THE FIX ON FIBERS: A Roundtable Discussion of Synthetic Fibers in the Workplace

By T.J. Lentz, Kathleen MacMahon and Ralph Zumwalde

Fibers—tiny, synthetic fibers with near magical qualities—comprise a diversity of materials that have become profuse and nearly inextricably woven into the patterns of our lives today. "Clothing, carpet, ceiling tiles and building materials," says Ralph Zumwalde of NIOSH, Cincinnati, "all of these products are composed in some part of synthetic fibers." Zumwalde led a roundtable discussion on *Synthetic Fibers in the Workplace: Where Less Fiber is Healthier* at AIHCE 2000 in Orlando on May 23.

Fibers have long held an interest for occupational safety and health practitioners, the most controversial case in point being the asbestos legacy. Judging from the focus and discussion of the roundtable, participants and audience members were aware of the history with asbestos fibers and eager to draw from this experience in addressing issues with newer and different synthetic fibers.

Why Focus on Synthetic Fibers?

Aside from the previously noted prevalence of synthetic fibers in modern-day products, the fibrous properties that give them some of their important properties (such as tensile strength, high heat resistance and light weight) also contribute to their ability to pose a potential respiratory hazard for workers exposed to airborne fibers during manufacturing and handling. Accordingly, there is a responsibility to "focus on preventive measures and stewardship programs initiated and being developed to ensure safe production and handling of synthetic fibers," according to Zumwalde. "The objective [of the roundtable] is to create a forum for examining these programs and to stimulate collaborations among participants and other partners with an interest in this topic."

The partners to which Zumwalde referred included panel representatives from academia, labor, industry and government. While the discussion frequently focused on universal concerns and strategies for addressing safe handling of synthetic fibers, each panelist contributed a unique perspective in identifying the pertinent issues for this topic.

Overview of Health Issues

As John Dement of Duke University Medical Center, Durham, N.C., noted in his presentation, there are important distinctions among fiber types that are most easily described in terms of chemical and physical characteristics. He recognized two major classes of synthetic fibers: synthetic vitreous fibers, comprised of continuous filament glass fibers, insulation wool, microfibers and ceramic fibers; and synthetic organic fibers, including carbon/graphite fibers, polyamide fibers and polyolefin fibers.

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For each of the independent fiber types, diameter and length distributions have been studied and characterized, as dimensions are one of the factors linked to fiber respirability and toxicity. Throughout the literature, Dement noted, there are examples of studies with each of these fibers, some of which have been associated with health effects including pleural changes, non-malignant lung disease, mesothelioma and lung cancer.

On the strength of these studies and consideration of the factors associated with fiber toxicity (dose, dimensions and durability), research and regulatory groups such as the National Toxicology Program and the International Agency for Research on Cancer have classified specific types of synthetic fibers individually on the basis of their carcinogenic potential. Dement's message was that research questions persist regarding the toxicity of synthetic fibers, but these questions should stimulate research issues such as:

- Fiber respirability (<3-4 µm in diameter);
- Fiber durability in the lungs;
- Fiber surface characteristics and splitting patterns;
- Fiber dimensions as related to pathogenicity (inducing fibrosis, mesothelioma or lung cancer);
- Understanding the fibrosis-lung cancer relationship; and
- Conducting well-designed, long-term epidemiologic studies of workers with occupational exposures to specific synthetic fibers.

A Labor Perspective

It was particularly clear from the presentation by Bill Kojola of AFL-CIO, Washington, D.C., that the labor perspective regarding synthetic fibers is colored by the history of asbestos. "Organized labor has been essentially suspicious of exposure to all fibers," began Kojola. "We would like to be convinced that exposure to a particular fiber is not hazardous." He acknowledged that labor is very interested in following the research in epidemiologic studies with refractory ceramic fibers. Although health concerns with glass fibers and mineral wool are "fuzzy," Kojola believes there is clearly concern about skin irritation from these two fibers.

Among his general observations and priority areas for synthetic fibers, Kojola listed the following:

- A continuing need to focus on durability and solubility issues with the understanding that more soluble fibers are generally less hazardous;
- A need for cooperative agreements and voluntary standards involving labor, government and industry equally, as these are perhaps more efficient means for providing protection and circumventing difficult and drawn-out standard-setting processes; and
- A need for communicating safe work practices and methods for reducing exposures (e.g., use of manual versus power tools to limit dust generation; better dust collection equipment on tools; preventing take-home dust exposures; training for supervisors, managers and workers; and appropriate respiratory protection).

Kojola cited several progressive developments and promising initiatives with synthetic fibers, including the ACGIH TLVs®, the NAIMA/OSHA Health and Safety Partnership Program, the RCF product stewardship program and the ILO Code of Practice for handling mineral wool and glass fibers.

Product Stewardship: Risk Management for RCF

Refractory ceramic fibers, invented in 1942 and first commercially produced in the 1950s, have been produced in greater quantities since the rapid growth of this industry first began in the 1970s. Recognizing the potential for occupational exposure to airborne fibers for workers manufacturing RCF, the industry began sponsoring studies to investigate possible health effects as early as 1984. From that initiative, the Refractory Ceramic Fibers Coalition has developed a comprehensive product stewardship plan that includes health effects research, communication efforts, special studies (with EPA, OSHA and NIOSH), product research/reformulation and workplace monitoring. Health effects studies include toxicology studies with rats and hamsters, epidemiologic studies with a cohort of U.S. RCF manufacturing workers and quantitative risk assessment modeling.

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"The industry has also lowered its recommended exposure guideline from 2 f/cm³ [as an eight-hour TWA] in the late-1980s to 1 f/cm³ in the mid-1990s and again to 0.5 f/cm³ in 1997, based on prudence and technical feasibility," noted Dean Venturin of Unifrax Corp., Amherst, N.Y. These reductions have been attributed to specific elements of the RCF product stewardship plan, including worker education and communication tools (including multilingual training materials), engineering controls (dust collection at point of generation, improved hood designs), process controls (minimized product handling, use of hand tools) and selection and use of proper respiratory protective equipment.

Air Sampling Methods for Fibers

Focusing specifically on the sampling and analysis for airborne synthetic organic fiber dust, Steve Hacker of Solutia Inc., St. Louis, provided the following background observations:

- Exposures to dust of these materials have not been associated with specific health concerns;
- There is no established exposure limit (except that for particulate not otherwise regulated); and
- There is no standard sampling methodology, but there are several options for evaluating workplace exposures (NIOSH Method 0500 for total particulates not otherwise regulated, NIOSH Method 0600 for respirable particulates not otherwise regulated and NIOSH Method 7400 for asbestos and other fibers by PCM).

Hacker identified several sampling issues, including the need to develop a sampling strategy for synthetic organic fibers and determining how to validate the sampling method (fiber generation with even distribution). Other issues include the sensitivities of available methods and deciding which counting methods for fibers should be used—PCM, TEM or SEM.

To address these issues, a polyaramid fiber generation protocol was developed at DuPont with a multiport sampling system. This protocol was used to validate analytic methods in the laboratory, while field sampling was performed to characterize total and respirable dust using personal and area samples. Respirable fibers were also measured in the field using a modified NIOSH 7400 method ("A" counting rules for fibers with diameter <3 µm, consistent with the WHO fiber definition). Cowl rinsing was performed and analyzed to characterize fibers that might be collected on the air sampling cassette cowl.

Based on comparison of laboratory and field testing results, Hacker noted that the successful generation of consistent fibers in the laboratory led to the validation of the modified NIOSH 7400 method for field sampling of synthetic organic fibers. In addition, the study determined that cowl washing was not required and that exposure concentrations to synthetic organic fiber dust during manufacturing was low.

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North American Insulation Manufacturers Association Perspective

"In 1995, OSHA published its list of priority issues as part of its priority planning process, and that list included synthetic fibers," noted Tom Calzavara of Johns Mansville, Littleton, Colo., in his introductory statement. Perhaps this fact did the most to pique interest in addressing occupational health issues with synthetic fibers. The list was also significant in that it distinguished priority topics it had designated for either rulemaking activities or voluntary agreements.

That event served as a catalyst for a partnership effort between NAIMA (representing 95 percent of domestic glass fiber and 100 percent of domestic mineral wool manufacturing) and federal OSHA, according to Angus Crane of NAIMA, Alexandria, Va. Last year, a product of that partnership was unveiled as the NAIMA/OSHA Health and Safety Partnership Program. The plan features respiratory protection requirements for specific jobs (regardless of exposure), worker training and outreach, exposure characterization plans and a permissible exposure limit of 1 f/cm^3. In May 2000, on the one-year anniversary of HSPP, NAIMA presented OSHA with an annual report describing progress in achieving objectives of the program, which will take shape as elements are implemented over the next several years.

OSHA Activities on Synthetic Fibers

On the heels of the overview of the NAIMA HSPP, Adam Finkel of OSHA expressed the agency's perspective on this agreement. "For OSHA, this agreement involved a consideration of trade-offs. In one sense, we [OSHA] could get a relatively expeditious agreement in place which would provide greater worker protection, but this also allows the possibility of settling on an exposure limit which might not be as low as desirable." Finkel noted that a more stringently worded regulation, even if it could have been promulgated, would likely have had more symbolic than practical value given that "exposures are relatively low in manufacturing operations but are of concern among installers, removers and other users of SVF products."

Because the "HSPP puts responsibility for product stewardship on manufacturers, who have greater resources and influence over end-users for implementing controls and measures for safe handling of synthetic fibers," Finkel claimed the agreement holds the promise of providing users with both the motivation and the means to change their behavior, something a regulation would not. However, Finkel also acknowledged difficulties with the process of drafting the HSPP, mainly stemming from mistrust among some of the manufacturers and end-users and the challenges of achieving participation from all potential partners who will be impacted by the plan. While the plan is widely recognized as an innovative tool to "broaden worker protection despite decreasing government resources and power to regulate," according to Finkel, he recognized that OSHA still wields "the hammer" to enforce the agreement and other OSHA standards that apply to this industry as necessary.

Shared Responsibility

Overall, participants expressed cautious optimism about partnerships as the means to accommodate the increasing demand for synthetic fibers while ensuring the safety of workers who manufacture and use these materials. One audience member cited concern about how conditions of voluntary agreements would be communicated to the users of these materials so that industrial hygienists could facilitate the implementation of specific terms of the agreements and evaluate their effectiveness. Perhaps this comment best illustrates why so many audience members were compelled to attend and participate actively in an AIHCE roundtable discussion of synthetic fibers, tackling an important issue which, even near the Magic Kingdom, is no walk in the park.

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Technical Exchange is a feature offering a forum to discuss real-life experiences in technical areas. These experiences are informational and are not peer reviewed. However, submissions are reviewed for technical accuracy. They are intended to help IHs share information for the benefit of all industrial hygiene professionals.

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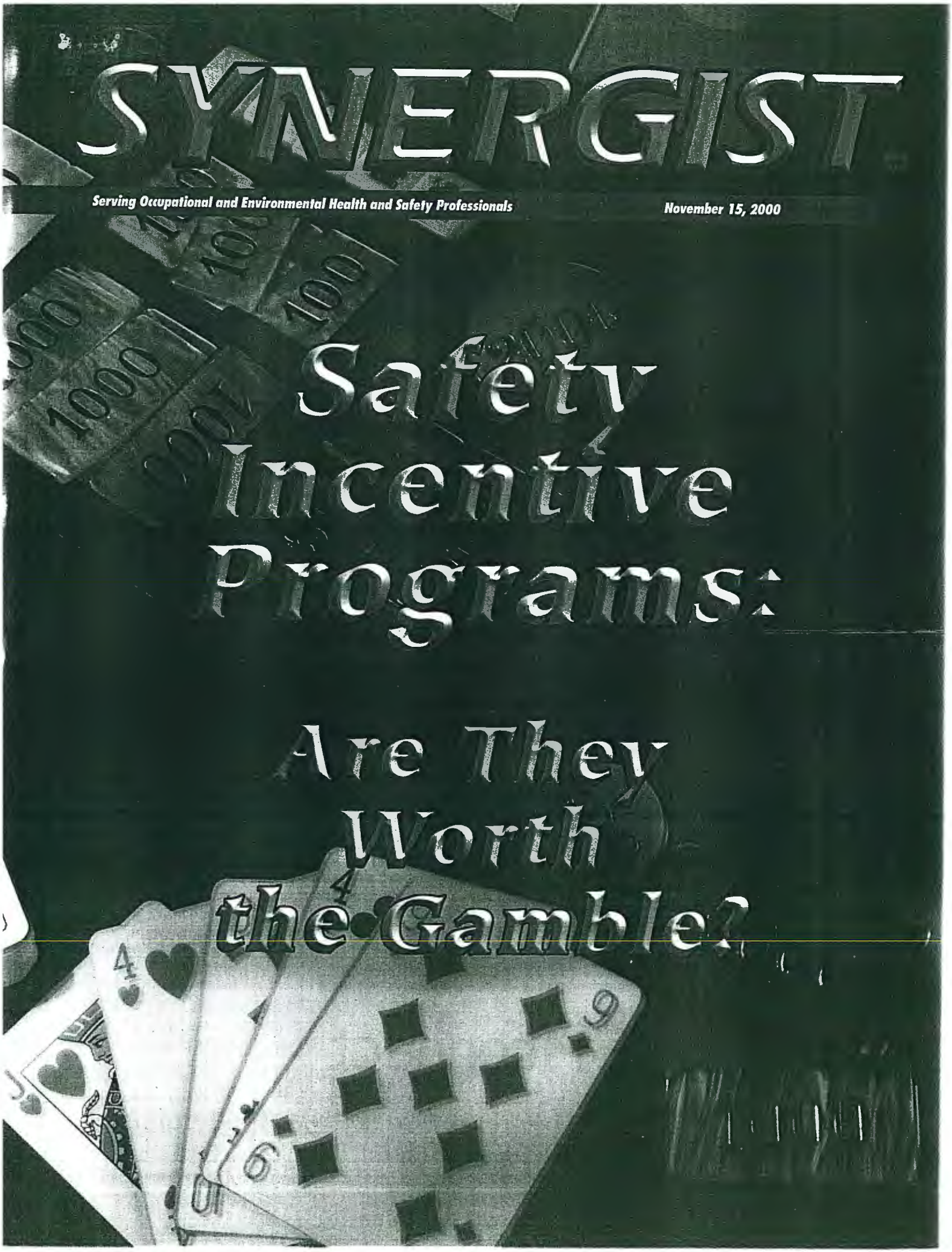
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