WHITE PAPER

The Criticality of Proactive Maintenance on Isolated Phase Bus Duct Systems

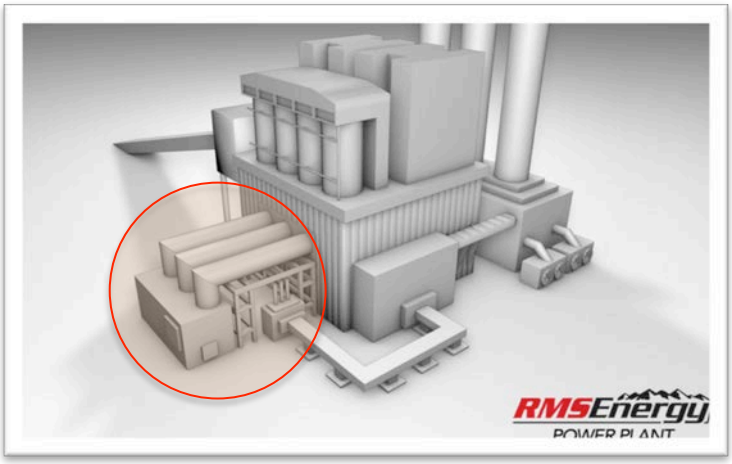
Introduction

Isolated Phase Bus Duct (IPBD) is the main conduit for power distribution in a power generation facility. With current carried between the generator and a step-up transformer solely via the IPBD system, it is the undisputable critical core of any power generation operation. The need for proactive maintenance cannot be overstated in order to mitigate the risk of repairs, downtime, or catastrophic equipment failure that often occur due to lack of inspections or continual improvements.

What is an Isolated Phase Bus?

Isolated Phase Bus (IPB) is used to carry very large currents, typically between a generator and a step-up transformer, in power generation facilities.

Each phase conductor is enclosed in its own separate grounded metal housing, with each housing separated from each other by air. By enclosing conductors in separate housings there is considerable protection from faults between the generator and the transformer. Conductors are generally hollow aluminum tubes or aluminum bars, supported within the housing on porcelain or polymer insulators. There are generally two types of housings: continuous and non-continuous, with the latter being the older design requiring more maintenance.



IPB systems are designed to carry continuous current ratings of 3,000 amperes to 45,000 amperes, and rated for voltages from 5kV on up to about 38kV. With larger current ratings, a forced cooled system is used to blow air through the enclosures in order to maintain ANSI set temperature limits. The cooling air is then typically re-circulated through a heat exchanger before reentering the bus.

IPB systems are usually custom designed for a particular plant and can be just as unique to maintain.

Other types of bus systems include:

- Metal-enclosed segregated phase bus
- Cable bus duct
- Non-segregated Phase Bus (NSPB)

IPB and Bus Duct System Failure Can Be Prevented

As fast as demand on power is increasing, the tolerance for any system downtime is diminishing. It's essential that power generation facilities invoke a proactive inspection and maintenance program to ensure that critical power transmission systems operate without interruption. The key to more uptime is preventative maintenance.

System failures can occur from a variety of sources, including condensation, debris, dirt, poor grounding, cracked weld joints, and even improper installation. Proper inspections, cleaning and monitoring of your IPB system is crucial to creating a routine maintenance plan that will help to ensure parts are undamaged and equipment is running optimally.

The Process of Maintenance

Some of the best preventative maintenance processes in the industry are customized to each situation or facility. Such processes typically include:

- **Full diagnostics**, which use a combination of approaches to identify weaknesses and damage, including a complete visual inspection, thermal imaging, EMI diagnostics, and Hi-Pot and Megger testing to identify damaged support insulators, corrosion, faulty bus connections, stray currents, defective insulation and damaged hardware.

- **Comprehensive analysis**, which combines all data from the diagnostics to give the facility a full report on the findings.

- **Proposed solutions**, which outlines a prescribed plan to repair any damage or system weaknesses, ensuring proper material inventory before the job starts, as well as providing appropriate documentation.

- **Implementation**, which executes on the approved solutions plan to perform the cleaning, repair, or replacement of any weak or damaged hardware, insulators and/or gasket material.

- **Testing**, to ensure that the IPB is properly restored and performing optimally.

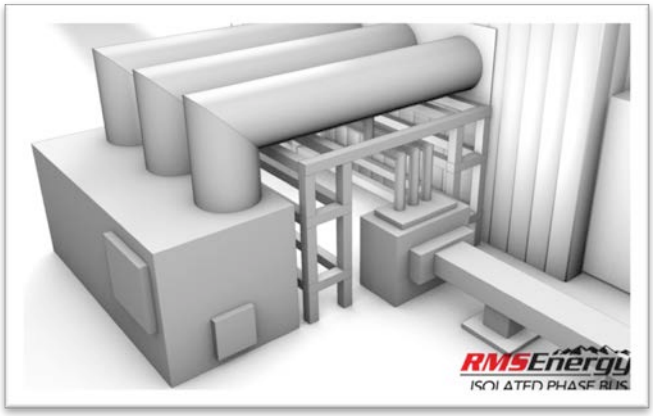
Service Approaches to Maintenance

IPB systems are not maintenance-free. Often, plant managers will make an incorrect assumption that IPB systems are self-maintained with little human intervention needed. However, IPB systems should be treated with utmost importance, being inspected, cleaned, monitored and maintained on a regular basis for optimal performance.

Typical service approaches to maintenance of IPB systems include:

- Cleaning bus walls, equipment and insulators, inside and out
- Removal of debris or other loose material from the bus enclosure
- Replacing insulators that are damaged or aged
- Re-silvering of plated terminals
- Verifying ground connections

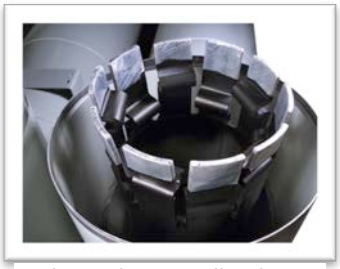
Components of IPB That Need Regular Inspections



There are several critical components of IPB systems that must be inspected regularly and maintained proactively. These components include:

- Termination assemblies / Expansion joints *(including flex connectors and bellows)*
- Insulators
- Grounding connections
- Seal-off bushing
- Drain plugs

Termination Assemblies / Expansion Joints



Above: Aluminum alloy shunt

Termination assemblies connect the bus duct to other equipment. These assemblies are in enclosure chambers that include flexible connectors, copper adapters and most typically, stainless steel hardware. Targeted visual inspections should be performed on torque values for hardware, signs of pitting, heating and other surface irregularities, as well as proper application of grease to prevent corrosion. Expansion joints are usually welded

laminated shunt assemblies on the conductor that allow for expansion, contraction, vibration and minor system alignment. Shunts are factory welded at one end and welded to the conductor at the other end. Inspections for heating, surface degradation, and delamination should be preformed regularly. Such inspections will uncover problems that can prevent terminations, expansion joints and disconnect links from degrading or failing, and to ensure that shunt connections are strong on either end of the weld.

The current-carrying joints of the IPBD system are the flex connectors, which can be either laminated or braided type and are critical to the primary power flow. Laminated flex connectors should have regular visual inspection to look for cracks in the lamination and general delamination, as well as corrosion, discoloration or signs of heat. Braided flex connectors need inspection to uncover fraying or heating. Both types need to be inspected for over-torqueing of the connecting hardware (embossing) or under-torqueing, which can cause heating problems.

Above: Damaged bellow (top); Repaired bellows (bottom)

Bellows are also key components to expansion joints, reducing the chance of cracking in the joints to allow for the expansion and contraction of the IPB system.

Various types of expansion bellows include: **Bolted type**, requiring higher levels of maintenance; **Welded type**, requiring low levels of maintenance; and **Rubber boot**, also requiring a high degree of maintenance. All bellows, regardless of type, are critical to the IPB function and must be inspected regularly for irregularities, cracks, tears or other forms of damage.

Insulators

Above: Cracked insulator

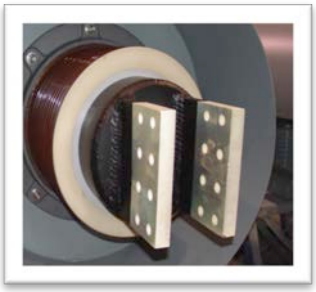
Wear and tear on insulating material most often results in Electrical Partial Discharge (EPD). EPD is the discharge of electricity through worn or damaged insulation, which can cause major equipment degradation and lead to electrical fires.

Various types of insulating material, like epoxy, porcelain, fiberglass and silicone, should be inspected for dust, water, moisture, and hairline cracks.

Grounding

There are typically two types of grounding schemes for isolated phase bus duct, single point or multipoint. Cable and ground pad condition must be verified as well as proper bolting. Improper grounding can create circulating currents and heating of nearby or connected equipment such as steel support structures. If grounding problems are suspected, please contact us for further investigation.

Seal-Off Bushing



The seal-off bushings prevent potential migration of hydrogen, fire, or debris by isolating one section of bus from another. They provide a barrier at the building wall, firewall or generator termination.

Cracks, moisture, seal quality, and the distance between the conductor and the enclosure are critical maintenance inspection points to maintain seal integrity.

Drain Plugs

In lieu of a heater or air pressurization, drain plugs are often used to accommodate for moisture drainage from critical components for a lower cost alternative. The inside of the Isolated Phase Bus Duct must be completely dry to avoid a potential flashover. Inspection of drain plugs is essential to identify any potential blockage to ensure water outflow is uninterrupted.

RMS Energy Co, LLC is a professional nationwide construction and consulting firm with highly trained and experienced installation professionals who perform all aspects of Isolated Phase Bus (IPB) duct inspections and maintenance, including removal, reinstallation, retrofitting and testing. Our services also include cutting, aluminum welding, and transformer termination compartment removal, reinstallation, and provision of replacement parts. We work with the main bus manufacturers to deliver a turnkey solution to you. With an industry low EMR, our priorities are focused on safety, quality, schedule and budget.

RMS ENERGY CO., LLC
www.RMSEnergy.com | 888-683-3630