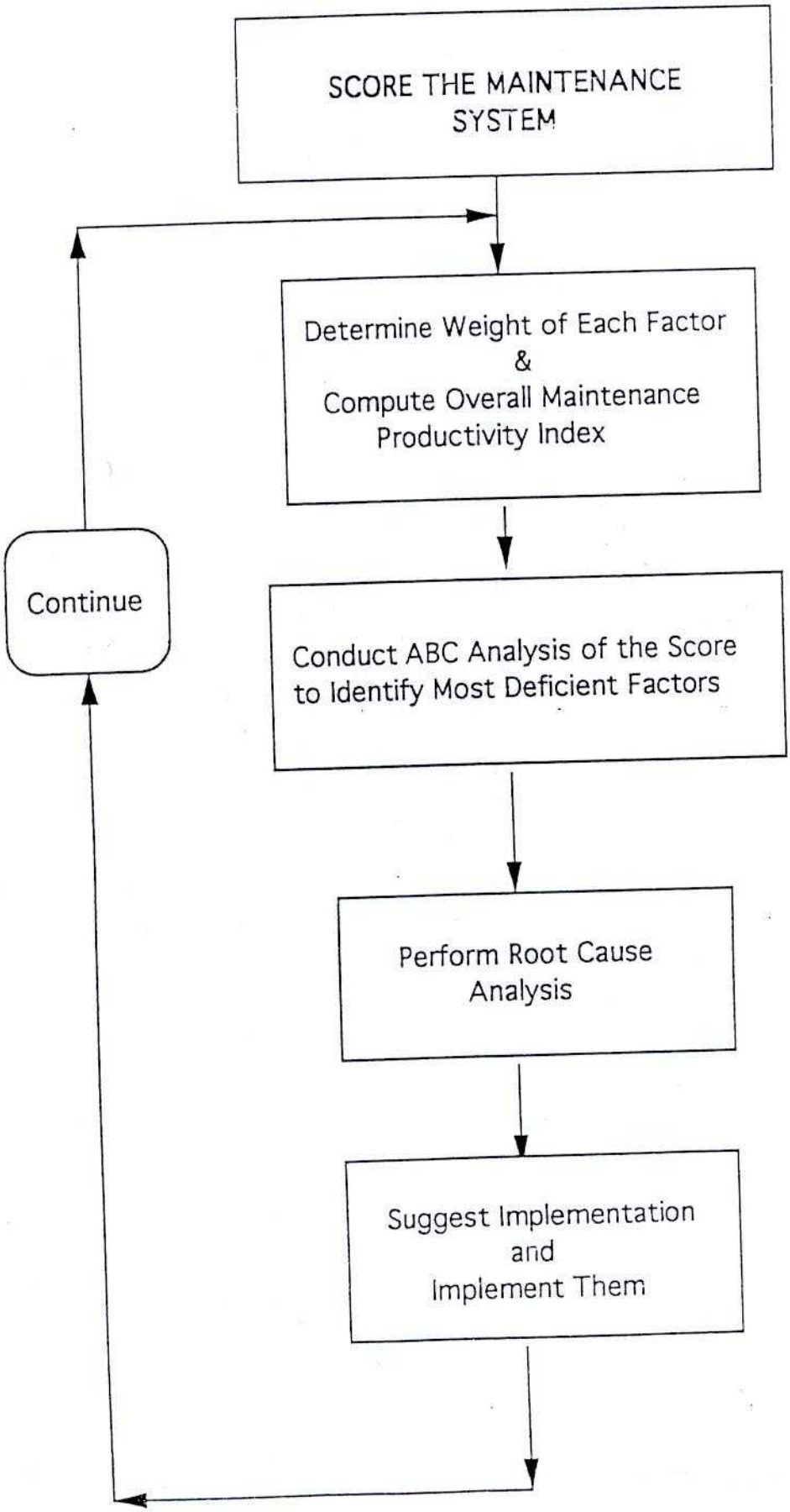
CONTINUOUS IMPROVEMENT OF MAINTENANCE SYSTEMS



8. Facilities

9. Material and Tool Control

10. Preventive Maintenance and Equipment History

11. Engineering and Condition Monitoring

12. Work Measurement and Incentive

13. Labour Productivity

14. Information System

How to Score the Maintenance System

- Form a Team

- Answer Each Question to the best of your knowledge

- Based on the Answer, give a Grade

- For each Factor, get the Average Grade

- Determine Weight of each Factor

- Multiply Score of each Factor by the Weight of each Factor (S_iW_i).

1. Organization and Staffing

- Mission and Objective
- Effective Organization Structure
- Effective Span of Control
- Proper Job Description

2. Manpower Training

- Yearly Training Program
- Types of Training Program
- Productivity Training

3. Planner Training

- Does a planner job exist. Is there any special training for him ?

4. Craft Training

- Formal Training to the Craft
- Who Performs the Training
- Skill Requirements

5. Motivation

- Work Climate
- Stability of Work Force
- Moral of Work Force

6. Management Control and Budget

- What Type of Data Collected for Control
- What Type of Reports are Preapred
- Frequency
- Follow-up and Review

7. Work Order Planning & Scheduling

- Work Order is the Heart of the System
- Percentage of Work Planned
- Scheduling Techniques
- Review of Planning Function

8. Facilities

- Proper Layout of Maintenance Shops
- Tools Availability
- Safety Equipment and Safety
- Space for Offices Supervisors
- Job Working Conditions, such as, Light, etc.

9. Material and Tool Control

- Store Catalog
- Material Control Policies
- Standard List of Tools
- Material Orders Delivered on Time

10. Planned Maintenance and Equipment History

- History Records
- How Much you Review of the History
- Planned Maintenance Program
- Reports on Maintenance

11. Engineering & Condition Monitoring

- Reliability Engineering
- Do you use MTBF and MTTR
- Diagnostic Routines

12. Work Measurements and Incentive

- Do you have Standard Time
- What Method used for Determining them.
- What Type of Incentive Program you have ?

13. Labour Productivity

- Productivity = Standard Time / Actual Time
- Utilization = Time Spent Doing Work / Total Time
- What Type of Reports you have ?

14. Information System

- Requirements
- Use

How Good is Maintenance

1. Organization and staffing
2. Training
3. Planner training
4. Craft training
5. Motivation
6. Management controls of budget and costs
7. Work order planning and scheduling
8. Facilities
9. Materials and tool control
10. Preventive maintenance and equipment history
11. Engineering and condition maintenance
12. Work measurement incentive
13. Labor productivity
14. Information system

Audit Evaluation Criteria

Listed below are the fourteen evaluation criteria, each accompanied by a list of questions. Answer the questions *after careful review and discussion*

1 Organization and staffing

1. Objective:
   - (a) Clearly defined [10]
   - (b) Vague [4]
   - (c) Not defined [0]
2. Organization chart:
   - (a) Current and complete [10]
   - (b) Not reviewed periodically [6]
   - (c) Not correct or incomplete [4]
   - (d) Does not exist [0]
3. Job description: Does each supervisor have his and his crew's?
   - (a) All [10]
   - (b) Over 90% [9]
   - (c) 80-89% [8]
   - (d) 70-79% [7]
   - (e) 50-69% [6]
   - (f) Less than 50% [0]
4. What is the worker to supervisor ratio?
   - (a) 12-15:1 [10]
   - (b) 8-11:1 [8]
   - (c) 16-20:1 [8]
   - (d) less than 8:1 or over 20:1 [5]

5. What support functions do you have? Maintenance Engineering, Planning Engineering, Planner, Material Coordinator, Training Coordinator, Stores.

(a) All 6	10
(b) 4 or 5, no Planner	6
(c) 1-3	4
(d) 0	0

6. Do you use a written manpower control policy and management goals weekly?

(a) Yes	10
(b) have, but not used weekly	5
(c) don't have or don't use	0

2 Manpower Training

1. Do you have a master training plan covering higher management, supervision, support and craft?

(a) All	10
(b) three	7
(c) two	5
(d) one	2
(e) none	0

2. Productivity training is included for:

(a) All	10
(b) three	7
(c) two	7
(d) one	5
(e) none	0

3. Is the training

(a) formal plus on-the-job?	10
(b) on-the-job only?	5
(c) None	0

3 Planner training

1. Do you have a Planner/Estimator function?

(a) Yes	10
(b) No	0

2. Is there a formal training plan for planners?

(a) Formal training	10
(b) on-the-job	5
(c) no training plan	0

3. Does the plan include: work order, planning methods, scheduling, productivity, methods improvement, material planning, project planning, field checking, maintenance standards, maintenance practices, multi-craft planning, application of time standards, computer use communications?

(a) All	10
(b) 75%	7
(c) 50%	5
(d) 25%	2
(e) None	0

4 Craft training planning

1. Is there a formal craft training plan?

(a) Yes	10
(b) on-the-job	5
(c) None	0

2. Is training done by:

(a) staff	10
(b) staff plus line management	5
(c) other hourly	0

3. What percent of crafts are included?

(a) All [10]
(b) 75% [7]
(c) 50% [5]
(d) 25% [2]
(e) None [0]

4. Are there minimum job skill requirements for each job?

(a) All [10]
(b) 75% [7]
(c) 50% [5]
(d) 25% [2]
(e) None [0]

5 Motivation

1. Is the overall management labor climate

(a) positive [10]
(b) neutral [7]
(c) negative [0]

2. Randomly select ten examples of substandard job performance. What percent are ""rate" problems as opposed to "skill" problems?

(a) 100% [10]
(b) 80-99% [2]
(c) 60-79% [4]
(d) 40-59% [6]
(e) 20-39% [8]
(f) 0-19% [10]

3. Have you conducted a climate survey recently?

(a) Yes [10]
(b) more than two years ago [5]
(c) never [0]

4. What is your annual turnover due to quits and discharge for Saudi's?

(a) less than 2% [10]
(b) 3-5% [7]
(c) 6-10% [5]
(d) more than 10% [0]

5. What is your annual turnover due to quits and discharge for non-Saudi's?

(a) less than 2% [10]
(b) 3-5% [7]
(c) 6-10% [5]
(d) more than 10% [0]

6. What percent of productive hours are lost due to late starts and early quits?

(a) less than 2% [10]
(b) 3-5% [7]
(c) 6-10% [5]
(d) more than 10% [0]

6 Management controls of budget and costs

1. Do you use shop floor, work measurement, budgets, and actual historical costs to control your program?

(a) All three [10]
(b) budgets and costs [5]
(c) costs only [3]
(d) none [0]

2. Which control indices and trends are used: percent downtime, performances, cost per standard hour, productivity, backlog, level of service, overtime?

(a) All [10]
(b) 6 [7]
(c) 4 or 5 [5]
(d) 2 to 3 [2]
(e) less than 2 [0]

3. what is the time lag between end of period and receipt of control report?

(a) A day or less [10]
(b) 2-4 days [5]
(c) more than 5 days [0]

4. How often are reports prepared?

(a) Weekly [10]
(b) Monthly [5]
(c) less frequently [0]

5. How is time and work reported?

(a) by individual and job [10]
(b) by day [5]
(c) by week [3]
(d) by month [1]
(e) none [0]

6. How are reports distributed?

(a) to foremen plus summaries to higher management [10]
(b) to foremen only [5]
(c) not distributed to line organization or not prepared [0]

7 Work order planning and scheduling

1. What percent of man-hours worked is covered by a written work order?

(a) Over 90% [10]
(b) 80-89% [8]
(c) 70-79% [7]
(d) 50-69% [5]
(e) Less than 50% [0]

2 What percent of work orders have enough lead time for planning (2 to 4 weeks)?

(a) More than 90% [10]
(b) 80-89% [8]
(c) 70-79% [7]
(d) 69% or less [5]
(e) none [0]

3. What percent of work orders have all of the following items pre-planned: crew size, work content by craft, materials, special tools and equipment, multicraft sequencing, engineered and job time standards, job site access, scheduled date?

(a) More than 90% [10]
(b) 80-89% [8]
(c) 70-79% [7]
(d) 69% or less [5]
(e) none [0]

4. Is all overhaul work pre-planned and scheduled?

(a) all [10]
(b) major jobs only [5]
(c) none [0]

5. Does foreman check quality and completeness of:

(a) every job [10]
(b) most jobs [7]
(c) half [5]
(d) less than half [0]

8 Facilities

1. Do you have a current plant floor plan?
   - (a) Updated within the last year [10]
   - (b) two to four years old [6]
   - (c) older or none [0]

2. Are maintenance shop locations and layouts:
   - (a) ideal [10]
   - (b) good [8]
   - (c) fair [7]
   - (d) poor [0]

3. Is housekeeping
   - (a) superior [10]
   - (b) excellent [9]
   - (c) good [8]
   - (d) fair [7]
   - (e) poor [0]

4. Are safety equipments and signs always used?
   - (a) In all areas [10]
   - (b) most [7]
   - (c) some [2]
   - (d) none [0]

5. Are equipment and tools effectively located:
   - (a) better than average [10]
   - (b) average [7]
   - (c) below average [5]

6. Are equipment and tools available for the crafts and workload:
   - (a) better than average [10]
   - (b) average [7]
   - (c) below average [5]

7. Does office space for supervisor and staff average:
   - (a) more than 75 square feet per person? [10]
   - (b) about 75 square feet per person? [7]
   - (c) less than 75 square feet per person? [5]
   - (d) none? [0]

8. Is illumination for the task performed
   - (a) better than average [10]
   - (b) average [7]
   - (c) below average [5]
   - (d) poor [2]

9. Are the following services scheduled for maintenance at proper intervals annually: Electric, air, water, gas, steam, sewer and refuse removal?
   - (a) All [10]
   - (b) 75% [7]
   - (c) 50% [5]
   - (d) 25% [2]
   - (e) none [0]

10. What percent of custodial employees are covered by daily routes and engineering standards?
    - (a) Over 95% [10]
    - (b) 89-90% [9]
    - (c) 65-85% [7]
    - (d) 0-65% [4]
    - (e) None [0]

11. Are all cranes, hoists and lifting equipment covered by a preventive maintenance (PM) plan?

(a) All [10]
(b) 75% [7]
(c) 50% [5]
(d) 25% [2]
(e) None [0]

9 Materials and tool control

1. Do you have an up-to-date stores catalog?

(a) All items except pre-expended [10]
(b) major items [7]
(c) some items [4]
(d) none [0]

2. Do you have a perpetual inventory system for major items and spares?

(a) All [10]
(b) 75% [7]
(c) 50% [5]
(d) 25% [2]
(e) None [0]

3. Do you have a reordering system for high volume, low cost pre-expended items?

(a) All [10]
(b) 75% [7]
(c) 50% [5]
(d) 25% [2]
(e) None [0]

4. Are all except pre-expended items withdrawals controlled by use of a withdrawal procedure?

(a) All [10]
(b) 75% [7]
(c) 50% [5]
(d) 25% [2]
(e) None [0]

5. Is there tool control procedure in use for all company tools?

(a) All [10]
(b) 75% [7]
(c) 50% [5]
(d) 25% [2]
(e) None [0]

6. Are there standard lists of tools provided to individuals by the company and provided by the individual?

(a) Yes [10]
(b) company only [5]
(c) individual only [5]
(d) neither [0]

7. How many tools are out of service for repair?

(a) none [10]
(b) 10% [8]
(c) 20% [7]
(d) more [0]

8. Are economic order quantities calculated?

(a) all items [10]
(b) most [7]
(c) some [5]
(d) none [0]

9. Are minimum/maximum levels set and maintained?

(a) all [10]
(b) most [7]
(c) some [5]
(d) none [0]

10. Does purchasing maintain a vendor rating system for suppliers?

(a) all [10]
(b) most [7]
(c) some [5]
(d) none [0]

11. What percent of material orders are delivered on time?

(a) 100% [10]
(b) 90% [9]
(c) 80-89% [8]
(d) 70-79% [7]
(e) 60-69% [6]
(f) 59

10 Planned maintenance and equipment history

1. What percent of your major equipment has a record of repair history?

(a) All [10]
(b) 75% [7]
(c) 50% [5]
(d) 25% [2]
(e) None [0]

2. How many history records are reviewed at least once a year?

(a) All [10]
(b) 75% [7]
(c) 50% [5]
(d) 25% [2]
(e) None [0]

3. What percent of your major equipment is covered by planned maintenance (PM) routines?

(a) All [10]
(b) 75% [7]
(c) 50% [5]
(d) 25% [2]
(e) None [0]

4. What equipment is covered by all of the following reports: downtime trends, PM compliance with schedule, written PM instructions, total PM man-hours, high repair item man-hours?

(a) All [10]
(b) 75% [7]
(c) 50% [5]
(d) 25% [2]
(e) None [0]

5. How frequently are the reports prepared?

(a) weekly [10]
(b) monthly [7]
(c) less frequently [4]
(d) none [0]

11 Engineering and condition maintenance

1. Reliability engineering is used to control downtime on what percent of your major equipment?

(a) 100% [10]
(b) 75% [7]
(c) 50% [5]
(d) 25% [2]
(e) None [0]

2. What percent of equipment histories are analyzed to statistically determine current mean time between failures (MTBF) and mean time to repair (MTTR)?

(a) 100% [10]
(b) 75% [7]
(c) 50% [5]
(d) 25% [2]
(e) None [0]

3. What percent of major repair and construction projects have an engineer assigned?

(a) 100% [10]
(b) 75% [7]
(c) 50% [5]
(d) 25% [2]
(e) None [0]

4. On what percent of your major equipment diagnostic routines (Vibration analysis, heat sensing, erosion, corrosion, electrical, gauging) are used on a regular, scheduled basis?

(a) 95% [10]
(b) over 60 to 80% [7]
(c) over 40 to 60% [5]
(d) up to 40% [2]
(e) none [0]

12 Work measurement incentives

1. How are time maintenance standards set?

(a) Predetermined time, time study and standard data [10]
(b) direct measurement and time study [6]
(c) work sampling [5]
(d) estimates [4]
(e) none [0]

2. What application system is used?

(a) Slotting and work content compression [10]
(b) direct measurement [5]
(c) none [0]

3. What percent of actual hours worked is covered by standards?

(a) more than 85% [10]
(b) 70-84% [7]
(c) less than 70% [4]
(d) none [0]

4. Are job times on the work order for the foreman and craftsman to see?

(a) yes [10]
(b) given to the foreman only [5]
(c) neither [0]

5. What percent of maintenance workers are paid by a wage incentive plan tied to output?

(a) over 95% [10]
(b) over 80-95% [9]
(c) over 60-80% [7]
(d) over 40-60% [5]
(e) less than 40% [0]

6. What type of incentive plan are you using?

(a) salary adjustment [10]
(b) pay raise [7]
(c) bonus [5]
(d) none [0]

13 Labor productivity

1. Standard man-hours / Actual man-hours (to be obtained from company records

   (a) ≥ 0.8 [10]
   (b) ≥ 0.75 [7]
   (c) ≥ 0.5 [5]
   (d) ≤ 0.5 [0]

2. Do you have daily work time card for all workers?

   (a) more than 85% [10]
   (b) 70-84% [7]
   (c) less than 70% [5]
   (d) none [0]

3. Productivity reports are prepared:

   (a) by individual [10]
   (b) by area [6]
   (c) for the whole maintenance department [3]
   (d) none [0]

14 Information system

1. Does your maintenance system include any computer support?

   (a) yes [10]
   (b) no [0]

2. Which information categories are available in your information system: payroll, time reporting, work order, job planning, daily scheduling for routine work, long range scheduling for projects, management control reports, down-time, equipment history, planned maintenance, stores and material control, statistical analysis, cost justification?

   (a) All [10]
   (b) 75% [7]
   (c) 50% [5]
   (d) 25% [2]
   (e) None [0]

3. Is your computer system:

   (a) on line [10]
   (b) batch [5]
   (c) none [0]

4. Does the system match capabilities with individual responsibility?

   (a) always [10]
   (b) most of the time [7]
   (c) sometimes [5]
   (d) no [0]

5. Are reports timely?

   (a) weekly or more frequently [10]
   (b) monthly [5]
   (c) less often [0]

6. Is the information complete and reliable?

   (a) always [10]
   (b) most of the time [7]
   (c) sometimes [5]
   (d) no [0]

7. How good is your security system at controlling who has access and to what level?

   (a) Excellent [10]
   (b) Adequate [7]
   (c) inadequate [3]
   (d) none [0]

Audit of Maintenance Program

Form # 1

Factor	Score
1. Organization & Staffing	3.00
2. Training	0.00
3. Planner Training	0.00
4. Craft Training	2.50
5. Motivation	6.33
6. Management controls of budget & costs	0.00
7. Work order planning & scheduling	2.00
8. Facilities	4.73
9. Materials & tool control	3.45
10. Planned maintenance & eqpt history	6.80
11. Engineering & Condition Monitoring	3.00
12. Work measurements incentive	0.00
13. Labor Productivity	0.00
14. Information system	0.00

Audit of Maintenance Program

Form # 2

Factor	Overall rank	Weight
1. Organization & Staffing	Critical	0.5
2. Training	Major	0.3
3. Planner Training	Critical	0.5
4. Craft Training	Major	0.3
5. Motivation	Important	0.2
6. Management controls of budget & costs	Critical	0.5
7. Work order planning & scheduling	Major	0.3
8. Facilities	Important	0.2
9. Materials & tool control	Major	0.3
10. Planned maintenance & eqpt history	Critical	0.5
11. Engineering & Condition Monitoring	Critical	0.5
12. Work measurements incentive	Major	0.3
13. Labor Productivity	Critical	0.5
14. Information system	Critical	0.5

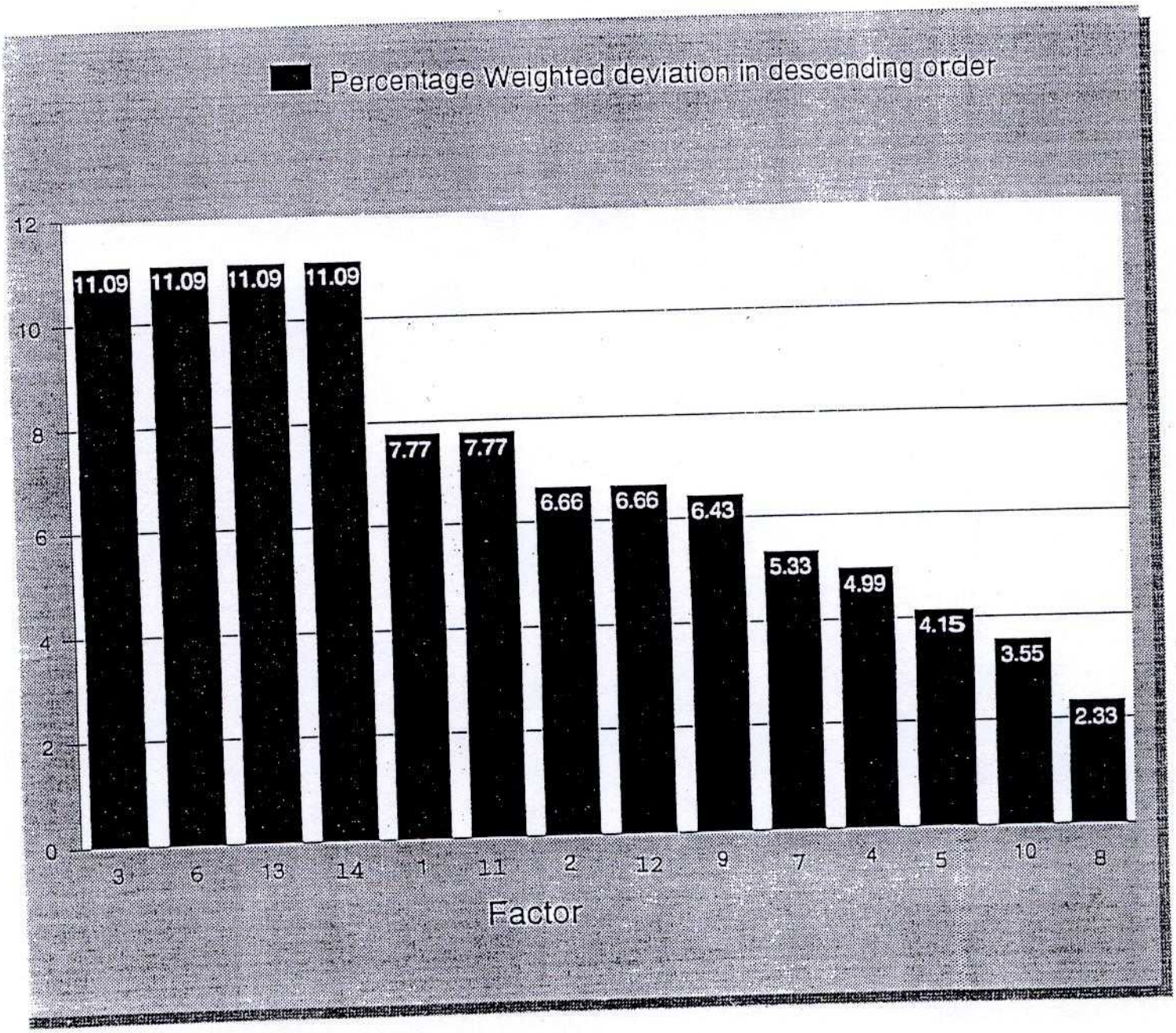
Audit of Maintenance Program

Form # 3

or	Score S_i	Weight W_i	Weighted score $W_i S_i$	Ideal score I_i	Weighted ideal score $W_i I_i$
rganization & Staffing	3.00	0.50	1.50	10.00	5.00
raining	0.00	0.30	0.00	10.00	3.00
lanner Training	0.00	0.50	0.00	10.00	5.00
raft Training	2.50	0.30	0.75	10.00	3.00
lotivation	6.33	0.20	0.13	10.00	2.00
lanagement controls of budget & costs	0.00	0.50	0.00	10.00	5.00
ork order planning & scheduling	2.00	0.30	0.60	10.00	3.00
acilities	4.73	0.20	0.95	10.00	2.00
laterials & tool control	3.45	0.30	0.10	10.00	3.00
Planned maintenance & eqpt history	6.80	0.50	3.40	10.00	5.00
Engineering & Condition Monitoring	3.00	0.50	1.50	10.00	5.00
Work measurements incentive	0.00	0.30	0.00	10.00	3.00
Labor Productivity	0.00	0.50	0.00	10.00	5.00
Information system	0.00	0.50	0.00	10.00	5.00

Form # 4

Factor	Weight deviation $w_i I_i - w_i S_i$	Percent weighted deviation $\frac{(w_i I_i - w_i S_i)}{\sum_{i=1}^{14}(w_i I_i - w_i S_i)} \times 100$
1. Organization & Staffing	3.50	7.77
2. Training	3.00	6.66
3. Planner Training	5.00	11.09
4. Craft Training	2.25	4.99
5. Motivation	1.87	4.15
6. Management controls of budget & costs	5.00	11.09
7. Work order planning & scheduling	2.40	5.33
8. Facilities	1.05	2.33
9. Materials & tool control	2.90	6.43
10. Planned maintenance & eqpt history	1.60	3.55
11. Engineering & Condition Monitoring	3.50	7.77
12. Work measurements incentive	3.00	6.66
13. Labor Productivity	5.00	11.09
14. Information system	5.00	11.09


Percentage Weighted deviation in descending order
12
10
8
6
4
2
0
11.09
11.09
11.09
11.09
7.77
7.77
6.66
6.66
6.43
5.33
4.99
4.15
3.55
2.33
3
6
13
14
1
11
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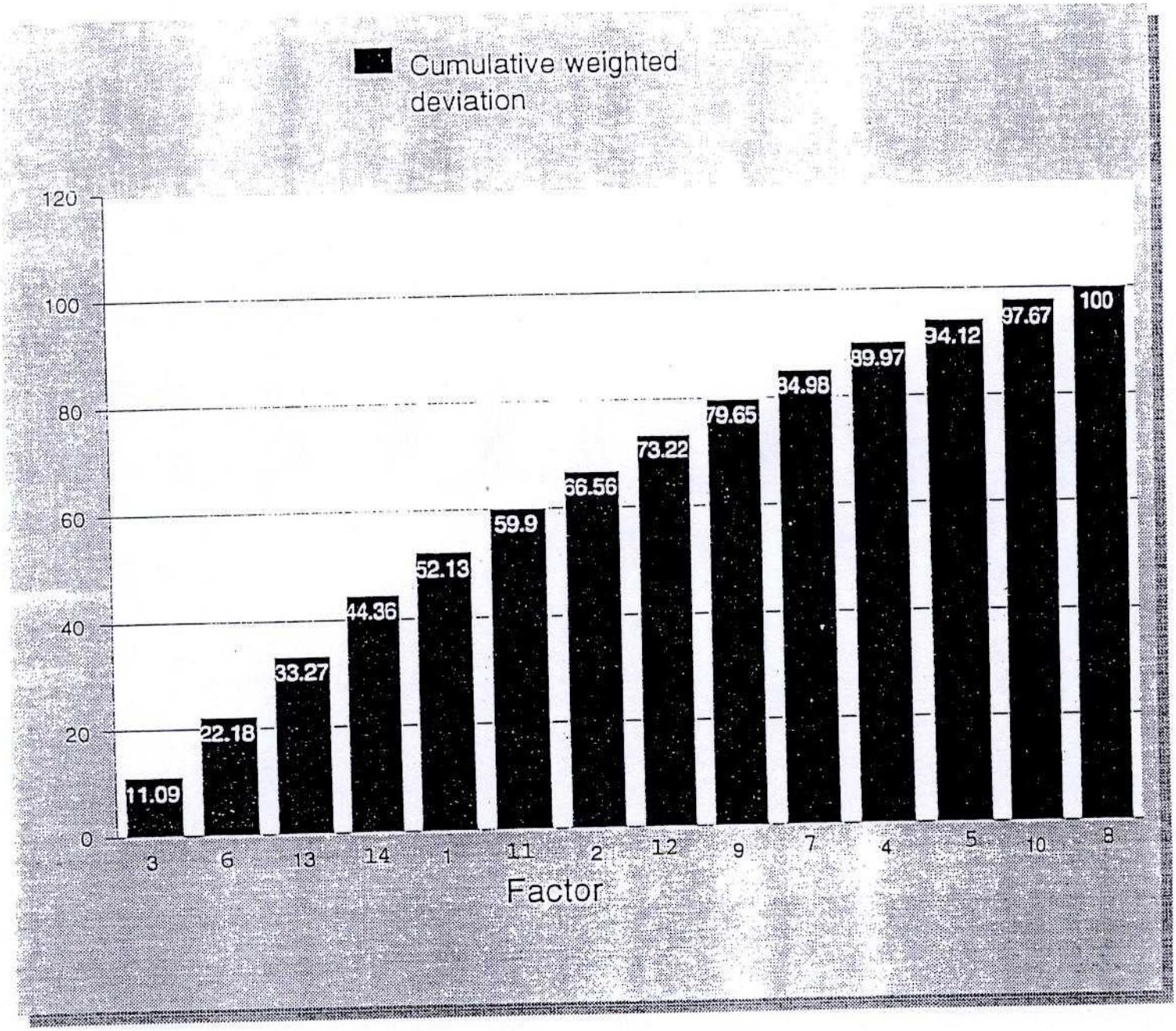
8
Factor


Cumulative weighted deviation
120
100
80
60
40
20
0
11.09
22.18
33.27
44.36
52.13
59.9
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73.22
79.65
84.98
89.97
94.12
97.67
100
3
6
13
14
1
11
2
12
9
7
4
5
10
8
Factor

1. Organization and Staffing

In case organization and staffing is found deficient, possible corrective actions are :

a. Establish suitable supervisor-worker ratio

b. Establish suitable planner worker ratio

c. Develop specific job description

d. Develop best mix between centralized and area maintenance

e. Establish good support functions

f. Use written labor control policy

2. Manpower Training

In case management training is categorized in class A or B, a training program for management must be launched and must be updated yearly. The program must include productivity, project management, and supervisory skill training.

3. Planner Training

The possible corrective actions for planner training if categorized in class A or B are :

a. Planner should be the most experienced person

b. Planner must coordinate with all maintenance areas

c. Planner must utilize modern planning and scheduling techniques

d. Planner must be trained in new analytical methods in planning and scheduling.

4. Craft Training

The possible corrective actions craft training are :

a. Establish a yearly training program for all crafts

b. Establish craft certification program

5. Motivation

If motivation is categorized in class A or B, possible corrective actions are :

a. Make worker feel part of company

b. Establish excellent reward policy

c. Reduce annual turn-over and review the turn-over causes bi-yearly

d. Conduct informal survey to see craft moral.

6. Management and Budget Control

If case management and budget control is found to be in class A or B, possible corrective actions are :

a. Establish guidelines for budget estimation

b. Analyze utilization using percent down-time

c. Establish a monthly maintenance report

d. Establish group inspection programs.

Audit of Maintenance Program

Form # 5

Factor	Percent weighted deviation in descending order
1. Planner Training	11.09
2. Management controls of budget & costs	11.09
3. Labor Productivity	11.09
4. Information system	11.09
5. Organization & Staffing	7.77
6. Engineering & Condition Monitoring	7.77
7. Training	6.66
8. Work measurements incentive	6.66
9. Materials & tool control	6.43
10. Work order planning & scheduling	5.33
11. Craft Training	4.99
12. Motivation	4.15
13. Planned maintenance & eqpt history	3.55
14. Facilities	2.33

7. Work Order Planning & Scheduling

a. Design a simple work order

b. Coordinate with other Departments in the Plant

c. Computerize the work order system

d. Develop job standards

e. Develop standard jobs

f. Improve scheduling methods by using possible mathematical programming techniques

8. Facilities

If facilities is found to be in class A or B, possible corrective actions are :

a. Reorganize the location of maintenance facilities

b. Enhance the practice of safety

c. Establish preventive maintenance for major equipments

d. Establish a program for tool custody

e. Establish equipment availability reports.

9. Stores, Material & Tool Control

If case stores, material, and tool control is categorized as in class A or B, possible corrective actions are :

a. Establish a catalog for spares on hand

b. Establish a list of approved vendors

c. Analyze maintenance delays due to parts

d. Review and update inventory policy regularly

e. Use ABC analysis to establish material requirements and reorder levels

10. Preventive Maintenance and Equipment History

a. Establish a record of repair history of major equipment

b. Cover essential equipment by preventive maintenance

c. Review preventive maintenance frequency

11. Engineering and Condition Monitoring

In case engineering and condition monitoring is categorized in class A or B, possible corrective actions are :

a. Establish diagnostic routine for major equipment

b. Analyze equipment down-time every six months

c. Control down-time of equipment using predictive maintenance

12. Labour Productivity

a. Establish a system for collecting data on actual time spent on the jobs by crafts

b. Relate actual time spent performing a job to its standard time

c. In the maintenance monthly report calculate craft productivity index (C.P.I.) using the following formula :

$$C.P.I. = \frac{\text{Actual Time}}{\text{Job Standard}} * \text{Utilization}$$

utilization is the percentage of the crafts were gainfully working and can be obtained using work sampling.

d. Review backlog by crafts.

13. Work Measurement & Incentives

In case work measurement and incentives is found to be deficient, possible corrective actions are :

a. Establish job standards

b. Review backlog trends and identify reasons for it

c. Balance work load and manpower requirements

d. Review manpower requirements yearly

e. Investigate the possibility of contract maintenance

14. Information System

a. Identify maintenance requirements

b. Establish computer support for various maintenance functions

c. Establish a better system for data collection

d. Develop an information system which meets the requirements in (a) above.

Maintenance Costs

1. Maintenance cost per unit of production.

$$\text{Cost per unit} = \frac{\text{Total maintenance costs}}{\text{Total units produced}}$$

2. Inventory turnover rate per year.

$$\text{Rate} = \frac{\text{Annual consumption costs}}{\text{Average dollar inventory}}$$

3. Ratio of labor costs to material costs of maintenance.

$$\text{Ratio} = \frac{\text{Total maintenance labor costs}}{\text{Total maintenance materials costs}}$$

4. Percent supervision costs of total maintenance costs.

$$\% = \frac{\text{Total costs of supervision}}{\text{Total maintenance costs}} \times 100$$

5. Maintenance costs as percent of total manufacturing cost.

$$\% = \frac{\text{Total maintenance costs}}{\text{Total manufacturing costs)}} \times 100$$

6. Cost of a maintenance hour.

$$\$ = \frac{\text{Total cost of maintenance}}{\text{Total man-hours worked}}$$

7. Progress in cost reduction efforts.

$$\text{Index} = \frac{\%\ \text{Maintenance man-hours spent on scheduled jobs}}{\text{Maintenance cost/Units of production}}$$

8. Labor cost to apply $1.00 worth of materials.

$$\text{Labor cost} = \frac{\text{Labor dollars}}{\text{Materials dollars}}$$

9. Preventive maintenance costs as percent of total breakdown maintenance costs.

$$\% = \frac{\text{Total PM costs (including production losses)}}{\text{Total breakdown costs}}$$

Maintenance effectiveness

1. Emergency man-hours.

$$\% = \frac{\text{Man-hours spent on emergency jobs}}{\text{Total direct maintenance hours worked}} \times 100$$

2. Emergency and all other unscheduled man-hours.

$$\% = \frac{\text{Man-hours of emergency and unscheduled jobs}}{\text{Total maintenance man-hours worked)}} \times 100$$

3. Equipment downtime caused by breakdown.

$$\% = \frac{\text{Downtime caused by breakdown}}{\text{Total downtime}} \times 100$$

4. Evaluation of predictive and preventive maintenance.

$$\% = \frac{\text{Predictive and preventive inspections completed}}{\text{Predictive and preventive inspections scheduled}} \times 100$$

Also

$$\% = \frac{\text{Jobs resulting from inspections}}{\text{Inspections completed}} \times 100$$