Reply

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The last paragraph of my paper (Achtemeier, 1979) relating the threat of severe weather to weather modification activities in the High Plains reads as follows: "Severe weather threat information for the site of any cloud seeding operation should be available to program planners prior to the onset of projects. The avoidance of severe weather may or may not be an integral part of the project design. However, the designers should have the opportunity to preview the potential hazards."

In his comments, Howell has taken the position of a project planner who feels either little need for severe weather threat information or a willingness to attempt modification during such circumstances. It appears that this view stems from a belief that operational cloud seeding—rain simulation, hail suppression and severe weather mitigation—can be undertaken with confidence to produce the desired effects.

Information on severe weather hazards would be of less importance if it were known that cloud seeding *always* decreased hail, *always* increased rainfall—but not too much—and mitigated all other severe weather phenomena such as floods, high winds and tornadoes. However, it appears that this view is not widely accepted among meteorologists with experience in weather modification. The Weather Modification Advisory Board (WMAB, 1978, p. 65) summarized interviews with scientists and others as follows:

> Almost without exception, the proponents believe that cloud seeding will have the desired effect or have no effect at all, discounting the possibility that the results may be negative—that is, producing less rain or more hail, rather than the opposite. The views of opponents of cloud seeding appear to be just as firmly rooted . . . . In many cases, the views of advocates and opponents both seem to be based more on intuition than on solid evidence . . . . There is a clear need for better evidence on which users can base decisions about cloud seeding.

In their study of societal impacts of hail suppression, Changnon *et al.* (1977) surveyed scientists and found that "A majority of scientists indicate no belief in a hail suppression capability, but a sizeable minority indicates that a moderate (>20%) capability for suppressing hail now exists. At best, the average belief must be labeled 'don't know'."

Clearly there exists among a large number of scientists associated with weather modification some doubt that cloud seeding will always have the desired effect. In projects that have been evaluated, the "effect," if any, has been buried in natural variability, and most rain enhancement and hail mitigation efforts, though encouraging, have not been statistically significant at the 5% level. Furthermore, little is known about the effect of cloud seeding on the dynamics of storms that produce floods, high winds and tornadoes. Major lawsuits concerning ongoing cloud seeding efforts have followed two major floods, one in Rapid City and one in Los Angeles.

Given these uncertainties, the WMAB (p. 72) was led to propose that "All operational cloud seeding projects should have onsite, real-time monitoring of meteorological phenomena necessary to recognize seedable opportunities and to recognize severe weather events in sufficient time to avoid contributing to natural calamities."

Some states already have enacted weather modification laws that require cloud seeders to shut down operations in the threat of severe weather. Program planners need to know something about how many seeding opportunities would be lost to these shutdowns. Therefore, information regarding severe weather frequency within a proposed cloud seeding area should be useful, at least in deciding whether to take the risks involved.

The proposed partnership between operational cloud seeding and the insurance industry follows from Howell's views concerning the maturity of operational cloud seeding. However, it appears that this view is not widely accepted within the insurance industry. Although cloud seeding/insurance company partnerships do exist (Davis, 1975), an aggressive participation in cloud seeding by American insurance companies is not expected (Changnon, 1977). Aside from economic factors, insurance companies show little interest in taking on the additional risk. The companies that operate or sponsor hail suppression projects would need to self-insure, a potentially costly venture, and would be exposed to a litigious public which, "not infrequently through juries regards insurance

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companies as a logical source of remedy for whatever ails it . . . ."

Since cloud seeding science is not yet established and in the event of disaster the social impacts could be immense, cloud seeding project operators need to consider the risks involved in the pretense of contributing to natural calamities. Therefore, severe weather threat information for the site of any cloud seeding operation should be available to program planners prior to the onset of projects. The avoidance of severe weather may or may not be an integral part of the project design. However, the designers should have the opportunity to preview the potential hazards.

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