WAKE FOREST UNIVERSITY

RMF Engineering
Reliability. Efficiency. Integrity.

Central Heating Plant Upgrade

February 2014

WAKE FOREST
UNIVERSITY

RMF Engineering
Reliability. Efficiency. Integrity.

Agenda

- Wake Forest University
- District Utilities
- Existing System
- Project Goals
- Project Overview
- Efficiency Improvements
- Projects Results
- Q&A

Who is WFU?

Private ACC School

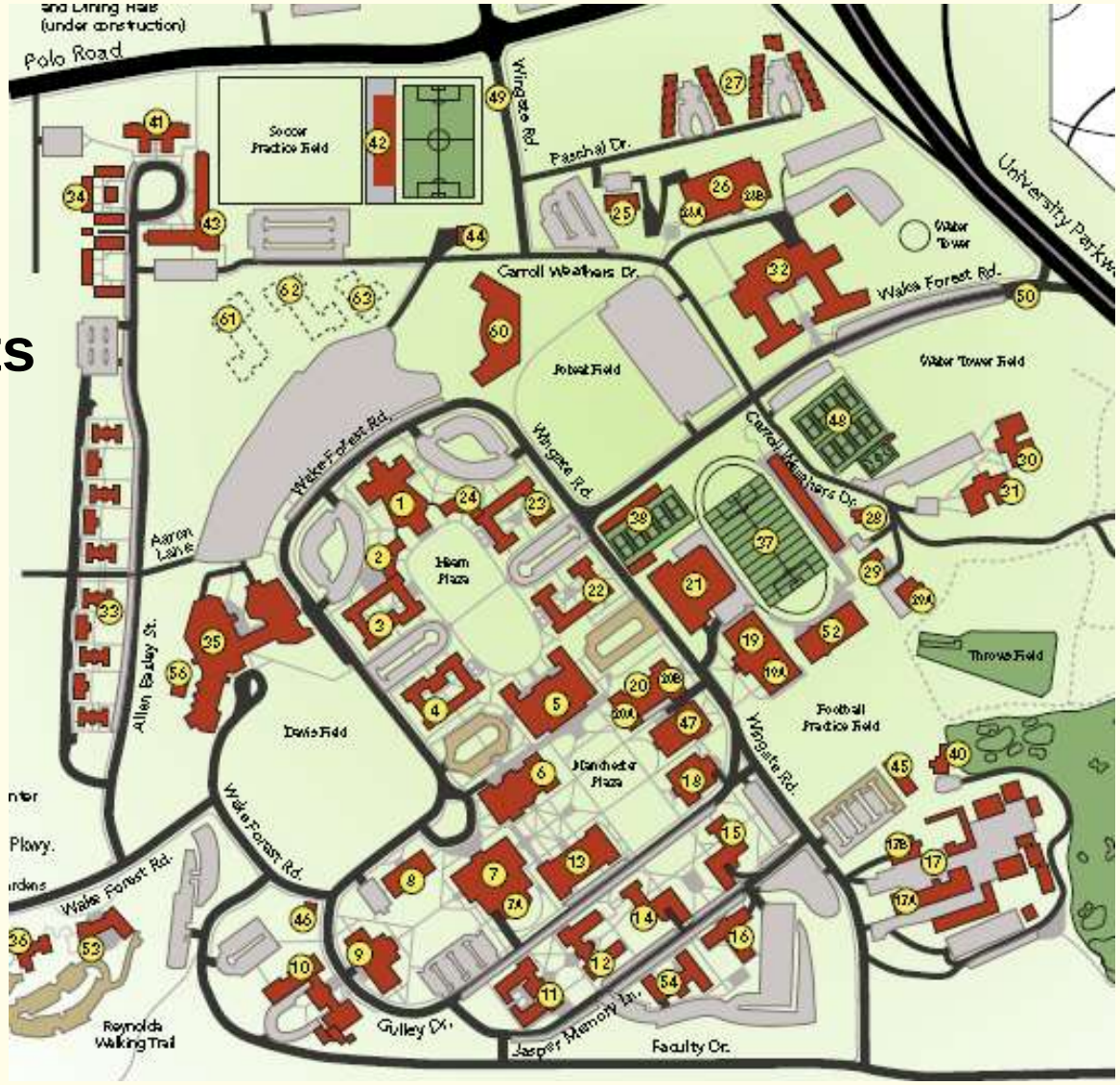
Winston-Salem, NC

~5,000 Undergrads

~7,500 Total Students

Recent Growth

- **4 New Buildings**
- **2.7 – 3.1 million s.f.**
- **59/63 Buildings**
- **3,400/3,880 Beds**



District Utilities

- **Most Buildings Served By District Utilities**
  - **Steam – 121,000 pph Connected Capacity, Historical Min ~ 6,000 pph, Max - ~ 44,000pph**
  - **Electric – 20 MW (Duke Energy) Transformer, 13 MW Peak**
  - **Chilled Water – Campus Loop w/ 4 Plants, 6,700 Tons Capacity, 5,200 Tons Peak**
  - **Water/Sewer – Campus Loop, 2 Feeds From City**
  - **Stormwater – Two Primary Outfalls**

Duke Energy

Piedmont Natural Gas

TEXICAN Horizon Energy Marketing

Winston-Salem • Forsyth County City/County Utilities Water • Sewer • Solid Waste Disposal

	Budget FY14
Steam	$2,625,112
Electric	$4,125,577
Chilled Water	$1,237,234
Wtr/Swr	$702,778
Storm Wtr	$179,498
Total FY14	$8,870,199

Steam Distribution

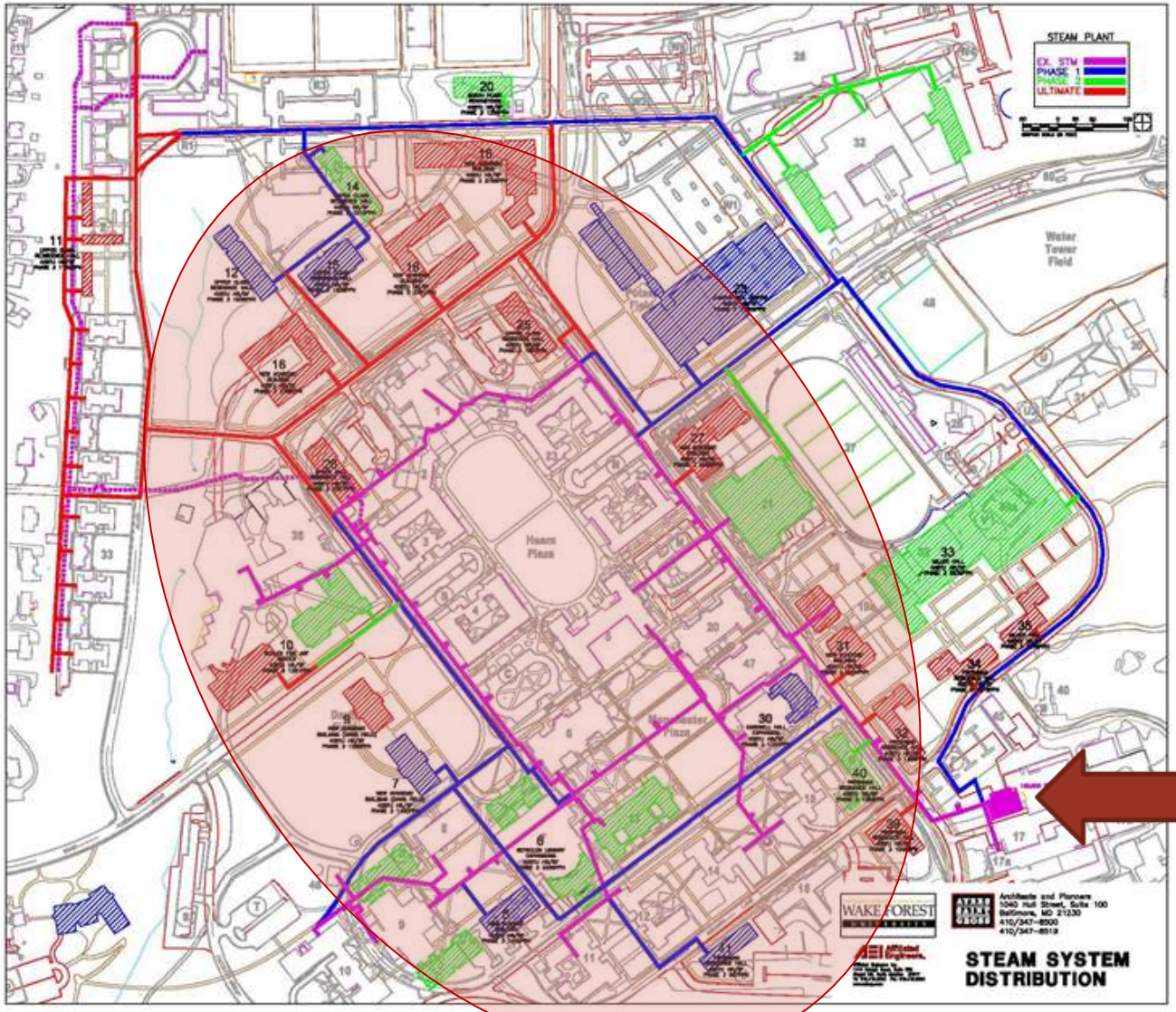


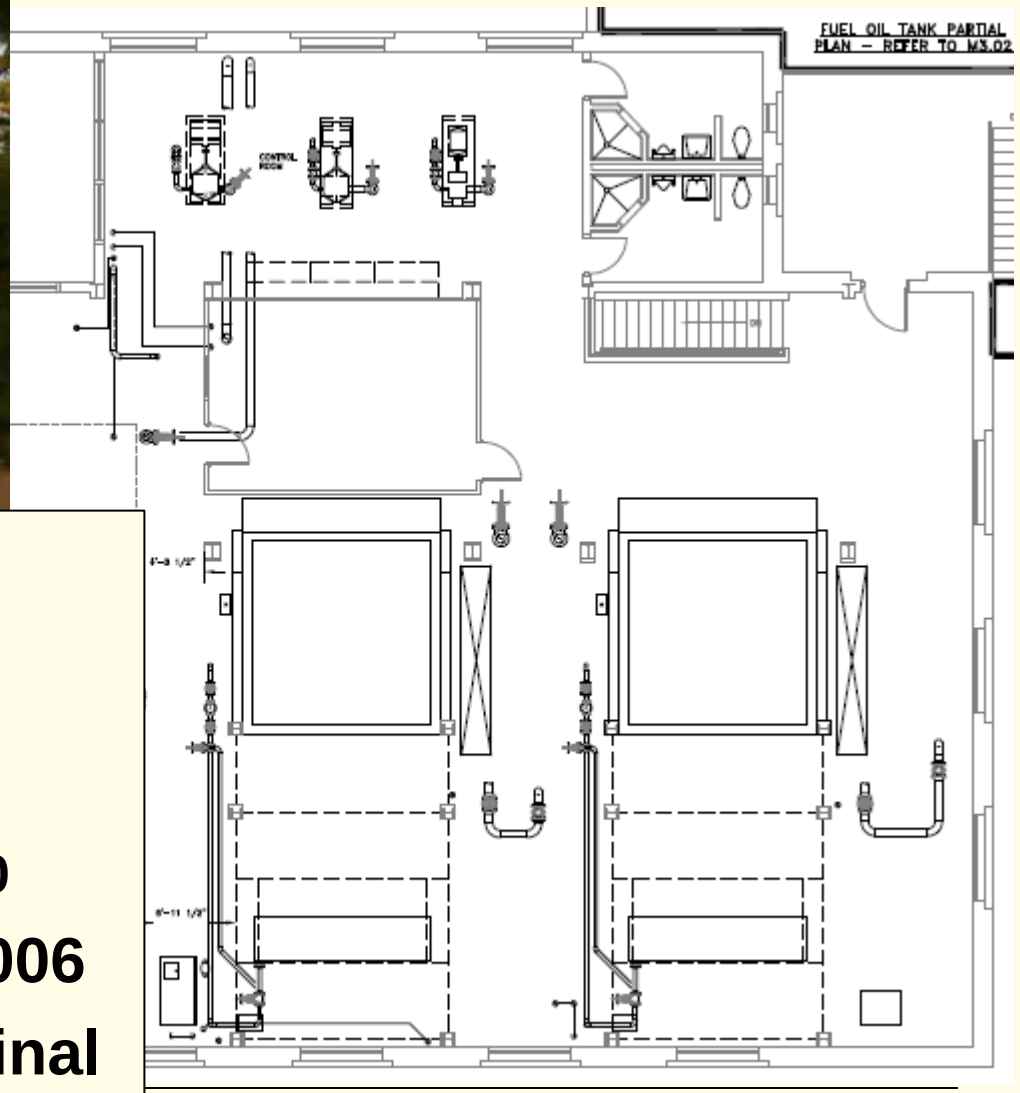
Figure II-5: Future Steam Distribution

Campus Loop

- 1.1 Miles in Accessible Tunnels
- 95 psi Distribution
- 80% + Condensate Return

Central Plant

Existing Plant



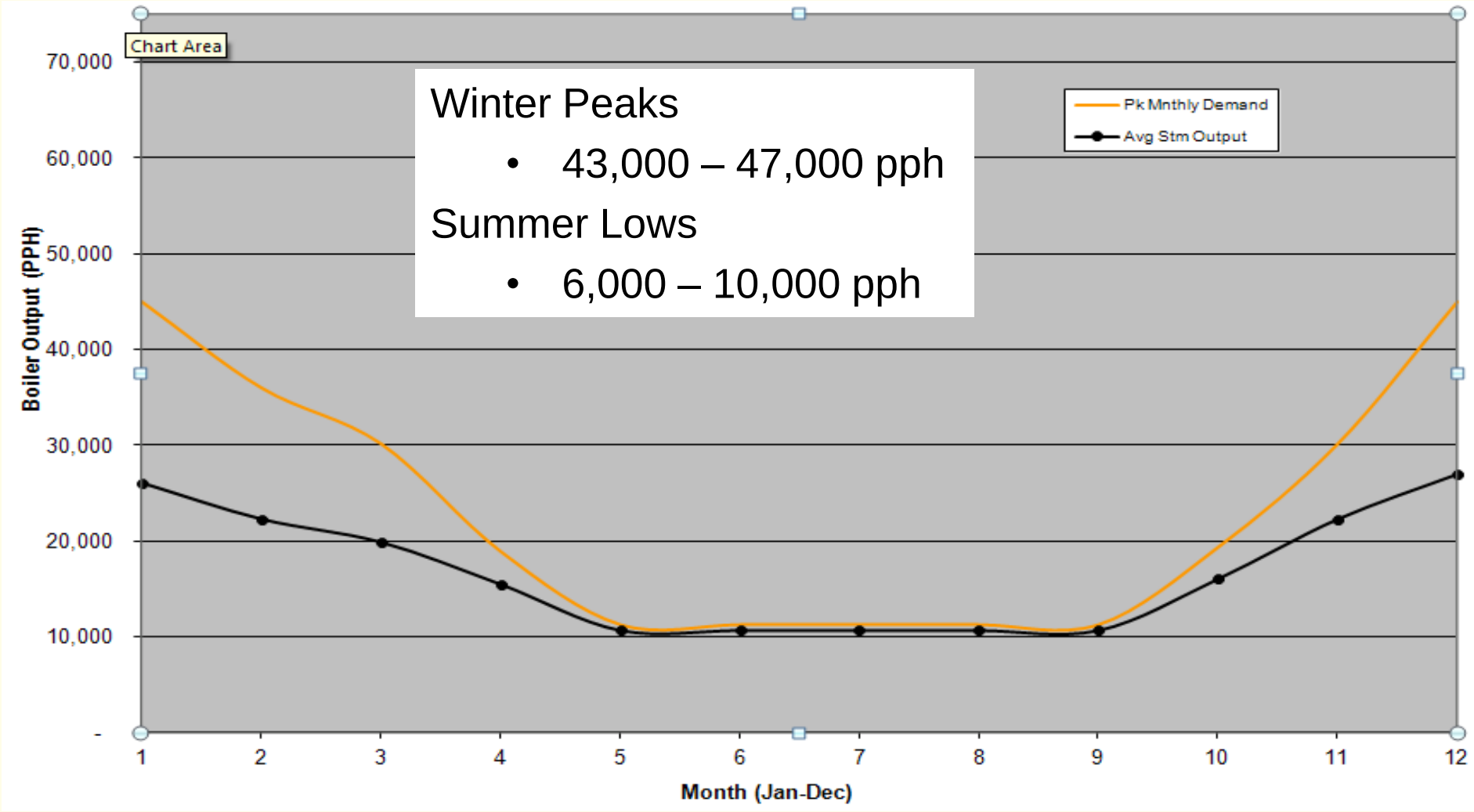
2 – 1954 Erie City Boilers

- Ea. 50,000 lbs Steam/Hr
- Natural Gas & No. 2 Oil
- 1 Orig, 1 Retubed (1998)
- Boiler Controls Updated 2010

Plant Controls Updated 2006

Sub-Systems Mostly Original

Historical Steam Load



Project Goals

- **Increase Steam Generation Capacity**
  - Campus Growth
  - Master Plan
- **Eliminate or Minimize Annual May Steam Shutdown**
  - Increase Redundancy in Sub-Systems, Isolation Valves
- **Renewal of Steam Generation Sub-Systems**
  - FCAP, Repair History, Useful Life, Code Compliance
- **Improve Plant Efficiency**
  - Co-gen, New Technology, Boiler Efficiency
- **Road Map for Steam Plant of the Future**
  - Possible Buildings (5 Years), 3% Growth Beyond 5 Years

Capacity – 5 Year

Winter Peaks

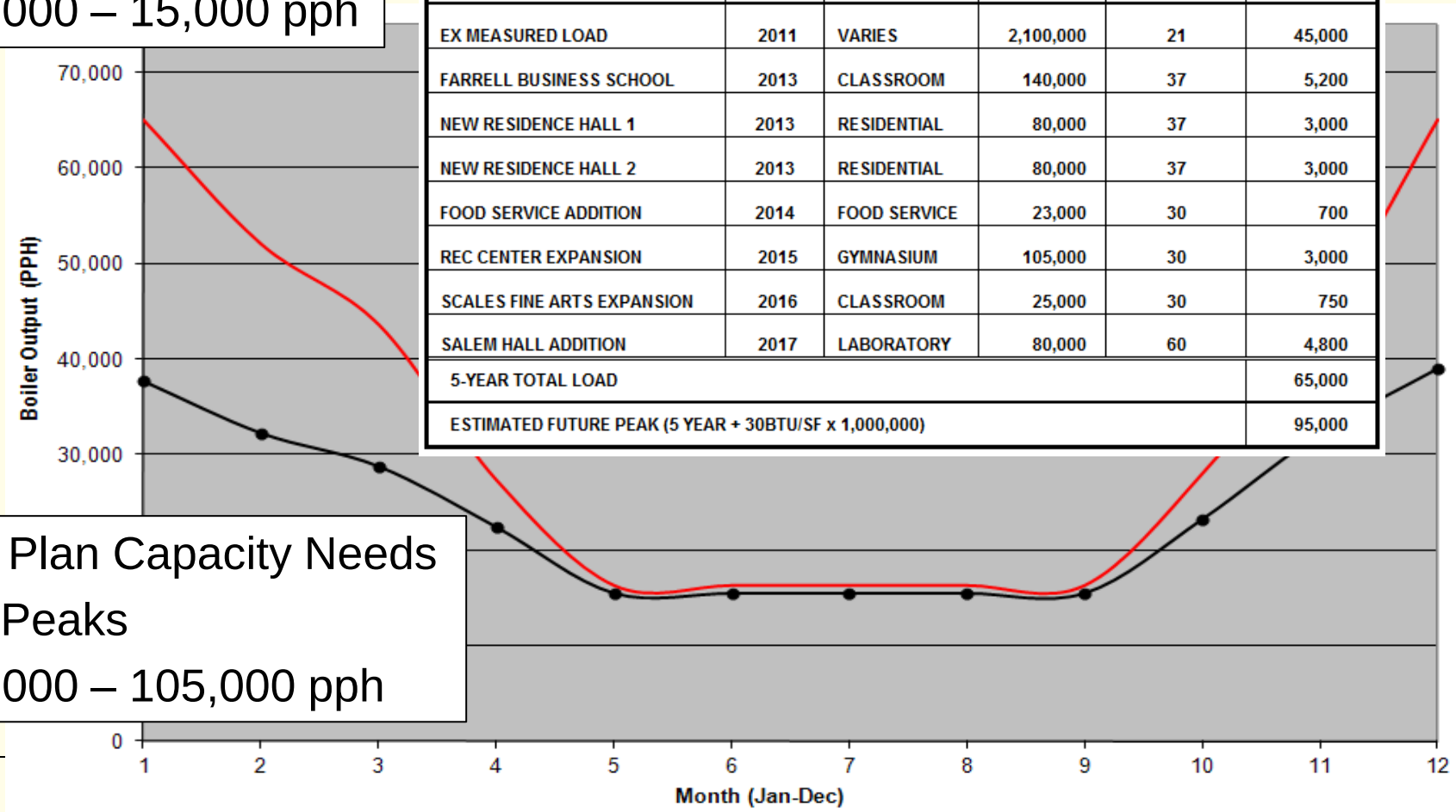
65,000 – 70,000 pph

Summer Lows

10,000 – 15,000 pph

PROJECTED STEAM LOADS
WAKE FOREST UNIVERSITY

BUILDING NAME	YEAR BUILT	OCCUPANCY	GROSS AREA (GSF)	UNITARY FACTOR (BTU/HR-SF)	STEAM LOAD (PPH)
EX MEASURED LOAD	2011	VARIES	2,100,000	21	45,000
FARRELL BUSINESS SCHOOL	2013	CLASSROOM	140,000	37	5,200
NEW RESIDENCE HALL 1	2013	RESIDENTIAL	80,000	37	3,000
NEW RESIDENCE HALL 2	2013	RESIDENTIAL	80,000	37	3,000
FOOD SERVICE ADDITION	2014	FOOD SERVICE	23,000	30	700
REC CENTER EXPANSION	2015	GYMNASIUM	105,000	30	3,000
SCALES FINE ARTS EXPANSION	2016	CLASSROOM	25,000	30	750
SALEM HALL ADDITION	2017	LABORATORY	80,000	60	4,800
5-YEAR TOTAL LOAD					65,000
ESTIMATED FUTURE PEAK (5 YEAR + 30BTU/SF x 1,000,000)					95,000

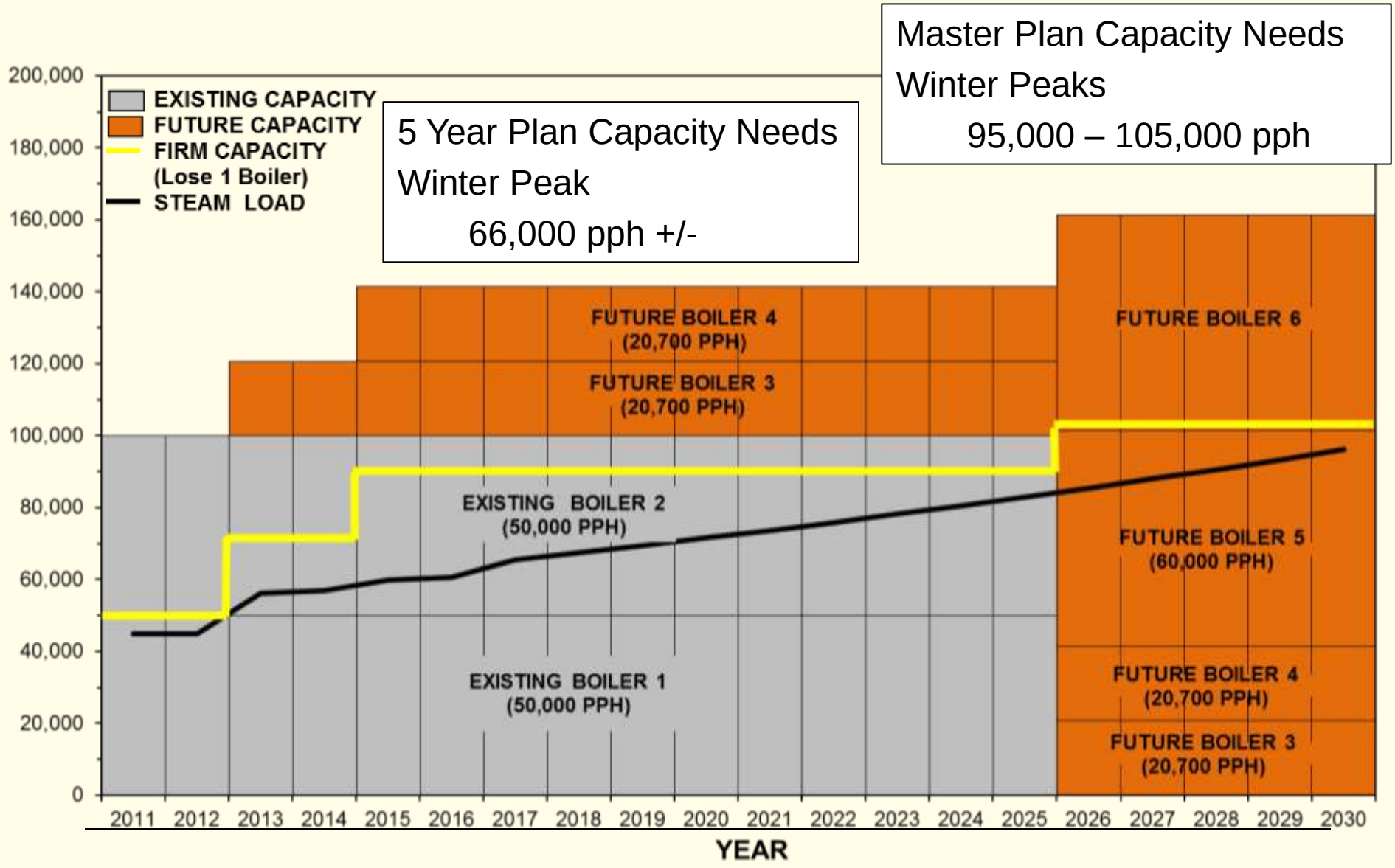


Master Plan Capacity Needs

Winter Peaks

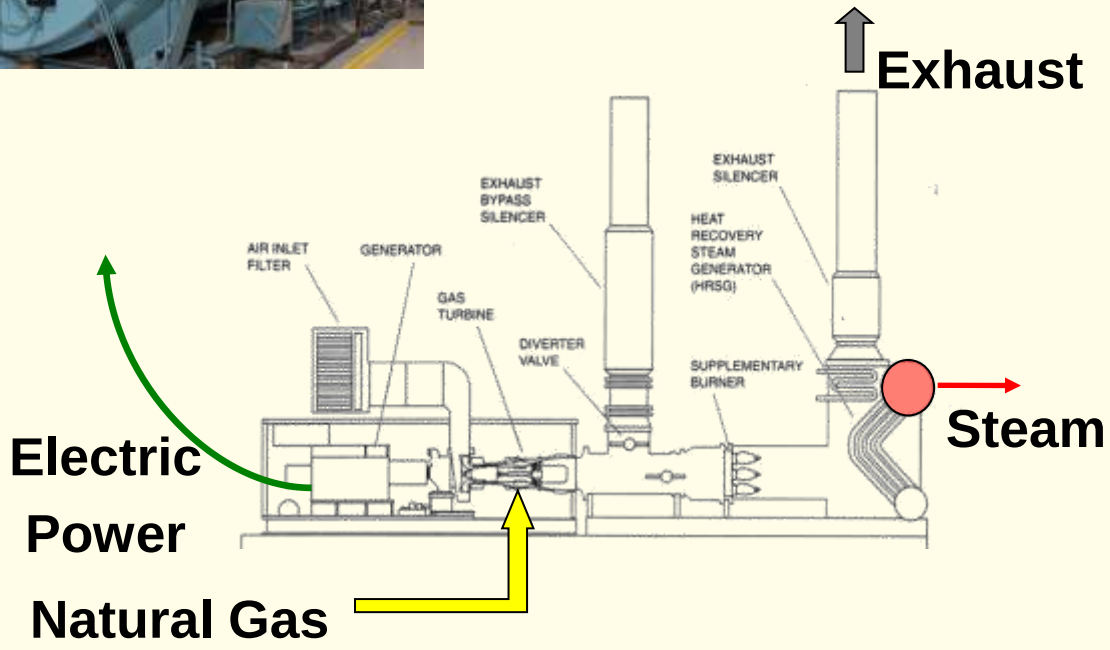
95,000 – 105,000 pph

Capacity – Master Plan



Considerations

Solar - Mercury 50		
Electric Output	4,600	kW
Unfired Steam	13,800	pph
Installed Cost	$ 15,768,000	
Annual Net Savings	$ 409,434	
Year 1 ROI	3%	
Simple Payback	38.5	Yr



Upgrade Plan

2 – 20,700 pph Boilers

- 1 in 2013, 1in 3- 10 years

Redundant Sub-Systems

- Make-up Water, Condensate Tanks, Feedwater Pumps, Deaireator

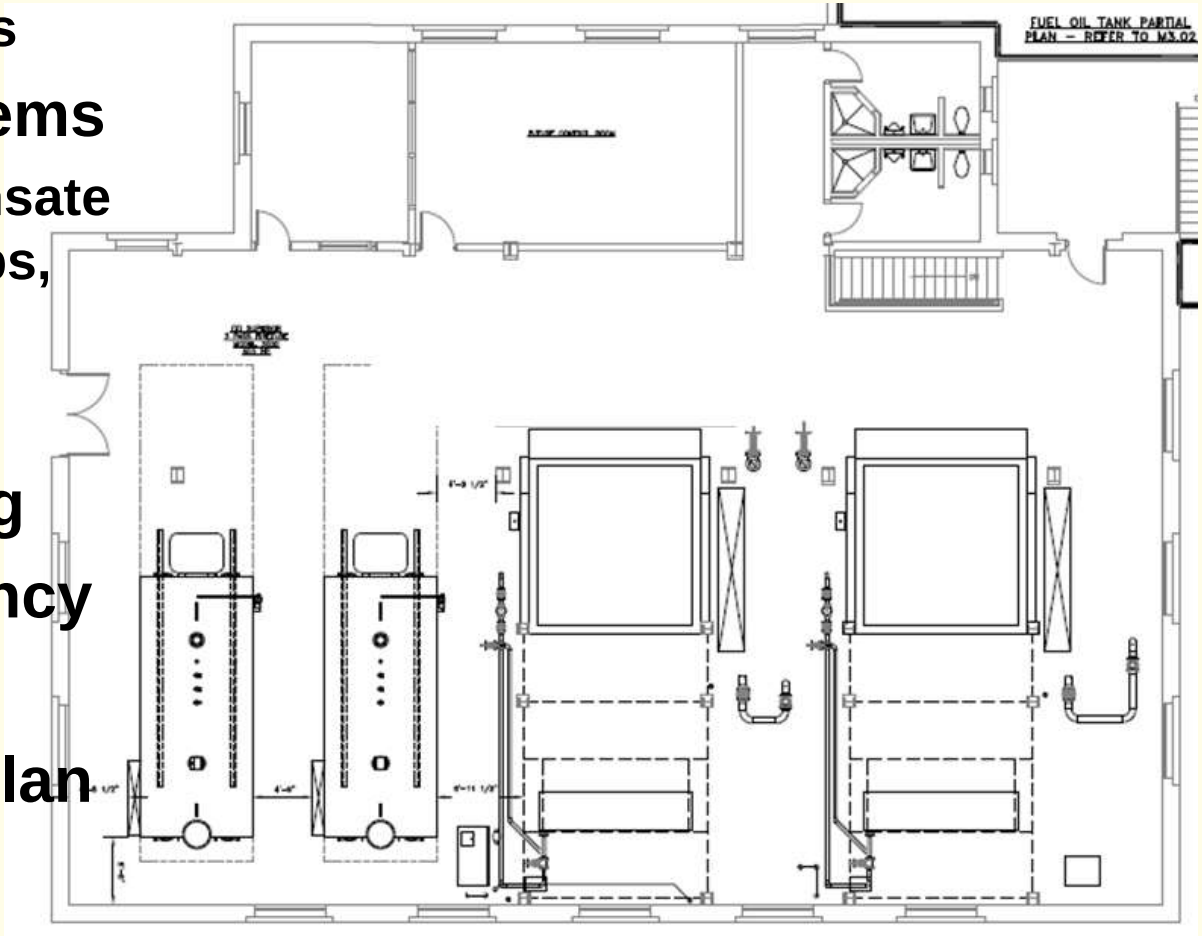
New Control Room

Improve Sub-Metering

Improve Plant Efficiency

Code Compliance

Steam Plant Master Plan



Redundant Equipment

DA Tank

Condensate Return Tank

Feedwater Pumps

Efficiency Measures

ENERGY CONSERVATION MEASURES

WAKE FOREST UNIVERSITY - BOILER ADDITION

OPTION NO.	DESCRIPTION	ANNUAL ENERGY DATA		LCCA ECONOMIC METRICS	
		INSTALLATION COST ($)	PLANT FUEL TO STEAM EFFICIENCY (%)	SIMPLE PAYBACK (YRS)	FIRST YEAR ROI (%)
	EXISTING PLANT		77.8%	---	----
BASE	2x 600 BHP FIRETUBE BOILERS (N+1) [41,400 PPH]	BASE	81.7%	---	----
1	TRADITIONAL FEED WATER ECONOMIZER	$114,814	84.0%	3.8	26.2%
2	FW ECONOMIZER AND CBD HEAT EXCHANGER	$204,874	84.5%	5.3	19.0%
3	CBD HX AND CBW FEEDWATER AND MAKEUP WATER ECONOMIZERS	$281,157	85.5%	5.4	18.4%
4	CBD HX AND DCI FEEDWATER AND CONDENSATE ECONOMIZERS	$800,160	85.8%	14.2	7.1%

Efficiency Measures

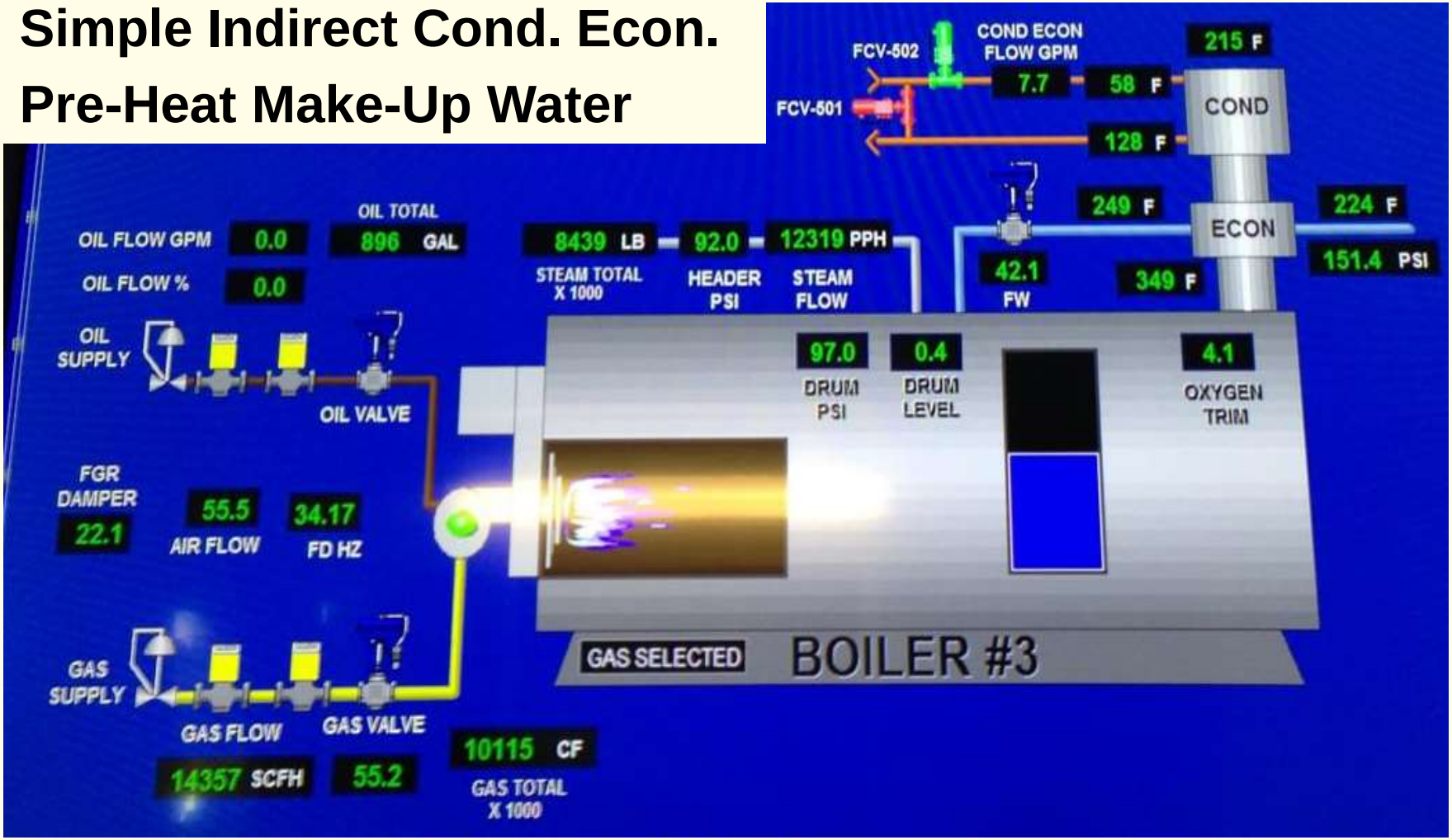
- **Fully Metered Controls w/ O2 Trim**
- **VFD Boiler Fan**
- **Continuous Blow-Down HX**
- **Flash Recovery**

Condensing Economizer

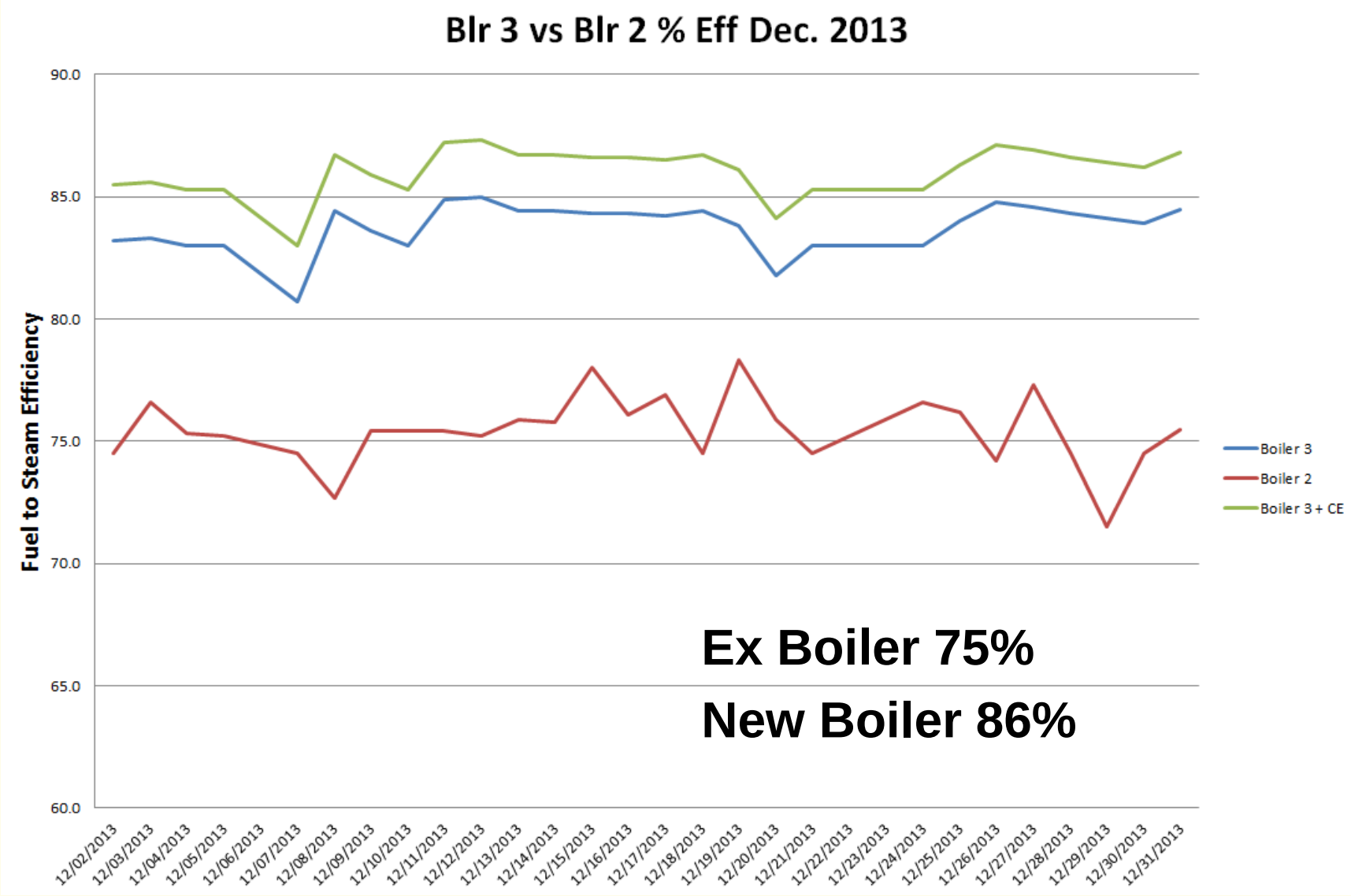
Key Design Considerations

- Available Heat Sinks
- Direct vs Indirect Contact
- Make-Up Location
- Stack Materials
- Packaged vs Custom

Simple Indirect Cond. Econ. Pre-Heat Make-Up Water



Energy Performance



Summary

- **Increased Steam Generation Capacity**
  - 20,700 pph + Retuned Ex Boilers
- **Minimized Annual May Steam Shutdown**
  - Redundancy
  - Isolation Valves
  - Distribution Challenges Remain
- **Renewed of Steam Generation Sub-Systems**
  - FCAP, Repair History, Useful Life, Code Compliance
- **Improved Steam Plant Efficiency**
  - New Technology, Boiler Efficiency
- **Road Map for Steam Plant of the Future**
  - Possible Buildings (5 Years), 3% Growth Beyond 5 Years
- **Road Map the Future**
  - UOC – Utilities Operations Center

Utilities Operations Center (UOC)

New Steam Plant Control Room

Utilities Monitoring

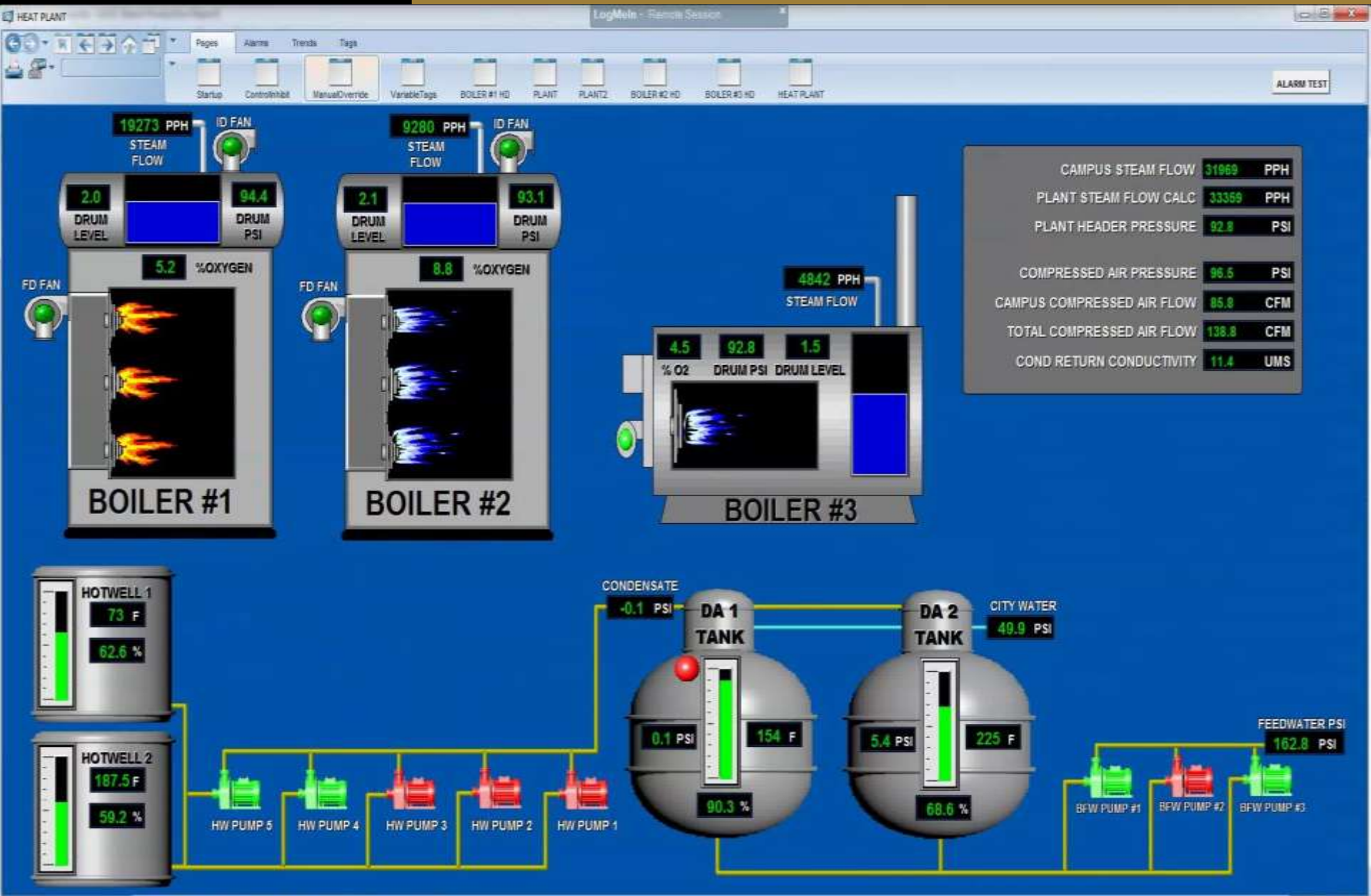
Campus BAS Monitoring

Off Hours Call Center

WAKE FOREST UNIVERSITY

RMF Engineering
Reliability. Efficiency. Integrity.

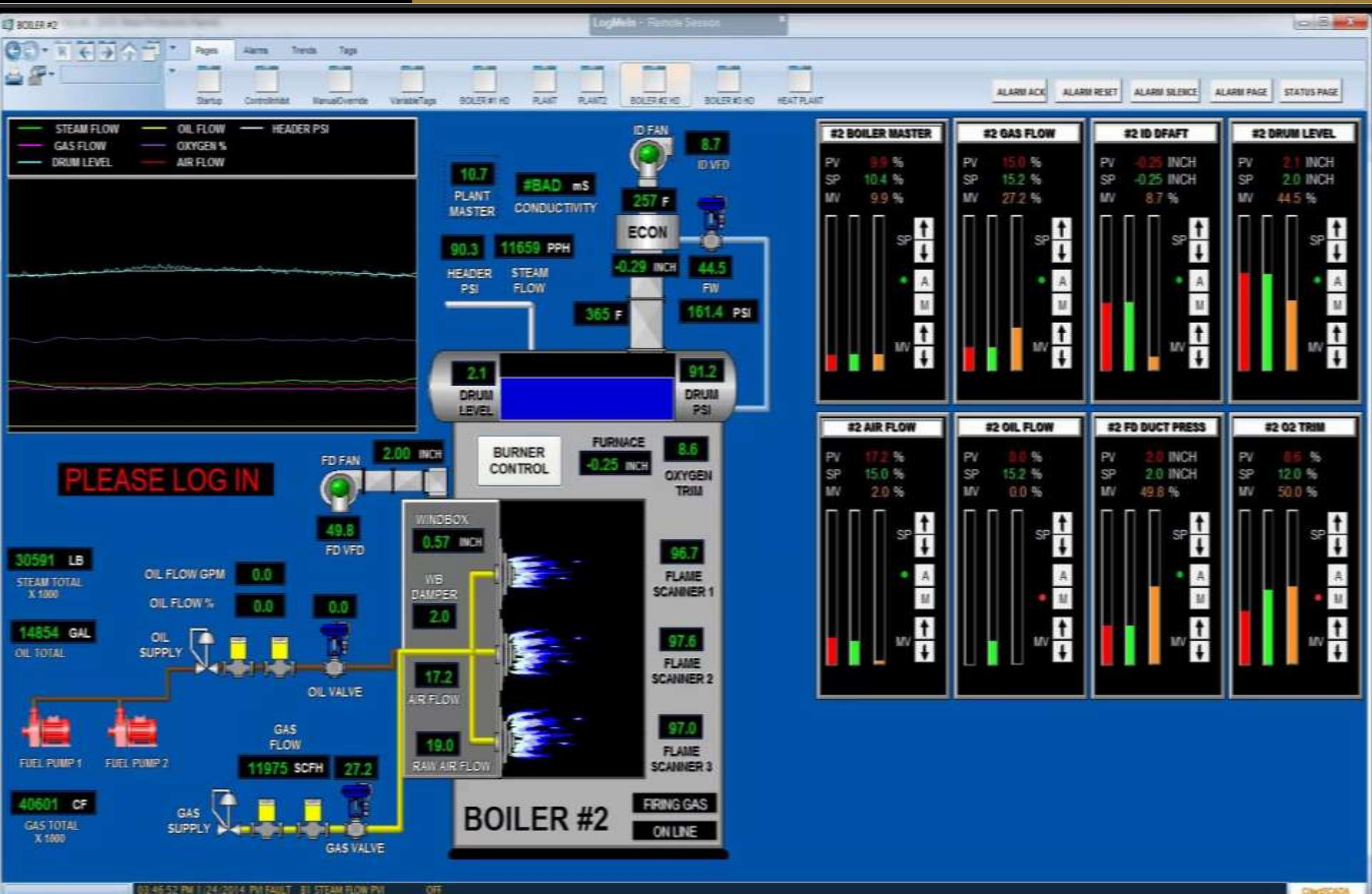
UOC Screens



WAKE FOREST UNIVERSITY

RMF Engineering
Reliability. Efficiency. Integrity.

UOC Screens



WAKE FOREST UNIVERSITY

RMF Engineering
Reliability. Efficiency. Integrity.

UOC Screens

OA Temp: 25.5 °F | OA Humidity: 29.2 %RH | OA Enthalpy: 8.8 BTU/lb | OA CO2: 430 ppm | Dev-32581 | Jan 29, 2014 10:59 AM

ALARMS

Smoke Alarm: | Fan Runtime Alm: | Bad RAT Sensor:
Freezestat: | Htg Coil Energy Waste Alm: | Bad Preht Sensor:
Hi/Lo Static Press: | Clg Coil Energy Waste Alm: | SAT Alarm Setpt: 8 °F
Comm Fail w/Aircuity: | Clg Capacity Shortage Alm: | Htg Coil SAT Alm Setpt: 8 °F
Filter Alm: | Bad SAT Sensor: | Freeze Prot. Alm Setpt: 35 °F
Comm Fail w/Global: | Bad MAT Sensor: | Freeze Prot Alm Reset:

AREA STATUS

Occupied Cmmd: Occupied
Occupied: | NHL: | NLL:
Warmup: | Afterhrs Ovrd:
Cooldown:

	# Needed
# Of VAV Press Req: 3	3
# Of VAV Clg Req: 3	4
# Of VAV CO2 Req: 5	1

Farrell - AHU-5 VLC1
Serves North Grd Floor /Mech P...

Home | Previous

VLC Prop
AHU-3 VLC2
AHU-4 VLC2
AHU-5 VLC2
AHU-6 VLC2
AHU-7 VLC2
AHU-8 VLC2

RETURN AIR
Temp: 49.8 °F
Dewpt: 0.9 °F
CO2: 379 ppm

Relief Damper Position 100.0 %

RA Damper Position 62.0 %

OA Damper Position 38.0 %

DEHUMIDIFICATION
Disable Dehumid: | Dehumid Mode:
Return Air Dewpt: 0.9 °F
Dewpt Setpt: 58 °F
Dehumid Signal: 0.0 %
Dehumid SAT Setpt: 65.0 °F
SAT Setpt-Low Limit: 52 °F

SUPPLY AIR TEMP / PRESSURE

	TEMP	Static Press
Temp / Press:	60.1 °F	1.49 in.wc
Current Setpt:	65.0 °F	1.50 in.wc
Setpt-Warmup:	75 °F	
Setpt-High Limit:	65 °F	2.00 in.wc
Setpt-Low Limit:	55 °F	0.50 in.wc
Setpt-Manual:	55 °F	2.00 in.wc
Setpt Mode:	Auto	Auto
Reset Increment Setpt:	0.3 °F	0.10 in.wc
Reset Bump Time:	5 min	5 min

DAMPER CONTROL

Economizer
Econo Favorable (Aircuity):
Bldg Iso Dmprs Open:
Disable Economizer: | Econo Mode:
MAT Signal: 0.0 %
Low MAT Econo Limit Signal: 100.0 %
Econo Max Pos. Setpt: 95 %
Econo OAT Lockout (Comm Fail): 60 °F
Force Economizer ON:

CO2 Control
Disable CO2 Control: | CO2 Mode:
Current Min OAD Position: 38.0 %
Min OAD Pos-Min Setpt: 11 %
Min OAD Pos-Max Setpt: 38 %
CO2 Dmpr % Bump Time: 0 min
CO2 Dmpr % Increment: 1 %
ERV Press Request:

Space Pressure (Relief Damper)
Space Pressure: 0.070 in.wc
Space Pressure Sig: 100.0 %
Space Pressure Setpt: 0.05 in.wc

MA TEMP
MA Temp: 46.2 °F
Current Setpt: 62.0 °F
MAT Diff Setpt: 3 °F

Post HWC Temp 62.0 °F

PREHT VALVE
Vlv Cmmd: 64.9 %
HW Request:
Current Htg SA Temp Setpt: 60.0 °F
Htg Temp Diff Setpt: 5 °F
Htg Temp Low Limit Setpt: 45 °F
Preht MAT Low Limit Setpt: 45 °F

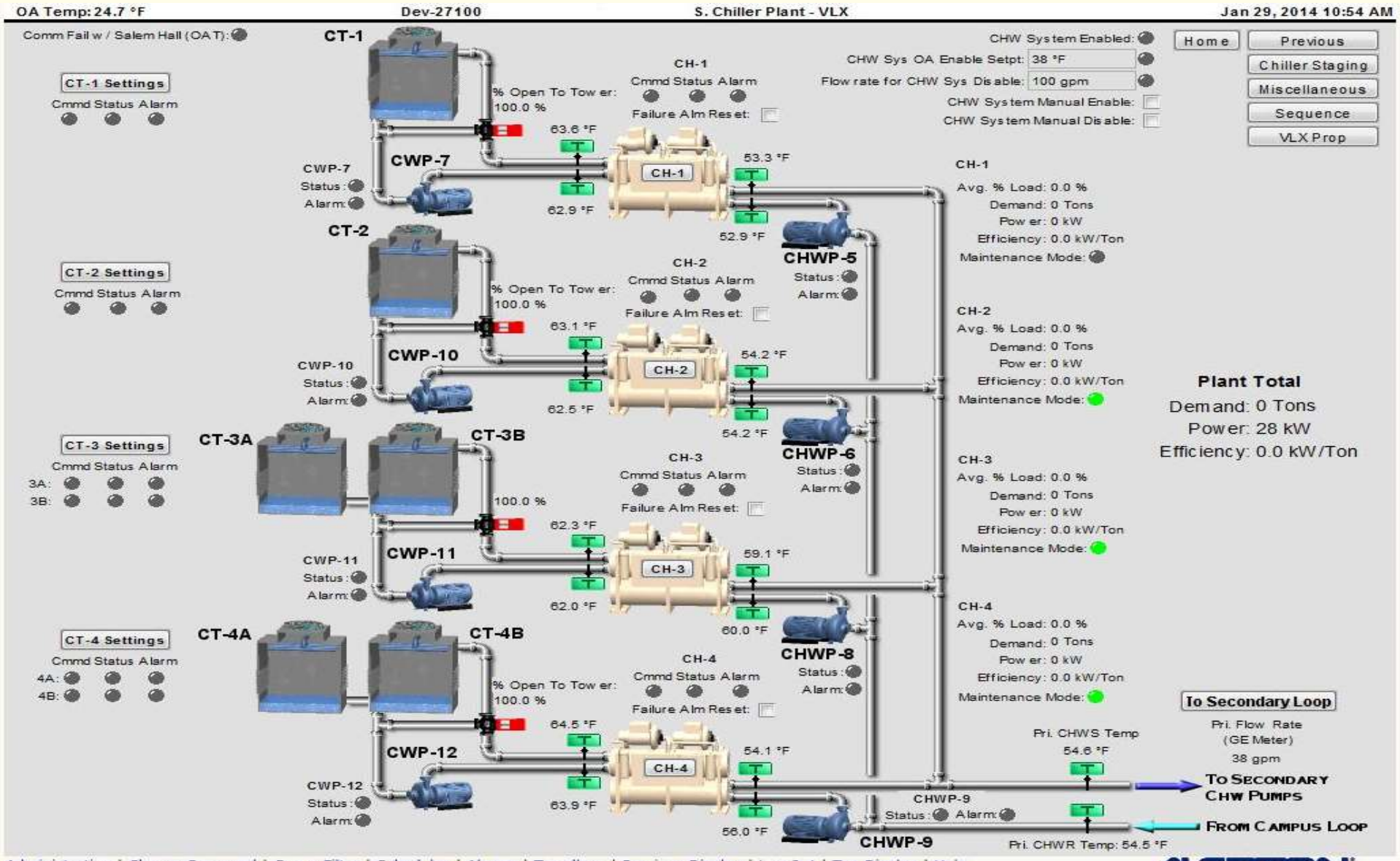
CHW VALVE
Vlv Cmmd: 0.0 %
CHW Request:

SUPPLY FAN
Disable Unit: | In Cmmd | Status | Alarm | Hand
Status Alm Reset:
VFD Speed: 90.9 %
VFD Min. Speed: 20 %
Fan Runtime: 5685 hrs
Fan Runtime Alm Setpt: 10000 hrs

WAKE FOREST UNIVERSITY

RMF Engineering
Reliability. Efficiency. Integrity.

UOC Screens



WAKE FOREST UNIVERSITY

RMF Engineering
Reliability. Efficiency. Integrity.

Before

WAKE FOREST UNIVERSITY

RMF Engineering
Reliability. Efficiency. Integrity.

After

WAKE FOREST UNIVERSITY
RMF Engineering
Reliability. Efficiency. Integrity.
Questions??
RMF Engineering
Reliability. Efficiency. Integrity.
AC
CORPORATION
Established 1935
ChemTreat
LONG
CONSTRUCTION CO., INC.
MARTIN CONTROL
& Equipment Company
Facility Dynamics
ENGINEERING