Risk Management Proposal:
Fresh mango (*Mangifera indica*) fruit from Viet Nam

FOR PUBLIC CONSULTATION

Date: 9 November 2011
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Purpose
The purpose of this document is to:
- Provide a summary of the risks associated with mango (*Mangifera indica*) for human consumption from Viet Nam
- Provide rationale and outline the preferred options for managing biosecurity risks
- Seek stakeholder feedback on the proposed management options and importing requirements

Background
The Government of Viet Nam’s Plant Quarantine Division, Plant Protection Department, Ministry of Agriculture and Rural Development, (MARD) has requested access to the New Zealand market for fresh mango fruit (*Mangifera indica*) for consumption. New Zealand does not have a trade history with Viet Nam and this pathway has the potential to introduce exotic pests and diseases. Therefore, an assessment is required to determine the appropriate risk mitigation measures.

Commodity description
Fresh *Mangifera indica* L. (Sapindales: Anacardiaceae) for human consumption is defined as commercially-produced mango fruits with skin, flesh and seed, with a small portion of stem attached but not including leaves.

Source information
The following assessment draws on the significant body of information that already exists for this commodity from Viet Nam and other countries. Existing Import Risk Analyses and other information were used to identify risk groups of organisms and the appropriate measures to mitigate their risk of introduction. The documents were:
- Existing Import Health Standards for mango from Australia, Cook Islands, Ecuador, Fiji, New Caledonia, Peru, Philippines, Thailand, Tonga, Taiwan, USA (California)
- Pest list jointly developed by Landcare Research and Viet Nam’s MARD and funded by NZAID
- A general literature and internet search
- DAFF (2008) Final Import Risk Analysis (IRA) for Fresh Mango Fruit from India

(The latter two import risk analyses were used for assessments of pests common to both India and Viet Nam)

Objective
The objective of the proposed measures is to effectively manage known biosecurity risks associated with the importation of mangoes (*Mangifera indica*) for human consumption from Viet Nam in a way that is consistent with New Zealand’s domestic legislation and
Risk Assessment

Identified risk organism groups

The pest list identified 27 organisms associated with Vietnamese mangoes as potential risk organisms (Appendix 2). MAF has categorised these risk organisms into three groups based on their association with the fruit. These groups were: internal arthropods (i.e. found feeding internally in fruit), external arthropods (i.e. found on the fruit surface) and fruit pathogens (Table 1).

<table>
<thead>
<tr>
<th>Risk Group</th>
<th>Characteristics</th>
<th>Example risk organisms</th>
</tr>
</thead>
</table>
| External arthropods| Mainly polyphagous; Mango is a known host; At least one life stage likely to be  | *Aulacaspis tuberculatus* (common mango scale)  
|                    | present on fruit at harvest; Relevant life stages may be mobile; and actively    | *Ceroplastes floridensis* (Florida wax scale)    
|                    | disperse or be sessile.                                                         | *Ceroplastes rubens* (pink wax scale)    
|                    |                                                                                 | *Chrysomphalus aonidum* (circular scale)     
|                    |                                                                                 | *Coccus viridis* (green scale)              
|                    |                                                                                 | *Ferrisia virgata* (guava mealybug)         |
| Internal arthropods| Adult or larvae feed within the fruit; Mango is a known host; Mangoes are used  | *Bactrocera* spp. (fruit flies)             |
|                    | by at least one life stage; Little capacity for active dispersal.              |                                                                                        |
| Fruit Pathogens    | Systemic infection of mango plants; Some infected fruits may be asymptomatic;   | *Pestalotiopsis mangiferae* (grey leaf spot of mango)  
|                    | Dispersal mainly through rain splash.                                          | [NB: No regulated bacterial or viral organisms were identified as risks]    |

Organisms were only identified as risk organisms and included on the regulated organism list for the commodity (Appendix 2) if they were:

1. present in Viet Nam, and
2. absent from New Zealand or under official control, and
3. likely to be present on the pathway if risk was unmitigated, and
4. known to be associated with fruit, and
5. their hosts included species present in New Zealand, and
6. if climatically they were able to establish in New Zealand, and/or
7. they are likely to cause high economic impact to New Zealand (e.g. fruit fly).

Internally feeding organisms were assessed as the highest risk requiring specific measures and included all species of *Bactrocera* (Diptera: Tephritidae). Any incursions of fruit fly could disrupt trade and potentially mean large economic losses for New Zealand exporters of fruit fly host material.

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1 The SPS agreement states that measures must not discriminate unfairly between countries or between imported and domestically produced goods. Where there is a choice of measures to reduce the risk to an acceptable level, WTO members must choose the one that restricts trade the least. Similar risks associated with trade must be managed consistently, even if the item comes from different countries (MAFBNZ 2009).
Risk Management

The following assessment of pre- and post-harvest practises reflects the current systems approach for risk management employed by Viet Nam for commercially produced mangoes. It is proposed that these practises combined with specific post-harvest treatment (such as vapour heat treatment or irradiation) and other MAF requirements (e.g. phytosanitary inspection) are used to manage the risks to New Zealand posed by regulated organisms associated with the importation of mangoes from Viet Nam.

Pre-Harvest Practises

The in-field pest management practises for the production of mangoes in Viet Nam are in brief:

- Annual flooding of orchards to kill fruit fly pupae;
- Pre-flowering pesticide treatments for arthropods and fungi above threshold levels;
- Post-flowering and fruit pesticide treatments above threshold levels for specific pests such as diamond back moth, cotton bollworm, thrips, red spiders and anthracnose and wefted/striped flower;
- Fruit bagging to reduce fruit fly infestation and anthracnose infection;
- Orchard hygiene which involves removal of fallen fruit under a Good Agricultural Practise (GAP) scheme administered by Provincial Governments;
- Specific fruit fly trapping programme to reduce and forecast pest prevalence;
- Specific fruit fly baiting programme to manage fruit fly post-bagging.

Post-Harvest Procedures

Mangoes are routinely graded and washed. The procedure is as follows:

1) De-sapping (quality step);
2) Washing with clean water and drying (likely to remove external arthropods);
3) Sorting/grading to remove damaged/overripe/infested/infected fruit. The grading process is likely to remove fruit showing obvious signs of fungal and bacterial disease;
4) Fruits are packed for disinfestation by vapour heat treatment (into perforated trays) or for irradiation in export cartons.

Visual Inspection

Visual inspection of fruit occurs at several points during the routine production and post-harvest pathway for Vietnamese mangoes. These include:

- In-field monitoring during the growing season
- Harvesting
- Post-washing sorting and grading
- Packaging fruit for treatment
- Packaging of fruit for export (if above differs from packaging for treatment)
- Visual phytosanitary inspection

A visual inspection at multiple points of the pathway provides opportunities to remove infested/infected fruit and is considered an appropriate risk management option for regulated organisms such as mealybugs and scale insects as they are easily detected on the surface of mango fruit (DAFF 2004).

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2 Fruit for export from Viet Nam to New Zealand must be produced commercially and have effective traceability systems at all stages of the export chain. This ensures that it is produced to the described standard practices to reduce the risk of pathogen infection and pest infestation, especially with respect to economically important species of fruit fly.
Treatment of arthropods

The current pre- and post-harvest procedures are aimed at reducing regulated organism load rather than removing all risk arthropods associated with mangoes from Viet Nam. Therefore, a treatment is necessary to mitigate residual risk, especially from internally feeding arthropods such as fruit fly. MARD has indicated a treatment preference for vapour heat treatment (VHT) or irradiation. Viet Nam exports vapour heat treated dragon fruit to Japan (Viet Nam Net/VNA, 2009) and irradiated dragon fruit to the USA and therefore has the process and quality systems established for these treatment types.

A description and efficacy data for VHT (fruit pulp temperature ≥ 46.5°C, held for ≥ 30 minutes) and irradiation (at 400 Gy absorbed energy) against arthropod groups has been discussed previously in the risk management proposal for mangoes from India http://www.biosecurity.govt.nz/biosec/consult/draft-ihs-mangoes-india.

Treatment with 150 Gy prevents adult fruit fly emergence from pupae (99.99% efficacy) (FAO 2009). Both treatment types are considered to be efficacious against specific target groups and are required by MAF for the importation of mangoes from other countries (MAF 1999) however, in the absence of specific efficacy data for the risk organisms or a comprehensive import risk analysis for mangoes from Viet Nam, the proposed treatment temperature/dosage requirements are higher than for existing pathways.

Phytosanitary Inspection and Certification by MARD

MAF requires a phytosanitary certificate issued by MARD to accompany mangoes exported from Viet Nam to New Zealand. Before a phytosanitary certificate is issued, MARD must conduct phytosanitary inspection to ensure that the number of packaged fruit is consistent with the number of disinfested fruits, traceability labelling is complete (including an official seal on the sides of packages), packaging is insect-proof and that all other importing country requirements have been met.

Where phytosanitary inspection occurs post-treatment (i.e. vapour heat treatment) the disinfestation facility is suspended from export, if live arthropods are detected on inspection, pending the results of an investigation.

Post-inspection Product Security

MAF requires methods to be implemented to ensure post-inspection product security include segregation of product, insect-proof packaging, insect screening of storage facilities, at least yearly pre-season insecticide treatment of storage facility, and secure loading and transport of fruit.

Verification inspection on arrival in New Zealand

MAF may inspect a sample taken from each lot on arrival in New Zealand to verify risk management actions undertaken were effective. The sampling procedure will be in accordance with section 4.4 of the MAF IHS 152-02. If a treatment has failed, or regulated organisms, extraneous plant material or trash are intercepted, one or more of the following actions will be undertaken: re-sorting of the consignment, treatment where an efficacious treatment is available, re-shipment or destruction of the consignment and/or the temporary suspension of the pathway on the detection of regulated organisms for which pre-export phytosanitary measures are required. The suspension will continue until the cause of the non-
compliance has been identified and corrective actions have been implemented and approved by MAF.

Note: Independent of the measures, phytosanitary sample inspection by MARD and verification inspection upon arrival in New Zealand by MAF will take place.

**Auditing**

MAF will monitor interceptions of hitchhikers and the appropriateness/effectiveness of phytosanitary measures on the commencement of trade. Currently, hitchhikers have their regulatory status classified on the MAF Biosecurity Organisms Register for Imported Commodities (BORIC) (http://www.maf.govt.nz/biosecurity/pests-diseases/registers-lists/boric/).
Summary of the mango export pathway from Viet Nam

EXPORT PATHWAY
The export pathway (Figure 1) was compiled from information sourced from MARD and actions required by MAF.

1. Vietnamese commercial mango growers manage pests by chemical and cultural strategies (such as fruit bagging) under a GAP scheme administered by Provincial Governments. The measures reduce the natural level of fruit flies and other arthropods of concern during mango production.

2. Packhouses (which may be part of treatment facilities) receive mangoes from export approved growers and lots are identified by orchard/production unit code/variety/date of harvest, for traceability.

3. Damaged and diseased fruit is removed and segregated from export fruit prior to undergoing post-harvest processing. Processing involves de-sapping of fruit followed by washing with clean water and drying. Damaged and blemished fruit are removed and labelled for disposal. Fruit suitable for export are graded according to size and weight.

Export quality mangoes are either packed into perforated trays for vapour heat treatment while maintaining traceability information;

OR

Export quality mangoes are packed into cartons for treatment by irradiation and export. Carton ventilation and handholds are taped to prevent infestation by contaminating pests. Cartons exhibit traceability labels and irradiation symbols e.g. Radura.

An officer, authorised by MARD (as the recognised National Plant Protection Organization, NPPO), samples and visually inspects all consignments and packaging for soil, animal or plant debris, arthropods and fruit pathogens prior to irradiation.

4. Mangoes are disinfested with saturated vapour at an approved VHT facility. The temperature of the treatment chamber is escalated up to 47.2°C and when the fruit pulp temperature reaches $\geq 46.5^\circ$ is held for $\geq 30$ minutes. Treatments are carried out under the supervision of a MARD authorised officer.
Individual fruits are packed into cartons for export. Carton ventilation and handholds are taped to prevent infestation by contaminating pests. Cartons exhibit traceability labels.

OR

Cartons are transported to an approved irradiation treatment facility in refrigerated trucks and unloaded in a secure docking facility to prevent reinestation of fruit. A MARD officer or approved person verifies traceability information on cartons. Mango cartons are treated at a minimum absorbed irradiation dose of 400 Gy using Cobalt 60. Regulated arthropod organisms (undetected during visual inspection) are killed or sterilised by irradiation treatment at a minimum absorbed dose of 400 Gy. Treatment is carried out under the supervision of, and verified by, an officer authorised by the NPPO.

5. Treated fruit is secured against post-treatment reinestation. A phytosanitary certificate is issued by MARD once all requirements are verified.

[NB: For VHTed consignments of mangoes this includes an officer, authorised by MARD (as the recognised National Plant Protection Organization, NPPO), sampling and visually inspecting consignments and packaging for soil, animal or plant debris and regulated organisms prior to export. Irradiated fruit is inspected prior to treatment (step 3)].

6. Certified fruit is loaded in refrigerated trucks for transport to the port of export. Export documents including the phytosanitary certificate, specifying treatment and additional declarations, accompanies each consignment that is either air or sea freighted.

7. Fruit and relevant export documents are examined in New Zealand by MAF biosecurity inspectors to ensure compliance with New Zealand’s phytosanitary requirements.

8. Any consignment not complying with New Zealand’s phytosanitary requirements is treated, re-shipped or destroyed. The exporting country is notified of the non-compliance.

9. Fruit receiving biosecurity clearance is able to be distributed by the importer.
Proposed Import Health Standard Requirements

Based on the evaluation of measures for the management of risk organism groups, the following specific requirements for mangoes (Commodity Sub-Class: Fresh Fruit/Vegetables) from Viet Nam are proposed:

NB: The following requirements are represented and expanded upon in the draft IHS:

Pre-shipment requirements

Only mangoes produced in accordance with the Official Assurance Programme (OAP) and IHS and certified on a phytosanitary certificate may be imported.

Phytosanitary measures

All mango fruit for export to New Zealand must be sourced from orchards that produce commercial mangoes under standard cultivation, pest-control, harvesting and packing activities. During harvest, infested, infected or damaged fruit must be discarded prior to treatment.

MAF requires a mandatory pre-export treatment for high risk regulated organisms, e.g., economically important fruit fly species. MAF currently approves vapour heat treatment at a fruit pulp temperature of $\geq 46.5\,^\circ C$ for $\geq 30$ minutes or irradiation at a minimum absorbed dose of 400 Gy as a treatment for regulated arthropod organisms associated with mangoes from Viet Nam.

The application of vapour heat treatment or irradiation must be in accordance with the OAP between the Viet Nam NPPO and MAF. In addition, the application of the irradiation treatment must be carried out in accordance with the International Standards for Phytosanitary Measures publication No.18 Guidelines for the use of irradiation as a phytosanitary measure.

Inspection of the consignment

MAF requires that the Viet Nam NPPO samples and visually inspects the consignment according to official procedures for all the regulated organisms specified by MAF and ensures that it conforms to New Zealand’s current import requirements. A phytosanitary certificate should not be issued if live regulated organism(s) are detected, unless the consignment is effectively treated, that is, irradiation treatment at 400 Gy.

If organisms are found which are not listed in the import health standard, the Viet Nam NPPO must establish their regulatory status. This information is available in MAF’s “Biosecurity Organisms Register for Imported Commodities” http://www.maf.govt.nz/biosecurity-animal-welfare/pests-diseases/boric.aspx

Transit requirements

The Viet Nam NPPO must ensure that the consignment (prior to export) is held in a manner to ensure that infestation or reinfestation does not occur following phytosanitary certification.

Documentation

Official Assurance Programme

Mangoes may only be imported into New Zealand from Viet Nam under the terms of the OAP agreed between New Zealand and Viet Nam.
Phytosanitary Certificate

A completed phytosanitary certificate issued by the Viet Nam NPPO must accompany all mango consignments exported to New Zealand.

Additional declarations to the phytosanitary certificate:

The mangoes in this consignment have:

for vapour heat treated fruit:

i. been visually inspected in accordance with appropriate official procedures and found free from regulated organisms.

OR

for irradiated fruit

ii. been visually inspected in accordance with appropriate official procedures and found free from regulated plant pathogens

AND

iii. been produced in accordance with terms of the Official Assurance Programme between MAF New Zealand and the Plant Quarantine Division, Ministry for Agriculture and Rural Development (MARD) of Viet Nam.

Note: The treatment type, temperature and duration or dose rate shall be specified in the treatment section of the phytosanitary certificate.
References


NPPO (1998) National Organization of Plant Protection (NPPO). *Pest list on mango.* [Based on surveys done by NIPP (National Institute for Plant Protection, now Plant Protection Research Institute); voucher specimens from surveys held at the institute in Hanoi.]


http://nlbif.eti.uva.nl/bis/diaspididae.php?selected=beschrijving&menunetry=soorten&id=169


### APPENDIX 1: Summary of Control Points for the Proposed VHT or Irradiation Mango Pathway

This summary identifies points, steps or procedures where control can be applied to prevent or minimise biosecurity risk to an acceptable level. Grey areas indicate critical control points that are required by MAF as part of the Official Assurance Programme (OAP) agreed with Viet Nam.

<table>
<thead>
<tr>
<th>Pathway Step</th>
<th>Description of Measures</th>
<th>Risk Group Targeted</th>
<th>Risk Management Outcomes</th>
<th>Monitoring procedures (who, what, when, how)</th>
<th>Verification procedures (i.e. objective evidence (who, what, other))</th>
<th>Related Documentation Standards/Agreements</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1 Production</strong></td>
<td><strong>In-field pest control</strong></td>
<td>Internal/external arthropods Fruit pathogens</td>
<td>Low infestation/ infection of harvested fruit</td>
<td>GAP scheme administered by provincial governments</td>
<td>• Provincial government verification procedures e.g. checks of grower records, spray diaries, grower training records etc.</td>
<td>• GAP standard • MARD grower export approval • Valid orchard registration/approval number</td>
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<tr>
<td></td>
<td><strong>Chemical and cultural pest management strategies used for the control of mango pests including fruit fly, Lepidoptera, thrips, aphids, fruit borers and fungal pathogens</strong></td>
<td><strong>Internal/external arthropods Fruit pathogens</strong></td>
<td><strong>Low infestation/ infection of harvested fruit</strong></td>
<td><strong>GAP scheme administered by provincial governments</strong></td>
<td><strong>• Provincial government verification procedures e.g. checks of grower records, spray diaries, grower training records etc.</strong></td>
<td><strong>• GAP standard • MARD grower export approval • Valid orchard registration/approval number</strong></td>
</tr>
<tr>
<td><strong>2 Harvest &amp; Transport to pack house</strong></td>
<td>Registered/export-approved growers transport fruit to export approved insect-proof pack houses</td>
<td>Low infested/ infected fruit from registered growers accepted by approved pack houses</td>
<td>Pack house staff check grower export registration/traceability information on arrival of fruit at pack house</td>
<td>• MARD verification procedures e.g. orchard and pack house export approvals</td>
<td>• MARD verification procedures e.g. checks of segregation of non-compliant fruit, washing and inspection records</td>
<td>• Register of growers/orchards eligible to export mangoes to NZ • MARD pack house export approval</td>
</tr>
<tr>
<td><strong>3 Pack House Processing</strong></td>
<td>Fruit sorted, washed, hot water dipped and graded</td>
<td>Internal and external arthropods Epiphytic fruit pathogens</td>
<td>Removal of visually detectable infested/infected fruit</td>
<td>Pack house staff remove infested/infected fruit by hand and clearly label for disposal</td>
<td>• MARD verification procedures e.g. checks of segregation of non-compliant fruit, washing and inspection records</td>
<td>• Documented pack house procedures</td>
</tr>
<tr>
<td></td>
<td><strong>De-sapped fruit washed with clean water; infested/infected fruit removed</strong></td>
<td><strong>Internal and external arthropods Epiphytic fruit pathogens</strong></td>
<td><strong>Removal of visually detectable infested/infected fruit</strong></td>
<td><strong>Pack house staff remove infested/infected fruit by hand and clearly label for disposal</strong></td>
<td><strong>• MARD verifies that traceability information accompanies fruit</strong></td>
<td><strong>• Documented pack house procedures • Export compliance programme/workplan</strong></td>
</tr>
<tr>
<td></td>
<td><strong>The traceability of fruit is maintained</strong></td>
<td></td>
<td><strong>Pack house staff only pack washed, sanitized and graded fruit into perforated trays for vapour heat treatment</strong></td>
<td><strong>Pack house staff only pack washed, sanitized and graded fruit into perforated trays for vapour heat treatment</strong></td>
<td><strong>• MARD verifies that traceability information accompanies fruit</strong></td>
<td><strong>• Documented pack house procedures • Export compliance programme/workplan</strong></td>
</tr>
<tr>
<td><strong>3 Fruit Packaging</strong></td>
<td><strong>Packaging for treatment</strong></td>
<td>Internal and external arthropods Fruit pathogens</td>
<td>Fruit is prepared for vapour heat treatment</td>
<td>Pack house staff only pack washed, sanitized and graded fruit into perforated trays for vapour heat treatment</td>
<td>• MARD verifies that traceability information accompanies fruit</td>
<td>• Documented pack house procedures • Export compliance programme/workplan</td>
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<td></td>
<td><strong>VHT treated mango</strong></td>
<td><strong>Internal and external arthropods Fruit pathogens</strong></td>
<td><strong>Fruit is prepared for vapour heat treatment</strong></td>
<td><strong>Pack house staff only pack washed, sanitized and graded fruit into perforated trays for vapour heat treatment</strong></td>
<td><strong>• MARD verifies that traceability information accompanies fruit</strong></td>
<td><strong>• Documented pack house procedures • Export compliance programme/workplan</strong></td>
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<td></td>
<td><strong>Only washed, sanitized and graded fruit is packed into clean perforated trays for VHT treatment</strong></td>
<td><strong>Fruit is secured against reinfection</strong></td>
<td><strong>Traceability information allows product to be traced back and traced forward</strong></td>
<td><strong>Pack house staff only pack washed, sanitized and graded fruit into insect-proofed cartons for irradiation</strong></td>
<td><strong>• MARD verifies that traceability information accompanies fruit</strong></td>
<td><strong>• Documented pack house procedures • Export compliance programme/workplan</strong></td>
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<td><strong>OR</strong></td>
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<td></td>
<td><strong>Irradiated mango</strong></td>
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<td></td>
<td><strong>Only washed, sanitized and graded fruit is packed into single layer export cartons. Carton ventilation and handholds are taped to prevent infestation by contaminating pests</strong></td>
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<td><strong>The traceability of fruit is maintained</strong></td>
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<tr>
<td>Pathway Step</td>
<td>Description of Measures</td>
<td>Risk Group Targeted</td>
<td>Risk Management Outcomes</td>
<td>Monitoring procedures (who, what, when, how)</td>
<td>Verification procedures i.e. objective evidence (who, what, other)</td>
<td>Related Documentation Standards/Agreements</td>
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<tr>
<td><strong>4 Vapour Heat Treatment</strong></td>
<td>Mangoes are treated at fruit pulp temperature ≥ 46.5°C for at least 30 minutes. Treated fruit is packed into clean cartons and ventilation and handholds are taped to prevent infestation by contaminating pests. Cartons show relevant, accurate traceability information i.e. production unit code number, packing house code number, date and lot number.</td>
<td>Internal and external arthropods [Re-infesting] internal and external arthropods</td>
<td>Internal and external arthropods, remaining after washing, are killed No reinfestation of packaged fruit can occur</td>
<td>Treatment is carried out under the supervision of, and verified by a MARD officer. Traceability information allows product to be traced back and traced forward.</td>
<td>▪ MARD confirm that the fruit pulp temperature probes are appropriately set and positioned. ▪ MARD confirm accuracy of thermometers prior to treatment ▪ Pre-season checks of VHT facility and equipment ▪ MAF conducts initial pre-export and periodic verification</td>
<td>▪ MARD and MAF approval for VHT facility ▪ MAF IHS^1 ▪ Documented treatment facility procedures ▪ Export compliance programme/workplan</td>
</tr>
</tbody>
</table>

**OR**

**4 Irradiation treatment**

Packaged mangoes are treated at a minimum absorbed dose of 400 Gy using Cobalt 60 gamma irradiation to kill or sterilize contaminating arthropods. | Internal and external arthropods | Internal and remaining external arthropods are sterilized or killed | Treatment is carried out under the supervision of, and verified by a MARD authorised officer. | ▪ Irradiated cartons are easily identified through traceability information and irradiation symbol ▪ Pre-season checks of maintenance/calibration (such as dosimetry systems, dose mapping) records of irradiation facility by MARD ▪ MARD check training records ▪ MAF conducts initial pre-export and periodic verification | ▪ MAF IHS^1 ▪ ISO/ASYM 51204 (2004) ▪ ISPM 18 and Good Irradiation Practice ▪ Documented treatment facility procedures ▪ Export compliance programme/workplan |

**5 Phytosanitary certification**

A visual phytosanitary inspection at the appropriate sample size verifies that the measures at the above critical control points have been applied resulting in the absence of live regulated organisms^2 on export fruit. NB: Irradiated fruit is visually inspected before treatment. | Internal, external arthropods and fruit pathogens | Fruit and packaging is free of detectable regulated organisms, traceability information is correct and cartons are pest-proof | ▪ MARD staff visually inspect fruit post-VHT treatment or pre-irradiation treatment for regulated pests ▪ MARD check traceability information prior to export ▪ MARD check all MAF phytosanitary requirements have been met ▪ MARD reject/resort/retreat if requirements are not met | ▪ MARD verify that all fruit has undergone above critical control point measures and that traceability information is correct ▪ MARD issue phytosanitary certificate as assurance that all MAF requirements have been met and additional declarations have been completed and verified ▪ MAF conducts initial pre-export and periodic verification | ▪ Export compliance programme/workplan ▪ MAF IHS ▪ MARD export phytosanitary certification procedures |

**5 Post-certification product security**

Treated fruit is secured against post-treatment reinfestation and mixing with untreated fruit. | [Re-infesting] Internal, external arthropods and fruit pathogens | No reinfestation/re-infection or substitution of treated product | Storage facility staff ensure that product is segregated from untreated product and secured | ▪ Consignment matches phytosanitary certificate ▪ MAF conducts initial pre-export and periodic verification | ▪ MAF IHS ▪ Export compliance programme/workplan |
<table>
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</tr>
</thead>
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<tr>
<td>6 Transport to NZ</td>
<td>Export fruit [† accompanying documentation] is air or sea freighted to New Zealand in sealed containers</td>
<td>[Re-infesting] internal and external arthropods and fruit pathogens</td>
<td>No reinfection, re-infection or substitution of treated product</td>
<td>MARD seals containers and records seal number on phytosanitary certificate</td>
<td>▪ Seal number on container matches phytosanitary certificate ▪ MARD phytosanitary procedures ▪ ISPMs ▪ Export compliance programme/workplan</td>
<td></td>
</tr>
<tr>
<td>7 &amp; 8 Inspection on arrival in NZ</td>
<td>Documentation, seal(s) and fruit may be inspected before being cleared, treated, reshipped or destroyed. NB: This is a verification step only, NOT a measure</td>
<td>No substitution has occurred and phytosanitary certificate matches consignment</td>
<td>Documentation checked to ensure IHS and OAP requirements have been met.</td>
<td>A MAF biosecurity inspector checks accompanying export documentation (e.g. seal number, treatment information and additional declarations) and may inspect sample of fruit for presence of live regulated pests(^5).</td>
<td>▪ MAF Border Clearance Procedures (BCPs)</td>
<td></td>
</tr>
<tr>
<td>9 Distribution</td>
<td>Cleared product available for distribution throughout NZ</td>
<td></td>
<td></td>
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</tbody>
</table>

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\(^1\) Control points – points in the production and/or post-production chain where it is possible to control or remove risks

\(^2\) Critical control points – points in the production and/or post-production chain where it is essential (and a requirement by MAF) to control or remove risks

\(^3\) MARD – Viet Nam’s designated NPPO: Ministry of Agriculture and Rural Development

\(^4\) MAF IHS - Import Health Standard for Mango from Viet Nam

\(^5\) Regulated pest - A quarantine pest or a regulated non-quarantine pest [FAO, 2010]. A pest of potential economic importance in New Zealand and not yet present there, or present but either not widely distributed and being officially controlled, or a regulated non-quarantine pest, or having the potential to vector another regulated pest into New Zealand.
**APPENDIX 2: Proposed Risk Organism List**

*Explanatory Note*

Exclusions from the list include:

1. All non-regulated organisms/present in New Zealand and not considered a vector or potential vector.
2. Organisms unlikely to follow the pathway, including:
   a. Organisms not associated with fruit (e.g. *Aonidiella inornata* feed primarily on the leaves and bark of the mango trees (Gupta & Singh, 1988) and are therefore unlikely to follow the pathway).
   b. Organisms that prevent fruit entering the export chain:
      i. Organisms that cause pre-mature fruit drop (*Orgyia postica* (Lepidoptera: Lymantriidae), *Conogethes punctiferalis* (Lepidoptera: Pyralidae)).
      ii. Organisms that only infest over-ripe fruit.
      iii. Organisms that cause destructive and obvious fruit injury (e.g. *Deanolis albizonalis* (Lepidoptera: Pyralidae) causes fruit cracking and collapse).
   c. Organisms not expected to remain with the fruit during harvest because of size and/or mobility.
   d. Organisms not expected to remain with the fruit during post-harvest processing.
3. Organisms identified at genus level only, as a genus may contain species that are not pests of the commodity.
4. Organisms where insufficient evidence exists that they are present in Viet Nam.

[Important Note: This assessment is not comprehensive, especially with regard to climate suitability for organism establishment. Therefore, some organisms not added to the regulated organism list remain ‘regulated’ and may warrant action upon interception at the New Zealand border.]

<table>
<thead>
<tr>
<th>Organism</th>
<th>Taxonomy</th>
<th>Present in NZ?</th>
<th>Brief assessment</th>
<th>Measures to prevent entry &amp; establishment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EXTERNAL ARTHROPODS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Aphis craccivora</em> (Koch.)</td>
<td>Homoptera: Aphididae</td>
<td>Y Potential Vector (Lowe 1967)</td>
<td><em>A. craccivora</em> is an important vector of over 30 plant viruses. The aphid is polyphagous and vectors a range of viruses of beans, peas, beet, cucurbits and Cruciferae and other species (CABI 2010). Preventing its entry into NZ is a high priority.</td>
<td>Visual inspection</td>
</tr>
<tr>
<td><em>Aphis gossypii</em> (Glover)</td>
<td>Homoptera: Aphididae</td>
<td>Y Potential vector</td>
<td>Although <em>A. gossypii</em> is found in New Zealand, some aspects of its biology here are unknown e.g. whether populations require special overwintering hosts or if sexual forms are present and the persistency of viruses that may enter with it (MAFBNZ 2007b). The aphid vectors over 35 plant viruses (CABI 2010) and therefore preventing its entry into NZ is a high priority.</td>
<td>Visual inspection</td>
</tr>
<tr>
<td><em>Aphis spiraecola</em> (Patch)</td>
<td>Homoptera: Aphididae</td>
<td>Y Potential vector (Cottier 1953)</td>
<td>The aphid transmits a range of viruses, including <em>Plum pox virus</em> which is known to be present in restricted distribution in Viet Nam (CABI 2010). Preventing its entry into NZ is a high priority.</td>
<td>Visual inspection</td>
</tr>
<tr>
<td><em>Aulacaspis tubercularis</em> (Newstead)</td>
<td>Homoptera: Diaspididae</td>
<td>N</td>
<td>The scale has a warm temperate to tropical distribution. Its preferred host is <em>Mangifera indica</em> but other hosts include <em>Citrus</em> spp., avocado and cucurbits (CABI 2010). The scale poses a risk to New Zealand.</td>
<td>Visual inspection</td>
</tr>
<tr>
<td><em>Ceroplastes floridensis</em> (Comstock)</td>
<td>Homoptera: Coccidae</td>
<td>N</td>
<td>Present in Australia (Naumann 1993) but not in WA (DAWA 2003) indicating establishment is likely if it entered New Zealand on the mango pathway.</td>
<td>Visual inspection</td>
</tr>
<tr>
<td><em>Ceroplastes rubens</em> (Maskell)</td>
<td>Homoptera: Coccidae</td>
<td>N</td>
<td><em>C. rubens</em> is polyphagous including being a significant pest of <em>Citrus</em>. <em>C. rubens</em> impacts on a large number of plant species through direct feeding or secondary damage from sooty mould growth on their honey dew secretions (CABI 2010, MAFBNZ 2007b, MAFBNZ 2008a). There are no data on thermal tolerances or developmental thresholds in the literature but it does occur in some temperate regions suggesting that it could establish in NZ if it entered on imported mango fruit (MAFBNZ 2007b, MAFBNZ 2008a).</td>
<td>Visual inspection</td>
</tr>
<tr>
<td><em>Chrysomphalus aonidum</em> (L.)</td>
<td>Homoptera: Diaspididae</td>
<td>N</td>
<td>The scale has a low temperature threshold for development and is highly polyphagous. It attacks many plants of economic importance for New Zealand. The scale was eradicated from Auckland Domain Gardens in 2006 (MAFBNZ 2006, MAFBNZ 2009a).</td>
<td>Visual inspection</td>
</tr>
</tbody>
</table>
### Chrysomphalus dictyospermi (Morgan)

Homoptera: Diaspididae

- N: The scale has a low temperature threshold for development and is highly polyphagous (CABI 2010). It attacks many plants of economic importance for New Zealand including citrus (MAFBNZ 2009a & b). It is recognised as being transported on the fruit of its hosts.

- Visual inspection: [VHT measure or irradiation at 400 Gy likely to impact on this organism]

### Coccus viridis (Green)

Homoptera: Cocidae

- N: C. viridis has a broad host range and is a pest on Citrus species which are grown throughout New Zealand. This species is parthenogenetic and is found in NSW in Australia which is a reasonable indicator of being likely to establish in NZ (MAFBNZ 2007a, MAFBNZ 2008b).

- Visual inspection: [VHT measure or irradiation at 400 Gy likely to impact on this organism]

### Ferrisia virgata (Cockerell)

Homoptera: Pseudococcidae

- N: Ferrisia virgata is one of the most highly polyphagous mealybugs known, attacking plant species belonging to over 70 genera (Ben-Dov et al. 2010; CABI 2010). Many of the host species belong to the Leguminosae and Euphorbiaceae families.

- Visual inspection: [VHT measure or irradiation at 400 Gy likely to impact on this organism]

### Macocellicoccus hirsutus Green

Homoptera: Pseudococcidae

- N: Widely distributed throughout Asia, Africa, North America and the Pacific including South and Western Australia. Host plants include avocado, cabbage, cauliflower, citrus, cucurbits, capsicums, grapevine, maize, plum, tomato and ornamentals (CABI 2010).

- Visual inspection: [VHT measure or irradiation at 400 Gy likely to impact on this organism]

### Nipaecoccus nipae (Maskell)

Homoptera: Pseudococcidae

- N: Significant polyphagous pest species affecting 80 genera in 43 plant families including avocado, grapes, olives, and orchids. Damage caused by N. nipae may result in ornamental plants, fruit or cut flowers losing their market value (CABI 2010).

- Visual inspection: [VHT measure or irradiation at 400 Gy likely to impact on this organism]

### Nipaecoccus viridis (Newstead)

Homoptera: Pseudococcidae

- N: Distributed throughout Asia, North America and parts of Australia. The mealybug has a wide host range including asparagus, avocado, citrus, grapevine and potato (CABI 2010).

- Visual inspection: [VHT measure or irradiation at 400 Gy likely to impact on this organism]

### Oligonychus mangiferus (Rahman & Sapra)

Acari: Tetranychidae

- N: The mite has a wide host range (Bolland et al. 1998, INRA 2010) including avocado and grape. It also has a high reproductive rate (Jeppson et al. 1975). It is established in some parts of Australia except Western Australia (APPPD 2004, as cited in DAFF 2005) indicating it could establish in New Zealand.

- Visual inspection: [VHT measure or irradiation at 400 Gy likely to impact on this organism]

### Pseudaulacaspis cockerelli (Cooley)

Homoptera: Diaspididae

- N: Polyphagous (including ornamental hosts), occurs in temperate climates (Ulenberg 2010).

- Visual inspection: [VHT measure or irradiation at 400 Gy likely to impact on this organism]

### Pseudaulacaspis pentagona (Targioni-Tozzetti)

Homoptera: Diaspididae

- N: P. pentagona is a highly polyphagous and destructive species. It can overwinter in cold climates and therefore it is likely that this species could establish in the northern parts of the North Island, on the East Coast or the northern part of the South Island (MAFBNZ 2008b), indicating it could establish in New Zealand.

- Visual inspection: [VHT measure or irradiation at 400 Gy likely to impact on this organism]

### Rastrococcus spinosus (Robinson)

Homoptera: Pseudococcidae

- N: Distribution appears to be mainly restricted to tropical regions. Host plants include citrus (CABI 2010).

- Visual inspection: [VHT measure or irradiation at 400 Gy likely to impact on this organism]

### Toxoptera aurantii (Boyer de Fonscolombe)

Homoptera: Aphididae

- Y: Potential vector

- Visual inspection: [VHT measure or irradiation at 400 Gy likely to impact on this organism]

### Internal Arthropods

### Bactrocera correcta (Bezzi)

Diptera: Tephritidae

- N: Wide economically important host range. Temporary populations of any fruit fly species could have an economic impact in New Zealand. Ongoing surveillance for fruit fly requires that we notify trading partners of any incursions, which could disrupt trade and potentially mean large economic losses for exporters of fruit fly host material.

- Visual inspection: VHT ≥ 46.5º for ≥ 30 minutes or irradiation at generic 400 Gy dosage

### Bactrocera curcurbitae (Coquillet)

Diptera: Tephritidae

- N: The melon fly is an internationally recognised pest on a wide range of host plants. Many of its known hosts are common horticultural and garden species grown throughout New Zealand. It is likely to be able to establish and cause unwanted consequences in many parts of New Zealand. It also has high fecundity and is very mobile (MAFBNZ 2007a).

- Visual inspection: VHT ≥ 46.5º for ≥ 30 minutes or irradiation at generic 400 Gy dosage

### Bactrocera dorsalis (Hendel)

Diptera: Tephritidae

- N: B. dorsalis is an internationally recognised pest on a wide range of host plants. Many of its known hosts are common horticultural and garden species grown throughout New Zealand. It also has potential to impact some native NZ species. It should be able to establish and cause unwanted consequences in many parts of New Zealand. It has high
<table>
<thead>
<tr>
<th>Genus</th>
<th>Family</th>
<th>Risk Category</th>
<th>Description</th>
<th>Method of Detection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bactrocera tau (Walker)</td>
<td>Diptera: Tephritidae</td>
<td>N</td>
<td>Broad economically important host range. Temporary populations of any fruit fly species could have an economic impact in New Zealand. Ongoing surveillance for fruit fly requires that we notify trading partners of any incursions, which could disrupt trade and potentially mean large economic losses for exporters of fruit fly host material.</td>
<td>VHT ≥ 46.5º for ≥ 30 minutes or irradiation at generic 400 Gy dosage</td>
</tr>
<tr>
<td>Bactrocera tuberculata (Bezzi)</td>
<td>Diptera: Tephritidae</td>
<td>N</td>
<td>Known hosts include peach which is commonly grown in NZ for domestic and export markets. Temporary populations of any fruit fly species could have an economic impact in New Zealand. Ongoing surveillance for fruit fly requires that we notify trading partners of any incursions, which could disrupt trade and potentially mean large economic losses for exporters of fruit fly host material.</td>
<td>VHT ≥ 46.5º for ≥ 30 minutes or irradiation at generic 400 Gy dosage</td>
</tr>
<tr>
<td>Bactrocera zonata (Saunders)</td>
<td>Diptera: Tephritidae</td>
<td>N</td>
<td>Few economically important hosts, however temporary populations of any fruit fly species could have an economic impact in New Zealand. Ongoing surveillance for fruit fly requires that we notify trading partners of any incursions, which could disrupt trade and potentially mean large economic losses for exporters of fruit fly host material.</td>
<td>VHT ≥ 46.5º for ≥ 30 minutes or irradiation at generic 400 Gy dosage</td>
</tr>
</tbody>
</table>

**PLANT PATHOGENS**

<table>
<thead>
<tr>
<th>Genus</th>
<th>Class</th>
<th>Order</th>
<th>Risk Category</th>
<th>Description</th>
<th>Method of Detection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ceratocystis paradoxa (Dade) C. Moreau [teleomorph] (anamorph: Thielaviopsis paradoxa)</td>
<td>Ascomycetes: Microascales</td>
<td>N</td>
<td>A post harvest pathogen, symptoms of which can usually be seen with the naked eye (CABI 2007 as cited in DAFF 2008). Other hosts include Zea mays.</td>
<td>Visual inspection</td>
<td></td>
</tr>
<tr>
<td>Macrophoma mangiferae (Hing. &amp; Sharma)</td>
<td>Ascomycetes: Dothideales</td>
<td>N</td>
<td>DAFF (2008) states that the fungus causes post-harvest fruit rot in mango and symptoms can be easily detected in the field on mango leaves and stems, particularly on young seedlings and young grafted plants. USDA (2006) identifies the primary host is mango and that it can weakly infect Ficus carica, Eryobotrya japonica, Eugenia jambolina, and Vitis vinifera.</td>
<td>Visual inspection</td>
<td></td>
</tr>
<tr>
<td>Pestalotiopsis mangiferae [Synonym: Pestalotia mangifera (Hemm.) Steyaert]</td>
<td>Mitosporic fungi</td>
<td>N</td>
<td>This fungus has a wide host range including many ornamentals and Fitis and has a cosmopolitan distribution (excluding Europe). It therefore poses a risk to NZ.</td>
<td>Visual inspection</td>
<td></td>
</tr>
</tbody>
</table>

Presence in Viet Nam was determined from the following sources:
- Blackman & Eastop (2010)
- CABI (2010)
- Crosby (2009)
- Dat (2008)
- Huang & Crosby (2009)
- NIPP (1999)
- NPOO (1998)
- Waterhouse (1993)

Plant part(s) affected was determined from the following sources: Government of Viet Nam, CABI (2010) and USDA (2006).

Unless otherwise referenced arthropod presence/absence records were checked against:
- Charles & Henderson 2002 (Homoptera: Diaspididae)
- Dugdale (1988) and Hoare (2001) (Lepidoptera)
- Manson (1987) (mites)
- Scott & Emerson (1999) (insects and mites)
- Spiller & Wise (1982) (Insecta)
- Teulon et al. (2004) (Hemiptera: Aphididae)
- PPIN 2010 (MAF’s Plant Pest Information Network database)

Fungus presence/absence records were checked against:
- Farr et al. 2010
- Landcare 2010
- PPIN 2010
- CABI 2010