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U.S. Department of the Interior
National Park Service
Cultural Resources

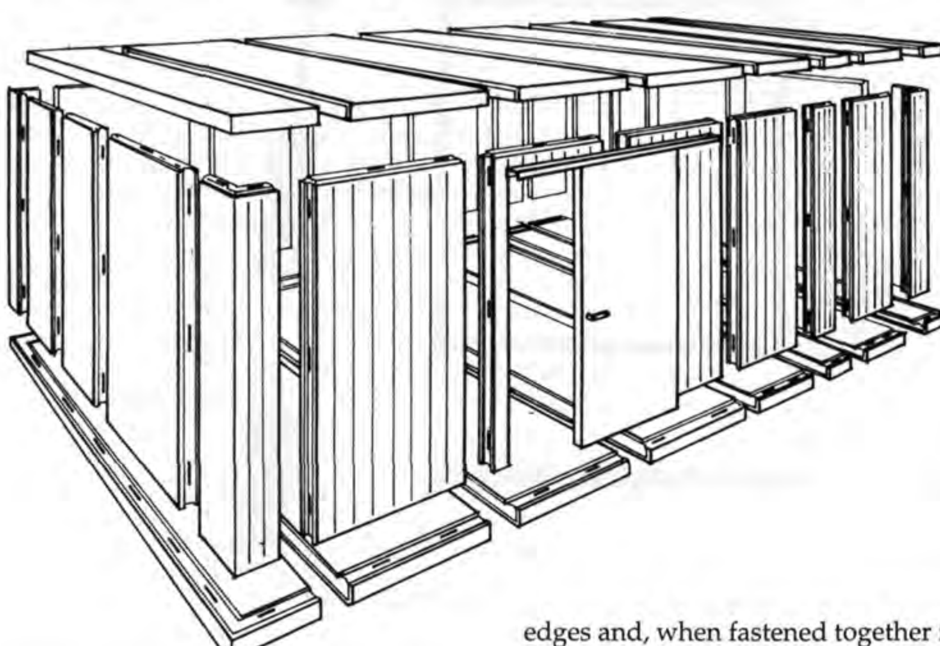
Collection Storage–Making a Case for Microenvironments

Donald R. Cumberland, Jr.

Because of the wide range of climatic conditions and variety of buildings used for collection storage, the National Park Service (NPS) relies on the ability of museum cabinets and prefabricated modular structures to provide quality collection storage space for NPS museums. Specialized museum storage cabinets and prefabricated modular structures contribute to the preservation of museum collections by enclosing museum objects in a beneficial microenvironment—one free of ambient light, dust, insects, and rodents and, most importantly, having stable relative humidity (RH) and temperature conditions. Stabilized high quality conditions reduce physical and chemical stress on objects, slow deterioration and, thereby, lead to long-term preservation.

Many museums, including NPS museums, use specialized museum storage cabinets as primary containment for museum objects in storage. These cabinets generally have double wall construction, locking doors and no glazing. They also have gasketing around the door jamb that reduces air exchanges, enabling a microenvironment to surround the objects.

Prefabricated modular structures, such as those manufactured by Bally Engineered Structures in Bally, PA, are becoming increasingly popular for storing museum collections, either within an existing building or as a self-contained, stand-alone exterior building. (We will use the term "Bally" to describe this building system, although Bally is but one of a number of manufacturers. Bally products are the ones most frequently used at NPS sites.) Bally buildings are similar in construction to walk-in refrigerators and are highly-effective in maintaining an appropriate museum environment because of superior insulation and virtually air-tight construction.



Exploded view of a museum storage facility showing the various prefabricated units that comprise the walls, corners, floor, ceiling, and sliding doors. Drawing by Christina Henry.

Storage space is formed by assembling foam-core (generally high-density polyurethane), metal clad (aluminum or galvanized steel) panels. The panels of most of the manufacturers have an insulation "R" value above 30; Bally panels are R-34. The panels are gasketed along the edges and, when fastened together form air-tight joints. The panels are light-weight and are quickly and easily assembled with ordinary hand tools. (In one instance at Harpers Ferry, WVA, an inexperienced NPS staff put together a non-conditioned Bally building of 100 square feet in less than one hour). Panels can be carried through the building's doors and assembled inside. Weatherproof roof panels are available to allow the building to be placed outside on a concrete slab.

(continued on page 2)

(continued from page 1)

In order to justify this reliance on its storage equipment, the NPS tested these storage containers to determine their effectiveness in creating and maintaining stable RH and temperature conditions both with and without the influence of environmental conditioning equipment.

The test consisted of monitoring projects at two sites in which conditions were recorded in several locations with each location experiencing different environmental conditions and having different environmental requirements. Each monitoring location or "station" indicates either the ambient weather conditions or a sequential layer of microenvironment.

Conditions were monitored for each of the following functions:

- maximum 24-hour RH change, which compares ambient RH conditions with the RH stabilizing effects of each layer of microenvironment;
- maximum/minimum RH levels, which indicate the range of RH conditions;
- maximum 24-hour temperature change, which compares ambient temperatures with the temperature stabilizing effects of each layer of microenvironment;
- maximum/minimum temperature levels, which indicate the range of temperature conditions.

Both projects involved assembling a Bally building, installing museum cabinets and hygrothermographs, and recording conditions over an extended period of time.

The Harpers Ferry Project

This project was conducted from February 23, 1987, to February 20, 1988, in the northwest corner room on the third floor of Building 33 at Harpers Ferry National Historical Park. Building 33 is a three-story stone and stucco structure with no climate control on the third floor. Unconditioned space was necessary to more accurately determine the buffering effects of each layer of microenvironment. The first and second floors of Building 33 are used as ranger offices and are heated and air-conditioned. The joists supporting the second story ceiling and the third story floor are uninsulated and may have allowed some heat transfer from the lower stories to the third floor.

The purpose of this project was to determine the effectiveness of NPS equipment in maintaining microenvironments within virtually unconditioned space within a historic structure. This situation is representative of what is found in many parks: collection storage in a dedicated space that has no active environmental controls.

Hygrothermographs were placed in six monitoring stations as indicated below and on Figure 1.

Station 1. Recorded conditions within a museum cabinet in the unconditioned Bally building.

Station 2. On top of a cabinet (Station 1 in the Bally building) to record conditions within the Bally building itself.

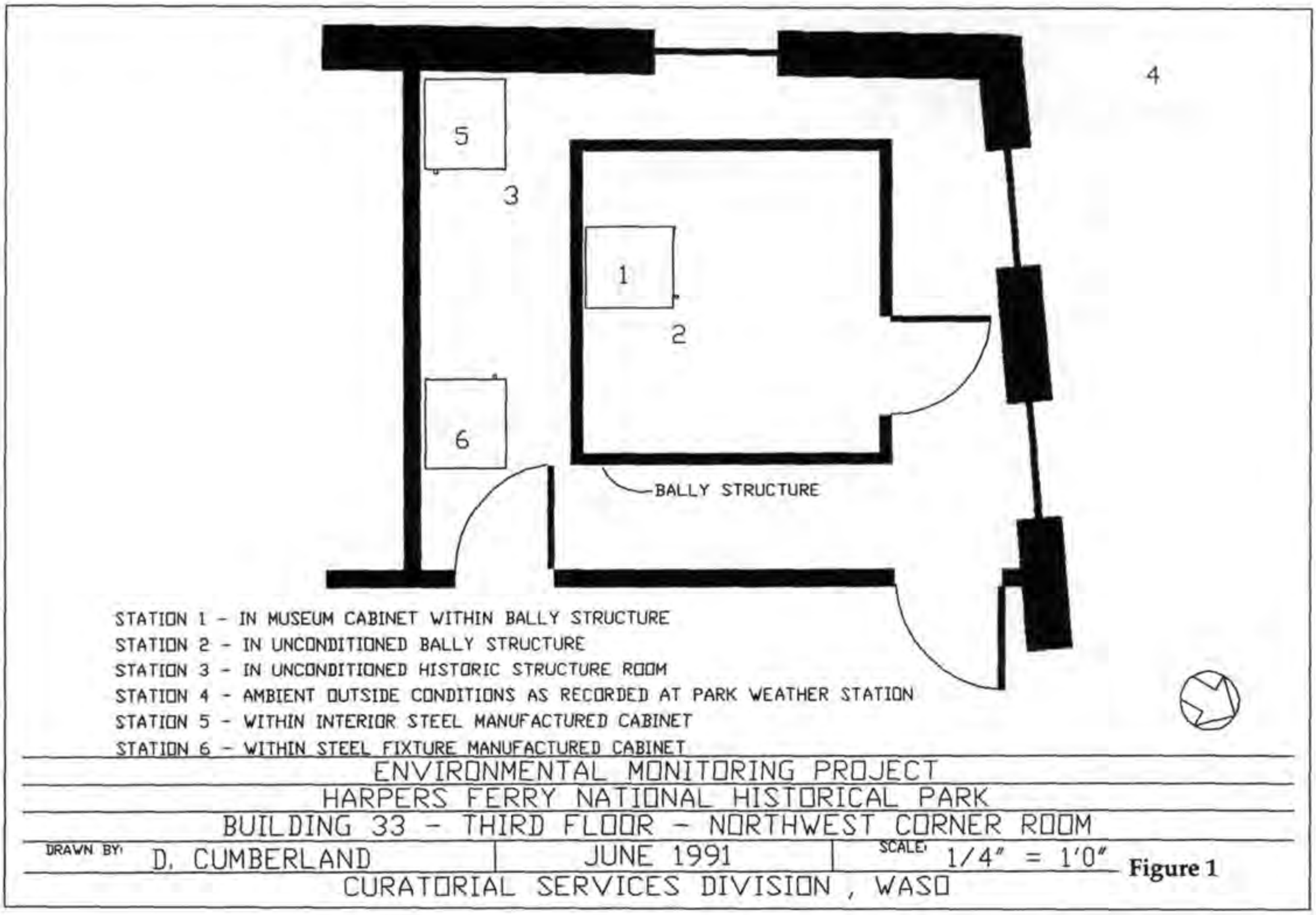


Figure 1

Station 3. Exposed in the unconditioned northwest corner room on the third floor of Building 33 to record room conditions.

Station 4. In the park's weather station to record ambient weather conditions.

During the test of the Bally building a comparison of the buffering effectiveness was made between cabinets of two different manufacturers. This cabinet test took place in the same northwest corner room of Building 33, but not within the Bally building. The unconditioned third-story room allowed sufficient fluctuation of conditions to make possible a determination of whether one brand of cabinet was superior to the other in maintaining a stable internal microenvironment.

Station 5. Within a museum cabinet manufactured by the Interior Steel Equipment Company, Cleveland, Ohio.

Station 6. Within a museum cabinet manufactured by the Steel Fixture Manufacturing Company, Topeka, Kansas.

The hygrothermographs at all stations recorded for 31-day intervals. The charts were changed at the end of each interval. Accurate information regarding station number and dates were entered on the charts. The hygrothermographs were calibrated using an electronic hygrometer on February 23, June 1, and October 21, 1987, or approximately once every four months.

An analysis of the records resulted in the information in Figure 2. Salient information on the chart was organized in graph form to produce Figure 3, which represents the highest and lowest temperatures and humidities recorded during the test period, and Figure 4, which represents the greatest 24-hour change of RH and temperature.

Figure 5 gives results of the test comparing the two brands of museum storage cabinets ability to maintain stable interior RH conditions. The test also allows the performance of the cabinets to be compared against the Bally building.

Fort Pulaski Project

From January 2, 1988 to January 4, 1989, a monitoring project was conducted in the 19th century masonry coastal fortification at Fort Pulaski National Monument near Savannah, GA. Monitoring took place in a west side casemate two rooms south of the sally port. (See Figure 6 for a diagram of the collection storage casement showing the Bally building.) Minimal conditioning (i.e. to human comfort range) is provided by a heating, ventilation, and airconditioning (HVAC) system in the casemate. In addition, the Bally building is conditioned to museum quality levels with a dedicated heat pump HVAC system.

The purpose of this project was to determine the effectiveness of a Bally building and a cabinet within the Bally building to maintain stable microenvironments within space that has minimal controls (i.e. the casement) and within a Bally structure having dedicated environmental controls. This situation at Fort Pulaski represents more sophisticated and better quality control than what commonly is found in most NPS museums and can be considered optimum.

Hygrothermographs were placed in four stations in order to monitor the ambient outdoor conditions and conditions within three layers of microenvironment (i.e. the historic casemate, the Bally building, and within a cabinet in the Bally building) as depicted in the drawing in Figure 6. Stations were designated as follows:

Station 1. Recorded conditions within a cabinet in the conditioned Bally building;

Station 2. On top of the cabinet (Station 1) to record conditions within the Bally building;

Station 3. Exposed in the minimally conditioned casemate to record conditions there;

Station 4. In the park's weather station to record ambient conditions.

A second test to compare cabinets by manufacturer was considered unnecessary and was not undertaken. Consequently, this project did not require Stations 5 and 6.

Hygrothermographs were recorded on a 7-day (weekly) basis. Four or five charts were analyzed to organize information in approximately 30-day increments that roughly corresponded to the calendar months. This information was used to produce the data in Figure 7 and the graphs in Figures 8 and 9.

Test Results

The following two parameters were incorporated into the findings:

First, the fluctuation rate of 24 hours was selected as representative of the diurnal (day/night) cycle. The diurnal cycle generally experiences the greatest temperature and RH differential and is the time span when most physical and chemical damage to objects occurs. However, because of the buffering effects of the museum storage equipment, fluctuations in sequential layers of microenvironment were delayed and did not exactly correspond to the day/night cycle. Because of this phenomenon it is felt a 24-hour rather than a true day/night cycle indicated changes more realistically.

Secondly, infrequent fluctuations of durations of two hours or less were not accounted for on the data sheets and diagrams because the hysteresis (i.e. the time lag exhibited by an object in reacting to changes in the forces, in this instance the RH and temperature, affecting it) of most materials that make up museum objects does not allow sufficient time for the objects to react.

Harpers Ferry Project Findings

Hygrothermograph records reveal that over the course of the two-year testing period and without any energy input for heating, cooling and humidity control, the greatest 24-hour RH and temperature changes recorded on the interior of the Bally building were 6% and 6°F respectively (which were virtually the same changes recorded for inside the cabinet within the Bally building). These findings are quite impressive when compared to the maximum 24-hour fluctuation of 25% RH and 47°F temperature recorded in the historic structure room itself and 63% RH and 46°F temperature recorded in the weather station.

Conditions within the cabinet inside the Bally building were essentially the same as those in the Bally building itself, indicating that the cabinets contributed little additional climate control.

Cabinets by both manufacturers were equal in maintaining a stable microenvironment.

(continued on last page)

HARPERS FERRY PROJECT

MICROENVIRONMENT TEST

MICROENVIRONMENT COMPARISON

DATE		STATION 1	STATION 2	STATION 3	STATION 4
2/23/87 -3/24/87	MAX. TEMP.	60	60	61	75
	MIN. TEMP	48	48	48	19
	MAX. 24 HR. TEMP. CHANGE	4	4	7	46
	MAX. RH	48	47	67 1/2	86
	MIN. RH	37 1/2	36	34	14
	MAX. 24 HR. RH CHANGE	3	6	20	63
3/24/87 -4/20/87	MAX. TEMP.	65	64	65	74
	MIN. TEMP	53	52	50	27
	MAX. 24 HR. TEMP. CHANGE	5	5	7	33
	MAX. RH	46	52	79	83 1/2
	MIN. RH	38	41	41	21
	MAX. 24 HR. RH CHANGE	3	3	25	59
4/20/87 -5/18/87	MAX. TEMP.	77	73	87	87
	MIN. TEMP	61	60	60	35
	MAX. 24 HR. TEMP. CHANGE	2	3	5	41
	MAX. RH	54	58	68	83
	MIN. RH	42 1/2	45	42 1/2	21
	MAX. 24 HR. RH CHANGE	3	3	12	59
5/18/87 -6/15/87	MAX. TEMP.	84	83	86	95
	MIN. TEMP	69	66	67	48
	MAX. 24 HR. TEMP. CHANGE	4	4	5	32
	MAX. RH	54	56	79	90
	MIN. RH	45	44	40	36
	MAX. 24 HR. RH CHANGE	4	3	14	64
6/15/87 -7/13/87	MAX. TEMP.	81	80	82	94
	MIN. TEMP	74	74	72	59
	MAX. 24 HR. TEMP. CHANGE	2	2	5	28
	MAX. RH	62	62	76	90
	MIN. RH	55	54	54	39
	MAX. 24 HR. RH CHANGE	2	2	12	51
7/13/87 -8/8/87	MAX. TEMP.	87	87	88	99
	MIN. TEMP	74	74	72	58
	MAX. 24 HR. TEMP. CHANGE	4	4	6	39
	MAX. RH	70	66	74	94
	MIN. RH	57	53	50	37
	MAX. 24 HR. RH CHANGE	4	3	12	52
8/8/87 -9/3/87	MAX. TEMP.	82	82	83	97
	MIN. TEMP	69	79.	67	52
	MAX. 24 HR. TEMP. CHANGE	2	3	6	35
	MAX. RH	69	63	93	92 1/2
	MIN. RH	60	56	52	36
	MAX. 24 HR. RH CHANGE	3	4	22	55
9/3/87 -10/1/87	MAX. TEMP.	73	73	74	87
	MIN. TEMP	65	65	63	47
	MAX. 24 HR. TEMP. CHANGE	2	2	3	25
	MAX. RH	75	71	88	92
	MIN. RH	63	56	54	38
	MAX. 24 HR. RH CHANGE	3	2	15	43
10/1/87 -11/5/87	MAX. TEMP.	65	65	64	76
	MIN. TEMP	53	53	50	33
	MAX. 24 HR. TEMP. CHANGE	2	3	5	35
	MAX. RH	57	55	60	90
	MIN. RH	54	51	47	32
	MAX. 24 HR. RH CHANGE	2	2	15	54
11/5/87 -12/1/87	MAX. TEMP.	67	67	66	76
	MIN. TEMP	52	52	48	23
	MAX. 24 HR. TEMP. CHANGE	6	6	7	33
	MAX. RH	59	56	80	96
	MIN. RH	50	48 1/2	37	31
	MAX. 24 HR. RH CHANGE	4	5	25	56
12/1/87 -1/5/88	MAX. TEMP.	58	58	56	65
	MIN. TEMP	46	46	41	21
	MAX. 24 HR. TEMP. CHANGE	4	4	5	31
	MAX. RH	57	57	70	91
	MIN. RH	51	47	40	32
	MAX. 24 HR. RH CHANGE	3	3	15	59
1/5/88 -2/1/88	MAX. TEMP.	49	48	47	62
	MIN. TEMP	37	35	31	6
	MAX. 24 HR. TEMP. CHANGE	3	3	4	31
	MAX. RH	41	42	82	89
	MIN. RH	37	36	36	24
	MAX. 24 HR. RH CHANGE	2	2 1/2	24	42
2/1/88 -2/26/88	MAX. TEMP.	52	54	54	64
	MIN. TEMP	35	35	35	28
	MAX. 24 HR. TEMP. CHANGE	5	5	6	35
	MAX. RH	40	48	62	92
	MIN. RH	38	35	29	22
	MAX. 24 HR. RH CHANGE	1 1/2	3	19	63

CABINET TEST

CABINET COMPARISON

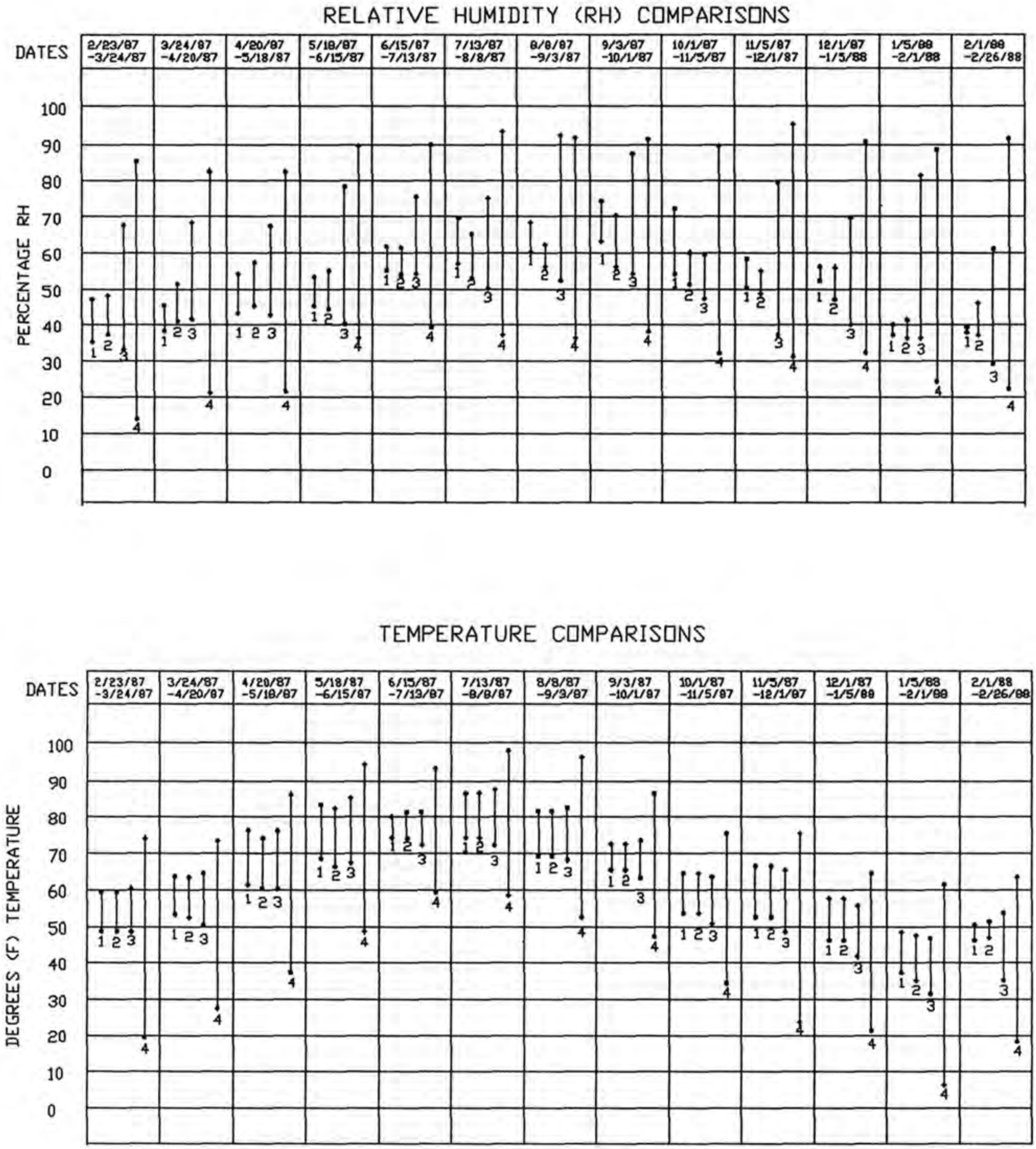
DATE	STATION 5	STATION 6
2/23/87 -3/24/87	60	-*
	48	-*
	6	-*
	47 1/2	-*
	40	-*
	6	-*
3/24/87 -4/20/87	64	-*
	51	-*
	7	-*
	52	-*
	42	-*
	5	-*
4/20/87 -5/18/87	76	79
	59	63
	6	5
	59	58 1/2
	44	49
	4	4
5/18/87 -6/15/87	83	86
	66	68
	5	6
	57	66
	48	52
	5	6
6/15/87 -7/13/87	82	82
	72	72
	6	6
	63	65
	55	55
	4	4
7/13/87 -8/8/87	86	87
	72	72
	6	6
	72	71
	59	58
	5	4
8/8/87 -9/3/87	82	82
	67	68
	5	8
	67	65
	58 1/2	57
	4	5
9/3/87 -10/1/87	72	73
	62 1/2	63
	3	4
	76	75
	62	57
	3	3
10/1/87 -11/5/87	65	64
	51	51
	6	5 1/2
	74	69
	54	54
	5	3
11/5/87 -12/1/87	66	67
	49	50
	8	8
	62	62
	51	48
	5	6
12/1/87 -1/5/88	55	57
	45	42
	7	6
	60	60
	55	47
	4	6
1/5/88 -2/1/88	54	50
	36	37
	3	4 1/2
	55	49
	38	38
	2	4
2/1/88 -2/26/88	54	55
	38	39
	5	6
	52 1/2	54
	38	36
	3	6 1/2

STATION 1 - IN CABINET IN BALLY STRUCTURE
STATION 2 - EXPOSED IN BALLY STRUCTURE
STATION 3 - *IN UNCONDITIONED ROOM WITHIN HISTORIC STONE BUILDING*
STATION 4 - AMBIENT OUTSIDE CONDITIONS
STATION 5 - WITHIN INTERIOR STEEL MANUFACTURED CABINET IN UNCONDITIONED ROOM
STATION 6 - WITHIN STEEL FIXTURE MANUFACTURED CABINET IN UNCONDITIONED ROOM

* - STEEL FIXTURE CABINET UNAVAILABLE FOR TEST UNTIL APRIL, 1988.

Figure 2

HARPERS FERRY PROJECT
MONTHLY MAXIMUM/MINIMUM LEVELS



STATION 1 - IN CABINET IN BALLY STRUCTURE
STATION 2 - IN UNCONDITIONED BALLY STRUCTURE
STATION 3 - IN UNCONDITIONED ROOM WITHIN HISTORIC STRUCTURE
STATION 4 - AMBIENT OUTDOOR CONDITIONS

Figure 3

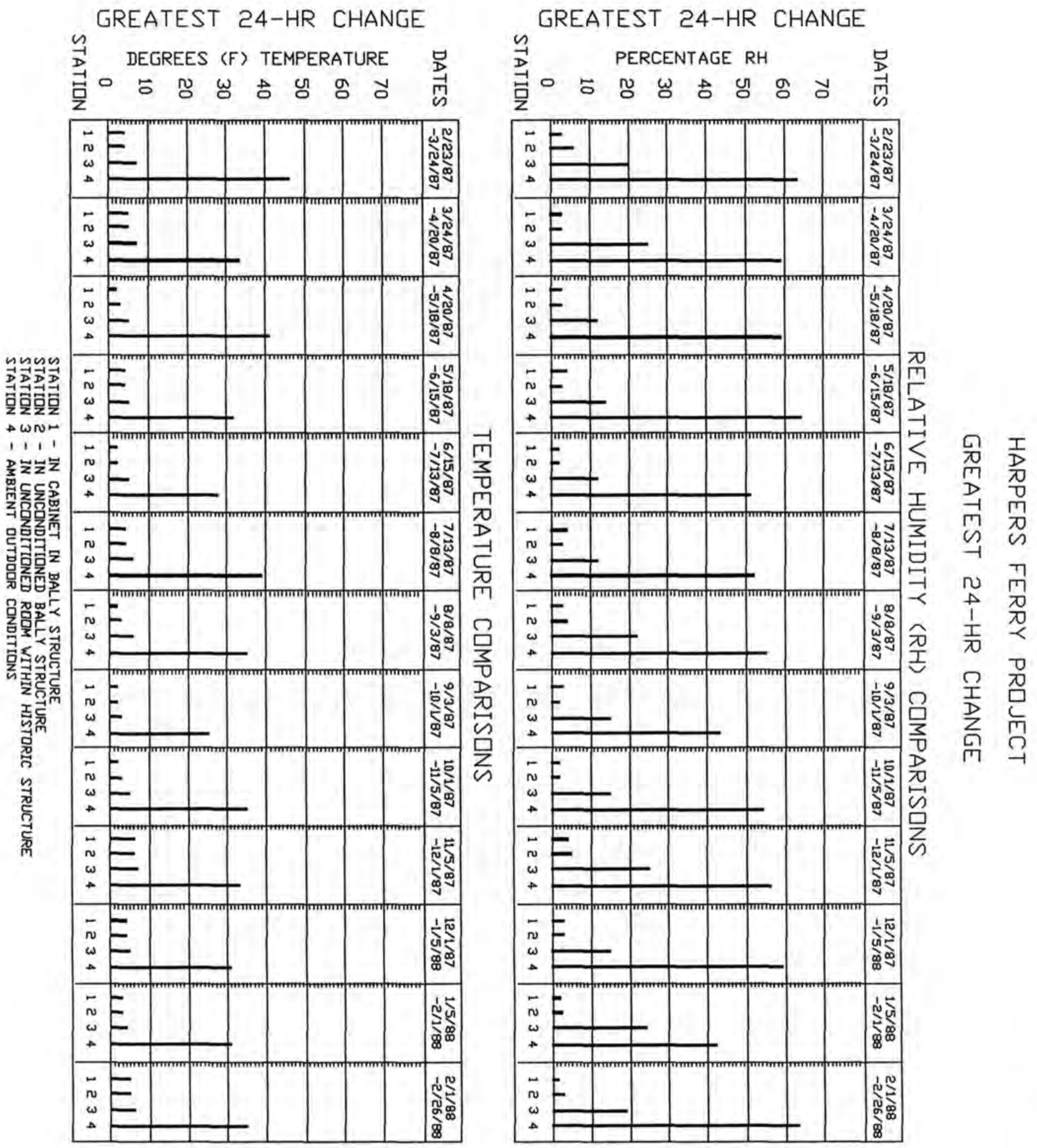
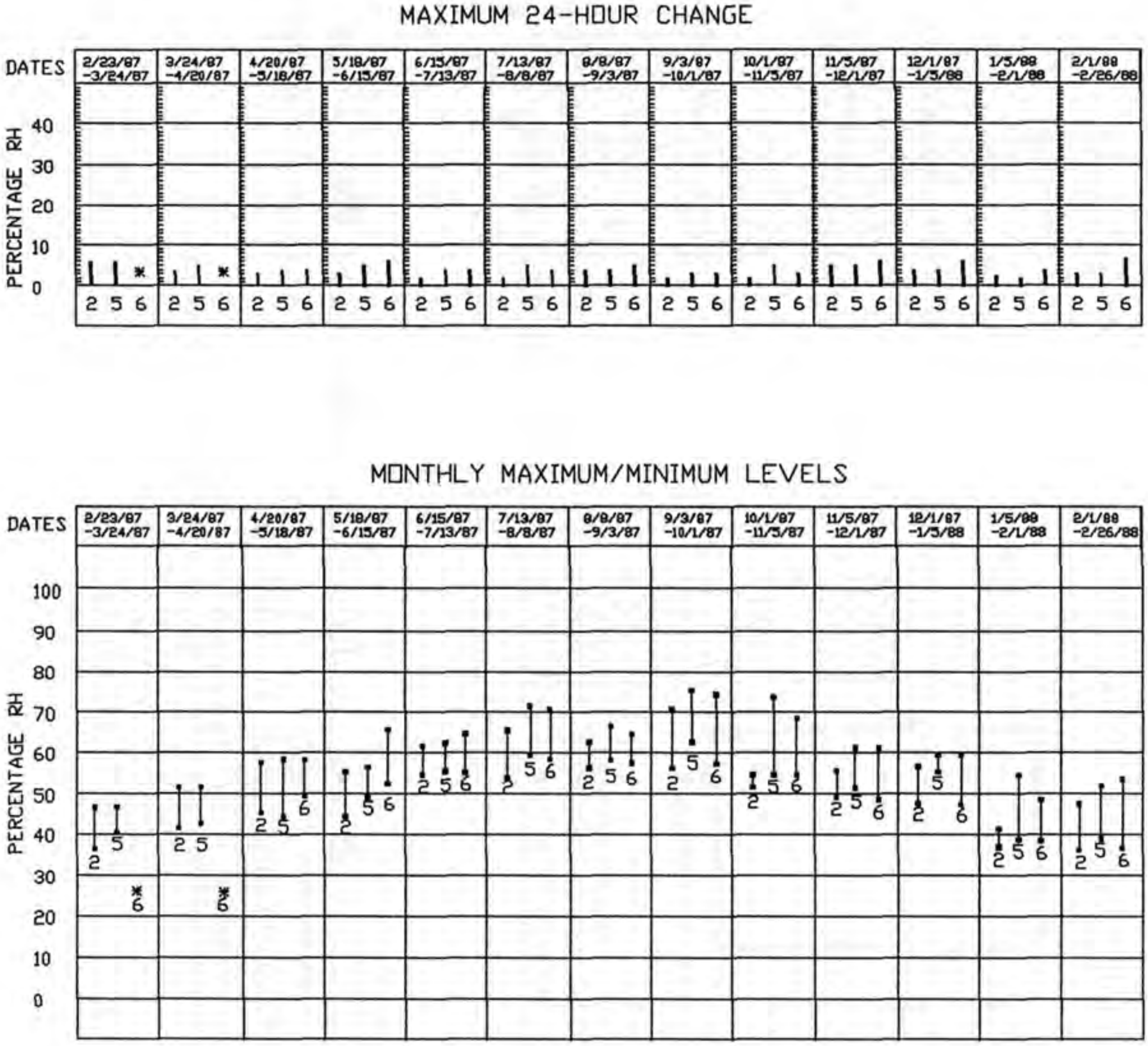

HARPERS FERRY PROJECT
GREATEST 24-HR CHANGE
RELATIVE HUMIDITY (RH) COMPARISONS
GREATEST 24-HR CHANGE
PERCENTAGE RH
DATES
STATION
0
10
20
30
40
50
60
70
2/23/87 -3/24/87
3/24/87 -4/20/87
4/20/87 -5/18/87
5/18/87 -6/15/87
6/15/87 -7/13/87
7/13/87 -8/8/87
8/8/87 -9/3/87
9/3/87 -10/1/87
10/1/87 -11/5/87
11/5/87 -12/1/87
12/1/87 -1/5/88
1/5/88 -2/1/88
2/1/88 -2/26/88
1 2 3 4
TEMPERATURE COMPARISONS
GREATEST 24-HR CHANGE
DEGREES (F) TEMPERATURE
STATION 1 - IN CABINET IN BALLY STRUCTURE
STATION 2 - IN UNCONDITIONED BALLY STRUCTURE
STATION 3 - IN UNCONDITIONED ROOM WITHIN HISTORIC STRUCTURE
STATION 4 - AMBIENT OUTDOOR CONDITIONS

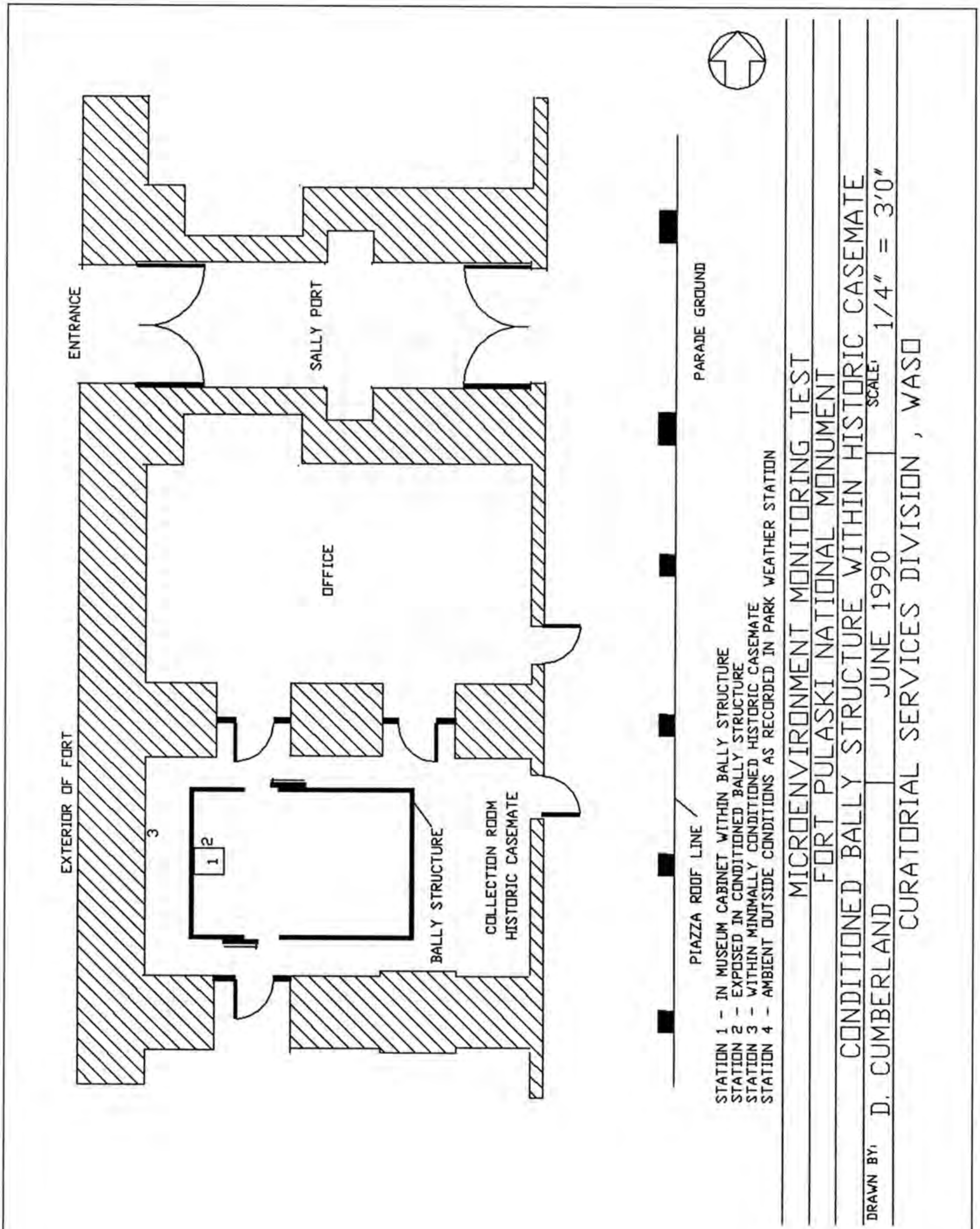
Figure 4

HARPERS FERRY PROJECT
RELATIVE HUMIDITY (RH) COMPARISONS
BETWEEN MUSEUM STORAGE CABINETS AND BALLY STRUCTURE



STATION 2 - IN UNCONDITIONED BALLY STRUCTURE
STATION 5 - WITHIN A MUSEUM STORAGE CABINET MANUFACTURED BY INTERIOR STEEL EQUIPMENT CORP. IN AN UNCONDITIONED ROOM
STATION 6 - WITHIN A MUSEUM STORAGE CABINET MANUFACTURED BY STEEL FIXTURE MFG. CO. IN AN UNCONDITIONED ROOM
* - STEEL FIXTURE MANUFACTURED CABINET UNAVAILABLE FOR TEST UNTIL APRIL, 1988

Figure 5



EXTERIOR OF FORT
ENTRANCE
SALLY PORT
OFFICE
COLLECTION ROOM
HISTORIC CASEMATE
BALLY STRUCTURE
1
2
3
PIAZZA ROOF LINE
PARADE GROUND
STATION 1 - IN MUSEUM CABINET WITHIN BALLY STRUCTURE
STATION 2 - EXPOSED IN CONDITIONED BALLY STRUCTURE
STATION 3 - WITHIN MINIMALLY CONDITIONED HISTORIC CASEMATE
STATION 4 - AMBIENT OUTSIDE CONDITIONS AS RECORDED IN PARK WEATHER STATION
MICROENVIRONMENT MONITORING TEST
FORT PULASKI NATIONAL MONUMENT
CONDITIONED BALLY STRUCTURE WITHIN HISTORIC CASEMATE
DRAWN BY: D. CUMBERLAND
JUNE 1990
SCALE: 1/4" = 3'0"
CURATORIAL SERVICES DIVISION, WASO

Figure 6

FORT PULASKI PROJECT
MICROENVIRONMENT TEST

MICROENVIRONMENT COMPARISON

DATE	CONDITION	STATION 1	STATION 2	STATION 3	STATION 4
1/2/88 -2/6/88	MAX. TEMP.	61	63	57	76
	MIN. TEMP	52	54	40	28
	MAX. 24 HR. TEMP. CHANGE	2	2	9	24
	MAX. RH	51	51	97	89
	MIN. RH	49	45	32	30
	MAX. 24 HR. RH CHANGE	1	1	41	53
2/6/88 -3/5/88	MAX. TEMP.	60	64	56	72
	MIN. TEMP	51	55	40	27
	MAX. 24 HR. TEMP. CHANGE	2	2	9	32
	MAX. RH	52	49	96	89
	MIN. RH	50	45	35	21
	MAX. 24 HR. RH CHANGE	1/2	1	45	63
3/5/88 -4/2/88	MAX. TEMP.	64	66	62	80
	MIN. TEMP	55	58	45	33
	MAX. 24 HR. TEMP. CHANGE	2	2	11	33
	MAX. RH	53	50	95	91
	MIN. RH	50	44	31	18
	MAX. 24 HR. RH CHANGE	1/2	1	58	68
4/2/88 -4/30/88	MAX. TEMP.	68	71	70	90
	MIN. TEMP	61	62	52	46
	MAX. 24 HR. TEMP. CHANGE	2	2	8	30
	MAX. RH	53	51	96	90
	MIN. RH	51	45	32	22
	MAX. 24 HR. RH CHANGE	1/2	3	51	63
4/30/88 -6/4/88	MAX. TEMP.	69	72	70	90
	MIN. TEMP	64	66	60	56
	MAX. 24 HR. TEMP. CHANGE	2	3	6	27
	MAX. RH	53	49	93	87
	MIN. RH	52	45	48	31
	MAX. 24 HR. RH CHANGE	1/2	2	42	55
6/4/88 -7/4/88	MAX. TEMP.	72	76	75	96
	MIN. TEMP	66	66	66	63
	MAX. 24 HR. TEMP. CHANGE	2	2	5	25
	MAX. RH	53	51	91	100
	MIN. RH	51	45	62	38
	MAX. 24 HR. RH CHANGE	1/2	2	18	55
7/4/88 -7/30/88	MAX. TEMP.	72	76	77	96
	MIN. TEMP	68	70	71	69
	MAX. 24 HR. TEMP. CHANGE	1	2	3	20
	MAX. RH	54	50	95	100
	MIN. RH	52	47	72	44
	MAX. 24 HR. RH CHANGE	1/2	1	18	54
7/30/88 -8/27/88	MAX. TEMP.	80	80	79	97
	MIN. TEMP	70	72	74	73
	MAX. 24 HR. TEMP. CHANGE	2	4	3	22
	MAX. RH	55	55	92	100
	MIN. RH	53	47	64	46
	MAX. 24 HR. RH CHANGE	1/2	1	28	51
8/27/88 -10/1/88	MAX. TEMP.	79	85	76	93
	MIN. TEMP	68	69	67	63
	MAX. 24 HR. TEMP. CHANGE	1	2	4	22
	MAX. RH	55	70	96	100
	MIN. RH	53	47	71	51
	MAX. 24 HR. RH CHANGE	1	1	18	45
10/1/88 -10/29/88	MAX. TEMP.	69	72	71	87
	MIN. TEMP	65	67	60	47
	MAX. 24 HR. TEMP. CHANGE	1	1	5	29
	MAX. RH	53	50	93	98
	MIN. RH	50	46	49	34
	MAX. 24 HR. RH CHANGE	1	3	24	58
10/29/88 -12/3/88	MAX. TEMP.	67	70	65	82
	MIN. TEMP	60	63	57	39
	MAX. 24 HR. TEMP. CHANGE	2	2	7	30
	MAX. RH	52	52	99	94
	MIN. RH	51	46	42	28
	MAX. 24 HR. RH CHANGE	1/2	1	43	59
12/3/88 -1/4/89	MAX. TEMP.	62	67	61	77
	MIN. TEMP	53	56	42	27
	MAX. 24 HR. TEMP. CHANGE	1	1	8	31
	MAX. RH	52	51	99	91
	MIN. RH	51	46	43	26
	MAX. 24 HR. RH CHANGE	1/2	1	51	64

STATION 1 - IN MUSEUM CABINET WITHIN BALLY STRUCTURE
STATION 2 - EXPOSED IN CONDITIONED BALLY STRUCTURE
STATION 3 - WITHIN CONDITIONED HISTORIC CASEMATE CONTAINING BALLY STRUCTURE
STATION 4 - AMBIENT OUTSIDE CONDITIONS

Figure 7

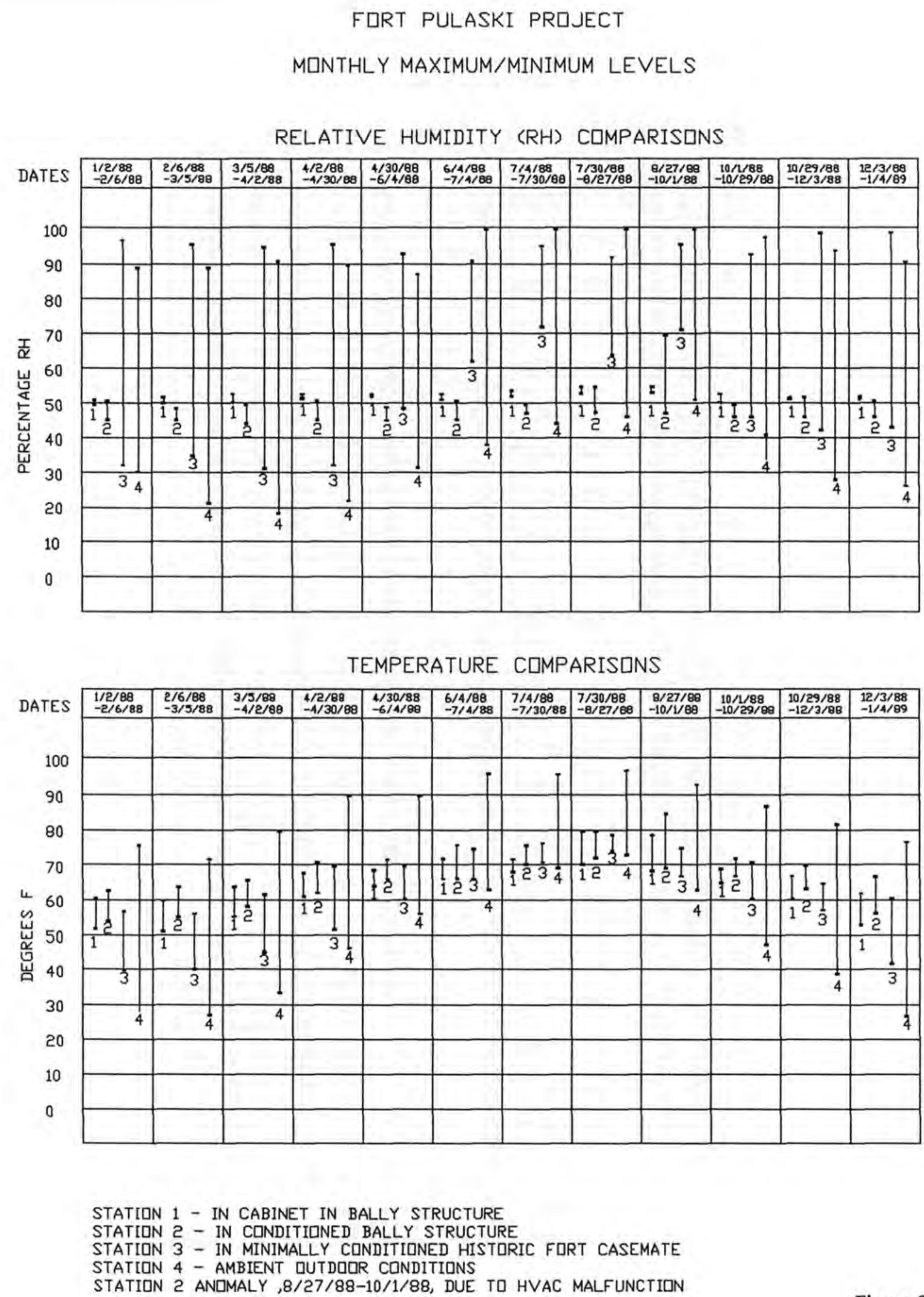

FORT PULASKI PROJECT
MONTHLY MAXIMUM/MINIMUM LEVELS
RELATIVE HUMIDITY (RH) COMPARISONS
DATES
1/2/88 -2/6/88
2/6/88 -3/5/88
3/5/88 -4/2/88
4/2/88 -4/30/88
4/30/88 -6/4/88
6/4/88 -7/4/88
7/4/88 -7/30/88
7/30/88 -8/27/88
8/27/88 -10/1/88
10/1/88 -10/29/88
10/29/88 -12/3/88
12/3/88 -1/4/89
PERCENTAGE RH
TEMPERATURE COMPARISONS
DEGREES F
STATION 1 - IN CABINET IN BALLY STRUCTURE
STATION 2 - IN CONDITIONED BALLY STRUCTURE
STATION 3 - IN MINIMALLY CONDITIONED HISTORIC FORT CASEMATE
STATION 4 - AMBIENT OUTDOOR CONDITIONS
STATION 2 ANOMALY ,8/27/88-10/1/88, DUE TO HVAC MALFUNCTION

Figure 8

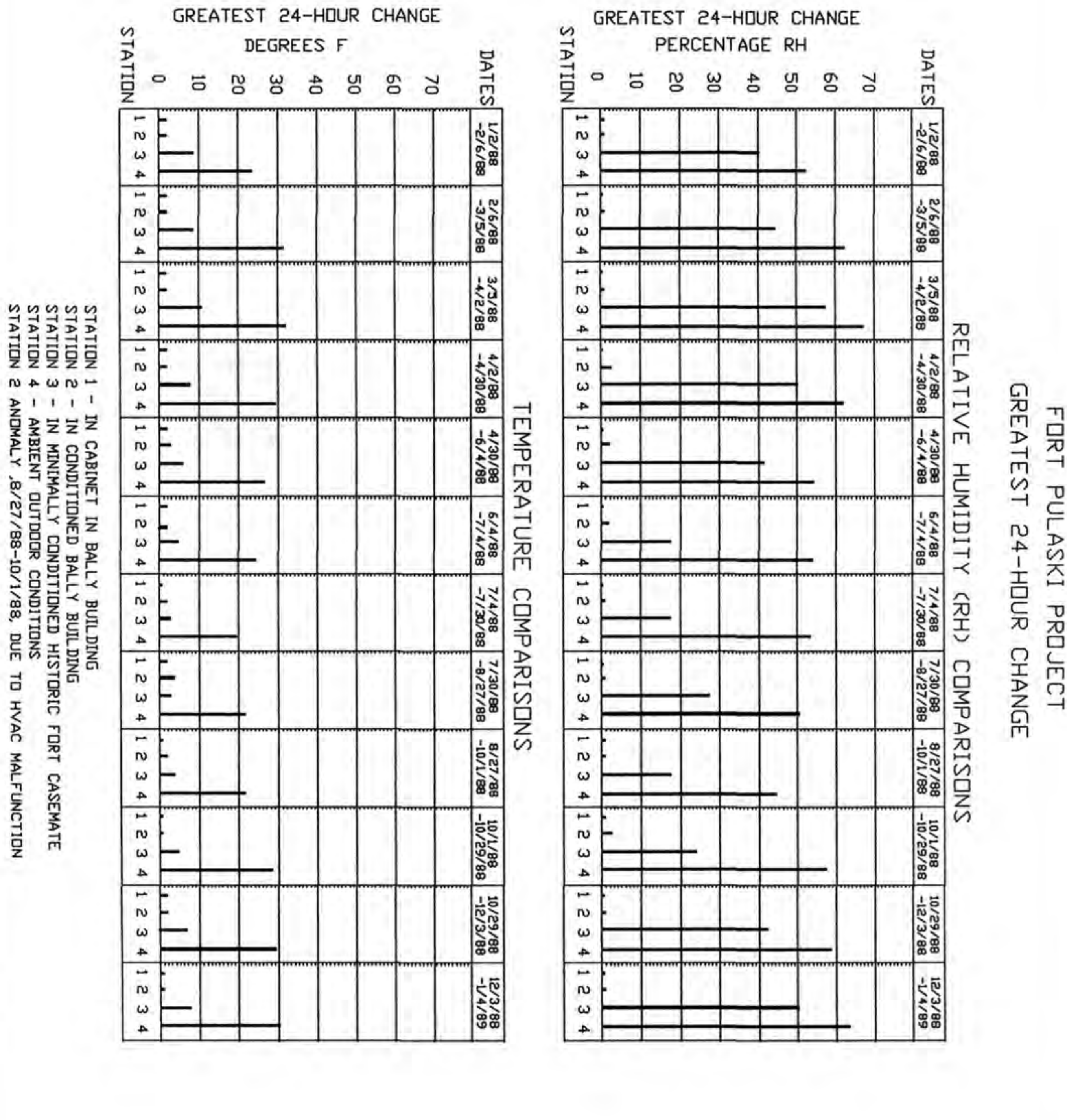

FORT PULASKI PROJECT
GREATEST 24-HOUR CHANGE
RELATIVE HUMIDITY (RH) COMPARISONS
GREATEST 24-HOUR CHANGE
PERCENTAGE RH
TEMPERATURE COMPARISONS
GREATEST 24-HOUR CHANGE
DEGREES F
DATES
STATION
1/2/88 -2/6/88
2/6/88 -3/5/88
3/5/88 -4/2/88
4/2/88 -4/30/88
4/30/88 -6/4/88
6/4/88 -7/4/88
7/4/88 -7/30/88
7/30/88 -8/27/88
8/27/88 -10/1/88
10/1/88 -10/29/88
10/29/88 -12/3/88
12/3/88 -1/4/89
STATION 1 - IN CABINET IN BALLY BUILDING
STATION 2 - IN CONDITIONED BALLY BUILDING
STATION 3 - IN MINIMALLY CONDITIONED HISTORIC FORT CASEMATE
STATION 4 - AMBIENT OUTDOOR CONDITIONS
STATION 2 ANOMALY 8/27/88-10/1/88, DUE TO HVAC MALFUNCTION

Figure 9

(continued from page 3)

The unconditioned Bally building was equivalent to the museum cabinets in maintaining a stable microenvironment in the same unconditioned space.

Fort Pulaski Project Findings

The greatest 24-hour changes at the weather station were 68% RH and 33°F temperature. The casemate with the HVAC system set to conditions of human comfort levels experienced a surprisingly large 24-hour maximum RH change of 58% and a less radical temperature change of 11°F. The Bally building, with a heat pump dedicated to controlling interior conditions enabled almost perfect conditions to be maintained. The conditioned Bally building maintained interior conditions at desired levels with maximum 24-hour changes of 3% RH and 2°F temperature. Average 24-hour changes of RH and temperature were 1/2% and 1°F respectively. The cabinet within the Bally building never experienced a 24-hour change greater than 1% and had an average change of only 1/2%. The greatest and average temperature changes inside the cabinet were 2°F and 1°F respectively.

The abnormally high RH and temperature levels in Station 2 during the period August 27, 1988 through October 1, 1988 were a result of an HVAC equipment malfunction.

Conclusion

Based on this test, the NPS has determined that the museum cabinets and Bally buildings used for collection storage are effective in creating and maintaining microenvironments for the preservation of museum collections. When used in unconditioned space, the equipment was able to maintain stable conditions at an acceptable level (6% maximum RH and 6°F maximum temperature change) without energy input and the expense of operating environmental control equipment. When used in space with minimal environmental control, a Bally building with a dedicated HVAC system maintained virtually ideal conditions (i.e. appropriate temperature and RH ranges with extremely little fluctuation—1% RH and 2°F temperature).

If the ability to maintain a stable microenvironment is used as a measure of preservation benefit to a museum collection, most collection preservation can be achieved with containment of objects in passive, unconditioned museum cabinets or Bally buildings. Preservation benefit is enhanced by the active use of environmental control within the Bally building or the space containing the Bally building or museum cabinets. This conclusion suggests that objects with little humidity and temperature sensitivity may be adequately stored simply by containment in cabinets or in an unconditioned Bally building. However, collections comprised of organic materials and most mixed collections are more humidity and temperature sensitive and would benefit from the enhanced stability produced by conditioning a Bally building or by conditioning the space containing the cabinets or Bally building.

The National Park Service is fortunate to have selected and used equipment that met the requirements for object preservation. The past and future use of this equipment has and will be crucial to the preservation of NPS collections.

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