National Exams May 2003

98-MMP-B3, Mine Equipment Selection and Maintenance

3 hours duration

NOTES:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper a clear statement of any assumptions made

2. Any non-communicating calculator is permitted. This is an Open Book exam. Note to candidates: you must indicate the type of calculator being used, i.e. write the name and model designation of the calculator on the first inside left hand sheet of the exam work book.

3. Any five questions constitute a complete paper. Only the first five questions as they appear in your answer book will be marked.

4. All questions are of equal value

(20 marks) 1. Compare the following pieces of surface mining equipment:

- Hydraulic Loaders
- Electrice cable (rope) shovels
- Hydraulic shovels
- Drag lines

with respect to

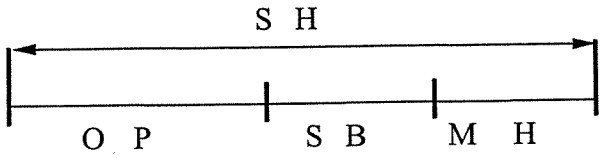
a. Mobility
b. Flexibility (in terms of coping with varied muck pile and/or pit geometries)
(4 marks) (each) c. Sensitivity to fragmentation (size distribution) characteristics of the material being handled
d. Infrastructure requirements
e. Equipment size (in terms of range of payloads)

(20 marks) 2. Maintainability is key to achieving optimum maintenance results. In the context of conventional industrial equipment, maintainability is viewed as an attribute of the design and installation of the equipment - and hence by extension as an attribute of the design of the plant in which the equipment is installed. Discuss how mine design can impact the maintainability of mining equipment. (Hint: Choose a minining scenario and investigate how various design decisions could impact maintenance.)

(20 marks) 3. Drilling

a. What were the historical advantages of hydraulically powered underground drilling equipment, in comparison to pneumatically powered drills? Were there any disadvantages?
b. What benefits are associated with percussive drilling? Why are percussive drills more prevalent in underground mining, in comparison to surface mining?
(4 marks) (each) c. What selection criteria would you use to choose between top-hammer and in-the-hole (down-the-hole) percussive drills?
d. What factors govern the selection of percussive frequency (blow rate), rotation speed, and feed (thrust) force for percussive drilling?
e. What factors govern the selection of rotation speed and feed (thrust) force for rotary drilling?

(20 marks) 4. The relationship amongst operating hours (OP), standby hours (SB), maintenance hours (MH), and scheduled hours (SH) is shown in the figure below:



Based on the above relationships, the key performance indicators (KPI's) for equipment maintenance and operations can be defined.

a. Define *Mechanical Availability* in terms of these relationships.
b. Define *Physical Availability* in terms of these relationships.
c. Define *Utilization of Availability* in terms of these relationships.
d. Define *Effective Utilization* in terms of these relationships.

(2.5 marks) (each) e. Which of the above KPI's is the most relevant single measure of maintenance effectiveness? Justify your answer.

f. Does maintenance effectiveness impact utilization? Justify your answer.
g. Does improved reliability of all critical components/subsystems in a machine necessarily improve the machine's *physical* availability? Fully explain your answer.
h. What impact can improving maintainability have on a machine's *mechanical* availability? Fully explain your answer.

(20 marks) 5. Define and compare the following terms:

a. Corrective Maintenance
b. Run-To-Failure Maintenance

(4 marks) (each) c. Scheduled (Fixed Time) Maintenance
d. Preventive Maintenance
e. Predictive Maintenance

(20 marks) 6. This question focuses on large open pit haul trucks.

a. Truck design have become progressively larger over the past several decades. What are the potential benefits of larger haul trucks? What are some possible disadvantages?

(5 marks) (each) b. Under what circumstances would a trolley-assist system be used? What are the advantages and disadvantages of such a system?

c. What are the distinguishing design features of mechanical drive trucks? What impact, if any, do these design features have on the reliability and maintainability of these machines?
d. What are the distinguishing design features of mechanical drive trucks? What impact, if any, do these design features have on the reliability and maintainability of these machines?

7. (20 marks) Many older large surface rotary blast-hole drills utilise d.c. electric motors to impart rotation to the drill string. These motors need to be changed out periodically to be reconditioned (e.g. to replace commutation brushes.) A mine with a fleet of such drills has been changing out these motors after every 800 hours of operation. However, the occurrence of motor failures has suddenly increased.

The following data on the d.c. motor failures is available:

Time to Failure	# of Failures
100-200	2
200-300	3
300-	2
400-	2
500-	1
600-	3
700-	7
800	19

a) (10 marks) (each) By evaluating these failure statistics, comment on whether the problem is likely due to poor reconditioning or operator/environment influences such as repeated stalls.

b) What additional failure data would be useful in investigating this problem?