

Holtec International®

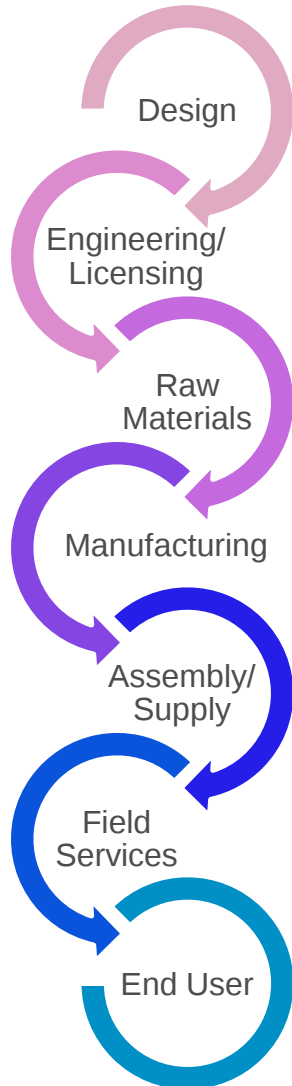
NRC - Metamic™ Neutron Absorbers for Spent Fuel
Applications

March 14, 2013

a generation ahead by design



- Corporate Overview
- Nanotec
- Metamic™
- Fabrication
- Quality Control & Testing
- Operating Experience



- Holtec's nuclear mission and vision are met by maintaining in-house:
 - Design
 - Engineering
 - Licensing
 - Fabrication
 - Critical Material Supply
 - Site Installation
 - Construction
 - Deployment / Installation
- This allows for:
 - Integrated solutions for customers
 - Control over quality, delivery, and costs
 - Coupling of design, fabrication, deployment

Divisions of Holtec



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Holtec Manufacturing Division Pittsburgh, Pennsylvania

- Heavy manufacturing of heat exchanger components and spent fuel casks and canisters for the international power generation market



Orrvilon Manufacturing Division Orrville, Ohio

- Aluminum Extrusion and Systems Fabrication, including Metamic and Metamic-HT



Nuclear Power Division Marlton, New Jersey

- Supplier of equipment and services to the international nuclear market to support waste and used fuel management



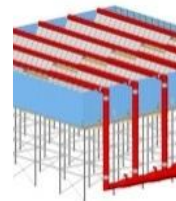
Nanotec Metals Division Lakeland, Florida

- Development and fabrication of special materials, including neutron absorbing materials for the nuclear power industry



Power Plant Components Division Marlton, New Jersey

- Design and construction of heat transfer equipment and related ancillaries to support nuclear, fossil, and renewable power generation industries



Air Cooled Condensing Division San Diego, California

- Design of advanced air cooling technologies, including stainless tubes to stainless tube sheet ACC fin designs

Divisions of Holtec



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Holtec Ukraine

Kiev, Ukraine

- Nuclear plant decommissioning and development, licensing, and supply of equipment for management of waste and used fuel generated from (Soviet-designed) nuclear reactors



Sizelon

Sizewell, England

- Project management for business development for nuclear projects in the United Kingdom



Holtec India

Pune, India

- Technical services to support nuclear, fossil, and renewable power generation industries



SMR

Marlton, New Jersey

- Technical services team developing the SMR-160 (160 MWe) Small Modular Reactor

Holtec senior staff has authored over 300 technical papers and books.



- Mechanical Design of Heat Exchangers and Pressure Vessel Components
K.P. Singh, A.I. Soler
1984 Arcturus Publishers
- An Elastic Plastic Analysis of the Integral Tubesheet in U-tube HX
K.P. Singh, A.I. Soler
Int. J. Pres. Ves. & Piping 27 (1987) 37-384
- Transient Response of Large Inertia Cross Flow Heat Exchangers
K.P. Singh, Yu Wang, K.Lulianetti
ASME Papers: 91-JPGC-NE-27
- Thermal Expansion Induced Stresses in U-Bends of Shell-and Tube Heat Exchangers
K.P. Singh
Engineering For Power, vol. 101, No. 4 Oct. '79
- Tubesheet Analysis - A Proposed ASME Design Procedure
A.I. Soler, S.M. Caldwell, K.P. Singh
- Predicting Flow Induced Vibration in U-Bend Regions
K.P. Singh
- An Analysis of the Improvement in the Thermal Performance of a Surface Condenser Equipped with Tweener Supports
K.P. Singh, R. Nadig, A.I. Soler



Holtec has received over 30 patents....

this number continues to grow

Designs and Equipment

United States Patent [19]
Singh [45] Patent Number: 6,064,710
[45] Date of Patent: May 16, 2000

[54] APPARATUS SUITABLE FOR TRANSPORTING AND STORING NUCLEAR FUEL RODS AND METHODS FOR USING THE APPARATUS
[76] Inventor: Krishna P. Singh, 230 Normandy Cir., Palm Harbor, Fla. 34688

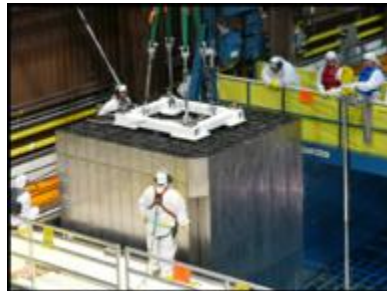
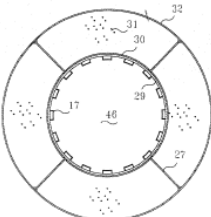
[21] Appl. No.: 09/239,085
[22] Filed: Jan. 27, 1999
Related U.S. Application Data

[62] Division of application No. 08/058,114, May 19, 1993, Pat. No. 5,380,725
[51] Int. Cl.: G21C 10/06; G21C 19/02
[52] U.S. Cl.: 376/272; 250/506.1; 250/507.1
[58] Field of Search: 376/272; 250/506.1; 250/507.1

References Cited
U.S. PATENT DOCUMENTS
4,770,844 9/1988 Davis, Jr. 376/272
5,063,299 11/1991 Efferting 250/507.1
5,332,657 8/1993 Kovack et al. 376/272
5,373,540 12/1994 DeCormier, Sr. et al. 376/272
5,406,601 4/1995 Blodgett et al. 376/272
5,438,397 8/1995 Lehnert et al. 376/272
5,513,232 4/1996 Jones et al. 376/272
5,546,436 8/1996 Jones et al. 376/272
5,612,343 10/1997 Warner et al. 250/507.1
5,641,570 6/1997 Tansik et al. 376/272
5,646,971 7/1997 Howe 376/272
5,668,843 9/1997 Wainger 376/272
5,844,111 12/1998 Walls et al. 376/272
5,882,347 4/1999 Singh 376/272

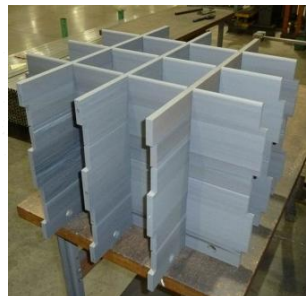
FOREIGN PATENT DOCUMENTS
1257299 12/1987 Germany 376/272

8 Claims, 14 Drawing Sheets



- Racks
- Casks
- Heat Exchanger Tech.
- Ancillary Equipment
- Reactors

Materials and Fabrication Processes

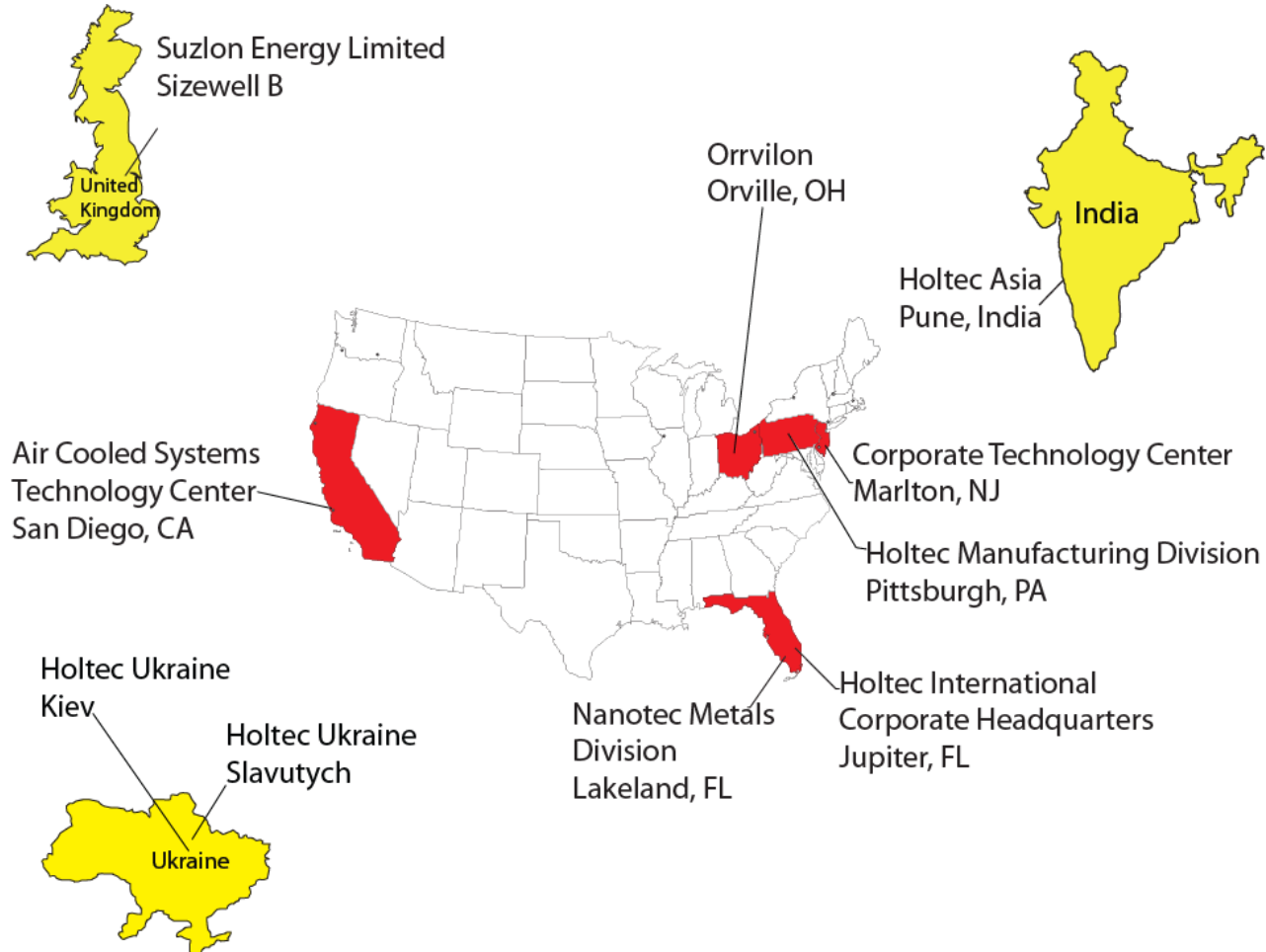


- Metamic
- Metamic-HT
- Holtite A
- Holtite B
- Friction Stir Welding (pending)

Holtec International Offices



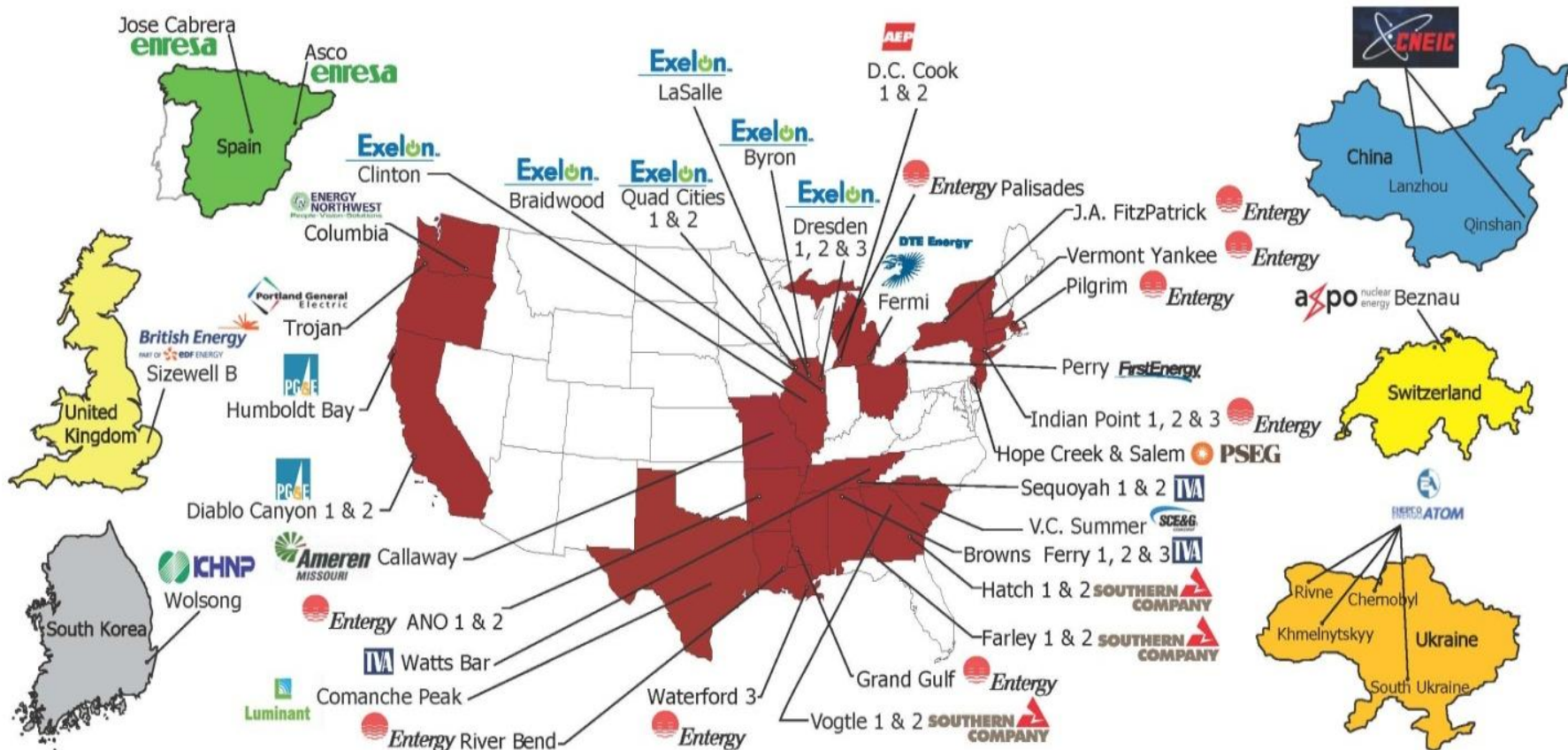
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Holtec's Worldwide Business Centers

Worldwide Dry Storage Clients

- More than 500 Holtec HI-STORM Systems are currently loaded at more than 65 nuclear plant sites



Domestic Wet Storage Projects

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Ameren
Callaway - PWR

American Electric Power
D.C. Cook 1 & 2 - PWR

CENG
Nine Mile 1 & 2 - BWR

Detroit Edison Co.
Fermi 2 - BWR

Dominion Energy
Kewaunee - PWR
Millstone 1 - BWR & 3 - PWR

Duke Energy Corp.
McGuire 3 & 4 - PWR
Shearon Harris - PWR

Entergy
ANO 1 & 2 - PWR
Indian Point 2 - PWR
J.A. FitzPatrick - BWR
Palisades - PWR
Pilgrim - BWR
Vermont Yankee - BWR
Waterford 3 - PWR

Exelon
Braidwood 1 & 2 - PWR
Byron 1 & 2 - PWR
Clinton - BWR
LaSalle 1 - BWR
Limerick 1 & 2 - BWR
Oyster Creek - BWR
Three Mile Island 1 - PWR
Zion 1 & 2 - PWR

FirstEnergy
Beaver Valley 1 & 2 - PWR
Davis-Besse - PWR

Nebraska Public Power District
Cooper - BWR

NextEra/Florida Power & Light
Duane Arnold - BWR
St. Lucie 1 & 2 - PWR
Turkey Point 3 & 4 - PWR

Northeast Utilities System
Connecticut Yankee - PWR

Omaha Public Power District
Fort Calhoun - PWR

Pacific Gas and Electric Co.
Diablo Canyon 1 & 2 - PWR

PPL Susquehanna LLC
Susquehanna 1 & 2 - BWR

PSEG Nuclear
Hope Creek - BWR
Salem 1 & 2 - PWR

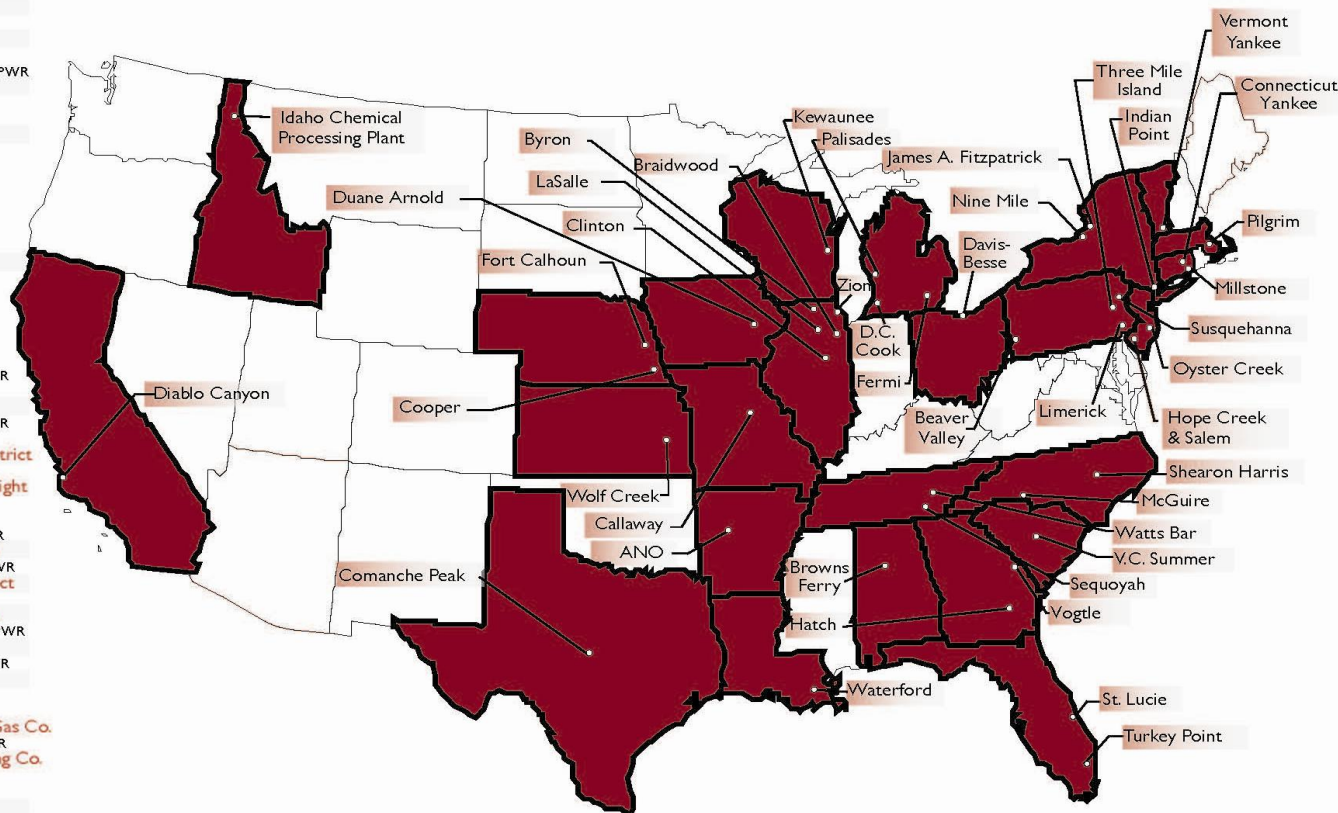
South Carolina Electric & Gas Co.
V.C. Summer 2 & 3 - PWR

Southern Nuclear Operating Co.
Hatch 1 & 2 - BWR
Vogtle 1, 2, 3 & 4 - PWR

TVA Nuclear
Browns Ferry 2 & 3 - BWR
Sequoyah - PWR
Watts Bar 1 - PWR

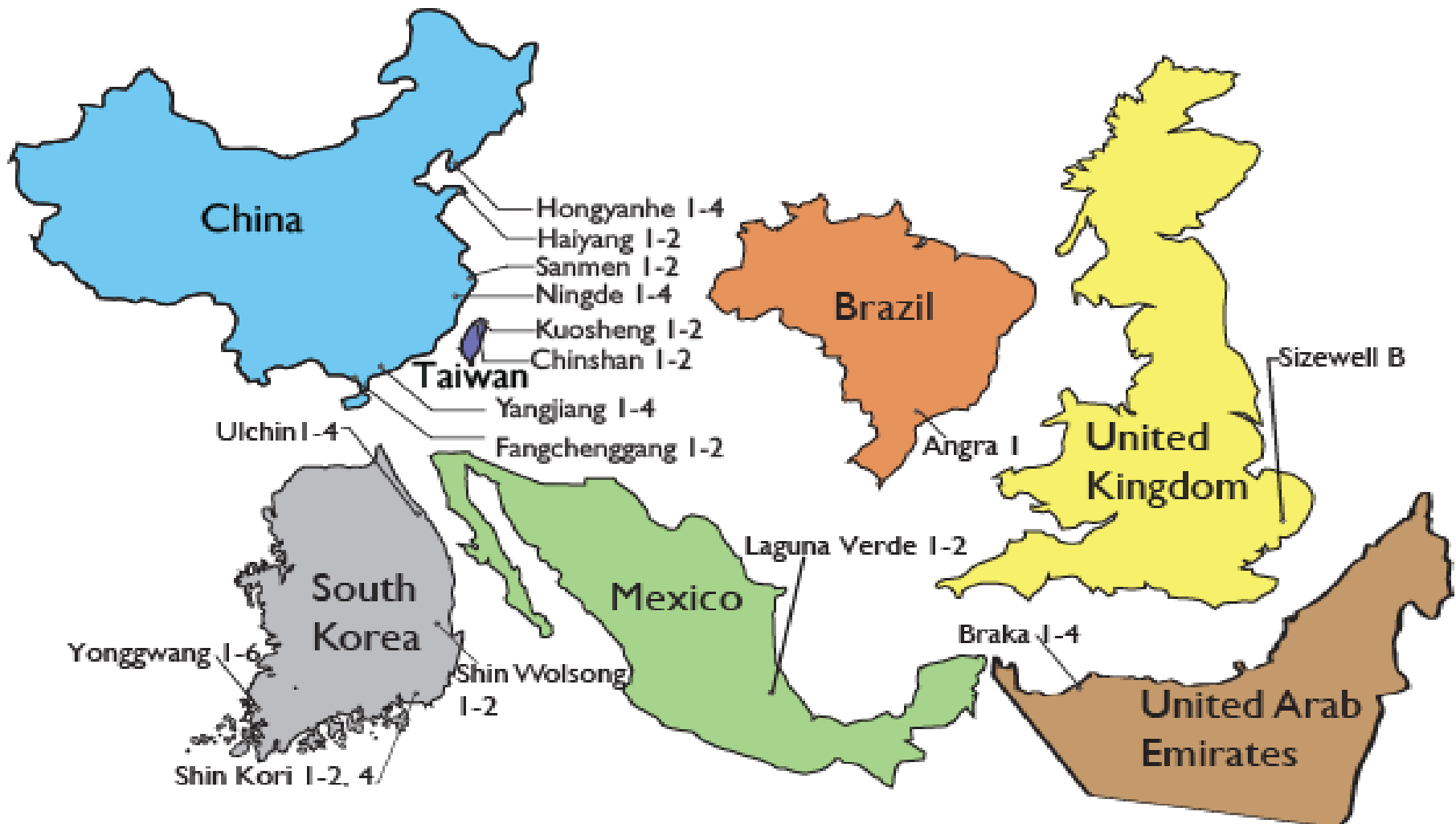
Luminant (TXU Energy)
Comanche Peak 1, 2, 3 & 4 - PWR

Westinghouse
Idaho Chemical Processing Plant
Wolf Creek Nuclear Operating Corp.
Wolf Creek - PWR



International Wet Fuel Storage Projects

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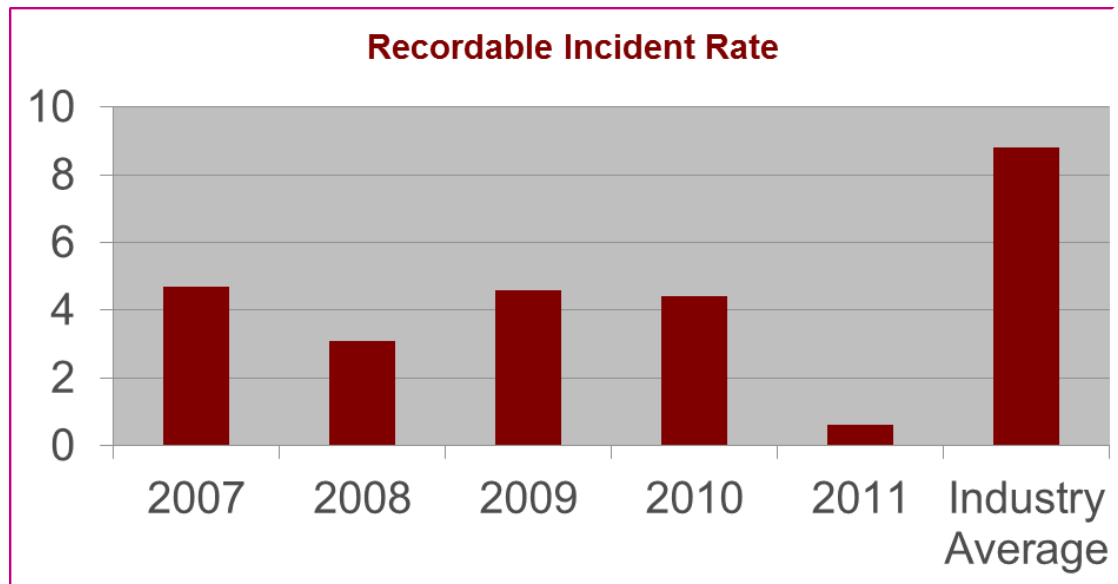
Safety Commitment

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- Holtec's commitment to safety has led to zero lost time accidents in the field during our eighteen years of field services activities involving both wet and dry storage projects
 - Zero Recordable Injuries Goal
 - Safety record among best in industry
 - State certified safety committee



Recordable Incident Rate – 0.6 – Industry Rate – 8.8
Lost Time Incident Rate – 0.0 – Industry Rate – 5.0



- The Holtec Quality Assurance Program is structured to assure the quality of the products and services offered are the finest available anywhere
- The Holtec Quality Assurance (QA) Program seeks to assure absolute compliance with the applicable ASME Boiler and Pressure Vessel Code and regulatory requirements for design, procurement, fabrication and delivery of quality equipment, parts and components furnished to the nuclear industry. This program complies with the ASME Boiler and Pressure Vessel Code Section III, Divisions 1 and 3, 10CFR50 Appendix B, and contractual requirements.
 - 10CFR50 Appendix B Certified QA Program
 - 10CFR71 Subpart H (Approval Number 0784) Certified QA Program
 - 10CFR72 Subpart G Certified QA Program
 - NQA-1 Certified QA Program
 - Triennially inspected by the U.S. NRC, NUPIC, and other organizations

Quality Assurance

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- Holtec has a proven Quality Assurance Program (10CFR 50 certified QA Program, ISO 9001)
- Holtec Design centers and fabrication facilities operate under the same QA Program
- Holtec holds all ASME Code stamps actively used in the industry (nuclear and non-nuclear)
- Regular industry and regulatory audits



- Nanotec Metals, located in Lakeland, Florida is a 28,000 ft² fabrication and testing facility
- Production of Metamic™
- Production of products that utilize Metamic™
- Other Capabilities
 - Material Development and Testing
 - Powder Blending and Billet Manufacturing
 - Product Rolling and Shearing
 - Passivation/Anodizing
 - Neutron Attention Testing
 - Extrusion of Special Form Products



- METAMIC™ is a Metal Matrix Composite (MMC)
- Porosity-Free MMC fabricated with Aluminum-6061 alloy powder and nuclear-grade Boron Carbide Powder
- Fully dense material (100% theoretical density)
- Homogeneous distribution of boron carbide particulate can be obtained in the composite microstructure
- Fabricated under USNRC 10CFR50 QA Program as Safety Related (SR)

- Materials qualification program was carried out to qualify Metamic™
 - EPRI Report details the results
- Homogeneous
- B4C Loading – 10% - 33%
- The physical and neutronic properties of Metamic™ are essentially unaltered under exposure to elevated temperatures (750°F - 900°F, 400°C - 480°C) and high radiation levels (1E+11 rads gamma).
- No detectable change in the neutron attenuation characteristics under accelerated corrosion tests (Boric Acid, 2500 ppm Boron, 90 day soak at 200°F/90°C, ~20yrs SFP T)
- YS = 20-33 ksi, UTS = 33 – 40 ksi
- Excellent stability in all chemical and thermal environments

- Quality raw aluminum 6061 powder purchased
- Quality raw Boron Carbide powder purchased
- Mixed and blended in required ratios
- Cold Isostatic Pressed to make “Green” billets
- Billets Sintered



- Billets are extruded into panels
- Panels undergo successive rolling at temperature to reduce cross section
 - This is done in multiple passes
 - Multiple pieces as the original shape increases in size
- Once desired thickness is achieved the panels are cut to dimension



Metamic™ Insert

- Metamic™ Panels are sandwiched between the MPC Basket and a sheath of metal
- Sheath of metal and basket are welded to hold Metamic™ in place.



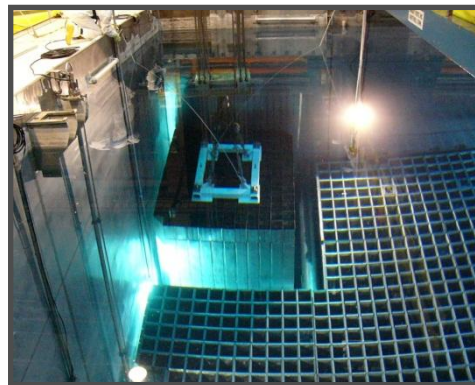
Spent Fuel Storage Rack



- Quality suppliers of raw materials
- Mixture content confirmed through wet chemistry
- Visual inspection throughout the fabrication process
- Dimensional inspection according to the desired product
- Neutron attenuation testing according to sampling plan to verify B4C content
- Record keeping for traceability



- Used in over 40 spent fuel pools and numerous dry storage casks – no incidents of degradation
 - 12 Reactors in China
 - 8 Reactors in Korea
 - 20+ Reactors in USA
 - Progress Energy, Exelon, PG&E, etc.
 - Started in 2003
- Coupon Surveillance Services
- Wet Rack installation
- Dream Inserts
 - Reactivity Mitigation
 - Boraflex Remedy
- Dry Storage Applications



Wet Storage Rack Installation

