NSRP | National Shipbuilding Research Program

Insulated Bus Pipe (IBP), Revolutionary Alternative to Cables for Shipboard Power Distribution

DEC 11, 2018

Electrical Panel Meeting

Background

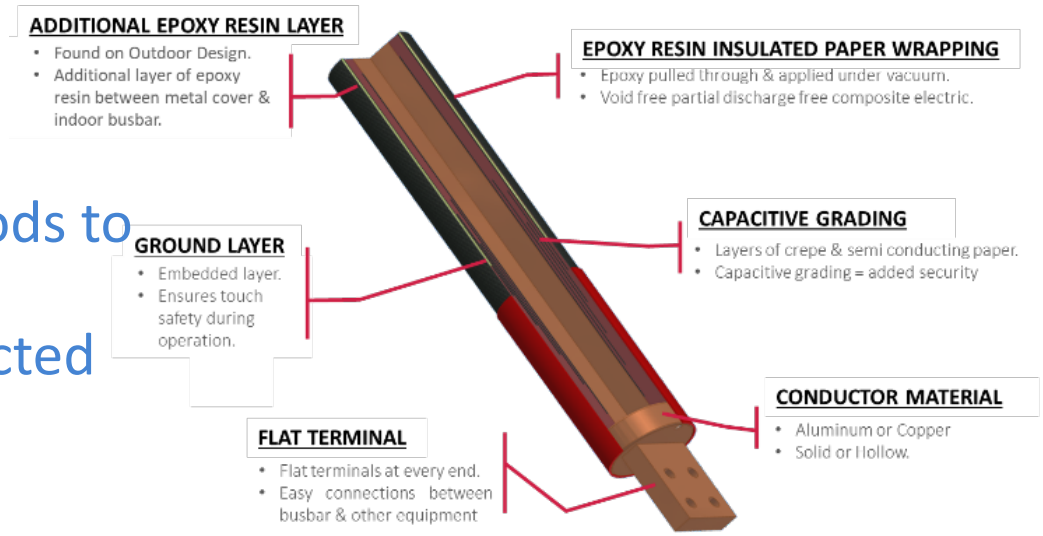
- Cables used since the advent of electrical distribution in 1800's
- Primary cable advancements are in standardization and insulation materials
- Copper carries a finite amount of current
- Skin effect and size precludes the use of large conductors for AC
- Only option for supplying high current loads is parallel cables
- Cable bend radius is over twelve times the overall diameter, or 26.4" minimum for typical 400 MCM cable
- Cables run after a ship is fully assembled, does not support modular construction
- Cable repulls costly and time-consuming

About IBP

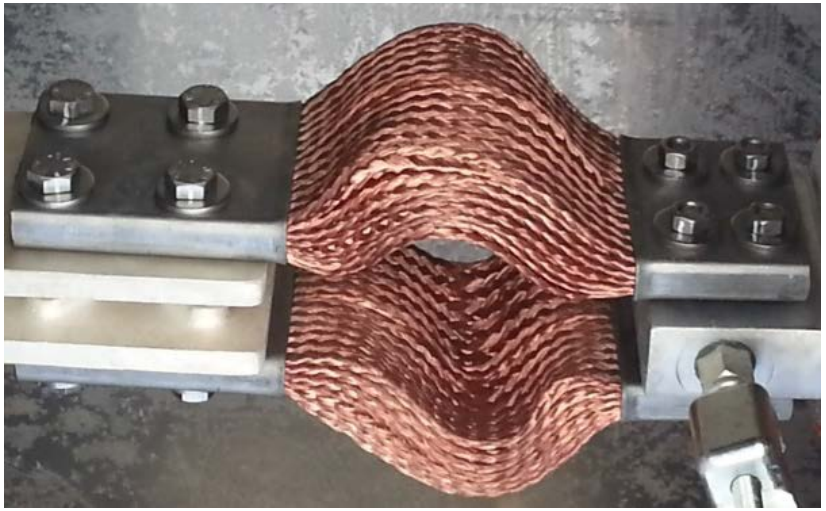
- Touch-safe power distribution able to be shaped into complex shapes
- Multiple sizes available
  - AC applications up to 36 kV and 6.5 kA
  - DC applications up to 60 kV and 7 kA
- Shielding/protection options
  - EM shielding
  - High temperature capability
  - Stainless steel outer layer
- Prefabricated sections installed similarly to pipes
- Bend radius limited by mechanical strength of conductor
  - 7.2kV AC/12kV DC at 2kA allows an 8” bend radius
- Designed for 40+ year life

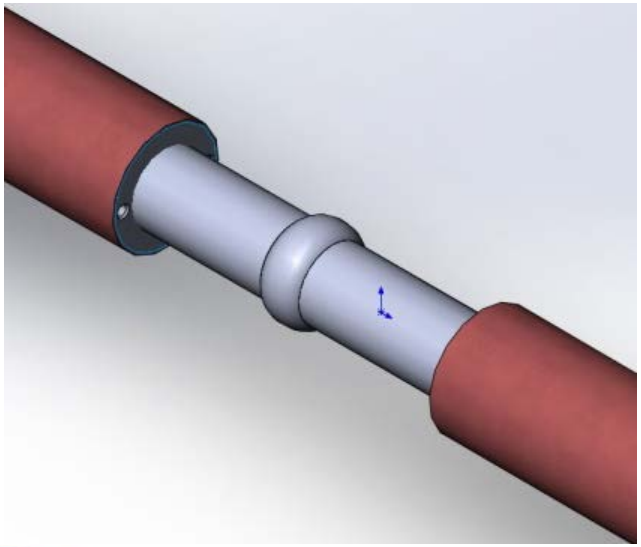
IBP Construction

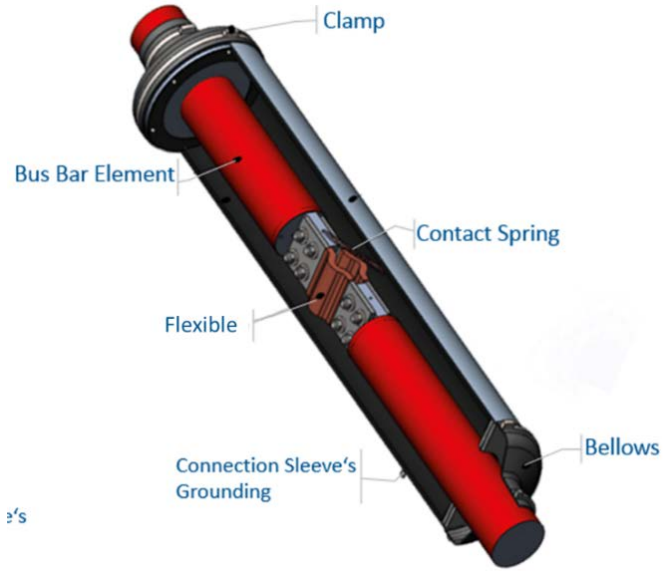
- Copper or aluminum conductor, can be solid or hollow
- Up to 30’ sections are standard
- Alternating layers of insulating/semiconducting crepe paper vacuum impregnated with resin
- Up to IP68 construction
- High temperature coatings
- Shielding options
- Multiple connecting methods to suit application
- Connecting sleeve constructed similar to IBP



IBP Connection Methods







IBP Benefits

- Provides SWAP-C savings for increased endurance and design margin
- Supports modular ship construction, savings cost, and schedule
- Significant space and weight savings
- Manufactured into complex shapes, can be placed in tight spaces
- Rigid construction ensures accurate model
- High abrasion resistance, increased survivability
- Repairs easily accommodated, only the damaged section is replaced

Testing Completed

- Navy has performed a number of tests on IBP
- No MIL-STD governs IBP, so mostly cable tests performed
- Tests performed chosen by NSWC PD and interested Program Offices

Test Category	Test Performed
Shock and Vibration	MIL-STD-901D
	MIL-STD-167-1
Electrical Compliance	Shield Continuity
	Insulation Resistance
	Partial Discharge
	Conductor Resistance
	AC Voltage Withstand
	Basic Insulation Test, IEC 60502
	Three Phase Bolted Fault, ANSI C37.23
	EMI Radiated, MIL-STD-46E RE101
	Free Air Ampacity
Installation Compliance	Watertight Integrity
	Centering and Circularity
	Drip
	Shrinkage
	Gas Flame
	Acid Gas Equivalent
	Halogen Content
	Smoke Index
	Toxicity
Ordnance Survivability	Riflemen
	Fragmentation

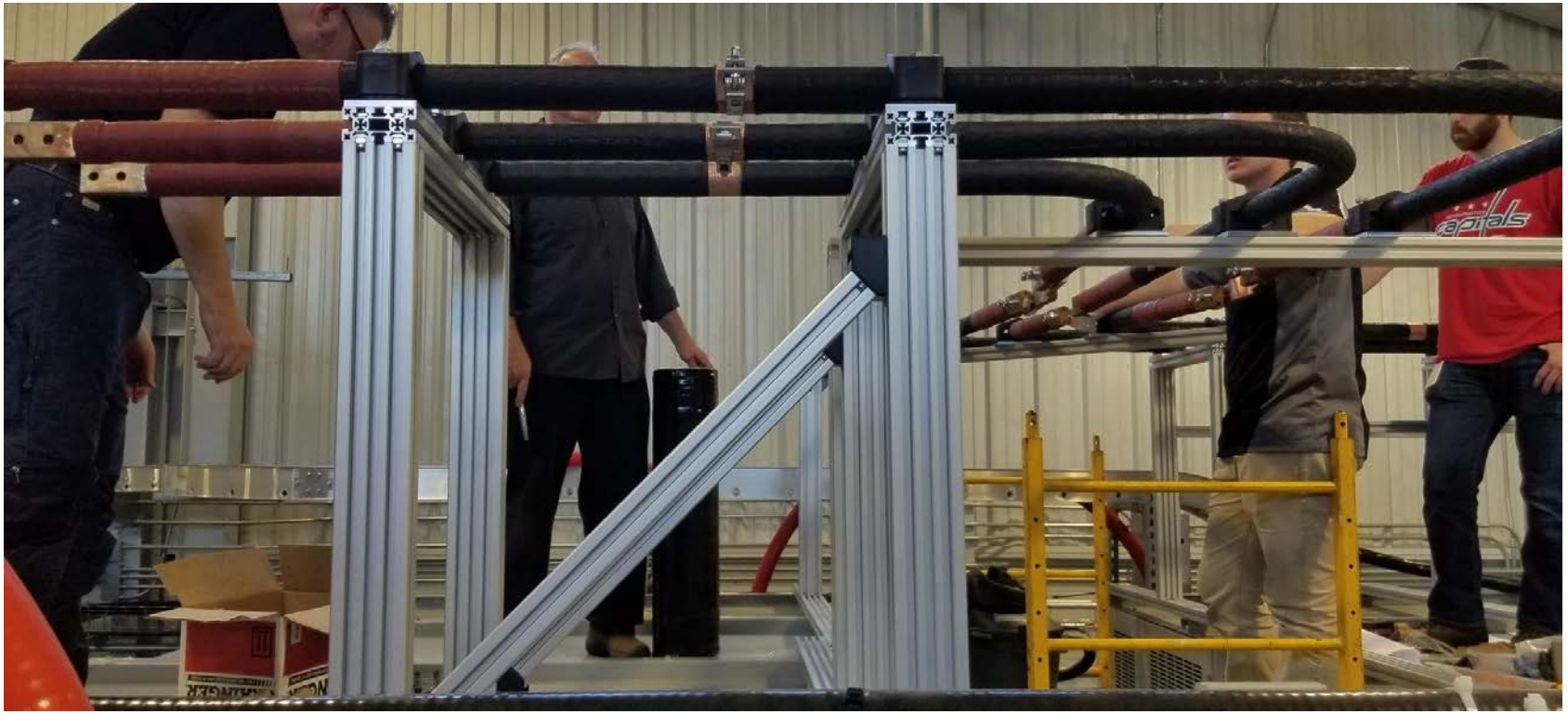
2018 Project Status

- Current project
  - Manufacture AC and DC sections of IBP, JUL 2018
  - Perform updated Return on Investment (ROI) calculation for DDG 51 FLT II, SEP 2018
  - Perform land-based demonstration at Florida State University Center for Advanced Power Systems (FSU CAPS), JAN 2019

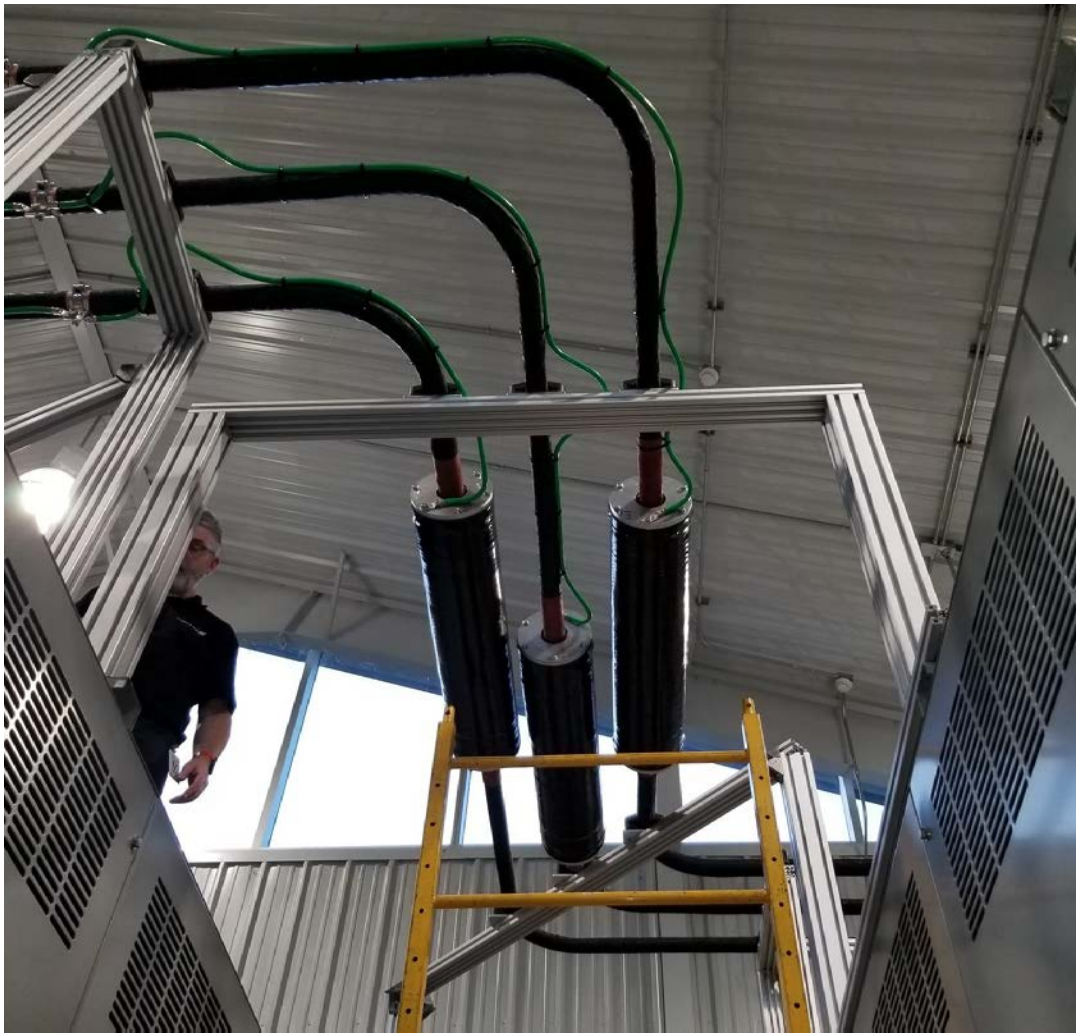
First Production

DC Cart

AC Run



AC Run



2019 Proposed Project Overview

- Current project developed US Navy (USN) Return on Investment and will provide a demonstration for stakeholders to observe
- IBP must be qualified before USN can utilize
- This proposal provides a path to qualify IBP and will develop a coaxial section of IBP to reduce magnetic fields and space
  - Must work with stakeholders and Tech Warrant Holder (TWH) community to determine tests for qualification
  - ABS providing cost share to further qualify for commercial use
  - Conduct the qualification test for IBP at AeroNav test lab
  - Write a detailed Technical Final Report to include updated ROI estimate and draft specification for IBP

IBP Outlook

- Current project has shown exceptional potential for Navy and shipyards
  - 78% weight savings
  - 20% labor savings (Estimated using pipes)
- This last project will qualify IBP, allowing Navy use
- OEMs are involved in this project to integrate IBP with new weapon systems, sensors, and electrical equipment
- With Large Future Surface Combatant, IBP will have already been integrated on small scale applications, making whole ship low risk

Conclusion

- Provides numerous benefits to designers, builders, and the Navy
- Benefits increased with high power loads
- Increased design margin for future upgrades
- IBP has already passed a number of tests, and will work with Tech Warrant Holder community to determine qualification path
- Once qualified, IBP will be available for shipboard integration