Society of SAME American Military Engineers

Importance of an O&M Program

(or How My BMS Almost Put Me in JAIL!)

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J. Woody Thompson, PE, CEM, CxA, CBCP, CPMP, REP, LEED AP

Commissioning &
Energy Region Leader

Training Objectives

- What & Why of O&M
- Computerized Maintenance Management System (CMMS)
- Types of Maintenance Programs
- Predictive Maintenance Technologies
- Commissioning & Retro-Commissioning
- Metering for O&M
- Energy/Building Management System

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O&M: Definition

- Decisions & Actions to Maintain Property & Equipment
  - Efficiency/Optimization Opportunities
  - Routine Activities

- Operational Efficiency
  - Preventive, Predictive, & Reliability-Centered Activities
  - Monitor, Track, Trend, & Document

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O&M: What Is It?

- Most Cost-Effective Method:
  - Reliability
  - Safety
  - Energy Efficiency

- INADEQUATE MAINTENACE PROGRAMS = #1 Energy Waste
  - Most Savings: Low Cost w/ Immediate Action
  - 5%-20% Savings w/ LITTLE Capital Investment

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O&M: Why?

- Legislative Mandates
- Energy Budget Savings: Improved Operations
- Improved Reputation & Confidence by Management
- Healthy/Sustainable Facility

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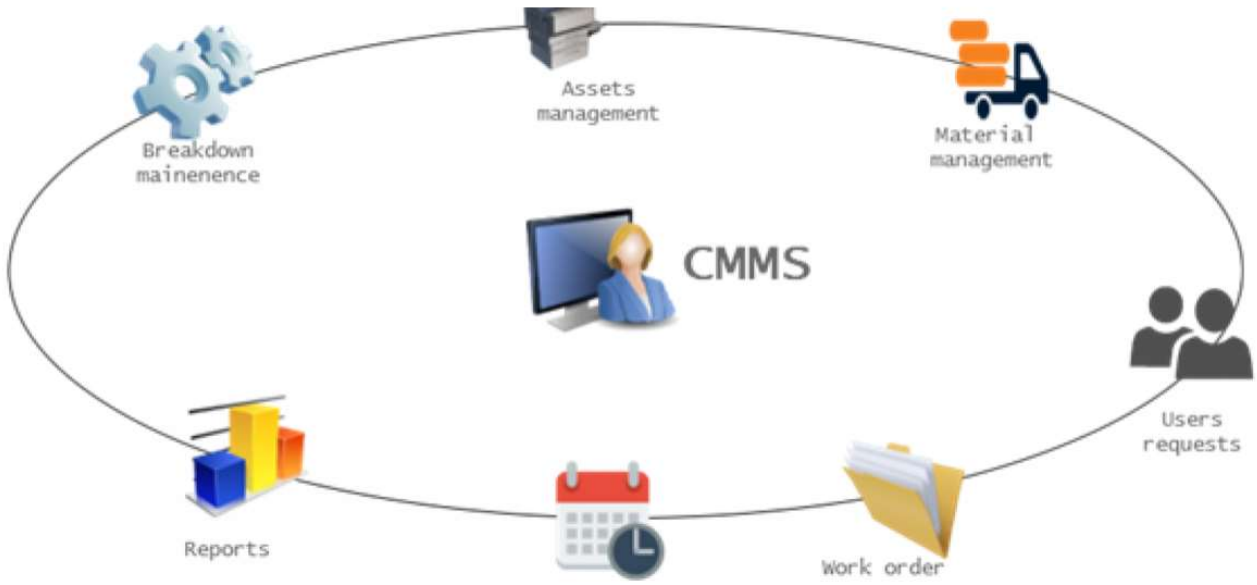
Computerized Maintenance Management System (CMMS)

- Needs Assessment
- Capabilities
- Benefits
- Pitfalls



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Computerized Maintenance Management System (CMMS)

» Needs Assessment

- Track & Verify Work Orders
- Access to Historical Information
- Inventory Control
- Archiving Documents: Electronic Based
- Compliance w/ Life, Health & Safety Requirements
- Asset Management Procedures

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Computerized Maintenance Management System (CMMS)

» Capabilities

- Electronic Tracking & Documentation
  - *Work Orders*
  - *History*
  - *Scheduled/Unscheduled Activities*
  - *Training Compliance*
  - *Technical & Procedural Information*
  - *MUCH MORE*

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Computerized Maintenance Management System (CMMS)

» Benefits

- Predictive/Proactive to Potential Problems
- Improved Planning – Improves Staff Resources
- Improved Inventory Forecasting
- Maintaining Optimal Equipment Performance – LESS DOWNTIME!

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Computerized Maintenance Management System (CMMS)

» Pitfalls

- Improper Selection of CMMS Vendor
- Inadequate Training on Use of CMMS
- Poor Implementation of CMMS
- Inconsistent Use of CMMS (No Commitment)

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Maintenance Programs

- Reactive (>55%)
- Preventative (31%)
- Predictive (12%)
- Reliability Centered (2%)

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Maintenance Programs

» Reactive (>55%) – Unplanned Activities

- Advantage (Perception): Low Cost / Less Staff

- Disadvantages (Reality):
  - *Increased Cost – Unplanned Downtime*
  - *Increased Labor Cost – Overtime*
  - *Increased Cost – Repair/Replace Equipment*
  - *Inefficient Use of Staff Resources*

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Maintenance Programs

» Preventative (31%) - Time Based Activities

– Advantages:
  - *Cost effective*
  - *Flexibility w/ Schedule*
  - *Increased Life Cycle*
  - *Energy Savings*
  - *Reduced Failure*
  - *12%-18% Savings Over Reactive Program*

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Maintenance Programs

» Preventative (31%) – Time Based Activities

– Disadvantages:
  - *Catastrophic Failures Still Occur*
  - *Labor Intensive*
  - *Possible Performance of Unneeded Maintenance*
  - *Increased Potential for Incidental Damage*

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Maintenance Programs

» Predictive (12%) – Need Based Activities

- Advantages
  - *Increased Operational Life*
  - *Preemptive Corrective Actions*
  - *Decreased Downtime*
  - *Decreased Costs*
  - *Improved Worker Safety & Morale*
  - *Energy Savings – 8%-12% Over Preventive Program*

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Maintenance Programs

» Predictive (12%) – Need Based Activities

  – Disadvantages
    - *Increased Investment of Diagnostic Equipment*
    - *Increased Investment in Training*
    - *Savings Potential Not Seen by Management*

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Maintenance Programs

» Reliability Centered – Activities Unique to Maintenance Requirements of Individual Equipment

– Advantages:
  - *Eliminates Unnecessary Maintenance*
  - *Reduced Sudden Failures*
  - *Increased Focus on Critical Equipment*
  - *Increased Equipment Reliability*
  - *Focus on Root Cause Analysis*

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Maintenance Programs

» Reliability Centered – Activities Unique to Maintenance Requirements of Individual Equipment

  – Disadvantages:
    - *Significant Costs: Startup, Training, Diagnostic Equipment*
    - *Savings Potential Not Seen by Management*

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Predictive Maintenance Technologies

- Thermography
- Lubricant & Wear Particle Analysis
- Ultrasonic Analysis
- Vibration Analysis
- Motor Analysis
- Performance Trending

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Technologies	Applications	Pumps	Electric Motors	Diesel Generators	Condensers	Heavy Equipment/ Cranes	Circuit Breakers	Valves	Heat Exchangers	Electrical Systems	Transformers	Tanks, Piping
Vibration Monitoring/Analysis		X	X	X		X						
Lubricant, Fuel Analysis		X	X	X		X					X	
Wear Particle Analysis		X	X	X		X						
Bearing, Temperature/Analysis		X	X	X		X						
Performance Monitoring		X	X	X	X				X		X	
Ultrasonic Noise Detection		X	X	X	X			X	X		X	
Ultrasonic Flow		X			X			X	X			
Infrared Thermography		X	X	X	X	X	X	X	X	X	X	
Non-destructive Testing (Thickness)					X				X			X
Visual Inspection		X	X	X	X	X	X	X	X	X	X	X
Insulation Resistance			X	X			X			X	X	
Motor Current Signature Analysis			X									
Motor Circuit Analysis			X				X			X		
Polarization Index			X	X						X		
Electrical Monitoring										X	X	

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Commissioning / Retro-Commissioning

- **Commissioning** is performed specifically to ensure that the finished facility operates in accordance with the owner's documented project requirements (OPR) and the construction documents (BOD).
- **Retro-Commissioning** is the commissioning process as applied to an existing facility that has never been commissioned. Focus is on building performance and how to improve utility/energy consumption.
- **Re-Commissioning** is the commissioning process as applied to an existing building that had been commissioned but no longer meets owner's current operational need.

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Retro-Commissioning Process

Process applied to a building that was **NEVER COMMISSIONED**.

The retro-commissioning process involves activities that are integrated into every phase of the project . . .

NOT A MAINTENANCE CONTRACT!

NOT JUST AN ENERGY STUDY!

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Metering for O&M

- One-Time/Spot Measurement
- Run-Time Measurement
- Short-Term Monitoring
- Long-Term Monitoring

Metering for O&M

- One-Time/Spot Measurement – "Baseline" Activity
  - Advantages
    - *Lowest Cost*
    - *Ease of Use*
    - *Non-Intrusive*
    - *Fast Results*
    - *Advantages*
  - Disadvantages
    - *Low Accuracy*
    - *Limited Application*
    - *Measures Single Operating Parameter*

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Metering for O&M

- Run-Time Measurement
  - Advantages
    - *Low Cost*
    - *Ease of Use*
    - *Non-Intrusive*
    - *Constant-Load Devices*
  - Disadvantages
    - *Limited Application*
    - *Measures Single Operating Parameter*
    - *Additional Calculations/Assumptions*

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Metering for O&M

- Short-Term Monitoring
  - Advantages
    - *Mid-Level Cost*
    - *Quantify Magnitude & Duration*
    - *Relatively Fast Results*
  - Disadvantages
    - *Mid-Level Accuracy*
    - *Limited Application*
    - *More Difficult to Install/Monitor*

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Metering for O&M

- Long-Term Monitoring
  - Advantages
    - *Highest Accuracy*
    - *Quantify Magnitude & Duration*
    - *Captures Most Variance*
  - Disadvantages
    - *High Cost*
    - *Most Difficult to Install/Monitor*
    - *Time Duration for Results*

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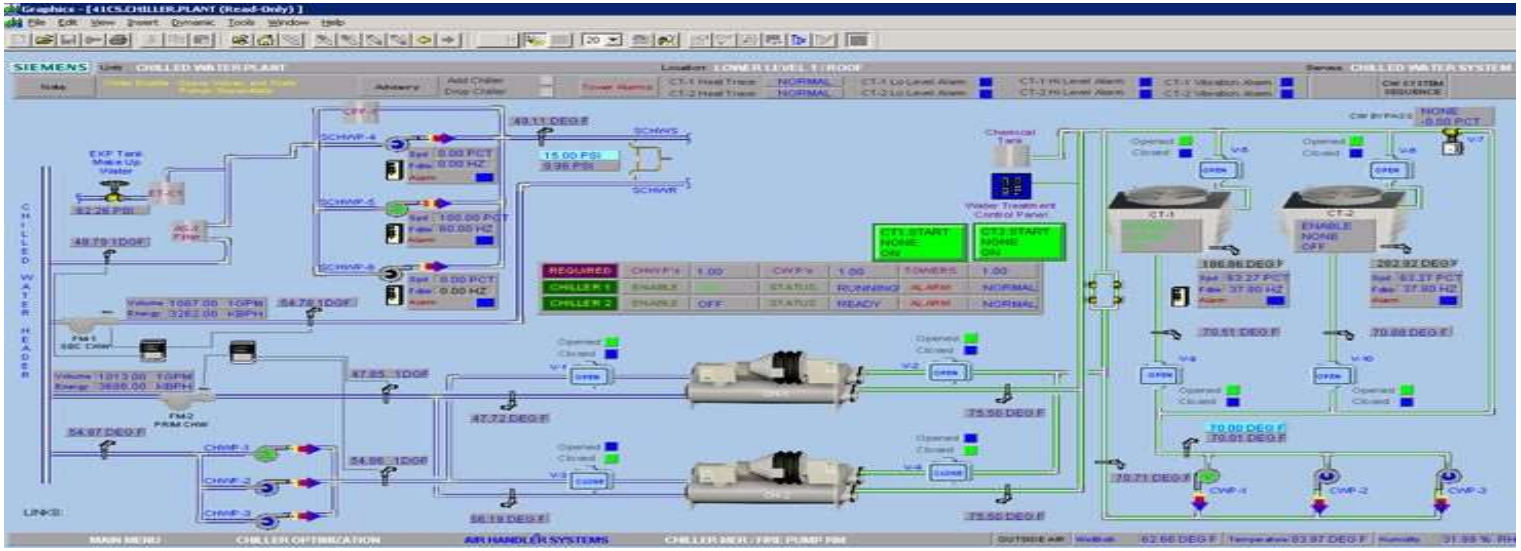
Energy/Building Management Systems

- HVAC Scheduling, Temperature/Pressure Setpoints
- HVAC Tune-Up & Maintenance



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Energy/Building Management Systems

- HVAC Scheduling, Temperature/Pressure Setpoints, Alarms
  - Direct Digital Control (DDC) Optimal Start/Stop
  - DDC Holiday Scheduling
  - Temperature Setpoints
  - Pressure Setpoints
  - Understanding Alarms

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Energy/Building Management Systems

- HVAC Tune-Up & Maintenance for DDC Reliability
  - Valves
  - Sensor Calibration
  - Belt-Driven System
  - System Overrides
  - Simultaneous Heating and Cooling

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Energy/Building Management Systems

- How to Stay Out of JAIL!
  - Federal Courthouse
  - DDC Shortfalls
    - *Software Upgrades*
    - *Overrides*
    - *Software Upgrades*
    - *Training*

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Description	Comments	Maintenance Frequency			
		Daily	Weekly	Semi-Annually	Annually
Overall visual inspection	Complete overall visual inspection to be sure all equipment is operating and safety systems are in place	X			
Verify control schedules	Verify in control software that schedules are accurate for season, occupancy, etc.	X			
Verify setpoints	Verify in control software that setpoints are accurate for season, occupancy, etc.	X			
Time clocks	Reset after every power outage	X			
Check all gauges	Check all gauges to make sure readings are as expected		X		
Control tubing (pneumatic system)	Check all control tubing for leaks		X		
Check outside air volumes	Calculated the amount of outside air introduced and compare to requirements		X		
Check setpoints	Check setpoints and review rational for setting		X		
Check schedules	Check schedules and review rational for setting		X		
Check deadbands	Assure that all deadbands are accurate and the only simultaneous heating and cooling is by design		X		
Check sensors	Conduct thorough check of all sensors – temperature, pressure, humidity, flow, etc. – for expected values			X	
Time clocks	Check for accuracy and clean			X	
Calibrate sensors	Calibrate all sensors: temperature, pressure, humidity, flow, etc.				X

10 Steps for Operational Efficiency

- 1. Increase Management Awareness (ongoing)
- 2. Track O&M Activities (ongoing)
- 3. Identify Your “Problem Children”
- 4. Address at Least One
- 5. Look for Operational Efficiencies

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10 Steps for Operational Efficiency

- 6. Diagnostic/Forensic Analysis
- 7. Trend Data
- 8. Create “Operational Efficiency” Project
- 9. Highlight Your Success (esp. to Management)
- 10. Find Next Optimization Opportunity (Go to Step 3)

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U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

FEDERAL ENERGY MANAGEMENT PROGRAM

Release 3.0

Operations & Maintenance Best Practices

A Guide to Achieving *Operational Efficiency*

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Open Discussion & Questions

THANK YOU!

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J. Woody Thompson
woody.thompson@rsandh.com
210-301-4819