



# ISPE CASA Energy Management Forum - Energy Management of Capital Projects at Novartis

Lee Willmon, Head of Health, Safety and Environment  
Vaccines and Diagnostics  
Holly Springs, NC  
16 Sept 10



# Agenda

---

- Holly Springs Capital Project Overview
- Overview of Energy Standards at Novartis
- Capital Project Energy Challenge Review – How we evaluate projects at Novartis
- Technical Energy Saving Application - Heat Recovery Chiller
- Q&A – 5 minutes
- Technical Energy Saving Application – Heat Pipes
- Q&A – 5 minutes
- If time allows: Technical Energy Saving Application - Chilled Water Plant

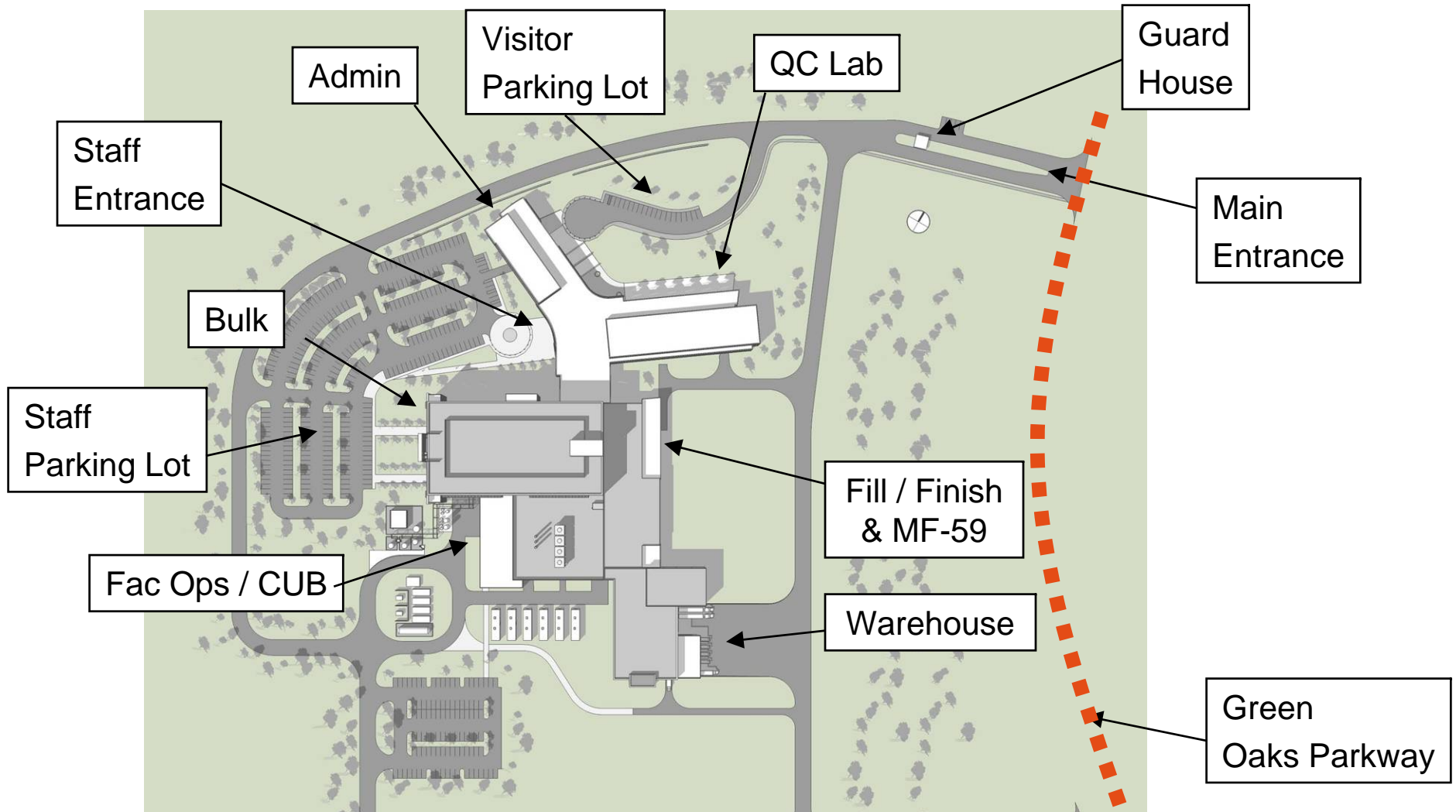
# Holly Springs Facility Summary

---

- Novartis Vaccines and Diagnostics vaccine manufacturing facility located in Holly Springs, North Carolina
- Advanced technologies for flu vaccines
  - Cell culture instead of conventional technology using fertilized chicken eggs
- Designed to manufacture bulk and finished product (pre-filled syringes) for seasonal and pandemic influenza vaccines

# Holly Springs Facility Summary

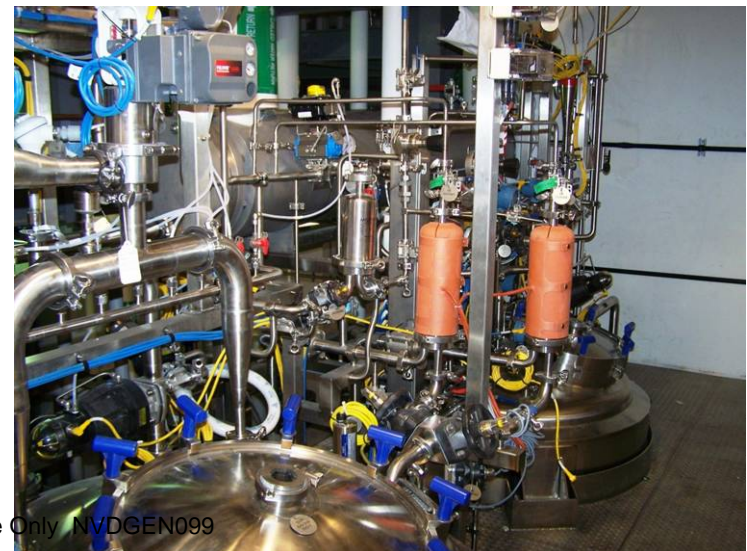
## Project Scope Summary – Facility Layout



# Holly Springs Facility Summary

## *Bulk Building Description*

- Two cell culture lines (3 x 5,000L each)
- Two downstream processing (purification) lines
- Annual bulk seasonal flu capacity of 50 M doses (trivalent) or 150 M doses (monovalent) within 6 months after declaration of a pandemic
- Media preparation, buffer charging and equipment preparation
- Designed for BSL2+, capable to upgrade to BSL3
- Dedicated decon autoclaves for solid waste and biowaste inactivation for liquid waste
- Locker rooms to support bulk operations





# Holly Springs Facility Summary

## *Fill Finish Building Description*

- One 350L scale MF59 adjuvant line\*
- One 1200L Formulation Suite
- One pre-filled syringe line
  - Utilizes isolator technology
  - E-beam used for decontaminating tubs of syringes
  - Automated inspection machine
  - Packaging equipment including labeler and cartoner
- Supporting equipment preparation

\* MF59 is not currently included in any US approved vaccines



# Holly Springs Facility Summary

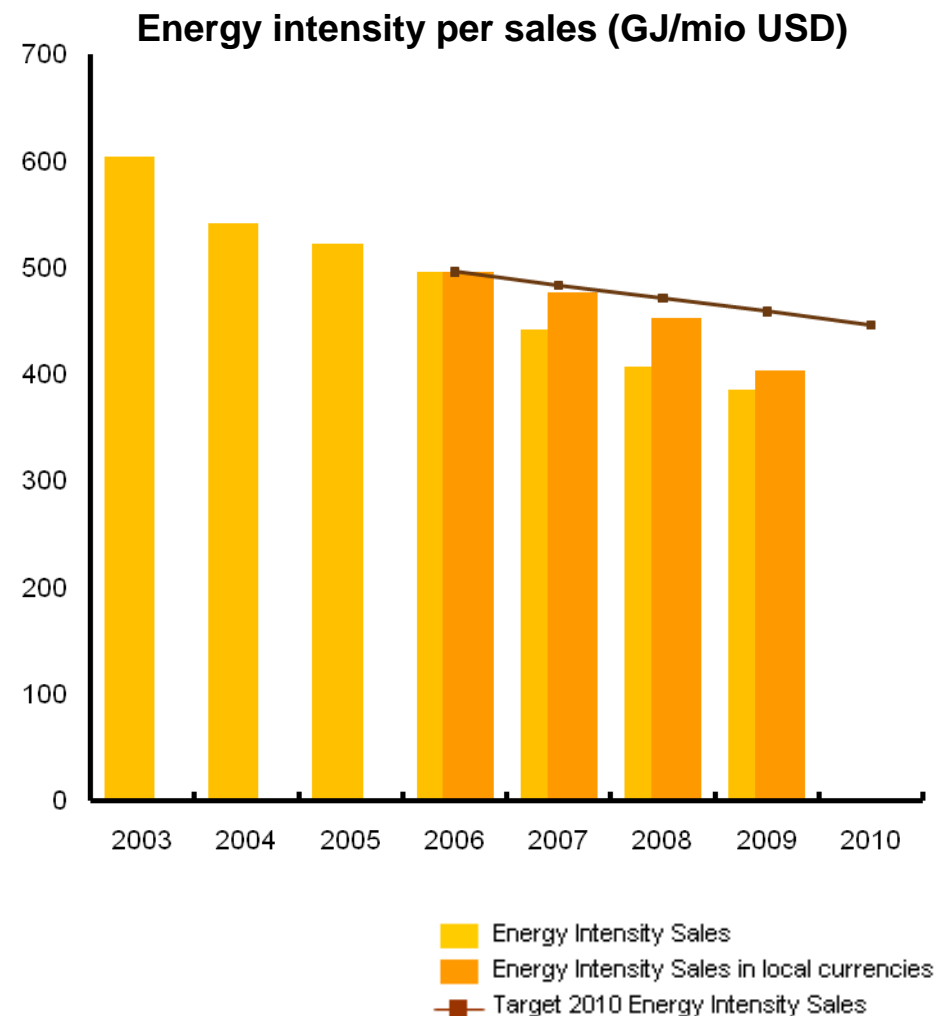
## QC Laboratory/ Administrative Building Description

- QC Laboratory wing includes microbiology, chemistry, biochemistry and virology labs
- Supporting glass wash and autoclave areas
- Dedicated decon autoclaves for solid waste and biowaste inactivation for liquid waste
- Designed with BSL3 capability in Sterility, PCR and Virology
- Administrative wing includes 90 work stations, cafeteria, and training rooms



# Novartis 2009 Performance: Energy Efficiency

- Novartis Group results from continuing operations 2003-2009:
  - Target over 4 years – 10% reduction
  - Improvements since 2006 (over 3 years): 22% (in USD sales)





# Novartis Corporate Energy Standards (Guidelines)

---

- Apply to all Novartis sites, worldwide
- Guideline 13 – Energy management at Novartis
  - Site energy manager
  - Site auditing and reporting
  - Checklists and indexes
  - Energy challenge of capital projects (review prior to approval)
- Guideline 14 – Energy Standards for Buildings and Equipment
  - Building efficiency requirements
  - Technical specifications for buildings, equipment and refrigerants

# HSE Corporate Guideline 13

## *Objectives of the Energy Challenge of Capital Projects*

---

- HSE Guideline 13 provides information on what to consider, who to involve and how to proceed
- Capital Appropriation Request (CAR) requires that aspects of HSE and energy conservation are considered in capital projects
- The Energy Manager/HSE is involved at the conceptual design and at each stage of the project
- The energy challenge should consider the size and circumstances of the investment project: comprehensive, simplified or rapid
- The total cost of ownership (investment and operational cost) are taken into account as basis for a decision
- Energy projects are allowed to pay back over the life of the asset

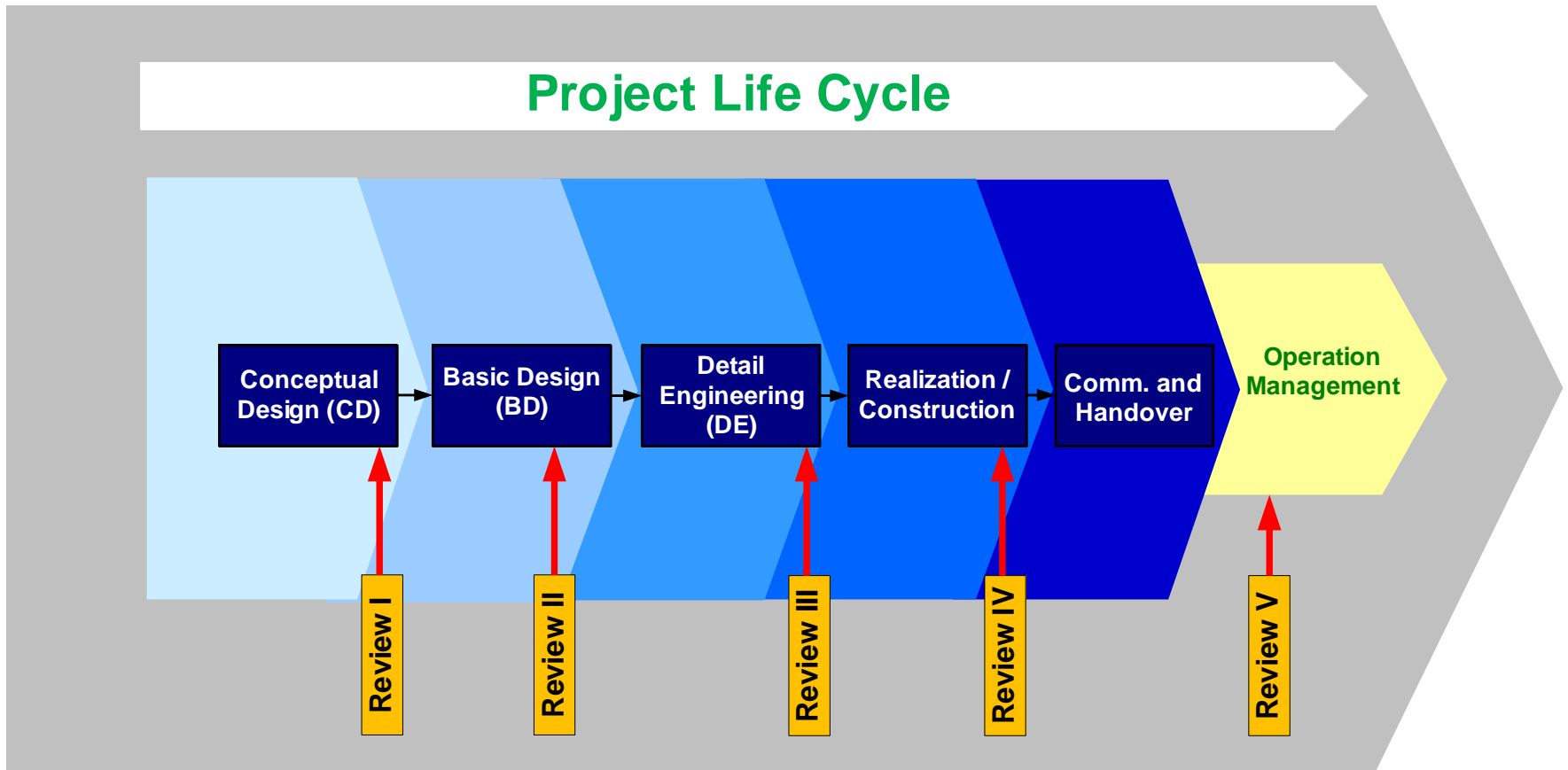
# How capital projects are reviewed for energy efficiency

*Standard set of steps at various stages of the capital project*

---

- Review 1 – Identification of Aspects to be evaluated
- Review 2 – Identification of opportunities for energy efficiency and GHG reduction
- Review 3 – Detailed evaluation of energy saving options
- Review 4 – Checks to ensure that selected energy saving options have been incorporated
- Review 5 – Review of early operating experience – validating projections and estimates

# Project energy challenging process according to CHSE Guidance Note 13.3



## Step 1: Identification of Holly Springs Project Aspects

*Generate List of Key Energy Consumers/Generators at the site*

---

- The Holly Springs project energy challenge focused on the following systems:
  - Air Handling Units
  - Chilled Water Plant and Heating Hot Water Plant
  - Boilers
  - Cooling Towers
  - Air Compressors
  - Lighting
  - Building Envelope



## Step 2/3: Identification of Risks and Opportunities

### *Key Energy Scenarios, Zoning and Interface Issues*

---

- The following opportunities were identified for the project and installed
  - Chilled Water and Heating Hot Water Plant - Optimization
  - Air Handling Unit – Filters
  - Air Handling Unit – Heat pipes
  - Air Handling Unit – Direct Driven Fans
  - Sealing of Ducts
  - Steam Plant – Boiler savings, several small boilers used
  - Cooling Towers – Reclaimed Water
  - Air Compressors – Variable speed drives
  - Lighting – Sensors, dimmers, bulbs
  - Building Envelope – Window shading

## Step 4/5: Systems Installed and Data Collected

---

- Evaluation Currently Underway
- Building Automation System evaluation
- System optimization and commissioning
  - About 50% complete
- Metering and data collection opportunities still exist



## ISPE-CASA Energy Management Forum

Heat Recovery Chiller System

Alexander Mitrovic, PE, CEA

Novartis, Holly Springs, NC, September 2010



# Heat Recovery Chiller System

---

- Basic principle of HRC system
  - Recover waste heat from chillers for HVAC heating
    - Avoid steam usage
  - Increase total efficiency of chilled/heating water plant
    - Select design with lowest life cycle cost
    - Lower our cost of goods at the Holly Springs site
  - Reduce overall consumption of resources
    - Natural Gas, and therefore CO<sub>2</sub> emissions
    - Water savings from cooling tower and boiler make-up
    - Chemical treatment of water

# Heat Recovery Chiller System

---

## ■ Design details

- One 800-ton heat recovery chiller, with constant volume pumps
- Supplies 135 °F water to heating hot water system, and 40 °F water to chilled water system
- HRC is not piped to cooling tower. All heat must be rejected to the HHW loop. Minimum turndown of 30%
- COP (Coefficient of Performance) is increased since chiller is simultaneously heating and cooling

$$\text{COP} = \frac{\text{Useful work}}{\text{Input work}}$$

**The Bigger  
The Better!**

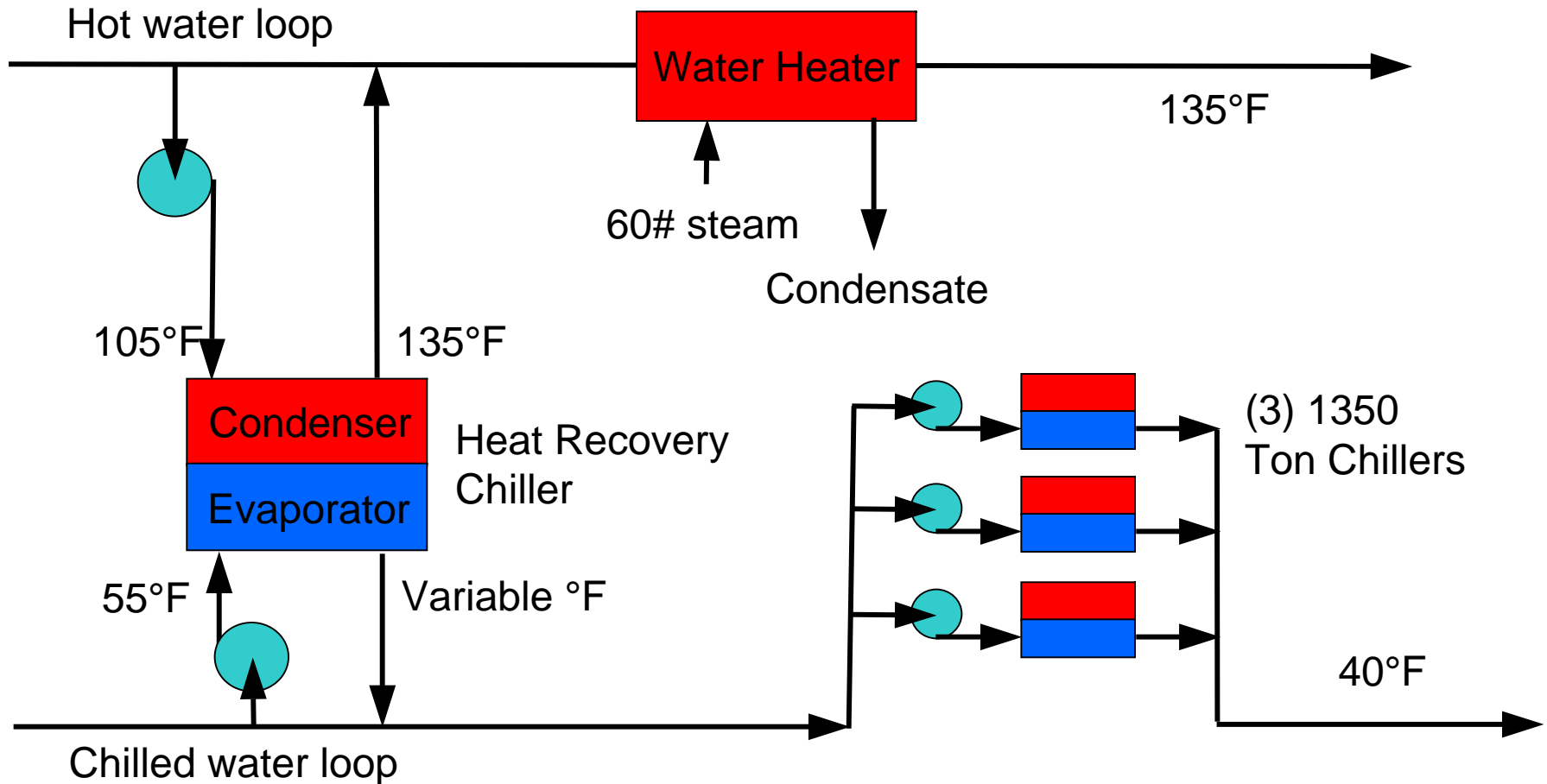


# Heat Recovery Chiller System

---



# Heat Recovery Chiller System



# Heat Recovery Chiller System

---

- What were the major achievements, impacts, benefits?
  - Annual calculated savings of:
    - \$750,000 in utility bills
    - 7,240 tons CO<sub>2</sub> emissions
    - 13,724,000 gallons water
    - Chemical treatment of water
  - Simple payback of 15 months
  - Sidecar arrangement does not impact CHW plant
  - Boilers are not needed to provide HHW for site, but are ready as a standby heating source during HRC servicing or failure

# Heat Recovery Chiller System

---

- What were the most important early challenges?
  - Operating data for the equipment
    - Analyzing sizing and low load limitations for 24/7 operation
    - Heat balance required since heat cannot be dissipated to towers
    - This was only the 6<sup>th</sup> HRC built by York for the NA market
  - Selecting most efficient heating hot water temperature to be supplied by HRC for all HVAC systems
    - This temperature determines the design point for all heating coils
  - Difficult to convince others to try new technologies

# Heat Recovery Chiller System

---

## ■ Implementation issues:

- Since Holly Springs was a green field site, there was no load during start-up of equipment. A 1000 ton rental plate and frame heat exchanger was installed to provide a false load.
- We were unable to simulate low load conditions, so the HRC was only tuned for maximum load.
- These issues were discovered when HRC was operating at minimum load. Local chiller service group was unable to troubleshoot and needed support from corporate engineering.
- Two parameters were modified and machine ran fine.
- Power issues continue to cause issues with communications between starter and HRC.



# ISPE-CASA Energy Management Forum

---

- Thank you for your interest in our heat recovery chiller!
- Any questions?



# ISPE-CASA Energy Management Forum

Heat Pipe Application in Air Handling Units

Alexander Mitrovic, PE, CEA

Novartis, Holly Springs, NC, September 2010



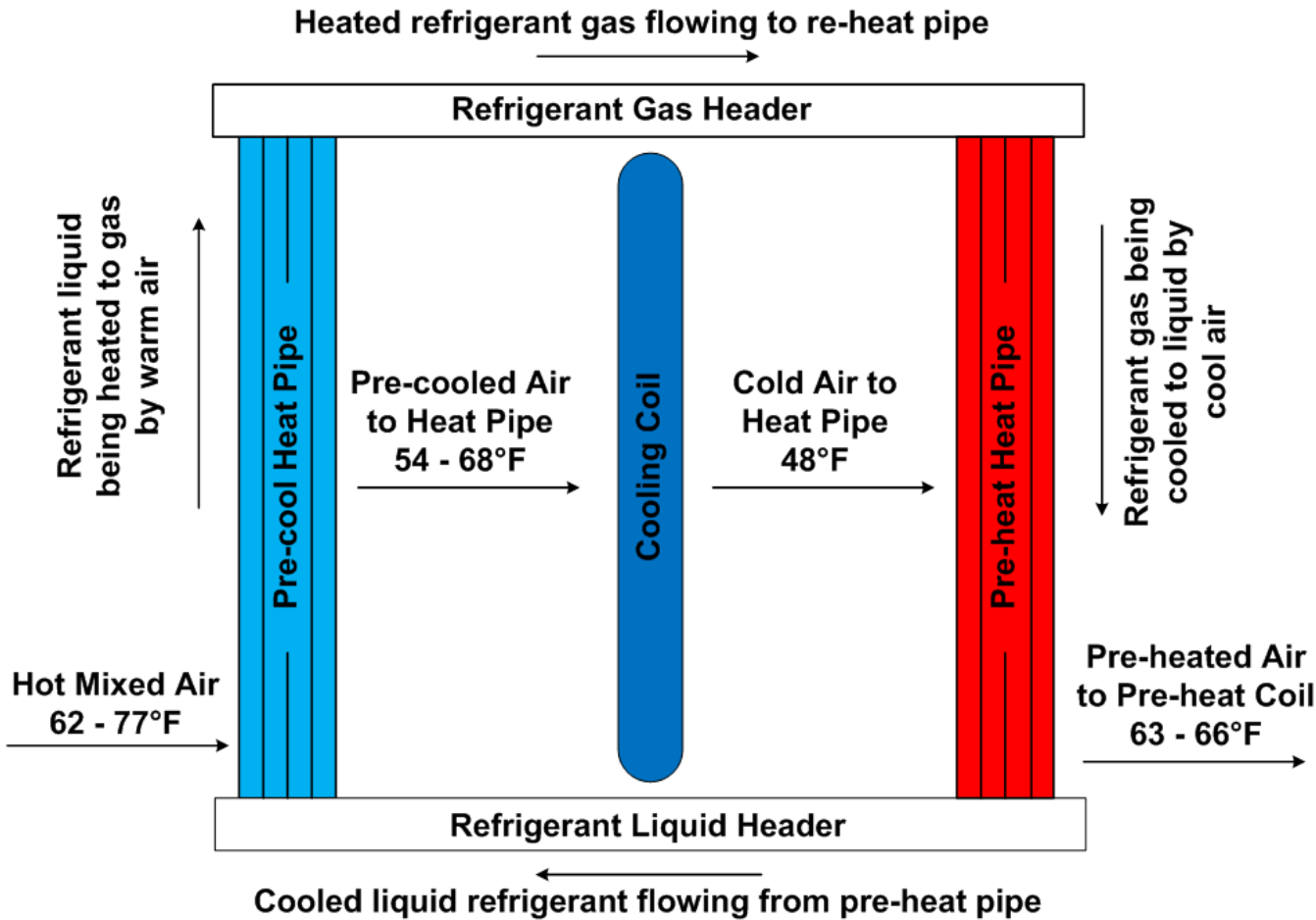
# Heat Pipe Application in Air Handling Units

---

- Basic principle of system
  - Passive refrigerant run-around loop
  - Use heat upstream of chilled water coil to reheat air downstream of cooling coil and in doing so pre-cool the air entering cooling coil
  - Lower cooling and reheat loads

# Heat Pipe Application in Air Handling Units

## HOW SYSTEM OPERATES



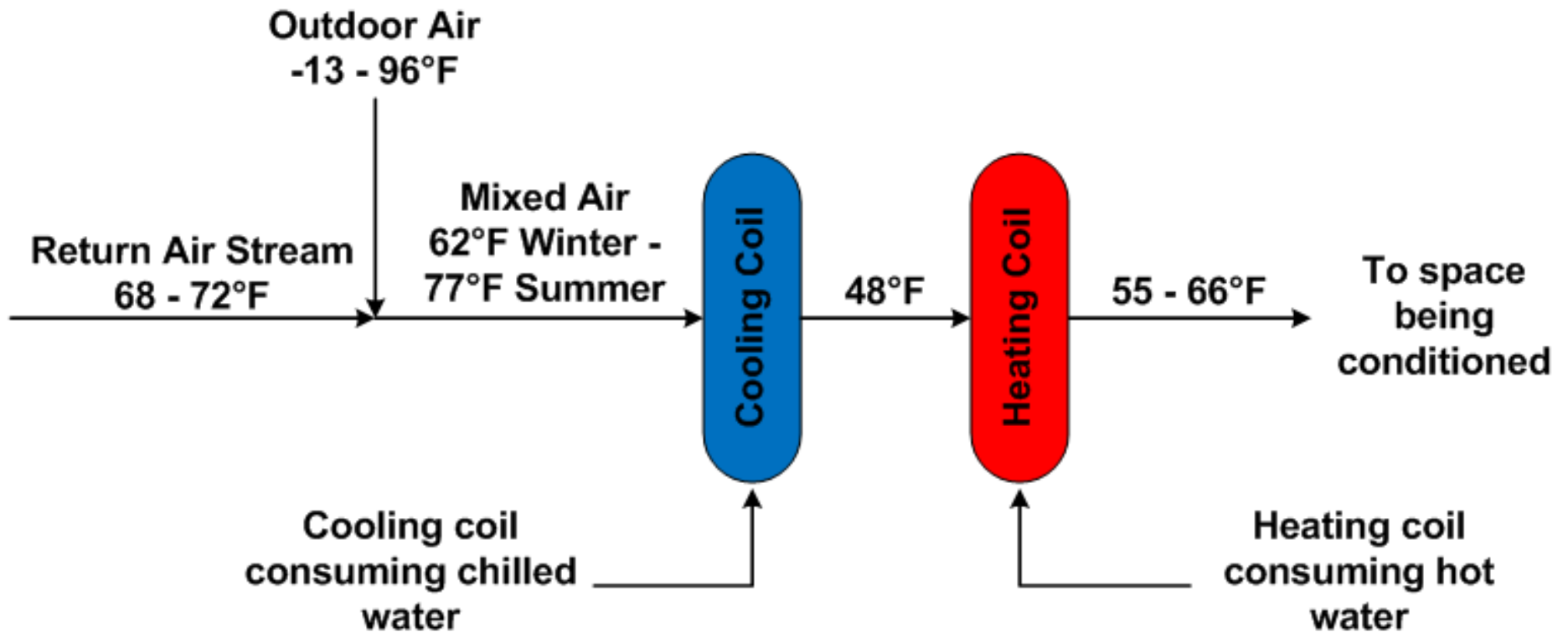
# Heat Pipe Application in Air Handling Units

---

- Typical process ... Dehumidification
  - Return and outdoor air mix together to produce an air stream with temperature of 62 °F (16.7 °C) in winter, to 77 °F (25 °C) in summer
  - Cool air to 48 °F (8.9 °C) to drop enough moisture from the air to maintain less than 60% RH in process areas
  - Reheat air to 55 °F (12.8 °C) to 66 °F (18.9 °C) to maintain space temperature

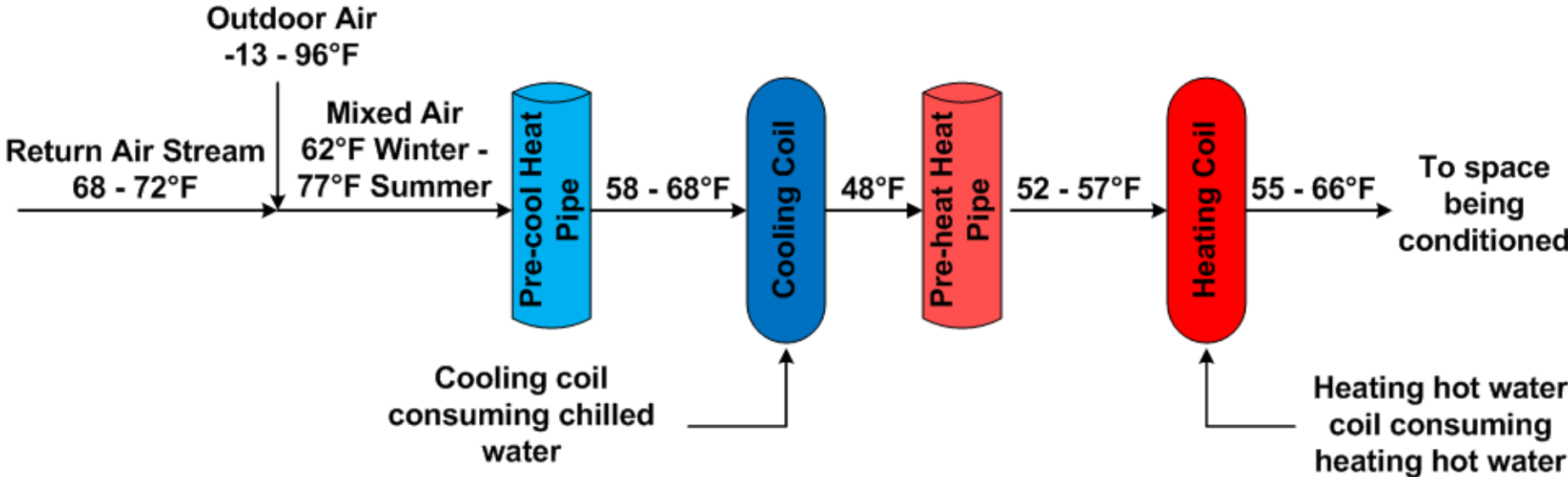
# Heat Pipe Application in Air Handling Units

## STANDARD DEHUMIDIFICATION PROCESS



# Heat Pipe Application in Air Handling Units

## PROPOSED DEHUMIDIFICATION PROCESS



# Heat Pipe Application in Air Handling Units

---

- Payback analysis factors
  - First cost of heat pipe
  - Additional maintenance of heat pipe
  - Added first cost due to larger fan HP requirement
  - Energy saved on reduced cooling coil load
  - Energy saved on reduced reheat coil load
  - Added energy cost of running fans at higher BHP
  
- Payback period
  - Retrofit applications typically 3+ years
  - New equipment application typically 2-3 years



# Heat Pipe Application in Air Handling Units

ANNUAL ELECTRICAL ENERGY SAVINGS						
Annual Energy Savings				Kw/Ton	Savings Kw/Year	Cost Savings
Ton-Hr Chilled Water Saved				747,799		
Heat recovery Chiller Savings						
Therms				95,189	(Note 1)	
Ton-Hrs				587,586	1.3	763,862 \$61,109
VFD Chiller Savings						
Ton-Hrs				160,213	0.66	105,741 \$ 8,459
Additional Fan power						
23.06 BHP * 95% Eff. * 0.7457 Kw/hp					N/A	-158,564 -\$12,685
Total Annual Electric Savings						711,039 \$56,883
\$0.08 per Kw-Hr		Note 1: Included in Energy for generating Ton-Hrs chilled water.				
Annual Tower Water Reduction Savings						
Water Savings = 160,213 Ton-Hrs * 2.146473 Gallon/Ton-Hr =					343,893	\$2,528
<b>Total Annual Cost Savings</b>						<b>\$59,411</b>

# Heat Pipe Application in Air Handling Units

---

## ■ Implementation issues:

- The pre-cooling coils were installed with a standard depth drain pan, but the fins are horizontal, so there was minor condensate carryover on high humidity days
  - Mist eliminators are being assessed
  - Typical heat pipe installation leaves no space between the cooling coils and heat pipe coils, so condensate carryover is not an issue
  - However, we designed service access between coil sections for maintainability, so this causes potential for carryover
- Minor issues with control valves which were immediately resolved
- Early coordination issue with three AHUs placed heat pipe coils in different AHU sections. Intent was to locate cooling coil and heat pipe coils in same AHU section so that heat pipes could be pre-piped in heat pipe manufacturers facility.
  - This required more field time than expected

# ISPE-CASA Energy Management Forum

---

- Thank you for your interest in our heat pipe application!
- Any questions?



## ISPE-CASA Energy Management Forum

Variable Primary Flow Chilled Water Plant

Alexander Mitrovic, PE, CEA

Novartis, Holly Springs, NC, September 2010



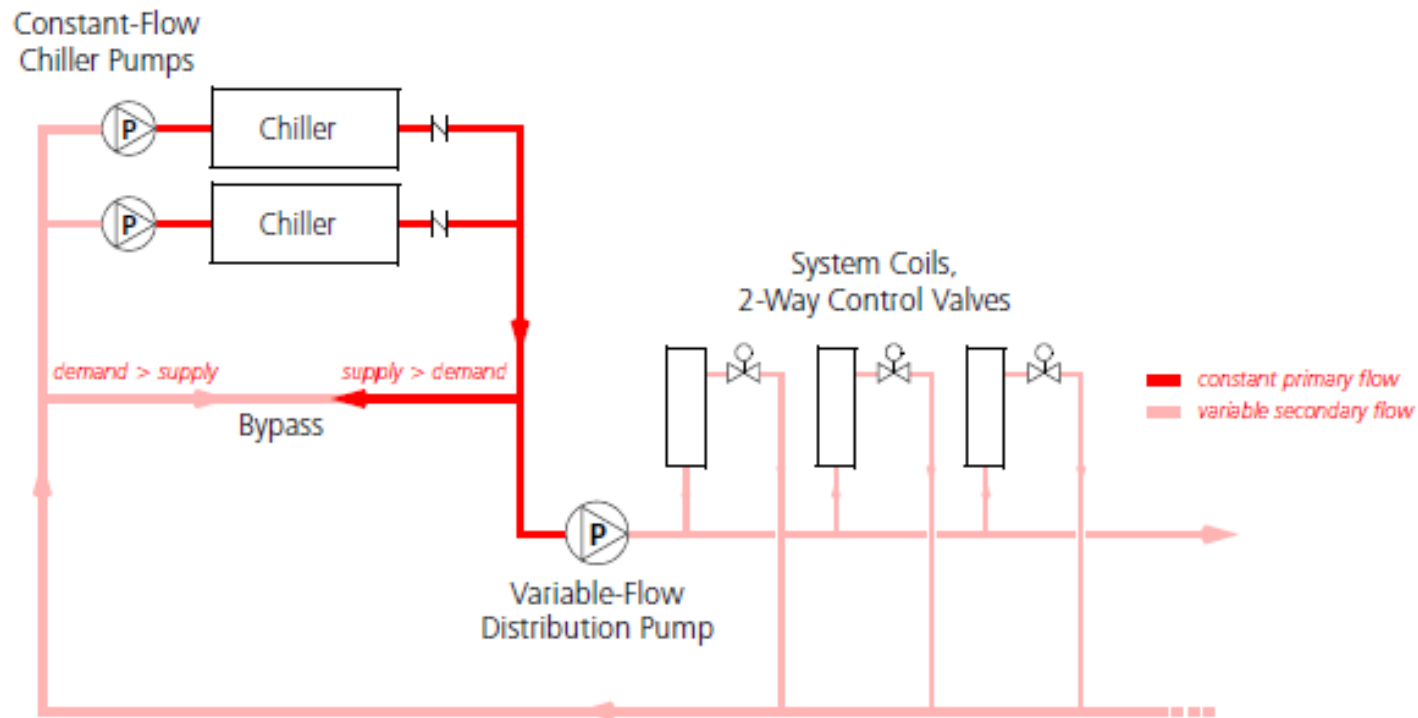
# Variable Primary Flow Chilled Water Plant

---

- Basic principle of design
  - Utilize variable speed chillers with variable speed pumping
  - Increase delta T through chiller
  - Eliminate secondary pump set
  - Primary pump set is variable speed
- Typical primary-secondary pumping system
  - Chillers are constant speed with constant speed pumping
  - Provides lower than design delta T through chiller due to bypass leg, which decreases efficiency
  - Requires primary AND secondary pump sets
  - Secondary pump set is variable speed

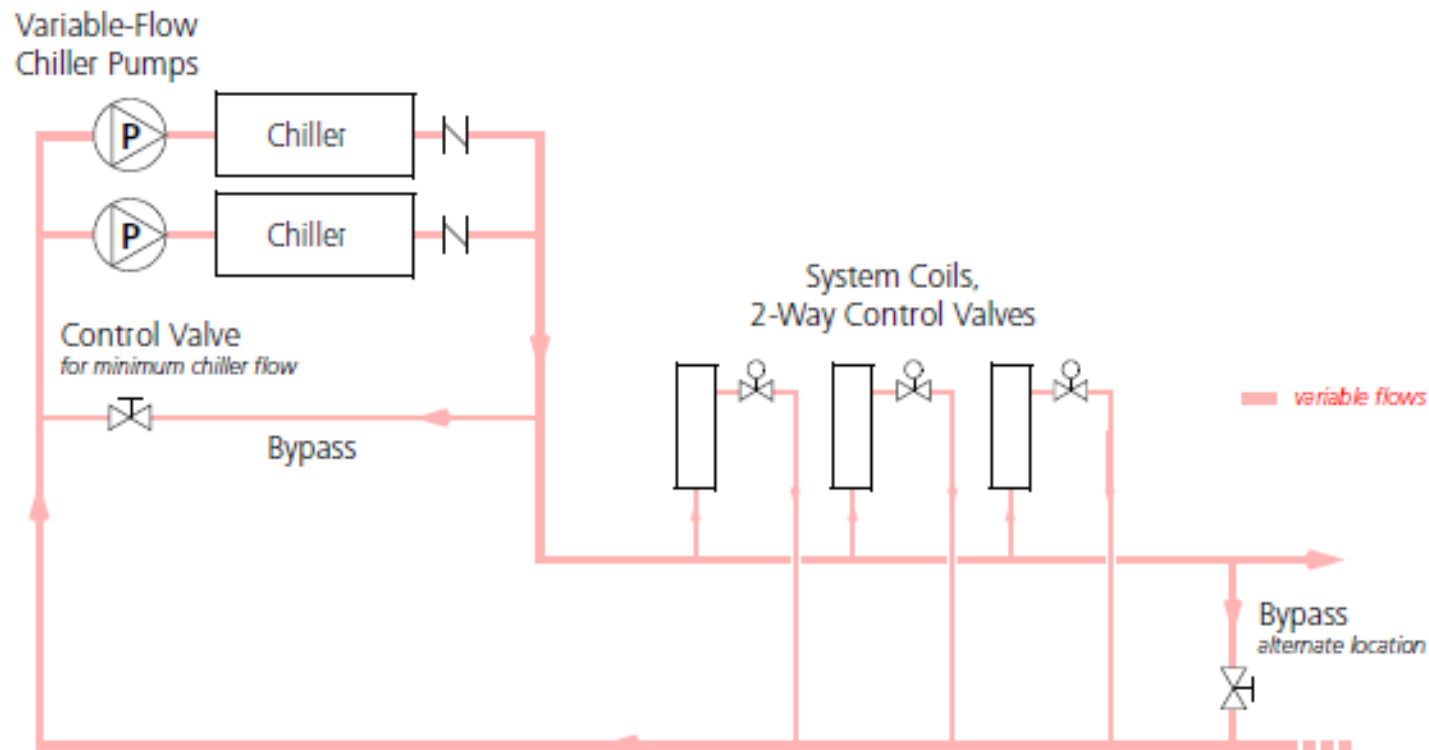
# Variable Primary Flow Chilled Water Plant

## Traditional Primary-Secondary Pumping



# Variable Primary Flow Chilled Water Plant

## Variable Primary Flow



# Variable Primary Flow Chilled Water Plant

---

- Advantages of Variable Primary Flow
  - Lower first cost
  - Less pumping energy
  - Less floor space and potentially lower building cost
- Disadvantages of Variable Primary Flow
  - More complex controls compared to primary-secondary systems
- Best applications for Variable Primary Flow
  - Industrial plants with high base load and multiple chillers
  - Plants with sophisticated design engineers and utility operators that understand the controls



# Variable Primary Flow Chilled Water Plant

---

## ■ Implementation issues

- Staging of chillers was tricky. Initial control sequence was too cumbersome and was later simplified.
  - Overflow running chillers during stage up to avoid tripping
- Need to deliver 40+/- 2 °F water for process requirements, so staging of chillers needs to hold this requirement
  - Set point was lowered during chiller staging
- Plant cannot be run in manual, so utility operator training with continual reinforcement is required
- Power quality issues in Holly Springs area
  - Modified internal chiller controls to prevent nuisance trips
  - Rapid restart algorithm so chillers can be brought back online quickly

# ISPE-CASA Energy Management Forum

---

- Thank you for your interest in our energy program!
- Any questions about...
  - Heat recovery chiller?
  - Heat pipes?
  - Variable primary flow?