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BTD-350

SITE SELECTION GUIDE

BTD-350 Series
Thunderstorm Detectors

BTD-350 User Guide
Site Selection

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1 INTRODUCTION

This guide is provided to assist installers in the selection of sites suitable for the BTD-350 thunderstorm detector on marine vessels and offshore platforms. The information is provided to supplement that given in the sensor manual; therefore, it is recommended that the manual is studied before consulting this guide.

1.1 Applicability

This guide is primarily provided for installers of the BTD-350 on marine vessels and offshore platforms. The installation of BTD-350 sensors in a fixed terrestrial location such as a port or harbour is not covered in this guide, for such installations please consult the BTD-300 Site Selection Guide (Doc101730).

Due to the complex environment associated with marine vessels and offshore platforms, it is recommended that installation specific guidance is sought from Biral.

2 DETECTION PRINCIPLES

2.1 Lightning Flashes

All BTD series sensors detect and range lightning flashes by observing the extremely low frequency changes in the atmospheric electric field associated with the charge neutralisation in a cloud caused by the lightning flash. There are very few other natural or man made phenomena that can cause such changes, hence the very low false alarm rate, but there are factors that can alter the atmospheric electric field in such a way as to reduce the detection efficiency and alter the range estimation. These factors are discussed in section 3.1.

2.2 Pre-Strike Warning

A powerful feature of the BTD series is the ability to warn of the possibility of overhead lightning before the first lightning flash. This ability results from the measurement of charged precipitation striking the sensor's antenna, and from observing the charge carried by small particles blown past the sensor. The way in which these measurements can be altered by local factors is discussed in section 3.2.

2.3 Lightning Flash Bearing

BTD-350 sensors are fitted with a Direction Finder allowing both the range and bearing of lightning flashes to be reported. The Direction Finder uses a standard radio location technique in the Low Frequency (LF) radio band to determine the bearing of a lightning flash. Radio based detectors are susceptible to interference as discussed in section 3.3 below. Because the presence of a lightning flash is detected by observing low frequency changes to the atmospheric electric field as described above, the use of radio location to solely determine the bearing to the flash does not increase the false alarm rate.

3 SITE SELECTION

3.1 Lightning Detection Considerations

3.1.1 General

For the BTD-350 to achieve the published performance without adjustment, the atmospheric electric field around the sensor should not be distorted by fixed or moving objects. Distortions to the field are caused by fixed objects that rise above the surrounding ground plane, such as shipping containers, vessel superstructure, cranes, and masts. Local distortions are also caused by moving objects passing close to the sensor, such as people. Large objects that suddenly change their charge, such as when a helicopter lands, or sudden changes in the ground potential around the sensor, also change the local atmospheric electric field and can reduce performance. For marine vessels and offshore platforms, the ground plane is ultimately defined by the sea surface but can be taken as any unobstructed horizontal surface that extends 20 m from the base of the sensor in all directions.

In general, fixed objects result in a change to the detection efficiency and range estimation accuracy, whilst moving objects and phenomena causing a sudden change in the field may result in false alarms or lower detection efficiency.

3.1.2 Ideal Site

The ideal site for a BTD series detector is a flat, level deck with no superstructure, masts, cranes, or structures close by. The requirements can be stated more precisely as follows:

- Flat, level surface extending 20 m from the sensor in all directions with no obstacles higher than approximately 20 cm within 2 m of the sensor.
- No obstacles of any kind closer than approximately 3 times their height.
- No overhead obstructions, for example cables or crane booms.
- No frequent movement of people or equipment within 10 m.
- No ventilation duct exhaust within 20 m.
- The sensor should not be located where it will be subjected to the exhaust gases from either the vessel propulsion system or generators.

The requirement for an object to be no more than 3 times its height from the sensor means, if the top of a mast is 5 m above the base of the BTD sensor it should be located more than 15 m in the horizontal plane from the base of the mast.

3.1.3 Acceptable Site

An acceptable site is one where the BTD can provide an acceptable level of performance but some adjustment to the factory settings is likely to be required. The requirements are as follows:

- Flat, level surface extending 10 m from the sensor in all directions with no obstacles higher than approximately 20 cm within 2 m of the sensor. See additional comments below.
- No obstacles of any kind closer than half their height above the base of the sensor.
- No overhead obstructions, for example cables.
- No frequent movement of people or equipment within 5 m.
- No ventilation duct exhaust within 10m.
- The sensor should not be located where it will be subjected to the exhaust gases from either the vessel propulsion system or generators.

Where a sensor is positioned on the flat roof of a structure or section of deck, the requirement to have no objects closer than half their height above the base of the sensor still applies. For example, if a BTD sensor and a 10 m antenna are both positioned on a flat roof, the BTD sensor must be more than 5 m from the antenna.

When the sensor is installed on a flat roof or deck area it should be located as close to the centre as possible. This reduces the impact of the distortion of the atmospheric electric field that occurs close to the edge of a raised area.

The BTD may be positioned at the edge of a deck or superstructure roof area. The requirement to have no objects closer than half their height above the base of the sensor still applies.

It is not recommended that the BTD sensor is installed on sections of the vessel or platform that are significantly above the ground plane as this significantly changes the electric field experienced by the sensor as well as increasing the risk of a direct lightning strike on the sensor. Whilst the BTD sensor has protection against nearby lightning strikes, it will be damaged or destroyed by a direct strike. Such damage is not covered by the warranty.

3.1.4 Unacceptable Site

An unacceptable site is one where the performance of the BTD sensor will be reduced to an unacceptable level or multiple false alarms will be reported. Unacceptable sites include those with any one of the following characteristics:

- Overhead obstructions such as cables, crane booms, netting, flags or streamers.
- Obstacles closer than half their height above the base of the sensor.

- Frequent movement of people or equipment within 5 m.
- Close proximity to ventilation exhausts or the exhaust gases from either the vessel propulsion system or generators.

3.1.5 Sites with Significant Movable Structures

Where large movable structures exist on the vessel or platform their impact on BTD performance must be considered. Movable structures include cranes and the support legs of jackup platforms. In selecting the installation site, the worst-case configuration of the movable structure must be considered.

Due to their movable nature the impact of these structures on the detection efficiency and range accuracy of the BTD sensor will not be fixed. Locating the BTD as far away from movable structures as possible will reduce their impact on performance.

3.1.6 Electrostatically Charged Objects

Whilst there are very few phenomena that can cause local changes in the atmospheric electric field which are characteristic of lightning the following are known, and appropriate precautions should be taken.

- Aircraft Touch Down. Aircraft in flight become charged by the passage of particles over their surface. This charge is rapidly discharged as the aircraft touches the landing pad and can be seen by a BTD sensor as a distant lightning flash if the sensor is in close proximity to the touch down point. It is recommended that where BTD sensors are used on platforms with helipads they are placed no closer than 100m from the helipad. Where it is essential to locate the sensor closer than 50m it may be possible to adjust the sensor’s settings to reduce or eliminate false lightning reports caused by aircraft touch down, or these may be accepted as resulting from a known event. Consult Biral for further information.
- Aircraft Flight Path. It is recommended to avoid placing BTD sensors in areas where they will be overflown at low level by arriving or departing aircraft.
- Low Flying Birds. Birds, as well as aircraft, become charged in flight, and are known to cause false reports of distant lightning if they fly very low directly over the sensor. In most locations such events are very rare, perhaps one or two reports a year, but locations should be chosen that avoid areas of intense bird activity where possible. Birds in general, even when perched on the sensor antenna, have no significant impact on performance, meaning bird deterrent measures are not required. Do not attempt to fix bird spikes to any part of the sensor as these will significantly reduce performance.

3.1.7 Changes in Ground Potential

The antenna of a BTD sensor measure changes in the atmospheric electric field with respect to ground. If the ground plane on which the sensor sits is subject to a change in potential it will be detected by the sensor's antenna and may result in false lightning reports or reduced detection efficiency.

Significant changes in ground potential are rare but can be caused by ground return currents associated with high power machinery. Where such currents exist, either the cause should be eliminated, or the sensor should be moved.

To operate correctly every BTD series sensor must be adequately grounded. It is recommended that a local ground connection is used, especially in circumstances where the protective ground cable associated with the mains power supply is of extended length. For marine vessels and offshore platforms direct local connection to the vessel or platform structure is recommended.

Note: Where a local ground connection is used to provide earthing for electrical safety, it is the installer's responsibility to ensure an adequate earth termination is achieved in accordance with the local laws and regulations.

3.1.8 Range Estimation Errors

The range accuracy of reported lightning discharges will be degraded if the site is non ideal. The extent of the degradation cannot be easily predicted and may result in either an over or underestimation of range. Providing the physical configuration of the vessel or platform does not significantly alter a range correction factor can be applied to the sensor. See the BTD-300 User Manual (Section 5.3) and BTD-300 Control Software Manual (Section 5.2.3) for details of how to enter a site range correction.

Methods for estimating the range error are detailed in section 4.

3.2 Pre-Strike Warning Considerations

To ensure any BTD series sensor provides the best possible pre-strike warning of a thunderstorm it is necessary to avoid locations where a significant number of charged particles are discharged into the air. Activities that generate charged particles include jet washing, water cooled air-conditioning equipment, jet engine exhaust, the exhaust from internal combustion engines, and breaking waves. Whilst it is very unlikely that these sources will cause a false warning of potential thunderstorm activity, they can interfere with the detection process and reduce the sensor's ability to report strong electric field warnings.

Charged precipitation warnings may also be affected by the sources listed above as they may cause naturally occurring precipitation to become charged. Charged precipitation warnings may also be generated in situations where the sensor is exposed to water drops from a high-pressure hose or fire suppression system. Locations where this can occur should be avoided.

3.3 Flash Bearing Considerations

3.3.1 Vessels and Movable Platforms

The BTD direction finder reports flash bearings relative to the North indicator on the direction finder enclosure. On vessels and platforms that move it is recommended that the direction finder is aligned to the vessel such that flash bearings are relative to the vessel.

3.3.2 General

The Direction Finder of a BTD series sensor can be affected by static disturbances to the local magnetic field and by local sources of electromagnetic radiation. Static disturbances cause an offset in the reported direction whilst local noise sources can either cause the reported bearings to be dispersed from their true position or, in the case of a strong noise signal, all lightning will be reported as having the same bearing. The causes and site selection considerations are discussed below.

3.3.3 Static Magnetic Disturbances

Marine vessels and offshore platforms are typically large ferrous structures and can be expected to cause a local disturbance in the Earth's magnetic field.

As the effect of a static disturbance to the local magnetic field is an offset to the reported bearing, a correction can be applied using the BTD Control Software. The Direction Finder angle offset feature is discussed in section 3.5 of the BTD-300 User Manual.

3.3.4 Electric Power Transformers and Generating Equipment

Electric power transformers, electrical power generators and power distribution cables can all generate significant magnetic fields which may affect the reported bearing of lightning flashes. As this type of equipment varies significantly in power and design, no definitive guidance can be given as to a safe separation distance, it is however recommended that a minimum separation distance for unshielded cables of 40m is used where possible.

3.3.5 Local Radio Frequency Interference – Transmitters

The Direction Finder can be thought of as a wide band radio receiver designed to receive the strong low frequency (~100kHz) electromagnetic signals produced by lightning discharges. The wide bandwidth of the Direction Finder receiver means a greater number of sources can interfere with its operation, however as most signals are transmitted in a very narrow band at relatively low power they seldom contain sufficient power to have a significant impact on the Direction Finder's operation. The obvious exception to this is where a low power transmitter is located very close to the Direction Finder, meaning a significant amount of power is delivered to the

Direction Finder receiver, resulting in errors in the reported bearing of lightning flashes.

The Direction Finder constantly assesses its local operating environment and adjusts its detection thresholds accordingly. This provides a good level of protection against constantly transmitted frequency modulated signals as they effectively appear as a constant background against which lightning signals are easily seen. Signals that are only transmitted intermittently or are transmitted using amplitude modulation are not so easily removed and can look very like lightning signals to the Direction Finder.

The safe working distance between the Direction Finder and a radio transmitter will depend on the transmission frequency and strength of the signal. For low to moderate power transmitters a minimum separation distance of 20m is recommended. For high power transmitters, especially at lower frequencies, a greater distance may be required. The design of the transmitting antenna also has an effect; placing the BTD in line with the primary axis of a directional antenna will require a significantly greater separation distance than would be required for an omnidirectional antenna using the same power. It must also be remembered that even a directional antenna will emit significant amounts of radiation away from the primary axis.

The power of an electromagnetic signal drops with the inverse square of the distance from the transmitter, i.e. doubling the distance results in the power dropping by a factor of four. Increasing the distance between a BTD and a radio transmitter by only a small amount can have a significant impact on performance.

Where a radio link or radio modem is used to connect the data output of the BTD to a remote computer, the radio equipment must be located away from the BTD sensor. On no account should the radio equipment be mounted on the BTD or on its support pole. Even Wi-Fi links with directional antenna produce enough interference at close range to disrupt the Direction Finder's operation.

Where the Direction Finder is influenced by a local radio transmitter and it is not possible to move the BTD to another location, improvements in performance may be achieved by rotating the Direction Finder. If the source of the interference is known, pointing the North indicator on the Direction Finder at 45º to the source may be effective. For mobile phone masts and other very high frequency sources an angle of 90º may prove more effective. Some degree of experimentation will be required in all cases. Once an optimum location has been found the Direction Finder offset adjustment feature of the BTD can be used to allow the correct bearing to be reported.

3.3.6 Other Sources of Radio Frequency Interference

Wide band radio frequency interference can be generated by industrial processes and electrical equipment. Wide band interference is particularly problematic as more energy is coupled to the receiver of the Direction Finder and the source is typically poorly controlled. The following are typical sources of interference:

- Electrical arc welding operations
- Large brushed AC and DC motors
- Insulator breakdown on high voltage power transmission lines
- Poorly supressed petrol engine ignition systems

Unless measures can be taken to supress emissions, the only solution may be to move the BTD sensor away from the noise source. Recommended separation distances cannot be given as the strength of the signal will vary with the source type, design and power.

4 CORRECTING RANGE ESTIMATION ERRORS

Unless the BTD is in an ideal site some degree of range error can be expected. The error may not be substantial but may be noticeable when flashes are compared to a lightning location network. The following sections describe how to determine the size of the error and apply a correction. If the vessel or platform has a significant movable structure a perfect correction for all possible configurations may not be possible.

4.1 Finding the Actual Lightning Range

There are several options to independently find the actual distance to lightning, some of the best are detailed below.

For all the methods discussed below, to increase confidence of the comparison results, it is best to compare many flashes and find a typical range reported by the BTD and the independent method. Always make sure that you are comparing lightning flashes detected by the BTD and an independent method which occurred at the same time.

4.1.1 National Lightning Location Network

Lightning detection by a national lightning location network is usually the best option for locating lightning flashes as you can see individual flashes in near real-time. This service can normally be found on your national weather service website or good quality lightning data sites such as www.lightningmaps.org.

Identify individual flashes that are shown by both the BTD and the lightning location network and record the range reported by the BTD and the distance from the BTD to the flash as shown on the lightning location network. For best results choose a small localised storm and average the BTD range and lightning network distance for several flashes.

To determine the distance of the flash as reported by the lightning network it may be necessary to printout the lightning network's map display and then measure the distance between the flash and the sensor's location.

4.1.2 Rain Radar

If the storm is small and isolated, use an online rain radar site, normally available from your national weather service, to find the heaviest precipitation. This is normally where the lightning is found.

4.2 Entering the Direction Finder Offset

Where possible combine the results from several storms in different directions around the BTD. The last 128 flashes detected by the BTD can be downloaded in CSV format using the BTD Control Software, see section 5.2.2.2 of the BTD Control Software Manual for details.

For each flash divide the actual distance by the range reported by the BTD to obtain a ratio. Calculate the average ratio across several flashes and storms. Use the Site Calibration function of the BTD Control Software, as described in section 5.2.3 of the BTD Control Software Manual, to change the range calibration:

- In the **Enter Actual Distance** dialog box enter the calculated average ratio
- In the **Enter Reported Distance** dialog box enter 1.0

5 ADJUSTING THE DIRECTION FINDER OFFSET

The vessel or platform can be expected to distort the Earth's local magnetic field resulting in an offset to the reported flash bearings. The offset may not be large but may be noticeable when a map display is compared to a lightning location network. The following sections describe how to determine the size of the offset and apply a correction. Where the local magnetic field is distorted, the correction may not remove completely the offset for all reported directions.

5.1 Finding the Actual Lightning Direction

There are several options to independently find the actual direction to lightning, some of the best are detailed below.

For all the methods discussed below, to increase confidence of the comparison results, it is best to compare many flashes and find a typical direction reported by the BTD Direction Finder and the independent method. Always make sure that you are comparing lightning flashes detected by the BTD and an independent method which occurred at the same time.

5.1.1 National Lightning Location Network

Lightning detection by a national lightning location network is usually the best option for locating lightning flashes as you can see individual flashes in near real-time. This service can normally be found on your national weather service website or good quality lightning data sites such as www.lightningmaps.org.

Identify individual flashes that are shown by both the BTD and the lightning location network and record the direction reported by the BTD and the direction from the BTD to the flash as shown on the lightning location network. For best results choose a small localised storm and average the BTD direction and lightning network direction for several flashes.

To determine the direction of the flash as reported by the lightning network it may be necessary to printout the lightning network's map display and then measure the direction between North and flashes at the sensor's location. The direction is measured clockwise from North at the sensor's location to the flash reported by the lightning network.

Where possible combine the results from several storms in different directions around the BTD. For each flash subtract the BTD direction from the lightning network direction. Calculate the average difference between the BTD direction and that of the lightning network to obtain the offset value.

5.1.2 Rain Radar

If the storm is small and isolated, use an online rain radar site, normally available from your national weather service, to find the heaviest precipitation. This is normally where the lightning is found.

Average the direction reported by the BTD for several lightning flashes and estimate the direction from the BTD location to the heart of the storm on the rainfall radar. The direction is measured clockwise from North at the sensor’s location to the flash reported by the lightning network. Subtract the average BTD direction from the estimated direction taken from the rain radar to obtain the offset value.

Where possible combine the results from several storms in different directions around the BTD.

5.2 Entering the Direction Finder Offset

The Direction Finder offset is entered using either the sensor’s command line interface or using the BTD-300 sensor software. Details of how to enter the offset are given BTD sensor manual and the BTD-300 Sensor Software manual.