UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2009/2010

SUBJECT NAME	:	ENGINEERING MATERIALS SELECTION
SUBJECT CODE	:	BDA 2042
COURSE	:	2 BDD/ 2BDI
EXAMINATION DATE	:	NOVEMBER 2009
DURATION	:	2 HOURS
INSTRUCTION	:	ANSWER FOUR (4) QUESTION ONLY FROM SEVEN (7) QUESTIONS

THIS EXAMINATION PAPER CONTAIN ELEVEN (11) PAGES

Q1 (a) A new employed worker is given a task to design and produce two different products for her company with limited budget. Suggest and explain TWO (2) suitable methods of materials selection for her to apply by considering the needs of "Market Pull vs. Technology Push". (10 marks)

(b) Why density of each group of engineering materials differ from one another. Describe your answer with the help of examples of the named materials.

(10 marks)

(c) State at least THREE (3) classes of engineering materials that have low K_{IC} . What is the main property of these materials?

(5 marks)

Q2 Mr Me want to manufacture a material into a long filament.

i) Suggest ONE (1) suitable manufacturing process that can be used to make long filament. (4 marks)

ii) How Mr Me knows the stiffness of the material is suitable for the selected manufacturing process (with an appropriate curve). (15 marks)

iii) Compare the possible answer for ii) with ONE (1) different class of engineering material in terms of their curves. (6 marks)

Q3 a) A microchip may only consume milliwatts, but the power is dissipated in a tiny volume. The power is low but the power-density is high. As chips shrink and clock-speeds grow, heating becomes a problem. Heating is kept under control by attaching the chip to a heat sink, taking pains to ensure good thermal contact between the chip and the sink. To prevent electrical coupling and stray capacitance between chip and heat sink, the sink must be a good electrical insulator, meaning a resistivity, $\rho e > 10^{19} \mu\Omega.cm$. But to drain heat away from the chip as fast as possible, it must also have the highest possible thermal conductivity, λ.

i) List the function, objective, constraints and free variable for this design case.

(5 marks)

ii) From the available charts, draw or sketch the suitable region and identify TWO (2) suitable materials that can be used as heat sink?

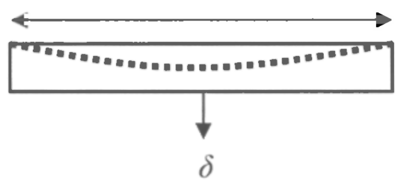
(5 marks)

b) Electrical power, today, is generated centrally and distributed by overhead and underground cables. Buried lines are costly so cheaper overhead transmission is widely used. A large span is desirable because the tower are expensive, but so too is a low electrical resistance to minimize power loses. The span of cable between two towers must support the tension needed to limit its sag and to tolerate wind and ice loads. Consider the tower spacing L is fixed at a distance that requires a cable with a strength σf of at least 80 MPa and the objective is to minimizing resistivity losses.

i) From the available charts, identify TWO (2) suitable materials for this application? (5 marks)

c) Explain briefly the differences between the loading for tie, beam, shaft and coloum with and without shape factors. (10 marks)

Q4 Mirror as circular disc with specific diameter, ***2R*** and mean thickness, **t**, supported at its periphery. When horizontal, it will deflect under its own weight, ***m;*** when vertical it will not deflect significantly. This distortion must be small enough that it does not interfere with performance. In practice, the deflection, ***δ*** of the midpoint of the mirror must be less than the wavelength of light. Additional requirements: no creep and low thermal expansion.



The mass of the mirror, $m = \pi R^2 t \rho$

The elastic deflection, $\delta = (3/4\pi)(mgR^2/Et^3)$

i) List the function, objective, constraints and free variable for this design case.
(3 marks)

ii) What is the measure of performance for this design? (2 marks)

iii) Derive the lightest mirror Material Index, M for the elastic deflection.
(15 marks)

iv) Based on the selection criteria from above conditions, sketch clearly your selection region in available charts (FIGURE 2). Show all the calculation in details.
(5 marks)

Q5 a) Heat-treatable Carbon and Low Alloy Steel are predominantly used in quenched and tempered condition. What are the main classes of heat-treatable Carbon and Low Alloy Steel based on its major uses. Give the examples of these materials. (12 marks)

b) An engineer from Excellent-Tech Steel manufacturing company needs to design a steel that requires 40 mm diameter round bar with a minimum hardness of 1100 MPa tensile strength which equivalent to 330 HB at about the 1/2-radius position in its cross section. The steel will be heat-treated in a nonscaling atmosphere and will be quenched in mildly agitated oil bath at an equivalent velocity of 200 ft/min.

i) Select the appropriate steels via hardenability procedure by using the given charts (Refer to FIGURE 3,4 and 5).

(7 marks)

ii) List at least six (6) alloy steels that can be used for the mentioned application (Refer to TABLE 1).

(6 marks)

Q6 (a) Weldability of a material is one of the factors considered for a structural steel selection.

(i) What is weldability? Give the factors that influence weldability.

(5 marks)

(ii) Explain the predominant joining process (fusion welding) in detail.

(10 marks)

(b) Ti-6-4 is available in three forms; wrought, cast or sintered with wrought product form is the most used in market. Usually, the selection of correct wrought titanium alloys starts with determining whether if the attributes of the reference titanium alloy, *alloy A* are suitable with the design. If there are other improved attributes required for the design, then the right wrought titanium alloys (either near-beta and beta alloys or near alpha and alpha alloys) could be identified by assessing certain required improved attributes of the alloys in comparison to *alloy A* attributes.

(i) What is *alloy A*?.

(ii) List the comparable attributes which leads to selection of;

- near-beta and beta alloys
- near-alpha and alpha alloys

(10 marks)

Q7 (a) What is a function of abrasive ceramic? Give TWO (2) example of abrasive ceramic material.

(4 marks)

(b) Explain briefly THREE (3) requisite properties of abrasive ceramic

(9 marks)

(c) Explain why polypropylene plastic is a suitable raw material for production of drink bottle?

(6 marks)

(b) How antioxidant additives protect materials from heat, light and chemical oxidation?

(6 marks)

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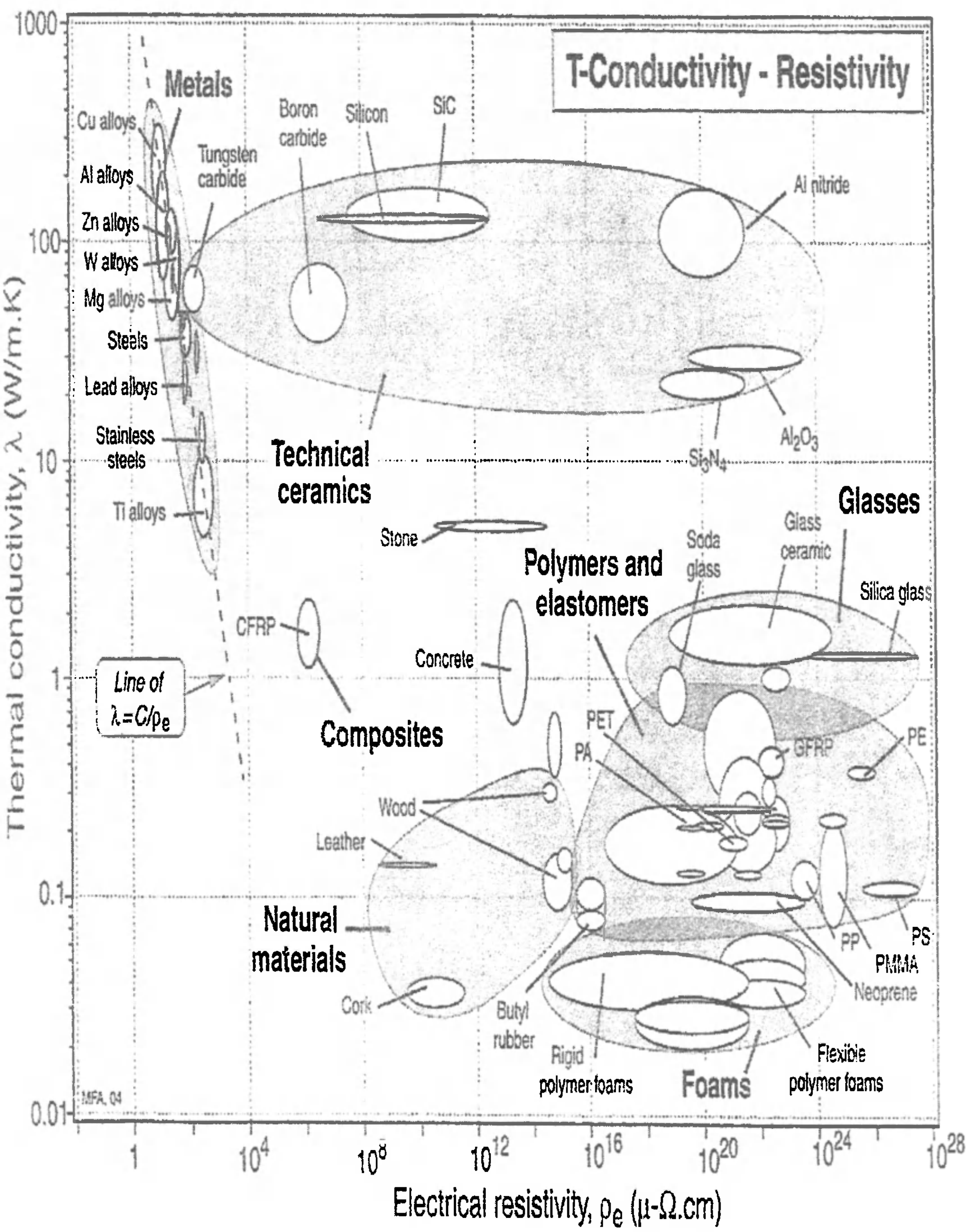

FIGURE 1

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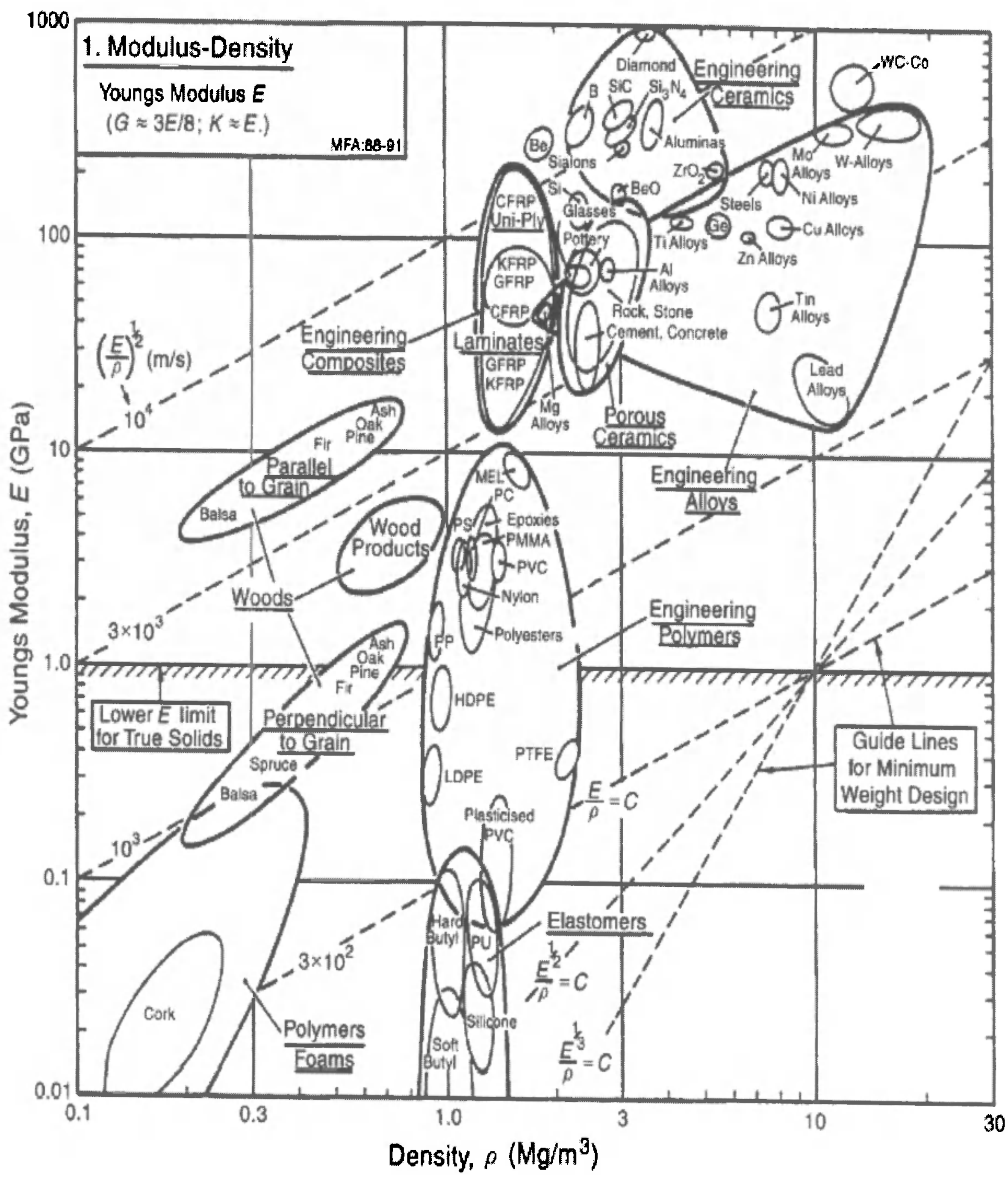

FIGURE 2

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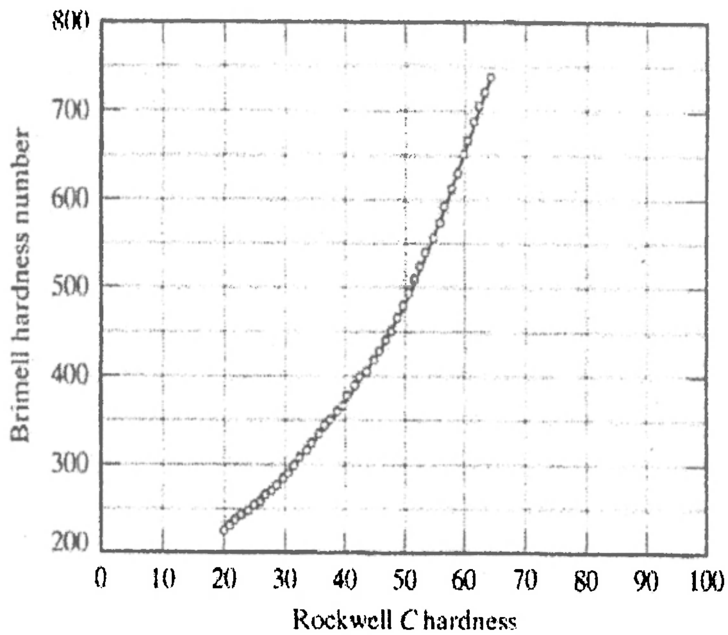

FIGURE 3

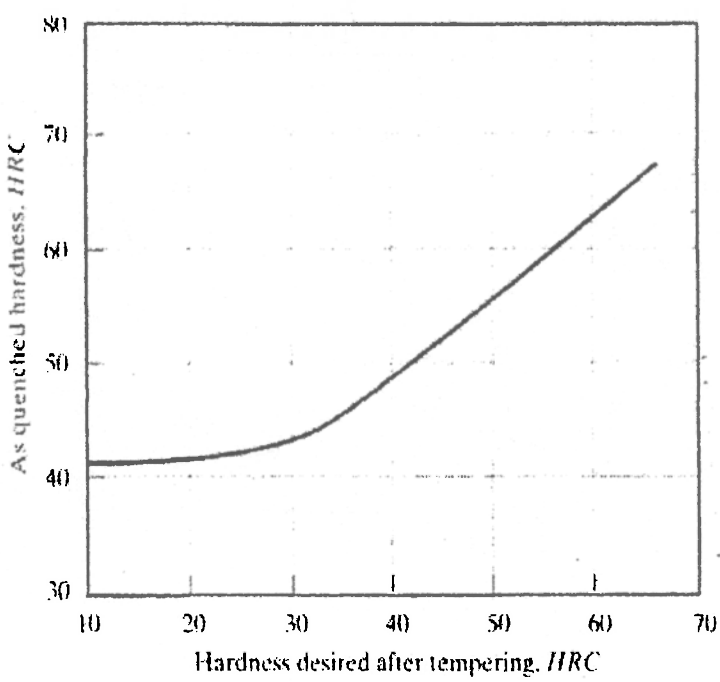

FIGURE 4

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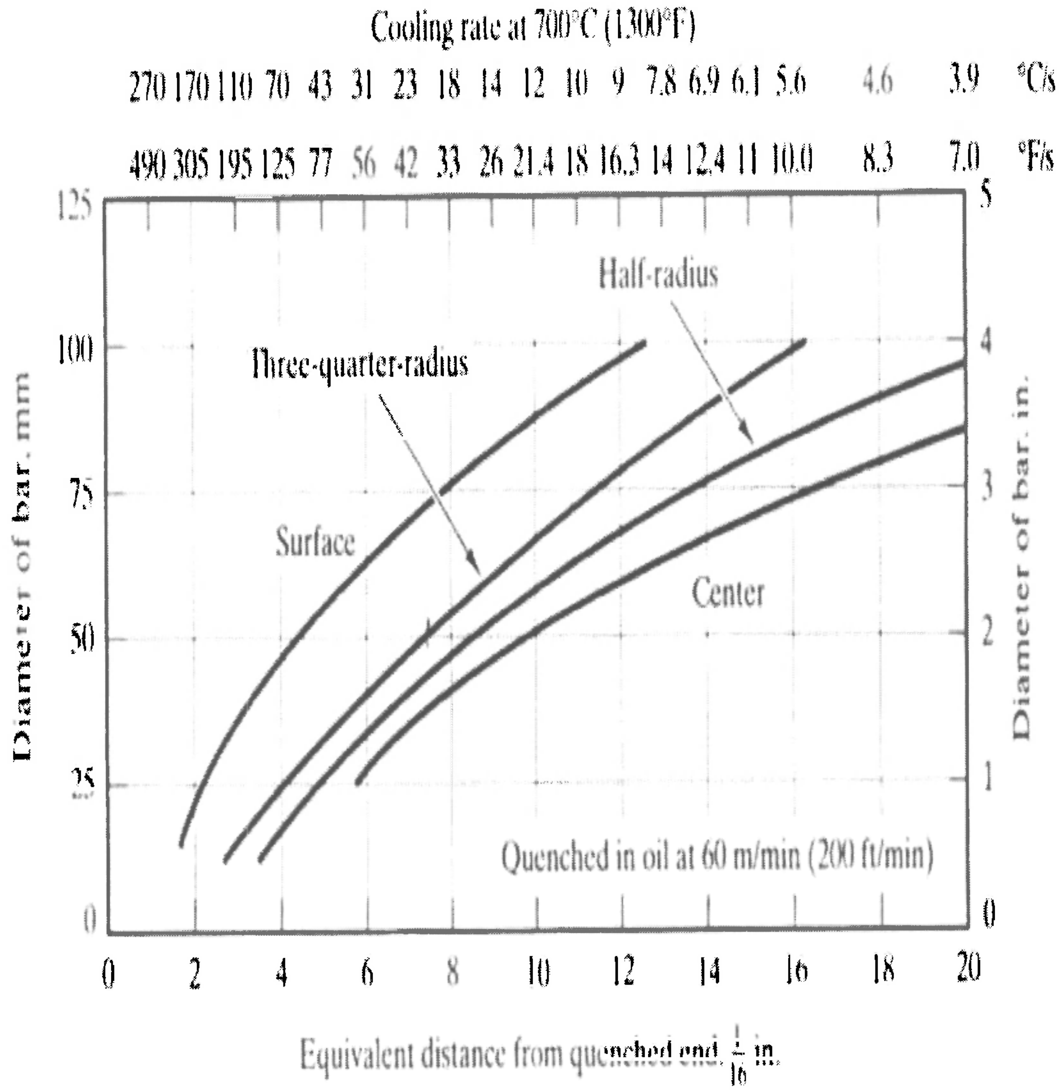

FIGURE 5

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Distance from quenched end, 1/16th in.	H steels with a minimum hardenability curve that intersects the specified hardness at the indicated distance from the quenched end of the hardenability specimen
40 HRC (Continued)	
10 $\frac{1}{2}$	6150, 50B60
11	4140
11 $\frac{1}{2}$	81B45, 8650, 5152
12	86B30
13	51B60
14	8655
15	4142
15 $\frac{1}{2}$	8750
18	4145, 8653, 8660
19	9840, 86B45
20	4147
24	4337, 4150
32	4340
36+	E4340, 9850
45 HRC	
1	4027, 4028, 8625
1 $\frac{1}{2}$	8627, 1038
2	4032, 1042, 1146, 1045
2 $\frac{1}{2}$	4130, 5130, 8630, 4037, 1050, 5132
3	1330, 5046, 1541
3 $\frac{1}{4}$	1050
3 $\frac{1}{2}$	1335, 5135, 4042, 4047
4	8635, 1141
5	8637, 1340, 5140, 50B46, 4053, 9260, 15B37
5 $\frac{1}{2}$	5145, 4063
6	4135, 4640, 4068, 1345
6 $\frac{1}{2}$	8640, 8740, 5150, 94B30
7	4137, 8642, 6145, 9261, 50B40
7 $\frac{1}{2}$	8742, 50B44, 5155
8	8645, 5147
8 $\frac{1}{2}$	4140, 6150, 5160, 9262, 50B50
9	50B60
9 $\frac{1}{2}$	81B45, 8650, 86B30
10	5152
11	51B60, 8655
11 $\frac{1}{2}$	4142
12	8750

Classification of H steels according to minimum hardness at various Jominy equivalent cooling distances from quenched end

TABLE 1