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Feature | Quality and Testing/Certification

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# Testing the Quality of Luxury Appliances

Consumers of built-in luxury appliances from Sub-Zero Inc. and Wolf Appliance Inc. pay for and expect a high degree of reliability.

While the companies perform extensive traditional reliability testing on all appliances and major subcomponents in their own laboratories, there is always a question about whether the effects of shipping and installation will be detrimental to long-term operation.

In addition, the ovens, refrigerators, and freezers under development have multiple fans and exhausts that come on at different times in the operating cycle, and it is possible that under certain conditions, harmful resonance in one area of the product could damage electronics in other areas.

Furthermore, new models invariably contain innovations without a long field history. For this reason more than any other, Sub-Zero Inc. and its cooking-appliance business unit Wolf Appliance Inc. (Madison, WI, U.S.) sought outside testing expertise. The combined companies turned to Intertek and its laboratories in Grand Rapids and Livonia, MI, U.S., to run Highly Accelerated Life Testing (HALT) and Failure Mode Verification Testing (FMVT).

HALT was run on control-circuit boards to determine whether durability was affected as a result of the change from conventional processing to one that met the requirements of the EU's Restriction of Hazardous Substances (RoHS) Directive. Both old and new boards from several different product models were subjected to HALT and the differences were documented.

"While standard functional testing could determine whether the RoHS-compliant boards met the stated requirements, only a testing method that exposed the product to stress extremes could determine whether there were likely to be any long-range effects," says Jon Hammond, manager of reliability for Wolf Appliance.

"Our goal was to make the RoHS board design as robust as our current board." He adds that RoHS has affected processing of virtually

*Intertek customized its Failure Mode Verification Testing (FMVT) for this new E-series double oven from Wolf Appliance Inc.*

every part, even down to the ink and tape on wire harnesses.

One particular concern with the printed circuit boards was solder. "Some industry literature says RoHS-compliant solder is not as strong. We worked with our supplier to select the right solder, and HALT verified that it met our standards."

Testing printed circuit boards using HALT is valuable, but it does not yield information concerning the performance of an entire product when exposed to stress extremes. Intertek's patented accelerated stress testing process for revealing inherent design weaknesses, FMVT, addresses this problem. When Sub-Zero and Wolf had the testing company test a new model of double oven and a new under-counter refrigerator/freezer, they had their first experiences with FMVT.

"Both products were created using a combination of existing and totally new components," says Hammond. "This leads to a situation where interactions between components are possible and could lead to loss of function under certain stress conditions."

FMVT amplifies known sources of stress to magnitudes that are limited by "reasonable" failure modes, defined as a failure that could conceivably occur throughout the life of a product. Typical stress sources include six-axis vibration, temperature, humidity, voltage variation, contamination, UV or solar light, and dynamic loading.

Hammond describes the process of working with Intertek as collaborative and says a number of people from the reliability and design engineering groups at Sub-Zero and Wolf worked with Intertek on the test plan up front. "There's no set recipe for FMVT. Intertek looks at what the customer hopes to get out of the test."

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Test plans were developed that included the simultaneous imposition of eight or nine different stressors. An example of how the test plan was customized came about as a result of input from a Wolf engineer. The engineer wanted to stress the porcelain finish by including a test that would mimic something spilling over.

A strong test plan is the result of good communication and collaboration, says Ted E. Fine, PE, Intertek account manager. And they are essential in the actual testing stage as well. Engineers from Sub-Zero and Wolf worked alongside Intertek's project manager and assistant at the laboratory in Detroit. "FMVT is a very complex test, and there is no need for a company to pay our test engineers to become expert in their product so long as their engineers participate in the process," says Fine.

Hammond agrees. "The challenge in any of these tests is how to identify when a significant failure occurs. Think about a refrigerator. We design it to be as quiet as possible. Having the ability to monitor that is a challenge, so we have reliability and design engineers with intimate knowledge of the product on-site. They know how the product should operate normally, so when it does run outside a specification they can recognize it, stop the testing, and figure out what's wrong."

*Intertek likes to have a customer's engineers on-site for laboratory tests, such as those it performed on this new under-counter refrigerator/freezer from Sub-Zero Inc.*

Intertek has two types of machines for FMVT testing, the larger of which handles appliances weighing more than 100 lb. The laboratory received the appliances about a week or two in advance of testing in order to build the fixturing that would get vibrations into the product.

Appliances were tested at 10 levels, beginning with what approximated normal service conditions up to extreme tests which, Fine says, wouldn't happen in a million years. "This is the level at which the product might end up in pieces all over the floor."

He adds that even though there may be no failures at lower levels, it's important to start testing at the bottom and progress through all levels in order to gather reliable data. "The accumulation of stress is as important as individual stress."

At the end of each test period, the product was subjected to a group of function checks and component examinations. When testing was complete, Intertek provided a list of observed issues, which Sub-Zero and Wolf engineers and designers could take as a starting point for product improvements.

"Since FMVT pinpoints specific issues, the redesign process proceeds quickly and the resulting product is much more reliable," says Fine, whose background is engineering.

After a review of test results, few design changes were needed, says Hammond. "We found that a certain type of screw worked better than others. Vibration caused some to back out. We also changed some wire routing. During vibration we found places where there was potential scraping of wires. When you're routing the wires, you wouldn't think they would move where they did.

"Overall, we were very pleased with the performance of our products. It made the design group very happy and reinforced our design efforts to make a very robust, long-lasting product."