MINISTRY OF HEALTH
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29 October 2018

[redacted]

Ref: H201806659

Dear [redacted]

Response to your request for official information

I refer to your request to the Ministry of Health (the Ministry) of 30 September 2018 under the Official Information Act 1982 (the Act) for:

> *'What evidence can you provide that proves 5G telecoms technology is relatively safe (for humans and the environment) from sources that are genuinely independent from the telecoms or 5G infrastructure industries?*
>
> *What is the evidence that the extent of its planned roll-out and connection to devices is safe?'*

Information relating to your request is available on the Ministry's website at the following address: https://www.health.govt.nz/your-health/healthy-living/environmental-health/radiation-environment/cellsites.

In addition, the Interagency Committee on the Health Effects of Non-Ionising Fields (the Committee) considered this matter at its most recent meeting.

The Committee provides the Director-General of Health with high quality, independent scientific and technical advice on potential health effects from exposures to extremely low or radiofrequency fields.

Further information about the Committee is available on the Ministry's website at: https://www.health.govt.nz/our-work/radiation-safety/non-ionising-radiation/research-non-ionising-radiation

At its meeting in August 2017, the Committee reviewed the attached background paper (Please refer Appendix One).

The Meeting notes record:
" 5G Deployment: s 9(2)(a) *spoke to* [redacted] *paper on 5G deployment, and highlighted the need to ensure that reliable information about the deployment of 5G infrastructure, effects on exposures to RF fields, and health be available ahead of time.* s 9(2)(a) *commented that government and the industry need to work together on this.*

The Ministry of Health is seen as a credible source of information and should prepare information on health and have this on its website. If the issue develops then ways to communicate more proactively could be investigated. "

Further information may also be available from Radio Spectrum Management (RSM) a business unit of the Ministry of Business, Innovation and Employment (MBIE) responsible for efficiently and effectively managing the radio spectrum in New Zealand. The RSM website is as follows: https://www.rsm.govt.nz/.

I trust this information fulfils your request. You have the right, under section 28 of the Act, to ask the Ombudsman to review any decisions made under this request.

Please note that this letter (with your personal details removed) may be published on the Ministry of Health website.

Yours sincerely

Dr. William Rainger
Deputy Director-General
Population Health and Prevention

Appendix One

Introduction of 5G cellphone technology

These notes are based on conversations and presentations at the recent Bioelectromagnetics meeting, a Radio Spectrum Management (RSM) discussion document on frequency allocations for 5G and submissions on that document.

The next generation of mobile phone technologies has been under development for several years, and widespread introduction is expected to begin around 2020. In the meantime some limited experimental networks have been set up in a few countries, as well as some test laboratories.

The main changes to be brought by 5G (some of which may not be apparent to users) are:

- Faster data rates
- Use of much higher frequency bands around 26 GHz (and perhaps higher), sometimes referred to as "millimetre wave" (mmWave), which until now have been used mainly for point to point communication. (Frequencies similar to those used currently will also be used.)
- Shorter latency (ie less delay in transferring data through the networks).
- Beam forming antennas in base stations, which will allow the radio signal to be dynamically directed towards where it is needed, and massive MIMO[1].

A recent Radio Spectrum Management consultation noted that initially 5G would be likely to use frequencies around 3.5 GHz, and 26 GHz frequencies would be introduced later, and then maybe other frequency bands around 1.5 GHz and 600 MHz[2]. All these frequencies are covered under the existing RF field exposure Standard NZS 2772.1:1999

The first applications of 5G are likely to be for fixed wireless internet access.

The modulation of 5G signals (ie the way information is encoded onto the radio wave) is similar to 4G.

Likely effects on infrastructure

Initially 5G connections between a mobile device and the network will be controlled over the 4G network, with the data transferred over 5G. Eventually 5G will be a standalone system.

The people I spoke to all confirmed that initial deployments will be at frequencies around 3.5 GHz. The physical shape of 5G deployments is still not that clear. Beamforming antennas will look like flat rectangular panels, which could be readily integrated onto the sides of buildings (but less easy to blend in on a lamppost). A beamforming antenna could be about 0.8 x 0.8 m and capable of forming 48 independent radio beams. These could be fixed or (eventually) steerable. While 3.5 GHz signals would normally provide poorer coverage than the frequencies currently used for

[1] MIMO: multiple input/multiple output – transmitting and receiving more than one data signal over the same radio channel. Massive refers to there being more than around 10 independent signals on the same channel.

[2] To provide some context, cellular systems currently use frequencies around 700 and 900 MHz, 1.8 and 2.1 GHz, with some around 2.7 GHz. WiFi uses frequencies around 2.4 and 5.5 GHz.

4G (especially in buildings), most people said that the higher signal gains from beamforming antennas would compensate for this and a 5G network would overlay well with current 4G coverage.

Once 26 GHz infrastructure comes along, the antennas will be smaller and more discreet, perhaps like the WiFi antennas currently used in outdoor areas. They will, however, need to be more densely spaced than current base stations in order to provide in-building coverage.

5G exposures

Downlink

Telstra Australia presented results from exposure measurements made in a test system set up at their 5G Innovation Centre on the Gold Coast. They have a 27 GHz indoor network operating at a similar power to current indoor networks but with an EIRP[3] around 16 watts, and an outdoor antenna on a high tower with a maximum EIRP of 63 watts (somewhat lower than a typical outdoor suburban 3G or 4G installation).

Exposure measurements made with the antennas in a test mode at fixed power showed good agreement with calculated exposures. Measurements in normal use, with high loads on the 5G indoor system (from computer gaming) showed that the 5G exposures were similar to those from the 3G and 4G transmitters also operating.

There was a demonstration (on video) of the effects of the beamforming antennas. Effectively a beamforming antenna is composed of many (eg 48) individual sub-antennas which each service a different area. Only the sub-antenna(s) servicing devices actively communicating through the site are active at any time. In the demonstration a device in a car downloaded data over a 5G link, and the exposure from the downlink was monitored on a meter nearby. The car was driven away while the device was still downloading, and once it was about thirty metres away the (stationary) meter reading dropped down because the device was now being serviced by a different sub-antenna. (For comparison, if the download had been happening over a 4G link using a conventional antenna, the exposure would have remained the same as the car drove away because the conventional antenna produces a single beam covering a whole 120° sector, rather than many sub-beams serving much smaller areas.)

Exposure assessment - downlink

Because of the beamforming characteristics of 5G antennas, exposure assessment is likely to be more complex than currently. Measuring exposures (at least, maximum exposures at some location) will be more difficult unless it is possible to ensure that the sub-beam pointing in that direction is transmitting. New measurement equipment will have to be developed for mmWave frequencies if we are to have the same capabilities and convenience as at present.

Because of the likely intermittent nature of transmissions through each sub-antenna, there has been talk of using statistical models to make theoretical assessments of exposures from the base stations, in particular for determining the compliance boundary[4] around an antenna. These statistical models take account of the time averaging in exposure Standards. Some work has suggested that if these models are used compliance boundaries could be about one half to one third of the size that they would be if it were assumed that every sub-antenna transmits

[3] EIRP is the effective transmit power after taking account the gain (focussing effect) of the antenna

[4] The compliance boundary is the region around an antenna outside which exposures do not exceed the exposure limit.

continuously at full power. IEC 62232 (which covers the evaluation of exposures from base stations) already contains guidance on the use of statistical models for "smart" (beamforming) antennas but notes that "This requires a detailed analysis specific to the employed technology and with due consideration for any site-specific factors."

Regulatory bodies appear to be taking a cautious approach to this method: one speaker at the BioEM meeting said that the FCC in the US will be taking a worst-case, not statistical, approach, and I believe that Sweden is thinking along the same lines. The validity of a statistical model depends on the assumptions behind it, and at the moment there is no real data against which statistical models could be validated. For that reason a conservative worst-case approach seems appropriate until there is data to suggest that some relaxations could be allowed with no real risk of overexposure.

Exposure assessment - uplink

New techniques to measure exposures from devices operating at frequencies above 6 GHz have been largely settled and formalising the testing Standards is now in progress.

Health effects research

As noted previously, the frequencies to be used by 5G networks are already covered by the NZ exposure Standard NZS 2772.1 and are widely used for point to point communication links. The Standard does not differentiate between different modulation schemes (except for very intense pulses) but is only interested in the time average exposure, and there is no good reason to believe that modulation is important in determining health effects. (As also noted previously, 5G modulation will be similar to that used in 4G.)

While most health research has concentrated on frequencies less than about 3 GHz, a fair amount of research has been conducted at higher frequencies. The recent draft revision of the IEEE C95.1 RF field exposure Standard contained an appendix reviewing health research findings at frequencies >6 GHz. There have also been many dosimetry studies looking at the relationship between exposure and temperature increase, and it is well established that as frequency increases most of the energy is absorbed in the skin, with very little absorbed in deeper organs (at 26 GHz, most of the energy is absorbed in the first 1-2 mm of the skin).

Feedback from RSM consultation

About 75 submitters on the RSM consultation raised health issues. (This was in response to a section where industry feedback was requested on whether 5G antennas would comply with the exposure limits in NZS 2772.1:1999, and asked the questions "What regulatory issues need to be considered from a 5G perspective in New Zealand?" and "What aspects of these regulatory issues are most significant for 5G?"

Many submissions were based on material on the Stop Smart Meters website[5] and included the following points:

- There will be increased RF exposures because of the increased number of sites
- In particular, sites could be only 250 m apart (based on Massey University material)
- There are no mandatory safety Standards for mobile devices
- The NZ government should commission testing of devices, and make the information available on a website

[5] www.stopsmartmeters.org.nz/uncategorized/submissions-5g-consultation-now-available-online/

- Limits in NZS 2772.1:1999 are set too high, especially in comparison with other countries
- Limits might be relaxed in order to accommodate 5G
- RF was classified 2B by IARC, and New Zealand has a high cancer rate
- NZ should wait to see what health effects there are overseas before introducing 5G here

Many of these submissions came from people who considered themselves EHS. The Stop Smart Meters piece also commented that internet access is already good enough and does not need improvement, and that New Zealand did not need 1 million internet connections per sq km (an upper limit on what 5G could enable according to the RSM paper), and these comments were also repeated in many of the submissions.

Other health-related comments made in submissions include the following

- An appeal to the EU authored by Nyberg and Hardell for a moratorium on 5G deployment
- Findings of the NTP study
- 5G photons have higher energy
- Specific studies have demonstrated effects of mm waves
- 5G modulations have not been tested in health research
- Increased incidence of cancer near cellsites
- Health risks from wearable technology

Several submitters suggested that many trees would have to be cut down to enable propagation of 5G signals.

The submissions made about health highlight that while there has been a great deal of talk about the 5G technology, very little has been said about matters that are important to many people, such as how it will affect their environment (both in terms of infrastructure and exposures) and what has been done by way of health research to ensure its safety. As always happens when there is an information vacuum, the first material available rushes in to fill it up. Both industry and government need to ensure that basic information is available, such as:

- What will typical 5G infrastructure look like (both in terms of individual sites and the density of sites)?
- What will typical transmit powers be, and how will exposures be affected?
- What health research has been done?

Responses to some of these comments are tabulated below:

Comment	**Response**
There will be increased RF exposures because of the increased number of sites	There may be a small increase, even if the number of sites stays the same. On the other hand, if data is carried on a 5G rather than 4G network exposures may be unaffected or even decrease, as 5G is more efficient at data transfer.
Sites could be only 250 m apart	The shape of deployment remains to be seen. This close spacing would mainly apply to 26 GHz sites, which are likely to be some years away. Closer spacing of sites would mean they operate at lower power.
There are no mandatory safety Standards for mobile devices	This is correct: New Zealand effectively relies on other countries having mandatory Standards which makes it

Comment	Response
	unlikely that phones not complying with those Standards would be manufactured for the small New Zealand market.
The NZ government should commission testing of devices, and make the information available on a website	This is for government to decide, but it would be more important to specify what testing Standards are to be used and then rely on data from accredited testing laboratories. SAR data from phones is already widely available on websites (and linked from the MoH site).
Limits in NZS 2772.1:1999 are set too high, especially in comparison with other countries	See Appendix A and Section 5 of the Interagency Report to Ministers
Limits might be relaxed in order to accommodate 5G	Limits would be based on health research, not industry needs.
RF was classified 2B by IARC	See section 4.2.2 and Appendix B of the Interagency Report to Ministers
Nyberg and Hardell appealed to the EC for a moratorium on 5G deployment	Two EC responses rejecting this appeal, and explaining the reasons for that rejection, are available. (http://www.stopsmartmetersbc.com/wp-content/uploads/2017/11/To-Prof.-Nyberg-and-Prof.-Hardell-5G-Appeal-Scientists-and-doctors-warn-of-potential serious-health-effects-of-5G-Reply-from-John-F.-Ryan-Director-European-Commission-October-13-2017.pdf,http://www.stralskyddsstiftelsen.se/wp-content/uploads/2018/01/2nd_reply_EU_to_RN_LH.pdf)
Findings of the NTP study	The final report has yet to be published, and exposures were greater than those allowed by Standards and far greater than environmental exposures from base stations.
5G photons have higher energy	The photon model is not really relevant at these frequencies as each photon has far less energy than the thermal energy of molecules. The energy absorbed depends on the strength of the source (and many other factors)
Specific studies have demonstrated effects of mm waves	Taking the results of individual studies in isolation is not how health risk assessments are carried out – they should be based on a review of all relevant studies.