

SURVEY OF INDUSTRY PRACTICES IN WEATHER MODIFICATION
PRELIMINARY REPORT OF WMA COMMITTEE ON INDUSTRY PRACTICES

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Some time ago the Weather Modification Association made a commitment to attempt to determine "industry practice" in the weather modification field. There were a number of reasons for undertaking this study, but one of the major reasons was the federal rule on weather modification reporting. This rule states that if a weather modification activity report indicates a significant departure from practices generally employed in similar circumstances then state officials will be notified. Since these industry practices have never been specified, it is important that the full range of practices be determined.

A committee was appointed by the WMA executive board to conduct a survey and make public the results. The committee named was Arnett Dennis, Ron Lininger and Keith Brown as Chairman. A questionnaire was designed to provide answers as to the range of practices currently employed in weather modification. There was no intent to define the best or correct technique or to identify the techniques used on specific projects or by individual operators.

The following information is a preliminary summary of the results of this survey. A more detailed study will be presented at a later date. Caution should be used in interpreting these results since there has been almost no editing of the returned questionnaires and there are many potential sources of bias. For example, one respondent returned questionnaires for twenty-one different projects, all conducted in a similar manner, and thus introducing a bias in the frequency distribution of industry practices. Another source of misleading information might be found in the number and qualifications of the personnel supervising seeding projects since one individual may supervise several projects and therefore be counted several times.

It will require a careful analysis of the questionnaires to obtain meaningful information on industry practices. It is intended that this data base will be made available to anyone with an interest in this subject.

The questionnaire was mailed to 46 recipients and approximately 26 responded with information on 70 projects conducted during 1974 within the United States. The mailing list was compiled using information from the NOAA report dated March 1974 "Weather Modification Activity Reports", the WMA membership list and personal knowledge of the committee members.

QUESTIONNAIRE FOR DETERMINING INDUSTRY PRACTICE IN WEATHER MODIFICATION

1. Is project primarily research or operational?

11 Totally or mostly research -- Other (specify) _____
55 Totally or mostly operational _____
4 Both research and operation _____

2. Type of project (check more than one if applicable).

57 Precipitation increase 10 Fog dispersal
23 Orographic 3 Warm fog
41 Convective clouds 8 Cold fog
8 Hail suppression 1 Ice fog
2 Other (specify) (1) Hurricane, (1) Fog prevention _____

3. Is project primarily a winter, summer, or year-round operation?

24 Winter Other (specify) _____
38 Summer _____
8 Year-round _____

4. How many months per year does the project operate (average)?

1 One month or less 29 Five to seven months
33 Two to four months 7 Eight to twelve months

5. How many square miles does the target area cover?

1 No specified target area 5 5000 to 9999 square miles
12 Less than 100 square miles 3 10,000 to 29,000 square miles
23 100 to 999 square miles 1 30,000 to 50,000 square miles
25 1000 to 4999 square miles -- Over 50,000 square miles

6. What seeding agent(s) or techniques are used on this project? (Check more than one if applicable.)

60 Silver iodide -- Detergent materials
6 Mixed with NaI 2 Vented liquid propane
22 Mixed with NH₄I -- Mechanical or thermal devices
22 Pyrotechnic units -- Other organic substances
7 Dry Ice 3 Other (specify) Electrostatically
1 Salt charged water; lithium chloride;
-- Urea or other fertilizer material polyelectrolite

7. How is (are) the seeding agent(s) dispersed? (Check more than one if applicable)

--	No seeding agents used	No. of	Avg. No.	Output per site (gm/hr)		
43	Released from ground	Sites	Sites/Proj.	Low	High	Avg.
<u>17</u>	Propane-Acetone Burner	<u>196</u>	<u>12</u>	<u>1.5</u>	<u>350</u>	<u>17</u>
<u>21</u>	Arc Type	<u>347</u>	<u>17</u>	<u>0.5</u>	<u>2.0</u>	<u>1.2</u>
--	Impregnated String Type	--	-	-	-	-
<u>3</u>	Pyrotechnics	<u>6</u>	<u>2</u>	<u>144</u>	<u>200</u>	<u>153</u>
<u>2</u>	Other (specify)					
	<u>Propane venting</u>	<u>48</u>	<u>24</u>		10 gal/hour	
35	Released from aircraft - How many?	<u>98</u>		Low	High	Avg.
<u>23</u>	Pyrotechnics - Output gms/unit?			<u>20</u>	<u>100</u>	<u>62</u>
<u>13</u>	Acetone type burner - Output gms/hour?			<u>1.5</u>	<u>400</u>	<u>151</u>
<u>1</u>	Liquid spray - Gallon per minute?					<u>10</u>
<u>8</u>	Solid material - Pounds per minute?			<u>3</u>	<u>60</u>	<u>20</u>

8. What seeding mode(s) is (are) utilized? (Check more than one if applicable)

- 33 Seeding of entire storm
- 26 Seeding of selected portions of storm
- 7 Seeding only convective bands, squall lines or fronts
- 13 Seeding only individual cells
- 38 Ground based seeding in or upwind of target
- 22 Aerial seeding at cloud base
- 17 Aerial seeding at or above cloud top
- 21 Aerial seeding at selected temperature level (specify) (1) +1°C
(1) -4°C, (4) -10°C
(11) - 5°C, (1) -5 to -10°
- 24 Aerial seeding over target area
- 23 Aerial seeding upwind of target area
- 3 Other (specify) Aerial seeding at specific elevation; seeding in clear air
to create stratus

9. Which evaluation techniques are employed in this project? (Check more than one if applicable)

- 2 No evaluation made
- 18 Randomized
- Randomized cross-over design
- 45 Target-Control
- 32 Percent of historical average analysis
- 29 Observation of physical changes in atmosphere
- 14 Economic or operational success
(reduced crop damage, increased
flight operations during fog,
etc.)
- 29 Other (specify) (7) Model comparison
of predicted and observed result;
(21) Isohyetal target-control (non-
statistical); (1) hail from seeded &
non seeded cells

10. Which parameters are used in evaluating this project? (Check more than one if applicable)
- | | |
|-------------------------------|--|
| <u>51</u> Rainfall total | <u>9</u> Hailfall analysis |
| <u>12</u> Rainfall intensity | <u>10</u> Other meteorological parameters
(visibility, ceiling, RVR, etc.) |
| <u>7</u> Snowpack | <u>4</u> Other (specify) <u>(2)</u> Insurance data;
(1) Rainfall duration; (1) physical characteristics |
| <u>10</u> Streamflow | |
| <u>17</u> Radar echo analysis | |
11. What is (are) the source(s) for upper air data for project operations? (Check more than one if applicable)
- | | |
|---|--------------------------|
| <u>7</u> No upper air data used | |
| <u>56</u> National Weather Service regular observation network | |
| <u>2</u> Project Pibal | |
| <u>16</u> Project Rawinsonde(s). What is the average number of observations made per day by Project Rawinsonde. | |
| On operational days? | On non-operational days? |
| <u>3</u> One | <u>7</u> None |
| <u>2</u> Two | <u>3</u> One |
| <u>2</u> Three | <u>5</u> Two |
| <u>9</u> Four or more | <u>-</u> Three |
| | <u>1</u> Four or more |
12. How many radar sites are used in operating this project?
- | | |
|----------------|------------------------|
| <u>37</u> None | <u>4</u> Two |
| <u>22</u> One | <u>6</u> Three or more |
13. What is the maximum effective range of radar coverage? (Combined coverage from all radars)
- | | |
|-----------------------------|----------------------------|
| <u>35</u> No radar | <u>21</u> 101 to 200 miles |
| <u>4</u> Less than 50 miles | <u>1</u> Over 200 miles |
| <u>6</u> 50 to 100 miles | |
14. How are radar data recorded? (Check more than one if applicable)
- | | |
|---|---------------------------------------|
| <u>35</u> No radar | <u>4</u> Periodic photograph of scope |
| <u>1</u> No record | <u>6</u> Magnetic tape recording |
| <u>17</u> Manual tracing from scope | <u>7</u> Other (specify) _____ |
| <u>22</u> Time lapse photography of scope | |
15. Other than seeding aircraft, how many airplanes are used for observation purposes?
- | | |
|----------------|------------------------|
| <u>59</u> None | <u>-</u> Two |
| <u>2</u> One | <u>5</u> Three or more |

16. Which of the following parameters are measured and recorded routinely by either seeding or observation aircraft?

<u>29</u> No aircraft	<u>23</u> Cloud dimensions
<u>4</u> None	<u>25</u> Vertical motions
<u>31</u> Temperature	<u>30</u> Aircraft position
<u>9</u> Humidity or Dew Point	<u>29</u> Aircraft altitude
<u>8</u> Cloud liquid water content	<u>9</u> Radar echos
<u>5</u> Hydrometeor samples	<u>11</u> Cloud photography
<u>15</u> Turbulence	<u>4</u> Other (specify) <u>Icing; electric charge</u>
<u>9</u> Nuclei concentration	<u>RVR; winds, visibility, ceiling</u>

17. How is precipitation measured in the project area? (Check more than one if applicable)

6 No measurements
47 Existing (NWS, FAA, SCS, etc.) instrumentation
30 Special project instrumentation

18. How many precipitation stations of each type are located within the target area?

33 Not applicable

Non-Recording Raingages:

<u>10</u> 1 - 5	<u>16</u> 11 or more
<u>2</u> 6 - 10	

Recording Raingages:

<u>10</u> 1 - 5	<u>17</u> 11 or more
<u>2</u> 6 - 10	

Telemetered Raingages:

<u>5</u> 1 - 5	<u>2</u> 11 or more
<u>3</u> 6 - 10	

Snow depth or water equivalent measurements:

<u>6</u> 1 - 5	<u>2</u> 11 or more
<u>1</u> 6 - 10	

Telemetered snow pack data:

<u>8</u> 1 - 5	<u>--</u> 11 or more
<u>1</u> 6 - 10	

Hail sensors:

<u>2</u> 1 - 5	<u>6</u> 11 or more
<u>-</u> 6 - 10	

19. How many surface wind observations from the project area are available for real-time use by project personnel?

5 None

6 4 to 6

54 1 to 3

4 7 or more

20. How many personnel are assigned to this project? (Do not include generator operators hired locally)

	Meteorologist*		Technical**		Other	
	Full Time	Part Time	Full Time	Part Time	Full Time	Part Time
None	3	3	3	1	2	2
One	18	3	5	28	1	5
2 to 4	35	8	14	7	1	4
5 or more	2	2	13	10	5	2

* Meteorologist includes those with a degree in atmospheric sciences or at least five years experience in a professional level job in meteorology.

** Technical personnel includes technicians and pilots not qualified as meteorologists.

21. What qualifications does the Project Director* possess? (Check more than one if applicable)

16 Certified by WMA

50 Degree in Atmospheric Sciences

5 Less than three years experience in weather modification

18 Three to seven years experience in weather modification

40 Over seven years experience in weather modification

2 Other (specify) Retired airline pilot; airline office

* Project Director is defined as the person having direct and immediate control over the decision to conduct an operation.

22. What qualifications does the person(s) possess who determines the precise moment and location for initiating a seeding action (ie: A pilot who ignites a pyro when he finds an updraft, etc.) (Check more than one if applicable)

7 Certified by WMA

41 Degree in Atmospheric Sciences

9 Less than three years experience in weather modification

21 Three to seven years experience in weather modification

39 Over seven years experience in weather modification

2 Other (specify) _____

23. What is the distance from the target area to the Project Office where major control of seeding operations is located?
- | | |
|---------------------------|---------------------------|
| <u>40</u> Within 20 miles | <u>3</u> 101 to 200 miles |
| <u>2</u> 21 to 50 miles | <u>0</u> 201 to 500 miles |
| <u>3</u> 51 to 100 miles | <u>21</u> Over 500 miles |
24. Which of the following information sources are available in the Project Office?
- | | |
|---------------------------------|--|
| <u>48</u> Service A teletype | <u>3</u> APT Satellite receiver |
| <u>38</u> Service C teletype | <u>18</u> Other (specify) <u>Telecopier; BuRec</u> |
| <u>43</u> NWS Facsimile Service | <u>data terminal; telephone to weather office</u> |
25. Which of the following are used as major inputs to seeding decisions? (Real-time usage)
- | | |
|--------------------------|--|
| <u>57</u> Forecast skill | <u>47</u> Radar data |
| <u>9</u> Computer models | <u>17</u> Telemetered weather observations |
| <u>18</u> Nomograms | <u>38</u> Visual observations |
26. Are there specific criteria for suspending seeding operations based on safety or damage considerations written and filed for this project?
- | | |
|---------------|--------------|
| <u>56</u> Yes | <u>13</u> No |
|---------------|--------------|
27. If so, which of the following items are specified. (Check more than one if applicable)
- | | |
|--|--|
| <u>45</u> Precipitation totals | <u>4</u> Avalanche |
| <u>34</u> Precipitation intensity | <u>8</u> Air mass temperature |
| <u>40</u> Flood potential | <u>10</u> Wind speed or direction |
| <u>33</u> Severe weather (thunderstorm, tornado, etc.) | <u>9</u> Other <u>Hurricane position; runway conditions; reservoir storage; snowpack</u> |
28. Was an Environmental Impact Statement or report prepared and filed for this project?
- | | |
|---------------|--------------|
| <u>13</u> Yes | <u>56</u> No |
|---------------|--------------|
29. Who provides the funding for this project? (Check more than one if applicable)
- | | |
|--|--|
| <u>13</u> Federal Government | <u>10</u> Industry |
| <u>5</u> State Government | <u>27</u> Other (specify) <u>Private funds; airlines; university</u> |
| <u>12</u> County or local government | |
| <u>7</u> District (Water users Assoc., etc.) | |
30. Who actually operates this project?
- | | |
|-------------------------------------|---|
| <u>7</u> Federal Government | <u>47</u> Private meteorological company |
| <u>4</u> State Government | <u>4</u> Other industry |
| <u>5</u> County or local government | <u>7</u> Other (specify) <u>Aviation FBO; non-profit associations</u> |
| <u>2</u> University | |