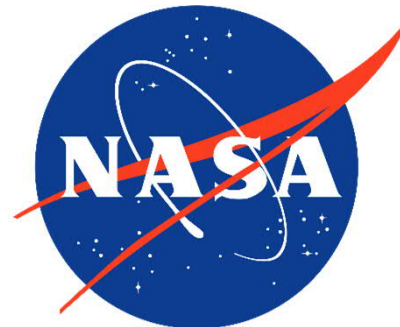

NASA Johnson Space Center



Steven W. Spanbauer

Senior Vice President

Energy Systems Group - Federal Business Unit

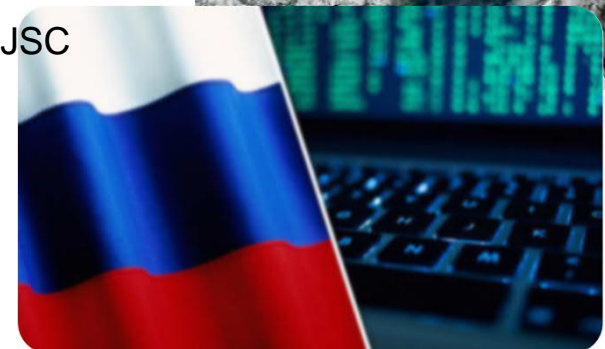
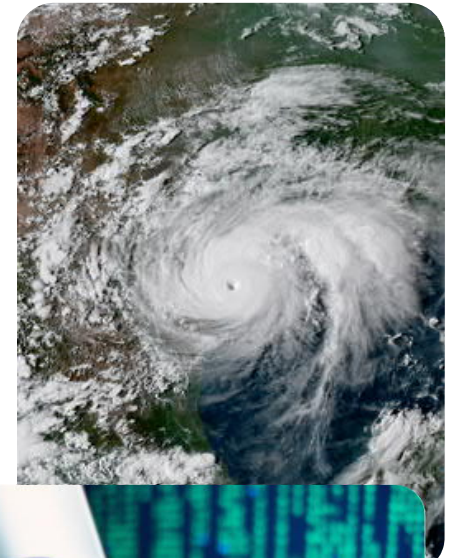
What is JSC?

- “The Pentagon of NASA”
 - Established in 1961
 - Home of Mission Control Center for NASA’s Human Space Flight Program
- One of NASA’s largest research and development centers
- Occupies 1,620 acres southeast of downtown Houston
- Mission Control for tracking the International Space Station and other international space exploration missions
- Home to the Orion Spacecraft, test site of the James Webb Telescope and other satellites, the NASA and European Astronaut Corps, and other advanced human exploration projects



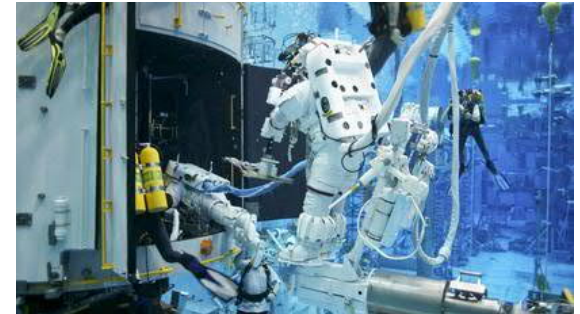
Project Drivers – “Houston, we have a problem”

- Persistent Hurricane and Flooding Threats to Critical JSC Missions
 - 2010-2017, 1-2 Hurricanes on average per year
- 2011 – Severe Drought Conditions Texas State-Wide
 - Record Number of +100 degree days
 - Load Shedding by JSC
 - Brown Out Potential
- December 14, 2012
 - Truck driver accident with electrical tower and caused JSC Site Electrical Outage
- Cybersecurity Concerns
 - U.S. utility sector faces millions of attempted cyber intrusions a day
- Energy Goals
 - JSC was red on the metric for energy reduction
 - Currently JSC is in the green



CHP = Energy Resiliency and Security

- JSC/CHP takes pressure off the strained grid
- Increased Energy Security
 - CHP provides JSC with an “island grid” for power
 - JSC controls reliability and availability of the power plant
 - Self generation of ~70% of base power consumption
 - Provides ~ 11.9 MW of onsite power generation
 - Provides all site steam load, 40-60% peak chilled water load
 - Power to critical JSC facilities
 - Including Mission Control for the International Space Station, which has one turbine completely dedicated to its operation
- Energy and Cost Reduction
 - Steam used to offset 6000 tons of electric chillers
 - Lower energy rates due to lower peak rates
 - Reduces energy intensity from 212,716 BTU/GSF to 103,616 BTU/GSF
 - Meets all energy reduction goals through 2032



Summary: An ESPC Funded CHP Microgrid

Contract Type & Value

- DOE ESPC
- \$49.9 Million
- \$1 Million AFFECT Grant Award

Scope

- Combined Heat & Power / Chilled Water Optimization
- Facility Operations
- Repair & Replacement

Technologies

- Two 5.7 Megawatt (MW) Combustion Turbines
- Two 50,000 lb/hr Heat Recovery Steam Generators (HRSG) with Economizers and 25,000 lb/hr Duct Burners to supply 6,000 tons of steam turbine chillers
- Two Selective Catalytic Reduction (SCR) Emissions Control Systems
- 500 Kw Back Pressure Steam Turbine Generator
- Paralleling Substation and Combustion Turbine MCC
- Steam Turbine Generator Step-up Transformer
- 750 Kw diesel black start emergency generator



Resiliency in Action

- The onsite electricity generation from the CHP plant boosts JSC's reliability and resilience
 - Allows the facility to operate in the event of a major power outage by guaranteeing access to continuous energy
 - Facility efficiency improvements mean it needs less total energy, thus extending the length of time JSC could operate as an islanding microgrid separate from the power grid



“Houston, ESG has a solution”

- More important now than ever to combat growing threats with mission critical energy
- Crossed the chasm into the growth area of the next era of energy
- Performance contracting is a critical way to implement resiliency solutions and cybersecurity
- Not just theory – this CHP microgrid is in practice and effective in delivering resilient energy to NASA’s critical mission

