Exhibit No. 301

Commission – Exhibit 301
1968 Study
File No. WC-2021-0129

A STUDY OF THE EFFECT OF TIME OF SERVICE AND TOTAL REGISTRATION ON 5/8" METER ACCURACY AT ST. LOUIS COUNTY WATER COMPANY ST. LOUIS COUNTY, MISSOURI

TABLE OF CONTENTS

Purpose - 1968 Study

To collect, organize, review and present performance data of 5/8" meters in service for varying lengths of time in excess of nine years and for meters having unusually high registration.

This report also illustrates limited comparisons of meter data obtained in the 1950 and 1960 studies.

Conclusions

1. The 1968 study shows that meter performance at 1/8 gpm improves with increasing service age from 10 through 17 years as measured by both average per cent registration and per cent of total meters meeting minimum performance percentage.

2. The 1968 study shows that average meter performance at 2 gpm is acceptable throughout the service ages of 10 through 17 years. Eighty-nine to 91 per cent of total meters tested registered in an acceptable range in the service period 13 through 16 years.

Test results show that all meters with 15 years' service show an average of 100 per cent registration. Ninety-one per cent of these meters performed within acceptable limits of 98.5 per cent - 101.0 per cent registration.

Summary

1. Chart 1 is two overlay plottings of the duration curves for meters with 10 years, 13 years, 15 years and 17 years of service. Test results at 1/8 gallon per minute indicate a general improvement of the performance characteristics of these meters as the period of service progresses. This is illustrated as follows:

Per cent of Meters Testing in Excess of 80% Accuracy

64% of the 10-year group

79% of the 13-year group

85% of the 15-year group

93% of the 17-year group

The 2 gallon rate indicates very close configuration for each of the four year-groups studied.

2. Charts II and III illustrate plottings of average per cent registration for all meters in each of the year-groups. Chart II represents average performance at 1/8 gpm and again, following the same pattern shown in the duration curve plottings on Chart I, indicates a steady and significant increase in the average registration for meters 10 through 17 years, followed by a rather abrupt drop-off in performance in the 18th year.

Average performance at the 2 gallon rate illustrated on Chart III is not as graphic as that illustrated at the 1/8 rate; however, it is clear that following the 10th year of service, all remaining group averages fell between 99.7 and 100 per cent. This is excellent performance.

3. Charts IV and V present graphically those meters testing within or outside of established performance limits. Chart IV, illustrating performance at a 2 gpm rate, shows that meters performing acceptably within a range of 98.5 to 101 per cent represented only a variation of from 87 per cent to 91 per cent of the total for the years of service 10 through 17 and reached a maximum of 91 per cent at the 15th year of service.

Chart V shows steadily progressive improvement in performance at the 1/8 gallon per minute test through the 17th year.

4. Charts VI and VII present a comparison of the three separate and independent studies conducted by this Company over a span of approximately 18 years.

Group comparison for these studies is limited because the earlier 1950 and 1960 studies failed to obtain large enough numbers of meters in all of the year-groups surveyed in 1968 to allow direct significant com-

parison.

The 1950 study did not survey meters beyond 13 years of service and the sum of all meters surveyed in the 1960 study in the service-age period 14 through 20 years amounted to only 116 meters. Comparisons are therefore available only for the first four years between 10 and 13, along with meters showing high registrations.

These comparisons indicate reasonably good conformance between the three studies, if consideration is given to the fact that meters repaired during the 1936 to 1940 period were allowed to use a change gear combination 0.77 per cent higher than the present "gear up" limit. In a number of cases subsequent wear-in of other components within the meter would result in relatively higher percentages of registration, particularly in the upper ranges of the 2 gallon rate.

Presentation of Findings

Graphical forms of analysis were chosen as being the most suitable method of presentation of date of this type.

Chart I is an overlay plotting of the duration curves for four year-groups in the 1968 study: 10, 13, 15, and 17 years of service. These curves were plotted for each test rate so that any point on the curve may be read "X% of total meters tested registered more than Y%." Charts I through XII represent the duration curves for each of the two flow rates for each year-group studied.

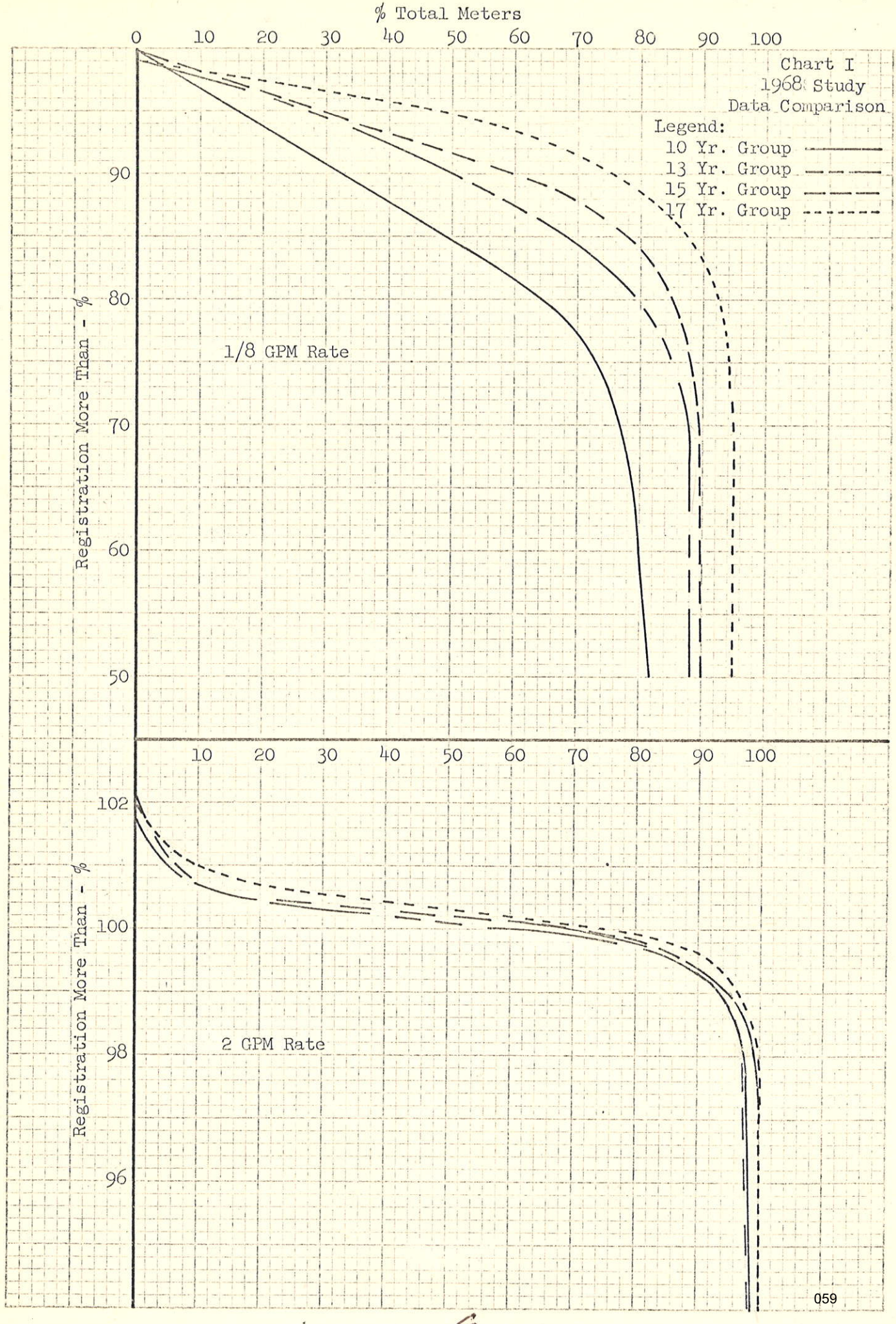
Charts II and III show the average percentage registration for all meters in each of the year-groups studied at the rates of flow indicated.

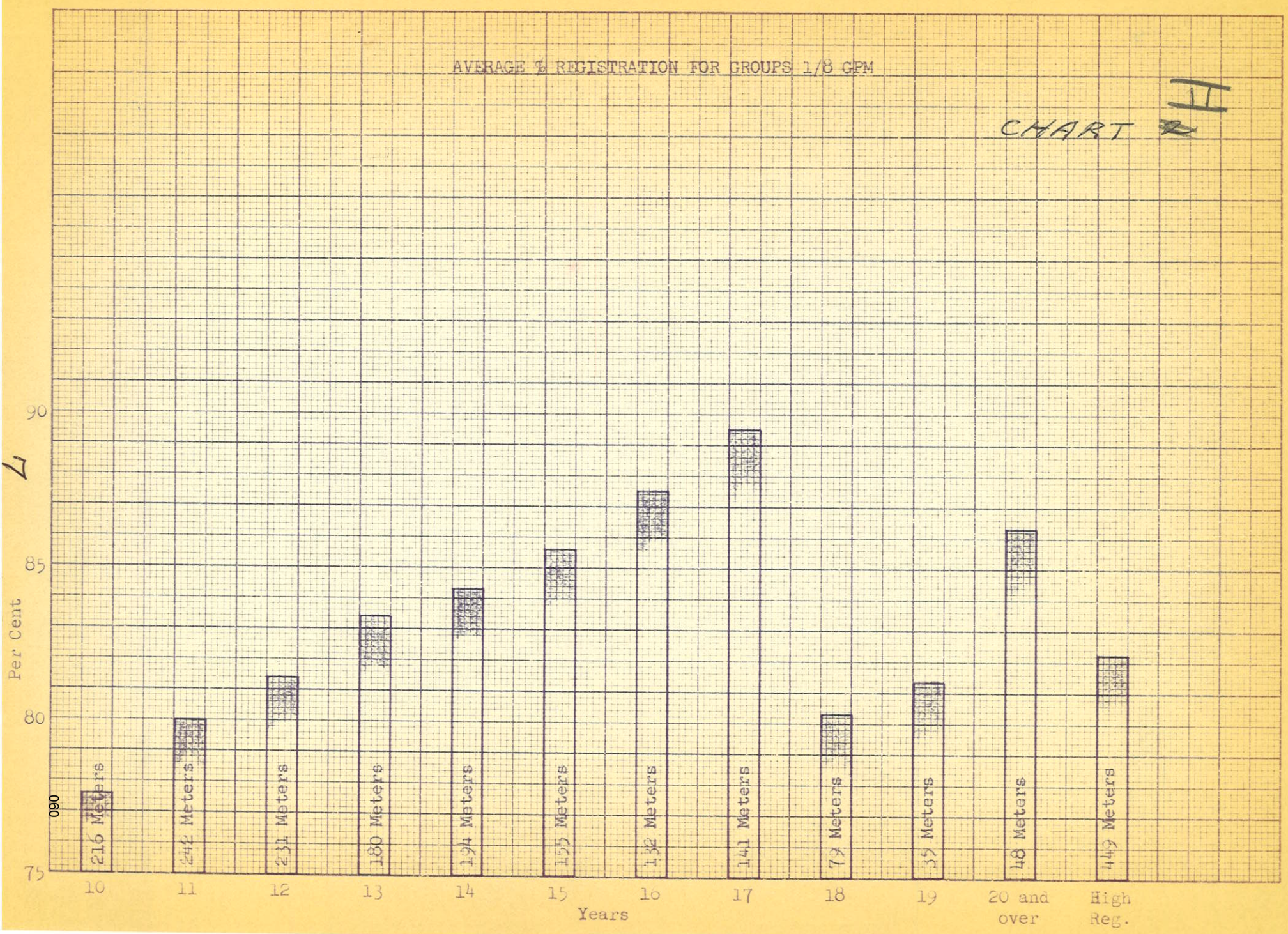
Charts IV and V show the distribution of meter performance broken down into the per cent of meters in each specific group that registered less than the minimum standard, more than a maximum standard, and within an acceptable range.

Charts VI and VII show the distribution of meter performance for those age groups of meters available allowing direct performance comparison between the 1950, the 1960, and the 1968 studies. In both 1950 and 1960 inadequate quantities of meters were obtainable to provide individual year comparison for those year-groups over 13. These charts indicate out-of-range performance meters at the two basic test rates in the same manner as Charts IV and V.

HISTORICAL RECORD
SYSTEM GROWTH - 10-YEAR METER CHANGE PROGRAM

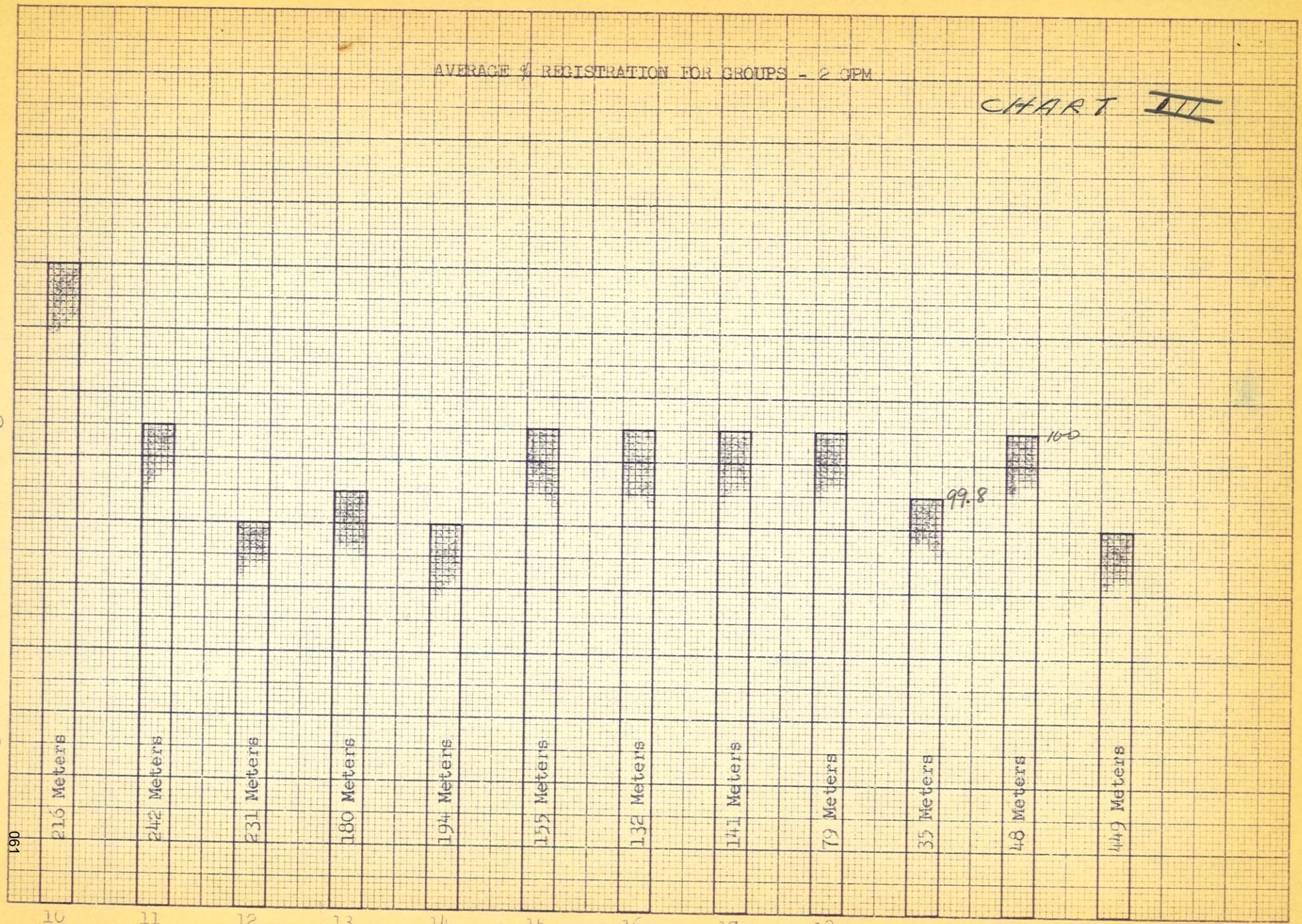
Year	No. Meters In Service As of Jan. 1	Meter Growth During Year	10 yr and older Changes Made During Year
1945	58,958	871	3,190
1946	59,829	2,476	3,030
1947	62,305	3,919	2,975
1948	66,224	4,366	5,240
1949	70,590	5,109	4,900
1950	75,699	6,369	6,045
1951	82,068	6,658	5,225
1952	88,726	6,734	4,700
1953	95,460	6,590	3,335
1954	102,050	9,279	3,760
1955	111,329	9,452	4,770
1956	120,781	8,230	4,640
1957	129,011	6,523	3,057
1958	135,534	6,266	5,212
1959	141,800	7,674	6,973
1960	149,474	7,861	7,992
1961	157,335	6,097	9,058
1962	163,432	5,914	11,543
1963	169,346	6,263	8,215
1964	175,609	7,229	9,214
1965	182,838	7,361	7,596
1966	190,199	6,707	6,734
1967	196,906	5,606	11,008
1968	202,512	6,621	10,166
1969	209,133	5,914	6,577
1970	215,047		


% Total Meters
0 10 20 30 40 50 60 70 80 90 100
Chart I
1968 Study
Data Comparison
Legend:
10 Yr. Group
13 Yr. Group
15 Yr. Group
17 Yr. Group
Registration More Than - %
90 80 70 60 50
1/8 GPM Rate
10 20 30 40 50 60 70 80 90 100
Registration More Than - %
102 100 98 96
2 GPM Rate


AVERAGE % REGISTRATION FOR GROUPS 1/8 GPM
CHART II
Per Cent
90
85
80
75
216 Meters
242 Meters
231 Meters
180 Meters
194 Meters
155 Meters
132 Meters
141 Meters
79 Meters
35 Meters
48 Meters
449 Meters
10
11
12
13
14
15
16
17
18
19
20 and over
High Reg.
Years

AVERAGE % REGISTRATION FOR GROUPS - 2 GPM

CHART III



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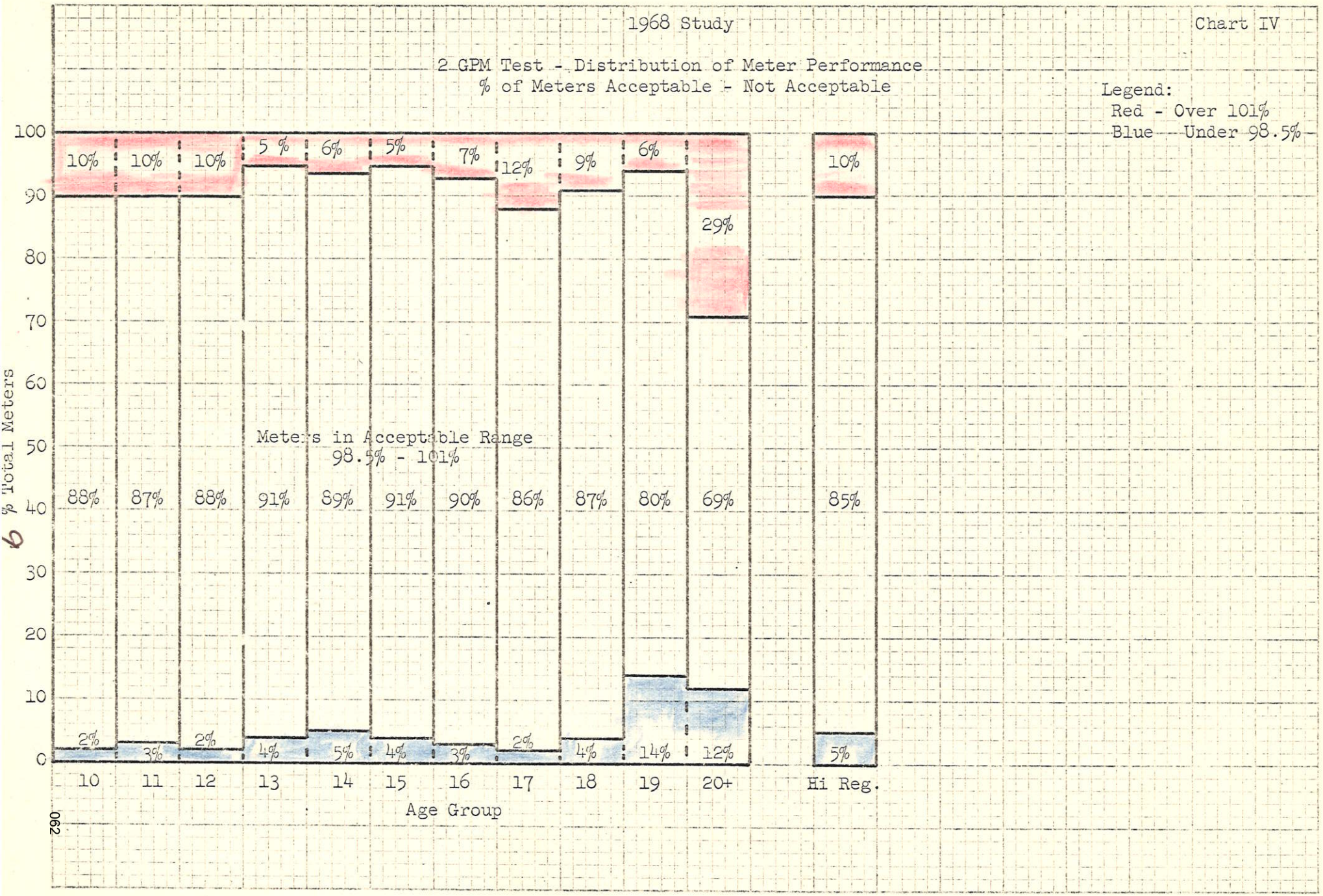
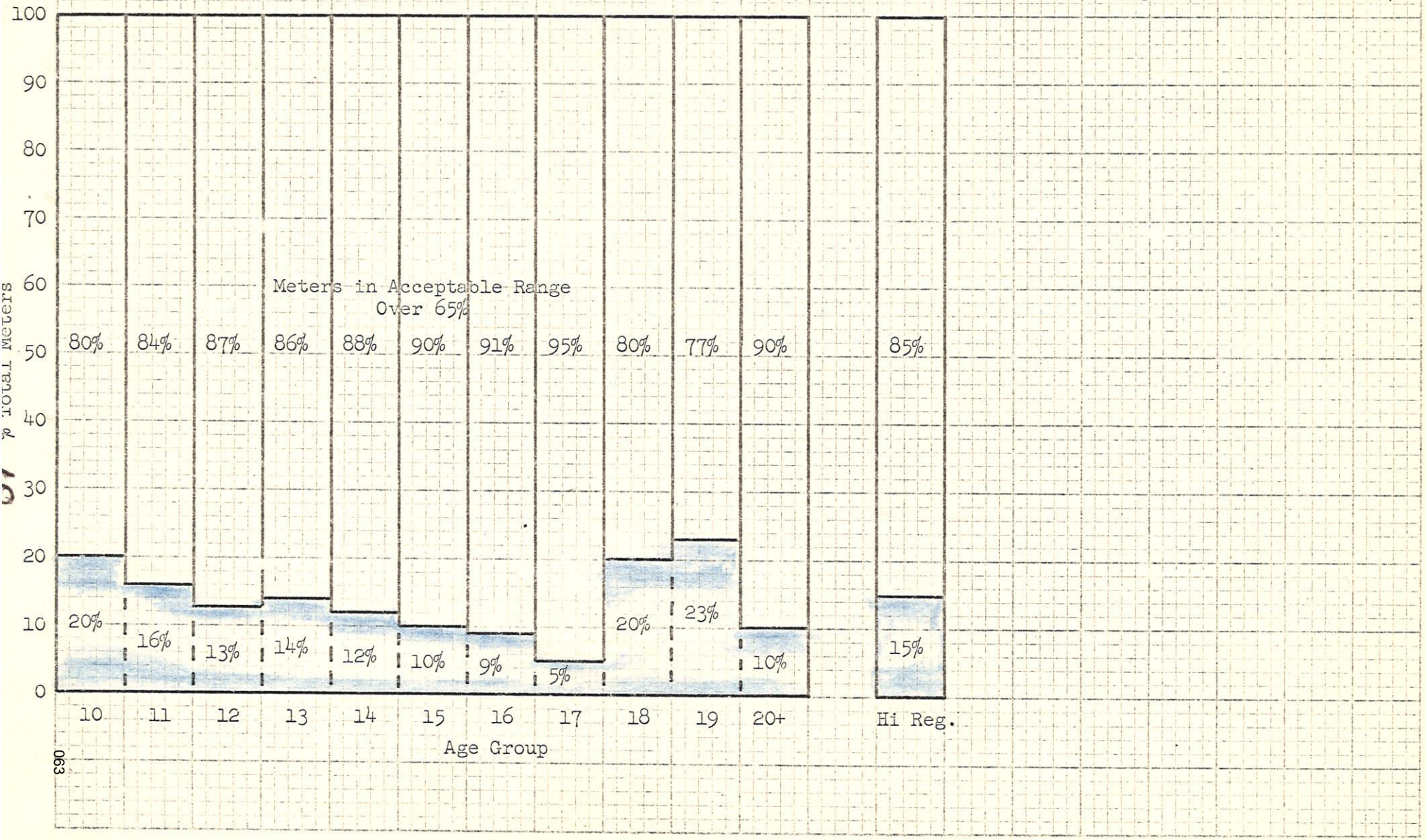

1968 Study
Chart IV
2 GPM Test - Distribution of Meter Performance
% of Meters Acceptable - Not Acceptable
Legend:
Red - Over 101%
Blue - Under 98.5%
% Total Meters
Meters in Acceptable Range
98.5% - 101%
10% 10% 10% 5% 6% 5% 7% 12% 9% 6% 29% 10%
88% 87% 88% 91% 89% 91% 90% 86% 87% 80% 69% 85%
2% 3% 2% 4% 5% 4% 3% 2% 4% 14% 12% 5%
10 11 12 13 14 15 16 17 18 19 20+ Hi Reg.
Age Group
062

1968 Study

Chart V

1/8 GPM Test - Distribution of Meter Performance
% of Meters Acceptable - Not Acceptable

Legend: Blue - Under 65%



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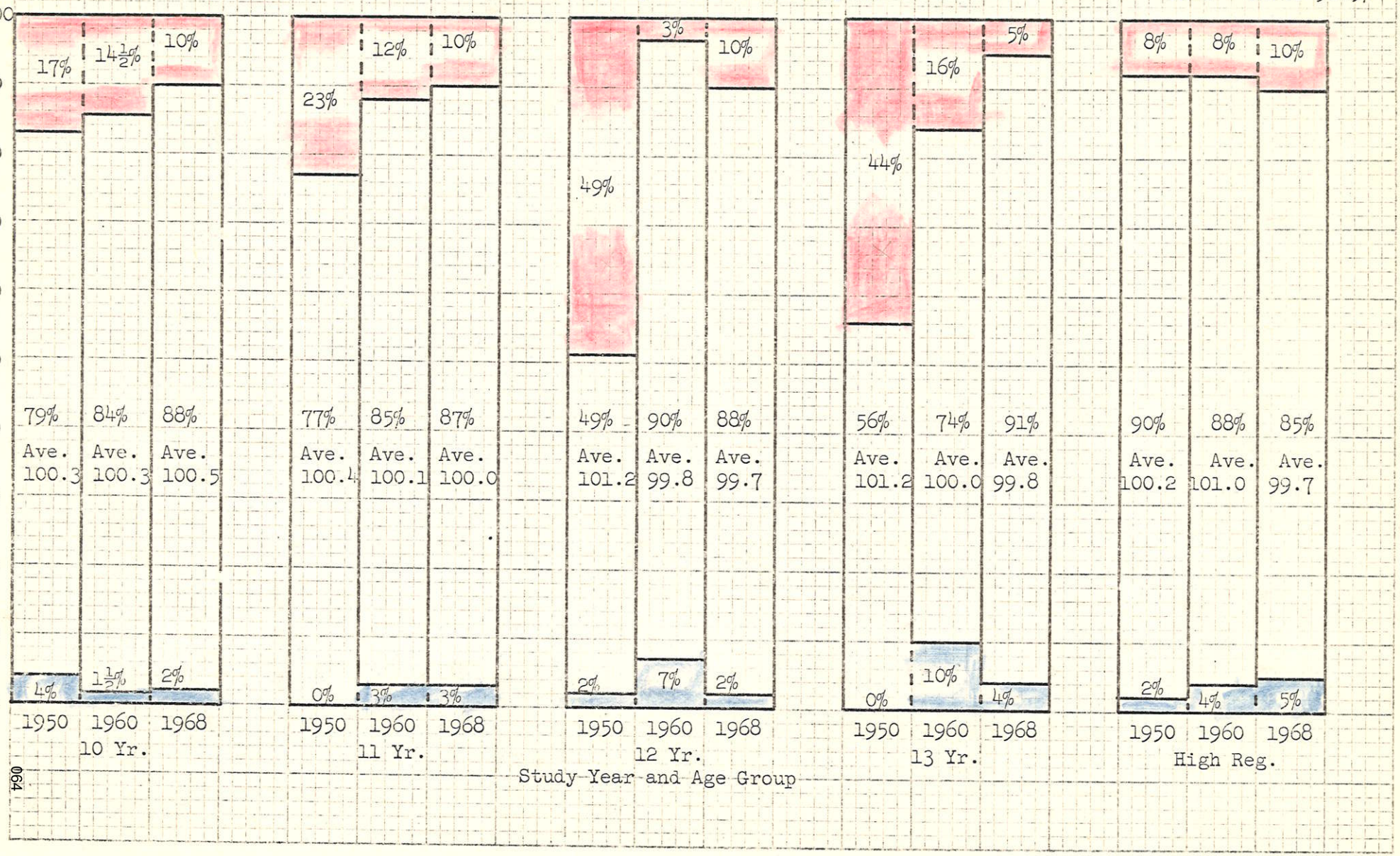
Study Comparison
1950 - 1960 - 1968 Data

Chart VI

2 GPM Rate - Years Shown
% Meters Acceptable - Not Acceptable

Legend:
Red - Over 101%
Blue - Under 98.5%



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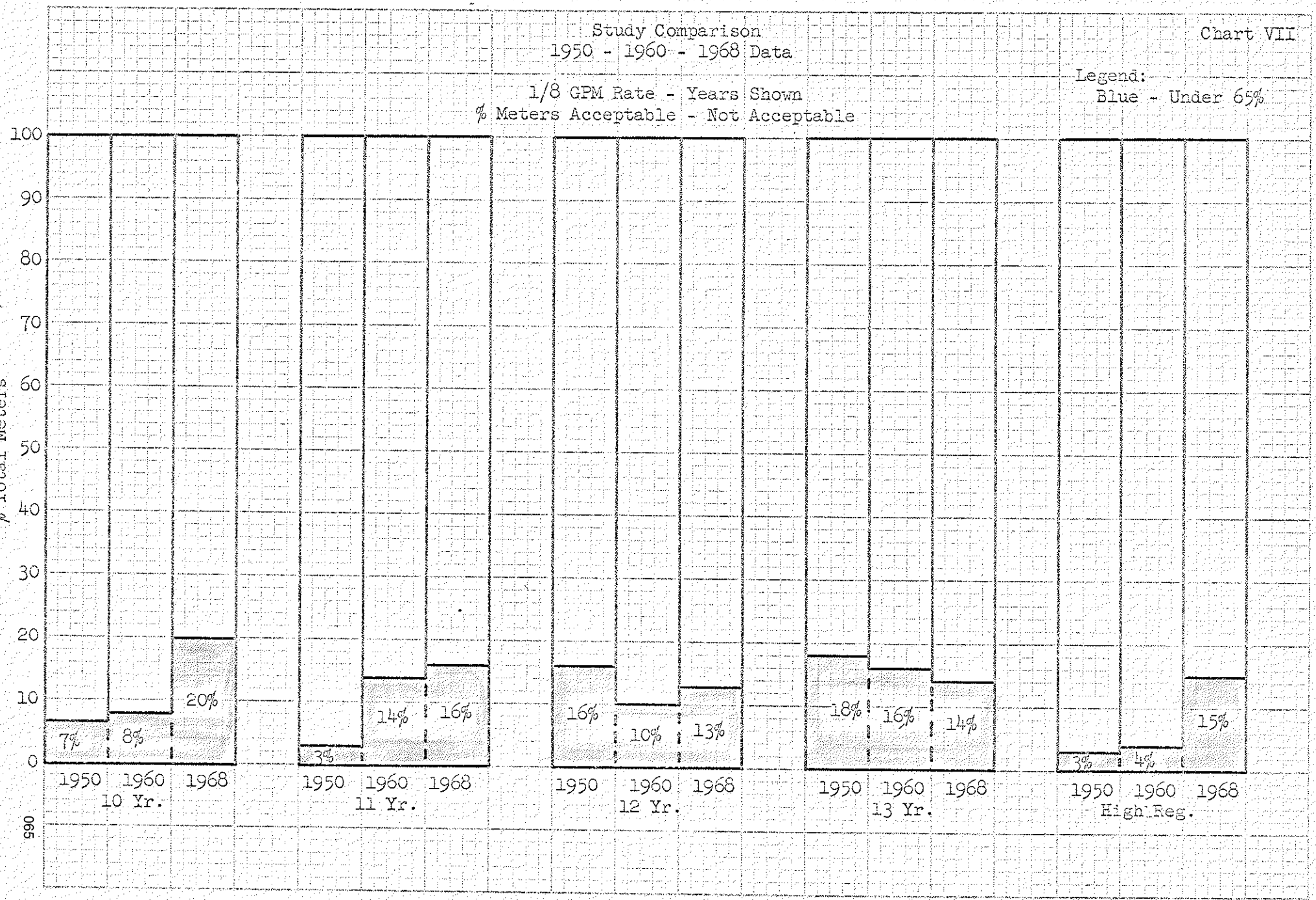
Study Comparison
1950 - 1960 - 1968 Data
Chart VII
1/8 GPM Rate - Years Shown
% Meters Acceptable - Not Acceptable
Legend:
Blue - Under 65%
% Total Meters
100
90
80
70
60
50
40
30
20
10
0
7%
8%
20%
3%
14%
16%
16%
10%
13%
18%
16%
14%
3%
4%
15%
1950
1960
1968
10 Yr.
11 Yr.
12 Yr.
13 Yr.
High Reg.

CHART 1

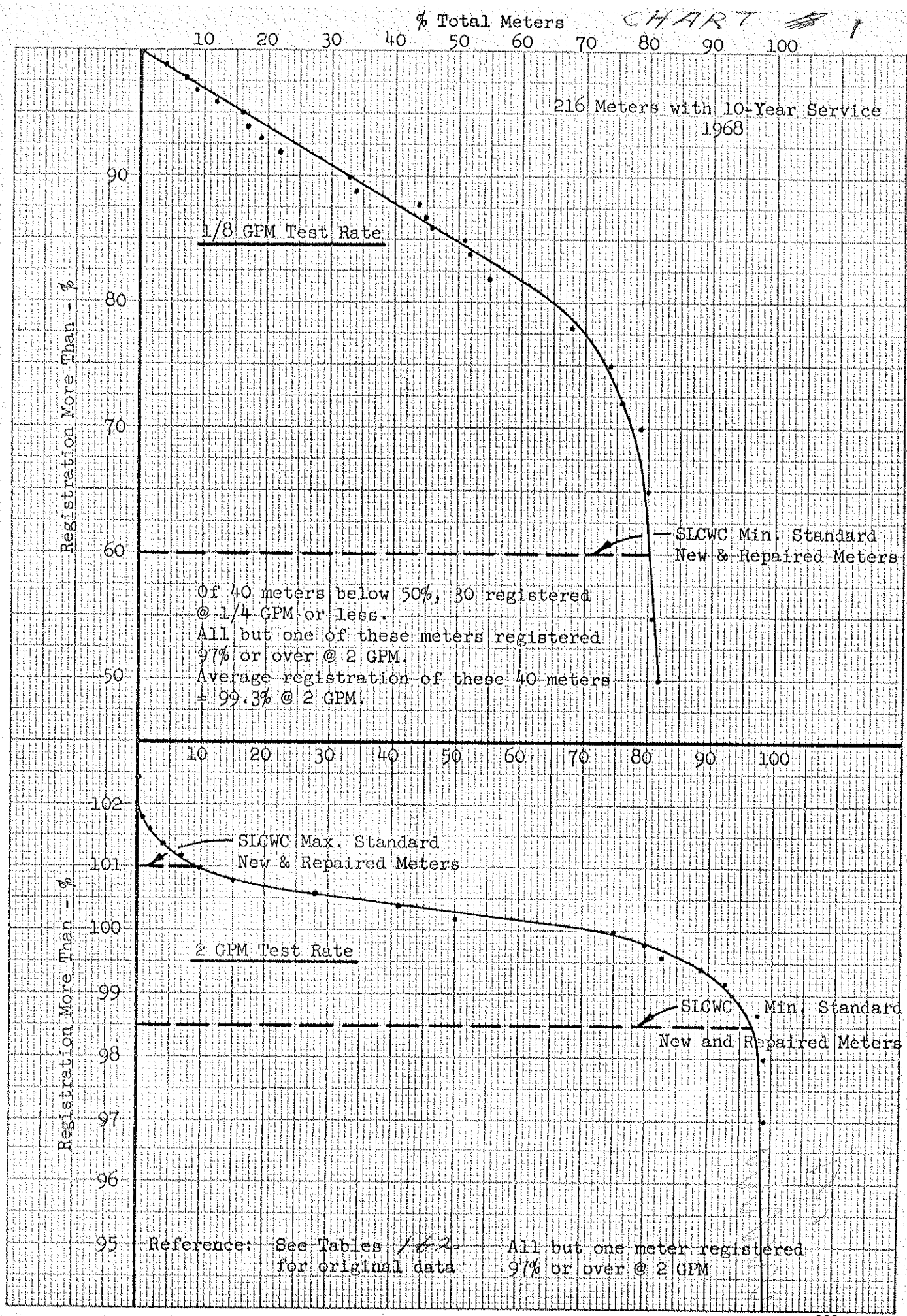

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CHART # 2

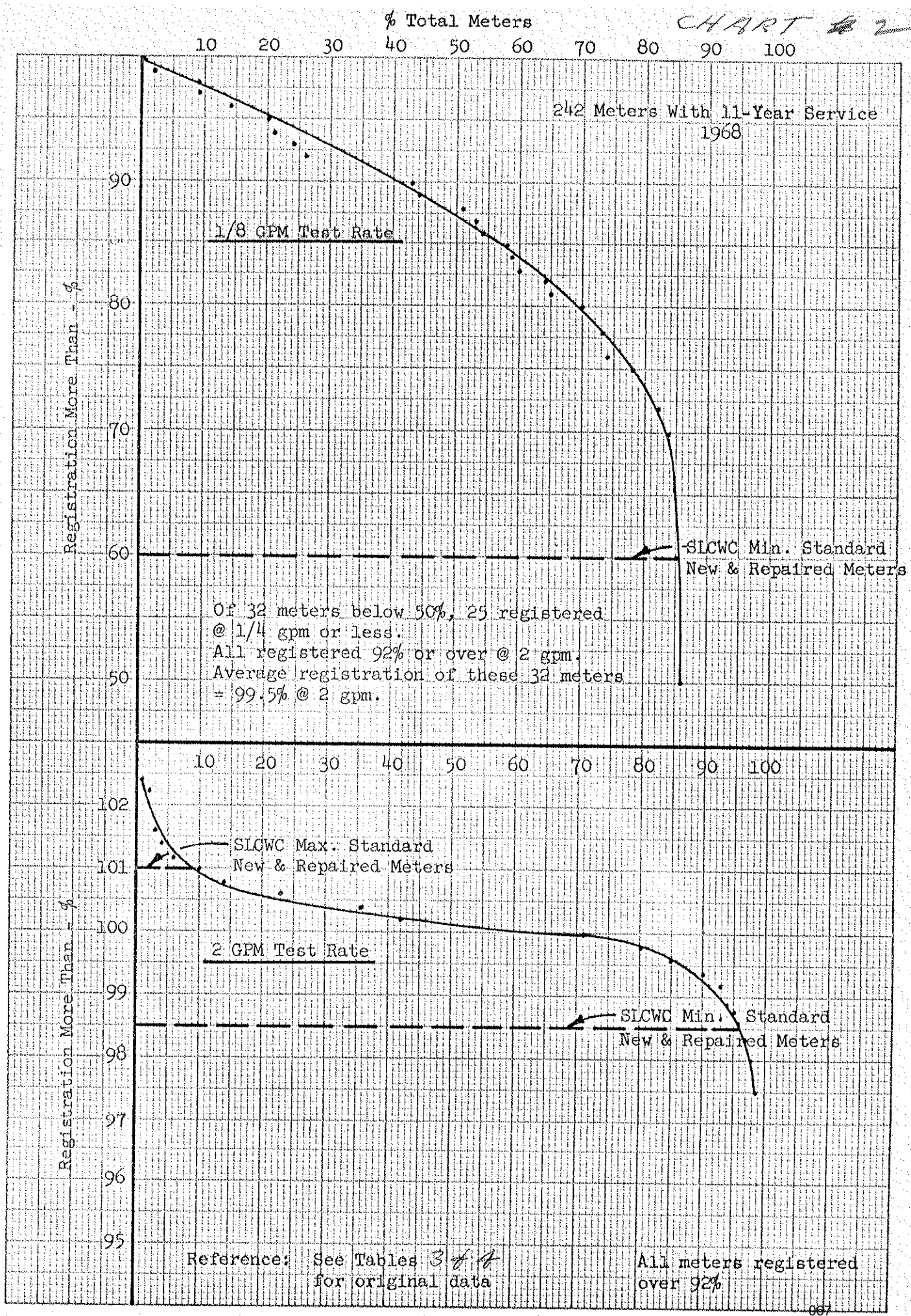

% Total Meters
10 20 30 40 50 60 70 80 90 100
242 Meters With 11-Year Service
1968
1/8 GPM Test Rate
Registration More Than - %
90
80
70
60
50
SLCWC Min. Standard
New & Repaired Meters
Of 32 meters below 50%, 25 registered
@ 1/4 gpm or less.
All registered 92% or over @ 2 gpm.
Average registration of these 32 meters
= 99.5% @ 2 gpm.
10 20 30 40 50 60 70 80 90 100
102
101
100
99
98
97
96
95
SLCWC Max. Standard
New & Repaired Meters
2 GPM Test Rate
SLCWC Min. Standard
New & Repaired Meters
Registration More Than - %
Reference: See Tables 3 & 4
for original data
All meters registered
over 92%

CHART # 3

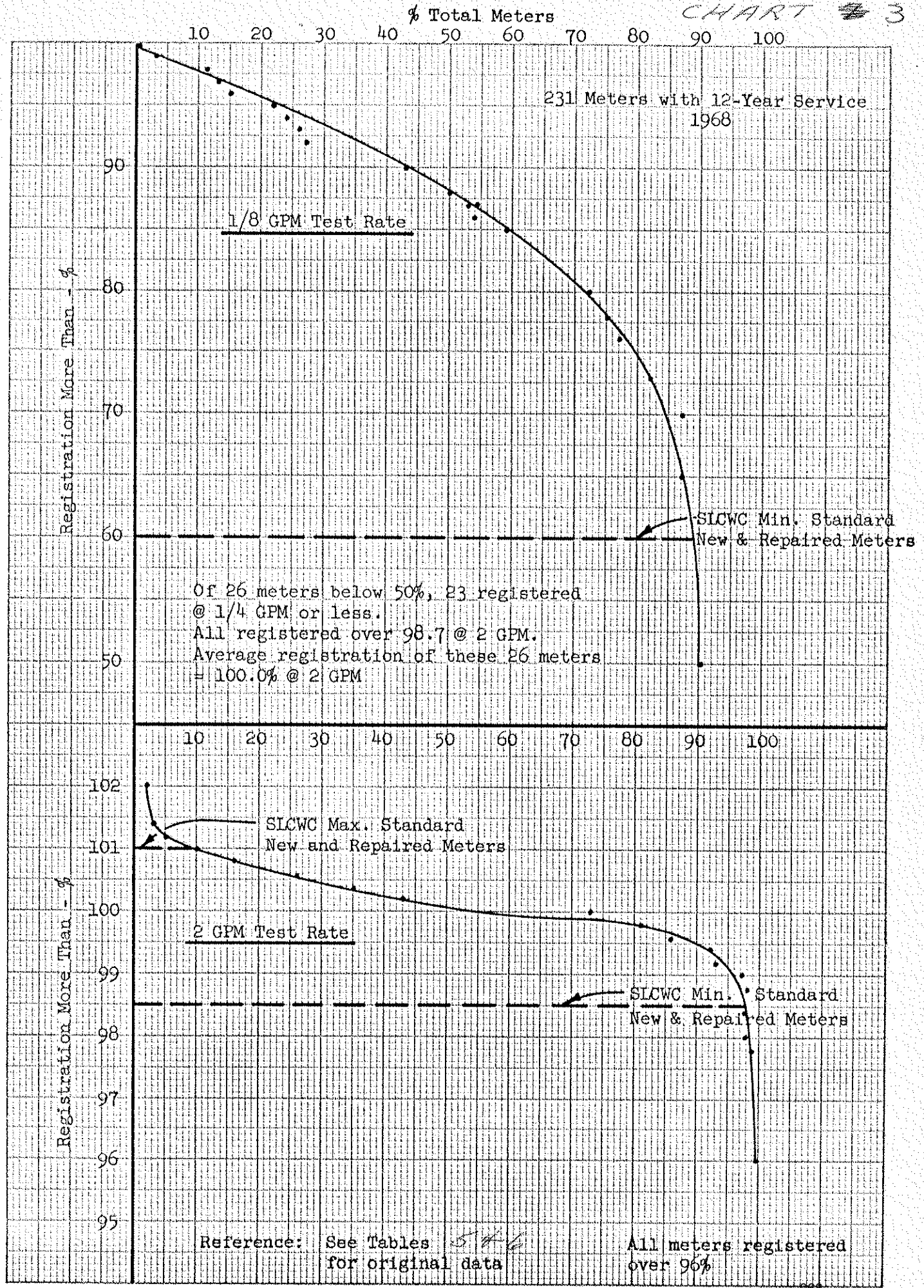

% Total Meters
10 20 30 40 50 60 70 80 90 100
231 Meters with 12-Year Service
1968
1/8 GPM Test Rate
Registration More Than - %
90
80
70
60
50
SLCWC Min. Standard
New & Repaired Meters
Of 26 meters below 50%, 23 registered
@ 1/4 GPM or less.
All registered over 98.7 @ 2 GPM.
Average registration of these 26 meters
= 100.0% @ 2 GPM
10 20 30 40 50 60 70 80 90 100
102
101
100
99
98
97
96
95
SLCWC Max. Standard
New and Repaired Meters
2 GPM Test Rate
SLCWC Min. Standard
New & Repaired Meters
Registration More Than - %
Reference: See Tables 5 & 6
for original data
All meters registered
over 96%

CHART # 4

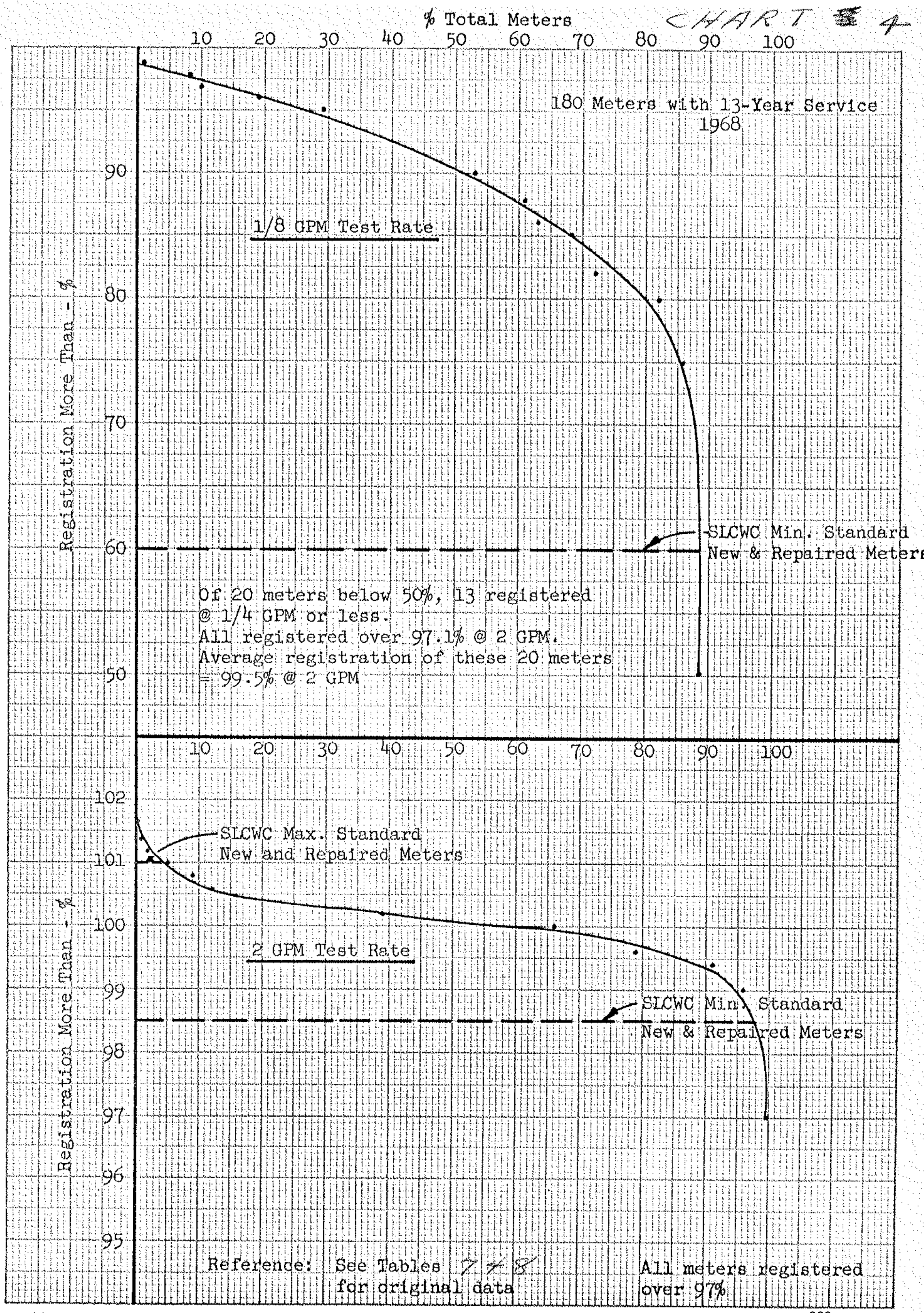

% Total Meters
10 20 30 40 50 60 70 80 90 100
180 Meters with 13-Year Service
1968
Registration More Than - %
90
80
70
60
50
1/8 GPM Test Rate
SLCWC Min. Standard
New & Repaired Meters
Of 20 meters below 50%, 13 registered
@ 1/4 GPM or less.
All registered over 97.1% @ 2 GPM.
Average registration of these 20 meters
= 99.5% @ 2 GPM
10 20 30 40 50 60 70 80 90 100
102
101
100
99
98
97
96
95
SLCWC Max. Standard
New and Repaired Meters
2 GPM Test Rate
SLCWC Min. Standard
New & Repaired Meters
Reference: See Tables 7 & 8
for original data
All meters registered
over 97%

CHART # 5

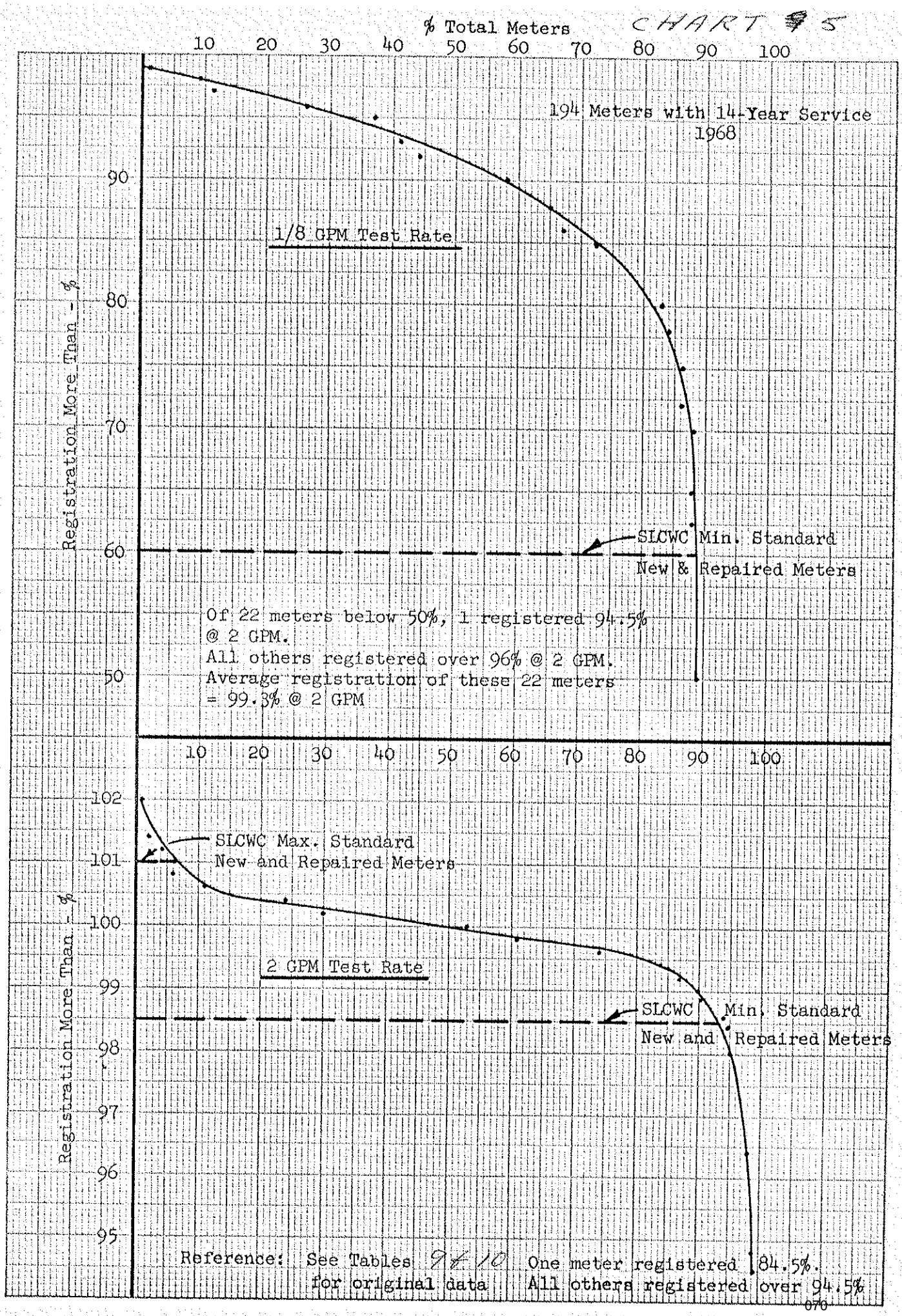

% Total Meters
10 20 30 40 50 60 70 80 90 100
194 Meters with 14-Year Service
1968
1/8 GPM Test Rate
Registration More Than - %
90
80
70
60
50
SLCWC Min. Standard
New & Repaired Meters
Of 22 meters below 50%, 1 registered 94.5%
@ 2 GPM.
All others registered over 96% @ 2 GPM.
Average registration of these 22 meters
= 99.3% @ 2 GPM
10 20 30 40 50 60 70 80 90 100
102
101
100
99
98
97
96
95
SLCWC Max. Standard
New and Repaired Meters
2 GPM Test Rate
SLCWC Min. Standard
New and Repaired Meters
Registration More Than - %
Reference: See Tables 9 & 10 for original data
One meter registered 84.5%.
All others registered over 94.5%

CHART 6

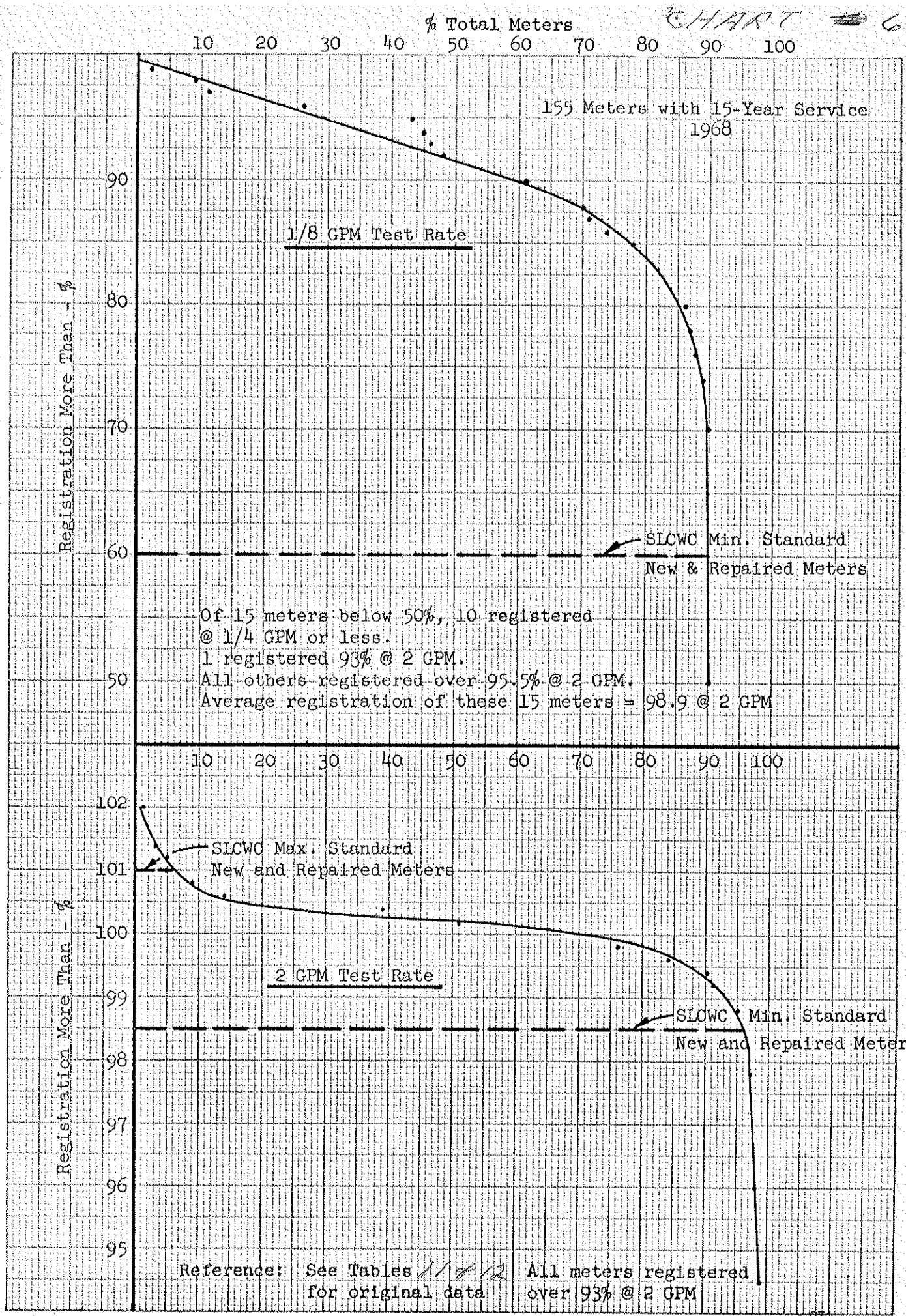
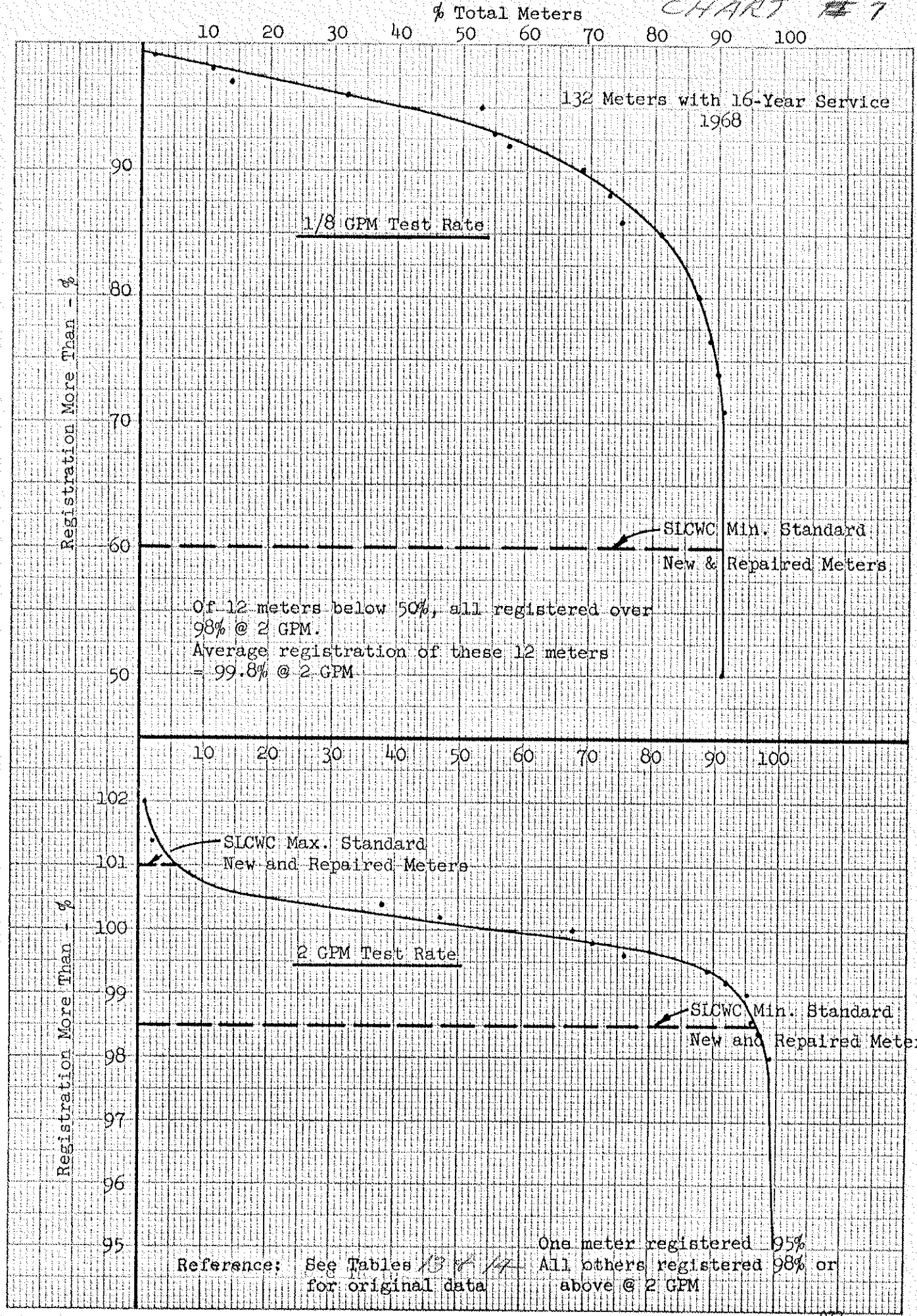


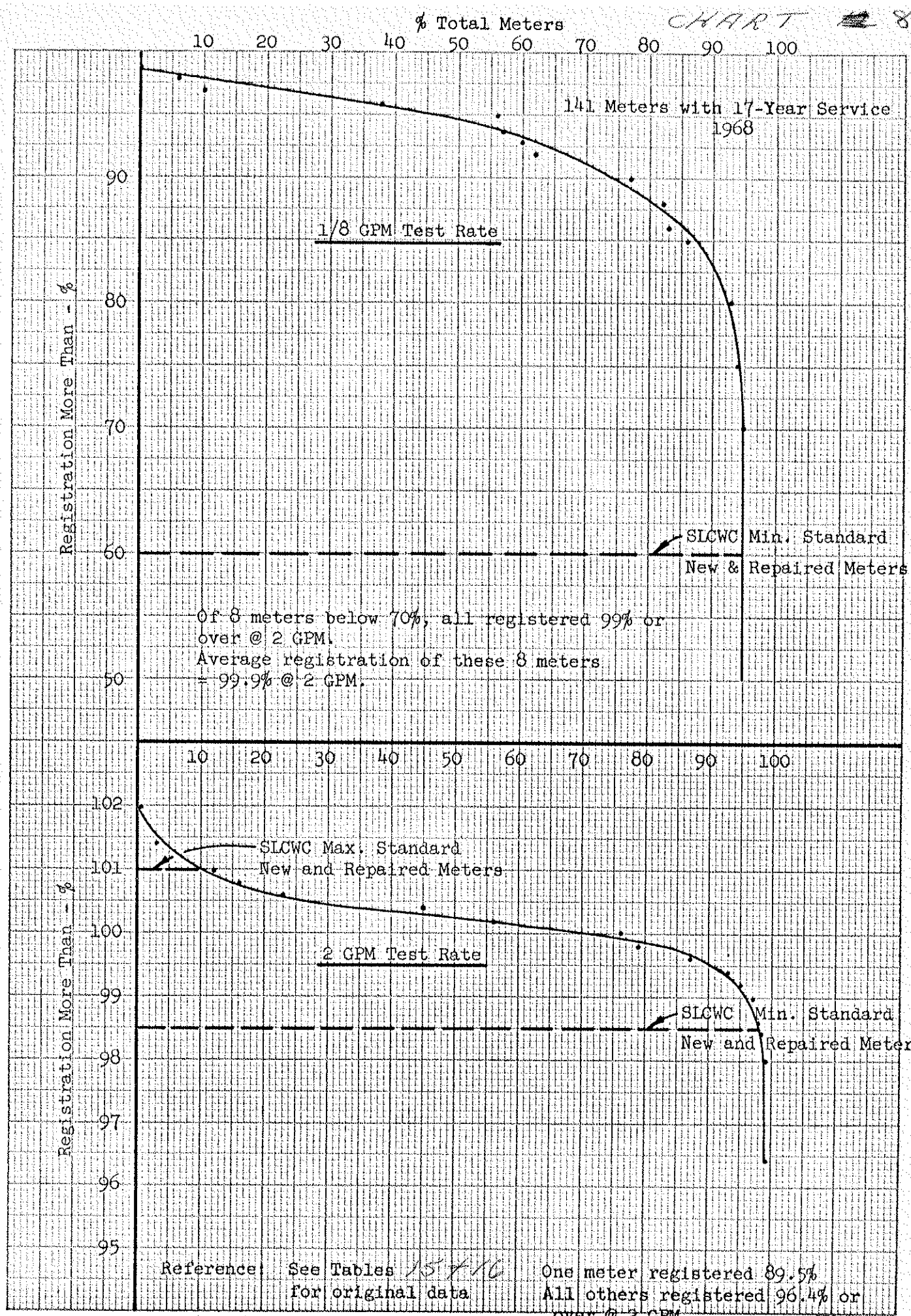
CHART #7



Reference: See Tables 13 & 14 for original data

072

CHART 8



Reference: See Tables 15 & 16 for original data

One meter registered 89.5%
All others registered 96.4% or over @ 2 GPM

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CHART 9

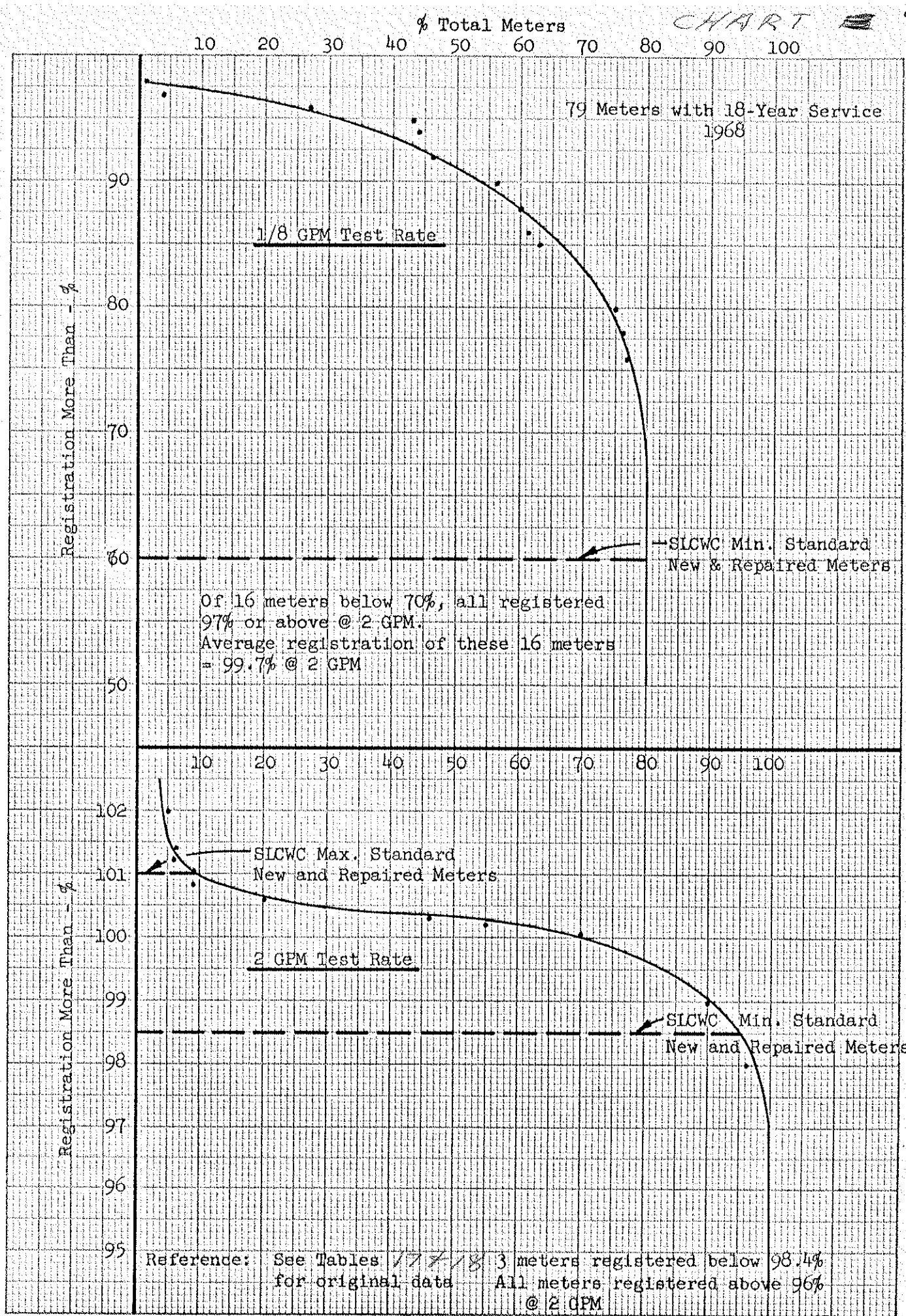

CHART ~~1~~ 10

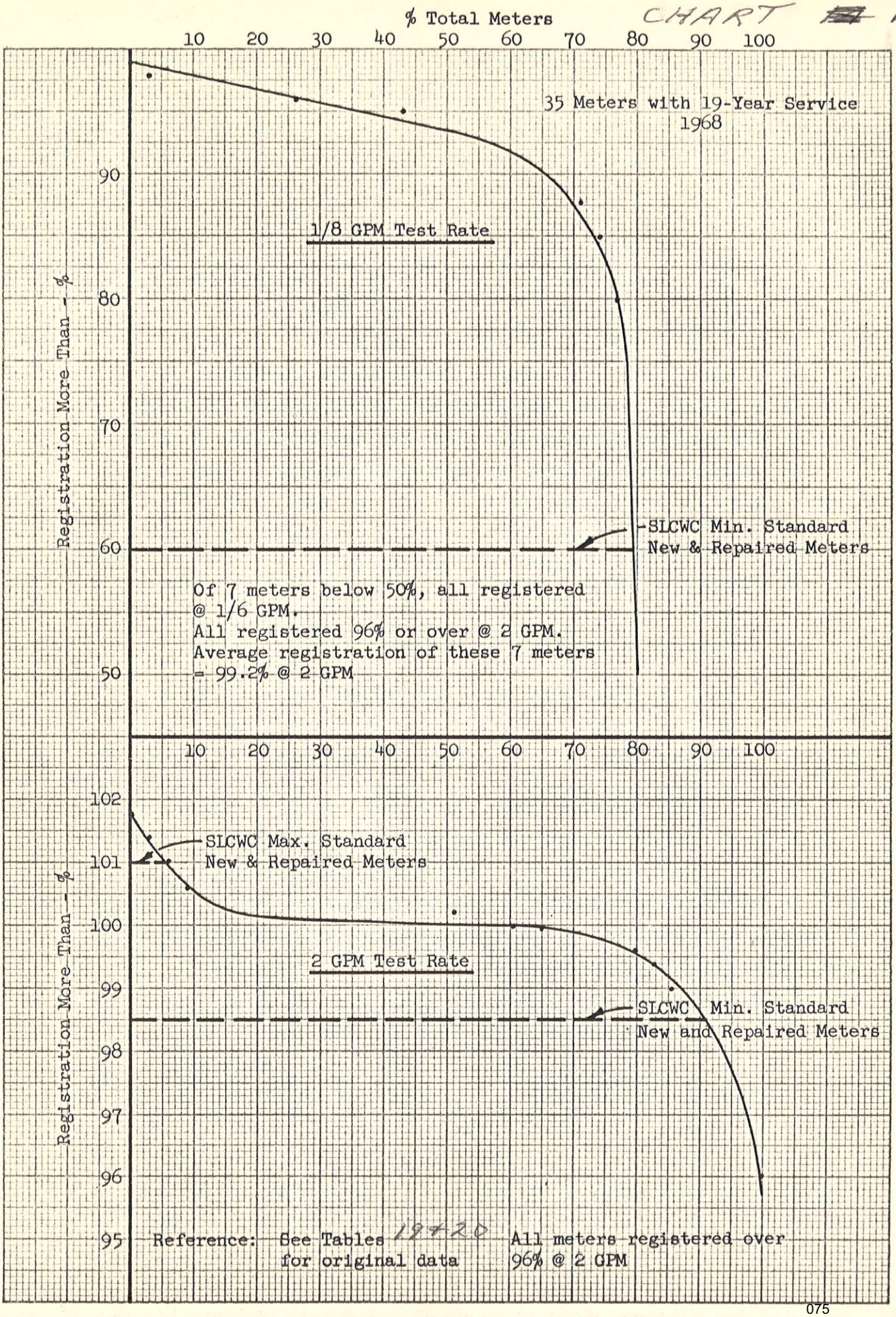

CHART 11

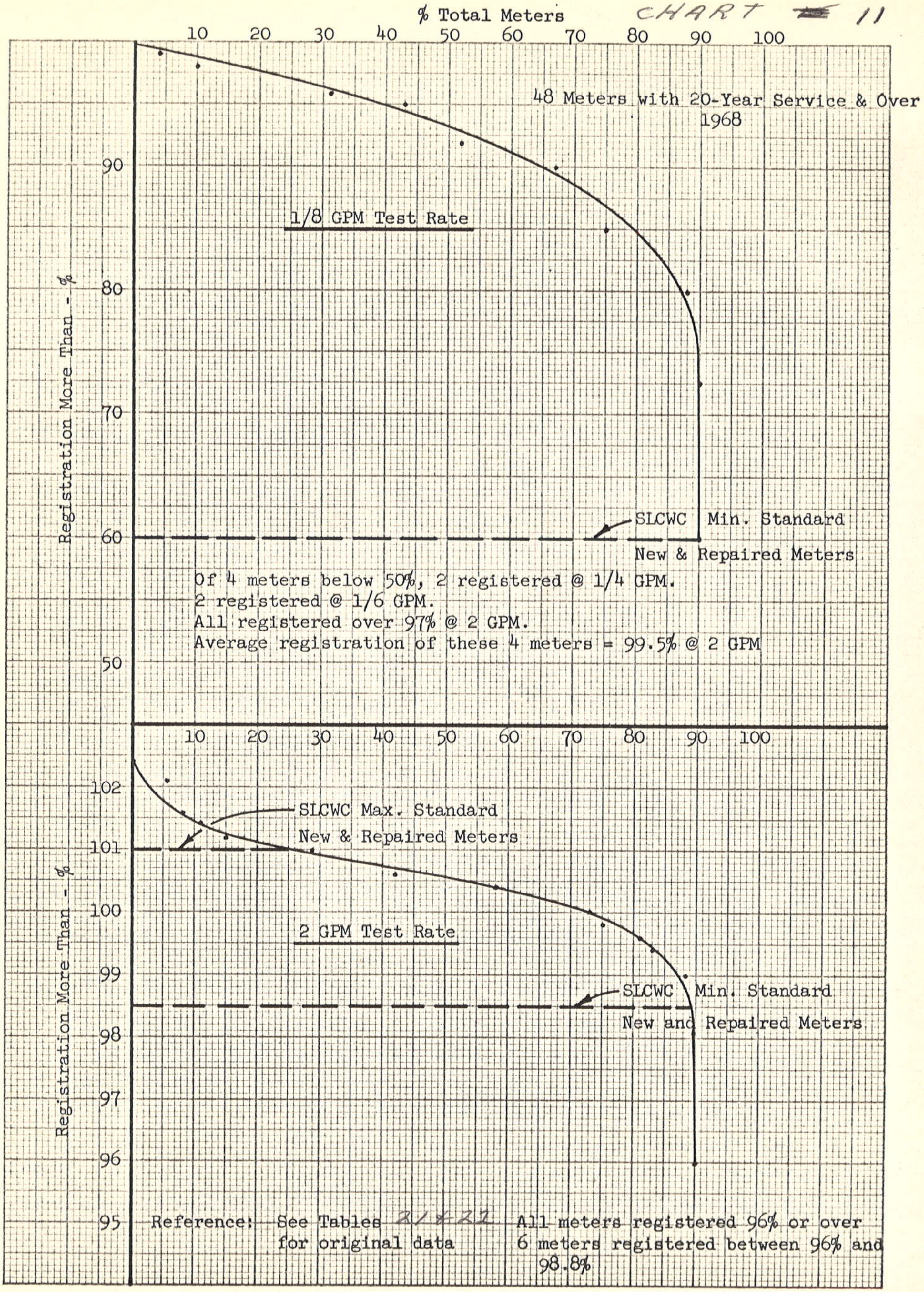
% Total Meters
10 20 30 40 50 60 70 80 90 100
48 Meters with 20-Year Service & Over
1968
1/8 GPM Test Rate
Registration More Than - %
90
80
70
60
50
SLCWC Min. Standard
New & Repaired Meters
Of 4 meters below 50%, 2 registered @ 1/4 GPM.
2 registered @ 1/6 GPM.
All registered over 97% @ 2 GPM.
Average registration of these 4 meters = 99.5% @ 2 GPM
10 20 30 40 50 60 70 80 90 100
SLCWC Max. Standard
New & Repaired Meters
2 GPM Test Rate
Registration More Than - %
102
101
100
99
98
97
96
95
SLCWC Min. Standard
New and Repaired Meters
Reference: See Tables 21 & 22
for original data
All meters registered 96% or over
6 meters registered between 96% and
98.8%

CHART ~~No~~ 12

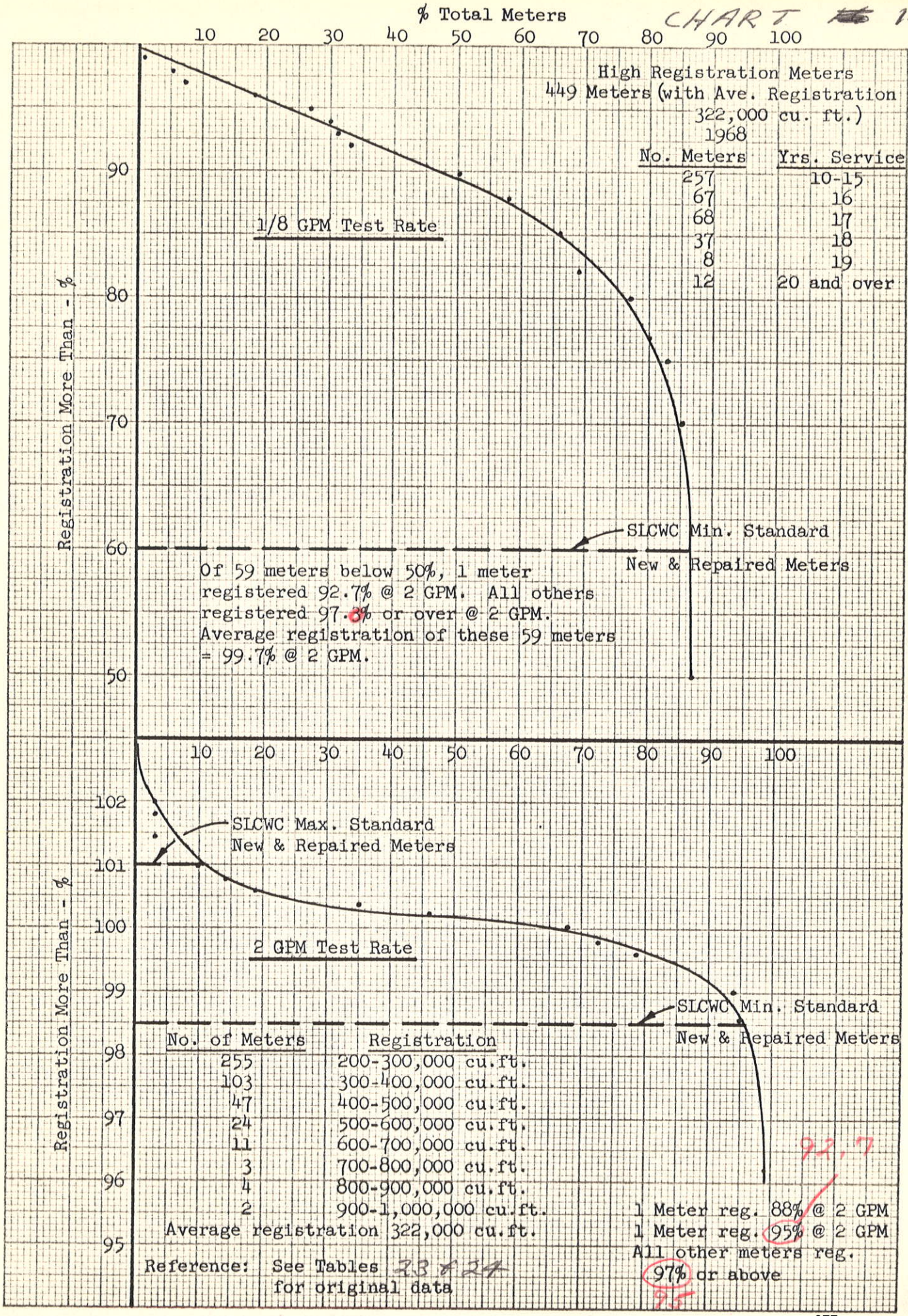

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TABLE 1

10-YEAR STUDY GROUP - 1968
1/8 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
40	216	100	*
1	176	82	50
2	175	81	55
2	173	80	65
7	171	79	70
5	164	76	72
12	159	74	75
7	147	68	78
22	140	65	80
7	118	55	82
1	111	52	84
12	110	51	85
1	98	46	86
2	97	45	87
22	95	44	88
2	73	34	89
23	71	33	90
8	48	22	92
4	40	19	93
2	36	17	94
8	34	16	95
7	26	12	96
4	19	9	97
12	15	7	98
3	3	4	99
0	0	0	100

* 14 meters reg. @ 1/6 gpm
16 meters reg. @ 1/4 gpm
7 meters reg. @ 1/2 gpm
1 meter reg. @ 3/4 gpm
2 meters reg. @ 1 gpm

TABLE 2

10-YEAR STUDY GROUP - 1968
2 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
1	216	100	59
1	215	99	97
3	214	99	98
7	211	98	98.7
4	204	94	99
7	200	93	99.2
14	193	89	99.4
7	179	83	99.6
10	172	80	99.8
54	162	75	100
19	108	50	100.2
29	89	41	100.4
27	60	28	100.6
12	33	15	100.8
7	21	10	101
6	14	7	101.2
4	8	4	101.4
1	4	2	101.6
2	3	1	101.8
1	1	1/2	102
0	0	0	102.5

TABLE 3

11-YEAR STUDY GROUP - 1968
1/8 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
32	242	100	*
2	210	87	0
2	208	86	50
3	206	85	60
8	203	84	70
6	195	81	72
10	189	78	75
2	179	74	76
7	177	73	78
14	170	70	80
2	156	65	81
11	154	64	82
1	143	60	83
1	142	59	84
12	141	58	85
2	129	54	86
4	127	53	87
16	123	51	88
4	107	44	89
39	103	43	90
7	64	26	92
7	57	24	93
2	50	21	94
15	48	20	95
11	33	14	96
16	22	9	98
6	6	2	99

* 13 meters reg. @ 1/6 gpm
12 meters reg. @ 1/4 gpm
7 meters reg. @ 1/2 gpm

TABLE 4

11-YEAR STUDY GROUP - 1968
2 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
4	242	100	0
1	238	99	97.5
3	237	98	98
2	234	97	98.4
1	232	96	98.6
3	231	95	98.8
3	228	94	99
5	225	93	99.2
15	220	91	99.4
12	205	85	99.6
20	193	80	99.8
71	173	71	100
15	102	42	100.2
31	87	36	100.4
21	56	23	100.6
10	35	14	100.8
10	25	10	101
6	15	6	101.2
3	9	4	101.4
1	6	3	101.6
4	5	2	102.2
1	1	1/2	102.4

TABLE 5

12-YEAR STUDY GROUP - 1968
1/8 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
26	231	100	*
4	205	90	50
1	201	87	65
9	200	87	70
3	191	83	72
11	188	82	75
3	177	77	76
8	174	75	78
30	166	72	80
12	136	59	85
2	124	54	86
7	122	53	87
16	115	50	88
36	99	43	90
3	63	27	92
4	60	26	93
6	56	24	94
16	50	22	95
3	34	15	96
6	31	13	97
18	25	11	98
6	7	3	99
1	1	1/2	100

* 4 meters reg. @ 1/6 gpm
19 meters reg. @ 1/4 gpm
2 meters reg. @ 1/2 gpm
1 meter reg. @ 1 gpm

TABLE 6

12-YEAR STUDY GROUP - 1968
2 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
0	231	100	0
1	231	100	96
1	230	99	96.4
1	229	99	97.8
1	228	98	98.4
1	227	98	98.6
3	226	98	98.8
8	223	97	99
4	215	93	99.2
13	211	92	99.4
12	198	86	99.6
19	186	81	99.8
67	167	73	100
20	100	43	100.2
21	80	35	100.4
22	59	26	100.6
14	37	16	100.8
12	23	10	101
4	11	5	101.2
2	7	3	101.4
5	5	2	102

TABLE 7

13-YEAR STUDY GROUP - 1968
1/8 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
20	180	100	*
5	160	89	50
8	155	86	75
18	147	82	80
6	129	72	82
10	123	68	85
2	113	63	86
16	111	61	88
43	95	53	90
17	52	29	95
17	35	19	96
3	18	10	97
13	15	8	98
2	2	1	99

* 9 meters reg. @ 1/6 gpm
4 meters reg. @ 1/4 gpm
6 meters reg. @ 1/2 gpm
1 meter reg. @ 1 gpm

TABLE 8

13-YEAR STUDY GROUP - 1968
2 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
0	180	100	0
8	180	100	97.0
8	172	96	99
21	164	91	99.4
24	143	79	99.6
49	119	66	100
49	70	39	100.2
7	21	12	100.6
5	14	8	100.8
5	9	5	101
1	4	2	101.2
3	3	1	101.8
0	0	0	102.2

TABLE 9

14-YEAR STUDY GROUP - 1968
1/8 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
22	194	100	*
1	172	89	50
4	171	88	70
1	167	86	72
1	166	86	75
2	165	85	76
2	163	84	78
21	161	83	80
10	140	72	85
2	130	67	86
1	128	66	87
15	127	65	88
28	112	58	90
4	84	43	92
5	80	41	93
4	75	37	95
29	50	26	96
4	21	11	97
15	17	9	98
2	2	1	99
0	0	0	100

* 16 meters reg. @ 1/6 gpm
1 meter reg. @ 1 gpm
5 meters reg. @ 1/4 gpm

TABLE 10

14-YEAR STUDY GROUP - 1968
2 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
1	194	100	84.5
2	193	99	94.5
7	191	98	96.4
1	184	95	98
1	183	95	98.4
7	182	94	98.6
1	175	90	98.8
6	174	90	99
5	168	87	99.2
20	163	84	99.4
24	143	74	99.6
17	119	61	99.8
45	102	53	100
11	57	30	100.2
25	46	24	100.4
10	21	11	100.6
6	11	6	101.0
2	5	3	101.2
1	3	2	101.4
2	2	1	102

TABLE 11

15-YEAR STUDY GROUP - 1968
1/8 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
15	155	100	*
2	140	90	70
1	138	89	74
1	137	88	75
1	136	88	76
1	135	87	78
13	134	86	80
7	121	78	85
4	114	74	86
1	110	71	87
15	109	70	88
20	94	61	90
1	74	48	92
4	73	47	93
2	69	45	94
27	67	43	95
23	40	26	96
3	17	11	97
11	14	9	98
3	3	2	99
0	0	0	100

* 6 meters reg. @ 1/6 gpm
4 meters reg. @ 1/4 gpm
1 meter reg. @ 1/2 gpm
2 meters reg. @ 3/4 gpm
1 meter reg. @ 1 gpm
1 meter reg. @ 1½ gpm

TABLE 12

15-YEAR STUDY GROUP - 1968
2 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
1	155	100	0
2	154	99	94.5
2	152	98	96.4
1	150	97	97.8
1	149	96	98.4
1	148	96	98.6
6	147	95	99
1	141	91	99.2
10	140	90	99.4
12	130	84	99.6
10	118	76	99.8
29	108	70	100
19	79	51	100.2
38	60	39	100.4
8	22	14	100.6
6	14	9	100.8
1	8	5	101
3	7	5	101.2
2	4	3	101.4
2	2	1	102

TABLE 13

16-YEAR STUDY GROUP - 1968
1/8 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
12	132	100	*
1	120	91	72
1	119	90	75
3	118	89	78
9	115	87	80
7	106	81	85
3	99	75	86
5	96	73	88
16	91	69	90
2	75	57	92
3	73	55	93
28	70	53	95
23	42	32	96
5	19	14	97
12	14	11	98
2	2	2	99
0	0	0	100

* 8 meters reg. @ 1/6 gpm
2 meters reg. @ 1/4 gpm
2 meters reg. @ 1/2 gpm

TABLE 14

16-YEAR STUDY GROUP - 1968
2 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
1	132	100	95
2	131	99	98
2	129	97	98.4
1	127	96	98.6
5	126	95	99
4	121	92	99.2
16	117	89	99.4
7	101	76	99.6
4	94	71	99.8
29	90	68	100
11	61	46	100.2
30	50	38	100.4
6	20	15	100.6
5	14	10	100.8
6	9	7	101
1	3	2	101.4
2	2	1	102

TABLE 15

17-YEAR STUDY GROUP - 1968
1/8 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
8	141	100	*
1	133	95	70
1	132	94	75
10	131	93	80
4	121	86	85
1	117	83	86
0	116	82	87
7	116	82	88
21	109	77	90
4	88	62	92
3	84	60	93
2	81	57	94
25	79	56	95
40	54	38	96
5	14	10	97
9	9	6	98
0	0	0	99

* 4 meters reg. @ 1/6 gpm
2 meters reg. @ 1/4 gpm
2 meters reg. @ 1/2 gpm

TABLE 16

17-YEAR STUDY GROUP - 1968
2 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
1	141	100	0
1	140	99	96.4
1	139	99	98
1	138	98	98.6
4	137	97	99
2	133	95	99.2
8	131	93	99.4
12	123	87	99.6
4	111	79	99.8
28	107	76	100
15	79	56	100.2
31	64	45	100.4
10	33	23	100.6
6	23	16	100.8
13	17	12	101
3	4	3	101.4
1	1	1/2	102

TABLE 17

18-YEAR STUDY GROUP - 1968
1/8 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
16	79	100	*
2	63	80	70
1	61	77	76
1	60	76	78
9	59	75	80
2	50	63	85
1	48	61	86
3	47	60	88
8	44	56	90
1	36	46	92
1	35	44	94
13	34	43	95
18	21	27	96
2	3	4	97
1	1	1	98
0	0	0	99

* 7 meters reg. @ 1/6 gpm
5 meters reg. @ 1/4 gpm
3 meters reg. @ 1/2 gpm
1 meter reg. @ 3/4 gpm

TABLE 18

18-YEAR STUDY GROUP - 1968
2 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
0	79	100	94.5
1	79	100	96
1	78	99	96.4
1	77	98	97.8
3	76	96	98.4
2	73	92	98.8
7	71	90	99
2	64	81	99.4
6	62	79	99.6
1	56	71	99.8
12	55	70	100
7	43	55	100.2
20	36	46	100.4
3	16	20	100.6
6	13	16	100.8
2	7	9	101
1	5	6	101.4
4	4	5	102

TABLE 19

19-YEAR STUDY GROUP - 1968
1/8 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
7	35	100	*
1	28	80	50
1	27	77	80
1	26	74	85
3	25	71	88
7	22	63	90
6	15	43	95
8	9	26	96
1	1	3	98
0	0	0	99

* 7 meters reg. @ 1/6 gpm

TABLE 20

19-YEAR STUDY GROUP - 1968
2 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
5	35	100	96
1	30	86	99
1	29	83	99.4
5	28	80	99.6
5	23	61	100
15	18	51	100.2
1	3	9	100.6
1	2	6	101
1	1	3	101.4
0	0	0	101.8

TABLE 21

20-YEAR & OVER STUDY GROUP - 1968
1/8 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
4	48	100	*
1	44	91	0
0	43	90	60
0	43	90	68
0	43	90	70
1	43	90	75
6	42	88	80
4	36	75	85
7	32	67	90
0	25	52	91
2	25	52	92
8	23	43	95
10	15	31	96
0	15	31	97
3	5	10	98
2	2	4	99

* 2 meters reg. @ 1/6 gpm
2 meters reg. @ 1/4 gpm

TABLE 22

20-YEAR & OVER STUDY GROUP - 1968
2 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
6	48	100	0
0	42	88	98.9
2	42	88	99
1	40	83	99.4
3	39	81	99.6
1	36	75	99.8
7	35	73	100
8	28	58	100.4
6	20	42	100.6
7	14	29	101
2	7	15	101.2
1	5	11	101.4
1	4	8	101.6
3	3	6	102

TABLE 23

HIGH REGISTRATION GROUP - 200,000 CU. FT. AVG. - 1968
1/8 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
59	449	100	*
8	389	87	50
9	381	85	70
26	372	83	75
37	346	77	80
15	309	69	82
36	295	66	85
33	259	58	88
78	226	50	90
1	148	33	91
6	147	33	92
8	141	31	93
11	133	30	94
42	122	27	95
50	80	18	96
8	30	7	97
19	22	5	98
3	3	1/2	99
0	0	0	100

* 32 meters reg. @ 1/6 gpm
15 meters reg. @ 1/4 gpm
8 meters reg. @ 1/2 gpm
3 meters reg. @ 1 gpm
1 meter reg. @ 1½ gpm

TABLE 24

HIGH REGISTRATION GROUP - 200,000 CU. FT. AVG. - 1968
2 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
5	449	100	0
18	444	99	96.2
6	426	95	98.6
66	420	94	99
29	354	79	99.6
19	325	73	99.8
99	306	68	100
49	207	46	100.2
72	158	35	100.4
25	86	19	100.6
17	61	14	100.8
29	44	10	101
1	15	3	101.4
2	14	3	101.8
9	12	3	102
3	3	1/2	102.4

Meter Survey - 1968 Study

Appendix A

The attached curve reproduced from one published by Neptune Meter Company represents the typical performance curve for a 5/8" Trident Meter which is representative of all those meters included in this study.

The accuracy portion of this curve indicates that a normal meter registers with peak efficiency at approximately 2 to 3 gpm and that between this point and its rated capacity of 20 gpm there is a very slight drop in accuracy of approximately 1%.

In 1960 and 1961 the Business Management Division of the California Section, AWWA conducted a detailed water usage survey on some 2300 individual domestic water consumers to determine -

A) The pattern of domestic water consumption; that is - what proportion of the total water used occurred at varying rates of flow - and -

B) The most economical period for water meter removal.

Of 2,000 5/8" meters tested, the following flow distribution was found to be representative -

0 to 1 gallon per minute - 10%

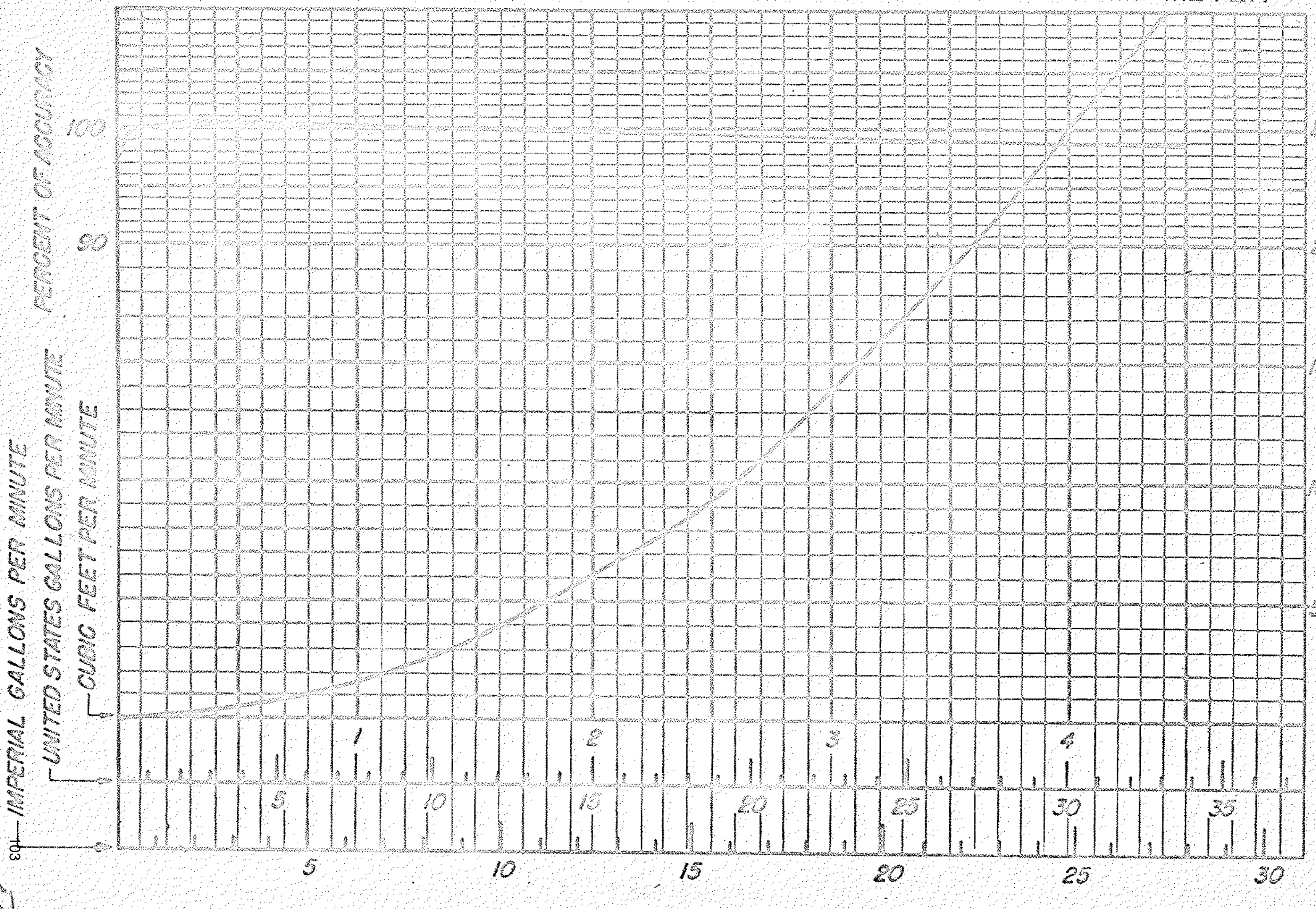
1 to 6 gallon per minute - 73%

Over 6 gallons per minute- 17%

These data indicate that the rate of consumption and the optimum meter performance are at relatively the same points on this performance curve.

NEPTUNE METER CO.

ACCURACY AND LOSS OF HEAD CURVES OF 5/8" TRIDENT C.I.B. METER



5/8" TRIDENT C.I.B. METER

CHART Nº 64500-1

APPENDIX B

Collection of Data

The individual record cards for each of the approximate 140,000 meters owned for 10 or more years were surveyed. Any meters removed from the system after 10 or more years of continuous service were recorded on tally sheets by years of such service.

Information recorded consisted of:

Meter number

Removal date

Job number

This information enabled access into other permanent (15 year) records which supplied:

a) Confirmation of meter number, removal date, job number

b) Registration at removal

c) Test performance at 2 gpm; 1/8 gpm

These data (b and c) were the basis of this report.

For meters in the 10, 11 and 12-year service groups, data were compiled in each age group for the first 200-250 meters encountered in the respective service groups. This procedure conforms to the definition of "random sampling" as used in statistical analysis. These quantities of meters were comparable in number to the 10 and 11-year study groups in the 1960 survey.

Accepting the random sampling techniques, statistical analysis of the performance of the 11-year group of 242 meters indicates that random sampling of a like group would reproduce the 2 gpm group average of 100 per cent obtained, within the range of 99.7 per cent to 100.3 per cent with 95 per cent dependability.

For meters in the 13-year through 19-year service groups, all

meters out of the 140,000 owned by this Company longer than 10 years were surveyed and data compiled on all such meters encountered.

Meters included in the 20-year and over service group were obtained in the same manner as those for the 13 through 19-year groups and represent the sum of all meters of 20 years service and longer. The oldest service period found in this group was 31 years.

The High Registration group is made up of all meters found to have registered over 200,000 cubic feet after 10 or more years of service.