

OBTAINING AND USING PERFORMANCE INFORMATION FROM YOUR LAB

Labs 21 2003 Annual
Conference

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RETRIEVING PERFORMANCE INFORMATION FROM YOUR LAB



OBJECTIVES

- Performance Measurement
- Performance Benchmarking
- Commissioning*
- Performance Enhancement*

* Topics for another discussion

Performance Measurement

Essential Components

- Energy Management and Controls System (EMCS)
- Comprehensive Metering
- Information Portals
- Enhanced Trending Software or Energy Information System

Performance Measurement Types

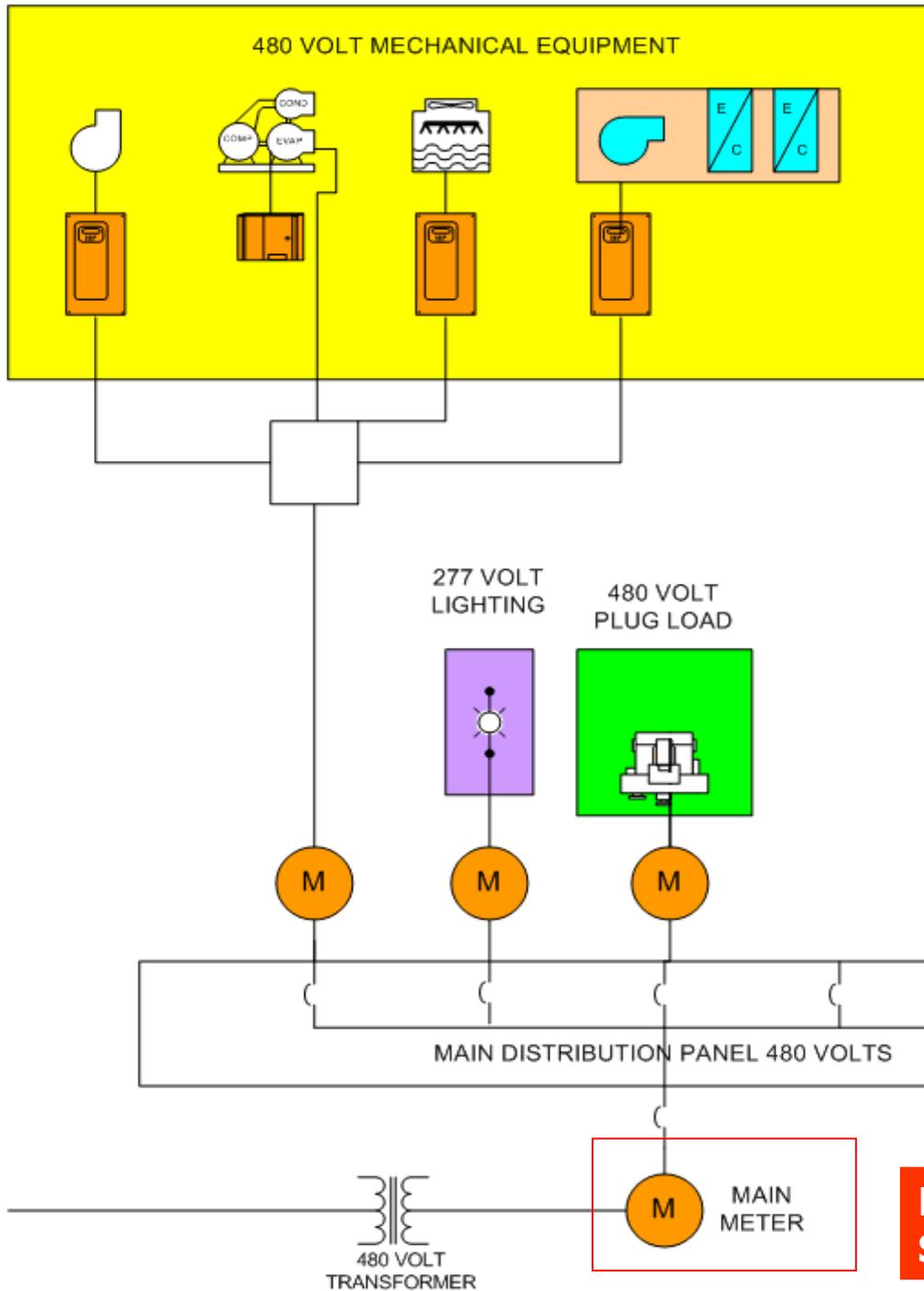
- Electrical Load Disaggregation and Measurement
 - Separate & Measure 3 Basic Electrical Components
- Operational Monitoring
 - Measure the Lab Ventilation, Heating and Cooling Requirements, and Other Relevant Operations

Electrical Load Disaggregation

- Separate 3 Basic Electrical Components
 - Plug and Process Load - User Controlled - equipment usually not permanently affixed to building
 - Lighting - User and Facilities Controlled
 - Mechanical - Facilities Controlled HVAC, Laboratory Supply and Exhaust Equipment, Elevators, Pumps, Compressors Etc.

Electric Metering

- Building Main - Socketed Revenue Quality Meter
- Distribution Circuits - Networked Electronic Meters
- Sub Panels with Mixed Loads - Networked Circuit Monitors



SIMPLE SINGLE LINE ELECTRICAL DIAGRAM

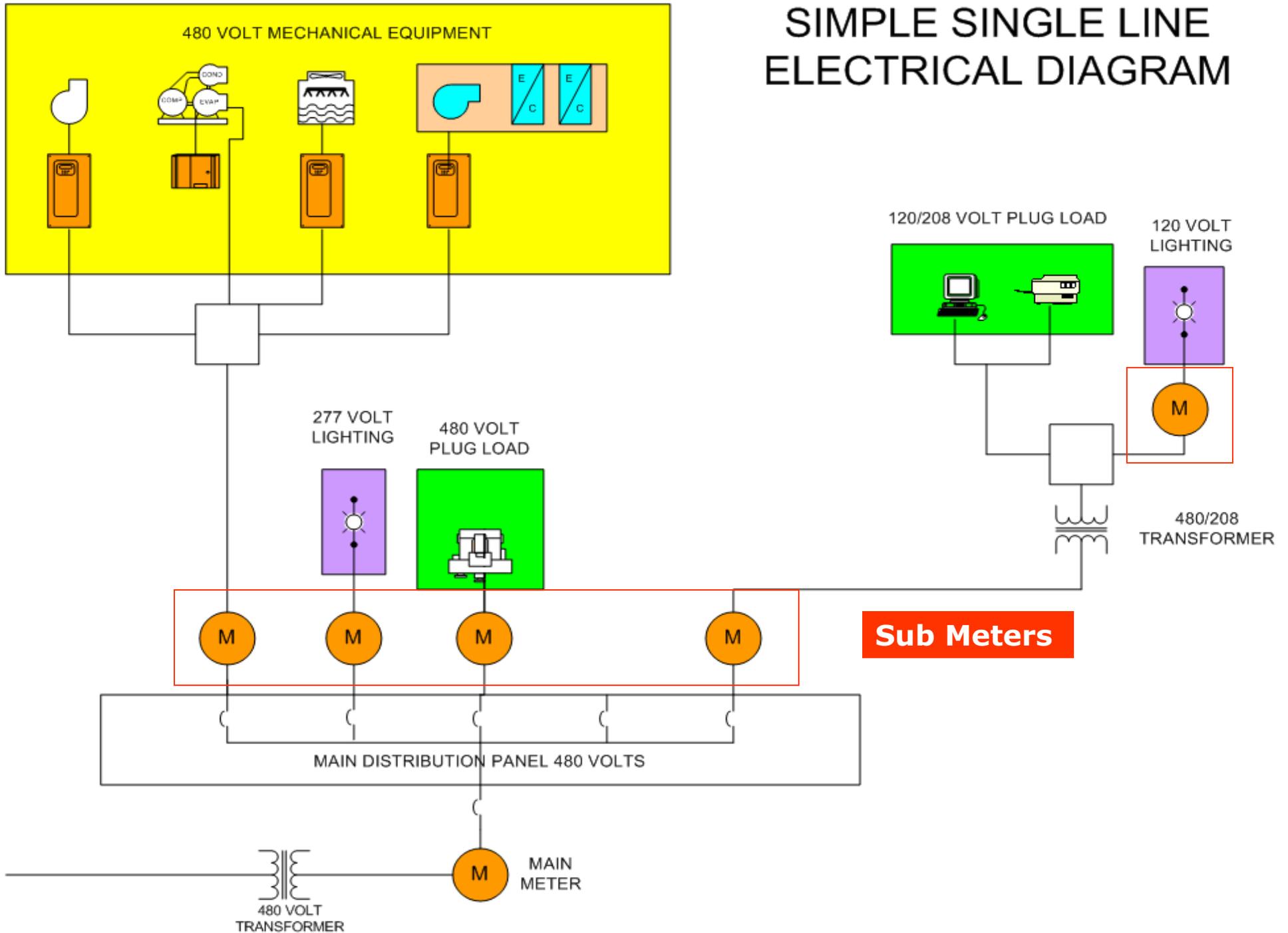
Revenue Quality Socketed Meter

Main Meter

- Socketed
- Programmable
- Revenue Quality
- Memory Storage
 - Stored Demand Profile
- Modem
- KYZ Pulsed Output to EMS



SIMPLE SINGLE LINE ELECTRICAL DIAGRAM

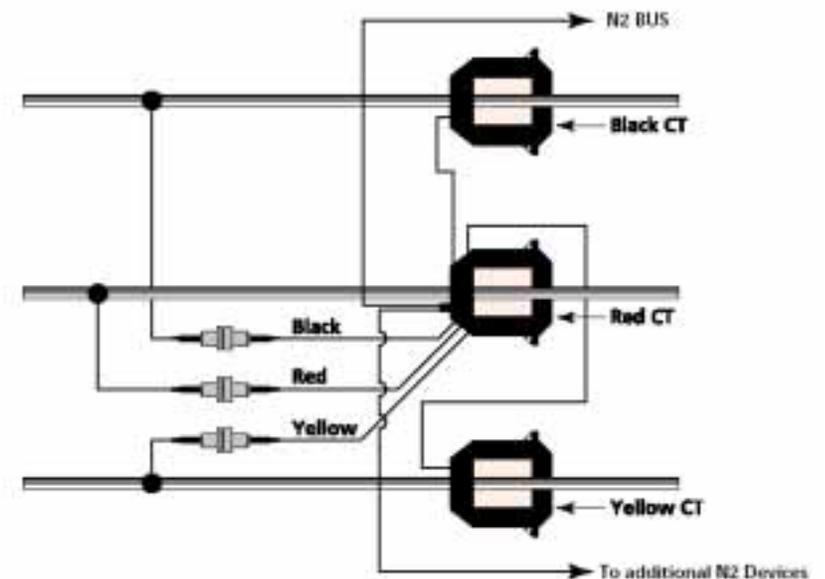


Sub Meters

- Networked to EMCS
 - Modbus
 - N2
 - LonTalk
- True RMS
 - Accuracy with Non-Linear Loads
- Easy Retrofit Installation
- Pulsed or 4-20 ma Output Available

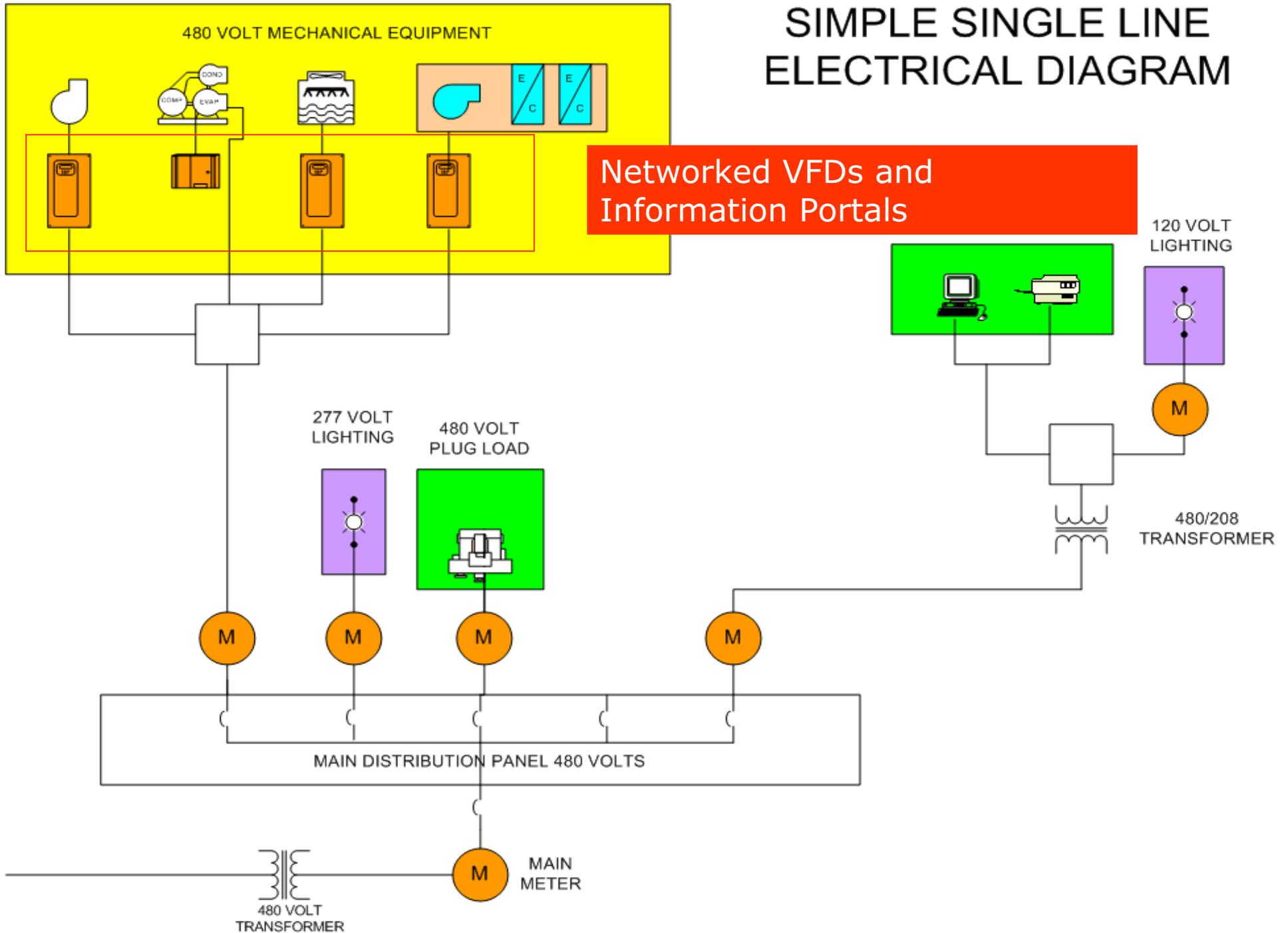


TYPICAL 208/480 VAC 3 ϕ , 3,4 WIRE INSTALLATION



SIMPLE SINGLE LINE ELECTRICAL DIAGRAM

Networked VFDs and Information Portals



Variable Frequency Drives & Soft Start Controllers

- Networked RS-485
 - Modbus
 - N2
 - LonTalk
- Energy Information Mapped Into EMCS
 - kW
 - % Command
 - Power Factor
 - Amperage
 - Status



Information Portals

- Provide Operational Data From 3rd Party Equipment to EMCS
- Chillers
- Generators
- Lighting Systems
- Metering Systems



Information Portals

Example

- Trane Tracer Summit Panel
 - Bacnet interface to Metasys EMCS
 - kW
 - % Load
 - Power Factor
 - Other Operating Data



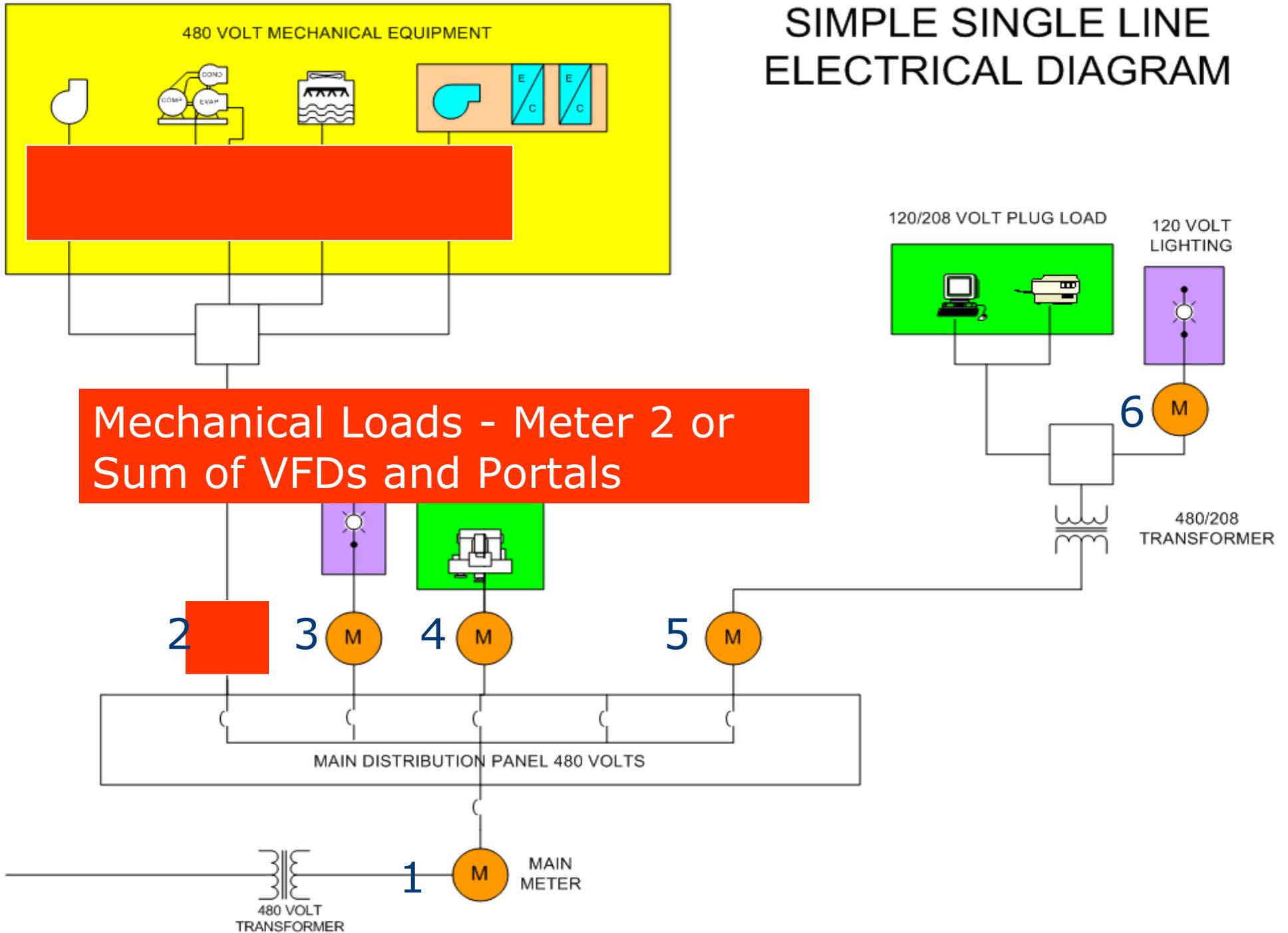
Electrical Circuit Load Types

- 480 Volt 3 Phase Circuits w/ Neutral
 - Large 3 Phase Fans, Pumps and Other Mechanical
 - Large Process Load - Research
 - 277 Volt Lighting - Majority of Lighting
- 208 Volt 3 Phase Circuits w/ Neutral
 - 208 Volt Mechanical
 - 208 Volt Process
 - 120 Volt Plug Load
 - 120 Volt Lighting

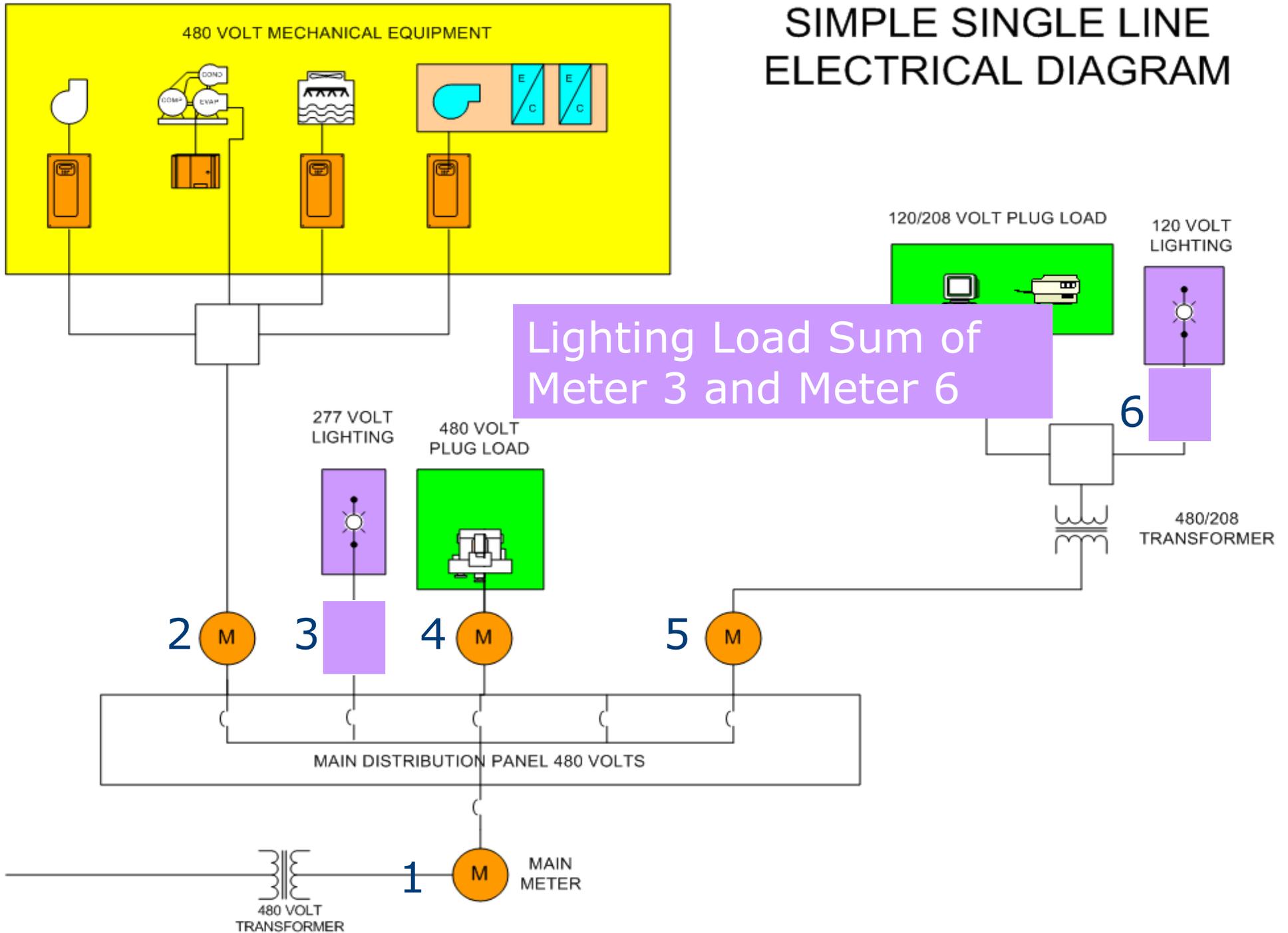
Disaggregation Calculation

- Meter Data Collected by EMCS
- Use Addition and Subtraction of Meters to Isolate Load Types
- Calculation Performed by EMCS or Energy Information System Software

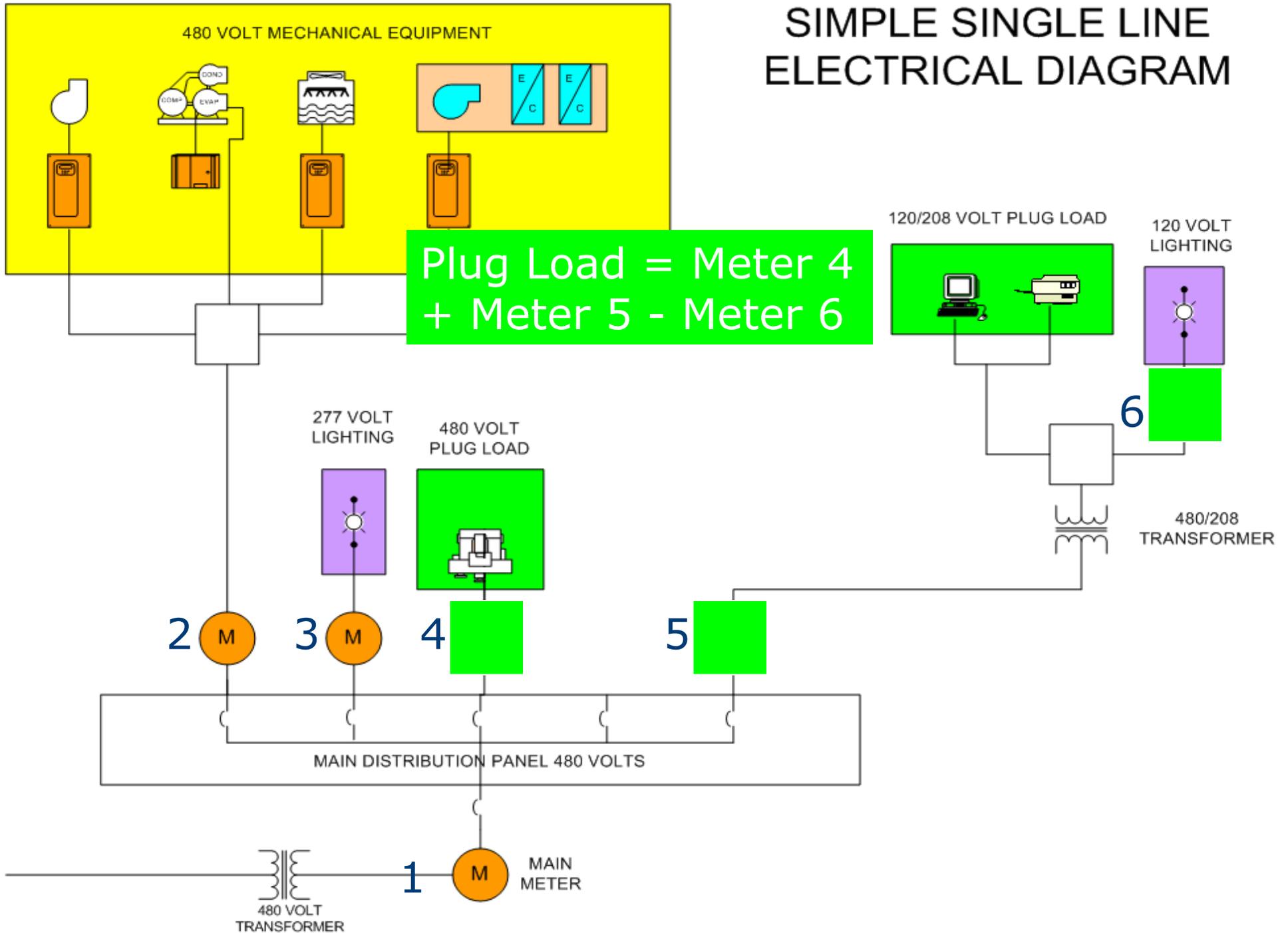
SIMPLE SINGLE LINE ELECTRICAL DIAGRAM



SIMPLE SINGLE LINE ELECTRICAL DIAGRAM



SIMPLE SINGLE LINE ELECTRICAL DIAGRAM



WEST OFFICE/LAB WING

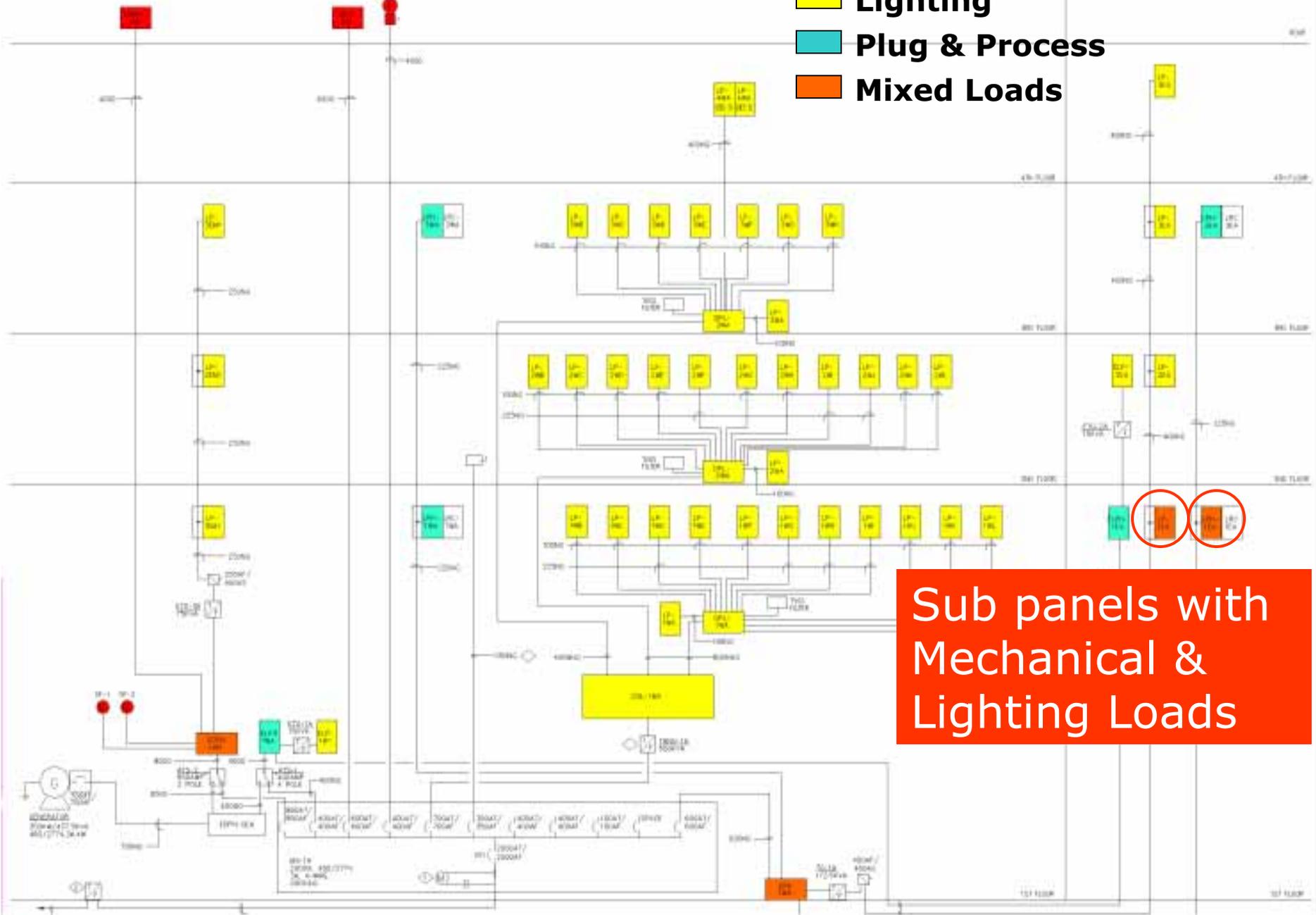
EAST OFFICE WING

Mechanical

Lighting

Plug & Process

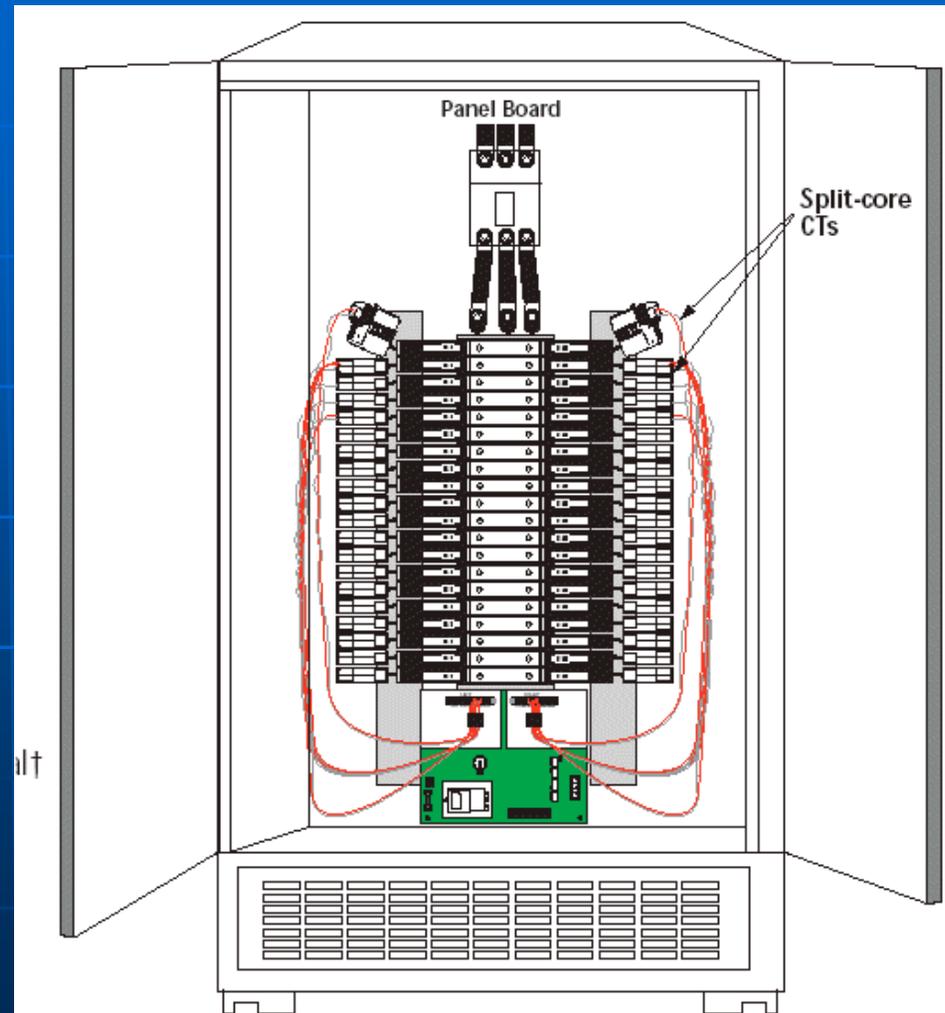
Mixed Loads



Sub panels with Mechanical & Lighting Loads

Mixed Loads

- Use “Circuit Monitors” to Monitor Power of Odd Circuits in a Subpanel
- RS-485 Networked and Mapped into EMCS



Operational Monitoring

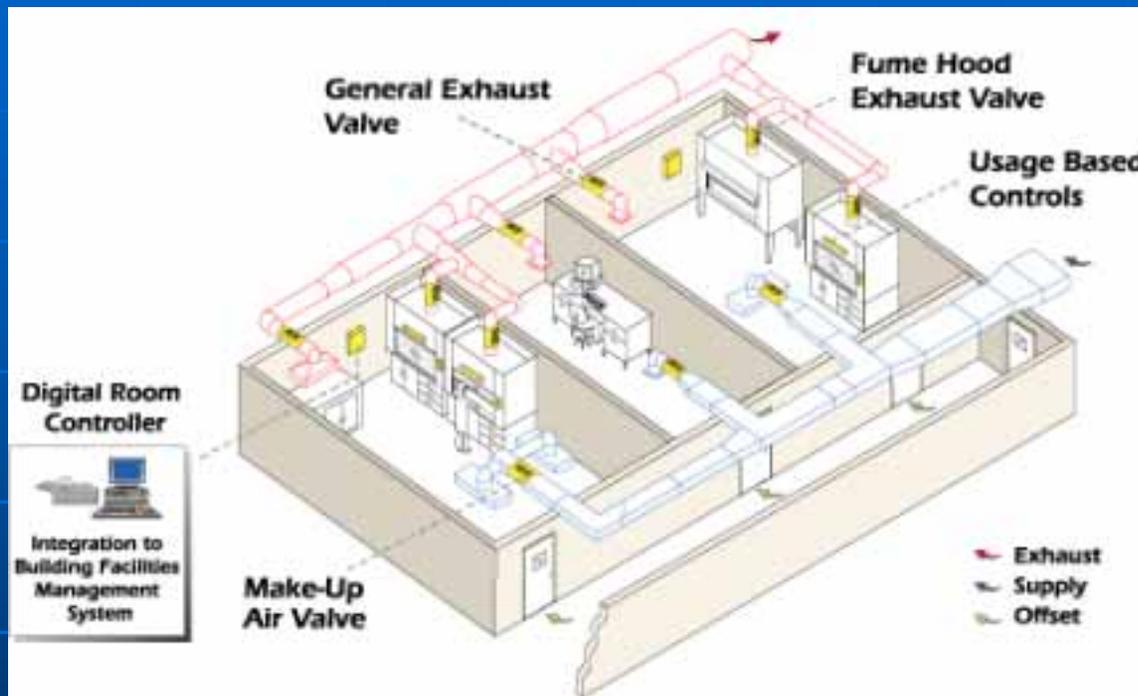
Retrieving Operational Data From Your Lab

- Air Flow Monitoring
- Temperature
- Sash Position
- Cooling and Heating Demand
- Exhaust System Performance

Laboratory Control System

- Networked to EMCS
- Provides For Adjustment and Monitoring of Many Operational Points
 - Fume Sash Position
 - Exhaust, Supply and General Exhaust Flows
 - Room Setpoints and Temperatures
 - Occupancy

VAV Laboratory Control System



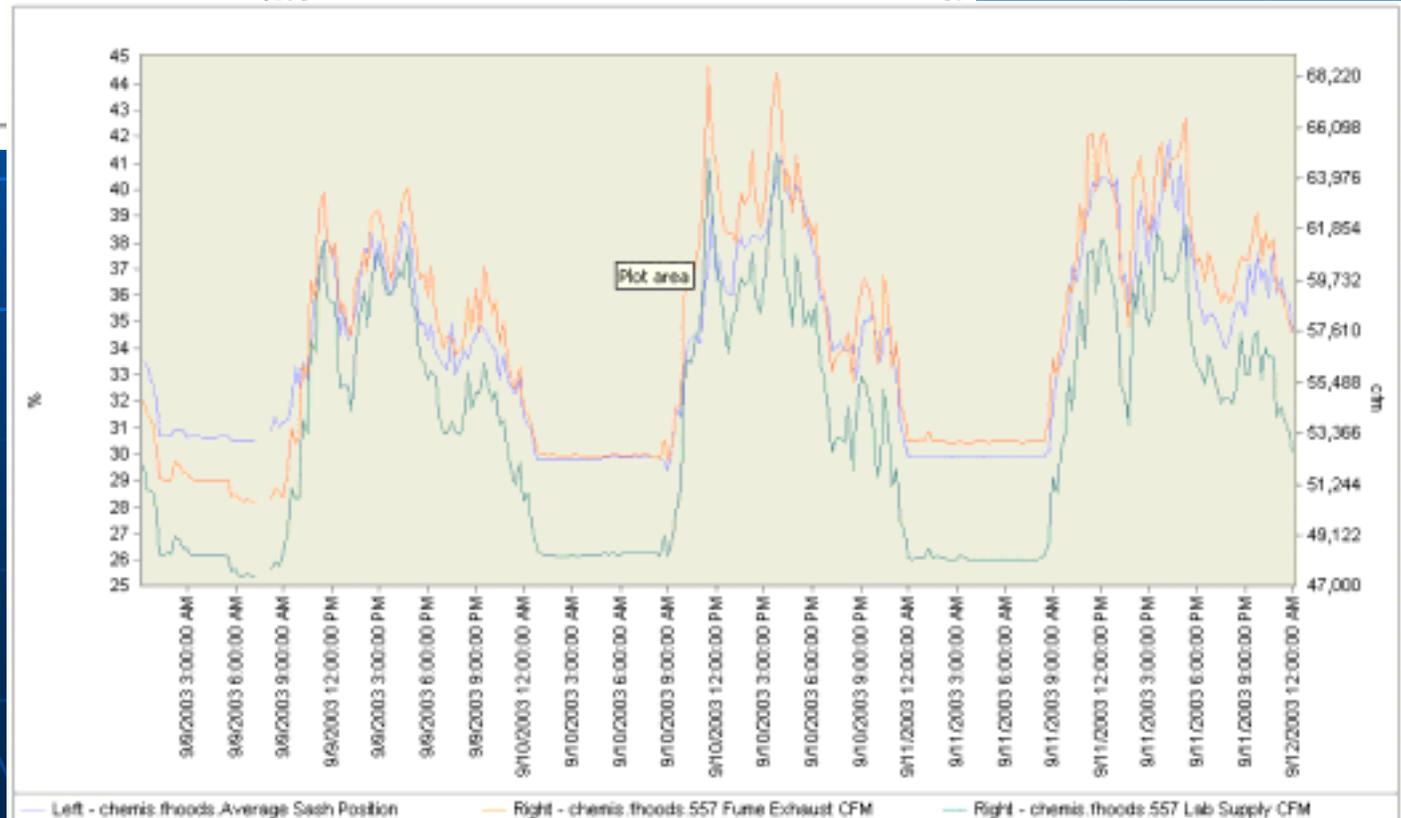
Fume Hood System Operating Data Brought into EMCS Through a Network Gateway

VAV Laboratory Control System

Operating Data

Analog Inputs				Analog Outputs					
Attr	Cnd	Descrip.	Value	Units	Attr	Cnd	Descrip.	Value	Units
AI_1		Lab_Tnp	70.7	Deg F	AO_1		LabOFFst	14.0	% Cmd
AI_2		RemoteSP	70.1	Deg F	AO_2		Thrn1Dnd	100.0	% Cmd
AI_3		LabOFFst	280.0	CFM	AO_3		Htg_Cnd	0.0	%
AI_4		Hd1_Flow	0.5	CFM					
AI_5		Hd2_Flow	1043.2	CFM					
AI_6		Hd1_Sash	0.0	% Open					
AI_7		Hd2_Sash	44.5	% Open					
AI_8		Hd1Cnd	1.0	CFM					
AI_9		Hd2Cnd	1027.3	CFM					
AI_10		MakupFlo	1745.0	CFM					
AI_11		GenExh	778.1	CFM					

Graph of Average Sash Position & Total Exhaust and Supply CFM



Left - chemis fhoods Average Sash Position Right - chemis fhoods 557 Fume Exhaust CFM Right - chemis fhoods 557 Lab Supply CFM

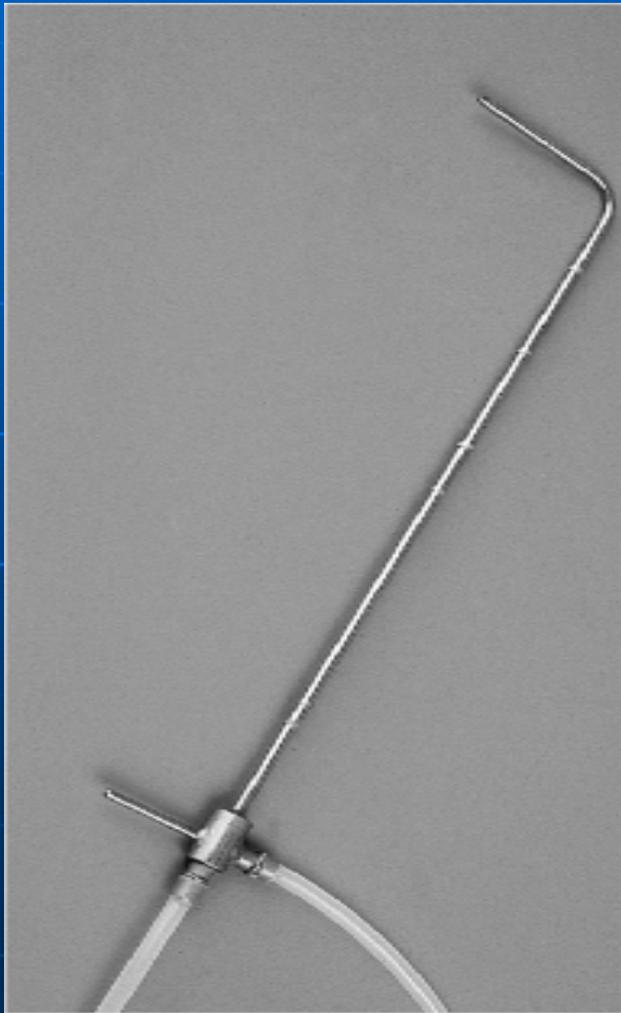
Flow Monitoring For Constant Volume Systems



- Supply Flows Can Be Measured at the Air Handler Using a Fan Inlet Flow Ring
- Provides Accurate Measurement Using a Differential Pressure Transducer



Flow Monitoring For Constant Volume Systems



- Exhaust Flows Can Be Measured Using a Pitot Tube and Pressure Transducer
- Traverse Velocity Measurements Taken After Installation in Duct for Calibration
- Square Root Extraction & CFM Calculation Done with EMCS

Heating & Cooling Energy Flow Measurement



- BTU Meter
- Flow, Supply and Return Temperature, Accumulated BTU and BTUH
- Front Panel Display
- Networked to EMCS

Performance Benchmarking Using Real-time Data

Essential Elements

- Metering and EMCS
- Energy Information System or Enhanced Trend Logging System

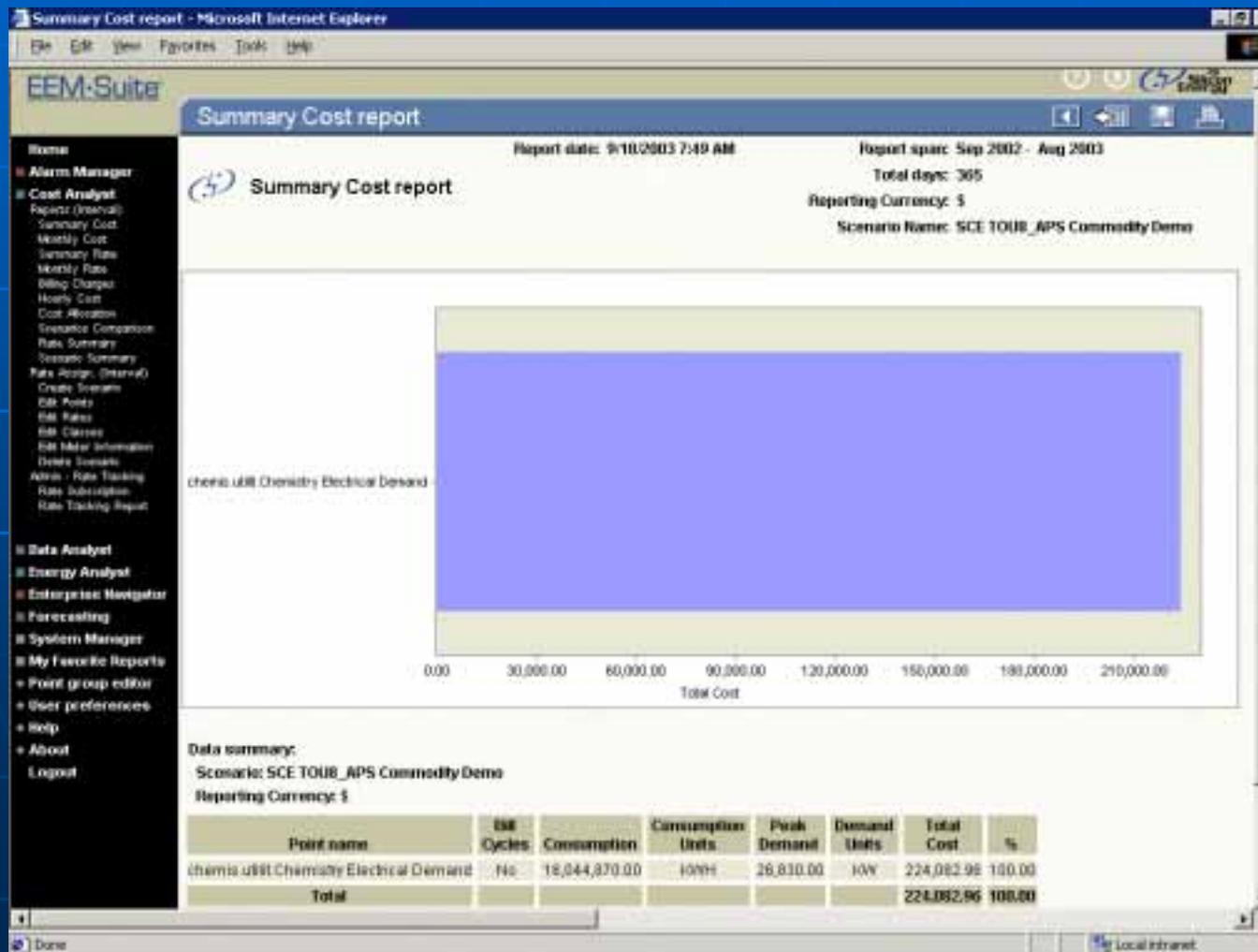
Basic Benchmarking Data Elements

- Annual Energy Costs
- Annual Gas Therms
- Annual kWh
 - Total Building
 - Ventilation
 - Cooling Plant
 - Lighting
 - Plug/Process Load
- Peak Demand kW
 - Total Building
 - Ventilation
 - Cooling Plant
 - Lighting
 - Plug/Process Load
- Peak Cooling Tons
- Average Cooling Tons

Basic Benchmarking Data Elements

- Peak CFM
 - Exhaust
 - Supply
 - General Exhaust
- Average CFM
 - Exhaust
 - Supply
 - General Exhaust
- Room Temperatures
- Relative Humidity

Benchmarking Examples Using Energy Information System



Annual
Electrical
Cost

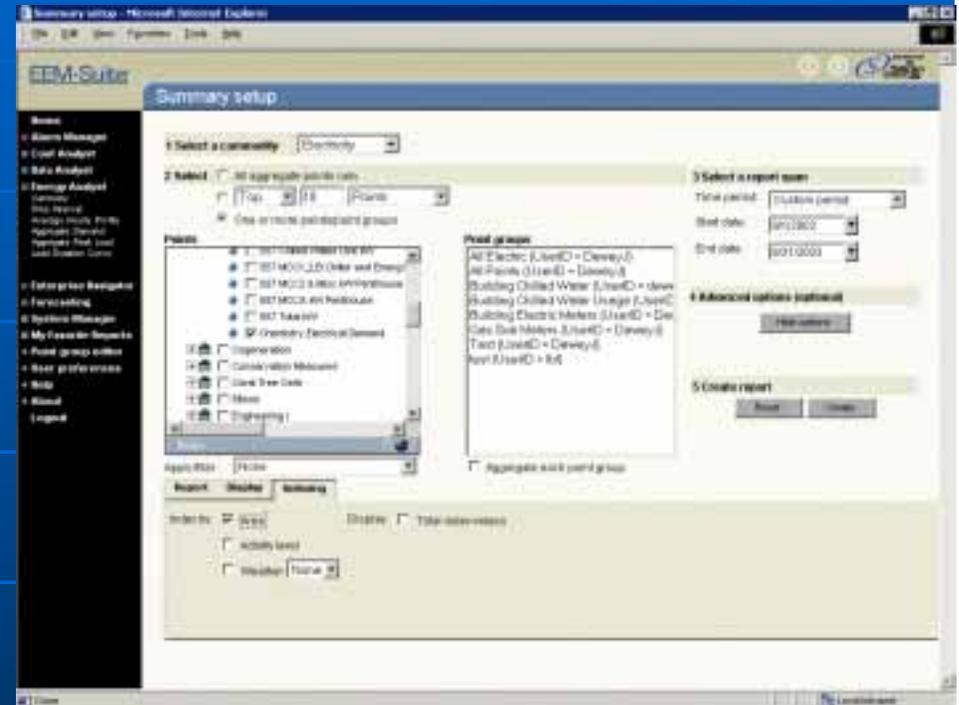
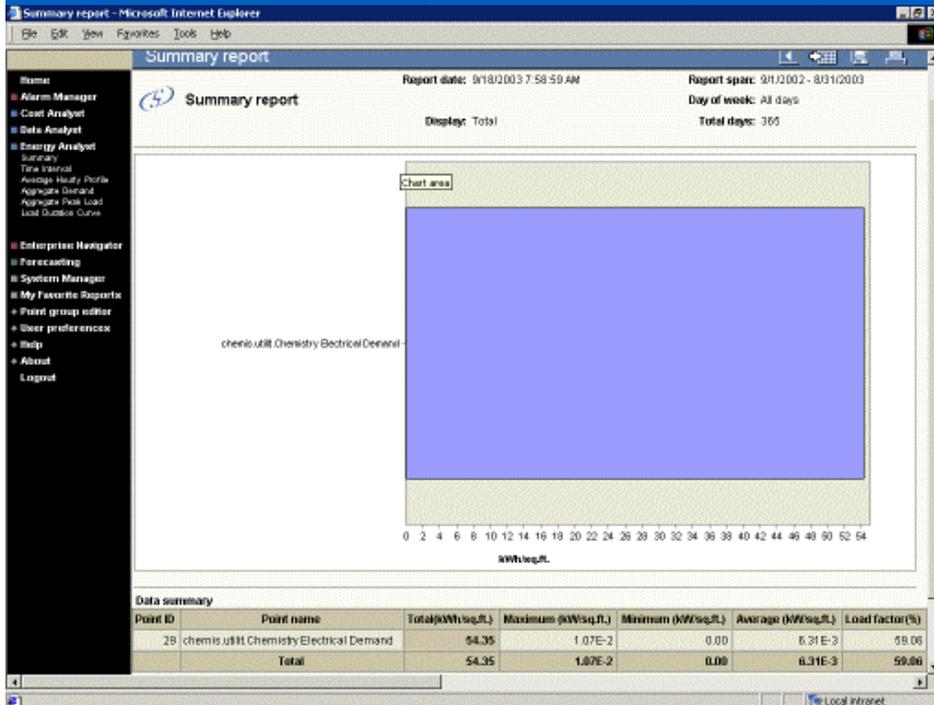
Utility
Rates
Modeled
and
Applied to
Electrical
Usage and
Demand

Benchmarking Examples Using Energy Information System

Electrical Usage Per Month with Minimum, Average and Maximum Demand

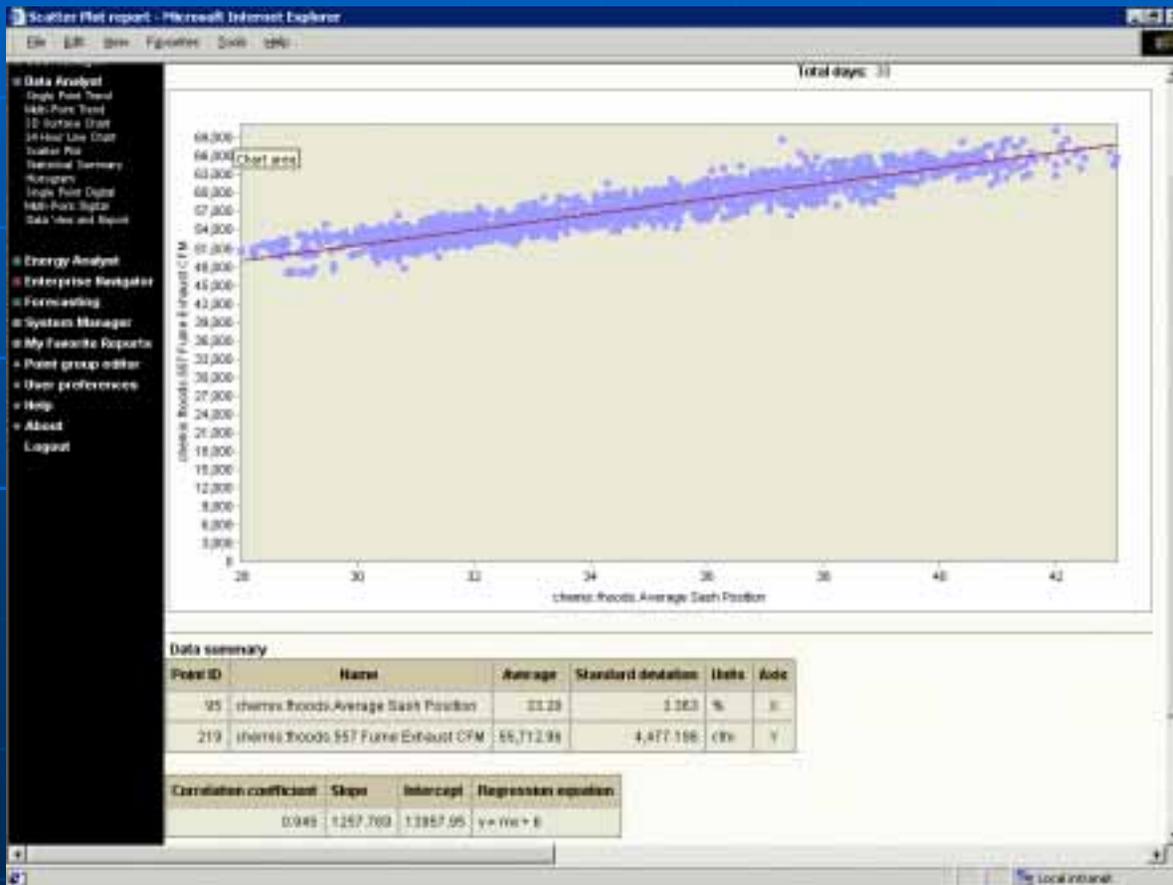


Benchmarking Examples Using Energy Information System



Index Usage By Square Footage or Other Parameters, kWh and Therms Can Be Converted to kBtus

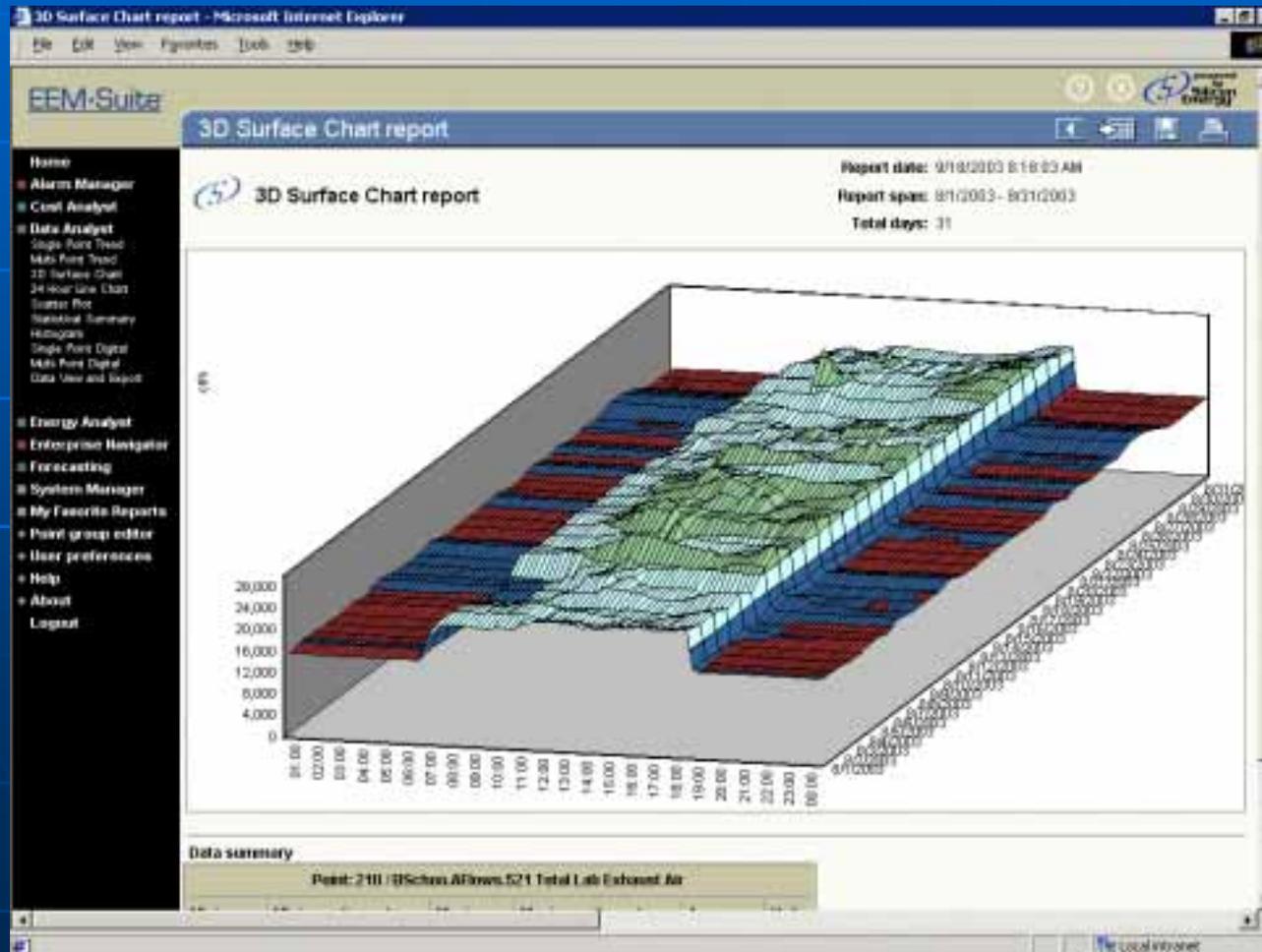
Benchmarking Examples Using Energy Information System



Scatter Plots with Linear Regression

Graph Shows the Relationship Between Average Sash Position and Exhaust CFM

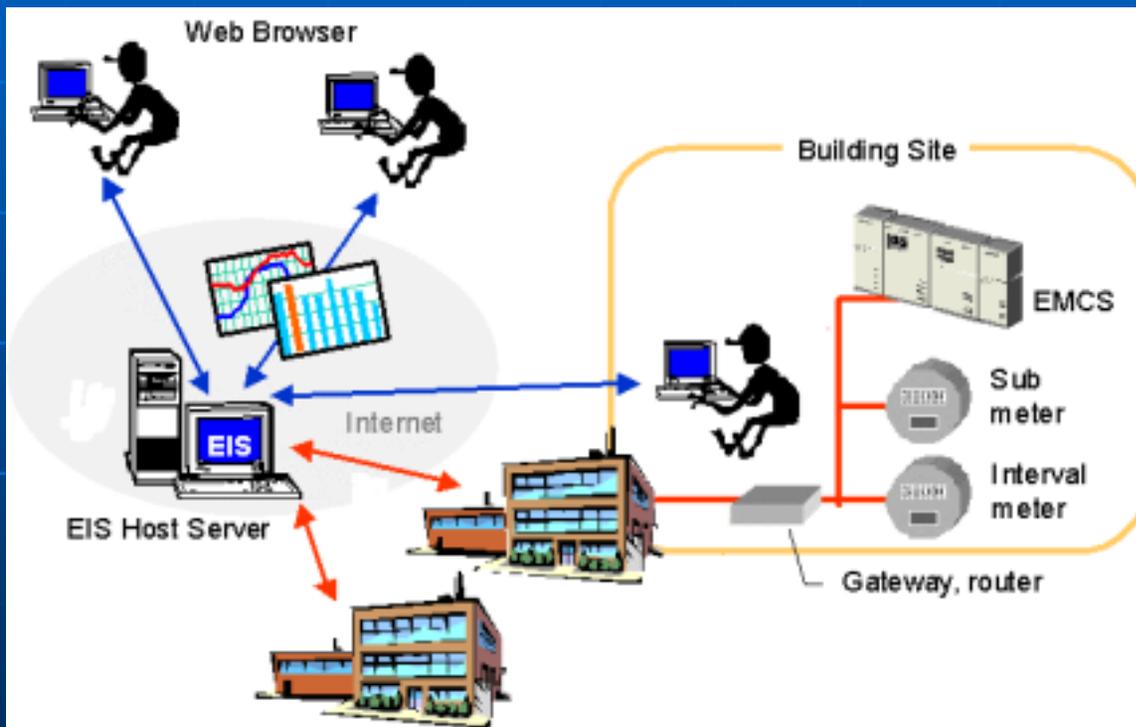
Benchmarking Examples Using Energy Information System



3D Surface Plot

Shows the Effect of Night Temperature Setback on Supply CFM

Energy Information System



- Data are collected at the building
- A communication device dispatches data
- The data is sent to a database server via Internet.
- The database server stores and archives the data
- EIS users access the server remotely by a web browser

Keys To Success

- New Buildings: Develop a metering standard and make sure it is designed into the job.
- Use energy conservation rebates and incentives available through your utility to fund your hardware and software systems.
- Install as much metering as your budget permits - a little information can go a long way