



# Building Operator Certification – Level I



*A Partnership of the  
NYC Department of Education  
Division of School Facilities,  
International Union of Operating  
Engineers, and the  
City University of New York*



Class 4

# Planned Maintenance

## Objectives

- Understand the goals of Planned Maintenance and various maintenance approaches
- Review basic skills and steps for a maintenance planning process
- Improve your ability to plan maintenance within the context of the school management process

# Agenda

- Discussion of Maintenance at your School
- Maintenance Approaches
- Maintenance Planning
- Exercise: Planning & Documenting PM
- Maintenance Documentation
- Exercise: Improving Projects
- Class Reading Assignments

# Discussion of Maintenance

What types of logs do you have at your school?





# Goals of Planned Maintenance

## Why do we maintain equipment?

### Outcomes from equipment maintenance

#### Reliability

- Reduce breakdowns, nuisance trips
- Avoid unanticipated outages, emergencies

#### Extended Life

- To reduce the cost of equipment failures
- To reduce capital equipment replacement budgets

#### Benefits for the occupants of building

- Increase reliability and comfort of the space
- Better quality of indoor environment

# Goals of Planned Maintenance

## Why do we maintain equipment?

### Costs and Risks from failure of equipment

- Loss of building occupancy
- Possible Hazards
  - IAQ problems (ventilation lost, no heat)
  - health and safety (lighting, alarm systems)
  - loss of data and records
- Overtime costs of unplanned emergency repairs or costs of equipment replacement

**Cost of planned maintenance is lower than the cost of the effects of a failure + repair of the failure.**

# Goals of Planned Maintenance

## When is a piece of equipment likely to fail?

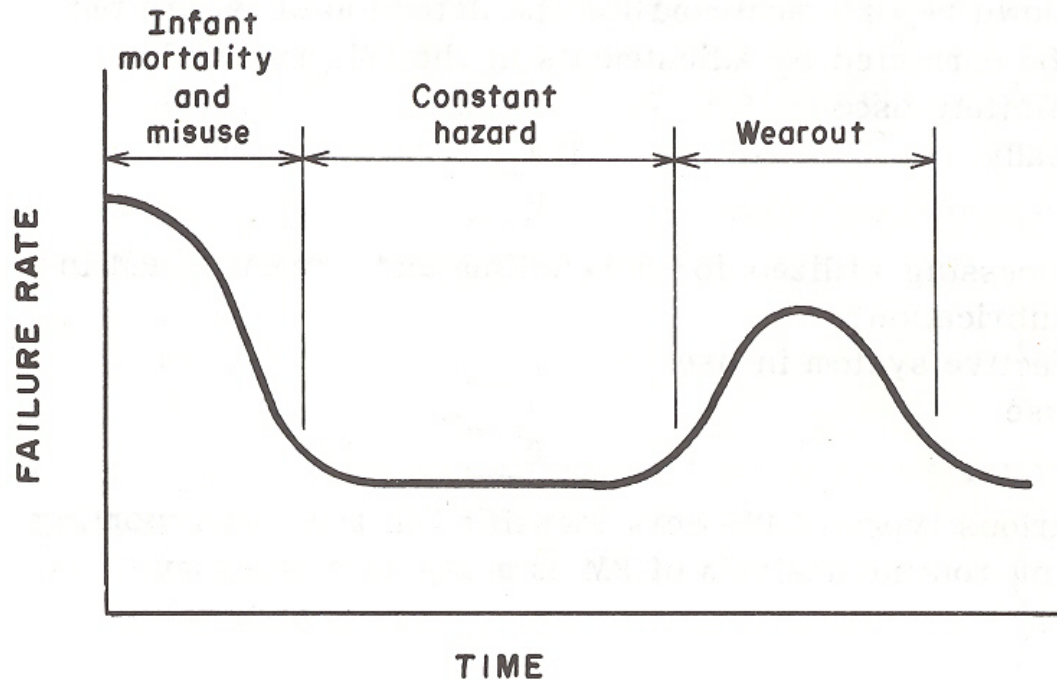


FIGURE 8-1 Mortality curve based on Robert Lusser's con



# Goals of Planned Maintenance

## Why do we maintain equipment?

### Discussion Exercise

- In pairs, share the two most common kinds of equipment failure that you have experienced
- When Debriefing with the whole group, each pair to contribute at least one unique kind of equipment failure to the list

# Maintenance Approaches

- Reactive, run-to-failure, break-down
- Corrective
- Planned
  - Preventive - Scheduled / Run-time
  - Predictive - Condition-based

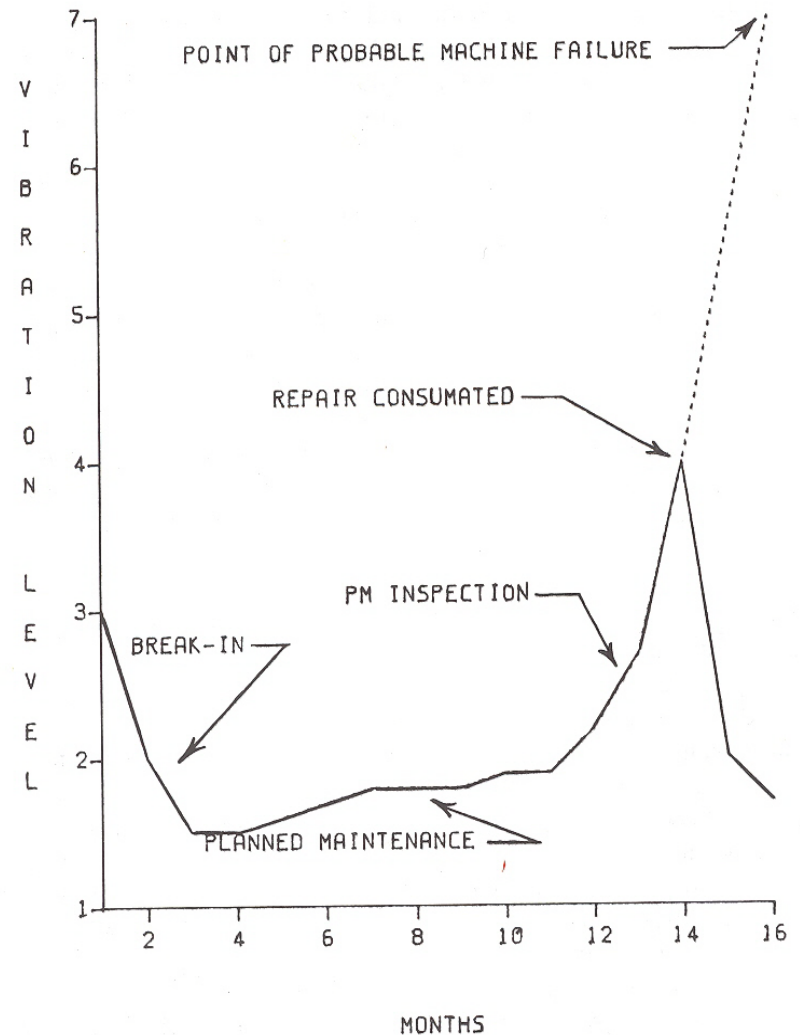
*When are each of the above appropriate?*

*Be familiar with definitions, use texts - IAQS, FEMP*

# Maintenance Approaches

## Corrective Maintenance

- Correct the small problems before they become big problems
- Repairs are made to equipment after a minor failure of equipment.
- Unscheduled maintenance
- Repair Work Orders are written to identify the corrective work to perform.



# Maintenance Approaches

## Preventive Maintenance

### Periodic, scheduled servicing of equipment

- Time periods based on calendar time OR on run-time

#### Advantages

- Simple to plan
- Routine work orders generated
- Little or no instrumentation

#### Disadvantages

- All equipment treated equally
- High manpower requirements

# Maintenance Approaches

## Predictive – Conditions are Measured

*How do you measure the condition of equipment?*

- Infra-red thermograph
- Vibration analysis
- Lube Oil Analysis
  
- BOILER STACK THERMOMETER
- CONDENSATE RETURN TEMPERATURE

# Maintenance Approaches

## Group Discussion

- What approaches and techniques are in use in your facility?
- What has worked well?
- Why?
  
- What have you tried that encountered barriers?

# Break

## Announcement

### New Book – IAQ Solutions ( IUOE )

If you have not received this book, because you were not here last week, get your book today ( record this is in the remarks section of the attendance log ).

## Section 2

- Maintenance Planning
- Exercise: Planning & Documenting PM



# Discussion of Maintenance

**What are the types of maintenance that you are doing at your school?**



# Establishing a Preventive Maintenance Program

See IAQS text. Ch 10 and CD, including sample Forms

## PM Survey Form -

- Inventory of all equipment in the facility
- Survey is done to build a Master Equipment List
- Create a record for each piece of equipment, with:
  - Tag No.
  - Location
  - Model No.
  - Serial No.
  - Maintenance requirement

### Facility PM Survey Form

Form Number:	Date of Survey:	Name:	
Date of Equipment Purchase:	Purchase Price:		
Equipment Name:	System:		
Location:	Floor:	Zone:	
Installing Contractor's Information:			
Address:			
Phone:	Fax:		
Manufacturer Name and Address:			
Phone:	Fax:		
Model Number:	Serial Number:		
Frame:	Type:	Duty Rating:	HP:
Full Load Amps:	Run Amps:	Voltage:	Phase:
Hertz (cycles):	RPM:	Max Ambient Temp.:	Service Factor:
Location of Disconnect:	Panel Fed From and Location:		
Type of Fuses:	Number of Fuses:	Overload Protection:	
Belt Size:	Number of Belts:	Belt Tension:	
Sheave Type and Size:	ID:	OD:	Shaft Size:
Bearing Size:	Bearing Type:	Number of Bearings:	
Greaseable Bearing:	Nongreaseable Bearing:	Condition:	
Other Lubrication:			
Filter Type(s):			
Filter Size:	Number of Filter:	Filter Reading:	



# Establishing a Preventive Maintenance Program

See IAQS text. Ch 10 and CD, including sample Forms

## The PM Chart

- Determine maintenance requirements and frequencies, for each piece of equipment
- Bring all requirements together onto a single chart
  - Show weekly, monthly, annual actions

### PM Chart

(PM Tasks to be Performed)

Annual: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Biannual: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Bimonthly: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Monthly: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Biweekly: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Weekly: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_



# Preventive Maintenance Program

## PM Work Orders

- To assign the maintenance tasks to the staff
- Includes: task to be done, tools required, parts required, estimated time to perform the task
- Develop a system for generating and assigning Work Orders at appropriate times
  - Manual System - Maintenance Log
  - Computerized Maintenance Mgt System (CMMS)
- Have a system for tracking all Work Orders issued

# Work Order Summary

## PM Work Order – contains

- Specific PM tasks to be performed
- Tools and supplies needed for the task
- Regularly scheduled interval for the PM  
(Weekly, Monthly, Quarterly, Annually)

## PM Work Order is Completed – then it goes ...

- One copy goes to Equipment History Record
- One copy goes to Chief Engineer ( CE )

# Preventive Maintenance Program

## Equipment History Record

A system of files and records with the history of work performed for all equipment and the reference information

- Equipment History File
- Master Equipment List
- Operating Manuals & Manufacturer Data

# Establishing a Preventive Maintenance Program

How do you set up a Preventive Maintenance Program?

# ***Corrective Work Orders = Repair Work Orders***

## **What they are:**

- Break-down work
- Complaint response
- Corrective work (repairs)

## **How they are used: [ IAQ Solutions Book ]**

- Requested by anyone in the facility
- Processed by the facility management
- Walk through inspection by facility manager
- Any type of equipment: water fountain to walls, to structural problems or foundation



# Establishing a Preventive Maintenance Program

## Labor Needs Analysis

- Determine the person-hours required for each maintenance task
- Determine the frequency of each task

$$\textit{Hours/task} \times \textit{Frequency/year} = \textit{Hours / year}$$

- Determine the person-hours required for all in-house maintenance tasks

# Maintenance Planning Process

## PM Labor Needs Analysis

Equipment to be PM'd	PM Hours / Unit / Year	Number of Units	Hours Required / Year
Boilers	150	3	450
Exhaust Fans	24	10	240
Unit Ventilators	12	50	600
Fire & Life Safety	64	1	64
Daily Inspections	500	1	500
Supervise contracted services	120	1	120
Total Hours / Year			

*(Hours shown above are examples only)*

# Maintenance Planning Process

## PM Labor Needs Analysis

### Calculating Labor Needs

PM Hours / Unit / Year = **time per action x frequency**, from reference tables

$$1 \text{ FTE} - 35 \times 52 = 1,820 \text{ hours/yr}$$

**Note:** Allow time for unscheduled maintenance, for example complaint response

# Maintenance Planning Process

## PM Labor Needs Analysis

**What do you do when PM Labor Needs exceeds available manpower?**

- Prioritize equipment and actions (Reliability-centered maintenance planning)
  - Focus resources on most critical equipment
  - Some equipment is “run-to-failure”
- Determine specialist services required from outside contractors
  - What are some examples?

# Break

## Project Folders

- these stay in the classroom, please do not take them with you.

# Section 3

- Maintenance Documentation
- Exercise: Improving Projects

# Discussion of Maintenance

What kind of maintenance record system do you have for the equipment at your school?

# Maintenance Planning Process

## Building & Systems Documentation

- Logs and service / repair histories
- Building Plans & System Prints
- Manuals
  - Manufacturer's information
  - Facility operating plan / requirements
  - **Control Sequences of Operations**
  - Reports: Testing & Balancing, Commissioning, etc.
  - Maintenance specifics



# Exercise – Review Projects

## Activity

- Work in groups share your projects with others
- Discuss observations and areas for improvement
- Debriefed as a whole group at end of activity

## Time

- 20 minutes for whole exercise

# Class Reading Assignments

**SBCIC pages 45 – 66**

see Schools Resources Bibliography for weblink, or

[www.smartstructuresdist.com/highperformance.pdf](http://www.smartstructuresdist.com/highperformance.pdf)

Pages 45-66 (Building Blocks #6 to # 16)

***Reminder:*** Hand in your project next week

***See Next Slide !***



# Routine for Class 5 – Class and Exam

- Hour 1 – Class with some new material
- Hour 2 – Review Session for Exam
- Hour 3 – Exam is multiple choice – 25 Q

**Routine** – We move the desks into longer columns during the break, right before the exam. We slide the desks into columns.