

SteamTainer®: A Thermal Phytosanitary Alternative to Chemical Fumigation for Wood Logs and Wood Products

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Issue / Challenge

Logs and raw wood materials transported in containers represent a recognised phytosanitary pathway for wood-boring insects and quarantine pests. Global container traffic now exceeds 800 million TEUs annually, with sustained growth in recent years contributing to an increased risk of pest dissemination through international trade. This risk is amplified by:

- increasing trade volumes;
- climate change and pest adaptation;
- strengthened inspection and interception measures by importing countries.

At the same time, phytosanitary authorities face growing pressure to reduce reliance on chemical fumigation. Environmental and health concerns, together with regulatory restrictions, have led to the phase-out or limitation of fumigants such as methyl bromide and sulfurly fluoride.

The core challenge is to ensure **effective phytosanitary security for high-risk wood commodities**, while:

- aligning with Integrated Pest Management (IPM) principles;
- remaining compatible with port logistics;
- meeting diverse national regulatory requirements.

This has created a clear need for **scientifically validated, non-chemical treatments** capable of targeting biologically active pest zones.

Actions taken

SteamTainer® was developed over a three-year research and development programme, combining progressive experimental phases, field trials and technical evaluations.

The programme aimed to:

- assess thermal efficacy against wood-borne pests;
- validate consistency with IPM principles;
- ensure operational feasibility within port logistics constraints;
- deliver a safe, scalable and user-friendly solution.

Technical principle

SteamTainer® uses the controlled injection of dry or superheated steam into sealed maritime containers, enabling:

- directional steam injection along the container axis;
- progressive diffusion throughout the container volume;
- penetration beyond the bark into biologically active wood layers.

IPM-based treatment strategies include:

- **fresh logs**: targeting peripheral biologically active layers (under bark and sapwood);
- **sawn wood**: core temperature control where regulatory compliance requires it.

The system requires no structural modification of containers, can be rapidly installed on-site, and is adaptable to logs, sawn timber and wood by-products.

Key results

Thermal performance and efficacy

- Achieved 71.1 °C for 75 minutes under bark, meeting phytosanitary requirements of specific importing countries.
- Achieved 56 °C for 30 minutes in deeper wood layers, targeting biologically active pest zones.
- Thermal parameters are based on established time-temperature lethality relationships.

Scientific basis

- 56 °C / 30 minutes ensures protein denaturation and enzymatic inactivation across insect developmental stages.
- 71.1 °C / 75 minutes under bark provides an enhanced safety margin, including against wood-associated fungi and moulds.
- High moisture content in fresh logs enhances heat transfer through capillary structures.
- Heat treatment principles are recognised within ISPM and NAPPO frameworks.

Validation and control

- Demonstrated thermal homogeneity, cycle stability and repeatability.
- Cold-point methodology validated using internal multipoint probes and infrared thermal imaging.
- Confirmed uniform heat distribution throughout the container.

Operational and environmental benefits

- Treatment duration: 3–5 hours, depending on protocol.
- Non-destructive: no wood darkening and no fire risk under controlled steam conditions.
- Compatible with heterogeneous loads and plant debris.
- Full digital traceability via a dedicated monitoring application, including continuous temperature logging, automated compliance verification and generation of treatment reports.

Conclusions

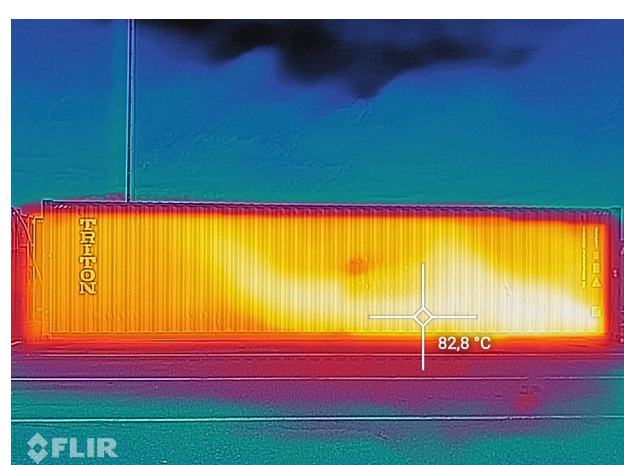
SteamTainer® provides a non-chemical, IPM-aligned phytosanitary solution for containerised wood commodities, offering an effective alternative to chemical fumigation.

Operational deployment at port level demonstrates that thermal treatment can deliver:

- rapid treatment cycles;
- high safety standards;
- reliable compliance with quarantine and pre-shipment requirements.

Multiple study and trial campaigns have confirmed performance, repeatability and robustness under real export conditions. Regulatory acceptance granted in France in 2025 for heat treatment of logs destined for China confirms confidence in the technology.

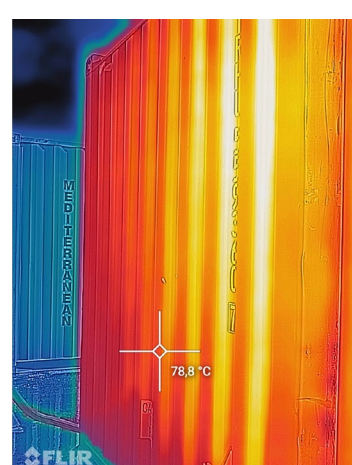
Growing European interest reflects fumigant phase-out, pesticide reduction policies, strengthened IPM strategies and the need for resilient trade solutions. SteamTainer® is currently implemented in France and is under evaluation for wider international deployment.



Infrared thermography demonstrating the lateral horizontal steam diffusion along the container wall, confirming directional flow dynamics.



Door area – Infrared thermography identifying the artificial cold-point reference zone generated by the injection methodology



Infrared thermography showing the significant thermal impact of steam at the farthest injection reach on the rear wall of the container.

