NEW ZEALAND AGRICULTURAL ENGINEERING INSTITUTE

THE HYDRAULIC PERFORMANCE of TROUGH VALVES

PROJECT REPORT

P/2

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THE HYDRAULIC PERFORMANCE

OF

TROUGH VALVES

by

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THE HYDRAULIC PERFORMANCE OF TROUGH VALVES

1. INTRODUCTION

The design of a farm water supply system involves:

(i) An estimate of the average long-term demands of water.
(ii) An estimate of the peak rates of flow to be expected at points within the system.
(iii) The design of the hydraulic components of the system.

Proper selection of such components as pumps and motors can be made from the wealth of manufacturer's information available to the designer. Similarly, much useful data has been published on the hydraulic performance of the commercially available types of reticulation piping.

Most farm water supply systems incorporate water troughs for stock watering fed from the reticulation system through trough valves. The trough valve is often the last hydraulic component on the water supply line to a particular watering point. When operating at the head available, it must be capable of delivering water to the trough at the rate of flow specified by the designer. At the same time, the valve must effectively seal against the maximum head operative at the watering point.

To select a trough valve to perform in accordance with predetermined design considerations, knowledge of the hydraulic performance of commercially available valves must be available to designers. In New Zealand, to this time, information of this type has not been accessible. Otherwise satisfactory designs of water supply systems have not been successful because of inappropriate selection of trough valves at watering points. Designers have been aware of this gap in necessary data for a considerable time.

The New Zealand Agricultural Engineering Institute (NZAEI) have recently conducted a series of hydraulic performance tests on trough valves of various designs submitted free of charge by manufacturers throughout New Zealand. The results of these tests are discussed and presented in this paper. The selection of valves tested represents the more common types used for water supply systems in New Zealand, and as new valves are obtained or developed similar tests will be conducted to bring design information up to date.

2. HYDRAULIC CHARACTERISTICS OF TROUGH VALVES

The features of trough valve performance that are of interest to designers are:

(i) The pressure at which the valves will seal effectively when fitted with the standard sized float available on the market. This will generally indicate the upper limit of pressure for which the valve is suitable.

(ii) The flow characteristics of the trough valve at various pressures. That is, the rate at which the valve will deliver water to the supply point for a particular pressure available at the valve.

3. TEST PROCEDURE

The tests on the trough valve were carried out at the Fluid Mechanics Laboratory of the Engineering School, University of Canterbury, Ilam.

Pressure measurements were taken using calibrated test pressure gauges of the Bourdon type. Discharge was computed at various pressure settings using a 500 gallon weighing tank and a stop watch for time measurement.

The test rig is shown in diagrammatic form in Fig. 1.

3.1 Sealing Tests:

To find the upward force necessary to seal the valve against leakage at various pressures a calibrated spring balance S was used connected to the end of the arm of the trough valve. Pressures at B were regulated by operating the bypass line using valve D, thus dissipating a part of the head available from the constant head supply at E.

3.2 Flow Characteristic Tests:

Discharge rate was computed by measuring the quantity of water collected in the weighing tank W from the valve under test at A and measuring the time interval with the stopwatch T. Pressure settings at B were regulated by operating the bypass line using valve D.

4. PRESENTATION OF TEST RESULTS

4.1 The recommended maximum working pressure of each valve is indicated on the individual performance graphs. This value is based on the sealing effort of a half submerged polythene float of $4\frac{1}{4}$ inches diameter fitted to the end of the operating arm of the trough valve.

The exceptions to this criteria are the valves of A. & T. Burt Pty. Ltd. and Hansen Engineering Pty. Ltd., which employ special floats, and the Fowler Trough Valve which does not utilise the conventional ball-arm sealing mechanism.

4.2 The flow characteristics of the trough valves are presented as individual graphs for each valve tested. A selection chart has been drawn up indicating the valves suitable for specific pressure and discharge increments. The individual performance graphs of these valves can then be consulted and the designer can choose a suitable component.

5. DESCRIPTION OF VALVES TESTED

Full details of the valves tested are given in Appendix One, and selected pertinent information is reproduced on the individual performance graphs.

APPENDIX ONE

DESCRIPTION OF TROUGH VALVES TESTED

Test Mark	Description	Nominal Nozzle Dia. (in.)	Actual Nozzle Dia. (in.)	Recommended Working Head (ft.)
Supplier:	G. Methven & Co., Dunedin			
M1	½ x 2 x 40 T/F	7/64	0.119	350
M2	½ x 2 x 39	7/64	0.118	250
M3	½ x 1¼ x 39A	N.A.	9/16	50
M4	½ x 2 x 39L M.P.	3/16	0.187	200
M5	¾ x 1¼ x 39A	N.A.	11/16	12
M6	¾ x 2 x 39	3/16	0.154	215
M7	¾ x 1¼ x 40 T/F	3/16	0.158	300
M8	1 x 1¼ x 39A	N.A.	0.820	7
M9	1 x 2 x 39	3/16	0.188	200
Supplier:	Hardware Manufacturing Co., New Lynn			
HM1	½ x 73 L.P.	N.A.	0.488	50
HM2	½ x 73 F	¼	0.252	250
HM3	½ x 73 M.P.	3/16	0.187	380
HM4	½ x 73 H.P.	7/64	0.121	300
HM5	½ x 225 H/L	7/64	0.122	375
HM6	¾ x 70 L.P.	N.A.	0.486	50
HM7	¾ x 70 M.P.	5/16	0.311	110
HM8	¾ x 70 H.P.	7/64	0.124	375
HM9	¾ x 235 H/L	7/64	0.122	375
Supplier:	Spackman Engineering Co., Wellington			
S1	½ inserted seat	7/64	0.130	250
S2	Secol	7/64	0.116	250
S3	¾ inserted seat	3/16	0.155	280

Test Mark	Description	Nominal Nozzle Dia. (in.)	Actual Nozzle Dia. (in.)	Recommended Working Head (ft.)
Supplier:	H.J. Assmus & Co., Auckland			
A1	½ trough filter	3/16	0.189	200
A2	¾ trough filter	3/16	0.189	200
Supplier:	F. & W. Fowler Ltd., Auckland			
F1	Diaphragm operated	N.A.	5 at 0.255	F1 300 F1A 50
Supplier:	A. & T. Burt, Christchurch			
B1	¾ Wilkes pattern	¾	¾	250
Supplier:	Hansen Engineering, Whangarei			
H1	Hi flow Diaphragm	N.A.	N.A.	150

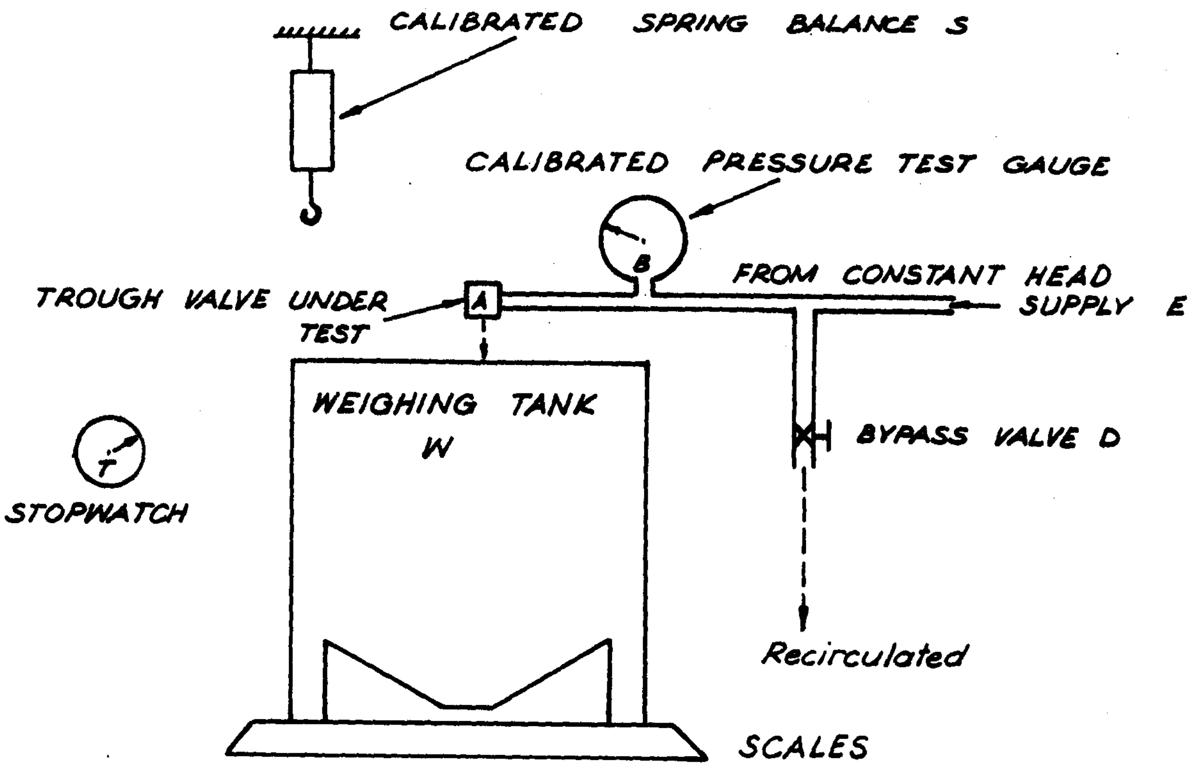
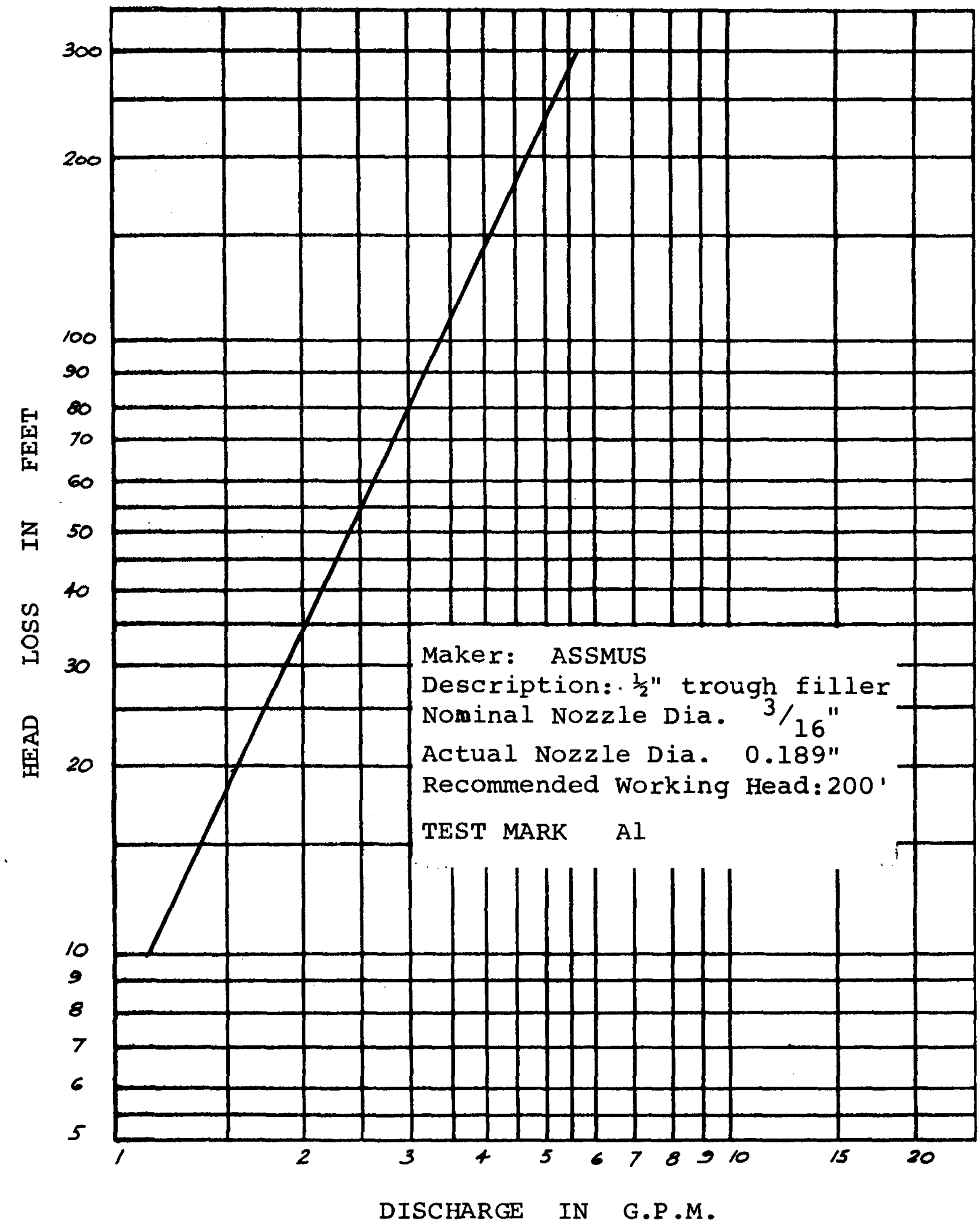
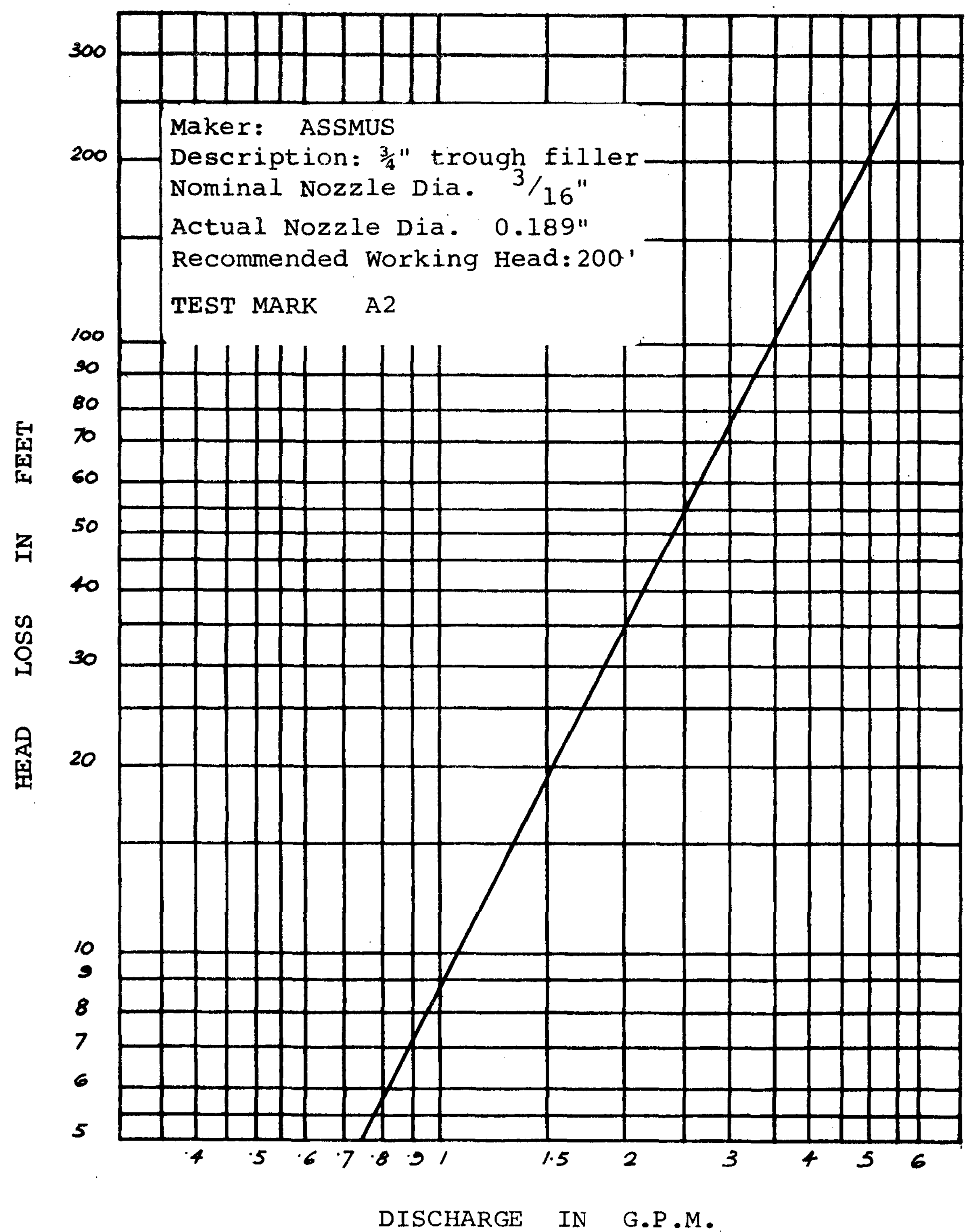

CALIBRATED SPRING BALANCE S
CALIBRATED PRESSURE TEST GAUGE
B
FROM CONSTANT HEAD SUPPLY E
TROUGH VALVE UNDER TEST
A
WEIGHING TANK W
T
STOPWATCH
BYPASS VALVE D
Recirculated
SCALES

Fig. One

RANGE OF HEAD LOSS AVAILABLE IN FEET	·5 – 1	1 – 2	2 – 3	3 – 5	5 – 7	7 – 10	10 – 20
250 – 300			M1 HM5 F1 M2 HM9 HM1 S2	M6 A1 M7 A2 HM4	M4 M9 S3		
200 – 250			M1 HM5 F1 M2 HM9 HM1 S2	M6 A1 M7 A2 HM4	M4 S3 M9 HM3		
150 – 200			M1 HM5 F1 M2 HM9 HM1 S2	M4 M9 A2 M6 HM4 M7 A1	HM3 S3		
100 – 150		M1 HM4 HM9 M2 HM5 S2	M6 HM5 F1 HM1 S3	M4 M9 A1 M7 HM3 A2	HM3	HM2	
80 – 100		M1 HM4 S2 M2 HM5 HM1 HM9	M6 F1 M7 S3	M4 A1 M9 A2 HM3		HM2	HM7
60 – 80		M1 HM4 S2 M2 HM5 HM1 HM9	M4 S3 F1 M6 A1 M7 A2	M9 HM3	HM2	HM7	H1
50 – 60		M1 HM4 S2 M2 HM5 HM1 HM9	M4 M9 A2 M6 S3 F1 M7 A1	HM3	HM2	HM7 H1	M3
40 – 50		M1 HM1 HM9 M2 HM4 S2 M6 HM5	M4 A2 M7 S3 M9 A1 F1	F1A HM3	HM2 H1	HM7	M3
30 – 40	S2	M1 HM1 S1 M2 HM4 S3 M6 HM5 A1 M7 HM9 A2	M4 M9 HM3 F1	F1A H1	HM2 HM7		M3 HM2 HM6
20 – 30	M1 HM5 S1 M2 HM9 S2 HM4	M4 M9 S3 M6 HM1 A1 M7 HM4 A2	HM3 F1 H1 F1A	HM2	HM7	M3 HM2 HM6	
15 – 20	M1 HM4 S1 M2 HM5 S2 HM1 HM9	M4 M9 S3 M6 HM3 A1 M7 H1 A2	F1A F1	HM2 HM7		M3 HM2 HM6	
10 – 15	M1 HM1 HM9 M2 HM4 S1 H1 HM5 S2	M4 M9 A1 M6 HM3 A2 M7 S3	F1A F1	HM2 HM7	M3 HM6	HM2	
5 – 10	M1 HM1 S1 M2 HM4 S3 M4 HM5 A2 M6 HM9 S2 M7 H1	F1 F1A M9 HM3	HM2 HM7	HM6 HM7 M3	HM2		M5 M8

RANGE OF DISCHARGE REQUIRED IN G.P.M.


300
200
100
90
80
70
60
50
40
30
20
10
9
8
7
6
5
HEAD LOSS IN FEET
Maker: ASSMUS
Description: ½" trough filler
Nominal Nozzle Dia. 3/16"
Actual Nozzle Dia. 0.189"
Recommended Working Head: 200'
TEST MARK A1
1
2
3
4
5
6
7
8
9
10
15
20
DISCHARGE IN G.P.M.


Maker: ASSMUS
Description: ¾" trough filler
Nominal Nozzle Dia. 3/16"
Actual Nozzle Dia. 0.189"
Recommended Working Head: 200'
TEST MARK A2
300
200
100
90
80
70
60
50
40
30
20
10
9
8
7
6
5
HEAD LOSS IN FEET
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·6
·7
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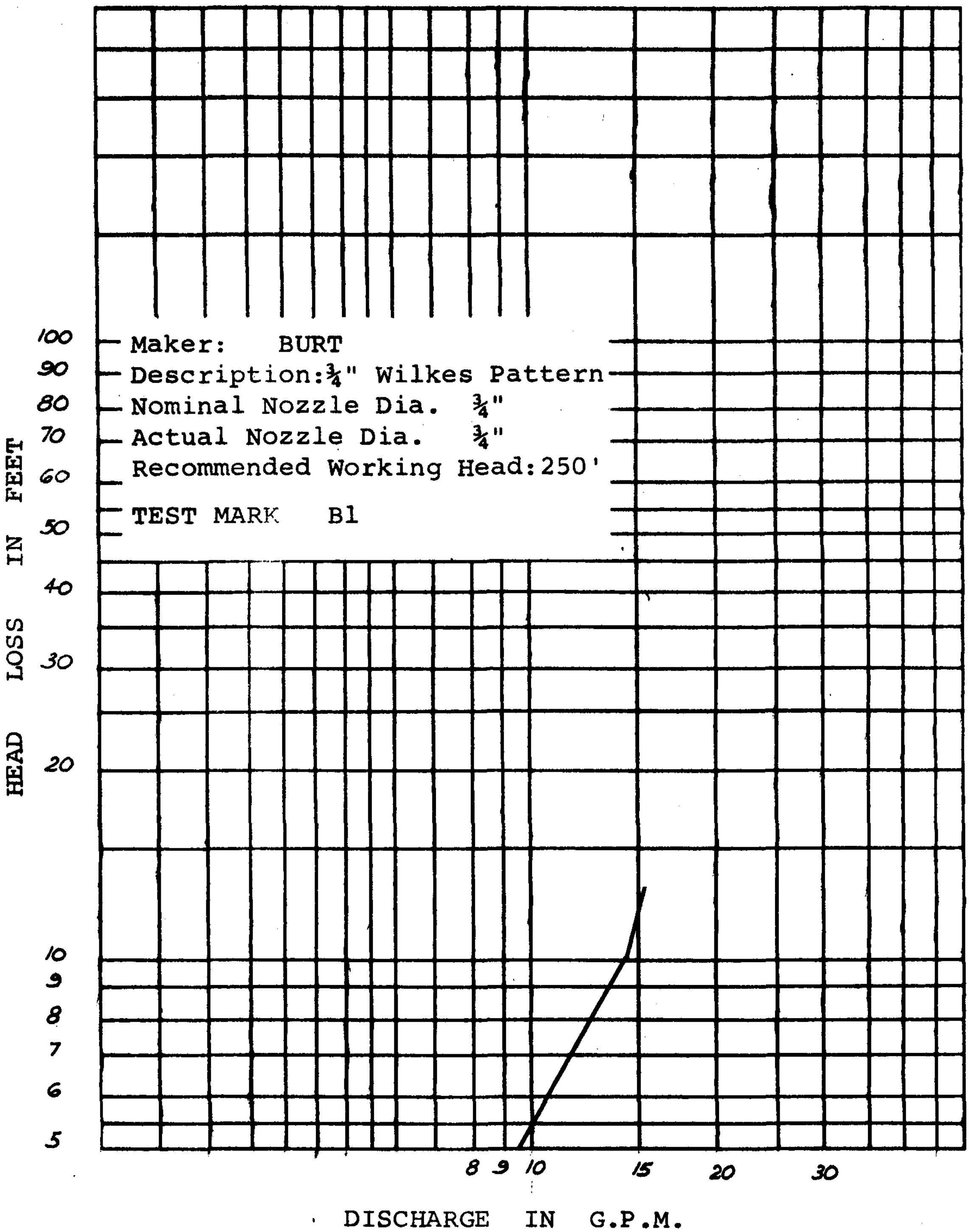
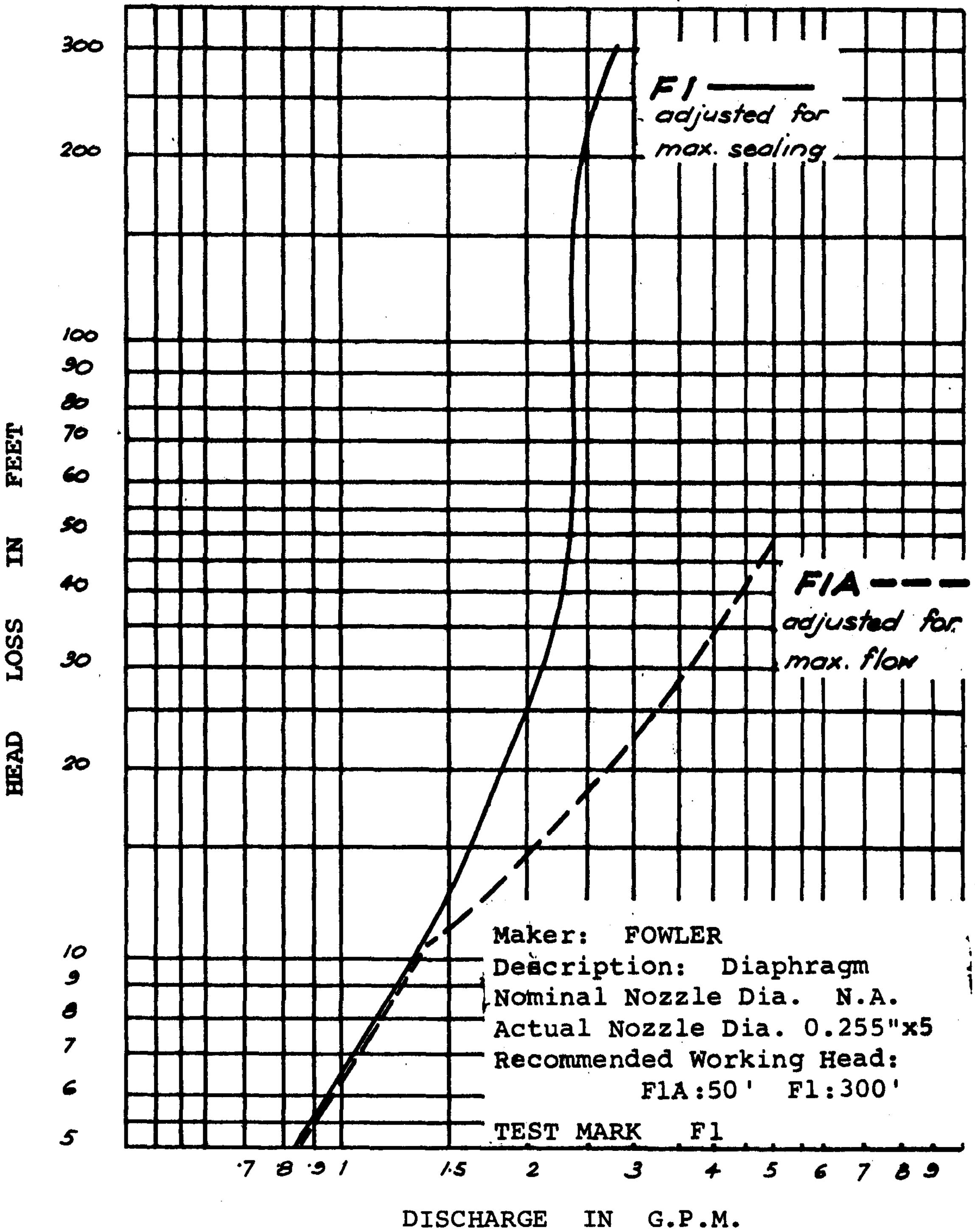
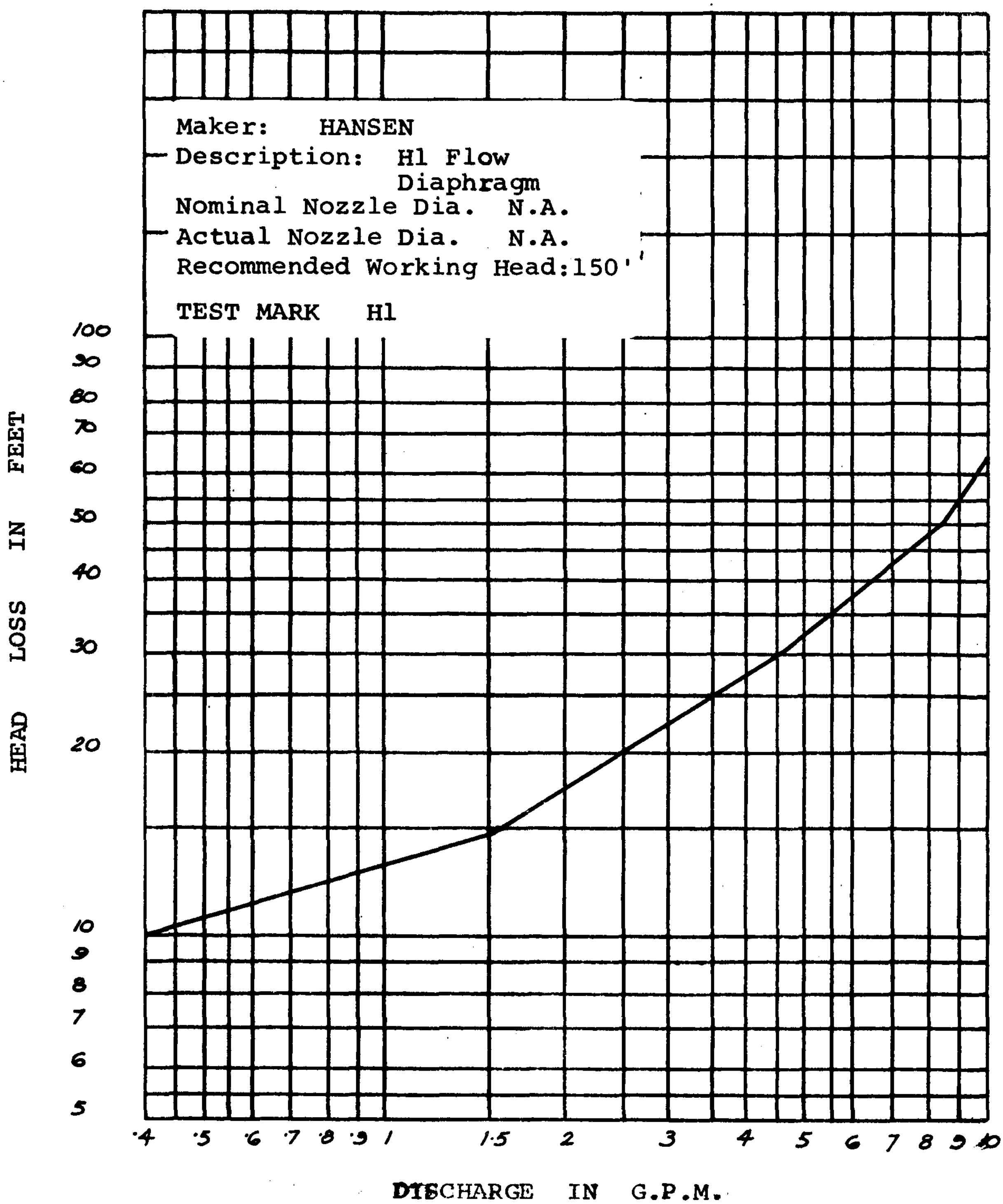
1
1·5
2
3
4
5
6
DISCHARGE IN G.P.M.

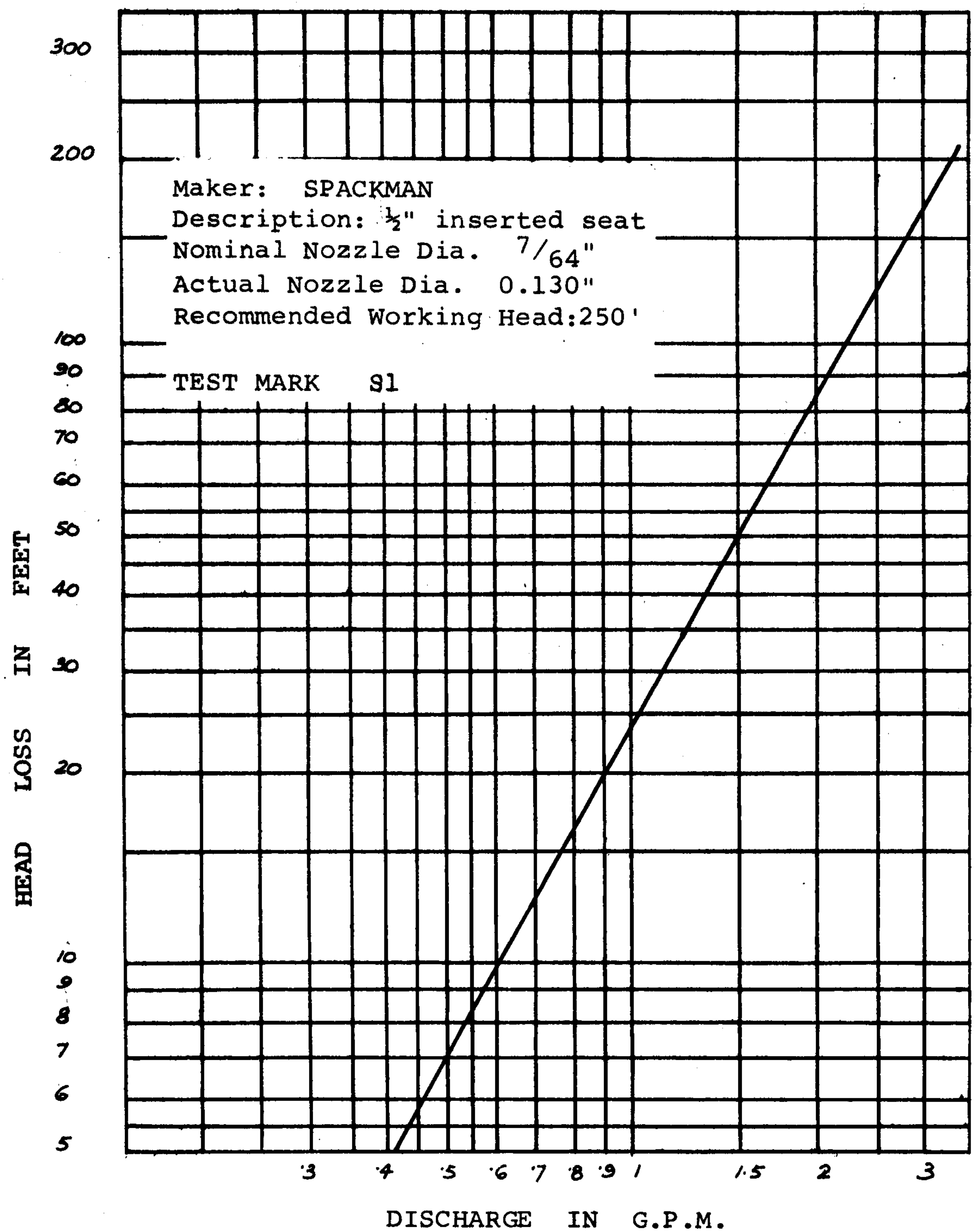

Maker: BURT
Description: ¾" Wilkes Pattern
Nominal Nozzle Dia. ¾"
Actual Nozzle Dia. ¾"
Recommended Working Head: 250'
TEST MARK B1
HEAD LOSS IN FEET
100
90
80
70
60
50
40
30
20
10
9
8
7
6
5
8
9
10
15
20
30
DISCHARGE IN G.P.M.



HEAD LOSS IN FEET
300
200
100
90
80
70
60
50
40
30
20
10
9
8
7
6
5
·7 8 ·9 1 1·5 2 3 4 5 6 7 8 9
DISCHARGE IN G.P.M.
F1 ——— adjusted for max. sealing
F1A - - - adjusted for max. flow
Maker: FOWLER
Description: Diaphragm
Nominal Nozzle Dia. N.A.
Actual Nozzle Dia. 0.255"x5
Recommended Working Head:
F1A:50' F1:300'
TEST MARK F1



Maker: HANSEN
Description: H1 Flow Diaphragm
Nominal Nozzle Dia. N.A.
Actual Nozzle Dia. N.A.
Recommended Working Head:150''
TEST MARK H1
100
90
80
70
60
50
40
30
20
10
9
8
7
6
5
HEAD LOSS IN FEET
·4 ·5 ·6 ·7 ·8 ·9 1 1·5 2 3 4 5 6 7 8 9 10
DISCHARGE IN G.P.M.


Maker: SPACKMAN
Description: ½" inserted seat
Nominal Nozzle Dia. 7/64"
Actual Nozzle Dia. 0.130"
Recommended Working Head:250'
TEST MARK S1
HEAD LOSS IN FEET
300
200
100
90
80
70
60
50
40
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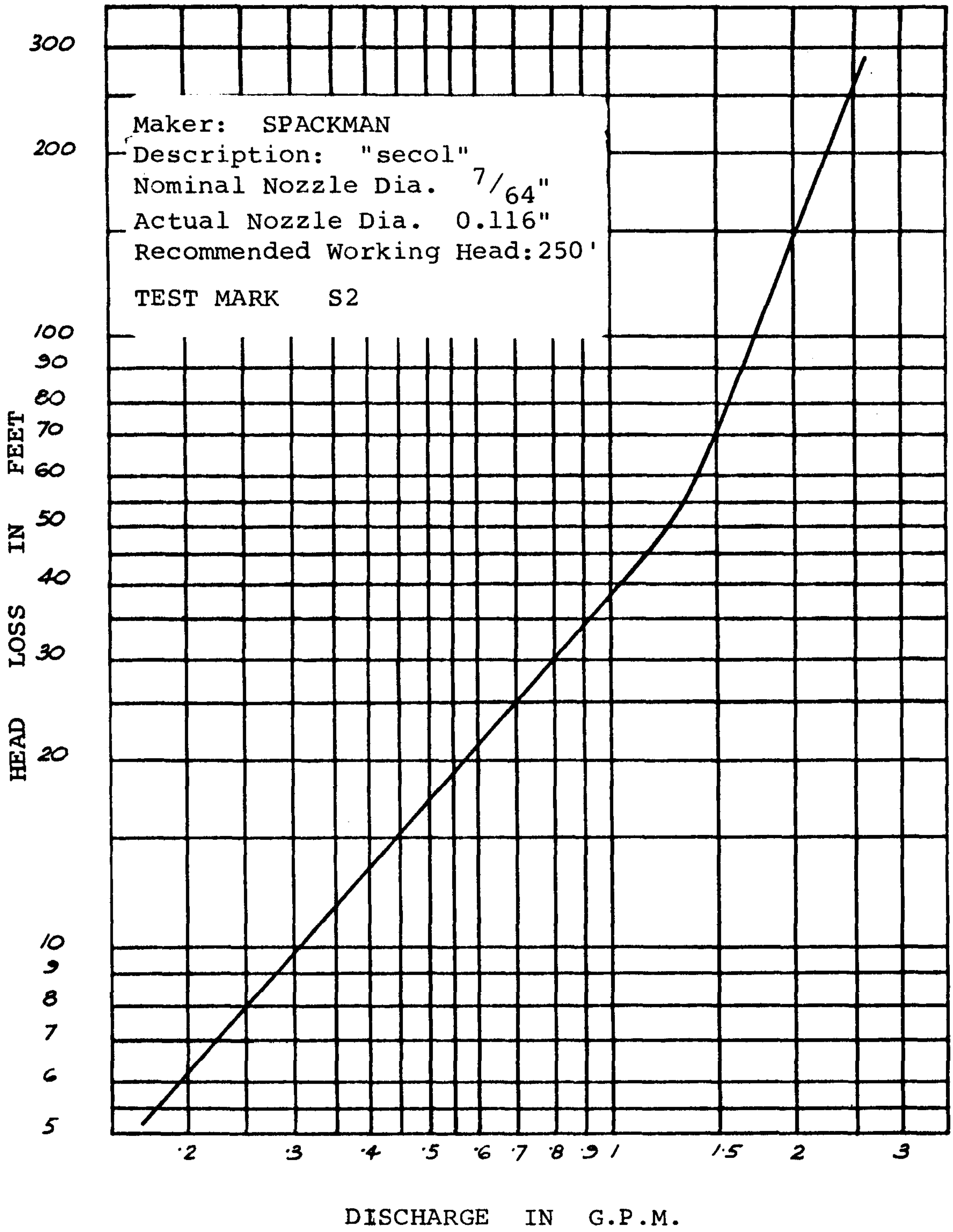
5
·3 ·4 ·5 ·6 ·7 ·8 ·9 1 1·5 2 3
DISCHARGE IN G.P.M.



Maker: SPACKMAN
Description: "secol"
Nominal Nozzle Dia. 7/64"
Actual Nozzle Dia. 0.116"
Recommended Working Head: 250'
TEST MARK S2
HEAD LOSS IN FEET
300
200
100
90
80
70
60
50
40
30
20
10
9
8
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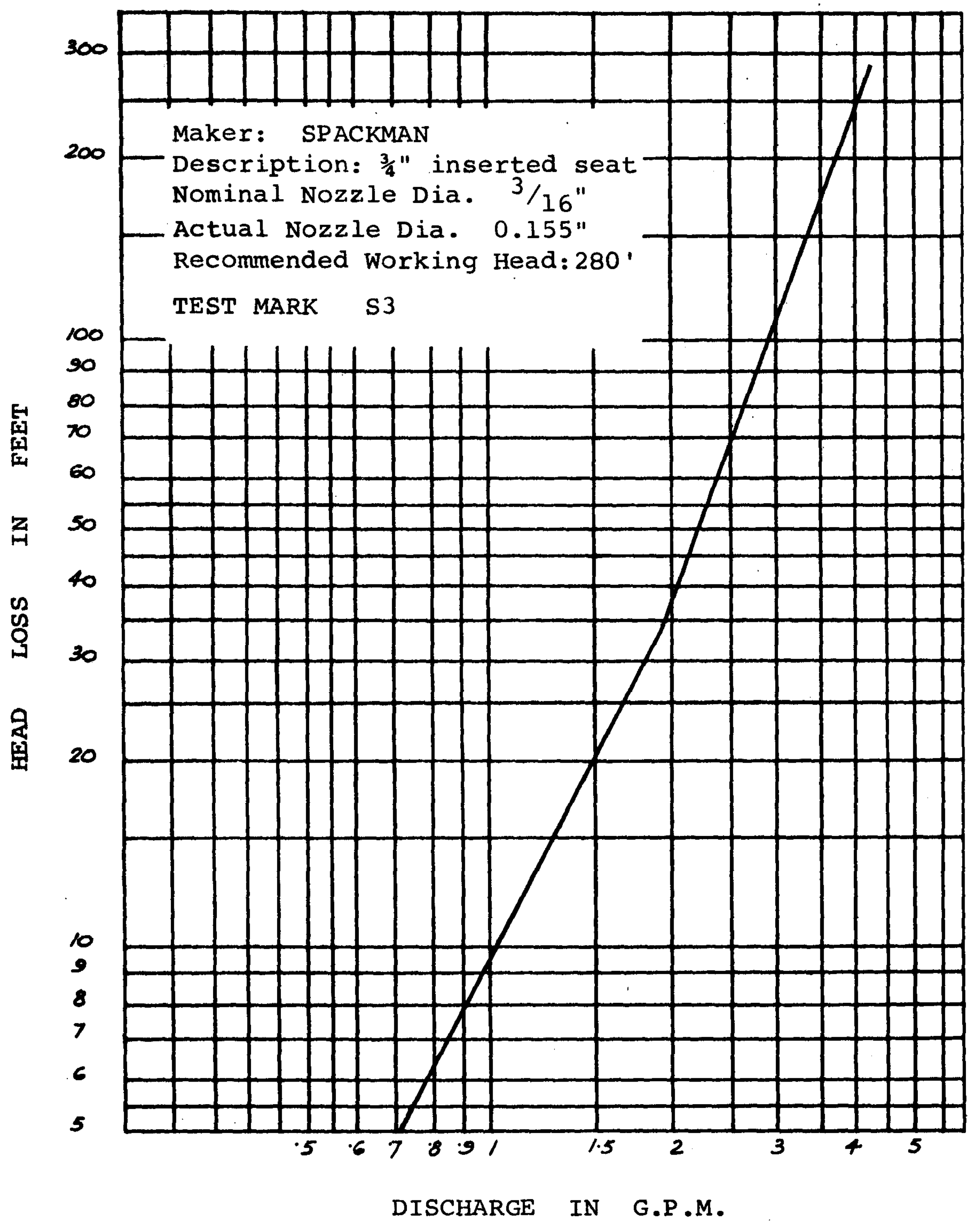
2
3
DISCHARGE IN G.P.M.


Maker: SPACKMAN
Description: ¾" inserted seat
Nominal Nozzle Dia. 3/16"
Actual Nozzle Dia. 0.155"
Recommended Working Head: 280'
TEST MARK S3
300
200
100
90
80
70
60
50
40
30
20
10
9
8
7
6
5
HEAD LOSS IN FEET
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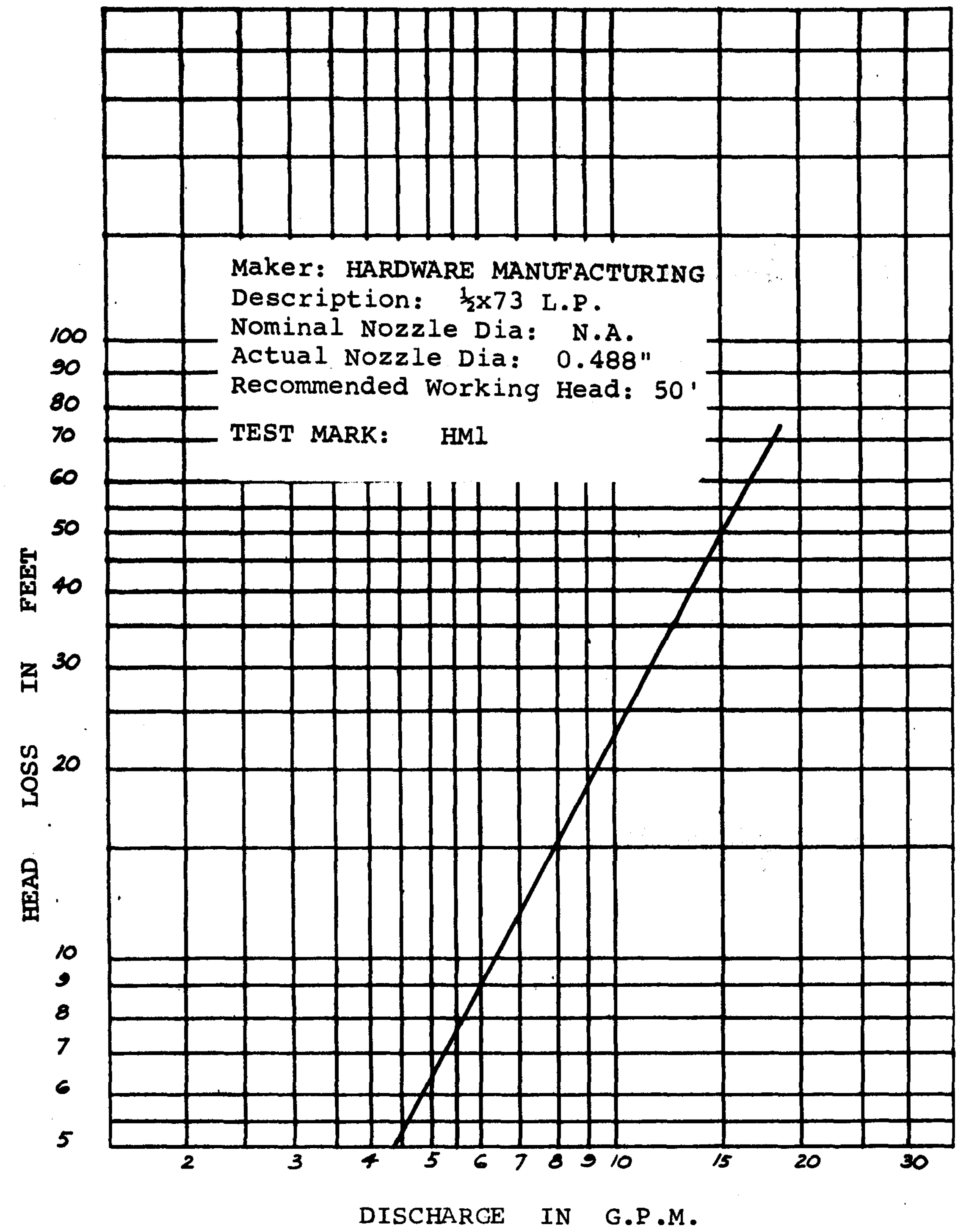
1
1·5
2
3
4
5
DISCHARGE IN G.P.M.


Maker: HARDWARE MANUFACTURING
Description: ½x73 L.P.
Nominal Nozzle Dia: N.A.
Actual Nozzle Dia: 0.488"
Recommended Working Head: 50'
TEST MARK: HM1
HEAD LOSS IN FEET
100
90
80
70
60
50
40
30
20
10
9
8
7
6
5
2
3
4
5
6
7
8
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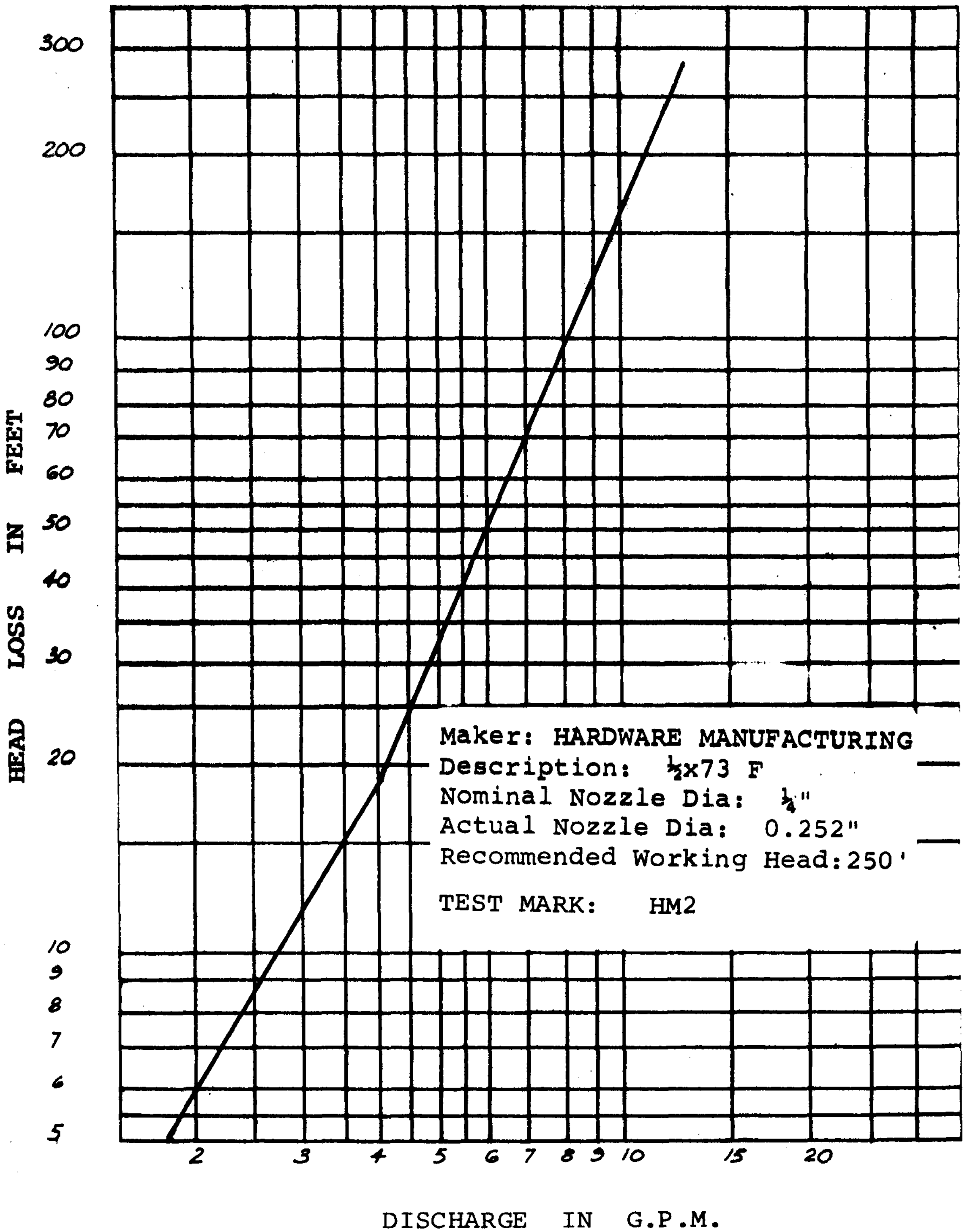
15
20
30
DISCHARGE IN G.P.M.


Maker: HARDWARE MANUFACTURING
Description: ½x73 F
Nominal Nozzle Dia: ¼"
Actual Nozzle Dia: 0.252"
Recommended Working Head: 250'
TEST MARK: HM2
HEAD LOSS IN FEET
300
200
100
90
80
70
60
50
40
30
20
10
9
8
7
6
5
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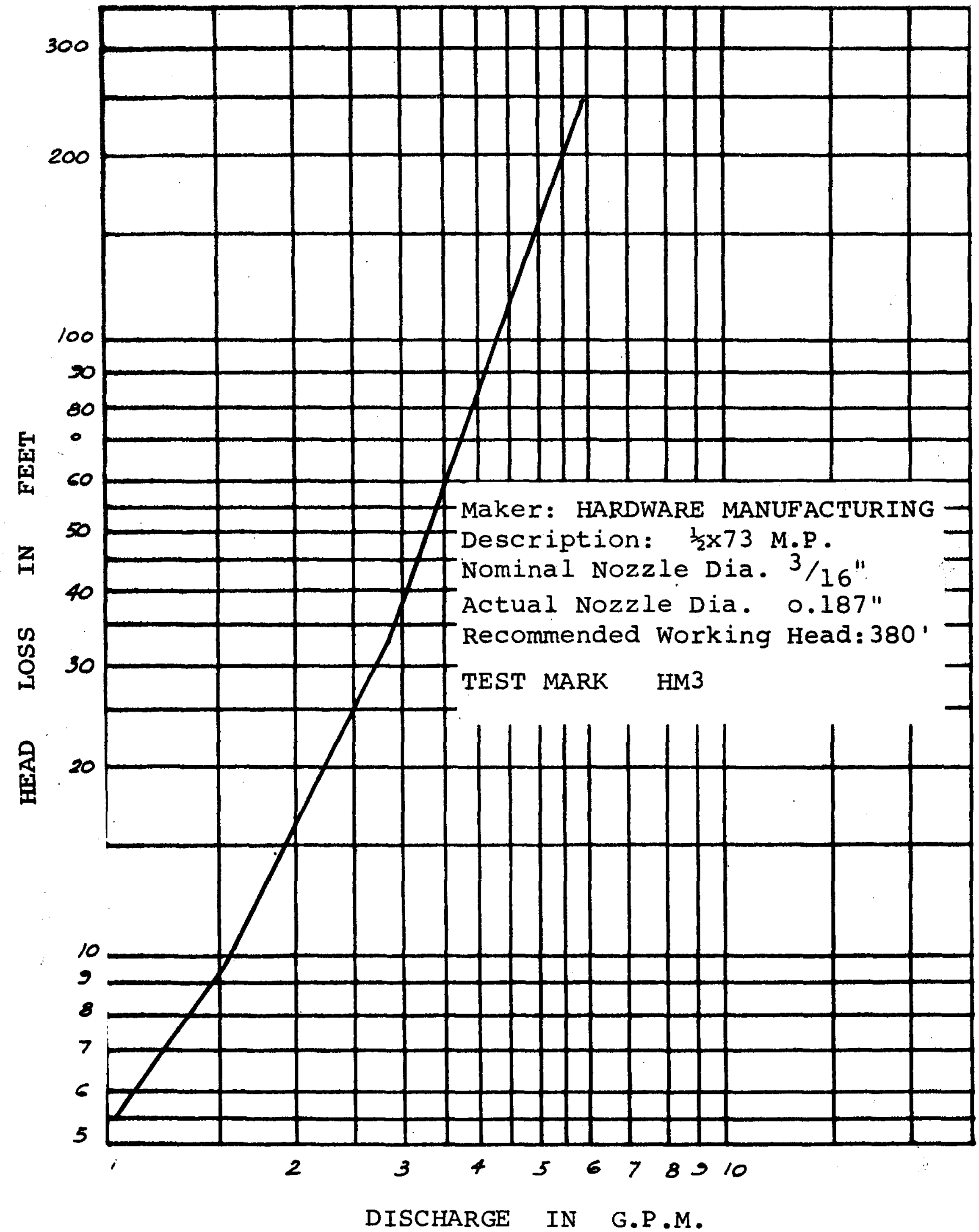
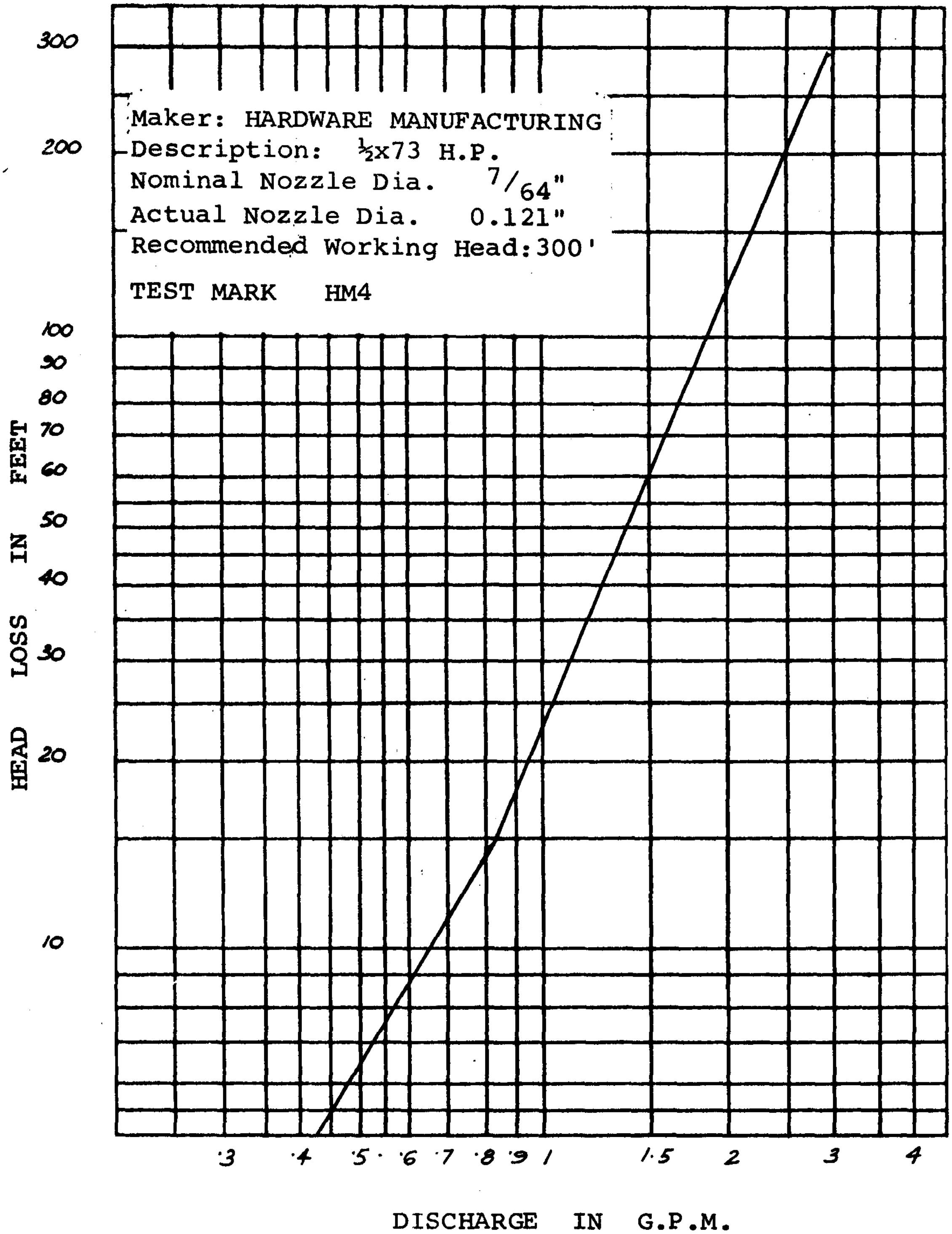
15
20
DISCHARGE IN G.P.M.



300
200
100
90
80
60
50
40
30
20
10
9
8
7
6
5
HEAD LOSS IN FEET
1
2
3
4
5
6
7
8
9
10
DISCHARGE IN G.P.M.
Maker: HARDWARE MANUFACTURING
Description: ½x73 M.P.
Nominal Nozzle Dia. 3/16"
Actual Nozzle Dia. o.187"
Recommended Working Head: 380'
TEST MARK HM3



Maker: HARDWARE MANUFACTURING
Description: ½x73 H.P.
Nominal Nozzle Dia. 7/64"
Actual Nozzle Dia. 0.121"
Recommended Working Head: 300'
TEST MARK HM4
HEAD LOSS IN FEET
300
200
100
90
80
70
60
50
40
30
20
10
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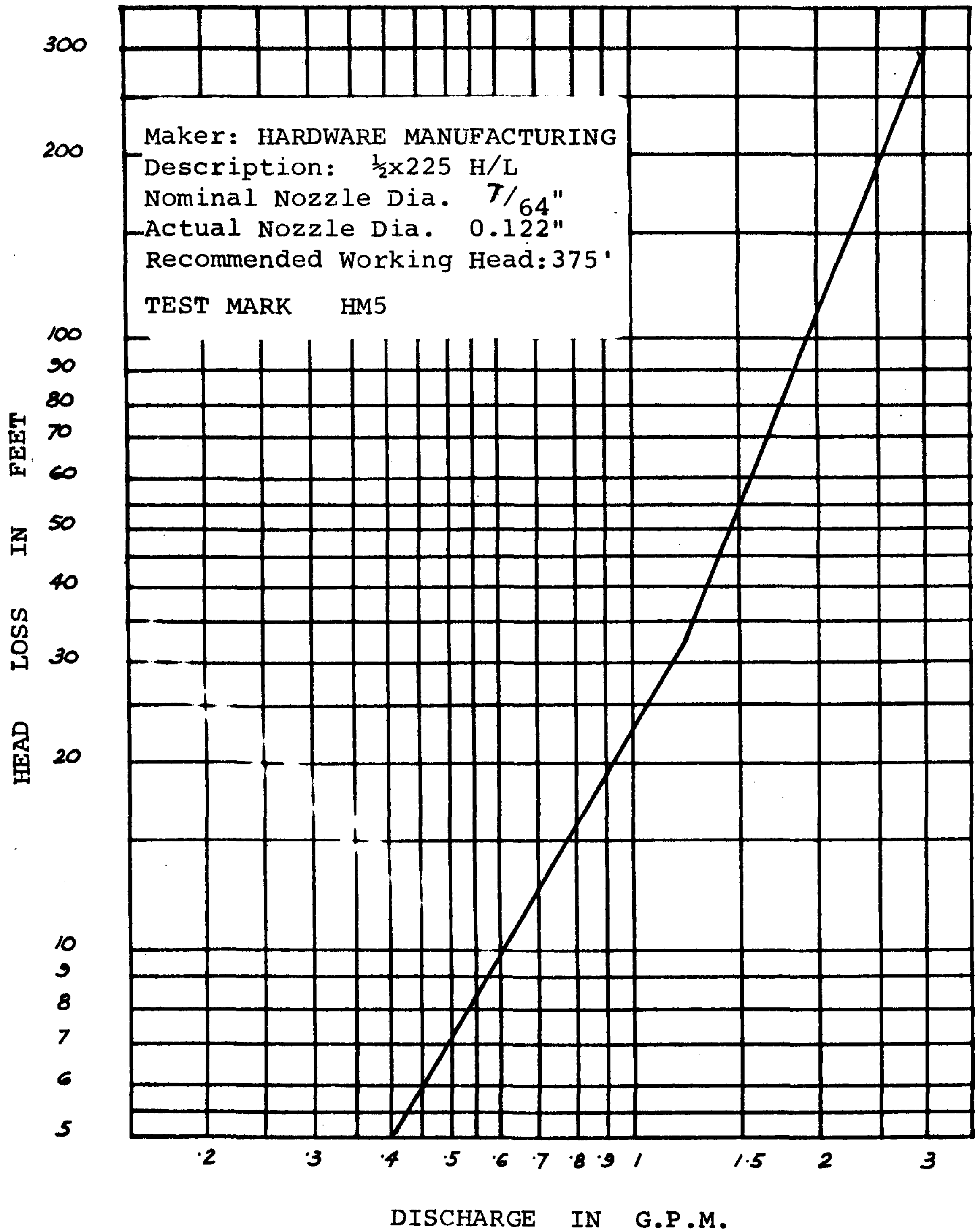
3
4
DISCHARGE IN G.P.M.



Maker: HARDWARE MANUFACTURING
Description: ½x225 H/L
Nominal Nozzle Dia. 7/64"
Actual Nozzle Dia. 0.122"
Recommended Working Head: 375'
TEST MARK HM5
HEAD LOSS IN FEET
300
200
100
90
80
70
60
50
40
30
20
10
9
8
7
6
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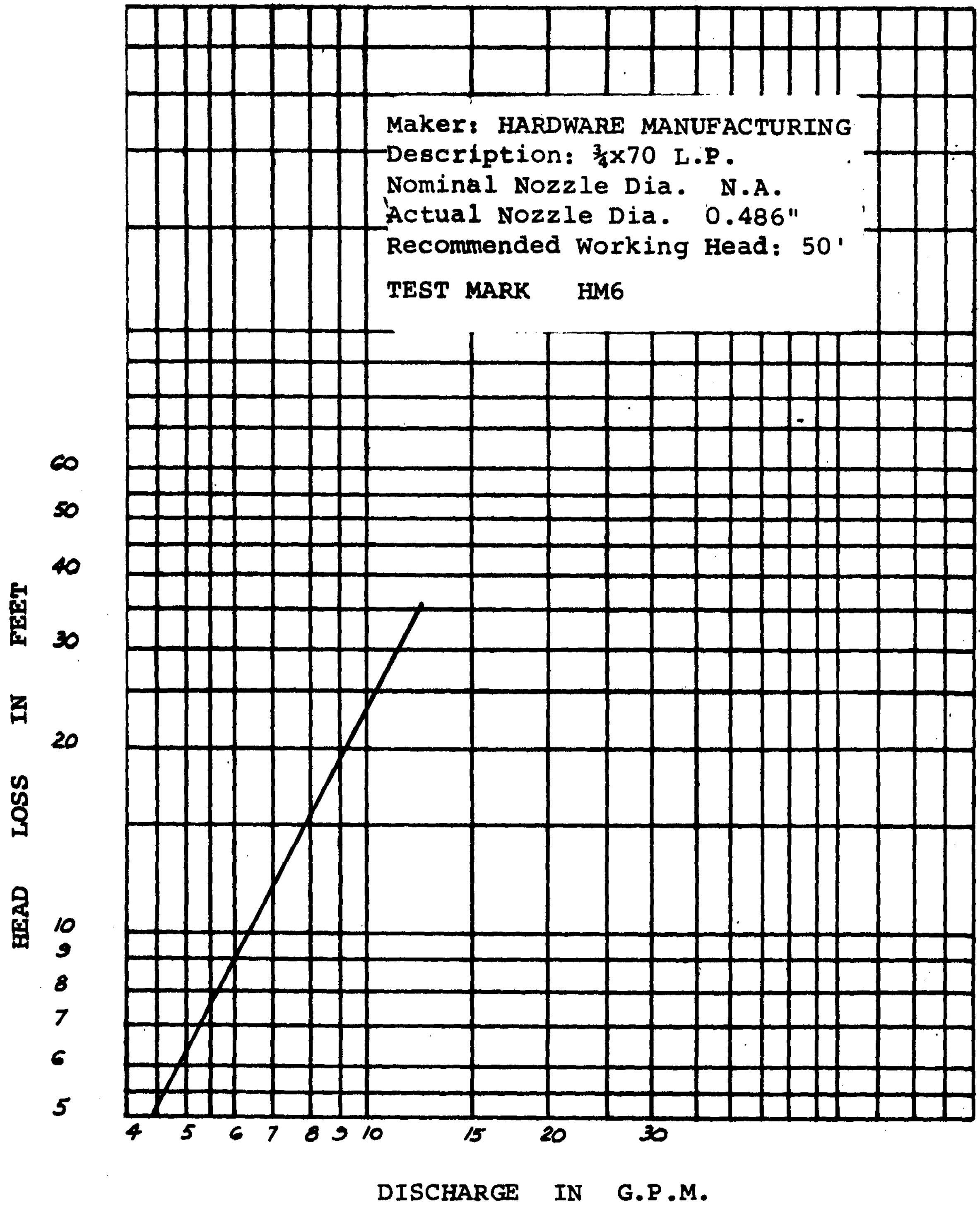
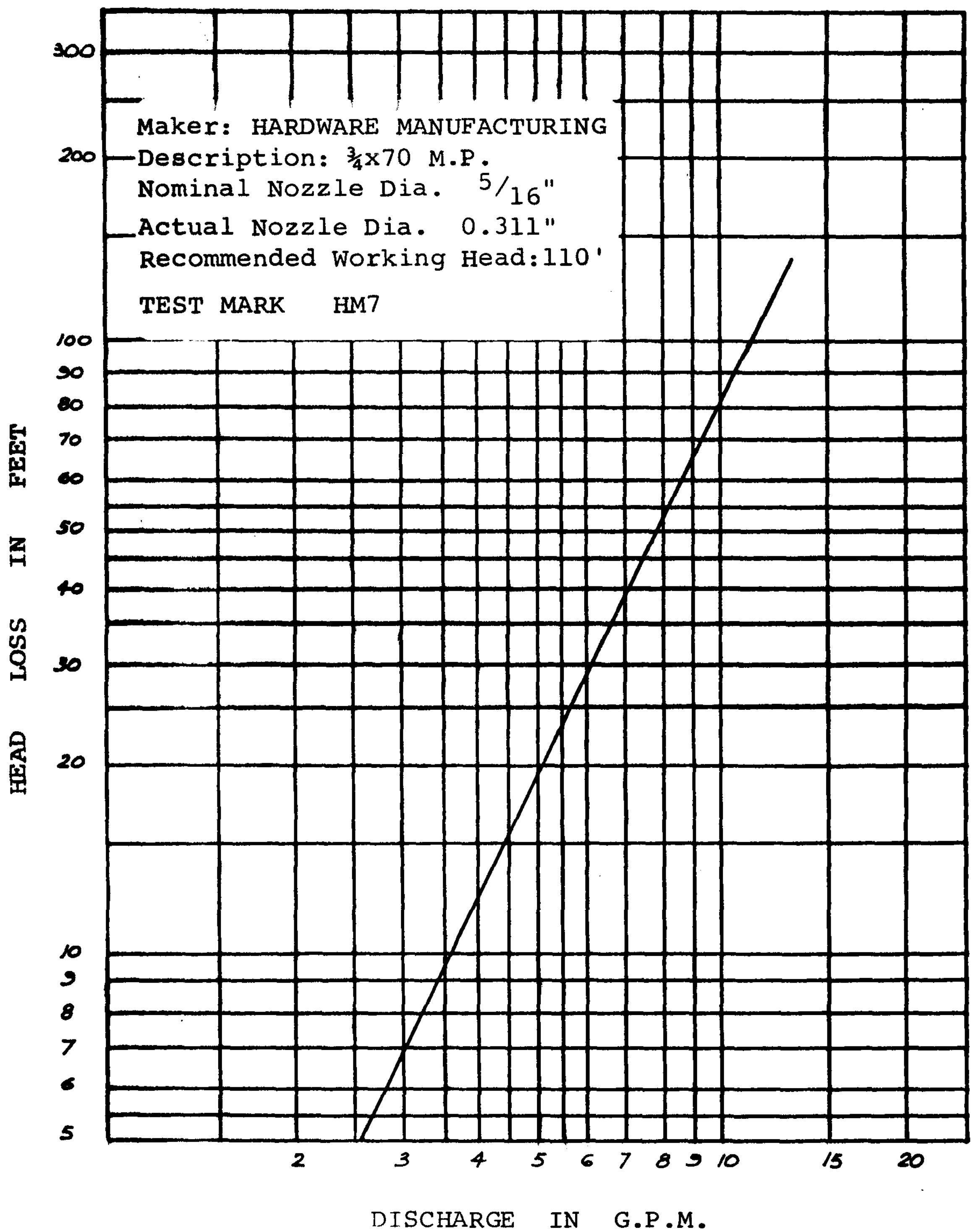
1
1·5
2
3
DISCHARGE IN G.P.M.


Maker: HARDWARE MANUFACTURING
Description: ¾x70 L.P.
Nominal Nozzle Dia. N.A.
Actual Nozzle Dia. 0.486"
Recommended Working Head: 50'
TEST MARK HM6
HEAD LOSS IN FEET
60
50
40
30
20
10
9
8
7
6
5
4 5 6 7 8 9 10 15 20 30
DISCHARGE IN G.P.M.


Maker: HARDWARE MANUFACTURING
Description: ¾x70 M.P.
Nominal Nozzle Dia. 5/16"
Actual Nozzle Dia. 0.311"
Recommended Working Head:110'
TEST MARK HM7
HEAD LOSS IN FEET
300
200
100
90
80
70
60
50
40
30
20
10
9
8
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6
5
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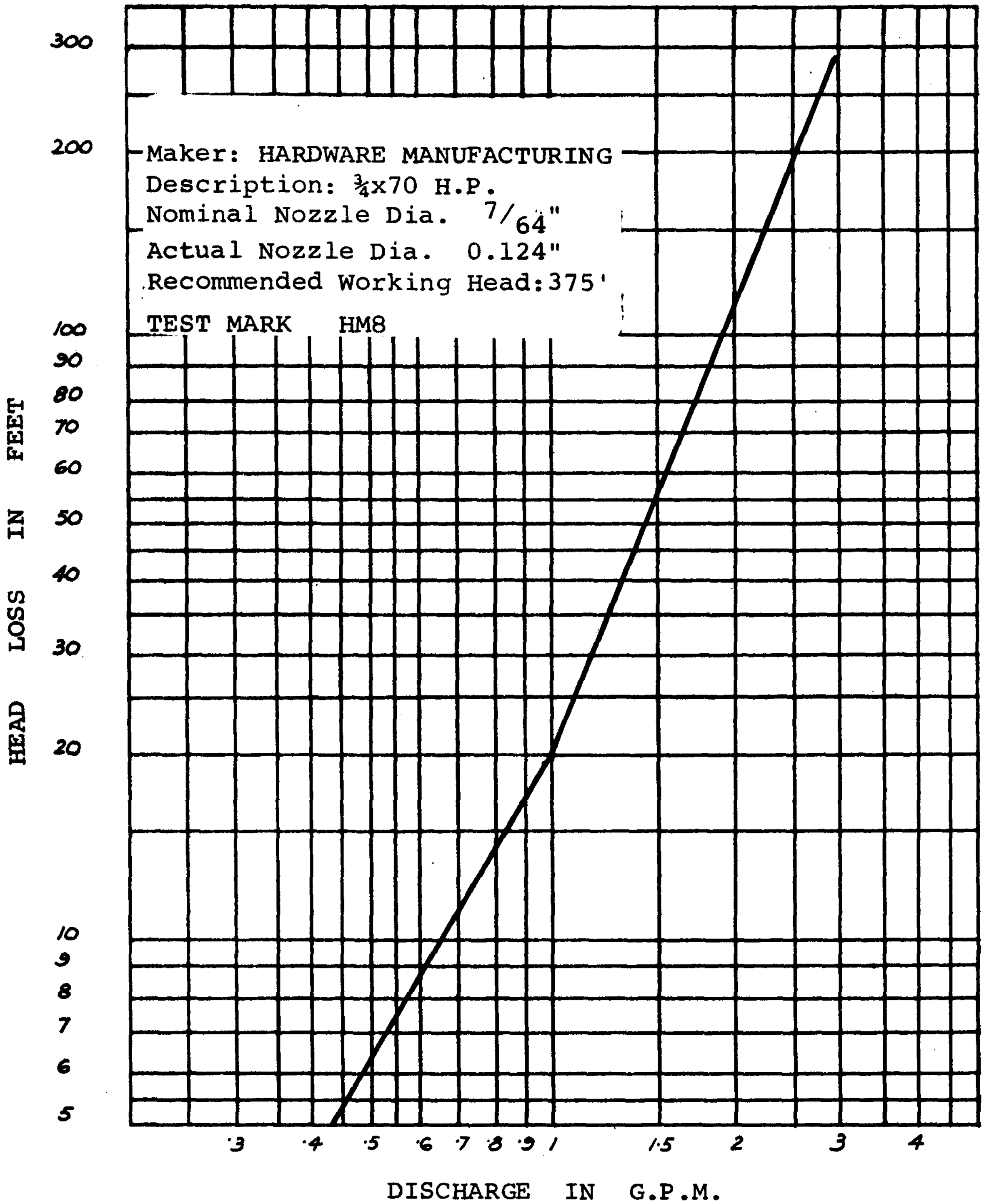
10
15
20
DISCHARGE IN G.P.M.


Maker: HARDWARE MANUFACTURING
Description: ¾x70 H.P.
Nominal Nozzle Dia. 7/64"
Actual Nozzle Dia. 0.124"
Recommended Working Head:375'
TEST MARK HM8
300
200
100
90
80
70
60
50
40
30
20
10
9
8
7
6
5
HEAD LOSS IN FEET
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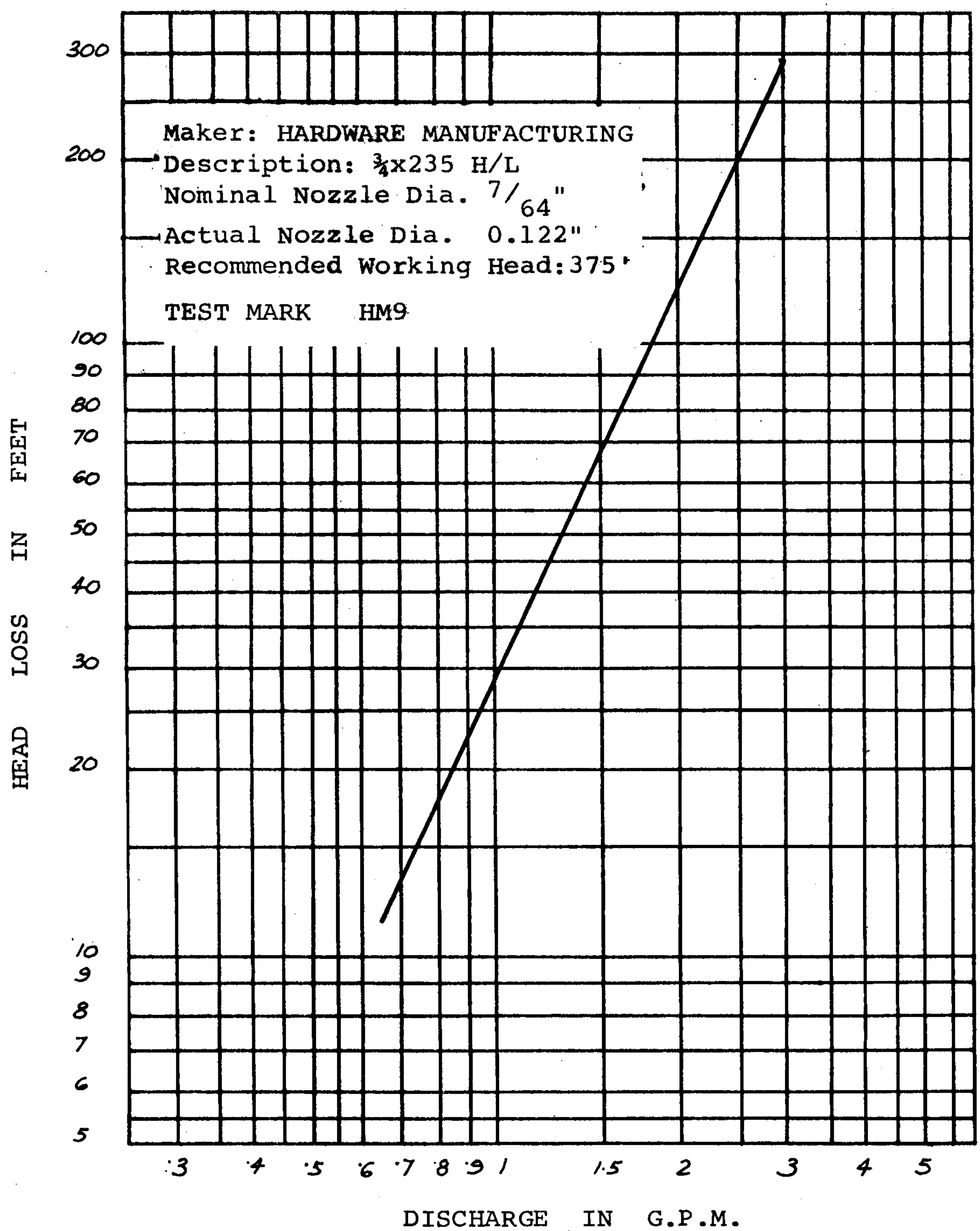
1
1·5
2
3
4
DISCHARGE IN G.P.M.


Maker: HARDWARE MANUFACTURING
Description: ¾x235 H/L
Nominal Nozzle Dia. 7/64"
Actual Nozzle Dia. 0.122"
Recommended Working Head: 375'
TEST MARK HM9
300
200
100
90
80
70
60
50
40
30
20
10
9
8
7
6
5
HEAD LOSS IN FEET
·3
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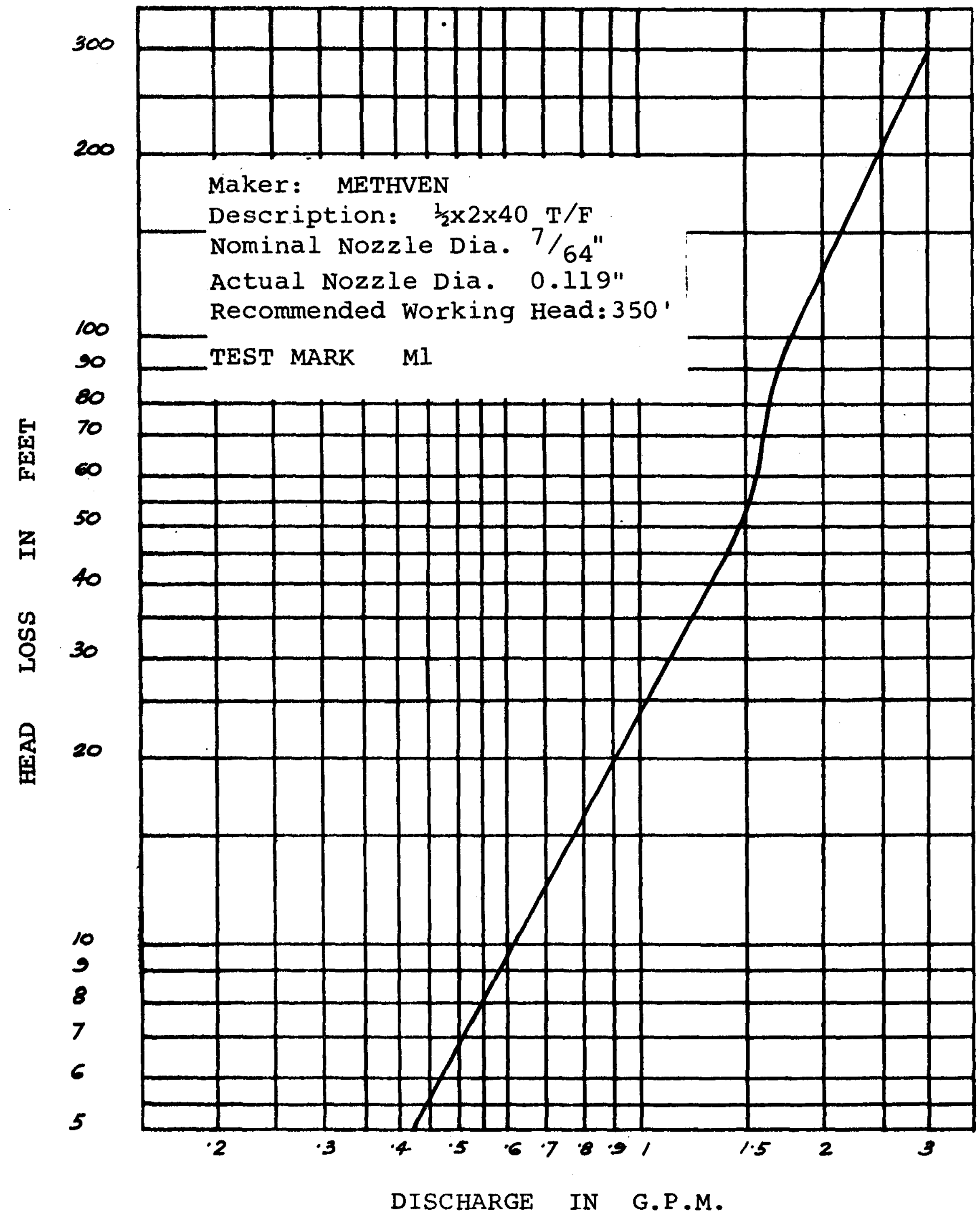
1
1.5
2
3
4
5
DISCHARGE IN G.P.M.


Maker: METHVEN
Description: ½x2x40 T/F
Nominal Nozzle Dia. 7/64"
Actual Nozzle Dia. 0.119"
Recommended Working Head: 350'
TEST MARK M1
HEAD LOSS IN FEET
300
200
100
90
80
70
60
50
40
30
20
10
9
8
7
6
5
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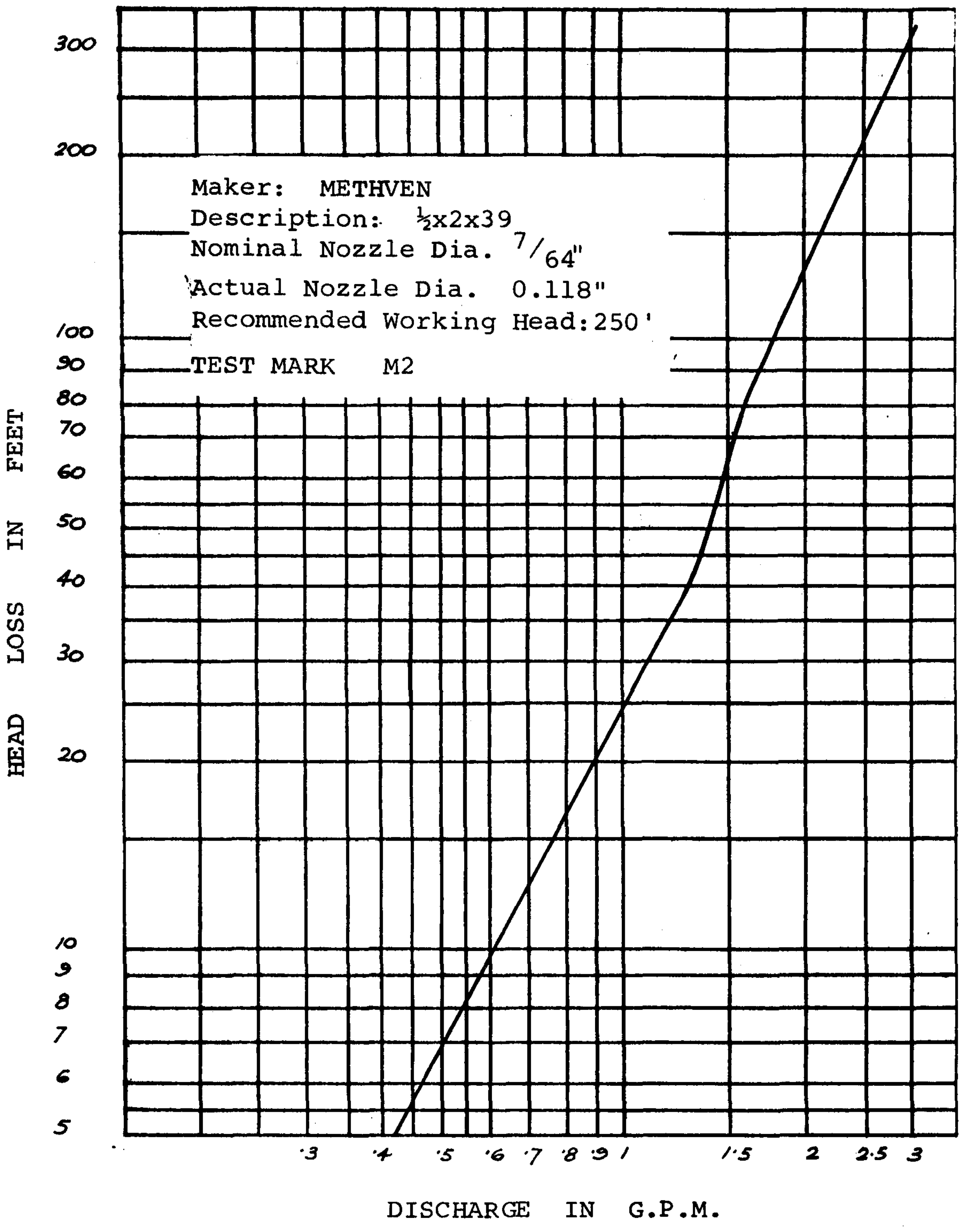
1
1·5
2
3
DISCHARGE IN G.P.M.


Maker: METHVEN
Description: ½x2x39
Nominal Nozzle Dia. 7/64"
Actual Nozzle Dia. 0.118"
Recommended Working Head: 250'
TEST MARK M2
HEAD LOSS IN FEET
300
200
100
90
80
70
60
50
40
30
20
10
9
8
7
6
5
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·6
·7
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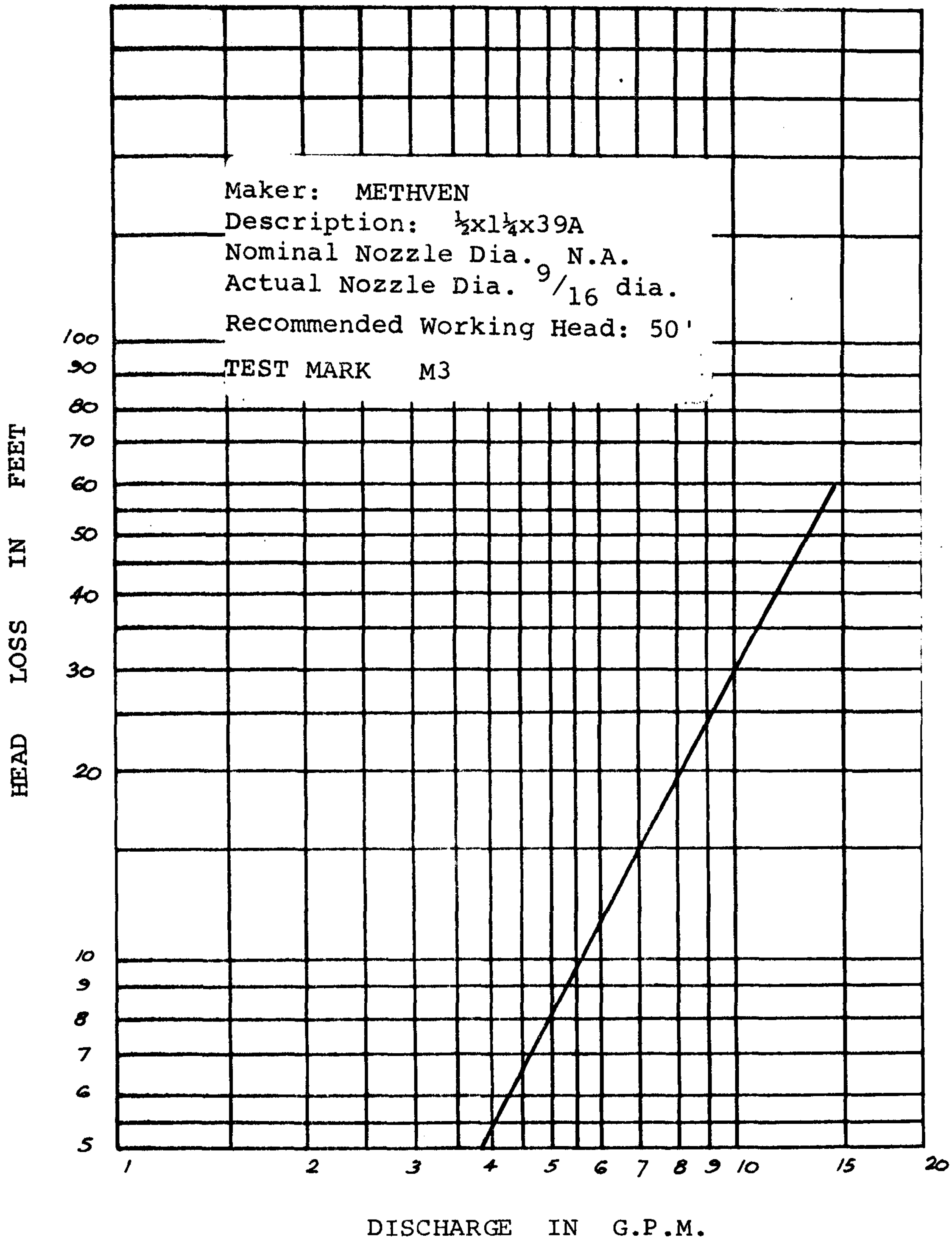
·9
1
1·5
2
2·5
3
DISCHARGE IN G.P.M.


Maker: METHVEN
Description: ½x1¼x39A
Nominal Nozzle Dia. N.A.
Actual Nozzle Dia. 9/16 dia.
Recommended Working Head: 50'
TEST MARK M3
HEAD LOSS IN FEET
100
90
80
70
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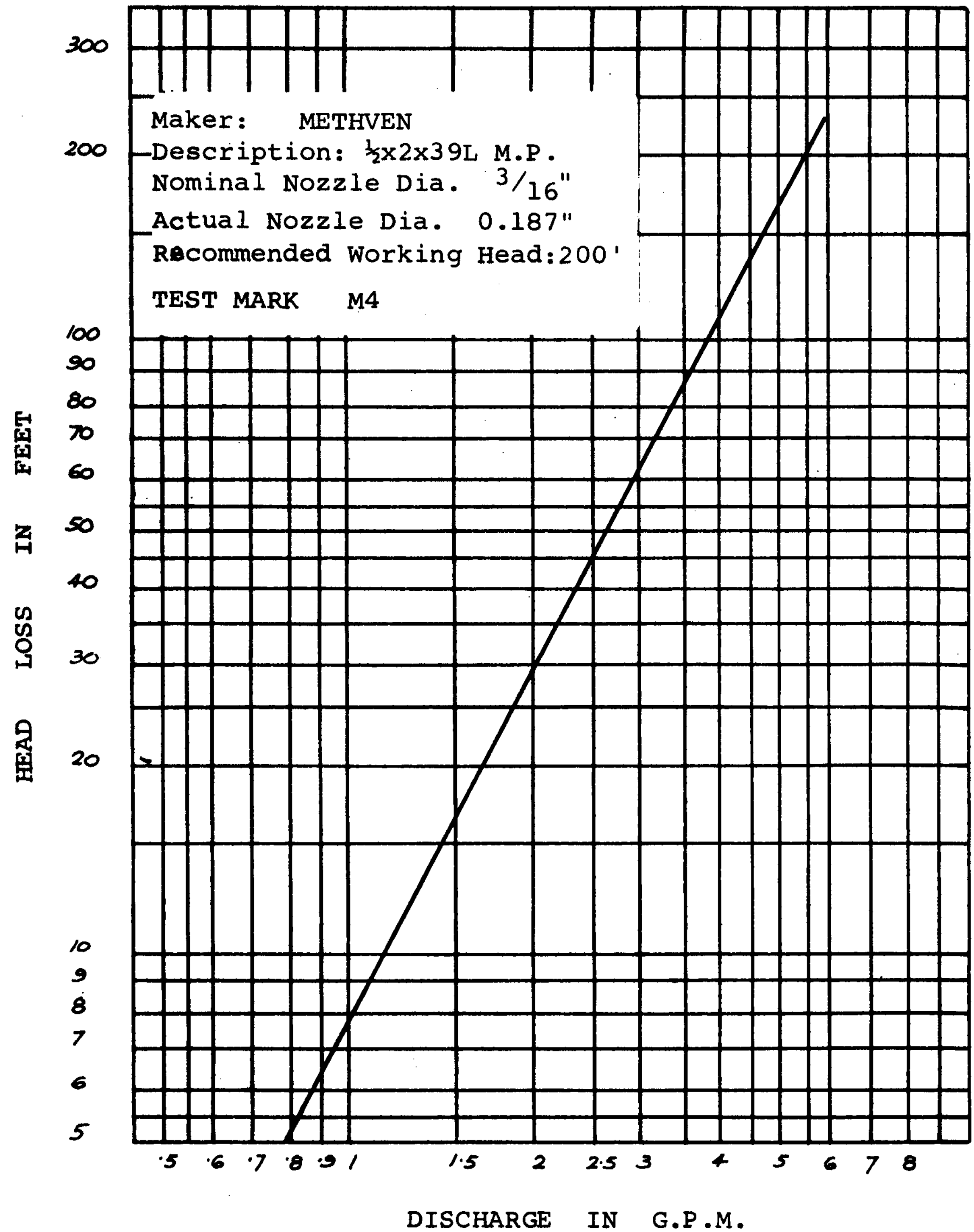
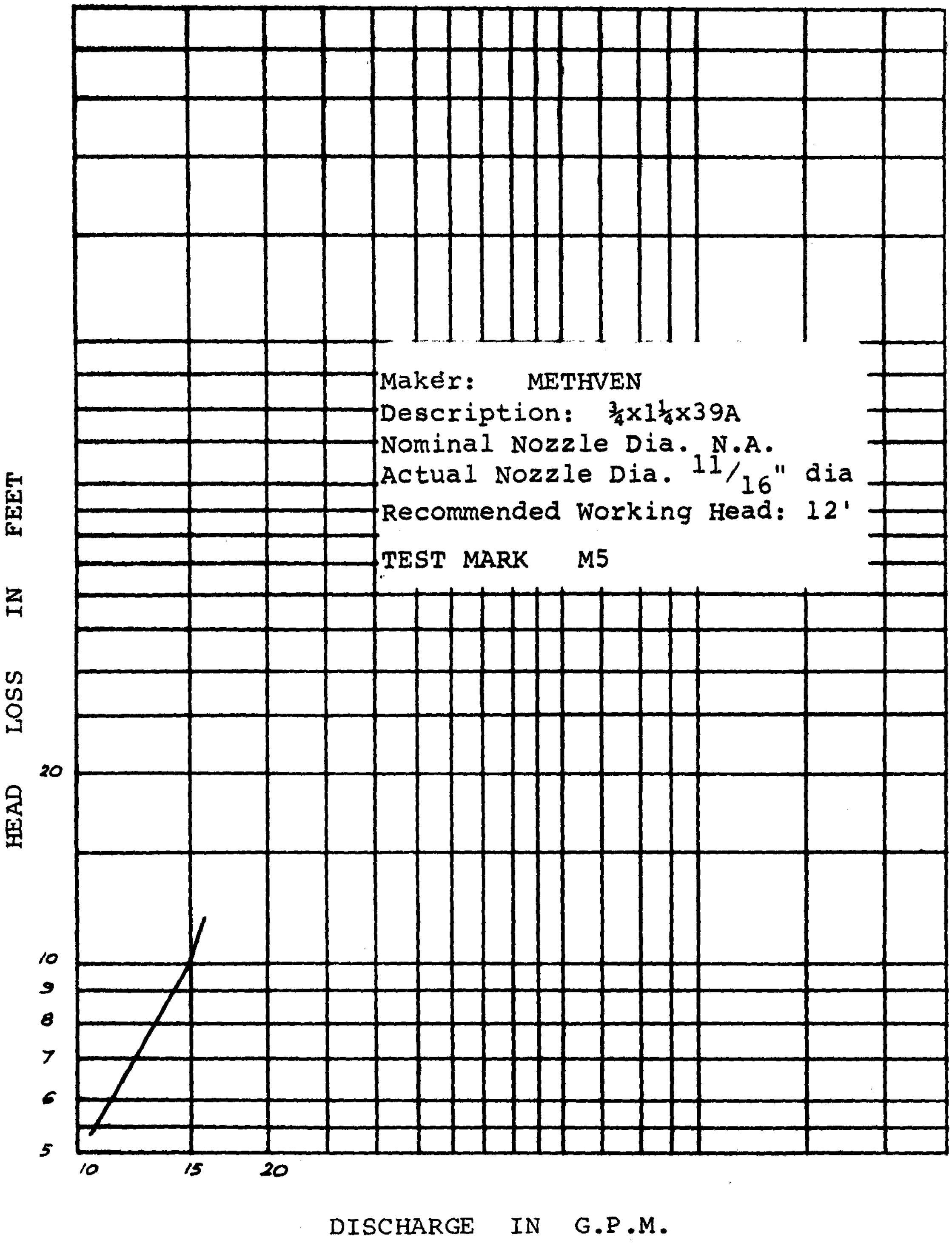
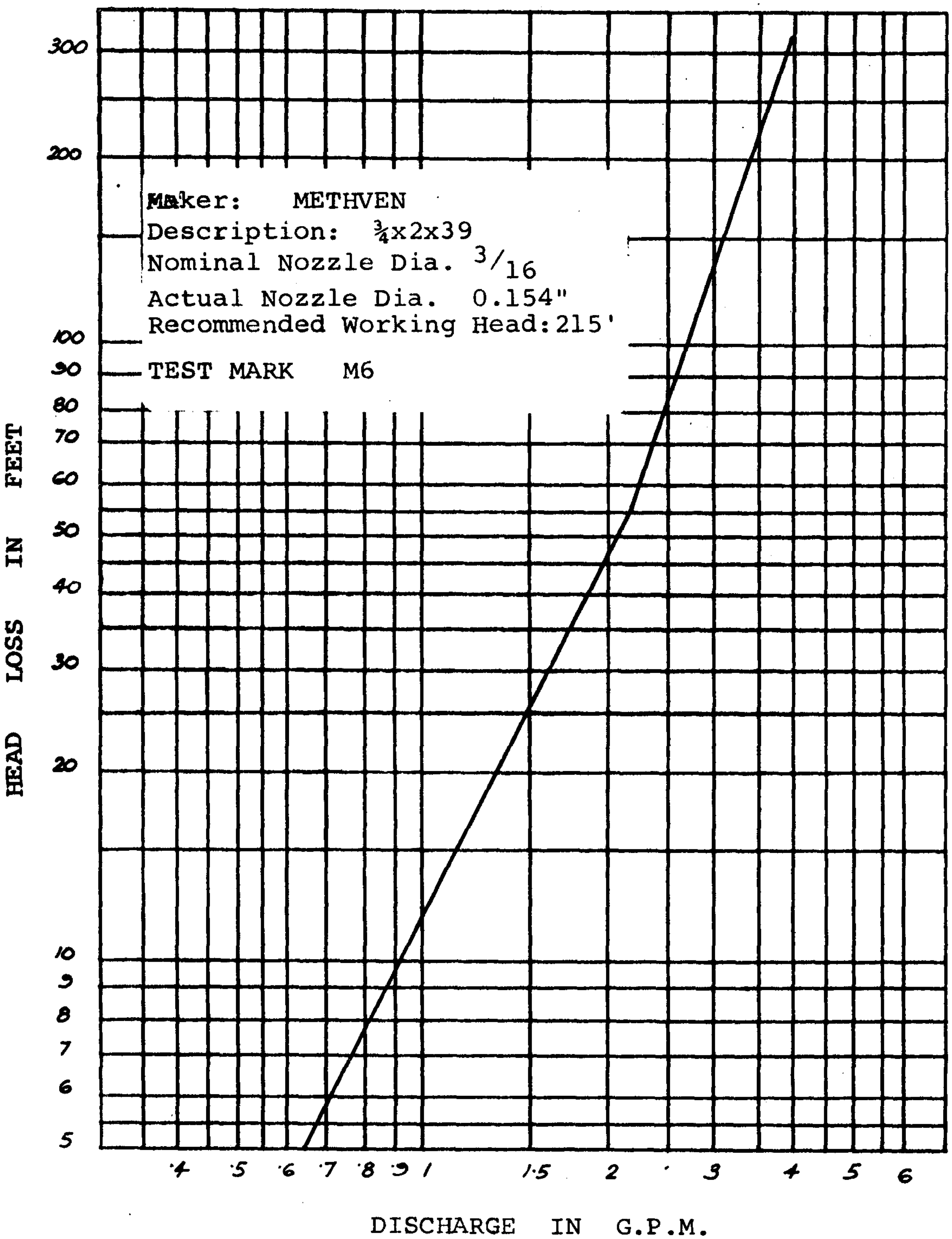
15
20
DISCHARGE IN G.P.M.



Maker: METHVEN
Description: ½x2x39L M.P.
Nominal Nozzle Dia. 3/16"
Actual Nozzle Dia. 0.187"
Recommended Working Head:200'
TEST MARK M4
HEAD LOSS IN FEET
300
200
100
90
80
70
60
50
40
30
20
10
9
8
7
6
5
·5 ·6 ·7 ·8 ·9 1 1·5 2 2·5 3 4 5 6 7 8
DISCHARGE IN G.P.M.


Maker: METHVEN
Description: ¾x1¼x39A
Nominal Nozzle Dia. N.A.
Actual Nozzle Dia. 11/16" dia
Recommended Working Head: 12'
TEST MARK M5
HEAD LOSS IN FEET
20
10
9
8
7
6
5
10
15
20
DISCHARGE IN G.P.M.



Maker: METHVEN
Description: ¾x2x39
Nominal Nozzle Dia. 3/16
Actual Nozzle Dia. 0.154"
Recommended Working Head: 215'
TEST MARK M6
300
200
100
90
80
70
60
50
40
30
20
10
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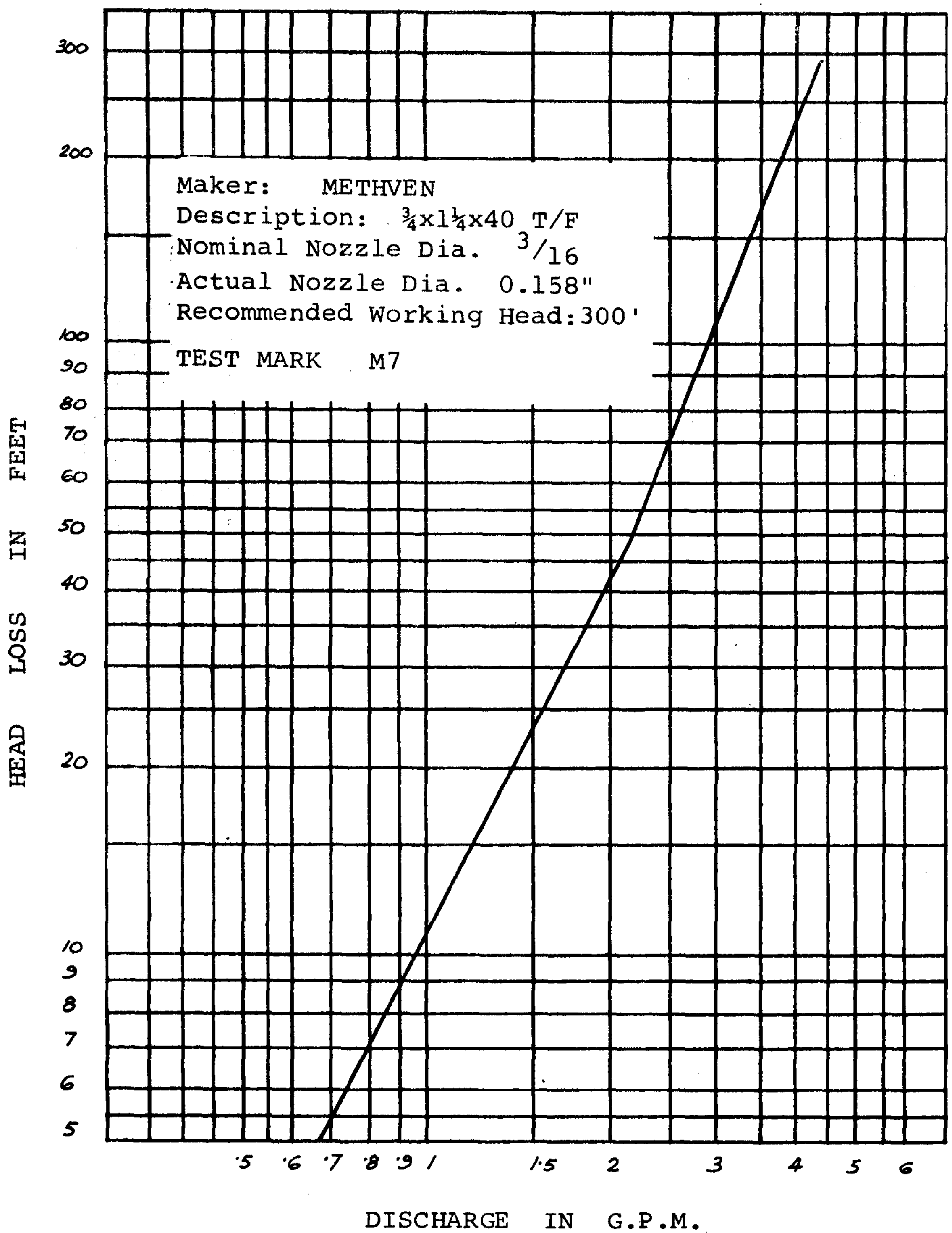
·4 ·5 ·6 ·7 ·8 ·9 1 1·5 2 3 4 5 6
HEAD LOSS IN FEET
DISCHARGE IN G.P.M.


Maker: METHVEN
Description: ¾x1¼x40 T/F
Nominal Nozzle Dia. 3/16
Actual Nozzle Dia. 0.158"
Recommended Working Head: 300'
TEST MARK M7
HEAD LOSS IN FEET
300
200
100
90
80
70
60
50
40
30
20
10
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·5 ·6 ·7 ·8 ·9 1 1·5 2 3 4 5 6
DISCHARGE IN G.P.M.