MINIMUM SPECIFICATIONS AND GUIDELINES

FOR THE OPERATION OF EGOS DRIFTING BUOYS

Revision 1.1

November 2002

Issued by the European Group on Ocean Stations

Contents

1. INTRODUCTION

In 1988, as a long term follow-up to the activities pursued under COST[1] Action 43, a number of European organisations decided to establish the European Group on Ocean Stations - EGOS - as a joint operational project to co-ordinate their actions and activities related to the provision of meteorological and oceanographic data. The parties to the Project agreed to co-operate in the implementation and maintenance of marine stations in European and adjacent waters, particularly the data sparse areas of the North Atlantic.

Co-ordination and implementation of the EGOS programmes is the responsibility of the EGOS Management Committee. EGOS programmes are based on voluntary contributions of the participants.

Contributions to the programmes are provided within the following categories :

- Buoys, and contributions towards buoy operational costs ;
- Programme service, deployment service, data reception, data dissemination and quality control ;
- Monetary support e.g. to finance the EGOS Technical Secretariat for programme co-ordination.

Buoys of various designs and capabilities are provided and used. In order to ensure data quality and compatibility it is necessary that the buoys fulfil some basic requirements.

This document has, therefore, been prepared with the objective of serving as a guideline for the operation of buoys in the EGOS drifting buoy programme. It contains specifications which are considered as the minimum specifications when procuring drifting buoys to ensure optimal use of resources, good data quality and an integrated programme. Some details are proposed regarding documentation, testing and buoy operation.

The criteria are established primarily for drifting buoys operating under the specific conditions of the EGOS programme.

The basic criteria are summarised as follows:

- EGOS encompasses operational programmes, with no defined time limit. It is expected that the programmes will continue for a period of many years ;
- EGOS operates buoys in the data sparse area of the North Atlantic. The area is defined as that between 30 to 65°N, 50°W and the European Continent, including adjacent seas : the Baltic Sea ; the North Sea and the Mediterranean Sea ;
- The programme is based on voluntary contributions from its members ;
- Data quality and reliability must fulfil the requirements for operational data ;
- The maximum drift-time for a buoy in the EGOS area is usually of the order of 1- 2 years ;
- Buoys provided to the EGOS programme will be deployed as required for the operational programme ;
- The buoys remain the property of the contributor and may be excluded from the programme when they have drifted out of the EGOS area ;

[1] A list of acronyms is given in annex I.

- Deployment of a buoy will be made in agreement with the owner ;
- EGOS buoys are quality controlled and removed from GTS in case of corrupt data ;
- EGOS buoys are usually deployed by merchant ships but some are also deployed by aircrafts and research vessels.

Currently, due to available deployment services, EGOS buoys are regularly deployed along the following three routes :

1. By ships sailing from Reykjavik to the East Coast of North America ;
2. By ships sailing from Denmark to West Greenland ;
3. By ships sailing from United Kingdom and France to the West Indies.

EGOS buoys are also regularly deployed on the 20th western meridian between 44°N and 50°N by France and in Icelandic waters by Iceland. Deployment by aircrafts can be done in various areas but they must be planned a long time before.

Since the deployments are restricted primarily to these routes or areas, the configuration of the buoy network will not always be optimal. However, through experience it is to some extent possible to predict where the buoys will drift and thus plan the deployment in accordance with current network distribution and the estimated drift pattern. More variability in the deployment pattern may be achieved by air deployment.

Buoys which are deployed in the western part of the area drift mainly northeastwards to the European coast. The drift patterns are rather irregular depending on the prevailing winds and the currents. However, in general the buoys drift across the Atlantic following an easterly route which leads towards Iceland and the Faeroes, or Western UK or Ireland. If the buoys pass the Faeroes, they will drift into the Norwegian Sea and either drift ashore in Norway or follow the currents into the Barents sea. The maximum drift time in these waters is of the order of one and a half to two years.

Buoys deployed in the Southern part of the North Atlantic, drift more slowly, and may be in the area for more than two years. On the basis of these experiences it is thus concluded that the expected maximum drift time for buoys in the EGOS programme is of the order of two years. Therefore, taking into account the period of testing and calibration before deployment it is recommended that EGOS buoys be designed to operate for and be provided with batteries sufficient for an operational period of two years.

2. DATA REQUIREMENTS

The parameters required in the EGOS drifting buoy observing programmes are, in order of priority :

- Air pressure
- Sea surface temperature
- Air pressure tendency
- Wind speed and direction
- Air temperature
- Subsurface temperature
- Salinity
- Surface current

Data availability and data timeliness are two main requirements from data users. Numerical models require observations regularly spread out in time and space. Basically 8 observations a day per 500 km x 500 km, would be a realistic aim. The shortest cut off times are closed to 2 hours but re-assimilation schemes can use a 12-hour old observation. Forecasters require more timeliness to have the observations plotted on their charts. Cut off times are generaly less than 2 hours.

3. THE DRIFTING BUOYS

Various types of buoys have been used in the EGOS programmes. These buoys can be classified in two types (FGGE buoys and SVP drifters). In each class, buoys are very similar with respect to size, physical characteristics and operational life time.

Buoys from different manufacturers have been used :

- CMR/SIPRO (C/S), METOCEAN and ELTA for FGGE buoys ;
- METOCEAN, CLEARWATER and TECHNOCEAN for SVP drifters.

3.1 Buoy hull, markings and identification

General characteristics of FGGE buoys are a length of about 2.3-2.4 meters, about 90 kg in weight and a diameter of about 0.6-0.8 meters. Buoys which measure wind speed and direction are approximately 1.0-1.5 meter longer. METOCEAN buoy hulls are made of anodized or painted aluminium. The C/S buoys are made of glass fibre/polyester. ELTA Marisonde buoys are made of polyethylene.

SVP drifters are very different from FGGE buoys in physical appearance. They are spherical, approximately 35 cm diameter and they weight about 30 kg. They are also equipped with a 'holeysock' sub surface drogue and immersion sensors to detect periods when the buoy is submerged. Whatever their manufacturer is, SVP-Baro drifters are built according to a construction manual issued by DBCP (Technical Document n°4 – 2001).

Following standard recommendations, FGGE buoys are painted yellow above the water-line, but are white in the region of the air temperature sensors to reduce the effect of the solar radiation. Below the water-line the buoys are painted with anti fouling coating in black, brown or red colour.

It is recommended that buoys in EGOS programmes are marked as follows :

- Name of the owner and telephone number ;
- Argos Id. No ;
- The name ODAS.

These markings are sufficient to identify the buoys in case they drift ashore or are picked up. It is recommended that the markings are limited to the absolute minimum in order to avoid confusion or misleading information. The letters should be large enough to be read at some distance; 8 - 10 cm high letters are recommended. The letters should be covered with clear lacquer as a protection.

3.2 Data acquisition system

Most modern data acquisition systems include a microprocessor based measurement unit, an internal clock and a data memory. Experience has shown that an independent "watchdog", which restarts the system in case the system programme fails, is also recommended. A back-up battery will ensure that the real-time clock works during periods when the main power is shut off. If a GPS is installed, it is recommended that the GPS clock signal is used for correction of the real-time clock.

It is essential that only high quality components are utilised and that all electronic assemblies are made according to at least the ISO standard. A principal system test should be made and included in the manufacturers documentation to prove that the system will work satisfactorily over a long period of time and survive extreme temperature conditions (-20°C to +60°C).

The mechanical design and construction should ensure that the electronic circuit board and the mechanical parts are secured safely to avoid components working loose and chafing during the continuous movement that the buoy will be subject to at sea. All screws should be sealed.

The electronics must be adequately protected against moisture, water intrusion or condensation. In order to avoid condensation it is recommended that the instrument container be filled with dry nitrogen gas or include a bag of desiccant. A separate water tight instrument container is recommended as an extra precaution against moisture.

It should be noted that some batteries produce corrosive gases; if appropriate, measures should be taken to avoid such gases from getting in contact with the electronics.

3.3 Variables to be measured

Variable	Range	Resolution	Accuracy	Uncertainty
Air pressure	900 - 1060 hPa	0.1 hPa	± 0.1 hPa	± 1.0 hPa
Air pressure tendency	0 - 25 hPa	0.1 hPa	± 0.2 hPa	± 0.2 hPa
Sea temperature	-5 to +30°C	0.1 K	± 0.1 K	± 0.5 K
Air temperature	-20 to +35°C	0.1 K	± 0.1 K	± 1.0 K
Wind speed	0 - 40 ms^{-1}	0.5 ms^{-1}	± .5 ms^{-1} or ± 10%	± 1 ms^{-1} or ± 10%*
Wind direction	1 -360 deg	10 deg	± 5 deg.	± 15 deg.

Table 1: Range commonly used for each variable, resolution and accuracy[2] recommended by WMO for general operational use of meteorological data and typical uncertainties in measurements from operational drifting buoys.

(*) Because of the low sensor height, uncertainties in wind speed measurements apply to low wind speed and low sea states only.

Table 1 lists the range commonly used for each variable, the resolution and the accuracy recommended in the WMO Guide to Meteorological Instruments and Methods of Observations for general operational use of meteorological data (referenced in Annex II).

[2] The stated value of required accuracy represents the uncertainty of the reported value with respect to the true value and indicates the interval in which the true value lies with a stated probability. The recommended probability level is 95 per cent, which corresponds to the 2σ-level for a normal (Gaussian) distribution of the variable.

In practice, however, limitations in the measurement and reporting resolution of drifting buoys in common use means that general requirements are difficult to achieve or assess. Therefore, WMO recognizes that measurements carried out by operational drifting buoys can be less accurate. The last column gives the typical uncertainties in measurements from drifting buoys according to the WMO guide.

3.3.1 Air pressure

Since air pressure is the most important observation, special care should be taken to ensure reliable air pressure data.

Only barometers with a proven record of reliability and long term stability should be used. The DIGIQUARTS barometer, produced by Paroscientific, proved to have a very good long-term stability and reliability. It has been in widespread use on EGOS buoys for several years. However, being relatively expensive, it has been gradually replaced by less expensive but also reliable pressure sensors mainly produced by AIR then VAISALA.

The air inlet port is an important part of the air pressure observing device. It is essential that the air-inlet port is designed to avoid Pitot effects and any moisture from penetrating into the instrument, whilst at the same time allowing the barometer to respond freely to air pressure changes. The devices currently used perform satisfactorily, even on SVP drifters which can be submerged by waves one third of the time.

Air pressure is recorded as a period average (at least 60 sec.) in order to reduce the effect of wave motion. A dedicated de-spiking algorithm is used on SVP drifters to remove from the average the measurements made while the barometer port is submerged. The range for air pressure varies slightly for the different types of buoys, but the range 900 to 1060 hPa is recommended. Pressure tendency and pressure tendency characteristics are also calculated and reported. Air pressure tendency is recorded as the difference between the current observation and the observation made three hours previously.

3.3.2 Sea Surface Temperature

Sea surface temperature is observed, either by an external sensor located on the hull below surface level, or by a sensor clamped to or in close contact with the inside of the hull and thus observing the temperature of the metal hull at the same level. Typically depths of measurement are 50 - 100 cm below the sea surface (less for SVP drifters).

The sea surface temperature measuring range should cover the range from -5 to +30°C. with an accuracy of 0.5 K or better. The lower limit of -5°C , although below the freezing temperature of sea water, is recommended because errors in transmitted data can arise from data acquisition system or sensor failure, or through sensor calibration offsets or drift with time. Having such a limit will mean that such errors will be more readily identified and the validity of the data improved from buoys operating in ocean regions where the actual sea temperature is close to the critical freezing temperature.

3.3.3 Air Temperature

Air temperature is observed by a shielded thermometer near the top of the buoy. Inadequate shielding against solar radiation and protection from rain or sea spray can be a serious problem. The air temperature observations from drifting buoys are, therefore, currently the subject of further investigation and development. Most of the EGOS drifting buoys are equipped with air-temperature sensors, with the exception of SVP drifters on which this measurement is unrealistic.

3.3.4 Surface Current

Most of the EGOS FGGE buoys currently being deployed are free drifting buoys without any drogues attached. A drogue is designed to lock the buoy to a specific water mass and will normally slow the drift speed and keep the buoy in the same waters for a longer period of time. In the north of the EGOS area this may have some advantages since the drift speed is rather high. However, there has been some reluctance to introduce drogues on FGGE buoys because theymay be, or appear to be, more complicated and difficult to deploy. So the ship crews may therefore unwilling to carry out this service.

The SVP drifter has been designed to track the mean current at 15 m depth using a 7 m holey-sock drogue. Its smaller physical size means that it does not present the same difficulties for deployment. Algorithms have been developed to detect when the buoy is submerged and therefore exclude erroneous measurements.

3.3.5 Wind

FGGE buoys, which provide wind measurements, are topped with an aerodynamic mast which rotates them under the wind influence. The wind direction is simply obtained by the reading of a compass, integral with the buoy hull. These buoys are fitted with a roll damping disc at their bottom to prevent random rotation due to waves. Masts are topped with a cup-type anemometer or equivalent to provide wind speed measurements. Mean wind speed is a linear function of the number of revolutions made by the anemometer shaft in 10 minutes. For the mean direction, it is preferable to get the direction of the mean vector. A solution to get this direction easily is to sample compass readings at a constant number of shaft anemometer revolution. Mean sines and cosines give directly the mean wind direction.

Wind measurements on SVP drifters are under evaluation. The drifters use a fixed vane to rotate them in the wind's eye. As for FGGE buoys, the wind direction is obtained thanks to a compass reading. Pitch and roll information derived from a fluxgate compass are used to reject direction values when the drifter is tilted above 30 degrees. To measure the wind speed, the WOTAN technique (Wind Observation Through Ambient Noise) is used. Wind generates noise in the frequency range comprised between 500 Hz and 50 kHz. An hydrophone, located 10 meters below the surface, samples the underwater sound. Mean wind speed is computed thanks to the energy level measued at specific frequencies.

3.3.6 Subsurface temperature

Subsurface temperature is observed by a so-called bathythermic chain. Temperature sensors (thermistor, PT100 or similar probes) are distributed along a wire expanded under the buoy. Generally a pressure sensor provides the depth of the line bottom. For cost considerations, the measurements are mostly done inside drifting buoys. Digital data transfert will allow more sensors and longer chains when this technique will be cheaper than now.

3.3.7 Salinity

Surface salinity measurements are under evaluation. The main problem is bio-fouling which rapidly covers the probe.

3.4 Batteries

Various types of batteries are utilised with the different types of buoys. Those in most widespread use are alkaline or lithium based. Li-batteries have the advantage of high power density, a long shelf life and constant voltage. They have the disadvantage that they may be subject to restrictions or not be accepted for transport via commercial aircraft. They may also become hazardous if in direct contact with water. Alkaline batteries are generally subject to fewer restrictions, but may have a more limited operational life-time. This is more crucial for SVP drifters which haven't the capability to carry as many batteries than FGGE buoys. Drifter lifetimes may be shorter than the requirements : two years for EGOS buoys.

All batteries should be equipped with protective diodes and Li-batteries should be handled according to the manufacturers' instruction[3].

3.5 Data transmission system

Data retrieval is presently based on the Argos system which also provides information for calculating the buoy position. GPS is also used on buoys and the in situ calculated position is then included in the Argos message along with the other parameters. Platform Transmitter Terminals (PTT) from various manufacturers are used and included in the data acquisition unit. The PTTs must be certified for use with the NOAA polar orbiting satellites and by Service Argos. The transmission system is thus standardised, a feature which facilitates testing and maintenance. The transmitted power is 1-2 Watts and the frequency is 401.650 ± 0.004 MHz.

The antennas used are omni-directional in order to ensure uniform and optimal transmissions independent of orientation of the free drifting buoy.

Until May 2002, EGOS buoy data were collected through CLS/Argos in Toulouse and two independant Local User Terminals (LUTs) located in Oslo and Sondre Stromfjord (Greenland) respectively. The LUT of Sondre Stromfjord is operated by the Danish Meteorological Institute (see item 13). Since May 2002, the LUT of Oslo, operated by the Norwegian Meteorological Institute, has been linked to CLS/Argos. Raw data received at this LUT are now processed in Toulouse among these received from other receiving stations.

Testing of the buoys may be facilitated through the use of a local test receiver with a suitable decoding programme, especially if the test receiver stores all data for subsequent analysis; such test receivers are available commercially. A final test should always include data reception via the Argos system or via one of the operating LUTs.

4. BUOY DATA FORMAT

For a long time, the data format for the drifting buoys was developed for the FGGE programme. Only asynoptic observations could be reported on the GTS through Service Argos. An extension of this format, developed during the COST-43 programme, permitted reporting of the most recent synoptic observation. This format is still used without any great

[3] It should also be noted that Li-batteries, which are not in use, will develop a passivating internal layer which must be removed in order to draw full power from the batteries. This can be done by the use of a constant "bleeding" resistance which ensures a constant discharge, keeping the batteries in an operational state. An alternative is to "wake" up the batteries by a temporary heavy load which "burns off" the passivating layer.

modifications. Although there is currently no standard EGOS format, the DBCP-M2 format, is recommended[4].

Examples of data formats used by EGOS buoys are given in the Annex IV.

EGOS buoy data include the most recent asynoptic or hourly observations plus several observations stored aboard the buoy when there are no satellite in sight. Stored observations can be previous hourly observations, synoptic or "half synoptic" (i.e. 01:30, 04:30, 07:30 UTC…).

It should be noted that data which are transmitted via the satellite system are often corrupted by transmission errors. The "common format" includes a checksum to reject most of the corrupted messages. Even if this format is not used, it is strongly recommended to use a technique such as checksum computation to eliminate transmission errors.

5. BUOY DOCUMENTATION

A new buoy should be delivered with the documentation satisfying the requirements specified by JCOMM. The minimum documentation should be :

1. A general technical description of the buoy systems detailing :
   - The buoy hull, material, colour, marking and identification ;
   - Total dimensions, shape, weight, overall length ;
   - Details of any special shipping or handling requirements.

2. Brief technical description of the data acquisition system :
   - Type and Serial No of data acquisition system ;
   - PTT type. Serial No, Argos Id. No ;
   - Type of sensors, Serial Nos., accuracy, range, sampling rate, averaging methods, data ;
   - Power requirement, voltage, current consumption per year ;

3. Batteries
   - Battery type, voltage(s), capacity and battery arrangement (diagram).

4. Data
   - Argos Id. No., Programme No.
   - Argos data format.
   - Conversion formulae.

5. System calibration certificate.

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[4] The implementation of the GTS chain at Service Argos in 1993 gave to the users a very great flexibility. Now it is possible to report data on the GTS for an infinite number of formats. The main problems with the "old" format is the fact that it can't be used to report new parameters without any changes in deep. In 1998, Meteo-France proposed at DBCP-XIV a new Argos format so-called "common format" with many advantages. The format is independant of the strategy used to collect and store the data. It is easy to extend when new sensors are needed. It could be shortened to save energy. Pages are identical when they are used to report stored data. Observation times are easy to retrieve with a minimum risk of errors. This format has been adopted by several institutions such as GDC. Named DBCP-M1, it was slightly modified in 2001 to take in account new 28-bits PTT addresses. The new version is called DBCP-M2.

- Test certificates for the various sensors.
- Total integrated system test certificate.

6. Records of data reception via the Argos system.

6. TESTING

When the buoy is received by the owner or his representative it should be started and tested. The following procedure is recommended:

The buoy should be assembled and switched on according to the manufacturer's instructions, and ideally, tested in an upright position. If this is impractical it is acceptable to test the buoy laying on its side. It is convenient if the data can be received on a test unit, but the system should always be checked finally and correct operation confirmed by data reception via the CLS Argos system. For this reason, the technical file must be correctly initiated for the buoy at CLS/Argos prior to the test.

Spot measurements over the range for the various variables should be made under controlled conditions in order to check that the system is working according to the specifications.

Current minimum practice for check Data Measurements include:

- Check measurements of Air Temperature (AT), made at the same height and in close proximity to the AT sensor on the buoy. It is important to ensure good ventilation of both the buoy and reference sensors.
- Check measurements of Sea Surface Temperature (SST) made by placing a reference thermometer on or in close proximity to the buoy sea temperature sensor and placing the buoy in a water filled vessel and stirring the water well.
- Check measurements of Air Pressure made using a calibrated reference barometer at the same height as the pressure sensor in the buoy. This should be monitored over some time, in order to cover a variation in the air pressure.

Synoptic observations should be monitored over several days in order to obtain a sufficient data record.

Mean differences and variances of (check observation minus buoy data) are computed. Mean differences are used as a correction in the actual data conversion formula used by the CLS Argos and the LUT operators. The variance of differences gives a measure of confidence in the data.

Final system tests should always include data reception via CLS/Argos or via a Local User Terminal (LUT).

7. DEPLOYMENT

Prior to deployment it is essential to ensure that the system is working properly and the data correctly received. The buoy should therefore be started well in advance of departure from the deployment centre. It is recommended that the buoy is not switched off after the final test.

The buoy data are received via CLS Argos or a LUT, and this provides an opportunity to cancel the deployment if any error occurs in the final period just before the deployment. These are normally made from ships of opportunity and the buoys are deployed when a given latitude or longitude is crossed. Since the buoy is operating, it is easy to monitor it during transit and determine when and where the buoy was actually deployed.

8. GTS TRANSMISSION

GTS transmission, for a buoy, is under the responsibility of a Programme GTS Co-ordinator (PGC). The PGC, who can be the EGOS Technical Co-ordinator or the buoy owner, sends the details of data formats to CLS/Argos and the LUT operators, if possible in advance to save time. If the buoy is not yet deployed, he requests not to send the data on the GTS. The PGC arranges for the allocation of an appropriate WMO Id. No, according to the location of the deployment (see map in annex V). When the buoy is deployed, the PGC provides CLS/Argos and the LUTs with the WMO Id. No with request to convert the raw data, code them according to the appropriate WMO code (FM-18 BUOY at present) and disseminate them via the GTS. The PGC will thereafter inform the EGOS Technical Secretary of the new deployment. In practice, the Technical Co-ordinator of EGOS acts as PGC for most of the drifting buoys of that programme.

9. DATA QUALITY EVALUATION AND CONTROL

The performance of the EGOS buoys are carefully monitored throughout their entire life time.

Data quality control is carried out on various time scales :

- Quasi-real-time control is made by the Icelandic Meteorological Office in Reykjavik. Data users, possibly outside EGOS members, can also send warning messages to the Internet buoy QC mailing list of DBCP when they point out quality problems. These messages are received by PGCs who can take the appropriate actions after checking themselves.
- Weekly and monthly quality controls are carried out by the UK Meteorological Office in Bracknell and by Meteo-France in Brest. Data received on the GTS are checked to see if they don't overpass limits, if they are not fixed and if their variations are not too high. Statistics of differences with model short term forecasts or background fields are also computed. These statistics and those provided by other centres such as NMC and ECMWF can be seen on the Web server of CMM (Centre de Meteorologie Marine of Meteo-France) through a friendly interface. Statistics provided by Meteo-France are shared according to the origin of the GTS data (CLS/Argos or LUTs).

When a PGC is aware of a problem or a status change for one of the buoys being under his responsability, he requests CLS/Argos and/or the LUT operators to correct the calibration values or to stop the data transmission on the GTS for a particular sensor or for all of them. When all data transmission is stopped for a buoy, the buoy owner can ask CLS/Argos to transfer it in backup mode in order to save PTT fees.

It is strongly recommended for PGCs to manage their actions on GTS transmission through an electronic form. Since 1998, PGCs can modify themselves the GTS transmission status of their buoys at CLS/Argos through automatic emails. This possibility doesn't yet exist at LUTs but GTS status changes are requested through emails having a normalized subject field.

If a buoy stops transmitting, the CLS/Argos and the LUT operators are instructed to delete this PTT No. from the operational list. The respective Argos Id. No. and the WMO Id. No. will then be made available for reuse after some time.

Similarly, if a buoy drifts ashore or is recovered, CLS Argos and the LUT operators will be instructed to delete the data from GTS and the PTT No. transferred to BACKUP mode.

The results of the data quality control and consequent actions are circulated in the monthly report on the EGOS drifting buoys.

10. BUOY RECOVERY

The drifting buoys are expendable and not intended to be recovered and reused. It has therefore been agreed by the EGOS members that a buoy which has drifted out of the operational area, or stopped transmitting is no longer part of the programme, and it is up to the owner to decide on the future use of the buoy in such circumstances.

Some buoys do drift up on beaches and are recovered and others have been picked up at sea; very few have been picked up prematurely. The value of a recovered buoy has been a matter of discussion, and it depends on where and when the buoy is recovered and the condition of the buoy when it is found.

A buoy which has stopped transmitting after it has drifted ashore will normally have very little or only marginal value, although in EGOS the refurbishment and redeployment of even these buoys turned out to be economic in many cases and became a not unusual practice.

Buoys which are picked up in open sea while they are still operating may normally be worth refurbishing and redeploying.

The legal aspect of drifting buoys have been the topic at several international meetings, but so far there is no international law or regulation regarding the legal conditions for buoys operating in international waters.

As to the reward for recovering buoys, national laws will be applied. The relevant laws and practice vary from one country to another. In most countries stranded goods belong to the government, but in some cases to the owner of the land where the goods have drifted ashore. The finder may be entitled to a reward which reflects the value of the goods in the state which it is found, and the effort in recovering it.

In EGOS the following practice has been applied : depending on where a buoy is washed ashore the owner takes action to try to assess its condition and determine whether it should be recovered for reuse. In many occasions, it could be useful to request the help of a local meteorological or oceanographic agency (EGOS and/or DBCP participants). If it is decided to recover the buoy, the finder is offered a reward, usually up to 300 GBP. Buoys often drift ashore at remote locations and it will obviously be too costly to inspect the buoys where they are found prior to making a final decision. If the finder accepts the offer he will be instructed to send the buoy to the address which is agreed to by the owner. If the finder does not accept the reward offered, he will be asked to hand the buoy over to the appropriate authorities.

11. REFURBISHMENT OF BUOYS

Since the EGOS drifting buoys are expendable, and not designed to be refurbished and reused, the refurbishment of buoys which have been recovered is considered if it seems economic. Any recovered buoy should be checked very carefully, and its condition noted.

By and large, only buoys in exceptionally good condition are reused. This means buoys which are still operating satisfactorily when they are recovered or buoys where it is known that they have stopped only because of exhausted batteries.

Any moisture or water ingress should immediately qualify the buoy electronics for scrapping. The mechanical parts may be repaired and reused but it should be noted that units which have been flooded must be cleaned thoroughly to get rid of all salt particles. Soft materials and plastics are particularly difficult to clean sufficiently well.

Before reuse the normal test procedures, as if testing a new buoy, should be applied.

12. CLS/ARGOS SERVICE

12.1 Data collection and location service

Access to the Argos data collection and location system must be accepted by Service Argos. An application form must be filled out and submitted to CLS for approval. This application includes information on the programme, the area of operation, number of platforms and time limit of the programme. In addition some technical details on type of transmitters, type of equipment, data format, data processing and data handling are requested.

The Argos application form may be filled out in co-operation with the manufacturer of the buoys, and/or the EGOS Technical Co-ordinator. If the application form is approved, CLS/Argos will issue a programme number and the programme password (4 letters), and the Argos Id. No (PTT number) which identifies the transmitter (PTT) for each buoy. A copy of the Argos ID application form is given in annex VII of the Guide to Data Collection and Location Services using Service Argos (DBCP Technical document n°3). This information must be provided to the manufacturer when the buoys are ordered. It should be noted that when the programme is initiated, each transmission which is received by CLS/Argos will be subject to a charge. During long test phases there may therefore be a cost-saving by transmitting into a dummy load antenna to prevent the data from being received by the satellite.

Service Argos provide data from platforms through global and regional coverages. On global coverage, the data received from a buoy are stored aboard a satellite before being downloaded to one of the three main stations of the system. Thanks to this, data can be collected from any part of the World. Service Argos also operates Local User Terminals (LUT) of which the data are processed as those coming from the global coverage. Regional coverage allows a better data timeliness. Data from buoys drifting in North Atlantic can be collected by the Service Argos LUTs of Wallops Island, Halifax, Lannion, Las Palmas and Toulouse.

In addition to the request of new Id. numbers by providing CLS/Argos with the characteristics of the transmitters, buoy owners must manage these Argos Ids as long as they are allocated to their programmes. These tasks aren't part of the PGC tasks. Actions consists in :

- requesting moves from a programme to another for a PTT. This is possible under certain conditions ;
- requiring processing changes. Under certain conditions, a PTT can be put into Back Up or Inactive Status processing services at Argos if it continues to emit after the measurements failed. The charge for this PTT are then divided by 2.5 or 6 ;
- returning Id. numbers for PTTs which definitely stopped transmitting.

12.2 The Argos Joint Tariff Agreement (JTA)

The Argos Joint Tariff Agreement (JTA) is an agreement between a number of users and Service Argos, where the users guarantee to pay for an agreed service defined as number of "PTT years" at a specified price. The terms of the agreement are negotiated and renewed annually.

Requirements are co-ordinated at national level through a Representative Organization for a Country or Group of Countries (ROC) and act on behalf of the national users.

13. INDEPENDENT LUT SERVICES

In operational systems providing observations from data sparse areas it is very important that as many as possible of these observations are received and distributed on the GTS in near real-time. However, because of the predefined orbits of the NOAA satellites and the limited number of receiving stations in the global processing chain, there may be long periods where no data are received via CLS Argos. In addition to the LUTs operated by Service Argos, EGOS buoy data had been also received by two independant LUTs for several years. One, operated by the Norwegian Meteorological Institute in Oslo has been linked to Service Argos since May 2002. A second one, operated by the Danish Meteorological Institute at Søndre Strømfjord (Greenland) is still active. Due to their location, these two independant LUTs together gave reasonable cover for the EGOS operational area and it has been clearly demonstrated that the use of these LUTs increased the data recovery rate from the EGOS buoys by some 20-40% before CLS Argos increased the number of its own LUTs in the North Atlantic. In addition, the timeliness was on average kept to approximately 20-40 minutes from the time of observation to the time when the data arrives at the users via the GTS.

Being not linked to Service Argos, the use of independant LUTs presents some inconvenients. Locations computed by LUTs are less accurate than these computed by Service Argos. For meteorological purposes, positions computed by LUTs are quite acceptable. However, sometimes a LUT can't no more compute a position correctly. A fixed wrong position is transmitted for the buoy. The PGC must inform as soon as possible the LUT operator of the problem. Then, the position can be reset thanks to a right one obtained at CLS/Argos

Since the two LUTs and Service Argos partly disseminate the same information it may occur that the same data were received from three sources. This had been discussed and was generally accepted in view of the overall increase in total data availability and improved timeliness.

The existence of three different sources for GTS dissemination significantly increased the work of the PGC too. However, the benefit obtained from the independant LUTs was judged positive with regards to the inconvenients.

14. REPORTING

Information on EGOS buoys are compiled and archived at the EGOS Technical Secretariat, which also keeps a record on the behaviour and history of the buoys. These records include copies of technical specifications with Argos Id. No., programme identification and pass word, owner and operator, calibration sheets, certificates and data format, results of predeployment tests, date and location of deployment, WMO No. and date of start of data dissemination via GTS, changes of buoy status, and any changes of calibration or GTS messages. It also includes data on when and where the buoy ceased to be operational and when it was finally taken off the list of EGOS buoys. This information is available to EGOS members on request.

Information on new deployments and changes of the operational status are circulated to the EGOS members and co-operating parties on a regular monthly basis.

15. LEGAL STATUS OF ODAS

The draft Convention on the Legal Status of Ocean Data Acquisition Systems, Aids and Devices (ODAS), worked out by the Intergovernmental Oceanographic Commission (IOC), in co-operation with several other international organizations, didn't really take shape until now.

However, the Preparatory Conference of Governmental Experts to Formulate a Draft Convention on ODAS (1972, UNESCO) recognised that the uniform application of the provisions of the Technical Annexes to the preliminary draft Convention is of importance to safety of both ODAS and ships. It therefore agreed that these Technical Annexes should be used by Member States, on a voluntary basis, as guidelines for national measures. Technical Annex II - Marking and Signals - was later on modified upon request by IOC and WMO.

ANNEX I

LIST OF NAMES AND ACRONYMS

CBS	Commission for Basic Systems
CLS	Collecte Localisation Satellites (Argos and Doris systems)
CGC	Co-ordination Group for COSNA
CMM	Centre de Meteorologie Marine of Meteo-France
CMM	Commission of Marine Meteorology of WMO
CMR	Christian Michelsen Research
COSNA	Composite Observation System for the North Atlantic
COST	European Co-Operation in the field of Scientific and Technical Research
DBCP	Data Buoy Co-operation Panel
DMI	Danish Meteorological Institute
DNMI	Norwegian Meteorological Institute
DWD	Deutscher Wetterdienst
ECMWF	European Centre for Medium Range Weather Forecasting
EGOS	European Group on Ocean Stations
FGGE	First Global GARP Experiment
GARP	Global Atmosphere Research Programme
GDC	Global Drifter Center of NOAA
GPS	Global Positioning System
GTS	Global Telecommunication System of WMO
IMCO	Intergovernmental Maritime Coordination
IMO	Icelandic Meteorological Office
IMO	International Maritime Organisation
IMS	Irish Meteorological Service
IOC	Intergovernmental Oceanographic Commission
JCOMM	Joint WMO-IOC technical Commission for Oceanography and Marine Meteorology
JTA	Joint Tariff Agreement (with Argos)
KNMI	Royal Netherlands Meteorological Institute
LUT	Local Users Terminal
NMI	Norwegian Meteorological Institute
NOAA	National Oceanic and Atmospheric Administration
ODAS	Ocean Data Acquisition System
PTT	Platform Transmitter Terminal
ROC	Representative Organization for a Country or Group of Countries (JTA)
SCOS	Drifting buoy programme for Southern part of North Atlantic
SEG	Scientific Evaluation Group of CGC
SMHI	Swedish Meteorologiska och Hydrologiska Institut
SOBA	System for Operational Buoys in the Atlantic
SVP	Surface Velocity Programme
UKMO	United Kingdom Meteorological Office
WOCE	World Ocean Circulation Experiment
WMO	World Meteorological Organization
WWW	World Weather Watch (WMO)

ANNEX II

BIBLIOGRAPHY

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Reference guide to the GTS sub-system of the Argos processing system,
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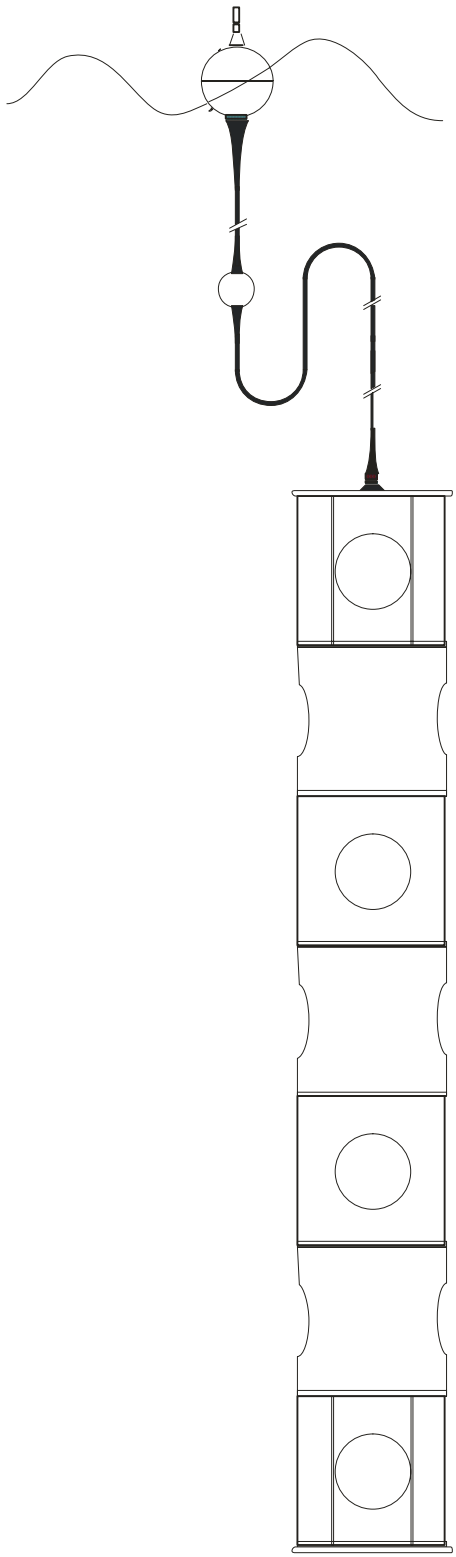
ANNEX III

EXEMPLE OF DRIFTING BUOY USED IN EGOS
SVP-B drifter



SVP type drifters are designed to track the mean current at 15 m depth using a 7 m holey sock drogue. They are composed of three main components :

- A surface float, housing the Argos transmitter, batteries, sea surface temperature probe and drogue-loss (immersion) sensor. Drogue loss is detected by a change in the immersion behaviour of the surface float.
- A tether assembly, which connects the surface float to the sub-surface drogue.
- A dimensionally-stable drogue, designed to perform well under adverse conditions and to be easy to deploy.

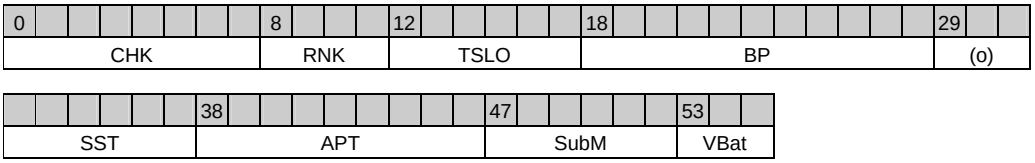
The SVP-B drifter is a SVP drifter equipped with a barometer to measure the atmospheric pressure at the sea level. The float is topped with a short mast containing the barometer port. The port allows the atmospheric pressure to reach the barometer but it prevents the water from entering in the pipe which links the port to the barometer inside the float.

On SVP-B drifters, air pressure is sampled during about 3 minutes. A despiking algorithm is used to remove the over-pressure due to the fact that the float is often submerged by the waves.

Specifications for the manufacture of SVP-B drifters are detailed in a DBCP document (see bibliography in Annex II).

ANNEX IV

DATA FORMATS USED IN EGOS DRIFTING BUOYS
DBCP-M2 recommended format (56 bits)



(o) First three bits of Sea Surface Temperature

	Item	Bits	Min	Max	Formula / Comments (n = word value)
CHK	Checksum	8	0	255	Checksum = n Example : Lower 8 bits of the sum of other bytes
RNK	Rank of observation	4	0	15	Rank = n (see note here below)
TSLO	Time Since Last Obs.	6	0	63	TSLO(min) = n (see note here below) This timer starts at 0 when the sensor data is updated in the transmission and counts minutes until the next data update.
BP	Barometric Pressure	11	900.0	1104.7	Press(hPa) = 0.1 n + 900
SST	Sea Surface Temp.	9	-2.0	38.88	SST(°C) = 0.08 n – 2
APT	Air Pressure tendency	9	-25.0	26.1	APT(hPa) = 0.1 n – 25
SubM	Submergence Count	6	0	100	Percent of time submerged = 100 n / 127
VBat	Battery Voltage	3	Free	Free	Vbat(V) = Free

Data are stored in the buoy memory in blocks of observations. Each block contains one single observation. Blocks are Block_Period minutes apart (e.g. every 30 minutes, every hour). One block (one observation) is transmitted in one Argos message. One Argos message contains only one block.

Rank is encoded in the Argos message. Rank of the most recent observation transmitted is 0. The rank of a given observation is incremented each time a new observation is carried out.

Age of the observation at the time of the next block update (AGEB) in the buoy memory is encoded in the Argos message. Age of the observation at the time of the Argos message transmission is therefore:

Age = Rank x Block_Period + AGEB

And observation time can therefore be computed as following:

Observation time = Acquisition time by the satellite - Age

If hourly observations are needed (Block_Period=60), the buoy must be activated so that a new observation is available on the hour. If synoptic observations are requested (Block_Period=180), the buoy must be activated accordingly. Please refer to DBCP Techn. Doc. n° 4, revision 1 for more details about the DBCP-M2 format.

DBCP-M2 format can be preceded by two 32-bits blocks containing the GPS data in case the buoy is equipped with this location system. It's assumed that the GPS data are related to the same hour than for other mesurements.

0	8	29
Pos-CHK	Latitude	(o)

32	51
Longitude	Free

(o) First three bits of Longitude

	Item	Bits	Min	Max	Formula / Comments (n = word value)
CHK	Pos. block checksum	8	0	255	Checksum = n (over the 7 next bytes)
Lat	Latitude	21	-90	90	Lat(deg) = 0.0001 n – 90
Lon	Longitude	22	0	360	Lon(dg) = 0.0001 n

Conmar GPS-buoy format (192 bits) still used for a few buoys

0	10	14	22
Air Pressure	VBat	SST	Air temperature

32	40	48	56
Air pressure tendancy	Not used	Not used	Air press. characteristic

64	74	80	86
Air Pressure	Synoptic hour	Not used	Air temperature

96	104	112	120
Air pressure tendancy	Max Air Temp.	Min Air Temp.	Air press. characteristic

128	136
Position time	Latitude

160	168
Not used	Longitude

	Item	Bits	Min	Max	Formula / Comments (n = word value)
BP	Barometric Pressure	10	920.0	1060.0	Press(hPa) = 140/1023 n + 920
VBat	Battery Voltage	4	11.25	17.5	Vbat(V) = 5/12 n + 11.25
SST	Sea Surface Temp.	8	-2.0	23.5	SST(°C) = 0.1 n – 2
AT	Air Temperature	10	-60.0	30.0	AT(°C) = 90/1023 n – 60
APT	Air Pressure Tendency	8	0.0	25.5	APT(hPa) = 0.1 n
APC	Tend. Characteristic	8	0	7	APC = n (2, 4 or 7 according to WMO code)
SynH	Synoptic Hour	6	00	21	SynH = n
PosT	Position time	8	00	21	PosT = n
Lat	Latitude	24	-90	90	Lat(deg) = 0.001 n - 90
Lon	Longitude	24	0	360	Lon(deg) = 0.001 n

ANNEX V

WMO SEA AREAS
for use in assigning buoy identifiers