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WEATHER MODIFICATION: THE NEED FOR A NATIONAL POLICY

By Peter E. Graf

Since mankind first made an imprint on Earth weather has been central to peoples' existence, determining how they lived, where they lived, and often whether they lived. To ancient mankind, drought, flood, cold, wind and famine were expressions of the moods of the gods. Ritual and ceremony, supplications to the awesome deities of Nature, made up much of the fabric of the early religions.

As civilization advanced, mankind learned to adapt to the environment. Clothing and shelter afforded protection from the elements; fire gave warmth. As organized societies grew and formed towns and cities, cultivation of arid lands became necessary to support growing populations; vast systems of canals were developed to bring water where it was needed. The Mesopotamians, whose civilization was well settled in the 4th millenium B.C., transformed a barren plain into fertile farmland by a network of canals. Portions of the aqueducts upon which much of Roman

GOLDEN GATE LAW REVIEW

civilization depended still stand. The California Water Project is only one of the vast modern schemes to transport water over long distances.

Management of water is big business. The construction of dams or reservoirs for flood control or water storage is often a source of controversy. While no one doubts the necessity of water for human survival, debate over the merits of bringing water to the people, or the people to the water, will be endless. A great deal of effort is being directed toward more effective utilization of the available supplies. Improved treatment of waste water, recycling and desalinization, better collection or water “harvesting” systems, and reduction of evaporative losses all offer some hope.

ARTIFICIAL CLOUD SEEDING

Against this background, the mixed reactions that greeted the announcement, in 1946, that precipitation could be induced by injection of dry ice into a cloud are not surprising.¹ For the optimist it offered the promise of a bright new world without water shortages. Enthusiasts envisioned the beginning of man’s control of climate. The scientific community, however, was far more skeptical.²

The discovery of artificial nucleation³—a classic example of serendipity—emerged as a byproduct of wartime research on aircraft icing headed by Irving Langmuir and Vincent J. Schaefer at the General Electric Company (G.E.). The Army and Navy were sufficiently impressed to fund studies of cloud physics and the mechanisms of precipitation at G.E. under “Project Cirrus”

¹ *Man-made Snowstorms; Scientist Can Make It Fall in Laboratory or in the Sky*, LIFE, Dec. 30, 1946, at 52. *Can Science Do Something About Your Town’s Weather*, SCI. ILLUSTRATED, May 1947, at 13. Spencer, *The Man Who Can Make It Rain*, SATURDAY EVENING POST, Oct. 25, 1947, at 24. Strohm, *They’re Tampering with Your Weather*, COUNTRY GENTLEMAN, March 1951, at 21.

² *Weather Control Remote*, SCIENCE NEWS LETTER, March 31, 1951, at 198.

³ Schaefer, *The Production of Ice Crystals in a Cloud of Super-Cooled Water Droplets*, 104 SCIENCE 457 (1946).

until 1952.⁴ In 1947 Bernard Vonnegut discovered that silver iodide crystals were extremely effective at promoting nucleation⁵ and this chemical remains the most widely used seeding agent, either injected from aircraft or as a smoke from ground-based generators.

The commercial possibilities attracted a variety of operators from crop-dusters with a handy biplane to Ph.D meteorologists who were anxious to exploit the new technology. Only the more competent and skilled operators survived those disillusioning early years. From the basic research and later through bitter experience by the practitioners it was found that the criteria that render a cloud ripe for seeding are critical. Wind velocities, temperature profiles, convective currents, and the density of natural nuclei are some of the factors that have been sorted out from the remarkable accumulation of data contributed by commercial interests and research scientists over the years.⁶

At a Senate Committee hearing on weather modification legislation in 1966, Dr. Vonnegut stated that:

The physics of cloud seeding is now sufficiently well understood that if the cloud-seeding operation fails to produce observable changes in the behavior of the cloud, we are justified in questioning the conduct of the seeding operation or the competence of the observation. On similar grounds, from what we know of the diversity of clouds and the diversity of seeding methods, it is clear that the outcome of a seeding operation will depend in a complicated way on many factors. While there is much we have yet to learn, I think we are quite safe in concluding that the results will vary markedly depending on the cloud and

⁴FINAL REPORT OF THE ADVISORY COMMITTEE ON WEATHER CONTROL 6 (1957) (*hereinafter cited as* ADVISORY COMMITTEE).

⁵Vonnegut, *The Nucleation of Ice Formation by Silver Iodide* 18 J. APPL. PHYS. 593 (1947).

⁶Thom, *An Evaluation of a Series of Orographic Cloud Seeding Operations*, in ADVISORY COMMITTEE. *supra* note 4, at 25.

GOLDEN GATE LAW REVIEW

what, when, where and how much seeding is done.⁷

THE ADVISORY COMMITTEE ON WEATHER CONTROL—1953

Between 1951 and 1953 congressional hearings were held on several bills relating to weather modification. Testimony from water users—ranchers, farmers, utilities, municipalities—indicated that between three and five million dollars were spent annually on cloud seeding operations. Recognizing the need for impartial evaluation, Congress established the Advisory Committee on Weather Control in 1953 to “study and evaluate public and private experiments in weather control” and to recommend “the extent to which the United States should experiment with, engage in, or regulate activities designed to control weather conditions”.⁸

In its final report issued at the end of 1957, the committee concluded that, on the basis of statistical evaluations,

... the seeding of winter-type storm clouds in mountain areas in western United States produced an average increase in precipitation of 10 to 15 percent from seeded storms with heavy odds that this increase was not the result of natural variations in the amount of rainfall.⁹

The committee recommended support for a broad research program in the atmospheric sciences to provide a foundation of knowledge for the most effective development of weather modification. The proposal was made that the National Science Foundation (NSF) “be designated to promote and support research in the needed fields, and to coordinate research projects. It should also constitute a central point for the assembly, evaluation, and dissemination of information.”

⁷ *Hearings on S.23 and S.2961 Before the Senate Comm. on Commerce*, 89th Cong., 1st & 2nd Sess., ser. 89-58, pt. 1, at 280 (1966).

⁸ Act of Aug. 13, 1953, Pub. L. No. 83-256, 15 U.S.C. § 311.

⁹ *ADVISORY COMMITTEE*, *supra* note 4, at vi, viii.

NATIONAL SCIENCE FOUNDATION WEATHER MODIFICATION PROGRAM—1958

Following these proposals, Congress enacted, in 1958, Public Law 85-510 which authorized and directed NSF to

... initiate and support a program of study, research and evaluation in the field of weather modification, giving particular attention to areas that have experienced floods, drought, hail, lightning, fog, tornadoes, hurricanes, or other weather phenomena, and to report annually to the President and Congress thereon.¹⁰

While NSF supported a modest program in basic research on weather modification (for example, \$2 million in 1956), its main role was collecting and disseminating information. Reports were received on a voluntary basis until 1966 when regulations were issued requiring advance notice of weather modification projects and periodic reporting. In 1968 this authority was terminated in anticipation of new regulatory legislation.¹¹

Coordination of activities among the federal agencies has been carried out through the Interdepartmental Committee for Atmospheric Sciences (ICAS), formed in 1959 to satisfy joint interests and responsibilities of NSF, and the newly formed Federal Council for Science and Technology within the Executive Office of the President.¹² A panel within ICAS was formed to deal specifically with weather modification. The opportunity for informal exchange between those from different departments

¹⁰WEATHER AND CLIMATE MODIFICATION: REPORT OF THE SPECIAL COMMISSION ON WEATHER MODIFICATION TO THE NATIONAL SCIENCE FOUNDATION, 4 (1965) (*hereinafter cited as* NSF-66-3).

¹¹Johnson, *Federal Organization for Control of Weather Modification*, 10 NAT'L. RES. J. 222, 235 (1970).

¹²Executive Order No. 10, 807, 3 C.F.R. 329 (1959-1963).

GOLDEN GATE LAW REVIEW

active in their own programs was provided by the annual interagency conferences organized by the NSF.¹³

WEATHER MODIFICATION PROGRAMS IN THE FEDERAL DEPARTMENTS AND AGENCIES

Operational programs in weather modification have been carried on by several federal departments and agencies to satisfy certain mission oriented goals. The earliest sponsors were the military departments through programs such as Project Cirrus.¹⁴ The Department of Agriculture, through the Forest Service, has supported Project Skyfire which attempts to change cloud structures through seeding in order to reduce the occurrence of lightning.¹⁵ The Department of Commerce, through a succession of agencies¹⁶ responsible for forecasting and monitoring the weather, has been investigating in Project Stormfury, a means for moderating severe storm systems through seeding techniques. Research on tropical clouds from which hurricanes are born has been promising, but is far from operational.¹⁷ In Project Lake Effect, the National Oceanic and Atmospheric Administration is testing the feasibility of inland diversion of Great Lakes snow storms to reduce the snow load on highly populated lake shore communities. Rainmaking techniques have been rumored to be in use by the military in Indochina with no explicit denial or amplification coming from the Defense Department.¹⁸ The Federal Aviation Agency has supported a modest program of dispersing fog from airport runways, while operational systems have been organized at some fifteen airports.

¹³NSF 66-3. *supra* note 10, at 132.

¹⁴ADVISORY COMMITTEE. *supra* note 4.

¹⁵*Modify Lightning*, TECHNOLOGY REVIEW, March-April 1972, at 57.

¹⁶U.S. Weather Bureau; then Environmental Science Services Administration (ESSA) by Reorg. No. 2, 1965; now National Oceanic and Atmospheric Sciences Administration (NOAA) by Reorg. No. 4, 1970.

¹⁷Simpson. Woodley, *Seeding Cumulus Clouds in Florida*, 172 SCIENCE 117 (1971); Howard, Matheson, North, *The Decision to Seed Hurricanes*, 176 SCIENCE 1191 (1972); Meyer, *Toward Hurricane Surveillance and Control*, TECHNOLOGY REVIEW, Oct.-Nov. 1971, at 59.

¹⁸Shapley, *Rainmaking: Rumored Use over Laos Alarms Arms Experts, Scientists*, 176 SCIENCE 1216 (1972).

WEATHER MODIFICATION

The Department of the Interior has been the most aggressive in promoting the use of cloud seeding to augment water supplies. What began with an initial appropriation of \$100,000 in 1962 accelerated, through Project Skywater, to an annual spending of over \$5 million by fiscal 1970. Such research is supported at 16 institutes, universities, and governmental agencies. Two major efforts are in the pilot stage: one involves winter storms in the Rocky Mountains, principally the Colorado River Basin; the other focuses on summer storms in the Great Plains. Both are supervised by the Bureau of Reclamation.¹⁹

The growth of the federal programs seems to fulfill statements made by the Select Committee on National Water Resources of the U.S. Senate of the 86th Congress. After an investigation of weather control, they reported:

In spite of the inconclusive findings and inherent problems, it seems obvious that increased funds for research should be appropriated and development activated. Weather modification offers one of the cheapest and best means of increasing our needed future water resources.²⁰

Clearly, any federal organization of weather modification activities must recognize these active programs and permit the originators to retain much of the independence and control that has carried them this far. The growth of these programs, despite the lack of a national policy, is reflected in the following figures which summarize federal annual expenditures dedicated to weather modification:

¹⁹ *Water: The Environmental Challenge*, 6 U.S. DEPT. OF THE INTERIOR CONSERVATION YEARBOOK 87 (1970).

²⁰ *Hearings on S. 22 and S. 2916 Before the Senate Comm. on Commerce* 89th Cong. 2nd Sess., 89-59, pt.2, at 426 (1966).

GOLDEN GATE LAW REVIEW

Fiscal year	Millions of Dollars
1959 ²¹	2.8
1966 ²²	7.2
1970 ²³	11.8
1972 ²⁴	20.0

NATIONAL SCIENCE FOUNDATION AND NATIONAL ACADEMY OF SCIENCES STUDIES

In 1966 two reports were issued which effectively acknowledged the possibility of ultimately realizing substantial benefits from weather modification. Both reports advocated the adoption of a federally funded and coordinated operationally oriented program. A two year study by a National Academy of Sciences' Panel on Weather and Climate Modification concluded:

There is increasing but still somewhat ambiguous statistical evidence that precipitation from some types of cloud and storm systems can be modestly increased or redistributed by seeding techniques . . . Specifically, we find some evidence for precipitation increases of as much as 10 or 20 percent over periods ranging from weeks to years.²⁵

The report by the NSF Special Commission on Weather Modification covering roughly the same period came to essentially the same conclusion, recognizing the need for a central coordinating body while stating that:

²¹NSF 66-3, *supra* note 10, at 127.

²²*Id.*

²³Howe, *Legal Moguls: Ski Areas, Weather Modification, and the Law*, 33 U. PITT. L. REV. 59, 62 (1971).

²⁴Oppenheimer, Lambright, *Technology Assessment and Weather Modification*, 45 S. CAL. L. REV. 570-576 (1972).

²⁵Weather and Climate Modification—Problems and Prospects, Report of the National Academy of Sciences—National Research Council, 1966, at 4 (NAS-NRC 1350).

WEATHER MODIFICATION

Federal agencies should undertake such operational activities as may be required for the effective discharge of their missions.²⁶

The principal elements of a national program were listed as:

1. . . . a strengthened program of fundamental research in the atmospheric sciences and . . . complementary research in the biological and social sciences.
2. . . . a concerted effort directed specifically at the development of what may be called the technology of weather and climate modification.
3. . . . provision for operational application by both the public and private sectors as the feasibility and efficacy of modification techniques are validated.
4. . . . such regulation as may be required to protect the public interest and advance the state of the art.²⁷

The Commission recommended that, at the current state of the art, regulation be limited to promoting the expansion of federal weather modification activities; where these conflicted with local programs or regulations, the federal activity should prevail. Also, the federal government should be empowered to

. . . provide to Federal grantees and contractors indemnification or other protection against liability to the public for damages caused by federal programs of weather and climate modification.²⁸

²⁶NSF 66-3, *supra* note 10, at 32.

²⁷*Id.* at 30.

²⁸*Id.* at 111.

HEARINGS ON SENATE BILLS S.23 AND S.2916—1966

Studies as well as changes in thinking reflected in the final report stirred Congress to develop legislation consistent with the recommendations. The time seemed ripe for a full scale national effort to derive for the public whatever benefits might lie in this upstart technology. The planners, however, hadn't reckoned with the political realities. Jealousy between departments and their Congressional spokesmen prevented the unified effort envisioned in the study reports.

Senate Bill S.23 would have directed the Secretary of the Interior to conduct a program, in cooperation with NSF, to increase the usable precipitation in at least five water-short areas of the country. Twenty million dollars was authorized to cover an eight year period from 1963 to 1971. Since this amount was less than the annual rate being spent by the Bureau of Reclamation on such projects (\$3 million and expected to increase) the Secretary of the Interior testified against the measure.²⁹

Senate Bill S.2875 would have authorized the Secretary of the Interior to carry out a comprehensive research and development program for increasing precipitation. This bill reached much further than the preceding proposal in setting up a central facility with regional operations centers. It included provisions for indemnifying and licensing all activities affecting atmospheric water resources. Except for the licensing provision, the bill was not meant to give the Interior Department authority over research conducted by other federal agencies. Nevertheless, because the bill had the effect of subordinating all weather modification activities to the problem of water resources, it drew wide criticism.³⁰

Senate Bill S.2916 would have given the Department of Commerce the lead in carrying out research and development on

²⁹ *Hearings on S.23 and S.2961, supra* note 20 at 320.

³⁰ *Supra* note 11, at 239.

WEATHER MODIFICATION

all phases of weather modification. It authorized the Secretary to issue regulations to control commercial operations that might conflict with federal programs. While the other agencies would have been permitted to retain responsibility for their own programs, the bill required that any operational program designed to affect the atmosphere beyond a radius of 150 miles obtain prior Congressional approval. This feature was particularly criticized for possibly impeding research on large storm systems. The bill also gave the Secretary authority to obtain whatever information or reports of any “persons as may be deemed necessary . . . to carry out the provisions of this Act, but this authority shall not be exercised if adequate and authoritative data are available from any federal agency”.³¹

Coordination was provided by giving the Secretary authority to

. . . initiate studies, in cooperation with the Federal Council for Science and Technology, on the coordination of activities in such fields by agencies of the Federal Government, make recommendations encouraging such coordination to such agencies, and report to the Congress not later than one year after the effective date of this Act recommendations for such additional legislation as he deems advisable to carry out such coordination; . . . ³²

The hearings on these bills brought together everyone who had been involved with weather modification at any time during its growth. The totality of the effort, albeit often fragmentary and lacking in scientific rigor, was impressive. No one could doubt that there were often substantial effects from cloud seeding. The problem was to control these effects to the best advantage. The statements naturally reflected the vested interests of the speakers. Commercial operators spoke enthusiastically of their successes;

³¹S.2961, § 4(b) (1), see *Hearings, supra* note 7, at 81.

³²S.2916, § 3(8). see *Hearings, supra* note 7, at 81.

GOLDEN GATE LAW REVIEW

they looked to the federal government to provide regulatory authority to assure competence in the profession, to protect them from unlimited liability, and to establish standards for uniform litigation. Detailed regulation, they felt, should be left to local and state government within the framework of national policy.

The testimony of the Weather Control Research Association (now the Weather Modification Association) summed up the prevailing views of those active in the field. The Association's members included representatives from over 50 private and governmental organizations including universities, research institutes, private and public utilities, power and water companies and districts, private meteorological firms, state and local governments, and federal agencies. The Association opposed strong central control:

We are apprehensive that a single Government operating agency with full responsibility for the development of weather modification will tend slowly to build toward stifling Federal bureaucracy and control. At this stage of development, it is important to maintain independence and debate and diversity of approach in solving the many problems ahead.³³

Under "Regulation and Licensing" the Association proposed

... a separate, regulatory or licensing Commission . . . independent of any operational or coordinating Government groups . . . adequately funded to provide realistic monitoring of the effects of weather-modification activities.³⁴

With regard to legal aspects the statement read:

³³ *Hearings on S.23 and S.2916, supra* note 7, at 83.

³⁴ *Id.*

WEATHER MODIFICATION

We recognize the need for and encourage the passage of Federal laws designed to strengthen, encourage, and promote scientific field research and operational programs performed by professional level persons and groups. Such laws should afford protection to the public from unqualified cloud seeders acting without regard for the best interests of the community, and, at the same time, these laws should afford protection to legitimate operators by defining liability and by the provision that litigation be handled uniformly at the Federal level.³⁵

Spokesmen for the federal agencies reinforced the optimistic outlook for weather modification. While sharing concern with the operators over detailed interference with operational activities, they expressed the desirability of permitting the agencies freedom to pursue their own mission oriented goals within the framework of the coherent national policy.

Testimony of the Assistant Secretary of Commerce for Science and Technology, J. H. Hollomon, urged immediate legislation:

(1) to authorize appropriate limitations on State and private weather modification activities which would interfere with Federal research, and (2) to clarify existing authority to permit regulations to be issued requiring full reporting of private activities before they occur.³⁶

He also raised “the question of indemnification” which he said “must be settled before large-scale research is undertaken for the Government by private contractors or grantees”.³⁷

³⁵ *Id.* at 84.

³⁶ *Id.* at 190.

³⁷ *Id.* at 175.

PUBLIC LAW 92-205, DECEMBER 18, 1971

The competing bills of 1966 never passed. Renewed attempts were made in the following year in S.373 and H.R.5734.³⁸ Failure to agree on who should lead a federal program again led to a stalemate. It became apparent that legislative progress in this area is best made in small steps. The earlier proposals failed for attempting too much, too fast. With the sides fairly evenly drawn, neither prevailed.

The legislative log jam was finally broken by passage in late 1971 of Public Law 92-205, approved December 18, 1971. In view of the ambitious and comprehensive proposals of earlier years, Public Law 92-205 was a fairly modest enactment simply providing for the reporting of weather modification activities to the Secretary of Commerce, who was charged with the responsibility for maintenance and publication of such reports. Activities conducted by federal agencies or their contractors, however, were exempted from the reporting requirements. Reports were to be made available before, during, and after such operations. The Secretary was vested with the authority to inspect records or other properties pertinent to weather modification. Such authority was not to extend to information otherwise available from any other federal agency.

Proposed Rules have been published.³⁹ Written views were invited prior to September 11, 1972. No oral hearings have been scheduled. The Rules will be administered by the National Oceanic and Atmospheric Administration (NOAA) through its Office of Environmental Modification.

While the Act falls far short of providing the governmental machinery for coordination and promotion of weather modification activities that most proponents agree is necessary, it is a step in the right direction. In effect, a central body was given the

³⁸ Cited in Mann, *The Yuba City Flood: A Case Study in Weather Modification Litigation*, 49 BULL. AM. METEOR. SOC'Y 690, 711.

³⁹ 37 FEDERAL REGISTER 11679 (1972).

WEATHER MODIFICATION

authority to obtain reports and records, an authority which NSF had held until terminated by Congress in 1968.⁴⁰ Public Law 92-205 placed responsibility for collecting and disseminating data with the group that is best equipped to handle such activities. Major subdivisions of NOAA include the Environmental Data Service and the National Weather Service. Clearly, an essential aspect of evaluating the effectiveness of artificial modification is knowing what the unmodified weather might have been. In an earlier article dealing with the problems of evaluation and assessment the need for such data was noted:

Most importantly, progress toward resolving the uncertainties that continue to plague weather modification attempts will come with the adoption of a standard procedure for giving worldwide notice of impending experiments together with opportunity for criticism of the experimental design, followed by giving the world scientific community access to all data as fast as they are produced.⁴¹

The exemption of the federal agencies from participation in this data collecting program is an unfortunate capitulation to interdepartmental wrangling. While the information will probably be available through other channels such as ICAS, this omission leaves a big gap in the data base and still leaves unresolved the policy question of where the lead should lie.

ELEMENTS OF A FEDERAL PROGRAM OF WEATHER MODIFICATION

Public Law 92-205 partially satisfies the first requirement for an effective national program of weather modification: data collection and dissemination. Still lacking are provisions for (1) coordination and planning; (2) regulation and licensing; and (3)

⁴⁰Pub. L. No. 90-407, July 18, 1968; cited in Davis, *State Regulation of Weather Modification*, 12 ARIZ. L. REV. 35, 60 (1970).

⁴¹Mayes, Decker, *Experimental Design and Data News Service*, 171 SCIENCE 215 (1971).

GOLDEN GATE LAW REVIEW

indemnification. Overriding these deficiencies is the need for a clear statement of national policy that recognizes weather modification as a technology in the public interest deserving the support and leadership of the federal government. Until weather control and modification is given this boost in status, it will continue to be carried as a stepchild of higher priority programs and bootlegged in the research budgets of federal agencies.

Coordination and Planning

The machinery for planning and coordination exists in principle, though with recent government reorganization it is difficult to predict the form in which it will ultimately be cast. The Interdepartmental Committee for Atmospheric Sciences was created to satisfy the planning function by NSF in 1959. However, it was never given legislative authority to insist on compliance. This committee has been useful as a forum for exchanging information and promoting cooperation between the various operating agencies. Until 1973 the President's Office of Science and Technology (OST), was in the best position to implement any policy which might be established.

On January 26, 1973 the White House announced that OST was abolished and its duties would be transferred to the National Science Foundation (NSF). The fate of ICAS is unclear; presumably it returns to NSF where it was originally formed. With the general deemphasis of science, however, it is doubtful that ICAS will find much executive support in promoting new projects. On the other hand, as a body dedicated to coordinating and translating fragmented research efforts into operational and productive programs, ICAS or an equivalent group may be quite at home in an administration which preaches governmental economy. A subcommittee or panel dedicated to weather modification and chaired by someone outside the mission oriented agencies should provide the independence and objectivity required to fairly review the input from operating agencies and set priorities. Consultation with non-governmental bodies such as the National Academy of

WEATHER MODIFICATION

Sciences and the National Engineering Council would be valuable.

The need for adequate assessment in formulating and coordinating programs in weather modification was the subject of a recent review. The authors cite three elements for an effective assessment body:⁴²

- (1) independence from conflicting agency missions,
- (2) political and bureaucratic power to assure that its technological assessments are used in the decision-making process . . . ,
- (3) resources of professional competence and financial support.

They suggest that the General Accounting Office (GAO), because of its unique position between the legislative and executive branches, may best meet these criteria. As a general investigative body of Congress GAO has become increasingly involved in evaluating policies and programs as well as the strictly financial performance of executive agencies; technical assessments may become a logical extension of their functions. While acknowledging that NSF possesses most of the requisite characteristics, the authors of the recent review feel "it lacks professional competence and attitudes in social science and legal disciplines". On the other hand, GAO lacks the technical competence and stature that seem necessary to fairly assess and nurture the growth of weather modification as a reliable technology. A body within NSF can be most effective at the current state of the art. Input from GAO may be useful to fill in what NSF lacks in legislative rapport.

Regulation and Licensing

Currently the only regulation of weather modification activities is that provided by the states. A survey in 1970 indicated that 29 states had laws dealing with weather modification.⁴³ These

⁴² *Supra* note 24, at 593.

⁴³ Schleusener, *Weather Modification Regulation*, IR3 PROC. AM. SOC'Y CIVIL ENG. 281 (1970).

GOLDEN GATE LAW REVIEW

regulations vary widely in scope. Some require nothing more than reporting weather modification activities; others require licensing, but with no functional standards or criteria of competence; still others require a showing of financial responsibility in case of liability. Maryland has simply prohibited modification activities for several consecutive two year periods,⁴⁴ while Pennsylvania permits a local option. Because of this diversity and because the weather recognizes no political boundaries, establishing at least minimal federal standards seems desirable. States feeling the need for more restrictive laws should be permitted this option. Water rich regions will clearly have a different attitude toward cloud seeding than regions where water is in short supply.

The Weather Modification Association has compiled elements of a Model Law which could provide the framework for a federal regulatory scheme.⁴⁵ These elements include creation of a board empowered to: (1) license operators; (2) set qualifications for licenses; (3) require a show of financial responsibility; and (4) review operational plans and issue permits regulating times and areas for operation to avoid overlap. Operators would be required to publish a descriptive notice of intent in the principal newspapers of the counties affected on two consecutive weeks prior to a planned project, and would be required to make their records available for public inspection. The board would have the power to hold hearings, hear complaints, and make determinations of fact.

While such a comprehensive scheme at the federal level may be premature, as one commentator points out, the lag between drafting and final acceptance of regulations, especially in a new field, can be considerable.⁴⁶ Preparation of a federal regulatory

⁴⁴Frenzen, *Weather Modification; Policy and Law*, 12 B.C. IND. & COM. L. REV. 503, 511 (1971).

⁴⁵*Supra* note 43.

⁴⁶*Supra* note 11, at 261.

WEATHER MODIFICATION

program is certainly in order if weather modification is to be promoted as a national policy and more operators enter the field. At the very least, promulgation of licensing standards to assure a professional level of competence would enhance the public's confidence in and acceptance of this skeptically regarded technology.

Administration of such a regulatory scheme may ultimately require a separate entity along the lines of the FCC or ICC. However, initial administration might, logically fall within the charter of the Environmental Protection Agency (EPA).

Indemnification

The question of liability is raised in every review on the subject of weather modification. While no judgment has yet granted damages due to weather modification, the potential liability can be enormous. If the operator is successful in his defense, the cost and delay caused by litigation can have a severe impact on his business.

Seven cases are cited since 1950 in which weather modifiers have been brought to trial.⁴⁷ Three of these cases were brought for damages from flooding allegedly caused by nearby seeding activities.⁴⁸ In none of the cases did the complainant succeed in establishing a causal relationship. In three of the other cases injunctive relief was sought. In *Slutsky v. City of New York*,⁴⁹ resort owners sought to enjoin activities of a rainmaker hired by the city of New York to relieve a drought. The court held that:

This court must balance the conflicting interests between a remote possibility of inconvenience to plaintiff's resort and its guests with the problem of maintaining and supplying the in-

⁴⁷ See reference cited in note 44 for a thorough review of the cases.

⁴⁸ *Samples v. Irving P. Krick, Inc.*, Civ. Nos. 6212, 6223, 6224 (W.D.Okla, 1954). *Auvil Orchard Co. v. Weather Modification Inc.*, No. 19268 (Super.Ct. Chelan Cty. Wash. 1956). *Adams v. California* No. 10112 (Super.Ct. Sutter Cty, Cal. 1964).

⁴⁹ 97 N.Y.S.2d 238 (Super.Ct. N.Y. Cty. 1950).

GOLDEN GATE LAW REVIEW

habitants of the City of New York . . . with an adequate supply of . . . water.⁵⁰

In the other two cases, landowners sought cessation of seeding undertaken to suppress hail on grounds that they were being deprived of “their” rain. In *Southwest Weather Research, Inc. v. Jones*,⁵¹ the seeders were enjoined from further activity; whereas, in *Pennsylvania Natural Weather Modification Association v. Blue Ridge Weather Modification Association*,⁵² the petition was denied. In the latter opinion the court summed up the inevitable problem facing decision makers in weather modification, the resolution between conflicting interests and values:

No individual has the right to determine for himself what his needs are and produce those needs by artificial means to the prejudice and detriment of his neighbors. However, we feel that this cannot be an unqualified right . . . weather modification activities undertaken in the public interest (as opposed to private interests) and under the direction and control of governmental authorities should and must be permitted.

It will be some time before any clear legal lines evolve through court decisions. Scattered suits continue to be brought and worked out, case by case, through the traditional balancing process, each court wrestling with the problem of relating cause and effect. The weighing of rather vague probabilities will be an exercise in frustration for judge and jury alike. Forecasting natural weather effects can be as uncertain as predicting the outcome of artificial seeding.

In view of the uncertainties in the present state of the art and

⁵⁰ *Id.* at 240

⁵¹ 160 Tex. 104, 327, S.W. 2d 417 (1959).

⁵² 44 Pa. D.&C. 2d 749, 760 (C.P. Fulton Cty. 1968) In Pennsylvania *ex rel.* Township of Ayr v. Fulk, No. 53 (C. P. Fulton Cty. Pa. Feb. 28, 1968), the seeder was held in violation of a local ordinance prohibiting seeding.

in a particular court's treatment of litigation, it behooves any weather modifier to obtain financial protection from possible liability, however remote, Irving P. Krick, who has headed companies active in weather modification since 1948, in testimony at the 1966 Senate hearings, reported that commercial insurance was available.⁵³ For experienced operators who had established good operating records, the rate was about one percent, which he felt was reasonable. He noted that in the early days the rates were about 10 percent and insurers hard to find. With the accumulation of positive evidence, and especially after his successful defense in *Samples v. Irving P. Krick, Inc.*,⁵⁴ Krick noted significant reductions in rates and increasing interest of insurance companies.

While private insurance is probably available at reasonable rates to experienced operators, the tremendous losses that could be sustained, while unlikely, make it highly desirable to have some form of disaster insurance underwritten by the federal government. This will become increasingly important as the magnitude of modification projects increases.

For example in *Adams v. California*,⁵⁵ a case involving a rather limited target area, a total of \$13 million was claimed for damages from flooding of the Feather and Yuba Rivers in December 1955, where the flooding was allegedly caused by cloud seeding. The defendants, the State of California, Pacific Gas and Electric Company, and North American Weather Consultants (NAWC) prevailed, but not without long and costly litigation.⁵⁶

The question of indemnification will have to be settled before large-scale projects are undertaken by the federal government, and private development of weather modification is to be encouraged and find public acceptance.

⁵³ *Hearings on S.23 and S.2916, supra* note 20, at 401

⁵⁴ Cir. Nos. 6212, 6223, 6224 (W. D. Okla. 1954).

⁵⁵ No. 10112 (Super.Ct. Sutter Cty. Cal. 1964).

⁵⁶ *Hearings on S.23 and S.2916, supra* note 7, at 76, testimony by Robert Elliott, President, North American Weather Consultants; *see also* Mann, *supra* note 38, for a detailed accounting of the litigation.

GOLDEN GATE LAW REVIEW

The Atomic Energy Commission (AEC) has met this need in the nuclear field by a combined insurance/indemnity program providing coverage up to \$560 million, set forth in Regulation 10 *Code of Federal Regulations* 140 pursuant to Public Law 85-256, September 2, 1957, amendment to the Atomic Energy Act of 1954.⁵⁷ Its provisions call for: (a) a showing of insurance or other financial protection against public liability by the licensee up to a maximum of \$60 million, depending on the size and location of the installation; (b) indemnification up to \$500 million over the required financial protection, provided by the federal government.

Insurance costs vary from rates of four percent for the first one million dollars to about one-tenth of that sum when the total \$60 million protection is required. Insurance is provided by two syndicates formed by commercial insurers. The safety record has been so good that refunds from premium reserves have been paid to holders of nuclear liability commercial policies since 1967.⁵⁸

While the AEC program is probably much broader than anything the Congress would support at this time, it does provide a framework for developing a scheme appropriate to the needs of weather modification programs. It is necessary to start protecting the public, the operator, and the sponsor.

NATIONAL ENVIRONMENTAL POLICY ACT (NEPA) OF 1969

The National Environmental Policy Act (NEPA) of 1969, effective January 1, 1970, adds a new dimension to the regulatory and legal machinery. The Act includes among its goals:⁵⁹

(a) assure for all Americans safe, healthful,

⁵⁷Atomic Energy Commission 23rd Semiannual Report to Congress, July-Dec. 1957, at 177.

⁵⁸Atomic Energy Commission Annual Report to Congress for 1970, at 101.

⁵⁹Donovan, *The Federal Government and Environmental Control: Administration Reform on the Executive Level*, 12 B.C. IND. & COM. L. REV. 541, 543 (1971).

WEATHER MODIFICATION

productive and esthetically and culturally pleasing surroundings;

(b) attain the widest range of beneficial uses for the environment without degradation, risk to health or safety, or other undesirable and unintended consequences;

(c) achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities;

(d) enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

The Act requires that federal agencies prepare environmental impact statements for any contemplated major action, including a description of adverse effects and a discussion of alternatives. In principle, this places concern for environmental effects on an equal footing with the traditional engineering and economic considerations that enter into project planning. The exercise of self examination hopefully will force the agency to (1) recognize potential problems of pollution, or misuse, or interference with public interests, and (2) revise, modify, or abandon its plans accordingly.

In little more than two years over 4000 environmental impact statements had been reviewed by the staff of the Council on Environmental Quality, created by the 1969 Act.⁶⁰ The Council is charged with responsibility for promoting federal compliance with NEPA and for advising the President on environmental matters. The statements are reviewed for their adequacy and credibility, rather than on their specific merits, and summarized in a monthly publication. The public exposure of potential environmental effects is often sufficient to goad the agencies into acting with due concern for the public interest.

⁶⁰Gillette, *National Environmental Policy Act: How Well Is It Working?* 176 SCIENCE 146, 148 (1972).

GOLDEN GATE LAW REVIEW

Where the "self-enforcement" feature has failed, suits filed by citizens' groups have found a very receptive climate in the federal courts. From almost 200 complaints about one in six has actually resulted in delaying or halting a project.⁶¹ While experience with NEPA has been brief and case law is presently limited, the courts have shown an insistence on honesty and objectivity in the environmental impact statement. The decisions indicate that agencies will have to take the initiative in considering environmental values and that these are to be weighed equally alongside technical and economic values in decision making.⁶²

One writer⁶³ has suggested that a strict reading of NEPA would at least rule out federally supported weather modification activities on a large scale. The advocate of modification now has the added burden of persuading a more critical and informed audience that the proposed program is consistent with the goals of NEPA.

On the other hand, the Act promotes an awareness of the environment and of its finite natural resources that may well facilitate acceptance and support of weather modification activities. The Act acknowledges the essential relation between mankind and the environment and recognizes their mutual dependence. It admits, in effect, that mankind's activity has for the most part diminished the quality of the environment, and declares as national policy the redress of that imbalance. Weather modification can be a valuable tool in the achievement of such a goal, offering the promise of reduction of loss of life and property from severe storms and of enrichment of water supplies without disruption to the landscape. Can the environmentalist find fault with a technology which substitutes increased rain-fall for increased dams, spares forests by suppressing lightning, and defuses hurricanes to save lives?

⁶¹Gillette, *National Environmental Policy Act; Signs of Backlash Are Evident*, 176 SCIENCE 30, 31 (1972).

⁶²Johnson, *Environmental Litigation: Lessons from the Courts*, 42 CIVIL ENGINEERING—ASCE 55, 58 (Jan. 1972).

⁶³*Supra* note 44, at 530.