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**GUIDELINE FOR
 BEARING
 GREASE SAMPLING**

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1. DISCLAIMER

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2. SCOPE

This document seeks to provide guidance in how to properly collect grease samples from the main roller bearing and product swivel bearing from the most common CALM buoy type, i.e. the one from Single Buoy Moorings. It also seeks to provide some information on what is being analyzed and why.

3. GENERAL

Proper lubrication of roller bearings is essential for reliable operation. The lubricant provides a separating film between the bearing rolling elements, raceways and cages to prevent metal-to-metal contact. By controlling surface contact, the lubricant is able to minimize the effect of surface contact, namely undesired friction that otherwise would generate excessive heat, metal fatigue and wear. The lubricant also prevents contamination damage by being renewed.

In the CALM buoy operating and maintenance manuals it is usually recommended to:

- Lubricate the bearings and check for adequate grease returns on a monthly basis. *This recommendation is to ensure that the lubricant present in the bearing is as uncontaminated as possible and thereby offers good clean film between the metal surfaces, and that grease contaminated with wear particles and external contaminants is expelled from the bearing.*
- Take samples of used grease for laboratory analysis from the main bearing outlets and CPU bearing outlets on a yearly basis. *What is important in this recommendation is that grease sampling is the technique used to monitor the condition of the bearing. What should be noted is that the time laps between the injection of grease and the sampling remains the same in order to be able to trace a meaningful trend. A more frequent sampling than recommended is preferable as it will allow detection of deterioration earlier and it will also help personnel to maintain a proficiency in the adequate technique to collect samples free from external contamination.*

The maintenance programs are usually set up so that the amount of grease injected on a monthly basis allows for the grease to be completely renewed every 6 months. A good additional indicator to monitor is therefore the consumption of grease (if you are not using at least the bearings' full grease volume every half year then you have an issue with your lubricating regime).

The purpose of the grease sampling is to assess the condition of a bearing by analyzing the grease content and thereby determining the levels of wear elements and eventual external contaminants.

4. SAMPLING KIT

The following is required for the sampling operation:

- Sampling plastic containers or bottles with a minimum capacity of 50 cc each.
- 50 cc syringe.
- Rags.
- One grease pump and grease.

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5. CALM BUOY MAIN ROLLER BEARING – FLAT-MOUNTED TYPE

1.1.1 DESCRIPTION

This is the mounting type of the second generation of main roller bearing (supplied since 1984). The bearing is flat mounted (i.e. the contact joint between bearing and fixed or rotating support is on the same side – underneath the bearing). Water barrage can be in steel or GRP.

On the bottom side of the inner ring of the bearing, there are 6 equally spaced grease relief ports (1/2" NPT) for the top rollers and 6 equally spaced relief ports (1/2" NPT) for the bottom rollers, 3 of each (at 120 degrees) should be chosen as collecting ports.

There are 18 equally spaced ports 1/4" NPT for the top rollers and 18 equally spaced 1/4" NPT ports for the bottom rollers all located on the top side of the outer ring of the bearing.

1.1.2 STEPWISE PROCEDURE

Step 1: identify sampling points where grease will be collected. 3 of the top roller relief ports and 3 of the bottom roller relief ports should be chosen (at 120°).

Step 2: Permanently mark the sampling ports.

Step 3: Remove the pig tail tubing of the chosen relief ports and clean area to avoid external contamination when collecting the sample. *If a degree of cleanliness is not maintained, then environmental contaminants will be evident.*

Step 4: Inject fresh grease in the grease injection ports located directly above the chosen sampling points.

Step 5: Collect at least 50 cc at each chosen 1/2" NPT port using the syringe and transfer to container taking care to avoid any external contamination (water, dirt, paint...). Mark each container with terminal name, sampling point location. Take care to seal each container.

Step 6: Collect at least 50 cc of fresh grease being used in the lubrication scheme in order to give a reference point for the laboratory. Mark container with grease type, brand name and batch number.

6. CALM BUOY PRODUCT SWIVEL

1.1.3 DESCRIPTION

The product swivel has 3 grease sample holes located at the bottom ring plugged with special 3/4" NPT plugs, and has 14 grease nipples on the top ring.

1.1.4 STEPWISE PROCEDURE

Step 1: Identify sampling points.

Step 2: Permanently mark the sampling ports.

Step 3: Remove the plugs and clean area to avoid external contamination when collecting the sample. *If a degree of cleanliness is not maintained, then environmental contaminants will be evident.*

Step 4: Inject fresh grease in the grease injection ports located directly above the chosen sampling points.

Step 5: Collect at least 50 cc at each sampling point using the syringe and transfer to container taking care to avoid any external contamination (water, dirt, paint...). Mark each container with terminal name, sampling point location. Take care to seal each container.

Step 6: Collect at least 50 cc of fresh grease being used in the lubrication scheme in order to give a reference point for the laboratory. Mark container with grease type, brand name and batch number.

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7. GREASE ANALYSIS

Typical raceway material specifications include 36NiCrMo 10V (2.5% Ni and 1.4% Cr), while typical roller specifications include X40Cr 13 (12% to 14% Cr). This and other factors allow the analyst to determine whether the wear is predominantly from the race or the roller. Analysis efforts can therefore be concentrated on iron, nickel and chromium.

Copper and other brass/bronze elements may indicate condition, where copper based spacer rings are used. Secondary data from ICP includes lithium and calcium - basic metallic soap constituents; silicon, aluminum, magnesium - airborne dust and dirt; then sodium, zinc, phosphorus and lead - which tend to originate in the anti-corrosion, anti-wear and EP additives used to improve the performance of the grease.

Grease samples should preferably be processed at operator's laboratory or nearby local laboratory. The list of contents to be measured (in ppm) and analyzed for each sample should at least include the following elements:

- Iron (Fe)
- Nickel (Ni)
- Chromium (Cr)
- Water (H₂O)
- Molybdenum (Mo)
- Aluminium (Al)
- Tin (Sn)
- Copper (Cu)
- Zinc (Zn)
- Magnesium (Mg)
- Sodium (Na)
- Chlorine (Cl)
- Sulphur (S)

8. TYPICAL INDICATIVE VALUES

The critical aspect when using grease sampling to monitor the condition of a bearing is the quality and reliability of the sample and that the developing trends give consistent results for the purpose for which they are intended. A sudden change in the trend should lead to a rechecking (re-sampling) in order to seek confirmation for the sudden change.

Below values are indicative only

Fe content (in ppm)		Status of bearing
750		Suitable for further service
1500		Warning – close to alert limit
5000		Warning – wear values are at the limit – prepare to change the bearing
15000		Unsuitable for further service