MISSOURI AMERICAN – ST. LOUIS COUNTY

1995 STUDY OF METER ACCURACY

VALIDATING 15 YEAR LIFE FOR METERS

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1995 METER STUDY

Purpose:

The purpose of this study is to see if our current 15 year meter change program for 5/8" meters is still appropriate, or if there is a need to revise the years between changes, or to increase or decrease the mileage between changes.

Study Parameters:

This study, like the 5/8" meter studies done in 1968, 1972 and 1990, includes meters having service periods from 15 through 20 years and mileage of 100,000 cu. ft. through 600,000 cu. ft.. In both the 1995 and 1990 studies meters with plastic chambers were included along with meters with bronze chambers. The total number of meters tested in this study was 5004 for both age and mileage.

Conclusion:

From the data it can be concluded that at 1/8 GPM and 2 GPM our current service period of 15 years should continue to be used for 5/8" meters (see charts 1 and 2). It can also be concluded that at 1/8 GPM and 2 GPM our present overhaul period of 400,000 cu. ft. is still the appropriate usage for meters to be overhauled (see charts 21 and 22).

Presentation of Data:

The method of presenting data using tables and graphs parallels the previous studies. The test standards of 98.5% to 101% at 2 GPM have been changed to account for the roll-sealed register Neptune now manufactures. The new standard is 98.5% to 102% at 2 GPM and the 1/8 GPM standard remains 65% as in 1990, both of these standards are still more strict than AWWA new meter standards. The meters that do not test to these minimum accuracies are rebuilt. Meters that test between 65% and 70% accuracy at 1/8 GPM, or that test between 98.5% and 99.5% at 2 GPM are regeared but not rebuilt. No meter is returned to service unless they are accurate to 70% and 99.5% at the respective flows.

Charts 1 and 2 are a plotting of the duration curves for 15, 18 and 20 years of service. The curves were plotted for each rate so that any point of the curve may be read X% of total meters did register more than Y%.

Charts 3 and 4 show average percentage registration for all meters in each of the years studied at each flow rate. Also it shows the amount of meters in each group.

Charts 5 thru 8 compare data from the 1990 study to 1995. These charts show the percent of meters at each flow rate (1/8 and 2 GPM) that registered within the acceptable ranges, and those that registered outside the acceptable ranges.

Charts 9 thru 20 are the 15, 16, 17, 18, 19 and 20 year curves for each of the flow rates (1/8 and 2 GPM). Following each set of charts is a tabulation of information for those charts.

Charts 21 and 22 are a plotting of the range of meter accuracies for meters with usage of 400,000, 500,000 and 600,000 cu. ft.. The curves were plotted for each rate so that any point of the curve may be read X% of total meters did register more than Y%.

Charts 23 and 24 show the overall average accuracy of each group of meters with usage of 100,000 thru 600,000 cu. ft.. Also included in the charts are the amount of meters in each group.

Charts 25 and 26 show the percent of meters that registered outside the acceptable ranges. Charts also include the number of meters in each group.

Charts 27 and 28 compare data from the 1990 study to 1995. These charts show the percent of meters at each flow rate (1/8 and 2 GPM) that registered within the acceptable ranges.

Charts 29 thru 40 are the 100,000 thru 600,000 cu. ft. curves for each of the flow rates (1/8 and 2 GPM). Following each set is a tabulation of information for those charts.

Summary of Data Presented:

Charts 1 and 2 are a plotting of the duration curves for meters with 15, 18 and 20 years of service. These curves indicate that meters in the field beyond 15 years show a marked drop in accuracy.

Charts 3 and 4 are bar graphs illustrating the average percent of registration and the total number of meters in each age group. In the sensitivity test (1/8 GPM), the average registration ranged from 57% to 87%. All year groups show average accuracies in the acceptable range except the 20 year age group.

In the 2 GPM test the average percent of registration shows a steady percentage from 15 thru 17 years, then the percent of registration drops below the acceptable range from 18 thru 20 years. This duplicates the findings of the 1990 study at 2 GPM., which also showed a decline in registration below the acceptable range after 17 years.

Charts 5 thru 8 are a comparison of the 1990 Meter Accuracy Study to 1995 data. The sensitivity test (1/8 GPM test results) indicate that the 1995 meter group 15 thru 20 years drops in accuracy as the age of the meter increases. There is a significant drop after 16 years and again after 19 years.

At the standard rate of 2 GPM, the average accuracy of the 1995 meter group of 15 and 16 years show approximately

the same accuracy, while in year 17 thru 20 there is a significant drop in accuracy. In studying charts 5 and 6 I would conclude that our current age change standard of 15 years is still sufficient.

Charts 9 thru 20 show the predictable drop in accuracies as age increases.

Charts 21 and 22 are a plotting of the duration curves for meters with 400,000, 500,000 and 600,000 cu. ft. of usage. The sensitivity test (1/8 GPM) indicates a drop between 400,000 and 500,000 cu. ft., and a significant drop to 600,000.
At the standard rate of 2 GPM, there is a substantial drop off after 400,000 cu. ft. at the SLCWC minimum standard of 98.5%.

Charts 23 and 24 are bar graphs of meter groups whose usage registration varies from 100,000 cu. ft. to 600,000 cu. ft.. In the sensitivity test (1/8 GPM) registration drops after the 100,000 cu. ft. group then steadily improves thru 500,000 cu. ft. when it drops again, however all test are above SLCWC minimum standard. The average accuracy for the 1/8 GPM test ranged from 67.5% to 80.5%.
The 2 GPM test indicates the average accuracy ranged from 96.2% to 99.1%. In the 100,000 cu. ft. thru 500,000 cu. ft. test groups the average accuracy remained fairly consistent,

with the exception of the 200,000 cu. ft. group which was much lower. The reason for the drop off in the 200,000 cu. ft. test group was that in this category there was an excessive number of dead meters at both test levels.

Charts 25 and 26 show the percent of meters that registered outside acceptable SLCWC standards.

Charts 27 and 28 show the meters that registered within the acceptable ranges at both flow rates. The sensitivity test (1/8 GPM) results indicate a steady number of meters in the acceptable range with the exception of 200,000 and 600,000 cu. ft.. The 200,000 cu. ft. category is low because there is a greater percentage of dead meters (12%) than the rest of the test groups. The 600,000 cu. ft. group drops because of normal poor performance at that level and very few meters in test group.

At the standard rate (2 GPM) the levels are fairly consistent as was the case in 1990. The percentage levels are lower than in 1990. The reason being there are more than twice as many meters in the 1995 study as in the 1990 study. Which should give us a more accurate picture.

Charts 29 thru 40 show the predictable drop in accuracies as usage increases.

An important difference between the studies of 1990 and 1995 is that in 1995 there were 5004 meters compared to 1096 for service years and 1934 for mileage in the 1990 study. This should account for the changes in data between the two years. The 1995 study data should be a more accurate picture of our meter program.

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RANGE OF METER ACCURACIES AT
15,18 AND 20 YEARS - 1/8 G.P.M. TEST

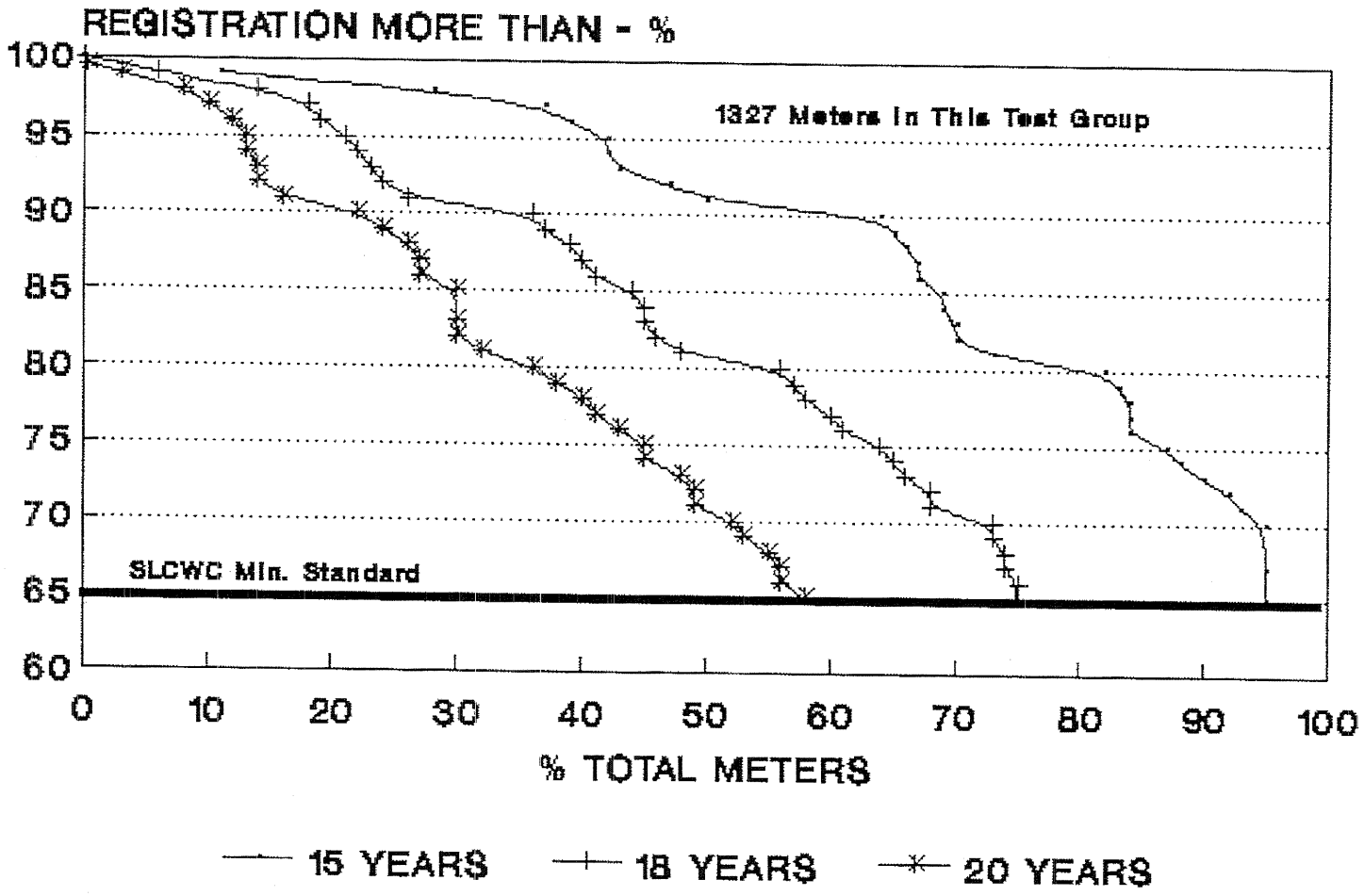


CHART 1 - SEPTEMBER 1995

8

RANGE OF METER ACCURACIES AT
15,18, AND 20 YEARS - 2 G.P.M. TEST

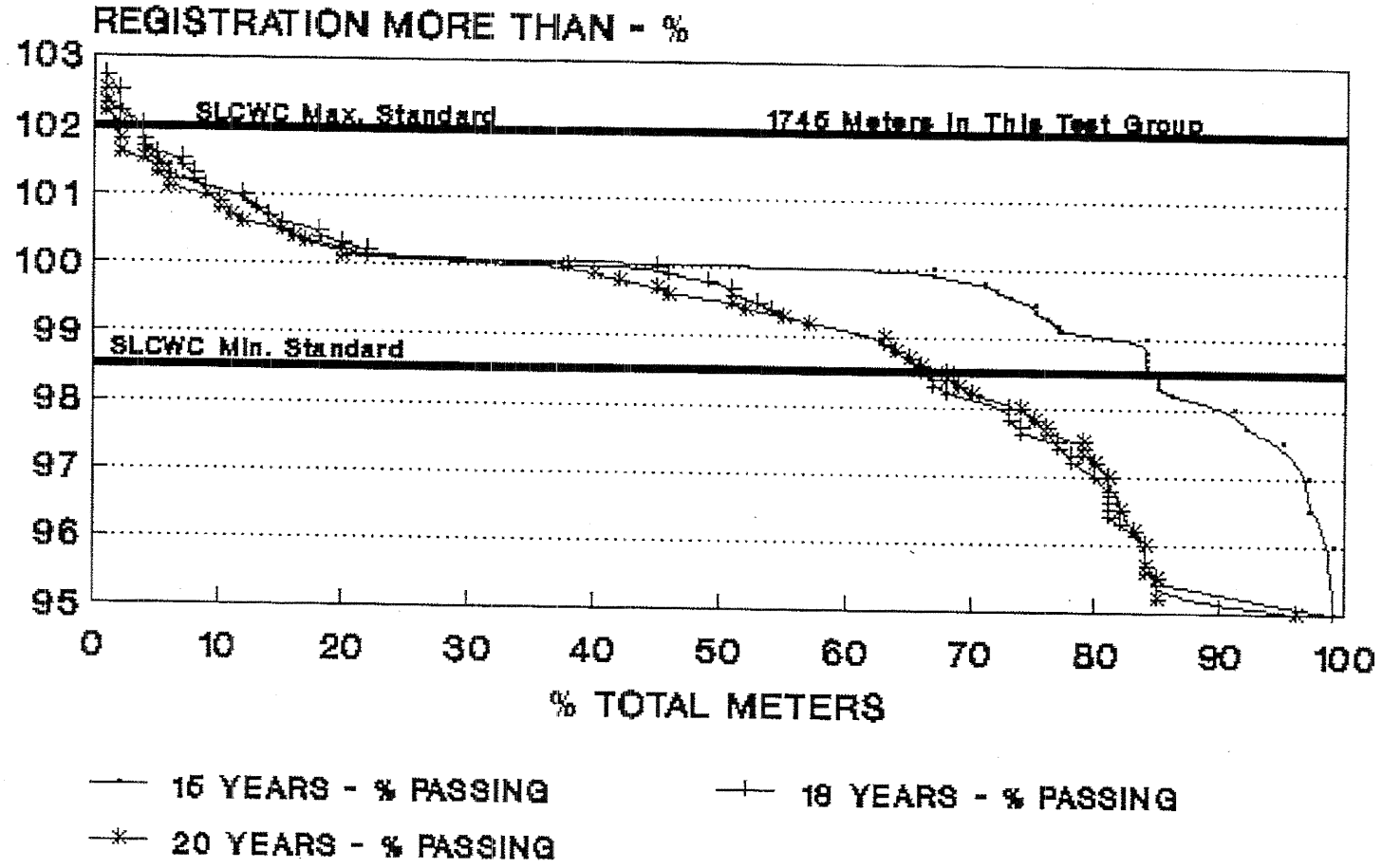
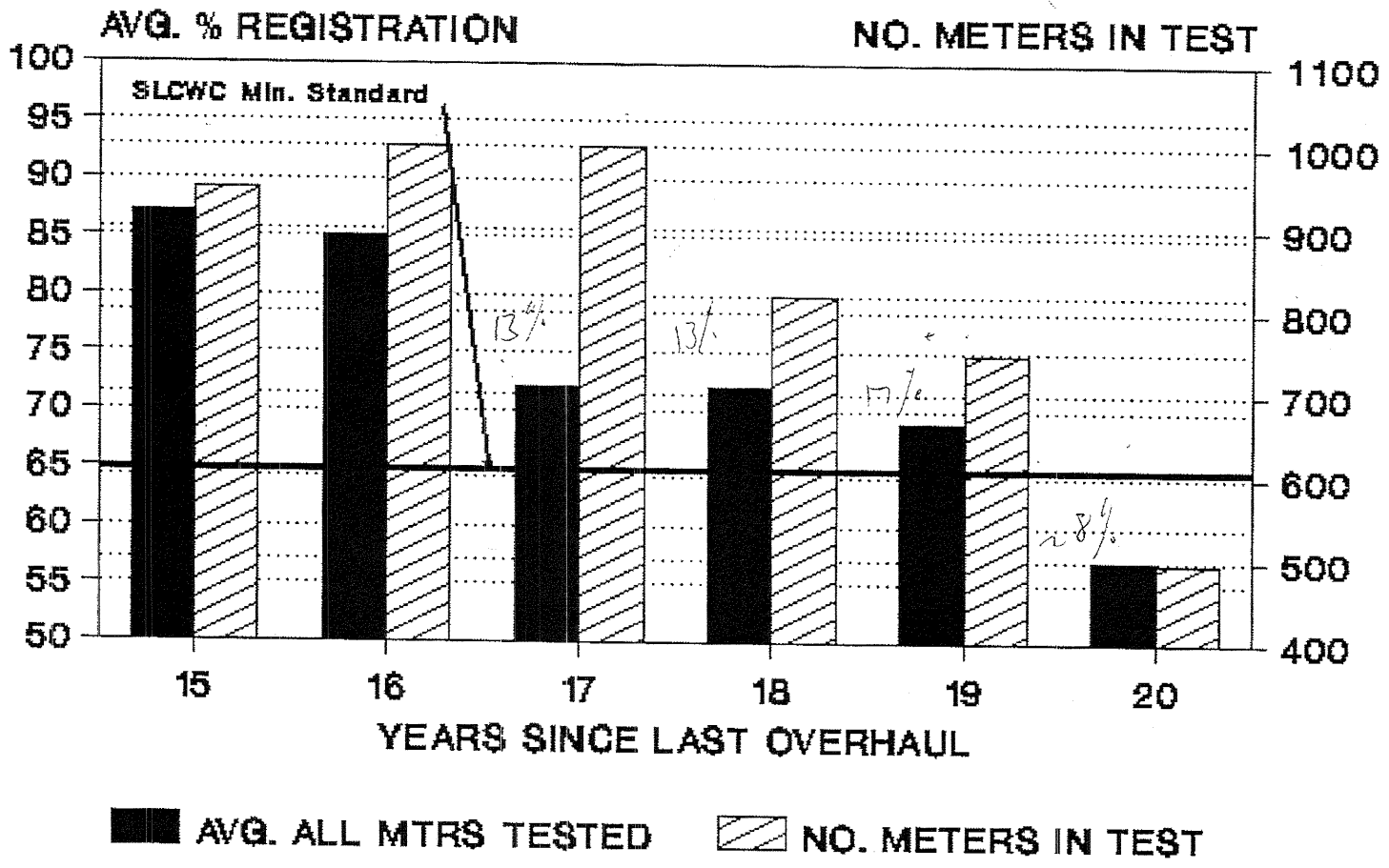


CHART 2 - SEPTEMBER 1995

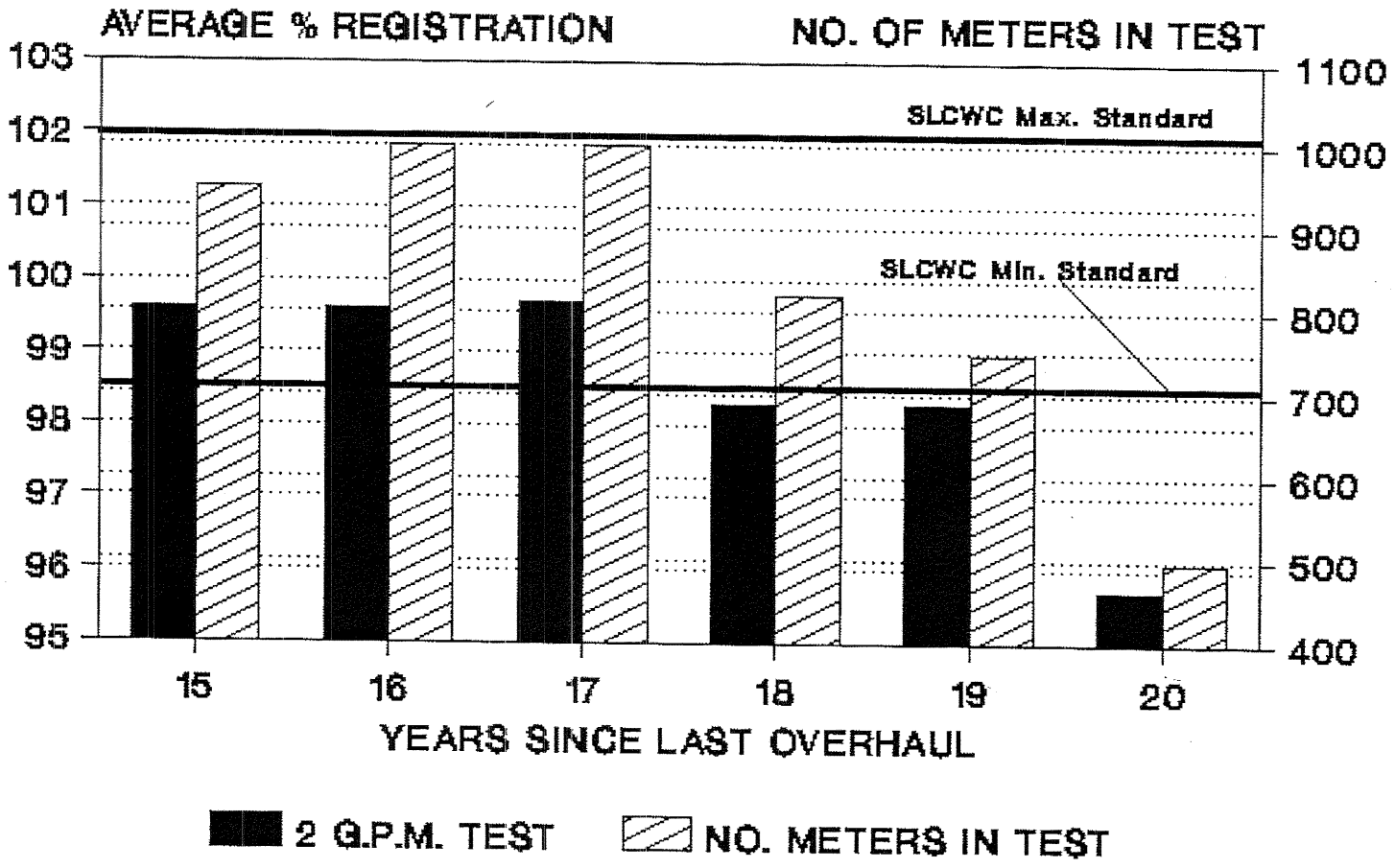
OVERALL ACCURACY BY YEAR
AVG % ACCURACY FOR GROUP 1/8 G.P.M.



ACCEPTABLE RANGE: ABOVE 65%

CHART 3 - SEPTEMBER 1995

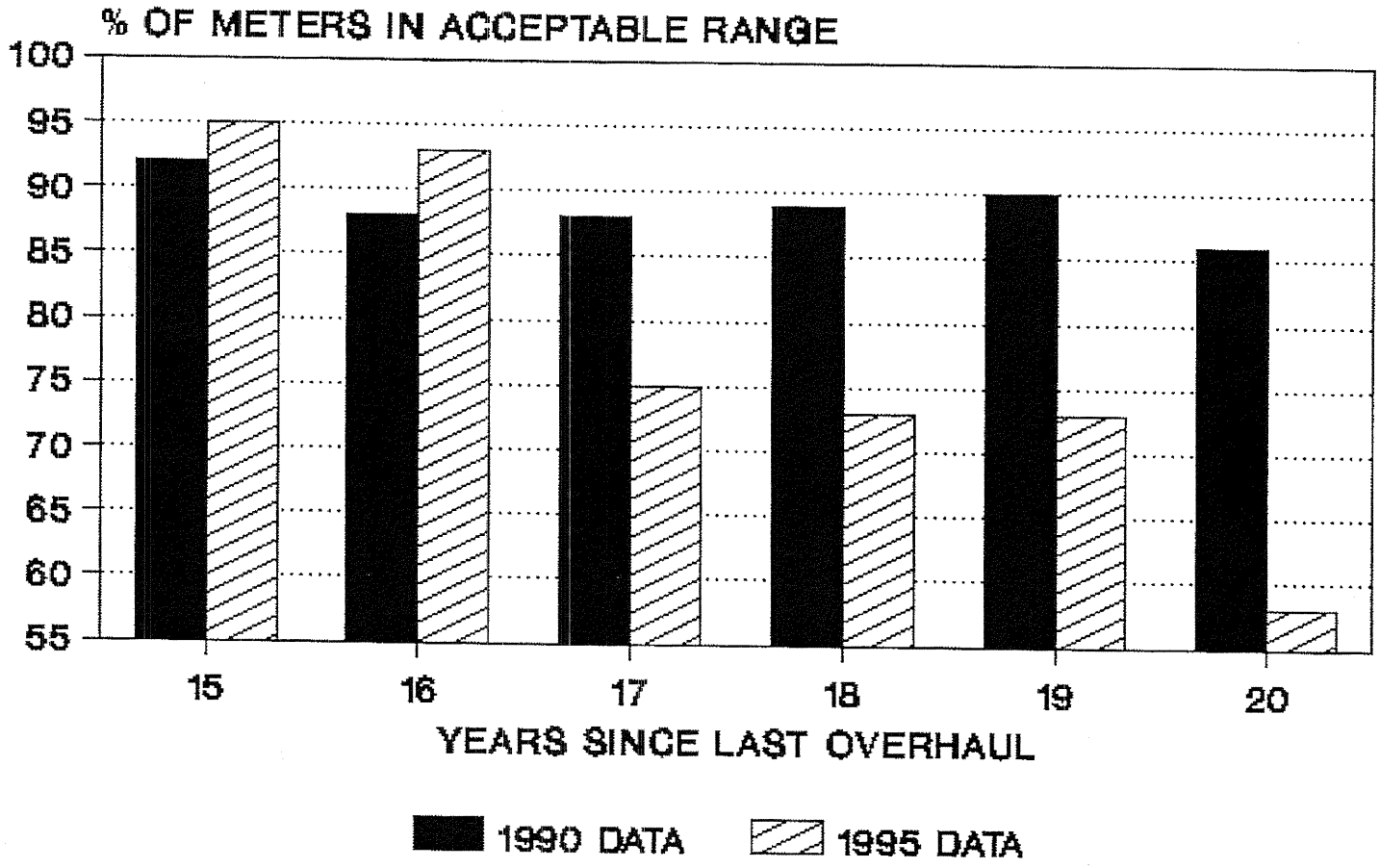
OVERALL ACCURACY BY YEAR
AVERAGE % ACCURACY FOR GROUP 2 G.P.M.



ACCEPTABLE RANGE 98.5% - 102%

CHART 4 - SEPTEMBER 1995

METER COMPARISON 1990 VERSUS 1995
1/8 G.P.M. TEST



ACCEPTABLE RANGE: ABOVE 65%

CHART 5 - SEPTEMBER 1995

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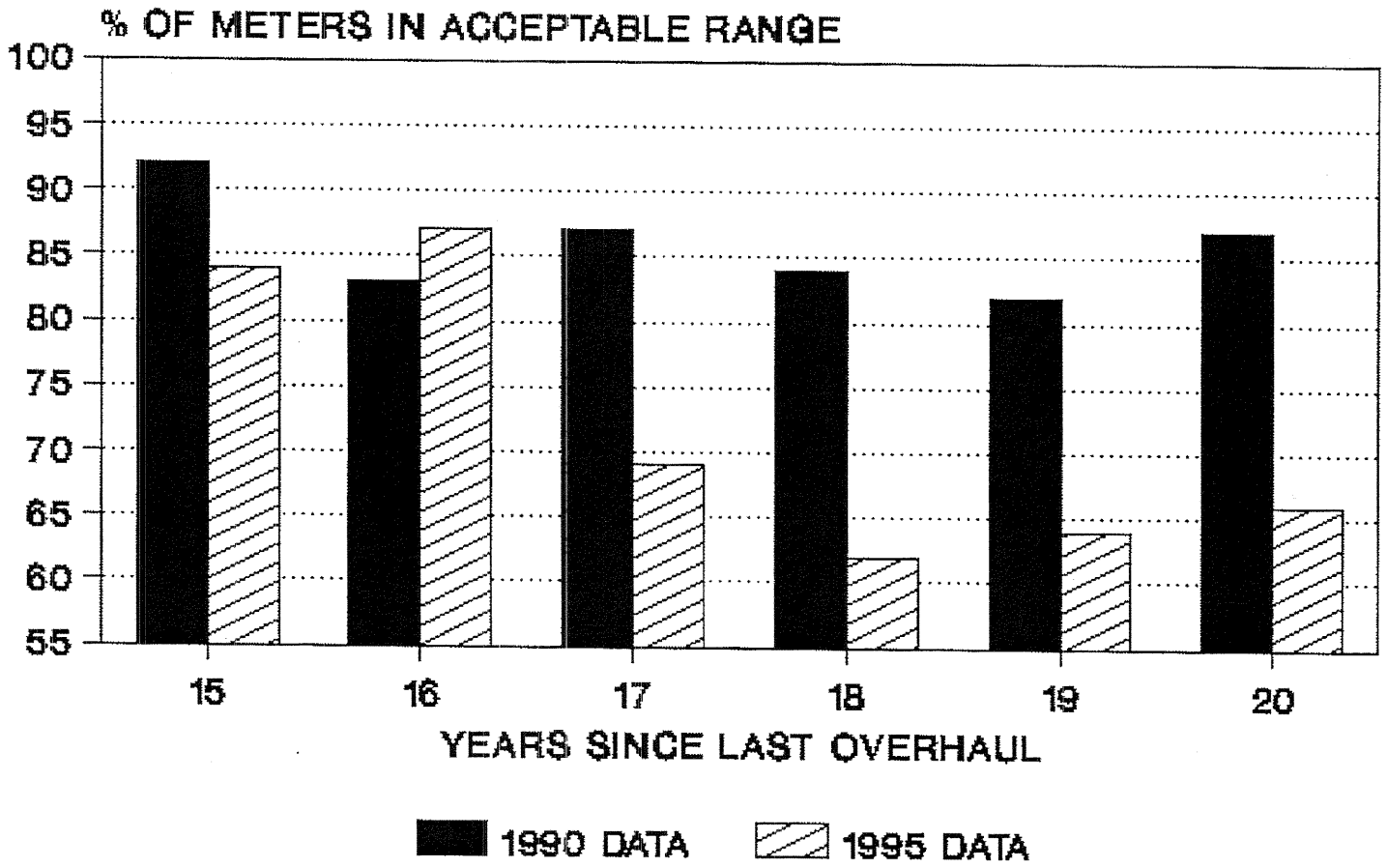
METER COMPARISON 1990 VERSUS 1995
2 G.P.M. TEST

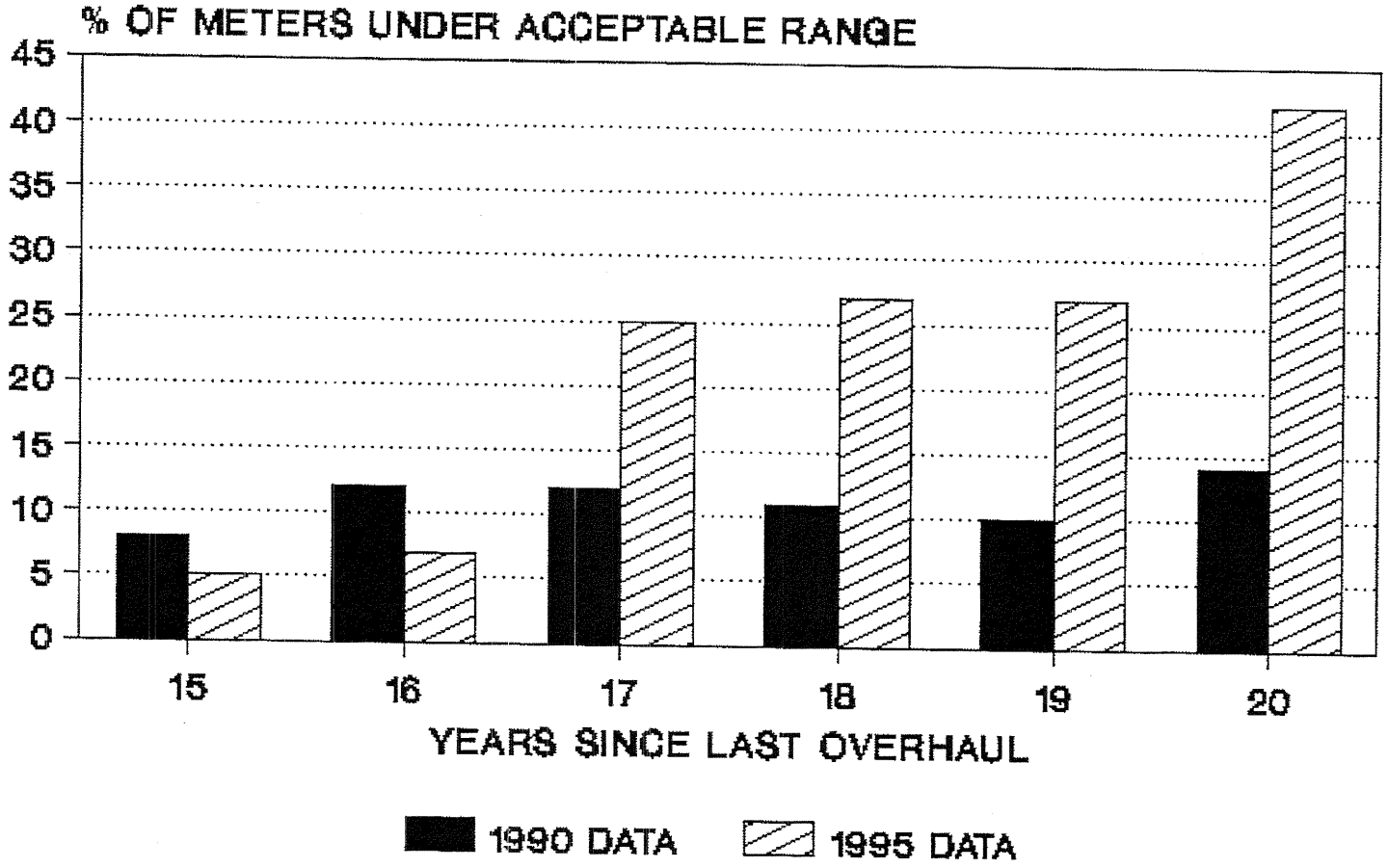


ACCEPTABLE RANGE: 98.5% - 102%

CHART 6 - SEPTEMBER 1995

13

METER COMPARISON 1990 VERSUS 1995
1/8 G.P.M. TEST



ACCEPTABLE RANGE: ABOVE 65%

CHART 7 - SEPTEMBER 1995

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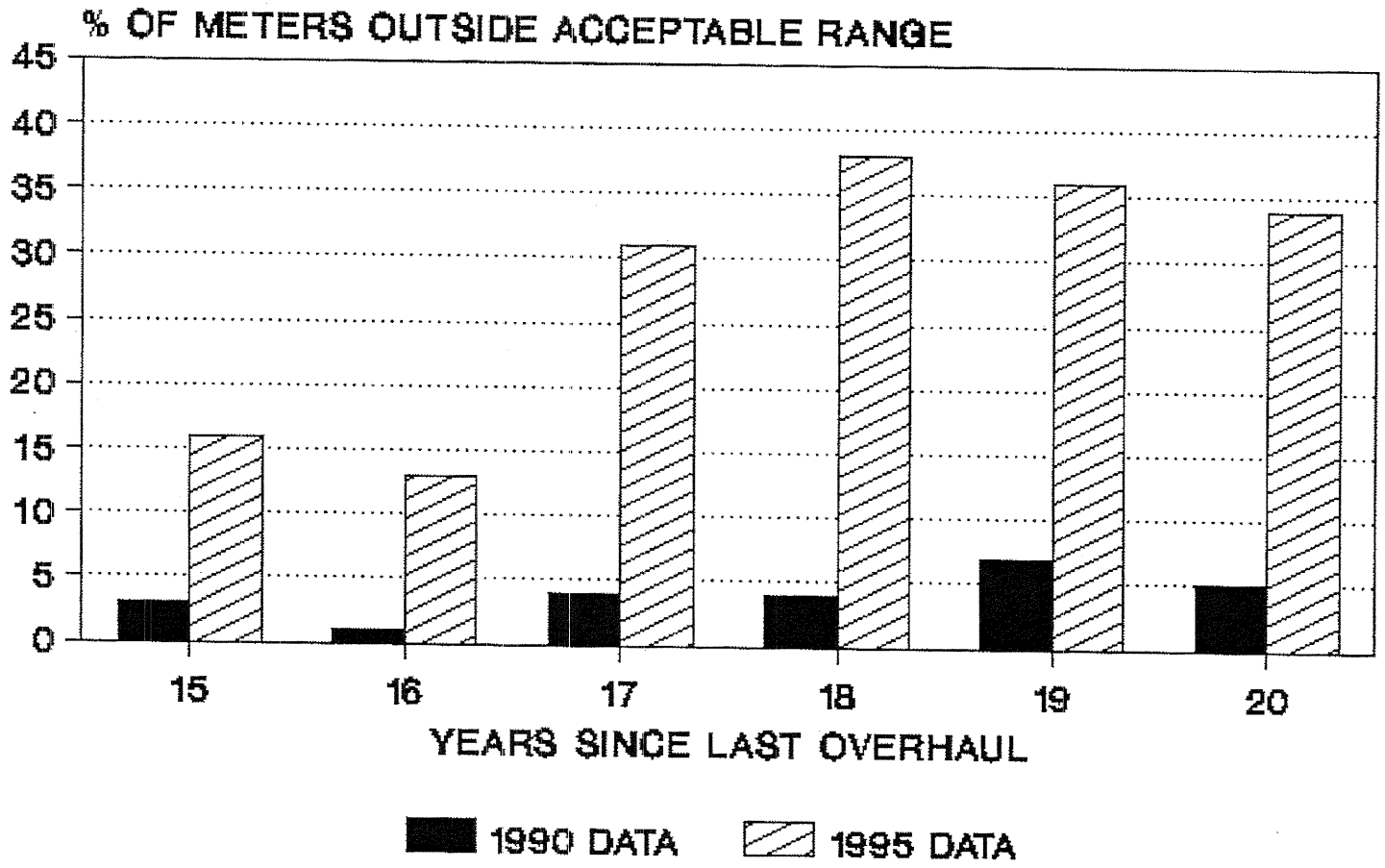
METER COMPARISON 1990 VERSUS 1995
2 G.P.M. TEST



ACCEPTABLE RANGE: 98.5% - 102%

CHART 8 - SEPTEMBER 1995

15

15 YEARS METER STUDY GROUP
1/8 G.P.M. TEST

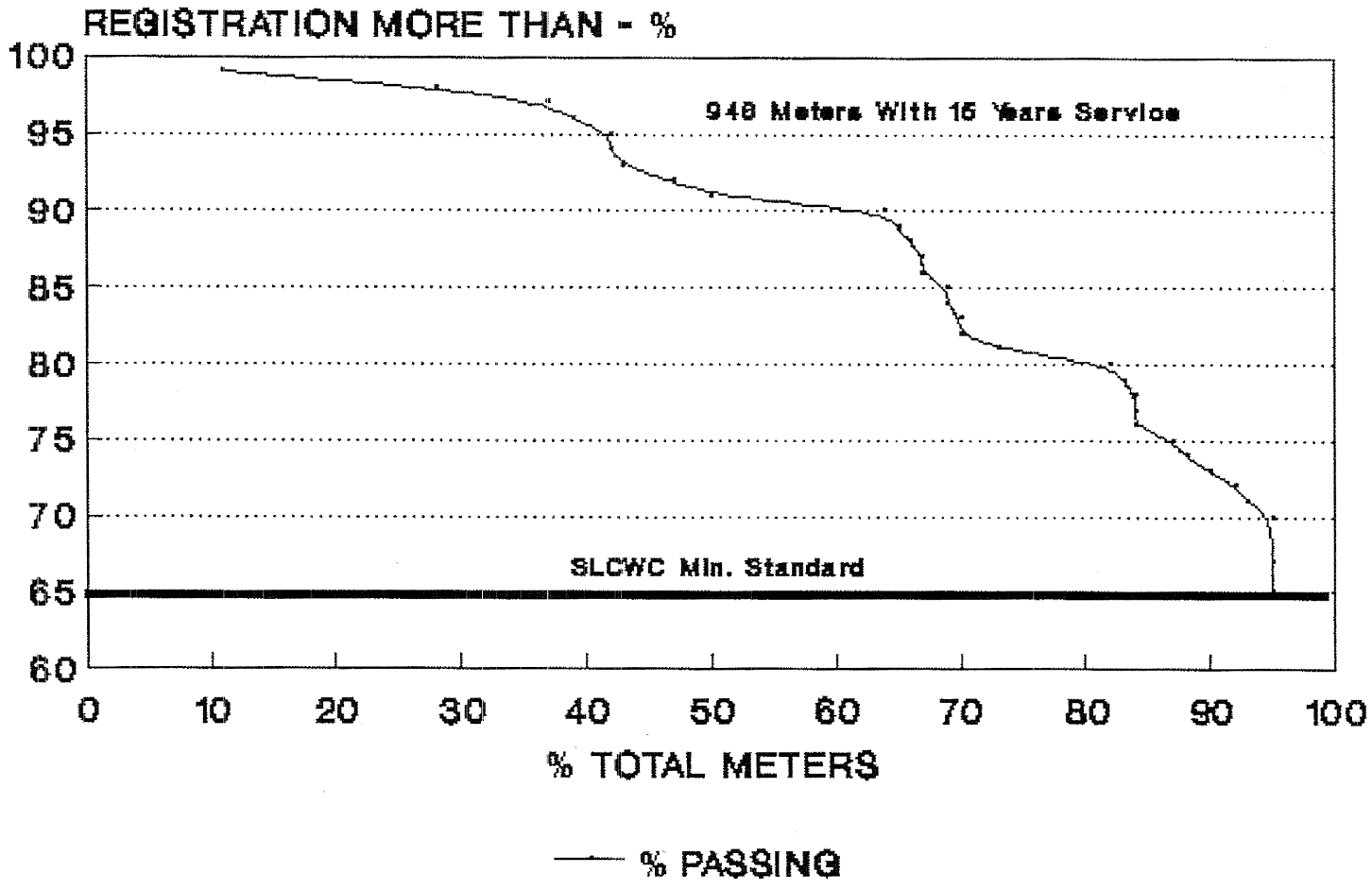


CHART 9 - SEPTEMBER 1995

15 YEARS METER STUDY GROUP
2 G.P.M. TEST

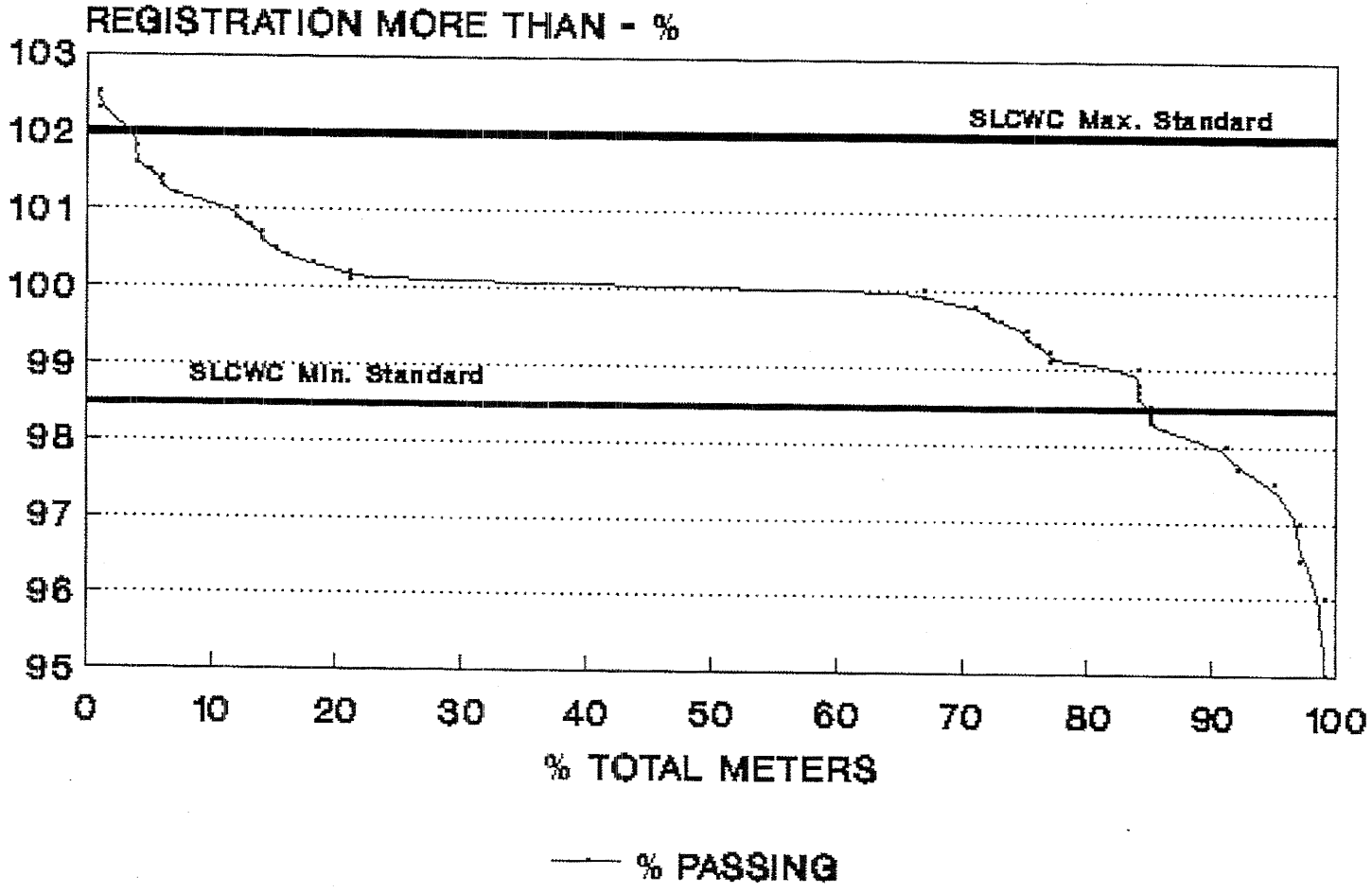


CHART 10 - SEPTEMBER 1995

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15 YEAR STUDY GROUP - 1995
1/8 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
44	946	100	*
1	902	95	65
2	901	95	67
21	899	95	70
9	878	93	71
15	869	92	72
18	854	90	73
10	836	88	74
27	826	87	75
5	799	84	76
3	794	84	77
10	791	84	78
9	781	83	79
78	772	82	80
28	694	73	81
7	666	70	82
3	659	70	83
4	656	69	84
19	652	69	85
3	633	67	86
6	630	67	87
13	624	66	88
5	611	65	89
129	606	64	90
35	477	50	91
39	442	47	92
3	403	43	93
7	400	42	94
28	393	42	95
17	365	39	96
83	348	37	97
158	265	28	98
107	107	11	99

* 44 Meters registered less than 65%. Average registration for this group was 37.48%

15 YEAR STUDY GROUP - 1995
2 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
1	946	100	*
13	945	99	95
17	932	99	96
1	915	97	96.5
19	914	97	97
29	895	95	97.5
1	866	92	97.7
56	865	91	98
1	809	86	98.2
1	808	85	98.3
1	807	85	98.4
9	806	85	98.5
1	797	84	98.6
3	796	84	98.7
2	793	84	98.8
63	791	84	99
1	728	77	99.1
6	727	77	99.2
9	721	76	99.3
6	712	75	99.4
20	706	75	99.5
5	686	73	99.6
12	681	72	99.7
34	669	71	99.8
4	635	67	99.9
428	631	67	100
4	203	21	100.1
25	199	21	100.2
18	174	18	100.3
12	156	16	100.4
9	144	15	100.5
5	135	14	100.6
6	130	14	100.7
6	124	13	100.8
2	118	12	100.9
51	116	12	101
4	65	7	101.2
2	61	6	101.3
9	59	6	101.4
9	50	5	101.5
1	41	4	101.6
1	40	4	101.8
29	39	4	102
1	10	1	102.3
7	9	1	102.5
1	2	.2	105
1	1	.1	115.5

* 1 Meter Dead

139 Meters registered less than 98.5%. Average registration for this group was 97.23%

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16 YEARS METER STUDY GROUP
1/8 G.P.M. TEST

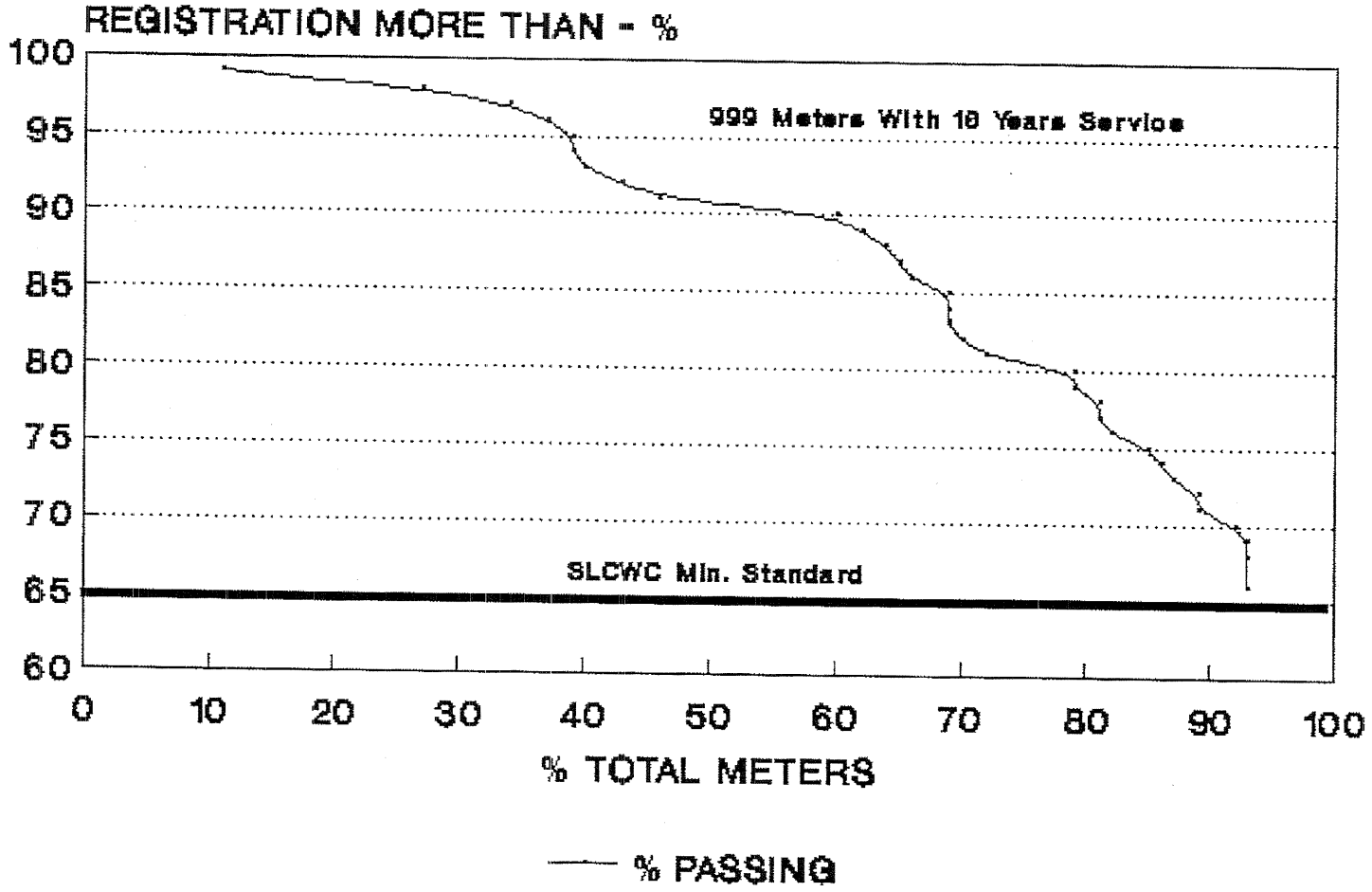

CHART 11 - SEPTEMBER 1995

20

16 YEARS METER STUDY GROUP
2 G.P.M. TEST

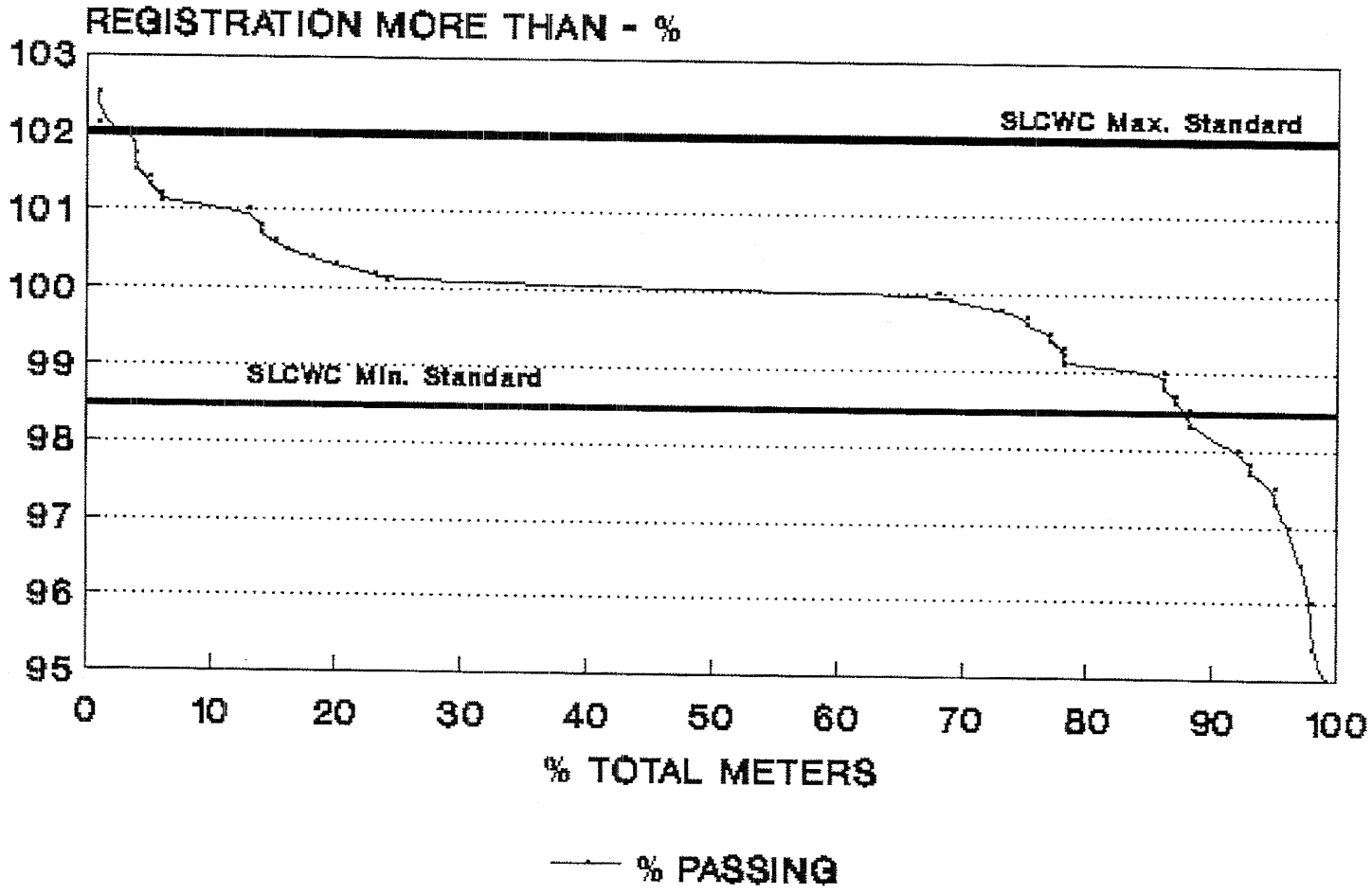

CHART 12 - SEPTEMBER 1995

16 YEAR STUDY GROUP - 1995
1/8 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
70	999	100	*
2	929	93	66
1	927	93	68
3	926	93	69
30	923	92	70
7	893	89	71
21	886	89	72
10	865	87	73
8	855	86	74
28	847	85	75
10	819	82	76
4	809	81	77
12	805	81	78
8	793	79	79
64	785	79	80
22	721	72	81
8	699	70	82
1	691	69	83
5	690	69	84
28	685	69	85
7	657	66	86
8	650	65	87
25	642	64	88
16	617	62	89
141	601	60	90
30	460	46	91
31	430	43	92
5	399	40	93
5	394	39	94
24	389	39	95
30	365	37	96
66	335	34	97
160	269	27	98
109	109	11	99

* 70 Meters registered less than 65%. Average registration for this group was 30.62%

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16 YEAR STUDY GROUP - 1995
2 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
1	999	100	*
1	998	99	90
21	997	99	95
1	976	98	95.4
10	975	98	96
1	965	97	96.5
12	964	96	97
1	952	95	97.3
24	951	95	97.5
2	927	93	97.7
3	925	93	97.8
45	922	92	98
1	877	88	98.3
8	876	88	98.5
2	868	87	98.6
3	866	87	98.7
2	863	86	98.8
1	861	86	98.9
76	860	86	99
1	784	78	99.1
7	783	78	99.2
3	776	78	99.3
5	773	77	99.4
14	768	77	99.5
8	754	75	99.6
17	746	75	99.7
42	729	73	99.8
7	687	69	99.9
441	680	68	100
5	239	24	100.1
36	234	23	100.2
21	198	20	100.3
13	177	18	100.4
13	164	16	100.5
8	151	15	100.6
8	143	14	100.7
6	135	14	100.8
67	129	13	101
1	62	6	101.1
9	61	6	101.2
1	52	5	101.3
8	51	5	101.4
5	43	4	101.5
3	38	4	101.7
27	35	4	102
2	8	1	102.1
6	6	1	102.5

* 1 Meter Dead

122 Meters registered less than 98.5%. Average registration for this group was 97.01%

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17 YEARS METER STUDY GROUP
1/8 G.P.M. TEST

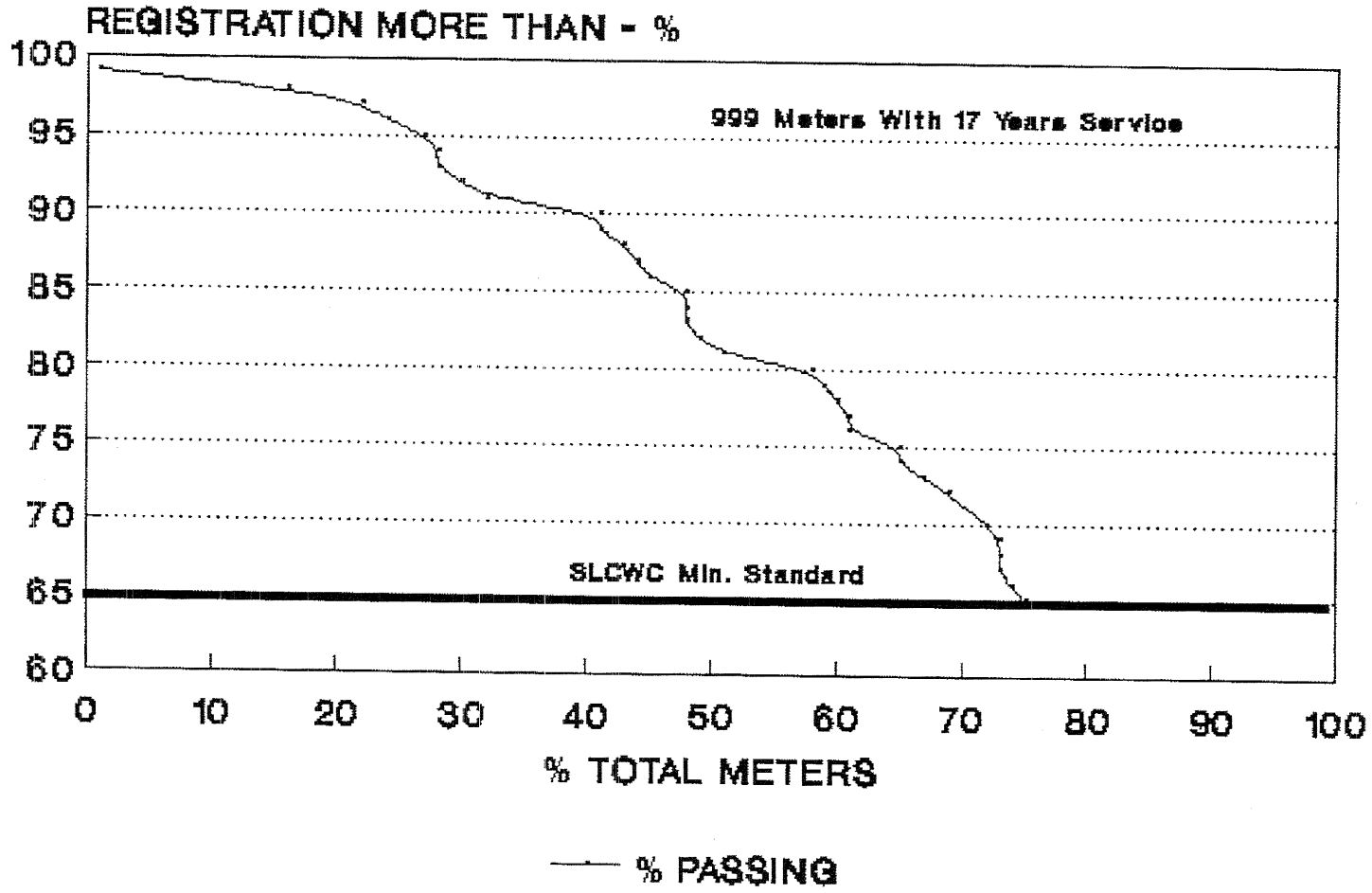

CHART 13 - SEPTEMBER 1995

17 YEARS METER STUDY GROUP
2 G.P.M. TEST

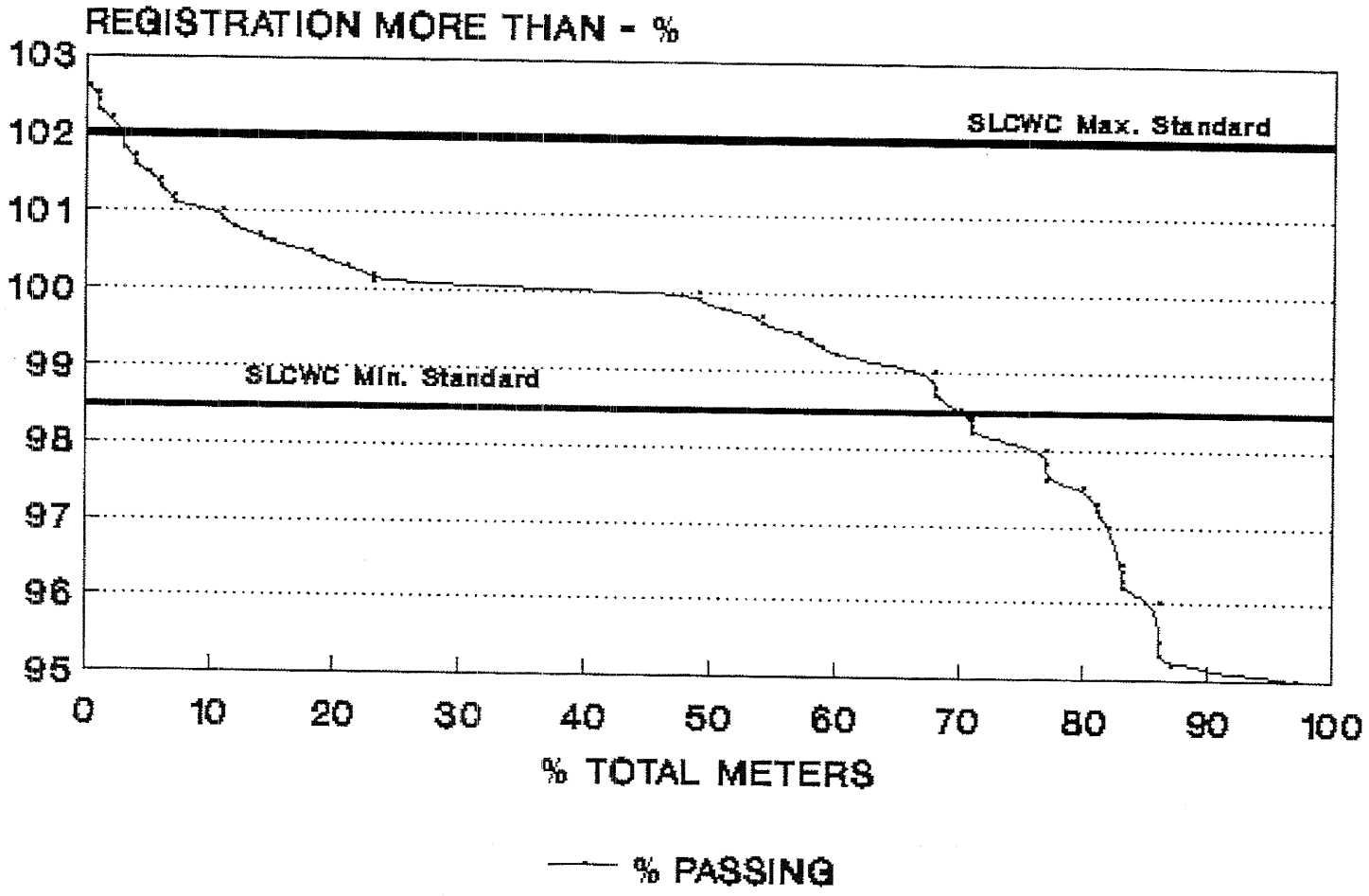

CHART 14 - SEPTEMBER 1995

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17 YEAR STUDY GROUP - 1995
1/8 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
251	999	100	*
10	748	75	65
5	738	74	66
3	733	73	67
3	730	73	68
9	727	73	69
29	718	72	70
15	689	69	72
20	674	67	73
8	654	65	74
34	646	65	75
3	612	61	76
7	609	61	77
12	602	60	78
10	590	59	79
69	580	58	80
18	511	51	81
12	493	49	82
3	481	48	83
3	478	48	84
29	475	48	85
9	446	45	86
7	437	44	87
17	430	43	88
5	413	41	89
89	408	41	90
15	319	32	91
23	304	30	92
6	281	28	93
4	275	28	94
30	271	27	95
23	241	24	96
57	218	22	97
91	161	16	98
69	70	1	99
1	1	.1	101

* 100 Meters Dead

151 Meters registered less than 65%. Average registration for this group was 40.58%

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17 YEAR STUDY GROUP - 1995
2 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
20	999	100	*
1	979	98	75
1	978	98	82.5
1	977	98	86.4
1	976	98	91
1	975	98	92
1	974	97	92.2
2	973	97	93
1	971	97	94
105	970	97	95
1	865	87	95.2
1	864	86	95.3
4	863	86	95.5
25	859	86	96
1	834	83	96.2
2	833	83	96.3
1	831	83	96.4
6	830	83	96.5
16	824	82	97
1	808	81	97.2
3	807	81	97.3
32	804	80	97.5
4	772	77	97.6
3	768	77	97.8
56	765	77	98
2	709	71	98.2
1	707	71	98.3
2	706	71	98.4
21	704	70	98.5
2	683	68	98.7
5	681	68	98.8
79	676	68	99
8	597	60	99.2
11	589	59	99.3
10	578	58	99.4
27	568	57	99.5
5	541	54	99.6
23	536	54	99.7
19	513	51	99.8
6	494	49	99.9
258	488	49	100
5	230	23	100.1
20	225	23	100.2
13	205	21	100.3
14	192	19	100.4
32	178	18	100.5
10	146	15	100.6
17	136	14	100.7
6	119	12	100.8

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17 YEAR STUDY GROUP - 1995 CONT.
2 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
2	113	11	100.9
39	111	11	101
4	72	7	101.1
6	68	7	101.2
6	62	6	101.3
5	56	6	101.4
13	51	5	101.5
2	38	4	101.6
3	36	4	101.7
4	33	3	101.8
14	29	3	102
4	15	2	102.2
2	11	1	102.3
2	9	1	102.4
5	7	1	102.5
2	2	.2	102.6

* 20 Meters Dead

275 Meters registered less than 98.5%. Average registration for this group was 92.58%

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18 YEARS METER STUDY GROUP
1/8 G.P.M. TEST

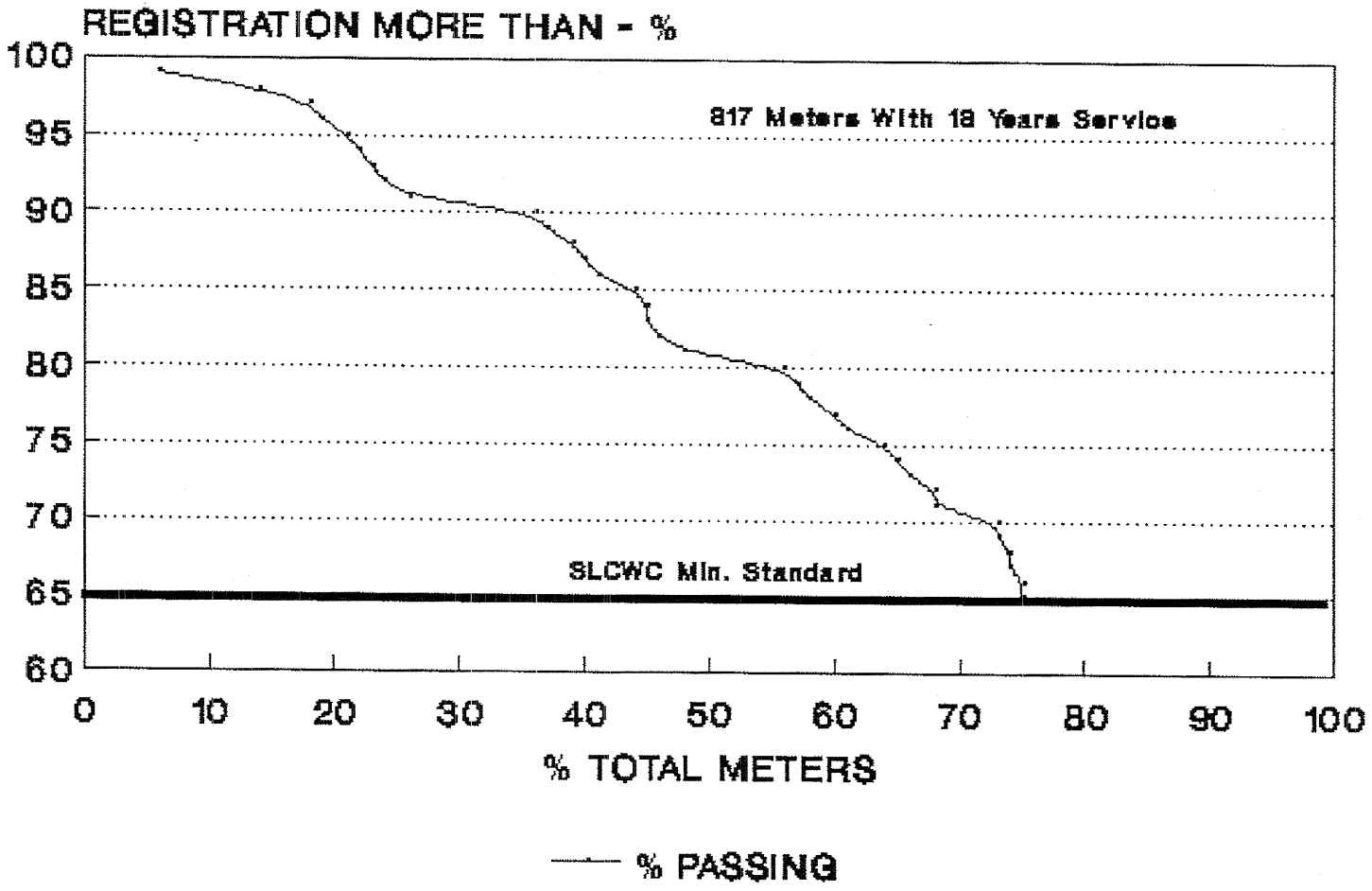

CHART 15 - SEPTEMBER 1995

18 YEARS METER STUDY GROUP
2 G.P.M. TEST

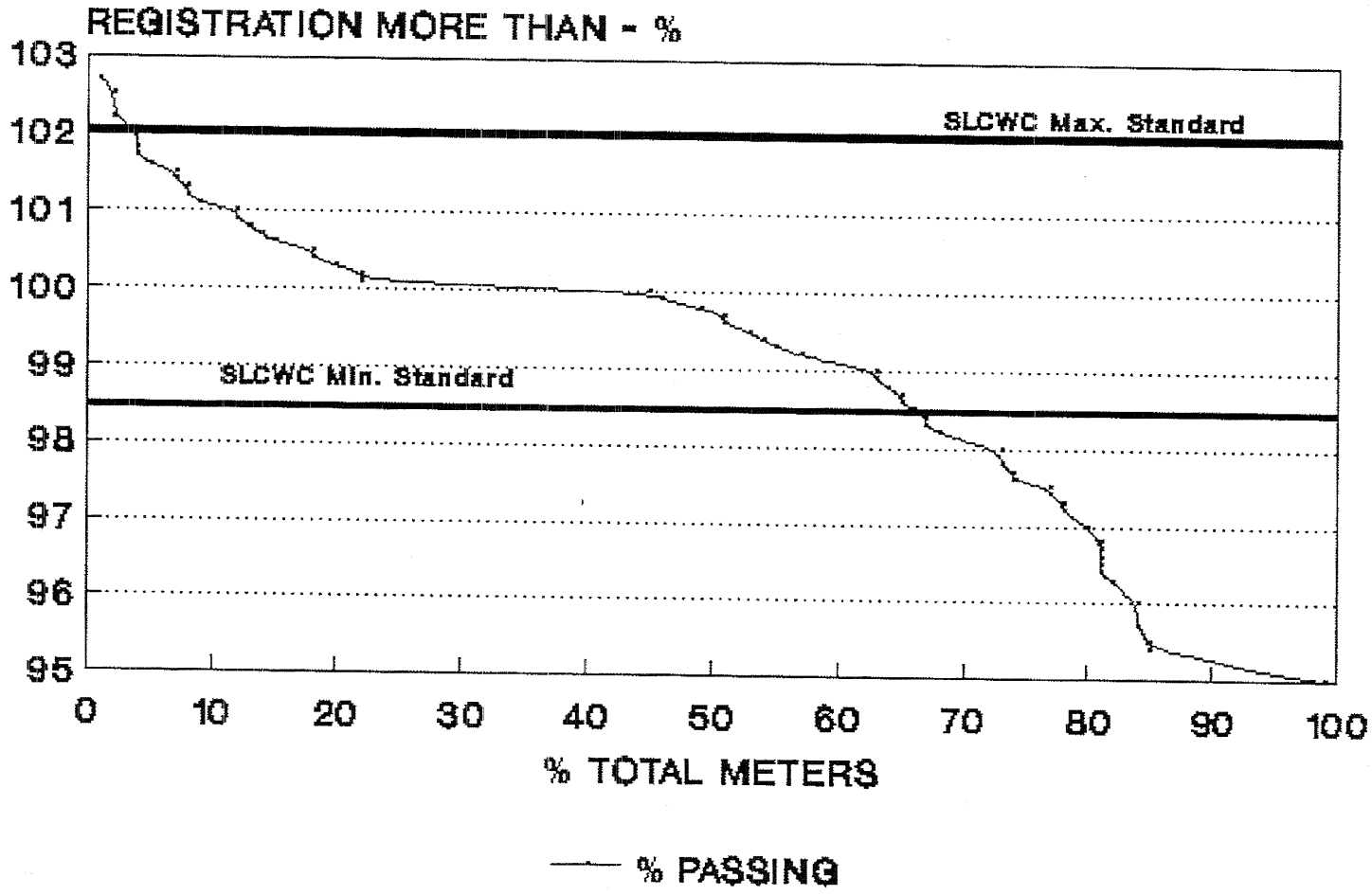

CHART 16 - SEPTEMBER 1995

18 YEAR STUDY GROUP - 1995
1/8 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
204	817	100	*
4	613	75	65
3	609	75	66
3	606	74	67
5	603	74	68
5	598	73	69
36	593	73	70
3	557	68	71
14	554	68	72
7	540	66	73
13	533	65	74
25	520	64	75
7	495	61	76
11	488	60	77
12	477	58	78
11	465	57	79
62	454	56	80
14	392	48	81
8	378	46	82
5	370	45	83
4	365	45	84
28	361	44	85
5	333	41	86
7	328	40	87
18	321	39	88
10	303	37	89
79	293	36	90
14	214	26	91
12	200	24	92
9	188	23	93
7	179	22	94
16	172	21	95
9	156	19	96
34	147	18	97
66	113	14	98
46	47	6	99
1	1	.1	100

* 66 Meters Dead

138 Meters registered less than 65%. Average registration for this group was 41.15%

31

18 YEAR STUDY GROUP - 1995
2 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
4	817	100	*
1	813	99	89
1	812	99	90
1	811	99	92
1	810	99	94
115	809	99	95
1	694	85	95.4
8	693	85	95.5
1	685	84	95.7
16	684	84	96
3	668	82	96.3
2	665	81	96.4
3	663	81	96.5
1	660	81	96.6
1	659	81	96.7
1	658	81	96.8
20	657	80	97
2	637	78	97.2
3	635	78	97.3
1	632	77	97.4
27	631	77	97.5
3	604	74	97.6
2	601	74	97.7
6	599	73	97.8
39	593	73	98
4	554	68	98.2
6	550	67	98.3
2	544	67	98.4
12	542	66	98.5
3	530	65	98.6
1	527	65	98.7
10	526	64	98.8
1	516	63	98.9
52	515	63	99
11	463	57	99.2
9	452	55	99.3
6	443	54	99.4
18	437	53	99.5
4	419	51	99.6
18	415	51	99.7
20	397	49	99.8
8	377	46	99.9
187	369	45	100
3	182	22	100.1
12	179	22	100.2
16	167	20	100.3
8	151	18	100.4
19	143	18	100.5
11	124	15	100.6

32

18 YEAR STUDY GROUP - 1995 CONT.
2 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
6	113	14	100.7
7	107	13	100.8
3	100	12	100.9
27	97	12	101
2	70	9	101.1
2	68	8	101.2
7	66	8	101.3
5	59	7	101.4
14	54	7	101.5
4	40	5	101.6
2	36	4	101.7
1	34	4	101.8
15	33	4	102
1	18	2	102.2
8	17	2	102.5
4	9	1	102.7
3	5	1	103
2	2	.2	103.5

* 4 Meters Dead

271 Meters registered less than 98.5%. Average registration for this group was 96.22%

19 YEARS METER STUDY GROUP
1/8 G.P.M. TEST

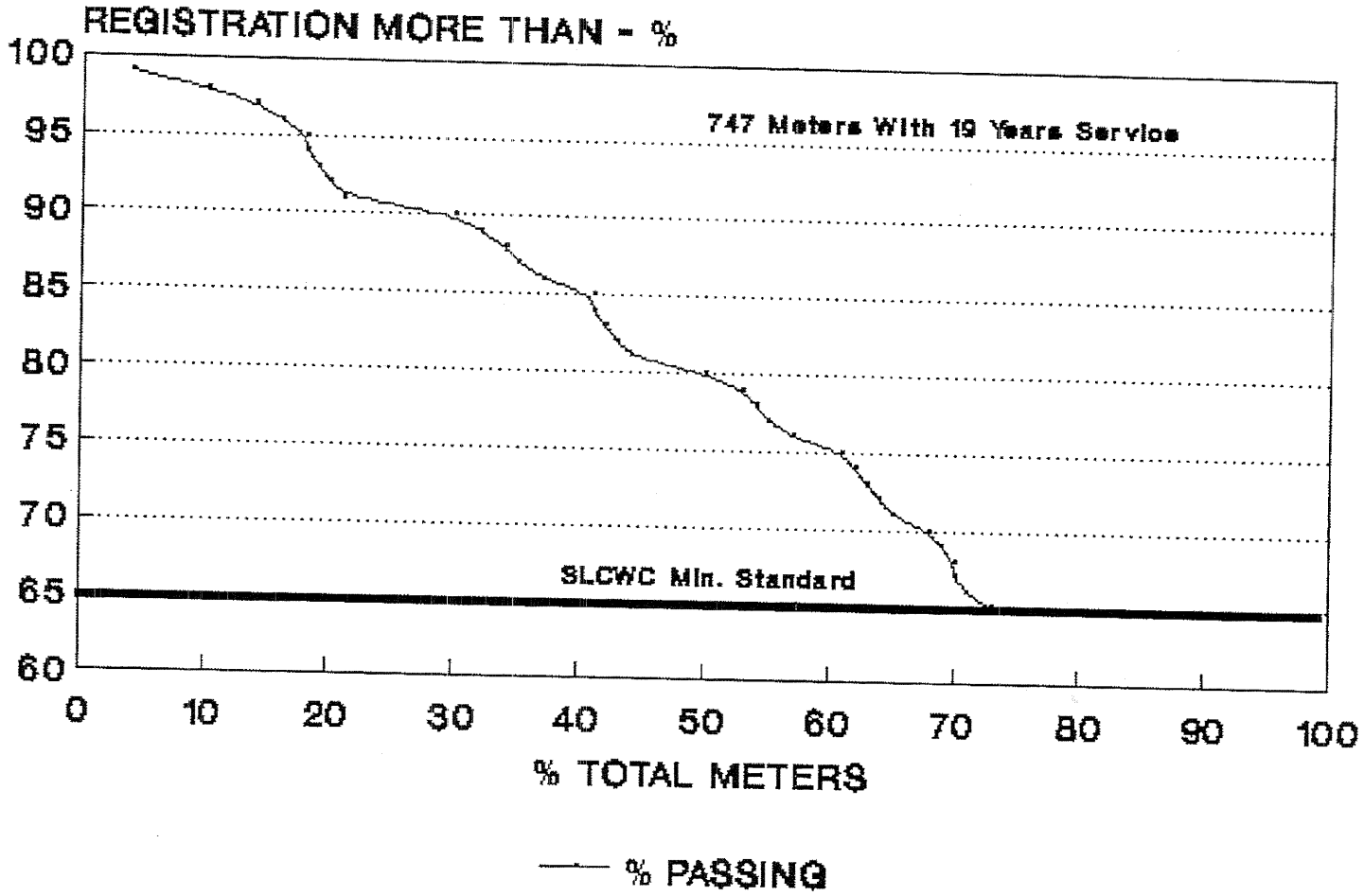

CHART 17 - SEPTEMBER 1995

19 YEARS METER STUDY GROUP
2 G.P.M. TEST

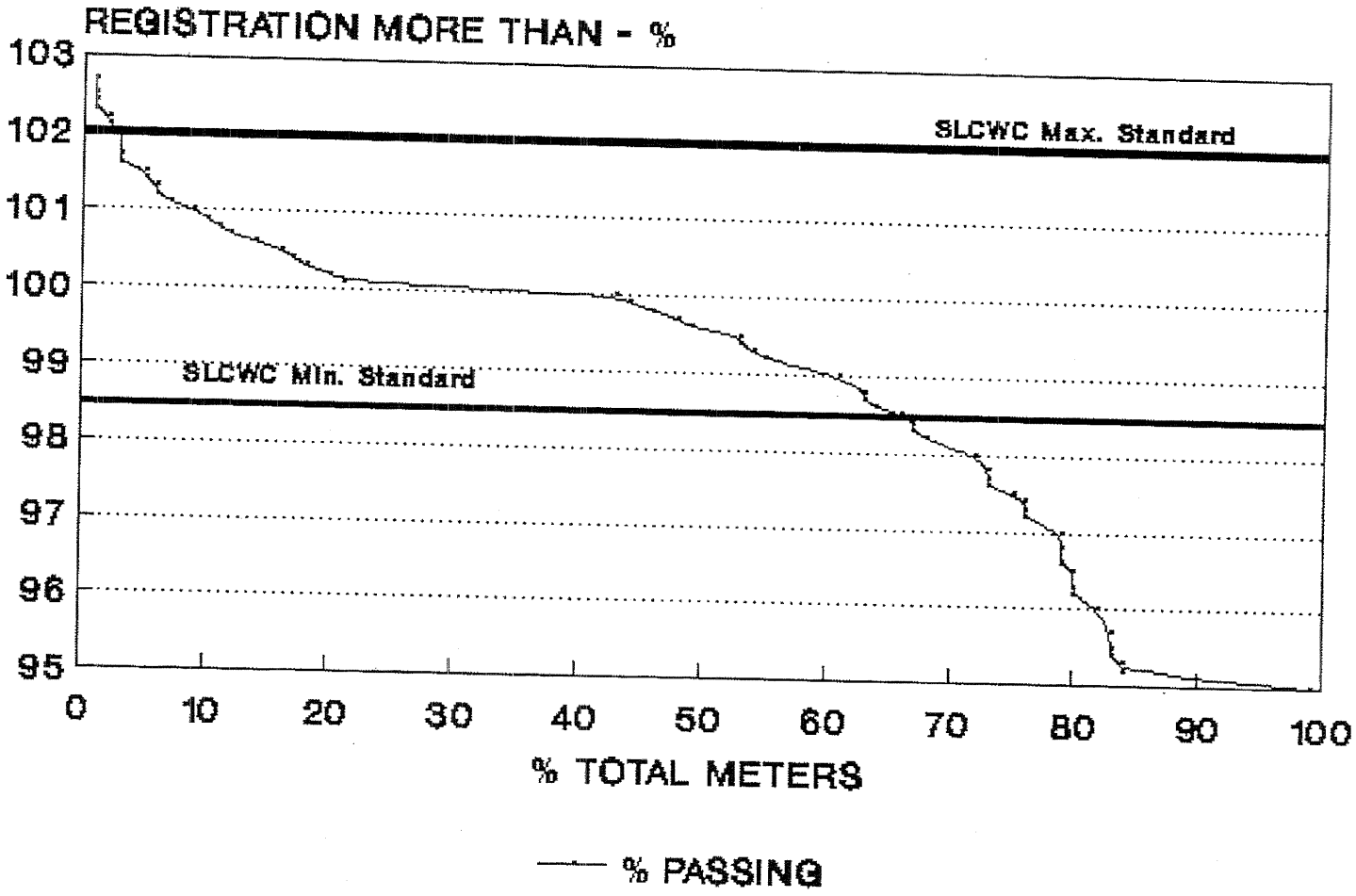

CHART 18 - SEPTEMBER 1995

35

19 YEAR STUDY GROUP - 1995
1/8 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
203	747	100	*
12	544	73	65
7	532	71	66
4	525	70	67
3	521	70	68
11	518	69	69
23	507	68	70
5	484	65	71
11	479	64	72
8	468	63	73
4	460	62	74
30	456	61	75
13	426	57	76
6	413	55	77
12	407	54	78
20	395	53	79
49	375	50	80
7	326	44	81
6	319	43	82
5	313	42	83
5	308	41	84
27	303	41	85
17	276	37	86
8	259	35	87
12	251	34	88
16	239	32	89
67	223	30	90
9	156	21	91
8	147	20	92
4	139	19	93
2	135	18	94
14	133	18	95
11	119	16	96
30	108	14	97
48	78	10	98
30	30	4	99

* 78 Meters Dead

125 Meters registered less than 65%. Average registration for this group was 41.22%

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19 YEAR STUDY GROUP - 1995
2 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
3	747	100	*
1	744	99	89
1	743	99	89.5
1	742	99	90
2	741	99	93
1	739	99	93.1
113	738	99	95
1	625	84	95.2
1	624	84	95.3
1	623	83	95.4
5	622	83	95.5
1	617	83	95.7
15	616	82	96
1	601	80	96.2
1	600	80	96.3
9	599	80	96.5
1	590	79	96.6
1	589	79	96.8
18	588	79	97
1	570	76	97.2
5	569	76	97.3
1	564	76	97.4
15	563	75	97.5
1	548	73	97.6
2	547	73	97.7
4	545	73	97.8
35	541	72	98
4	506	68	98.2
3	502	67	98.3
5	499	67	98.4
15	494	66	98.5
6	479	64	98.6
5	473	63	98.7
9	468	63	98.8
47	459	61	99
9	412	55	99.2
7	403	54	99.3
1	396	53	99.4
26	395	53	99.5
8	369	49	99.6
17	361	48	99.7
14	344	46	99.8
7	330	44	99.9
169	323	43	100
3	154	21	100.1
15	151	20	100.2
12	136	18	100.3
6	124	17	100.4
16	118	16	100.5

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19 YEAR STUDY GROUP - 1995 CONT.
2 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
12	102	14	100.6
9	90	12	100.7
6	81	11	100.8
6	75	10	100.9
19	69	9	101
3	50	7	101.1
4	47	6	101.2
3	43	6	101.3
3	40	5	101.4
12	37	5	101.5
3	25	3	101.6
3	22	3	101.7
4	19	3	102
1	15	2	102.1
3	14	2	102.2
1	11	1	102.3
1	10	1	102.4
5	9	1	102.5
1	4	1	102.7
1	3	.4	103
1	2	.2	103.5
1	1	.1	107.7

* 3 Meters Dead

250 Meters registered less than 98.5%. Average registration for this group was 96.08%

38

20 YEARS METER STUDY GROUP
1/8 G.P.M. TEST

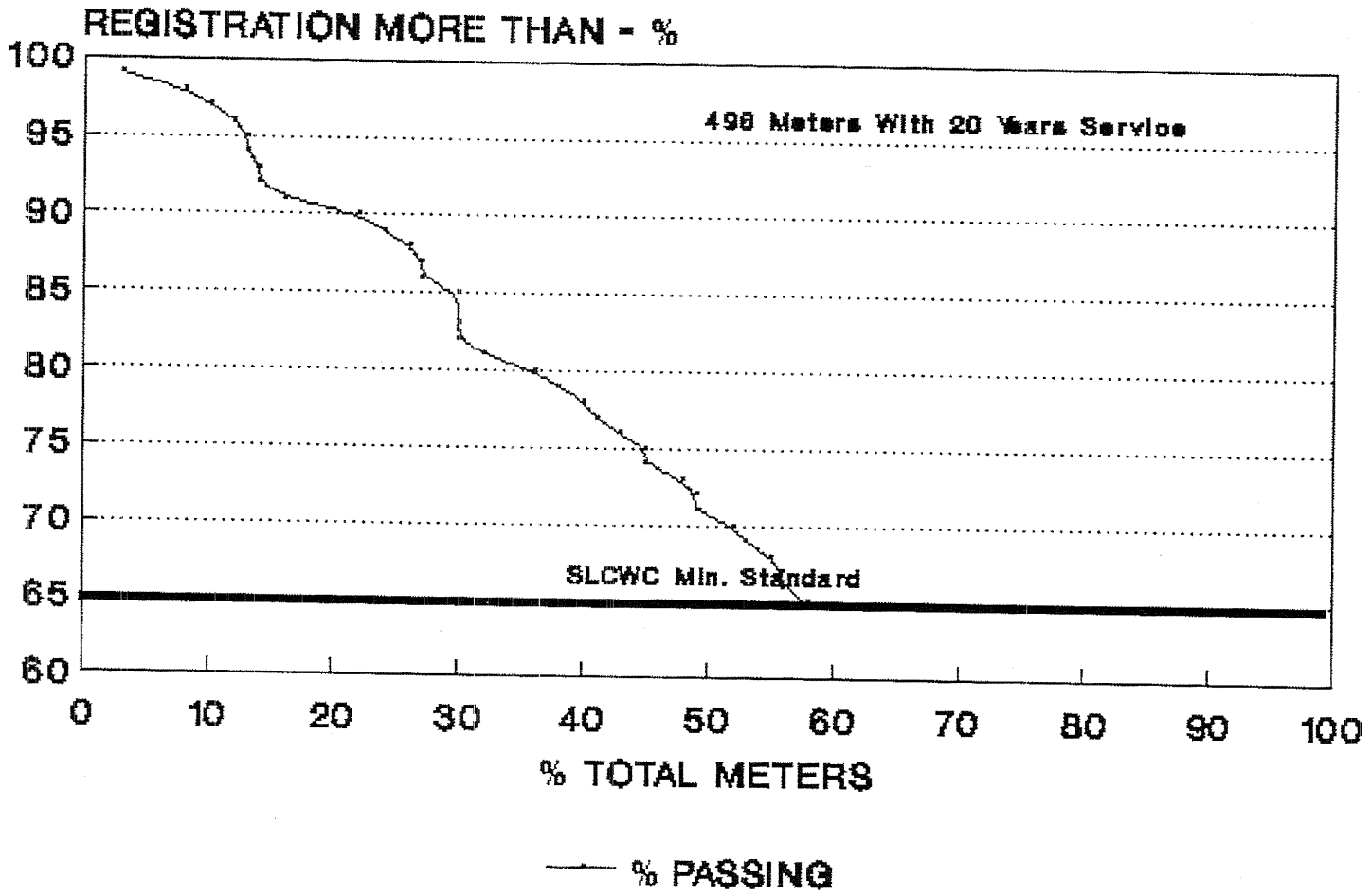

CHART 19 - SEPTEMBER 1995

20 YEARS METER STUDY GROUP
2 G.P.M. TEST

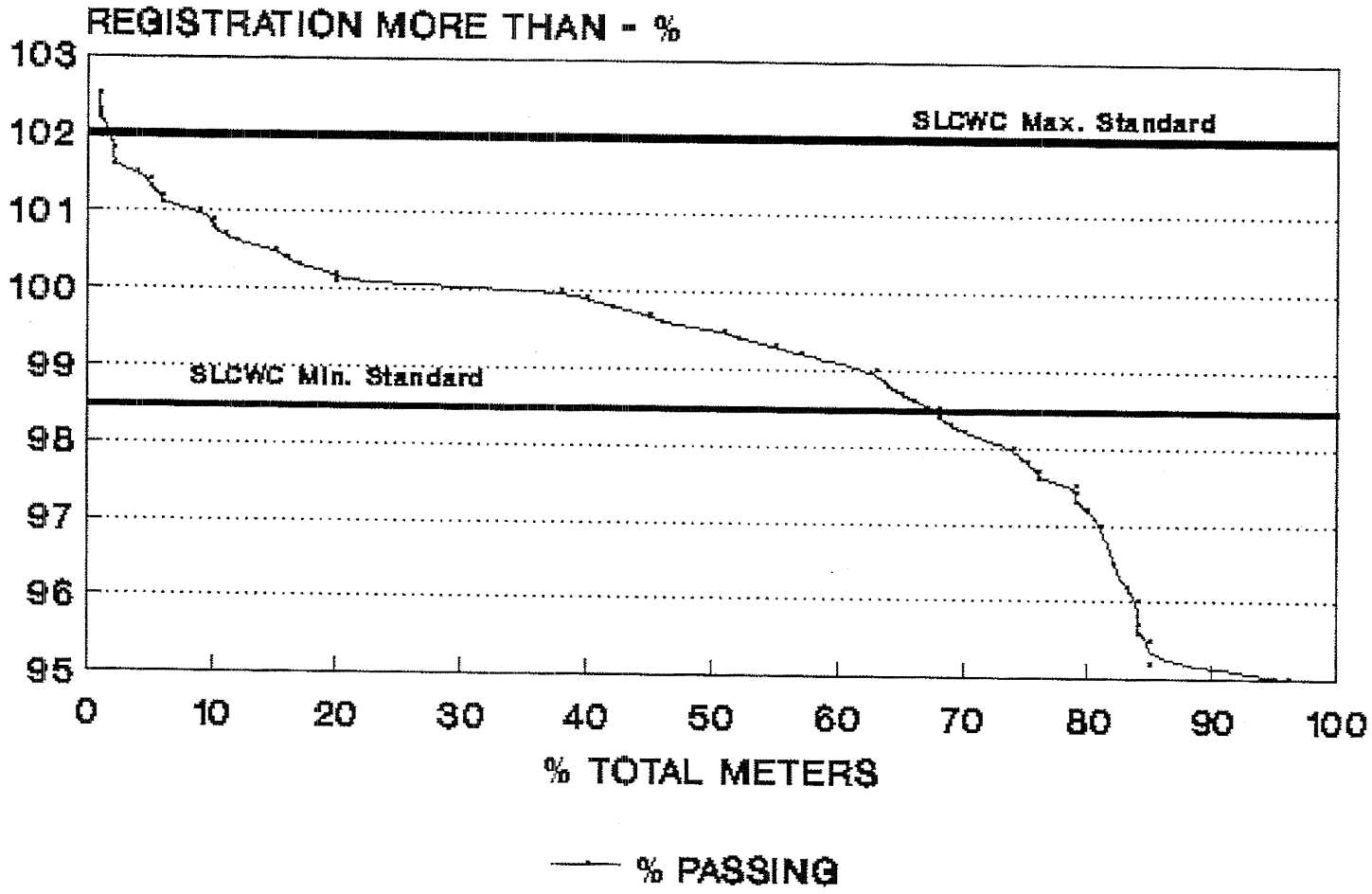

CHART 20 - SEPTEMBER 1995

40

20 YEAR STUDY GROUP - 1995
1/8 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
209	496	100	*
7	287	58	65
4	280	56	66
2	276	56	67
9	274	55	68
9	265	53	69
12	256	52	70
3	244	49	71
5	241	49	72
12	236	48	73
1	224	45	74
11	223	45	75
10	212	43	76
5	202	41	77
9	197	40	78
11	188	38	79
18	177	36	80
8	159	32	81
3	151	30	82
1	148	30	83
12	147	30	85
3	135	27	86
3	132	27	87
11	129	26	88
8	118	24	89
29	110	22	90
11	81	16	91
3	70	14	92
1	67	14	93
1	66	13	94
7	65	13	95
7	58	12	96
10	51	10	97
26	41	8	98
14	15	3	99
1	1	.2	99.5

* 113 Meters Dead

96 Meters registered less than 65%. Average registration for this group was 42.15%

41

20 YEAR STUDY GROUP - 1995
2 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
21	496	100	*
54	475	96	95
1	421	85	95.2
1	420	85	95.5
1	419	84	95.6
1	418	84	95.7
7	417	84	96
2	410	83	96.2
7	408	82	96.5
6	401	81	97
2	395	80	97.2
1	393	79	97.3
1	392	79	97.4
12	391	79	97.5
4	379	76	97.6
4	375	76	97.7
5	371	75	97.8
20	366	74	98
3	346	70	98.2
5	343	69	98.3
1	338	68	98.4
10	337	68	98.5
3	327	66	98.6
7	324	65	98.7
4	317	64	98.8
30	313	63	99
11	283	57	99.2
15	272	55	99.3
5	257	52	99.4
23	252	51	99.5
6	229	46	99.6
13	223	45	99.7
12	210	42	99.8
8	198	40	99.9
89	190	38	100
3	101	20	100.1
13	98	20	100.2
8	85	17	100.3
5	77	16	100.4
11	72	15	100.5
4	61	12	100.6
6	57	11	100.7
2	51	10	100.8
3	49	10	100.9
17	46	9	101
1	29	6	101.1
3	28	6	101.2
2	25	5	101.3
1	23	5	101.4

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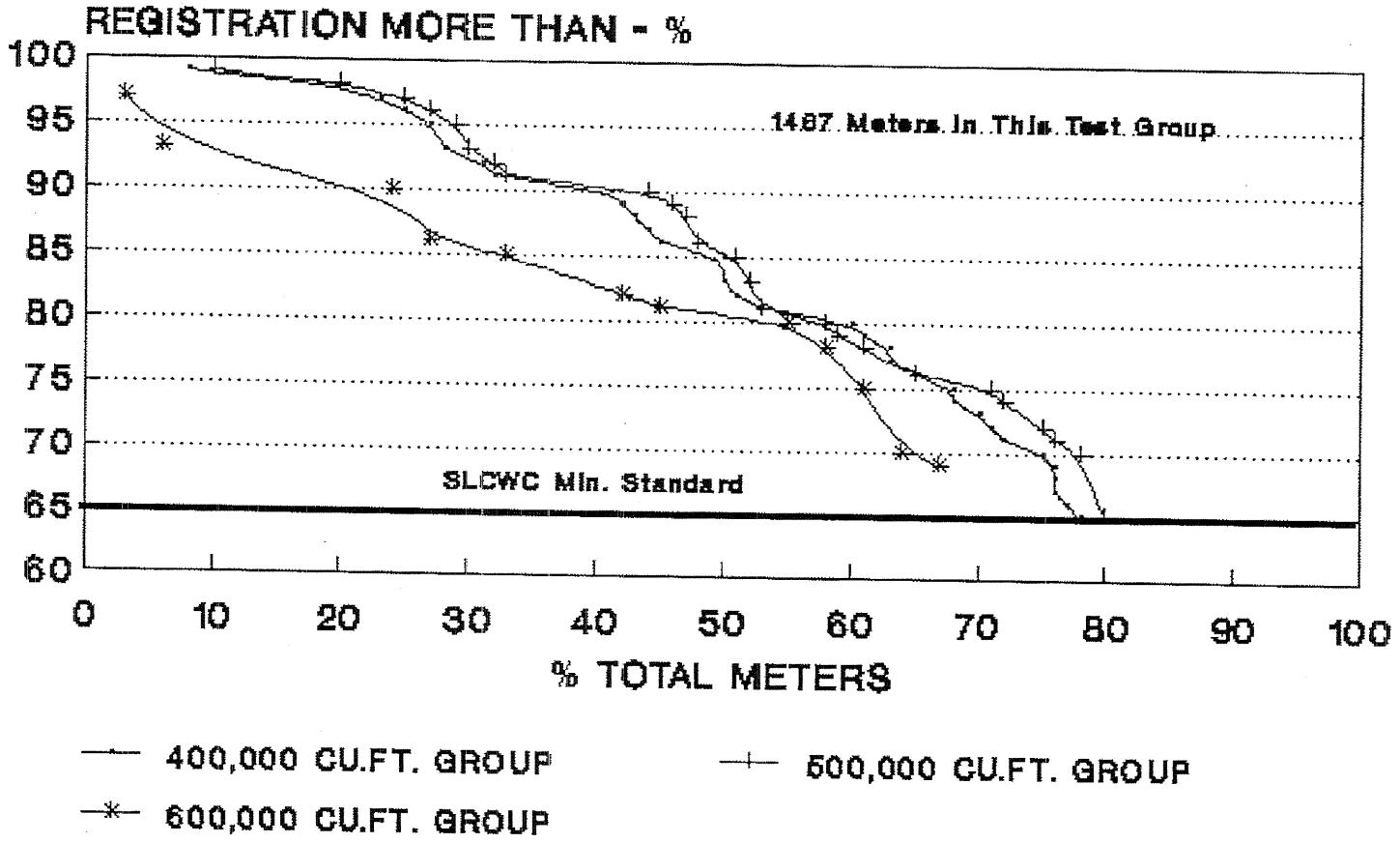
20 YEAR STUDY GROUP - 1995 CONT.
2 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
10	22	4	101.5
2	12	2	101.6
2	10	2	101.8
1	8	2	102
2	7	1	102.2
2	5	1	102.3
1	3	1	102.5
1	2	.4	103
1	1	.2	104

* 21 Meters Dead

138 Meters registered less than 98.5%. Average registration for this group was 96.43%

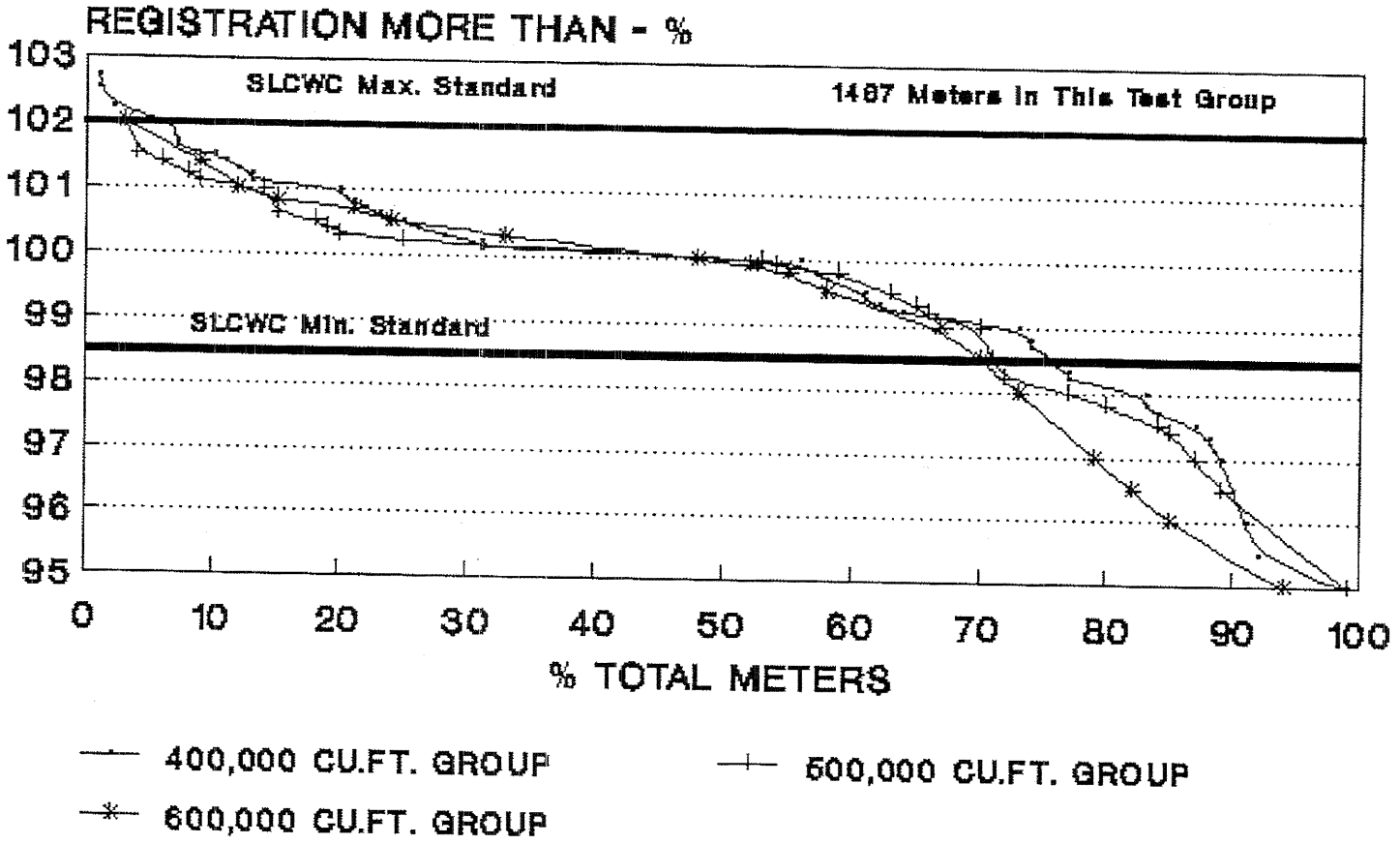
400/500/600,000 CU.FT. USAGE STUDY GROUP
1/8 G.P.M. TEST



ACCEPTABLE RANGE OVER 65%

CHART 21 - SEPTEMBER 1995

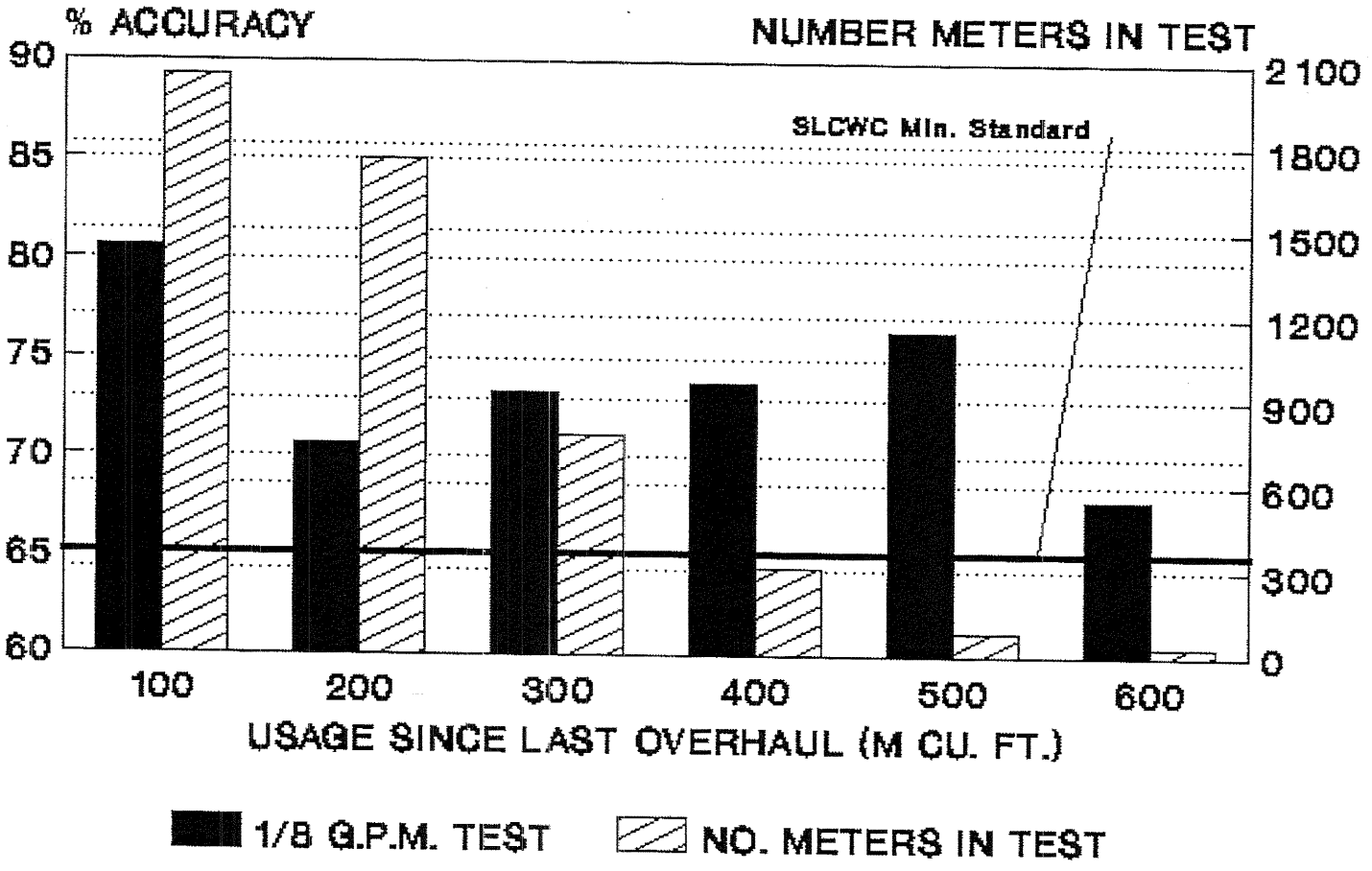
400/500/600,000 CU.FT. USAGE STUDY GROUP
2 G.P.M. TEST



ACCEPTABLE RANGE 98.5% - 102%

CHART 22 - SEPTEMBER 1995

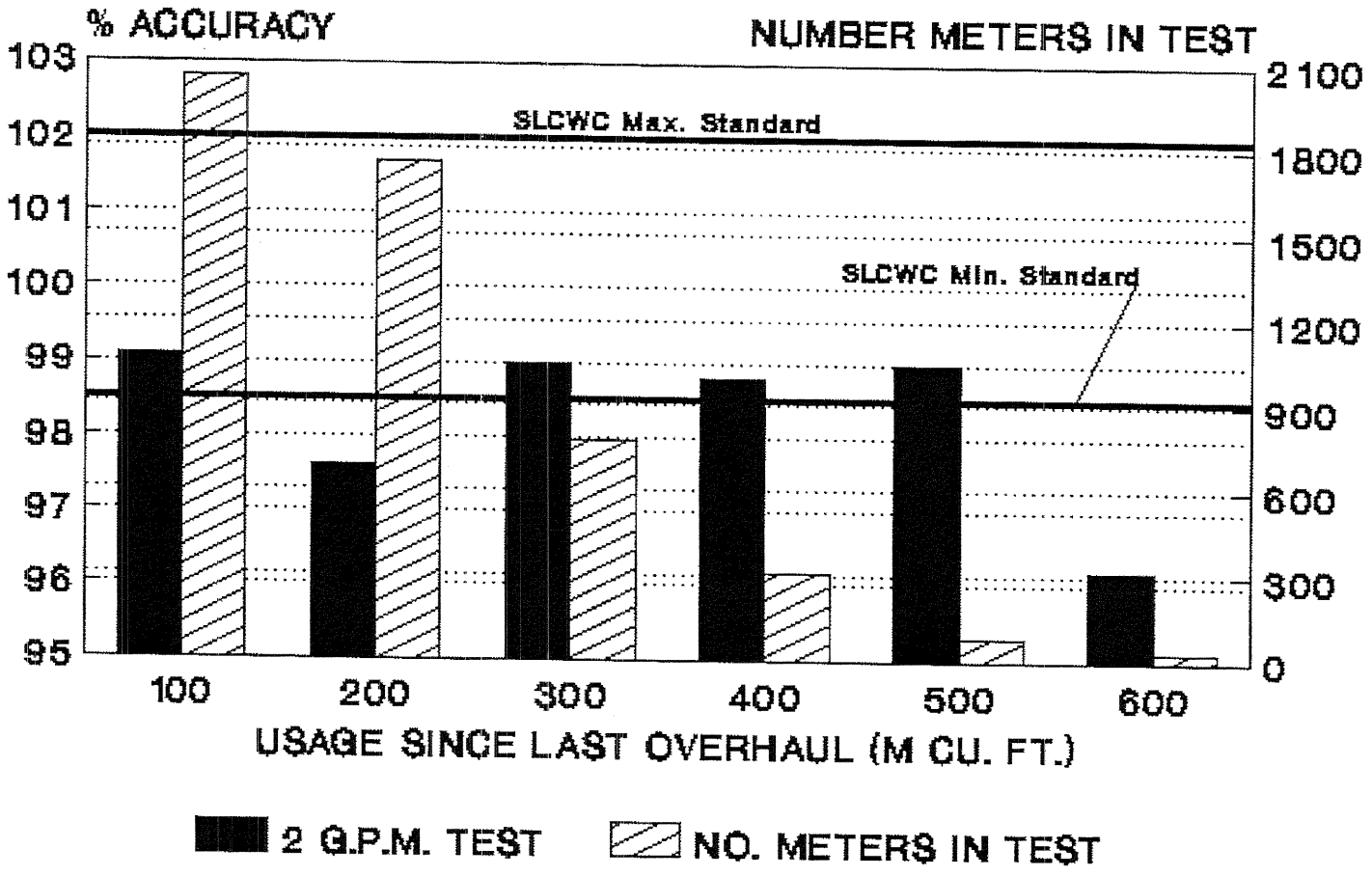
USAGE COMPARED TO AVG. % ACCURACY
1/8 G.P.M. TEST



ACCEPTABLE RANGE OVER 65%

CHART 23 - SEPTEMBER 1995

USAGE COMPARED TO AVG. % ACCURACY
2 G.P.M. TEST

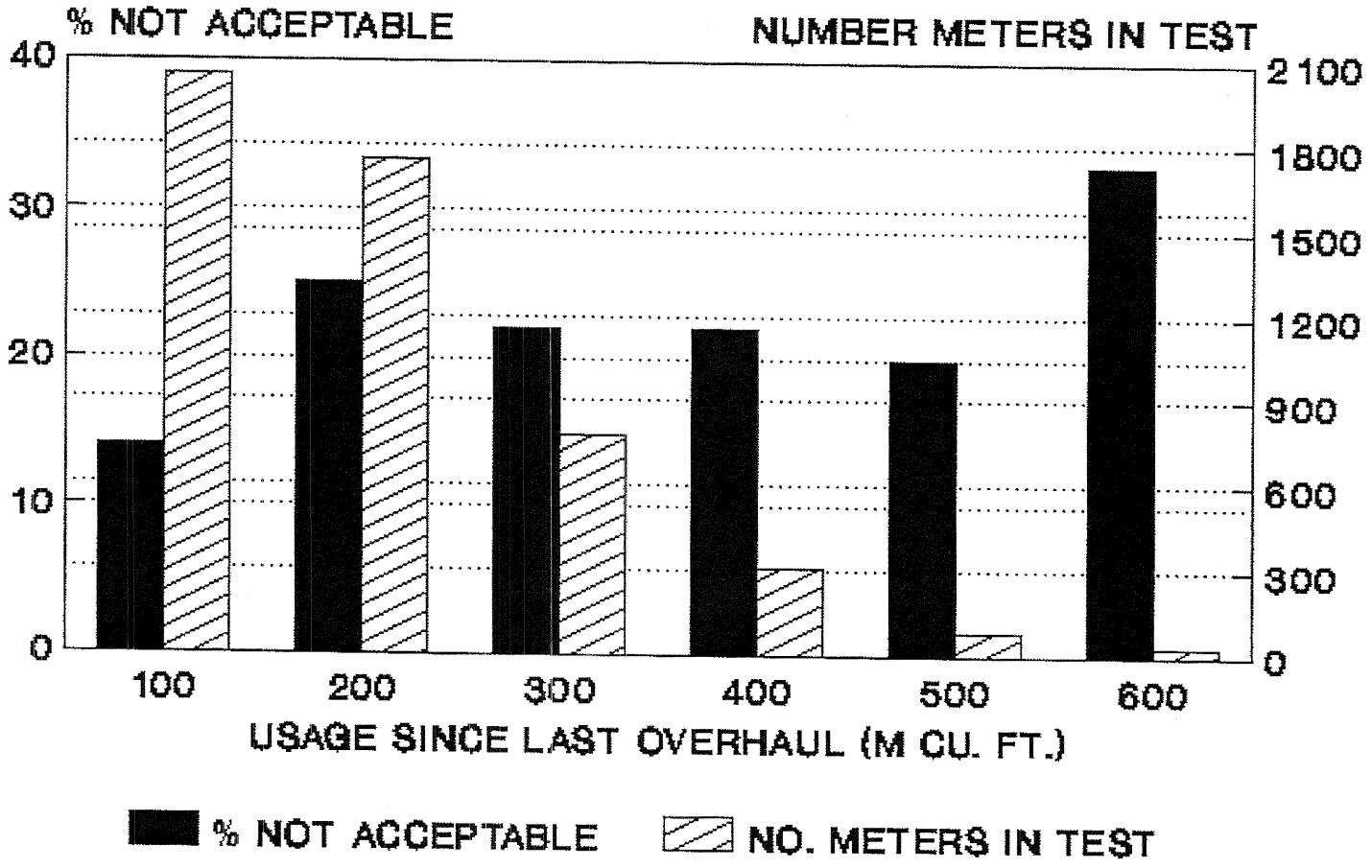


ACCEPTABLE RANGE 98.5% - 102%

CHART 24 - SEPTEMBER 1995

276

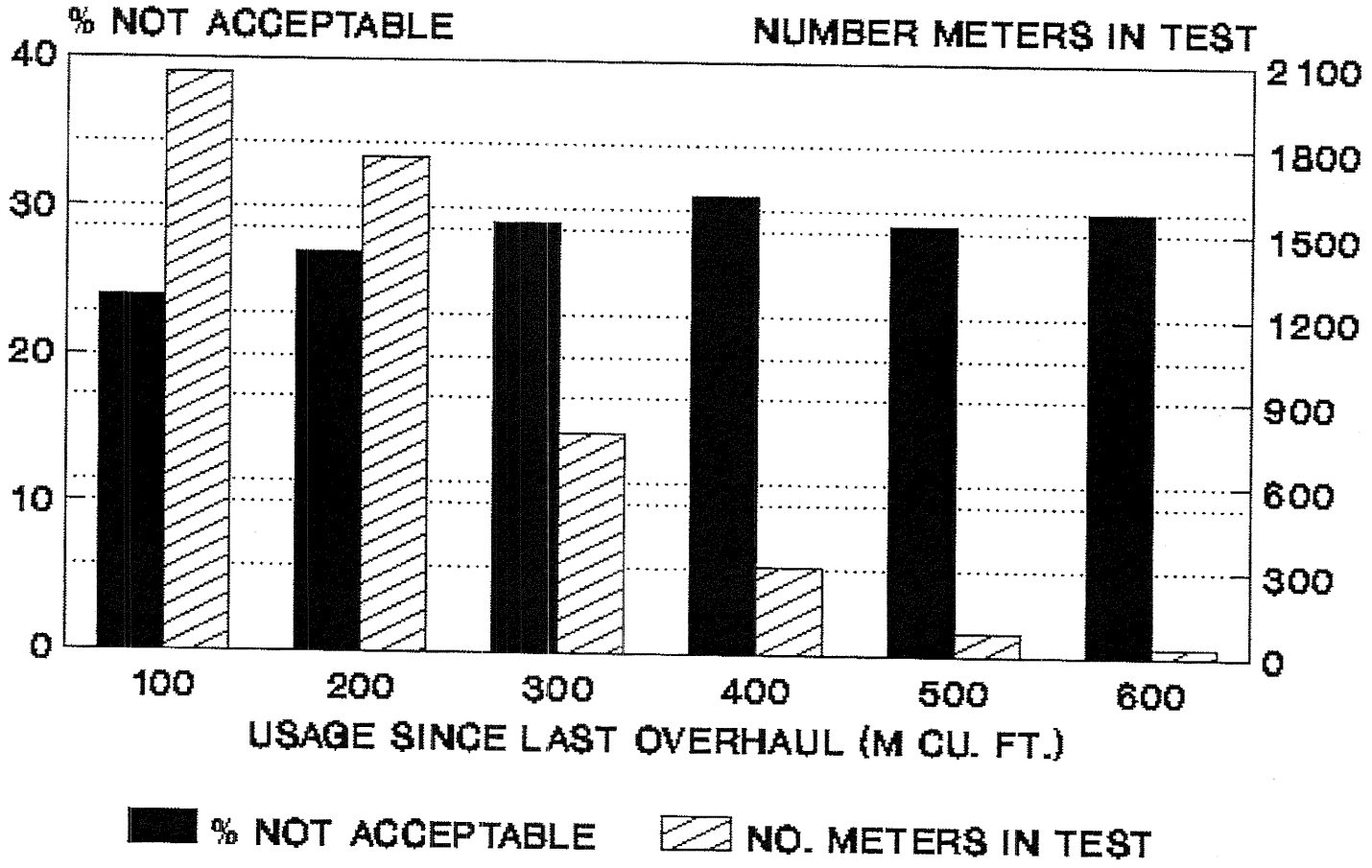
USAGE COMPARED TO AVG. % ACCURACY
1/8 G.P.M. TEST



METERS UNDER ACCEPTABLE RANGE OF 65%

CHART 25 - SEPTEMBER 1995

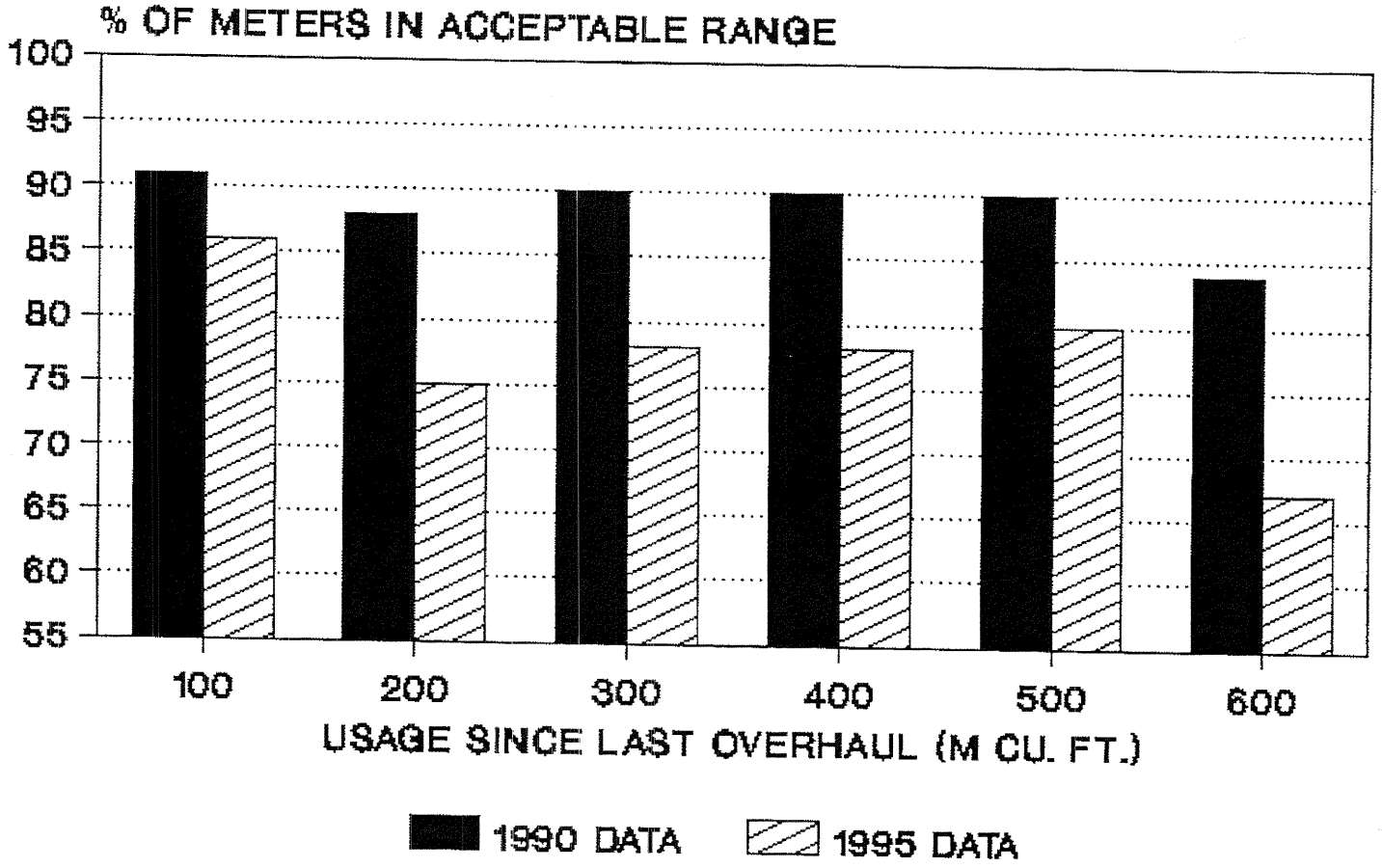
USAGE COMPARED TO AVG. % ACCURACY
2 G.P.M. TEST



OUTSIDE ACCEPTABLE RANGE OF 98.5% - 102

CHART 26 - SEPTEMBER 1995

METER COMPARISON 1990 VERSUS 1995
1/8 G.P.M. TEST

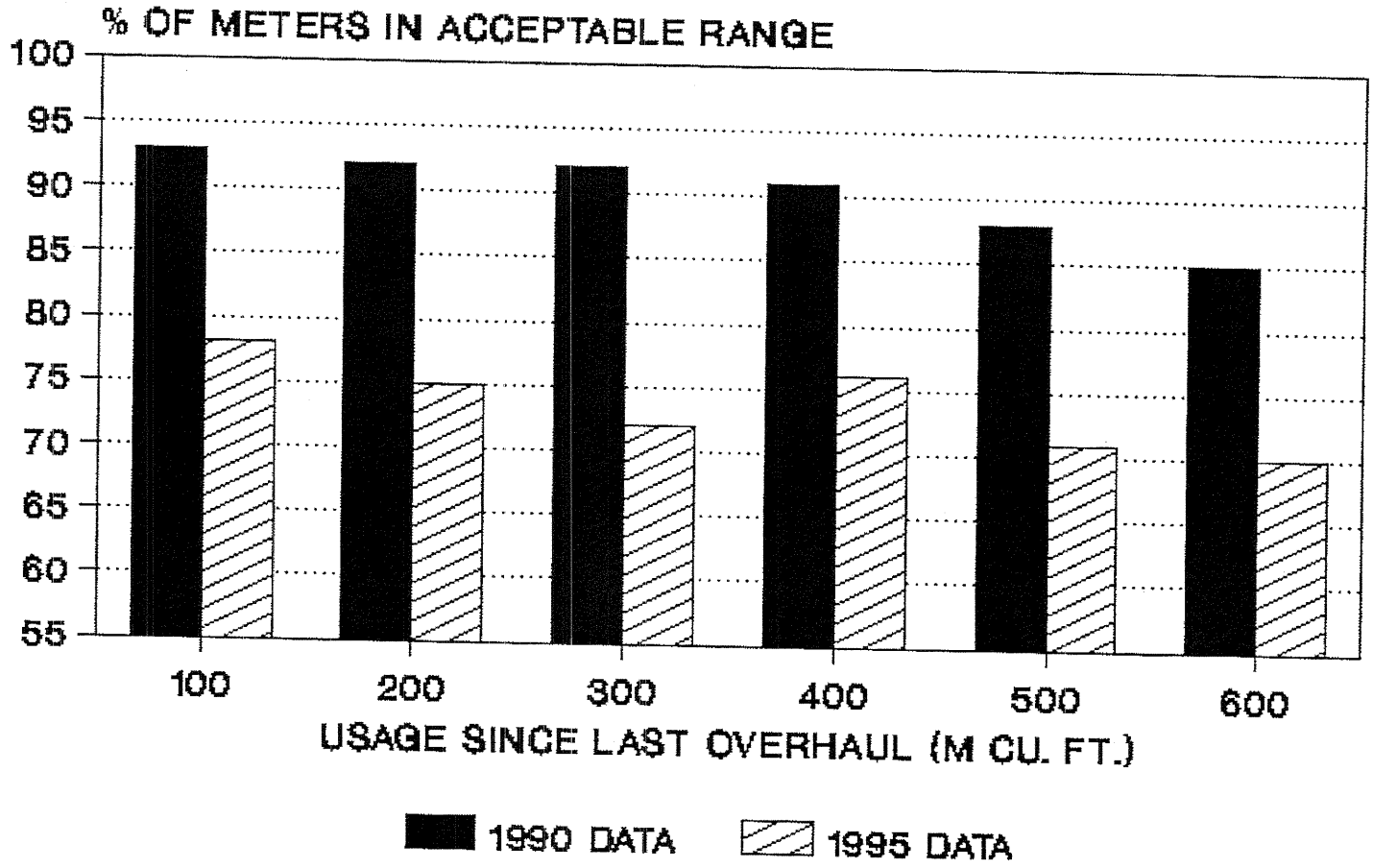


ACCEPTABLE RANGE: ABOVE 65%

CHART 27 - SEPTEMBER 1995

50

METER COMPARISON 1990 VERSUS 1995
2 G.P.M. TEST



ACCEPTABLE RANGE: 98.5% - 102%

CHART 28 - SEPTEMBER 1995

100,000 CU. FT. USAGE STUDY GROUP
1/8 G.P.M. TEST

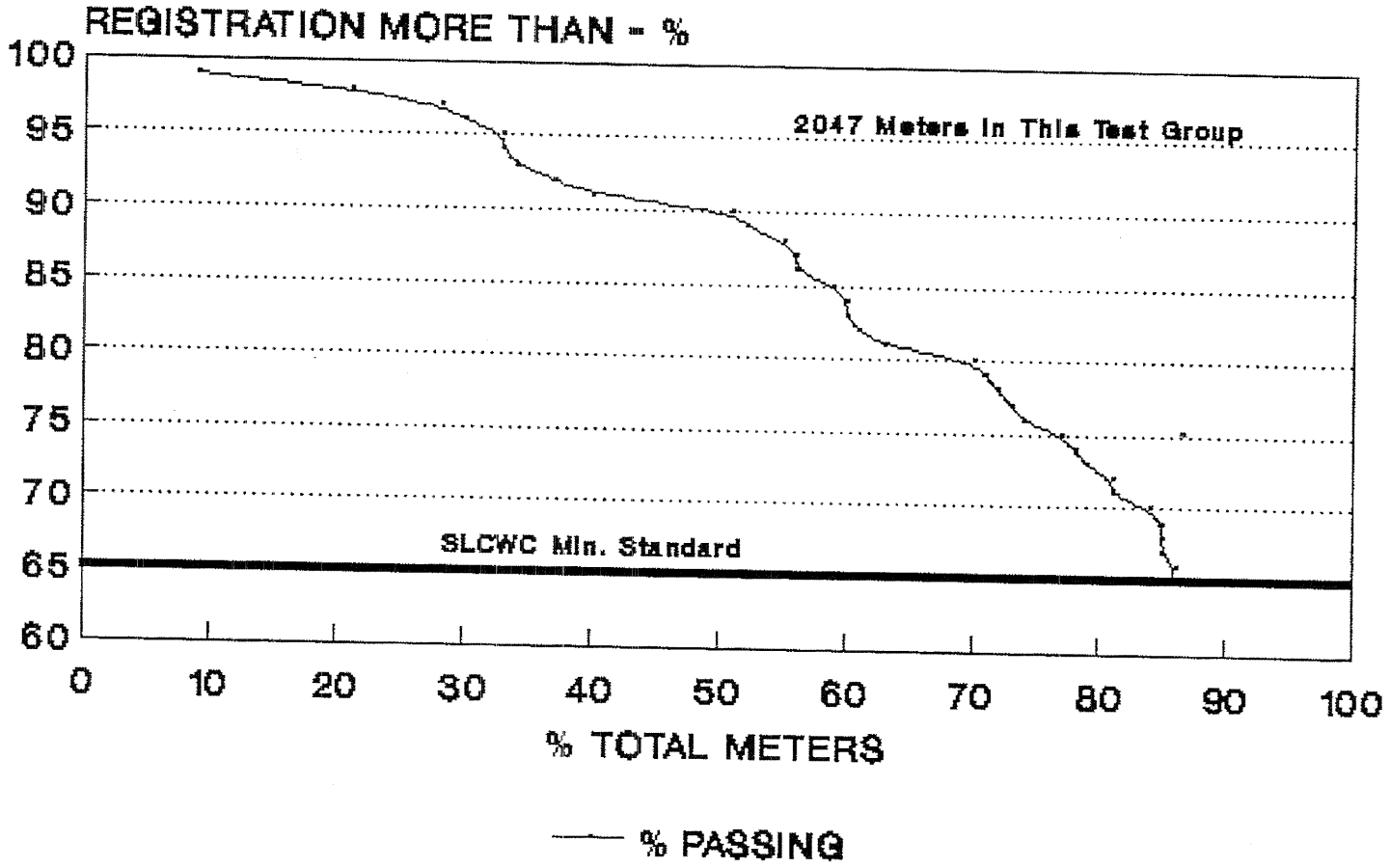


CHART 29 - SEPTEMBER 1995

52

100,000 CU. FT. USAGE STUDY GROUP
2 G.P.M. TEST

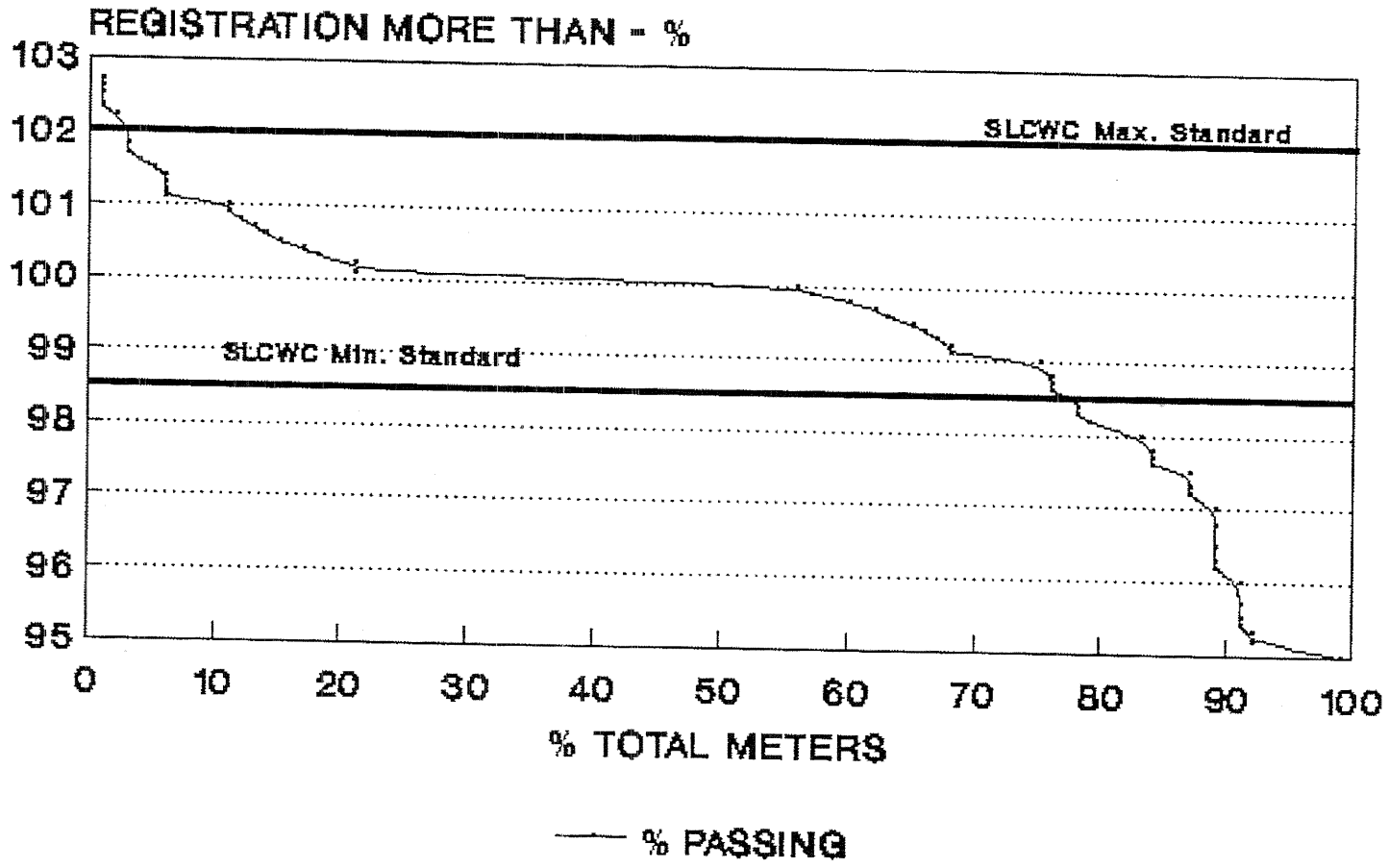


CHART 30 - SEPTEMBER 1995

100,000 CU. FT. USAGE STUDY GROUP - 1995
1/8 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
282	2047	100	*
13	1765	86	65
7	1752	86	66
3	1745	85	67
6	1742	85	68
11	1736	85	69
60	1725	84	70
13	1665	81	71
31	1652	81	72
33	1621	79	73
19	1588	78	74
60	1569	77	75
19	1509	74	76
13	1490	73	77
24	1477	72	78
30	1453	71	79
133	1423	70	80
47	1290	63	81
17	1243	61	82
7	1226	60	83
10	1219	60	84
58	1209	59	85
12	1151	56	86
18	1139	56	87
53	1121	55	88
34	1068	52	89
219	1034	51	90
60	815	40	91
54	755	37	92
18	701	34	93
10	683	33	94
58	673	33	95
48	615	30	96
136	567	28	97
245	431	21	98
186	186	9	99

* 64 Meters Dead

218 Meters registered less than 65%. Average registration for this group was 41.50%

100,000 CU. FT. USAGE STUDY GROUP - 1995
2 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
2	2047	100	*
1	2045	99	10.1
1	2044	99	75
1	2043	99	89
1	2042	99	89.5
1	2041	99	90
1	2040	99	91
1	2039	99	92
3	2038	99	93
1	2035	99	94
159	2034	99	95
1	1875	92	95.2
1	1874	92	95.3
1	1873	91	95.4
5	1872	91	95.5
1	1867	91	95.7
36	1866	91	96
1	1830	89	96.2
1	1829	89	96.3
8	1828	89	96.5
1	1820	89	96.8
39	1819	89	97
2	1780	87	97.2
6	1778	87	97.3
45	1772	87	97.5
8	1727	84	97.6
5	1719	84	97.7
8	1714	84	97.8
98	1706	83	98
5	1608	79	98.2
4	1603	78	98.3
4	1599	78	98.4
31	1595	78	98.5
7	1564	76	98.6
8	1557	76	98.7
7	1549	76	98.8
151	1542	75	99
1	1391	68	99.1
16	1390	68	99.2
22	1374	67	99.3
14	1352	66	99.4
54	1338	65	99.5
15	1284	63	99.6
39	1269	62	99.7
65	1230	60	99.8
22	1165	57	99.9
708	1143	56	100
14	435	21	100.1
50	421	21	100.2

55

100,000 CU. FT. USAGE STUDY GROUP - 1995 CONT.
2 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
32	371	18	100.3
23	339	17	100.4
38	316	15	100.5
20	278	14	100.6
16	258	13	100.7
12	242	12	100.8
7	230	11	100.9
90	223	11	101
4	133	6	101.1
11	129	6	101.2
4	118	6	101.3
15	114	6	101.4
25	99	5	101.5
7	74	4	101.6
2	67	3	101.7
3	65	3	101.8
30	62	3	102
3	32	2	102.2
1	29	1	102.3
16	28	1	102.5
1	12	1	102.6
2	11	1	102.7
4	9	.4	103
2	5	.2	103.5
1	3	.1	105
1	2	.1	107.7
1	1	.1	108.5

* 2 Meters Dead

450 Meters registered less than 98.5%. Average registration for this group was 96.16%

56

200,000 CU. FT. USAGE STUDY GROUP
1/8 G.P.M. TEST

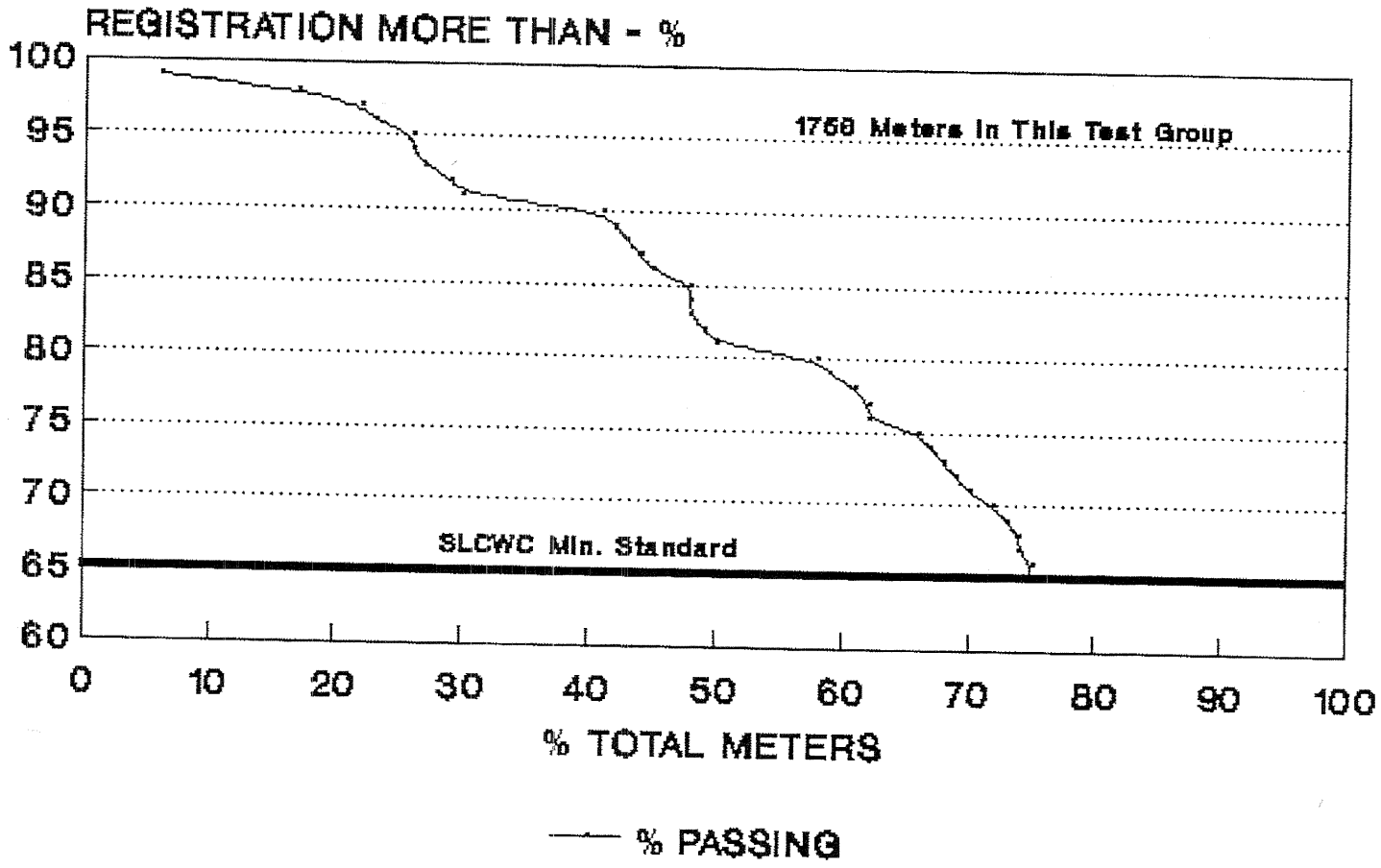


CHART 31 - SEPTEMBER 1995

200,000 CU. FT. USAGE STUDY GROUP
2 G.P.M. TEST

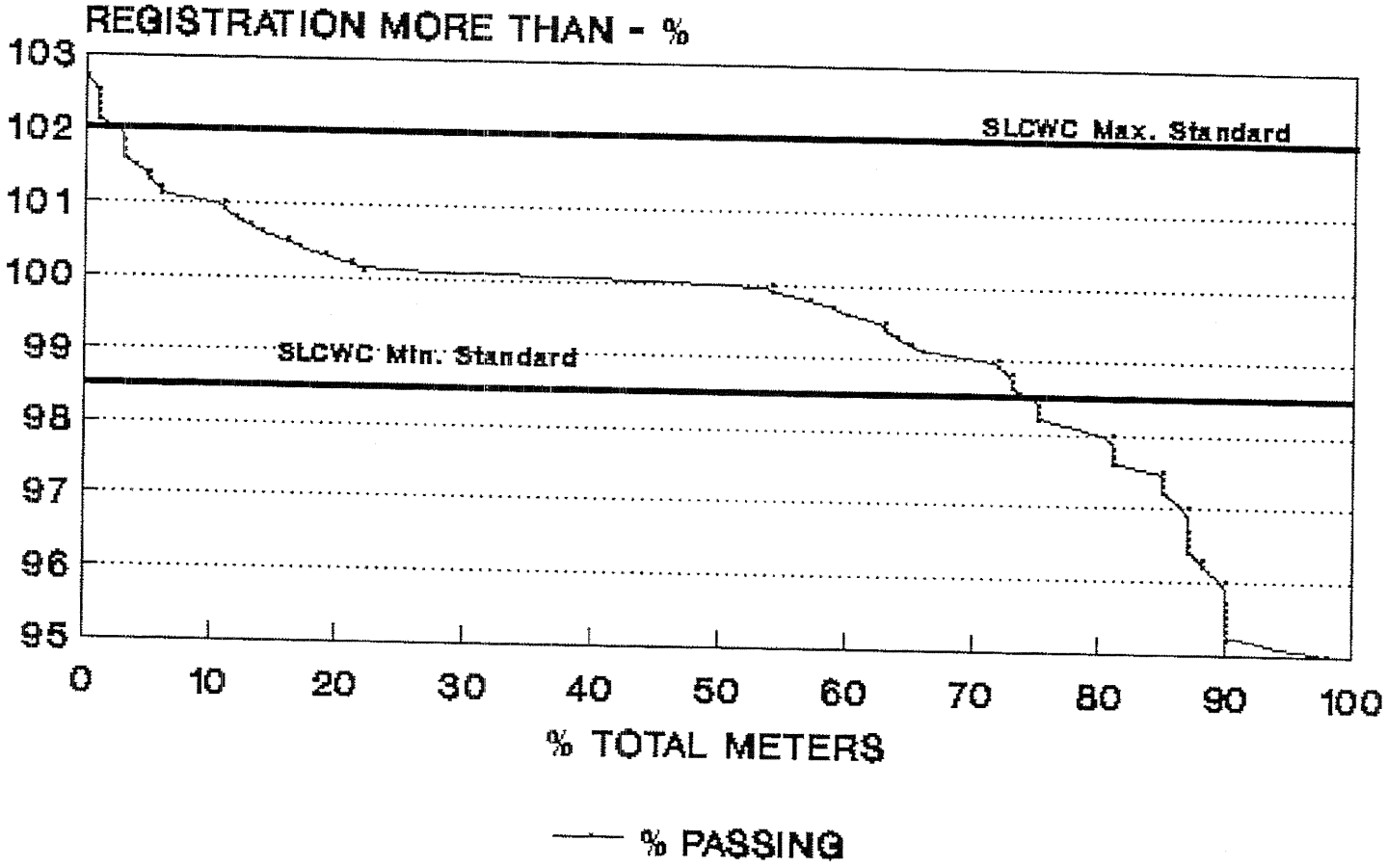


CHART 32 - SEPTEMBER 1995

58

200,000 CU. FT. USAGE STUDY GROUP - 1995
1/8 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
437	1756	100	*
10	1319	75	65
7	1309	75	66
9	1302	74	67
6	1293	74	68
14	1287	73	69
45	1273	72	70
8	1228	70	71
27	1220	69	72
24	1193	68	73
18	1169	67	74
54	1151	66	75
16	1097	62	76
18	1081	62	77
30	1063	61	78
16	1033	59	79
132	1017	58	80
26	885	50	81
12	859	49	82
5	847	48	83
4	842	48	84
47	838	48	85
14	791	45	86
15	777	44	87
23	762	43	88
15	739	42	89
193	724	41	90
28	531	30	91
35	503	29	92
6	468	27	93
11	462	26	94
39	451	26	95
29	412	23	96
90	383	22	97
183	293	17	98
108	110	6	99
1	2	.1	100
1	1	.1	101

* 215 Meters Dead

222 Meters registered less than 65%. Average registration for this group was 38.34%

59

200,000 CU. FT. USAGE STUDY GROUP - 1995
2 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
29	1756	100	*
1	1727	98	82.5
1	1726	98	86.4
1	1725	98	90
1	1724	98	94
139	1723	98	95
1	1584	90	95.2
1	1583	90	95.3
1	1582	90	95.4
6	1581	90	95.5
1	1575	90	95.6
2	1574	90	95.7
31	1572	90	96
2	1541	88	96.2
5	1539	88	96.3
3	1534	87	96.4
8	1531	87	96.5
2	1523	87	96.6
1	1521	87	96.7
26	1520	87	97
4	1494	85	97.2
2	1490	85	97.3
1	1488	85	97.4
56	1487	85	97.5
2	1431	81	97.6
3	1429	81	97.7
10	1426	81	97.8
93	1416	81	98
2	1323	75	98.2
5	1321	75	98.3
4	1316	75	98.4
28	1312	75	98.5
3	1284	73	98.6
7	1281	73	98.7
15	1274	73	98.8
2	1259	72	98.9
106	1257	72	99
1	1151	66	99.1
22	1150	65	99.2
16	1128	64	99.3
10	1112	63	99.4
47	1102	63	99.5
17	1055	60	99.6
41	1038	59	99.7
46	997	57	99.8
11	951	54	99.9
558	940	54	100
9	382	22	100.1

60

200,000 CU. FT. USAGE STUDY GROUP - 1995 CONT.
2 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
46	373	21	100.2
25	327	19	100.3
26	302	17	100.4
34	276	16	100.5
21	242	14	100.6
18	221	13	100.7
11	203	12	100.8
6	192	11	100.9
77	186	11	101
5	109	6	101.1
9	104	6	101.2
9	95	5	101.3
7	86	5	101.4
18	79	4	101.5
2	61	3	101.6
5	59	3	101.7
5	54	3	101.8
24	49	3	102
2	25	1	102.1
4	23	1	102.2
4	19	1	102.3
2	15	1	102.4
10	13	1	102.5
2	3	.1	102.7
1	1	.1	115.5

* 29 Meters Dead

415 Meters registered less than 98.5%. Average registration for this group was 96.46%

61

300,000 CU. FT. USAGE STUDY GROUP
1/8 G.P.M. TEST

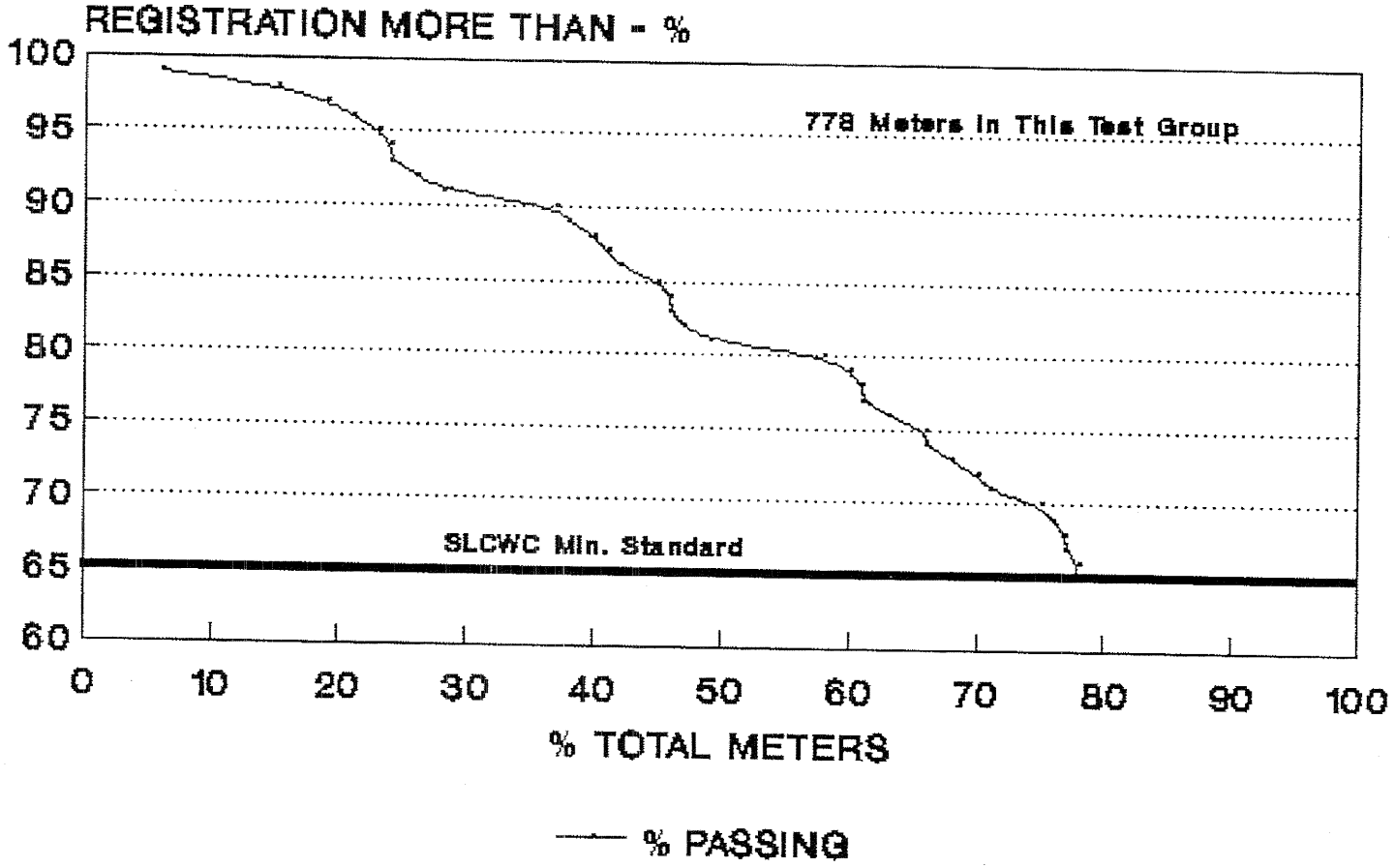


CHART 33 - SEPTEMBER 1995

300,000 CU. FT. USAGE STUDY GROUP
2 G.P.M. TEST

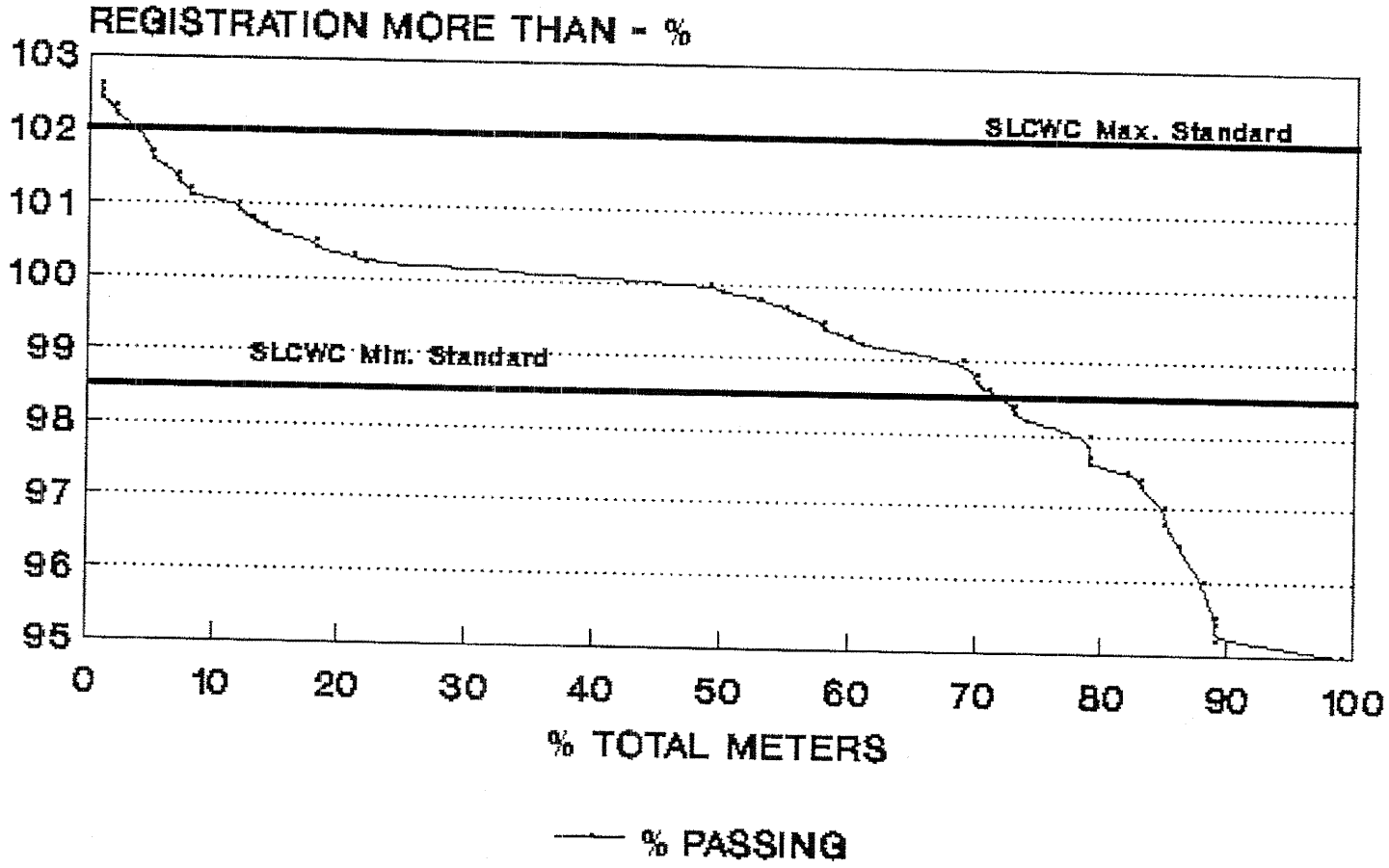


CHART 34 - SEPTEMBER 1995

300,000 CU. FT. USAGE STUDY GROUP - 1995
1/8 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
168	778	100	*
5	610	78	65
5	605	78	66
1	600	77	67
8	599	77	68
9	591	76	69
33	582	75	70
3	549	71	71
17	546	70	72
14	529	68	73
5	515	66	74
22	510	66	75
10	488	63	76
3	478	61	77
7	475	61	78
17	468	60	79
68	451	58	80
15	383	49	81
8	368	47	82
4	360	46	83
7	356	46	84
21	349	45	85
10	328	42	86
4	318	41	87
17	314	40	88
7	297	38	89
69	290	37	90
19	221	28	91
18	202	26	92
1	184	24	93
5	183	24	94
12	178	23	95
15	166	21	96
32	151	19	97
71	119	15	98
48	48	6	99

* 57 Meters Dead

111 Meters registered less than 65%. Average registration for this group was 40.86%

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300,000 CU. FT. USAGE STUDY GROUP - 1995
2 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
1	778	100	92
1	777	99	92.2
1	776	99	93
80	775	99	95
1	695	89	95.2
1	694	89	95.4
5	693	89	95.5
18	688	88	96
6	670	86	96.5
1	664	85	96.8
18	663	85	97
3	645	83	97.3
1	642	83	97.4
25	641	82	97.5
2	616	79	97.6
1	614	79	97.7
39	613	79	98
5	574	74	98.2
4	569	73	98.3
2	565	73	98.4
13	563	72	98.5
5	550	71	98.6
3	545	70	98.7
7	542	70	98.8
60	535	69	99
8	475	61	99.2
12	467	60	99.3
7	455	58	99.4
14	448	58	99.5
4	434	56	99.6
18	430	55	99.7
22	412	53	99.8
6	390	50	99.9
209	384	49	100
12	175	22	100.2
20	163	21	100.3
6	143	18	100.4
18	137	18	100.5
8	119	15	100.6
11	111	14	100.7
5	100	13	100.8
2	95	12	100.9
29	93	12	101
1	64	8	101.1
6	63	8	101.2
4	57	7	101.3
3	53	7	101.4

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300,000 CU. FT. USAGE STUDY GROUP - 1995 CONT.
2 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
11	50	6	101.5
3	39	5	101.6
4	36	5	101.7
17	32	4	102
2	15	2	102.2
2	13	2	102.3
2	11	1	102.4
4	9	1	102.5
2	5	1	102.6
2	3	.3	103
1	1	.1	103.5

* 0 Meters Dead

215 Meters registered less than 98.5%. Average registration for this group was 96.36%

66

400,000 CU. FT. USAGE STUDY GROUP
1/8 G.P.M. TEST

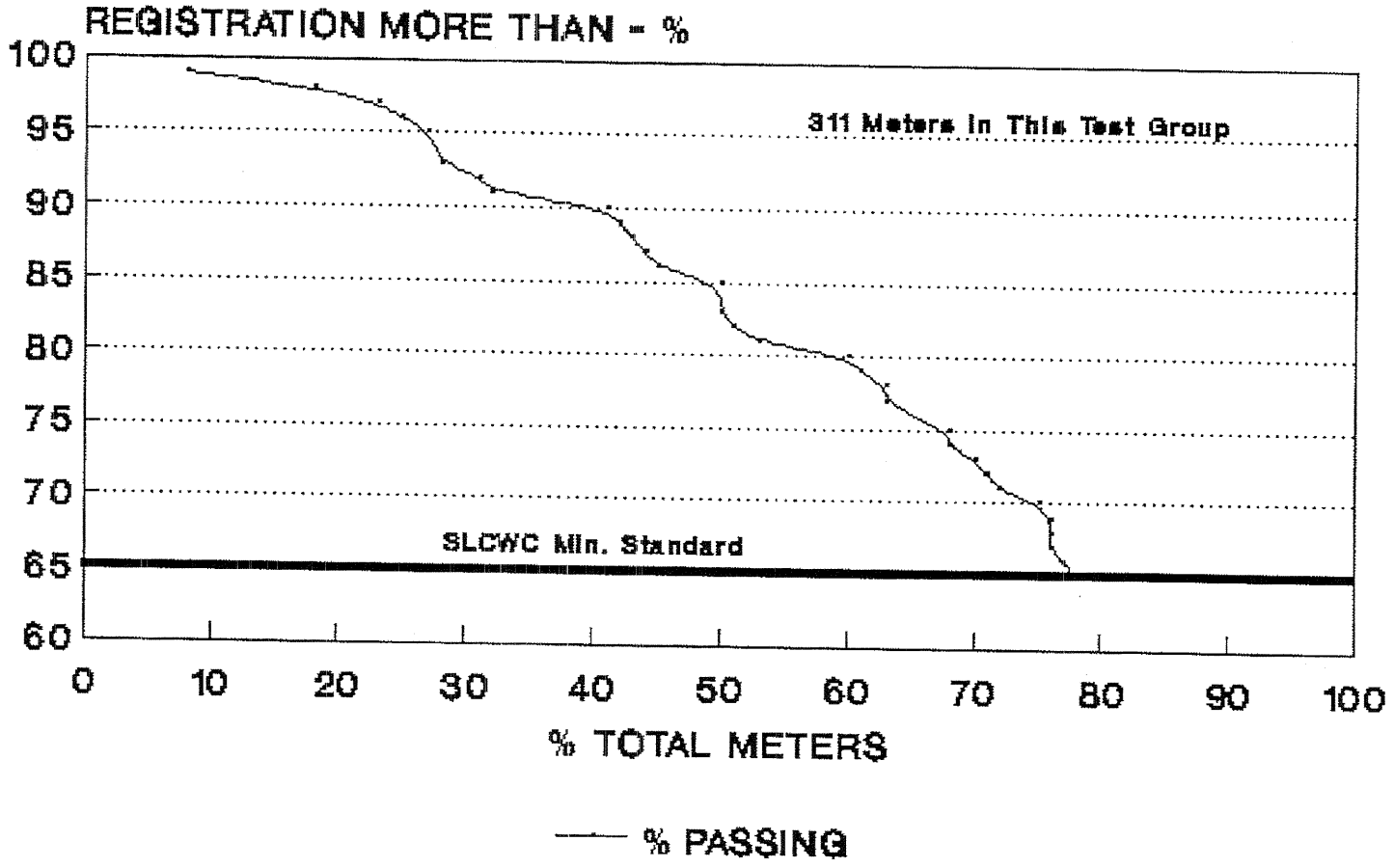

CHART 35 - SEPTEMBER 1995

400,000 CU. FT. USAGE STUDY GROUP
2 G.P.M. TEST

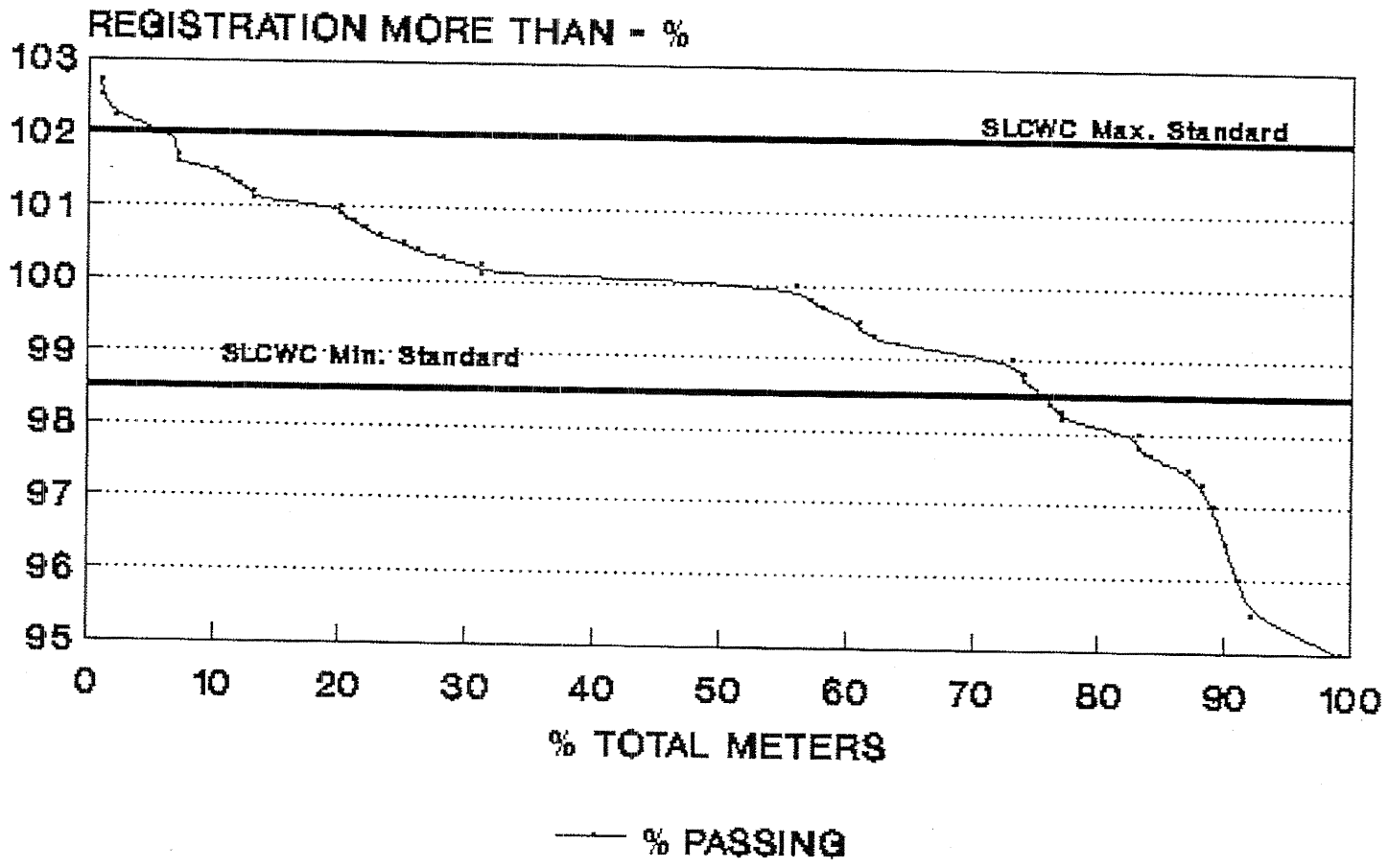

CHART 36 - SEPTEMBER 1995

400,000 CU. FT. USAGE STUDY GROUP - 1995
1/8 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
67	311	100	*
5	244	78	65
2	239	77	66
1	237	76	67
1	236	76	68
2	235	76	69
10	233	75	70
2	223	72	71
4	221	71	72
4	217	70	73
3	213	68	74
13	210	68	75
2	197	63	77
4	195	63	78
5	191	61	79
20	186	60	80
7	166	53	81
4	159	51	82
1	155	50	83
13	154	50	85
5	141	45	86
2	136	44	87
2	134	43	88
3	132	42	89
28	129	41	90
6	101	32	91
8	95	31	92
2	87	28	93
8	85	27	95
4	77	25	96
17	73	23	97
32	56	18	98
24	24	8	99

* 25 Meters Dead

42 Meters registered less than 65%. Average registration for this group was 39.79%

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400,000 CU. FT. USAGE STUDY GROUP - 1995
2 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
2	311	100	*
24	309	99	95
1	285	92	95.5
4	284	91	96
3	280	90	96.5
4	277	89	97
2	273	88	97.3
10	271	87	97.5
2	261	84	97.7
1	259	83	97.8
17	258	83	98
1	241	77	98.2
4	240	77	98.3
1	236	76	98.4
4	235	76	98.5
2	231	74	98.7
3	229	74	98.8
28	226	73	99
5	198	64	99.2
2	193	62	99.3
2	191	61	99.4
9	189	61	99.5
3	180	58	99.7
3	177	57	99.8
77	174	56	100
1	97	31	100.1
9	96	31	100.2
7	87	28	100.3
2	80	26	100.4
7	78	25	100.5
2	71	23	100.6
3	69	22	100.7
4	66	21	100.8
1	62	20	100.9
20	61	20	101
2	41	13	101.1
1	39	13	101.2
4	38	12	101.3
2	34	11	101.4
9	32	10	101.5
1	23	7	101.6
1	22	7	101.7

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400,000 CU. FT. USAGE STUDY GROUP - 1995 CONT.
2 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
14	21	7	102
3	7	2	102.2
2	4	1	102.5
1	2	1	102.7
1	1	.3	104

* 2 Meters Dead

74 Meters registered less than 98.5%. Average registration for this group was 96.70%

71

500,000 CU. FT. USAGE STUDY GROUP
1/8 G.P.M. TEST

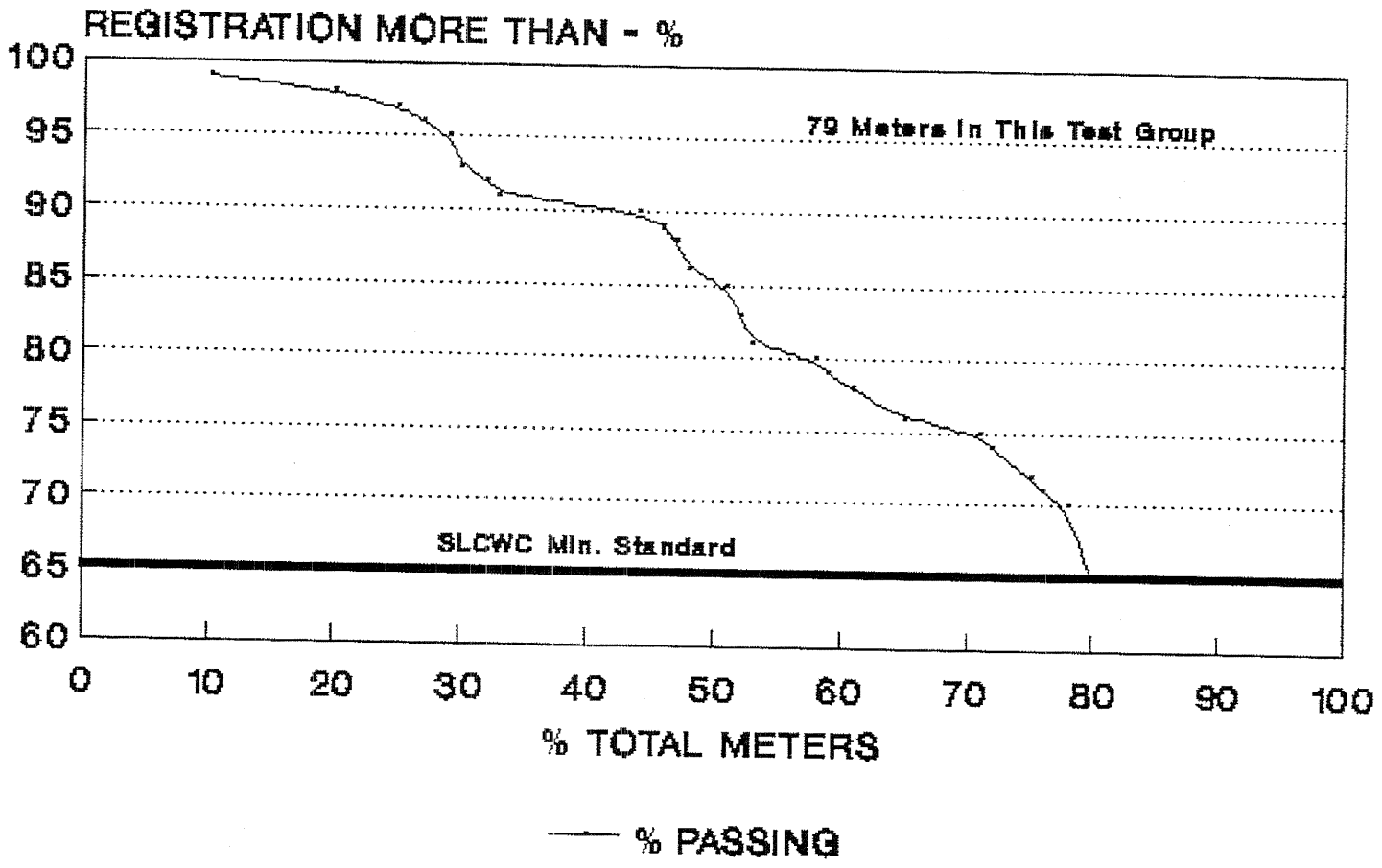

CHART 37 - SEPTEMBER 1995

500,000 CU. FT. USAGE STUDY GROUP
2 G.P.M. TEST

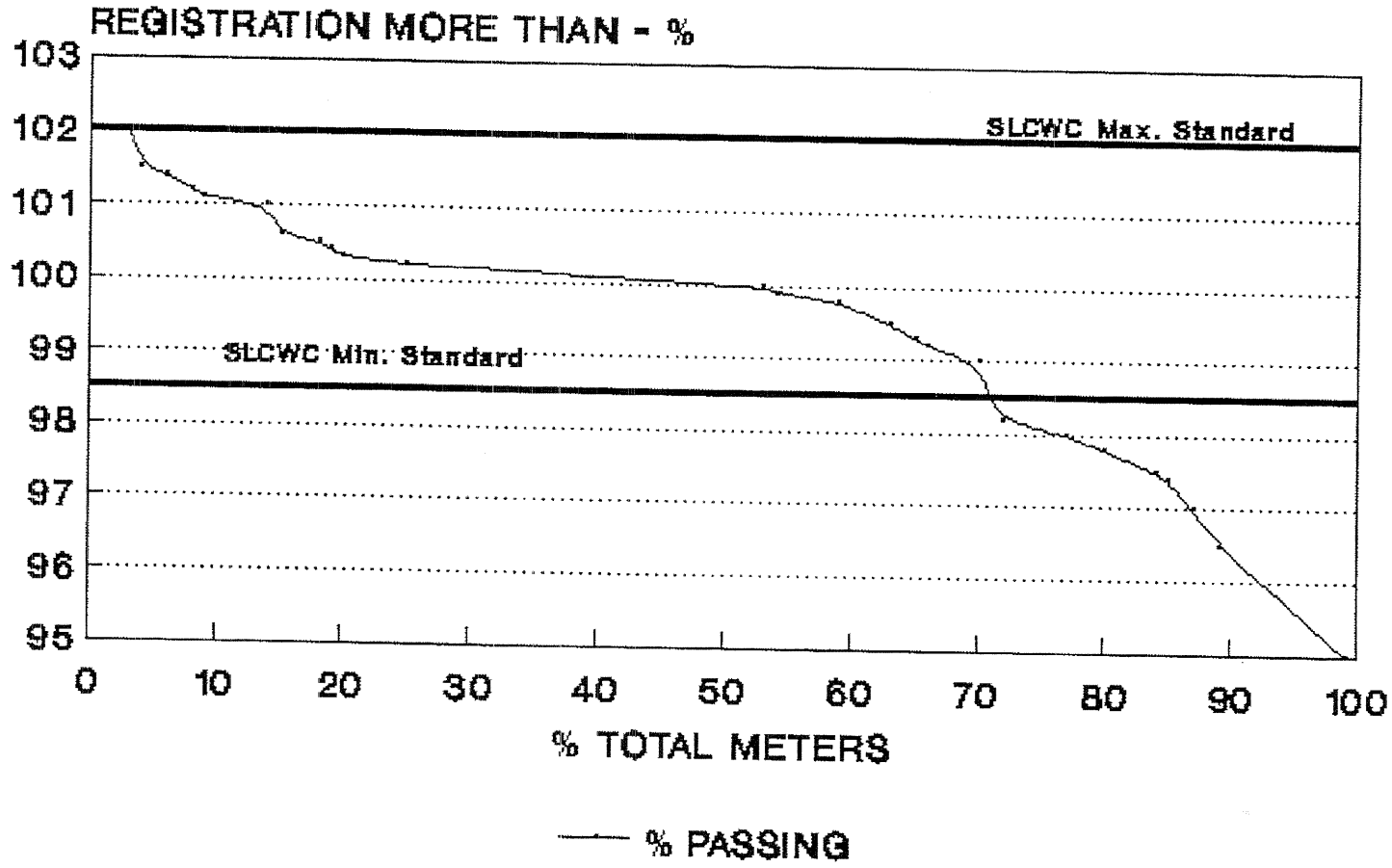

CHART 38 - SEPTEMBER 1995

500,000 CU. FT. USAGE STUDY GROUP - 1995
1/8 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
16	79	100	*
1	63	80	65
2	62	78	70
1	60	76	71
2	59	75	72
1	57	72	74
5	56	71	75
3	51	65	76
1	48	61	78
1	47	59	79
4	46	58	80
1	42	53	81
1	41	52	83
2	40	51	85
1	38	48	86
1	37	47	88
1	36	46	89
9	35	44	90
1	26	33	91
1	25	32	92
1	24	30	93
2	23	29	95
1	21	27	96
4	20	25	97
8	16	20	98
8	8	10	99

* 4 Meters Dead

12 Meters registered less than 65%. Average registration for this group was 43.92%

74

500,000 CU. FT. USAGE STUDY GROUP - 1995
2 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
1	79	100	89
8	78	99	95
1	70	89	96.5
2	69	87	97
1	67	85	97.4
3	66	84	97.5
2	63	80	97.8
4	61	77	98
1	57	72	98.2
1	56	71	98.5
3	55	70	99
1	52	66	99.2
1	51	65	99.3
3	50	63	99.5
4	47	59	99.8
1	43	54	99.9
22	42	53	100
4	20	25	100.2
1	16	20	100.3
1	15	19	100.4
2	14	18	100.5
1	12	15	100.6
4	11	14	101
1	7	9	101.1
1	6	8	101.2
2	5	6	101.4
1	3	4	101.5
2	2	3	102

* 0 Meters Dead

23 Meters registered less than 98.5%. Average registration for this group was 96.31%

75

600,000 CU. FT. USAGE STUDY GROUP
1/8 G.P.M. TEST

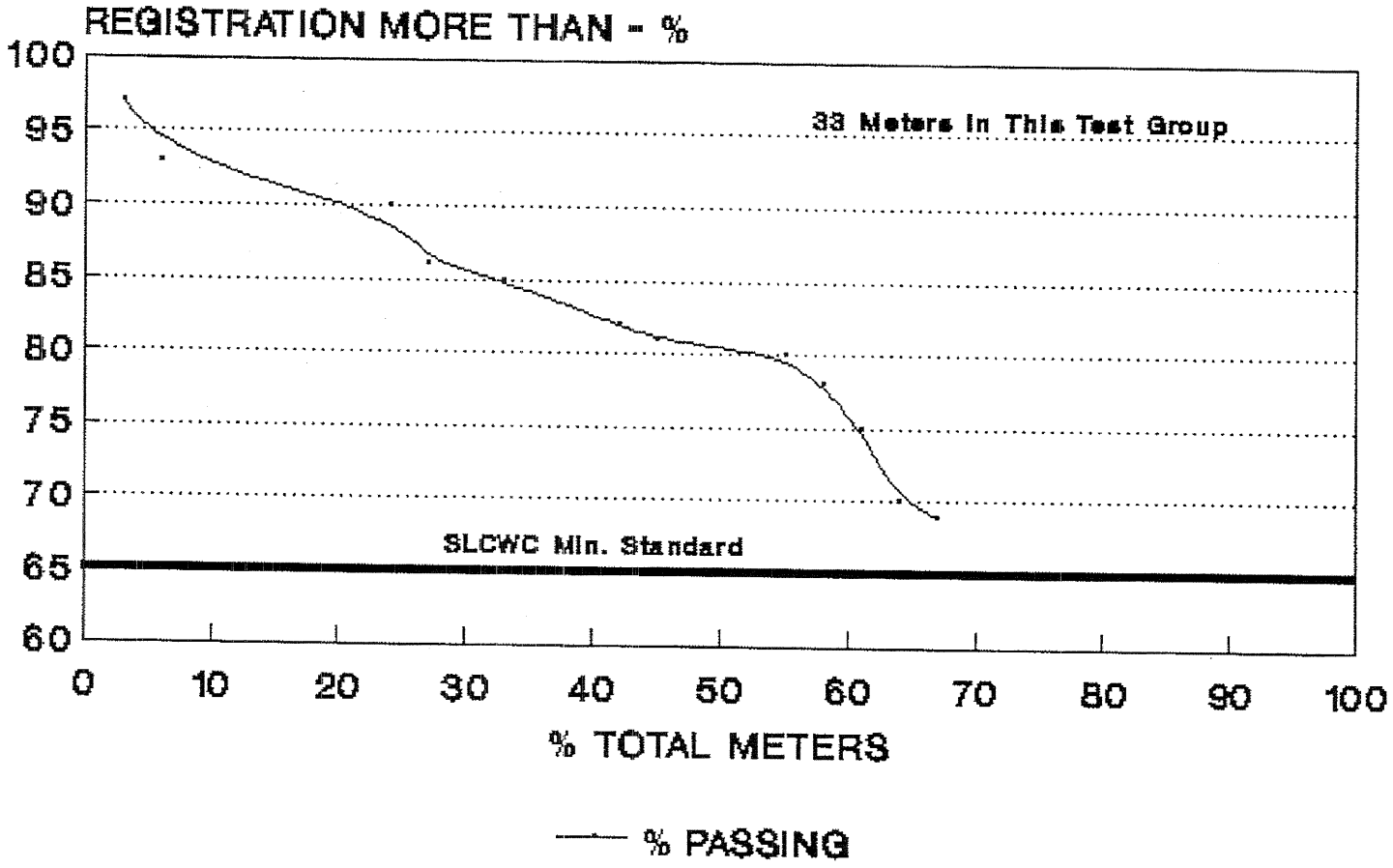

CHART 39 - SEPTEMBER 1995

600,000 CU. FT. USAGE STUDY GROUP
2 G.P.M. TEST

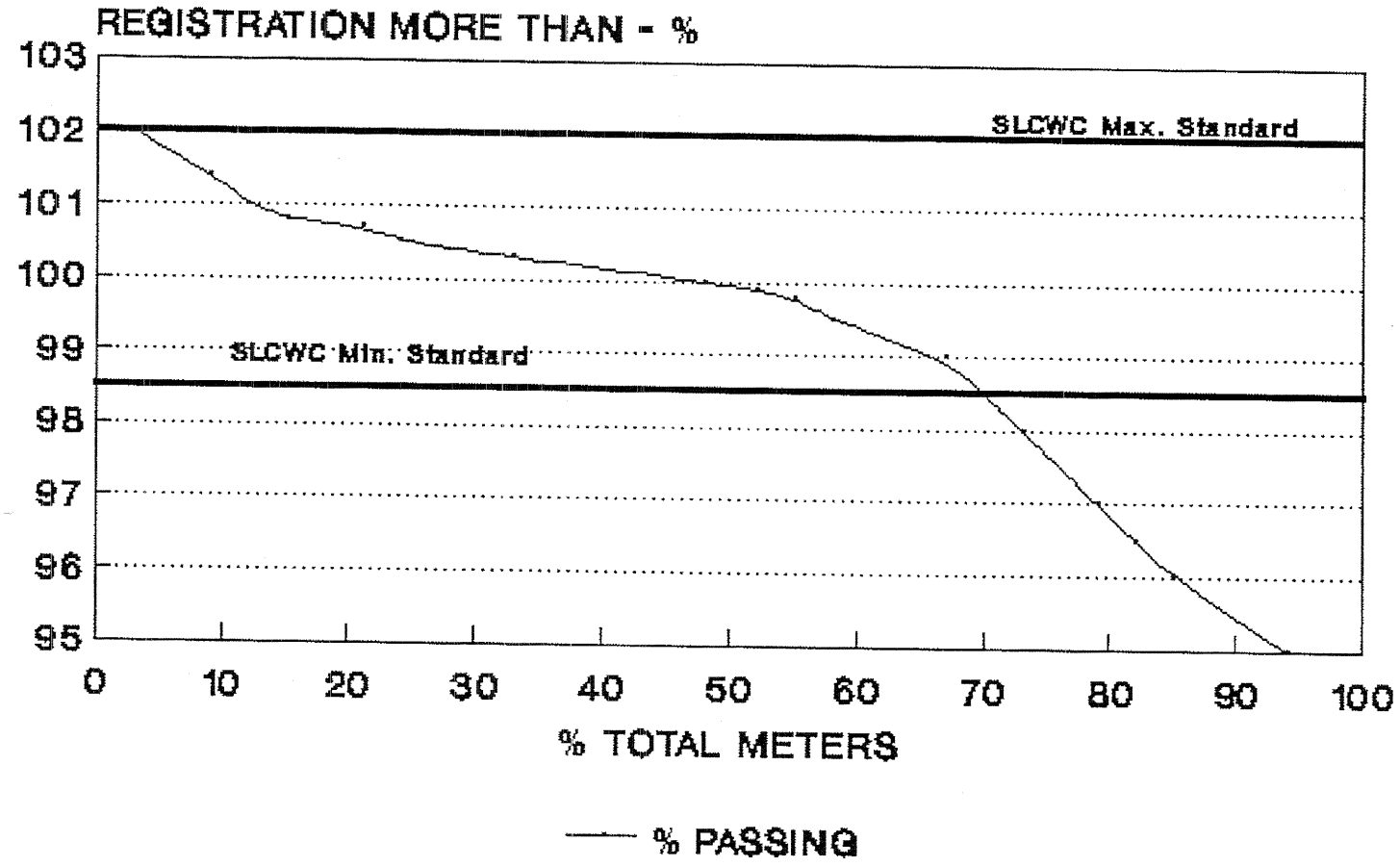

CHART 40 - SEPTEMBER 1995

77

600,000 CU. FT. USAGE STUDY GROUP - 1995
1/8 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
11	33	100	*
1	22	67	69
1	21	64	70
1	20	61	75
1	19	58	78
3	18	55	80
1	15	45	81
3	14	42	82
2	11	33	85
1	9	27	86
6	8	24	90
1	2	6	93
1	1	3	97

* 0 Meters Dead

11 Meters registered less than 65%. Average registration for this group was 35.91%

78

600,000 CU. FT. USAGE STUDY GROUP - 1995
2 GPM FLOW

Number of Meters	Cumulative No. Meters	Summation of Total Tested - %	% Reg. More Than
1	33	100	10
1	32	97	90
3	31	94	95
1	28	85	96
1	27	82	96.5
2	26	79	97
1	24	73	98
1	23	70	98.5
3	22	67	99
1	19	58	99.5
1	18	55	99.8
1	17	52	99.9
5	16	48	100
3	11	33	100.3
1	8	24	100.5
2	7	21	100.7
1	5	15	100.8
1	4	12	101
2	3	9	101.4
1	1	3	102

* 0 Meters Dead

10 Meters registered less than 98.5%. Average registration for this group was 86.95%

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APPENDIX A

COLLECTION OF DATA:

The data for this study was collected from our Data Processing Department. They were instructed to randomly pull from 10 year changes various meters that met both the years in service and usage parameters set forth for this meter study. The data was recorded in the following way.

1. Meter Number
2. Year of Last Overhaul
3. Mileage on Meter
4. Test Performance at 1/8 GPM & 2 GPM

There was no effort made in any way to control the number of meters used in this study. The sampling of meters selected was random and unbiased.

Listed below is the number of meters used in this study, first by years in service and second by total mileage recorded on the meter.

Service Years	15	16	17	18	19	20	Total
No. of Meters	946	999	999	817	747	496	5004

Mileage (M Cu. Ft.)	100	200	300	400	500	600	
No. of Meters	2047	1756	778	311	79	33	5004

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Test Standard:

St. Louis County Water Company uses the following standard to allow incoming meters to be returned to service:

Accuracy must be between 98.5% - 102% @ 2 GPM

Accuracy must be over 65% @ 1/8 GPM*

*Normal industry standard for sensitivity testing is 1/4 GPM

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APPENDIX B

HISTORICAL RECORD

SYSTEM GROWTH - VERSUS METER CHANGES

(All Meter Sizes)

Year	No. Meters In Service As of Jan. 1	Meter Growth During Year	Changes Made During Year
1972	223,131	4,919	2,206
1973	228,052	4,589	4,286
1974	232,641	3,005	8,566
1975	235,646	2,906	7,913
1976	238,552	4,644	8,680
1977	243,196	4,778	6,617
1978	247,974	4,841	6,762
1979	252,815	4,149	9,567
1980	256,964	1,915	14,575
1981	258,879	1,772	16,099
1982	260,651	1,234	14,463
1983	261,885	2,569	11,184
1984	264,454	2,921	7,237
1985	267,375	3,115	5,651
1986	270,490	3,866	7,912
1987	274,356	4,431	6,617
1988	278,787	4,450	8,760
1989	283,237	2,506	11,680
1990	285,743	3,412	17,853
1991	289,155	1,666	15,287

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APPENDIX B CONT.

HISTORICAL RECORD

SYSTEM GROWTH - VERSUS METER CHANGES

(All Meter Sizes)

Year	No. Meters In Service As of Jan. 1	Meter Growth During Year	Changes Made During Year
1992	290,821	2,632	17,884
1993	293,453	2,882	16,611
1994	296,335	3,361	17,471
1995	299,696	1,875*	13,309*

* Data Thru September 1, 1995

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