STD RESEARCH CORPORATION

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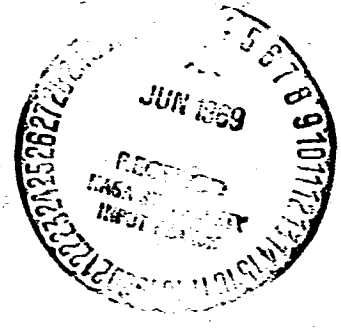
TELEPHONE: (213) 684-1771

Contract No. NASW-1759

STD 003-66-9

AN INVESTIGATION OF THE INFLUENCE OF CONTROLLED TURBULENCE ON GASEOUS DISCHARGES



Monthly Progress Report No. 9

12 March through 11 April 1969

Prepared for

National Aeronautics & Space Administration Headquarters

Office of Advanced Research & Technology, Research Division

Dr. Karlheinz Thom, Code RRE

Washington, D. C. 20546

20 April 1969

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NASW-1759
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To: National Aeronautics and Space Administration
Washington, D. C. 20546

Attention: Dr. Karlheinz Thom
Code RRE

Subject: 9th Monthly Progress Report NASW-1759
"An Investigation of the Influence of Controlled Turbulence on Gaseous Discharges"

Contract: NASW-1759

Principal Investigator: S. T. Demetriades

Period Covered: 12 March through 11 April 1969

This is the ninth in a series of Monthly Progress Reports submitted in partial fulfillment of subject contract.

Prepared by:

S. T. Demetriades

Approved by:

S. T. Demetriades
Principal Investigator

STD Research Corporation

S. T. Demetriades
President and Technical Director

CC:
Mr. William F. Berry, DCRL-DPCD (letter of transmittal only)
Mr. Sidney Breger, DP-PR (letter of Transmittal only)

1.0 FOREWORD

The project reported herein is being performed by STD Research Corporation under the direction of S. T. Demetriades, Principal Investigator. This project is sponsored by National Aeronautics and Space Administration Headquarters, Office of Advanced Research and Technology, Research Division, Washington, D. C. under Contract No. NASW-1759. The total amount of this contract is $51,654. The effective start date was 12 July 1968.

2.0 OBJECTIVE

The objective of this investigation is to study the effect of controlled turbulence on gaseous discharges. Experimental apparatus will be built in order to induce turbulence in the region of an arc and to study the effect of this turbulence on the stability and characteristics of the arc. Optical observation of the arc behavior will be carried out. A theoretical study of the dispersion D-criterion for non-equilibrium seeded and unseeded plasmas will also be made.

The results of the investigation should be very useful to numerous programs of plasma physics and related devices including plasma accelerators, arc wind-tunnels and MHD power generators.

3.0 ACTIVE PERSONNEL AND MANPOWER EXPENDED

The professional personnel and assistants active in this investigation and the man-hours expended on this contract by them during the ninth reporting period (12 March - 11 April 1969) are given in the following tabulation:

	Man-Hours	
Professional Personnel	This period	Cumulative
S. T. Demetriades	40	396
S. H. Schwartz	-	492
J. Sutton	-	172
C. Deichler	44	496
S. Hagen	54	166
C. Maxwell	40	240
M. Jones	-	183
M. Caloyannides	-	25
W. Pounder	40	40
Totals	218	2210

4.0 PROGRESS AND STATUS

Experiments during this period were primarily concerned with measuring the electrode voltage drop. The newly constructed apparatus for maintaining constant current through the Westinghouse rectifiers (hence, through the electrodes) as the electrode spacing changed was operated with much success; the current could be easily adjusted to within a few per cent of a constant value.

Data were taken at various electrode spacing across a nitrogen plasma stream with stagnation enthalpy 2080 ± 50 BTU/lb. The 1 mm diam. wire, 5 mesh screen described in Progress Report No. 7 was used. The current was carefully monitored and adjusted to 32.3 ± 0.3 amps when the screen was out. Current was not constant to within as fine a tolerance when the screen was in, due to the fact that many alternating screen-in and screen-out runs are taken at a time, and it was experimentally more convenient to adjust carefully the current when the screen was out and to simply monitor the current with the screen in (27.2 ± 1.5 amps).

Figure 1 shows the effects of varying the electrode separation. The points represent averages of voltages measured at constant current for various electrode gaps. It can be seen that when the electrode separation is larger than approximately $\frac{1}{2}$", the electrode voltage drops increase more or less linearly. We infer that this spacing, $\frac{1}{2}$", is roughly associated with the point at which the electrodes cease to interfere (geometrically) with the plasma jet. By extrapolating to a closed gap, $\Delta = 0$, where the entire voltage drop is associated with the

electrodes and the (negligible) losses in the cables, we see that about 30 volts are lost through the electrodes under these conditions. (For this purpose we have used the secreen-out data as the more reliable of the two sets presented).

This electrode voltage drop is somewhat higher than we had assumed previously. To see the effect of this higher correction to the gap conductance data, some of the data presented in Progress Report No. 7 of this contract were reanalyzed on the basis of a 30 volt electrode drop. The results are given in Table I. These values may be compared to the values given in Tables V and VI of Progress Report No. 7. Obviously, the conductance enhancement ratio is increased by this larger voltage correction. In Progress Report No. 7 we had also noted a certain relationship between the conductance properties of the gap with two screens of different Reynolds number. The data corresponding to the same two screens were subjected to the present reanalysis, and it was found that the above-noted relationship is not affected by the larger electrode drop.

More measurements of the electrode voltage drops in different operating conditions are to be carried out in the future.

5.0 PLANS FOR NEXT MONTH

In addition to the measurements mentioned above, we plan to carry out during the following analysis an analytical study of the effect of turbulence on gaseous discharges, including the influence of finite reaction rates and electron nonequilibrium.

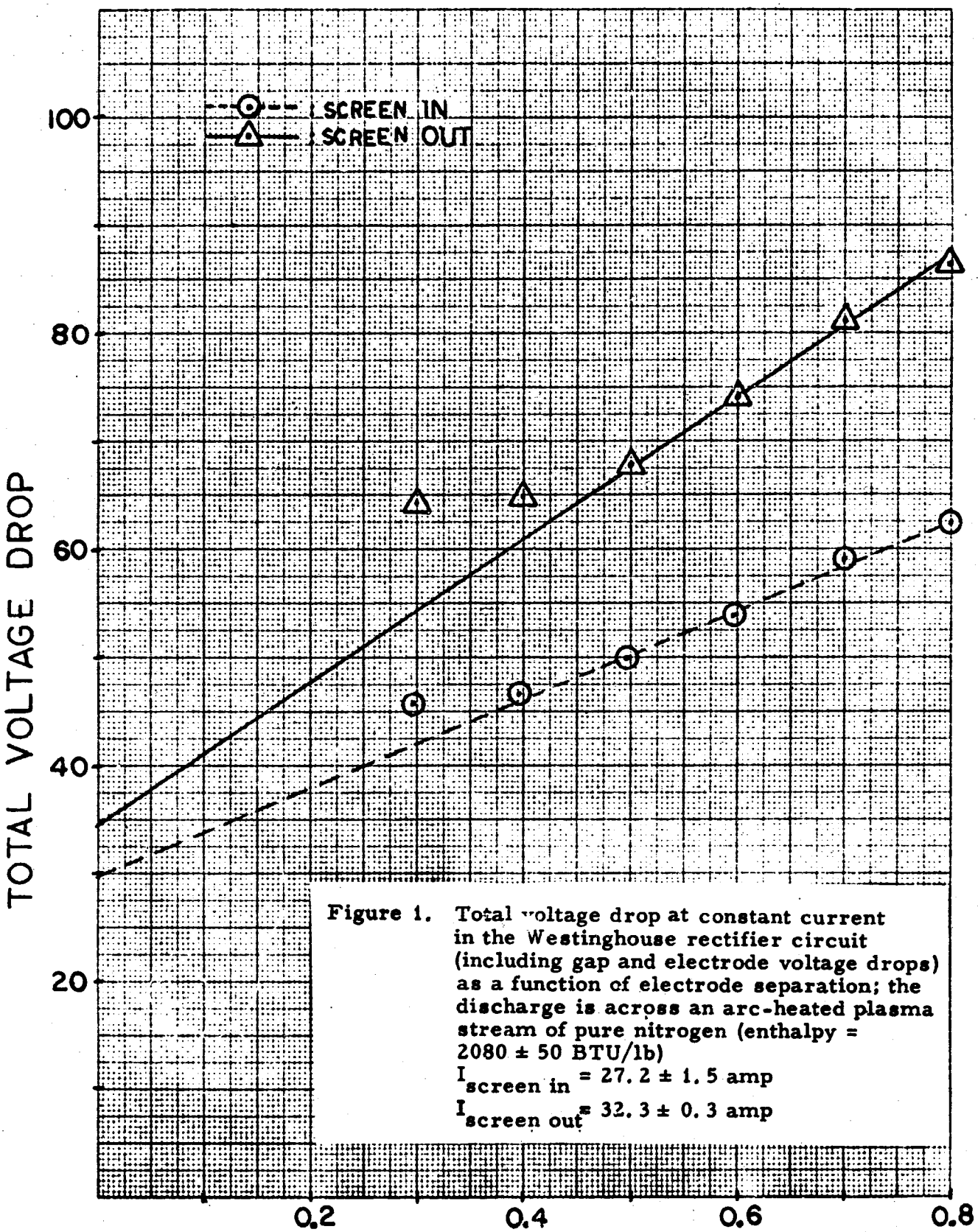

Figure 1. Total voltage drop at constant current in the Westinghouse rectifier circuit (including gap and electrode voltage drops) as a function of electrode separation; the discharge is across an arc-heated plasma stream of pure nitrogen (enthalpy = 2080 ± 50 BTU/lb)
$I_{\text{screen in}} = 27.2 \pm 1.5$ amp
$I_{\text{screen out}} = 32.3 \pm 0.3$ amp

TABLE I

CROSS-ARC CHARACTERISTICS IN
PURE N_2 WITH A 0.38 mm WIRE DIAMETER SCREEN.
ELECTRODE SEPARATION = 0.5".

a. Data taken with a 1 mm wire diam., 5 mesh screen.

Run No.	H (BTU/lb)	SCREEN IN V (volt)	SCREEN IN I (amp)	SCREEN IN SIGMA (mho)	SCREEN OUT V (volt)	SCREEN OUT I (amp)	SCREEN OUT SIGMA (mho)	RATIO Σ_{in}/Σ_{out}
184-A	1468.	30.0	31.5	1.05	50.0	27.	.54	1.94
184-B	1758.	29.0	31.0	1.07	47.0	27.0	.57	1.86
184-C	1940.	29.0	32.0	1.10	46.0	30.0	.65	1.69
184-D	2110.	27.5	31.0	1.13	44.5	29.5	.66	1.70
184-E	2410.	25.0	33.0	1.32	42.0	28.0	.67	1.98
184-F	2580.	24.0	35.0	1.46	39.0	28.0	.72	2.03
184-G	2820.	22.0	46.0	2.09	40.0	28.0	.70	2.99

b. Data taken with a 0.38 mm wire diam., 10 mesh screen.

Run No.	H (BTU/lb)	SCREEN IN V (volt)	SCREEN IN I (amp)	SCREEN IN SIGMA (mho)	SCREEN OUT V (volt)	SCREEN OUT I (amp)	SCREEN OUT SIGMA (mho)	RATIO Σ_{in}/Σ_{out}
185-A	1465.	26.0	35.0	1.35	45.0	25.0	.56	2.42
185-C	1890.	25.0	32.0	1.28	42.0	25.0	.60	2.15
185-D	2150.	22.0	32.0	1.45	38.0	22.0	.58	2.51
185-E	2320.	22.0	31.0	1.41	38.0	20.0	.53	2.68
185-F	2500.	22.0	33.0	1.50	36.0	21.0	.58	2.57
185-G	2510.	24.0	35.0	1.46	35.0	24.0	.69	2.13