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To: Airborne Science Data Users
From: Richard Hang and John McGrath Code RI

Subject: Overview of the Airborne Science DC-8 Information Collection and
          Transmission System (ICATS)

1. 0 GENERAL INFORMATION:

This memorandum describes the on-board Airborne Science DC-8 Information
Collection and Transmission System (ICATS) designed, assembled, and programmed by
the Research Instrumentation (RI) Branch and the ICATS post flight data processing,
archive and data access system developed by Code F.

Functions of the on-board ICATS include: (1) Interfacing to and processing avionics and
environmental parameters derived from Navigational Management System, Global
Positioning System, Central Air Data Computer, Embedded GPS/INS and analog voltage
sources from aircraft and experimenters. (2) Furnishing engineering unit values of
selected parameters and computed functions for real-time video display and archiving
ASCII data at experimenter stations, (3) Archiving the engineering unit values of all
Appendix A parameters on data storage for post flight retrieval.

The resulting post-flight archiving system provides World Wide Web (www) based
access with secure permission-based remote login. The data will be available anytime 24
hours/day, 7 days/week. In addition to the World Wide Web an ftp server is also
available.

2.0 OVERVIEW OF ICATS
        2.1 Hardware Configuration
Hardware components for ICATS consist of a prime and spare VME chassis and
associated hardware. Located in the housekeeping rack between the Mission Director
and Navigator station. Prime and spare Sun Ultra 80 work stations and associated
hardware located at the operator station in the DC-8.

            2.1.1   VME chassis
                    All computations and data interfaces for the ICATS system are
                    implemented in a 20 slot VME chassis, which presently contains a
                    CPU controller card, MIL-STD-1553 and ARINC-429 interface
                    cards, analog/digital converter card and a broadcast memory card.
                    The broadcast memory card is used to interface with the Sun Ultra
                    80 installed in the Operator Station. The Numeric Parameter
                    Display Page routine is run in this chassis.

2.1.2   ICATS Operator Station
The ICATS operator station contains two Sun Ultra 80 workstations. The Ultra 80 will serve as a control point for all ICATS functions. Boot-up and all archiving functions are implemented in the Ultra 80. Track plot and Parameter Plot routines are run in this computer. The Mission Managers PC used for keyboard entry commentary is connected to the Ultra 80. Ultra 80 hard drives will be used for archiving mission Binary data at 1 & 10 samples/sec and ASCII data at 1 sample/sec.

2.2 Other ICATS Hardware.
2.2.1   The ICATS operator station contains a PC laptop. This laptop computer will serve as a back up for logging the ASCII data generated during the flight. The laptop can also be used to boot-up the VME chassis.

2.2.2   A broadcast memory hub has been established. The Ultra 80 workstation communicates with the broadcast memory card in the VME chassis via a fiber optic line.

2.2.3   A ethernet hub connects the VME Chassis, Sun Ultra 80, printer, mission directors X term, and experimenter stations.

2.2.4   RS-232 lines route data to each experimenter station.

2.2.5   CD read/write hardware to burn either ASCII and/or Binary file up to 700 Mb for on mission archiving.

2.2.6   RS-232 line connects Mission Manager PC to Ultra 80.

2.2.7   DC-8 network printer is available for use by all DC-8 mounted experiments.

2.2.8   NOAA Satellite Weather Pictures
This Lockheed Automatic Picture Transmission (APT) system is located at the ICATS operator station. When on a remote deployment or during a flight, the onboard APT system can be used to obtain near real time observation of weather.

2.2.9   Software Configuration
The Unix system installed in the VME chassis utilizes the VxWorks operating system. Code RI has written software specific to the DC-8 mission requirements. Output of this software is described in this memorandum. Code F has written software specific to the DC-8 post-flight data processing, archiving and data access system.

3.0 DATA SOURCES FOR THE ICATS SYSTEM

ICATS receives digital and analog input signals from a number of sources. All data is acquired by ICATS at 30 samples per second. This data is converted to engineering-units and recorded in Binary format at 1 & 10 samples/sec. The ASCII files of selected data is distributed and stored at 1 sample/sec.

3.0.1   Digital Input Signals
MIL-STD-1553 bus data
Honeywell Embedded GPS/INS
Radar Altimeter (RA)
ARINC-429 bus data
Navigational Management System (NMS)
Air Data Computer (ADC)
Global Positioning System (GPS)

3.0.2   GPS Updated Time Code Receiver
Aircraft Time Code Generator furnishes time to all requirements on aircraft. The TCG receives updates from a GPS receiver. ICATS has a time card reader which continuously syncs the IRIG-B from TCG and inputs data to memory at 30 samples per second. Time code values are combined in ICATS and are available to users in real time and post flight as parameter "Time". Time is available in ASCII format with a range of 00:00:00.000 to 23:59:59.999 and also is contained in the post flight Binary files.

The Aircraft Time Code Generator also provides time to the video distribution system, providing a time tag for all video displays and recorded video.

3.0.3   Mission manager's log
The Mission Managers Log file enables the Mission Manager to provide time stamped keyboard entry commentary of his observations or those from other sources. The logging subsystem automatically records the start and end of data runs, annotating them with present time, position, and altitude and other information. ICATS provides the capability for future upgrades to the existing log file system.

3.0.4   Analog Sources
A 64 channel high speed analog to digital converter card resides in the ICATS VME chassis for analog signals from aircraft and environmental sensors. This card will also be used for analog signals routed to the VME from experimenters hardware. These analog inputs are converted to engineering units and become part of the parameter data base as listed in Appendix A. These analog sources include the following:

- -Rosemount Model 1241 A6CD for cabin altitude.
- -General Eastern Model 1011A thermoelectric hygrometer.
- -EG&G Model 300 cooled mirror hygrometer system.
- -Barnes Engineering Co. PRT-5 infrared radiometer.
- -Honeywell ANP-222 electronic altimeter system.
- -Analog signals routed to ICATS from experimenters.

4.0 OUTPUT PARAMETERS AVAILABLE FROM ICATS

Appendix A lists output parameters from ICATS which are available in the data base for use in display, computations, and archiving. This appendix identifies the (1) source for each parameter, (2) the ICATS parameter identification code (PARM ID), (3) units for the parameter (deg., ft/sec, knots, deg C, etc), (4) sign convention definition if appropriate (for example for vertical speed + for ascending, - for descending) (5) parameter range (for example (GPS alt range – 1000 to 131,072 ft) (6) other comments.

Attachment B shows the ASCII parameter set and format for the ICATS parameters distributed on the 1200, 9600 and 19.2K baud rates from the RS-232 distribution systems. This set of ASCII parameters (9600/19.2k) is what will be archived at 1 sample/sec. For each mission, additional parameters from the ICATS output parameter list may be added or substituted within the limitations of the RS-232 system.

5.0 VIDEO DISTRIBUTION SYSTEM IN ICATS

5.1 Parameter alphanumeric displays: The DC-8 closed circuit television system displays to the on-board experimenters choices from a number of video sources including a data page of parameters which is generated in the ICATS system and sent out in NTSC format to the video switching system. The present format consists of 2 columns of 17 parameters each. Parameter name, engineering unit's value, and units are displayed in each column.

5.2 Track Plot on TV monitor
The ICATS system generates a Track Plot of the DC8 flight.

5.3 Parameter Plot on TV monitor
The ICATS system generates a Parameter Plot consisting up to 6
parameters on the y-axis.

5.4 Video recorders
Includes three VHS format time lapse which can provide 2 to 6 hours of
continuous recording. A quad video splitter is available to consolidate
four video NTSC views onto one NTSC distribution cable. This feature
can be used for comparison of related video images.

6.0 RS-232 DATA LINE TO EXPERIMENTER-OPERATED COMPUTERS

The ICATS provides the ASCII formatted engineering unit data to
experimenter-operated computers via RS-232 line at a rate of one
sample/sec. Transmission rates of 1200, 9600 and 19.2 baud is available.
Formats are shown in Appendix B.

A data distribution subsystem accepts the standard RS-232-C signal
outputs from the ICATS serial output interface, converts the signal to RS-
422 (for noise immunity and improved signal-to-noise) and distributes the
data along both sides of the aircraft. The signals are tapped at intervals
and regenerated as RS-232-C at each experiment station. Each station has
three DB-25 connectors, each dedicated to one of the three baud rates
(1200,9600, and 19.2K) for use by the experimenters. Connectors may be
used simultaneously, in any combination. The signals are opto-isolated
from the main data path and the RS-232-C drivers are current limited in
order to protect the system from defective experimenter equipment or
accidental shorting of output lines. The experiment station box may be
configured as a modem (DCE) or as a computer (DTE). The configuration
is defined by a switch setting at each experiment station box. This switch
functionally exchanges pins two and three of the DB-25 connector.

7.0 ON-DEPLOYMENT DATA DELIVERY AVAILABLE AFTER FLIGHT

During the flight mission, data output parameters discussed in Section 4.0 are archived in both Binary (1 & 10 samples/sec) and ASCII format (1 sample/sec) to hard disc on ICATS Sun Ultra 80 located in the ICATS operator station.

7.1 Experimenter retrieval of data on aircraft on deployment:
       a) ICATS create a hard copy of track plot or parameter plot if required.
       b) Access the data through an ethernet connection to an ftp or http server.
       c) ICATS produce a SCSI 8 mm tape and/or CD if required.
       d) ICATS make a SCSI 8 mm tape for use with portable UNIX workstation (laptop) which runs ORACLE software.

7.2 Experimenter retrieval of data off aircraft on deployment:
       a) Data will be made available on the World Wide Web and ftp server.
       b) CD, Disc or 8 mm tape.

8.0 DRYDEN BASED ICATS POST FLIGHT DATA DELIVERY AND ARCHIVING

8.1 ICATS data archive:
       NASA will utilize a Sun Ultra 80 and associated storage capacity as host for the data archive of all data referenced in Section 4 of this memorandum. This parameter set may change as DC-8 missions continue.

       The NASA archive will contain the ICATS DC-8 Binary files at 1 & 10 samples/sec.

       The NASA archive will contain the ICATS ASCII files at 1sample/sec with parameters on the 9600/19.2k baud.

8.2   ICATS data retrieval methods:
       Access to the Sun Ultra 80 ftp server.

       In addition, the Sun Ultra 80 will be configured as a web server. Data requests may be made with a Web Browser. Data downloads may be made with a Web Browser. Data PARM ID codes identifying parameters, parameter ranges and sign conventions will be the same as those referenced in Section 4.