NEXT GENERATION FIRE SUPPRESSION TECHNOLOGY: A RESEARCH STRATEGY AND PLAN

Richard G. Gann
Fire Science Division
Building and Fire Research Laboratory
National Institute of Standards and Technology
Gaithersburg, MD 20899

Halon 1301, CF_3Br, has been used extensively to protect vital Department of Defense systems and facilities from unwanted fires often caused by enemy attack. The fire protection for most current weapons systems has been, in fact, designed around its excellent capabilities. Because of the chemical's high suppression efficiency, there has been minimal engineering for optimal distribution and design concentration.

Unfortunately, halon 1301 has now been found to contribute significantly to stratospheric ozone depletion, and commercial production has ceased by law as of January 1, 1994. Government agencies and private firms have created "banks" of new or recycled halon 1301 as a temporary means of continuing protection. Near-term replacement of this suppressant has become a high priority. There has been some examination of commercially available "drop-in" replacements (generally aliphatic halocarbons), and the best of these will soon be identified.

The use of different technologies or dissimilar fluids is not a near-term possibility for protecting current weapons systems. Significant re-engineering of the multiple and diverse hardware requires time and billions of dollars, while increasing production of a chemical from laboratory to meeting commercial demands can take years. Thus, there is little ongoing systematic research on new approaches.

The Office of Advanced Technology under the Director of Defense Research and Engineering is concerned that there be effective and efficient fire protection for future systems. They have requested the development of a research plan to create and develop next-generation fire suppression technologies appropriate for Department of Defense needs that match the effectiveness of halon 1301 without its associated environmental penalties. This plan has been developed with the collaboration of experts in fire science, the contributing disciplines, instrumentation, and testing. It is intended to commence during FY 1995 and reach completion in 8 years.

Experience has shown that the development and examination of new fire suppressant technologies is not likely to be brief or easy. First, a quick survey of fires for which the DoD currently uses halon 1301 showed an extremely broad range of fire locations, fuels burning modes, and required times for suppression (10^{-2} - 10 seconds). The hazards to be avoided include harm to people, thermal damage to equipment, post-fire corrosion, loss of visibility, overpressure. Second, successful suppressants must possess a wide variety of desirable properties. Third, a number of the more obvious chemicals have already been tested and found wanting. Fourth, the environmental demands on the agents will likely change during the course of the program.

To address this broad spectrum of applications and constraints, the strategy is to conduct a program comprising six technical thrusts:

- Fire Suppression Principles: conception and examination of the mechanisms of flame extinguishment.

- New Suppression Concepts: generation of new ideas.

- Emerging Technology Identification and Improvement: finding approaches that are already under development and accelerating their maturation. This will likely involve partnering with commercial firms.

- Suppression Optimization: developing the knowledge to obtain the highest efficiency of each candidate technology.

- Laboratory Testing: developing/adapting and implementing lab-scale methods for evaluating the key properties for suppressants and suppression system components.

- Real-Scale Validation: ascertaining the performance of candidates at real scale. This will make use of appropriately-enhanced existing DoD (etc.) facilities.

Elements of these will be performed concurrently and synergistically. New ideas generated, for instance, during validation tests will then be examined further. New instrumentation developed during laboratory testing may be adapted for real-scale tests. This approach will result in the establishment of a broad understanding of the suppression process and a diversity of tested approaches. This will enable the prompt development of further technology should future requirements change.

Each element of the program will make use of existing facilities and will coordinate with other on-going programs. The research will be performed by experts in the critical technical areas and focussed on the plan objective. The research will involve the best technical experts, making extensive use of capabilities within the Federal laboratories.

The research plan will begin with:

- An in-depth survey to identify the characteristics and environment of the fire types for which halons are currently deployed.

- A workshop to hear about the realm of technologies currently under development.

- Studies to establish the mechanistic basis for fire suppression.

- Completion of development of laboratory methods for measuring and characterizing the benefits and drawbacks of candidate technologies.

As designed, this program should quickly begin producing a steady flow of ideas for further development and examination. Those ideas showing promise will be pursued to the point of practical demonstration. To the extent that a given approach is appealing to a business, partnership arrangements will be arranged to enable commercialization. All information on chemicals and systems and their test results will be in the public domain.

We are highly confident that this program will succeed in providing demonstrated and documented alternatives that are sufficiently effective that the DoD users will have real options. We believe that this output will have broad applicability to non-defense fire protection as well.