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Sandia National Laboratories Climatic Facilities in Buildings 6630, 6631, 9970A and 6750

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SANDIA NATIONAL LABORATORIES CLIMATIC FACILITIES
IN BUILDINGS 6630, 6631, 9970A AND 6750

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ABSTRACT

This document is intended to inform potential customers of the various environmental chambers available for use in testing. Descriptions of the temperature and humidity limits, data acquisition capabilities and the sizes are given for each environmental chamber. All of these chambers are located in Area III or the Coyote Test Area and are operated by Division 7531 personnel.

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I. INTRODUCTION

This report is meant as a general description of the environmental chambers available for quick reference by potential customers.

Seven chambers are described. Temperature limits, humidity limits and control about a set point are listed. The size of the chamber opening(s) and cavity opening are detailed along with data acquisition and plotting capabilities. Other capabilities (salt fog and pressure or altitude) are described along with any auxiliary equipment available.

II. CHAMBER DESCRIPTIONS

A. EC-70 (Environmental Chamber #70)

EC-70 is located in Building 6630 in Area III. An overall view of EC-70 can be seen in Figure 1. It is the largest and most versatile chamber available. The chamber is actually one chamber 35 ft long by 10.5 ft wide by 10.75 ft high. It has a center door which rises and drops vertically. This enables the one 35 ft long chamber to be broken into two 17 ft long chambers. Each half-chamber (north and south) can be individually controlled to different temperatures and humidities so that two different tests can be performed simultaneously.

At each end there is a personnel door 3 ft by 7 ft. The end of each half-chamber fully opens so the cavity size is also the opening size.

Dry bulb temperature can be controlled from a low of about -100 F to a maximum of about +200 F. A fixed temperature and humidity set point at a fixed location can be controlled to about ± 2 F. Again, each half of the chamber can be controlled to different temperatures if the center door is lowered. Temperature can also be cycled between any values within the limits given, assuming the chamber can respond faster than the cycling times desired. For instance, if it is desired to cycle a test sample from

-100 F to +200 F in 5 minutes, it probably is not possible, but if the cycle time is a day, the chamber can respond. Maximum temperature response rates on the order of 2 F/min are possible, so, for instance, one could go from 0 F to 120 F and back to 0 F in 2 hours.

Temperature "shocks" can also be performed in EC-70. This is where the center door is a necessity. If one wishes to expose a test item initially at room temperature to a "shock" at -100 F, one need only keep one half of EC-70 at room temperature and the other at -100 F. Then open the center door, transfer the item from one half to the next via the track (to be detailed later), and then close the center door again. This operation typically takes about 1.5 minutes.

Besides steady state runs, cycling and temperature shocks, the chamber can be programmed to any desired temperature profile, assuming that the heating and cooling equipment are of sufficient capacity to handle the ensuing loads. Control at varying temperatures is not as good as for steady state runs. The control is perhaps ± 5 F during transient runs as compared with about ± 2 F for steady state runs.

Humidity limits on EC-70 (each side) are from a low near 5% to a high of about 98%. These are values of relative humidity as is commonly reported in weather reports, not absolute humidity as is used in thermodynamics texts. The control about a fixed set point during a steady state run is about $\pm 5\%$. As with temperature, humidity "shocks" and humidity cycling can be performed and any reasonable humidity profile can be programmed into the system. Unfortunately, it is very difficult to control relative humidity in a transient situation and so limits about a varying set point are large. Control of relative humidity at temperatures below 32 F is extremely difficult at best and almost impossible to any degree with wet bulb - dry bulb control systems. So when the dry bulb temperature drops below 35 F the wet bulb sensing element is deactivated and humidity is left to drift on its own. So when one speaks of control of RH to $\pm 5\%$, it is strictly only at dry bulb

temperatures above about 35 F. This applies to EC-70 and all other chambers described herein.

The data acquisition system (DAS) used in EC-70 is manufactured by Hewlett Packard and is designated the 2113B. It is capable of automatically monitoring thermocouples, pressure transducers, strain gages or any other electrical output type of transducer. The voltage limit on the high level inputs to the DAS is +10 V which accommodates most transducers. Low level inputs can detect potentials in the millivolt range. At this time no low level channels are available but can be installed if needed.

There are 16 high level voltage channels available now with a range of +10 V on each channel. In addition, the DAS is capable of monitoring 64 Type K (chromel-alumel) thermocouples through a Type K reference junction. More Type K thermocouples could be monitored if another reference junction was procured. There also exists a 32 channel Type T thermocouple (copper-constantan) reference junction that could be installed, if the need arose. The thermocouple reference junction and part of the DAS can be seen in Figure 2. This part of the DAS is located adjacent to EC-70 in Building 6630. The remaining parts of the DAS are located in Building 6631 and are connected via hard wire. Figure 3 shows a view of the DAS equipment in Building 6631.

Data monitoring scan rates are variable through a wide range of values. Rates as fast as a scan every 5 seconds (over all channels) are typical in short tests and as long as one scan every hour are typical in long term tests. A video display of 48 data channels is possible on scan rates down to once every 5 sec. Scan rates less than once every 5 sec are possible (to a minimum of once every second) but the video display is not possible in this range.

Data output is available in either tabulated form or graphical form. Tabulated output has the appropriate test title, test number and, of course, the desired data in digital format. The video display also has digital format, while the graphical output has standard x-y plot with time on the horizontal axis and temperature (or other output) on the vertical axis. Temperature may be

expressed in any of the scales desired, namely F, C, K or R. Other variations such as multiple thermocouple outputs on one graph are possible as long as the operating personnel are appropriately informed.

There also exists in EC-70 the ability to perform altitude tests which simulate conditions that are different than those of the normal barometric pressure in Albuquerque. The altitude range is from about -2,500 ft to +100,000 ft and is programmable. The maximum rate of change to 50,000 ft is about 3,000 ft/min and the total elapsed time to reach 90,000 ft from ambient barometric pressure is about one half hour.

Other miscellaneous capabilities include being able to remotely control the chamber, and opening and closing the doors from Building 6631 so that test units that contain high explosives can be tested in EC-70 (Bldg. 6630) but controlled and the data monitored from Building 6631. Auxiliary equipment includes a track system and cart to easily transport test units into and out of the chamber and a crane to lift heavy items onto the track carts. The cart and track system can also be remotely controlled from Building 6631. The maximum test weight is about 40,000 lb and the crane is rated at about 30,000 lb.

B. EC 154 & 155

Environmental Chamber #154-155 is located in Building 6630 in Area III. It used to be two separate chambers but is now combined into one. The overall size of the combination is about 8 ft high x 12 ft wide by 20.7 ft long and the door opening is 7.5 ft x 8 ft (there is also a personnel door opening). A photograph is shown in Figure 4.

The chamber can simulate both temperature and humidity environments. The dry bulb temperature limits are from about -40 F on the lower end to about 180 F on the upper range. The control on dry bulb temperature about a fixed set point is about ± 2 F, the same as with EC-70.

Humidity limits in EC 154-155 are from a low of about 20% to a high of about 80%. The control about a fixed set point is about $\pm 5\%$ as with EC-70.

No temperature or humidity shocks are possible in EC 154-155 since there is no partition, the chamber size is fixed.

The crane available for use in Building 6630 can be used to position test items near EC 154-155 in the same manner as EC-70, but the track and cart used in EC-70 is not available for use in EC 154-155.

Data acquisition is essentially the same as with EC-70 since they are both located in the same building. Some amount of work would be necessary to record large numbers of data channels but the job would not be formidable.

EC 154-155 has no capabilities for pressure or altitude testing, but it does have capabilities for testing high explosive items.

C. EC-157

Environmental Chamber #157 is located in Building 6631 in Area III. The chamber compartment is about 8 ft wide by 15 ft long by 8 ft high. The door opening (personnel and test door) is about 6 ft by 7 ft. Figure 5 shows a photograph of EC-157.

EC-157 has temperature and humidity control capabilities. The dry bulb temperature range is from a low of about -65 F to a high of 170 F. Control is a typical ± 2 F about a fixed set point. Temperature profiles are programmable in the whole range and are accomplished via a chart recorder.

Humidity limits on EC-157 range from a low of about 5% to a high of about 95%. Control under steady state conditions (fixed dry bulb and % RH) is the same as was mentioned with the other chambers, namely $\pm 5\%$.

There is no automatic data acquisition on EC-157. The temperature and humidity in EC-157 are recorded on paper charts but any test item instrumentation would have to be recorded separately on a data logger or some appropriate device.

No crane is available in Building 6631 nor is there any track or cart system. There are no provisions for altitude or pressure testing or testing of high explosives items.

D. EC-156

Environmental Chamber #156 is located underground in Building 9970A. Building 9970A is located in the Coyote Canyon test complex southeast of Area III and east of the Central Receiver Test Facility. Figure 6 shows a photograph of EC-156. This chamber is specifically used for long term testing of items that contain high explosives.

The physical size of EC-156 is the same as that of EC-157 but its capabilities are different. Therefore, EC-156 is 8 ft wide by 15 ft long by 8 ft high with a door opening of 6 ft by 7 ft.

EC-156 has only temperature control capabilities--no humidity, pressure or altitude control is possible. The temperature range is from 35 F to 170 F and is programmable via charts. Control is ± 3 F in the whole range available. A small refrigeration unit is used for control and for achieving temperatures below ambient, but this chamber is normally used for heating only.

There are no data acquisition capabilities at all associated with EC-156. The chamber temperature is not recorded, the only means of knowing the temperature in the chamber would be to provide a chart recorder or data logger. The chamber (as with most of the chambers) is protected by an "over-temperature" alarm and equipment failure alarms.

As with EC-157 no on-site cranes, hoists or carts are available for use with heavy test items.

E. EC-100

Environmental Chamber #100 is located in Building 6630. The chamber cavity is about 5 ft wide by 7.3 ft long by 6.8 ft high with a door opening of 2.8 ft wide by 6.5 ft high. A photograph of EC-100 can be seen in Figure 7.

The chamber has only temperature control and has limits of 40 F to 150 F. Control about a fixed set point is about ± 3 F. Again, as

with EC-156, EC-100 has minimal provisions for cooling so the range below ambient is not extensive. There are no provisions for humidity control or to simulate altitude or pressure values other than the ambient conditions, but it can be used to test high explosive items.

At this time there are no data acquisition provisions at all. However, since the chamber is located near EC-70, the DAS used with EC-70 can be fitted for use with EC-100. Therefore, the data acquisition capabilities available for use with EC-70 are theoretically available for use with EC-100.

Since EC-100 is in Building 6630, the crane is available for positioning heavy or awkward test items. The track and cart used in EC-70 runs past EC-100 so could be used to position items in the general proximity of EC-100. However, the track does not go inside EC-100 (as it does with EC-70) so cannot be used to position test items directly inside EC-100.

F. EC-99

Environmental Chamber #99 is a special chamber that is able to simulate "salt-fog" and rain environments. It is located in Building 6630 towards the very north end of the building. The test compartment size is about 8 ft wide by 28.8 ft long by 6.8 ft high. There are door openings at each end of the chamber which are about 6.8 ft high by 8 ft wide (same size as compartment). One of the doors opens to the out-of-doors so heavy or awkward test items can be installed directly from the outside. The other door opens to an area similar to those near EC-70, EC-100, and EC 154-155. Therefore, the crane (but not the track) is available to position test items in the vicinity of EC-99. A photograph of EC-99 can be seen in Figure 8. This chamber, like all others in Building 6630, can be used to test high explosive items.

Temperature control is possible from ambient temperature to about 100 F. Control is about ± 4 F about a fixed set point.

There is no direct control of humidity because there is really no need. Either a salt-fog or rain condition requires a very high %

RH value, on the order of 95%, so variation and control are not necessary.

For a salt-fog condition to be established a solution is made with salinity variations anywhere from 5% to 20%. Since test conditions are usually specified as either 5% or 20% salinity, the variability is not usually used (but is available).

To produce a rain condition, one need only spray pure water through the nozzles provided. A rainfall rate up to 8 in. per hour and as low as 4 in. per hour can be produced. It may not be possible to deliver rates lower than 4 in. per hour because of equipment limitations.

As the system is configured now, data acquisition is minimal. Temperature is the only variable that is recorded and is done so on chart recorders. Since EC-99 is located in Building 6630, it may be possible to monitor other instrumentation with the DAS used on EC-70, but that has not been a requirement up to this point.

G. EC-112

Environmental Chamber 112 is located in an underground pit near Building 6750 in Area III. The chamber cavity is about 3 ft wide x 3 ft long x 3 ft high and has a door opening 3 ft wide by 3 ft high. A photograph of EC-112 in the pit can be seen in Figure 9.

The chamber has both temperature and humidity control capabilities. The temperature range of control is from a low of -100 F to a high of +250 F. Control at a constant temperature and a constant humidity is about ± 2 F. Temperature profiles may be programmed into a microprocessor and temperature controller. The microprocessor and temperature controller are located in Building 6750, while the chamber is located in a pit some distance away from the building. Therefore, there is remote control of the chamber from inside Building 6750.

Humidity control is from a low of 20% to a high of about 95% and has about a $\pm 5\%$ variability about a fixed set point. Remote humidity control can also be accomplished with the microprocessor and temperature controller since a wet bulb - dry bulb system is used to control humidity.

At the time of this writing, there is automatic data acquisition for use with this chamber. It consists of a Hewlett-Packard 2113B DAS and a 36 channel Type K thermocouple reference junction. The overall capabilities of the 2113B DAS were detailed when discussing EC-70 and will not be repeated here. The only basic difference is the size of the thermocouple reference junction; the unit in 6630 (EC-70) has 64 channels, and the unit in 6750 (EC-112) has 36 channels. If a larger reference junction can be found, it can be used with EC-112. The physical location of the DAS is in Building 6750 but the data is transmitted (via hard wire to Building 6631, the main computer base for the climatic chambers) and recorded. So the data is stored and can be plotted only from Building 6631.

The pit is about 12 ft in diameter and 22 ft deep and may be thought of as a large steel pipe in the ground with a steel cover. The pit is located about 95 ft west of Building 6750 and is exposed to the outdoors. The pit cover keeps the chamber protected from most environmental hazards (see Figure 10). A crane of 8,000 lb capacity is available to remove the cover and to lower test items into the chamber. This chamber, because of its remote control capabilities and underground location, is suitable for testing items that contain high explosives. No provisions are available for pressure or altitude testing.

III. SUMMARY

To provide a quick reference guide to show the general capabilities available in the chambers mentioned above, Table I is provided. It shows a summary including chamber number, location, size, temperature limits, temperature control, humidity limits and control data acquisition capabilities, special features and auxiliary equipment available.

TABLE I - SUMMARY OF CLIMATIC CHAMBERS

Chamber #	Location Bldg. #	Size Width x Length x Height	Temperature Parameters	Humidity Parameters	Data Acquisition	Special Features	Auxiliary Equipment
EC-70	6630	10.5 ft x 35 ft x 10.75 ft cavity 10.5 ft x 10.75 ft door	-100 F to 200 F with +2 F control at a fixed set point	5% to 98% with +5% control at fixed set point	By computer DAS, 16 high level (+10 V) and 61 type K thermocouple channels, variable scan rates	Temperature & humidity shocks, pressure & altitude simulation from -2500 ft to +100,000 ft, remote control (can test HE)	Moveable center partition, moveable track with cart, 30,000 lb crane. Remote control of cart and track system and doors.
EC154-155	6630	12 ft x 20.7 ft x 8 ft cavity 7.5 ft x 8 ft door	-40 F to 180 F with +2 F control at a fixed set point	20% to 80% with +5% control at a fixed set point	Same as EC-70	Can test items with high explosives	Crane usable
EC-157	6631	8 ft x 15 ft x 8 ft cavity 6 ft x 7 ft door	-65 F to 170 F with +2 F control	5% to 95% with +5 control	Chamber temp. & humidity recorded on paper charts only	No high explosive test items permitted	--
EC-156	9970A	8 ft x 15 ft x 8 ft cavity 6 ft x 7 ft door	35 F to 170 F with +3 F control	No humidity control	No recording capabilities	Underground, specifically for long term testing with high explosives	--
EC-100	6630	5 ft x 7.3 ft x 6.3 ft cavity 2.8 ft x 6.5 ft door	40 F to 150 F with +3 F control	No humidity control	No acquisition at this time but can be modified to use computer DAS	Can test items with high explosives	Crane available
EC-99 salt-fog & rain chamber	6630	3 ft x 28.8 ft x 6.8 ft cavity 3.8 ft x 8 ft doors	Ambient to 100 F	No control - nominal value near 95%	Temperature chart recorded. Computer DAS could be used if necessary	Salt-fog-5% to 20% salinity Rain - 4-8 inches/hr rainfall rate	Crane available, 2 doors, one available to out of doors. Can test high explosive items.
EC-112	6750	3 ft x 3 ft x 3 ft cavity, 3 ft x 3 ft door	-100 F to 250 F with +2 F control	20% to 95% with +5% control	By computer DAS 36 type K thermocouple channels, 16 high level channels, variable scan rates	Underground in pit, specially for high explosive test items	8,000 lb crane available

Figure 1
Photograph of EC-70

Figure 2
Thermocouple Reference Junction and Part
of DAS Located in Building 6630

C82-100, 425
M970167
UNC

Figure 3
Computer DAS Equipment Located in Building 6631

Figure 4
Photograph of EC 154-155

C82-100,428
M970167
UNC

C82-100,424
M970167
UNC

Figure 5
Photograph of EC-157

Figure 6
Photograph of EC-156

C82-100,426
M970167
UNC

C82-100,430
M970167
UNC

Figure 7
Photograph of EC-100

C82-100, 578
M970167
UNC

Figure 8
Photograph of EC-99

C82-100,480
M970167
UNC

Figure 9
EC-112 in Pit Near Building 6750

Figure 10
Steel Cover Over EC-112

C82-100,481
M970167
UNC

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