Duke Edwardsport IGCC Simulator
Overview

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Duke Energy

Quick facts:

• 150+ years of service
• 7.5 million electric customers
• 52,700 megawatts of generating capacity
• 1.6 million natural gas customers
• Fortune 125 company
• Traded on NYSE as DUK
• Dow Jones Sustainability Index for North America
Duke is committed to determining the most efficient and environmentally sound ways to meet the growing demand for electricity over the next 10 to 15 years by developing a range of options to reduce demand and increase efficiency, all while reducing the impact on the environment.

Looking Forward

New Natural Gas Generation
Ensuring an affordable, reliable and cleaner energy supply.

Renewable Energy
- 2,300 MW wind power
- 600 MW solar power

Nuclear energy is one of the cleanest power sources in the world

Edwardsport IGCC
Decommissioning Retired Coal Plants
What is IGCC?

Integrated Gasification Combined Cycle

- Gasification – Coal converted to synthetic natural gas (syngas) in a high pressure, low oxygen reaction
- Syngas Coolers – Steam produced by gasification integrated with HRSGs
- Syngas Cleanup – Impurities removed before GTs: Acid Gas (CO2, H2S, NH3), SOx, NOx, Hg, particulates
- Combined Cycle – 2 X Gas Turbines, 2 X HRSGs, and ST
2 x 1 Combined Cycle

- Gross Station Output – 800 MW
- Net Station Output – 618 MW

Power Block

- 2 GE 7FB Syngas Combustion Turbines – 236 MW (each)
- 1 GE G13 Steam Turbine – 326 MW
- 2 Doosan HRSG’s
Gasification

- 2 GE Gasifier Trains
- 2 Air Products Air Separation Units
- 2 Claus Sulfur Recovery Units
- 2 Honeywell UOP Acid Gas Removal Units
Edwardsport IGCC

- Simulator project schedule duration of 15 months
  - Discrepancies tracked electronically 600+ to 6 remain at end of FAT
- Systems modeled: 40+
  - Main simulator includes 6 primary areas fully integrated (with divisions and external parameters for Station Desktop Training)
  - Air Separation, Power Block, Gasifier, Acid Gas Removal / Sulfur Removal Unit, Grey Water, Water Treatment.
    - GE Mark VIe I/O interface points to model: 108,463
    - Hardware: 4 HP Servers, 11 HP Thin Clients, 4 Data Highways (primary PDH, UDH & backup PDH, UDH)
- WSC Resources assigned:
  - 1 PM, 2 programmers, 5 senior engineers, 3 staff engineers
- Duke Energy Resources:
  - Plant - 3 OTS, 6 CRO, 2 PTC, 2 DCS
  - Central Engineering, Regional Engineering
What went wrong with the first simulator?

- Duke was not involved in the process of building the simulator
- Contractors only responsible for their part of the contract but not for overall integration
- Multiple simulation environments for the power and process plant
- Accepted pre start-up of the plant without the commissioning updates
- Complex Fiber and Ethernet network (shared memory between systems)
- Simulator only allowed runtime software license (gasifier)
- Very complex to upgrade due to the multiple vendors involved
What went right with the second WSC simulator?

- Followed Duke standard approach of being heavily involved in all aspects of the simulator design, integration, and testing
- Central Engineering, Regional Engineering, GE System Engineer, Plant Support – DCS, OTS, CRO, PTC
- One modeling environment covering all power and process
- Teamwork between Duke/GE/WSC
  - Duke Energy trained on 3KM and GE network software (DCS engineers, PTC, Simulator Instructor)
- GE DCS hardware install at WSC
  - Thick Clients installed mid-February
- GE DCS new VM Ware Servers
  - Thin Clients installed and current plant database was installed May 29 (post spring outage)
Project Schedule

- Simulator project schedule duration of 15 months – on schedule
  - Project Kickoff: July 27, 2016
  - Models Review: January 30, 2017
- GE DCS Hardware/SW install at WSC
  - Thick Clients installed: March 28, 2017
  - Current plant database installed: May 29, 2017 (post-spring outage)
- Pre-FAT: March 6 – June 2 (9 weeks)
- FAT: June 5 – August 11 (7 weeks)
- SAT: September 11 – December 1 (6 weeks, 3 main, 2 DSKTP)
• Good communication between all parties involved: GE/Duke/WSC
• Good initial data collection using GE BOX for faster communication
• Quick and professional responses to Data Requests
• Detailed project design and careful design review from Duke
• Model review at the end of model development
• 2-month-long pre-FAT
• 4 Hardware platforms provided by GE for simultaneous development and testing
• Very professional, knowledgeable, and motivated team from the end customer
• 23,000+ documents
  ▪ P&IDs, piping ISOs, HMI screenshots, flow diagrams, etc.
  ▪ Database for organizing by system, searching, and flagging
• 2 weeks allotted for data acquisition
  ▪ Started 2 months in advance
  ▪ Prioritization of documents
• Single point of contact – Dan Zilly
  ▪ Cooperation from Process Owners/System Engineers
  ▪ 56 Data Requests
• PI Data live during pre-FAT
Simulator Overview

- 108,000+ IO points
  - 103,000 MarkVIe
  - 5,000 PLC
- 42 MarkVIe Controller Tasks
- 8 FlowBase Tasks

12 PLC Tasks (emulated)
- CO2 Recycle, Preheat Burner, Reaction Furnace, York Compressor

- 3 Hard Panel touch screens
Network Structure

Diagram showing the structure of network nodes with labels like VWR1, VWR2, VWR3, EWS1, LIVEW1, INSTR_STAT, CRM1_SVR, CRM2_SVR, CRM3_SVR, CRM4_SVR, CRM5_SVR, CRM6_SVR, CRM7_SVR, CRM8_SVR, and Simulation Host.
Simulator Room

FAT
Simulator Room

Site Installation
What is a Desktop Simulator?

A separate, self-contained simulator of a plant system that operates independently of all other plant systems.
Desktop Simulators

1. Plant divided into 6 separate systems
   1. Gasifier
   2. Powerblock
   3. AGR/SRU
   4. ASU
   5. Grey Water
   6. Water Treatment

2. Isolated Mark VIe Virtual Controllers

3. Boundary Conditions
   - Instructor controlled
   - Constant
Gasifier

HP & LP Steam (PB)
Natural Gas (PB)
Circ Water (PB)

GASIFIER

Gasification
Coal Handling
Coal Grinding
Slag Handling
LTGC (AGR)
Black Water

Syngas (AGR)
Grey Water (GW)
Gasifier

Syngas Cooler
Syngas (AGR)
Steam (GI)
Diluent N2 (ASU)
Demin Water (WTR)

Gas Turbines
Steam Turbine
HRSG
FW & Cond
Cooling Water
Circulating Water

Extraction Air (ASU)
HP & LP Steam (GI) (AGR) (ASU)
Power Block

HP Drum & Superheater
AGR/SRU

LTGC (GI)
CO2 Recycle
Acid Gas Removal
Clean Syngas Conditioning
Sulfur Furnaces
Tail Gas Units
Thermal Oxidizers

MP & LP Steam (PB)
Raw Syngas (GI)
N2 (ASU)
Cooling Water (PB)

Syngas (PB)
Hydro Rx Tail Gas Redux

Keep in between 425 and 600

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ASU

- Extraction Air (PB)
- Cooling Water (PB)
- HP & LP Steam (PB)

Main Air Compressors
- Booster Air Compressors
- Diluent N2 Compressors

N2 (AGR)
- Diluent N2 (PB)
Grey Water

Grey Water
Blowdown (GI)

LP Steam (PB)

Cooling Water (PB)
Grey Water

Concentrator 2
Water Treatment

Gravity Filters
Micro Filters
ROs
Mixed Beds
Demin Water

Cooling Tower Make-up (PB)
Gravity Filters
Desktop Simulators

- Parallel and separate system testing and operator training
- Controlled steady-state and transient testing
- Simultaneous separate model system development
- Less processors used – can run the desktop simulator outside of simulator host
- Syncing main integrated simulator and desktop simulators
Moving forward in 2018, the main focus of the simulator training will be on:

- Plant De-Rate scenarios built from real events
- Build multiple scenarios involving the usage of plant Emergency Operating Procedures
- Standard Operating Procedures
- Initial and cross-training for Operations personnel
- Utilize simulator for training of other disciplines, including maintenance, I&C and engineering
THANK YOU!

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