Using AMSS on BBC Radio 4 to Send Data to Subsurface Locations

*AMSS (AM Signalling System) was originally developed by the BBC to transmit data, using a subcarrier, on a long-wave broadcast transmission. Similar in concept to the more well-known RDS (Radio Data System) that operates on VHF stations, AMSS was standardised in 2006 by ETSI as an extension to the Digital Radio Mondiale system. Because long-wave broadcasts can be received underground, AMSS may, as **David Gibson** explains, provide a convenient method of broadcasting emergency data to miners trapped underground.*

Direct through-the-earth communication can be extremely limited in scope and usually has to use a low frequency and a large antenna system. Even mine communication systems using kilometre-wide loops and tens of kilowatts of power can fail (in accordance with theory) to achieve good communication depths and, of course, are not straightforward to deploy in an emergency.

Over the years, I have collected anecdotal information concerning the reception of long-wave broadcast signal underground. Cavers have reported that, whilst their induction radios have failed to work in deep caves, they have been able to receive BBC Radio 4 (on 198kHz) at underground camps.

Although penetration of the earth at 198kHz should, in theory, be well below the level required for communications, there are various physical mechanisms that could explain the phenomenon reported by cavers. One such is favourable propagation along subsurface strata and there is also the possibility that a powerful radiating transmitter at a great distance may give rise to a stronger underground signal than a less powerful and non-radiating local induction loop. In mining, it has been shown that propagation is also favoured by the metallic mine infrastructure.

The question therefore arises of how a 1MW broadcast transmitter could be utilised for subsurface communication – one-way communication, of course. The infrastructure to do this is already in place because long-wave broadcast transmissions have the capability to carry Radio Data System (RDS) signals. On VHF, this is the information that tells you which FM station you are tuned to. A similar system for long-wave broadcasts was originally developed by the BBC to carry, amongst other data, control signals for industrial use, e.g. for switching your electricity meter to the nighttime 'Economy 7' tariff; a service now known as radio teleswitching [1, 2]. I noted, some 20 years ago, this possibility for subsurface communication [3]: If a rescue organisation could lease data packets on this system, it could prove to be a simple method of providing emergency communication from the surface to trapped cavers or, more likely, miners.

This signalling system has been in existence for a long while, and at least two articles appeared in the hobbyist electronics press some 20 years ago [4, 5]. The system is known, these days, as AMSS (AM signalling system) and was standardised, some ten years ago (in 2006) by ETSI as an extension to the Digital Radio Mondiale (DRM) system. Essentially, the data is bi-phase-modulated onto a 25 Hz subcarrier, which then phase-modulates the 198kHz carrier at ±22.5°. The combination of low data-rate and low angle of modulation ensures that there is no interference with the audio signal. There are 30 blocks of 50 bits of data that are repeated every minute. The last block before the minute contains date and time information and all blocks include a CRC word. Because the carrier is at only 198kHz, the demodulation and decoding task can easily be carried out in a small low-power microprocessor (e.g. a PIC rather than a Raspberry Pi). A summary of AMSS is given in Wikipedia [6] and includes links to some useful reference material [7, 8]; also see [9]. Additionally, the Wikipedia page on the BBC Droitwich transmitter [10] includes a link to a specification [11].

A few years ago, I was working on a project funded by the European Commission's Research Fund for Coal and Steel to study emergency support technologies for miners [12]. One aspect of this was how to provide resilient communications that would survive a major incident in a deep coal mine. It was intended to make measurements of the BBC Radio 4 signal strength underground, but this did not take place, due – in part – to the difficulty in getting the necessary equipment approved for use underground in a hazardous atmosphere. If this work is followed-up, and if the signal strength proves favourable, AMSS could be a useful facility – provided the commercial structure is in place to allow the leasing of this data capacity.

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