

REQUIREMENTS IN WEATHER MODIFICATION

- THE STATES VIEWPOINT -

Conrad G. Keyes, Jr., Executive Director

North American Interstate Weather Modification Council
Las Cruces, New Mexico

A need for the prudent design and critical analysis of all weather modification efforts was expressed in the early meetings of the North American Interstate Weather Modification Council (Keyes, 1976). Around the time of the U. S. Weather Modification Advisory Board's accomplishments, created by Public Law 94-490, the NAIWMC became involved in defining the technical capability of weather modification, legal uncertainties of the technology, federal research requirements by the states, and new law requirements for coordination of weather modification activities.

Starting in 1976, the Council's Executive Committee began using the questionnaire approach to obtain the states' views on important issues confronting the Council. The primary category of regular membership in the Council is state or provincial agencies, however, it is important to realize that political sub-divisions, scientific societies, and professional organizations also provide input to most actions of the Council via the affiliate member category (see Figure 1).

Involvement by the States and Provinces

Each year, questions that are asked the Council members are: Where and how is the weather modification regulation controlled in your state or province? What is the states' involvement and present position on weather modification?

A summary of the objective observations from the 1976 through 1978 responses imply:

1. Thirty-seven states or provinces have enacted a statute that deals with weather modification.
2. Most states or provinces control weather modification activities by regulation within a Department of Water/Natural Resources or a Department of Agriculture.
3. Only a few states or provinces have any direct involvement in on-going weather modification programs, however, the number has gone from six to twelve during the drought of 1976/1978.
4. Several states in the U.S. support the concept of Federal funding of further research and development in weather modification.
5. Very few states or provinces have taken a position on operational

weather modification programs, however, actions are providing more input from time to time.

The detailed responses on the above questions have been reported by the American Water Resources Association (Keyes, 1977) and to the U. S. Weather Modification Advisory Board.

Research Needs - States' Viewpoint

A certain amount of criticism and controversy has surrounded the subject of cloud seeding or weather modification during the last decade (Schaefer, 1970; NAS 1973; NWC 1973; Fleagel, et. al., 1974; Changnon, 1975; Farhar and Mewes, 1976; Howell, 1977; among others). Recent discussions have provided information that indicates the potential of weather modification as a tool for the dissipation of fog in and around airports, increasing usable water supplies for domestic, agricultural and industrial processes; decreasing hail for increased crop and fiber production; and the reduction of damage from severe storms (BuRec, 1973; Dennis, et.al., 1975; Vardiman, et.al., 1976; Bark, 1977; Changnon, 1977; Miller, 1977; Pellett, et.al., 1977; WMA, 1977; and Woodley, et.al., 1977; among others).

A plan was established in June 1976 to determine the future research needs of each of the NAIWMC member states. The meetings sponsored by the Weather Modification Program Office of NOAA and the NAIWMC provided the first input on the needs in future weather modification research. Around the same time, planning for the USBR Colorado River Weather Modification Augmentation Demonstration Program obtained input concerning the requirement for further research in that basin.

Questions that have been asked of the weather modification agency in each state or province have included:

1. Has Federal research in weather modification been adequate? What methods -- fog dispersal, snowpack enhancement, rainfall augmentation and hail suppression?
2. What areas of weather modification need more research and development? i.e., instrumentation, delivery systems, artificial nuclei, physical evaluation, statistical evaluation, societal studies and legal aspects?
3. What fraction of total Federal effort in weather modification should be devoted to research, development, demonstration and operations?
4. What fraction of total Federal effort in weather modification should be devoted to the various seeding objectives: snowpack increase, rain enhancement, hail suppression, hurricane wind suppression, inadvertent affects, others?
5. What fraction of total Federal effort should be devoted to the different aspects of weather modification: scientific, socio-economic, institutional, environmental?

The responses of the states and organizations within the states are very similar to those of the scientific community with regards to adequacy of Federal weather modification research: i.e., decrease the scientific uncertainties by conducting research in artificial nuclei delivery systems, cloud physics of precipitation processes and environmental systems associated with cloud seeding effects.

A summary table of the categories of needed weather modification is provided in Table 1. Without question, the majority of state governments recommend evaluation of ongoing, long-term operational programs as their major category. Next in line would be further development of the seeding technology and the other aspects which will eventually determine its acceptance: economic, environmental and societal studies.

The recommended fractions of the total Federal effort in weather modification vary according to the needs of each state or the organizations within the states (see Tables 2 through 4).

As far as the type of projects for the future: the states recommend pilot projects, then research, demonstration and operations (according to total percentage in each category in Table 2). The responses of most states would appear to agree with the WMAB report -- conduct confirmatory experiments before proceeding further with demonstration and operation programs. Obviously this may not be the case in the states that have been involved with recent statewide programs.

Looking at the seeding objective recommendations (Table 3): the Western area states are definitely more interested in snowpack augmentation and rain enhancement, most of the plains and midwest states are interested in both rain enhancement and hail suppression, and many midwest and eastern states lean to inadvertent weather modification studies. It is apparent that a coordinated effort in each region could be possible, i.e., regional research and development laboratories as suggested in the U.S. WMAB report.

With respect to the recommendations concerning the different aspects of weather modification (Table 4), most of the future Federal efforts should be concerned with weather systems and seeding methods. However, it is obvious that at least 20%-30% should be spent on the environmental, institutional and socio-economic aspects of weather modification. In other words, long-term, well-designed and coordinated mission programs should be preferred over short-term objective programs of the past.

New Law Requirements

The recommendations of the U. S. Weather Modification Board will be considered in Congress in the near future, probably in the first session of the 96th Congress. What most people do not realize is that many "users" of the technology have been discussing items for a national policy and uniform standards and/or regulation since June 1974, the initial beginning of the NAIWMC. Other organizations American Society of Civil Engineers, American Meteorological Society, Domestic Council, National Academy of Science and the Weather Modification Association) have made similar excellent suggestions for a national policy in the past, however, the political

influence of the major "users" has not been predominate in such testimony.

After reviewing the responses from the states to the questions concerning Federal regulation and new law requirements, as well as summarizing the recent hearings of the U.S. Weather Modification Advisory Board, a comprehensive policy to coordinate all weather resources management should include:

1. Uniform application and control of projects through development of a common law among the states and provinces. The common law should include:
 - a. Purpose and definition of weather modification and cloud seeding.
 - b. Control boards for licensing of operators, permit system for projects, monitoring of research and operations, and inter-governmental coordination and cooperation.
 - c. State sovereignty of the additional water from weather resources management.
 - d. Non-acceptance of liability, i.e., states should not perform the actual seeding operations.
2. Development of a national weather resources management policy that indicates:
 - a. Federal government mission would include research, development and demonstration projects.
 - b. State government major mission in regulation and standardization of programs in and adjacent to their states.
 - c. Local and/or county government provide decision-making in actual operations in their areas.
3. Creation of a national Weather Resources Management Commission or Board to facilitate cooperation between projects of the Federal agencies and programs of the states and provinces.

It seems reasonable that most Federal agencies having missions involving climate and weather prediction or research and development of weather resources cannot realistically coordinate regulation of such across lower order governmental boundaries. However, a national Weather Resources Management Commission could and should suggest minimum standards if the states or provinces fall behind in their regulation function.

Summary

Several states, provinces and organizations therein are aware of the requirement to develop necessary coordination to solve problems of inter-state weather modification programs of the future. About one-third of the states and provinces on the North American Continent have defined their

awareness of relationships with Federal programs of the past and with funding of future activities in the technology. With only a few exceptions, most individuals and groups associated with the NAIWMC indicate that new law requirements should include the establishment of national policies in research and development, a coordinated effort of the Federal activities through National Weather Resources Management Commission(s), and a common licensing and permit system by the states and provinces throughout the Continent.

Since atmospheric water or development of weather resources management is part of the hydrologic cycle that most states or group of states control now, why not include the regulation thereof in the "law of the rivers". An excellent intergovernmental resources management program can make it work in the different regions of the Continent.

REFERENCES

- Bark, L. Dean 1977: Can we do something about the weather? Bulletin 605, Ag. Exp. Sta., Kansas State University, Manhattan and North Central Regional Publication 237.
- Bureau of Reclamation, 1973: Project Skywater -- An introduction to Rivers in the Sky, U.S. Dept. of the Interior, 31 pp.
- Changnon, Stanley A., Jr., 1975: The Paradox of Planned Weather Modification, Bulletin, AMS, 56, pp. 27-37.
- Changnon, Stanley A., 1977: On the status of hail suppression, Bulletin, AMS, 58(1), pp. 20-28.
- Dennis, A. A., J. R. Miller, Jr., D. E. Cain and R. L. Schwaller, 1975: Evaluation by Monte Carlo Tests of Effects of Cloud Seeding on Growing Season Rainfall in North Dakota, J. Appl. Meteor., 14(5), pp. 959-969.
- Farhar, Barbara C. and Julia Mewes, 1976: Social acceptance of weather modification: The emergent South Dakota controversy. Inst. of Behav. Sci. Monograph #23, Univ. of Colorado, Boulder,
- Fleagle, R. G., J. A. Crutchfield, R. W. Johnson, W. F. Abdo, 1974: Weather Modification in the Public Interest, AMS and the Univ. of Washington Press, 88 pp.
- Howell, Wallace E., 1977: An overview of the Skywater IX Conference on precipitation management and the environment, presentation at Weather Modification Association meeting, April 15, Salt Lake City, DAWRM, BuRec, Denver.
- Keyes, C. G., Jr., 1976: NAIWMC - Formation and Its Activities through 1975, The Journal of Weather Modification, 8(1), Weather Modification Association, Box 8116, Fresno, CA. pp. 157-163.

- Keyes, C. G., 1977: North American Interstate Weather Modification Council - Needs, Goals, Purpose and Activities, Water Resources Bulletin, Ameri. Water Resources Assoc., 13(5), pp. 917-932.
- Miller, James R., Jr., 1977: Weather modification -- an update, Bulletin 77-1, Inst. of Atmos. Sciences, S. D. School of Mines and Technology, Rapid City, 13 pp.
- National Academy of Sciences, 1973: Weather & Climate Modification -- Problems and Progress, 2101 Constitution Ave., Washington, D.C. pp. 93-113.
- National Water Commission, 1973: Water Policies for the Future, Final report to the President and to the Congress of the United States, Supt. of Doc., U.S. GPO, Washington, D.C., pp. 346-351.
- Pellett, J. L., R. S. Leblang and M. R. Schock, 1977: Evaluation of recent operational weather modification projects in the Dakotas, WMB Report 77-1, N.D. Weather Modification Board, Bismarck, 54 pp.
- Schaefer, Vincent J., 1970: A Call for Action, The Jour. of Weather Modification, 2(2), pp. 1-13.
- Vardiman, L., J. A. Moore, and R. D. Elliott, 1976: Generalized seedability criteria for winter orographic clouds. Paper presented at Second WMO Scientific Conference on Weather Modification, WMO 443, Geneva, pp. 41-48.
- Weather Modification Association 1977: Weather Modification - Some Facts About Seeding Clouds, WMA, P.O. Box 8116, Fresno, CA 16 pp.
- Woodley, W. L., Simpson, R. Biondini, J. Berkeley, 1977: Rainfall results, 1970-1975, Florida Area Cumulus Experiment, Science, 195(4280), pp. 735-742.

TABLE 1.

CATEGORIES OF WEATHER MODIFICATION RESEARCH

- I. Evaluation
 - A. Of operation programs
 - B. Physical studies
 - C. Extended area effects
- II. Seeding technology
 - A. Transport and delivery methods
 - B. New seeding agents
 - C. Hail suppression methods
 - D. Public education
 - E. New tools, i.e., satellites
- III. Economic, environmental and societal studies
 - A. Economic benefits
 - B. Societal studies
 - C. Inadvertent studies
 - D. Toxicity of agents
- IV. Planning and management
 - A. Short range
 - B. Long range
 - C. Local topographic effects

Legend:

- PERMANENT REGULATORY
- TEMPORARY REGULATORY
- BOARD OF DIRECTORS
- A** AFFILIATE
- ED** EXECUTIVE DIRECTOR

TABLE 2. SUMMARY OF TOTAL FEDERAL EFFORT, Type of Weather Modification Programs

Area/State	Research	Pilot	Demonstration	Operations
<u>East</u>				
Maryland	65%	35%	-0-	-0-
Pennsylvania	10%	25%	15%	50%
Virginia	20%	80%	-0-	-0-
<u>Midwest</u>				
Illinois	30%	30%	40%	-0-
Kansas	50%	35%	15%	-0-
Michigan	50%	40%	10%	-0-
Missouri	40%	60%	-0-	-0-
North Dakota				
WMB	-0-	65%	25%	10%
UND	40%	20%	20%	20%
South Dakota	20%	20%	60%	-0-
<u>West</u>				
Arizona				
Water Commission	-0-	20%	80%	-0-
Salt River Proj.	25%	25%	50%	-0-
U of A - Law	20%	50%	30%	-0-
California				
DWR	40%	40%	15%	5%
CRB	- - -	supports USBR in Demonstration Project		- - -
Colorado	40%	35%	15%	10%
Montana	30%	30%	30%	10%
Nevada	30%	50%	10%	10%
Utah	20%	50%	20%	10%
<u>Southeast</u>				
Tennessee	25%	50%	25%	-0-
Texas	30%	40%	20%	10%
<u>North</u>				
Alberta	10%	30%	20%	40%
Quebec	50%	30%	20%	-0-
Saskatchewan	60%	40%	-0-	-0-

TABLE 3. SUMMARY OF TOTAL FEDERAL EFFORT, Seeding Objectives

Area/State	Snowpack	Rain Enhancement	Hail Suppression	Hurricane Wind	Inadvertent	Other
<u>East</u>						
Maryland	20%	-0-	10%	-0-	30%	30%
Pennsylvania	15%	40%	15%	10%	20%	-0-
Virginia	20%	70%	-0-	-0-	10%	-0-
<u>Midwest</u>						
Illinois	-0-	60%	10%	-0-	20%	10%
Kansas	15%	40%	25%	10%	5%	5%
Michigan	5%	30%	10%	5%	30%	20%
Missouri	20%	30%	15%	20%	5%	10%
North Dakota						
WMB	20%	35%	35%	5%	5%	-0-
UND	20%	45%	15%	10%	10%	-0-
South Dakota	15%	35%	20%	15%	15%	-0-
<u>West</u>						
Arizona						
Water Commission	80%	-0-	-0-	-0-	-0-	20%
Salt River Proj.	50%	40%	10%	-0-	-0-	-0-
U of A - Law	20%	45%	10%	10%	15%	-0-
California	15%	35%	10%	15%	-0-	25%
Montana	25%	50%	20%	5%	-0-	-0-
Nevada	30%	45%	20%	-0-	5%	-0-
Utah	35%	55%	10%	-0-	-0-	-0-
<u>North</u>						
Alberta	- - - - -		No estimate of breakdown		- - - - -	
Quebec	10%	60%	20%	10%	-0-	-0-
Saskatchewan	20%	-0-	20%	-0-	20%	40%
<u>Southeast</u>						
Tennessee	-0-	20%	10%	-0-	20%	50%
Texas	10%	50%	25%	10%	5%	-0-

TABLE 4. SUMMARY OF TOTAL FEDERAL EFFORT, Different Aspects of Weather Modification

Area/State	Weather Systems	Seeding Methods	Socio- Economic	Institutional	Environmental
<u>East</u>					
Maryland	50%	25%	5%	10%	10%
Pennsylvania	25%	50%	10%	5%	10%
Virginia	60%	20%	10%	-0-	10%
<u>Midwest</u>					
Illinois	60%	10%	10%	10%	10%
Kansas	50%	25%	10%	5%	10%
Michigan	40%	25%	10%	5%	20%
Missouri	50%	13%	12%	13%	12%
North Dakota					
WMB	30%	35%	10%	15%	10%
UND	40%	20%	10%	15%	15%
South Dakota	30%	30%	20%	10%	10%
<u>West</u>					
Arizona					
Salt River Proj.	50%	25%	15%	-0-	10%
U of A - Law	25%	55%	6%	9%	5%
Water Commission	40%	40%	-0-	-0-	20%
California	20%	20%	20%	20%	20%
Montana	- - - - 70%	- - - -	5%	5%	20%
Nevada	40%	20%	20%	20%	-0-
Utah	50%	25%	10%	10%	5%
<u>North</u>					
Alberta	25%	10%	20%	30%	15%
Quebec	30%	30%	30%	5%	5%
Saskatchewan	60%	30%	-0-	-0-	10%
<u>Southeast</u>					
Tennessee	25%	20%	-0-	-0-	55%
Texas	45%	20%	10%	10%	15%

"NON-REVIEWED"