Groundwater Remediation and Alternate Energy at NASA White Sands Test Facility

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Facility Operations
NASA White Sands Test Facility
• White Sands Test Facility (WSTF) Overview and Core Capabilities
• WSTF Groundwater Remediation Program
• Alternate Energy Programs
  – Wind Energy
  – Solar- Energy Storage Testbed
    • Solar
    • Vehicle Plug-in
    • Flow Battery Energy Storage
  – Utility-Size Peak Shaving Solar Generation Plant
WSTF Core Capabilities

- Remote Hazardous Testing of Reactive, Explosive, and Toxic Materials and Fluids
- Hypergolic Fluids, Materials, and Systems Testing
- Oxygen Materials and System Testing
- Hypervelocity Impact Testing
- Flight Hardware Processing
- Propulsion Testing
Remote Hazardous Testing

Reactive, Explosive, and Toxic Materials and Fluids

2000 lbs LH₂/LO₂ Test

Solid Propellant Test

500 lbs LH₂/LO₂ Test
Laboratories

• Micrometeoroid/Debris Hypervelocity Impact Testing
• Propellant and Explosion Hazards Assessment
• Research on Flammability of Materials including Metals in Oxygen-enriched Atmospheres
Hardware Processing

Critical Flight Hardware Assembly

Flight Critical System Components Refurbishment

Flight Hardware Production
Propulsion Test

Cassini – Saturn Orbit Insertion
Engine Glows during 3-h 20-min Continuous Firing

Shuttle PRCS Thruster
Hot-fire Testing

Minuteman Qualification Firing inside Vacuum Test Cell
Propulsion Test

Night Firing of Shuttle Forward RCS Primary and Vernier Thrusters
• Historic operations and practices in the 1960s resulted in contamination of WSTF’s groundwater.
  – Propulsion system testing programs:
    • N-Nitrosodimethylamine (NDMA)
    • Dimethylnitramine (DMN)
  – Component servicing and cleaning operations:
    • Trichloroethene (TCE)
    • Tetrachloroethene (PCE)
    • Freons: (11, 21, and 113)

• WSTF contaminated groundwater is NASA HQ’s greatest liability (estimated at $350M).
Restoration Program

• Priority: Protect the public’s health and the health of our workforce.
  – Containment
    • Stop the migration of contaminated groundwater
    • Address greatest health-risk liability first, then address source areas
      – Plume front
      – Mid-plume
      – Source areas
  – Restoration
    • Clean up the environment to preexisting conditions
Public and Employee Assessment

- No impact to any drinking water well
  - Includes public wells and NASA supply well
- No public exposure
  - Groundwater is several hundred feet below ground
  - No air or surface water exposure
  - Plume is moving very slowly west
    - Plume front treatment system will stop this westward movement.
- NASA performs on-going groundwater monitoring
  - More than 200 wells and zones routinely sampled
  - 850+ samples obtained monthly and analyzed for over 300 different contaminants
Containment and Restoration

- A Staged Approach over 60 years:
  - Attack the greatest risk to public health first
    - Stabilize the plume front (in progress)
  - Stop migration of contaminant into the plume front
    - Extraction and treatment at the Mid-Plume Constriction Area (~2009)
    - 100% design review completed, Construction start January 2009
  - Stop migration into the Mid-Plume Constriction Area
    - Clean up the source areas (~2012-2015)
Containment and Restoration

**Conceptual Model Summary**

1. San Andres Mountains
   - Hydrologic Inputs:
     a. Groundwater Recharge
     b. Precipitation/Runoff
   - Hydrologic Outputs:
     a. Underflow to Industrial Area
     b. Runoff to Industrial Area
   - Geologic Framework:
     a. Shallow and Exposed Fractured Sedimentary Rocks

2. Fractured Sedimentary Rock Aquifer
   - Hydrologic Inputs:
     a. Underflow
     b. Recharge from Mountain Runoff
     c. No Groundwater Production
     d. Contaminants
   - Hydrologic Outputs:
     a. Underflow with Contaminants
     b. Limited Runoff
   - Geologic Framework:
     a. Fractured Sedimentary Rocks
     b. Fault Contact with Volcanic Rocks

3. Fractured Volcanic Rock Pediment Aquifer
   - Hydrologic Inputs:
     a. Underflow from Industrial Area
     b. Limited Recharge through Infiltration
     c. Contaminants with Underflow
   - Hydrologic Outputs:
     a. Underflow with Contaminants
     b. No Groundwater Production
   - Geologic Framework:
     a. Fractured Volcanic Rocks
     b. Low Permeability Zones
     c. WETZ Contact with Distal Area

4. Alluvial Aquifer
   - Hydrologic Inputs:
     a. Industrial Area
     b. Contaminants with Underflow
   - Hydrologic Outputs:
     a. Contaminants Removed by PFTS
     b. Groundwater Production
     c. Underflow
   - Geologic Framework:
     a. Well-Graded Aquifers
     b. Hydrologic Boundary Effects with Bedrock
     c. Higher Permeability than Fractured bedrock
Contaminated water containing nitrosamines and VOCs → Air Strippers → Particulate filtration → VOCs Removed → Water Filters → UV-Tower → UV-Photolysis of Nitrosamines → Treated water injected back into aquifer.
Calgon Rayox® Tower UV Reactor in Bldg. 650

Effluent

Influent

UV Lamp Enclosures
Alternate Energy

Wind Energy

(Artist’s rendition)
• Wind Energy
  – Quartzite Mountain monitored since 2005
  – Determined to be a class 4 to class 5 wind site
  – Initial Environmental Assessment (EA) performed by WSTF Environmental
  – Issues associated with EA:
    • Bat study (Fall 2007/Spring 2009)
    • Radar issues with WSMR (formed working group with WSMR test operations)
      • Cost for road to access planned wind farm about $5-6 M
  – Developers interested in constructing wind and solar
  – El Paso Electric Company (EPEC) interested in future wind project
Photovoltaic System

- Photovoltaic (PV) system will provide peak shaving during daylight hours
- Test bed for Plumefront energy storage (flow battery technology)
- Charge storage batteries
- Provide peak shaving
- Provide shading for vehicles in parking lot
- Provide plug-in for autos
- Could be used for PV test bed
  - Installation of separate modules (different technologies)

Efficiency of PV modules

- Commercial modules: 10-22%

Irradiance = 1000 Watt/m²
100 - 220 Watts
Electrical power

1 m
Shaded PV Structure Plan View

23,293 sq m
Area Available

101 roof area minus penthouse 13676'

100 roof area minus penthouse 13720'

PV Shade Area

Parking Area 72676'

Fitness Center Area 42189'

Sloped Roof 6080'

1200 sq m
PV shade
Test Bed Renewable System
• Charges batteries throughout the day during off-peak load demand
• Discharges batteries during peak load demand
  - Determines benefits of using Flow batteries as energy storage for plume front system (discharge in solar off-peak hours or at night)
  - Evaluates the economic benefits of the system and monitoring the operation and performance of the PV and batteries (Zinc-Bromine/Vanadium)
  - Collects data to evaluate overall system performance, and to verify the storage system operates when necessary and provides necessary power required
Battery discharges (100%) during customer peak usage, reducing the customer load.

Battery capacity of 100 kWh will be discharged in 1 h, twice a day.
Energy Storage Unit

Battery Bank
• Two 50 kWh battery modules connected electrically in parallel
• A control system (Power Conversion System (PCS) inverter)
• A pair of electrolyte storage tanks
• Electrolyte circulation equipment

Advantages
• Uses electrodes that do not take part in the reactions, consequently there is no material deterioration that would cause long term loss performance
• Rapid recharge (2-4 hours)
• Deep discharge capability (100%)
• Built-in thermal management system
• Can be used for large scale application
System Energy Production

Monthly PV System Energy Production kWh

Annual Energy = 94,426 kWh/yr
Alternate Energy

Utility-size Solar Peak Shaving

Nevada Solar One
• NASA-owned land at WSTF considered for a solar-power generation plant
  – Approximately 400 acres
• Plant will be built and operated by the developer
• Developer is responsible for **ALL** financing of design, construction, and operation
• Current Electrical Power to WSTF
  – 69kV Transmission line to Apollo Substation from El Paso Electric Company
  – Substation rated for 15 MW (reached capacity in June 2006)
  – 24kV distribution line down to NASA land area
• NASA needs power to support site
  – Currently NASA has a ~5.5 MW peak load
  – DOD installation on site also interested in renewable energy
• Preliminary Environmental Assessment (EA) has been completed, but a complete EA is required prior to construction start
• NASA facility-type support is available, but cost is associated
Peak Shaving Solar Plant

• RFI on GovBiz (14 responses)
  – Number: 2008LUA
  – Posted Date: May 14, 2008
  – Response Date: May 27, 2008
  – 14 responses received

• Industry Day on Aug 12, 2008
  – MMA Renewable Ventures, LLC
  – Abencs/Abengoa
  – Acciona
  – International Power America
  – EverGuard Roofing, LLC
  – Greenlight Sunstream Holdings, LLC (dba Helios Energy)
  – Consolidated Solar Technologies
  – North Wind, Inc.
  – Juwi Solar
Peak Shaving Solar Plant

- New website for vendors generated
- In process of posting project information and Q&A
- Working with National Renewable Energy Laboratory (NREL) and New Mexico State University (NMSU) on the Request for Proposal (RFP)
- Options:
  - Provide land to El Paso Electric Company for 92 MW Concentrating Solar Power (CSP) plant
  - Sell power to Public Service Company of New Mexico (PNM) or other New Mexico utilities
  - Sell power out-of-state
  - Use power only behind the meter (NASA, White Sands Missile Range (WSMR), Holloman Air Force Base (HAFB), Fort Bliss)
Questions?