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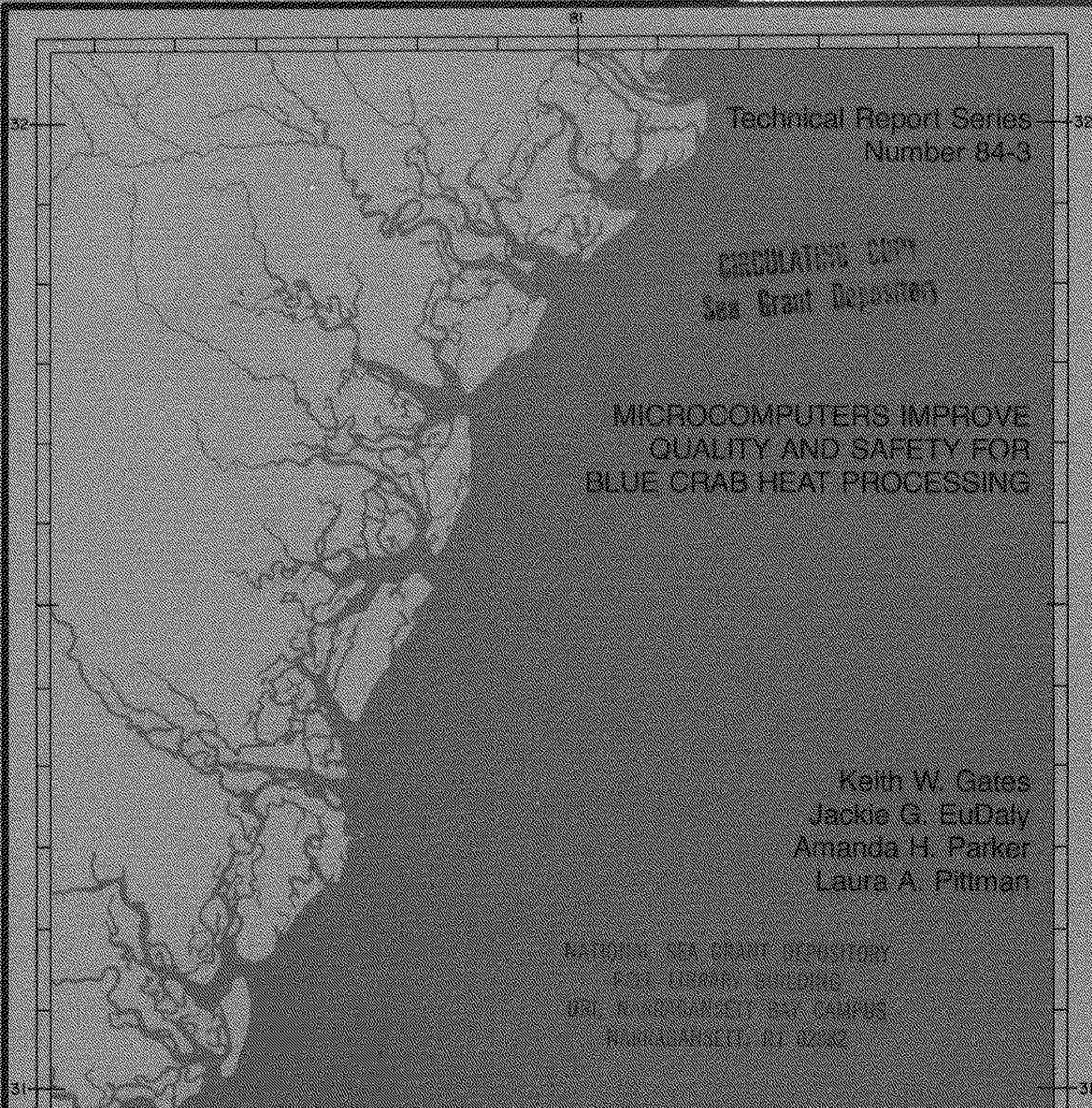

Technical Report Series
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MICROCOMPUTERS IMPROVE QUALITY AND SAFETY FOR BLUE CRAB HEAT PROCESSING

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Technical Report 84-3

by

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1984

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ABSTRACT

The Marine Extension Service offers crab processors a new and effective method to optimize their retort and pasteurization operations, assuring maximum yields, product quality, safety, and shelf life. The use of in-plant microprocessors and microcomputers can tailor thermal processing requirements to the needs of each plant while assuring uniform quality and safety. Introduction of total heat or the F-value concept provides processors with much more flexibility than could be achieved under the traditional system of pasteurizing a one-pound can of crab meat to an internal temperature of 185°F (85°C) for one minute.

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INTRODUCTION

The majority of blue crab processors on the Atlantic Coast rely on pressurized steam to retort live blue crabs prior to removing cooked meat from the crab bodies. The recovered meat, which is usually handpicked, is then marketed as "fresh" crab meat with a refrigerated shelf life of 10 to 14 days, or is canned and pasteurized in a hot water bath to produce a refrigerated product with a shelf life greater than six months. Both the retorting and pasteurization processes require controlled time/temperature relationships to insure product safety, quality, and yield.

Several hundred to several thousand pounds of live blue crabs are cooked to an internal temperature of 235°F (112.8°C) in large horizontal or vertical steam pressure retorts at 15 pounds per square inch. If the crabs are cooked at a lower temperature, the meat is too moist, is difficult to pick, has excessive bacterial populations, and has a short shelf life. Cooking for too long a time dessicates the meat and reduces the percentage yield. The cooked crabs are backed and the meat is removed by trained pickers or, less frequently, by a crab-picking machine. The meat then can be packed as "fresh" or placed in cans, pouches, or sealed plastic containers for hot water pasteurization. Most crab meat is hot-water pasteurized (186-190°F, 85.5-87.8°C) in one-pound cans (#401) to an internal temperature of 185°F (85°C). Traditional blue crab meat pasteurization specifications require that the 185°F (85°C) temperature be maintained at the geometric center of the can for one minute (9). Processing for too short a period or at much lower temperatures causes the meat to be undercooked, which usually results in early spoilage of the product and in the potential development of toxins produced by Type E *Clostridium botulinum*. Cooking at an excessive temperature or for an extended period causes the meat to turn blue. The blue coloration is not harmful, but the meat is usually unacceptable to the consumer (1, 11, and 12).

Rapid and efficient cooling is needed to assure quality and safety. National Blue Crab Industry Association Pasteurization Guidelines require that recirculating cooling water be used to reduce pasteurized meat temperatures to less than 55°F (12.8°C) within 180 minutes of pasteurization. Meat temperatures must be brought to 36°F (2.2°C) within 18 hours and held between 32°F (0°C) and 36°F (2.2°C) during subsequent shipping and storage. Meat temperatures at or below 36°F (2.2°C) prevent the growth of Type E *Clostridium botulinum* that may have contaminated the meat through improper can seams(9). Type E can produce a deadly toxin above 38°F (3.3°C).

Over the last several years, blue crab processors have come under increasing pressure from consumers, from state and federal regulatory agencies, and from within the industry itself to improve product quality and safety. The National Blue Crab Industry Association adopted industry-wide pasteurization guidelines in February 1984 that detailed specific equipment and processing requirements for pasteurized meat. Rising energy and raw materials costs have increased the financial incentive for processors to establish energy conservation measures and improve product yields.

Several years ago, Georgia blue crab processors requested thermal processing assistance from the Marine Extension Service. The plant operators wanted to improve steam distribution within their retorts to provide for a more even cook. Poor steam distribution overcooks some crabs while undercooking others. The processors also wished to standardize their pasteurization operations, introduce product sizes and packaging types different from the traditional 16-ounce can, and improve product cooling.

METHODS

In response to processors' requests, the Marine Extension Service developed a portable system to monitor in-plant time/temperature relationships for the retorting of live blue crabs and the pasteurization of blue crab meat. A portable Digitec 1100 data logger and a Digitec Model 6010 data store capable of monitoring 20 separate channels are used to record time/temperature data on magnetic tape. Data transfer to diskette on an IBM Personal Computer is achieved through an RS-232 port at 1200 Baud using PC-Talk software (3). Type T copper-constan thermocouples measure the internal temperatures of crabs and temperatures at the geometric center of cans and retort pouches.

Internal crab and one-pound can (#401) temperatures are monitored by 2 -1/16" molded plastic thermocouples (O.F. Ecklund Company). Eight-ounce can (#307) temperatures are monitored by 1 -11/16" molded plastic thermocouples (O.F. Ecklund Company). Pouch temperatures are measured by 20-or 24-gauge copper constan thermocouple wires inserted through brass stuffing box fittings (O.F. Ecklund Company). Thermocouples are inserted into the sides of cans to be pasteurized through a threaded stainless steel thermocouple receptacle. The receptacle holds the thermocouple in place through a hole previously cut by a can punch. The thermocouple, at the can's geometric center, is then sealed into the can with the appropriate amount of crab meat (Figure 1). Temperature values are transmitted to the Digitec data logger through tefloncoated copper-constan thermocouple wire. One probe monitors the water bath temperature and 9 to 19 probes monitor internal can temperatures. Automatic temperature readings are recorded once every minute during the cooking and cooling cycles.

A copper-constan thermocouple is inserted through the first joint of the blue crab's swimmeret into the center of the body cavity and wired into place across the lateral spines with nickel-chromium wire (Figure 2). During most retort studies, two probes monitor steam temperatures at the top and bottom of vertical retorts, and 8 to 18 probes monitor the internal temperatures of crabs distributed throughout the cooking baskets. Temperature readings are taken electronically every 8 to 10 seconds.

COMPUTER PROGRAMS

The IBM Personal Computer is used to organize time/temperature data, calculate F-values, and provide graphics output supported by Lotus Symphony software (4). The computer can also be used as a terminal to support Statistical Analytical System (SAS) (5, 6) graphics that plot temperature versus time for pasteurization and retort studies.

F-value is defined as the equivalent in minutes at a given temperature (T_{RT} = reference temperature) of all heat considered with respect to its capacity to destroy spores or vegetative cells of a particular organism (7, 8, 9, 10). The F-value is the number of minutes at a given temperature required to kill a known population of organisms in a given food under specified conditions. The traditional 16-ounce can (#401) of crab meat held for 185°F (85°C) for one minute has an F-value of:

$$F_{185}^{16} = 31 \text{ minutes}$$

If the can of crab meat could be instantly heated to 185°F (85°C), held at that temperature for 31 minutes and then instantly cooled, the total F-value would be 31 minutes. The traditional pasteurization process achieves the same equivalent F-value by heating and cooling the meat gradually over approximately a two-to three-hour period and holding the internal can temperature at 185°F (85°C) for one minute (7, 8, 9, 10).

The superscript 16 (F_{185}^{16}) is the Z-value determined for Type E Clostridium botulinum. The Z-value is defined as the number of degrees Fahrenheit needed for the thermal destruction curve to traverse one log cycle. That is, a change of 16°F is required to reduce the number of bacterial vegetative and/or spore cells by a factor of ten. If the pasteurization temperature were raised 16°F, from 185°F to 201°F, then cooking for one minute at 201°F would kill the same number of bacteria as a ten-minute cook at 185°F. The higher the Z-value, the greater the organism's resistance to heat (7, 8, 9, 10). Adherence to established F and Z values assures the destruction of spoilage and disease organisms, including spores of Type E Clostridium botulinum which can germinate and produce toxin in crab meat.

Interval and cumulative F-values are calculated by the computer with the following formula (8):

$$F_0 = (t_2 - t_1)\left[10^{\left(\frac{T_{1,2} - T_{RT}}{Z}\right)}\right]$$

F_0 = F-value of time interval $(t_2 - t_1)$

t_1 = Time of the first temperature measurement

t_2 = Time of the second temperature measurement

$T_{1,2}$ = Mean temperature in the interval $(t_2 - t_1)$

T_{RT} = Reference temperature

Z = Z-value

Cumulative F-values are determined by summing interval F-values over time (Figure 3).

Four programs, written for the IBM-PC in BASICA, were developed to read temperatures from diskette storage, calculate F-interval and F-total values, and print the results for each monitored probe. An example of a final printout for a pasteurization study is presented in Figure 4.

Program One (Appendix) reads the Digitec output (Figure 5) from retort monitoring that was written to a diskette with PC-Talk, extracts the temperature readings, and writes them to a new diskette file that is processed by Program Two (Appendix). Probe numbers, times, temperatures, and F-internal and F-total values are printed by the program. Program Three writes temperature values recorded by the Digitec (Figure 6) during pasteurization to a new diskette file for processing by Program Four (Appendix). The printout includes probe numbers, times, temperatures, and F-interval and F-total values.

Temperature values for retort and pasteurization cooks are plotted against time using Lotus Symphony (4), SAS Graph, or SAS Plot (3,4). Using the random file created by Program One, Program Five in BASICA prepares time/temperature retort data to be "imported" into the Lotus Symphony program (4) for graphic presentation on a dot matrix printer or a pen plotter. Program Three and Program Six perform the same function for pasteurization data. Typical graphs of retort and pasteurization cooks are presented in Figures 7, 8, 9, and 10.

MICROCOMPUTERS AND THE PROCESSOR

The Marine Extension Service offers crab processors a new and effective method to optimize their retort and pasteurization operations, assuring maximum yields, product quality, safety, and shelf life. The use of in-plant microprocessors and microcomputers can tailor thermal processing requirements to the needs of each plant, while assuring uniform product quality and safety.

Introduction of total lethal heat, or the F-value concept, provides processors with much more flexibility than could be achieved under the traditional system of pasteurizing a one-pound can (#401) of crab meat to an internal temperature of 185°F (85°C) for one minute. Meat can safely be pasteurized at lower water bath temperatures for longer periods as long as the total F-value equals 31 (10). The possibility of blueing is reduced, particularly in South Atlantic and Gulf of Mexico crab meat, which is more susceptible to discoloration (11,12). New packaging sizes and types, including smaller cans, retortable plastic containers, and retortable pouches, can be introduced safely to the marketplace after appropriate thermal processing parameters are established for each container type.

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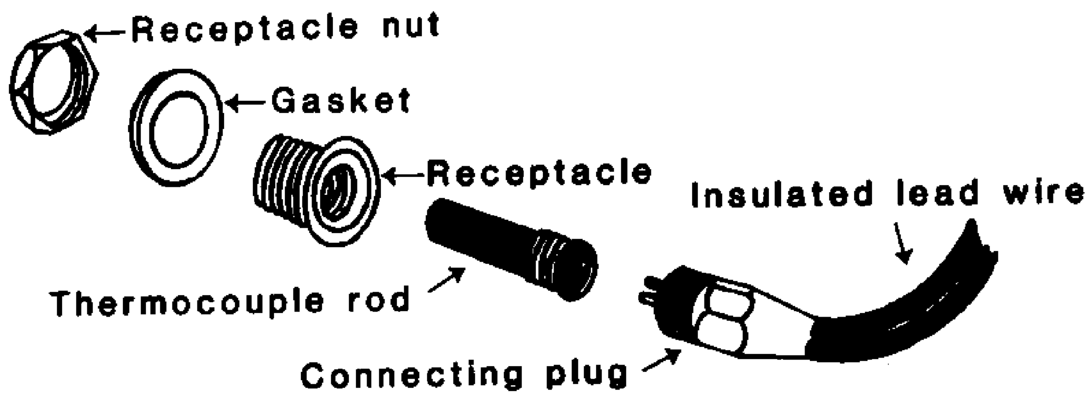
FIGURES



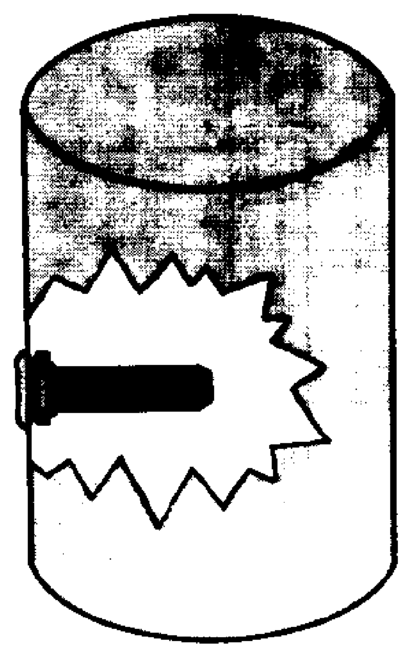


Figure 1. Detail of thermocouple placement in cans of crab meat to be monitored during pasteurization.

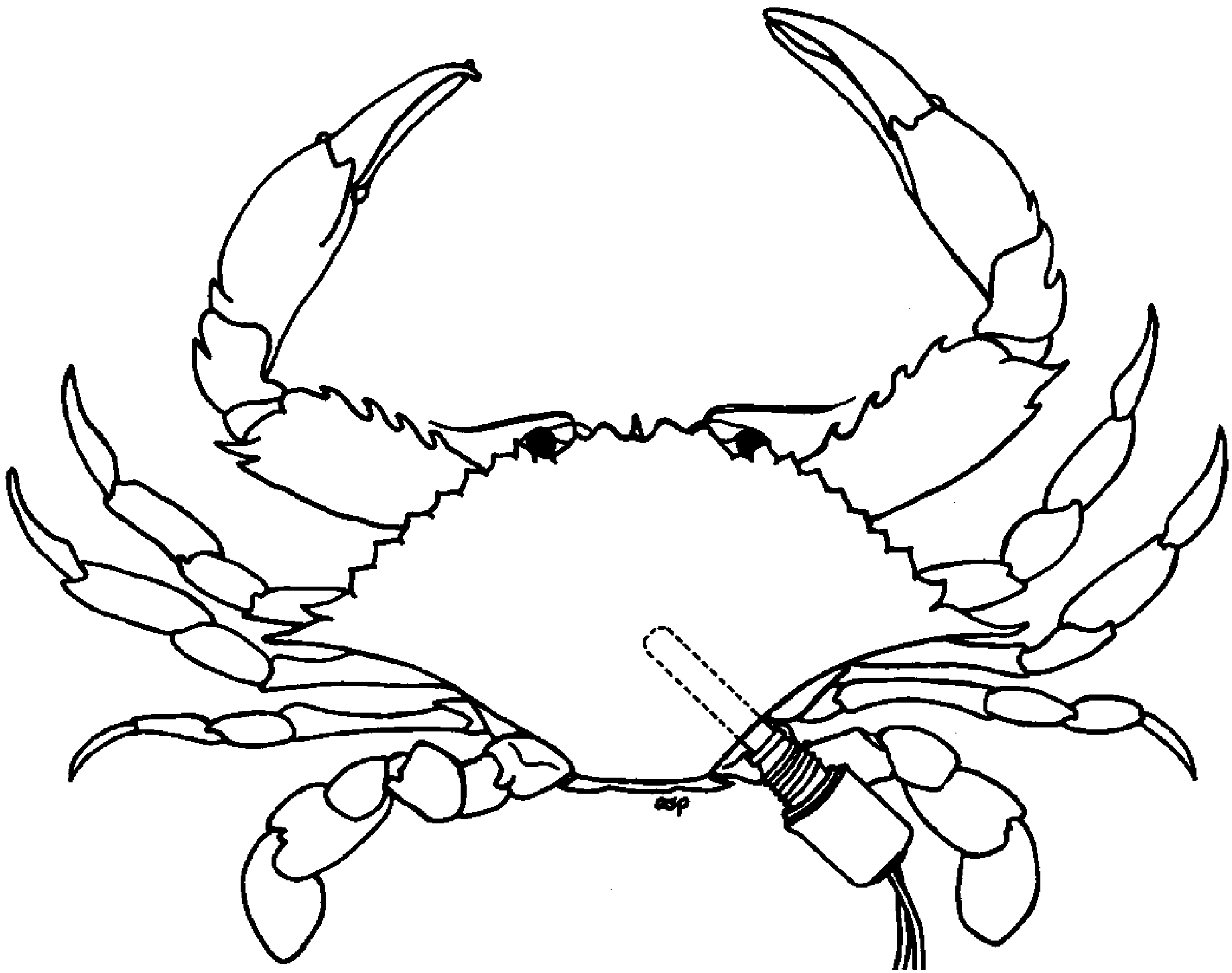
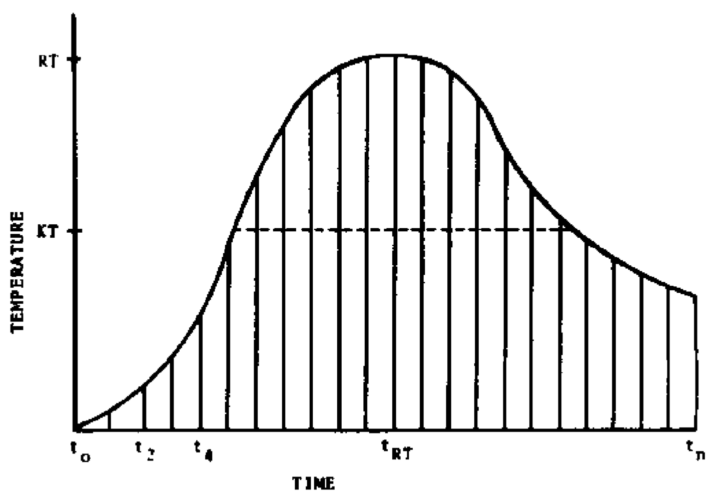


Figure 2. Detail of thermocouple placement in blue crabs during the retort cook.

TOTAL F-VALUE



RT = Reference Temperature

KT = Killing Temperature

$$F_T = \sum_{o}^{n} F_o + F_1 + F_2 + \cdots + F_n$$

$$F_o = (t_2 - t_1)\, 10^{\frac{T_{1,2} - T_{RT}}{z}}$$

Figure 3. Summing the total F-value over time (t_o - t_n) for the intervals t_n - t_{n-1}.

YOUR CRAB PLANT
HOT WATER PASTEURIZATION
CAN
16 OUNCE
17 / 9 / 84

PROBE NO.	TIME	TEMP. F	F-INTER.	F-TOTAL
0	10	49.10	0.000000	0.000000
0	20	67.10	0.000000	0.000000
0	30	68.90	0.000001	0.000001
0	40	70.70	0.000001	0.000002
0	50	74.30	0.000001	0.000003
0	60	80.60	0.000003	0.000006
0	70	93.20	0.000018	0.000024
0	80	111.20	0.000244	0.000268
0	90	129.20	0.003255	0.003523
0	100	147.20	0.043401	0.046924
0	110	165.20	0.578762	0.625686
0	120	183.20	7.717912	8.343598
0	130	188.60	16.788050	25.131650
0	140	185.00	10.000000	35.131650
0	150	180.50	5.232991	40.364640
0	160	171.50	1.433013	41.797650
0	170	162.50	0.392419	42.190070
0	180	149.00	0.056234	42.246300
0	190	131.00	0.004217	42.250520
0	200	113.00	0.000316	42.250830
0	210	95.00	0.000024	42.250860
0	220	77.00	0.000002	42.250860
0	230	59.00	0.000000	42.250860
0	240	45.50	0.000000	42.250860

Figure 4. Example printout of F-interval, F-total, probe number and temperature values from a pasteurization cook.

00	+0022.	C	313	14:44:57
01	+0019.	C	313	14:44:58
02	+0019.	C	313	14:44:59
03	+0017.	C	313	14:44:59
04	+0017.	C	313	14:45:00
05	+0032.	C	313	14:45:01
06	+0035.	C	313	14:45:01
07	+0032.	C	313	14:45:02
08	+0020.	C	313	14:45:03
09	+0013.	C	313	14:45:04
10	+0016.	C	313	14:45:04
11	+0055.	C	313	14:45:05
00	+0016.	C	313	14:45:06
01	+0021.	C	313	14:45:06
02	+0014.	C	313	14:45:07
03	+0081.	C	313	14:45:08
04	+0016.	C	313	14:45:08
05	+0039.	C	313	14:45:09
06	+0035.	C	313	14:45:10
07	+0031.	C	313	14:45:11
08	+0010.	C	313	14:45:11
09	+0017.	C	313	14:45:12
10	+0019.	C	313	14:45:13
11	+0055.	C	313	14:45:13
00	+0027.	C	313	14:45:14
01	+0019.	C	313	14:45:15
02	+0021.	C	313	14:45:15
03	+0014.	C	313	14:45:16
04	+0024.	C	313	14:45:17
05	+0034.	C	313	14:45:17
06	+0030.	C	313	14:45:18
07	+0034.	C	313	14:45:19
08	+0011.	C	313	14:45:20
09	+0021.	C	313	14:45:20
10	+0014.	C	313	14:45:21
11	+0056.	C	313	14:45:22
00	+0030.	C	313	14:45:22
01	+0016.	C	313	14:45:23
02	+0021.	C	313	14:45:24
03	+0019.	C	313	14:45:24
04	+0024.	C	313	14:45:25
05	+0035.	C	313	14:45:26
06	+0027.	C	313	14:45:26
07	+0039.	C	313	14:45:27
08	+0011.	C	313	14:45:28
09	+0021.	C	313	14:45:29
10	+0010.	C	313	14:45:29
11	+0064.	C	313	14:45:30
00	+0034.	C	313	14:45:31
01	+0025.	C	313	14:45:31

Figure 5. Digitec Data Store output set on continuous scan for the pressurized retorting of blue crabs.

```
CH   DATA    PAR 319  10:50:14
00  +0005.   C   319  10:50:15
01  +0005.   C   319  10:50:17
02  +0005.   C   319  10:50:18
03  +0005.   C   319  10:50:20
04  +0005.   C   319  10:50:21
05  +0005.   C   319  10:50:22
06  +0005.   C   319  10:50:24

CH   DATA    PAR 319  10:51:01
00  +0008.   C   319  10:51:02
01  +0009.   C   319  10:51:04
02  +0007    C   319  10:51:05
03  +0008.   C   319  10:51:06
04  +0009.   C   319  10:51:08
05  +0007.   C   319  10:51:09
06  +0006.   C   319  10:51:11

CH   DATA    PAR 319  10:52:00
00  +0010.   C   319  10:52:02
01  +0011.   C   319  10:52:03
02  +0012.   C   319  10:52:05
03  +0013.   C   319  10:52:06
04  +0010.   C   319  10:52:07
05  +0011.   C   319  10:52:09
06  +0021.   C   319  10:52:10

CH   DATA    PAR 319  10:53:01
00  +0015.   C   319  10:53:02
01  +0016.   C   319  10:53:04
02  +0017.   C   319  10:53:05
03  +0015.   C   319  10:53:06
04  +0016.   C   319  10:53:08
05  +0017.   C   319  10:53:09
06  +0015.   C   319  10:53:11

CH   DATA    PAR 319  10:54:00
00  +0020.   C   319  10:54:02
01  +0021.   C   319  10:54:03
02  +0022.   C   319  10:54:04
03  +0023.   C   319  10:54:06
04  +0024.   C   319  10:54:07
05  +0023.   C   319  10:54:09
06  +0022.   C   319  10:54:10

CH   DATA    PAR 319  10:55:01
```

Figure 6. Digitec Data Store output set at a one-minute scan interval for the pasteurization of blue crab meat.

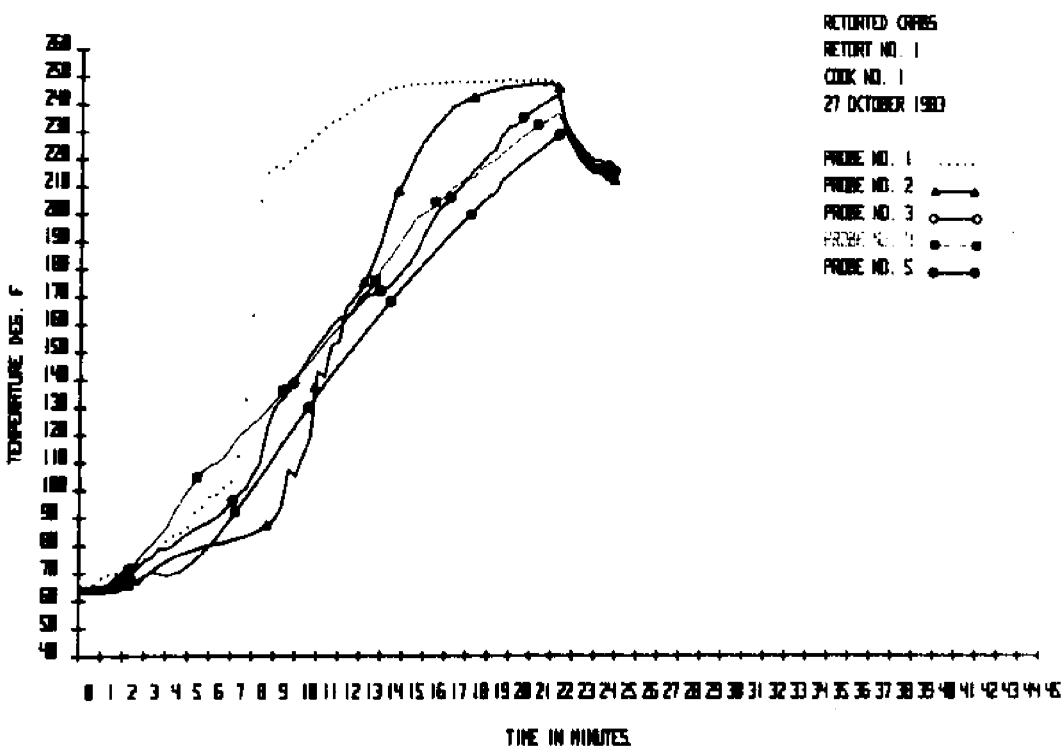


Figure 7. Typical thermal processing curves of a steam retort at a crab plant. Probe #1 monitored steam temperature, while probes #2 - #5 measured internal crab temperatures.

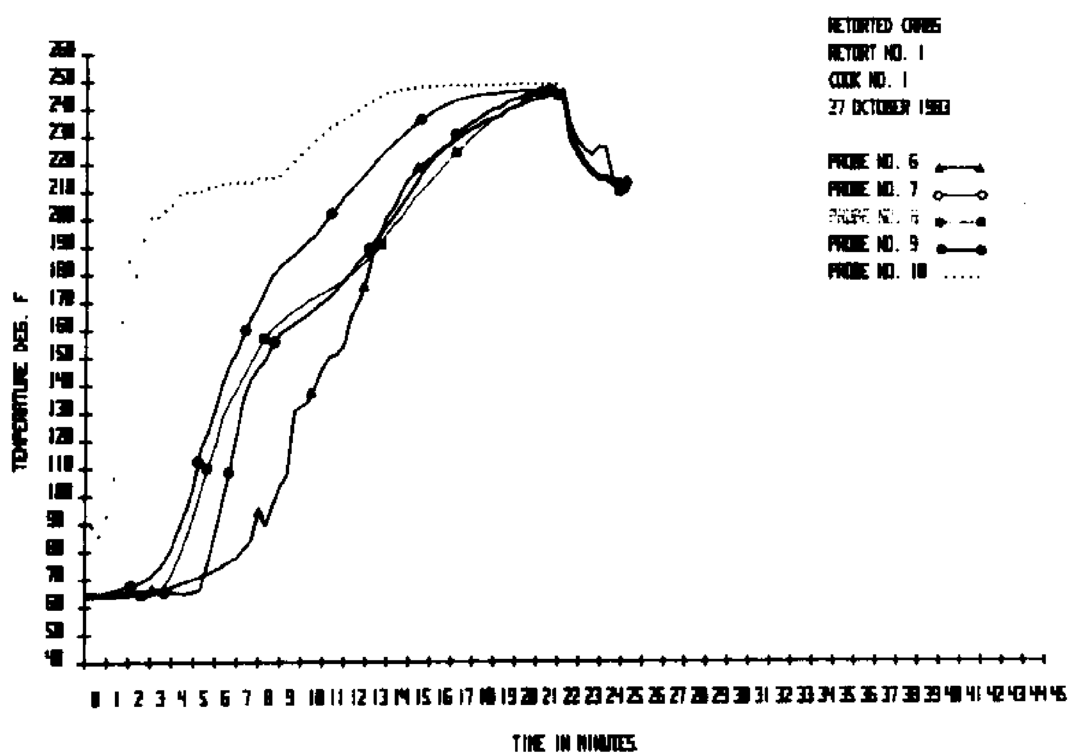


Figure 8. Typical thermal processing curves of a steam retort at a crab plant. Probe #10 monitored steam temperature, while probes #6 - #9 measured internal crab temperatures.

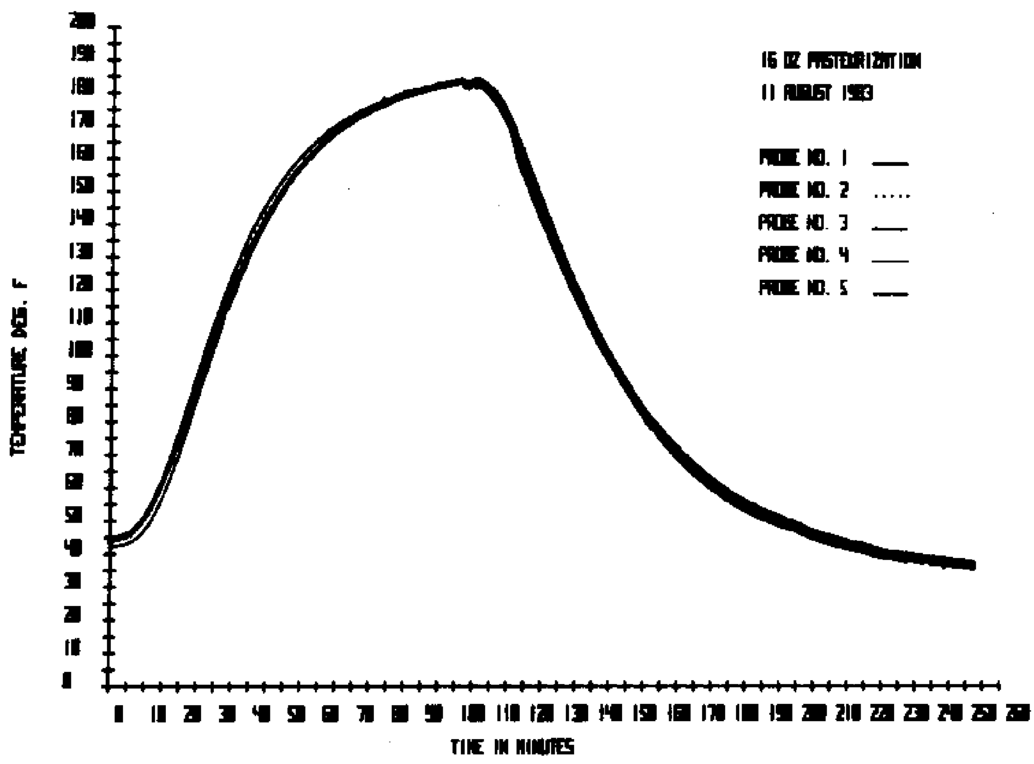


Figure 9. Typical thermal processing curves for 16-ounce pasteurized crab meat cooked at a crab plant. Probes #1 - #5 measured the internal temperatures of crab meat in cans.

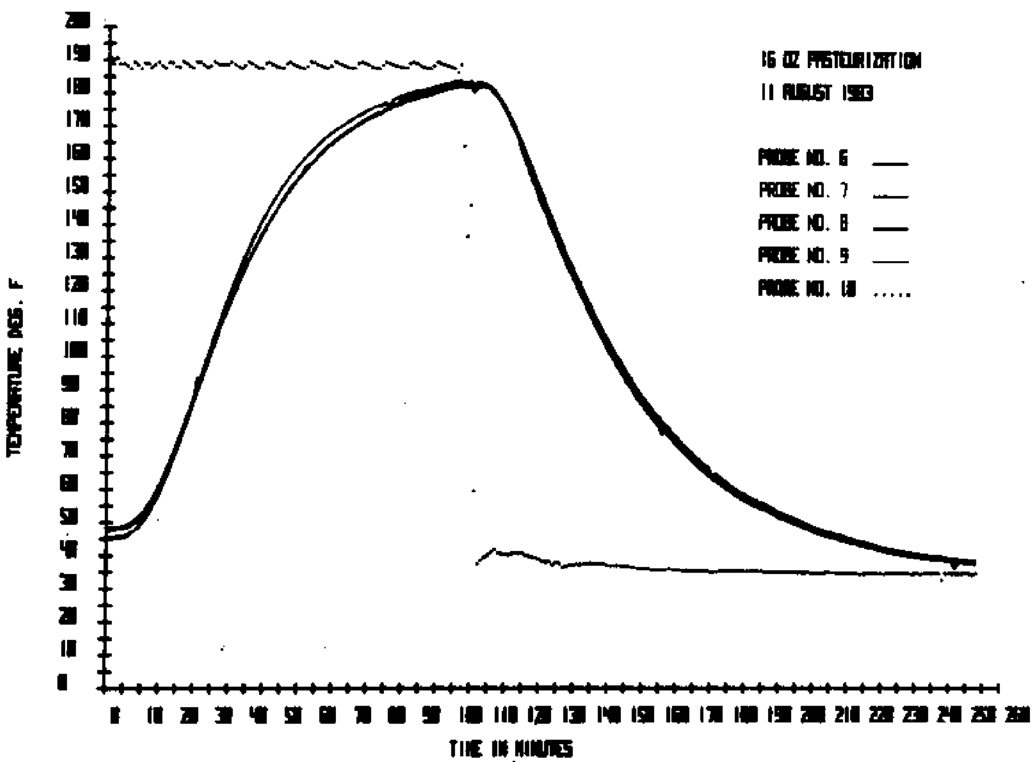


Figure 10. Typical thermal processing curves for 16-ounce pasteurized crab meat cooked at a crab plant. Probes #6 - #9 measured the internal temperatures of crab meat, while probe #10 monitored water temperature.

APPENDIX

PROGRAM NUMBER ONE COPIES DIGITEC RETORT DATA TO RANDOM FILE

```
10 REM PROGRAM LOADS SEQUENTIAL DIGITEC  FILE TO RANDOM
20 PRINT "THIS PROGRAM WILL ACCEPT A MAXIMUM OF 6500 OBSERVATIONS"
30 PRINT
40 DIM TEMP$(6500)
50 PRINT "NUMBER OF OBSERVATIONS, X"
60 INPUT X%
70 OPEN "C:DIGI.TXT" FOR INPUT AS #1
80 OPEN "C:DIGI-R.BAS" AS #2 LEN=20
90 FIELD #2, 20 AS TEMP1$
100 PRINT
110 PRINT
120 PRINT "WORKING!"
130 PRINT
140 PRINT
150 REM DIGITEC VALUES ARE INPUT AND STORED IN RANDOM FILE DIGI-R.
BAS
160     FOR I%=1 TO X%
170     INPUT #1, TEMP$(I%)
180     LSET TEMP1$=TEMP$(I%)
190     PUT #2, I%
200     IF EOF(1) THEN GOTO 220
210     NEXT I%
220 CLOSE #1
230 CLOSE #2
240 BEEP
250 END
```

Program One. Reads digitec temperature data from retort studies and creates a random temperature file for Program Two.

PROGRAM NUMBER TWO CALCULATES F-VALUES FOR RETORT DATA

```
10 REM PROGRAM CALCULATES F-INTERVAL AND F-TOTAL VALUES FOR RETORT
20 LPRINT CHR$(27)CHR$(70)CHR$(54)CHR$(54)
30 LPRINT CHR$(27)CHR$(53)
40 LPRINT
50 REM INPUTS PLANT NAME, DATE, AND PROCESSING PARAMS. FOR RETORT
60 PRINT "NAME OF PROCESSING PLANT"
70 INPUT A$
80 LPRINT A$
90 LPRINT "STEAM RETORT COOK"
100 LPRINT "LIVE BLUE CRABS"
110 LPRINT "ONE LIVE BLUE CRAB PER PROBE"
120 PRINT "DATE DAY","MONTH","YEAR"
130 INPUT Q,R,S
140 LPRINT Q;"/";R;"/";S
150 PRINT:PRINT
160 LPRINT:LPRINT:LPRINT
170 PRINT "NUMBER OF OBSERVATIONS, PROBES*NUMBER OF READINGS,X":IN
PUT X
180 PRINT "NUMBER OF PROBES, Y":INPUT Y
190 PRINT "TIME INTERVAL,TM":INPUT TM
200 PRINT "Z-VALUE,ZV (STANDARD VALUE FOR RETORT COOK IS 18)":INPU
T ZV
210 PRINT "REFERENCE TEMPERATURE,RT (STANDARD VALUE IS 235)":INPUT
 RT
220 PRINT
230 REM READS TEMPERATURE FROM DIGI-R AND WRITES TO DIGINUM.BAS
240 OPEN "C:DIGI-R.BAS" AS #1 LEN=20
250 FIELD #1, 20 AS TEMP1$
260 OPEN "C:DIGINUM.BAS" AS #2 LEN=12
270 FIELD #2, 12 AS TEMPC$
280     FOR I=1 TO X
290     GET #1, I
300     N=4:M=6
310     Z$=MID$(TEMP1$,N,M)
320     Q=VAL(Z$)
330     PRINT Q
340     LSET TEMPC$=MKS$(Q)
350     PUT #2, I
360     IF EOF(1) THEN GOTO 380
370     NEXT I
380 CLOSE #1:CLOSE #2
390 PRINT
400 REM SORTS TEMPERATURE DATA FOR A SPECIFIC PROBE AND CONVERTS C
 TO F
410 OPEN "C:DIGINUM.BAS" AS #1 LEN=12
420 FIELD #1, 12 AS TEMPC$
430 OPEN "C:TEMPARY.BAS" AS #2 LEN=12
440 FIELD #2, 12 AS TEMPC1$
450     FOR I=1 TO X
460     GET #1, I
470     A=CVS(TEMPC$)
480     LSET TEMPC1$=MKS$(A)
490     PUT #2, I
500     PRINT A
510     IF EOF(1) THEN GOTO 530
520     NEXT I
530 PRINT
```

Program Two. Calculates F-values for retort monitoring.

```
540 BEEP
550 PRINT "PROBE NUMBER,P":INPUT P
560 OPEN "C:PROBE.BAS" AS #3 LEN=12
570 FIELD #3, 12 AS TEMPF$
580 PRINT
590 AA=0
600     FOR I=P+1 TO X STEP Y
610     AA=AA+1
620     GET #2, I
630     A1=CVS(TEMPC1$)
640     PRINT A1
650     Z=((9/5)*A1)+32
660     PRINT Z
670     PRINT
680     LSET TEMPF$=MKS$(Z)
690     PUT #3, AA
700     IF EOF(1) THEN GOTO 720
710     NEXT I
720 PRINT
730 CLOSE #1: CLOSE #2: CLOSE #3
740 REM WRITES TEMPERATURES 1 THRU (X/Y)-1 TO FILE BI
750 OPEN "C:PROBE.BAS" AS #1 LEN=12
760 FIELD #1, 12 AS TEMPF$
770 OPEN "C:BI.BAS" AS #2 LEN=12
780 FIELD #2, 12 AS TEMPBI$
790 BB=0
800     FOR I=1 TO ((X/Y)-1)
810     BB=BB+1
820     GET #1, I
830     BI=CVS(TEMPF$)
840     LSET TEMPBI$=MKS$(BI)
850     PUT #2, BB
860     IF EOF(1) THEN GOTO 890
870     PRINT BI
880     NEXT I
890 PRINT
900 CLOSE #1:CLOSE #2
910 REM WRITES TEMPERATURES 2 THRU X/Y TO FILE CJ.BAS
920 OPEN "C:PROBE.BAS" AS #1 LEN=12
930 FIELD #1, 12 AS TEMPF$
940 OPEN "C:CJ.BAS" AS #2 LEN=12
950 FIELD #2, 12 AS TEMPCJ$
960 CC=0
970     FOR I=2 TO (X/Y)
980     CC=CC+1
990     GET #1, I
1000    CJ=CVS(TEMPF$)
1010    LSET TEMPCJ$=MKS$(CJ)
1020    PUT #2, CC
1030    PRINT CJ
1040    IF EOF(1) THEN GOTO 1060
1050    NEXT I
1060 CLOSE #1:CLOSE #2
1070 PRINT
1080 REM CALCULATES AVERAGE INTERVAL TEMPERATURE BY COMBINING FILE
S BI AND CJ
1090 OPEN "C:BI.BAS" AS #1 LEN=12
1100 FIELD #1, 12 AS TEMPBI$
1110 OPEN "C:CJ.BAS" AS #2 LEN=12
1120 FIELD #2, 12 AS TEMPCJ$
1130 OPEN "C:AVGTEMP.BAS" AS #3 LEN=12
1140 FIELD #3, 12 AS AVGTEMP$
1150     FOR I=1 TO ((X/Y)-1)
1160     GET #1, I
1170     GET #2, I
1180     BI1=CVS(TEMPBI$)
```

Program Two. Continued.

```
1190     CJ1=CVS(TEMPCJ$)
1200     AVGT=(BI1+CJ1)*.5
1210     LSET AVGTEMP$=MKS$(AVGT)
1220     PRINT AVGT
1230     PUT #3, I
1240     IF EOF(1) THEN GOTO 1260
1250     NEXT I
1260 CLOSE #1:CLOSE #2:CLOSE #3
1270 PRINT
1280 REM CALCULATES F-INTERVAL VALUE
1290 OPEN "C:AVGTEMP.BAS" AS #1 LEN=12
1300 FIELD #1, 12 AS AVGTEMP$
1310 OPEN "C:F-INTERV.BAS" AS #2 LEN=12
1320 FIELD #2, 12 AS FINT$
1330     FOR I=1 TO ((X/Y)-1)
1340     GET #1, I
1350     AT=CVS(AVGTEMP$)
1360     FI=(TM)*(10^((AT-RT)/ZV))
1370     PRINT FI
1380     LSET FINT$=MKS$(FI)
1390     PUT #2, I
1400     IF EOF(1) THEN GOTO 1420
1410     NEXT I
1420 CLOSE #1:CLOSE #2
1430 PRINT
1440 REM CALCULATES F-TOTAL VALUE
1450 OPEN "C:F-INTERV.BAS" AS #1 LEN=12
1460 FIELD #1, 12 AS FINT$
1470 OPEN "C:F-TOTAL.BAS" AS #2 LEN=12
1480 FIELD #2, 12 AS FTOTAL$
1490 FT=0
1500     FOR I=1 TO ((X/Y)-1)
1510     GET #1, I
1520     FI1=CVS(FINT$)
1530     FT =FT+FI1
1540     LSET FTOTAL$=MKS$(FT)
1550     PUT #2, I
1560     PRINT FT
1570     IF EOF(1) THEN GOTO 1590
1580     NEXT I
1590 CLOSE #1:CLOSE #2
1600 REM PRINTS PROBE NO., TIME, TEMP. F, F-INTERVAL, AND F-TOTAL
1610 OPEN "C:AVGTEMP.BAS" AS #1 LEN=12
1620 FIELD #1, 12 AS AVGTEMP$
1630 OPEN "C:F-INTERV.BAS" AS #2 LEN=12
1640 FIELD #2, 12 AS FINT$
1650 OPEN "C:F-TOTAL.BAS" AS #3 LEN=12
1660 FIELD #3, 12 AS FTOTAL$
1670 LPRINT
1680 PRINT:PRINT
1690 PRINT "PROBE NO.";"       ";"TIME";"       ";"TEMP. F";"
   ";"F-INTER
V.";
1700 PRINT "                   ";"F-TOTAL"
1710 PRINT "     "
1720 PRINT "     "
1730 LPRINT " "
1740 LPRINT "PROBE NO.";"       ";"TIME";"       ";"TEMP. F";"
  ";"F-INTER."
;
1750 LPRINT "                   ";"F-TOTAL"
1760 LPRINT "   "
1770 LPRINT "   "
1780 TMT=0
1790     FOR I=1 TO ((X/Y)-1)
1800     TMT=TMT+TM
```

```
1810     GET #1, I
1820     GET #2, I
1830     GET #3, I
1840     AT2=CVS(AVGTEMP$)
1850     FI2=CVS(FINT$)
1860     FT2=CVS(FTOTAL$)
1870     PRINT USING "##";P;
1880     PRINT "            ";
1890     PRINT USING "###.##";TMT;
1900     PRINT "       ";
1910     PRINT USING "###.##";AT2;
1920     PRINT "           ";
1930     PRINT USING "###.######";FI2;
1940     PRINT "              ";
1950     PRINT USING "###.######";FT2
1960     LPRINT "   ";
1970     LPRINT USING "##";P;
1980     LPRINT "        ";
1990     LPRINT USING "###.##";TMT;
2000     LPRINT "       ";
2010     LPRINT USING "###.##";AT2;
2020     LPRINT "        ";
2030     LPRINT USING "###.######";FI2;
2040     LPRINT "         ";
2050     LPRINT USING "###.######";FT2
2060     IF EOF(1) THEN GOTO 2100
2070     IF EOF(2) THEN GOTO 2100
2080     IF EOF(3) THEN GOTO 2100
2090     NEXT I
2100 CLOSE #1:CLOSE #2:CLOSE #3
2110 LPRINT " "
2120 LPRINT " "
2130 LPRINT CHR$(12)
2140 REM LOOP TO PROCESS ANOTHER PROBE
2150 BEEP
2160 PRINT "WOULD YOU LIKE THE READOUT ON ANOTHER PROBE, Y OR N?"
2170 INPUT Z$
2180 IF Z$="Y" THEN 390 ELSE 2190
2190 LPRINT CHR$(27)CHR$(79)CHR$(49)CHR$(49)
2200 END
```

Program Two. Continued.

PROGRAM NUMBER THREE COPIES PASTEURIZATION DATA TO RANDOM FILE

```
10 REM PROGRAM LOADS SEQUENTIAL FILE TO RANDOM FILE FOR DIGITEC DA
TA
20 PRINT "THIS PROGRAM WILL ACCEPT A MAXIMUM OF 6500 OBSERVATIONS"
30 PRINT
40 DIM TEMP$(6500)
50 PRINT "NUMBER OF OBSERVATIONS, X"
60 INPUT X%
70 OPEN "C:DIGI.TXT" FOR INPUT AS #1
80 OPEN "C:DIGI-PAS.BAS" AS #2 LEN=20
90 FIELD #2, 20 AS TEMPPAS$
100 PRINT
110 PRINT
120 PRINT "WORKING!"
130 PRINT
140 PRINT
150 REM DIGITEC VALUES ARE INPUT AND STORED IN RANDOM FILE DIGI-PA
S.BAS
160     FOR I%=1 TO X%
170     INPUT #1, TEMP$(I%)
180     LSET TEMPPAS$=TEMP$(I%)
190     PUT #2, I%
200     IF EOF(1) THEN GOTO 220
210     NEXT I%
220 CLOSE #1
230 CLOSE #2
240 BEEP
250 END
```

Program Three. Reads Digitec temperature data from pasteurization studies and writes a temperature file for Program Four.

PROGRAM NUMBER FOUR CALCULATES F-VALUES FOR PASTEURIZATION DATA

```
10 REM PROGRAM CALCULATES F-INTERVAL AND F-TOTAL VALUES FOR PASTEU
RIZATION
20 LPRINT CHR$(27)CHR$(70)CHR$(54)CHR$(54)
30 LPRINT CHR$(27)CHR$(53)
40 LPRINT
50 REM INPUTS PLANT NAME, DATE, AND PROCESSING PARAMETERS FOR PAST
EURIZATION
60 PRINT "NAME OF PROCESSING PLANT"
70 INPUT A$
80 LPRINT A$
90 LPRINT "HOT WATER PASTEURIZATION"
100 PRINT "TYPE OF CONTAINER"
110 INPUT C$
120 LPRINT C$
130 PRINT "CONTAINER SIZE, NUMBER, UNITS"
140 INPUT D,D$
150 LPRINT D;D$
160 PRINT "DATE DAY","MONTH","YEAR"
170 INPUT Q,R,S
180 LPRINT Q;"/";R;"/";S
190 PRINT:PRINT
200 LPRINT:LPRINT:LPRINT
210 PRINT "NUMBER OF LINES INPUT FROM DIGITEC BEFORE SPACES AND LA
BELS REMOVED"
220 INPUT G
230 PRINT "NUMBER OF PROBES, Y":INPUT Y
240 PRINT "TIME INTERVAL,TM":INPUT TM
250 PRINT "Z-VALUE,ZV (STANDARD VALUE FOR PASTEURIZATION IS 16)":I
NPUT ZV
260 PRINT "REFERENCE TEMPERATURE,RT (STANDARD VALUE IS 185 F)":INP
UT RT
270 PRINT
280 REM READS TEMPERATURE VALUE FROM DIGI-PAS DATA LINE AND WRITES
 TO DIGI-R1
290 OPEN "C:DIGI-PAS.BAS" AS #1 LEN=20
300 FIELD #1, 20 AS TEMPPAS$
310 OPEN "C:DIGI-R1.BAS" AS #2 LEN=12
320 FIELD #2, 12 AS TEMPP1$
330     FOR I=1 TO G
340     GET #1, I
350     N=4:M=6
360     Z$=MID$(TEMPPAS$,N,M)
370     PRINT Z$
380     LSET TEMPP1$=Z$
390     PUT #2, I
400     IF EOF(1) THEN GOTO 420
410     NEXT I
420 CLOSE #1:CLOSE #2
430 PRINT:PRINT:PRINT:PRINT
440 REM REMOVES "DATA" FROM DIGITEC DATA LINE
450 OPEN "C:DIGI-R1.BAS" AS #1 LEN=12
460 FIELD #1, 12 AS TEMPP1$
470 OPEN "C:DIGI-R2.BAS" AS #2 LEN=12
480 FIELD #2, 12 AS TEMPP2$
490 Q$="            "
500 D$=" DATA       "
510 AA=0
```

Program Four. Calculates F-values for pasteurization monitoring.

```
520     FOR I=1 TO G
530     GET #1, I
540     ZZ$=TEMPP1$
550     IF ZZ$=D$ THEN GOTO 610 ELSE GOTO 560
560     LSET TEMPP2$=ZZ$
570     PRINT ZZ$
580     GG=GG+1
590     PUT #2, GG
600     IF EOF(1) GOTO 620
610     NEXT I
620 CLOSE #1:CLOSE #2
630 PRINT:PRINT:PRINT
640 X=0
650 REM REMOVES NULL LINES FROM TEMPERATURE DATA
660 OPEN "C:DIGI-R2.BAS" AS #1 LEN=12
670 FIELD #1, 12 AS TEMPP2$
680 OPEN "C:DIGI-R3.BAS" AS #2 LEN=12
690 FIELD #2, 12 AS TEMPP3$
700     FOR I=1 TO GG
710     GET #1, I
720     ZZZ$=TEMPP2$
730     IF ZZZ$=Q$ THEN GOTO 790 ELSE GOTO 740
740     LSET TEMPP3$=ZZZ$
750     PRINT ZZZ$
760     X=X+1
770     PUT #2, X
780     IF EOF(1) GOTO 800
790     NEXT I
800 CLOSE #1:CLOSE #2
810 PRINT:PRINT:PRINT
820 REM WRITES TEMPERATURES MINUS "DATA" AND NULL LINES TO DIGINUM
.BAS
830 OPEN "C:DIGI-R3.BAS" AS #1 LEN=12
840 FIELD #1, 12 AS TEMPP3$
850 OPEN "C:DIGINUM.BAS" AS #2 LEN=12
860 FIELD #2, 12 AS TEMPC$
870     FOR I=1 TO X
880     GET #1, I
890     ZZZZ$=MID$(TEMPP3$,1,6)
900     ZZ=VAL(ZZZZ$)
910     LSET TEMPC$=MKS$(ZZ)
920     PRINT ZZ
930     PUT #2, I
940     IF EOF(1) THEN GOTO 960
950     NEXT I
960 CLOSE #1:CLOSE #2
970 PRINT:PRINT:PRINT
980 REM SORTS TEMPERATURE DATA FOR A SPECIFIC PROBE AND CONVERTS C
 TO F
990 OPEN "B:DIGINUM.BAS" AS #1 LEN=12
1000 FIELD #1, 12 AS TEMPC$
1010 OPEN "C:TEMPARY.BAS" AS #2 LEN=12
1020 FIELD #2, 12 AS TEMPC1$
1030     FOR I=1 TO X
1040     GET #1, I
1050     A=CVS(TEMPC$)
1060     LSET TEMPC1$=MKS$(A)
1070     PUT #2, I
1080     PRINT A
1090     IF EOF(1) THEN GOTO 1110
1100     NEXT I
1110 PRINT
1120 BEEP
1130 PRINT "PROBE NUMBER,P":INPUT P
1140 OPEN "C:PROBE.BAS" AS #3 LEN=12
1150 FIELD #3. 12 AS TEMPF$
```

Program Four. Continued.

```
1160 PRINT
1170 AA=0
1180     FOR I=P+1 TO X STEP Y
1190     AA=AA+1
1200     GET #2, I
1210     A1=CVS(TEMPC1$)
1220     PRINT A1
1230     Z=((9/5)*A1)+32
1240     PRINT Z
1250     PRINT
1260     LSET TEMPF$=MKS$(Z)
1270     PUT #3, AA
1280     IF EOF(1) THEN GOTO 1300
1290     NEXT I
1300 PRINT
1310 CLOSE #1: CLOSE #2: CLOSE #3
1320 REM WRITES TEMPERATURES 1 THRU (X/Y)-1 TO FILE BI
1330 OPEN "C:PROBE.BAS" AS #1 LEN=12
1340 FIELD #1, 12 AS TEMPF$
1350 OPEN "C:BI.BAS" AS #2 LEN=12
1360 FIELD #2, 12 AS TEMPBI$
1370 BB=0
1380     FOR I=1 TO ((X/Y)-1)
1390     BB=BB+1
1400     GET #1, I
1410     BI=CVS(TEMPF$)
1420     LSET TEMPBI$=MKS$(BI)
1430     PUT #2, BB
1440     IF EOF(1) THEN GOTO 1470
1450     PRINT BI
1460     NEXT I
1470 PRINT
1480 CLOSE #1:CLOSE #2
1490 REM WRITES TEMPERATURES 2 THRU X/Y TO FILE CJ.BAS
1500 OPEN "C:PROBE.BAS" AS #1 LEN=12
1510 FIELD #1, 12 AS TEMPF$
1520 OPEN "C:CJ.BAS" AS #2 LEN=12
1530 FIELD #2, 12 AS TEMPCJ$
1540 CC=0
1550     FOR I=2 TO (X/Y)
1560     CC=CC+1
1570     GET #1, I
1580     CJ=CVS(TEMPF$)
1590     LSET TEMPCJ$=MKS$(CJ)
1600     PUT #2, CC
1610     PRINT CJ
1620     IF EOF(1) THEN GOTO 1640
1630     NEXT I
1640 CLOSE #1:CLOSE #2
1650 PRINT
1660 REM CALCULATES AVERAGE INTERVAL TEMPERATURE BY COMBINING FILE
S BI AND CJ
1670 OPEN "C:BI.BAS" AS #1 LEN=12
1680 FIELD #1, 12 AS TEMPBI$
1690 OPEN "C:CJ.BAS" AS #2 LEN=12
1700 FIELD #2, 12 AS TEMPCJ$
1710 OPEN "C:AVGTEMP.BAS" AS #3 LEN=12
1720 FIELD #3, 12 AS AVGTEMP$
1730     FOR I=1 TO ((X/Y)-1)
1740     GET #1, I
1750     GET #2, I
1760     BI1=CVS(TEMPBI$)
1770     CJ1=CVS(TEMPCJ$)
1780     AVGT=(BI1+CJ1)*.5
1790     LSET AVGTEMP$=MKS$(AVGT)
1800     PRINT AVGT
```

Program Four. Continued.

```
1810     PUT #3, I
1820     IF EOF(1) THEN GOTO 1840
1830     NEXT I
1840 CLOSE #1:CLOSE #2:CLOSE #3
1850 PRINT
1860 REM CALCULATES F-INTERVAL VALUE
1870 OPEN "C:AVGTEMP.BAS" AS #1 LEN=12
1880 FIELD #1, 12 AS AVGTEMP$
1890 OPEN "C:F-INTERV.BAS" AS #2 LEN=12
1900 FIELD #2, 12 AS FINT$
1910     FOR I=1 TO ((X/Y)-1)
1920     GET #1, I
1930     AT=CVS(AVGTEMP$)
1940     FI=(TM)*(10^((AT-RT)/ZV))
1950     PRINT FI
1960     LSET FINT$=MKS$(FI)
1970     PUT #2, I
1980     IF EOF(1) THEN GOTO 2000
1990     NEXT I
2000 CLOSE #1:CLOSE #2
2010 PRINT
2020 REM CALCULATES F-TOTAL VALUE
2030 OPEN "C:F-INTERV.BAS" AS #1 LEN=12
2040 FIELD #1, 12 AS FINT$
2050 OPEN "C:F-TOTAL.BAS" AS #2 LEN=12
2060 FIELD #2, 12 AS FTOTAL$
2070 FT=0
2080     FOR I=1 TO ((X/Y)-1)
2090     GET #1, I
2100     FI1=CVS(FINT$)
2110     FT =FT+FI1
2120     LSET FTOTAL$=MKS$(FT)
2130     PUT #2, I
2140     PRINT FT
2150     IF EOF(1) THEN GOTO 2170
2160     NEXT I
2170 CLOSE #1:CLOSE #2
2180 REM PRINTS PROBE NO., TIME, TEMP. F, F-INTERVAL, AND F-TOTAL
2190 OPEN "B:AVGTEMP.BAS" AS #1 LEN=12
2200 FIELD #1, 12 AS AVGTEMP$
2210 OPEN "B:F-INTERV.BAS" AS #2 LEN=12
2220 FIELD #2, 12 AS FINT$
2230 OPEN "C:F-TOTAL.BAS" AS #3 LEN=12
2240 FIELD #3, 12 AS FTOTAL$
2250 LPRINT
2260 PRINT:PRINT
2270 PRINT "PROBE NO.";"        ";"TIME";"        ";"TEMP. F";"
    ";"F-INTER
V.";
2280 PRINT "                    ";"F-TOTAL"
2290 PRINT "    "
2300 PRINT "    "
2310 LPRINT " "
2320 LPRINT "PROBE NO.";"       ";"TIME";"        ";"TEMP. F";"
   ";"F-INTER."
;
2330 LPRINT "                    ";"F-TOTAL"
2340 LPRINT "    "
2350 LPRINT "    "
2360 TMT=0
2370     FOR I=1 TO ((X/Y)-1)
2380     TMT=TMT+TM
2390     GET #1, I
2400     GET #2, I
2410     GET #3, I
2420     AT2=CVS(AVGTEMP$)
```

Program Four. Continued.

```
2430     FI2=CVS(FINT$)
2440     FT2=CVS(FTOTAL$)
2450     PRINT USING "##";P;
2460     PRINT "           ";
2470     PRINT USING "###.##";TMT;
2480     PRINT "     ";
2490     PRINT USING "###.##";AT2;
2500     PRINT "          ";
2510     PRINT USING "###.######";FI2;
2520     PRINT "           ";
2530     PRINT USING "###.######";FT2
2540     LPRINT "  ";
2550     LPRINT USING "##";P;
2560     LPRINT "          ";
2570     LPRINT USING "###.##";TMT;
2580     LPRINT "        ";
2590     LPRINT USING "###.##";AT2;
2600     LPRINT "          ";
2610     LPRINT USING "###.######";FI2;
2620     LPRINT "             ";
2630     LPRINT USING "###.######";FT2
2640     IF EOF(1) THEN GOTO 2680
2650     IF EOF(2) THEN GOTO 2680
2660     IF EOF(3) THEN GOTO 2680
2670     NEXT I
2680 CLOSE #1:CLOSE #2:CLOSE #3
2690 LPRINT " "
2700 LPRINT " "
2710 LPRINT CHR$(12)
2720 REM LOOP TO PROCESS ANOTHER PROBE
2730 BEEP
2740 PRINT "WOULD YOU LIKE THE READOUT ON ANOTHER PROBE, Y OR N?"
2750 INPUT Z$
2760 IF Z$="Y" THEN 980 ELSE 2770
2770 LPRINT CHR$(27)CHR$(79)CHR$(49)CHR$(49)
2780 END
```

Program Four. Continued.

PROGRAM NUMBER FIVE PREPARES RETORT DATA FOR LOTUS GRAPHICS

```
10 PRINT "PROGRAM PREPARES SORTED DIGITEC FILE FOR GRAPHICS, CONTI
NUOUS DATA"
20 PRINT "NUMBER OF OBSERVATIONS, PROBES*NUMBER OF READINGS,X":INP
UT X
30 PRINT "NUMBER OF PROBES, Y":INPUT Y
40 PRINT "TIME INTERVAL IN MINUTES, TM":INPUT TM
50 REM READS TEMPERATURE FROM DIGI-R AND WRITES TO DIGINUM
60 OPEN "C:DIGI-R.BAS" AS #1 LEN=20
70 FIELD #1, 20 AS TEMP1$
80 OPEN "C:DIGINUM.BAS" AS #2 LEN=12
90 FIELD #2, 12 AS TEMPC$
100     FOR I=1 TO X
110     GET #1, I
120     N=4:M=6
130     Z$=MID$(TEMP1$,N,M)
140     Q=VAL(Z$)
150     PRINT Q
160     LSET TEMPC$=MKS$(Q)
170     PUT #2, I
180     IF EOF(1) THEN GOTO 200
190     NEXT I
200 CLOSE #1:CLOSE #2
210 PRINT
220 AA=0
230 REM SORTS TEMPERATURE DATA FOR A SPECIFIC PROBE AND CONVERTS C
 TO F
240 OPEN "C:DIGINUM.BAS" AS #1 LEN=12
250 FIELD #1, 12 AS TEMPC$
260 OPEN "C:TEMPARY.BAS" AS #2 LEN=12
270 FIELD #2, 12 AS TEMPC1$
280     FOR I=1 TO X
290     GET #1, I
300     A=CVS(TEMPC$)
310     LSET TEMPC1$=MKS$(A)
320     PUT #2, I
330     PRINT A
340     IF EOF(1) THEN GOTO 360
350     NEXT I
360 PRINT
370 BEEP
380 PRINT "PROBE NUMBER,P":INPUT P
390 OPEN "C:PROBE.BAS" AS #3 LEN=30
400 FIELD 3, 6 AS PROBE$, 12 AS TEMPF$, 12 AS TIM$
410 PRINT
420 TI=0
430     FOR I=P+1 TO X STEP Y
440     AA=AA+1
450     TI=TI+TM
460     GET #2, I
470     A1=CVS(TEMPC1$)
480     PRINT P;A1;TI
490     Z=((9/5)*A1)+32
500     LSET PROBE$=MKS$(P)
510     LSET TEMPF$=MKS$(Z)
520     LSET TIM$=MKS$(TI)
530     PUT #3, AA
540     IF EOF(1) THEN GOTO 560
```

Program Five. Prepares Digitec retort data for Lotus graphics.

```
550    NEXT I
560 PRINT
570 CLOSE #1: CLOSE #2: CLOSE #3
580 BEEP
590 REM INCLUDES ANOTHER PROBE AND/OR WRITES DATA TO DIGI-GRAF.DAT
A
600 REM TEMPERATURE, TIME OF TEMPERATURE READING, AND PROBE # ARE
WRITTEN
610 PRINT "WOULD YOU LIKE ANOTHER PROBE, Y=1 OR N=0":INPUT RR
620 IF RR=1 THEN GOTO 230 ELSE 630
630 DIM P(2100), A1(2100),TI(2100)
640 OPEN "C:PROBE.BAS" AS #1 LEN=30
650 FIELD #1, 6 AS PROBE$, 12 AS TEMPF$, 12 AS TIM$
660 OPEN "B:DIGIGRAF.BAS" FOR OUTPUT AS #2
670    FOR I=1 TO AA
680    GET #1, I
690    P=CVS(PROBE$)
700    Z=CVS(TEMPF$)
710    TI=CVS(TIM$)
720    PRINT #2,USING "###.###  "; P; Z; TI
730    PRINT USING "###.###  "; P; Z; TI
740    NEXT I
750 CLOSE #1:CLOSE #2
760 END
```

Program Five. Continued.

PROGRAM NUMBER SIX PREPARES PAST. DATA FOR LOTUS GRAPHICS

```
10 REM PROGRAM PREPARES DIGITEC FILE FOR GRAPHICS, NON-CONTINUOUS
DATA
20 PRINT "NUMBER OF LINES INPUT FROM DIGITEC BEFORE SPACES AND LAB
ELS REMOVED"
30 INPUT G
40 PRINT "NUMBER OF PROBES, Y":INPUT Y
50 PRINT "TIME INTERVAL,TM":INPUT TM
60 REM READS TEMPERATURE VALUE FROM DIGI-PAS DATA LINE AND WRITES
TO DIGI-R1
70 OPEN "C:DIGI-PAS.BAS" AS #1 LEN=20
80 FIELD #1, 20 AS TEMPPAS$
90 OPEN "C:DIGI-R1.BAS" AS #2 LEN=12
100 FIELD #2, 12 AS TEMPP1$
110     FOR I=1 TO G
120     GET #1, I
130     N=4:M=6
140     Z$=MID$(TEMPPAS$,N,M)
150     PRINT Z$
160     LSET TEMPP1$=Z$
170     PUT #2, I
180     IF EOF(1) THEN GOTO 200
190     NEXT I
200 CLOSE #1:CLOSE #2
210 AA=0
220 PRINT:PRINT:PRINT:PRINT
230 REM REMOVES "DATA" FROM DIGITEC DATA LINE
240 OPEN "C:DIGI-R1.BAS" AS #1 LEN=12
250 FIELD #1, 12 AS TEMPP1$
260 OPEN "C:DIGI-R2.BAS" AS #2 LEN=12
270 FIELD #2, 12 AS TEMPP2$
280 Q$="            "
290 D$=" DATA       "
300 GG=0
310     FOR I=1 TO G
320     GET #1, I
330     ZZ$=TEMPP1$
340     IF ZZ$=D$ THEN GOTO 400 ELSE GOTO 350
350     LSET TEMPP2$=ZZ$
360     PRINT ZZ$
370     GG=GG+1
380     PUT #2, GG
390     IF EOF(1) GOTO 410
400     NEXT I
410 CLOSE #1:CLOSE #2
420 PRINT:PRINT:PRINT
430 X=0
440 REM REMOVES NULL LINES FROM TEMPERATURE DATA
450 OPEN "C:DIGI-R2.BAS" AS #1 LEN=12
460 FIELD #1, 12 AS TEMPP2$
470 OPEN "C:DIGI-R3.BAS" AS #2 LEN=12
480 FIELD #2, 12 AS TEMPP3$
490     FOR I=1 TO GG
500     GET #1, I
510     ZZZ$=TEMPP2$
520     IF ZZZ$=Q$ THEN GOTO 580 ELSE GOTO 530
530     LSET TEMPP3$=ZZZ$
540     PRINT ZZZ$
```

Program Six. Prepares Digitec pasteurization data for Lotus graphics.

```
550     X=X+1
560     PUT #2, X
570     IF EOF(1) GOTO 590
580     NEXT I
590 CLOSE #1:CLOSE #2
600 PRINT:PRINT:PRINT
610 REM WRITES TEMPERATURES MINUS "DATA" AND NULL LINES TO DIGINUM
620 OPEN "C:DIGI-R3.BAS" AS #1 LEN=12
630 FIELD #1, 12 AS TEMPP3$
640 OPEN "C:DIGINUM.BAS" AS #2 LEN=12
650 FIELD #2, 12 AS TEMPC$
660     FOR I=1 TO X
670     GET #1, I
680     ZZZZ$=MID$(TEMPP3$,1,6)
690     ZZ=VAL(ZZZZ$)
700     LSET TEMPC$=MKS$(ZZ)
710     PRINT ZZ
720     PUT #2, I
730     IF EOF(1) THEN GOTO 750
740     NEXT I
750 CLOSE #1:CLOSE #2
760 PRINT:PRINT:PRINT
770 REM SORTS TEMPERATURE DATA FOR A SPECIFIC PROBE AND CONVERTS C
 TO F
780 OPEN "C:DIGINUM.BAS" AS #1 LEN=12
790 FIELD #1, 12 AS TEMPC$
800 OPEN "C:TEMPARY.BAS" AS #2 LEN=12
810 FIELD #2, 12 AS TEMPC1$
820     FOR I=1 TO X
830     GET #1, I
840     A=CVS(TEMPC$)
850     LSET TEMPC1$=MKS$(A)
860     PUT #2, I
870     PRINT A
880     IF EOF(1) THEN GOTO 900
890     NEXT I
900 PRINT
910 BEEP
920 PRINT "PROBE NUMBER,P":INPUT P
930 OPEN "C:PROBE.BAS" AS #3 LEN=30
940 FIELD #3, 6 AS PROBE$, 12 AS TEMPF$, 12 AS TIM$
950 PRINT
960 TI=0
970     FOR I=P+1 TO X STEP Y
980     AA=AA+1
990     TI=TI+TM
1000    GET #2, I
1010    A1=CVS(TEMPC1$)
1020    PRINT P;A1;TI
1030    Z=((9/5)*A1)+32
1040    SET PROBE$=MKS$(P)
1050    LSET TEMPF$=MKS$(Z)
1060    LSET TIM$=MKS$(TI)
1070    PUT #3, AA
1080    IF EOF(1) THEN GOTO 1100
1090    NEXT I
1100 PRINT
1110 CLOSE #1: CLOSE #2: CLOSE #3
1120 BEEP
1130 REM LOOP TO INCLUDE ANOTHER PROBE AND/OR WRITE DATA TO DIGIGR
AF.BAS
1140 REM TIME OF TEMPERATURE READING FROM TIME INTERVAL AND PROBE
# INCLUDED
1150 PRINT "WOULD YOU LIKE ANOTHER PROBE, YES=1 OR NO=0":INPUT RR
1160 IF RR=1 THEN GOTO 770 ELSE 1170
1170 DIM P(2100), A1(2100), TI(2100)
```

Program Six. Continued.

```
1180 OPEN "C:PROBE.BAS" AS #1 LEN=30
1190 FIELD #1, 6 AS PROBE$, 12 AS TEMPF$, 12 AS TIM$
1200 OPEN "B:DIGIGRAF.BAS" FOR OUTPUT AS #2
1210     FOR I=1 TO AA
1220     GET #1, I
1230     P=CVS(PROBE$)
1240     Z=CVS(TEMPF$)
1250     TI=CVS(TIM$)
1260     PRINT USING "###.###    "; P; Z; TI
1270     PRINT #2, USING "###.###    "; P; Z; TI
1280     NEXT I
1290 CLOSE #1:CLOSE #2
1300 END
```

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Program Six. Continued.