Sonardyne Comments to BOEM 30 CFR Part 250
RIN 1010- AD68

In 30 CFR Part 250, Section 250.442 (Page 44) it is stated that:

"BOEMRE believes additional evaluation is necessary to determine the reliability of acoustic signal transmission as a mandatory backup control system. Industry academics and other stakeholders have raised concerns about how the difference in water temperature between water layers (deepwater thermocline) will affect the transmission of the acoustic signal to the BOP stack when installed in deepwater. Similar concerns were raised about how different salinities between water layers , noise from a wild well or other subsea noise may interfere with the successful transmission of the acoustic signals to the BOP stack.

Further investigation of these concerns is needed before deciding to require the installation of an acoustic backup control system."

Established in 1971, Sonardyne is an international group of companies manufacturing subsea instrumentation. We specialize in the development of solutions for underwater navigation, acoustic positioning, subsea communications, through-water control and surface and subsea inertial navigation. Applications for our technology are found within the offshore industry areas of oilfield exploration, construction and drilling as well as ocean science. In many of these areas, the products we have developed and the techniques we have pioneered have become the operational standard.

In the past five years Sonardyne has advanced its subsea signal processing methods from analog tone to sophisticated digital wideband signals; similar in many way to the advancement of cell phone technology from analogue to digital. It was this new technology that successfully contributed to the simultaneous multiple operator engineering efforts to cap the Macondo well in the Gulf of Mexico.

As a specialist provider of deepwater acoustic positioning and communication systems, with four decades of experience in the offshore oil & gas industry, Sonardyne wishes to add the following clarifications in relation to the above concerns:

Whilst it is true that variations in temperature (deepwater thermocline) and salinity between water layers can cause diffraction of acoustic signals, this is absolutely not an issue for the vertical or near-vertical communication path between a drilling rig and its BOP stack, and only affects communications over long horizontal distances. If the horizontal range does not exceed the water depth, there will be no problems due to diffraction

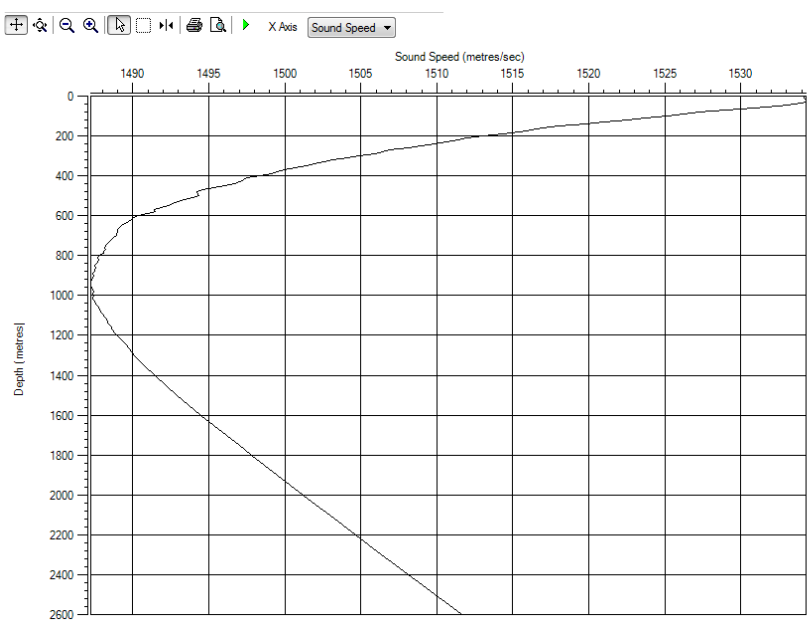
For example, for a wellhead located in 1,000m (3,000 ft) water depth, the area on the surface from which communication will be entirely unaffected by thermal or salinity differences, would be a circle of diameter 2,000m (6,000 ft) centred above the wellhead.

This is clearly demonstrated by the fact that every deepwater dynamically positioned rig and drillship uses an acoustic positioning system in addition to GPS, as a reference input to the dynamic positioning system. These systems operate by using a hull-mounted acoustic transceiver to interrogate, and receive replies from, an array of seabed acoustic beacons, over a transmission path that is very similar, to that of an acoustic BOP system (i.e. near-vertical). These systems operate 24 hours a day 365 days a year in all regions and all environments from tropical to arctic, without suffering from any form of unreliability due to thermal or salinity effects.

These concerns may have been expressed by individuals with experience of naval sonar systems, particularly in applications such as submarine detection, where the target is typically only a few hundred feet below the surface and at a horizontal range of several thousand feet. Under such circumstances and at such shallow angles, signal diffraction due to thermal and salinity variations can be a serious issue, but not in the near-vertical geometry of an acoustic BOP system.

Sonardyne has extensive experience of modelling acoustic transmission paths, based upon detailed measurement of the sound velocity profile through the water column and has its own proprietary computer model for doing this. We are able to provide ample evidence from many different locations, to confirm that near-vertical acoustic propagation does not suffer from any such unreliability.

A typical sound velocity profile and raytrace from the Gulf of Mexico is shown below for illustration.



Depth	Sound Speed	Salinity	Temp
0.00	1534.17	24.24	36.3
10.00	1534.17	24.24	36.3
20.00	1534.27	24.22	36.3
30.00	1534.29	24.15	36.3
40.00	1533.60	23.79	36.4
50.00	1532.44	23.20	36.5
60.00	1530.84	22.42	36.7
70.00	1529.02	21.71	36.6
80.00	1527.26	20.98	36.6
90.00	1526.17	20.49	36.7
100.00	1525.18	20.07	36.6
110.00	1523.70	19.51	36.6
120.00	1522.51	19.02	36.6
130.00	1520.96	18.47	36.5
140.00	1519.79	18.01	36.4
150.00	1518.02	17.41	36.3
160.00	1516.90	16.96	36.3
170.00	1516.21	16.69	36.3
180.00	1515.42	16.40	36.2
190.00	1514.31	16.01	36.2
200.00	1512.99	15.55	36.1
210.00	1511.98	15.20	36.0
220.00	1511.35	14.96	36.0
230.00	1510.61	14.68	36.0
240.00	1509.91	14.43	35.9
250.00	1508.96	14.10	35.9
260.00	1508.09	13.80	35.8
270.00	1506.86	13.39	35.7
280.00	1506.45	13.21	35.8
290.00	1505.91	13.02	35.7
300.00	1504.83	12.68	35.6
310.00	1504.13	12.42	35.6
320.00	1503.14	12.10	35.6
330.00	1502.55	11.89	35.5
340.00	1501.92	11.67	35.5

Figure 1. Variation of Sound Speed with Water Depth

The plot above shows variation in sound speed (horizontal axis) plotted against water depth (vertical axis) from the surface to 2,600 metres depth.

As is typical for a sound velocity profile, the variation in sound speed close to the surface is due primarily to thermal effects, whereas below 1000m it is due principally to pressure effects.

The manner in which this sound speed variation affects the propagation path is shown in the plot below.

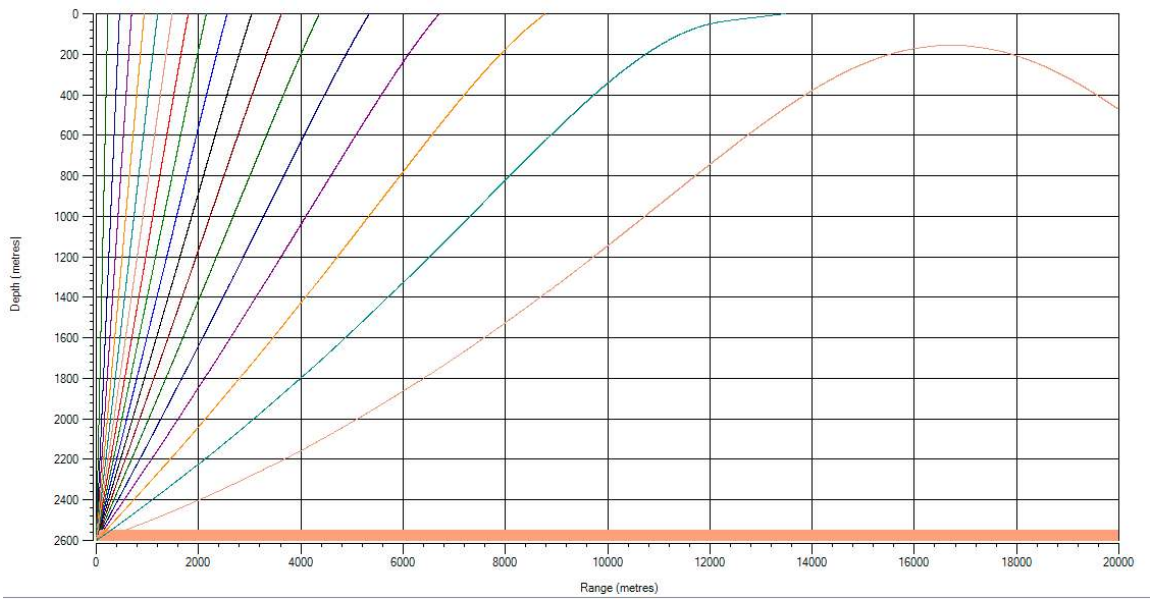


Figure 2. Propagation Path from Seabed (2,600m) to Surface.

This plot shows the path taken by sound waves launched from the seabed at different angles and clearly shows that the propagation path is essentially a straight line until the horizontal range reaches 8,000 – 12,000m i.e. 3 to 4 times the water depth. Only beyond this range do the effects of diffraction begin to have an impact. If we remain within a horizontal range of 2,600m (equal to the water depth) the propagation path is completely unaffected by diffraction.

Of more concern, in the case of a subsea blowout would be the potential for a large oil & gas plume to be present in the water column above the wellhead. This can have a detrimental effect upon acoustic signals which pass through it, and for this reason, we have developed means of circumventing any plume.

The surface transceiver can be fitted to an ROV and during a subsea blow-out can be moved close to the wellhead, to communicate over a shorter range and away from any oil & gas plume. This gives a much higher signal to noise ratio and much greater likelihood of successful communication.

Additionally, a relay transponder can be deployed on the seabed at the beginning of a drilling operation, a suitable distance away from the wellhead, where it can communicate horizontally to the BOP. This enables acoustic signals from the surface to avoid the need to pass through any oil & gas plume below the rig. These signals can be transmitted from the rig, received

by the relay transponder and passed on to the BOP. This capability is present within the current generation of acoustic BOP control system.

The issue of the extreme level of noise from a wild well had always been a source of concern for acoustic systems. Sonardyne acoustic systems were employed extensively during the Macondo incident. The operational experience gained by Sonardyne during the aftermath the Macondo incident has served to demonstrate that reliable two-way acoustic communication can be consistently achieved, even within a few feet of the blowout.

During the operations to cap the well, a number of Sonardyne acoustic transponders were connected to pressure sensors within the containment cap. These transponders were located only feet away from the venting plume and were interrogated every few seconds by an ROV-mounted transceiver. They were able to consistently transmit error-free pressure data in real time despite the extreme levels of noise present. Additionally we were able to gather valuable information on the level and spectral content of the noise, which will be used to produce further enhancements to our acoustic BOP backup systems.

Acoustic backup BOP controllers are currently being used successfully in Brazil and Norway. Their use is customary, strongly encouraged and provides an additional measure of safety. The acoustic BOP system can also provide a critical communication link to read information from the main BOP in the event that communication from the multiplex cables is lost.

In addition to addressing these areas of concern, Sonardyne would also make certain recommendations for any acoustic backup systems to be adopted. These include:

- An additional Portable Control System should be kept on standby at a shore base or on a local support vessel in the event that the rig's system cannot be operated or the rig is destroyed. An additional ROV-mountable transceiver should also be kept available for emergency intervention by ROV.

- A single cable usually connects the Sonardyne SEM to the client BOP (as there is usually only one connector available on the BOP) and this is a single point failure which could be eliminated if BOP manufacturers provided dual connectors on their BOP acoustic pods, as two cables could then be used.

- A serial communication link should be provided from the acoustic backup system to the main BOP stack, in order that pressure and status information from within the BOP stack could be retrieved acoustically even if all multiplex cable communication to the BOP has been lost. This would simplify and reduce the risk of operations following a major incident. The Sonardyne acoustic backup system includes such a serial link, but modifications would be required on most client's BOP control systems to make use of it.