

FILED

MAY 18, 2021

Missouri Public
Service Commission

Exhibit No. 300

Commission – Exhibit 300
1960 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

Presentation of Data
 Conclusions
 Data Collection
 Meter Test Standards
 Presentation of Findings Page 1 - 3

Historical Record - System Growth Page 4

10-Yr. Change Program: Potential - Actual Work Load Page 5

10-Yr. Change Program: Meter Change - Cost Data Page 6

15-Yr. Change Program: Meter Change - Cost Data Page 7

10- 15-Yr. Change Program: Cost Comparison. Page 8

Charts 1 thru 16 - Duration Curves, Year-Group Data Page 9 - 24

Appendix

Original Data for Duration Curves

Tables 1 thru 24

PURPOSE

To determine accuracies of meters in service for varying lengths of time and for different total registration.

CONCLUSIONS

1. There was good, basic conformance between the data collected in the 1950 and the 1960 studies.
2. There did not appear to be any significant difference in the general conformation of the duration curves plotted, indicating that representative samplings of the meters in each year-group had been obtained.
3. These data indicate that there would be little or no significant difference in the overall efficiency of the operation of these water meters by the extension of the service period from the present 10-year cycle to one 15 years or longer.
4. These data indicate that there would be little or no significant difference in the overall efficiency of the operation of these water meters by the extension of the registration limitation from 200,000 cu. ft. to 300,000 cu. ft. or over.
5. Significant savings will be effected in future operating costs related to the routine changes of meters by an extension of meter time cycle and registration limits. (Conclusions 3 and 4.) Because a transition period of five (5) years or longer will be needed to eliminate the present backlog and equalize loading on the meter department, there will be no immediate decrease in meter maintenance expense. A longer meter change cycle will, however, reduce the future increases in departmental costs.

DATA COLLECTION - 1960 STUDY

Meters were selected in the order they were received in the meter department and classified by years of service and/or total registration as the current work tickets were processed against permanent records as part of normal departmental procedure. Meters having 10 years service or longer were studied and the following data recorded:

Meter number
Age (from purchase date)
Book/account (location of current service address)
Type of register
Set date
Removal date
Test data % accuracy at 1/8 GPM
 % accuracy at 2 GPM
Total Registration
Years of current service

Subsequent to these original data, the meter records were separated into year-groups and essentially the same information re-entered on new forms. These year-group forms were the basis for the duration curves plotted for this report.

Meters used as part of the "high registration" group were those meters recording in excess of 200,000 cubic feet. In some cases, this registration was acquired in less than 10 years.

DATA COLLECTION - 1950 STUDY

In the 1950 study, the overall information collected was not as extensive, however, the data concerning the period of service, registration, and test results are directly comparable.

METER TEST STANDARDS - 1960 STUDY

Meters included in the 1960 study were geared, prior to their completed service period, to standards established by this Company based on our experience under local conditions. Comparison of these standards with those of the American Water Works Association are as follows:

<u>Meter Size</u>	<u>Test Rate</u>	<u>Accuracy Standards</u> <u>St. Louis County Water Co.</u>		
		<u>Repaired</u>	<u>Returned From Service</u>	<u>AWWA</u>
5/8"	1/8 gpm	Over 60%	Over 65%	- - -
	1/4 gpm	- - -	- - -	90-101.5
	2 gpm	98.5-100.5	99-101%	98.5-101.5

It should be noted that our minimum flow of one pint per minute is half that established by AWWA as being a measure of the "sensitivity" of a meter. While 60% and 65% are used as our minimum sensitivity, the average for all the meters was between 84% and 85%.

The average meter, under normal service conditions, will gain approximately 0.5% in registration over a 2-4 year period of service and, therefore, repaired meters are normally geared to the range of 99-100%, within the limitations of available gear combinations. Test data included in this report reflects this gain in percentage of registration during service. This gain is primarily a result of light mineral deposition on the walls of the measuring chamber and is self-limiting as a result of the close tolerances between the chamber walls and the operating face of the disc. Some degree of "wear-in" of new parts is also involved.

METER TEST STANDARDS - 1950 STUDY

Standards in effect during the 1950 study compare with the 1960 work with one exception. During the 1936-40 period, when these meters were placed in service, a specific gear combination, 34-25, was used which allowed a "gear-up" of 0.77% higher than the present "gear-up" limit of 0.33% above trial gearing. Should this "gear-up" have been necessitated by excessive friction either in the packing or any other bearing surface which subsequent "wear-in" would eliminate, this past practice could be responsible for relatively higher percentages of registration indicated by some of the meters in this study.

PRESENTATION OF FINDINGS

A graphical form of analysis was chosen as being the most suitable method of presentation of data of this type.

Chart One shows the average percentage registration for all the meters in each of the year-groups studied.

Chart Two shows the cumulative percentage of meters in each 1960 study year-group plotted as those meters registering less than the registration percentage shown at a flow of 2 gpm.

Chart Three is the same as Chart Two except at a rate of flow of 1/8 gpm.

Subsequent charts consist of duration curves for each year-group in the two studies. Curves were plotted for each test rate so that any point on the curves may be read X% of total meters tested registered more than Y% at either of the two flow rates used.

HISTORICAL RECORD
SYSTEM GROWTH - 10-YEAR METER CHANGE PROGRAM

<u>Year</u>	<u>No. Customers In System As of Jan. 1</u>	<u>Customer Growth During Year</u>	<u>No. 10-Year Changes Made During Year</u>
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

10-YEAR CHANGE PROGRAM
POTENTIAL - ACTUAL WORK LOAD

Year	No. Customers In System	1/10 of Customers In System	Customer Growth During Year	Total Potential 10-Year Changes	Year	10-Year Changes Made
1949	70,590	7,059	5,109	12,168	1959	6,973
1950	75,699	7,570	6,369	13,939	1960	7,992
1951	82,068	8,207	6,658	<u>14,865</u>	1961	<u>9,058</u>
				Total Potential Changes Period 1959-61	Total Changes Made Period 1959-61	24,023

WORK LOAD REDUCTION - (POTENTIAL LESS ACTUAL)
IN 10 YEARS - 40,972 - 29,723

% WORK LOAD REDUCTION IN 10 YEARS - (REDUCTION/POTENTIAL)
11,249/40,972 = 27.5%

% WORK LOAD REDUCTION IN 15 YEARS = 27.5% x 1.5 = 41.25%

*Backlog (Changes to be Made)
as of 12/31/61 13,700

Backlog (Changes to be Made)
as of 1/1/59 8,000

Net Increase in Backlog of
Changes due in period 1959-1961 5,700

10-YEAR CHANGE PROGRAM

POTENTIAL CHANGES			REDUCTION			*COST DATA				
Year	1/10 Customers in System	Customer Growth	Total Potential Changes	Year	% Reduction in 10 Yrs.	Net Reduction	Net 10-Yr. Change	Field Service (Remove-Reset) \$3.30/unit	Shop Service (Test-Repair) \$2.71/unit	Total Cost of Program /Yr.
.952	8873	6734	15607	1962	27.5	4300	11307	\$37,300	\$30,600	\$67,900
.953	9546	6590	16136	1963	27.5	4440	11696	38,600	31,700	70,300
.954	10205	9279	19484	1964	27.5	5350	14134	46,600	38,300	84,900
.955	11133	9452	20585	1965	27.5	5650	14935	49,300	40,500	89,800
.956	12078	8230	20308	1966	27.5	5590	14718	48,600	39,900	88,500
.957	12901	6523	19424	1967	27.5	5340	14084	46,500	38,200	84,700
.958	13553	6266	19819	1968	27.5	5450	14369	47,400	38,950	86,350
.959	14180	7674	21854	1969	27.5	6000	15854	52,300	42,900	95,200
.960	14947	7861	22808	1970	27.5	6280	16528	54,500	44,800	99,300
.961	15733	6097	21830	1971	27.5	6010	15820	52,200	42,900	95,100
.962	16343	7000	23343	1972	27.5	6420	16923	55,800	45,800	101,600

88 *Based on 1961 Unit Costs

15-YEAR CHANGE PROGRAM

POTENTIAL CHANGES			REDUCTION			*COST DATA				
Year	1/15 of Customers in System	Customer Growth	Total Potential Changes	Year	% Reduction in 15 Yrs.	Net Reduction	Net 15-Yr. Change	Field Service (Remove-Reset) \$3.30/unit	Shop Service (Test-Repair) \$2.71/unit	Total Cost of Program /Yr.
1952	5920	6734	12654	1967	41.25	5220	7434	\$24,550	\$20,100	\$44,650
1953	6360	6590	12950	1968	41.25	5350	7600	25,100	20,600	45,700
1954	6800	9279	16079	1969	41.25	6630	9449	31,200	25,700	56,900
1955	7420	9452	16872	1970	41.25	6950	9922	32,750	26,900	59,650
1956	8050	8230	16280	1971	41.25	6710	9570	31,600	25,900	57,500
1957	8610	6523	15133	1972	41.25	6240	8893	29,300	24,100	53,400
1958	9025	6266	15291	1973	41.25	6300	8991	29,650	24,350	54,000
1959	9450	7674	17124	1974	41.25	7060	10064	33,200	27,250	60,450
1960	9970	7861	17831	1975	41.25	7360	10471	34,550	28,350	62,900
1961	10480	6097	16577	1976	41.25	6830	9747	32,150	26,350	58,500
1962	10880	7000	17880	1977	41.25	7380	10500	34,650	28,450	63,100

o *Based on 1961 Unit Costs

**See Table on Page 5
% Reduction Factor

COST COMPARISON 10-YR. - 15-YR. PROGRAM

<u>Year</u>	<u>10-Year Change Program</u>		<u>15-Year Change Program</u>		<u>Year</u>	<u>15-Year Change Program</u>		<u>Net Savings*</u>
	<u>Net 10-Yr. Changes</u>	<u>Total Cost /Yr.*</u>	<u>Net 15-Yr. Changes</u>	<u>Total Cost /Yr.*</u>		<u>Net 15-Yr. Changes</u>	<u>Total Cost /Yr.*</u>	
1962	11307	\$67,900			1962			
1963	11696	70,300			1963			
1964	14134	84,900			1964			
1965	14935	89,800			1965			
1966	14718	88,500			1966			
1967	14084	84,700			1967	7434	\$14,650	\$40,050
1968	14369	86,350			1968	7600	45,700	40,650
1969	15854	95,200			1969	9449	56,900	38,300
1970	16528	99,300			1970	9922	59,650	39,650
1971	15820	95,100			1971	9570	57,500	37,600
1972	16923	101,600			1972	8893	53,400	48,200

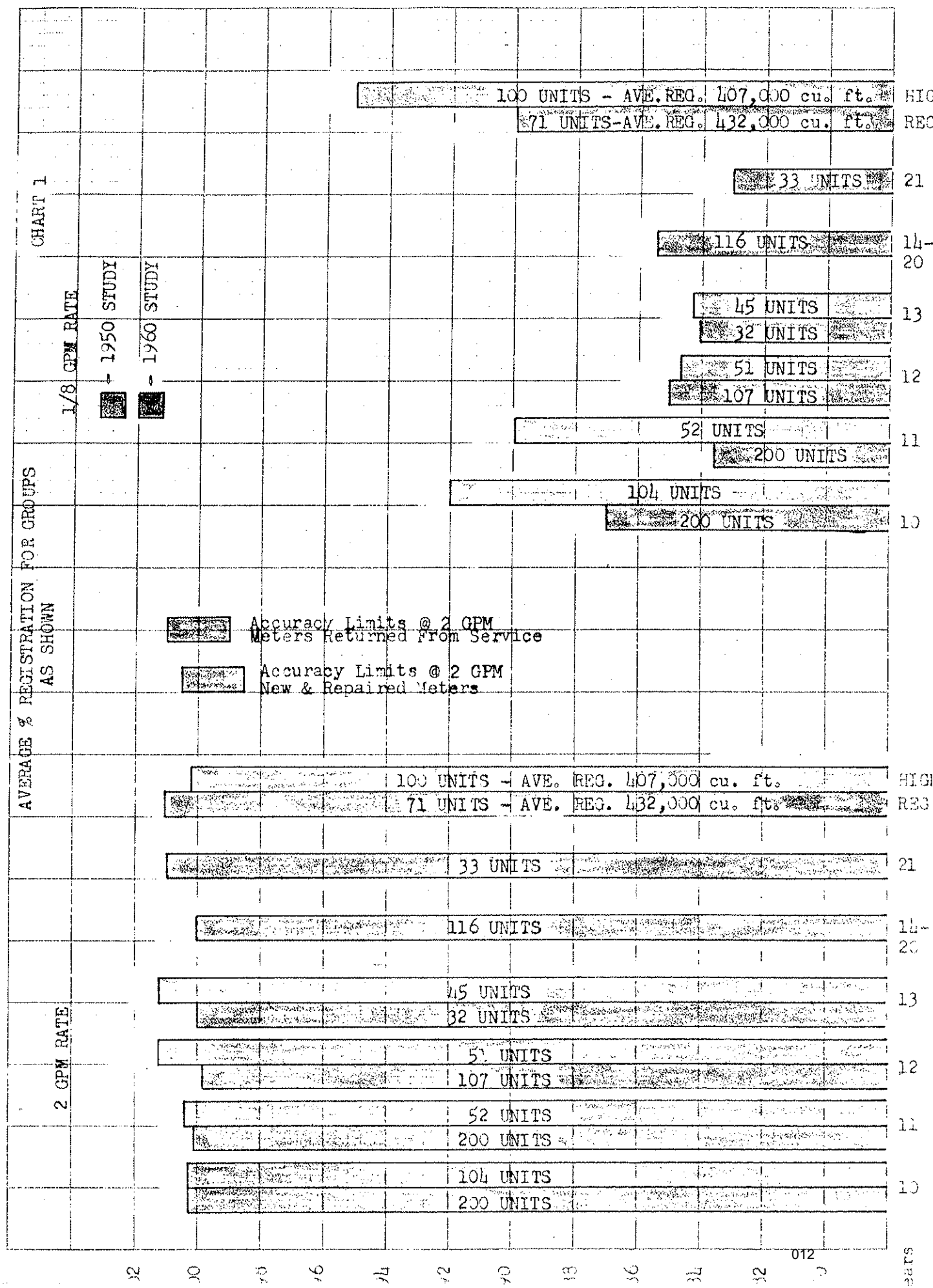
Transition Period

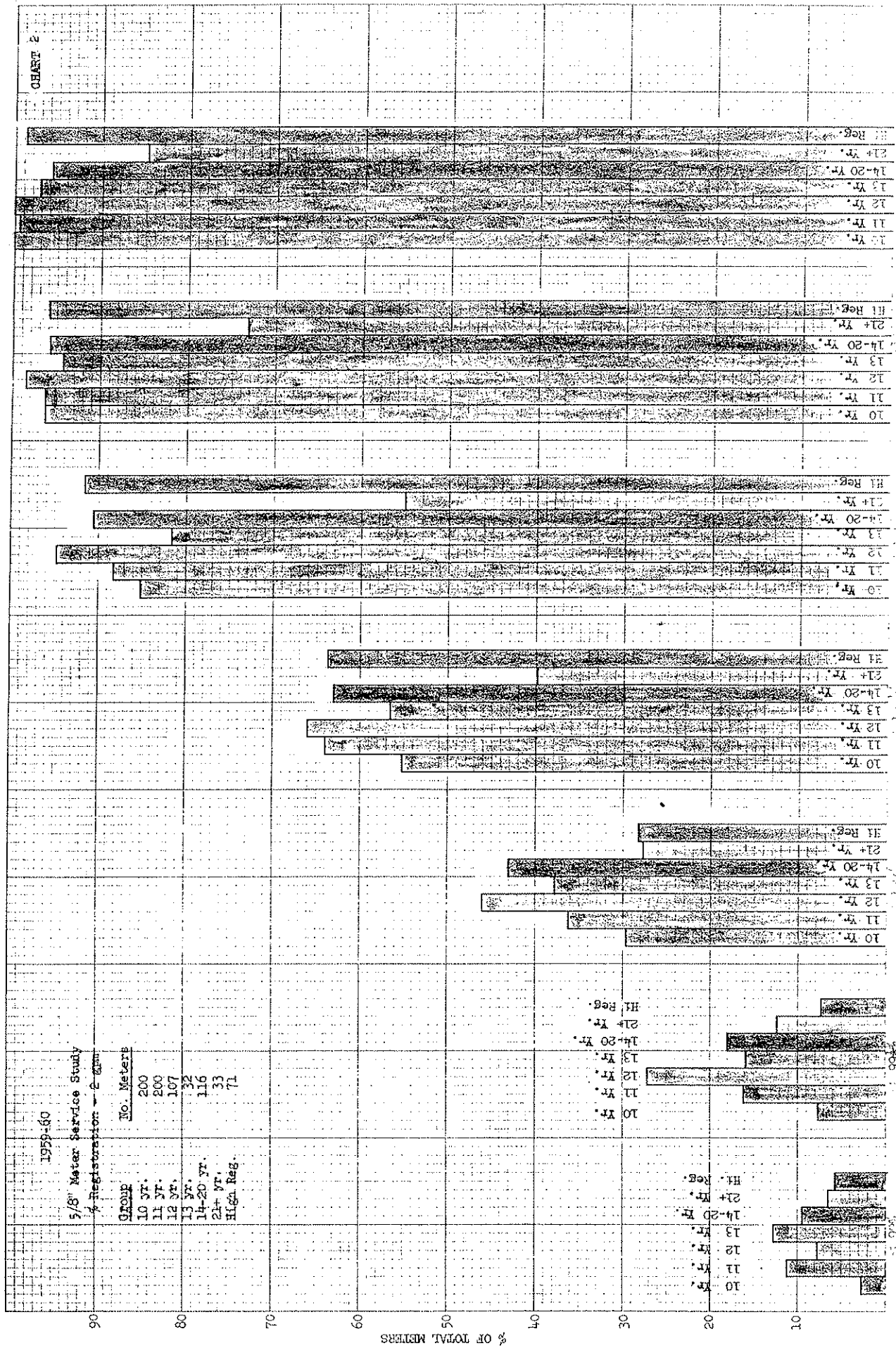
to

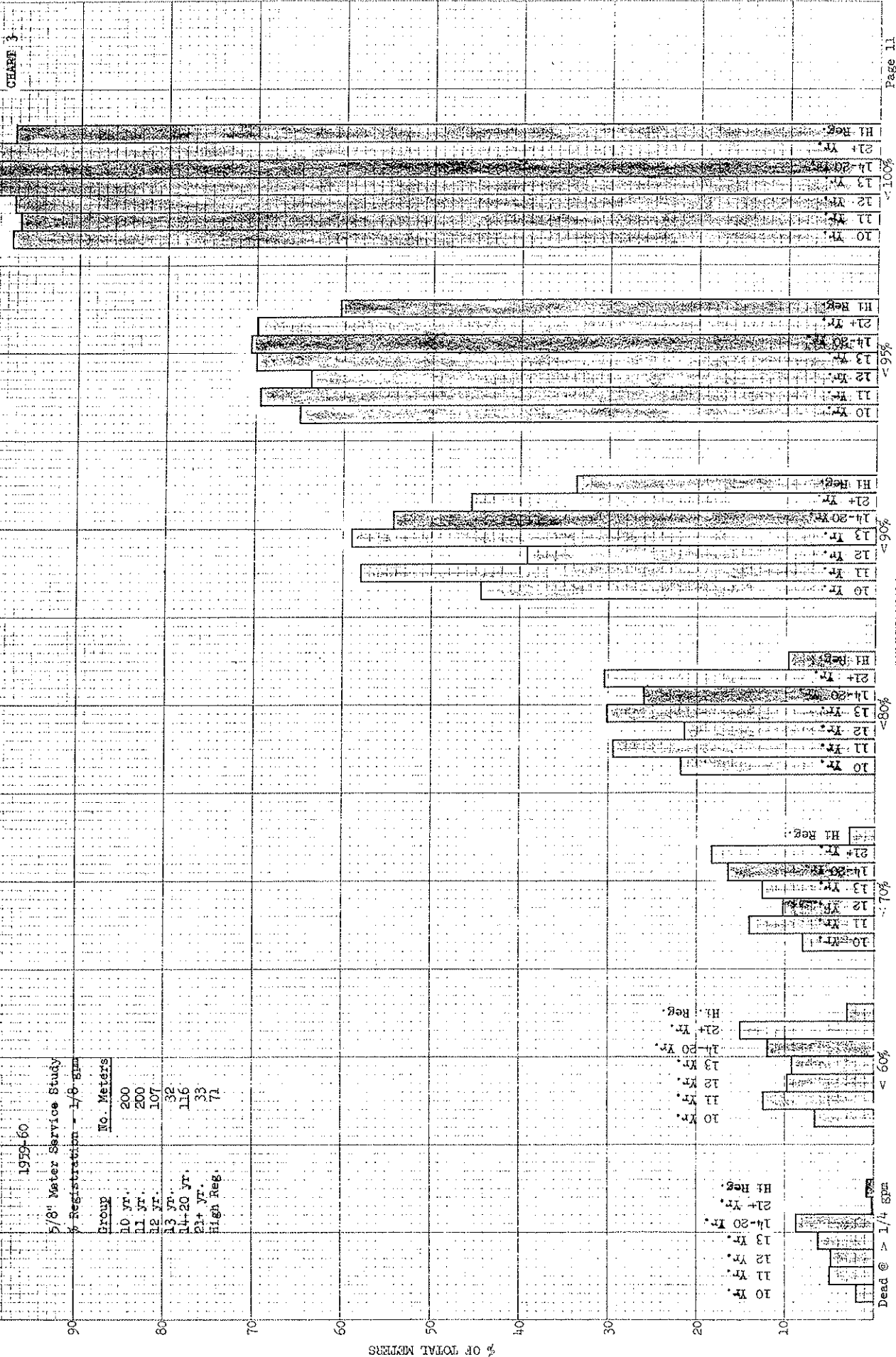
15-Year Change Program

*Based on 1961 Unit Costs

KROFFEL & BROWN CO. INC. - NEW YORK, N.Y.
 100 W. 40th St. - New York, N.Y.

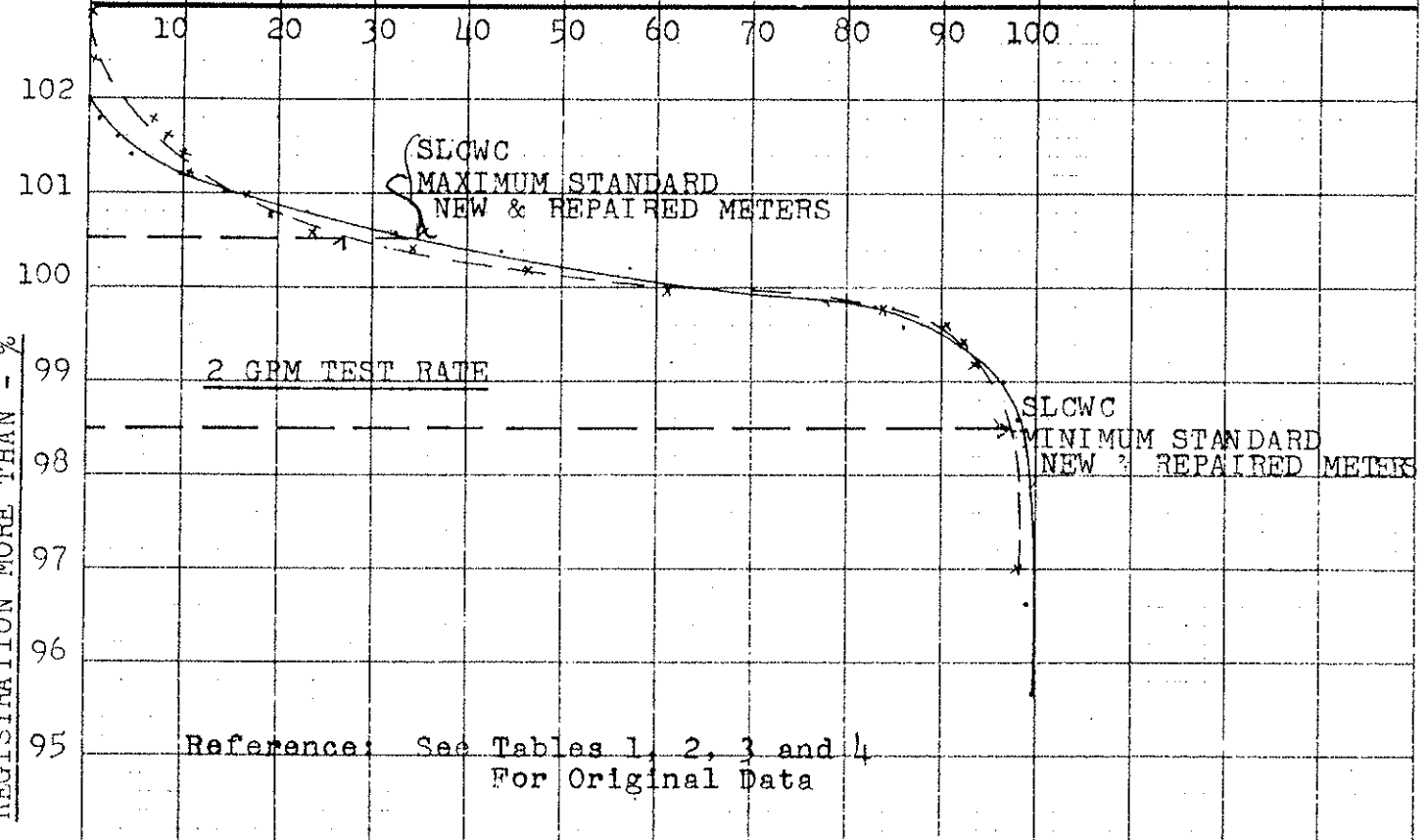
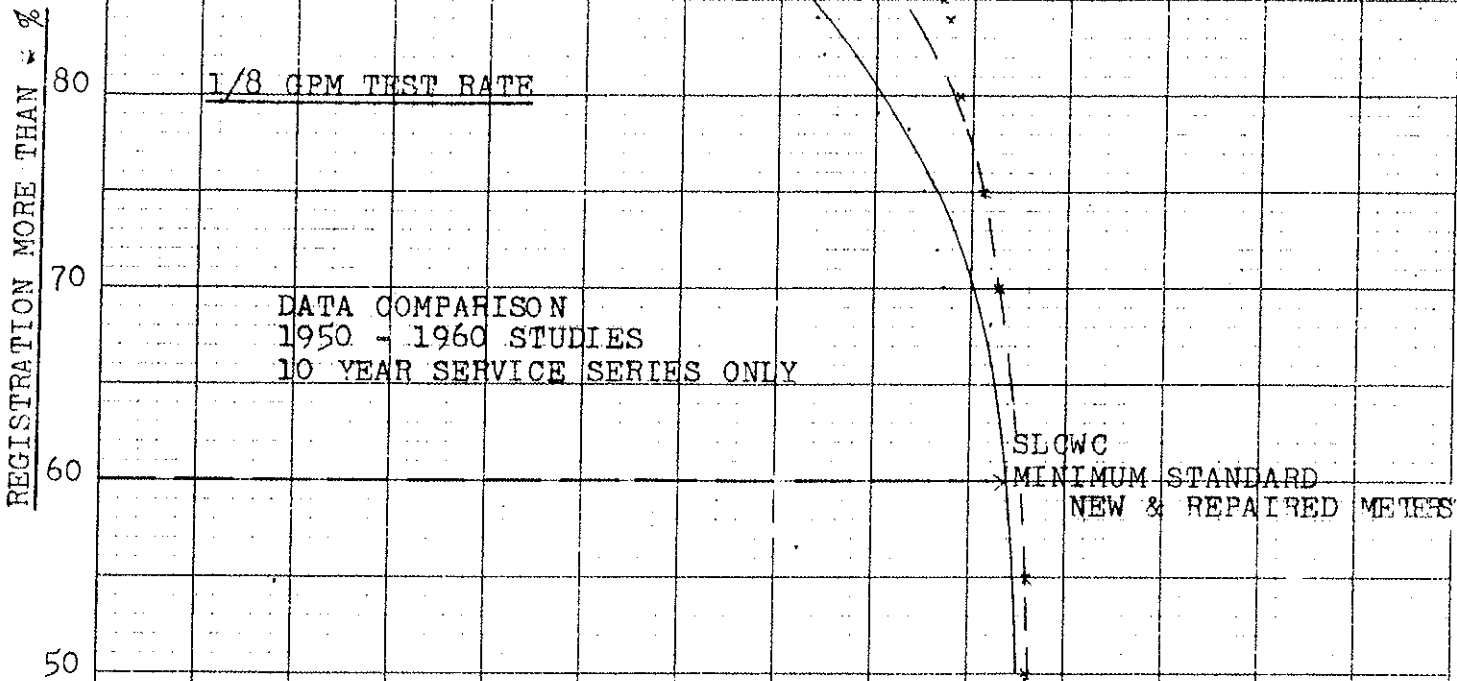






DATA COMPARISON
METERS W/10 YEAR SERVICE

• - - - - 1960 STUDY - 200
x - - - - x 1950 STUDY - 104

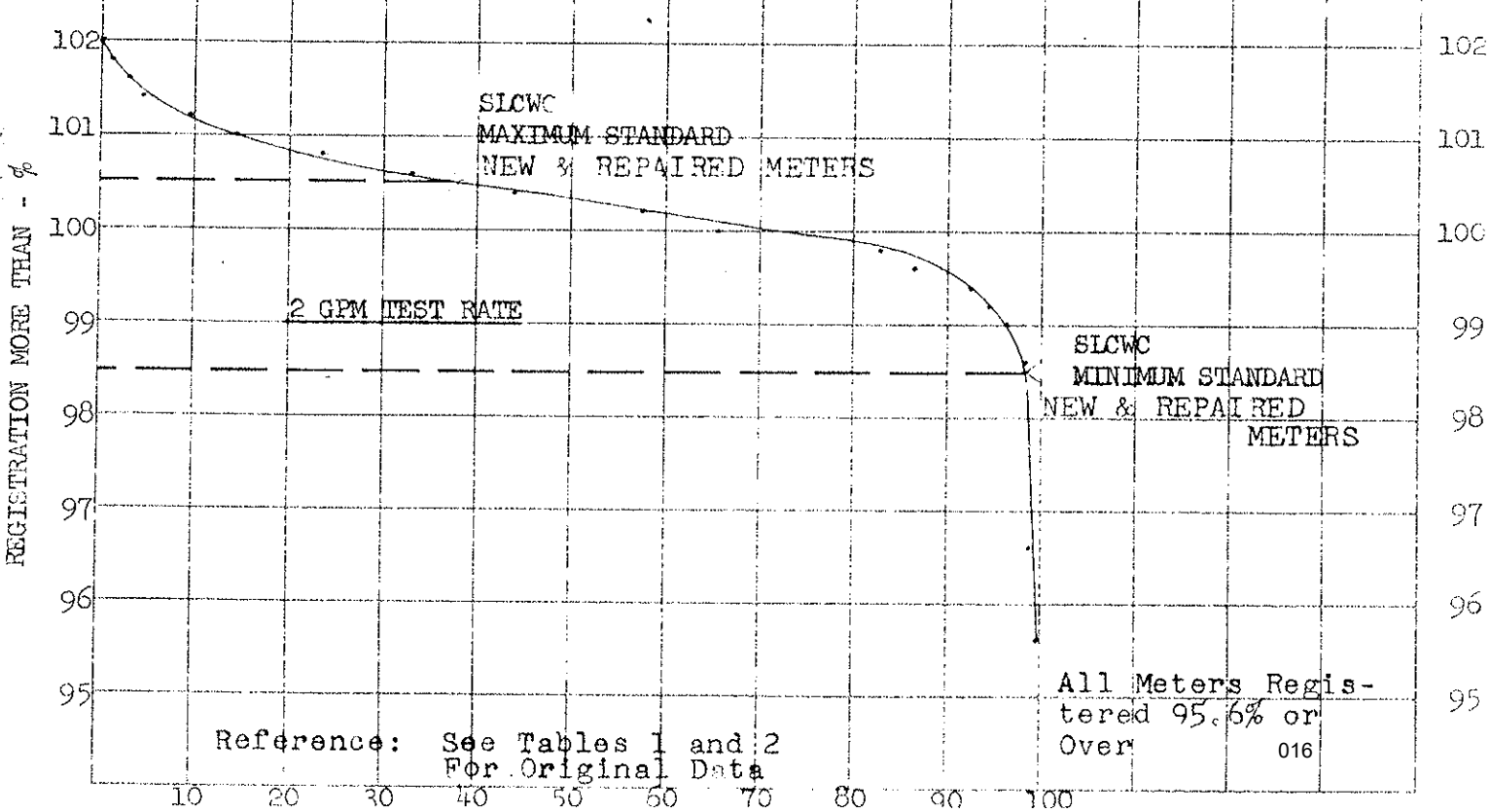
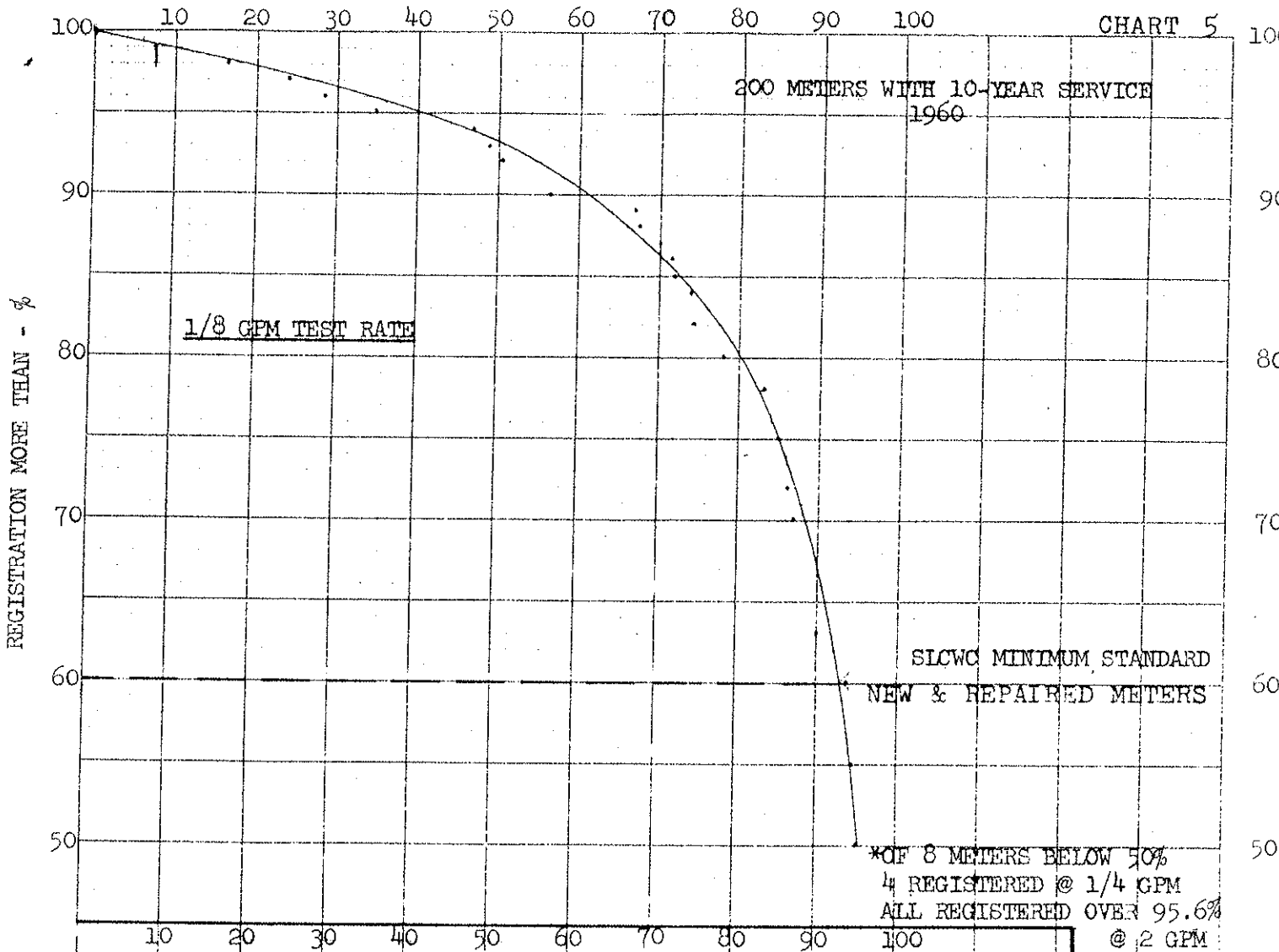


Reference: See Tables 1, 2, 3 and 4
For Original Data

ROBERT & ESSER CO., N. Y. C.
110 W. 40th St. New York 18, N. Y.

% OF TOTAL METERS

CHART 5



% OF TOTAL METERS

104 METERS WITH 10-YEAR SERVICE 1950

REGISTRATION MORE THAN - %

10 20 30 40 50 60 70 80 90 100

1/8 GPM TEST RATE

SLCWC MINIMUM STANDARD NEW & REPAIRED METERS

OF 2 METERS BELOW 50% BOTH REGISTERED @ 1/6 GPM ALL REGISTERED OVER 91.4% @ 2 GPM

10 20 30 40 50 60 70 80 90 100

SLCWC MAXIMUM STANDARD NEW & REPAIRED METERS

2 GPM TEST RATE

SLCWC MINIMUM STANDARD NEW & REPAIRED METERS

One Meter Registered Below 97%

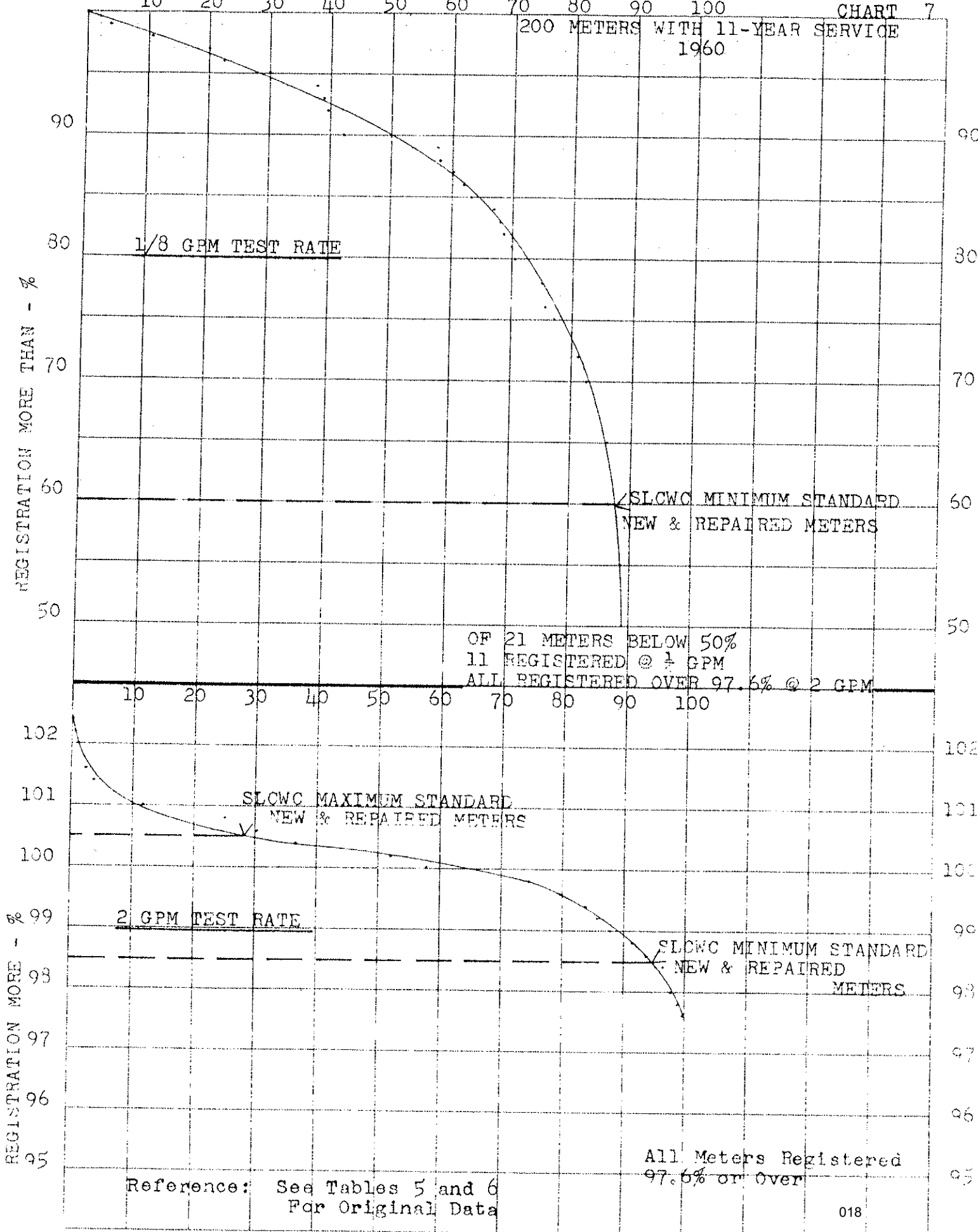
REGISTRATION MORE THAN - %

Reference: See Tables 3 and 4 For Original Data

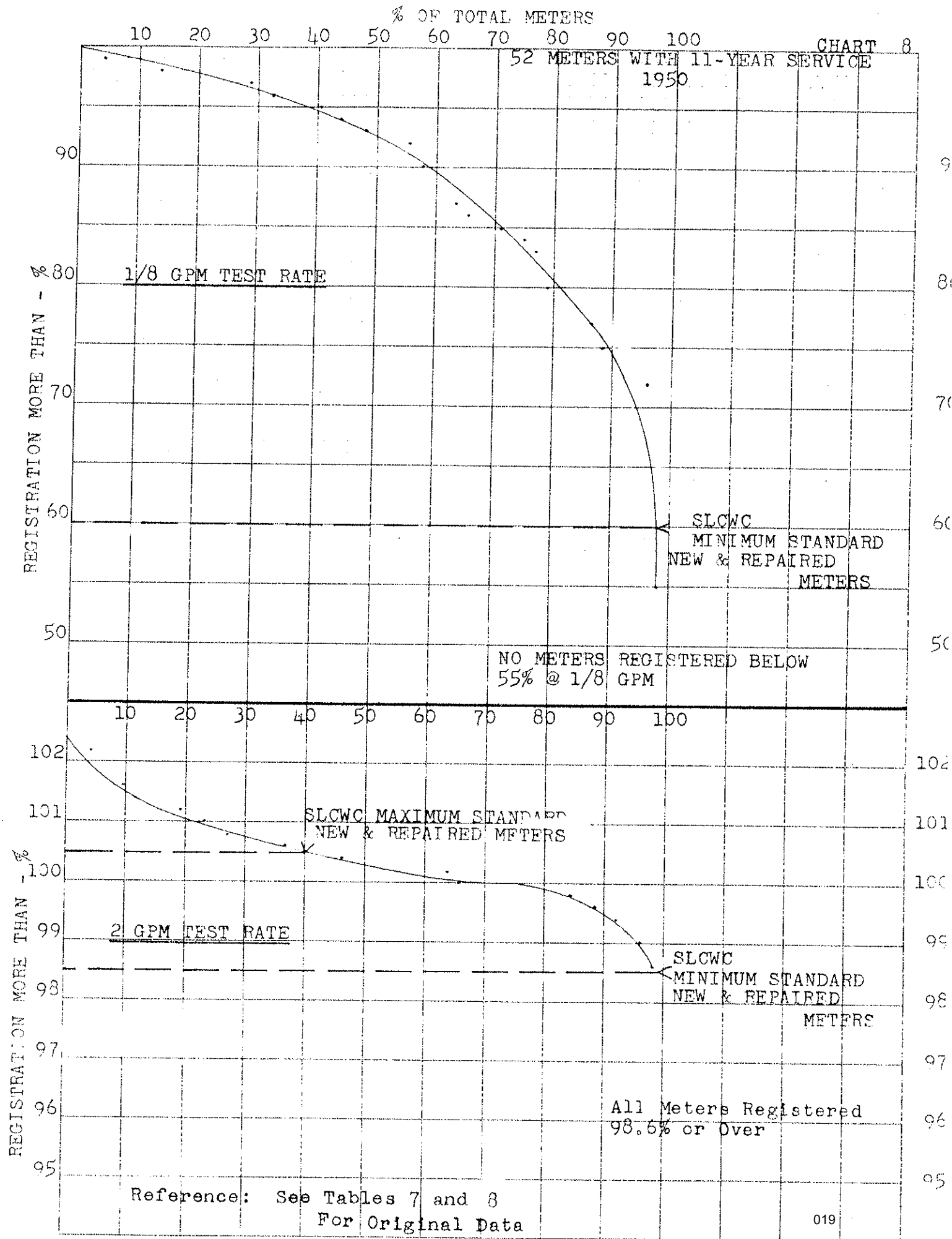
% OF TOTAL METERS

CHART 7

200 METERS WITH 11-YEAR SERVICE
1960

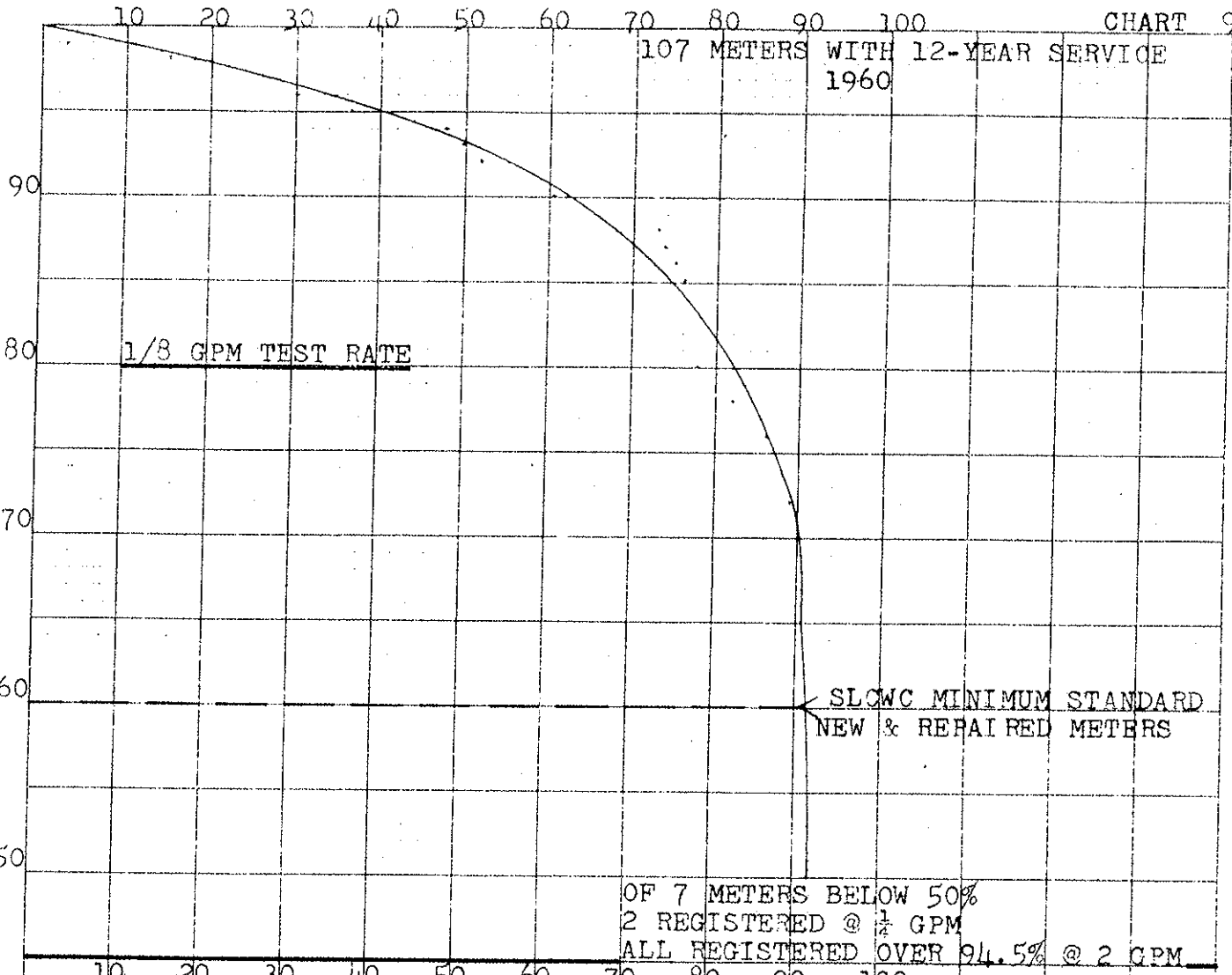


Reference: See Tables 5 and 6
For Original Data



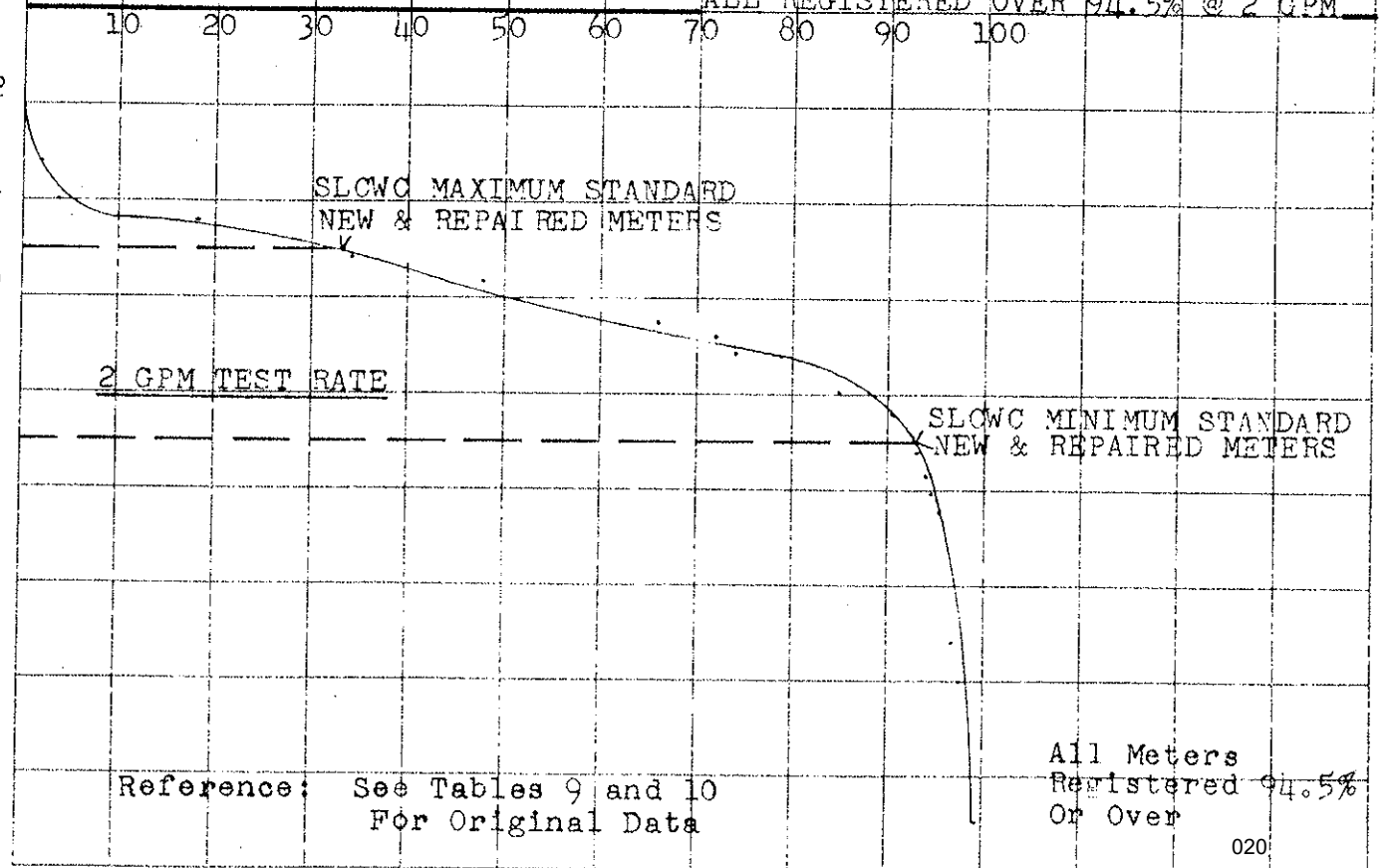
107 METERS WITH 12-YEAR SERVICE
1960

REGISTRATION MORE THAN - %



OF 7 METERS BELOW 50%
2 REGISTERED @ 1/4 GPM
ALL REGISTERED OVER 94.5% @ 2 GPM

REGISTRATION MORE THAN - %



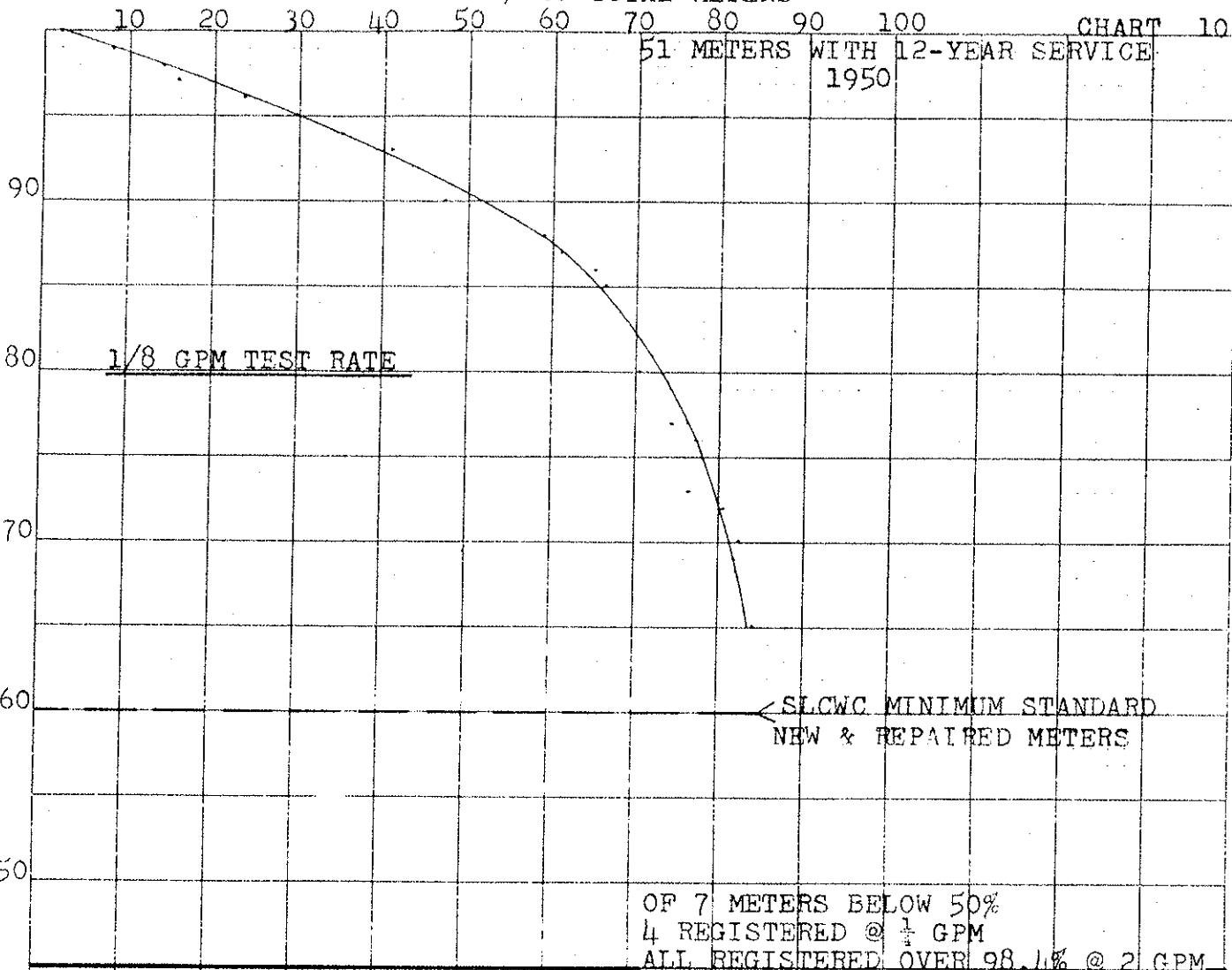
Reference: See Tables 9 and 10
For Original Data

All Meters
Registered 94.5%
Or Over

% OF TOTAL METERS

51 METERS WITH 12-YEAR SERVICE 1950

REGISTRATION MORE THAN - %

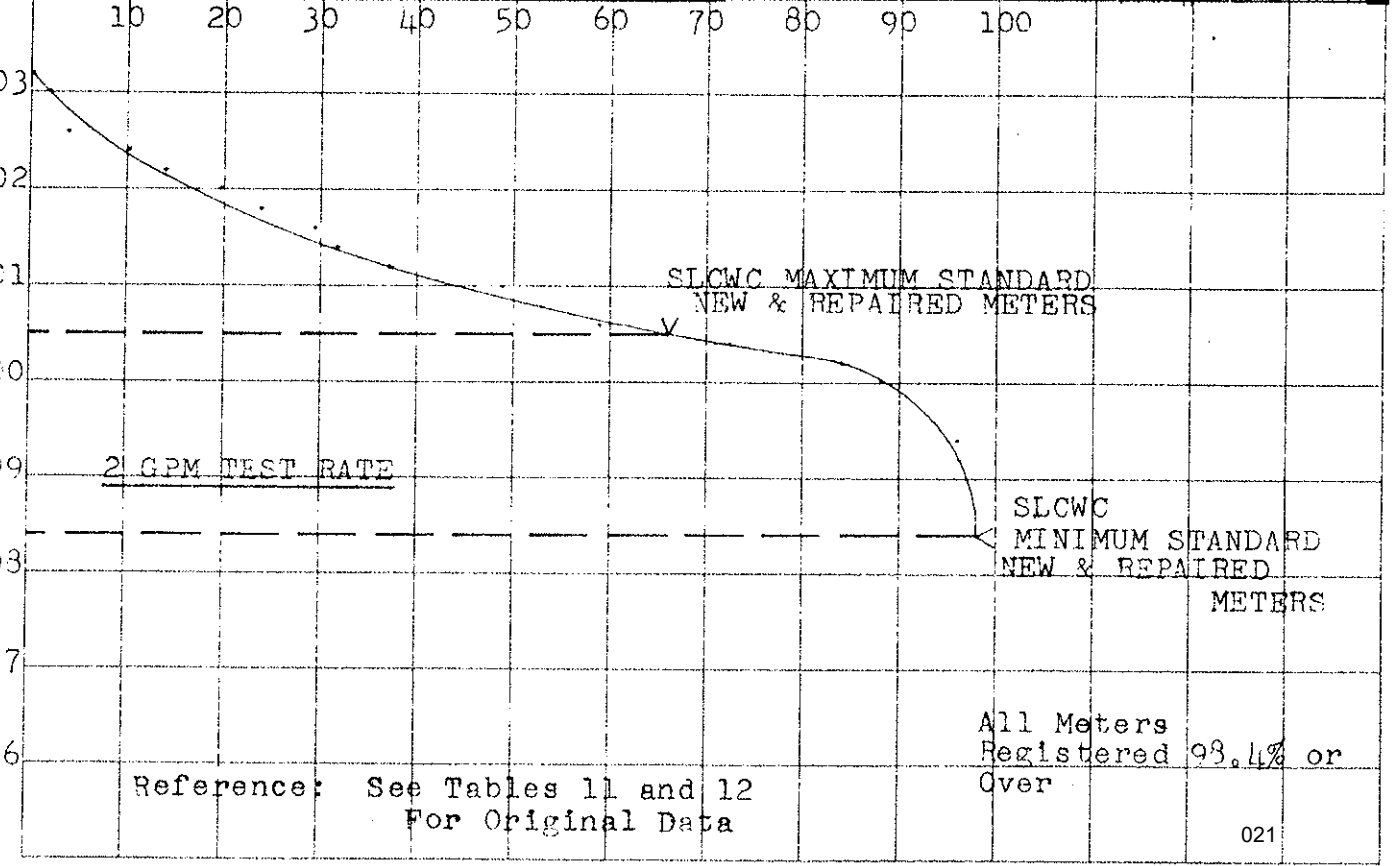


1/8 GPM TEST RATE

← SLCWC MINIMUM STANDARD
NEW & REPAIRED METERS

OF 7 METERS BELOW 50%
4 REGISTERED @ 1/4 GPM
ALL REGISTERED OVER 98.1% @ 2 GPM

REGISTRATION MORE THAN - %



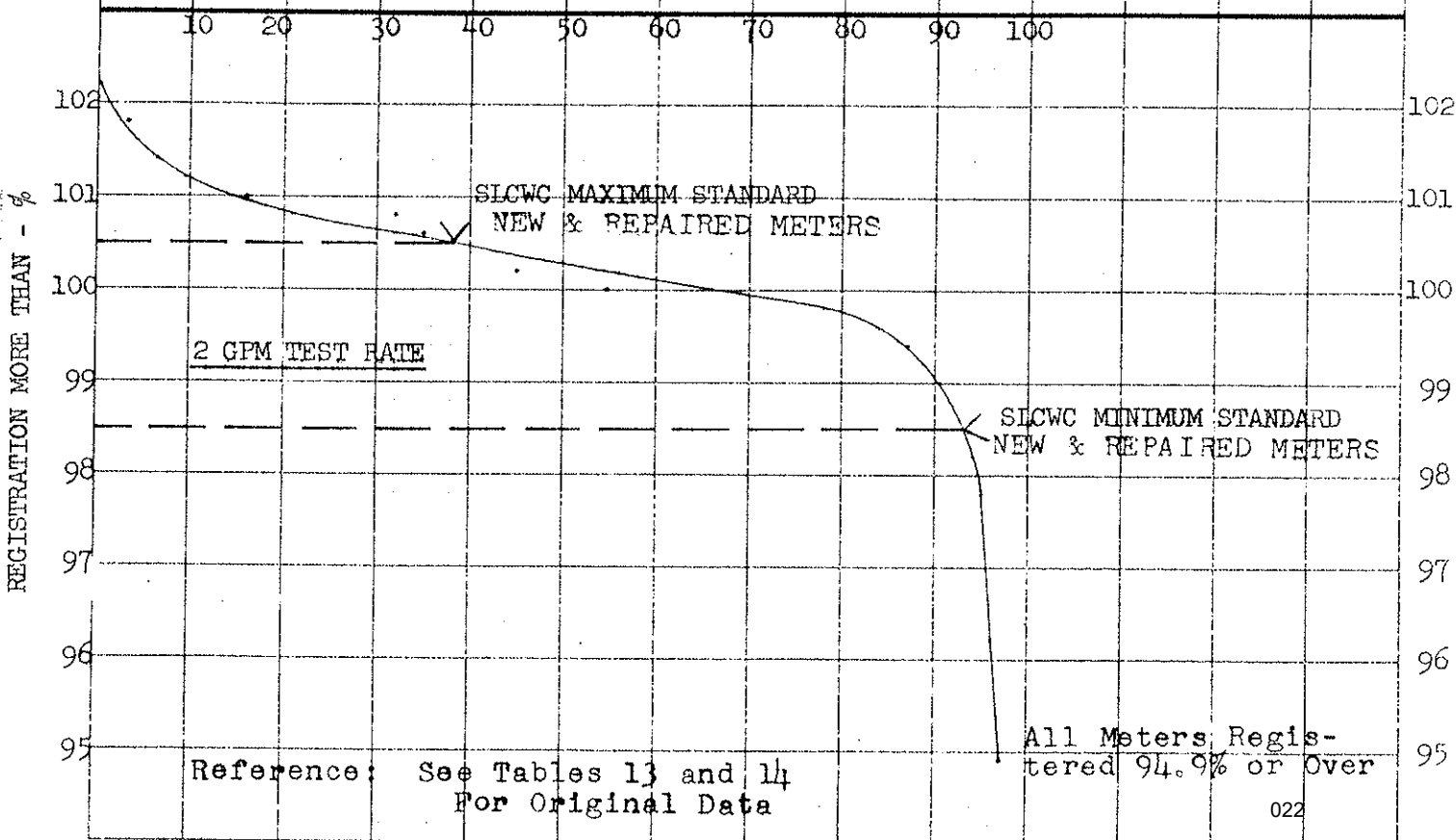
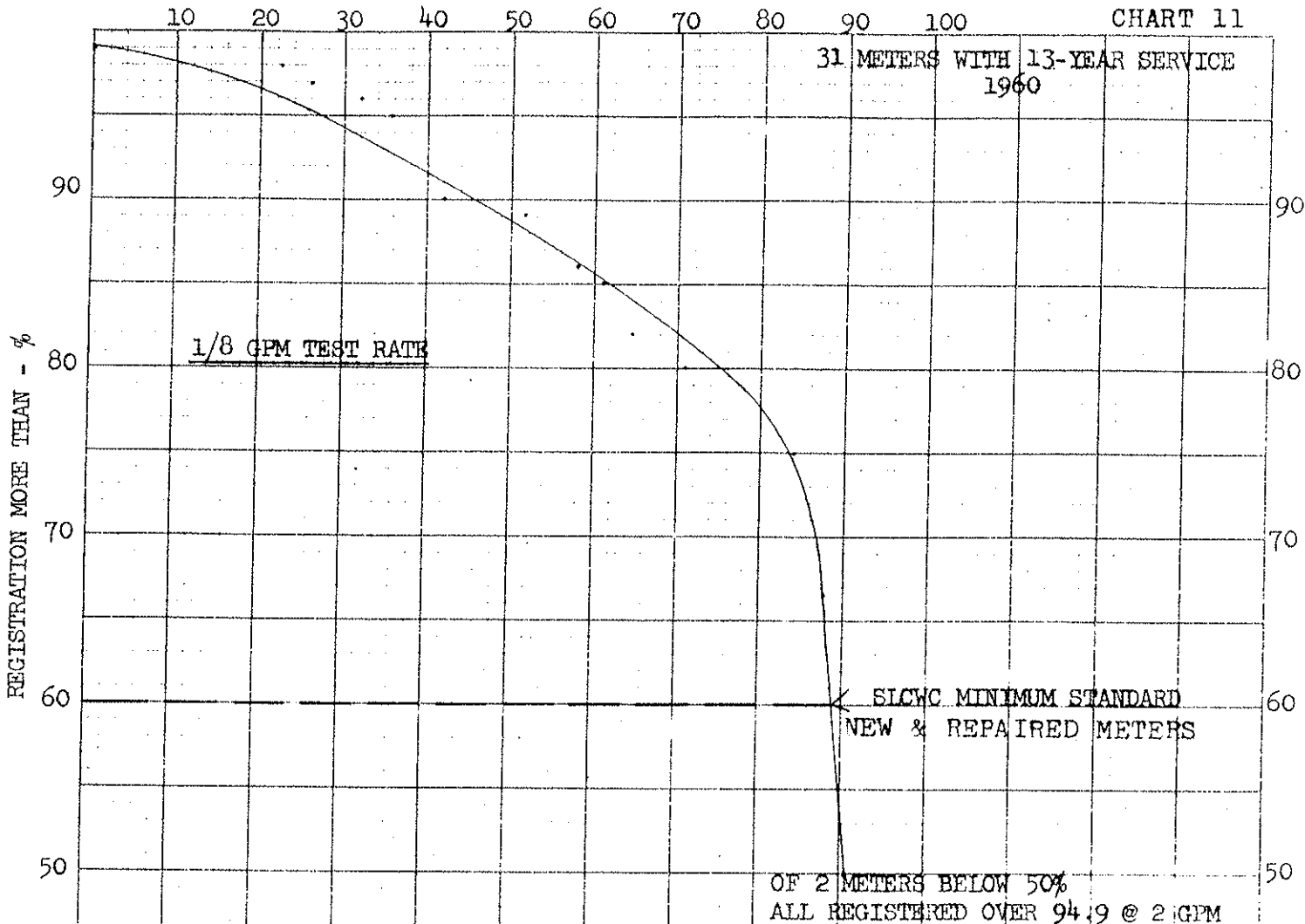
2 GPM TEST RATE

SLCWC MAXIMUM STANDARD
NEW & REPAIRED METERS

SLCWC
MINIMUM STANDARD
NEW & REPAIRED
METERS

All Meters
Registered 98.4% or
Over

Reference: See Tables 11 and 12
For Original Data



Reference: See Tables 13 and 14 For Original Data

REPRODUCED FROM THE NATIONAL BUREAU OF STANDARDS

116 METERS WITH 14-20 YEARS SERVICE 1960

10 20 30 40 50 60 70 80 90 100

90

80

70

60

50

1/8 GPM TEST RATE

SLCWC MINIMUM STANDARD NEW & REPAIRED METERS

14 METERS BELOW 65% ALL REGISTERED 89% OR OVER @ 2 gpm

10 20 30 40 50 60 70 80 90 100

102

101

100

99

98

97

96

95

SLCWC MAXIMUM STANDARD NEW & REPAIRED METERS

2 GPM TEST RATE

SLCWC MINIMUM STANDARD NEW & REPAIRED METERS

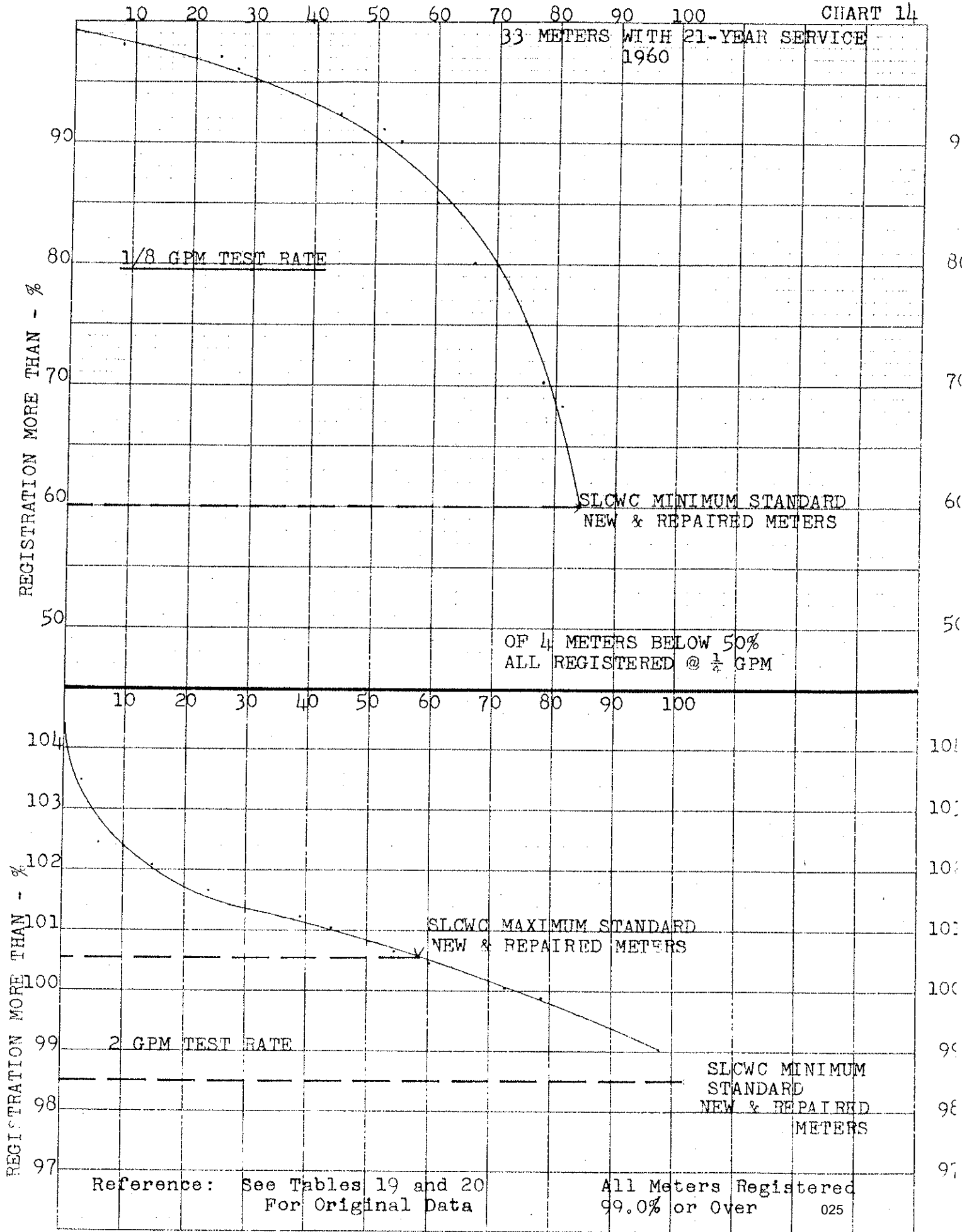
Reference: See Tables 17 and 18. For Original Data

4 Meters Tested Below 94% - All Registered 89% Or Over 024

KEUFFEL & ESSER CO. N. Y. INC. 1960
Printed in the U.S.A.

% OF TOTAL METERS

CHART 14



FLOTTEN & KASPER CO., INC. METERS
 1000 10th St. N.W., Wash., D.C. 20004

71 METERS WITH AVERAGE
REGISTRATION - 432,000 CU. FT.
1960

No. Meters	Yr. Service
31	Under 10 Yr.
36	10 - 15 Yr.
4	Over 15 Yr.

REGISTRATION MORE THAN - %

1/8 GPM TEST RATE

SLCWC MINIMUM STANDARD
NEW - REPAIRED METERS

1 METER BELOW 50%
REGISTERED AT 1/6 GPM
REGISTERED 101.5 @ 2 GPM

10 20 30 40 50 60 70 80 90 100

REGISTRATION MORE THAN - %

SLCWC MAXIMUM STANDARD
NEW - REPAIRED METERS

2 GPM TEST RATE

SLCWC MINIMUM
STANDARD - NEW
REPAIRED METERS

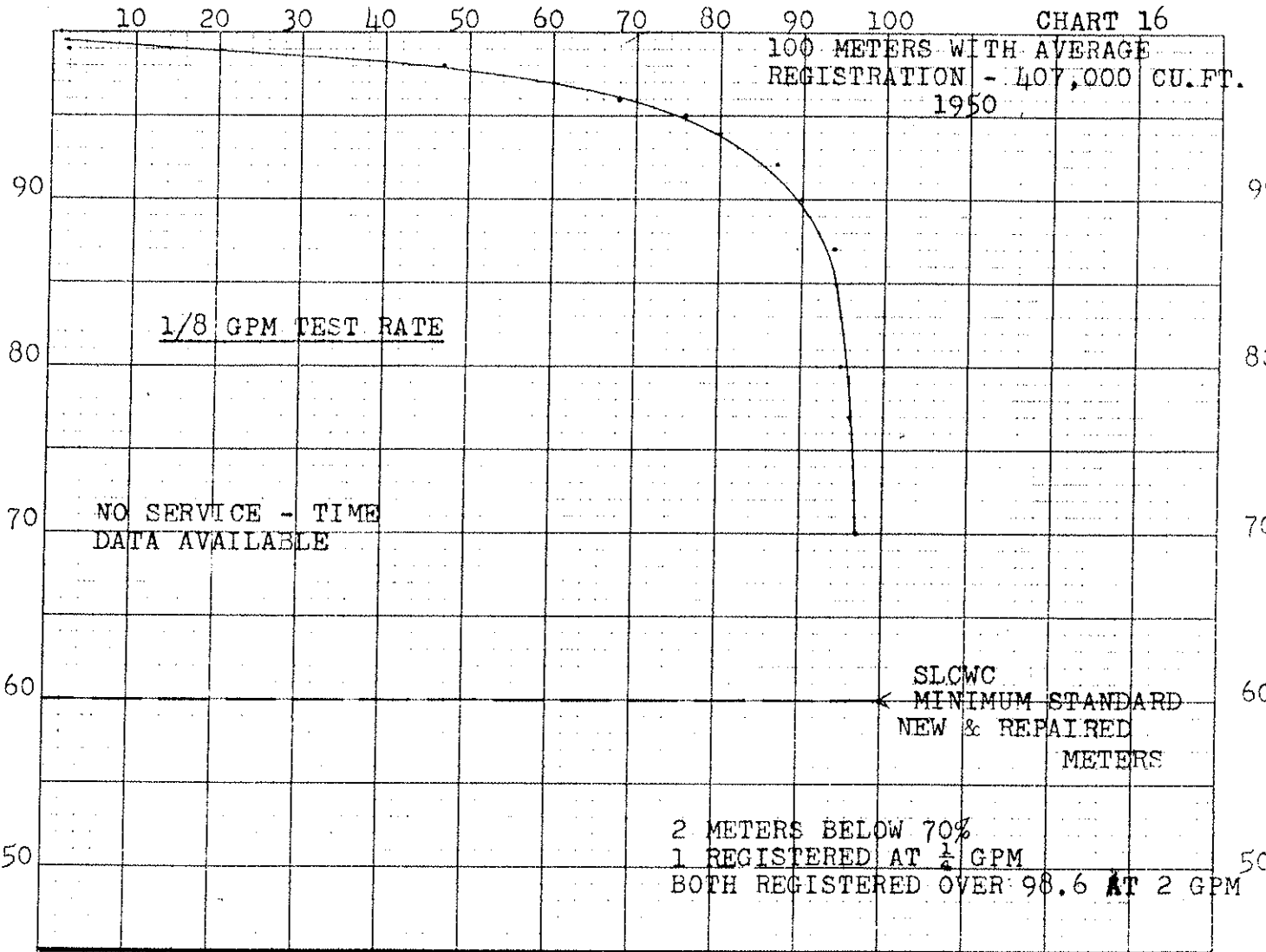
No. of Meters	Registration
18	200-300,000 cu. ft.
9	300-400,000 cu. ft.
23	400-500,000 " "
9	500-600,000 " "
6	600-700,000 " "
2	700-800,000 " "
3	800-900,000 " "
1	900-1,000,000 " "

Average Registration - 432,000 cu. ft.

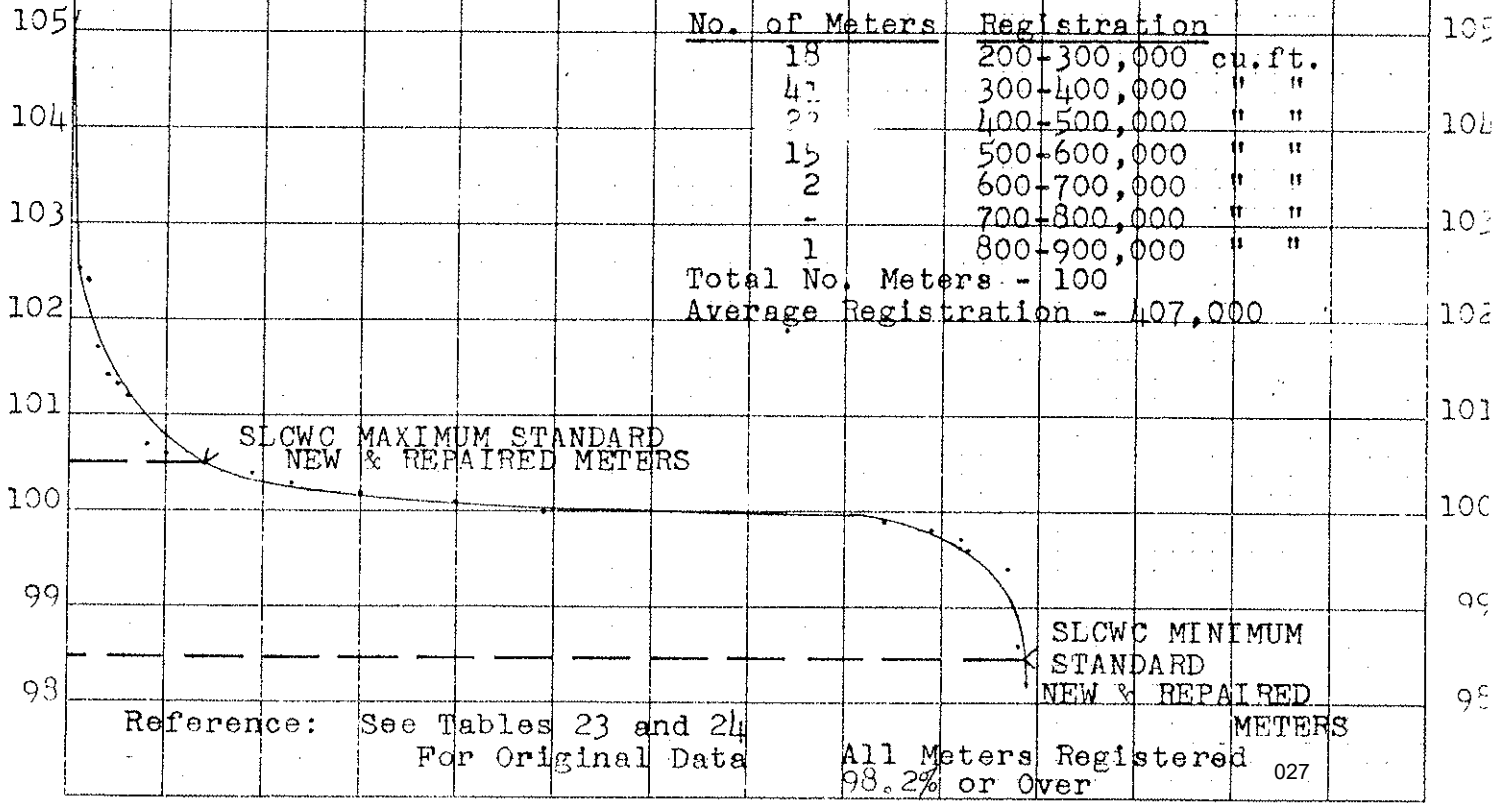
All Meters Registered 96.2
or Over

Reference: See Tables 21 and 22
For Original Data

100 METERS WITH AVERAGE
REGISTRATION - 407,000 CU.FT.
1950



10 20 30 40 50 60 70 80 90 100



No. of Meters	Registration
18	200-300,000 cu.ft.
41	300-400,000 " "
20	400-500,000 " "
15	500-600,000 " "
2	600-700,000 " "
-	700-800,000 " "
1	800-900,000 " "
Total No. Meters - 100	
Average Registration - 407,000	

Reference: See Tables 23 and 24
For Original Data

All Meters Registered
98.2% or Over

REPRODUCED FROM THE RECORDS OF THE
 U.S. DEPARTMENT OF THE INTERIOR
 GEOLOGICAL SURVEY

10-YEAR STUDY GROUP - 1960
1/8 GPM FLOW

<u>Number of Meters</u>	<u>Cumulative No. Meters</u>	<u>Summation of Total Tested - %</u>	<u>% Reg. More Than</u>
8	200	100	*
2	192	96	0
1	190	95	50
2	189	94½	55
2	187	93½	60
1	185	92½	65
10	184	92	68
1	174	87	70
3	173	86½	72
4	170	85	75
10	166	83	78
7	156	78	80
1	149	74½	82
6	148	74	84
1	142	71	85
1	141	70½	86
5	140	70	87
1	135	67½	88
21	134	67	89
12	113	56½	90
3	101	50½	92
4	98	49	93
24	94	47	94
13	70	35	95
9	57	28½	96
15	48	24	97
28	33	16½	98
5	5	2½	99
0	0	0	100

*2 meters reg. @ 50%

4 meters reg. @ 1/4 gpm

4 meters reg. between 1/4 and 1 gpm

10-YEAR STUDY GROUP - 1960
2 GPM FLOW

<u>Number of Meters</u>	<u>Cumulative No. Meters</u>	<u>Summation of Total Tested - %</u>	<u>% Reg. More Than</u>
1	200	100	95.5
1	199	$99\frac{1}{2}$	95.6
1	198	99	96.6
4	197	$98\frac{1}{2}$	98.6
4	193	$96\frac{1}{2}$	99
4	189	$94\frac{1}{2}$	99.2
12	185	$92\frac{1}{2}$	99.4
7	173	$86\frac{1}{2}$	99.6
35	166	83	99.8
16	131	$65\frac{1}{2}$	100
27	115	$57\frac{1}{2}$	100.2
22	88	44	100.4
19	66	33	100.6
18	47	$23\frac{1}{2}$	100.8
10	29	$14\frac{1}{2}$	101
10	19	$9\frac{1}{2}$	101.2
3	9	$4\frac{1}{2}$	101.4
4	6	3	101.6
2	2	1	101.8
0	0	0	102

10-YEAR STUDY GROUP - 1950
1/8 GPM FLOW

<u>Number of Meters</u>	<u>Cumulative No. Meters</u>	<u>Summation of Total Tested - %</u>	<u>% Reg. More Than</u>
2	104	100	*
1	102	98	0
1	101	97	50
1	100	96	55
2	99	95	60
2	97	93	70
3	95	$91\frac{1}{2}$	75
1	92	$88\frac{1}{2}$	80
1	91	$87\frac{1}{2}$	81
8	90	$86\frac{1}{2}$	85
1	82	79	86
3	81	78	87
3	78	75	88
4	75	72	90
9	71	68	93
4	62	$59\frac{1}{2}$	94
7	58	$55\frac{1}{2}$	95
8	51	49	96
13	43	41	97
28	30	29	98
2	2	2	99
0	0	0	100

* 2 meters reg. @ 1/2 gpm

10-YEAR STUDY GROUP - 1950
2 GPM FLOW

<u>Number of Meters</u>	<u>Cumulative No. Meters</u>	<u>Summation of Total Tested - %</u>	<u>% Reg. More Than</u>
1	104	100	91.3
1	103	99	91.4
1	102	98	97
3	101	96½	98.6
2	98	94	99.2
1	96	92	99.4
7	95	91	99.6
24	88	84	99.8
15	64	61½	100.
13	49	47	100.2
11	36	34½	100.4
4	25	24	100.6
3	21	20	100.8
7	18	17	101.
1	11	10½	101.2
1	10	9½	101.4
2	9	8½	101.6
1	7	6½	101.8
1	6	5½	102.
4	5	5	102.2
1	1	1	102.4
0	0	0	103.

11-YEAR STUDY GROUP - 1960
1/8 GPM FLOW

<u>Number of Meters</u>	<u>Cumulative No. Meters</u>	<u>Summation of Total Tested - %</u>	<u>% Reg. More Than</u>
21	200	100	*
1	179	89 $\frac{1}{2}$	0
1	178	89	50
4	177	88 $\frac{1}{2}$	55
1	173	86 $\frac{1}{2}$	60
9	172	86	65
1	163	81 $\frac{1}{2}$	70
2	162	81	72
6	160	80	74
3	154	77	75
1	151	75 $\frac{1}{2}$	76
9	150	75	78
1	141	70 $\frac{1}{2}$	80
3	140	70	81
1	137	68 $\frac{1}{2}$	82
2	136	68	83
8	134	67	84
2	126	63	85
2	124	62	86
6	122	61	87
1	116	58	88
31	115	57 $\frac{1}{2}$	89
5	84	42	90
1	79	39 $\frac{1}{2}$	92
3	78	39	93
15	75	37 $\frac{1}{2}$	94
15	60	30	95
5	45	22 $\frac{1}{2}$	96
19	40	20	97
14	21	10 $\frac{1}{2}$	98
7	7	3 $\frac{1}{2}$	99
0	0	0	100

* 1 meter reg. @ 50%
11 meters reg. @ 1/4 gpm
10 meters reg. between 1/4 and 1 $\frac{1}{2}$ gpm

TABLE 6

11-YEAR STUDY GROUP - 1960
2 GPM FLOW

<u>Number of Meters</u>	<u>Cumulative No. Meters</u>	<u>Summation of Total Tested - %</u>	<u>% Reg. More Than</u>
1	200	100	97.5
1	199	99 $\frac{1}{2}$	97.6
3	198	99	97.8
2	195	97 $\frac{1}{2}$	98.
6	193	96 $\frac{1}{2}$	98.4
4	187	93 $\frac{1}{2}$	98.6
8	183	91 $\frac{1}{2}$	98.8
4	175	87 $\frac{1}{2}$	99.
4	171	85 $\frac{1}{2}$	99.2
8	167	83 $\frac{1}{2}$	99.4
10	159	79 $\frac{1}{2}$	99.6
35	149	74 $\frac{1}{2}$	99.8
10	114	57	100.
31	104	52	100.2
13	73	36 $\frac{1}{2}$	100.4
10	60	30	100.6
27	50	25	100.8
9	23	11 $\frac{1}{2}$	101.
7	14	7	101.2
2	7	3 $\frac{1}{2}$	101.4
3	5	2 $\frac{1}{2}$	101.6
1	2	1	102.
1	1	$\frac{1}{2}$	102.2
0	0	0	102.4

11-YEAR STUDY GROUP - 1950
1/8 GPM FLOW

<u>Number of Meters</u>	<u>Cumulative No. Meters</u>	<u>Summation of Total Tested - %</u>	<u>% Reg. More Than</u>
1	52	100	*
1	51	98	55
4	50	96	72
1	46	$88\frac{1}{2}$	75
4	45	$86\frac{1}{2}$	77
1	41	79	80
1	40	77	83
2	39	75	84
3	37	71	85
1	34	$65\frac{1}{2}$	86
3	33	$63\frac{1}{2}$	87
1	30	$57\frac{1}{2}$	90
4	29	$55\frac{1}{2}$	92
2	25	48	93
2	23	44	94
4	21	$40\frac{1}{2}$	95
2	17	$32\frac{1}{2}$	96
8	15	29	97
5	7	$13\frac{1}{2}$	98
2	2	4	99
0	0	0	100

* 1 meter reg. @ 55%

11-YEAR STUDY GROUP - 1950
2 GPM FLOW

<u>Number of Meters</u>	<u>Cumulative No. Meters</u>	<u>Summation of Total Tested - %</u>	<u>% Reg. More Than</u>
1	52	100	98.5
1	51	98	98.6
2	50	96	99.0
2	48	92	99.4
2	46	$88\frac{1}{2}$	99.6
10	44	$84\frac{1}{2}$	99.8
1	34	$65\frac{1}{2}$	100.
9	33	$63\frac{1}{2}$	100.2
5	24	46	100.4
5	19	$36\frac{1}{2}$	100.6
2	14	27	100.8
2	12	23	101.
4	10	19	101.2
1	6	$11\frac{1}{2}$	101.4
2	5	$9\frac{1}{2}$	101.6
1	3	6	102.
2	2	4	102.2
0	0	0	102.4

12-YEAR STUDY GROUP - 1960
1/8 GPM FLOW

<u>Number of Meters</u>	<u>Cumulative No. Meters</u>	<u>Summation of Total Tested - %</u>	<u>% Reg. More Than</u>
7	107	100	*
2	100	$93\frac{1}{2}$	0
1	98	$91\frac{1}{2}$	50
1	97	$90\frac{1}{2}$	65
1	96	90	70
1	95	89	72
1	94	88	74
1	93	87	75
4	92	86	76
5	88	82	78
1	83	$77\frac{1}{2}$	80
2	82	$76\frac{1}{2}$	85
1	80	75	86
1	79	74	87
13	78	73	88
10	65	$60\frac{1}{2}$	90
2	55	$51\frac{1}{2}$	92
2	53	$49\frac{1}{2}$	93
12	51	$47\frac{1}{2}$	94
7	39	$36\frac{1}{2}$	95
3	32	30	96
13	29	27	97
13	16	15	98
3	3	3	99
0	0	0	100

* 2 meters reg. @ 50%
2 meters reg. @ 1/4 gpm
5 meters reg. between 1/4 gpm and $1\frac{1}{2}$ gpm

12-YEAR STUDY GROUP - 1960
2 GPM FLOW

<u>Number of Meters</u>	<u>Cumulative No. Meters</u>	<u>Summation of Total Tested - %</u>	<u>% Reg. More Than</u>
1	107	100	94.4
2	106	99 $\frac{3}{4}$	94.5
1	104	97	96.0
1	103	96 $\frac{1}{2}$	96.4
1	102	95 $\frac{1}{2}$	97.8
1	101	94 $\frac{1}{2}$	98.0
1	100	93 $\frac{3}{4}$	98.4
2	99	92 $\frac{3}{4}$	98.6
6	97	90 $\frac{3}{4}$	98.8
1	91	85	99.0
11	90	84	99.2
2	79	74	99.4
7	77	72	99.6
15	70	65 $\frac{1}{2}$	99.8
4	55	51 $\frac{1}{2}$	100.0
15	51	47 $\frac{1}{2}$	100.2
6	36	34	100.4
11	30	28	100.6
15	19	18	100.8
1	4	3.7	101.0
1	3	2.8	101.2
2	2	1.9	101.4
0	0	0	102.

12-YEAR STUDY GROUP - 1950
1/8 GPM FLOW

<u>Number of Meters</u>	<u>Cumulative No. Meters</u>	<u>Summation of Total Tested - %</u>	<u>% Reg. More Than</u>
7	51	100	*
1	44	86 $\frac{1}{2}$	0
1	43	84 $\frac{1}{2}$	65
1	42	82 $\frac{1}{2}$	70
2	41	80 $\frac{1}{2}$	72
1	39	75 $\frac{1}{2}$	73
2	38	74 $\frac{1}{2}$	77
2	36	70 $\frac{1}{2}$	80
1	34	66 $\frac{1}{2}$	85
2	33	65	86
1	31	61	87
6	30	59	88
3	24	47	90
3	21	41	93
3	18	35	94
3	15	29 $\frac{1}{2}$	95
4	12	23 $\frac{1}{2}$	96
1	8	15 $\frac{1}{2}$	97
3	7	14	98
3	4	8	99
1	1	2	100
0	0	0	101

* 1 meter reg. @ 65%
4 meters reg. @ 1/4 gpm
3 meters reg. between 1/4 gpm and 1 gpm

TABLE 12

12-YEAR STUDY GROUP - 1950
2 GPM FLOW

<u>Number of Meters</u>	<u>Cumulative No. Meters</u>	<u>Summation of Total Tested - %</u>	<u>% Reg. More Than</u>
1	51	100	98.3
1	50	98	98.4
4	49	96	99.4
2	45	88	100.
6	43	84	100.2
7	37	72 $\frac{1}{2}$	100.4
3	30	59	100.6
2	27	53	100.8
6	25	49	101.
3	19	37	101.2
1	16	31 $\frac{1}{2}$	101.4
3	15	29 $\frac{1}{2}$	101.6
2	12	23 $\frac{1}{2}$	101.8
3	10	19 $\frac{1}{2}$	102.
2	7	14	102.2
3	5	10	102.4
1	2	4	102.6
1	1	2	103.
0	0	0	103.2

TABLE 13

13-YEAR STUDY GROUP - 1960
1/8 GPM FLOW

<u>Number of Meters</u>	<u>Cumulative No. Meters</u>	<u>Summation of Total Tested - %</u>	<u>% Reg. More Than</u>
3	31	100	*
2	28	90 $\frac{1}{2}$	50
4	26	84	75
2	22	71	80
1	20	64 $\frac{1}{2}$	82
1	19	61	85
2	18	58	86
3	16	51 $\frac{1}{2}$	88
2	13	42	90
1	11	35 $\frac{1}{2}$	95
2	10	32	96
1	8	26	97
7	7	22 $\frac{1}{2}$	98
0	0	0	99

* 1 meter reg. @ 50%
2 meters reg. @ 1/4 gpm

13-YEAR STUDY GROUP - 1960
2 GPM FLOW

<u>Number of Meters</u>	<u>Cumulative No. Meters</u>	<u>Summation of Total Tested - %</u>	<u>% Reg. More Than</u>
1	31	100	94.8
2	30	97	94.9
1	28	90 $\frac{1}{2}$	99.0
1	27	87	99.4
9	26	84	99.6
3	17	55	100.0
3	14	45	100.2
1	11	35	100.6
5	10	32	100.8
2	5	16	101.0
1	3	9 $\frac{1}{2}$	101.2
1	2	6 $\frac{1}{2}$	101.4
1	1	3.2	101.8
0	0	0	102.2

13-YEAR STUDY GROUP - 1950
1/8 GPM FLOW

<u>Number of Meters</u>	<u>Cumulative No. Meters</u>	<u>Summation of Total Tested - %</u>	<u>% Reg. More Than</u>
6	45	100	*
2	39	86½	0
2	37	82	70
1	35	77½	77
2	34	75½	78
2	32	71	80
2	30	66½	83
3	28	62	85
2	25	55½	87
6	23	51	88
1	17	38	90
1	16	35½	92
1	15	33	93
3	14	31	94
5	11	24½	95
1	6	13½	96
2	5	11	97
3	3	6½	98
0	0	0	100

* 2 meters reg. @ 70%
5 meters reg. @ 1/4 gpm
1 meter reg. between 1/4 and 1/2 gpm

TABLE 16

13-YEAR STUDY GROUP - 1950
2 GPM FLOW

<u>Number of Meters</u>	<u>Cumulative No. Meters</u>	<u>Summation of Total Tested - %</u>	<u>% Reg. More Than</u>
3	45	100	99.9
6	42	93	100.
5	36	80	100.2
6	31	69	100.4
3	25	55 $\frac{1}{2}$	100.6
2	22	49	100.8
4	20	44 $\frac{1}{2}$	101.
4	16	35 $\frac{1}{2}$	101.2
3	12	26 $\frac{1}{2}$	101.4
1	9	20	101.6
3	8	19 $\frac{1}{2}$	101.8
3	5	11	102.2
1	2	4 $\frac{1}{2}$	102.4
1	1	2.2	102.6
0	0	0	103.2

TABLE 17

14-20 YEAR STUDY GROUP - 1960
1/8 GPM FLOW

<u>Number of Meters</u>	<u>Cumulative No. Meters</u>	<u>Summation of Total Tested - %</u>	<u>% Reg. More Than</u>
13	116	100	*
1	103	89	0
5	102	88	65
3	97	83 $\frac{1}{2}$	70
8	94	81	75
1	86	74	80
1	85	73	82
3	84	72	84
1	81	70	85
4	80	69	87
23	76	65 $\frac{1}{2}$	88
2	53	45 $\frac{1}{2}$	90
2	51	44	92
1	49	42	93
14	48	41	94
5	34	29	95
3	29	25	96
11	26	22	97
15	15	13	98
0	0	0	99

*1 meter reg. @ 65%
7 meters reg. @ 1/4 gpm
6 meters reg. between 1/4 and 1 $\frac{1}{2}$ gpm

TABLE 18

14-20 YEAR STUDY GROUP - 1960
2 GPM FLOW

<u>Number of Meters</u>	<u>Cumulative No. Meters</u>	<u>Summation of Total Tested - %</u>	<u>% Reg. More Than</u>
1	116	100	88.9
1	115	99	89.
1	114	98	92.
1	113	97	92.5
1	112	96 $\frac{1}{2}$	94.
1	111	95 $\frac{1}{2}$	97.
1	110	95	97.2
1	109	94	98.
2	108	93	98.8
1	106	91 $\frac{1}{2}$	99.
3	105	90 $\frac{1}{2}$	99.2
6	102	88	99.4
30	96	82 $\frac{1}{2}$	99.8
10	66	57	100.0
13	56	48	100.2
9	43	37	100.4
7	34	29	100.6
16	27	23	100.8
1	11	9 $\frac{1}{2}$	101.0
5	10	8 $\frac{1}{2}$	101.2
2	5	4	101.4
1	3	2 $\frac{1}{2}$	102.0
1	2	1 $\frac{1}{2}$	102.2
1	1	1	102.4
0	0	0	103.2

21-YEAR STUDY GROUP - 1960
1/8 GPM FLOW

<u>Number of Meters</u>	<u>Cumulative No. Meters</u>	<u>Summation of Total Tested - %</u>	<u>% Reg. More Than</u>
4	33	100	*
1	29	87	0
1	28	84	60
1	27	81	68
1	26	78	70
3	25	75	75
2	22	66	80
2	20	60	85
1	18	54	90
2	17	51	91
5	15	45	92
1	10	30	95
1	9	27	96
5	8	24	97
3	3	9	98
0	0	0	99

*1 meter reg. @ 60%
4 meters reg. @ 1/4 gpm

21-YEAR STUDY GROUP - 1960
2 GPM FLOW

<u>Number of Meters</u>	<u>Cumulative No. Meters</u>	<u>Summation of Total Tested - %</u>	<u>% Reg. More Than</u>
3	33	100	98.9
1	30	91	99.0
1	29	87	99.4
2	28	84	99.6
2	26	78	99.8
4	24	72	100.
2	20	60	100.4
4	18	54	100.6
1	14	42	101.
4	13	39	101.2
1	9	27	101.4
3	8	24	101.6
3	5	15	102.
1	2	6	102.4
1	1	3	103.4
0	0	0	104.4

TABLE 21

HIGH REGISTRATION GROUP - OVER 432,000 CU. FT. AVG. - 1960
1/8 GPM FLOW

<u>Number of Meters</u>	<u>Cumulative No. Meters</u>	<u>Summation of Total Tested - %</u>	<u>% Reg. More Than</u>
			*
2	71	100	0
1	69	97 $\frac{1}{2}$	50
2	68	96	70
2	66	93	75
1	64	90	80
3	63	89	82
2	60	84 $\frac{1}{2}$	85
1	58	82	88
10	57	80 $\frac{1}{2}$	89
1	47	66 $\frac{1}{2}$	90
6	46	65	91
1	40	56 $\frac{1}{2}$	92
2	39	55	93
10	37	52	94
3	27	38	95
3	24	34	96
9	21	29 $\frac{1}{2}$	97
10	12	17	98
2	2	3	99
0	0	0	100

* 1 meter reg. @ 50%
1 meter reg. @ 1/6 gpm

HIGH REGISTRATION GROUP -- OVER 432,000 CU. FT. AVG. -- 1960
2 GPM FLOW

<u>Number of Meters</u>	<u>Cumulative No. Meters</u>	<u>Summation of Total Tested -- %</u>	<u>% Reg. More Than</u>
1	71	100	96.1
2	70	$98\frac{1}{2}$	96.2
2	68	96	98.6
2	66	93	99.0
4	64	90	99.6
18	60	$84\frac{1}{2}$	99.8
5	42	59	100.0
11	37	52	100.2
8	26	$36\frac{1}{2}$	100.4
4	18	$25\frac{1}{2}$	100.6
8	14	20	100.8
3	6	$8\frac{1}{2}$	101.0
1	3	4	101.4
1	2	3	101.8
1	1	$1\frac{1}{2}$	102.0
0	0	0	102.4

HIGH REGISTRATION GROUP - OVER 407,000 CU. FT. AVG. - 1950
1/8 GPM FLOW

<u>Number of Meters</u>	<u>Cumulative No. Meters</u>	<u>Summation of Total Tested - %</u>	<u>% Reg. More Than</u>
2	100	100	*
1	98	98	0
1	97	97	70
1	96	96	77
1	95	95	80
4	94	94	87
3	90	90	90
7	87	87	92
4	80	80	94
8	76	76	95
8	68	68	96
13	60	60	97
45	47	47	98
1	2	2	99
1	1	1	100
0	0	0	101

* 1 meter reg. @ 70%
1 meter reg. @ 1/4 gpm
1 meter reg. @ 0.4 gpm

HIGH REGISTRATION GROUP - OVER 407,000 CU. FT. AVG. - 1950
2 GPM FLOW

<u>Number of Meters</u>	<u>Cumulative No. Meters</u>	<u>Summation of Total Tested - %</u>	<u>% Reg. More Than</u>
1	100	100	98.1
1	99	99	98.2
1	98	98	98.6
4	97	97	99.4
1	93	93	99.6
3	92	92	99.7
5	89	89	99.8
35	84	84	99.9
9	49	49	100.0
10	40	40	100.1
7	30	30	100.2
4	23	23	100.3
5	19	19	100.4
4	14	14	100.5
2	10	10	100.6
2	8	8	100.7
1	6	6	101.2
1	5	5	101.3
1	4	4	101.4
1	3	3	101.7
1	2	2	102.4
1	1	1	102.5
0	0	0	105.1