# Bibliography


1. ADENDORFF, S.A. & DE WIT, P.W.C. 1997. Production and Operations Management – A South African Perspective. 2nd ed. Goodwood, Western Cape: International Thompson Publishing Southern Africa (Pty) Ltd. 349 p.
2. AHMAD, M & BENSON, R. 2000. Benchmarking in the process industries. Trowbridge: Cromwell Press. 155 p.
3. AUSTRALIAN MARITIME COLLEGE. 2005. Quality and Improvement. [Web] http://www.amc.edu.au/quality/improvement/ [Date of Access: 01 September 2005].
4. CHASE, R.B., JACOBS, F.R. & AQUILANO, N.J. 2004. Operations Management for Competitive Advantage. 10th ed. New York: McGraw Hill / Irwin. 765 p.
5. COETZEE, J.L. 1997. Maintenance. Hatfield RSA: Maintenance Publishers Pty (Ltd). 475p.
6. HELLRIEGEL, D, JACKSON, S.E., SLOCUM Jr., J.W. 2002. Management – A competency – based Approach. 9th ed. Canada: South Western, a division of Thompson Learning. 561p.
7. HUGHES, R.L. 2000 Strategic Maintenance Management [Web:] http://www.reliabilityweb.com/art04/strategic_mm.htm [Date of access: 16 Jul. 2005].
8. JOHNSON, B. 1996. Polarity Management: Identifying and managing unsolvable problems. 2nd ed. Amherst, Mass.: HRD-Press. 267 p.
9. JONES, E.K., DUPONT, E.I., ROSENTHAL, ROHM & HAAS Co. 1997. Assessing Maintenance Performance. [Web] http://www.mt-online.com/current/11-97mm.html [Date of access: 16 Jul. 2005].
10. KATILA, P. 2000. Applying Total Productive Maintenance (TPM) Principles in the Manufacturing system. [Web:] http://epubl.luth.se/1402-1536/2000/23/LTU-TR-0023-SE.pdf [Date of access: 16 Jul. 2005].

11. LEDET W. P. 2004. Measuring and tracking ownership. [Web] http://www.manufacturinggame.com/2004JulyNewsletter.pdf [Date of access: 04 Aug 2005].
12. MIDDLE EAST TECHNICAL UNIVERSITY. 2005. A brief introduction of total productive maintenance. [Web] http://www.me.metu.edu.tr/me407/seminer/tpm2004A_ver3.ppt#319 [Date of access: 20 Jul 2005].
13. MOUBRAY J. 1997. Reliability Centered Maintenance. 2nd ed. Oxford: Butterworth – Heinemann. 423p.
14. PETERS, R.W. 2002. Maximizing Maintenance Operations for Profit Optimization: The Journey to Maintenance Excellence. [Web] http://www.plant-maintenance.com/articles/PathForward.pdf [Date of Access: 25 Aug 2005].
15. PETERSON, B. 2000. Reliability Solutions for Industry with a Human Touch. SAMI Corp. [Web] http://www.samicorp.com/PublicationsPages/Newsletters/Winter%202000.pdf [Date of access: 19 Jul 2005].
16. PRODUCTIVITY FACTORY. 2000. OEE: Overall equipment effectiveness. [Web] http://www.tpfeurope.com/EN_OEEinfo.html [Date of access: 19 Jul 2005].
17. RELIABILITY WEB. 2001. Manufacturing and Business Excellence. [Web:] http://www.reliabilityweb.com/excerpts/excerpts/01Making%20Common%20Sense.pdf [Date of access: 16 Jul. 2005].
18. WILD, R. 1991. Production and Operations Management. 4th ed. Oxford: Alden Press. 792p.

# Appendix A – Maintenance Strategy for a Heavy Engineering Environment

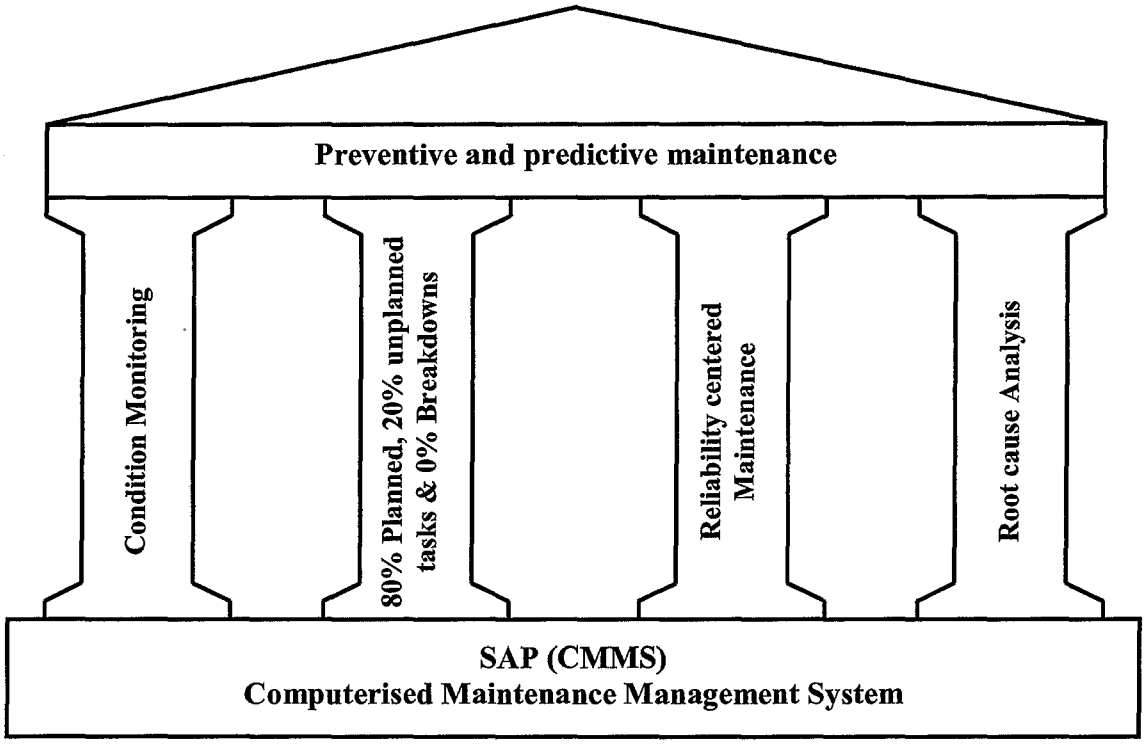
## MAINTENANCE VISION

*Operational Excellence through world class maintenance*

## MAINTENANCE MISSION

*To provide a maintenance function that adds maximum sustainable value through the optimization of asset performance, availability and reliability*

## MAINTENANCE PHILOSOPHY




- **Preventive and predictive maintenance.**
- **Training of production on the first line of maintenance systems & philosophy.**
- **Integrated holistic approach regarding performance of production and maintenance.**
- **Common basic maintenance approach for the Works, along SAP principles and system discipline.**
- **Adhering to basics:**
  - **Minimum tolerance for failure repetitions.**
  - **Minimum patch up jobs or temporary quick-fix repairs.**
- **Continuous Improvement**
  - **Increased condition based maintenance.**
  - **Improving operation stability by the prevention of breakdowns.**
  - **Annual benchmarking**

## *MAINTENANCE OBJECTIVES AND STRATEGY*

### *OBJECTIVES*

- **Move from reactive to preventive and predictive maintenance.**
- **Achieve 80% planned and 20% unplanned maintenance.**
- **Establishment and tracking of fixed maintenance measurements on order to continuously evaluate the quality of maintenance.**
- **Establish a culture of holistic approach within both maintenance & production disciplines on all levels of the organisation (know each other's business).**

### *STRATEGY*

- **80% of all maintenance activities are planned well in advance on the CMMS**
- **20% of maintenance tasks are planned after condition monitoring and inspections.**
- **There is zero or 0% tolerance for failures**
- **Utilising RCM II approach to determine maintenance plans for equipment.**
- **Condition monitoring to ensure that no unmanaged failures occurs.**
  - **Structured inspection system**
  - **Statistical process control**
  - **Vibration measurement**
  - **Tribology**
  - **Thermography**
- **Formally documented root cause analysis of failures.**
- **Enhanced maintenance training on all levels of maintenance personnel.**

## *MANAGEMENT, PROCESS MONITORING AND TRACKING*

| | |
|---|---|
| **Daily** | • **Ensure proper execution of planned maintenance tasks.**<br>• **Updating of system with future plans.**<br>• **Root Cause Analysis on equipment failure and rectify data packs and maintenance plans.** |
| **Weekly** | • **Ensure 80% of work planned 1 week in advance with resource balancing.**<br>• **Follow up on RCA targets.**<br>• **Report on maintenance process performance and disciplines together with equipment performance.** |
| **Monthly** | • **Condition monitoring of Critical on Critical equipment.**<br>• **Plant availability tracking.** |
| **6 Monthly** | • **Full maintenance audit to ensure compliance with stated goals according to fixed measurements set.** |

# Appendix B – Question set for evaluation of Maintenance Performance Elements

## *Maintenance (capability assurance)*

**Question Type A/D: Element: 1 Plant condition monitoring**

**Practice: 1.1 Equipment maintenance plans**

**Question:** How is equipment maintenance plans applied to ensure the capability of equipment is assured according to the user's needs?

---

**Question Type A/D: Element: 1 Plant condition monitoring**

**Practice: 1.2 Careful operations**

**Question:** How is maintenance departments involved in setting up of operational procedures regarding the careful operations of equipment, what is the approach and how is it deployed?

---

**Question Type A/D: Element: 1 Plant condition monitoring**

**Practice: 1.3 Equipment inspections**

**Question:** How is the frequency and scope of work regarding equipment inspections determined?

---

**Question Type A/D: Element: 1 Plant condition monitoring**

**Practice: 1.4 Predictive maintenance**

**Question:** How do you approach predictive maintenance and to what extent is this approach deployed?

---

**Question Type A/D: Element: 1 Plant condition monitoring**

**Practice: 1.5 Preventive maintenance triggers**

**Question:** How are the principles of preventive maintenance used and utilised in order to improve the condition of equipment and reduce losses?

---

**Question Type R: Element: 1 Plant condition monitoring**

**Question:** A) What principles are used to identify the areas of measure for determining the equipment's condition?
B) Is an effective historic database of these results kept?
C) Is this data being used to determine the current condition of the equipment by comparing the actual trend data to the baseline data of the equipment?

**Question Type I: Element: 1 Plant condition monitoring**

**Question:** What systems are in place to ensure that the use of condition monitoring of equipment is improved over time. How is the effective use of condition monitoring measured to ensure reduction of losses?

---

**Question Type A/D: Element: 2 Work origination**

**Practice: 2.1 Information required to originate work**

**Question:** What data is used in order to originate work, how is the quality of this data verified in order to ensure effective work planning and execution?

---

**Question Type A/D: Element: 2 Work origination**

**Practice: 2.2 Work origination methodology**

**Question:** What systems and procedures are in place to identify and automatically generate new work? How and what data is captured for historic reference?

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**Question Type A/D: Element: 2 Work origination**

**Practice: 2.3 Review and feedback**

**Question:** Is the requestor of the work timely informed of the progress and status of the work?

---

**Question Type I: Element: 2 Work origination**

**Question:** Is historically captured data on the CMMS utilised to improve the creation of routine maintenance tasks?

---

**Question Type R: Element: 2 Work origination**

**Question:** A) Is work origination measured in different categories?
B) Are these categories trended and communicated?
C) Is this data effectively used to improve the reduction of losses over the long term?

---

**Question Type A/D: Element: 3 Planning**

**Practice: 3.1 Information required for planning**

**Question:** What systems & structures are in place to determine the need for information required to do effective planning?

**Question Type A/D: Element: 3 Planning**

**Practice: 3.2 Planning methodology**

**Question:** How are new jobs prioritised with respect to planning and resource scheduling?

---

**Question Type A/D: Element: 3 Planning**

**Practice: 3.3 Creating a standard job library**

**Question:** Are standard jobs compiled using a scientific approach based on the OEM specifications. Are these tasks reviewed according to the current state of the equipment's condition?

---

**Question Type R: Element: 3 Planning**

**Question:** A) Is effective planning compared to not performing planning at all in terms of actual and potential losses?
B) Is a database of this information kept and available?
C) Is historical data being used as an input for planning new tasks?

---

**Question Type I: Element: 3 Planning**

**Question:** Are post mortem meetings being held after job execution and compared to the baseline planning in order to serve as future improvement initiatives?

---

**Question Type A/D: Element: 4 Scheduling**

**Practice: 4.1 Scheduling (two weekly, monthly)**

**Question:** How are resources scheduled over the medium term (two weekly and monthly), how does this interact with the planning process?

---

**Question Type A/D: Element: 4 Scheduling**

**Practice: 4.2 Scheduling (daily)**

**Question:** What is the availability of resource for scheduling on the short term (daily)?

---

**Question Type I: Element: 4 Scheduling**

**Question:** How are the systems and procedures regarding scheduling of resources reviewed and improved?

**Question Type R: Element: 4 Scheduling**

**Question:** A) How is scheduling measured?
B) Are all the parties involved in scheduling identified and is scheduling data communicated?
C) Is historical data used to improve the results obtained from scheduling?

---

**Question Type A/D: Element: 5 Work allocation and execution**

**Practice: 5.1 Information for allocation and execution**

**Question:** What information is currently being used for effective work execution?

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**Question Type A/D: Element: 5 Work allocation and execution**

**Practice: 5.2 Methods of allocation and execution**

**Question:** Is the efficiency of work execution measured against the original planning?

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**Question Type A/D: Element: 5 Work allocation and execution**

**Practice: 5.3 Communicating shift handover**

**Question:** What systems are being used to communicate the information required to hand over work from one team to another, how is this information required determined?

---

**Question Type A/D: Element: 5 Work allocation and execution**

**Practice: 5.4 Equipment handover**

**Question:** Is there a system in place to hand over equipment to the user; is a checklist in place to ensure that all the needs of the user are satisfied after work completion? Who are the parties involved in the official handover (maintenance disciplines and customers)?

---

**Question Type R: Element: 5 Work allocation and execution**

**Question:** A) How is the effectiveness of work allocation and execution measured?
B) Is historical data being kept of work execution measures?
C) How is this data being used to explain gaps between baseline planning of work and the actual execution of the work?

---

**Question Type A/D: Element: 6 Work Completion and recording**

**Practice: 6.1 Work completion and history recording methodology**

**Question:** What approach is followed in determining what data must be recorded and captured?

**Question Type A/D: Element: Element: 6 Work Completion and recording**

**Practice: 6.2 Information recorded as history at closure**

**Question:** Is data recorded at completion of work stored in an understandable manner for easy future reference. Are deviations recorded to ensure effective benchmarking for the future?

---

**Question Type I: Element: 6 Work Completion and recording**

**Question:** Is data recorded being used to improve work completion and how is this integrated with planning and scheduling?

---

**Question Type R: Element: 6 Work Completion and recording**

**Question:** A) Is the quality of work completion data being verified?
B) Is this data being used to communicate the current state of effective work completion?
C) Is the data effectively interpreted in order to understand the gaps that exist?

---

**Question Type A/D: Element: 7 Shutdown management**

**Practice: 7.1 Shutdown formulation**

**Question:** What method is being used in order to effectively collect information required for shutdown planning?

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**Question Type A/D: Element: 7 Shutdown management**

**Practice: 7.2 Shutdown planning**

**Question:** What tools are being used in order to plan shutdowns (e.g. Bar charts, resource planning, process pipeline planning)?

---

**Question Type A/D: Element: 7 Shutdown management**

**Practice: 7.3 Shutdown execution**

**Question:** How is shutdown execution managed especially towards scope changes, what criteria is being used to accept scope changes?

---

**Question Type A/D: Element: Element: 7 Shutdown management**

**Practice: 7.4 Start up and commissioning**

**Question:** How is commissioning managed especially from the customer and safety point of view?

**Question Type A/D: Element: 7 Shutdown management**

**Practice: 7.5 Post shutdown review**

**Question:** Is post mortem meetings being held and are all deviations (from planed time and planed scope) of the original plan recorded with reasons in order to eliminate future losses?

---

**Question Type R: Element: 7 Shutdown management**

**Question:** A) Is baseline planning of downtime and the scope of work available?
B) Is the progress of work measured against the baseline and communicated?
C) Is the data being used to understand the gaps that exist?

---

**Question Type I: Element: 7 Shutdown management**

**Question:** Is previous historical data being used as inputs to planning with respect to improvement?

---

**Question Type A/D: Element: 8 Facilities, equipment and tools**

**Practice: 8.1 Tools**

**Question:** What criteria are being used to determine the tools required for the work (e.g. safety)?

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**Question Type A/D: Element: 8 Facilities, equipment and tools**

**Practice: 8.2 Facilities and equipment**

**Question:** How are the facilities and equipment required, determined to ensure minimum losses (e.g. workshop location etc.)?

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**Question Type A/D: Element: 9 Determining root cause of losses**

**Practice: 9.1 Determining root cause of losses**

**Question:** To what extent is an analytical and scientific approach followed to determine areas of improvement for RCA?

---

**Question Type R: Element: 9 Determining root cause of losses**

**Question:** A) Is the actions implemented from RCA processes measured to determine the loss reduction achieved?
B) Are the actions measured against the expected completion date?
C) Are implemented RCA actions reviewed for effectiveness after implementation?

**Question Type I: Element: 9 Determining root cause of losses**

**Question:** How regular is the RCA process reviewed in order to improve it?

---

**Question Type A/D: Element: 10 Achieving improvement in Capability assurance**

**Practice: 10.1 Routine improvement**

**Question:** What approach is followed to improve the capability of equipment and to reduce losses, are losses recorded in different categories and analysed to focus improvement initiatives?

---

**Question Type A/D: Element: 10 Achieving improvement in Capability assurance**

**Practice: 10.2 Focused improvement**

**Question:** Are improvement initiatives aimed at improving specific losses identified?

---

**Question Type R: Element: 10 Achieving improvement in Capability assurance**

**Question:** A) Are losses and the causes thereof determined?
B) Are losses displayed in revenue lost and well communicated?
C) Is the data being used to understand the nature and cause of the loss; are actions being implemented in order to reduce / eliminate these losses?

---

**Question Type R: Maintenance (capability assurance)**

**Question:** What are the results achieved form overall equipment capability management?

---

**Question Type I: Maintenance (capability assurance)**

**Question:** What initiatives are currently being implemented in order to improve the overall equipment efficiency management?

---

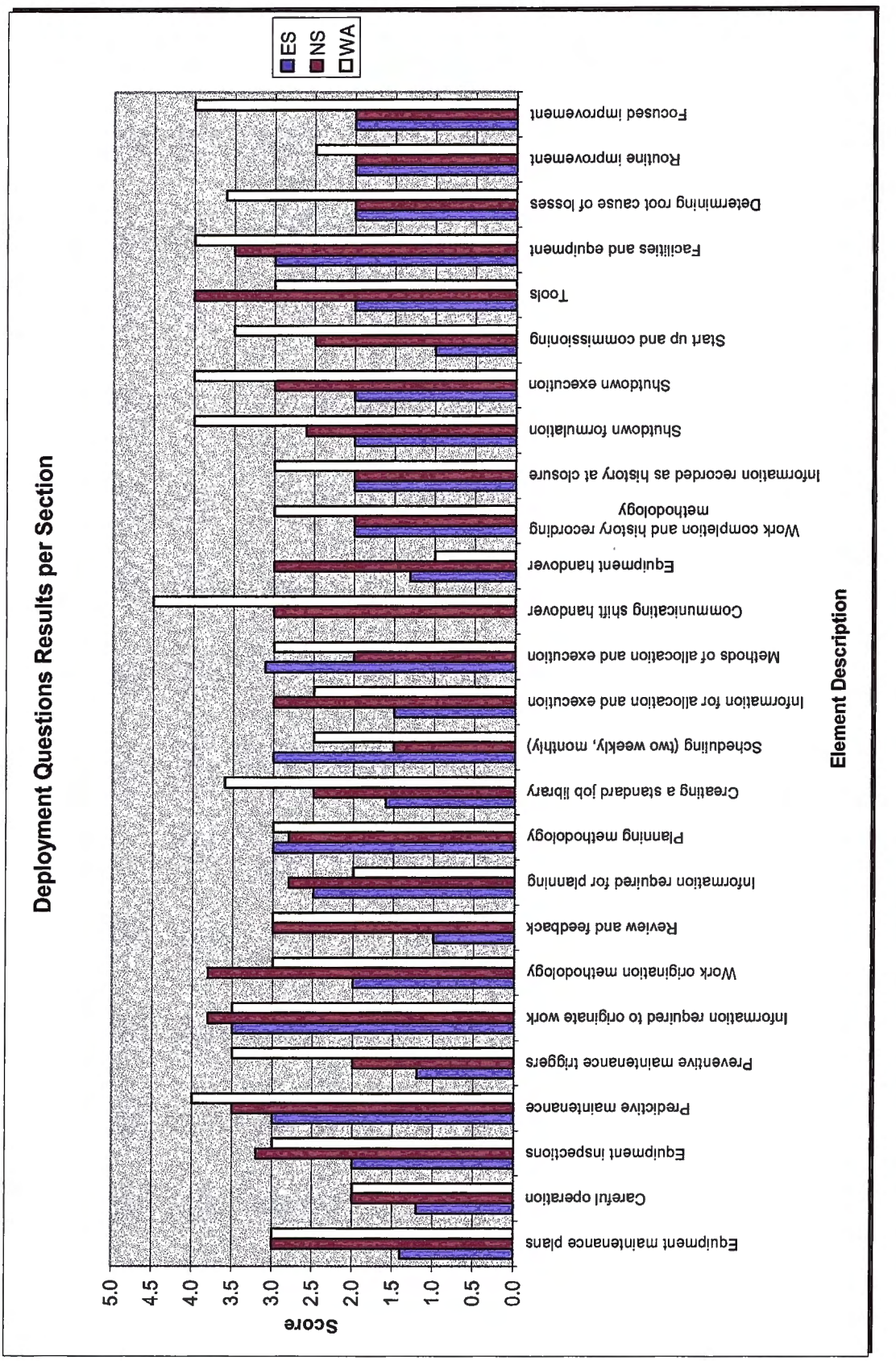
# Appendix C – Results from Maintenance Performance Elements Evaluation

| Ref. | Maintenance (capability assurance) Measurement | | | QT* | ES* | NS* | WA* |
|---|---|---|---|---|---|---|---|
| 0.0 | Maintenance (capability assurance) | | | R | 3.0 | 2.5 | 3.0 |
| 0.0 | | | | I | 3.7 | 2.5 | 3.5 |
| 1.0 | 1 | Equipment maintenance plans | | R | 2.5 | 3.0 | 3.6 |
| 1.0 | | | | I | 2.0 | 3.0 | 3.0 |
| 1.1 | | 1.1 | Equipment maintenance plans | A | 2.0 | 3.0 | 3.5 |
| 1.1 | | | | D | 1.4 | 3.0 | 3.0 |
| 1.2 | | 1.2 | Careful operation | A | 2.0 | 3.0 | 3.0 |
| 1.2 | | | | D | 1.2 | 2.0 | 2.0 |
| 1.3 | | 1.3 | Equipment inspections | A | 2.0 | 4.0 | 3.5 |
| 1.3 | | | | D | 2.0 | 3.2 | 3.0 |
| 1.4 | | 1.4 | Predictive maintenance | A | 2.1 | 4.0 | 4.5 |
| 1.4 | | | | D | 3.0 | 3.5 | 4.0 |
| 1.5 | | 1.5 | Preventive maintenance triggers | A | 1.5 | 2.0 | 4.0 |
| 1.5 | | | | D | 1.2 | 2.0 | 3.5 |
| 2.0 | 2 | Work origination | | R | 0.6 | 3.5 | 3.0 |
| 2.0 | | | | I | 2.0 | 3.5 | 3.0 |
| 2.1 | | 2.1 | Information required to originate work | A | 2.5 | 4.0 | 4.5 |
| 2.1 | | | | D | 3.5 | 3.8 | 3.5 |
| 2.2 | | 2.2 | Work origination methodology | A | 3.5 | 4.0 | 4.0 |
| 2.2 | | | | D | 2.0 | 3.8 | 3.0 |
| 2.3 | | 2.3 | Review and feedback | A | 1.5 | 3.5 | 3.0 |
| 2.3 | | | | D | 1.0 | 3.0 | 3.0 |
| 3.0 | 3 | Planning | | R | 3.5 | 2.5 | 4.0 |
| 3.0 | | | | I | 1.5 | 2.2 | 3.0 |
| 3.1 | | 3.1 | Information required for planning | A | 3.6 | 3.0 | 2.0 |
| 3.1 | | | | D | 2.5 | 2.8 | 2.0 |
| 3.2 | | 3.2 | Planning methodology | A | 4.0 | 3.5 | 4.0 |
| 3.2 | | | | D | 3.0 | 2.8 | 3.0 |
| 3.3 | | 3.3 | Creating a standard job library | A | 2.0 | 2.0 | 4.0 |
| 3.3 | | | | D | 1.6 | 2.5 | 3.6 |
| 4.0 | 4 | Scheduling | | R | 4.0 | 3.0 | 4.0 |
| 4.0 | | | | I | 2.5 | 2.5 | 3.8 |
| 4.1 | | 4.1 | Scheduling (two weekly, monthly) | A | 3.5 | 3.0 | 3.5 |
| 4.1 | | | | D | 3.0 | 1.5 | 2.5 |
| 5.0 | 5 | Work allocation and execution | | R | 2.5 | 3.0 | 3.0 |
| 5.1 | | 5.1 | Information for allocation and execution | A | 2.5 | 3.5 | 3.0 |
| 5.1 | | | | D | 1.5 | 3.0 | 2.5 |
| 5.2 | | 5.2 | Methods of allocation and execution | A | 3.6 | 3.5 | 4.0 |
| 5.2 | | | | D | 3.1 | 2.0 | 3.0 |
| 5.3 | | 5.3 | Communicating shift handover | A | 0.0 | 3.5 | 4.5 |

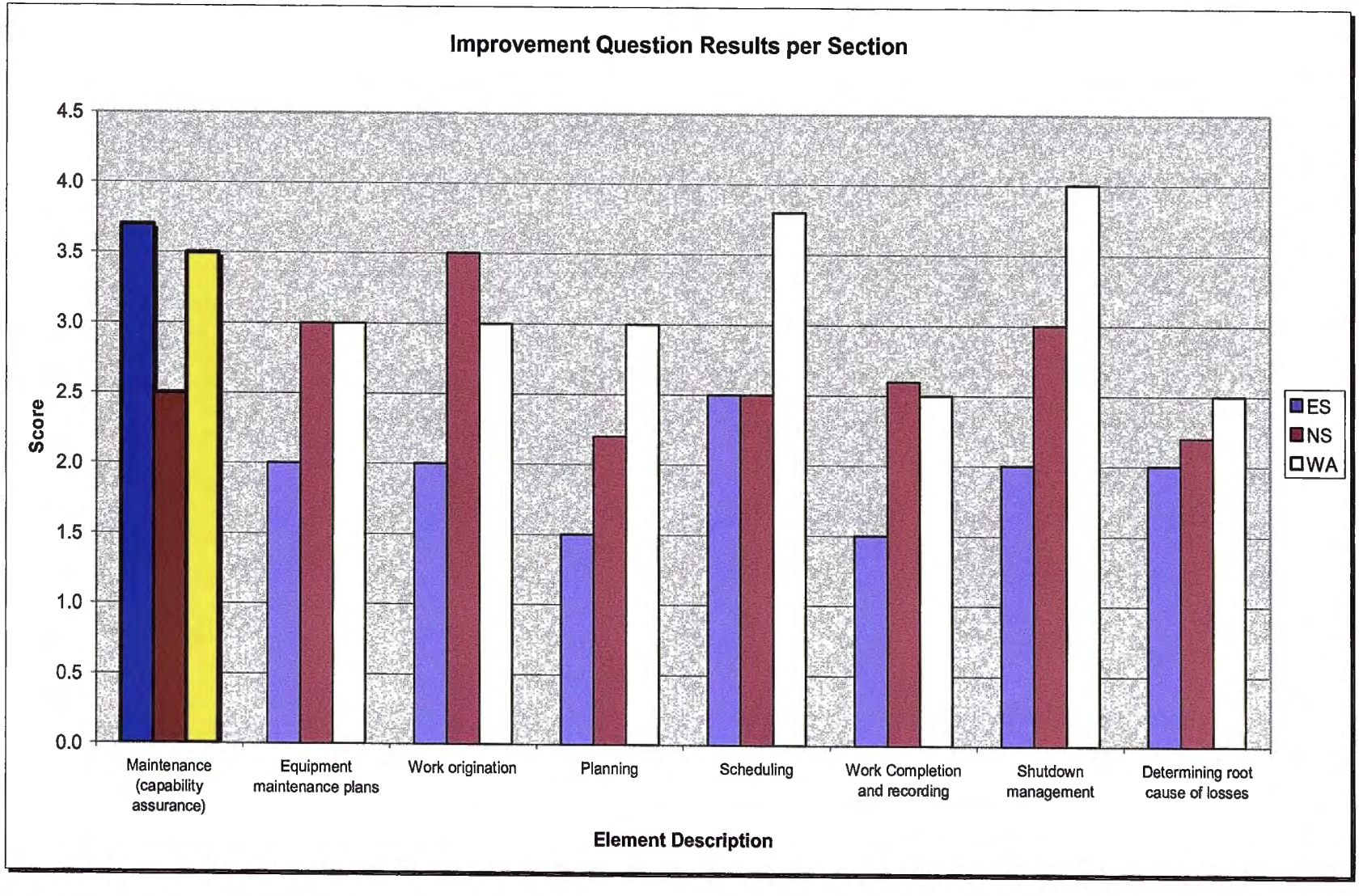
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 5.3 | | | | D | 0.0 | 3.0 | 4.5 |
| 5.4 | | 5.4 | Equipment handover | A | 3.0 | 3.5 | 4.5 |
| 5.4 | | | | D | 1.3 | 3.0 | 1.0 |
| 6.0 | 6 | Work Completion and recording | | R | 2.0 | 2.5 | 3.0 |
| 6.0 | | | | I | 1.5 | 2.6 | 2.5 |
| 6.1 | | 6.1 | Work completion and history recording methodology | A | 3.0 | 2.8 | 4.0 |
| 6.1 | | | | D | 2.0 | 2.0 | 3.0 |
| 6.2 | | 6.2 | Information recorded as history at closure | A | 2.5 | 3.0 | 4.0 |
| 6.2 | | | | D | 2.0 | 2.0 | 3.0 |
| 7.0 | 7 | Shutdown management | | R | 1.5 | 2.5 | 4.0 |
| 7.0 | | | | I | 2.0 | 3.0 | 4.0 |
| 7.1 | | 7.1 | Shutdown formulation | A | 2.5 | 3.0 | 4.0 |
| 7.1 | | | | D | 2.0 | 2.6 | 4.0 |
| 7.2 | | 7.2 | Shutdown execution | A | 2.5 | 3.5 | 4.5 |
| 7.2 | | | | D | 2.0 | 3.0 | 4.0 |
| 7.3 | | 7.3 | Start up and commissioning | A | 2.0 | 3.0 | 4.0 |
| 7.3 | | | | D | 1.0 | 2.5 | 3.5 |
| 8.1 | 8 | Facilities, equipment and tools 8.1 | Tools | A | 2.0 | 4.0 | 4.0 |
| 8.1 | | | | D | 2.0 | 4.0 | 3.0 |
| 8.2 | | 8.2 | Facilities and equipment | A | 4.0 | 3.5 | 4.0 |
| 8.2 | | | | D | 3.0 | 3.5 | 4.0 |
| 9.0 | 9 | Determining root cause of losses | | R | 3.0 | 2.0 | 4.0 |
| 9.0 | | | | I | 2.0 | 2.2 | 2.5 |
| 9.1 | | 9.1 | Determining root cause of losses | A | 3.5 | 2.5 | 3.7 |
| 9.1 | | | | D | 2.0 | 2.0 | 3.6 |
| 10.0 | 10 | Achieving improvement in Capability assurance | | R | 3.5 | 2.6 | 3.6 |
| 10.1 | | 10.1 | Routine improvement | A | 3.5 | 3.0 | 3.0 |
| 10.1 | | | | D | 2.0 | 2.0 | 2.5 |
| 10.2 | | 10.2 | Focused improvement | A | 3.0 | 3.0 | 5.0 |
| 10.2 | | | | D | 2.0 | 2.0 | 4.0 |

* QT = Question Type
ES = Engineering Services
NS = North and South Plants
WA = West and Advalloy Plants

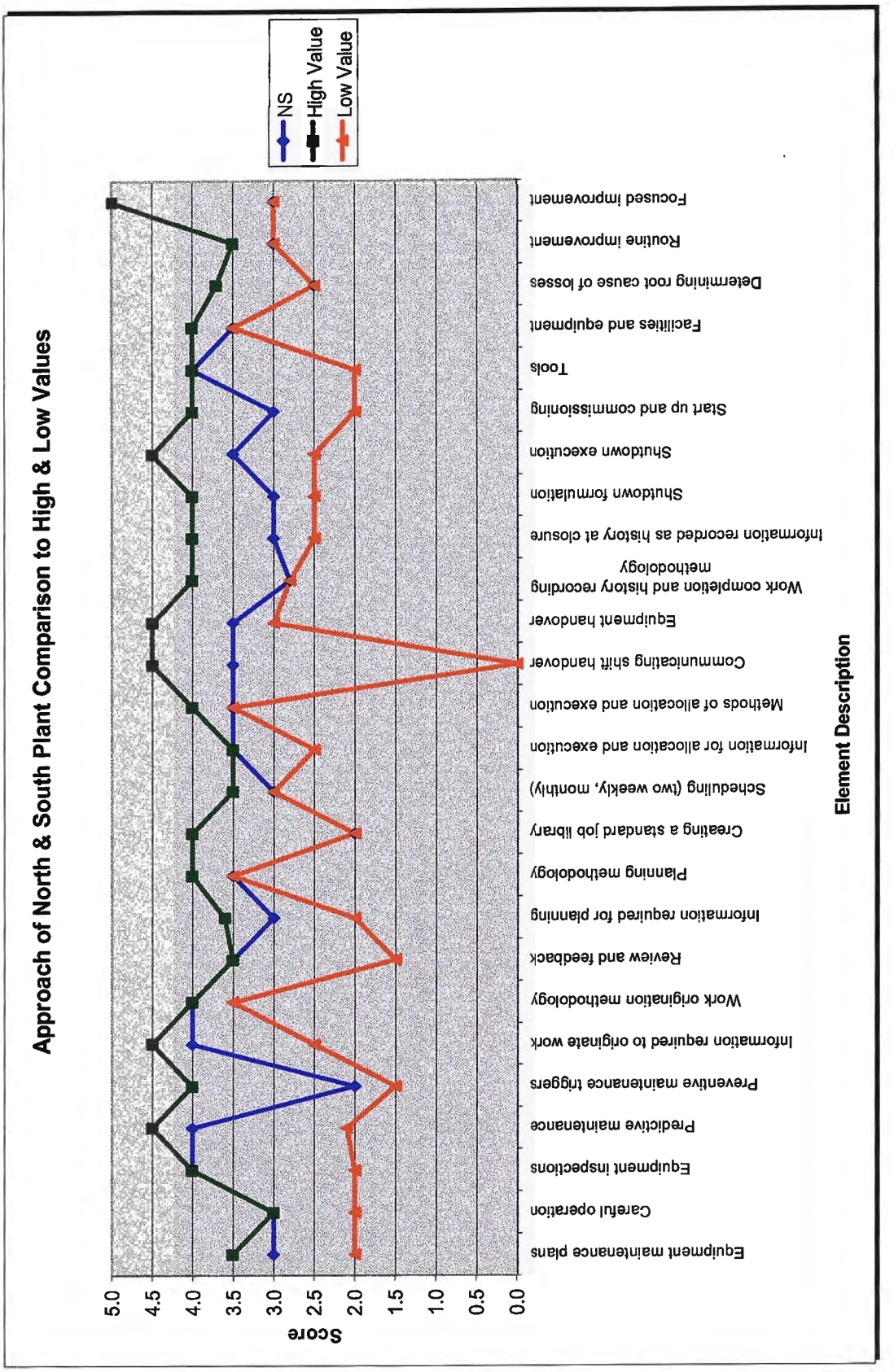
Approach Question Results per Section
Score
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Element Description
Equipment maintenance plans
Careful operation
Equipment inspections
Predictive maintenance
Preventive maintenance triggers
Information required to originate work
Work origination methodology
Review and feedback
Information required for planning
Planning methodology
Creating a standard job library
Scheduling (two weekly, monthly)
Information for allocation and execution
Methods of allocation and execution
Communicating shift handover
Equipment handover
Work completion and history recording methodology
Information recorded as history at closure
Shutdown formulation
Shutdown execution
Start up and commissioning
Tools
Facilities and equipment
Determining root cause of losses
Routine improvement
Focused improvement
ES
NS
WA


Deployment Questions Results per Section
ES
NS
WA
Score
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Element Description
Equipment maintenance plans
Careful operation
Equipment inspections
Predictive maintenance
Preventive maintenance triggers
Information required to originate work
Work origination methodology
Review and feedback
Information required for planning
Planning methodology
Creating a standard job library
Scheduling (two weekly, monthly)
Information for allocation and execution
Methods of allocation and execution
Communicating shift handover
Equipment handover
Work completion and history recording methodology
Information recorded as history at closure
Shutdown formulation
Shutdown execution
Start up and commissioning
Tools
Facilities and equipment
Determining root cause of losses
Routine improvement
Focused improvement

Results Question Results per Section
Score
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ES
NS
WA
Maintenance (capability assurance)
Equipment maintenance plans
Work origination
Planning
Scheduling
Work allocation and execution
Work Completion and recording
Shutdown management
Determining root cause of losses
Achieving improvement in Capability assurance
Element Description


Improvement Question Results per Section
Score
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ES
NS
WA
Maintenance (capability assurance)
Equipment maintenance plans
Work origination
Planning
Scheduling
Work Completion and recording
Shutdown management
Determining root cause of losses
Element Description

Approach of Engineering Services Results Comparison to High & Low Values
ES
High Value
Low value
Score
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Element Description
Equipment maintenance plans
Careful operation
Equipment inspections
Predictive maintenance
Preventive maintenance triggers
Information required to originate work
Work origination methodology
Review and feedback
Information required for planning
Planning methodology
Creating a standard job library
Scheduling (two weekly, monthly)
Information for allocation and execution
Methods of allocation and execution
Communicating shift handover
Equipment handover
Work completion and history recording methodology
Information recorded as history at closure
Shutdown formulation
Shutdown execution
Start up and commissioning
Tools
Facilities and equipment
Determining root cause of losses
Routine improvement


Approach of North & South Plant Comparison to High & Low Values
NS
High Value
Low Value
Score
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Element Description
Equipment maintenance plans
Careful operation
Equipment inspections
Predictive maintenance
Preventive maintenance triggers
Information required to originate work
Work origination methodology
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Equipment handover
Work completion and history recording methodology
Information recorded as history at closure
Shutdown formulation
Shutdown execution
Start up and commissioning
Tools
Facilities and equipment
Determining root cause of losses
Routine improvement
Focused improvement

Approach of West and Advalloy Plant Comparison to High & Low Values
WA
High Value
Low Value
Score
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Element Description
Equipment maintenance plans
Careful operation
Equipment inspections
Predictive maintenance
Preventive maintenance triggers
Information required to originate work
Work origination methodology
Review and feedback
Information required for planning
Planning methodology
Creating a standard job library
Scheduling (two weekly, monthly)
Information for allocation and execution
Methods of allocation and execution
Communicating shift handover
Equipment handover
Work completion and history recording methodology
Information recorded as history at closure
Shutdown formulation
Shutdown execution
Start up and commissioning
Tools
Facilities and equipment
Determining root cause of losses
Routine improvement
Focused improvement

Deployment of Engineering Services - Comparison to High & Low Values
ES
High Value
Low value
Score
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Element Description
Equipment maintenance plans
Careful operation
Equipment inspections
Predictive maintenance
Preventive maintenance triggers
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Shutdown formulation
Shutdown execution
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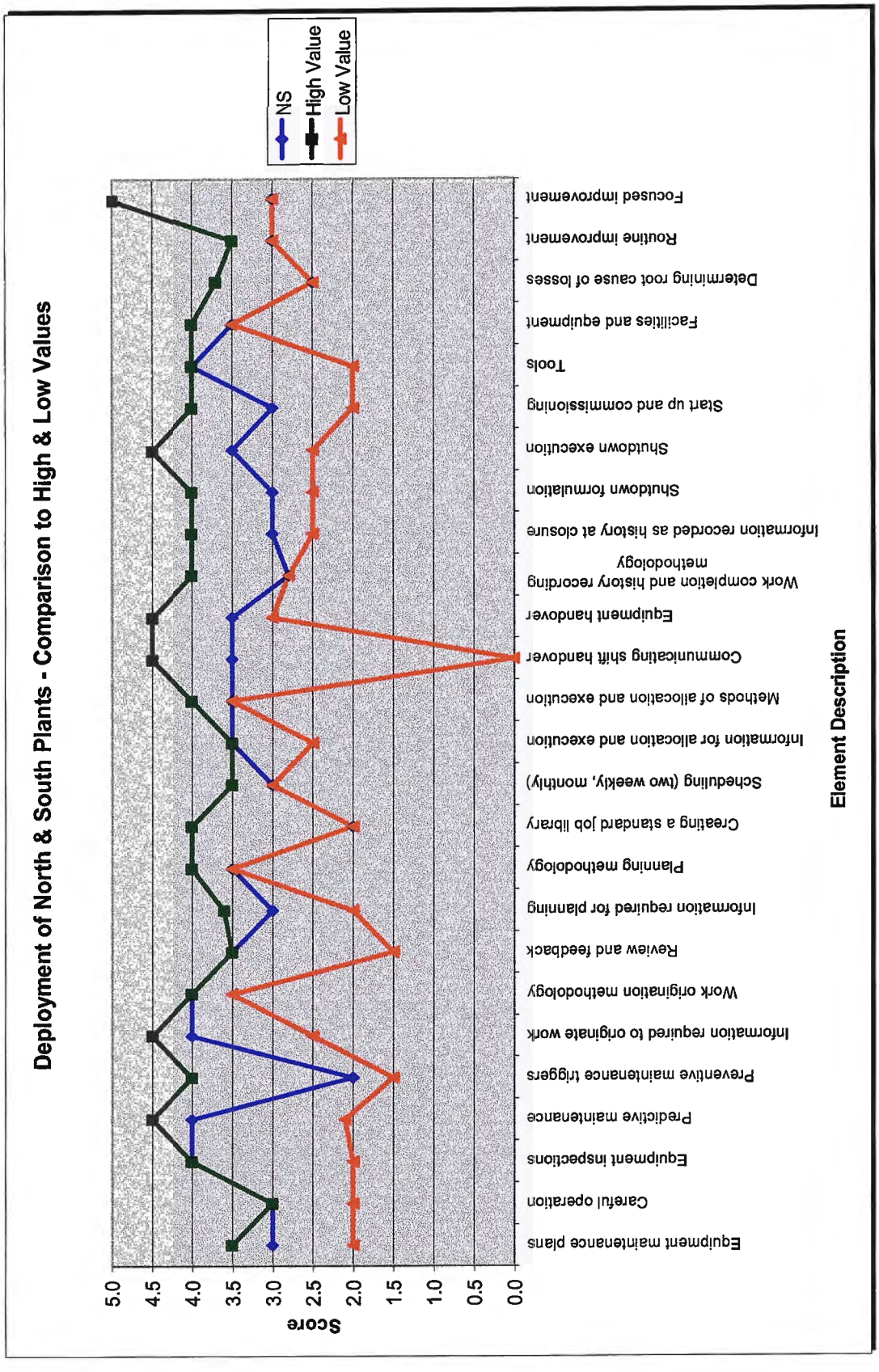
Tools
Facilities and equipment
Determining root cause of losses
Routine improvement


Deployment of North & South Plants - Comparison to High & Low Values
NS
High Value
Low Value
Score
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
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0.0
Element Description
Equipment maintenance plans
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Focused improvement

Deployment of West and Advalloy Plants - Comparison to High & Low Values
WA
High Value
Low Value
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5.0
4.5
4.0
3.5
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2.5
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Tools
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Results Questions of Engineering Services - Comparison to High & Low Values
ES
High Value
Low value
Score
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Maintenance (capability assurance)
Equipment maintenance plans
Work origination
Planning
Scheduling
Work allocation and execution
Work Completion and recording
Shutdown management
Determining root cause of losses
Achieving improvement in Capability assurance
Element Description

Results Questions of North & South Plants - Comparison to High & Low Values
NS
High Value
Low Value
Score
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
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0.0
Maintenance (capability assurance)
Equipment maintenance plans
Work origination
Planning
Scheduling
Work allocation and execution
Work Completion and recording
Shutdown management
Determining root cause of losses
Achieving improvement in Capability assurance
Element Description

Result Questions of West and Advalloy Plants - Comparison to High & Low Values
WA
High Value
Low Value
Score
5.0
4.5
4.0
3.5
3.0
2.5
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1.5
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Maintenance (capability assurance)
Equipment maintenance plans
Work origination
Planning
Scheduling
Work allocation and execution
Work Completion and recording
Shutdown management
Determining root cause of losses
Achieving improvement in Capability assurance
Element Description

Improvement Questions of Engineering Services - Comparison to High & Low Values
ES
High Value
Low value
Score
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
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0.0
Maintenance (capability assurance)
Equipment maintenance plans
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Work Completion and recording
Shutdown management
Determining root cause of losses
Achieving improvement in Capability assurance
Element Description

Improvement Questions of North & South Plants - Comparison to High & Low Values
NS
High Value
Low Value
Score
5.0
4.5
4.0
3.5
3.0
2.5
2.0
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Element Description

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Work Completion and recording
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Achieving improvement in Capability assurance
Element Description

Opportunities per Section According to Internal Benchmarking Figures
(Approach)
Score
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Element Description
Equipment maintenance plans
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Shutdown execution
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Tools
Facilities and equipment
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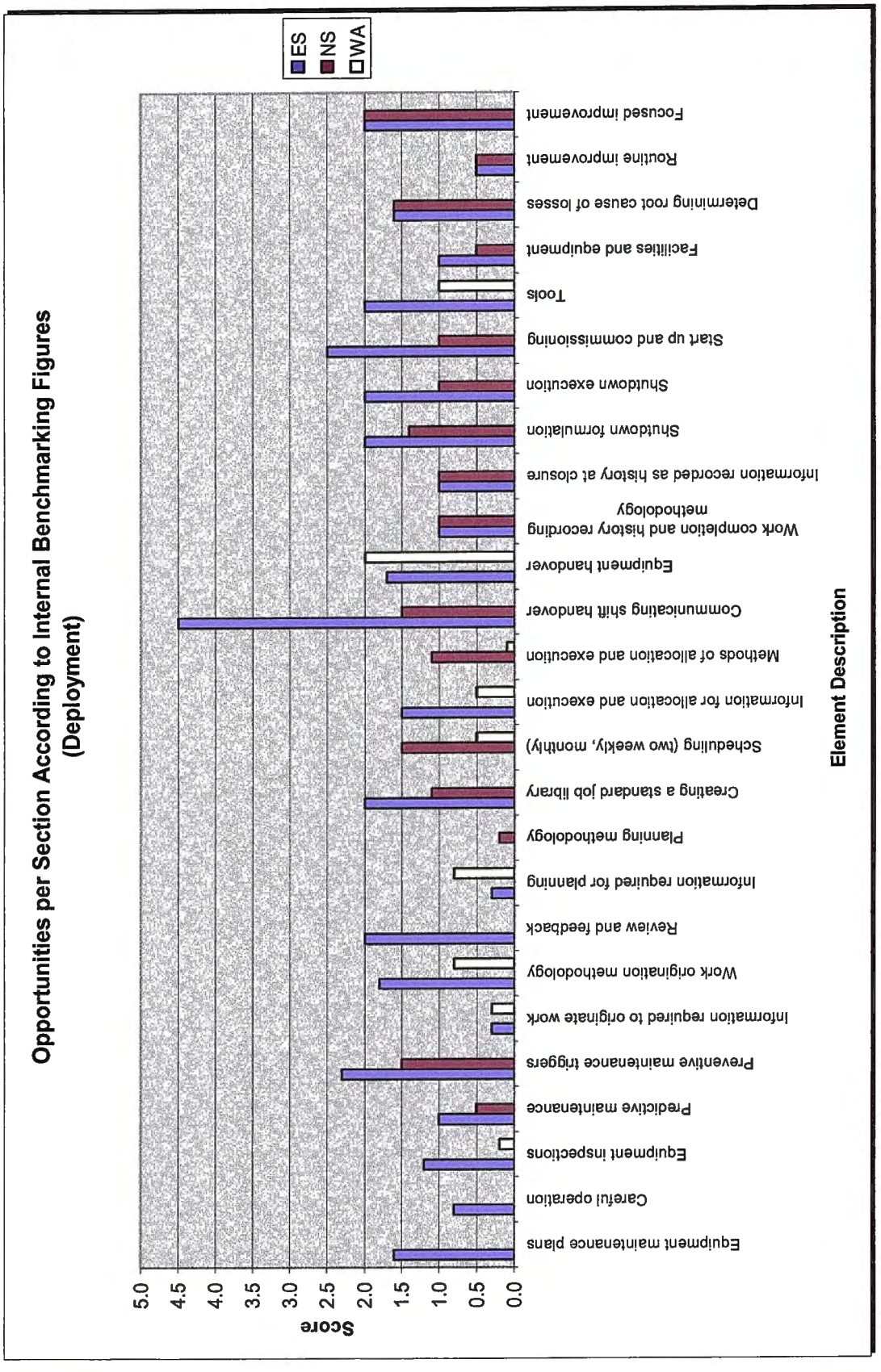
Routine improvement
Focused improvement
ES
NS
WA


Opportunities per Section According to Internal Benchmarking Figures
(Deployment)
ES
NS
WA
Score
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
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Shutdown execution
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Routine improvement
Focused improvement

Opportunities per Section According to Internal Benchmarking Figures
(Results)
ES
NS
WA
Score
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Maintenance (capability assurance)
Equipment maintenance plans
Work origination
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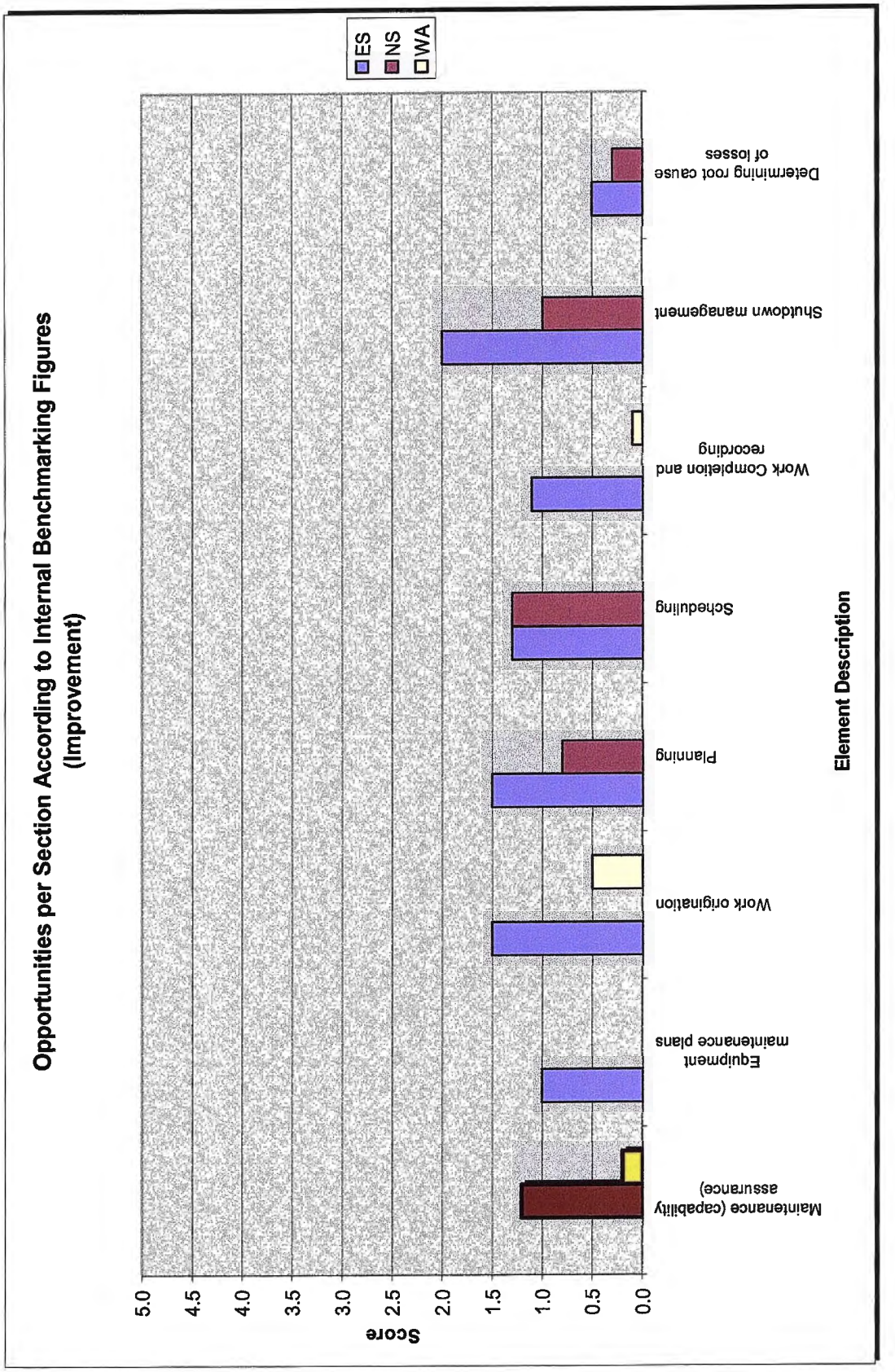
Scheduling
Work allocation and execution
Work Completion and recording
Shutdown management
Determining root cause of losses
Achieving improvement in Capability assurance
Element Description


Opportunities per Section According to Internal Benchmarking Figures
(Improvement)
ES
NS
WA
Score
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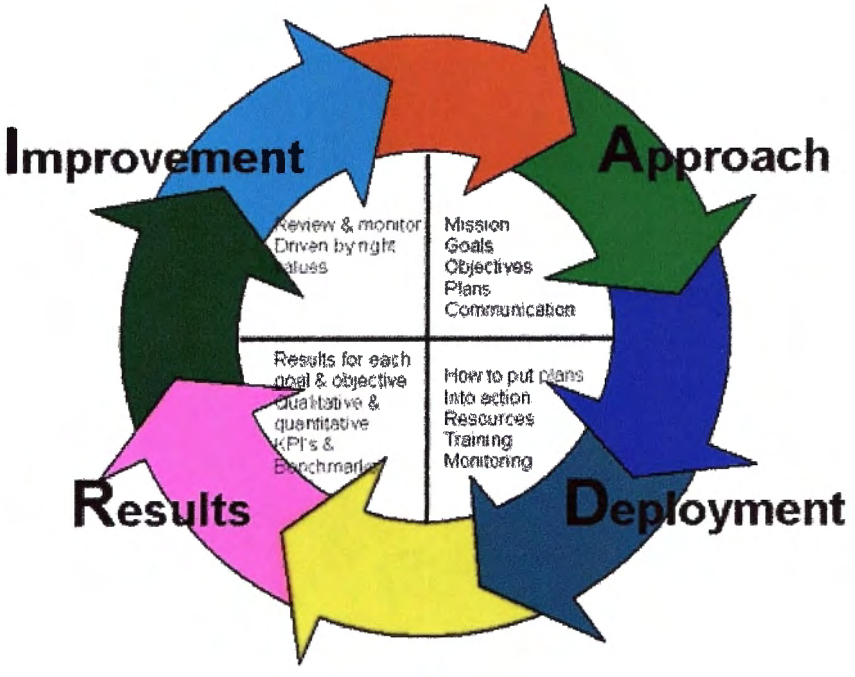
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Maintenance (capability assurance)
Equipment maintenance plans
Work origination
Planning
Scheduling
Work Completion and recording
Shutdown management
Determining root cause of losses
Element Description

# Appendix D – The ARDI Cycle for Improvement

## AMC - Quality and Improvement

The ADRI cycle is similar to the Plan-Do-Act-Check model found in many quality systems. Both are designed to prompt the user to ask simple questions that will assist in the implementation of improvement initiatives.




### How to undertake a quality improvement project (using the ADRI cycle)

Quality improvement projects are best conducted as a team exercise. The people in your work-group are the best people to understand quality issues affecting their everyday work life. Form a small team of interested people, have a discussion on the variety of issues affecting your work and start swapping ideas on how to improve things.

Before commencing a quality improvement project, staff members are encouraged to read through the ADRI users guide below:-

### Stage 1 – Approach

| What the user should do and what questions to ask | Useful information |
|---|---|
| 1. What are the objectives of the organisation and how will my quality improvement project assist with achieving those objectives? | The AMC Strategic Plan contains the organisations' mission, vision, goals, strategies and KPIs. This will help you identify those projects which have the greatest value to the organisation. |
| 2. Are these objectives well established and accepted by all stakeholders? | The objectives in the AMC Corporate Plan should be widely disseminated and reflected in other plans such as Faculty Plans and policies in the Document Library. This will help you assess the suitability of existing KPIs and whether new KPIs are needed. |

| | |
|---|---|
| 3. Define the problem you are trying to resolve or the process you are trying to improve. Is the resolution of this problem in line with the organisations' objectives? | As above |
| 4. Briefly define the current situation using readily available data to establish a "base-line" | A quick review of existing KPI's will often assist you in "setting the picture" so you can readily see opportunities for improvement. |
| 5. Sketch out a plan for your quality improvement project and discuss it with others. | The Management & Projects Analyst can advise you on planning your project and point you towards other data sources or other people in the organisation with similar interests. The Quality Enhancement Committee (QEC) and its associated working parties may be able to offer some valuable advice or support. |

## Stage 2 – Deployment

| What the user should do and what questions to ask | Useful information |
|---|---|
| 1. How am I going to put my quality improvement project into action? | The document AMC Principles and Approaches to Quality & Improvement will give you some guidelines on how to plan a project. Likewise the Management & Projects Analyst can also give you some advice. |
| 2. Who will work on this project and are they suitably trained? Do I need additional resources? | If you need assistance resourcing your project you can approach your Program or Faculty Head and brief them about the value of your idea. Alternatively the QEC through the Management and Projects Analyst can also give you some advice on suitable training courses or resource availability. |
| 3. What additional data will I need to measure the success of my project? | Before deploying any plan it is wise to first think of how you are going to measure the impact of your initiative. You may be able to use existing KPI's or you may need to develop entirely new measures. The Management and Projects Analyst can give you some direction on this topic. |
| 4. Analyse the data and identify some possible solutions. | This part relies heavily on team-work. Use the available data to brainstorm possible solutions in your work-group. This may require gathering new data and undertaking some root-cause analysis, or it may involve some simple discussions. The greater the number of ideas – the better. You may also choose to get advise from someone outside your work-group – a fresh set of eyes will often see different solutions. |
| 5. Set a target and implement your quality improvement plan. | Use the available data to set a challenging but realistic target for your project. This may involve some benchmarking to see how well we perform against other like-organisations. Implement the plan. |

## Stage 3 – Results

| What the user should do and what questions to ask | Useful information |
|---|---|
| 1. What are the results from implementing this plan? | Monitor the progress of your project by collecting data (eg KPI's) that you had earlier decided would be a suitable measure of success. Plot these data on a time-series graph so you can see the improvement. Benchmark the data against those of other organisations. |

| | |
|---|---|
| 2. Do I understand how these results were achieved? Are the targets achievable? | The graphing of a measurable improvement over time is a good way to show that your project has worked. In turn this shows that you have accurately understood the problem, defined that the project is relevant to the organisations' strategic objectives and implemented an effective improvement strategy. If you have been successful, then your improvement initiative will be repeatable and you can modify your project to attain a realistic target. |

## Stage 4– Improvement

| **What the user should do and what questions to ask** | **Useful information** |
|---|---|
| 1. How can I review this improvement project? How can the results be further improved? | Ongoing monitoring of the results of your project and further discussion of the results amongst your work-group may produce ideas as to how you can further improve the process or outcomes. You may also choose to look further afield for opinions or undertake further benchmarking to see how other institutions perform. When you have developed a new strategy to improve the outcomes of your project, or decide to undertake a new project, it is time to start the ADRI cycle again. |
| 2. How can the rest of the organisation learn from this quality improvement project. | If you have successfully completed the ADRI cycle and have achieved the desired improvement, share your findings with other work groups in the organisation. This may be through informal discussion and staff meetings or a formal presentation or briefing paper. Other work-groups will be interested to hear of your work and they may be able to apply a similar plan to improve their areas of responsibility. The QEC and the Management & Projects Analyst will be keen to hear of the progress and outcomes of your project. |

**Quality** is often described as the degree to which *a set of inherent characteristics fulfils requirements*. Therefore attaining quality is the first step in the cycle.

**Continuous Improvement** is described as *recurring activity to increase the ability to fulfillment of requirements*. Consequently improvement is the second step in the cycle.