SMR -160

Unconditionally Safe & Economical Green Energy Technology for the 21st Century

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Holtec International Company Overview

- Established in USA since 1986
- Annual Revenues: Over $400 Million USD
- Backlog: 4.0 Billion USD
- Over 700 employees
- No history of long-term debt
- Self financed company growth – D&B (4A1)
- Power Generation Technologies
- 35 Patents plus 29 Pending
- 750,000 Square Feet of Manufacturing - USA
A Global Leader in Power Generation Technologies

- Heat Transfer Equipment
- Spent Fuel and Non-Fuel Waste Dry Storage and Transport Casks
- In-pool Spent Fuel Storage Racks
- Dry Spent Fuel Loading Equipment
- Vertical Air Cooled Condensers
- Technical and Consulting Services

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• The Past……

• ................The Present.........

• ...........................................The Future
It Started Here

• Atoms for Peace
• To provide abundant electrical energy in the power-starved areas of the world
• Nuclear Energy to serve the needs rather than the fears of mankind
• Birth of IAEA

Dwight D. Eisenhower
Atoms for Peace
Delivered 8 December 1953, United Nations General Assembly
First Nuclear Powered Plants

On September 30, 1954, NAUTILUS became the first commissioned nuclear powered ship in the United States Navy.

Shippingport Atomic Power Station in Shippingport, Pennsylvania, the first full-scale nuclear power generating station in the United States which began operating in 1957.
Current Nuclear Powered Plants

- **US**: 104 Reactors – 100GW
- **World**: 430 Reactors - 372GW
- One in Five US households is powered by Nuclear Energy
When the Curiosity rover touched down on Mars August 6th, a specially designed nuclear generator kicked into action.

Multi-Mission Radioisotope Thermoelectric Generator, or MMRTP, an energy source that relies on the heat generated by decaying plutonium dioxide to run Curiosity. It’s designed to run at least one Martian year, which is almost two Earth years.
• SMR-160 is being developed by SMR LLC, a subsidiary of Holtec International

• Enhanced Safety and Security ("Fukushima-proof")
  – passive safety features, underground core, secure, smaller "source term"

• Attractive Investment Opportunity
  – lower initial capital investment, shorter construction duration, lower operational costs, quicker return on investment, low carbon emissions

• It is SMR-160’s mission to light up the ill-lit areas on the globe with affordable pollution free energy
SMR 160 Benefits

- Each unit is Autonomous
- Small Capital Outlay
- Competitive cost
- Small footprint, ~5 Acres and inconspicuous
- Short construction time, ~3 Years
- Robust design for all accidents and beyond design basis accidents
  - Passive safety systems
  - Reactor is underground
  - Spent fuel storage underground
- Long refueling cycle, Approx. 4 years
- Short outage period, 5 days
- High capacity factor, >99%

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An Overview of SMR-160

The containment is merely 45 feet in diameter, the Enclosure Structure is 52 feet I.D..

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Enhanced Safety & Security Features

- The reactor core is located deep underground.
- Because the reactor water is unborated it has a strong negative reactivity coefficient, the reactor becomes subcritical as soon as the water temperature in the core begins to rise above the design point.
- Passively cooled for both normal or forced shut down scenarios by thermo-siphon action.
- Double protection against crashing aircraft. Fuel is protected by airplane crash resistant Enclosure Structure & Containment Bldg.
- Containment remains passively self-cooling indefinitely after a LOCA.
• Enhanced Safety & Security Features (cont’d)
  – The Containment & its internals designed to withstand the strongest Design Basis Earthquake postulated for any existing U.S. or international nuclear plant location.
  – The RCS, fuel pool and small break LOCA are passively cooled during a station black out event.
  – Post-LOCA peak pressure is reduced to 50% of its peak value in less than one hour by purely passive action (regulatory requirement is 24 hours).
  – All safety systems are inside the containment.
  – Diesel power used only for (non-safety functions such as start up and for DC battery charging.)
• Fuel packaged in a Unitary Cartridge (Holtec Patent)
  – Refueling occurs by changing out a single cartridge that facilitates rapid refueling.
  – Specialized tooling required to remove fuel
  – Design hardened against security threats
• Fuel Cartridge is a multi-function device serves as:
  – a fuel rack in the pool
  – a “fuel basket” for dry storage
• Low turbulence in the Core protects fuel from fretting damage.
• Underground location of safety systems to provide:
  – Immunity from external natural events.
  – Maximum protection from malevolent human intervention.
  – Minimum occupational and off-site dose.

• In the event of a station black-out (Fukushima accident), the reactor’s post-scram heat is rejected to the atmosphere by purely passive means (Holtec patent): The Containment is accident-immune.

• Even a postulated massive cracking of the fuel pool structure (such as Fukushima after the earthquake) will not expose fuel to a dry condition: The fuel stored in the pool will remain safely under water even if the pool structure sustains massive cracks (after a cataclysmic event such as an earthquake).
• SMR-160’s non-safety waste heat rejection can be directly to air (reliance on a natural water source for cooling virtually eliminated, if desired).

• Holtec provides innovative air cooled condensers in two configurations:
  – HI-MAX which is a horizontal A-frame design
  – HI-VACC which stands for Holtec International Vertical Air Cooled Condenser
• SMR-160 is 160 MWe and is engineered to provide safe, reliable, clean energy to support the world’s growing population and energy needs.

• Distributed power generation eliminates reliance on a robust transmission grid.

• Sized to supply off-the-grid independent energy to vital infrastructure assets such as national labs & defense installations.

• Ideally sized for cogeneration, district heating & desalination plants.

• Black start capable.

• Generation capacity at a site can be incrementally increased by adding units.
• Siting process has begun

• Vision
  – Create “nuclear neighborhood”
  – Reduce infrastructure costs

• Initial criteria
  – Seismically stable
  – Good soil conditions
  – Groundwater > 100 ft.
  – No impact to existing safety basis

• Dark red locations are highest scores
South Carolina Nuclear Footprint

$2.2 billion in payroll
Nearly $5 billion in earned income
Over 28,074 Current Jobs
Small Modular Reactors for Civil Nuclear Power Leadership

When we enhance nuclear security, we’re in a stronger position to harness safe, clean nuclear energy. When we develop new, safer approaches to nuclear energy, we reduce the risk of nuclear terrorism and proliferation.

President’s Vision

National Energy & Nuclear Goals
• Climate/Clean Energy
• National Security
  • Non-proliferation
• Energy Security
• Competitiveness

Align U.S. Electricity Sector Goals to National Goals
• License 2 or more ultra-safe SMR designs
• Multiple Factory Manufacture
  • U.S. Navy Industrial Base
• Compete with Natural Gas to replace coal
  • Financial Incentives (?)
  • Government first user
• Global Market Leader

"By 2035, 80 percent of America’s electricity will come from clean energy sources”

Timely Goal

3/26/2012
Hankuk Univ

2011
State of the Union
SMR Markets

- US Utilities – Plant Additions and Replacements
- City / Municipal Power
- National labs & defense installations.
- Cogeneration, district heating desalination plants.
- Global Utilities / Governments
- US NNOG
Exelon Perspective on SMRs

✓ Advantages
  • Incremental additions/losses to grid
  • Smaller capital investment
  • “Installation” vs. “construction”

✓ Challenges
  • Operating and maintenance costs
  • Capital cost/kw installed

✓ Business Opportunities
  • Add to existing fleet
  • Operate under contract for non-nuclear owners

✓ Possible applications
  • Distributed generation
  • Repowering coal facilities
  • Additions to existing nuclear facilities
  • Military installations
Small Modular Reactor Technology

SMRs play a critical roll in the US energy future

- Scaleable (50-1000 Mwe +)
- Much less capital intensive
- Safest technology to date
- Can be load following and black start capable
- Can be air-cooled
- Designed and manufactured in the USA

Entergy Nuclear wants to operate SMRs
Creation of Energy Manufacturing Jobs - Model

State of SC

Manufacturing Jobs

Manufacturers (Holtec - SMR LLC)

Utilities (SCANA)

NuHub

SRS
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