DOCKET NO. **SA- 516**

EXHIBIT NO. **23H**

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C

ADDENDUM 1 TO THE FLIGHT TEST GROUP CHAIRMAN'S FACTUAL REPORT OF INVESTIGATION

(121 Pages)

FACTUAL REPORT

NATIONAL TRANSPORTATION SAFETY BOARD

Office of Research and Engineering
Washington, D.C.

January 31, 2000

ADDENDUM 1 TO THE FLIGHT TEST GROUP CHAIRMAN'S FACTUAL REPORT OF INVESTIGATION

A. ACCIDENT: DCA-96-MA-070

Location:	East Moriches, New York
Date:	July 17, 1996
Time:	2031 Eastern Daylight Time
Airplane:	Boeing 747-131, N93119

B. GROUP IDENTIFICATION

The group met at JFK Airport on July 11, 1997, through July 20, 1997. The following group members participated in the investigation.

Chairman:	Daniel R. Bower, Ph.D. NTSB
Test Director:	Robert Benzon NTSB
Member:	Michael Collins Federal Aviation Administration
Member:	Roland Johnson Boeing Commercial Airplane Company
Member:	Steve Green Air Line Pilots Association
Member:	Terry Stacey Trans World Airlines

Additional participants were involved for the implementation of the Flight Test. These participants were:

Member:	Kevin Rickard Evergreen Airlines
Member:	Steven A. Bongardt FBI/DOD Coordinator
Member:	Robert L. Swaim NTSB Systems Group Chairman
Member:	Merritt Birky, Ph.D. NTSB Fire and Explosion Group Chairman

FlightCrew:

Captain:	Dale M. Ranz Boeing
First Officer:	Jamie C. Loesch Boeing
Flight Engineer:	George E. Kegebein Boeing

C. SUMMARY

This document is an addendum to the original Flight Test Group Factual Report dated November 19, 1997. The original report (Exhibit 23A) detailed the flight test program in support of the TWA flight 800 accident investigation. Exhibit 23F presented temperature data for the TWA800 emulation flight, and this addendum report presents additional temperature data plots of the flight test data for the 5 other flights directed by the NTSB in the flight test series. (Data for the 3 test flights performed for Boeing contain data considered to be proprietary by Boeing and are not included in this report, but was reviewed by the NTSB staff.). Data presented in this addendum report include temperature measurements of the CWT ullage, CWT bottom surface, and 4 inches below the CWT surface in the environmental control system (ECS) air-conditioning pack bay.

D. DETAILS OF THE INVESTIGATION

Section I – Flight Test Series

The flight tests consisted of a total of nine flights. Three of the nine flights were performed for Boeing Aircraft. Boeing Commercial Airplane Group has determined that the data from the flights performed for Boeing is proprietary product development information. The flight test procedure, preflight operation of the ECS units, and flight profiles utilized in the six NTSB flights are summarized in the original document. The data contained in this report are the temperature data from the three flights performed with approximately 50 gallons of fuel in the CWT, and different combinations of ECS units in operation. The temperature data for the flight performed with 6000 pounds of fuel loaded prior to a 3 hour pack operation, and the flight with 12,000 pounds of fuel added immediately prior to taxi after a 1 hour ECS pack operation are also presented in this report. For all of the flights, the ascent flight path of TWA 800 were determined in detail and these conditions were approximated as closely as practical in all of the flight tests. CWT ullage fuel/air vapor samples were obtained on several flights at taxi, takeoff, and at altitude, and liquid fuel samples were obtained from the CWT before and after several flights. The results from the testing performed on the liquid and vapor samples are contained in separate exhibits. The flights detailed in this report are shown in the table below, with the pack operation and fuel loads noted for each flight. Details of each flight, including the time of day of each major event (pack start, taxi, liftoff, etc.) are contained in the original report.

TABLE 1
FLIGHT TEST PARMETERS

Flight	ECS Packs in Operation	ECS Duration before take-off	Fuel in CWT	Additional Data Obtained	Data Exhibit
1	2 & 3	2.5 hours	50 Gallons (from Athens)	Liquid Fuel Sample	23H
2	All 3	2.5 hours	50 Gallons (from Athens)	Fuel/Air Vapor and Liquid Fuel Sample	23H
3	1 & 3	3.5 hours	50 Gallons (from Athens)	Fuel/Air Vapor and Liquid Fuel Sample	23F
4	1 & 2	3 hours	50 Gallons (from Athens)	Fuel/Air Vapor and Liquid Fuel Sample	23H
5	All 3	3 hours	6000 pounds	Liquid Fuel Sample and EMI	23H
6	2 & 3	1.5 hour	12000 pounds (1/2 hour before taxi)		23H
(Boeing)	1 & 3	3 hours	50 Gallons	(Proprietary)	
(Boeing)	1 & 3	3 hours	50 Gallons	(Proprietary)	
(Boeing)	1 & 3	3 hours	50 Gallons	(Proprietary)	

Section II – Flight Tests Description

The instrumentation and procedures followed for each of the flights was detailed in the original report. Vapor and liquid sampling was performed on these flights as shown in the above table, and results of the testing of those samples are included in a separate exhibit by the Fire and Explosion Group Chairman. An ascent profile similar to the TWA800 emulation was used for all the flight tests, however slight variations may have occurred to conform to Air Traffic Control requests. For all flight tests performed, the temperature instrumentation is at the same locations detailed in the original report. The data collected in all of the flights were downloaded using the same custody protocol and procedure as used for the TWA800 emulation flight data and described in the original report.

The data plots included in this addendum contain graphical representations of the temperature-time histories of several CWT ullage, surface locations, and ECS pack bay temperatures for each flight. Examination of the data as recorded (one sample per second) showed that the temperatures varied relatively slowly with time. Displaying the data at one sample per minute still accurately captures the temperature change with time, and allowed the creation of smaller data files. Hence, the data for an entire flight has been sub-sampled[1] to one sample every 60 seconds. The data in this addendum is displayed as a function of elapsed time, which represents the elapsed time of the data recording during each respective flight test. The time of day for key events in each flight test can be found in the original report. Flights 5 and 6 were performed with additional fuel added to the CWT. The timing of the fuel addition and conditions (Liquid fuel temperature, ambient temperature) are described in the original report.

This addendum shows the additional flight test data in graphical form. All of the data collected for each NTSB flight is contained on a CD-ROM, consisting of an MS Excel file of the recorded data for each flight. The Test Item Requirements List (TIRL) in Exhibit 23E is used to identify each recorded parameter and the location of the instrumentation in these electronic files.

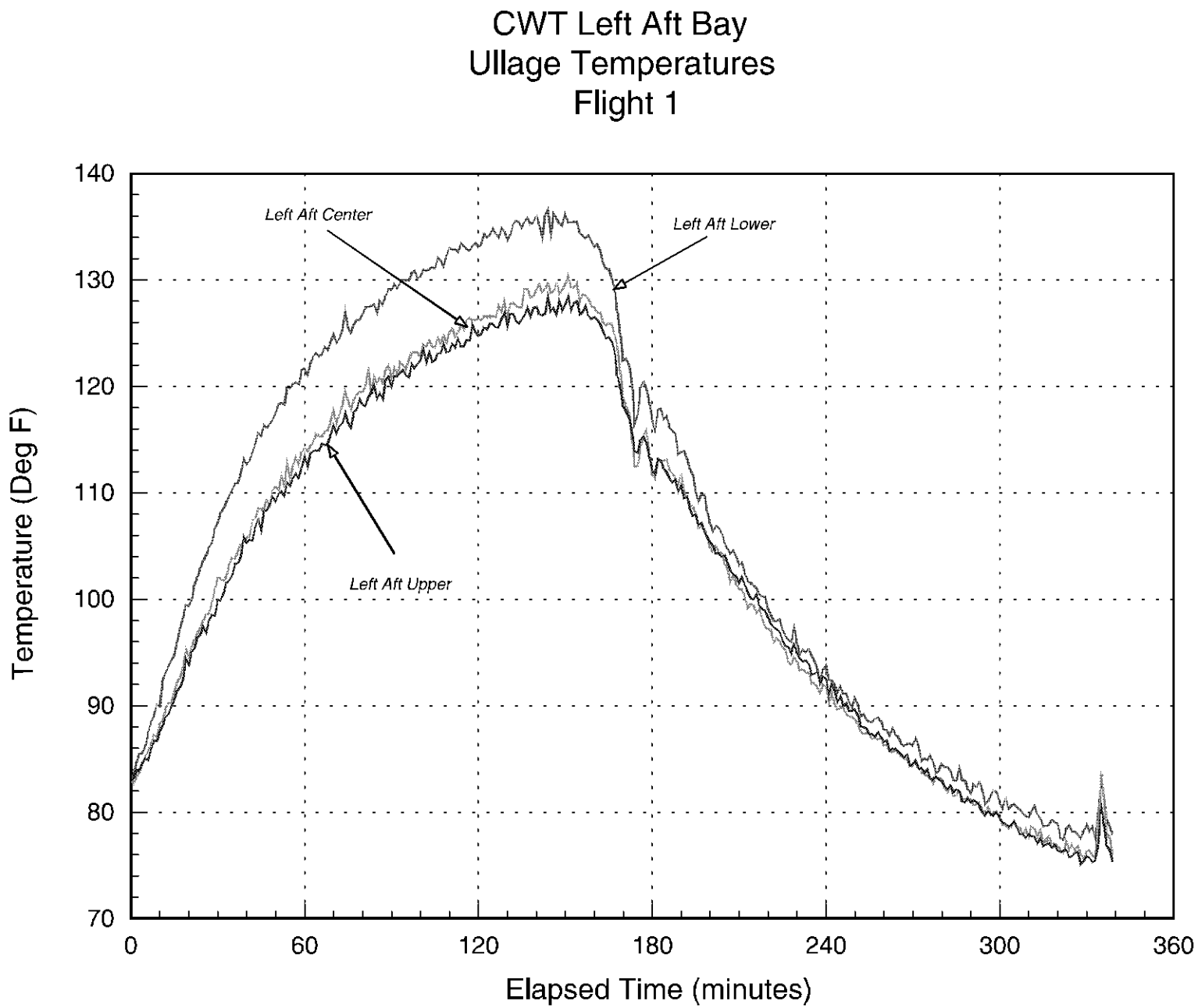
The subsequent addenda are organized as follows:

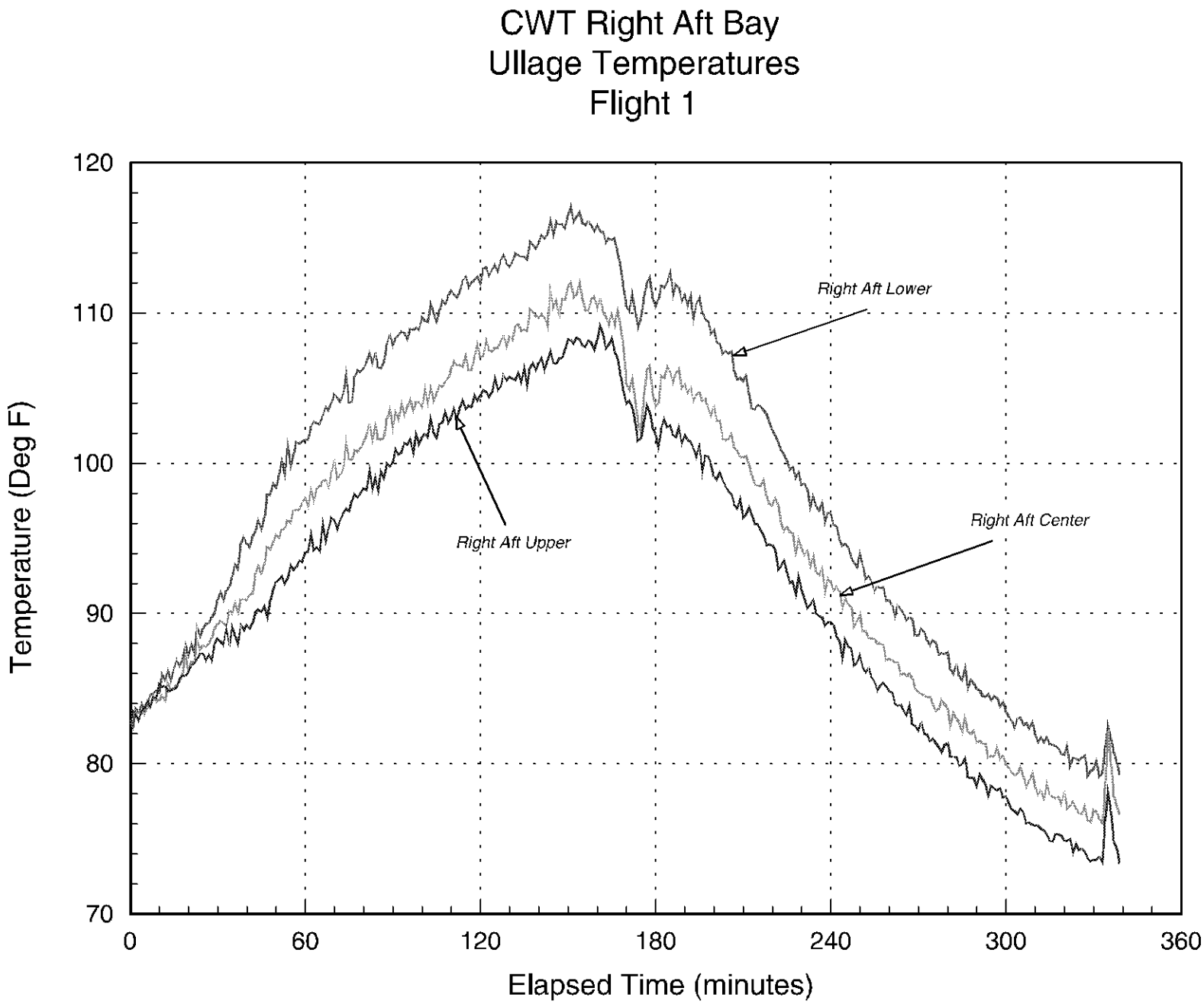
Addendum I-1 through I-22 : Results from flight test 1
Addendum II-1 through II-23 : Results from flight test 2
Addendum IV-1 through IV-22 : Results from flight test 4
Addendum V-1 through V-22 : Results from flight test 5
Addendum VI-1 through VI-22 : Results from flight test 6

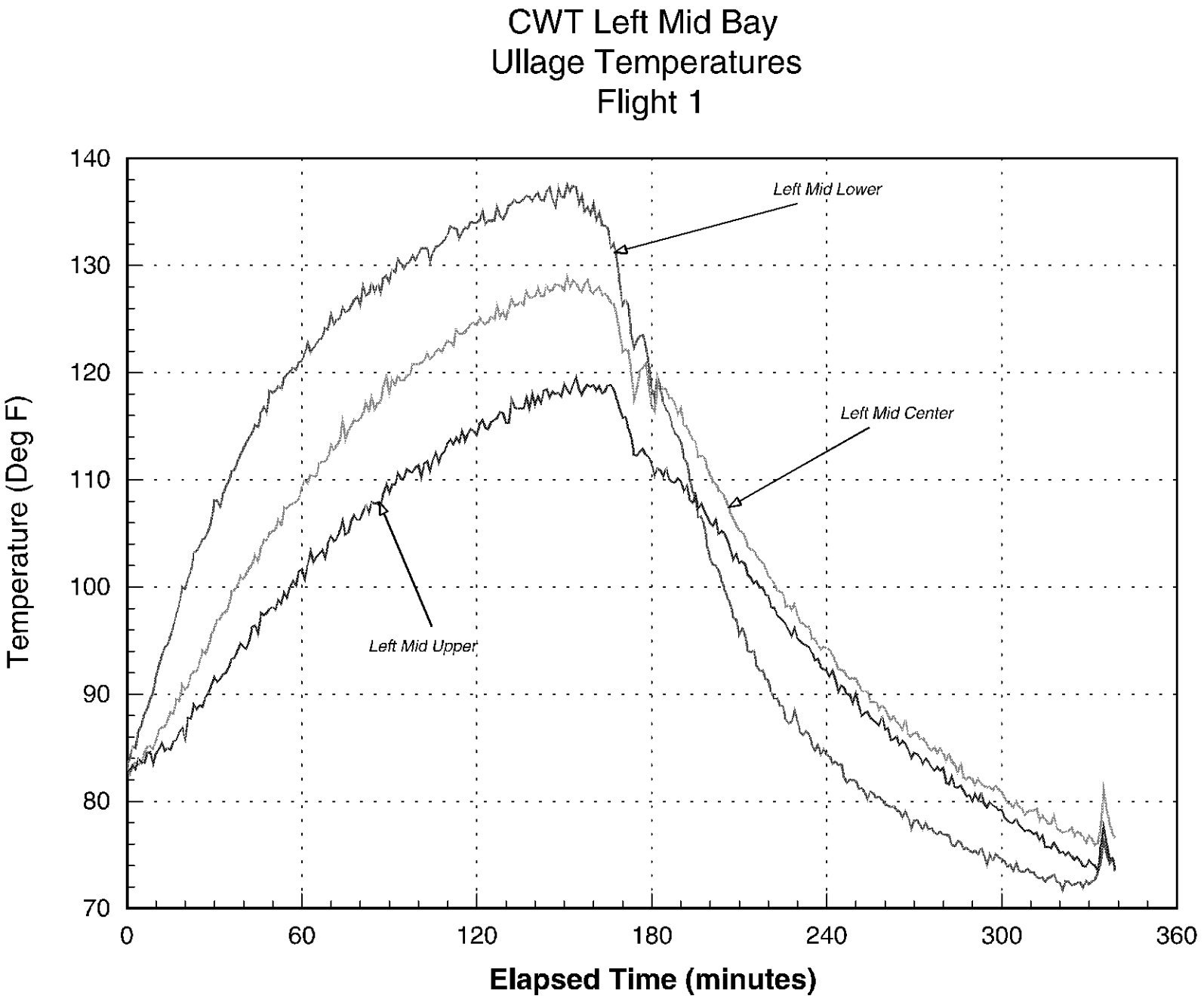
[1] Sub-sampled refers to the process of sampling data at a lower rate than recorded.

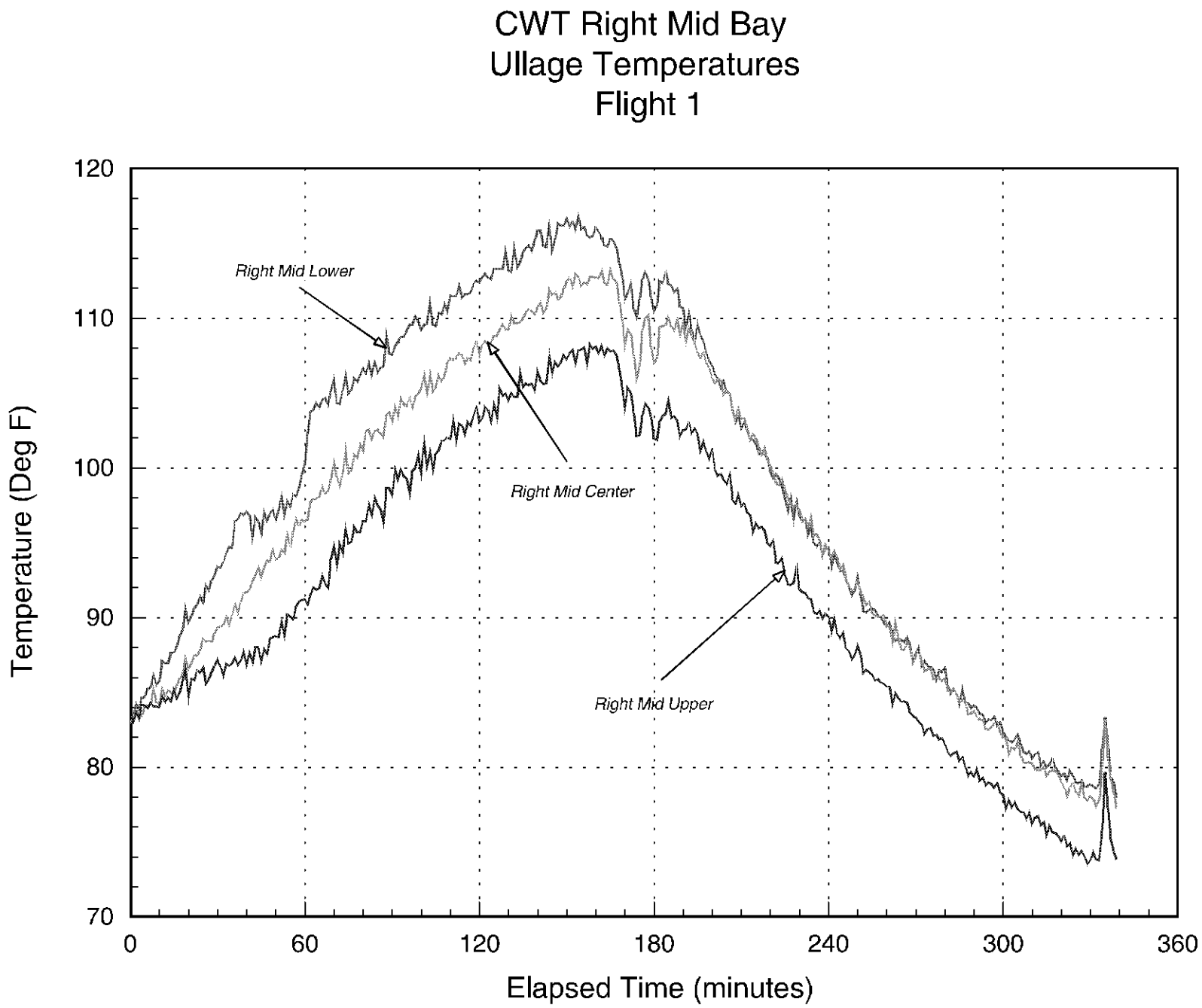
Daniel R. Bower, Ph.D.
Aerospace Engineer
Flight Test Group Chairman

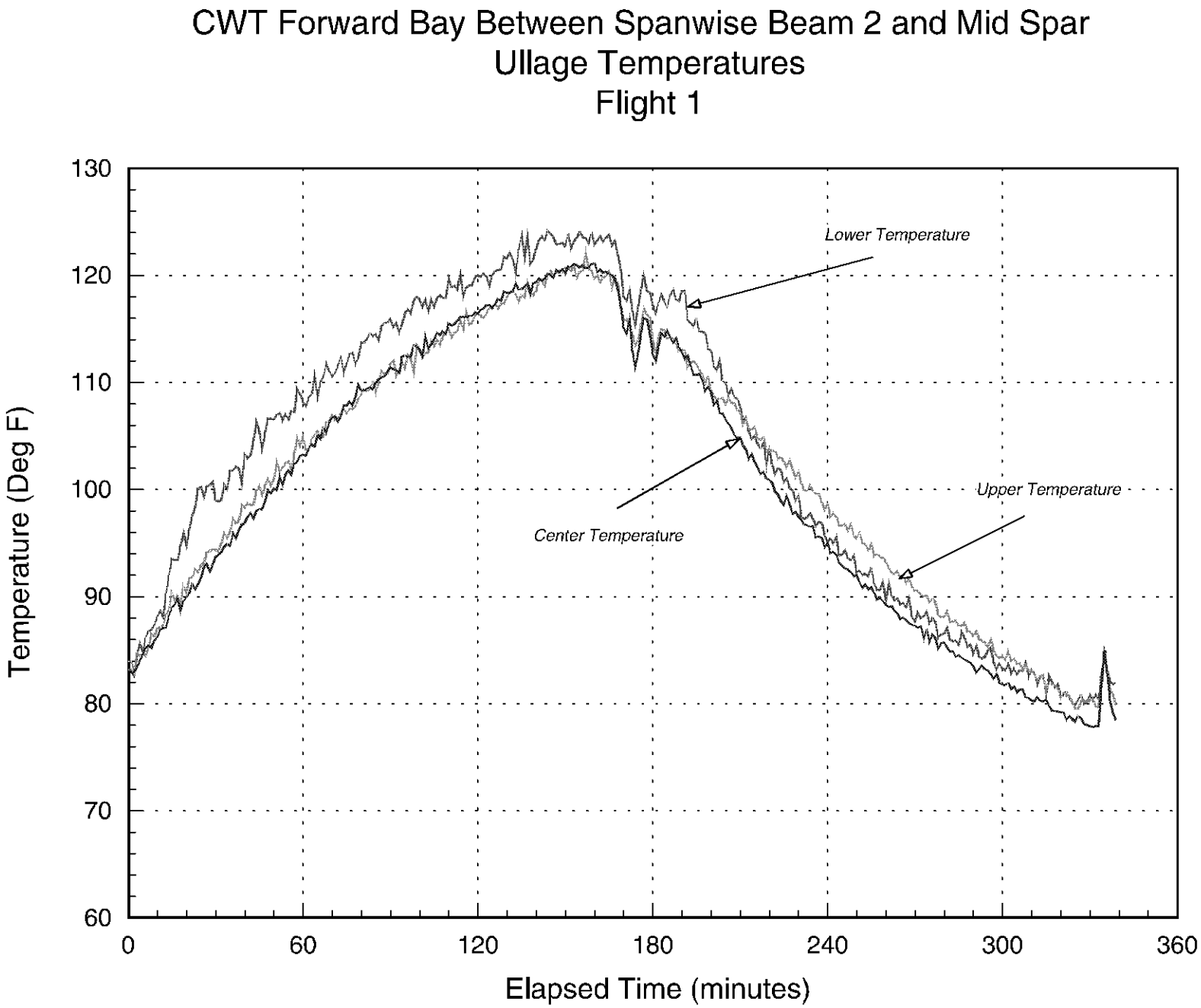
FLIGHT TEST RESULTS
FLIGHT 1

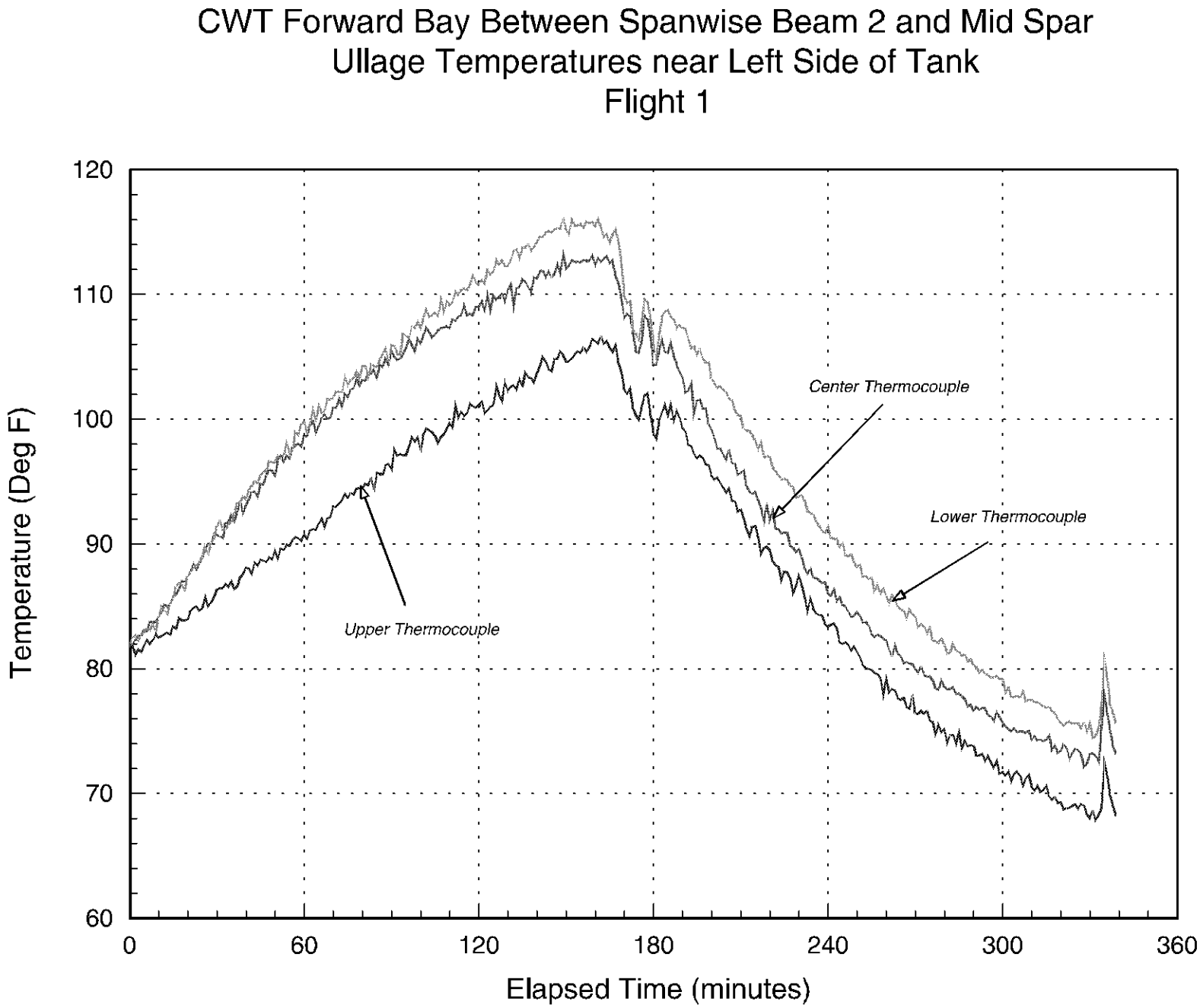

CWT Left Aft Bay
Ullage Temperatures
Flight 1
Left Aft Center
Left Aft Lower
Left Aft Upper
Temperature (Deg F)
Elapsed Time (minutes)
140
130
120
110
100
90
80
70
0
60
120
180
240
300
360

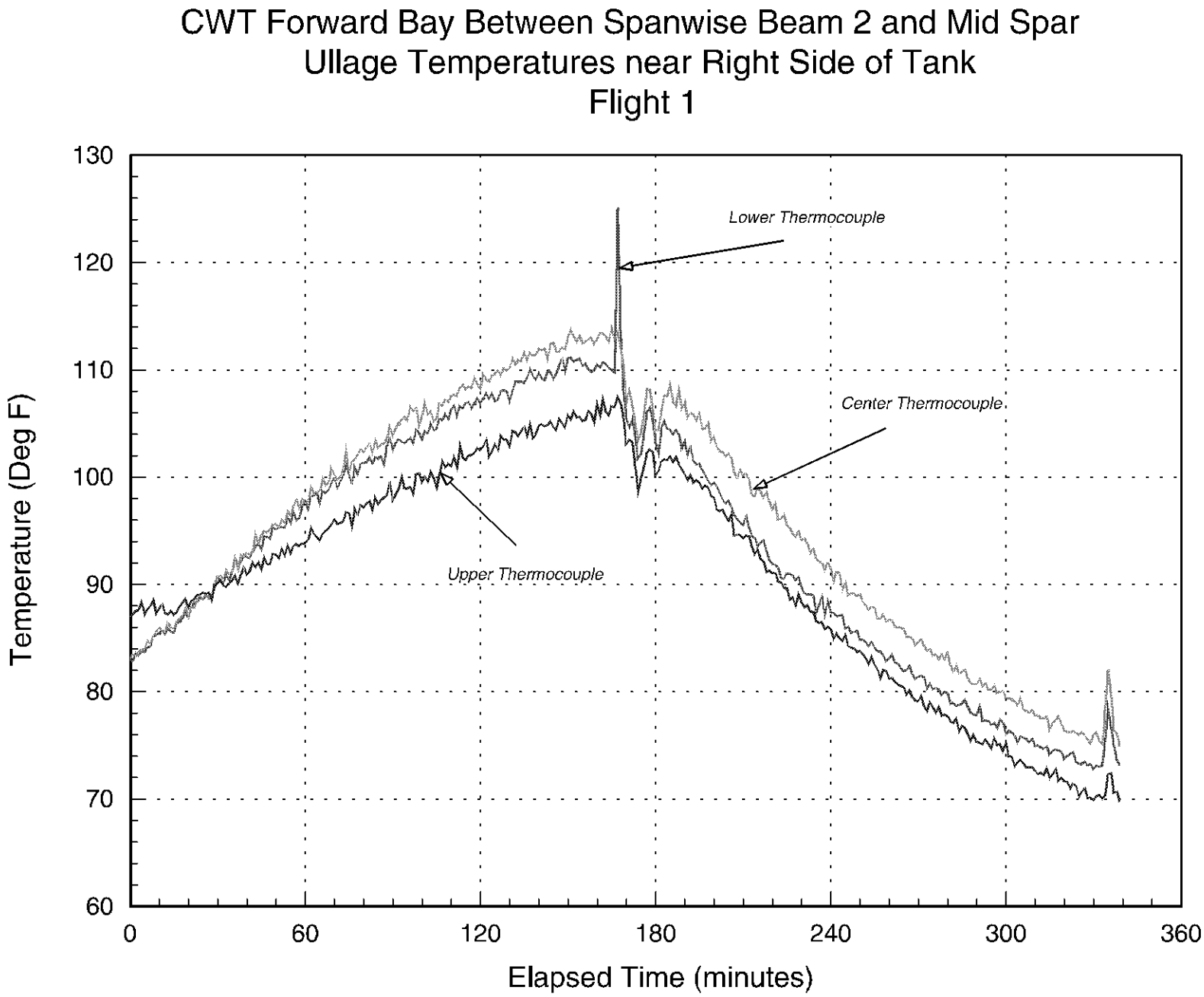

CWT Right Aft Bay
Ullage Temperatures
Flight 1
Temperature (Deg F)
120
110
100
90
80
70
0
60
120
180
240
300
360
Elapsed Time (minutes)
Right Aft Lower
Right Aft Center
Right Aft Upper

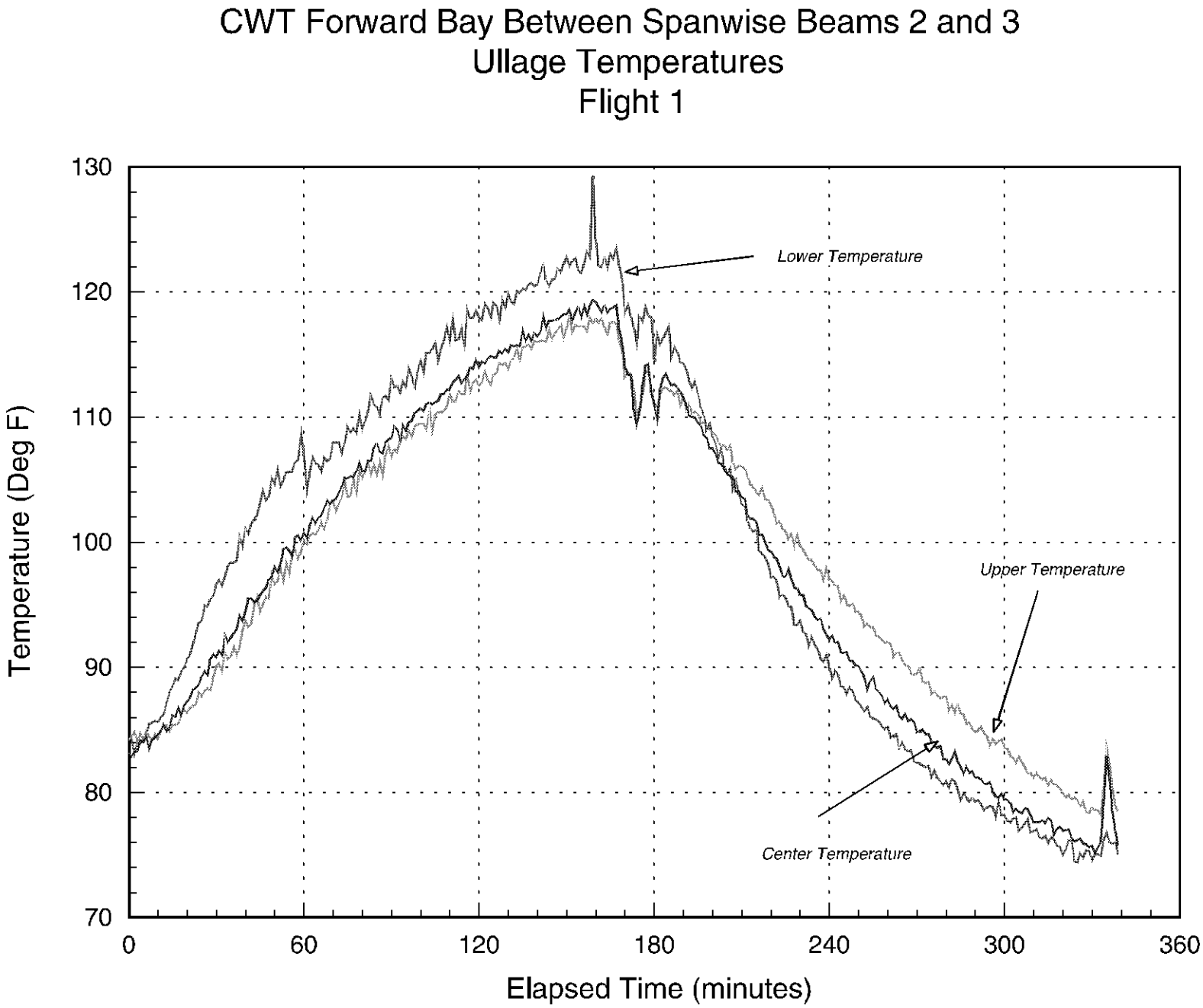

CWT Left Mid Bay
Ullage Temperatures
Flight 1
Temperature (Deg F)
140
130
120
110
100
90
80
70
0
60
120
180
240
300
360
Elapsed Time (minutes)
Left Mid Lower
Left Mid Center
Left Mid Upper

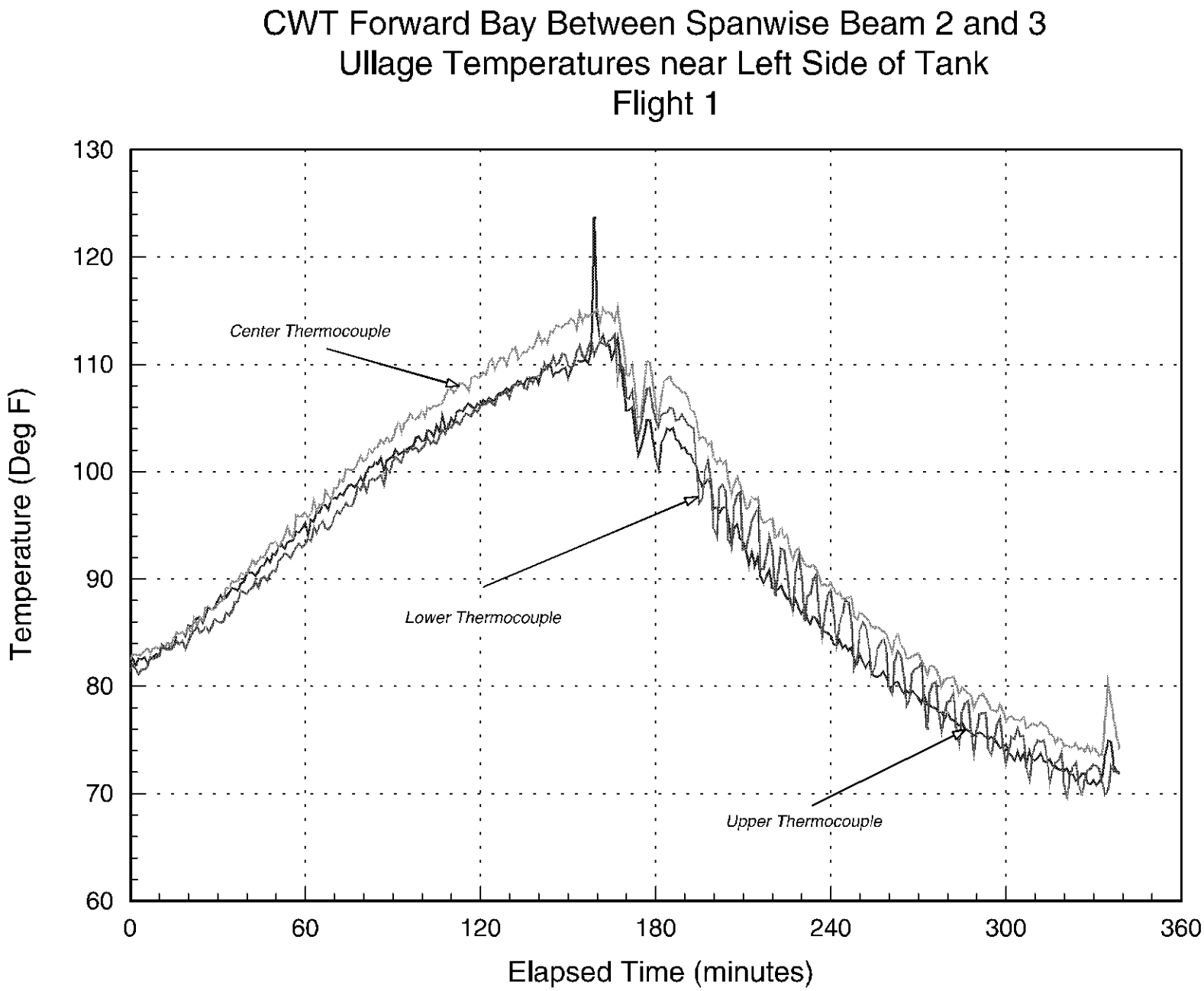

CWT Right Mid Bay
Ullage Temperatures
Flight 1
Right Mid Lower
Right Mid Center
Right Mid Upper
Temperature (Deg F)
Elapsed Time (minutes)
120
110
100
90
80
70
0
60
120
180
240
300
360

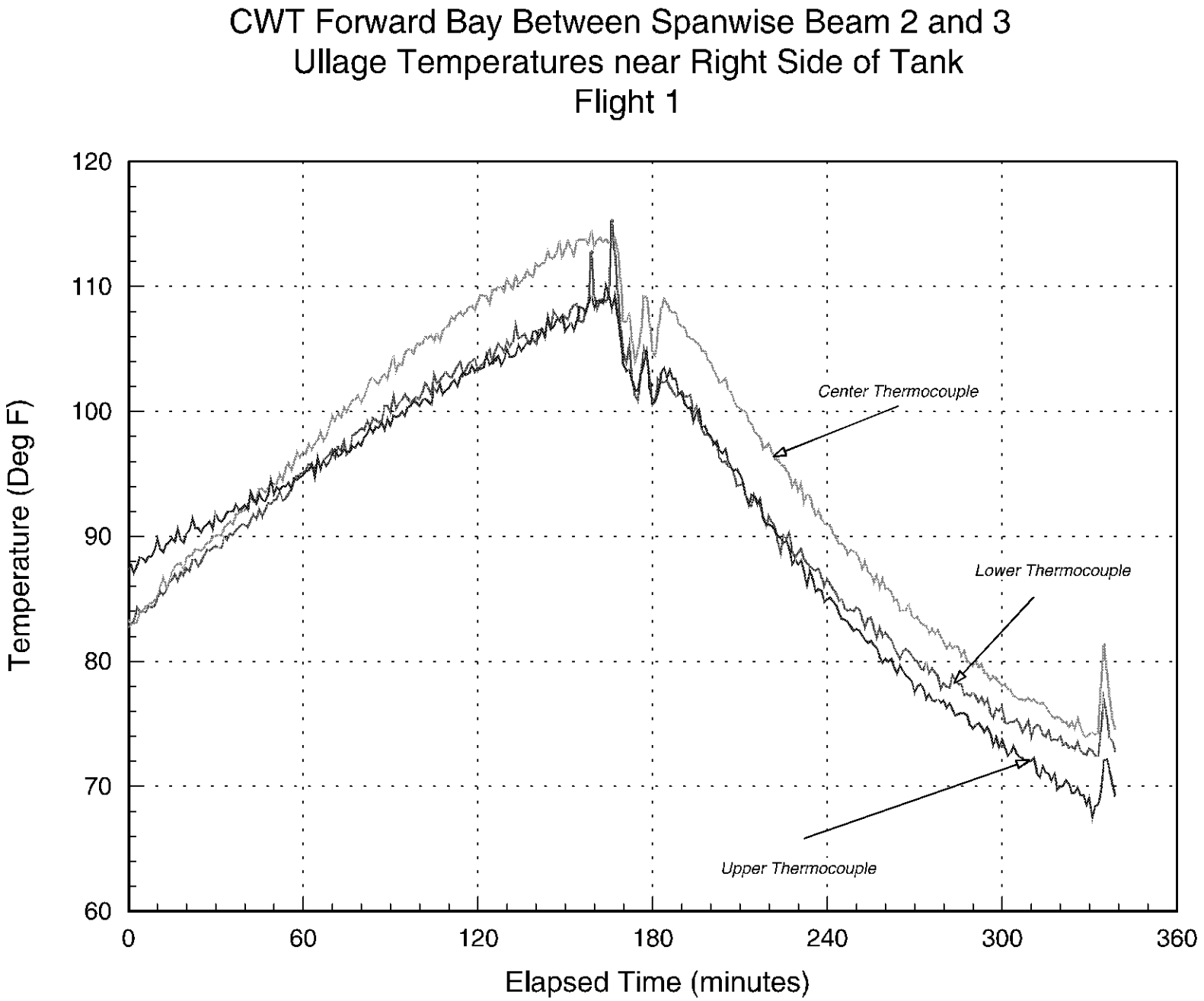

CWT Forward Bay Between Spanwise Beam 2 and Mid Spar
Ullage Temperatures
Flight 1
Temperature (Deg F)
130
120
110
100
90
80
70
60
0
60
120
180
240
300
360
Elapsed Time (minutes)
Lower Temperature
Upper Temperature
Center Temperature

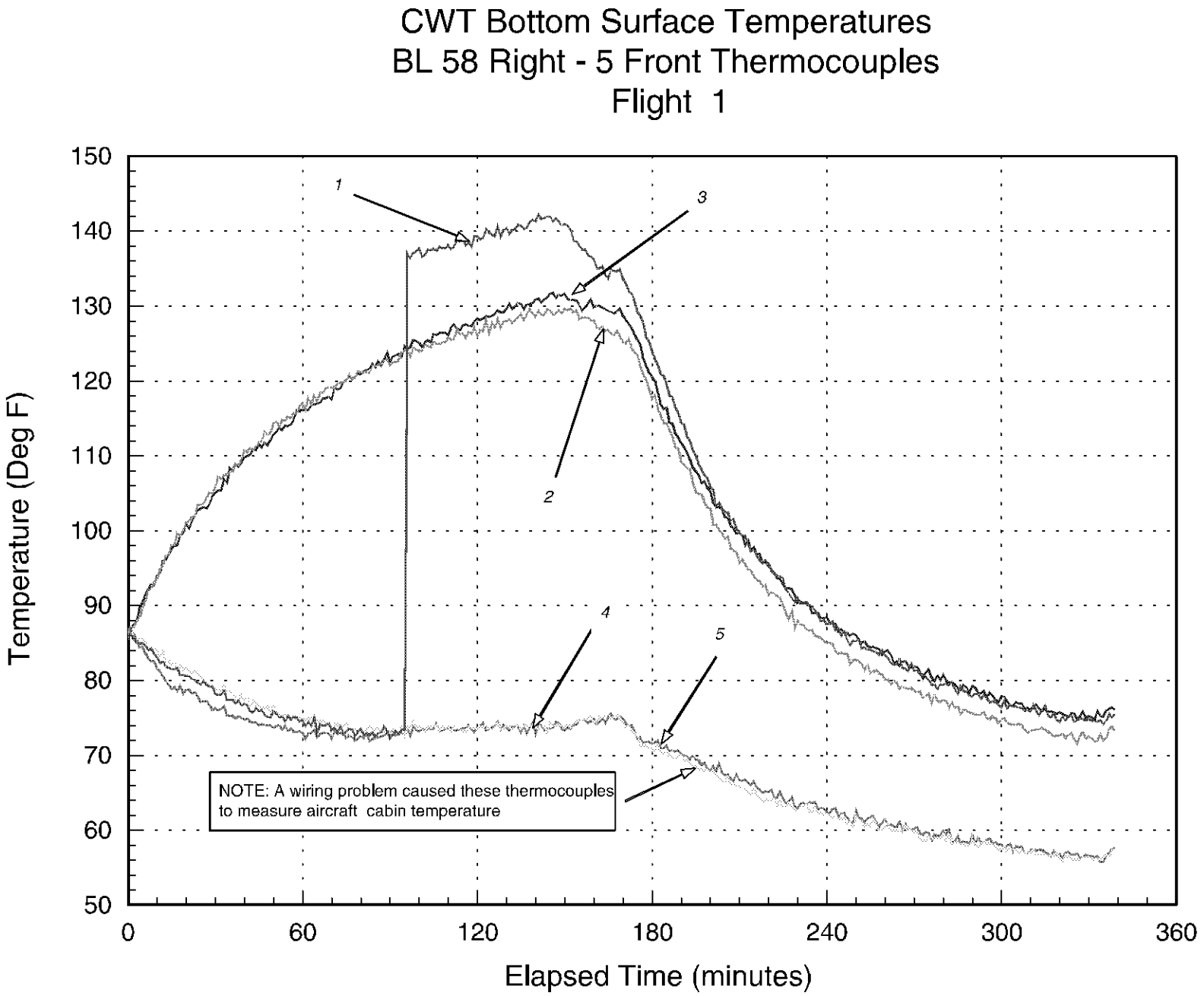

CWT Forward Bay Between Spanwise Beam 2 and Mid Spar
Ullage Temperatures near Left Side of Tank
Flight 1
Temperature (Deg F)
120
110
100
90
80
70
60
0
60
120
180
240
300
360
Elapsed Time (minutes)
Center Thermocouple
Lower Thermocouple
Upper Thermocouple

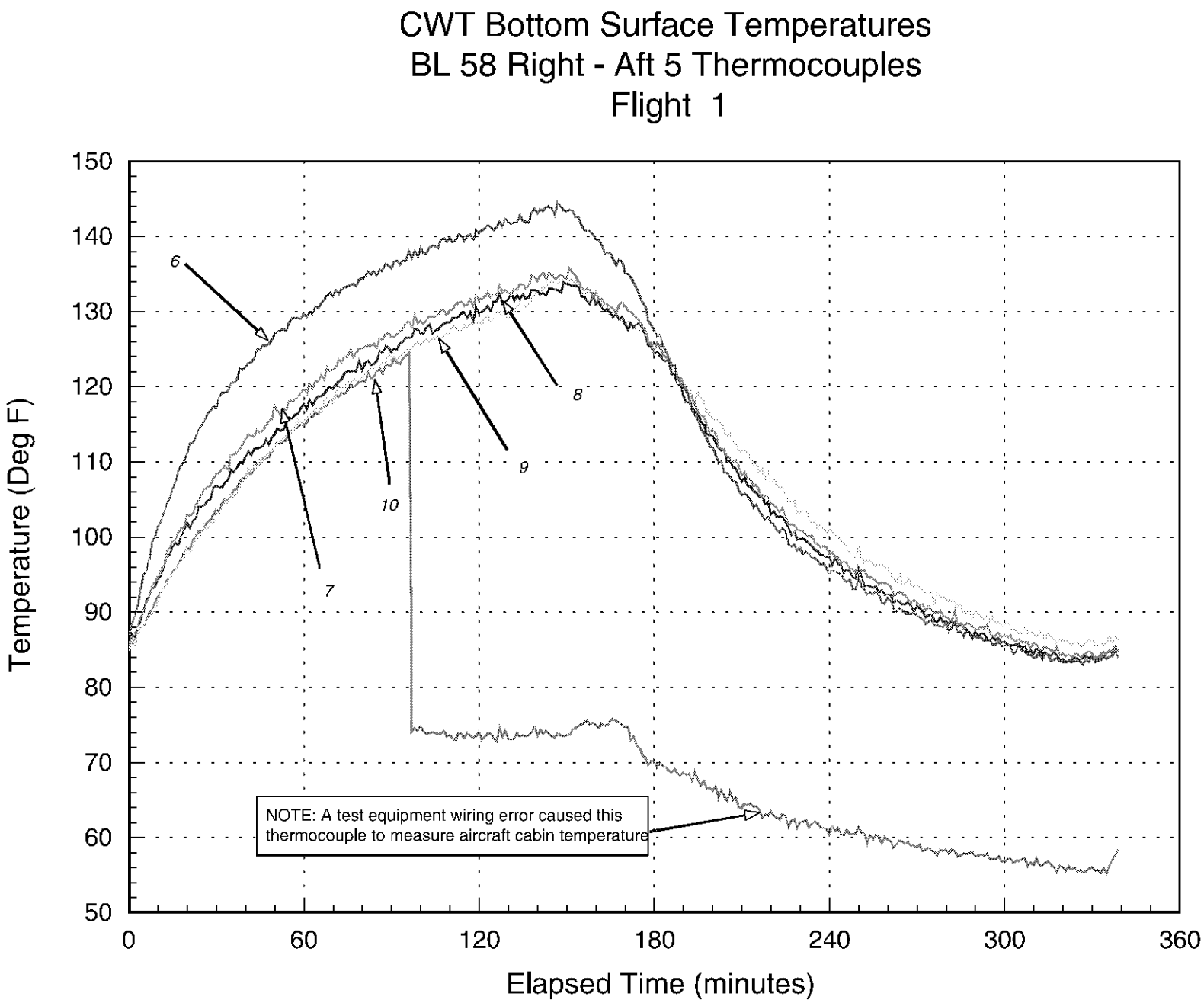

CWT Forward Bay Between Spanwise Beam 2 and Mid Spar
Ullage Temperatures near Right Side of Tank
Flight 1
Lower Thermocouple
Center Thermocouple
Upper Thermocouple
Temperature (Deg F)
130
120
110
100
90
80
70
60
0
60
120
180
240
300
360
Elapsed Time (minutes)

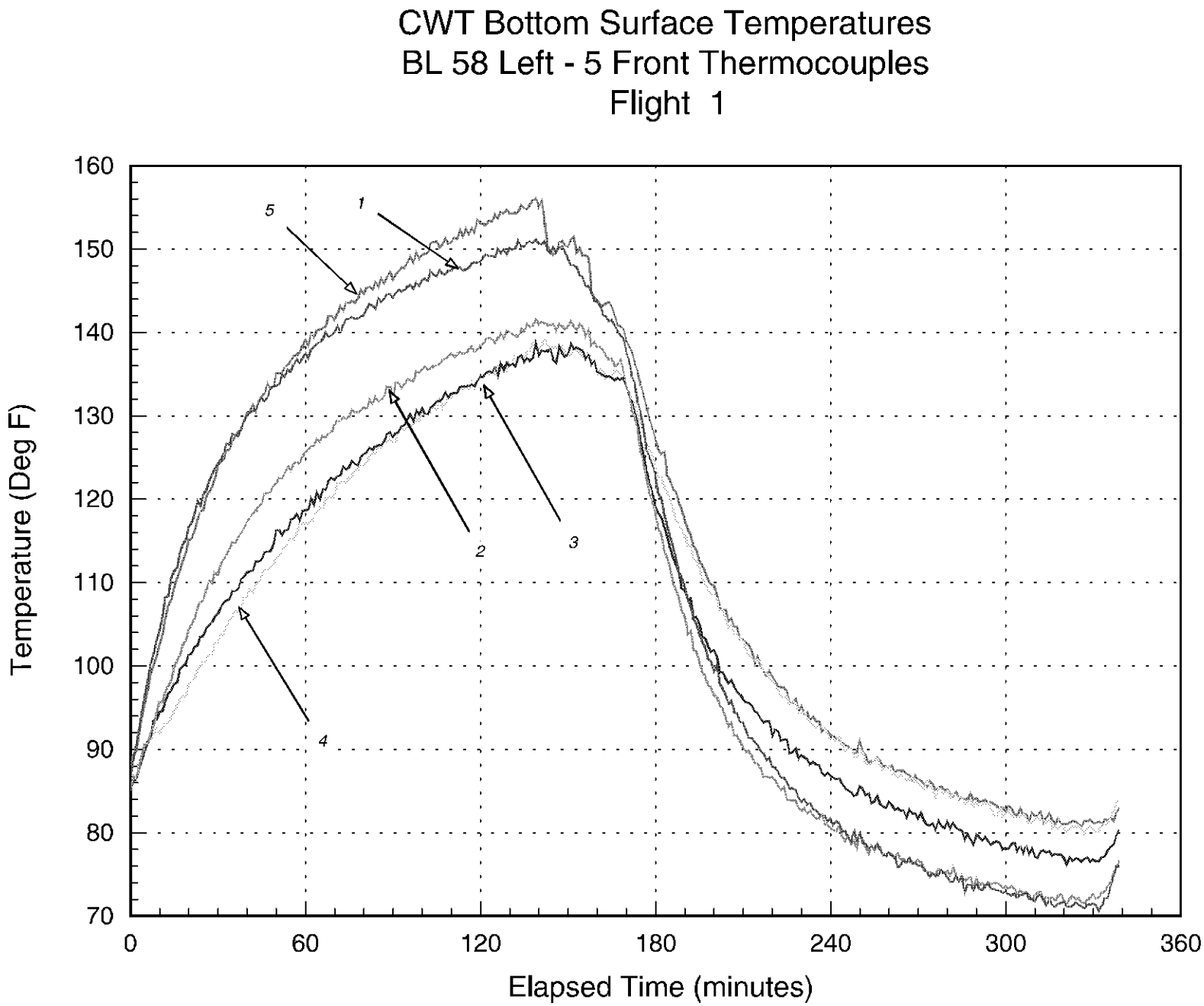

CWT Forward Bay Between Spanwise Beams 2 and 3
Ullage Temperatures
Flight 1
Temperature (Deg F)
130
120
110
100
90
80
70
0
60
120
180
240
300
360
Elapsed Time (minutes)
Lower Temperature
Upper Temperature
Center Temperature

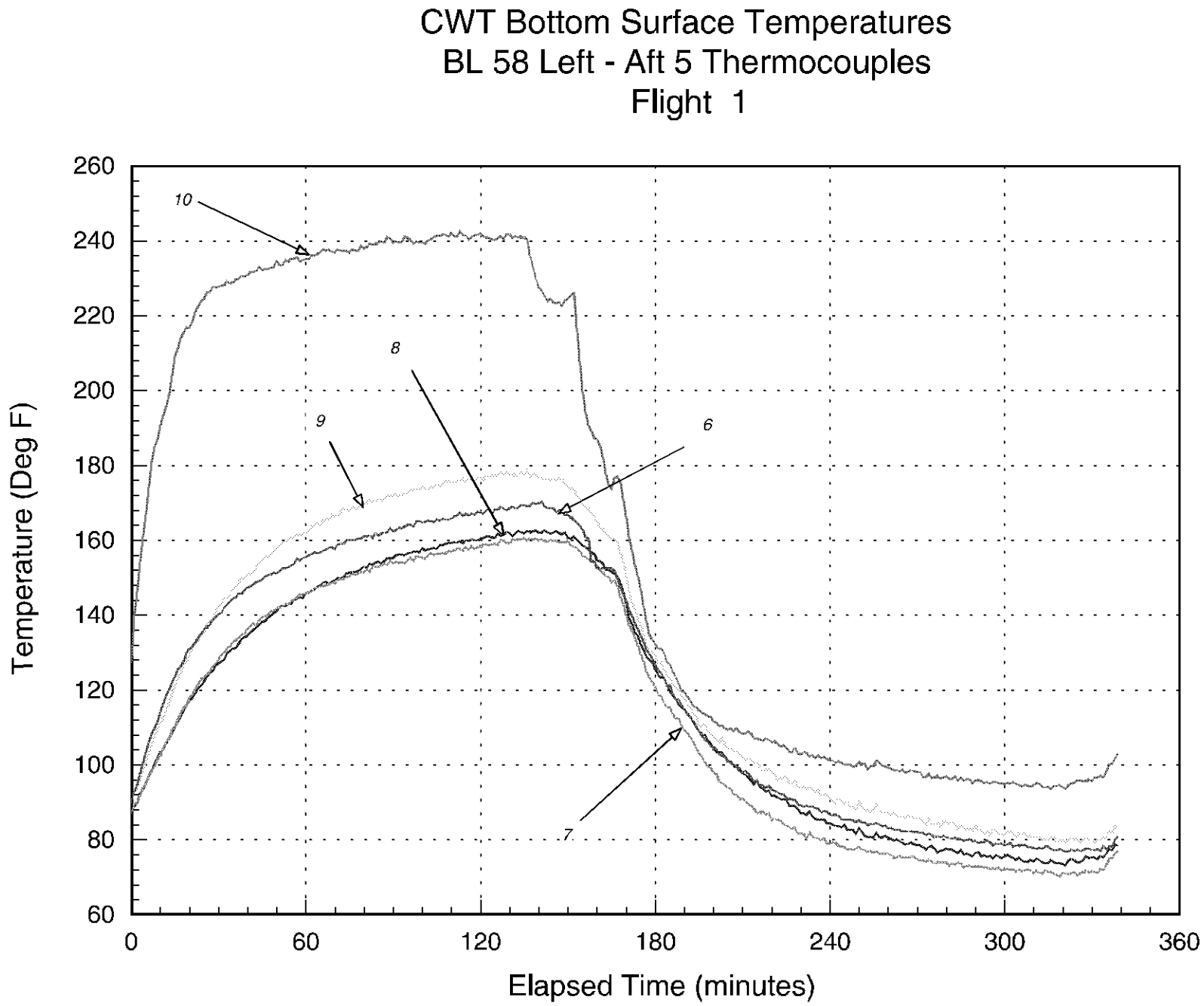

CWT Forward Bay Between Spanwise Beam 2 and 3
Ullage Temperatures near Left Side of Tank
Flight 1
Temperature (Deg F)
130
120
110
100
90
80
70
60
0
60
120
180
240
300
360
Elapsed Time (minutes)
Center Thermocouple
Lower Thermocouple
Upper Thermocouple

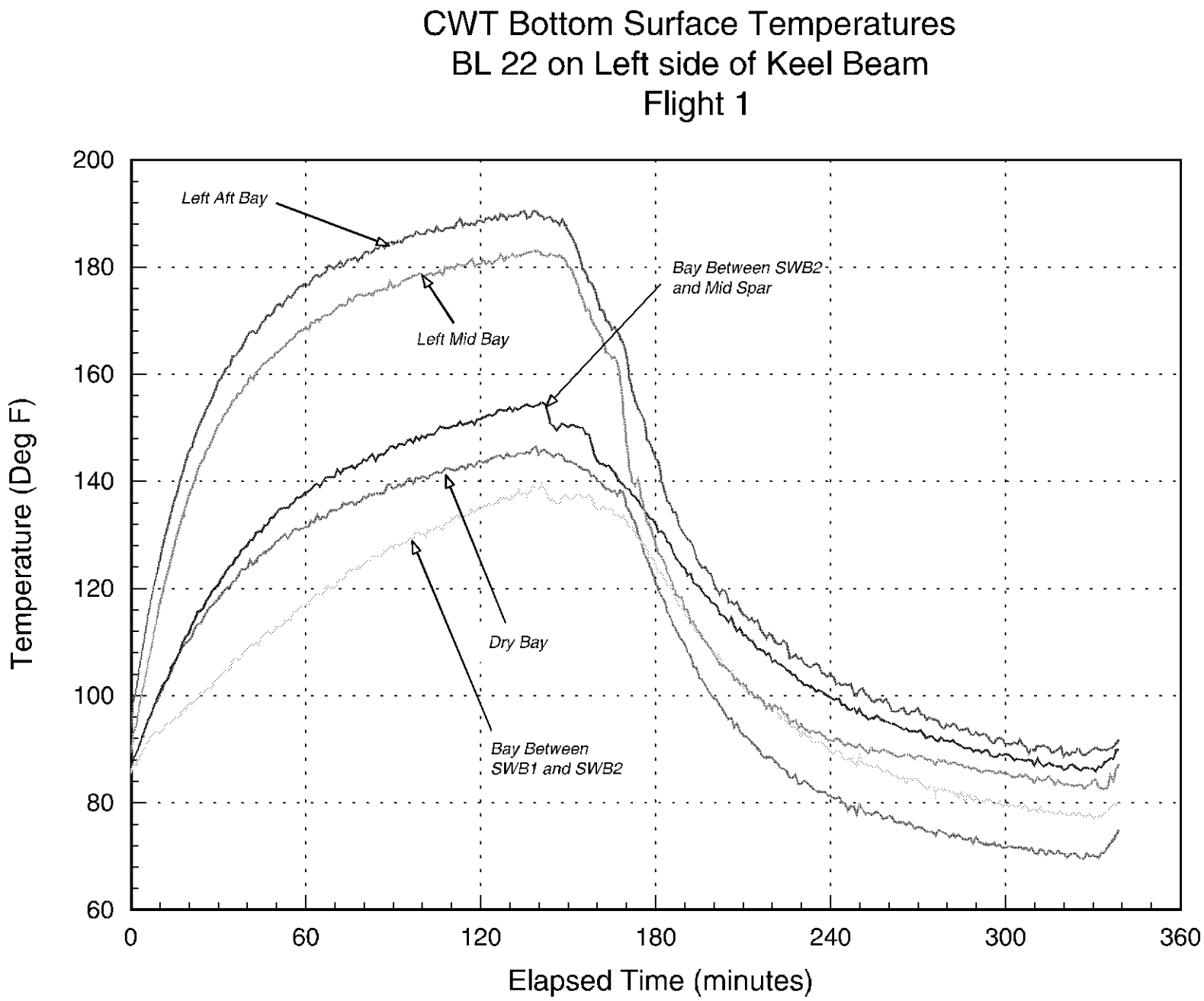

CWT Forward Bay Between Spanwise Beam 2 and 3
Ullage Temperatures near Right Side of Tank
Flight 1
Temperature (Deg F)
120
110
100
90
80
70
60
0
60
120
180
240
300
360
Elapsed Time (minutes)
Center Thermocouple
Lower Thermocouple
Upper Thermocouple

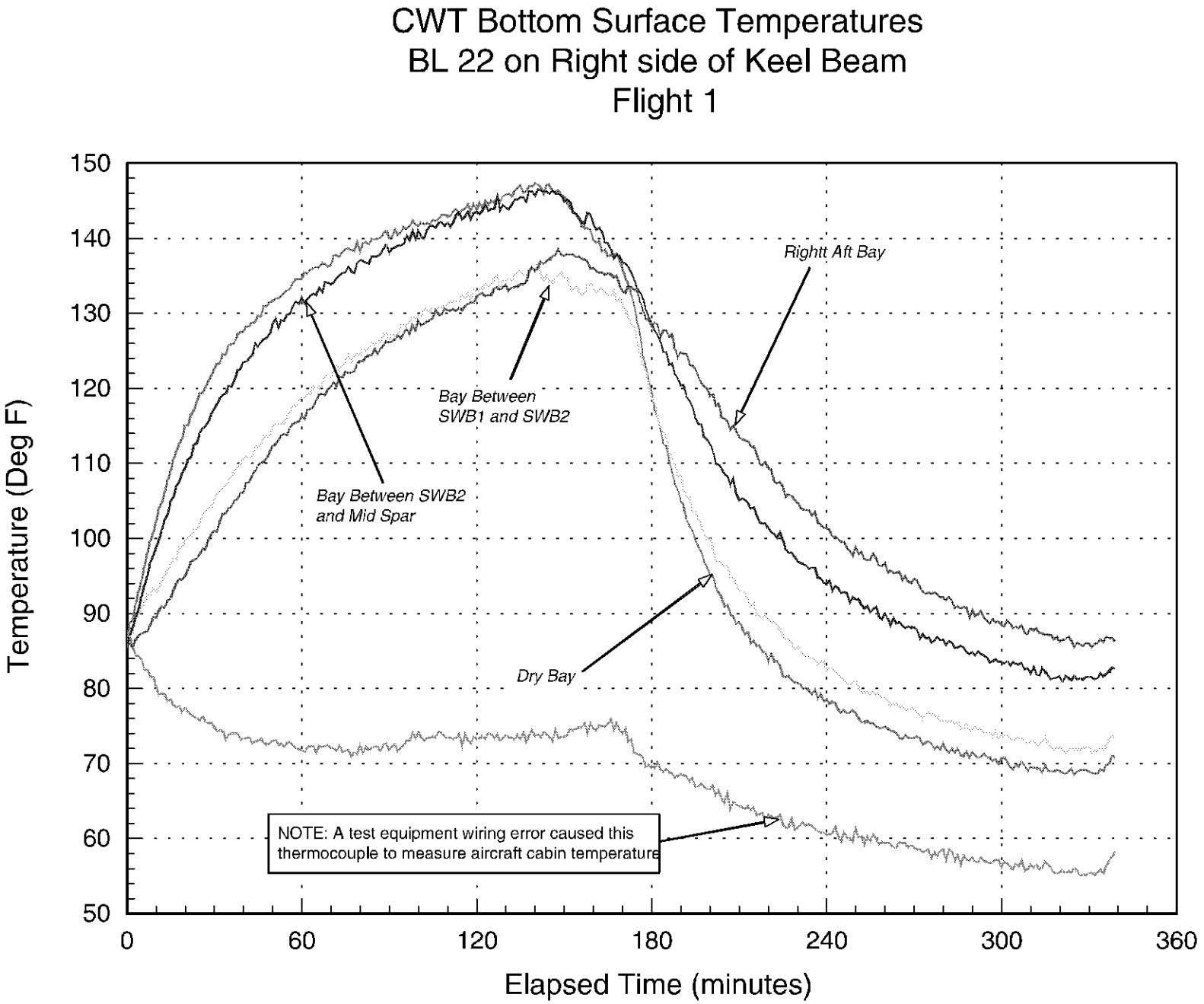

CWT Bottom Surface Temperatures
BL 58 Right - 5 Front Thermocouples
Flight 1
Temperature (Deg F)
Elapsed Time (minutes)
150
140
130
120
110
100
90
80
70
60
50
0
60
120
180
240
300
360
1
2
3
4
5
NOTE: A wiring problem caused these thermocouples to measure aircraft cabin temperature

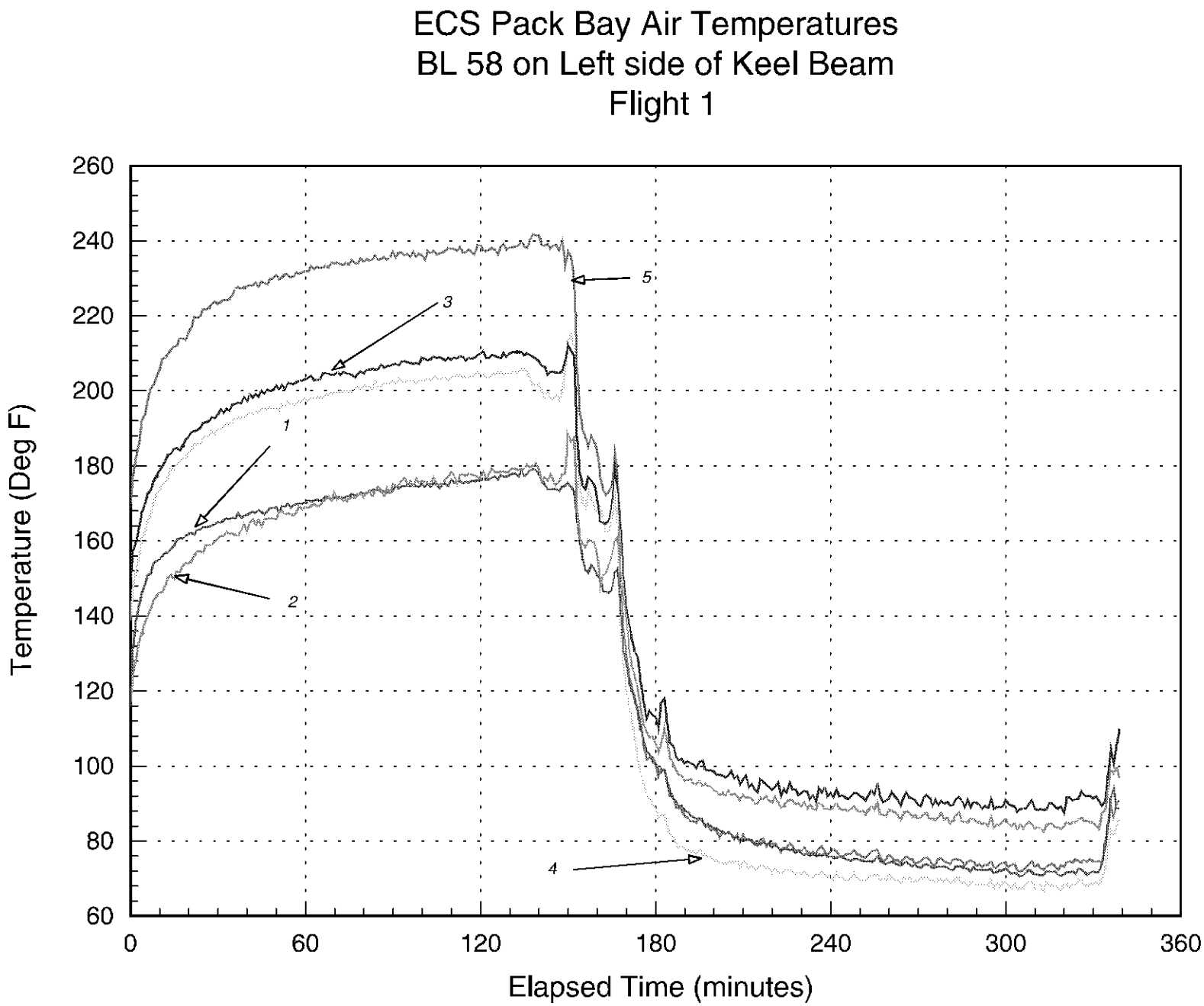

CWT Bottom Surface Temperatures
BL 58 Right - Aft 5 Thermocouples
Flight 1
Temperature (Deg F)
Elapsed Time (minutes)
150
140
130
120
110
100
90
80
70
60
50
0
60
120
180
240
300
360
6
7
8
9
10
NOTE: A test equipment wiring error caused this thermocouple to measure aircraft cabin temperature

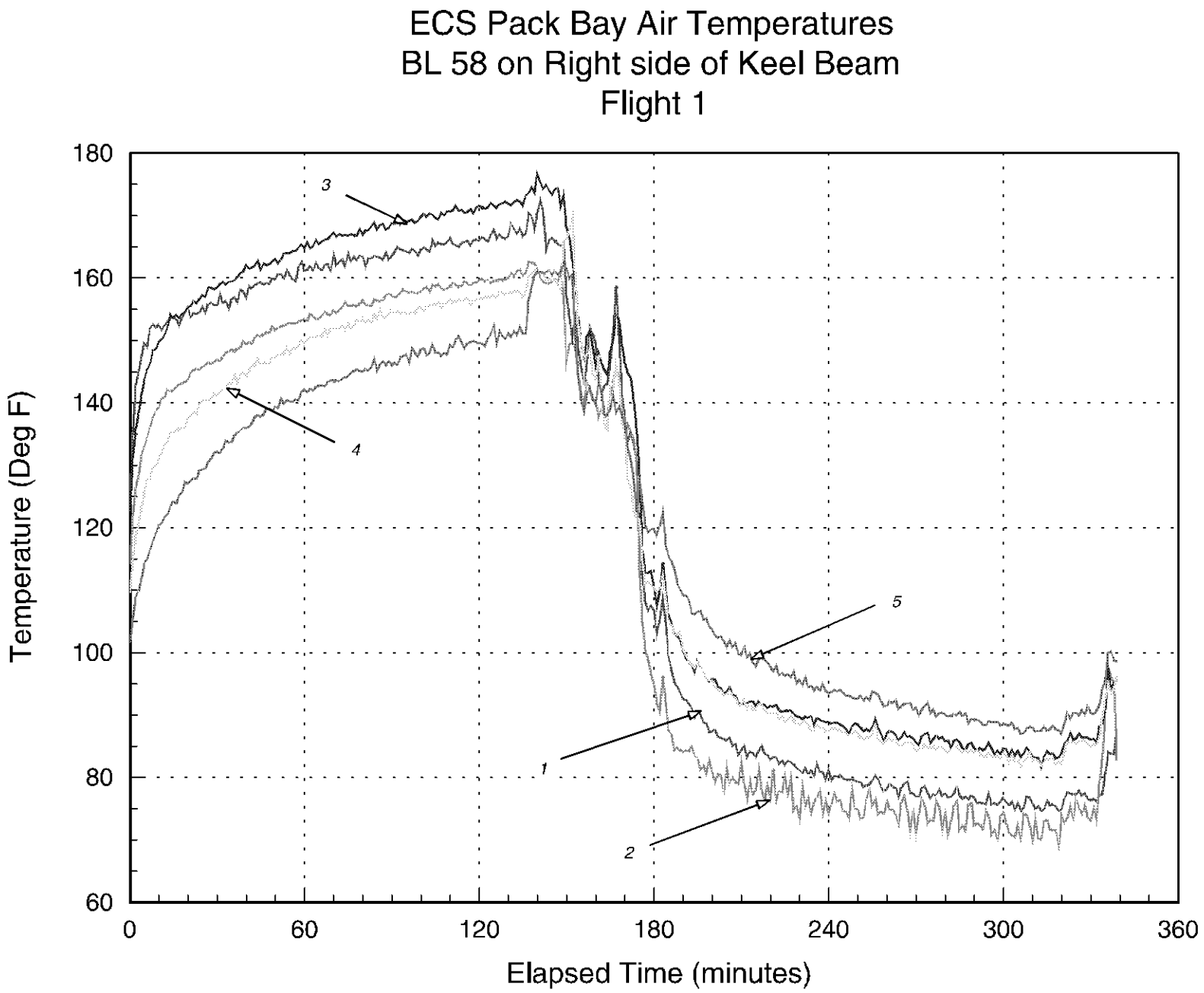

CWT Bottom Surface Temperatures
BL 58 Left - 5 Front Thermocouples
Flight 1
Temperature (Deg F)
Elapsed Time (minutes)
160
150
140
130
120
110
100
90
80
70
0
60
120
180
240
300
360
1
2
3
4
5

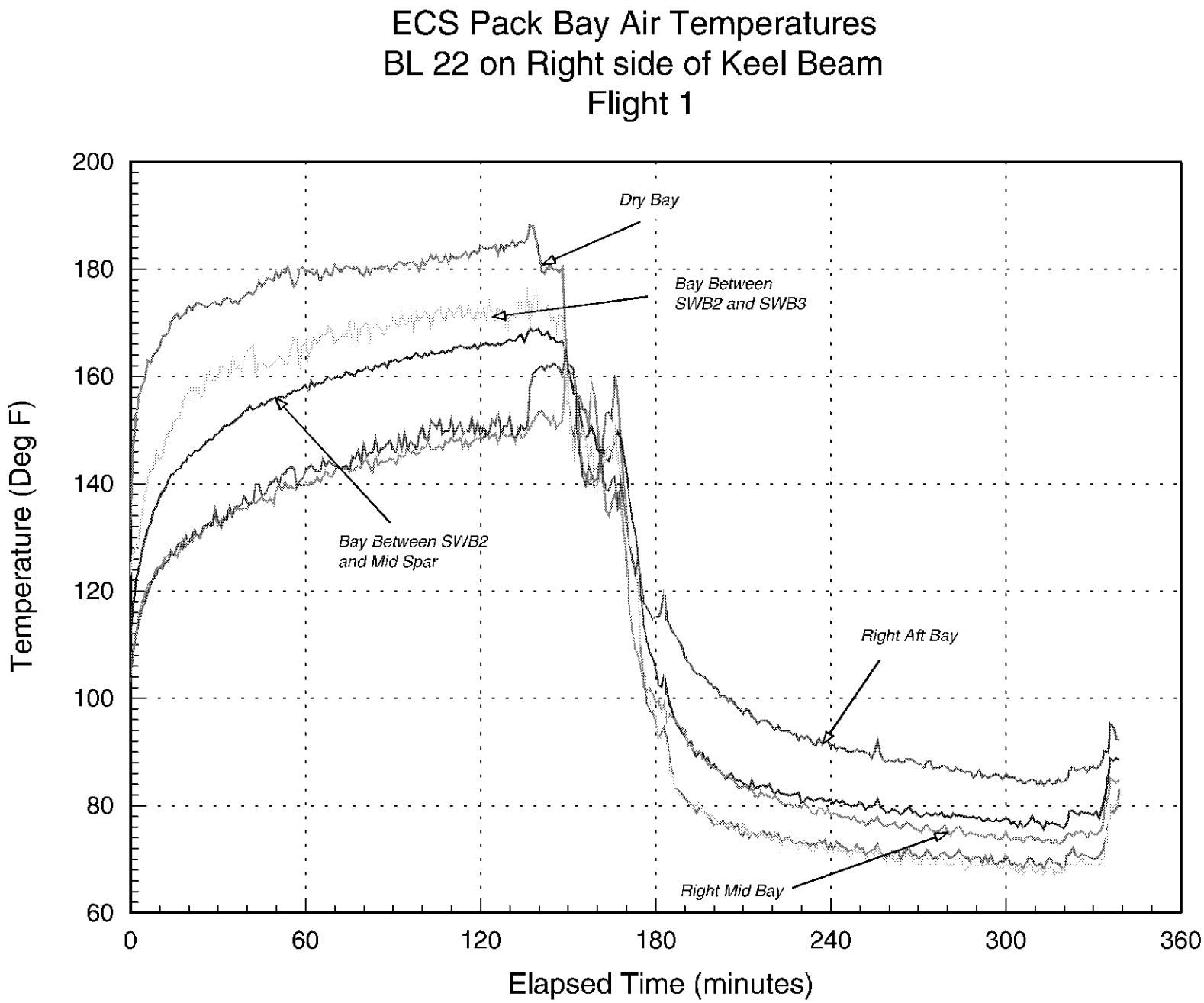

CWT Bottom Surface Temperatures
BL 58 Left - Aft 5 Thermocouples
Flight 1
Temperature (Deg F)
Elapsed Time (minutes)
260
240
220
200
180
160
140
120
100
80
60
0
60
120
180
240
300
360
10
8
9
6
7


CWT Bottom Surface Temperatures
BL 22 on Left side of Keel Beam
Flight 1
Left Aft Bay
Left Mid Bay
Bay Between SWB2
and Mid Spar
Dry Bay
Bay Between
SWB1 and SWB2
Temperature (Deg F)
Elapsed Time (minutes)
200
180
160
140
120
100
80
60
0
60
120
180
240
300
360

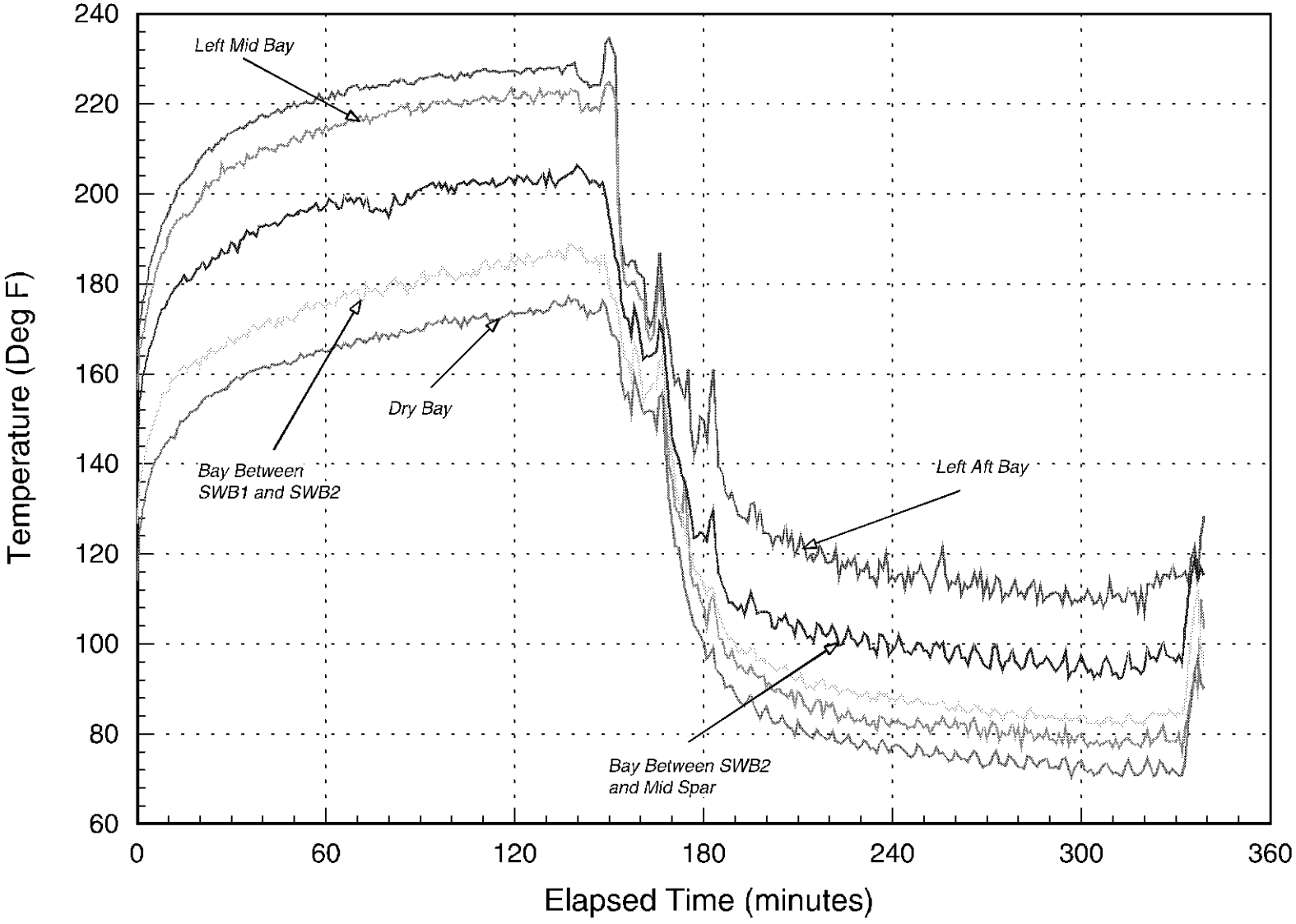

CWT Bottom Surface Temperatures
BL 22 on Right side of Keel Beam
Flight 1
Temperature (Deg F)
Elapsed Time (minutes)
150
140
130
120
110
100
90
80
70
60
50
0
60
120
180
240
300
360
Rightt Aft Bay
Bay Between
SWB1 and SWB2
Bay Between SWB2
and Mid Spar
Dry Bay
NOTE: A test equipment wiring error caused this
thermocouple to measure aircraft cabin temperature

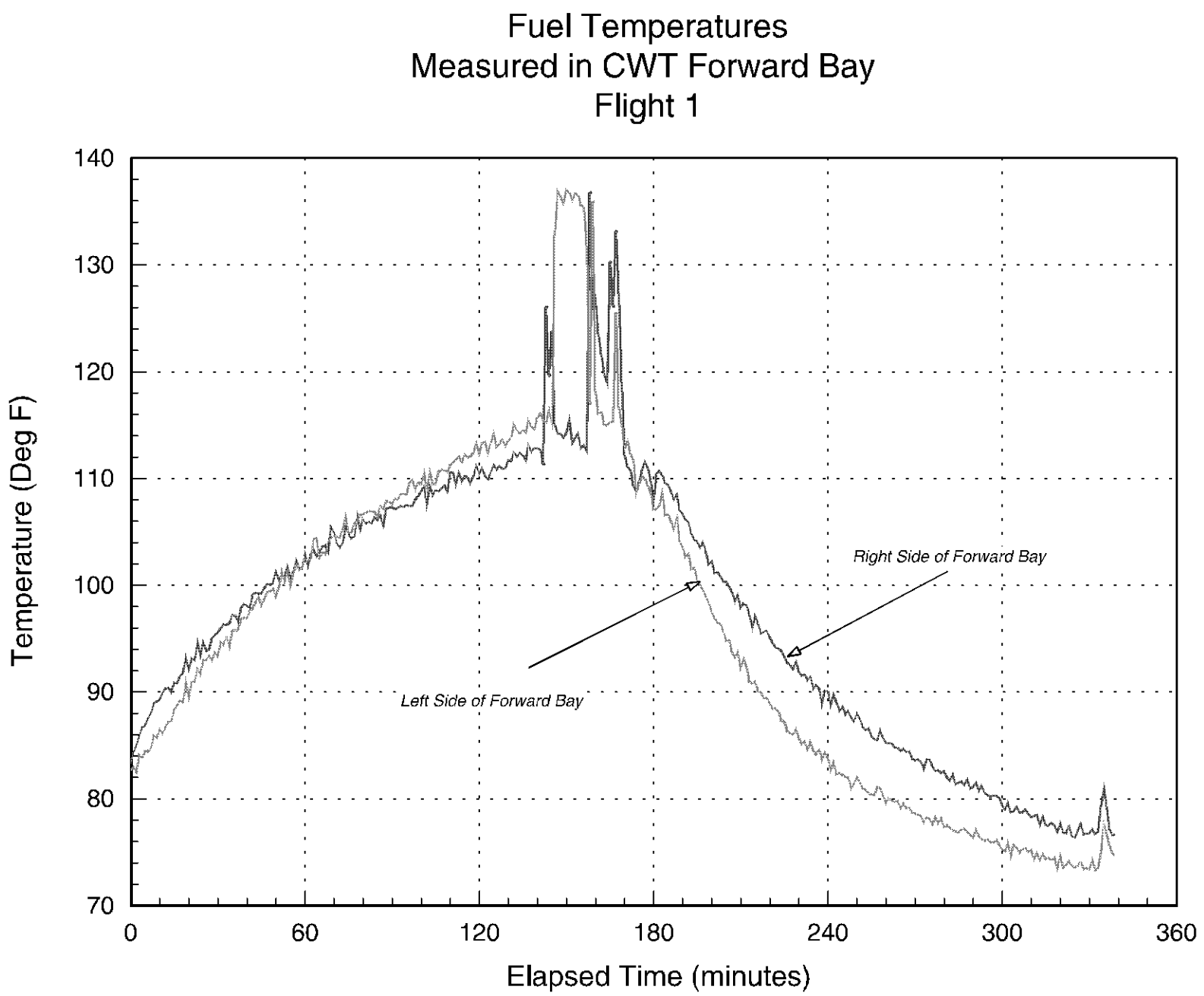

ECS Pack Bay Air Temperatures
BL 58 on Left side of Keel Beam
Flight 1
Temperature (Deg F)
Elapsed Time (minutes)
260
240
220
200
180
160
140
120
100
80
60
0
60
120
180
240
300
360
1
2
3
4
5

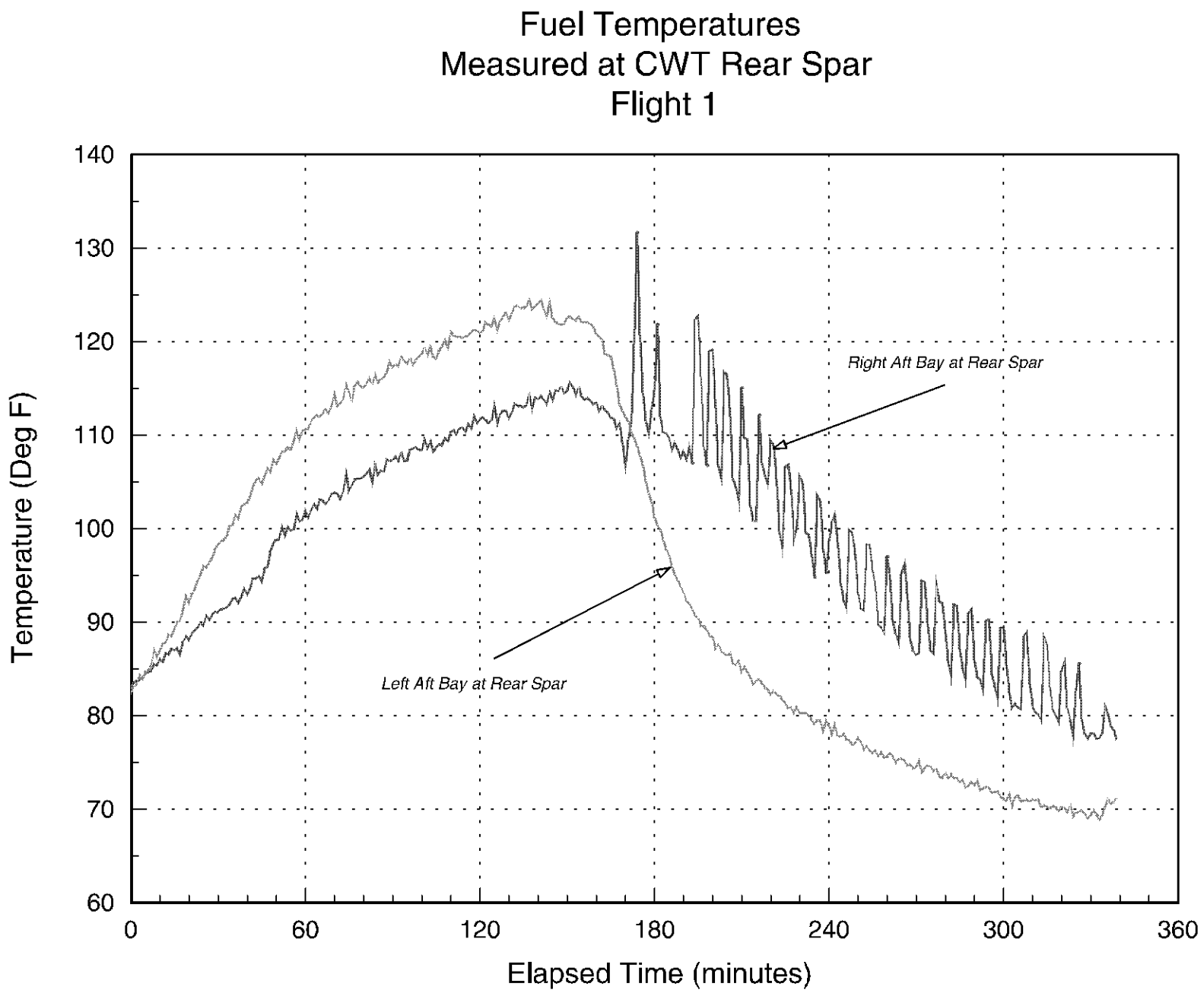

ECS Pack Bay Air Temperatures
BL 58 on Right side of Keel Beam
Flight 1
Temperature (Deg F)
Elapsed Time (minutes)
180
160
140
120
100
80
60
0
60
120
180
240
300
360
1
2
3
4
5


ECS Pack Bay Air Temperatures
BL 22 on Right side of Keel Beam
Flight 1
Temperature (Deg F)
Elapsed Time (minutes)
200
180
160
140
120
100
80
60
0
60
120
180
240
300
360
Dry Bay
Bay Between
SWB2 and SWB3
Bay Between SWB2
and Mid Spar
Right Aft Bay
Right Mid Bay

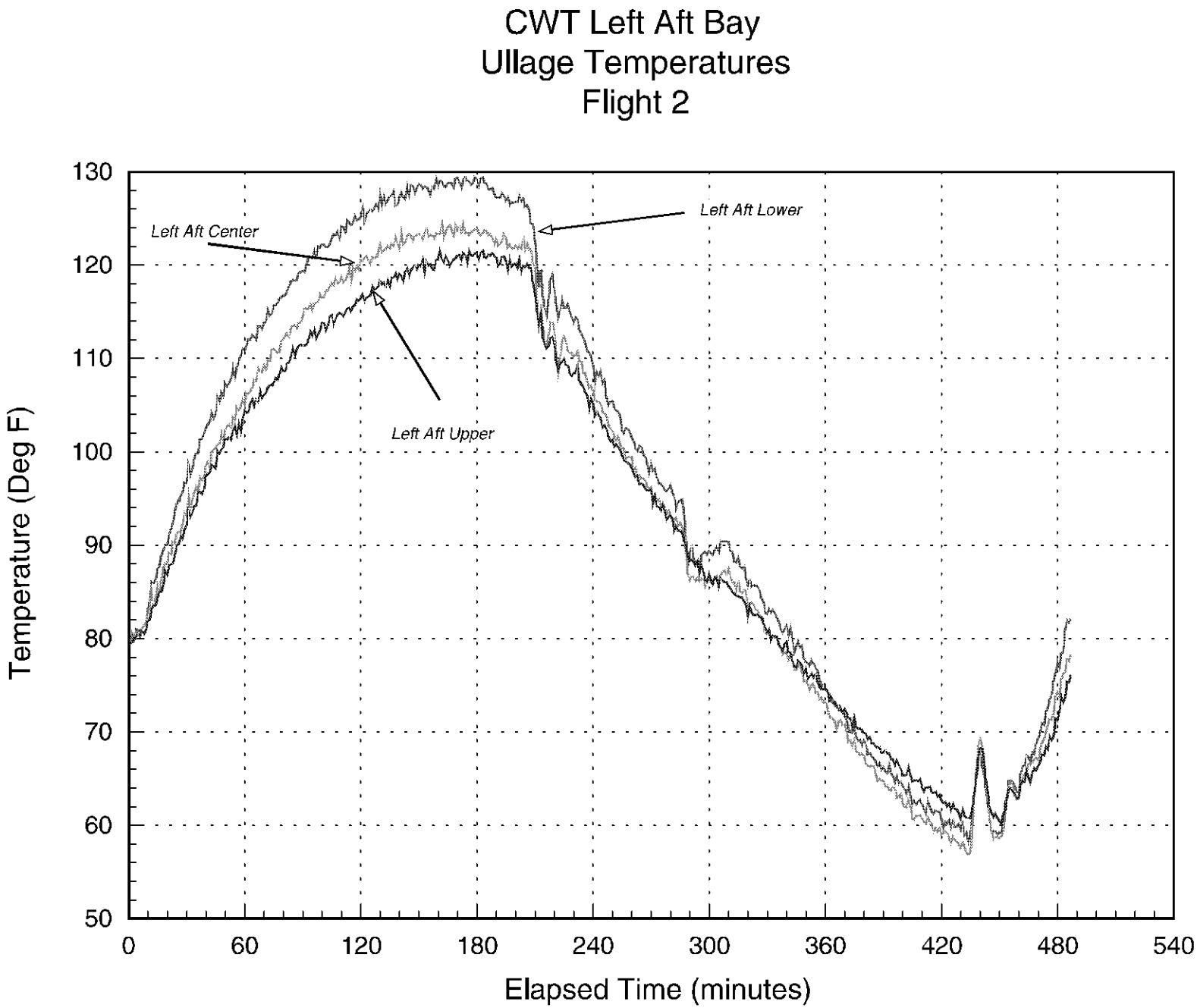
ECS Pack Bay Air Temperatures
BL 22 on Left side of Keel Beam
Flight 1

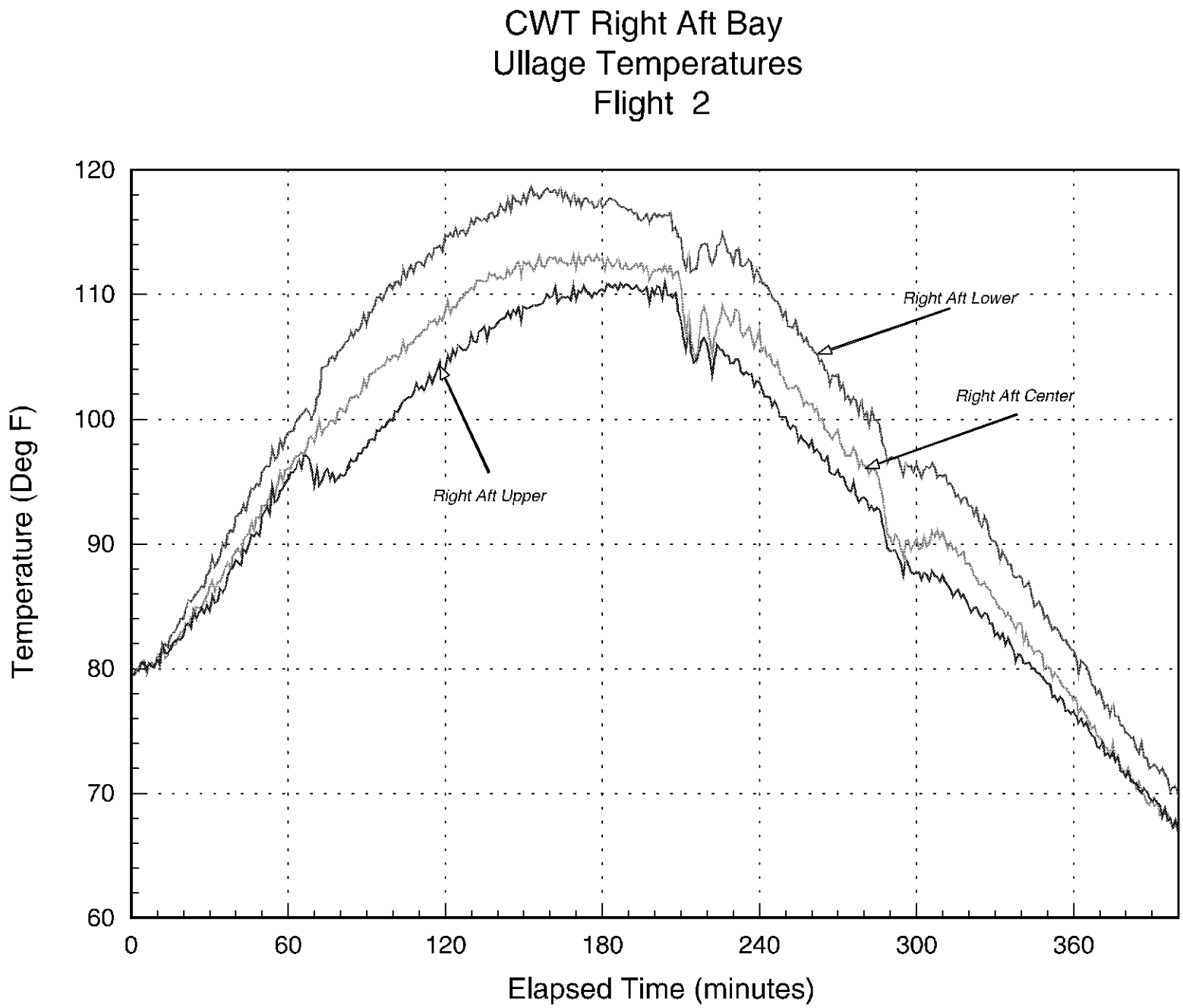


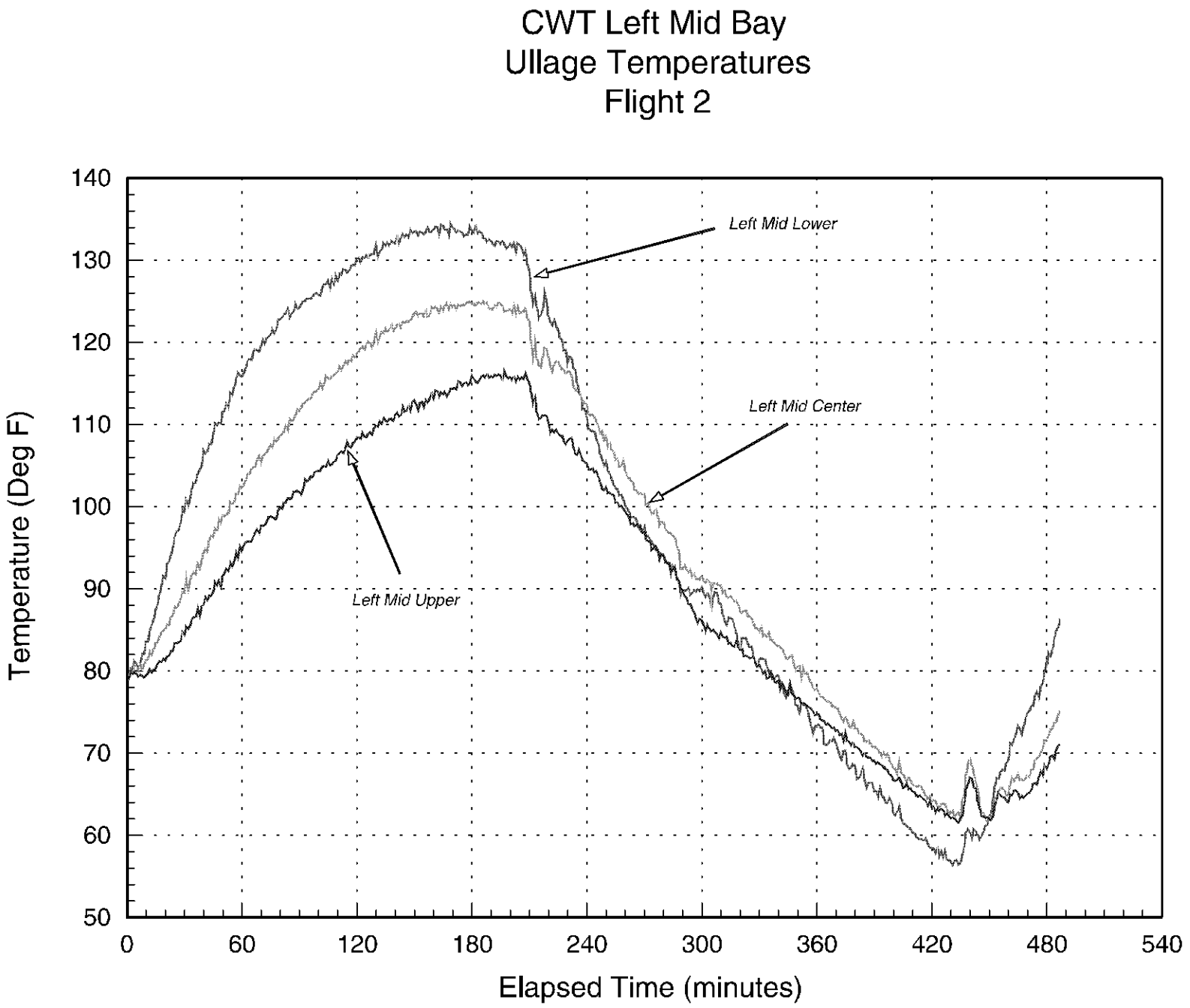

Fuel Temperatures
Measured in CWT Forward Bay
Flight 1
Temperature (Deg F)
140
130
120
110
100
90
80
70
0
60
120
180
240
300
360
Elapsed Time (minutes)
Right Side of Forward Bay
Left Side of Forward Bay

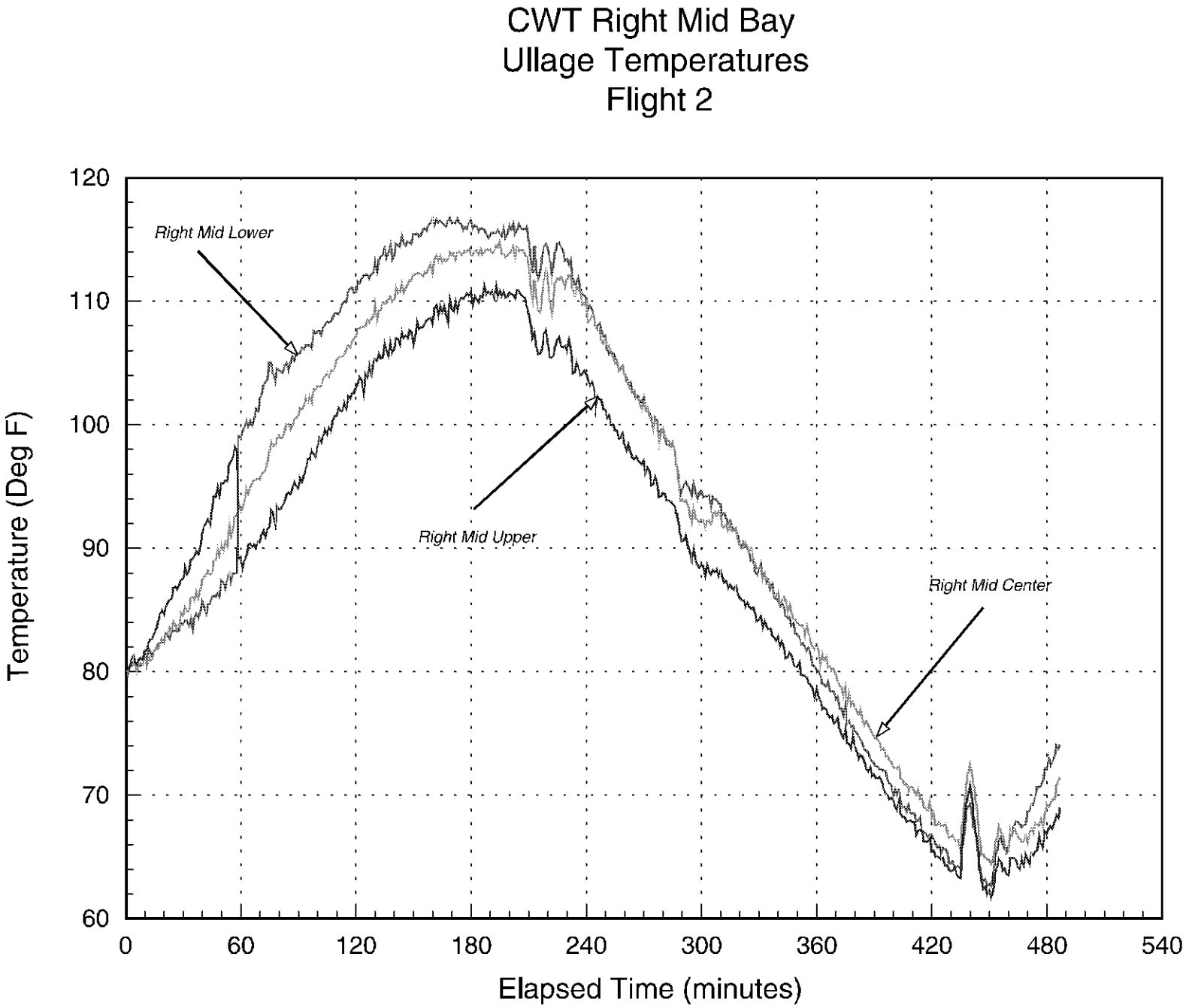

Fuel Temperatures
Measured at CWT Rear Spar
Flight 1
Temperature (Deg F)
140
130
120
110
100
90
80
70
60
0
60
120
180
240
300
360
Elapsed Time (minutes)
Right Aft Bay at Rear Spar
Left Aft Bay at Rear Spar

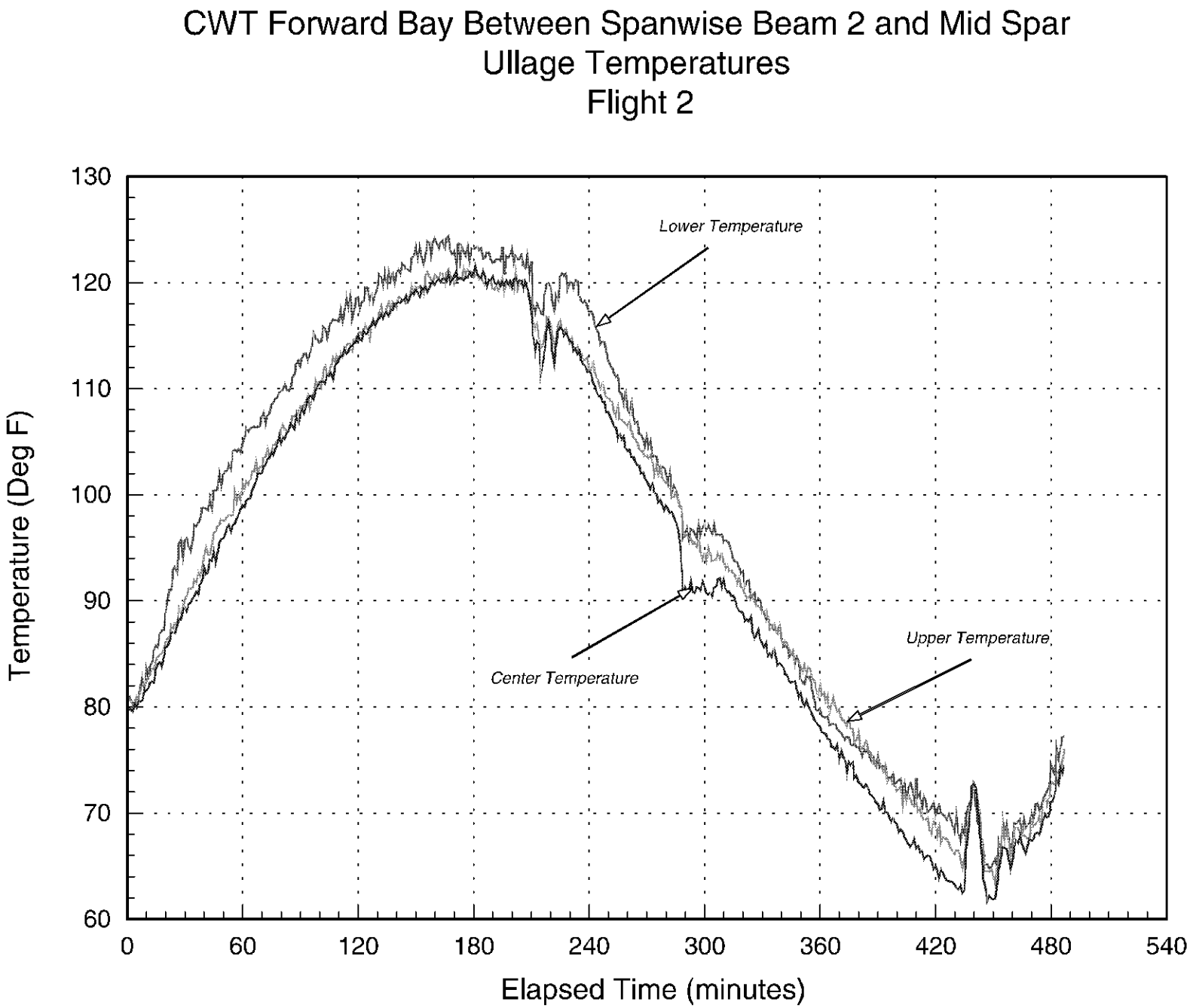
FLIGHT TEST RESULTS
FLIGHT 2

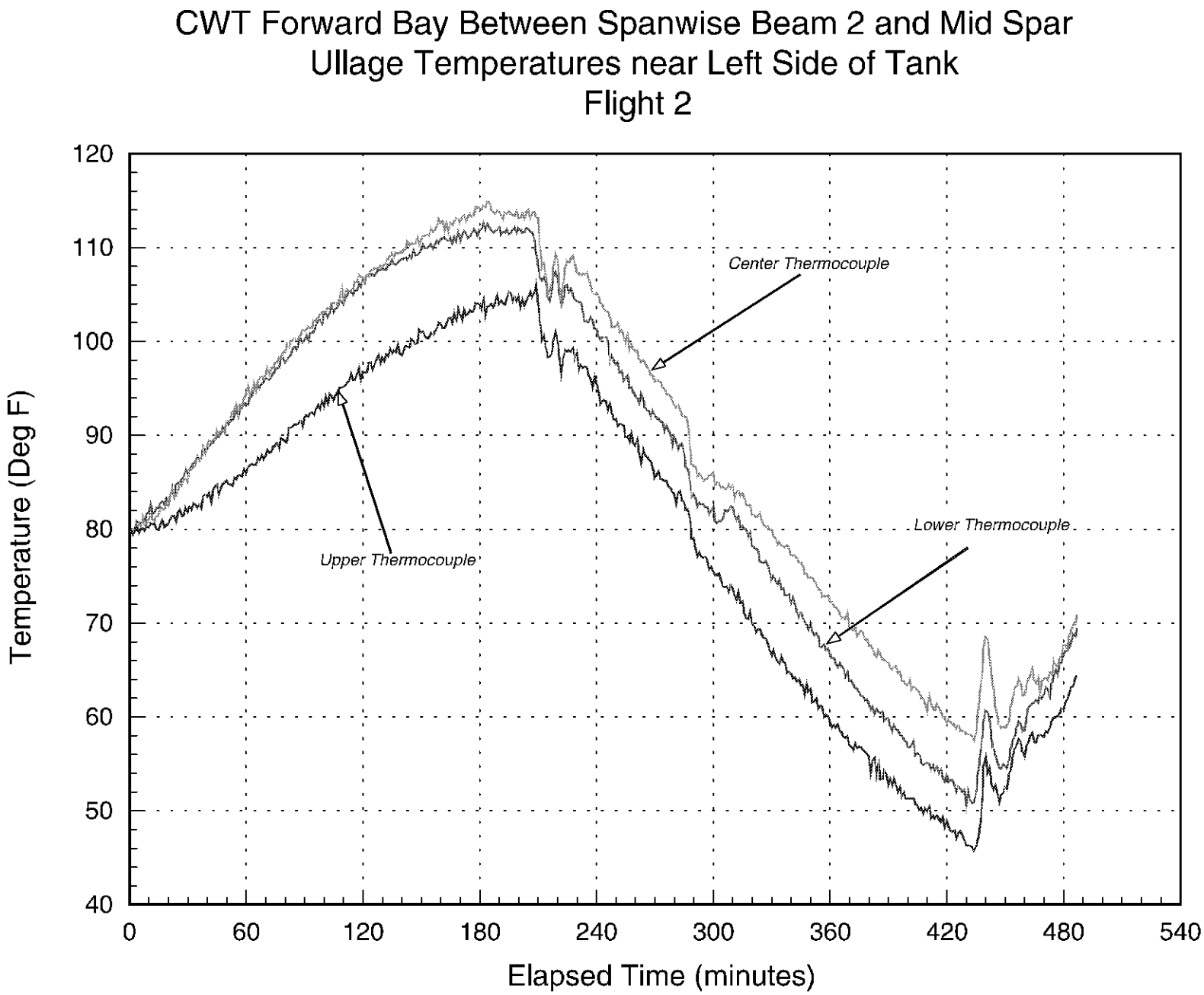

CWT Left Aft Bay
Ullage Temperatures
Flight 2
Left Aft Center
Left Aft Lower
Left Aft Upper
Temperature (Deg F)
Elapsed Time (minutes)
130
120
110
100
90
80
70
60
50
0
60
120
180
240
300
360
420
480
540

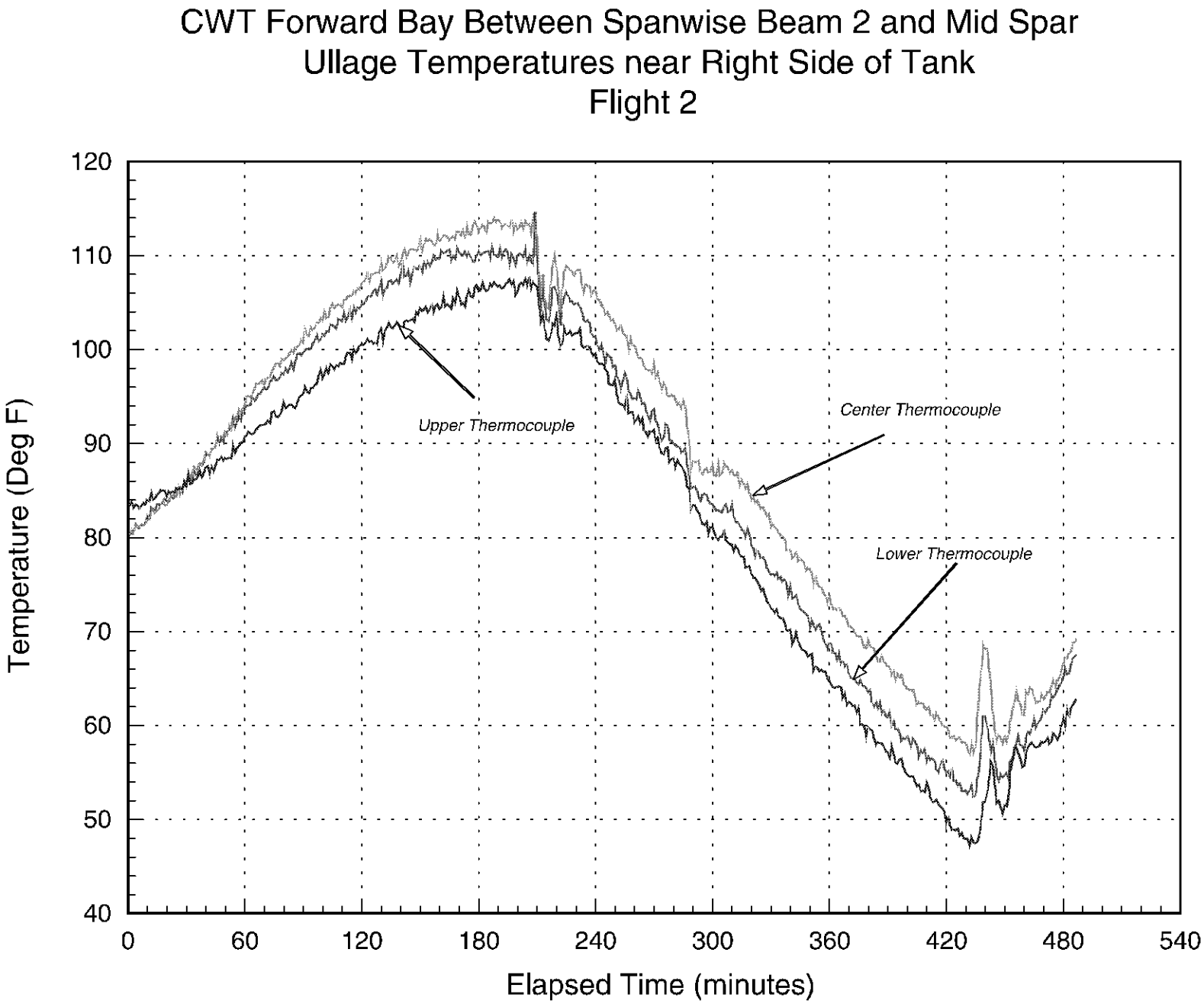

CWT Right Aft Bay
Ullage Temperatures
Flight 2
Temperature (Deg F)
120
110
100
90
80
70
60
0
60
120
180
240
300
360
Elapsed Time (minutes)
Right Aft Lower
Right Aft Center
Right Aft Upper

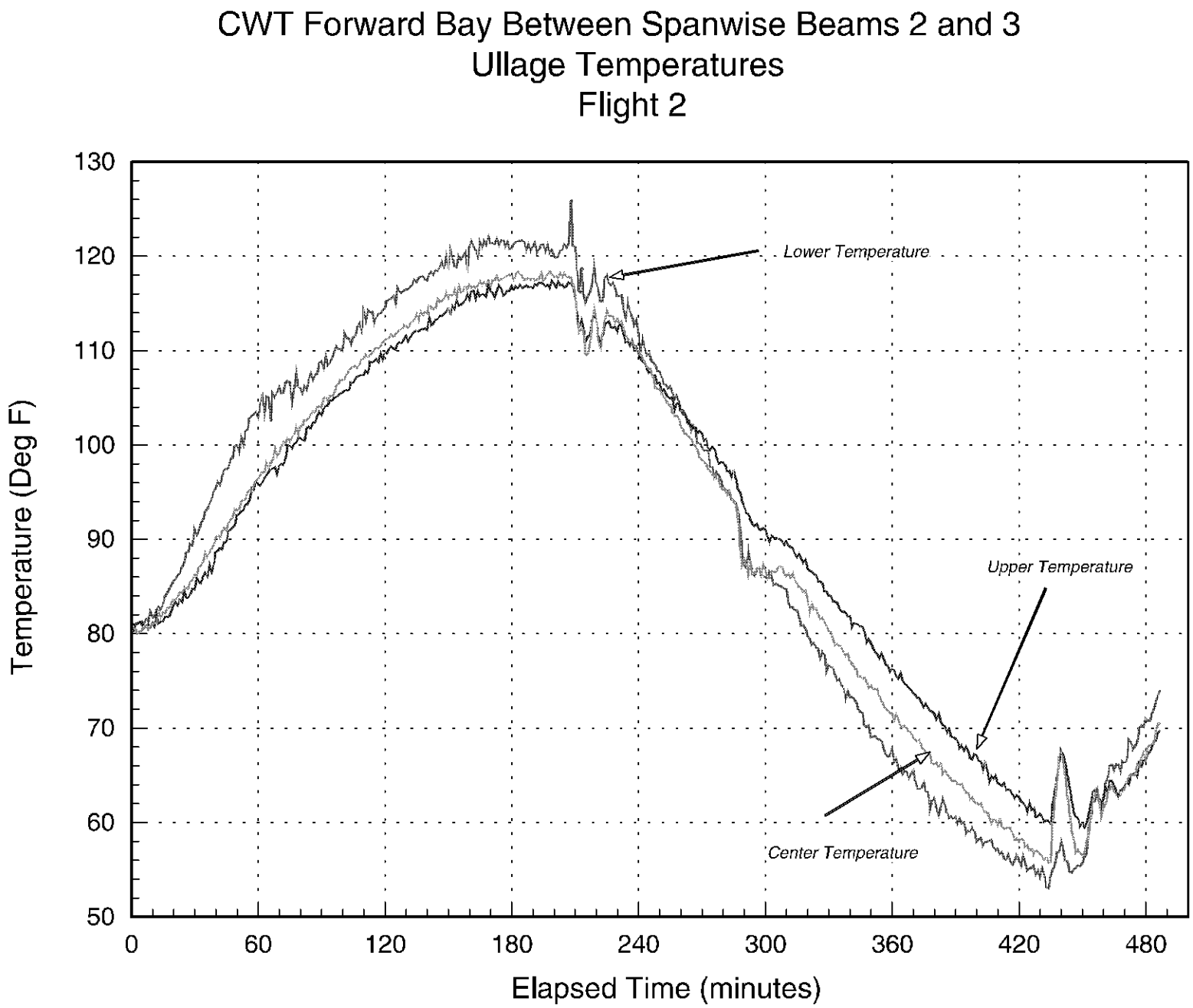

CWT Left Mid Bay
Ullage Temperatures
Flight 2
Left Mid Lower
Left Mid Center
Left Mid Upper
Temperature (Deg F)
Elapsed Time (minutes)
140
130
120
110
100
90
80
70
60
50
0
60
120
180
240
300
360
420
480
540

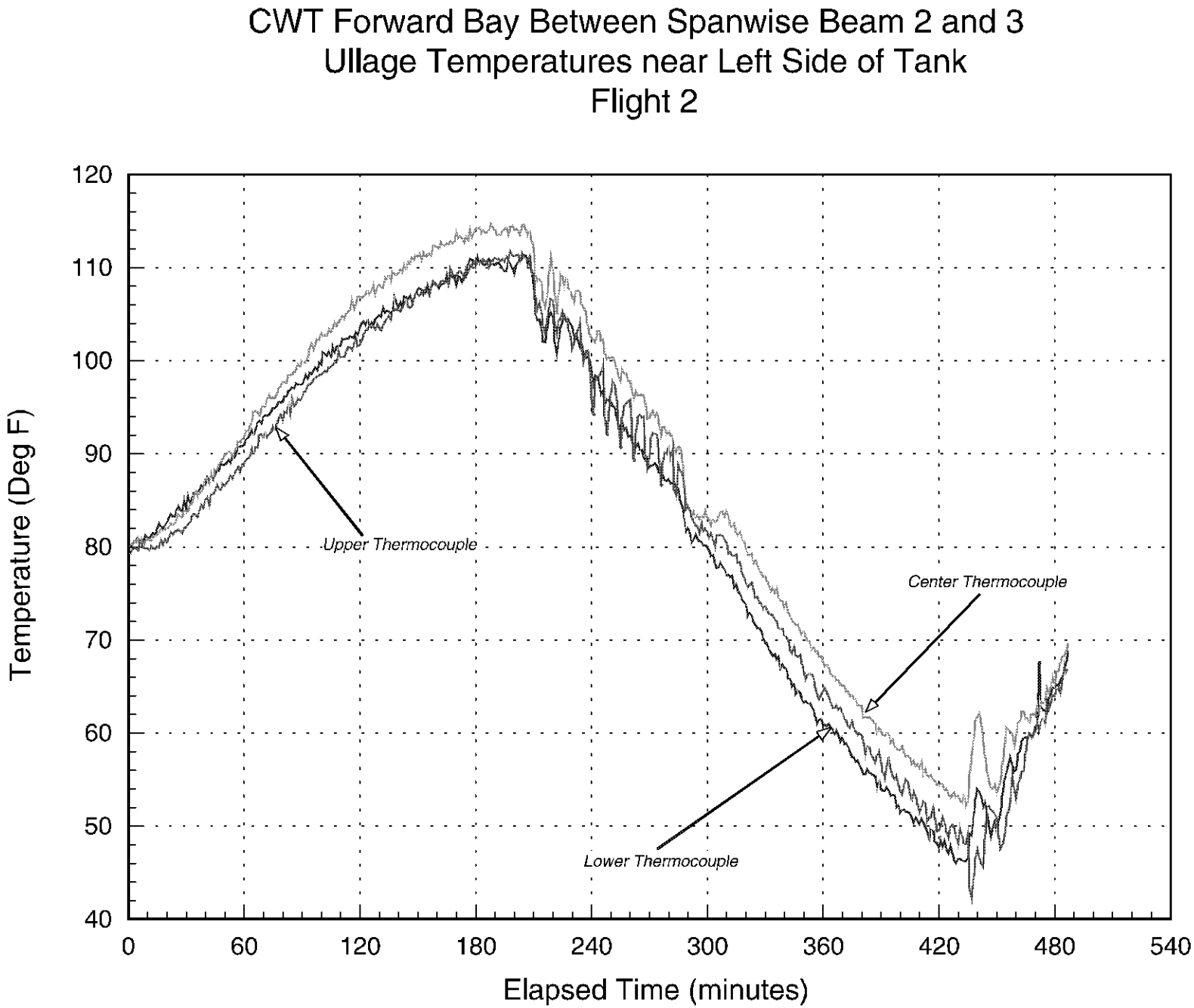

CWT Right Mid Bay
Ullage Temperatures
Flight 2
Right Mid Lower
Right Mid Upper
Right Mid Center
Temperature (Deg F)
Elapsed Time (minutes)
120
110
100
90
80
70
60
0
60
120
180
240
300
360
420
480
540

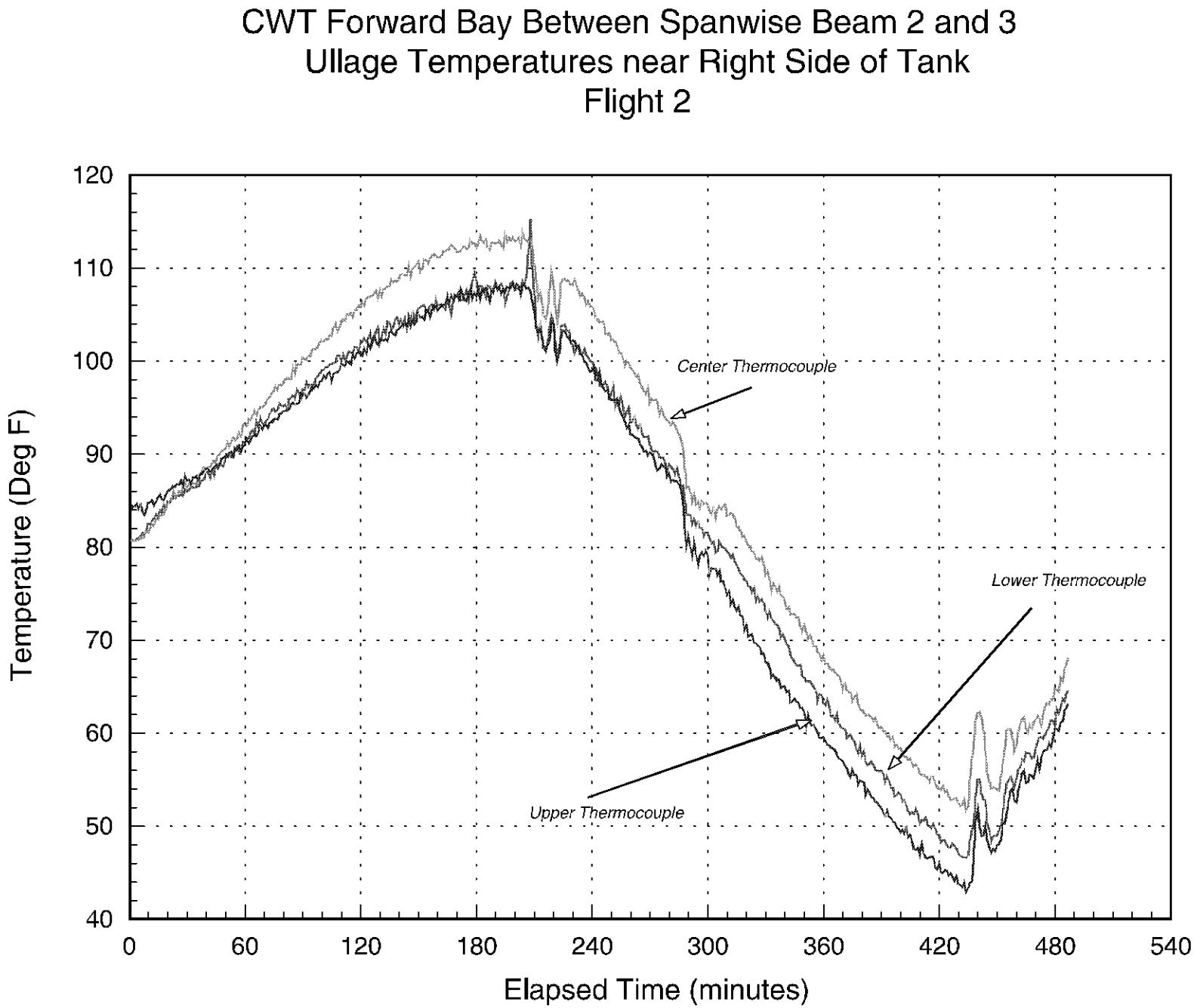

CWT Forward Bay Between Spanwise Beam 2 and Mid Spar
Ullage Temperatures
Flight 2
Lower Temperature
Center Temperature
Upper Temperature
Temperature (Deg F)
Elapsed Time (minutes)
130
120
110
100
90
80
70
60
0
60
120
180
240
300
360
420
480
540

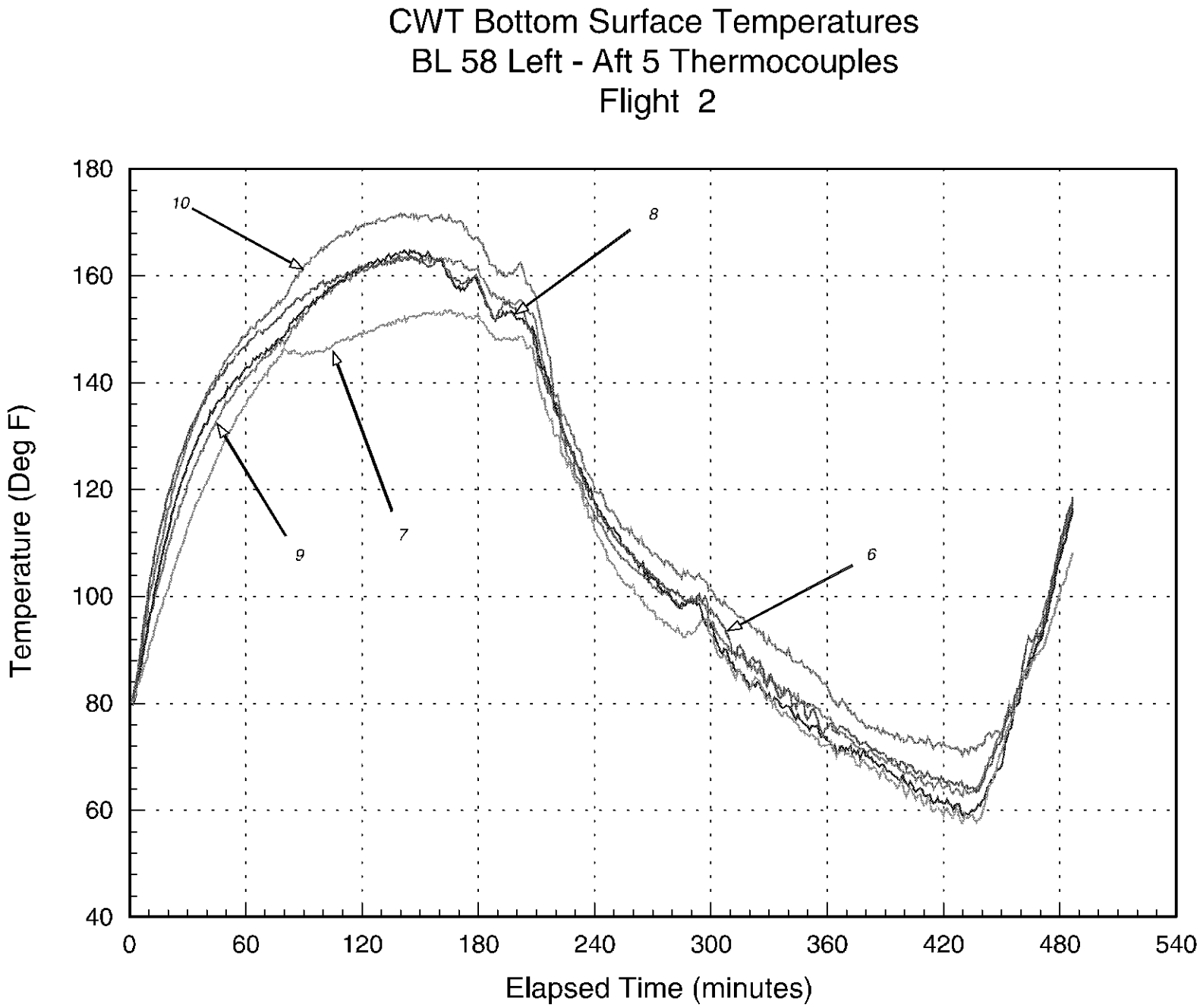

CWT Forward Bay Between Spanwise Beam 2 and Mid Spar
Ullage Temperatures near Left Side of Tank
Flight 2
Temperature (Deg F)
120
110
100
90
80
70
60
50
40
0
60
120
180
240
300
360
420
480
540
Elapsed Time (minutes)
Center Thermocouple
Lower Thermocouple
Upper Thermocouple

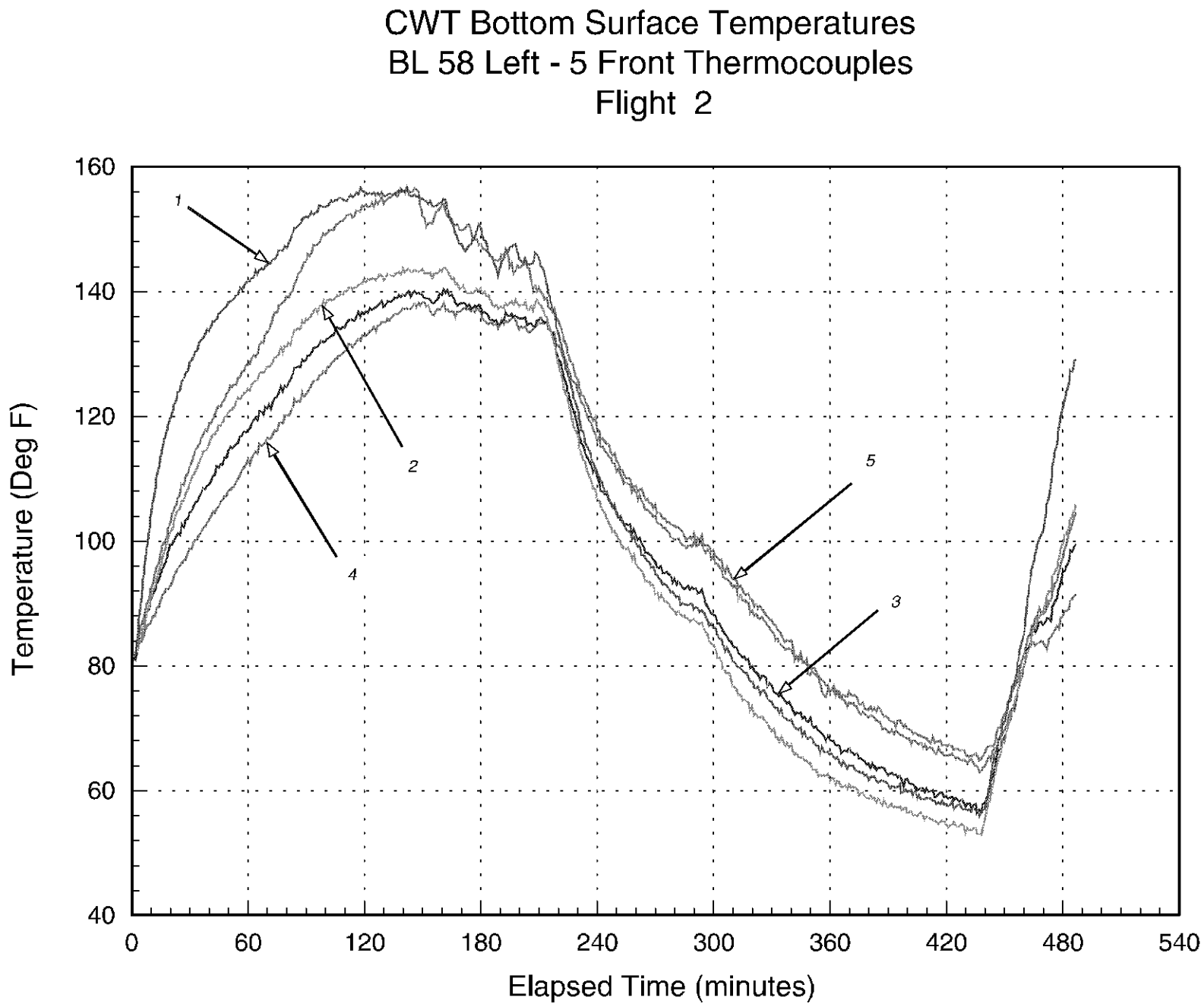

CWT Forward Bay Between Spanwise Beam 2 and Mid Spar
Ullage Temperatures near Right Side of Tank
Flight 2
Temperature (Deg F)
120
110
100
90
80
70
60
50
40
0
60
120
180
240
300
360
420
480
540
Elapsed Time (minutes)
Upper Thermocouple
Center Thermocouple
Lower Thermocouple

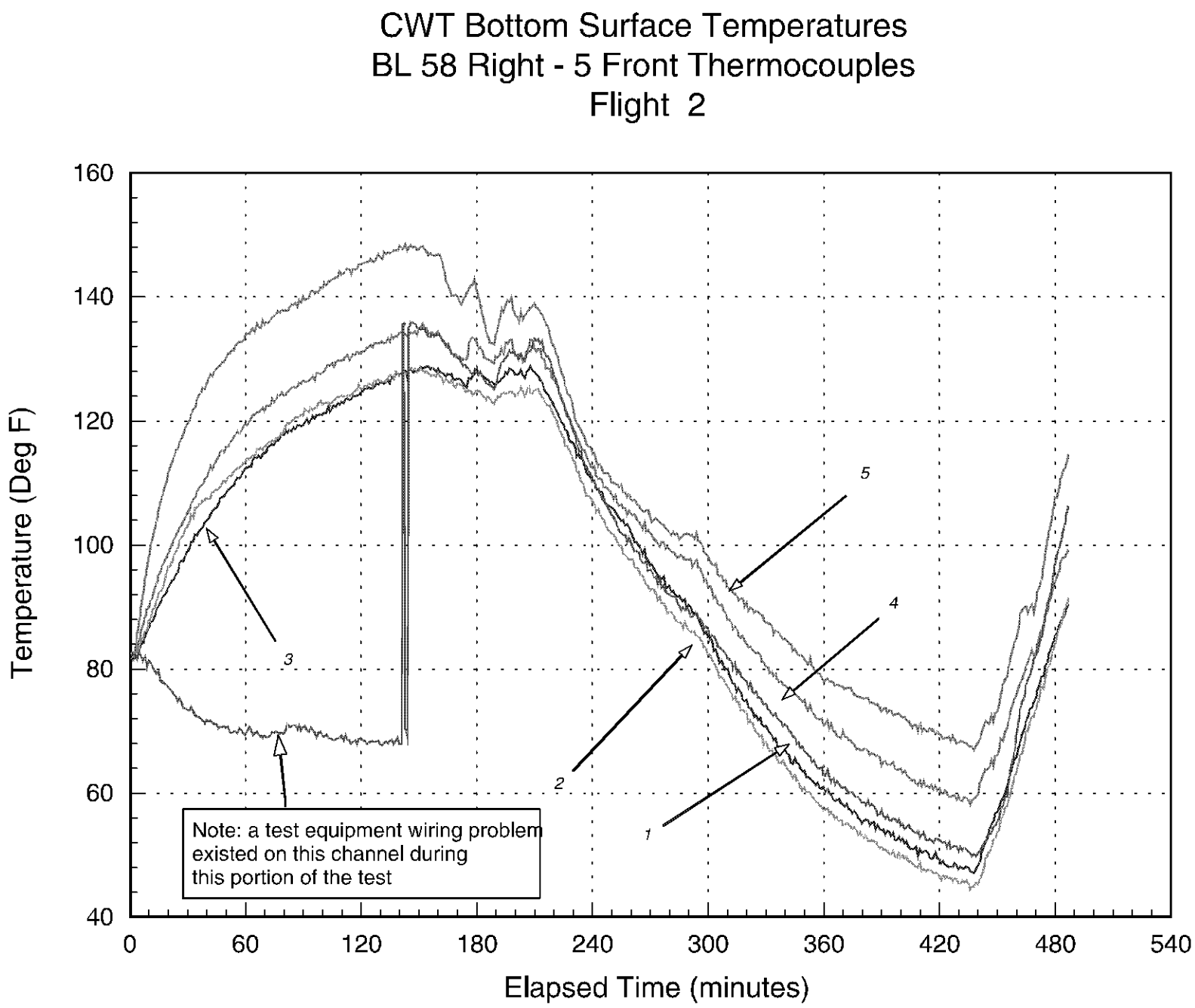

CWT Forward Bay Between Spanwise Beams 2 and 3
Ullage Temperatures
Flight 2
Temperature (Deg F)
130
120
110
100
90
80
70
60
50
0
60
120
180
240
300
360
420
480
Elapsed Time (minutes)
Lower Temperature
Upper Temperature
Center Temperature

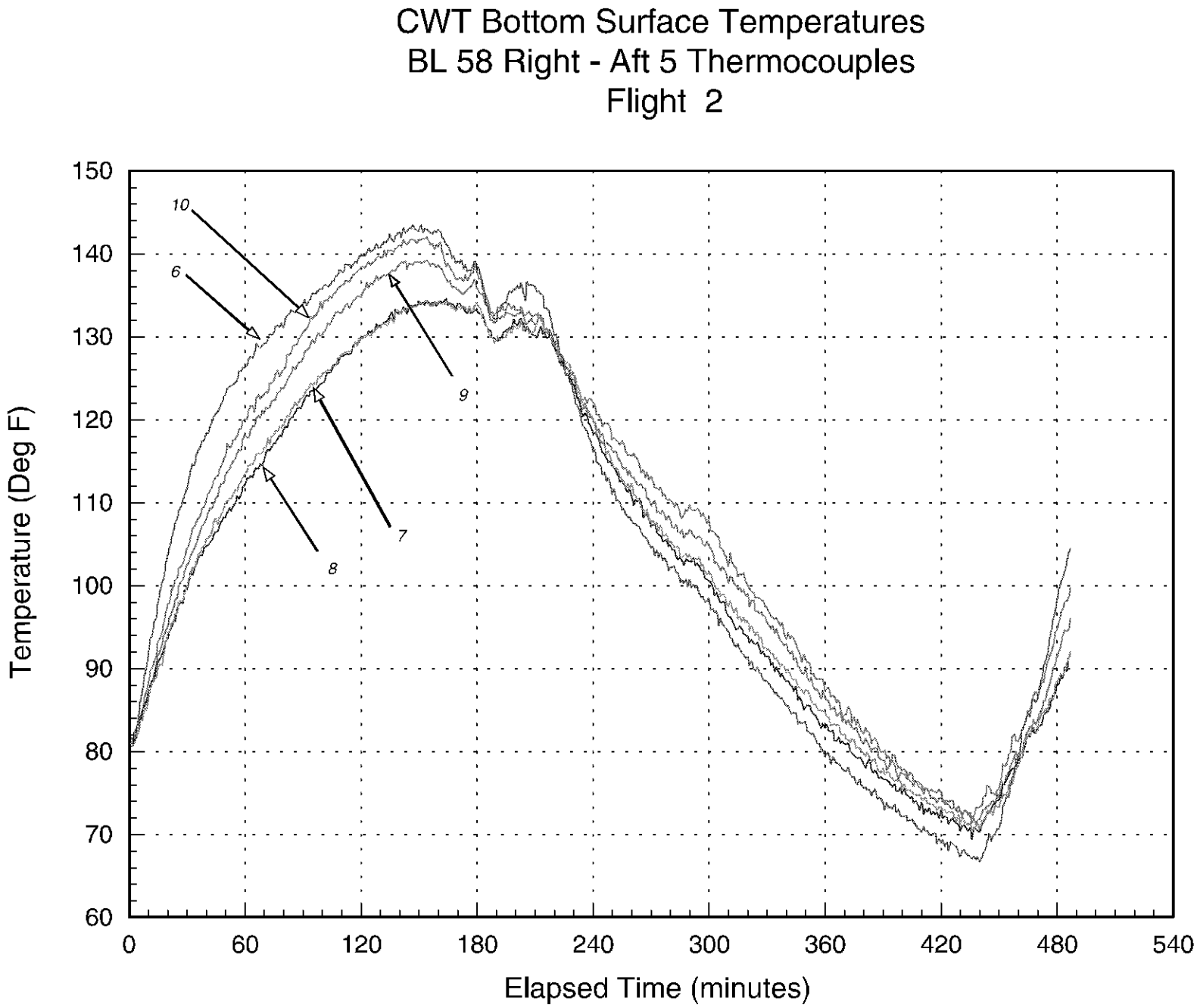

CWT Forward Bay Between Spanwise Beam 2 and 3
Ullage Temperatures near Left Side of Tank
Flight 2
Temperature (Deg F)
120
110
100
90
80
70
60
50
40
0
60
120
180
240
300
360
420
480
540
Elapsed Time (minutes)
Upper Thermocouple
Center Thermocouple
Lower Thermocouple

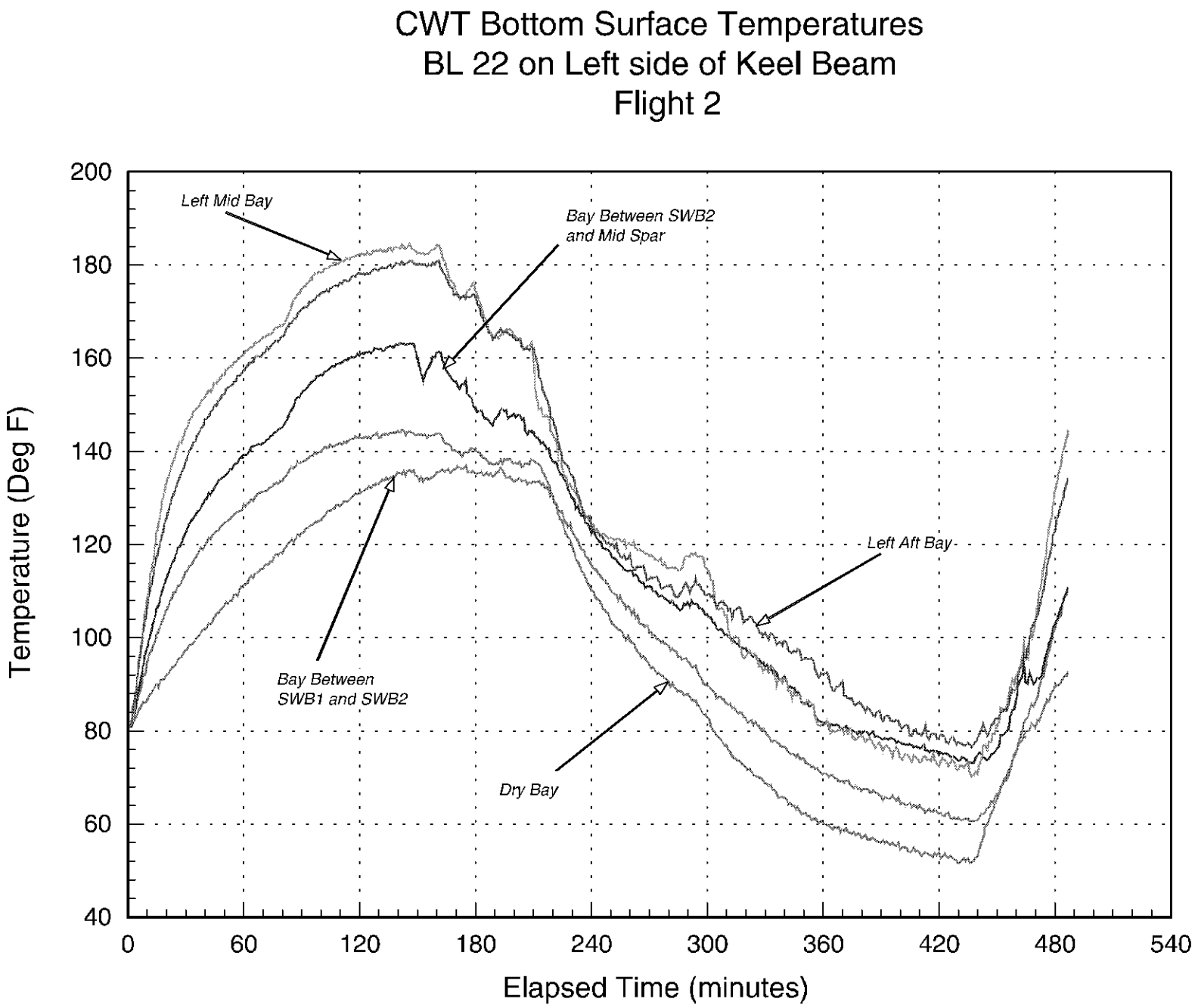

CWT Forward Bay Between Spanwise Beam 2 and 3
Ullage Temperatures near Right Side of Tank
Flight 2
Temperature (Deg F)
120
110
100
90
80
70
60
50
40
0
60
120
180
240
300
360
420
480
540
Elapsed Time (minutes)
Center Thermocouple
Lower Thermocouple
Upper Thermocouple

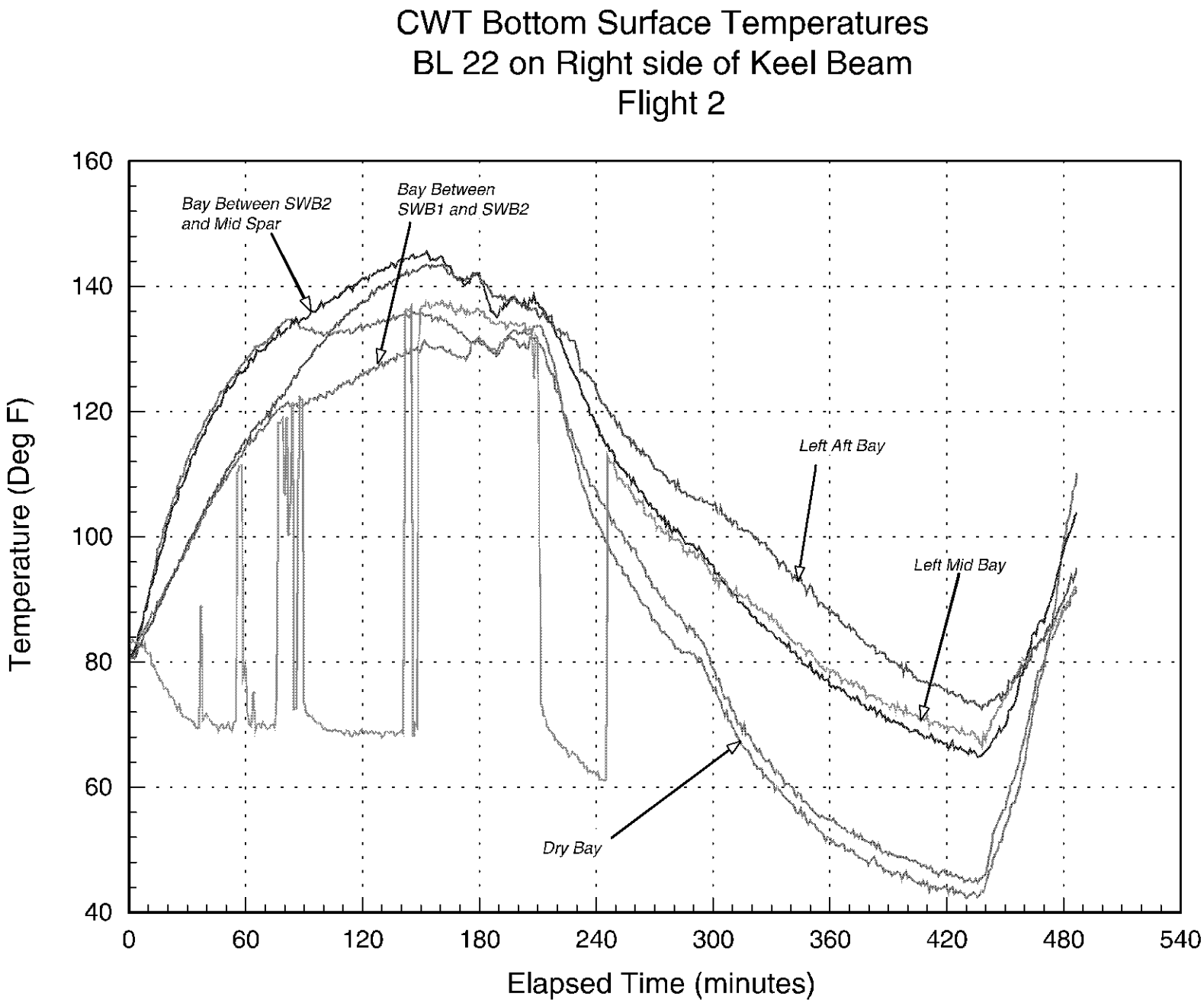

CWT Bottom Surface Temperatures
BL 58 Left - Aft 5 Thermocouples
Flight 2
Temperature (Deg F)
Elapsed Time (minutes)
180
160
140
120
100
80
60
40
0
60
120
180
240
300
360
420
480
540
10
8
7
9
6

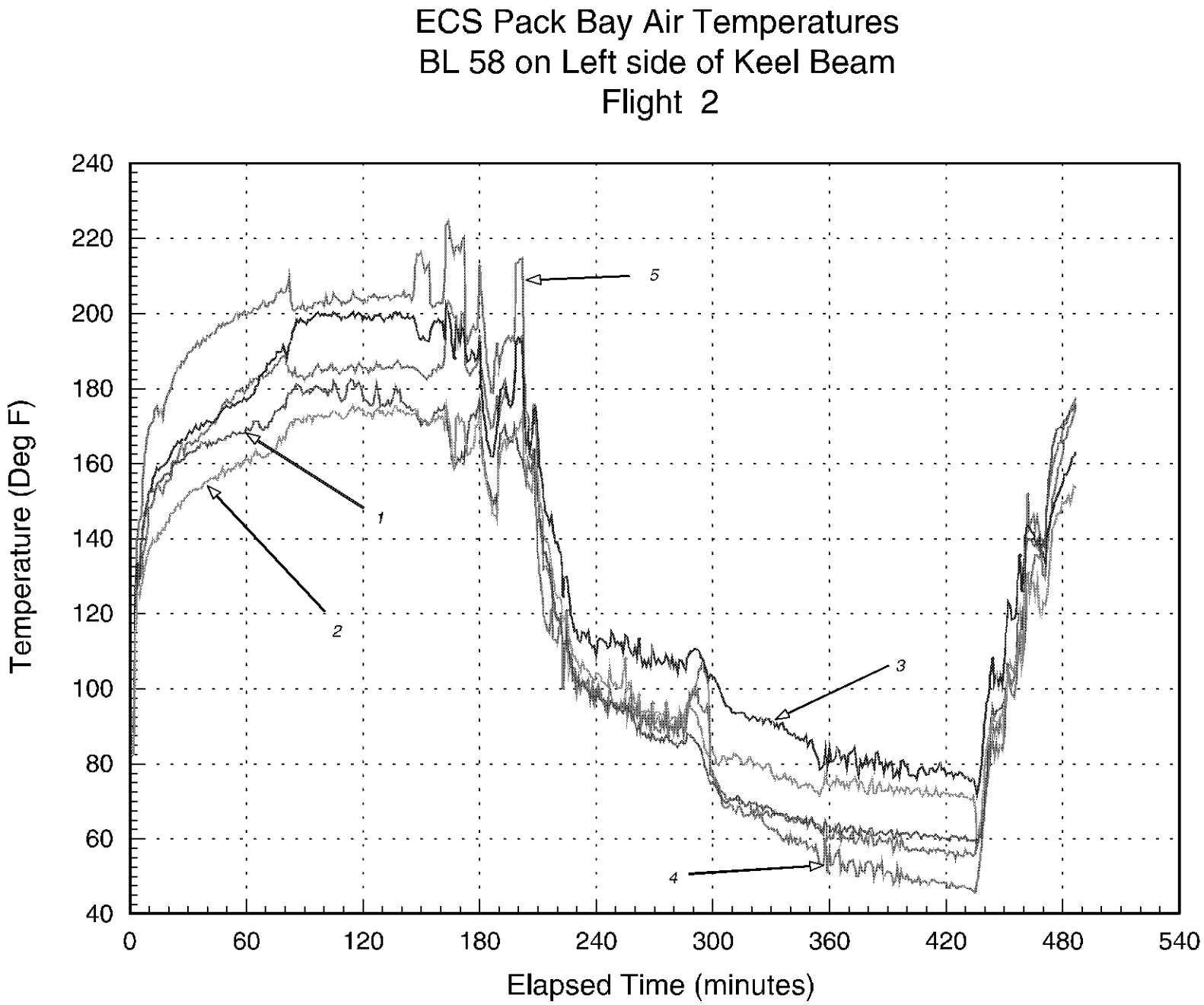

CWT Bottom Surface Temperatures
BL 58 Left - 5 Front Thermocouples
Flight 2
Temperature (Deg F)
Elapsed Time (minutes)
160
140
120
100
80
60
40
0
60
120
180
240
300
360
420
480
540
1
2
3
4
5

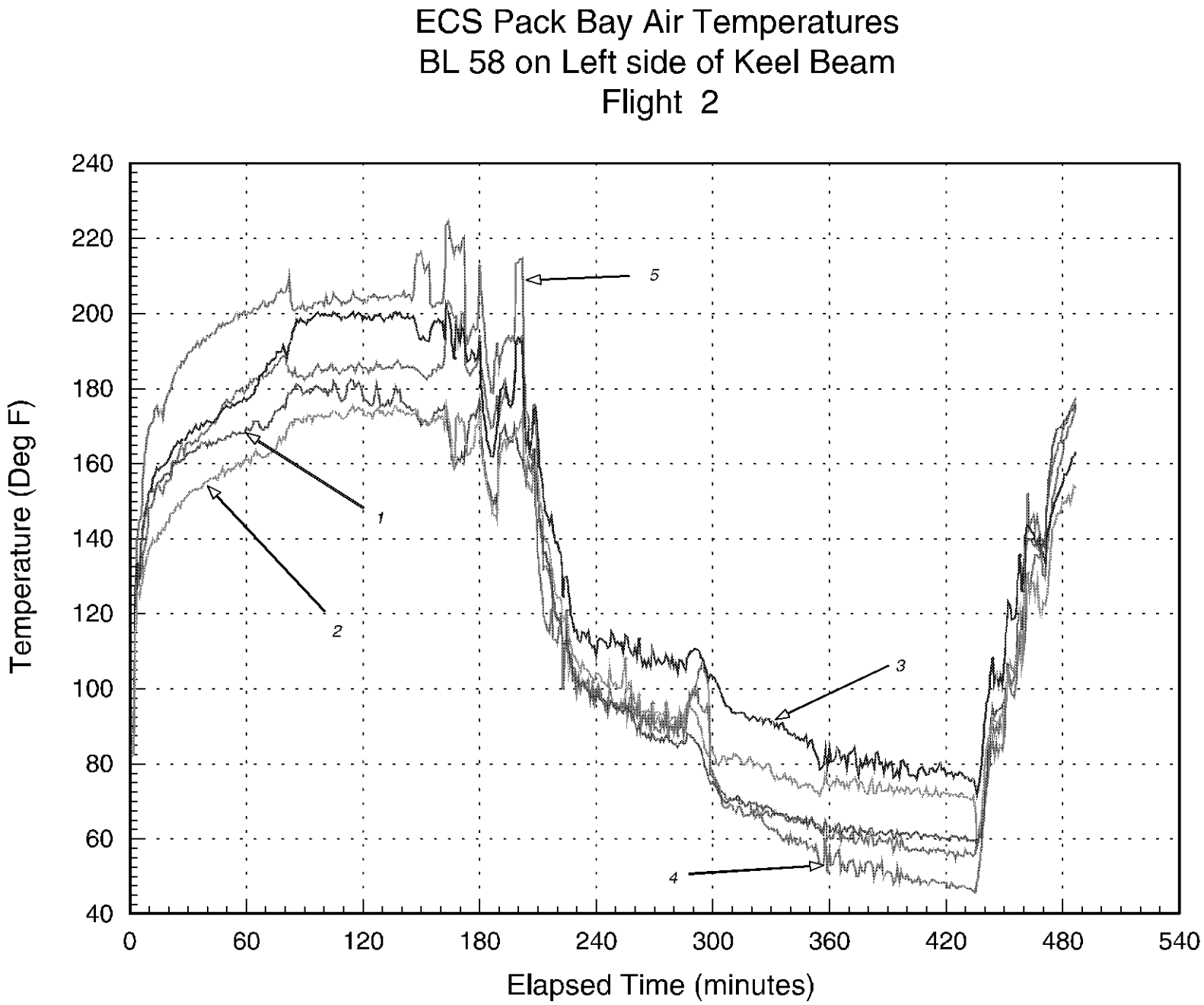

CWT Bottom Surface Temperatures
BL 58 Right - 5 Front Thermocouples
Flight 2
Temperature (Deg F)
160
140
120
100
80
60
40
0
60
120
180
240
300
360
420
480
540
Elapsed Time (minutes)
1
2
3
4
5
Note: a test equipment wiring problem existed on this channel during this portion of the test

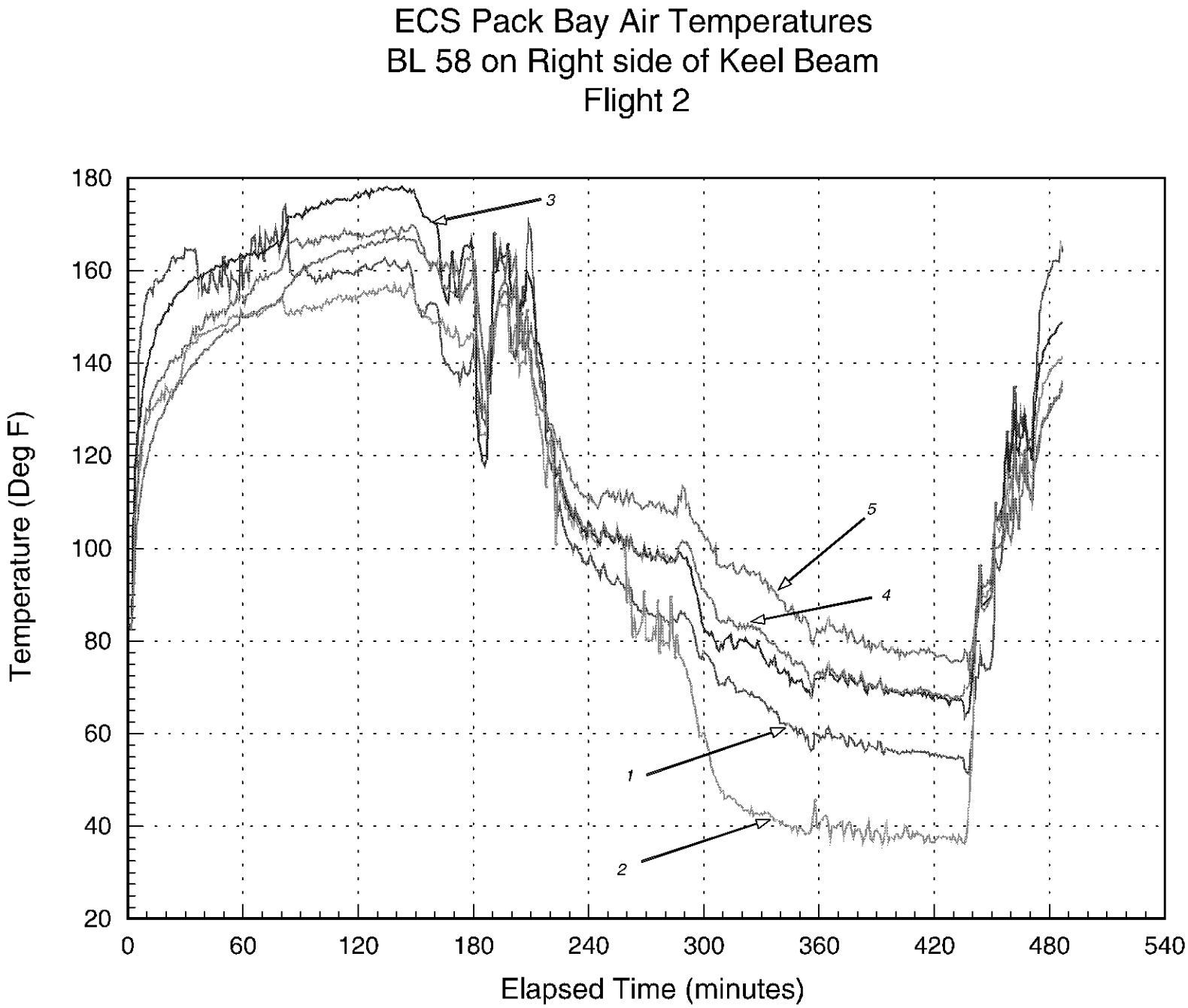

CWT Bottom Surface Temperatures
BL 58 Right - Aft 5 Thermocouples
Flight 2
Temperature (Deg F)
Elapsed Time (minutes)
150
140
130
120
110
100
90
80
70
60
0
60
120
180
240
300
360
420
480
540
10
6
9
7
8

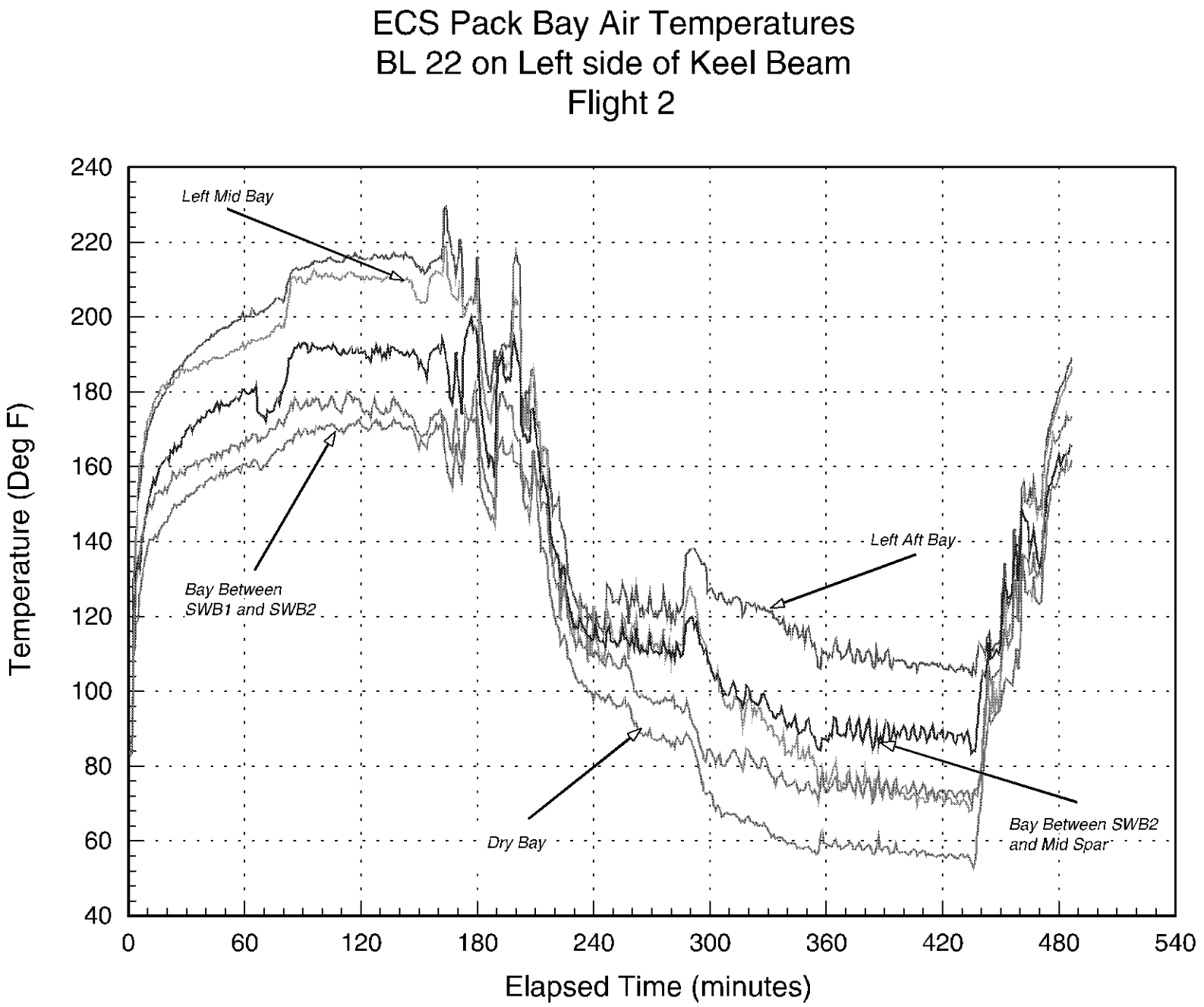

CWT Bottom Surface Temperatures
BL 22 on Left side of Keel Beam
Flight 2
Left Mid Bay
Bay Between SWB2
and Mid Spar
Left Aft Bay
Bay Between
SWB1 and SWB2
Dry Bay
Temperature (Deg F)
Elapsed Time (minutes)
200
180
160
140
120
100
80
60
40
0
60
120
180
240
300
360
420
480
540

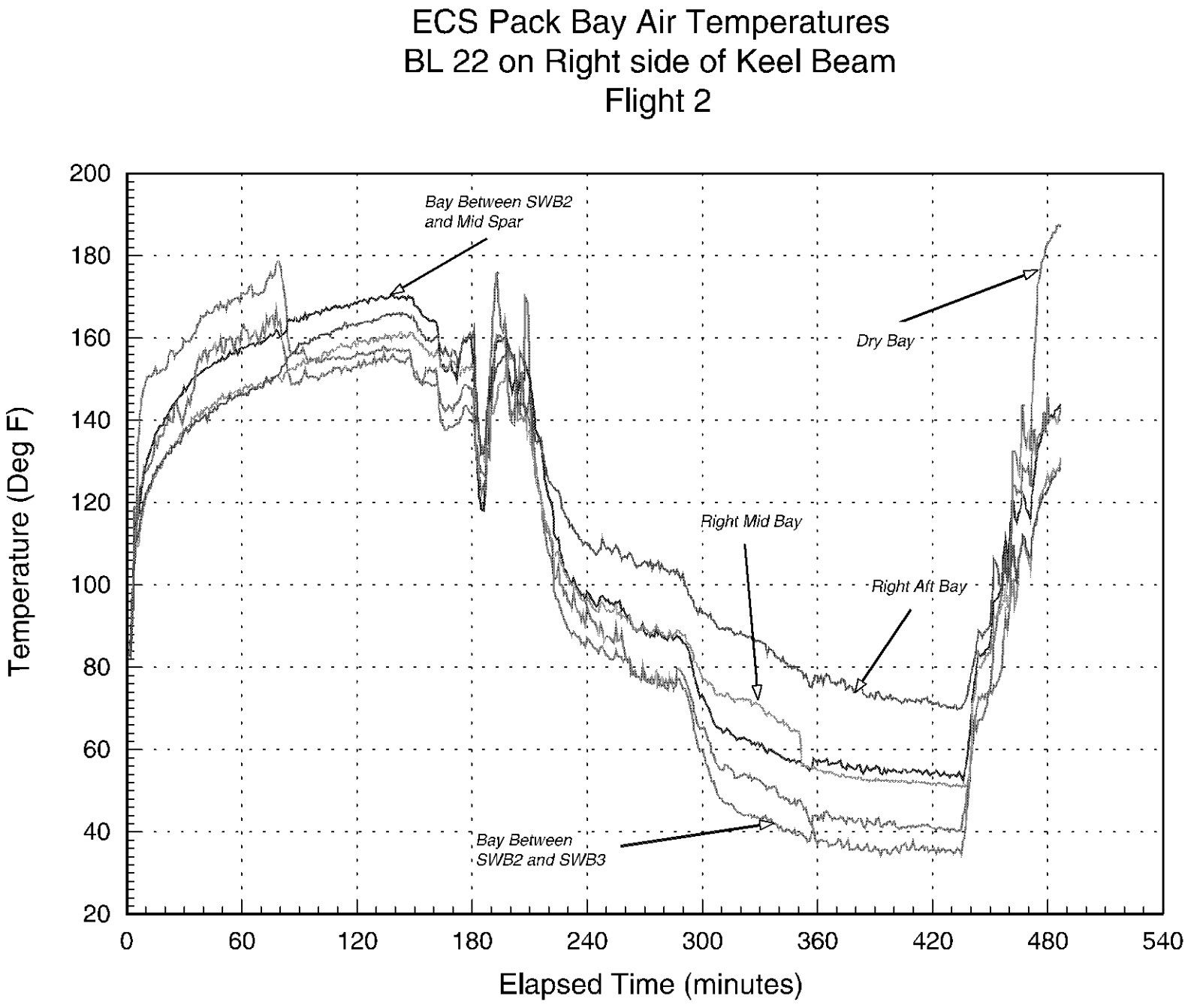

CWT Bottom Surface Temperatures
BL 22 on Right side of Keel Beam
Flight 2
Bay Between SWB2 and Mid Spar
Bay Between SWB1 and SWB2
Left Aft Bay
Left Mid Bay
Dry Bay
Temperature (Deg F)
Elapsed Time (minutes)
160
140
120
100
80
60
40
0
60
120
180
240
300
360
420
480
540

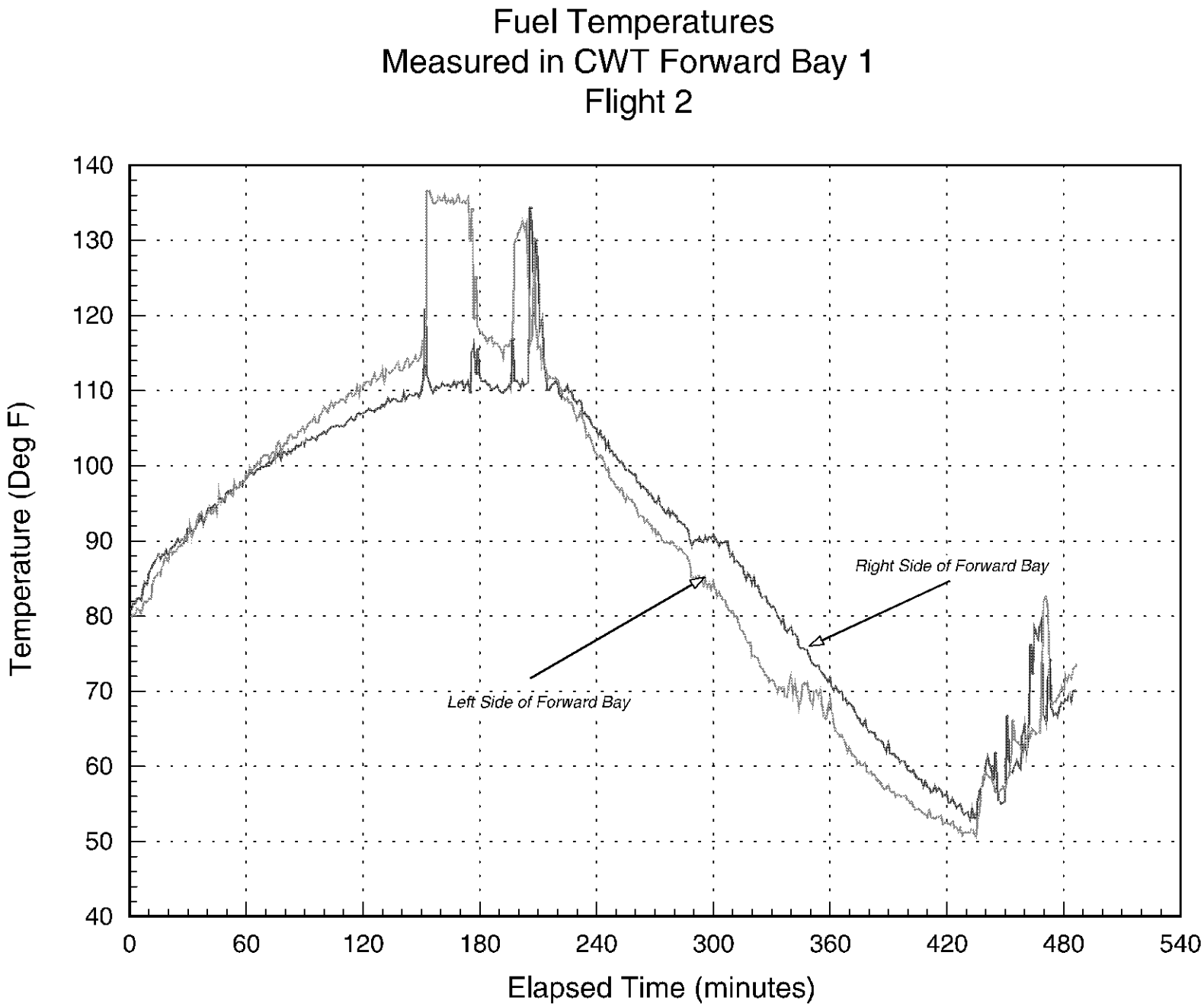

ECS Pack Bay Air Temperatures
BL 58 on Left side of Keel Beam
Flight 2
Temperature (Deg F)
240
220
200
180
160
140
120
100
80
60
40
0
60
120
180
240
300
360
420
480
540
Elapsed Time (minutes)
1
2
3
4
5

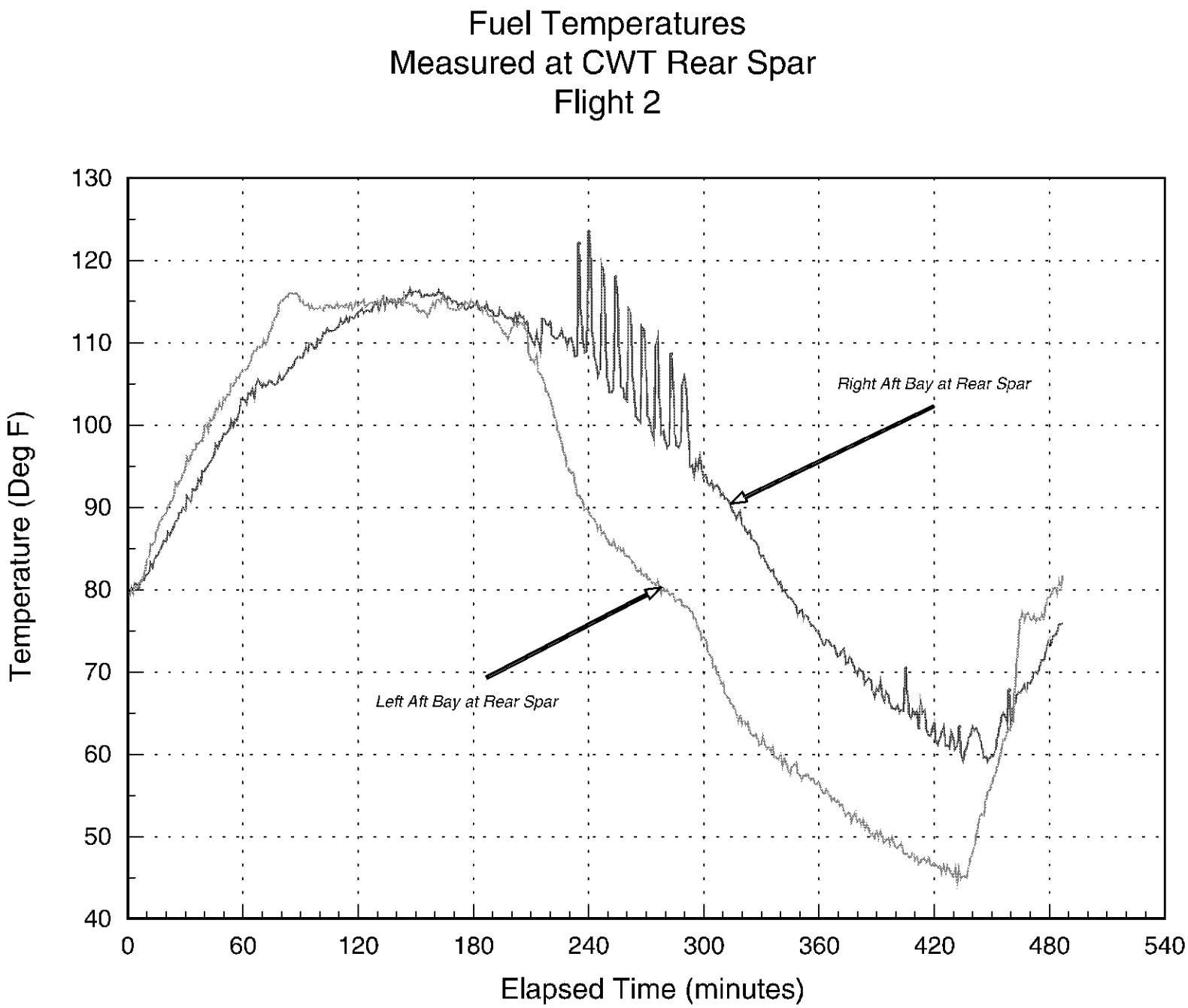

ECS Pack Bay Air Temperatures
BL 58 on Left side of Keel Beam
Flight 2
Temperature (Deg F)
240
220
200
180
160
140
120
100
80
60
40
0
60
120
180
240
300
360
420
480
540
Elapsed Time (minutes)
1
2
3
4
5


ECS Pack Bay Air Temperatures
BL 58 on Right side of Keel Beam
Flight 2
Temperature (Deg F)
Elapsed Time (minutes)
180
160
140
120
100
80
60
40
20
0
60
120
180
240
300
360
420
480
540
1
2
3
4
5

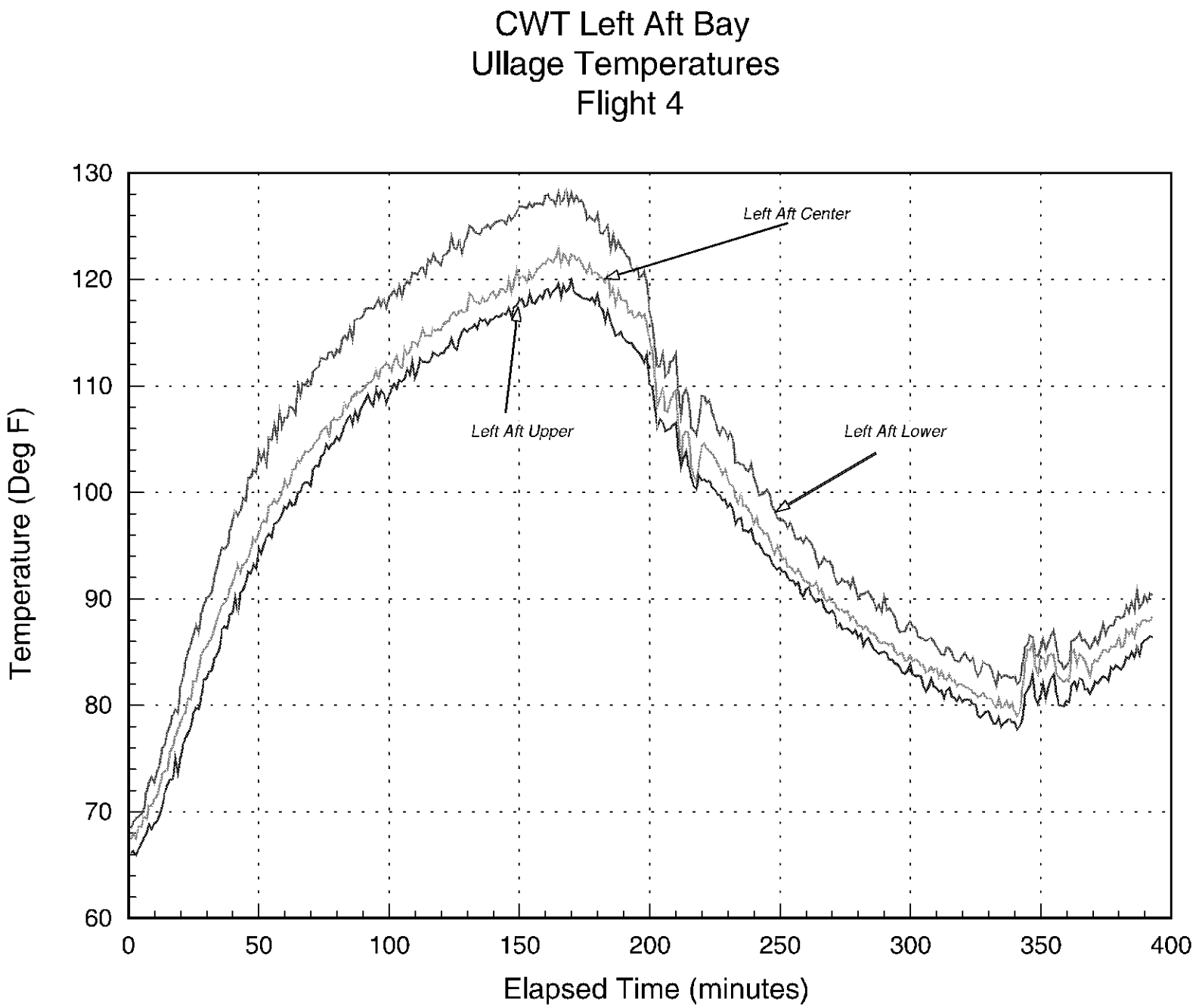

ECS Pack Bay Air Temperatures
BL 22 on Left side of Keel Beam
Flight 2
Left Mid Bay
Bay Between
SWB1 and SWB2
Left Aft Bay
Dry Bay
Bay Between SWB2
and Mid Spar
Temperature (Deg F)
Elapsed Time (minutes)
240
220
200
180
160
140
120
100
80
60
40
0
60
120
180
240
300
360
420
480
540

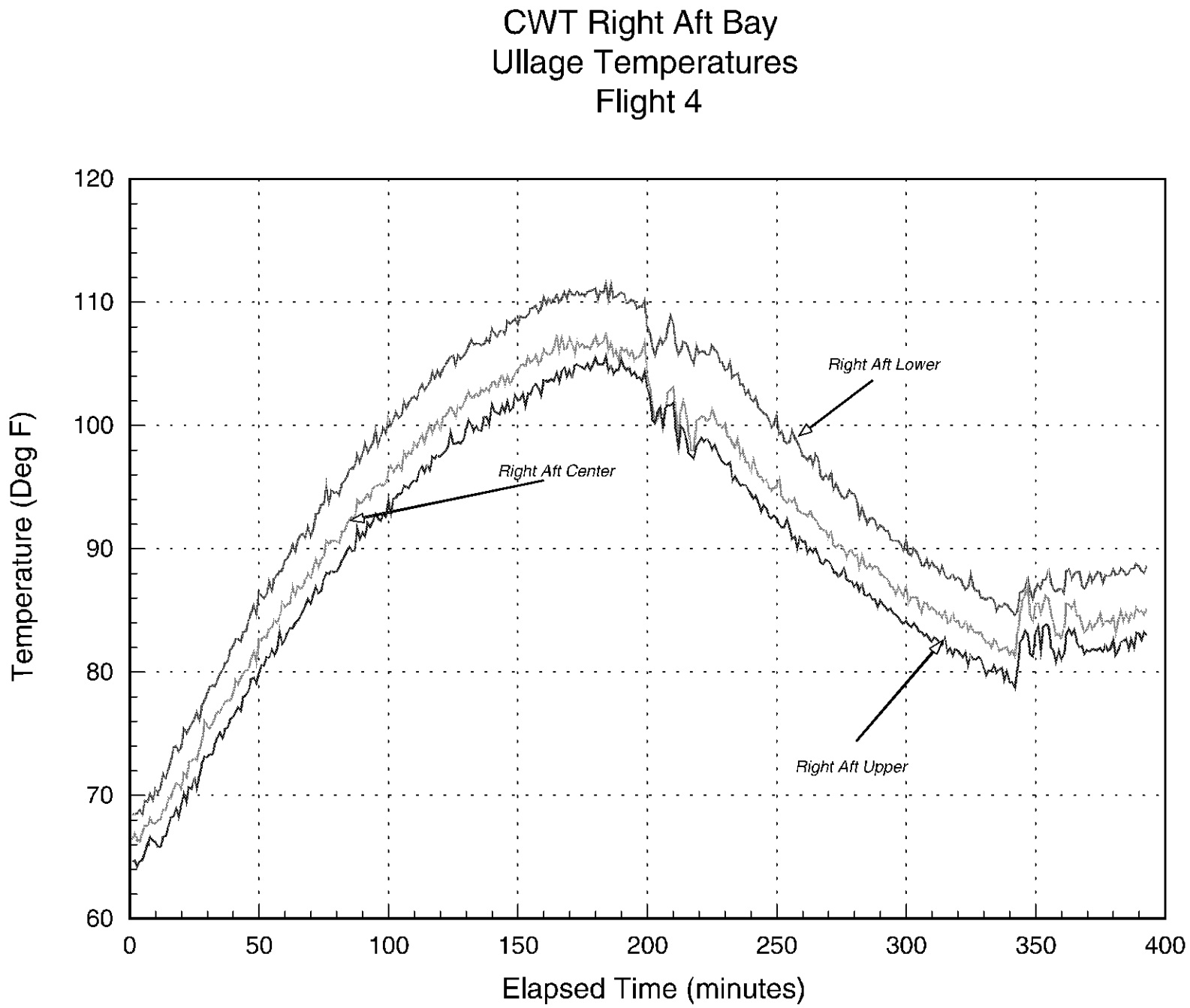

ECS Pack Bay Air Temperatures
BL 22 on Right side of Keel Beam
Flight 2
Temperature (Deg F)
Elapsed Time (minutes)
200
180
160
140
120
100
80
60
40
20
0
60
120
180
240
300
360
420
480
540
Bay Between SWB2 and Mid Spar
Dry Bay
Right Mid Bay
Right Aft Bay
Bay Between SWB2 and SWB3

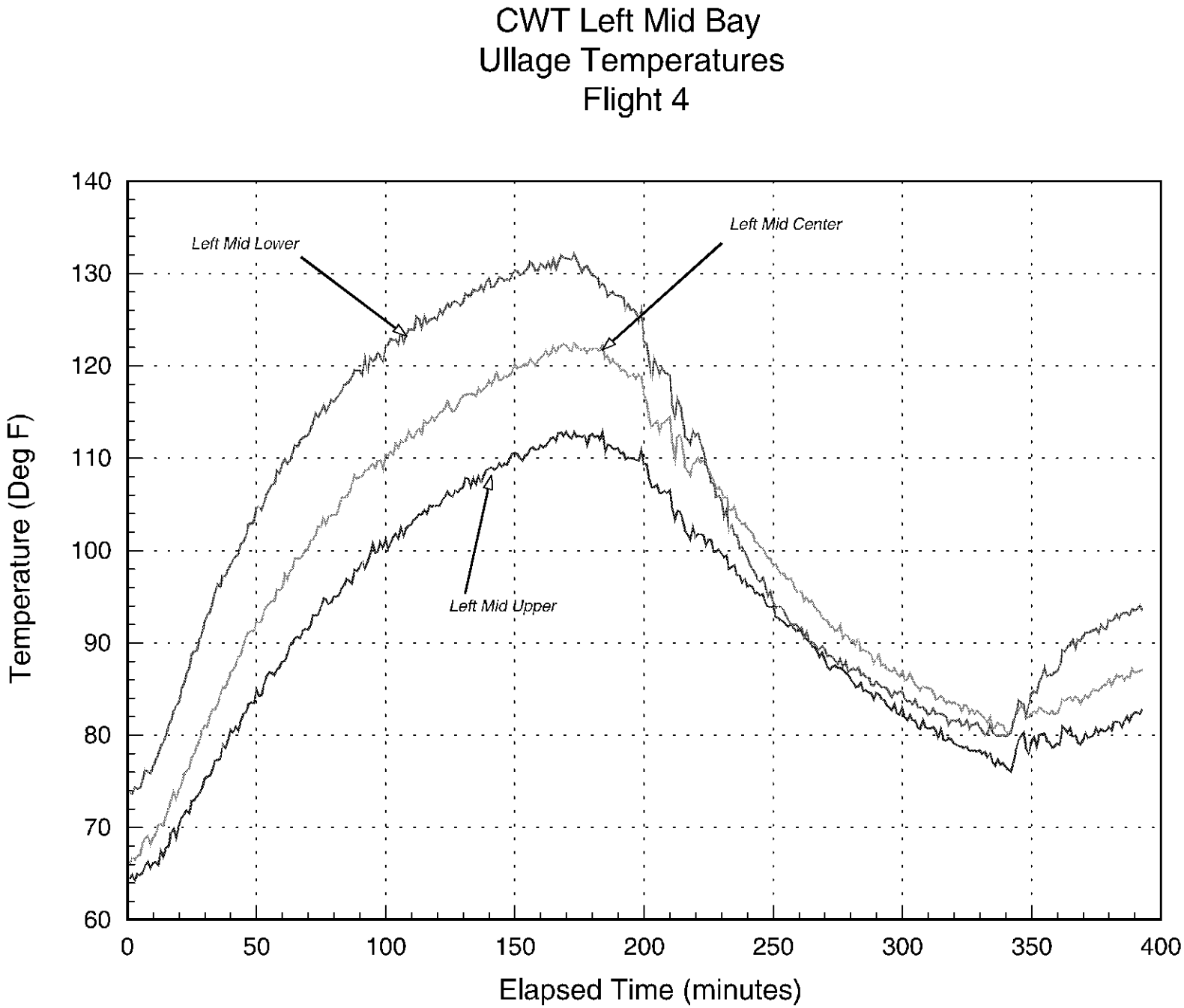

Fuel Temperatures
Measured in CWT Forward Bay 1
Flight 2
Temperature (Deg F)
140
130
120
110
100
90
80
70
60
50
40
0
60
120
180
240
300
360
420
480
540
Elapsed Time (minutes)
Right Side of Forward Bay
Left Side of Forward Bay

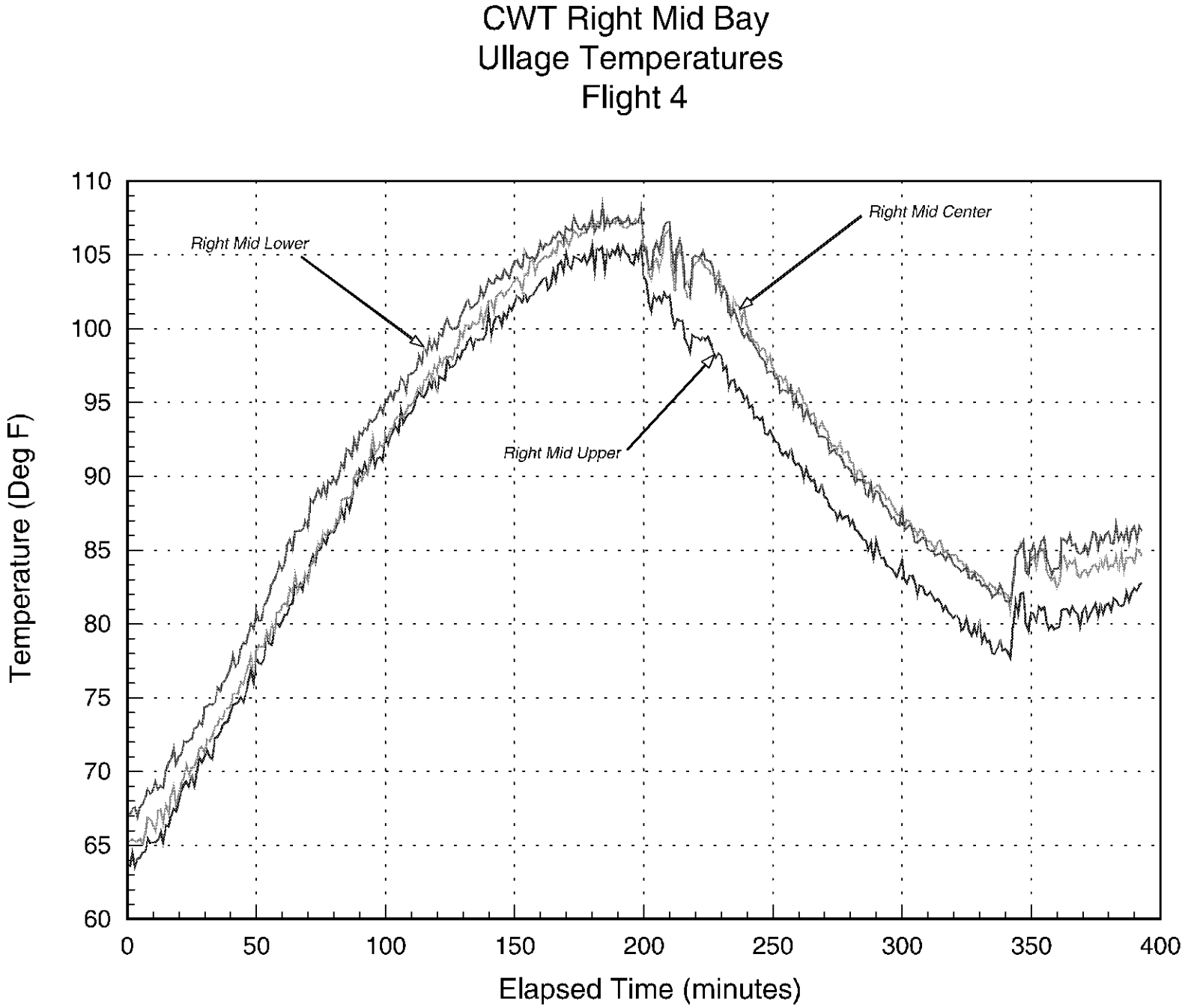

Fuel Temperatures
Measured at CWT Rear Spar
Flight 2
Temperature (Deg F)
130
120
110
100
90
80
70
60
50
40
0
60
120
180
240
300
360
420
480
540
Elapsed Time (minutes)
Right Aft Bay at Rear Spar
Left Aft Bay at Rear Spar

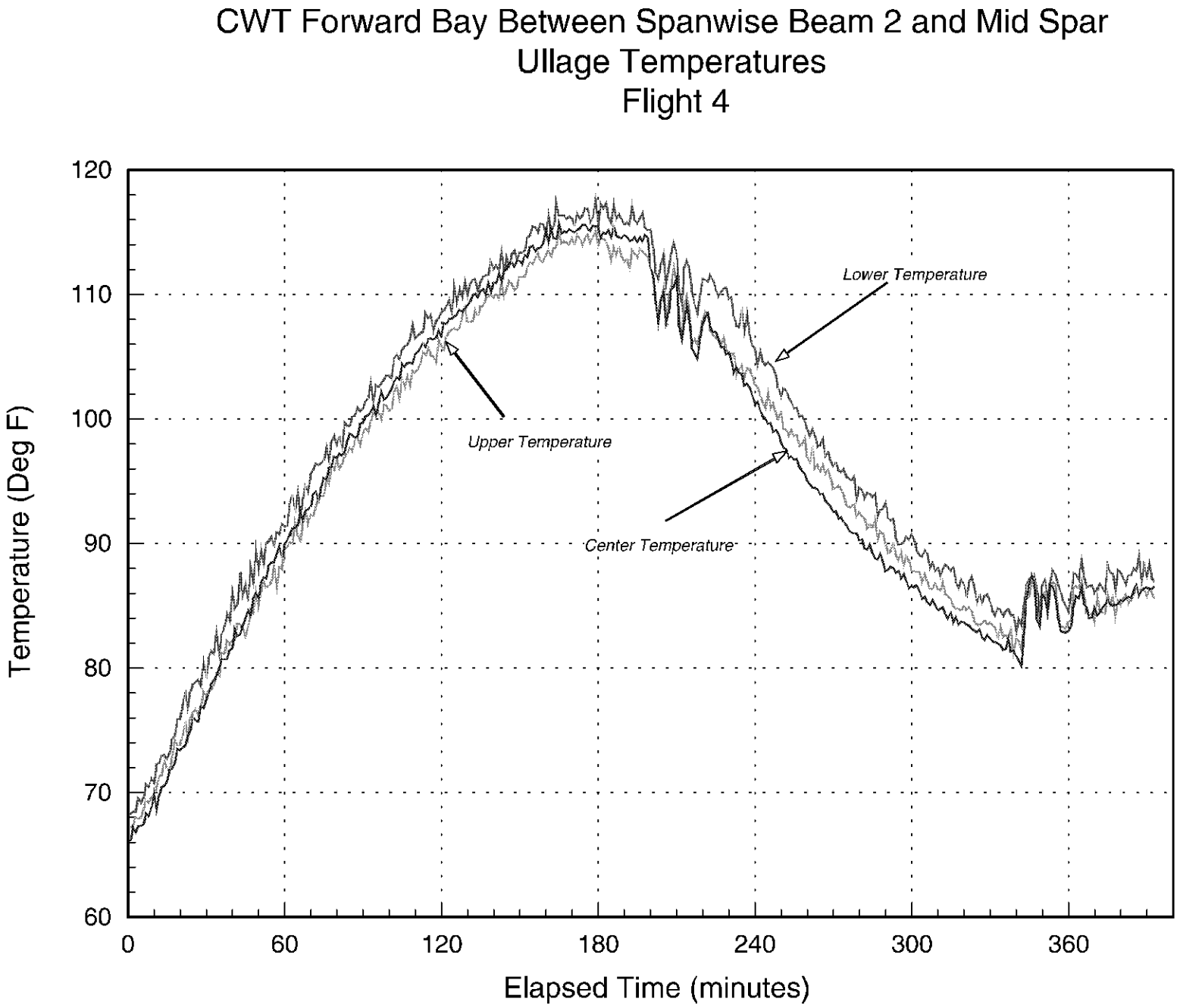
FLIGHT TEST RESULTS
FLIGHT 4

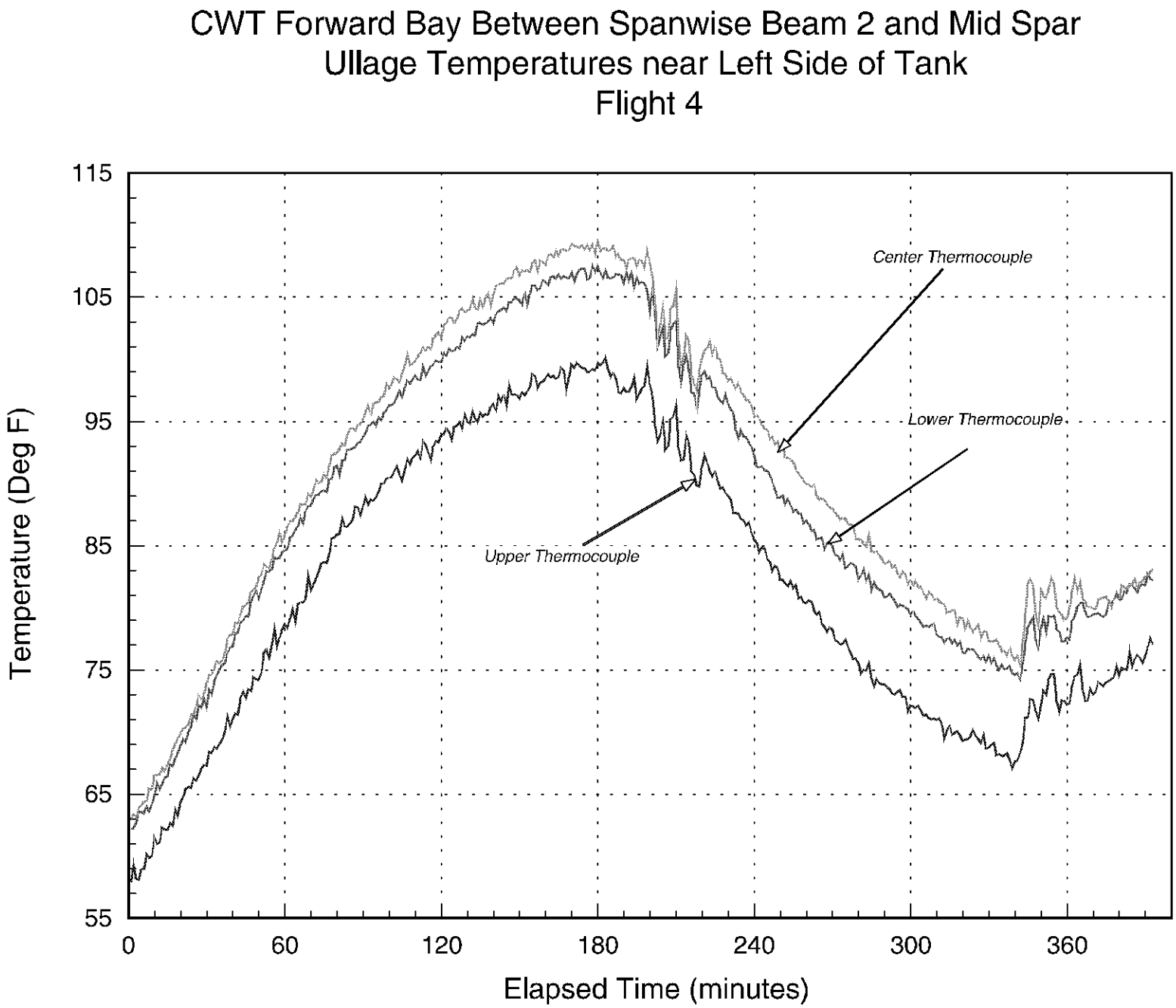

CWT Left Aft Bay
Ullage Temperatures
Flight 4
Left Aft Center
Left Aft Upper
Left Aft Lower
Temperature (Deg F)
Elapsed Time (minutes)
130
120
110
100
90
80
70
60
0
50
100
150
200
250
300
350
400


CWT Right Aft Bay
Ullage Temperatures
Flight 4
Temperature (Deg F)
Elapsed Time (minutes)
120
110
100
90
80
70
60
0
50
100
150
200
250
300
350
400
Right Aft Lower
Right Aft Center
Right Aft Upper

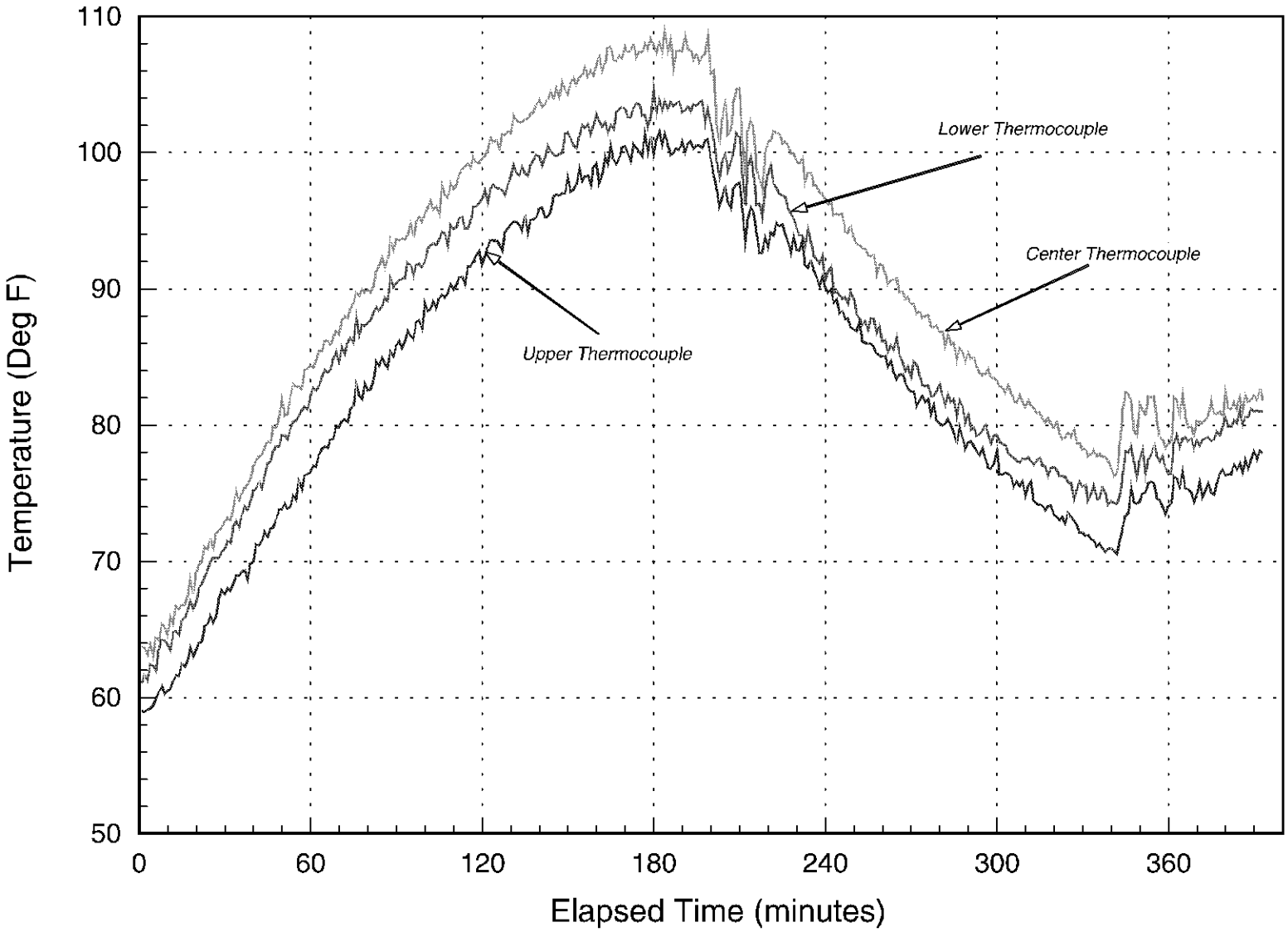

CWT Left Mid Bay
Ullage Temperatures
Flight 4
Left Mid Lower
Left Mid Center
Left Mid Upper
Temperature (Deg F)
Elapsed Time (minutes)
140
130
120
110
100
90
80
70
60
0
50
100
150
200
250
300
350
400

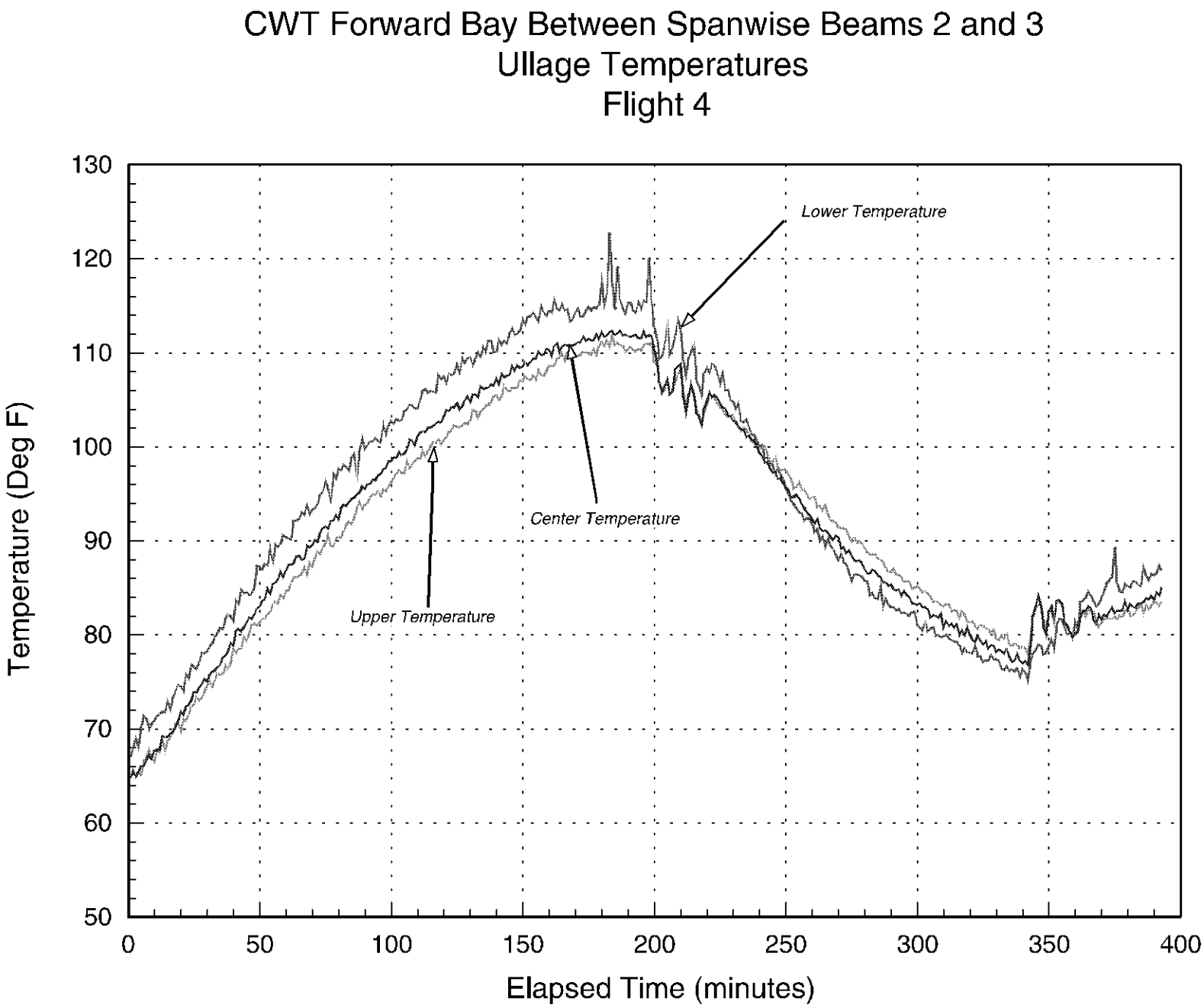

CWT Right Mid Bay
Ullage Temperatures
Flight 4
Right Mid Lower
Right Mid Center
Right Mid Upper
Temperature (Deg F)
Elapsed Time (minutes)
110
105
100
95
90
85
80
75
70
65
60
0
50
100
150
200
250
300
350
400

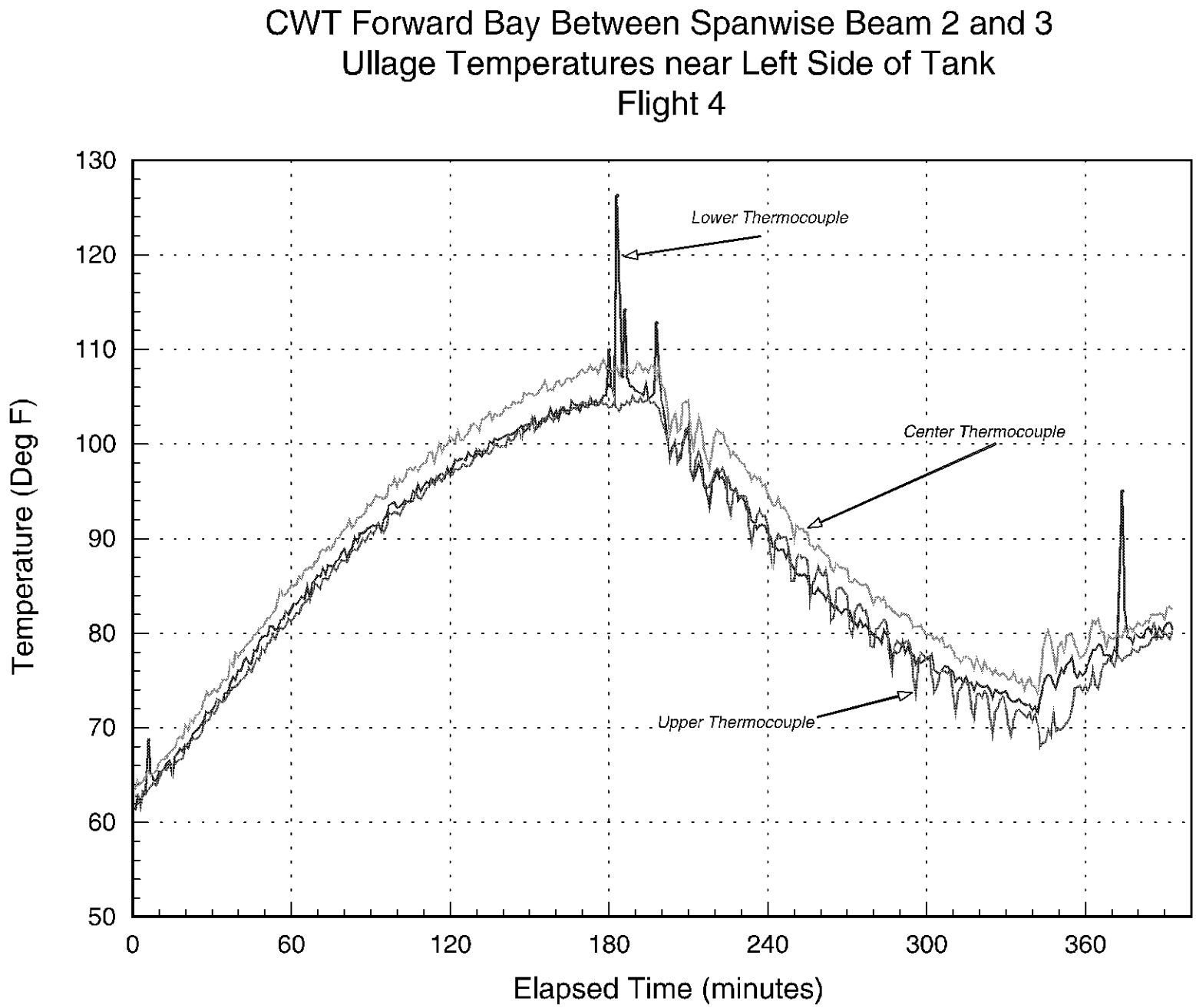

CWT Forward Bay Between Spanwise Beam 2 and Mid Spar
Ullage Temperatures
Flight 4
Temperature (Deg F)
120
110
100
90
80
70
60
0
60
120
180
240
300
360
Elapsed Time (minutes)
Lower Temperature
Upper Temperature
Center Temperature

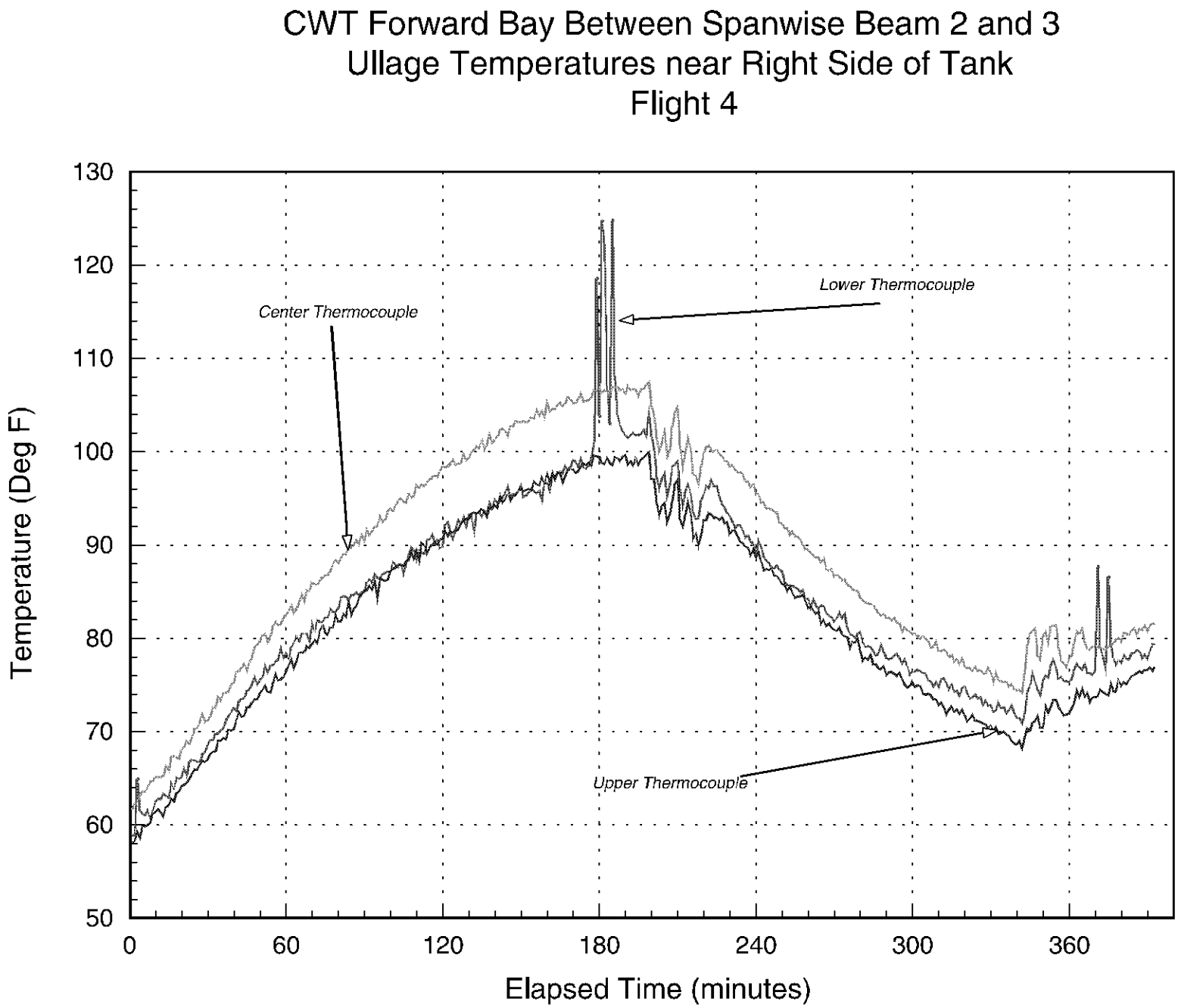

CWT Forward Bay Between Spanwise Beam 2 and Mid Spar
Ullage Temperatures near Left Side of Tank
Flight 4
Temperature (Deg F)
115
105
95
85
75
65
55
0
60
120
180
240
300
360
Elapsed Time (minutes)
Center Thermocouple
Lower Thermocouple
Upper Thermocouple

CWT Forward Bay Between Spanwise Beam 2 and Mid Spar
Ullage Temperatures near Right Side of Tank
Flight 4

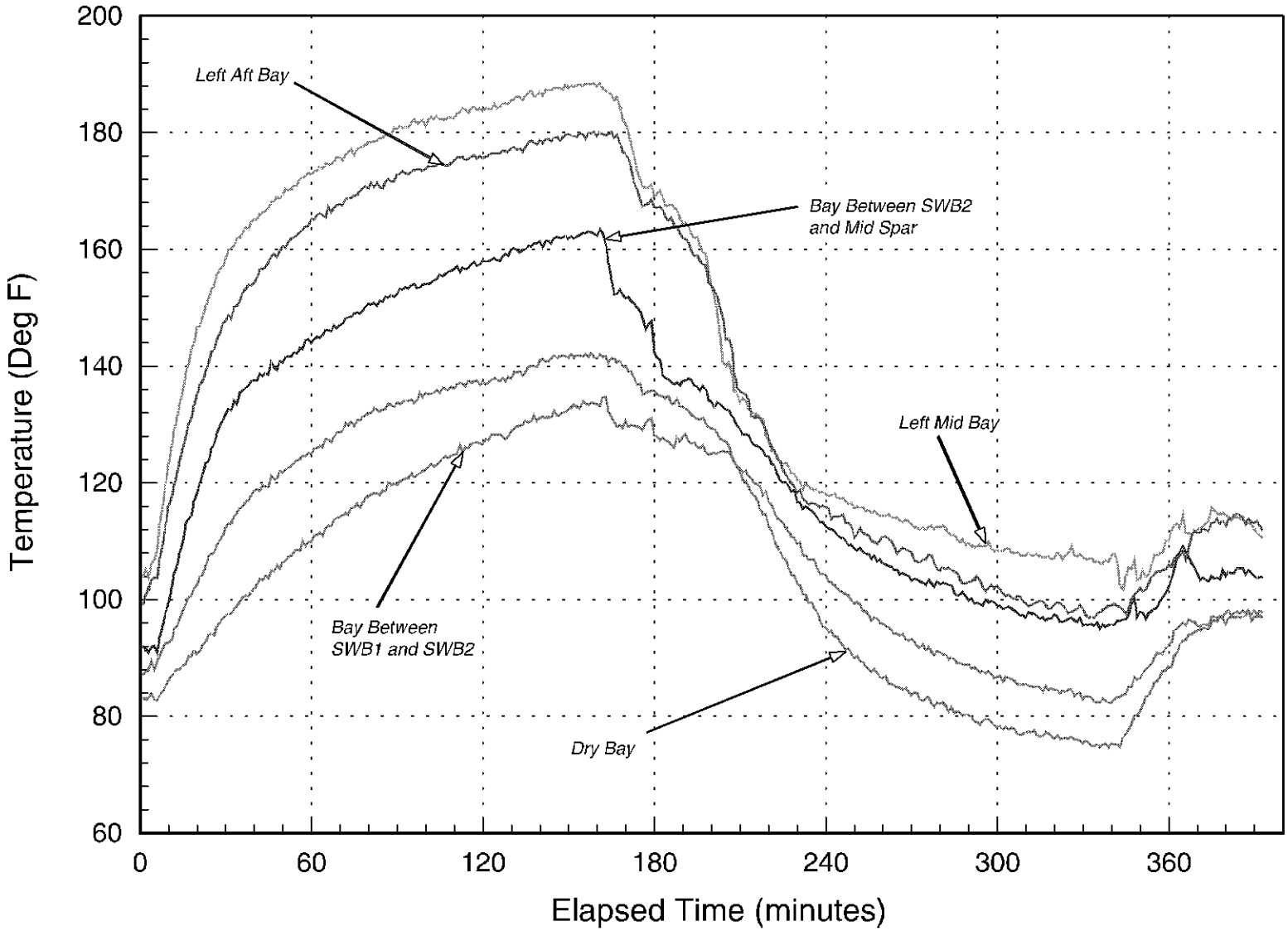


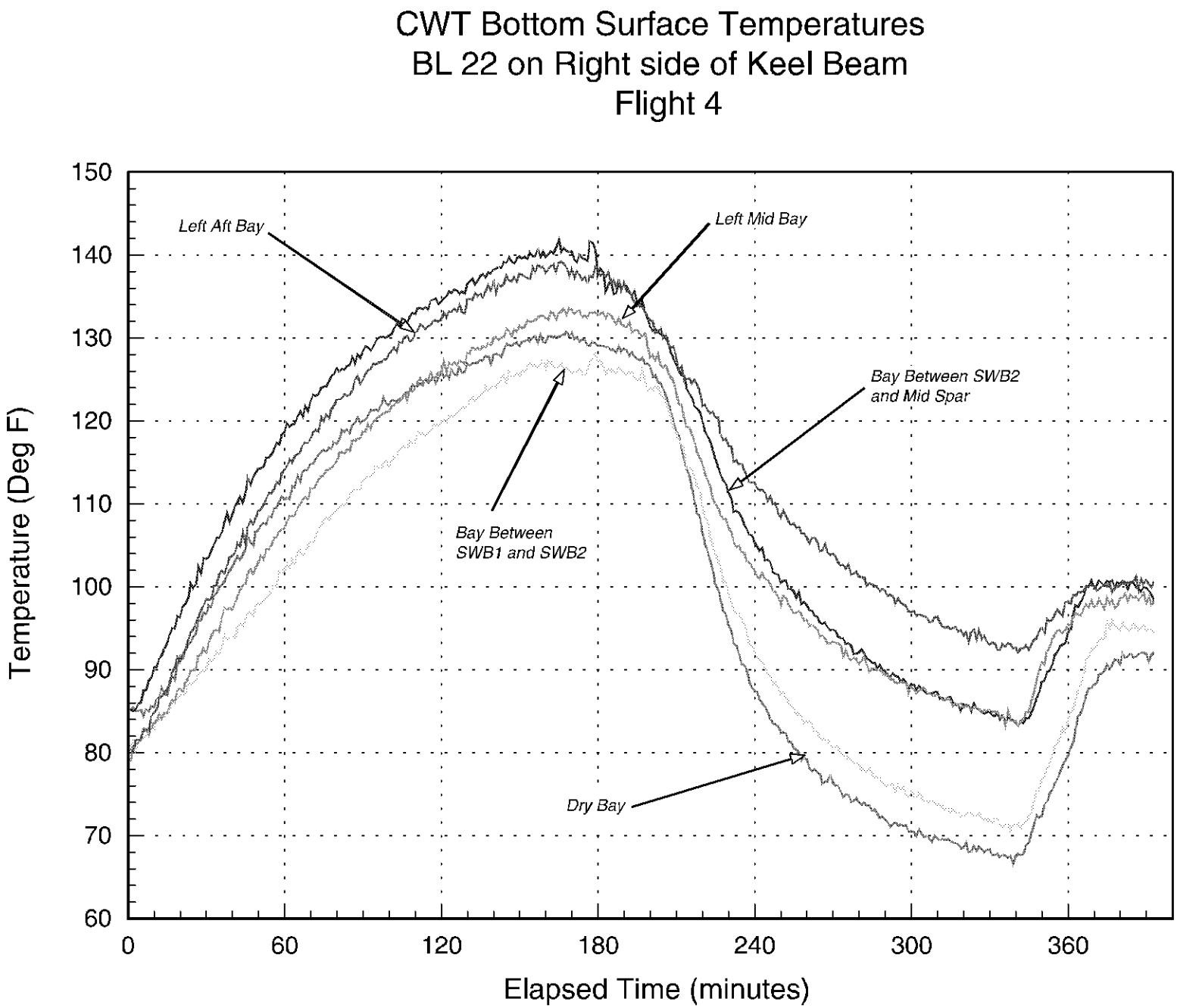

CWT Forward Bay Between Spanwise Beams 2 and 3
Ullage Temperatures
Flight 4
Temperature (Deg F)
Elapsed Time (minutes)
Lower Temperature
Center Temperature
Upper Temperature
130
120
110
100
90
80
70
60
50
0
50
100
150
200
250
300
350
400

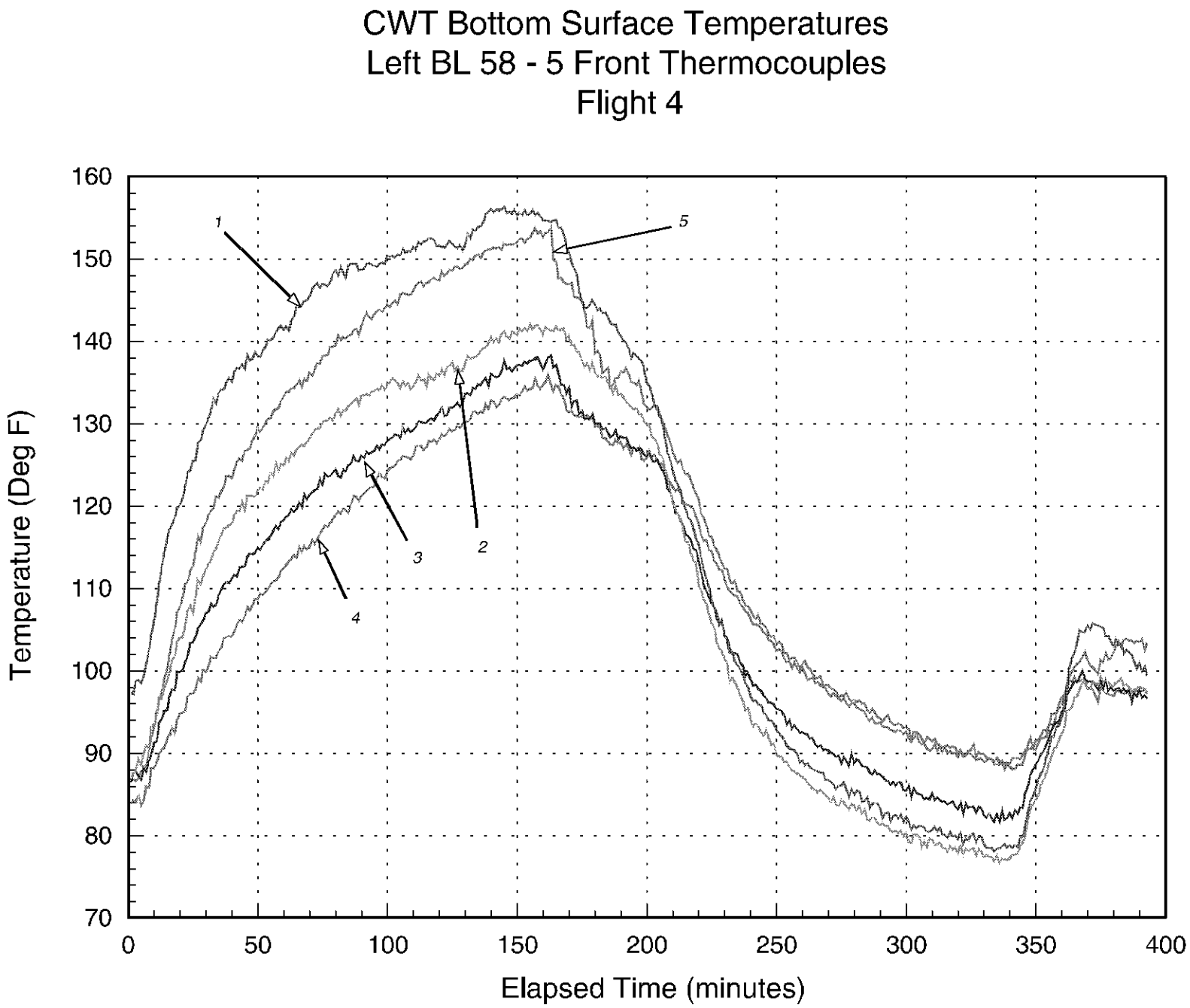

CWT Forward Bay Between Spanwise Beam 2 and 3
Ullage Temperatures near Left Side of Tank
Flight 4
Lower Thermocouple
Center Thermocouple
Upper Thermocouple
Temperature (Deg F)
130
120
110
100
90
80
70
60
50
0
60
120
180
240
300
360
Elapsed Time (minutes)

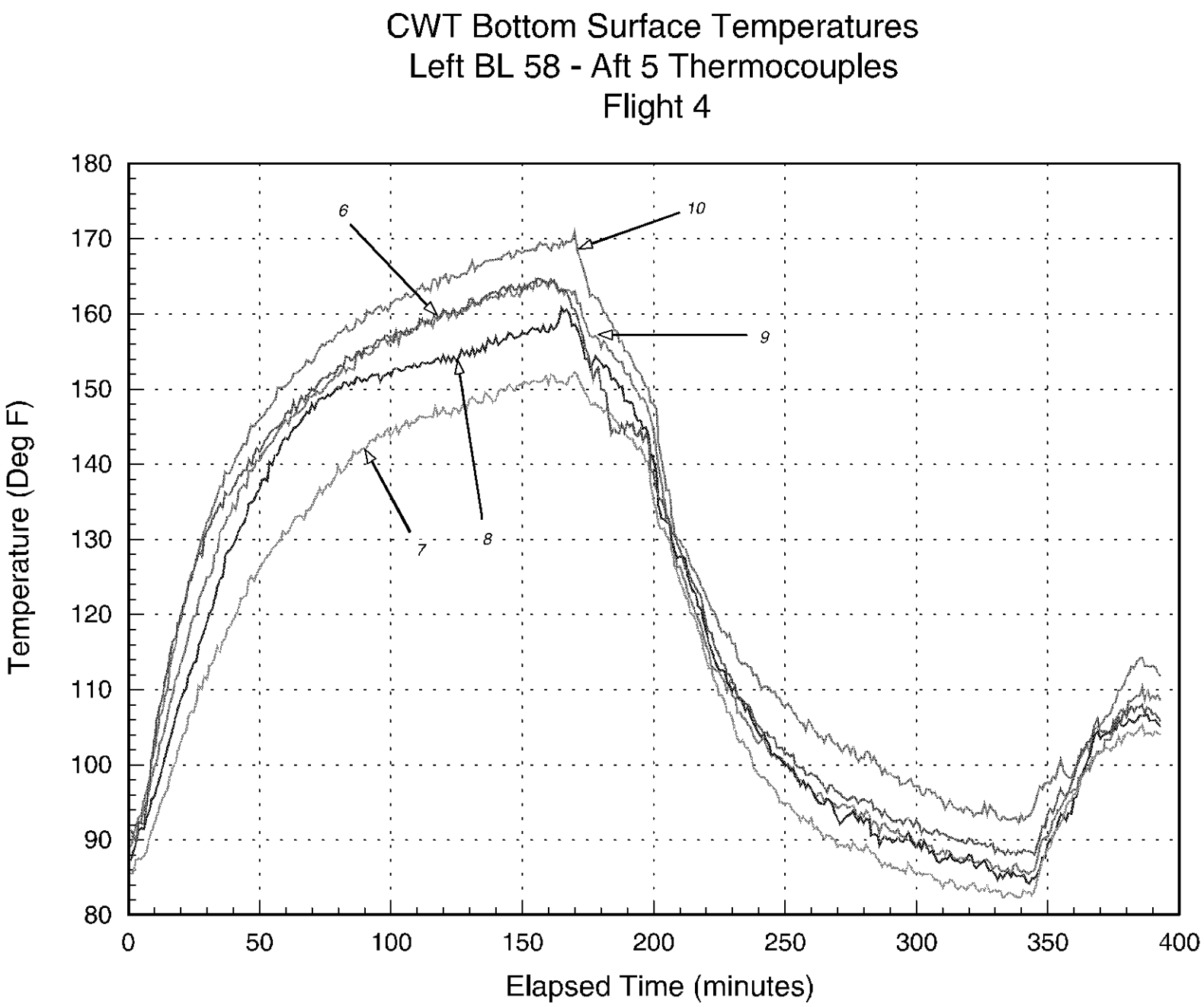

CWT Forward Bay Between Spanwise Beam 2 and 3
Ullage Temperatures near Right Side of Tank
Flight 4
Temperature (Deg F)
130
120
110
100
90
80
70
60
50
0
60
120
180
240
300
360
Elapsed Time (minutes)
Center Thermocouple
Lower Thermocouple
Upper Thermocouple

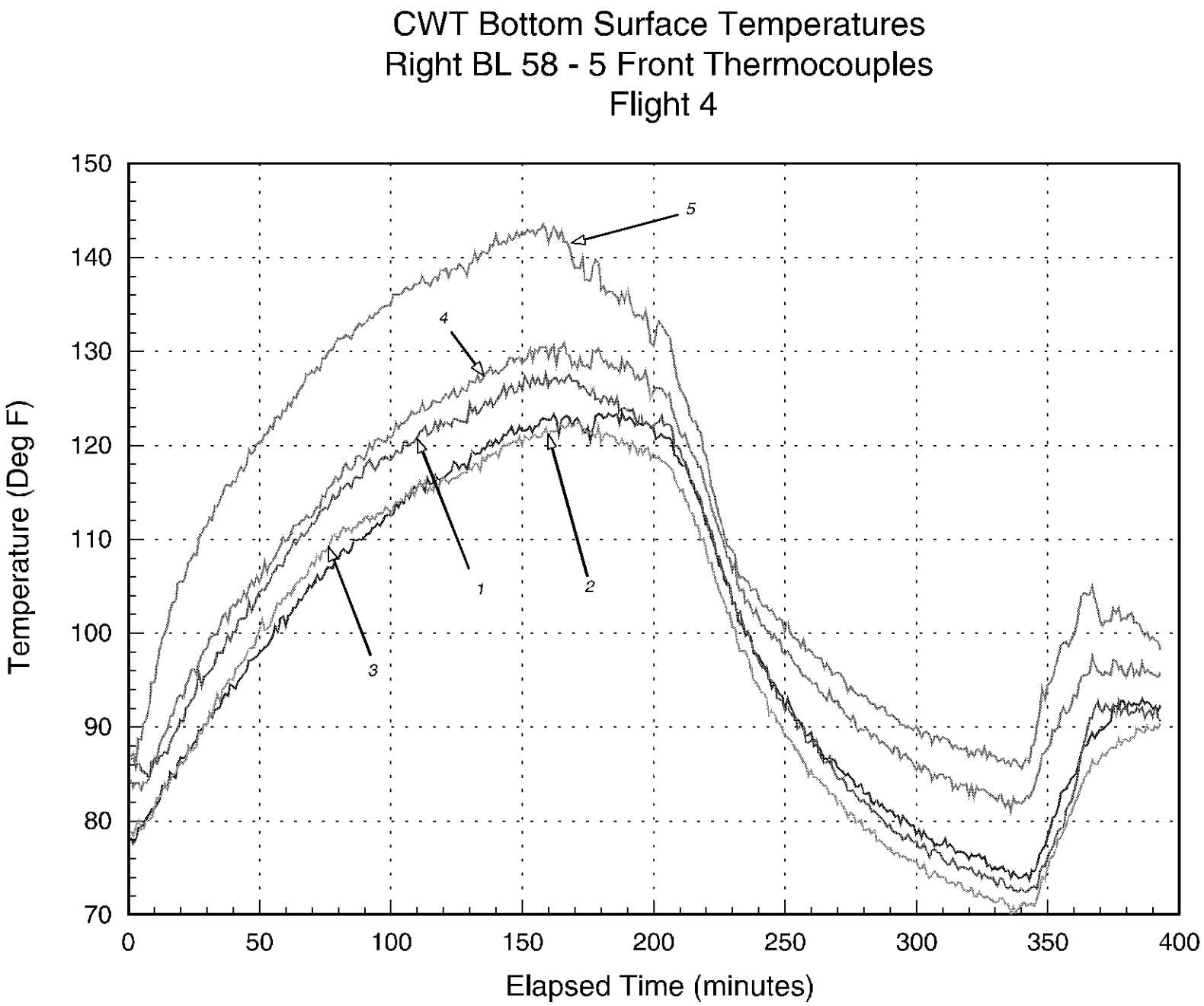
CWT Bottom Surface Temperatures
BL 22 on Left side of Keel Beam
Flight 4

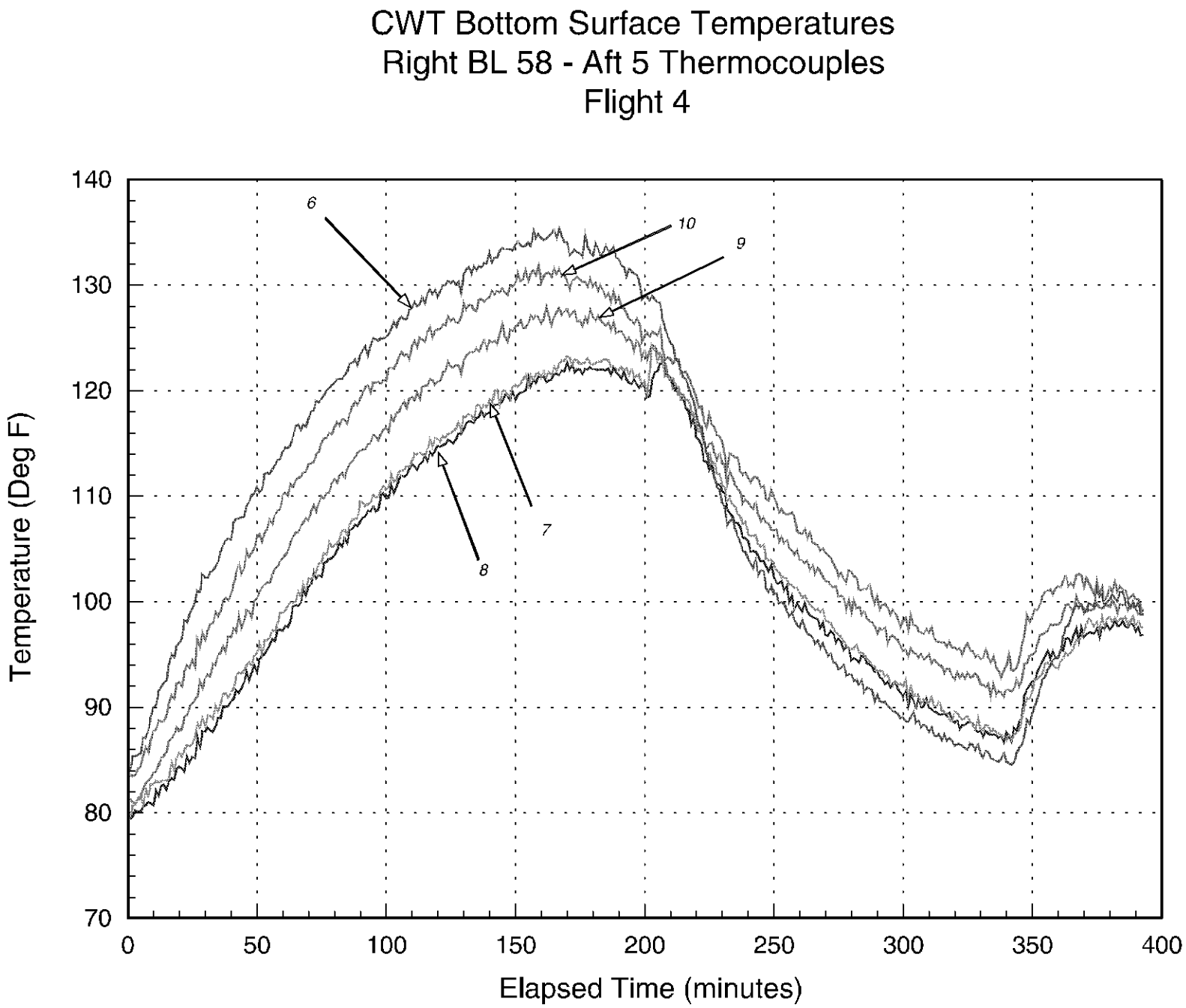



CWT Bottom Surface Temperatures
BL 22 on Right side of Keel Beam
Flight 4
Left Aft Bay
Left Mid Bay
Bay Between SWB2
and Mid Spar
Bay Between
SWB1 and SWB2
Dry Bay
Temperature (Deg F)
Elapsed Time (minutes)
150
140
130
120
110
100
90
80
70
60
0
60
120
180
240
300
360

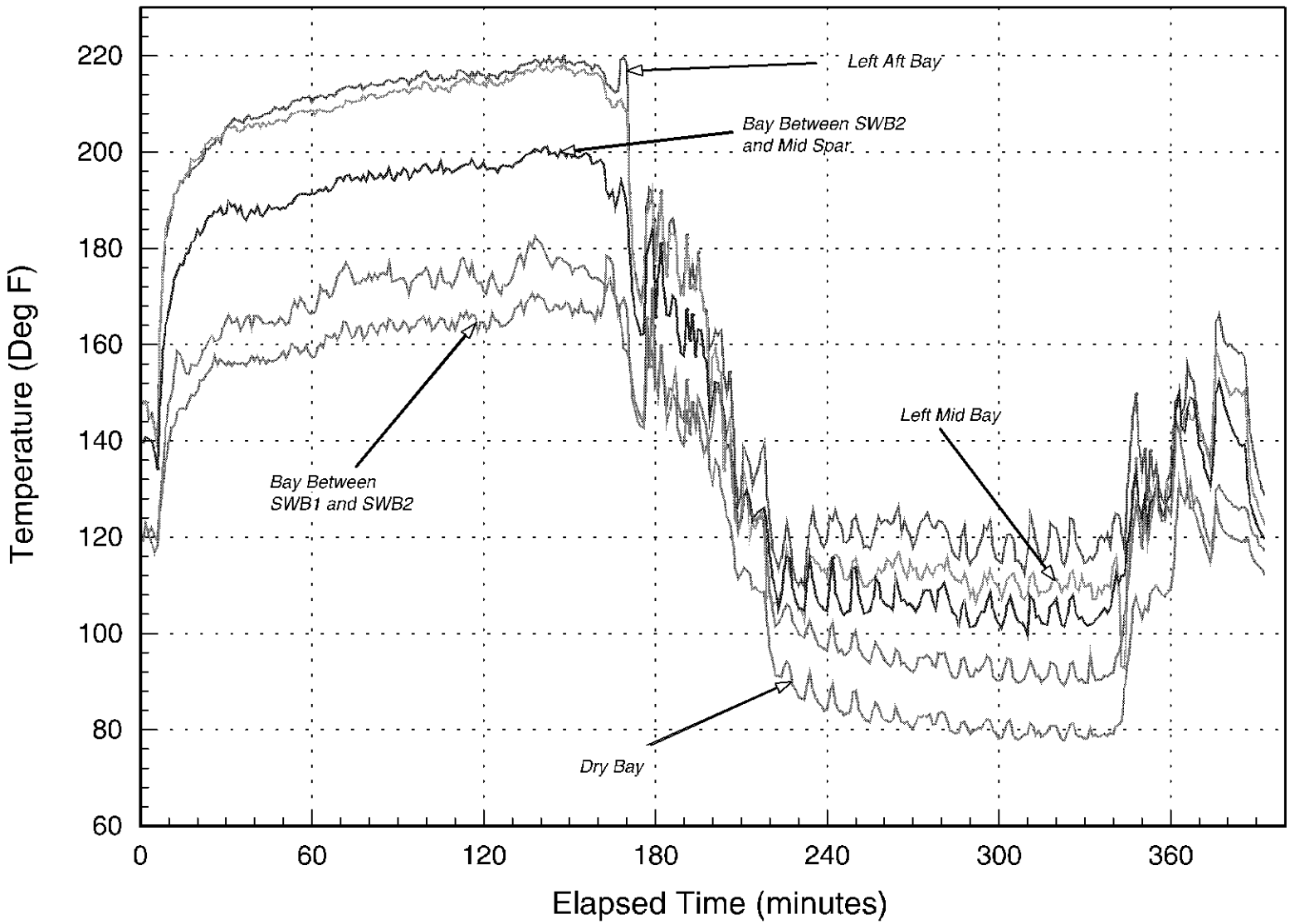

CWT Bottom Surface Temperatures
Left BL 58 - 5 Front Thermocouples
Flight 4
Temperature (Deg F)
Elapsed Time (minutes)
160
150
140
130
120
110
100
90
80
70
0
50
100
150
200
250
300
350
400
1
2
3
4
5


CWT Bottom Surface Temperatures
Left BL 58 - Aft 5 Thermocouples
Flight 4
Temperature (Deg F)
Elapsed Time (minutes)
180
170
160
150
140
130
120
110
100
90
80
0
50
100
150
200
250
300
350
400
6
10
9
7
8

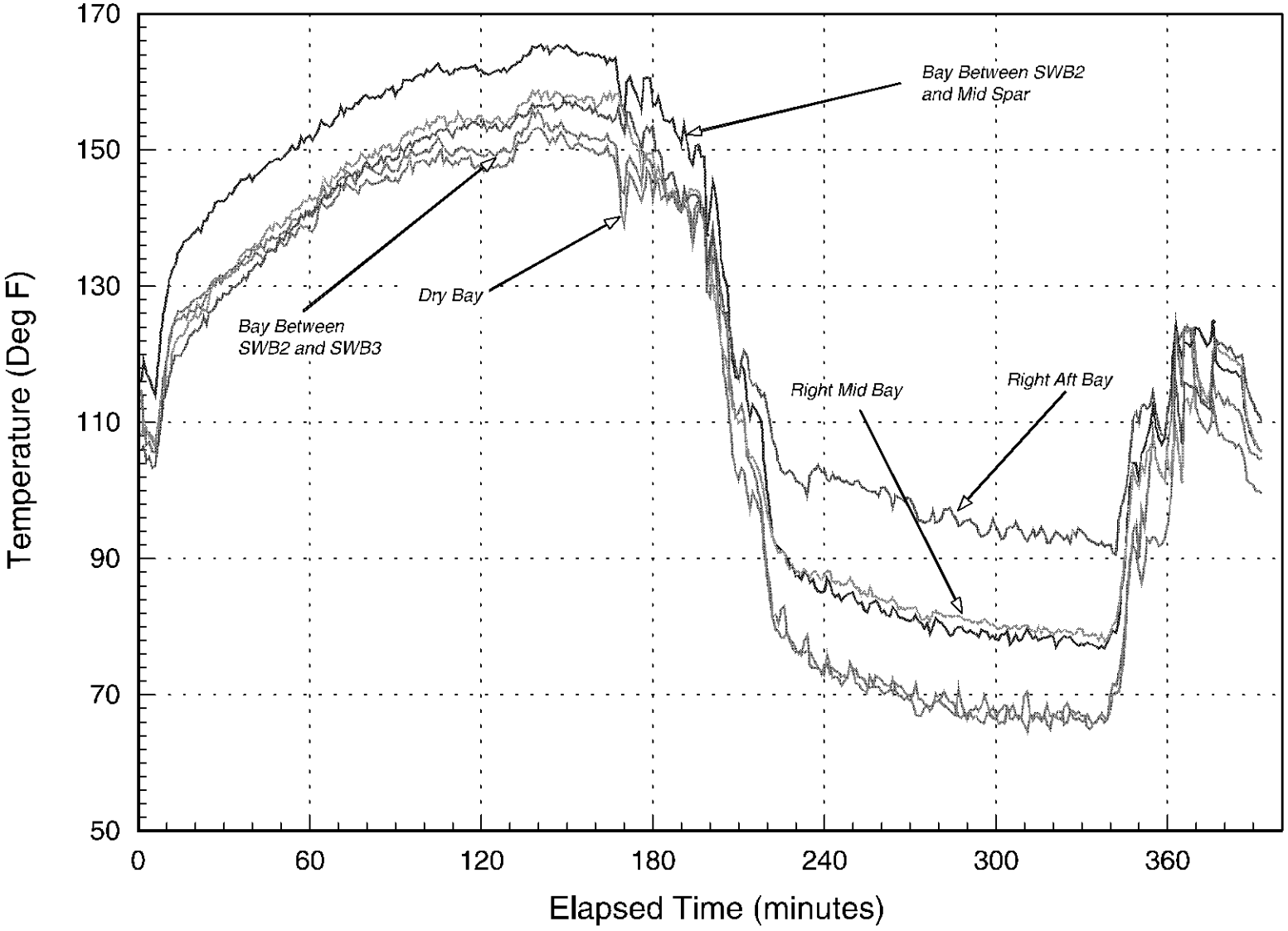

CWT Bottom Surface Temperatures
Right BL 58 - 5 Front Thermocouples
Flight 4
Temperature (Deg F)
Elapsed Time (minutes)
150
140
130
120
110
100
90
80
70
0
50
100
150
200
250
300
350
400
1
2
3
4
5


CWT Bottom Surface Temperatures
Right BL 58 - Aft 5 Thermocouples
Flight 4
Temperature (Deg F)
Elapsed Time (minutes)
140
130
120
110
100
90
80
70
0
50
100
150
200
250
300
350
400
6
10
9
7
8

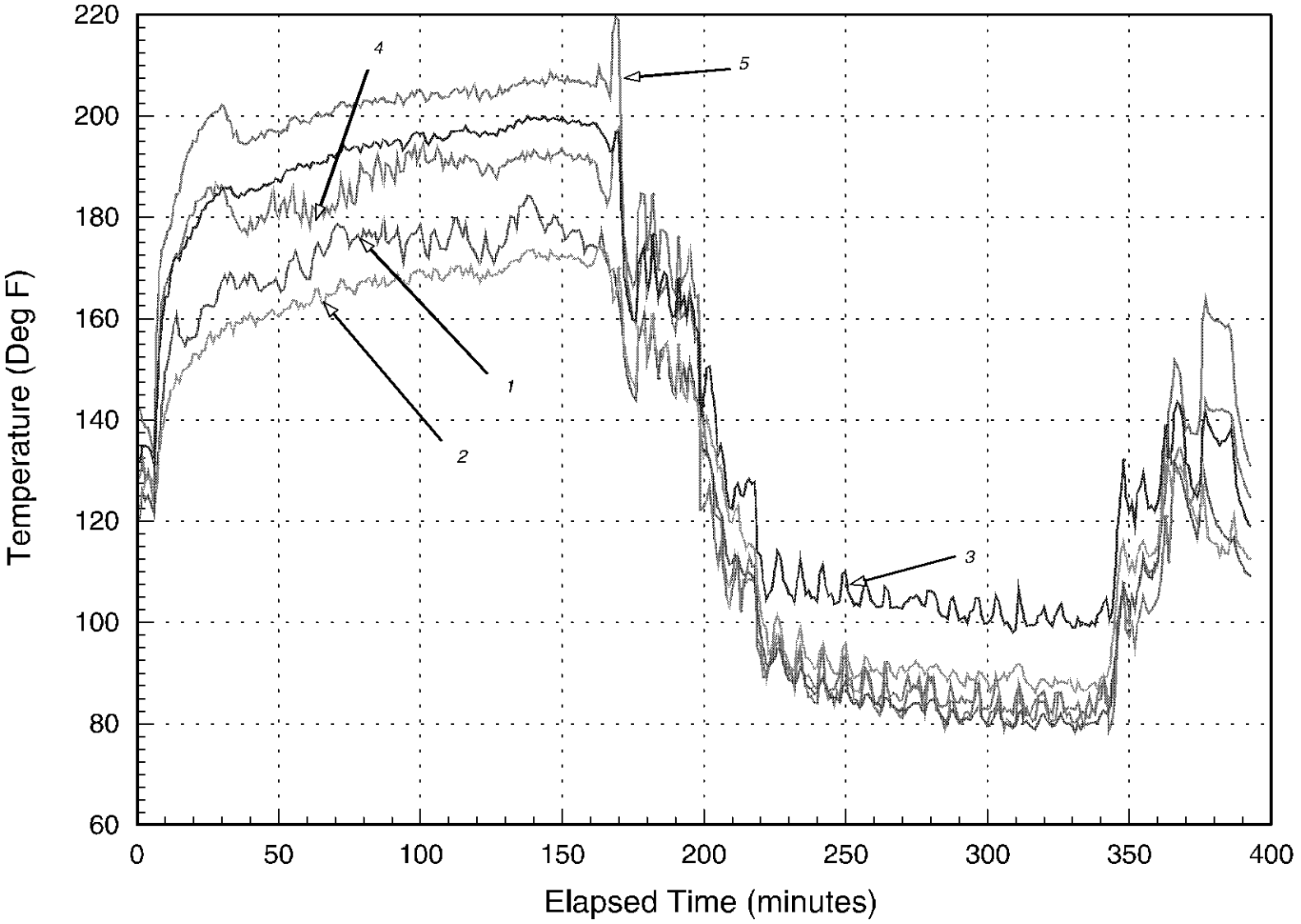
ECS Pack Bay Air Temperatures
BL 22 on Left side of Keel Beam
Flight 4

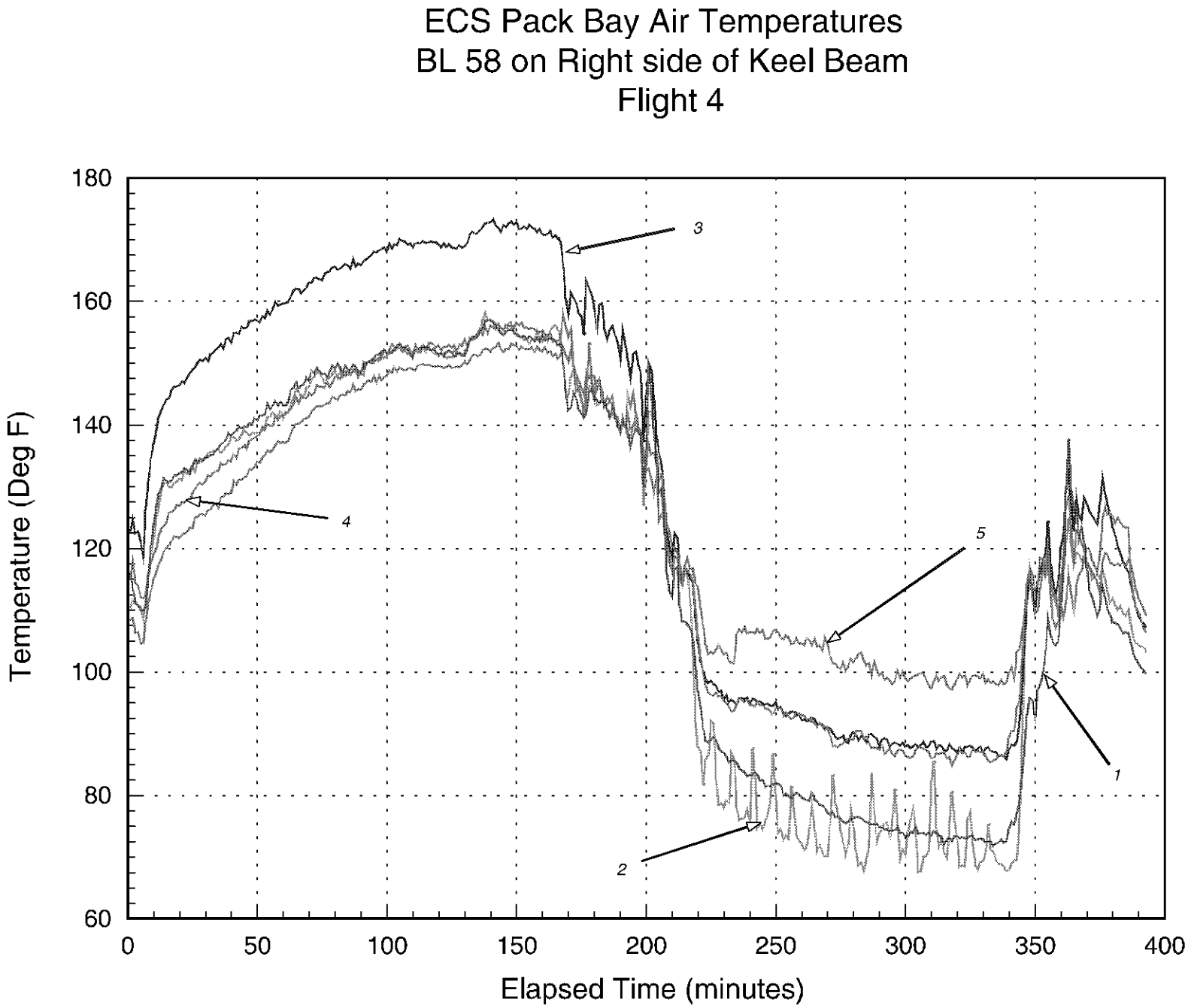


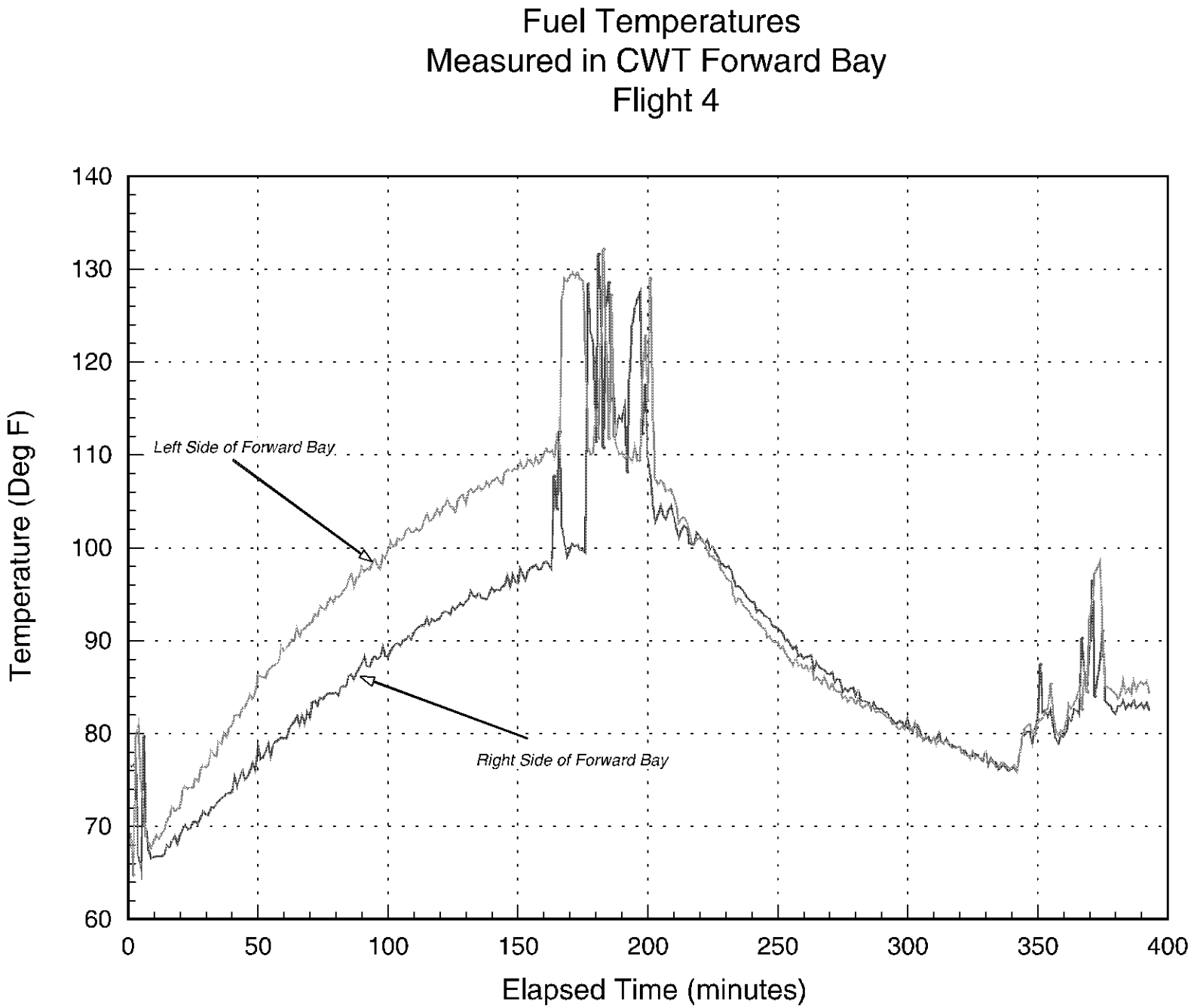
ECS Pack Bay Air Temperatures
BL 22 on Right side of Keel Beam
Flight 4

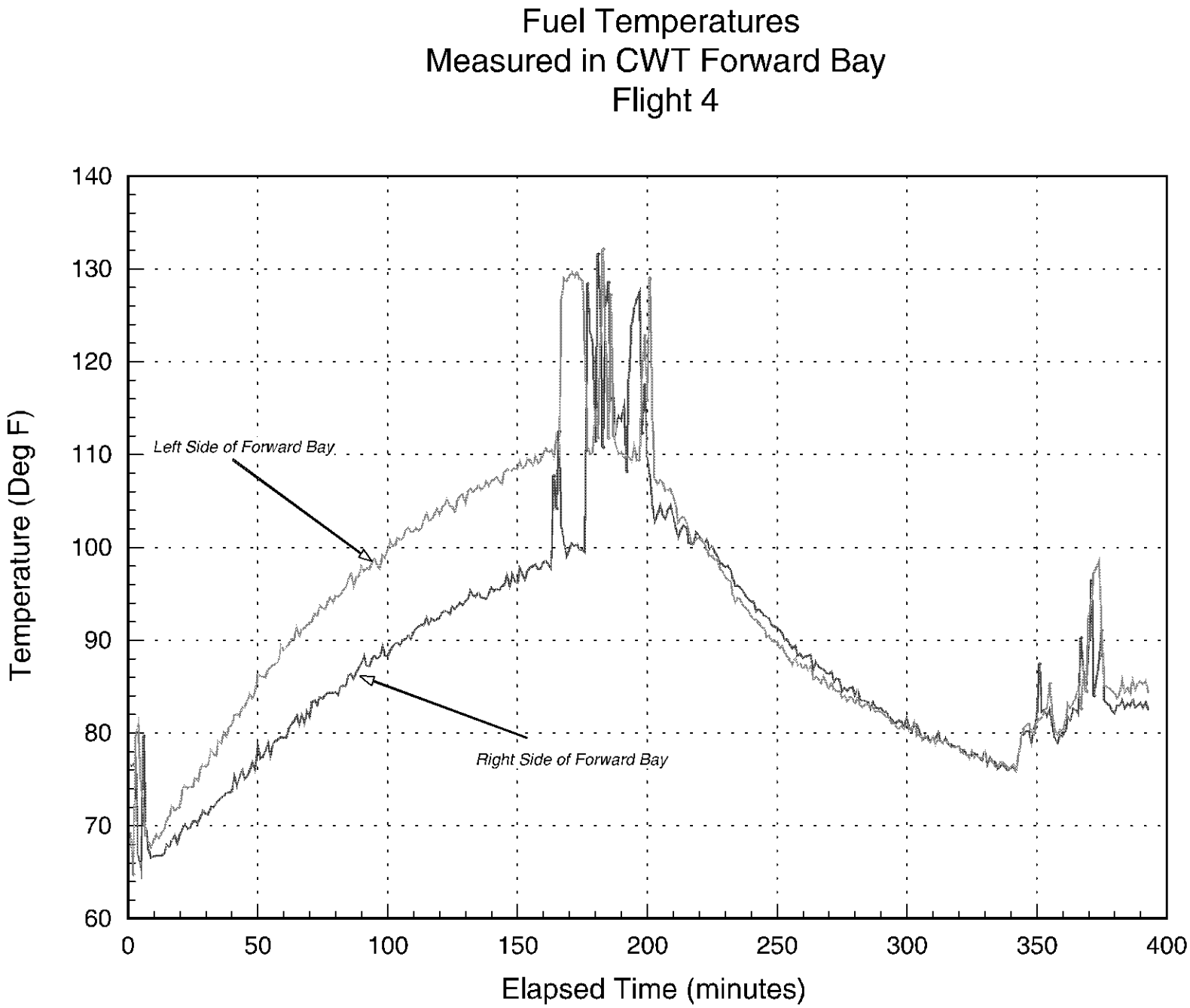


ECS Pack Bay Air Temperatures
BL 58 on Left side of Keel Beam
Flight 4

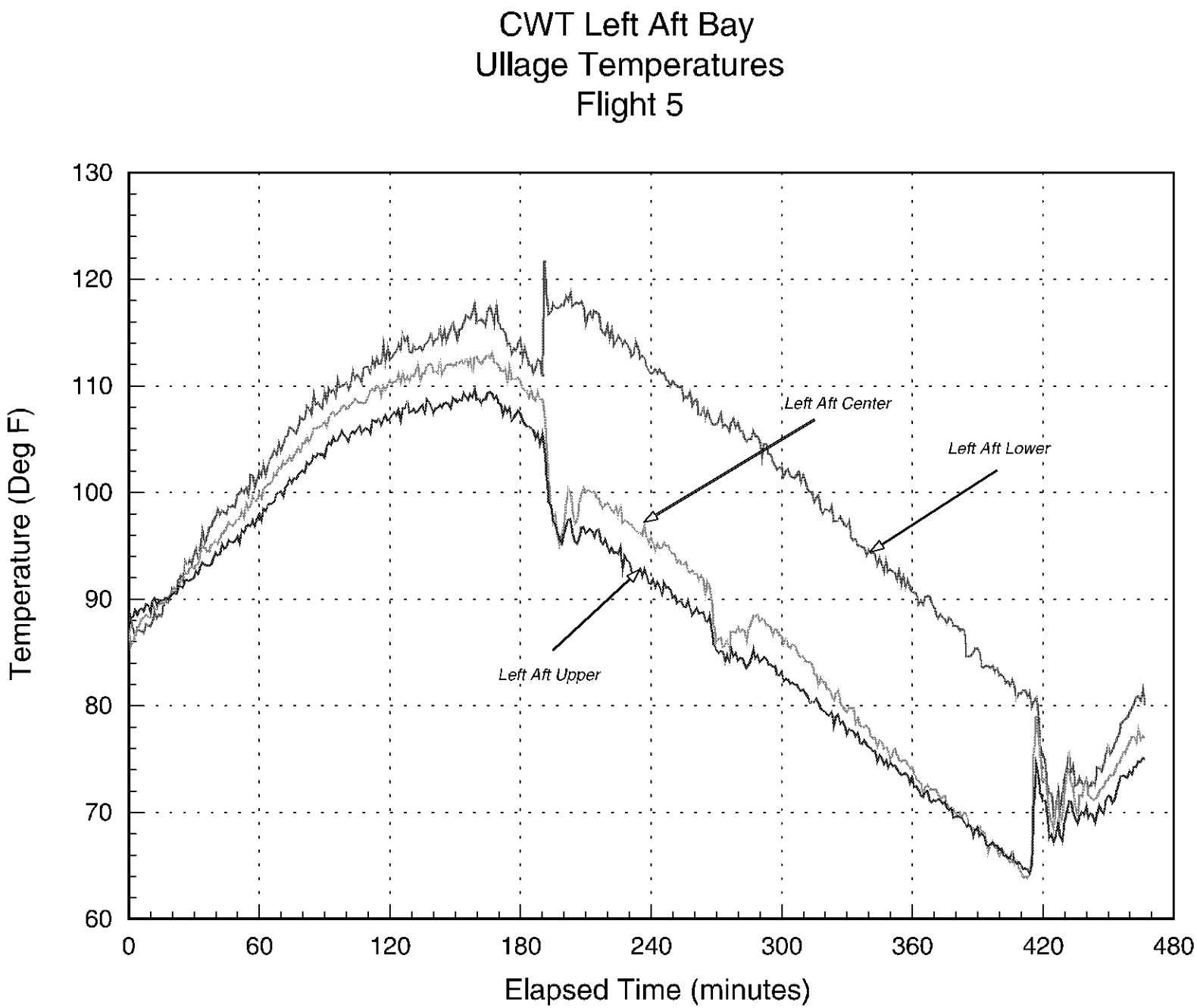


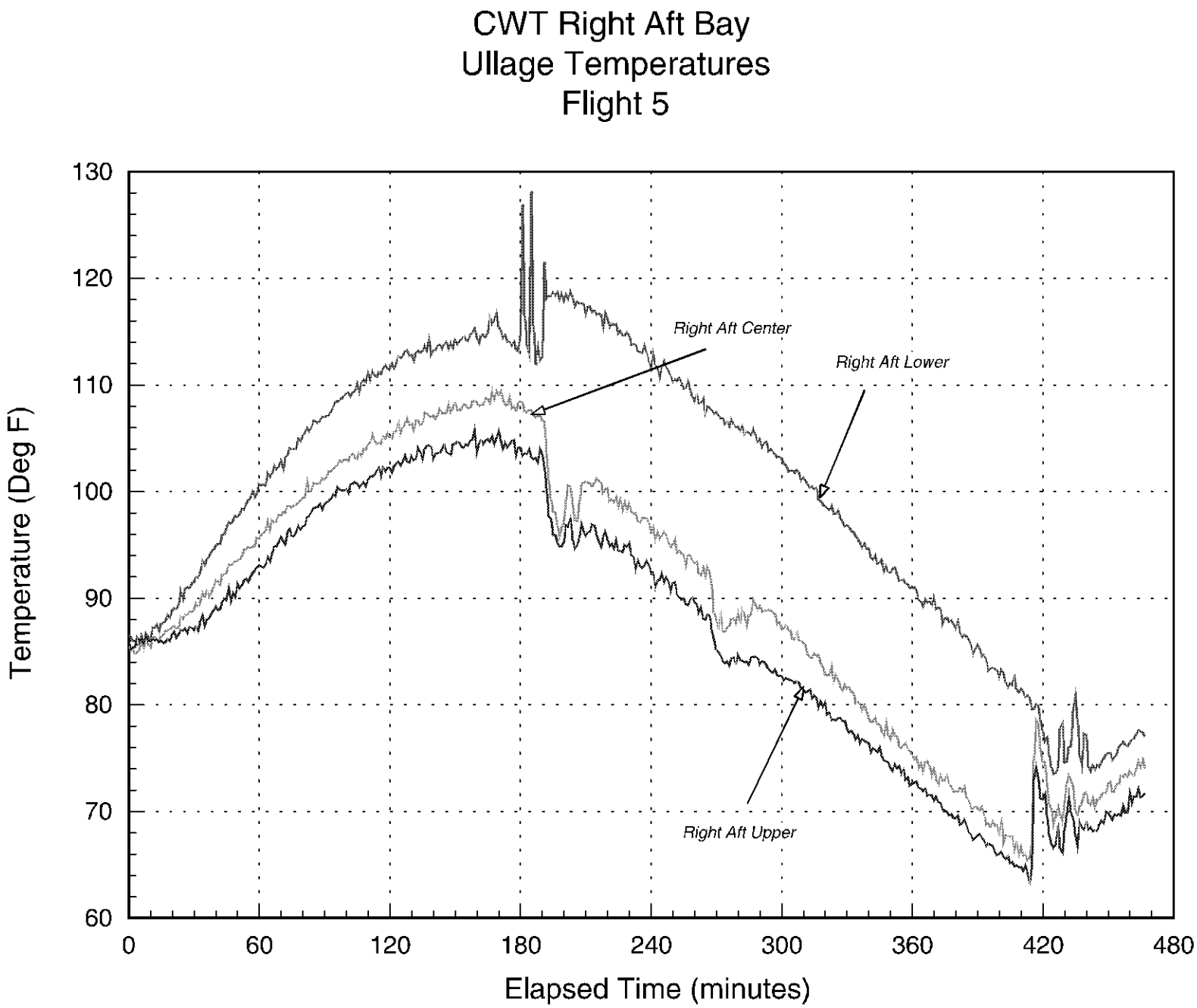

ECS Pack Bay Air Temperatures
BL 58 on Right side of Keel Beam
Flight 4
Temperature (Deg F)
Elapsed Time (minutes)
180
160
140
120
100
80
60
0
50
100
150
200
250
300
350
400
1
2
3
4
5

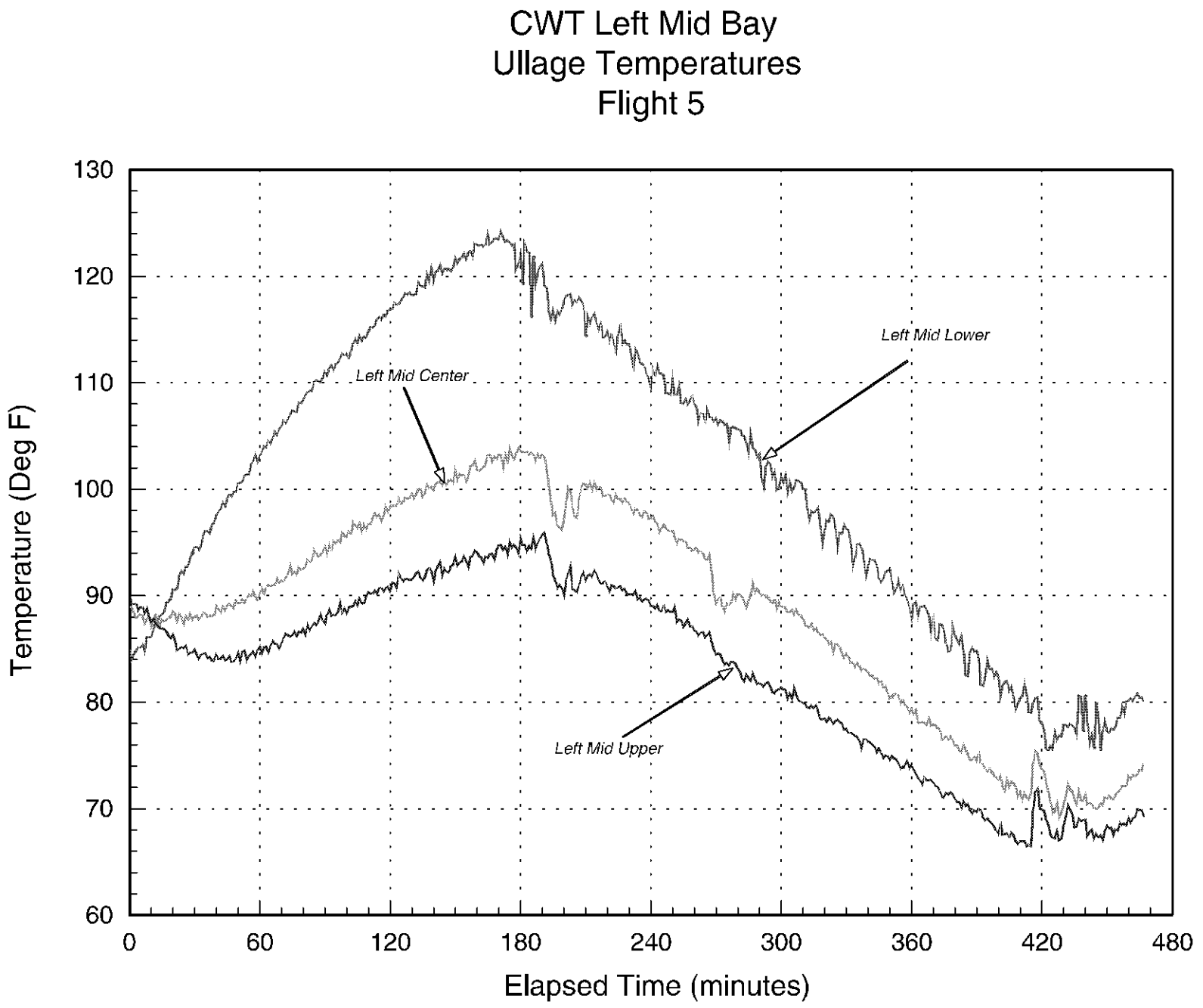

Fuel Temperatures
Measured in CWT Forward Bay
Flight 4
Temperature (Deg F)
140
130
120
110
100
90
80
70
60
0
50
100
150
200
250
300
350
400
Elapsed Time (minutes)
Left Side of Forward Bay
Right Side of Forward Bay

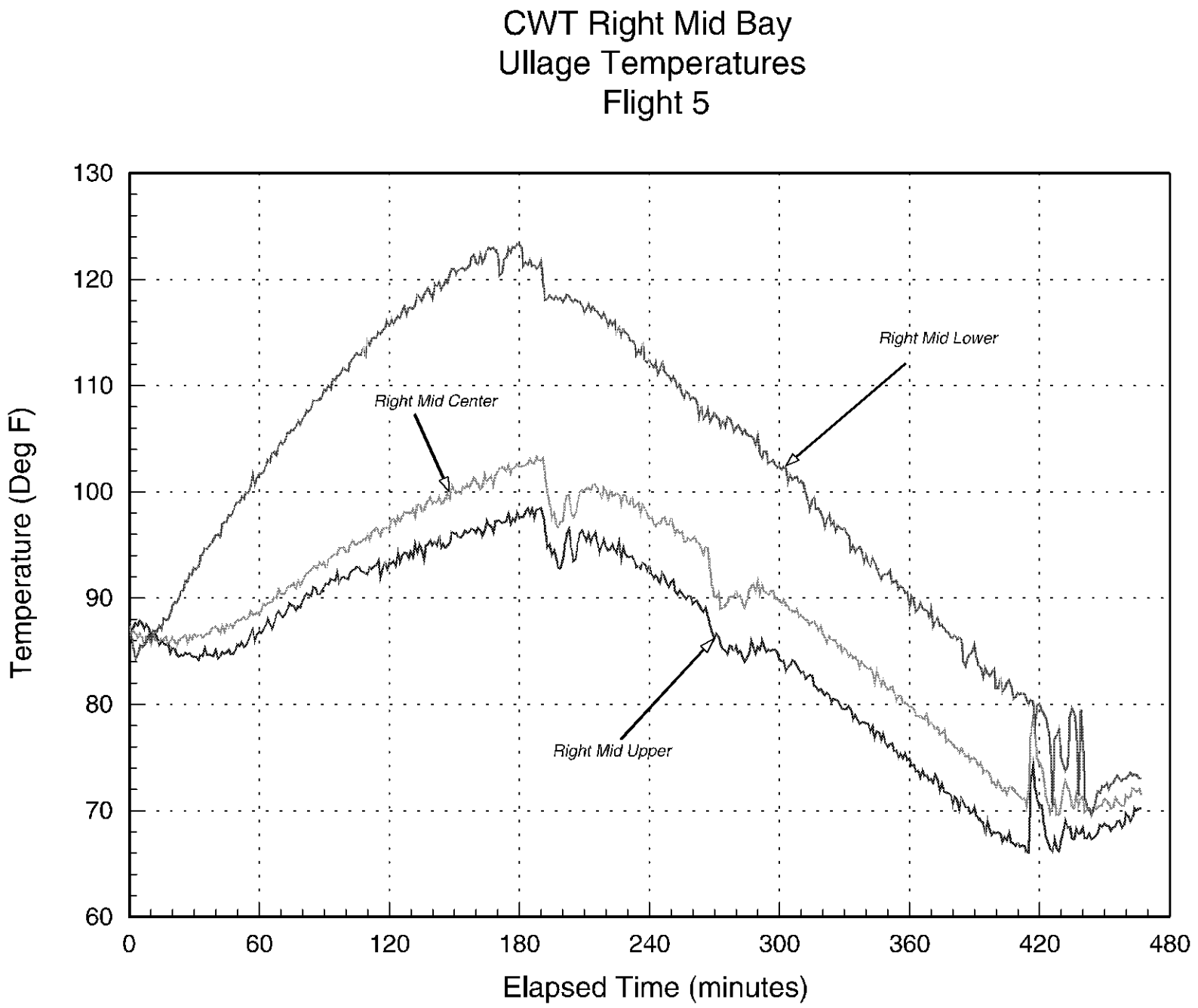

Fuel Temperatures
Measured in CWT Forward Bay
Flight 4
Temperature (Deg F)
140
130
120
110
100
90
80
70
60
0
50
100
150
200
250
300
350
400
Elapsed Time (minutes)
Left Side of Forward Bay
Right Side of Forward Bay

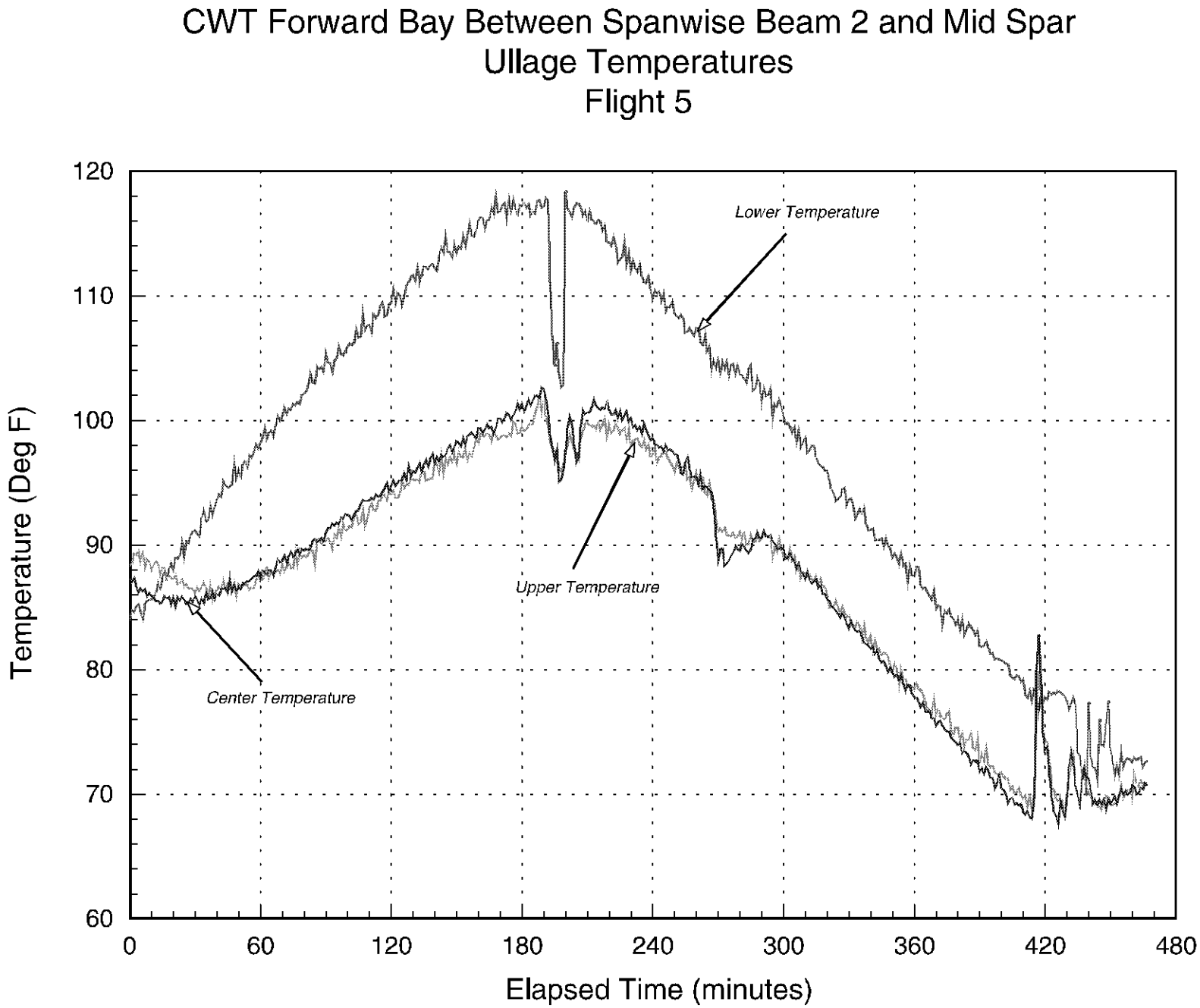
FLIGHT TEST RESULTS
FLIGHT 5

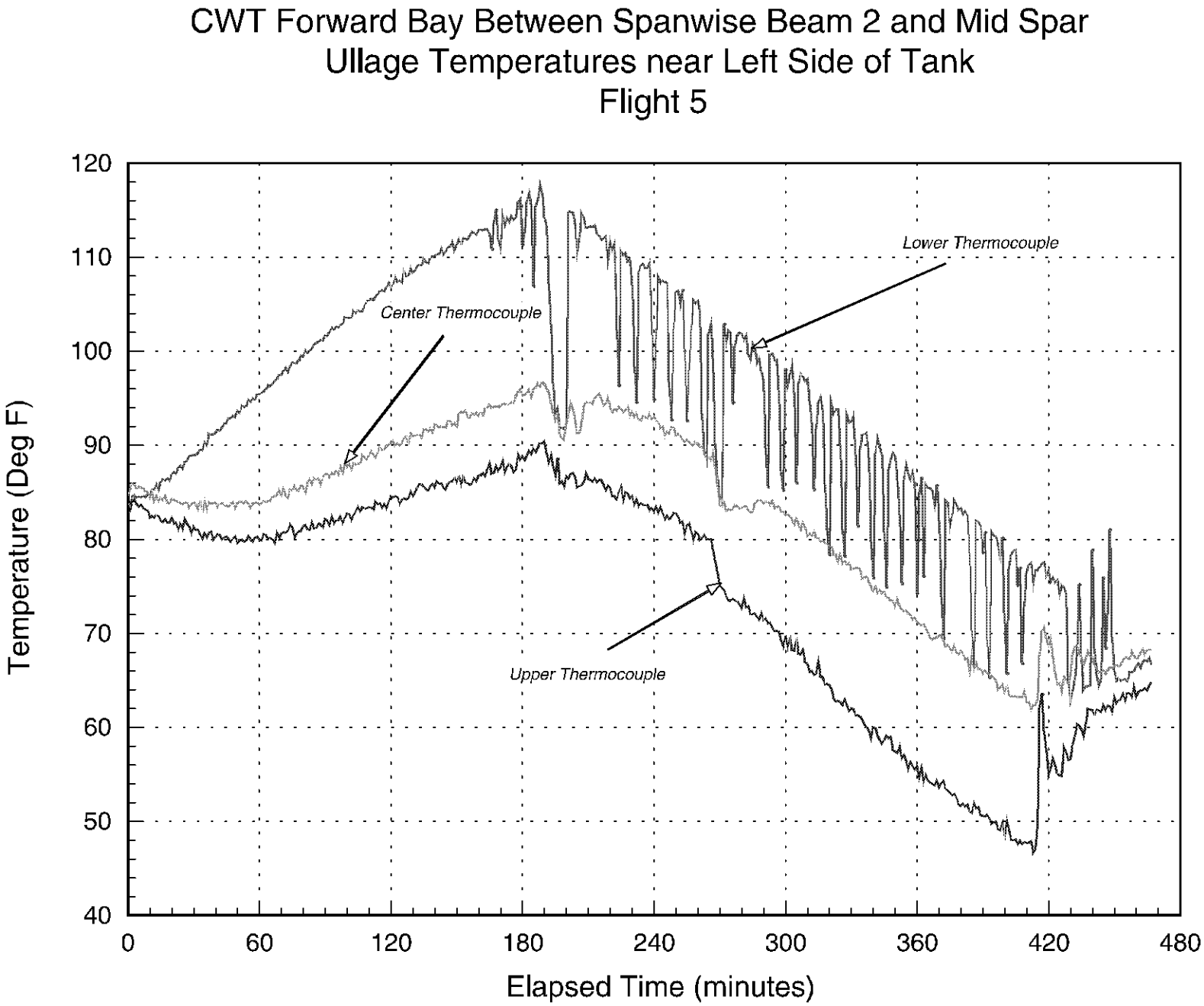

CWT Left Aft Bay
Ullage Temperatures
Flight 5
Temperature (Deg F)
130
120
110
100
90
80
70
60
0
60
120
180
240
300
360
420
480
Elapsed Time (minutes)
Left Aft Center
Left Aft Lower
Left Aft Upper

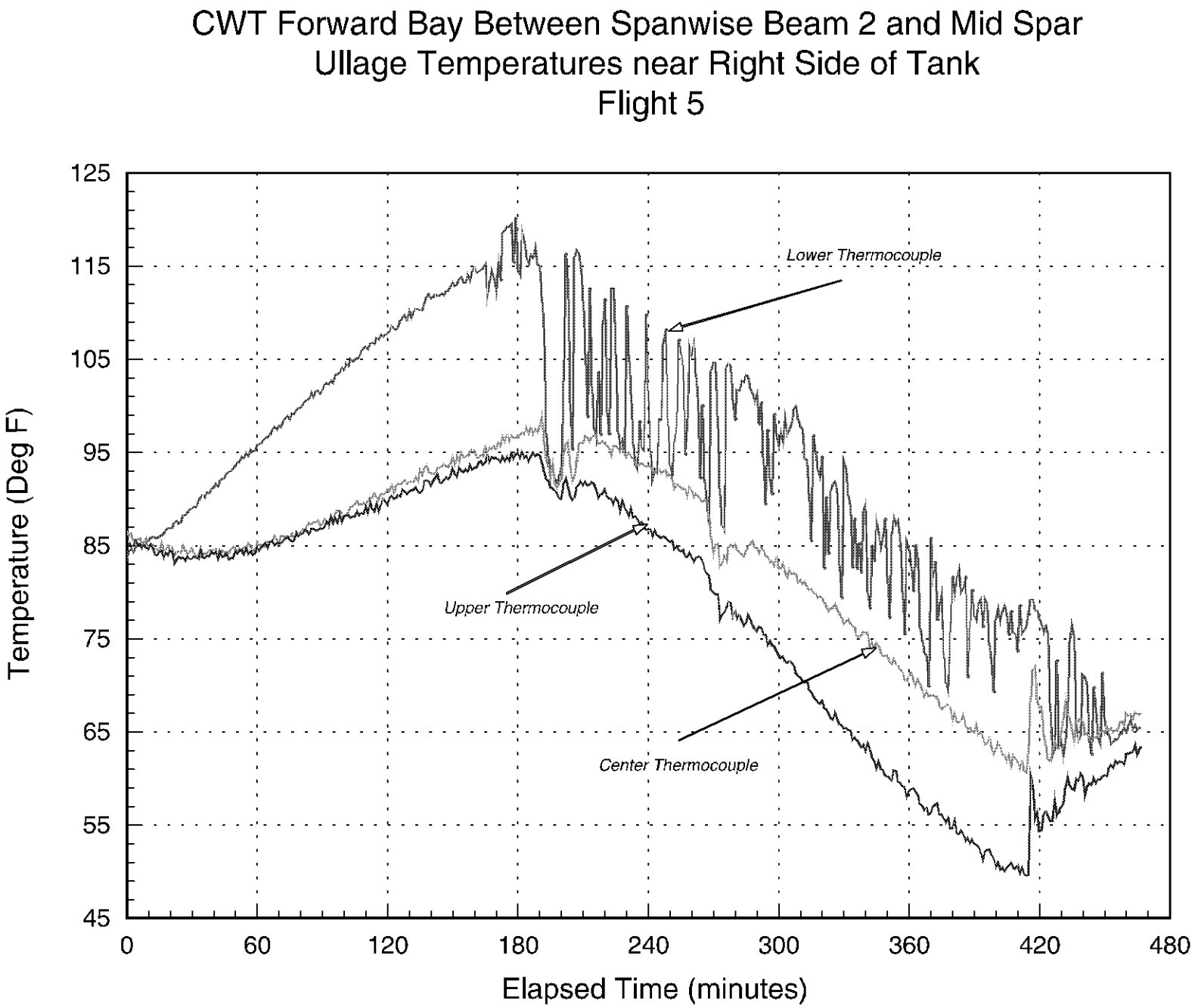

CWT Right Aft Bay
Ullage Temperatures
Flight 5
Temperature (Deg F)
130
120
110
100
90
80
70
60
0
60
120
180
240
300
360
420
480
Elapsed Time (minutes)
Right Aft Center
Right Aft Lower
Right Aft Upper

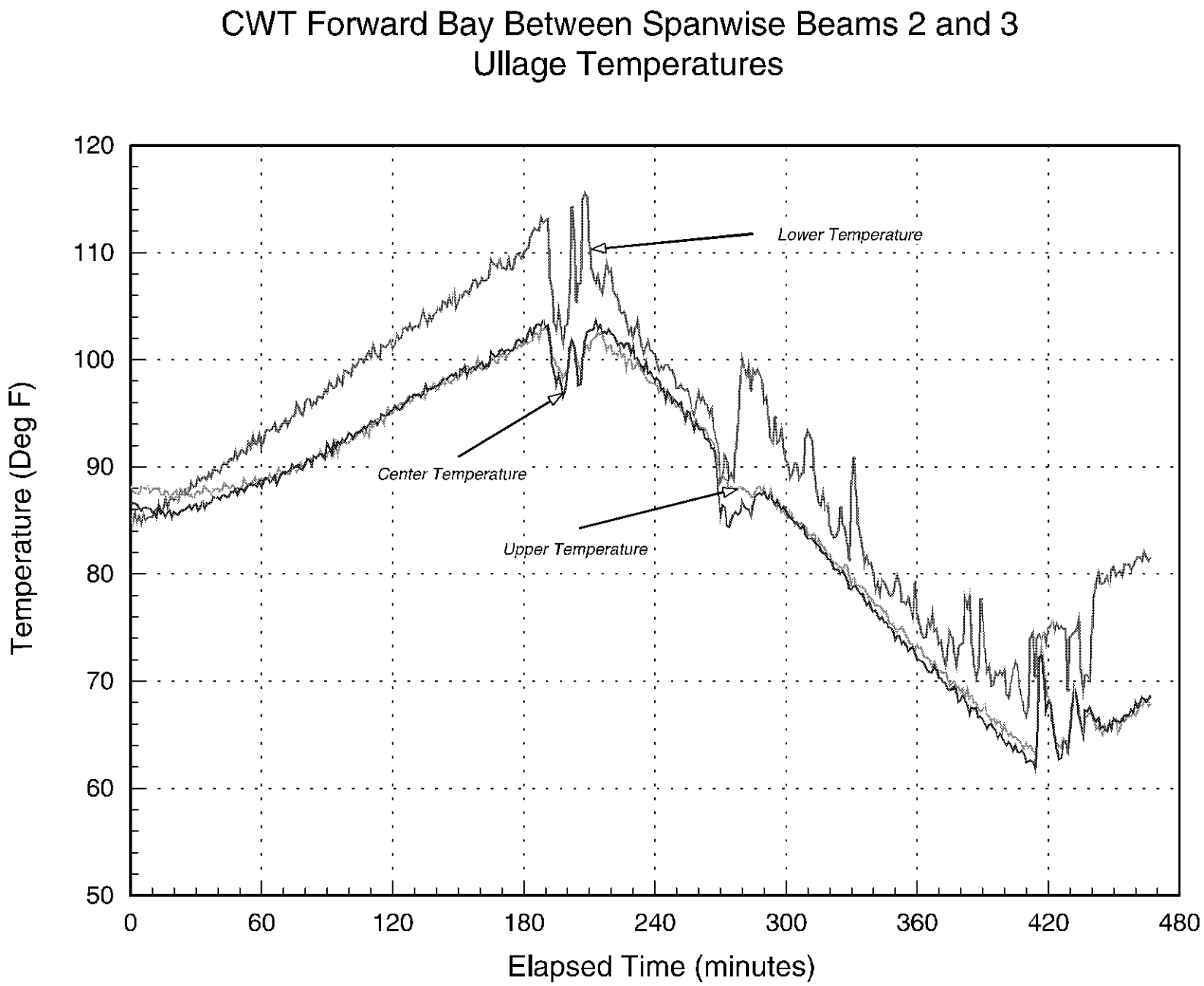

CWT Left Mid Bay
Ullage Temperatures
Flight 5
Temperature (Deg F)
130
120
110
100
90
80
70
60
0
60
120
180
240
300
360
420
480
Elapsed Time (minutes)
Left Mid Lower
Left Mid Center
Left Mid Upper


CWT Right Mid Bay
Ullage Temperatures
Flight 5
Temperature (Deg F)
130
120
110
100
90
80
70
60
0
60
120
180
240
300
360
420
480
Elapsed Time (minutes)
Right Mid Lower
Right Mid Center
Right Mid Upper

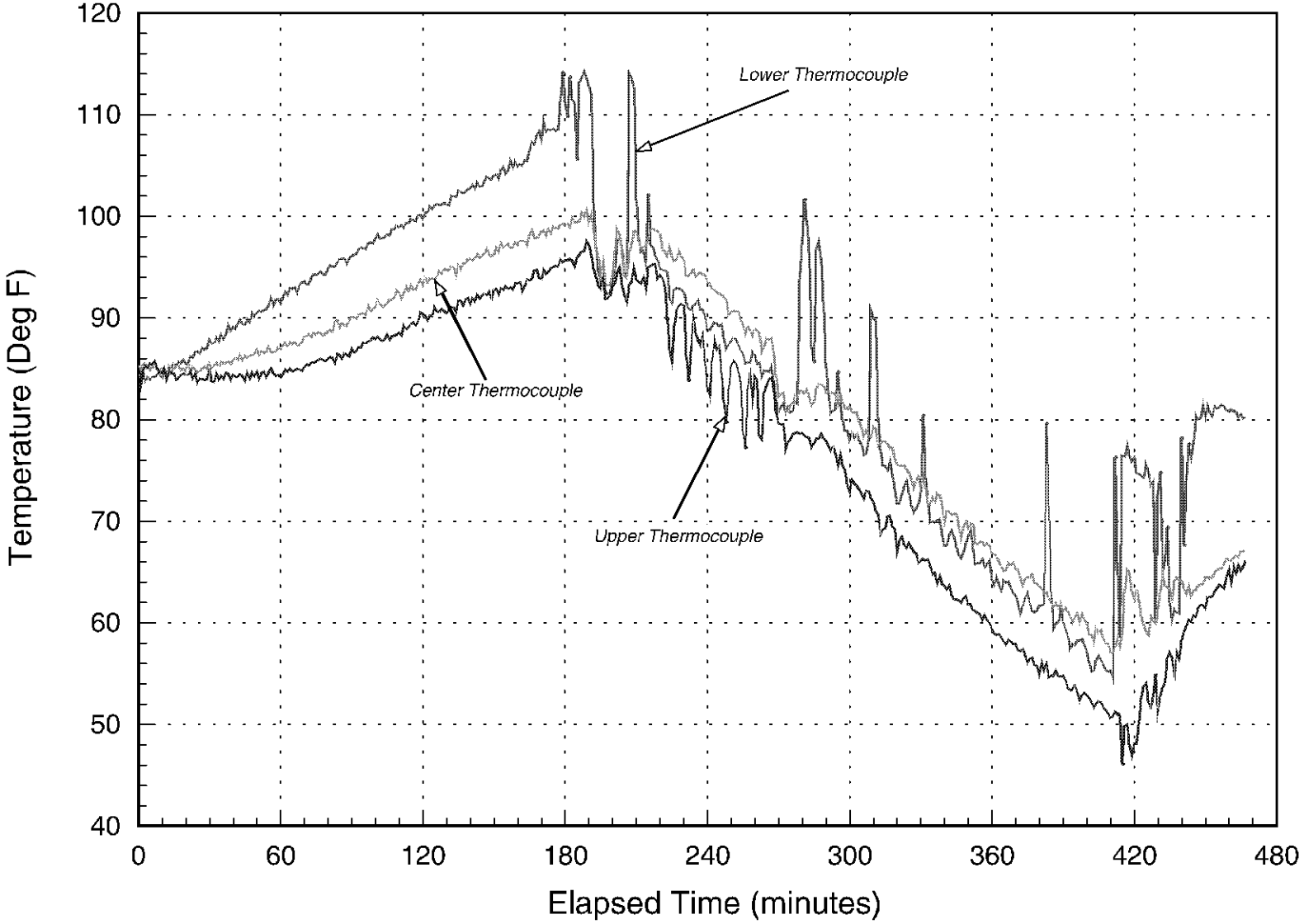

CWT Forward Bay Between Spanwise Beam 2 and Mid Spar
Ullage Temperatures
Flight 5
Temperature (Deg F)
120
110
100
90
80
70
60
0
60
120
180
240
300
360
420
480
Elapsed Time (minutes)
Lower Temperature
Upper Temperature
Center Temperature

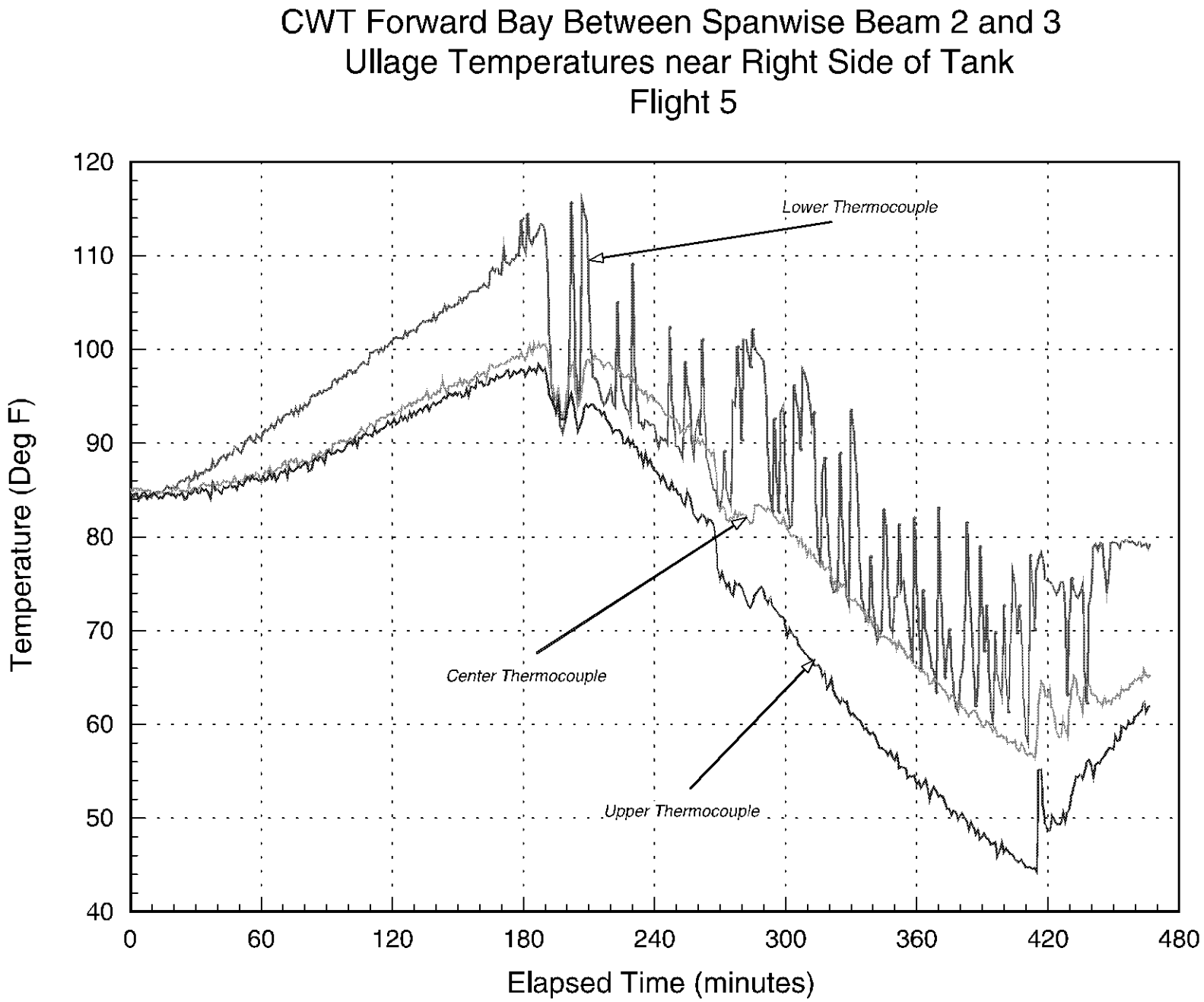

CWT Forward Bay Between Spanwise Beam 2 and Mid Spar
Ullage Temperatures near Left Side of Tank
Flight 5
Lower Thermocouple
Center Thermocouple
Upper Thermocouple
Temperature (Deg F)
Elapsed Time (minutes)
120
110
100
90
80
70
60
50
40
0
60
120
180
240
300
360
420
480

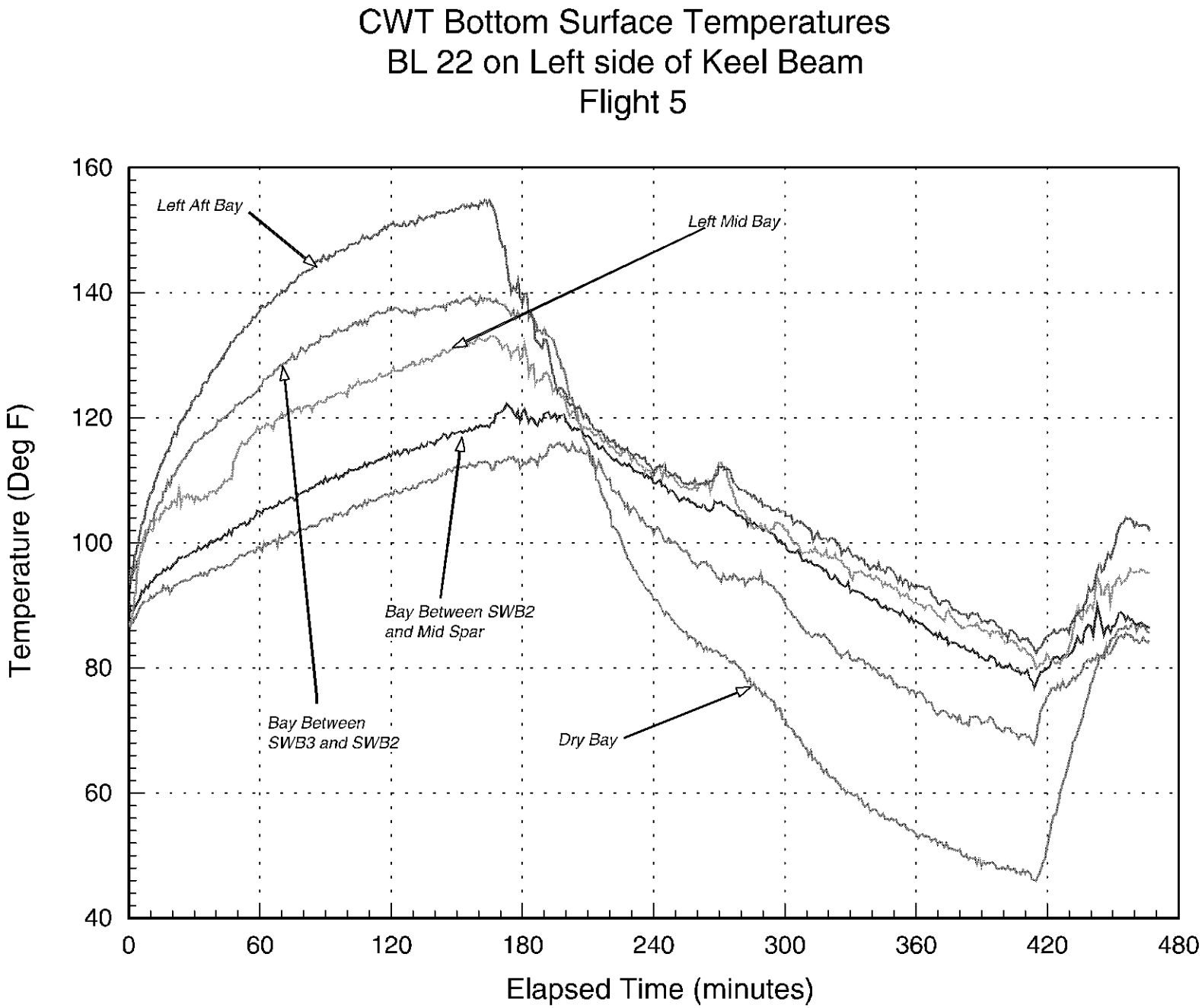

CWT Forward Bay Between Spanwise Beam 2 and Mid Spar
Ullage Temperatures near Right Side of Tank
Flight 5
Temperature (Deg F)
125
115
105
95
85
75
65
55
45
0
60
120
180
240
300
360
420
480
Elapsed Time (minutes)
Lower Thermocouple
Upper Thermocouple
Center Thermocouple

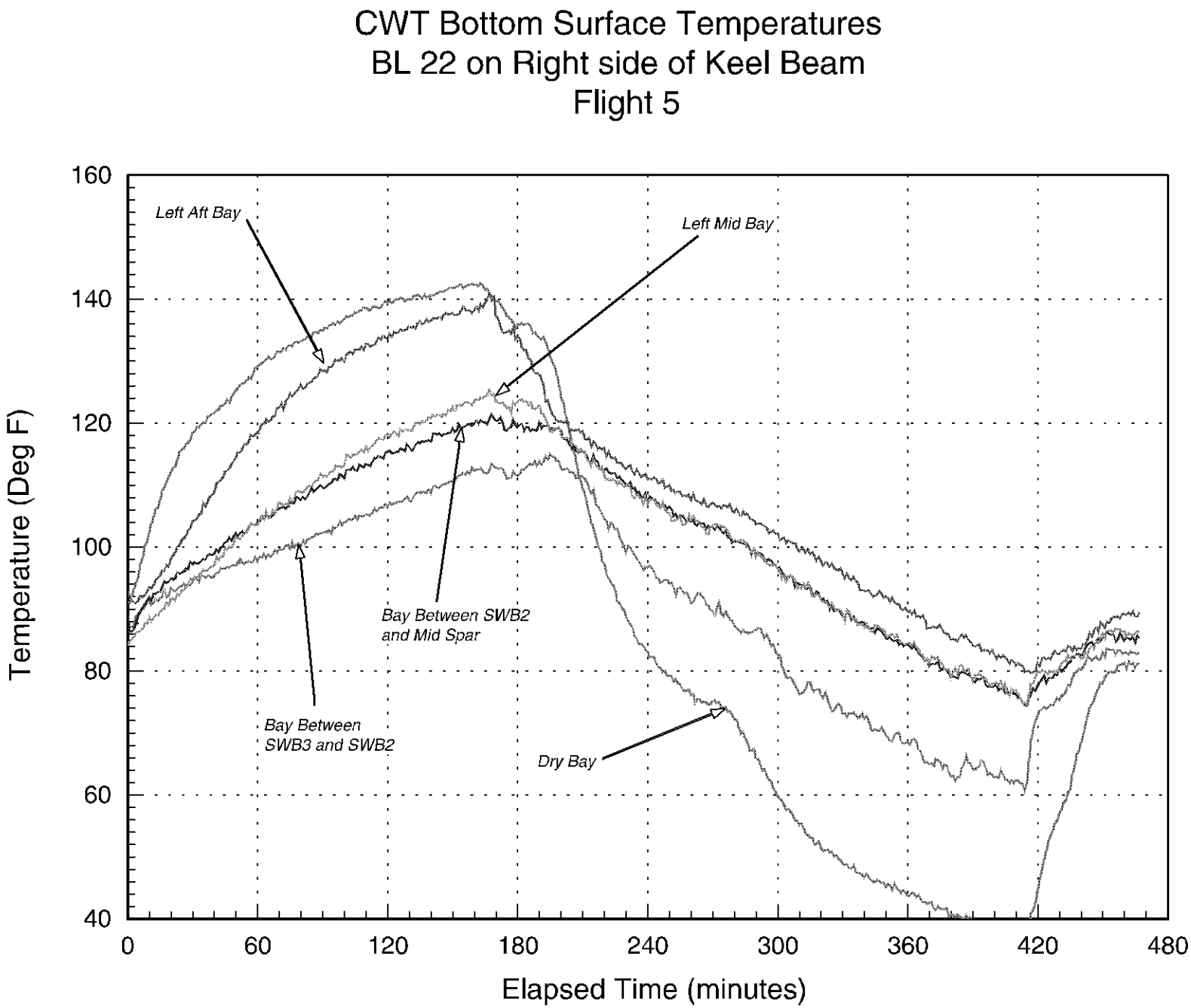

CWT Forward Bay Between Spanwise Beams 2 and 3
Ullage Temperatures
Lower Temperature
Center Temperature
Upper Temperature
Temperature (Deg F)
Elapsed Time (minutes)
120
110
100
90
80
70
60
50
0
60
120
180
240
300
360
420
480

CWT Forward Bay Between Spanwise Beam 2 and 3
Ullage Temperatures near Left Side of Tank
Flight 5

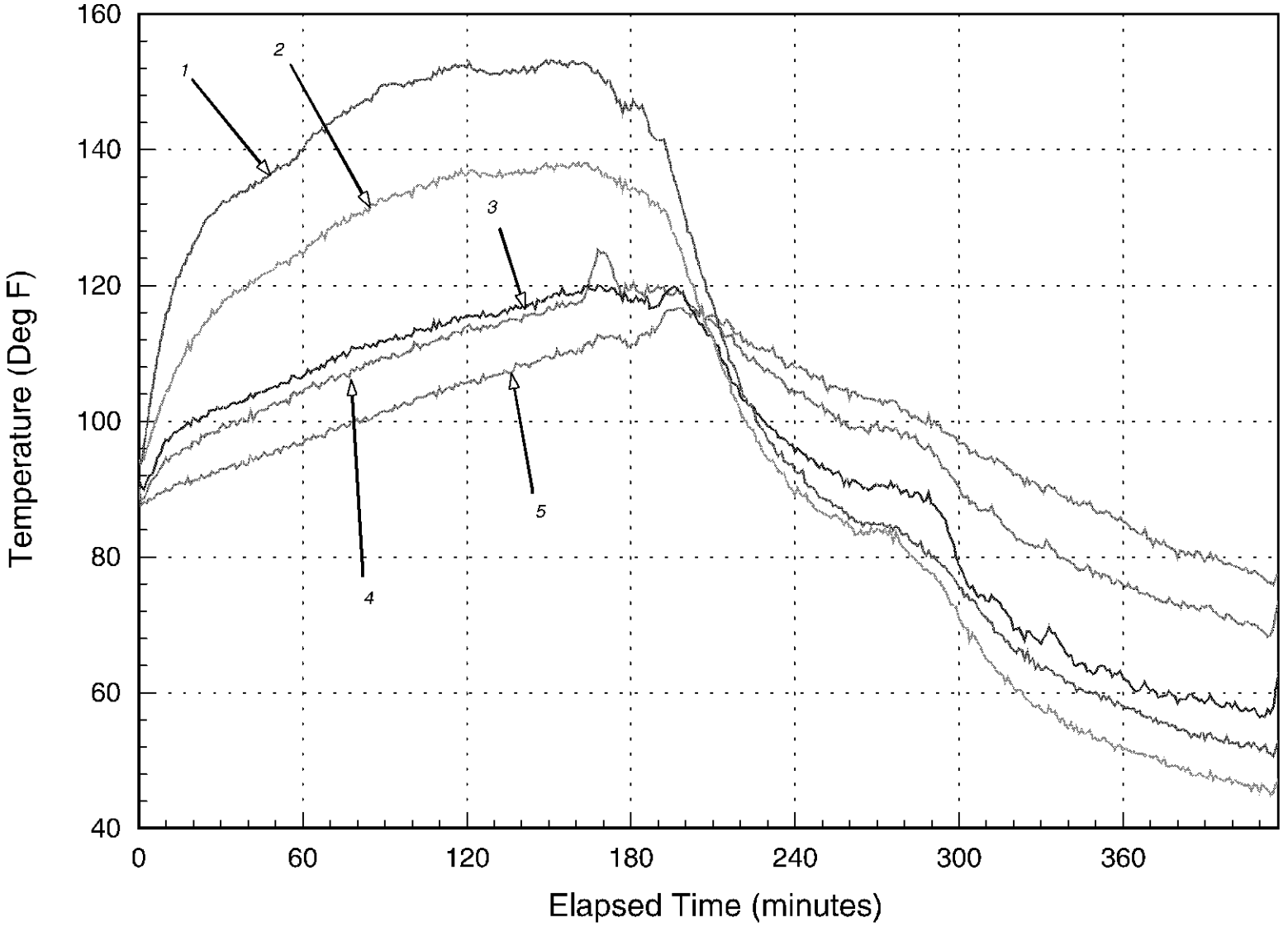


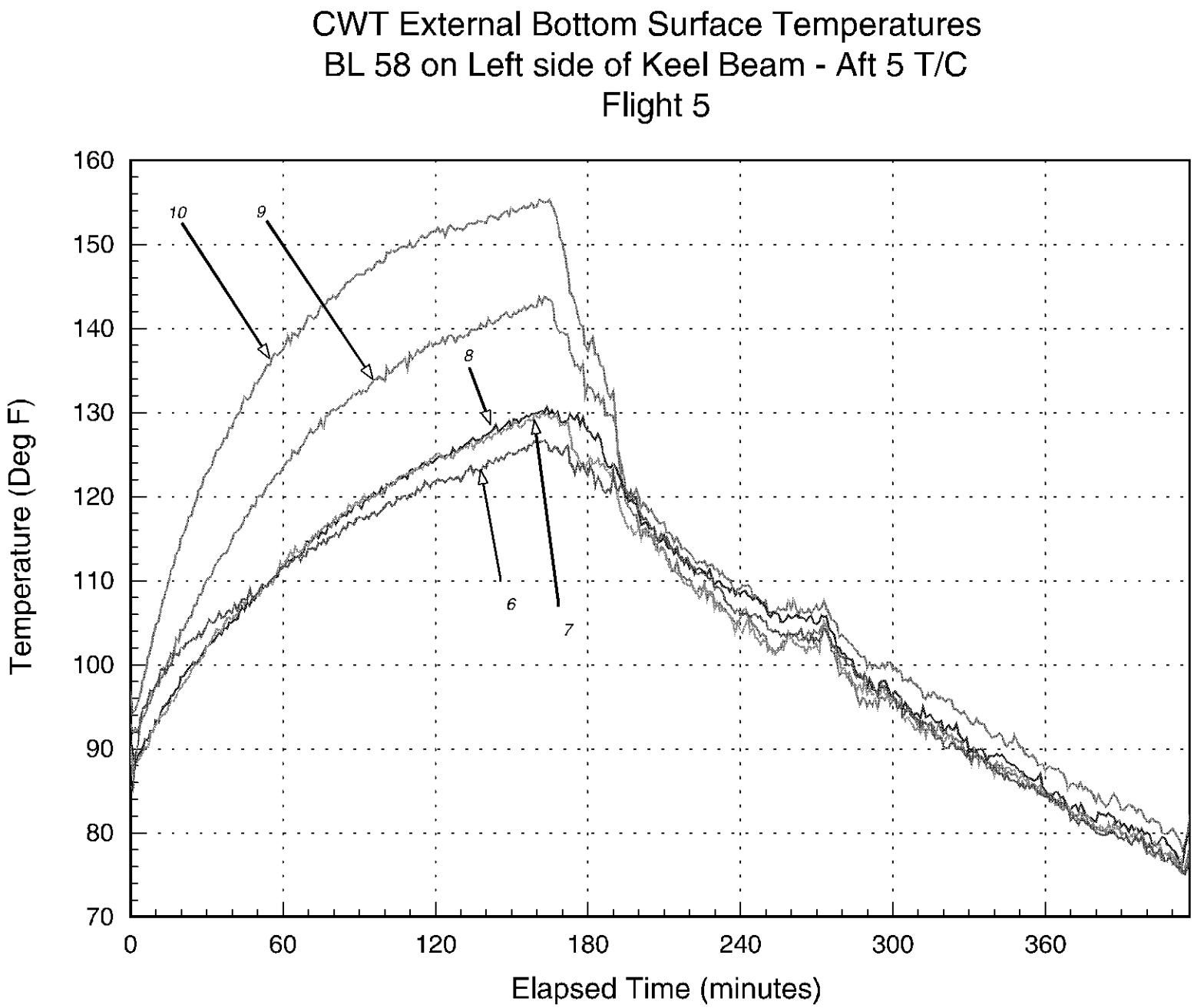

CWT Forward Bay Between Spanwise Beam 2 and 3
Ullage Temperatures near Right Side of Tank
Flight 5
Lower Thermocouple
Center Thermocouple
Upper Thermocouple
Temperature (Deg F)
Elapsed Time (minutes)
120
110
100
90
80
70
60
50
40
0
60
120
180
240
300
360
420
480


CWT Bottom Surface Temperatures
BL 22 on Left side of Keel Beam
Flight 5
Left Aft Bay
Left Mid Bay
Bay Between SWB2
and Mid Spar
Bay Between
SWB3 and SWB2
Dry Bay
Temperature (Deg F)
Elapsed Time (minutes)
160
140
120
100
80
60
40
0
60
120
180
240
300
360
420
480

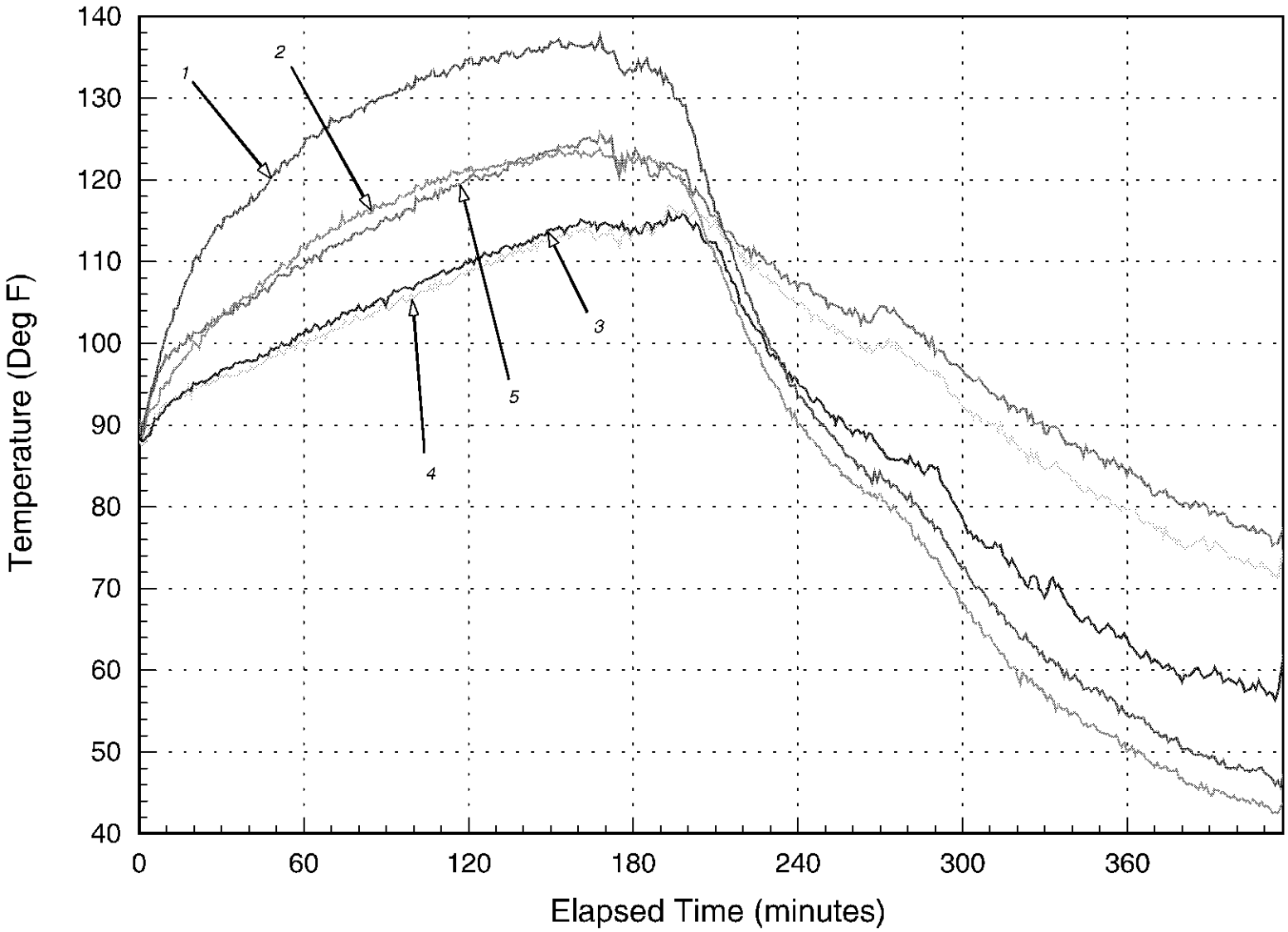

CWT Bottom Surface Temperatures
BL 22 on Right side of Keel Beam
Flight 5
Left Aft Bay
Left Mid Bay
Bay Between SWB2
and Mid Spar
Bay Between
SWB3 and SWB2
Dry Bay
Temperature (Deg F)
Elapsed Time (minutes)
160
140
120
100
80
60
40
0
60
120
180
240
300
360
420
480

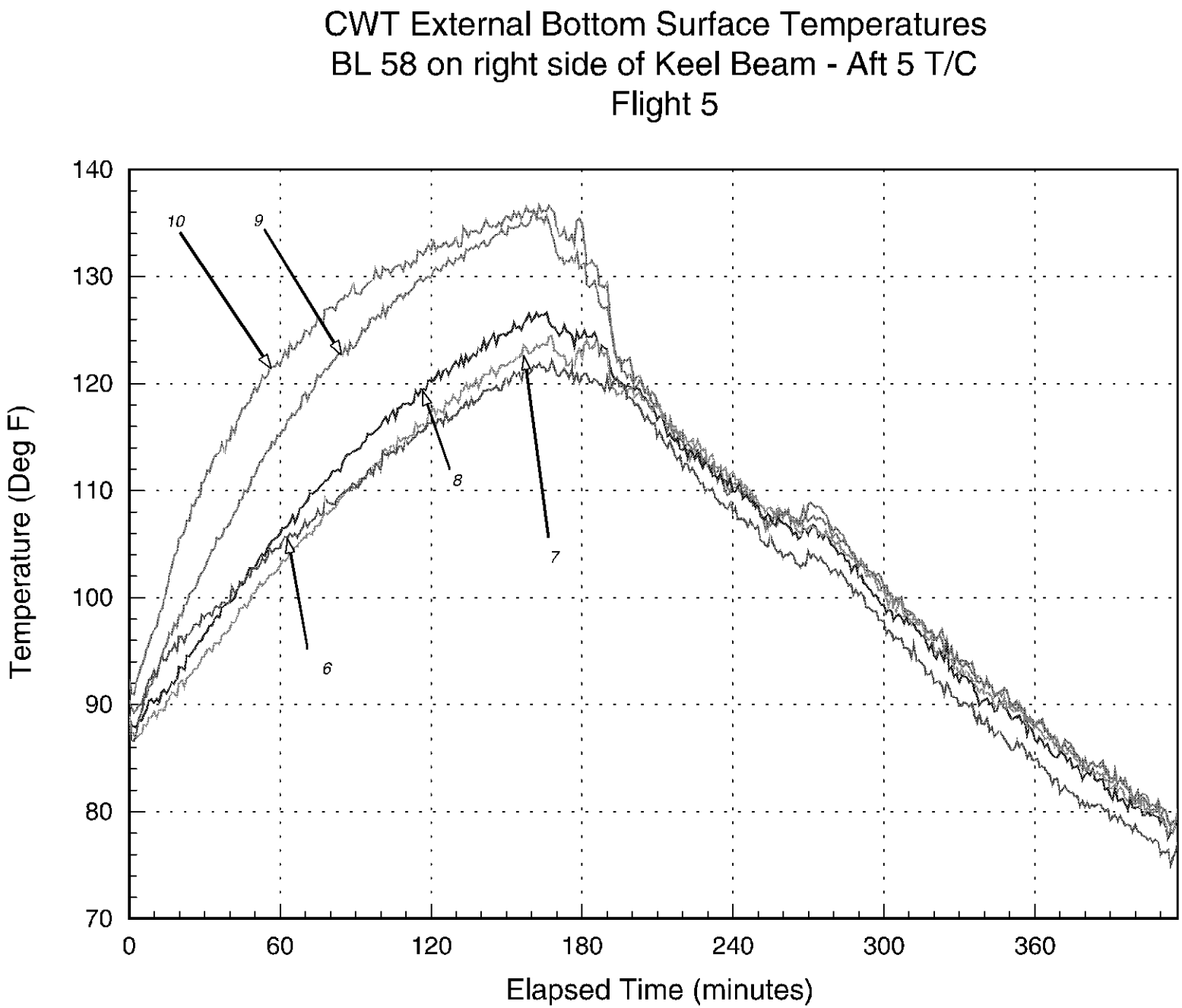
CWT External Bottom Surface Temperatures
BL 58 on Left side of Keel Beam - Front 5 T/C
Flight 5



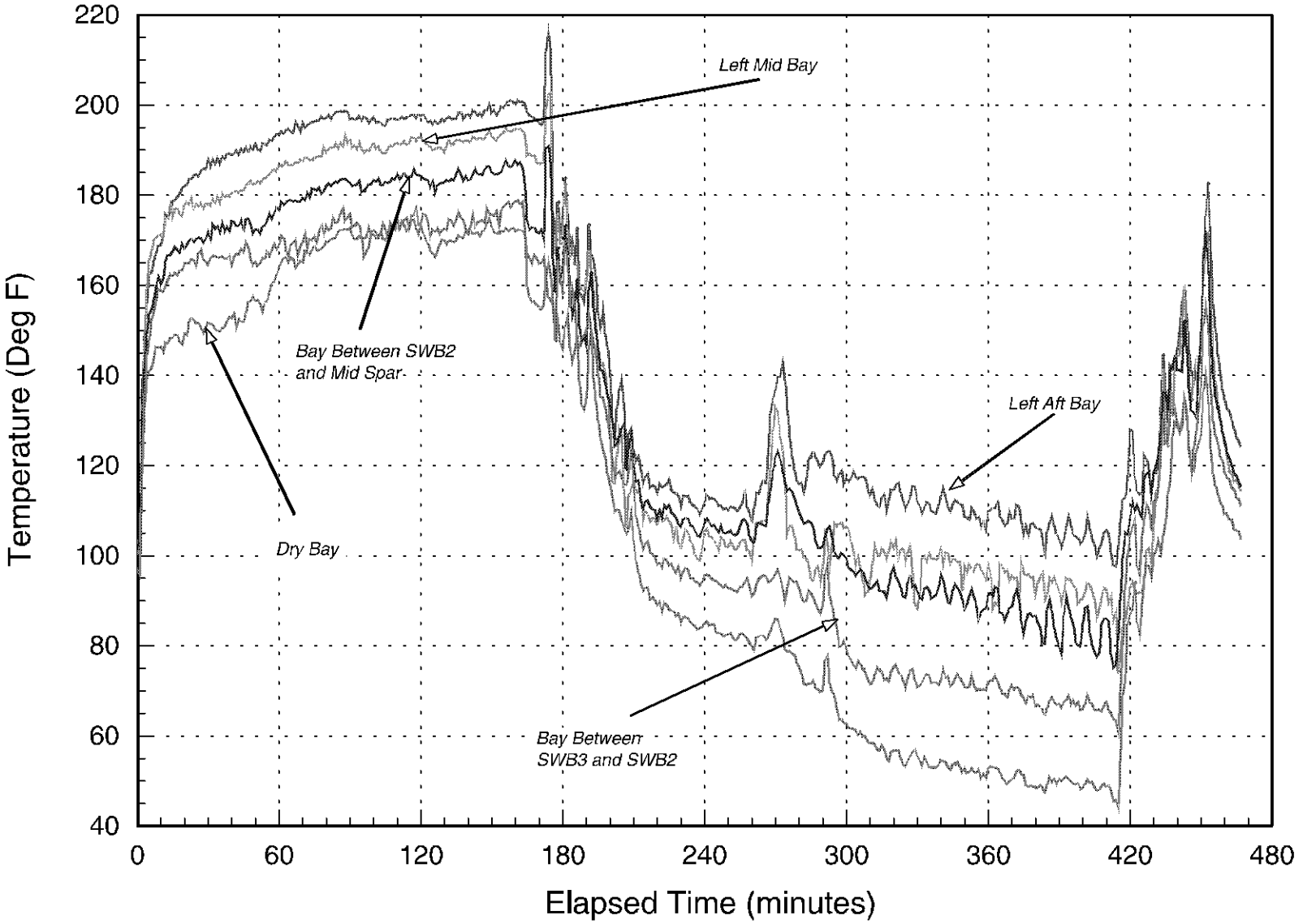

CWT External Bottom Surface Temperatures
BL 58 on Left side of Keel Beam - Aft 5 T/C
Flight 5
Temperature (Deg F)
Elapsed Time (minutes)
160
150
140
130
120
110
100
90
80
70
0
60
120
180
240
300
360
10
9
8
6
7

CWT External Bottom Surface Temperatures
BL 58 on right side of Keel Beam - Front 5 T/C
Flight 5

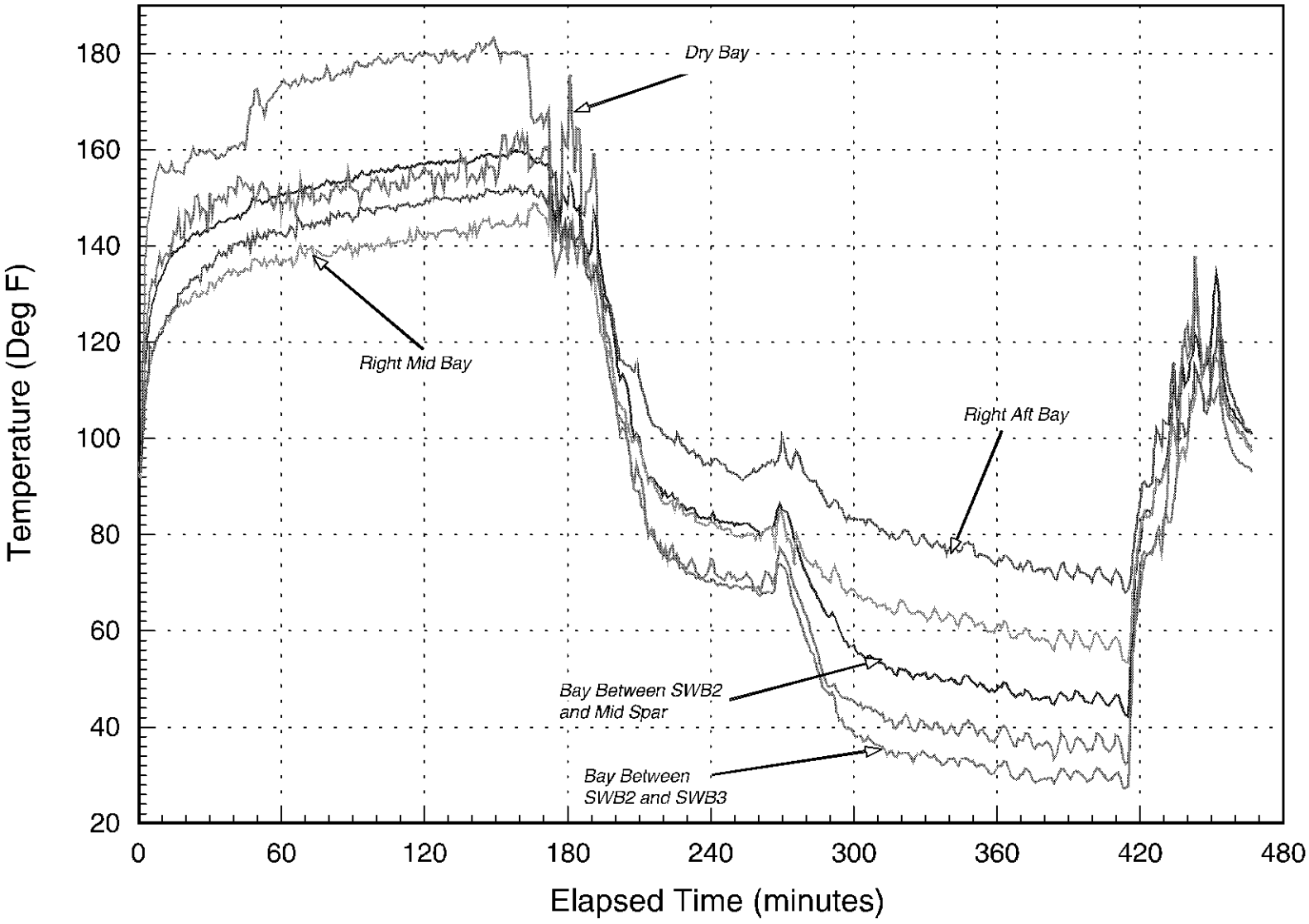


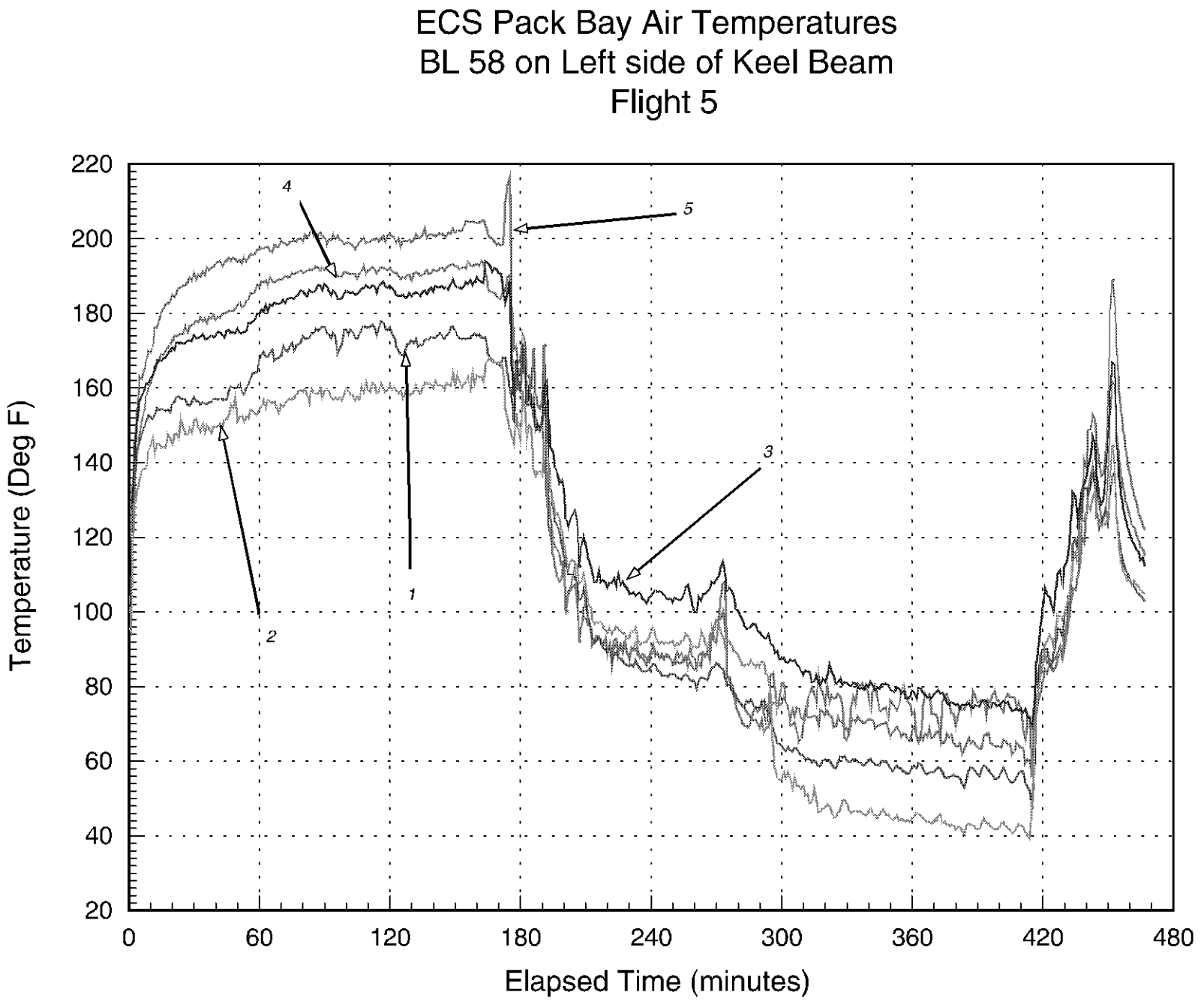

CWT External Bottom Surface Temperatures
BL 58 on right side of Keel Beam - Aft 5 T/C
Flight 5
Temperature (Deg F)
Elapsed Time (minutes)
140
130
120
110
100
90
80
70
0
60
120
180
240
300
360
10
9
8
7
6

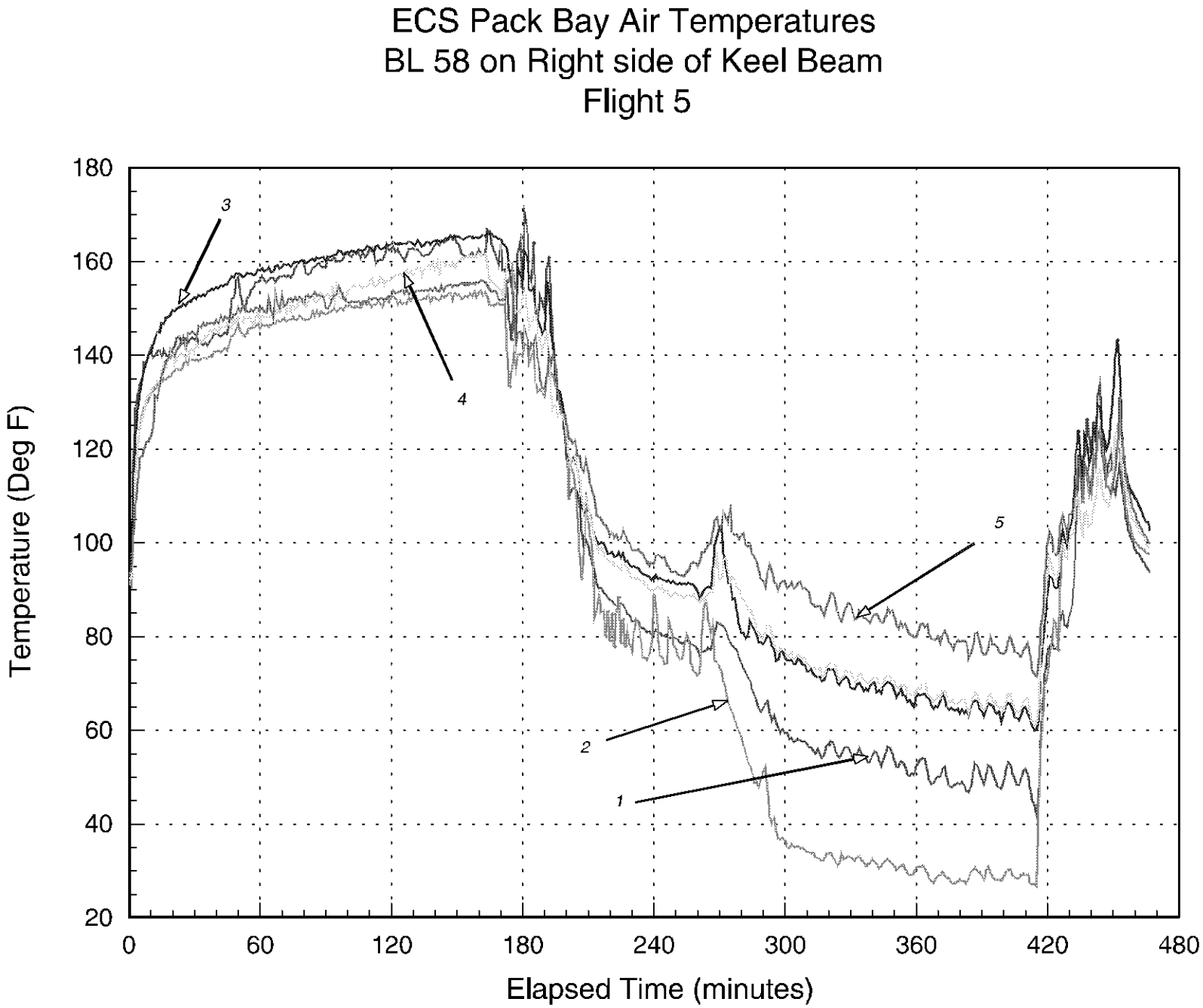
ECS Pack Bay Air Temperatures
BL 22 on Left side of Keel Beam
Flight 5

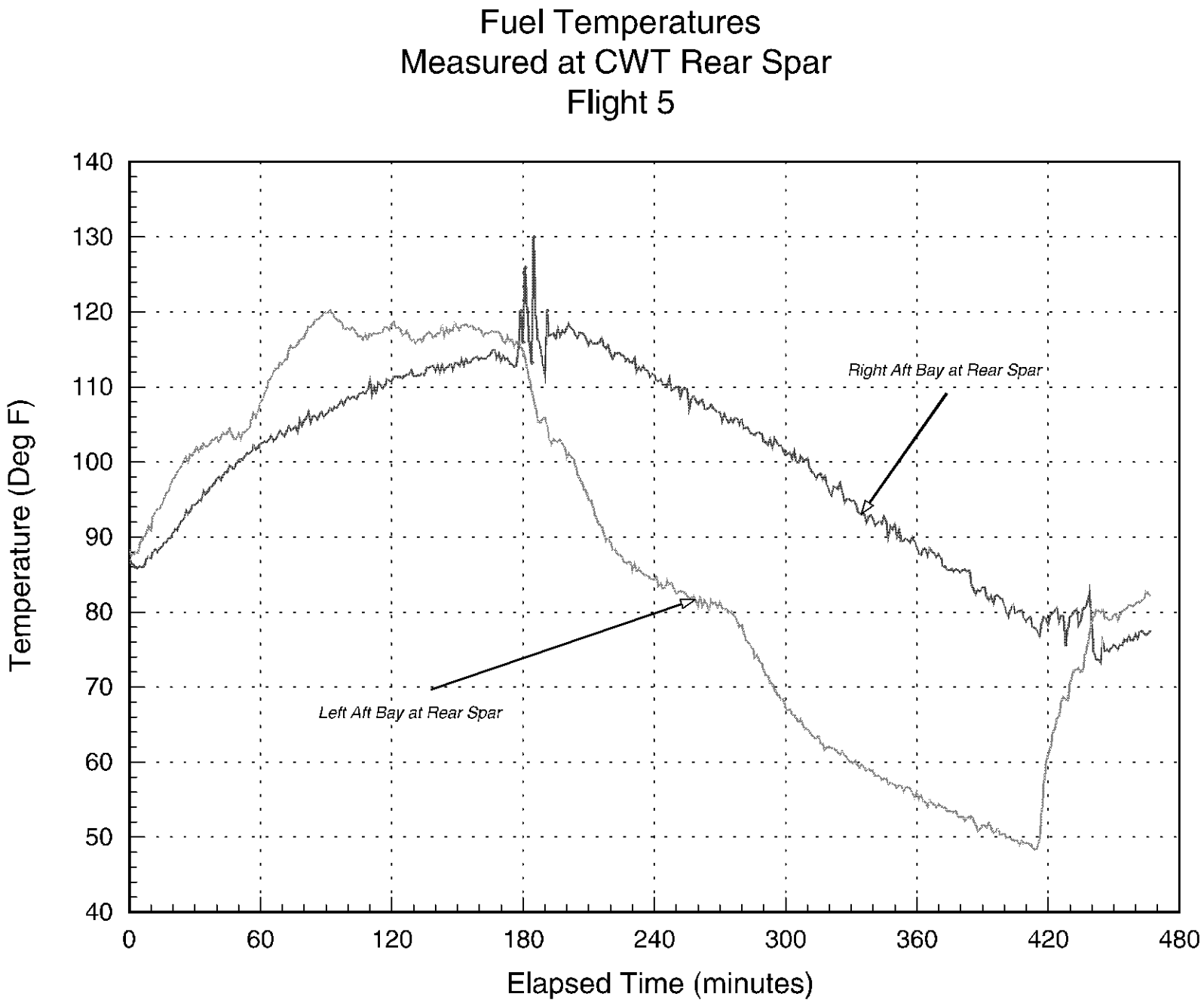


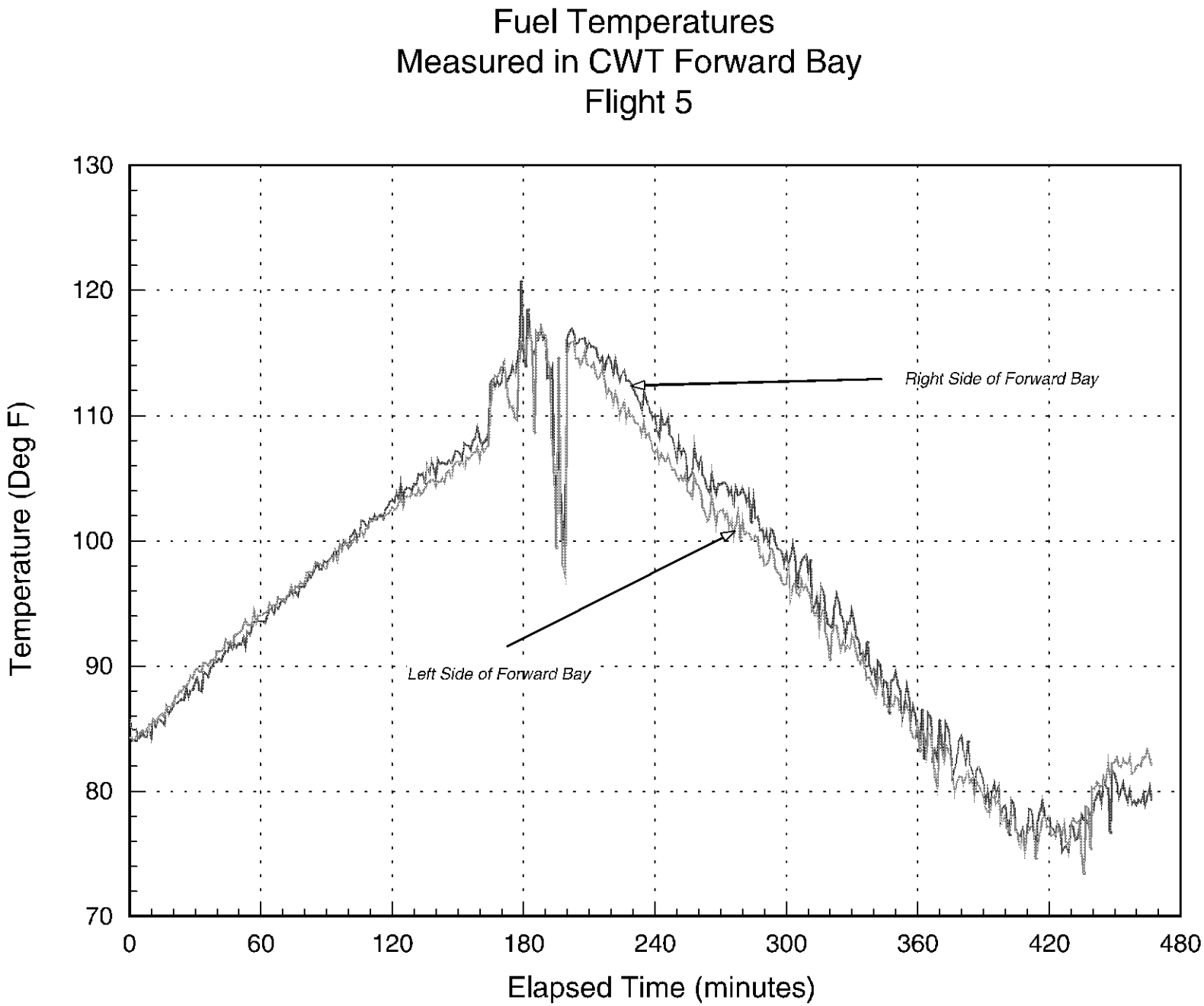
ECS Pack Bay Air Temperatures
BL 22 on Right side of Keel Beam
Flight 5



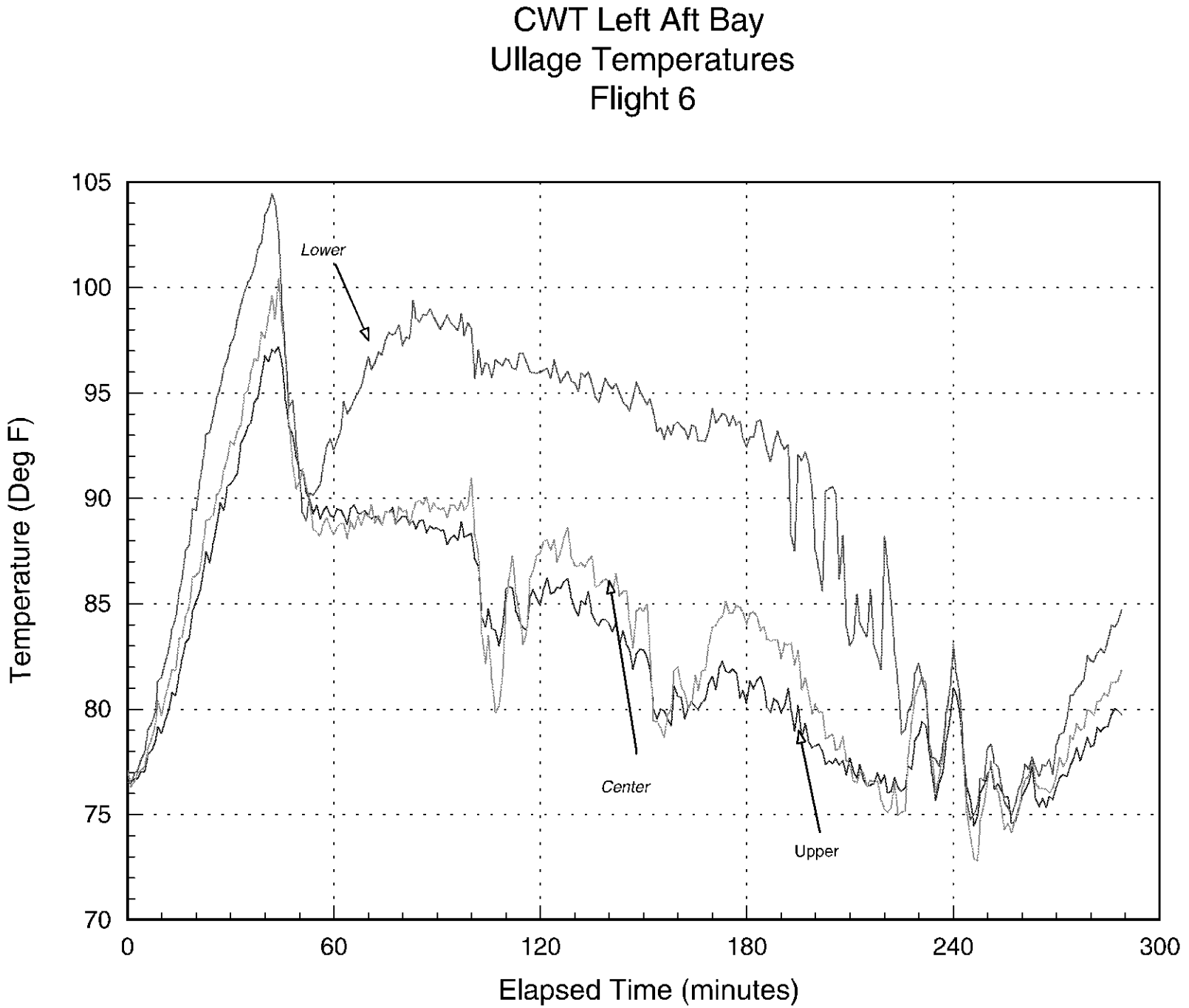

ECS Pack Bay Air Temperatures
BL 58 on Left side of Keel Beam
Flight 5
Temperature (Deg F)
Elapsed Time (minutes)
220
200
180
160
140
120
100
80
60
40
20
0
60
120
180
240
300
360
420
480
1
2
3
4
5

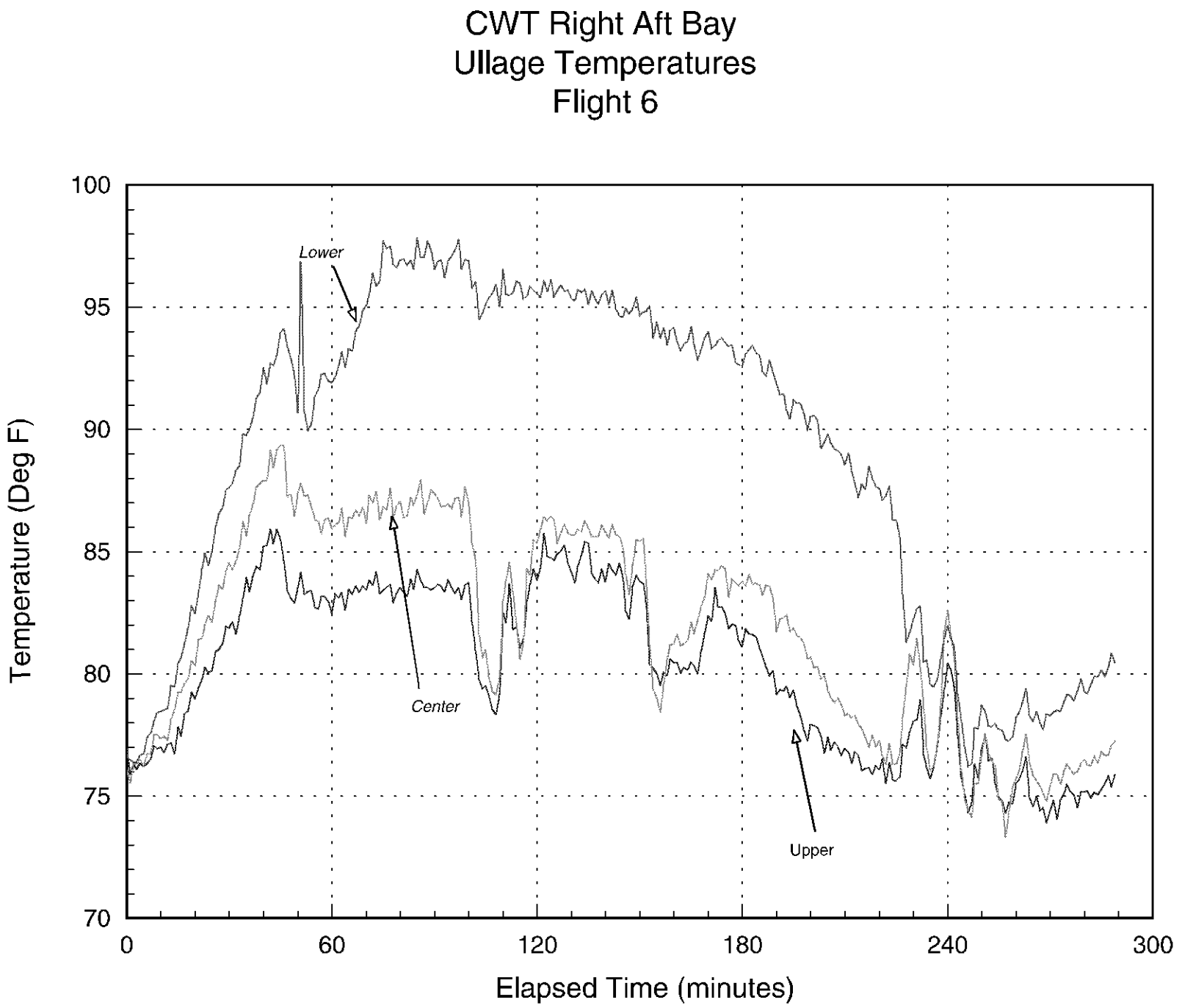

ECS Pack Bay Air Temperatures
BL 58 on Right side of Keel Beam
Flight 5
Temperature (Deg F)
Elapsed Time (minutes)
180
160
140
120
100
80
60
40
20
0
60
120
180
240
300
360
420
480
1
2
3
4
5

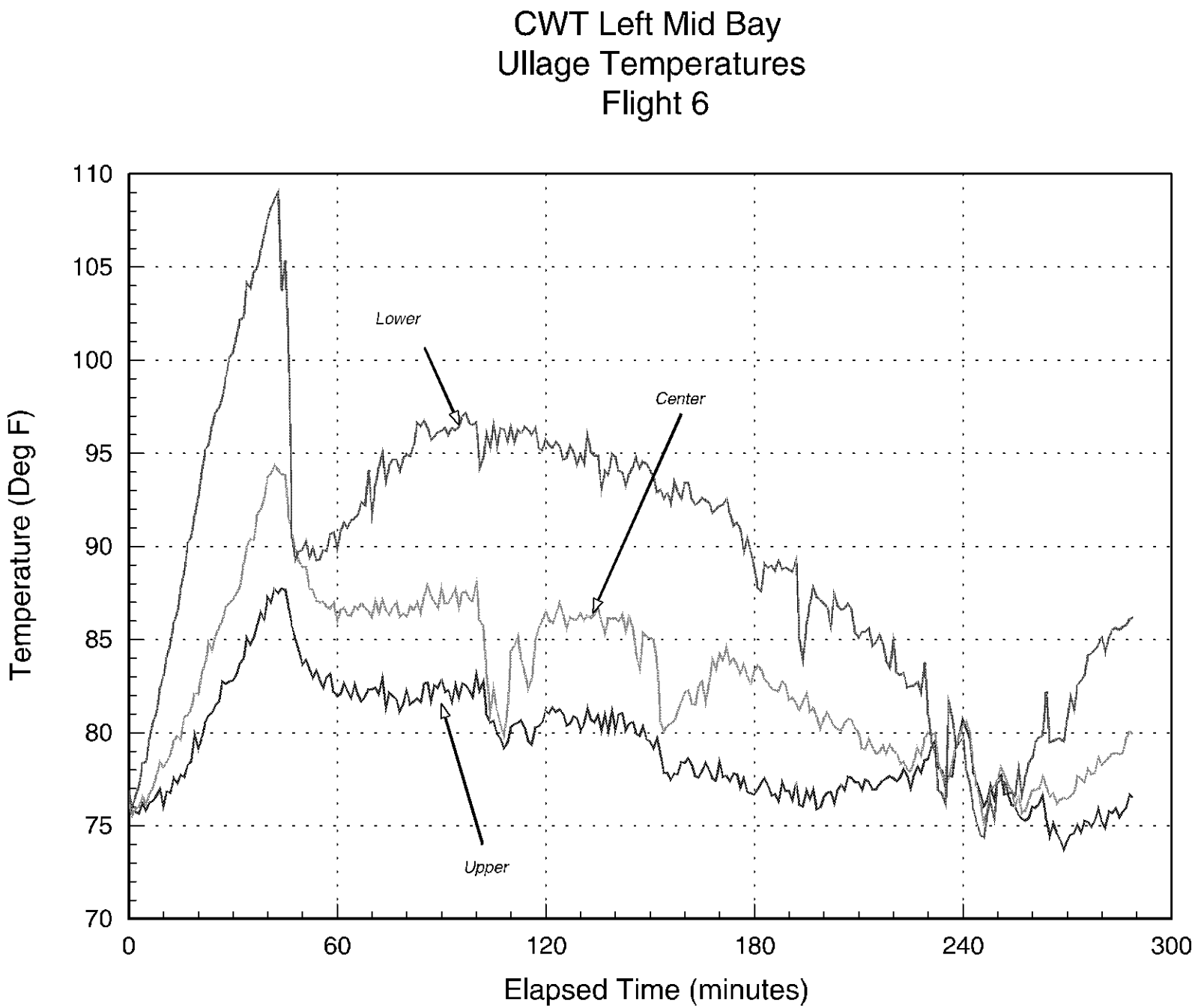

Fuel Temperatures
Measured at CWT Rear Spar
Flight 5
Temperature (Deg F)
140
130
120
110
100
90
80
70
60
50
40
0
60
120
180
240
300
360
420
480
Elapsed Time (minutes)
Right Aft Bay at Rear Spar
Left Aft Bay at Rear Spar

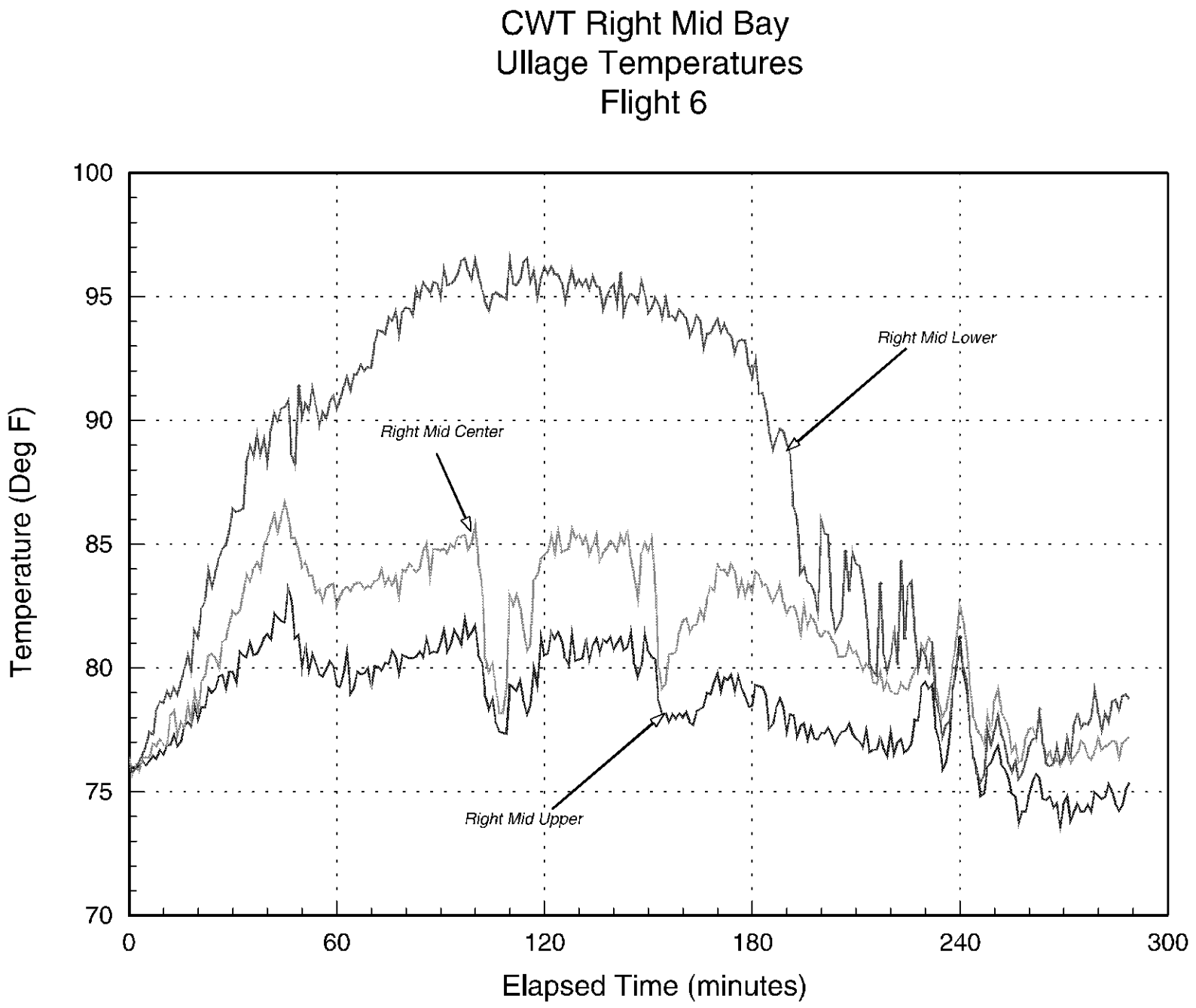

Fuel Temperatures
Measured in CWT Forward Bay
Flight 5
Temperature (Deg F)
130
120
110
100
90
80
70
0
60
120
180
240
300
360
420
480
Elapsed Time (minutes)
Right Side of Forward Bay
Left Side of Forward Bay

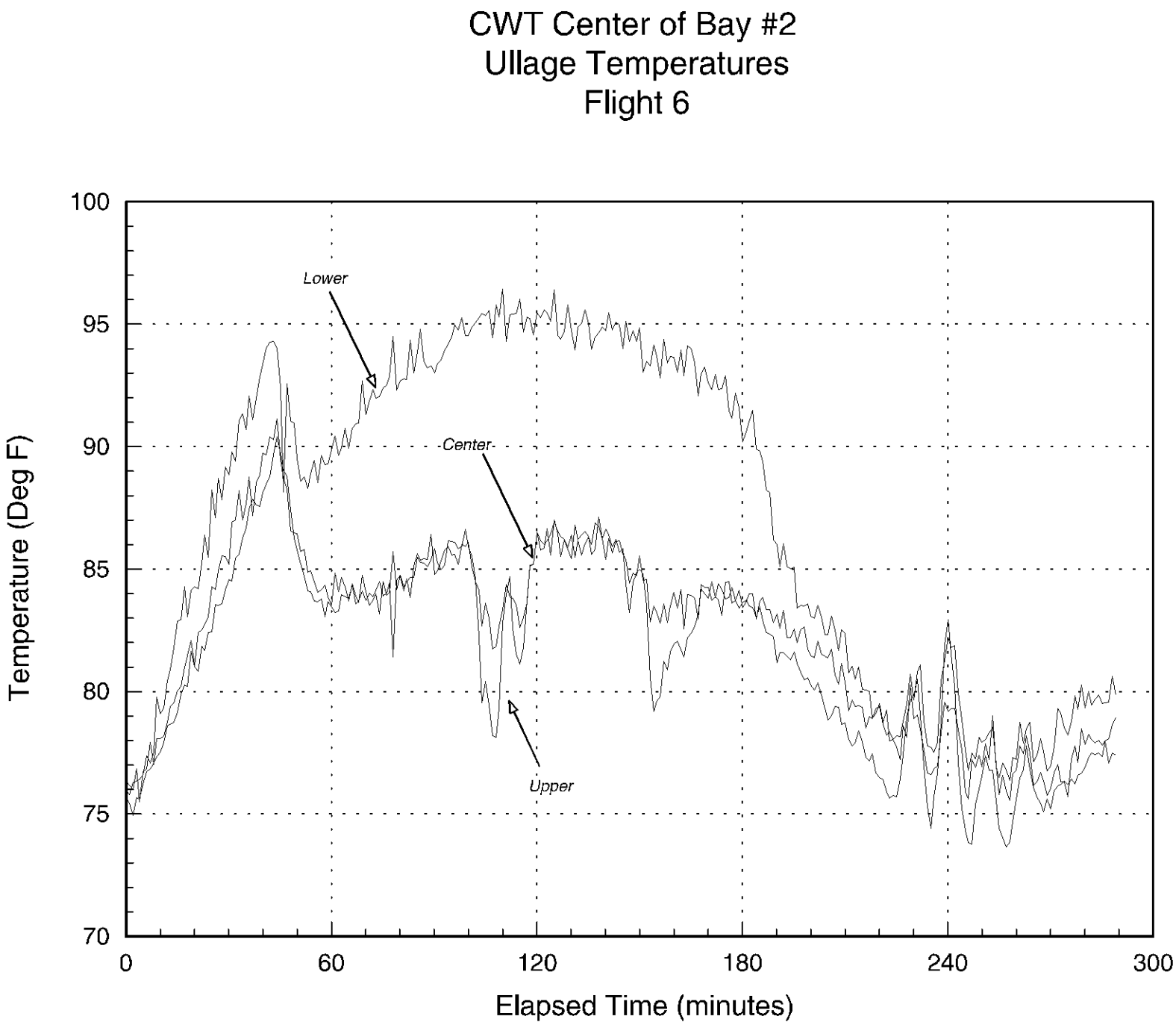
FLIGHT TEST RESULTS
FLIGHT 6

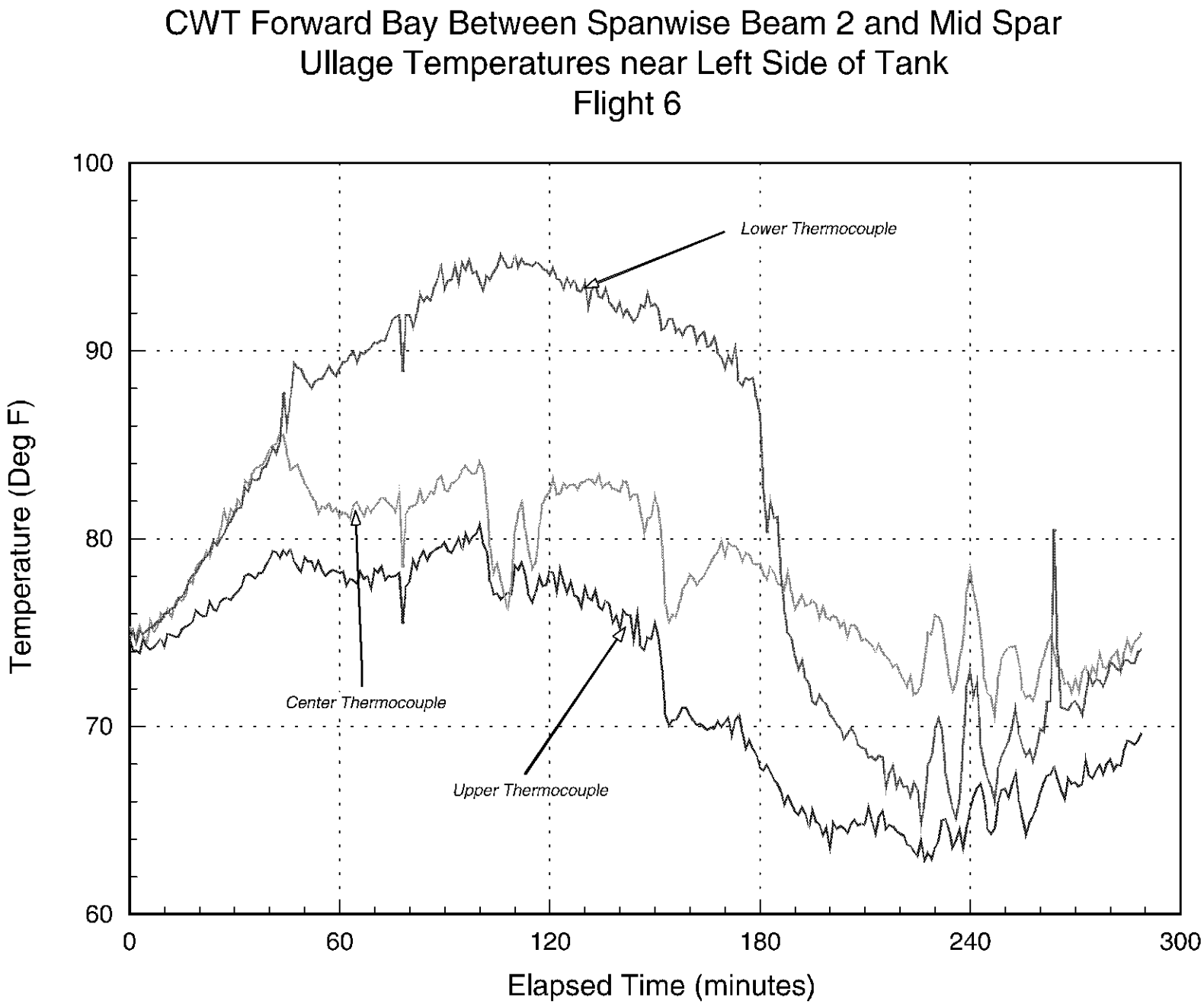

CWT Left Aft Bay
Ullage Temperatures
Flight 6
Temperature (Deg F)
105
100
95
90
85
80
75
70
0
60
120
180
240
300
Elapsed Time (minutes)
Lower
Center
Upper


CWT Right Aft Bay
Ullage Temperatures
Flight 6
Temperature (Deg F)
100
95
90
85
80
75
70
0
60
120
180
240
300
Elapsed Time (minutes)
Lower
Center
Upper

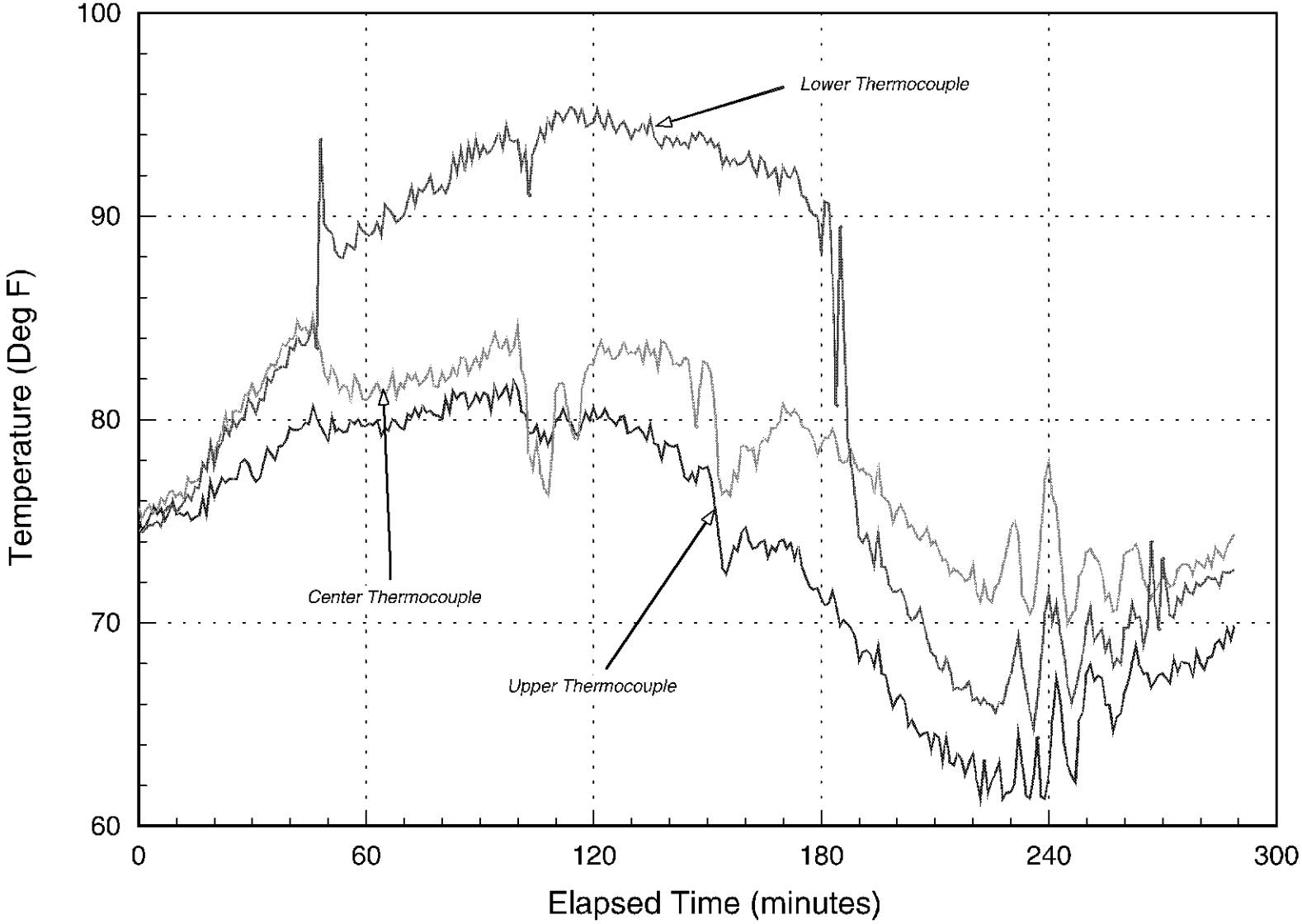

CWT Left Mid Bay
Ullage Temperatures
Flight 6
Temperature (Deg F)
110
105
100
95
90
85
80
75
70
0
60
120
180
240
300
Elapsed Time (minutes)
Lower
Center
Upper

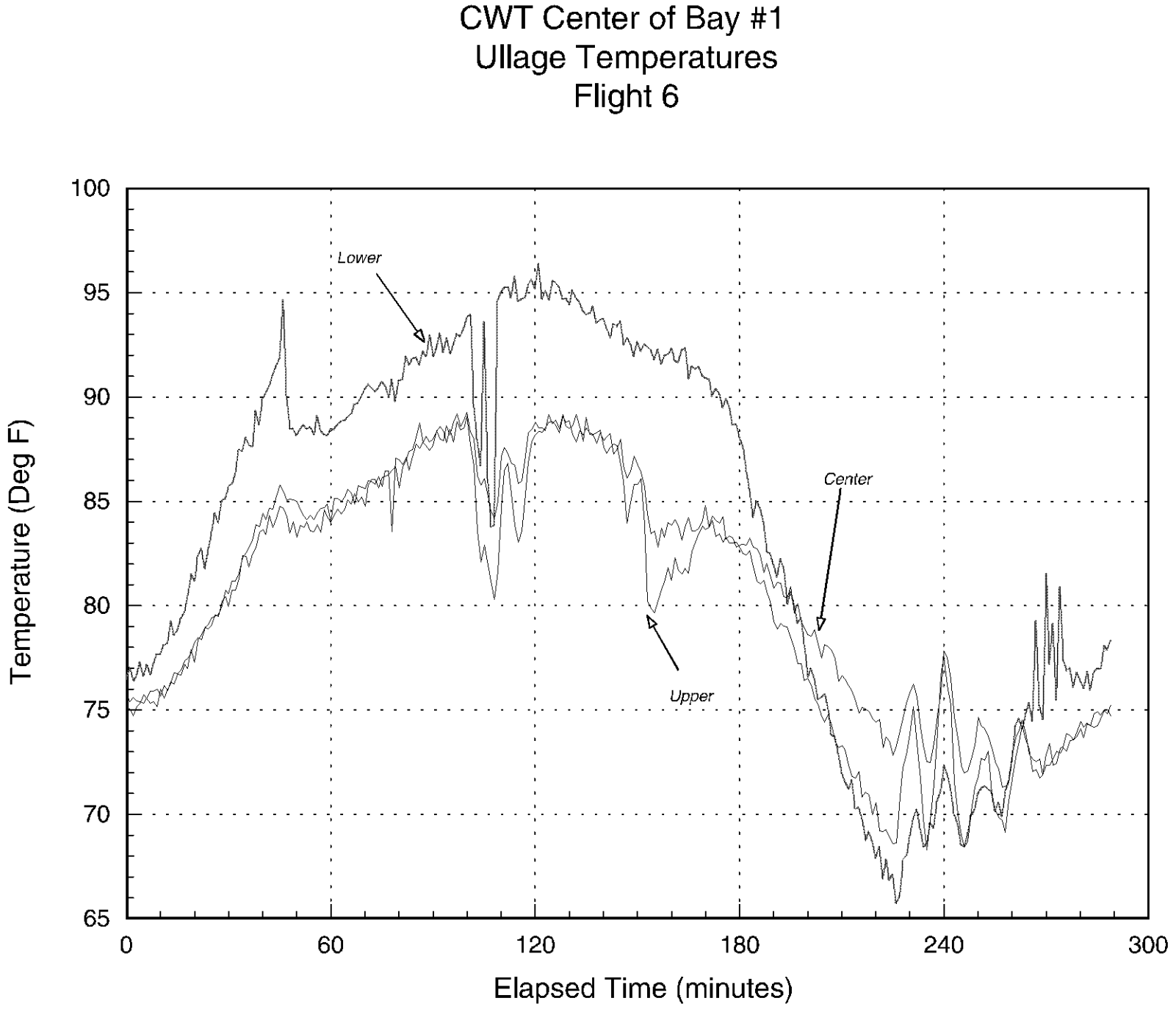

CWT Right Mid Bay
Ullage Temperatures
Flight 6
Temperature (Deg F)
100
95
90
85
80
75
70
0
60
120
180
240
300
Elapsed Time (minutes)
Right Mid Lower
Right Mid Center
Right Mid Upper

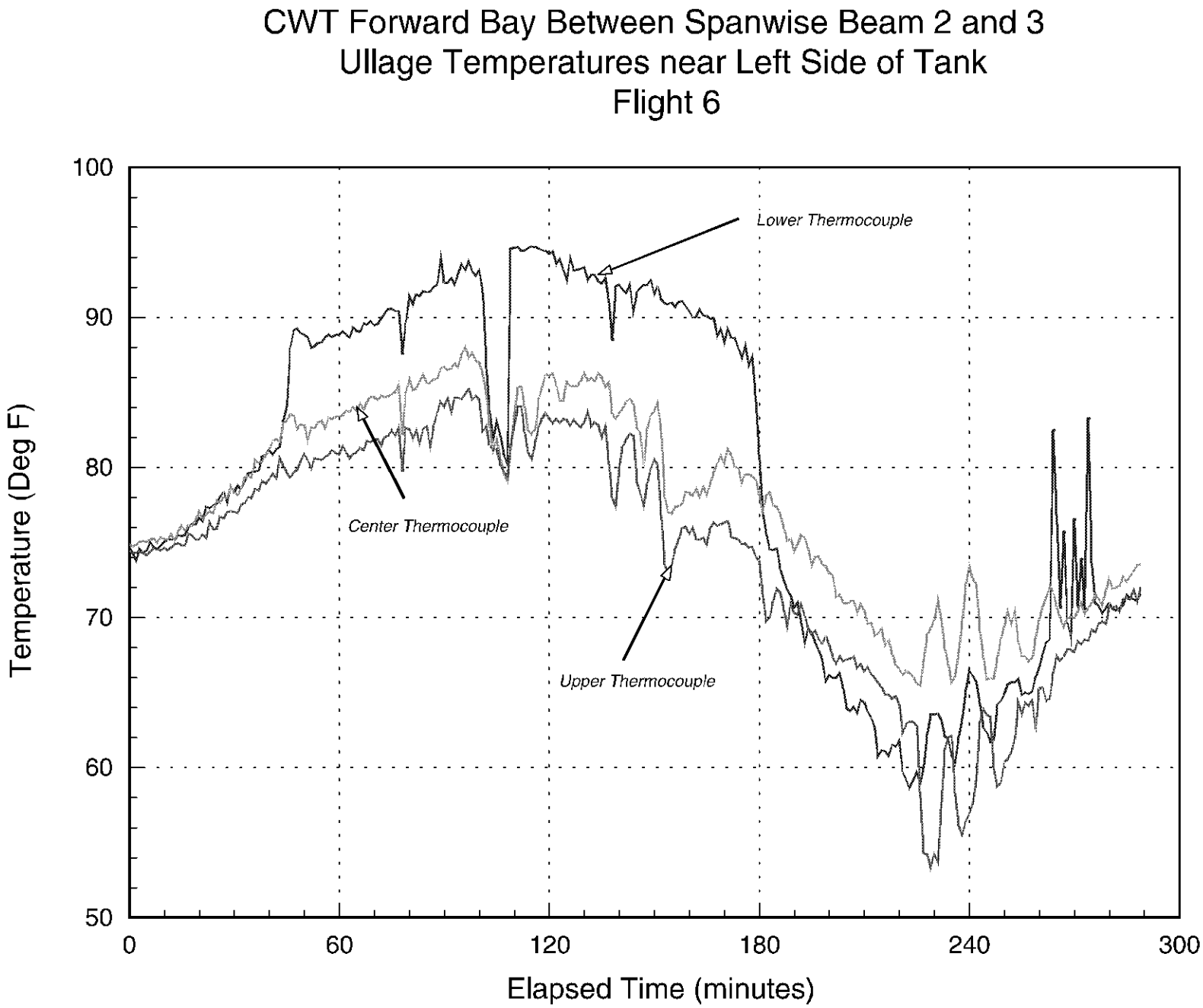

CWT Center of Bay #2
Ullage Temperatures
Flight 6
Lower
Center
Upper
Temperature (Deg F)
Elapsed Time (minutes)
100
95
90
85
80
75
70
0
60
120
180
240
300

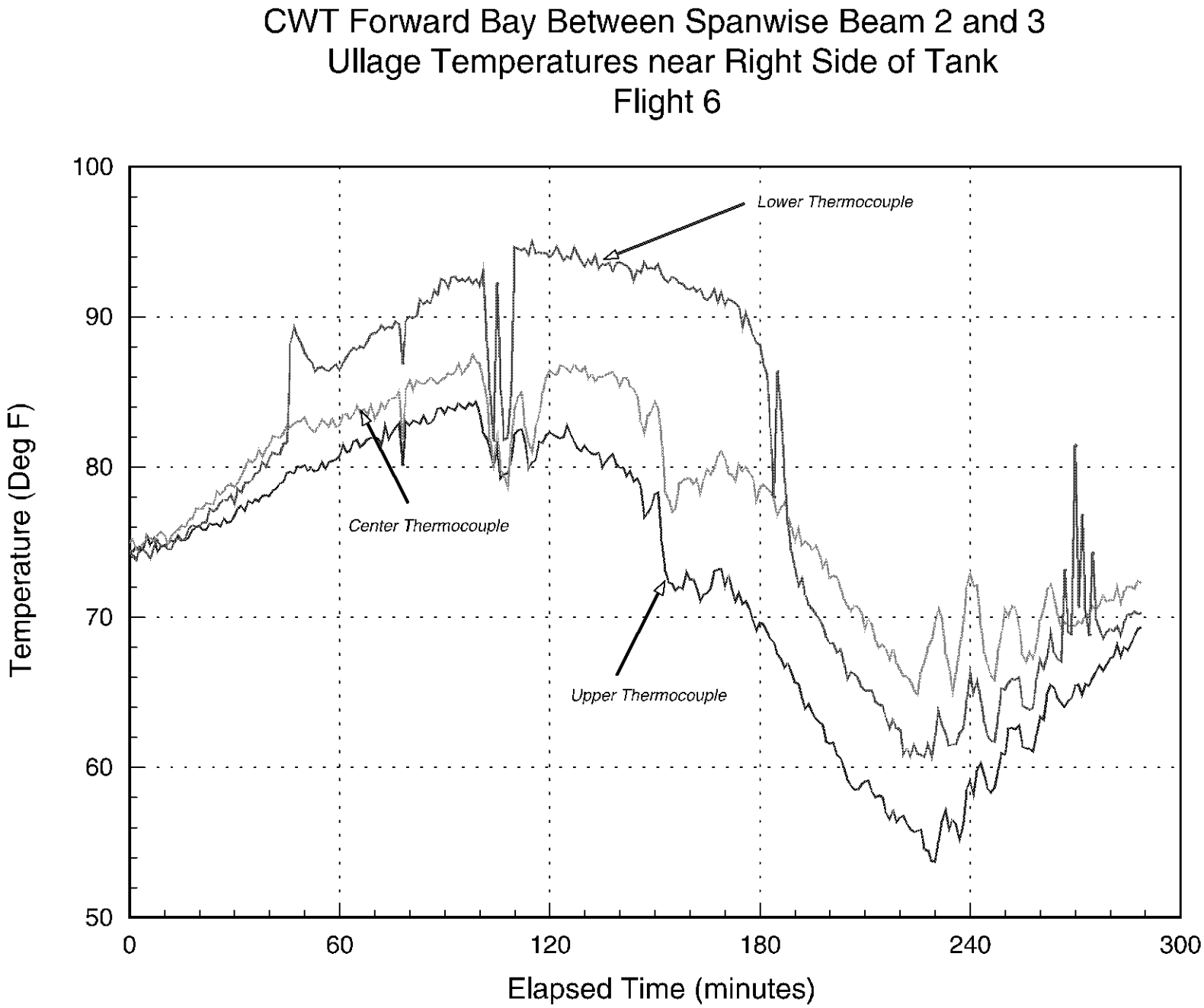

CWT Forward Bay Between Spanwise Beam 2 and Mid Spar
Ullage Temperatures near Left Side of Tank
Flight 6
Temperature (Deg F)
100
90
80
70
60
0
60
120
180
240
300
Elapsed Time (minutes)
Lower Thermocouple
Center Thermocouple
Upper Thermocouple

CWT Forward Bay Between Spanwise Beam 2 and Mid Spar
Ullage Temperatures near Right Side of Tank
Flight 6

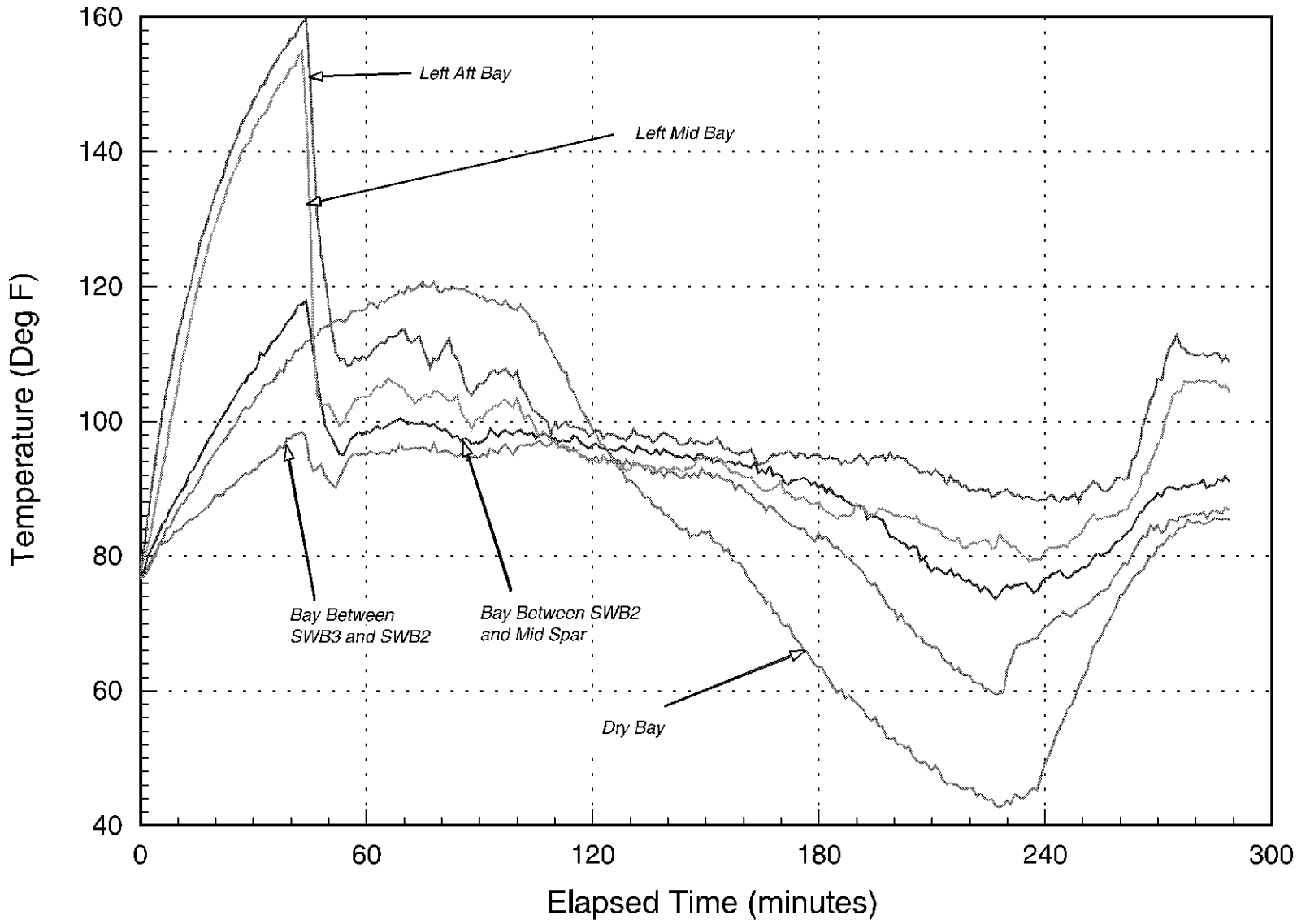


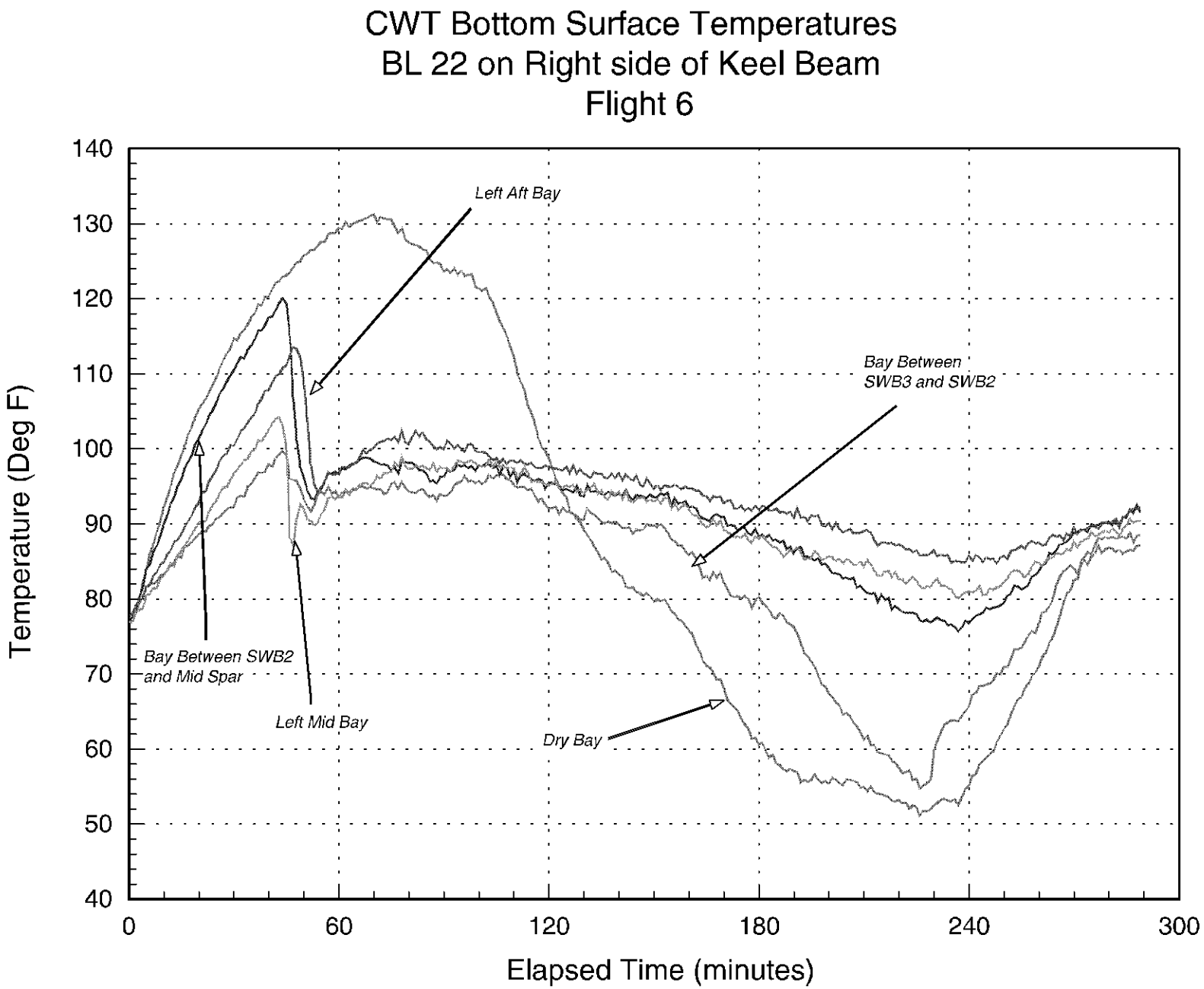

CWT Center of Bay #1
Ullage Temperatures
Flight 6
Temperature (Deg F)
100
95
90
85
80
75
70
65
0
60
120
180
240
300
Elapsed Time (minutes)
Lower
Center
Upper


CWT Forward Bay Between Spanwise Beam 2 and 3
Ullage Temperatures near Left Side of Tank
Flight 6
Lower Thermocouple
Center Thermocouple
Upper Thermocouple
Temperature (Deg F)
100
90
80
70
60
50
0
60
120
180
240
300
Elapsed Time (minutes)

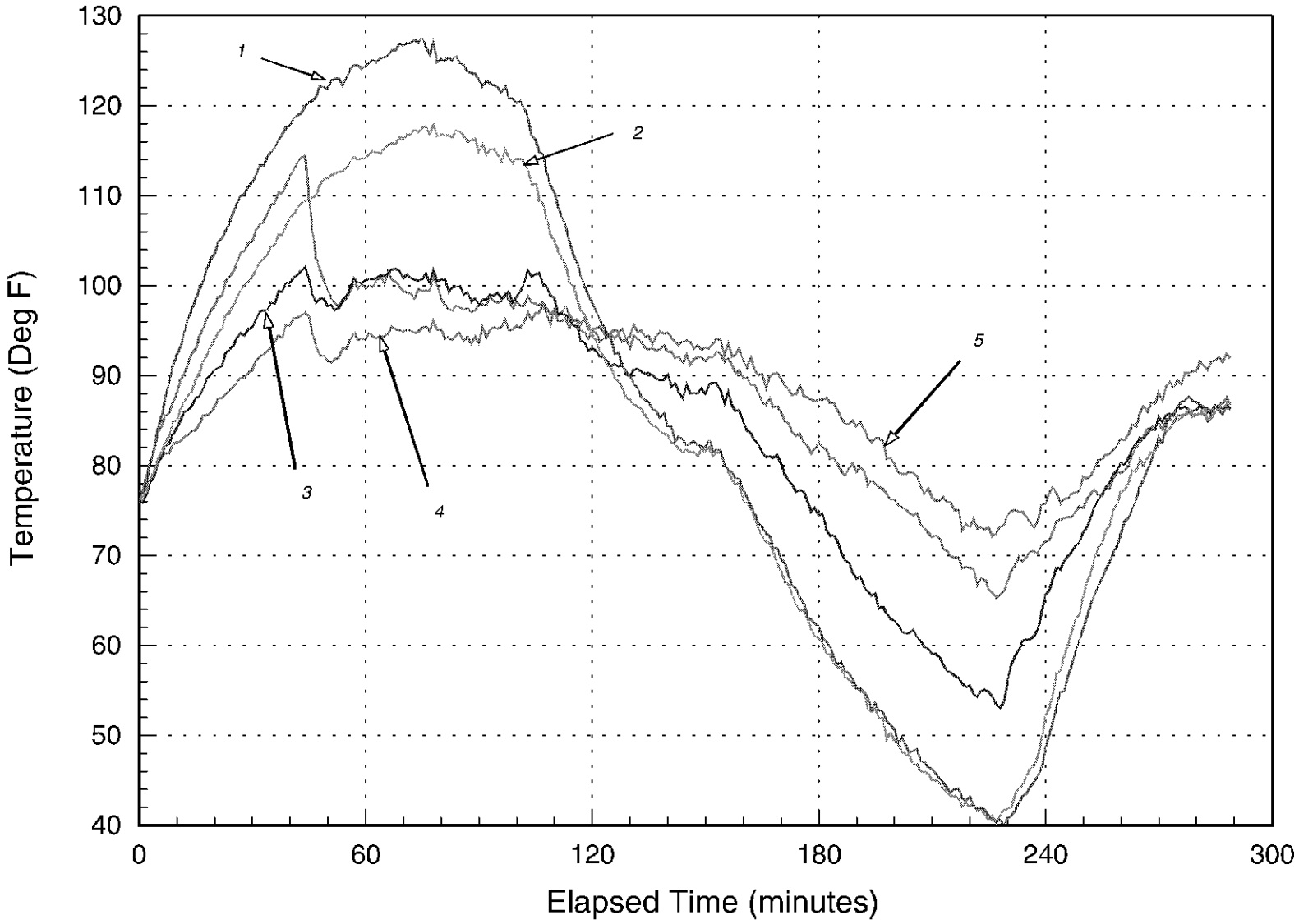

CWT Forward Bay Between Spanwise Beam 2 and 3
Ullage Temperatures near Right Side of Tank
Flight 6
Lower Thermocouple
Center Thermocouple
Upper Thermocouple
Temperature (Deg F)
100
90
80
70
60
50
0
60
120
180
240
300
Elapsed Time (minutes)

CWT Bottom Surface Temperatures
BL 22 on Left side of Keel Beam
Flight 6

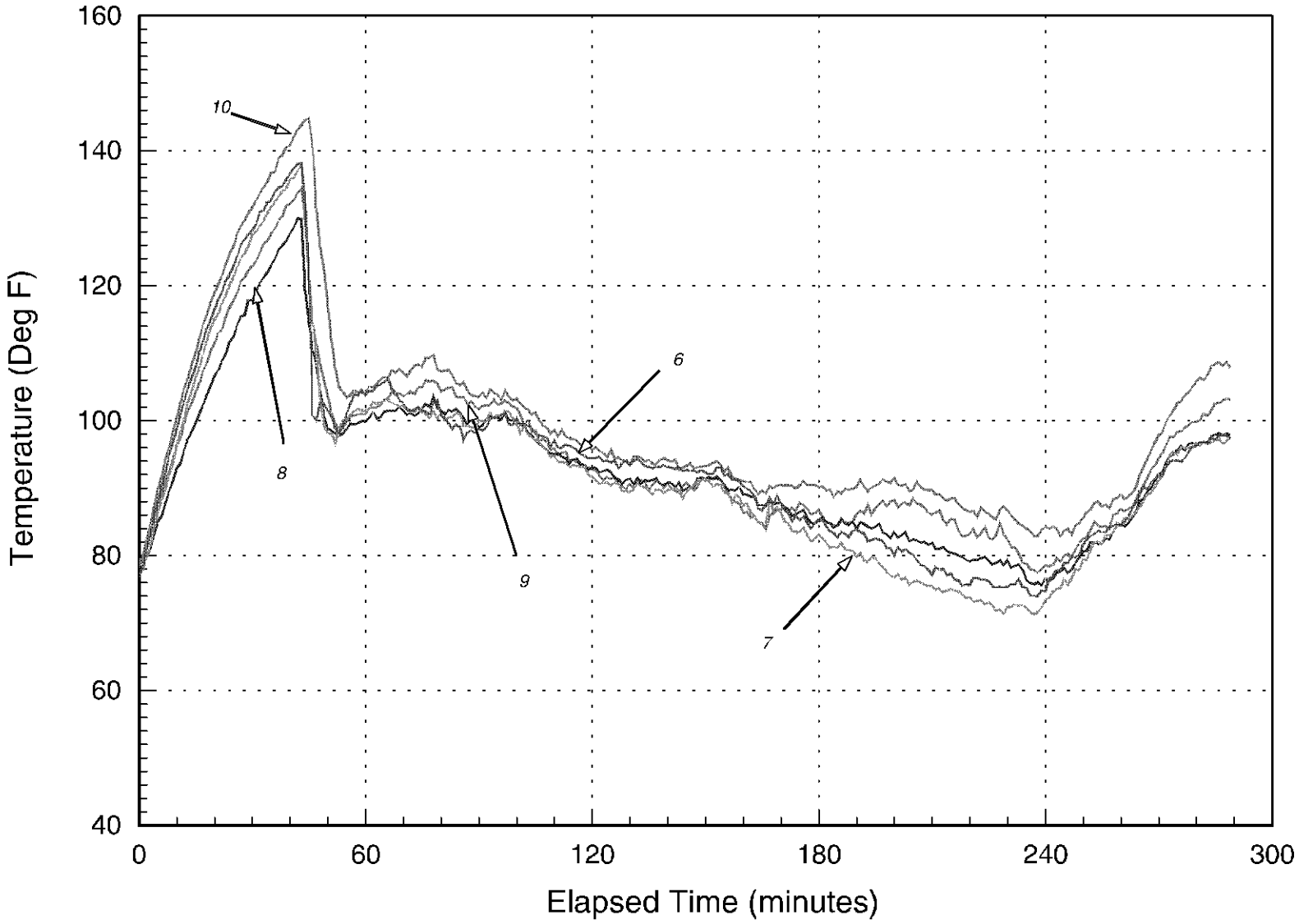



CWT Bottom Surface Temperatures
BL 22 on Right side of Keel Beam
Flight 6
Temperature (Deg F)
Elapsed Time (minutes)
140
130
120
110
100
90
80
70
60
50
40
0
60
120
180
240
300
Left Aft Bay
Bay Between SWB3 and SWB2
Bay Between SWB2 and Mid Spar
Left Mid Bay
Dry Bay

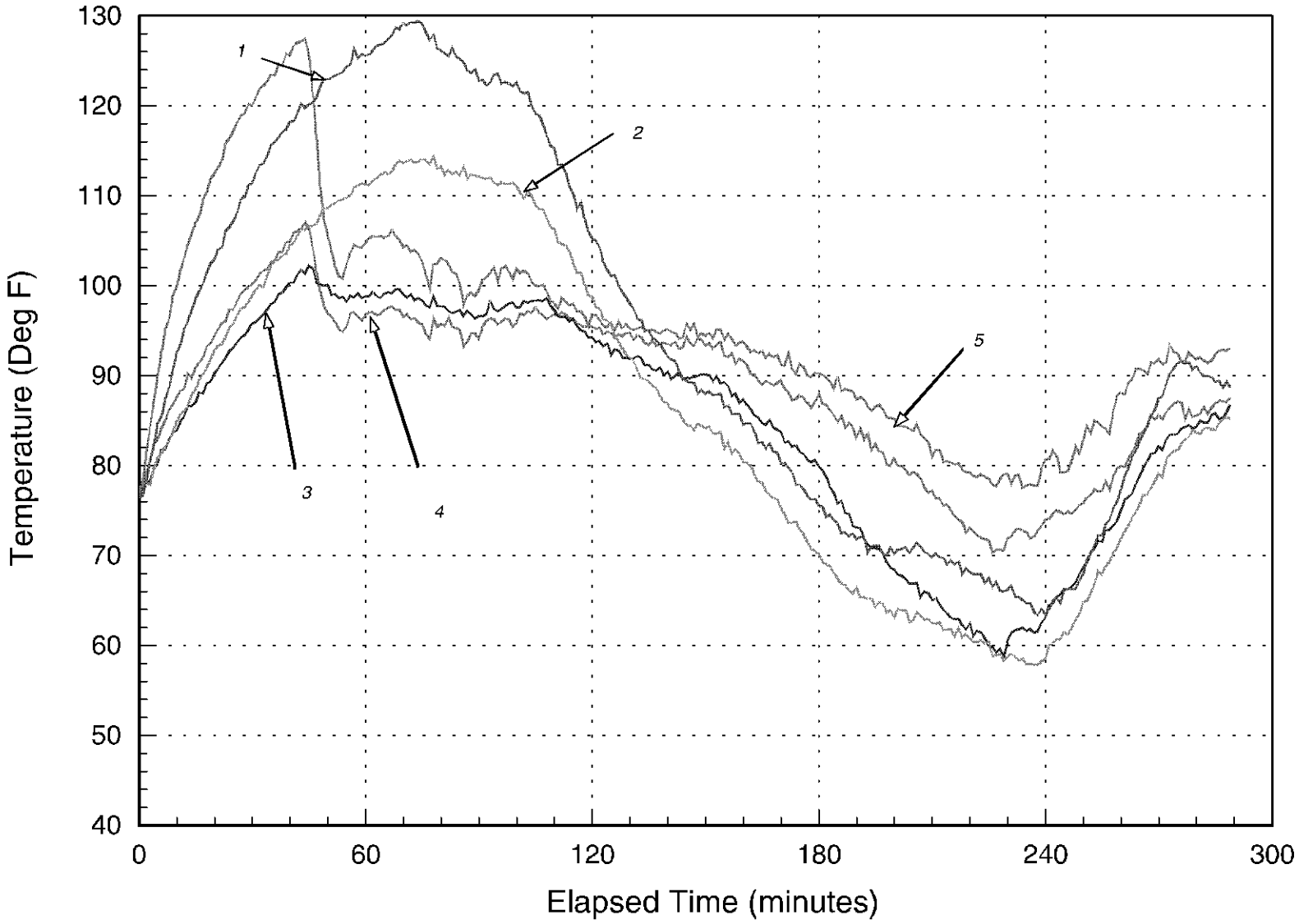
CWT External Bottom Surface Temperatures
BL 58 on Left side of Keel Beam - Front 5 T/C
Flight 6



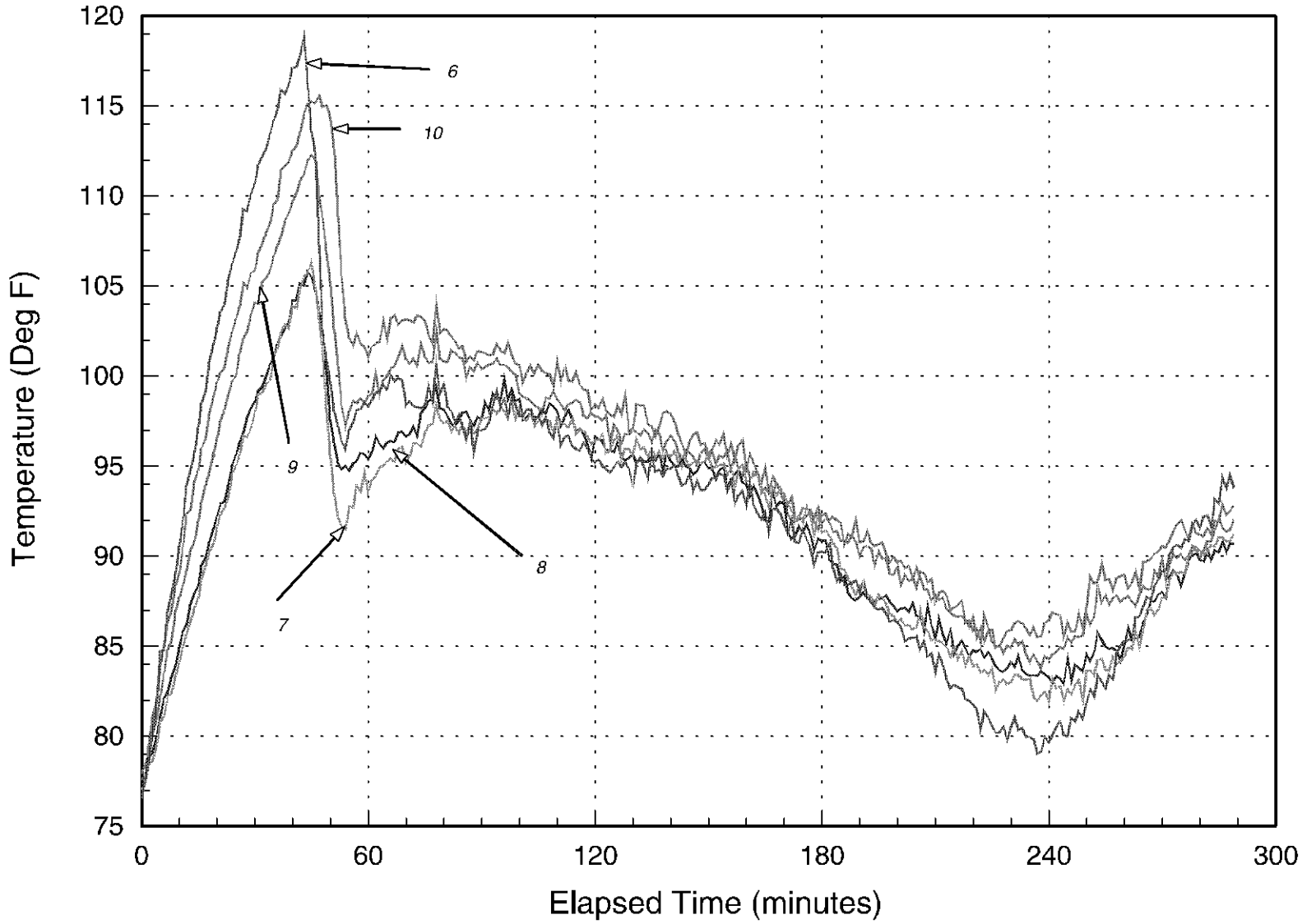
CWT External Bottom Surface Temperatures
BL 58 on Left side of Keel Beam - Aft 5 T/C
Flight 6

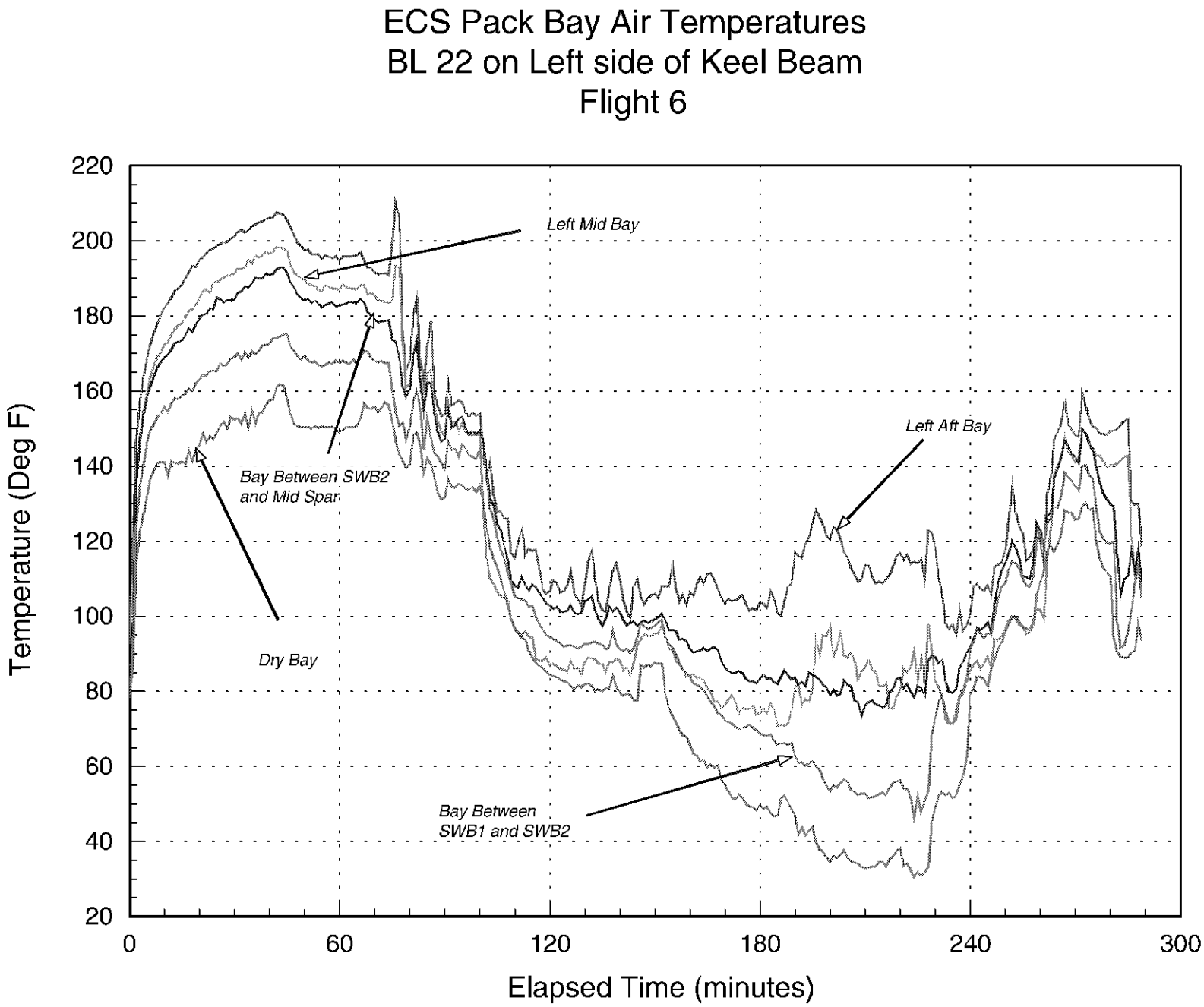


CWT External Bottom Surface Temperatures
BL 58 on Right side of Keel Beam - Front 5 T/C
Flight 6

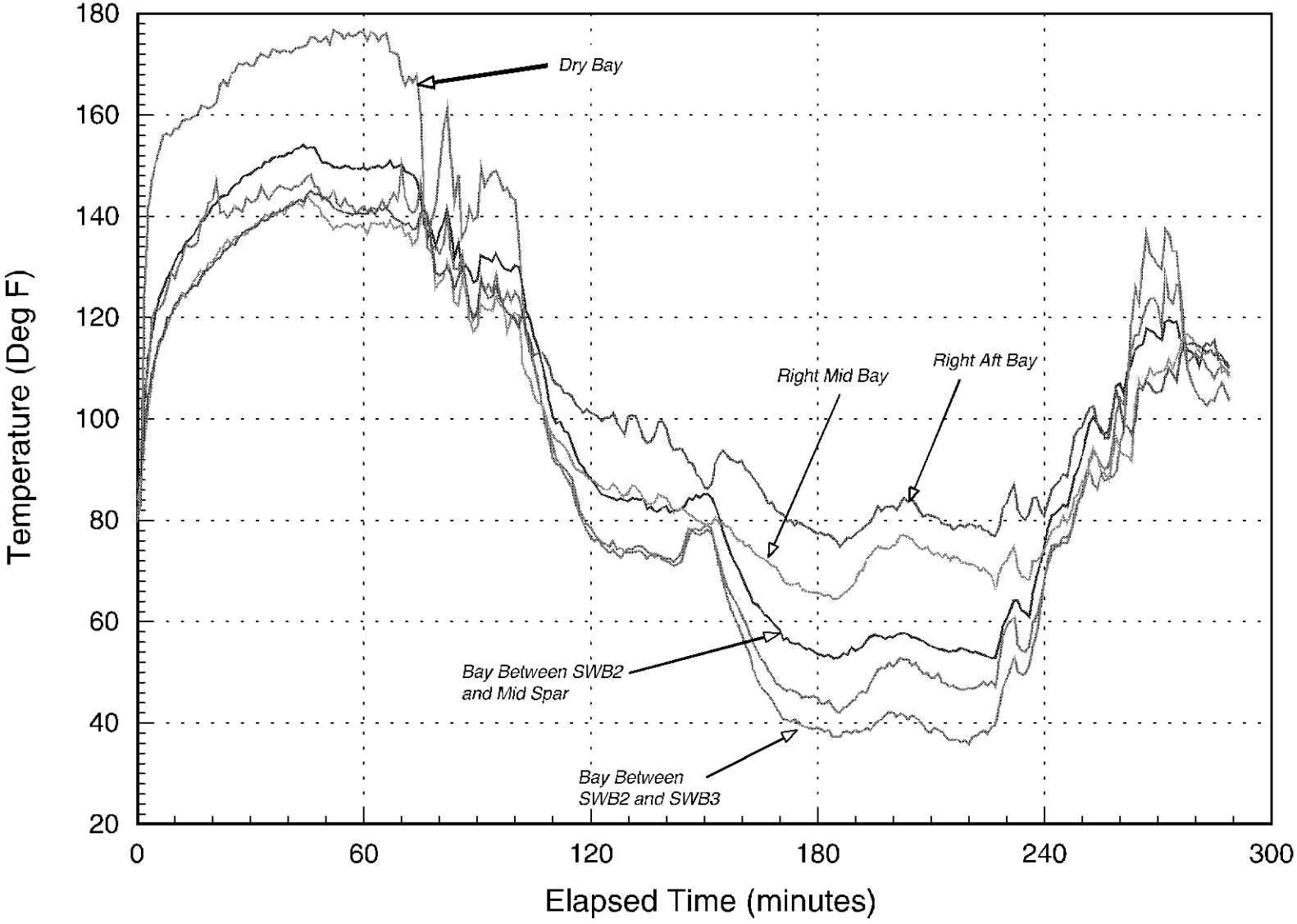


CWT External Bottom Surface Temperatures
BL 58 on Right side of Keel Beam - Aft 5 T/C
Flight 6

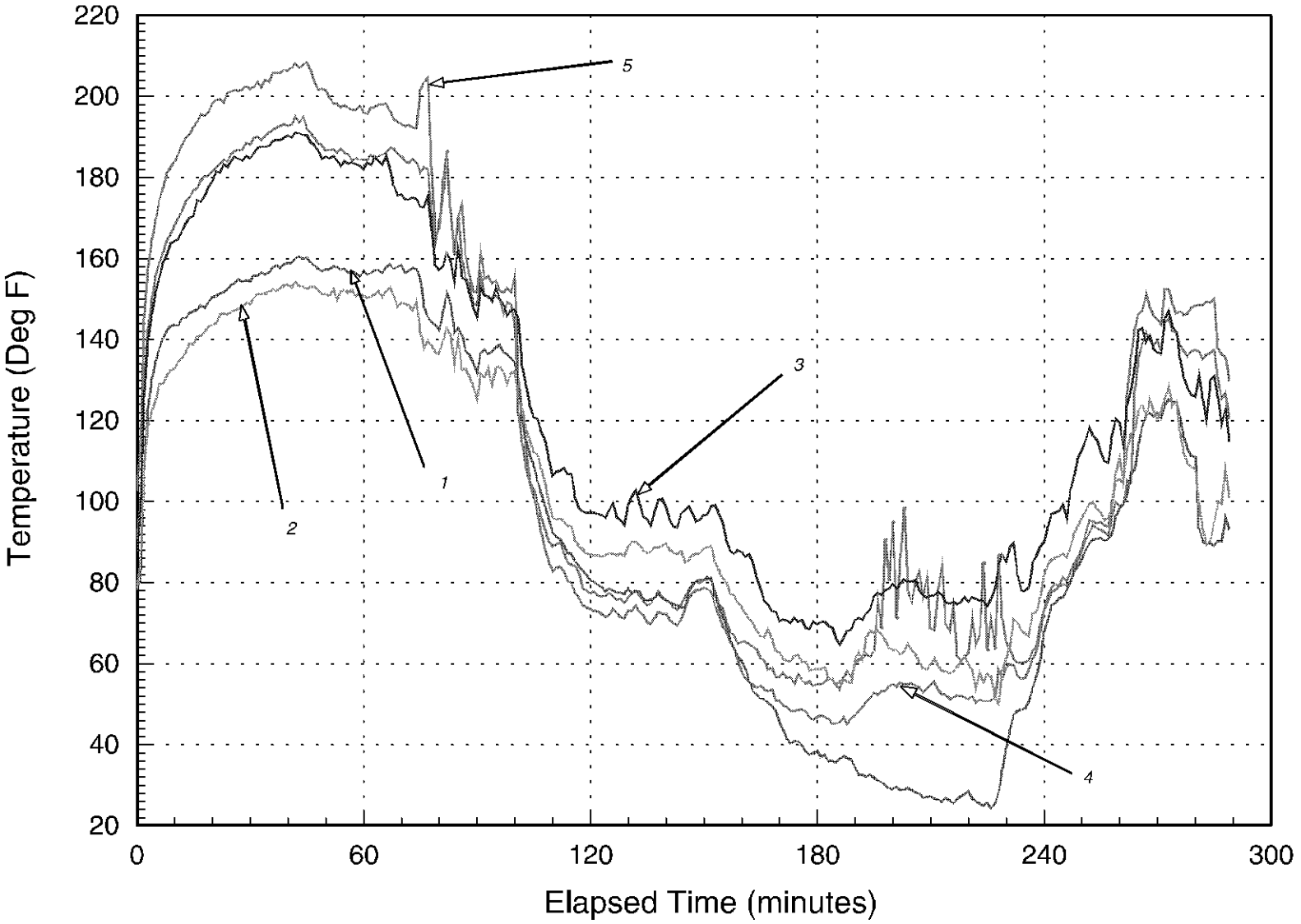


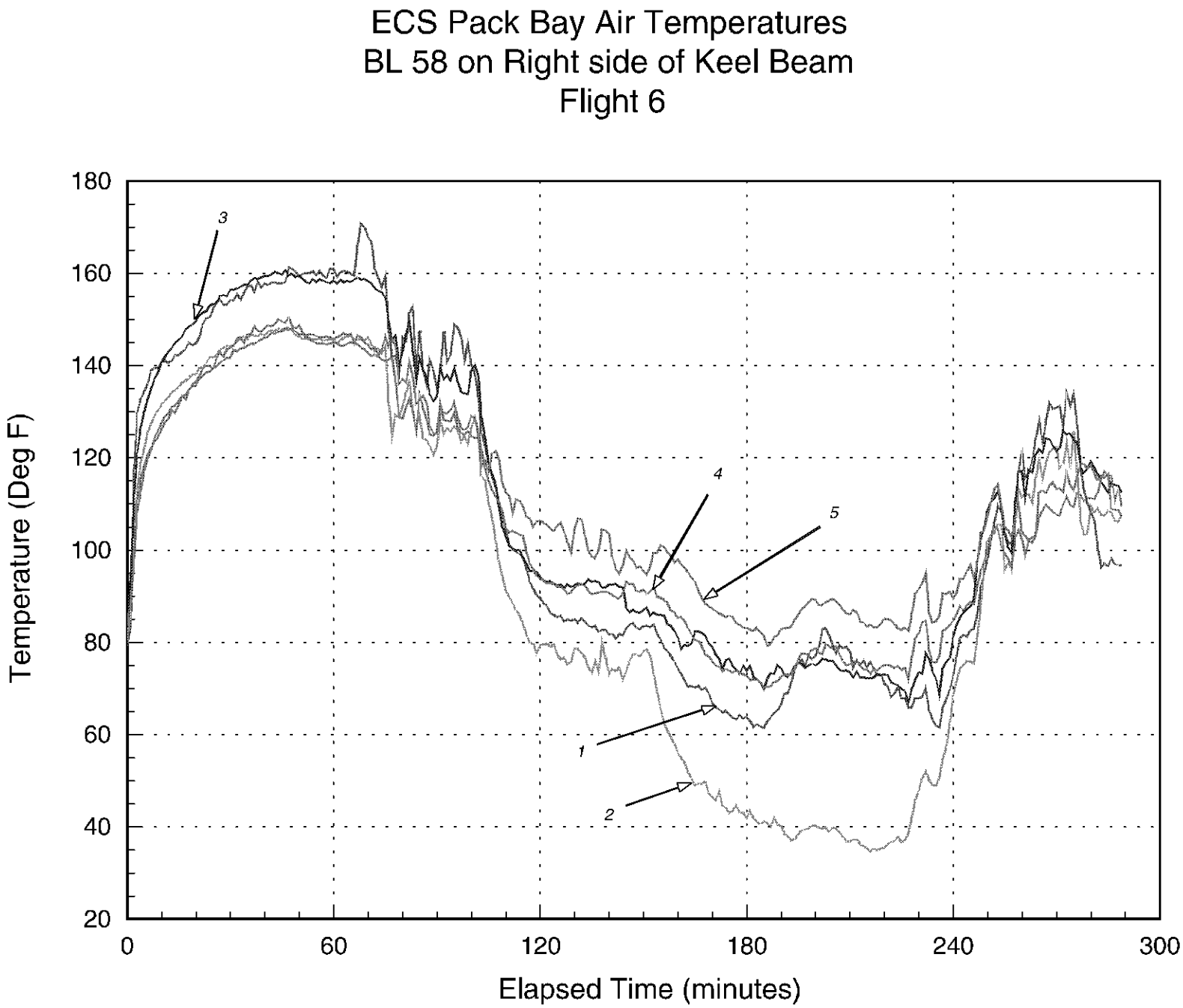

ECS Pack Bay Air Temperatures
BL 22 on Left side of Keel Beam
Flight 6
Temperature (Deg F)
Elapsed Time (minutes)
220
200
180
160
140
120
100
80
60
40
20
0
60
120
180
240
300
Left Mid Bay
Left Aft Bay
Bay Between SWB2
and Mid Spar
Dry Bay
Bay Between
SWB1 and SWB2

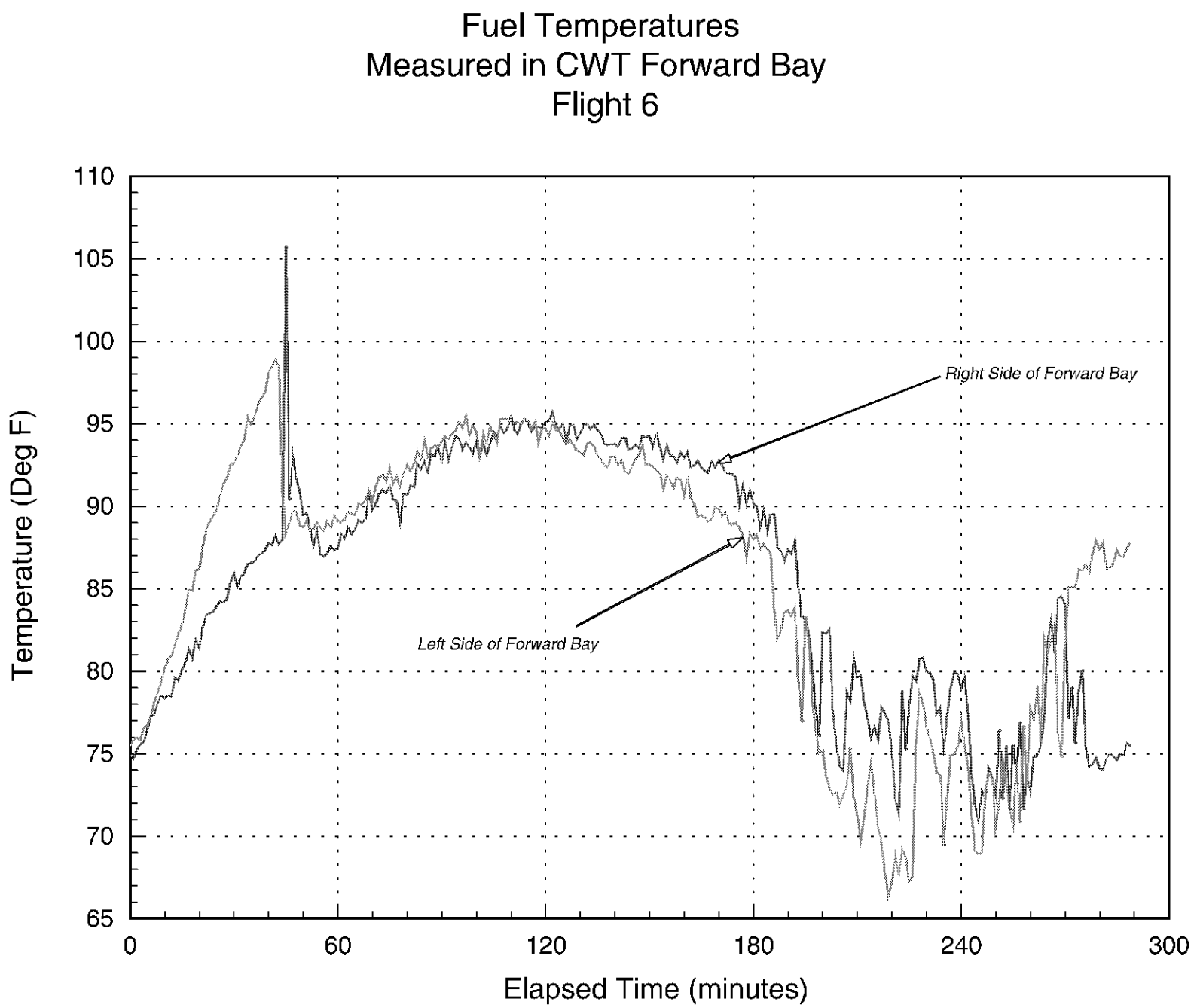
ECS Pack Bay Air Temperatures
BL 22 on Right side of Keel Beam
Flight 6

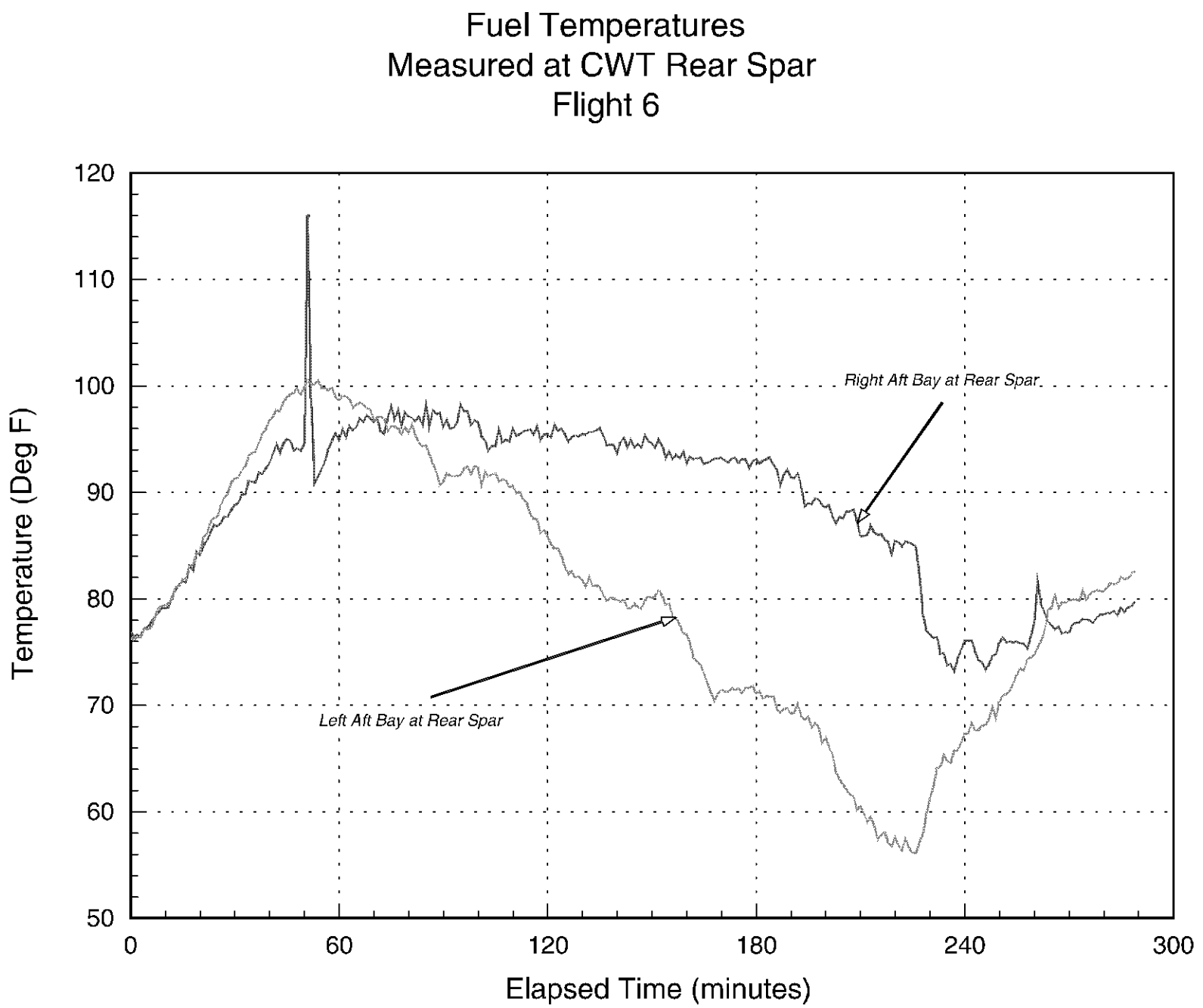


ECS Pack Bay Air Temperatures
BL 58 on Left side of Keel Beam
Flight 6




ECS Pack Bay Air Temperatures
BL 58 on Right side of Keel Beam
Flight 6
Temperature (Deg F)
Elapsed Time (minutes)
180
160
140
120
100
80
60
40
20
0
60
120
180
240
300
1
2
3
4
5


Fuel Temperatures
Measured in CWT Forward Bay
Flight 6
Temperature (Deg F)
110
105
100
95
90
85
80
75
70
65
0
60
120
180
240
300
Elapsed Time (minutes)
Right Side of Forward Bay
Left Side of Forward Bay


Fuel Temperatures
Measured at CWT Rear Spar
Flight 6
Temperature (Deg F)
120
110
100
90
80
70
60
50
0
60
120
180
240
300
Elapsed Time (minutes)
Right Aft Bay at Rear Spar
Left Aft Bay at Rear Spar