3M Transcript for the following interview: Episode 85 Non-Ionising Radiation

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Welcome to the 3M Science of Safety podcast presented by 3M Australia and New Zealand Personal Safety Division. This is a podcast that is curious about the science and systems of all things work, health and safety, that keep workers safe and protect their health. I am Mark Reggers, an occupational hygienist, who likes to ask the questions Why, How, and Please Explain. Whether you are a safety professional, occupational hygienist, or someone with any level of WHS responsibility in the workplace, maybe you are a user of safety equipment or maybe you are a bit of a safety nerd who finds this stuff really interesting, then this is a podcast for you.

(R) Today, we're talking all about non-ionising radiation with Robert Blackley. Welcome back, Robert.

(B) Thanks for having me, Mark.

(R) Last time, we spoke about ionising radiation. We couldn't not do the other half of the spectrum, of the non-ionising radiation part, but before we get started, can you please introduce yourself, who are you, where are you from and what do you do?

(B) My name's Robert Blackley. I'm a radiation protection advisor at ANSTO, the Australian Nuclear Science and Technology Organisation. I've been there for over 19 and a half years now, working in ionising radiation and to a lesser degree, in non-ionising radiation as well.

(R) And I also did an episode with Carmen about ANSTO and who they are, so if you are interested, do go back and listen to that one. That'll set the scene what it means when you say you work at ANSTO. So, we spoke ionising radiation last time, so what is non-ionising radiation, and the difference between the two?

(B) Well generally speaking, radiation is the emission of energy from a source that can then go on and interact with matter and that can come from natural sources or from artificial sources.

(R) So, natural like the sun, as an example?

(B) That's right. And it may be in the form of particles or some electromagnetic radiation. Now, you can break it down a couple of different ways, but one of the helpful ways is to break it down to ionising radiation and non-ionising radiation. So, ionising radiation has enough energy to knock electrons off an atom that it interacts with and cause an ion. Non-ionising radiation doesn't have that level of energy though. So, as you said, today we're going to be talking more about non-ionising radiation.

(R) Now, we did delve quite a bit deeper into the ionising radiation side of things last time, so I do recommend those who are interested to jump back and listen to that. So, how are these different types of radiation related to the electromagnetic spectrum?

(B) Well, non-ionising radiation is found at the long wavelength end of the electromagnetic spectrum. So, you have ionising radiation at the short wavelength end and non-ionising radiation at the other. So, at the long wavelength of the spectrum, the non-ionising radiation may have enough energy to excite molecules and atoms and cause them to vibrate faster. So, this can be good, or it can be potentially bad for human health. So, the most obvious example of non-ionising radiation exciting molecules causing them to vibrate is a microwave oven where the radiation causes water molecules to vibrate faster and it creates heat, therefore cooking your food.

(R) A very important thing in the kitchen. People may not think about it as a radiation source that's sitting there in every household probably across Australia and nearly across the world.

(B) I will point out though that the design of those is very safe, so the radiation is contained within the actual unit itself, just before people start to get panicked.

(R) That's what we like to hear, yes.

(B) So, with non-ionising radiation, there are a number of different parts of the electromagnetic spectrum that people are probably familiar with, so starting with extremely low frequency radiation, and generally speaking when you look at a diagram, it's normally on the left hand side of the spectrum, and as we increase the frequency through the radio frequency section, through microwaves, through the visible light portions of the spectrum, and into the ultraviolet range.

(R) So, when you say, 'long wavelengths', how long are we talking here? Metres, kilometres; what kind of distance do you mean?

(B) Well, it's quite a big variety. So, the wavelengths that you have for extremely low frequency radiation, the far end is maybe a couple of thousand kilometres or more.

(R) That's pretty decent.

(B) That's right and frequencies of about a hundred hertz or less than that. Radio frequencies; they're somewhere between one to a hundred metres and have a frequency of about 1 million to a 100 million hertz. Microwaves that we use to heat food have wavelengths of about a hundredth of a metre long and have frequencies of about 10 billion hertz, so just to give you an idea of that range.

(R) So, we've got these different wavelengths, as you say, for all the different parts of the electromagnetic spectrum, but what are the actual different types of non-ionising radiation that people may be familiar with or what terminology that comes to mind when we talk about these types of things?

(B) Yeah, there's a couple of different ones that people might be familiar with such as ultraviolet radiation, and with ultraviolet radiation, it's generally broken down into three smaller parts that people might be familiar with, particularly when you're looking at sun sense.

(R) I was just about to say I bought some sunscreen on the weekend and yeah, it has UVA and UVB on the package there.

(B) That's right, so UVA is the ultraviolet radiation in the range of 315 nanometres up to 400 nanometres and this is the stuff that generally is thought to contribute to premature ageing and wrinkling of the skin and potentially a contributor towards skin cancer as well. UVB is one that people might be very familiar with and that's in the range of 280 nanometres to 315 nanometres and that's actually more

dangerous than UVA and it's considered to be one of the major causes of skin cancer as well as sunburning and cataracts in the eyes as well. Ultraviolet radiation C is in the range of 100 nanometres to 280 nanometres and it is actually extremely dangerous. However, generally speaking, it doesn't reach the earth's surface due to the absorption in the atmosphere by ozone, which is fine, as long as you don't have a hole in the ozone layer.

(R) Well, we won't comment on that, will we? I mean, that's from the sun. Are these used in workplaces, industrial type locations, these UVA, B and C ultraviolet rays?

(B) Yeah, so in the workplace UV radiation from the sun is really important to be considered, but there are other sources. So, there's a couple of artificial UV radiation sources, some of which emit high levels of UV radiation. So, arc welders are used in industry and they can produce fairly intense UV radiation emissions and so, one thing, if workers are working in this type of thing have been exposed to welding radiation, then they may suffer similar health effects to workers who have been overexposed to solar UV radiation as well. There are other forms of artificial UV radiation sources such as fluorescent mercury vapour, metal halide and quartz halogen lamps used in industry. They can also appear in offices, and in the home as well. However, I will point out that in offices and homes, the levels of ultraviolet radiation are generally quite low. And ultraviolet radiation lamps are often used in industry for sterilisation as well, so in micro labs and things like that.

(R) So, we've got ultraviolet radiation. What other types of non-ionising radiation are there?

(B) Well, there's visible and infrared radiation and that can be broken down into a couple of different areas. There's radio frequency which can be from radar,

microwave ovens, MRI scans, mobile telephones, televisions, FM radio, AM radio, all of those and then there's extremely low frequency radiation as well.

(R) So, we'll probably think most people are familiar with or have heard of obviously microwave ovens and mobile phone towers and television frequencies and FM and AM, so it's pretty much non-ionising radiation is all around us, but people may not think of it in those terms by the sounds of it. Where might you find the visible and infrared types of radiation, some of those other ones, in workplaces?

(B) Yeah, so with the UV, just to go back on that one, then you might find that in micro labs or perhaps sewerage treatment plants, and of course, if you're outdoors exposed to sun. For infrared, then you can get that in areas where there's heating required or potentially sometimes in some beauty treatments as well. RF of course is telecommunications, so mobile phones, microwaves as we're talking about, mobile phone towers or TV or radio transmitters workers. There's also radio frequency radiation for people who weld with plastic as well. So, they can use that to heat up the plastic to weld it. You can get in Wi-Fi, medical of course and of course emergency services as well from their two-way radios. And then you've got your extremely low frequency radiation which is just general electrical circuits in the house and from appliances, from powerlines, that type of thing.

(R) Now, when we talk about other hazards here, we talk about route of entry. Is there a specific route of entry that non-ionising radiation is impacting humans, or could potentially impact humans?

(B) Yeah, it's a little bit different from other types of occupational hazards; you don't have internal and external radiation hazards. However, it's normally from a source that's external to the body, and so you'd have been exposed to that electromagnetic radiation. Now, the exposure mechanisms; they actually get quite complicated and it depends upon the wavelength. So, we've spoken about the

breadth of the wavelength there and it also depends on the part of the body that's exposed as well. So, there's quite a bit of complication around how the exposure mechanism actually works and it varies quite a lot.

(R) Probably not the right platform to delve into those depths, but there can be an effect. So, my question is, when is it a health risk, or when should it be of concern to people or workers with these different types of non-ionising radiation sources that are all around us?

(B) Well, non-ionising radiation can have a couple of different health effects. There's what they sometimes refer to as non-thermal health effects, which include issues with neurological and biological effects and there's what they call thermal effects which means it can heat the biological tissue and potentially cause tissue damage. However, there is a little bit of debate around the use of those terms and the appropriateness of that. It's been clearly shown that for high levels of exposure, these effects. However, at low levels of exposure, similar to other hazards, our bodies are generally able to manage these types of effects, meaning that we don't suffer that detrimental tissue damage. Now, the key thing to prevent it being a concern is to minimise both the acute and chronic exposures. So, high acute doses are very rare and should not occur at the workplace and so, they're fairly unlikely as well in everyday life.

(R) As you say, more of a workplace, industrial, large bit of equipment or process that you're going to receive those high doses by the sound of it.

(B) Yeah, that's right. So, if we went through again, just breaking it down and looking at the different types of radiation, then with UV, ultraviolet radiation, due to the very short penetration depth of ultraviolet radiation, the main organs that are at risk are the skin and the eyes. So, with regard to the eyes, the main risk is photokeratitis, photo conjunctivitis and cataracts, with cataracts being one of the

most common types of eye damage in Australia. And obviously from ultraviolet radiation, one of the key health risks is skin cancer as well, which people would be very familiar with, especially in Australia.

(R) Absolutely.

(B) For radio frequency radiation, one of the key concerns is thermal effects from acute exposures and the eye is an organ that is particularly susceptible to sustained elevated temperatures and so that can actually lead to cataracts as well. Now, there's been a lot of studies in this area around the potential effect that radio frequency energy may have on causing DNA damage or influencing tumour production. So, there's lots of studies, particularly around mobile phones and mobile phone towers.

(R) That's one that came to mind for myself, that you hear about the most concern from people maybe living near those towers.

(B) Now, the balance of evidence from all the different reports that I've read suggests that exposure to radio frequency fields is not mutagenic and therefore unlikely to act as an initiator or promoter of cancer. So, there's actually been, as I said, lots of different studies over the last at least 30 years or so on the relationship to cancer and to personal use of mobile phones, which from all the different reports, shows that there's actually no consistent evidence of an increased risk there. However, I will point out that there's lots more studies going on in this space, particularly as technology changes and as people's personal usage changes as well.

(R) Like a lot of hazards, studies evolve and a different approach of things, that that may change how society approaches that, but yeah, it's obviously everchanging and we need to keep our eye on it.

(B) Yeah, that's right, and of course, the studies over time of course, they get longer, so you get to see if there's any longer-term health effects as well. There's also extremely low frequency radiation and we know that at high acute doses, then that can affect the function of the nervous system. However, exposure to high levels of extremely low frequency radiation is extremely rare, apart from in medical exposures to patients and of course in some specialised occupational exposures. So, generally speaking, they won't occur in people during their day-to-day living and shouldn't occur at work. Now, there are some more studies looking at epidemiological research where they say there may be an association between long term exposures to higher than normal extremely low frequency magnetic fields, and so that can be ... if you're living in close proximity to transmission lines or other electrical supply infrastructure, or if your domestic wiring is pretty haywire, and particularly around the link there to potential increased rates of childhood leukaemia. However, there's lots more work that needs to happen in this particular space, because there's issues around some of the methodology used and potential of bias in the study cases, and also the fact that laboratory tests don't support this. However, hopefully more studies in this area will continue.

(R) Now, is there an exposure standard for non-ionising radiation, like we commonly talk about with coal dust and welding fumes? But does one exist for non-ionising radiation types?

(B) Yeah, so with the breadth of the electromagnetic spectrum that we were talking about, there's a number of different standards that apply to sources of non-ionising radiation. So, for manufacturers who are producing these types of sources, then there's a lot of standards that need to be adhered to in terms of how they actually manufacture their product. But rest assured that the products that you're receiving will be meeting these standards. For workplaces, many of the standards are produced by the federal regulator for radiation safety, which is the Australian

Radiation Protection and Nuclear Safety Agency or ARPANSA. Two of the key ones are the Radiation Protection Series number 3, which deals with the radio frequency part of the electromagnetic spectrum and RPS12, Radiation Protection Series number 12, which deals specifically with ultraviolet sources. So, through these, occupational exposure is only permitted after a thorough risk assessment has been performed, the appropriate risk management things is put in place and control measures are also put in place. And so, it also has in there a number of different exposure limits, and that's all to do with the complexities around how those things can interact with our bodies.

(R) That's talking about workers. What about for the general public? There's a lot of non-ionising radiation sources that the general public would be exposed to. Is there any way to control exposures for them?

(B) Yeah, the general public is an interesting one because their exposure is less controlled. In many cases, the general public are actually unaware of their exposure to radio frequency fields. Also, individual members of the general public may be continually exposed from a number of different sources, and so you can't reasonably expect them to take precautions to minimise or avoid exposure. So, as a result, the limits for them are much more restrictive than for occupational exposed workers, just to account for all of those things.

(R) Obviously a lot of small doses may potentially add up, so we want to limit those doses as much as possible, depending on where those sources are, which are very wide and varied that we've spoken about. So, how does a workplace actually monitor / measure these different types of exposures that workers may be getting exposed to?

(B) Well, for most of these sources of radiation, there are many types of monitors that are available commercially, so these include area monitors you can use for

monitoring the near and far measurements around things like an antenna, as well as there being personal monitors for people to wear when they're doing it. And the latter one, the personal monitors can be particular important for people who work in telecommunications and have to work in close proximity to transmission antennas or radar systems where they're more likely to have the potential to be exposed to higher radiation fields. So, there's a couple of different types of monitors, quite specific to the wavelength of the radiation we're talking about. So, you can have broadband UV biometers and pyranometers and they're generally used to measure and monitor solar ultraviolet radiation. So, you put that out on a horizontal surface and that way you get the exposure from the entire hemisphere of the sky, because there's a number of different aspects to how that solar radiation reaches you, not just directly from the sun. And so, these types of devices actually measure both direct from the sun as well as the scattered ultraviolet radiation. And then for industrial ultraviolet lamps, then you're going to use different types of detectors because you're using it as a point source.

(R) But for workplaces that do have this, there are monitors that may be suitable to actually determine exposure, which is a good thing. So, if you do, do check it out.

(B) That's right. I do need to point out that taking the measurements and correlating to that exposure and comparing it to the standards can be a very complicated operation, and so it's really important that you understand exactly what you're measuring and also importantly what you're not measuring and how it applies to the various standards. So, having proper training and gaining the right experience is really essential in that, otherwise you can make the wrong conclusions.

(R) Or go down a different decision pathway, control pathway that may not actually be on point. So, you do want to make sure you are correct in whatever you're doing, whatever process you're about to go down.

(B) That's right. Also, just another little side note is that it's important to note that some people may also have medical devices that are susceptible to things like radio frequency interference or metallic implants that also need to be considered in your occupational workplace exposure. So, if this is you and you do work around these sorts of radio frequency sources, then you should probably discuss that either with your doctor or your specialist.

(R) Talking about medical devices and health, can you get health monitoring for different types of non-ionising radiation exposure, or is it just a case of, "I've been sunburnt and look at my skin," and that's about it? What's happening in this space?

(B) Yeah, so in the case of an acute high level of radiation exposure from these sources, then you can get things like skin burns and stuff like that, so it's a case of monitoring that sort of thing. Obviously at lower levels, that doesn't show up, so it's very similar to thinking about exposure to the sun from UV radiation.

(R) And I want to reiterate that we're talking about non-ionising radiation here, so we've spoken about a lot of sources and measuring, and to make a difference like all the hazards we speak about on this particular podcast is the control aspects. So, what control should workplaces be considering in this space?

(B) In terms of managing non-ionising radiation hazards, then they're very similar to other occupational hazards, and so we do follow the standard hierarchy of controls and that involves having a good management plan in place where those can be implemented. There is some PPE that can be used at the lower end of the hierarchy of controls, however, that's really specific depending on what type of radio frequency radiation you're exposed to.

(R) And the task and your interaction. Anything like PPE and these controls, have really does come to that task specific assessment, but there is some stuff out there by the sounds of it.

(B) Yeah, that's right, so depending on what you're doing, so leather work gloves generally provide good protection against contact current shocks from passively charged and reradiation structures, however they're not going to be suitable against contact with high power live radio frequency conductors. There are suits that people can wear, because in Hollywood, everyone wants to wear suits, so you can have personal protective suits and they basically work in a similar way to a faraday cage and they have that shielding effect. However, they only work if it's a complete faraday cage and you're completely covered by that. So, again, those things like suits and gloves, they can all have their place, but they are at the lower end of the hierarchy of controls and so, having the avoidance in the first place and having the right engineering controls is a much better way of doing things.

(R) I know we did a welding episode last year. We spoke about the UV light, so in the welding space, having those auto darkening lenses goes a long way in that space, but once again, very specific to welding, so understanding what your tasks and hazards are, are pretty important. So, to try and tie this all up, we've done a bit of a high-level overview of non-ionising radiation, but what would be some of those key points you want to leave with our listeners today?

(B) Yeah, so non-ionising radiation can be a workplace hazard. However, just like other occupational hazards, with the right controls in place, these sources can be worked with nice and safely. However, you need to make sure you've got those good measures in place and a good sound plan.

(R) And that starts with a risk assessment and doing a thorough approach in that process to lead into those more appropriate controls. So, good points there. So,

for those that do want to get more information on ionising and non-ionising radiation that we've speaking about today, where can they head?

(B) Probably the easiest place I'd recommend is to go to the ARPANSA webpage, which is www.arpansa.gov.au and from there, it actually gives a lot of good general information about non-ionising radiation and it's got a lot of other links to useful resources as well such as the World Health Organisation and a lot of the studies that are occurring there. So, I'd recommend that as the first place, and that will take you off into lots of other resources.

(R) Excellent resource there. Well, thank you so much for coming in again, Robert. I appreciate your time.

(B) Thank you very much for having me.

(R) Thanks for listening, everyone. You can get into contact with the show by sending an email to scienceofsafetyanz@mmm.com if you have any questions, topic suggestions or guests you think would be great to get in the studio, or if you need any help in your workplace, 3M are certainly here to help. You can also visit our website 3m.com.au/sospodcasts for further resources on non-ionising radiation, as well as all the other episodes we have recorded so far. Be sure to subscribe, rate, review and share through Apple Podcasts, Spotify, Google Podcasts or wherever you get this podcast from. And as Robert T Kiyosaki said, "Failure defeats losers. Failure inspires winners." Thanks for listening and have a safe day.