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METEOROLOGICAL DATA COLLECTION

VIA ERTS-A DATA RETRANSMISSION FACILITIES

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TYPE III -- FINAL REPORT

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1. ABSTRACT

1.1 The Atmospheric Instruments Branch of the Atmospheric Environment Service has been involved in the design, development and implementation of meteorological data acquisition systems for several years. These systems are being used in a number of operational and research programs. The Meteorological Automatic Reporting Station (MARS) is used in the national weather network, for example. In keeping an eye to future requirements in both the operational and research areas, several satellite data retransmission programs are being evaluated as potential techniques for data communications from automatic data acquisition systems in remote areas. The ERTS program has provided "hands-on" experience in the interfacing, installation, logistics and other problem areas related to these types of programs and has verified the usefulness of polar orbiting satellites in remote data acquisition applications.

2. INTRODUCTION

2.1 Several types of data acqusition systems were considered initially for use with the ERTS Data Collection Platform (DCP). A standard Meteorological Data Acquisition (MDA) system was developed to meet a specific hydrometeorological requirement for remote, battery operated low temperature application for research support.

2.2 Interfacing the DCP to the data system and obtaining ground support for data flow were anticipated as being the area of most concern during the ERTS program participation.

3. OBJECTIVES

The objectives of the proposed use of ERTS DCP's and the ERTS A & B data communication systems are:

3.1 To serve as a facility for the onsite testing of experimental automatic meteorological, climatological and hydrometeorological stations;

3.2 To serve as a facility for the onsite testing of experimental meteorological sensors and transducers;

3.3 To evaluate the use of polar-orbiting satellites in the transmission of semi-real-time data for future operational and research programs of the Atmospheric Environment Service, Department of the Environment.

3.4 To accelerate the installation and collection of climatological data from several points in the Canadian Arctic.

3.5 To provide experience in logistic support related to multi-disciplinary data flow through national/international organizations.

4. BACKGROUND

4.1 The automation of data measurement and collection in the Atmospheric Environment Service (AES) began in the early 1960's with the procurement and evaluation of a USWB type of automatic land-line station -- AMOS 3. From this beginning was developed

the Canadian Meteorological Automatic Reporting Station (MARS-1), an electro-mechanical system linked into the land-line teletype circuits. Eighteen of these are now in use in operational or research networks in Canada.

4.2 In the latter 1960's, a battery powered, low temperature, hydrometeorlogical automatic telemetry station (HATS) was developed for use in mountain snowfields to measure temperature, rain and snow-pack water equivalent with electro-mechanical sensors, and has an integrated circuit electronic data processor. After three winters of successful testing of the prototype station at the 7000 foot level on Mount Enderby in the Canadian Rocky Mountains, six operational stations were purchased. These are linked into a UHF voice and data radio communication circuit.

4.3 Subsequently, a variety of data systems, developed from standard MDA assemblies for recording or radio telemetry, have been built and are in various stages of development and evaluation. Included in these, are:

- A wind data station with radio telemetry link, installed on the British Columbia coast;
- A line powered lake-shore automatic station for the IFYGL;

- A battery powered recording station for lake buoys for the IFYGL;
- An operational climatological arctic recording station (CARS);
- An operational MARS-2 for hourly reports on the teletype network.

4.4 A prototype Hydrometeorological Automatic Recording and Telemetry System (HARTS) was also developed using MDA assemblies for serial digital DCP usage during the ERTS-A experiment. A broad objective is the development of a family of practical automatic stations to measure, record and/or transmit data for climatological and/or real time purposes, usable in any part of Canada.

5. TECHNIQUES

5.1 HARTS was developed using standard MDA assemblies, of which several are common to a number of other data acquisition systems. The first system was developed to measure water equivalent of snow, temperature, wind speed and accumulated precipitation. The associated sensors are: a snow pillow (Goodyear 5' x 5' collapsible utility tank) with a pressure transducer for snow pack measure-

ments, a 200 ohm platinum resistance bulb with a radiation shield for temperature measurements, an AES type 45 cupwheel anemometer for wind measurements and a Fischer & Porter weighing precipitation gauge with mechanical encoding contacts for accumulated precipitation measurements. A wind shield was used on the Fischer & Porter to minimize errors due to air turbulence. A typical installation is shown in Figure 1 and the initial test site is shown in Figure 2.

5.2 A close-up of the temperature sensor and radiation shield is shown in Figure 3. Figure 4 is a close-up of the snow pillow and pressure transducer with its associated electronics.

5.3 A digital electronic interface card was designed from preliminary specification information for the data collection platform. This interface contained the necessary control logic and memory circuitry to enable standard AES MDA systems to utilize the ERTS data collection platform as an output peripheral. This interface is shown in Figure 5. Upon receipt of the DCP, minor design changes on the interface were necessary to incorporate changes in the serial digital input specifications. This interface assembly has been fully tested and operates satisfactorily with the DCP under a wide range of environmental

and system power variations. It can handle up to 64 bits of serial digital data, the ERTS system maximum.

5.4 For the initial tests a HARTS sampling interval of 24 hours was used on the data system to provide a "worst-case" test of the interface assembly and to establish a constant data storage for several orbital passes for adjacent data retrieval checks. The DCP platform identification was 6330.

This system operated satisfactorily unattended throughout the winter under varying snow, ice, cloud and wind conditions with no noticable degredation in data quality. Generally, data retrievals were obtained during 3 to 5 successive 3 minute DCP transmission intervals for 3 or 4 adjacent orbital passes. The next retrievals were obtained in the same sequence approximately 12 hours later. The system was taken out of service on September 16, 1973. No data link failures occurred but an instrument failure was intermittently detected on the precipitation channel due to mechanical corrosion on the encoding contacts.

5.5 The retrieval data via the ERTS data collection system is obtained thrcugh two sources. The binary data, which is decoded and processed at the National

Data Processing Facility (NDPF) at Goddard, Maryland, is sent to us via surface mail either directly or via the U.S. Embassy in Ottawa which yields a data delay of up to one week. The faster data retrieval path is via telephone lines and teletype equipment to the Canada Centre for Remote Sensing in Ottawa on a call-up basis through their computer facilities which were established to support Canadian programs related to ERTS and other future satellite programs. This method yields "pseudo-real-time" data retrieval on a same day or at least a next day basis and also provides individual user specified data processing and format control. This method is also subject to surface communications problems and computer down-time which produces lower quality and less reliable data. Figure 6 illustrates the data flow paths.

6. ACCOMPLISHMENTS

6.1 Two other MDA systems were built during the first test period to support hydrometeorological programs related to flow forecasting in the Applied Hydrology Division. These systems are identical to the system which was tested at Downsview except for

the addition of a Leopold Stevens Memomark II stream level gauge and the sampling interval was changed to 6 hours. A magnetic cassette tape recorder was included in these systems to provide a redundant backup for the data retrieval. One system was installed on the Albany River in northern Ontario in mid-September, 1973. It was connected to a DCP (ID.#6102) which was procured by that Division. Data retrieval rates are approximately the same as those obtained at Downsview with equally high quality and reliability. This system is continuing to operate satisfactorily.

6.2 Data errors were detected in the stream level information but reports have confirmed that sensor difficulties were the cause. The second system was to be installed in late 1973 on the Nahatlatch River in south-central British Columbia. This site was chosen since a representative sampling of the Fraser River watershed could be obtained for flow forecasting. The DCP at this site (#6232) also belongs to the Applied Hydrology Division. Logistic difficulties delayed the installation of the data system until late spring, 1974 but the platform is presently connected to some of the sensors via the parallel digital and the analog inputs.

6.3 A Climatological Automatic Recording System (CARS), which was developed for arctic climatological, long term, remote, data recording applications, was planned to be tested on Peisters ice island in the Beaufort Sea near 72°N by 140°W. The purpose of this test was to obtain representative CARS testing information for the future CARS program as well as to provide logistic and instrumentation experience to the Beaufort Sea instrumentation group for a northern resource development support project. The CARS was interfaced with the ERTS DCP (#6330) to provide far north link evaluations and first-look data retrieval from this station during these tests. This ice island has a westward movement of approximately 30 miles per month and is presently approximately 40 miles off the north slope of Alaska near Point Barrow. The system measures, records and transmits via ERTS, temperature, wind direction, wind run, accumulative precipitation, sampling number and station identification. The sampling interval is set for 3 hours.

6.4 The system was installed in the summer of 1974 and will be retrieved in the spring of 1975. To date, there have been no data retrievals via the

ERTS link. We anticipate that the CARS is operating satisfactorily but the location, which is marginally in the Goldstone, California communication range, and the environment, which is marginally within the DCP design specifications, are the major factors against ERTS data retrieval.

7. FUTURE ACTIVITIES

7.1 In January 1973, our plans included the purchase of three more DCP's for continued ERTS evaluation linked with the development of the Climatological Automatic Recording Stations. However, the delay of the implementation of this program together with consideration of the program objectives related to satellite evaluations, ERTS DCP costs, ERTS DCP availability and proposed AES participation in other similar satellite programs have resulted in our ERTS tests being based entirely on one DCP.

7.2 If the Beaufort Sea DCP is retrieved, the Atmospheric Instruments Branch would like to continue its participation in the ERTS data collection system program during the ERTS Follow-on Investigation Program with a continuation of the stated objectives.

8. CONCLUSIONS

8.1 The ERTS tests to date have provided considerable experience and confidence in satellite data retransmission programs and have generated continued enthusiasm for further evaluations of this and other similar programs.

8.2 The 18-day cyclic data retrieval timing and the 12 hour down time between orbits restrict the use of this type of data retransmission to specific types of programs. Operational real or pseudo-real time network applications which require more data, more often (i.e. hourly) and interrogated application or user triggered applications appear to be best implemented via geostationary satellites rather than polar orbiting satellites. The Geostationary Operational Environmental Satellite (GOES) and the potential Canadian UHF multipurpose satellite are both of high interest to AES at the present time.

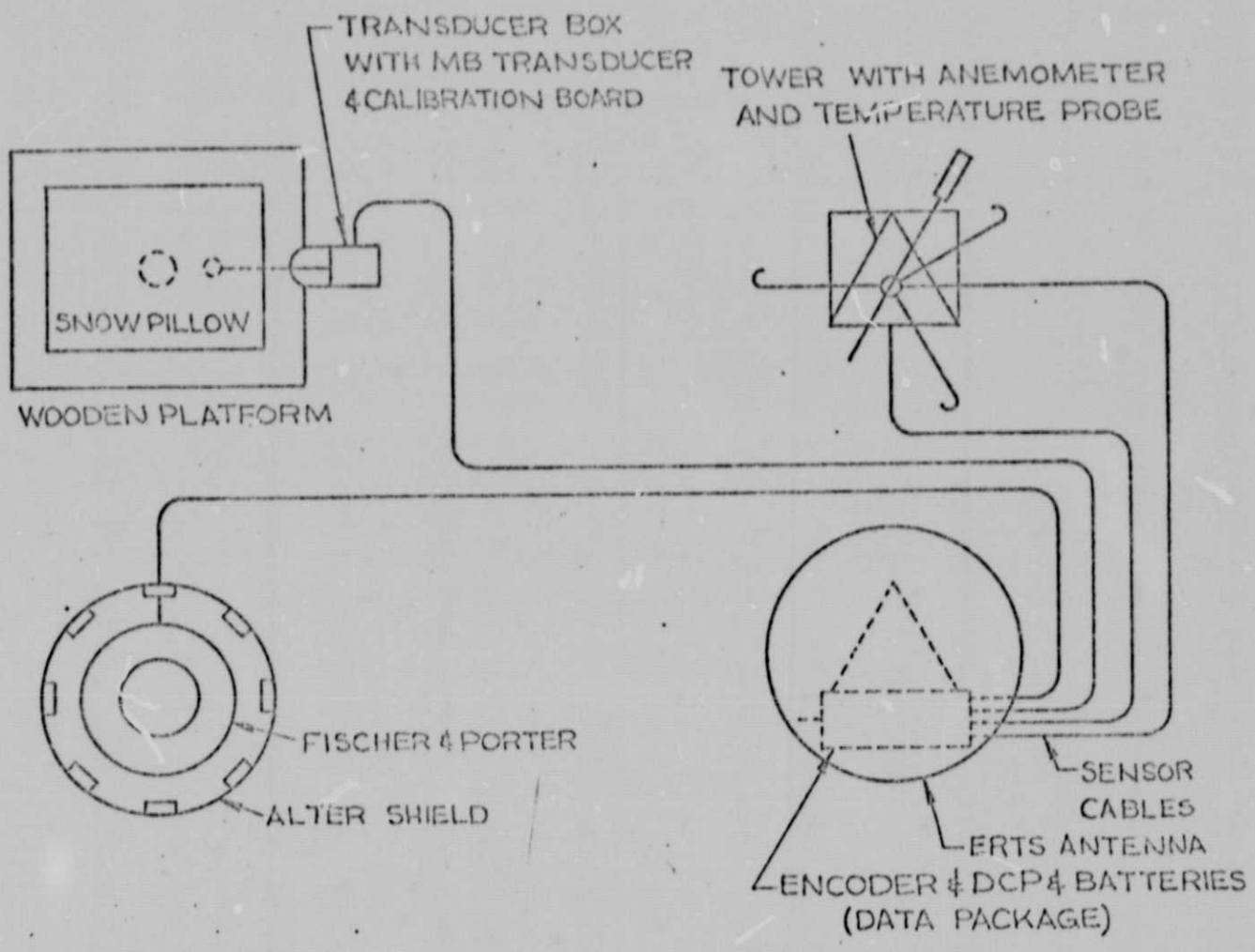

FIGURE 1. INSTALLATION PLAN

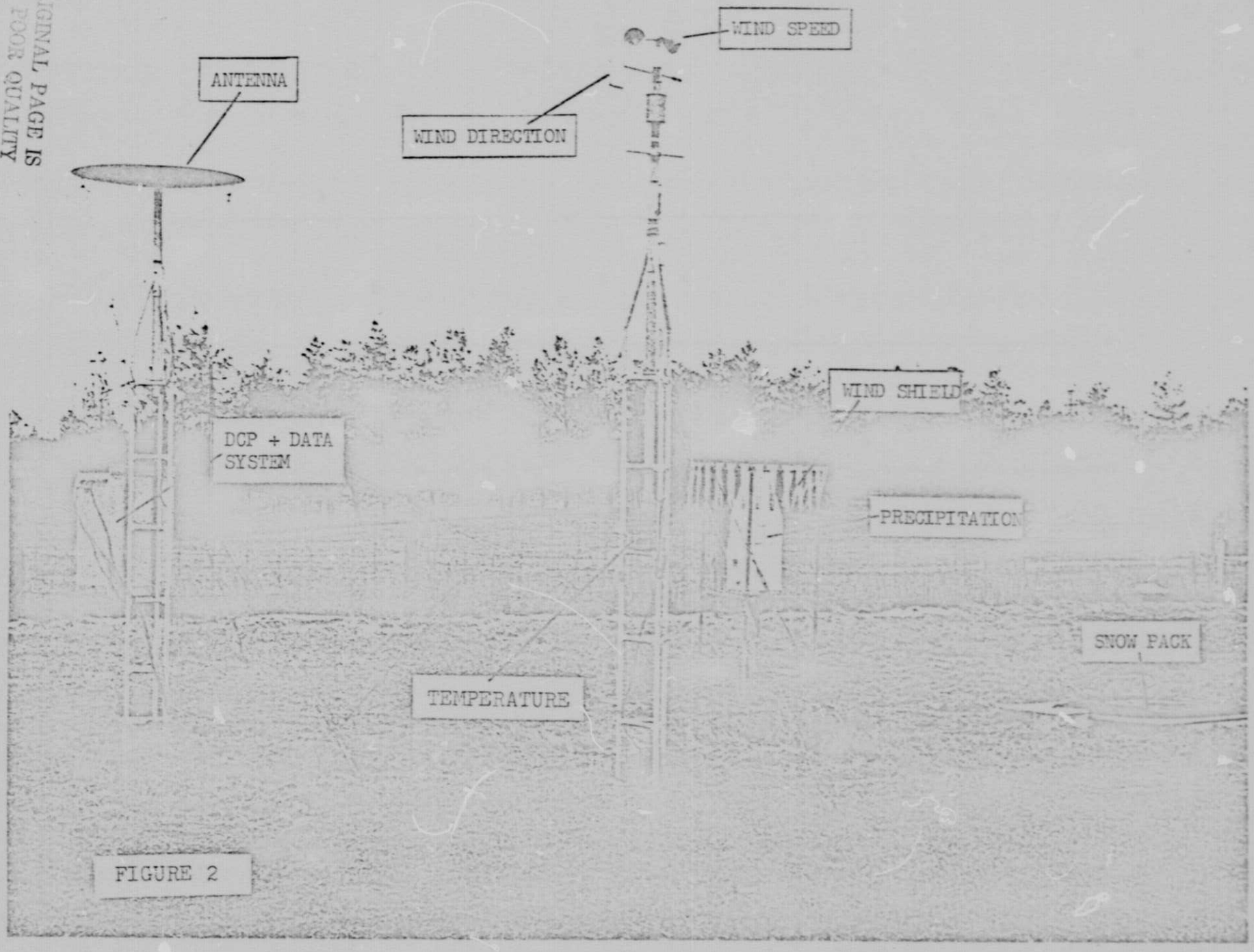

FIGURE 2

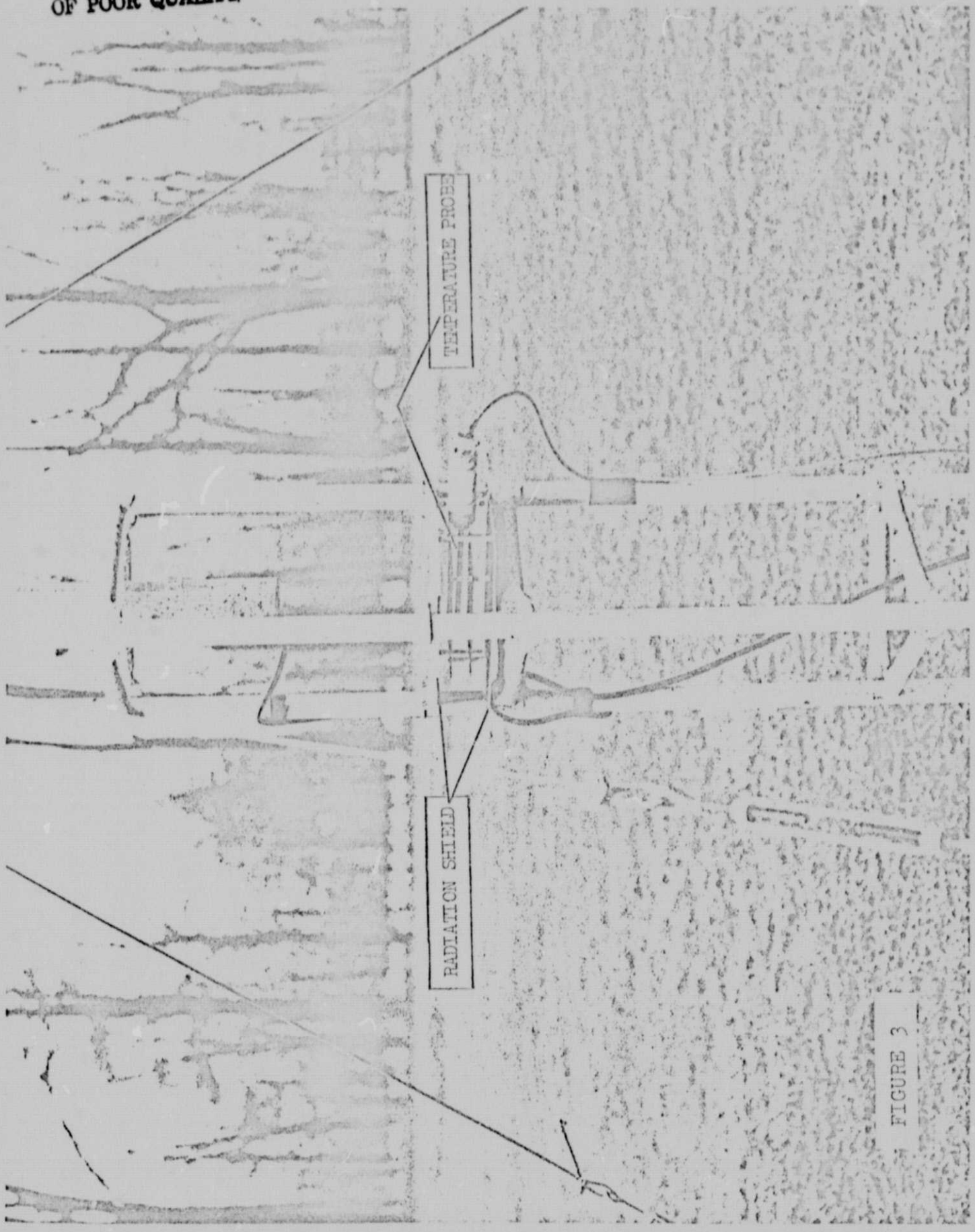

FIGURE 3

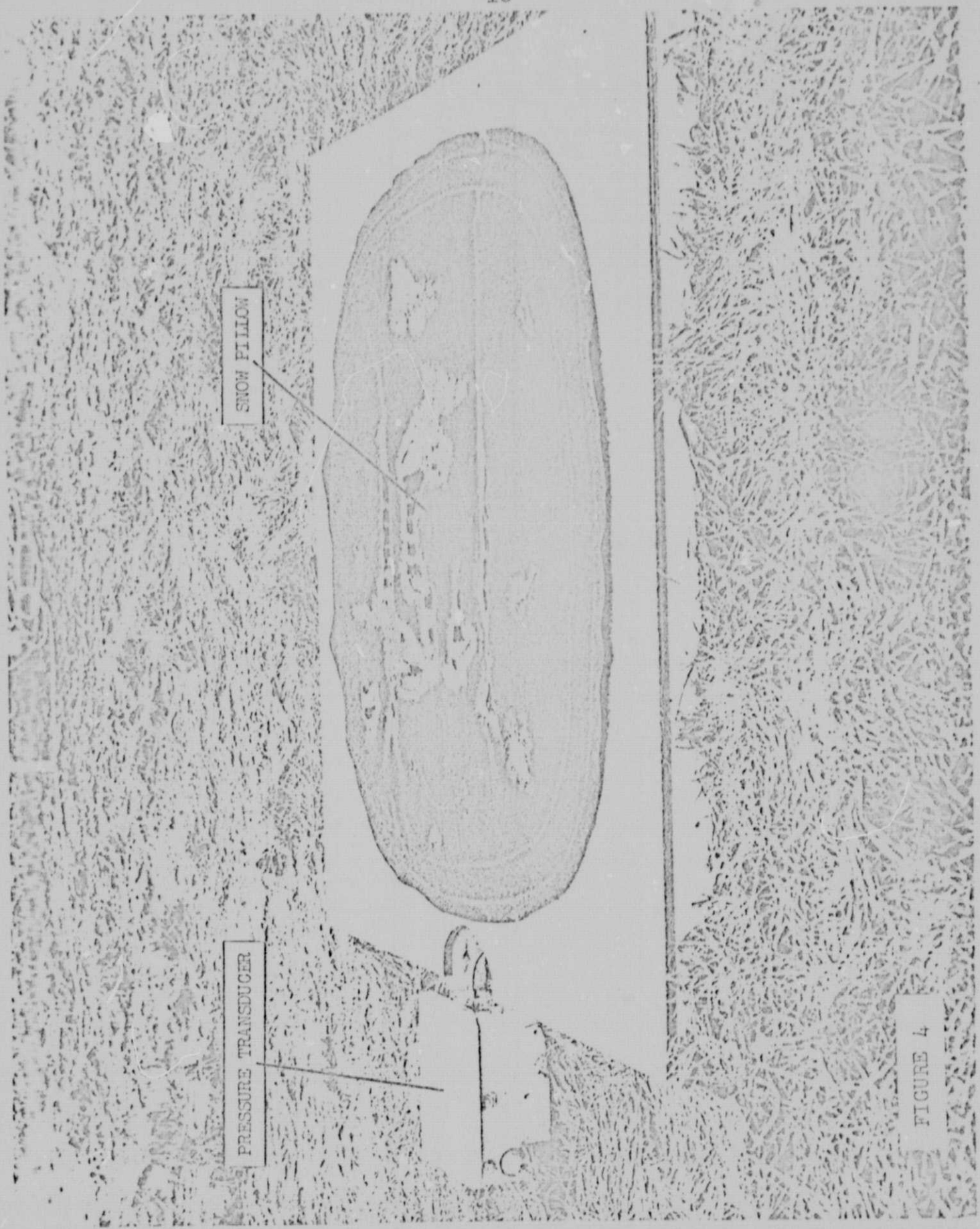

FIGURE 4

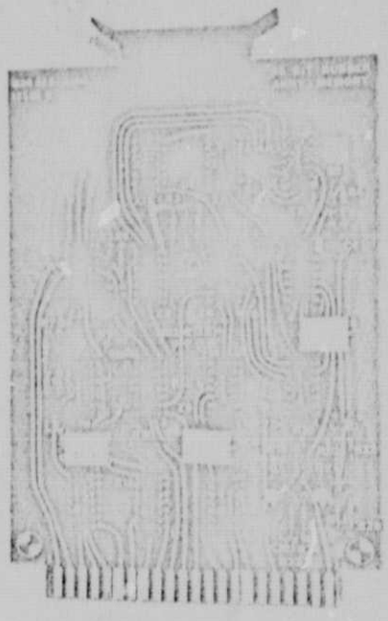

FIGURE 5 - ERTS DCP/ DATA SYSTEM INTERFACE

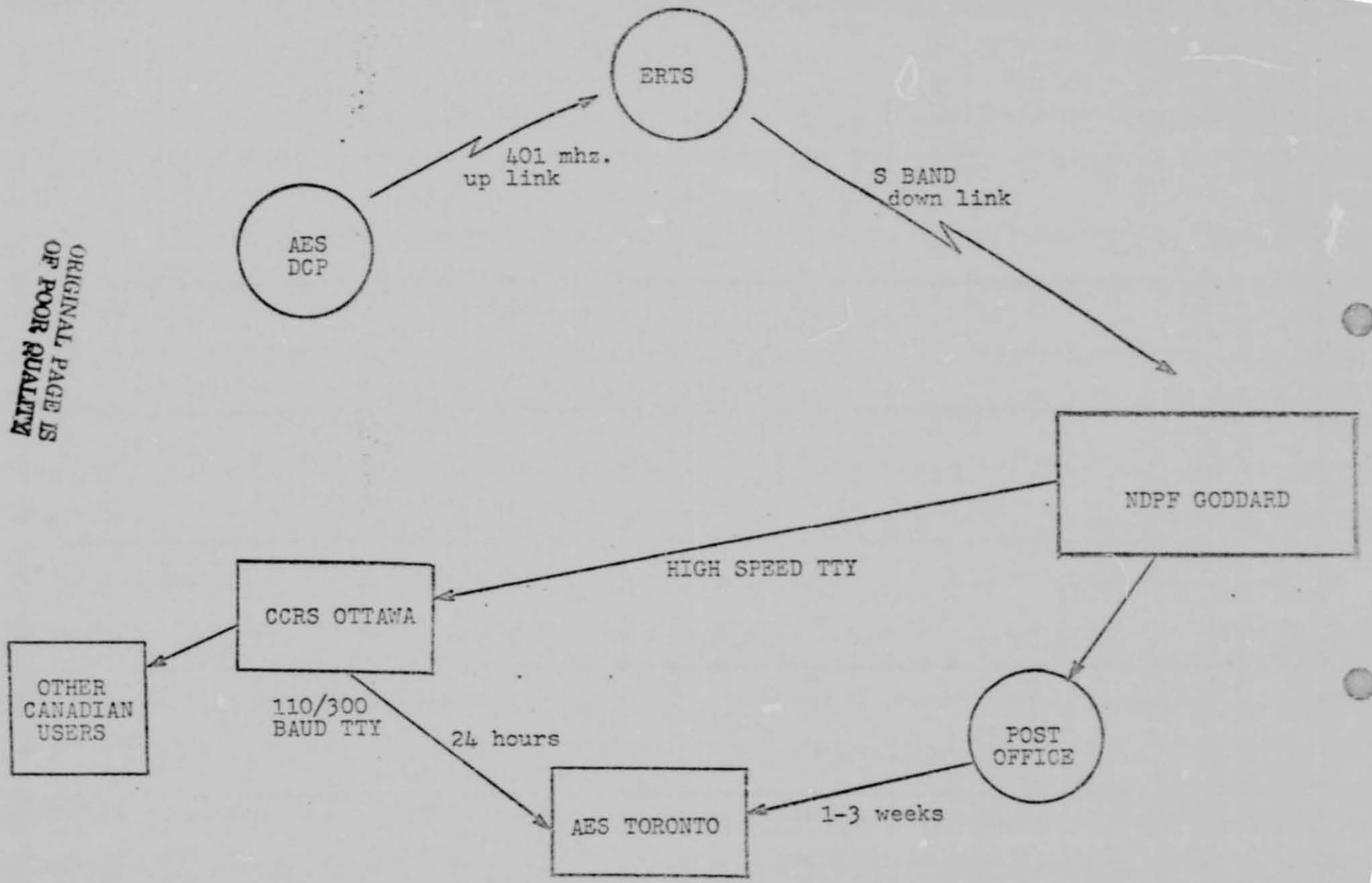

FIGURE 6 - REMOTE DCP TO USER DATA FLOW PATHS

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APPENDIX A

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ERTS INTERFACE DOCUMENTATION - MDA413A1

Oct. 25, 1972 64 BIT RUBBER MEMORY MDA 413A1

1. FUNCTION:

1.1

This card consists of a variable length memory of up to 64 bits, which serially stores data from an MDA encoder.

1.2

Data cycling is controlled by an encoder control flip-flop or a DCP control flip-flop and a seven stage counter is used for bit position control.

1.3

Data input side of card is DTL compatible and DCP output side of card is TTL compatible.

2. DESCRIPTION: (See drawing C1070-413A1) & (Refer to Figure 1).

2.1

The board operates in three modes; standby, encoder control and DCP control.

2.2

When encoder turns ON, the "logic 0" pulse received on Pin 10 sets the encoder control flip-flop at Z5-8 and Z4-6 generates a 10 μs clear pulse to clear the bit counter Z1-2.

2.3

Z3-10 generates a "logic 0" to inhibit internal oscillator during either encoder control mode or DCP control mode.

2.4

Z5-13 places an inhibit on DCP control (MDA Priority Override) Z3-6, to prevent garbling of data during memory updating cycle by a DCP sampling.

2.5

The inhibit is removed from encoder clock pulse gating (Z10-10) and data from encoder is sampled and entered into memory (Z6-15) as follows: 16 digits are selected by Pins 3 through 9 and Pins C, D, E, F, H, J, K, L & M and bits 2^0 through 2^3 are selected at Pins N, P, R & 15. Bits are sampled in middle via Pin 16 pulse. When 64 bits have been counted a "logic 1" level from Z1-3 inhibits further Cp entry into memory shift register and bit counter.

2.6

A "logic 0" on Z2-12 removes inhibit from internal oscillator Z2-3 which automatically shifts to bit 64 if there are less than 64 bits entered from the encoder and then oscillator self inhibits.

2.7

A "logic 0" stop pulse on Pin 11 is required prior to encoder turn OFF to inhibit MDA encoder input logic ahead of the "logic 0" condition that occurs during power down on the MDA encoder.

2.8

When DCP turns ON (every 180 seconds) the "logic 0" control level on Pin 22 sets DCP control flip-flop Z5-6, and Z4-15 generates a 10 μsec clear pulse to clear the bit counter.

2.9

Z6 is placed in a recirculate mode by a "logic 1" on Z6-10 and data is recycled back intoomemory as it is sampled.

2.10

When a "logic 1" enable signal is placed on Pin W, data is sampled by DCP "logic 1" clock pulse on Pin X and "logic 1" true data from memory is available serially on Pin 18.

2.11

When the DCP shuts-off, the DCP control flip-flop clears, and the internal oscillator has its inhibit removed which automatically shifts to bit 64 and then self inhibits due to the "logic 0" on Z4-10.

2.12

The board is now in standby mode awaiting a new DCP cycle or MDA update with the circuit in the following condition:

a) Data residing in memory

b) Bit counter at 64

c) DCP and encoder control flip-flops in clear position.

2.13

Q1 to Q2 are used in the DCP clock enable and DCP Clock input circuits respectively to provide TTL to CMOS conversion.

2.13.1

When a TTL "logic 1" arrives on Pins W and X, Q1 and Q2 ground Z7-3 and Z7-5 which puts a "logic 1" on Z7-2 and Z7-4, Z11-2 gives a "logic 0" and Z7-6 feeds a "logic 1" into Z6.

2.14

Diode D3 acts as an isolator for "logic 1" levels between CMOS output and Data collection platform TTL by reverse biasing when a "logic 1" level occurs.

3. APPLICATION:

3.1

This board is used to receive and store data from an MDA encoder periodically and then transmit that data to the ERTS data control platform on command when activated every 180 seconds.