing shall be tested at the Contractor's expense. Tests shall be done at an approved laboratory and in the presence of the Engineer or his Representative who shall be given 2 days notice of the tests. The equipment used for testing shall be capable of determining compressive and shear loads to within $\pm 3\%$ and deflections to within $\pm 1\%$. Where necessary to achieve the specified accuracy of testing, equipment shall be calibrated and results obtained corrected accordingly. Bearings shall only be tested after a minimum period of two days elapsed after pressure moulding.

(ii) Stiffness in Compression

Each bearing shall be tested for stiffness in compression. The rated load at zero shear is as shown on the Drawings.

Bearings which exceed the relevant tolerance given in Table 16.2.c on the compressive stiffness as shown on the Drawings may be rejected.

(iii) Stiffness in Shear

After completion of the tests on the stiffness in compression, all bearings shall be tested in shear. (The rated load at maximum shear deflection capacity are given on the Drawings).

The effective shear stiffness at zero shear is shown on the Drawings. Bearings which exceed a tolerance of $\pm 20\%$ on this shear stiffness shall be rejected.

(iv) Test With Applied Rotation

One representative bearing selected by the Engineer from every twenty bearings, or part thereof, of each size of bearing shall be tested. Bearings to be tested shall be subject to an angular rotation equivalent to the rotational capacity at rated load at zero shear rounded to the nearest 0.005 radian (or given on the Drawings in the case of non-standard bearings). The angular rotation shall be applied at right angles to the long axis of the bearing while applying the rated load at zero shear.

On completion of rotation test the bearing shall again be loaded in compression in accordance with Clauses 16.2.2.3.b.ii, above and its compressive stiffness determined. Should this stiffness differ from that previously determined by more than 10%, the bearing, and those bearings represented by it, may be rejected.

(v) Visual faults

During the tests for compression and shear stiffness and under rotation, close observation of the bearings shall be maintained so as to detect any fault or variation due to lack of elastomer to steel bond, misplaced plates or inadequately cured elastomer etc.

Should any bearing exhibit any sign of failure such as:

- splitting
- permanent deformation or
- significantly irregular or unsymmetrical surface bulging.

then, unless the Contractor can demonstrate to the Engineer that the fault can be rectified satisfactory, such bearings shall be rejected.

16.2.2.4 Test Certificates

The Contractor shall supply a copy of the test certificates showing details of the results from the tests set out in Clauses 16.2.2.3 for each sample of the elastomer used in the manufacture of bearings, and of the hardness and stiffness in compression of the bearings and note whether any tolerances have been exceeded or whether any faults have been observed.

Table 16.2.a – Properties of Elastomer

Properties	Methods of Test	Requirements
Hardness	ASTM D 2240	48 min
Ultimate		5.75 min
Tensile Strength	ASTM D 412	17.5 MPa min
Tear Resistance	ASTM D 624 - Die. C	40.0 kN/m min
Compression Set	ASTM D 395 Method B (22 hrs 70 degrees Celsius)	25% max
Ozone resistance *	ASTM D 1149 20% strain at 40 degrees Celsius ± 1 and 1 ppm	No cracking visible by eye after 100 hrs
Accelerated Ageing	ASTM D 573	Maximum Permissible change in properties : Hardness +4 Tensile Strength $\pm 10\%$ Ultimate Tensile Strength -15%
Statistic Modulus in compression and shear **	ASTM D 945	Values to be recorded

* Evidence of recent testing of identical material may be accepted by the Engineer

**Three samples per job where required by the Engineer.

Table 16.2.b – Tolerances on Dimension

Dimension	Tolerance (mm)	
	Rectangular ≤ 350x170 mm and Circular ≤ 330 mm Ø	Rectangular ≤ 350x170 mm and Circular ≤ 330 mm Ø
Plan dimensions	±2.0	±4.0
Bearing thickness		
T ≤ 100 mm	±1.0	±1.0
T > 100 mm	±2.0	±2.0
Rubber side cover	±2.0	±4.0
Outer rubber layer thickness *	±0.5	±0.5
Inner rubber layer thickness *	±0.5	±0.5
Out of parallel between top and bottom surfaces, or between any two non-adjacent plates *	≤ 1.0	±2.0

These dimensions may be determined by probing or drilling a small diameter hole subsequently plugged with identical material to that used in the manufacture of the bearings.

Table 16.2.c – Tolerances on Compressive Stiffness

Compressive Deflection * (mm)	Layer Thickness (mm)	Tolerance (%)
< 0.75	6	30
	9,12,15,18	25
0.75 to 1.25	6	25
	9,12,15,18	20
1.25 to 4.0	6	25
	9,12,15,18	20
2.5 to 4.0	6	20
	9,12,15,18	15
> 4	6	15
	9,12,15,18	15

Note The tolerance for compressive stiffness is based on allowances for variations in properties of elastomer, layer and overall bearings thicknesses and measurement of compressive deflection.

* As measured from 0.1 to 1.1 times the rated compressive load at zero shear.

16.2.3 Installation

16.2.3.1 Marking and Delivery of Elastomeric Bearings

Each elastomeric bearing shall be clearly labelled or marked with the part number or type, or other specified identification number.

The bearings shall be wrapped in a double thickness of reinforced paper, lapped and taped. They shall be packed in timber crates, with styrene inserts and packing to prevent movement and to protect corners and edges. The crates shall be of substantial construction, well braced and strapped and marked with the contents.

Care shall be taken to avoid damage to the bearings during transport and handling prior to and during installation.

16.2.4 Installation of Elastomeric Bearings

a. Bearing Pedestals

Pedestals (where applicable) shall be cast monolithic with the substructure concrete with aggregate not less than 10 mm diameter. Alternatively they may be cast afterwards with a construction joint set at least 25 mm below the top of the supporting concrete or bonded to the concrete with an approved bonding agent after scabbling.

Pedestals shall be cured in accordance with the requirements of Section 9 this Specification for a minimum period of 7 days.

The bearing pedestals shall not loaded before 10 days after casting.

Cored holes shall be provided in the position as shown on the Drawings.

Upper surfaces of pedestals shall receive a Class 2 finish in accordance with the requirements of Section 9 of this Specification.

Tolerances on line and level of the bearing surfaces shall in accordance with the requirements of Section 9 of this Specification with the additional requirement that the permissible deviation at any point under a 300 mm straight edge placed level in any direction is 1mm.

b. Mortar Pads

Mortar pads, where shown on the Drawings, shall be a stiff cement mortar as specified in Section 9 of this Specification.

Concrete surfaces shall be treated as for pedestals before placing mortar and shall be cool and damp immediately before mortar placing.

Mortar shall be compacted by hammering and shall be trowelled and extended a minimum of 25 mm beyond the bearing edge and finished to a neat inclined face.

Finish and tolerance shall be as for pedestals. The mortar shall be cured under damp hessian for 7 days, or alternatively as consented to by the Engineer.

c. Installation

Elastomeric bearings shall be accurately aligned of the pedestals or mortar pad in the position shown on the Drawings.

The superstructure concrete, if cast in place, may be cast directly over the bearings provided that there is no disturbance to the bearing during these operations and also that there is a minimum 25 mm horizontal extension of the concrete soffit all around the bearing edge.

Where steelwork or precast concrete is to be placed on the bearing the member may be placed directly onto the elastomeric bearing. If any gaps greater than 1 mm occur then the member shall be lifted to permit coating the top of the bearing with an excess amount of an approved epoxy mortar and the member re-seated. Any excess of mortar squeezed out is to be removed immediately before it has set and the bearing cleaned and adjacent surfaces made good.

Placing of the bearing, mortar and steel or concrete member shall only be carried out in the presence of the Engineer or his representative and the bearing shall be temporarily restrained as necessary to avoid any disturbance in position during member placing operations.

Rubber sheet end bearing strips shall be bonded to the ends of girders of the spillway bridge as shown on the Drawings using an approved epoxy resin. The access road bridge does not have rubber sheet end bearing pads.

16.2.5 Measurement and Payment

Measurement, for payment, for elastomeric bearing pads and rubber sheet shall be made of the number of elastomeric bearing pads supplied, inspected and accepted by the Engineer.

Measurement of the number of rubber sheets shall not be made.

16.2.6 Payment

Payment for elastomeric bearing pads and rubber sheet (rubber sheet applicable to item P.1.1 only) will be made at the respective rates entered in the Bill of Quantities (items P.1.1 and P.1.2) which shall include full payment for providing all labour, materials tools, equipment and any other work incidental to the supply and installation of the bearing pads and rubber sheet.

Payment for the item will include handling, storage, temporary supports, placing, construction of bearing pedestals (where applicable), placing holding down bolts (where applicable) supply and application of approved epoxy resin, and finishing and no separate payment will be made for any of these.

16.3 BRIDGE EXPANSION JOINTS

16.3.1 General

The Contractor shall furnish and construct bridge expansion joints in accordance with the Drawings, the Specification and the directions of the Engineer.

16.3.2 Materials

Steel components shall be galvanised structural steel complying with the requirements of Section 11.

Asphaltic jute chord shall consist of jute fibre impregnated with asphalt.

Asphaltic plug shall comprise hot mix surface course as specified in Clause 10.10.

Rubber sheet for shall be as specified in Clause 16.2.

16.3.3 Fabrication of Steel Plate

The steel plate shall be fabricated in not more than two lengths per joint. Completed units shall be hot dip galvanised. All fabrication shall be in accordance with Section 11.

16.3.4 Installation

a. Spillway Bridge

The expansion gaps between the deck slabs and the abutments shall be cleaned out of all debris and checked that the clear space as indicated on the Drawings exists.

The asphaltic jute chord shall be attached to the pins on the fabricated metal plate and placed over the joint taking care to ensure that it is bearing uniformly on the supporting concrete.

The asphalt plug shall be placed carefully over the metal plate and formed and compacted to the road profile as shown on the Drawings.

b. Access Road Bridge

The expansion gaps between the deck slabs and the abutments shall be cleaned out of all debris and checked that the clear space as indicated on the Drawings exists.

Rubber sheet strips shall be bonded to the surfaces of the concrete as shown on the Drawings using an approved epoxy resin.

16.3.5 Measurement and Payment

Payment shall be made for completing bridge expansion joints for the spillway bridge and for the access road bridge in accordance with this specification at the respective lump sum prices tendered therefor in the Bill of Quantities (Items P.2.1 and P.2.2) which shall include the cost of all materials, labour and equipment and all incidentals required to complete the expansion joints.

Payment for the asphalt plugs shall be measured and paid for under item J.6.

16.4 DRAINAGE PUMPS

16.4.1 General

The Contractor shall furnish, install, test and commission submersible drainage pumps as shown in the Drawings, as specified in this Clause and as directed or approved by the Engineer.

Pumps shall be manufactured by reputable suppliers of submersible pumps which have an excellent performance history of reliable, low maintenance in similar conditions to which the pumps are required to operate.

16.4.2 Submissions

The Contractor shall submit full technical details of the pumps proposed for installation in the Works for the Engineer's reference and approval.

16.4.3 Requirements

Pumps to be installed in the gallery shall comply with the following:

Item	Type and Requirements
Type	Submersible, electric motor-driven pump
Capacity	0.2 m ³ / minute at 12 m head
Power Supply	3-Phase, 380 V AC
Number of Pumps	2; one duty, one on standby with automatic cut-in in event of failure of duty pump
Water Level Control	By water level depth sensors

Pumps to be installed in the hydropower station shall comply with the following:

Item	Type and Requirements
Type	Submersible, electric motor-driven pump
Capacity	0.5 m ³ / minute at 18 m head
Power Supply	3-Phase, 380 V AC
Number of Pumps	2; one duty, one standby
Water Level Control	Manual at local panel

16.4.4 Installation and Testing

Installation and testing shall be carried out in accordance with procedures prepared by the Contractor and which have been approved by the Engineer.

16.4.5 Measurement and Payment

Measurement shall be made of the number of submersible drainage pumps of each type, completed, commissioned and approved by the Engineer.

Payment for submersible drainage pumps shall be made at the rates tendered therefor in the Bill of Quantities (Items P.4.1 and P.4.2) which rates shall include the cost of supplying the pumps complete with all electrical wiring and control systems and level sensors (where applicable), installing, testing, commissioning and all incidental costs.

16.5 WATER LEVEL STAFF GAUGES

16.5.1 General

The Contractor shall furnish and install water level staff gauges in accordance with this specification, the Drawings and as directed or approved by the Engineer.

16.5.2 Requirements

Staff gauges and associated fittings and fastenings shall be of stainless steel material as specified in Section 11.

Figures and calibration shall be clear and crisp to enable reading in poor light conditions.

Calibration for staffs shall be such that they read the vertical depth of water regardless of the inclination of the staff itself.

16.5.3 Submittal

The Contractor shall submit shop Drawings and technical details of proposed materials, marking patterns, etc. for the Engineer's review and approval in accordance with the procedures in Clause 1.4.

16.5.4 Installation

Staff gauges shall be installed firmly and plumb and accurately set to the correct elevation based on the site datum in the locations shown on the drawing.

16.5.5 Measurement and Payment

Measurement, for payment, for water level staff gauges shall be made of the number of staff gauges of each type installed and approved by the Engineer.

Payment for water level staff gauge shall be made at the rates tendered therefor in the Bill of Quantities (Items P8.1 and P.8.2) which shall include the cost of supply, installation, surveying and all other associated costs.