

Development of High Temperature Insulated Bus Pipe (HTIBP) for High Energy Naval Systems

A Path Forward Plan – Update

HIGH TEMPERATURE INSULATED BUS PIPE GAS
FLAME CIRCUIT INTEGRITY TESTING

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Background:



- In October 2004, PMS-378 tasked NAVSSES Code 982 to evaluate commercial Insulated Buspipe (IBP) products from two foreign vendors. Testing that was performed in FY 2005 provided good results with the exception of flame / heat resistance. The samples failed to pass the Naval 3 hour Gas flame Circuit Integrity (GFCI) test.
- An SBIR was funded beginning in FY 2007 to develop IBP using high temperature (HT) insulation (N07-201, UniTech LLC). A polyamide resin developed by NASA called RP-46 was used as the insulation material. RP-46 Insulation curing issues are still unresolved. UniTech LLC completed Phase II without positive results. The SBIR Project has not been extended at this time.
- In FY11 a NSRP Panel Project called 'Insulated Bus Pipe Installation Methods' was completed. A follow on NSRP Special Project was initiated to identify potential HTIBP vendors. With no vendors ready to produce 'production' level parts, this special project was cancelled.

Background (cont):



- Subsequently in early 2014, ONR 33 and NSRP provided NAVSSES, Code 982 funding to identify and investigate other vendor's products and to perform testing on any promising products identified.
- A Russian company (with a manufacturing facility underway in New Orleans) called Telefen GmbH has a 3 phase IBP product that uses high temperature insulation. They also manufacture a single phase IBP, but is not presently high temperature rated.
- Telefen offered to ship a high temperature rated 3 phase IBP to the Navy for 3 hour GFCI testing. The plan was that if the 3 phase product successfully passed the 3 hour GFCI test, that Telefen would develop a single phase high temperature IBP sample for additional GFCI testing
- Telefen shipped the sample to NAVSSES in August 2014. Aero Nav labs in College Point, NY was contracted by National Ship Research Program (NSRP) to perform Navy 3 hour GFCI testing on the 3 phase Telefen provided sample. The sample was shipped to Aero Nav in October 2014. The 3 hour GFCI test was scheduled to be performed on November 18th.

Approach:

- The Navy 3 Hour GFCI test plan was followed for this testing.
- A 24" ribbon burner was placed across the three phases of the Tefefen sample. A Hi-pot was used to provide the 8 kV to the center terminal, while the outer two terminals were connected to the return ground of the Hi-pot. The current was monitored by the meter on the Hi-pot.
- Since the sample was open ended, the only current is a small leakage current that is determined by the capacitance of the sample.



Figure 1: Set up showing 3 Phase IBP sample, Gas piping, and electrical connections.

Test Underway:

- When the setup was complete, the gas flame was ignited and set as described in the test plan. Then the Hi-pot was energized and set to 8 kV. The initial leakage current was 3.6 mA. If the leakage current exceeds 250 mA, the sample is considered to have failed the test.
- The time was 1350 when the flame and voltage were applied.
- Within a few minutes, white smoke and a yellow flame appeared on the sample just above the gas burner. A call to Telefen confirmed our suspicion that a layer of varnish had been applied to the sample and it was burning off. After about 10 more minutes the smoke and yellow flame had dissipated.
- The leakage current was monitored every 15 minutes. It remained constant at 3.6 mA. At 1650, the test was complete with the sample passing. Photos of the test are presented below:

Photos of Test



Figure 2: Hi-Pot used to provide 8 kV to sample

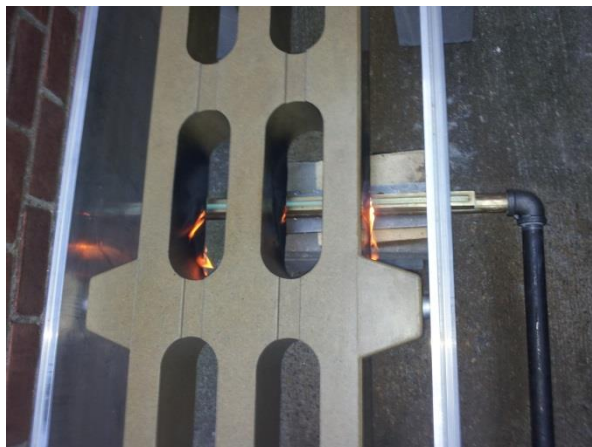


Figure 3: Yellow flame due to surface varnish burning off.

Photos of Test (cont):



Figure 4: Yellow Flame and Smoke dissipated after a 30 minutes



Figure 5: Hi-Pot set at 8 kV and leakage current holding steady at 3.6 mA

Summary:



- Owing to the success of this 3 phase Telefen IBP sample in this flame test, Telefen has agreed to develop a single phase HTIBP that will be made available within a few months to the Navy for further gas flame testing.



Figure 6: Telefen Single Phase IBP rated at 15 kV at 1300 Amps.

- In addition to that testing, a full HTIBP qualification test program will be prepared and presented to the NAVSEA electrical tech warrant holder for concurrence. An ONR swampworks effort will be proposed to fund this effort.



BACKUP SLIDES



Electrical Energy Demands of Future



Combatants

- Established trend of ever increasing electrical power requirements
 - Hybrid Ship Propulsion utilizes electrical energy as a conversion medium
 - Directed Energy Weapons utilize electrical power vice explosive propellants
 - Increased surveillance capability needs result in higher electrical power requirements
 - EMALS allows for sophisticated launch control, uses electrical power vice steam

Increased Electrical Requirements result in challenges to distribute Electrical Power

Challenges IBP Resolves



- Power Cables become large and unwieldy
 - High Power circuits require multiple conductors
 - Dangerous and time consuming to install / connect
 - Bend radii are large, compartments are dedicated to changing direction
- Insulated Bus Pipe
 - Accepted to reduce weight and space claims
 - Can be installed as part of blocks/modules and then connected
 - Turns are prefabricated, thus small radii are possible

US Navy History of IBP



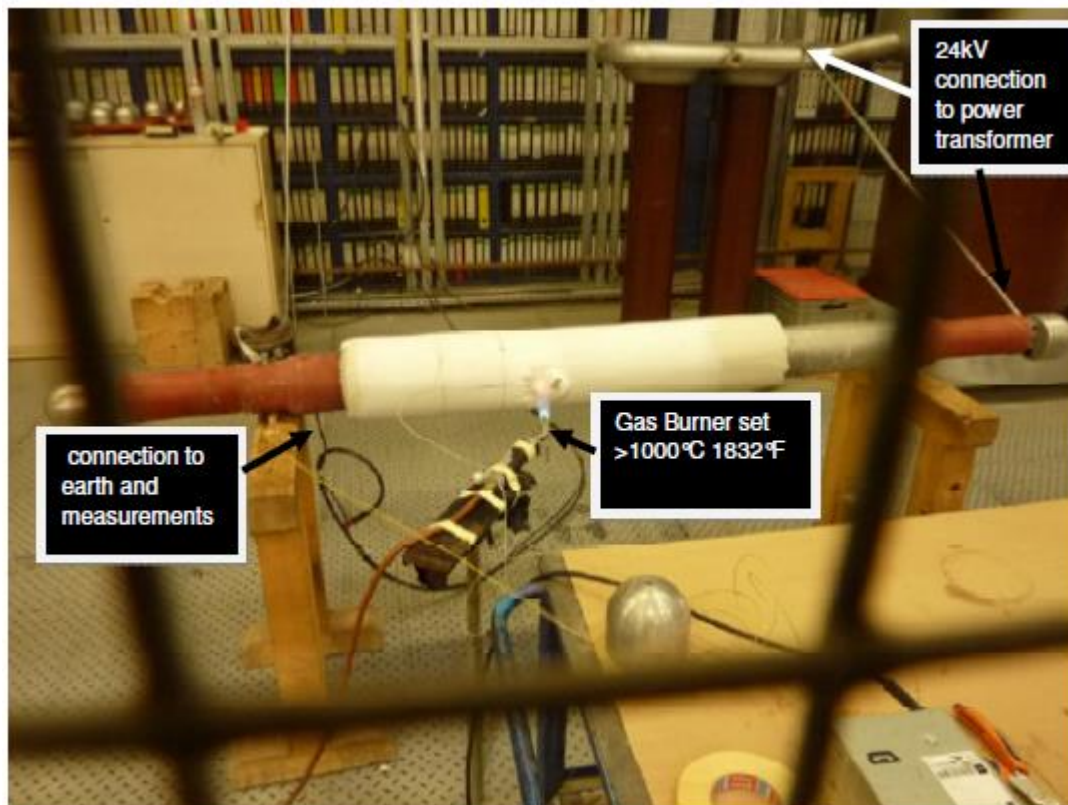
- Testing performed in FY 2005 provided good results with the exception of flame / heat resistance
- An SBIR was funded beginning in FY 2007 to develop high temperature insulation (N07-201, UniTech LLC)
 - Insulation curing issues are still unresolved
 - ***Phase II complete without positive result***
 - ***Project was not extended at this time***
- NSRP Panel Project FY 2011;
 - ‘Insulated Buss Pipe Installation Methods’
- NSRP Special Project to identify potential HTIBP vendors
 - Cancelled, no vendors ready to produce ‘production’ level parts
- There has been consistent and growing interest by the Shipyards to pursue IBP to address both schedule risk and cost issues

US Navy IBP Current



- **ONR Project is currently being funded to advance HTIBP development. NSRP providing an additional \$38 K for this effort**
- IEEE is currently working on standards for marine application (1580.1), many shipbuilders are participating
- Ritz Transformer has developed and flame tested their version of HTIBP. **Teamed with RTC Electro Corp. (Tefelen USA)**
 - Test not correctly performed, they are seeking funding to perform ‘Navy Test’
 - German Company with US production facilities in Lavonia, GA
 - RTC Electro has separated from Ritz Transformer, and is opening a US facility in New Orleans under the name: Tefelen www.Tefelen.com
 - Tefelen shipped HTIBP samples to NAVSSES/Philly for Gas Flame Test
- NAVSSES and PMS 320 developing preliminary documentation for a proposed Swampworks Effort to take HTIBP from TRL 3/4 to 7/8

Ritz Transformer Corp. Developed HTIBP Sample Flame Test



Ceramic Coated Sample performed successfully for 4 hours energized at 24 kV.
Test location was Ritz facility in Kirchaich, Germany on 6 Nov 2013



Initial Recommended Path to Implementation (Part 1 of proposed Swampworks Program)



- **Perform Navy 3 Hour Gas Flame Circuit Integrity Test on Telefen HTIBP sample**
 - **AeroNav Labs under contract to perform 3 hour GFCI test in Oct 2014 - 6 Month Effort**
- **Material Qualification**
 - Test requirements proposed by NAVSSES for review and approval by SEA 05Z TWH (G. Blalock) – **1 Year Effort**
- **LBES installation / test**
 - DDG-1000 application proposed between switchboard and harmonic filters of AIM motor. – **6 Month Effort**
- **Final qualification test would be DDG 1002**



Parallel Part 2 Swampworks Effort to HTIBP Qualification Testing



- Rigorous Business Case for US Navy applications
 - Design approach is different
 - Material cost is likely higher
- Connection Techniques need to be investigated and proven Navy Ship Board Ready
- Design and build practices need to be established
- Specifications and installation methods need to be matured
 - Develop requirements for DC systems in parallel
- Need to establish standard parts approach
 - Avoid unique parts for each builder / ship class
- Need to characterize maintenance requirements
- Limited modifications by shipbuilder
- Need to mature manufacturing base



Potential Stakeholders for HTIBP



- NAVSEA 05Z Technical Warrant
- Electric Ships Office (AC and DC)
- HII Ingalls shipbuilding – LPD/LHD (7.7 kV AC)
- Bath Iron Works – DDG-1000 (4160 Vac)
- PEO IWS (Radar Systems, 1000 V DC)
- PMS 405 Directed Energy Weapons (1000 V DC)
- NSRP Program Manager/Executive Control Board
- NSRP Electrical Technology Panel



Interested Shipyards



- GD - Bath Iron Works
- HII - Newport News
- GD - Electric Boat
- HII - Ingalls
- Bollinger
- GD - NASSCO



NSRP Special Project



- IBP Design Manual
 - Criteria for IBP Utilization
 - Standardized Part Recommendations
 - Design Standards
 - Installation / Repair procedures
- Business Case Analysis Support Data
 - Difference in design details
 - Difference in installation labor
 - Difference in material costs (complete installation)
 - Secondary impacts
- NSRP Electrical Technologies Panel approached the NAVY



IBP Benefits vice Cabling



- Inherently supports modular construction
- Improved reliability/life resulting in lower maintenance costs
- Ship ALTS / modification savings (no cable re-pull or splices)
- Supports a broad range of applications such as surface ships, submarines and weapons systems
- Improved survivability (improved blast/fragmentation, flame integrity and emergency repair)
- Size and weight reductions
- Arrangements benefits (less termination space, tighter bend radius, no tangle-box)