



Name and Description of Measure	
Name of Measure	Cold Treatment for Tephritid Fruit Flies
Measure Type	Physical
Active Ingredient	N/A
Schedule	<p>(1) 1.1 °C /14 days, 1.67 °C / 16 days, 2.2 °C / 18 days (T107-a, for <i>C. rosa</i>).</p> <p>1. (2) 0 °C / 11 days, 0.56 °C / 13 days, 1.1 °C / 15 days, 1.67 °C/ 17 days (T107-a-1 / T107-c for <i>Anastrepha fraterculus</i>).</p> <p>2. (3) 0 °C / 11 days, 0.56 °C / 14 days, 1.1 °C / 18 days, 1.67 °C / 20 days, 2.2 °C / 22 days (T107-d for <i>Bactrocera tryoni</i>).</p> <p>(4) 0 °C / 40 days, 0.6 °C / 42 days, 3.3 °C 90 days for (<i>Rhagoletis pomonella</i>)</p> <p>Treatment schedules are as detailed in the USDA-APHIS Treatment Manual for the stated species.¹ Treatment schedules for <i>R. pomonella</i> derives from Canadian requirements for apple consignments from the USA.²</p>
Target Pest	<p>3. <i>Anastrepha fraterculus</i></p> <p>4. <i>Anastrepha serpentina</i></p> <p>5. <i>Bactrocera dorsalis</i></p> <p>6. <i>Bactrocera tryoni</i></p> <p>7. <i>Ceratitis rosa</i></p> <p>8. <i>Rhagoletis pomonella</i></p> <p>9. <i>Rhagoletis species</i></p>
<ul style="list-style-type: none"> Included in ISPM 28 	<ul style="list-style-type: none"> Annexes 16, 17, 18, 35, 37 for <i>Bactrocera tryoni</i> occurring on various commodities.³⁻⁷ Annexes 24-29, 34, 36, 41 describe cold treatment schedules for other tephritids of phytosanitary importance.⁸⁻¹⁶
<ul style="list-style-type: none"> References 	<ul style="list-style-type: none"> USDA-APHIS treatment Manual¹ Interstate Certification Assurance: Cold Treatment ICA-07.¹⁷ Phytosanitary Requirements to Prevent the Introduction and Spread of Apple Maggot.²

Other information (Please complete as many fields as possible)
Is there quantitative or qualitative evidence to indicate the measure is effective
<p>Basic research evaluations have been widely conducted and have established that the disinfestation requirements of various fresh fruits typically fall within the criteria set out by the USDA-APHIS Treatment Manual requirement for a cold exposure of 1.1 °C for 14-18 days depending on species / assemblage.¹ The specific treatment identifier (T107-a etc.) from the manual is included with the various exposure regimes listed above as well as the species to which it specifically applies.</p> <p>Cold treatment data is available for the other tephritid species not specifically dealt with by the Treatment Manual and are cited here to indicate that, with the exception of the cold-tolerant <i>R. pomonella</i>, the described treatment regimes would be effective against the named tephritids of phytosanitary concern with respect to apple fruit. The measure described above for <i>R. pomonella</i> derives from Canadian requirements for apple fruit entering Canada from the USA.²</p> <ul style="list-style-type: none"> • <i>Anastrepha fraterculus</i> ^{18–20} • <i>Anastrepha serpentina</i> • <i>Bactrocera tryoni</i> ^{3–5,21,22} • <i>Bactrocera dorsalis</i> ^{23–26} • <i>Ceratitis rosa</i> ^{27–29} • <i>Rhagoletis pomonella</i> ²⁸ • <i>Rhagoletis</i> species <p>Cold treatment phytosanitary schedules for application against tephritid fruit flies in fresh fruit (including apples) is covered by official guidance from a number of jurisdictions including Australia³⁰ New Zealand³¹ and the United States.¹ For example, the USA has specific guidelines for importation of apples (and other deciduous fruit) that specifically requires in-transit cold treatment for use against, for example, <i>C. rosa</i>.¹</p>
Does experience from use in international trade indicate that the measure is effective?
<p>Cold treatment is widely used as a phytosanitary measure and Australia, India, New Zealand, South Africa and the United States, amongst other nations, indicate it as one of the phytosanitary measures that can be used to ensure consignment compliance (exports and imports).^{1, 32 – 35.}</p> <p>The utility of cold treatment as a phytosanitary measure for fresh fruit means that it can be applied to exports from the majority of apple exporting countries, covering several million tonnes of trade. The jurisdictions that include cold treatments as a phytosanitary option have largely maintained their status as being free of the named tephritids, or have limited spread in cases where a given species is present (e.g. <i>R. tryoni</i> in Australia). The lack of change in the geographic distribution of some species could be seen as indicative of the effectiveness of the phytosanitary methods employed during the international transportation of fresh fruit. However, in many cases the lack of spread in the distribution</p>

of a quarantine insect cannot be attributed to any one single measure as several procedures may be used (alternate treatments, eradication programmes, systems approaches etc.).

However, the above notwithstanding:

- *Bactrocera tryoni* has not spread outside of Eastern Australia.^{36,37}
- *Rhagoletis pomonella* is thought to have spread within the USA³⁸ due to the transport of infested fruit but has continued to be restricted to North America despite suitable environments existing elsewhere.^{39,40}
- *Ceratitis rosa* has remained restricted to southern Africa despite suitable ecological niches existing in several areas outside of its current range, including some in Europe.⁴¹
- *Bactrocera dorsalis* has, however, spread extensively over the last 30 years although eradication programmes have restricted its establishment outside of Asia.⁴²

Has the measure been successfully used to manage non-compliant consignments?

Phytosanitary cold treatments are primarily conducted pre-shipment or during transit. This procedure, therefore, is undertaken to ensure compliance and, as a result, is not an appropriate measure for dealing with non-compliant consignments once they have reached their destination and other measures are likely more appropriate.

Has the measure been successfully used to effectively manage pest risk domestically?

Cold treatments are largely employed as in-transit phytosanitary measures during shipping⁴³ and, as a result, the procedure is primarily used for internationally-traded consignments. Pre-shipment cold treatment, which is considered cheaper, is also undertaken within some jurisdictions.⁴⁴ However, in Australia cold treatments are also used as a phytosanitary measure for fruit that is destined for interstate movement within the country, with the prevention of the spread of fruit flies being one of the primary aims of this undertaking.³⁰ Cold treatments are indicated as one of the available phytosanitary measures that can be implemented to ensure compliance for fruit leaving mainland Australia for, for example, Norfolk Island or Tasmania. Such cold treatments are conducted under the provisions of the Interstate Certification Assurance ICA-07 (cold treatment) procedure.³⁰

The existence of several cold treatment protocols produced by governmental agencies of, for example, Australia, New Zealand, South Africa and the USA, indicates that the procedure is considered effective as a phytosanitary measure against tephritid fruit flies of phytosanitary importance associated with fresh fruit exports.^{1,17,35}

Cold treatment is a procedure designed to achieve compliance through effectively disinfesting commodity consignments and is not a measure that can typically be employed in eradication programmes or, for the most part, in dealing with outbreaks.

Has the measure been used successfully by the private sector or authorized entities?

Cold-treatments of fresh fruit are typically undertaken during shipping and, as such, procedures are typically carried out by the private sector. Operators include general shipping companies, such as Maersk (Denmark) and Kuehne+Nagel (Switzerland), and more specialist companies such as Purfresh

transport (USA), MTS Logistics (USA), TIBA transport (Spain), CMA CGM group (France), amongst many others.

In some cases, the cold treatment regimes advertised by shipping companies do not map directly onto the schedules described above, possibly as a certain degree of overage is employed to ensure efficient disinfestation.

The equipment and procedures used for the transport and motoring of fruit undergoing in-transit cold treatment are sophisticated and subject strict protocols, covering calibration of equipment, stacking of fruit, monitoring and handling.³⁵

Has the measure has been identified as an effective pest risk management option based on a PRA or comparable technical evaluation?

- Inclusion in the USDA-APHIS Treatment Manual of various schedules indicates that cold treatment regimes constitute viable and efficacious phytosanitary measures for use against tephritid fruit flies.¹
- Extensive documents from competent bodies in Australia (*R. pomonella*)⁴⁵ and New Zealand (*B. dorsalis*, *R. pomonella*)⁴⁶ have examined the risk associated with tephritid fruit flies associated with fresh apple consignments.
- The pest specific plant health response plan for *R. pomonella* from the UK describes the risk associated with this pest and includes the cold-treatment schedule (Part 4) detailed above.⁴⁷
- A PRA produced by Washington State details the cold tolerance of *R. pomonella* that necessitates the longer cold treatment schedule required for this pest described above.⁴⁸
- The risks associated with the named tephritids have been similarly analysed for other fresh fruit imports by some countries.²⁶
- Published data of cold treatments have been used in New Zealand to produce a model to predict the parameters required for use against different fruit fly species and to suggest various alternative treatment schedules.⁵⁰
- A risk assessment for fruit leaving mainland Australia indicates cold treatments as an accepted phytosanitary measure (targeting tephritids) for fruit exported to Norfolk Island.⁵¹
- No imports of listed fruit are accepted into Tasmania unless they have been exposed to cold treatments as detailed in Interstate Certification Assurance (ICA) protocol ICA-07 (detailed in the Plant Biosecurity Manual Tasmania, 2023).⁵²

Is the measure, relevant to the pest, adopted in an ISPM or regional standard?

There is no international cold treatment standard that operates multilaterally. Instead, cold treatment protocols are typically agreed at a bilateral level. A recent example being that of the agreed protocol for apple exports from South Africa to India that describes regimes identical to schedule 1 (above).⁵³ India has made similar bilateral agreements with the UK, several European countries and Australia with respect to apple imports.⁵⁴

Cold storage is included in ISPM 14 (The use of integrated measures in a systems approach for pest risk management as part of a systems approach) and ISPM 35 (Systems approach for pest risk management of fruit flies (Tephritidae).^{55,56}

ISPM 28 Annexes 16-18, 35 and 37 specifically describe phytosanitary cold treatments against *B. tryoni*.³⁻⁷ Other Annexes (24-29, 34, 36) deal with cold-treatments targeting a tephritid not associated with apples (*C. capitata*).⁸⁻¹⁵

The schedules (or variants thereof) detailed above are adopted as regional standards in Australia (ICA-07),³⁰ New Zealand (Importation and clearance of fresh fruit and vegetables into New Zealand, Standard 152.02),⁴⁶ South Africa³⁵ and the USA¹³³

References

1. Animal and Plant Health inspection Service. *Treatment Manual*. 940 pp (2016). https://www.aphis.usda.gov/import_export/plants/manuals/ports/downloads/treatment.pdf.
2. Government of Canada, C. F. I. A. D-00-07: Phytosanitary Requirements to Prevent the Introduction and Spread of Apple Maggot, *Rhagoletis pomonella* (Walsh). <https://inspection.canada.ca/plant-health/invasive-species/directives/date/d-00-07/eng/1323819375916/1323819868990> (2011).
3. FAO / IPPC. ISPM 28 Phytosanitary treatments for regulated pests PT 16: Cold treatment for *Bactrocera tryoni* on *Citrus sinensis*. 6 pp (2015).
4. FAO / IPPC. ISPM 28 Phytosanitary treatments for regulated pests PT 17: Cold treatment for *Bactrocera tryoni* on *Citrus reticulata* x *C. sinensis*. 6 pp (2015).
5. FAO / IPPC. ISPM 28 Phytosanitary treatments for regulated pests PT 18: Cold treatment for *Bactrocera tryoni* on *Citrus limon*. 6 pp (2015).
6. FAO / IPPC. ISPM 28 Phytosanitary treatments for regulated pests PT 37: Cold Treatment for *Bactrocera tryoni* on *Vitis vinifera*. 6 pp (2021).
7. FAO / IPPC. ISPM 28 Phytosanitary treatments for regulated pests PT 35: Cold treatment for *Bactrocera tryoni* on *Prunus avium*, *Prunus salicina* and *Prunus persica*. 6 pp (2021).
8. FAO / IPPC. ISPM 28 Phytosanitary treatments for regulated pests PT 24: Cold treatment for *Ceratitis capitata* on *Citrus sinensis*. 6 pp (2017).
9. FAO / IPPC. ISPM 28 Phytosanitary treatments for regulated pests PT 25: Cold treatment for *Ceratitis capitata* on *Citrus reticulata* x *C. sinensis*. 6 pp (2017).
10. FAO / IPPC. ISPM 28 Phytosanitary treatments for regulated pests PT 26: Cold treatment for *Ceratitis capitata* on *Citrus limon*. 6 pp (2017).
11. FAO / IPPC. ISPM 28 Phytosanitary treatments for regulated pests PT 27: Cold treatment for *Ceratitis capitata* on *Citrus paradisi*. 6 pp (2017).
12. FAO / IPPC. ISPM 28 Phytosanitary treatments for regulated pests PT 28: Cold treatment for *Ceratitis capitata* on *Citrus reticulata*. 6 pp (2017).
13. FAO / IPPC. ISPM 28 Phytosanitary treatments for regulated pests PT 29: Cold treatment for *Ceratitis capitata* on *Citrus clemantina*. 6 pp (2017).
14. FAO / IPPC. ISPM 28 Phytosanitary treatments for regulated pests PT 34: Cold treatment for *Ceratitis capitata* on *Prunus avium*, *Prunus salicina* and *Prunus persica*. 6 pp (2021).

15. FAO / IPPC. ISPM 28 Phytosanitary treatments for regulated pests PT 36: Cold treatment for *Ceratitis capitata* on *Vitis vinifera*. 6 pp (2021).
16. FAO / IPPC. ISPM 28 Phytosanitary treatments for regulated pests PT 41: Cold treatment of *Bactrocera zonata* on *Citrus sinensis*. 6 pp (2022).
17. Department of Primary Industries and Regional Development. Interstate Certification Assurance: Cold Treatment (ICA-07). 34 pp (2018).
18. Dias, V. S. *et al.* Relative tolerance of three morphotypes of the *Anastrepha fraterculus* complex (Diptera: Tephritidae) to cold phytosanitary treatment. *Journal of Economic Entomology* **113**, (2020).
19. Valderrama, J. K., Serrano, M. S. & Fischer, G. Larval mortality of *Anastrepha fraterculus* (Wiedemann) (Diptera: Tephritidae) in fruits of pineapple guava (*Acca sellowiana* [O. Berg] Burret) during a cold quarantine treatment. *Revista Colombiana de Entomología* **31**, 171–176 (2005).
20. Willink, E. *et al.* Quarantine cold treatments for *Ceratitis capitata* and *Anastrepha fraterculus* (Diptera: Tephritidae) for citrus in Argentina: conclusions after 10 years of research. Fruit Flies of Economic Importance: From Basic to Applied Knowledge Proceedings of the 7th International Symposium on Fruit Flies of Economic Importance. 285-293 (2006).
21. De Lima, C. P. F., Jessup, A. J., Cruickshank, L., Walsh, C. J. & Mansfield, E. R. Cold disinfestation of citrus (*Citrus* spp.) for Mediterranean fruit fly (*Ceratitis capitata*) and Queensland fruit fly (*Bactrocera tryoni*) (Diptera: Tephritidae). *New Zealand Journal of Crop and Horticultural Science* **35**, 39–50 (2007).
22. De Lima, C. P., Jessup, A. J., Mansfield, E. R. & Daniels, D. Cold treatment of table grapes infested with Mediterranean fruit fly *Ceratitis capitata* (Wiedemann) and Queensland fruit fly *Bactrocera tryoni* (Froggatt) (Diptera: Tephritidae). *New Zealand Journal of Crop and Horticultural Science* **39**, 95–105 (2011).
23. Kao W. Lin *et al.* Cold treatment for guava fruits infested with oriental fruit fly, *Bactrocera dorsalis* (Diptera: Tephritidae). *Applied Entomology and Zoology* **55** (1), 37-44, 2020-02.
24. Manrakhan A, Daneel JH, Stephen PR, & Hattingh V. Cold tolerance of immature stages of *Ceratitis capitata* and *Bactrocera dorsalis* (Diptera: Tephritidae). *J Econ Entomol* **115**, 482–492 (2022).
25. Myers, S. W., Cancio-Martinez, E., Hallman, G. J., Fontenot, E. A. & Vreysen, M. J. B. relative tolerance of six *Bactrocera* (Diptera: Tephritidae) species to phytosanitary cold treatment. *Journal of Economic Entomology* **109**, (2016).
26. Yamamoto, T. *et al.* Cold disinfestation of Takan orange against *Bactrocera dorsalis* (Diptera: Tephritidae). *Research Bulletin Plant Protection Japan* **53**, 1-9 (2017).
27. Ware, A. B. & du Toit, C. L. N. Cold disinfestation of ‘Hass’ avocado (*Persia americana*) of three species of fruit fly (Diptera: Tephritidae)-*Ceratitis capitata*, *Ceratitis rosa*, and *Ceratitis cosyra*. *Journal of Economic Entomology* **110**, 954-960 (2017).
28. Weems, H. V. & Fasulo, T. R. Apple maggot - *Rhagoletis pomonella* (Walsh). https://entnemdept.ufl.edu/creatures/fruit/tropical/apple_maggot_fly.htm.
29. Ware, A., B.A.Tate, Stephen, P. R., Daneel, J. H. & Beck, R. R. Cold disinfestation of Mediterranean (*Ceratitis capitata* [Wiedemann]) and Natal (*Ceratitis rosa* Karsh) fruit fly-

- infested litchis (*Litchi chinensis* Sonn.). *SA Litchi Growers' Association Yearbook* **16**, 47–51 (2004).
30. Department of Primary Industries and Regional Development. 07 Interstate Certification Assurance Cold Treatment Version 6.2, 34 pp (2018)
<https://www.interstatequarantine.org.au/wp-content/uploads/2018/05/WA-ICA-7.pdf> (2018).
 31. Biosecurity New Zealand. Import Risk Analysis: Fresh stonefruit from Idaho, Oregon and Washington. 294 pp (2009).
 32. MAF Biosecurity New Zealand. MAF biosecurity New Zealand standard 152.02 importation and clearance of fresh fruit and vegetables into New Zealand. 421 pp (2012)
<https://www.mpi.govt.nz/dmsdocument/1147-Importation-and-Clearance-of-Fresh-Fruit-and-Vegetables-into-New-Zealand-Import-Health-Standard> (2012).
 33. USA Deciduous Export Programme. Work plan for the USDA preclearance inspection and cold treatment of South African deciduous fruit designated for export to the United States of America. http://www.old.dalrrd.gov.za/doaDev/sideMenu/Food%20Import%20&%20Export%20Standard/docs/Protocol_USA_excludingapricot.pdf (2007).
 34. Government of Canada, C. F. I. A. Phytosanitary Requirements to prevent the introduction and spread of apple maggot, *Rhagoletis pomonella* (Walsh). <https://inspection.canada.ca/plant-health/invasive-species/directives/date/d-00-07/eng/1323819375916/1323819868990#app2> (2011).
 35. PPCEB. HP04U-Procedure for in-transit cold treatment to eradicate fruit flies in apples and pears shipped from South African ports to the United States of America. 18 pp (2010).
 36. Dominiak, B. C. & Daniels, D. Review of the past and present distribution of Mediterranean fruit fly (*Ceratitis capitata* Wiedemann) and Queensland fruit fly (*Bactrocera tryoni* Froggatt) in Australia. *Australian Journal of Entomology* **51**, 104–115 (2012).
 37. Dominiak, B. C. & Mapson, R. Revised distribution of *Bactrocera tryoni* in Eastern Australia and effect on possible incursions of Mediterranean fruit fly: Development of Australia's Eastern Trading Block. *Horticultural Entomology* **110**, 2459–2465 (2017).
 38. Hood, G. R. *et al.* The Geographic Distribution of *Rhagoletis pomonella* (Diptera: Tephritidae) in the Western United States: Introduced Species or Native Population? *Annals of the Entomological Society of America* **106**, 59–65 (2013).
 39. Geng, J., Li, Z. & Rajotte, E. G. Potential geographical distribution of *Rhagoletis pomonella* (Diptera: Tephritidae) in China. *Insect Science* **18**, 575–582 (2011).
 40. Kumar, S., Yee, W. L. & Neven, L. G. mapping global potential risk of establishment of *Rhagoletis pomonella* (Diptera: Tephritidae) using MaxEnt and CLIMEX niche models. *Journal of Economic Entomology* **109**, 2043–2053 (2016).
 41. De Meyer M, Robertson MP, Peterson AT, & Mansell MW. Ecological niches and potential geographical distributions of Mediterranean fruit fly (*Ceratitis capitata*) and Natal fruit fly (*Ceratitis rosa*). *Journal of Biogeography* **35**, 270–281 (2009).
 42. Zeng, Y. Global distribution and invasion pattern of oriental fruit fly, *Bactrocera dorsalis* (Diptera: Tephritidae). *Journal of Applied Entomology* **143**, 165–176 (2019).
 43. Lubello, P. & Codron, J.-M. In-transit cold treatment: a case of institutional path dependence. *Journal of Institutional Economics* **16**, 463–479 (2020).

44. Codron, J. M., Lubello, P. & Lizarraga, I. P. Phytosanitary protocols and constraints relating to apple exports - comparison of three major exporting countries: France, Italy and Chile. *Agence Nationale de la Recherche*. 39 pp (2019)
45. Final report for the review of biosecurity import requirements for fresh apple fruit from the Pacific Northwest states of the United States of America. 380 pp (2022).
46. MAF Biosecurity New Zealand. Ministry for Primary Industries Standard 152.02 Importation and Clearance of Fresh Fruit and Vegetables into New Zealand. 394 pp (2012).
47. Defra. Pest specific plant health response plan: *Rhagoletis pomonella* (apple maggot fly). 37 pp (2022)
48. Sansford, D. C. E., Mastro, M. V., Reynolds, M. J. R. & Collins, F. Pest Risk Analysis (PRA) for apple maggot (*Rhagoletis pomonella*) moving on municipal green waste into the Pest-Free Area (PFA) of the state of Washington, USA. 272 pp (2016).
49. Australian Gov. Extension of nectarine import risk analysis to peaches, plums and apricots from China. 19 pp (2017).
50. Ministry of Primary Industries. A novel method of determining a cold treatment for fruit flies associated with citrus. 25 pp (2021)
51. Australian Government. Risk assessment – fresh stone fruits (apricots, peaches, nectarines, plums and cherries) for human consumption into Norfolk Island from mainland Australia. <https://www.agriculture.gov.au/biosecurity-trade/import/goods/external-territories/norfolk-island-produce/stone-fruits>
52. Plant Biosecurity Manual Tasmania 2023 Edition. 172 pp (2023).
53. **HP04U-PROCEDURE-FOR-IN-TRANSIT-COLD-TREATMENT-TO-ERADICATE-FRUIT-FLIES-IN-APPLES-AND-PEARS-SHIPPED-FROM-SOUTH-AFRICAN-PORTS-TO-THE-UNITED-STATES-OF-AMERICA.pdf. (Repeated)**
54. Department of Agriculture, Cooperation and Farmers Welfare (India). Committee on Sanitary and Phytosanitary measures notification. **[Indian Notice apropos apples – cannot find link anymore]**
55. FAO / IPPC. ISPM14 The use of integrated measures in a systems approach for pest risk management. 16 pp (2017).
56. FAO / IPPC. ISPM 35 Systems approach for pest risk management of fruit flies (Tephritidae). 26 pp (2012).