SECTION 1 - HYDROMETEOROLOGICAL AUTOMATED DATA SYSTEM

1.0 Introduction

This section provides an overview to the Hydrometeorological Automated Data System (HADS).

With this background material, the HADS users should understand how it works and how it can be used most effectively for their offices. HADS was designed to provide random and self-timed data to assist the forecaster in various program areas including Fire Weather, Agricultural Weather, and Hydrologic forecasting. HADS currently decodes a wide variety of hydrometeorological data types from more than 10,000 reporting sites; operating in all 50 of the United States, Canada, Mexico, Puerto Rico, the Virgin Islands and several Central American countries.

1.1 Overview

As HADS decodes data and produces reports, it interfaces with many computer systems. The web image located at http://www.nws.noaa.gov/oh/hads/data_path.html details the data and processing path of the HADS environment. HADS processed data receives input from Geostationary Operational Environmental Satellite Data Collection Platforms (GOES DCPs). The observation and transmission timing schemes for the GOES DCPs sites are described in Section 2.

The NWS Weather Forecast Offices (WFOs) and River Forecast Centers (RFCs) provide input to HADS in the form of user report record definitions via the password protected web pages.

The web page locations for enacting changes to user reports have been distributed via nws.noaa.gov mail and are not included in this document.

For assistance and guidance regarding the user report pages, send mail to:
hadssystem@gateway2.nws.noaa.gov

The WFOs and the RFCs are expected to modify the content of the office's specific report records via the realtime interactive processes made available at these web pages..

GOES DCP Input

The National Environmental Satellite, Data, and Information Service (NESDIS) GOES Data Collection System (DCS) is comprised of the DCPs, the NESDIS Command and Data Acquisition (CDA) System and Data Acquisition Processing System (DAPS).

The components of the NESDIS systems are collectively referred to as the GOES DCS.

This satellite-based system collects a variety of environmental data from locations in the Western Hemisphere. The system is a data relay network for more than 19,000 DCPs which transmit data to one of two GOES satellites (East and West). These data are relayed to the NESDIS CDA ground station located at Wallops Island, Virginia. The data are then relayed over dedicated telecommunication circuits to the NWS Telecommunications Gateway (NWSTG) in Silver Spring, Maryland (SSMC2), where the information is then routed to the HADS computer systems.

The NWSTG computers normally receive raw GOES DCP data via a telecommunication circuit within 2 minutes of the DCP transmission. This raw data is then transferred to an another server in usually one to two minute cycles. HADS then retrieves all new data files from this server and processes this data in a 3 minute cycle.

Methods are in place to specifically filter-out certain DCP messages...those deemed as not providing any useful hydro-met. This helps to increase the efficiency of HADS processing since data from all of the active DCPs in the GOES DCS are forwarded to HADS by the NWSTG.

An archive of 72 hours of raw data is maintained within HADS.

The DCS facility also maintains 72 hours of raw data. If a communications outage should occur between the DCS at Wallops Island and the NWSTG in Silver Spring, the DCS is capable of holding and then forwarding all of the data not relayed during an outage. HADS is likewise capable of retrieving, processing and then distributing all of this ‘back-logged’ data.

Field Office Input

NWS field offices provide a unique type of input to HADS.

The WFO and RFC users instruct HADS in defining exactly which data sites and which data types HADS must send to their offices.

These User Report definitions are maintained in a relational database, accessible via password protected Internet Web pages. Details of these pages are provided in Section 3 of this document.

Groups

Certain group definitions for DCP sites are maintained automatically within HADS. As stations are defined, they are assigned to both state and Hydrologic Service Area (HSA) groups. Whenever a new site is added or deleted, the state and HSA groups are automatically updated.

Reports

All User Reports are created and distributed via a single method, know as a Send On Receipt Report (SORR).

SORRs are created and data distributed in an "as-received-basis" meaning that when raw data arrives from a DCP, it is translated into the Standard Hydrometeorological Exchange Format (SHEF) and is immediately placed into a data product and forwarded for distribution. Since the HADS processing program executes in a 3 minute cycle, all data received and processed during this 3 minute period is properly formatted and placed into a user's unique report. Offices with large numbers of DCPs in their area may receive a HADS product every 3 minutes, other offices not as frequently. River Forecast Centers, with their larger areas and therefore larger number of reporting sites will mostly likely receive lengthy messages every 3 minutes.

Reports are to be created and maintained by each user and tailored to the needs of each individual office. Reports can also be created by the HADS Network Manager. Section 3 of this handbook details the methods for creating user reports.

Report Content

HADS does not filter any data! All data received is made available and distributed to NWS offices.

If a DCP sends 4- one hour readings every 4 hours, then an office receiving this site will likewise receive the 4 - one hour readings every 4 hours.

If a DCP sends 12 - 5 minute readings every hour, then an office receiving this site will likewise receive the 12 - 5 minute readings every hour.

Report content is extremely variable since DCP reporting characteristics vary greatly. DCPs transmit their data in 1, 2, 3, 4 and 6 hour reporting cycles.

DCPs are programmed to record and transmit sensor information at time intervals ranging from as little as every 5 minutes, to as great as just once every 6 hours.

It is the responsibility of the HADS Network technicians to understand and to correctly translate these wide range of reporting characteristics, so report content is correct and data recipients acquire valid information.

Product Names

Each NWS user of HADS has been assigned a unique product identifier and a unique World Meteorological Organization (WMO) communications header.

The products for NWS offices are created as OHRRSxxx**,** where '**xxx**' is the three-letter AWIPS identifier of an office (i.e., OHRRSPHI).

A complete listing of each office's product names and their associated WMO headers is maintained on the Internet at http://www.nws.noaa.gov/oh/hads/new_wmo_headers.html

Displays

All displays of HADS information are available via the HADS web pages. These pages include DCP site configuration information pages, decode data pages and raw observational data.

Interactions with any of these pages is performed in real-time, via web based applications, such as PERL and JAVA scripts which in turn interact with the HADS database.

Section 1.2 HADS Network

The HADS network consists of land-based GOES DCPs. The GOES DCPs are owned by Federal and state agencies, private firms, and city governments. NESDIS is responsible for assigning the GOES DCP address, channel assignment, and transmit schedule for all GOES DCPs in the GOES DCS. NESDIS relays the GOES DCP raw data from Wallops Island, Virginia, to the NWSTG via a dedicated circuit. The data are then processed by HADS.

The NWS field offices determine whether a particular GOES DCP should be part of the HADS network and coordinate with the HADS network technicians in having a reporting location become part of the HADS Network.

A National Weather Service Location Identifier (NWSLI) is used to identify GOES DCP sites. A newly reporting sites will not be added to the HADS Network until a valid NWSLI is provided by the appropriately responsible NWS office.

Section 1.2.1 DCP Types

NESDIS provides users with the capability to collect data primarily from two DCP types:

-Self-timed DCPs with a GPS controlled clock
-Random-reporting DCPs

The vast majority of the DCPs deployed today for hydrometeorological data collection are either the self-timed or the self-timed plus the random-reporting capability. NOAA NESDIS certifies all DCP types and manufacturers that are used on the NOAA NESDIS GOES DCS.

Self-Timed DCPs

The most common type of DCP currently in use is the self-timed platform. Such DCPs transmit at assigned times, on assigned channels, at 1, 2, 3, 4 or 6 hour intervals. These assigned transmission times are actually time intervals (or time slots) of 10 seconds to 1-minute duration (the 0 second through the 59th second of each minute). A self-timed DCP is expected to transmit any time during its assigned time slot but not to overlap adjacent time slots. The transmission times are controlled by precision timers contained within the DCP.

A maximum of 60 self-timed DCPs, cycling every 4 hours, can transmit in an hour on a self-timed channel. However, if each platform transmits once every 3 hours, a total of 180 DCPs can share a channel. Such DCPs must always transmit at regular intervals. There is no flexibility to adapt the reporting frequency because of changing conditions. If the transmission time changes accidently, the transmission may block another DCP's transmission. The reliability of this approach for individual transmissions is near 100 percent and is generally limited only by the DCP equipment reliability.

Many of today’s DCPs use a variant of the self-timed DCP in which 10, 15, 20, or 30 second rather than 60-second time slots and incorporate a significantly higher quality timer to prevent drifting from its assigned slot. However, two, three, or four times as many platforms could share a channel and each platform could then transmit much more often and as frequently as once an hour.

Random-Reporting DCPs

The most sophisticated DCP, from a technological point of view, is the "intelligent" model that is able to control the rate of data transmission based upon rate(s) of change of the parameter(s) being sensed. Data transmission rates are infrequent when the parameters being sensed are stable. The transmission rate increases as the parameter being sensed begins to change. Generally, an event (e.g., rising rivers, heavy precipitation, etc.) causes the data to be transmitted. The transmissions are unscheduled in time and randomly arrive at the ground station. Random reports are transmitted on a different channel than the self-timed reports.

Random-reporting DCPs offer two primary advantages. First, there is no requirement for rigid scheduling; so the complexity of a DCP can be reduced, which increases platform reliability and reduces platform costs (e.g., the need for high-performance receivers or clocks in each platform can be eliminated). Second, platforms can (within limits) transmit when conditions warrant rather than on a fixed schedule; transmissions can be driven by the events being reported. This ability to adapt the rate of reporting to the changing conditions is of significant value to a number of GOES DCS users.

The two characteristics of random reporting (described above) can be separated, if desired; transmissions can be unscheduled without being adaptive. For example, DCPs could take measurements at some fixed interval determined by a stable, but not necessarily synchronized, clock and could transmit at random delays thereafter. This procedure eliminates the need to synchronize each DCP clock with external time; more importantly, clock drift would preclude consistent interference with another platform or user. The important point under random reporting is that the specifications on DCP clock stability and synchronization are driven solely by the user's measurement timing requirements rather than by the link protocol (as is the case in all self-timed DCPs).

The advantages of random reporting, however, are not achieved without some cost. Random reporting has two primary disadvantages. First, the probability of successfully receiving a given message is limited by the activity on the channel. Random DCP transmissions may need to be repeated to ensure a satisfactory probability of successful reception. Second, a random-reporting network will often require more sophisticated computer analysis at the receiving site to store and decode the incoming messages. The time of message arrival is not predictable, and some messages will be received more than once. Random reports are somewhat more complicated to decode and store because they lack the convenient, predetermined nature of other DCP data.

Section 1.3 SHEF Codes and Units

HADS uses SHEF to transmit data to field offices. Table 1.3--1 contains a list of SHEF physical elements used in HADS, their definitions, and the applicable units (English and SI). In SHEF messages, different data types are keyed by a seven-character Parameter Code represented by the character string '**PEDTSEP**'. The string is defined as follows:

PE = Physical Element (gage height, precipitation, etc.);

D = Duration Code (instantaneous, hourly, daily, etc.);

T = Type Code (observed, forecast, etc.);

S = Source Code (a refinement of type code to indicate how data were created or transmitted);

E = Extremum Code (maximum, minimum, etc.);

P = Probability Code (90%, 10%, etc.).

When fully specified, the parameter code string contains six "keys" for database identification. Defaults have been assigned for each attribute (except PE) so that most hydrometeorological data can be identified by a "minimum key" of two characters. The "full key" is used primarily in the transmission of unique hydrometeorological data.

In HADS, only the first four keys (PE, D, T, S) are used. These keys are described further below. For more details, users should consult the SHEF Code specification document which is available through the Regional Hydrologists.

PE- Physical Element--This is always specified by a two-character code.

Typical physical elements are discharge (QR), gage height (HG), reservoir forebay elevation (HF), or precipitation increment (PP).

The first character of the code usually defines the basic category of the data while the second character provides additional detail. Certain characters within the table have special meaning (e.g., physical element codes beginning with 'D' are reserved for Date/Data elements).

D - Duration--The duration character and physical element (PE) together describe the majority of observed hydrometeorological data.

The duration code describes the time period to which an observed or computed increment applies. If the physical element is a continuous function, such as river discharge, the reported value is an average for the indicated duration. If the physical element is not continuous, such as precipitation increment, the value is a summation over the duration specified. The durations used for HADS are shown in Table 1.3--2.

T - Type--The type character is used to describe the basic category of the hydrometeorological data being transmitted. These types include real-time observed, forecast, processed, contingency, and historical.

Since the HADS processes real-time observation data only, the type code is always 'R'.

S - Source--The source character is a refinement of the type code which may indicate how the hydrometeorological data were created or transmitted. The source is always associated with a Type Code.

By using the two-character Type/Source combination, one can distinguish data values created from multiple sources or transmitted over differing paths from a single sensor. Several basic data paths have been assigned source characters to accomplish this identification.

The source code utilized by HADS is a '**G**' (for GOES DCP data).

Table 1.3--1. SHEF Physical Elements, Definitions, and Units Used in HADS

Physical Element Code	Unit	Parameter Name Description
EP	(IN, MM)	Evaporation-Pan Increment The change in depth of water over a specified duration in an evaporation pan.
HB(V)	(FT,M)	Depth of Reading 1/ The vertical or perpendicular elevation of an observation below a given datum.
HG	(FT,M)	Height, River Stage The elevation of the water surface at a specified station above some arbitrary zero datum.
HK	(FT,M)	Height, Lake Above a Specified Datum The elevation of the water surface at a specified station above some arbitrary zero datum. This elevation is usually not referenced to Mean Sea Level (MSL).
HP	(FT,M)	Elevation, Pool The elevation of the impoundment not necessarily observed immediately above a dam or hydroelectric plant intake structure. The term is usually referenced to MSL.
HT	(FT,M)	Elevation, Project Tailwater Stage The elevation of the water surface immediately downstream from a dam or hydroelectric power plant. This elevation is usually referenced to MSL.
LS	(KAF,MCM)	Lake Storage (Volume) The quantity of water contained in a lake, in cubic units.
MM		Fuel Moisture, Wood (%) The water content of a fuel particle expressed as a percent of the ovendry weight of the fuel particle.
MT	(DF,DC)	Fuel Temperature, Wood Probe A physical element measured by a thermistor temperature element embedded within a Ponderosa Pine dowel. The sensor simulates short-time (10 hour) constant fuels located on the floor of forests and

		provides a composite temperature affected by precipitation, relative humidity, air temperature, and solar radiation.
PA	(IN-HG, KPA)	Pressure-Atmospheric The pressure exerted by the atmosphere as a consequence of gravitational attraction exerted upon the "column" of air lying directly above the point in question.
PC	(IN,MM)	Precipitation, Accumulator The summation of precipitation collected, beginning at a specified date and time.
PP	(IN,MM)	Precipitation, Actual Increment The precipitation amount observed during a specified time period.
QA	(KCFS,CMS)	Discharge-Adjusted for Storage at Project Only The amount of volume which reached a stream channel, adjusted to the volume which would have occurred except for storage changes at upstream reservoirs. This does not adjust for irrigation diversions. This term is used extensively in water supply forecasting.
QR	(KCFS,CMS)	Discharge, River The flow measured at a point along a stream.
RI	(LY)	Radiation-Accumulated Incoming Solar Over Specified Duration in Langleys The summation over specified duration of energy propagated through space in the form of an advancing disturbance in electric and magnetic fields existing in space.
SD	(IN,CM)	Snow Depth The actual depth of snow on the ground at any instant during a storm or after any single snowstorm or series of storms.
SW	(IN,MM)	Snow-Water Equivalent The depth of water that would result from the melting of a snowpack or a snow sample. Thus, the water equivalent of a new snowfall is the same as the amount of precipitation represented by that snowfall.

TA	(DF,DC)	Temperature, Air (Dry Bulb) Temperature of the air. (Technically, the temperature registered by the dry-bulb thermometer of a psychrometer.)
TD	(DF,DC)	Temperature-Dew Point The temperature to which a given parcel of air must be cooled at constant pressure and constant water vapor content in order for saturation to occur.
TM	(DF,DC)	Temperature, Air (Wet Bulb) The temperature an air parcel would have if cooled adiabatically to saturation at constant pressure by evaporation of water into it, all latent heat being supplied by the parcel.
TN	(DF,DC)	Temperature-Air (Min) The minimum air temperature for 24 hours ending at the time indicated in the SHEF message. A "send" code whose full SHEF parameter code is TAIRZNZ.
TS(V)	(DF,DC)	Temperature-Air Soil 1/ The surface temperature of bare soil at a specified depth.
TW(V)	(DF,DC)	Temperature-Water 1/ The temperature of water at a specified depth.
TX	(DF,DC)	Temperature-Air (Max) The maximum air temperature for the 24 hours ending at the time indicated in the SHEF message. A "send" code whose full SHEF parameter code is TAIRZXZ.
UC	(MI,KM)	Wind-Accumulated, Wind Travel Accumulated wind travel.
UD		Wind, Direction (Tens of Degrees) The wind direction most frequently observed during a given period.
UL	(MI,KM)	Wind-Travel Length Accumulator Over Specified Duration Accumulated wind travel over a specified duration.

UP	Mi/HR,M/SEC	Peak Wind Speed The highest wind speed observed in time intervals of the DCP (15 min, 1 hour, 3 hour, etc.) 2/
UR		Peak Wind Direction (Degrees) Wind direction associated with the peak wind speed.
US	(MI/HR,M/SEC)	Wind, Speed The velocity of air in motion relative to the surface of the earth.
VB		Voltage - Battery (Volt) Electromotive force or difference in electrical potential in a battery.
WC	(UMHOS/CM)	Water Conductance A measure of the conducting power of a solution.
0WL	(PPM,MG/L)	Water, Suspended Sediment The quantity by weight of very fine soil particles that remain in suspension in water for a considerable period of time.
WO	(PPM,MG/L)	Water, Dissolved Oxygen The amount of oxygen dissolved in water.
WP		Water, PH (PH Value) The reciprocal of the logarithm of the hydrogen-ion concentration. The concentration is the weight of hydrogen ions, in grams per liter of solution.
WT	(JTU)	Water, Turbidity An analytical quantity usually reported in turbidity units determined by measurements of light diffraction.
WV	(FT/SEC,M/SEC)	Water Velocity
XR		Humidity, Relative (%,%) The (dimensionless) ratio of the actual vapor pressure of the air to the saturation vapor pressure, expressed in

	percent.
YA	Number of 15-minute periods a river has been above a specified critical level. 2/
YC	Random Report Cause Number Number indicates why a random report was transmitted. 2/
YF	Forward Power 2/
YR	Reflected Power 2/
YS	Sequence Number 2/
YT	Number of 15-minute periods since a random report was generated due to an increase of 0.4 inches of precipitation.

NOTES:

1/The symbol '(V)' in the above list refers to a vector physical element. These physical elements sometimes are measured at different depths or heights by multiple sensors at the same location. The depths or heights are not specified.

2/Where no SHEF Parameter Code is available, or where a sensor is not identifiable 'Z' Parameter Codes are used by HADS for internal use. These Z code are not presented to HADS users but are maintained for data decoding and raw message parsing.

Table 1.3--2. Duration Codes.

Code	Explanation
I	Instantaneous
H	One Hourly
B	Two Hourly
T	Three Hourly
F	Four Hourly
Q	Six Hourly
K	Twelve Hourly
L	Eighteen Hourly
D	Daily (Twenty-Four Hourly)