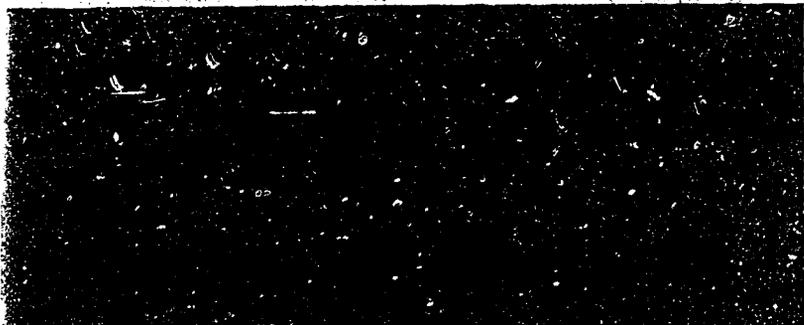


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VULNERABILITY OF SANDIA CORPORATION SUPPLIERS

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L. J. Vortman - 5112  
(Appendix compiled by Dorothy Delap)

AUG 6 1964

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ABSTRACT

Sandia Corporation supplier vulnerability is analyzed and recommendations are made to improve continuity of production in event of enemy attack. (This is a result of the Operation Alert exercise of 1958.)

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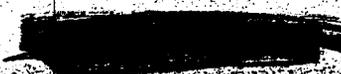
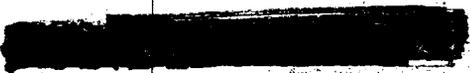
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## VULNERABILITY OF SANDIA CORPORATION SUPPLIERS

### Introduction

As a part of the Opal 58 (Operation Alert 1958) exercise, the vulnerability to enemy attack of Sandia Corporation suppliers was examined. The examination included 109 suppliers shown in the August 1958 Mobilization Base Planning List prepared by Sandia Corporation Department 2520. Of these suppliers, 46 are designated as suppliers of critical items, that is, items the loss of which would either stop or seriously hamper the production of some weapon.

### Discussion

Results of the Opal 58 examination are summarized in Table I. It should be emphasized that the picture painted by Opal 58 is not a valid portrayal of supplier vulnerability.\* It is, in effect, only one sample in a Monte Carlo study of possible attacks. The relative vulnerability of several locations as determined from a Monte Carlo study should be about the same as the relative vulnerability posited for a single successful saturation attack. This is true because of the large number of imponderables in any attack situation. The most important of these are:

1. Lack of information concerning enemy war plans, especially with regard to
  - a. Targets selected and
  - b. Number, yield, and distribution of weapons on each target.
2. Inability to predict the success of defensive measures.
3. Difficulties in prediction of the extent of burned-out areas, which is a function of combustibles present and the direction of the wind at the time of the attack.
4. Variations in direction of fallout, a function of wind direction.

---

\* Two samples will illustrate this point. General Mills was listed as undamaged because it was assumed in Opal 58 that the weapon designated for Minneapolis was detonated several miles from the target. Ordinarily one would expect the plant to be destroyed in an attack. Opal 58 also assigned a 10-mt burst to south Los Angeles, leaving all plants in northern Los Angeles suburban areas undamaged. Logically, a larger yield or multiple hits of smaller yields would be expected.

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If, for comparative purposes, a completely successful saturation attack is assumed, the picture changes from that of Table I (Opal 58) to that of Table II.

The two tables show that half the suppliers of critical items undamaged in Opal 58 would also probably be undamaged in any attack. These suppliers were:

- |                             |                         |
|-----------------------------|-------------------------|
| Food, Machine, and Chemical | Riverside, California   |
| Universal Match Co.         | Ordill, Illinois        |
| Wheaton Engineering Co.     | Wheaton, Illinois       |
| Eagle-Picher                | Joplin, Missouri        |
| Bendix Aviation             | Eatontown, New Jersey   |
| Bendix Aviation             | Sidney, New York        |
| Sonotone                    | No. Tonawanda, New York |

The situation is not very encouraging. Table II shows that only 7 (15 percent) of the 46 suppliers of critical items are located in nonvulnerable areas. This percentage certainly should be higher; 15 percent in vulnerable areas would be more reasonable.

From an analysis of the data, certain axioms emerge which should definitely be applied to suppliers of critical items and applied where convenient to suppliers of noncritical items. They are:

1. No sole source should be located in a vulnerable area.
2. When sources are dual, the company responsible for the major part of the production should be located in a nonvulnerable area.
3. If the Item 2 situation is not possible, at least one of the two companies should be in a nonvulnerable area.

In general, Table II makes evident that in its purchasing policy, Sandia Corporation has not paid enough attention to continuity of production in the event of a national emergency. Since old contracts are being completed and new ones let, it would be possible during a 5-year period to reverse the present unfavorable situation.

Recommendations

It is recommended that Sandia Corporation take immediate steps to improve the continuity of production in event of enemy attack. Specifically it is suggested that:

1. In considering dual suppliers, not more than one be chosen in a vulnerable area.
2. The Sandia Corporation General Attorney (6000) explore the legal means available for giving preference (at additional cost if necessary) to suppliers in nonvulnerable areas.
3. Sandia Corporation urge AEC to approve and adopt those measures which appear most feasible.

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TABLE I

	<u>Suppliers of Critical Items</u>	<u>Suppliers of Noncritical Items</u>
Destroyed, Heavily Damaged, or Completely Burned	21	30
Damaged Moderately or Probably Burned	2	11
Damaged Lightly, Not Burned	7	7
Not Damaged	<u>16</u>	<u>15</u>
TOTAL	46	63

TABLE II

	<u>Suppliers of Critical Items</u>	<u>Suppliers of Noncritical Items</u>
Destroyed, Heavily Damaged, or Completely Burned	36	47
Damaged Moderately or Probably Burned		8
Damaged Lightly, Not Burned	3	2
Not Damaged	<u>7</u>	<u>6</u>
TOTAL	46	63

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## APPENDIX

## Supplier Vulnerability Data

The purpose of the following phase of Opal 58 was to determine the effect of a nuclear attack on the suppliers of critical items to Sandia Corporation.

To facilitate identification of the vulnerable suppliers, a summary data sheet has been compiled which classifies the suppliers by state and city. It also lists for each location the yield of the hypothetical weapon dropped, the distance from ground zero to the supplier's location, overpressure, thermal radiation, and a description of the supplier's vulnerability.

The procedure for determining the vulnerability of a supplier was as follows:

- A. A supplier was chosen from the July Mobilization Base Planning List and checked against the Attack Pattern listing (FCDA) for 1958. For suppliers near attack locations, the coordinates of ground zero and the location of the supplier were noted. The yield, number of weapons, and types of burst (surface or 800-foot) were also noted.
- B. Locations were found on appropriate area maps. Army Map Service maps were used because of their uniformity of scale (1:25,000) and coordinate system.
- C. The map distance between GZ and the supplier location was measured and converted to feet.
- D. Overpressure versus distance was determined<sup>1/</sup> and scaled to the yields listed in the attack pattern. A graph of pressure versus scaled distance was plotted and smoothed. All overpressure values were read from the graph.
- E. Thermal radiation ( $\text{cal/cm}^2$ ) was taken from a distance versus thermal energy graph.<sup>2/</sup> Atmospheric visibility was assumed to be from 2 to 50 miles.
- F. Vulnerability was determined by considering the pressure and thermal effects on the suppliers' buildings.<sup>3/</sup> The following general information was used as a guide:

<u>1. Building Type</u>	<u>Overpressure for Failure (psi)</u>
a. Wood frame	3
b. Masonry and reinforced concrete frame	5.5
c. Reinforced concrete walls	15
d. Metal	3
<u>2. Thermal (<math>\text{cal/cm}^2</math>)</u>	
3-6 -- Ignition of newspaper and combustible material	
10-15 -- Charring of unpainted woods	
6-18 -- Ignition of deciduous leaves and pine needles	

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15 -- Ignition of sound wood

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25 and over -- Burning in almost all type structures

Because thermal damage varies greatly, three arbitrary categories were chosen:

1. Above 20 cal/cm<sup>2</sup>
2. 10-20 cal/cm<sup>2</sup>
3. Below 10 cal/cm<sup>2</sup>

Certain burning

Probable burning

Little or no burning

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## LIST OF REFERENCES

1. The Effects of Nuclear Weapons, (ed.) Samuel Glasstone, DOD/AEC, Washington, D.C., June 1957 (Figure 3.94a).
2. Ibid. (Distances for surface bursts were scaled down to 60 per cent of those given in Figure 7.119.)
3. Description of suppliers' buildings supplied by Administrative and Coordinating Department, 4330, Sandia Corporation.

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OPERATION ALERT - 1958

State	City	Name of Supplier	Building Type	Yield	Distance (ft)	Overpressure (psi)	Thermal Radiation (cal/cm <sup>2</sup> )	Vulnerability
Arizona	Phoenix	Phoenix Engineering and Mfg.*	B	1 mt	29,000	2.0	7	light damage
California	Los Angeles	Cannon Electric Co.*	B	10 mt	47,150	2.7	24	damaged and burned
	"	Acme Elec. Inc.	B	"	33,000	4.6	50	damaged and burned
	"	Christie Elec. Corporation	A, C & D	"	27,500	6.3	90	destroyed (A&D), dam.(C), burned
	"	Waste King Corporation	B	"	16,250	16.7	250	destroyed and burned
	"	Calcor Corporation	B & D	"	42,700	3.0	33	destroyed (D), dam.(B&D)
	"	Walsco Electronics Corp.	C & D	"	38,500	3.6	37	destroyed (D), dam.(C), burned
	"	Precision Sheet Metal*	B	"	40,250	3.4	35	damaged, burned
	"	W. A. Plummer Mfg.	A	"	32,100	4.8	50	destroyed, burned
	"	Mechanical Specialties	B	"	44,350	2.9	30	damaged, burned
	"	Univox Corporation	B	"	42,500	3.1	34	damaged, burned
	"	Mullenbach Elec. Mfg.	A & D	"	22,450	9.0	140	destroyed, burned
	Beverly Hills (LA)	Associated Products	B	10 mt (LA)	65,200	1.6	12	lt. damage, prob. burned
	"	Litton Industries	B	"	65,300	1.6	13	" "
	Pasadena (LA)	Applied Physics*	B	"	73,200	1.4	9	light damage, prob. burned
	"	General Logistics	B	"	63,600	1.7	14	" "
	Hollywood (LA)	Technical Products Co.	B	"	59,100	1.9	15	" , burned
	N. Hollywood (LA)	Bendix Aviation*	B	"	100,500	0	5	no damage
	"	Wells Industries Corp.	D	"	99,000	<1.0	6	"
	"	Enterprise Dev. and Mfg.*	B	"	106,500	<1.0	4	no damage
	Burbank (LA)	Coast Machine Products	B	"	95,000	<1.0	6	"
	"	Hall-Scott Elec. Div.	B	"	96,700	<1.0	6	"
	Santa Monica (LA)	Service Metal Fabricator	B	"	75,350	1.3	9	lt. damage
	"	Reynolds Industries	B	"	76,950	1.3	9	"
	Glendale (LA)	Ames Harris Neville	B	"	71,700	1.5	10	" , prob. burn
	Van Nuys (LA)	Preshaw and Thompson*	B	"	116,200	<1.0	4	no damage
	Culver City (LA)	Technical Elec. Corp.	B	"	52,200	2.3	19	damaged, burned
	"	Greenfield Tool and Stamping	B	"	54,600	2.1	17	"
	Inglewood (LA)	Multitek Company	B	"	36,150	4.0	43	damaged, burned
	Maywood (LA)	Magnum Products Co.	B	"	19,250	11.8	150	destroyed, burned
	Downey (LA)	A and D Machine Co.	B	"	30,450	5.3	60	" , burned
	Riverside (LA)	Food, Machine, and Chem.*	B	"	270,000	0	0	no damage
	Solano Beach (LA)	Billjack Scientific Institute	D	"	530,000	0	0	no damage
	Santa Barbara	Jefferson Elec. Prod.	A & B	"	400,000	0	0	no damage
	Gardena (LA)	Basic Tool Industries	B & D	"	20,000	11.0	150	destroyed, burned
	Richmond (San Fran)	Beckman Instrument	B	10 mt (San F)	755,000	0	9	no damage

\*Suppliers of critical items

Building Type:

- A - wood frame
- B - masonry and reinforced concrete frame
- C - reinforced concrete wall
- D - metal

( ) - Nearest burst

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## OPERATION ALERT - 1958

State	City	Name of Supplier	Building Type	Yield	Distance (ft)	Over-pressure (psi)	Thermal Radiation (cal/cm <sup>2</sup> )	Vulnerability
Colorado	Denver	Ramo-Wooldridge Corporation*	B	(2) 5 mt	43,300	2.2	15	heavy damage, prob. burned
	"	Screw Machine Products, Inc.	B	"	4,700	230	1800	destroyed, burned
	"	Colorado Fuel and Iron Corp.	B	"	5,700	125	1250	" "
	"	American Chain and Cable Co.	B	"	14,200	15	150	" "
Connecticut	Middletown (Hartford)	Raymond Engineering Lab.*	B	20 mt (Hartf.)	79,200	1.9	14	moderate dam., prob. burned
	Waterbury (Hartford)	U. S. Time Corporation	B	1 mt	11,100	9.0	80	destroyed, burned
	Bridgeport	Singer Manufacturing Co.*	B	1 mt	8,300	15	100	destroyed, burned
Delaware	Wilmington	Atlas Powder Company*	A	160 kt	17,750	1.6	3	heavy damage
	"	Hercules Powder Co.*	A	"	10,650	3.5	10	destroyed, prob. burned
Illinois	Chicago	Meteorola*	B	10 mt	38,300	3.6	37	damaged, burned
	"	Guardian Electric Co.*	B	"	22,450	9	120	destroyed, burned
	"	Amphenol Electronics Corp.*	B	"	20,700	10.5	140	destroyed, "
	"	Cook Electric Company	B	"	38,700	3.6	35	damaged, burned
	St. Charles (Chicago)	Dukane Corporation	B	"(Chicago)	36 miles	0	0	no damage
	Wheaton (Chicago)	Wheaton Engineering Co.*	A & B	"(Chicago)	23 miles	0	2	no damage
Indiana	Ordill (E. St. Louis)	Universal Match Co.*	A	None	-	0	0	no damage
	Indianapolis	Packard Mfg. Corp.	A	None	-	0	0	no damage
	Ft. Wayne	American Steel Dredge Co.	B	1 mt	34,300	1.5	4.5	lt. damage
	"	Bowser Inc. (Ft. Wayne Div.)	B	1 mt	32,950	1.6	4.5	"
	South Bend (Ft. Wayne)	Edwards Iron Works	B	None	-	0	0	no damage
	Warsaw (Ft. Wayne)	Arnolt Corporation	B	None	-	0	0	no damage
Iowa	Richmond (Ft. Wayne)	Knowles Tool Corporation	B	None	-	0	0	no damage
	Sioux City	Wincharger Corporation*	B	1 mt	6,300	25.0	200	destroyed, burned
Kansas	Kansas City (K.C., Mo.)	Radio Industries	B	10 mt (KC, Mo.)	14,140	22.0	300	destroyed, burned
Kentucky	Lexington (Frankfort)	Irving Air Chute Co.	B	1 mt (Frankf.)	23 miles	0	0	no damage
Maryland	Baltimore	Catalyst Research*	B	10 mt †	{34,320	{4.3	{45	heavy damage, burned
				10 mt	{48,700	{2.5	{20	
	Towsen (Baltimore)	S Bendix Aviation*	B	10 mt † (Balt.)	{46,200	{2.7	{70	destroyed, burned
			B	10 mt	{17,160	{15.0	{250	

\*Suppliers of critical items

†Knockdown over target

## Building Type:

- A - wood frame
- B - masonry and reinforced concrete frame
- C - reinforced concrete walls
- D - metal

( ) - nearest burst

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OPERATION ALERT - 1958

State	City	Name of Supplier	Building Type	Yield	Distance (ft)	Over-pressure (psi)	Thermal Radiation (cal/cm <sup>2</sup> )	Vulnerability
Massachusetts	Boston	Edgerton, Germeshausen & Grier, Inc.	B	10 mt †	7,700	100	1300	destroyed, burned
	Newton (Boston)	Raytheon Mfg. Co.*	C	10 mt † (Bos.)	29,000	5.8	70	damaged, burned
	Danvers (Boston)	Columbia Broadcasting	B	"	87,500	1.1	17	light damage, prob. burned
	(Lawrence)				79,200	1.3	7	light damage, prob. burned
	Salem (Boston)	Cannon Electric Co.	B	"	81,850	1.2	21	light damage, burned
	(Lawrence)				95,000	1.0	6	light damage, burned
	Beverly (Boston)	Bomac Laboratories	B	"	87,100	1.1	20	light damage, burned
	(Lawrence)				97,700	<1.0	6	light damage, burned
	Notwood (Boston)	American Radiator and San.*	B	"	68,650	1.6	30	light damage, burned
	New Bedford	Aerovox Corporation	B	10 mt	50,150	2.3	50	damaged, burned
North Adams	Sprague Electric*	B	None	-	-	-	none	
Michigan	Jackson (Detroit)	Sparton Electronics*	B	(2) 5 mt (Det.)	370,000	0	0	no damage
					345,000	0	0	no damage
	Ferndale (Detroit)	C. M. Smillie and Co.	B	"	27,800	4.1	40	heavy damage, burned
					22,450	6.3	65	heavy damage, burned
Minnesota	Minneapolis	General Mills*	B	10 mt ‡	83,000	1.2	6	lt. damage
	St. Paul (Minneapolis)	Telex, Inc.*	B & D	10 mt (Minneap.)	79,000	1.3	7	lt. damage
	"	Farwell, Ozmun, Kirk and Co.*	B	"	83,000	1.2	6	lt. damage
	Hopkins (Minneapolis)	Minneapolis, Honeywell Reg. Co.*	B	"	103,500	0	5	no damage
Missouri	St. Louis	Greenleaf Mfg. Co.*	B	10 mt	47,200	2.7	22	damaged, burned
	Kansas City	Bendix Aviation	B	"	50,750	2.4	20	damaged, burned
	Joplin	Eagle-Picher*	B	None	-	-	-	
New Jersey	Newark (NYC)	Continental Electric*	B	4 mt (NYC)	88,700	<1.0	2	little or no damage
	Carlstadt (NYC)	Curtiss-Wright*	B	"	71,700	1.0	4	little or no damage
	Teterboro (NYC)	Robinson Aviation	B	"	84,500	<1.0	0	little or no damage
	Eatontown (Lakewood)	Bendix Aviation*	D	5 kt (Lw)	84,500	0	3	little or no damage

\*Suppliers of critical items  
†Knockdown over target  
‡Knockdown short of target

Building Type:  
A - wood frame  
B - masonry and reinforced concrete frame  
C - reinforced concrete wall  
D - metal  
( ) - nearest burst

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## OPERATION ALERT - 1958

State	City	Name of Supplier	Building Type	Yield	Distance (ft)	Over-pressure (psi)	Thermal Radiation (cal/cm <sup>2</sup> )	Vulnerability
New York	Syracuse	Pass and Seymour Inc.*	B	(A) 50 kt	3,960	12	27	destroyed, burned
	Elmhurst (NYC)	Kollman Instrument*	B	4 mt (NYC)	33,700	3	20	mod. damage, burned
	Little Neck (NYC)	Hazeltine Elec. Corp.*	B	"	37,500	2.5	14	lt. damage, prob. burned
	Elmsford (NYC)	Sonotone*	B	"	100,300	0	2	no damage
	N. Tonawanda (Buffalo)	Wurlitzer Corporation*	B	2 mt (Buffalo)	77,200	<1.0	1.5	no damage
	Sidney	Bendix Aviation*	B	None	-	-	-	none
New Mexico	Albuquerque	Machine Eng. Corp.*	B	5 mt	31,500	3.5	30	damaged, burned
	"	Acoma Corporation	B & D	"	40,700	1.9	16	damaged, burned
	"	Sandia Corp.	B & C	"	5,300	160	1400	destroyed, burned
	"	New Mexico Tent and Awning	B	"	28,830	4	30	damaged, burned
	"	Dale Products	B	"	10,560	27	300	destroyed, burned
	"	Benischek Mfg.*	B	"	22,800	4.3	60	damaged, burned
	"	Que Enterprises	B	"	23,000	6.1	55	heavy damage, burned
	"	AEF Industries*	B & D	"	24,850	5.4	50	heavy damage to dest. burned
	Alameda	Sun Country Ind.	A	5 mt (ABQ)	53,000	1.6	9	lt. damage
Nebraska	Columbus (Omaha)	Dale Products	B	None	-	-	-	no damage
Ohio	Dayton	Globe Industries*	B	(2) 6 mt	13,860	17	240	destroyed, burned
	Toledo	Rowe Industries	B	5 mt	21,100	7	70	destroyed, burned
Pennsylvania	Philadelphia	Leeds and Northrup	B & D	2 mt	27,200	2.7	16	damaged, burned
	"	Borroughs Corporation	B	"	12,600	10	80	destroyed, burned
	Pittsburgh	Westinghouse Elec. Corp.*	B	5 mt	24,200	5.5	55	heavy damage, burned
Texas	Dallas	Texas Instruments*	B	5 mt †	60,750	1.2	9	light damage
	Cleburne	Roberts Mfg. Co.	A & B	None	-	-	-	no damage
Wisconsin	Racine	John Oster Mfg.*	C	1 mt	3,850	100	550	destroyed, burned
	Janesville (Racine)	G. W. Borg Corp.	A	None	-	-	-	no damage

\*Suppliers of critical items

†Knockdown short of target

(A) - Aerial burst

## Building Type:

- A - wood frame
- B - masonry and reinforced concrete frame
- C - reinforced concrete wall
- D - metal

( ) - nearest burst

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