PHOSPHINE AS AN ALTERNATIVE TO METHYL BROMIDE FOR THE FUMIGATION OF PINE LOGS AND SAWN TIMBER.

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The research programme was designed to provide data in support of phosphine for in-transit fumigation of export Pinus radiata pine logs from New Zealand. The programme delivered the following key outcomes:

- Efficacy data from laboratory exposures included Cerambycidae (*Prionoplus reticularis*), bark beetles (*Hylastes ater, Hylurgus ligniperda)* and dry wood termites (*Kalotermes brouni*) as well as adding to existing data on burnt pine beetle (*Arhopalus ferus*) eggs. The current specification of 200ppm for 10 days was shown to be effective in all life stages, data suggesting this specification could be lowered without compromising efficacy. Operational trials supported laboratory findings and extended the data to include several other insect species.

- Mortality thresholds for key risk insects were shown to be below the currently required 200ppm and data suggests fumigant concentration might be more important than exposure time in achieving 100% mortality. Data also suggests a high initial fumigant concentration could enhance efficacy.

- Depletion of fumigant in ships' holds during the voyage is almost certainly a result of adsorption by the logs. Depletion may not necessarily result in lower efficacy since it is a reflection of penetration of the fumigant into the wood, a desirable property for action against insects under the bark or in the wood.

- Detailed on-ship monitoring of in-hold phosphine concentration along with oxygen levels, RH, and temperature were consistent with earlier findings by a number of similar monitoring exercises. The single charge treatment of 2g/m³ declining to about 50ppm by day 11 while the top-up treatment (initial 2g/m³ plus 1.5g/m³ on day 5) remained above 200ppm. In chamber trials both treatments were found to be equally effective, with 100% mortality of all insects and life stages

- Application by direct generation of phosphine gas was shown to be an effective replacement for methyl bromide in the fumigation of sawn timber for surface infestations of hitchhiking Arhopalus beetles, an outcome which suggests much wider potential for phosphine use against surface pests of forest produce. Monitoring of fumigant dispersion through the timber stacks, and within plastic wrapped timber packets, showed phosphine to be a far more active disperser than methyl bromide, information also considered relevant to in-hold log fumigation.

- Monitoring is a key requirement of both research trials and operational fumigation. Simple, reliable, and cheap phosphine monitoring tools would be a considerable asset for both verification of treatment for quarantine

authorities and also for operational trial monitoring. A careful evaluation of both passive (e.g. detector tubes) and active (e.g. gas analysis) monitoring tools would be worthwhile, particularly if total dose rather than concentration/time were to be accepted as a treatment specification.

- Narcosis effect is considered unlikely to be an issue at the phosphine concentrations being used for logs and the ameliorating influence of bark and wood covering the target species. The high dose treatments undertaken in the present series of efficacy trials using drywood termite nymphs (Zhang and van Epenhuijsen 2005) tend to support this view with no decrease in mortality in those subjected to an initial 1200 ppm followed by 200 ppm compared with those subjected to a continuous 200 ppm.

Conclusion: The current specification of phosphine at 200ppm for 10 days was shown to be effective in all life stages for insects associated with P.Radiata, data suggested this specification could be lowered without compromising efficacy.