September 2015

SIEMENS DEMAND FLOW™
### Demand Flow™
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Prepared by –

Lee Kolomeitz  
Siemens Demand Flow™  
Principle Engineering – Asia Pacific  
Adv Dip Mech Eng, Dip PM
Demand Flow™
Central Chilled Water Plants

Typical Plant Characteristics

- Most chilled water plants have some form of constant flow pumping
- Most plants bypass chilled water flow – excessive pumping energy
- Operate best with wide temperature splits across the chiller – at or near original design intent (known as "delta-T")
- Usually operate at design intent conditions only 5% of the time

Chilled Water Plant Operational Shortcomings

- Most plants today are plagued with "Low Delta-T Syndrome"
- Inefficiently operated 95% of the time due to design
- The Industry has tried to solve these issues with limited success
- Often plant efficiency is sacrificed for comfort
- Nominal plant capacity is usually never realized – causing perceived need for additional chillers
Demand Flow™
Central Chiller Plant Energy Use

5 fundamental subsystems of a chilled water system that consumes energy and influences deliverable capacity;

- Chilled Water Pumping
- Condenser Water Pumping
- Chillers
- Cooling Tower Fans
- Air Side

These 5 subsystems are interdependent

- Energy and deliverable capacity are interdependent
- Often what is done in the name of energy conservation results is a "transfer of energy" among these 5 subsystems with no net savings realized, or increase in energy

As the Solutions Provider, Siemens understands these technical relationships, delivering a "holistic" approach to CPO
What is Demand Flow?

Overview

Siemens have pieced it together... and created a holistic solution to form an unique energy and operational cost saving application for central water-cooled chiller plants.

Demand Flow optimises central chilled water systems to reduce a plant’s total energy consumption by 20% - 50%.

Demand Flow is based on a proven & patented design pioneered using “variable system pressure curve technology”, not used in the Industry.

“Demand Flow is really an application of Thermodynamics, Pump Laws & the Refrigeration cycle via Mathematical Control Algorithms”
Demand Flow™
What is Demand Flow?

The Difference

• Effectively establishes only One Chilled Water Loop, virtually eliminating all Bypass Water.
• *Dynamically* balances CHW Decouplers resulting in Zero Directional Flow.
• Precise control of variable water flow thru Chiller Evaporator and Condenser within manufacturers minimum turn-down parameters.
• Derive Optimised Pressure and Temperature set-points on Chilled and Condenser Water systems based on changing system dynamics – not on “datasheet performance”.
• Costly VFDs are **not** required on the Chillers.

Effects

• Increases system deliverable tonnage by ‘unlocking’ true plant nominal capacity.
• Manages compressor “lift” and maps “surge” protection point, effectively eliminates refrigerant flow issues at low load conditions.
• Significant reduction in plant wear & tear, lower pump shaft mileage and increased equipment longevity.
Demand Flow™
What is Demand Flow?

What do we look for?

- Water-cooled Centrifugal and Screw type chillers with minimum plant capacity > 400 RTons (1400 kWr) and high Ton-Hour producing Loads.
- Retrofit Applications of Existing or Problematic Plants, or New Construction Build Projects
- Characteristics of inefficient plant operation:
  - Excessive bypass of chilled water flow
  - Constant volume pumping with high pump shaft mileage
  - Continuous full speed ineffective operation, or undesirable chiller plant cycling On/Off activity.
  - Comfort sacrificed for efficiencies
  - Minimal operation at Design intent Conditions, plagued by Low Delta-T.

“Siemens Demand Flow simply provides – colder water, for less utility dollars”
Demand Flow™
The Benefits -

Chillers
Real-time mapping of optimal flow and temperature setpoints to ensure chiller runs at ‘sweet-spot’ under all loads conditions, 365-days/year.

Pumps
True variable flow of chilled water to precisely meet the actual system cooling needs of the facility, instead of circulating bypassed water resulting in an artificial load.

Cooling Towers
Ensures the optimal tower approach is achieved when ambient wet-bulb is favorable by deriving the precise condenser water flow & fan speed.

“Demand Flow ensures we only produce & deliver the volume of water the system actually needs”
Demand Flow™
Concept & Principles

Typical Industry Practise – Control System to Constant Pressure with VFD

Feet of Head

Variable speed pump curves

Constant Pressure*

Operating points

*requires VFD on Pump

Central Chilled Water Plants
What is Demand Flow?
Case Study-Short Video
Case Study-Robina Hosp
Conclusion & Contacts
### Demand Flow™
#### Concept & Principles

**Siemens VPCL logic – Creates System Efficiency Curves for Optimal Pump Speed**

- **Mathematically Calculated Dynamic Variable System Pressure Curve**
- Continually polling critical zones & environmental conditions for starved flow.
- Derive the Optimal Operating point based on System Demand
- Dynamically calculates & resets optimal Setpoint before any field condition goes into “stress”.

---

**Graph: Variable speed pump curves**

- **Feet of Head**
- **GPM**

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Demand Flow™
Concept & Principles
Patented – Variable Pressure Curve Logic (VPCL)

- Promotes compressor suction superheat resulting in Increased Cooling Effect
- Reduces Refrigerant ‘Flash-gas’ by creating further Liquid Sub-Cooling resulting in Increased Cooling Effect.
- Effortlessly manages compressor “lift & surge” protection under all Loads Conditions
Robina Hospital Chiller Plant Optimisation – Case Study

Table of Contents

With permission granted by -

Queensland Health
Maree McKay
Service Director – Robina Hospital

Prepared by –

Lee Kolomeitz & Kieran McLean
Demand Flow
Business Development
CEM®, CMVP®

• Facility Overview
• Project Motivations
• Evaluation & Assessment
• Results
Robina Hospital Chiller Plant Optimisation - Case Study

Facility Overview

Robina Hospital is the 6th largest hospital in Queensland with 364-beds and a suite of inpatient and outpatient services.

The facility has undergone constant expansion over the past 15 years:

- 2000 – Constructed as a private hospital offering some public services
- 2002 – Acquired by QLD Government
- 2007 – Stage 1 expansion adding 25 beds
- 2012 – Stage 2 & 3 expansions doubling number of beds
Robina Hospital Chiller Plant Optimisation - Case Study

Chilled Water System – 2007

► Facility Overview
► Project Motivations
► Evaluation & Assessment
► Results

Original Central Chiller Plant
3x Reciprocating Water Cooled Chillers (768kWr)

AX Building Chiller Plant
1x Air-Cooled Chiller
Robina Hospital Chiller Plant Optimisation - Case Study

Chilled Water System – 2012

Link between Chiller Plants

New Central Chiller Plant
3x Centrifugal Water Cooled Chillers
(2500 kWr)

(original)

Original Central Chiller Plant
3x Reciprocating Water Cooled Chillers
(768 kWr)

AX Building Chiller Plant
1x Air-Cooled Chiller

Facility Overview
Project Motivations
Evaluation & Assessment
Results
Robina Hospital Chiller Plant Optimisation - Case Study

Chilled Water System – 2012

Facility Served by 3x Chiller Plants operating in the following modes:

- Low Load – 2x older plants serve entire facility
- Normal – new plant serves entire facility
- Independent – all 3 plants operate independently of each other
Control Strategies

- Constant Volume Primary Pumps
- Constant Volume Condenser Water Pumps
- Variable Volume Secondary Pumps with Pressure Reset
Robina Hospital Chiller Plant Optimisation - Case Study

Project Motivations

1. Simplification of Chilled Water System Operation
2. Improve facility energy efficiency & Operational Expenditure
3. Reduce maintenance requirements of 3 separate Chiller Plants
4. Improve De-Humidification Control of Operating Theatres
Two projects were initially being considered:

1. Mechanical upgrade to improve Dehumidification
2. Energy Optimisation Project focusing on Chiller Plant

Demand Flow™ provided possibility of addressing both issues

Qld Health went to market and engaged Siemens to complete a detailed feasibility study to further understand chilled water network and benefits of Demand Flow™
# Robina Hospital Chiller Plant Optimisation - Case Study

## Annualised Data Modeled – Baseline vs Projected Savings (Guaranteed)

### Facility Overview

### Project Motivations

### Evaluation & Assessment

### Results

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<th>AS BUILT</th>
<th>HOURS</th>
<th>PLV Tons</th>
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**Total/ Average:** 8760 | 739 | 582 | 3,529,202 | 4,011,886 | 0.329 | 423,504 | 2681 | 2516 | 427 | 6.64 | 5 | 7 | 7

### Demand Flow

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**Total/ Average:** 8760 | 739 | 582 | 3,529,202 | 4,011,886 | 0.329 | 423,504 | 2681 | 2516 | 427 | 6.64 | 5 | 7 | 7

### Annualised Data Modeled – Baseline vs Projected Savings (Guaranteed)

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<th>Demand Flow Savings</th>
<th>Total KWH Savings</th>
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### Additional Tables and Calculations

- **Percent Savings:**
  - As Built Plant Electrical Costs: 26%
  - Demand Flow Plant Electrical Costs: 28%

- **Additional Savings Breakdown:**
  - Xpander Savings: 0%
  - Demand Flow AHU Savings: 0%
  - Condenser Reclaim (decameter): 0%

- **Total KWH Savings:** 792,281

---

**Page 21:** 11-09-2015
Facility Overview
Project Motivations
Evaluation & Assessment
Results

Robina Hospital Chiller Plant Optimisation - Case Study

Annual Electrical kW Modeled – Baseline vs Projected Savings (Guaranteed)

![Chart showing annual KW profile with data points and trend lines for As Built, Demand Flow, and DF & Replacement Chiller kW.](chart.png)
Robina Hospital Chiller Plant Optimisation - Case Study

Evaluation and Assessment – Findings

- 22-26% reduction in chilled water plant energy consumption
- Max 3.3 year payback period guaranteed (energy savings only)
- 22% Internal Rate of Return
- Redundancy of 2 inefficient chiller plants
- Improvements in dehumidification control
- No Chiller Variable Speed Drives required
- Simplified operation and plant for the Hospital Engineering Staff
Robina Hospital Chiller Plant Optimisation

Results – More than Energy Savings!

- Plant Consolidation
- Facility Reliability Improvements
- Chilled Water System Efficiency
- Energy Savings & Greenhouse Gas Emission Reduction
- Consolidation of 3x Chilled Water Plants to 1
Robina Hospital Chiller Plant Optimisation Results – First 8 Months of Savings

• **26%** Saving in Chiller Plant Consumption

• **676,216 kWh** saved (85% of annual target)

• Reduction of **554 Tonnes of CO$_2$** emissions

• Anticipated payback of 2.5 ahead of a 3.3 year guarantee
Demand Flow™
Case Study – Robina Hospital
Results – First 8 Months of Savings

Cumulative Target vs. Actual Savings (kWh)
Robina Hospital Chiller Plant Optimisation

Results – System Efficiency Improvement

New Technology, All-Available Speed Chiller Plants
High-Efficiency, Optimized Chiller Plants
Standard Code Based Chiller Plants
Older Chiller Plants
Chiller Plants with Repairable Design or Operational Problems

<table>
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<th></th>
<th>Excellent</th>
<th>Good</th>
<th>Fair</th>
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PRE-OPTIMISATION
(Annual Average 0.93 kW/Ton)
(Annual Average System COP 3.8)

POST-OPTIMISATION
(Annual Average 0.66 kW/Ton)
(Annual Average System COP 5.3)

Source: “All Variable Speed Chiller Plants”, ASHRAE Journal, September 2001

* Includes Chiller, Pumps and CT Fans Combined
Robina Hospital Chiller Plant Optimisation
Results – Facility Improvements

• Improved humidification control of operating theatres

• Increase in deliverable plant capacity

• Effective management of chiller lift

• Eliminates refrigerant flow issues at low load conditions

• Stripped artificial base load (& plant ton-hours) during winter season from over-cooling and hunting plant conditions.
<table>
<thead>
<tr>
<th>Contact Name</th>
<th>Position</th>
<th>Contact Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lee Kolomeitz</td>
<td>Demand Flow – Principle Engineering Expert</td>
<td>Mobile: 0428 455 244 E-mail: <a href="mailto:Lee.Kolomeitz@siemens.com">Lee.Kolomeitz@siemens.com</a></td>
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<td>Mobile: 0437 615 529 E-mail: <a href="mailto:Mark-Davies@siemens.com">Mark-Davies@siemens.com</a></td>
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<td>Maree McKay</td>
<td>Qld Health Service Director – Robina Hospital</td>
<td>E-mail: <a href="mailto:Maree.McKay@health.qld.goc.au">Maree.McKay@health.qld.goc.au</a></td>
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