Designed For Nuclear Meltdown

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Exposure to ionizing radiation is believed to be dangerous for humans. The rays or particles can damage human tissue based on the exposure; typically, the more radiation, the more damage.

As Japan's nuclear disaster continues, the Fukushima 50 and others risking their lives to prevent a nuclear catastrophe have been exposed to dangerous levels of radiation as they attempt to stabilize the power plants. The Fukushima Daiichi plant was badly damaged in the March 11, 2011 earthquake and tsunami that knocked out nuclear reactor cooling systems and caused radiation leaks.

Workers at the plant, more than 200 total, rotate in groups of 50 (thus the name) and are exposed to higher radiation levels than a typical plant worker would be exposed to throughout his or her entire career.

Dr. Ronald DeMeo, president and CEO of Miami-based Radiation Shield Technologies (RST) was at home watching news coverage from the devastated Japanese areas when he was shocked to see workers at the plant wearing nonwoven fabrics.

"Would you ever think of wearing a nonwoven fabric in an X-ray environment in a hospital? No, it's worthless," says DeMeo. Nonwovens are fabric-like material made from long fibers, bonded together by chemical, mechanical, heat, or solvent treatment; they typically lack strength unless reinforced by a backing.

"The nonwoven surgical gown doesn't do anything for radiation, so why would it be any different in the field? If you're dealing with ionizing radiation, such as X-ray or gamma, which is really just the same in terms of photon energy, why on earth would you use a nonwoven to attenuate that? You're talking about paper vs. heavy metal. It's silly even to ask to compare."

DeMeo is the developer of Demron, the world's first nuclear radiation-blocking, anti-chemical, and biological-protective fabric for personal-protection systems (full-body suits, shields, etc.) DeMeo had some penetration in the Asian markets, but he knew it wasn't the time or the place for a sales call. With such a fluid and chaotic situation, DeMeo felt that the path of least resistance was to go ahead and send more than 200 full-body nuclear radiation-protection suits to Japan. Because of their unique material, the radiation-blocking suits protect against multiple threats, such as infrared radiation, extreme heat, nuclear fallout, and biological and chemical agents.

According to DeMeo, the initial product was very different from the product used today. "I was trying to better protect myself against ionized radiation from the X-ray machine in the operating room," says DeMeo. A board-certified anesthesiologist and pain-management specialist, DeMeo mapped the radiation dispersal in the operating room and tried to place shielding products between himself and the X-ray. In doing so, he realized that the aprons he was using were not nearly adequate. By his best estimate, the apron only covered about 30 percent of his body's surface area.

"People in my field were beginning to develop carcinomas [invasive malignant tumors that consist of transformed epithelial cells], skin burns, and dysplasia [a pre-cancerous change in cells and tissues]," says DeMeo.

The shielding products weren't cutting it, and DeMeo started searching the market for an apron and shield alternative — he came up empty-handed.

"The design was quite inadequate, often with a lot of gaps and openings, and they didn't fit well," says DeMeo. "I started tinkering with different types of metals and trying to incorporate them in different ways. I started using brand products and combining them into a fiber with limited success — the fiber would often fall out of the substrate. I started incorporating resins to try and hold the metal in place in the fabric."

As DeMeo tinkered with different resins, resin technology continued to advance. Metals were incorporated into resin, and metals became smaller, down to the nano scale. Using nano-procedures, DeMeo tried to achieve a higher density in a better packing material without losing the ability to flex and blend. After ten years of development, Demron is a dense fabric that still acts like a metal, but makes us feel more comfortable. Meanwhile, it has increased compliance use as the resins have advanced to make them more impermeable to oxygen, which leads to better attenuation and barrier qualities for chemical agents. DeMeo's pet project evolved into a multi-hazard fabric.

DeMeo buys the nanos direct — and notes the high cost — and uses a one-step proprietary process that allows him to have a decent population of metal, around 20 nm, for tighter packing inside of the polymer. The metal-to-metal interaction remains because the distance between the metals is close enough that the material retains some of its thermal conductive properties without losing its ability to flex and bend.

The nano-fiber is embedded into a resin, which varies according to the product. DeMeo started out with basic polypropylene and metallocene polyethylene resins, and as the polymer technology advanced he incorporated it into the resin.

"We worked with multiple polymer groups and experts, machine manufacturers as well," recalls DeMeo. "The machines weren't designed for incorporating these types of products into resin, and a lot of modifications had to be made."

In turn, the suits can be customized to fit the situations, but they top out around ten pounds in weight. If the scenario calls for additional protection, RST adds a torso vest to the suit since the chest is more sensitive to higher energy sources.

Working With Machine Manufacturers

The greatest machine design challenge for RST wasn't retrofitting existing machines for a new process; it was the sales dance between company and client. Every time DeMeo called the manufacturer in an attempt to modify his machine, the company in question pushed a new custom solution rather than offering a re-engineered remedy.

"The hardest part was trying to use conventional equipment and processes to try and make the product," says DeMeo. "To use customized equipment would not

really be cost effective."

"The people that helped us the most were the actual resin manufacturers," says DeMeo. "They had machine technicians onsite since they had a vested interest in our success."

RST incorporated fibers to give the suit the texture and feel of fabric — it has the characteristics of denim in terms of tear strength, flexibility, and breathability. The fibers have inherent problems with attracting particulate, and, if exposed, the user has to undergo standard decontamination procedures.

The suit cost averages $1,700 dollars, but DeMeo stresses that he doesn't outsource anything. RST manufactures from raw materials to the finished product all in-house. And the end-users love it, according to DeMeo. After all, it's designed specifically for, and by, the end-user.

"You have to let the end-user drive the product," DeMeo insists. "Don't let yourself drive the product. You want to get your data and testing done appropriately and get some honest feedback so you can make the changes that fit the person you are trying to serve, not what you think they need." Remember, DeMeo is a doctor, not a fashion designer; understanding size, fit, weight distribution, and ergonomics wasn't his forte.

Honest feedback was easy to find for DeMeo's bottom-up approach to product design. He approached several firemen, policemen, and army infantrymen who were eager to participate, to test the product. "Many of these guys feel that manufacturers really don't include them," he adds. "When you go with a top-down approach, and you're shooting for spec, you wind up with a big, green Gumby suit."

DeMeo presented his suit as an R&D project and asked the servicemen if they would like to be a part of the process, because at the end of the day, he believes that they will be the greatest influencers in the purchase of the product.

"You want your suit to be your best marketer. You want it to sell itself," DeMeo says. "The more time you spend doing that, the less time and money you spend marketing the product to try and convince the end-user. If you come out too early, you're basically competing against yourself. Sometimes you only get one shot to see somebody, especially those in the military and police. You want to make sure that the first encounter is a positive one. You'll spend a fortune trying to convince people that you're right."

Seven days after DeMeo shipped the suits out to the Fukushima 50, delivery remains the greatest challenge. As the suits lie in a box in a Singapore warehouse, he is working diligently with embassies, navigating through the many channels in the political process. Here's hoping the suits find their way before greater tragedy strikes.

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