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XW-31, 3-2
Project No. T-16657
Case No. 661.00
Ref. Sym: 1613(187)

TO: DISTRIBUTION

Re: Pressure and Humidity Test of XW-31 Warhead

Reference: Report issued February 11,1960, Same Project No., Ref. Sym: 1613(169)

Summary of Test

A W-31 Warhead with the "O" ring seal removed was placed in a humidity-altitude chamber and subjected to 95 percent relative humidity while the pressure was cycled to simulate normal atmospheric pressure changes during weapon storage. The pressure was cycled 57 mm Hg. for a total of 198 cycles before the desiccant failed to bring the relative humidity down to 14 percent at 80°F.

Reason for Test

This test was requested by C. J. Mauck, Division 1247. This report was written with the cooperation of J. A. Leonard, Division 1247.

Warheads are pressurized to prevent ambient humidity from getting inside the system where it might cause damage through corrosion and deterioration of the high explosive and electrical systems. Desiccant is provided inside the warhead to absorb any humidity that might get in during storage as well as residual humidity introduced during assembly. The worst possible condition which could occur is complete loss of the pressure seal, which would allow breathing of ambient air as the atmospheric pressure changes.

LASL requirements state that regardless of pressure, the humidity must never exceed a level equivalent to 50% at 45°F. At sea level pressure this would be a specific humidity of 22 gr per pound of dry air. This is equivalent to 14 percent relative humidity at 80°F.

The pressure of warheads in stockpile is checked periodically. If there is a possibility that a warhead has lost pressure for a period of 30 days, it is assumed that the humidity has gone above the limit and the detonators and detonator cables are replaced.

It has been felt that even if a pressure seal has failed for some period of time, the desiccant capacity would be sufficient to hold the humidity to a safe level. The object of this test was to determine the maximum period of time that an unsealed W31 could remain in stockpile under the most severe atmospheric conditions before the warhead internal humidity level shall have risen above an acceptable level.

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To accomplish this, it was assumed that the warhead would be stored in a high humidity environment in which the barometric pressure changes were extreme in both magnitude and frequency. It was felt that the worst possible conditions should be used to guarantee that the warhead was overtested.

Following is the text of a letter from Mr. L. B. Smith, Division 5111, giving extreme atmospheric pressure changes over varying time intervals.

Period	Magnitude of Change		Reference
	Total	Rate	
1. Less than 2 minutes	10% of ambient (3 in. of Hg)	90 in./hr	1
2. 3 - 24 hours	2.07 in./3 hrs	0.69 in./hr	2
3. 2 days to 1 week	2.36 in.	0.014 in.hr	
4. 6 months	1.77 in.	0.403×10^{-3} in./hr	3

Those values in (1) represent changes accompanying tornadoes. Those in (2) are extremes noted with hurricanes. Those in (3), with periods 2 days to one week, are produced by passage of transitory high and low pressure cells as customarily seen on the weather map. These latter figures are estimated since actual verifying statistics are not available at the moment. Those changes in (4) with periods of six months result from tripling the maximum difference in sea level pressure between January and July over the northern hemisphere. Data used to compute these normals covers a period of 40 years. It is possible, of course, for short period oscillations of greater extremes to exist within these longer period trends.

References:

1. Garbell, Maurice, 1947, Tropical and Equatorial Meteorology, Pitman Publishing Corporation, New York, page 85.

2. Flora, S.D., 1953: Tornadoes of the United States, U. of Oklahoma Press, Norman, Oklahoma, page 26.

3. Brier, Glenn W., 1952: "Forty-year sea level pressure and sunspots", Tellus, V4, No. 3. August, pages 262-269.

In order to assure an overtest, it was decided to use the maximum pressure change, ignoring tornadoes and hurricanes, of 2.36 inches Hg. (60 mm Hg.)

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at maximum relative humidity (95%). Overtest is further assured by the facts that the maximum pressure changes occur in the winter when the specific humidity is not high.

Procedure

An Aminco humidity indicator and a pressure transducer were installed inside the warhead to be tested. Two eight-unit bags of dry desiccant (approx. 2% water by weight) were placed in the appropriate container inside the warhead. For comparison purposes, the free air volume of the W31 is 4100 $in.^3$. The warhead was assembled, leaving out the "O" ring between the cover assembly and the case.

The assembled unit was placed in an altitude-humidity chamber, which was maintained at 95 percent RH. The chamber pressure was reduced to 60 mm Hg. below laboratory pressure and held. Monitoring the pressure in the chamber and inside the warhead indicated that less than one minute was required for the pressures to equalize. Relative humidity inside the warhead at this time was 1.6 percent. The chamber pressure was then increased to laboratory pressure. Again, approximately one minute was required for the pressures to equalize. The relative humidity inside the warhead at this time was 10.6 percent. Approximately three hours were required for the desiccant to bring the relative humidity inside the warhead down to the original 1.6 percent.

In order to reduce the time required for each cycle of the test, it was decided to install a small blower inside the warhead to circulate the air around the desiccant.

A subsequent trial run indicated that less than 30 minutes was required for the desiccant to bring the RH down to the starting point. Running the blower increased the temperature inside the warhead less than 2°F. Based on this information, it was decided to use the following automatic one hour pressure cycle for the tests. Reduce pressure from (laboratory ambient) to (laboratory ambient - 60 mm Hg.) in 2 minutes; hold at (laboratory ambient - 60 mm Hg.) for 5 minutes; raise from (laboratory ambient - 60) to (laboratory ambient) in 2 minutes; hold at (laboratory ambient) for 51 minutes.

Before starting the pressure cycling for the first test, the desiccant was removed and replaced with dry desiccant, which had been weighed accurately. The warhead was then subjected to 76 pressure cycles. Due to inaccuracies in fabrication of the pressure controlling cam, the average pressure change during each cycle was approximately 90 mm Hg. instead of the desired 60 mm Hg. It was attempted to hold the chamber RH at 95 percent; however, during the test, water was inadvertently introduced into the chamber resulting in the possibility of introducing some water directly into the warhead.

The second test was set up the same as the first except a new cam was cut, which gave an average pressure change of 57 cm Hg. New desiccant was weighed and placed inside the warhead before beginning pressure cycling. Chamber relative humidity was held at 90 to 95 percent.

Several times during the test, pressure cycling was stopped at laboratory ambient pressure during non-working hours.

Upon completion of the test, the desiccant was weighed to determine the weight gained. Moisture content of the desiccant was also determined by testing on a Gordon-Campbell Moisture Tester.

Results

During the first test, 54 cycles were completed before the desiccant failed to bring the relative humidity inside the warhead down to 14 percent at 80°F. This is equivalent to 22 gm of moisture per pound of dry air. Desiccant weight at the beginning of the test was 479 gm. Upon completion of 76 cycles, the desiccant weighed 512 gm for an increase of 43 gm or 9 percent. It is felt that the results of this test were invalid since pressure cycle was not correct and since water was introduced into the chamber.

During the second test, 198 cycles were completed before the desiccant failed to bring the RH down to 14 percent at 80°F. Desiccant weight was 481 gm at the beginning of the test and 528 upon completion of 198 cycles for a net increase of 47 gm or 9.8 percent. Testing the desiccant on the Gordon-Campbell Moisture Tester showed 10.3 percent increase in desiccant weight. See Figures 1 and 2 for maximum and minimum relative humidity inside the warhead during each cycle.

Conclusions

Based on these extreme environmental conditions, the W31 warhead could safely withstand 198 maximum atmospheric pressure cycles without exceeding the humidity specification. As pointed out before, the test was conducted at the extreme possible atmospheric pressure changes and extreme humidity. Based on a 2 to 7 day pressure cycle, this could represent a storage period of from 396 to 1386 days, depending upon how optimistically one would interpret the results.

H. G. PAGE - 1612-3

1613 Project Engineer: D. W. BAUDER - 1613-3

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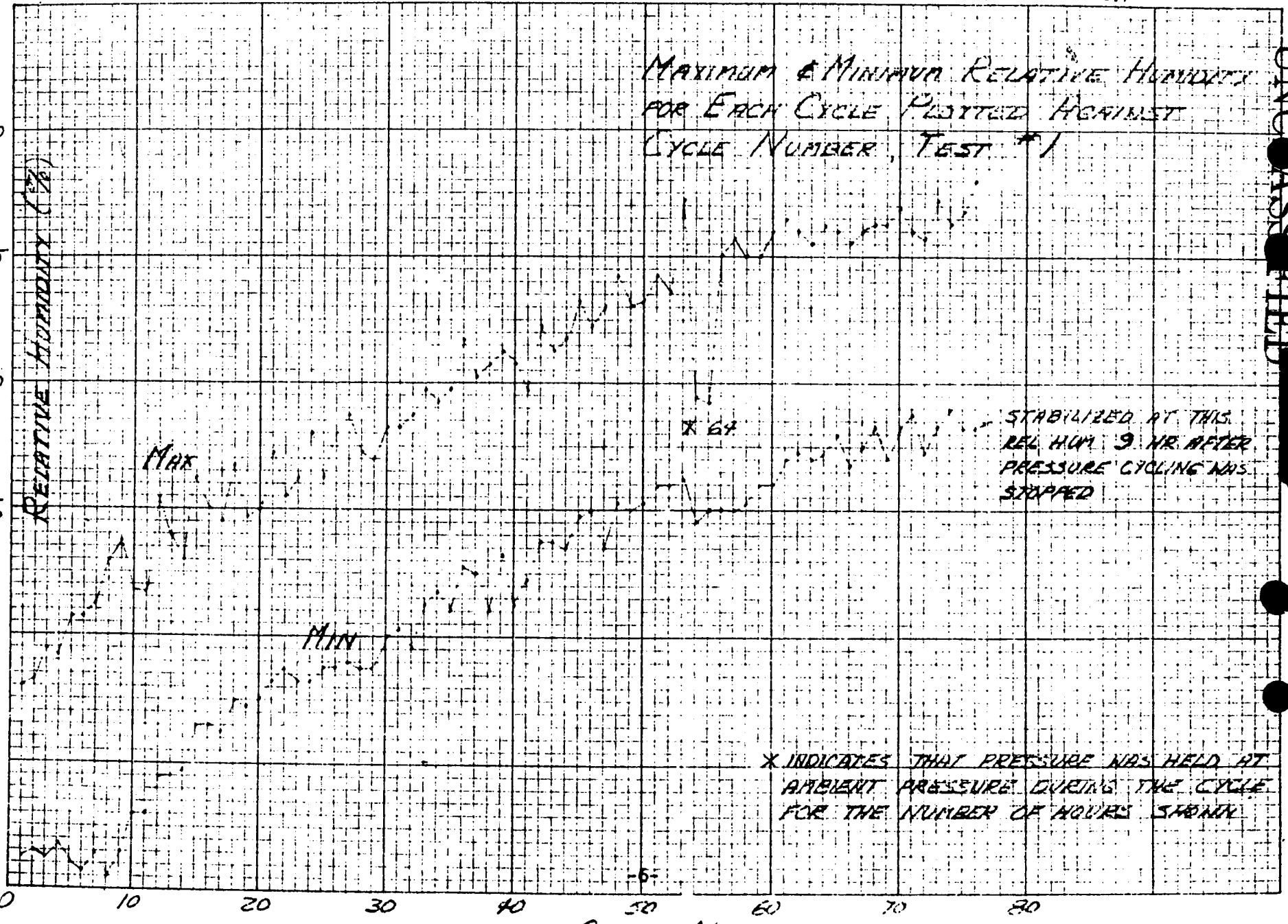
Maximum & Minimum Relative Humidity for Each Cycle Plotted Against Cycle Number, Test #1



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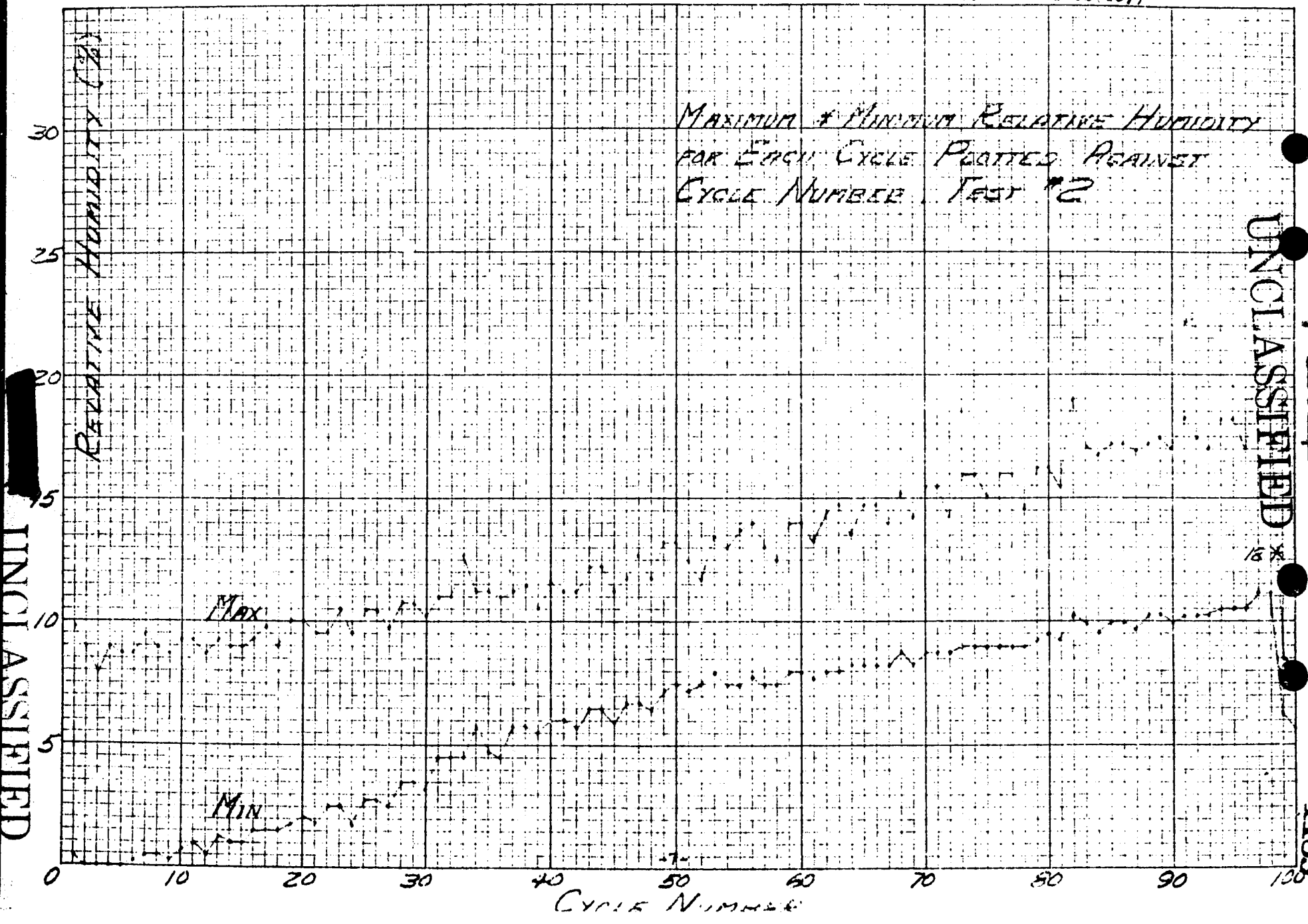

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