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OIA-2023-4786

7 August 2023

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Dear [redacted]

I refer to your email of 20 July 2023 requesting the Air Matters report provided to the New Zealand Defence Force. Your request has been considered in accordance with the Official Information Act 1982 (OIA).

Enclosed is the Air Matters report dated 17 August 2021. Signatures are withheld in accordance with section 9(2)(k) of the OIA to avoid the malicious or inappropriate use of information, such as phishing, scams or unsolicited advertising.

You have the right, under section 28(3) of the OIA, to ask an Ombudsman to review this response to your request. Information about how to make a complaint is available at www.ombudsman.parliament.nz or freephone 0800 802 602.

Please note that responses to official information requests are proactively released where possible. This response to your request will be published shortly on the NZDF website, with your personal information removed.

Yours sincerely

**AJ WOODS**
Air Commodore
Chief of Staff HQNZDF

**Enclosure:**
1. Air Matters report

# NEW ZEALAND DEFENCE FORCE

AIR MATTERS REPORT 21037

Lead Risk Assessment – New Zealand Defence Force

Report Date: 17/08/2021

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|---|---|
| Air Matters Report: | 21037 |
| Date: | 17/08/2021 |
| Status: | FINAL |

## EXECUTIVE SUMMARY

The New Zealand Defence Force (NZDF) has identified lead exposure as a risk to health in their workplaces and approached Air Matters to undertake a high-level health risk assessment. The main deliverable was to provide a technical report with indicative areas of high, moderate and low risk to health from lead exposure (from walkthrough surveys), priorities for action, indicative approach for future assessments and an assessment of current mitigation strategies.

The assessment of risk has been based on a qualitative assessment approach in the Simplified Occupational Hygiene Risk Management Strategies by the Australian Institute of Occupational Hygienists (*Firth, I. et. al., 2020*). The risk assessments have been grouped generally for those workers that have been considered similarly exposed. The groups are not typically just single service related but encompass similar functions across all three services (Army, Navy and Air Force).

*Table E1: Summary of areas considered high and moderate risk.*

| Risk Category | High | Moderate |
|---|---|---|
| **Group within NZDF** | Ammunition destruction | Parachute Bay (Ohakea) |
| | Indoor ranges (UTF, BTF, Tube ranges) | Bullet catcher material maintenance |
| | Outdoor ranges (short ranges, long ranges, large munition ranges) | Armourers |
| | | Defence Technology Agency (Ballistics) |

The health effects from exposure to lead are reasonably well understood and wide ranging. Exposure can accumulate over a long period of time and be stored in the body causing health effects well after the actual exposure. Biological blood testing via blood lead levels in the most way to determine whether someone has been exposed to lead but research shows that it can be misleading.

The recommendations are divided into different groups that require similar action and are ranked in priority for action.

1. Place lead shot used within the parachute weight bags (Ohakea) and personal training vests (Woodbourne) in plastic bags before being placed in the fabric covering for each item. DASH to lead with support from Unit leads at Ohakea and Woodbourne.

The following areas require further investigation through Occupational Hygiene exposure assessments and will need external specialist help to complete them.

2. During firing at all ranges – indoor (UTF, BTF, tube ranges) and outdoor (short and long) plus vehicle mounted weapon firing (Waiouru). This will also need to include a review of actual hygiene practises at long ranges and during exercises. For example, do soldiers end up eating and drinking on ranges? What impact does this have on exposure? This review needs to identify the constraints that occur on range or during an exercise and suggest practical solutions to help reduce exposure in the military training environment. Assessments led by Directorate of Safety with follow up blood testing looked after by Directorate of Health.
3. Exposure to lead from ammunition destruction by Defence Munition Management Group (DMMG). This is to also include a review of actual practises during ammo burns (as with firing ranges) in comparison to what is required in the SOP. Led by DMMG with support from the Directorate of Safety.

4. Exposure assessments in the marker's gallery at long ranges and during raking of bullet catchers. Led by the Directorate of Safety as this needs to be assessed and controlled (if required) across all NZDF ranges.
5. Quantify armourer's exposure through surface swabbing and observations of process and practise around known or presumed sources of lead. In addition, collate all blood lead level test results to determine patterns (or lack thereof). This needs to be led through both Directorates of Safety and Health as this group is NZDF wide and requires review of health information and also exposure assessments.

The following areas need procedures produced to develop a minimum level of control.

6. Develop a procedure (or minimum level requirements) for bullet catcher material removal. Distribute to contractors and sub-contractors as part of their agreement. Developed and implemented by DEI.
7. Develop and implement a SOP for a soldering station set up across the whole of NZDF (Directorate of Safety implemented) where a well-designed system is used as a reference point (e.g. Ohakea Avionics). This requires the collation of current soldering station set up, an SOP and time and resource to implement changes to those that require it. Developed and implemented by Directorate of Safety.
8. Facilities Management providers must provide SOPs for lead paint maintenance and removal. These SOPs need to be reviewed by DEI with the review requiring the same (or similar) level of control requirement regardless of location within the NZDF. A standardised approach to lead paint maintenance and removal is needed NZDF wide. Implemented by DEI.

The following recommendations require further more detailed on-site reviews.

9. Review Babcock's procedure around lead paint removal and observe to ascertain effectiveness. NAVOSH should lead this detailed review.
10. Investigate the state of the buried historic fuel tank at Woodbourne. This needs investigation by DEI.
11. Undertake a process review for all metalwork shops across NZDF that deal with brass or lead. Directorate of Safety should collate this information through the single service health and safety teams.
12. Current work on lead in building paint, lead dust in buildings and in soils around buildings by DEI needs to continue in order to complete a database of information to be used to assess risk.

Finally, there are opportunities within the NZDF that can be expanded upon to help the NZDF in its management of risk around lead exposure. Certain areas of the NZDF have tools or processes that can be used throughout the NZDF if a unified approach to managing risk is taken. NZDF also have constraints that will slow the progress towards managing the risk around lead and this primarily comes back to the current lack of availability of technical knowledge within NZDF that is primarily focused on occupational health risks.

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## Terms and abbreviations

| Terms & abbreviations | Explanation |
|---|---|
| µg/dL | Microgram per deci-litre |
| ACGIH | American Conference of Governmental Industrial Hygienists |
| ASF | Air Slope Factor |
| ATSDR | Agency for Toxic Substances and Disease Registry |
| BEI | Biological exposure indices |
| BLL | Blood lead levels |
| BTF | Battle Training Facility |
| CAI | Civilian Ammunition Inspector |
| DASH | D Aviation Safety and Health |
| DEI | Defence Estate and Infrastructure |
| DEOS | Defence Explosive Ordnance School |
| DMMG | Defence Munition Management Group |
| DoH | Directorate of Health |
| DoS | Directorate of Safety |
| DTA | Defence Technology Agency |
| EOD | Explosive Ordnance Division |
| GP | General Practitioner of Health |
| HSW (GRWM) | Health and Safety at Work (General Risk and Workplace Management) Regulations 2016. |
| HSWA | Health and Safety at Work Act 2015, New Zealand's workplace health and safety law. |
| JSA | Job Safety Analysis |
| LAVs | Light Armoured Vehicles |
| $mg/m^3$ | Milligrams per cubic meter of air |
| NAVOSH | Navy Occupational Safety and Health |
| NIOSH | National Institute of Occupational Safety and Health |
| NRC | National Research Council |
| NZDF | New Zealand Defence Force |
| Ototoxic substances | Exposure to some chemicals can result in hearing loss. Hearing loss is more likely to occur if a worker is exposed to both noise and ototoxic substances than if exposure is just to noise or ototoxic substances alone. |

| | |
|---|---|
| PCBU | Person Conducting a Business or Undertaking |
| PPE | Personal Protective Equipment |
| PT | Personal Training |
| RCO | Range Controlling Officer |
| RNZIR | Royal New Zealand Infantry Regiment |
| SAS | Special Air Service |
| SCS | Seamanship Combat Specialist |
| SECFOR | Security Force |
| SOP | Standard Operating Procedure |
| Swab | Surface sampling for lead generally following NIOSH method 9100 |
| TWA | Time weighted average |
| UTF | Urban Training Facility |
| WES | Workplace Exposure Standard |

# 1. INTRODUCTION

## Scope

The New Zealand Defence Force (NZDF) has identified lead exposure as a risk to health in their workplaces and approached Air Matters to undertake a high-level health risk assessment. The following was detailed in the brief from NZDF.

*Lead is considered a hazardous substance and is classified as toxic (Class 6) and eco toxic (Class 9) under the Hazardous Substances and New Organisms Act (1996). Lead exposure may cause significant health issues, with certain populations being more sensitive. In an NZDF workplace context, lead exposure may result from:*

a) *Use of small arms and canon ammunition in confined spaces, such as indoor ranges or poorly ventilated vehicles. Academic research demonstrates that weapon use on outdoor ranges also exposes certain populations to hazardous concentrations of lead. Key positions such as safety staff and coaches, where extended and intimate contact with transient range users is likely, are at particular risk.*
b) *The disposal of ammunition through incineration*
c) *A process which exposes workers to the fumes and dust from the manufacturing or testing ammunition such as detonators*
d) *Handling, using or disposing of lead containing materials where the lead becomes exposed to the environment and can enter the body via an exposure route (dermal or inhalation)*
e) *The use of lead based paint and exposure to lead paint dust*
f) *Using abrasive power tools on paint which contains lead*
g) *Welding and radiator repairs which may cause exposure to lead fumes and dust.*

*Exposure to lead is a significant occupational health issue for NZDF that requires ongoing assessment, risk control, risk management, review and monitoring. NZDF is required to ensure all members have access to occupational health and occupational hygiene assessments, and ongoing monitoring where exposure to health hazards and risks is known or suspected to have occurred.*

The main deliverable was detailed as follows with detail about what needs to be included in this report.

*Production of a technical report (aligned to international or Australian/New Zealand standards) identifying significant lead hazard exposure, and exposure evaluation with recommendations for control and health monitoring. The output must inform the requirements for an NZDF health monitoring programme for lead exposure.*

- *Base/camp lead processes*
- *Indicative exposure to lead hazards assessment (non-measured high/medium/low)*
- *Priority for action (significant exposure to lead hazards)*
- *Indicative methodology for future exposure to lead hazards assessment (detailed survey with outline costings)*
- *Assessment of current mitigation strategies (including effectiveness)*

This technical report outlines the main components of the scope detailed with the approach to the walkthrough surveys and risk assessments explained below.

### Walkthrough surveys

During the months of May and June 2021 the following list of camps and bases were visited. This visit was in the form of an occupational hygiene walkthrough survey.

- Whenuapai Air Force Base
- Defence Technology Agency, Devonport
- Devonport Naval Base
- BTF facility, Papakura
- Waiouru Army Camp
- Linton Army Camp
- Ohakea Air Force Base
- Trentham Army Camp
- Woodbourne Air Force Base
- Burnham Army Camp
- Glen Tunnel Ammo Storage

During the walkthrough survey a lead indicator test was occasionally used in areas with regular use of lead containing material (e.g. firing points on ranges, armourers, areas with soldering). A 3M LeadCheck Swab was used as an in-field indicative test of where lead was present on surfaces in areas of interest. This is not a quantitative test but provides further information to base the risk assessment on.

### Approach to risk assessments

In general, a walkthrough survey is carried out to understand processes in a workplace through observations and spot measurements. In this case there was a focus on processes that were known to contain lead. During most of the time on site the processes involving lead exposure risk were not taking place so the majority of assessment is based on discussions with personnel on site and having them explain the process.

Prior to the site visits, questionnaires (refer to Appendix A for example) were sent around the NZDF and were used to ascertain an understanding of the knowledge within NZDF about risk assessments in general as well as any known lead sources and the risk associated with them. These responses as well as internal NZDF documentation informed the approach to the site visits. The identified lead sources in this questionnaire were referenced from a Safe Work Australia national survey (Driscoll, T. 2014) into workplace exposures to known or suspected carcinogens of which some forms of lead fall into.

Responses were received from the following:

- 16 Field Regiment and School of Artillery
- 1 RNZIR
- 2/1 RNZIR
- 3 Combat Services Support Battalion

- Queen Alexandra's Mounted Rifles
- Army Command School
- Trade Ttttraining School
- Defence Estate and Infrastructure
    - General response
    - Papakura Battle Training Facility
- RNZAF DASH (one response for all of Air Force)

From the information obtained through the questionnaires and the walkthrough survey's, a high-level risk assessment was carried out. The risk assessment was based on guidance detailed within the Simplified Occupational Hygiene Risk Management Strategies by the Australian Institute of Occupational Hygienists (Firth, I. et al). The following information was collated in order to make a determination on risk.

- Existing controls (assigned a rank generally based on position in control hierarchy)
- Control effectiveness
- Frequency of exposure
- Duration of exposure
- Estimated level for exposure (primarily based on lead indicator swab)
- Consequence (always severe)
- Likelihood –

| **Rating** | **Description** | |
|---|---|---|
| A | Almost certain | Regular contact with the potential lead hazard at very high levels. |
| B | Likely | Periodic contact with the potential lead hazard at very high levels or regular contact at high levels. |
| C | Possible | Periodic contact with the potential lead hazard at high levels or regular contact at moderate levels. |
| D | Unlikely | Periodic contact with the potential lead hazard at moderate levels or regular contact at low levels. |
| E | Rare | Periodic contact with potential lead hazard at low levels. |

- Additional notes

In order to determine an overall risk rating the following matrix was used. Likelihood is based on the Occupational Hygienist's determination from controls, frequency, duration and level of exposure.

| ***Likelihood*** | ***Consequence*** |
|---|---|
| | Severe |
| Almost certain | **High** |
| Likely | **High** |
| Possible | **Moderate** |
| Unlikely | **Low** |
| Rare | **Low** |

The expanded risk assessments are presented in Appendix B of this report. A summary of the outcome has been included in Section 5 and includes the group with similar exposures, location (or personnel), identified source of lead exposure and the designated risk level.

## 2. LEGAL FRAMEWORK

The Health and Safety at Work Act 2015 is the key piece of legislation in terms of Health and Safety in New Zealand with Part 2, Section 30 detailing the key principle as to its intent.

This section states:

***30 Management of risks***

*(1) A duty imposed on a person by or under this Act requires the person—*

*(a) to eliminate risks to health and safety, so far as is reasonably practicable; and*

*(b) if it is not reasonably practicable to eliminate risks to health and safety, to minimise those risks so far as is reasonably practicable.*

*(2) A person must comply with subsection (1) to the extent to which the person has, or would reasonably be expected to have, the ability to influence and control the matter to which the risks relate.*

In relation to lead and the NZDF, lead is considered a risk to health. It has acute and chronic health effects and affects all the major organ systems in the body at very low blood lead levels (ATSDR, August 2020). NZDF has a duty to eliminate or minimise the health risk from lead (and other exposures) in the workplace. One of the aims of this report is to look at the lead health risk from a whole of NZDF perspective in order to help identify where the risk is present but to also assess the level of risk posed in each of these situations. This is necessary before the risk can be managed.

In addition to managing risks, the NZDF (as a PCBU) must consult with other PCBU's that also have a duty to manage risks and specifically in this case, lead exposure risk.

***34 PCBU must consult other PCBUs with same duty***

*(1) If more than 1 PCBU has a duty in relation to the same matter imposed by or under this Act, each PCBU with the duty must, so far as is reasonably practicable, consult, co-operate with, and co-ordinate activities with all other PCBUs who have a duty in relation to the same matter.*

*(2) A person who contravenes subsection (1) commits an offence…*

In addition to the above, the Primary Duty of Care detailed in Section 36 outlines more specific duties for the PCBU. Section 36 is presented below.

***36 Primary duty of care***

*(1) A PCBU must ensure, so far as is reasonably practicable, the health and safety of—*

*(a) workers who work for the PCBU, while the workers are at work in the business or undertaking; and*

*(b) workers whose activities in carrying out work are influenced or directed by the PCBU, while the workers are carrying out the work.*

*(2) A PCBU must ensure, so far as is reasonably practicable, that the health and safety of other persons is not put at risk from work carried out as part of the conduct of the business or undertaking.*

*(3) Without limiting subsection (1) or (2), a PCBU must ensure, so far as is reasonably practicable, —*

*(a) the provision and maintenance of a work environment that is without risks to health and safety; and*

*(b) the provision and maintenance of safe plant and structures; and*

*(c) the provision and maintenance of safe systems of work; and*

*(d) the safe use, handling, and storage of plant, substances, and structures; and*

*(e) the provision of adequate facilities for the welfare at work of workers in carrying out work for the business or undertaking, including ensuring access to those facilities; and*

*(f) the provision of any information, training, instruction, or supervision that is necessary to protect all persons from risks to their health and safety arising from work carried out as part of the conduct of the business or undertaking; and*

*(g) that the health of workers and the conditions at the workplace are monitored for the purpose of preventing injury or illness of workers arising from the conduct of the business or undertaking.*

*(4) Subsection (5) applies if—*

*(a) a worker occupies accommodation that is owned by, or under the management or control of, a PCBU; and*

*(b) the occupancy is necessary for the purposes of the worker's employment or engagement by the PCBU because other accommodation is not reasonably available.*

*(5) The PCBU must, so far as is reasonably practicable, maintain the accommodation so that the worker is not exposed to risks to his or her health and safety arising from the accommodation.*

Section 36 of the health and safety legislation provides more detail into what generally needs to be done to support the management of risk stated in Section 30 (above).

The PCBU is responsible for the health and safety of their own workers as well as those they have influence over. An example of this would be the sub-contractors that are brought in to remove bullet catcher material. This also extends to ensuring the health and safety of other persons is taken into consideration.

The detail in subsection 3 of Section 36 talks about providing an environment, equipment, systems of work, handling and storage, facilities for welfare, training and instruction for workers. It also requires that worker health is monitored to prevent injury or illness. These points directly relate to this project around lead in that the controls in place were reviewed during the walkthrough survey in order to identify gaps. The requirement to monitor worker health includes blood lead level testing but also extends out to other non-invasive forms of testing (surface swabs and air testing to reflect inhalation) that are associated with a concentration unlikely to cause adverse health effects. The measurement of

worker health is the point where controls can be confirmed as making a difference to exposure and hence help confirm that risk is being managed to prevent injury or illness.

The last two subsections (4 and 5) relate to accommodation and maintaining it to ensure that the worker is not exposed to health and safety risks. This is applicable as NZDF maintain residences around New Zealand that are used by NZDF personnel but are owned and managed by NZDF. This is a function of Defence Estate and Infrastructure and is relevant to lead when lead paint is removed and any subsequent contamination of the environment.

## 3. LEAD HAZARD

The toxicity of lead has been known for a very long time with a very large amount of literature available that evaluates the health effects. The U.S. Department of Health and Human Services, Agency for Toxic Substances and Disease Registry (ATSDR) has produced a Toxicological Profile for Lead (dated August 2020) and has the primary source for the health effect information summarised in this section.

Other sources of literature have also been reviewed and these will be referenced where applicable.

The ATSDR summarises that exposure to lead is primarily determined through internal exposure metrics (lead in blood or bone) rather than measurement in air or on surfaces. This makes it difficult to correlate between external and internal metrics due to the fact that the correlation is unknown or uncertain. However, others have attempted to correlate the two with this often happening in the workplace where exposures are generally greater than for the general public.

> *"To quantify exposure, epidemiological studies on the toxicity of Pb rely on internal exposure metrics, rather than measurements of external exposures (e.g., concentration of Pb in water or air) or ingested dose. The most common internal dose metric for Pb is the concentration of Pb in blood (PbB, typically expressed in terms of µg/dL). Blood Pb concentration reflects both ongoing exposure and Pb stores in bone, which can be transferred to blood. Because of the relatively rapid elimination of Pb from blood compared to bone, blood Pb will reflect mainly the exposure history of the previous few months and not necessarily the larger burden of Pb in bone (see Section 3.1). As a result, a single PbB measurement may not be a reliable metric for Pb body burden or cumulative exposure. Longitudinal measurements of PbB can be used to construct a cumulative blood Pb index (CBLI), which may be a better reflection of exposure history; however, the CBLI will not capture shorter-term variation in exposure that may occur between measurements.*
>
> *The health effects of Pb are the same, regardless of the route of exposure (e.g., inhalation or ingestion).*
>
> *Environmental exposure to Pb occurs continuously over a lifetime and Pb is retained in the body for decades. Because internal dose metrics cannot define the complete history of exposure, the exposure duration and timing that correlates most strongly with the observed health effect are typically unknown or highly uncertain. (ATSDR, August 2020)"*

It is important to note that lead in blood is only reflective of the previous few months' exposure due to the relatively rapid elimination from blood versus bone, where it is largely stored in place of calcium. ATSDR notes that a single blood lead level measurement is not a reliable metric of the body burden

that lead poses. This is an important point to take into consideration when considering who, why and when blood lead level tests are carried out as a method to determine whether risk is being minimised or if someone has been affected by lead exposure in the workplace.

> *"Toxic effects of Pb have been observed in every organ system that has been rigorously studied. Clinical significance of some of the organ system effects at low levels of exposure and blood Pb is more substantial than for others (e.g., neurological, renal, cardiovascular, hematological, immunological, reproductive, and developmental effects). This is not surprising because the mechanisms that induce toxicity are common to all cell types and because Pb is widely distributed throughout the body. Adverse health effects have been observed in these systems at PbB ≤10 µg/dL. Exposure thresholds for effects on specific organ systems have not been identified (i.e., no safe level has been identified). (ATSDR, August 2020)"*

Lead effects many organ systems and adverse health effects occur even with blood lead levels are well below the current New Zealand biological indices published by WorkSafe New Zealand.

ATSDR set minimum risk levels for toxic substances but in the case of lead it has not been derived due to the fact that effects in children occur at the lowest blood lead levels studied. In the case of NZDF, children do not make up part of the workforce but studies related to adults show that even at minimal blood lead levels (≤10 µg/dL) there are noted health effects in epidemiological studies in the large range of organ systems lead is known to effect.

> *"… epidemiological studies have evaluated the health effects of Pb in all organ systems. For the most studied endpoints (neurological, renal, cardiovascular, hematological, immunological, reproductive, and developmental), effects occur at the lowest PbBs studied (≤5 µg/dL). Because the lowest PbBs are associated with serious adverse effects (e.g., declining cognitive function in children), MRLs for Pb have not been derived. (ATSDR, August 2020)"*

The current WorkSafe New Zealand Workplace Exposure Standards and biological exposure indices (Edition 12-1, November 2020) publish the following relevant levels for inorganic lead:

| **Substance** | **Standard** | **Notes** |
|---|---|---|
| Lead, inorganic dusts and fumes, as Pb | TWA – 0.05 mg/m$^3$ | 6.7B – suspected carcinogen |
| Lead BEI (inorganic) | 20 µg/dL<br>Suspension levels:<br>30 µg/dL – males and females not of reproductive capacity.<br>10 µg/dL – females of reproductive capacity and those pregnant and/or breastfeeding. | Ideally no exposure to lead for pregnant women or women planning to become pregnant. |

The ACGIH notes (ACGIH 2001a in National Academy of Sciences, NRC, 2012) that a level of 30 µg/dL will decrease the likelihood of the following:

- Psychologic and psychomotor effects that appear to occur at BLLs over 30 µg/dL.
- Changes in nerve conduction and latency intervals that appear to occur at BLLs over 30 µg/dL.
- A reduction in hematologic reserve capacity (one study) at BLLs over 40 µg/dL.

- Increased blood pressure and incidence of hypertension; effects at BLLs under 30 µg/dL are expected to be very small.
- Renal impairment with minor effects reported at BLLs under 30 µg/dL and increased proteinuria at BLLs of 40 µg/dL.
- Spontaneous abortions and effects on male fertility that appear to occur at BLLs over 30 µg/dL.
- Decreased length of gestation and decreased birth weight; expert reviews indicate that effects appear to be associated with BLLs over 30 µg/dL.

Particle size is also another important determinant of internal dose with smaller particles, like those associated with fume (under 0.1 µm in aerodynamic diameter), better absorbed by inhalation and ingestion than larger particles (*National Academy of Sciences, NRC, 2012*). About 50% of the lead deposited in the respiratory tract is absorbed and reaches the systemic circulation whereas net absorption of ingested lead from the adult digestive tract is appreciably lower (less than 8% to 10%) (*O'Flaherty 1993 in National Academy of Sciences, NRC, 2012*). A further paper (*Laidlaw, M. et al*) suggests that elevated blood lead levels at indoor firing ranges are the results of greater absorption through inhalation compared to ingestion and dermal absorption due to the greater uptake of lead via the respiratory system than the gastrointestinal system. This paper also suggests that outdoor ranges presumably are well ventilated by natural airflow but do not necessarily prevent lead exposure from shooting activities.

The US Department of Defence asked the National Research Council (NRC) to evaluate potential health risks related to recurrent lead exposure of firing-range personnel (National Academy of Sciences, NRC, 2012). Within this extensive and very relevant publication, the NRC details known health effects at the relevant blood lead levels (µg/dL).

The following general summary of non-cancer health effects are those that have data from blood lead levels (BLL) under 40 µg/dL (*National Academy of Sciences, NRC, 2012*).

- Neurological effects
  - Neurobehavioral performance decrement – begins at 18 µg/dL (symptoms found as low as 12 µg/dL)
  - Change in mood – 27-30 µg/dL
  - Decrements in peripheral sensory nerve function – begins at 28-30 µg/dL
  - BLLs over 10 µg/dL are associated with lead-induced hearing loss that might enhance noise-induced hearing loss
  - Decrease in conduction velocity in visual pathway – 17-20 µg/dL
  - Benchmark dose level for postural sway is 14 µg/dL
  - Parasympathetic and sympathetic integrity compromised over 20 µg/dL
  - Quantitative EEG found increased beta activity in 81% of lead-exposed workers who's mean BLL was 29 µg/dL.
  - Cumulative lead dose that reflects past high lead exposure may be a strong predictor of decrements in neurobehavioral performance even in the absence of an association with current BLL.

- Hematopoietic effects (leading to anaemia)
  - Possible effects on circulating haemoglobin concentrations from 20 µg/dL.
- Renal effects
  - The following adverse effects can be seen in BLL up to 40 µg/dL - increases in serum creatinine, impaired creatinine clearance, and glomerular filtration rate and by alterations in renal endocrine functioning that may contribute to delayed blood regeneration capacity and hypertension.
- Reproductive effects
  - Adverse developmental effects in infants and children – prenatal BLL <10 µg/dL
  - Reduced fetal growth and low birth weight – maternal BLL <5 µg/dL
- Immunological effects
  - Inconclusive evidence at present with further research needed.
- Cardiovascular effects
  - The following adverse effects can be seen in BLL up to 40 µg/dL as well as cumulative does measures (e.g. tibia lead concentration) - increased blood pressure, hypertension, cardiovascular mortality, and subclinical cardiovascular outcomes.

On the basis of nonhuman experimental evidence, lead and lead compounds have been recognized as probably or likely to be carcinogenic in humans by several authoritative organizations, including the International Agency for Research on Cancer (IARC 2006), the National Toxicology Program (NTP 2004, 2011), and the US Environmental Protection Agency (EPA 2012) (*National Academy of Sciences, NRC, 2012*).

The NRC publication provides the following general summary for cancer effects from lead.

- Strong evidence for benign and malignant renal tumours in animals
- The kidney has been found to be a target organ for increased BLL by any route
- Lung-cancer risk is not clear through animal studies
- Lead exposure via inhalation has not been well studied
- Some studies showed tumour induction at concentrations that were not cytotoxic and thus supported mechanisms at micromolar concentrations.
- There is additional epidemiologic evidence on both renal and brain cancers.

The health effect of lead is wide ranging and relatively well understood due to the identification of lead of a toxic substance very early in its use. The information collated above shows that even at levels below the current Workplace Exposure Standard Biological Indices level of 20 µg/dL (0.97 µmol/l) there are health risks that remain. As of 9 April 2021, the Ministry of Health had lowered the notification level for blood lead to 0.24 µmol/l (equates to ~5 µg/dL). If blood lead levels are above this notification level, then the health practitioner (or lab) notifies the local medical officer of health. If this occurs in a workplace setting WorkSafe New Zealand are advised. There is a disconnect between the Ministry of Health notification level and that published in the Workplace Exposure Standards and Biological Indices by WorkSafe New Zealand. The Ministry of Health level is considerably lower but, based on the information above, providing an alert at a level which may protect against possible health risk.

## 4. RISK ASSESSMENTS

The table (Table 4.2) on the following four pages provides a summary of the risk assessments carried out and attachments in Appendix B providing more detail.

The assessment of risk has been based on the Simplified Occupational Hygiene Risk Management Strategies by the Australian Institute of Occupational Hygienists (Firth, I. et. al., 2020). The risk assessments have been grouped generally for those workers that have been considered similarly exposed. The groups are not typically just single service related but encompass similar functions across all three services (Army, Navy and Air Force). The risk assessment is based on the Occupational Hygienists determination while taking into account the following;

- Existing controls
- Control effectiveness (initial observation)
- Frequency of exposure
- Duration of exposure
- Estimated exposure level (on site swab and literature research)
- Additional points observed

The above points are taken into consideration for the likelihood of exposure and are combined with the health consequence of exposure to inorganic lead. In this case the health consequence of lead has been given a 'severe' consequence due to its possible carcinogenicity as well as the wide ranging and extensive non-cancer health effects from a very low concentration.

The likelihood has been determined based on the following (Table 4.1) with the classification of likelihood being largely based on the professional opinion of the Occupational Hygienists involved but supported by current controls, apparent control effectiveness, frequency of exposure, duration of exposure and an estimated contaminant level.

*Table 4.1: Hazard likelihood rating matrix*

| Likelihood | | Risk Rating |
|---|---|---|
| **Almost certain** | Regular contact with the potential hazard at very high levels | **High** |
| **Likely** | Periodic contact with potential hazard at very high levels or regular contact with the potential hazard at high levels. | **High** |
| **Possible** | Periodic contact with potential hazard at high levels or regular contact with the potential hazard at moderate levels. | **Moderate** |
| **Unlikely** | Periodic contact with potential hazard at moderate levels or regular contact with the potential hazard at low levels. | **Low** |
| **Rare** | Periodic contact with the potential hazard at low levels. | **Low** |

*Table 4.2: Risk assessment summary for different groups across NZDF.*

| Group | | Personnel or location | Source of lead exposure | | Risk rating |
|---|---|---|---|---|---|
| Ammunition destruction | | DMMG, DEOS, EOD, CAI (civilians) | Cleaning up of disposed shells from incinerator. PPE used and processes variable. High possibility of exposure during clean up puts people at risk. Regular blood lead tests are carried for DMMG staff. | | High |
| Indoor ranges | | BTF (Papakura) | Heavy use indoors of firearms by SAS (primarily). Literature indicates that indoor firing poses the greatest risk to health from lead in ammunition primer and bullets themselves. | | High |
| | | UTF (Burnham) | Blanks primarily used in some enclosed spaces (makeshift urban environment). Blanks contain lead styphnate in primer. Risk present but very little data available to quantify (swabs, blood results or air sampling) | | High |
| | | Tube ranges (NZDF wide) | More infrequent use versus ranges and lower amount of ammunition used. Lead risk present and considered an indoor facility, which are known to increase risk. More information needed to quantify level of risk. | | High |
| Outdoor ranges | Short ranges | Primarily: SECFOR (Air Force), SCS (Navy), SAS (Army Special Forces), 1st Battalion, 2nd/1st Battalion (Army) | Short ranges are typically on base/camp and normally have a slightly enclosed firing position and surrounds. Fume build up possible. | Raking bullet catcher at the end of shoot is an additional source of exposure. | High |
| | Long ranges | | Swabs in the long range markers gallery area indicated lead plus heavy weapons (machine guns) are used that may pose an increased risk. | | High |
| | Annual weapon qualifications | | Annual weapons training for most NZDF Strategic and Operational staff over normally half a day at a short range. | | Low |
| | Larger munitions | Artillery, LAVs and ship (frigate) deck guns | Less infrequent use of weapons versus smaller arms hence the relatively lower risk rating. Lead exposure still possible due to the presence of lead styphnate in the primer. This primer can be | | High |

| | | | | |
|---|---|---|---|---|
| | | | inhaled and ingested if covering surfaces in and around the weapon. In 105mm ammunition a thin lead foil is used as a part of the propelling charge which is designed to chemically remove copper that is deposited inside the barrel. It is not known if this same situation occurs on the LAV weapon systems. | |
| Note: Much of the ammunition used by NZDF, including blanks, contain lead styphnate in the primer. The combustion of this primer plus the friction of the bullet against the barrel both generate airborne lead that could be inhaled directly or accumulate on hands/face/clothes and be subsequently ingested. This has already been identified by Defence Health in Health Instruction 022/17 dated 07 June 2020. | | | | |
| Parachute bay (Ohakea) | | Specifically seen in Ohakea | Lead shot filled weighted fabric bags. Handled all day, every day with lead indicator swab showing lead present likely due to oxidising lead shot. More investigation needed but immediate control possible by placing lead shot in plastic bags to encase it. | Moderate |
| Bullet catcher material maintenance | | Defence Estate & Infrastructure (DEI) contractors and sub-contractors | Risk to contaminated material from bullet catcher that is currently managed by the sub-contractor who produce a JSA on the risks posed. JSA is reviewed by DEI.<br>Two occasions recently (Burnham and Linton) where lead contaminated dust was released into the environment around a tube range effecting adjacent workshops/building. Possible indication that processes around control needs improvement. | Moderate |
| Armourers | | Across all three services | Observations identified limited interaction with lead contamination and good hygiene practises generally applied. However, this group do work around weapons, fire weapons in tube ranges and possibly exposed from ammunition residue so exposure possibility remains. More work needed to quantify exposure and risk to health effects. | Moderate |
| Defence Technology Agency (DTA) | | DTA personnel | Ballistics research-based work, so amount of ammunition used is relatively low. Regularly use indoor ranges (every 6 weeks) and will have own tube range facility soon so frequency may increase. | Moderate |
| Soldering | | Includes all electrical related trades (Electricians, avionics, signal squadrons etc.) | Soldering has more significant risks such as to rosin. Soldering does not pose a significant lead fume risk due to the low temperatures (lead fume is generated at 500°C and above) | Low |

| | | | | |
|---|---|---|---|---|
| Battery bays | | All camps/bases | Dead batteries are stored for disposal off site with a recycling facility or contractor. Very little interaction with lead-acid batteries. Air Force undertakes annual blood tests for these workers. | Low |
| Ground support workshops | | Across all three services | Minor amounts of in-situ soldering required and application/removal of lead wheel weights. | Low |
| Personal training vests | | Specifically seen at Woodbourne | Weighted PT vests filled with lead shot. Lead presence confirmed through a swab on the outside of the vest. Vests are used occasionally. Control through placing lead shot into plastic bags before inserting into PT vests. | Low |
| Ship maintenance | | Babcock (Navy contractor) and Navy personnel | Large scale paint removal occurs by contractor in a dry dock setting where a procedure is followed to manage the risk to workers involved in paint removal and in the vicinity.<br>Navy personnel occasionally have to remove paint and re-apply while alongside but this is now rare on the newer navy ships. | Low |
| Lead paint removal | Residential | NZDF wide (Contractors carry out work) | General approach is to maintain the existing paint. Large works carried out inter-tenancy which will limit non-worker exposure. Risk reduced due to identified risk prior to job and use of appropriate controls. Infrequency of large-scale removal work reduces likelihood of exposure. | Low |
| | Defence estate | | General approach is to maintain the existing paint. Presence of lead paint is known or being developed currently. Low frequency of large-scale works lowers worker exposure potential. Woodbourne was only location where example of poor maintenance could have posed an immediate risk to NZDF personnel in the workplace (Location: Supply building). | Low |
| Lead in soil (residential) | | NZDF wide | Contamination of soil in halo around the building (~2m out) could occur if poor practise carried out during removal or maintenance of lead containing paint. No evidence seen that shows where soil is contaminated. | Low |

| | | | |
|---|---|---|---|
| | | Negligible risk for workers but residents of homes could be exposed if use the soil close to homes.<br>Investigations needed to identify those residential properties with lead in paint, whether work has occurred on that paint and the resulting lead in soil level. DEI currently has an investigation underway, reviewing the presence, distribution and concentration of contaminants in soil in the NZDF housing portfolio. | |
| Lead paint dust (residential) | NZDF wide | Historic use of lead paint on interior surfaces of NZDF houses, and to a minor extent the tracking of lead paint contaminated soil into houses, has over time potentially deposited lead paint dust onto interior surfaces and carpets. DEI is currently investigating this issue. | Low |
| Buried fuel tank | Woodbourne only | Historical fuel tank confirmed as having had contained leaded fuel. Unknown state at present. Further investigation needed to determine if it poses environmental or workplace health hazard. | Low |
| Surface and Safety | Air Force | Very limited interaction with lead containing products. PPE worn and work area affords high level of protection. | Low |
| Metalwork shop | Ohakea, Devonport, Linton and Trentham<br>(Possibility of others) | Work with brass does occur in both locations. Irregular jobs involving it and unknown proportion of lead in the brass worked on. Further investigation warranted but mainly around work practises. | Low |
| Firefighters | NZDF wide | Very rare likelihood of exposure. Cannot be planned for but PPE is worn and cleaned afterwards.<br>Other non-lead exposures more important to manage. | Low |
| Engineers | Plumbers and builders (Army) | Low frequency interaction with lead flashings on roofs and lead pipe. | Low |

# 5. DISCUSSION

**High risks**

*Ammunition destruction*

DMMG carry out 'burns' about twice per year and these are carried by different groups of people and in different incinerators in the two locations visited, Glen Tunnel and Waiouru. At Glen Tunnel the incineration of ammunition was seen occurring in metal lockers (four total with approximately 1 tonne of ammunition able to be disposed of at a time) placed within a tray in a paddock on site. Once the burn process ends the brass shells and other metal (including lead) is cleaned out by hand. The personnel who carried out this task (uniformed Army personnel) wore gloves, disposable respirator and cotton overalls. It was mentioned that disposable overalls should have been worn and were detailed in the DMMG standard operating procedure (SOP). The SOP was not seen. The location of the burn was not near any washing facilities. Glen Tunnel also has a modern ammo incinerator that is designed to dispose of 200kg of ammunition at a time with emissions passed through an afterburner before release into the atmosphere. The lowering of environmental effects and compliance with regulatory requirements is the main reason for using the purpose-built incinerator but low throughput frustrates the users. The modern incinerator still requires the manual removal of material, which will more than likely include lead and material contaminated in lead.

Waiouru also use the modern incinerator and restrictions placed on them by the resource consent for disposal means that this in the only method of disposal. The process was not being carried out during the walkthrough survey but the same DMMG SOP was followed as discussed in Glen Tunnel. CAI collect the ammunition from the public and are responsible for the ammo burn at Waiouru, which is a different group of people from those at Glen Tunnel.

Army also carry out drum bin burns of small arms ammo at Waiouru. These are carried out for training purposes to simulate burns in operational environments where incinerators are not available. Further details about these rudimentary burn training exercises should be requested from the army ammo techs.

Kauri Point also disposes of ammunition but this location was not visited.

As part of the follow up around ammunition destruction after the walkthrough assessment a report from 2013 was provided that investigated the personal exposure (including lead) during the use of the ammunition destructor at Waiouru (*Miller, SGT D. October 2013*). This indicated that there was a risk to the effects from lead through ingestion via poor hygiene procedures.

Further investigation is needed around ammunition destruction with detail provided in Section 6 of this report.

*Ranges and range users*

Ranges have range standing orders, range maintenance schedules and then site risk assessments associated with them and these appear to be generally appropriate in outlining the important health and safety matters relating to lead exposure. All the documentation relating to ranges have not been

reviewed in detail. The matters these documents address about the risk from lead do not detail how the health of workers are monitored to prevent illness or injury as required by the Health and Safety at Work Act 2015. A proactive approach to health and safety is needed and this includes quantifying or semi-quantifying the health risk before effects occur, especially in those instances considered high risk.

The BTF facility is regularly used by various groups for training exercises and this is primarily the 1 NZSAS regiment (SAS). Due to their frequent use of weapons at this facility as well as at the outdoor ranges the SAS would be considered to be a group at high risk from the effects of lead. The SAS have had blood level tests on occasion plus extensive work has occurred in commissioning the BTF facility to ensure the ventilation system in place is fit for purpose. A process of understanding the level of lead contamination within the BTF is also underway through DEI and Weapons and Range Safety so the appropriate cleaning can take place. Further investigation linking lead contamination to worker/soldier health is needed at the BTF. A focus on understanding the lead exposure level for the SAS regiment and Facilities Management company employees is recommended as groups of workers considered high risk. Outcomes from this investigation can be applied to other BTF user groups based on frequency of use.

Tube ranges are considered high risk but compared to the BTF (and UTF) are used much less intensely but nevertheless they are indoors with people present during firing of weapons that will produce lead fume and particulate that could be inhaled or ingested. Tube ranges have in-built ventilation systems designed to control worker exposure to airborne hazards. More information is needed to quantify health risk via ingestion and inhalation routes through monitoring as well as confirming that ventilation is effective at controlling the lead hazard, however, it was noted that there have been elevate BLL for armourers at the Linton Tube Range.

Operations at the UTF use blanks but these still contain lead styphnate that will be released as fume from the weapon. Quantification of amount of lead is needed from this location as no information was available or provided. Further investigation will help refine the risk level from lead for personnel using this facility.

Personnel that undertake a range controlling officer (RCO) role with SECFOR, SCS, 1st and 2nd/1st Battalions and others, are present on ranges more frequently than other groups. Due to the greater time duration and frequency that instructors spend on the range, and being close to the firing line, it is assumed that they are at greater risk from lead than occasional users. A systematic approach to assessing exposure for each of these groups in detail is needed which may lead to monitoring in all or some of the different groups. Another consideration (especially with the Battalions) is the posting cycle of 3 years where personnel may only be exposed (or possibly heavily exposed) for a limited period of time.

In relation to Army ranges particularly it was noted during the walkthrough assessments (observations and discussion) that the common range hygiene rule of washing hands prior to eating and the restriction of refraining from eating and drinking on the range was not always followed or possible. The ranges used by Army are aften removed from the camp itself whereas Air Force bases all have a range situated within them with a basin for hand washing and the ability to more easily eat and drink away from the range. This limits the ability for hand washing facilities. Anecdotal suggestions were that training taking

place on ranges (that often took place all day or for multiple days) often did not necessarily move away from the range itself to eat or drink due to training requirements. This was observed specifically down at the short range in Burnham where the group involved in range training ate in close proximity to the range itself. There was no designated hand washing facility at this range other than a portaloo. This requires further investigation and potential interventions to resolve any issues in a relative quick and easy manner.

It is anticipated that exposure risk at outdoor ranges via inhalation is less than at indoor ranges due to the greater opportunity for natural air movement to take airborne particulate and fume away from the range. However, inhalation is not the only route of lead into the body. The indicator swabs were used at a variety of short and long ranges and where rain did not have the opportunity to wash away contamination there was generally a presence of lead. A focus on collecting further detail on exposure from the regular users in the first instance is a practical approach with solutions to control applied across the NZDF.

Additional activities that may pose a risk to lead exposure on ranges include the use of other types of weapons (e.g. machine guns), especially under sustained fire, the positioning of people in the marker gallery on the range where targets are prepared and the raking of the bullet catcher at the end of a shoot. Larger calibre weapons have been reported to result in a higher blood lead level (*Demmeler et al. (2009) in Laidlaw, M. 2017*). The markers gallery had confirmed lead presence in Waiouru and this is assumed at all other locations. Further detailed investigations are needed around quantifying exposures in the markers gallery and on range. The raking and preparing of the bullet catcher post shoot is a process carried out by two people who are required to wear gloves and a disposable respirator. The exposure to lead in the markers gallery and during raking the bullet catcher was confirmed in *Corlett, N., 2016* where some limited sampling was undertaken at the Paul Parsons range. The PPE used is appropriate but the ability to wash hands/arms/face afterwards is limited in some ranges so alternatives are needed such as the use of wipes designed to remove heavy metals.

Annual weapon qualification visits are not considered high risk due to the short length of time on range meaning the potential for development of adverse effects is minimised.

*Larger munitions*

The use of large calibre munitions by artillery, cannons on the LAVs and the Navy frigate deck guns all have a risk of lead exposure from the explosions created when firing the round. The source of exposure follows the same principle as for the rifles and pistols in that all these rounds appear to contain lead styphnate in the primer. This was confirmed by investigating the SDS for live and blank 105mm round. Although not actually able to be seen there was anecdotal discussion about a previous investigation into lead presence inside the LAVs after firing. The LAVs have a bag that collects the fume after firing the cannon, but these are not always used. The artillery shells (105mm) have been confirmed as containing a lead hazard (swab and SDS review). The exposure to Navy personnel was not explored in detail but cleaning of the barrels is a process carried out although loading and unloading of shells is done automatically. It is assumed that these munitions contain lead but more investigation is needed during a detailed assessment of exposure.

There have positive indications of the presence of lead hazard for personnel involved with the weapons systems that use the larger munitions. The amount of fume (and hence possible lead) produced is greater than a rifle but the rate of fire is much less. The nature of training exercises (living in and around vehicles for an extended period) means that there is a possibility for exposure after than actual firing process and the fume cloud produced.

DMMG is currently working collaboratively with DEI to set up an environmental, health and safety risk assessment framework for the procurement and through-life management of all ammunition used by NZDF. This framework establishment is intended to improve NZDF's protection of both its personnel and the environment from the potential effects of handling, use and disposal of ammunition poses (which can include risk posed by lead). The framework has not yet been reviewed by Defence Health or the Directorate of Safety, but their input would be invaluable to the overall intention of the framework.

**Moderate risks**

*Bullet catcher material*

DEI manage the contaminated material being removed from the bullet catchers. The proactive removal of this material is something that is a relatively new process due to previous bullet catcher material at ranges being so heavily contaminated that disposal was difficult. Removal of bullet catcher material is primarily driven by the need to maintain the ballistic safety of the bullet catcher, as opposed to managing build-up of contamination on the bullet catcher. The risk of lead exposure during this process comes when the facilities management contractor for the camp or base utilises a sub-contractor to remove the contaminated material. The risk comes from the airborne dust that is generated along with physically coming into contact with the contaminated material. A process is developed by the sub-contractor along with a job safety analysis [JSA] (an example was seen relating to material removal) that is then reviewed by DEI. The primary focus of this JSA (and that of DEI) is to protect the environment. There have been incidents reported during the walkthrough assessments around the removal of material from tube ranges where contaminated material has spread around localised areas of a camp and impacted other adjacent work areas. This suggests that DEI need to increase the control over this type of work. An approach would be for DEI to detail a general process that all contractors (or sub-contractors) must include into their own site-specific plan. The NZDF have a requirement to work with other PCBU's (and vice versa) to ensure that risk to health and safety is managed appropriately for all workers. DEI is currently reviewing the bullet catcher removal process in partnership with the W&RS Branch and the local sub-contractors at each camp and base.

*Armourers*

Armourers are a group across the NZDF who carry out a very similar role within each single service. The risk comes from handling weapons that may or may not be lead contaminated after firing. Typically, weapons are cleaned by the user and armourers will be repairing or maintaining weapons that have been cleaned. Swab indicator tests across the different armourer units visited had variable levels of presence indicated (some positive while others not). Armourers also use tube ranges, which are considered a high risk area but the comparatively low rate of fire and monthly use is considered to

lower the risk slightly. Further detailed investigation is necessary for this group but the risk, primarily based on observations during these walkthrough assessments, was not considered high.

The exposure to lead in the armoury (or through armoury functions such as cleaning weapons) by other NZDF personnel (e.g. soldiers etc) also needs to be assessed through the detailed investigation mentioned above. Cleaning of weapons occurs in a variety of locations and some may pose a greater risk of adding to the lead burden on the body (e.g. cleaning weapons within the barracks).

*DTA*

The Ballistics and Personal Protection team within DTA have assisted DMMG, DEI and others with looking at the health risks associated with lead but this is not their primary function.

As part of the project's that DTA undertake they regularly use indoor ranges for test firing weapon systems. This occurs on average about once every six weeks but they are in the process of building their own tube range at DTA in Devonport that will enable more regular testing and more time spent in a range.

At present there is no health-related policy about lead exposure and as the personnel are civilians, they are required to obtain blood tests for lead from their own GP. This is not currently carried out. With the introduction of the new tube range there will be a range standing order and DTA policy developed that will cover exposure to lead and the risks to health as a result.

The level of risk assigned is due to the common use of indoor ranges but further detailed assessment of the exposures in the new tube range to be built at DTA is necessary to refine this risk level and to help guide the policy and range standing orders.

*Parachute bay*

The issue with lead picked up in the parachute bay at Ohakea is relatively small in scale but the frequency at which the weighted bags are used poses the greatest risk through ingestion if good hand hygiene is not followed. This source of exposure can be better controlled by isolating the lead source from the worker through wrapping the lead shot in plastic. This can be something that happens immediately but in the meantime a process of thorough hand washing is needed.

**Low risks**

*Soldering*

The risk of inhalation or ingestion of lead when soldering is limited due to the high temperatures required to generate lead fume (400-500°C). Fume generated from soldering has other health risks associated with it not related to lead that need to be controlled. From the site walkthroughs there were many variations of a soldering bench with many appearing sufficient but some not. It is suggested that a standard approach across NZDF to controls around soldering is established and rolled out to manage the risks associated with these tasks. This should also include the regular change out of filters used in the fume collectors as this was a process that was lacking in some locations.

*Lead paint removal*

In general, the lead paint removed from buildings is carried out occasionally and, in most circumstances, it is maintained in a state that prevents exposure to people or the environment. Facilities management providers carry out (or sub-contract) any paint removal or maintenance work and this is a reactive process. As part of the DEI Contamination Management programme, DEI are currently identifying where lead paint is present on the exterior of residential and estate building stock. DEI is also conducting a separate study into the presence and potential risk posed by lead paint dust inside NZDF houses. The process around lead removal has not been seen or reviewed in any detail but this process should and can be done in a way to limit (or prevent) lead contamination of the environment (being external and internal of the building). It is recommended that DEI conducts a refreshed review of the Facilities Management processes for lead paint removal, and the process of identifying where in the NZDF residential building stock lead paint and lead paint dust exists continues.

*Lead in soils*

Lead in soils in the NZDF residential housing area is being investigated at present by DEI as very little information is available on historical contamination. Lead paint removal, and historic routine water blasting of properties, can add to soil contamination if not carried out with appropriate controls in place. There may be lead in soils within a limited zone around a building that contains, or previously contained, lead paint. If people are living in a home with lead–impacted soils, then this can be controlled or remediated as there are published guidelines that will limit the risk to health. No further steps are recommended other than to establish and expedite a process of obtaining soil lead values in those areas considered high risk or with a possibility of lead contamination. Further decisions can then be made from this information.

The Ministry of Health (*Ministry of Health, 2021*) identifies a few main points in lead hazard identification:

- *Lead contamination of soil around residential properties occurs mainly as a result of deterioration, damage or removal of exterior lead-based paintwork.*
- *The contribution of soil lead to total cumulative lead exposure is highly variable, depending on such things as the content and bioavailability of lead in the soil and the behaviour of people in the household, particularly children.*
- *The soil contaminant standards (SCS) in the National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health are based on people being routinely exposed to bare soil and consuming home-grown produce, where applicable.*
- *The SCS of 210 µg/g can be considered as a 'level of concern' for a residential setting and is recommended as a trigger for investigation.*

*Lead paint dust (residential)*

The Ministry of Health suggests that the US Environmental Protection Agency clearance levels can be use as a guide for whether lead is present at a level that is considered problematic. In December 2020 the USEPA reduced these levels to 110 µg/m$^2$ for floors and 1080 µg/m$^2$ for interior window sills.

The investigation into lead paint dust indoors by DEI was raised at a very late stage in the project but the Ministry of Health has published an excellent reference document for public health units that can and should be used by the NZDF to ensure that lead associated with paint is managed appropriately.

*Personal training vests*

Weighted vests are used in the personal training programme that are filled with lead shot. Swab tests show a presence of lead. The risk is considered low as they are worn infrequently and users will normally shower after wearing. Immediate controls can be considered which will involve placing the lead shot into plastic before being placed into the vests.

*Ship maintenance*

A Navy engineering contractor, Babcock, undertakes the maintenance of paint containing lead used on the hulls of Navy ships. Babcock has a process to control personal and environmental risks from lead but the walkthrough surveys did not check this process in any detail. NZDF should at least see this process and comment on it to Babcock directly if not seen as being sufficient or not being carried out in accordance with the operating procedure.

In addition to the contractor, Navy personnel were noted as occasionally having to undertake urgent paint repairs to ships. This occurred more regularly on the older ships (e.g. Canterbury) but much less frequently with the newer ships in service. The risk is considered low as this occurs infrequently and in small quantities.

*Historic buried fuel tank*

Further investigation is needed around this specific potential source of leaded fuel. Environmental contamination could occur if it is leaking which could lead to effects on people. Information has been obtained by the safety advisor through a military museum that tank historically used with leaded fuel.

*Metalwork shops*

Specific metal shop visited in Ohakea with indication that lead can used very occasionally but brass more commonly. Other parts of NZDF also have interaction with metal and commonly brass (e.g. Navy workshops). Brass contains a certain proportion of lead (typically 3-8%). Some more detail (initially through observations) needed as to the controls around metal fume in these types of workshops. If observations during the use of controls warrant it then possible exposure monitoring to take place to check the controls work as intended.

*Other areas*

All other areas not mentioned in detail within the discussion interact with lead containing material rarely so that further investigation is not warranted at this point. It is worth noting that regular reviews of all risks should be undertaken to ensure that any physical changes in the workplace or in process has not increased the risk.

## 6. RECOMMENDATIONS

The recommendations detailed in this section are ordered from most important to action through to a lower priority of required action. The recommendations detail the suggested steps of action and also the group that should instigate further investigation or the immediate action.

The following recommendation require immediate action to control exposures.

1. Place lead shot used within the parachute weight bags and personal training vests in plastic bags before being placed in the fabric covering for each item.

The action required is relatively simple but with a large impact on reducing the potential for lead exposure through ingestion. Once the lead shot in both the parachute weights and personal training vests are in plastic bags and replaced into their respective coverings a lead surface recheck needs to occur.

DASH should lead this action with support from the Unit leads at the areas in question (Personal Training in Woodbourne and Parachute Bay in Ohakea).

The following areas require further investigation through Occupational Hygiene exposure assessments. A suggested exposure assessment methodology is detailed further on in this section.

2. During firing at all ranges – indoor (UTF, BTF, tube ranges) and outdoor (short and long) plus vehicle mounted weapon firing (Waiouru). The initial focus of the exposure assessment should be on the RCO's and supporting personnel (where appropriate).
3. This will also need to include a review of actual hygiene practises at long ranges and during exercises. For example, do soldiers end up eating and drinking on ranges due to practicality. What impact does this have on exposure? Are there washing facilities available at ranges and are they used? This review needs to identify the constraints that occur on range or during an exercise and suggest practical solutions to help reduce exposure in the military training environment. It is expected that some quantification of exposure pre and post intervention (e.g. use of D-Lead wipes as a replacement for running water and soap) will occur to ascertain the interventions effectiveness.

The exposure assessments at the firing ranges needs to be led by the Directorate of Safety in order to keep an overarching view of the risks at the weapons ranges that are used across all three services; Army, Navy and Air Force. Expertise is likely to be needed to carry out these assessments and this could be sought from DASH, NAVOASH and Army Health and Safety if appropriate expertise is available. Once the assessments have determined the level of risk for personnel involved with range use the Directorate of Health needs to be involved so blood lead tests can be included in the continual monitoring of health. Blood tests should only occur once the risk level has been determined.

4. Ammunition destruction by DMMG – Waiouru, Kauri Point and Glen Tunnel. This also needs to include a review of actual practises during ammo burns (as with firing ranges) in comparison to what is required in the SOP. The sampling carried out will be used to confirm effectiveness of current practise at limiting the risk of exposure primarily through ingestion.

This assessment needs to be lead through DMMG with support from Directorate of Safety. DMMG primarily conduct the ammunition burns but there are also involvement in the burns from DEOS and CAI. Again, expertise will be needed for this assessment as it will require quantification of lead on surfaces and then linking that to possible ingestion (or inhalation) of the lead hazard.

5. Exposure assessments in the marker's gallery at long ranges and during raking of bullet catchers.

Some preliminary assessment of marker's gallery exposure to lead occurred in the past (*Corlett, N., 2016*) but more detailed personal exposure monitoring is necessary to be able to compare results to the Workplace Exposure Standard for lead (TWA – 0.05 mg/m$^3$). This should be led through the Directorate of Safety as this needs to be assessed and controlled (if required) across all NZDF ranges. The Land Worthiness Authority will potentially need involvement once the assessment has been completed in order to include new requirements into range standing orders (if necessary).

6. Quantify armourer's (and armoury function) exposure through surface swabbing and observations of process and practise around known or presumed sources of lead. In addition, collate all blood lead level test results to determine patterns (or lack thereof). This is to include the function of cleaning weapons by all NZDF personnel.

This needs to be led through both Directorates of Safety and Health as it requires review of health information and also observations and samples collected during armourers' normal tasks. Armourers across the NZDF carry out very similar roles so the exposure profile is likely to be very similar for small arms regardless of where they are located (Army, Navy or Air Force). Armourers who work with large munitions could have a different exposure profile and this should be explored in more detail through this process. In addition to the trained armourers, soldiers within the NZDF clean their own weapon and the risk posed by this needs to be assessed in some detail through this investigation.

The following areas need procedures produced to develop a minimum level of control. Once established this minimum level control needs to be implemented at all relevant sites and audited to ensure compliance with these procedures are occurring.

7. Develop a procedure (or minimum level requirements) for bullet catcher material removal. Distribute to contractors and sub-contractors as part of their agreement.
8. Develop and implement a SOP for a soldering station set up across the whole of NZDF (Directorate of Safety implemented) where a well-designed system is used as a reference point (e.g. Ohakea Avionics). This requires the collation of current soldering station set up, an SOP and time and resource to implement changes to those that require it.
9. Facilities Management providers must provide SOPs for lead paint maintenance and removal. These SOPs need to be reviewed by DEI with the review requiring the same (or similar) level of control requirement regardless of location within the NZDF. A standardised approach to lead paint maintenance and removal is needed NZDF wide.

For the bullet catcher material and lead paint maintenance or removal DEI need to lead this implementation as they are an overarching department within NZDF that can standardise the control approach. The standardisation of soldering stations should be lead by Directorate of Safety with involvement from the single service health and safety branches.

The following recommendations require further more detailed on-site reviews by NZDF to ascertain the current procedures used to control health risk from lead. This further detailed assessment may require exposure assessments but initially more detail is needed.

10. Review Babcock's procedure around lead paint removal and observe to ascertain effectiveness. NAVOSH should lead this detailed review.
11. Investigate the state of the buried historic fuel tank at Woodbourne. This needs investigation by DEI.
12. Undertake a process review for metalwork shops across NZDF that deal with brass or lead. All metalwork shops need to be identified across all single services with controls detailed and observed. Once the detail has been obtained the detail will inform further actions across NZDF or on a site-by-site basis. Directorate of Safety should collate this information through the single service health and safety teams who can be on the ground and visiting these workshops.
13. For all current work on lead in building paint, lead dust in buildings and in soils around buildings the process of investigation by DEI needs to continue. This should with a view to complete a database of information. The information in the database needs to be reviewed based on risk, which will include activities that interact with lead containing material. Actions to control exposure need to be applied accordingly.

### Method for exposure assessments

In order to monitor the health of workers (as required by HSWA) around exposure to lead the most direct method is to measure blood lead levels and compare to the WES BEI of 20 µg/dL. However, as discussed in Section 3 the interpretation of lead levels in blood can be difficult if there have been long term or historic lead exposures as it will be released over time from storage in bones. Blood lead is the most widely understood metric in terms of effects on the body but lead in blood is only applicable to exposures in the previous few months so even though time of the day of the test is not critical the timing of the test after an activity of interest is an important consideration. Blood tests are an invasive process so this needs to be considered before deciding if it is to be used as a regular approach to monitoring health. A single annual blood test looking for lead exposure may not be sufficient to understand the risk to health.

Alternatively, where airborne lead is present (e.g. firing weapons at ranges) monitoring in air can be used as an indicator to quantify risk before blood testing. There is a calculated link between lead in air and lead in blood and is described as an air slope factor (ASF). Safe Work Australia published 'Review of hazards and health effects of inorganic lead – implications for WHS regulatory policy' in July 2014 that details the process followed to determine the ASF factor, which is the contribution of lead in air to blood lead levels. At 0.05 mg/m$^3$ of lead in inhalable dust (the NZ WES-TWA value) the ASF factor has been calculated at 0.42. This equates to a blood lead level of 21 µg/dL (just slightly above the lead NZ WES-BEI). The reference publication does state there are uncertainties in calculating the ASF value plus the implication of historical lead exposures and individual variability in blood lead levels when exposed to the same levels of lead. This is not an absolute calculation and should be used as an indication only. Exposure monitoring for lead through analysis in an inhalable dust sample can be used as an indicator of lead exposure from airborne lead (produced from firing weapons) and whether it can be reasonably

expected that current lead exposures are being controlled to minimise health effects (Note: control, through removal, of airborne lead can only really occur within indoor range facilities). This approach is also supported by the fact that about half of lead reaching the respiratory tract is absorbed in the body (*O'Flaherty 1993 in National Academy of Sciences, NRC, 2012*).

Swabs can be used to quantify the amount of lead on a surface and will generally be used to determine the amount deposited before and after an activity known or suspected to comprise of lead. For example, before and after a period on the range firing a weapon or before and after the cleaning of a weapon. The results should be looked at relative to each other rather than comparing to a guideline value as there are very few available and not necessarily applicable to a workplace setting. Ingestion of lead has a low uptake in the body with less than 10% absorbed through the digestive tract (*O'Flaherty 1993 in National Academy of Sciences, NRC, 2012*). This means that with good workplace hygiene practises it is possible to manage the health risks to lead from the transmission pathway of hand to mouth.

The following provides a suggested approach to sampling at those high-risk areas where Occupational Hygiene assessments are recommended to occur.

| Location(s) | Type of sampling | Number of samples | Notes |
|---|---|---|---|
| All ranges – during firing of weapons<br>(Start with sampling around instructors where many personnel use a range. Some coverage of tube ranges should also occur) | Air sampling - personal | 3x instructors<br>3x students/range users | All ranges should be covered as each location may vary based on design and/or weather conditions. Sampling should be repeated at least once to increase variability and hence reliability of data.<br>Swabbing to occur before and after a meal break especially at ranges where people are far away from facilities (e.g. West Melton, Waiouru). |
| | Swab sampling of hands and clothing | Same people as air sampling. 3x swabs at minimum – before, during and after. | |
| Markers gallery – at each long range | Air sampling - personal | 3-6x personnel per range depending on time spent in area. More people in area = more samples | Airborne lead possible from impact of lead bullet. |
| | Swab sampling of hands and clothing | Same people as air sampling. 3x swabs at minimum – before, during and after. | |
| Raking bullet catchers – samples from all ranges | Swab sampling of hands and clothing | Before raking, immediately after raking and then after cleaning hands. | Bullet catcher material can be dusty hence monitoring to confirm whether lead is a risk. |
| | Air sampling - personal | 2x personnel involved | |
| Armourers<br>(and armoury functions) | Swab sampling of hands and clothing | Before and after tasks during the day where lead could be present. Incorporate swabs around hygiene practises to determine if this reduces lead levels. | Interventions could be introduced to improve hygiene practises. Swabs to check. |
| Ammunition destruction | Swab sampling of hands, clothing and vehicle | Swabs to cover the two people typically involved in emptying ash and shells from incinerator. | Approach will be to ensure that hygiene procedures are working to limit the possible ingestion of lead. |

The addition of blood tests could occur if air sampling results obtained indicate elevated levels (geometric mean of the dataset above 0.03 mg/m$^3$, being just over 50% of the WES-TWA) or if large

quantities are found through swabs. This will help to confirm the link between lead (airborne and on surfaces) in the workplace and levels in the body. Focusing blood tests on those groups with elevated airborne or surface levels will also provide information on whether health if being impacted.

The process described above needs to be supervised and/or undertaken by an Occupational Hygienist or someone with suitable experienced in exposure monitoring.

## 7. OPPORTUNITIES

The following are areas of positive current practise that need to be expanded or utilised across the NZDF. The individual situations were seen to carried out to a high standard and are recommended to be explored further.

- Review and utilise useful parts of the Lockheed Martin tube range plans. The operation of Lockheed Martin tube range in Trentham was seen to be run very well. Any differences in on the ground procedure or process between this tube range and NZDF tube ranges could be investigated. Improvements upon this further investigation could then be rolled out NZDF wide.
- Utilise current DASH framework of having an embedded Occupational Hygienist. This could be utilised within each health and safety arm of each single service (Army H&S and NAVOSH). Alternatively, have Occupational Hygienists and/or Occupational Hygiene Technicians available that can be used NZDF wide. Support would be needed to implement training and employment of more personnel. DASH have a process that this could be based around. Establishing this capability will ensure NZDF can monitor the health of workers as required by HSWA.
- Use DASH Occupational Health SOP for health monitoring for lead exposure across NZDF (DASH OH SOP-10, Version 1). Train relevant people in its use to risk assess those people who need a blood test when this arises in reaction to a situation. Embed this process in the units that need it most so that it can be used proactively and not just referred to reactively. This is a tool that can be used to manage risk as required by HSWA.
- Presence of D-Lead soap appeared commonly throughout NZDF ranges and armoury units. Use was discussed generally and range standing orders all include requirement to wash hands before eating or drinking. This product can, and should, be established as a common tool to decontaminate in all situations. Testing (through swabs) can be used to determine how well it removes heavy metals from hands etc. in order to validate its widespread use. This product has a variety of options, including wipes, that can used in locations where running water is not available as a method to decontaminate before eating, drinking, driving vehicles etc.
- Utilise non-invasive techniques (air testing and swab testing) to refine risk assessments. This will be a training opportunity for DASH Occupational Hygienists (Force Health Protection Officers) in training, Occupational Nurses (NZDF wide) and any other Health and Safety personnel that are looking for practical experience around exposure monitoring.
- As mentioned in the discussion above, provide a standard approach to soldering benches across the NZDF. If there is soldering happening, then the LEV set up should all be the same

(or very similar). Utilise a system that works well and roll this out across the NZDF. The Avionics units at Ohakea and Whenuapai were observed as having appropriate set ups that could be utilised across NZDF. There were many variations seen and some would not be sufficient to control exposures. This needs further investigation first and consideration is needed on the frequency of soldering.

- Provide general education awareness and training across the NZDF around lead. Initially focus on those areas where lead is a high and moderate risk. Some people had a good understanding and can share their knowledge but many people spoken with had very little knowledge on the presence of lead, why lead is an important hazard to control and how they can control it.

## 8. CONSTRAINTS

Contrary to the opportunities available to grow wider capabilities within the NZDF around the hazard of lead there were also constraints observed that will impact on the ability of the NZDF to satisfy its obligations under HSWA.

There is a lack of access to expertise to enable a robust and complete assessment of risk to hazards, including lead, present in the NZDF. In relation to lead, there is very limited monitoring of health currently to determine whether current controls and practises will prevent illness. This is traditionally done through blood tests but there has not been the detailed oversight on lead to determine who should get a blood test or why they should get a blood test. The current DASH SOP for health monitoring for lead exposure goes some way to closing this out but this is used by a small group of personnel and is a reactive process that requires an incident to occur or someone to come forward or be nominated. This does not satisfy the HSWA which requires risk to be managed to prevent illness in the first place. The limited processes in place are designed at reacting to a situation that may have already caused a health effect.

The role of an Occupational Hygienist is to anticipate, recognise, evaluate, communicate and control environmental stressors in, or arising from, the workplace that may result in injury, illness, impairment, or affect the wellbeing or workers. This function was not observed to be happening during the walkthrough assessment on the camps and bases plus during conversation with health and safety representatives. The anticipation and recognition are the two vital initial pieces of work that separates out the role that an Occupational Hygienist fills over a H&S representative, occupational nurse or occupational physician.

This report goes some way in anticipating and recognising the lead risks across NZDF but further detailed work is needed. At present the NZDF do not have this internal capability.

Dr Ian R Gardner Pty Ltd presented a review of Occupational health in NZDF in November 2016 and highlighted many of the same gaps that we have seen through this more focused project.

The Directorate of Health (DoH) and Directorate of Safety (DoS) generate policy at a strategic level that focuses on areas of health and safety that HSWA requires. However, there are parts of the DoS order and instructions that relate to protecting hazards in the workplace that impact on the health of workers yet these refer to managing safety throughout. The DoH orders and instructions cover ensuring

that personnel are fit and able to do their work but not necessarily the explicit proactive assessment of exposures with the view to control risk. The single service health and safety units; DASH, NAVOSH, Army Health and Safety, all utilise these policies and put them into practise. There is a further layer and that comes at the tactical level, or those on the ground actioning the policies and instructions. These people are the ones that see the hazards on a day-to-day basis but were not seen to have the expertise, skills or authority to address health risk that can be complex and require detail investigation.

As identified by Dr Gardner in his report and discussed during the walkthrough assessments as part of this project, there is a lack of health support for civilian staff that are often in an environment that have lead exposure risks. The military health services do not provide blood tests to civilian staff as a way to monitor health around lead exposure and they have to approach their own GP for this function. There might be some variation to this across the NZDF but in essence the blood test is currently a function used to monitor the health of workers required under HSWA. This process of accessing blood tests needs to be made more robust and accessible for civilian staff. If they are not undertaking this health surveillance due to it being too difficult to access owing to the requirement to self-manage then this is a failing on behalf of NZDF. Routine blood tests may still continue to some extent but the exposure assessment detailed in Section 6 will hopefully provide data in a way that takes the personal responsibility of blood tests away from civilian staff.

In conversations with DEI they are in the process of employing their own H&S team that will be spread across the camps and bases. Although this is arguably a vital function to have within the team, they need the appropriate expertise (or the ability to call on the expertise) within them, much the same as the other health and safety groups within NZDF. The H&S team within DEI also have a responsibility to integrate and communicate with DASH, NAVOSH and Army Health and Safety as there will no doubt be crossover during some activities.

## 9. CONCLUSION

This project for the NZDF had the following objectives:

- Identify processes within NZDF that involve lead
- Provide an indicative exposure risk for processes that involve lead
- Identify a priority for action
- Provide a methodology for lead exposure assessment
- Discuss current mitigation opportunities

The sections within this report discuss each of the above points in some detail with the end result being that there are identified areas within NZDF that are considered to be at high risk of exposure to lead. This is based on the initial walkthrough assessments carried out and supported by information provided by NZDF and publicly accessible literature research.

Until proven otherwise, through exposure monitoring, the areas of high risk are ammunition destruction and all weapons ranges (all type and variety). There are further moderate risk areas that are not considered as higher priority but still needing further detailed assessment or immediate action. These

include, the Parachute Bay (immediate action and follow up), bullet catcher material management, the armourers, and Defence Technology Agency (through use of tube ranges).

At present the information seen to assess the health risk to lead collected by NZDF is limited and undertaken sporadically. There is no systematic approach to lead exposure and so the NZDF is failing to carry out its function under HSWA to monitor the health of NZDF personnel. Blood lead testing that is carried out does not appear to occur in a way that focuses on the highest potential risk areas (being ranges). There are valuable procedures within the NZDF (DASH lead risk assessment SOP) but these need to be used in a more proactive way.

The priorities for action are generally split into three sections and are detailed in Section 6 of this report. The management of lead shot in weighted bags used in the parachute bay at Ohakea plus lead shot used within personal training vests are a relatively easy and immediate action that needs to take place. The other actions are grouped into detailed exposure assessments and further detailed desktop review of task or process.

An approach for priority lead exposure assessments has been detailed within Section 6. This outlines an approach to workplace monitoring around the identified high and moderate risk areas. This monitoring needs to be undertaken by an Occupational Hygienist or someone suitably qualified and experienced. The intent of monitoring is to provide quantitative detail to support the risk assessments so they can be refined and adjusted accordingly. It is envisioned that the required monitoring will be a long-term project with regular re-assessment of risk once more data becomes available.

Finally, there are opportunities within the NZDF that can be expanded upon to help the NZDF in its management of risk around lead exposure. Certain areas of the NZDF have tools or processes that can be used throughout the NZDF if a unified approach to managing risk is taken. NZDF also have constraints that will slow the progress towards managing the risk around lead and this primarily comes back to the current lack of availability of technical knowledge within NZDF that is primarily focused on occupational health risks.

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# APPENDICES

## APPENDIX A: QUESTIONNAIRE

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Auckland, New Zealand / W: airmatters.co.nz

26/03/2021

**Baseline Lead Questionnaire – Base/Camp Unit level, NZDF.**

Air Matters has been contracted to conduct a full scoping of all potentially hazardous areas, processes and practises across New Zealand Defence Force in relation to lead exposure.

As a part of this assessment the initial step is to gather information across the different levels of the organisation to understand the detail on health and safety management but also to understand the particular possible lead sources.

| | | | |
|---|---|---|---|
| Unit Name | | | |
| Physical location | (Physical loc(s) to which this questionnaire refers) | | |
| POC | Name: | Rank: | Appointment: |
| Contact details | Internal Phone: | Mobile: | Email: |

The questions prepared below are specifically designed for Unit level response.

*Please add more lines if your answer requires it.*

1. **Lead hazard identification (specific to lead)**

   1.1. When do you identify the lead hazard in the work you carry out?

   1.2. How do you identify the lead hazard?

   1.3. What lead hazards have you currently identified?

   This could be in the form of a risk register but please highlight where lead is identified as a hazard.

1.4. More specifically could you please identify whether any of the following sources are present, and if so, where the work is carried out (location and unit/department):

1.4.1. Lead acid battery production or disposal

| | | |
|---|---|---|
| Yes | No | Location: |
| | | Comment: |

1.4.2. Lead acid battery recycling

| | | |
|---|---|---|
| Yes | No | Location: |
| | | Comment: |

1.4.3. Lead foundry work

| | | |
|---|---|---|
| Yes | No | Location: |
| | | Comment: |

1.4.4. Chemical use with lead as a component

| | | |
|---|---|---|
| Yes | No | Location: |
| | | Comment: |

1.4.5. Lead smelting or refining

| | | |
|---|---|---|
| Yes | No | Location: |
| | | Comment: |

1.4.6. Work with leaded glass

| | | |
|---|---|---|
| Yes | No | Location: |
| | | Comment: |

1.4.7. Work with lead containing paints (painting or removal)

| | | |
|---|---|---|
| Yes | No | Location:<br>Comment: |

1.4.8. Vehicle radiator repairs

| | | |
|---|---|---|
| Yes | No | Location:<br>Comment: |

1.4.9. Use of leaded fuels

| | | |
|---|---|---|
| Yes | No | Location:<br>Comment: |

1.4.10. Indoor firing ranges

| | | |
|---|---|---|
| Yes | No | Location:<br>Comment: |

1.4.11. Maintenance work on ship, bridges and houses containing lead paint

| | | |
|---|---|---|
| Yes | No | Location:<br>Comment: |

1.4.12. Excavation of rock/soil containing lead

| | | |
|---|---|---|
| Yes | No | Location:<br>Comment: |

1.4.13. Welding and grinding work (primarily leaded steel)

| | | |
|---|---|---|
| Yes | No | Location:<br>Comment: |

1.4.14. Soldering work

| | | |
|---|---|---|
| Yes | No | Location:<br>Comment: |

1.4.15. Machining brass, bronze, lead-plated metal or leaded alloys

| | | |
|---|---|---|
| Yes | No | Location:<br>Comment: |

1.4.16. Plumbing work

| | | |
|---|---|---|
| Yes | No | Location:<br>Comment: |

1.4.17. Building (or other structure) demolition

| | | |
|---|---|---|
| Yes | No | Location:<br>Comment: |

1.4.18. Remediation of any lead contaminated material

| | | |
|---|---|---|
| Yes | No | Location:<br>Comment: |

1.4.19. Handling lead flashings

| | | |
|---|---|---|
| Yes | No | Location:<br>Comment: |

2. **What groups of workers do you have that may have a greater exposure to lead (to your knowledge)**

2.1.1. Firefighters and fire investigators

| | | |
|---|---|---|
| Yes | No | Location: |
| | | Comment: |

2.1.2. Ammo Techs

| | | |
|---|---|---|
| Yes | No | Location: |
| | | Comment: |

2.1.3. Armourers

| | | |
|---|---|---|
| Yes | No | Location: |
| | | Comment: |

2.1.4. Others (Who may through the course of their duty be exposed to one or multiple lead sources)

| | | |
|---|---|---|
| Yes | No | Location: |
| | | Comment: |

3. **Risk assessments (general questions around process)**

3.1. Who would carry out a risk assessment for lead exposure for the specific unit/base/camp?

3.2. When is the risk assessment carried out?

3.3. What risk assessment technique is commonly used? (refer Section 3.1.7 of DFI 0.71)

3.4. How is it determined which technique is the most applicable? (refer Section 3.1.7 of DFI 0.71)

4. **Controls/Treatments**

4.1. What controls or treatments do you currently have for identified lead hazards?

4.2. How are appropriate controls and treatments determined? Who is responsible?

4.3. Who is responsible for determining the appropriate treatment/control and checking that it works as intended?

4.4. What is the process to change a treatment of a hazard (being temporary) into a control?

5. **Training**

5.1. What is covered in staff training around health effects associated with lead?

5.2. How and what is covered in training (or SOPs) around the use of PPE for lead hazards?

6. **Health and Safety Audits**

6.1. What are the basic steps involved in a Health and Safety audit?

6.2. Do audits cover checks of the management of individual hazards?

6.3. Are checking controls covered in audits? If yes, what specifics are you checking for?

6.4. How often do audits take place?

7. Finally, can you please tell me in your own words what you understand the difference to be between health-related hazards and safety related hazards?

We appreciate your help in answering these questions.

Nick Browne (MNZOHS)

Rob Murray (MNZOHS)

## APPENDIX B: RISK ASSESSMENTS AND MATRICES

The following list explains how controls were generally assessed with effectiveness decreasing from level A through to D. (Source: *Firth, I. et. al., 2020*)

Controls

A – Control measures dependent on adequate maintenance (of plant/equipment/parts) to be effective

B - Control measures dependent on activation of a device to be effective.

C – Control measures dependent on correct work practises and supervision to be effective.

D – Control measures dependent on correct wearing of personal protective equipment.

| Location/ Unit/Group | Existing controls (A, B, C, D) | Controls effective? Y/N | Frequency of exposure (how often in day/week?) | Duration of exposure (hours at a time?) | Estimated or measured exposure level (swab result) | Consequence rating | Likelihood rating | Notes |
|---|---|---|---|---|---|---|---|---|
| Armourers (same trade across all three services) | Nil – lead not identified by RNZAF as being a risk. Same with all bases visited (Ohakea, Woodbourne and Whenuapai). Army considers armourers to be more at risk from lead but primarily from tube range use. Annual blood tests for armourers.<br><br>Exposure will be from handling of weapons after firing inc. cleaning and servicing. Some firing as a check that weapons work after repair/servicing. | Admin controls mainly with some PPE used such as gloves. D-Lead soap used at most locations visited. Actual use of PPE and hand washing process being followed is variable. | Likely to be daily but considered regular exposure nonetheless. However, there is a low throughput of work in general. | Few hours at a time (low throughput of work most of the time) | Lead present on a few benches that were swabbed. Lead present at ranges where personnel go to test fire. | Severe | Possible | The tasks undertaken are:<br>• Presence on range to supervise gun cleaning.<br>• Gun servicing<br>• Gun cleaning (user primarily cleans)<br>• Handling unused ammo<br>• Sorting brass for disposal<br>• Reload unused ammo into boxes (no gloves)<br>(Above points are RNZAF only)<br>• Washing of hands standard practise before meal breaks<br>• Army use tube ranges to test weapons (lead swab indicate presence)<br>• Burnham have PPE requirements for tube range. |

| Location/ Unit/Group | Existing controls (A, B, C, D) | Controls effective? Y/N | Frequency of exposure (how often in day/week?) | Duration of exposure (hours at a time?) | Estimated or measured exposure level (swab result) | Consequence rating | Likelihood rating | Notes |
|---|---|---|---|---|---|---|---|---|
| 25m range (Whenuapai) | Designated clean area and firing areas.<br><br>C – main control is to follow range standing order which has a health and hygiene section within it.<br><br>Admin procedures around washing before eating. | Very little info to say that controls are effective. Blood lead tests are not routine so unsure if admin procedures are followed/working. No air monitoring seen for RNZAF ranges but may be around from past when OH were on staff.<br><br>Follow up with Jeff (OHN) | SECFOR are high users (refer separate RA)<br><br>RNZAF staff typically annual.<br><br>Navy will occasionally book range out for use but bring own RCO and supervisors. | Several hours use at a time. Dependent on class size.<br><br>Typically, one group will be on range for several hours (approx. 2-3hrs) | Positive at range firing area.<br><br>Negative on prep/rest area.<br><br>Positive on cleaning benches at back. | Severe | Likely (SECFOR & Navy SCS)<br><br>Rare (Most Navy and RNZAF personnel) | Exposure of concern from firing of weapons and the fume that is generated from barrel. (Trentham RSO has some good info on this.)<br><br>Standard bullet round (5.56 round) used on range (same with other ranges in NZDF).<br><br>Pistols can produce more fume from firing due to the shorter barrel. Confirmed through swab tests by Paragon.<br><br>Other exposures come from raking down the bullet catcher and collecting brass. The raking is done by the trainees and normally two people are involved. They are required to wear a respirator and gloves while doing this job. Collecting brass is also another exposure source and wearing gloves is suggested in RSO (for Whenuapai).<br><br>Airforce ranges are on base and typically have a basin facility within them for washing. Length of time on range is short enough that meal breaks are not needed.<br><br>Burnham (Aylesbury) short range had portaloo set up but no hand washing facilities.<br><br>West Melton (long range) has accommodation block with hand |
| 25m ranges (Woodbourne & Ohakea) | C – main control is to follow range standing order which has a health and hygiene section within it.<br><br>Admin procedures around washing before eating. | No routine blood tests for range users or SECFOR who are the RCO for RNZAF ranges.<br><br>Swab monitoring from Navy range shows lead on hands/clothing. | | | Positive tests generally across the three RNZAF ranges with some variation | | | |

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| 25m ranges (Army camps) | C – range standing orders | No routine blood testing. Ad hoc sampling at best. No indication from anyone that results indicate a problem but unsure of detail around process.<br><br>Info from NZDF as a whole indicate that lead is present at ranges. Unsure if at levels that are considered problematic or if controls are working to limit intake | One week in every two months at range.<br><br>Exercises are quarterly for ~2 weeks. | Actual firing is around 2 hours duration total in a day. (This is an estimate only and taken anecdotally from conversations)<br><br>Other exposure could come from other activities e.g. smoke grenades, raking, cleaning, spending time around contaminated surfaces/areas | Positive at some locations on army ranges. | Severe | Unlikely for most infantry if use for one week every two months if typical.<br><br>Likely for those you use ranges more regularly such as RCO | washing facilities but ranges are a long distance from the ranges and practise areas.<br><br>Army typically take pack lunches and have available near ranges during breaks. Aylesbury range – soldiers eating a snack behind 25m range between time on range with no visible cleaning of hands before doing so.<br><br>For long ranges:<br>• Machine gun use, which anecdotally produces a significant amount of fume and especially during sustained fire.<br>• Variable exercises on range including walking forward through fume in close quarter (CQB) training scenarios.<br>• Record is kept of all ammunition used on ranges<br>• "Butts area" located around targets produced positive lead result in Waiouru (not tested at Burnham) |
| Long ranges (West Melton & Waiouru) | C – range standing orders | | | | Positive at 300m point at West Melton.<br><br>Positive in target area - Waiouru | | | |

| Location/ Unit/Group | Existing controls (A, B, C, D) | Controls effective? Y/N | Frequency of exposure (how often in day/week?) | Duration of exposure (hours at a time?) | Estimated or measured exposure level (swab result) | Consequence rating | Likelihood rating | Notes |
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| Large munitions –<br><br>LAVs cannon<br><br>Artillery<br><br>Navy (5 inch) deck guns | Munitions are encased so limited exposure during handling prior to firing.<br><br>Often auto loaded.<br><br>Very limited controls seen for lead.<br><br>Navy use anti-static whites when firing guns | n/a | Cleaning is regular process but only after use of weapons.<br><br>Training occurs regularly. | Multiple hours at at a time (in general) | SDS generally confirm that lead styphnate present in the rounds used (blanks and live).<br><br>Lead swab on 105 cannon (artillery) = positive.<br><br>Previous assessments on LAV and artillery show that lead present around personnel operating them. | Severe (highest rating) | Possible<br><br>(lower likelihood versus using other weapons is the infrequent use in comparison) | The 105mm charge uses a thin lead foil sheet sewn into one of the bags to chemically remove copper that is deposited on the gun barrel when a round is fired.<br><br>Navy did not believe that 5 inch ammunition contained lead but could not be certain.<br><br>In comparison to a rifle or pistol these weapons are fired much less frequently but the amount of fume produced per charge is significantly more.<br><br>These weapons are fired in the outdoors which encourages the fume to move away from the personnel around them.<br><br>Personnel exposure could be high over a short period (during training exercises) due to personnel extended periods around the weapons. |

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| DTA -<br><br>Use ranges for testing. | Use other ranges e.g. ESR and BTF and soon to be their own range.<br><br>A – relay on ventilation system and to a lesser extent health and hygiene components of RSO.<br><br>Remote fire most of the time so that they are about 2m away from the weapon. (lowers exposure) | Assumed Y<br><br>Ranges not seen (except BTF) | Every 6 weeks there is typically range time.<br><br>This may increase in frequency when DTA get their own range at end of 2021. | Typically, 6-8 hours on a range. And time on a range is for a period of one week. (can on occasion be longer) | Present due to indoor ranges being the primary location.<br><br>Outdoor ranges used at times but spot checks show these will have lead deposits too. | Severe | Possible | Requirement to clean up after tests.<br><br>Handle lead bullets in ballistics gel.<br><br>Highly variable munitions handled.<br><br>Normally low rate of fire but some occasions it can be high.<br><br>Can be on a range supervising a shoot if that is part of testing regime.<br><br>There is no DTA policy on lead exposure assessment related to health.<br><br>With their own range DTA will develop there own policy around lead exposure.<br><br>As civilians it is difficult to get blood tests done. Cannot use camp/base health services. Info held with personal doctor not occupational nurse (or other). The onus is on the individual to get a blood test and recoup the costs. |

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| DE&I - Remediation of range catchers and stop butts.<br><br>Work by contractors/ Subcontractors. | The sub-contractor doing the remediation work details a plan with job risk assessment (JSEA) that DEI look at. The plans that were seen (very minimal examples) had JSEA but the detail within them was minimal.<br><br>DEI primarily focus on the environment but also now (at June 2021) are employing 9 H&S officers into the group to oversee some of the detail. | No feedback from sub-contractor. Mention from DEI that sub-contractors are required to feedback on BLL but privacy a concern so don't.<br><br>No air monitoring known to occur. | Remediation of ranges occurs infrequently but this is being tightened up so that the material is not so contaminated that it cannot be disposed of.<br><br>More than annually but maybe less than every 10 years. | Multiple days | Present (assumed due to the high level of contamination known in the stop butt/bullet catcher material.) | Severe | Unlikely<br><br>Not constant exposure. Project based and infrequently and carried out with controls | All range stop butts/catchers are changed out by a specialised sub-contractor.<br><br>BTF cleaning is contractor run.<br><br>H&S Officers are now being employed to help with those aspects of the contractors and sub-contractors plans that environmentally focused staff can remove themselves from.<br><br>Contractor staff are in scope of project but sub-contractor likely not. Predominantly contractor staff that do the remediation work.<br><br>PAE down to Ohakea and then Spotless for remainder of country.<br><br>FM contractor will sub-contract out specialist work like range remediation. |

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| DE&I - Remediation of houses with lead paint.<br><br>Work by contractors/ subcontractors | C – process driven<br><br>The sub-contractor doing the remediation work details a plan with job risk assessment (JSEA) that DEI look at. The plans that were seen (very minimal examples) had JSEA but the detail within them was minimal.<br><br>DEI primarily focus on the environment but also now (at June 2021) are employing 9 H&S officers into the group to oversee some of the detail. | No feedback from sub-contractor. Mention from DEI that sub-contractors are required feedback on BLL but privacy a concern so don't.<br><br>No air monitoring known to occur. | Healthy homes programme involves removing lead from buildings.<br><br>Typically, inter-tenancy so disruption to tenants minimum.<br><br>Will only reactively remove lead paint if it is an issue that is triggered by maintenance.<br><br>Overall frequency very low. | Possible multi day job for one house/building. | Present<br><br>(Assumed to be there for houses of certain age) | Severe | Unlikely<br><br>(due to infrequency of work) | Lead paint only remcved/maintained inter-tenancy and maintenance driven at present. Contractors (or maybe sub-contractors) do this work. |

| Location/ Unit/Group | Existing controls (A, B, C, D) | Controls effective? Y/N | Frequency of exposure (how often in day/week?) | Duration of exposure (hours at a time?) | Estimated or measured exposure level (swab result) | Consequence rating | Likelihood rating | Notes |
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| DE&I - Remediation of NZDF estate with lead paint.<br><br>Work by contractors/ subcontractors | C – process driven<br><br>Contractor removing lead prepares a plan with controls that is reviewed by DE&I. | Some JSEA examples seen.<br><br>Environmental heavy focus. | Will only reactively remove lead paint if it is an issue that is triggered by maintenance.<br><br>Overall frequency very low. | Few working shifts per building | Present in buildings of a certain age (unlikely that any lead paint removal has been carried out) | Severe | Unlikely<br><br>(due to infrequency of work) | Process around lead paint removal has not been reviewed. |
| DE&I – Lead presence in soil | Current work is to identify what locations have lead present.<br><br>Unknown controls as not discussed. | n/a | Project based when being remediated.<br><br>Potentially daily to weekly for residential houses. | For remediation – several working days per site.<br><br>For residents – hours at a time. | Unknown.<br><br>Potential exposure for remediation comes from ingestion and possibly inhalation for dry material that becomes airborne.<br><br>Residents could possibly ingest if in soil and relevant activities carried out (e.g., gardening) | Severe | Rare | The likelihood is unlikely to change even when exposure level can be quantified.<br><br>Limited possibility for workers due to process driven task with controls.<br><br>Limited possibility for residents primarily due to small area where contamination could be present, small group of activities that will pose a risk, limited routes of exposure and low frequency of any possible exposure. |

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| Ohakea – Parachute Bay (lead shot used within weighted bags) | None seen | n/a | Used very regularly during each day | Frequent picking up and placing bag – only few seconds at a time (periodic) | Swab showed presence of lead | Severe | Possible | Control of this hazard discussed immediately once identified and action was discussed to occur immediately.<br>Solution was to place lead shot in plastic bags to limit the oxidised lead being able to be released. |
| BTF cleaning (DEI) | D – primarily PPE used to protect staff (normally contractors) | Uncertain | Monthly clean of 30/50m range.<br><br>Quarterly and Annual cleans also and deeper cleans | Multiple hours (~4hrs) at present | Present<br><br>Extensive surface sampling carried out by DEI but report still to be seen as to the quantify of lead. | Severe | Likely | Specfic maintenance document with schedule of detail of what needs to be done. |

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| Ammunition destruction - Glen Tunnel<br><br>(Also at Kauri Point but not part of surveys) | SOP for the ammunition destruction (not seen). Requires use of certain PPE to protect personnel involved. | No – gaps evident in process during visits.<br><br>No disposable overalls, limited cleaning facilities available, high potential to track contaminants away from work areas | Twice per year. The ammo burns take place each day across a working week | Assumed to be exposed for a full day (8hrs) for each of the two weeks destruction carried out. | Present – Confirmed through visual observations of lead and previous monitoring of process by RNZAF Occupational Hygienist. | Severe | Likely | The exposure to lead occurs primarily during the clean up of burnt ammunition from the destructor. This is a dirty process that has a high chance of passing to the personnel involved via inhalation and ingestion.<br>Previous sampling by RNZAF showed that inhalation potential was low but ingestion was likely due to high levels present.<br><br>Periodic contact but at very high concentrations. New destructor requires more frequent handling of burnt ammo due to capacity. |

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| CAI – part of Trentham squad<br><br>4 staff | Use purpose built incinerator<br><br>Use respirators, overalls and gloves when handling material.<br><br>Showers, handwashing, laundry at the EPF (Explosive Processing Facility). Lead specific detergent used | Yes | When collecting ammo, tip into containers rather than scoop out with hands. Can use gloves<br><br>Burn over a week period and 11 weeks per year (ACS). No longer use old burner at Waiouru | 11 weeks<br><br>Also work with DMMG on disposals | BLL random and not common. Different system for civilians and NZDF | Severe | Likely | Collect ammo, flare, fireworks from police and other public sources. Transport to Waiouru, repack, store and dispose<br><br>ACS for 9mm and 5.56mm<br><br>Good procedure around the use of the ACS. Possible exposure when waste is removed and handled post destruction. |

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| DMMG (Part of E Squadron in Trentham)<br><br>16 staff. All staff do demo except the 2 civilians in the group<br><br>Storage of ammo, repair (not in Waiouru) and disposal | Distance from disposal site – 1.7km.<br><br>Cross wind from disposal site<br><br>Gloves if picking up shrapnel<br><br>Wash hands before eating and drinkng | Yes | 8-10 detonations per year (max 1 tonne)<br><br>Takes a few days to prepare and then up to 6 detonations a day.<br><br>After detonation the RCO and Safety Officer clear pits. Generally no shrapnel removed by hand, sometimes additional detonation required (Rare) | Takes a number of days but detonation very quick | Exposure from plume and from working in contaminated soils | Severe | Possible<br><br>(BLL done on all DMMG staff annually. Two elevated levels but supposedly not related to work.) | Detonation done in Zone 1. DEI has done soil sampling in the area.<br><br>Engineer plant support to cover pits once cleared. |

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| BTF | A – ventilation system that has been checked and confirmed as appropriate | Likely Yes but limited info to confirm this | More frequently than weekly for SAS.<br><br>Much less for other users | Full day at a time | Present – confirmed through extensive sampling by DE&I | Severe | Likely | Firing of weapons indoors poses the greatest potential risk to health (based on literature).<br><br>Robust systems in place at BTF but very limited processes in place to determine that the systems are limiting the effect on health.<br><br>No regular blood tests seen nor exposure monitoring from a health point of view. |
| UTF | Range standing orders (C)<br><br>Detailed information not seen | Unknown | Unknown | Hours at a time | Likely present but uncertain | Severe | Likely | Primarily blanks used in facility but blanks have been confirmed as containing lead styphnate via SDS.<br><br>The unknown at this facility plus the possible risk due to it being semi-indoors means that the likelihood (and hence risk) needs to be high unless proven otherwise. |

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| Tube ranges (all) | A – ventilation present in all<br><br>Ventilation systems are present in each tube range designed to take fume away from firing position.<br><br>Range standing orders for each.<br><br>Burnham has requirement to wear additional PPE (coverall, gloves etc) | Possible<br><br>No evidence seen to be certain | Regularly – around monthly | Multiple hours at a time | Present – swabs in some tube ranges had positive result | Severe | Likely | Much less frequent use of the range versus other types of ranges.<br><br>Considered and indoor range with known increased risk potential.<br><br>Lack of detailed information from these types of facilities.<br><br>Variable processes around controls at each tube range visited.<br><br>Robust systems seen at Lockheed Martin tube range at Trentham. |

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| Battery bays (NZDF wide) | No specific controls | n/a | Batteries handled daily but no reconditioning or interaction with internals.<br><br>Terminals (lead) brushed and replaced but very occasional | Less than hour | Not determined | Severe | Rare | Storage and charging area on camps and bases for lead acid batteries.<br><br>Old batteries that no longer work are kept in these areas for disposal through a contractor who comes to site or are taken off site by a designated person. |

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| Woodbourne (historic underground fuel tank) | None seen | n/a | No known exposure as unused | n/a | Uncertain | Severe | Rare | Research undertaken by base H&S showed that leaded fuel was historically stored in tank.<br><br>Tank is in an unknown condition and may be an environmental contamination risk.<br><br>Worker exposure not likely but unknown nature of tank provides doubt. |

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| Firefighters (primarily RNZAF but NZDF wide) | PPE worn (breathing apparatus etc.) | not assessed | Very sporadic and unknown due to the unknown nature of the environments that firefighters enter | Variable | Not determined | Severe | Rare | The likelihood of NZDF firefighters having exposure to lead is very low due to the low frequency of call outs in general and also the low chance that a call will involve an environment that will contain lead.<br><br>Firefighters do not know what the specific exposures are before they respond. They protect themselves generally and this will apply to lead. |

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| Ground support (e.g. vehicle workshops) | No controls seen or discussed.<br><br>Hand washing was generally known when dealing with lead but uncertain whether followed | Unsure | Approximately weekly | Less than an hour | Lead present in weights | Severe | Unlikely | Lead exposure comes from handling lead wheel weights and soldering in some vehicle workshops by the mechanics.<br><br>Mechanics at Linton are required to remove weapons from the LAVs. |

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| Metalwork shops – brass and lead plate<br><br>(NZDF wide but seen/discussed at Ohakea and Devonport) | Some local exhaust ventilation used | Not assessed | Irregular (not typical daily tasks) | Up to a few hours in a day | Likely present | Severe | Unlikely | The common metal handled that poses a possible lead risk is brass. Brass contains a certain proportion of lead but typically low (<10%).<br><br>Assessment of controls (e.g. extraction) needed to determine that they are effective and used properly. |

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| Woodbourne (Personal Training) | n/a | n/a | Occasional (monthly or greater) | Hours at a time | Lead detected on outside of weighted personal training vests | Severe | Unlikely | PT vests are used in fitness training to replicate the weight and style of vests worn by personnel.<br><br>All personnel shower after training.<br><br>Exposure can be managed by placing lead shot, used as weight, in plastic bags inside the vest. |

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| Babcock Engineering (contractor for ship maintenance) | SOP for lead paint removal of paint from ships in dry dock (most significant lead exposure risk) | Likely to detail unknown | Occasional (during large servicing projects which are years apart) | Multiple days | Highly likely to be present | Severe | Low | Processes exist to control lead paint exposure both to their own workers, adjacent workers and the environment.<br><br>If these are followed then exposure should be managed and low but there is uncertainty about how well this is carried out.<br><br>The infrequent nature of this work, detailed control systems and the lack of heavy involvement of NZDF personnel means that the health risk is considered low. |

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| Surface and Safety (RNZAF) | Airline breathing for when painting in booth | Not assessed | Annually (if at all) | No exposure likely due to PPE worn | n/a | Severe | Rare | Surface and safety do not deal with any lead containing paint in their normal work. Occasionally an old plane is stripped and/or repainted in the paint bay and these aircraft may have lead paint based. |

| Location/ Unit/Group | | Existing controls (A, B, C, D) | Controls effective? | Frequency | Duration | Estimated exposure | Consequence | Likelihood | Notes |
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| SME Trade Training Wing | Plumbers | None | N/A | Variable | Variable | Unknown | Severe | Low | Dealing with lead flashing, lead nails, galvanised spouting soldering. Most of the training is carried out at Wellington Tech. Hazards and PPE explained during block course training.<br>Also spend time out with trades working on commercial and residential work. |
| | Carpentry | Risk assessments carried out which will include lead<br>Half face masks and fit testing | Yes | Variable | Variable | Unknown | Severe | Low | Dealing with lead based paint , lead flashin on roofs, counter weights in sashes.<br>DEI have register of asbestos and soil contamination.<br>Spotless are more likely to carryout basic maintenance work and they have procedures for working with lead. |

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| Navy (in discussion with NAVOSH) | Range and small arms | Follow range standing orders and general requirement of the range (e.g. washing of hands, no eating or drinking on range etc.) | Not able to be confirmed | Annually for weapon qualification (Navy generally)<br><br>SCS trade use ranges much more frequently (similar to RNZAF SECFOR) | Typically, most of the day will be spent at the range with a few hours spent firing (at minimum) | Not determined | Severe | Rare for annual quals.<br><br>Likely for SCS trade | No regular blood tests for Navy personnel (confirmed through Navy Health).<br><br>50 cal. Machine guns are fired at sea during training exercises.<br><br>Boarding practise at sea requires Navy personnel to carry arms but either unloaded or with blanks. |
| | Naval supply depot (batteries) | - | - | - | - | - | Severe | Rare | Handle lead acid batteries but are disposed of via a contractor.<br>No recycling or refurbishment of batteries. |
| | Fleet Engineering (Weapons Technicians) | Flash proof cotton clothing worn when handling 5-inch gun muritions | Not determined | Operational training determined.<br><br>In peace time (being most of the time) the operations do not involve weaponry. | Hours to day depending on operational practise tempo. | Assumed to be present on barrel of guns | Severe | Possible | During operational practise the tempo slowly ramps up and when it is high there is much more interaction with munitions.<br><br>Cleaning of large deck guns (5 inch cannons) do occur and is a possible source of exposure. |

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| Navy (in discussion with NAVOSH) | Trade training school | LEV used. Barrier creams encouraged (soldering). Washing and hands after work. | Not determined | Infrequent with lead | Few hours at a time when it does happen | Unknown | Severe | Rare | Soldering practise on lead free solder.<br><br>Welding/grinding not on leaded metals.<br><br>Naval brass (3-8% lead) sometimes handled and used. |
| | Operational vessels | - | - | Occasional around electronic repairs whilst at sea | <hour | - | Severe | Rare | No lead based solder wire indicated as being used but based on other Defence Force services lead is very common in solder. |
| | Divers | - | - | Limited information able to be obtained but further information needed initially on whether the ordinance used has a lead containing substance within it and then the likelihood of exposure can be estimated. | | | Severe | Rare | Explosive ordinance composition unlikely to contain lead but limited detailed info provided. |