



**Brüel & Kjær Vibro**



## **Application Note**

# **Monitoring strategy – Nigeria LNG**



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<b>Location</b>	Bonny Island, Rivers State, Nigeria
<b>Monitoring system</b>	Compass (online and offline)
<b>Monitoring strategy</b>	Integrated, plant-wide machine protection, condition and performance monitoring
<b>Machines monitored</b>	Online: 150 critical machines and 750 fin-fans Offline: 960 auxiliary machines
<b>Interfacing</b>	Data import/export to DCS
<b>Comm.</b>	1999-2000 (trains 1, 2), 2002 (train 3), 2005 (trains 4) 2006 (train 5), 2007 (train 6)
<b>Services</b>	Long-term service agreement



Figure 1. Nigeria LNG plant.

### Compass selected for all trains

The Compass monitoring system was selected by Shell in 1996 and commissioned in 1998 for machine protection and condition monitoring of all critical machines and many auxiliary machines in the gas treatment, refrigeration and liquefaction cycles of both trains 1 and 2. The monitoring system was subsequently extended to trains 4, 5 and 6 when these units were built.

Even before the trains were operational, the monitoring system

was used for pre-delivery string testing of the LNG machines at the vendor's factory prior to shipment to Nigeria. This reduces the risk of detecting potential machine faults on-site, which could cause delays. Compass also provided completely independent machine verification since Brüel & Kjær Vibro is not aligned to the machine manufacturer.

The monitoring strategy for all trains is similar. For the critical machines, condition monitoring is done online continuously and includes protection. Some of the machines are also performance monitored, such as the gas

Nigeria LNG is one of the world's largest producers of liquefied natural gas (LNG) with a total capacity of 22 million tons/year of LNG, plus 5 million tons of LPG and condensate. This production capacity accounts for 10% of the world-wide LNG consumption. Formal studies are already underway to add a seventh train.



turbines and the compressors for mixed refrigerant, propane refrigerant, end flash, LPG storage and loading compressors. Many of the process parameters used in the thermodynamic calculations for performance monitoring are imported into Compass from the distributed control system (DCS).

While trains 1, 2 and 3 are cooled by water, trains 4, 5 and 6 are cooled by fin-fans. These are not critical machines but require online condition monitoring. 1500 online vibration channels are used for this.

For the non-critical auxiliary machines (balance-of-plant), the VT-80 and VP-80 portable monitoring instruments are used for monitoring hundreds of machines throughout the plant. Although many of these machines are spared, their operation becomes critical if one of them is down for maintenance. Offline condition monitoring plays an important role here.

In 2017 all online monitoring systems were upgraded to Compass 6000 version 10, which were also compliant to the newest IT standards for security.

### Integrated monitoring solution

As a plant-wide monitoring solution, an interface was implemented to export measurement values and alarm information from Compass to the DCS to keep plant operators informed on the condition of the

machines. The DCS was also used for time synchronization for the monitoring system. This is important for root cause analysis when comparing data from different machines for a specific event (e.g. a machine trip).

There is generally one central server for each train, where vibration, process and performance data trends can be correlated in the same plots. This is important for diagnostic purposes. Compass also allows relevant information to be displayed for all five trains in a single screen. As there are so many machines being monitored at the LNG plant, it is important to have a quick overview and assessment over all relevant parameters.

The monitoring system is 100% web-enabled, so operators can securely access the Compass database and system setup on any computer without specialist software or licenses. This also allows the Brüel & Kjær Vibro Diagnostic Center in Denmark to provide many remote services without a site visit.

### Long-term service agreement

Brüel & Kjær Vibro specialists are onsite several visits each year to take care of contingencies. Training is often done onsite, as for example when new personnel arrive. Services include:

- Help desk
- Software update
- System optimization

- Preventive monitoring system maintenance
- Training (system operator, system administrator, diagnosis and vibration analysis)

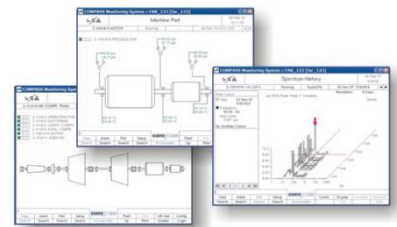


Figure 2. Screen view of the mixed refrigerant compressor train 2, showing a spectrum history plot (right) from the helping motor outboard bearing.

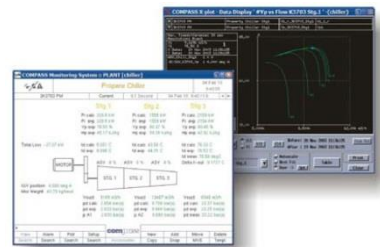


Figure 3. Screen view of the train 2 propane chiller compressor (left) and an efficiency vs. flow/speed compressor map plot for the first stage (right).

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