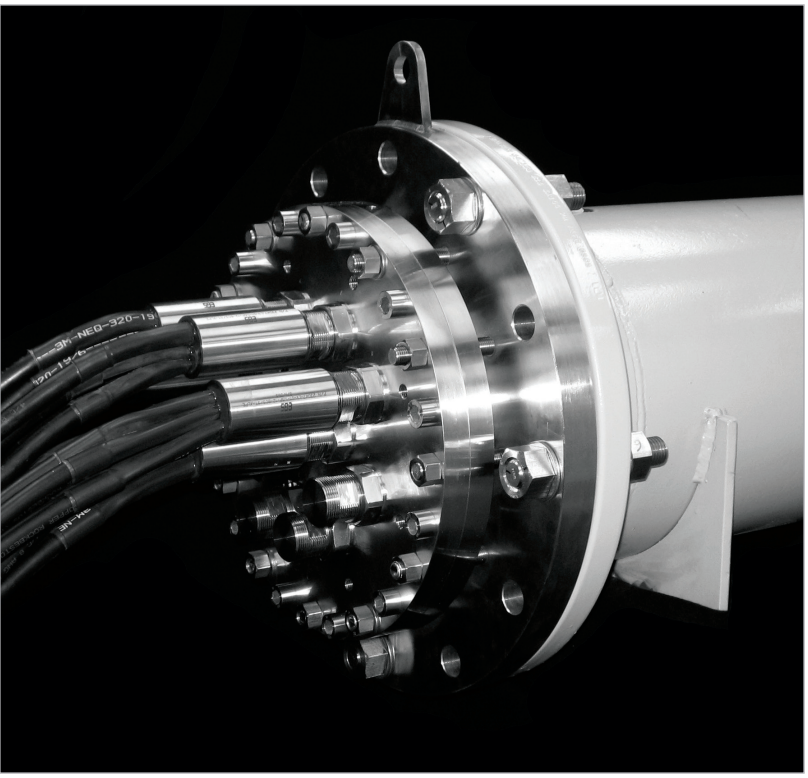
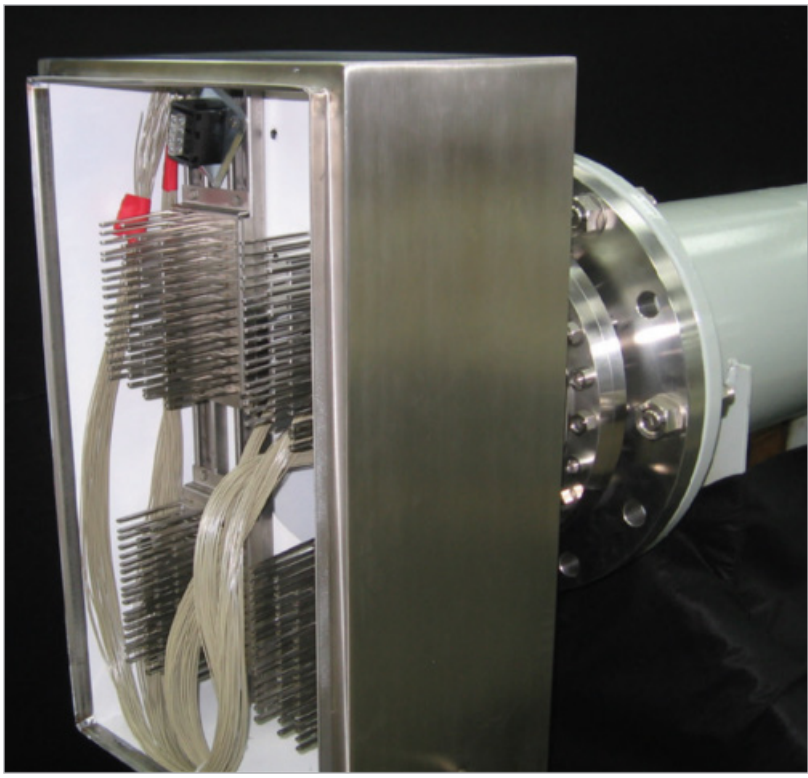
CURTISS-WRIGHT

Nuclear





Electrical Penetration Assemblies

www.cwnuclear.com

Introduction

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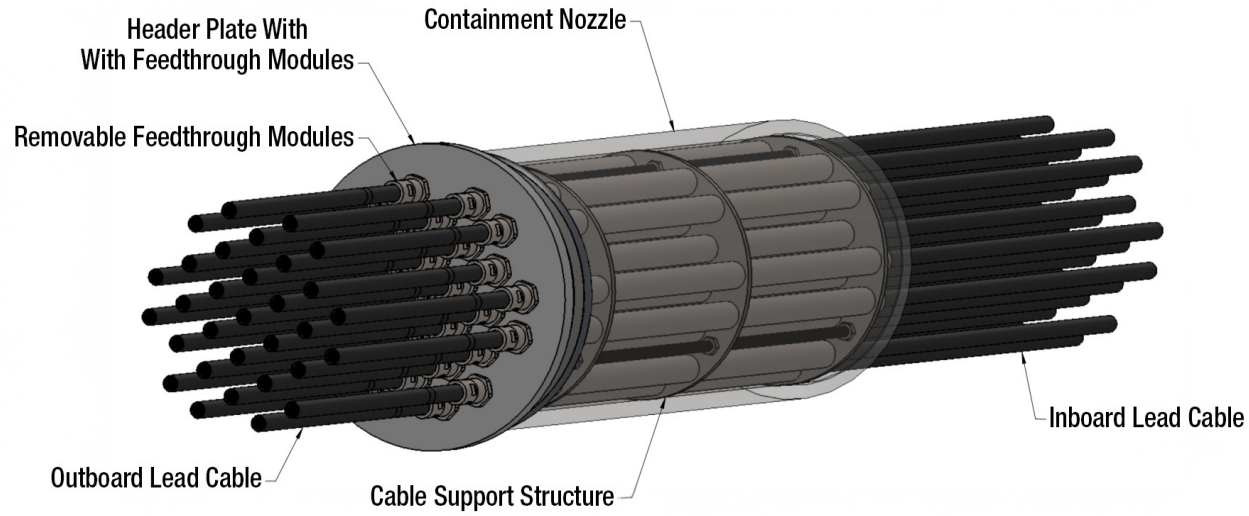
Introduction

Curtiss-Wright offers a comprehensive range of products and services supporting the global nuclear power industry. Our electrical connection product organization has over thirty-five (35) years of experience, which is incorporated into each equipment design. This results in a product which is fully functional and dependable. Our equipment is designed for the nuclear industry to current codes, regulations, and qualification criteria.

Electrical Penetration Assemblies (EPAs) transfer electrical power and signals through the nuclear power plant containment wall while ensuring the containment pressure boundary is maintained during design basis events. This dual-function, safety-related and mechanical device makes the EPA a unique nuclear component. Our Electrical Penetration Assemblies (EPAs) are manufactured in accordance with 10CFR50 Appendix B, ASME NQA-1, and our ASME NPT Certificate. Whether it's life extension testing, replacement of existing operating plant EPAs, or development of new designs for future generations, Curtiss-Wright can provide the customer service, engineering support, and quality hardware demanded by the unique environments of nuclear power.

EPA feedthrough modules can be supplied with Curtiss-Wright factory installed harsh environment nuclear qualified connectors, such as our GRAYBOOT connectors, multi-pin Quick Disconnect Connectors (QDCs), or compact splices to minimize installation cost and time. We can also offer enclosures with connector mounting racks as well as flexible metal conduits for cable protection, and other connector options.

Electrical Penetration Assembly Product Overview



Overview

Curtiss-Wright EPAs can be provided as a complete assembly or as individual feedthrough modules engineered to interface with existing plant bulkhead flanges. EPAs include a header plate populated with removable/replaceable feedthrough modules of the required size and quantity, leakage monitoring assembly, nozzle cable support structure, and required lead wire/cable to reach terminations at junction boxes or equipment located in the plant (see figure above). Our header plates and feedthrough modules are fabricated from corrosion resistant stainless steel material. Header plates can be designed to be welded or bolted (with double aperture seals) to containment nozzles. Feedthrough modules are supplied with double internal and external seals to ensure that no single failure will result in a loss of penetration pressure integrity.

Curtiss-Wright's EPAs and associated feedthrough modules are environmentally qualified through mechanical and electrical testing in accordance with standard IEEE 317 "IEEE Standard for Electrical Penetration Assemblies in Containment Structures for Nuclear Power Generating Stations" and in accordance with mechanical testing specified in ASME Section III Section NE-6000.

Our feedthrough modules are removable and replaceable from the header plate flange and can be supplied in bulkhead flange sizes from 4-inch to 18-inch Nominal Pipe Size (NPS). Curtiss-Wright offers the following EPA feedthrough module types:

- Low Voltage Power & I&C Feedthroughs
- Medium Voltage Feedthroughs
- Coaxial and Triaxial Feedthroughs
- Fiber Optic Feedthroughs

EPA Feedthrough Module Product Line

Low Voltage Power and I&C Feedthroughs

Curtiss-Wright offers two Low Voltage I&C and Power feedthrough modules designs. One with XLPE insulated stranded copper conductors, and the other with Kapton insulated solid copper conductors.

Feedthroughs supplied with XLPE insulated (decaBDE free) conductors and jacketed lead cable (CSPE or XLPO) are robust materials used widely in the nuclear power industry that can be run directly into plant cable trays. Stranded copper conductors offer benefits to solid conductors in that they are more flexible and can withstand more bending than solid conductors. Feedthrough modules with XLPE insulated wire are offered in various sizes, depending on the customer requirements from 1-inch to 4-inch in diameter. Low smoke halogen free (LSHF) lead cable is also available upon request.

Feedthrough modules with solid copper Kapton (Polyimide) insulated conductors offer the benefits of having no internal connections and a higher wire density (smaller wire O.D.) due to the high dielectric strength of the polyimide insulation. Feedthrough with Kapton are offered in module sizes from 1-inch to 2.5-inch.

EPA with Kapton Insulated Wire Feedthroughs

Kapton Insulated Wire Feedthrough (2.5-inch Size)

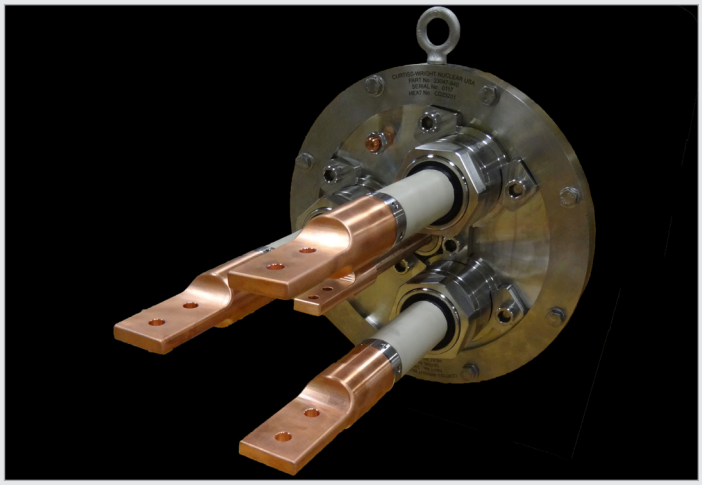
XLPE Insulated Wire Feedthrough Assembly

EPA with XLPE Insulated Wire Feedthroughs

EPA Feedthrough Module Product Line

Medium Voltage Feedthroughs

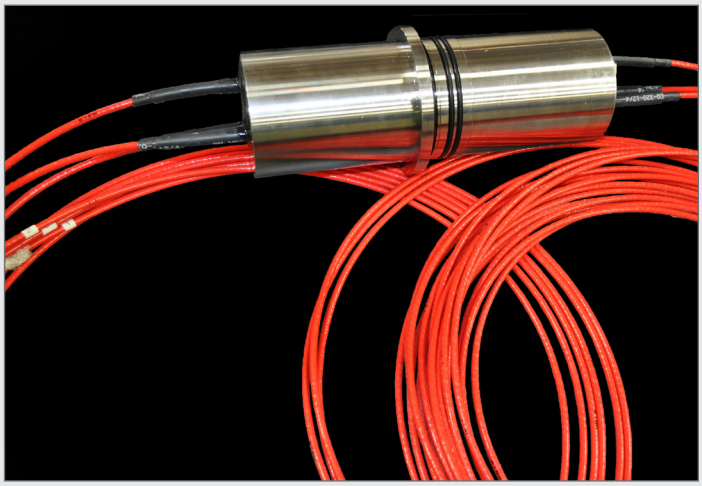
Curtiss-Wright supplies Medium Voltage EPAs up to 5 kV rate voltage that are qualified in accordance with IEEE317. EPAs include removable/replaceable feedthrough modules, busbars or lead cable, nozzle support structure, junction boxes with cable glands and grounding strips, termination lugs, and insulating kits/boots for connection to field cables.



EPA with 1500 MCM Medium Voltage Feedthroughs

Coaxial & Triaxial Feedthroughs

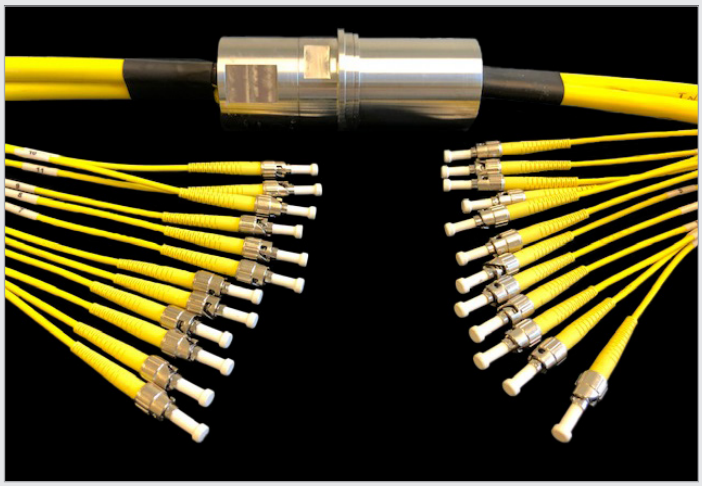
Curtiss-Wright supplies Coaxial (i.e. RG59 or similar) and Triaxial feedthroughs that maintain conductor shields through the feedthrough module from inboard to outboard end. Feedthrough modules are designed to interface with Coaxial and Triaxial Cables of various construction types and materials. Feedthroughs can also be supplied with ceramic-to-metal seals and HN connectors. Feedthrough modules are offered in various sizes depending on customer requirements from 1.5-inch to 4-inch in diameter.



Coaxial/Triaxial Feedthrough (4-Inch Size)

Fiber Optic Feedthroughs

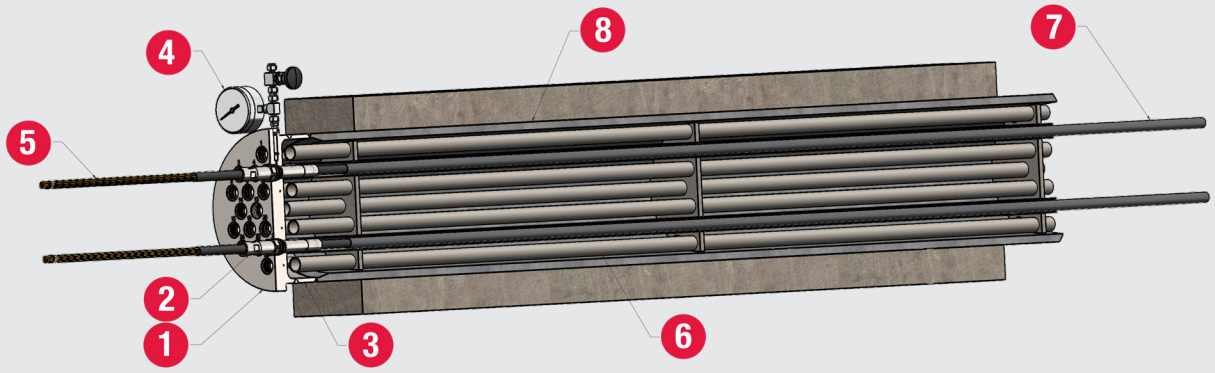
Fiber Optic EPAs are supplied with radiation hardened fiber optic cables in our 1.5-inch size feedthrough module. Each module can support up to 10 multi-mode fiber channels per module. Fiber Optic EPAs are qualified to function during normal nuclear power plant operating conditions (temperature & radiation) and to maintain the containment pressure boundary during/after seismic and LOCA design basis events in accordance with IEEE 317 leakage requirements.



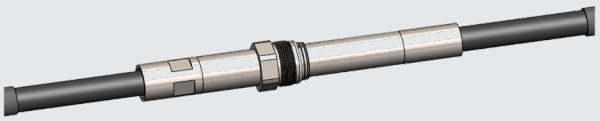
Fiber Optic Feedthrough (1.5-Inch Size)

EPA Components & Features

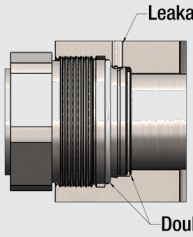
EPA Components



Removable/Replaceable Feedthrough Module



Feedthrough Module/Header Plate Double Metal Seal



1. Stainless Steel Header Plate
2. Removable Feedthrough Modules
3. Carbon Steel Transition
4. Leakage Monitoring Gauge Assembly
5. Outboard Cable
6. Cable Support Assembly
7. Inboard Cable
8. Carbon Steel Containment Nozzle

EPA Port Density* Per Nozzle Size

Port Size	Penetration Nozzle size NPS (Schedule 80)					
	4-inch	8-inch	10-inch	12-inch	14-inch	18-inch
1.0-inch	4	12	19	31	38	55
1.5-inch	2	7	10	16	21	32
2.0-inch	1	5	7	10	14	19
2.5-inch	1	3	4	7	10	16

*Approximate.

Low Voltage I&C & Power Conductor Quantities

Feedthroughs with XLPE Insulated Wire

Approximate Conductor Density per Port Size

Wire Size		Quantity of Conductors Per Feedthrough Size	
AWG	mm^2	1.5-inch	2-inch
2/0	67.4	1	3
2	33.6	3	6
4	21.2	4	10
6	13.3	6	12
8	8.4	8	15
10	5.3	12	22
12	3.3	24	48
14	2.1	30	55
16	1.31	36	69
18	0.8	42	69
RG59 Coaxial		3,4	7

Note: For other Feedthrough module sizes, contact Curtiss-Wright engineering.

Conductor Density for 1.5-Inch Feedthroughs per Nozzle Size

Conductor Size		Penetration Nozzle Size - NPS (Inches)					
AWG	mm^2	4-inch	8-inch	10-inch	12-inch	14-inch	18-inch
2/0	67.4	2	7	10	16	21	32
2	33.6	6	21	30	48	63	96
4	21.2	8	28	40	64	84	128
8	8.4	16	56	80	128	168	256
10	5.3	24	84	120	192	252	384
12	3.3	48	168	240	384	504	768
14	2.1	60	210	300	480	630	960
16	1.31	72	252	360	576	756	1152
18	0.8	84	294	420	672	882	1344
Coaxial (RG59)		8	28	40	64	84	128

Note: 1) Larger sizes not listed are available; quantities per flange can be provided.
2) Actual quantities may be limited by nozzle temperature requirements.

Feedthroughs with Kapton (Polyimide) Insulated Wire

Approximate Conductor Density Per Port Size

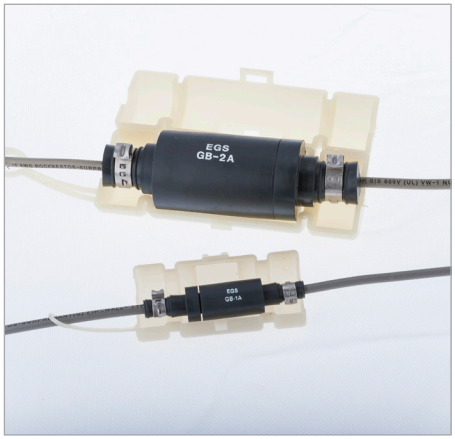
Wire Size		Quantity of Conductors Per Feedthrough Size		
AWG	mm^2	1-inch	1.5-inch	2.5-inch
8	8.4	8	34	56
10	5.3	11	48	80
12	3.3	16	72	107
14	2.1	18	88	134
16	1.31	32	102	150
18	0.8	36	122	150

Conductor Density for 1.5-Inch Feedthroughs per Nozzle Size

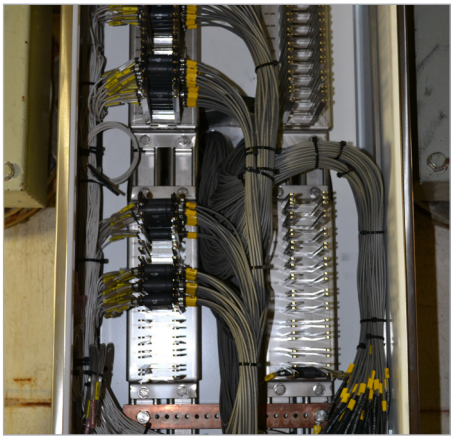
Conductor Size		Penetration Nozzle Size - NPS (Inches)					
AWG	mm^2	4-inch	8-inch	10-inch	12-inch	14-inch	18-inch
8	8.4	68	238	340	544	714	1088
10	5.3	96	336	480	768	1008	1536
12	3.3	144	504	720	1152	1512	2304
14	2.1	176	616	880	1408	1848	2816
16	1.31	204	714	1020	1632	2142	3264
18	0.8	244	854	1220	1952	2562	3904

Note: Actual quantities may be limited by nozzle temperature requirements.

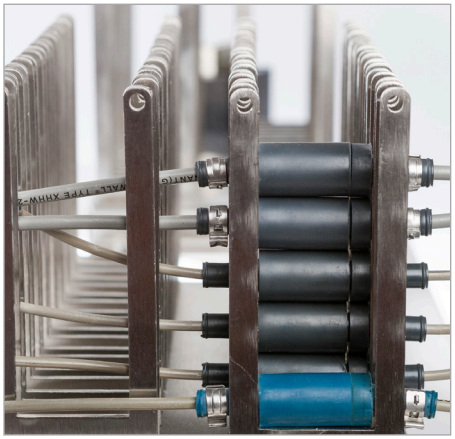
Accessories



EGS GRAYBOOT "A"



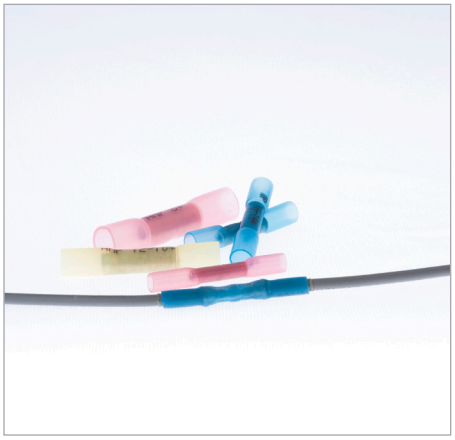
Junction Box



EGS GRAYBOOT Mounting Rack

EGS Quick Disconnect Connectors

EGS Flexible Metal Conduit



EGS Compact Splice

Accessories

Junction Boxes

Junction boxes can be supplied for both inboard and outboard sides of penetrations. Supplied enclosures provide protection for the electrical connections, easy access for maintenance, and organization of wires.

Qualified Connectors

- *Quick Disconnect Connectors:* a value added device designed to provide an environmental seal of an electrical connection or equipment interface.
- *GRAYBOOTS:* a single conductor, quick-disconnect, elastomer body, sealed connector whose performance in accident conditions is equivalent to nuclear grade heat shrink tubing or uninterrupted nuclear grade wire with regard to insulation resistance and leakage current.
- *Compact Splice:* a light-weight, simple solution to single conductor splicing needs. The EGS Compact Splice is CSA qualified for use with both solid conductor and stranded wire use.
- *Flexible Metal Conduit:* a leak-tight pressure boundary designed to withstand an accident environment. The flexible metal conduit utilizes all metallic construction, thus eliminating concern for time-temperature and radiating aging effects.

Applicable Codes & Standards

Quality Program

Quality Assurance is inherent in all activities performed at Curtiss-Wright. It is at the very heart of everything we do. As an organization, we are proud our legacy serving the nuclear power industry with quality and accuracy at every single stage of the design, fabrication/manufacturing, procurement, testing, documentation, and shipping processes.

Curtiss-Wright's Quality Assurance program, meeting the requirements of 10CFR50 Appendix B, is routinely audited to maintain active status on our customers' Approved Supplier List (ASL) and for new customers. We have been audited by the Nuclear Regulatory Commission (NRC), Korean Institute of Nuclear Safety (KINS), American Society of Mechanical Engineering (ASME), DOE, Nuclear Industry Assessment Corporation (NIAC), and the Nuclear Procurement Issues Corporation (NUPIC).

Applicable Standards

- ASME Section III Code
- IEEE 317-1983/2013
- IEEE 323-1974/1983/2003
- IEEE 344-1975/1987/2004
- KBE EP-146
- KBE EP-154
- 10CFR50/Appendix B
- 10CFR21
- NQA-1

N NPT

Activities conducted in accordance with the requirements of the ASME Boiler and Pressure Vessel Code.

Contact Information

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