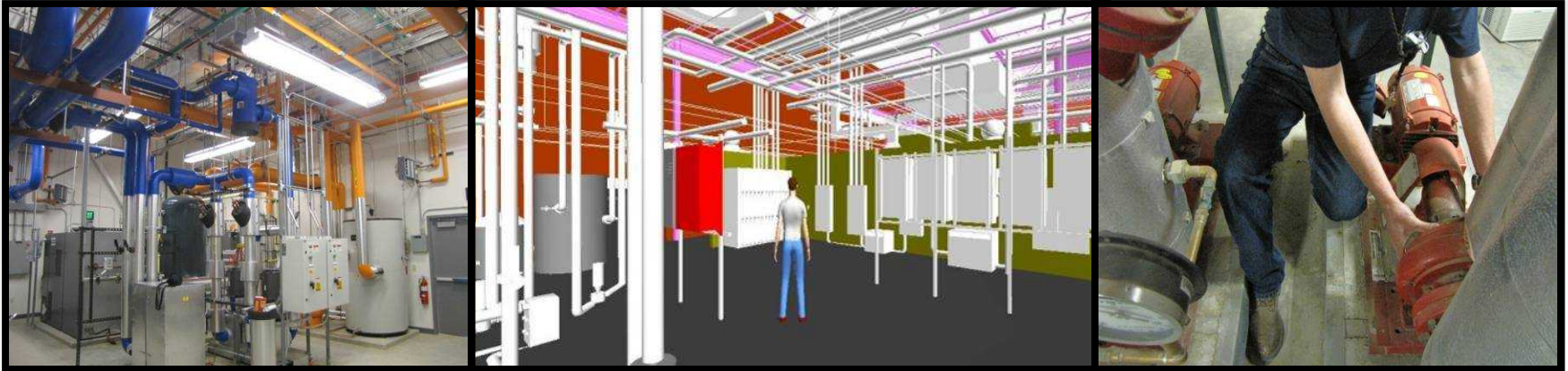


“Meaningful Management” 2011 SAND2011-2045C

BIM for FM

Design for Maintenance strategy



Birgitta Foster
Facilities BIM Champion
SSA/Sandia National Labs

April 6, 2011

Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.



Disclaimer

“The **views expressed** in this presentation are **those of the author** and do not reflect the official policy or position of Sandia National Laboratories, Dept of Energy, or the US Government.”

Overview



Introduction



Owners : Cost of **NOT** doing BIM



BIM for Operational Savings

“Design for Maintenance” Strategy



Tying it all together



Resource Recommendations

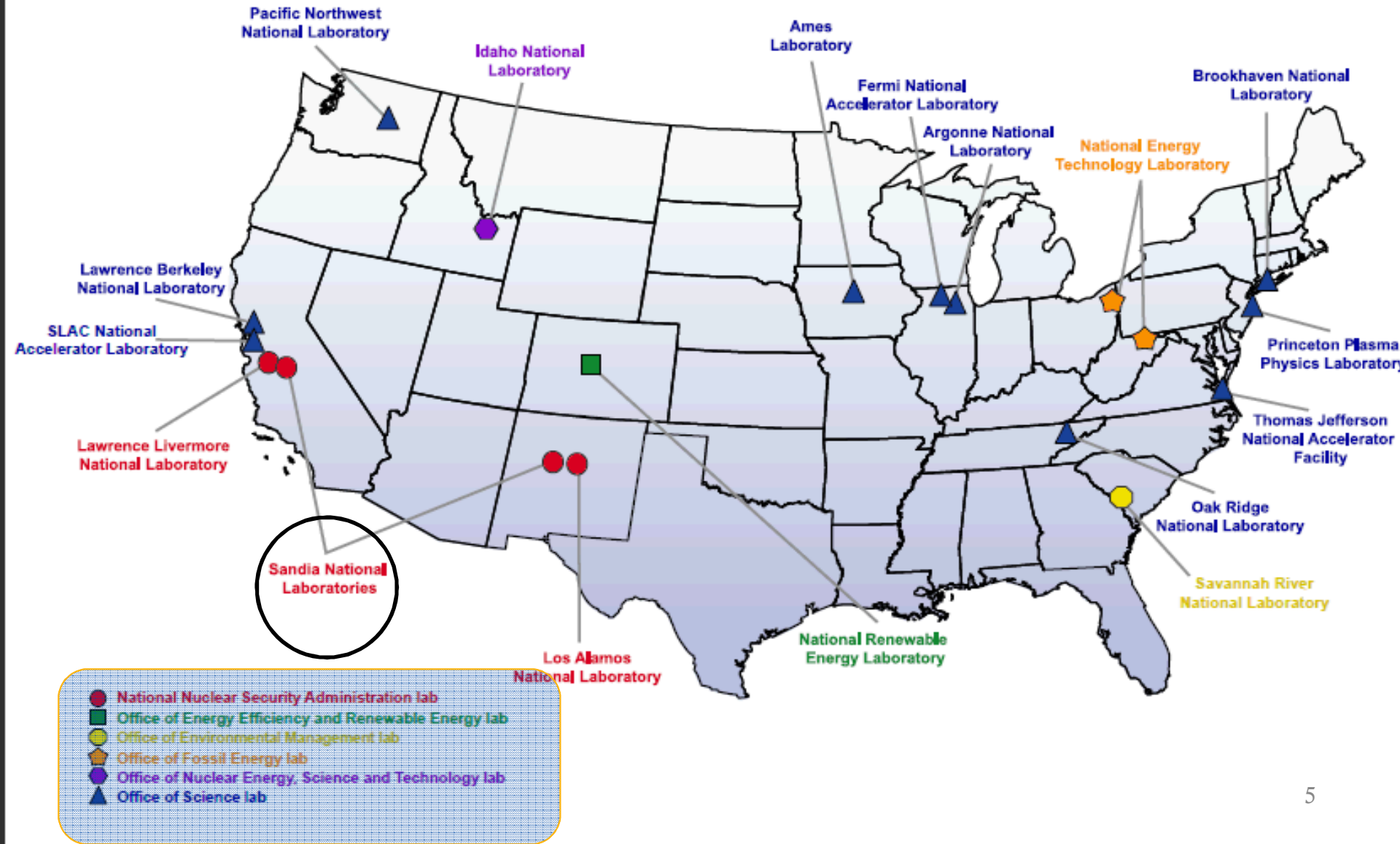
Birgitta Foster, BSME, MBA

Career Path

- **Manufacturer** : Ingersoll Rand
- **Engineering & Construction** : John Brown E&C
- **Fabrication** : Caterpillar
- **General Contractor**: for Intel
- **Specialty Contractor** : for Intel/Sandia National Labs
- **Mechanical Contractor** : for Sandia National Labs
- **Owner** : Sandia National Labs



DEPARTMENT OF ENERGY NATIONAL LABORATORIES



DOE : GO/CO* structure



*Gov't Owned/Contractor Operated



Sandia
National
Laboratories

National Missions

SANDIA'S NATIONAL SECURITY MISSIONS



Nuclear Weapons

Ensure a safe, secure, & reliable nuclear deterrent.



Energy & Infrastructure Assurance

Ensure clean, abundant, & affordable energy and water.



Nonproliferation

Reduce proliferation of weapons of mass destruction & threat of accidents.



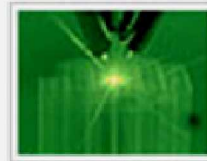
Defense Systems & Assessments

Help maintain U.S. military weapon-systems superiority.



Homeland Security

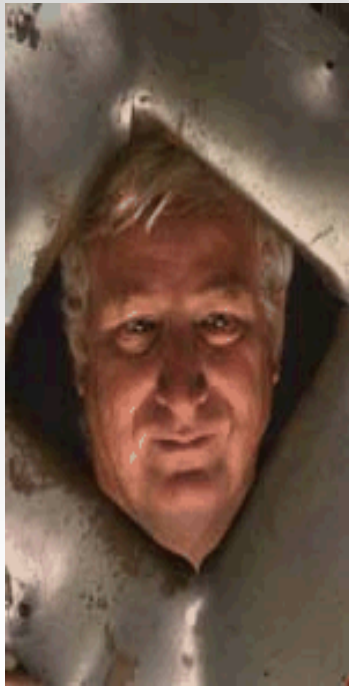
Help protect our nation against terrorism through advanced technology.



Science, Technology, & Engineering

Conduct R&D programs to support all national security missions.

Mission: Tech Transfer



Magic Cube

The Sandia-developed "Magic Cube" can blow a fragment-free hole in 1/4-inch steel. It can be used to **safely look at a terrorist bomb inside a vehicle** or create an **opening to see accident victims** and send them supplies.



Sandia
National
Laboratories

www.sandia.gov

Sandia National Laboratories - Windows Internet Explorer
http://www.sandia.gov/index.html

Sandia National Laboratories

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SECURING A PEACEFUL AND FREE WORLD THROUGH TECHNOLOGY

Gene sequencing for biofuels
Researchers to study microbial genes in arid grasslands » [Full Story](#)

News







- ▶ Gene sequencing for biofuels
- ▶ Magnetic mixing creates a stir
- ▶ Perspectives on energy policy

60th Anniversary
60 ways Sandia Labs has impacted the nation

Sandia 2008
The Labs' annual report (with video)

Lab Accomplishments
Key milestones for 2009

SANDIA'S NATIONAL SECURITY MISSIONS

 Nuclear Weapons Ensure a safe, secure, & reliable nuclear deterrent.	 Energy & Infrastructure Assurance Ensure clean, abundant, & affordable energy and water.
 Nonproliferation Reduce proliferation of weapons of mass destruction & threat of accidents.	 Defense Systems & Assessments Help maintain U.S. military weapon-systems superiority.
 Homeland Security Help protect our nation against terrorism through advanced technology.	 Science, Technology, & Engineering Conduct R&D programs to support all national security missions.

RESOURCES FOR...

- Community
- Employees & Retirees
- News Media
- Partners & Collaborators
- Students
- Suppliers
- Visitors

FOLLOW US



Sandia
National
Laboratories

Sandia Overview

Four sites (~ 1100 bldg, 7M GSF)

- NM (Albuquerque)
- CA (Livermore)
- NV (Tonopah)
- HI (Kauai)

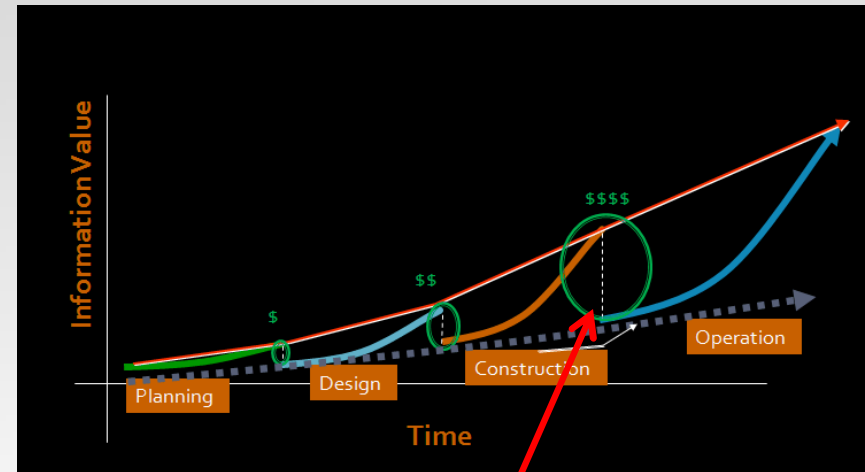
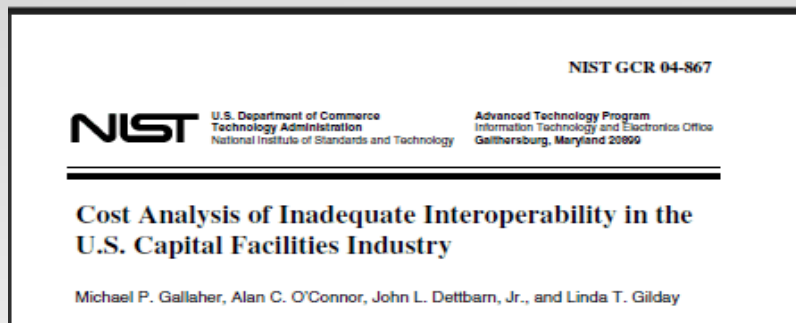
Sandia - NM site

- 891 Bldgs
- 6M GSF
- 8700 acres



Owners: Cost of NOT doing BIM

NIST Survey (2004)



Industry Inefficiency Costs : \$15B/yr

- 66% borne by Owners
- Increased O&M costs = \$9.9B/yr
- \$0.23/ existing SF/yr

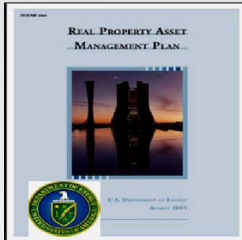
Putting in to Context...@0.23/SF



Sandia

- 6M GSF

Costing : \$1.38 M/yr



DOE

- 127M GSF

Costing : \$29 M/yr

All Federal Agencies

- 3.38B GSF

Costing : \$0.77 B/yr

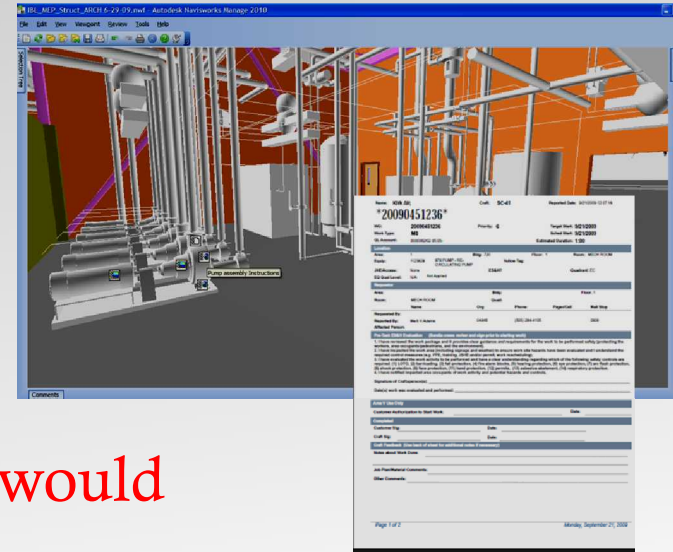


NIST Study Validation

NIST Study = ~\$1.4M

Sandia “straw man” survey

Using BIM, if you could get all needed information in 5 minutes, how much time would that save?



Response: up to 2 hours per work order (WO)

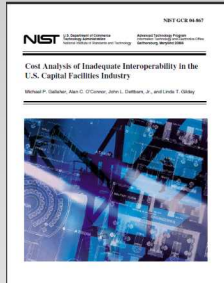
$$2 \text{ hrs/WO} \times \$50/\text{hr} = \$100/\text{WO}$$

$$\text{WO/yr} = \sim 24,000$$

Potential savings: \$2.4 M/year

BIM for FM : Evidence of savings

2004



NIST Industry Study
Cost Analysis of Inadequate Interoperability

2009



NIST Validation
"Straw man" Survey

2010



BIM for FM Survey :
"View of the future for FM"



UNM BIM for FM Survey :

"View of the Future for Facilities Management"

Francisco Forns-Samso

Graduate student

Construction Program

Civil Engineering Department



THE UNIVERSITY *of*
NEW MEXICO

Survey on BIM for FM





Survey on BIM for FM

- 77% Owners
- Majority manage campus-type facilities
- over 50% over 1M GSF
 - 22% 1-5M GSF
 - 35% over 5M GSF
- Respondents were a good cross-section with Education, Office, Gov't, Laboratory
- Majority had over 30,000 WO per year
- There is a perceived time savings up to 40% per WO

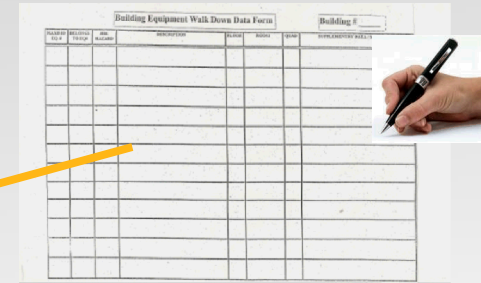
FM Data Collection dilemma

- Current condition : **Inefficient**

Manual / Reentry

Not Trusted

Hard to locate



- Future vision : **Efficient**

Automated

Manufacture supplied

Entered Once, then Shared



What data do we infer?

Assets Bulletins: (0) Go To Reports Start Center Profile Sign Out Help **IBM**

Find: Select Action:

List Asset Spare Parts Safety Meters Specifications

Asset: 1006361 891: CIRCULATING CHILLED WATER PUMP # Site: SNMFAC Attachments:

Status: OPERATING Yellow Tag #: L00515 Classification: PUMP

Details

Parent: Maintain Hierarchy? ☐

Location: 891 Energy Technology Office and Lab Building

Bin: Rotating Item: Meter Group:

Priority: 2 Serial #: 740113-2 Failure Class: Item Type: Asset/Property: REAL SNL Site: ALBUQUERQUE

JSHE/Access: P Qual Level: N/A Supp Data: VERIFIED Room: BASEMENT EQUIP ROOM Floor: BASEMENT Quad: NE Model #: 5L-3 Catalog #: Condition:

Purchase Information

Vendor: Manufacturer: WEINMAN WEINMAN, AMW INDUSTRIES

Installation Date: Warranty Expiration Date: Purchase Price: 0.00 Replacement Cost: 0.00 PO:

Costs

Total Cost: 75.17 YTD Cost: 0.00 Budgeted: 0.00 Inventory: 0.00 GL Account: 0000362/02 05

Downtime

Asset Up? ☒ Last Changed Date: Total Downtime: 0.00

Modified

Changed By: KNMEHLH Changed Date: 3/29/00 8:04 AM

How to collect data?

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	AE to complete this section								CONTRACTOR to complete this section						
	Asset number	EQUIPMENT Classification	New Replace Remove	AREA	Location (Bldg#)	RM	FLR	Quadrant	Manufacturer	Model #	Catalog #	Serial Number	Installation date	Warranty Expiration date	
2															
3	100567	PUMP	Replace	I	880	26	BSMT	NE	Goulds						
4		PUMP	New	I	880	26	BSMT	NE							
5	100570	MOTOR	Replace	I	880	26	BSMT	NE	Baldor						
6		MOTOR	New	I	880	26	BSMT	NE							
7		CHILLER	New	I	880	26	BSMT	NE							
8	101845	CHILLER	Remove	I	880	26	BSMT	NE	Trane						
9	101846	CHILLER	Replace	I	880	26	BSMT	NE	Trane						
10		BOILER	New	I	880	26	BSMT	NE							
11															

Autodesk Revit Architecture 2010 - [5940036_MEP 2-25-2010.rvt - Schedule: MASTER EQUIP...]

Home Insert Annotate Modify Massing & Site Collaborate View Manage Add-Ins Modify Schedule/Quantities

Schedule

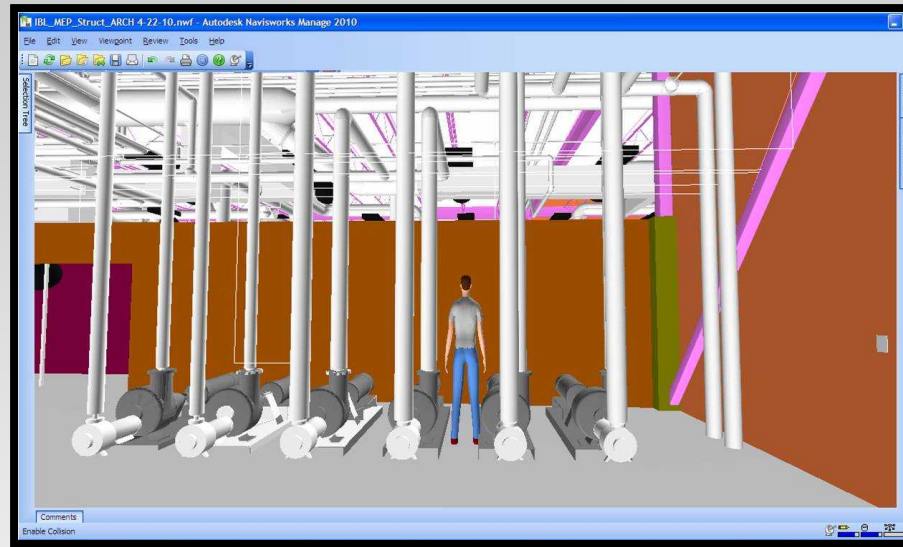
MASTER EQUIPMENT LIST - Asset Changes

AE to complete this section								CONTRACTOR to complete this section						
Asset Number	EQUIPMENT Classification	New Replace Remove	AREA	Location (Bldg#)	Room	Floor	Quadrant	Manufacturer	Model	Catalog #	Serial #	Installation Date	Warranty Exp	JSHE/Access
111	PUMP	NEW	I	720	212	1st	NW	BELL & G	1510 5A					
112	PUMP	NEW	I	720	212	1st	NW	BELL & G	1510 5A					
113	PUMP	NEW	I	720	212	1st	NW	BELL & G	1510 4BC					
114	PUMP	NEW	I	720	212	1st	NW	BELL & G	1510 4BC					
115	PUMP	NEW	I	720	212	1st	NW	BELL & G	1510 2BC					
116	PUMP	NEW	I	720	212	1st	NW	BELL & G	1510 2BC					
121	BOILER	NEW	I	720	212	1st	NW	LOCHINV	PBN-1002-					
122	BOILER	NEW	I	720	212	1st	NW	LOCHINV	PBN-1002-					
245	AIRHDLR	NEW	I	720		ROOF	NE							
247	CHILLER	NEW	I	720		1st	NW							
256	MOTOR	NEW	I	720	212	1st	NW							

Operational Savings with BIM

- ☒ Know there is a need
 - ☒ Know there are perceived savings
 - ☒ Cost Reduction Strategies
 - ☒ Energy
 - ?? Operations and Maintenance
- “Design for Maintenance” Strategy***

“Design for Maintenance” strategy

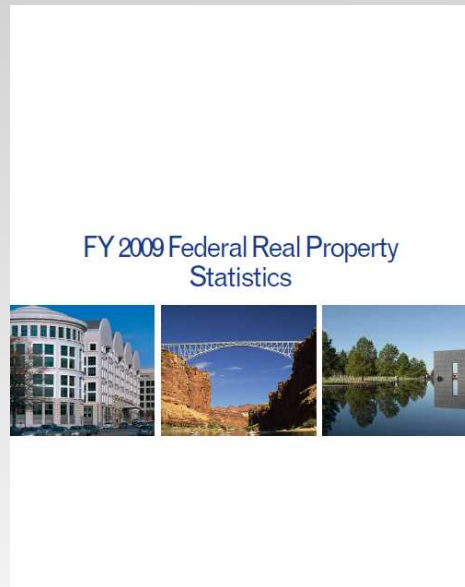


“Maintenance Friendly”

NOT “Maintenance Friendly”



Federal Agency Overview



Agency Profile: FY 2009 Total Number of Buildings and Structures and Total Building Square Footage

Overview

Agency Name	Total	Total
Army	nd	
Interior		
Air Force		
Navy	Federal Communications Commission	65 170,000
Transportation		
Agriculture	National Archives and Records Administration	32 5,170,000
Homeland Security		
State	DC Court Services and Offender Supervision Agency	11 294,000
Corps of Engineers		
Veterans Affairs	National Gallery of Art	8 1,414,000
General Services Administration	United States Holocaust Memorial Council	5 320,000
National Science Foundation	Merit Systems Protection Board	4 59,000
Justice	Office of Personnel Management	2 81,000
Labor		
Health and Human Services	John F. Kennedy Center for the Performing Arts	1 1,500,000
United States Department of Education		
Information Systems		
Commonwealth Development Corporation		
Smithsonian Institution		
National Foundation for the Performing Arts		
Peace Corps		
Totals	912,780	3,388,992,000

Total GSF

* Agencies listed in blue font (those same agencies subject to the CFO Act) are required to submit data under EO 13327 and sections 901 (b)(1) and (b)(2) of title 31, United States Code.

Federal Agency Overview



Key Statistics: FY 2009 CFO Act Agencies

The chart on this page represents data from the 24 agencies required to submit data (those same agencies subject to the CFO Act). All data in this report starting on this page through the end of the report includes data from only those agencies.

FY 2009 Federal Real Property Statistics

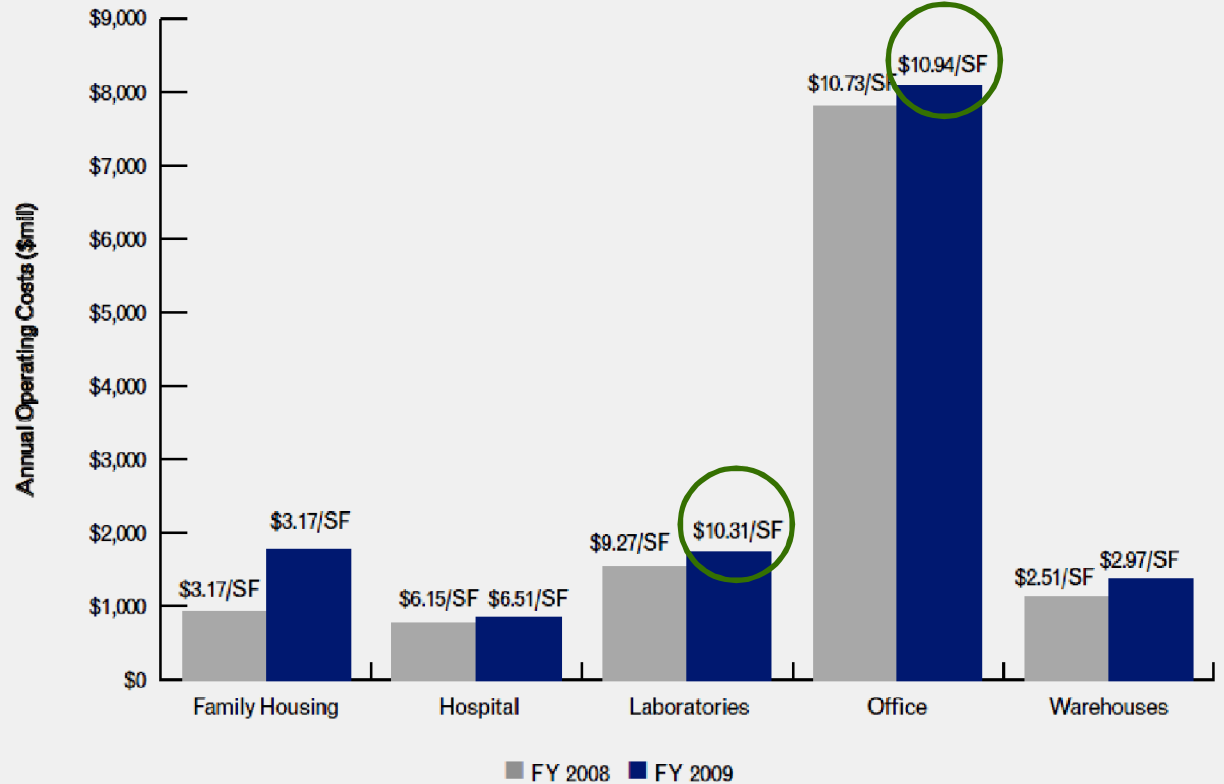
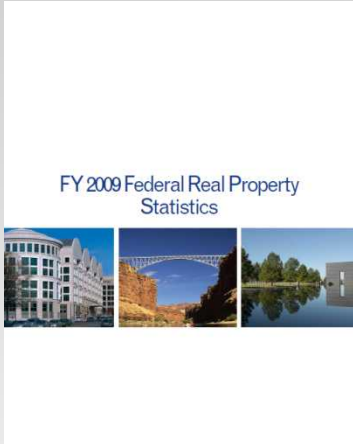


	FY 2008	FY 2009	Variance
Total Federal Building Assets ²	406,000	429,000	23,000
Total Area of Building Assets ³	3.26 billion square feet	3.34 billion square feet	71.0 million square feet
Total Federal Structures	489,000	482,000	-7,000
Total Federal Land Acreage	40,905,000	39,790,000.00	-1,115,000
Total Federal Buildings and Structures	895,000	911,000	16,000

² May include multiple leases in one building.

³ All square feet data is represented in gross square feet.

Federal Buildings: Annual Operating Costs by Building Predominant Use and Square Footage



Federal Annual Operating Costs

■ Custodial

- Pest control/refuse collection
- Recycling costs

■ Roads/Grounds

- Landscaping/snow-ice removal

■ Utilities

- Plant operations and energy

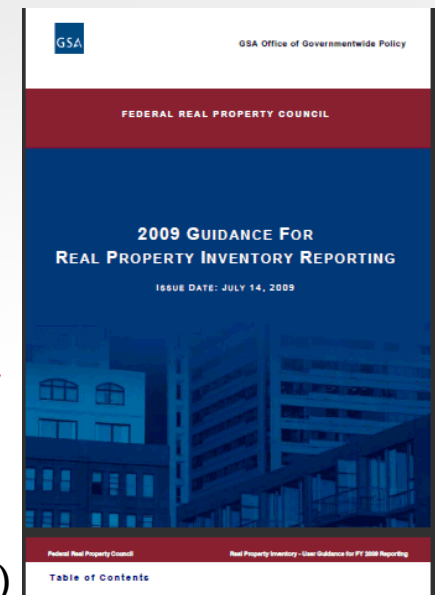
■ Reoccurring Maintenance and Repair

- Work orders

(source : FRPC Real Property Inventory – Users Guidance FY09)

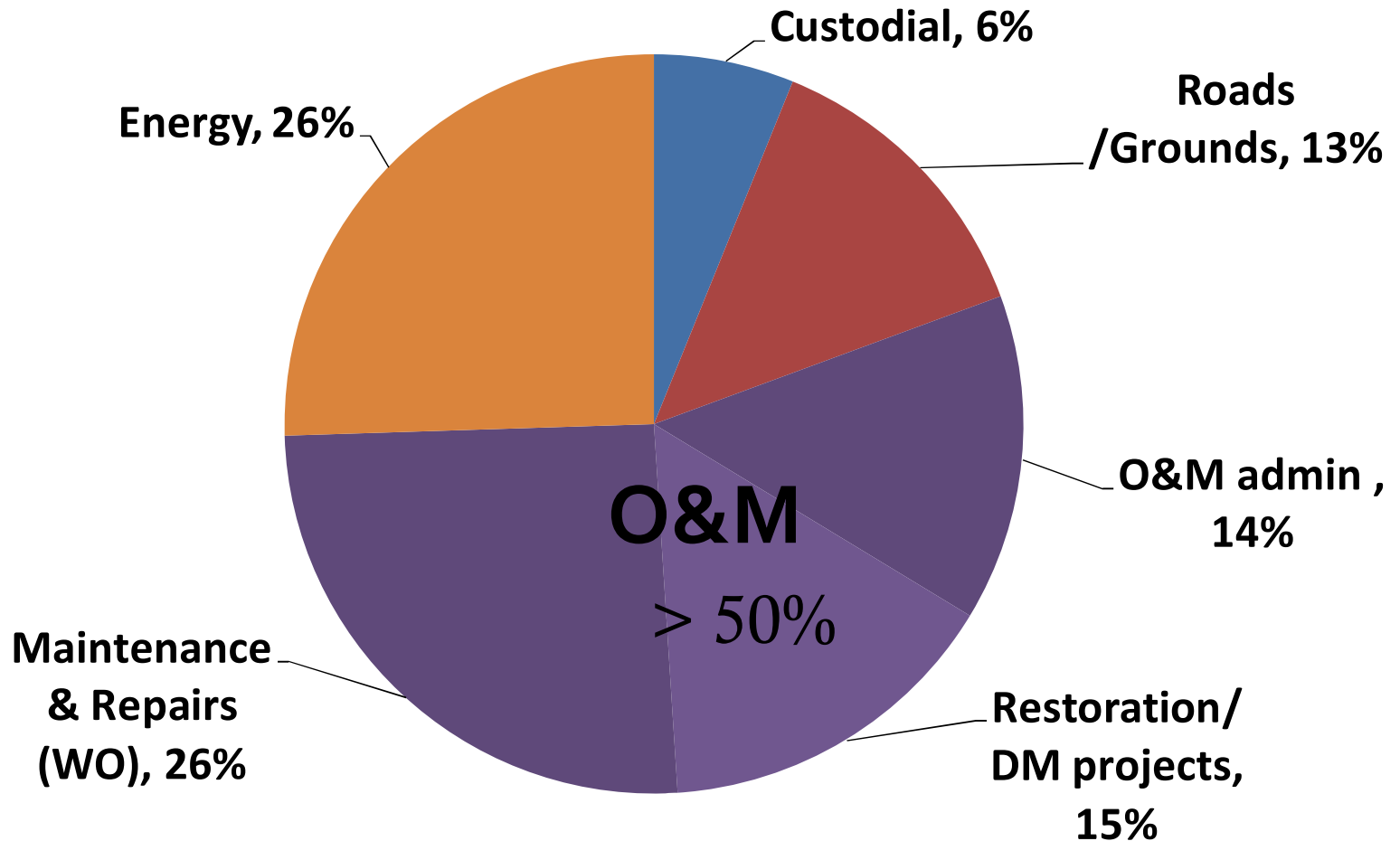
Owned Buildings			
	Annual Operating Costs	Total Square Feet (SF)	Annual Operating Costs/SF
FY 2008	\$12,036,779,000	2,588,928,000	\$4.65
FY 2009	\$13,212,448,000	2,576,552,000	\$5.13

http://www.gsa.gov/graphics/ogp/FY2009_FRPR_Statistics.pdf



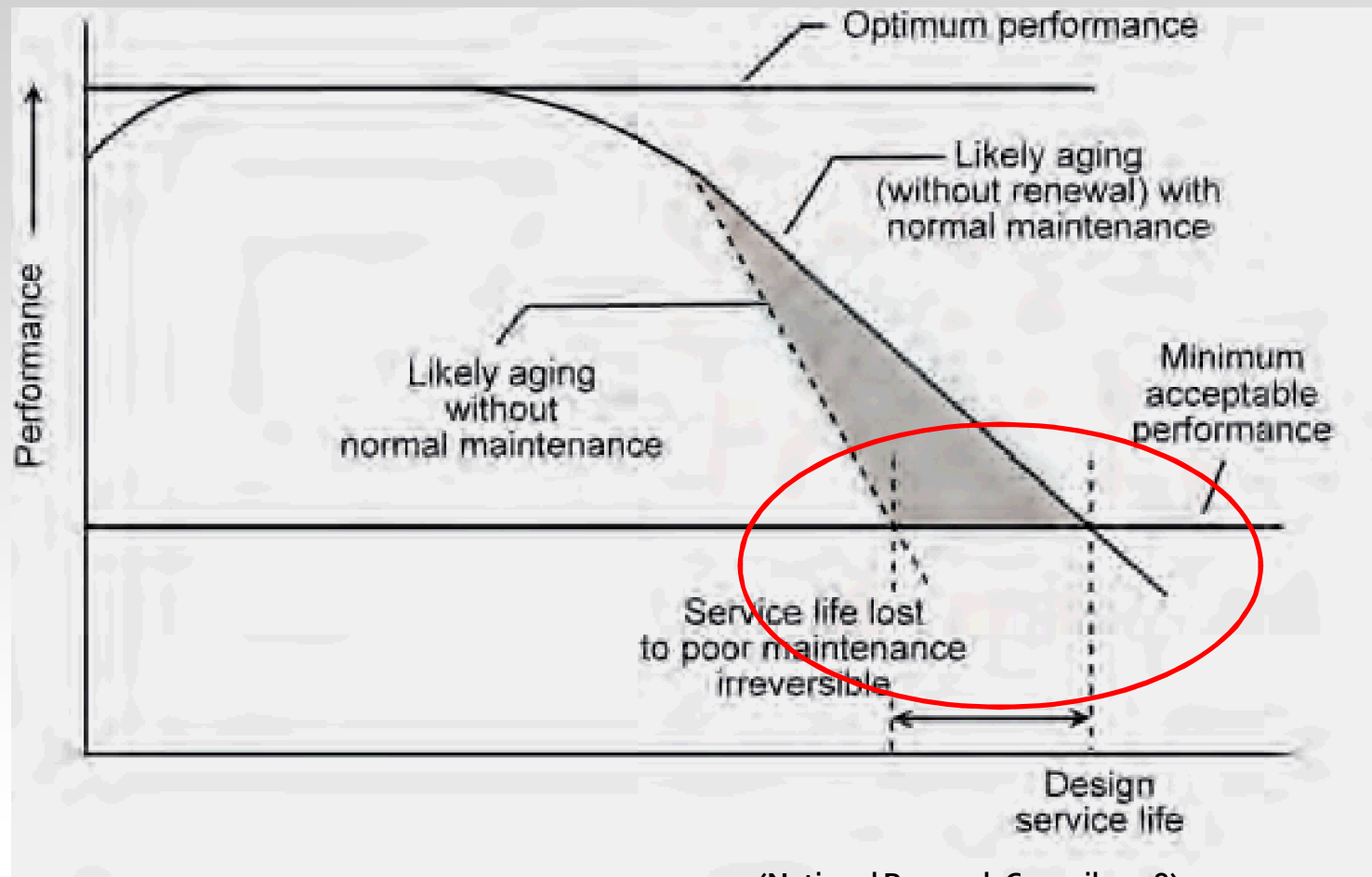
Covering Operating Costs :

Space Charge Back



“Design For Maintenance” Strategy:

Main Premise



(National Research Council 1998).

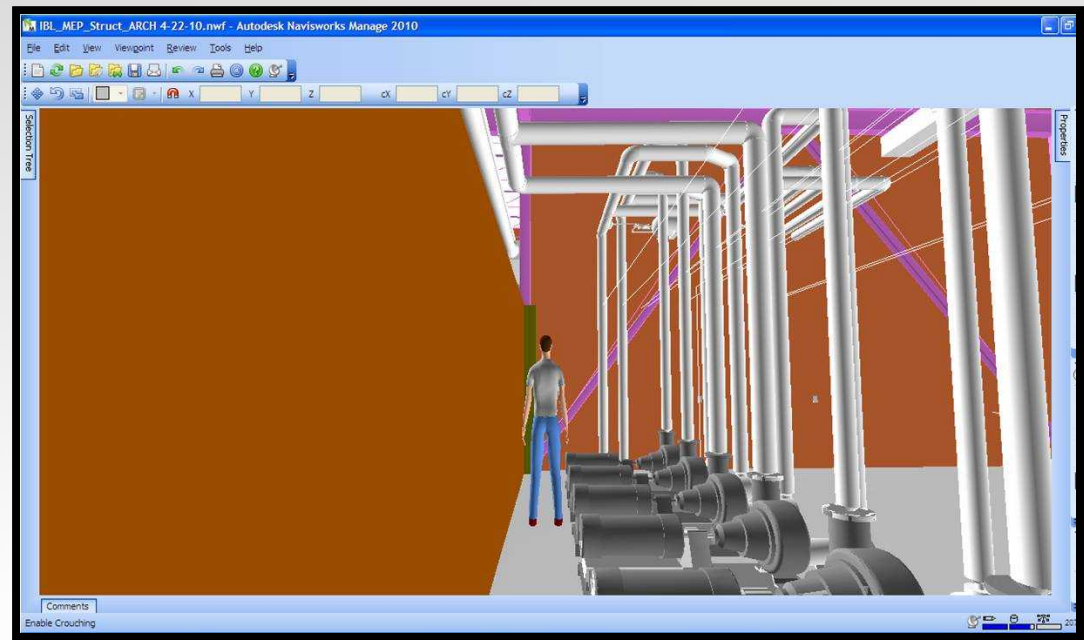
“Maintenance Friendly”



NOT “Maintenance Friendly”



“Maintenance Friendly”

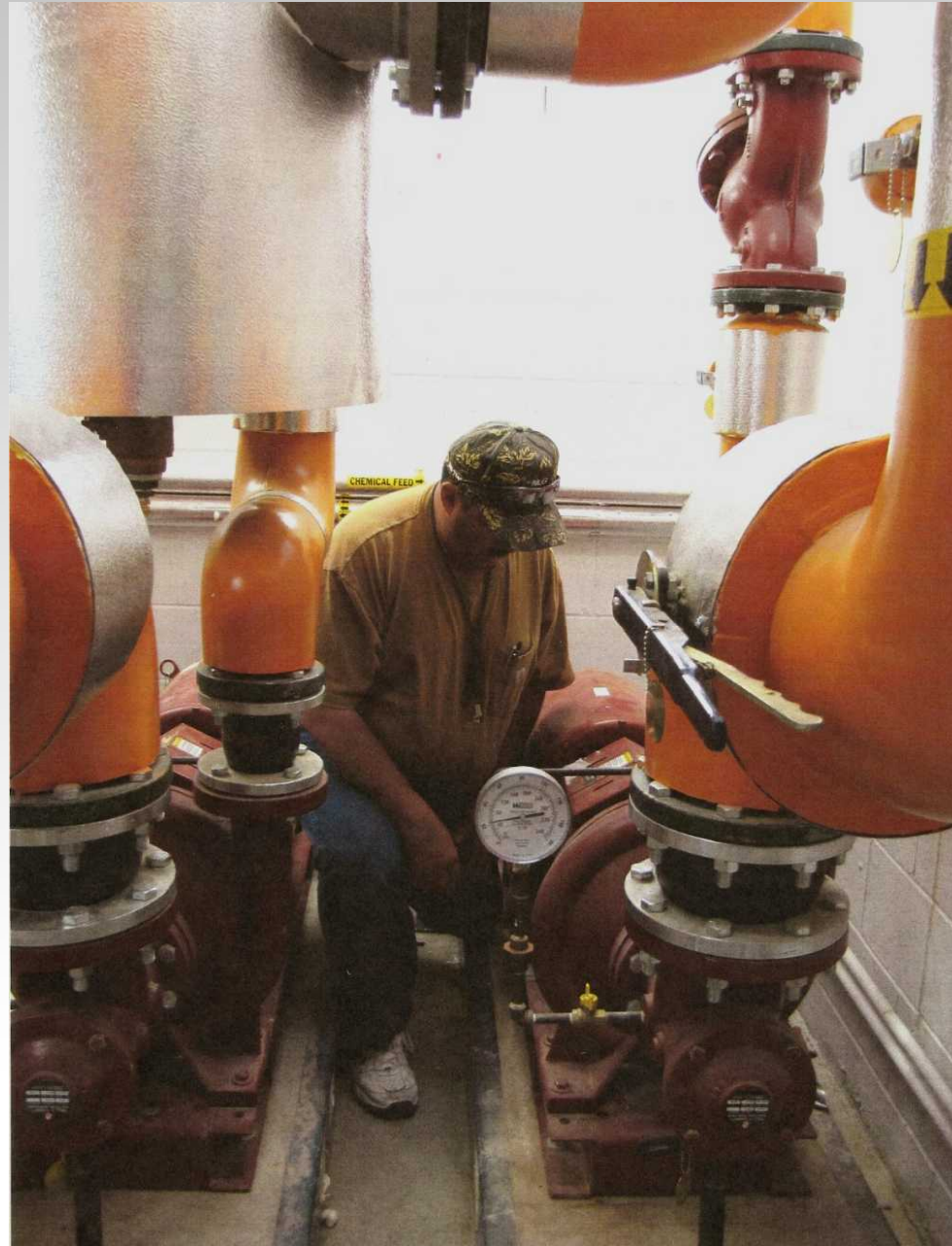


NOT “Maintenance Friendly”



O&M Impact :
2x PM time
4x CM time

..... Over 25 years



Maintenance :

Equipment Check Lists

9.9.11 Pumps Checklist

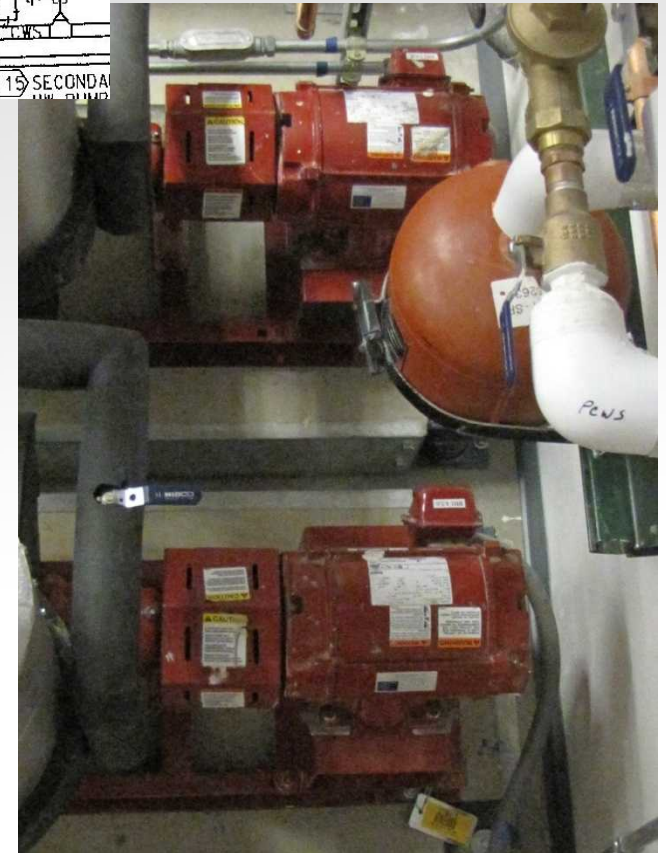
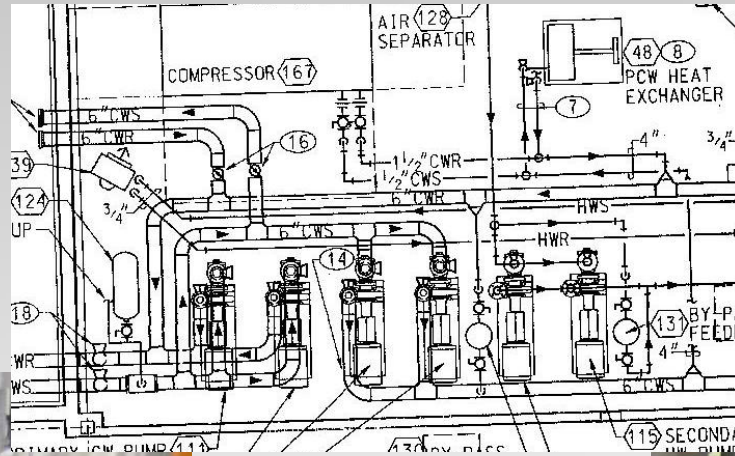
Description	Comments	Maintenance Frequency			
		Daily	Weekly	Monthly	Annually
Pump use/sequencing	Turn off/sequence unnecessary pumps	X			
Overall visual inspection	Complete overall visual inspection to be sure all equipment is operating and safety systems are in place	X			
Check lubrication	Assure that all bearings are lubricated per the manufacture's recommendation			X	
Check packing	Check packing for wear and repack as necessary. Consider replacing packing with mechanical seals.			X	
Motor/pump alignment	Aligning the pump/motor coupling allows for efficient torque transfer to the pump			X	
Check mountings	Check and secure all pump mountings			X	
Check bearings	Inspect bearings and drive belts for wear. Adjust, repair, or replace as necessary.				X
Motor condition	Checking the condition of the motor through temperature or vibration analysis assures long life				X

(FEMP: O&M Best Practice 3.0)

9.10.10 Electric Motors Checklist

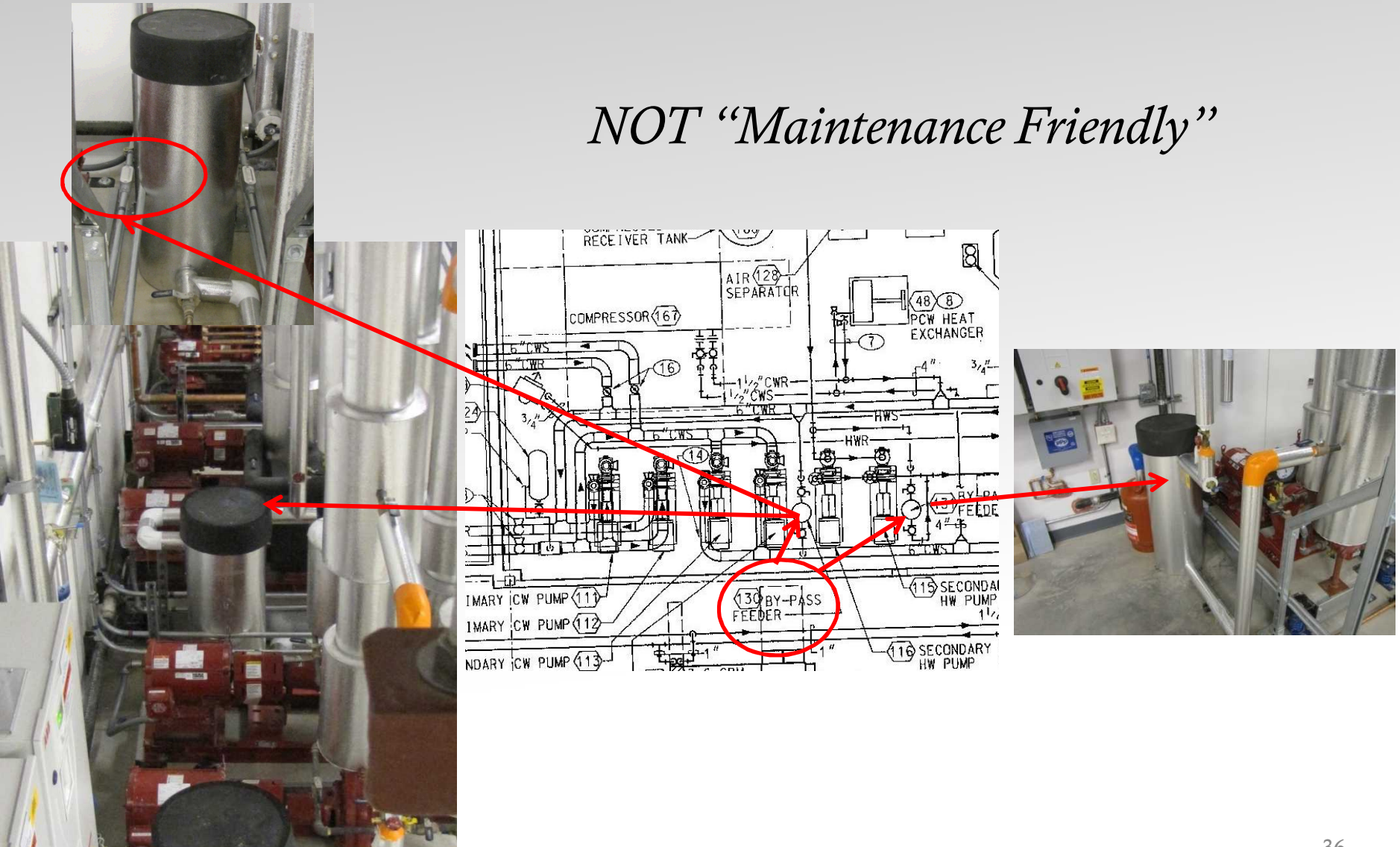
Description	Comments	Maintenance Frequency			
		Daily	Weekly	Monthly	Annually
Motor use/sequencing	Turn off/sequence unnecessary motors	X			
Overall visual inspection	Complete overall visual inspection to be sure all equipment is operating and safety systems are in place	X			
Motor condition	Check the condition of the motor through temperature or vibration analysis and compare to baseline values		X		
Check lubrication	Assure that all bearings are lubricated per the manufacture's recommendation			X	
Check packing	Check packing for wear and repack as necessary. Consider replacing packing with mechanical seals.			X	
Motor alignment	Aligning the motor coupling allows for efficient torque transfer to the pump			X	
Check mountings	Check and secure all motor mountings			X	
Check terminal tightness	Tighten connection terminals as necessary			X	
Cleaning	Remove dust and dirt from motor to facilitate cooling			X	
Check bearings	Inspect bearings and drive belts for wear. Adjust, repair, or replace as necessary.				X
Motor condition	Checking the condition of the motor through temperature or vibration analysis assures long life				X
Check for balanced three-phase power	Unbalanced power can shorten the motor life through excessive heat build up				X
Check for over-voltage or under-voltage conditions	Over- or under-voltage situations can shorten the motor life through excessive heat build up				X

NOT "Maintenance Friendly"



By-Pass Feeders locations....

NOT “Maintenance Friendly”



By-Pass Feeder location....

“Maintenance Friendly”



Steam Traps....

Reporting IBM.

Page 1 of 1

Job Plan Details

1453: Steam Trap Bi-Annual PM

Organization: ORGNMFAC	Priority: 0	Owner:
Site: SNMFAC	Interruptible?: N	Group Owner:
Type: MAINTENANCE	Supervisor:	Labor Group:
Duration: 00:11	Crew:	

Job Plan Tasks

Task ID	Description	Duration	Nested Job Plan	Meter Name	Owner
10	Visually check for leaks**	00:04			
20	Read cautions**	00:01			
30	Leak detection device**	00:02			
40	Ultrasonic and infrared temperature**	00:04			
50	Fill out maintenance report**	00:00			
60	For easy access 20 minutes per steam trap.	00:00			
70	For hard access 45 minutes per steam trap.	00:00			

Labor

Task ID	Craft	Skill Level	Vendor	Contract	Labor	Qty	Hours	Rate
	M-R					1	00:11	46.47

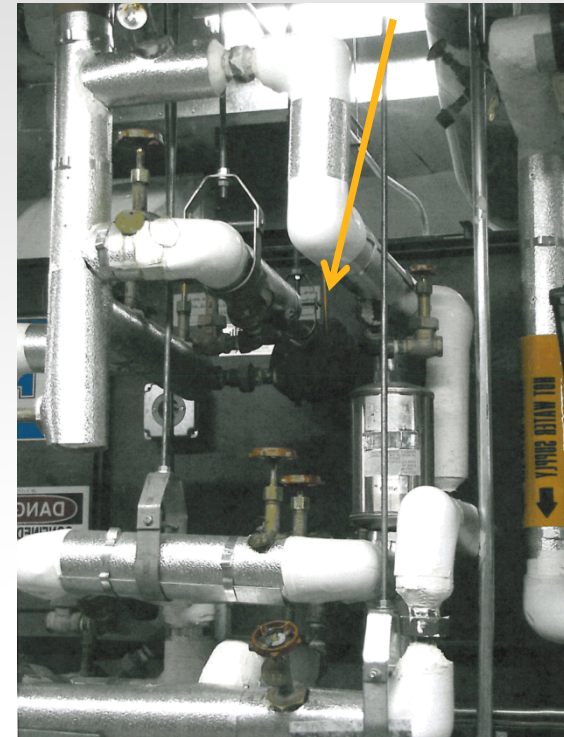
Total Planned Labor: 8.52

October 6, 2010 2:48:40 PM MDT

Steam Traps....

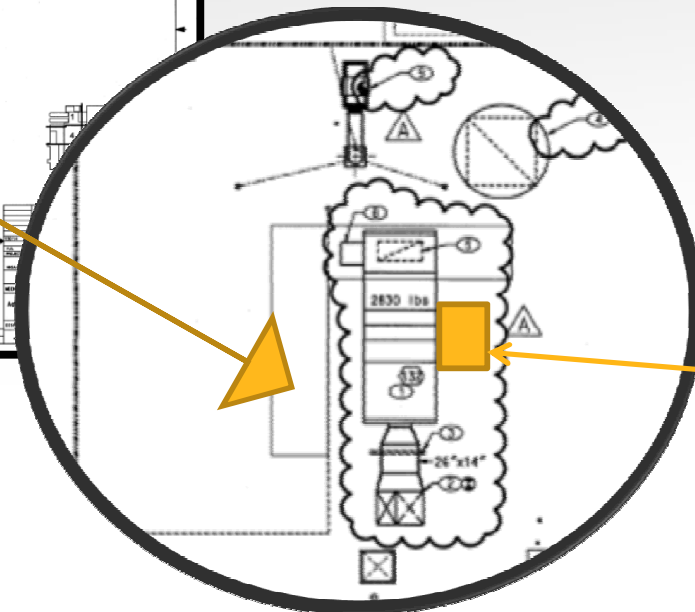
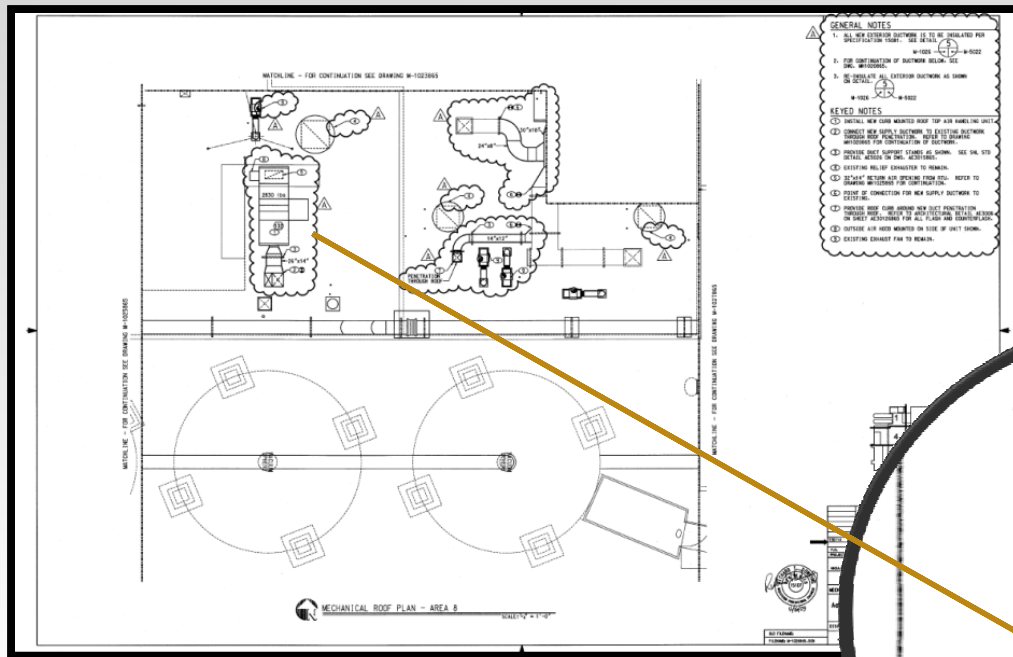


NOT “Maintenance Friendly”



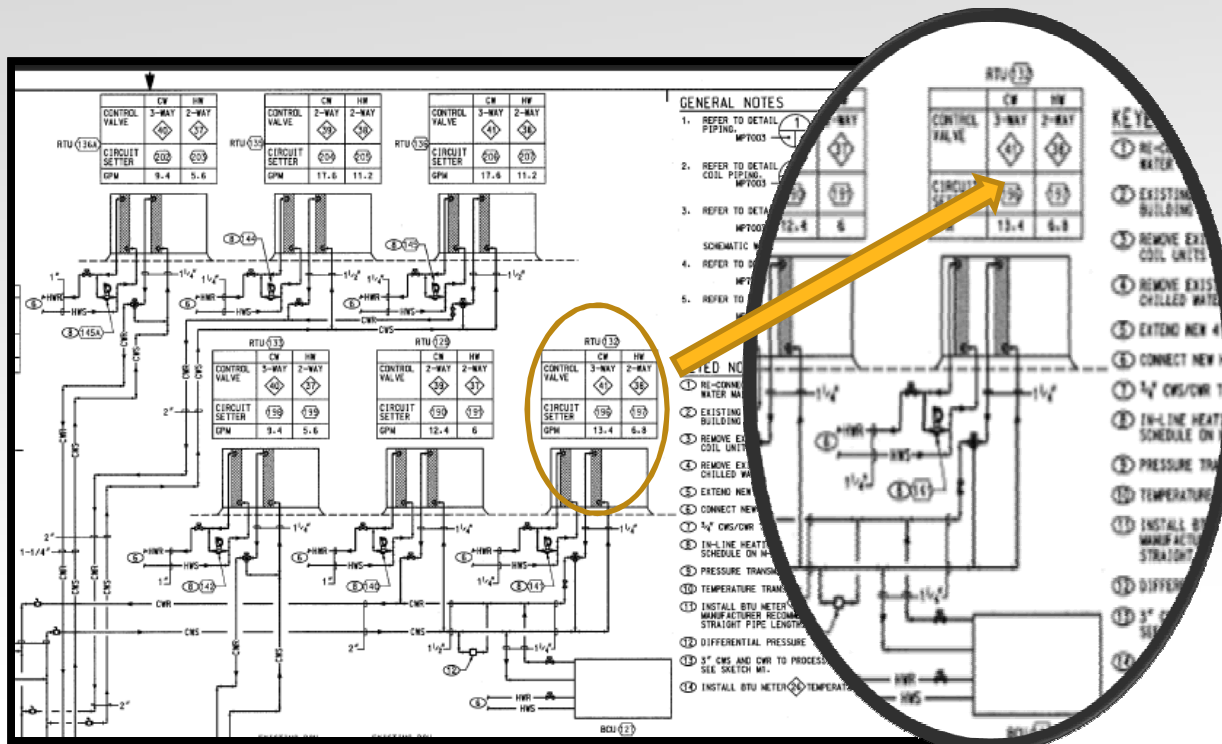
“Maintenance Friendly”

Roof Top Unit (RTU) : piping



External box
for
HW/CW piping

Roof Top Unit (RTU) : piping



External box :

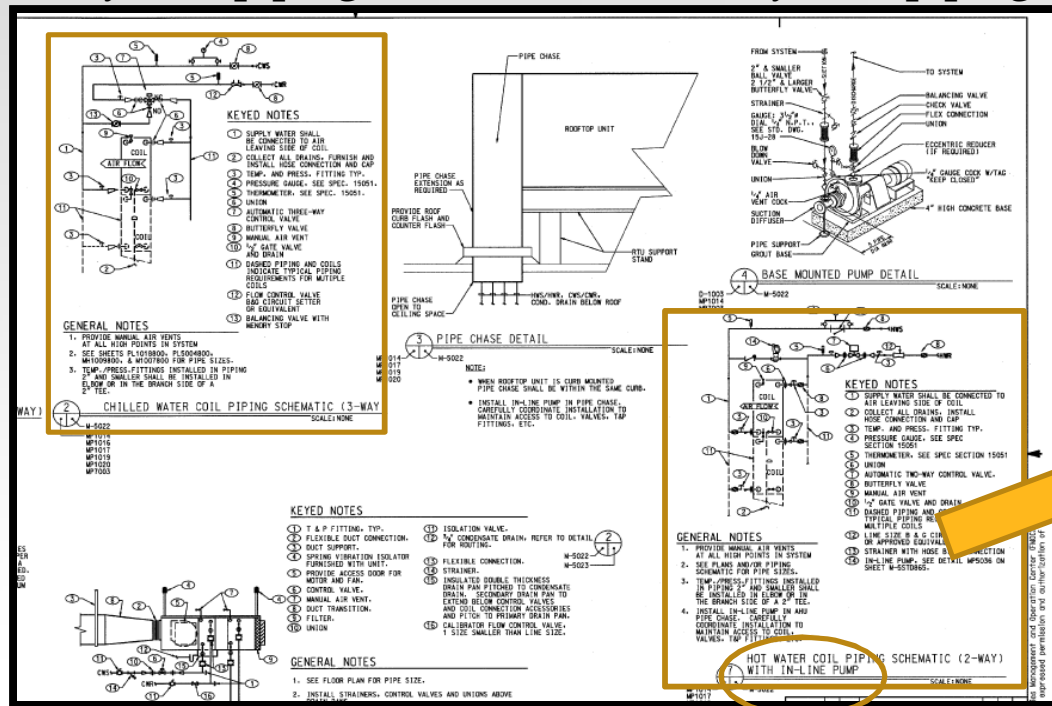
2-way HW piping
3-way CW piping

Roof Top Unit (RTU) : piping

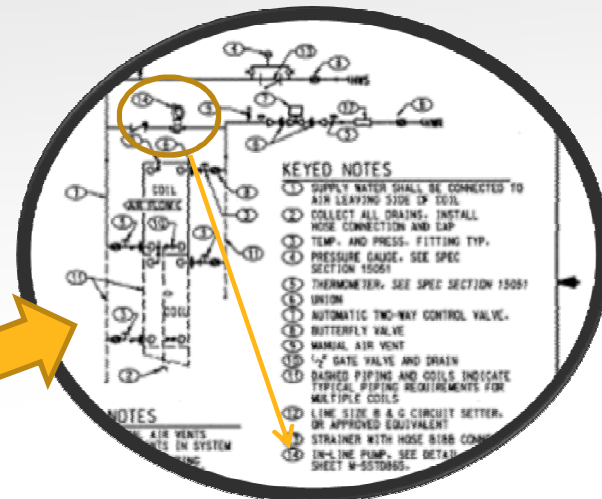
Standard Detail

3-way CW piping

2-way HW piping



pump



Roof Top Unit (RTU) : piping



Pump failed in 2 months :
design issue
or
poor quality ??

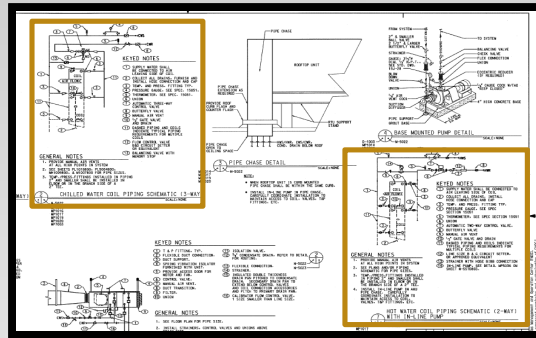


“MEANS & METHODS” ??

RTU piping install

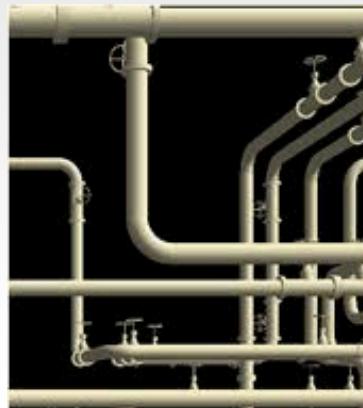
Current 2D

- Design = **0 hrs**
- Install = **48 hrs**
Mech Contractors
 - Field design = 16 hrs
 - Install = **32 hrs**
- O&M = **8 hrs**



If BIM enabled

- Design = **8 hrs**
- Install = **24 hrs**
Mech Contractor
 - Field design = 0 hrs
 - Prefab = **8 hrs**
 - Install = **16 hrs**
- O&M = **4 hrs**



**8 Hrs of BIM design could
reduced Install and O&M by 50%**

Latest example... Relief Fan

Dec 1, 2010 **Forward email from a Facilities Senior Manager**

From: Q J
Sent: Wednesday, December 01, 2010 05:03 PM
To: Foster, Birgitta T
Subject: FW: Building Relief Fan Access

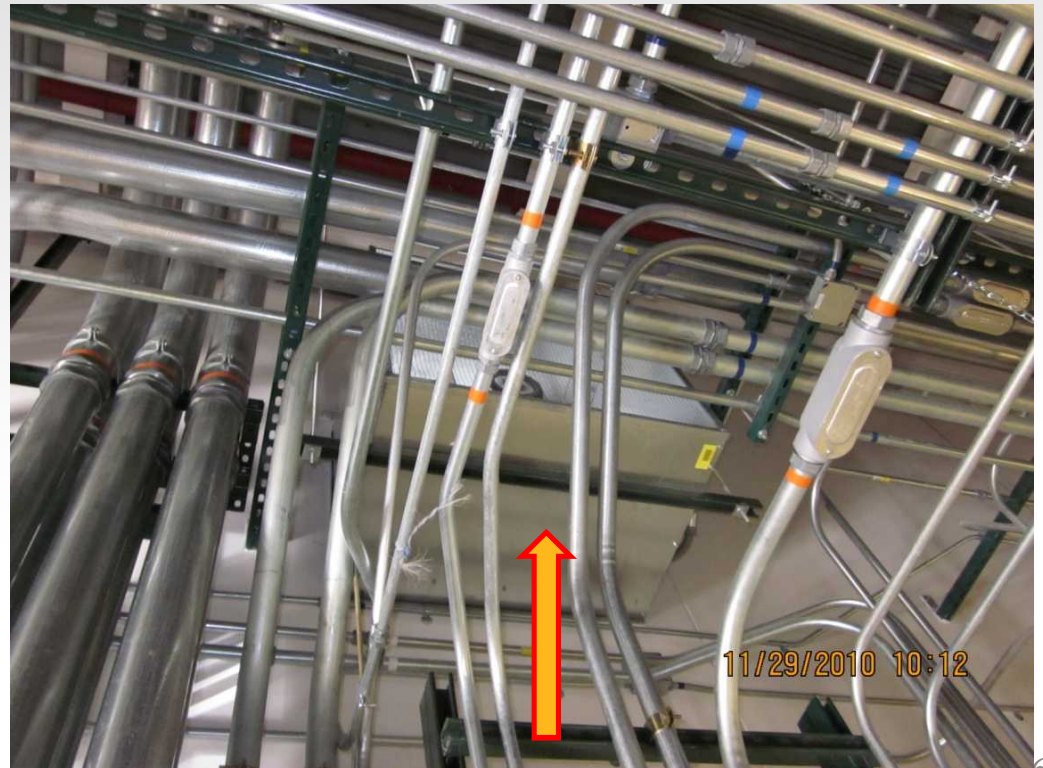
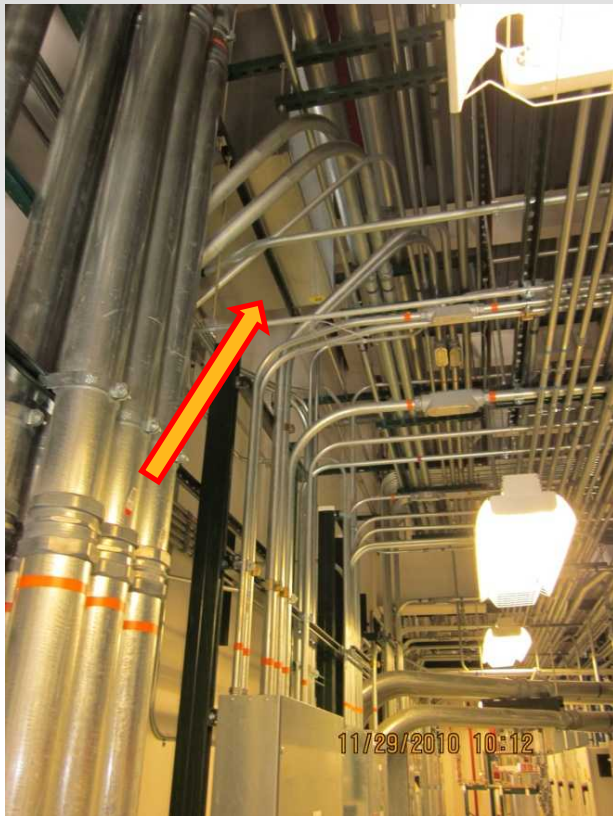
BIM anyone?

from Service Manager team

“Unless a team member can find an innovative access solution I will be **initiating an end of any maintenance activities for Relief Fan, EF1,.....I could not find a means of improving access to this fan..** thanks for bringing this to our attention the safety concerns that are associated with gaining access to this piece of equipment”

Latest example...Relief Fan

“I have put in service request ...to find a solution to meeting the relief needs of the building, perhaps another exhaust fan can be used....Please **discontinue any Preventative Maintenance to this exhaust fan.**”



Four Maintenance Strategies

Reactive Maintenance (Breakdown or Run-to-Failure Maintenance)

Basic philosophy

- Allow machinery to run to failure.
- Repair or replace damaged equipment

Cost: \$18/hp/yr

This maintenance philosophy allows damaged equipment only when obvious in fashion are about \$18 per horsepower. Equipment shutdowns do not affect production.

Preventive Maintenance (Time-Based Maintenance)

Basic philosophy

- Schedule maintenance activities at predetermined time intervals
- Repair or replace damaged equipment

Cost: \$13/hp/yr

This philosophy entails the replacement of damaged equipment is repaired. It has shown the costs of operation approach are that it works well with enough knowledge, skills, and

Predictive Maintenance (Condition-Based Maintenance)

Basic philosophy

- Schedule maintenance activities when mechanical or operational conditions warrant.
- Repair or replace damaged equipment before obvious problems occur.

Cost: \$9/hp/yr

This philosophy consists of scheduling maintenance conditions warrant by periodically monitoring lubrication degradation, or by observing equipment to a predetermined unacceptable level. Components so as to prevent a more costly failure. Studies have shown that when it is done correctly, advantages of this approach are and time to perform the predictive maintenance in an orderly fashion. It also provides some of the need for a high parts inventory. Since it is likely to be an increase in production capacity.

Reliability Centered Maintenance (Pro-Active or Prevention Maintenance)

Basic philosophy

- Utilizes predictive/preventive maintenance techniques with root cause failure analysis to detect and pinpoint the precise problems, combined with advanced installation and repair techniques, including potential equipment redesign or modification to avoid or eliminate problems from occurring.

Cost: \$6/hp/yr

This philosophy utilizes all of the previously discussed predictive/preventive maintenance techniques, in concert with root cause failure analysis. This not only detects and pinpoints precise problems that occur, but ensures that advanced installation and repair techniques are performed, including potential equipment redesign or modification, thus helping to avoid problems or keep them from occurring. According to studies, when it is done correctly, operating in this fashion costs about \$6 per hp per year. One advantage to this approach is that it works extremely well if personnel have the knowledge, skills, and time to perform all of the required activities. As with the predictive-based program, equipment repairs can be scheduled in an orderly fashion, but additional improvement efforts also can be undertaken to reduce or eliminate potential problems from repeatedly occurring. Furthermore, it allows lead-time to purchase materials for necessary repairs, thus reducing the need for a high parts inventory. Since maintenance work is performed only when it is needed, and extra efforts are put forth to thoroughly investigate the cause of the failure and determine ways to improve machinery reliability, there can be a substantial increase in production capacity.

“Design For Maintenance” Strategy

SELECT.....

your Maintenance Strategy

Table 5.5.1. Reliability centered maintenance element applications

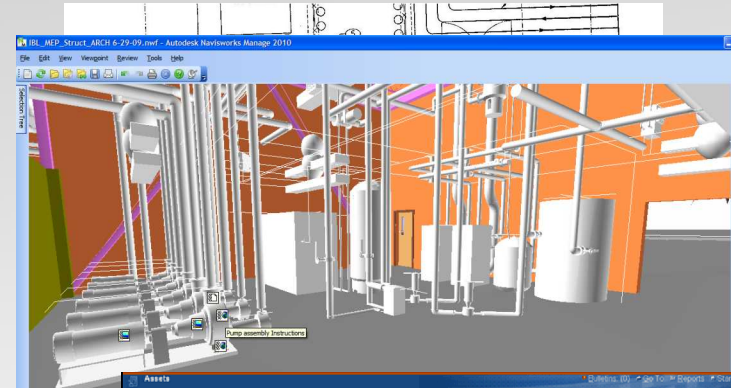
Reliability Centered Maintenance Hierarchy		
<i>Reactive</i> Element Applications	<i>Preventive</i> Element Applications	<i>Predictive</i> Element Applications
Small parts and equipment	Equipment subject to wear	Equipment with random failure patterns
Non-critical equipment	Consumable equipment	Critical equipment
Equipment unlikely to fail	Equipment with known failure patterns	Equipment not subject to wear
Redundant systems	Manufacturer recommendations	Systems which failure may be induced by incorrect preventive maintenance

THEN.....

Share with your Design Teams !

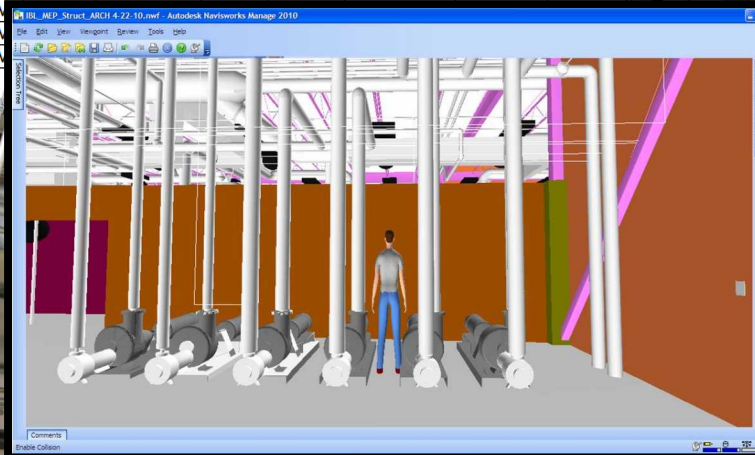
OWNERS...Tying it all together

- Visual : 3D Models
- Data collection



Assets		Find		Select Action		Start Center		Sign Out		IBM	
Line	Asset	Location	Serial #	Manufacturer	Model #	Category	Room	Floor	Condition	Warranty	Expiration
100567	PUMP	Replace	880	26	BSMT	NE	Goulds				
100570	MOTOR	Replace	880	26	BSMT	NE	Baldor				
101845	CHILLER	Remove	880	26	BSMT	NE					
101846	CHILLER	Replace	880	26	BSMT	NE					
	BOILER	New	880	26	BSMT	NE					

Details		Purchase Information		Costs		Modified	
Asset #	Serial #	Manufacturer	Model #	Vendor	Manufacturer	Total Cost	Warranty
100567	261102	Goulds	261102	VERMAN	VERMAN, ARMY INDUSTRIES	75.17	30000.00
100570	261102	Baldor	261102	VERMAN	VERMAN, ARMY INDUSTRIES	0.00	30000.00
101845	261102		261102	VERMAN	VERMAN, ARMY INDUSTRIES	0.00	30000.00
101846	261102		261102	VERMAN	VERMAN, ARMY INDUSTRIES	0.00	30000.00
	261102		261102	VERMAN	VERMAN, ARMY INDUSTRIES	0.00	30000.00





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