BTD-300

SITE SELECTION GUIDE

BTD-300 Series
Thunderstorm Detectors

BTD-300 User Guide
Site Selection

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1 INTRODUCTION

This guide is provided to assist installers in the selection of suitable sites for the BTD-300 thunderstorm detector. 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-300 on land based sites. The information provided is also generally applicable to the BTD-350, especially when it is installed in a fixed terrestrial location such as a port or harbour. The installation of BTD-350 sensors on vessels and fixed or movable platforms is not covered in this guide. It is recommended that installation specific guidance is sought from Biral for such installations.

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-300 sensors can be fitted with an optional 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-300 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 ground level, such a buildings, trees and masts, and by moving objects passing close to the sensor, such as vehicles and people. Large objects that suddenly change their charge, such as when an aircraft lands, or sudden changes in the ground potential around the sensor, also change the local atmospheric electric field and can reduce performance.

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 field with no buildings, trees, mast or other structures close by. The requirements can be stated more precisely as follows:

- Flat, level ground with no obstacles higher than approximately 20 cm (including vegetation) within 2 m of the sensor.
- No obstacles of any kind closer than approximately 3 times their height.
- No overhead obstructions, for example cables.
- No frequent movement of people, animals or vehicles within 10 m.

The requirement for an object to be no more than 3 times its height from the sensor means, if a building is 5m high the sensor should be located more than 15 m from the building.

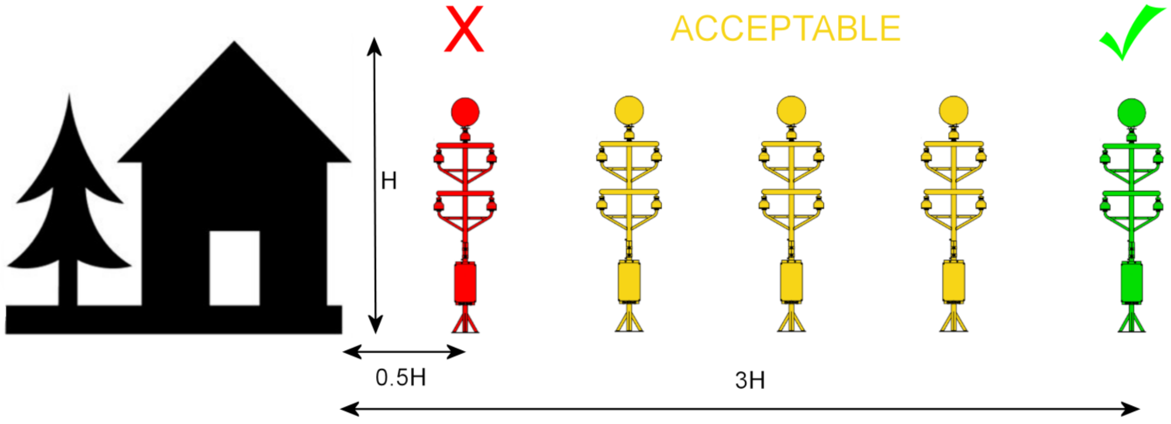
3.1.3 Acceptable Site

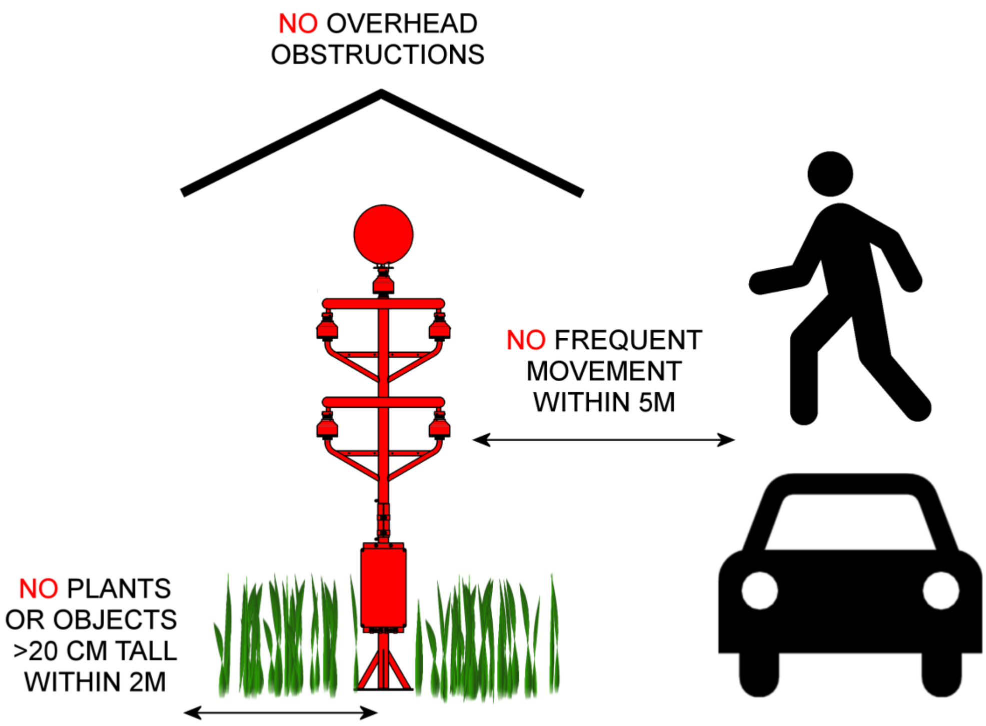
An acceptable site is one where the BTD can provide an acceptable level of performance but some adjustment to the factory settings is likely to be required. The requirements are as follows:

- Sensor can be positioned above ground level on a flat roof. 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, animals or vehicles within 5 m.

Where a sensor is positioned on a flat roof, 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 10m antenna are both positioned on a flat roof, the BTD sensor must be more than 5m from the antenna.

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





It is not recommended that the BTD sensor is installed on the roof of a tall building 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 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, rooves, netting, flags or streamers.
- Obstacles closer than half their height above the base of the sensor.
- Frequent movement of people, animals or vehicles within 5 m.

3.1.5 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 air over their surface. This charge is rapidly discharged as the aircraft touches the ground and can be seen by a BTD sensor as a distance lightning flash if the sensor is in close proximity to the touch down point. It is recommended that where BTD-300 sensors are used on airfields they are placed no closer than 100m to the centre line of any runway. Where it is essential to locate the sensor closer than 100m it may be possible to adjust the sensor's settings to reduce or eliminate false lightning reports caused by aircraft touch down. Consult Biral for further information.
- 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.

3.1.6 Changes in Ground Potential

The antenna of a BTD sensor measure changes in the atmospheric electric field with respect to ground. If the ground 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 the breakdown of buried cables or 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 soils in most temperate regions a 1m good quality ground rod is sufficient to provide a local ground for correct operation of the sensor. In dry soils a longer rod or matt may be required. Earthing kits with 2.4m ground rods are available from Biral.

Note: Where a local ground rod 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.

3.2 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 and the exhaust from internal combustion engines. 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 spray or irrigation system. Locations where this can occur should be avoided.

3.3 Flash Bearing Considerations

3.3.1 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.

3.3.2 Static Magnetic Disturbances

Static magnetic disturbances are typically caused by large ferrous metal objects in the vicinity of the sensor. These may be steel framed buildings, storage tanks and industrial process equipment. The local magnetic field may also be disturbed by naturally occurring iron rich rock formations.

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

To avoid the need to apply an offset, it is recommended the sensor is installed at least 40m from any large ferrous metal object. Successful operation may be achieved within 5m of ferrous metal objects, however a significant offset correction may be required.

3.3.3 Electric Power Transformers and Generating Equipment

Electric power transformers, electrical power generators and overhead 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 of 40m is used where possible.

3.3.4 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 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 transmissions 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 the 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.

3.3.5 Other Sources of Radio Frequency Interference

Wide band radio frequency interference can be generated by industrial processes, electrical equipment and local infrastructure. 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
- Trains or trams powered by overhead electrical cables or live rails

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 ADJUSTING THE DIRECTION FINDER OFFSET

If the Direction Finder is not correctly aligned to True North or if there are local distortions in the Earth's magnetic field the reported direction may have an offset. The offset is not usually 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.

4.1 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.

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 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.

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.

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.

4.2 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.