Guidelines for sea level data transmissions through GTS in the frame of coastal hazard warning systems.

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1. Purpose of the guide

This guide is aimed at European tide gauge networks providers who are using the Eumetsat DCS system and the GTS as a mean of data transmission. It sums up the different steps and best practices from DCP hardware choice and configuration to GTS data collection. **It is based on SHOM experience with GTS tide gauge network.**

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2. Reference links and documents

All the references are online, and may change or be updated in the future.

[1] TD16 – Meteosat Data Collection and Distribution:
http://www.eumetsat.int/website/wcm/idc/idcplg?IdcService=GET_FILE&dDocName=PDF_TD16_MSG_CRS&RevisionSelectionMethod=LatestReleased&Rendition=Web

[2] Ad hoc International Forum of Users of Satellite Data Telecommunication Systems (Sat-Com Forum)
http://ioc-unesco.org/index.php?option=com_oe&task=viewEventRecord&eventID=1298

[3] WMO GTS - WMONo 49 Technical Regulations
http://www.wmo.int/pages/prog/www/TEM/GTS/index_en.html

[4] Eumetsat approved list of Equipment Manufacturers :
http://www.eumetsat.int/website/home/Data/DataDelivery/EquipmentManufacturers/index.html

[5] EUMETSAT DCP Admission Form:
http://www.eumetsat.int/website/wcm/idc/idcplg?IdcService=GET_FILE&dDocName=PDF_REG_04_DCP&RevisionSelectionMethod=LatestReleased&Rendition=Web

[6] Internet access to EUMETSAT public DCP service:
http://oiswww.eumetsat.org/SDDI/webapps/publicdcp/logon.jsp

[7] World Meteorological Organization Manual on the Global Telecommunication System (WMO – No. 386)
http://www.wmo.int/pages/prog/www/ois/Operational_Information/Publications/WMO_386/WMO_386_Vol_I_2009_en.pdf

[8] IOC Sea Level Monitoring Facility services

http://www.ioc-sealevelmonitoring.org/meta.php

[9] World Meteorological Organization Manual on Codes (WMO-No. 306)
http://www.wmo.int/pages/prog/www/WMOCodes.html

[10] A brief description of the CREX sea level bulletins to be issued by the Australian Bureau of Meteorology on GTS
http://www.wmo.int/pages/prog/www/ois/Operational_Information/Newsletters/2000_2009/2008/Jan08/CREXbulletinsBOM.pdf

[11] NOAA Technical Report NOS CO-OPS 026 http://www.co-ops.nos.noaa.gov/publications/NOAA_Technical_Report_NOS_COOPS_026.pdf

5 Acronyms

SHOM: Service hydrographique et océanographique de la marine

DCP: Data Collection Platform

DCS: Data Collection System

GTS: Global Telecommunication System

WMO: World Meteorological Organization

TWC : Tsunami Warning Center

CREX: Character form for the Representation and EXchange of meteorological data

GOES: Geostationary Operational Environmental Satellite

GTS : Global Telecommunication System

EUMETSAT : European Organization for the Exploitation of Meteorological Satellites

NOAA : National Oceanic and Atmospheric Administration

JMA : Japan Meteorological Agency

ISRO : Indian Space Research Organization

CMA : China Meteorological Administration

MCC : Main Control Center

RTH : Regional Telecommunication Hub

6 Background

SHOM has been using the Eumetsat Data Collection System since the end of 2008 and the installation of its first tide gauge DCP in Mayotte as part of the Indian Ocean tsunami warning network. In the following years, several SHOM tide gauges have had a satellite data transmission added in addition to their traditional mobile or landline phone modem. The advantages offered, in addition to data redundancy, are a very stable and secure system (unlike phone lines subject to frequent cuts and operators reliability) and a direct access to GTS via Eumetsat.

The data format chosen by SHOM and described in this document is the WMO CREX code. The reason of this choice lies in the simplicity of this directly user-readable code (as opposed to binary code) and the fact that it is quite widely used by tide gauge operators (Australia, New Zealand, U.S.A) and by SHOM partner Météo-France. It is also a well-documented WMO format.

7 System overview

7.1 Data Collection System

Worldwide, DCS are operated by the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT), the National Oceanic and Atmospheric Administration (NOAA, USA), the Japan Meteorological Agency (JMA, Japan), the China Meteorological Administration (CMA, China), the Indian Space Research Organization (ISRO, India), and Roshydromet (Russia). The first three provide global coverage except for the Polar Regions. The EUMETSAT operational satellite (Meteosat) is located over the equator at a longitude of 0° :

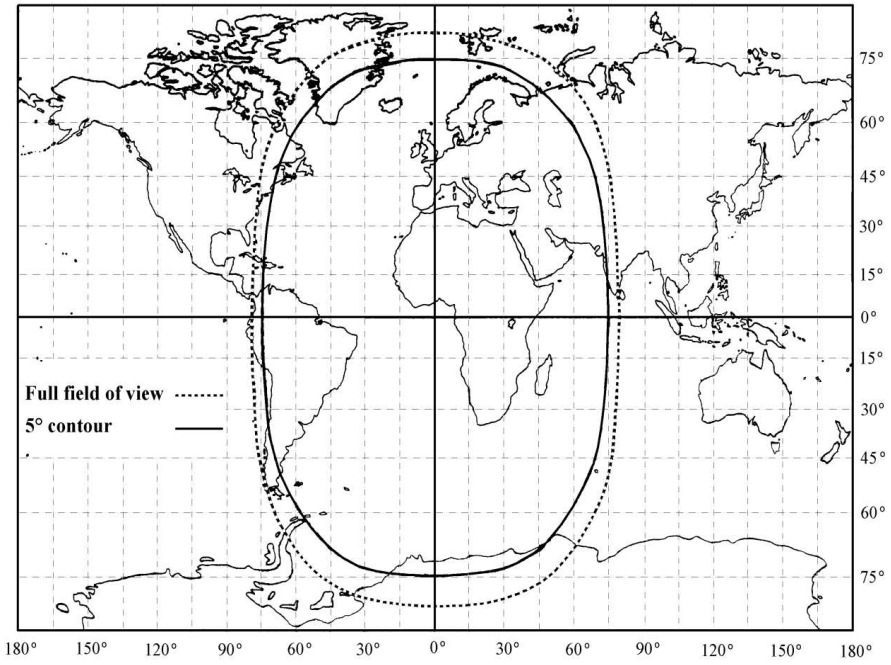

Fig. 1 : Meteosat 0° DCS Coverage Area (courtesy from [1])

DCS are mainly used for collecting meteorological data from remote observing stations, water management (e.g. sea and river levels, river flow rates including alert mode for flood warnings), and tsunami monitoring. **Access to the EUMETSAT DCS is free, provided the data is environmental.** The TD16 document [1] published by EUMETSAT gives the user an extensive set of information on EUMETSAT DCS, the main part of the current guide being just a summary of TD16.

In 2013 EUMETSAT reported 131 DCP operators from 68 countries, with about 1100 allocated regional DCPs, and 650 transmitting DCPs [2]. SHOM for instance has been successfully using EUMETSAT DCS for tide gauges located in France, Indian Ocean (Mayotte, La Réunion, Madagascar) and the Caribbean (Martinique, Guadeloupe and Guyane).

In other regions SHOM also operates DCPs registered to JMA in the Pacific Ocean and some partners (IPGP) are using GOES for other stations located in the Caribbean.

After being emitted by measuring stations, DCP messages are transpo by the Meteosat spacecraft, received at the ground station and then transmitted immediately to the Main Control Centre (MCC) in Darmstadt, Germany. At the MCC the messages are processed and distributed to users including the GTS Regional Telecommunication Hub (RTH) interface in Offenbach, Germany (Figure 2). The data disseminated on the GTS in the form of bulletins can then be received by different registered organisms such as Tsunami Warning Centres and national meteorological offices.

The Global Telecommunication System (GTS) is defined as: "The co-ordinated global system of telecommunication facilities and arrangements for the rapid collection, exchange and distribution of observations and processed information within the framework of the World Weather Watch" [3]. Its availability is the responsibility of the WMO.

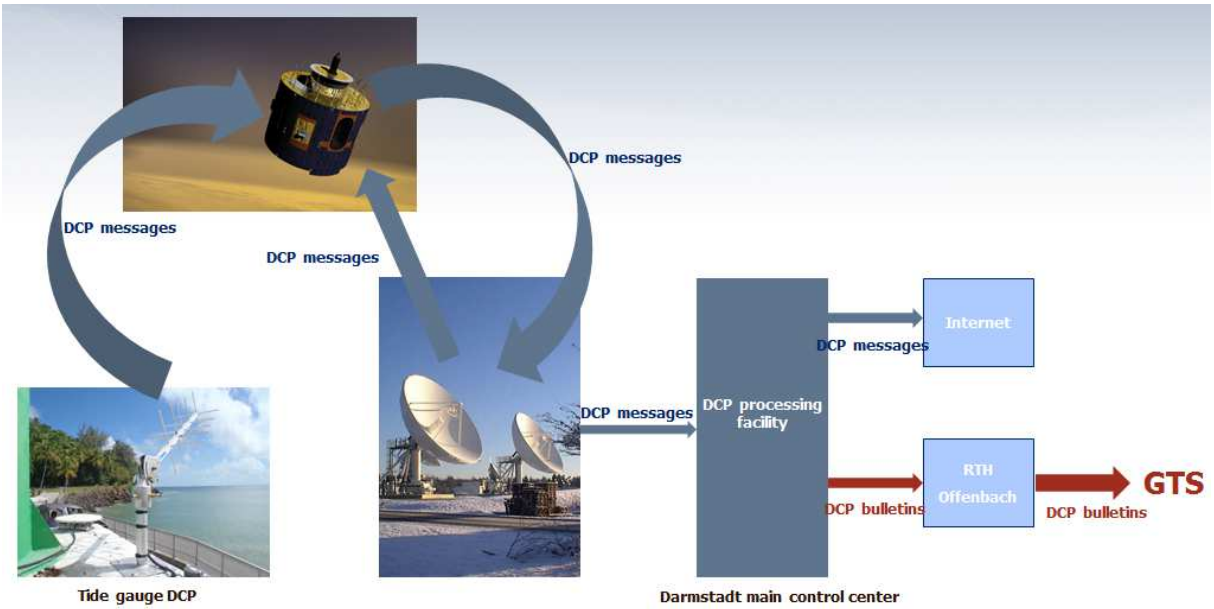

Fig. 1 : Data Collection System (simplified)

7.2 Data Collection Platform

All DCP operators wishing to use the Meteosat system to relay DCP bulletins and messages are required to operate with a certified DCP Radio Transmitter. A list of certified manufacturers is provided and updated by EUMETSAT [4]. Meteosat DCPs transmit data at a standard rate of 100 bauds and can transmit 649 bytes in 60 seconds. As far as tide gauges are concerned, this is sufficient for sea level data.
EUMETSAT recently introduced High Rate DCP (HRDCP) that transmits at 1200 baud and can transmit 653 bytes of data in 10 seconds. However there is no certified HRDCP on the market at the time of writing.

A complete tide gauge station is generally composed of one (or more) sensor, a datalogger and one or more communication equipment including the DCP Radio Transmitter. Depending upon which manufacturer is chosen for each one of those components, it is more or less straightforward to put the whole system together. If upgrading an existing tide gauge to satellite DCS, one has to carefully select the most appropriate instrumentation if part of the existing system is to be kept. Most manufacturers sell a “plug and play” DCP if used with their own datalogger, but to adapt a third party DCP to an existing datalogger requires some versatility from the datalogger as each DCP has its own communication protocol. SHOM has had experience with two manufacturers, OTT and Sutron, both of which transmitters implied a development of SHOM’s own datalogger in order to interact with the DCP. Sutron’s

Satlink2 transmitter however has the advantage of also being a datalogger where a set of sensors can be directly plugged in and can thus operate as a standalone solution. DCP transmitters generally communicate via a serial port with the datalogger/sensor. It has also a GPS antenna input for getting accurate timing, and a RF output for the transmitting antenna. This later can either be directional (e.g Yagi) or omnidirectional antenna. Depending upon the model and the baud rate used, the output power during transmission varies between 5 and 12W.

Fig. 3 : Example of SHOM tide gauge station components with DCP

7.3 DCP Application and Operation

The allocation of time slots and channel frequencies is the responsibility of EUMETSAT. **The DCP operator in order to register and obtain a transmission slot must complete and return to EUMETSAT the DCP Admission Form [5].** The main purpose of the DCP Application Form is to establish the DCP Type, its reporting frequency, the distribution method including the WMO GTS bulletin header (section 7.4.1), and the processing information. An example, filled for a SHOM tide gauge, is given in Appendix 9.1.

The requested DCP can be of three types: Self-Timed (transmit at regular given intervals), Alert (transmit short messages when the value of one or more measured parameters exceeds a pre-set threshold) or Hybrid (combination of the two previous modes). In the case of a tide gauge network aiming at near-real time data collection designed for warning systems (e.g Tsunami alert), self-timed DCPs with a transmit interval of 15 (Indian and Pacific Oceans) to 6 minutes (Mediterranean and Caribbean seas) are a sensible choice. However, for narrow seas such as Mediterranean or Caribbean seas, efforts from IOC and Satellite operators to reduce the transmit interval under 5 minutes.

Upon the application acceptance by EUMETSAT, the user is allocated the following parameters that need to be programmed in his transmitter:

- DCP Address : 8 hexadecimal characters for DCP identification
- DCP Name : Chosen by the user, typically the name of the DCP location
- Channel Frequency : A fixed standard DCP will be assigned on one of the 157 regional channels within the frequency range 402.2005 – 402.4345 MHz [1]
- Channel number: Number corresponding to the assigned frequency. **The EUMETSAT numbering having changed recently, care has to be given when programming a radio transmitter that generally uses the old numbering format.** Frequency numbering given in [1] thus has to be cross-checked with the numbering given in the transmitter's manual.
- DCP Allocation timeslots : Time at which the DCP will transmit (all DCP have an accurate internal clock coupled with GPS synchronization)

7.4 DCP data distribution

The most efficient method for data distribution is through GTS. EUMETSAT also provides an Internet access to the messages for the DCP operator [6]. The user may use this web service for visualizing and testing its transmitted messages but it is not designed as a global data distribution system.

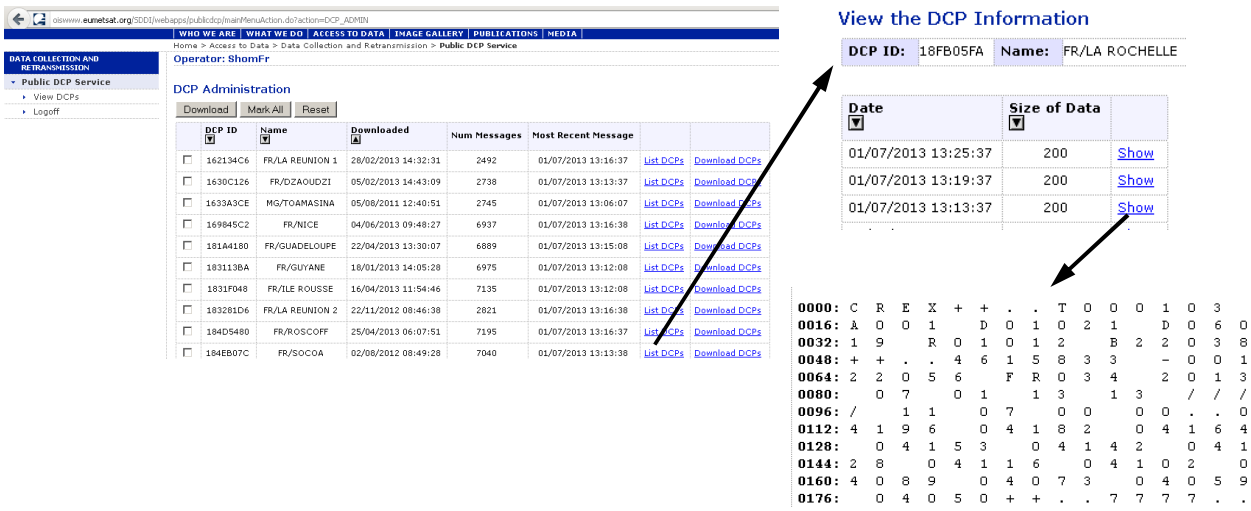

Fig. 4: Internet access to EUMETSAT public DCP service

To enable the routing of DCP data via the GTS, the DCP messages must adhere to the formats, structures and procedures as defined by the WMO. A GTS bulletin contains the following information:

- Abbreviated Header
- Code Identifier
- Meteorological Message

7.4.1 Abbreviated Header

WMO headers are determined using WMO definitions [7]. An example from a header originating from a SHOM tide gauge would be SZIO01 EUMS 031216

The Bulletin Header Code specifies the type and form of the data along with geographical information (6 characters, here SZIO01). The first two characters of this code identify the data type: for tide gauge data, SZ is adequate since "SZ is allocated to sea-level data and deep-ocean tsunami data in any alphanumerical form including CREX" [7]. The next two characters identify the region or area of the DCP: IO stands for Indian Ocean (CA would stand for Caribeean, etc..) and the numbers differentiate between bulletins but do not hold specific meaning.

Then the Originating Location Indicator represents the station originating or compiling the GTS bulletin (4 characters, EUMS). For EUMETSAT DCPs processed by Offenbach RTH the Originating Location Indicator is EUMS.

Following those two first codes is the Date-Time Group that specifies the day of the month and the time (UTC) of the observation or compilation of the bulletin (6 characters, 031216 for a message compilation on the third day of the month at 12:16 UTC)

7.4.2 Code Identifier

The Code Identifier identifies the type of data contained within the message. CREX++ will e.g. identify a CREX message.

7.4.3 Meteorological message

The Meteorological Message consists of the actual bulletin data, which can contain up to 15 Kilobytes for ASCII coded messages or 500 Kilobytes of binary coded data.

The specification for the timeliness for delivery of DCP bulletins to the GTS interface is within 10 minutes of arrival at the EUMETSAT Mission Control Centre, which can be constraining for early warning system such as tsunami warning in Mediterranean and Carabbean seas. National meteorological offices or institutes equipped with a special equipment (around 10k€/year), such as TWCs, have direct access to GTS in order to get the messagers as sooner as possible. For sea level data providers, for which few extra minutes of delay is acceptable, the sea level data and messages can be vizualise and downloaded through the IOC Sea Level Station Monitoring facility. This service, developed and operated by the Flanders Marine Institute (VLIZ) in the frame of IOC, offers tide gauge data providers a unique web tool to share their data. Participation is easy and a simple login request allows users to set up a GTS station on the map of the website [8]. It is a free service and no equipment is needed. In 2014, around 900 tide gauges worldwide were displayed, with almost half of them using a GTS connection.

8 CREX code

8.1 Background

CREX (**C**haracter form for the **R**epresentation and **EX**change of meteorological data) is a table driven code approved by the WMO for the representation and exchange of observational data. A table driven code means that the form and content of the data contained in the message are described within the message itself. A formal description of the code and an extensive listing of associated tables can be found on WMO documents accessible from the WMO

website [9]. However for a more straightforward usage of CREX code for tide gauge data, the reader may refer to two documents from the Australian BOM [10] and from NOAA [11] which accurately sums up tide data CREX descriptors and provide message examples.

8.2 SHOM CREX example

The following is an example of a message generated by a DCP operated by SHOM. SHOM tide gauge DCPs in the Mediterranean region have a transmit interval of 6 min allowing the transmission of 6 1-min water level measurements. In addition the previous 6 measurement are added to the data section in order to have replicate messages for redundancy. A message thus contains 12 measurements. Data descriptors used in the header allow to specify:

- CREX version used
- Data type
- Tide gauge location (Lat. /Long.)
- Type of increments
- Date of measurements
- Various quality checks
- Measurement datum

The whole message is reproduced and decoded below :

```
CREX++
T000103 A001 D01021 D06019 R01012 B22038++
4615833 -00122056 FR034 2013 07 01 13 25 //// 11 07 00 01
04038 04023 04009 04002 03989 03975 03962 03951 03934 03922 03907 03907++
7777
```

Interpretation of the example:

Line	***Group***	***Meaning***
1	CREX	Indicator of a CREX message
2	T000103	CREX Master Table Number 00, Edition 01, Version 03
	A001	Data type 001: Surface data – sea
	D 01 021	Location with high accuracy lat/long.
	D 06 019	Tide report identification, water level checks, time increments
	R01012	Replicate 1 descriptor 12 times
	B22038	Tidal elevation with respect to local chart datum
	++	End of data section
3	4615833	Latitude: 46.15833 degree
	-00122056	Longitude: -001.22056 degree
	FR034	SHOM tide station number FR034
	2013	Year: 2013
	07	Month: July
	01	Day: 01
	13	Hour: 13h UTC
	25	Minute of the first measurement in the message : 25
	////	No SST data
	11	Good data
	07	No manual water level checks performed
	00	Time increment : 0 minutes applied to the base time of 2013/07/01 13:25 UTC

	01	Time increment of 1 minute
4	04038	Tide elevation of 4 038 mm at hour 13h25UTC,
	04023	Tide elevation of 4 023 mm at hour 13h26UTC,
	….	etc… (12 measurements altogether)
	+ +	end of Data section
5	7777	End of CREX message

9 Appendix

9.1 EUMETSAT DCP Admission Form [5] filled for a SHOM tide gauge

EUMETSAT

Registration for DCP Admissions

The purpose of this form is to enable you the user to register for DCP Admissions to the Meteosat system and for DCP processing via the GTS. The details supplied by you will be recorded in a database to enable efficient record keeping and future correspondence but will not be passed on to any third party.

We recommend that you read carefully the attached Explanatory Notes before completing this form.

For further information on all services provided by EUMETSAT, please consult the relevant service Technical Description. A set of Technical Descriptions is available on the EUMETSAT website: www.eumetsat.int

Section A: Contact Information *(to be completed by all Users, please write in capitals)*

A.1 Operator Details

Name of User:	S.H.O.M		
Organisation *(if applicable)*:	S.H.O.M		
Street:	13 RUE DU CHATELLIER		
Postal Code:	CS92803129228	Telephone No: *	+33 298 221 687
City:	BREST CEDEX 2	Fax No.: *	+33 298 220 366
Country:	FRANCE	E-mail: *	ronim-mat@shom.fr

A.2 Responsible Officer *(if different from above)*

Name:	
Telephone No: *	
Fax No.: *	
E-mail: *	

A.3 Alternative point of contact *(where applicable)*

Name:			
Street:			
Postal Code:		Telephone No:	
City:		Fax No.:	
Country:		E-mail:	

** Compulsory Field*

1

Section B: General DCP Information

Please read the attached Explanatory Notes before completing the following sections.

B.1 Type of DCP, i.e. timing of transmissions. Please mark the relevant box with an "X".

X	Self-timed
	Alert
	Hybrid

B.2 Transmission Channel. Please mark the relevant box with an "X".

X	Regional
	International

B.3 Location of DCP. Please mark the relevant box with an "X".

X	Fixed Location
	Mobile

B.4 Application of DCP. Please mark the relevant box with an "X".

	Ship. Please give call sign: ……
	Meteorological. Please give the WMO Station No.: ……
	Seismological
	Hydrological
X	Other *(please specify)*: …TIDE GAUGE……

B.4.1 Does your application form part of a WMO sponsored Programme?

	Yes. Please give Programme name: ……
X	No

B.5 Technical Data of DCP

B.5.1 Name and Address of DCP Manufacturer:

Company: ……SUTRON……
Street/P.O. Box: …… 21300 RIDGETOP CIRCLE……
……
Postal Code: ……20166…… Telephone No.: ..(703) 406-2800……
City: STERLING, VA Fax No.: ……..(703) 406-2801……
Country: U.S.A

B.5.2 DCP Type:

Model Number: ……SATLINK 2……SL2-G312-1B……
Output Power: ……..7 WATTS……

B.5.3 Can the DCP be programmed to transmit on more than one channel during operational deployment?

[ ]	Yes
[X]	No

If yes, please specify:

.....
.....
.....
.....

B.5.4 Which of the following operational characteristics can be modified by the DCP operator? Please mark the relevant box/es with an "X".

Transmission Timeslot(s)	[ ]	Yes	[X]	No
Transmission Channel	[ ]	Yes	[X]	No
DCP Address	[ ]	Yes	[X]	No

Section C: Information on DCP operations

C.1 Deployment. Please mark the relevant box with an "X" and provide the necessary information.

[X] Test

Start Date of Test: .....01/10/2014 .....
Duration of Test: .....2 DAYS.....
Country:.....FRANCE.....
Latitude: .....48°24'31'' N.....
Longitude: .....4°30'10'' W.....
In case of mobile DCP, please give operations range: .....
.....

[X] Operational

Start Date: .....08/10/2014.....
End Date (if known): .....ONGOING.....
Country: .....FRANCE.....
Latitude: .....44°12'39'' N .....
Longitude: .....01°17'43'' W.....
In case of mobile DCP, please give operations range: .....
.....

C.2 Maintenance of DCP

[X]	Regular maintenance	Expected number of maintenance per year: .....2.....
[X]	Emergency maintenance	How soon can the DCP be reached: .....1 DAY..... Limitation of access (please specify): .....

C.3 DCP Network/Stand-alone

Is the DCP part of an existing network?

[X]	Yes
[ ]	No

If yes, please specify:
.....SHOM TIDE GAUGES DCP NETWORK.....
.....
.....

C.4 DCP Operations. For what purpose are you operating your DCP? Please mark the relevant box with an "X".

[X]	Full DCP operations
[ ]	DCP operations for test purposes only

Section D: DCP Transmissions and Processing Requirements

D.1 Alert Operations (if applicable). Please indicate the expected frequency of occurrence and duration:
.....
.....

Expected number per year: .....
Typical duration (hours): .....

D.2 Data Format. Please mark the relevant box with an "X".

[ ]	Alphanumeric, International Alphabet No. 5
[ ]	Binary Coded Decimal
[X]	CREX (Character Representation and EXchange of meteorological data)
[ ]	BUFR (Binary Universal Form Representation of meteorological data)
[ ]	Other *(please specify)*: .....

D.3 Requested Transmission Times. Please refer to the explanation notes for further information before indicating the requested transmission times in the table below.

Transmission Time			Deviation Minutes	Transmission Length Seconds
Hour	Minute	Repetition Rate		
HH	MM	6 MIN.		45 SEC.

D.4 Requested data distribution. Please mark the relevant box/es with an "X".

	EUMETCast - *If yes, please complete the EUMETCast Registration Form*
X	Internet - *If yes, please contact EUMETSAT User Service to receive a Username and Password*
	Direct Dissemination

Note that data routing via GTS is compulsory.

For any questions related to registration, please contact the EUMETSAT User Service Helpdesk at ops@eumetsat.int.

Section E: GTS Processing

E.1 What is the intended GTS distribution? Please mark the relevant box with an "X".

	International
	Regional
X	National
	Dedicated Station(s). Please specify: .....

E.2 Special requests for processing. Is the DCP data to be combined with data from other DCPs?

	Yes
X	No

If yes, please specify:

.....
.....

E.3 Please specify in the following table the associated WMO Code, Code Identifier and the recommended Bulletin Header.

GTS Processing Table					
Requested Transmission Times			WMO Code	Code Identifier	Recommended Bulletin Header *- Compulsory*
Start Hour	Minute	Repetition Rate			
HH	MM	6 MIN.			SZFR01

E.3.1 Please give a list of DCPs to be concatenated into a single GTS Bulletin:

.....
.....
.....
.....
.....
.....
.....
.....