Revision History			
Rev.	**Description**	**Date**	**Approved By**
-	First issue	2023-08-02	Lungeanu Liviu dan

Similar To:	Created By: **Rajesh Maradani**		EID **A024**
First Made For: **F6080G22**	Approved By: **Lungeanu, Liviu dan**		IEC61355-1 No **-**
GE Power	Document Type: **Ordering Drawing**		Sheet Size **A**
	Document Title: Isolated Phase busduct specification (IPBD)		
Creation Date **2023-08-02**	Drawing Number 309T1742	Revision **-**	Sheet **1 of 34**

Table of Contents

1. EQUIPMENTS AND SERVICES TO BE SUPPLIED

1.1. General

The Seller shall supply **I**solated **P**hase **B**us (IPB) Duct Systems and associated service in compliance with IEC standard for metal-enclosed bus and with the documents constituting the equipment technical specification, for Hsintao power plant.

None of the statements or selections of this specification or associated documents alters the Seller‘s contractual obligations to provide any item or service necessary of the efficient, safe and reliable design, operation, construction and test of the low voltage switchgear in the stated location.

Deviations from this specification require prior written authority from the product engineer.

1.2. Scope of Supply and Services

The detailed list hereafter is a non-exhaustive enumeration. Omission from this list of any item indispensable for the efficient, safe and reliable operation of the equipment shall not relieve the Seller of his obligation to provide a coherent set of equipment complying with the rules of the trade.

- **List of equipments**

❑ Main Isolated bus-duct system from Generator to GSUT.

Each busduct system includes:

- Connection to the generator output terminals located on top of the generator, including flexible connectors. On site dielectric testing shall be possible when connectors are removed.
- Main bus straight sections
- Connection to Generator Step-up Transformer including flexible connectors. Dielectric testing shall be possible when connectors are removed
- Main bus supports (including all necessary chemical type anchor bolts, bolts and nuts), Refer IPBD layout drawing.
- IPBD secondary supports
- Main bus expansion joints (bellows).
- One three-phase building wall pass with gasket and fire-resistant wall frame internal fire resistant seal-off bushing inside IPB enclosure. All seals shall be fire resistant with a minimum one-hour rating.

- Grounding connection points (for maintenance) for connection of temporary short-circuit and grounding device, including inspection cover plate with transparent window shall be provided. Located at the IPB section on top of the main IPB.
- Pressurizing system including all equipment, accessories and devices for operation and indication (pressurized air supplied by Buyer)
- Anti-condensation heaters for bus-duct sections. Inclusive minimum 2 junction boxes for the anti-condensation heaters, wiring and cables up to the heaters.
- Condensate discharge drains at the lowest points of each equipment connection
- Accessories (terminal box, heating, etc.). All completely assembled and wired as shown in the specification drawings enclosed herein
- Short circuit bridges for IPB enclosures
- Hardware to connect Generator terminal enclosure (GTE) to IPBD
- Rating plates
- Name plates

- **List of accessories**

❑ Mobile short-circuit & grounding device including medium voltage detector

- **List of tools and test equipment**

❑ One (1) set of accessories and special tools for erection, commissioning and extraordinary maintenance. In case the seller does not recommend any special tool, the seller has to specifically confirm that no special tool is required.

- **List of consumables for erection and commissioning**

The seller shall provide as a minimum, the following spare parts for the commissioning phase, packed into a clearly marked box and shipped with the busduct. Those parts shall be separately quoted.

❑ Aluminium welding wires for site welding. The welding machine is out of scope

❑ One (1) set of electrical components

❑ Three (3) pieces of each type of bus-ducts insulators

❑ One (1) insulator of each type for cubicle

❑ One (1) set of bolts and nuts, washers

❑ One (1) flexible neoprene bellow of each type

- ❑ One (1) set of flexible connectors with bolting of each type
- ❑ One (1) neoprene gasket at wall pass
- ❑ Touch-up paint (black and finish paint)
- ❑ Additional parts to be proposed by the Seller and to be added

- **List of recommended spare parts for {three years} maintenance**

- ❑ Separate quoted list to be proposed by the Seller and to be added As basis:
  - (…) each type of insulators
  - (…) set of electrical components
  - (…) flexible neoprene bellows of each type
  - (…) flexible connectors of each type
  - (…) electro-valve for pressurization system
  - (…) manometer for pressurization system
  - {(…) auxiliary relay}
  - {(…) air pressure switch}
  - {(…) space heater for main section}

- **List of services**

The seller shall provide all services that are necessary for the supply of the specified equipment as well as but not limited to the services as specified in the following chapters. This includes as minimum:

- ❑ Delivery of necessary documents. Minimum is defined in the document submittal list. See 6
- ❑ Equipment design including thermal and mechanical calculation, procurement of materials
- ❑ Loading and force data, including short circuit forces, shall be provided by Seller, for design and supply of primary support structures, by others
- ❑ Manufacturing and manufacture supervision, scheduling and expediting
- ❑ Inspections and tests during factory acceptance test.
- ❑ Cleaning, painting and coating, shop assembly
- ❑ Packing for shipment

- Storage

- **Seller's special services**

- Participation to all technical and commercial co-ordination work with Buyer: a project manager shall be designated and shall be responsible for the whole order not only till the delivery of the material but till the end of its commissioning on site

- Support during engineering (including meetings with the Employer)

1.3. Options and Alternatives

The options and alternatives listed below shall be described and quoted by the seller.

The seller may also propose alternatives that may improve the performance or reduce cost of the tender, or reduce the environmental impact.

The seller shall indicate the latest dates for taking up of the options/alternatives without affecting the design or delivery of the equipment and services listed above are to be indicated with the options.

Options:

- Addition or deletion of 1m section of each type of branch
- Addition or deletion of 3 elbows (one per phase) of each type of branch
- Solar protection sun shade, for outdoor part of the main bus
- Supervision during erection at site
- Welding on site by qualified welder
- Recommended spare parts for {3 years} operation
- Seismic calculation
- Separate list to be proposed by the Seller and to be added.

1.4. Conflicting Requirements

In case of any inconsistencies or conflicting requirements within this specification or between this specification and any other document forming part of subject purchase order, the seller shall indicate such to the product engineer and shall obtain its written directive.

1.5. Notification of Works and Services being subcontracted.

The seller shall not subcontract portions of the supply or services without prior approval by GE. The seller shall notify the product engineer which of the major packages he intends to subcontract and where the production facilities are located.

2. LIMITS OF SUPPLY

The limits of supply indicated herein do not relieve the Seller of his obligation to assure the continuity and compatibility of his supply with interfacing plant and equipment and to report on this to the Product Engineer.

2.1. Inclusive limits

If not specifically stated otherwise in part **Error! Reference source not found.**, the limits of supply for each interface point shall be:

- At the terminals and flanges of the generator
- At the terminals and flanges of the generator Step-up transformer
- At the instrument air pipe connection for the air pressurizing cabinet
- At the terminals for the power, control and protection signals
- At grounding connection pads of generator, cubicles and all transformers
- At the building structures and generator housing for supports.

Screws, nuts, washers and sealing for connection of the bus-duct, flanges and supports have to be provided by the Seller

2.2. Equipment excluded from the supply

- Concrete structures and civil works
- Generator star-point equipment and neutral point cubicle

2.3. Services excluded

- Transport to site
- Erection and commissioning on site (see 1.3)

2.4. Interfaces

When the seller is not able to supply the equipment directly with the correct connections as defined herein, he shall supply the equipment with adaptation parts so that the interface is unchanged.

Interfaces are described in the following documents referenced in the technical specification.

- Single line diagram - 306T8576
- IPBD layout diagram - 309T0535

- Generator outline diagram - 137T9493
- Generator step-up transformer outline customer drawing number – 21A1A1978
- GA Drawing for Generator terminal enclosure (GTE)- 63631048
- Site specific condition - 306T2389

2.5. PART NUMBER

S.No	Part number	Proposed loose materials
1	309T1742P0001	Isolated phase busduct (IPBD), support structures & air pressurization cabinet

3. BASIC DATA FOR DESIGN

3.1. Dimensioning conditions

3.1.1. Site Conditions

3.1.1.1. Equipment location

Location will be partly indoor, partly outdoor.

3.1.1.2. Site specific conditions

IPBD need to be designed based on below site data condition.

Site specific condition - 306T2389

Ambient condition, Wind loading, seismic details & structural code requirement are indicated in site specific condition document, IPBD need to be designed based on this data.

4. TECHNICAL GUARANTEES

The Seller shall guarantee the following values for the above-defined operating conditions, without any tolerances/uncertainties other than those specified hereafter. Measurement inaccuracy allowances are included in the tolerances specified.

Approval of design, documents, inspection and tests does not affect the contractual rights of the purchaser, and under no circumstances waives contractual obligations of the seller, especially with regard to design, construction and materials.

The seller is fully responsible for his entire scope of work.

All material shall be new and shall be selected by the seller according to the requirements described in this specification. Only proven type material should be used. Prototypes are not allowed.

Main Features

- No exposed “hot” parts
- Safety proof against contact
- Safety proof against externally caused short circuits
- Protection against dirt and moisture
- “Flux-free” (magnetic field outside the bus enclosure less than 5% of conductor field)
- Low power losses

4.1. Performance Guarantees

4.1.1. Design Point Performance

The Seller guarantees the performance of his equipment as stipulated by the Standards.

The rated continuous current of the main section shall be calculated to match the generator output current with gas turbines operating at their continuous nominal rating, and with generator at rated power factor and generator voltage at rated minimum value.

The temperature during rated continuous current flow shall not exceed the limits given in ANSI/IEEE C37.23 table 5 and 6 -for bus conductors, enclosure and supports.

The main section shall be designed to withstand for a period of one second, the thermal and mechanical effects of an external metallic three-phase short-circuit on generator transformer or generator terminals within the normal variation voltage.

The total losses (conductor + enclosure) shall not exceed {600 W/m/phase1}

4.1.2. Liquidated Damages

The value of liquidated damages and items subject to liquidated damages are fixed in the Purchase Order.

Should the total losses (conductor + enclosure) at rated voltage and rated current (i.e 100% load), as determined by the routine tests, exceed the guaranteed values indicated in Enclosure 1, a liquidated damage will be applied.

The value of the liquidated damages is fixed in the Supplier’s Contract.

4.1.3. Rejection

Should the Isolated Phase Busduct's performances, as determined by the Factory Acceptance Test, fail to comply the standards and the design requirements described in part 4 of this document, Buyer reserves the right to reject the entire equipment.

4.1.4. Other guarantees

The Seller guarantees:

- State of the art design and correct operation in all operating modes and conditions
- Faultless construction and appropriate selection and treatment of material

4.1.5. RAM study

A RAM (Reliability, Availability, Maintainability) evaluation of the total plant down to equipment level will be performed by GE.

To carry out this study the seller has to deliver the following information for the major equipment of his scope:

- MTBF (Mean Time Between Failures)
- MTTR (Mean Time To Repair)
- Any planned inspection and its duration

4.2. Performance Test Requirement

GE's minimum requirements for performance test during Factory Acceptance Test are defined in the 'Quality Control Plan' listed in the Equipment Technical specification.

The Routine, Special and Type tests on LV switchgear shall be performed as per the requirement of listed norms and any other standard referenced in the part 5.1, with a minimum as below. Seller's test programme shall be prepared according to the present chapter. It shall contain project specific test procedures, test values and acceptance criteria.

The seller shall comply with the test requirements of the Shop Inspection and Test Program (ITP), listed the equipment technical specification. The ITP indicates as a minimum the Employer's witness points and the quality records, which have to be handed over to the Employer. Each test required in the ITP shall be clearly referred in the quality documentation with the same test item as in the ITP. The ITP is subject to changes within the first three months after the order.

All the equipment of the IPB system shall be tested in accordance with the applicable portions of IEC62271-200, 60298, 60694, 60076-1, 60044-1, 60044-2, ASME, ANSI IEEE C37-23 and C37-24 and the Specification.

4.2.1. Type tests

Following type tests shall be carried on one unit of each type, to be selected by GE Engineer, after having been subject to routine tests: *For Sellers new to GE, temperature rise should be carried out on each unit.*

Test Description	Applicable Standard *{select applicable check box}*		Remarks
	No.	**clause**	
1. temperature rise test	☒ IEC 62271-200	Sub clause 6.6	The type test on similar equipment are valid
	☐ IEEE C37.23	Section 6.2.2	
2. impulse test	☒ IEC 62271-200	Sub clause 6.6	The type test on similar equipment are valid
	☐ IEEE C37.23	Section 6.2.1.2	
3. short circuit test	☒ IEC 62271-200	Sub clause 6.6	The type test on similar equipment are valid
	☐ IEEE C37.23	Section 6.2.3	

4.2.2. Routine tests

Bus-duct (enclosures and conductors)

Test Description	Applicable Standard *{select applicable check box}*		Remarks
	No.	**clause**	
1. dimensional and visual check	IEC 62271-200	7.5	
2. paint thickness checking	procedures		
3. visual checking of welding			
4. power frequency withstand test	☒ IEC 62271 – 200 ☐ IEEE C37.23	7.1 6.2.1	
5. conformity checking according to drawings			
6. final check prior to shipping, completeness of delivery and Q-Records, release for shipping			

Supporting frame work

Test Description	Applicable Standard		Remarks
	No.	**clause**	
1. dimensional checking			
2. galvanization thickness checking	EN ISO 1461		> 85 μm
3. visual checking of welding			

4. conformity checking according to drawings	drawings	10.3	
5. final check prior to shipping, completeness of delivery and Q-Records, release for shipping	drawings	10.4	

Aluminium sheets:

Test Description	Applicable Standard		Remarks
	No.	clause	
1. checking of the raw material of the chemical, mechanical, electrical properties			
2. visual checking			
3. dimension and tolerances			

Extruded aluminium for conductors:

Test Description	Applicable Standard		Remarks
	No.	clause	
1. checking of the raw material of the chemical, mechanical, electrical properties			
2. visual checking			
3. dimension and tolerances			

Welding wire:

Test Description	Applicable Standard		Remarks
	No.	clause	
1. chemical composition			
2. dimensions checking			

{Porcelain *or* Epoxy} insulators (certificate of conformity to be provided)

Test Description Sample test	Applicable Standard		Remarks
	No.	clause	
1. dimensional checking	IEC 168	10.2	
2. mechanical strength test			
3. temperature cycle test			

4. power frequency puncture voltage test			
5. porosity test			
6. visual checking of surface finish			
7. electrical routine test			

Epoxy resin seal-off bushings (certificate of conformity to be provided)

Test Description	Applicable Standard		Remarks
	No.	clause	
1. visual checking of surface finish			
2. dimensional checking			

Flexible connections copper braids (certificate of conformity to be provided)

Test Description	Applicable Standard		Remarks
	No.	clause	
1. dimensions and finish			
2. thickness of plating of connection pads			
3. adherence test of plating of connections pads			
4. checking of copper wire for elongation, electrical resistance, plating			

Rubber gaskets, ethylene propylene flexible expansion and sealing bellow (certificate of conformity to be provided)

Test Description	Applicable Standard		Remarks
	No.	clause	
1. dimensions			
2. insulation check			

Gaskets in ethylene propylene neoprene silicone (certificate of conformity to be provided)

Test Description	Applicable Standard		Remarks
	No.	clause	
1. dimensions			
2. surface finish			

Pressurization cabinet and junction boxes (certificate of conformity to be provided)

Test Description	Applicable Standard		Remarks
	No.	clause	
1. paint thickness checking			
2. checking of internal equipment			
3. checking of wiring			
4. checking of lockings			
5. dielectric test on auxiliary and main circuit			
6. air circuit test(if applicable)			
7. functional test			

5. DESIGN REQUIREMENTS

5.1. Regulations, codes and standards

The IPB is specified and shall be rated, designed, tested and furnished in accordance with the requirements of IEC. The Seller shall provide in its datasheets reference to the applicable code, standards and/or regulation.

The isolated phase bus duct and accessories supplied shall be the type of self-cooled, metal-enclosed with non-ventilated enclosure and shall be designed, constructed, rated, tested and perform in accordance with the applicable requirements.

In the exceptional case when no standard or code is available, equipment shall be designed, manufactured, installed and tested in accordance with the best current industrial practices. The design will take into account the best available technology, the rules of the trade, and the impact of the equipment on the local environment i.e.: existing/new equipment / buildings.

Where the Seller's standards differ from those specified, the deviation shall be clearly indicated and the relevant standards provided for the product engineer approval.

Units: the international system of units (SI) shall be used with the exceptions as shown.

Equipment designation: the KKS power plant designation system (Kraftwerk Kennzeichen System) shall be used.

The specified equipment shall fulfill the requirements of the latest edition of the standards, as applicable, and of local, state and national regulations, laws and codes applicable at the plant location. If a code or standard contradicts this specification or a requirement of the Product Engineer, the Seller shall indicate such to the Product Engineer and shall request its written directive.

In general, the following codes and standards are applicable for the equipment / system specified according to European standards. Local *{country of plant}* standard has to be considered.

- IEC 60137 Insulation bushings for alternating voltage above 1000 V
- IEC 60060-1 High-Voltage Test Techniques, Part 1: General Definitions and Test Requirements
- IEC 60060-2 High-Voltage Test Techniques, Part 2: Measuring Systems
- IEC 60071-1 Insulation Coordination, Part1: Definitions, principles and rules
- IEC 60071-2 Insulation Coordination, Part 2: Application guide
- IEC 60076-10 power transformers determination of sound level
- IEC 60085 Thermal evaluation and classification of electrical insulation
- IEC 60099 Surge arresters – Part 4 – Metal oxide surge arresters without gaps for AC systems
- IEC 62271-200 A.C. metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to 52 kV
- IEC 62271-102 Alternating current disconnectors and earthing switches
- IEC 60694 Common clauses for high voltage switchgear and controlgear standards
- IEC 60060-1 High voltage test techniques - general definitions and test requirements
- IEC 60060-2 High voltage test techniques – Measuring Systems
- IEC 60044-1 Current transformers (if applicable)
- IEC 60044-2 Inductive voltage transformers (if applicable)
- IEC 60270 Partial discharge measurements
- IEC 60273 Characteristics of indoor and outdoor post insulators for systems with nominal voltages greater than 1000 V
- IEC 60168 Test on indoor and outdoor post insulators of ceramic material or glass for systems with nominal voltage greater than 1000 V
- IEC 60529 Degrees of protection provided by enclosures (IP code)

Due to the lack of an appropriate IEC standard for IPBs, the equipment shall be in accordance to the following IEEE standards:

- ANSI/IEEE-C37-23 Guide for the Metal-enclosed Bus-duct and calculating losses in isolated Phase bus duct
- ANSI/IEEE-C37-24 Guide for evaluating the effect of solar radiation on Outdoor Metal-clad switchgear

5.2. Purchaser standards

Refer to the Equipment Technical specification

5.3. Constructional requirements

5.3.1. General

Each component shall be designed for the useful plant life: 25 years.

It shall be shop assembled to the maximum extent possible with regard to shipment size and unit weight. Lifting lugs shall be provided such as to allow easy lifting with standard lifting gear.

5.3.2. Safety

The system design shall guarantee the highest level of personal safety during its installation, operation, maintenance and repair. The equipment shall comply with international, national and local safety requirements during erection and operation such as:

- Safety notices and labels
- Audible noise levels
- Minimum risk of contact with exposed live parts of circuits operating above a prescribed voltage by use of earthed metal barriers or insulating shrouds and screens: any live metal part of apparatus and terminals energized above 25 V_{AC} or 60 V_{DC} shall be IP20 or shrouded.

5.3.3. Design criteria

5.3.3.1. General data

The manufacturer shall guarantee and be responsible for the strength of all parts to withstand all electrical, mechanical and other forces, as well as thermal effects, under all operating conditions.

A 3-Phase Isolated Phase Bus-duct (IPB) with Conductor and Enclosure made of aluminium (99.5%) shall connect for the GT IPB the generator terminals and Generator step-up transformer.

The main sections of the IPBs shall be capable of transferring the energy from the power plant into the main transformer/HV network. The IPBs shall be designed for outdoor /indoor installation, depending on location; for the detailed location, refer to the general arrangement in the equipment technical specification.

Connections lengths for GT IPB:

Main bus length per unit (addition of the length of the 3 phases)	: 80 m

5.3.3.2. Electrical data for GT IPB

Rated Nominal Voltage	:	18 kV
Bus rated voltage	:	29.5 kV
Rated frequency	:	☐ 50 Hz ☒ 60 Hz
Rated Impulse Withstand (BIL)	:	125 kV
Rated Frequency Withstand (dry 1 minute)		50 kV

Main bus

IPB Continuous Self Cooled Current Rating (according ANSI/IEEE-C37.23 and considering Solar radiation on outdoor part according ANSI/IEEE-C37.24)	:	8.5 kA at 40 deg C ambient Temperature
3-Phase Initial Peak (I_{p3})	:	245 kA peak
3-Phase Initial Symmetrical ($I_{k3''}$)	:	125 kA rms
1-Second Thermal Symmetrical (I_{th})	:	90 kA rms

System data

Temperature rise at 40°C ambient temperature, according ANSI-C37.23

IPB Conductor hottest spot, at termination	:	65 K
IPB Enclosure hottest spot, at termination	:	40 K
Final Temperatures conductor / enclosure	:	105 / 80°C

5.3.3.3. Construction data

Degree of protection	:	IP65
Painting colour (IPB, cubicles)	:	RAL7032 (Pebble Grey)

5.3.3.4. Auxiliary voltage

If required		
- Rated voltage	:	240 VAC +10% / -15%
- Earthing mode	:	TT

5.3.4. IPB general description

This specification covers an outdoor/indoor, self-supporting, leak-tight IPB (Isolated Phase Bus-duct) system and all supports, flexible conductors for termination, duct expansion joints, and miscellaneous materials required to install the equipment at the site and to provide a continuous AC power bus assembly that meets all requirements as stated in applicable industry standards and included specifications. Particular attention shall be given to the necessity for withstanding without damage or danger, the electromechanical forces and static and dynamic stresses which may arise during normal conditions, vibrations, fluctuations in temperature, flash-over or other circumstances.

IPB shall be design that the dismantling of equipment connected will not be obstructed by non-dismountable IPB part.

The design shall be such that any mechanical damage caused by a fault on the connections themselves should be confined as far as possible to the immediate vicinity of the fault.

All interfaces of the Isolated Phase Bus-duct System with the Generator and all connected transformers are in the full responsibility of the IPB System Seller.

Seal off bushings shall be provided after the flexible conductor braids of the IPB, for the generator connections.

The IPB enclosure at the generator connection after the seal-off bushing shall have openings (air exits) of the least **50,000 mm2** per phase at the upper part (highest point) and at the lower part at least **45,000 mm2** per phase.

The entire Bus-duct shall be supplied as a complete and properly co-ordinated system and be checked at the manufacturing facility to insure an easy and smooth field installation process.

5.3.5. Isolated phase bus construction

The Isolated-Phase Bus-Duct System shall consist of the proper components required to have a complete field-installed system.

Fixing points for supports and short-circuit bridges have to be welded in factory. As a general rule shall apply: all welding that can be executed in the factory are mandatory to be finished before shipping. All welding that have to be executed on site shall be clearly marked with “site welding” on erection drawings. Bus-duct section design of elbows and tee taps shall minimise field welding, especially at the intersections of elbow legs and main bus-duct.

Sufficient amount of **welding wire for site welding** has to be supplied. The amount of site welding, including type of wire has to be indicated in enclosure 1.

Bus-duct assemblies, each phase separately, shall be self-supporting suitable for damage free pick-up by mobile crane on site. Packing shall be such that IPB assemblies arrive on site undamaged.

Each section shipped shall be suitable for overhead lifting, interstate trucking, as a complete assembly, and compatible with transport operation without the need for special permits or escorts.

The IPB system shall be designed to allow a possible settlement of 20 mm between the building and the outdoor Bus-duct structure foundation.

The Bus-duct systems shall be designed to allow a construction tolerance of ±20 mm alignment in any lateral or longitudinal direction between the positions of all Electrical Equipment Assemblies connected to the IPB Duct.

The Bus-duct system shall be designed with expansion joints to allow linear expansion of IPB, without causing any stress in the IPB itself or any of the electrical equipment connected to the IPB Duct.

It is the responsibility of the IPB Seller to co-ordinate the IPB to the following equipment:

- Generator Terminals
- Generator Step-up transformer low voltage terminals

If any information is required from GE, it shall be the Isolated Phase Bus-Duct Seller's responsibility to request such information in writing from GE.

5.3.6. Bus-duct enclosures

Enclosures shall be of the continuous bonded type designed to safely carry circulating currents without exceeding the allowable temperature rise.

The IPB enclosure shall be dust-tight and weatherproof.

The individual phase enclosures are separated from each other. At each end of the connection, the enclosures are short-circuited between themselves by aluminium sheets welded onto the enclosure giving the induced current free passage from one enclosure to another. For this type of connection, the magnetic field, outside the enclosures, resulting from normal service is practically nil. Losses generated in the nearby metal structure are therefore practically nil, and there are no particular measures due to the IPB to be considered for their temperature rises. The same applies to the reinforced concrete walls and support platform near to the isolated phase bus routing.

Electromagnetic stress caused by the short-circuit AC components is negligible. Only stress caused by the difference between the enclosure and the conductor short-circuit DC current components will remain. This stress is used to define the distance between two insulator groups and the spacing between IPB support structures.

All field-welded connections shall be furnished with bevel preparation for welding (if applicable).

Easy access to all insulators shall be provided.

The indoor-outdoor construction shall consist of a building wall-pass frame and support plate of non-magnetic material with a weatherproof barrier. The wall-pass frame furnished shall fit the building opening provided by others.

Seal-off bushings shall be provided to prevent flow of air between bus-duct sections to wide differences in temperature.

Condensate discharge drains shall be provided at low points for removing trapped moisture.

The enclosure sections must be adequately braced by support structures, as required at the generator and generator circuit breaker enclosures.

The positioning and attachment to the related building surfaces or structures must be properly co-ordinated by the IPB seller.

The grounding system shall be in accordance to the Generator Bus Duct Enclosure Earthing / Grounding Principles (see equipment technical specification). The delivery shall include all accessories and **flexible-grounding conductors** to connect the IPB enclosure to the Generator and Generator Step-up Transformer. **The Bus-duct enclosure of phase L1 will be used as grounding bus for the complete generator output system up to the generator Step-up transformer.** The IPB is only connected to the grounding grid at designated points.

The Bus-duct enclosure shall be electrically isolated from the support structures. The support structures will be grounded separately. The IPB enclosures shall be electrically bonded to minimize induced currents in the surrounding metal structures. Each bus-duct enclosure and each electrical connection between bus-duct enclosures shall provide a continuous path for currents equal to the maximum current ratings of the enclosed bus.

The enclosure currents, which are thereby, built up reach as much as 95% of the conductor currents. The magnetic field outside the enclosure is almost completely, compensated thus eliminating losses to the surroundings.

Measures shall be taken to ensure sufficient electrical conductivity at the bolted connection between parts of the enclosure, to reduce the appearance of hotspot. This includes sufficient bolts in number, size and torque and absence of paint at the contact surface (keeping corrosion protection).

5.3.7. Bus-duct conductor

The bus-duct conductor material shall be **tubular or octagonal** shaped in **aluminium 1050A** (99.5%) as required to carry the continuous rated current and supported on epoxy or porcelain insulators.

The Bus-duct system shall be capable of withstanding the specified short circuit currents.

The Isolated Phase Buses are delivered fully workshop prefabricated. The conductors are placed in their enclosures set onto their definitive support insulators, which have been suitably adjusted. Temporary blocking devices will be fixed between the conductors and enclosures to keep the conductors in position until the bus sections are assembled on site.

All field-welded connections shall be furnished with bevel preparation for welding.

Bolted bus joint terminations must be silver-plated. Stainless steel bolts, nuts, and except spring washers shall be used.

5.3.8. Bus-duct electrical equipment termination

The IPB Seller is responsible to co-ordinate and supplies all hardware, flexible connectors, expansion joints, gaskets, etc., required to connect other electrical equipment to the IPB Duct.

Flexible connectors shall be provided at every IPB ducts connection to other electrical equipment. These connectors shall be properly sized, flexible, silver plated copper extension braids.

The flexible copper braids shall be designed such that the minimal clearance distances to other live parts, ground or insulating barriers according to the relative standard will be guaranteed.

The flexible connections are bolted at both ends. The bolts are tightened by means of a torque wrench according to the torque setting stated in the assembly drawings and erection instructions. The contact surfaces (joining points) of IPB are silvered.

The IPB Duct System shall be designed to provide sufficient isolation space between consecutive conductor lengths to allow for equipment testing purposes when the flexible connectors are removed.

The short-circuit bridges shall be provided at every IPB ducts connection to other electrical equipment The short circuit bridges are sized so as to guarantee the temperature rises stated for the enclosures and to match the short-circuit withstand capacity.

Enclosure's connections to the generator circuit breaker will be welded on both sides.

It shall be the responsibility of the IPB seller to co-ordinate the design of the **IPB duct connection at the Step-up transformer,**. It has to be possible to lift the bushing from above, with a sling attached to a mobile crane. Any non-dismountable IPB connection parts shall not obstruct the above procedure.

In designing the layout of the connections to these terminals particular attention must be paid to satisfying the following requirements:

- It shall be possible to gain access for the withdrawal of the generator rotor with the connections in position.
- It shall be ensured that the minimum possible quantity of parts need be disconnected or removed in order to allow the generator stator to be changed and to facilitate reasonable general maintenance on the generator.
- The arrangement of the sheaths and their associated supports shall be such that the generator transformer and the unit/station service transformer may be removed with the minimum of disturbance thereto and a replacement transformer can be put into operation easily, without modification to the transformer or to the connections and sheaths

Grounding connection points (for maintenance) for connection of temporary short-circuit and grounding device, including inspection cover plate {with transparent window} shall be provided.

5.3.9. Bus-duct insulators

Insulators should be **"porcelain or epoxy type"**, with sufficient long creepage distance to allow for safe operation for the useful life of the equipment. They should be mounted in such a manner as to allow movement of the conductor due to expansion and to provide strength and absorption of forces created by short circuit currents.

Each insulator is fitted onto a support which is welded on the enclosure. The support is fitted with an inspection door which is used both for assembly and dismantling of the insulator.

The fitting of the head of the insulators on to the conductor may be either fixed or loose to allow for the expansion of the conductor

5.3.10. IPB supports

Full IPB Support components shall be provided by the IPB Seller for field installation of IPB.

For IPB support supply detail please refer to IPBD layout drawing number 309T0535.

All supports shall be of hot dip galvanised steel angle bars, with all necessary hot dip galvanized anchor bolts, bolts, nuts and washers.

The Bus-duct supports shall be designed to carry all forces caused by static and dynamic loads of the IPB, without creating any stresses at the termination of the electrical equipment connected to the IPB.

All supports shall be connected to the main grounding grid.

Following has to be supplied:

- All supports indoor and outdoor including all necessary anchor bolts, bolts and nuts.
- All supports as mentioned in drawing number 309T0535 need to be supplied.
- Machine hall: IPB can be supported onto the steel structure of the building
- Grounding material for supports.

The design of the IPB and its supports shall conform to the drawing “Transformers & Generator Bus-duct – General Arrangement” and the other detailed equipment drawings, refer to the Equipment Technical specification.

5.3.11. Mobile grounding & short circuit device

An appropriate mobile grounding & short circuit device including medium-voltage detector and insulating rod shall be part of scope of supply for each unit, for the grounding points indicated at the chapter 5.3.8.

5.3.12. Pressurized air system, cabinet

The Isolated Phase Bus-duct system shall be pressurized with a slight positive pressure dry air to

prevent condensation, moisture ingress, corrosion, etc. It shall be connected between the generator, the generator transformer, (The pressurized air is supplied by others, refer to the equipment general technical requirement for air specification)

The air consumption is limited to 3% to 5% of the enclosure volume per hour.

The system shall include but not be limited to the following components:

- Pressure regulator to reduce incoming instrument air supply to a pressure suitable for the IPB enclosure.
    - The following alarm signals shall be provided in the terminal box. It shall be provided on dry contact.
    - Low pressure-, high pressure- alarm for IPB air pressure:

- In case of the necessity of a power supply to the pressurization cubicle, power loss-alarm (fail safe)

- Local pressure gauge for IPB pressure and pressure gauge for supply pressure visible via sight glass. The pressure gauges shall be mounted at convenient height so that a person standing on the ground can easily read it.

- Necessary pressure relief devices and schemes.

The protection degree of the pressurization cubicle shall be IP54

5.3.13. Anti-condensation heaters, junction boxes

When applicable, space heaters with thermostat control shall be foreseen as are necessary to avoid condensation built-up in the event of cooling off in the bus-duct. A minimum of 12 pieces shall be

installed at, but not be limited to:

- 3 pieces at step-up transformer connection

- 3 pieces at generator side

The heaters are to be rated for 240 VAC, single phase.

The heaters have to be split up into a minimum of two groups. A minimum of two power supply cables will be connected to the junction boxes located on the bus-duct. All other heaters shall be connected in parallel to this two power supplies.

The junction boxes are to be provided by the busduct supplier.

The junction boxes shall be equipped with space heaters. GE will supply a total of two (2) single phase supply feeders.

Provide complete instructions for field construction, including but not limited to, schematic showing

how to interconnect the various Isolated- Phase Bus-Duct section heaters circuit, termination junction boxes and showing heaters terminations junction boxes location and identification.

The installation material (conduits, fittings, junction boxes, etc.) for the connection and installation of the heaters shall be supplied with the bus-duct.

The general alarm for the protection MCBs has the following position: The protection degree of the junction boxes shall be IP65.

5.3.14. Internal wiring *{see electrical equipment, general requirement}*

5.3.14.1. Wiring

Wiring cables shall be of stranded copper conductors having a PVC, heat-resistant and flame-retardant insulation. Wiring cables shall be rated for 0,6/1,0 kV, cross-section 1.5 mm2 of this document. Interconnection between transport units shall be

factory pre-wired with prefabricated, multi-core cables and identified in accordance with installation drawings.

Each wire shall be permanently identifiable at each termination in accordance with the reference designation of the terminal and device to which it is connected. When markers are used, they shall be of isolating, heat and moisture resistant material. Split marking type (Phoenix PATO or equivalent) is not allowed.

Rigid, heat-resistant and flame-retardant wire ways (or cable-ducts/conduit) with snap-on covers shall be provided for all wires. Movable wires shall be protected with flexible conduits. Each wire way shall be sufficiently sized to have at least 20% spare space.

5.3.14.2. Wiring colour code

- Bicolour combination green and yellow is reserved for the protective conductors. Protective conductor wires shall be bicolour green and yellow.

- The colour blue is reserved for the neutral conductors. Neutral conductor wires shall be blue.

- The internal wires that are not blue or green/yellow shall be black.

5.3.14.3. Terminal blocks

External circuits shall be connected to electrical equipments by means of interface terminals blocks. The connection of more than one wire to one terminal is permitted only where the terminal is designed for that purpose.

Terminal blocks shall be mounted on metal rails type DIN NS35:7.5, NS35:15, NS32. They shall be located at the side (vertically) or bottom (horizontally) of the enclosure so as to allow easy cable connection. Terminals shall be of non-hygroscopic and non-flammable material. Terminal blocks energized above 25 VDC or 60 VAC shall be separated shrouded or IP2X.

Terminals for power cables shall be of screw type, rated for at least 600V/20A and suitable for the used cross-section.

Terminal for control cables shall be of screw or spring-cage type, suitable for wires from 0.2 to 6 mm^2. On each terminal block for control cable, 20 % spare terminals (minimum 4 in number) shall be mounted.

Protruding insulating barriers shall separate adjacent terminals which wires of different voltage, polarity or phase are connected to. Terminals and terminal blocks shall be clearly identified. Terminals shall be numbered consecutively, beginning from left to right or top to bottom.

5.3.15. Interchangeability

All IPB parts, components and modules of same rating and application shall be identical and interchangeable. Where the supply includes several identical items of equipment, each of the constituent parts of one item shall be identical to and interchangeable with corresponding part of the other items.

5.3.16. Nameplates and labels

Nameplates have to be supplied according the applicable standards. They shall be engraved in English. *{or other language}*

Nameplates shall adequately mark the busduct systems and shall indicate at least the following:

- KKS number and system description
- Manufacturer's name
- Type designation or identification number
- Applicable standards
- Rated voltages
- Rated current and frequency
- Rated duration of short circuit
- Rated short-time and peak withstand currents

All instruments, valves and devices shall be functionally labeled both on and next to the device, having the same designation as in the seller's documentation.

6. DOCUMENT SUBMITTAL

The Seller is requested to issue with their bid (and included in the level 2 specification) a Design and Manufacturing Schedule indicating the design process stages:

- Concepts freeze
- Basic Engineering activities
- Internal Design review schedule (GE will indicate participation)
- Detail design freezes dates
- Placing of orders dates
- Interface design reviews and freeze with GE, Arrangement, Electrical

6.1. Document Code Number

Documents shall be prepared in accordance with the project document rules listed in the Equipment Technical specification. The document code numbers are defined in the document submittal list (see technical specification).

6.2. Document Delivery Schedule

Documents shall be delivered in accordance with the schedule listed below. Vendor shall indicate agreement with this schedule by placing an "X" in the box or propose an alternate schedule in writing along with the bid. Blanket exceptions to the schedule or such as "drawings will be available 6 to 8 weeks after receipt of order" will not be allowed. GE reserves the right to not evaluate proposals with schedule not filled in or which do not comply with the required end-customer document delivery requirements.

Description	DIS Code	GE Required Date	Vendor Proposed Date
Equipment Outline	DIS-106	4 weeks from PO	
Equipment Elementary	DIS-110,112	4 weeks from PO	
Operation & Maintenance Manuals	DIS-201	4 weeks from PO	
Two Year Recommended Spare Parts	DIS-202	4 weeks from PO	
When supplier requires completion/approval of all drawings to support their manufacturing and shipping requirements.			

Operation & maintenance manuals and two-year recommended spare parts lists shall be distributed per DIS-201 and DIS-202, respectively.

Field-marked prints will be returned to the supplier after installation is complete. "As Installed" prints shall be prepared per DIS-132 and shall be revised and resubmitted two (2) weeks after receipt of the field-marked prints

6.3. As-built documentation

At about the time of the contractual acceptance of the overall power station by the Employer, the Seller shall modify and reissue all its impacted drawings and documents based on site records (red correx). In the case the site activities are not in the Seller scope, the Product Engineer will transmit the site records.

From the transmittal date of the site records, the Seller shall submit the revised drawings and documents within three (3) weeks. The revision is to be marked "record issue" (instruction will be given together with the red-marked drawing).

The drawings that are part of the final documentation are, in addition to the .pdf files, to be ended-over in native format (.dwg is the preferred format).

7. SHIPMENT AND FIELD SERVICES

7.1. General

Refer to the packing and shipping requirement listed in the purchase order. In general, no equipment shall be released for packaging and shipment without GE's shipping release instructions.

7.2. Packaging, transportation and handling

All parts shall be marked for identification and suitably preserved and packed according to GE's Packing, marking and material handling instruction – refer to the purchase order.

Silver plated shall be protected with grease and cover.

Section openings shall be protected against dust with plastic cover.

7.3. Storage

If required, the Seller shall provide temporary storage of the specified equipment to comply with the shipment schedule.

In addition the Seller shall provide storage conditions and procedures to GE transport department – refer to the purchase order -, if the delivered equipment has to be stored by GE after take-over. Detailed information has to be provided for storage before and/or after dismantling of the packaging.

7.4. Erection

Erection is carried out under the supervision of GE's site management in compliance with the Seller's erection instructions.

7.5. Commissioning

Commissioning is carried out under the supervision of GE's commissioning engineer.

8. ENCLOSURE 1: EQUIPMENT DESIGN DATA (TO BE PROVIDED BY SELLER)

8.1. Documents to be submitted with tenders

The following documents shall be submitted to GE with the Seller's bid.

- **List of deviations:** If any deviations exist between the Seller's tender and the requirements of this specification, its enclosures and reference documents, the Seller shall list them giving the exact reference. If there is no deviation, the Seller shall give a written acceptance of the complete GE's specification, its enclosures and reference documents. This list will be part of the *specification level 2*.
- Below part 8.2 filled by the Seller
- Documents listed in the document submittal list as "Doc required with offer"

8.2. Equipment design data to be submitted with tenders

The following data shall be submitted to GE with the Seller's bid.

8.2.1. General information

Seller's name	
Factory location	
Project	
Equipment	Isolated Phase Busducts
KKS designation numbers	
Design max. ambient temperature [°C]	
Design min. ambient temperature [°C]	
Design average ambient temperature [°C]	
Seismic capability	

8.2.2. Main components

	Manufacturer	Country of Origin
Conductor		
Enclosure		
Insulator		

Auxiliaries (please precise):		
Partial discharge sensor type (catalogue/ brochure to be submitted with offer)		

The Seller shall submit with his offer the data sheet/pamphlets of the main components.

Applicable standards

List of considered standards:

	IEC	
	IEC	
	IEC	
	IEC	
	IEC	
	IEC	

8.2.3. Electrical data

Rated operational voltage [kV]	
Rated maximum voltage [kV]	
Rated Frequency [Hz]	
Rated impulse withstand voltage [V]	
AC test voltage for power circuit [kV]	
Rated Frequency Withstand voltage (dry 1 minute) [kV]	

8.2.4. Construction data for GT IPB

Main bus		
Conductor type /material		
diameter [mm]		
thickness [mm]		
square section [mm^2]		
weight [kg/m]		
Enclosure type /material		
diameter [mm]		
thickness [mm]		
square section [mm^2]		
weight [kg/m]		
Insulator type /material		
creepage distance [mm]		
Rating:Current		A @40+C
Guaranteed Losses conductor + enclosure		W/m/phase
S/C withstand current Ik3"		kA rms
Ip3		kA peak
Ith (1 sec)		kA rms
Final Temperatures at ___ °C ambient at ___ °C ambient at ___ °C ambient at ___ °C ambient	Conductor °C °C °C °C	Enclosure °C °C °C °C
Max. Temperature rise at Generator Breaker Connection	Conductor °C	Enclosure °C
Protection Class (IP)		
Sun shade	Yes/No/Option	

Branch bus		
Conductor type /material		
diameter [mm]		
thickness [mm]		
square section [mm^2]		
weight [kg/m]		
Enclosure type /material		
diameter [mm]		
thickness [mm]		
square section [mm^2]		
weight [kg/m]		
Insulator type /material		
creepage distance [mm]		
Rating:Current		A @40+C
Guaranteed Losses conductor + enclosure		W/m/phase
S/C withstand current Ik3"		kA rms
Ip3		kA peak
Ith (1 sec)		kA rms
Final Temperatures at 40 °C ambient at 45 °C ambient	Conductor °C °C	Enclosure °C °C
Protection Class (IP)		

Continuous Current rating vs. ambient temperature of main IPB

Ambient temperature	**Continuous Current Capability**	
	Indoor [A]	**Outdoor [A]**
°C		
°C		
°C		
°C		
°C		

8.2.5. Bill of quantities

Item	Quantity	
	Main bus	Branch bus
One phase length	m	m
One phase angle	unit	unit
One phase T-off	unit	unit

8.2.6. Accessories

Item	Quantity
Type and diameter of welding wire	
Length of site welding One phase angle	
Amount of delivered welding wire	
Grounding device type	
Voltage detector type	

List of spare parts	Quantity