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National Weather Service

Range of Radar Detection Associated with Precipitation Echoes of Given Heights by WSR-57 at Missoula, Montana.

RAYMOND GRANGER

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U. S. DEPARTMENT OF COMMERCE
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NATIONAL WEATHER SERVICE

NOAA Technical Memorandum NWSTM WR-85

RANGE OF RADAR DETECTION ASSOCIATED WITH PRECIPITATION ECHOES OF GIVEN HEIGHTS BY THE WSR-57 AT MISSOULA, MONTANA

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Missoula, Montana

WESTERN REGION
TECHNICAL MEMORANDUM NO. 85

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RANGE OF RADAR DETECTION ASSOCIATED WITH PRECIPITATION ECHOES OF GIVEN HEIGHTS BY THE WSR-57 AT MISSOULA, MONTANA

I. INTRODUCTION

To properly interpret radar information, the "user" must understand the capability and limitations of the radar [1]. This report was prepared to supplement previous reports [2,3], which had shown the amount of radar beam blocking due to the mountainous terrain surrounding the Missoula, Montana, WSR-57 radar (see Figure 1). The radar is located atop an 8,000-foot peak near Missoula. A blocking diagram had been prepared which showed the height that reflective particles would have to reach in order to penetrate the radar beam (see Figure 2).

The data described in the following pages will show the range of radar detection associated with precipitation echoes of given heights.

II. METHOD

At Missoula, Montana, a portion of the hourly radar observation consists of a paper overlay on which all precipitation echoes have been traced. The radar-indicated height of the precipitation echoes are entered for the more important echoes. Observation time limits have made it impossible to do more than a random sampling of radar tops of the more significant precipitation echoes.

The hourly radar overlays were examined closely for the years 1968 and 1969. The locations of all echoes for specific ranges of maximum radar tops were noted on grid maps. An assumption was made that all echo tops did not exceed the indicated maximum top.*

The map used to locate the echoes was divided into grids of 10 minutes latitude and 15 minutes longitude, or approximately 10-nautical-mile squares, see Figure 3. The grid map is the fire-weather forest boundary radar overlay developed by this station for use during the forest-fire season for locating convective echoes with respect to forest areas [4]. The size of the grid on this map gave sufficient detail to echo location. By placing the grid overlay over the regular hourly overlay on a light table, the echo location could be accurately and easily noted.

Separate grid maps were used for the different ranges of tops:

10,000 ft msl and below	18,000 - 20,000 ft msl
11,000 - 12,000 ft msl	21,000 - 25,000 ft msl
13,000 - 14,000 ft msl	26,000 - 30,000 ft msl
15,000 - 17,000 ft msl	greater than 30,000 ft msl.

*Note that the top of a radar echo is the top of the precipitation column within the cloud and can differ from the top of the visual cloud by as much as one-thousand to two-thousand feet.

The first year of data examined showed less than 500 cases for some of the above ranges of tops. A second year was examined for those ranges that had less than 500 cases. It was hoped that at least 500 cases in each height range could be examined but even with two years of data, a few of the height ranges lacked sufficient cases.

Height Range	Cases in: 1968	1969	Total
10,000 ft msl or less	136	244	340
11,000 - 12,000 ft msl	421	(266)part.	687
13,000 - 14,000 ft msl	868	--	868
15,000 - 17,000 ft msl	1425	--	1425
18,000 - 20,000 ft msl	587	--	587
21,000 - 25,000 ft msl	487	(150)part.	637
26,000 - 30,000 ft msl	180	231	411
greater than 30,000 ft msl	189	158	347

When a total of ten occurrences were entered in a particular grid, no other occurrences were tabulated for that grid. Figure 3 through 10 show the range of echo heights. On each chart the enclosed blank area indicates those grid areas in which at least ten occurrences were tabulated. Grid areas enclosed by single hatching had 5 to 9 occurrences, and grid areas enclosed by double hatching had 2 to 4 occurrences. The dotted line on some of the charts is the nearest height line taken from the blocking diagram , Figure 1.

Figures 11 and 12 show a summary of the range height comparisons for ten or more occurrences in the enclosed grid squares.

III. DISCUSSION

Several assumptions were made in the course of this study:

1. All echoes shown on overlays were no higher than the maximum radar top.
2. Radar beam propagation was normal.
3. Echoes beyond the range at which tops could be measured were also no higher than the indicated maximum radar top.
4. Height indicator of the radar was always properly calibrated.
5. The highest top was measured.
6. The overlay was properly located on the radarscope when echo location was tabulated.

All these items could have been in error at some time; so data in this report provides only general estimate of tops and range.

The charts 3 - 10 show clearly the operational range of the Missoula radar for various precipitation tops. Only generalized statements can be made regarding the range-height comparisons. The enclosed blank area

shows where precipitation echoes of that height will be seen "nearly all the time". The extended area indicated by the single hatching shows where precipitation echoes of that height will be seen "some of the time". The extended area bounded by the double hatching shows where precipitation echoes of that height will be seen "now and then". The terms used to describe the frequency of detection are hardly precise but percentages of detection could not be determined by the method for this report.

An interesting sidelight obtained during this study was the frequency by month of the various ranges of tops (see Table I).

IV. REFERENCES

1. Benner, H. P. *Interpreting the Rarep,* Western Region Technical Memorandum No. 8, May 1966.

2. Pappas, R. G. *Derivation of Radar Horizons in Mountainous Terrain,* Western Region Technical Memorandum No. 22, April 1967.

3. Granger, R. *The WSR-57 Radar Program at Missoula, Montana,* Western Region Technical Memorandum No. 34, October 1968.

4. Peterson, R. R. *Transmitting Radar Echo Locations to Local Fire Control Agencies for Lightning Fire Detection,* Western Region Technical Memorandum No. 20, March 1967.

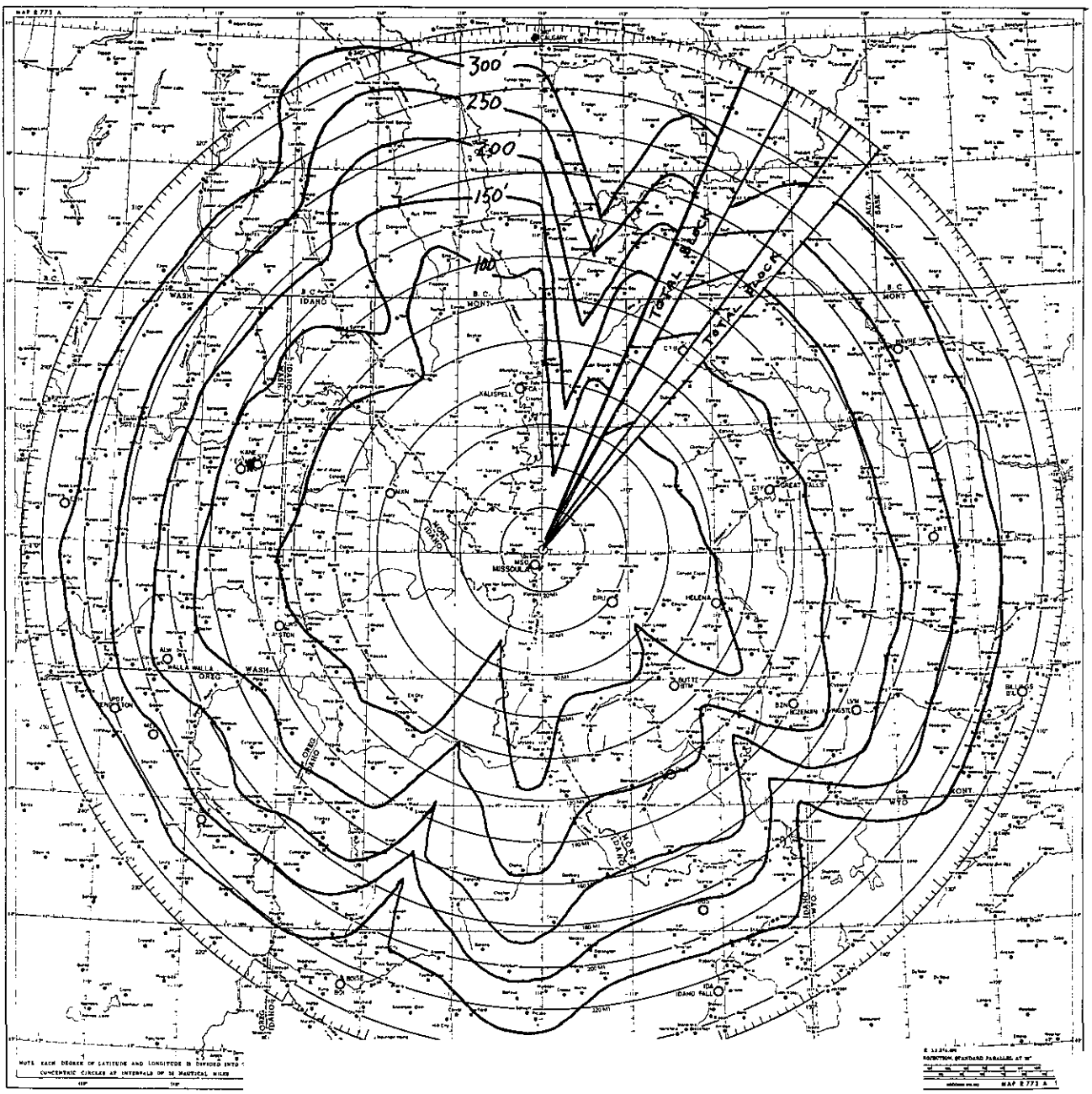

Figure 1. WSR-57 Radar Beam Blocking Chart, Missoula WSO, Montana. (Heights in hundreds of feet.)

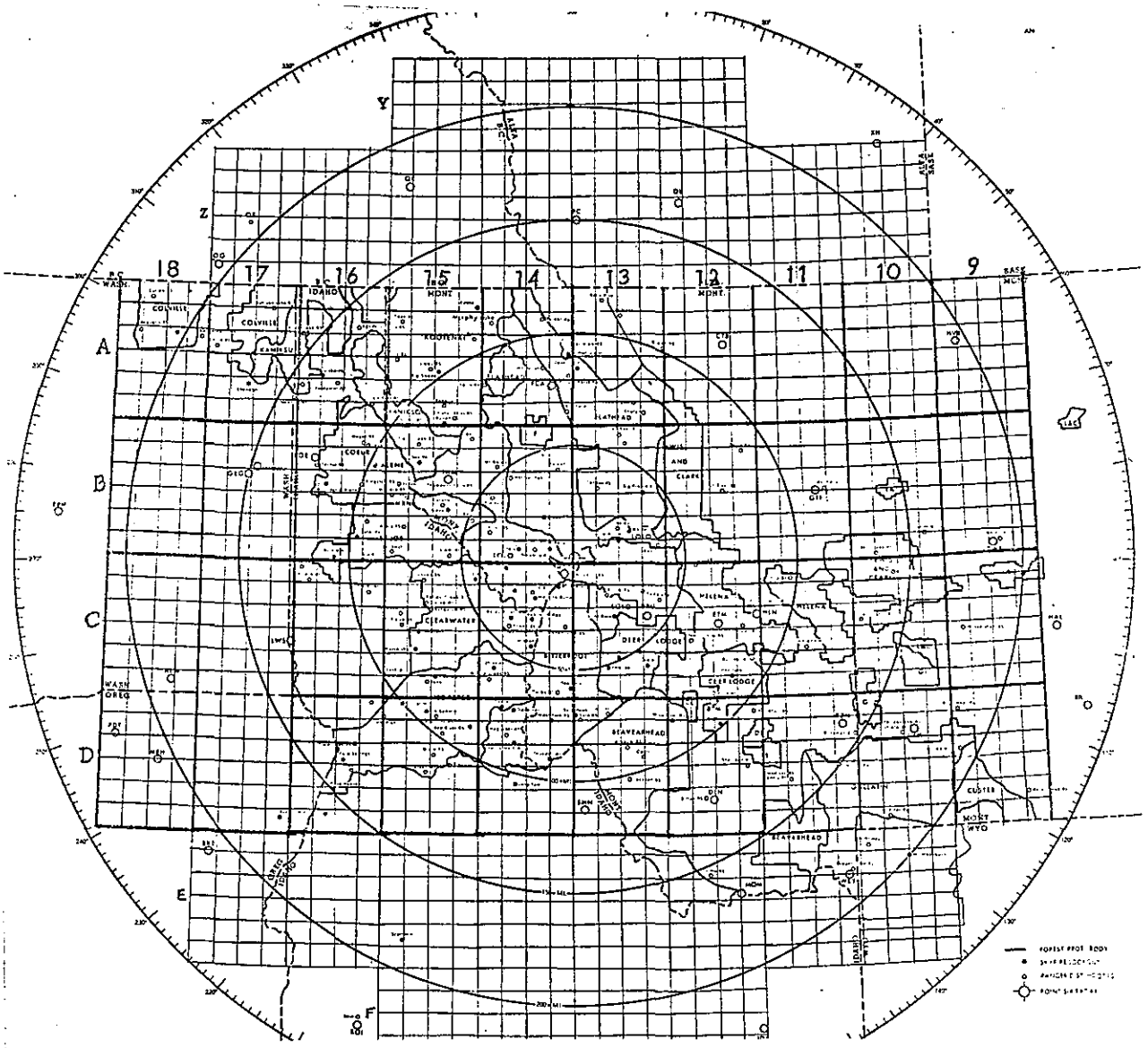

Figure 2. Fire-Weather Forest Boundary Radarscope Overlay Used for Locationg Convective Echoes with Respect to Forest Areas.

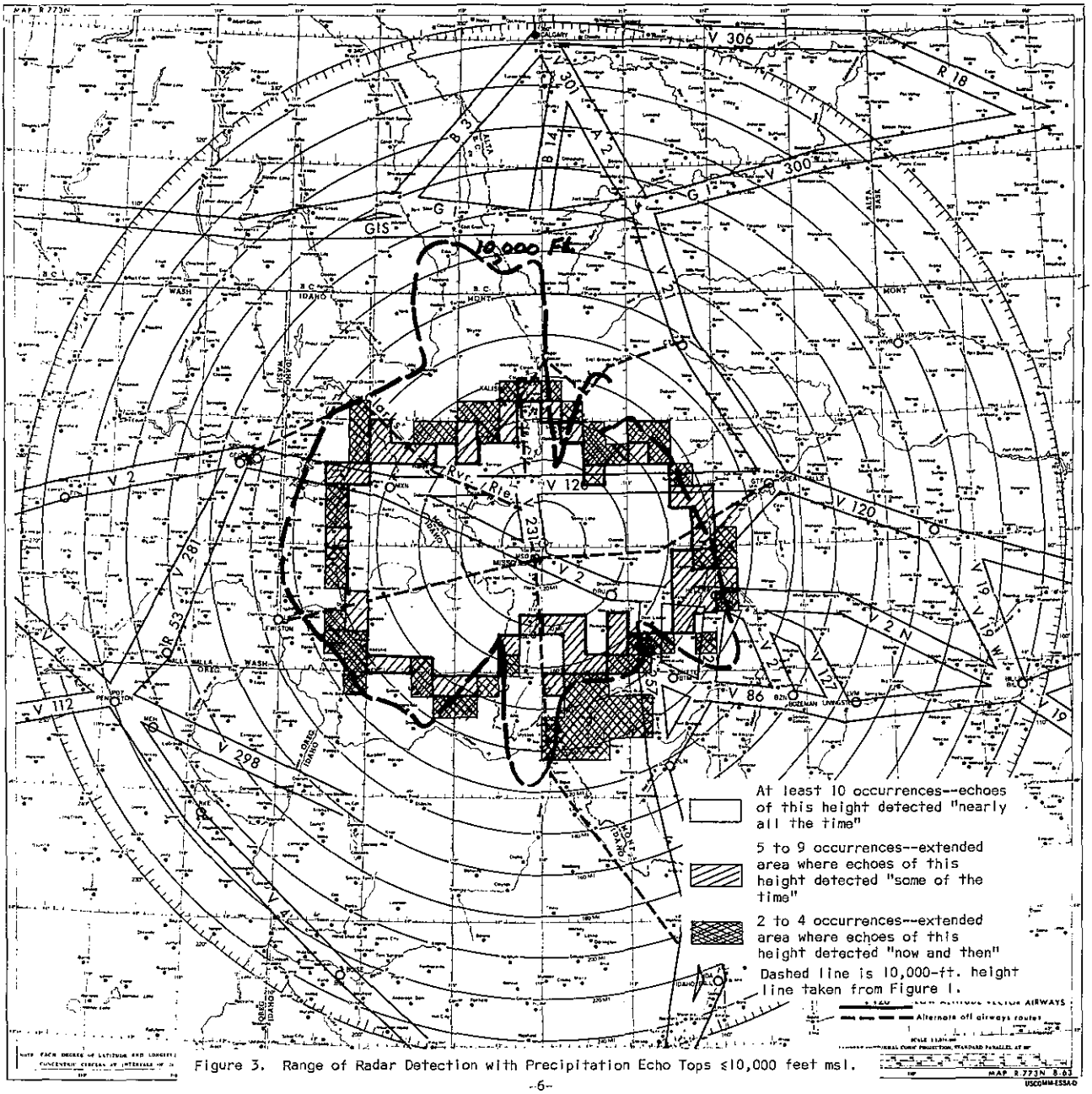

Figure 3. Range of Radar Detection with Precipitation Echo Tops ≤10,000 feet msl.

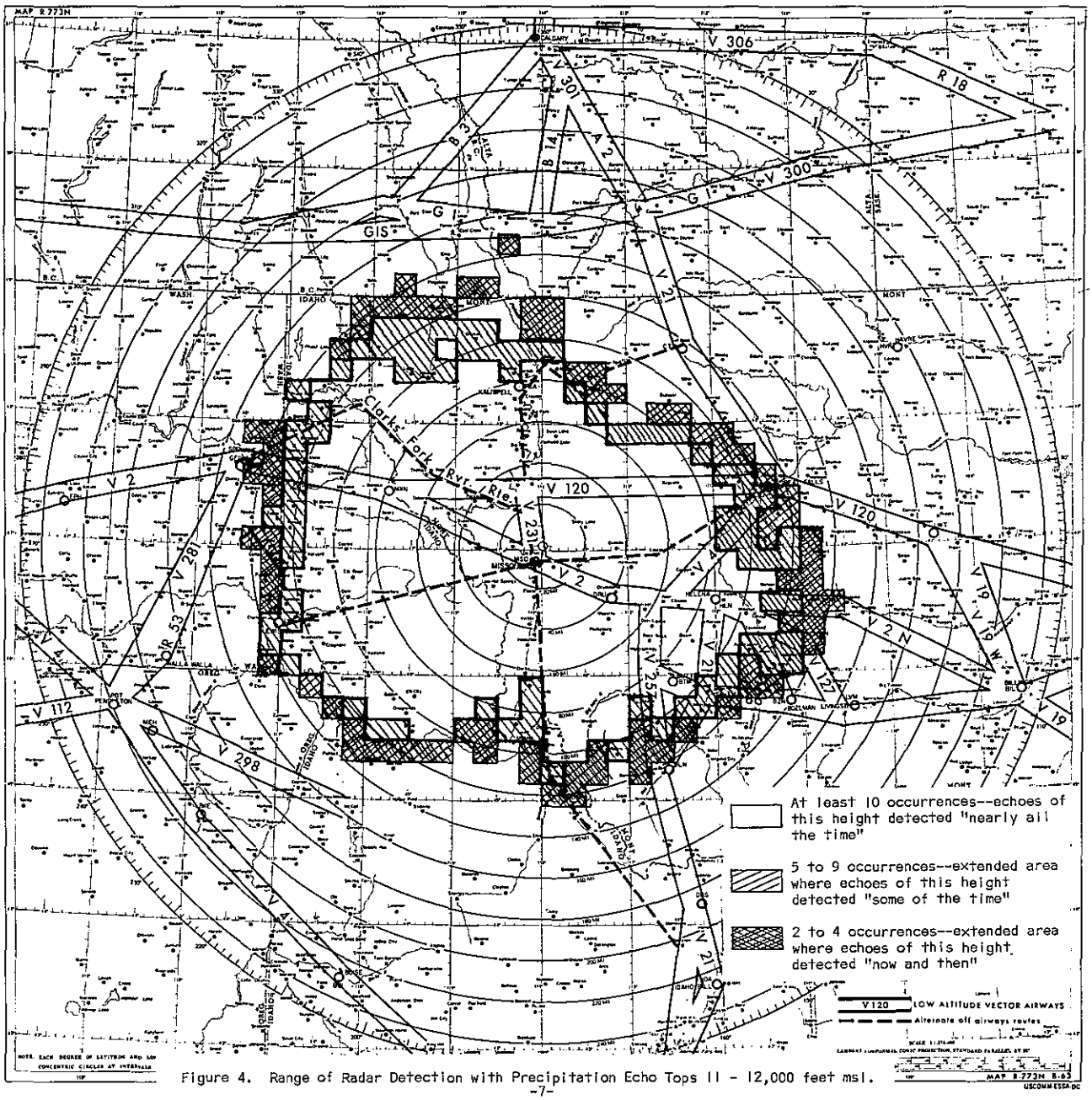

Figure 4. Range of Radar Detection with Precipitation Echo Tops 11 - 12,000 feet msl.

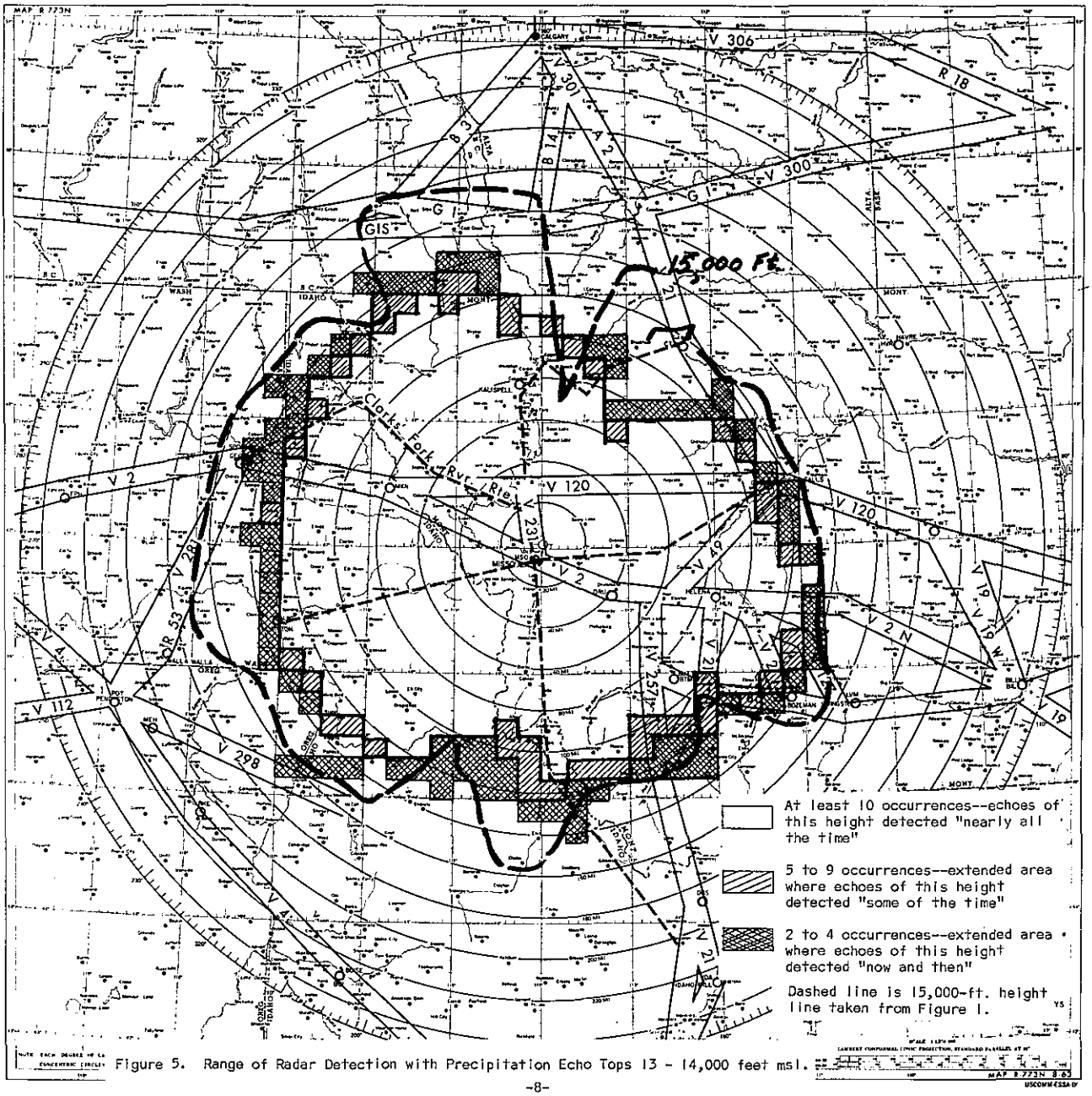

Figure 5. Range of Radar Detection with Precipitation Echo Tops 13 - 14,000 feet msl.

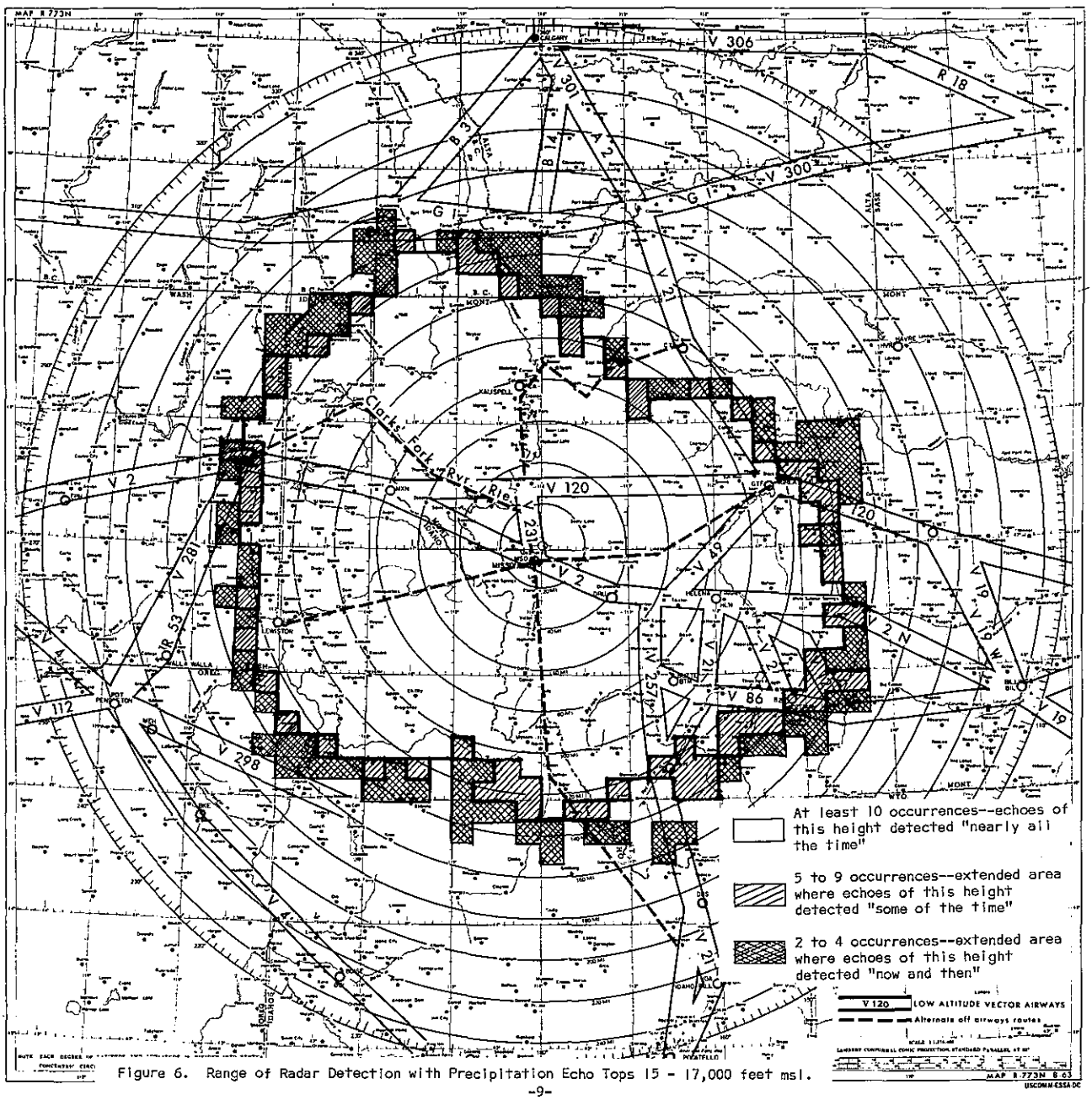

Figure 6. Range of Radar Detection with Precipitation Echo Tops 15 - 17,000 feet msl.

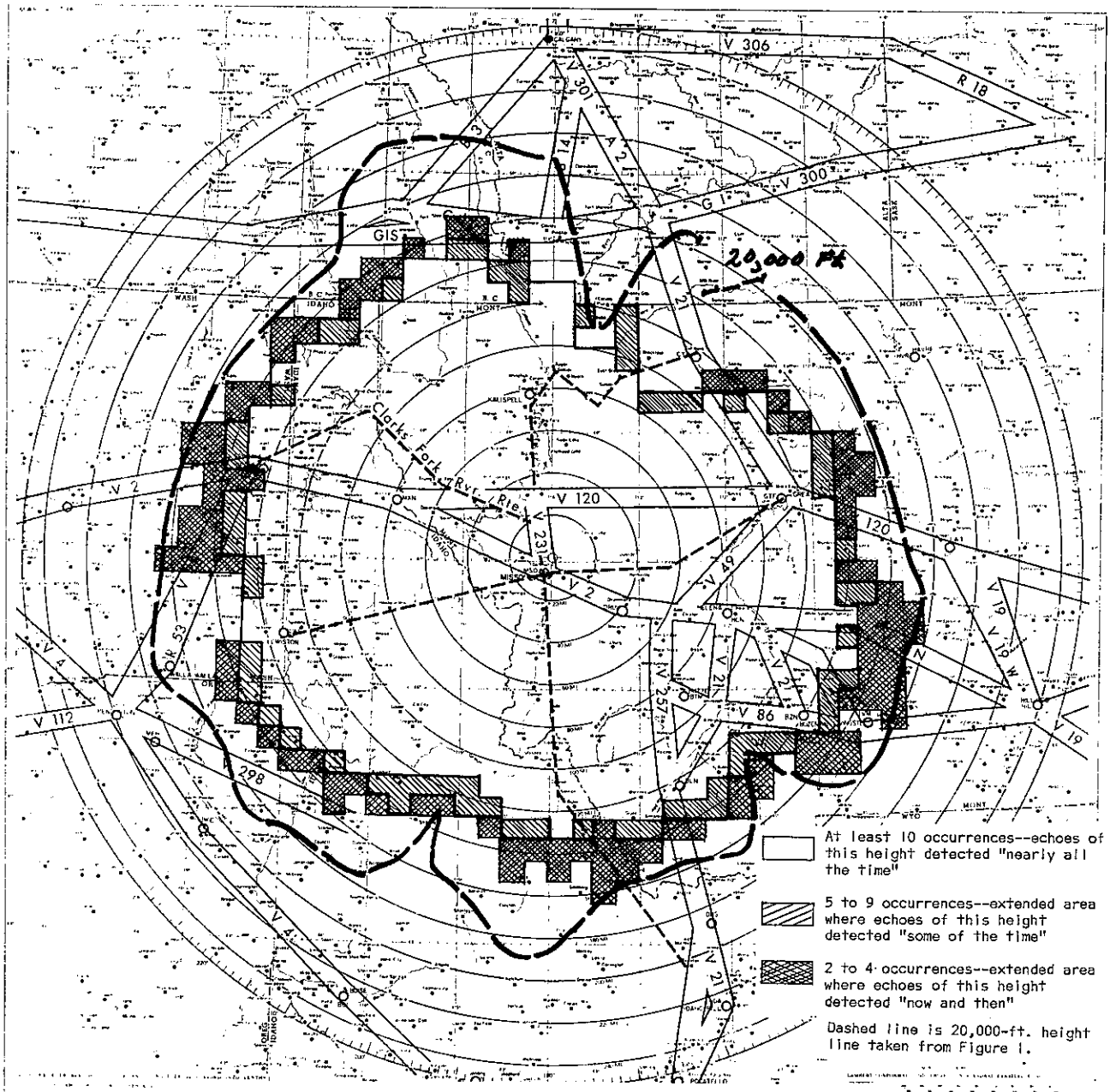

Figure 7. Range of Radar Detection with Precipitation Echo Tops 18 - 20,000 feet msl.

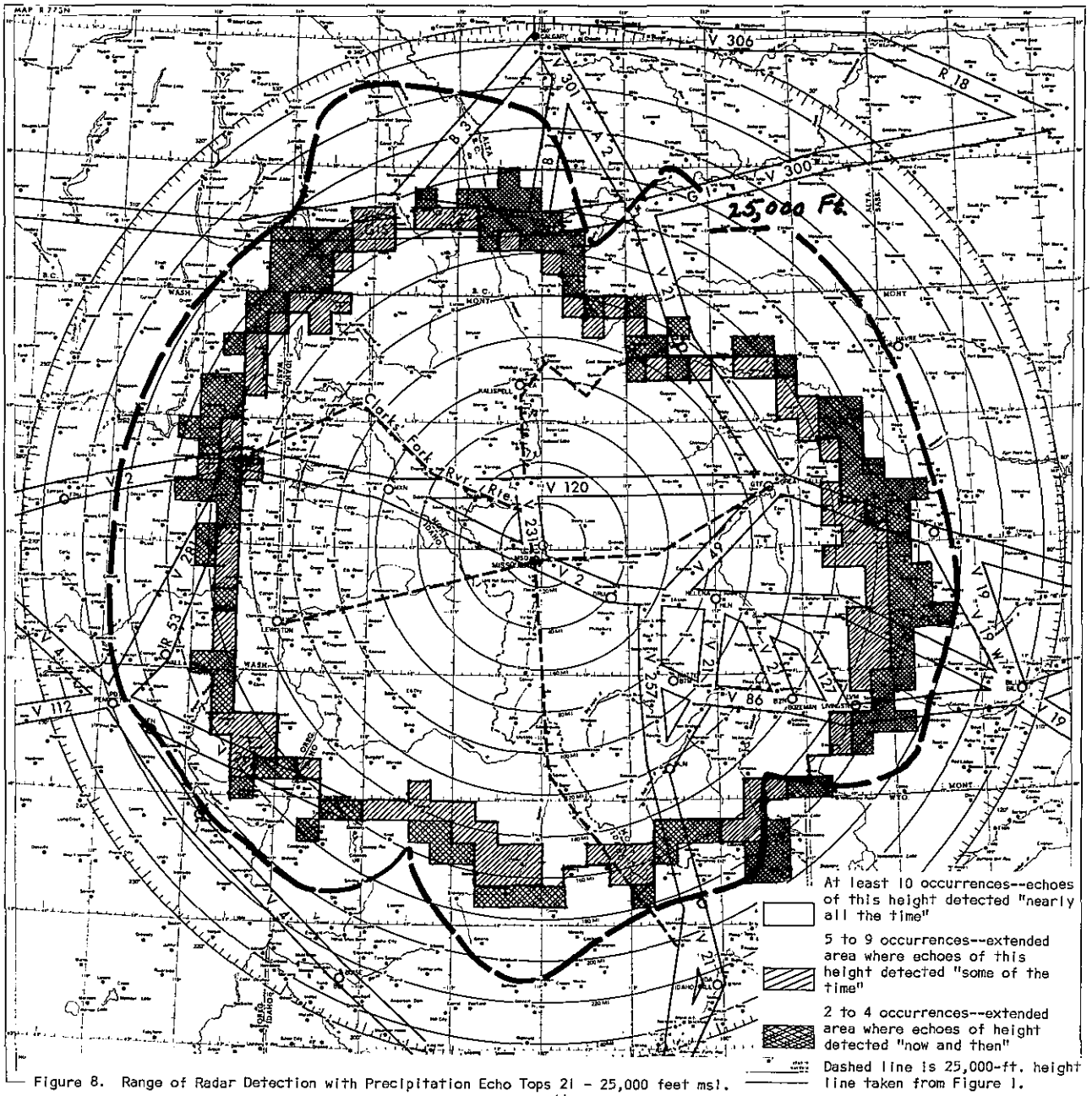

Figure 8. Range of Radar Detection with Precipitation Echo Tops 21 - 25,000 feet msl.

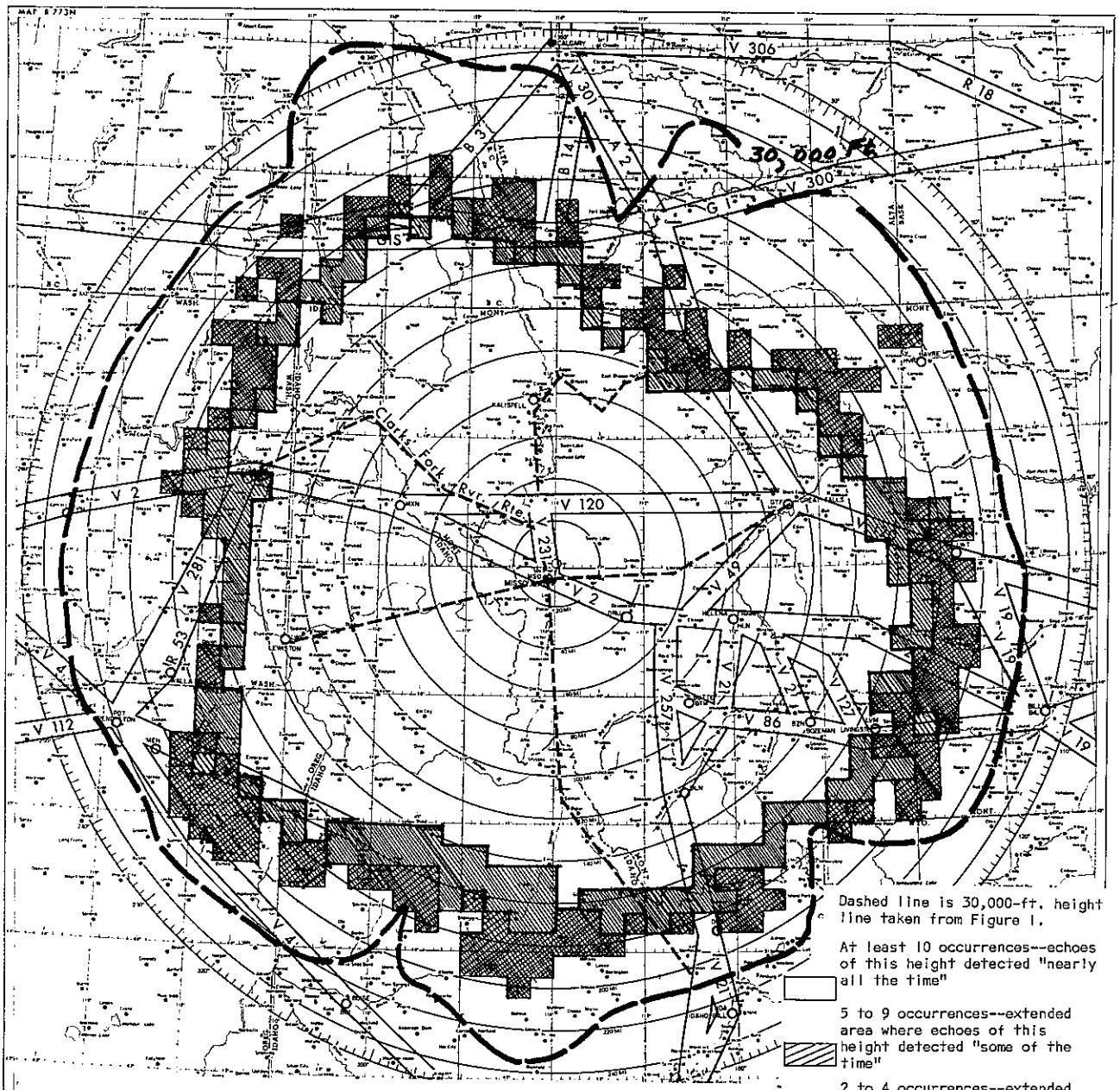

Figure 9. Range of Radar Detection with Precipitation Echo Tops 26 - 30,000 feet msl.

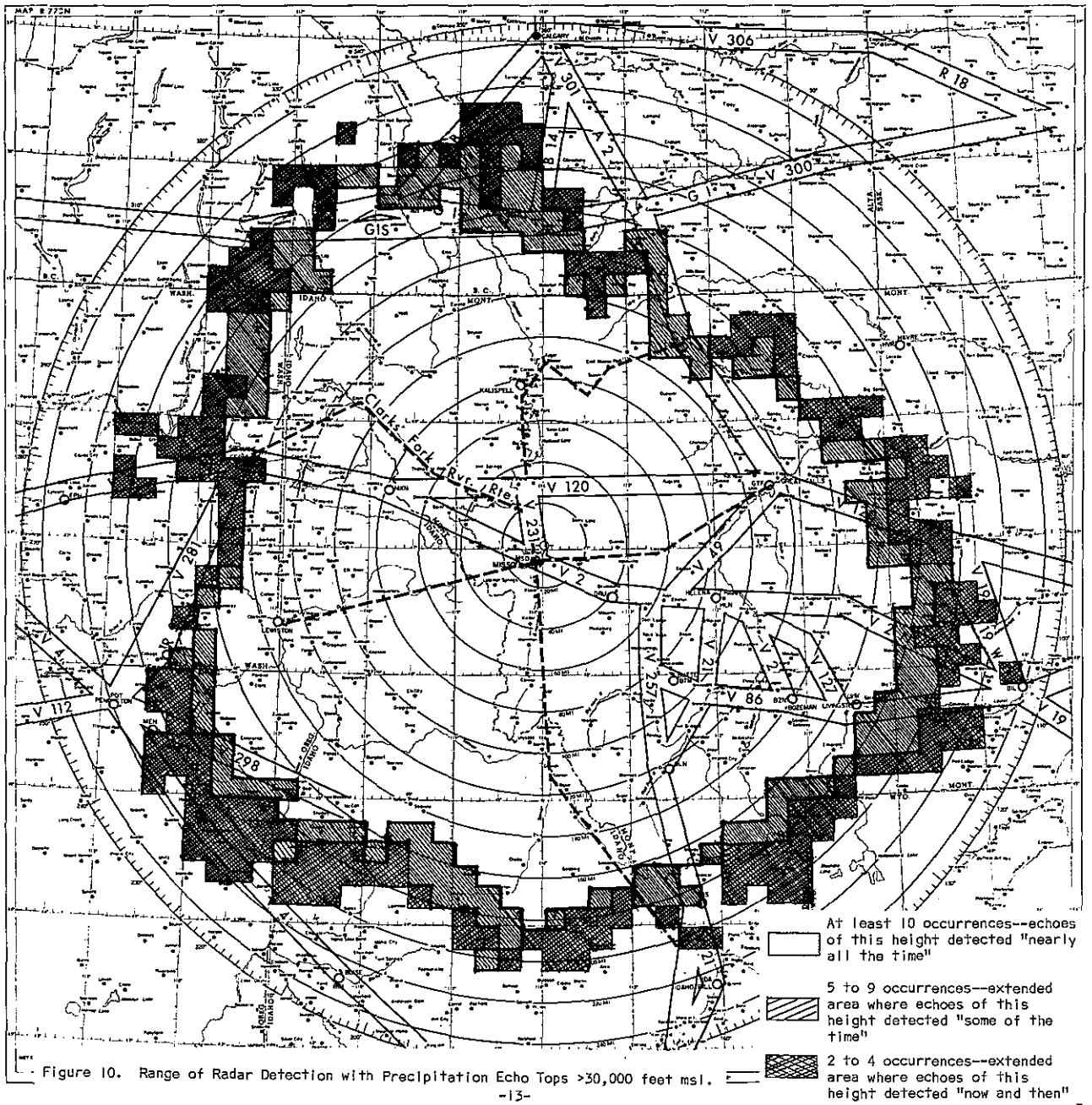

Figure 10. Range of Radar Detection with Precipitation Echo Tops >30,000 feet msl.

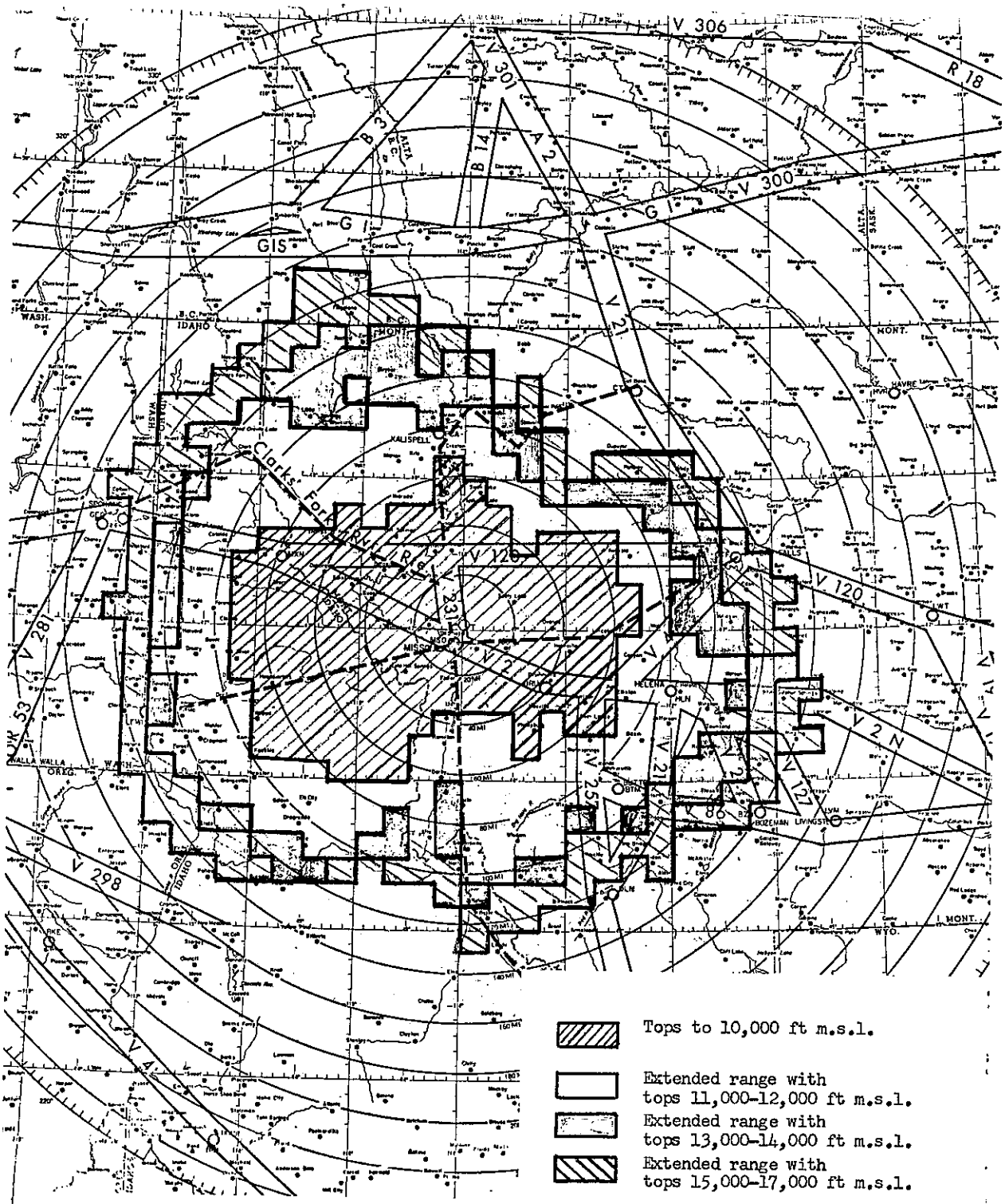

Figure 11. Ranges of Radar Detection of Precipitation Echoes of Various Heights. These Ranges Based Upon at Least 10 occurrences of Echoes within the 10 Nautical Mile Squares Shown in Figure 3.

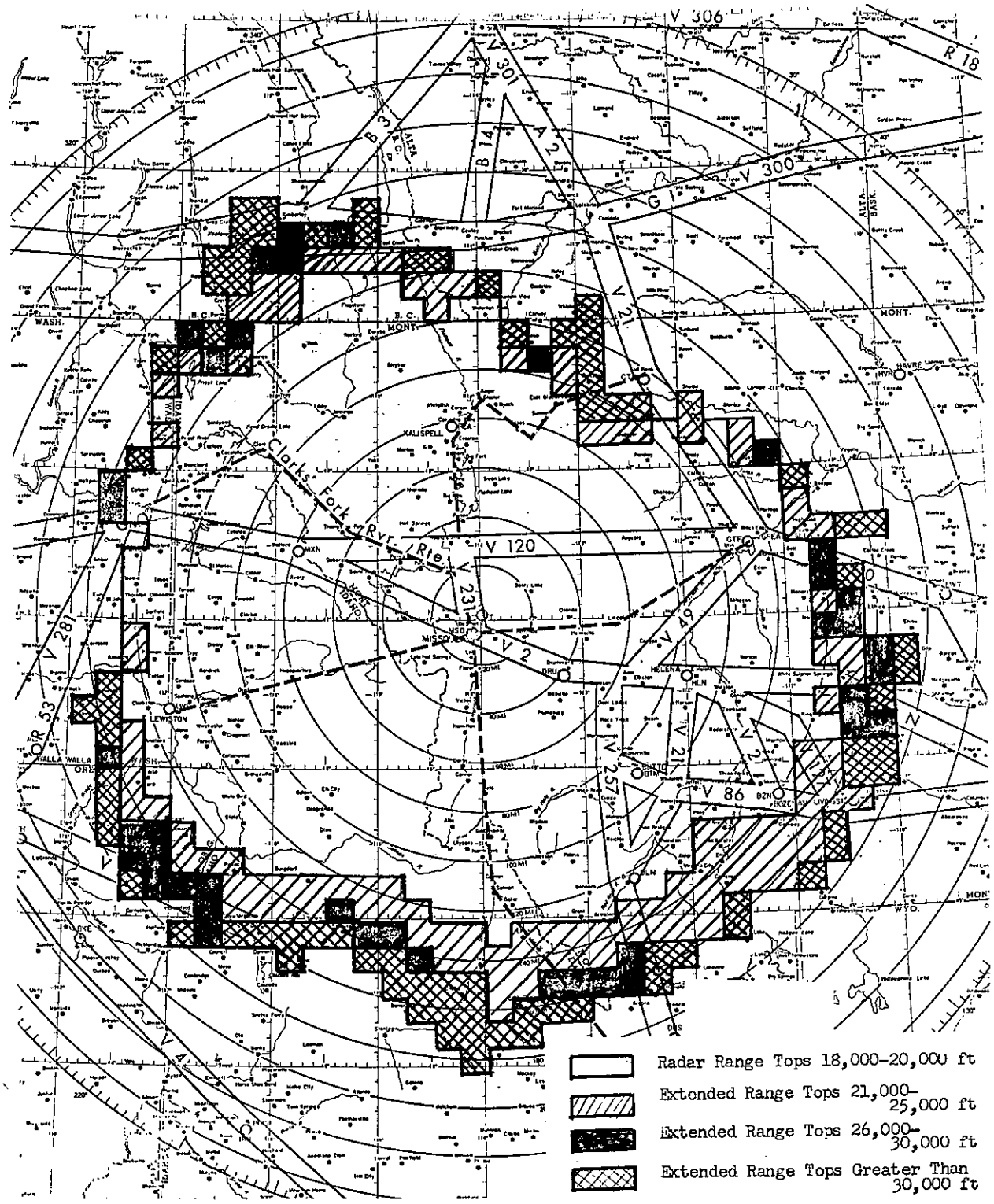

Figure 12. Ranges of Radar Detection of Precipitation Echoes of Various Heights. These Ranges Based Upon at Least 10 Occurrences of Echoes within the 10 Nautical Mile Squares Shown in Figure 3.

TABLE I

FREQUENCY OF RADAR-MEASURED TOPS OF PRECIPITATION ECHOES,
MISSOULA, MONTANA

	Height in Hundreds of Feet							
	90-100	110-120	130-140	150-170	180-200	210-250	260-300	Above 300
1968								
Jan	33	69	106	66	18			
Feb	15	44	34	117	25	18	2	
Mar	5	56	156	133	11	5	3	
Apr	8	78	101	110	33	23	1	
May	8	15	54	113	63	65	26	8
Jun	4	20	70	124	89	74	33	23
Jul		3	14	36	40	52	29	76
Aug		11	13	68	110	121	44	63
Sep	1	8	38	91	76	94	39	19
Oct	6	20	59	200	46	19		
Nov	14	48	95	183	27	7	3	
Dec	42	49	128	184	49	9		
TOTAL	136	421	868	1425	587	487	180	189
1969								
Jan	3	28	41	159	20	8		
Feb	32	88	68	45	10	2		
Mar	15	22	65	60	8	6	1	
Apr	24	45	94	101	45	30	11	16
May	2	11	43	88	61	41	20	8
Jun	6	28	34	67	52	53	35	37
Jul		6	22	44	27	59	47	18
Aug		2	2	14	17	45	45	28
Sep	5	5	8	62	85	154	70	51
Oct	23	50	55	126	50	19	2	
Nov	22	48	53	46	16	4		
Dec	112	90	65	58	2			
TOTAL	244	423	550	870	393	421	231	158
1968-69								
Jan	36	97	147	225	38	8		
Feb	47	132	102	162	35	20	2	
Mar	20	78	221	193	19	11	4	
Apr	32	123	195	211	78	53	12	16
May	10	26	97	201	124	106	46	16
Jun	10	48	104	191	141	127	68	60
Jul		9	36	80	67	111	76	94
Aug		13	15	82	127	166	89	91
Sep	6	13	46	153	161	248	109	70
Oct	29	70	114	326	96	38	2	
Nov	36	96	138	229	43	11	3	
Dec	154	139	193	242	51	9		
TOTAL	380	844	1418	2295	980	908	411	347