Before a Decision-Making Committee
Of the Environmental Protection Authority

APP203660

Under	the Hazardous Substances and New Organisms Act 1996
In the matter of	the modified reassessment of methyl bromide
By	**Stakeholders in Methyl Bromide Reduction Inc** Applicant

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STATEMENT OF EVIDENCE OF JOHN WILLIAM ARMSTRONG

27 JULY 2020

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INTRODUCTION

1. My full name is John William Armstrong, and I am known as Jack Armstrong.

Qualifications and Experience

2. I am a biosecurity consultant and director of Quarantine Scientific Limited.

3. I completed B.A. (1969) and M.A. (1974) degrees in Biology from California State University at Fresno, and a PhD in Entomology from the University of Hawaii at Manoa in 1979.

4. I worked for the United States Department of Agriculture's Agricultural Research Service (ARS) for almost 40 years, and for most of that time I held the position of Research Entomologist. During the first decade, I worked on the development of treatments, including fumigants, to prevent damage caused by insects during storage. During the last three decades of my employment with ARS, I was responsible for the research and development of phytosanitary treatments, including fumigants, to facilitate the export of commodities through quarantine barriers both within the United States and to overseas markets. I developed numerous treatments that were approved by the USDA for commercial application on export products using a variety of technologies that included fumigation (e.g., methyl bromide treatments for use at low, ambient and high temperatures), heat or cold treatment, non-host status, and irradiation. I hold a US patent on the high-temperature forced-air quarantine treatment technology.

5. I retired from ARS in 2007 and moved to New Zealand, where I established Quarantine Scientific Ltd. In my role with that company I have provided advice to on phytosanitary treatments to private commercial enterprises, Crown Research Institutes, the Ministry for Primary Industries, the New Zealand forest product export industry and horticulture industry. I have also been involved in projects working with Plant and Food Research in the Pacific Islands funded by the Ministry of Foreign Affairs and Trade.

6. I have been the independant scientific adviser to the board of Stakeholders in Methyl Bromide Reduction Inc (**STIMBR**) since 2011. In that role, I have been involved with research into methyl bromide and alternative phytosanitary treatments, principally for export logs and other products.

7. I have authored or co-authored over 150 publications over my career including peer-reviewed scientific journal articles, a textbook on quarantine treatments, chapters in other quarantine treatment textbooks, client-funded research reports and scientific literature reviews.

Background

8. I have been engaged by STIMBR over the last ten years to prepare several reports. The reports that I have prepared, either individually or as part of a group of authors, that are of relevance to the reassessment of methyl bromide and have been provided to the EPA are:

   (a) JW Armstrong, DW Brash, A Hall, BC Waddell "Standardisation of Methyl Bromide use for New Zealand Log Exports" (November 2011).

   (b) JW Armstrong, DW Brash, BC Waddell "Comprehensive literature review of fumigants and disinfestation strategies, methods and techniques pertinent to potential use as quarantine treatments for New Zealand export logs (October 2014). This work was co-funded by STIMBR and the Ministry of Business, Innovation and Employment.

   (c) JW Armstrong "Review of proposed concepts and technologies to recapture and/or destroy residual methyl bromide (MB) after log fumigations at New Zealand ports" (September 2017, revised June 2019).

9. I assisted STIMBR in its response to the EPA's requests for further information, which were provided on or about 28 June 2019. My revisions to the paper referred to above at paragraph 8(c) were prepared as part of the response to that information request.

Scope of Evidence

10. This statement will cover:

    (a) The availability of alternative fumigant and non-fumigant treatments to methyl bromide for the phytosanitary treatment of export logs.

    (b) The possibility that methyl bromide treatment rates could be reduced while still providing an adequate phytosanitary treatment.

(c) The available technologies to recapture or destroy methyl bromide after a fumigation.

(d) Responses to points made by some submitters to this reassessment.

11. The reports that I have authored and have been submitted to the Decision-making Committee form a part of my evidence.

Code of Conduct

12. I understand this reassessment is to be determined by a Decision-making Committee of the Environmental Protection Authority. However, I have read the Code of Conduct for expert witnesses in the Environment Court Practice Note 2014 and I have complied with it when preparing this evidence. Other than when I state that I am relying on the advice of another person, this evidence is within my area of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

EXECUTIVE SUMMARY

13. My evidence in summary is:

(a) The best alternative fumigant to methyl bromide for the treatment of export logs is ethanedinitrile. There are some other potential chemical and non-chemical treatments but each of these has issues in terms of its efficacy and technological and economic feasibility.

(b) The methyl bromide concentrations required by New Zealand's trading partners for log fumigations could be reduced while still providing adequate quarantine security for the purposes of international trade. If New Zealand's trading partners accept the proposed lower methyl bromide treatment rates, then the amount of methyl bromide being released into the atmosphere would be significantly reduced.

(c) There are no commercially viable recapture technologies for use in large scale log fumigations that are capable of reaching the end concentration of 5ppm prescribed by current EPA controls. The only technologies that are feasible at a commercial scale are those developed by Genera. At the time I completed my report, the data indicated that Genera's technologies could recapture 80% of methyl bromide, but the data it has since provided indicate that its technologies can only reliably and consistently recapture a minimum of 30% efficiency for large log stacks (with higher efficiencies up to around 80% achievable in optimal conditions and for smaller log stacks). The other technologies, including some promoted by submitters to this reassessment, have not been demonstrated with adequate data as commercially feasible for large scale log stack and ship hold fumigations, and there are difficulties in scaleability of those technologies.

ALTERNATIVE FUMIGANT AND NON-FUMIGANT TREATMENTS FOR EXPORT LOGS

14. There are a number of potential alternatives to methyl bromide for the phytosanitary treatment of export logs and processed forest products. However, not many of these have potential, based on the current state of technology to replace methyl bromide as a phytosanitary treatment for logs on a commercial scale. In this section, I identify some of the alternatives, discuss how they could be used, and the difficulties with commercial application. The full details of the alternatives that I have assessed are set out in the review that I led in 2014.[1]

Ethanedinitrile

15. The best alternative that has been identified is ethanedinitrile (EDN), which is a fumigant.

16. STIMBR commissioned research to develop efficacy data for EDN using three forest insect species found in association with pine. The data from commercial-scale confirmatory tests showed that the treatment rate recommended by laboratory studies was an efficacious phytosanitary treatment.

17. STIMBR has also commissioned a techno-economic assessment of EDN, which confirmed that it was a viable alternative to methyl bromide and there are

[1] JW Armstrong, DW Brash, BC Waddell "Comprehensive literature review of fumigants and disinfestation strategies, methods and techniques pertinent to potential use as quarantine treatments for New Zealand export lots (October 2014).

no significant technical issues that would prevent its use as an alternative phytosanitary treatment for export logs. EDN log fumigations would be carried out in a similar manner to methyl bromide log fumigations.

18. These reports were presented to the Ministry of Primary Industries (MPI), and I understand MPI is attempting to obtain trading partner agreement to the use of EDN as a phytosanitary treatment for forest products. I also understand that the Australian government has approved the use of EDN as a phytosanitary treatment for sawn timber during the flight season *of the* hitchhiking insect*, Arhopalus ferus* (Burnt pine longhorn beetle).

19. There is currently an application before the EPA seeking approval to import and manufacture EDN in New Zealand. If EDN use is approved, then the use of methyl bromide could potentially fall to less than 10% of current levels (i.e. methyl bromide use would potentially continue only for limited biosecurity purposes such as for imported products with intercepted insects that must be fumigated).

Sulphuryl fluoride

20. Sulphuryl fluoride, a greenhouse gas, is another fumigant, and it is a distant second possible alternative to methyl bromide (after EDN). It is widely used in other countries as a fumigant, especially against termites. However, sulphuryl fluoride is not entirely effective against insect eggs, and it has been found to present both health and environmental risks. Additionally, uneconomical fumigation times would be required to provide quarantine security, and fumigation with sulfuryl fluoride is not accepted for forest pests by New Zealand’s largest trading partner, China.

Phosphine

21. Phosphine, a slow-acting fumigant requiring 240-hour fumigations of logs, is currently used to treat logs carried in the hold of ships bound for China. Phosphine cannot fully replace methyl bromide because it is not accepted by all trade partners (for instance, India) and it can only be used in ship-holds in transit due to the length of time required for effective fumigation. Despite these limitations, the use of phosphine on New Zealand log exports avoids the use of about 1900 tonnes of methyl bromide per annum.

Joule heating

22. Joule heating of logs involves passing electrical current through the log to be treated in order to heat it to a temperature that kills pests.

23. Joule heating as a possible phytosanitary treatment has been proven at the concept level by University of Canterbury scientists. There has since been further investment in research on the development of a pilot-scale Joule heating log treatment facility. However, Joule heating is not yet at a point where a decision can be made whether it is a viable commercial-scale treatment. It may be an effective solution in the medium to long-term.

Irradiation

24. Irradiation as a phytosanitary treatment involves exposing the product to electron beam, X-ray or gamma radiation in order to kill or reproductively sterilise insects. It is used in some countries as a phytosanitary treatment. The use of this technology for treating logs is not considered to be economically viable since irradiation treatment facilities would be needed at each port; more than one facility would probably be required to meet throughput needs; and gamma radiation from radioactive cobalt isotopes (that are unavailable in New Zealand) would be needed in order to generate sufficient radioactive intensity to rapidly treat export volumes of logs.

Debarking

25. Debarking involves using a machine capable of removing the bark from a log product before it is exported.

26. China permits the use of debarking as a risk reduction measure. Debarking is not an approved phytosanitary treatment. It has a higher associated risk of infestation, because insects can survive in any residual bark that remains after debarking. A percentage of residual bark is allowed in every shipment. If insects are intercepted then the trading partner would need to treat the product with methyl bromide, at the expense of the exporter, adding cost and use of the fumigant. Frequent interceptions could jeopardise the willingness of the trading partner to continue to accept debarked products.

Pest management systems

27. STIMBR has investigated options to reduce the use of methyl bromide by seeking to understand the life cycle of forest insects, quantify their population dynamics, and identify potential pest-free periods.

28. Research was undertaken to identify whether there are areas '*free from known pests*' or areas of '*low pest prevalence*' that could allow logs to be exported without fumigation. The research concluded that insects are flying over much of the year in most forest production regions, and there are no significant areas without insects or with low pest prevalence.

29. A separate research project investigated whether light traps could be used to reduce or eliminate the risk of *Arhopalus ferus* adult infestations of forest products during the flight season. The data did not support the use of the traps to reduce the risk of *A. ferus* adults being found as hitch hikers on processed forest products.

30. Overall, while investigations are ongoing into whether insect management approaches can avoid or reduce the need for phytosanitary treatments, there are a number of significant issues to be overcome which prevent an insect management approach being used as an alternative to methyl bromide fumigation.

REDUCED TREATMENT RATES FOR METHYL BROMIDE FUMIGATIONS

31. Research has shown that the current methyl bromide treatment rates for log fumigation can be reduced to 40 g/m^3 throughout the year and still maintain phytosanitary efficacy. This research includes a paper that I led in 2011,[2] and more recent papers that I contributed to.[3]

32. The proposed treatment rate of 40g/m^3 is significantly lower than the rates required by the Chinese Government, which are currently 80 and 120g/m^3, depending on the ambient temperature during fumigation. The rate is also

[2] JW Armstrong, D Brash, A Hall, BC Waddell "Standardisation of Methyl Bromide use for New Zealand Log Exports" (November 2011).

[3] AJ Najar-Rodriguez, MKD Hall, AR Adlam, S Afsar, K Esfandi, C Wilksa, E Noakes, GK Clare, A Barrington, K Richards, DW Brash "Developing a science-based quarantine treatment based on reduced methyl bromide concentrations to disinfest New Zealand *Pinus radiata* export logs" (2019, publication forthcoming in the Journal of Stored Products Research).

lower than the rates required by the Indian Government, which are 48 to 72g/m^3 again depending on the temperature during fumigation.

33. If the lower treatment rate was accepted by New Zealand's trading partners, it would result in a reduction of an estimated 235 tonnes of methyl bromide used annually in New Zealand.

RECAPTURE AND DESTRUCTION TECHNOLOGIES

34. Recapture and destruction technologies are applied after the commodity has been fumigated but before the fumigation enclosure is opened. The technologies are used to reduce the amount of methyl bromide present in the headspace of the fumigation enclosure prior to venting.

35. Possible methods to capture and/or destroy methyl bromide include using a liquid scrubbing material (such as sodium thiosulfate) that adsorbs the methyl bromide, removes it from the air, and reacts with it to convert it into other compounds.

36. Another method involves controlled extraction of the air from the headspace using fans to pass the air through an activated carbon bed, where the methyl bromide moleculres adsorb to the carbon bed. In some methods, methyl bromide can be recovered from the carbon bed for re-use in further fumigation cycles.

37. Regardless of the method, at the end of the recapture process, there will still be some methyl bromide in the headspace that must be ventilated to the atmosphere. But the amount of methyl bromide that will be emitted has been reduced.

38. A number of methyl bromide recapture and destruction technologies have been designed, and I have reviewed the operation and efficacy of these in my revised June 2019 report.

39. Most of the technologies have either not been developed for use outside of scientific laboratories, or have been developed for use only on small-scale commercial operations but without any demonstrated scaleability for large scale commercial operations (such as log stacks and ship holds). Some examples of the technologies that I have reviewed are:

(a) Electric arc plasma destruction systems, which involve the use of extremely high temperatures to thermally destroy toxic compounds . These systems are not commercially viable because they are too expensive, would occupy too large of a footprint in the port (where space is at a premium), and are not portable. STIMBR received a proposal from Dr VS Nair in relation to an electric arc system in April 2016. In response, STIMBR requested further information about the operating costs and whether the system could be operated as a compact and mobile system. Further information was not provided.

(b) Ozone is an oxidising compound that could potentially be used to react with methyl bromide as part of a recapture and destruction system. However, ozone is unstable and toxic. Ozone molecules bind rapidly with water such as the moisture content in logs, and ozone is highly reactive with base metals, such as copper wiring. Ozone is corrosive to fabrics and plastics, such as the plastic tarpaulins used for log fumigations. Because of the difficulty of handling ozone and its highly reactive nature, it is not a viable candidate.

(c) A cooling system could be deployed to chill the air in the fumigation enclosure to well below the boiling point of methyl bromide (4.4°C) and then condense liquid methyl bromide out of the air. Ecotool Systems has proposed to build a trial plant based on this theory. The concept may work in the laboratory. But no data have been produced to show that such a technology would work at the scale required to treat logs commercially. Scaling it up to commercial conditions would be challenging: it would be difficult (energy consuming and costly) to cool the large volume of air that is present in a log stack fumigation and then collect the methyl bromide that condenses from the air.

(d) Gas recompression could be used to recover methyl bromide by moving the atmosphere from the headspace at the end of fumigation through a chiller and compressor process to reliquify the gaseous methyl bromide. Aurecon and Biodesorb have carried out desktop studies of this option that indicated the concept was technically feasible. But no prototype has been produced to test its efficacy and commercial viability. If it were commercially viable it would require significant capital outlay and major modification of port structures and logistics to facilitate the removal of water from the air containing the methyl bromide. This would involve setting up "bogie" wheelsets holding activated carbon. These bogie wheelsets would move around the port between log stacks, where methyl bromide would be captured on the activated carbon, and a central extraction and compression hub, where the methyl bromide would be released and reliquified.

(e) Desclean Belgium have reported research on a methyl bromide recovery system that recaptures methyl bromide on a catalytic-activated microporous carbon. Its reports state that this technology can only recover up to 60% of methyl bromide when deployed as a mobile system. But the technology was not commercialised, and the business ceased operating.

(f) Value Recovery have developed a thiosulfate-based scrubbing solution, which is being used at a facility in California to recapture methyl bromide after the small scale fumigation of horticulture products. Value Recovery reports that its technology has a recapture efficiency of between 86 and 95 per cent. However, this system operates at around 1 per cent of the scale required for log stack fumigations at ports in New Zealand, and it has not been demonstrated as scaleable. Genera's report on this system is Appendix D to my revised June 2019 report.

(g) EnviroFume/Bletchley Ltd's system, which involves the use of a thiosulfate scrubber, was tested in April 2015. The results indicated that it did not effectively destroy methyl bromide.

(h) Nordiko has developed a system for recapture of methyl bromide onto activated carbon and subsequent destruction with a sodium thiosulfate scrubber. This system is used in New Zealand and Australia for small scale methyl bromide fumigations, such as shipping containers. However, as with the Value Recovery system, there is a lack of efficacy data for commercial use in log stack fumigations. Nordiko has not provided efficacy data to STIMBR, and has declined STIMBR's offer to fund the cost of verifying its system under commercial conditions. One issue with active carbon systems is that water vapour in the air will adsorb to the carbon in preference to methyl bromide, which means that a large water vapour removal system is required before the air reaches the activated carbon. This become a particular issue when scaling up as the volume of air increases.

(i) MeBrom has developed a thermal destruction system, where air containing methyl bromide is compressed and inserted into a combustion chamber, and the methyl bromide is destroyed at high pressure and temperatures. Genera tested this system after a fumigation of a stack of pine logs under tarpaulin. It reported that the system achieved a slight decline in methyl bromide concentrations after three hours, but the decline was not statistically significant. Genera suggested that the system needs to be scaled up by 50 to 100 times in order to conduct commercial scale recapture on log stacks. Of concern in relation to this technology is that it can emit hydrogen bromide and hydrobromic acid, which are themselves hazardous substances. Genera's report on this system is Appendix C to my 2019 revised report.

40. In summary, none of the technologies that I have just described has been demonstrated as commercially viable for large scale fumigation enclosures.

41. The only recapture methods that have been developed for use on a commercial scale for log stack fumigations are two systems owned by Genera.

42. The first is a liquid scrubbing system, the details of which are provided in Appendix F to my June 2019 revised report. Genera has indicated that its test results show that 70% recapture efficiency is achievable after 3 to 4 hours, but that achieving greater recapture efficiency would be difficult due to desorption of methyl bromide from the fumigated product and reduced efficiency when the sorptive and destructive materials are reused. I understand that Genera has recently advised STIMBR that:

(a) its technology is able to reliably recapture 30– 50% of the available methyl bromide remaining in the headspace prior to venting for large scale fumigations (volumes of logs greater than 1000 JAS);[4]

[4] "JAS" means "Japanese Agricultural Standard", and is an industry standard cubic metre measurement of log volume.

(b) the recapture efficiencies that can be achieved with its technology are around 50%–60% for medium sized log stacks (600–800 JAS of logs); and around 80% for small log stacks (200–400 JAS of logs); and

(c) any further improvements in recapture efficacy will be small.

This information has come to light after I prepared my June 2019 report.

43. The second of Genera's systems involves cooling the air in the enclosure after fumigation to remove moisture, and then capturing the methyl bromide on activated carbon. The methyl bromide is then released from the activated carbon by increasing temperature and/or decreasing pressure. The released methyl bromide can be re-used for a second fumigation. Genera reports that in preliminary testing on an "average sized log stack" the system captured 80% of the available methyl bromide in 1 to 2 hours.

44. While this technology is promising, there will likely be difficulties to overcome in developing this technology of the scale required for routine use with commercial scale log stacks. These include the potential for any hydrobromic acid that is formed to corrode the activated carbon. As well, Genera's report does not provide any information about the costs of operating its activated carbon system, which may be significant due to the need to cool and then reheat air.

45. Notably, neither of Genera's technologies can feasibly reduce methyl bromide concentrations under the tarpaulin prior to venting to below 5ppm.

46. Genera's reports that its technologies could achieve recapture of 80% of the methyl bromide in the headspace were the basis for STIMBR's application. However, as I have noted, Genera has more recently reported to STIMBR that it can achieve recapture in the region of 80% only in certain conditions (ie with optimal weather, temperature, humidity conditions, with fresh scrubber solution, and for smaller log stack sizes). Where there is a departure from those conditions, the achievable level of recapture is in the region of 30–50% for large log stacks. I understand that Genera will be providing further information to the reassessment about the operation and effectiveness of its technologies.

47. In my opinion, based on all of the recapture technology systems that I have evaluated, there is no effective way to recapture methyl bromide down to

concentrations below 5ppm (or levels close to that) in a time frame that is commercially viable for log stacks. The main difficulties are scaleability of any technology to handle large volumes of air, the costs of doing so, and the sorptive properties of the fumigated commodity.

48. Based on my comprehensive review of progress with recapture technologies over the past decade, I do not foresee a major improvement or step-change in available technology that will lead to a significant increase in the level of recapture that is able to be consistently achieved. If the recapture standard is to be re-set at a level that enables continued use of methyl bromide for quarantine and pre-shipment purposes for log stacks and ship holds, then in my view the level cannot be any higher than the best currently available technology from Genera is able to consistently achieve.

49. As to recapture for logs in ship holds, there are no recapture technology systems that have been demonstrated as effective for ship hold fumigations, and I have seen no indication in my reviews that such a technology will become available. The principal challenges are the volume of the ship hold, the large volume of logs stowed in the hold, the configuration required when stowing the logs, and the inability to actively agitate the air within the hold to speed the process of methyl bromide desorption. It would be aspirational to assume that these difficulties with recapture technology would be able to be overcome with a ten year extension to the recapture deadline for ship holds, and what is more likely in my view is that a ten year extension would allow time to implement an alternative treatment (such as EDN if its use is approved with workable controls).

50. I appreciate that in making any changes to the recapture standard, the DMC will need to consider the efficacy and feasibility of recapture technology for log fumigations alongside other matters, such as potential effects on human health. Such other matters are outside my area of expertise.

RESPONSES TO POINTS RAISED BY SUBMITTERS

51. In this section I respond to points raised by some submitters in their written submissions provided to the EPA.

Kevin Bartolo and EIM Research Pty Ltd

52. Mr Bartolo's submission is filed on behalf of EIM Research Pty Ltd. He states that EIM gas destruction technology is scaleable and can recapture methyl bromide down to concentrations below 200ppm. Mr Bartolo says that the EIM technology is the same as the MeBrom technology that I described above at paragraph 39(i)of this statement (see page 3, paragraph (d) of his submission).

53. As I explained above, the EIM/MeBrom system was tested by Genera. It was not effective to reduce methyl bromide concentrations to a statistically significant degree within three hours for a log stack fumigation. It would need to be scaled up significantly to have commercial feasibility.

54. Mr Bartolo claims that the EIM/MeBrom thermal decay technology can eliminate 99% of methyl bromide remaining after a fumigation. The data he relies on does not support this claim, or indicate that the technology is commercially scaleable for log stack fumigations. Pages 9 to 17 of his submission refers to eight tests that have been carried out on the EIM/MeBrom system:

(a) Test 1 was carried out on 10 May 2017. The technology was applied to 33m^3 of timber pallets after the product had been fumigated with methyl bromide at 32g/m^3 . This test is not comparable with a commercial fumigation of a log stack, which is typically 1000 m^3 and required to be fumigated with at least 48g/m^3 of methyl bromide (the lowest treatment rate currently accepted by the Indian Government). This test does not demonstrate that the technology is commercially feasible for log stack fumigations.

(b) Tests 2, 3, 4, 5 and 6 were for emissions of hydrogen bromide, carbon monoxide, dioxins and furans, and alkyl furans. These tests are not pertinent to the claim that 99% of methyl bromide was eliminated.

(c) Test 7 was a test for methyl bromide destruction, carried out on 33m^3 of pine pallets. The methyl bromide concentration to which the technology was applied was 20g/m^3, which is less than the concentration in the fumigation enclosure. As above, this is not comparable to a commercial fumigation of a log stack, which is much larger and has a higher initial concentration of methyl bromide.

The tests results also reveal that the destruction was not 99% effective; rather, the destruction reduced concentrations from 5000ppm to 160ppm and then "tailed off". Even though 5000ppm is not a useful comparator as a starting concentration, this test underscores how unrealistic a 5ppm standard is: even after a 96.8% reduction, the resultant 160ppm concentration is thirty-two times greater than 5ppm.

(d) Test 8 was for methyl bromide destruction in a wet atmosphere. No data are provided as to the moisture content of the product being fumigated or the humidity of the container. Again, the test was carried out on a very small quantity ($33m^3$) of pine pallets, on air with an initial methyl bromide concentration of $20g/m^3$. The concetration reduced from around 5000ppm to 95ppm and then tailed off, which is a less than 99% effective destruction of methyl bromide.

Mebrom NZ Ltd

55. MeBrom states in its submission that "there appears to be technology that is starting to realistically approach the full recovery in log stacks, and we feel that this will be commercially available in the next year or so ahead".

56. As noted above, the technology operated by MeBrom is the same or similar to that operated by EIM. Neither submitter has proven feasibility of the technology they are promoting to achieve "full recovery" or anything close to it required for methyl bromide fumigations of log stacks and ship holds.

Melanie Miller

57. Dr Miller states that STIMBR has "failed to exhaust all of the technical possibilities for recapture" and "viable alternatives".

58. I disagree. I am confident, given the significant reviews and inquiries I have undertaken on technologies available worldwide, that there are no technologies with the potential to achieve recapture to concentrations below 5ppm (or anything approaching that level) that are commercially feasible for large scale fumigations.

59. I have also reviewed possible alternative phytosanitary treatments. I am confident that there are no alternatives that are currently available for use on a commercial scale as a replacement for methyl bromide.

Stephen Scherrer and Lanxess Corporation

60. I agree with most of Mr Scherrer's submission (excepting his comments about EDN), but raise one point of clarification.

61. Mr Scherrer refers to a 1998 scientific paper that presented a model of methyl bromide concentrations over time. The model was an exponential decay curve, and it suggests that it would take a long time to reduce methyl bromide concentrations to 5ppm. It is important to understand that the 1998 paper that Mr Scherrer cites was a <u>mathematical</u> model of methyl bromide concentrations during the <u>ventilation</u> of a fumigation enclosure at a constant ventilation flow rate. The model was not based on measured data, and was not attempting to model the effects of recapture technology. Mr Scherrer comments that, according to the model, an 80% reduction was reached in 16 minutes but an additional 64 minutes was required to reach the 5ppm level. That comment must not be misinterpreted as reflecting the concentrations and timeframes that can be achieved in the real world using recapture technology.

CONCLUSIONS

62. In summary, the conclusions I have reached in my various reports for STIMBR over the last ten years are:

(a) The best alternative fumigant to methyl bromide for the treatment of export logs is ethanedinitrile.

(b) Other fumigants and non-chemical options have not been demonstrated as being technically feasible and/or commercially viable.

(c) The methyl bromide rates listed in the phytosanitary treatment schedules required by New Zealand's trading partners for log fumigations could be reduced while still providing adequate quarantine security for the purposes of international trade.

(d) There are no commercially viable recapture technologies for use in the log export industry that can reduce methyl bromide concentrations to 5ppm. Indeed, many of the technologies do not operate at the scale required for log stack and ship hold fumigations.

If the recapture standard is to be re-set at a level that enables continued use of methyl bromide for quarantine and pre-shipment purposes, then in my view the level cannot be any higher than the best currently available technology from Genera is able to consistently achieve.

(e) There is no known or foreseeable technology capable of achieving significant recapture from ship holds. If ship-hold fumigation with methyl bromide is to continue, more time is needed to develop new technology (which is aspirational), or transition to an alternative such as EDN.

JOHN WILLIAM ARMSTRONG
27 July 2020