CONTROL OF STORED PRODUCT PESTS: PRELIMINARY STUDIES TO EVALUATE THE POTENTIAL OF USING HEAT IN AN ENVIRONMENTAL CHAMBER

Alfred L. Hoch*, Dan Topp, Brian C. Zeichner, Zia Mehr, and Kristina Hutchison

Studies were conducted to determine if pallets of commercially packaged stored food products (rice, flour, macaroni, oats, and dog food) could be heated to temperatures (120°F for 1 hr) lethal to insects in a temperature controlled environmental chamber without damaging the food or packaging. Some of the specific objectives of these studies were: to develop temperature profiles over time for different types of commodities exposed to moderate heat (150°F) and high heat (190°F), to determine the effect of heat on the quality of the commodities/packaging, and to evaluate costs associated with the heating process.

The test was conducted in a SAFE-HEAT Thermal Pest Chamber provided by TOPP Construction Services, Inc. This chamber is manufactured from an insulated shipping container (20 ft long, 9 ft wide, and 8 ft high). The floor has a 2 inch high aluminum ribbing to facilitate increased air circulation and heat distribution beneath palletized products. An additional advantage of the metal flooring is that it rapidly picks up heat which can kill those insects that come in contact with it after leaving the product.

The environmental chamber was heated by a direct-fired propane heater system which provided about 3000 cfm of 150°F or 190°F heated air into the chamber through a duct in the upper portion of the back wall. Heated air was vented out the primary exhaust duct located at the lower level of the chamber's back wall and through two small, low level, side wall exhaust ports (5x6 inch).

Temperatures in the chamber and commodities were monitored with thermocouples and data loggers ($\pm$ 2.7°F accuracy) at 30 minute intervals or less. To obtain temperatures for products in the interior of the pallet, the palletized products were unstacked and temperature probes were placed at various locations on and within the products, then the pallets were reassembled.

 The authors affiliation are: Alfred Hoch, Kristina Hutchison, and Brian Zeichner, U. S. Army Center for Health Promotion and Preventive Medicine, Aberdeen Proving Ground, MD 21010-5422; Daniel Topp, Topp Construction Services INC, P.O. Box 504, Media, PA 19063; Zia Mehr, Defense Logistic Agency, CAAE, FT Belvoir, VA 22060-6219.

Heater output temperatures were maintained within ± 5 degree Fahrenheit of the target heater temperatures of 150°F or 190°F. Air temperature differences within the chamber were no greater than 10°F. The differences in air temperatures within the chamber were primarily due to the obstruction of air flow caused by the pallets of stored products and due to heat being absorbed by the products.

The palletized products (rice, 1800 lb; macaroni, 800 lb; flour, 360 lb; oats, 270 lb ; and dog food, 1,000 lb) were heat treated for approximately 30 hours at each of the heat treatments regimes (moderate or high temperature). Figures 1, 2 and 3, 4 show the temperature profiles for selected sites within the palletized rice and macaroni, respectively. Of the five sites monitored in the moderate temperature trial, only two sites (rice packs located in the center of the bottom and 3rd tier of a four tier stack) failed to reach the target temperature of 120°F. In the high temperature treatment trial, all sites reached and exceeded the target temperature of 120°F. In the macaroni pallet, all sites exceeded the target temperature of 120°F within 28 and 23 hours in the moderate and high temperature trials, respectively. In the oats pallet, all sites within the product exceeded the target temperature of 120°F within 10 hr and 15 hr at the moderate temperature and high temperature trials, respectively. In the flour, the target temperature of 120°F was achieved, although only a partial pallet of one and a half tiers was treated. Of all the stored food products, dog food was the most resistant to heat penetration. Only those sacks of dog food which were located to the margins of the pallet reached temperatures of 120°F at the moderate temperature. At the high temperature treatment, the center of the pallet did not reach target temperature; however, this area continued to rise in temperature for 10 hours following the heater shut off.

Even though the quality of the heated products has not been analyzed, it was observed that at a temperature of 190°F, the flour became caked and the glued seams of the dog food packaging failed. Therefore, heat treatment at a temperature of 190°F may not be an alternative for heat sensitive products that are to be marketed. Perhaps, if lower temperatures (130 to 150°F) were used for a longer period of time these same products may not be adversely affected and still be marketable. Nevertheless, heat treatment of commodities at 190°F could serve as an alternative to fumigation to disinfest those commodities scheduled for disposal.

These studies clearly indicate that temperatures lethal to stored product pests can be achieved in palletized food products and that heat treatment can be used as an alternative to fumigation with certain restrictions. Additional work to reduce heat treatment costs and develop guidelines for treating different products will be required to determine the economical feasibility of replacing fumigation with heat treatment.

FIGURE 1. TEMPERATURE PROFILE OF PACKAGED RICE (10 lb sack) MONITORED AT DIFFERENT LOCATIONS WITHIN A PALLET WHEN HEATED AT A MODERATE TEMPERATURE (150°F).

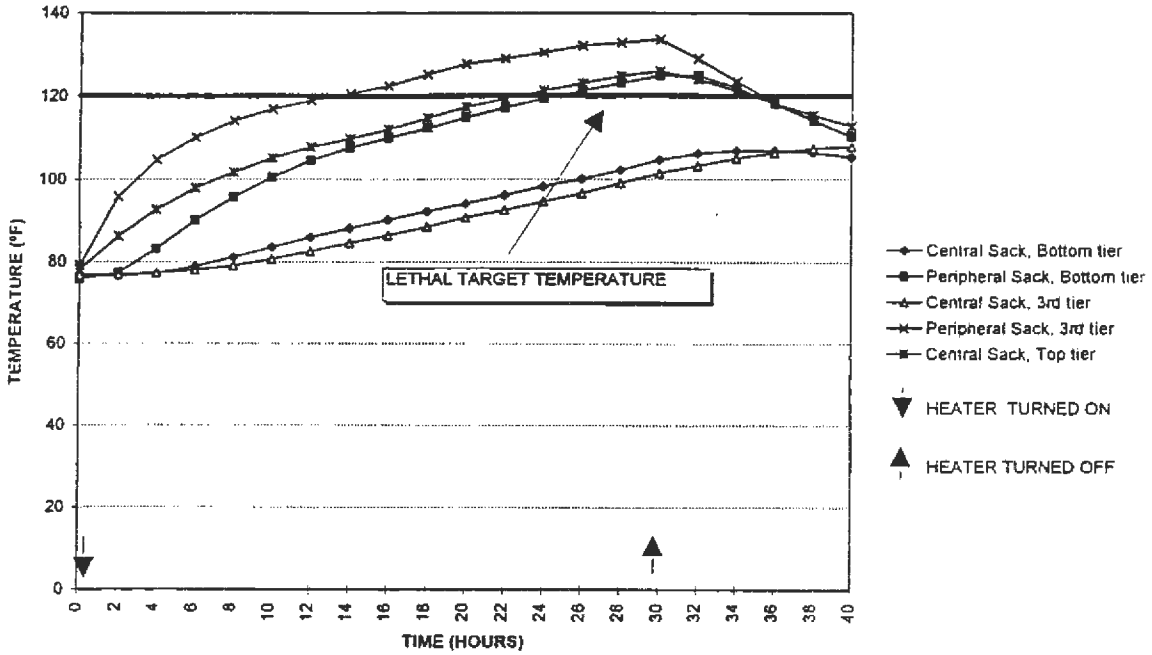

FIGURE 2. TEMPERATURE PROFILE OF PACKAGED RICE (10 LB) MONITORED AT DIFFERENT LOCATIONS WITHIN A PALLET WHEN HEATED AT A HIGH TEMPERATURE (190°F).

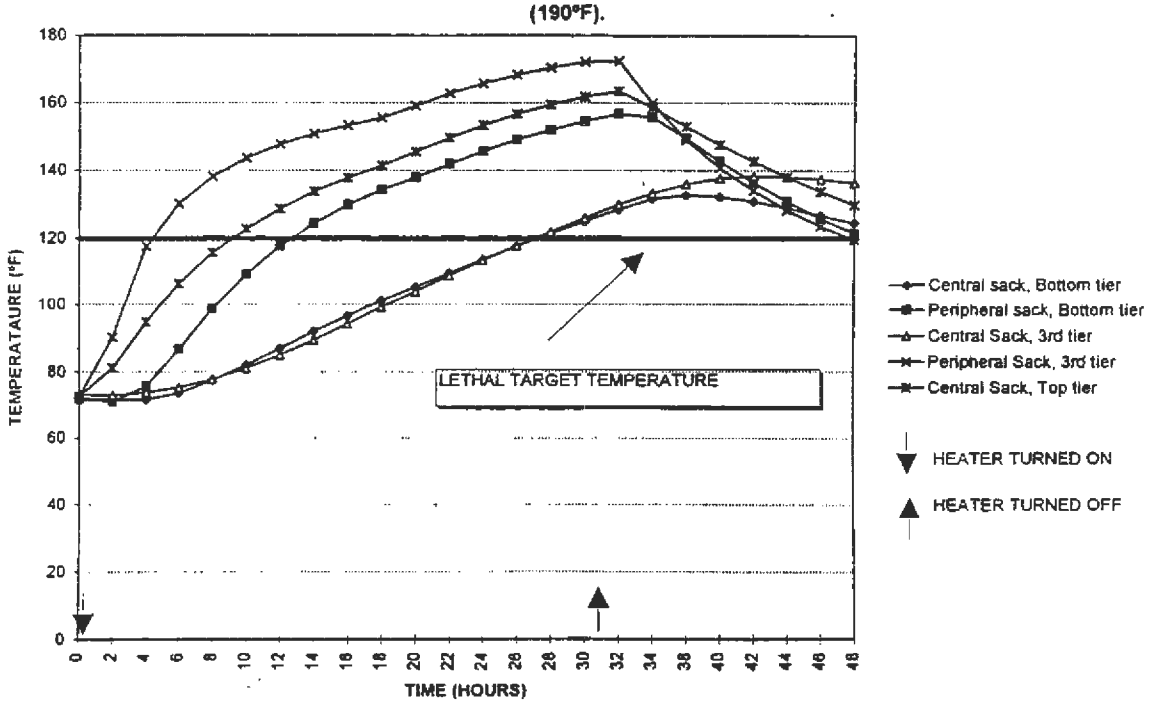

FIGURE 3. TEMPERATURE PROFILE OF MACARONI (20 lb box) MONITORED AT DIFFERENT LOCATIONS WITHIN A PALLET WHEN HEATED AT A MODERATE TEMPERATURE (150°F).

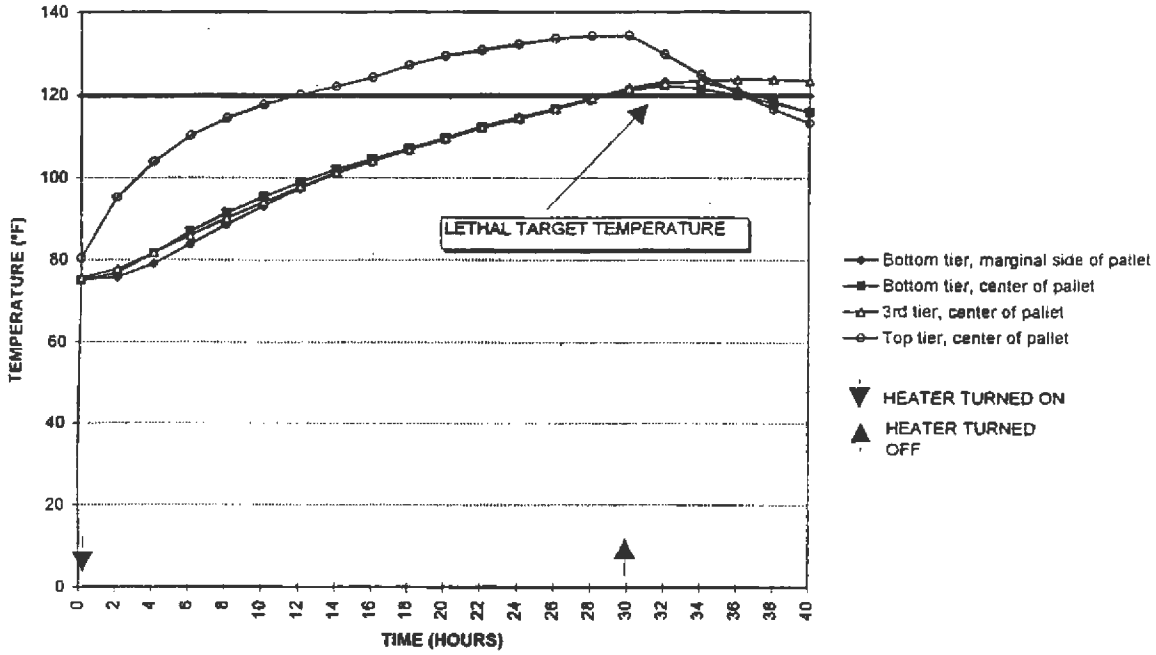

FIGURE 4. TEMPERATURE PROFILE OF MACARONI (20 lb box) MONITORED AT DIFFERENT LOCATIONS WITHIN A PALLET WHEN HEATED AT A HIGH TEMPERATURE (190°F).