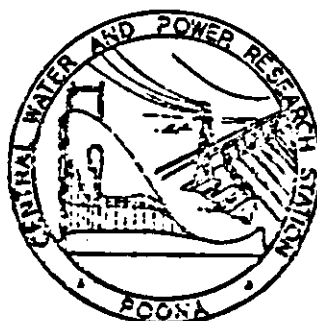


EFFECT OF TEMPERATURE AND BOUNDARY ON CURRENTMETER RATINGS

by
M G Hiranandani
and
P C Saxena



Technical Memorandum HLO :
September 1960

GOVERNMENT OF INDIA
CENTRAL WATER AND POWER RESEARCH STATION
Poona, India

*Central Water and Power Research Station
Poona, India*

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**EFFECT OF TEMPERATURE AND BOUNDARY ON
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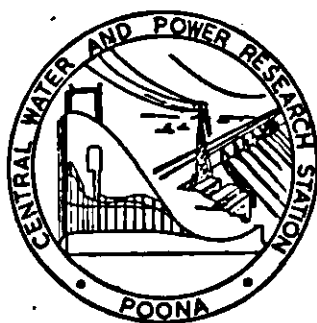
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PREFACE

The present investigation for evaluating the effects of varying immersion positions of the currentmeter for its rating runs under water and of varying temperatures was initiated for the purpose of laying down standards for currentmeter calibrations and observations in the field.

The investigation has brought to light that currentmeter calibrations, for the range of temperatures tested, remain unaffected by normal temperature changes.

In regard to boundary effect, currentmeter observations in the field as well as calibrations in the rating tank will be subject to an error of less than 0.6% provided velocities are observed at a minimum distance of 12 inches at the sides as well as at the bottom.

The collaboration of Sarvashri C V Gole, Dy Director, G M Panchang, S V Chitale and P K Kulkarni, Chief Research Officers is gratefully acknowledged.

APPENDIX I

Revolutions (R) / sec and velocity (V) ft/sec observed for experimental calibration runs
of Watts type currentmeter No 91891

Distance from side wall (inches)	DISTANCE FROM BOTTOM (INCHES)															
	6				12				66				72			
	REPLICATE															
	1		2		1		2		1		2		1		2	
	R	V	R	V	R	V	R	V	R	V	R	V	R	V	R	V
5	.44	.99	.50	1.00	.43	.98	0.46	1.01	.70	1.54	.44	.95	.46	1.01	.43	.98
	.66	1.47	.69	1.50	.64	1.47	0.69	1.51	.88	1.93	.68	1.49	.69	1.52	.69	1.47
	.85	1.93	.76	1.66	.86	1.95	0.82	1.79	.91	1.99	.76	1.61	.89	1.91	.87	1.81
	1.03	2.33	1.02	2.22	1.12	2.52	1.01	2.18	1.05	2.27	.96	2.10	1.10	2.38	1.03	2.24
	1.35	3.06	1.28	2.74	1.33	3.02	1.41	3.03	1.28	2.74	1.26	2.65	1.35	2.89	1.35	2.90
	1.50	3.61	1.45	3.94	1.80	4.07	1.86	3.98	1.78	3.87	1.71	3.69	1.77	3.83	1.64	3.59
	2.07	4.71	2.16	4.70	2.07	4.67	2.34	5.01	2.19	4.67	2.17	4.66	2.24	4.83	2.12	4.54
	2.43	5.60	2.60	5.86	2.62	6.00	2.73	5.93	2.77	5.96	2.62	5.66	2.77	6.00	2.66	5.76
	3.01	6.73	3.16	7.26	2.97	6.76	3.34	7.24	3.16	6.83	3.11	6.78	3.17	6.91	3.14	6.84
	3.53	7.95	3.71	8.21	3.64	8.23	3.90	8.44	3.68	7.96	3.56	7.74	3.70	8.08	3.66	7.92
12	.47	1.01	.46	1.02	.48	1.01	.44	.97	.43	.97	.43	1.02	.46	1.01	.40	1.03
	.67	1.50	.68	1.53	.69	1.51	.66	1.48	.68	1.52	.67	1.52	.68	1.49	.66	1.53
	.78	1.64	.81	1.74	.96	2.05	.83	1.77	.82	1.81	.81	1.76	.84	1.82	.87	1.87
	1.02	2.21	1.08	2.40	1.06	2.30	.98	2.15	1.03	2.28	1.13	2.44	1.11	2.40	1.06	2.49
	1.32	2.80	1.26	2.72	1.38	2.91	1.20	2.57	1.30	2.82	1.50	3.17	1.33	2.86	1.36	2.91
	1.63	3.54	1.63	3.63	1.65	3.64	1.74	3.81	1.66	3.68	1.73	3.74	1.70	3.67	1.76	3.83
	2.02	4.52	2.11	4.66	2.25	4.83	2.13	4.63	2.14	4.73	2.36	5.11	2.25	4.90	2.26	4.95
	2.70	5.96	2.53	5.76	2.61	5.86	2.55	5.76	2.67	5.92	2.87	6.18	2.72	5.91	2.77	6.10
	3.05	6.64	3.10	6.93	3.03	6.67	3.02	6.75	3.24	7.14	3.31	7.17	3.30	7.18	3.20	7.02
	3.56	7.76	3.57	7.99	3.51	7.78	3.48	7.67	3.62	8.04	3.85	8.35	3.80	8.26	3.75	8.23
18	.47	1.04	.45	1.00	.45	1.01	.46	1.02	.46	1.07	.46	1.00	.47	1.02	.45	.99
	.69	1.53	.68	1.49	.68	1.52	.68	1.52	.69	1.51	.69	1.50	.71	1.53	.68	1.48
	.83	1.79	.87	1.87	.83	1.84	.85	1.87	.90	1.94	.89	1.92	.95	2.05	.96	2.08
	1.01	2.20	1.12	2.44	1.00	2.21	.94	2.09	1.00	2.13	1.08	2.32	1.11	2.39	1.06	2.28
	1.17	2.53	1.33	2.89	1.19	2.60	1.44	3.15	1.13	2.42	1.13	2.44	1.29	2.71	1.49	3.27
	1.68	3.70	1.83	3.99	1.66	3.80	1.89	3.91	1.27	2.76	1.68	3.64	1.88	4.09	1.69	3.66
	2.21	4.85	2.18	4.76	2.03	4.52	2.20	4.83	1.89	4.10	2.12	4.76	2.27	4.93	2.26	4.90
	2.51	5.50	2.61	5.74	2.51	5.57	2.58	5.75	2.28	4.91	2.69	5.85	2.77	6.03	2.51	5.58
	3.03	6.66	3.16	6.86	3.02	6.76	3.18	7.04	2.95	6.41	3.19	6.92	3.22	6.97	3.21	7.09
	3.45	7.65	3.77	8.20	3.56	7.99	3.57	7.90	3.47	7.52	3.66	7.99	3.78	8.22	3.41	7.51
24	.46	1.02	0.41	1.01	.46	1.02	.41	1.03	.45	1.00	.45	1.00	.44	.98	.45	.99
	.69	1.52	.68	1.53	.70	1.52	.67	1.51	.68	1.49	.69	1.52	.67	1.47	.69	1.51
	.81	1.76	.94	2.02	.77	1.70	.83	1.84	.90	1.96	.73	1.54	.81	1.78	.81	1.73
	1.05	2.26	.99	2.16	1.06	2.29	1.07	2.30	1.08	2.35	.94	2.04	1.05	2.28	1.04	2.29
	1.26	2.75	1.44	3.10	1.20	2.43	1.25	2.68	1.37	2.98	1.17	2.50	1.18	2.65	1.18	2.36
	1.71	3.70	1.69	3.68	1.57	3.42	1.75	3.78	1.82	4.04	1.59	3.47	1.65	3.58	1.74	3.77
	2.12	4.72	2.34	5.19	2.08	4.55	2.17	4.71	2.27	4.88	2.18	4.71	2.17	4.71	2.18	4.72
	2.60	5.76	2.80	6.16	2.65	5.86	2.62	5.78	2.66	5.83	2.60	5.68	2.63	5.71	2.63	5.71
	3.17	6.92	3.24	7.02	3.06	6.72	3.25	7.04	3.21	7.01	3.02	6.60	3.16	6.88	3.18	6.95
	3.67	7.87	3.72	8.02	3.68	7.97	3.69	7.98	3.79	8.25	3.49	7.65	3.61	7.85	3.66	8.03
72	.44	1.00	.46	1.01	.45	.99	.46	.99	.45	.97	.34	.76	.46	1.00	.46	.99
	.67	1.49	.69	1.52	.67	1.48	.69	1.49	.70	1.50	.55	1.20	.70	1.51	.70	1.49
	.70	1.56	.92	2.01	.77	1.62	.91	1.93	.91	1.93	.91	1.97	.92	1.96	.79	1.70
	1.03	2.28	.94	2.07	1.06	2.31	1.17	2.51	1.16	2.51	1.10	2.40	1.00	2.16	1.08	2.32
	1.19	2.61	1.27	2.73	1.28	2.59	1.20	2.74	1.37	2.93	1.33	2.92	1.16	2.46	1.16	2.49
	1.59	3.50	1.59	3.67	1.77	3.85	1.69	3.84	1.78	3.83	1.71	3.73	1.73	3.73	1.70	3.64
	2.08	4.55	2.12	4.78	2.13	4.63	2.20	4.75	2.31	4.94	2.29	5.04	2.47	5.26	2.28	4.92
	2.50	5.61	2.47	5.61	2.47	5.51	2.57	5.82	2.90	6.24	2.58	5.69	2.64	5.64	2.77	5.99
	3.00	6.65	3.63	7.93	2.98	6.70	3.13	6.74	2.36	7.29	3.27	7.22	3.19	6.87	3.25	7.00
	3.63	7.93	3.06	6.96	3.61	7.89	3.72	8.02	3.91	8.34	3.71	8.20	3.82	8.19	3.71	7.98

APPENDIX II

Revolution (R)/ sec and velocity (V) ft/sec observed for experimental calibration runs of Watts type currentmeter No. 91891 at different depths along central vertical

Distance from bottom (Inches)	REPLICATE											
	1		2		3		4		5		6	
	R	V	R	V	R	V	R	V	R	V	R	V
6	.44	1.00	.44	1.01	.45	.98	.47	.99	.46	1.01	.45	1.00
	.67	1.49	.82	1.82	.68	1.47	.69	1.50	.69	1.53	.65	1.49
	.70	1.56	1.17	2.57	.86	1.85	.97	2.04	.86	1.85	.92	1.97
	1.03	2.28	1.67	3.66	1.10	2.35	1.21	2.57	1.05	2.28	1.06	2.29
	1.19	2.61	2.12	4.71	1.37	2.94	1.48	3.17	1.26	2.68	1.35	2.95
	1.59	3.50	2.62	5.84	1.63	3.59	1.91	4.12	1.81	3.93	1.85	4.02
	2.08	4.55	3.22	7.10	2.20	4.87	2.17	4.78	2.15	4.72	2.16	4.76
	2.50	5.61	3.48	7.63	2.53	5.72	2.62	5.88	2.53	5.64	2.57	5.64
	3.00	6.65			3.10	6.73	3.15	6.91	3.06	6.68	3.11	6.78
	3.63	7.93			3.67	7.87	3.82	8.25	3.57	7.75	3.64	7.91
12	.45	.99	.46	.99	.36	.78	.44	.99	.45	1.00	.46	1.00
	.67	1.48	.69	1.49	.79	1.72	.77	1.73	1.14	2.50	.75	1.65
	.77	1.62	.91	1.93	1.24	2.67	1.18	2.63	1.23	2.70	1.27	2.77
	1.06	2.31	1.17	2.51	1.48	3.19	1.60	3.53	1.71	3.64	1.68	3.65
	1.28	2.59	1.20	2.74	2.14	4.59	2.07	4.53	2.15	4.55	2.13	4.62
	1.77	3.85	1.69	3.84	2.75	5.93	2.61	5.75	2.63	5.80	2.67	5.80
	2.13	4.63	2.20	4.75	3.15	6.80	3.20	6.97	3.02	6.65	2.85	6.18
	2.47	5.51	2.57	5.82	3.76	8.10	3.60	7.82	3.56	7.77	3.43	7.44
	2.98	6.70	3.13	6.74								
	3.61	7.89	3.72	8.02								
18	.45	.98	.44	.99	.44	.95	.44	.97	.44	.98	.45	1.01
	.80	1.71	.67	1.48	.86	1.84	.79	1.72	.79	1.73	.78	1.72
	1.21	2.62	.72	1.58	1.29	2.75	1.30	2.81	1.28	2.76	1.23	2.68
	1.59	3.41	1.08	2.40	1.65	3.52	1.53	3.31	1.76	3.79	1.60	3.47
	2.24	4.83	1.24	2.69	2.26	4.82	2.17	4.67	2.08	4.52	2.20	4.78
	2.61	5.62	1.68	3.65	2.61	5.66	2.67	5.83	2.81	6.08	2.63	5.77
	3.06	6.61	2.00	4.60	3.24	6.94	3.19	6.89	3.20	6.96	3.15	6.91
	3.55	7.66	2.59	5.66	3.67	7.91	3.54	7.62	3.98	8.72	3.94	8.56
			2.98	6.59								
			3.61	7.82								
24	.45	.97	.42	.98	.44	.96	.46	.99	.45	.97	.45	.99
	.80	1.73	.87	1.97	.83	1.80	.86	1.92	.85	1.86	.77	1.67
	1.24	2.66	1.25	2.67	1.20	2.62	1.24	2.70	1.19	2.59	1.17	2.57
	1.71	3.68	1.70	3.67	1.78	3.83	1.73	3.75	1.54	3.34	1.80	3.90
	2.17	4.70	2.13	4.60	2.25	4.87	2.18	4.71	2.17	4.72	2.20	4.77
	2.75	5.93	2.71	5.91	2.60	5.62	2.76	5.98	2.43	5.25	2.54	5.51
	3.07	6.76	3.00	6.55	3.29	7.10	3.04	6.67	2.94	6.47	2.89	6.28
	3.66	7.91	3.65	7.91	3.76	8.16	3.72	8.06	3.80	8.20	3.64	7.85
30	.46	1.01	.46	1.02	.45	1.00	.44	.99	.44	.99	.45	1.00
	.67	1.46	.71	1.54	.90	1.98	.79	1.73	.76	1.70	.89	1.99
	1.04	2.24	1.01	2.19	1.23	2.68	1.08	2.35	1.13	2.48	1.22	2.64
	1.14	2.46	1.15	2.48	1.82	3.94	1.62	3.50	1.76	3.87	1.76	3.83
	1.30	2.84	1.29	2.89	2.19	4.75	2.06	4.47	2.07	4.52	2.19	4.75
	1.73	3.76	1.71	3.81	2.79	6.07	2.78	5.99	2.68	5.83	2.78	6.05
	2.30	5.04	2.31	4.99	3.24	7.13	3.31	7.15	3.13	6.82	3.19	6.91
	2.71	6.06	2.65	5.81	3.77	8.24	4.01	8.66	3.83	8.30	3.60	7.76
	3.13	6.83	3.27	7.14								
	3.77	8.25	3.61	7.90								

Height above bottom (Inches)	REPLICATE											
	1		2		3		4		5		6	
	R	V	R	V	R	V	R	V	R	V	R	V
42	.31 .49 .81 1.06 1.20 1.59 2.73 3.14 3.68	.69 1.08 1.78 2.31 2.61 3.49 5.86 6.78 7.93	.38 .59 .83 1.50 1.70 1.63 2.22 2.57 3.14 3.69	.81 1.28 1.80 3.21 3.64 3.49 4.79 5.51 6.77 7.93	.49 .68 .85 1.09 1.31 1.63 2.21 2.72 3.18 3.71	1.04 1.47 1.80 2.34 2.79 3.51 4.71 5.82 6.83 8.00	.34 .52 .76 1.00 1.25 1.59 2.11 2.54 3.01 3.56	.76 1.16 1.69 2.21 2.76 3.52 4.68 5.67 6.70 7.94	.36 .35 .61 .86 1.03 1.22 1.60 2.07 2.58 3.07	.81 .78 1.34 1.89 2.26 2.69 3.53 4.66 5.74 6.83	.51 .64 .95 1.10 1.25 1.91 2.16 2.76 3.16 3.69	1.09 1.37 2.01 2.37 2.66 4.13 4.63 5.96 6.78 7.95
48	.32 .80 .99 1.22 1.66 2.22 2.59 3.11 3.66	.71 1.72 2.16 2.62 3.57 4.77 5.59 6.71 7.89	.37 .59 .88 1.00 1.31 1.76 2.22 2.70 3.21 3.69	.80 1.30 1.88 2.18 2.81 3.80 4.76 5.83 6.91 6.96	.39 .56 .78 1.04 1.24 1.66 2.16 2.69 3.10 3.60	.87 1.24 1.72 2.26 2.68 3.59 4.70 5.65 6.71 7.78	.37 .58 .81 1.06 1.27 2.22 2.69 3.19 1.69 3.73	.85 1.27 1.74 2.28 2.76 4.84 5.81 6.92 3.66 8.08	.37 .56 .79 1.02 1.27 1.63 2.22 2.62 3.11 3.59	.83 1.23 1.74 2.23 2.77 3.55 4.87 5.79 6.89 7.98	.39 .63 .82 1.08 1.27 1.71 2.12 2.73 3.27 3.75	.85 1.36 1.76 2.33 2.73 3.71 4.57 5.91 7.04 8.08
60	.37 .65 .81 1.16 1.25 1.80 2.20 2.85 3.23 3.76	.84 1.43 1.77 2.56 2.76 4.04 4.81 6.28 7.08 8.19	.36 .62 .90 1.12 1.30 1.69 2.17 2.59 3.12 3.76	.81 1.36 1.95 2.42 2.79 3.65 4.71 5.67 6.79 8.22	.35 .56 .94 1.17 1.38 1.80 2.28 2.74 3.17 3.69	.81 1.23 1.98 2.49 2.92 3.92 4.98 5.97 6.90 8.07	.29 .59 .92 1.17 1.40 1.90 2.21 2.89 3.23 3.68	.65 1.31 1.97 2.50 2.97 4.13 4.80 6.31 7.02 8.02	.37 .64 .94 1.15 1.43 1.70 2.22 2.80 3.08 3.73	.81 1.39 2.04 2.43 3.10 3.64 4.82 6.12 6.70 8.16	.38 .64 .87 1.13 1.33 1.90 2.21 2.79 3.30 3.71	.82 1.38 1.83 2.42 2.80 4.12 4.72 6.00 7.09 8.01
66	.45 .70 .91 1.16 1.37 1.78 2.31 2.90 3.36 3.91	.97 1.50 1.93 2.51 2.93 3.83 4.94 6.24 7.29 8.34	.34 .55 .90 1.10 1.33 1.71 2.29 2.58 3.27 3.71	.76 1.20 1.97 2.40 2.92 3.73 5.04 5.69 7.22 8.20	.47 .67 .88 1.06 1.33 1.72 2.27 2.65 3.12 3.61	1.01 1.48 1.85 2.61 2.87 3.78 4.98 5.83 6.94 7.98	.45 .80 1.16 1.58 2.12 2.72 3.04 3.78	.98 1.73 2.54 3.44 4.64 5.94 6.65 8.27	.48 .68 .89 1.05 1.37 1.76 2.18 2.85 3.18 3.62	1.02 1.51 1.90 2.33 2.93 3.69 4.79 6.29 6.76 7.97	.45 .67 .79 1.17 1.32 1.73 2.08 2.76 3.05 3.60	1.00 1.49 1.73 2.54 2.85 3.80 4.52 6.06 6.70 7.94
72	.46 .70 .92 1.00 1.16 1.73 2.47 2.63 3.19 3.82	1.00 1.51 1.96 2.16 2.46 3.73 5.26 5.60 6.87 8.19	.46 .70 .79 1.08 1.16 1.70 2.28 2.77 3.25 3.71	.99 1.49 1.70 2.32 2.49 3.64 4.92 5.99 7.00 7.98	.44 .81 1.12 1.61 2.18 2.59 2.90 3.72	1.04 1.77 2.44 3.50 4.76 5.65 6.32 8.08	.45 .89 1.24 1.62 2.00 2.56 3.13 3.58	1.00 1.91 2.70 3.53 4.37 5.60 6.85 7.82	.46 .81 1.34 1.72 2.23 2.73 3.14 3.73	.98 1.76 2.88 3.69 4.82 5.91 6.81 8.03	.44 .72 1.17 1.68 2.23 2.72 3.01 3.68	.97 1.56 2.51 3.69 4.87 5.92 6.58 8.00

India, Central Water and Power Research Station, Poona
EFFECT OF TEMPERATURE AND BOUNDARY ON
CURRENTMETER RATINGS by M G Hiranandani and
P C Saxena, September 1960, pp 14+xiii-illus-tables (Technical
Memorandum HLO 1)

Experimental ratings were made of currentmeters
i at regulated temperature conditions in a small circular
tank, and
ii at different positions along cross-section of Ship Model
Towing tank.

The differences between velocities for different temperatures
from 5-40°C were estimated to have standard deviation not
exceeding $\pm 1\%$.

Currentmeter observations in the field as well as calibration in the
rating tank will be subject to negligible boundary effect (which
will be less than 0.6%) provided the velocities are observed at a
distance of not less than 12 inches from the sides as well as bottom.
An error up to 1.2% may be expected if velocity observations are
taken six inches above the bottom and 5 inches from the side.

- 1 Currentmeter ratings
- 2 Temperature Effect, on
- 3 Boundary Effect, on

- I M G Hiranandani
- II P C Saxena
- III CWPRS Technical Memorandum HLO 1

India, Central Water and Power Research Station, Poona
EFFECT OF TEMPERATURE AND BOUNDARY ON
CURRENTMETER RATINGS by M G Hiranandani and
P C Saxena, September 1960, pp 14+xiii-illus-tables (Technical
Memorandum HLO 1)

Experimental ratings were made of currentmeters
i at regulated temperature conditions in a small circular
tank, and
ii at different positions along cross-section of Ship Model
Towing tank.

The differences between velocities for different temperatures
from 5-40°C were estimated to have standard deviation not
exceeding $\pm 1\%$.

Currentmeter observations in the field as well as calibration in the
rating tank will be subject to negligible boundary effect (which
will be less than 0.6%) provided the velocities are observed at a
distance of not less than 12 inches from the sides as well as bottom.
An error up to 1.2% may be expected if velocity observations are
taken six inches above the bottom and 5 inches from the side.

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CWPRS TECHNICAL MEMORANDUMS

SUBJECT CLASSIFICATION

Subject	Symbol
Water studies & Hydrology	HLO
Rainfall & Runoff	
Regeneration & Losses	
Quantity of Water	
Fluid Mechanics	FLM
Design of Hydraulic Structures	HYD
River Training & Flood Control	HYR
Irrigation, Drainage & Reclamation	IRD
Surface & subsurface irrigation	
Water requirements of crops	
Soil survey and crop pattern	
Drainage	
Reclamation	
Navigation	NAV
Ports, Harbours & Estuaries	
Inland Navigation	
Coastal Erosion	
Ships & Navigation Crafts	
Structural Design	STD
Soil Mechanics & Foundation Engineering	SFE
Investigations	
Stability, deformations & displacements of earth structures	
Foundation studies including geophysical	
Construction Materials & Practices	CMP
Concrete Technology	
Building & other Materials	
Instrumentation	IST
Model and Prototype comparisons	MPC
Other miscellaneous	MIS

Printed by S. B. Kulkarni, I. A. S., Municipal Commissioner, Poona Municipal Corporation, at the
Poona Municipal Press, Ghole Road, Poona 5.

Published by M. G. Hiranandani, Director, Central Water and Power Research Station, Poona 3.