Crew Green
CONSULTING

Excerpts from the 'Squidgygate' report prepared for *The Sunday Times*

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4. Why Mr Reenan could not have received other Cellnet base stations.

4.1. In January 1993 two staff from *The Sunday Times* and I visited Mr Reenan and examined his receiving facilities. Mr Reenan's memory of the events seemed good considering that they had taken place some three years ago, and he stated quite clearly that the receiving system we examined was more or less exactly the same as that used on the evening when the recording had been made. He claimed little knowledge of radio, and in fact he demonstrated quite eloquently in the course of the visit that he possessed hardly any.

4.2. Cellular radio makes use of frequencies in the UHF (ultra-high frequency) region, which implies relatively short range. It also implies that they exhibit what are known as *line-of-sight* characteristics, meaning that they behave rather like light rays and are easily deflected or blocked by obstacles. In the UK, analogue cellular radio systems of the period used frequencies between 915 and 950MHz for transmission from their base stations.

4.3. Mr Reenan's house was in Park Road, Abingdon. As a potential site for VHF and UHF reception I judged it as relatively poor since the area was not elevated and there was a poor 'take-off' in most directions. Indeed there was a large church about 50 yards away, which would have been expected to act as a considerable obstruction to reception of frequencies which nominally have line-of-sight characteristics. In this connection it was noted that neither my Cellnet mobile telephone nor the Vodafone telephone belonging to a member of *The Sunday Times's* staff worked anywhere in Mr Reenan's home or the immediate vicinity.

4.4. At the time of my visit the local Cellnet base station was at Abingdon Town, just over one mile away from Mr Reenan's location, and the local Vodafone base was about 6.5 miles away in a different direction. As mentioned earlier, it is established fact that the Cellnet base station was not operational at the time of the alleged conversation. Neither was the Vodafone base station operational. No doubt Vodafone could confirm the precise date if required but notes made during the investigation suggest that an on-air date early in 1991 was established at some stage.

4.5. At better locations than Mr Reenan's and with better reception facilities, it was usually possible in the days of analogue cellular telephone systems to receive several base stations. However, for reasons discussed shortly, this was emphatically not the case with Mr Reenan's installation.

4.6. Mr Reenan used an Icom IC-R7000 scanning receiver. This was capable of covering a frequency range of 25MHz-1000MHz (and to 2000MHz with reduced sensitivity). From personal experience the IC-R7000 could scan across the 915-950MHz frequency range used for analogue cellular base stations and receive them perfectly well.

4.7. However, all radio receivers require a proper antenna to give of their best and in this respect Mr Reenan's receiving facilities were extremely inadequate. Contrary to some highly misinformed reports in the contemporary press, Mr Reenan had and used nothing more elaborate than his domestic UHF Yagi-type television antenna for scanning reception. In addition, the connection between the antenna and the receiver was a long run of ordinary semi-air-spaced coaxial cable. The latter point is relevant since at frequencies in the 900MHz region this type of cable does not work well. A high proportion of the signal produced by the antenna is lost by attenuation in the cable before it reaches the receiver.

4.8. For a variety of technical reasons a Yagi-type TV antenna is an extremely poor choice for reception of frequencies outside the range for which it has been designed and constructed. Any Yagi antenna is inherently a very ‘narrow-band’ device and the ordinary domestic TV antenna would be expected to exhibit little or no gain at frequencies around 900MHz. It would also be expected to display a very unpredictable polar diagram. The implication of the latter point is that the antenna might not respond at all or respond very poorly to signals from certain directions.

4.9. Furthermore, the television antennas in Mr Reenan's area obtained their signal from the transmitter site at Beckley, near Oxford. Like the majority of UK main-station terrestrial TV broadcast transmitters, this employs what is known as *horizontal polarisation* – i.e. the elements of an antenna designed to receive signals from it are placed horizontally. In contrast, all cellular telephone services use *vertical* polarisation; the familiar cellular antenna on the roof or wing of a car is (or should be) vertical. Attempting to receive vertically polarised signals on a horizontally polarised antenna leads to a marked reduction in signal strength because of a phenomenon called *polarisation coupling loss.* Other things being equal, the overall reduction due to this cause amounts to a factor of about 100. Mr Reenan’s television antenna had horizontally disposed elements.

4.10. Given this combination of a poor VHF/UHF site and a very sub-standard antenna and feeder, it was not at all surprising that Mr Reenan's receiving system performed very poorly when tuned across the frequencies of cellular base stations.

4.11. At this period there was a very simple method of assessing the performance of any installation for receiving cellular telephone signals. It took advantage of the fact that every base station radiated a continuous data transmission on a predetermined frequency. This was known as the "forward control channel" (FOCC) and was used by mobile telephones for several purposes.

4.12. In the UK analogue cellular systems the forward control-channel frequencies were located in two groups around 935 and 943MHz. At a reasonable site and with a moderate antenna, it was normally found that at least two associated with the local Cellnet and Vodafone base stations could be heard at good strength at most places in the UK. Depending on the elevation and “take-off” of the site and the height of the antenna, others from base stations some distance away might also have been audible.

4.13. Only one FOCC was audible on Mr Reenan's receiving system. This was on a frequency of 943.2125MHz, which was established by subsequent simple experiment (in essence by driving to its location with a hand-held scanning receiver) to be that of the FOCC of the Cellnet base station at Abingdon Town. Cellnet subsequently confirmed that this was the correct frequency for the Abingdon Town FOCC. At Mr Reenan's location this FOCC was not by any means a strong signal. In technical terms it deflected the receiver's S-meter to about S6, which was insufficient to produce full quieting and some noise could be heard. In lay terms it might be described using words such as "weak", "noisy", "fluttery", "hissy" and so on. Considerable fading was also heard and was visible as variation of the S-meter.

4.14. The local Vodafone base station's FOCC on 935.7875MHz, the identity of which was also confirmed by driving to its location, was essentially inaudible at Mr Reenan's site and no transmissions on its voice-output frequencies could be resolved into usable audio. In fact the receivers' squelch control needed to be turned fully anti-clockwise in order to hear the Vodafone FOCC at all, implying that the signal was below the receiver's inherent sensitivity threshold. Under no circumstances could intelligible conversations have been recorded from this source.

4.15. With the squelch control reset so that the receiver was just muted (i.e. as it would be set in normal use) it took no less than 22 minutes of continuous scanning to find a telephone conversation taking place. When found, it displayed similar characteristics to that of the Cellnet FOCC. The S-meter reading was similar and there was audible fading, flutter and smooth noise which occasionally degraded into rough noise. Occasionally, for periods of a few seconds, the audio would reduce beneath the squelch threshold of the IC-R7000, which would consequently mute until the signal became strong enough to lift the squelch. At no time was the signal clear of noise. The frequency on which the receiver's scan had stopped was subsequently established to be one of those carried on the Cellnet base station at Abingdon Town.

4.16. A brief recording of the conversation was made and was used for later checking and assessment purposes.

4.17. Taking all these factors into consideration, the inevitable conclusion was that Mr Reenan's receiving set-up was very poor. Indeed, given some other issues – such as his manifest ignorance about how to use the receiver to the best of its capabilities, his inability to use the programmed scan-limit mode in the IC-R7000 and his very inadequate understanding of how cellular radio worked – it was considered rather surprising that he ever heard anything at all.

4.18. On a minor point, it should be noted that Mr Reenan recorded the output from his ICR-7000 receiver by means of a microphone suspended a few inches above the receiver's speaker and connected directly to a cassette recorder. The significance of this is discussed at 6.9.

6. The recording allegedly made by Mr Reenan.

6.1. As presented, the tape recording had the following features:

6.2. The female party's voice did not display the characteristic compressed quality associated with analogue cellular radio. It sounded relatively natural, with quite a wide dynamic range. The quality of the male party's voice, in contrast, was very typical of one transmitted via a normal cellular telephone. It sounded companded and *band-limited*, i.e. with a noticeably restricted frequency range. Subsequent measurements showed that the band limiting was characteristic of that used in the UK cellular telephone systems with a steep roll-off around 3kHz. By contrast, there appeared to be some energy at over 4kHz in the female speech. Taken with the lack of audible companding, this latter point immediately suggested that the recording might not have been obtained off-air in the manner outlined by the media.

6.3. There was no detectable trace of SAT present on the recording although the equipment used for the analysis could have resolved the presence of SAT at levels of around 100dB lower than the speech. This is a very large amount indeed. By contrast, on test recordings of both conversation and plain carrier over cellular radio made at Mr Reenan's home by myself on the occasion of my visit, SAT was clearly audible on subsequent replay and measured about 36dB below the speech. This is a much less large amount. Subsequent extensive measurements with an Icom IC-R7000 receiver similar to Mr Reenan's showed that this level of SAT was habitually associated with recordings of analogue cellular base stations made from it.

6.4. To clarify this point, the exact level of the SAT heard on a recording of a conversation transmitted from an analogue cellular base station and received on a particular type of receiver would be a function of the precise circuit arrangements in that receiver. However, there would inevitably have been *some* level of SAT audible and measurable. The complete absence of SAT on the recording was a further important indicator that it might not have been made in the manner described.

6.5. To put the same point the other way round, if it was wished to give the impression that a recording made via direct tapping had actually been recorded via analogue cellular radio, it would have been necessary to add SAT to it at the appropriate level.

6.6. There were rather loud data bursts every 11.4 seconds. By ear, these sounded very like FVC data signals.

6.7. There was a slight difference in volume level (technically about 6dB) between the two parties.

6.8. The signal-to-noise ratio of the recording was generally quite good, although the audio quality was not especially so. Its duration was about 26min. In that time there was no evidence whatsoever of fading, flutter or other disturbances associated with a radio channel.

This is not remotely consistent with the observations discussed at 4.15 and a further implication is mentioned at 7.10.

6.9. It was noticeable that there was neither any room acoustic on the recording nor any extraneous sounds. Given Mr Reenan's method of recording conversations by means of a microphone suspended directly above the receiver's speaker, one would have expected to have detected a degree of audible colouration in the sound due to the acoustic properties of the room in which the recording was made. One might also have expected to hear other extraneous domestic sounds which in the ordinary course of events would have been picked up by the microphone. Such sounds are a prominent feature of the so-called 'Camillagate' recording, which was stated to have been made via direct positioning of a microphone in proximity to the speaker of a scanning receiver and certainly sounds as though it was.

6.10. There was a very high level of 50Hz hum on the recording. This frequency is very low (it is the same as the UK mains electricity supply and expressed as a musical note is approximately the G three octaves below middle C). The level was about 13dB below peak speech. There was also another even lower note audible on the recording. This was at a frequency of 31Hz (approximately the bottom B on an organ manual) and was also at relatively high level. It is very important to be aware that frequencies as low as this could not for technical reasons a) be transmitted by an analogue cellular base station b) make their way through the filters and other circuitry in either Mr Reenan's receiver or any other scanning receiver c) be recorded by Mr Reenan's recorder at anything like the levels found on the recording.

6.11. At this stage and in consultation with *The Sunday Times* staff, it was decided to commission a London-based colleague to make a series of precision audio measurements on the recording and to verify and confirm the findings so far. My choice of this particular colleague was partly for ease of access by London-based newspaper staff and partly because I wished for a second opinion as to the absence of SAT on the recording; at that time his equipment was capable of better resolution than my own. His conclusions entirely verified the information set out above and confirmed the absence of SAT and the presence of the low-frequency components.

6.12. Whilst this work was in progress, it was noted that the "databursts" – which initially sounded as though they might be FVC data messages – occurred every 11.4 seconds. However, since there was no mechanism within cellular radio which could transmit them at this repetition rate (see 5.8 above) it was suspected that they might not be genuine FVC data. Examination with an oscilloscope confirmed that the waveform was regular and not that of a genuine FVC databurst.

6.13. Adding weight to this point is that the purported FVC messages were almost as loud as the speech. To put the point in more technical language, they were within a few dB of being at peak speech level. However, if they were real, they should have been somewhere between 16 and 20dB below peak speech as received on a scanning receiver tuned to the

transmit frequency of a cellular base station. In addition, they did not mute the audio from the handset but merely applied a degree of "ducking" to it. See 5.9 above.

6.14. As a final observation, it should be noted that for technical reasons real FVC data recorded via a direct tap at the local end would have been barely audible or measurable. In calls made via a UK analogue cellular system, FVC data was not usually heard by the landline party.

6.15. These suppositions were based on knowledge of both wired telephone and cellular radio systems. They were all subsequently checked by direct measurement and tests in co-operation with Cellnet, although the latter were conducted unofficially and as a personal favour by senior members of Cellnet's then management team who kindly assisted my investigations.

The final report ran to 14 sections with two technical appendices.