

ELECTRICITY GENERATING AUTHORITY OF THAILAND

Supplemental Notice No. 2

Invitation to Bid No. BBS1-L-01

**Supply and Construction of Transmission Line
230 kV Bhumibol 2 – Bhumibol**

**Transmission System for Hydro-Floating Solar
Hybrid Project Bhumibol Dam Unit 1**

The attached Supplemental Notice shall be considered as part of the bidding documents No. BBS1-L-01.

As acknowledgement of receipt that all additions, deletions and revisions contained in this Supplemental Notice are incorporated into the above bidding documents, Bidder is requested to sign and return this acknowledgement via email address : jitpimon.pon@egat.co.th within three (3) days from the date of the announcement of this Supplemental Notice on <http://www4.egat.co.th/fprocurement/biddingeng/>.

The original acknowledgement which is manually signed in ink by a person or persons duly authorized shall be included in the proposal to be submitted on the bid opening date.

ELECTRICITY GENERATING AUTHORITY OF THAILAND

April 29, 2026

ACKNOWLEDGEMENT

This undersigned Bidder hereby certifies that the additions, deletions and revisions set forth in this Supplemental Notice to Invitation to Bid No. BBS1-L-01 are incorporated as part of the above bidding documents and will be fully included in any bids which he may submit.

Signed _____

Title _____

Company _____

Date _____

ELECTRICITY GENERATING AUTHORITY OF THAILAND

SUPPLEMENTAL NOTICE NO. 2

INVITATION TO BID NO. BBS1-L-01

SUPPLY AND CONSTRUCTION OF TRANSMISSION LINE
230 kV BHUMIBOL 2 – BHUMIBOLTRANSMISSION SYSTEM FOR HYDRO-FLOATING SOLAR
HYBRID PROJECT BHUMIBOL DAM UNIT 1

The following supplemental information is hereby given for the above described Invitation:

Volume III of V

Replace pages 1 and 2 of “Specifications for Invar Conductor and Hardware Assemblies and Line Accessories (Revision 1) And Requirements and Design Criteria of Invar Conductor” with the revised pages with Rev.1 attached.

Bid submitted must be in accordance with this Notice. Receipt of this Notice shall be acknowledged by the Bidder on the proposal included in the Bidding Documents in the space provided on page C4, Article C-4 Supplemental Notices.

ELECTRICITY GENERATING
AUTHORITY OF THAILAND

.....April 29 , 2026.....

**SPECIFICATIONS FOR INVAR CONDUCTOR AND HARDWARE
ASSEMBLIES AND LINE ACCESSORIES (REVISION 1)**

AND

REQUIREMENTS AND DESIGN CRITERIA OF INVAR CONDUCTOR

**INVITATION TO BID NO. BID NO. BBS1-L-01
SUPPLY AND CONSTRUCTION OF TRANSMISSION LINE
230 kV BHUMIBOL 2 – BHUMIBOL**

**SPECIFICATIONS FOR INVAR CONDUCTOR AND HARDWARE
ASSEMBLIES AND LINE ACCESSORIES (REVISION 1)**

**INVITATION TO BID NO. BBS1-L-01
SUPPLY AND CONSTRUCTION OF TRANSMISSION LINE
230 kV BHUMIBOL 2 – BHUMIBOL**

SECTION A
INVAR CONDUCTOR

A-1. General

This section provides a *functional specification* for Invar conductor. It is the **general information** for the design, fabrication and test of Invar conductor.

A-2. Standard

The conductor shall conform to the following International Standards, which shall mean latest revisions, with amendments/changes adopted and published, unless specifically stated otherwise in the Specification.

IEC 60468:1974	Method of measurement of resistivity of metallic materials
IEC 60888:1987	Zinc-coated steel wires for stranded conductors
IEC 60889:1987	Hard-drawn aluminium wire for overhead line conductors
IEEE 524-1980	Guide to the Installation of Overhead Transmission Line Conductors

Reference to standards and specifications, or to equipment and materials, of a particular manufacture shall be considered as followed by "or equivalent". The Contractor may propose equivalent standards, specifications, materials of equipment which shall be equal in every respect to that specified. If the Contractor for any reason proposes equivalents to, or deviations from, the above standards, the Contractor shall state the exact nature of the change, the reason for making the change and shall submit complete specifications of the materials, as well as copies of pertinent standards, for the approval of EGAT. EGAT's decision in the matter of quality will be final.

A-3. Conductor Requirements

The conductor to be supplied shall have characteristics conforming to those shown in the attached document for Requirements and Design Criteria for Invar Conductor.

A-4. Materials

a. Thermal Resistant Aluminum Alloy Wires

The thermal resistant aluminum alloy strands shall be drawn from thermal resistant aluminum alloy rods. Thermal resistant aluminum alloy rods shall be manufactured through suitable heat treatment.

b. Aluminum Clad Invar Wires

The aluminum clad invar strands shall be composed of a high strength bare invar (Nickel-iron alloy) core with substantially uniform and continuous aluminum covering thoroughly bonded to it.

A-5. Workmanship

a. Forming and Finishing

All the thermal resistant aluminum alloy and aluminum clad invar strands shall be smooth, uniform and free from all imperfections, such as spills and splits, cracks, die marks, scratches, rust etc., after drawing and also after stranding.

The finished conductor shall be smooth, compact, uniform and free from all imperfections including kinks (protusion of wires), wire cross over, over riding, looseness (wire being dislocated by finger/hand pressure and/or unusual bangle noise on tapping), material inclusions, white rust, powder formation or black spot (on account of reaction with trapped rain water etc.) dirt, grit etc.

The invar strands shall be aluminum clad and shall have a minimum aluminum thickness as given in "Minimum thickness of aluminum cladding" after stranding.

The aluminum cladding shall be smooth, continuous, of uniform thickness, free from imperfections.

The invar wire rods shall be of such quality and purity that, when drawn to the size of the strands specified, the finished strands and the individual wires shall be of uniform quality and conform to the requirements of "the detail of aluminum clad invar strand"

The invar strands shall be preformed and post formed in order to prevent spreading of strands in the event of cutting of composite core wire.

Care shall be taken to avoid, damages during pre-forming and post-forming operation.

b. Cleaning

The conductor shall be free from excessive amounts of die grease, metal particles and dirt.

The Contractor shall describe in complete detail the method which he proposes to use in normal production to clean the conductor.

The effectiveness of the cleaning process shall be subject to verification.

A-6. Joints in Wires

a. Thermal Resistant Aluminum Alloy Wires

During stranding, no thermal resistant aluminum alloy wire welded shall be made of the purpose of achieving the required conductor length.

No joint shall be permitted in the individual wires of the finished conductor.

b. Aluminum Clad Invar Wires

There shall be no joint of any kind in the finished wire entering into the manufacture of the strand. There shall also be no strand joints or strand splices in any length of the completed stranded invar core of the conductor.

A-7. Tests

The acceptance values for all type tests, acceptance tests and specified tests shall be as specified in conductor characteristics and/or as proposed by the Contractor.

a. Type Tests

The following type tests shall be carried out to prove the process of manufacture and general conformity of the material to this specification. One set of type tests shall be made once on samples prior to commencement of commercial production against the order.

- (1) Heat Resistance Test on Thermal Resistant Aluminum Alloy Wire. Breaking load test shall be carried out in accordance with IEC 60889 before and after heating the

sample in uniform heat furnace at 280 °C (+5/-3 °C) temperature for one hour. The breaking strength of the wire after heating shall not be less than 90% of the breaking strength before heating.

(2) Type Tests on Aluminum Clad Invar Wire

- (a) Coefficient of linear expansion on aluminum clad invar wire. The temperature and elongation on a sample shall be continuously measured & recorded at intervals of approximate 15 °C from 15 °C to 230 °C while changing the applied heating temperature. Coefficient of linear expansion from 15 °C to 230 °C temperature shall be obtained for aluminum clad invar wire from the measured results.
- (b) Bending test on aluminum clad invar strand. A sample of aluminum clad invar strand measuring 30 cm in length shall be subjected to bending with help of a vise. The vise length of wire should be 5 cm and radius of bend 4.8 mm. The bending should be first 90 degrees left and then 90 degrees right. After this operation the strand should be cut at the bending point. There should be no separation of invar and aluminum at the bending point after this operation.

(2) Type Tests on Stranded Conductor

- (a) UTS test on stranded conductor. Circles perpendicular to the axis of the conductor shall be marked at two places on a sample of conductor of minimum 5m length between fixing arrangement suitable fixed by appropriate fittings on a tensile testing machine. The load shall be increased at a steady rate upto 50% of minimum specified UTS and held for one minute. The circles drawn shall not be distorted due to relative movement of strands. Thereafter the load shall be increased at steady rate to minimum UTS and held for one minute. The conductor sample shall not fail during this period. The applied load shall then be increased until the failing load is reached and the value recorded.
- (b) DC resistance test on stranded conductor. On a conductor sample of minimum 5m length, two contact-clamps shall be fixed with a predetermined bolt torque. The resistance shall be measured. The test shall be repeated at least five times and the average value recorded. The value obtained shall be corrected to the value at 20 °C. The resistance corrected at 20 °C shall conform to the requirements of this specification and proposal data of the Contract.
- (c) Stress-strain test. A sample section of the complete conductor and of invar core shall be given tensile strength tests to obtain representative short-time and repeated stress-strain curves. The samples of conductor shall be obtained from the first satisfactory production run. The gage length shall be 13 meters. Test report shall include complete tabulated data and plotted stress-strain curves (or, if automatic recording extensionmeters have been used, only the plotted stress-strain curves need be supplied) so that initial and final modulus of elasticity values may be determined. Such stress-strain tests shall be completely performed in accordance with the standard method proposed and adopted by the Aluminum Association, 750 Third Avenue, New York, N.Y. 10017.
- (d) Creep test Creep tests shall be run in complete accordance with the standard method proposed and adopted by the Aluminum Association, 750 Third Avenue, New York, N.Y. 10017.
- (e) Coefficient of linear expansion. The temperature and elongation on a sample shall be continuously measured & recorded at intervals of approximate 15 °C

from 15 °C to 230 °C while changing the applied heating temperature. Coefficient of linear expansion from 15 °C to 230 °C temperature shall be obtained for aluminum clad invar wire from the measured results.

b. Acceptance Tests

One set of the following acceptance tests shall be carried out on samples taken from each lot offered for pre-despatch inspection, for the purpose of acceptance of that lot.

- (1) Visual and Dimensional Check on Drum. The drums shall be visually and dimensionally checked to ensure that they conform to proposal data of the Contract.
- (2) Visual Check For Joints Scratches Etc. And Length Measurement Of Conductor By Rewinding. The conductor shall be visually checked for scratches, joints etc. and generally conformity to the requirements of this specification.
- (3) Dimensional Check On Aluminum Clad Invar And Aluminum Alloy Strands. The individual strands shall be dimensionally checked to ensure that they conform to proposal data of the Contract.
- (4) Check For Lay-Ratios Of Various Layers. The lay-ratios of various layers shall be checked to ensure that they conform to the requirements of this specification.
- (5) Aluminum Thickness Test On Aluminum Clad Invar Strands. The individual strands shall be checked to ensure that they conform to proposal data.
- (6) Torsion and Elongation Tests On Aluminum Clad Invar Strands. The test procedure shall be as per clause No. 10.3 of IEC 60888. In torsion test, the number of complete twists before fracture shall not be less than 18 on a length equal to 100 times the standard diameter of the strand. In case test sample length is less or more than 100 times the stranded diameter of the strand, the minimum number of twists will be proportioned to the length and if number comes in the fraction then it will be rounded off to next higher whole number. In elongation test, the elongation of the strand shall not be less than the specific value in proposal data.
- (7) Breaking Load Test On Aluminum Clad Invar And Thermal Resistant Aluminum Alloy Strands. The tests shall be carried out in accordance with IEC 60889 and the results shall meet the specific value in proposal data.
- (9) Wrap Test On Aluminum Clad Invar Strands. The aluminum clad invar strand shall be wrapped around a mandrel of diameter 5 times that of strand to form a helix of eight turns. The strand shall then be unwrapped. No breakage of strand shall occur.
- (10) Minimum Conductivity Test on Thermal Resistant Aluminum Alloy Strands. Resistivity test shall be conducted in accordance with IEC 60468 / IEC 60889 to conform minimum conductivity as specified in proposal data.
- (11) Heat Resistance Test On Thermal Resistant Aluminum Alloy Strands. Breaking load test shall be carried out before and after heating the sample in uniform heat furnace at 280 °C (+5/-3 °C) temperature for one hour. The breaking strength of the wire after heating shall not be less than 90% of the breaking strength before heating.
- (12) Minimum Conductivity Test On Aluminum Clad Invar Strands. Resistivity test shall be conducted in accordance with IEC 60468 to conform minimum conductivity as specified in proposal data.

All the tests shall be carried out on thermal resistant aluminum alloy and invar strands after stranding only.

c. Routine Tests

The routine tests shall be carried out on the material to check requirements which are likely to vary during production as follows:

- (1) Check to ensure that **no joints** are per Specification.
- (2) Check that there are no cuts, fins etc., on the strands.
- (3) Check that drum are as per Specification.
- (4) All acceptance test mentioned in Article 7.b above shall also be carried out on each reel.

d. Tests during Manufacture

Tests during manufacture shall mean those tests, which are to be carried out during the process of manufacture and end inspection by manufacturer to ensure the desired quality of the end product to be supplied by him. One set of these tests shall be conducted on a sample of each lot.

- (1) Chemical analysis of Aluminum alloy used for making thermal resistant aluminum alloy strands
- (2) Chemical analysis of invar used for making invar strands

Samples taken from the Aluminum and invar strands shall be chemically/spectrographically analyzed as specified in proposal data.

e. Specific Tests

The type tests shall be conducted once on a sample of conductor before the conductor **first delivery**.

- (1) Temperature of surround area (ambient temperature) at maximum continuous temperature and no wind condition. Relation between temperature and distance from conductor will be examined.
- (2) Temperature of a current loaded conductor under rainfall condition. The condition of rainfall ratio (intensity) for the test shall be approved by EGAT. The test will be carried out under artificial rainfall.
- (3) Sag-tension properties (sag behavior at high temperature)
- (3) Ampacity Tests

For the ampacity tests, 12 m conductor shall be mounted in the test frame and loaded to 250 kg. This load shall be maintained throughout the duration of the experiment. After that, the conductor's surface shall be heated to the test temperature 210 °C and maintained for a period of 30 minutes. A multimeter will be used to measure the current and potential difference during the 30 minutes hold. Readings shall be taken at three locations along the conductor. For each test, either three or five thermocouples (depending on the length of the conductor) shall be used to measure the temperature of the conductor at different locations along the length of the conductor and an additional thermocouple will be used to record the ambient temperature. The measured current shall not be less than the requirements of this specification.

f. Test Report

Four (4) copies of the reports of the above tests shall be submitted to EGAT for approval.

A-8. Packing

a. Reel

The complete conductor shall be furnished on either metal or wooden reels, equipped with lagging bound on the reels with two circumferential steel straps. The steel straps shall be 32 x 0.8 mm galvanized steel and shall be stapled to alternate lags. The reels shall be of such construction as to assure delivery of the conductor to the field, free of displacement and damage. They shall be constructed to withstand all normal stresses due to handling and stringing operations, and to prevent damage to the conductor during normal construction practices but are not required to be designed to withstand the forces required for braking during tension stringing.

There shall be no sharp objects that may damage the conductor. The increase of distance between reel flanges anywhere on the circumference due to forces applied during reeling, delivery, handling, and stringing shall not be more than two-thirds of the diameter of the conductor. Two or more dog holes shall be provided near the arbor hole.

Chemically inert and waterproof material shall be wrapped around the drum and strapped or glued to the flange surface of all reels. The material shall be at least 0.6 millimeter thick and shall remain securely attached to the reel. Any glue used shall be chemically inert and shall be used in such a manner as not to harm the conductor at any time.

The conductor on each reel shall be securely fastened at both ends by the use of adjustable screw clamps after the conductor has been taped to prevent damaging to the conductor and fastened under tension to the flange by the use of galvanized steel wire, 2 mm diameter. The tension shall be such that no looseness will be transmitted to the internal layers. The conductor shall be tightly and uniformly spooled on the reel with each wrap laid snugly against the side of the preceding wrap, and the first and last wrap in each layer shall fit snugly against the flange of the reel. The transition from one layer to the next layer above shall be made with a minimum of void space.

Winding of conductor on the reels shall conform to the left or right hand rule, as applicable, as detailed in IEEE Standard 524-1992.

The clearance between the outermost layer of the conductor and the lagging bound shall not be less than 75 mm.

Materials used in or on the reels and conductor shall neither adhere to the conductor nor produce corrosion during outdoor storage.

The packing shall be carried out with caution to protect the conductor from moisture, salt or any impurities which may cause rust or harmful effects to the conductor.

In case wooden reels are employed, the Contractor shall treat them with chemical solution to prolong the life of service. The solution used for such treatment shall be harmless to conductor and approved by EGAT. The Contractor shall submit for EGAT's approval drawings detailing all dimensions of reel, type and sizes of each piece of wood assembled, through bolts, steel arbor and fixing bolts, steel strap bound on the reel and materials to protect the conductor from moisture or harmful effects.

b. Marking

The following information shall be marked with paint on the reels and clearly indicated on at least one metal tag firmly attached to the reel :

- Contractor and/or Manufacturer's name or trade mark.
- Manufacturer's plant location
- Purchaser's name
- Reel number
- Date of manufacturing
- Destination
- Size
- Actual length
- Gross weight and tare weight
- Contract number

An arrow, showing the direction in which the reel should be rolled, shall be marked on each side of reel at the position of the outer end of conductor placed.

c. Shipping

The Contractor shall exercise every precaution to adequately protect all shipments against damage in transit and the Contractor shall be liable for and assume the entire risk of damage or loss while the equipment is in transit and prior to delivery. The Contractor shall assume responsibility for filing and prosecuting any claim against the carrier. Vessels and cars in which equipment is shipped shall be reasonably clean and free from foreign material which could in any way injure the equipment. Any expense incurred by EGAT as a result of improper shipping of equipment will be backcharged to the Contractor.

SECTION B

HARDWARE ASSEMBLIES AND LINE ACCESSORIES FOR INVAR CONDUCTOR

This Section specifies particular technical requirements for hardware assemblies and line accessories, in addition to those already specified in Specifications No. C-2 (Rev.6), for Invar Conductor.

The technical requirement for hardware assemblies and line accessories for Invar Conductor shall generally conform to those specified in Section D: Insulator Assemblies, Section F: Line Accessories, Attachment No. 1: Tests for Transmission Line Hardware/Fittings of Specifications No. C-2 (Rev.6) and Specification No. TL-03 (Rev.0): Specification for Spacer Damper and Rigid Spacers respectively with the additional requirements for the following equipment in order to make the assemblies and accessories suitable to be used with Invar conductor.

B-1. Compression Type Dead End Clamps

The material of compression type dead end clamps for Invar Conductor shall be suitable for continuing good performance corresponding to the maximum temperature. The current carrying capacity of compression type dead end clamps shall not be less than that of Invar Conductor as specified in Requirements and Design Criteria of Invar Conductor attached with these Specifications for Invar Conductor and Hardware Assemblies & Line Accessories.

B-2. Line Accessories

The current carrying capacity of conductor connection, repairs and armor rod shall not be less than that of Invar Conductor as specified in Requirements and Design Criteria of Invar Conductor. The material not specifically covered herein shall be of standard commercial quality suitable for the intended use. The Contractor shall be responsible for satisfactory performance of complete conductor system along with accessories offered by the Contractor for continuous operation at 210°C.

For spacer damper and rigid spacer damper, they shall maintain all requirements as specified in Specification No. TL-03 (Rev.0) and shall have good performance under operating temperature of Invar Conductor. The elastomer and non-metallic material shall be capable of withstanding continuous operating temperature up to 210°C without permanent loss of essential properties. The energy absorption assembly shall be designed to provide effective damping throughout operating temperature range.

B-3. Test of Hardware Assemblies and Line Accessories

Test of hardware assemblies and line accessories for Invar Conductor shall generally conform to ATTACHMENT No.1: TESTS FOR TRANSMISSION LINE HARDWARE/FITTING of Specifications No. C-2 (Rev.6). In addition, tension sleeve and dead end clamp for Invar Conductor shall comply with requirement of Article 7 of BS 3288: Part 1: 1997, provided that the temperature of conductor during each cycle of the test shall be 210(+10/-5) °C.

B-4. Sag and Tension Table for Stringing of Invar Conductor

The Contractor shall provide initial Sag and Tension Table for Invar Conductor and submit it to EGAT for approval before commencement of Stringing Work.

REQUIREMENTS AND DESIGN CRITERIA OF INVAR CONDUCTOR

**INVITATION TO BID NO. BID NO. BBS1-L-01
SUPPLY AND CONSTRUCTION OF TRANSMISSION LINE
230 kV BHUMIBOL 2 – BHUMIBOL**

REQUIREMENTS AND DESIGN CRITERIA FOR INVAR CONDUCTOR
FOR SUPPLY AND CONSTRUCTION OF TRANSMISSION LINE
230 kV BHUMIBOL 2 – BHUMIBOL

1. CONDUCTOR CHARACTERISTICS

The INVAR Conductor supplied for the subject transmission lines shall have characteristics conforming to the following requirements.

<u>Description</u>	<u>INVAR Conductor</u>	
Minimum breaking strength	14,050	kg
Outside diameter, not more than	33.91	mm
Weight of conductor, not more than	2,040 (Totally)	kg/km
Continuous current capacity, not less than (see <u>Note</u>)	1,840 (with solar)	A
Max. Operating temperature – continuous	210	°C
Direction of lay	Outer Right Hand	
Length of each reel, not less than	1,140	m

Note: Thermal limit conditions of conductor are as follows:

Maximum conductor temperature	210 °C
Ambient temperature	35 °C
Wind velocity	2.2 km/hr
Solar intensity	0.06 w/cm ²
Solar absorption	0.75
Emissivity of surface area	0.60

2. DESIGN CRITERIA

The conductor shall be designed to have characteristic as mentioned above with its maximum tension and maximum sag not exceeding the tension worst case and maximum sag of EGAT typical design and of the existing transmission line, in case of conductor replacement work, at any ruling span.

3. TECHNICAL INFORMATION OF TRANSMISSION LINES

3.1 Conductor Information for EGAT's Typical Transmission Line

(a) Conductor

Nominal size	1272 MCM
Material	ACSR/GA
Stranding	42x4.42 AL/7x2.46 ST

Total area	677.77	mm ²
Diameter	33.91	mm
Weight	2.04	kg/m
Ultimate strength	14,050	kg
Modulus of elasticity	6,200	kg/mm ²
Coefficient of linear expansion	0.0000213	/°C

(b) Operation Condition

Nominal voltage	230	kV
Maximum operating conductor temperature	75	°C
Ambient temperature	35	°C
Solar intensity	0.06	W/cm ²
Solar absorption coefficient of conductor surface	0.75	
Wind velocity	2.2	km/hr
Relative emissivity of surface area	0.6	
Current power carrying capacity		
With solar	1,078	A
Without solar	1,197	A

3.2 Sag & Tension Data

The INVAR Conductor shall be designed to have its maximum tension and maximum sag not exceeding those shown herein.

Tension and Sag - Ruling Span 430 m

Case				Condition	Tension and Sag Controls		
27°C +	Wind	100.00	kg/m ²	Final	Tension ≤	5557	kg
27°C +	Wind	64.00	kg/m ²	Final	Tension ≤	4337	kg
27°C +	Wind	20.50	kg/m ²	Final	Tension ≤	3249	kg
27°C +	No Wind			Final	Tension ≤	3091	kg
40°C +	No Wind			Final	Tension ≤	2979	kg
6°C +	No Wind			Final	Tension ≤	3300	kg
27°C +	Wind	20.50	kg/m ²	Initial	Tension ≤	3745	kg
Max. Operating Temperature				Final	Sag ≤	17.29	m