NASA CONTRACTOR REPORT

NASA CR-61357

MASS-ENERGY BALANCE FOR AN S-IC ROCKET EXHAUST CLOUD DURING STATIC FIRING

By Michael R. Smith and Richard E. Forbes

Institute of Environmental Sciences
Mississippi State University
State College, Mississippi 39726

August 4, 1971

Prepared for

NASA-GEORGE C. MARSHALL SPACE FLIGHT CENTER
Marshall Space Flight Center, Alabama 35812

TECHNICAL REPORT STANDARD TITLE PAGE

1. REPORT NO. NASA CR-61357	2. GOVERNMENT ACCESSION NO.	3. RECIPIENT'S CATALOG NO.
4. TITLE AND SUBTITLE MASS-ENERGY BALANCE FOR AN S-IC ROCKET EXHAUST CLOUD DURING STATIC FIRING		5. REPORT DATE August 4, 1971
		6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Michael R. Smith and Richard E. Forbes		8. PERFORMING ORGANIZATION REPORT # IES-70-10-1
9. PERFORMING ORGANIZATION NAME AND ADDRESS Institute of Environmental Sciences, Mississippi State University, State College, Mississippi 39762		10. WORK UNIT NO.
		11. CONTRACT OR GRANT NO. Grant No. NGL 25-001-32
12. SPONSORING AGENCY NAME AND ADDRESS NASA, Washington, D. C. 20546		13. TYPE OF REPORT & PERIOD COVERED Contractor
		14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES Technical Coordinator: George Fichtl, Aerospace Environment Division, Aero-Astrodynamics Laboratory, Marshall Space Flight Center, Alabama 35812.

16. ABSTRACT

Many factors affect the rise rate, growth, and ultimate geometry of exhaust clouds produced by the static firing of space boosters. The mass, heat, and momentum inputs into the cloud along with the prevailing meteorological conditions significantly affect the cloud formation and dissipation process. An analytical approach to the cloud growth phenomenon must consider the coupled effects of conservation of mass, momentum, and energy, in addition to the equation of state and appropriate initial and boundary conditions.

A mass-energy balance has been determined for the exhaust cloud generated during the static firing of the S-IC rocket engine (first stage of the Apollo V flight system) at the NASA Mississippi Test Facility. Measurements show that approximately 40,300 lb per second of cooling water are evaporated and entrained into the exhaust jet, which possesses a mass flux of 28,680 lb per second. The total energy of the exhaust products was 1.321×10^{10} calories per second; however, after evaporating the cooling water only 0.5293×10^{10} calories per second was available as sensible heat and kinetic energy. The total energy flux of the mixture was 1.765×10^{10} calories per second.

Thus, the available energy flux of the mixture as it was ejected into the atmosphere was about 40% of the total energy flux of the exhaust products and about 30% of the total energy flux of the mixture of the cooling water and the exhaust products.

17. KEY WORDS Cloud Growth Phenomena Meteorological Conditions Mass-Energy Balance Mass-Energy Flux	18. DISTRIBUTION STATEMENT Unclassified - unlimited E. D. Geissler Director, Aero-Astrodynamics Laboratory

19. SECURITY CLASSIF. (of this report)	20. SECURITY CLASSIF. (of this page)	21. NO. OF PAGES	22. PRICE
UNCLASSIFIED	UNCLASSIFIED	27	$3.00

MSFC - Form 3292 (May 1969)

I. INTRODUCTION

Many factors affect the rise rate, growth, and ultimate geometry of exhaust clouds produced by the static firing of space boosters. The mass, heat, and momentum inputs into the cloud along with the prevailing meteorological conditions significantly affect the cloud formation and dissipation process. An analytical approach to the cloud growth phenomena must consider the coupled effects of conservation of mass, momentum, and energy, in addition to the equation of state and appropriate initial and boundary conditions.

Mass inputs into the exhaust cloud include the combustion products, entrainment of mass from the surrounding environment and water vapor introduced into the cloud from evaporation of cooling water in the exhaust deflector. During static firing of the S-IC at NASA's Mississippi Test Facility water is sprayed into the exhaust deflector at the rate of approximately 1.099×10^6 liters per minute. The heat output rate of the S-IC (1.34×10^{10} calories per second) is adequate to completely evaporate this flow rate of water. The water spray and exhaust flame are well mixed in the exhaust deflector leading one to believe that a significant fraction of cooling water may be evaporated into the exhaust cloud during the static firing.

Many empirical relationships used to calculate cloud or plume growth include the heat rate (Q_H) of the source. Q_H for the S-IC exhaust cloud may vary significantly depending on whether one chooses to include or neglect that fraction of the heat output used to evaporated the cooling water.

The evaporation of cooling water will not only affect the heat input to the cloud but the mass input as well. Complete evaporation of the cooling water would provide a mass input to the cloud exceeding the mass input of the combustion products.

The effect of cooling water evaporation on the heat and mass input to the cloud make it mandatory that the water evaporation rate be determined before proceeding with cloud geometry calculations.

II. DETERMINATION OF WATER EVAPORATION RATE

A drawing of the S-IC static test area is shown to scale in Figure 1. The S-IC test stand (Building 4220), is a massive steel and concrete structure designed to restrain the S-IC stage (first booster stage) of the Saturn V vehicle during static test firings. The stand has two test positions, B1 and B2. While this permits mounting and readying two boosters, only one would be fueled and fired at a time.

During the static firings 1.099×10^6 liters of water per minute are required to cool and wash the flame deflector. An alternate capacity of 4.43×10^5 liters per minute of deluge water is provided on the stand itself for fire protection, cooling and washdown. A flume from each test position directs cooling water to a discharge basin for collection and later burning of residual fuel.

The High Pressure Industrial Water, Emergency Power Generating and Heating Complex (building 4400), as its name indicates, serves a threefold purpose implemented by the following facilities: (1) a pumping plant with a maximum capacity of 1.263 x 10^6 liters per minute to supply industrial water for deluge and fire fighting to the test stands, barge docks, and other hazardous areas; (2) a 7,500 KVA power generating plant and switchgear to supply standby power for the test complex; (3) a 1.137 x 10^{10} calories/hr. water heating plant to supply circulating hot water for building and fuel tank heating and for operating absorption refrigerating units. These facilities are located in one main building; a small second floor area contains offices and the control room for the complex.

The high pressure water provided to the test stand is drawn from the circular reservoir (4335) which is approximately 244 meters in diameter. The water flows through a 2.44 meter inside diameter pipe to the test stand. Water from three deep wells (4320, 4321, 4322) is used to replenish the reservoir at approximately 5.30 x 10^4 liters per minute and 300^o K. The discharge basin (north-east of test stand) provides a holding area for any cooling water which is not evaporated as well as catching and retaining spillage of RP-1 fuel.

One may easily determine the quantities of water evaporated if the quantity of water supplied to the test stand and the run-off to the discharge basin are known. The water evaporated is simply the difference of these two quantities.

The quantity of water provided to the test stand during the S-IC-11R static firing was determined by two methods. The first method consisted of using a float type level indicator in the circular reservoir where the float position was indicated by the voltage drop across a precision potentiometer. From the known geometry of the circular reservoir, the water drawn out between successive levels could be calculated. The second method of determining the water pumped to the test stand used the pump discharge curves provided by the pump manufacturers. Using the pump speed and discharge pressure one may enter the pump curve and determine the water discharge rate per pump. This rate is multiplied by the number of pumps operating to yield the total flow rate provided to the test stand. A comparison of the flow calculated by both methods for the S-IC-11R static firing (and for the previous test) indicates a good agreement between the two methods. Flow rates used in the following calculations are based on the pump discharge data.

The first attempt to measure the water run-off from the S-IC test stand employed a stage of water level recorder (Stevens Type-F) mounted in the discharge basin. The stage recorder was modified to change the 8-day time interval to a 3-hour interval. The stage recorder was installed in the S-IC discharge basin approximately 76.2 meters north and 122 meters east of the exhaust deflector (Figure 1).

The stage recorder was activated through use of a remote release cable which was actuated by the LOX barge personnel when they cleared the S-IC test complex. Actuation of the stage recorder occurred at approximately T_0 - 60 minutes, such that if a countdown hold of several hours was encountered a time-history record of the water level could not be obtained. In addition, the accuracy of the water level measurements resulted in water quantity errors on the order of 5-10% of the total water pumped to the test stand during the static firing.

On the S-IC-12 static firing (Nov. 3, 1969) and on the S-IC-14 static firing (April 16, 1970) countdown holds in excess of three hours were encountered and no useful water level data were obtained. On the S-IC-13 static firing (Feb. 6, 1970) the barge personnel neglected to actuate the stage recorder. In each test a 16 mm movie camera was employed to record the water level by photographing a water level rod attached to the stage recorder housing. On the S-IC-12 and S-IC-14 static firing the extended hold periods resulted in light conditions which were insufficient for photographing the water level. On the S-IC-13 static firing, photographic records were made of the water level. In view of the lack of accuracy and reliability in the preceeding method of measuring the water level change in the discharge basin, an improved method was developed for use on the S-IC-11R (June 25, 1970) and subsequent static firings.

The second method of measuring the water discharge from the S-IC test stand employed a water level indicator and water velocity rake mounted in the B-2 discharge flume on the S-IC test stand (Figure 1). The water level indicator was composed of a slide-wire potiometer mounted to a balanced float (Figure 2). The slide wire and float were mounted in a 15.24 cm. diameter pipe which was attached to a 1.270 cm. steel plate. The plate was attached to the flume with four .952 cm. studs and anchor nuts. The water velocity rake was constructed with eight (8) logarithmically spaced total pressure tubes and a static pressure port at the bottom of the discharge flume (Figure 2). The total head tubes were attached to a staff, which in turn was attached to a 1.270 cm. steel plate. The static port was installed 12.70 cm. from the leading edge of the plate and the leading edge of the plate was rounded to minimize turbulence. The installation of the velocity rake and water level indicator is shown in Figure 3.

The total head tubes and the static port were connected to 0-6.89 newtons/cm^2 pressure transducers and the signals were routed to an R-BOX on the S-IC test stand. The data were recorded on a Beckman System in the Data Acquisition Facility (DAF) at the NASA-MTF. The water level signal was recorded in a similar manner. The water flow data were recorded from T_0 - 5 minutes at a rate of 25 samples per second. The data were time-averaged on 1.0 second intervals and presented in both graphical and tabular form. From these data it was possible to estimate the water quantity discharge from the S-IC test stand.

III. RESULTS OF WATER FLOW TESTS

The results of tests to determine the water flow rate supplied to the test stand during the static firing indicate that the flow rate can be accurately determined from the pump pressure and R.P.M. data, and the manufacturer's pump curves. The nominal water flow rate supplied to the test stand during at S-IC static firing was determined to be 1.099×10^6 liters per minute.

The water level indicator failed to function on the S-IC-11R static firing; however, the water velocity rake provided data adequate for determining both water discharge velocity and water depth. Plots of the pressure data from the water velocity rake are given in Figure 4. The pressure data for the total head tube at the position 40.6 cm. above the discharge flume (H16.0) indicated that waves were occassionally covering the tube when the water flow was at 100% of rated flow (1.099×10^6 liters/min). Previous observation of the water discharge in the flume during water flow tests prior to the actual static firing indicated that the waves usually possessed an estimated height of 5-8 cm. with an occasional maximum estimated height of 10-15 cm. Thus if the H16.0 total head tube was frequently covered at any time prior to the static firing, the water level should have been within 5-8 cm. of the 40.6 cm. position. Calculation of the water flow depth from the static pressure data at 100% water flow prior to static firing indicated a water flow depth (d) of 37.15 cm. Calculation of the water flow depth based on rated quantity flow at 100% flow (1.099×10^6 liters/min), the average water velocity from the measured velocity profile, and the cross sectioned area of the flume discharge indicated a flow depth of 37.42 cm. The close agreement of the above water flow depth values, indicated that for all practical purposes the water flow depth can be determined from the static pressure reading. The water velocity profile in the discharge flume at 100% flow (1.099×10^6 liters/min) is presented in Figure 5. Analysis of the tabulated data (Appendix) indicates that the water flow depth decreased progressively from d = 25.4 cm. at T_o + 10 seconds to d = 2.54 cm. at T_o + 71.5 seconds. The static pressure reading dropped to a minimum at T_o + 76.5 seconds. The static firing was terminated prematurely at T_o + 78 seconds and the water depth increased abruptly at approximately T_o + 80 seconds.

From observation of the water flow test prior to the S-IC-11R static firing it was noted that it took about a minute for the water flow depth to decrease to approximately zero if the water flow was abruptly stopped while at about 80% flow. In the pressure plots (Figure 4) it can be observed that the water level was reduced to zero in approximately seventy-five seconds; and it is anticipated that this was residual water which was in the flume at the point of ignition. The fact that the water level dropped to less than 1.27 cm. indicated that very little, if any, water is added to the discharge flow during the static firing. A water flow depth of 1.27 cm. would be less than 2% of the total 1.099×10^6 liters/min. pumped to the test stand. Water flow measurements recorded with the velocity rake for static firing S-IC-15 on 30 September 1970 essentially duplicated those obtained during firing S-IC-11R. The water depth again decreased progressively from approximately 37.1 cm. at T_o to less than 1.27 cm. to T_o + 70 seconds. Therefore, it is concluded that for purposes of establishing a mass-energy balance for the S-IC rocket engine exhaust cloud, it is appropriate to assume that all of the water pumped to the test stand deflector is atomized or vaporized.

IV. DETERMINATION OF MASS-ENERGY BALANCE

Water at approximately 300^o K is pumped to the test stand at a rate of 1.099×10^6 liters per minute (18,280 kilograms/sec). The measurements of water discharge from the test stand indicate that essentially 100% of this water is evaporated and is entrained into the cloud in vapor form. There was contention by some test stand personnel that part of the water was atomized and did not enter the exhaust cloud. Observation of the spray particle size during pre-static-firing water flow tests indicated that the droplets were of the order of 100 microns in mean diameter. In an environment of 300^o K and 50% humidity, a 100 micron droplet will evaporate before it falls 3.048 meters. Temperatures at 152.4 meters from the test stand have been measured and found to range about 311^o K near the ground to over 400^o K at 18-25 meters above the ground. The estimated average temperature of the exhaust products at the flame bucket is about 1875° K. In this type of environment it is anticipated that any atomized water would be vaporized instantaneously. In addition the affect of the exhaust jet impingement on the cooling water would be to atomize the water into smaller droplets than those produced on the pre-static-firing water flow test. Consequently, it is concluded that 18,280 kg. of water is vaporized each second and that this mass is entrained into the exhaust jet.

The rate of production of combustion products for a typical S-IC static firing is approximately 12,970 kilograms per second. The average temperature and velocity of the exhaust products at the exit of the engine at 1875 K and 2287 meters/sec, respectively at atmospheric pressure (Ref. 1). The exhaust products are approximately 69% carbon dioxide and 31% water with a weighted specific heat of 0.437 calories per gram per Kelvin (Ref. 3). The total energy of the exhaust gases was computed to be:

Enthalpy	=	8.50×10^{9} calories/second (Ref. 373° K)
Kinetic Energy	=	8.15×10^{9} calories/second
Total Energy	=	1.665×10^{10} calories/second

The above total energy value of 1.665×10^{10} calories per second under actual test conditions compared favorably with the value of 1.34×10^{10} calories/second quoted for standard atmospheric conditons (Ref. 2).

In order to determine the mass and energy released into the atmosphere, it is necessary to consider how these values will be used.

For instance, if one is interested in only the mass and energy flux at the test stand deflector, these values could be determined as the sum of the mass and energy of both the water and exhaust gases. However, if one is interested in the energy flux into the atmosphere which is available to produce free and forced convection of the exhaust cloud, the energy required to vaporize the water and raise it to some final temperature must be considered. Since the mass of the vaporized water is approximately 130% of the mass of the exhaust gases, the flux of available energy into the atmosphere will be an order of magnitude smaller than the total flux of the rocket engines. Obviously this difference will significantly affect the rate of growth and maximum cloud height. Also as the water vapor condenses, the latent heat will be released and this energy will be available to drive the cloud to greater altitudes.

Assuming that negligible entrainment of atmospheric air occurs in the vicinity of the deflector and neglecting compressibility, the properties of the exhaust jet may be computed downstream of the deflector bucket at a point where mixing of the exhaust products and the water vapor is complete. Employing the conservation of momentum principle and assuming that the initial velocity of the water vapor is zero, the velocity of the gas-water vapor mixture at the downstream location can be computed as follows:

$$MV \text{ (at deflector)} = MV \text{ (after complete mixing)}$$

$$M_g V_g + M_w V_w = (M_g + M_w) V_m \quad (1)$$

where

M = mass

V = velocity of mass

g = gas

w = water vapor

m = gas-water vapor mixture

Substituting into equation (1):

$$(12970)(2287) = (12970 + 18280)\, V_m$$

$$V_m = 950 \text{ meters/sec.}$$

The final temperature and available energy content of the mixture of gas products and water vapor may be estimated by determining the energy required to vaporize the water, raise the water vapor to the final temperature, and accelerate the mixture to the mixture velocity calcualted above. The energy required to evaporate the water and to raise the water vapor and combustion gases mixture to the final temperature is computed as follows:

To raise the water from initial temperature to boiling point:

$$\dot{Q}_1 = 18{,}280 \text{ Kg/sec. } (1.0)(\text{cal/g } ^{\circ}\text{K})(373\text{-}300)^{\circ}\text{K}$$

$$\dot{Q}_1 = 1.332 \times 10^9 \text{ cal/sec.}$$

To vaporize the water:

$$\dot{Q}_2 = 18{,}280 \text{ Kg/sec. } (541. \text{ cal/gm})(1000. \text{ gm/Kg})$$

$$\dot{Q}_2 = 9.86 \times 10^9 \text{ cal/sec.}$$

To raise the water vapor and combustion gases mixture to final temperature:

$$\dot{Q}_3 = 31{,}250 \text{ Kg/sec. } (.400 \text{ cal/g } ^{\circ}\text{K})(T_m - 373 \text{ K}).$$

The specific heat of the water vapor - combustion gas mixture used in the equation for $\dot{Q}_3$ was determined by trial and error. A value was assumed for T_m which allowed C_p to be calculated since the composition of the mixture is known. This procedure was repeated until the assumed value of Tm satisfied the energy equation.

Conducting an energy balance for the mixture, it can be shown that the total available energy of the mixture (TE_m) is equal to:

$$TE_m = KE_m + \dot{Q}_w$$

where:

$$\dot{Q}_w = \dot{Q}_1 + \dot{Q}_2 + \dot{Q}_3 \qquad (2)$$

and KE_m represents the kinetic energy of the mixture.

Now:

$$KE_m = \frac{(31,250)\ (950)^2}{2} = 3.38 \times 10^9 \text{ cal/sec.} \qquad (3)$$

Combining equations (2) and (3);

$$\dot{Q}_3 = TE_m - KE_m - \dot{Q}_1 - \dot{Q}_2 \qquad (4)$$

Substituting into equation (4) the following relationship is obtained:

$$1.25\ (10^7)(T_m - 373) = 1.665\ (10^{10}) - 3.38\ (10^{10}) - .1332\ (10^{10}) - .986\ (10^{10}) \qquad (5)$$

The final mixture temperature as obtained from equation (5) is;

$$T_m = 539 \text{ KELVIN}$$

Thus the mixture of combustion products and water vapor has a velocity of 950 meters/sec. and a temperature of 539°K. The properties of the exhaust gases, cooling water, and the mixture are summarized in Table I.

TABLE I. PROPERTIES OF COMBUSTION PRODUCTS AND COOLING WATER FOR TYPICAL S-IC STATIC FIRING			
	Combustion Products	Cooling Water	Mixture
mass flow rate	12,970 Kg/sec.	18,280 Kg/sec.	31,250 Kg/sec.
mass velocity	2,287 meters/sec.	0	950 meters/sec.
temperature	$1875^{o}K$	$300^{o}K$	$539^{o}K$
specific heat	0.437 calories/$g^{o}K$	1.0 calories/$g^{o}K$	0.400 calories/$g^{o}K$

V. SUMMARY

A mass-energy balance has been determined for the exhaust-cloud generated during the static firing of the S-IC rocket engine (first stage of the Apollo V flight system) at the NASA Mississippi Test Facility. Measurements show that approximately 18,280 Kg/sec. of cooling water are evaporated and entrained into the exhaust jet which possesses a mass flux of 12,970 Kg/sec. The total energy of the exhaust products was 1.665×10^{10} calories per second; however, after evaporating the cooling water only 0.546×10^{10} calories per second was available as sensible heat and kinetic energy.

REFERENCES

1. Covington, C. J. & Suarez, Harry. Letter report, "S-IC Static Test Data," September 1970. S-IC Engine data provided by Mr. Rudy Oliver, Boeing Company, New Orleans, Louisiana and Mr. Phil Hampton, Rocketdyne, Downey, California.

2. Susko, Michael; Kaufman, John W., and Hill, Kelly. Rise Rate and Growth of Static Test Vehicle Engine Exhaust Clouds*, NASA Marshall Space Flight Center; Aero-Astrodynamics Research Review No. 7. *Extracted from NASA TM X-53782.

3. Lopez, Manuel. Private Communication, the MITRE Corporation, Bedford, Massachusetts. September 1970.

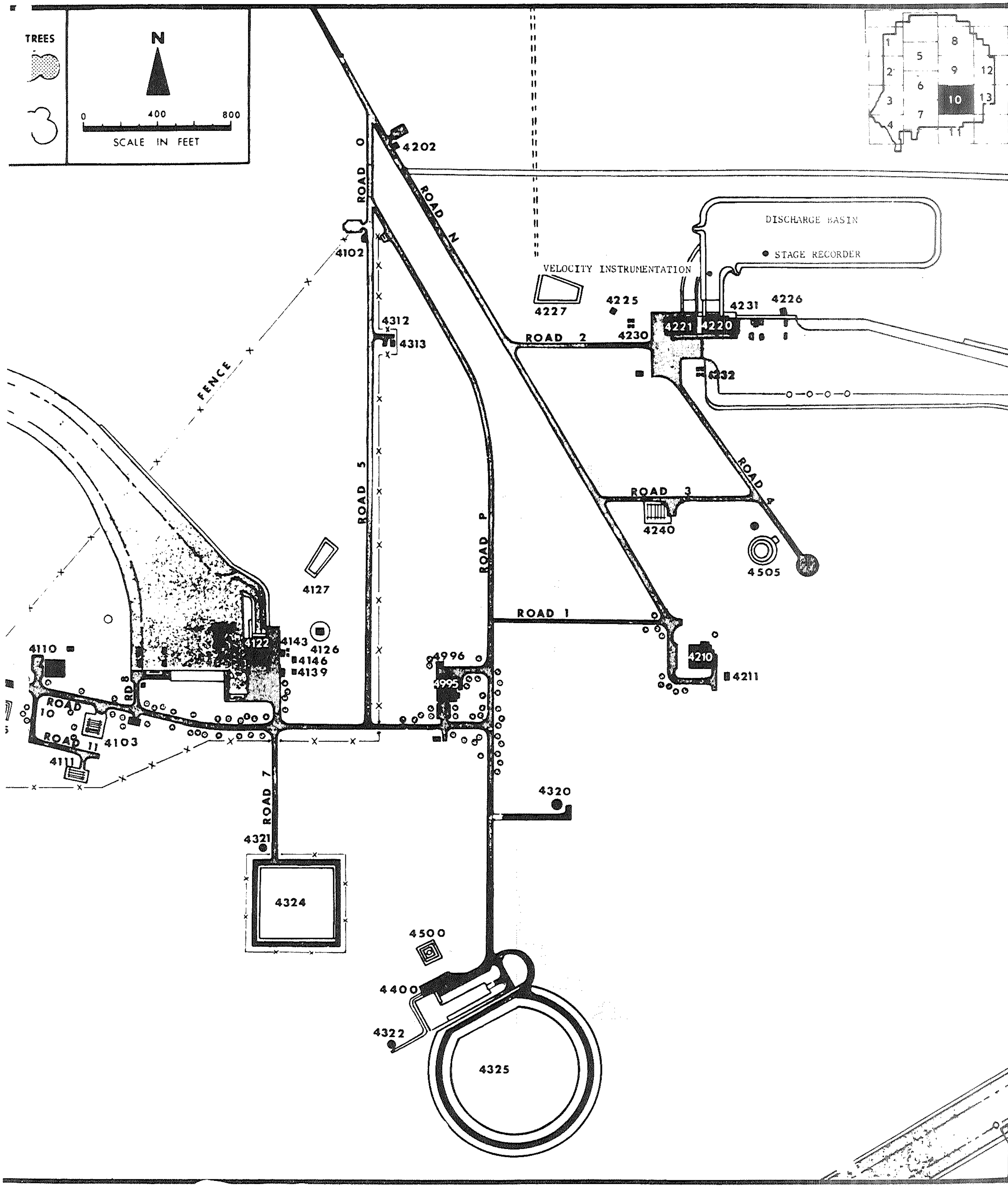

FIGURE 1: SCHEMATIC OF S-IC TEXT COMPLEX AT THE NASA MISSISSIPPI TEST FACILITY

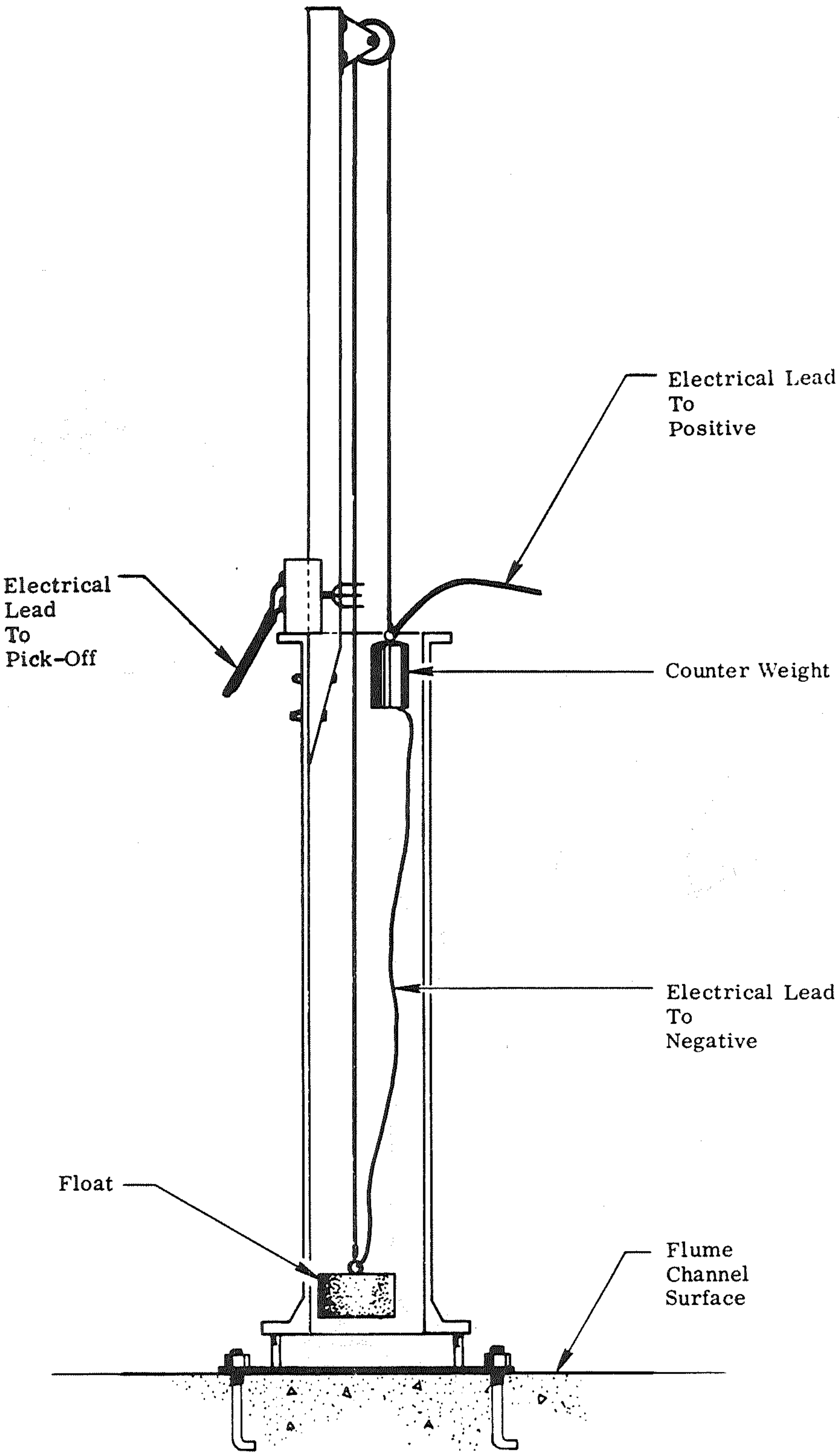

Figure 2-A. Water Level Indicator.

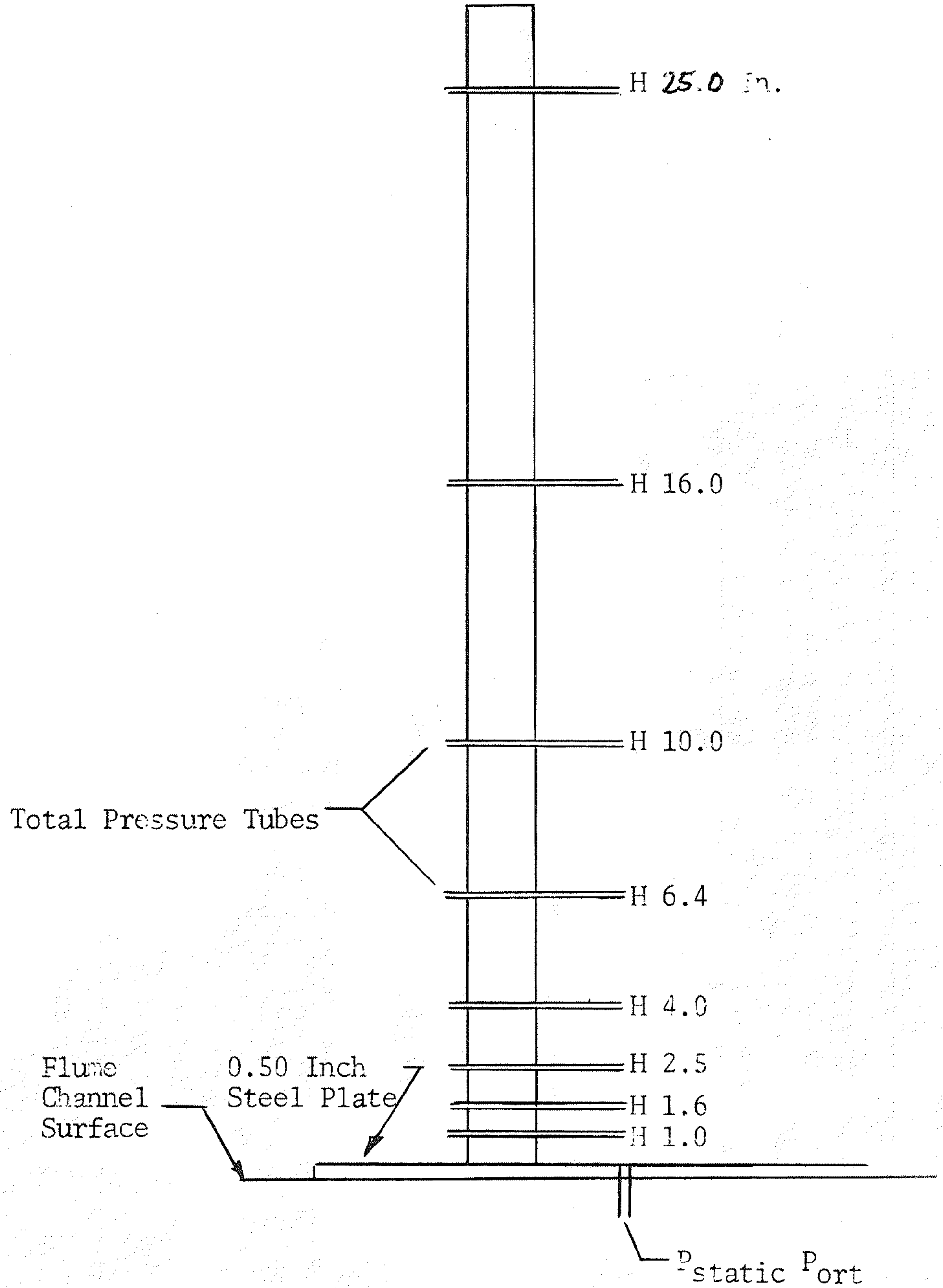

Figure 2-B. Water Velocity Rake

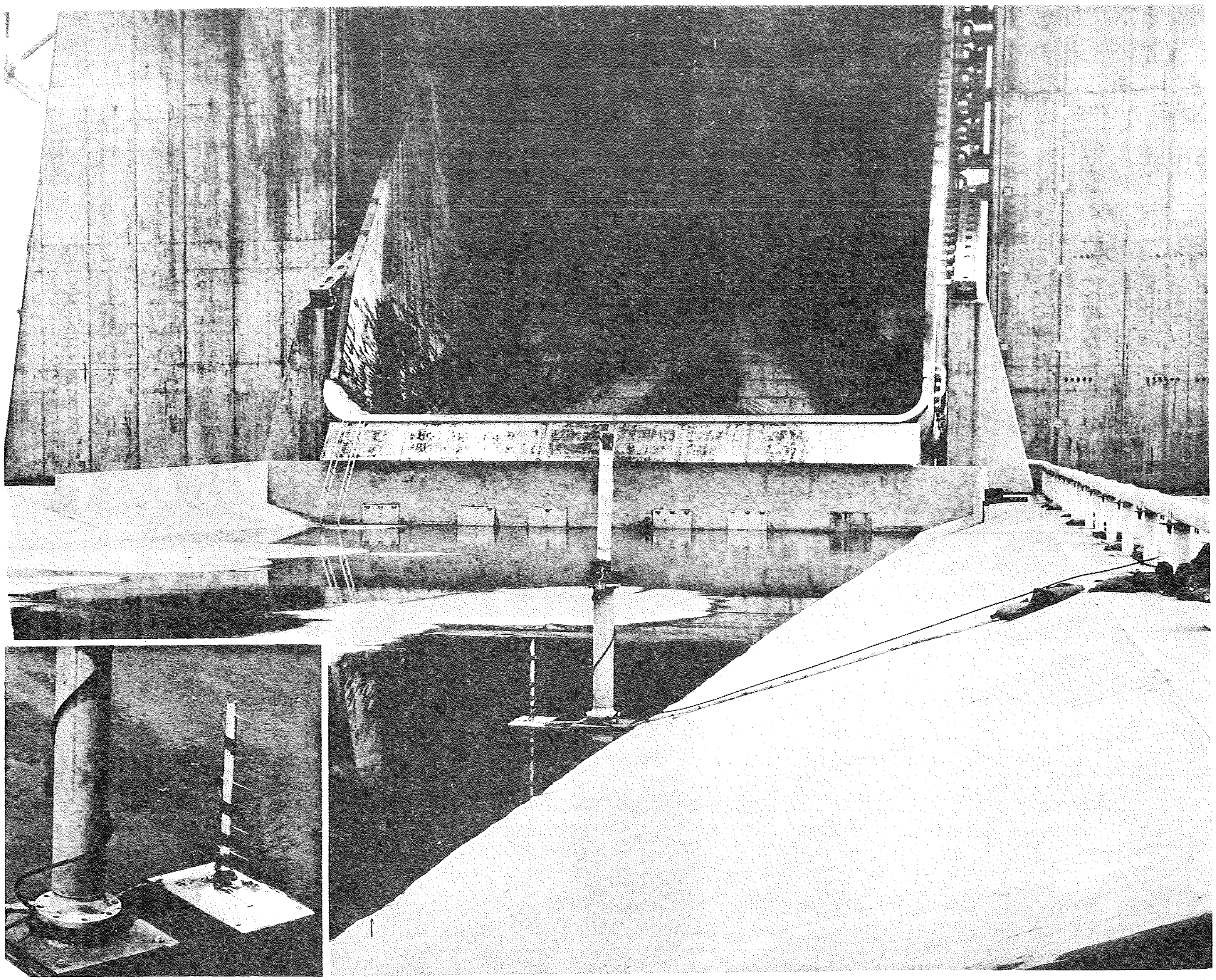

FIGURE 3: INSTALLATION OF WATER LEVEL AND VELOCITY INSTRUMENTATION IN S-IC-B2 FLUME

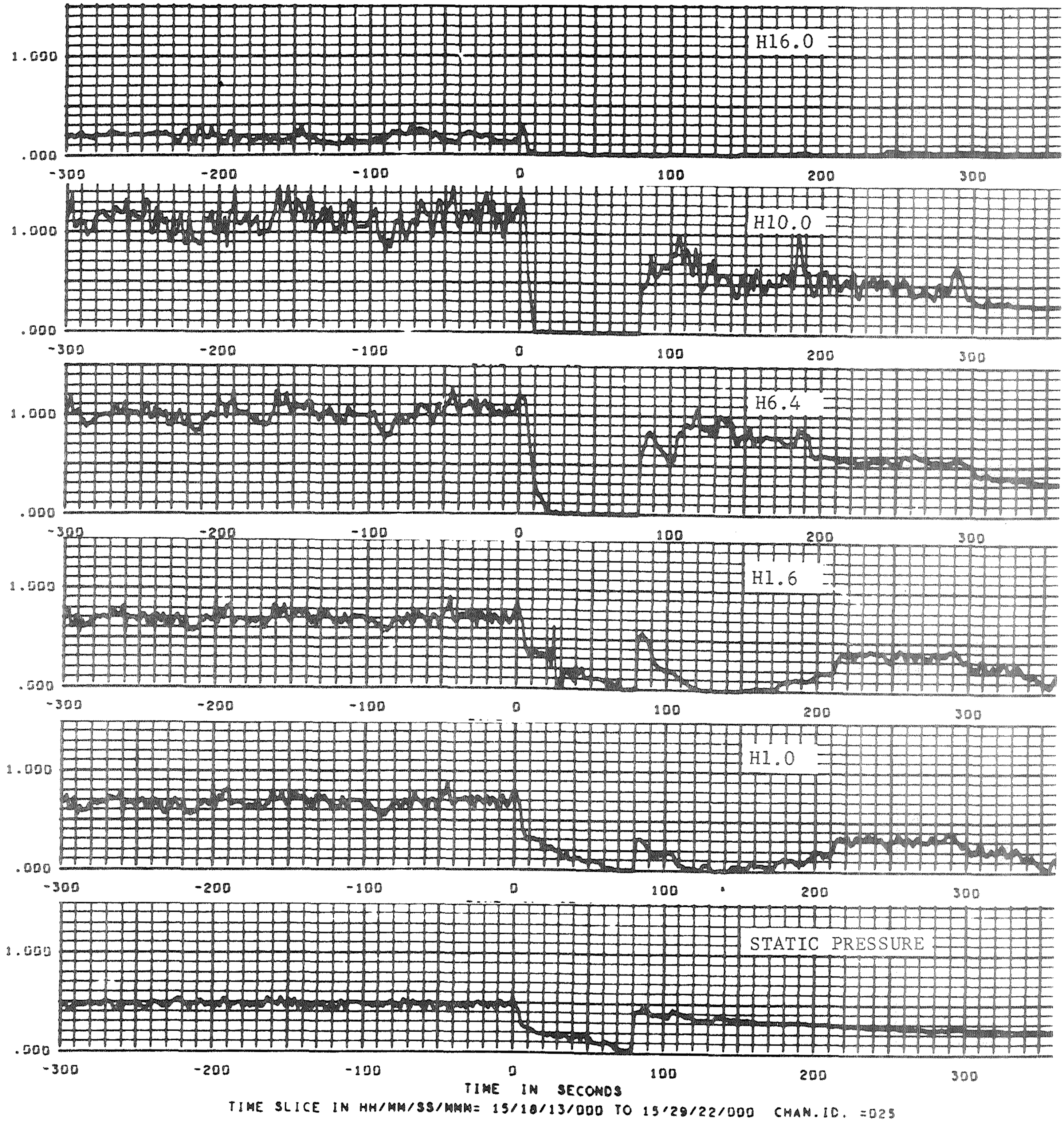

FIGURE 4: TIME HISTORY OF STATIC & TOTAL PRESSURE ON WATER VELOCITY RAKE.

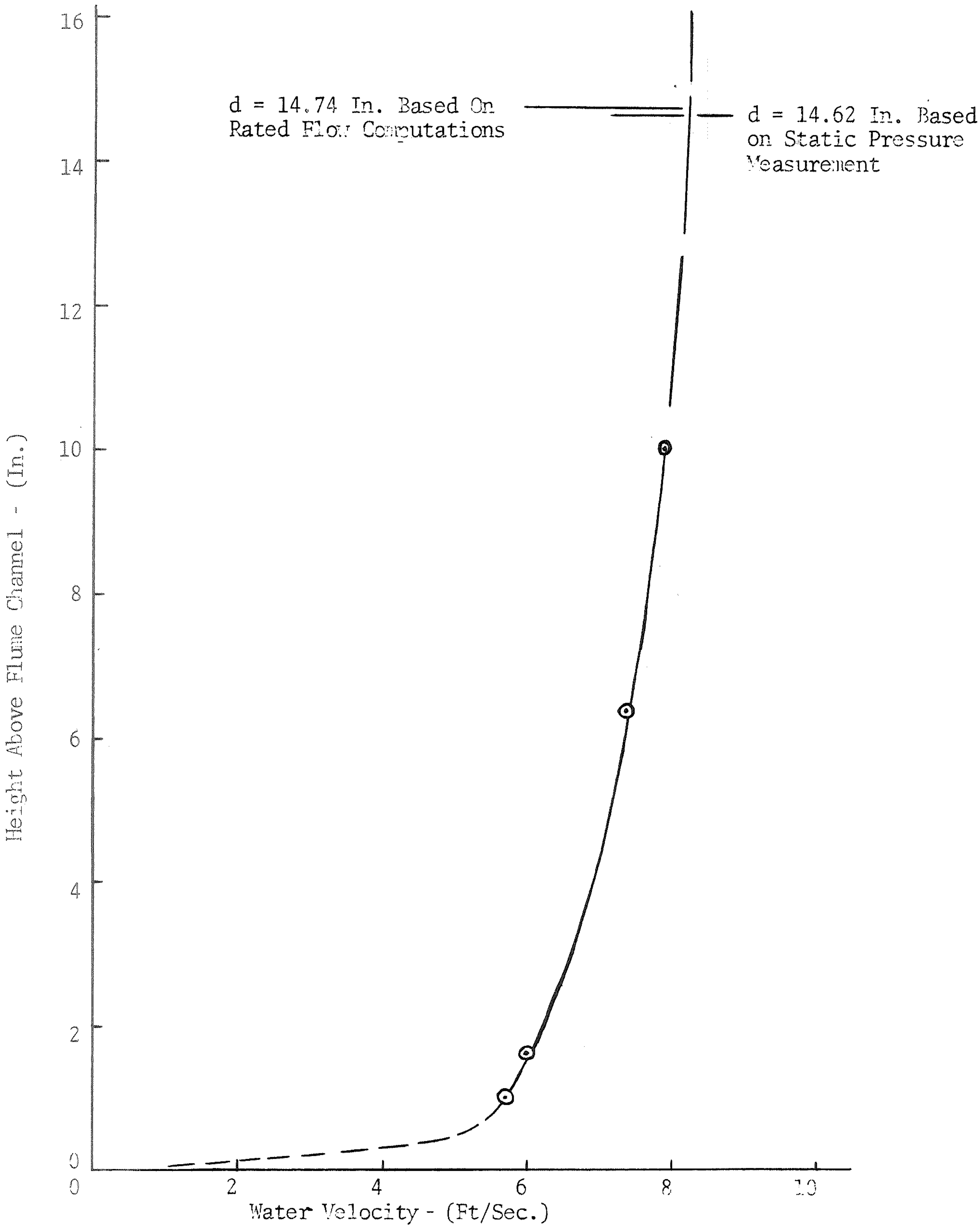

Figure 5. Measured Water Velocity Profile in S-IC-B2 Discharge Flume at 100% Design Flow (290,000 G. P. M.).

APPENDIX I

SIC-11
GROUND MEASUREMENTS
BECKMAN SYSTEM
A/D SYSTEM NO 3
MSU SPECIAL
TEST NO. 111-3Ø3
DATE ØG/25/7Ø
START 15 18 13
STOP 15 29 22

PRELIMINARY
----------->

MSU SPECIAL 111-303 PRELIMINARY

ID.-SIC-11 TYP-DAF DATE-06/25/70 TABULATION OF AVERAGES TIME 0 =15 23 13 PAGE

ENG DATA 10KC SAM RATE A/D SYSTEM NO 3 SCAN - C CALIB. STEP -N/A T-111-3

	TIME SEC	D065035 PSID	D065036 PSID	D065037 PSID	D065038 PSID	D065039 PSID	D065040 PSID	D065041 PSID	D065042 PSID	D065043 PSID	G65003 RAW
-	43.797	.515	.898	.934	1.006	.054	1.284	.098	.136	1.547	116.81
-	42.794	.459	.842	.856	.909	.053	1.236	.098	.132	1.357	116.81
-	41.791	.428	.699	.726	.787	.052	1.139	.097	.128	1.104	116.81
-	40.788	.461	.676	.698	.758	.051	1.089	.095	.125	1.098	116.80
-	39.784	.437	.647	.640	.691	.052	1.015	.097	.124	1.020	116.80
-	38.781	.498	.674	.678	.775	.051	1.041	.096	.146	1.085	116.80
-	37.778	.500	.748	.768	.872	.052	1.110	.096	.226	1.257	116.81
-	36.775	.463	.700	.726	.828	.052	1.088	.097	.199	1.193	116.80
-	35.772	.499	.720	.760	.858	.052	1.106	.096	.213	1.243	116.80
-	34.769	.494	.742	.777	.886	.052	1.127	.096	.224	1.255	116.82
-	33.766	.431	.711	.739	.863	.052	1.125	.096	.226	1.137	116.82
-	32.763	.505	.717	.740	.861	.053	1.132	.096	.234	1.113	116.79
-	31.760	.496	.753	.783	.903	.054	1.181	.097	.234	1.340	116.80
-	30.756	.482	.760	.784	.870	.053	1.153	.096	.219	1.288	116.81
-	29.753	.414	.639	.658	.711	.052	1.044	.097	.208	1.008	11[illegible].91
-	28.750	.502	.677	.689	.757	.053	1.051	.097	.217	1.115	116.82
-	27.747	.505	.765	.785	.932	.056	1.172	.097	.213	1.345	116.81
-	26.744	.478	.746	.775	.903	.054	1.174	.098	.203	1.282	116.79
-	25.741	.432	.612	.626	.689	.053	1.025	.097	.191	1.001	116.81
-	24.738	.498	.675	.697	.804	.055	1.043	.098	.182	1.137	116.81
-	23.735	.512	.783	.797	.933	.055	1.117	.097	.176	1.335	116.80
-	22.732	.504	.753	.775	.885	.054	1.153	.097	.177	1.409	116.80
-	21.729	.528	30	.749	.831	.054	1.173	.097	.238	1.427	116.80
-	20.725	.479	.702	.711	.780	.055	1.095	.097	.207	1.274	116.81
-	19.722	.474	.669	.672	.741	.053	1.028	.097	.185	1.126	116.82
-	18.719	.515	.716	.722	.812	.055	1.068	.097	.199	1.308	116.79
-	17.716	.500	.769	.795	.921	.056	1.156	.097	.172	1.471	116.80
-	16.713	.495	.748	.763	.858	.055	1.089	.098	.170	1.242	116.81
-	15.710	.448	.645	.654	.721	.054	1.002	.097	.156	1.046	116.80
-	14.707	.461	.704	.701	.784	.053	1.008	.096	.147	1.057	116.80
-	13.704	.523	.754	.751	.841	.053	1.035	.096	.140	1.183	116.80
-	12.701	.461	.740	.762	.852	.053	1.069	.097	.136	1.249	116.80
-	11.698	.496	.712	.732	.805	.052	1.054	.096	.144	1.185	116.80
-	10.694	.408	.643	.683	.760	.052	1.026	.096	.136	.993	116.81
-	9.691	.500	.628	.657	.720	.052	.971	.097	.146	.915	116.79
-	8.688	.469	.622	.652	.742	.053	1.002	.098	.138	1.020	116.79
-	7.685	.540	.724	.757	.867	.054	1.065	.097	.139	1.245	116.81
-	6.682	.528	.789	.825	.943	.054	1.115	.098	.134	1.313	116.81
-	5.679	.479	.719	.742	.821	.054	1.055	.098	.131	1.180	116.80
-	4.676	.470	.642	.648	.722	.053	1.028	.097	.128	1.145	116.80
-	3.673	.469	.643	.656	.736	.053	1.022	.096	.129	1.147	116.79
-	2.670	.506	.679	.706	.770	.052	1.021	.094	.172	1.169	116.80
-	1.667	.490	.698	.729	.789	.011	1.062	.051	.140	1.317	116.82
-	0.663	.534	.860	.881	.927	.229	1.221	.268	.217	1.349	116.81
+	0.340	.445	.664	.683	.763	.108	1.085	.137	.032	1.183	116.80
+	1.343	.577	.863	.929	1.028	.145	1.227	.162	.181	1.381	116.81
+	2.346	.569	.817	.873	.972	.110	1.185	.115	.387	1.306	116.80
+	3.349	.462	.758	.784	.859	.115	1.210	.144	.292	1.330	116.80
+	4.352	.480	.701	.720	.796	.177	1.190	.174	.237	1.225	116.80
+	5.355	.342	.521	.552	.615	.141	1.074	.162	.154	.822	116.79
+	6.358	.311	.454	.482	.524	.168	.954	.182	.058	.607	116.81

MSC SPECIAL 111-303 PRELIMINARY

ID.-SIC-11 TYP-DAF DATE-06/25/70 TABULATION OF AVERAGES TIME 0 =15 23 13

ENG DATA 10KC SAM RATE A/D SYSTEM NO 3 SCAN - C CALIB. STEP -N/A T-1

	TIME SEC	D65035 PSID	D65036 PSID	D65037 PSID	D65038 PSID	D65039 PSID	D65040 PSID	D65041 PSID	D65042 PSID	D65043 PSID	C65003 RAW
+	7.361	.262	.377	.400	.430	.174	.758	.148	.010	.437	116.82
+	8.364	.246	.335	.364	.404	.190	.632	.156	.019	.334	116.80
+	9.368	.264	.321	.357	.390	.231	.550	.193	.013	.243	114.31
	10.371	.285	.317	.349	.371	.245	.438	.182	.045	.059	116.81
+	11.374	.236	.313	.362	.387	.270	.358	.188	.028	.000	110.10
+	12.377	.266	.334	.387	.409	.317	.298	.196	.000 -	.004	116.70
+	13.380	.227	.295	.350	.378	.307	.217	.175 -	.002 -	.025	116.80
+	14.383	.295	.368	.420	.458	.396	.230	.223 -	.038	.013	113.84
+	15.386	.162	.282	.316	.355	.360	.158	.191 -	.112 -	.026	116.44
+	16.389	.218	.323	.366	.395	.419	.193	.212 -	.002	.034	106.99
+	17.392	.205	.303	.353	.371	.429	.138	.186 -	.086 -	.007	66.10
+	18.395	.202	.333	.373	.377	.469	.088	.224 -	.099	.004	111.73
+	19.399	.183	.195	.338	.338	.512	.051	.242 -	.073 -	.008	66.76
+	20.402	.204	.228	.327	.342	.522	.018	.212 -	.154 -	.004	102.48
+	21.405	.223	.263	.365	.366	.565	.041	.250 -	.173	.026	113.00
+	22.408	.167	.250	.676	.357	.567	.008	.222 -	.196 -	.030	116.80
+	23.411	.192	.229	.105	.308	.579	.027	.243 -	.057	.000	116.79
+	24.414	.169	.242	.291	.281	.609	.007	.249 -	.161 -	.012	116.81
+	25.417	.222	.258	.178	.291	.664	.048	.277	.006	.027	116.81
+	26.420	.187	.230	1.278	.276	.687 -	.002	.271 -	.186 -	.033	116.80
+	27.423	.201	.235 -	.512	.245	.682	.025	.257 -	.027	.001	111.61
+	28.426	.150	.193	.210	.223	.685 -	.039	.236 -	.016 -	.053	111.37
+	29.430	.177	.205	.093	.413	.725	.014	.275	.015 -	.016	116.80
+	30.433	.165	.193 -	.090	1.120	.737 -	.021	.268	.008 -	.025	116.81
+	31.436	.155	.183	.025	.515	.752 -	.006	.275 -	.105 -	.014	116.80
+	32.439	.167	.127	.151	1.018	.776	.022	.289	.006	.002	116.80
+	33.442	.161	.120	.213	1.207	.780	.005	.285 -	.149 -	.008	116.81
+	34.445	.195	.159	.205	1.240	.813	.003	.305 -	.057 -	.023	116.82
+	35.448	.149	.141	.161	1.610	.810 -	.009	.278 -	.008 -	.036	116.80
+	36.451	.198	.173	.164	1.293	.876	.016	.316 -	.052 -	.010	116.81
+	37.454	.185	.147	.171	1.125	.898	.000	.321 -	.029 -	.026	116.81
+	38.457	.140	.099	.147	1.507	.898 -	.040	.317 -	.090 -	.055	116.81
+	39.461	.168	.130	.097	1.275	.938	.001	.330 -	.062 -	.026	116.82
+	40.464	.141	.124	.121	1.128	.972 -	.045	.340 -	.039 -	.063	116.81
+	41.467	.155	.121	.257	1.315	.989	.014	.369	.036 -	.004	116.80
+	42.470	.153	.116	.144	1.218	.995 -	.011	.358 -	.052 -	.031	116.82
+	43.473	.176	.151	.152	1.127	1.033 -	.057	.387 -	.018 -	.068	116 81
+	44.476	.177	.130	.175	.793	1.037 -	.074	.380 -	.004 -	.064	116.79
+	45.479	.210	.153	.250	.647	1.078 -	.022	.413	.009 -	.046	[illegible]
+	46.482	.134	.112	.145	.650	1.031 -	.011	.339 -	.004 -	.013	116.80
+	47.485	.189	.071	.088	.849	1.070 -	.027	.389 -	.014 -	.039	116.77
+	48.488	.188	.095	.115	.831	1.095 -	.041	.384 -	.006 -	.035	116.76
+	49.492	.203	.107	.117	.787	1.109 -	.017	.389 -	.003 -	.037	116.74
+	50.495	.174	.090	.147	.820	1.097 -	.073	.376 -	.008 -	.058	116.75
+	51.498	.141	.097	.110	.881	1.105 -	.047	.370 -	.010 -	.053	116.74
+	52.501	.122	.085	.096	.916	1.099 -	.070	.360 -	.027 -	.077	116.74
+	53.504	.160	.105	.107	.793	1.131 -	.028	.416	.000 -	.056	116.74
+	54.507	.131	.102	.112	.607	1.121 -	.079	.398 -	.032 -	.080	116.76
+	55.510	.119	.119	.127	.457	1.144 -	.028	.410 -	.004 -	.050	116.75
+	56.513	.131	.097	.101	.207	1.123 -	.044	.387	.010 -	.035	116.74
+	57.516	.096	.093	.124	.734	1.134 -	.054	.411	.000 -	.059	116.75

MSU SPECIAL 111-303 PRELIMINARY

TC.-SIC-11 TYP-DAF DATE-06/25/70 TABULATION OF AVERAGES TIME 0 =15 23 13 PAGE

ENG DATA 1CKC SAM RATE A/D SYSTEM NO 3 SCAN - C CALIB. STEP -N/A T-111-3

	TIME SEC	D65035 FSID	D65036 FSID	D65037 FSID	D65038 FSID	D65039 FSID	D65040 FSID	D65041 FSID	D65042 FSIC	D65043 FSID	665003 RAW
+	58.519	.083	.076	.080	.958	1.143 -	.063	.393 -	.006 -	.062	116.74
+	59.523	.128	.104	.099	.563	1.165 -	.021	.445	.011 -	.050	116.74
+	60.526	.087	.017	.085	.435	1.127 -	.033	.412 -	.008 -	.063	116.75
+	61.529	.087	.015	.053	.425	1.133 -	.074	.414 -	.032 -	.093	116.76
+	62.532	.118	.027	.072	.853	1.152 -	.062	.432	.009 -	.051	116.75
+	63.535	.121	.023	.009	1.007	1.157 -	.042	.435 -	.031 -	.059	116.74
+	64.538	.125	.040	.096	1.283	1.178 -	.051	.450	.000 -	.055	116.75
+	65.541	.115	.046	.096	1.131	1.184 -	.011	.481	.010 -	.039	116.74
+	66.544	.105	.013	.034	1.421	1.156 -	.041	.434	.000 -	.036	116.75
+	67.547	.089	.034	.050	1.519	1.188 -	.059	.477 -	.019 -	.072	116.74
+	68.550	.104	.038	.027	1.024	1.208 -	.051	.495 -	.006 -	.052	116.74
+	69.554	.081 -	.008	.252	1.004	1.205 -	.054	.497 -	.028 -	.080	116.75
+	70.557	.036 -	.116 -	.080	.157	1.210 -	.119	.484 -	.032 -	.097	116.75
+	71.560	.041 -	.165 -	.066 -	.006	1.156 -	.099	.426 -	.034 -	.068	116.73
+	72.563	.039 -	.135 -	.039 -	.007	1.186 -	.072	.450 -	.044 -	.060	116.74
+	73.566	.039 -	.122 -	.030 -	.007	1.200 -	.063	.454 -	.027 -	.061	116.75
+	74.569	.042 -	.111 -	.025 -	.007	1.210 -	.058	.457 -	.024 -	.053	116.75
+	75.572	.033 -	.099 -	.019 -	.006	1.222 -	.054	.464 -	.023 -	.046	116.75
+	76.575	.025 -	.095 -	.021 -	.006	1.226 -	.056	.468 -	.023 -	.047	116.75
+	77.578	.030 -	.098 -	.010 -	.007	1.221 -	.064	.469 -	.035 -	.052	116.75
+	78.581	.037 -	.099 -	.008 -	.006	1.218 -	.069	.473 -	.042 -	.055	116.75
+	79.585	.035 -	.102 -	.013 -	.007	1.214 -	.071	.476 -	.045 -	.057	116.76
+	80.588	.031 -	.104 -	.016 -	.007	1.210 -	.074	.479 -	.045 -	.061	116.75
+	81.591	.118 -	.102 -	.012 -	.007	1.205 -	.061	.482 -	.045 -	.066	116.76
+	82.594	.311	.128	.265 -	.007	1.208	.294	.484 -	.037	.078	116.76
+	83.597	.440	.349	.584 -	.007	1.193	.667	.487 -	.044	.541	116.75
+	84.600	.442	.333	.583 -	.007	1.178	.684	.489 -	.054	.490	116.75
+	85.603	.434	.317	.567 -	.007	1.171	.752	.491 -	.054	.497	116.74
+	86.606	.427	.304	.551 -	.008	1.161	.823	.493 -	.056	.502	116.74
+	87.609	.476	.290	.536 -	.007	1.151	.852	.496 -	.063	.752	116.75
+	88.612	.492	.274	.520 -	.008	1.140	.858	.498 -	.068	.802	116.75
+	89.616	.472	.250	.484 -	.007	1.126	.825	.500 -	.073	.657	116.74
+	90.619	.456	.232	.449 -	.008	1.110	.799	.502 -	.082	.630	116.75
+	91.622	.445	.210	.390 -	.007	1.097	.786	.505 -	.083	.570	116.75
+	92.625	.428	.182	.331 -	.008	1.078	.750	.508 -	.080	.559	116.74
+	93.628	.413	.156	.294 -	.007	1.062	.726	.510 -	.081	.589	116.75
+	94.631	.397	.149	.269 -	.007	1.044	.711	.512 -	.085	.638	116.75
+	95.634	.384	.146	.239 -	.008	1.027	.688	.514 -	.086	.643	116.75
+	96.637	.408	.159	.232 -	.007	1.010	.668	.516 -	.015	.712	116.74
+	97.640	.400	.162	.228 -	.008	.994	.646	.517 -	.009	.658	116.75
+	98.643	.394	.164	.215 -	.007	.979	.625	.519 -	.030	.668	116.74
+	99.647	.378	.177	.203 -	.008	.961	.593	.522 -	.049	.677	116.74
+	100.650	.394	.174	.192 -	.007	.948	.557	.523	.031	.696	116.75
+	101.653	.391	.169	.183 -	.008	.931	.528	.524	.026	.746	116.75
+	102.656	.385	.179	.188 -	.007	.915	.508	.526	.006	.763	116.74
+	103.659	.381	.206	.204 -	.007	.902	.542	.529 -	.008	.822	116.74
+	104.662	.374	.192	.192 -	.007	.888	.578	.532 -	.022	.856	116.73
+	105.665	.363	.189	.189 -	.007	.873	.565	.533 -	.037	.761	116.74
+	106.668	.388	.191	.192 -	.007	.862	.705	.533 -	.039	.919	116.74
+	107.671	.470	.170	.173 -	.007	.847	.887	.535 -	.037	1.092	116.73
+	108.674	.451	.155	.154 -	.007	.828	.829	.537 -	.045	.942	116.74

MSU SPECIAL 111-303 PRELIMINARY

ID.-SIC-11 TYP-DAF DATE-06/25/70 TABULATION OF AVERAGES TIME 0 =15 23 13 P

ENG ·ATA 10KC SAM RATE A/D YSTEM NO 3 SCAN - C CALIB. STEF -N/A T-11

		D65035	D65036	D65037	D65038	D65039	D65040	D65041	D65042	D65043	G65003
	TIME SEC	FSID	FSID	FSID	FSID	FSID	FSID	FSID	FSID	FSID	RAW
+	109.678	.437	.128	.141	-.007	.813	.830	.538	-.049	.847	116.75
+	110.681	.425	.049	.123	-.007	.797	.846	.540	-.033	.654	116.74
+	111.684	.418	.068	.117	-.006	.783	.891	.541	.008	.826	116.74
+	112.687	.417	.041	.103	-.007	.767	.962	.543	.003	.948	116.73
+	113.690	.406	.055	.093	-.007	.751	.919	.546	-.008	.836	116.73
+	114.693	.392	.060	.083	-.007	.735	.880	.547	-.019	.654	116.73
+	115.696	.384	.032	.073	-.008	.722	.900	.547	-.028	.640	116.76
+	116.699	.376	.012	.058	-.006	.707	.896	.548	-.035	.583	116.74
+	117.702	.379	.022	.048	-.007	.695	.948	.549	-.034	.700	116.73
+	118.705	.382	.049	.045	-.006	.685	1.013	.552	-.033	.882	116.75
+	119.709	.383	.033	.037	-.007	.675	1.043	.556	-.033	.860	116.73
+	120.712	.379	-.044	.023	-.006	.663	1.092	.555	-.033	.609	116.73
+	121.715	.367	.021	.017	-.006	.650	.957	.555	-.038	.504	116.74
+	122.718	.359	.037	.024	-.007	.641	.907	.557	-.037	.468	116.73
+	123.721	.350	.016	.017	-.006	.630	.896	.558	-.040	.450	116.73
+	124.724	.342	-.002	.009	-.007	.619	.864	.559	-.044	.431	116.74
+	125.727	.341	.019	.006	-.007	.611	.878	.559	-.046	.554	116.72
+	126.730	.346	.058	.009	-.007	.604	.884	.561	-.046	.730	116.72
+	127.733	.349	.042	.005	-.006	.596	.883	.562	-.047	.707	116.74
+	128.736	.343	.067	.002	-.007	.586	.898	.562	-.048	.591	116.74
+	129.740	.350	.066	.005	-.006	.582	.884	.564	-.042	.724	116.74
+	130.743	.354	.050	.002	-.006	.577	.932	.566	-.035	.781	116.74
+	131.746	.347	.060	.000	-.006	.569	.819	.567	-.036	.569	116.72
+	132.749	.342	.051	-.002	-.005	.564	.808	.567	-.033	.491	116.72
+	133.752	.340	.021	-.006	-.005	.558	.883	.568	-.026	.553	116.74
+	134.755	.349	.016	-.005	-.005	.553	.959	.569	-.022	.615	116.73
+	135.758	.360	-.035	-.010	-.006	.548	1.043	.570	-.014	.582	116.73
+	136.761	.369	-.006	-.010	-.005	.545	1.008	.572	-.007	.651	116.73
+	137.764	.374	-.014	-.011	-.006	.542	.989	.575	.002	.546	116.73
+	138.767	.374	.020	-.014	-.005	.533	.934	.573	.000	.612	116.72
+	139.771	.376	.004	-.012	-.005	.529	.980	.573	.002	.561	116.72
+	140.774	.382	-.023	-.018	-.006	.521	1.018	.573	.003	.532	116.72
+	141.777	.377	.005	-.019	-.006	.516	.975	.573	.003	.527	116.73
+	142.780	.374	.014	-.019	-.005	.511	.949	.575	.005	.510	116.74
+	143.783	.368	.005	-.020	-.005	.504	.958	.576	.006	.464	116.73
+	144.786	.362	.000	-.022	-.005	.498	.812	.576	.006	.393	116.72
+	145.789	.358	.027	-.017	-.005	.494	.754	.578	.005	.374	116.73
+	146.792	.355	.042	-.011	-.005	.491	.739	.579	.009	.372	[illegible]
+	147.795	.353	.061	-.001	-.005	.486	.746	.579	.009	.452	116.73
+	148.798	.359	.053	.009	-.005	.485	.804	.580	.014	.618	116.73
+	149.802	.360	.048	.010	-.005	.481	.810	.581	.016	.624	116.73
+	150.805	.358	.045	.010	-.005	.477	.827	.582	.018	.574	116.73
+	151.808	.354	.037	.008	-.005	.472	.799	.582	.018	.429	116.74
+	152.811	.350	.044	.009	-.005	.468	.772	.583	.018	.381	116.72
+	153.814	.350	.045	.012	-.006	.466	.832	.585	.019	.446	116.72
+	154.817	.356	.035	.013	-.005	.463	.928	.584	.020	.635	116.73
+	155.820	.356	.048	.014	-.006	.459	.882	.586	.020	.577	116.74
+	156.823	.352	.041	.017	-.005	.456	.739	.587	.020	.471	116.73
+	157.826	.349	.036	.016	-.005	.452	.712	.585	.018	.480	116.73
+	158.829	.347	.088	.022	-.005	.451	.755	.585	.019	.682	116.72
+	159.833	.345	.080	.023	-.005	.447	.796	.587	.019	.694	116.73

MSU SPECIAL 111-303 PRELIMINARY

IC.-SIC-11 TYP-DAF DATE-06/25/70 TABULATION OF AVERAGES TINE 0 -15 23 13 PAG

ENG DATA 10KC SAM RATE A/D SY EM NO 3 SCAN - C CALIB. STEP -N/A T-111-

TIME SEC	D65035 FSID	D65036 FSID	D65037 FSID	D65038 FSID	D65039 FSID	D65040 FSID	D65041 FSID	D65042 FSID	D65043 FSID	G65003 RAW
+ 160.836	.342	.074	.024	- .005	.444	.770	.588	.019	.553	116.73
+ 161.839	.340	.082	.024	- .005	.440	.791	.587	.017	.594	116.73
+ 162.842	.337	.062	.024	- .005	.437	.783	.588	.016	.431	116.72
+ 163.845	.337	.062	.026	- .005	.435	.766	.589	.017	.445	116.73
+ 164.848	.335	.060	.028	- .005	.433	.813	.587	.020	.450	116.73
+ 165.851	.333	.062	.028	- .005	.429	.821	.587	.020	.469	116.71
+ 166.854	.333	.072	.029	- .005	.427	.811	.588	.021	.536	116.72
+ 176.158	.333	.061	.031	- .005	.425	.807	.589	.020	.587	116.73
+ 178.025	.324	.103	.078	- .004	.403	.759	.590	.019	.627	116.74
+ 179.025	.325	.106	.085	- .004	.400	.748	.591	.018	.572	116.73
+ 180.025	.322	.126	.100	- .006	.396	.716	.592	.017	.582	116.67
+ 181.025	.322	.137	.106	- .004	.397	.722	.590	.016	.549	116.73
+ 182.025	.327	.158	.109	- .004	.395	.740	.590	.019	.701	116.70
+ 183.025	.326	.126	.108	- .005	.392	.752	.588	.019	.642	116.68
+ 184.025	.321	.089	.102	- .005	.386	.737	.581	.018	.503	116.73
+ 185.025	.318	.129	.111	- .005	.384	.703	.579	.015	.447	116.73
+ 186.025	.322	.121	.116	- .005	.386	.725	.580	.019	.604	116.74
+ 187.025	.326	.141	.121	- .004	.384	.769	.580	.024	.848	116.75
+ 188.025	.332	.124	.121	- .005	.382	.882	.581	.031	1.052	116.75
+ 189.025	.332	.101	.119	- .005	.379	.833	.582	.029	.927	116.70
+ 190.025	.334	.101	.122	- .005	.381	.885	.586	.030	.863	116.61
+ 191.025	.333	.059	.116	- .005	.379	.904	.585	.032	.680	116.70
+ 192.025	.333	.091	.117	- .005	.376	.834	.585	.030	.640	116.70
+ 193.025	.332	.106	.121	- .005	.376	.818	.586	.028	.598	116.73
+ 194.025	.332	.084	.118	- .005	.372	.833	.585	.028	.610	116.72
+ ..5.025	.330	.070	.113	- .005	.370	.823	.580	.027	.669	116.73
+ 196.025	.326	.088	.113	- .005	.365	.693	.576	.024	.495	116.68
+ 197.025	.326	.106	.119	- .006	.365	.610	.573	.023	.421	116.68
+ 198.025	.325	.134	.125	- .004	.364	.612	.570	.021	.405	116.72
+ 199.025	.323	.139	.127	- .004	.361	.606	.569	.023	.452	116.71
+ 200.025	.319	.148	.138	- .005	.360	.583	.570	.023	.421	116.75
+ 201.025	.318	.194	.155	- .006	.357	.617	.572	.021	.590	116.72
+ 202.025	.319	.195	.161	- .003	.360	.623	.573	.023	.656	116.74
+ 203.025	.318	.216	.177	- .005	.356	.616	.574	.023	.613	116.76
+ 204.025	.319	.208	.184	- .003	.356	.616	.575	.022	.620	116.73
+ 205.025	.318	.197	.185	- .003	.355	.620	.575	.023	.651	116.75
+ 206.025	.318	.221	.192	- .003	.354	.617	.576	.023	.683	116.72
+ 207.025	.314	.190	.192	- .005	.350	.616	.577	.023	.627	116.73
+ 208.025	.314	.147	.186	- .005	.349	.603	.580	.023	.440	116.76
+ 209.025	.312	.179	.191	- .004	.347	.599	.575	.020	.522	116.72
+ 210.025	.312	.193	.194	- .003	.349	.610	.571	.022	.669	116.73
+ 211.025	.312	.161	.191	- .005	.343	.622	.570	.022	.664	11[illegible].76
+ 212.025	.310	.166	.191	- .005	.344	.578	.567	.022	.534	116.69
+ 213.025	.310	.168	.193	- .005	.344	.589	.569	.022	.585	116.66
+ 214.025	.310	.185	.205	- .004	.341	.574	.570	.023	.522	116.64
+ 215.025	.308	.258	.281	- .005	.341	.571	.571	.022	.423	116.70
+ 216.025	.307	.289	.308	- .005	.340	.570	.572	.021	.476	116.66
+ 217.025	.303	.301	.324	- .004	.337	.561	.572	.020	.434	116.72
+ 218.025	.305	.336	.369	- .004	.337	.577	.572	.023	.532	116.72
+ 219.025	.303	.369	.394	- .005	.337	.586	.574	.022	.582	116.66
+ 220.025	.301	.345	.392	- .005	.333	.579	.573	.021	.561	116.70