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HANFORD ATOMIC PRODUCTS OPERATION - RICHLAND, WASHINGTON

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Appendix to RSC-Hanford Report - Trip Report,
Hanford Works, March 30 - April 14, 1948

AUTHOR

R. C. Wanta and F. D. White

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Appendix to RSC-Hanford Report

This document consists of 10 pages
and Table I of 2 pages. Copy No.
of 16 copies. Series E.

Richland, Washington
April 14, 1948

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Thru: Chief, Special Scientific Services

WORK 1 OF 1, SERIES MA

Subject: TRIP REPORT, HANFORD WORKS, MARCH 30 - APRIL 14, 1948

Dear Sir:

This trip was made in response to a request of Mr. R. S. Warner, Jr.,
Atomic Energy Commission. The purpose of the visit, as stated by Mr.
Warner and amplified by Messrs. A.E. Gorman and G. H. Christenson of
his office, was to provide an answer to these questions:

- a. Are Hanford meteorological instrumentation, methods, and re-
cords adequate? Do they conform to generally recognized
practice? Are they effectively utilized?
- b. What is the percentage frequency of wind classified according
to conditions normal, least favorable and most favorable for
dilution?
- c. What is the habitability of the Wahluke Slope north and north-
east of the Columbia River, considering stack gases, various
stack heights, any pertinent meteorological features? What is
the habitability if the only contaminating sources are the piles?
- d. In preparation for and in the event of a major catastrophe
with attendant relief and evacuation operations, what additional
observations should be taken? What weather data should be
assembled from the general vicinity of Hanford? What sampling
program should take place immediately after the accident?

To these may be added a question raised by Dr. Parker in connection with
the high level of contamination at the ground in the vicinity of the
separations areas:

- e. What meteorological conditions bear on the "partial" problem?

The questions are discussed below in similar order.

Principal people contacted were: Mr. David Shaw, Area Manager, Atomic
Energy Commission, Mr. Roy Hagaman, Chief of Operations, Atomic Energy
Commission, Mr. W. K. Crane, Assistant to the Chief of Operations,
Atomic Energy Commission, Dr. H. H. Parker, Health Instruments, General

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Electric; Dr. P. E. Church, Meteorological Consultant to General Electric; Mr. D. Jenne, Supervisor, Meteorology Group, General Electric, and members of the Health Instruments and Meteorology units.

A. Hanford Meteorology Group

The Meteorology Group consists of a supervisor and seven technicians. None is a professional meteorologist. Dr. P. E. Church of the University of Washington organized the group and serves as meteorological consultant, visiting the area on the average four days a month. The Meteorology Group reports to the production (separation) plant. ©

The chief responsibility of the group is to prepare forecasts which determine whether or not the separations plants will omit gases from their stacks. These are "batch" processes, roughly averaging five hours. An expected "least dilution" of 500 or more at the ground of stack gases (200 ft. stacks) constitutes a favorable forecast. The stacks normally emit during the hours 0800 to 1600. In the typical operating condition, the stack gases remain aloft, i.e., infinite dilution at the ground in the neighborhood of the stack at the time of emission, except for large particles that may be present. Forecasts are also prepared for the electrical department (high winds), the construction units (general weather), and so forth.

The technique of forecasting dilutions of waste stack gases is based upon a large number of measurements of oil-fog smoke released from a 200 foot stack under varying meteorological conditions, during a preliminary research period in 1943 and 1944. It is Dr. Church's contribution that technicians having little previous weather experience prepare with a high degree of accuracy, 8-hour forecasts giving dilutions hour by hour. Based upon preliminary research, a chart has been prepared by Dr. Church which gives "least dilution" when entered with temperature change with height in the lowest 200 foot and wind speed at 200 foot.

The weather instrumentation has been reported previously, but briefly consists of a 400 foot tower, with continuously recorded wind direction at 100 foot intervals beginning at 100 foot, and continuously recorded wind speed at 7 foot and at 50 foot intervals beginning at 50 foot; cyclically recorded temperature just below soil surface, at 4 foot and at 50 foot intervals beginning at 50 foot; and complete pilot balloon equipment. Hourly airway type observations are taken. Hourly wind data from the 100 Areas on the northern side of the reservation are telephoned to the group. Knowledge of the general weather situation affecting the area is gained by telephone call to the Seattle District Forecast Center. Positions of fronts, pressure centers, and significant isobars are plotted on sectional maps, and movement of fronts and pressure centers is given. These telephone calls are the bases for the local forecast, though one must also mention the

local airway broadcasts from neighboring range stations, from which hourly reports from local airports are copied. There is no teletype facility.

Considering the large volume of data handled daily, the records are maintained in good order. All records are still classified. Many of the forms in use are local and non-standard, as one must expect in a unique facility of this type. There was little evidence that old charts and records were being utilized for research purposes, although Dr. Church stated that certain phenomena are being investigated. Here is a considerable pool of data from which much additional knowledge of pollution and diffusion may be obtained.

Summaries of meteorological data are prepared by group personnel from day to day. Forecasts are verified routinely. Summaries are prepared in a form most useful for the production unit to which the group is attached. More will be said about this in the following section.

B. Wind Direction by Dilution Class

Unfortunately, Hanford meteorological data have not been summarized in this form. The nearest approach, in the monthly meteorological summary, is the percentage frequency of wind direction and respective mean speeds (200 ft. level) for each of the three eight hour periods beginning at midnight, and separately, the percentage frequency of the various "least" dilution classes: less than 500, 500-1000, greater than 1000, and aloft for similar 8-hour periods, Table I shows a summary for January, April, July and October of 1947.

Meteorological data accompanying Health Instrumentation reports fall short of what they might be. In connection with the "particle" problem, we prepared two and one-half months of wind direction-dilution data. These data showed that a wind rose for the condition when gases remain aloft may be significantly different from the case when gases come to the ground in the neighborhood of the stack with small or large dilution. A memorandum was prepared for Dr. Parker suggesting a form of summarization of wind-dilution data that may be more useful for analysis of his group's areal measurements.

(Table I)

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C. Wahluke Slopes

The Wahluke Slope area is shaped like a giant kidney bean, the Columbia River forming the more curved southern boundary, while the crest of the Saddle Mountain forms the northern and northeastern boundary. The course of the River is southward on the west, crossing the crest at Beverly Gap, then eastward at a distance of about 12 miles south of the crest for about 15 miles, then northeastward for about 12 miles to a point 5 miles south of the crest, and finally southeastward for about 20 miles at an average distance from the ridge line of about 8 miles. Along this tortuous path the river drops about 100 feet, from 450 to 350 feet above sea level. A 200 to 500 foot bluff parallels the river on the slope side at distances up to a mile from the north bank, except where the course of the river lies northeastward; along this 12 mile stretch the bluffs lie about 3 miles northwest of the river and are hardly worth the name, rising gently only 150 feet.

The separation plants lie about 12 miles south southwest of the most northerly point of the river. The three pile areas are each situated within a mile of the south bank of the river as follows: where the river moves eastward (100-B); northeastward, near the northernmost point (100-D); and, southeastward (100-F). Sea level elevations for the pile areas are roughly 450, 425, and 400 feet, respectively. The elevation of the surface at the 200 foot stacks of the separation plants is about 700 feet.

With respect to stack gases from the separations area, Dr. Parker states that Wahluke Slope is as safe as Richland. At first glance this is surprising when one considers that Richland lies about 25 miles to the southeast, whereas the average distance from separation plant to Wahluke Slope is about 11 miles. This apparent discrepancy is explained by the usual meteorological conditions for the time of separations plant operations; west northwest wind with waste gases remaining aloft when near the stacks. Westerly through north northwesterly winds prevail over winds with southerly components during plant operating hours in approximately the ratio 3 to 1.

With regard to change of stack height, it must be remembered that the effectiveness of a stack in lowering concentration of effluent at the ground increases nearly with the square of the height.² A decrease from 200 feet to say, 50 feet would increase stack waste concentration in the vicinity of the stack more than ten fold. In spite of this fact, air moving approximately horizontally with respect to sea level could enter the Wahluke Slope, particularly in the central portion. Although increasing stack height above 200 feet would improve conditions at the ground in the immediate vicinity of the stack the effect at distances of 10 miles would be negligible.

Seasonal wind data for the three pile areas indicate that a considerable amount of air from the pile areas enters the Wahluke Slope at its relatively low central portion. Wind rose data for the pile areas which was prepared for us during this visit, show that whereas 100-B has a single maximum direction frequency at West (about 25%); 100-D has a double maximum, west (about 40%) and east (about 12%), and 100-F has a different double maximum, west (about 22%) and southeast (about 16%).

To understand that no air contamination source exists in the pile areas. The consequences on the Wahluke Slope of a disaster in this area will be discussed in the following section.

It must be remembered that although winds with southerly component occur less frequently than those with northerly (ratio 5 to 7), winds with southerly component do occur. Of course, an accident or catastrophe does not wait on wind direction. At distances of ten miles, the stable case (gases remain aloft in neighborhood of stack) would be the worst for the Slope. Profiles of the radioactivity "trend" of vegetation at 50 foot intervals down the southeast end of Rattlesnake Mountain, at a distance of about 12 miles from the separations plant, from 3500 to 400 ft. above sea level, show highest "trend" in the layer from the sea level elevation of the top of the separations stacks to 1000 feet above. Although "least dilutions" of less than 500 at the ground present an undesirable hazard for personnel in the nearest half mile from the stack, it is certainly the most favorable condition at distances of say, 10 miles from the stack. Church 1 has given the following representative values of least dilution:

Stack distance	500'	1000'	5000'
Unstable air (gases to ground)			
400	900	15000 *	
Stable air (gases remain aloft)			
--	150 *	1300	

*extrapolated

The consequences at greater distances than one mile is evident. Furthermore, in the unstable case the average dilution is much greater than the least, (ratio 6 to 1) whereas the average dilution in the blanket of gas aloft in the stable case is, according to Church, only 4 times the least. Where the gas layer meets a slope or other intercepting landform at distances of 10 or more miles, it will certainly present the most significant case for study. Reliable estimates of dilutions at such distances in the stable case are not available; it is believed that detailed study of measurements jointly by Health Instruments and Meteorology, such as the Rattlesnake profiles may lead to reliable estimates of dilution at moderate distances within the stable layer.

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D. Catastrophe

The type of catastrophe generally being considered is not an explosion carrying material to great heights, but rather a "puff" more or less instantaneously resulting in a cloud of contaminant a hundred or so feet in depth. The meteorological condition which will carry this cloud a long distance (say, 19 miles or more) with least dilution is the stable case, the one for which gases from a stack remain aloft in the vicinity of the stack. Assuming that a catastrophe is equally likely to occur at any hour of the day, its meteorological data shows that there is 1 chance in 6 that the slowly diluting low hanging cloud will travel toward Benton City, Richland, or Pasco.

The most vulnerable portion of the Wapluke Slope for a catastrophe in the separation areas appears to be the eastern half. Wind statistics by dilutions are not available, as has been mentioned earlier, but the frequency of southwest winds in the 200 area is relatively high (15%). It is understood that the hazards resulting from a catastrophe in the 200 area would be less than those resulting from a catastrophe in the 100 area. Therefore, the Central portion of the Slope in the region where the bluffs recede from the river is particularly likely to be passed by the cloud when the wind has any southerly component. On the basis of wind frequency, the western half of the Wapluke Slope is least likely to be passed by the cloud.

Several previously published estimates of hazard resulting from a catastrophe in one of the pile areas agree that a human being could tolerate one or two hours exposure at a distance of the order of a mile. The assumed dilution of the cloud is 8500, after 1 mile of movement in a 1 mile per hour wind during stable conditions when the initial size of the cloud approximates the size of the pile building, based in part on some oil-fog measurements made by Church. Since the assumed weather conditions are by no means rare in the 100 areas (stable conditions occur about 33%; winds under 6 mph about 40%), the exceedingly important assumption of dilution equaling 8500 at one mile should be further checked. Since oil-fog measurements were based upon practically a point source, the dilution for an area or volume source of contaminant may be less by as much as one order of magnitude. Unsafe conditions within 10 miles of a pile catastrophe would make most of the Wapluke Slope untenable.

Wind rose data for four months of the year for each of the 100 areas was prepared at our request during this visit. It is obvious that winds in the lowest 50 feet in the pile areas are significantly different from winds at the 200 area. Detailed study of wind conditions in the areas could be undertaken as background data against the event of a disaster. For a similar purpose, more observations of location of the fumes from the separations stacks after nights of operation in stable conditions could be made before the rising sun caused rapid dilution of this layer.

In the latest revision (December, 1947) of the master evacuation plan, no cognizance is taken of weather observations outside the Hanford bowl. Presumably the general weather situation and latest upper wind and temperature data would be obtained from the Seattle District Forecast Center. It is not comforting to imagine a weather technician with no previous professional meteorological training at the Control Center during an evacuation, making the necessary best use of weather data from within and outside the Hanford bowl, and assisting in the interpretation of health physics measurements.

The roving Health Instrument Survey cars which would "attempt to locate and follow the hazard boundaries", would also attempt to "augment the wind information supplied by meteorology". These cars are not equipped with hand anemometers or means for more accurately estimating wind direction, such as compasses. No provision is made in the evacuation plan for measurement of hazard boundary aloft.

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E. "Particle" Problem

An urgent problem facing Dr. Parker at the present time is the presence of exceptionally high levels of radioactivity at the ground within half a mile of the separations stacks. It is understood that the details have been reported separately by Dr. Parker. Small particles (1 micron to 0.1 millimeter) are suspected, and the source is believed effective continuously (24 hours/day). Comparison of measurements made during January, 1948, and a more complete survey made in March shows a shift in position of regions of maximum intensity as though the radioactive particles were drifting with the sand. Areas of low scrub showed higher number of particles or carriers per square foot than bare areas.

Reference material on sand movement was requested for Hanford from the Weather Bureau Library. A summary of wind direction frequency by dilution classes for all hours for the interval between measurements was prepared. More consideration will be given to the meteorological aspects of this problem during the balance of the trip.

References:

1. Meteorological Section Report, January 1943 to July 1944, by P. E. Church, C. A. Gosline Jr., O. H. Newton, J. F. Littingly, L. F. Markus, March 24, 1945.
2. Bosanquet, C. H., and J. L. Pearson, Trans. Faraday Society, London, vol. 32 p. 1249, 1936. See also: Sutton, O.G., Quarterly Journal Royal Meteorological Society, London, vol. 73 p. 431.

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F. Recommendations and Conclusions

Although it is impossible to do a thorough and complete job in a short visit such as ours, the following recommendations and conclusions have been offered to various people at Hanford and are expressed here for your information.

1. Hanford Meteorology Group

- a. Closer routine coordination should be maintained with Health Instruments.
- b. Weather data should be summarized to answer specific requests or problems as well as for purely climatological purposes.
- c. Meteorology should sponsor radioactivity measurements in order to obtain detailed information on dilution problems and supplement meteorological records. These measurements could be in the form of meteorological tower radioactivity profiles and additional slope studies.
- d. A full time professional meteorologist is needed on the staff to interpret meteorological studies for departments requiring this information. He would also be immediately available for disaster control.
- e. Since much meteorological data is being collected daily close coordination with the Weather Bureau is essential in order that all routine observational techniques may be standardized. The possibility and advantages of putting all meteorological records on IBM cards was discussed.

Note: We have been informed that the Meteorology Group is soon being transferred to the Health Instruments Division. This unit has the largest need for meteorological records and correlations. Dr. Parker stated that a professional meteorologist may be needed either on consultant or full time basis, and that the Weather Bureau may be asked to serve further.

2. Wabluke Slope

- a. Under normal operating conditions, and prevailing wind directions, it appears that less hazard exists for this area than for the Richland - Pasco area. The western portion of the slope is less likely to receive any degree of contamination than the central or eastern portion.

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- b. In the event of a catastrophe, any portion of the slope may be affected. This is especially true if the dilution figure of 8500 used in computing the dangerous area proves too large.
- c. During our short visit, the meteorological data from the pile area could not be thoroughly analyzed. This study should be continued.

3. Catastrophe

- a. If it is shown that large areas may be affected by a catastrophe, immediate steps must be taken to obtain thorough and complete meteorological information from the Seattle District Forecast Center at a moment's notice. This information should be interpreted by the best meteorologist available. Practice "emergencies" should be called.
- b. The dilution figure of 8500 used in estimating the limit of the hazard area should be independently checked by several meteorological experts.
- c. Arrangements should be made to equip all emergency survey cars with hand wind equipment. It would be advantageous to have a helicopter available for survey work.

Sincerely yours,

Raymond C. Wanta
METEOROLOGIST

Fred D. White
METEOROLOGIST

Distribution:

- Cy 1 - Addressee
 - Cy 2 & 3 - Dr. H. Wexler, Washington, DC
 - Cy 4 - Mr. R. C. Wanta, Wash., DC
 - Cy 5 - Mr. F.D. White, Wash., DC
 - Cy 6 - Weather Bureau Files, Wash., DC
- [REDACTED]

TABLE I

Wind and Dilution Summary, Hanford

Wind - 200 ft. above surface

Dilution - Calculated from observed lapse rate and wind speed

<u>JANUARY 1947</u>	<u>00-08</u>		<u>08-16</u>		<u>16-24</u>		<u>Month</u>	
<u>Dilutions</u>	<u># hrs.</u>	<u>%</u>	<u># hrs.</u>	<u>%</u>	<u># hrs.</u>	<u>%</u>	<u># hrs.</u>	<u>%</u>
Less than 500	6	2	54	22	0	0	60	8
500-1000	11	5	86	34	18	7	115	16
Greater than 1000	47	19	54	22	57	23	158	21
Aloft	184	74	54	22	173	70	411	55

<u>Direction</u>	<u>Mean</u>		<u>Mean</u>		<u>Mean</u>		<u>Mean</u>	
	<u>Speed</u>	<u>%</u>	<u>Speed</u>	<u>%</u>	<u>Speed</u>	<u>%</u>	<u>Speed</u>	<u>%</u>
N	4.0	10	4.2	21	4.8	8	4.3	13
NE	2.5	5	4.5	8	5.2	2	4.0	5
E	3.8	2	3.8	5	2.2	2	3.5	3
SE	3.3	6	3.5	4	6.1	10	4.8	7
S	16.0	7	5.1	6	13.4	9	12.0	19
SW	17.6	9	17.5	15	15.6	16	16.7	13
W	11.8	24	18.5	13	13.3	21	13.9	19
NW	10.0	34	7.7	21	8.8	30	9.0	29
VBL	1.6	3	1.6	6	1.0	1	1.6	3
CL	0.0	0	0.0	1	0.0	1	0.0	1

<u>APRIL 1947</u>	<u>00-08</u>		<u>08-16</u>		<u>16-24</u>		<u>Month</u>	
<u>Dilutions</u>	<u># hrs.</u>	<u>%</u>	<u># hrs.</u>	<u>%</u>	<u># hrs.</u>	<u>%</u>	<u># hrs.</u>	<u>%</u>
Less than 500	9	4	133	56	20	8	162	22
500-1000	26	11	71	29	37	15	134	19
Greater than 1000	59	24	36	15	110	46	205	28
Aloft	146	61	0	0	73	31	219	31

<u>Direction</u>	<u>Mean</u>		<u>Mean</u>		<u>Mean</u>		<u>Mean</u>	
	<u>Speed</u>	<u>%</u>	<u>Speed</u>	<u>%</u>	<u>Speed</u>	<u>%</u>	<u>Speed</u>	<u>%</u>
N	5.1	10	9.5	17	10.0	4	8.1	10
NE	2.4	2	7.1	11	6.3	8	6.3	7
E	3.3	3	3.9	9	3.8	2	3.7	5
SE	3.6	2	4.6	12	8.0	9	5.8	8
S	9.3	3	6.3	8	5.2	5	6.5	5
SW	14.7	15	13.9	17	17.2	13	15.1	15
W	10.4	32	17.1	11	15.1	20	13.1	21
NW	11.6	29	13.2	11	15.9	37	13.9	26
VBL	1.0	1	2.7	4	3.0	1	2.4	2
CL	0.0	3	0.0	0	0.0	1	0.0	1

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Table I - Page 2

JULY 1947	00-08		08-16		16-24		Month	
Dilutions	# hrs.	%	# hrs.	%	# hrs.	%	# hrs.	%
Less than 500	1	1	97	39	3	1	101	14
500 - 1000	65	26	141	57	82	33	238	39
Greater than 1000	81	32	10	4	133	54	224	30
Aloft	101	41	0	0	30	12	131	17

Direction	Mean Speed	%	Mean Speed	%	Mean Speed	%	Mean Speed	%
N	7.1	3	6.5	14	7.7	1	6.7	6
NE	2.1	2	6.0	10	6.5	4	5.6	5
E	3.5	1	4.9	7	6.9	3	5.3	3
SE	---	0	4.7	4	---	0	4.7	1
S	6.8	2	6.5	7	7.8	2	6.8	4
SW	11.6	9	12.3	32	13.7	10	12.4	17
W	10.7	33	9.0	10	14.5	28	12.0	24
NW	13.2	47	8.7	9	20.1	51	16.1	36
VBL	4.0	2	4.2	7	3.5	1	4.1	3
CM	0.0	1	0.0	0	0.0	0	0.0	1

OCTOBER 1947	00-08		08-16		16-24		Month	
Dilutions	# hrs.	%	# hrs.	%	# hrs.	%	# hrs.	%
Less than 500	0	0	33	13	0	0	33	4
500-1000	39	16	177	69	81	33	291	39
Greater than 1000	39	16	36	15	66	26	141	19
Aloft	170	68	8	3	101	41	279	38

Direction	Mean Speed	%	Mean Speed	%	Mean Speed	%	Mean Speed	%
N	6.2	13	5.0	15	5.6	8	5.5	12
NE	2.8	3	5.2	8	7.8	5	5.6	5
E	4.2	4	4.3	8	5.5	6	4.7	6
SE	6.0	8	5.4	15	5.7	15	5.6	13
S	14.4	7	9.5	12	12.0	8	11.5	9
SW	13.2	15	20.8	17	16.4	18	16.9	16
W	8.6	16	8.1	7	9.7	15	8.9	13
NW	9.5	32	7.8	17	12.2	24	10.0	25
VBL	1.7	2	1.7	1	1.5	1	1.6	1
CM	0.0	0	0.0	0	0.0	0	0.0	0

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