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Memorandum

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AX CAN ENVIRONMENTAL TEST AT SITE CHARLIE

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ABSTRACT

Underground igloo storage of four AX cans for approximately one and one half years proved a less severe condition than aboveground storage. The 3 psig air pressure test was demonstrated to be undesirable under the test conditions. Fifteen pounds of activated silica gel controlled the % RH satisfactorily. This indicates that a permissible leakage rate should be sought.

Case No. 445.0

February 25, 1953

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AX CAN ENVIRONMENTAL TEST AT SITE CHARLIE

Introduction:

This test of four AX cans (H-96) which were pressure checked at Sandia Corporation on July 7, 1951 then flown to site Charlie for igloo storage from July 10, 1951 to December 17, 1952, was made to determine if the rejection of H-96's (on the basis of failure to hold 3 psig air pressure without leaking) was warranted.

Because some H-96's do not fit their bases properly the rubber ring gaskets do not assure sealing. An interim procedure stipulating that PR 1301 (a strippable sealant) be applied to all H-96's was issued October 22, 1951.

Two very good and two leaky cans were tested. The enclosed cartridge in each was protected from excessive humidity by 15 lbs of silica gel (in 1 lb bags).

Can No. 1 leaked at gasket area.
Can No. 2 did not leak but was opened to the atmosphere through a breather desiccator.
Can No. 3 remained sealed.
Can No. 4 leaked freely.

All were stored in underground igloo No. 309 for 17-1/4 months. This type storage seldom experiences daily temperature change in excess of 2°F, but during the test as much as 10°F variation was recorded. The relative humidity averaged approximately 80%.

The four AX cans were assembled and pressure checked at Sandia on July 7, 1951. On July 9, 1951 they were shipped by C-47 aircraft to site Charlie, then transported by truck to the storage igloo. This phase of the test was particularly significant since all cans were subject to atmospheric pressure (plugs had been removed for air shipment and were not replaced until just prior to underground storage).

Rain fell in the area on both July 9 and 10, 1951 (0.20" and 0.17" respectively).

Summary of Results and Recommendations:

1. After 17-1/4 months underground igloo storage all four H-96's contained very low relative humidity atmosphere. Their humidity indicator card readings were recorded weekly and remained below 20% RH (20% was the lowest RH reading obtainable from the cards used).

2. At the conclusion of the test, cans No. 1, No. 2 and No. 3 contained atmosphere of approximately 3% RH. Can No. 4 (which leaked very badly) contained atmosphere of approximately 10% RH.

3. Since diurnal temperature variation was usually only 2°F, moisture pickup from breathing in storage was not as significant as during shipment by plane and truck under saturation conditions.

4. During storage, the dew point was usually only 1°F or 2°F below the minimum recorded daily temperature and was reached at least once. (August 2, 1951).

5. Under the test conditions, the protection afforded all four units by 15 lbs of activated silica gel was excellent. It was demonstrated that in underground igloo storage, it is not necessary to effectively seal these containers having 15 lbs of activated silica gel inside.

Conclusions:

1. Underground igloo storage in high percent RH is not as severe a storage condition as aboveground storage where the percent RH may be much less, but daily temperature change is significantly higher.

2. For underground igloo storage of H-96 (AX can) 3 psig air pressure testing is unnecessary (and undesirable if moist air is used) when 15 lbs of activated silica gel is used for each 1-1/2 year storage period.

3. Since the slightly leaky can (No. 1) was maintained at a low percent RH, comparable with the sealed can (No. 3), a permissible leakage rate may be determined. This has been confirmed by other tests and is under investigation by Division 1521.

Description of Test Cans:

H-96 (AX can) is a protective container for storing and shipping the cartridge.
Approximate inside dimensions: 30" dia. x 48".
Approximate volume 20 cu. ft.
Approximate volume cartridge 5 cu. ft.

Fifteen pounds of silica gel was already inside each can when pressure tested.
Can No. 1 was new, but failed the 3 psig air pressure test five times.
Tests were applied, using 20% RH air.

Can No. 2 was new and passed the air pressure test. Actually 4 psig was applied twice and there was no sign of leakage. However, during shipment and storage, this can was vented to the atmosphere through a breather desiccator.

Can No. 3 was an old can which passed the 3 psig air pressure test five times. This can was fitted with breather valves which were allowed to operate during air shipment only; they were sealed off by a pipe plug while in igloo storage.

Can No. 4 leaked so much that 3 psig would not build up in the can from a 40 psig air line. A negligible per cent of breathing could occur through the attached breather desiccator.

DATA

Can No.	Silica Gel Grams start	Silica Gel Grams end	Difference Grams Pick-Up	% Pick-up by weight	%RH+ by wt	%RH GCT*
1 (leaky)	6952.3	7083.8	131.5	1.9	3	3
2 Vented to atmosphere through breather desiccator 414.5	7016.7	7107.6	90.9	1.3	2	2.5
		441.2	26.7	6.5	15	7
3 (sealed)	7067.2	7177.4	110.2	1.6	2.5	2.5
4 very leaky breather desiccator 414.5	6972.8	7386.9	414.1	5.9	10	6.4
		428.6	14.1	3.4	6	3.3

*Gordon Campbell Tester

+Equilibrium useful concentration versus relative humidity curve by F. C. Dehler

SHIPPING AND STORAGE DATA

Location	Operation	Date	Max. Temp. of	Min. Temp. of	Wet/Dry Bulb	% RH
Sandia	Pressure Test	7/7/51	101	72	73/54	27
Sandia	Pressure Test	7/8/51	101	71	71/49	20
Sandia	Loaded in C-47	7/9/51	102	73	75/49	10
Site Charlie	Unloaded from C-47	7/9/51	87	70	.20" rain	100
	Trucked to igloo	7/10/51		61	.17" rain	88

STORAGE DATA SITE CHARLIE - STRUCTURE 309

Date	% RH Max	% RH Min	Temp °F Max	Min	°F Dew Point
7/21/51	88	87	60	59	57
8/2/51**	87	84**	68	62	63**
9/2/51	80	80	64	60	58
10/5/51	88	88	63	62	60
11/1/51	85	84	62	61	58
12/15/51	84	83	60	60	56
1/15/52	94	84	59	59	57
2/12/52	90	89	60	59	57
3/1-3/52	91	91	59	58	56
4/52	98	97	59	59	59
5/23/52	95	95	61	61	59
6/52	96	96	61	61	60

No data after June, 1952

** This data indicates that although the highest RH recorded in the structure for a particular day is only 87 , actually the dew point was reached and moisture

condensed on walls and other exposed surfaces. This points up a definite shortcoming of our present data recording system. For example, it appears likely from this that an operator could find it necessary to wipe moisture from the glass face of a humidity instrument indicating less than 100% RH. See reference 1 (par. 148)

GEORGE R. HOLLADAY - 1521

DISTRIBUTION:

1/11A - L. J. Paddison, 1500
2/11A - G. C. McDonald, 1210
3/11A - L. E. Lamkin, 1280
4/11A - A. F. Cone, 1510
5/11A - G. H. Roth, 1520
6/11A - W. M. O' Neill, 1540
7/11A - L. R. Neibel, 1550
8/11A - H. E. Viney, 1521
9/11A - G. R. Holladay, 1521-2
10,11/11A - G. Byrne, 1921-3 (2)

APPENDIX 1

From January 15 to January 19, 1953 a supplementary test was performed at Sandia on a sealed H-96 (AX can) with cartridge to determine moisture introduced by pressurizing.

This can was pressurized to 3 psig with 20% RH air ($75^{\circ}/53^{\circ}$F) five times, over a four day period.

Sixty 2 oz. bags of silica gel were used to adsorb moisture. The 3702g of desiccant adsorbed 25g of moisture. To keep desiccant adsorption of atmospheric moisture to a minimum, 15 two oz. bags were weighed together both at start and conclusion of the test.

It is estimated that approximately 16g of the moisture pickup resulted from the pressure testing and 9g from handling and weighing of desiccant. Silica gel used in the test of the four AX cans was weighed separately. It is estimated that the moisture adsorbed, due to exposure to atmospheric moisture, was at least 36g. This was calculated on basis of adsorption of 0.15g moisture per oz.

$$15 \text{ lb} \times 16 \text{ oz/lb} \times 0.15 \text{g/oz.} = 36 \text{g.}$$

A portable compressor, with no provision for keeping entrained moisture out of the line, was used to pressurize the four cans. This fact means that some of the 60g (of No. 3 can) assigned in appendix 3 to transportation for all cans could have come from the compressed air.

APPENDIX 2

Calculation of weight of moisture to saturate the H-96 AX can at test conditions:

Approximate volume of H-96 empty = 20 cu ft.
Approximate weight of cartridge = 700 lbs.
Assumed average density of contents = 140 lb/cu ft.
700 lb/140 lb cu ft. = 5 cu ft.
20 cu ft. - 5 cu ft. = 15 cu ft. at one atmosphere

Temp °F	Wt of moisture in 15 cu ft. saturated air	
60	.00831* lb water/cu ft. x 15 cu ft. x 454g/lb	= 6g Approx
70	.00115 x 15 x 454	= 8g Approx
87	.001958 x 15 x 454	=13g Approx

At 3 psig, 75°F wt of moisture in 15 cu ft. saturated air

$$\frac{(14.696 - .430 + 3.0) \times 144 \times 15 \times .01881^{**}) \times 454}{53.3 \times (460 + 75)} = 11\text{g Approx}$$

*See reference 1 pps 24 and 25

**See reference 1 lbs water vapor/lb d. a.

APPENDIX 3

Estimates of moisture adsorption

	Slight Leak	Breather Desiccator	Sealed	Very Leaky
AX can No.	1	2	3	4
Grams moisture adsorbed	132	118	110	428
Grams moisture from pressure test and handling desiccant	50	50	50	50
Grams moisture pickup during transportation (plane and truck)	60	60	60*	60
Grams moisture pickup during igloo storage	22	8	0	318

Years of safe life stored under conditions tested

$$\frac{7000g \times 0.10 \text{ (useful conc.)} \times 17.3 \text{ mo.}}{132g \text{ moisture pickup} \times 12 \text{ mo/year}} = 7\text{-}1/2 \text{ years}$$

Remain below 20% RH (years	7-1/2	8	9**	2
30%	11-1/2	12-1/2	13-1/2	3-1/2
40%	17-1/2	19-1/2	21	5

Pounds silica gel required to maintain safe RH during the 17.3 mo. test.

Lbs to remain below 20% RH	3	3	3	10
Lbs to remain below 30% RH	2	2	2	7
Lbs to remain below 40% RH	1-1/4	1-1/4	1-1/4	4-1/4

$$\frac{132g}{454g/lb \times 0.10***} = 3 \text{ lbs}$$

*This minimum value assigned to all, although it is quite likely that more moisture was adsorbed in the leaky cans No. 1 and No. 4 which were not protected by breather valve or breather desiccator.

**An actual life is assigned the sealed can since the prediction was based on a definite moisture adsorption per unit time. Obviously, this can could last indefinitely.

***See Reference 2

APPENDIX 4

Calculation of the number of saturated volumes (of 15 cu. ft. at given temperatures and one atmosphere pressure) from which 15 lbs silica gel will adsorb moisture enough to maintain RH less than a desired percent.

for 10% : .06 x 15 lb x 454g/lb = 407g

RH	% By Wt.	Wt Moisture g	Temp °F	g moisture in 15 cu. ft. sat. air
10	6	407	60	6
20	10	680	70	8
30	15	1020	87	13
40	23	1560		

For 10% RH

.06 x 15 x 454 = 407g
407/6 = 68 sat. volumes

g moisture per 15 cu ft. sat. volume	Temp °F	Sat. Vols. Controlled to below 10% RH	Sat. Vols Controlled to below 20% RH	Sat. Vols. Controlled to below 30% RH	Sat. Vols. Controlled to below 40% RH
6	60	68	113	170	260
8	70	51	85	127	195
13	87	31	52	78	120

Calculation of minimum number of times the silica gel had adsorbed enough moisture to saturate each test can at storage conditions.

Can No.	g estimated moisture pickup	g moisture to sat. at 60°F	Minimum number of sat. vols.
1	92	6	15
2	78	6	13
3	70	6	12
4	388	6	65

REFERENCE LITERATURE

1. Zimmerman, O. T. and Lavine, I
Industrial Research Services
Psychrometric Tables and Charts

2. Dehler F. C., Silica Gel, Its use as a Dehydrating Agent
Davidson Chemical Corp.